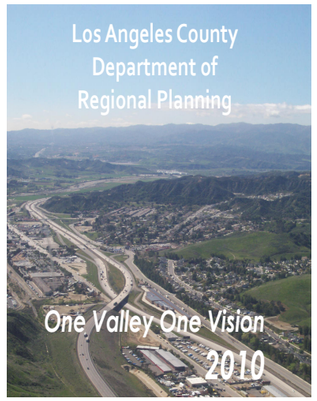

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Proposed
Santa Clarita Valley
Area Plan

Volume II
Appendix 1.0 – 3.13

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Volume II
Appendix 1.0 – 3.13

One Valley One Vision
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Volume II

Appendix 1.0 – 3.13

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TABLE OF CONTENTS

Volume I

Section			Page
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1.0-1
2.0	PROJECT DESCRIPTION		2.0-1
3.0	Environmental Impact Analysis		3.0-1
	3.1	Land Use	3.1-1
	3.2	Transportation and Circulation	3.2-1
	3.3	Air Quality	3.3-1
	3.4	Global Climate Change	3.4-1
	3.5	Agricultural Resources	3.5-1
	3.6	Aesthetics	3.6-1
	3.7	Biological Resources	3.7-1
	3.8	Cultural Resources	3.8-1
	3.9	Geology, Soils, Seismicity	3.9-1
	3.10	Mineral Resources	3.10-1
	3.11	Hazards and Hazardous Materials	3.11-1
	3.12	Hydrology and Water Quality	3.12-1
	3.13	Water Service	3.13-1
	3.14	Community Services	3.14-1
	3.15	Public Services	3.15-1
	3.16	Parks and Recreation	3.16-1
	3.17	Utilities and Infrastructure	3.17-1
	3.18	Noise	3.18-1
	3.19	Population and Housing	3.19-1
4.0	CUMULATIVE IMPACTS		4.0-1
5.0	EFFECTS FOUND NOT TO BE SIGNIFICANT		5.0-1
6.0	ALTERNATIVES		6.0-1
7.0	UNAVOIDABLE SIGNIFICANT IMPACTS		7.0-1
8.0	SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES		8.0-1
9.0	GROWTH-INDUCING IMPACTS		9.0-1
10.0	LIST OF PREPARERS		10.0-1
11.0	REFERENCES		11.0-1

Appendices

Volume II

1.0 Notice of Preparation, Responses to the NOP, Scoping Meeting Information, and Public Workshops
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PCPOA OVOV Concerns; dated December 23, 2008
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Valley Industrial Association Letter to the City of Santa Clarita; dated February 6, 2009

3.2 One Valley One Vision Valley-wide Traffic Study, prepared by Austin-Foust Associates, Inc.; dated June 2010

3.3 Air Quality Emission Calculations

3.4 Global Climate Change Documentation
Greenhouse Gas Emission Calculations
Comparison of CAPCOA Greenhouse Gas Policies with One Valley One Vision

3.9 Soil Types and Characteristics of the County's Planning Area

3.13 Water Service Information
California's Groundwater Bulletin 118, Update 2003, October 2003
2005 Urban Water Management Plan

Volume III

3.13 Water Service Information (continued)

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin; dated August 2005

California Department of Water Resources, "State Water Project Delivery Reliability Report 2007" (August 2008)

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Volume IV

3.13 Water Service Information (continued)

Carollo Engineers, "Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer, Technical Memorandum No. 3 Bench and Pilot Test Results" (February 2004)

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Stipulation to Dismiss Plaintiffs' Claims and Defendants' Counterclaim, August 20, 2007

Volume IV (continued)

3.13 Water Service Information (continued)
AMEC Geomatrix, Progress Letter Report from Hassan Amini, Ph.D., Project Coordinator, to DTSC, September 15, 2009
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Volume V

3.13 Water Service Information (continued)
Biological Opinion for the Delta smelt, 2008
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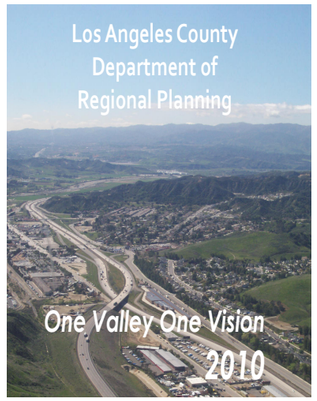

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Area Plan

Volume III
Appendix 3.13 (continued)

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Volume III

Appendix 3.13 (continued)

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Volume III

Appendix 3.13 (continued)

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TABLE OF CONTENTS

Volume I

Section			Page
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1.0-1
2.0	PROJECT DESCRIPTION		2.0-1
3.0	Environmental Impact Analysis		3.0-1
	3.1	Land Use	3.1-1
	3.2	Transportation and Circulation	3.2-1
	3.3	Air Quality	3.3-1
	3.4	Global Climate Change	3.4-1
	3.5	Agricultural Resources	3.5-1
	3.6	Aesthetics	3.6-1
	3.7	Biological Resources	3.7-1
	3.8	Cultural Resources	3.8-1
	3.9	Geology, Soils, Seismicity	3.9-1
	3.10	Mineral Resources	3.10-1
	3.11	Hazards and Hazardous Materials	3.11-1
	3.12	Hydrology and Water Quality	3.12-1
	3.13	Water Service	3.13-1
	3.14	Community Services	3.14-1
	3.15	Public Services	3.15-1
	3.16	Parks and Recreation	3.16-1
	3.17	Utilities and Infrastructure	3.17-1
	3.18	Noise	3.18-1
	3.19	Population and Housing	3.19-1
4.0	CUMULATIVE IMPACTS		4.0-1
5.0	EFFECTS FOUND NOT TO BE SIGNIFICANT		5.0-1
6.0	ALTERNATIVES		6.0-1
7.0	UNAVOIDABLE SIGNIFICANT IMPACTS		7.0-1
8.0	SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES		8.0-1
9.0	GROWTH-INDUCING IMPACTS		9.0-1
10.0	LIST OF PREPARERS		10.0-1
11.0	REFERENCES		11.0-1

Appendices

Volume II

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3.13 Water Service Information
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Volume III

3.13 Water Service Information (continued)

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Volume IV

3.13 Water Service Information (continued)

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Volume IV (continued)

3.13 Water Service Information (continued)
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Volume V

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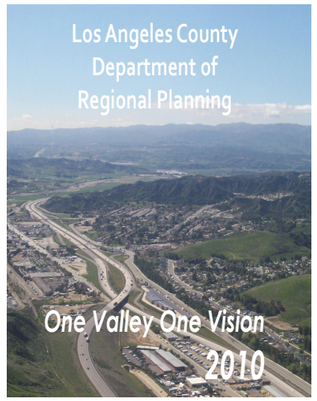

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TABLE OF CONTENTS

Volume I

Section			Page
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1.0-1
2.0	PROJECT DESCRIPTION		2.0-1
3.0	Environmental Impact Analysis		3.0-1
	3.1	Land Use	3.1-1
	3.2	Transportation and Circulation	3.2-1
	3.3	Air Quality	3.3-1
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	3.9	Geology, Soils, Seismicity	3.9-1
	3.10	Mineral Resources	3.10-1
	3.11	Hazards and Hazardous Materials	3.11-1
	3.12	Hydrology and Water Quality	3.12-1
	3.13	Water Service	3.13-1
	3.14	Community Services	3.14-1
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4.0	CUMULATIVE IMPACTS		4.0-1
5.0	EFFECTS FOUND NOT TO BE SIGNIFICANT		5.0-1
6.0	ALTERNATIVES		6.0-1
7.0	UNAVOIDABLE SIGNIFICANT IMPACTS		7.0-1
8.0	SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES		8.0-1
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Volume III

3.13 Water Service Information (continued)

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United States Environmental Protection Agency, "Perchlorate Update" (March 2002)

Volume IV

3.13 Water Service Information (continued)

Carollo Engineers, "Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer, Technical Memorandum No. 3 Bench and Pilot Test Results" (February 2004)

California Department of Water Resources, "Bulletin 132-04, Management of the California State Water Project" (September 2005)

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Volume IV (continued)

3.13 Water Service Information (continued)
AMEC Geomatrix, Progress Letter Report from Hassan Amini, Ph.D., Project Coordinator, to DTSC, September 15, 2009
CLWA News Release, September 14, 2009
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CLWA Memorandum from Brian J. Folsom to CLWA Board of Directors, October 1, 2009
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Volume V

3.13 Water Service Information (continued)
Biological Opinion for the Delta smelt, 2008
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NOAA/NMFS release summarizing the 2009 Biological Opinion, June 4, 2009
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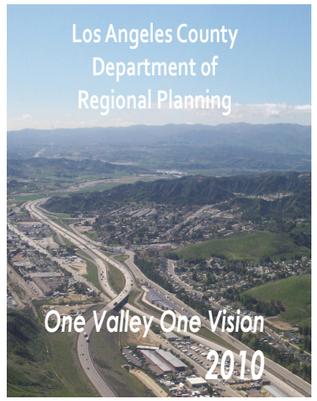

Revised Draft Program EIR
for the
County of Los Angeles'
Proposed
Santa Clarita Valley
Area Plan

Volume V
Appendix 3.13
(continued) – 3.18

November 2010

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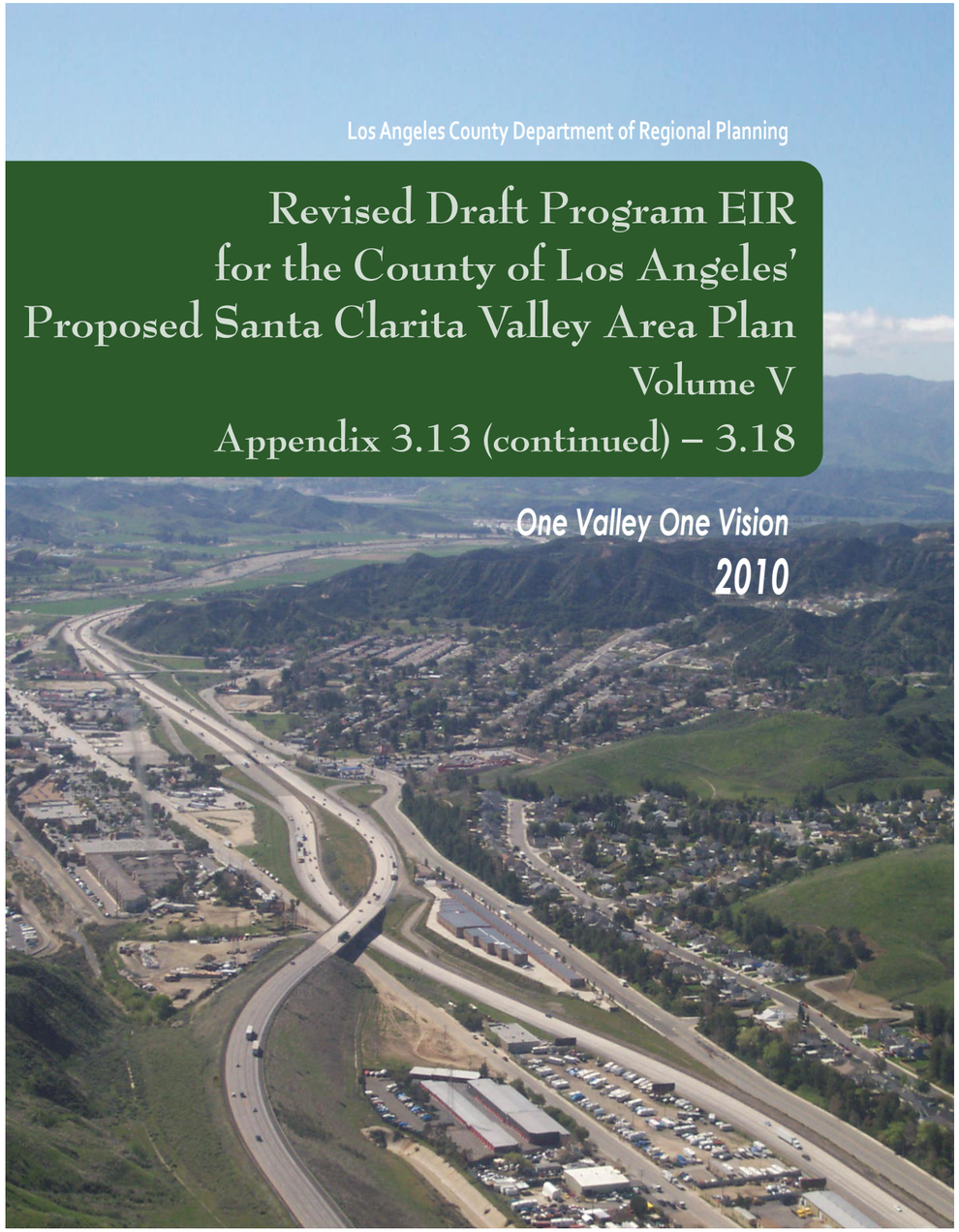

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November 2010

Revised Draft Program EIR for the County of Los Angeles' Proposed Santa Clarita Valley Area Plan

Volume V

Appendix 3.13 (continued) – 3.18

Submitted to:

Mitch Glaser, Supervising Regional Planner
County of Los Angeles
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320 West Temple Street
Los Angeles, California 90012

Prepared by:

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November 2010

TABLE OF CONTENTS

Volume I

Section			Page
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1.0-1
2.0	PROJECT DESCRIPTION		2.0-1
3.0	Environmental Impact Analysis		3.0-1
	3.1	Land Use	3.1-1
	3.2	Transportation and Circulation	3.2-1
	3.3	Air Quality	3.3-1
	3.4	Global Climate Change	3.4-1
	3.5	Agricultural Resources	3.5-1
	3.6	Aesthetics	3.6-1
	3.7	Biological Resources	3.7-1
	3.8	Cultural Resources	3.8-1
	3.9	Geology, Soils, Seismicity	3.9-1
	3.10	Mineral Resources	3.10-1
	3.11	Hazards and Hazardous Materials	3.11-1
	3.12	Hydrology and Water Quality	3.12-1
	3.13	Water Service	3.13-1
	3.14	Community Services	3.14-1
	3.15	Public Services	3.15-1
	3.16	Parks and Recreation	3.16-1
	3.17	Utilities and Infrastructure	3.17-1
	3.18	Noise	3.18-1
	3.19	Population and Housing	3.19-1
4.0	CUMULATIVE IMPACTS		4.0-1
5.0	EFFECTS FOUND NOT TO BE SIGNIFICANT		5.0-1
6.0	ALTERNATIVES		6.0-1
7.0	UNAVOIDABLE SIGNIFICANT IMPACTS		7.0-1
8.0	SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES		8.0-1
9.0	GROWTH-INDUCING IMPACTS		9.0-1
10.0	LIST OF PREPARERS		10.0-1
11.0	REFERENCES		11.0-1

Appendices

Volume II

1.0 Notice of Preparation, Responses to the NOP, Scoping Meeting Information, and Public Workshops
Notice of Preparations for the Draft Environmental Impact Report
Scoping Meeting Notes Summary of Verbal Comments and Flyer; dated August 12, 2008
Ventura County Office of Agricultural Commissioner Comment on NOP; dated August 8, 2008
OVOV Noise Element Questions, submitted by Bob Werner; dated February 17, 2009
Ventura County Public Works Agency, Transportation Department, Comment on NOP; dated August 14, 2008
City Comments
Friends of the Santa Clara River Comment on NOP; dated August 25, 2008
Ventura County Air Pollution Control District Comment on NOP; dated August 26, 2008
Caltrans Comment on NOP; dated August 28, 2008
South Coast Air Quality Management District Comment on NOP; dated July 31, 2008
Ventura County Watershed Protection District Comment on NOP; dated August 26, 2008
Ventura County Watershed Protection District Comment on NOP; dated September 2, 2008
Agua Dulce Town Council Comment on NOP; dated September 11, 2008
Los Angeles County Department of Public Works Comment on NOP; dated September 22, 2008
OVOV November 2008 Workshop Comment Cards
PCPOA OVOV Concerns; dated December 23, 2008
Thomas M. Surak Comment on NOP; dated May 27, 2009
Valley Industrial Association Letter to the City of Santa Clarita; dated February 6, 2009

3.2 One Valley One Vision Valley-wide Traffic Study, prepared by Austin-Foust Associates, Inc.; dated June 2010

3.3 Air Quality Emission Calculations

3.4 Global Climate Change Documentation
Greenhouse Gas Emission Calculations
Comparison of CAPCOA Greenhouse Gas Policies with One Valley One Vision

3.9 Soil Types and Characteristics of the County's Planning Area

3.13 Water Service Information
California's Groundwater Bulletin 118, Update 2003, October 2003
2005 Urban Water Management Plan

Volume III

3.13 Water Service Information (continued)

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin; dated August 2005

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Volume IV

3.13 Water Service Information (continued)

Carollo Engineers, "Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer, Technical Memorandum No. 3 Bench and Pilot Test Results" (February 2004)

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Volume IV (continued)

3.13 Water Service Information (continued)
AMEC Geomatrix, Progress Letter Report from Hassan Amini, Ph.D., Project Coordinator, to DTSC, September 15, 2009
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Volume V

3.13 Water Service Information (continued)
Biological Opinion for the Delta smelt, 2008
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APPENDIX 1.0

Notice of Preparation, Responses to the NOP, Scoping Meeting Information, and Public Workshops

Notice of Preparation for the Draft Environmental Impact Report

NOTICE OF PREPARATION

Lead Agency:		Consulting Firm:	
Agency *Name*	City of Santa Clarita	*Name*	Impact Sciences
Street Address	23920 Valencia Blvd, Suite 302	*Street Address*	803 Camarillo Street, Suite A
City/State/Zip	Santa Clarita, California 91355	*City/State/Zip*	Camarillo, California 93012
Contact	Jeff Hogan, AICP, Senior Planner	*Contact*	Ms. Judith Charles
Telephone	(661) 255-4330	*Telephone*	(805) 437-1900

SUBJECT: Notice of Preparation of Draft Environmental Impact Report for the One Valley, One Vision General Plan EIR

One Valley, One Vision (OVOV) is a joint effort between the City of Santa Clarita (City), the County of Los Angeles (County), and Santa Clarita Valley (Valley) residents and businesses to create a single vision and guidelines for the future growth of the Valley and the preservation of natural resources. The result of this project will be a General Plan document and Environmental Impact Report (EIR) for the buildout of the entire Santa Clarita Valley Planning Area (Planning Area). The Planning Area includes the City and its four communities Canyon Country, Newhall, Saugus, and Valencia and the County communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce, and the future Newhall Ranch (see attached July 10, 2008 Prelimary Land Use Map).

Realizing that development within both jurisdictions can have regional implications, the City and County have jointly endeavored to prepare planning policies and guidelines to guide future development within the Santa Clarita Valley. The result of this work effort will require the adoption of two separate documents. The City will adopt a new General Plan and EIR, while the County will adopt a new Area Plan to replace the Santa Clarita Valley Area Wide Plan and prepare its own EIR.

We need to know the views of your agency as to the scope and content of the environmental information, which is germane to your agency's statutory responsibilities in connection with the proposed project. Your agency may need to use the City's OVOV General Plan EIR prepared by our agency when preparing your permit or other approval for the project.

Planning Area

The Planning Area combines two geographical areas, the City corporate limits and the unincorporated area of the County within Santa Clarita Valley as described above. The Planning Area was defined mutually by the City and County and represents the area for which both jurisdictions have joint interest in planning. The Planning Area is located in southern California at the northernmost portion of Los Angeles County (North County). It is situated at the convergence of Los Angeles and Ventura counties, approximately 35 miles northwest of downtown Los Angeles.

Project Background

In 2000, the City and County kicked-off Phase I of the OVOV process, by conducting a series of citizens and stakeholder workshops to solicit feedback from the community regarding their vision for the future of the Santa Clarita Valley. Phase II of the OVOV included development of a community-guided Vision Statement and Guiding Principles. The Vision Statement and 35 Guiding Principles developed during Phase II, served as tools to guide the development of the General Plan goals and policies and the General Plan Land Use Map.

Phase III of OVOV included the creation of a Technical Background Report (TBR) that has been used as a starting point to evaluate future buildout of the Planning Area by providing a snapshot of current population, jobs, housing, infrastructure, community services, health and safety, and environmental conditions within the Planning Area. Phase IV of OVOV will culminate in the preparation of the preferred land use plan for the planning area in coordination with areawide circulation planning. Phases V and VI will complete the preparation of the various state-mandated elements and the Program Environmental Impact Report.

Project Description

The City is preparing a comprehensive update to its General Plan and an associated EIR for the proposed Planning Area. Development within the City and County shall be consistent with the OVOV's Vision and Guiding Principles, which are intended to sustain and enhance environmental resources, economic vitality, and the social well being of its residents. The following seven General Plan elements are either available or will soon be available on the City's website www.santa-clarita.com/vgp:

- Draft Safety Element
- Draft Conservation and Open Space Element
- Draft Land Use Element
- Draft Circulation and Noise Elements (available 9/16/08)
- Draft Housing Element (available 10/21/08)

Land Use Element and Map

The Land Use Element is generally considered to be the most representative of and essential to the General Plan, because it guides and directs the physical development of the community. This element constitutes the required Land Use Element for the City's General Plan; in addition, it forms the land use component of the Area Plan adopted for the Santa Clarita Valley by the County. It designates the general location of eight land uses–residential, commercial, mixed use, industrial, public and institutional, transportation, communication, and utilities; open space and recreation, and non-urban / agriculture. The Land Use Element addresses the permitted density and intensity of the various land use designation as reflected on the City's General Land Use Map and it forms the land use component of the Area Plan adopted for the Santa Clarita Valley. The following is a brief description of the Land Use Map Designations.

- **Residential:** Residential uses include dwelling units developed at various densities and with varying housing types, including single-family detached, single-family attached (condominiums), multiple-family (apartments), mobilehome parks, and senior housing. Special residential uses include live-work units and group living facilities.

- **Commercial:** Commercial development includes both retail and offices providing goods and services to the general public, and wholesale and service uses provided to businesses. Commercial uses also include food services, personal services, automobile services, entertainment and hospitality services, and regional commercial uses such as big box retailers and auto malls.

- **Mixed Use:** The mixed use category generally includes commercial retail, office, and service uses intermingled with higher density residential uses, within a master-planned complex designed to ensure that residents are not adversely impacted by commercial traffic or operations, and that businesses benefit from the proximity of customers living nearby. The benefits of mixed-use

development include a reduction in vehicle trips by residents to shopping areas, and the proximity of residents to employment-generating uses.

- **Industrial:** The industrial category includes heavy manufacturing, less intensive industrial uses that are typically located in business parks, and research and development complexes. Light industrial activities include warehousing, wholesale trade, and some assembly. Heavy industrial uses include fabrication and assembly of large items, resource extraction, processing of raw or recycled materials, and businesses that use or generate hazardous materials.

- **Public and Institutional:** Government buildings, libraries, schools, fire stations, museums, cultural and community centers, and other similar public uses are typical of this category. In addition, private schools, churches, convalescent care and other social care facilities, private meeting and convention facilities, and similar uses are included. Special uses in this category include correctional facilities.

- **Transportation, Communication, and Utilities:** This category includes freeways and major arterials, railroads, park and ride lots, truck terminals, airports, communication facilities, electric power and natural gas facilities, solid waste and liquid waste disposal, transfer facilities, reservoirs and pumping stations, treatment plants, and similar uses.

- **Open Space and Recreation:** This category includes the Angeles National Forest and land used for agriculture, private and public recreational facilities, and local and regional parks. Golf courses and water bodies are also included.

- **Non-Urban/Agriculture:** Non-urban lands are used for low-density residential uses on large lots, in areas characterized by rural development interspersed with natural open space. Agricultural lands are used for grazing, horticulture, row, field, and tree crops, and limited keeping of livestock, horses and other large animals.

- **Specific Plan:** The Specific Plan designation indicates those lands in the planning area governed by a Specific Plan. Allowable land uses and intensity of development are those permitted by the Specific Plan.

Circulation Element

The Circulation Element plans for the continued development of efficient, cost-effective and comprehensive transportation systems that are consistent with regional plans, local needs, and the Valley's community character. A comprehensive transportation network of streets and highways, multi-use trails, bus transit, commuter rail, and airport facilities

provides mobility options to Valley residents and businesses. The Circulation Element contains a map showing major transportation facilities within the Santa Clarita Valley, including streets and highways, rail and public transit routes, stations and terminals, and airport facilities.

Housing Element

The separate Housing Elements prepared for the City and the County contains policies and programs to ensure that adequate housing is provided to meet the needs of all Valley residents. These elements address the need for affordable housing, housing for people with special needs, constraints to providing affordable housing, the agency's progress in meeting its housing goals, quantified objectives for provision of housing, a survey or adequate sites for housing, a resource inventory, and identification of at-risk affordable units and methods of preservation.

Noise Element

The Noise Element contains maps and policies to ensure that residents are not exposed to health risks or nuisances due to noise generated from freeways and high-volume roadways, airports, industrial and recreational uses, special events, and other uses emitting loud sounds. Policies in the Noise Element address sound attenuation measures, such as setbacks, noise barriers, and buffering, to protect the public health, safety, and welfare.

Open Space and Conservation Element

The Open Space and Conservation Element contain maps and policies to ensure preservation of an open space greenbelt around most portions of the Santa Clarita Valley, in addition to preserving water quality, historic and cultural resources, scenic views, and providing recreational facilities to enhance the quality of life for Valley residents. Significant Ecological Areas (SEAs) are ecologically important fragile land and water areas that are valuable as plant and animal communities and are often important to the preservation of threatened or endangered species. SEAs as designated by the County will be presented on a map included in the Open Space and Conservation Element.

Safety Element

The Safety Element contains maps and policies to ensure that residents are not exposed to health risks due to air pollution, earthquakes, wildland fires, or other environmental hazards, and that adequate provisions are made for crime prevention, law enforcement, and fire protection services.

Potential Environmental Effects

Potential environmental effects that will be addressed in the EIR include effects to the following:

• Aesthetics	• Land Use / Planning
• Agricultural Resources	• Mineral Resources
• Air Quality	• Noise
• Biological Resources	• Population / Housing
• Climate Change	• Public Services
• Geology / Soils	• Recreation
• Hazards / Hazardous Materials	• Transportation / Traffic
• Hydrology / Water Quality	• Utilities / Service Systems
• Cultural Resources	

Further refinement of the scope of technical issues to be addressed will be occurring through the planning process, including input received in response to this NOP.

Intended Uses of the EIR

The City will use the EIR to consider the environmental effects, mitigation measures, and alternatives, when reviewing the proposed General Plan approval. The EIR will serve as the CEQA compliance document for adoption of the General Plan. It will also serve as the programmatic environmental document that may be referenced in implementing future actions in the General Plan. Subsequent project-level activities identified in the General Plan will be examined in the light of the program EIR to determine whether an additional environmental document must be prepared prior to project approval and implementation.

Where to Respond with Comments

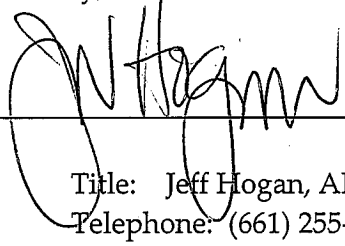
Due to the time limits mandated by State law, your response must be sent at the earliest possible date, but not later than 30 days after receipt of this notice. As such, the comment period for the Notice of Preparation begins on July 25, 2008, and ends on August 25, 2008. Please send your written responses to Jeff Hogan at the address shown above. We would appreciate the name of a contact person in your agency.

Scoping Meeting

To help assist and promote local participation, a Scoping Meeting (see attached Scoping Meeting Notice) will be held to present the proposed project and to solicit suggestions from the public and responsible agencies on the content of the Draft EIR. This meeting will be held on August 4, 2008, 6:00 p.m. in the Council Chambers of Santa Clarita City Hall, 23920 Valencia Blvd., Santa Clarita, California 91355.

Project Title: One Valley, One Vision

Date:



Title: Jeff Hogan, AICP, Senior Planner
Telephone: (661) 255-4330

NOTICE OF PREPARATION

(The Notice of Preparation Comment Period has been extended to 12.31.08)

The purpose of the Notice of Preparation is to solicit comments and direction from other agencies and the public to define the scope of the Environmental Impact Report and other issues to analyze in it. The City is not asking for comments on the draft OVOV sections as part of the Notice of Preparation process, but rather for comments as to what issues should be addressed in this project's Environmental Impact Report.

Lead Agency:		Consulting Firm:	
Agency *Name*	City of Santa Clarita	*Name*	Impact Sciences
Street Address	23920 Valencia Blvd, Suite 302	*Street Address*	803 Camarillo Street, Suite A
City/State/Zip	Santa Clarita, California 91355	*City/State/Zip*	Camarillo, California 93012
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The Planning Area combines two geographical areas, the City corporate limits and the unincorporated area of the County within Santa Clarita Valley as described above. The Planning Area was defined mutually by the City and County and represents the area for which both jurisdictions have joint interest in planning. The Planning Area is located in southern California at the northernmost portion of Los Angeles County (North County). It is situated at the convergence of Los Angeles and Ventura counties, approximately 35 miles northwest of downtown Los Angeles.

Project Background

In 2000, the City and County kicked-off Phase I of the OVOV process, by conducting a series of citizens and stakeholder workshops to solicit feedback from the community regarding their vision for the future of the Santa Clarita Valley. Phase II of the OVOV included development of a community-guided Vision Statement and Guiding Principles. The Vision Statement and 35 Guiding Principles developed during Phase II, served as tools to guide the development of the General Plan goals and policies and the General Plan Land Use Map.

Phase III of OVOV included the creation of a Technical Background Report (TBR) that has been used as a starting point to evaluate future buildout of the Planning Area by providing a snapshot of current population, jobs, housing, infrastructure, community services, health and safety, and environmental conditions within the Planning Area. Phase IV of OVOV will culminate in the preparation of the preferred land use plan for the planning area in coordination with areawide circulation planning. Phases V and VI will complete the preparation of the various state-mandated elements and the Program Environmental Impact Report.

Project Description

The City is preparing a comprehensive update to its General Plan and an associated EIR for the proposed Planning Area. Development within the City and County shall be

consistent with the OVOV's Vision and Guiding Principles, which are intended to sustain and enhance environmental resources, economic vitality, and the social well being of its residents. The following seven General Plan elements are either available or will soon be available on the City's website www.santa-clarita.com/vgp:

- Draft Safety Element
- Draft Conservation and Open Space Element
- Draft Land Use Element
- Draft Circulation and Noise Elements (available Fall 2008)
- Draft Housing Element (available Fall 2008)

Land Use Element and Map

The Land Use Element is generally considered to be the most representative of and essential to the General Plan, because it guides and directs the physical development of the community. This element constitutes the required Land Use Element for the City's General Plan; in addition, it forms the land use component of the Area Plan adopted for the Santa Clarita Valley by the County. It designates the general location of eight land uses–residential, commercial, mixed use, industrial, public and institutional, transportation, communication, and utilities; open space and recreation, and non-urban / agriculture. The Land Use Element addresses the permitted density and intensity of the various land use designation as reflected on the City's General Land Use Map and it forms the land use component of the Area Plan adopted for the Santa Clarita Valley. The following is a brief description of the Land Use Map Designations.

- **Residential:** Residential uses include dwelling units developed at various densities and with varying housing types, including single-family detached, single-family attached (condominiums), multiple-family (apartments), mobilehome parks, and senior housing. Special residential uses include live-work units and group living facilities.

- **Commercial:** Commercial development includes both retail and offices providing goods and services to the general public, and wholesale and service uses provided to businesses. Commercial uses also include food services, personal services, automobile services, entertainment and hospitality services, and regional commercial uses such as big box retailers and auto malls.

- **Mixed Use:** The mixed use category generally includes commercial retail, office, and service uses intermingled with higher density residential uses, within a master-planned complex designed to ensure that residents are not adversely impacted by commercial traffic or operations, and that businesses benefit from the proximity of customers living nearby. The benefits of mixed-use development include a reduction in vehicle trips by residents to shopping areas, and the proximity of residents to employment-generating uses.

- **Industrial:** The industrial category includes heavy manufacturing, less intensive industrial uses that are typically located in business parks, and research and development complexes. Light industrial activities include warehousing, wholesale trade, and some assembly. Heavy industrial uses include fabrication and assembly of large items, resource extraction, processing of raw or recycled materials, and businesses that use or generate hazardous materials.

- **Public and Institutional:** Government buildings, libraries, schools, fire stations, museums, cultural and community centers, and other similar public uses are typical of this category. In addition, private schools, churches, convalescent care and other social care facilities, private meeting and convention facilities, and similar uses are included. Special uses in this category include correctional facilities.

- **Transportation, Communication, and Utilities:** This category includes freeways and major arterials, railroads, park and ride lots, truck terminals, airports, communication facilities, electric power and natural gas facilities, solid waste and liquid waste disposal, transfer facilities, reservoirs and pumping stations, treatment plants, and similar uses.

- **Open Space and Recreation:** This category includes the Angeles National Forest and land used for agriculture, private and public recreational facilities, and local and regional parks. Golf courses and water bodies are also included.

- **Non-Urban/Agriculture:** Non-urban lands are used for low-density residential uses on large lots, in areas characterized by rural development interspersed with natural open space. Agricultural lands are used for grazing, horticulture, row, field, and tree crops, and limited keeping of livestock, horses and other large animals.

- **Specific Plan:** The Specific Plan designation indicates those lands in the planning area governed by a Specific Plan. Allowable land uses and intensity of development are those permitted by the Specific Plan.

Circulation Element

The Circulation Element plans for the continued development of efficient, cost-effective and comprehensive transportation systems that are consistent with regional plans, local needs, and the Valley's community character. A comprehensive transportation network of streets and highways, multi-use trails, bus transit, commuter rail, and airport facilities provides mobility options to Valley residents and businesses. The Circulation Element contains a map showing major transportation facilities within the Santa Clarita Valley, including streets and highways, rail and public transit routes, stations and terminals, and airport facilities.

Housing Element

The separate Housing Elements prepared for the City and the County contains policies and programs to ensure that adequate housing is provided to meet the needs of all Valley residents. These elements address the need for affordable housing, housing for people with special needs, constraints to providing affordable housing, the agency's progress in meeting its housing goals, quantified objectives for provision of housing, a survey or adequate sites for housing, a resource inventory, and identification of at-risk affordable units and methods of preservation.

Noise Element

The Noise Element contains maps and policies to ensure that residents are not exposed to health risks or nuisances due to noise generated from freeways and high-volume roadways, airports, industrial and recreational uses, special events, and other uses emitting loud sounds. Policies in the Noise Element address sound attenuation measures, such as setbacks, noise barriers, and buffering, to protect the public health, safety, and welfare.

Open Space and Conservation Element

The Open Space and Conservation Element contain maps and policies to ensure preservation of an open space greenbelt around most portions of the Santa Clarita Valley, in addition to preserving water quality, historic and cultural resources, scenic views, and providing recreational facilities to enhance the quality of life for Valley residents. Significant Ecological Areas (SEAs) are ecologically important fragile land and water areas that are valuable as plant and animal communities and are often

important to the preservation of threatened or endangered species. SEAs as designated by the County will be presented on a map included in the Open Space and Conservation Element.

Safety Element

The Safety Element contains maps and policies to ensure that residents are not exposed to health risks due to air pollution, earthquakes, wildland fires, or other environmental hazards, and that adequate provisions are made for crime prevention, law enforcement, and fire protection services.

Potential Environmental Effects

Potential environmental effects that will be addressed in the EIR include effects to the following:

• Aesthetics	• Land Use / Planning
• Agricultural Resources	• Mineral Resources
• Air Quality	• Noise
• Biological Resources	• Population / Housing
• Climate Change	• Public Services
• Geology / Soils	• Recreation
• Hazards / Hazardous Materials	• Transportation / Traffic
• Hydrology / Water Quality	• Utilities / Service Systems
• Cultural Resources	

Further refinement of the scope of technical issues to be addressed will be occurring through the planning process, including input received in response to this NOP.

Intended Uses of the EIR

The City will use the EIR to consider the environmental effects, mitigation measures, and alternatives, when reviewing the proposed General Plan approval. The EIR will serve as the CEQA compliance document for adoption of the General Plan. It will also

serve as the programmatic environmental document that may be referenced in implementing future actions in the General Plan. Subsequent project-level activities identified in the General Plan will be examined in the light of the program EIR to determine whether an additional environmental document must be prepared prior to project approval and implementation.

Where to Respond with Comments

(The Notice of Preparation Comment Period has been extended to 12.31.08)

Please send your written responses to Jeff Hogan at the address shown above. We would appreciate the name of a contact person in your agency.

Purpose Notice of Preparation

The purpose of the Notice of Preparation is to solicit comments and direction from other agencies and the public to define the scope of the Environmental Impact Report and other issues to analyze in it. The City is not asking for comments on the draft OVOV sections as part of the Notice of Preparation process, but rather for comments as to what issues should be addressed in this project's Environmental Impact Report.

Scoping Meeting

To help assist and promote local participation, a Scoping Meeting was conducted on the project to solicit suggestions from the public and responsible agencies on the content of the Draft EIR. This meeting was held on August 4, 2008, 6:00 p.m. in the Council Chambers of Santa Clarita City Hall, 23920 Valencia Blvd., Santa Clarita, California 91355.

Project Title: One Valley, One Vision

Date:

Title: Jeff Hogan, AICP, Senior Planner
Telephone: (661) 255-4330

Scoping Meeting Notes Summary of Verbal Comments and Flyer; dated August 12, 2008

IMPACT SCIENCES, INC.
803 Camarillo Springs Road, Suite A
Camarillo, California 93012
Telephone: (805) 437-1900 Fax: (805) 437-1901
www.impactsciences.com

Offices in Southern California, Bay Area, and Sacramento Valley

MEMORANDUM

TO: Jeff Hogan, Senior Planner **Job. No.** 0112.020

FROM: Susan Tebo, Associate Principal

DATE: August 12, 2008

SUBJECT: One Valley-One Vision Scoping Meeting Comments

On August 4, 2008, the City of Santa Clarita and County of Los Angeles conducted a scoping hearing to solicit comments regarding the proposed update to the City of Santa Clarita General Plan and unincorporated Los Angeles County Area Plan, commonly known as One Valley-One Vision (OV-OV). The scoping comment period ends on August 28, 2008. Listed below are the comments made at the scoping meeting:

- Keep equestrian trails open.
- Preserve special standards districts for Alderbrook, Placerita Canyon, Sand Canyon, Happy Valley planning areas.
- There must be consideration for bicycle and pedestrian transportation. Of concern is access to roads, bus, rail and nighttime security lighting (Happy Valley and Sand Canyon).
- There should be a reference to existing Community Service Districts and Special Standards Districts (include all districts).
- An overlay of wildlife corridors should be shown.
- There should be a section on greenhouse gases and climate change.
- Mineral Resources and mining resources should be discussed.
- Existing parks and trails need to be discussed.
- There should be floodway/floodplain and fire overlay maps prepared illustrating hazard areas.
- SEA's should be shown on an overlay.
- The Draft EIR will have a 120-day review period.
- A Development Monitoring System (DMS) needs to be adopted.
- Alternative energy sources should be encouraged (if not required)—such as wind and solar.
- Financial incentives to encourage solar energy should be pursued.
- The General Plan amendment process should be clearly defined and how the changes affect the different elements of the Plan.
- Input from adjacent communities should be solicited on the land use plan.
- There is a concern regarding "urban villages."
- There was a suggestion that workshops to inform the community of changes to the land use plan should be conducted.

- Impacts of urban center and transition of land uses should be discussed.
- Flood channels should not be lined in concrete. Placerita Creek should remain recreational .
- Concern was voiced regarding the destruction of ridgelines and oak trees. Specific language should be included to restrict destruction of ridgelines and to require oak relocations.
- There is a concern with the revision to the General Plan "opening up" the codes .
- There is a perception that the developer has flexibility and more development opportunity with the use of Specific Plans.
- There was a request to see a comparison of changes from old to new.
- A request was made to compare the County General Plan overlay to the City General Plan-where does the new General Plan begin and end with relationship to the County's new Area Plan.
- A concern was voiced regarding the overall changes proposed for the General Plan.
- Low-income residents should be targeted: teachers, government workers and police.
- Advancements in water planning should be explored including conservation.
- The Smiser Specific Plan was mentioned noting a concern that when it is rezoned—that it be rezoned with certainty. There was discussion that Specific Plans allow too much leeway. More restrictions need to be included in the Specific Plans-particularly in the Calgrove Corridor-Santa Clarita Valley Gateway).
- There was a concern with growth in the community.
- The City should implement a "feathering" method of developing a transitioning zone between new and existing developments. If there is not room for "feathering" then square footage should be limited.
- There is a concern with focusing low incomes in high density areas.
- All existing waterways should be shown in the General Plan.
- There is a concern that high density areas not be limited to low-income residents.
- With regard to the Circulation Element, when was the last time that the traffic model was updated? New traffic counts should be taken because commute patterns have shifted. Solid traffic assumption must be used in the traffic analysis. The freeway must be considered in the traffic analysis.
- The Circulation Element should show one-two alternative roads outside of the Valley.
- An income vs. cost of housing analysis needs to be prepared-fiscal analysis.
- Identify land use areas for mitigation banking.
- Energy efficiency and green building should be investigated.
- Cultural resources need to be addressed in terms of public facilities for art/cultural uses.
- Workforce housing and inclusionary zoning must be addressed.
- The hospital and public health facilities must be addressed.
- Impacts occur when urban villages are situated adjacent to existing neighborhoods. This concept must be monitored (land use and traffic) in order to keep safety and harmony in existing neighborhoods.
- A concern was voiced regarding placing future high density in rural areas.
- There needs to be a balance between urban and non-urban areas.
- Traffic and open space must be looked at integrally when considering the trail connection to open space areas.

- The City should consider using language found in the Santa Barbara and Pasadena General Plans with regard to the importance of public input and the role that the public has in this process
- The Circulation Element must address the I-5/405 bottleneck.
- There needs to be a "reality check" of roadways at buildout conditions. The EIR must consider that not all roadways will be built at the time of development buildout.
- How will people located in the unincorporated areas of the County be noticed? All property owners would be notified of new proposed zoning.
- Better out-reach for the General Plan is needed.
- Senior housing and an aging population is a critical issue which needs to be addressed.
- Low-income housing for seniors will be needed in the future.
- Water supply in the Calgrove corridor needs to be addressed. It was stated that water quality is poor in this area.
- The floodplain in the Calgrove area needs to be addressed.
- There is concern with the Lyons Canyon project located in unincorporated Los Angeles County and its impact at the I-5/Calgrove interchange. This project should be reviewed in combination with the proposed Smiser project.
- Local residents do not want to see the City develop as a "Century City." Restrictions and limitations on height should be required. No more than 4-5 stories.
- Development should be buffered around wildlife corridors and open space areas.
- There is a concern with the known contaminated areas in the City: NTS, Whitaker-Bermite, High Shear, Kaiser Century. The General Plan should designate these sites as Brownfield sites.
- Traffic mitigation for urban villages must be analyzed on new on/off-ramps to SR-14 and I-5.
- The General Plan should specifically address Agua Dulce. This discussion should include statements acknowledging that the area is dependent upon water wells. Consequently, the water supply must be protected. Furthermore, commercial projects proposed for this area must be studied closely—especially gas stations that could possibly impact the water source.
- The Agua Dulce area could use commercial use code enforcement attention.
- Placerita Canyon is already a village.
- North Newhall Specific Plan area has taken away 20% of this community.
- What are the alternatives of the General Plan? Would the existing General Plan be an Alternative?
- Urban Villages should include trails to existing neighborhoods.
- Golf carts should be allowed on trails.
- Examine the possibility of providing energy alternatives.
- What percentage of this effort is under the jurisdiction of the City and County?
- The City should become self-reliant for water and energy as much as possible.
- There is a concern with freeway levels of traffic in neighborhoods.

Environmental Impact Report Scoping Meeting
For the Joint Valleywide General Plan
August 4th, 2008, 6:00PM

Please join the City of Santa Clarita and the County of Los Angeles for the Environmental Impact Report (EIR) scoping meeting, for OVOV, the Joint Valleywide General Plan and provide input on the General Plan project and environmental issues.

August 4th, 2008, 6:00 p.m.

City of Santa Clarita
23920 Valencia Blvd.
Santa Clarita, CA 91355
Council Chambers

Find out more at www.santa-clarita.com/vgp

Contact:
Mitch Glaser
Principal Planner
(213) 974-6476

Contact:
Jeff Hogan, AICP
Senior Planner
(661) 255-4330

Ventura County Office of Agricultural Commissioner Comment on NOP; dated August 8, 2008

Office of
AGRICULTURAL COMMISSIONER
P.O. Box 889, Santa Paula, CA 93061
815 East Santa Barbara Street
Telephone: (805) 933-2926 Ext. 228
FAX: (805) 525-8922

Agricultural Commissioner
Henry S. Gonzales

Chief Deputy
Susan Johnson

August 8, 2008

Mitch Glaser
County of Los Angeles
Department of Regional Planning
320 West Temple Street, Room 1352
Los Angeles, CA 90012

Subject: Notice of Preparation - One Valley One Vision, Update to Santa Clarita Valley-wide Area Plan for Los Angeles County

Dear Mr. Glaser:

Thank you for the opportunity to comment on the scope and content for the environmental document for the One Valley One Vision project. The comment deadline is August 26, 2008.

Project Description: The One Valley One Vision (OVOV) is a joint effort between the County of Los Angeles, City of Santa Clarita, and Santa Clarita Valley residents and businesses to create a single vision and guidelines for the future growth of the valley and the preservation of natural resources. The Area Plan will include the County communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce and the future Newhall Ranch; and the City of Santa Clarita and its four communities of Canyon Country, Newhall, Saugus and Valencia. The County will adopt a new Area Plan to replace the Santa Clarita Valley Area Plan, and prepare its own EIR; and the City of Santa Clarita will adopt a new General Plan and EIR. There will be two EIRs that evaluate portions of the project.

Comments: The Ventura County Agricultural Commissioner's staff comments on the following topics: Agricultural Soils, Water, Air Quality/ Microclimates, Pests and Diseases, and Land Use Incompatibility. Ventura County evaluates projects according to the thresholds and methodologies set forth in the Ventura County Initial Study Assessment Guidelines. The Guidelines are viewable at: www.ventura.org/planning under "Ordinances and Regulations." The Ventura County Agricultural Commissioner's staff recognizes that other jurisdictions may use different thresholds of significance in their evaluations.

Agricultural Soils. This evaluation pertains to the amount of farmland that will be

converted to a non-agricultural use. Farmland is identified and classified on the Department of Conservation Farmland Mapping and Monitoring Program Important Farmland Inventory. The scope and content of the One Valley One Vision EIRs should include identifying the classes of farmland soils, their locations, and the number of acres of each class that are intended to be converted to non-agricultural uses. The EIRs may propose mitigation measures that can be uniformly applied. The Ventura County Agricultural Commissioner's Office is currently evaluating proposals for standard mitigation measures from existing uniformly applied policies that limit the loss of agricultural soils in Ventura County. Los Angeles County and City jurisdictions may have uniformly applied policies that could serve as standard mitigation measures. If Los Angeles County and the City jurisdictions deem that the amount farmland to be converted to urban uses under One Valley One Vision is significant with unavoidable environmental effects, the EIRs should include consideration and adoption of a Statement of Overriding Considerations pursuant to CEQA for each EIR. This will allow the proponents of individual projects to cite the One Valley One Vision EIRs as having previously identified and considered the loss of agricultural soils as each subsequent project is evaluated.

Agricultural Water. This evaluation pertains to the effects on the local area's quantity from the conversion of agricultural water to non-agricultural uses as well as on water quality in discharges and run-off. The Ventura County Initial Study Guidelines to do not quantify a general significance threshold for water quantity; the evaluation is case-by-case. The significance threshold for agricultural water quality aims to identify and reduce Total Dissolved Solids (TDS) to no greater than 1200 milligrams per liter in the impact area. The Ventura County Water Resources Division also evaluates the effects of projects on this resource. The scope and content of the One Valley One Vision EIRs should include these subjects.

Agricultural Air Quality and Microclimates. This evaluation pertains to increased dust or harmful emissions from new non-agricultural projects or a decrease in solar access on adjacent farmland from new tall structures. The Ventura County Initial Study Guidelines thresholds of significance for increased dust and decreased solar access are 10 percent, respectively. The Ventura County Air Pollution Control District also evaluates the effects of new projects on this resource. The scope and content of the One Valley One Vision EIR should include these subjects.

Agricultural Pests and Diseases. This evaluation pertains to the introduction of agricultural pests or diseases into nearby agricultural areas. The Ventura County Initial Study Guidelines do not quantify a significance threshold; the evaluation is case-by-case. The analysis considers the types of new uses that will be permitted adjacent to existing agricultural land and focuses on reducing vectors and dust from any new uses.

Land Use Incompatibility. This evaluation pertains to the introduction of incompatible uses adjacent to agricultural areas. The Ventura County Initial Study Guidelines consider most human intensive uses within 300 feet of irrigated agriculture to pose a significant effect on agricultural resources. Mitigation measures may include site re-design with extended setbacks and/or other measures such as fencing and vegetative screening. The Ventura County Agricultural Policy Advisory Committee (APAC) adopted the Agricultural/Urban Buffer Policy in July 2006 to provide application and design standards for such measures. The Buffer Policy is viewable at: www.ventura.org/agcommissioner under "Land Use Planning." The policy includes an optional 150-foot extended setback with a vegetative barrier as an alternative to the policy standard 300-foot setback. Distances are measured from new structures or human intensive outdoor areas on the project site to the common lot boundary line with the off-site adjacent farmland. This allows the farm property owner to have maximum use of his farmland. The APAC Buffer Policy may be updated to include a set of reduction and waiver criteria that have been used in APAC's project evaluations. These include small project parcel size, un-farmable areas immediately adjacent to the project site, extensive existing vegetative screening, etc. The scope and content of the One Valley One Vision EIRs should include this topic.

This communication has been reviewed by Ventura County Chief Deputy Agricultural Commission Susan Johnson.

Thank you for the opportunity to comment.

If you have any questions about this response, please contact me at the telephone number or email address below.

Thank you.

Sincerely,

Rita Graham
Agricultural Land Use Planner
(805) 933-2926 Ext. 228
rita.graham@ventura.org

OVOV Noise Element Questions, submitted by Bob Werner;
dated February 17, 2009

OVOV NOISE ELEMENT QUESTIONS
Submitted by: Bob Werner 2/17/09

1. Where is the Traffic Analysis that this element is based on?

2. How far from the roads were the noise measurements in Exhibit N-5a taken?

3. Exhibit N-5a legend states that 'Leq' is used, and the explanatory text says that 'Noise measurements were made of the short-term Leq values.' (page N-13)
CNEL, which is the parameter used in this element (page N-9), is a '24-hour, time-weighted energy average noise level…'.
CNEL is used in the Appendix starting on page N-36 for future planning.
Please clarify the correlation between what appears to be a 'snapshot' measurement (Leq) used for current conditions, and future planning estimates, which are based on CNEL.

4. How did Newhall Ave. between Sierra Hwy and Valle del Oro go from 49,000 ADT (in the Masters College raffic analysis of 2008) in the interim year to 40,000 ADT in this noise analysis?
Notably, for Sierra Hwy between Newhall Ave and Dockweiler, the ADTs are 9,000 (Masters College traffic analysis) and 23,000 (OVOV).
Sierra Hwy between Dockweiler and Placerita Canyon is 26,000 (Masters College traffic analysis) and 39,000 (OVOV).
These numbers are very different, and need explanation, especially because the traffic volume on Sierra Highway is far higher in the OVOV, but far lower on Newhall Ave in the same OVOV.

5. How does Newhall Ave 'NW of Valle del Oro' have 33,000 ADT (OVOV) when Newhall Ave from Sierra Hwy to Valle del Oro has 40,000 ADT?
Under current conditions, there is more traffic west of VDO on Newhall Ave (50,000 ADT vs. 45,000 according to the Masters College traffic analysis of 2008).
There will certainly not be a decrease of traffic on Newhall Ave. west of VDO, because some of the traffic diverted off Sierra Hwy onto Dockweiler will go down VDO and back to Newhall Ave.

6. How are you going to fit 23,000 ADTs on Newhall Ave between Market and Lyons?

7. The 'current general plan freeway noise contour distances for freeways' has 316,000 ADTs on SR-14 between I-5 and Placerita Canyon.
The 'proposed general plan freeway noise contour distances for freeways' has 230,000 ADTs for the same stretch of road.
Where did 86,000 ADTs go?

8. Dockweiler Drive has 2 segments in all the lists:

	Current GP	OVOV

Dockweiler from Sierra Hwy to mid-section	25,000	24,000
Dockweiler from mid-section to mid-section	22,000	18,000

Where is this 'mid-section' and what happens to the 6,000 ADTs that just disappear?

9. On page N26, the proposed policy for residential development in the I-5 corridor 'prohibits residential buildings within 150 feet from the I-5 CENTERLINE' (emphasis added).
The California Air Resources Board has recommended that residences be located 500 feet from the EDGE OF THE FREEWAY (emphasis added).
Estimating the width of I-5 at 200 feet in the Santa Clarita valley, the OVOV policy would permit residential development only 50 feet from the edge of the roadway, instead of the 500 feet recommended.
How can this difference be justified?

Ventura County Public Works Agency, Transportation Department,
Comment on NOP; dated August 14, 2008

PUBLIC WORKS AGENCY
TRANSPORTATION DEPARTMENT
Traffic, Advance Planning & Permits Division

M E M O R A N D U M

DATE: August 14, 2008

TO: Resource Management Agency, Planning Division
Attention: Kari Finley

FROM: Nazir Lalani, Deputy Director

SUBJECT: **REVIEW OF DOCUMENT 08-032, ONE VALLEY ONE VISION – SANTA CLARITA VALLEYWIDE AREA PLAN UPDATE (OVOV)**.
Notice of Preparation of a Draft Environmental Impact Report (NOP) for the Santa Clarita Valley-Wide Area Plan Update
Lead Agency – **County of Los Angeles**

Pursuant to your request, the Public Works Agency -- Transportation Department has reviewed the Notice of Preparation of a Draft Environmental Impact for the Santa Clarita Valleywide Area Plan Update.

The OVOV is a comprehensive update to the Santa Clarita Valley-Wide Area Plan to establish common guidelines for new development that will lead to greater cooperation and an enhanced quality of life for residents of Santa Clarita Valley.

Our comments are as follows:

1. We generally concur with the comments in the NOP for those areas under the purview of the Transportation Department. However, no project specific impacts on County of Ventura roadways were identified in the NOP.

2. The cumulative impacts of this project, when considered with the cumulative impacts of all other approved (or anticipated) development projects in the Santa Clarita Valley, are potentially significant on the roads in the County of Ventura.

3. It is recommended that the environmental document address the potential adverse impacts on County of Ventura roads in the area.

Our review is limited to the impacts this project may have on Ventura County's Regional Road Network.

Please call me at 654-2080 if you have questions.

F:\transpor\LanDev\Non_County\08-032(LA-Santa Clarita).doc

City Comments

DEPARTMENT OF TRANSPORTATION
DISTRICT 7, REGIONAL PLANNING
IGR/CEQA BRANCH
100 MAIN STREET, MS # 16
LOS ANGELES, CA 90012-3606
PHONE: (213) 897-6696
FAX: (213) 897-1337

Flex your power!
Be energy efficient!

IGR/CEQA No. 080808AL, NOP
One Valley One Vision
County Project No. R2007-01226
Vic. LA-05/126/14
SCH # 2008071133

September 15, 2008

Mr. Jeff Hogan
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

Dear Mr. Hogan:

Thank you for including the California Department of Transportation (Caltrans) in the environmental review process for the above referenced project. The One Valley One Vision, OVOV, project is a comprehensive update to the Santa Clarita Valley wide Area Plan to establish common guidelines for new development that will lead to greater cooperation and an enhanced quality of life for residents of Santa Clarita Valley.

The OVOV is a joint effort between the County of Los Angeles, City of Santa Clarita, and Santa Clarita Valley residents and businesses to create a single vision and guidelines for the future growth of the Valley and the preservation of natural resources. The result of the work effort will require the County to adopt a new Area Plan to replace the Santa Clarita Valley Area Plan and prepare its own Environmental Impact Report, EIR, while the City will adopt a new General Plan and EIR.

The California Department of Transportation (Caltrans) as the State agency responsible for planning, operations, and maintenance of State highways, shares similar transportation goals with the both County of Los Angeles and City of Santa Clarita. We are pleased with the comprehensive planning approach both local government agencies are pursuing and present the following comments:

"Caltrans is particularly interested in the transportation planning roles of local general plans and suggests that the following areas be emphasized.

- Coordination of planning efforts between local agencies and Caltrans.
- Preservation of transportation corridors for future system improvements; and
- Development of coordinated transportation system management plans that achieve the maximum use of present and proposed infrastructure."

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PLANNING DIVISION
SEP 17 2008
CITY OF SANTA CLARITA

Circulation Element

It is widely known that Southern California highways are heavily congested especially during morning and evening peak periods. We realize that to improve mobility there is the need for capacity enhancing improvements as well as other innovative alternatives. The State highway facilities that provide regional access to the subject Santa Clarita Valley Area and are therefore likely to be impacted by future development activity are Interstate 5 (I-5), State Route 14 (SR-14), and State Route 126 (SR-126).

Interstate 5

- The *Golden State Gateway Coalition website (http://www.goldenstategateway.org/?p=7#q6) provides the following information:*

"....In the northern Los Angeles County, the I-5 currently carries more than 200,000 vehicles every day. This includes more than 19,000 trucks. These daily numbers add up to a staggering 73 Million vehicles – including 7 Million trucks – every year. As commerce and population growth occur in Southern California, these numbers will increase...."

" ...The I-5 freeway is already nearly at capacity, with Los Angeles County's population expected to grow by 3 million in the next 2 decades, it would soon be beyond its capacity without major improvements. Traffic is projected to increase by 65% in the next 10 years and 114% in the next 20 years. Airport passenger and cargo traffic in the Los Angeles-southern Kern County region is expected to double in the next 2 decades, while seaport traffic is expected to triple...."

State Route 14

- Existing daily traffic volumes along the SR 14 corridor range from 137,000 ADT between I-5 to San Fernando Rd., to 30,900 ADT between Avenue I and Kern County Line, per Caltrans District 7, SR 14 Transportation Concept Report, September 2003.

- Currently, an operating deficiency exists on SR14 between I-5 and San Fernando Rd. The level of service on this segment is F0 during the AM peak period on the southbound side of the route and F0 during the PM peak period on the northbound side of the route (Caltrans District 7, SR 14 Transportation Concept Report, September 2003).

- SR 14 is designated as a Super Truck Route (STR). SR 14 is also part of the Surface Transportation Assistance Act (STAA) truck network, which provides freeway access for oversized trucks. Regional truck traffic is expected to increase by 40% by 2020, with virtually no capacity available to handle this additional volume (Caltrans District 7, SR 14 Transportation Concept Report, September 2003).

State Route 126

SR-126 functions as a terminal access route to the national network for the Surface Transportation Assistance Act (STAA) for trucks. Truck volume in 2001 ranged from 4% to 30% of ADT in Los Angeles County, and 4.5% to 10% of ADT in Ventura County (Caltrans District 7, SR 126 Transportation Concept Report, November 2004).

New development will increase use of local and regional roadways and the circulation element can identify strategies the County and the City will pursue to maintain good levels of service. We understand that mitigating cumulative traffic impacts may present some challenges. Given that the Los Angeles County's Congestion Management Program debit and credit system has been suspended, we recommend the County consider an alternate local funding plan towards regional transportation improvements. We request the County consider implementing a funding program to contribute to improvements on the State highway system, including impacted I-5, SR-14, SR-126, and on/off ramps. Local funding efforts may include a region or community wide traffic impact program. When local matching funds are offered, public funds may become available and improvements may be streamlined and/or expedited. County of Los Angeles and City of Santa Clarita may take this opportunity to include policies that allow it to procure funds towards regional transportation improvements such as additional mixed flow lanes, High Occupancy Lanes (HOV), and truck lanes on I-5; as well as modifications to I-5/SR-14 interchange.

Procuring funds toward freeway segments, freeway interchanges, freeway on/off-ramps, as well as for bus and rail transit facilities should also be in the goals of the local government agencies. A local funding strategy may provide a fair and predictable mechanism for individual developments to address their individual and cumulative transportation impacts to State facilities and satisfactory comply with the California Environmental Quality Act (CEQA).

Other traffic mitigation alternatives may include vehicular demand reducing strategies, such as incentives for commuters to use transit i.e. park-and-ride lots, discounts on monthly bus and rail passes, vanpools, etc.

To avoid delays and any misunderstandings in the traffic impact analysis, we request to be involved in its development. We may provide assistance in our areas of expertise such as transportation modeling, mainline freeway analysis, system and corridor planning, environmental and community impact assessment, as well as identifying critical operational deficiencies affecting freeway congestion, speed, and delay.

For State thresholds and guidance on the preparation of acceptable traffic studies, please refer to the Statewide Guide for the preparation of Traffic Impact Studies at:

http://www.dot.ca.gov/hq/traffops/developserv/operationalsystems/reports/tisguide.pdf

If significant impacts were anticipated on the State highway system, Caltrans would work with the local governments to identify appropriate traffic mitigation measures.

We remind you that traffic impact studies that are in compliance with Los Angeles County's Congestion Management Program (Metro's CMP), are not necessary satisfactory to Caltrans, the agency with jurisdiction over State highway facilities. The thresholds for significance on State highway facilities may be different than those applied in the CMP.

Land Use Element and Other Elements

As you are aware, there is a critical relationship between land use and transportation. The quality of the State transportation system operation can affect the quality of the local circulation system operation. The Circulation Element of the General Plan needs to be consistent with the Land-Use and Housing Elements of the General Plan. During the past couple decades, population and economic growth has been strong in Los Angeles County, and projections show that this growth will continue. In addition to planning for highway improvements, we recommend that vehicle-trip reducing strategies be implemented through land-use decisions.

We recommend that special attention be given to the jobs-and-housing balance concept. Communities with predominantly residential allocations should be encouraged to set aside areas for office, commercial/retail, and open space uses. Benefits of balanced communities include: reduction of long morning and evening commutes on State highways, shorter trips which in turn would reduce the consumption of fuel and air pollutants. It may also change direction of trips. Instead of most traffic traveling in one direction during peak periods, some trips may be diverted in the opposite direction. Other land use strategies may include Transit-Oriented Developments (TODs).

- We encouraged the application of the State Regional Blueprint Program, SCAG's Compass Blueprint Program, and transportation planning principles in their General Plan update:

  - **California Regional Blueprint Planning Program (http://calblueprint.dot.ca.gov)**

    The Regional Blueprint Planning Program is intended to better inform regional and local decision-making, through pro-active engagement of all segments of the population as well as critical stakeholders in the community, business interests, academia, builders, environmental advocates, and to foster consensus on a vision and preferred land use pattern. It is anticipated that the regional blueprint planning grants will build capacity for regional collaboration and integrated planning that will in turn enable regions to plan to accommodate all their future growth, thereby reducing need for sprawl.

    The grants for regional collaborative decision-making will lead to adoption of blueprint plans that will:

    1. Foster a more efficient land use pattern that (a) supports improved mobility and reduced dependency on single-occupant vehicle trips, (b) accommodates an adequate supply of housing for all incomes, (c) reduces impacts on valuable habitat, productive farmland, and air quality, (d) increases resource use efficiency, and (e) results in safe and vibrant neighborhoods.

    2. Provide consumers more housing and transportation choices.

    3. Improve California's economic competitiveness and quality of life.

    4. Reduce costs and time needed to deliver transportation projects through informed early public and resource agency involvement.

5. Secure local government and community support, including that of under-represented groups, to achieve the resulting comprehensive vision through including innovative computer models and public involvement activities.

6. Establish a process for public and stakeholder engagement that can be replicated to build awareness of and support for critical infrastructure and housing needs.

- **SCAG Compass Blueprint Program (http://www.compassblueprint.org/about)**
  Compass Blueprint is a new way to look at how the region grows. The Compass Blueprint Growth Vision is a response, supported by a regional consensus, to the land use and transportation challenges facing Southern California now and in the coming years.

The *Growth Vision encourages:*

- Focusing growth in existing and emerging centers and along major transportation corridors
- Creating significant areas of mixed-use development and walkable communities
- Targeting growth around existing and planned transit stations
- Preserving existing open space and stable residential areas

Housing Element
As we indicated previously, continued high growth is expected for Los Angeles County, which will have impacts to our State transportation facilities. We ask that efforts be made to provide affordable housing for all income levels to ensure that substantial numbers of employees can afford to purchase homes and live in proposed residential projects.

We look forward to reviewing the traffic study. Again, we would welcome an opportunity to participate in its development.

If you have any questions, please feel free to contact me at (213) 897-6696 or Alan Lin the project coordinator at (213) 897-8391 and refer to IGR/CEQA No. 080808AL.

Sincerely,

ELMER ALVAREZ
IGR/CEQA Program Manager

cc: Scott Morgan, State Clearinghouse

COUNTY OF LOS ANGELES
Public Health

JONATHAN E. FIELDING, M.D., M.P.H.
Director and Health Officer

JONATHAN E. FREEDMAN
Acting Chief Deputy

Environmental Health
ANGELO J. BELLOMO, REHS
Director of Environmental Health

ALFONSO MEDINA, REHS
Director of Environmental Protection Bureau

KEN MURRAY, CHIEF R.E.H.S.
Solid Waste Management Program/Local Enforcement Agency
5050 Commerce Drive
Baldwin Park, California 91706
TEL (626) 430-5540 · FAX (626) 813-4839

www.lapublichealth.org

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August 13, 2008

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SEP 09 2008

CITY OF SANTA CLARITA

Jeff Hogan
AICP Senior Planner
City of Santa Clarita
23920 Valencia Blvd., suite 302
Santa Clarita, CA 91355

SUBJECT: Notice of Preparation of Draft Environmental Impact Report for the One Valley, One Vision General Plan EIR.

Dear Mr. Hogan:

The Los Angeles County Solid Waste Management Program is the Local Enforcement Agency (LEA) for the City of Santa Clarita (City). As the LEA, it is our responsibility to enforce the requirements of the California Code of Regulations (CCR) Title 14 and Title 27. The proposed EIR is intended to comply with the requirements of the California Environmental Quality Act (CEQA) by providing an analysis of the plans' potentially significant environmental impacts. Within the scope of our review, we will consider the impact(s) and the mitigation measures the plan will have on the management of solid waste within the City and the plan area. Upon reviewing the Notice of Preparation for the proposed EIR, we have the following comments:

Solid Waste

The development of this plan will increase the generation of solid waste in the Santa Clarita Valley area. This will create a negative impact on the solid waste management infrastructure within Los Angeles County. Mitigation measures must be identified so as to provide a solution for the increase in solid waste generation. The plan must consider that landfills and other solid waste facilities in the Los Angeles County have a limit on the tonnage received per day and hours of operation, and no new landfills are expected to be created in the Los Angeles County area.

At the present time there are no transfer stations or materials recovery facilities (MRF) in the Santa Clarita area to help process the solid waste stream. How will this issue be mitigated?

Consider the following:

a. How much solid waste per household or establishment will be generated as a result of the planned development, and how much solid waste will be diverted/recycled?

b. Where will the waste be taken for disposal, and is there a plan to convert or divert the residual waste into a useable resource such as energy, compost, or fuels?

c. How will hazardous wastes that are extracted from the solid waste stream be disposed?

Traffic

As a result of the planned development, a traffic analysis needs to describe how the roads and traffic patterns will accommodate the additional waste collection vehicles. The traffic analysis needs to describe the safe and adequate circulation of waste collection vehicles throughout the Valley and how it will impact the traffic flow in the area. The increased vehicle impacts on the roads should also be addressed in the noise and emissions sections as well.

Land use

Within the land use studies, information needs to include surveys in the proposed planning areas to determine if such areas have been used as a solid waste or hazardous waste disposal area in the past, and if any such area is within 1,000 feet of a planned development, a post-closure land use plan must be developed as required by CCR Title 27.

If the General Plan for the proposed Planning Area includes the construction of a solid waste processing facility such as a transfer station or a materials recovery facility (MRF), all environmental documents pertaining to the construction of these must be submitted to the LEA for review and approval. Failure to do so will result in the delay of permit issuance.

Thank you for giving our office the opportunity to provide comments on this project, if you have any questions please call me at 626-430-5540.

Sincerely,

Nelly Castellanos, REHS III
Solid Waste Management Program

Parks Designation Description

Calgrove Corridor Coalition

August 26, 2008

Mr. Hogan, AICP
Senior Planner
City of Santa Clarita
23920 Valencia Blvd.
Santa Clarita, CA 9135

Re: Calgrove Corridor Coalition Request for Clarification-Notice of Preparation of Land Use L-33

Dear Mr. Hogan;

The Calgrove Corridor Coalition is asking for clarification on the Land Use Element/Parks section, and requesting clarification response dates for such changes.

We previously printed the Land Use section dated DRAFT July, 2008 on L-33 and it stated:

"The City has adopted a standard of five acres per 1000 residents and the County has adopted a standard of three acres per 1000."

Today, August 26, 2008 we were looking up information and noticed that the PARKS section L-34 is dated July 28, 2008 and now states:

" In the past, the City the County have both, adopted a standard of three acres per 1000 residents."

We would appreciate your prompt response.

Annette Lucas

Annette Lucas, Co-chair
Calgrove Corridor Coalition

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Background Section ends with a needs assessment which identifies current deficiencies in park area and facilities.

Table PR-6 shows that developed City and County parks within the City of Santa Clarita presently provide 172 acres (28 percent) of the park acreage needed to meet its goal of 605.82. City parks account for one quarter of the existing acreage; only 10 percent of the goal. Based upon the 5/1,000 standard, City and County parks which serve the entire planning area, including the City, are presently providing 249 acres (38 percent) of the improved parkland needed to meet the planning area's requirement of 654 acres. These park sites also often have unbuilt housing that adds population. When unimproved parkland is considered, the deficiency of parkland decreases to 538 acres and 310 acres for the City and planning area, respectively. Schools are not considered as public parkland since public use is restricted. However, for evaluation purposes only, when school sites are used for park purposes, the deficiency between improved recreational open space and the amount of park space required to meet the 5 acres/1,000 person standard, narrows to 221 acres for the entire planning area.

PARK FACILITIES NEEDS ASSESSMENT

School facilities and lands have become valuable financial assets for school districts. School sites have been closed and sold or leased for alternative uses to help generate additional financial resources. Long-term reliance on school grounds for open space and parkland purposes can lead to significant future parkland and facility deficiencies.

The National Recreation and Parks Association (NRPA) has developed park standards that can act as a guide for the development of park facilities. The Santa Clarita park facilities needs assessment is based on a standard of 5 acres of parkland per 1,000 persons.

Enrollment is estimated at 1,000 students. The Master's College is planning a facility expansion on the current campus.

The challenge to provide additional school facilities needed to support new development will be met through on-going cooperation between the City, County, and school districts. Master-planned communities, such as Newhall Ranch, provide for school sites and funding mechanisms in their specific plans. As infill occurs in other portions of the planning area, however, it will be necessary to explore all options to alleviate over-crowding. Policies have been included in the General Plan to address coordination of land use planning with school facility planning.

Parks

The provision of adequate park space and facilities to serve residents is not only required by State planning law, but is recognized as necessary to provide for public health and quality of life. Parkland provides recreational and aesthetic benefits as well as increased environmental quality, through maintenance of open space, permeable land area for surface water infiltration and percolation, trees and vegetation for habitat, and the economic benefits of increased property values. The Land Use Element is required to consider the number, size, and distribution of parklands and facilities to ensure that these public amenities will be adequate to serve the ultimate population level at build-out of uses permitted by the Land Use Map.

Based on a 2003 GIS inventory, the Valley contains over 14,000 acres of parkland, including both local and regional parks located within City and County areas; however, much of this parkland consists of natural open space and is not developed for active recreational uses. There are four State Parks located within the Planning Area, totaling about 12,950 acres: Castaic Lake Recreation Area, Placerita Canyon State Park, Vasquez Rocks State Park, and the Santa Clarita Woodlands. In addition, recreational facilities within the Angeles National Forest and Los Padres National Forest lands within and adjacent to the planning area are available for public use by Valley residents. A more detailed discussion of specific park locations and acreage is contained in the Conservation and Open Space Element.

In addition to parkland, the Valley contains an integrated trail system traversing both City and County areas and available for use by equestrians, hikers, joggers, and cyclists. Long-term plans call for a continuous trail along the Santa Clara River, to be completed as right-of-way is acquired. Schools also provide land and facilities for recreational use on a limited basis, through joint use agreements.

Developed parkland in the planning area accommodates a variety of organized sports, including soccer, baseball, tennis, volleyball, basketball, and a skateboard park. Facilities also include picnic areas and playgrounds. A 58-acre Sports Complex was constructed by the City within a former industrial complex in 2002, with an aquatic center added in 2003. Future expansion plans include multi-purpose fields, a second gymnasium, an expanded skate park, and other amenities. The County has constructed a 53-acre sports complex in Castaic. Both the City and County operate recreational programs at their park facilities. Passive recreational areas include conservancy land located in Towsley Canyon and the Water Conservatory Garden and Learning Center owned by Castaic Lake.

The City has adopted a standard of five acres per 1000 residents and the County has adopted a standard of three acres per 1000. Based on these standards and without considering improvements or distribution of facilities, the planning area has adequate overall parkland acreage to serve the existing population. However, more parks to handle specific recreational

amenities. The County has constructed a 53-acre sports complex in Castaic. Both the City and County operate recreational programs at their park facilities. Passive recreational areas include conservancy land located in Towsley Canyon and the Water Conservatory Garden and Learning Center owned by Castaic Lake.

In the past, the City and County have both , adopted a standard of three acres per 1000 residents. Based on these standards and without considering improvements or distribution of facilities, the planning area has adequate overall parkland acreage to serve the existing population. However, more parks to handle specific recreational needs, such as ball fields for youth, are needed to better serve the existing population and future growth. Within the City, there are only about 1.5–2 acres of developed parkland per 1000 population. Another issue for park development is distribution of park facilities, as many local parks are concentrated within master planned communities, and outlying areas have access to fewer local parks. There is a need for additional regional parks with ball fields throughout the Valley, as both City and County residents are active park users in this family-oriented community.

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Deleted: and the County has adopted a standard of three acres per 1000

It is anticipated that future dedications of parkland will be made from new developments in the planning area as development occurs. In addition, both the City and the County are planning for a variety of new parks to serve the growing population's recreational needs.

The City and County will continue to explore joint use opportunities with school districts, utility corridors, and other service providers and agencies to expand parkland and recreational facilities, including trails and playfields. It will be critical in the future to identify sources of funding and reserve lands for future parkland as the planning area continues to develop, in order to provide adequate parkland for all residents.

Libraries

The County of Los Angeles operates all public libraries in the planning area, including the Main Branch in Valencia, the Jo Anne Darcy Branch in Canyon Country, the Newhall Branch, and a bookmobile that serves the communities of Castaic, Acton, Agua Dulce, Val Verde, and the Friendly Valley senior community. The County's system contains over eight million items in its collections and provides inter-library loan programs with other local and national libraries. Santa Clarita library branches also maintain local and regional history collections.

In addition to the public libraries, schools provide library facilities to their students. Both Cal Arts and The Master's College provide libraries for students, and College of the Canyons opens their library to both students and the general public.

Based on the County Library's service guidelines, the area and number of items within the Santa Clarita branches are not meeting service level standards. As population increases based on growth anticipated by the General Plan, it will be necessary to increase funding to support library development. In order to meet the library needs of new development in the Valley, both the City and County assess a development impact fee for library construction. Other funding sources include property taxes, bond measures, and voter-approved special taxes.

In 2008 the City Council approved purchase of three parcels on San Fernando Road so that the City can move ahead with plans to build a new public library in Downtown Newhall. Along with the new community center, this new library facility is part of the plan to revitalize Downtown Newhall.

Local Government Offices

STATE OF CALIFORNIA

GOVERNOR'S OFFICE *of* PLANNING AND RESEARCH

STATE CLEARINGHOUSE AND PLANNING UNIT

ARNOLD SCHWARZENEGGER
GOVERNOR

CYNTHIA BRYANT
DIRECTOR

Notice of Preparation

July 29, 2008

To: Reviewing Agencies

Re: One Valley, One Vision General Plan EIR
SCH# 2008071133

Attached for your review and comment is the Notice of Preparation (NOP) for the One Valley, One Vision General Plan EIR draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

Jeff Hogan
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

Scott Morgan
Project Analyst, State Clearinghouse

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AUG 05 2008
CITY OF SANTA CLARITA

Attachments
cc: Lead Agency

1400 10th Street P.O. Box 3044 Sacramento, California 95812-3044
(916) 445-0613 FAX (916) 323-3018 www.opr.ca.gov

State Clearinghouse Data Base

SCH# 2008071133
Project Title One Valley, One Vision General Plan EIR
Lead Agency Santa Clarita, City of

Type NOP Notice of Preparation

Description The City is preparing a comprehensive update to its General Plan and an associated EIR for the proposed Planning Area. Development within the City and County shall be consistent with the OVOV's Vision and Guiding Principles, which are intended to sustain and enhance environmental resources, economic vitality, and the social well being of its residents. The following seven General Plan elements are either available or will soon be available on the City's website wwww.santa-clarita.com/vgp:

- Draft Safety Element
- Draft Conservation and Open Space Element
- Draft Circulation and Noise Elements (available 9/16/08)
- Draft Housing Element (available 10/21/08)

Lead Agency Contact

Name Jeff Hogan
Agency City of Santa Clarita
Phone (661) 255-4330 **Fax**
email
Address 23920 Valencia Boulevard, Suite 302
City Santa Clarita **State** CA **Zip** 91355

Project Location

County Los Angeles
City Santa Clarita
Region
Cross Streets
Lat / Long
Parcel No.
Township **Range** **Section** **Base**

Proximity to:

Highways
Airports
Railways
Waterways
Schools
Land Use Residential, Commercial, Mixed Use, Industrial, Public and Institutional, Transportation, Communication, and Utilities, Open Space and Recreation, Non-Urban/Agriculture, Specific Plan

Project Issues Aesthetic/Visual; Agricultural Land; Air Quality; Biological Resources; Other Issues; Geologic/Seismic; Toxic/Hazardous; Water Quality; Archaeologic-Historic; Landuse; Minerals; Noise; Population/Housing Balance; Public Services; Recreation/Parks; Traffic/Circulation

Reviewing Agencies Resources Agency; Department of Conservation; California Energy Commission; Cal Fire; Department of Parks and Recreation; Department of Water Resources; Department of Fish and Game, Region 5; Department of Health Services; Office of Emergency Services; Native American Heritage Commission; State Lands Commission; Caltrans, Division of Aeronautics; California Highway Patrol; Department of Housing and Community Development; Caltrans, District 7; Regional Water Quality Control Board, Region 4

Date Received 07/29/2008 **Start of Review** 07/29/2008 **End of Review** 08/27/2008

Note: Blanks in data fields result from insufficient information provided by lead agency.

NOP Distribution List

County: Los Angeles **SCH#** [illegible]

Resources Agency

- [■] **Resources Agency** Nadell Gayou
- [ ] **Dept. of Boating & Waterways** David Johnson
- [ ] **California Coastal Commission** Elizabeth A. Fuchs
- [ ] **Colorado River Board** Gerald R. Zimmerman
- [■] **Dept. of Conservation** Sharon Howell
- [■] **California Energy Commission** Dale Edwards
- [■] **Cal Fire** Allen Robertson
- [ ] **Office of Historic Preservation** Wayne Donaldson
- [■] **Dept of Parks & Recreation** Environmental Stewardship Section
- [ ] **Central Valley Flood Protection Board** Mark Herald
- [ ] **S.F. Bay Conservation & Dev't. Comm.** Steve McAdam
- [■] **Dept. of Water Resources** Resources Agency Nadell Gayou
- [ ] _____ Conservancy

Fish and Game

- [ ] **Depart. of Fish & Game** Scott Flint Environmental Services Division
- [ ] **Fish & Game Region 1** Donald Koch
- [ ] **Fish & Game Region 1E** Laurie Harnsberger
- [ ] **Fish & Game Region 2** Jeff Drongesen
- [ ] **Fish & Game Region 3** Robert Floerke
- [ ] **Fish & Game Region 4** Julie Vance
- [■] **Fish & Game Region 5** Don Chadwick Habitat Conservation Program
- [ ] **Fish & Game Region 6** Gabrina Gatchel Habitat Conservation Program
- [ ] **Fish & Game Region 6 I/M** Gabrina Getchel Inyo/Mono, Habitat Conservation Program
- [ ] **Dept. of Fish & Game M** George Isaac Marine Region

Other Departments

- [ ] **Food & Agriculture** Steve Shaffer Dept. of Food and Agriculture
- [ ] **Depart. of General Services** Public School Construction
- [ ] **Dept. of General Services** Robert Sleppy Environmental Services Section
- [■] **Dept. of Public Health** Veronica Malloy Dept. of Health/Drinking Water

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- [■] **Office of Emergency Services** Dennis Castrillo
- [ ] **Governor's Office of Planning & Research** State Clearinghouse
- [■] **Native American Heritage Comm.** Debbie Treadway
- [ ] **Public Utilities Commission** Ken Lewis
- [ ] **Santa Monica Bay Restoration** Guangyu Wang
- [■] **State Lands Commission** Marina Brand
- [ ] **Tahoe Regional Planning Agency (TRPA)** Cherry Jacques

Business, Trans & Housing

- [■] **Caltrans - Division of Aeronautics** Sandy Hesnard
- [ ] **Caltrans - Planning** Terri Pencovic
- [■] **California Highway Patrol** Shirley Kelly Office of Special Projects
- [■] **Housing & Community Development** Lisa Nichols Housing Policy Division

Dept. of Transportation

- [ ] **Caltrans, District 1** Rex Jackman
- [ ] **Caltrans, District 2** Marcelino Gonzalez
- [ ] **Caltrans, District 3** Jeff Pulverman
- [ ] **Caltrans, District 4** Tim Sable
- [ ] **Caltrans, District 5** David Murray
- [ ] **Caltrans, District 6** Moses Stites
- [■] **Caltrans, District 7** Vin Kumar
- [ ] **Caltrans, District 8** Dan Kopulsky
- [ ] **Caltrans, District 9** Gayle Rosander
- [ ] **Caltrans, District 10** Tom Dumas
- [ ] **Caltrans, District 11** Jacob Armstrong
- [ ] **Caltrans, District 12** Ryan P. Chamberlain

Cal EPA

Air Resources Board

- [ ] Airport Projects Jim Lerner
  - [ ] Transportation Projects Ravi Ramalingam
  - [ ] Industrial Projects Mike Tollstrup
- [ ] **California Integrated Waste Management Board** Sue O'Leary
- [ ] **State Water Resources Control Board** Regional Programs Unit Division of Financial Assistance
- [ ] **State Water Resources Control Board** Student Intern, 401 Water Quality Certification Unit Division of Water Quality
- [ ] **State Water Resources Control Board** Steven Herrera Division of Water Rights
- [ ] **Dept. of Toxic Substances Control** CEQA Tracking Center
- [ ] **Department of Pesticide Regulation**

Regional Water Quality Control Board (RWQCB)

- [ ] **RWQCB 1** Cathleen Hudson North Coast Region (1)
- [ ] **RWQCB 2** Environmental Document Coordinator San Francisco Bay Region (2)
- [ ] **RWQCB 3** Central Coast Region (3)
- [■] **RWQCB 4** Teresa Rodgers Los Angeles Region (4)
- [ ] **RWQCB 5S** Central Valley Region (5)
  - [ ] **RWQCB 5F** Central Valley Region (5) Fresno Branch Office
  - [ ] **RWQCB 5R** Central Valley Region (5) Redding Branch Office
- [ ] **RWQCB 6** Lahontan Region (6)
  - [ ] **RWQCB 6V** Lahontan Region (6) Victorville Branch Office
- [ ] **RWQCB 7** Colorado River Basin Region (7)
- [ ] **RWQCB 8** Santa Ana Region (8)
- [ ] **RWQCB 9** San Diego Region (9)

- [ ] **Other** _____

Last Updated on 07/24/2008

August 5, 2008

Jason Smisko, Senior Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, CA 91355

Dear Jason:

I am writing in followup to the July 14 Public Discussion of the One Valley One Vision Draft Land Use Element of the General Plan.

Although you mentioned to Leon Worden and myself following the meeting that Special Standards were to remain for Placerita Canyon east of the MWD right of way, I believe that more needs to be acknowledged. West of the MWD was also part of the Original Special Standards designation. As several Placerita Canyon residents commented, the existence of Special Standards for Placerita Canyon needs to be emphasized in the Planning Document. While Placerita Canyon is presented as a rural residential area...equestrian oriented on page L-11, nowhere is this to be found in the Land Use Goals, section. LU 1.2.6. Instead Placerita Canyon is described only as "eclectic..... providing an orderly connection to Newhall through the Downtown Newhall Specific Plan".

I would like to suggest that the wording in Section LU 1.2.6 for Placerita Canyon be amended to reflect the preservation of the rural equestrian character governed by Special Standards, keeping the unique community nature at the forefront when considering development of the North Newhall Specific Plan and connections thereof.

Simply put, if as the plan says, the Santa Clarita Valley is a Valley of Villages, then Placerita Canyon is a village onto itself, roots lying deep from years of history and reflective of passion for the lifestyle that it represents. It is my conviction that any future planning on currently vacant land here should reflect the characteristics of this canyon, including incorporation of Special Standards, as any development indeed becomes the Placerita Gateway, the gateway into Placerita Canyon.

Sincerely,

Linda

Linda Tarnoff
21618 Oak Orchard Road
Newhall 91321
HaveAHunchRanch@aol.com

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AUG 11 2008
CITY OF SANTA CLARITA

c. Planning Commissioners

WATER RECLAMATION
SOLID WASTE MANAGEMENT

COUNTY SANITATION DISTRICTS
OF LOS ANGELES COUNTY

1955 Workman Mill Road, Whittier, CA 90601-1400
Mailing Address: P.O. Box 4998, Whittier, CA 90607-4998
Telephone: (562) 699-7411, FAX: (562) 699-5422
www.lacsd.org

STEPHEN R. MAGUIN
Chief Engineer and General Manager

July 30, 2008

File No: SCV-00.04-00

Mr. Mitch Glaser
Countywide Studies Section
Los Angeles County
Department of Regional Planning
320 West Temple Street
Los Angeles, CA 90012

RECEIVED
PLANNING DIVISION
AUG 05 2008
CITY OF SANTA CLARITA

Dear Mr. Glaser:

One Valley One Vision, County Project No. R2007-01226

The County Sanitation Districts of Los Angeles County (Districts) received a Notice of Preparation of a Draft Environmental Impact Report for the subject project on July 28, 2008. We offer the following comments regarding sewerage service:

1. Portions of the project area are outside the jurisdictional boundaries of the Districts and will require annexation into the Santa Clarita Valley Sanitation District before sewerage service can be provided to any proposed development. For a copy of the Districts' Annexation Information and Processing Fees sheets, go to www.lacsd.org, Will Serve Program, Obtain Will Serve Letter, and click on the appropriate link on page 2. For more specific information regarding the annexation procedure and fees, please contact Ms. Donna Kitt at extension 2708.

2. The Districts own, operate, and maintain only the large trunk sewers that form the backbone of the regional wastewater conveyance system. Local collector and/or lateral sewer lines are the responsibility of the jurisdiction in which they are located. As such, the Districts cannot comment on any deficiencies in the local sewerage system within the project area except to state that presently no deficiencies exist in Districts' facilities that serve the Santa Clarita Valley.

3. The District operates two water reclamation plants (WRPs), the Saugus WRP and the Valencia WRP, which provide wastewater treatment in the Santa Clarita Valley. These facilities are interconnected to form a regional treatment system known as the Santa Clarita Valley Joint Sewerage System (SCVJSS). The SCVJSS has a design capacity of 28.1 mgd and currently processes an average flow of 21 mgd.

4. For a copy of the Districts' average wastewater generation factors, go to www.lacsd.org, Information Center, Will Serve Program, Obtain Will Serve Letter, and click on the appropriate link on page 2.

Recycled Paper

5. The Districts are authorized by the California Health and Safety Code to charge a fee for the privilege of connecting (directly or indirectly) to the Districts' Sewerage System or increasing the strength or quantity of wastewater attributable to a particular parcel or operation already connected. This connection fee is a capital facilities fee that is imposed in an amount sufficient to construct an incremental expansion of the Sewerage System to accommodate any proposed development. Payment of a connection fee will be required before a permit to connect to the sewer is issued. For a copy of the Connection Fee Information Sheet, go to www.lacsd.org, Information Center, Will Serve Program, Obtain Will Serve Letter, and click on the appropriate link on page 2. For more specific information regarding the connection fee application procedure and fees, please contact the Connection Fee Counter at extension 2727.

6. In order for the Districts to conform to the requirements of the Federal Clean Air Act (CAA), the design capacities of the Districts' wastewater treatment facilities are based on the regional growth forecast adopted by the Southern California Association of Governments (SCAG). Specific policies included in the development of the SCAG regional growth forecast are incorporated into clean air plans, which are prepared by the South Coast and Antelope Valley Air Quality Management Districts in order to improve air quality in the South Coast and Mojave Desert Air Basins as mandated by the CAA. All expansions of Districts' facilities must be sized and service phased in a manner that will be consistent with the SCAG regional growth forecast for the counties of Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial. The available capacity of the Districts' treatment facilities will, therefore, be limited to levels associated with the approved growth identified by SCAG. As such, this letter does not constitute a guarantee of wastewater service, but is to advise you that the Districts intend to provide this service up to the levels that are legally permitted and to inform you of the currently existing capacity and any proposed expansion of the Districts' facilities.

If you have any questions, please contact the undersigned at (562) 908-4288, extension 2717.

Very truly yours,

Stephen R. Maguin

Ruth I. Frazen
Customer Service Specialist
Facilities Planning Department

RIF:rf

c: W. Hogan, City of Santa Clarita
D. Kitt

Doc #: 1081284.1

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390
www.nahc.ca.gov
ds_nahc@pacbell.net

RECEIVED
PLANNING DIVISION
AUG 0 7 2008
CITY OF SANTA CLARITA

July 31, 2008

Mr. Jeff Hogan
CITY OF SANTA CLARITA
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

Mr. Mitch Glaser
County of Los Angeles Department of Regional Planning
320 West Temple Street, Room 1354
Los Angeles, CA 90012

Re: SCH# 2008071133; and SCH#2008071119; CEQA Notice of Preparation (NOP) draft Environmental Impact Report (DEIR) for the One Valley, One Vision General Plan; City of Santa Clarita; County of Los Angeles Regional Planning #R2007-01226; Los Angeles County, California

Dear Mr.Hogan and Mr. Glaser:

Thank you for the opportunity to comment on the above-referenced document. The Native American Heritage Commission is the state agency designated for the protection of California's Native American cultural resources. The California Environmental Quality Act (CEQA) requires that any project that causes a substantial adverse change in the significance of an historical resource, that includes archeological resources, is a 'significant effect' requiring the preparation of an Environmental Impact Report (EIR per the California Code of Regulations § 15064.5(b)(c) (CEQA Guidelines). In order to comply with this provision, the lead agency is required to assess whether the project will have an adverse impact on these resources within the 'area of potential effect (APE),' and if so, to mitigate that effect. To adequately assess the project-related impacts on historical resources, the Commission recommends the following action:

√ Contact the appropriate California Historic Resources Information Center (CHRIS). Contact information for the 'Information Center' nearest you is available from the State Office of Historic Preservation in Sacramento (916/653-7278). The record search will determine:

- If a part or the entire (APE) has been previously surveyed for cultural resources.
- If any known cultural resources have already been recorded in or adjacent to the APE.
- If the probability is low, moderate, or high that cultural resources are located in the APE.
- If a survey is required to determine whether previously unrecorded cultural resources are present.

√ If an archaeological inventory survey is required, the final stage is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.

- The final report containing site forms, site significance, and mitigation measurers should be submitted immediately to the planning department. All information regarding site locations, Native American human remains, and associated funerary objects should be in a separate confidential addendum, and not be made available for pubic disclosure.
- The final written report should be submitted within 3 months after work has been completed to the appropriate regional archaeological Information Center.

√ Contact the Native American Heritage Commission (NAHC) for:

* A Sacred Lands File (SLF) search of the project area and information on tribal contacts in the project vicinity who may have information on cultural resources in or near the APE. Please provide us site identification as follows: USGS 7.5-minute quadrangle citation with name, township, range and section. This will assist us with the SLF.

- Also, we recommend that you contact the Native American contacts on the attached list to get their input on the effect of potential project (e.g. APE) impact. In many cases a culturally-affiliated Native American tribe or person will be the only source of information about the existence of a cultural resource.

√ Lack of surface evidence of archeological resources does not preclude their subsurface existence.

- Lead agencies should include in their mitigation plan provisions for the identification and evaluation of accidentally discovered archeological resources, per California Environmental Quality Act (CEQA)

§15064.5 (f) of the California Code of Regulations (e.g. CEQA Guidelines). In areas of identified archaeological sensitivity, a certified archaeologist and a culturally-affiliated Native American Monitor, with knowledge of cultural resources, are recommended to monitor all ground-breaking construction activities.

Lead agencies should include in their mitigation plan provisions for the disposition of recovered artifact, in consultation with culturally-affiliated tribes.

√ Lead agencies should include provisions for discovery of Native American human remains or unmarked cemeteries in their mitigations plans.

- CEQA Guidelines §15064.5(d) requires the lead agency to work with the Native Americans identified by this Commission if the Initial Study identifies the presence or likely presence of Native American human remains within the APE. CEQA Guidelines provide for agreements with Native American groups, identified by the NAHE, to ensure the appropriate and dignified treatment of Native American human remains and any associated grave goods.
- Health and Safety Code §7050.5, Public Resources Code §5097.98 and CEQA Guidelines §15064.5(d) mandate procedures to be followed in the event of an accidental discovery of any human remains in a location other than a dedicated cemetery.

√ Lead agencies should consider avoidance, as defined in CEQA Guidelines §15370 when significant cultural resources are discovered during the course of project planning or execution.

Please feel free to contact me at (916) 653-6251 if you have any questions.

Sincerely,

Dave Singleton
Program Analyst

Attachment: Native American Contact List.

Cc: State Clearinghouse

Native American Contacts
Los Angeles County
July 31, 2008

Charles Cooke
32835 Santiago Road
Acton , CA 93510
(661) 733-1812 - cell
suscol@intox.net
Chumash
Fernandeno
Tataviam
Kitanemuk

Beverly Salazar Folkes
1931 Shadybrook Drive
Thousand Oaks , CA 91362
805 492-7255
(805) 558-1154 - cell
Chumash
Tataviam
Fe∓rnandeño

Fernandeno Tataviam Band of Mission Indians
William Gonzalaes, Cultural/Environ Depart
601 South Brand Boulevard, Suite 102
San Fernando , CA 91340
ced@tataviam.org
(818) 837-0794 Office
(818) 581-9293 Cell
(818) 837-0796 Fax
Fernandeno
Tataviam

LA City/County Native American Indian Comm
Ron Andrade, Director
3175 West 6th Street, Rm. 403
Los Angeles , CA 90020
(213) 351-5324
(213) 386-3995 FAX

Tongva Ancestral Territorial Tribal Nation
John Tommy Rosas, Tribal Admin.
,
tattnlaw@gmail.com
310-570-6567
Gabrielino Tongva

San Fernando Band of Mission Indians
John Valenzuela, Chairperson
P.O. Box 221838
Newhall , CA 91322
tsen2u@msn.com
(661) 753-9833 Office
(760) 885-0955 Cell
(760) 949-1604 Fax
Fernandeño
Tataviam
Serrano
Vanyume
Kitanemuk

Randy Guzman - Folkes
1931 Shadybrook Drive
Thousand Oaks , CA 91362
ndnrandy@hotmail.com
(805) 905-1675 - cell
Chumash
Fernandeño
Tataviam
Shoshone Paiute
Yaqui

This list is current only as of the date of this document.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resources Code and Section 5097.98 of the Public Resources Code.

This list is only applicable for contacting local Native Americans with regard to cultural resources for the propose SCH#2008071133; and SCH#2008071119; CEQA Notice of Preparation (NOP); draft Environmental Impact Report (DEIR) for the One Valley, One Vision (Los Angeles County #R2007-01226)' City of Santa Clarita; County of Los Angeeles, California.

GOVERNOR'S OFFICE OF EMERGENCY SERVICES
DISASTER ASSISTANCE PROGRAMS BRANCH
3650 SCHRIEVER AVENUE
MATHER, CALIFORNIA 95655
PHONE: (916) 845-8101 FAX: (916) 845-8381

August 1, 2008

Jeff Hogan
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

RE: Notice of Preparation for a Draft Environmental Impact Report for the One Valley, One Vision General Plan Update, SCH# 2008071133

Dear Mr. Hogan:

Thank you for the opportunity to comment on your Notice of Preparation for a Draft Environmental Impact Report (DEIR) for the city's general plan update. In preparing the general plan and accompanying DEIR, the city should examine the sections of state planning law that involve potential hazards the city may face. For your information, I have underlined specific sections of state planning law where identification and analysis of hazards are discussed (see Attachment A).

Prior to the release of the draft general plan or within the DEIR, city staff or your consultants should examine each of the requirements in state planning law and determine if there are hazard issues within the community which the general plan should address. A table in the DEIR (or general plan) which identifies these specific issues and where they are addressed in the general plan would be helpful in demonstrating the city has complied with these requirements. If the DEIR determines that state planning law requirements have not been met, it should recommend that these issues be addressed in the general plan as a mitigation measure.

We note that state planning law includes a requirement for consultations with state agencies in regard to information related to hazards. OES would be happy to share all available information at our disposal to facilitate the city's ability to comply with state planning and environmental laws.

If you have any questions about these comments, please contact Andrew Rush at (916) 845-8269 or andrew.rush@OES.ca.gov.

Sincerely,

Dennis Castrillo
Environmental Officer

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CITY OF SANTA CLARITA

cc: State Clearinghouse

Attachment A

Hazards and State Planning Law Requirements
(All citations are from the Government Code)

65302. Seven mandated elements

The general plan shall consist of a statement of development policies and shall include a diagram or diagrams and text setting forth objectives, principles, standards, and plan proposals. The plan shall include the following elements:

(a) A land use element which designates the proposed general distribution and general location and extent of the uses of the land for housing, business, industry, open space, including agriculture, natural resources, recreation, and enjoyment of scenic beauty, education, public buildings and grounds, solid and liquid waste disposal facilities, and other categories of public and private uses of land. The land use element shall include a statement of the standards of population density and building intensity recommended for the various districts and other territory covered by the plan. The land use element shall identify areas covered by the plan that are subject to flooding and shall be reviewed annually with respect to those areas. The land use element shall designate, in a land use category that provides for timber production, those parcels of real property zoned for timberland production pursuant to the California Timberland Productivity Act of 1982, Chapter 6.7 (commencing with Section 51100) of Part 1 of Division 1 of Title 5.

(g) A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of the Public Resources Code, and other geologic hazards known to the legislative body; flooding; and wildland and urban fires. The safety element shall include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, peakload water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards. Prior to the periodic review of its general plan and prior to preparing or revising its safety element, each city and county shall consult the Division of Mines and Geology of the Department of Conservation and the Office of Emergency Services for the purpose of including information known by and available to the department and the office required by this subdivision.

(d) A conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources. That portion of the conservation element including waters shall be developed in coordination with any countywide water agency and with all district and city agencies which have developed, served, controlled or conserved water for any purpose for the county or city for which the plan is prepared. Coordination shall include the discussion and evaluation of any water supply and demand information described in Section 65352.5, if that information has been submitted by the water agency to the city or county. The conservation element may also cover:

(1) The reclamation of land and waters.

(2) Prevention and control of the pollution of streams and other waters.

(3) Regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan.

(4) Prevention, control, and correction of the erosion of soils, beaches, and shores.

(5) Protection of watersheds.

(6) The location, quantity and quality of the rock, sand and gravel resources.

(7) Flood control.

65302.3. Consistency with airport land use plans

(a) The general plan, and any applicable specific plan prepared pursuant to Article 8 (commencing with Section 65450), shall be consistent with the plan adopted or amended pursuant to Section 21675 of the Public Utilities Code.

65302.6. Development of a local hazard mitigation plan

(a) A city, county, or a city and county may adopt with its safety element pursuant to subdivision (g) of Section 65302 a local hazard mitigation plan (HMP) specified in the federal Disaster Mitigation Act of 2000 (P. L. 106-390). The hazard mitigation plan shall include all of the following elements called for in the federal act requirements:
(1) An initial earthquake performance evaluation of public facilities that provide essential services, shelter, and critical governmental functions.
(2) An inventory of private facilities that are potentially hazardous, including, but not limited to, multiunit, soft story, concrete tilt-up, and concrete frame buildings.
(3) A plan to reduce the potential risk from private and governmental facilities in the event of a disaster.

65560. Definitions (Open-Space Lands)

(a) "Local open-space plan" is the open-space element of a county or city general plan adopted by the board or council, either as the local open-space plan or as the interim local open-space plan adopted pursuant to Section 65563.

(b) "Open-space land" is any parcel or area of land or water which is essentially unimproved and devoted to an open-space use as defined in this section, and which is designated on a local, regional or state open-space plan as any of the following:

(1) Open space for the preservation of natural resources including, but not limited to, areas required for the preservation of plant and animal life, including habitat for fish and wildlife species; areas required for ecologic and other scientific study purposes; rivers, streams, bays and estuaries; and coastal beaches, lakeshores, banks of rivers and streams, and watershed lands.

(2) Open space used for the managed production of resources, including but not limited to, forest lands, rangeland, agricultural lands and areas of economic importance for the production of food or fiber; areas required for recharge of ground water basins; bays, estuaries, marshes, rivers and streams which are important for the management of commercial fisheries; and areas containing major mineral deposits, including those in short supply.

(3) Open space for outdoor recreation, including but not limited to, areas of outstanding scenic, historic and cultural value; areas particularly suited for park and recreation purposes, including access to lakeshores, beaches, and rivers and streams; and areas which serve as links between major recreation and open-space reservations, including utility easements, banks of rivers and streams, trails, and scenic highway corridors.

(4) Open space for public health and safety, including, but not limited to, areas which require special management or regulation because of hazardous or special conditions such as earthquake fault zones, unstable soil areas, flood plains, watersheds, areas presenting high fire risks, areas required for the protection of water quality and water reservoirs and areas required for the protection and enhancement of air quality.

Calgrove Corridor Coalition

August 16, 2008

Mr. Jeff Hogan, AICP
Senior Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, CA 91355

Re: *Calgrove Corridor Coalition* Request for Clarification – Notice of Preparation of Draft Environmental Impact Report for the One Valley, One Vision General Plan EIR

Dear Mr. Hogan,

This is a follow to your recent letter to the *Calgrove Corridor Coalition* requesting our response to the above One Valley, One Vision Notice of Preparation.

After preliminary review of the Land Use section of the July 2008 OVOV draft, we are requesting clarification and additional information in order to provide our reply.

Specifically, we are requesting that the City of Santa Clarita Planning Department provide us a side by side comparison of the existing and proposed land use development standards for all zoning designations. To the extent there are new zoning designations, please also provide this information. This comparison should include all general requirements for the zones, such as:

1. Floor area ratio
2. Setback from right-of-way
3. Building and structure height
4. Structure setback from residential zones or uses
5. Parking requirements
6. Setbacks for public and semi-public uses from residential property uses

We request that this information be provided to us by end of business on Wednesday, August 20, 2008, in order for us to respond by the NOP deadline of August 25, 2008.

Respectfully,

Annette Lucas and Glenda Bona, co-chairs
Calgrove Corridor Coalition

CC Bob Kellar, Mayor
Ken Pulskamp, City Manager
Paul Brotzman, Director of Planning

August 25, 2008
To: Jeff Hogan, Senior Planner
From: Valerie Thomas
661.755.3793
Bionic1@sbcglobal.net
Re: One Valley One Vision Scoping Meeting Comments

General Comments:

1. Santa Clarita's original General Plan was authored by many citizens who worked diligently for nearly two years listening to community groups before they finalized their vision for the City. There were then community meetings at which ordinary citizens could offer comments and changes. Only after this process was completed, was a formal EIR implemented. One Valley One Vision has been drawn up primarily by City and County staff with occasional meetings with developers and major civic groups. No neighborhood meetings have been held to solicit their vision for the City over the next decade. The process needs to involve ordinary citizens and established neighborhoods before any further formalizing of One Valley One Vision is done.
2. This whole process is flawed by the inconsistency of dates for cutting off comments: Senior City Planner Hogan gives August 25 as the cutoff date for comments; Impact Sciences, Inc. gives August 28, 2008 as the cutoff date.
3. Santa Clarita's original General Plan was designed for a lower population at buildout than that being considered under One Valley One Vision. What state law requires acceptance of the higher population level? Have citizens' concerns been addressed in this discrepancy? Has the process addressed how the additional population will affect resources such as water availability, air quality, etc.?
4. Any changes made in regard to any of the planning elements should be made with the least disruption possible to existing neighborhoods and then only with discussions and negotiations with the affected neighborhoods.
5. Santa Clarita should demand as Los Angeles (city) does, that when a developer proposes a project, he lays the entire proposal out. That way, a developer would not be able to get permits for small parts of a project thus spending money and "vesting" so he is more likely to be able to get permits for a larger project than would otherwise have been permitted.

Air Quality

1. The Santa Clarita Valley (both City and County areas) frequently has the worst air quality in the Los Angeles County basin. OVOV needs to address planning/development/traffic circulation standards to ameliorate these conditions.

Hydrology

1. FEMA has been actively surveying the Santa Clarita Valley and drawing up new maps. While these maps are still preliminary, in many cases, FEMA foresees the likelihood of more disastrous flooding possibilities. Neither the City of Santa Clarita nor Los Angeles County should be allowed to request changes in these proposed designations or have development approved in these areas until the maps have been through the full public hearing process and formally adopted.
2. Santa Clarita has an ordinance that prohibits any land use that affects the flow of water either upstream or downstream of the project. That law needs to be a provision of One

Valley One Vision and it needs to be implemented stringently with severe financial consequences for any developer whose project creates flooding.

3. In addition to concerns about flooding, recharge needs to be addressed. Since the Santa Clarita Valley gets 50% of its water supplies from local underground sources, areas designated by FEMA as Floodways and Floodplains need to be preserved to allow for recharge into the local aquifers.

Land Use/Planning

1. The proposed One Valley One Vision Land Use Planning Map shows several areas (such as The Avenues and the North Newhall area) in the Valley designated as SP (Specific Plan). None of those plans have been adopted. The neighborhoods have not been consulted about these proposed changes; full plans have not been presented either to the neighborhoods or to any of the planning entities.
2. Per Land Use Policy LU 1.2.6: "In Placerita Canyon, preserve the eclectic neighborhood character, encourage provision of needed infrastructure through implementation of the North Newhall Specific Plan." Under the Present UDC, Placerita Canyon is a Special Standards District designed to preserve the rural equestrian nature of the area. The North Newhall Specific Plan has **not** been approved, despite the presumptive language of the Land Use element. Nor has Santa Clarita City staff consulted Placerita Canyon residents regarding these proposed changes.
3. No existing neighborhood should have its established zoning and nature disrupted to accommodate new neighborhoods.
4. Traffic flow needs to be analyzed at buildout and at the heaviest possible times – peak traffic hours and when school is in session to determine a given neighborhood can accommodate the projected development.
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Transportation/Traffic

1. Analyze traffic flows at projected buildout.
2. Do traffic counts at the heaviest traffic times; in school zones, do the traffic count when schools are in session not during vacation times.
3. Use peak hour times to measure traffic flow, or at least run peak hour analyses and 24-hour averages so Staff and the community can make a fair evaluation.
4. Make sure no existing neighborhoods are unequally impacted with changes in the circulation element such as Benz Road.

August 25, 2008
To: Jeff Hogan, Senior Planner
From: Valerie Thomas
661.755.3793
Bionic1@sbcglobal.net
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DEPARTMENT OF TRANSPORTATION
DIVISION OF AERONAUTICS – M.S.#40
1120 N STREET
P. O. BOX 942873
SACRAMENTO, CA 94273-0001
PHONE (916) 654-4959
FAX (916) 653-9531
TTY 711

Flex your power!
Be energy efficient!

August 13, 2008

RECEIVED
PLANNING DIVISION
AUG 28 2008
CITY OF SANTA CLARITA

Mr. Jeff Hogan
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

Dear Mr. Hogan:

City of Santa Clarita's Notice of Preparation of a Draft Environmental Impact Report for One Valley, One Vision General Plan; SCH# 2008071133

The California Department of Transportation (Caltrans), Division of Aeronautics (Division), reviewed the above-referenced document with respect to airport-related noise and safety impacts and regional aviation land use planning issues pursuant to the California Environmental Quality Act (CEQA). The Division has technical expertise in the areas of airport operations safety and airport land use compatibility. We are a funding agency for airport projects and we have permit authority for public-use and special-use airports and heliports. The following comments are offered for your consideration.

The proposal is for the One Valley, One Vision General Plan, a joint effort between the City of Santa Clarita and the County of Los Angeles. The Santa Clarita Valley Planning Area includes the City of Santa Clarita and its four communities of Canyon Country, Newhall, Saugus, and Valencia. It also includes the County communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce, and the future Newhall Ranch. The Agua Dulce Airpark airport is located within the proposed planning area.

In accordance with State law, California Public Utilities Code (PUC) Section 21676 *et seq.*, prior to the amendment of a general plan or specific plan, or the adoption or approval of a zoning ordinance or building regulation within the planning boundary established by the airport land use commission (ALUC), the local agency shall first refer the proposed action to the Los Angeles County ALUC.

The proposal should also be coordinated with Agua Dulce Airpark staff to ensure its compatibility with future as well as existing airport operations.

General plans and elements must clearly demonstrate intent to adhere to ALUC policies to ensure compliance with compatibility criteria. Direct conflicts between mapped land use designations in a general plan and the ALUC criteria must be eliminated. A general plan needs to include (at the very least) policies committing the county to adopt compatibility criteria essential to ensuring that such conflicts will be avoided. The criteria do not necessarily need to be spelled out in the general plan. There are a number of ways for a city or county to address the airport consistency issue, including:

- Incorporating airport compatibility policies into the update.
- Adopting an airport-combining zoning ordinance.
- Adopting an "Airport Element" into the general plan.
- Adopting the airport compatibility plan as a "stand alone" document or as a specific plan.

CEQA, Public Resources Code 21096, requires the California Airport Land Use Planning Handbook (Handbook) be utilized as a resource in the preparation of environmental documents for projects within airport land use compatibility plan boundaries or if such a plan has not been adopted, within two nautical miles of an airport. The Handbook provides a "General Plan Consistency Checklist" in Table 5A and a "Possible Airport Combining Zone Components" in Table 5B. The Handbook is a resource that should be applied to all public use airports and is available on-line at http://www.dot.ca.gov/hq/planning/aeronaut/documents/ALUPHComplete-7-02rev.pdf.

Since communities vary greatly in size and character from urban to rural, the level of noise deemed acceptable in one community is not necessarily the same for another community. Federal and State regulations regarding aircraft noise do not establish mandatory criteria for evaluating the compatibility of proposed land use development around airports (with the exception of the 65 dB CNEL "worst case" threshold established in the State Noise Standards for the designated "noise problem" airports). For most airports in California, 65 dB CNEL is considered too high a noise level to be appropriate as a standard for land use compatibility planning. This is particularly the case for evaluating new development in the vicinity of the airport. The 60 dB CNEL, or even 55 dB CNEL, may be more suitable for new development around most airports. For a further discussion of how to establish an appropriate noise level for a particular community, please refer to Chapter 7 of the Caltrans Handbook, available at http://www.dot.ca.gov/hq/planning/aeronaut/documents/ALUPHComplete-7-02rev.pdf.

Sound insulation, buyer notification and avigation easements are typical noise mitigation measures. These measures, however, do not change exterior aircraft noise levels. Noise mitigation measures are not a substitute for good land use compatibility planning for new development.

The planned height of buildings, antennas, and other objects should be checked with respect to Federal Aviation Regulation (FAR) Part 77 criteria if development is close to the airport, particularly if situated within the runway approach corridors. General plans must include policies restricting the heights of structures to protect airport airspace. To ensure compliance with FAR Part 77 "Objects Affecting Navigable Airspace," submission of a Notice of Proposed Construction or Alteration (Form 7460-1) to the Federal Aviation Administration (FAA) may be required. Form 7460-1 is available on-line at https://oeaaa.faa.gov/oeaaa/external/portal.jsp and should be submitted electronically.

Education Code Section 17215 requires a school site investigation by the Division prior to acquisition of land for a proposed school site located within two miles of an airport runway. Our recommendations are submitted to the State Department of Education for use in determining acceptability of the site. This should be a consideration prior to designating residential uses in the vicinity of an airport. The Division's school site evaluation criteria is available on-line at http://www.dot.ca.gov/hq/planning/aeronaut/regulations.html.

Business and Professions Code Section 11010 and Civil Code Sections 1102.6, 1103.4, and 1353 address buyer notification requirements for lands around airports and are available on-line at http://www.leginfo.ca.gov/calaw.html. Any person who intends to offer subdivided lands, common interest developments and residential properties for sale or lease within an airport influence area is required to disclose that fact to the person buying the property.

Land use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife-aircraft collisions. The FAA recommends that landfills, wastewater treatment facilities, surface mining, wetlands and other uses that have the potential to attract wildlife, be restricted in the vicinity of an airport. FAA Advisory Circular (AC150/5200-33B) entitled "Hazardous Wildlife Attractants on or Near Airports" addresses these issues. For further information, please refer to the FAA website http://wildlife-mitigation.tc.faa.gov/public_html/index.html.

The protection of airports from incompatible land use encroachment is vital to California's economic future. Agua Dulce Airpark is an economic asset that should be protected through effective airport land use compatibility planning and awareness. Although the need for compatible and safe land uses near airports in California is both a local and a state issue, airport land use commissions and airport land use compatibility plans are key to protecting an airport and the people residing and working in the vicinity of an airport. Consideration given to the issue of compatible land uses in the vicinity of an airport should help to relieve future conflicts between airports and their neighbors.

These comments reflect the areas of concern to the Division with respect to airport-related noise and safety impacts and regional airport land use planning issues. We advise you to contact our Caltrans District 7 office concerning surface transportation issues.

Thank you for the opportunity to review and comment on this proposal. If you have any questions, please call me at (916) 654-5314.

Sincerely,

Sandy Hesnard

SANDY HESNARD
Aviation Environmental Specialist

c: State Clearinghouse, Los Angeles County ALUC, Agua Dulce Airpark

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
320 WEST 4TH STREET, SUITE 500
LOS ANGELES, CA 90013

August 21, 2008

Mitch Glaser
Los Angeles County
320 West Temple Street, Room 1354
Los Angeles, CA 90012

Jeff Hogan
City of Santa Clarita
23920 Valencia Blvd. Suite 302
Santa Clarita, CA 91355

Dear Sirs:

Re: SCH# 2008071119; One Valley One Vision

The California Public Utilities Commission (Commission) has jurisdiction over the safety of highway-rail crossings (crossings) in California. The California Public Utilities Code requires Commission approval for the construction or alteration of crossings and grants the Commission exclusive power on the design, alteration, and closure of crossings.

The Commission is in receipt of the *Notice of Completion & Environmental Document Transmittal-NOP* from the State Clearinghouse. As the state agency responsible for rail safety within California, we recommend that the County/City add language to the general plan update so that any future planned development adjacent to or near Metrolink's Antelope Valley Line tracks is planned with the safety of the rail corridor in mind. New developments may increase traffic volumes not only on streets and at intersections, but also at at-grade highway-rail crossings. This includes considering pedestrian circulation patterns/destinations with respect to railroad right-of-way

Mitigation measures to consider include, but are not limited to, the planning for grade separations for major thoroughfares, improvements to existing at-grade highway-rail crossings due to increase in traffic volumes and continuous vandal resistant fencing or other appropriate barriers to limit the access of trespassers onto the railroad right-of-way.

If you have any questions, please contact Varouj Jinbachian, Senior Utilities Engineer at 213-576-7081, vsj@cpuc.ca.gov, or me at rxm@cpuc.ca.gov, 213-576-7078.

Sincerely,

Rosa Muñoz, PE
Utilities Engineer
Rail Crossings Engineering Section
Consumer Protection & Safety Division

C: Elizabeth Mahoney, SCRRA

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AUG 28 2008
CITY OF SANTA CLARITA

Metropolitan Transportation Authority
One Gateway Plaza
Los Angeles, CA 90012-2952
213.922.2000 Tel
metro.net

Metro

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PLANNING DIVISION
AUG 01 2008
CITY OF SANTA CLARITA

July 28, 2008

Mr. Jeff Hogan, AICP, Senior Planner
City of Santa Clarita
23920 Valencia Blvd, Suite 302
Santa Clarita, CA 91355

Dear Mr. Hogan:

Thank you for the opportunity to comment on the Notice of Preparation (NOP) for the One Valley, One Vision project. This letter conveys recommendations from the Los Angeles County Metropolitan Transportation Authority (Metro) concerning issues that are germane to our agency's statutory responsibilities in relation to the proposed project.

A Traffic Impact Analysis (TIA), with highway, freeway, and transit components, is required under the State of California Congestion Management Program (CMP) statute. The CMP TIA Guidelines are published in the "2004 Congestion Management Program for Los Angeles County", Appendix D. The geographic area examined in the TIA must include the following, at a minimum:

1. All CMP arterial monitoring intersections, including monitored freeway on/off-ramp intersections, where the proposed project will add 50 or more trips during either the a.m. or p.m. weekday peak hour (of adjacent street traffic); and
2. Mainline freeway-monitoring locations where the project will add 150 or more trips, in either direction, during either the a.m. or p.m. weekday peak hour.

Among the required steps for the analysis of development-related impacts to transit are:

3. Evidence that in addition to Metro, all affected Municipal transit operators received the NOP for the Draft EIR;
4. A summary of the existing transit services in the area;
5. Estimated project trip generation and mode assignment for both morning and evening peak periods;
6. Documentation on the assumptions/analyses used to determine the number and percentage of trips assigned to transit;
7. Information on facilities and/or programs that will be incorporated into the development plan that will encourage public transit usage and transportation demand management (TDM) policies and programs; and
8. An analysis of the expected project impacts on current and future transit services along with proposed project mitigation.

Metro looks forward to reviewing the Draft EIR. If you have any questions regarding this response, please call me at 213-922-6908 or by email at chapmans@metro.net. Please send the Draft EIR to the following address:

Metro CEQA Review Coordination
One Gateway Plaza MS 99-23-2
Los Angeles, CA 90012-2952
Attn: Susan Chapman

Sincerely,

Susan Chapman
Program Manager, Long Range Planning

Michael A. Naoum
27301 Eaglehelm Drive
Santa Clarita, CA 91387
661-252-9275
310-267-4821

August 4, 2008

Mr. Jason Smisko
Sr. Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, California 91355

Dear Mr. Smisko:

Since adequate community input time was not offered at the One Valley One Vision meeting on July 15, 2008, attached are my comments regarding the draft Land Use Element plan as well as comments on the Housing Element meeting. Kindly forward a copy of this letter to the Planning Commission.

One Valley One Vision – Land Use Element. Overall, I feel the Land Use Element fails to adequately take into account the existing suburban quality of the City, geographic distances between jobs and housing, the lack of existing density and a constrained road network including I5 and SR14 when trying to become an "urban center" with public transit oriented transportation. It offers developers plenty of flexibility but does not provide to the community the best, most rigorous, highest value planning tool. I'd suggest that the City develop more of a best practices approach rather than just using State minimums as our standards. We should be looking at communities like Westlake Village for standards – not the San Fernando Valley.

- While you indicated the General Plan should be general in nature, there are sometimes specific unapproved items mentioned in the plan that are troubling and should be removed. For example:
    - Part 1D indicates that the existing Canyon Country Metrolink station is planned to be relocated. This should be deleted since it is showing specificity in what should be a general plan.

- Part 1E identifies areas such as Val Verde and Halsey Canyon developed as low-density rural areas based on their residents' desire for retreat from high-intensity urban centers. Special use areas Sand and Placerita Canyon should be added to that list.

- The land use element shows a desire to preserve open space but would appear to allow dense "villages" in areas deemed to be floodplains, Significant Ecological Areas, desirable open areas and wildlife corridors.

  This is inconsistent with Guiding Principal 6b in the One Valley One Vision document dated 11/9/01 which states "a. Uses and improvements (within the Santa Clara River corridor and its major tributaries" shall be limited to those that benefit the community's use of the river in its natural state." And "b. Development on properties adjacent to, but outside the defined primary river corridor shall be: - located and designed to protect the river's water quality, plants, and animal habitats, controlling the density of uses, drainage runoff (water treatment) and other relevant elements".

  Furthermore, objective LU 1.2 states that the City will "maintain the distinctive community character of villages and neighborhoods throughout the planning area by establishing densities and design guidelines appropriate to the particular needs and goals of each area...." policy LU 1.2.5 states that "In Sand Canyon, ensure compatibility of development with existing rural, equestrian lots and the adjacent National Forest land; provide additional recreational trail links; and protect the Santa Clara River from incompatible development." This is contrary to the City's statement in the Land use element that the Canyon Country Metrolink station will be relocated to a high density village proposed in the Santa Clara riverbed just below Sand Canyon.

- While village concepts are promoted, the concept is new and there is no evidence that villages, especially large scale ones, far away from the bulk of the jobs in the City and tied principally to Metrolink for transportation will work to relieve congestion. If I am looking to live in a high density community served by public transit, why would I want to sit on a train for an hour just to live in Santa Clarita? If I want high density, I'll live in a truly urban area and minimize my commute time and dollars. Additionally, unless one works in downtown Los Angeles, or near the train stations in Glendale or Burbank, Metrolink is not a very efficient form of transportation.

- Having high density, low and moderate income housing, far from the major job centers employing these residents (Valencia Industrial Center and Magic Mountain) doesn't seem rational – especially when considering that a bus trip from Canyon Country to the Valencia Industrial Center takes between 60 and 90 minutes (when leaving from the closest Soledad stop that would be near the proposed new Canyon Country Metrolink location envisioned for a high density urban village development).

- Village concepts are supported by the City because of reduced land use and potentially traffic impacts if adjacent to functional public transit. Why is it that the County is allowing villages without being linked to public transit?

- The City is allowing greater density without a corresponding requirement for an increase in open or public spaces or any offsetting benefit for the public at large. Infill and villages with higher densities are promoted as a way to reduce land use (in theory to allow for more open space). Under the proposed plan, there is no offset required by the developers receiving these density bonuses to provide a funding mechanism to set aside those opens spaces the City is selling as so important to preserve and touting as a carrot arising from promoting higher density villages and infill projects. Creating these offsets and funding mechanisms is much like allowing the transfer of air rights among parcels in downtown areas where a higher building is allowed on one parcel based on the development rights purchased from another parcel – thus creating an open or public space.

- My vision of an urban center is an area with high quality, close (meaning walkable-within 1/4th mile) public transportation, with high density residential areas, incorporating jobs, amenities, retail and entertainment so that the use of cars is unattractive. I'm pessimistic that can be accomplished here.

- The transportation infrastructure needed for true urban centers in Santa Clarita will never be economic because of the lack of density and sprawling geography. We don't have the necessary density and can't get it without essentially starting the City over with density throughout the Santa Clarita valley. Santa Clarita is not Downtown Los Angeles or the Wilshire Corridor and we shouldn't be viewing developments in the same way they can. While the City has made great strides with providing Public Transportation to work and a few entertainment destinations, Public Transportation does not work for most folks in our lower density car oriented community.

- There appears to be an unwillingness to require project improvements that could add costs for development interests. The City should be looking at a number of avenues to improve the quality of life for all residents and stakeholders, not just be concerned with keeping costs at a minimum for developers and businesses. Some examples contained in the Land Use Element include:

    - Policy LU 6.1.2 designates the Santa Clara River corridor along with its major tributaries as Open Space and restricts development within 50 feet of the stream banks. THIS IS THE STATE MINIMUM! Between allowing bank stabilization and this minimal setback, the City is being disingenuous when it says it will "maintain the natural beauty of the City's rivers and streams. All too often the bike and walking trails are closed for long periods of time because CLWA is installing a new water line in the same, limited space. We should increase this setback to 250 feet to reduce the amount of bank stabilization and fill required and to allow for uses other than a walking and biking path along river

and stream areas. Open space doesn't need to be limited to just what the City buys.

- The City could be requiring employers of a certain size (say 100 employees) to provide showers for employees using bicycles. Instead, policy LU 5.1.3 has little to no teeth. It says the City will "require safe secure, clearly illuminated walkways and bicycle facilities in all commercial and business centers." A bicycle facility could be viewed as a post a bike could be locked to. Other cities require these facilities. Why can't we?

- The City could be requiring buildings to meet LEED requirements under LU 7.1.3 rather than just "encourage development of energy-efficient buildings". The State just revised energy efficiency codes. There is no reason why the City can't be more of a leader on this than a follower!

To summarize my input on the Land Use Element, I'd like to see the Element better blend with the currently developed areas of the City (since it is mostly built out), require more than minimums for code and setback requirements, and better preserve and be clearer over what the real plan is when there are conflicts between land use, open space, environmental, transportation, safety and infrastructure goals. This will avoid some of the double talk that exists in the current document.

In terms of the **Housing Element**, I'd like to see inclusionary requirements for low and moderate income housing – especially if the area's these developments may go must be designated in the land use plan as having 30 units per acre zoning. While the City has provided this density allowance in the past, developers have not done their part to include this element, instead choosing the market rate pricing approach.

It is clear we can't depend on developers' benevolence to accomplish this State mandated requirement. We must require developers to set aside units to meet this low income requirement especially since the density has been increased providing them an opportunity to build more units with lower per unit land costs. Additionally, since the lower income housing is needed primarily to support workers in the Valencia Industrial Center, the higher density housing should be in close proximity to those jobs. This will reduce the demand on our transportation infrastructure. Other areas of the community could be considered for Senior Housing since Seniors burden on the transportation infrastructure occurs during non-peak hours.

If you have questions or want clarification, please feel free to call.

Respectfully,

Michael Naoum

cc: Commissioner Burkhart
Commissioner Berger
Commissioner Ostrom
Commissioner Trautman
Commissioner Kennedy
Planning Manager Webber

Jeff Hogan

From: Jason Smisko
Sent: Monday, August 11, 2008 11:22 AM
To: Jeff Hogan; 'Judith Charles'; 'stebo@impactsciences.com'; 'Glaser, Mitch'
Subject: FW: OVOV EIR Scoping Meeting

Comment for the records.

From: CHARLES O'CONNELL [mailto:chuckoconnell@prodigy.net]
Sent: Friday, August 08, 2008 9:27 PM
To: Jason Smisko
Subject: OVOV EIR Scoping Meeting

Hi Jason- Good scoping meeting on Monday night. My input is as follows: The One Valley One Vision EIR should address the following- 1) adequacy of highway-freeway facilities to handle future demand as the population almost doubles; alternate routes should be available should the 5/14 freeway be devastated by another quake and just to handle future demand . At the very least , we need an extension of Reseda Blvd [or similar highway] over the hills to the SFV and possibly the tunnel extending San Fernando Road through to Roxford in Sylmar. 2) The adequacy of hospital facilities to meet the needs of increased population is a MUST. The expansion of HMNMH as presently proposed is INADEQUATE to meet future needs. CJO'Connell, PE, 25018 Smokewood Way, Stevenson Ranch, CA 91381 .

U.S. Department of Homeland Security
FEMA Region IX
1111 Broadway, Suite 1200
Oakland, CA. 94607-4052

FEMA

August 18, 2008

RECEIVED
PLANNING DIVISION
AUG 22 2008
CITY OF SANTA CLARITA

Jeff Hogan, AICP, Senior Planner
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, California 91335

Dear Mr. Hogan:

This is in response to your request for comments on the Notice of Preparation of Draft Environmental Impact Report for One Valley, One Vision General Plan Environmental Impact Report.

Please review the current effective Flood Insurance Rate Maps (FIRMs) for the City of Santa Clarita (Community 060729), Map revised September 29, 1989. Please note that the City of Santa Clarita, Los Angeles County, California is a participant in the National Flood Insurance Program (NFIP). The minimum, basic NFIP floodplain management building requirements are described in Vol. 44 Code of Federal Regulations (44 CFR), Sections 59 through 65.

A summary of these NFIP floodplain management building requirements are as follows:

- All buildings constructed within a riverine floodplain, (i.e., Flood Zones A, AO, AH, AE, and A1 through A30 as delineated on the FIRM), must be elevated so that the lowest floor is at or above the Base Flood Elevation level in accordance with the effective Flood Insurance Rate Map.

- If the area of construction is located within a Regulatory Floodway as delineated on the FIRM, any ***development*** must not increase base flood elevation levels. **The term *development* means any man-made change to improved or unimproved real estate, including but not limited to buildings, other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials.** A hydrologic and hydraulic analysis must be performed *prior* to the start of development, and must demonstrate that the development would not cause any rise in base flood levels. No rise is permitted within regulatory floodways.

- All buildings constructed within a coastal high hazard area, (any of the "V" Flood Zones as delineated on the FIRM), must be elevated on pilings and columns, so that the lowest horizontal structural member, (excluding the pilings and columns), is elevated to or above the base flood elevation level. In addition, the posts and pilings foundation and the structure attached thereto, is anchored to resist flotation, collapse and lateral movement due to the effects of wind and water loads acting simultaneously on all building components.

- Upon completion of any development that changes existing Special Flood Hazard Areas, the NFIP directs all participating communities to submit the appropriate hydrologic and hydraulic data to FEMA for a FIRM revision. In accordance with 44 CFR, Section 65.3, as soon as practicable, but not later than six months after such data becomes available, a community shall notify FEMA of the changes by submitting technical data for a flood map revision. To obtain copies of FEMA's Flood Map Revision Application Packages, please refer to the FEMA website at http://www.fema.gov/business/nfip/forms.shtm.

Please Note:

Many NFIP participating communities have adopted floodplain management building requirements which are more restrictive than the minimum federal standards described in 44 CFR. Please contact the local community's floodplain manager for more information on local floodplain management building requirements. The City of Santa Clarita floodplain manager can be reached by calling Christina Monde, Floodplain Coordinator, at (661) 255-4959.

If you have any questions or concerns, please do not hesitate to call Cynthia McKenzie of the Mitigation staff at (510) 627-7190.

Sincerely,

Gregor Blackburn, CFM, Branch Chief
Floodplain Management and Insurance Branch

cc:
Christina Monde, Floodplain Coordinator, Department of Public Works, City of Santa Clarita
Rick Sun, P. E., Los Angeles County, Department of Public Works, Watershed Management Division
Garret Tam Sing/Salomon Miranda, State of California, Department of Water Resources, Southern District
Cynthia McKenzie, Floodplanner, CFM, DHS/FEMA Region IX
Alessandro Amaglio, Environmental Officer, DHS/FEMA Region IX

DEPARTMENT OF CONSERVATION

DIVISION OF LAND RESOURCE PROTECTION

801 K STREET • MS 18-01 • SACRAMENTO, CALIFORNIA 95814

PHONE 916 / 324-0850 • **FAX** 916 / 327-3430 • **TDD** 916 / 324-2555 • **WEBSITE** conservation.ca.gov

August 28, 2008

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PLANNING DIVISION
SEP 04 2008
CITY OF SANTA CLARITA

Mr. Jeff Hogan, Senior Planner
City of Santa Clarita
23920 Valencia Boulevard, Suite 302
Santa Clarita, CA 91355

Dear Mr. Hogan:

Subject: Notice of Preparation Environmental Impact Report - One Valley, One Vision General Plan SCH #2008071133

The Department of Conservation's (Department) Division of Land Resource Protection (Division) has reviewed the Notice for the referenced project. The Division monitors farmland conversion on a statewide basis and administers the California Land Conservation (Williamson) Act and other agricultural land conservation programs. We offer the following comments and recommendations with respect to the project's impacts on agricultural land and resources.

The project involves the Santa Clarita Valley Planning Area, which encompasses the City of Santa Clarita and the communities of Canyon Country, Newhall, Saugus, Valencia, Stevenson Ranch, Castaic, Val Verde, Agua Dulce and the future Newhall Ranch in Los Angeles County. The joint effort between the City, County and residents is to guide future growth in the Valley and preserve natural resources.

Agricultural Setting of the Project

The Draft Environmental Impact Report (DEIR) should describe the project setting in terms of the actual and potential agricultural productivity of the land. The Division's Important Farmland Map for the County should be utilized to identify land within the project site and surrounding land that may be impacted. In addition, we recommend including the following items of information to characterize the agricultural land resource setting of the project.

- Describe current and past agricultural use of the project area. Include data on the types of crops grown, crop yields and farm gate sales values.
- Describe the full agricultural resource value of the soils of the site. We recommend the use of economic multipliers to assess the total contribution of the site's potential or actual agricultural production to the local, regional and state economies. University of California Cooperative Extension Service, Natural Resources Conservation Service and the United States Department of Agriculture (USDA) are good sources of economic multipliers.

Other forms of mitigation may be appropriate, including directing a mitigation fee to invest in supporting the commercial viability of the remaining agricultural land in the project area, County or region through a mitigation bank that invests in agricultural infrastructure, water supplies, marketing, etc.

Information about agricultural conservation easements is available on the Department's website or by contacting the Division at the address and phone number listed below. The Department's website address is:

http://www.conservation.ca.gov/dlrp/index.htm

Thank you for the opportunity to comment on the DEIR. If you have questions on our comments, or require technical assistance or information on agricultural land conservation, please contact the Division at 801 K Street, MS 18-01, Sacramento, California 95814; or, phone (916) 324-0850.

Sincerely,

Brian Leahy
Assistant Director

State of California - The Resources Agency ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
South Coast Region
4949 Viewridge Avenue
San Diego, CA 92123
(858) 467-4201

RECEIVED
PLANNING DIVISION
SEP 04 2008
CITY OF SANTA CLARITA

August 28, 2008

Mr. Jeff Hogan
City of Santa Clarita
23920 Valencia Blvd, Suite 302
Santa Clarita, California 91355

Subject: **Notice of Preparation of Draft Environmental Impact Report for the One Valley, One Vision General Plan EIR, Los Angeles County**

Dear Mr. Hogan:

The Department of Fish and Game (Department) has reviewed the above-referenced Notice of Preparation (NOP) of a Draft Environmental Impact Report (DEIR) for the One Valley, One Vision General Plan relative to impacts to biological resources. The Department understands the result of the project will be a comprehensive update of its Area Plan document and EIR for the buildout of the entire Santa Clarita Valley Planning Area. The Planning Area includes the City of Santa Clarita and its four communities Canyon Country, Newhall, Saugus, and Valencia and the County communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce, and the future Newhall Ranch. The Department supports the goal of the County and City working together to develop one seamless plan in order to address current and future needs for the public and for the conservation of the valuable natural resources within the planning area. The Department also understands that the work effort will require the adoption of two separate documents. The City will adopt a new General Plan and EIR, while the County will adopt a new Area Wide Plan to replace the Santa Clarita Valley Area Wide Plan and prepare its own EIR.

The California Wildlife Action Plan, a recent Department guidance document, identified the following stressors affecting wildlife and habitats within the project area: 1) growth and development; 2) water management conflicts and degradation of aquatic ecosystems; 3) invasive species; 4) altered fire regimes; and 5) recreational pressures. The Department looks forward to working with the City of Santa Clarita to minimize impacts to fish and wildlife resources with a focus on these stressors.

The following statements and comments have been prepared pursuant to the Department's authority as Trustee Agency with jurisdiction over natural resources affected by the project (CEQA Section 15386) and pursuant to our authority as a Responsible Agency under the California Environmental Quality Act (CEQA), Section 15381 over those aspects of the proposed project that come under the purview of Fish and Game Code Section 1600 et seq. regarding impacts to streams and lakes.

The Department's general concerns regarding potential impacts to biological resources from project implementation are direct and indirect impacts to the Santa Clara River watershed and the associated vegetation communities and wildlife. Special attention should be given to the South Coast Missing Linkages Project, specifically the San Gabriel Mountains to Castaic Range is critical for preserving ecosystem processes in the South Coast Ecoregion. This and other

linkages are absolutely critical in establishing a protected area network for the South Coast Ecoregion.

The linkage is extremely diverse, supporting 20 distinct natural communities. Habitat types in the linkage include Coastal sage scrub, chaparral, coast live oak woodlands in canyons, and high quality riparian scrub and woodlands at lower elevations. In the eastern portion of the linkage there is a shift to a xeric landscape characterized by desert scrub, with scattered juniper and Joshua tree woodlands. Among the sensitive natural communities that occur are alluvial fan sage scrub, southern cottonwood willow riparian forest, southern riparian scrub, southern sycamore alder riparian, freshwater marsh, coast live oak riparian forest, vernal pool, mainland holly-leaved cherry woodland, valley needlegrass grassland, and coastal sage scrub. These habitats are among the rarest and most sensitive ecosystem types in the United States. Conservation of parcels within the linkage will contribute to the preservation of these communities. The Department recommends that the areas within the linkage be considered as high priority open space within this planning document for the City and County.

While each of the vegetation communities is important in their own right, it is also important that the natural hydrology of the linkage remain intact. The Santa Clara River is a prominent feature, draining 3,108 km^2 (1,200 mi^2) of the San Gabriel, Castaic, Santa Susana, and Sierra Madre mountains and cutting transversely through the linkage along Soledad Canyon. As one of the last free flowing natural riparian systems left in southern California, the Santa Clara River supports a diversity of aquatic, semi-aquatic, and terrestrial organisms. The essential habitats in the upper watershed and headwater streams in the planning area are largely intact, providing breeding sites, traveling routes, and other resources for wildlife; natural flood control; recharge of groundwater basins; nutrient cycling; and helping to sustain the river to its estuary in Ventura County. Many species that depend on low-elevation habitats are now federally and or state-listed as endangered, threatened, or sensitive.

Riparian zones and associated buffers rank highly and many of the tributary drainages are in an undisturbed state. However, some parcels within the flood plain of the Santa Clara River have been impacted by development and would therefore benefit from conservation and restoration. This restoration would have an added benefit of expanding habitat for several special status species, including the unarmored threespined stickleback (*Gasterosteus aculeatus williamsoni*), a federal and state endangered species and state Fully Protected species. Two other native fish are also present in the planning area, the federally threatened and state species of special concern Santa Ana sucker (*Catostomus santaanae*) and the state species of special concern arroyo chub (*Gila orcutti*) also occur here.

The Department recognizes the opportunities for better communication and planning between the City, the County, and your constituents as a result of this project. However, the Department wants to ensure that resource conservation remains a high priority and the redrafting of the General Plan and the Area Specific Plan doesn't reduce priority open space opportunity within the planning area while trying to accommodate the proposed development needs and meet the needs of the many special interest groups.

To enable Department staff to adequately review and comment on the proposed project we recommend the following information, where applicable, be included in the Draft Environmental Impact Report:

1. A complete, recent assessment of flora and fauna within and adjacent to the project area, with particular emphasis upon identifying endangered, threatened, and locally unique species and sensitive habitats (Attachment 1).

a. A thorough recent assessment of rare plants and rare natural communities, following the Department's Guidelines for Assessing Impacts to Rare Plants and Rare Natural Communities.

b. A complete, recent assessment of sensitive fish, wildlife, reptile, and amphibian species. Seasonal variations in use of the project area should also be addressed. Recent, focused, species-specific surveys, conducted at the appropriate time of year and time of day when the sensitive species are active or otherwise identifiable, are required. Acceptable species-specific survey procedures should be developed in consultation with the Department and U.S. Fish and Wildlife Service.

c. Rare, threatened, and endangered species to be addressed should include all those which meet the California Environmental Quality Act (CEQA) definition (see CEQA Guidelines, Section 15380).

d. The Department's Biogeographic Data Branch in Sacramento should be contacted at (916) 322-2493 (www.dfg.ca.gov/biogeodata) to obtain current information on any previously reported sensitive species and habitats, including Significant Natural Areas identified under Chapter 12 of the Fish and Game Code. Also, any Significant Ecological Areas SEAs) or Environmentally Sensitive Habitats (ESHs) or any areas that are considered sensitive by the local jurisdiction that are located in or adjacent to the project area must be addressed.

2. A thorough discussion of direct, indirect, and cumulative impacts expected to adversely affect biological resources, with specific measures to offset such impacts. This discussion should focus on maximizing avoidance, and minimizing impacts.

a. CEQA Guidelines, Section 15125(a), direct that knowledge of the regional setting is critical to an assessment of environmental impacts and that special emphasis should be placed on resources that are rare or unique to the region.

b. Project impacts should also be analyzed relative to their effects on off-site habitats and populations. Specifically, this should include nearby public lands, open space, adjacent natural habitats, and riparian ecosystems. Impacts to and maintenance of wildlife corridor/movement areas, including access to undisturbed habitat in adjacent areas are of concern to the Department and should be fully evaluated and provided. The analysis should also include a discussion of the potential for impacts resulting from such effects as increased vehicle traffic, outdoor artificial lighting, noise and vibration.

c. A cumulative effects analysis should be developed as described under CEQA Guidelines, Section 15130. General and specific plans, as well as past, present, and anticipated future projects, should be analyzed relative to their impacts on similar plant communities and wildlife habitats.

d. Impacts to migratory wildlife affected by the project should be fully evaluated including proposals to remove/disturb native and ornamental landscaping and other nesting habitat for native birds. Impact evaluation may also include such elements as migratory butterfly roost sites and neo-tropical bird and waterfowl stop-over and staging sites. All migratory nongame native bird species are protected by international treaty under the Federal Migratory Bird Treaty Act (MBTA) of 1918 (50 C.F.R. Section 10.13). Sections 3503, 3503.5 and 3513 of the California Fish and Game Code prohibit take of birds and

their active nests, including raptors and other migratory nongame birds as listed under the MBTA.

e. Impacts to all habitats from City or County required Fuel Modification Zones (FMZ). Areas slated as mitigation for loss of habitat shall not occur within the FMZ.

f. Proposed project activities (including disturbances to vegetation) should take place outside of the breeding bird season (February 1- September 1) to avoid take (including disturbances which would cause abandonment of active nests containing eggs and/or young). If project activities cannot avoid the breeding bird season, nest surveys should be conducted and active nests should be avoided and provided with a minimum buffer as determined by a biological monitor (the Department recommends a minimum 500-foot buffer for all active raptor nests).

3. A range of alternatives should be analyzed to ensure that alternatives to the proposed project are fully considered and evaluated. A range of alternatives which avoid or otherwise minimize impacts to sensitive biological resources including wetlands/riparian habitats, alluvial scrub, coastal sage scrub, should be included. Specific alternative locations should also be evaluated in areas with lower resource sensitivity where appropriate.

a. Mitigation measures for project impacts to sensitive plants, animals, and habitats should emphasize evaluation and selection of alternatives which avoid or otherwise minimize project impacts. Compensation for unavoidable impacts through acquisition and protection of high quality habitat elsewhere should be addressed with off-site mitigation locations clearly identified.

b. The Department considers Rare Natural Communities as threatened habitats having both regional and local significance. Thus, these communities should be fully avoided and otherwise protected from project-related impacts (Attachment 2).

c. The Department generally does not support the use of relocation, salvage, and/or transplantation as mitigation for impacts to rare, threatened, or endangered species. Department studies have shown that these efforts are experimental in nature and largely unsuccessful.

4. A California Endangered Species Act (CESA) Permit must be obtained if the project has the potential to result in "take" of species of plants or animals listed under CESA, either during construction or over the life of the project. CESA Permits are issued to conserve, protect, enhance, and restore State-listed threatened or endangered species and their habitats. Early consultation is encouraged, as significant modification to the proposed project and mitigation measures may be required in order to obtain a CESA Permit. Revisions to the Fish and Game Code, effective January 1998, require that the Department issue a separate CEQA document for the issuance of a CESA permit unless the project CEQA document addresses all project impacts to listed species and specifies a mitigation monitoring and reporting program that will meet the requirements of a CESA permit. For these reasons, the following information is requested:

a. Biological mitigation monitoring and reporting proposals should be of sufficient detail and resolution to satisfy the requirements for a CESA Permit.

b. A Department-approved Mitigation Agreement and Mitigation Plan are required for plants listed as rare under the Native Plant Protection Act.

5. The Department opposes the elimination of watercourses (including concrete channels) and/or the canalization of natural and manmade drainages or conversion to subsurface drains. All wetlands and watercourses, whether intermittent, ephemeral, or perennial, must be retained and provided with substantial setbacks which preserve the riparian and aquatic habitat values and maintain their value to on-site and off-site wildlife populations. The Department recommends a minimum natural buffer of 100 feet from the outside edge of the riparian zone on each side of drainage.

   a. The Department requires a Streambed Alteration Agreement (SAA), pursuant to Section 1600 et seq. of the Fish and Game Code, with the applicant prior to any direct or indirect impact to a lake or stream bed, bank or channel or associated riparian resources. The Department's issuance of a SAA may be a project that is subject to CEQA. To facilitate our issuance of the Agreement when CEQA applies, the Department as a responsible agency under CEQA may consider the local jurisdiction's (Lead Agency) document for the project. To minimize additional requirements by the Department under CEQA the document should fully identify the potential impacts to the lake, stream or riparian resources and provide adequate avoidance, mitigation, monitoring and reporting commitments for issuance of the Agreement. Early consultation is recommended, since modification of the proposed project may be required to avoid or reduce impacts to fish and wildlife resources.

Thank you for this opportunity to provide comment. Please contact Mr. Dan Blankenship, Staff Environmental Scientist, at (661) 259-3750 if you should have any questions and for further coordination on the proposed project.

Sincerely,

Edmund J. Pert
Regional Manager
South Coast Region

cc: Helen Birss
Dan Blankenship
Betty Courtney
Scott Harris
Chron file
State Clearinghouse

Guidelines for Assessing the Effects of Proposed Projects on Rare, Threatened, and Endangered Plants and Natural Communities

State of California
THE RESOURCES AGENCY
Department of Fish and Game
December 9, 1983
Revised May 8, 2000

The following recommendations are intended to help those who prepare and review environmental documents determine **when** a botanical survey is needed, **who** should be considered qualified to conduct such surveys, **how** field surveys should be conducted, and **what** information should be contained in the survey report. The Department may recommend that lead agencies not accept the results of surveys that are not conducted according to these guidelines.

1. Botanical surveys are conducted in order to determine the environmental effects of proposed projects on all rare, threatened, and endangered plants and plant communities. Rare, threatened, and endangered plants are not necessarily limited to those species which have been "listed" by state and federal agencies but should include any species that, based on all available data, can be shown to be rare, threatened, and/or endangered under the following definitions:

A species, subspecies, or variety of plant is "endangered" when the prospects of its survival and reproduction are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, over-exploitation, predation, competition, or disease. A plant is "threatened" when it is likely to become endangered in the foreseeable future in the absence of protection measures. A plant is "rare" when, although not presently threatened with extinction, the species, subspecies, or variety is found in such small numbers throughout its range that it may be endangered if its environment worsens.

Rare natural communities are those communities that are of highly limited distribution. These communities may or may not contain rare, threatened, or endangered species. The most current version of the California Natural Diversity Database's List of California Terrestrial Natural Communities may be used as a guide to the names and status of communities.

2. It is appropriate to conduct a botanical field survey to determine if, or to the extent that, rare, threatened, or endangered plants will be affected by a proposed project when:

a. Natural vegetation occurs on the site, it is unknown if rare, threatened, or endangered plants or habitats occur on the site, and the project has the potential for direct or indirect effects on vegetation; or
b. Rare plants have historically been identified on the project site, but adequate information for impact assessment is lacking.

3. Botanical consultants should possess the following qualifications:

a. Experience conducting floristic field surveys;
b. Knowledge of plant taxonomy and plant community ecology;
c. Familiarity with the plants of the area, including rare, threatened, and endangered species;
d. Familiarity with the appropriate state and federal statutes related to plants and plant collecting; and,
e. Experience with analyzing impacts of development on native plant species and communities.

4. Field surveys should be conducted in a manner that will locate any rare, threatened, or endangered species that may be present. Specifically, rare, threatened, or endangered plant surveys should be:

a. Conducted in the field at the proper time of year when rare, threatened, or endangered species are both evident and identifiable. Usually, this is when the plants are flowering.

When rare, threatened, or endangered plants are known to occur in the type(s) of habitat present in the project

area, nearby accessible occurrences of the plants (reference sites) should be observed to determine that the species are identifiable at the time of the survey.

b. Floristic in nature. A floristic survey requires that every plant observed be identified to the extent necessary to determine its rarity and listing status. In addition, a sufficient number of visits spaced throughout the growing season are necessary to accurately determine what plants exist on the site. In order to properly characterize the site and document the completeness of the survey, a complete list of plants observed on the site should be included in every botanical survey report.

c. Conducted in a manner that is consistent with conservation ethics. Collections (voucher specimens) of rare, threatened, or endangered species, or suspected rare, threatened, or endangered species should be made only when such actions would not jeopardize the continued existence of the population and in accordance with applicable state and federal permit requirements. A collecting permit from the Habitat Conservation Planning Branch of DFG is required for collection of state-listed plant species. Voucher specimens should be deposited at recognized public herbaria for future reference. Photography should be used to document plant identification and habitat whenever possible, but especially when the population cannot withstand collection of voucher specimens.

d. Conducted using systematic field techniques in all habitats of the site to ensure a thorough coverage of potential impact areas.

e. Well documented. When a rare, threatened, or endangered plant (or rare plant community) is located, a California Native Species (or Community) Field Survey Form or equivalent written form, accompanied by a copy of the appropriate portion of a 7.5 minute topographic map with the occurrence mapped, should be completed and submitted to the Natural Diversity Database. Locations may be best documented using global positioning systems (GPS) and presented in map and digital forms as these tools become more accessible.

5. Reports of botanical field surveys should be included in or with environmental assessments, negative declarations and mitigated negative declarations, Timber Harvesting Plans (THPs), EIR's, and EIS's, and should contain the following information:

a. Project description, including a detailed map of the project location and study area.
b. A written description of biological setting referencing the community nomenclature used and a vegetation map.
c. Detailed description of survey methodology.
d. Dates of field surveys and total person-hours spent on field surveys.
e. Results of field survey including detailed maps and specific location data for each plant population found. Investigators are encouraged to provide GPS data and maps documenting population boundaries.
f. An assessment of potential impacts. This should include a map showing the distribution of plants in relation to proposed activities.
g. Discussion of the significance of rare, threatened, or endangered plant populations in the project area considering nearby populations and total species distribution.
h. Recommended measures to avoid impacts.
i. A list of all plants observed on the project area. Plants should be identified to the taxonomic level necessary to determine whether or not they are rare, threatened or endangered.
j. Description of reference site(s) visited and phenological development of rare, threatened, or endangered plant(s).
k. Copies of all California Native Species Field Survey Forms or Natural Community Field Survey Forms.
l. Name of field investigator(s).
m. References cited, persons contacted, herbaria visited, and the location of voucher specimens.

Sensitivity of Top Priority Rare Natural Communities in Southern California

Sensitivity rankings are determined by the Department of Fish and Game, California Natural Diversity Data Base and based on either number of known occurrences (locations) and/or amount of habitat remaining (acreage). The three rankings used for these top priority rare natural communities are as follows:

S1.# Fewer than 6 known locations and/or on fewer than 2,000 acres of habitat remaining.

S2.# Occurs in 6-20 known locations and/or 2,000-10,000 acres of habitat remaining.

S3.# Occurs in 21-100-known locations and/or 10,000-50,000 acres of habitat remaining.

The number to the right of the decimal point after the ranking refers to the degree of threat posed to that natural community regardless of the ranking. For example:

S1.1 = very threatened
S2.2 = threatened
S3.3 = no current threats known

Sensitivity Rankings (February 1992)

Rank	Community Name
S1.1	Mojave Riparian Forest
	Sonoran Cottonwood Willow Riparian
	Mesquite Bosque
	Elephant Tree Woodland
	Crucifixion Thorn Woodland
	Allthorn Woodland
	Arizonan Woodland
	Southern California Walnut Forest
	Mainland Cherry Forest
	Southern Bishop Pine Forest
	Torrey Pine Forest
	Desert Mountain White Fir Forest
	Southern Dune Scrub
	Southern Coastal Bluff Scrub
	Maritime Succulent Scrub
	Riversidean Alluvial Fan Sage Scrub
	Southern Maritime Chaparral
	Valley Needlegrass Grassland
	Great Basin Grassland
	Mojave Desert Grassland
	Pebble Plains
	Southern Sedge Bog
	Cismontane Alkali Marsh

S1.2	Southern Foredunes
	Mono Pumice Flat
	Southern Interior Basalt Flow Vernal Pool
S2.1	Venturan Coastal Sage Scrub
	Diegan Coastal Sage Scrub
	Riversidean Upland Coastal Sage Scrub
	Riversidean Desert Sage Scrub
	Sagebrush Steppe
	Desert Sink Scrub
	Mafic Southern Mixed Chaparral
	San Diego Mesa Hardpan Vernal Pool
	San Diego Mesa Claypan Vernal Pool
	Alkali Meadow
	Southern Coastal Salt Marsh
	Coastal Brackish Marsh
	Transmontane Alkali Marsh
	Coastal and Valley Freshwater Marsh
	Southern Arroyo Willow Riparian Forest
	Southern Willow Scrub
	Modoc-Great Basin Cottonwood Willow Riparian
	Modoc-Great Basin Riparian Scrub
	Mojave Desert Wash Scrub
	Engelmann Oak Woodland
	Open Engelmann Oak Woodland
	Closed Engelmann Oak Woodland
	Island Oak Woodland
	California Walnut Woodland
	Island Ironwood Forest
	Island Cherry Forest
	Southern Interior Cypress Forest
	Bigcone Spruce-Canyon Oak Forest
S2.2	Active Coastal Dunes
	Active Desert Dunes
	Stabilized and Partially Stabilized Desert Dunes
	Stabilized and Partially Stabilized Desert Sandfield
	Mojave Mixed Steppe
	Transmontane Freshwater Marsh
	Coulter Pine Forest
	Southern California Fellfield
	White Mountains Fellfield
S2.3	Bristlecone Pine Forest
	Limber Pine Forest

SCOPE
Santa Clarita Organization for Planning and the Environment
TO PROMOTE, PROTECT AND PRESERVE THE ENVIRONMENT, ECOLOGY
AND QUALITY OF LIFE IN THE SANTA CLARITA VALLEY
POST OFFICE BOX 1182, SANTA CLARITA, CA 91386

8-29-08

Jeff Hogan
City of Santa Clarita
23920 Valencia Blvd.
Santa Clarita, CA 91355

Mitch Glaser
County of LA, Dept. of Regional Planning
320 W. Temple St.
Los Angeles, CA 90012

Re: Notice of Preparation for the DEIR to Update the Couty and City of Santa Clarita General Plan
Delivered via email. Hard copy to follow by regular mail.

Dear Mr. Hogan and Mr. Glaser:

Thank you for the opportunity to provide input into the future contents of this environmental report. We request in advance that the public be granted at least a 120-day review period for this important planning document so that everyone has adequate time to evaluate and discuss its contents.

General Plan Comments

One issue that many of our members have brought to our attention is a concern that the melding of the City and County Plans will produce weaker protections for the planning process and the environment. Currently the County of Los Angeles must adhere to a Development Monitoring System (General Plan Amendment SP 86-173). Since this System was put in place as a result of a Court ordered settlement agreement, we do not believe that the County may just arbitrarily ignore this amendment. Nor may they exclude it from any update.

In the past, SCOPE has requested many times that the City adopt a similar plan amendment in order to more effectively analyze the capacity of existing infrastructure to support new growth. The City has refused. That refusal has resulted in such absurdities as the G& L Office Expansion EIR not discussing the sufficiency of the sewer capacity to handle the proposed office expansion. After the Sanitation District brought this problem to the Council's attention in a comment letter, G&L responded with a requirement to merely do a "study" after the office expansion is approved. A Development Monitoring System would ensure that expensive infrastructure needs such as sewer systems are paid for by the developers or at least all provisions to provide such required infrastructure are properly funded so that the existing residents may continue to depend on their current level of service.

We therefore request that the City include the County of Los Angeles' Development Monitoring System into any combined plan as a mitigation requirement for the additional growth for which the plan will provide.

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The City also does not have adequate protection for Significant Ecological Areas. This LA County General Plan designation has strict planning regulations to which developers must adhere whenever development is proposed in a SEA, including the requirement of producing an EIR. The City merely has an overlay designation that has not provided any real protection for these areas and the open space habitat they were meant to conserve. Evidence of this is clearly visible in the City's approval of all the development in the floodplain of the Santa Clara River and the loss of the endangered species that currently existed in those areas. Any melding of the two general plans must include the County's SEA regulations.

It also appears that the County has a much stronger Oak Tree Protection Ordinance. We request that this stronger ordinance be adhered to in any melding of the two planning jurisdictions.

To summarize, where one planning jurisdiction's regulations include stronger protections for the resources and the existing community, those regulations should be the controlling ordinance for any melded plan.

NOP Comments

Climate Change
The DEIR must include a section on the effects to global warming from any increase in the number of housing units. Information for calculating these impacts is available from the Attorney General's Office, the California Air Resources Board and the Association of Pollution Control Officers. Feasible mitigation measures may also be obtained from these agencies and other groups.

A "Green" Building ordinance should be developed and required as mitigation for greenhouse gas production caused by additional proposed growth. This ordinance should include standards that will increase energy and water efficiency and encourage the use of alternative energy sources such as wind and solar energy.

Floodplains
The DEIR must address the cumulative impacts of the loss of floodplain on downstream land uses and habitat, including increased velocity and erosion produced by concrete banks and the impacts of such banking on water quality (increases to pH levels as identified by the Regional Water Quality Board). The Plan must update its floodplain designation maps to comply with current state and federal laws. The Maps that are most protective of our local streams and the Santa Clara River should be used for this update. Good flood plain protection will improve water quality and water supply as well as provide habitat for native wildlife.

Water Supply
The DEIR should contain a Water Element that discusses how water will be provided for any future proposed growth. This discussion should disclose impacts to the Sacramento Delta and any other proposed areas of origin for new water sources. It should also fully and accurately disclose all impediments to obtaining additional water from those sources including supply reductions from climate change, impacts to endangered species and water quality degradation both in the area of origin and locally. This section should disclose water supply during a dry, normal and wet year

so that planners and the public may easily be apprised of the worst case scenario for which they must plan.

This section should include information on the water quality of our existing water sources. Information on the alluvial aquifer should include a discussion of the Chloride problem and how additional growth will impact the sanitation districts' ability to comply with the new Chloride Total Maximum Daily Load (TMDL) regulation that will go into effect soon. It should include full disclosure of the industrial contamination currently affecting many of the high producing wells in the Saugus aquifer. This disclosure should not only address ammonium perchlorate pollution and its health risk to children, but also the many additional cancer causing Volatile Organic Compounds in this water source.

Additional state water to supply new growth will increase chloride levels in the effluent produced by the Sanitation Plants. This section should fully disclose the impacts on the Chloride TMDL of increased growth.

This section should indicate from where the water supply for increased growth will come.

A drought tolerant landscape ordinance should be developed and required as mitigation. Recycled water systems should be required for open space and landscaped areas in all new development. Water retention systems such as roof to underground cistern storage systems, downspout disconnection to storm drain and lot contouring to retain rainfall on site and encourage recharge of the local aquifers should also be required for any new development.

Air Quality
The DEIR should clearly disclose the poor air quality that already exists in this valley due to high ozone and particulate matter pollution, and its impacts on increased asthma rates, especially in children. Further reductions in air quality due to additional proposed growth must be disclosed and mitigated.

Health Hazards
Contaminated sites must be fully disclosed and designated as such in the General Plan for the health, safety and welfare of the public. Estimated clean up time for such areas must be included in the DEIR.

Education
Planning for school sites should not include locations next to or on contaminated sites and freeways. It is a well-established fact that air pollutants are extremely high in areas adjacent to freeways.

Piece-mealing the General Plan Updates
State law requires an update to a City or County General Plan every ten years. The update to the Santa Clarita Plan is five years overdue, yet the City and the County continue to approve projects based on this plan and where needed to ensure project approval, merely amends the offending section for the developer.

Also, over the past several years the City of Santa Clarita has updated individual elements of the General Plan. These updates included changes to the Air Quality, Noise, Housing, and Parks and Open Space Elements.

We believe both these practices should not be allowed, as they constitute piece-mealing that is not allowed under CEQA, and seem to be a means of intentionally avoiding the requirement to provide an EIR for a General Plan Update.

Thank you in advance for your attention to these comments. We request that you provide our group with a hard copy as well as a disc of the DEIR when it becomes available so that we can circulate it to our members that may or may not have computer capabilities.

Sincerely,

Lynne Plambeck
President

Calgrove Corridor Coalition

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August 28, 2008

Mr. Jeff Hogan, AICP
Senior Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, CA 91355

Re: ***Calgrove Corridor Coalition*** **Response - Notice of Preparation of Draft Environmental Impact Report for the Land Use Element of One Valley, One Vision (OVOV)**

Dear Mr. Hogan,

At the request of the City of Santa Clarita, the Calgrove Corridor Coalition (CCC) is providing comment on the Notice of Preparation (NOP) for the Land Use Element of the OVOV. However, we are doing so without having received information we requested from the City which would have precisely defined the differences between the current and proposed Land Use designations.

Because the changes in Land Use designations have not been disclosed, we believe that the process of review for this draft EIR is flawed, and that the information contained in this draft is incomplete and misleading.

Without full and complete disclosure of the definitional changes, the residents of our Valley are not equipped to comprehend the impacts of the new Land Use definitions when contemplating issues and preparing comments. ***The burden is upon the drafters of this plan to provide the necessary information so the public can make an informed decision about this very important issue.*** This has not been done, and the importance of this concern cannot be understated.

In consideration of the above, the following outlines the CCC's preliminary response to specific aspects of the Land Use Element. Please note that we believe our response is consistent with the vision for gateway projects as outlined in the City's current General Plan - that higher density developments are not consistent with gateway locations such as the Smiser Ranch property.

Aesthetics
The Smiser Ranch property is located at the I-5 entrance to the City Santa Clarita, and is the first view of our Valley traveling northward through the Newhall Pass. Concerns about aesthetics regarding this property are therefore highly important and due special consideration.

We wish to point out the language in the existing General Plan, that states we "*continue the established pattern of attractive greenbelts, golf courses, open space, including the protection of adjacent significant ecological areas and entertainment/recreational amenities along I-5 ... and to strengthen and enhance the image of the city as a pleasant and fun place to live, work, visit and play.*"

These elements of the existing General Plan must be preserved. The Specific Plan (SP) designation for the Smiser Ranch property does not come close to doing this - in fact, it eliminates all existing zoning limitations. The height and density concerns of the many residential neighborhoods which comprise the CCC membership is a critical consideration that has not been properly addressed by the SP designation.

Air Quality
In the past the South Coast Air Quality Management District (SCAQMD) has found that the Santa Clarita Valley is already out of compliance with their standards. With increased density, traffic, and circulation, there will be additional negative impacts on air quality. Construction activities will also create a negative impact.

1. Has the SCAQMD addressed their concerns about the air quality in our Valley?
2. Has this been addressed in the draft NOP?

The public has a right to review the SCAQMD comments to the draft EIR prior to commenting on this section.

Hydrology
The uncertainty about future availability of water within the Southern California area should also be viewed as a potential constraint to development. The SCV also relies on local ground water supplies for domestic, commercial and agricultural uses - preservation and conservation of these resources must be paramount in the minds of land use planners. Existing and proposed land uses and operations must consider the consequences of degradation to ground water or surface water that is used to replenish the ground water supplies.

Land Use and Planning
As stated in our earlier comments regarding aesthetics, the SP designation is inappropriate for the Smiser Ranch property because it is extremely vague and not in compliance with the guiding principles of OVOV. The guiding principles state that "multi-family housing development's building massing shall complement the characteristics of surrounding single-family residential neighborhoods" such as those that surround the Smiser property. The SP designation does not preserve such requirements.

Also, the guiding principles state "the Santa Clara River corridor and its major tributaries shall be preserved as open space to accommodate storm water flows and protect critical plant and animal species." We note that the South Fork of the Santa Clara River flows through the Smiser property. In fact, the applicability of SP to the Smiser property may be in question; once CalTrans completes its plans to expand I-5 and in the process require land within the Smiser property boundaries, the remaining parcel may be too small to meet the 30-acre SP minimum.

Population and Housing

We disagree with the OVOV vision for population growth in the Santa Clarita Valley. The stated numbers are simply too large and do not support the quality of life requirements of most who live here - note that high-density housing in our Valley currently represents highest areas of crime.

The City's original General Plan was created in collaboration with many citizens and neighborhood groups throughout the Valley. This process took nearly two years of hard work prior to finalizing the current vision of the City. In contrast, the current draft EIR was developed primarily by the City and County staff with only occasional meetings with developers and major civic groups. The City and County need to go back to the residents of our community to seek input about ***their*** vision of the future of the Santa Clarita Valley, including population and housing goals, which we believe are significantly different than proposed in the City's OVOV view.

Recreation

The City has an alarming and growing deficit with its General Plan objectives for the development of parks. Even with the currently planned increase of 210 acres of parks, the city will still fall significantly short of its current park objectives. We are now aware of a significant, last minute change to the objectives which results in a decrease in the city's park objectives by 40%, from 5 acres per 1000 residents to 3 acres per 1000 residents. This is unacceptable. Also, the City's Guiding Principles state that parkland will be developed "with priority on locations that are not now adequately served." This designation fits the areas adjacent to and surrounding the Smiser property. The City must address the existing parkland deficit, but not by reducing the current parkland objectives. The CCC requests that this issue be considered as plans for the Smiser Ranch property progress.

Transportation and Traffic

Traffic in the Newhall Pass, especially at Calgrove Boulevard, is already problematic and poses many challenges for the residents of the surrounding communities. An SP designation for the Smiser Ranch property would only increase congestion. We believe larger roads and freeways are not the answer. Also, the draft EIR does not address what happens when there are major incidents on the I-5, which occur with discouraging regularity. When an accident takes place on I-5 in the vicinity of the Newhall Pass, it seriously impacts all the communities in the Calgrove Corridor. For example, during the most recent truck tunnel accident, traffic was at a standstill on both The Old Road and Wiley Canyon. In a major disaster such as an earthquake or fire, we have significant concerns about the ability of the existing road infrastructure to handle traffic and/or evacuation.

Conclusion

The Calgrove Corridor Coalition does not support launching any section of the EIR until all sections of the Draft EIR have been completed, including zoning definitional changes, and presented to the residents of Santa Clarita. Not only have circulation and housing elements not been presented to the public, we strongly feel that our community's ability to provide comment should be left open at least sixty (60) days after the final the staff presentations.

Respectfully,

Annette Lucas Glenda Bona

Annette Lucas and Glenda Bona
Co-chairs
Calgrove Corridor Coalition

cc: Bob Kellar, Mayor
Ken Pulskamp, City Manager
Paul Brotzman, Director of Planning

COUNTY OF LOS ANGELES

FIRE DEPARTMENT

1320 NORTH EASTERN AVENUE
LOS ANGELES, CALIFORNIA 90063-3294

(323) 890-4330

P. MICHAEL FREEMAN
FIRE CHIEF
FORESTER & FIRE WARDEN

August 19, 2008

Jason Smisko, Senior Planner
City of Santa Clarita
23920 Valencia Boulevard, Suite 300
Santa Clarita, CA 91355

Dear Mr. Smisko:

NOTICE OF PREPARATION, NORTH NEWHALL SPECIFIC PLAN STAGE I: LYONS AVENUE AT-GRADE CROSSING, SANTA CLARITA (FFER #200800131)

The Notice of Preparation has been reviewed by the Planning Division, Land Development Unit, Forestry Division, and Health Hazardous Materials Division of the County of Los Angeles Fire Department. The following are their comments:

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PLANNING DIVISION:

1. We do not have comments at this time.

LAND DEVELOPMENT UNIT:

1. We do not have comments at this time.

FORESTRY DIVISION – OTHER ENVIRONMENTAL CONCERNS:

1. The statutory responsibilities of the County of Los Angeles Fire Department, Forestry Division include erosion control, watershed management, rare and endangered species, vegetation, fuel modification for Very High Fire Hazard Severity Zones or Fire Zone 4, archeological and cultural resources, and the County Oak Tree Ordinance. Potential impacts in these areas should be addressed in the Draft Environmental Impact Report.

HEALTH HAZARDOUS MATERIALS DIVISION:

1. There are no comments at this time.

If you have any additional questions, please contact this office at (323) 890-4330.

Very truly yours,

FRANK VIDALES, ACTING CHIEF, FORESTRY DIVISION
PREVENTION SERVICES BUREAU

FV:lj

County of Los Angeles Public Library
7400 East Imperial Hwy., P.O. Box 7011, Downey, CA 90241-7011
(562) 940-8461, TELEFAX (562) 803-3032

Library

MARGARET DONNELLAN TODD
COUNTY LIBRARIAN

August 25, 2008

RECEIVED
PLANNING DIVISION
AUG 29 2008
CITY OF SANTA CLARITA

Jeff Hogan, AICP
Senior Planner
City of Santa Clarita
23920 Valencia Blvd, Suite 302
Santa Clarita, CA 91355

Dear Mr. Hogan:

NOTICE OF PREPARATION OF DRAFT ENVIRONMENTAL IMPACT REPORT FOR THE ONE VALLEY, ONE VISION GENERAL PLAN

This is to provide you with written comments on the Notice of Preparation of Draft Environmental Impact Report (EIR) for the One Valley, One Vision (OVOV) General Plan for the entire Santa Clarita Valley Planning Area. As indicated in the document you provided, the Santa Clarita Valley Planning Area includes the four communities in the City of Santa Clarita – Canyon Country, Newhall, Saugus, and Valencia – and the County communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce, and the future Newhall Ranch.

Service Level Guidelines

The County Library's current service level guidelines are a minimum of 0.50 gross square foot of library facility space per capita, 2.75 items (books and other libraries materials) per capita, and 1.0 public access computer per 1,000 people served. Additional facility planning guidelines include 4 parking spaces per 1,000 gross square feet of building size, and a land-to-facility size ratio of 4:1.

Existing Facilities and Resources (books and other library materials)

The County Library operates all public libraries within the Santa Clarita Valley. There are four community libraries in the Santa Clarita Valley Planning Area: three permanent facilities, plus one mobile library, the Santa Clarita Valley Bookmobile.

Library	Facility Size (sq. ft)	Collection Size (items)
Canyon Country Jo Anne Darcy	12,864	100,082
Newhall	4,842	50,278
Valencia	23,966	215,024
Santa Clarita Valley Bookmobile		10,512
Total – Santa Clarita Valley	**41,672**	**375,896**

Based on a valley-wide population of 213,857 (2000 U.S. Census), the combined facility space and collection of books and library materials for these libraries do not currently meet the County Library's service level guidelines in providing library services to the existing residents of the Santa Clarita Valley. These libraries have a combined shortage of a minimum of 65,257 sq. ft. of facility space and 212,211 items (books and other library materials).

Population growth would create additional demand for library services and would adversely affect the service capacity of the County libraries within the Santa Clarita Valley to adequately serve the existing residents in these service areas. In addition, the non-residential component of the OVOV General Plan could also have a potential, though indeterminable, impact on library services. People who work, but do not live, in the Santa Clarita Valley are likely to use local libraries during their time at work or while commuting to and from work.

Planned Service Improvements in the Santa Clarita Valley Area – New or Expanded Library Facilities

Castaic Library: This new library is located at 27971 Sloan Canyon Road, Castaic, CA 91384. The size of this library is 6,985 sq. ft. and is scheduled to open in the fall of 2008.

Acton/Agua Dulce Library: This new library is located at 33792 Crown Valley Road, Acton, CA 93510. The size of this library is 11,343 sq. ft. and is scheduled to open in late 2009. The Acton/Agua Dulce Library will serve the communities of Agua Dulce and Acton.

Canyon Country Jo Anne Darcy Library Expansion: The County Library is developing a plan to occupy an additional 4,500 sq. ft. of space in the existing building under the current lease with the City of Santa Clarita. No formal agreement between the City and County has been reached regarding occupancy of the additional space and a schedule for the required renovation work has not yet been established.

Newhall Library Replacement: As your City is aware, the City is planning to replace the existing Newhall Library with a larger facility as part of the Downtown Newhall Specific Plan project. Completion of that project by the City will expand the available library service capacity.

County Library Facilities Mitigation Fee

The County of Los Angeles applies a library facilities mitigation fee on new residential projects in all unincorporated areas served by the County of Los Angeles Public Library (*Los Angeles County Code,* Chapter 22.72). In order to mitigate the impact of residential projects on library services, the developer, or its successor in interest, will be required to pay the library facilities mitigation fee that is in effect at the time building permits for projects are issued. The OVOV Santa Clarita Valley Planning Area is located in the Library's Planning Area 1 (Santa Clarita Valley). The current mitigation fee for this area, which is adjusted annually based on changes in the Consumer Price Index, is $790 per residential unit. The fees are not levied on non-residential development projects.

If you have any questions or need additional information, please contact Malou Rubio at (562) 940-8450.

Sincerely,

Terri Maguire
Chief Deputy County Librarian

TM:DF:MR
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c: David Flint, Assistant Director, Finance and Planning
Malou Rubio, Staff Services
Robert Seal, Public Services Administration

Michael A. Naoum
27301 Eaglehelm Drive
Santa Clarita, CA 91387
661-252-9275
310-267-4821

November 9, 2008

Mr. Jason Smisko
Sr. Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, California 91355

Dear Mr. Smisko:

Since adequate community input time was not offered at the One Valley One Vision meeting on July 15, 2008, attached are my comments regarding the draft Land Use Element plan as well as comments on the Housing Element meeting. Kindly forward a copy of this letter to the Planning Commission.

One Valley One Vision – Land Use Element. Overall, I feel the Land Use Element fails to adequately take into account the existing suburban quality of the City, geographic distances between jobs and housing, the lack of existing density and a constrained road network including I5 and SR14 when trying to become an "urban center" with public transit oriented transportation. It offers developers plenty of flexibility but does not provide to the community the best, most rigorous, highest value planning tool. I'd suggest that the City develop more of a best practices approach rather than just using State minimums as our standards. We should be looking at communities like Westlake Village for standards – not the San Fernando Valley.

- While you indicated the General Plan should be general in nature, there are sometimes specific unapproved items mentioned in the plan that are troubling and should be removed. For example:
    - Part 1D indicates that the existing Canyon Country Metrolink station is planned to be relocated. This should be deleted since it is showing specificity in what should be a general plan.

- Part 1E identifies areas such as Val Verde and Halsey Canyon developed as low-density rural areas based on their residents' desire for retreat from high-intensity urban centers. Special use areas Sand and Placerita Canyon should be added to that list.

- The land use element shows a desire to preserve open space but would appear to allow dense "villages" in areas deemed to be floodplains, Significant Ecological Areas, desirable open areas and wildlife corridors.

  This is inconsistent with Guiding Principal 6b in the One Valley One Vision document dated 11/9/01 which states "a. Uses and improvements (within the Santa Clara River corridor and its major tributaries" shall be limited to those that benefit the community's use of the river in its natural state." And "b. Development on properties adjacent to, but outside the defined primary river corridor shall be: - located and designed to protect the river's water quality, plants, and animal habitats, controlling the density of uses, drainage runoff (water treatment) and other relevant elements".

  Furthermore, objective LU 1.2 states that the City will "maintain the distinctive community character of villages and neighborhoods throughout the planning area by establishing densities and design guidelines appropriate to the particular needs and goals of each area...." policy LU 1.2.5 states that "In Sand Canyon, ensure compatibility of development with existing rural, equestrian lots and the adjacent National Forest land; provide additional recreational trail links; and protect the Santa Clara River from incompatible development." This is contrary to the City's statement in the Land use element that the Canyon Country Metrolink station will be relocated to a high density village proposed in the Santa Clara riverbed just below Sand Canyon.

- While village concepts are promoted, the concept is new and there is no evidence that villages, especially large scale ones, far away from the bulk of the jobs in the City and tied principally to Metrolink for transportation will work to relieve congestion. If I am looking to live in a high density community served by public transit, why would I want to sit on a train for an hour just to live in Santa Clarita? If I want high density, I'll live in a truly urban area and minimize my commute time and dollars. Additionally, unless one works in downtown Los Angeles, or near the train stations in Glendale or Burbank, Metrolink is not a very efficient form of transportation.

- Having high density, low and moderate income housing, far from the major job centers employing these residents (Valencia Industrial Center and Magic Mountain) doesn't seem rational – especially when considering that a bus trip from Canyon Country to the Valencia Industrial Center takes between 60 and 90 minutes (when leaving from the closest Soledad stop that would be near the proposed new Canyon Country Metrolink location envisioned for a high density urban village development).

- Village concepts are supported by the City because of reduced land use and potentially traffic impacts if adjacent to functional public transit. Why is it that the County is allowing villages without being linked to public transit?

- The City is allowing greater density without a corresponding requirement for an increase in open or public spaces or any offsetting benefit for the public at large. Infill and villages with higher densities are promoted as a way to reduce land use (in theory to allow for more open space). Under the proposed plan, there is no offset required by the developers receiving these density bonuses to provide a funding mechanism to set aside those opens spaces the City is selling as so important to preserve and touting as a carrot arising from promoting higher density villages and infill projects. Creating these offsets and funding mechanisms is much like allowing the transfer of air rights among parcels in downtown areas where a higher building is allowed on one parcel based on the development rights purchased from another parcel – thus creating an open or public space.

- My vision of an urban center is an area with high quality, close (meaning walkable-within 1/4th mile) public transportation, with high density residential areas, incorporating jobs, amenities, retail and entertainment so that the use of cars is unattractive. I'm pessimistic that can be accomplished here.

- The transportation infrastructure needed for true urban centers in Santa Clarita will never be economic because of the lack of density and sprawling geography. We don't have the necessary density and can't get it without essentially starting the City over with density throughout the Santa Clarita valley. Santa Clarita is not Downtown Los Angeles or the Wilshire Corridor and we shouldn't be viewing developments in the same way they can. While the City has made great strides with providing Public Transportation to work and a few entertainment destinations, Public Transportation does not work for most folks in our lower density car oriented community.

- There appears to be an unwillingness to require project improvements that could add costs for development interests. The City should be looking at a number of avenues to improve the quality of life for all residents and stakeholders, not just be concerned with keeping costs at a minimum for developers and businesses. Some examples contained in the Land Use Element include:

    - Policy LU 6.1.2 designates the Santa Clara River corridor along with its major tributaries as Open Space and restricts development within 50 feet of the stream banks. THIS IS THE STATE MINIMUM! Between allowing bank stabilization and this minimal setback, the City is being disingenuous when it says it will "maintain the natural beauty of the City's rivers and streams. All too often the bike and walking trails are closed for long periods of time because CLWA is installing a new water line in the same, limited space. We should increase this setback to 250 feet to reduce the amount of bank stabilization and fill required and to allow for uses other than a walking and biking path along river

and stream areas. Open space doesn't need to be limited to just what the City buys.

- The City could be requiring employers of a certain size (say 100 employees) to provide showers for employees using bicycles. Instead, policy LU 5.1.3 has little to no teeth. It says the City will "require safe secure, clearly illuminated walkways and bicycle facilities in all commercial and business centers." A bicycle facility could be viewed as a post a bike could be locked to. Other cities require these facilities. Why can't we?

- The City could be requiring buildings to meet LEED requirements under LU 7.1.3 rather than just "encourage development of energy-efficient buildings". The State just revised energy efficiency codes. There is no reason why the City can't be more of a leader on this than a follower!

To summarize my input on the Land Use Element, I'd like to see the Element better blend with the currently developed areas of the City (since it is mostly built out), require more than minimums for code and setback requirements, and better preserve and be clearer over what the real plan is when there are conflicts between land use, open space, environmental, transportation, safety and infrastructure goals. This will avoid some of the double talk that exists in the current document.

In terms of the **Housing Element**, I'd like to see inclusionary requirements for low and moderate income housing – especially if the area's these developments may go must be designated in the land use plan as having 30 units per acre zoning. While the City has provided this density allowance in the past, developers have not done their part to include this element, instead choosing the market rate pricing approach.

It is clear we can't depend on developers' benevolence to accomplish this State mandated requirement. We must require developers to set aside units to meet this low income requirement especially since the density has been increased providing them an opportunity to build more units with lower per unit land costs. Additionally, since the lower income housing is needed primarily to support workers in the Valencia Industrial Center, the higher density housing should be in close proximity to those jobs. This will reduce the demand on our transportation infrastructure. Other areas of the community could be considered for Senior Housing since Seniors burden on the transportation infrastructure occurs during non-peak hours.

If you have questions or want clarification, please feel free to call.

Respectfully,

Michael Naoum

cc: Commissioner Burkhart
Commissioner Berger
Commissioner Ostrom
Commissioner Trautman
Commissioner Kennedy
Planning Manager Webber

Michael Naoum
27301 Eaglehelm Drive
Santa Clarita, CA 91387
661-252-9275

October 25, 2008

Santa Clarita Planning Commissioners
C\O Jason Smisko

Dear Commissioners:

Since traffic in Santa Clarita is usually cited as the most important issue by City residents, it behooves us to be diligent in our understanding, analysis and evaluation of the Circulation Element. One should ask if the traffic impacts shown in the plan are acceptable to you as a resident and user and if the approaches to have more walking, biking, taking local buses and commuting on trains will really work given our geographic dispersion, job locations for residents and road network.

Below are my comments on the October 2008 Circulation Element Draft.

- Only the 14 is an E Level of Service for the CMP roadways today. Under the new General Plan, all of the CMP roadways will be an E level of service including the I5, State Route 14, Sierra Highway, Magic Mountain Parkway, San Fernando Road (Newhall\Railroad) and SR 126 (page C-7 of the element). LOS E means significant delays and **average travel speeds of 33% or less of the free flow speed**. This doesn't align with Commissioner Ostroms' desire to have roads be at an A or B LOS. How would we evacuate the City if there were ever a need to do so?

- The Element had no statement on the Newhall Pass Level of Service either today or under build-out. Like it or not, 80% of our working residents must pass through it daily.

- There is a disconnect between the planned village locations and job centers. If we are looking to reduce traffic within the City, the village locations should be at or very close to the job centers identified in the Circulation element. Having folks commute from a village in Canyon Country to west Valencia doesn't make much sense.

- There is no "what if" included that identifies what happens to traffic if all planned roads are not built. As Mr. Smisko indicated, all of the planned roads have been on the map for some time (and many unbuilt for some time i.e. Via Princessa to

Wiley Canyon). 5 new bridges over the Santa Clara River are required while only 1 in the past 15 years had been built with one under construction.

- The Element indicates "the City minimizes cut-through traffic through circles, chokers and diverters". I'd like to see City Staff identify one location where we have each of these elements. They don't exist today and should not be mentioned in the Element as if we have them.

- The traffic model identified many needed improvements. Will new development be enough to fund these improvements? If not, how will they be funded? Assuming we have 5 new major roads with bridges over the River and they cost half of the cross valley connector ($125,000,000 each, along with 15 intersection improvements at $4,000,000 each (eminent domain) we have $685 million in today's costs. This doesn't include the cost of the other improvements mentioned (more parking at train stations, re-striping and widening projects, bus turnouts, bike paths, more buses, etc). We could well be looking at a $1 Billion plus price tag by the time this is said and done.

- There is no carbon footprint or greenhouse gas analysis. This needs to be present in this Plan. Analysis tools are available. The Element comment that standards and regulations concerning compliance with AB 32 are still being developed is no excuse to not use evaluation tools already in place to see if the City's plan will achieve the reductions required under AB 32. Standards and regulations like seismic codes constantly change – because they change is not a reason to ignore them. A tool developed by the California Air Resources Board, the Lawrence Berkley Lab and the California Energy Commission can be found at coolcalifornia.org. It's not like these are fly by night organizations.

- What are the assumptions used to drive the traffic study in the plan? Are we assuming that all new residents will work here? What are the assumed levels of bus and train ridership versus now? Why will the ratios change?

- Re-striping of 5 roads will eliminate bike lanes. Why aren't there plans to reinstate these if bicycling is identified as an important element of the plan?

- Are we ready to use eminent domain to improve our major intersections?

- Two of our major arterials will require at grade crossings which Metrolink has been reluctant to approve.

- How will bus turnouts be built on right of ways already completely full of concrete and asphalt (think Soledad)?

- While we are identifying that we want a pedestrian friendly community, with many of the road widening projects, the sidewalk will be immediately adjacent to the road. Furthermore, as a frequent pedestrian, crossing six and eight lane roads

is not very much fun. It will be difficult to put pedestrian safe islands in roads that will need to be wall to wall traffic lanes.

- The Element indicates that more turn signals will be put in place. While this may make turns safer, it also causes excess emissions because cars that could turn if the intersection is clear are not allowed to resulting in more idling.

- Page C-31 refers to truck parking regulations. What are they? I continue to see trucks parked long term on our roads.

- Figure C-4 shows an existing helipad at Henry Mayo. I keep reading this is not operational any longer and is contingent on the new master plan being approved. If not operational, it should be removed.

- Page C-41 identifies that bike racks have been installed on all buses. This is not true. Bike racks have not been installed on Express buses going to Lancaster\Palmdale, Van Nuys, Warner Center, Century City and Los Angeles.

- Policy C.3.1.6 says to "Promote the provision of showers and lockers" for bicyclists while Policy C.6.2.3 says "showers and changing rooms should be required". Which is it? If important, they should be required.

Please keep these items in mind when it comes time for your approval or disapproval of OVOV.

Sincerely,

Michael Naoum

Jeff Hogan

From: Jason Smisko
Sent: Monday, November 10, 2008 10:00 AM
To: Jeff Hogan; 'Judith Charles'; 'Susan Tebo'
Subject: FW: ONE VALLEY ONE VIEW

NOP Comment

From: Sandi Franco [mailto:sfranco@firstam.com]
Sent: Monday, November 10, 2008 9:58 AM
To: Bob Kellar; Ken Pulskamp; Jason Smisko
Subject: ONE VALLEY ONE VIEW

The future of Santa Clarita lays in your hands. Please do the right thing. We do not need to develop every piece of property (what little is left) to the point where it is over developed. Keeping density down in future projects will help protect the way of life we have now and for the future. We are already over burdened in our schools and on our roads.
If we continue on the path we seem to be heading down, Santa Clarita will no longer be a desirable place to live and raise a family.

Sandi Franco
Marketing Assistant
First American Home Warranty

7833 Haskell Ave., Van Nuys, CA 91406
Direct: 818 781 5050 Ext 7842
Mobile: 661 916 4564
Fax: 888 955 3557
Tollfree: 800 698 0422
Email: sfranco@firstam.com
Web: www.firstam.com/warranty

Jeff Hogan

From: Jason Smisko
Sent: Wednesday, November 19, 2008 10:31 AM
To: Jeff Hogan; 'Judith Charles'; 'Susan Tebo'
Subject: FW: OVOV

Since this came in electronically during the OVOV workshops, perhaps we should include it as a comment received during the NOP.

From: gmarndt@aol.com [mailto:gmarndt@aol.com]
Sent: Monday, November 10, 2008 7:53 PM
To: Jason Smisko
Subject: OVOV

I would like to express my concerns along with my neighbors over the General Plan changes for our valley. Density is not a solution to tax problems and budget shortfalls. Our roads, schools, freeways, fill in the blank are all overcrowded with the plan the way it is now. The Smiser Ranch property along with Hamburger Hill and the shopping centers of Stevensen Ranch will be the final straw that sends me and my tax dollars moving out of this beautiful city. The whole reason I moved here, OPEN SPACE!!!! You saw where greed got our country andthe banking system. This will have a similar ending. NO,NO,NO on higher density in SCV. We will be watching your vote and then we will vote.

Gary and Sherrie Arndt and the neighbors on DeWolfe Road in Newhall

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Thomas M. Surak

23712 Adamsboro Drive
Newhall, CA 91321

January 7, 2009

Mr. Jason Smisko, Senior Planner

City of Santa Clarita

Email: jsmisko@santa-clarita.com

Mr. Paul Novak, Planning Deputy

County of Los Angeles

Email: sosuna@lacbos.org

Re: Notice of Preparation - One Valley, One Vision

Dear Mr. Smisko and Mr. Novak:

I am pleased to be able to provide the following comments regarding the draft OVOV documents. In general, the documents appear to be deficient in many areas. They do not offer Santa Clarita residents the same protections and promises which currently exist in the General Plan. Also, as having participated in many aspects of the OVOV process, I can testify to the fact that it was overly cumbersome, often confusing and not at all conducive to inviting full participation by all interested parties. Several of my specific issues and concerns are discussed below. I expect similar comments will be submitted by other residents, which will require additional public participation before the OVOV process can move forward. I can only hope that this will lead to timely and successful resolution of all issues.

The City has not made a proper showing for why it is proposing significant revisions the existing General Plan. The City's flyer, "OVOV Facts and Benefits" which was widely circulated to the public, clearly states that the build-out population estimates adopted for the 1991 General Plan maxed at 521,977 people, and that the OVOV estimates a build-out population range of 444,000 to 485,000. The obvious yet unanswered question is then, "Why are increases in zoning densities, in many cases significant ones, being proposed for the OVOV?" The City cannot legitimately argue that the increased density is to accommodate non-residential development because most OVOV commercial zoning definitions allow for extremely high density (e.g., a minimum of 11 units per acre) residential use. These "commercial zone" residential densities overwhelm those of the surrounding neighborhoods, and such development can only be perceived as detrimental to nearby residents. As further discussed below, the City's concept of a "Valley of Villages" as laid out in the OVOV is not consistent with the principle of enhancing established neighborhoods, nor with development consistent with neighborhood community character, which are both key objectives stated in the OVOV.

Page L-39 of the current General Plan makes it clear that the land use designations adopted in 1991 "should not be construed as temporary holding categories awaiting higher density designations in the

future." It further states, "The Plan has looked at development suitability within the entire Santa Clarita Valley and applies designations for anticipated, long-term future development." The draft OVOV clearly makes a mockery of this promise. OVOV zoning densities are drastically increased throughout the valley.

Also, many new zoning categories are overly broad with respect to allowable types of applicable development. For example, the Regional Commercial, Community Commercial and Neighborhood Commercial zoning designations all allow for mixed use (i.e., residential) development, even though the OVOV also has separate "Mixed Use" zoning designations which more clearly convey the ability to allow such proposed developments. The General Plan is clear when it states "surrounding characteristics, preservation of neighborhood integrity and compatibility with existing uses shall also be taken into consideration in connection with new development proposals." The guiding theme of the OVOV, "A Valley of Villages", casts these neighborhood protections aside by requiring increasing density projects which are entirely inconsistent with the characteristics of surrounding neighborhoods.

The City's concept of a "Valley of Villages" conveniently avoids discussion on the subject of different housing types having different public service requirements. For example, persistent crime hotspots in the Santa Clarita Valley are highly correlated with housing density, e.g., the largest crime problems are associated with higher density housing near downtown Newhall and in Canyon Country. The OVOV does not consider or address additional financial and emotional costs which will be imposed upon existing residents as a consequence of increased crime associated with the OVOV's high density housing proposals.

The OVOV undermines existing neighborhood protections from such high density projects. These protections are inherent in the 1991 General Plan, which many who have since settled into Santa Clarita relied on when making their decision to move here. Without a showing of benefits to existing neighborhoods, one can readily conclude that the OVOV is primarily designed to provide developers an opportunity to further increase their profit opportunities through increased zoning densities. Such opportunities are properly restricted under the existing General Plan through its embedded protections provided to residents of Santa Clarita, and these protections must be maintained.

Some basic elements of the OVOV which must be understood to ensure full participation in the OVOV process were not (and may still not be) clearly communicated to the public. For example, the proposed zoning designation of the Smiser property located in my neighborhood near Calgrove & Wiley Canyon was recently (and unknowingly) revised. At the November public workshops which showcased the draft OVOV, the Smiser property zoning designation was clearly identified as Community Commercial. A completely new zoning designation for this property, Mixed Use – Neighborhood (MXN), has just recently been brought to my attention. However, one cannot readily determine that there has been a new zoning designation by reviewing the revised December 19 Preliminary Land Use map posted for public review, which is the key document for purposes of OVOV review and understanding. The blue and white striped color designation assigned to this MXN zoning designation on the map completely blends in with the blue and white stripe used to assumedly delineate the city boundary which is adjacent to the Smiser property. No reasonable person could have been expected to learn of this zoning change through periodic review of this map, yet that is what was expected from those attempting to participate in the OVOV process. I can only assume that this color scheme selection was just a coincidence and unintentional. However, it does illustrate one of the many unnecessary difficulties OVOV participants have had to overcome in order to properly become engaged in the OVOV process.

Another example of confusion derives directly from the exclusion of a critical clarification in the General Plan from the OVOV zoning definitions. The General Plan clarifies that appropriate project intensity "is generally expected to be between the low and mid-point of the allowable floor area ratio (FAR) range". Comparisons made by City Staff in documents and at public meetings which suggested that allowable city development under the General Plan and the OVOV were equivalent did not incorporate the lower FAR range clarification embedded in the General Plan, and thus overstated allowable development

under the General Plan. Stated another way, the OVOV will allow for much denser development even at similar FAR since it no longer requires project intensity to be at the lower end of the allowable FAR range. Unless the above clarification regarding a lower appropriate project intensity is incorporated into the OVOV, representations made regarding comparable allowable development under the General Plan and the OVOV were incorrect because they minimized impacts under the OVOV, and were likely to have diminished public participation in the OVOV process.

Also, there is language throughout the OVOV which lessens the certainty of limiting future development to the designated zoning. For example, page I-3 states "all subsequent planning and development decisions within the Santa Clarita Valley planning area shall be determined to be consistent with these documents, except as provided herein for any land use applications pending during the plan preparation and adoption process." This caveat completely undermines the ability of citizens to fully appreciate what is capable of being developed in their neighborhoods and other areas where they may have special concerns and interests, and effectively disengages many from actively participating in the OVOV process. In addition, this caveat is not consistent with public representations which have made. Please refer to an October 5, 2008 article in "The Signal" titled, "SCV ponders 'one vision' for growth" which quotes both of you as well as Paul Brotzman. This article includes the following statement: "Though general plans by definition are general, the state mandated documents must include a map that describes exactly what type of development can occur on every inch of land." I do not recall any clarification or rebuttal to this statement having been made by City or County staff. I also believe many more residents have read "the Signal" for information on the OVOV than have read through the several hundred pages of draft OVOV documents. The development flexibility being sought in the OVOV which I cited above does not comply with this statement. Therefore information provided to the majority of residents regarding the development flexibility sought within the OVOV is misleading at best. The City and County cannot assume that residents fully comprehend this development flexibility. Therefore the OVOV cannot be allowed move forward with this intended flexibility without further public disclosure and discussion.

The OVOV inadequately addresses how existing deficiencies in City parks and recreation facilities will be met. The OVOV states, "The Land Use Element is the City's and County's long-term blueprint for development of property to meet Santa Clarita Valley's future needs for ... parks, open space...including location for future uses within the planning area." It furthermore states, "The provision of adequate park space and facilities to serve residents is not only required by State planning law, but is recognized as necessary to provide for public health and quality of life." The OVOV further recognizes that "another issue for park development is distribution of park facilities, as many local parks are concentrated within master planned communities, and outlying areas have access to fewer local parks." The OVOV confirms that the City has a "standard" (the term "requirement" is used in the 1991 General Plan, which I interpret as the true intent) of five acres of park facilities per 1000 residents, and yet the City currently has "only about 1.5-2 acres of developed parkland per 1000 population", which is essentially unchanged from when the General Plan was adopted in 1991. (In fact, as of October 2008 the true ratio is 1.4 acres of parkland per 1000 population as stated by the City of Santa Clarita Parks, Recreation, and Community Services Commission, which increases the magnitude of the existing parkland deficiency.) In essence, notwithstanding the claims that significant parkland has been added since 1991, due to corresponding population growth there has been no significant progress made towards meeting the parkland "target" in almost two decades. This is especially true in areas which were identified as being underserved throughout that timeframe, which will have to be met through land acquisition using "additional funding sources." This is because the State's Quimby Act which has been used to acquire the majority of parkland added since 1991 only provides parkland (and only at an below "target" three acres per 1000 population) for residents of new developments.

The OVOV ignores the critical additional parkland requirement (per Policy LU 3.4.1) by stating that the Conservation and Open Space element "will not serve as a park master plan but will instead focus on broad policy issues relating to park planning." The OVOV just defers on this issue by identifying as City Task 8.1, "Complete and adopt a revised Park and Recreation Master Plan for the City by 2009." This is unacceptable. The OVOV must fully coordinate with the park master plan on a detailed level; by not

doing so, the OVOV invites development of remaining open areas which must be preserved for future parkland to meet the adopted parkland "target." This need for coordination holds especially true in areas which have an identified parkland deficiency and minimal remaining acreage which can help meet that deficiency. In fact, the Final Draft of the Parks, Recreation and Open Space Master Plan Update states, "Priority should be given to meeting the current (park) acreage deficit of 612 acres." However, the OVOV not only lacks any priority with respect to additional parkland in the OVOV, there are inherent barriers to the creation of additional parkland created by the OVOV.

For example, the Calgrove/Wiley Canyon neighborhood was identified in the existing General Plan as being "severely underserved" with respect to parks (this neighborhood is similarly identified as having a "service area gap" in the Final Draft of the Parks, Recreation and Open Space Master Plan Update, which I take as a euphemism). The only remaining undeveloped land which can be used for a neighborhood park in the Calgrove/Wiley Canyon area is the Smiser property. However, not only does the latest OVOV zoning of the Smiser property not include any reference to parkland, it instead proposes to increase the density allowed for development of that property! By increasing the allowable build densities on remaining undeveloped property such as Smiser, the OVOV increases the residual value of properties which are most suitable for helping close the significant gap between target and actual park acreage. Thus the OVOV will create further barriers to meeting the park master plan objectives by unnecessarily increasing the future cost of acquiring acreage for parkland. This will undermine the ability of and likely preclude the City from meet existing, let alone future, parkland needs under the prescribed "target".

The environmental aspect of the OVOV addresses climate issues only from a macro perspective; the issue of microclimate changes which are common with increased "urbanized" development such as that contemplated by the OVOV is ignored. Microclimate issues must be incorporated into the EIR study process to provide a complete and proper assessment of potential impacts from the build out proposed by the OVOV. Also, there is a lack of focus on increased noise associated with increased urban development, both during and after construction, as proposed in the OVOV. The importance of this issue cannot be ignored since increased noise pollution has the ability to undermine the tranquility that residents of Santa Clarita currently appreciate and will continue to expect in the future.

Please feel free to contact me for further clarification on the above.

Sincerely,

Thomas M. Surak

Calgrove Corridor Coalition

RECEIVED
PLANNING DIVISION
DEC 29 2008
CITY OF SANTA CLARITA

December 29, 2008

Jason Smisko, Senior Planner
City of Santa Clarita
23920 Valencia Boulevard
Santa Clarita, CA 91355

Re: ***Calgrove Corridor Coalition*** **Response - Notice of Preparation of One Valley, One Vision**

Dear Mr. Smisko,

This is the second NOP response from Calgrove Corridor Coalition (CCC). After receiving inaccurate and conflicting deadline dates, we now understand that the final date for NOP comments is December 31, 2008. We believe the OVOV process remains flawed and has not been transparent for the residents of Santa Clarita, and that public notification of revisions is almost non-existent when changes are made to the draft document.

CCC has repeatedly asked to be notified when changes are made to the draft OVOV document, particularly when the changes involve the Land Use Element or the Smiser property. We cannot support the OVOV draft when City staff leaves the research of revisions up to the public.

Early in the process, members of our leadership team met with Planning Director Paul Brotzman and we were assured that it was not the intent of the City to increase the density for the Smiser property. We are very concerned that the current document does not reflect prior commitments made by staff to maintain the current density.

Our coalition has repeatedly seen changes in the OVOV document that could potentially more than triple the density for the Smiser property. In the December 8, 2008 OVOV revision, the designation of Mixed Use Neighborhood (MXN) integrates characteristics of 2 other Land Use Elements -

- Neighborhood Commercial (NC) - allows a 35' height limit and not to exceed 75 % development coverage
- Community Commercial (CC) - allows a 50' height limit and development coverage of 80%

NC and CC have vastly different use requirements. Each of the 3 designations (NC, CC and MXN) includes the language, "except as otherwise permitted by the reviewing authority pursuant to discretionary review as prescribed by the unified development code." We are concerned that these vagaries will allow developers to see the land use elements as a negotiable moving target.

Not only are we disappointed that the changes are not being communicated, as promised, we are gravely concerned that the designations do not reflect our input about density. CCC does not support OVOV in its current state and our organization is looking for a land use description that enhances the existing neighborhood and provides an inviting entrance to our city. We support the commitment made by Paul Brotzman that the zoning designation would limit development to floor area ratio of no more than .375 and we look forward to a positive outcome.

Respectfully,

Annette Lucas and Glenda Bona, co-chairs
Calgrove Corridor Coalition

cc:

Mitch Glaser, Principal Planner
Ken Pulskamp, City Manager
Jeff Hogan, Associate Senior Planner
Paul Brotzman, Director of Community Development
Susan Tebo, Impact Sciences
Frank Ferry, Mayor
Bob Kellar, City Council Member
Marsha McLean, City Council Member
Laurie Ender, City Council Member
Laurene Weste, City Council Member

Friends of the Santa Clara River Comment on NOP;
dated August 25, 2008

Friends of the Santa Clara River

660 Randy Drive, Newbury Park, California 91320-3036 • (805) 498-4323

August 25, 2008

Mr. Mitch Glaser, Supervising Regional Planner
Los Angeles County Dept. of Regional Planing
320 West Temple Street Room 1354
Los Angeles, CA 90012

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California Native Plant Society
L.A./Santa Monica Mountains Chapter

Santa Clarita Organization for Planning the Environment (SCOPE)

Sierra Club
Angeles Chapter
Los Padres Chapter

Surfrider Foundation

Audubon Society
Ventura Chapter

Ventura County Environmental Coalition

Re: One Valley One Vision Notice of Preparation

Dear Mr. Glaser,

Friends of the Santa Clara River submit the following comments on the subject project.

The Santa Clarita area has seen vast development over the last two decades and continues to develop at a very rapid pace. Much of this development has encroached on the floodplain of the Santa Clara River and its tributaries. Yet, no agency - state, federal or other - has adequately analyzed the cumulative impacts of this massive floodplain development that continues unabated and is a part of many projects now on the drawing board or in some phase of approval.

The One Valley One Vision EIR must remedy this situation and finally provide a substantive analysis of these impacts to the river ecosystem.

Moreover, all of this floodplain development has placed thousands of homes within the path of potential flooding. The flooding problems associated with surging rivers and creeks, brought on by the 2005 rains in southern California, are well described in the Ventura County Star article of February 6, 2005 – "Rain-swollen rivers not easy to repair". Flood damage occurred in Santa Clarita during these floods.

Southern California rivers are among the "flashiest" in the world. Flows during the worst flood events tend to be very high compared to average flows. The Ventura River and Santa Clara Rivers, for example, show peak discharges over 30 times the mean annual flow for floods having a recurrence interval of 25 years. A major lesson to be learned from these facts is that these rivers, as well as many of their tributaries, are dangerous by nature and very difficult to tame.

Efforts to control flooding through extensive channelization do not have a promising history. A prime example of the failure of such projects is that of the San Lorenzo River, which runs through downtown Santa Cruz. The

channel was straightened, deepened and widened in response to public demand for extensive flood control measures after 1955 flood damage. All vegetation was removed from the banks to reduce roughness and channel walls were lined with rock and concrete. In less than 10 years the channel had filled with 12 million cubic feet of sediment, and could only handle a 25-year flood (4% chance of occurring in a given year). Millions of dollars had not only destroyed the river but failed to do much for flood protection.

There is a new floodplain management philosophy that is being increasingly adopted by communities across the country that works with nature, not against it. Wetlands are being protected and allowed to serve as natural flood basins. Such measures are of particular importance in southern California, which has lost over 90% of its wetlands. **OVOV, since it is a "vision" of what the valley should become, should include such measures.**

Thank you for your consideration of these comments.

Sincerely,

Ron Bottorff

Ron Bottorff, Chair

Ventura County Air Pollution Control District Comment on NOP;
dated August 26, 2008

VENTURA COUNTY
AIR POLLUTION CONTROL DISTRICT
Memorandum

TO: Kari Finley/Dawnyelle Addison, Planning DATE: August 26, 2008

FROM: Alicia Stratton

SUBJECT: Request for Review of Notice of Preparation for a Draft Environmental Impact Report (DEIR) for the One Valley One Vision Project, Los Angeles County Department of Regional Planning (Reference No. 08-032)

Air Pollution Control District staff has reviewed the subject project, which is a comprehensive update to the Santa Clarita Valleywide Area Plan to establish common guidelines for new development that will lead to greater cooperation and an enhanced quality of life for residents of the Santa Clarita Valley. The result of the project will be an Area Plan document and EIR for the buildout of the entire Santa Clarita Valley Planning Area. The Planning Area combines two geographic areas, the City corporate limits and the unincorporated area of the County within Santa Clarita Valley. It is situated at the convergence of Los Angeles and Ventura Counties.

The South Coast Air Quality Management District has jurisdiction over air quality in Los Angeles County, however, future development the Planning Area and its proximity to Ventura County could adversely impact Ventura County residents. District staff recommends the air quality section of the DEIR evaluate all potential air quality impacts to Ventura County that may result from the project. Specifically, the air quality assessment should consider reactive organic compound, nitrogen oxide emissions and particulate matter from all project-related motor vehicles and construction equipment.

If you have any questions, please call me at (805) 645-1426.

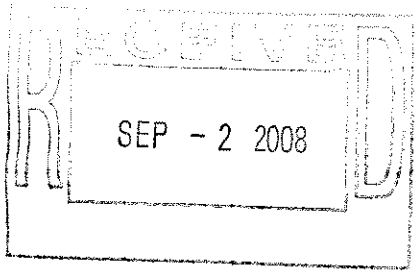
Caltrans Comment on NOP; dated August 28, 2008

DEPARTMENT OF TRANSPORTATION
DISTRICT 7, REGIONAL PLANNING
IGR/CEQA BRANCH
100 MAIN STREET, MS # 16
LOS ANGELES, CA 90012-3606
PHONE: (213) 897-6696
FAX: (213) 897-1337

Flex your power!
Be energy efficient!

IGR/CEQA No. 080733AL, NOP
One Valley One Vision
County Project No. R2007-01226
Vic. LA-05/126/14
SCH # 2008071119

August 28, 2008



Mr. Mitch Glaser
Department of Regional Planning
Los Angeles County
320 West Temple Street
Los Angeles, CA 90012

Dear Mr. Glaser:

Thank you for including the California Department of Transportation (Caltrans) in the environmental review process for the above referenced project. The One Valley One Vision, OVOV, project is a comprehensive update to the Santa Clarita Valley wide Area Plan to establish common guidelines for new development that will lead to greater cooperation and an enhanced quality of life for residents of Santa Clarita Valley.

The OVOV is a joint effort between the County of Los Angeles, City of Santa Clarita, and Santa Clarita Valley residents and businesses to create a single vision and guidelines for the future growth of the Valley and the preservation of natural resources. The result of the work effort will require the County to adopt a new Area Plan to replace the Santa Clarita Valley Area Plan and prepare its own Environmental Impact Report, EIR, while the County will adopt a new General Plan and EIR.

The California Department of Transportation (Caltrans) as the State agency responsible for planning, operations, and maintenance of State highways, shares similar transportation goals with the both County of Los Angeles and City of Santa Clarita. We are pleased with the comprehensive planning approach both local government agencies are pursuing and present the following comments:

"Caltrans is particularly interested in the transportation planning roles of local general plans and suggests that the following areas be emphasized.

- Coordination of planning efforts between local agencies and Caltrans.
- Preservation of transportation corridors for future system improvements; and
- Development of coordinated transportation system management plans that achieve the maximum use of present and proposed infrastructure."

Circulation Element

It is widely known that Southern California highways are heavily congested especially during morning and evening peak periods. We realize that to improve mobility there is the need for capacity enhancing improvements as well as other innovative alternatives. The State highway facilities that provide regional access to the subject Santa Clarita Valley Area and are therefore likely to be impacted by future development activity are Interstate 5 (I-5), State Route 14 (SR-14), and State Route 126 (SR-126).

Interstate 5

- The *Golden State Gateway Coalition website (http://www.goldenstategateway.org/?p=7#q6) provides the following information:*

"....In the northern Los Angeles County, the I-5 currently carries more than 200,000 vehicles every day. This includes more than 19,000 trucks. These daily numbers add up to a staggering 73 Million vehicles – including 7 Million trucks – every year. As commerce and population growth occur in Southern California, these numbers will increase...."

" ...The I-5 freeway is already nearly at capacity, with Los Angeles County's population expected to grow by 3 million in the next 2 decades, it would soon be beyond its capacity without major improvements. Traffic is projected to increase by 65% in the next 10 years and 114% in the next 20 years. Airport passenger and cargo traffic in the Los Angeles-southern Kern County region is expected to double in the next 2 decades, while seaport traffic is expected to triple...."

State Route 14

- Existing daily traffic volumes along the SR 14 corridor range from 137,000 ADT (between I-5 to San Fernando Rd.) to 30,900 ADT (between Avenue I and Kern County Line) (Caltrans District 7, SR 14 Transportation Concept Report, September 2003).

- Currently, an operating deficiency exists on SR14 between I-5 and SR 126. The level of service on this segment is F0 during the AM peak period on the southbound side of the route and F0 during the PM peak period on the northbound side of the route (Caltrans District 7, SR 14 Transportation Concept Report, September 2003).

- SR 14 is designated as a Super Truck Route (STR). SR 14 is also part of the Surface Transportation Assistance Act (STAA) truck network, which provides freeway access for oversized trucks. Regional truck traffic is expected to increase by 40% by 2020, with virtually no capacity available to handle this additional volume (Caltrans District 7, SR 14 Transportation Concept Report, September 2003).

State Route 126

SR-126 functions as a terminal access route to the national network for the Surface Transportation Assistance Act (STAA) for trucks. Truck volume in 2001 ranged from 4% to 30% of ADT in Los Angeles County, and 4.5% to 10% of ADT in Ventura County (Caltrans District 7, SR 126 Transportation Concept Report, November 2004).

New development will increase use of local and regional roadways and the circulation element can identify strategies the County and the City will pursue to maintain good levels of service. We understand that mitigating cumulative traffic impacts may present some challenges. Given that the Los Angeles County's Congestion Management Program debit and credit system has been suspended, we recommend the County consider an alternate local funding plan towards regional transportation improvements. Local funding efforts may include a region or community wide traffic impact program. We request the County consider implementing a funding program to contribute to improvements on the State highway system, including impacted I-5, SR-14, SR-126, and on/off ramps. When local matching funds are offered, public funds may become available and improvements may be streamlined and/or expedited. County of Los Angeles and City of Santa Clarita may take this opportunity to include policies that allow it to procure funds towards regional transportation improvements such as additional mixed flow lanes, High Occupancy Lanes (HOV), and truck lanes on I-5; as well as modifications to I-5/SR-14 interchange.

Procuring funds toward freeway segments, freeway interchanges, freeway on/off-ramps, as well as for bus and rail transit facilities should also be in the goals of the local government agencies. A local funding strategy may provide a fair and predictable mechanism for individual developments to address their individual and cumulative transportation impacts to State facilities and satisfactory comply with the California Environmental Quality Act (CEQA).

Other traffic mitigation alternatives may include vehicular demand reducing strategies, such as incentives for commuters to use transit i.e. park-and-ride lots, discounts on monthly bus and rail passes, vanpools, etc.

Caltrans requests inclusion in the environmental review process of land use projects within County and City General Plan areas and in all projects that have the potential to significantly impact traffic conditions on State highways. To avoid delays and any misunderstandings in the traffic impact analysis, we request to be involved in its development. We may provide assistance in our areas of expertise such as transportation modeling, mainline freeway analysis, system and corridor planning, environmental and community impact assessment, as well as identifying critical operational deficiencies affecting freeway congestion, speed, and delay.

For State thresholds and guidance on the preparation of acceptable traffic studies, please refer to the Statewide Guide for the preparation of Traffic Impact Studies at:

http://www.dot.ca.gov/hq/traffops/developserv/operationalsystems/reports/tisguide.pdf

If significant impacts were anticipated on the State highway system, Caltrans would work with the local governments to identify appropriate traffic mitigation measures.

We remind you that traffic impact studies that are in compliance with Los Angeles County's Congestion Management Program (Metro's CMP), are not necessary satisfactory to Caltrans, the agency with jurisdiction over State highway facilities. The thresholds for significance on State highway facilities may be different than those applied in the CMP.

Land Use Element and Other Elements

As you are aware, there is a critical relationship between land use and transportation. The quality of the State transportation system operation can affect the quality of the local circulation system operation. The Circulation Element of the General Plan needs to be consistent with the Land-Use and Housing Elements of the General Plan. During the past couple decades, population and economic growth has been strong in Los Angeles County. Projections show that this growth will continue.

We recommend that special attention be given to the jobs-and-housing balance concept. Communities with predominantly residential allocations should be encouraged to set aside areas for office, commercial/retail, and open space uses. Benefits of balanced communities include: reduction of long morning and evening commutes on State highways, shorter trips which in turn would reduce the consumption of fuel and air pollutants. It may also change direction of trips. Instead of most traffic traveling in one direction during peak periods, some trips may be diverted in the opposite direction. Other land use strategies may include Transit-Oriented Developments (TODs).

- We encouraged the application of the State Regional Blueprint Program's and SCAG's Compass Blueprint Program's land use and transportation planning principles in their General Plan update:

  - **California Regional Blueprint Planning Program (http://calblueprint.dot.ca.gov)**

    The Regional Blueprint Planning Program is intended to better inform regional and local decision-making, through pro-active engagement of all segments of the population as well as critical stakeholders in the community, business interests, academia, builders, environmental advocates, and to foster consensus on a vision and preferred land use pattern. It is anticipated that the regional blueprint planning grants will build capacity for regional collaboration and integrated planning that will in turn enable regions to plan to accommodate all their future growth, thereby reducing need for sprawl.

    1. The grants for regional collaborative decision-making will lead to adoption of blueprint plans that will:

    2. Foster a more efficient land use pattern that (a) supports improved mobility and reduced dependency on single-occupant vehicle trips, (b) accommodates an adequate supply of housing for all incomes, (c) reduces impacts on valuable habitat, productive farmland, and air quality, (d) increases resource use efficiency, and (e) results in safe and vibrant neighborhoods.

    3. Provide consumers more housing and transportation choices.

    4. Improve California's economic competitiveness and quality of life.

    5. Reduce costs and time needed to deliver transportation projects through informed early public and resource agency involvement.

6. Secure local government and community support, including that of under-represented groups, to achieve the resulting comprehensive vision through including innovative computer models and public involvement activities.

7. Establish a process for public and stakeholder engagement that can be replicated to build awareness of and support for critical infrastructure and housing needs.

- **SCAG Compass Blueprint Program (http://www.compassblueprint.org/about)**
  Compass Blueprint is a new way to look at how the region grows. The Compass Blueprint Growth Vision is a response, supported by a regional consensus, to the land use and transportation challenges facing Southern California now and in the coming years.

The *Growth Vision encourages:*

- Focusing growth in existing and emerging centers and along major transportation corridors
- Creating significant areas of mixed-use development and walkable communities
- Targeting growth around existing and planned transit stations
- Preserving existing open space and stable residential areas

Housing Element
As we indicated previously, continued high growth is expected for Los Angeles County, which will have impacts to our State transportation facilities. We ask that efforts be made to provide affordable housing for all income levels to ensure that substantial numbers of employees can afford to purchase homes and live in proposed residential projects.

We look forward to reviewing the traffic study. Again, we would welcome an opportunity to participate in its development.

If you have any questions, please feel free to contact me at (213) 897-6696 or Alan Lin the project coordinator at (213) 897-8391 and refer to IGR/CEQA No. 080733AL.

Sincerely,

ELMER ALVAREZ
IGR/CEQA Program Manager

cc: Scott Morgan, State Clearinghouse

South Coast Air Quality Management District Comment on NOP; dated July 31, 2008

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 • www.aqmd.gov

AUG 19 2008

July 31, 2008

Mr. Mitch Glaser
Countywide Studies Section
Los Angeles County
320 West Temple Street
Los Angeles, CA 90012

Dear Mr. Glaser:

Notice of Preparation of a Draft Environmental Impact Report (Draft EIR) for the One Valley One Vision Plan

The South Coast Air Quality Management District (SCAQMD) appreciates the opportunity to comment on the above-mentioned document. The SCAQMD's comments are recommendations regarding the analysis of potential air quality impacts from the proposed project that should be included in the draft environmental impact report (EIR). Please send the SCAQMD a copy of the Draft EIR upon its completion. **In addition, please send with the draft EIR all appendices or technical documents related to the air quality analysis and electronic versions of all air quality modeling and health risk assessment files. Without all files and supporting air quality documentation, the SCAQMD will be unable to complete its review of the air quality analysis in a timely manner. Any delays in providing all supporting air quality documentation will require additional time for review beyond the end of the comment period.**

Air Quality Analysis

The SCAQMD adopted its California Environmental Quality Act (CEQA) Air Quality Handbook in 1993 to assist other public agencies with the preparation of air quality analyses. The SCAQMD recommends that the Lead Agency use this Handbook as guidance when preparing its air quality analysis. Copies of the Handbook are available from the SCAQMD's Subscription Services Department by calling (909) 396-3720. Alternatively, the lead agency may wish to consider using the California Air Resources Board (CARB) approved URBEMIS 2007 Model. This model is available on the SCAQMD Website at: www.urbemis.com.

The Lead Agency should identify any potential adverse air quality impacts that could occur from all phases of the project and all air pollutant sources related to the project. Air quality impacts from both construction (including demolition, if any) and operations should be calculated. Construction-related air quality impacts typically include, but are not limited to, emissions from the use of heavy-duty equipment from grading, earth-loading/unloading, paving, architectural coatings, off-road mobile sources (e.g., heavy-duty construction equipment) and on-road mobile sources (e.g., construction worker vehicle trips, material transport trips). Operation-related air quality impacts may include, but are not limited to, emissions from stationary sources (e.g., boilers), area sources (e.g., solvents and coatings), and vehicular trips (e.g., on- and off-road tailpipe emissions and entrained dust). Air quality impacts from indirect sources, that is, sources that generate or attract vehicular trips should be included in the analysis.

The SCAQMD has developed a methodology for calculating PM2.5 emissions from construction and operational activities and processes. In connection with developing PM2.5 calculation methodologies, the SCAQMD has also developed both regional and localized significance thresholds. The SCAQMD requests that the lead agency quantify PM2.5 emissions and compare the results to the recommended PM2.5 significance thresholds. Guidance for calculating PM2.5 emissions and PM2.5 significance thresholds can be found at the following internet address: http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html.

In addition to analyzing regional air quality impacts the SCAQMD recommends calculating localized air quality impacts and comparing the results to localized significance thresholds (LSTs). LST's can be used in addition to the recommended regional significance thresholds as a second indication of air quality impacts when preparing a CEQA document. Therefore, when preparing the air quality analysis for the proposed project, it is recommended that the lead agency perform a localized significance analysis by either using the LSTs developed by the SCAQMD or performing dispersion modeling as necessary. Guidance for performing a localized air quality analysis can be found at http://www.aqmd.gov/ceqa/handbook/LST/LST.html.

It is recommended that lead agencies for projects generating or attracting vehicular trips, especially heavy-duty diesel-fueled vehicles, perform a mobile source health risk assessment. Guidance for performing a mobile source health risk assessment ("Health Risk Assessment Guidance for Analyzing Cancer Risk from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis") can be found on the SCAQMD's CEQA web pages at the following internet address: http://www.aqmd.gov/ceqa/handbook/mobile_toxic/mobile_toxic.html. An analysis of all toxic air contaminant impacts due to the decommissioning or use of equipment potentially generating such air pollutants should also be included.

Mitigation Measures

In the event that the project generates significant adverse air quality impacts, CEQA requires that all feasible mitigation measures that go beyond what is required by law be utilized during project construction and operation to minimize or eliminate significant adverse air quality impacts. To assist the Lead Agency with identifying possible mitigation measures for the project, please refer to Chapter 11 of the SCAQMD CEQA Air Quality Handbook for sample air quality mitigation measures. Additional mitigation measures can be found on the SCAQMD's CEQA web pages at the following internet address: www.aqmd.gov/ceqa/handbook/mitigation/MM_intro.html Additionally, SCAQMD's Rule 403 – Fugitive Dust, and the Implementation Handbook contain numerous measures for controlling construction-related emissions that should be considered for use as CEQA mitigation if not otherwise required. Other measures to reduce air quality impacts from land use projects can be found in the SCAQMD's Guidance Document for Addressing Air Quality Issues in General Plans and Local Planning. This document can be found at the following internet address: http://www.aqmd.gov/prdas/aqguide/aqguide.html. In addition, guidance on sitting incompatible land uses can be found in the California Air Resources Board's Air Quality and Land Use Handbook: A Community Perspective, which can be found at the following internet address: http://www.arb.ca.gov/ch/handbook.pdf. Pursuant to state CEQA Guidelines §15126.4 (a)(1)(D), any impacts resulting from mitigation measures must also be discussed.

Data Sources

SCAQMD rules and relevant air quality reports and data are available by calling the SCAQMD's Public Information Center at (909) 396-2039. Much of the information available through the Public Information Center is also available via the SCAQMD's World Wide Web Homepage (http://www.aqmd.gov).

The SCAQMD is willing to work with the Lead Agency to ensure that project-related emissions are accurately identified, categorized, and evaluated. Please call Gordon Mize, Ph.D., Air Quality Specialist, CEQA Section, at (909) 396-3302 if you have any questions regarding this letter.

Sincerely,

Steve Smith

Steve Smith, Ph.D.
Program Supervisor, CEQA Section
Planning, Rule Development and Area Sources

SS:GM:AK
LAC080729-02AK
Control Number

Ventura County Watershed Protection District Comment on NOP; dated August 26, 2008

VENTURA COUNTY
WATERSHED PROTECTION DISTRICT
PLANNING AND REGULATORY DIVISION
800 South Victoria Avenue, Ventura, California 93009
Sergio Vargas. Deputy Director - 805 650-4077

DATE: August 26, 2008

TO: Kari Finley, Resource Management

FROM: Sergio Vargas, P.E.
Deputy Director – Planning and Regulatory Division

SUBJECT: RMA 08-032.One Valley One Vision –
Santa Clarita Valleywide Area Plan Update

The Watershed Protection District has reviewed the above Notice of Preparation and our comments are as follows:

Thank you for the opportunity to allow us to comment on the Notice of Preparation for One Valley One Vision – Santa Clarita Valleywide Area Plan Update.

The areas within our purview that we would like to see special studies done will be in the Land Use Element and Safety Element in the EIR Section:

Potential Environmental Effects

- **Hydrology**
- **Hydraulic Hazards – Erosion and Siltation**
- **Water Quality**
- **Groundwater Quantity/Quality/Water Supply**

The Hydrologic, Hydraulic and Drainage Studies

This element would necessitate a comprehensive Drainage Study that will provide a clear understanding of the cumulative impact of the buildout of the entire Santa Clarita Valley Planning Area (Planning Area) to County of Los Angeles, city of Santa Clarita, Santa Clarita Valley and the effect it will have to the common waterway between our counties. The EIR should also incorporate mitigation measure that would eliminate increase in runoff and increase in erosion.

Water Quality

The document should consider both the temporary and permanent impacts to water quality resulting from both construction impacts and runoff from newly developed area. Some examples of impacts are erosion, siltation, and release runoff from paved and landscaped areas.

End of Text

Ventura County Watershed Protection District Comment on NOP; dated September 2, 2008

Ventura County

Watershed Protection District

Groundwater Section

MEMORANDUM

DATE: **September 2, 2008**

TO: **Kari Finley, RMA - Planning Division**

FROM: **Rick Viergutz, WPD – Groundwater Section**

SUBJECT: **RMA 08-032, Notice of Preparation - One Valley One Vision – Santa Clarita Valleywide Area Plan Update**

The Watershed Protection District – Groundwater Section has reviewed the above Notice of Preparation and has provided the following comments:

The Draft Environmental Impact Report (DEIR) discussion needs to address the following:

1) How will surface water and groundwater quantity and quality entering Ventura County from the area covered by the OVOV area plan change over time? The time interval discussed should include now, through build out of the project. Elements included in the time interval should include changes in surface water and groundwater quantity and quality.

RV:gl

F:\wris\archive4\rma 08-032.doc

Agua Dulce Town Council Comment on NOP; dated September 11, 2008

AGUA DULCE TOWN COUNCIL

33201 Agua Dulce Canyon Road * Box Number 8 * Agua Dulce, CA 91390
Website: www.AguaDulce-ca.com

- **Donal MacAdam, President**
  (661) 268-7402
  janicepeterson@aguadulcevineyards.com
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- **Gary Hebdon**
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  heb@thevine.net
- **Jim Jennings**
  (661) 268-1464
  jjennings3570@sbcglobal.net

September 11, 2008

Mr. Mitch Glaser mglaser@planning.lacounty.gov
Los Angeles County Department of Regional Planning
320 West Temple Street, Room 1352
Los Angeles, CA 90012

RE: One Valley, One Vision Project (OVOV)
Environmental Review Comment

Dear Mr. Glaser:

The Agua Dulce Town Council requests Los Angeles County Regional Planning reference the Agua Dulce Community Standards District and its authority in One Valley, One Vision (OVOV) General Plan Environmental Impact Report (EIR). We appreciate the opportunity to comment on issues to be included in the EIR.

Respectfully,

Donal MacAdam

Donal MacAdam, President
Agua Dulce Town Council - 2008

Cc: Rosalind Wayman, 5th District Senior Deputy rwayman@lacbos.org

Los Angeles County Department of Public Works Comment on NOP; dated September 22, 2008

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"To Enrich Lives Through Effective and Caring Service"

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IN REPLY PLEASE
REFER TO FILE: LD-1

September 22, 2008

TO: Mitch Glasser
County Wide Studies Section
Department of Regional Planning

FROM: Steve Burger
Land Development Division
Department of Public Works

NOTICE OF PREPARATION (NOP)
FOR AN ENVIRONMENTAL IMPACT REPORT (EIR)
ONE VALLEY ONE VISION
PROJECT NO. R2007-01226

We reviewed the NOP for the proposed subject project and concur that an EIR is required. The following comments are for your consideration and relate to the environmental document only:

Hazards–Geotechnical/Soils/Geology

All or portions of the City of Santa Clarita (including communities of Canyon Country, Newhall, Saugus, and Valencia), unincorporated communities of Stevenson Ranch, Castaic, Val Verde, Agua Dulce, and the future Newhall Ranch are located within potentially liquefiable areas per the State of California Seismic Hazard Zones Map-Whitaker Peak, Sleepy Valley, Val Verde, Newhall, Mint Canyon, Agua Dulce, Simi Valley East, Oat Mountain, and San Fernando Quadrangles. All geotechnical issues discussed in the NOP should be addressed in the EIR. Geotechnical reports should be included in the EIR as necessary.

If you have any question regarding soils and geology, please contact Jeremy Wan at (626) 458-4972.

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Services–Traffic/Access

The proposed Circulation Element plans for the continued development of efficient, cost-effective, and comprehensive transportation systems, which are consistent with regional plans, local needs, and the Valley's community character. It also identifies and promotes techniques for improving mobility beyond planning for construction of new streets and highways. Below are comments on the Circulation Element pertaining to traffic studies, neighborhood traffic calming, geometric design, and traffic signal operation. We recommend that you set up a meeting with the consultant and the City of Santa Clarita in order to reconcile these comments.

- The header on the document reads as "City of Santa Clarita General Plan," which is not representative of the One Valley One Vision Valleywide General Plan concept.

- Page C-3, second bullet–Per the Los Angeles County Highway Plan, State Route 126 west of the I-5 Freeway is classified as an expressway not a freeway.

- Page C-6, Intersection Capacity–Instead of expressing level of service exclusively in terms of delay, the County expresses level of service in terms of delay for unsignalized intersections and in terms of delay or volume-to-capacity ratios for signalized intersections.

- Page C-8, second paragraph–While the Congestion Management Plan states that local jurisdictions may define acceptable levels of service up to E, the County General Plan does not specify an acceptable level of service.

- Page C-11, Arterials and Collectors in the Santa Clarita Valley–The County General Plan does not specify an acceptable level of service; thus, the list of roadways not operating at level of service E or better should be revised to a list of roadways that are operating at or exceeding capacity. A capacity of 2,800 vehicles per through lane, assuming a 50-50 directional split and excluding turn lanes, should be used when determining the roadway capacity.

- Page C-11, Major Roadway Improvements Underway as of 2007–Hasley Canyon Road at I-5 Freeway Interchange improvement project should be included in this list.

- Page C-12, Transportation Management System–Public Works recently completed a traffic signal timing analysis of the traffic signals in the unincorporated area of the Santa Clarita Valley. Traffic signals at 22 intersections along The Old Road, Stevenson Ranch Parkway, Pico Canyon Road, and Copper Hill Drive were retimed to improve the overall progression of traffic. Synchronizing the signals and improving the operation and safety of the roadway significantly reduces delay and the potential for collisions, thereby alleviating motorist frustration, reducing air pollution, and decreasing vehicle operational costs.

  In addition to the above synchronized routes, Public Works is currently working on a communications analysis to install the appropriate communications device enabling the traffic signals in the unincorporated area of Santa Clarita to be monitored and controlled from our traffic signal control system located in the Traffic Management Center in Alhambra. This traffic signal control system provides for continuous monitoring of traffic conditions and will provide once-per-second monitoring of traffic signals. Traffic signal monitoring provides our engineering staff with immediate notification of signal malfunctions, thereby enabling faster and more efficient maintenance responses. The system also enables traffic signal timing to be controlled and coordinated from remote workstations to adjust to actual traffic conditions.

  Since the ultimate goal of a transportation management system is to enable monitoring via a traffic control system, it would be the County's desire to have all future signals connected to our system. Therefore, we would recommend that all future signal installations include the provision of communications to the County's central system. This communications could be via hardwire methods such as fiber optics or wireless radios, which are currently being deployed Countywide in other areas.

  To enable both Public Works and the City to work together to coordinate the operation of their traffic signals, we have begun discussions with City staff about connecting the City's traffic control system to the County's Information Exchange Network (IEN). The IEN is an advanced traffic management system and network capable of sharing information and control of various traffic control systems and field devices between agencies. The IEN is currently being deployed Countywide and will improve regional traffic flow with the exchange of traffic signal data among multiple agencies and will provide a coordinated response to traffic congestion and incidents. This will enable the City of Santa Clarita's traffic signal data to be incorporated into the IEN and to enable the City to receive data

from other agencies currently connected to the IEN. Additionally, the City of Santa Clarita will receive data from traffic signals in the unincorporated area and the neighboring City of Los Angeles area.

- Page C-16, Level of Service Standard–While the CMP states that local jurisdictions may define acceptable levels of service up to E, the County General Plan does not specify an acceptable level of service. Instead, the County determines whether the traffic generated by a project alone or cumulatively with other related projects, when added to existing traffic volumes, exceeds certain capacity thresholds of an intersection.

- Page C-16, Standard Cross Sections–The cross sections for the City of Santa Clarita and the County do not match and a standard should be agreed upon.

- Page C-42, Street and Highway System–We recommend that the design of circulation plans for proposed schools take into account any conflicts during drop-off/pick-up hours with morning and afternoon peak-hour traffic congestion in the surrounding area. This includes a careful review of a school's location to ensure that bicycle and pedestrian access are encouraged and if vehicles are anticipated to be used for drop-off/pick-up that the queuing created does not conflict with overall circulation.

- Page C-43, Objective C 2.2–We recommend that consistent standards are adopted in the implementation of Americans with Disabilities Act requirements such as curb ramp design, accessible pedestrian signal, etc.

- Page C-44, Objective C 2.2–We recommend the design plans for traffic signal modifications or new installations include the upgrade of poles for future left-turn phasing when warranted and the installation of a time base unit for future coordination.

- Page C-44, Objective C 2.3–Policy C2.3.4 is mislabeled as Policy C2.4.3.

- Page C-46, Objective C 3.2–Policy C3.2.3 is mislabeled as Policy C3.3.3.

- Page C-50, Objective C 6.1–We recommend the use of commuter bikeway signage.

- Page C-51, Objective C 7.1–We do not recommend the use of refuge islands for medians 4 feet wide or less.

- The County also has a program to reduce cut-through traffic through neighborhood streets. The information is available on Public Works' website at http://dpw.lacounty.gov/TNL/NTMP/Page_01.cfm.

- We also agree that a priority should be given to provide a healthy and safe circulation system to address safe pedestrian walkways and bikeways. Given this priority, typical roadway cross sections recommended by the City of Santa Clarita with wider pedestrian paths (Figures 4.4-3 and 4.4-4) are preferred. Other traffic-calming measures such as bulb outs, raised medians, narrower streets, pedestrian islands for wide roadways, and road diet-type of improvements should be considered for implementation to reduce pedestrian crash risk.

If you have any further questions regarding traffic/access, please contact Ron Matsuoka of our Traffic Studies Section at (626) 300-4709.

Services-Sewage Disposal

- The draft EIR should include discussion for the collection and disposal of the waste water that would be generated by the proposed project, especially its potential impact on the available capacity of the existing local sewer lines for both peak dry and wet weather flows pursuant with Statewide General Waste Discharge Requirements, Order No. 2006-0003. The draft EIR should also include discussion on the impact of the proposed project on the existing local and trunk sewer facilities.

- The City of Santa Clarita owns and Public Works' Consolidated Sewer Maintenance District is responsible for the operation and maintenance of the local sewer collection system within the City and the unincorporated Los Angeles County. All sewer construction within the project area shall comply with Public Works' Sewer Design standards.

If you have any question regarding sewer, please contact May Hong at (626) 300-3382.

Other-Environmental Safety

1. Solid Waste

   - Solid waste generated in the County of Los Angeles currently exceeds the available permitted daily landfill capacity. The proposed project will increase the generation of solid waste and negatively impact the Solid Waste Management infrastructure. Therefore, the proposed environmental document should identify what measures will be implemented to mitigate the impact. Mitigation measures may include waste reduction and recycling programs and development of infrastructure in the project to facilitate recycling.

   - School Districts are encouraged to take advantage of special County programs to encourage waste diversion by calling 1(888) CLEAN LA or visiting www.888CleanLA.com.

2. Hazardous Waste

   - The existing Hazardous Waste Management infrastructure in the County of Los Angeles is inadequate to handle the hazardous waste currently being generated. The proposed project may generate hazardous waste and/or household hazardous waste, which could adversely impact existing Hazardous Waste Management infrastructure. This issue should be addressed and mitigation measures provided. Mitigation measures may include, but are not limited to, providing new homeowners with educational materials on the proper management and disposal of household hazardous waste. The project proponent may contact Public Works for available educational materials by calling 1(888) CLEAN LA.

   - If any excavated soil is contaminated, or classified as hazardous waste by an appropriate agency, the soil must be managed and disposed of in accordance with applicable Federal, State, and local laws and regulations.

3. Storage Space for Recyclables

   The California Solid Waste Reuse and Recycling Access Act of 1991, as amended, requires each development project to provide an adequate storage area for collection and removal of recyclable materials. The environmental document should include/discuss standards to provide adequate recyclable storage areas for collection/storage of recyclable and green waste materials for this project.

4. Construction and Demolition Recycling Comment

   Construction projects with a total value of over $100,000 and demolition and grading projects in the County's unincorporated areas are required to recycle or reuse 50 percent of the construction and demolition debris generated per the County's Construction and Demolition Debris Recycling and Reuse Ordinance. A Recycling and Reuse Plan must be submitted to and approved by Public Works' Environmental Programs Division before a construction, demolition, or grading permit may be issued.

5. Building and Safety Issues

   - The Los Angeles County Building Code, Section 110.4, requires that buildings or structures adjacent to or within 200 feet (60.96 m) of active, abandoned, or idle oil or gas well(s) be provided with methane gas protection systems. If the project site contains or lies within 200 feet of active, abandoned, or idle oil or gas wells, this issue should be addressed and mitigation measure provided, and Public Works' Environmental Programs Division must be contacted for issuance of necessary permits.

   - The Los Angeles County Building Code, Section 110.3, requires that a building or structure located on or within 1,000 feet (304.8 m) of a landfill containing decomposable material must be protected against landfill gas intrusion. The project site contains landfills, so this issue should be addressed and mitigation measures provided. The discussion should include subsurface lateral migration of landfill gas, migration detection, and control and protection systems for affected enclosed buildings and structures. Public Works' Environmental Programs Division must be contacted for issuance of necessary permits.

6. Underground Storage Tanks/Industrial Waste/Stormwater Comments

   - Should any operation within the subject project include the construction, installation, modification, or removal of underground storage tanks, industrial waste treatment or disposal facilities, and/or storm water treatment facilities, Public Works' Environmental Programs Division must be contacted for required approvals and operating permits.

   - Food service establishments may be required to provide a grease treatment device and will be subject to review and approval by Public Works' Environmental Programs Division.

- All development and redevelopment projects which fall into one of the Standard Urban Stormwater Mitigation Plan project types, characteristics, or activities, must obtain Standard Urban Stormwater Mitigation Plan approval by the appropriate agency.

7. Supplemental Comments

   A number of landfill closures have been experienced within the last few years and more closures are expected to occur in the near future. As regional disposal facilities close, there is an increasing need for regional transfer facilities to efficiently transport solid waste generated to more distant processing or disposal facilities. These transfer facilities are essential for the cities in the County of Los Angeles and the unincorporated areas to be able to properly manage solid waste in accordance with the requirements of the California Integrated Waste Management Act of 1989, also known as AB 939, provided they are found to be environmentally and technically feasible.

   If you have any questions regarding environmental comments above, please contact Benjamin Cortez at (626) 458-2536.

If you have any questions or require additional information, please contact Toan Duong at (626) 458-4945.

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OVOV November 2008 Workshop Comment Cards

Element	Comment	Action	Timeline	Responsible Party	Resident Contact Info
OS	• Blue Streams should be noted. There are developments over the location of these streams. This should also be noted.				Katharine Squires 661-296-4305 kat_268@att.net
	• Glad to see that SEA's (Sig.Eco.Areas) have been included on maps. Strong language should be in place to protect these areas from development				
	• All fossils/specimens found during grading etc. should really be donated to the Los Angeles County Museum to be recorded.				
	• It is critical that development not be permitted in areas of extreme fire/earthquake danger, i.e. Lyons Cyn Ranch				
	• It is imperative that the best paleontologist etc., be consulted. The rate of uplift in the Towsley Cyn. Area is parallel to that of the Himalayas! A very good reason to limit development				
	• Limiting sprawl development is essential - continuing concern				
	• Having wildlife corridors on maps would be great to see				
ALL	• Conditions or New Zone Commercial Suburban for Smiser Property - 35 feet height limit - .375 x 1,611,720 sq. ft. = 604,375 sq. ft. - .50 x 1,511,720 sq. ft. = 805,860 sq. ft. - .75 x 1,611,720 sq. ft. = 1,208,790 sq. ft.				Calgrove Corridor Coalition Annette Lucas, Co Chair Glenda Bona, Co Chair
	• A beautiful entrance into the Santa Clarita Valley that feathers into the existing neighborhoods				
	• Wiley Canyon – No more than 4 lanes				
	• Green Belts throughout the development				
	• Calculation does not include CalTrans property taken away for freeway development				

Element	Comment	Action	Timeline	Responsible Party	Resident Contact Info
Land Use Housing Circulation Open Space EIR	• Connecting Dockweiler with Lyons will create a terrible unsafe condition for the Dockweiler residents. The Lyons crossing will create another unsafe train crossing at a time when more trains are being used for commuter transportation and movement of freight.				Sandra Cattell sumcatt@yahoo.com
	• All Blue Line Streams should be shown in transportation, housing, land use, safety, and circulation elements (not just floodway).				
	• Las Lomas area land purchase options by Palmer either have or are about to expire.				
	• Placerita creek, near South Fork, should be investigated as a SEA, definitely is an underground stream.				
	• Would like to see most of the property owned by Casden in Placerita become open space.				
	• Lyons Ranch project is unsafe. It is in an extreme high fire hazard area. It is also in an SEA.				
	• DO NOT ALLOW building in high fire hazard, flood hazard, and high earthquake hazard areas. We cannot afford this gambling with lives nor does the next of the community want to bear the expense.				
Land Use	• What is NET result of Down-Zone/Up-Zone density?				Tony Natoli 20842 Benz Rd. 661-296-7277 natolial@pacbell.net
Land Use	• 21563 Cleardale St. Newhall, CA 91321				Phil Rawlins 21565 Cleardale 661-259-3533 p_frawlins@sbcglobal.net
	• Lot 133. No Road, No Water				
	• Flood Plain goes through middle of property				
	• High risk fire zone				
	• New zoning not compatible with surrounding properties.				
	• Please find picture of property				
	• SEE ATTACHED PICTURE TO COMMENT CARD				
ALL	• Interactive mapping – City to create program similar to county re. current land use density and future land use density				Timben Boydston
OS	• Check final rule federal register shows boundary for Arroyo to				

Element	Comment	Action	Timeline	Responsible Party	Resident Contact Info
OS	• Property designation in Placerita Canyon				Phil Rawlins
	• Reconsider higher density residential designation along Los Canyon Road on east side of Sand Cyn Rd.				

PCPOA OVOV Concerns; dated December 23, 2008

PCPOA OVOV Concerns

Flood Concerns:

1. Maps must list all blue line streams.
2. Plan must protect both blue line streams and the recharge areas along them. The normal and usual flow of a blue line stream should never be channelized, built on or altered in any way.
3. Homes behind the blue line streams cannot be further isolated and threatened.
4. The newest FEMA studies and maps must be followed; building in Floodways must be assiduously avoided.
5. Water flow must be considered. In Placerita Canyon, the City did an engineering study in conjunction with the backbone sewer system that showed the system did not need lifts or pump stations; it could be gravity fed to what is now considered the "Cowboy Festival" parking lot. That clearly means that water drains to that field. If it is covered with buildings and concrete, water will back up in Placerita Canyon threatening residents and property.

Circulation Element:

1. A recent article in the Los Angeles Times indicated most commuter rail fatalities occur at at-grade crossings. The proposed Lyons to Dockweiler at-grade crossing will be very heavily traveled and the only viable way from Placerita Canyon into the City. Projected increased rail traffic over the next years and decades will only exacerbate circulation and safety problems.
2. Circulation studies on the Lyons to Dockweiler at-grade crossing must be done on "peak volume" basis.

Neighborhood Identity:

1. Poor planning can destroy a neighborhood. Placerita Canyon, from the railroad tracks to Sierra Highway, is designated a Special Standards District to protect our rural equestrian neighborhood. Any development within, or adjacent to, the Special Standards District should reflect the unique heritage of Placerita Canyon. There need to be adequate circulation and buffer zones to protect and preserve the rural equestrian nature.
2. The new MXN (Mixed Use Neighborhood) is not appropriate in a Special Standards District where up to four times the square footage of that in the Regional Mall would be allowed on the "Cowboy Festival" parking lot. The Mall is served by three major regional roads; Placerita Canyon is served by a single two-lane road. (Dockweiler, at build-out, is planned to be only a four-lane road.) Further, the area in Placerita Canyon is currently designated a Floodplain and is due to be upgraded to Floodway; it is totally unsuitable to the level of development discussed in the Land Use Portion of One Valley One Vision.

General Comments:

1. Placerita Canyon Property Owners' Association Board of Directors looks forward to presenting additional suggestions to strengthen the Special Standards District.
2. The Preliminary Land Use map (October 6, 2008) inexplicably shows a high density project (19 DU's per acre) in the middle of Placerita Canyon. We were told this was an error and would be corrected. Please do so.

Thomas M. Surak Comment on NOP; dated May 27, 2009

Thomas M. Surak

23712 Adamsboro Drive
Newhall, CA 91321

May 27, 2009

Mr. Jason Smisko, Senior Planner

City of Santa Clarita

Email: jsmisko@santa-clarita.com

Mr. Paul Novak, Planning Deputy

County of Los Angeles

Email: sosuna@lacbos.org

Re: Notice of Preparation - One Valley, One Vision

Dear Mr. Smisko and Mr. Novak:

I am pleased to be able to provide the following comments regarding the draft OVOV documents. In general, the documents appear to be deficient in many areas. They do not offer Santa Clarita residents the same protections and promises which currently exist in the General Plan. Also, as having participated in many aspects of the OVOV process, I can testify to the fact that it was overly cumbersome, often confusing and not at all conducive to inviting full participation by all interested parties. Several of my specific issues and concerns are discussed below. I expect similar comments will be submitted by other residents, which will require additional public participation before the OVOV process can move forward. I can only hope that this will lead to timely and successful resolution of all issues.

The City has not made a proper showing for why it is proposing significant revisions the existing General Plan. The City's flyer, "OVOV Facts and Benefits" which was widely circulated to the public, clearly states that the build-out population estimates adopted for the 1991 General Plan maxed at 521,977 people, and that the OVOV estimates a build-out population range of 444,000 to 485,000. The obvious yet unanswered question is then, "Why are increases in zoning densities, in many cases significant ones, being proposed for the OVOV?" The City cannot legitimately argue that the increased density is to accommodate non-residential development because most OVOV commercial zoning definitions allow for extremely high density (e.g., a minimum of 11 units per acre) residential use. These "commercial zone" residential densities overwhelm those of the surrounding neighborhoods, and such development can only be perceived as detrimental to nearby residents. As further discussed below, the City's concept of a "Valley of Villages" as laid out in the OVOV is not consistent with the principle of enhancing established neighborhoods, nor with development consistent with neighborhood community character, which are both key objectives stated in the OVOV.

Page L-39 of the current General Plan makes it clear that the land use designations adopted in 1991 "should not be construed as temporary holding categories awaiting higher density designations in the

future." It further states, "The Plan has looked at development suitability within the entire Santa Clarita Valley and applies designations for anticipated, long-term future development." The draft OVOV clearly makes a mockery of this promise. OVOV zoning densities are drastically increased throughout the valley.

Also, many new zoning categories are overly broad with respect to allowable types of applicable development. For example, the Regional Commercial, Community Commercial and Neighborhood Commercial zoning designations all allow for mixed use (i.e., residential) development, even though the OVOV also has separate "Mixed Use" zoning designations which more clearly convey the ability to allow such proposed developments. The General Plan is clear when it states "surrounding characteristics, preservation of neighborhood integrity and compatibility with existing uses shall also be taken into consideration in connection with new development proposals." The guiding theme of the OVOV, "A Valley of Villages", casts these neighborhood protections aside by requiring increasing density projects which are entirely inconsistent with the characteristics of surrounding neighborhoods.

The City's concept of a "Valley of Villages" conveniently avoids discussion on the subject of different housing types having different public service requirements. For example, persistent crime hotspots in the Santa Clarita Valley are highly correlated with housing density, e.g., the largest crime problems are associated with higher density housing near downtown Newhall and in Canyon Country. The OVOV does not consider or address additional financial and emotional costs which will be imposed upon existing residents as a consequence of increased crime associated with the OVOV's high density housing proposals.

The OVOV undermines existing neighborhood protections from such high density projects. These protections are inherent in the 1991 General Plan, which many who have since settled into Santa Clarita relied on when making their decision to move here. Without a showing of benefits to existing neighborhoods, one can readily conclude that the OVOV is primarily designed to provide developers an opportunity to further increase their profit opportunities through increased zoning densities. Such opportunities are properly restricted under the existing General Plan through its embedded protections provided to residents of Santa Clarita, and these protections must be maintained.

Some basic elements of the OVOV which must be understood to ensure full participation in the OVOV process were not (and may still not be) clearly communicated to the public. For example, the proposed zoning designation of the Smiser property located in my neighborhood near Calgrove & Wiley Canyon was recently (and unknowingly) revised. At the November public workshops which showcased the draft OVOV, the Smiser property zoning designation was clearly identified as Community Commercial. A completely new zoning designation for this property, Mixed Use – Neighborhood (MXN), has just recently been brought to my attention. However, one cannot readily determine that there has been a new zoning designation by reviewing the revised December 19 Preliminary Land Use map posted for public review, which is the key document for purposes of OVOV review and understanding. The blue and white striped color designation assigned to this MXN zoning designation on the map completely blends in with the blue and white stripe used to assumedly delineate the city boundary which is adjacent to the Smiser property. No reasonable person could have been expected to learn of this zoning change through periodic review of this map, yet that is what was expected from those attempting to participate in the OVOV process. I can only assume that this color scheme selection was just a coincidence and unintentional. However, it does illustrate one of the many unnecessary difficulties OVOV participants have had to overcome in order to properly become engaged in the OVOV process.

Another example of confusion derives directly from the exclusion of a critical clarification in the General Plan from the OVOV zoning definitions. The General Plan clarifies that appropriate project intensity "is generally expected to be between the low and mid-point of the allowable floor area ratio (FAR) range". Comparisons made by City Staff in documents and at public meetings which suggested that allowable city development under the General Plan and the OVOV were equivalent did not incorporate the lower FAR range clarification embedded in the General Plan, and thus overstated allowable development

under the General Plan. Stated another way, the OVOV will allow for much denser development even at similar FAR since it no longer requires project intensity to be at the lower end of the allowable FAR range. Unless the above clarification regarding a lower appropriate project intensity is incorporated into the OVOV, representations made regarding comparable allowable development under the General Plan and the OVOV were incorrect because they minimized impacts under the OVOV, and were likely to have diminished public participation in the OVOV process.

Also, there is language throughout the OVOV which lessens the certainty of limiting future development to the designated zoning. For example, page I-3 states "all subsequent planning and development decisions within the Santa Clarita Valley planning area shall be determined to be consistent with these documents, except as provided herein for any land use applications pending during the plan preparation and adoption process." This caveat completely undermines the ability of citizens to fully appreciate what is capable of being developed in their neighborhoods and other areas where they may have special concerns and interests, and effectively disengages many from actively participating in the OVOV process. In addition, this caveat is not consistent with public representations which have made. Please refer to an October 5, 2008 article in "The Signal" titled, "SCV ponders 'one vision' for growth" which quotes both of you as well as Paul Brotzman. This article includes the following statement: "Though general plans by definition are general, the state mandated documents must include a map that describes exactly what type of development can occur on every inch of land." I do not recall any clarification or rebuttal to this statement having been made by City or County staff. I also believe many more residents have read "the Signal" for information on the OVOV than have read through the several hundred pages of draft OVOV documents. The development flexibility being sought in the OVOV which I cited above does not comply with this statement. Therefore information provided to the majority of residents regarding the development flexibility sought within the OVOV is misleading at best. The City and County cannot assume that residents fully comprehend this development flexibility. Therefore the OVOV cannot be allowed move forward with this intended flexibility without further public disclosure and discussion.

The OVOV inadequately addresses how existing deficiencies in City parks and recreation facilities will be met. The OVOV states, "The Land Use Element is the City's and County's long-term blueprint for development of property to meet Santa Clarita Valley's future needs for … parks, open space…including location for future uses within the planning area." It furthermore states, "The provision of adequate park space and facilities to serve residents is not only required by State planning law, but is recognized as necessary to provide for public health and quality of life." The OVOV further recognizes that "another issue for park development is distribution of park facilities, as many local parks are concentrated within master planned communities, and outlying areas have access to fewer local parks." The OVOV confirms that the City has a "standard" (the term "requirement" is used in the 1991 General Plan, which I interpret as the true intent) of five acres of park facilities per 1000 residents, and yet the City currently has "only about 1.5-2 acres of developed parkland per 1000 population", which is essentially unchanged from when the General Plan was adopted in 1991. (In fact, as of October 2008 the true ratio is 1.4 acres of parkland per 1000 population as stated by the City of Santa Clarita Parks, Recreation, and Community Services Commission, which increases the magnitude of the existing parkland deficiency.) In essence, notwithstanding the claims that significant parkland has been added since 1991, due to corresponding population growth there has been no significant progress made towards meeting the parkland "target" in almost two decades. This is especially true in areas which were identified as being underserved throughout that timeframe, which will have to be met through land acquisition using "additional funding sources." This is because the State's Quimby Act which has been used to acquire the majority of parkland added since 1991 only provides parkland (and only at an below "target" three acres per 1000 population) for residents of new developments.

The OVOV ignores the critical additional parkland requirement (per Policy LU 3.4.1) by stating that the Conservation and Open Space element "will not serve as a park master plan but will instead focus on broad policy issues relating to park planning." The OVOV just defers on this issue by identifying as City Task 8.1, "Complete and adopt a revised Park and Recreation Master Plan for the City by 2009." This is unacceptable. The OVOV must fully coordinate with the park master plan on a detailed level; by not

doing so, the OVOV invites development of remaining open areas which must be preserved for future parkland to meet the adopted parkland "target." This need for coordination holds especially true in areas which have an identified parkland deficiency and minimal remaining acreage which can help meet that deficiency. In fact, the Final Draft of the Parks, Recreation and Open Space Master Plan Update states, "Priority should be given to meeting the current (park) acreage deficit of 612 acres." However, the OVOV not only lacks any priority with respect to additional parkland in the OVOV, there are inherent barriers to the creation of additional parkland created by the OVOV.

For example, the Calgrove/Wiley Canyon neighborhood was identified in the existing General Plan as being "severely underserved" with respect to parks (this neighborhood is similarly identified as having a "service area gap" in the Final Draft of the Parks, Recreation and Open Space Master Plan Update, which I take as a euphemism). The only remaining undeveloped land which can be used for a neighborhood park in the Calgrove/Wiley Canyon area is the Smiser property. However, not only does the latest OVOV zoning of the Smiser property not include any reference to parkland, it instead proposes to increase the density allowed for development of that property! By increasing the allowable build densities on remaining undeveloped property such as Smiser, the OVOV increases the residual value of properties which are most suitable for helping close the significant gap between target and actual park acreage. Thus the OVOV will create further barriers to meeting the park master plan objectives by unnecessarily increasing the future cost of acquiring acreage for parkland. This will undermine the ability of and likely preclude the City from meet existing, let alone future, parkland needs under the prescribed "target".

The environmental aspect of the OVOV addresses climate issues only from a macro perspective; the issue of microclimate changes which are common with increased "urbanized" development such as that contemplated by the OVOV is ignored. Microclimate issues must be incorporated into the EIR study process to provide a complete and proper assessment of potential impacts from the build out proposed by the OVOV. Also, there is a lack of focus on increased noise associated with increased urban development, both during and after construction, as proposed in the OVOV. The importance of this issue cannot be ignored since increased noise pollution has the ability to undermine the tranquility that residents of Santa Clarita currently appreciate and will continue to expect in the future.

Please feel free to contact me for further clarification on the above.

Sincerely,

Thomas M. Surak

Valley Industrial Association Letter to the City of Santa Clarita; dated February 6, 2009

VALLEY INDUSTRIAL ASSOCIATION OF SANTA CLARITA

A California Non-Profit Corporation
(I.R.C. §501(c)(6)) • Tax Identification No. 95-3996296

President and CEO
Kathy Norris

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February 6, 2009

Paul Brotzman
Director of Community Development
City of Santa Clarita
23920 Valencia Blvd., #300
Santa Clarita, CA 91355

Subject: VIA input to the City draft Housing Element and Circulation Element

Dear Mr. Brotzman,

Thank you to you and your City Staff members for calling the meeting with me and VIA board member Andy Pattantyus on January 15, 2009, to review the City's plans for complying with SB-2 requirements in the revision of the Housing Element, which currently exists in draft versions. Please send us a copy of the next draft as soon as it becomes available. In this letter, we first summarize the meeting, then we will get into the specific things that the business community (represented by VIA) would like to see included in the Housing Element and Circulation Element.

Summary of Meeting on Jan 15, 2009.

Attendees from VIA: Kathy Norris and Andy Pattantyus
Attendees from the City: Paul Brotzman, Tina Haddad, Jason Killebrew, Lisa Webber

Purpose of the meeting: Review SB-2 Affect on Business Parks

Summary. SB-2 requires each City and County in California to designate at least one zoning code where Homeless Shelters and Transitional Living Centers can exist "by-right", which means that Use Permits are not required to set-up an operation. The city of Santa Clarita has decided to handle the requirement by creating an "overlay" onto the zoning code "Business Park". The boundaries of the overlay encompass most of the area of the Centre Point Business Park and the Valencia Business Park. The Centre Pointe overlay area encompasses the current location of the Winter Shelter on Golden Valley Road. The City can still contractually apply constraints to any homeless shelter operation, regulating such parameters as the number of beds, operating hours, parking, etc.

Other. While we had everybody in the room, VIA made its interests known to the City re: Housing and Transportation

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Housing. First we talked about the Housing Element. The City says that it will make available sufficient land to build 4,000 low and very low income housing by 2014 at a density of 30 units per acre. The City cautioned that the City is required only to make the land available, but not to assure that the units get built. That is a "free market" issue. The City said the main problem is the lack of rentals. While nationally, the ownership to rental ratio is 65 / 35, in Santa Clarita Valley it is 80 / 20. The community shows a strong bias against rentals, because of the public's perception that crime and trouble is associated with rental developments.

Transportation. Next we talked about the Circulation Element. VIA talked about the need for more trains and more buses that start earlier in the day and leave later at night. The City responded by saying the issue is money. Trains and buses are subsidized, meaning that the fare does not cover the cost of operation. Thus, funding is needed. Santa Clarita is a part of the North LA Transportation Corridor. Thus, on every transportation project, we compete with the City of LA. We need to more actively lobby and more actively measure the needs. The City mentioned that lobbyist Arthur Sohikian is actively lobbying on behalf of the North LA County Transportation Corridor.

VIA indicated to the City that VIA expects the City to take a leadership position in solving these problems, which means doing more than the minimum required by law.

Housing Element Compliance with SB-2

As stated in the summary of the meeting, the primary purpose of the meeting was for the City to review with VIA the method of compliance to the state law SB-2, which requires that the City designate at least one zoning code where homeless shelters and transitional living centers can locate "by-right", without any use permits. As we understand it, the City intends to comply with the requirements by designating an "overlay" onto the zoning code Business Park (BP) which encompasses most of the Centre Pointe business park and the Valencia Industrial Park on the Northwest part of town. Impact on the community will be mitigated by City processes for review and community comment, as with any other development. We also understand that transitional housing and permanent supportive housing will be allowed in the zoning code "Residential".

The Valley Industrial Association supports this proposal.

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Housing Element and Workforce Housing

The Valley Industrial Association is a business organization, and, as such, it is our mission to support business and industry in the Santa Clarita Valley. VIA believes that in order for a city to be vibrant and successful, we not only need a variety of workers at all levels, but we need varied housing availability to support those workers and their families. This must be incorporated as a part of the City's general plan and housing element.

The Valley Industrial Association has been researching and advocating the subject of Workforce Housing for several years. We have conducted several forums, including a symposium and a panel discussion. We have also surveyed many of our member companies to identify the issues. We believe the issue can be best summarized as follows: ***A large number of hourly and salaried workers, such as factory workers, teachers, EMT, firemen, policemen and other essential service workers, who work in Santa Clarita cannot afford to live in Santa Clarita.*** We are talking about workers who earn between $30K and $60K per year. This results in a reliance on a non-local workforce that creates a number of challenges for our employers, including: high worker turnover, loss of workdays during a disaster (when freeways are shut-down), long and costly commutes for the lower tier of wage earners, and an inadequate labor pool to draw from when trying to fill job openings.

In this context, VIA has reviewed the November 20, 2008 draft of the Housing element. VIA understands that there is a newer draft that will be available in January or February, but we worked with the version available to us.

VIA's assessment is that the November 20, 2008 draft of the City of Santa Clarita housing element is minimally compliant with the state requirements, and on many issues does not meet the needs of the businesses represented by VIA.

The biggest deficiency is in the area of Work Force housing, which encompasses Low Income and Very Low Income. The current draft of the Housing Element lumps Low Income and Very Low Income housing together into one category. These categories are very distinctly different, and should be kept in two separated categories. The draft Housing Element says that against a need of 1,256 units of Very Low Income housing, only 20 were constructed? Why? How will the City assure that this same pattern does not repeat in the next 7 years? VIA understands that sufficient zoning will be designated to meet the need. But what if the free market does not fill the need? What pro-active steps will the City take to assure that the much needed housing gets built?

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Circulation Element and Transportation

VIA commends the City of Santa Clarita for doing an excellent job with Santa Clarita Transit, with MetroLink, with the Cross Valley connector, with Traffic Flow upgrades, and with repaving of major arteries within the industrial parks (ex: Rye Canyon Rd. repaving.). In spite of this excellence, there are some transportation needs that are not being met, and VIA would like to call the City's attention to these matters.

Ultimately, the business community in Santa Clarita needs easy access to a large and stable labor pool. Ideally, the workers should be able to live in the same community where they work, without long and expensive commutes. The members of VIA understand that any solution based on development and construction of housing will be at least a decade away, considering the pace of development and community input. Thus, VIA sees improved transportation as the interim method of assuring a stable and readily available workforce.

More could be done in the Section "Travel Demand Management". This section is vague and lacking in specific measures that the City could initiate, with co-operation and support from manufacturing employers and members of VIA. For example, one of the VIA manufacturing employers offered an incentive for workers to take the train from Palmdale and Lancaster to Santa Clarita. Only 4 out of hundreds of eligible workers took advantage of the incentive? Why? The City should investigate and find out. VIA has conducted some informal inquiries to learn about the issue. The trains do not leave early enough and late enough between Palmdale/Lancaster and Santa Clarita to even support a single shift with overtime (a ten or 11 hour workday). Thus, workers would have to sacrifice available working hours in order to take the train (using the incentive). Thus, they do not take the train.

VIA has responded to gaps in available public transportation by educating its members about the availability of van pools, and has promoted the use of several available services. The van pools can be contracted either by the employers, or by the workers directly independently of the employers. Through discussions with its members, VIA has found out that van pools and transportation incentives are extremely price sensitive, with as little as $5 to $10 per week being the difference between participation and non-participation. How many van pools are in operation to support Santa Clarita businesses? The City should know this, and should see van pools as an indicator of gaps in public transportation.

Transit Corridors. Missing in the Circulation Element is any discussion about the establishment of high density transportation corridors in the master plan that are specifically located in proximity to the zones and parcels designated as "high density" to encourage the development of transit oriented housing that is specifically well suited to the needs of the Santa Clarita hourly workforce.

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Hours of Operation. Section O. Summary of Circulation Needs. This section does not address the needs of the membership of VIA to get hourly workers from Palmdale / Lancaster / Pacoima / Santa Paula to Santa Clarita in the morning, and back at night. Also, the element does not support the transportation needs of manufacturers that would like to expand the use of their capitally intensive facilities to a two shift operation. Two shift operations would require trains and buses that leave outlying areas between 4:00 and 5:30 in the morning, and between noon and two in the afternoon, and returning in the late afternoon (after first shift) and returning after mid-night (after second shift).

Compliance with SB-375 "Anti-Sprawl" Bill

The current drafts of the Housing Element and Circulation Element do not address the requirements of SB-375. VIA strongly advocates that the drafts of these elements be

upgraded to address the requirements of SB-375 in the current revisions. Otherwise, both elements will have to be reviewed and upgraded again within 2 years to comply with SB-375. The basic principle of "anti-sprawl" is that workers should live in the same community where they work, resulting in a short reasonable commute that is energy efficient and reduces greenhouse gas emissions.

Both the Housing Element and the Circulation Element do not address the following question: ***How many hourly workers in Santa Clarita do not live in Santa Clarita?*** Is it 10,000? 20,000? How do the people who work in Santa Clarita, but live far away (Palmdale, Lancaster, Santa Paula, Frazier Park, Pacoima), get to work? When fully built out, the Industrial Parks in Santa Clarita will employ about 80,000 people. Will half of these workers face a 40 mile each way commute every day?

The Housing Element is completely devoid of any study or survey that quantifies the number of people who work in Santa Clarita, but do not live in Santa Clarita. During the public review and community input session in August of 2008 at the Newhall Community Center, VIA requested that the City take steps to quantify the number of people who work in Santa Clarita, but cannot afford to live in Santa Clarita. So far, there is no evidence that the City has attempted to quantify this very important number. As one example, Princess Cruises employs 2,000 people in Santa Clarita. Of these workers, 1,200 live in Santa Clarita, and 800 do not.

The Circulation Element does not address the subject of making provision for low income workers to live close to their workplaces, along high density transportation corridors such as trains, trolleys, and major bus routes. How long does it take for an hourly worker to get to work by bus and/or train? How many bus transfers are required? How much does it cost per month? How does that cost compare to car pooling and van pooling?

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Leadership

VIA would like the City of Santa Clarita to join VIA in taking a leadership position in the Housing Element and Circulation Element, by planning for the community's real needs, rather than what is minimally required by state law. The Industrial Community in Santa Clarita, represented by VIA, has real needs that are currently not being met in the planning and development processes. These needs are approximately summarized in this letter.

VIA would like to challenge the City of Santa Clarita to do the following:

1. While VIA admires the City's plan to comply with SB 2, we feel merely complying with minimum requirements isn't enough for such a forward thinking city like ours. We're so much better than that! Let's improve on the basics.
2. Help draft Housing and Circulation Elements that meet the needs of the business community and the hourly workers that work in Santa Clarita.
3. We need a more granular approach to housing. We need to make sure diverse housing across many spectrums of need is included. Each level must be clearly defined (low income and very low income should not be combined into a single level). A more granular approach is needed. The plan must be very specific. Where are single starting teachers going to live? Where are other public service employees like EMT, firemen, policemen going to live? Where is a newly graduated engineer going to live? How will the City assure that 4,000 units of low income and very low income housing are built? Simply stating that "the free market will take care of it" is not an answer. As well, we (the City and the business community) have the social responsibility to educate people about purchasing, the lending processes, and how to succeed financially.
4. The planning (for assuring that workers are available) needs to go beyond housing and should incorporate transportation and mobility (circulation elements). Currently, the Housing and Circulation Elements try to answer the question: "Where do the residents of Santa Clarita work, and how do they get to work?" Now, in the new revisions, we must also answer the question: "***Where do the workers of Santa Clarita live, and how will they get to work***?"
5. Where will the high density housing be built? Special consideration should be given to locating the housing near transportation hubs, or locating transportation hubs near the housing. Residents will need effective and reasonable transportation choices to get to the workplace.
6. The plan should be very specific about how properties/projects will be acquired and how the housing will be offered. Who will build it? Who will interview the applicants? If the free market does not respond (perhaps because they view the environment as "hostile") then what action will the City take to assure that there are bidders for the desired projects?
7. Will the City of Santa Clarita commit funds and/or land to Work Force housing? If so, how much?

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VIA will be happy to work with the City to assure that the needs of the industrial business community are met.

Please note that the content of this letter is approved by the board of VIA, and thus represents the needs of the industrial business community represented by VIA.

Sincerely,

Kathy Norris

Kathy Norris
President and CEO

cc: Tina Haddad
Jason Killebrew
Lisa Webber
Andy Pattantyus
Randy Moberg

APPENDIX 3.2

One Valley One Vision Valley-wide Traffic Study, prepared byAustin-Foust Associates, Inc.; dated June 2010

ONE VALLEY ONE VISION

VALLEY-WIDE TRAFFIC STUDY

TECHNICAL REPORT FOR THE CIRCULATION ELEMENTS OF THE SANTA CLARITA VALLEY AREA PLAN UPDATE (LOS ANGELES COUNTY) AND THE CITY OF SANTA CLARITA GENERAL PLAN UPDATE

JUNE 2010

AUSTIN-FOUST ASSOCIATES, INC.
TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING

ONE VALLEY ONE VISION

VALLEY-WIDE TRAFFIC STUDY

Technical Report for the Circulation Elements of the Santa Clarita Valley Area Plan Update (Los Angeles County) and the City of Santa Clarita General Plan Update

Prepared for:

City of Santa Clarita
County of Los Angeles

Prepared by:

Austin-Foust Associates, Inc.
2223 Wellington Avenue, Suite 300
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(714) 667-0496

June 22, 2010

CONTENTS

Page

1.0 INTRODUCTION 1-1
1.1 BACKGROUND 1-1
1.2 PERFORMANCE CRITERIA 1-3
1.2.1 Arterial Streets and Intersections 1-5
1.2.2 Freeway Segments 1-7
1.3 INFORMATION IN THIS REPORT 1-8
1.4 DEFINITIONS 1-8
1.5 REFERENCES 1-9

2.0 TRANSPORTATION SETTING 2-1
2.1 EXISTING ROADWAYS 2-1
2.1.1 Existing Traffic Volumes 2-4
2.1.2 Existing Levels of Service 2-4
2.2 FUTURE TRAFFIC GROWTH 2-10

3.0 ARTERIAL ROADWAYS 3-1
3.1 ROADWAY CLASSIFICATIONS 3-1
3.1.1 Major Arterial Highway 3-1
3.1.2 Secondary Arterial Highway 3-1
3.1.3 Limited Secondary Arterial Highway 3-2
3.1.4 Parkway 3-2
3.1.5 Collector Streets 3-2
3.1.6 Local Streets 3-2
3.1.7 Expressway 3-3
3.2 ROADWAY DIMENSIONS 3-3
3.3 PROPOSED ROADWAY PLAN 3-3

4.0 TRAFFIC ANALYSIS 4-1
4.1 LONG-RANGE TRAFFIC VOLUMES 4-1
4.2 LONG-RANGE LEVELS OF SERVICE 4-1
4.2.1 Arterial Roadway Segments 4-21
4.2.2 Arterial Intersections 4-22
4.3 FUTURE IMPROVEMENTS 4-24
4.4 FREEWAY ANALYSIS 4-24
4.4.1 I-5 Freeway 4-24
4.4.2 SR-14 Freeway 4-35
4.4.3 Freeway Traffic Volumes and LOS 4-36
4.5 CONGESTION MANAGEMENT PROGRAM ANALYSIS 4-36
4.6 GROUND TO PLAN ANALYSIS 4-39
4.6.1 OVOV Land Use with the Proposed Highway Plan Network 4-39

(Continued)

CONTENTS (Continued)

APPENDICES:
- A: Intersection Capacity Utilization Worksheets
- B: Land Use and Trip Generation Comparison
  1. 2004 and OVOV Buildout Plan
  2. Current City General Plan/County Area Plan and OVOV Buildout Plan
- C: OVOV Buildout Trip Generation by TAZ – AM, PM and ADT
- D: Traffic Model Data
  1. Traffic Analysis Zone (TAZ) Map
  2. Trip Rates
  3. Speed and Capacity Table
- E: Freeway D/C Calculations

LIST OF FIGURES

Page

Figure 1-1: OVOV Planning Area 1-2

Figure 2-1: Existing Roadway Network 2-2
Figure 2-2: Study Area Roadway Segment Identification Numbers 2-5
Figure 2-3: Study Area Intersection Identification Numbers 2-6
Figure 2-4: Average Daily Trafffic Counts – Existing Conditions (2005 to 2010) 2-7
Figure 2-5: AM Peak Hour Turning Movement Volumes - Existing Conditions (2007 to 2010) 2-8
Figure 2-6: PM Peak Hour Turning Movement Volumes - Existing Conditions (2007 to 2010) 2-9
Figure 2-7: Existing (2004) Average Daily Traffic (ADT) Percentages 2-16
Figure 2-8: OVOV Buildout Average Daily Traffic (ADT) Percentages 2-17
Figure 2-9: Total Average Daily Traffic (ADT) Volume Comparison 2-17

Figure 3-1: Typical Roadway Cross-Sections – Major and Secondary Arterial Highways 3-6
Figure 3-2: Santa Clarita OVOV Buildout Highway Plan 3-11

Figure 4-1: Average Daily Traffic Volumes – OVOV Buildout Conditions 4-2
Figure 4-2: AM Peak Hour Turning Movement Volumes – OVOV Buildout Conditions 4-3
Figure 4-3: PM Peak Hour Turning Movement Volumes – OVOV Buildout Conditions 4-4
Figure 4-4: Average Daily Traffic Volumes – Current General Plan Buildout Conditions 4-5
Figure 4-5: AM Peak Hour Turning Movement Volumes – Current General Plan Buildout Conditions 4-6
Figure 4-6: PM Peak Hour Turning Movement Volumes – Current General Plan Buildout Conditions 4-7
Figure 4-7: Intersection Level of Service Comparison – Principal Intersections 4-23

Figure A-1: Study Area Intersection Identification Numbers A-2
Figure D-1: SCVCTM Traffic Analysis Zones D-2

LIST OF TABLES

Page

Table 1-1: Level of Service Descriptions for Urban Streets 1-4
Table 1-2: Daily Roadway Capacity Values 1-5
Table 1-3: LOS Criteria for Arterials 1-6
Table 1-4: Arterial Intersection ICU Methodology 1-7
Table 1-5: LOS Criteria for Basic Freeway Segments 1-7

Table 2-1: ADT V/C and LOS – Existing Conditions (2005 – 2010) 2-11
Table 2-2: ICU and LOS Summary - Existing Conditions (2007 – 2010) 2-15
Table 2-3: Valley-wide Land Use and Trip Generation – Existing (2004) vs. OVOV Buildout 2-16
Table 2-4: Valley-wide Land Use and Trip Generation – Current Plan Buildout vs. OVOV Buildout 2-18
Table 2-5: Trip Length and VMT Comparison 2-19

Table 3-1: Roadway Classifications 3-4
Table 3-2: Highway Plan Roadways in the Planning Area 3-14

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions 4-8
Table 4-2: Buildout ICU Summary for Principal Intersections – Existing Lanes 4-19
Table 4-3: Buildout ICU Summary for Principal Intersections – Buildout Lanes 4-20
Table 4-4: Roadway Improvements to Build-Out the Highway Plan 4-25
Table 4-5: Intersection Improvements to Build-Out the Highway Plan 4-31
Table 4-6: Freeway Volume Summary 4-37
Table 4-7: Freeway Level of Service Summary 4-38
Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions 4-40
Table 4-9: ICU Summary for Principal Intersections – Existing Conditions vs OVOV Buildout Conditions 4-45

Table E-1: Freeway D/C Calculations – Existing Lanes E-2
Table E-2: Freeway D/C Calculations – Future Lanes E-2

1.0 INTRODUCTION

This report presents the results of a traffic study carried out for One Valley One Vision (OVOV). OVOV is a joint effort between the County of Los Angeles, the City of Santa Clarita, and Santa Clarita Valley residents and businesses to create a single vision and guidelines for the future growth of the Santa Clarita Valley and the preservation of natural resources. This traffic study presents information for the City of Santa Clarita General Plan Update and the Santa Clarita Valley Area Plan Update for the County of Los Angeles. More specifically, it contains existing and future traffic information that provides resource material that can assist the City and County in updating their Circulation Elements, and serves as a technical resource document for the Environmental Impact Reports being prepared by both the City and the County.

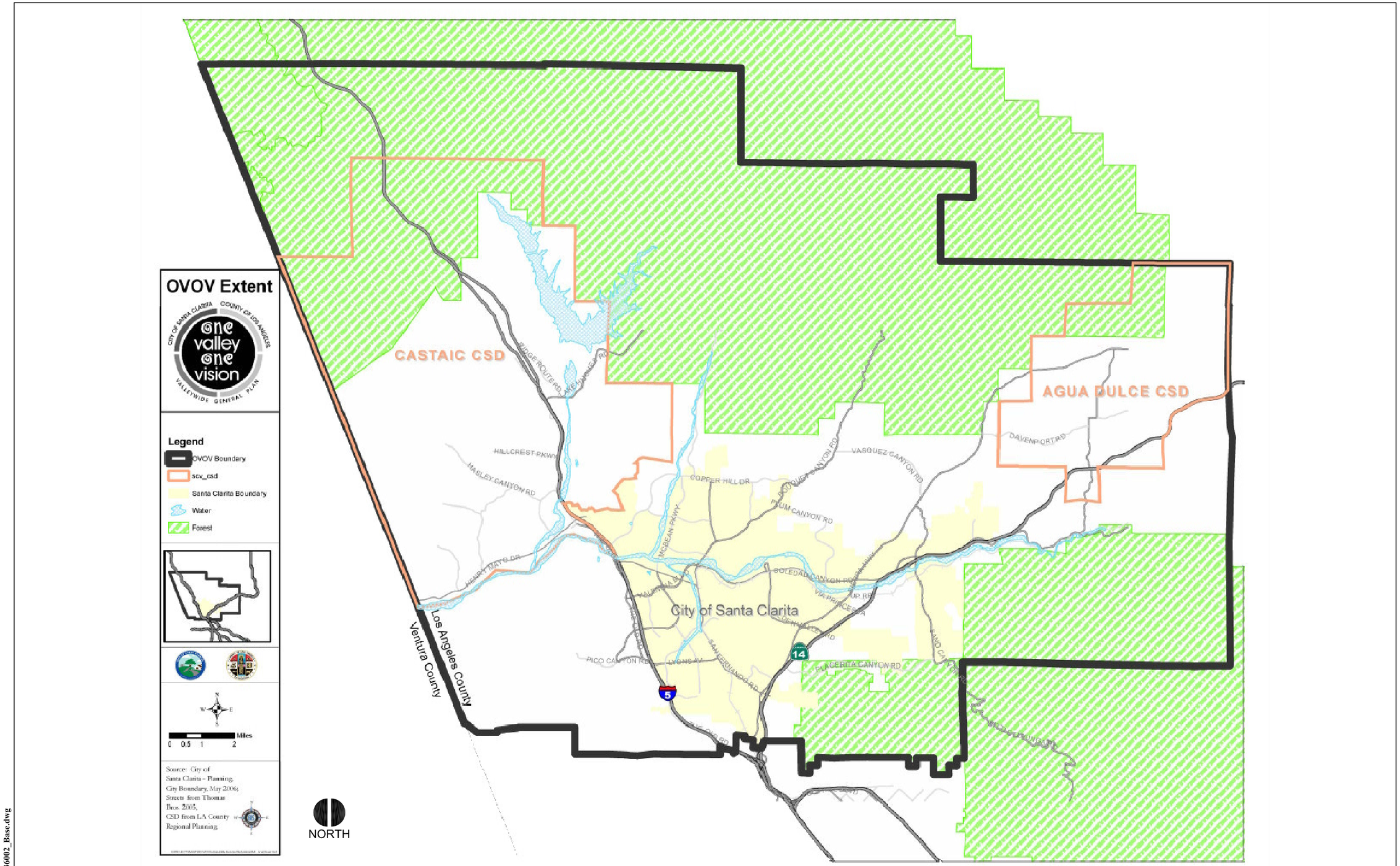
1.1 BACKGROUND

This traffic study was carried out to achieve three primary objectives:

1. Update the City and County's traffic forecasting model with current land use planning estimates
2. Prepare long-range traffic forecasts
3. Evaluate the proposed Land Use and Circulation Elements and propose potential changes to the arterial roadway component

The technical analysis results presented here pertain to the arterial roadway component of the City and County Circulation Elements. Existing conditions are compared with the anticipated growth in traffic on the City and County street system, and recommendations are made with respect to an updated arterial roadway component. A comparison is also made between long-range traffic forecasts based on the current City General Plan/County Area Plan and conditions based on the proposed OVOV Plan.

The area addressed in this traffic study includes the City, its sphere of influence, and unincorporated Los Angeles County areas of the Santa Clarita Valley. All three areas comprise what is referred to as the OVOV area, which is illustrated in Figure 1-1.



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To derive traffic forecasts, use is made of the Santa Clarita Valley Consolidated Traffic Model (SCVCTM). This traffic model produces peak hour and average daily traffic (ADT) forecasts for the OVOV area roadway system. Buildout land use data from the proposed City General Plan/County Area Plan Land Use Elements has been used as the basis for the traffic forecasts, thereby showing future circulation system needs in relation to future land use projections.

Part of this work effort involved updating the traffic model originally developed in 1994 (see discussion on SCVCTM in Chapter 2.0) with the land use data noted above. A major update was previously carried out in 2004 and periodic refinements were subsequently made up until this update.

1.2 PERFORMANCE CRITERIA

To evaluate the roadway system in relation to future land use in the OVOV area, use is made of performance criteria. These criteria include "performance standards" and "thresholds of significance." The latter are used for identifying individual land development project impacts in an EIR context, and while not specifically applied in a planning study of this type, they are given here for informational purposes. The performance standards form part of City and County Policy (e.g., in the City's Circulation Element and in the County Congestion Management Program) and represent desired operating conditions for the OVOV roadway system. For a Circulation Element to be in "balance" with the Land Use Element of the General Plan, the circulation system must achieve the performance standard criteria.

The performance criteria used here are based on two primary measures. The first is "capacity", which establishes the vehicle carrying ability of a roadway, and the second is "volume." The volume measure is either a traffic count (in the case of existing volumes) or a forecast for a future point in time. The ratio between the volume and the capacity gives a volume/capacity (V/C) ratio and based on that V/C ratio, a corresponding level of service (LOS) is defined. Traffic LOS is designated A through F with LOS A representing free flow conditions and LOS F representing severe traffic congestion. Traffic flow quality for each LOS is provided in Table 1-1 based on descriptions for arterial roadways as contained in the 2000 Highway Capacity Manual (HCM 2000).

The performance criteria are separated according to two components of the circulation system; arterial roadways and freeway segments. ADT data as well as peak hour data is used in both cases to establish V/C and LOS measures and to define the performance criteria. The following sections outline the criteria for each of the two components.

Table 1-1: Level of Service Descriptions for Urban Streets

Level of Service	Example	Flow Conditions	Percent of free flow speeds (FFS)
A		LOS "A" describes primarily free-flow operations at average travel speeds, usually about 90 percent of the FFS for the given street class. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Control delay at signalized intersections is normal..	90
B		LOS "B" describes reasonably unimpeded operations at average travel speeds, usually about 70 percent of the FFS for the street class. Vehicles are completely unimpeded in their ability to maneuver with the traffic stream. Control delay at signalized intersections is minimal.	70
C		LOS "C" describes stable operations; however, ability to maneuver and change lanes in midblock locations may be more restricted that at LOS "B," and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds of about 50 percent of the FFS for the street class.	50
D		LOS "D" borders on a range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS "D" may be due to adverse signal progression, inappropriate signal timing, high volumes, or a combination of these factors. Average travel speeds are about 40 percent of FFS.	40
E		LOS "E" is characterized by significant delays and average travel speeds of 33 percent or less of the FFS. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.	33
F		LOS "F" is characterized by urban street flow at extremely low speeds, typically one-third to one-fourth of the FFS. Intersection congestion is likely at critical signalized locations, with high delays, high volumes, and extensive queuing.	25

Source: Highway Capacity Manual 2000, Transportation Research Board, National Research Council

1.2.1 Arterial Streets and Intersections

Arterial roadway segments are evaluated using a generalized average daily traffic (ADT) capacity as summarized in Table 1-2. They are based on the type of roadway as classified in the City General Plan/County Area Plan Circulation Elements. It can be noted that these ADT capacity values are suitable for planning purposes, but they are not intended as precise measures of capacity. The ultimate capacity of a roadway is based upon a number of factors including the relationships between peak hour and daily traffic volumes, the roadway design features (allowing parking, driveway access and cross streets, the intersection geometrics, etc.), the amount of traffic crossing the roadway or turning onto or off of the roadway at intersecting roadways, and the actual turn movements at an intersection.

Table 1-2: Daily Roadway Capacity Values

General Plan Designation	Lanes	Ultimate Capacity (Level of Service "E")[1]
Major Arterial Highway	8	72,000
	6	54,000
Secondary Arterial Highway	4	36,000
Limited Secondary Arterial Highway	2	18,000
Collector[2]	2	15,000

[1]The ultimate capacity value is an estimate of the physical limit of daily traffic flows (level of service "E") based upon typical suburban peak hour characteristics. This value can vary significantly depending upon volume demand characteristics (amount of off-peak travel and duration of peak periods) as well as roadway design features (access, spacing, intersection geometrics, etc.).
[2]Collector roadways are not identified in the City/County Circulation Elements but are included in the traffic analysis on a limited basis.

Although level of service is an important factor in transportation planning, it is not the only or even the most important criterion used in all cases. Depending on the area being planned, other factors may be considered as having priority over expedited movement of vehicles. For example, in some commercial areas, high-speed vehicle movements could be detrimental to the desired character of development. In all portions of the OVOV planning area, traffic level of service must be weighed against other community priorities such as quality of life and environmental resource protection, in order to achieve a balanced approach to transportation and land use planning.

The County General Plan does not specify an acceptable LOS for the purpose of long-range planning, however in conformance with the Los Angeles County Congestion Management Program (LA CMP), the maximum acceptable level of service on arterial roads (i.e., major, secondary, and limited secondary highways) within the OVOV planning area is LOS E. The City strives to achieve LOS D or

better on arterial roads to the extent feasible given right-of-way and physical constraints, while recognizing that in higher density urban areas there is generally a tradeoff between vehicle LOS and other factors such as pedestrian mobility, and that LOS E is acceptable in those types of urban settings. In residential neighborhoods, vehicular LOS is less important than other factors, such as traffic volumes and speeds.

Table 1-3 summarizes the V/C ranges that correspond to LOS "A" through "F" for arterial roads and intersections as used by the City and the County.

Table 1-3: LOS Criteria for Arterials

LOS	Roadway V/C & Intersection ICU Ranges
A	0.00 – 0.60
B	0.61 – 0.70
C	0.71 – 0.80
D	0.81 – 0.90
E	0.91 – 1.00
F	Above 1.00
Source: Congestion Management Program of Los Angeles County	

Both the V/C ratio and the LOS are used in determining impact significance. As noted above, certain LOS values are deemed unacceptable, and increases in the V/C ratio which cause or contribute to the LOS being unacceptable are defined as a significant impact.

In establishing V/C based performance criteria, there are certain items that need to be addressed to obtain suitable V/C estimates and relate them to LOS. For instance, while average daily traffic (ADT) is a useful measure to show general levels of traffic on a facility and to provide data for other related aspects such as noise and air quality, highway congestion is largely a peak hour or peak period occurrence. Because of this, ADT is not used here as the sole basis for capacity evaluation, but instead this evaluation also evaluates those parts of the day when such congestion can occur, specifically the a.m. and p.m. peak hours.

Levels of service for arterial roadway intersections are determined based on operating conditions during the a.m. and p.m. peak hours. The intersection capacity utilization (ICU) methodology is applied, providing a planning level basis for determining V/C and LOS. This methodology sums the V/C ratios for the critical movements of an intersection and is the preferred intersection analysis procedure of the City of Santa Clarita and the County of Los Angeles. The ICU calculation methodology is summarized in Table 1-4.

Table 1-4: Arterial Intersection ICU Methodology

City of Santa Clarita ICU Calculation Methodology Level of service to be based on peak hour intersection capacity utilization (ICU) values calculated using the following assumptions: Saturation Flow Rates: 1,750 vehicles/hour/lane for all lanes Clearance Interval: .10
County of Los Angeles ICU Calculation Methodology Level of service to be based on peak hour intersection capacity utilization (ICU) values calculated using the following assumptions: Saturation Flow Rates: 1,600 vehicles/hour/lane for through lanes, right-turn lanes, and single left-turn lanes 2,880 vehicles/hour/lane for dual left-turn lanes (total of both lanes) Clearance Interval: .10

1.2.2 Freeway Segments

Table 1-5 summarizes the V/C ranges that correspond to LOS "A" through "F" for general freeway segments. The V/C ranges listed for freeway segments are based on the V/C and LOS relationships specified in the *2000 Highway Capacity Manual* (see Reference 1 in Section 1.5 and referred to as "*HCM 2000*" in this report) for basic freeway sections with free-flow speeds of 105 kilometers per hour (65 miles per hour), and are specified by the County's Congestion Management Program (CMP) for the evaluation of CMP freeway monitoring stations.

Table 1-5: LOS Criteria for Basic Freeway Segments

LOS	Freeway Segment Volume Density Ranges	Freeway Segment V/C Ranges
A	0.0 – 11.0	0.00 – 0.30
B	11.1 – 18.0	0.31 – 0.50
C	18.1 – 26.0	0.51 – 0.71
D	26.1 – 35.0	0.72 – 0.89
E	35.1 – 45.0	0.90 – 1.00
F	Above 45.0	Above 1.00
Sources: HCM 2000 Congestion Management Program of Los Angeles County		

1.3 INFORMATION IN THIS REPORT

The information presented in this report is arranged as follows:

Chapter 1.0 Introduction – background and scope plus a description of the performance criteria used in the traffic analysis.

Chapter 2.0 Transportation Setting – describes existing conditions with respect to circulation, and future growth forecasts.

Chapter 3.0 Arterial Roadways – presents the proposed roadway component of the City and County Circulation Elements.

Chapter 4.0 Traffic Analysis – discusses future traffic volumes and levels of service, and shows the improvements needed to implement the proposed roadway plan.

Technical appendices contain tabular data as appropriate, and traffic model data can be found in the previously referenced traffic model report.

1.4 DEFINITIONS

Certain terms used throughout this report are defined below to clarify their intended meaning:

ADT Average Daily Traffic. Generally used to measure the total two-directional traffic volumes passing a given point on a roadway.

CMP Congestion Management Program. A state mandated program administered by the Los Angeles County Metropolitan Transportation Authority (MTA) that provides a mechanism for coordinating land use and development decisions.

DU Dwelling Unit. Used in quantifying residential land use.

ICU	Intersection Capacity Utilization. A measure of the volume to capacity ratio for an intersection. Typically used to determine the peak hour level of service for a given set of intersection volumes.
LOS	Level of Service. A scale used to evaluate circulation system performance based on intersection ICU values or volume/capacity ratios of arterial segments.
Peak Hour	This refers to the hour during the a.m. peak period (typically 7 a.m. - 9 a.m.) or the p.m. peak period (typically 3 p.m. - 6 p.m.) in which the greatest number of vehicle trips are generated by a given land use or are traveling on a given roadway.
Tripend	A trip generation measure which represents the total trips entering and leaving a location.
TSF	Thousand Square Feet. Used in quantifying non-residential land uses, and refers to building floor area.
V/C	Volume to Capacity Ratio. This is typically used to describe the percentage of capacity utilized by existing or projected traffic on a segment of an arterial or intersection.
VPD	Vehicles Per Day. Similar to ADT, but more typically applied to trip generation (i.e., the amount of traffic generated by a given amount of land use).
VPH	Vehicles Per Hour. Used for roadway volumes (counts or forecasts) and trip generation estimates. Measures the number of vehicles in a one-hour period, typically the a.m. or p.m. peak hour.

1.5 REFERENCES

1. "Highway Capacity Manual 2000," Transportation Research Board, National Research Council, 2000.

2. "Santa Clarita Valley Consolidated Traffic Model Report," County of Los Angeles Department of Public Works, 1994.

3. "Draft Santa Clarita Valley Consolidated Traffic Model 2004 Update and Validation," City of Santa Clarita and County of Los Angeles Department of Public Works, June 2004.

4. "Transportation Concept Report, Interstate 5," California Department of Transportation District 7 Office of Advance Planning System Planning Unit, November 1998.

5. Project Report – I-5 HOV and Truck Lane Project from SR-14 to Parker Road in Los Angeles County," California Department of Transportation District 7, August 2009.

6. "Interregional Transportation Strategic Plan," California Department of Transportation, June 1998.

7. "North County Combined Highway Corridors Study Final Report," Los Angeles County Metropolitan Transportation Authority, June 2004.

8. "2004 Congestion Management Program for Los Angeles County," Los Angeles County Metropolitan Transportation Authority, July 2004.

2.0 TRANSPORTATION SETTING

This chapter discusses the transportation setting for the Santa Clarita Valley roadway system. Existing conditions are described including traffic volumes on the City and County street system and levels of service (LOS) for those same street system segments and for key intersections. Information on future land use and the corresponding increase in study area trip generation is also given and discussed in relation to its growth implications.

2.1 EXISTING ROADWAYS

The existing roadway system within the OVOV planning area is illustrated in Figure 2-1. Shown here is the number of lanes (midblock) on individual segments of the valley-wide roadway system.

The primary regional roadway components serving the Santa Clarita Valley are the I-5 and SR-14 freeways, passing through the Valley from north to south, and the SR-126 highway, which connects the Santa Clarita Valley to Ventura County. The I-5 freeway is listed as a "high priority corridor" on the National Highway System (NHS). The I-5 and the SR-14 freeways are part of the Surface Transportation Assistance Act (STAA) national truck network, and the SR-126 highway is a designated terminal access route for the STAA national truck network. 18 interchanges, 10 on I-5 and eight on SR-14, serve the Valley. The 10 interchanges on the I-5 are located at Sloan Canyon Road/Lake Hughes Road, Parker Road/Ridge Route Road, Hasley Canyon Road, SR-126/Newhall Ranch Road, Rye Canyon (at The Old Road), Magic Mountain Parkway, Valencia Boulevard, Stevenson Ranch Parkway/McBean Parkway, Pico Canyon Road/Lyons Avenue, and Calgrove Boulevard. The eight interchanges on the SR-14 are located at Agua Dulce Canyon Road, Soledad Canyon Road, Sand Canyon Road, Sierra Highway, Via Princessa, Golden Valley Road, Placerita Canyon Road, and Newhall Avenue.

Several major north-south arterials run through the Valley. Newhall Avenue/Railroad Avenue/Bouquet Canyon Road originates at the southern part of the SR-14 freeway, traverses the Valley, and terminates at Elizabeth Lake Road, just west of Palmdale, and well north of the OVOV boundaries. The roadway varies in width from two to eight lanes. Stevenson Ranch Road/McBean Parkway originates at Pico Canyon Road, traverses the City, and terminates at Copper Hill Drive. The roadway varies in width from four to eight lanes. Whites Canyon Road originates at Via Princessa and terminates at Bouquet Canyon Road. The roadway varies in width from four to six lanes. The Old Road originates

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near the SR-14/I-5 interchange and traverses the entire west side of the Valley, terminating north of Lake Hughes Road. The roadway varies in width from two to six lanes. Golden Valley Road originates just south of the SR-14 freeway, traverses the middle portion of the Valley, and terminates at Newhall Ranch Road. Sierra Highway originates near the SR-14/I-5 interchange, traverses the Valley on the east side, and terminates at Angeles Forest Highway just north of the Angeles National Forest and well north-east of the OVOV boundaries. Sierra Highway varies between two to six lanes.

Several east-west arterials serve the Valley and provide access to the I-5 and SR-14 freeways. Many of these arterials are incomplete and provide access to only portions of the Valley. To the north is Rye Canyon Road/Copper Hill Drive with four to eight lanes throughout and a half interchange at the I-5 freeway. The next arterial to the south is SR-126/Newhall Ranch Road, which varies from four to eight lanes throughout, provides an interchange to the I-5 freeway, and terminates at Golden Valley Road. Magic Mountain Parkway originates just west of the I-5 freeway and terminates at Railroad Avenue. The main east-west arterial is further to the south and exists as both Valencia Boulevard and Soledad Canyon Road, which varies from two to seven lanes throughout. Valencia Boulevard originates just west of the I-5 freeway, is renamed to Soledad Canyon Road at the Bouquet Canyon Road intersection, and terminates to the east of the SR-14 freeway near the Acton Canyon area and well east of the OVOV boundaries. This roadway features interchanges with the I-5 freeway as well as the SR-14 freeway. The final east-west arterial is Pico Canyon Road/Lyons Avenue, which varies from two to six lanes. This stretch of roadway is relatively short, starting west of Stevenson Ranch Parkway in the Santa Susana Mountains and terminating at Railroad Avenue. It also provides an interchange with the I-5 freeway. The Cross Valley Connector is a primarily east-west roadway formed by the combination of Newhall Ranch Road and Golden Valley Road. As Newhall Ranch Road, the Cross Valley Connector originates at the SR-126/I-5 interchange and continues east to Soledad Canyon Road. At Soledad Canyon Road, the Cross Valley Connector continues south as Golden Valley Road, resulting in a continuous roadway between SR-126 and the SR-14 freeway.

Within the Santa Clarita Valley, connectivity of the street network is interrupted by topographic constraints, including rolling terrain, canyons, and the Santa Clara River. In addition, the prevalent subdivision pattern comprised of local cul-de-sac streets with limited connectivity, acts to funnel all traffic onto collector and arterial streets. As a result, regional traffic is concentrated on a limited number of arterial streets. Projects such as the Via Princessa gap closure, and plans to create a new north-south connection through the center of the Valley (Santa Clarita Parkway), are examples of projects intended to increase connectivity.

2.1.1 Existing Traffic Volumes

Figure 2-2 shows the study area roadway segments included in this evaluation, which includes all roadway segments identified in the Highway Plan (see discussion in Chapter 3.0) and select collector streets. This analysis also includes key intersections of Highway Plan roadways, which are considered the principal intersections within the Santa Clarita Valley. As such, these principal intersections are required to accommodate significant volumes of traffic and are critical to vehicle mobility within the Santa Clarita Valley. Figure 2-3 shows the principal intersections included in this evaluation.

Existing average daily traffic (ADT) volumes on the study area street system are illustrated in Figure 2-4. These counts were collected at various times between 2005 to 2010 by the Traffic and Transportation Planning Division of the Department of Public Works of the City of Santa Clarita, by the Traffic and Lighting division of the County of Los Angeles Department of Public works, and by various development projects as part of their entitlement process. These counts provide a representative sample of existing traffic conditions throughout the Valley.

Illustrations of peak hour turning movement volumes for each principal intersection can be found in Figure 2-5 for the a.m. peak hour and in Figure 2-6 for the p.m. peak hour. As with the ADT counts, the peak hour counts were collected at various times between 2007 and 2010 and provide a representative sample of existing traffic conditions throughout the Valley.

2.1.2 Existing Levels of Service

As discussed in the performance criteria section of Chapter 1.0, LOS is based on two primary measures. The first is “capacity” which establishes the vehicle carrying ability of a roadway and the second is “volume.” The volume measure is either a traffic count (in the case of existing volumes) or a forecast for a future point in time. The ratio between the volume and the capacity gives a volume/capacity (V/C) ratio and based on that V/C ratio, a corresponding LOS is defined.

SEE INSET - BELOW RIGHT
SEE ABOVE RIGHT
LEGEND
xx
Link Study Location and Identification Numbers
Future Roadways
NORTH
NORTH
(reduced scale)
SIERRA HWY
SR-14
PLACERITA CYN
SOLEDAD CYN
VASQUEZ CYN
SAN MARTINEZ GRANDE CYN
POTRERO CYN
PICO CYN
LOST CANYON
CALGROVE
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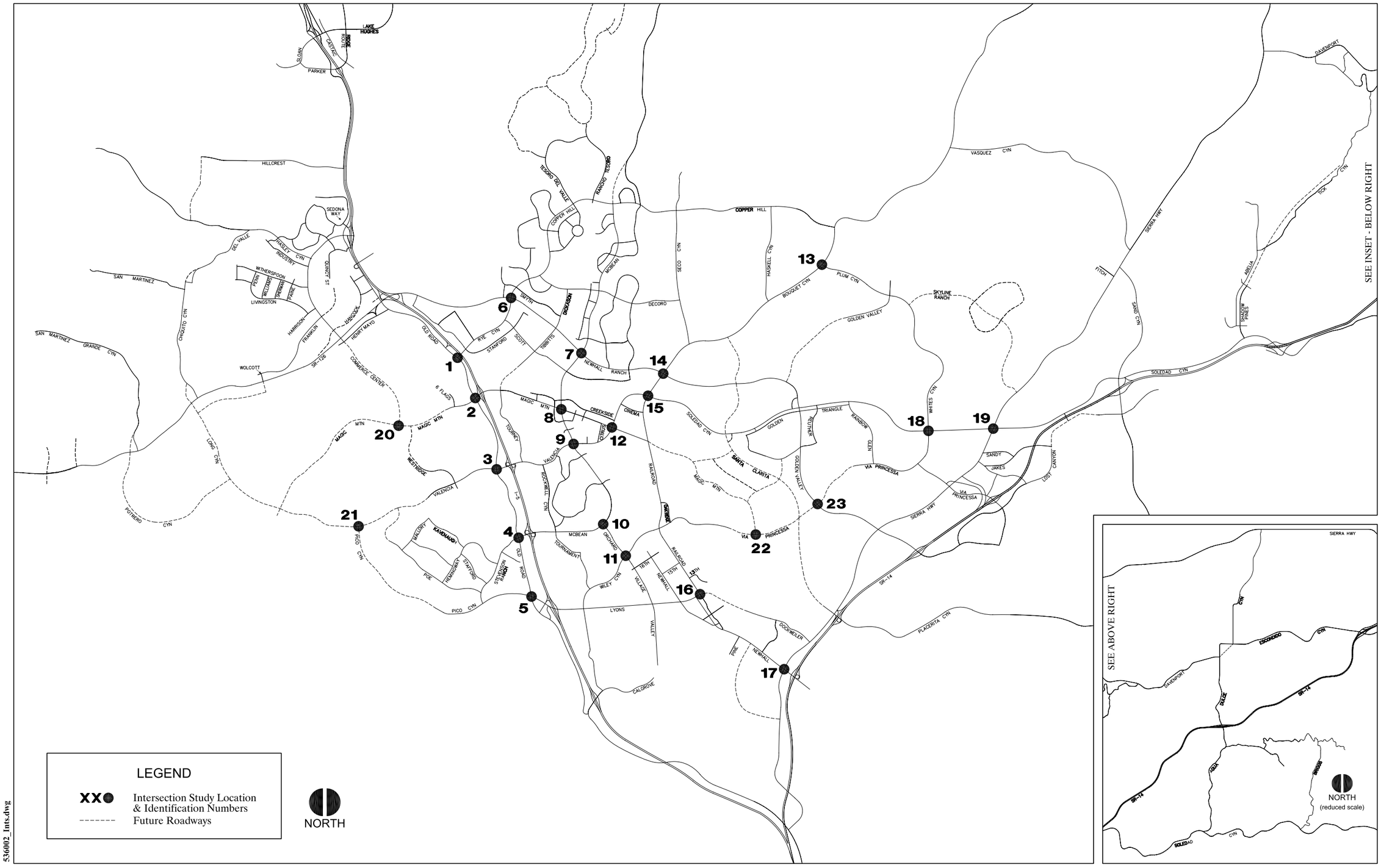

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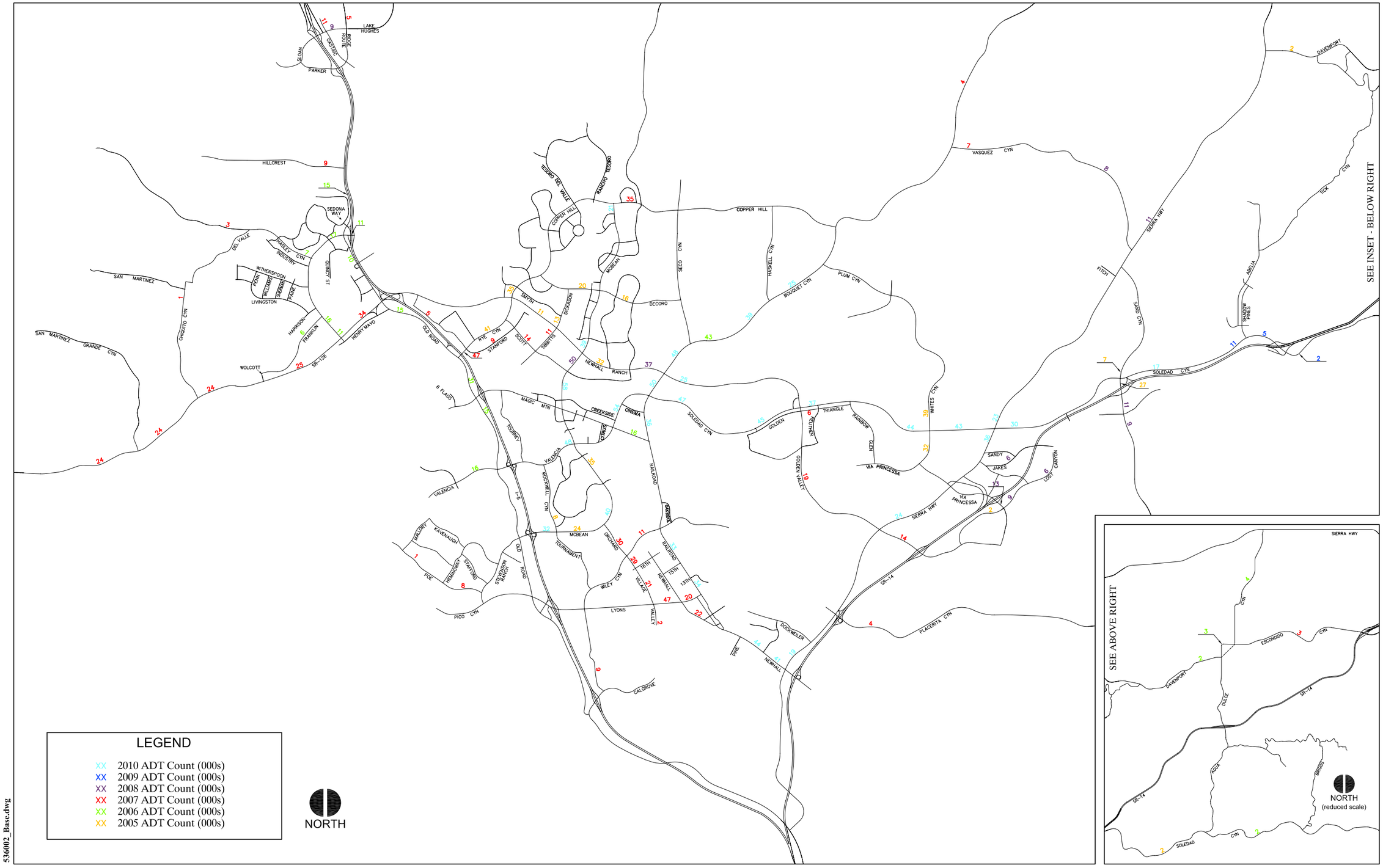

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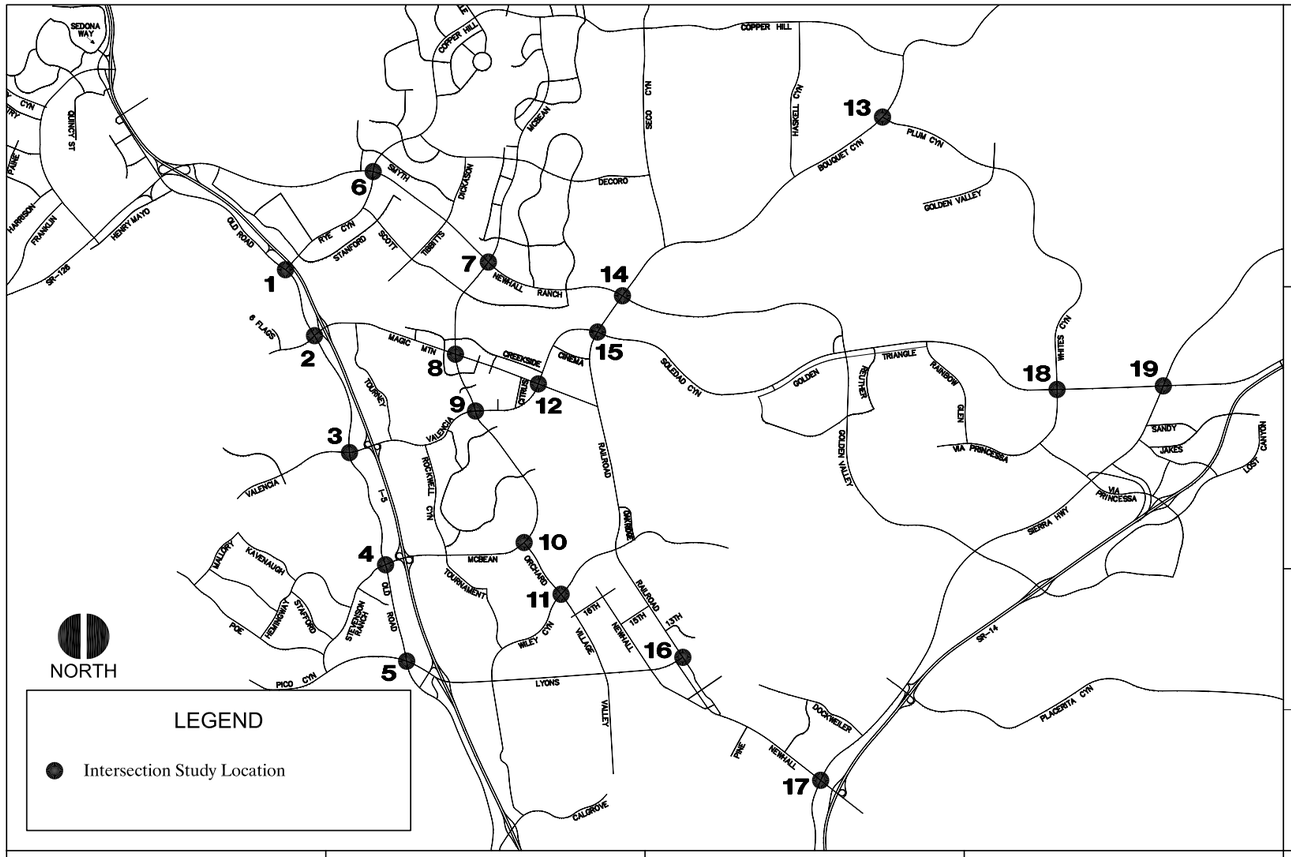

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261 189		990 252
	1026 311	

#2

143 287 2		976 17 123
26 21 4	70 411 17	

#3

121 157 233		137 756 107
312 886 542	107 257 668	

#4

67 458 369		73 216 337
614 616 184	103 326 63	

#5

341 520 28		391 349 67
69 760 86	80 338 86	

#6

133 1240 358		217 1038 366
441 510 76	32 381 41	

#7

275 1542 187		111 1397 639
103 566 193	212 431 394	

#8

387 1871 534		113 330 58
592 475 107	21 900 50	

#9

97 672 584		31 1149 314
360 722 78	182 772 218	

#10

25 32 19		48 507 778
38 436 253	592 39 327	

#11

117 777 283		96 268 152
172 125 272	113 754 218	

#12

25 1632 429		26 351 176
145 153 29	71 682 32	

#13

182 476 2		133 5 1364
6 10 43	633 209 14	

#14

324 2079 584		89 890 120
260 369 261	33 561 291	

#15

331 1218 917		230 1139 307
240 499 9	182 399 21	

#16

1095 220		
218 122	702 172	

#17

125 467 270		16 693 105
130 1144 235	21 47 70	

#18

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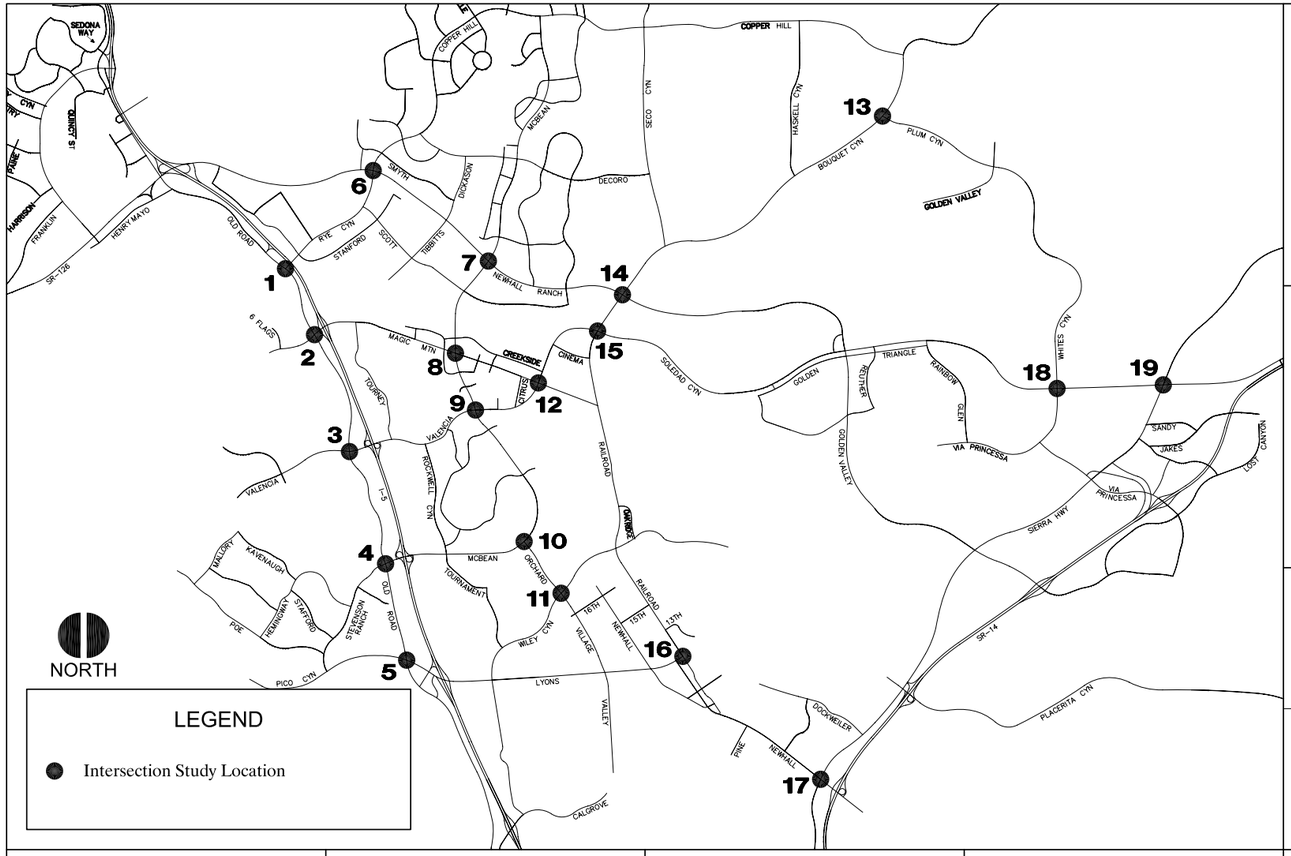

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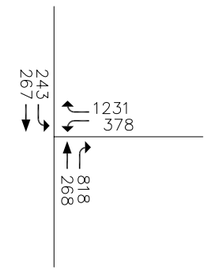

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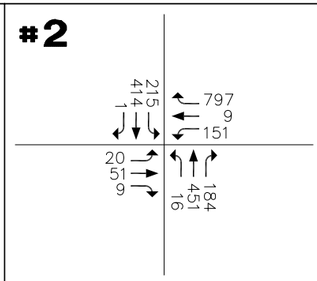

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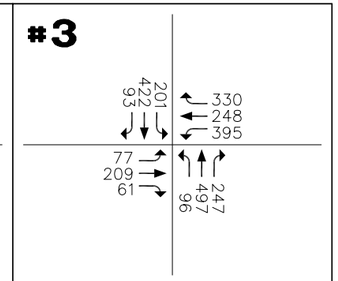

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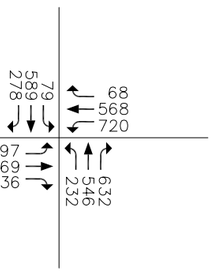

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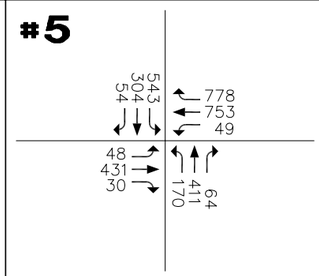

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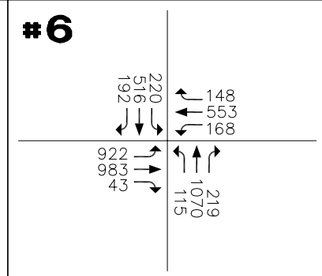

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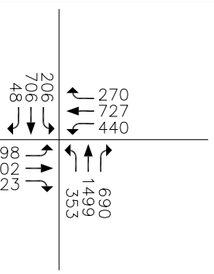

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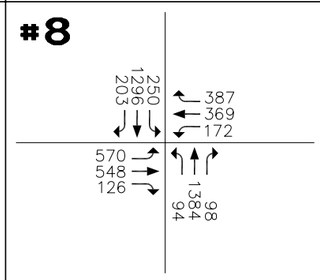

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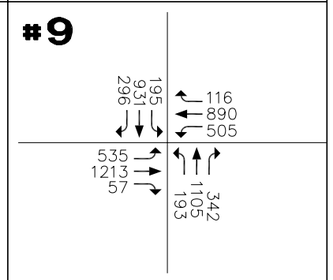

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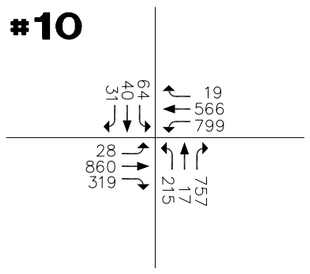

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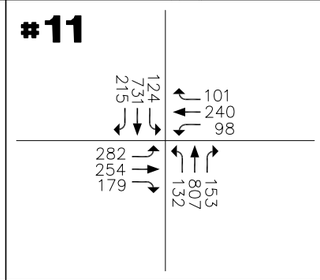

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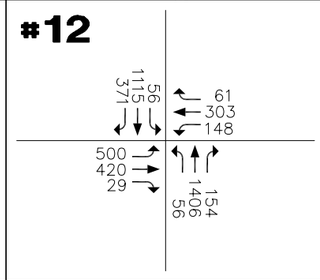

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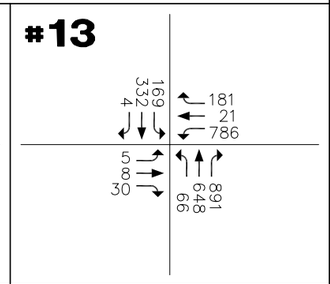

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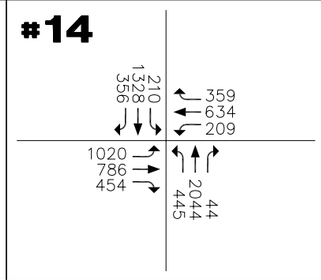

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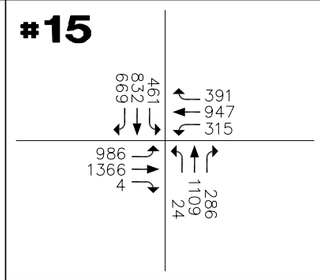

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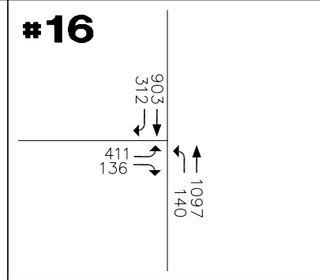

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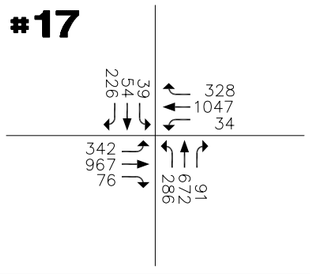

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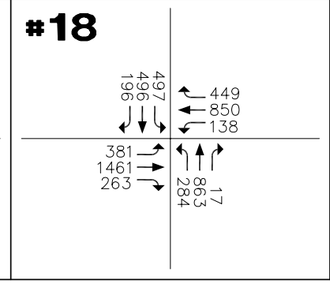

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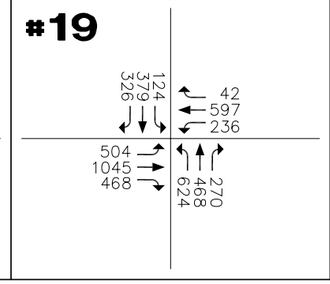

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Table 2-1 lists the existing ADT volumes and corresponding LOS and V/C values. As can be seen here, five roadway segments have V/C ratios greater than 1.00 and therefore do not meet the performance standard of LOS E or better

- Bouquet Cyn w/o Haskell (#15)
- Lyons Avenue between Orchard Village Road and Newhall Avenue (#92)
- McBean s/o Ave Scott (#114)
- Newhall Avenue between Lyons Avenue and Main Street (#131)
- Whites Canyon Road between Soledad Canyon Road and Pleasantdale Street (#288)

The results of the ICU LOS analyses for study area principal intersections are shown in Table 2-2 (detailed ICU worksheets are provided in Appendix A). The table shows that all intersections currently operate at LOS D or better.

2.2 FUTURE TRAFFIC GROWTH

Existing and future land use data formed the basis for preparing the future traffic volumes used in this traffic study. Future land uses tabulated by traffic analysis zone (TAZ) were provided by City and County staff and were derived by quantifying the data outlined in the proposed OVOV Land Use Element. Existing land use tabulated by TAZ was prepared as part of a comprehensive update and recalibration of the Santa Clarita Valley Consolidated Traffic Model (SCVCTM) undertaken in 2004 (see Reference 3 in Section 1.5). Data was provided for the entire OVOV area, which includes the City of Santa Clarita, its sphere of influence, and portions of unincorporated Los Angeles County. A comparison of 2004 to the proposed OVOV Buildout land use by TAZ is provided in Appendix B, and a comparison of the current City General Plan/County Area Plan Buildout land use to the proposed OVOV Buildout land use by TAZ is also provided in Appendix B.

The amount of traffic generated by a certain type of land use is estimated by applying a representative trip generation rate to the amount of land use in the area under consideration. The SCVCTM uses a predefined set of trip generation rates calibrated specifically to local conditions to calculate both peak hour and ADT trips by land use. A detailed listing of trip rates and the corresponding trip generation by TAZ is provided in Appendix D.

Table 2-1: ADT V/C and LOS – Existing Conditions (2005 – 2010)

Roadway Segment	Volume	Year	Lanes	Capacity	V/C	LOS
1. Agua Dulce n/o Escondido Cyn	4,000	2006	2	18,000	.22	A
2. Agua Dulce n/o Davenport	3,000	2006	2	18,000	.17	A
4. Agua Dulce s/o SR-14	<500	2005	2	18,000	.00	A
6. Ave Scott s/o Stanford	14,000	2007	4	36,000	.39	A
8. Ave Stanford s/o Vanderbilt	5,000	2007	4	36,000	.14	A
10. Ave Stanford s/o Rye Cyn	9,000	2007	4	36,000	.25	A
11. Bouquet Cyn n/o Vasquez	4,000	2007	2	18,000	.22	A
14. Bouquet Cyn e/o Haskell	25,000	2010	4	36,000	.69	B
15. Bouquet Cyn w/o Haskell	39,000	2010	4	36,000	1.08	**F**
16. Bouquet Cyn e/o Seco	43,000	2006	5	45,000	.96	E
17. Bouquet Cyn w/o Seco	48,000	2010	6	54,000	.89	D
18. Bouquet Cyn s/o Newhall Ranch	50,000	2010	8	72,000	.69	B
20. Bouquet Cyn n/o Magic Mtn	36,000	2010	4	36,000	1.00	E
25. Castaic n/o Lake Hughes	11,000	2007	4	36,000	.31	A
28. Chiquito Cyn s/o San Martinez Cyn	1,000	2007	2	18,000	.06	A
31. Commerce Center s/o Franklin	16,000	2006	6	54,000	.30	A
32. Commerce Center n/o SR-126	11,000	2006	6	54,000	.20	A
35. Copper Hill n/o Newhall Ranch	35,000	2005	8	72,000	.49	A
39. Copper Hill e/o McBean	35,000	2007	4	36,000	.97	E
43. Davenport e/o Sierra Hwy	2,000	2005	2	18,000	.11	A
44. Davenport w/o Agua Dulce	2,000	2006	2	18,000	.11	A
46. Decoro e/o Dickason	20,000	2005	4	36,000	.56	A
48. Decoro w/o Hillsborough	16,000	2005	4	36,000	.44	A
51. Dickason n/o Newhall Ranch	13,000	2005	4	36,000	.36	A
54. Escondido e/o Agua Dulce	3,000	2007	2	18,000	.17	A
55. Franklin e/o Wolcott Way	<500	2006	2	15,000	.00	A
56. Franklin w/o Commerce Center	6,000	2006	4	36,000	.17	A
62. Golden Valley s/o Centre Point	19,000	2007	4	36,000	.53	A
64. Golden Valley e/o Sierra Hwy	14,000	2007	6	54,000	.26	A

(Continued)

Table 2-1: ADT V/C and LOS – Existing Conditions (2005 – 2010) (Continued)

Roadway Segment	Volume	Year	Lanes	Capacity	V/C	LOS
68. Hasley Cyn w/o Del Valle	3,000	2007	2	18,000	.17	A
69. Hasley Cyn w/o Commerce Center	7,000	2006	4	36,000	.19	A
70. Hasley Cyn w/o The Old Road	17,000	2006	6	54,000	.31	A
71. Hasley Cyn w/o I-5	11,000	2006	4	36,000	.31	A
74. Hillcrest w/o The Old Road	9,000	2007	4	36,000	.25	A
75. Jakes Way e/o Canyon Park	6,000	2008	2	18,000	.33	A
77. Lake Hughes e/o Castaic	9,000	2008	4	36,000	.25	A
78. Lake Hughes e/o Ridge Route	2,000	2007	2	18,000	.11	A
85. Lost Cyn n/o Canyon Park	6,000	2008	4	36,000	.17	A
86. Lost Cyn n/o Via Princessa	9,000	2008	4	36,000	.25	A
87. Lost Cyn s/o Via Princessa	2,000	2005	2	18,000	.11	A
92. Lyons e/o Orchard Village	47,000	2007	4	36,000	1.31	**F**
93. Lyons w/o Main Street	20,000	2007	4	36,000	.56	A
105. Magic Mtn e/o Valencia	16,000	2006	4	36,000	.44	A
109. McBean s/o Copper Hill	21,000	2010	6	54,000	.39	A
112. McBean n/o Newhall Ranch	39,000	2010	6	54,000	.72	C
113. McBean s/o Newhall Ranch	50,000	2008	8	72,000	.69	B
114. McBean s/o Ave Scott	58,000	2010	6	54,000	1.07	**F**
117. McBean s/o Valencia	35,000	2005	6	54,000	.65	B
118. McBean n/o Orchard Village	40,000	2010	6	54,000	.74	C
119. McBean e/o Rockwell Cyn	24,000	2005	6	54,000	.44	A
120. McBean w/o Rockwell Cyn	32,000	2010	6	54,000	.59	A
124. Newhall Ranch e/o Rye Cyn	11,000	2005	8	72,000	.15	A
126. Newhall Ranch e/o McBean	32,000	2005	8	72,000	.44	A
127. Newhall Ranch w/o Bouquet Cyn	37,000	2008	8	72,000	.51	A
128. Newhall Ranch e/o Bouquet Cyn	25,000	2010	4	36,000	.69	B
131. Newhall s/o Lyons	22,000	2007	2	18,000	1.22	**F**
132. Newhall n/o Valle Oro	44,000	2010	6	54,000	.81	D
133. Newhall n/o Sierra Hwy	41,000	2010	6	54,000	.76	C

(Continued)

Table 2-1: ADT V/C and LOS – Existing Conditions (2005 – 2010) (Continued)

Roadway Segment	Volume	Year	Lanes	Capacity	V/C	LOS
136. Orchard Village s/o McBean	30,000	2007	4	36,000	.83	D
137. Orchard Village s/o Wiley Cyn	29,000	2007	4	36,000	.81	D
138. Orchard Village n/o Lyons	21,000	2007	4	36,000	.58	A
146. Placerita Cyn e/o SR-14	4,000	2007	2	18,000	.22	A
150. Poe s/o Mallory	1,000	2007	4	36,000	.03	A
151. Poe w/o Stevenson Ranch	8,000	2007	4	36,000	.22	A
155. Railroad s/o Oak Ridge	33,000	2010	4	36,000	.92	E
157. Railroad n/o Lyons	34,000	2010	4	36,000	.94	E
161. Ridge Route n/o Lake Hughes	5,000	2007	6	54,000	.09	A
166. Rockwell Cyn n/o McBean	8,000	2005	4	36,000	.22	A
168. Rye Cyn w/o Ave Scott	41,000	2005	6	54,000	.76	C
169. Rye Cyn e/o The Old Road	47,000	2007	6	54,000	.87	D
172. San Martinez Grande Cyn n/o SR-126	<500	2005	2	15,000	.00	A
174. Sand Cyn n/o Soledad Cyn	7,000	2005	2	18,000	.39	A
175. Sand Cyn s/o Soledad Cyn	27,000	2005	4	36,000	.75	C
176. Sand Cyn s/o SR-14	11,000	2008	2	18,000	.61	B
177. Sand Cyn s/o Lost Cyn	9,000	2008	2	18,000	.50	A
192. Sierra Hwy n/o Vasquez Cyn	11,000	2008	2	18,000	.61	B
195. Sierra Hwy n/o Soledad Cyn	23,000	2010	4	36,000	.64	B
196. Sierra Hwy s/o Soledad Cyn	36,000	2010	6	54,000	.67	B
198. Sierra Hwy s/o Via Princessa	24,000	2010	4	36,000	.67	B
201. Sierra Hwy n/o Newhall	19,000	2010	4	36,000	.53	A
211. Soledad Cyn e/o Bouquet Cyn	47,000	2010	6	54,000	.87	D
212. Soledad Cyn w/o Golden Valley	45,000	2010	6	54,000	.83	D
213. Soledad Cyn e/o Golden Valley	37,000	2010	6	54,000	.69	B
215. Soledad Cyn w/o Whites Cyn	44,000	2010	6	54,000	.81	D
216. Soledad Cyn e/o Whites Cyn	43,000	2010	6	54,000	.80	C
217. Soledad Cyn e/o Sierra Hwy	30,000	2010	6	54,000	.56	A
220. Soledad Cyn e/o SR-14 (at Sand Cyn)	17,000	2010	4	36,000	.47	A

(Continued)

Table 2-1: ADT V/C and LOS – Existing Conditions (2005 – 2010) (Continued)

Roadway Segment	Volume	Year	Lanes	Capacity	V/C	LOS
221. Soledad Cyn w/o Shadow Pines	11,000	2009	4	36,000	.31	A
222. Soledad Cyn e/o Shadow Pines	5,000	2009	4	36,000	.14	A
223. Soledad Cyn e/o SR-14	2,000	2009	2	18,000	.11	A
224. Soledad Cyn w/o Agua Dulce	2,000	2005	2	18,000	.11	A
225. Soledad Cyn e/o Agua Dulce	2,000	2006	2	18,000	.11	A
227. SR-126 w/o San Martinez Grande Cyn	24,000	2007	4	44,000	.55	A
228. SR-126 w/o Chiquito Cyn/Long Cyn	24,000	2007	4	44,000	.55	A
229. SR-126 w/o Wolcott	24,000	2007	4	44,000	.55	A
230. SR-126 w/o Commerce Center	25,000	2007	4	44,000	.57	A
231. SR-126 w/o I-5	34,000	2007	6	66,000	.52	A
239. The Old Road n/o Sedona Way	15,000	2006	2	18,000	.83	D
242. The Old Road n/o Biscailuiz	10,000	2006	2	18,000	.56	A
245. The Old Road s/o Henry Mayo	15,000	2006	4	36,000	.42	A
247. The Old Road n/o Magic Mtn	31,000	2006	4	36,000	.86	D
248. The Old Road s/o Magic Mtn	15,000	2006	4	36,000	.42	A
254. Tibbitts s/o Newhall Ranch	11,000	2007	6	54,000	.20	A
262. Valencia w/o The Old Road	16,000	2006	6	54,000	.30	A
266. Valencia w/o McBean	48,000	2010	7	63,000	.76	C
271. Valencia s/o Cinema	54,000	2010	6	54,000	1.00	E
273. Valley s/o Lyons	2,000	2007	4	36,000	.06	A
274. Vasquez Cyn e/o Bouquet Cyn	7,000	2007	2	18,000	.39	A
275. Vasquez Cyn w/o Sierra Hwy	8,000	2008	2	18,000	.44	A
283. Via Princessa n/o Lost Cyn	13,000	2008	5	45,000	.29	A
288. Whites Cyn n/o Soledad	39,000	2005	4	36,000	1.08	**F**
289. Whites Cyn s/o Soledad	32,000	2005	6	54,000	.59	A
290. Wiley Cyn e/o Orchard Village	11,000	2007	4	36,000	.31	A
294. Wiley Cyn n/o Calgrove	9,000	2007	2	18,000	.50	A

LOS in **Bold** exceeds performance criteria of LOS E.

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C
.81 - .90 D .91 – 1.00 E Above 1.00 F

Table 2-2: ICU and LOS Summary - Existing Conditions (2007 – 2010)

Intersection	AM Peak Hour ICU	AM Peak Hour LOS	PM Peak Hour ICU	PM Peak Hour LOS	Count Year
1. The Old Road & Rye Canyon	.61	B	.66	B	2009
2. The Old Road & Magic Mountain	.28	A	.32	A	2009
3. The Old Road & Valencia	.67	B	.44	A	2009
4. The Old Road & Stevenson Ranch	.58	A	.76	C	2009
5. The Old Road & Pico Canyon	.76	C	.71	C	2009
6. Rye/Copper Hill & Newhall Ranch	.63	B	.70	B	2010
7. McBean & Newhall Ranch	.73	C	.78	C	2010
8. McBean & Magic Mountain	.61	B	.76	C	2010
9. McBean & Valencia	.61	B	.74	C	2010
10. Orchard Village & McBean	.57	A	.68	B	2010
11. Orchard Village & Wiley Canyon	.60	A	.62	B	2010
12. Valencia & Magic Mountain	.58	A	.66	B	2010
13. Bouquet Canyon & Plum Canyon	.68	B	.73	C	2007
14. Bouquet Canyon & Newhall Ranch	.66	B	.82	D	2010
15. Bouquet Canyon & Soledad Canyon	.68	B	.77	C	2010
16. Railroad & Lyons	.57	A	.56	A	2009
17. Sierra Highway & Newhall	.57	A	.64	B	2008
18. Whites Canyon & Soledad Canyon	.80	C	.86	D	2008
19. Sierra Highway & Soledad Canyon	.67	B	.76	C	2008

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C .81 - .90 D .91 – 1.00 E Above 1.00 F

Table 2-3 lists existing (2004) and future (OVOV Buildout) land use for the Valley based on six generalized land use categories. As can be seen here, buildout of the planned OVOV land uses implies a growth in valley-wide tripends of around 121 percent. Figure 2-7 and Figure 2-8 graphically illustrate both existing (2004) and future (OVOV Buildout) ADT volumes listed in Table 2-3. Figure 2-9 graphically illustrates the increase in valley-wide tripends. As a basis of comparison, the current City General Plan/County Area Plan land use is also compared to the OVOV Buildout land use, and is reflected in Table 2-4. Important to note is that each tripend represents one end of a trip (or in other words, every trip has two tripends), and that the tripends tabulated in the previously referenced Table 2-3 and Table 2-4 are one of multiple factors that determine the actual volume of vehicles on the roadway system. Other factors, such as the relative proximity of complementary land use types, determine trip lengths. Vehicle trips in combination with trip lengths determine the number of vehicle miles traveled (VMT) on a daily basis.

Table 2-3: Valley-wide Land Use and Trip Generation – Existing (2004) vs. OVOV Buildout

Land Use Category	Units	Existing (2004)		OVOV Buildout		% Increase
		Amount	Tripends	Amount	Tripends	
SF Residential	DU	48,251	471,153	81,395	795,563	69%
MF Residential	DU	24,387	191,023	67,679	514,809	170%
Subtotal	*DU*	*72,638*	*662,176*	*149,074*	*1,310,372*	*98%*
Commercial Retail	TSF	9,157.63	515,716	23,585.06	1,230,042	139%
Commercial Office	TSF	2,072.12	25,996	17,311.53	205,851	692%
Industrial Park	TSF	18,332.42	107,565	40,735.96	240,697	124%
Subtotal	*TSF*	*29,562.17*	*649,277*	*81,632.55*	*1,676,590*	*158%*
Other (Schools, etc.)	--	--	176,541	--	301,424	71%
TOTAL		--	1,487,994	--	3,288,386	121%[1]

Where:
SF = Single Family
MF = Multi-Family
DU = dwelling units
TSF = thousand square feet of floor area
Tripends = Daily Tripends (one trip = 2 tripends)

[1]Represents an annual increase of approximately 2.6% (compounded) if buildout is presumed to occur over a 30 year period.

Figure 2-7: Existing (2004) Average Daily Traffic (ADT) Percentages

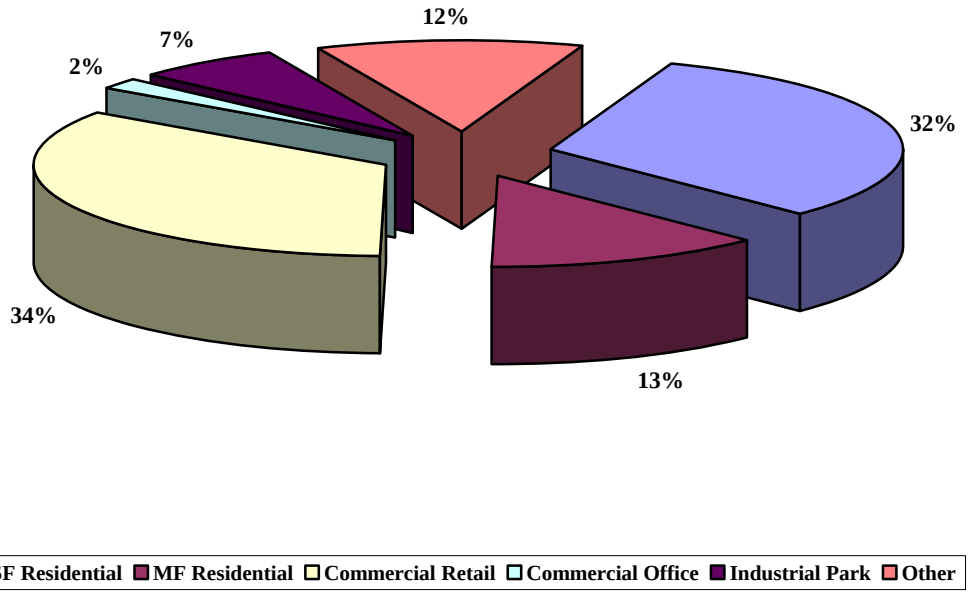


Figure 2-8: OVOV Buildout Average Daily Traffic (ADT) Percentages

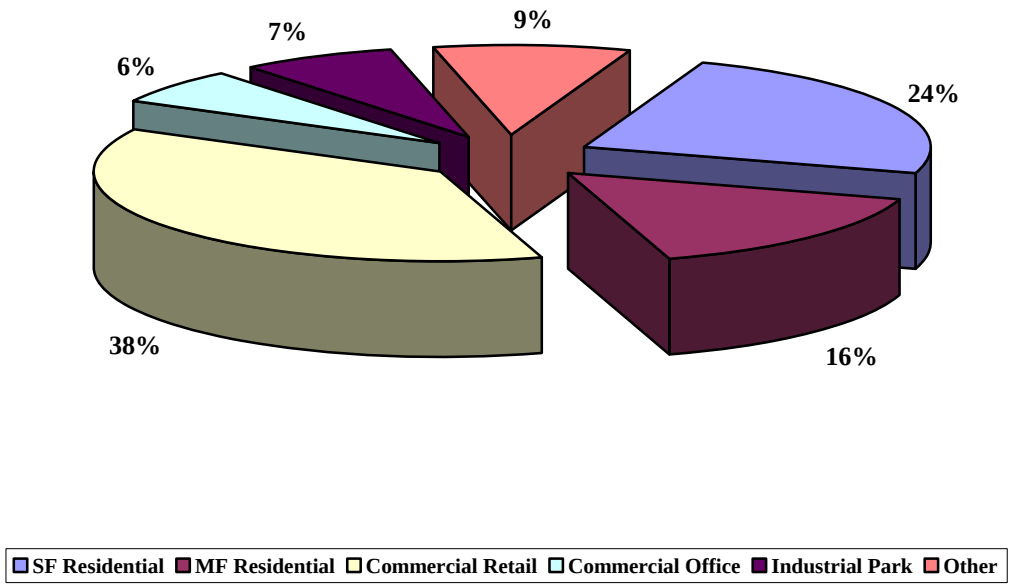


Figure 2-9: Total Average Daily Traffic (ADT) Volume Comparison

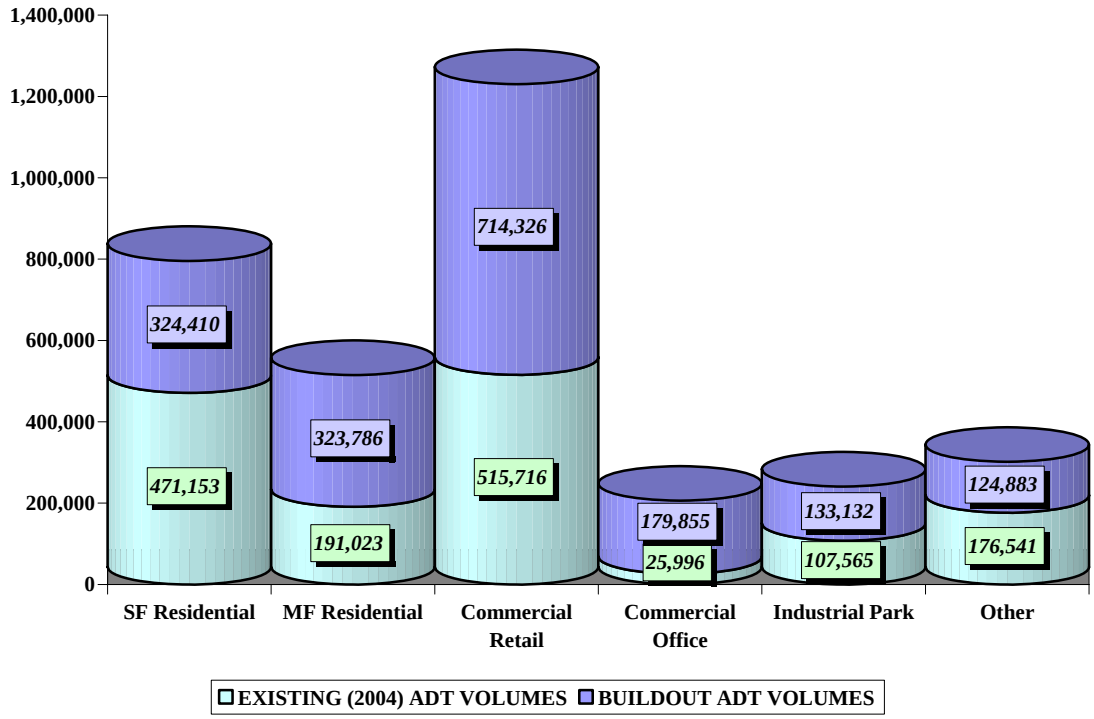


Table 2-4: Valley-wide Land Use and Trip Generation – Current Plan Buildout vs. OVOV Buildout

		Current Plan Buildout		Proposed OVOV Buildout		
Land Use Category	**Units**	**Amount**	**Tripends**	**Amount**	**Tripends**	**% Increase**
SF Residential	DU	89,373	877,112	81,395	795,563	-9%
MF Residential	DU	62,543	481,988	67,679	514,809	7%
Subtotal	*DU*	*151,916*	*1,359,100*	*149,074*	*1,310,372*	*-4%*
Commercial Retail	TSF	21,561.65	1,134,793	23,585.06	1,230,042	8%
Commercial Office	TSF	14,746.77	169,850	17,311.53	205,851	21%
Industrial Park	TSF	43,144.21	254,465	40,735.96	240,697	-5%
Subtotal	*TSF*	*79,452.63*	*1,559,108*	*81,632.55*	*1,676,590*	*8%*
Other (Schools, etc.)	--	--	288,885	--	301,424	4%
TOTAL		--	3,207,093	--	3,288,386	3%

Where:
SF = Single Family
MF = Multi-Family
DU = dwelling units
TSF = thousand square feet of floor area
Tripends = Daily Tripends (one trip = 2 tripends)

The proposed City of Santa Clarita Land Use Element describes how an emphasis has been placed on allowing mixed uses in order to allow residents to reach services in ways that are not exclusively automobile-dependent, such as by walking, biking and transit. Grouping mixed uses together also reduces the need for residents to take multiple vehicle trips to obtain services and reach employment centers, resulting in a net reduction in the number of vehicles on the roadway. The proposed OVOV land uses also represent a reduction in residential dwelling units of approximately 4 percent and an increase in office square footage of approximately 21 percent in comparison to the current City General Plan/County Area Plan. This change results in an improved jobs to housing balance for the Valley, which reduces the need for residents to commute outside of the Valley for employment.

The traffic forecasting process utilized by the SCVCTM derives vehicle trips based on trip distribution functions that take into account the geographical placement of land uses in relation to each other. As noted above, VMT is a function of both the number of trips and trip lengths and Table 2-5 provides a comparison between the current City General Plan/County Area Plan and the proposed OVOV land uses for these factors, as well as a comparison between existing conditions and the proposed OVOV plan.

Table 2-5: Trip Length and VMT Comparison

Scenario	Total Vehicle Trips (ADT)	Total VMT (veh-miles)	Average Trip Length (miles)
Existing (2004)	941,000	13,428,000	14.3
Proposed OVOV Land Uses with Existing Roadways	1,860,000	22,601,000	12.2
Difference	919,000	9,173,000	-2.1
	+98%[1]	+68%	-15%
Existing (2004)	941,000	13,428,000	14.3
Proposed OVOV Land Uses at Buildout[2]	1,860,000	21,532,000	11.6
Difference	919,000	8,104,000	-2.7
	+98%[1]	+60%	-19%
Current General Plan/Area Plan at Buildout	1,874,000	25,373,000	13.5
Proposed OVOV Land Uses at Buildout[2]	1,860,000	21,532,000	11.6
Difference	-14,000	-3,841,000	-1.9
	-1%	-15%	-14%

[1]Represents an annual increase of approximately 2.3% (compounded) if buildout is presumed to occur over a 30 year period.
[2]Includes buildout of the proposed Highway Plan.

Where:
ADT = Average Daily Trips
VMT = Vehicle Miles Traveled (daily)
Source: Santa Clarita Valley Consolidated Traffic Model (SCVCTM)

The above table shows that with the proposed OVOV land uses, the total number of vehicle trips is approximately 1 percent less than with the current City General Plan/County Area Plan and that the average trip length is reduced by approximately 1.9 miles. Total VMT is reduced by approximately 15 percent. These reductions are primarily due to factors inherent to the land use plan such as density, mixed use, and an improved jobs to housing ratio that reduces the number of commuter trips outside of the Valley.

In comparison to existing conditions, the proposed OVOV land uses result in approximately 98 percent more daily vehicle trips, but with just a 68 percent increase in daily VMT. Average trip length is reduced by 15 percent with the proposed land uses. With the implementation of the Highway Plan along with the proposed land uses, the VMT increase is approximately 60 percent over existing conditions, and average trip lengths are reduced by 19 percent in comparison to existing conditions.

The impact analysis provided in Chapter 4.0 compares roadway traffic volumes and LOS resulting from the proposed OVOV plan to forecasts based on the current City General Plan/County Area Plan, as well as to existing conditions.

3.0 ARTERIAL ROADWAYS

This chapter discusses the arterial roadway component of the City and County Circulation Elements. Referred to as the "Arterial Highway Plan" or simply the "Highway Plan," it provides recommendations for the Santa Clarita Valley's arterial roadway system.

3.1 ROADWAY CLASSIFICATIONS

The Highway Plan is defined using a hierarchy of arterial roadway classifications. Each is described by size and function, and has specific physical dimensions. The proposed Highway Plan maintains the general structure of the existing City and County Circulation Elements by utilizing the established roadway classifications of the current Highway Plan.

The functional classifications range from multi-lane expressways to two-lane undivided roadways.

3.1.1 Major Arterial Highway

This classification applies to six- to eight-lane roadways with raised landscaped medians (Urban) or painted medians (Rural). Their function is to carry high volumes of local and regional traffic. Unsignalized minor street and driveway access may be allowed but signalized access is preferred, and left-turn restrictions should be placed at unsignalized access locations. Curbside parking is prohibited. Bike lanes or bike trails can be employed in addition to sidewalk space. Traffic carrying capacities of around 54,000± vehicles per day for a six-lane roadway and 72,000± vehicles per day for an eight-lane roadway can be achieved depending on the degree of access control, peak period traffic loadings, and lane configurations at the major intersections.

3.1.2 Secondary Arterial Highway

This classification applies to four-lane roadways with raised landscaped medians (Sub-urban) or painted medians (Urban and Rural). In some areas of Urban Secondary, the painted median may allow for two-way left turns. Left turn restrictions will generally be placed at minor unsignalized driveways (i.e., median breaks will typically only be provided at intersections). As a primary traffic carrier, curbside

parking is prohibited. Bike lanes or bike trails can be employed in addition to sidewalk space. Traffic carrying capacities of 36,000± vehicles per day can be achieved depending on the degree of access control and peak period traffic loadings.

3.1.3 Limited Secondary Arterial Highway

This classification applies to two- to four-lane roadways generally without medians or bike lanes. This classification is generally less restrictive with respect to access to adjacent property. These routes are typically located in remote foothill, mountain and canyon areas. Their primary function is to provide access to low-density areas. Traffic carrying capacities of 18,000± vehicles per day for a two-lane roadway and 36,000± vehicles per day for a four-lane roadway can be achieved depending on the degree of access control and peak period traffic loadings.

3.1.4 Parkway

This classification applies to urban and non-urban routes having park-like features either within or adjacent to the roadway. The width of right-of-way varies as necessary to incorporate these features, but shall not be less than 80 feet. Traffic carrying capacities vary depending on the specific roadway improvements that are provided. Roadway improvements will vary based on the composition and volume of traffic to be carried.

3.1.5 Collector Streets

This classification applies to two-lane roadways in residential, commercial and industrial areas that serve some through traffic as well as the adjacent properties. Collectors connect local streets with arterial highways and balance mobility and access. Typically no median is provided and on street parking is allowed. While not as wide as an arterial highway, Collectors are typically wider than local streets in terms of right-of-way and lane widths. Traffic carrying capacities of 15,000± vehicles per day can be achieved depending on the degree of access control and peak period traffic loadings.

3.1.6 Local Streets

This classification applies to two-lane roadways in residential areas that serve the adjacent properties. Local streets are intended to provide access to adjacent land uses exclusively, and are not

designed or intended to carry through-traffic or allow for high speeds. Traffic carrying capacities of 10,000 vehicles per day or more are physically possible, but a maximum capacity of approximately 2,000± vehicles per day is targeted in order to provide an environment consistent with the adjoining residential uses.

3.1.7 Expressway

This classification applies to multi-lane State Highways under the jurisdiction of the California Department of Transportation (Caltrans). Expressways have restrictive access control consisting of grade-separated interchanges or signalized at-grade intersections with a minimum spacing of one mile. Traffic carrying capacities of around 44,000± vehicles per day for a four-lane expressway up to around 88,000± vehicles per day for an eight-lane expressway can be achieved depending on the degree of access control, peak period traffic loadings, and lane configurations at the major intersections.

The above roadway classifications are listed in Table 3-1 and conceptual cross-sections are illustrated in Figure 3-1.

3.2 ROADWAY DIMENSIONS

The preceding discussion on roadway classifications included general ranges for right-of-way (ROW) and pavement width. While the maximum value represents a desirable standard, variations in right-of-way width and specific roadway improvements will occur in certain cases due to physical constraints and/or right-of-way limitations. Hence, the roadway classifications may deviate from the standards where physical constraints exist, where preservation of community character dictates special treatment. Bikeways and sidewalks also affect the specific standards applied to various roadways. However, the overriding circulation goal is that all roadways carry the designated design volume of traffic at the desired performance standard.

3.3 PROPOSED ROADWAY PLAN

A recommended arterial roadway component of the City and County Circulation Elements (the Highway Plan) has been developed based on the traffic analysis presented in Chapter 4.0. The preparation of the traffic analysis consisted of evaluating the proposed OVOV buildout land uses in

Table 3-1: Roadway Classifications

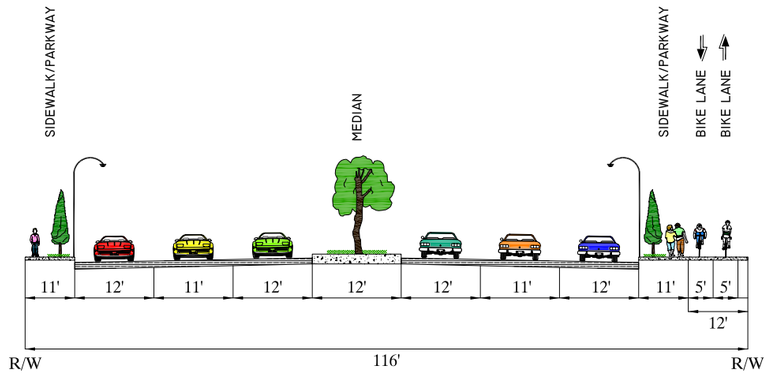
Highway Plan Classification	Functional Classification	Definition	Typical ROW Width (Curb-Curb Width)	Typical Configuration	Design Maximum Two-Way Daily Traffic Volume
MAJOR HIGHWAY	6 to 8 Lane Roadway	Arterials with at least 6 travel lanes for high mobility, designed with limited vehicular access to driveways and cross streets. The typical road section includes a raised landscaped median with left turn pockets at intersections. Street sections may include striped, on-street bikeways or separated bike paths.	108'-138' (84'-118')	6 – 8 lanes 12' Raised Median, or 12' Painted Median Bike Lanes or Trails No Parking Signalized side street access	54,000 (6L) 72,000 (8L)
SECONDARY HIGHWAY	4 Lane Roadway	Arterials with an ultimate design section of 4 travel lanes, designed for high mobility and with limited vehicular access from driveways and cross streets. The typical road section includes a median with left turn pockets provided at intersections. Secondary highways are designed to service both through traffic, and to collect traffic from collector and local streets.	86'-92' (58'-72')	4 Lanes 12' Raised Median, or 12' Painted Median Bike Lanes or Trails No Parking Signalized side street access	36,000
LIMITED SECONDARY HIGHWAY	2 to 4 Lane Roadway	Arterials with an ultimate roadway design section of 2 to 4 travel lanes and less restrictive access control. The typical road section does not include a median. These streets are designed to accommodate moderate volumes of traffic and are typically located in remote foothill, mountainous and canyon areas.	64' – 84' (28' – 64')	2 – 4 Lanes No Median No Bike Lanes No Parking	18,000 (2L) 36,000 (4L)
PARKWAY	2 or more Lane Roadway	Arterials having park-like features either within or adjacent to the roadway. Specific features vary depending on the composition and volume of traffic to be carried.	80' or more (varies)	2 or more Lanes	varies

(Continued)

Table 3-1: Roadway Classifications (Continued)

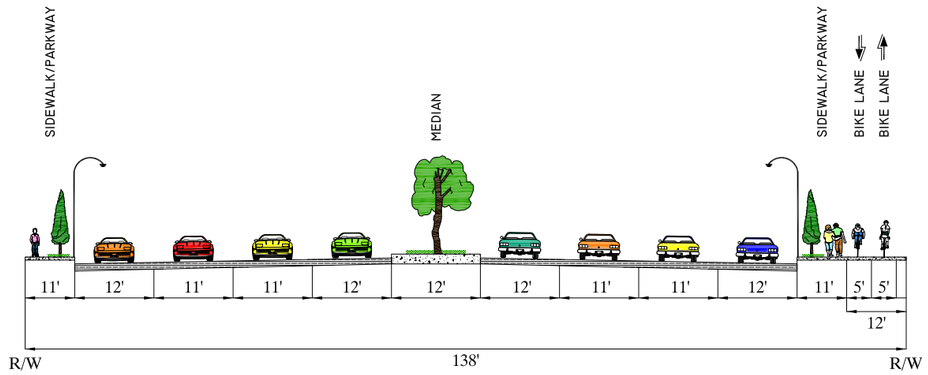
Highway Plan Classification	Functional Classification	Definition	Typical ROW Width (Curb-Curb Width)	Typical Configuration	Design Maximum Two-Way Daily Traffic Volume
COLLECTOR STREET	2 Lane Roadway	Streets which have an ultimate roadway design section of 2 travel lanes with limited vehicular access to the roadway from driveways and cross streets. The roadway is usually undivided and does not always accommodate left turn pockets at intersections. Collector streets are designed to provide both access and limited mobility, servicing local traffic from residential, commercial, and industrial uses and providing access to the arterial roadway system. Collector streets are not depicted on the adopted Highway Plan.	64' (40')	2 Lanes No Median No Bike Lanes Parking typically allowed.	15,000
LOCAL STREET	2 Lane Roadway	Streets which have an ultimate roadway design section of 2 travel lanes designed for full access and limited mobility. Local streets are not included on the adopted Highway Plan.	58'-60' (34'-36')	2 Lanes No Median No Bike Lanes Parking typically allowed.	2,500
EXPRESSWAY	4 to 8 Lane Roadway	Highways which have an ultimate roadway design section of 4 or more lanes that are part of the State Highway system. Expressways have restrictive access control consisting of grade-separated interchanges or at-grade signalized intersections with a minimum spacing of 1 mile.	200' (varies)	4 or More Lanes Median No Bike Lanes No Parking Grade Separation, or Signalized side-street access	44,000 (4L) 88,000 (8L)

MAJOR ARTERIAL HIGHWAY
(WITH BIKE TRAIL DETAIL)



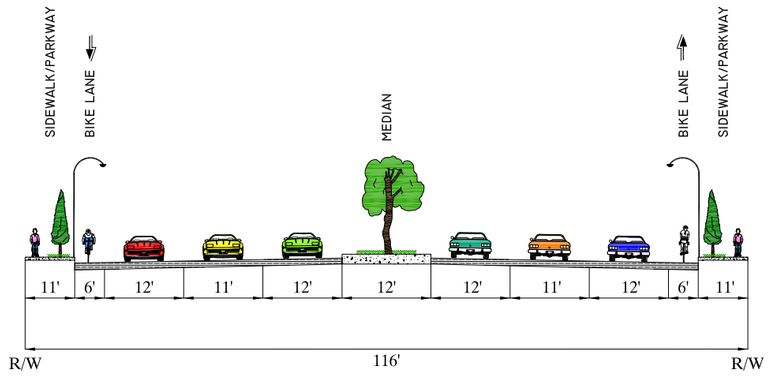
THREE LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

MAJOR ARTERIAL HIGHWAY
(EIGHT LANE ALTERNATIVE WITH BIKE TRAIL DETAIL)



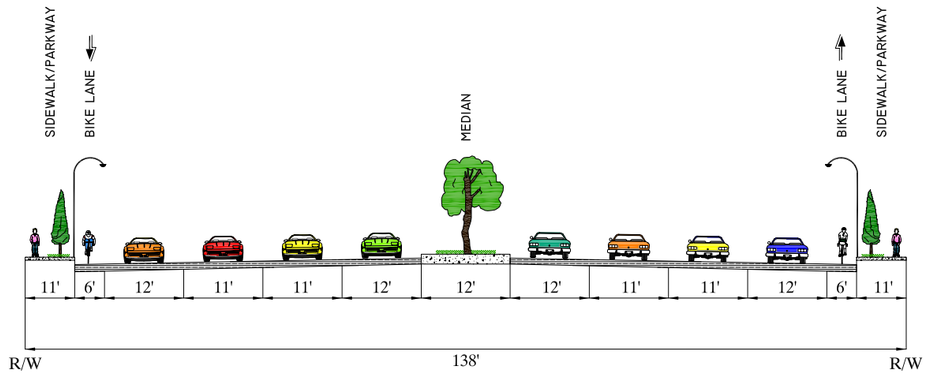
FOUR LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

MAJOR ARTERIAL HIGHWAY
(WITH BIKE LANE DETAIL)



THREE LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

MAJOR ARTERIAL HIGHWAY
(EIGHT LANE ALTERNATIVE WITH BIKE LANE DETAIL)



FOUR LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

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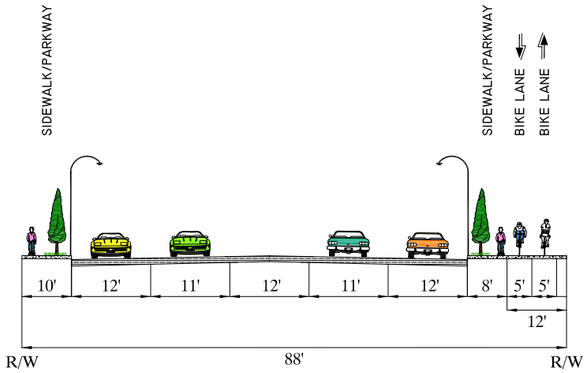
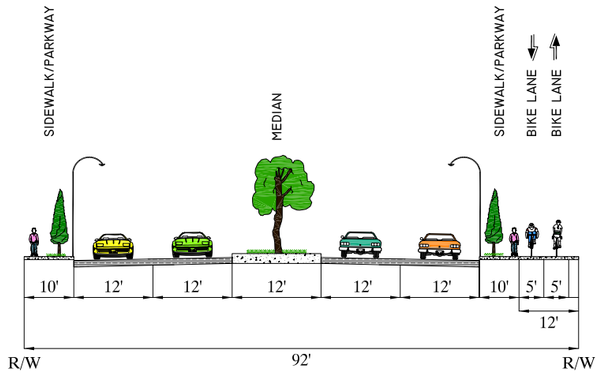
URBAN SECONDARY ARTERIAL HIGHWAY
(WITH BIKE TRAIL DETAIL)



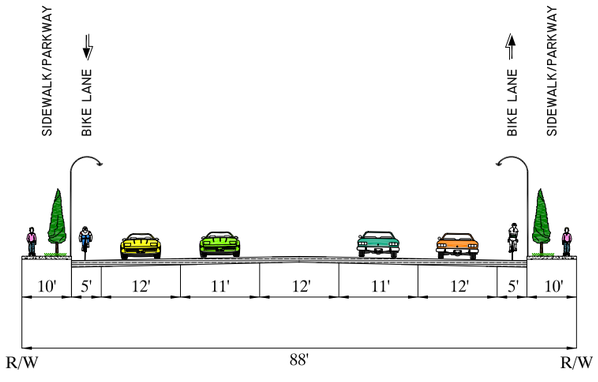
TWO LANES IN EACH DIRECTION WITH TWO WAY
LEFT TURN LANE, NO ON-STREET PARKING

SUB-URBAN SECONDARY ARTERIAL HIGHWAY
(WITH BIKE TRAIL DETAIL)



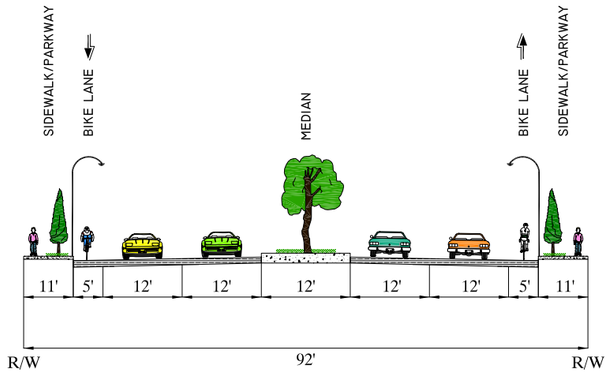
TWO LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

URBAN SECONDARY ARTERIAL HIGHWAY
(WITH BIKE LANE DETAIL)



TWO LANES IN EACH DIRECTION WITH TWO WAY
LEFT TURN LANE, NO ON-STREET PARKING

SUB-URBAN SECONDARY ARTERIAL HIGHWAY
(WITH BIKE LANE DETAIL)



TWO LANES IN EACH DIRECTION WITH RAISED
LANDSCAPE MEDIAN, NO ON-STREET PARKING

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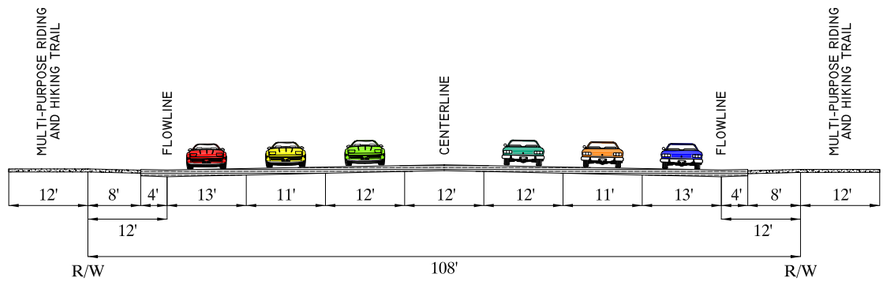
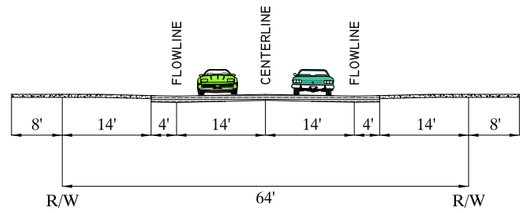
RURAL MAJOR HIGHWAY



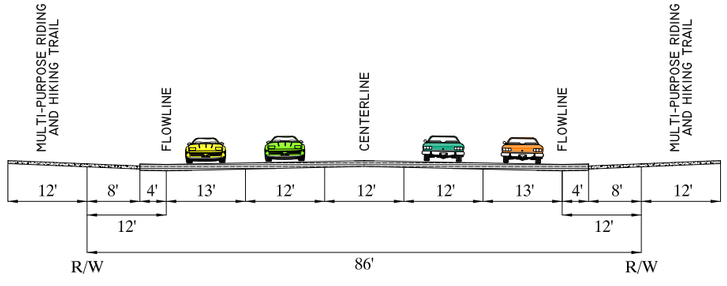
THREE LANES IN EACH DIRECTION WITH TWO WAY LEFT TURN LANE, NO ON-STREET PARKING

LIMITED SECONDARY ARTERIAL HIGHWAY



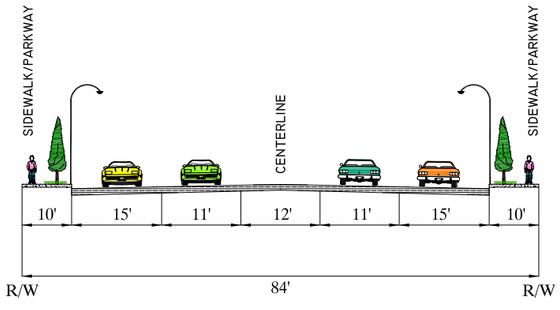
ONE LANE IN EACH DIRECTION WITH NO ON-STREET PARKING

RURAL SECONDARY HIGHWAY



TWO LANES IN EACH DIRECTION WITH TWO WAY LEFT TURN LANE, NO ON-STREET PARKING

LIMITED SECONDARY ARTERIAL HIGHWAY



TWO LANES IN EACH DIRECTION WITH NO ON-STREET PARKING

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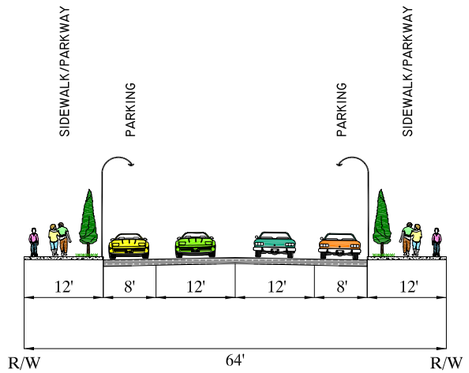
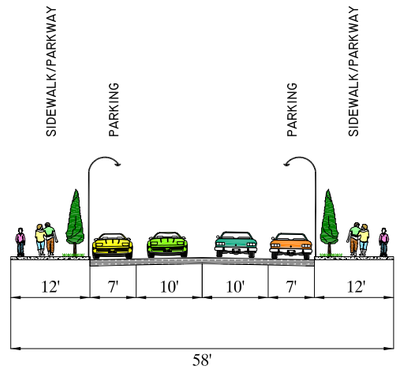
RESIDENTIAL COLLECTOR



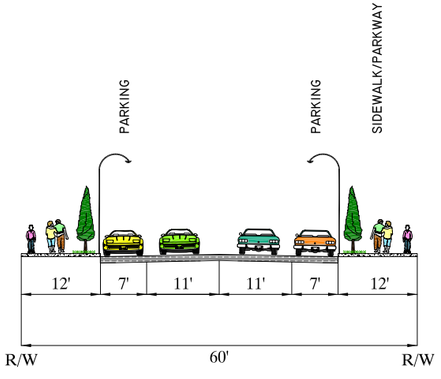
ONE LANE IN EACH DIRECTION WITH ON-STREET PARKING

RESIDENTIAL CUL-DE-SAC



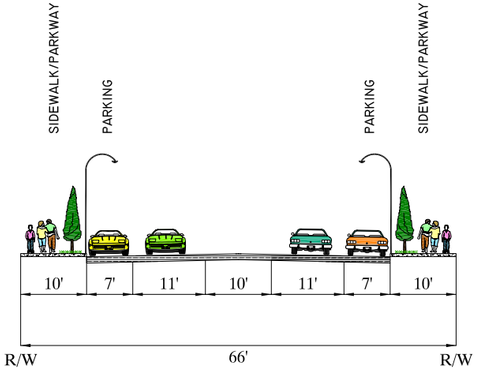
ONE LANE IN EACH DIRECTION WITH ON-STREET PARKING

RESIDENTIAL THROUGH STREET



ONE LANE IN EACH DIRECTION WITH ON-STREET PARKING

INDUSTRIAL/COMMERCIAL CUL-DE-SAC



ONE LANE IN EACH DIRECTION WITH TWO WAY LEFT TURN LANE, WITH ON-STREET PARKING

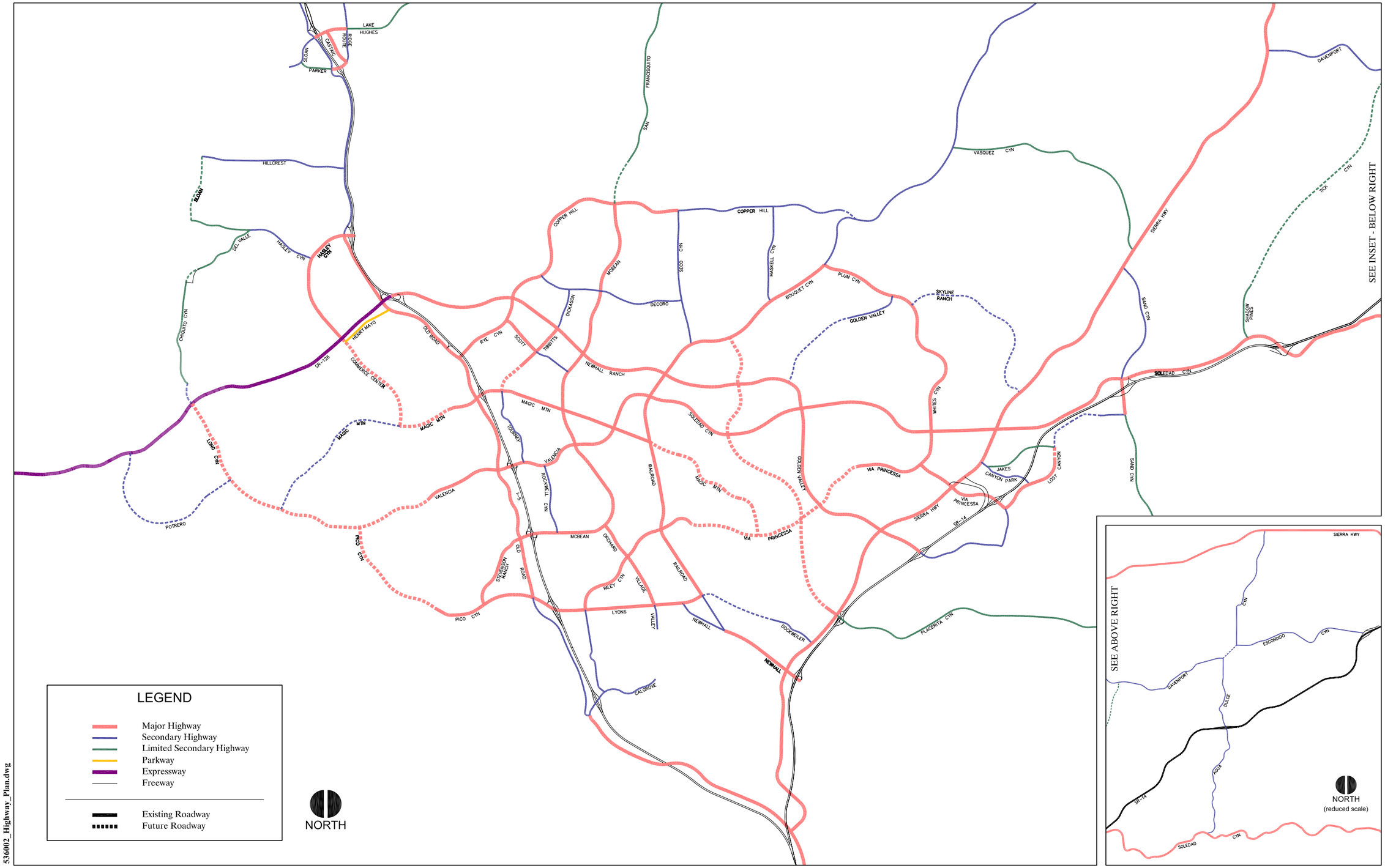
536002_Cross_Sections.dwg

conjunction with various alternatives of roadway configurations. From this analysis, a recommended Highway Plan evolved.

Figure 3-2 shows the proposed Highway Plan. Illustrated here by color and by line width are the recommended Highway Plan classifications as discussed earlier in this chapter. In the next chapter, future traffic volumes are estimated based on this Highway Plan to show its ability to serve the future traffic demands created by buildout of the OVOV land uses.

The recommended Highway Plan includes multiple changes from the current Highway Plans. Designations of the following roadway segments were recommended to be changed as a result of the traffic analysis:

1. **Lake Hughes Road from Ridge Route Road to Angeles National Forest Boundary** – Reclassify from a major highway to a limited secondary highway.
2. **Vasquez Canyon Road from Bouquet Canyon Road to Sierra Highway** – Reclassify from a secondary highway to a limited secondary highway.
3. **Sand Canyon Road from the Santa Clarita City boundary to Sierra Highway** – Reclassify from a major highway to a secondary highway along existing alignment.
4. **Shadow Pines Boulevard/Tick Canyon Road from Soledad Canyon Road to Davenport Road** – Reclassify from a secondary highway to a limited secondary highway.
5. **Bouquet Canyon Road from Plum Canyon Road to Vasquez Canyon Road** – Reclassify from a major highway to a secondary highway (realign planned secondary highway along the existing driven roadway).
6. **Skyline Ranch Road from Plum Canyon Road to Sierra Highway** – Reclassify planned major highway to a secondary highway (with an alternative section as approved for the development project through which this roadway passes).
7. **Valencia Boulevard/Potrero Canyon Road from the Newhall Ranch/Stevenson Ranch boundary to the planned Long Canyon Road** – Reclassify planned secondary highway to a major highway.
8. **Long Canyon Road from the planned Santa Clara River Bridge to the planned Valencia Boulevard/Potrero Canyon Road** – Reclassify planned secondary highway to a major highway.
9. **Pico Canyon Road from the Newhall Ranch/Stevenson Ranch boundary to Valencia Boulevard** – Reclassify planned secondary highway to a major highway.



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10. **Jakes Way from Canyon Park Boulevard to the planned Lost Canyon Road extension** – add classification for the existing roadway as a limited secondary highway.
11. **McBean Parkway from Copper Hill Drive to San Fransisquito Canyon Road** – Reclassify planned secondary highway to a limited secondary highway.
12. **San Fransisquito Canyon Road from the planned extension of McBean Parkway to the Angeles National Forest** – Reclassify from a secondary highway to a limited secondary highway.
13. **Lost Canyon Road from Jakes Way to Sand Canyon Road** – Reclassify planned major highway to a secondary highway.
14. **Placerita Canyon Road from Sierra Highway to Sand Canyon Road –** Reclassify planned secondary highway to a limited secondary highway.

Dockweiler Drive from Ivy Lane to Railroad Avenue – For Highway Plan purposes, Dockweiler Drive's entire length is a secondary highway. However, as a result of the 2009-approved The Master's College Master Plan, a section of Dockweiler Drive between Ivy Lane and the future intersection of Railroad Avenue and Lyons Avenue will not be striped to four-lane secondary highway standards. Instead, in an effort to have lower speeds on this segment and to maintain the existing residential community character, design features in this area are to include one travel lane in each direction and traffic calming measures such as on-street parking, medians and chokers. Full four-lane buildout to secondary highway standards will not occur on Dockweiler Drive until such time as traffic volumes warrant.

The following roadway segments were recommended to be removed from the Highway Plan as a result of the traffic analysis:

1. **16th Street from Orchard Village Road to Railroad Avenue** – Remove secondary (existing and planned) highway classification.
2. **Sloan Canyon Road from Hillcrest Parkway to Quail Valley Road** – Remove planned limited secondary highway classification.
3. **Castaic Road from Parker Road to Newhall Ranch Road** – Remove planned secondary highway classification.
4. **Biscailuz Drive from The Old Road to the previously planned extension of Castaic Road** – Remove planned secondary highway classification.

5. **Landmark Village (VTTM 53108) Spine Road** – Remove planned secondary highway classification.
6. **"A" Street (Mallory Drive) from Poe Parkway to Valencia Boulevard** – Remove planned secondary highway classification.
7. **Poe Parkway from Stevenson Ranch Parkway to Valencia Boulevard** – Remove secondary (existing and planned) highway classification.
8. **Cruzan Mesa Road from Whites Canyon Road to Sierra Highway** – Remove planned limited secondary highway classification.
9. **Newhall Avenue from 16th Street to Lyons Avenue** – Remove planned secondary highway classification.
10. **Seco Canyon Road north of Copper Hill Drive** – Remove existing limited secondary highway classification.
11. **Tournament Road** – Remove existing limited secondary highway classification.
12. **Lost Canyon Road east of Sand Canyon Road** – Remove existing limited secondary highway classification.

The following roadway alignments were recommended to be changed as a result of the traffic analysis:

1. **Long Canyon Road/Potrero Canyon Road/Valencia Boulevard at planned intersection** – Realign to make Long Canyon Road/Valencia Boulevard the continuous roadway.
2. **Chiquito Canyon Road/Long Canyon Road at State Route 126** – Revise alignments to create a continuous north/south roadway.
3. **Whites Canyon Road from Plum Canyon Road to Vasquez Canyon Road** – Revise alignment to connect from Plum Canyon Road to Sierra Highway (as the proposed Skyline Ranch Road).

Table 3-2 indicates the designation of all General Plan roadways as shown on the proposed Highway Plan.

Table 3-2: Highway Plan Roadways in the Planning Area

Roadway Classification	Roadway Segments in Planning Area
Expressways	SR-126
Major Highways	Avenue Scott (from Rye Canyon Road to Avenue Tibbitts) Avenue Tibbitts Bouquet Canyon Road (from Plum Canyon Road to Magic Mountain Parkway) Castaic Road (from Lake Hughes Road to Parker Road) Commerce Center Drive Copper Hill Drive (from Newhall Ranch Road to Seco Canyon Road) Golden Valley Road (from Newhall Ranch Road to SR-14 freeway) Hasley Canyon Road (from Commerce Center Drive to I-5 freeway) Lake Hughes Road (from The Old Road to Ridge Route Road) Long Canyon Road (from SR-126 to Valencia Boulevard) Lost Canyon Road (from Jakes Way to Via Princessa) Lyons Avenue Magic Mountain Parkway (from Commerce Center Drive to Via Princessa) McBean Parkway (from I-5 freeway to Copper Hill Drive) Newhall Avenue (from Railroad Avenue to SR-14 freeway) Newhall Ranch Road Orchard Village Road Parker Road (from The Old Road to Castaic Road) Pico Canyon Road Plum Canyon Road Railroad Avenue (from Magic Mountain Parkway to Lyons Avenue) Rye Canyon Road Sand Canyon Road (from Soledad Canyon Road to Lost Canyon Road) Santa Clarita Parkway Sierra Highway Soledad Canyon Road Stevenson Ranch Parkway The Old Road (from Hasley Canyon Road to Lyons Avenue) The Old Road (from Calgrove Boulevard to Sierra Highway) Valencia Boulevard Via Princessa (from Wiley Canyon Road to Lost Canyon Road) Whites Canyon Road Wiley Canyon Road (from Lyons Avenue to Via Princessa)

(Continued)

Table 3-2: Highway Plan Roadways in the Planning Area (Continued)

Roadway Classification	Roadway Segments in Planning Area
Secondary Highways	Agua Dulce Canyon Road Avenue Scott (from Avenue Tibbitts to McBean Parkway) Bouquet Canyon Road (from Plum Canyon Road to Angeles National Forest boundary) Calgrove Boulevard Canyon Park Boulevard Copper Hill Drive (from Seco Canyon Road to Bouquet Canyon Road) Davenport Road Decoro Drive (from Seco Canyon Road to Copper Hill Drive) Dickason Drive (from Newhall Ranch Road to Decoro Drive) Dockweiler Drive Escondido Canyon Road Golden Valley Road (from Newhall Ranch Road to Plum Canyon Road) Golden Valley Road (from SR-14 freeway to Via Princessa) Haskell Canyon Road (from Copper Hill Drive to Bouquet Canyon Road) Hasley Canyon Road (from Del Valle Road to Commerce Center Drive) Hillcrest Parkway Long Canyon Road (from Chiquito Canyon Road to SR-126) Lost Canyon Road (from Jakes Way to Sand Canyon Road) Magic Mountain Parkway (from Long Canyon Road to Commerce Center Drive) Newhall Avenue (from Lyons Avenue to Railroad Avenue) Potrero Canyon Road Railroad Avenue (from Lyons Avenue to Newhall Avenue) Ridge Route Road (from approximately ¾ mile north of Northlake Hills elementary school to Castaic Road) Rockwell Canyon Road Sand Canyon Road (from Sierra Highway to Soledad Canyon Road) Seco Canyon Road (from Copper Hill Drive to Bouquet Canyon Road) Skyline Ranch Road Sloan Canyon Road (from The Old Road to Quail Valley Road) The Old Road (from Oak Valley Road to Hasley Canyon Road) The Old Road (from Pico Canyon Road to Calgrove Boulevard) Tourney Road Valley Street (from Lyons Avenue to Happy Valley Drive) Via Princessa (from Lost Canyon Road to Golden Valley Road) Wiley Canyon Road (from Lyons Avenue to Calgrove Boulevard)

(Continued)

Table 3-2: Highway Plan Roadways in the Planning Area (Continued)

Roadway Classification	Roadway Segments in Planning Area
Limited Secondary Highways	Bouquet Canyon Road (from Angeles National Forest Boundary to Elizabeth Lake Road) Chiquito Canyon Road (from Del Valle Road to Long Canyon Road) Del Valle Road (from Chiquito Canyon Road to Hasley Canyon Road) Hasley Canyon Road (from Sloan Canyon Road to Del Valle Road) Jakes Way Lake Hughes Road (from Ridge Route Road to Pine Canyon Road) McBean Parkway (from San Francisquito Canyon Road to Copper Hill Drive) Placerita Canyon Road (from Sierra Highway to Sand Canyon Road) Ridge Route Road (from Templin Highway to approximately ¾ mile north of Northlake Hills elementary school) San Francisquito Canyon Road (from McBean Parkway to Elizabeth Lake Road) Sand Canyon Road (from Lost Canyon Road to Little Tujunga Canyon Road) Shadow Pines Boulevard Sloan Canyon Road (from Hillcrest Parkway to Hasley Canyon Road) Tick Canyon Road Vasquez Canyon Road
Parkways	Henry Mayo Drive (from Commerce Center Drive to The Old Road)

4.0 TRAFFIC ANALYSIS

This chapter presents long-range traffic data based on the proposed OVOV land uses and the proposed Highway Plan. Future levels of service findings are discussed and potential improvements needed to implement the plan are summarized.

4.1 LONG-RANGE TRAFFIC VOLUMES

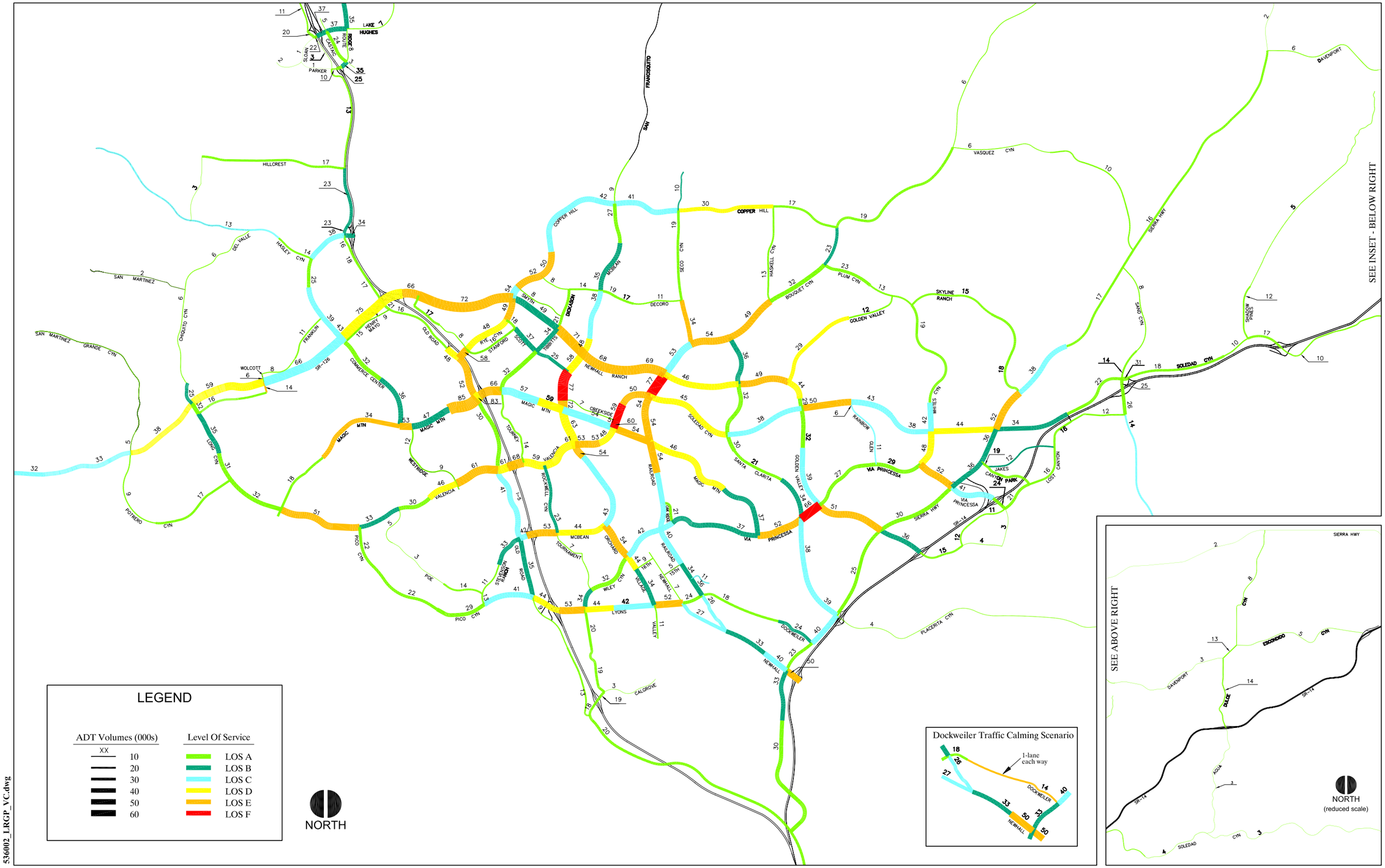
Future daily and peak hour traffic volumes on the analysis area circulation system were estimated for the proposed OVOV land uses and for the current City General Plan/County Area Plan land uses using traffic forecasts produced by the Santa Clarita Valley Consolidated Traffic Model (SCVCTM). They were derived for the roadway system described in the previous chapter, which represents buildout of the proposed Highway Plan.

Long-range ADT volumes for this roadway plan are shown in Figure 4-1, and peak hour volumes for principal intersections are provided in Figure 4-2 and Figure 4-3 for the a.m. and p.m. peak hours, respectively. They are labeled here as OVOV Buildout Conditions and represent buildout of the proposed OVOV land use plan. While a specific date that corresponds to buildout of the land use is indeterminable due to variations in market conditions, these forecasts can generally be considered a year-2035 horizon for planning purposes.

Traffic volumes based on the current City General Plan/County Area Plan traffic model are also presented for comparison purposes. ADT volumes are illustrated in Figure 4-4, and peak hour volumes for principal intersections are provided in Figure 4-5 and Figure 4-6 for the a.m. and p.m. peak hours, respectively.

4.2 LONG-RANGE LEVELS OF SERVICE

A comparison of OVOV Buildout Conditions to traffic forecasts based on the current City General Plan/County Area Plan is provided in Table 4-1. The table presents roadway segment V/C ratios and LOS values for each of the two scenarios. A comparable table for peak hour intersection conditions is provided in Table 4-2 and Table 4-3, which presents ICU and LOS values for each of the two scenarios based on existing intersection geometry as well as with buildout of the proposed Highway Plan.



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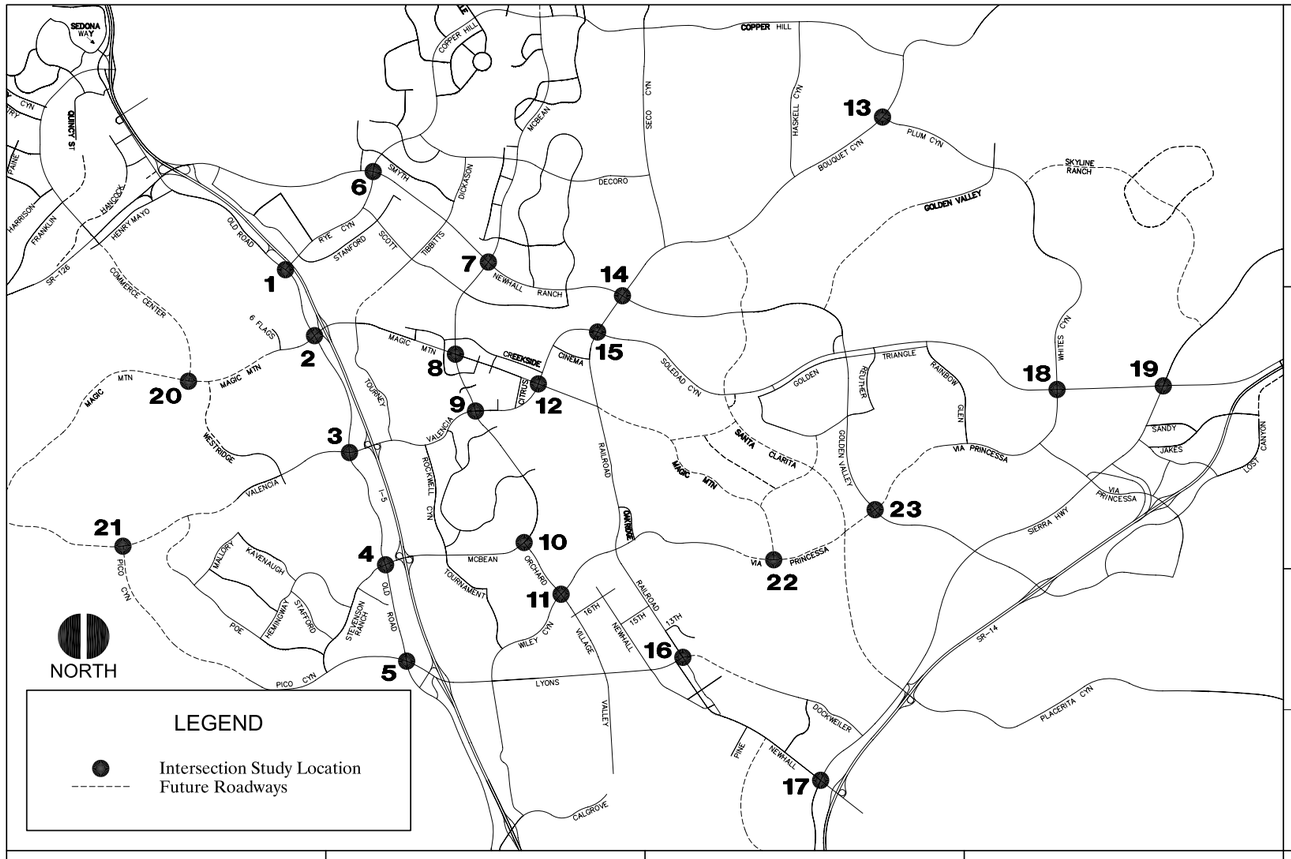

#1

700		910
450		860
	1640	
	1060	

#2

630		1390
120		1020
340		180
540	140	
1720	540	
140	400	

#3

130		350
200		1610
200		90
300	110	
2380	300	
370	730	

#4

170		630
260		250
20		250
130	300	
1110	390	
120	60	

#5

320		260
170		1270
130		10
380	50	
590	220	
100	120	

#6

90		660
1640		1230
1260		330
360	220	
540	1190	
280	430	

#7

530		60
1770		1760
200		970
100	910	
910	910	
310	250	

#8

580		370
1960		820
690		70
530	50	
1550	1260	
150	200	

#9

960	70	
900		220
		1060
		420
530	320	
1170	1020	
20	280	

#10

10		30
20		650
10		860
50	850	
440	60	
880	960	

#11

530		460
610		690
340		370
230	330	
370	710	
90	50	

#12

20		70
1640		1040
750		610
530	270	
910	830	
100	80	

#13

400		310
940		20
10		1050
10	600	
50	330	
60	10	

#14

110		70
2190		1420
750		570
270	270	
930	530	
850	550	

#15

400		280
1910		880
1250		160
300	230	
910	660	
120	20	

#16

210		250
680		320
200		50
190	70	
340	700	
130	50	

#17

60		10
770		1460
90		1000
50	260	
860	180	
460	210	

#18

590		220
1110		1140
230		570
100	140	
730	560	
130	430	

#19

300		180
930		790
850		280
550	100	
780	810	
110	160	

#20

860		
110		980
		670
620		
960		

#21

		850
		10
1780	20	
430	530	

#22

290		1110
30		1020
260		50
250	140	
810	180	
20	130	

#23

100		200
320		1310
590		140
500	40	
410	1300	
590	550	

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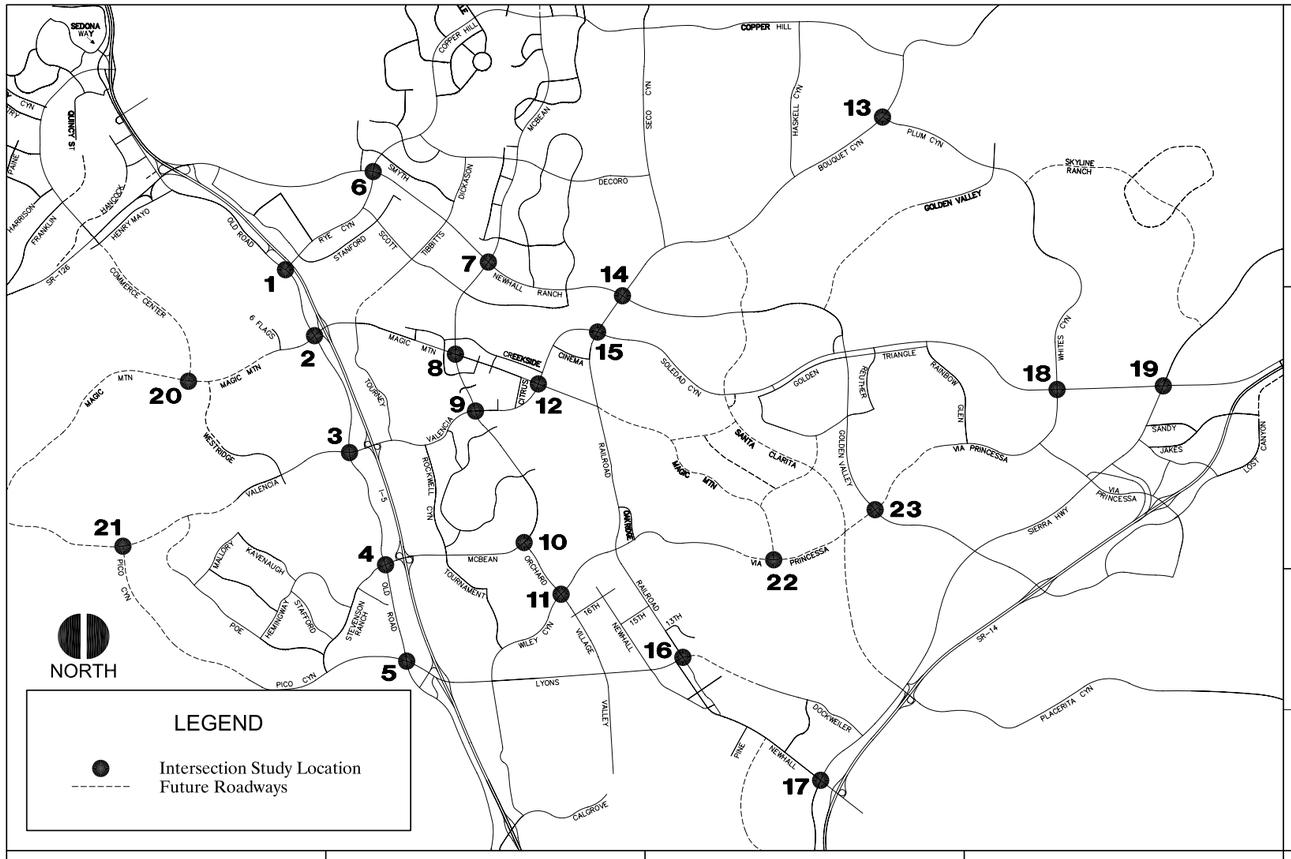

#1

890 / 870 ↓		1250 / 1320 ←
		1330 / 1300 ↑

#2

480 / 650 / 870 ↓		1460 / 1490 / 160 ←
520 / 2230 / 540 →		130 / 390 / 430 ↑

#3

320 / 760 / 210 ↓		570 / 2190 / 480 ←
240 / 1790 / 750 →		420 / 620 / 430 ↑

#4

620 / 900 / 260 ↓		270 / 960 / 870 ←
210 / 470 / 90 →		640 / 840 / 140 ↑

#5

510 / 360 / 470 ↓		570 / 1300 / 10 ←
90 / 890 / 250 →		100 / 660 / 190 ↑

#6

280 / 960 / 820 ↓		290 / 1050 / 470 ←
1040 / 1990 / 530 →		90 / 1350 / 390 ↑

#7

180 / 1340 / 60 ↓		480 / 1740 / 280 ←
250 / 1990 / 640 →		1220 / 2020 / 280 ↑

#8

340 / 2110 / 120 ↓		590 / 1330 / 220 ←
470 / 1780 / 400 →		270 / 2460 / 390 ↑

#9

220 / 1350 / 970 ↓		350 / 1200 / 730 ←
1000 / 1270 / 340 →		710 / 1370 / 190 ↑

#10

60 / 70 / 30 ↓		20 / 950 / 1140 ←
40 / 900 / 1200 →		110 / 60 / 910 ↑

#11

650 / 1140 / 150 ↓		540 / 710 / 390 ←
320 / 760 / 140 →		610 / 1050 / 80 ↑

#12

50 / 1250 / 580 ↓		40 / 970 / 470 ←
700 / 1300 / 40 →		690 / 1760 / 130 ↑

#13

260 / 350 / 10 ↓		250 / 20 / 630 ←
10 / 10 / 30 →		810 / 1050 / 60 ↑

#14

70 / 1430 / 440 ↓		100 / 970 / 150 ←
690 / 2040 / 1050 →		600 / 2490 / 890 ↑

#15

430 / 1400 / 820 ↓		780 / 950 / 400 ←
1300 / 1130 / 120 →		500 / 1760 / 100 ↑

#16

380 / 730 / 420 ↓		200 / 500 / 50 ←
300 / 540 / 80 →		70 / 970 / 0 ↑

#17

10 / 160 / 20 ↓		80 / 1190 / 450 ←
240 / 1560 / 300 →		1090 / 890 / 430 ↑

#18

310 / 1070 / 260 ↓		460 / 820 / 210 ←
460 / 1300 / 430 →		500 / 1160 / 400 ↑

#19

620 / 1010 / 630 ↓		390 / 610 / 220 ←
740 / 990 / 120 →		240 / 960 / 190 ↑

#20

1190 / 600 ↓		1350 / 840 ←
220 / 960 →		

#21

		1640 / 30 ←
1300 / 990 →		10 / 800 ↑

#22

1140 / 210 / 420 ↓		740 / 860 / 120 ←
290 / 1040 / 120 →		80 / 80 / 60 ↑

#23

510 / 920 / 540 ↓		100 / 550 / 50 ←
320 / 1130 / 1240 →		60 / 870 / 770 ↑

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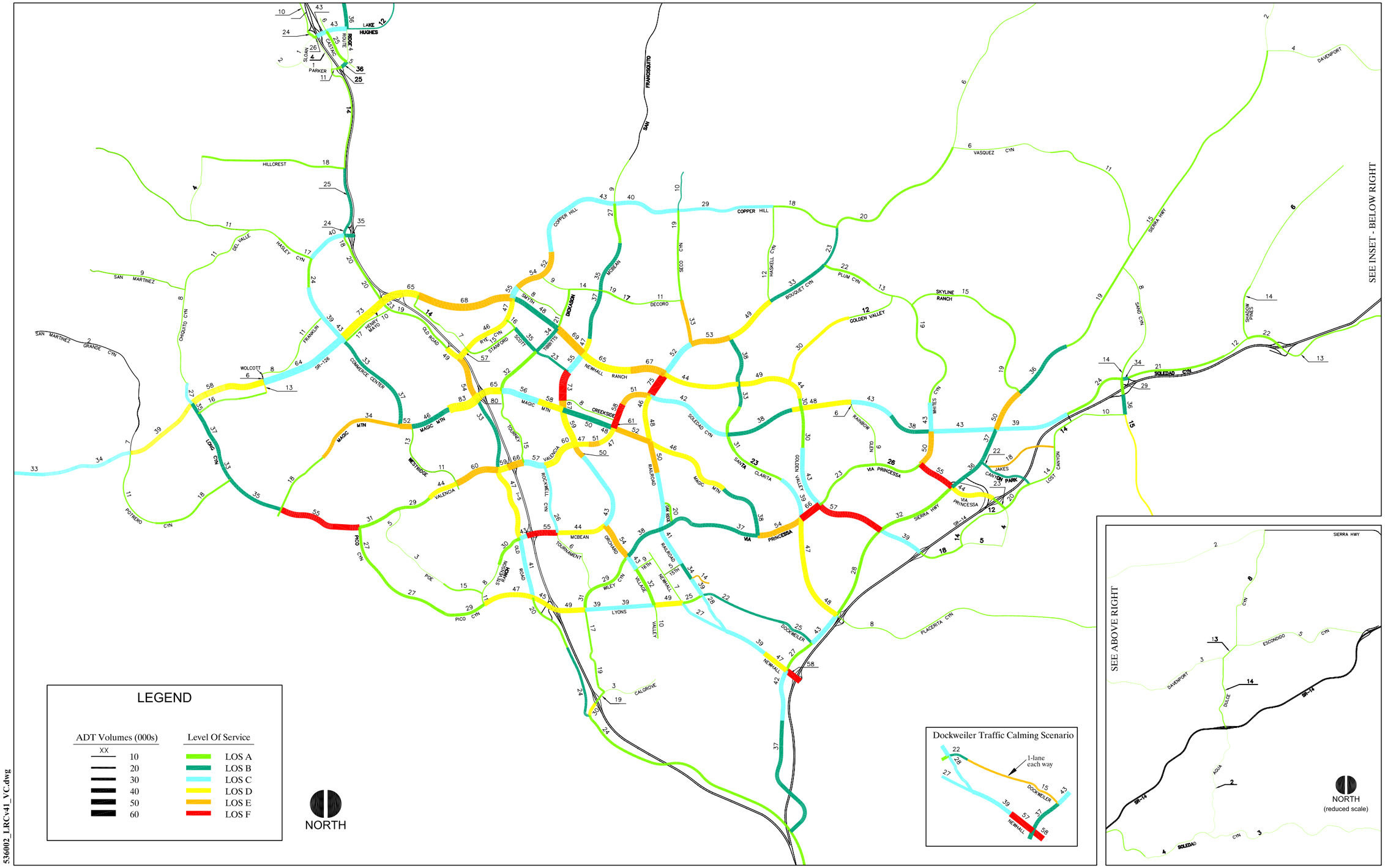

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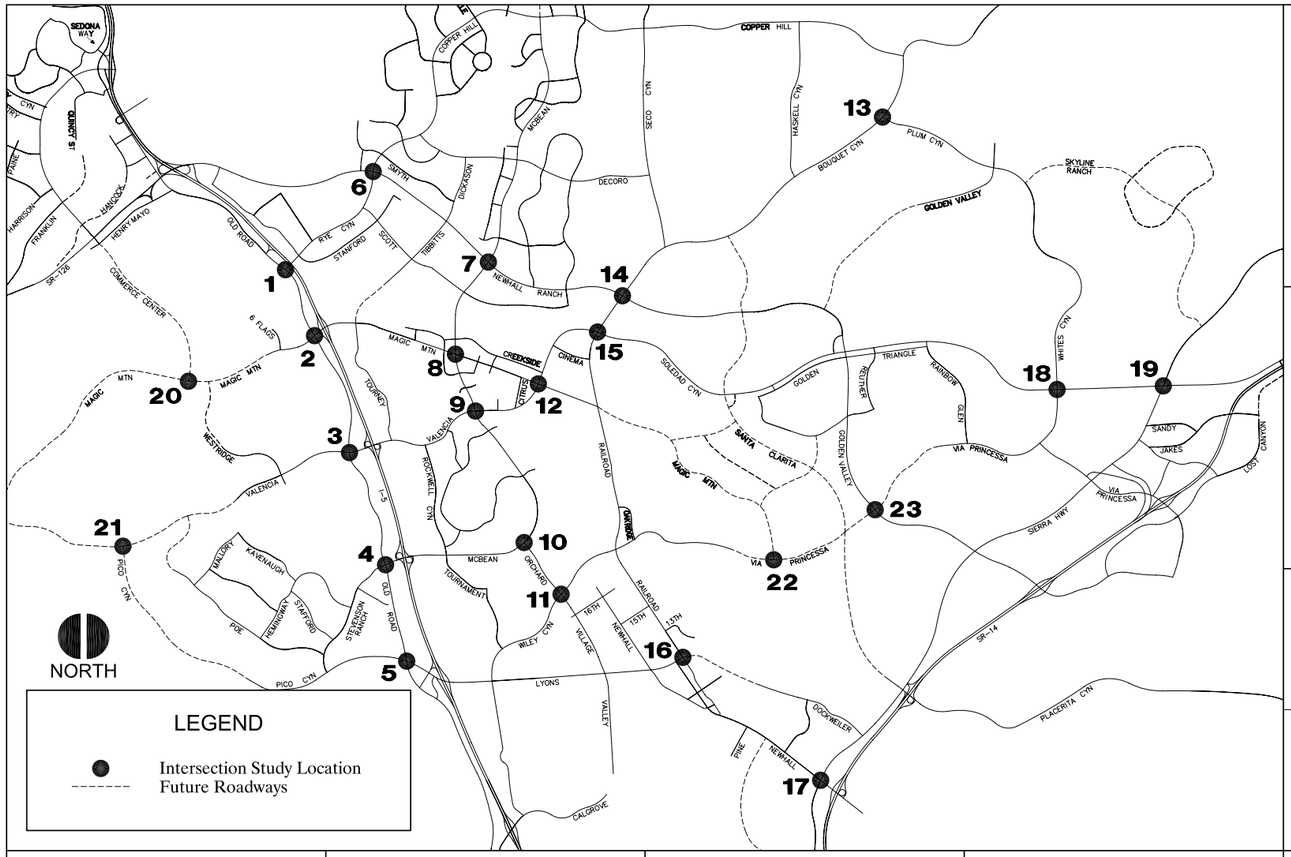

#1

280 / 430		950 / 890
		1590 / 1180

#2

670 / 100 / 320		1460 / 1020 / 150
510 / 1620 / 190		120 / 580 / 470

#3

140 / 270 / 170		370 / 1520 / 90
290 / 2200 / 420		110 / 390 / 770

#4

240 / 310 / 20		640 / 220 / 250
110 / 970 / 130		330 / 540 / 70

#5

330 / 180 / 180		300 / 1470 / 10
400 / 730 / 100		60 / 370 / 170

#6

80 / 1680 / 1270		700 / 1350 / 370
500 / 530 / 260		40 / 1100 / 360

#7

480 / 1700 / 230		60 / 1890 / 970
100 / 680 / 280		880 / 880 / 250

#8

430 / 1920 / 800		410 / 880 / 70
500 / 1340 / 130		40 / 1310 / 240

#9

70 / 880 / 970		290 / 1180 / 360
450 / 860 / 20		250 / 1060 / 270

#10

10 / 20 / 10		30 / 620 / 850
50 / 550 / 840		830 / 60 / 980

#11

510 / 670 / 280		500 / 540 / 340
190 / 300 / 70		320 / 750 / 30

#12

50 / 1610 / 720		90 / 1190 / 440
450 / 920 / 40		220 / 730 / 80

#13

400 / 900 / 10		310 / 20 / 1060
10 / 50 / 60		610 / 310 / 10

#14

110 / 2000 / 810		50 / 1340 / 570
260 / 710 / 890		300 / 500 / 670

#15

290 / 1890 / 1240		380 / 1020 / 120
340 / 840 / 120		110 / 620 / 20

#16

270 / 770 / 190		370 / 410 / 70
180 / 330 / 120		80 / 820 / 60

#17

120 / 830 / 120		0 / 1320 / 1100
30 / 1000 / 470		400 / 400 / 420

#18

560 / 1280 / 200		240 / 1250 / 510
90 / 640 / 120		110 / 650 / 400

#19

240 / 1130 / 650		260 / 1140 / 320
500 / 730 / 120		80 / 890 / 180

#20

840 / 110		1040 / 680
650 / 900		

#21

		880 / 10
1720 / 590		20 / 750

#22

380 / 10 / 260		1250 / 1030 / 20
250 / 880 / 10		60 / 40 / 30

#23

60 / 620 / 570		280 / 1370 / 210
600 / 320 / 800		30 / 1340 / 620

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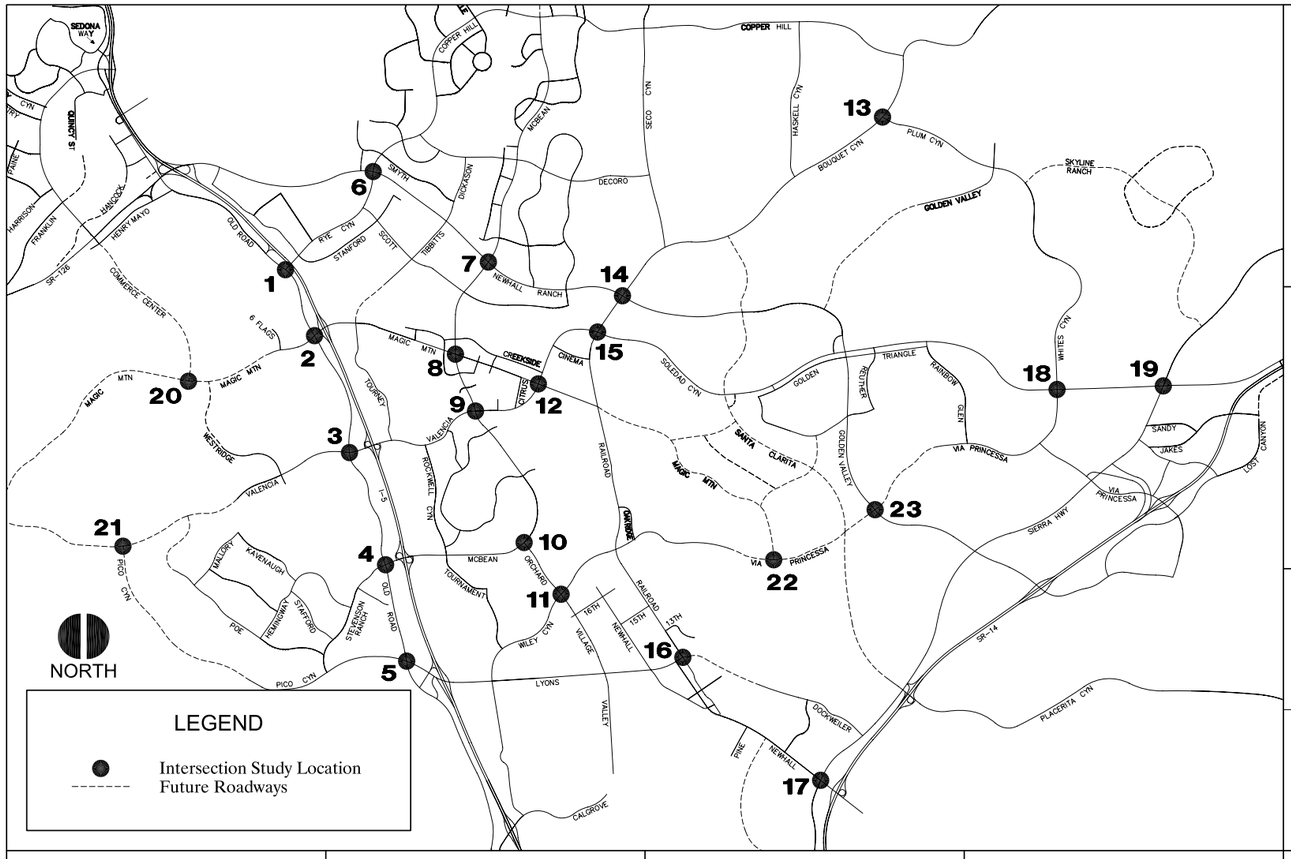

#1

980		1270
990		1220
	1280	
	1350	

#2

520		1480
640		1380
840		140
500	110	
2180	400	
570	440	

#3

400		540
700		2080
210		490
230	510	
1600	740	
780	470	

#4

450		350
1110		850
210		890
220	620	
400	1020	
90	170	

#5

520		620
550		1390
500		10
100	140	
1090	840	
270	180	

#6

280		270
950		990
770		470
980	80	
2100	1460	
430	270	

#7

180		450
1320		1590
70		240
320	1210	
2040	1960	
610	280	

#8

160		450
2260		1390
130		220
510	280	
1930	2380	
280	290	

#9

270		290
1310		930
980		600
940	700	
1400	1350	
370	160	

#10

60		20
70		910
30		1140
40	1100	
970	60	
1150	880	

#11

640		500
1090		580
160		380
290	570	
730	1080	
170	80	

#12

130		130
1150		1120
650		240
740	500	
1380	1710	
30	100	

#13

250		230
390		20
10		620
10	850	
10	1040	
30	60	

#14

70		100
1370		930
410		170
690	620	
2020	2350	
1100	810	

#15

530		490
1210		970
910		290
1370	470	
1240	1770	
40	100	

#16

480		290
810		620
390		70
300	100	
610	1050	
100	0	

#17

10		160
290		1220
10		630
140	1200	
1440	790	
520	480	

#18

320		420
1120		740
240		200
430	560	
1400	1170	
370	350	

#19

630		340
1080		540
580		160
640	250	
1320	1190	
120	150	

#20

1110		1310
650		800
220		
1010		

#21

		1590
		20
1160	10	
1270	910	

#22

1310		1100
60		860
400		50
270	30	
1110	30	
40	20	

#23

610		70
1080		460
570		50
400	100	
1110	1170	
1260	990	

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Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
1. Agua Dulce n/o Escondido Cyn	4	36,000	8,000	.22	A	8,000	.22	A
2. Agua Dulce n/o Davenport	4	36,000	13,000	.36	A	13,000	.36	A
3. Agua Dulce n/o SR-14	4	36,000	14,000	.39	A	14,000	.39	A
4. Agua Dulce s/o SR-14	4	36,000	2,000	.06	A	3,000	.08	A
5. Ave Scott s/o Rye Canyon	6	54,000	16,000	.30	A	18,000	.33	A
6. Ave Scott s/o Stanford	6	54,000	35,000	.65	B	37,000	.69	B
7. Ave Scott n/o McBean	4	36,000	23,000	.64	B	25,000	.69	B
8. Ave Stanford s/o Vanderbilt	4	36,000	14,000	.39	A	17,000	.47	A
9. Ave Stanford n/o Rye Cyn	4	30,000	7,000	.23	A	8,000	.27	A
10. Ave Stanford s/o Rye Cyn	4	36,000	15,000	.42	A	16,000	.44	A
11. Bouquet Cyn n/o Vasquez	4	36,000	6,000	.17	A	6,000	.17	A
12. Bouquet Cyn n/o Copper Hill	4	36,000	20,000	.56	A	19,000	.53	A
13. Bouquet Cyn e/o Plum Cyn	4	36,000	23,000	.64	B	23,000	.64	B
14. Bouquet Cyn e/o Haskell	6	54,000	33,000	.61	B	32,000	.59	A
15. Bouquet Cyn w/o Haskell	6	54,000	49,000	.91	E	49,000	.91	E
16. Bouquet Cyn e/o Seco	6	54,000	53,000	.98	E	54,000	1.00	E
17. Bouquet Cyn w/o Seco	8	72,000	52,000	.72	C	53,000	.74	C
18. Bouquet Cyn s/o Newhall Ranch	8	72,000	75,000	1.04	**F**	77,000	1.07	**F**
19. Bouquet Cyn s/o Soledad	6	54,000	46,000	.85	D	54,000	1.00	E
20. Bouquet Cyn n/o Magic Mtn	6	54,000	48,000	.89	D	54,000	1.00	E
21. Calgrove e/o The Old Road	4	36,000	30,000	.83	D	18,000	.50	A
22. Calgrove w/o Wiley Cyn	4	36,000	19,000	.53	A	19,000	.53	A
23. Calgrove e/o Wiley Cyn	4	36,000	3,000	.08	A	3,000	.08	A
24. Canyon Park e/o Sierra Hwy	4	36,000	22,000	.61	B	19,000	.53	A
25. Castaic n/o Lake Hughes	4	36,000	6,000	.17	A	5,000	.14	A
26. Castaic s/o Lake Hughes	6	54,000	25,000	.46	A	24,000	.44	A
27. Castaic s/o Ridge Route	2	15,000	5,000	.33	A	3,000	.20	A
28. Chiquito Cyn s/o San Martinez Cyn	2	18,000	8,000	.44	A	6,000	.33	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
29. Chiquito Cyn (Long Cyn) n/o SR-126	4	36,000	27,000	.75	C	25,000	.69	B
30. Commerce Center s/o Industry	6	54,000	24,000	.44	A	25,000	.46	A
31. Commerce Center s/o Franklin	6	54,000	39,000	.72	C	39,000	.72	C
32. Commerce Center n/o SR-126	6	54,000	43,000	.80	C	43,000	.80	C
33. Commerce Center s/o Henry Mayo	6	54,000	33,000	.61	B	32,000	.59	A
34. Commerce Center n/o Magic Mtn	6	54,000	37,000	.69	B	36,000	.67	B
35. Copper Hill n/o Newhall Ranch	8	72,000	55,000	.76	C	54,000	.75	C
36. Copper Hill s/o Decoro	6	54,000	54,000	1.00	E	52,000	.96	E
37. Copper Hill n/o Decoro	6	54,000	52,000	.96	E	50,000	.93	E
38. Copper Hill w/o McBean	6	54,000	43,000	.80	C	42,000	.78	C
39. Copper Hill e/o McBean	6	54,000	40,000	.74	C	41,000	.76	C
40. Copper Hill e/o Seco Cyn	4	36,000	29,000	.81	D	30,000	.83	D
41. Copper Hill e/o Haskell	4	36,000	18,000	.50	A	17,000	.47	A
42. Creekside e/o McBean Pkwy	4	36,000	8,000	.22	A	7,000	.19	A
43. Davenport e/o Sierra Hwy	4	36,000	4,000	.11	A	6,000	.17	A
44. Davenport w/o Agua Dulce	4	36,000	3,000	.08	A	3,000	.08	A
45. Decoro e/o Copper Hill	4	36,000	9,000	.25	A	8,000	.22	A
46. Decoro e/o Dickason	4	36,000	14,000	.39	A	14,000	.39	A
47. Decoro e/o McBean	4	36,000	19,000	.53	A	19,000	.53	A
48. Decoro w/o Hillsborough	4	36,000	17,000	.47	A	17,000	.47	A
49. Decoro w/o Seco Cyn	4	36,000	11,000	.31	A	11,000	.31	A
50. Del Valle n/o San Martinez	2	18,000	11,000	.61	B	6,000	.33	A
51. Dickason n/o Newhall Ranch	6	54,000	21,000	.39	A	21,000	.39	A
52. Dockweiler e/o Railroad	4	36,000	22,000	.61	B	18,000	.50	A
53. Dockweiler w/o Sierra Hwy	4	36,000	25,000	.69	B	24,000	.67	B
54. Escondido e/o Agua Dulce	4	36,000	5,000	.14	A	5,000	.14	A
55. Franklin e/o Wolcott Way	2	15,000	8,000	.53	A	8,000	.53	A
56. Franklin w/o Commerce Center	4	36,000	11,000	.31	A	11,000	.31	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
57. Golden Valley s/o Plum Cyn	4	36,000	12,000	.33	A	12,000	.33	A
58. Golden Valley n/o Newhall Ranch	4	36,000	30,000	.83	D	29,000	.81	D
59. Golden Valley n/o Soledad	6	54,000	44,000	.81	D	44,000	.81	D
60. Golden Valley s/o Soledad	6	54,000	30,000	.56	A	29,000	.54	A
61. Golden Valley n/o Centre Point	6	54,000	30,000	.56	A	32,000	.59	A
62. Golden Valley s/o Centre Point	6	54,000	43,000	.80	C	39,000	.72	C
63. Golden Valley s/o Via Princessa	6	54,000	57,000	1.06	F	51,000	.94	E
64. Golden Valley e/o Sierra Hwy	6	54,000	39,000	.72	C	36,000	.67	B
65. Golden Valley e/o SR-14	4	36,000	18,000	.50	A	15,000	.42	A
66. Golden Valley e/o Lost Cyn	4	36,000	5,000	.14	A	4,000	.11	A
67. Haskell Cyn n/o Bouquet	4	36,000	12,000	.33	A	13,000	.36	A
68. Hasley Cyn w/o Del Valle	2	18,000	11,000	.61	B	13,000	.72	C
69. Hasley Cyn w/o Commerce Center	4	36,000	17,000	.47	A	14,000	.39	A
70. Hasley Cyn w/o The Old Road	6	54,000	40,000	.74	C	38,000	.70	B
71. Hasley Cyn w/o I-5	6	54,000	35,000	.65	B	34,000	.63	B
72. Henry Mayo e/o Commerce Center	4	36,000	17,000	.47	A	15,000	.42	A
73. Henry Mayo w/o The Old Road	4	36,000	10,000	.28	A	9,000	.25	A
74. Hillcrest w/o The Old Road	4	36,000	18,000	.50	A	17,000	.47	A
75. Jakes Way e/o Canyon Park	2	18,000	18,000	1.00	E	12,000	.67	B
76. Lake Hughes w/o Castaic	6	54,000	43,000	.80	C	37,000	.69	B
77. Lake Hughes e/o Castaic	6	54,000	43,000	.80	C	37,000	.69	B
78. Lake Hughes e/o Ridge Route	2	18,000	12,000	.67	B	7,000	.39	A
79. Long Cyn s/o SR-126	6	54,000	35,000	.65	B	32,000	.59	A
80. Long Cyn s/o River Village	6	54,000	37,000	.69	B	35,000	.65	B
81. Long Cyn n/o Potrero Cyn	6	54,000	33,000	.61	B	31,000	.57	A
82. Long Canyon s/o Potrero Cyn	6	54,000	35,000	.65	B	32,000	.59	A
83. Lost Cyn w/o Sand Cyn	4	36,000	10,000	.28	A	12,000	.33	A
84. Lost Cyn n/o Jakes Way	4	36,000	14,000	.39	A	16,000	.44	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
85. Lost Cyn n/o Canyon Park	6	54,000	14,000	.26	A	16,000	.30	A
86. Lost Cyn n/o Via Princessa	6	54,000	20,000	.37	A	21,000	.39	A
87. Lost Cyn s/o Via Princessa	4	36,000	12,000	.33	A	11,000	.31	A
88. Lost Cyn n/o Golden Valley	4	36,000	14,000	.39	A	12,000	.33	A
89. Lyons e/o I-5	6	54,000	49,000	.91	E	53,000	.98	E
90. Lyons e/o Wiley Cyn	6	54,000	39,000	.72	C	44,000	.81	D
91. Lyons w/o Orchard Village	6	54,000	39,000	.72	C	42,000	.78	C
92. Lyons e/o Orchard Village	6	54,000	49,000	.91	E	52,000	.96	E
93. Lyons w/o Main Street	6	54,000	25,000	.46	A	24,000	.44	A
94. Magic Mtn e/o Long Cyn	4	36,000	18,000	.50	A	18,000	.50	A
95. Magic Mtn w/o Commerce Center	4	36,000	34,000	.94	E	34,000	.94	E
96. Magic Mtn e/o Commerce Center	6	54,000	52,000	.96	E	53,000	.98	E
97. Magic Mtn e/o Westridge	8	72,000	46,000	.64	B	47,000	.65	B
98. Magic Mtn w/o The Old Road	10	90,000	83,000	.92	E	85,000	.94	E
99. Magic Mtn e/o The Old Road	10	90,000	80,000	.89	D	83,000	.92	E
100. Magic Mtn e/o I-5	8	72,000	65,000	.90	D	66,000	.92	E
101. Magic Mtn e/o Tourney	8	72,000	56,000	.78	C	57,000	.79	C
102. Magic Mtn w/o McBean	8	72,000	58,000	.81	D	59,000	.82	D
103. Magic Mtn e/o McBean	8	72,000	50,000	.69	B	54,000	.75	C
104. Magic Mtn w/o Valencia	8	72,000	48,000	.67	B	51,000	.71	C
105. Magic Mtn e/o Valencia	6	54,000	52,000	.96	E	54,000	1.00	E
106. Magic Mtn e/o Bouquet Cyn	6	54,000	46,000	.85	D	46,000	.85	D
107. Magic Mtn n/o Via Princessa	6	54,000	38,000	.70	B	37,000	.69	B
108. McBean n/o Copper Hill	2	18,000	9,000	.50	A	9,000	.50	A
109. McBean s/o Copper Hill	6	54,000	27,000	.50	A	27,000	.50	A
110. McBean n/o Decoro	6	54,000	35,000	.65	B	35,000	.65	B
111. McBean s/o Decoro	6	54,000	37,000	.69	B	38,000	.70	B
112. McBean n/o Newhall Ranch	6	54,000	47,000	.87	D	48,000	.89	D

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
113. McBean s/o Newhall Ranch	8	72,000	55,000	.76	C	58,000	.81	D
114. McBean s/o Ave Scott	8	72,000	73,000	1.01	**F**	77,000	1.07	**F**
115. McBean n/o Magic Mtn	8	72,000	67,000	.93	E	72,000	1.00	E
116. McBean n/o Valencia	8	72,000	59,000	.82	D	63,000	.88	D
117. McBean s/o Valencia	6	54,000	50,000	.93	E	54,000	1.00	E
118. McBean n/o Orchard Village	6	54,000	43,000	.80	C	43,000	.80	C
119. McBean e/o Rockwell Cyn	6	54,000	44,000	.81	D	44,000	.81	D
120. McBean w/o Rockwell Cyn	6	54,000	55,000	1.02	**F**	53,000	.98	E
121. McBean w/o I-5	6	54,000	43,000	.80	C	42,000	.78	C
122. Newhall Ranch e/o I-5	8	72,000	65,000	.90	D	66,000	.92	E
123. Newhall Ranch w/o Rye Cyn	8	72,000	68,000	.94	E	72,000	1.00	E
124. Newhall Ranch e/o Rye Cyn	8	72,000	48,000	.67	B	49,000	.68	B
125. Newhall Ranch w/o McBean	8	72,000	69,000	.96	E	71,000	.99	E
126. Newhall Ranch e/o McBean	8	72,000	65,000	.90	D	68,000	.94	E
127. Newhall Ranch w/o Bouquet Cyn	8	72,000	67,000	.93	E	69,000	.96	E
128. Newhall Ranch e/o Bouquet Cyn	6	54,000	44,000	.81	D	46,000	.85	D
129. Newhall Ranch e/o Santa Clarita	6	54,000	49,000	.91	E	49,000	.91	E
130. Newhall n/o Lyons	2	15,000	7,000	.47	A	7,000	.47	A
131. Newhall s/o Lyons	4	36,000	27,000	.75	C	27,000	.75	C
132. Newhall n/o Valle Oro	6	54,000	39,000	.72	C	33,000	.61	B
133. Newhall n/o Sierra Hwy	6	54,000	47,000	.87	D	40,000	.74	C
134. Newhall s/o Sierra Hwy	6	54,000	58,000	1.07	**F**	50,000	.93	E
135. Oak Ridge e/o Railroad	4	36,000	20,000	.56	A	21,000	.58	A
136. Orchard Village s/o McBean	6	54,000	54,000	1.00	E	54,000	1.00	E
137. Orchard Village s/o Wiley Cyn	6	54,000	43,000	.80	C	44,000	.81	D
138. Orchard Village n/o Lyons	6	54,000	32,000	.59	A	34,000	.63	B
139. Parker e/o Sloan	2	18,000	1,000	.06	A	1,000	.06	A
140. Parker w/o I-5	6	54,000	11,000	.20	A	10,000	.19	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
141. Pico Cyn s/o Valencia	6	54,000	27,000	.50	A	22,000	.41	A
142. Pico Cyn w/o Whispering Oaks	6	54,000	27,000	.50	A	22,000	.41	A
143. Pico Cyn w/o Stevenson Ranch	6	54,000	29,000	.54	A	29,000	.54	A
144. Pico Cyn w/o The Old Road	6	54,000	47,000	.87	D	41,000	.76	C
145. Pico Cyn w/o I-5	6	54,000	45,000	.83	D	44,000	.81	D
146. Placerita Cyn e/o SR-14	2	18,000	8,000	.44	A	4,000	.22	A
147. Plum Cyn s/o Bouquet Cyn	6	54,000	22,000	.41	A	23,000	.43	A
148. Plum Cyn w/o Golden Valley	6	54,000	13,000	.24	A	13,000	.24	A
149. Poe s/o Valencia	4	36,000	5,000	.14	A	5,000	.14	A
150. Poe s/o Mallory	4	36,000	3,000	.08	A	3,000	.08	A
151. Poe w/o Stevenson Ranch	4	36,000	15,000	.42	A	14,000	.39	A
152. Potrero s/o SR-126	4	36,000	11,000	.31	A	9,000	.25	A
153. Potrero w/o Long Cyn	4	36,000	18,000	.50	A	17,000	.47	A
154. Railroad s/o Magic Mtn	6	54,000	50,000	.93	E	54,000	1.00	E
155. Railroad s/o Oak Ridge	6	54,000	41,000	.76	C	40,000	.74	C
156. Railroad n/o 13th St	6	54,000	34,000	.63	B	34,000	.63	B
157. Railroad n/o Lyons	6	54,000	39,000	.72	C	36,000	.67	B
158. Railroad s/o Lyons	4	36,000	28,000	.78	C	26,000	.72	C
159. Rainbow Glen s/o Soledad Cyn	2	15,000	6,000	.40	A	6,000	.40	A
160. Rainbow Glen n/o Via Princessa	2	15,000	9,000	.60	A	11,000	.73	C
161. Ridge Route n/o Lake Hughes	6	54,000	36,000	.67	B	35,000	.65	B
162. Ridge Route n/o Castaic	4	36,000	4,000	.11	A	8,000	.22	A
163. Ridge Route e/o I-5	6	54,000	36,000	.67	B	35,000	.65	B
164. Ridge Route btwn I-5 Ramps	6	54,000	25,000	.46	A	25,000	.46	A
165. Landmark e/o Long Cyn	4	36,000	16,000	.44	A	16,000	.44	A
166. Rockwell Cyn n/o McBean	4	36,000	26,000	.72	C	23,000	.64	B
167. Rye Cyn e/o Ave Scott	6	54,000	47,000	.87	D	49,000	.91	E
168. Rye Cyn w/o Ave Scott	6	54,000	46,000	.85	D	48,000	.89	D

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
169. Rye Cyn e/o The Old Road	7	63,000	57,000	.90	D	58,000	.92	E
170. San Martinez w/o Del Valle	2	15,000	9,000	.60	A	2,000	.13	A
171. San Martinez Grande Cyn n/o VTTM 60678	2	15,000	2,000	.13	A	<500	.00	A
172. San Martinez Grande Cyn n/o SR-126	4	36,000	7,000	.19	A	5,000	.14	A
173. Sand Cyn s/o Sierra Hwy	4	36,000	8,000	.22	A	8,000	.22	A
174. Sand Cyn n/o Soledad Cyn	4	36,000	14,000	.39	A	14,000	.39	A
175. Sand Cyn s/o Soledad Cyn	6	54,000	29,000	.54	A	25,000	.46	A
176. Sand Cyn s/o SR-14	6	54,000	36,000	.67	B	26,000	.48	A
177. Sand Cyn s/o Lost Cyn	2	18,000	15,000	.83	D	14,000	.78	C
178. Santa Clarita s/o Bouquet Cyn	6	54,000	38,000	.70	B	36,000	.67	B
179. Santa Clarita s/o Newhall Ranch	6	54,000	33,000	.61	B	32,000	.59	A
180. Santa Clarita s/o Soledad	6	54,000	31,000	.57	A	30,000	.56	A
181. Santa Clarita s/o Porta Bella	6	54,000	23,000	.43	A	21,000	.39	A
182. Santa Clarita n/o Via Princessa	6	54,000	39,000	.72	C	34,000	.63	B
183. Santa Clarita s/o Via Princessa	6	54,000	47,000	.87	D	38,000	.70	B
184. Santa Clarita w/o Sierra Hwy	6	54,000	48,000	.89	D	39,000	.72	C
185. Seco Cyn n/o Copper Hill	2	15,000	10,000	.67	B	10,000	.67	B
186. Seco Cyn s/o Copper Hill	4	36,000	19,000	.53	A	19,000	.53	A
187. Seco Cyn n/o Bouquet Cyn	4	36,000	33,000	.92	E	34,000	.94	E
188. Shadow Pines n/o Soledad Cyn	2	18,000	14,000	.77	C	12,000	.66	B
189. Shadow Pines n/o Grandifloras	2	18,000	6,000	.33	A	5,000	.28	A
190. Sierra Hwy w/o Agua Dulce	6	54,000	2,000	.04	A	2,000	.04	A
191. Sierra Hwy n/o Davenport	6	54,000	2,000	.04	A	2,000	.04	A
192. Sierra Hwy n/o Vasquez Cyn	6	54,000	15,000	.28	A	16,000	.30	A
193. Sierra Hwy s/o Sand Cyn	6	54,000	19,000	.35	A	17,000	.31	A
194. Sierra Hwy n/o Skyline Ranch	6	54,000	36,000	.67	B	38,000	.70	B
195. Sierra Hwy n/o Soledad Cyn	6	54,000	50,000	.93	E	52,000	.96	E
196. Sierra Hwy s/o Soledad Cyn	6	54,000	37,000	.69	B	36,000	.67	B

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
197. Sierra Hwy s/o Canyon Park	6	54,000	36,000	.67	B	36,000	.67	B
198. Sierra Hwy s/o Via Princessa	6	54,000	32,000	.59	A	30,000	.56	A
199. Sierra Hwy s/o Golden Valley	6	54,000	28,000	.52	A	25,000	.46	A
200. Sierra Hwy n/o Dockweiler	6	54,000	43,000	.80	C	40,000	.74	C
201. Sierra Hwy n/o Newhall	6	54,000	27,000	.50	A	23,000	.43	A
202. Sierra Hwy s/o Newhall	6	54,000	42,000	.78	C	33,000	.61	B
203. Sierra Hwy n/o SR-14	6	54,000	37,000	.69	B	30,000	.56	A
204. Skyline Ranch e/o Plum Cyn	4	36,000	15,000	.42	A	15,000	.42	A
205. Skyline Ranch w/o Sierra Hwy	4	36,000	19,000	.53	A	18,000	.50	A
206. Sloan Cyn e/o The Old Road	6	54,000	26,000	.48	A	22,000	.41	A
207. Sloan Cyn e/o Parker	4	36,000	1,000	.03	A	1,000	.03	A
208. Sloan Cyn w/o Parker	4	36,000	2,000	.06	A	2,000	.06	A
209. Sloan Cyn s/o Hillcrest	2	18,000	4,000	.22	A	3,000	.17	A
210. Smyth s/o Copper Hill	4	30,000	8,000	.27	A	8,000	.27	A
211. Soledad Cyn e/o Bouquet Cyn	6	54,000	42,000	.78	C	45,000	.83	D
212. Soledad Cyn w/o Golden Valley	6	54,000	38,000	.70	B	38,000	.70	B
213. Soledad Cyn e/o Golden Valley	6	54,000	48,000	.89	D	50,000	.93	E
214. Soledad Cyn e/o Rainbow Glen	6	54,000	43,000	.80	C	43,000	.80	C
215. Soledad Cyn w/o Whites Cyn	6	54,000	38,000	.70	B	38,000	.70	B
216. Soledad Cyn e/o Whites Cyn	6	54,000	43,000	.80	C	44,000	.81	D
217. Soledad Cyn e/o Sierra Hwy	6	54,000	39,000	.72	C	34,000	.63	B
218. Soledad Cyn w/o Sand Cyn	6	54,000	24,000	.44	A	22,000	.41	A
219. Soledad Cyn e/o Sand Cyn	6	54,000	34,000	.63	B	31,000	.57	A
220. Soledad Cyn e/o SR-14 (at Sand Cyn)	6	54,000	21,000	.39	A	18,000	.33	A
221. Soledad Cyn w/o Shadow Pines	6	54,000	12,000	.22	A	10,000	.19	A
222. Soledad Cyn e/o Shadow Pines	6	54,000	22,000	.41	A	17,000	.31	A
223. Soledad Cyn e/o SR-14	4	36,000	13,000	.36	A	10,000	.28	A
224. Soledad Cyn w/o Agua Dulce	4	36,000	4,000	.11	A	4,000	.11	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
225. Soledad Cyn e/o Agua Dulce	4	36,000	3,000	.08	A	3,000	.08	A
226. SR-126 at County Line	4	44,000	33,000	.75	C	32,000	.73	C
227. SR-126 w/o San Martinez Grande Cyn	4	44,000	34,000	.77	C	33,000	.75	C
228. SR-126 w/o Chiquito Cyn/Long Cyn	4	44,000	39,000	.89	D	38,000	.86	D
229. SR-126 w/o Wolcott	6	66,000	58,000	.88	D	59,000	.89	D
230. SR-126 w/o Commerce Center	8	88,000	64,000	.73	C	66,000	.75	C
231. SR-126 w/o I-5	8	88,000	73,000	.83	D	75,000	.85	D
232. Stevenson Ranch w/o Old Road	6	54,000	30,000	.56	A	33,000	.61	B
233. Stevenson Ranch n/o Poe	6	54,000	8,000	.15	A	11,000	.20	A
234. Stevenson Ranch n/o Pico Cyn	6	54,000	11,000	.20	A	13,000	.24	A
235. The Old Road n/o I-5 (at Lake Hughes)	4	36,000	10,000	.28	A	11,000	.31	A
236. The Old Road n/o Sloan Cyn	6	54,000	24,000	.44	A	20,000	.37	A
237. The Old Road n/o Parker	4	36,000	4,000	.11	A	3,000	.08	A
238. The Old Road n/o Hillcrest	4	36,000	14,000	.39	A	13,000	.36	A
239. The Old Road n/o Sedona Way	4	36,000	25,000	.69	B	23,000	.64	B
240. The Old Road n/o Hasley Cyn	4	36,000	24,000	.67	B	23,000	.64	B
241. The Old Road s/o Hasley Cyn	6	54,000	18,000	.33	A	16,000	.30	A
242. The Old Road n/o Biscailuiz	6	54,000	20,000	.37	A	18,000	.33	A
243. The Old Road n/o Turnberry	6	54,000	20,000	.37	A	17,000	.31	A
244. The Old Road n/o Henry Mayo	6	54,000	23,000	.43	A	21,000	.39	A
245. The Old Road s/o Henry Mayo	6	54,000	19,000	.35	A	16,000	.30	A
246. The Old Road n/o Rye Cyn	6	54,000	49,000	.91	E	48,000	.89	D
247. The Old Road n/o Magic Mtn	6	54,000	54,000	1.00	E	52,000	.96	E
248. The Old Road s/o Magic Mtn	6	54,000	33,000	.61	B	30,000	.56	A
249. The Old Road s/o Valencia	6	54,000	47,000	.87	D	41,000	.76	C
250. The Old Road s/o McBean	6	54,000	41,000	.76	C	35,000	.65	B
251. The Old Road s/o Pico	4	36,000	20,000	.56	A	9,000	.25	A
252. The Old Road n/o Calgrove	4	36,000	24,000	.67	B	13,000	.36	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
253. The Old Road s/o Calgrove	6	54,000	24,000	.44	A	20,000	.37	A
254. Tibbitts s/o Newhall Ranch	6	54,000	34,000	.63	B	34,000	.63	B
255. Tibbitts n/o Magic Mtn	6	54,000	32,000	.59	A	32,000	.59	A
256. Tournament s/o McBean	2	15,000	6,000	.40	A	7,000	.47	A
257. Tourney n/o Valencia	4	36,000	15,000	.42	A	14,000	.39	A
258. Valencia e/o Magic Mtn	6	54,000	55,000	1.02	**F**	51,000	.94	E
259. Valencia e/o Pico Cyn	6	54,000	31,000	.57	A	33,000	.61	B
260. Valencia e/o Poe	6	54,000	29,000	.54	A	30,000	.56	A
261. Valencia w/o Westridge	6	54,000	44,000	.81	D	46,000	.85	D
262. Valencia w/o The Old Road	7	63,000	60,000	.95	E	61,000	.97	E
263. Valencia e/o Old Road	8	72,000	59,000	.82	D	61,000	.85	D
264. Valencia e/o I-5	8	72,000	66,000	.92	E	68,000	.94	E
265. Valencia e/o Tourney	8	72,000	57,000	.79	C	59,000	.82	D
266. Valencia w/o McBean	8	72,000	60,000	.83	D	61,000	.85	D
267. Valencia e/o McBean	6	54,000	47,000	.87	D	53,000	.98	E
268. Valencia w/o Citrus	6	54,000	51,000	.94	E	53,000	.98	E
269. Valencia s/o Magic Mtn	6	54,000	47,000	.87	D	48,000	.89	D
270. Valencia n/o Magic Mtn	6	54,000	61,000	1.13	**F**	60,000	1.11	**F**
271. Valencia s/o Cinema	6	54,000	58,000	1.07	**F**	59,000	1.09	**F**
272. Valencia w/o Bouquet Cyn	6	54,000	51,000	.94	E	50,000	.93	E
273. Valley s/o Lyons	4	36,000	10,000	.28	A	11,000	.31	A
274. Vasquez Cyn e/o Bouquet Cyn	2	18,000	6,000	.33	A	6,000	.33	A
275. Vasquez Cyn w/o Sierra Hwy	2	18,000	11,000	.61	B	10,000	.56	A
276. Via Princessa e/o Oak Ridge	6	54,000	37,000	.69	B	37,000	.69	B
277. Via Princessa e/o Magic Mtn	6	54,000	54,000	1.00	E	52,000	.96	E
278. Via Princessa e/o Santa Clarita	6	54,000	66,000	1.22	**F**	66,000	1.22	**F**
279. Via Princessa w/o Rainbow Glen	6	54,000	23,000	.43	A	27,000	.50	A
280. Via Princessa e/o Rainbow Glen	6	54,000	26,000	.48	A	29,000	.54	A

(Continued)

Table 4-1: ADT V/C and LOS – Current General Plan Buildout Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Lanes	Capacity	Current GP			OVOV GP		
			Volume	V/C	LOS	Volume	V/C	LOS
281. Via Princessa s/o Whites Cyn	6	54,000	55,000	1.02	**F**	52,000	.96	E
282. Via Princessa s/o Sierra Hwy	6	54,000	44,000	.81	D	41,000	.76	C
283. Via Princessa n/o Lost Cyn	6	54,000	23,000	.43	A	24,000	.44	A
284. Via Princessa s/o Lost Cyn	6	54,000	4,000	.07	A	3,000	.06	A
285. Westridge s/o Magic Mtn	4	36,000	13,000	.36	A	12,000	.33	A
286. Westridge n/o Valencia	4	36,000	11,000	.31	A	9,000	.25	A
287. Whites Cyn s/o Skyline Ranch	6	54,000	19,000	.35	A	19,000	.35	A
288. Whites Cyn n/o Soledad	6	54,000	43,000	.80	C	42,000	.78	C
289. Whites Cyn s/o Soledad	6	54,000	50,000	.93	E	48,000	.89	D
290. Wiley Cyn e/o Orchard Village	6	54,000	38,000	.70	B	42,000	.78	C
291. Wiley Cyn e/o Tournament	6	54,000	29,000	.54	A	32,000	.59	A
292. Wiley Cyn n/o Lyons	6	54,000	31,000	.57	A	34,000	.63	B
293. Wiley Cyn s/o Lyons	4	36,000	17,000	.47	A	20,000	.56	A
294. Wiley Cyn n/o Calgrove	4	36,000	19,000	.53	A	19,000	.53	A
295. Wolcott n/o SR-126	2	15,000	6,000	.40	A	6,000	.40	A
296. Wolcott s/o SR-126	4	36,000	13,000	.36	A	14,000	.39	A
297. 13th St e/o Railroad	2	15,000	14,000	.93	E	11,000	.73	C
298. 16th St e/o Orchard Village	4	36,000	9,000	.25	A	9,000	.25	A

LOS in **Bold** exceeds performance criteria of LOS E.

Number of Occurrences

LOS	Current GP	OVOV GP
A-C	222	226
D	36	26
E	30	41
F	10	5

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C
.81 - .90 D .91 – 1.00 E Above 1.00 F

Table 4-2: Buildout ICU Summary for Principal Intersections – Existing Lanes

Existing Intersection Lanes								
	Current GP				OVOV GP			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
Intersection	**ICU**	**LOS**	**ICU**	**LOS**	**ICU**	**LOS**	**ICU**	**LOS**
1. The Old Road & Rye Canyon	1.58	**F**	2.31	**F**	1.74	**F**	2.30	**F**
2. The Old Road & Magic Mountain	.79	C	1.03	**F**	.78	C	1.06	**F**
3. The Old Road & Valencia	.85	D	.95	E	.84	D	.95	E
4. The Old Road & Stevenson Ranch	.72	C	1.05	**F**	.69	B	1.12	**F**
5. The Old Road & Pico Canyon	1.05	**F**	1.08	**F**	.93	E	.99	E
6. Rye/Copper Hill & Newhall Ranch	.85	D	.89	D	.81	D	.89	D
7. McBean & Newhall Ranch	.80	C	1.15	**F**	.83	D	1.16	**F**
8. McBean & Magic Mountain	.87	D	1.21	**F**	.97	E	1.24	**F**
9. McBean & Valencia	.70	B	.89	D	.71	C	.94	E
10. Orchard Village & McBean	.91	E	1.23	**F**	.94	E	1.26	**F**
11. Orchard Village & Wiley Canyon	1.00	E	1.42	**F**	1.04	**F**	1.42	**F**
12. Valencia & Magic Mountain	.98	E	1.13	**F**	1.10	**F**	1.25	**F**
13. Bouquet Canyon & Plum Canyon	.80	C	.76	C	.80	C	.77	C
14. Bouquet Canyon & Newhall Ranch	.97	E	1.16	**F**	1.00	E	1.17	**F**
15. Bouquet Canyon & Soledad Canyon	.80	C	.99	E	.78	C	1.00	E
16. Railroad & Lyons[2]	.71	C	.94	E	.60	A	.83	D
17. Sierra Highway & Newhall	1.31	**F**	1.29	**F**	1.14	**F**	1.23	**F**
18. Whites Canyon & Soledad Canyon	.89	D	.92	E	.86	D	.91	E
19. Sierra Highway & Soledad Canyon	.90	D	1.23	**F**	.86	D	1.10	**F**
20. Commerce Center & Magic Mtn[1]	.76	C	.74	C	.76	C	.77	C
21. Pico Canyon & Valencia Boulevard[1]	.85	D	.98	E	.75	C	.81	D
22. Magic Mountain & Via Princessa[1]	.57	A	.80	C	.61	A	.81	D
23. Golden Valley & Via Princessa[1]	.91	E	.83	D	.88	D	.76	C

LOS in **Bold** exceeds performance criteria of LOS E.

[1]Future Intersection (ICUs calculated using Buildout Lanes)
[2]Includes future 4th Leg of Intersection (ICUs calculated using Buildout Lanes)

Number of Occurrences

LOS	Current GP	OVOV GP
A-C	12	12
D	9	10
E	10	9
F	15	15

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C
.81 - .90 D .91 – 1.00 E Above 1.00 F

Table 4-3: Buildout ICU Summary for Principal Intersections – Buildout Lanes

Buildout Intersection Lanes								
Intersection	Current GP				OVOV GP			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	ICU	LOS	ICU	LOS	ICU	LOS	ICU	LOS
1. The Old Road & Rye Canyon	.70	B	1.00	E	.85	D	.99	E
2. The Old Road & Magic Mountain	.79	C	.84	D	.78	C	.86	D
3. The Old Road & Valencia	.85	D	.92	E	.84	D	.95	E
4. The Old Road & Stevenson Ranch	.68	B	.95	E	.65	B	.90	D
5. The Old Road & Pico Canyon	.96	E	1.07	**F**	.85	D	.97	E
6. Rye/Copper Hill & Newhall Ranch	.85	D	.89	D	.81	D	.89	D
7. McBean & Newhall Ranch	.80	C	.88	D	.83	D	.89	D
8. McBean & Magic Mountain	.75	C	.93	E	.77	C	.95	E
9. McBean & Valencia	.66	B	.85	D	.70	B	.87	D
10. Orchard Village & McBean	.79	C	.97	E	.78	C	.98	E
11. Orchard Village & Wiley Canyon	.74	C	.98	E	.78	C	.98	E
12. Valencia & Magic Mountain	.83	D	.95	E	.82	D	.86	D
13. Bouquet Canyon & Plum Canyon	.80	C	.76	C	.80	C	.77	C
14. Bouquet Canyon & Newhall Ranch	.84	D	.87	D	.86	D	.89	D
15. Bouquet Canyon & Soledad Canyon	.80	C	.90	D	.78	C	.90	D
16. Railroad & Lyons	.71	C	.94	E	.60	A	.83	D
17. Sierra Highway & Newhall	.99	E	.99	E	.86	D	.93	E
18. Whites Canyon & Soledad Canyon	.80	C	.92	E	.80	C	.90	D
19. Sierra Highway & Soledad Canyon	.88	D	.88	D	.86	D	.89	D
20. Commerce Center & Magic Mtn[1]	.76	C	.74	C	.76	C	.77	C
21. Pico Canyon & Valencia Boulevard[1]	.85	D	.98	E	.75	C	.81	D
22. Magic Mountain & Via Princessa[1]	.57	A	.80	C	.61	B	.81	D
23. Golden Valley & Via Princessa[1]	.91	E	.83	D	.88	D	.76	C

LOS in **Bold** exceeds performance criteria of LOS E.

[1]Future Intersection

	Number of Occurrences	
LOS	Current GP	OVOV GP
A-C	17	16
D	14	23
E	14	7
F	1	0

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C
.81 - .90 D .91 – 1.00 E Above 1.00 F

Descriptions of the roadway and intersection improvements needed to build out the proposed Highway Plan are provided in the following Section.

4.2.1 Arterial Roadway Segments

Section 1.2.1 discusses the Performance Criteria for Arterial Streets and Intersections used for this analysis, and that the maximum acceptable LOS on arterial roads within the OVOV planning area is LOS E. The traffic model forecasts indicate that the OVOV land use buildout conditions exceed LOS E (i.e., LOS F conditions) for the following five roadway segments:

- Bouquet Canyon Road between Newhall Ranch Road and Soledad Canyon Road (#18)
- McBean Parkway between Avenue Scott and Creekside Road (#114)
- Valencia Boulevard between Creekside Road and Magic Mountain Parkway (#270)
- Valencia Boulevard between Cinema Drive and Creekside Road (#271)
- Via Princessa between Santa Clarita Parkway and Golden Valley Road (#278)

In comparison, traffic model forecasts for the current City General Plan/County Area Plan buildout conditions indicate that LOS E is exceeded at the following 10 roadway segments:

- Bouquet Canyon Road between Newhall Ranch Road and Soledad Canyon Road (#18)
- Golden Valley Road between Via Princessa and Sierra Highway (#63)
- McBean Parkway between Avenue Scott and Creekside Road (#114)
- McBean Parkway between the I-5 freeway and Rockwell Canyon Road (#120)
- Newhall Avenue between Sierra Highway and SR-14 freeway (#134)
- Valencia Boulevard between Pico Canyon Road and Magic Mountain Parkway (West) (#258)
- Valencia Boulevard between Creekside Road and Magic Mountain Parkway (#270)
- Valencia Boulevard between Cinema Drive and Creekside Road (#271)
- Via Princessa between Santa Clarita Parkway and Golden Valley Road (#278)
- Via Princessa between Whites Canyon Road and Sierra Highway (#281)

In total, the proposed OVOV land uses result in five fewer LOS F roadway segments in comparison to the current City General Plan/County Area Plan traffic forecasts. In each case, the deficient locations with the proposed OVOV land uses are shown to be otherwise forecast as LOS F based

on the current City General Plan/County Area Plan.

4.2.2 Arterial Intersections

Intersection LOS estimates for the proposed OVOV land uses and for the current City General Plan/County Area Plan, for both existing and future intersection geometry, was presented in the previously referenced Table 4-2 and Table 4-3. The forecasts indicate multiple deficiencies based on the existing intersection geometry. Intersection improvements that are consistent with the proposed Highway Plan, details of which are provided in the following Section, result in conditions of LOS E or better for the proposed OVOV land uses at all principal intersections. In comparison, the current City General Plan/County Area Plan results in LOS F conditions at one principal intersection. An illustration of intersection LOS conditions based on both the proposed OVOV land uses and the current City General Plan/County Area Plan is provided in Figure 4-7. Overall, intersection operations are shown to improve with the proposed OVOV land uses in comparison to forecast conditions based on the current City General Plan/County Area Plan.

Both the City and the County have specific requirements regarding the LOS of intersections outlined in their traffic impact study guidelines. Each say that a change in ICU value of .01 or more for LOS E and F conditions, or a change of .02 or more for LOS D conditions, represents a significant impact at the individual project level. Furthermore, the County also says that a change of .04 or more for LOS C conditions represents a significant impact at the individual project level, as stated in the current Traffic Impact Analysis Guidelines of the County Department of Public Works. While not applied for long-range planning studies such as this, these guidelines provide an indication of the significant impacts to be expected as the OVOV area builds out over time.

Each of the principal intersections evaluated in this study, with the exception of Bouquet Canyon Road at Plum Canyon Road, are shown to exceed the significant impact criteria noted above when compared to existing conditions. As such, significant impacts are likely to be identified as part of the future project level impact studies that will be prepared as the Valley builds out in accordance with the proposed OVOV land uses. Mitigation measures beyond the future lane configurations identified in this study are likely not feasible due to right-of-way constraints. However, with the proposed OVOV land uses no intersection is forecast to exceed LOS E. In comparison, one intersection is forecast to exceed LOS E based on traffic model forecasts for the current City General Plan/County Area Plan.

CURRENT GENERAL PLAN

OVOV BUILDOUT PLAN

LEGEND

LOS A
LOS B
LOS C
LOS D
LOS E
LOS F
Future Roadways

NORTH

536002_Ints.dwg

4.3 FUTURE IMPROVEMENTS

Roadway improvements in the form of roadway widening and intersection improvements will be needed to build out the proposed Highway Plan. Table 4-4 lists the improvements needed to implement the recommended Highway Plan as illustrated in the previously referenced Figure 3-2. Table 4-5 summarizes the corresponding intersection lane improvements needed to achieve conditions of LOS E or better.

4.4 FREEWAY ANALYSIS

A planning level analysis has been prepared for select freeway segments within the OVOV area. The purpose of the analysis is to compare conditions based on the proposed OVOV land uses to traffic forecasts based on the current City General Plan/County Area Plan.

4.4.1 I-5 Freeway

The I-5 freeway is listed as a "high priority corridor" on the National Highway System (NHS). The corridor serves inter-regional travel in the north-south direction from California's most southern border with Mexico to Washington's most northern border with Canada. Within the OVOV area, the I-5 freeway is classified as an urban interstate (see Reference 4 in Section 1.5).

The I-5 freeway generally consists of four mix-flow lanes in each direction through the OVOV area. Through the SR-14 interchange area, the I-5 freeway consists of three mix-flow lanes in each direction along with two dedicated truck bypass lanes which are separated from the mainline lanes. Several interchanges provide access to the freeway as described in Section 2.1. A truck weigh station facility operated by the California Highway Patrol is located on the northbound side of the I-5 freeway just south of the SR-126 interchange. High Occupancy Vehicle (HOV) lanes have recently been constructed just south of the Santa Clarita Valley.

Caltrans planning documents have identified the I-5 freeway through this area as needing additional lanes to accommodate existing and anticipated increases in traffic volumes. Caltrans District 7 currently has a project to add additional lanes to the I-5 freeway between the SR-14 interchange and the Parker Road interchange, a distance of approximately 13.6 miles (see Reference 5 in Section 1.5). The project will extend the existing HOV lanes from the SR-14 interchange to just south of the Parker Road interchange, incorporate truck climbing lanes from the SR-14 interchange to the Pico Canyon

Table 4-4: Roadway Improvements to Build-Out the Highway Plan

Roadway/Segment	Improvement	Comments
Agua Dulce Canyon Road		
Between Sierra Highway and Escondido Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between Escondido Canyon Road and Davenport Road	Construct new 4 lane Secondary Highway	Gap closure segment
Between Davenport Road and Soledad Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Avenue Scott		
Between Rye Canyon Road and Avenue Tibbitts	Re-stripe roadway from 4 lanes to 6 lanes	
Avenue Tibbitts		
Between Avenue Scott and Avenue Hopkins	Re-stripe roadway from 4 lanes to 6 lanes	
Between Avenue Hopkins and Magic Mountain Parkway	Construct new 6 lane Major Highway	Includes new bridge over the Santa Clara River
Bouquet Canyon Road		
Between Angeles National Forest and Plum Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between Plum Canyon and future Santa Clarita Parkway	Re-stripe roadway from 4 lanes to 6 lanes	Will lose the existing Class II bike lane due to re-striping
Between future Santa Clarita Parkway and Seco Canyon Road	Re-stripe roadway from 5 lanes to 6 lanes	Will lose the existing Class II bike lane due to re-striping
Between Seco Canyon Road and Espuella Drive	Widen roadway from 6 lanes to an 8 lane Major Highway	Includes bridge widening
Between Soledad Canyon Road and Magic Mountain Parkway	Re-stripe roadway from 4 lanes to 6 lanes	
Castaic Road		
Between Lake Hughes Road and Ridge Route Road	Re-stripe roadway from 4 lanes to 6 lanes	
Commerce Center Drive		
Between Henry Mayo Drive and Magic Mountain Parkway	Construct new 6 lane Major Highway	Includes new bridge over the Santa Clara River
Copper Hill Drive		
Between Avenida Rancho Tesoro and San Francisquito Creek Bridge	Re-stripe roadway from 4 lanes to 6 lanes	
Between San Francisquito Creek Bridge and McBean Parkway	Widen roadway from 4 lanes to a 6 lane Major Highway	Includes widening bridge over the San Francisquito Creek
Davenport Road		
Between Sierra Highway and Agua Dulce Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Dockweiler Drive		
Between Railroad Avenue and Leonard Tree Lane	Construct new 4 lane Secondary Highway	
Between Leonard Tree Lane and Ivy Lane	Implement traffic calming measures with 1 lane in each direction, re-stripe roadway from 2 lanes to 4 lanes when traffic volumes warrant	Will lose the existing on-street parking if re-striped to 4 lanes

(Continued)

Table 4-4: Roadway Improvements to Build-Out the Highway Plan (Continued)

Roadway/Segment	Improvement	Comments
Escondido Canyon Road		
east of Agua Dulce Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Golden Valley Road		
Between Plum Canyon Road and Dorothy Street	Re-stripe roadway from 2 lanes to 4 lanes	
Between Dorothy Street and Newhall Ranch Road	Construct new 4 lane Secondary Highway	
Between Valley Center Drive and Center Pointe Parkway	Re-stripe roadway from 4 lanes to 6 lanes	
Between Center Pointe Parkway and Sierra Highway	Widen roadway from 4 lanes to a 6 lane Major Highway	
Haskell Canyon Road		
Between Copper Hill Drive and Grovepark Drive/Ridgegrove Drive	Re-stripe roadway from 2 lanes to 4 lanes	
Henry Mayo Drive		
Between Commerce Center Drive and The Old Road	Widen roadway from 2 lanes to a 4 lane Parkway	
Lake Hughes Road		
Between I-5 freeway and Castaic Road	Re-stripe roadway from 4 lanes to 6 lanes	
Long Canyon Road (future)		
Between Chiquito Canyon Road and SR-126	Construct new 4 lane Secondary Highway	
Between SR-126 and Valencia Boulevard	Construct new 6 lane Major Highway	Includes new bridge over the Santa Clara River
Lost Canyon Road		
Between Sand Canyon Road and La Veda Avenue	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between La Veda Avenue and Jakes Way	Construct new 4 lane Secondary Highway	
Between Jakes Way and railroad bridge	Construct new 6 lane Major Highway	
Between railroad bridge and Via Princessa	Re-stripe roadway from 4 lanes to 6 lanes	
Lyons Avenue		
Between Wiley Canyon Road and Railroad Avenue	Re-stripe roadway from 4 lanes to 6 lanes	Will lose the existing on-street parking due to re-striping

(Continued)

Table 4-4: Roadway Improvements to Build-Out the Highway Plan (Continued)

Roadway/Segment	Improvement	Comments
Magic Mountain Parkway		
Between Long Canyon Road and Commerce Center Drive	Construct new 4 lane Secondary Highway	
Between Commerce Center Drive and Westridge Parkway	Construct new 6 lane Major Highway	
Between Westridge Parkway and Six Flags Magic Mountain	Construct new 8 lane Major Highway	
Between Six Flags Magic Mountain and I-5 freeway	Widen roadway from 4 lanes to an 8 lane Major Highway	
Between I-5 freeway and Auto Center Drive	Re-stripe roadway from 6 lanes to 8 lanes	
Between Auto Center Drive and Valencia Boulevard	Widen roadway from 4 lanes to an 8 lane Major Highway	
Between Valencia Boulevard and Railroad Avenue	Re-stripe roadway from 4 lanes to 6 lanes	
Between Railroad Avenue and Via Princessa	Construct new 6 lane Major Highway	
McBean Parkway		
Between San Francisquito Canyon Road and Copper Hill Drive	Construct new 2 lane Limited Secondary Highway	
Between Avenue Scott and Creekside Road	Widen roadway from 6 lanes to an 8 lane Major Highway	Includes widening bridge over the Santa Clara River
Between Magic Mountain Parkway and Valencia	Re-stripe roadway from 6 lanes to 8 lanes	
Newhall Ranch Road		
Between Rye Canyon Road and Avenue Tibbitts	Widen roadway from 4 lanes to an 8 lane Major Highway	
Between Avenue Tibbitts and McBean Parkway	Widen roadway from 6 lanes to an 8 lane Major Highway	Includes widening bridge over the San Francisquito Creek
Between McBean Parkway and Bouquet Canyon Road	Re-stripe roadway from 7 lanes to 8 lanes	
Between Bouquet Canyon Road and Santa Clarita Parkway	Re-stripe roadway from 4 lanes to 6 lanes	
Between Santa Clarita Parkway and Golden Valley Road	Construct new 6 lane Major Highway	
Newhall Avenue		
Between Lyons Avenue and Railroad Avenue	Re-stripe roadway from 2 lanes to 4 lanes	Will lose the existing on-street parking due to re-striping

(Continued)

Table 4-4: Roadway Improvements to Build-Out the Highway Plan (Continued)

Roadway/Segment	Improvement	Comments
The Old Road		
north of Lake Hughes Road	Re-stripe roadway from 2 lanes to 4 lanes	
Between Lake Hughes Road and Sedona Way	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between Hasley Canyon Road and I-5 SB Ramps at Rye Canyon Road	Widen roadway from 4 lanes to a 6 lane Major Highway	
Between I-5 SB Ramps at Rye Canyon Road and Rye Canyon Road	Re-stripe roadway from 4 lanes to 6 lanes	
Between Rye Canyon Road and Magic Mountain Parkway	Widen roadway from 4 lanes to a 6 lane Major Highway	Includes widening bridge over the Santa Clara River
Between McBean Parkway and Lyons Avenue	Re-stripe roadway from 4 lanes to 6 lanes	
Between Sagecrest Circle (South) and Calgrove Boulevard	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between Calgrove Boulevard and Sierra Highway	Widen roadway from 4 lanes to a 6 lane Major Highway	
Orchard Village Road		
Between McBean Parkway and Lyons Avenue	Widen roadway from 4 lanes to a 6 lane Major Highway	
Parker Road		
Between The Old Road and I-5 freeway	Widen roadway from 2 lanes to a 6 lane Major Highway	
Pico Canyon Road		
Between Valencia Boulevard and Whispering Oaks Road	Construct new 6 lane Major Highway	
Between Whispering Oaks Road and I-5 freeway	Re-stripe roadway from 4 lanes to 6 lanes	
Plum Canyon Road		
Between Bouquet Canyon Road and Golden Valley Road	Re-stripe roadway from 4 lanes to 6 lanes	
Potrero Canyon Road (future)		
Between SR-126 and Long Canyon Road	Construct new 4 lane Secondary Highway	Includes new bridge over the Santa Clara River
Railroad Avenue		
Between Magic Mountain Parkway and Lyons Avenue	Re-stripe roadway from 4 lanes to 6 lanes	
Ridge Route Road		
Between I-5 freeway and Castaic Road	Widen roadway from 2 lanes to a 6 lane Major Highway	
Sand Canyon Road		
Between Sierra Highway and Soledad Canyon Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between SR-14 freeway and Lost Canyon Road	Widen roadway from 2 lanes to a 6 lane Major Highway	Includes widening bridge over the Santa Clara River

(Continued)

Table 4-4: Roadway Improvements to Build-Out the Highway Plan (Continued)

Roadway/Segment	Improvement	Comments
Santa Clarita Parkway (future)		
Between Bouquet Canyon Road and Sierra Highway	Construct new 6 lane Major Highway	Includes new bridge over the Santa Clara River
Shadow Pines Boulevard/Tick Canyon Road		
Between Grandifloras Road and Davenport Road	Construct new 2 lane Limited Secondary Highway	
Sierra Highway		
east of Agua Dulce Canyon Road	Widen roadway from 2 lanes to a 6 lane Major Highway	
Between Agua Dulce Canyon Road and Vasquez Canyon Road	Widen roadway from 2 lanes to a 6 lane Major Highway	
Between Vasquez Canyon and Soledad Canyon	Widen roadway from 4 lanes to a 6 lane Major Highway	
Between Via Princessa and Newhall Avenue	Re-stripe roadway from 4 lanes to 6 lanes	
Between Newhall Avenue and The Old Road	Widen roadway from 4 lanes to a 6 lane Major Highway	
Skyline Ranch Road (future)		
Between Whites Canyon Road and Sierra Highway	Construct new Secondary Highway	Will use an alternative section as approved for the development project through which this roadway passes
Sloan Canyon Road		
Between The Old Road and Parker Road	Widen roadway from 2 lanes to a 4 lane Secondary Highway	
Between Parker Road and Quail Valley Road	Re-stripe roadway from 2 lanes to 4 lanes	
Between Hillcrest Parkway and Hasley Canyon Road	Construct new 2 lane Limited Secondary Highway	
Soledad Canyon Road		
Between River Circle and SR-14 freeway	Re-stripe roadway from 4 lanes to 6 lanes	Will lose the existing Class II bike lane due to re-striping
east of SR-14 freeway	Widen roadway from 2 lanes to a 6 lane Major Highway	
Stevenson Ranch Parkway		
Between The Old Road and Pico Canyon Road	Re-stripe roadway from 4 lanes to 6 lanes	Will lose the existing Class II bike lane due to re-striping
Valencia Boulevard		
Between Long Canyon Road and existing Valencia Boulevard terminus just west of Boulder Crest Drive	Construct new 6 lane Major Highway	
Between I-5 freeway and McBean Parkway	Reconstruct roadway from 7 lanes to an 8 lane Major Highway	

(Continued)

Table 4-4: Roadway Improvements to Build-Out the Highway Plan (Continued)

Roadway/Segment	Improvement	Comments
Via Princessa		
Between existing Via Princessa terminus just east of Claibourne Court and existing Via Princessa terminus just west of Sheldon Avenue	Construct new 6 lane Major Highway	Gap closure segment
Between Sheldon Avenue and Rainbow Glen Drive	Widen roadway from 2 lanes to a 6 lane Major Highway	
Between Rainbow Glen Drive and Whites Canyon Road	Re-stripe roadway from 4 lanes to 6 lanes	
Between SR-14 freeway and Lost Canyon Road	Re-stripe roadway from 4 lanes to 6 lanes	
Whites Canyon Road		
Between Ashboro Drive and Soledad Canyon Road	Re-stripe roadway from 4 lanes to 6 lanes	
Wiley Canyon Road		
Bridge over Railroad Avenue	Widen roadway from 4 lanes to a 6 lane Major Highway	Includes bridge widening
Between bridge over Railroad Avenue and Lyons Avenue	Re-stripe roadway from 4 lanes to 6 lanes	Will lose the existing Class II bike lane due to re-striping
Between Wabuska Street and Calgrove Boulevard	Widen roadway from 2 lanes to a 4 lane Secondary Highway	

Table 4-5: Intersection Improvements to Build-Out the Highway Plan

Intersection	Improvement	Comments
1. The Old Road & Rye Canyon Road	Add 2nd & 3rd northbound through lanes Add 2nd southbound left-turn lane Add 3rd southbound through lane Add 2nd & 3rd westbound left-turn lanes	County intersection
2. The Old Road & Magic Mountain Parkway	Add 5th eastbound through lane Convert 3rd southbound through lane to a shared through/right-turn lane	County intersection
3. The Old Road & Valencia Boulevard	Modify traffic signal to provide eastbound right-turn overlap phasing	County intersection
4. The Old Road & Stevenson Ranch Parkway	Add 2nd southbound left-turn lane Add 1st westbound right-turn lane Modify traffic signal to provide northbound right-turn overlap phasing	County intersection
5. The Old Road & Pico Canyon Road	Add 2nd northbound left-turn lane Convert southbound right-turn lane to 2nd southbound through lane Convert westbound right-turn lane to 3rd westbound through lane	County intersection
6. Rye Canyon Road/Copper Hill Road & Newhall Ranch Road	None	City intersection; Existing geometry sufficient for build-out conditions.
7. McBean Parkway & Newhall Ranch Road	Add 2nd northbound right-turn lane Add 4th westbound through lane	City intersection
8. McBean Parkway & Magic Mountain Parkway	Add 4th northbound through lane Add 3rd eastbound through lane Modify traffic signal to provide westbound right-turn overlap phasing	City intersection
9. McBean Parkway & Valencia Boulevard	Convert 1st northbound right-turn lane to 4th northbound through lane Add 4th westbound through lane Modify traffic signal to provide northbound right-turn overlap phasing	City intersection; Will require ROW on north side of Valencia, east of McBean, to relocate the existing westbound right-turn lane.
10. Orchard Village Road & McBean Parkway	Add 1st eastbound right-turn lane Add 1st westbound right-turn lane Convert 3rd eastbound through lane to a shared through/right-turn lane	City intersection; North leg (hospital driveway) to be improved by site development Will require ROW from HMNMH site to realign McBean.

(Continued)

Table 4-5: Intersection Improvements to Build-Out the Highway Plan (Continued)

Intersection	Improvement	Comments
11. Orchard Village Road & Wiley Canyon Road	Add 3rd northbound through lane Convert 1st southbound through lane to 2nd southbound left-turn lane Convert southbound right-turn lane to 2nd southbound through lane (shared through/right) Convert 2nd eastbound left-turn lane to 3rd eastbound through lane Convert westbound right-turn lane to 3rd westbound through lane (shared through/right)	City intersection; No ROW required but placing new through lanes on Orchard Village adjacent to the curb (e.g., north of Wiley Cyn Road) requires removing the trees adjacent to the curb lane. Also requires removal of Bike Lane from westbound Wiley Cyn Road.
12. Valencia Boulevard & Magic Mountain Parkway	Add 1st northbound right-turn lane Add 3rd eastbound through lane Add 2nd westbound left-turn lane Convert westbound right-turn lane to 3rd westbound through lane (shared through/right)	City intersection; Will require ROW on south side of Magic Mtn., east and west of Valencia, and on east side of Valencia, south of Magic Mtn.
13. Bouquet Canyon Road & Plum Canyon Road	None	City intersection; Existing geometry sufficient for build-out conditions.
14. Bouquet Canyon Road & Newhall Ranch Road	Add 2nd southbound left-turn lane Add 2nd southbound right-turn lane Convert 3rd eastbound left-turn lane to 3rd eastbound through lane Add 4th eastbound through lane Modify traffic signal to provide westbound right-turn overlap phasing	City intersection; Will require ROW on west side of Bouquet, north of Newhall Ranch, for the 2nd right-turn lane.
15. Bouquet Canyon Road & Soledad Canyon Road	Add 4th northbound through lane	City intersection; Will require ROW on east side of Bouquet, south of Soledad, to relocate the existing northbound right-turn lane.

(Continued)

Table 4-5: Intersection Improvements to Build-Out the Highway Plan (Continued)

Intersection	Improvement	Comments
16. Railroad Avenue & Lyons Avenue	Add 1st & 2nd southbound left-turn lanes Convert 2nd eastbound left-turn lane to a shared left/through lane Convert eastbound right-turn lane to a shared through/right-turn lane Add 1st westbound left-turn lane Add 1st & 2nd westbound through lanes Add 1st westbound right-turn lane	City intersection; Lanes per proposed Lyons Avenue at-grade rail crossing.
17. Sierra Highway & Newhall Avenue	Add 1st northbound right-turn lane Convert 2nd northbound through lane to a shared through/right-turn lane Add 2nd westbound left-turn lane (can remove existing westbound right-turn lane)	City intersection; Can remove the existing westbound right-turn lane. Will require ROW on east side of Sierra, south of Newhall.
18. Whites Canyon Road & Soledad Canyon Road	Convert northbound right-turn lane to 3rd northbound through lane (shared through/right) Convert southbound right-turn lane to 3rd southbound through lane (shared through/right)	City intersection; Will require ROW on west side of Whites Cyn, south of Soledad Cyn.
19. Sierra Highway & Soledad Canyon Road	Convert northbound right-turn lane to 3rd northbound through lane (shared through/right) Add 2nd southbound left-turn lane Convert southbound right-turn lane to 3rd southbound through lane (shared through/right) Convert eastbound right-turn lane to 3rd eastbound through lane (shared through/right)	City intersection; Will require ROW on east side of Sierra, north of Soledad Cyn.
20. Commerce Center Drive & Magic Mountain Parkway	Add 1st & 2nd southbound left-turn lanes Add 1st southbound right-turn lane Add 1st & 2nd eastbound left-turn lanes Add 1st, 2nd & 3rd eastbound through lanes Add 1st, 2nd & 3rd westbound through lanes Add 1st westbound free-flow right-turn lane	Future County intersection; Lanes subject to change pending the final development plans for this area.
21. Pico Canyon Road & Valencia Boulevard	Add 1st & 2nd northbound left-turn lanes Add 1st northbound right-turn lane Add 1st, 2nd & 3rd eastbound through lanes (3rd through is shared through/right) Add 1st westbound left-turn lane Add 1st, 2nd & 3rd westbound through lanes	Future County intersection; Lanes subject to change pending the final development plans for this area.

(Continued)

Table 4-5: Intersection Improvements to Build-Out the Highway Plan (Continued)

22. Magic Mountain Parkway & Via Princessa	Add 1st northbound left-turn lane Add 1st northbound through lane Add 1st northbound right-turn lane Add 1st & 2nd southbound left-turn lanes Add 1st southbound through lane Add 1st southbound right-turn lane Add 1st eastbound left-turn lane Add 1st, 2nd & 3rd eastbound through lanes (3rd through is shared through/right) Add 1st westbound left-turn lane Add 1st, 2nd & 3rd westbound through lanes Add 1st westbound free-flow right-turn lane	Future City intersection; Lanes subject to change pending the final development plans for this area.
23. Golden Valley Road & Via Princessa	Add 1st & 2nd northbound left-turn lane Add 3rd northbound through lane Add 1st northbound right-turn lane Add 1st & 2nd southbound left-turn lane Add 3rd southbound through lane Add 1st southbound right-turn lane Add 1st & 2nd eastbound left-turn lane Add 1st, 2nd & 3rd eastbound through lanes Add 1st & 2nd eastbound right-turn lanes Add 1st & 2nd westbound left-turn lanes Add 1st, 2nd & 3rd westbound through lanes Add 1st westbound right-turn lane	Future City intersection; Lanes subject to change pending the final development plans for this area.

Road/Lyons Avenue interchange, and construct and/or extend auxiliary lanes between interchanges at six locations. A Project Approval and Environmental Document (PA&ED) has recently been completed for this project, and funding for construction is identified in the Los Angeles County Metropolitan Transportation Agency (Metro) 2009 Long Range Transportation Plan.

4.4.2 SR-14 Freeway

The SR-14 freeway, in conjunction with US 395, is one of the four major north-south corridors serving California. The corridor connects the Eastern Sierra and Western Nevada regions to the Southern California region. The Caltrans "Interregional Transportation Strategic Plan" identifies the SR-14/US-395 corridor as a "High Emphasis - Focus Route" (see Reference 6 in Section 1.5). The SR-14 freeway is designated as a Super Truck Route (STR), and is also part of the Surface Transportation Assistance Act (STAA) truck network, which provides freeway access for oversized trucks. Within Caltrans District 7, the SR-14 freeway serves as a major commuter route between Antelope Valley communities such as the Cities of Palmdale and Lancaster and the Los Angeles area.

Within the OVOV area, the SR-14 freeway generally consists of three to six lanes in each direction, including one HOV lane in each direction. From the I-5 freeway to the Newhall Avenue interchange, there are five mix-flow lanes and one HOV lane in each direction; from the Newhall Avenue interchange to the Golden Valley Road interchange, there are three mix-flow lanes and one HOV lane in each direction; from the Golden Valley Road interchange to the Sierra Highway interchange, there are four mix-flow lanes and one HOV lane in each direction; from the Sierra Highway interchange to the Sand Canyon Road interchange, there are three mix-flow lanes and one HOV lane in each direction; from the Sand Canyon Road interchange to the Soledad Canyon Road interchange, there are two mix-flow lanes and one HOV lane in each direction; and from the Soledad Canyon Road interchange to the Escondido Canyon Road interchange, there are two to three mix-flow lanes and one HOV lane in each direction.

The North County Combined Highway Corridors Study (see Reference 7 in Section 1.5), a joint study sponsored in part by Metro, Caltrans, the County of Los Angeles, and the City of Santa Clarita, identified the SR-14 freeway through the OVOV area as needing additional lanes to accommodate existing and anticipated increases in traffic volumes. The study identified a short-range plan to complete the mainline to a minimum of three lanes in each direction, and a long-range plan to complete the mainline to four lanes in each direction between the Newhall Avenue interchange and the Sand Canyon

interchange, and to add a dedicated truck lane between the I-5 freeway and the Placerita Canyon Road interchange. The study also identified a short-range plan to convert the existing HOV lanes to a reversible HOV lane configuration that would provide three HOV lanes in the peak travel direction. However, subsequent planning efforts by Caltrans and Metro have focused on utilizing two conventional (i.e., non-reversible) HOV lanes in each direction in-lieu of reversible HOV lanes.

Caltrans is currently constructing HOV lane direct connectors between the existing SR-14 HOV lanes and the existing I-5 HOV lanes. This project is estimated to be completed by 2013.

4.4.3 Freeway Traffic Volumes and LOS

A summary of traffic volumes for ADT, a.m. peak hour, and p.m. peak hour conditions is provided in Table 4-6 for six key freeway segments within the OVOV area. The traffic forecasts include growth outside of the OVOV plan area based on regional traffic projections. Calculations of demand to capacity (D/C) ratios are provided in Appendix E, and the corresponding LOS is summarized in Table 4-7. The freeway LOS estimates are calculated based on both the existing number of freeway lanes and the planned future lanes. In the case of the I-5 freeway, the planned future lanes are based on the I-5 HOV and Truck Lane project discussed in Section 4.4.1. In the case of the SR-14 freeway, the planned future lanes are based on the short-range plan outlined in the Metro study discussed in Section 4.4.2.

The freeway LOS summarized in the previously referenced Table 4-7 indicates that with the proposed OVOV land uses, freeway conditions are the same or one level of service better than with the current City General Plan/County Area Plan. When the future freeway lanes are taken into account, deficiencies occur with the current City General Plan/County Area Plan on the SR-14 freeway in the peak direction (i.e., southbound in the a.m. peak hour and northbound in the p.m. peak hour). With the proposed OVOV land uses, deficiencies are still expected to occur, although to a lesser extent and at fewer segments due to lower freeway traffic volumes.

4.5 CONGESTION MANAGEMENT PROGRAM ANALYSIS

The Los Angeles County Congestion Management Program (CMP) (See Reference 8 in Section 1.5) states that only development projects are subject to the CMP Land Use Analysis Program and the CMP Transportation Impact Analysis. As such, a literal CMP analysis is not required for the General Plan/Area Plan update.

Table 4-6: Freeway Volume Summary

Segment	ADT	AM Peak Hour		PM Peak Hour	
		NB	SB	NB	SB
I-5 south of Parker Interchange					
Existing Conditions	110,000	1,860	2,190	3,570	3,070
Current GP	240,000	5,140	6,950	8,760	7,980
Proposed OVOV GP	239,000	4,090	6,770	8,770	7,640
I-5 south of Valencia Interchange					
Existing Conditions	179,000	5,430	5,310	6,050	6,420
Current GP	269,000	8,540	9,970	9,730	10,320
Proposed OVOV GP	259,000	7,860	8,200	9,190	10,300
I-5 north of SR-14 Interchange					
Existing Conditions	202,000	5,600	6,610	6,970	6,410
Current GP	308,000	8,710	10,430	10,530	10,800
Proposed OVOV GP	269,000	7,540	7,380	8,700	10,480
SR-14 south of Aqua Dulce Interchange					
Existing Conditions	110,000	1,970	5,580	5,130	2,810
Current GP	200,000	4,260	11,970	11,300	5,190
Proposed OVOV GP	158,000	2,700	11,780	10,590	3,350
SR-14 south of Sierra Highway Interchange					
Existing Conditions	152,000	2,510	7,090	7,500	3,380
Current GP	279,000	5,020	15,330	15,430	7,100
Proposed OVOV GP	217,000	3,900	14,350	13,580	5,150
SR-14 north of I-5 Interchange					
Existing Conditions	176,000	2,950	8,350	8,430	4,100
Current GP	316,000	6,320	16,170	16,250	8,490
Proposed OVOV GP	230,000	5,100	13,920	13,390	6,820

Table 4-7: Freeway Level of Service Summary

Segment	AM Peak Hour		PM Peak Hour	
	NB	SB	NB	SB
Existing Freeway Lanes				
I-5 south of Parker Interchange				
Existing Conditions	A	A	B	B
Current GP	C	D	**F**	E
Proposed OVOV GP	C	D	**F**	E
I-5 south of Valencia Interchange				
Existing Conditions	C	C	D	D
Current GP	**F**	**F**	**F**	**F**
Proposed OVOV GP	E	**F**	**F**	**F**
I-5 north of SR-14 Interchange				
Existing Conditions	A	**F**	D	E
Current GP	**F**	**F**	**F**	**F**
Proposed OVOV GP	E	**F**	**F**	**F**
SR-14 south of Aqua Dulce Interchange				
Existing Conditions	A	C	C	B
Current GP	C	**F**	**F**	C
Proposed OVOV GP	B	**F**	**F**	B
SR-14 south of Sierra Highway Interchange				
Existing Conditions	A	C	D	B
Current GP	B	**F**	**F**	C
Proposed OVOV GP	B	**F**	**F**	C
SR-14 north of I-5 Interchange				
Existing Conditions	A	C	C	B
Current GP	C	**F**	**F**	C
Proposed OVOV GP	B	**F**	**F**	C
Future Freeway Lanes				
I-5 south of Parker Interchange				
Current GP	C	C	D	D
Proposed OVOV GP	B	C	D	D
I-5 south of Valencia Interchange				
Current GP	D	E	E	E
Proposed OVOV GP	D	D	E	E
I-5 north of SR-14 Interchange				
Current GP	D	D	E	D
Proposed OVOV GP	C	C	D	D
SR-14 south of Aqua Dulce Interchange				
Current GP	B	**F**	**F**	C
Proposed OVOV GP	A	**F**	**F**	B
SR-14 south of Sierra Highway Interchange				
Current GP	B	**F**	**F**	C
Proposed OVOV GP	B	**F**	**F**	B
SR-14 north of I-5 Interchange				
Current GP	B	**F**	**F**	C
Proposed OVOV GP	B	E	E	B

LOS in **Bold** exceeds performance criteria of LOS E.

CMP roadways within the OVOV area consist of the following:

- I-5 Freeway
- SR-14 Freeway
- SR-126 Expressway
- Sierra Highway from Newhall Avenue to the SR-14 freeway at Red Rover Mine Road
- Magic Mountain Parkway from the I-5 freeway to Railroad Avenue
- Railroad Avenue/Newhall Avenue from Magic Mountain Parkway to the SR-14 freeway

Section 4.2 shows that each of the CMP arterial roadways achieves the CMP LOS target of LOS E or better with the proposed OVOV land uses. Section 4.4.3 shows that the I-5 freeway achieves the CMP LOS target of LOS E or better with the proposed OVOV land uses. The SR-14 freeway is anticipated to operate at LOS F conditions in the peak direction with either the current City General Plan/County Area Plan or with the proposed OVOV land uses. However, with the proposed OVOV land uses, traffic volumes on the SR-14 freeway are lower and there are fewer segments at LOS F than with the current City General Plan/County Area Plan.

4.6 GROUND TO PLAN ANALYSIS

This section presents a comparison of the proposed plan to existing conditions. Existing conditions are compared to the scenario previously presented in Section 4.2, which consists of the proposed land use plan along with the proposed Highway Plan. This comparison demonstrates the net impact of both the proposed land use and Highway Plan.

4.6.1 OVOV Land Use with the Proposed Highway Plan Network

A comparison of traffic forecasts based on the proposed OVOV plan (the proposed land uses along with the proposed highway network) to existing conditions is provided in Table 4-8. The table presents roadway segment V/C ratios and LOS values for each of the two scenarios. A comparable table for peak hour intersection conditions is provided in Table 4-9.

The previously referenced Table 4-8 shows that four of the five roadway segments that are at LOS F for existing conditions are forecast to operate at LOS E or better with the proposed OVOV plan.

Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions

Roadway Segment	Existing Conditions			OVOV GP With Highway Plan		
	Volume	V/C	LOS	Volume	V/C	LOS
1. Agua Dulce n/o Escondido Cyn	4,000	.22	A	8,000	.22	A
2. Agua Dulce n/o Davenport	3,000	.17	A	13,000	.36	A
4. Agua Dulce s/o SR-14	<500	.00	A	3,000	.08	A
6. Ave Scott s/o Stanford	14,000	.39	A	37,000	.69	B
8. Ave Stanford s/o Vanderbilt	5,000	.14	A	17,000	.47	A
10. Ave Stanford s/o Rye Cyn	9,000	.25	A	16,000	.44	A
11. Bouquet Cyn n/o Vasquez	4,000	.22	A	6,000	.17	A
14. Bouquet Cyn e/o Haskell	25,000	.69	B	32,000	.59	A
15. Bouquet Cyn w/o Haskell	39,000	1.08	**F**	49,000	.91	E
16. Bouquet Cyn e/o Seco	43,000	.96	E	54,000	1.00	E
17. Bouquet Cyn w/o Seco	48,000	.89	D	53,000	.74	C
18. Bouquet Cyn s/o Newhall Ranch	50,000	.69	B	77,000	1.07	**F**
20. Bouquet Cyn n/o Magic Mtn	36,000	1.00	E	54,000	1.00	E
25. Castaic n/o Lake Hughes	11,000	.31	A	5,000	.14	A
28. Chiquito Cyn s/o San Martinez Cyn	1,000	.06	A	6,000	.33	A
31. Commerce Center s/o Franklin	16,000	.30	A	39,000	.72	C
32. Commerce Center n/o SR-126	11,000	.20	A	43,000	.80	C
35. Copper Hill n/o Newhall Ranch	35,000	.49	A	54,000	.75	C
39. Copper Hill e/o McBean	35,000	.97	E	41,000	.76	C
43. Davenport e/o Sierra Hwy	2,000	.11	A	6,000	.17	A
44. Davenport w/o Agua Dulce	2,000	.11	A	3,000	.08	A
46. Decoro e/o Dickason	20,000	.56	A	14,000	.39	A
48. Decoro w/o Hillsborough	16,000	.44	A	17,000	.47	A
51. Dickason n/o Newhall Ranch	13,000	.36	A	21,000	.39	A
54. Escondido e/o Agua Dulce	3,000	.17	A	5,000	.14	A
55. Franklin e/o Wolcott Way	<500	.00	A	8,000	.53	A
56. Franklin w/o Commerce Center	6,000	.17	A	11,000	.31	A
62. Golden Valley s/o Centre Point	19,000	.53	A	39,000	.72	C

(Continued)

Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Existing Conditions			OVOV GP With Highway Plan		
	Volume	V/C	LOS	Volume	V/C	LOS
64. Golden Valley e/o Sierra Hwy	14,000	.26	A	36,000	.67	B
68. Hasley Cyn w/o Del Valle	3,000	.17	A	13,000	.72	C
69. Hasley Cyn w/o Commerce Center	7,000	.19	A	14,000	.39	A
70. Hasley Cyn w/o The Old Road	17,000	.31	A	38,000	.70	B
71. Hasley Cyn w/o I-5	11,000	.31	A	34,000	.63	B
74. Hillcrest w/o The Old Road	9,000	.25	A	17,000	.47	A
75. Jakes Way e/o Canyon Park	6,000	.33	A	12,000	.67	B
77. Lake Hughes e/o Castaic	9,000	.25	A	37,000	.69	B
78. Lake Hughes e/o Ridge Route	2,000	.11	A	7,000	.39	A
85. Lost Cyn n/o Canyon Park	6,000	.17	A	16,000	.30	A
86. Lost Cyn n/o Via Princessa	9,000	.25	A	21,000	.39	A
87. Lost Cyn s/o Via Princessa	2,000	.11	A	11,000	.31	A
92. Lyons e/o Orchard Village	47,000	1.31	**F**	52,000	.96	E
93. Lyons w/o Main Street	20,000	.56	A	24,000	.44	A
105. Magic Mtn e/o Valencia	16,000	.44	A	54,000	1.00	E
109. McBean s/o Copper Hill	21,000	.39	A	27,000	.50	A
112. McBean n/o Newhall Ranch	39,000	.72	C	48,000	.89	D
113. McBean s/o Newhall Ranch	50,000	.69	B	58,000	.81	D
114. McBean s/o Ave Scott	58,000	1.07	**F**	77,000	1.07	**F**
117. McBean s/o Valencia	35,000	.65	B	54,000	1.00	E
118. McBean n/o Orchard Village	40,000	.74	C	43,000	.80	C
119. McBean e/o Rockwell Cyn	24,000	.44	A	44,000	.81	D
120. McBean w/o Rockwell Cyn	32,000	.59	A	53,000	.98	E
124. Newhall Ranch e/o Rye Cyn	11,000	.15	A	49,000	.68	B
126. Newhall Ranch e/o McBean	32,000	.44	A	68,000	.94	E
127. Newhall Ranch w/o Bouquet Cyn	37,000	.51	A	69,000	.96	E
128. Newhall Ranch e/o Bouquet Cyn	25,000	.69	B	46,000	.85	D
131. Newhall s/o Lyons	22,000	1.22	**F**	27,000	.75	C

(Continued)

Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Existing Conditions			OVOV GP With Highway Plan		
	Volume	V/C	LOS	Volume	V/C	LOS
132. Newhall n/o Valle Oro	44,000	.81	D	33,000	.61	B
133. Newhall n/o Sierra Hwy	41,000	.76	C	40,000	.74	C
136. Orchard Village s/o McBean	30,000	.83	D	54,000	1.00	E
137. Orchard Village s/o Wiley Cyn	29,000	.81	D	44,000	.81	D
138. Orchard Village n/o Lyons	21,000	.58	A	34,000	.63	B
146. Placerita Cyn e/o SR-14	4,000	.22	A	4,000	.11	A
150. Poe s/o Mallory	1,000	.03	A	3,000	.08	A
151. Poe w/o Stevenson Ranch	8,000	.22	A	14,000	.39	A
155. Railroad s/o Oak Ridge	33,000	.92	E	40,000	.74	C
157. Railroad n/o Lyons	34,000	.94	E	36,000	.67	B
161. Ridge Route n/o Lake Hughes	5,000	.09	A	35,000	.65	B
166. Rockwell Cyn n/o McBean	8,000	.22	A	23,000	.64	B
168. Rye Cyn w/o Ave Scott	41,000	.76	C	48,000	.89	D
169. Rye Cyn e/o The Old Road	47,000	.87	D	58,000	.92	E
172. San Martinez Grande Cyn n/o SR-126	<500	.00	A	5,000	.14	A
174. Sand Cyn n/o Soledad Cyn	7,000	.39	A	14,000	.39	A
175. Sand Cyn s/o Soledad Cyn	27,000	.75	C	25,000	.46	A
176. Sand Cyn s/o SR-14	11,000	.61	B	26,000	.48	A
177. Sand Cyn s/o Lost Cyn	9,000	.50	A	14,000	.78	C
192. Sierra Hwy n/o Vasquez Cyn	11,000	.61	B	16,000	.30	A
195. Sierra Hwy n/o Soledad Cyn	23,000	.64	B	52,000	.96	E
196. Sierra Hwy s/o Soledad Cyn	36,000	.67	B	36,000	.67	B
198. Sierra Hwy s/o Via Princessa	24,000	.67	B	30,000	.56	A
201. Sierra Hwy n/o Newhall	19,000	.53	A	23,000	.43	A
211. Soledad Cyn e/o Bouquet Cyn	47,000	.87	D	45,000	.83	D
212. Soledad Cyn w/o Golden Valley	45,000	.83	D	38,000	.70	B
213. Soledad Cyn e/o Golden Valley	37,000	.69	B	50,000	.93	E
215. Soledad Cyn w/o Whites Cyn	44,000	.81	D	38,000	.70	B

(Continued)

Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Existing Conditions			OVOV GP With Highway Plan		
	Volume	V/C	LOS	Volume	V/C	LOS
216. Soledad Cyn e/o Whites Cyn	43,000	.80	C	44,000	.81	D
217. Soledad Cyn e/o Sierra Hwy	30,000	.56	A	34,000	.63	B
220. Soledad Cyn e/o SR-14 (at Sand Cyn)	17,000	.47	A	18,000	.33	A
221. Soledad Cyn w/o Shadow Pines	11,000	.31	A	10,000	.19	A
222. Soledad Cyn e/o Shadow Pines	5,000	.14	A	17,000	.31	A
223. Soledad Cyn e/o SR-14	2,000	.11	A	10,000	.28	A
224. Soledad Cyn w/o Agua Dulce	2,000	.11	A	4,000	.11	A
225. Soledad Cyn e/o Agua Dulce	2,000	.11	A	3,000	.08	A
227. SR-126 w/o San Martinez Grande Cyn	24,000	.55	A	33,000	.75	C
228. SR-126 w/o Chiquito Cyn/Long Cyn	24,000	.55	A	38,000	.86	D
229. SR-126 w/o Wolcott	24,000	.55	A	59,000	.89	D
230. SR-126 w/o Commerce Center	25,000	.57	A	66,000	.75	C
231. SR-126 w/o I-5	34,000	.52	A	75,000	.85	D
239. The Old Road n/o Sedona Way	15,000	.83	D	23,000	.64	B
242. The Old Road n/o Biscailuiz	10,000	.56	A	18,000	.33	A
245. The Old Road s/o Henry Mayo	15,000	.42	A	16,000	.30	A
247. The Old Road n/o Magic Mtn	31,000	.86	D	52,000	.96	E
248. The Old Road s/o Magic Mtn	15,000	.42	A	30,000	.56	A
254. Tibbitts s/o Newhall Ranch	11,000	.20	A	34,000	.63	B
262. Valencia w/o The Old Road	16,000	.30	A	61,000	.97	E
266. Valencia w/o McBean	48,000	.76	C	61,000	.85	D
271. Valencia s/o Cinema	54,000	1.00	E	59,000	1.09	**F**
273. Valley s/o Lyons	2,000	.06	A	11,000	.31	A
274. Vasquez Cyn e/o Bouquet Cyn	7,000	.39	A	6,000	.33	A
275. Vasquez Cyn w/o Sierra Hwy	8,000	.44	A	10,000	.56	A
283. Via Princessa n/o Lost Cyn	13,000	.29	A	24,000	.44	A
288. Whites Cyn n/o Soledad	39,000	1.08	**F**	42,000	.78	C

(Continued)

Table 4-8: ADT V/C and LOS – Existing Conditions vs OVOV Buildout Conditions (Continued)

Roadway Segment	Existing Conditions			OVOV GP With Highway Plan		
	Volume	V/C	LOS	Volume	V/C	LOS
289. Whites Cyn s/o Soledad	32,000	.59	A	48,000	.89	D
290. Wiley Cyn e/o Orchard Village	11,000	.31	A	42,000	.78	C
294. Wiley Cyn n/o Calgrove	9,000	.50	A	19,000	.53	A
228. SR-126 w/o Chiquito Cyn/Long Cyn	24,000	.55	A	38,000	.86	D

LOS in **Bold** exceeds performance criteria of LOS E.

	Number of Occurrences	
LOS	Exist. Conditions	OVOV GP With Highway Plan
A-C	93	83 (226[1])
D	10	13 (26[1])
E	6	15 (41[1])
F	5	3 (5[1])

[1]Numbers in parentheses indicate the total number of segments included in the analysis of buildout conditions. Note that the analysis of buildout conditions includes more locations than the analysis of existing conditions due to the inclusion of future roadways as well as existing roadways where current traffic data is not available.

Level of service ranges:						
.00 - .60	A	.61 - .70	B	.71 - .80	C
.81 - .90	D	.91 – 1.00	E	Above 1.00	F

Table 4-9: ICU Summary for Principal Intersections – Existing Conditions vs OVOV Buildout Conditions

Buildout Intersection Lanes								
Intersection	Existing Conditions				OVOV GP With Highway Plan			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	ICU	LOS	ICU	LOS	ICU	LOS	ICU	LOS
1. The Old Road & Rye Canyon	.61	B	.66	B	.85	D	.99	E
2. The Old Road & Magic Mountain	.28	A	.32	A	.78	C	.86	D
3. The Old Road & Valencia	.67	B	.44	A	.84	D	.95	E
4. The Old Road & Stevenson Ranch	.58	A	.76	C	.65	B	.90	D
5. The Old Road & Pico Canyon	.76	C	.71	C	.85	D	.97	E
6. Rye/Copper Hill & Newhall Ranch	.63	B	.70	B	.81	D	.89	D
7. McBean & Newhall Ranch	.73	C	.78	C	.83	D	.89	D
8. McBean & Magic Mountain	.61	B	.76	C	.77	C	.95	E
9. McBean & Valencia	.61	B	.74	C	.70	B	.87	D
10. Orchard Village & McBean	.57	A	.68	B	.78	C	.98	E
11. Orchard Village & Wiley Canyon	.60	A	.62	B	.78	C	.98	E
12. Valencia & Magic Mountain	.58	A	.66	B	.82	D	.86	D
13. Bouquet Canyon & Plum Canyon	.68	B	.73	C	.80	C	.77	C
14. Bouquet Canyon & Newhall Ranch	.66	B	.82	D	.86	D	.89	D
15. Bouquet Canyon & Soledad Canyon	.68	B	.77	C	.78	C	.90	D
16. Railroad & Lyons	.57	A	.56	A	.60	A	.83	D
17. Sierra Highway & Newhall	.57	A	.64	B	.86	D	.93	E
18. Whites Canyon & Soledad Canyon	.80	C	.86	D	.80	C	.90	D
19. Sierra Highway & Soledad Canyon	.67	B	.76	C	.86	D	.89	D
20. Commerce Center & Magic Mtn[1]	n/a	n/a	n/a	n/a	.76	C	.77	C
21. Pico Canyon & Valencia Boulevard[1]	n/a	n/a	n/a	n/a	.75	C	.81	D
22. Magic Mountain & Via Princessa[1]	n/a	n/a	n/a	n/a	.61	B	.81	D
23. Golden Valley & Via Princessa[1]	n/a	n/a	n/a	n/a	.88	D	.76	C

[1]Future Intersection

	Number of Occurrences	
LOS	Exist. Conditions	OVOV GP With Highway Plan
A-C	36	16
D	2	23
E	0	7
F	0	0

Level of service ranges: .00 - .60 A .61 - .70 B .71 - .80 C
.81 - .90 D .91 – 1.00 E Above 1.00 F

The fifth segment that is at LOS F for existing conditions, McBean Parkway south of Avenue Scott, is shown to remain at LOS F with the OVOV plan. However, the V/C ratio at that location does not increase with the OVOV plan.

Whereas Table 4-8 (the comparison of existing conditions to OVOV Buildout Conditions) identifies three segments that are forecast to operate at LOS F, Table 4-1 (the comparison of the current City/County plan to OVOV Buildout Conditions) identifies five roadway segments that are forecast to operate at LOS F due to a greater number of locations evaluated in Table 4-1. The number of locations evaluated in the comparison of existing conditions to OVOV Buildout Conditions is limited to the locations where existing traffic data is available, hence a fewer number of locations are evaluated in Table 4-8.

The previously referenced Table 4-9 shows that with the proposed Highway Plan in place, there are no intersections forecast to exceed LOS E, as is also the case for existing conditions.

Appendix A

INTERSECTION CAPACITY UTILIZATION WORKSHEETS

Peak hour intersection volume/capacity ratios are calculated by means of intersection capacity utilization (ICU) values. ICU calculations were performed for the intersections shown in Figure A-1.

The procedure is based on the critical movement methodology, and shows the amount of capacity utilized by each critical move. A "de-facto" right-turn lane is used in the ICU calculation for cases where a curb lane is wide enough to separately serve both through and right-turn traffic (typically with a width of 19 feet from curb to outside of through-lane with parking prohibited during peak periods). Such lanes are treated the same as striped right-turn lanes during the ICU calculations, but they are denoted on the ICU calculation worksheets using the letter "d" in place of a numerical entry for right-turn lanes.

The methodology also incorporates a check for right-turn capacity utilization. Both right-turn-on-green (RTOG) and right-turn-on-red (RTOR) capacity availability are calculated and checked against the total right-turn capacity need. If insufficient capacity is available, then an adjustment is made to the total capacity utilization value. The following example shows how this adjustment is made.

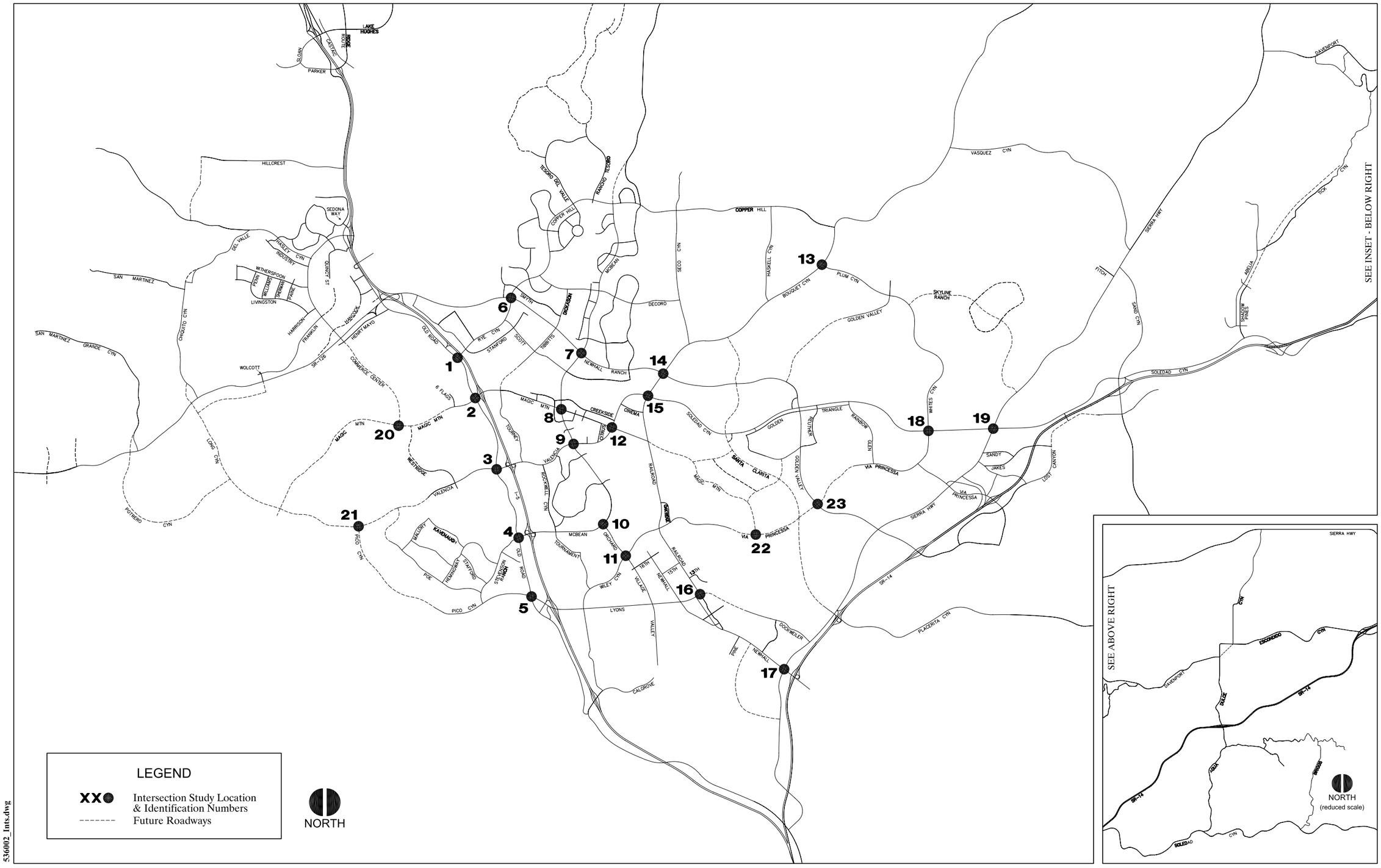
Example of Right-turn Capacity Utilization For Northbound Right

1. Right-Turn-On-Green (RTOG)

If NBT is critical move, then:
RTOG = V/C (NBT)
Otherwise,
RTOG = V/C (NBL) + V/C (SBT) - V/C (SBL)

2. Right-Turn-On-Red (RTOR)

If WBL is critical move, then:
RTOR = V/C (WBL)
Otherwise,
RTOR = V/C (EBL) + V/C (WBT) - V/C (EBT)



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3. Right-Turn Overlap Adjustment

If the northbound right is assumed to overlap with the adjacent westbound left, adjustments to the RTOG and RTOR values are made as follows:

RTOG = RTOG + V/C (WBL)
RTOR = RTOR - V/C (WBL)

4. Total Right-Turn Capacity (RTC) Availability For NBR

RTC = RTOG + factor x RTOR
Where factor = RTOR saturation flow factor (typically 75%)

5. Right-turn Adjustment for ICU Calculation

Right-turn adjustment is then as follows: Additional ICU = V/C (NBR) - RTC

A zero or negative value indicates that adequate capacity is available and no adjustment is necessary. A positive value indicates that the available RTOR and RTOG capacity does not adequately accommodate the right-turn V/C, therefore the right-turn is essentially considered to be a critical movement. In such cases, the right-turn adjustment is noted on the ICU worksheet and it is included in the total capacity utilization value. When it is determined that a right-turn adjustment is required for more than one right-turn movement, the word "multi" is printed on the worksheet instead of an actual right-turn movement reference, and the right-turn adjustments are cumulatively added to the total capacity utilization value. In such cases, further operational evaluation is typically carried out to determine if under actual operational conditions, the critical right-turns would operate simultaneously, and therefore a right-turn adjustment credit should be applied.

Shared Lane V/C Methodology

For intersection approaches where shared usage of a lane is permitted by more than one turn movement (e.g., left/through, through/right, left/through/right), the individual turn volumes are evaluated to determine whether dedication of the shared lane is warranted to any one given turn movement. The following example demonstrates how this evaluation is carried out:

Example of Shared Lane Utilization for Shared Left/Through Lane

1. Average Lane Volume (ALV)

$$ALV = \frac{\text{Left-Turn Volume + Through Volume}}{\text{Total Left + Through Approach Lanes (including shared lane)}}$$

2. ALV for Each Approach

$$ALV\ (Left) = \frac{\text{Left-Turn Volume}}{\text{Left Approach Lanes (including shared lane)}}$$

$$ALV\ (Through) = \frac{\text{Through Volume}}{\text{Through Approach Lanes (including shared lane)}}$$

3. Lane Dedication is Warranted

If ALV (Left) is greater than ALV then full dedication of the shared lane to the left-turn approach is warranted. Left-turn and through V/C ratios for this case are calculated as follows:

$$V/C\ (Left) = \frac{\text{Left-Turn Volume}}{\text{Left Approach Capacity (including shared lane)}}$$

$$V/C\ (Through) = \frac{\text{Through Volume}}{\text{Through Approach Capacity (excluding shared lane)}}$$

Similarly, if ALV (Through) is greater than ALV then full dedication to the through approach is warranted, and left-turn and through V/C ratios are calculated as follows:

$$V/C\ (Left) = \frac{\text{Left-Turn Volume}}{\text{Left Approach Capacity (excluding shared lane)}}$$

$$V/C\ (Through) = \frac{\text{Through Volume}}{\text{Through Approach Capacity (including shared lane)}}$$

4. Lane Dedication is not Warranted

If ALV (Left) and ALV (Through) are both less than ALV, the left/through lane is assumed to be truly shared and each left, left/through or through approach lane carries an evenly distributed volume of traffic equal to ALV. A combined left/through V/C ratio is calculated as follows:

$$\text{V/C (Left/Through)} = \frac{\text{Left-Turn Volume + Through Volume}}{\text{Total Left + Through Approach Capacity (including shared lane)}}.$$

This V/C (Left/Through) ratio is assigned as the V/C (Through) ratio for the critical movement analysis and ICU summary listing.

If split phasing has not been designated for this approach, the relative proportion of V/C (Through) that is attributed to the left-turn volume is estimated as follows:

If approach has more than one left-turn (including shared lane), then:

$$\text{V/C (Left)} = \text{V/C (Through)}$$

If approach has only one left-turn lane (shared lane), then:

$$\text{V/C (Left)} = \frac{\text{Left-Turn Volume}}{\text{Single Approach Lane Capacity}}.$$

If this left-turn movement is determined to be a critical movement, the V/C (Left) value is posted in brackets on the ICU summary printout.

These same steps are carried out for shared through/right lanes. If full dedication of a shared through/right lane to the right-turn movement is warranted, the right-turn V/C value calculated in step three is checked against the RTOR and RTOG capacity availability if the option to include right-turns in the V/C ratio calculations is selected. If the V/C value that is determined using the shared lane methodology described here is reduced due to RTOR and RTOG capacity availability, the V/C value for the through/right lanes is posted in brackets.

When an approach contains more than one shared lane (e.g., left/through and through/right), steps one and two listed above are carried out for the three turn movements combined. Step four is carried out if dedication is not warranted for either of the shared lanes. If dedication of one of the shared lanes is warranted to one movement or another, step three is carried out for the two movements involved, and then steps one through four are repeated for the two movements involved in the other shared lane.

1. The Old Road & Rye Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	1	1600	311	.19*	268	.17*
NBR	f		1026		818	
SBL	1	1600	261	.16*	243	.15*
SBT	2	3200	189	.06	267	.08
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	0	0	0		0	
EBR	0	0	0		0	
WBL	1	1600	252	.16*	378	.24*
WBT	0	0	0		0	
WBR	f		990		1231	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.61**		**.66**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	1	1600	1180	.74*	1350	.84*
NBR	f		1590		1280	
SBL	1	1600	280	.18*	980	.61*
SBT	2	3200	430	.13	990	.31
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	0	0	0		0	
EBR	0	0	0		0	
WBL	1	1600	890	.56*	1220	.76*
WBT	0	0	0		0	
WBR	f		950		1270	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.58**		**2.31**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	1	1600	1060	.66*	1300	.81*
NBR	f		1640		1330	
SBL	1	1600	700	.44*	890	.56*
SBT	2	3200	450	.14	870	.27
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	0	0	0		0	
EBR	0	0	0		0	
WBL	1	1600	860	.54*	1320	.83*
WBT	0	0	0		0	
WBR	f		910		1250	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.74**		**2.30**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	3	4800	1180	.25*	1350	.28*
NBR	2	3200	1590	.50	1280	.40
SBL	2	2880	280	.10*	980	.34*
SBT	3	4800	430	.09	990	.21
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	0	0	0		0	
EBR	0	0	0		0	
WBL	3	4320	890	.21*	1220	.28*
WBT	0	0	0		0	
WBR	2	3200	950	.30	1270	.40
Right Turn Adjustment			NBR	.04*		
Clearance Interval				.10*		.10*
Note: Assumes Right-Turn Overlap for WBR NBR						
TOTAL CAPACITY UTILIZATION				**.70**		**1.00**

1. The Old Road & Rye Canyon

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	3	4800	1060	.22*	1300	.27*
NBR	2	3200	1640	.51	1330	.42
SBL	2	2880	700	.24*	890	.31*
SBT	3	4800	450	.09	870	.18
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	0	0	0		0	
EBR	0	0	0		0	
WBL	3	4320	860	.20*	1320	.31*
WBT	0	0	0		0	
WBR	2	3200	910	.28	1250	.39
Right Turn Adjustment			NBR	.09*		
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for WBR NBR

TOTAL CAPACITY UTILIZATION **.85** **.99**

2. The Old Road & Magic Mountain

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	17	.01	16	.01
NBT	3	4800	411	.09*	451	.09*
NBR	1	1600	70	.04	184	.12
SBL	2	2880	143	.05*	215	.07*
SBT	3	4800	287	.06	414	.09
SBR	1	1600	2	.00	1	.00
EBL	2	2880	26	.01	20	.01
EBT	4	6400	21	.00*	51	.01*
EBR	1	1600	4	.00	9	.01
WBL	2	2880	123	.04*	151	.05*
WBT	4	6400	17	.00	9	.00
WBR	f		976		797	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.28**		**.32**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	470	.16	440	.15*
NBT	3	4800	580	.12*	400	.08
NBR	1	1600	120	.08	110	.07
SBL	2	2880	670	.23*	520	.18
SBT	3	4800	100	.02	640	.13*
SBR	1	1600	320	.20	840	.52
EBL	2	2880	510	.18*	500	.17
EBT	4	6400	1620	.25	2180	.34*
EBR	1	1600	190	.12	570	.36
WBL	2	2880	150	.05	140	.05*
WBT	4	6400	1020	.16*	1380	.22
WBR	f		1460		1480	
Right Turn Adjustment					SBR	.26*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.79**		**1.03**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	400	.14	430	.15*
NBT	3	4800	540	.11*	390	.08
NBR	1	1600	140	.09	130	.08
SBL	2	2880	630	.22*	480	.17
SBT	3	4800	120	.03	650	.14*
SBR	1	1600	340	.21	870	.54
EBL	2	2880	540	.19*	520	.18*
EBT	4	6400	1720	.27	2230	.35
EBR	1	1600	140	.09	540	.34
WBL	2	2880	180	.06	160	.06
WBT	4	6400	1020	.16*	1490	.23*
WBR	f		1390		1460	
Right Turn Adjustment					SBR	.26*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.78**		**1.06**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	470	.16	440	.15*
NBT	3	4800	580	.12*	400	.08
NBR	1	1600	120	.08	110	.07
SBL	2	2880	670	.23*	520	.18
SBT	2.5	6400	100	.03	640	.20*
SBR	1.5		320	.10	840	
EBL	2	2880	510	.18*	500	.17*
EBT	5	8000	1620	.20	2180	.27
EBR	1	1600	190	.12	570	.36
WBL	2	2880	150	.05	140	.05
WBT	4	6400	1020	.16*	1380	.22*
WBR	f		1460		1480	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.79**		**.84**

2. The Old Road & Magic Mountain

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	400	.14	430	.15*
NBT	3	4800	540	.11*	390	.08
NBR	1	1600	140	.09	130	.08
SBL	2	2880	630	.22*	480	.17
SBT	2.5	6400	120	.04	650	.20*
SBR	1.5		340		870	.27
EBL	2	2880	540	.19*	520	.18*
EBT	5	8000	1720	.22	2230	.28
EBR	1	1600	140	.09	540	.34
WBL	2	2880	180	.06	160	.06
WBT	4	6400	1020	.16*	1490	.23*
WBR	f		1390		1460	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.78**		**.86**

3. The Old Road & Valencia

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	668	.23*	96	.03
NBT	3	4800	257	.05	497	.10*
NBR	1	1600	107	.07	247	.15
SBL	2	2880	121	.04	201	.07*
SBT	3	4800	157	.03*	422	.09
SBR	1	1600	233	.15	93	.06
EBL	2	2880	312	.11*	77	.03
EBT	4	6400	886	.14	209	.03*
EBR	1	1600	542	.34	61	.04
WBL	2	2880	107	.04	395	.14*
WBT	3	4800	756	.16*	248	.05
WBR	f		137		330	
Right Turn Adjustment			SBR	.04*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.67**		**.44**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	770	.27*	470	.16*
NBT	3	4800	390	.08	740	.15
NBR	1	1600	110	.07	510	.32
SBL	2	2880	140	.05	400	.14
SBT	3	4800	270	.06*	700	.15*
SBR	1	1600	170	.11	210	.13
EBL	2	2880	290	.10*	230	.08*
EBT	4	6400	2200	.34	1600	.25
EBR	1	1600	420	.26	780	.49
WBL	2	2880	90	.03	490	.17
WBT	3	4800	1520	.32*	2080	.43*
WBR	f		370		540	
Right Turn Adjustment					EBR	.03*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.85**		**.95**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	730	.25*	430	.15*
NBT	3	4800	300	.06	620	.13
NBR	1	1600	110	.07	420	.26
SBL	2	2880	130	.05	320	.11
SBT	3	4800	200	.04*	760	.16*
SBR	1	1600	200	.13	210	.13
EBL	2	2880	300	.10*	240	.08*
EBT	4	6400	2380	.37	1790	.28
EBR	1	1600	370	.23	750	.47
WBL	2	2880	90	.03	480	.17
WBT	3	4800	1610	.34*	2190	.46*
WBR	f		350		570	
Right Turn Adjustment			SBR	.01*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.84**		**.95**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	770	.27*	470	.16*
NBT	3	4800	390	.08	740	.15
NBR	1	1600	110	.07	510	.32
SBL	2	2880	140	.05	400	.14
SBT	3	4800	270	.06*	700	.15*
SBR	1	1600	170	.11	210	.13
EBL	2	2880	290	.10*	230	.08*
EBT	4	6400	2200	.34	1600	.25
EBR	1	1600	420	.26	780	.49
WBL	2	2880	90	.03	490	.17
WBT	3	4800	1520	.32*	2080	.43*
WBR	f		370		540	
Clearance Interval				.10*		.10*
Note: Assumes Right-Turn Overlap for EBR						
TOTAL CAPACITY UTILIZATION				**.85**		**.92**

3. The Old Road & Valencia

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	730	.25*	430	.15*
NBT	3	4800	300	.06	620	.13
NBR	1	1600	110	.07	420	.26
SBL	2	2880	130	.05	320	.11
SBT	3	4800	200	.04*	760	.16*
SBR	1	1600	200	.13	210	.13
EBL	2	2880	300	.10*	240	.08*
EBT	4	6400	2380	.37	1790	.28
EBR	1	1600	370	.23	750	.47
WBL	2	2880	90	.03	480	.17
WBT	3	4800	1610	.34*	2190	.46*
WBR	f		350		570	
Right Turn Adjustment			SBR	.01*		
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for EBR

TOTAL CAPACITY UTILIZATION	**.84**	**.95**

4. The Old Road & Stevenson Ranch

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	63	.04*	232	.15*
NBT	3	4800	326	.07	546	.11
NBR	1	1600	103	.06	632	.40
SBL	1	1600	67	.04	79	.05
SBT	2	3200	458	.14*	589	.18*
SBR	1	1600	369	.23	278	.17
EBL	2	2880	614	.21*	197	.07
EBT	3	4800	616	.13	369	.08*
EBR	1	1600	184	.12	136	.09
WBL	2	2880	337	.12	720	.25*
WBT	2	3200	216	.09*	568	.20
WBR	0	0	73		68	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.58**		**.76**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	70	.04	170	.11
NBT	3	4800	540	.11*	1020	.21*
NBR	1	1600	330	.21	620	.39
SBL	1	1600	240	.15*	450	.28*
SBT	2	3200	310	.10	1110	.35
SBR	1	1600	20	.01	210	.13
EBL	2	2880	110	.04	220	.08*
EBT	3	4800	970	.20*	400	.08
EBR	1	1600	130	.08	90	.06
WBL	2	2880	250	.09*	890	.31
WBT	2	3200	220	.14	850	.38*
WBR	0	0	640	.40	350	
Right Turn Adjustment		Multi		.07*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.72**		**1.05**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	60	.04	140	.09
NBT	3	4800	390	.08*	840	.18*
NBR	1	1600	300	.19	640	.40
SBL	1	1600	170	.11*	620	.39*
SBT	2	3200	260	.08	900	.28
SBR	1	1600	20	.01	260	.16
EBL	2	2880	130	.05	210	.07*
EBT	3	4800	1110	.23*	470	.10
EBR	1	1600	120	.08	90	.06
WBL	2	2880	250	.09*	870	.30
WBT	2	3200	250	.16	960	.38*
WBR	0	0	630	.39	270	
Right Turn Adjustment		Multi		.08*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.69**		**1.12**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	70	.04	170	.11*
NBT	3	4800	540	.11*	1020	.21
NBR	1	1600	330	.21	620	.39
SBL	2	2880	240	.08*	450	.16
SBT	2	3200	310	.10	1110	.35*
SBR	1	1600	20	.01	210	.13
EBL	2	2880	110	.04	220	.08
EBT	3	4800	970	.20*	400	.08*
EBR	1	1600	130	.08	90	.06
WBL	2	2880	250	.09*	890	.31*
WBT	2	3200	220	.07	850	.27
WBR	1	1600	640	.40	350	.22
Right Turn Adjustment		Multi		.10*		
Clearance Interval				.10*		.10*
Note: Assumes Right-Turn Overlap for NBR						
TOTAL CAPACITY UTILIZATION				**.68**		**.95**

4. The Old Road & Stevenson Ranch

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	60	.04	140	.09
NBT	3	4800	390	.08*	840	.18*
NBR	1	1600	300	.19	640	.40
SBL	2	2880	170	.06*	620	.22*
SBT	2	3200	260	.08	900	.28
SBR	1	1600	20	.01	260	.16
EBL	2	2880	130	.05	210	.07
EBT	3	4800	1110	.23*	470	.10*
EBR	1	1600	120	.08	90	.06
WBL	2	2880	250	.09*	870	.30*
WBT	2	3200	250	.08	960	.30
WBR	1	1600	630	.39	270	.17
Right Turn Adjustment		Multi	.09*			
Clearance Interval			.10*			.10*
Note: Assumes Right-Turn Overlap for NBR						
TOTAL CAPACITY UTILIZATION			**.65**			**.90**

5. The Old Road & Pico Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	86	.05*	170	.11
NBT	2	3200	338	.13	411	.15*
NBR	0	0	80		64	
SBL	2	2880	341	.12	543	.19*
SBT	1	1600	520	.33*	304	.19
SBR	1	1600	28	.02	54	.03
EBL	1	1600	69	.04	48	.03*
EBT	2	3200	760	.24*	431	.13
EBR	1	1600	86	.05	30	.02
WBL	1	1600	67	.04*	49	.03
WBT	2	3200	349	.11	753	.24*
WBR	f		391		778	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.76**		**.71**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	170	.11	180	.11
NBT	2	3200	370	.13*	840	.31*
NBR	0	0	60		140	
SBL	2	2880	330	.11*	520	.18*
SBT	1	1600	180	.11	550	.34
SBR	1	1600	180	.11	500	.31
EBL	1	1600	400	.25*	100	.06*
EBT	2	3200	730	.23	1090	.34
EBR	1	1600	100	.06	270	.17
WBL	1	1600	10	.01	10	.01
WBT	2	3200	1470	.46*	1390	.43*
WBR	f		300		620	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.05**		**1.08**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1600	120	.08*	190	.12
NBT	2	3200	220	.08	660	.24*
NBR	0	0	50		100	
SBL	2	2880	320	.11	510	.18*
SBT	1	1600	170	.11*	360	.23
SBR	1	1600	130	.08	470	.29
EBL	1	1600	380	.24*	90	.06*
EBT	2	3200	590	.18	890	.28
EBR	1	1600	100	.06	250	.16
WBL	1	1600	10	.01	10	.01
WBT	2	3200	1270	.40*	1300	.41*
WBR	f		260		570	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.93**		**.99**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	170	.06	180	.06
NBT	2	3200	370	.13*	840	.31*
NBR	0	0	60		140	
SBL	2	2880	330	.11*	520	.18*
SBT	2	3200	180	.11	550	.33
SBR	0	0	180		500	
EBL	1	1600	400	.25*	100	.06*
EBT	2	3200	730	.23	1090	.34
EBR	1	1600	100	.06	270	.17
WBL	1	1600	10	.01	10	.01
WBT	3	4800	1470	.37*	1390	.42*
WBR	0	0	300		620	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.96**		**1.07**

5. The Old Road & Pico Canyon

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	120	.04	190	.07
NBT	2	3200	220	.08*	660	.24*
NBR	0	0	50		100	
SBL	2	2880	320	.11*	510	.18*
SBT	2	3200	170	.09	360	.23
SBR	0	0	130		470	.29
EBL	1	1600	380	.24*	90	.06*
EBT	2	3200	590	.18	890	.28
EBR	1	1600	100	.06	250	.16
WBL	1	1600	10	.01	10	.01
WBT	3	4800	1270	.32*	1300	.39*
WBR	0	0	260		570	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.85**		**.97**

6. Rye/Copper Hill & Newhall Ranch

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	41	.01*	115	.03
NBT	3	5250	381	.07	1070	.20*
NBR	f		32		219	
SBL	2	3500	133	.04	220	.06*
SBT	3	5250	1240	.24*	516	.10
SBR	f		358		192	
EBL	2	3500	441	.13*	922	.26*
EBT	4	7000	510	.07	983	.14
EBR	1	1750	76	.04	43	.02
WBL	2	3500	366	.10	168	.05
WBT	4	7000	1038	.15*	553	.08*
WBR	f		217		148	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.63**		**.70**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	360	.10*	270	.08
NBT	3	5250	1100	.21	1460	.28*
NBR	f		40		80	
SBL	2	3500	80	.02	280	.08*
SBT	3	5250	1680	.32*	950	.18
SBR	f		1270		770	
EBL	2	3500	500	.14*	980	.28
EBT	4	7000	530	.08	2100	.30*
EBR	1	1750	260	.15	430	.25
WBL	2	3500	370	.11	470	.13*
WBT	4	7000	1350	.19*	990	.14
WBR	f		700		270	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.85**		**.89**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	430	.12*	390	.11
NBT	3	5250	1190	.23	1350	.26*
NBR	f		220		90	
SBL	2	3500	90	.03	280	.08*
SBT	3	5250	1640	.31*	960	.18
SBR	f		1260		820	
EBL	2	3500	360	.10*	1040	.30*
EBT	4	7000	540	.08	1990	.28
EBR	1	1750	280	.16	530	.30
WBL	2	3500	330	.09	470	.13
WBT	4	7000	1230	.18*	1050	.15*
WBR	f		660		290	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.81**		**.89**

7. McBean & Newhall Ranch

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	394	.11*	353	.10
NBT	3	5250	431	.08	1499	.29*
NBR	1	1750	212	.12	690	.39
SBL	2	3500	275	.08	206	.06*
SBT	4	7000	1542	.22*	706	.10
SBR	f		187		48	
EBL	2	3500	103	.03*	198	.06
EBT	4	7000	566	.08	1402	.20*
EBR	1	1750	193	.11	323	.18
WBL	2	3500	639	.18	440	.13*
WBT	3	5250	1397	.27*	727	.14
WBR	1	1750	111	.06	270	.15
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.73**		**.78**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	250	.07	280	.08
NBT	3	5250	880	.17*	1960	.37*
NBR	1	1750	160	.09	1210	.69
SBL	2	3500	480	.14*	180	.05*
SBT	4	7000	1700	.24	1320	.19
SBR	f		230		70	
EBL	2	3500	100	.03*	320	.09*
EBT	4	7000	680	.10	2040	.29
EBR	1	1750	280	.16	610	.35
WBL	2	3500	970	.28	240	.07
WBT	3	5250	1890	.36*	1590	.30*
WBR	1	1750	60	.03	450	.26
Right Turn Adjustment					NBR	.24*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**1.15**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	250	.07	280	.08
NBT	3	5250	910	.17*	2020	.38*
NBR	1	1750	160	.09	1220	.70
SBL	2	3500	530	.15*	180	.05*
SBT	4	7000	1770	.25	1340	.19
SBR	f		200		60	
EBL	2	3500	100	.03	250	.07*
EBT	4	7000	910	.13*	1990	.28
EBR	1	1750	310	.18	640	.37
WBL	2	3500	970	.28*	280	.08
WBT	3	5250	1760	.34	1740	.33*
WBR	1	1750	60	.03	480	.27
Right Turn Adjustment					NBR	.23*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.83**		**1.16**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	250	.07	280	.08
NBT	3	5250	880	.17*	1960	.37*
NBR	2	3500	160	.05	1210	.35
SBL	2	3500	480	.14*	180	.05*
SBT	4	7000	1700	.24	1320	.19
SBR	f		230		70	
EBL	2	3500	100	.03	320	.09
EBT	4	7000	680	.10*	2040	.29*
EBR	1	1750	280	.16	610	.35
WBL	2	3500	970	.28*	240	.07*
WBT	4	7000	1890	.27	1590	.23
WBR	1	1750	60	.03	450	.26
Right Turn Adjustment			EBR	.01*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.88**

7. McBean & Newhall Ranch

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	250	.07	280	.08
NBT	3	5250	910	.17*	2020	.38*
NBR	2	3500	160	.05	1220	.35
SBL	2	3500	530	.15*	180	.05*
SBT	4	7000	1770	.25	1340	.19
SBR	f		200		60	
EBL	2	3500	100	.03	250	.07
EBT	4	7000	910	.13*	1990	.28*
EBR	1	1750	310	.18	640	.37
WBL	2	3500	970	.28*	280	.08*
WBT	4	7000	1760	.25	1740	.25
WBR	1	1750	60	.03	480	.27
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.83**		**.89**

8. McBean & Magic Mountain

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	50	.01*	94	.03
NBT	3	5250	900	.17	1384	.26*
NBR	f		21		98	
SBL	2	3500	387	.11	250	.07*
SBT	4	7000	1871	.27*	1296	.19
SBR	f		534		203	
EBL	2	3500	592	.17*	570	.16*
EBT	2	3500	475	.14	548	.16
EBR	1	1750	107	.06	126	.07
WBL	2	3500	58	.02	172	.05
WBT	3	5250	330	.06*	369	.07*
WBR	1	1750	113	.06	387	.22
Right Turn Adjustment					WBR	.10*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.61**		**.76**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	240	.07	290	.08
NBT	3	5250	1310	.25*	2380	.45*
NBR	f		40		280	
SBL	2	3500	430	.12*	160	.05*
SBT	4	7000	1920	.27	2260	.32
SBR	f		800		130	
EBL	2	3500	500	.14	510	.15
EBT	2	3500	1340	.38*	1930	.55*
EBR	1	1750	130	.07	280	.16
WBL	2	3500	70	.02*	220	.06*
WBT	3	5250	880	.17	1390	.26
WBR	1	1750	410	.23	450	.26
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.87**		**1.21**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	200	.06	390	.11
NBT	3	5250	1260	.24*	2460	.47*
NBR	f		50		270	
SBL	2	3500	580	.17*	340	.10*
SBT	4	7000	1960	.28	2110	.30
SBR	f		690		120	
EBL	2	3500	530	.15	470	.13
EBT	2	3500	1550	.44*	1780	.51*
EBR	1	1750	150	.09	400	.23
WBL	2	3500	70	.02*	220	.06*
WBT	3	5250	820	.16	1330	.25
WBR	1	1750	370	.21	590	.34
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.97**		**1.24**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	240	.07*	290	.08*
NBT	4	7000	1310	.19	2380	.34
NBR	f		40		280	
SBL	2	3500	430	.12	160	.05
SBT	4	7000	1920	.27*	2260	.32*
SBR	f		800		130	
EBL	2	3500	500	.14*	510	.15
EBT	3	5250	1340	.26	1930	.37*
EBR	1	1750	130	.07	280	.16
WBL	2	3500	70	.02	220	.06*
WBT	3	5250	880	.17*	1390	.26
WBR	1	1750	410	.23	450	.26
Clearance Interval				.10*		.10*
Note: Assumes Right-Turn Overlap for WBR						
TOTAL CAPACITY UTILIZATION				**.75**		**.93**

8. McBean & Magic Mountain

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	200	.06	390	.11
NBT	4	7000	1260	.18*	2460	.35*
NBR	f		50		270	
SBL	2	3500	580	.17*	340	.10*
SBT	4	7000	1960	.28	2110	.30
SBR	f		690		120	
EBL	2	3500	530	.15	470	.13
EBT	3	5250	1550	.30*	1780	.34*
EBR	1	1750	150	.09	400	.23
WBL	2	3500	70	.02*	220	.06*
WBT	3	5250	820	.16	1330	.25
WBR	1	1750	370	.21	590	.34
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for WBR

TOTAL CAPACITY UTILIZATION	**.77**	**.95**

9. McBean & Valencia

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	218	.06*	193	.06
NBT	3	5250	772	.15	1105	.21*
NBR	2	3500	182	.05	342	.10
SBL	2	3500	97	.03	195	.06*
SBT	3	5250	672	.13*	931	.18
SBR	2	3500	584	.17	296	.08
EBL	2	3500	360	.10*	535	.15
EBT	3	5250	722	.14	1213	.23*
EBR	1	1750	78	.04	57	.03
WBL	2	3500	314	.09	505	.14*
WBT	3	5250	1149	.22*	890	.17
WBR	1	1750	31	.02	116	.07
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR

TOTAL CAPACITY UTILIZATION **.61** **.74**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	270	.08*	160	.05
NBT	3	5250	1060	.20	1350	.26*
NBR	2	3500	250	.07	700	.20
SBL	2	3500	70	.02	270	.08*
SBT	3	5250	880	.17*	1310	.25
SBR	2	3500	970	.28	980	.28
EBL	2	3500	450	.13*	940	.27*
EBT	3	5250	860	.16	1400	.27
EBR	1	1750	20	.01	370	.21
WBL	2	3500	360	.10	600	.17
WBT	3	5250	1180	.22*	930	.18*
WBR	1	1750	290	.17	290	.17
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR

TOTAL CAPACITY UTILIZATION **.70** **.89**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	280	.08*	190	.05
NBT	3	5250	1020	.19	1370	.26*
NBR	2	3500	320	.09	710	.20
SBL	2	3500	70	.02	220	.06*
SBT	3	5250	960	.18*	1350	.26
SBR	2	3500	900	.26	970	.28
EBL	2	3500	530	.15*	1000	.29*
EBT	3	5250	1170	.22	1270	.24
EBR	1	1750	20	.01	340	.19
WBL	2	3500	420	.12	730	.21
WBT	3	5250	1060	.20*	1200	.23*
WBR	1	1750	220	.13	350	.20
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR

TOTAL CAPACITY UTILIZATION **.71** **.94**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	270	.08*	160	.05*
NBT	4	7000	1060	.15	1350	.19
NBR	1	1750	250	.14	700	.40
SBL	2	3500	70	.02	270	.08
SBT	3	5250	880	.17*	1310	.25*
SBR	2	3500	970	.28	980	.28
EBL	2	3500	450	.13*	940	.27
EBT	3	5250	860	.16	1400	.27*
EBR	1	1750	20	.01	370	.21
WBL	2	3500	360	.10	600	.17*
WBT	4	7000	1180	.17*	930	.13
WBR	1	1750	290	.17	290	.17
Right Turn Adjustment			SBR	.01*	NBR	.01*
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.66** **.85**

9. McBean & Valencia

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	280	.08*	190	.05*
NBT	4	7000	1020	.15	1370	.20
NBR	1	1750	320	.18	710	.41
SBL	2	3500	70	.02	220	.06
SBT	3	5250	960	.18*	1350	.26*
SBR	2	3500	900	.26	970	.28
EBL	2	3500	530	.15	1000	.29*
EBT	3	5250	1170	.22*	1270	.24
EBR	1	1750	20	.01	340	.19
WBL	2	3500	420	.12*	730	.21
WBT	4	7000	1060	.15	1200	.17*
WBR	1	1750	220	.13	350	.20
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION	**.70**	**.87**

10. Orchard Village & McBean

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1.5		327		215	
NBT	0.5	3500	39	.10*	17	.07*
NBR	2	3500	592	.17	757	.22
SBL	0	0	25		64	
SBT	1	1750	32	.03*	40	.06*
SBR	d	1750	19	.01	31	.02
EBL	1	1750	38	.02	28	.02
EBT	3	5250	436	.12*	860	.22*
EBR	0	0	253	.14	319	
WBL	2	3500	778	.22*	799	.23*
WBT	3	5250	507	.11	566	.11
WBR	0	0	48		19	
Clearance Interval				.10*		.10*

Note: Assumes N/S Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.57** **.68**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1.5		980		880	
NBT	0.5	3500	60	.30*	60	.27*
NBR	2	3500	830	.24	1100	.31
SBL	0	0	10		60	
SBT	1	1750	20	.02*	70	.07*
SBR	d	1750	10	.01	30	.02
EBL	1	1750	50	.03	40	.02
EBT	3	5250	550	.16*	970	.28*
EBR	0	0	840	.48	1150	.66
WBL	2	3500	850	.24*	1140	.33*
WBT	3	5250	620	.12	910	.18
WBR	0	0	30		20	
Right Turn Adjustment			EBR	.09*	EBR	.18*
Clearance Interval				.10*		.10*

Note: Assumes N/S Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.91** **1.23**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1.5		960		910	
NBT	0.5	3500	60	.29*	60	.28*
NBR	2	3500	850	.24	1110	.32
SBL	0	0	10		60	
SBT	1	1750	20	.02*	70	.07*
SBR	d	1750	10	.01	30	.02
EBL	1	1750	50	.03	40	.02
EBT	3	5250	440	.13*	900	.26*
EBR	0	0	880	.50	1200	.69
WBL	2	3500	860	.25*	1140	.33*
WBT	3	5250	650	.13	950	.18
WBR	0	0	30		20	
Right Turn Adjustment			EBR	.15*	EBR	.22*
Clearance Interval				.10*		.10*

Note: Assumes N/S Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.94** **1.26**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1.5		980		880	
NBT	0.5	3500	60	.30*	60	.27*
NBR	2	3500	830	.24	1100	.31
SBL	1.5		10	.01	60	
SBT	1.5	5250	20	.01*	70	.02*
SBR	1	1750	10	.01	30	.02
EBL	1	1750	50	.03	40	.02
EBT	2.5	7000	550	{.14}*	970	{.25}*
EBR	1.5		840		1150	
WBL	2	3500	850	.24*	1140	.33*
WBT	3	5250	620	.12	910	.17
WBR	1	1750	30	.02	20	.01
Clearance Interval				.10*		.10*

Note: Assumes N/S Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.79** **.97**

10. Orchard Village & McBean

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1.5		960		910	
NBT	0.5	3500	60	.29*	60	.28*
NBR	2	3500	850	.24	1110	.32
SBL	1.5		10	.01	60	
SBT	1.5	5250	20	.01*	70	.02*
SBR	1	1750	10	.01	30	.02
EBL	1	1750	50	.03	40	.02
EBT	2.5	7000	440	.13*	900	{.25}*
EBR	1.5		880	.25	1200	
WBL	2	3500	860	.25*	1140	.33*
WBT	3	5250	650	.12	950	.18
WBR	1	1750	30	.02	20	.01
Clearance Interval				.10*		.10*

Note: Assumes N/S Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.78** **.98**

11. Orchard Village & Wiley Cyn

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	218	.12*	132	.08
NBT	2	3500	754	.25	807	.27*
NBR	0	0	113		153	
SBL	1	1750	117	.07	124	.07*
SBT	2	3500	777	.22*	731	.21
SBR	1	1750	283	.16	215	.12
EBL	2	3500	172	.05	282	.08
EBT	2	3500	125	.07*	254	.12*
EBR	0	0	272	.16	179	
WBL	1	1750	152	.09*	98	.06*
WBT	2	3500	268	.08	240	.07
WBR	1	1750	96	.05	101	.06
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.60**		**.62**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	30	.02	80	.05
NBT	2	3500	750	.31*	1080	.47*
NBR	0	0	320		570	
SBL	1	1750	510	.29*	640	.37*
SBT	2	3500	670	.19	1090	.31
SBR	1	1750	280	.16	160	.09
EBL	2	3500	190	.05	290	.08
EBT	2	3500	300	.11*	730	.26*
EBR	0	0	70		170	
WBL	1	1750	340	.19*	380	.22*
WBT	2	3500	540	.15	580	.17
WBR	1	1750	500	.29	500	.29
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.00**		**1.42**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	50	.03	80	.05
NBT	2	3500	710	.30*	1050	.47*
NBR	0	0	330		610	
SBL	1	1750	530	.30*	650	.37*
SBT	2	3500	610	.17	1140	.33
SBR	1	1750	340	.19	150	.09
EBL	2	3500	230	.07	320	.09
EBT	2	3500	370	.13*	760	.26*
EBR	0	0	90		140	
WBL	1	1750	370	.21*	390	.22*
WBT	2	3500	690	.20	710	.20
WBR	1	1750	460	.26	540	.31
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.04**		**1.42**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	30	.02	80	.05
NBT	3	5250	750	.20*	1080	.31*
NBR	0	0	320		570	.33
SBL	2	3500	510	.15*	640	.18*
SBT	2	3500	670	.27	1090	.36
SBR	0	0	280		160	
EBL	1	1750	190	.11*	290	.17
EBT	3	5250	300	.07	730	.17*
EBR	0	0	70		170	
WBL	1	1750	340	.19	380	.22*
WBT	3	5250	540	.15*	580	.17
WBR	0	0	500	.29	500	.29
Right Turn Adjustment			WBR	.03*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.74**		**.98**

11. Orchard Village & Wiley Cyn

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	50	.03	80	.05
NBT	3	5250	710	.20*	1050	.30*
NBR	0	0	330		610	.35
SBL	2	3500	530	.15*	650	.19*
SBT	2	3500	610	.27	1140	.37
SBR	0	0	340		150	
EBL	1	1750	230	.13*	320	.18
EBT	3	5250	370	.09	760	.17*
EBR	0	0	90		140	
WBL	1	1750	370	.21	390	.22*
WBT	3	5250	690	.20*	710	.20
WBR	0	0	460	.26	540	.31
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.78**		**.98**

12. Valencia & Magic Mountain

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	32	.02*	56	.03
NBT	3	5250	682	.14	1406	.30*
NBR	0	0	71		154	
SBL	1	1750	25	.01	56	.03*
SBT	3	5250	1632	.31*	1115	.21
SBR	2	3500	429	.12	371	.11
EBL	2	3500	145	.04	500	.14*
EBT	2	3500	153	.05*	420	.13
EBR	0	0	29		29	
WBL	1	1750	176	.10*	148	.08
WBT	2	3500	351	.10	303	.09*
WBR	1	1750	26	.01	61	.03
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.58**		**.66**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	80	.05*	100	.06
NBT	3	5250	730	.18	1710	.42*
NBR	0	0	220		500	
SBL	1	1750	50	.03	130	.07*
SBT	3	5250	1610	.31*	1150	.22
SBR	2	3500	720	.21	650	.19
EBL	2	3500	450	.13	740	.21
EBT	2	3500	920	.27*	1380	.40*
EBR	0	0	40		30	
WBL	1	1750	440	.25*	240	.14*
WBT	2	3500	1190	.34	1120	.32
WBR	1	1750	90	.05	130	.07
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.98**		**1.13**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	80	.05*	130	.07
NBT	3	5250	830	.21	1760	.47*
NBR	0	0	270		690	
SBL	1	1750	20	.01	50	.03*
SBT	3	5250	1640	.31*	1250	.24
SBR	2	3500	750	.21	580	.17
EBL	2	3500	530	.15	700	.20
EBT	2	3500	910	.29*	1300	.38*
EBR	0	0	100		40	
WBL	1	1750	610	.35*	470	.27*
WBT	2	3500	1040	.30	970	.28
WBR	1	1750	70	.04	40	.02
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.10**		**1.25**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	80	.05*	100	.06
NBT	3	5250	730	.14	1710	.33*
NBR	1	1750	220	.13	500	.29
SBL	1	1750	50	.03	130	.07*
SBT	3	5250	1610	.31*	1150	.22
SBR	2	3500	720	.21	650	.19
EBL	2	3500	450	.13*	740	.21*
EBT	3	5250	920	.18	1380	.27
EBR	0	0	40		30	
WBL	2	3500	440	.13	240	.07
WBT	3	5250	1190	.24*	1120	.24*
WBR	0	0	90		130	
Clearance Interval				.10*		.10*
Note: Assumes Right-Turn Overlap for NBR						
TOTAL CAPACITY UTILIZATION				**.83**		**.95**

12. Valencia & Magic Mountain

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	80	.05*	130	.07
NBT	3	5250	830	.16	1760	.34*
NBR	1	1750	270	.15	690	.39
SBL	1	1750	20	.01	50	.03*
SBT	3	5250	1640	.31*	1250	.24
SBR	2	3500	750	.21	580	.17
EBL	2	3500	530	.15*	700	.20*
EBT	3	5250	910	.19	1300	.26
EBR	0	0	100		40	
WBL	2	3500	610	.17	470	.13
WBT	3	5250	1040	.21*	970	.19*
WBR	0	0	70		40	
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION	**.82**	**.86**

13. Bouquet Canyon & Plum Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	14	.01	66	.04
NBT	2	3500	209	.06*	648	.19*
NBR	1	1750	633	.36	891	.51
SBL	1	1750	182	.10*	169	.10*
SBT	2	3500	476	.14	332	.10
SBR	0	0	2		4	
EBL	0	0	6		5	
EBT	1	1750	10	.03*	8	.02*
EBR	0	0	43		30	
WBL	1.5		1364		786	
WBT	0.5	3500	5	.39*	21	.23*
WBR	1	1750	133	.08	181	.10
Right Turn Adjustment					NBR	.09*
Clearance Interval				.10*		.10*

Note: Assumes E/W Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.68** **.73**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	10	.01	60	.03
NBT	2	3500	310	.09*	1040	.30*
NBR	1	1750	610	.35	850	.49
SBL	1	1750	400	.23*	250	.14*
SBT	2	3500	900	.26	390	.11
SBR	0	0	10		10	
EBL	0	0	10		10	
EBT	1	1750	50	.07*	10	.03*
EBR	0	0	60		30	
WBL	1.5		1060		620	
WBT	0.5	3500	20	.31*	20	.18*
WBR	1	1750	310	.18	230	.13
Right Turn Adjustment					NBR	.01*
Clearance Interval				.10*		.10*

Note: Assumes E/W Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.80** **.76**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	10	.01	60	.03
NBT	2	3500	330	.09*	1050	.30*
NBR	1	1750	600	.34	810	.46
SBL	1	1750	400	.23*	260	.15*
SBT	2	3500	940	.27	350	.10
SBR	0	0	10		10	
EBL	0	0	10		10	
EBT	1	1750	50	.07*	10	.03*
EBR	0	0	60		30	
WBL	1.5		1050		630	
WBT	0.5	3500	20	.31*	20	.19*
WBR	1	1750	310	.18	250	.14
Clearance Interval				.10*		.10*

Note: Assumes E/W Split Phasing
Note: Assumes Right-Turn Overlap for NBR

TOTAL CAPACITY UTILIZATION **.80** **.77**

14. Bouquet Canyon & Newhall Ranch

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	291	.08*	445	.13
NBT	4	7000	561	.08	2044	.29*
NBR	1	1750	33	.02	44	.03
SBL	1	1750	324	.19	210	.12*
SBT	4	7000	2079	.30*	1328	.19
SBR	1	1750	584	.33	356	.20
EBL	3	5250	260	.05*	1020	.19*
EBT	2	3500	369	.11	786	.22
EBR	2	3500	261	.07	454	.13
WBL	2	3500	120	.03	209	.06
WBT	4	7000	890	.13*	634	.09*
WBR	1	1750	89	.05	359	.21
Right Turn Adjustment					WBR	.03*
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR EBR

TOTAL CAPACITY UTILIZATION **.66** **.82**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	670	.19*	810	.23*
NBT	4	7000	500	.07	2350	.34
NBR	1	1750	300	.17	620	.35
SBL	1	1750	110	.06	70	.04
SBT	4	7000	2000	.29*	1370	.20*
SBR	1	1750	810	.46	410	.23
EBL	3	5250	260	.05	690	.13
EBT	2	3500	710	.20*	2020	.58*
EBR	2	3500	890	.25	1100	.31
WBL	2	3500	570	.16*	170	.05*
WBT	4	7000	1340	.19	930	.13
WBR	1	1750	50	.03	100	.06
Right Turn Adjustment				SBR .03*		
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR EBR

TOTAL CAPACITY UTILIZATION **.97** **1.16**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	550	.16*	890	.25*
NBT	4	7000	530	.08	2490	.36
NBR	1	1750	270	.15	600	.34
SBL	1	1750	110	.06	70	.04
SBT	4	7000	2190	.31*	1430	.20*
SBR	1	1750	750	.43	440	.25
EBL	3	5250	270	.05	690	.13
EBT	2	3500	930	.27*	2040	.58*
EBR	2	3500	850	.24	1050	.30
WBL	2	3500	570	.16*	150	.04*
WBT	4	7000	1420	.20	970	.14
WBR	1	1750	70	.04	100	.06
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR EBR

TOTAL CAPACITY UTILIZATION **1.00** **1.17**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	670	.19*	810	.23*
NBT	4	7000	500	.07	2350	.34
NBR	1	1750	300	.17	620	.35
SBL	2	3500	110	.03	70	.02
SBT	4	7000	2000	.29*	1370	.20*
SBR	2	3500	810	.23	410	.12
EBL	2	3500	260	.07*	690	.20
EBT	4	7000	710	.10	2020	.29*
EBR	2	3500	890	.25	1100	.31
WBL	2	3500	570	.16	170	.05*
WBT	4	7000	1340	.19*	930	.13
WBR	1	1750	50	.03	100	.06
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR WBR EBR

TOTAL CAPACITY UTILIZATION **.84** **.87**

14. Bouquet Canyon & Newhall Ranch

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	550	.16*	890	.25*
NBT	4	7000	530	.08	2490	.36
NBR	1	1750	270	.15	600	.34
SBL	2	3500	110	.03	70	.02
SBT	4	7000	2190	.31*	1430	.20*
SBR	2	3500	750	.21	440	.13
EBL	2	3500	270	.08	690	.20*
EBT	4	7000	930	.13*	2040	.29
EBR	2	3500	850	.24	1050	.30
WBL	2	3500	570	.16*	150	.04
WBT	4	7000	1420	.20	970	.14*
WBR	1	1750	70	.04	100	.06
Clearance Interval				.10*		.10*

Note: Assumes Right-Turn Overlap for SBR WBR EBR

TOTAL CAPACITY UTILIZATION .86 .89

15. Bouquet Canyon & Soledad Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	21	.01*	24	.01
NBT	3	5250	399	.08	1109	.21*
NBR	1	1750	182	.10	286	.16
SBL	3	5250	331	.06	461	.09*
SBT	2.5	7000	1218	{.30}*	832	{.18}
SBR	1.5		917		669	
EBL	3	5250	240	.05*	986	.19*
EBT	3	5250	499	.10	1366	.26
EBR	0	0	9		4	
WBL	3	5250	307	.06	315	.06
WBT	2.5	7000	1139	.22*	947	{.18}*
WBR	1.5		230		391	{.16}
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.68**		**.77**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	20	.01*	100	.06
NBT	3	5250	620	.12	1770	.34*
NBR	1	1750	110	.06	470	.27
SBL	3	5250	290	.06	530	.10*
SBT	2.5	7000	1890	{.44}*	1210	{.25}
SBR	1.5		1240		910	
EBL	3	5250	340	.06*	1370	.26*
EBT	3	5250	840	.18	1240	.24
EBR	0	0	120		40	
WBL	3	5250	120	.02	290	.06
WBT	2.5	7000	1020	{.19}*	970	{.19}*
WBR	1.5		380		490	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.99**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	20	.01*	100	.06
NBT	3	5250	660	.13	1760	.34*
NBR	1	1750	230	.13	500	.29
SBL	3	5250	400	.08	430	.08*
SBT	2.5	7000	1910	{.44}*	1400	{.27}
SBR	1.5		1250		820	
EBL	3	5250	300	.06	1300	.25*
EBT	3	5250	910	.20*	1130	.24
EBR	0	0	120		120	
WBL	3	5250	160	.03*	400	.08
WBT	2.5	7000	880	.17	950	{.23}*
WBR	1.5		280		780	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.78**		**1.00**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	20	.01*	100	.06
NBT	4	7000	620	.09	1770	.25*
NBR	1	1750	110	.06	470	.27
SBL	3	5250	290	.06	530	.10*
SBT	2.5	7000	1890	{.44}*	1210	{.25}
SBR	1.5		1240		910	
EBL	3	5250	340	.06*	1370	.26*
EBT	3	5250	840	.18	1240	.24
EBR	0	0	120		40	
WBL	3	5250	120	.02	290	.06
WBT	2.5	7000	1020	{.19}*	970	{.19}*
WBR	1.5		380		490	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.90**

15. Bouquet Canyon & Soledad Canyon

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	20	.01*	100	.06*
NBT	4	7000	660	.09	1760	.25
NBR	1	1750	230	.13	500	.29
SBL	3	5250	400	.08	430	.08
SBT	2.5	7000	1910	{.44}*	1400	{.27}*
SBR	1.5		1250		820	
EBL	3	5250	300	.06	1300	.25*
EBT	3	5250	910	.20*	1130	.24
EBR	0	0	120		120	
WBL	3	5250	160	.03*	400	.08
WBT	2.5	7000	880	.17	950	{.22}*
WBR	1.5		280		780	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.78**		**.90**

16. Railroad & Lyons

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	172	.10*	140	.08*
NBT	2	3500	702	.20	1097	.31
NBR	0	0	0		0	
SBL	0	0	0		0	
SBT	2	3500	1095	.31*	903	.26*
SBR	1	1750	220	.13	312	.18
EBL	2	3500	218	.06*	411	.12*
EBT	0	0	0		0	
EBR	1	1750	122	.07	136	.08
WBL	0	0	0		0	
WBT	0	0	0		0	
WBR	0	0	0		0	
Clearance Interval				.10*		.10*

TOTAL CAPACITY UTILIZATION **.57** **.56**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	60	.03	0	.00
NBT	2	3500	820	.26*	1050	.33*
NBR	0	0	80		100	
SBL	2	3500	270	.08*	480	.14*
SBT	2	3500	770	.22	810	.23
SBR	1	1750	190	.11	390	.22
EBL	1.5		180		300	
EBT	1.5	5250	330	.12*	610	.19*
EBR	0		120		100	
WBL	1	1750	70	.04	70	.04
WBT	2	3500	410	.12*	620	.18*
WBR	1	1750	370	.21	290	.17
Right Turn Adjustment			WBR	.03*		
Clearance Interval				.10*		.10*
Note: Assumes E/W Split Phasing						

TOTAL CAPACITY UTILIZATION **.71** **.94**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	50	.03	0	.00
NBT	2	3500	700	.22*	970	.30*
NBR	0	0	70		70	
SBL	2	3500	210	.06*	380	.11*
SBT	2	3500	680	.19	730	.21
SBR	1	1750	200	.11	420	.24
EBL	1.5		190		300	
EBT	1.5	5250	340	.13*	540	.18*
EBR	0		130		80	
WBL	1	1750	50	.03	50	.03
WBT	2	3500	320	.09*	500	.14*
WBR	1	1750	250	.14	200	.11
Clearance Interval				.10*		.10*
Note: Assumes E/W Split Phasing						

TOTAL CAPACITY UTILIZATION **.60** **.83**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	60	.03	0	.00
NBT	2	3500	820	.26*	1050	.33*
NBR	0	0	80		100	
SBL	2	3500	270	.08*	480	.14*
SBT	2	3500	770	.22	810	.23
SBR	1	1750	190	.11	390	.22
EBL	1.5		180		300	
EBT	1.5	5250	330	.12*	610	.19*
EBR	0		120		100	
WBL	1	1750	70	.04	70	.04
WBT	2	3500	410	.12*	620	.18*
WBR	1	1750	370	.21	290	.17
Right Turn Adjustment			WBR	.03*		
Clearance Interval				.10*		.10*
Note: Assumes E/W Split Phasing						

TOTAL CAPACITY UTILIZATION **.71** **.94**

16. Railroad & Lyons

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	50	.03	0	.00
NBT	2	3500	700	.22*	970	.30*
NBR	0	0	70		70	
SBL	2	3500	210	.06*	380	.11*
SBT	2	3500	680	.19	730	.21
SBR	1	1750	200	.11	420	.24
EBL	1.5		190		300	
EBT	1.5	5250	340	.13*	540	.18*
EBR	0		130		80	
WBL	1	1750	50	.03	50	.03
WBT	2	3500	320	.09*	500	.14*
WBR	1	1750	250	.14	200	.11
Clearance Interval				.10*		.10*

Note: Assumes E/W Split Phasing

TOTAL CAPACITY UTILIZATION **.60** **.83**

17. Sierra Highway & Newhall

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	70	.02*	286	.08
NBT	2	3500	47	.02	672	.22*
NBR	0	0	21		91	
SBL	1	1750	125	.07	39	.02*
SBT	3	5250	467	.13*	54	.02
SBR	0	0	270	.15	226	.13
EBL	2	3500	130	.04	342	.10*
EBT	3	5250	1144	.26*	967	.20
EBR	0	0	235		76	
WBL	1	1750	105	.06*	34	.02
WBT	3	5250	693	.13	1047	.20*
WBR	1	1750	16	.01	328	.19
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.57**		**.64**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	420	.12*	480	.14
NBT	2	3500	400	.23	790	.45*
NBR	0	0	400		1200	.69
SBL	1	1750	120	.07	10	.01*
SBT	3	5250	830	.18*	290	.06
SBR	0	0	120		10	
EBL	2	3500	30	.01	140	.04
EBT	3	5250	1000	.28*	1440	.37*
EBR	0	0	470		520	
WBL	1	1750	1100	.63*	630	.36*
WBT	3	5250	1320	.25	1220	.23
WBR	1	1750	0	.00	160	.09
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.31**		**1.29**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	210	.06*	430	.12
NBT	2	3500	180	.10	890	.51*
NBR	0	0	260	.15	1090	.62
SBL	1	1750	60	.03	10	.01*
SBT	3	5250	770	.16*	160	.03
SBR	0	0	90		20	
EBL	2	3500	50	.01	240	.07
EBT	3	5250	860	.25*	1560	.35*
EBR	0	0	460	.26	300	
WBL	1	1750	1000	.57*	450	.26*
WBT	3	5250	1460	.28	1190	.23
WBR	1	1750	10	.01	80	.05
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**1.14**		**1.23**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	420	.12*	480	.14
NBT	1.5	5250	400	{.11}	790	{.33}*
NBR	1.5		400		1200	
SBL	1	1750	120	.07	10	.01*
SBT	3	5250	830	.18*	290	.06
SBR	0	0	120		10	
EBL	2	3500	30	.01	140	.04
EBT	3	5250	1000	.28*	1440	.37*
EBR	0	0	470		520	
WBL	2	3500	1100	.31*	630	.18*
WBT	3	5250	1320	.25	1220	.26
WBR	0	0	0		160	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.99**		**.99**

17. Sierra Highway & Newhall

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	210	.06*	430	.12
NBT	1.5	5250	180	{.05}	890	{.34}*
NBR	1.5		260		1090	
SBL	1	1750	60	.03	10	.01*
SBT	3	5250	770	.16*	160	.03
SBR	0	0	90		20	
EBL	2	3500	50	.01	240	.07
EBT	3	5250	860	.25*	1560	.35*
EBR	0	0	460	.26	300	
WBL	2	3500	1000	.29*	450	.13*
WBT	3	5250	1460	.28	1190	.24
WBR	0	0	10		80	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.86**		**.93**

18. Whites Canyon & Soledad Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	297	.08*	284	.08
NBT	2	3500	468	.13	863	.25*
NBR	1	1750	87	.05	17	.01
SBL	2	3500	443	.13	497	.14*
SBT	2	3500	815	.23*	496	.14
SBR	1	1750	383	.22	196	.11
EBL	2	3500	165	.05*	381	.11
EBT	3	5250	611	.15	1461	.33*
EBR	0	0	184		263	
WBL	2	3500	101	.03	138	.04*
WBT	3	5250	1357	.34*	850	.24
WBR	0	0	438		449	.26
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.86**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	400	.11*	350	.10
NBT	2	3500	650	.19	1170	.33*
NBR	1	1750	110	.06	560	.32
SBL	2	3500	560	.16	320	.09*
SBT	2	3500	1280	.37*	1120	.32
SBR	1	1750	200	.11	240	.14
EBL	2	3500	90	.03*	430	.12
EBT	3	5250	640	.14	1400	.34*
EBR	0	0	120		370	
WBL	2	3500	510	.15	200	.06*
WBT	3	5250	1250	.28*	740	.21
WBR	0	0	240		420	.24
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.89**		**.92**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	430	.12*	400	.11
NBT	2	3500	560	.16	1160	.33*
NBR	1	1750	140	.08	500	.29
SBL	2	3500	590	.17	310	.09*
SBT	2	3500	1110	.32*	1070	.31
SBR	1	1750	230	.13	260	.15
EBL	2	3500	100	.03	460	.13
EBT	3	5250	730	.16*	1300	.33*
EBR	0	0	130		430	
WBL	2	3500	570	.16*	210	.06*
WBT	3	5250	1140	.26	820	.23
WBR	0	0	220		460	.26
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.86**		**.91**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	400	.11*	350	.10
NBT	3	5250	650	.14	1170	.33*
NBR	0	0	110		560	
SBL	2	3500	560	.16	320	.09*
SBT	3	5250	1280	.28*	1120	.26
SBR	0	0	200		240	
EBL	2	3500	90	.03*	430	.12
EBT	3	5250	640	.14	1400	.34*
EBR	0	0	120		370	
WBL	2	3500	510	.15	200	.06*
WBT	3	5250	1250	.28*	740	.21
WBR	0	0	240		420	.24
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.92**

18. Whites Canyon & Soledad Canyon

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	430	.12*	400	.11
NBT	3	5250	560	.13	1160	.32*
NBR	0	0	140		500	
SBL	2	3500	590	.17	310	.09*
SBT	3	5250	1110	.26*	1070	.25
SBR	0	0	230		260	
EBL	2	3500	100	.03	460	.13
EBT	3	5250	730	.16*	1300	.33*
EBR	0	0	130		430	
WBL	2	3500	570	.16*	210	.06*
WBT	3	5250	1140	.26	820	.23
WBR	0	0	220		460	.26
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.80**		**.90**

19. Sierra Highway & Soledad Canyon

Existing Counts

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	385	.11*	624	.18*
NBT	2	3500	202	.06	468	.13
NBR	1	1750	153	.09	270	.15
SBL	1	1750	42	.02	124	.07
SBT	2	3500	476	.14*	379	.11*
SBR	1	1750	402	.23	326	.19
EBL	2	3500	193	.06*	504	.14
EBT	2	3500	649	.19	1045	.30*
EBR	1	1750	422	.24	468	.27
WBL	2	3500	284	.08	236	.07*
WBT	3	5250	1122	.22*	597	.12
WBR	0	0	25		42	
Right Turn Adjustment			SBR	.04*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.67**		**.76**

Current GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	180	.05	150	.04
NBT	2	3500	890	.25*	1190	.34*
NBR	1	1750	80	.05	250	.14
SBL	1	1750	240	.14*	630	.36*
SBT	2	3500	1130	.32	1080	.31
SBR	1	1750	650	.37	580	.33
EBL	2	3500	500	.14*	640	.18
EBT	2	3500	730	.21	1320	.38*
EBR	1	1750	120	.07	120	.07
WBL	2	3500	320	.09	160	.05*
WBT	3	5250	1140	.27*	540	.15
WBR	0	0	260		340	.19
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.90**		**1.23**

OVOV GP - Existing Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	160	.05	190	.05
NBT	2	3500	810	.23*	960	.27*
NBR	1	1750	100	.06	240	.14
SBL	1	1750	300	.17*	620	.35*
SBT	2	3500	930	.27	1010	.29
SBR	1	1750	850	.49	630	.36
EBL	2	3500	550	.16*	740	.21*
EBT	2	3500	780	.22	990	.28
EBR	1	1750	110	.06	120	.07
WBL	2	3500	280	.08	220	.06
WBT	3	5250	790	.18*	610	.17*
WBR	0	0	180		390	.22
Right Turn Adjustment			SBR	.02*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.86**		**1.10**

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	180	.05*	150	.04
NBT	3	5250	890	.18	1190	.27*
NBR	0	0	80		250	
SBL	2	3500	240	.07	630	.18*
SBT	3	5250	1130	.32*	1080	.31
SBR	0	0	650	.37	580	.33
EBL	2	3500	500	.14*	640	.18*
EBT	3	5250	730	.16	1320	.27
EBR	0	0	120		120	
WBL	2	3500	320	.09	160	.05
WBT	3	5250	1140	.27*	540	.15*
WBR	0	0	260		340	.19
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.88**		**.88**

19. Sierra Highway & Soledad Canyon

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	160	.05*	190	.05
NBT	3	5250	810	.17	960	.23*
NBR	0	0	100		240	
SBL	2	3500	300	.09	620	.18*
SBT	3	5250	930	.27*	1010	.29
SBR	0	0	850	.49	630	.36
EBL	2	3500	550	.16*	740	.21*
EBT	3	5250	780	.17	990	.21
EBR	0	0	110		120	
WBL	2	3500	280	.08	220	.06
WBT	3	5250	790	.18*	610	.17*
WBR	0	0	180		390	.22
Right Turn Adjustment			SBR	.10*		
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.86**		**.89**

20. Commerce Center & Magic Mountain

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	0	0	0		0	
NBR	0	0	0		0	
SBL	2	2880	840	.29*	1110	.39*
SBT	0	0	0		0	
SBR	1	1600	110	.07	650	.41
EBL	2	2880	650	.23*	220	.08*
EBT	3	4800	900	.19	1010	.21
EBR	0	0	0		0	
WBL	0	0	0		0	
WBT	3	4800	680	.14*	800	.17*
WBR	f		1040		1310	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.76**		**.74**

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	0	0	0		0	
NBT	0	0	0		0	
NBR	0	0	0		0	
SBL	2	2880	860	.30*	1190	.41*
SBT	0	0	0		0	
SBR	1	1600	110	.07	600	.38
EBL	2	2880	620	.22*	220	.08*
EBT	3	4800	960	.20	960	.20
EBR	0	0	0		0	
WBL	0	0	0		0	
WBT	3	4800	670	.14*	840	.18*
WBR	f		980		1350	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.76**		**.77**

21. Pico Canyon & Valencia

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	750	.26*	910	.32*
NBT	0	0	0		0	
NBR	1	1600	20	.01	10	.01
SBL	0	0	0		0	
SBT	0	0	0		0	
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	3	4800	1720	.48*	1160	.36*
EBR	0	0	590		1270	.79
WBL	1	1600	10	.01*	20	.01*
WBT	3	4800	880	.18	1590	.33
WBR	0	0	0		0	
Right Turn Adjustment					EBR	.19*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.85**		**.98**

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	2880	530	.18*	800	.28*
NBT	0	0	0		0	
NBR	1	1600	20	.01	10	.01
SBL	0	0	0		0	
SBT	0	0	0		0	
SBR	0	0	0		0	
EBL	0	0	0		0	
EBT	3	4800	1780	.46*	1300	.41*
EBR	0	0	430		990	.62
WBL	1	1600	10	.01*	30	.02*
WBT	3	4800	850	.18	1640	.34
WBR	0	0	0		0	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.75**		**.81**

22. Magic Mountain & Via Princessa

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	30	.02	20	.01
NBT	1	1750	40	.02*	30	.02*
NBR	1	1750	60	.03	30	.02
SBL	2	3500	380	.11*	1310	.37*
SBT	1	1750	10	.01	60	.03
SBR	1	1750	260	.15	400	.23
EBL	1	1750	250	.14*	270	.15*
EBT	3	5250	880	.17	1110	.22
EBR	0	0	10		40	
WBL	1	1750	20	.01	50	.03
WBT	3	5250	1030	.20*	860	.16*
WBR	f		1250		1100	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.57**		**.80**

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	1	1750	130	.07	60	.03
NBT	1	1750	180	.10*	80	.05*
NBR	1	1750	140	.08	80	.05
SBL	2	3500	290	.08*	1140	.33*
SBT	1	1750	30	.02	210	.12
SBR	1	1750	260	.15	420	.24
EBL	1	1750	250	.14*	290	.17*
EBT	3	5250	810	.16	1040	.22
EBR	0	0	20		120	
WBL	1	1750	50	.03	120	.07
WBT	3	5250	1020	.19*	860	.16*
WBR	f		1110		740	
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.61**		**.81**

23. Golden Valley & Via Princessa

Current GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	620	.18*	990	.28*
NBT	3	5250	1340	.26	1170	.22
NBR	1	1750	30	.02	100	.06
SBL	2	3500	60	.02	610	.17
SBT	3	5250	620	.12*	1080	.21*
SBR	1	1750	570	.33	570	.33
EBL	2	3500	600	.17*	400	.11
EBT	3	5250	320	.06	1110	.21*
EBR	2	3500	800	.23	1260	.36
WBL	2	3500	210	.06	50	.01*
WBT	3	5250	1370	.26*	460	.09
WBR	1	1750	280	.16	70	.04
Right Turn Adjustment			SBR	.08*	SBR	.02*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.91**		**.83**

OVOV GP - Buildout Lanes

	LANES	CAPACITY	AM PK HOUR VOL	AM PK HOUR V/C	PM PK HOUR VOL	PM PK HOUR V/C
NBL	2	3500	550	.16	770	.22*
NBT	3	5250	1300	.25*	870	.17
NBR	1	1750	40	.02	60	.03
SBL	2	3500	100	.03*	510	.15
SBT	3	5250	320	.06	920	.18*
SBR	1	1750	590	.34	540	.31
EBL	2	3500	500	.14*	320	.09
EBT	3	5250	410	.08	1130	.22*
EBR	2	3500	590	.17	1240	.35
WBL	2	3500	140	.04	50	.01*
WBT	3	5250	1310	.25*	550	.10
WBR	1	1750	200	.11	100	.06
Right Turn Adjustment			SBR	.11*	SBR	.03*
Clearance Interval				.10*		.10*
TOTAL CAPACITY UTILIZATION				**.88**		**.76**

Appendix B

LAND USE AND TRIP GENERATION COMPARISON

1. 2004 and OVOV Buildout Plan
2. Current City General Plan/County Area Plan and OVOV Buildout Plan

See Appendix D for Traffic Analysis Zone (TAZ) map and trip generation rates.

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
1	1 SF Residential	DU	345.00	3,416	567.00	5,613	222.00	2,197
	5 Industrial Park	TSF	--	--	275.00	1,650	275.00	1,650
	SUB-TOTAL			3,416		7,263		3,847
2	1 SF Residential	DU	336.00	3,326	535.00	5,297	199.00	1,971
	SUB-TOTAL			3,326		5,297		1,971
3	1 SF Residential	DU	641.00	6,346	3,313.00	32,799	2,672.00	26,453
	2 MF Residential	DU	--	--	1,288.00	9,600	1,288.00	9,600
	3 Commercial Retail	TSF	150.00	8,109	320.00	17,299	170.00	9,190
	5 Industrial Park	TSF	77.49	395	334.29	1,936	256.80	1,541
	6 Other	--	--	885	--	1,088	--	203
	SUB-TOTAL			15,735		62,722		46,987
5	1 SF Residential	DU	1.00	10	229.00	2,267	228.00	2,257
	3 Commercial Retail	TSF	2.01	74	27.01	2,201	25.00	2,127
	SUB-TOTAL			84		4,468		4,384
6	1 SF Residential	DU	10.00	99	409.00	4,049	399.00	3,950
	SUB-TOTAL			99		4,049		3,950
7	1 SF Residential	DU	--	--	722.00	7,148	722.00	7,148
	SUB-TOTAL			--		7,148		7,148
8	1 SF Residential	DU	10.00	99	97.00	960	87.00	861
	SUB-TOTAL			99		960		861
9	1 SF Residential	DU	1.00	10	320.00	3,168	319.00	3,158
	SUB-TOTAL			10		3,168		3,158
10	1 SF Residential	DU	12.00	119	12.00	119	0.00	0
	2 MF Residential	DU	184.00	1,472	184.00	1,472	0.00	0
	3 Commercial Retail	TSF	33.64	1,348	300.00	12,018	266.36	10,670
	SUB-TOTAL			2,939		13,609		10,670
11	1 SF Residential	DU	23.00	228	108.00	1,070	85.00	842
	2 MF Residential	DU	138.00	1,104	237.00	1,817	99.00	713
	3 Commercial Retail	TSF	29.67	2,756	62.97	5,589	33.30	2,833
	4 Commercial Office	TSF	1.23	14	1.23	14	0.00	0
	5 Industrial Park	TSF	--	--	41.82	251	41.82	251
	6 Other	--		--	--	5	--	5
	SUB-TOTAL			4,102		8,746		4,644
12	1 SF Residential	DU	213.00	2,109	252.00	2,495	39.00	386
	6 Other	--		--	--	996	--	996
	SUB-TOTAL			2,109		3,491		1,382
13	1 SF Residential	DU	464.00	4,594	641.00	6,346	177.00	1,752
	2 MF Residential	DU	54.00	432	54.00	432	0.00	0
	3 Commercial Retail	TSF	--	--	25.00	2,127	25.00	2,127
	SUB-TOTAL			5,026		8,905		3,879

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
14	1 SF Residential	DU	19.00	188	117.00	1,158	98.00	970
	SUB-TOTAL			188		1,158		970
15	1 SF Residential	DU	78.00	772	370.00	3,663	292.00	2,891
	SUB-TOTAL			772		3,663		2,891
16	1 SF Residential	DU	--	--	291.00	2,881	291.00	2,881
	SUB-TOTAL			--		2,881		2,881
17	1 SF Residential	DU	146.00	1,445	380.00	3,762	234.00	2,317
	SUB-TOTAL			1,445		3,762		2,317
18	1 SF Residential	DU	188.00	1,523	568.00	5,285	380.00	3,762
	2 MF Residential	DU	--	--	109.00	872	109.00	872
	3 Commercial Retail	TSF	--	--	21.00	1,786	21.00	1,786
	6 Other	--		--	--	18	--	18
	SUB-TOTAL			1,523		7,961		6,438
19	1 SF Residential	DU	1,306.00	12,929	1,577.00	15,612	271.00	2,683
	6 Other	--	--	2,828	--	4,022	--	1,194
	SUB-TOTAL			15,757		19,634		3,877
20	1 SF Residential	DU	245.00	2,426	245.00	2,426	0.00	0
	2 MF Residential	DU	136.00	1,088	136.00	1,088	0.00	0
	5 Industrial Park	TSF	50.00	300	174.00	1,044	124.00	744
	SUB-TOTAL			3,814		4,558		744
21	1 SF Residential	DU	620.00	6,138	655.00	6,485	35.00	347
	3 Commercial Retail	TSF	--	--	70.00	5,954	70.00	5,954
	SUB-TOTAL			6,138		12,439		6,301
22	1 SF Residential	DU	350.00	3,465	350.00	3,465	0.00	0
	SUB-TOTAL			3,465		3,465		0
23	1 SF Residential	DU	--	--	373.00	3,693	373.00	3,693
	SUB-TOTAL			--		3,693		3,693
24	1 SF Residential	DU	--	--	422.00	4,178	422.00	4,178
	SUB-TOTAL			--		4,178		4,178
25	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			--		1,088		1,088
26	3 Commercial Retail	TSF	--	--	72.90	2,702	72.90	2,702
	SUB-TOTAL			--		2,702		2,702
27	2 MF Residential	DU	--	--	256.00	1,766	256.00	1,766
	SUB-TOTAL			--		1,766		1,766

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
28	1 SF Residential	DU	91.00	901	1,077.00	10,662	986.00	9,761
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			901		11,750		10,849
29	6 Other	--		--	--	52	--	52
	SUB-TOTAL			--		52		52
30	2 MF Residential	DU	--	--	275.00	2,200	275.00	2,200
	SUB-TOTAL			--		2,200		2,200
31	1 SF Residential	DU	--	--	65.00	644	65.00	644
	2 MF Residential	DU	--	--	200.00	1,600	200.00	1,600
	6 Other	--	--	1,160	--	1,740	--	580
	SUB-TOTAL			1,160		3,984		2,824
32	2 MF Residential	DU	--	--	94.00	752	94.00	752
	SUB-TOTAL			--		752		752
33	3 Commercial Retail	TSF	--	--	61.00	5,189	61.00	5,189
	SUB-TOTAL			--		5,189		5,189
34	3 Commercial Retail	TSF	--	--	107.10	5,790	107.10	5,790
	SUB-TOTAL			--		5,790		5,790
35	1 SF Residential	DU	--	--	616.00	6,098	616.00	6,098
	2 MF Residential	DU	--	--	260.00	1,860	260.00	1,860
	SUB-TOTAL			--		7,958		7,958
36	1 SF Residential	DU	190.00	1,881	190.00	1,881	0.00	0
	2 MF Residential	DU	268.00	2,144	268.00	2,144	0.00	0
	SUB-TOTAL			4,025		4,025		0
37	1 SF Residential	DU	212.00	2,099	212.00	2,099	0.00	0
	2 MF Residential	DU	128.00	1,024	128.00	1,024	0.00	0
	6 Other	--	--	186	--	186	--	0
	SUB-TOTAL			3,309		3,309		0
38	2 MF Residential	DU	--	--	331.00	2,399	331.00	2,399
	3 Commercial Retail	TSF	--	--	50.00	4,253	50.00	4,253
	SUB-TOTAL			--		6,652		6,652
39	3 Commercial Retail	TSF	--	--	150.40	8,131	150.40	8,131
	5 Industrial Park	TSF	35.40	212	4,000.00	24,000	3,964.60	23,788
	SUB-TOTAL			212		32,131		31,919
40	3 Commercial Retail	TSF	--	--	200.00	10,812	200.00	10,812
	4 Commercial Office	TSF	--	--	116.70	1,190	116.70	1,190
	6 Other	--	--	24	--	24	--	0
	SUB-TOTAL			24		12,026		12,002

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
41	4 Commercial Office	TSF	--	--	177.60	2,053	177.60	2,053
	5 Industrial Park	TSF	91.90	551	685.94	4,116	594.04	3,565
	SUB-TOTAL			551		6,169		5,618
42	4 Commercial Office	TSF	--	--	696.85	8,056	696.85	8,056
	SUB-TOTAL			--		8,056		8,056
43	3 Commercial Retail	TSF	--	--	27.00	1,001	27.00	1,001
	4 Commercial Office	TSF	--	--	100.75	1,165	100.75	1,165
	SUB-TOTAL			--		2,166		2,166
44	1 SF Residential	DU	445.00	4,406	445.00	4,406	0.00	0
	3 Commercial Retail	TSF	10.00	371	35.00	2,498	25.00	2,127
	6 Other	--	--	725	--	1,450	--	725
	SUB-TOTAL			5,502		8,354		2,852
45	4 Commercial Office	TSF	--	--	464.94	5,375	464.94	5,375
	5 Industrial Park	TSF	--	--	1,215.00	7,290	1,215.00	7,290
	SUB-TOTAL			--		12,665		12,665
46	3 Commercial Retail	TSF	77.00	2,854	77.00	2,854	0.00	0
	5 Industrial Park	TSF	161.65	970	445.80	2,675	284.15	1,705
	SUB-TOTAL			3,824		5,529		1,705
47	5 Industrial Park	TSF	2,403.65	14,422	4,254.10	25,525	1,850.45	11,103
	SUB-TOTAL			14,422		25,525		11,103
48	5 Industrial Park	TSF	--	--	720.00	4,320	720.00	4,320
	SUB-TOTAL			--		4,320		4,320
49	5 Industrial Park	TSF	600.20	3,601	764.30	4,586	164.10	985
	SUB-TOTAL			3,601		4,586		985
50	1 SF Residential	DU	100.00	990	350.00	3,465	250.00	2,475
	6 Other	--	--	1,000	--	2,000	--	1,000
	SUB-TOTAL			1,990		5,465		3,475
51	5 Industrial Park	TSF	--	--	1,221.36	7,328	1,221.36	7,328
	SUB-TOTAL			--		7,328		7,328
52	1 SF Residential	DU	10.00	99	100.00	990	90.00	891
	SUB-TOTAL			99		990		891
53	1 SF Residential	DU	--	--	35.00	347	35.00	347
	SUB-TOTAL			--		347		347

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
54	1 SF Residential	DU	--	--	62.00	614	62.00	614
	2 MF Residential	DU	--	--	589.00	4,712	589.00	4,712
	SUB-TOTAL			--		5,326		5,326
55	1 SF Residential	DU	--	--	164.00	1,624	164.00	1,624
	2 MF Residential	DU	--	--	922.00	7,376	922.00	7,376
	6 Other	--		--	--	15	--	15
	SUB-TOTAL			--		9,015		9,015
56	1 SF Residential	DU	--	--	19.00	188	19.00	188
	2 MF Residential	DU	--	--	23.00	184	23.00	184
	SUB-TOTAL			--		372		372
57	3 Commercial Retail	TSF	--	--	55.40	4,712	55.40	4,712
	4 Commercial Office	TSF	--	--	1,274.60	13,144	1,274.60	13,144
	SUB-TOTAL			--		17,856		17,856
58	5 Industrial Park	TSF	850.20	5,101	1,123.00	6,738	272.80	1,637
	SUB-TOTAL			5,101		6,738		1,637
59	5 Industrial Park	TSF	764.00	3,820	764.00	3,820	0.00	0
	SUB-TOTAL			3,820		3,820		0
60	3 Commercial Retail	TSF	--	--	34.80	1,290	34.80	1,290
	4 Commercial Office	TSF	--	--	27.20	314	27.20	314
	5 Industrial Park	TSF	--	--	160.50	963	160.50	963
	SUB-TOTAL			--		2,567		2,567
61	4 Commercial Office	TSF	--	--	48.80	564	48.80	564
	5 Industrial Park	TSF	--	--	825.65	4,954	825.65	4,954
	SUB-TOTAL			--		5,518		5,518
62	3 Commercial Retail	TSF	--	--	19.50	723	19.50	723
	5 Industrial Park	TSF	--	--	430.64	2,584	430.64	2,584
	SUB-TOTAL			--		3,307		3,307
63	5 Industrial Park	TSF	250.02	1,500	575.00	3,450	324.98	1,950
	6 Other	--		--	--	2,444	--	2,444
	SUB-TOTAL			1,500		5,894		4,394
64	5 Industrial Park	TSF	2,742.00	16,452	3,161.48	18,969	419.48	2,517
	SUB-TOTAL			16,452		18,969		2,517
65	3 Commercial Retail	TSF	--	--	155.00	8,379	155.00	8,379
	5 Industrial Park	TSF	329.00	1,974	329.00	1,974	0.00	0
	SUB-TOTAL			1,974		10,353		8,379

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
66	3 Commercial Retail	TSF	102.60	5,547	170.45	9,215	67.85	3,668
	5 Industrial Park	TSF	329.00	1,974	329.00	1,974	0.00	0
	SUB-TOTAL			7,521		11,189		3,668
67	1 SF Residential	DU	--	--	163.00	1,614	163.00	1,614
	2 MF Residential	DU	--	--	90.00	720	90.00	720
	SUB-TOTAL			--		2,334		2,334
68	2 MF Residential	DU	156.00	1,076	208.00	1,435	52.00	359
	SUB-TOTAL			1,076		1,435		359
69	1 SF Residential	DU	--	--	76.00	752	76.00	752
	SUB-TOTAL			--		752		752
70	3 Commercial Retail	TSF	67.00	3,622	147.00	7,947	80.00	4,325
	5 Industrial Park	TSF	472.00	2,765	604.00	3,557	132.00	792
	6 Other	--	--	3,518	--	3,518	--	0
	SUB-TOTAL			9,905		15,022		5,117
71	6 Other	--	--	4,475	--	4,475	--	0
	SUB-TOTAL			4,475		4,475		0
72	3 Commercial Retail	TSF	--	--	60.00	2,224	60.00	2,224
	6 Other	--	--	508	--	508	--	0
	SUB-TOTAL			508		2,732		2,224
74	1 SF Residential	DU	--	--	153.00	1,515	153.00	1,515
	2 MF Residential	DU	--	--	147.00	1,176	147.00	1,176
	SUB-TOTAL			--		2,691		2,691
75	2 MF Residential	DU	--	--	149.00	1,192	149.00	1,192
	6 Other	--		--	--	46	--	46
	SUB-TOTAL			--		1,238		1,238
76	2 MF Residential	DU	--	--	188.00	1,297	188.00	1,297
	3 Commercial Retail	TSF	--	--	11.00	936	11.00	936
	SUB-TOTAL			--		2,233		2,233
78	5 Industrial Park	TSF	1,615.00	9,690	1,776.00	10,656	161.00	966
	SUB-TOTAL			9,690		10,656		966
79	5 Industrial Park	TSF	685.00	4,110	685.00	4,110	0.00	0
	SUB-TOTAL			4,110		4,110		0
80	5 Industrial Park	TSF	828.00	4,968	880.00	5,280	52.00	312
	SUB-TOTAL			4,968		5,280		312
81	5 Industrial Park	TSF	711.00	4,266	711.00	4,266	0.00	0
	SUB-TOTAL			4,266		4,266		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
82	5 Industrial Park	TSF	714.00	4,284	1,007.55	6,045	293.55	1,761
	SUB-TOTAL			4,284		6,045		1,761
83	5 Industrial Park	TSF	876.00	5,256	876.00	5,256	0.00	0
	SUB-TOTAL			5,256		5,256		0
84	5 Industrial Park	TSF	333.00	1,998	333.00	1,998	0.00	0
	SUB-TOTAL			1,998		1,998		0
86	3 Commercial Retail	TSF	62.26	7,436	82.76	8,196	20.50	760
	6 Other	--	--	296	--	296	--	0
	SUB-TOTAL			7,732		8,492		760
89	6 Other	--	--	2,000	--	3,000	--	1,000
	SUB-TOTAL			2,000		3,000		1,000
90	2 MF Residential	DU	--	--	360.00	2,880	360.00	2,880
	3 Commercial Retail	TSF	--	--	1,305.35	57,648	1,305.35	57,648
	5 Industrial Park	TSF	63.88	383	163.88	983	100.00	600
	SUB-TOTAL			383		61,511		61,128
91	3 Commercial Retail	TSF	43.38	2,345	247.38	13,373	204.00	11,028
	SUB-TOTAL			2,345		13,373		11,028
92	2 MF Residential	DU	--	--	1,333.00	10,664	1,333.00	10,664
	3 Commercial Retail	TSF	--	--	618.00	24,757	618.00	24,757
	4 Commercial Office	TSF	--	--	629.00	7,271	629.00	7,271
	6 Other	--		--	--	2,469	--	2,469
	SUB-TOTAL			--		45,161		45,161
93	3 Commercial Retail	TSF	11.00	408	20.00	741	9.00	333
	6 Other	--	--	1,391	--	1,391	--	0
	SUB-TOTAL			1,799		2,132		333
94	6 Other	--	--	16,000	--	24,000	--	8,000
	SUB-TOTAL			16,000		24,000		8,000
96	1 SF Residential	DU	--	--	123.00	1,218	123.00	1,218
	2 MF Residential	DU	--	--	881.00	7,048	881.00	7,048
	SUB-TOTAL			--		8,266		8,266
97	6 Other	--	--	2,620	--	2,620	--	0
	SUB-TOTAL			2,620		2,620		0
98	3 Commercial Retail	TSF	--	--	6.20	527	6.20	527
	4 Commercial Office	TSF	--	--	691.50	7,053	691.50	7,053
	SUB-TOTAL			--		7,580		7,580

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
99	2 MF Residential	DU	--	--	470.00	3,760	470.00	3,760
	6 Other	--		--	--	53	--	53
	SUB-TOTAL			--		3,813		3,813
100	3 Commercial Retail	TSF	--	--	23.00	1,956	23.00	1,956
	4 Commercial Office	TSF	--	--	220.00	2,543	220.00	2,543
	SUB-TOTAL			--		4,499		4,499
101	3 Commercial Retail	TSF	--	--	491.60	19,693	491.60	19,693
	SUB-TOTAL			--		19,693		19,693
102	1 SF Residential	DU	--	--	38.00	376	38.00	376
	2 MF Residential	DU	--	--	460.00	3,510	460.00	3,510
	3 Commercial Retail	TSF	--	--	10.50	893	10.50	893
	4 Commercial Office	TSF	--	--	9.50	110	9.50	110
	SUB-TOTAL			--		4,889		4,889
103	1 SF Residential	DU	--	--	95.00	940	95.00	940
	2 MF Residential	DU	--	--	169.00	1,352	169.00	1,352
	3 Commercial Retail	TSF	--	--	48.00	3,627	48.00	3,627
	6 Other	--		--	--	1,130	--	1,130
	SUB-TOTAL			--		7,049		7,049
104	1 SF Residential	DU	--	--	175.00	1,732	175.00	1,732
	2 MF Residential	DU	--	--	363.00	2,737	363.00	2,737
	3 Commercial Retail	TSF	--	--	252.00	13,623	252.00	13,623
	4 Commercial Office	TSF	--	--	370.00	4,277	370.00	4,277
	SUB-TOTAL			--		22,369		22,369
105	2 MF Residential	DU	--	--	144.00	994	144.00	994
	3 Commercial Retail	TSF	--	--	27.10	2,305	27.10	2,305
	4 Commercial Office	TSF	--	--	315.90	3,652	315.90	3,652
	SUB-TOTAL			--		6,951		6,951
106	2 MF Residential	DU	--	--	520.00	3,588	520.00	3,588
	SUB-TOTAL			--		3,588		3,588
107	1 SF Residential	DU	--	--	461.00	4,564	461.00	4,564
	2 MF Residential	DU	--	--	326.00	2,608	326.00	2,608
	6 Other	--		--	--	6,268	--	6,268
	SUB-TOTAL			--		13,440		13,440
108	2 MF Residential	DU	--	--	2,189.00	17,512	2,189.00	17,512
	6 Other	--		--	--	1,111	--	1,111
	SUB-TOTAL			--		18,623		18,623
109	1 SF Residential	DU	--	--	38.00	376	38.00	376
	SUB-TOTAL			--		376		376

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
110	1 SF Residential	DU	--	--	184.00	1,822	184.00	1,822
	2 MF Residential	DU	--	--	548.00	4,384	548.00	4,384
	6 Other	--		--	--	1,112	--	1,112
	SUB-TOTAL			--		7,318		7,318
111	6 Other	--		--	--	238	--	238
	SUB-TOTAL			--		238		238
112	1 SF Residential	DU	--	--	246.00	2,435	246.00	2,435
	6 Other	--		--	--	1,433	--	1,433
	SUB-TOTAL			--		3,868		3,868
113	2 MF Residential	DU	--	--	354.00	2,832	354.00	2,832
	SUB-TOTAL			--		2,832		2,832
114	2 MF Residential	DU	--	--	560.00	4,480	560.00	4,480
	SUB-TOTAL			--		4,480		4,480
115	1 SF Residential	DU	--	--	603.00	5,970	603.00	5,970
	SUB-TOTAL			--		5,970		5,970
116	2 MF Residential	DU	--	--	1,262.00	10,096	1,262.00	10,096
	3 Commercial Retail	TSF	--	--	628.50	25,178	628.50	25,178
	SUB-TOTAL			--		35,274		35,274
117	2 MF Residential	DU	--	--	1,261.00	10,088	1,261.00	10,088
	3 Commercial Retail	TSF	--	--	628.50	25,178	628.50	25,178
	SUB-TOTAL			--		35,266		35,266
118	2 MF Residential	DU	--	--	161.00	1,288	161.00	1,288
	SUB-TOTAL			--		1,288		1,288
119	2 MF Residential	DU	--	--	1,679.00	11,585	1,679.00	11,585
	SUB-TOTAL			--		11,585		11,585
120	2 MF Residential	DU	--	--	2,425.00	19,400	2,425.00	19,400
	3 Commercial Retail	TSF	--	--	283.30	15,043	283.30	15,043
	4 Commercial Office	TSF	--	--	75.00	867	75.00	867
	6 Other	--		--	--	1,110	--	1,110
	SUB-TOTAL			--		36,420		36,420
121	1 SF Residential	DU	--	--	168.00	1,663	168.00	1,663
	2 MF Residential	DU	--	--	418.00	3,344	418.00	3,344
	SUB-TOTAL			--		5,007		5,007
122	2 MF Residential	DU	--	--	176.00	1,408	176.00	1,408
	SUB-TOTAL			--		1,408		1,408

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
123	1 SF Residential	DU	--	--	452.00	4,475	452.00	4,475
	2 MF Residential	DU	--	--	272.00	2,176	272.00	2,176
	3 Commercial Retail	TSF	--	--	17.20	637	17.20	637
	SUB-TOTAL			--		7,288		7,288
124	2 MF Residential	DU	--	--	1,343.00	4,983	1,343.00	4,983
	SUB-TOTAL			--		4,983		4,983
125	6 Other	--		--	--	6,215	--	6,215
	SUB-TOTAL			--		6,215		6,215
126	3 Commercial Retail	TSF	--	--	150.00	8,109	150.00	8,109
	4 Commercial Office	TSF	--	--	336.00	3,884	336.00	3,884
	SUB-TOTAL			--		11,993		11,993
127	2 MF Residential	DU	--	--	888.00	7,104	888.00	7,104
	SUB-TOTAL			--		7,104		7,104
128	1 SF Residential	DU	--	--	450.00	4,455	450.00	4,455
	SUB-TOTAL			--		4,455		4,455
129	1 SF Residential	DU	--	--	177.00	1,752	177.00	1,752
	SUB-TOTAL			--		1,752		1,752
130	1 SF Residential	DU	708.00	7,009	708.00	7,009	0.00	0
	SUB-TOTAL			7,009		7,009		0
131	1 SF Residential	DU	--	--	14.00	139	14.00	139
	2 MF Residential	DU	--	--	1,273.00	10,184	1,273.00	10,184
	6 Other	--		--	--	249	--	249
	SUB-TOTAL			--		10,572		10,572
132	1 SF Residential	DU	436.00	4,316	436.00	4,316	0.00	0
	6 Other	--	--	1,130	--	1,130	--	0
	SUB-TOTAL			5,446		5,446		0
133	3 Commercial Retail	TSF	27.00	1,460	27.00	1,460	0.00	0
	SUB-TOTAL			1,460		1,460		0
134	1 SF Residential	DU	482.00	4,772	482.00	4,772	0.00	0
	SUB-TOTAL			4,772		4,772		0
135	1 SF Residential	DU	20.00	198	174.00	1,723	154.00	1,525
	2 MF Residential	DU	172.00	1,376	172.00	1,376	0.00	0
	6 Other	--	--	1,656	--	1,656	--	0
	SUB-TOTAL			3,230		4,755		1,525
137	4 Commercial Office	TSF	--	--	72.00	832	72.00	832
	SUB-TOTAL			--		832		832

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
138	3 Commercial Retail	TSF	100.00	5,406	120.00	6,487	20.00	1,081
	SUB-TOTAL			5,406		6,487		1,081
139	2 MF Residential	DU	96.00	662	474.00	3,271	378.00	2,609
	SUB-TOTAL			662		3,271		2,609
140	1 SF Residential	DU	--	--	428.00	4,237	428.00	4,237
	2 MF Residential	DU	--	--	1,266.00	10,128	1,266.00	10,128
	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	4 Commercial Office	TSF	--	--	31.00	358	31.00	358
	6 Other	--		--	--	593	--	593
	SUB-TOTAL			--		17,017		17,017
141	3 Commercial Retail	TSF	30.40	7,657	30.40	7,657	0.00	0
	4 Commercial Office	TSF	--	--	50.00	578	50.00	578
	SUB-TOTAL			7,657		8,235		578
142	2 MF Residential	DU	--	--	670.00	5,360	670.00	5,360
	SUB-TOTAL			--		5,360		5,360
143	1 SF Residential	DU	484.00	4,791	578.00	5,722	94.00	931
	2 MF Residential	DU	80.00	640	160.00	1,280	80.00	640
	6 Other	--		--	--	2,846	--	2,846
	SUB-TOTAL			5,431		9,848		4,417
144	1 SF Residential	DU	--	--	6.00	59	6.00	59
	SUB-TOTAL			--		59		59
145	3 Commercial Retail	TSF	874.22	40,255	874.22	40,255	0.00	0
	5 Industrial Park	TSF	74.50	380	74.50	380	0.00	0
	SUB-TOTAL			40,635		40,635		0
146	1 SF Residential	DU	314.00	3,109	314.00	3,109	0.00	0
	2 MF Residential	DU	296.00	2,368	296.00	2,368	0.00	0
	SUB-TOTAL			5,477		5,477		0
147	1 SF Residential	DU	46.00	455	140.00	1,386	94.00	931
	2 MF Residential	DU	--	--	667.00	4,712	667.00	4,712
	6 Other	--	--	1,088	--	1,101	--	13
	SUB-TOTAL			1,543		7,199		5,656
148	3 Commercial Retail	TSF	196.58	13,426	196.58	13,426	0.00	0
	SUB-TOTAL			13,426		13,426		0
149	1 SF Residential	DU	535.00	5,297	535.00	5,297	0.00	0
	2 MF Residential	DU	500.00	4,000	500.00	4,000	0.00	0
	3 Commercial Retail	TSF	34.85	2,964	34.85	2,964	0.00	0
	SUB-TOTAL			12,261		12,261		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
150	1 SF Residential	DU	114.00	1,129	114.00	1,129	0.00	0
	SUB-TOTAL			1,129		1,129		0
151	1 SF Residential	DU	--	--	71.00	703	71.00	703
	SUB-TOTAL			--		703		703
152	1 SF Residential	DU	279.00	2,762	892.00	8,831	613.00	6,069
	6 Other	--		--	--	47	--	47
	SUB-TOTAL			2,762		8,878		6,116
153	1 SF Residential	DU	--	--	424.00	4,198	424.00	4,198
	SUB-TOTAL			--		4,198		4,198
159	1 SF Residential	DU	4.00	40	4.00	40	0.00	0
	5 Industrial Park	TSF	--	--	16.00	80	16.00	80
	6 Other	--		--	--	233	--	233
	SUB-TOTAL			40		353		313
160	1 SF Residential	DU	--	--	95.00	940	95.00	940
	2 MF Residential	DU	--	--	95.00	352	95.00	352
	SUB-TOTAL			--		1,292		1,292
161	1 SF Residential	DU	533.00	5,277	640.00	6,336	107.00	1,059
	2 MF Residential	DU	531.00	4,248	650.00	5,200	119.00	952
	3 Commercial Retail	TSF	54.86	11,598	151.82	18,358	96.96	6,760
	4 Commercial Office	TSF	61.66	713	282.41	3,265	220.75	2,552
	6 Other	--	--	2,329	--	2,329	--	0
	SUB-TOTAL			24,165		35,488		11,323
162	1 SF Residential	DU	83.00	822	335.00	3,055	252.00	2,233
	3 Commercial Retail	TSF	--	--	102.42	5,537	102.42	5,537
	5 Industrial Park	TSF	--	--	240.00	1,440	240.00	1,440
	SUB-TOTAL			822		10,032		9,210
163	5 Industrial Park	TSF	--	--	1,000.00	6,000	1,000.00	6,000
	SUB-TOTAL			--		6,000		6,000
164	1 SF Residential	DU	100.00	990	204.00	2,020	104.00	1,030
	2 MF Residential	DU	--	--	86.00	319	86.00	319
	5 Industrial Park	TSF	--	--	30.00	180	30.00	180
	6 Other	--	--	73	--	73	--	0
	SUB-TOTAL			1,063		2,592		1,529

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
165	1 SF Residential	DU	36.00	356	86.00	851	50.00	495
	2 MF Residential	DU	80.00	640	287.00	2,296	207.00	1,656
	3 Commercial Retail	TSF	61.78	3,740	127.83	6,188	66.05	2,448
	4 Commercial Office	TSF	13.81	160	13.81	160	0.00	0
	5 Industrial Park	TSF	14.71	86	3,402.47	20,413	3,387.76	20,327
	6 Other	--	--	414	--	414	--	0
	SUB-TOTAL			5,396		30,322		24,926
166	1 SF Residential	DU	431.00	4,267	431.00	4,267	0.00	0
	2 MF Residential	DU	217.00	1,736	462.00	3,696	245.00	1,960
	3 Commercial Retail	TSF	54.36	4,349	74.36	7,082	20.00	2,733
	4 Commercial Office	TSF	30.10	348	30.10	348	0.00	0
	5 Industrial Park	TSF	11.00	56	11.00	56	0.00	0
	6 Other	--		--	--	242	--	242
	SUB-TOTAL			10,756		15,691		4,935
167	1 SF Residential	DU	180.00	1,782	196.00	1,940	16.00	158
	SUB-TOTAL			1,782		1,940		158
168	1 SF Residential	DU	247.00	2,445	247.00	2,445	0.00	0
	SUB-TOTAL			2,445		2,445		0
169	1 SF Residential	DU	127.00	1,257	127.00	1,257	0.00	0
	2 MF Residential	DU	94.00	752	94.00	752	0.00	0
	3 Commercial Retail	TSF	200.00	8,012	300.00	12,018	100.00	4,006
	4 Commercial Office	TSF	--	--	20.00	684	20.00	684
	6 Other	--		--	--	152	--	152
	SUB-TOTAL			10,021		14,863		4,842
170	1 SF Residential	DU	60.00	594	60.00	594	0.00	0
	SUB-TOTAL			594		594		0
171	1 SF Residential	DU	32.00	317	60.00	594	28.00	277
	6 Other	--	--	979	--	1,088	--	109
	SUB-TOTAL			1,296		1,682		386
172	1 SF Residential	DU	185.00	1,831	185.00	1,831	0.00	0
	SUB-TOTAL			1,831		1,831		0
173	1 SF Residential	DU	336.00	3,326	386.00	3,821	50.00	495
	SUB-TOTAL			3,326		3,821		495
174	2 MF Residential	DU	--	--	400.00	2,342	400.00	2,342
	3 Commercial Retail	TSF	35.00	1,892	350.00	18,535	315.00	16,643
	4 Commercial Office	TSF	--	--	350.00	4,046	350.00	4,046
	6 Other	--		--	--	2,469	--	2,469
	SUB-TOTAL			1,892		27,392		25,500

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
175	1 SF Residential	DU	162.00	1,604	380.00	3,108	218.00	1,504
	2 MF Residential	DU	160.00	1,280	210.00	1,625	50.00	345
	3 Commercial Retail	TSF	98.01	5,298	98.01	5,298	0.00	0
	6 Other	--	--	1,295	--	1,295	--	0
	SUB-TOTAL			9,477		11,326		1,849
176	1 SF Residential	DU	686.00	6,791	762.00	7,544	76.00	753
	2 MF Residential	DU	135.00	1,080	270.00	2,012	135.00	932
	3 Commercial Retail	TSF	337.59	13,100	337.59	13,100	0.00	0
	6 Other	--		--	--	326	--	326
	SUB-TOTAL			20,971		22,982		2,011
177	1 SF Residential	DU	477.00	4,722	477.00	4,722	0.00	0
	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	3 Commercial Retail	TSF	97.57	5,275	97.57	5,275	0.00	0
	6 Other	--	--	776	--	1,264	--	488
	SUB-TOTAL			12,885		13,373		488
178	1 SF Residential	DU	333.00	3,297	333.00	3,297	0.00	0
	3 Commercial Retail	TSF	28.31	1,419	28.31	1,419	0.00	0
	4 Commercial Office	TSF	14.81	171	50.81	587	36.00	416
	6 Other	--		--	--	102	--	102
	SUB-TOTAL			4,887		5,405		518
179	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	2 MF Residential	DU	--	--	209.00	775	209.00	775
	3 Commercial Retail	TSF	21.78	807	28.78	4,280	7.00	3,473
	4 Commercial Office	TSF	24.83	849	52.00	1,778	27.17	929
	6 Other	--	--	207	--	207	--	0
	SUB-TOTAL			3,516		8,693		5,177
180	1 SF Residential	DU	428.00	4,237	428.00	4,237	0.00	0
	6 Other	--		--	--	653	--	653
	SUB-TOTAL			4,237		4,890		653
181	1 SF Residential	DU	282.00	2,792	282.00	2,792	0.00	0
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			3,880		3,880		0
182	1 SF Residential	DU	276.00	2,732	276.00	2,732	0.00	0
	2 MF Residential	DU	229.00	1,832	238.00	1,904	9.00	72
	3 Commercial Retail	TSF	76.23	4,121	96.23	5,202	20.00	1,081
	6 Other	--	--	280	--	280	--	0
	SUB-TOTAL			8,965		10,118		1,153
183	2 MF Residential	DU	634.00	5,072	634.00	5,072	0.00	0
	3 Commercial Retail	TSF	--	--	3.50	298	3.50	298
	6 Other	--	--	5,838	--	6,956	--	1,118
	SUB-TOTAL			10,910		12,326		1,416

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
184	4 Commercial Office	TSF	--	--	100.00	1,156	100.00	1,156
	6 Other	--		--	--	528	--	528
	SUB-TOTAL			--		1,684		1,684
185	1 SF Residential	DU	344.00	3,406	344.00	3,406	0.00	0
	SUB-TOTAL			3,406		3,406		0
186	1 SF Residential	DU	150.00	1,485	150.00	1,485	0.00	0
	4 Commercial Office	TSF	108.90	3,724	402.00	13,748	293.10	10,024
	6 Other	--	--	2,104	--	5,720	--	3,616
	SUB-TOTAL			7,313		20,953		13,640
187	1 SF Residential	DU	111.00	1,099	111.00	1,099	0.00	0
	2 MF Residential	DU	307.00	2,456	426.00	2,897	119.00	441
	6 Other	--	--	36	--	36	--	0
	SUB-TOTAL			3,591		4,032		441
188	1 SF Residential	DU	72.00	713	72.00	713	0.00	0
	2 MF Residential	DU	216.00	1,728	216.00	1,728	0.00	0
	SUB-TOTAL			2,441		2,441		0
189	3 Commercial Retail	TSF	--	--	3.00	255	3.00	255
	6 Other	--	--	20,856	--	30,800	--	9,944
	SUB-TOTAL			20,856		31,055		10,199
190	1 SF Residential	DU	171.00	1,693	171.00	1,693	0.00	0
	SUB-TOTAL			1,693		1,693		0
191	4 Commercial Office	TSF	--	--	78.56	2,687	78.56	2,687
	SUB-TOTAL			--		2,687		2,687
192	1 SF Residential	DU	164.00	1,624	164.00	1,624	0.00	0
	2 MF Residential	DU	660.00	5,280	660.00	5,280	0.00	0
	6 Other	--		--	--	520	--	520
	SUB-TOTAL			6,904		7,424		520
193	4 Commercial Office	TSF	250.00	2,550	250.00	2,550	0.00	0
	SUB-TOTAL			2,550		2,550		0
194	6 Other	--	--	796	--	796	--	0
	SUB-TOTAL			796		796		0
195	2 MF Residential	DU	76.00	608	76.00	608	0.00	0
	SUB-TOTAL			608		608		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
196	2 MF Residential	DU	--	--	10.00	80	10.00	80
	3 Commercial Retail	TSF	--	--	2.50	93	2.50	93
	4 Commercial Office	TSF	--	--	34.55	399	34.55	399
	6 Other	--		--	--	1,646	--	1,646
	SUB-TOTAL			--		2,218		2,218
197	3 Commercial Retail	TSF	--	--	13.00	1,106	13.00	1,106
	4 Commercial Office	TSF	--	--	400.00	4,080	400.00	4,080
	SUB-TOTAL			--		5,186		5,186
198	1 SF Residential	DU	331.00	3,277	331.00	3,277	0.00	0
	SUB-TOTAL			3,277		3,277		0
199	3 Commercial Retail	TSF	5.00	652	5.00	652	0.00	0
	6 Other	--	--	1,951	--	1,951	--	0
	SUB-TOTAL			2,603		2,603		0
200	4 Commercial Office	TSF	385.10	3,928	578.00	5,896	192.90	1,968
	SUB-TOTAL			3,928		5,896		1,968
201	4 Commercial Office	TSF	--	--	160.00	1,632	160.00	1,632
	SUB-TOTAL			--		1,632		1,632
202	2 MF Residential	DU	50.00	345	560.00	3,864	510.00	3,519
	3 Commercial Retail	TSF	13.00	482	22.00	815	9.00	333
	4 Commercial Office	TSF	13.00	150	13.00	150	0.00	0
	6 Other	--	--	4,218	--	4,218	--	0
	SUB-TOTAL			5,195		9,047		3,852
203	2 MF Residential	DU	--	--	450.00	3,105	450.00	3,105
	3 Commercial Retail	TSF	742.00	29,725	2,000.00	80,120	1,258.00	50,395
	4 Commercial Office	TSF	--	--	125.00	1,445	125.00	1,445
	SUB-TOTAL			29,725		84,670		54,945
204	3 Commercial Retail	TSF	62.00	2,298	62.00	2,298	0.00	0
	4 Commercial Office	TSF	400.00	4,624	400.00	4,624	0.00	0
	6 Other	--	--	5,808	--	5,808	--	0
	SUB-TOTAL			12,730		12,730		0
205	3 Commercial Retail	TSF	47.30	2,557	100.00	5,406	52.70	2,849
	4 Commercial Office	TSF	198.89	2,299	850.00	9,826	651.11	7,527
	6 Other	--	--	1,700	--	3,399	--	1,699
	SUB-TOTAL			6,556		18,631		12,075
206	3 Commercial Retail	TSF	141.99	8,876	187.61	11,782	45.62	2,906
	SUB-TOTAL			8,876		11,782		2,906

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
207	3 Commercial Retail	TSF	--	--	6.00	782	6.00	782
	4 Commercial Office	TSF	230.00	2,659	350.00	4,046	120.00	1,387
	SUB-TOTAL			2,659		4,828		2,169
208	2 MF Residential	DU	234.00	1,872	234.00	1,872	0.00	0
	SUB-TOTAL			1,872		1,872		0
209	1 SF Residential	DU	414.00	4,099	414.00	4,099	0.00	0
	2 MF Residential	DU	352.00	2,816	352.00	2,816	0.00	0
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			8,003		8,003		0
210	1 SF Residential	DU	205.00	2,029	205.00	2,029	0.00	0
	2 MF Residential	DU	208.00	1,664	208.00	1,664	0.00	0
	3 Commercial Retail	TSF	148.10	8,006	148.10	8,006	0.00	0
	SUB-TOTAL			11,699		11,699		0
211	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	SUB-TOTAL			1,653		1,653		0
212	1 SF Residential	DU	252.00	2,495	252.00	2,495	0.00	0
	2 MF Residential	DU	272.00	2,176	272.00	2,176	0.00	0
	6 Other	--	--	179	--	179	--	0
	SUB-TOTAL			4,850		4,850		0
213	1 SF Residential	DU	275.00	2,723	275.00	2,723	0.00	0
	6 Other	--	--	233	--	233	--	0
	SUB-TOTAL			2,956		2,956		0
214	1 SF Residential	DU	--	--	49.00	485	49.00	485
	2 MF Residential	DU	107.00	738	181.00	1,330	74.00	592
	6 Other	--		--	--	74	--	74
	SUB-TOTAL			738		1,889		1,151
215	1 SF Residential	DU	80.00	792	80.00	792	0.00	0
	2 MF Residential	DU	52.00	416	52.00	416	0.00	0
	3 Commercial Retail	TSF	143.56	7,020	143.56	7,020	0.00	0
	6 Other	--	--	5,056	--	6,027	--	971
	SUB-TOTAL			13,284		14,255		971
216	1 SF Residential	DU	22.00	218	22.00	218	0.00	0
	2 MF Residential	DU	128.00	1,024	448.00	3,507	320.00	2,483
	3 Commercial Retail	TSF	149.96	8,107	204.96	11,080	55.00	2,973
	4 Commercial Office	TSF	10.45	121	65.45	757	55.00	636
	SUB-TOTAL			9,470		15,562		6,092

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
217	1 SF Residential	DU	202.00	2,000	202.00	2,000	0.00	0
	2 MF Residential	DU	16.00	128	386.00	3,011	370.00	2,883
	3 Commercial Retail	TSF	65.75	3,554	110.75	5,222	45.00	1,668
	4 Commercial Office	TSF	22.44	259	22.44	259	0.00	0
	5 Industrial Park	TSF	22.44	135	22.44	135	0.00	0
	SUB-TOTAL			6,076		10,627		4,551
218	1 SF Residential	DU	458.00	4,081	511.00	4,606	53.00	525
	2 MF Residential	DU	641.00	5,128	810.00	6,414	169.00	1,286
	3 Commercial Retail	TSF	64.25	2,381	557.87	24,488	493.62	22,107
	6 Other	--	--	88	--	1,176	--	1,088
	SUB-TOTAL			11,678		36,684		25,006
219	1 SF Residential	DU	--	--	20.00	198	20.00	198
	2 MF Residential	DU	--	--	250.00	2,000	250.00	2,000
	4 Commercial Office	TSF	--	--	100.00	1,020	100.00	1,020
	SUB-TOTAL			--		3,218		3,218
220	1 SF Residential	DU	2.00	20	8.00	79	6.00	59
	4 Commercial Office	TSF	--	--	100.00	1,020	100.00	1,020
	6 Other	--	--	1,348	--	1,348	--	0
	SUB-TOTAL			1,368		2,447		1,079
221	1 SF Residential	DU	309.00	2,969	380.00	3,672	71.00	703
	2 MF Residential	DU	6.00	48	6.00	48	0.00	0
	4 Commercial Office	TSF	--	--	50.00	510	50.00	510
	5 Industrial Park	TSF	144.40	866	144.40	866	0.00	0
	6 Other	--	--	1,417	--	1,417	--	0
	SUB-TOTAL			5,300		6,513		1,213
222	1 SF Residential	DU	33.00	327	55.00	545	22.00	218
	6 Other	--	--	3,091	--	3,861	--	770
	SUB-TOTAL			3,418		4,406		988
223	3 Commercial Retail	TSF	43.38	2,345	110.00	5,947	66.62	3,602
	4 Commercial Office	TSF	0.36	4	248.00	2,867	247.64	2,863
	5 Industrial Park	TSF	70.36	422	242.00	1,452	171.64	1,030
	6 Other	--		--	--	823	--	823
	SUB-TOTAL			2,771		11,089		8,318
224	1 SF Residential	DU	260.00	2,484	280.00	2,682	20.00	198
	2 MF Residential	DU	500.00	4,000	550.00	4,400	50.00	400
	3 Commercial Retail	TSF	81.68	3,027	116.68	4,324	35.00	1,297
	6 Other	--	--	2,469	--	4,011	--	1,542
	SUB-TOTAL			11,980		15,417		3,437
225	1 SF Residential	DU	156.00	1,544	156.00	1,544	0.00	0
	6 Other	--	--	1,776	--	1,776	--	0
	SUB-TOTAL			3,320		3,320		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
226	1 SF Residential	DU	300.00	2,970	300.00	2,970	0.00	0
	2 MF Residential	DU	292.00	2,336	292.00	2,336	0.00	0
	3 Commercial Retail	TSF	69.70	2,583	85.38	3,917	15.68	1,334
	6 Other	--		--	--	354	--	354
	SUB-TOTAL			7,889		9,577		1,688
227	1 SF Residential	DU	100.00	990	118.00	1,168	18.00	178
	2 MF Residential	DU	184.00	1,472	786.00	6,288	602.00	4,816
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			2,462		8,544		6,082
228	1 SF Residential	DU	358.00	3,544	385.00	3,811	27.00	267
	SUB-TOTAL			3,544		3,811		267
229	1 SF Residential	DU	74.00	733	178.00	1,763	104.00	1,030
	SUB-TOTAL			733		1,763		1,030
230	1 SF Residential	DU	1.00	10	10.00	99	9.00	89
	SUB-TOTAL			10		99		89
231	1 SF Residential	DU	--	--	5.00	50	5.00	50
	2 MF Residential	DU	--	--	51.00	408	51.00	408
	6 Other	--		--	--	69	--	69
	SUB-TOTAL			--		527		527
232	1 SF Residential	DU	--	--	10.00	99	10.00	99
	2 MF Residential	DU	--	--	850.00	5,865	850.00	5,865
	SUB-TOTAL			--		5,964		5,964
234	3 Commercial Retail	TSF	--	--	100.00	5,406	100.00	5,406
	4 Commercial Office	TSF	--	--	470.24	4,796	470.24	4,796
	SUB-TOTAL			--		10,202		10,202
235	3 Commercial Retail	TSF	60.20	3,254	240.00	12,974	179.80	9,720
	4 Commercial Office	TSF	24.00	245	80.00	816	56.00	571
	SUB-TOTAL			3,499		13,790		10,291
236	1 SF Residential	DU	--	--	808.00	8,000	808.00	8,000
	6 Other	--		--	--	1,101	--	1,101
	SUB-TOTAL			--		9,101		9,101
237	1 SF Residential	DU	--	--	225.00	2,228	225.00	2,228
	2 MF Residential	DU	--	--	570.00	3,933	570.00	3,933
	4 Commercial Office	TSF	--	--	99.00	1,144	99.00	1,144
	6 Other	--		--	--	63	--	63
	SUB-TOTAL			--		7,368		7,368

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
238	1 SF Residential	DU	--	--	399.00	3,950	399.00	3,950
	2 MF Residential	DU	--	--	123.00	984	123.00	984
	3 Commercial Retail	TSF	--	--	184.00	12,479	184.00	12,479
	4 Commercial Office	TSF	--	--	340.00	3,621	340.00	3,621
	5 Industrial Park	TSF	--	--	944.00	5,664	944.00	5,664
	6 Other	--		--	--	67	--	67
	SUB-TOTAL			--		26,765		26,765
239	3 Commercial Retail	TSF	87.12	3,229	337.29	12,500	250.17	9,271
	4 Commercial Office	TSF	170.26	1,968	262.87	3,039	92.61	1,071
	5 Industrial Park	TSF	310.00	1,860	387.07	2,322	77.07	462
	6 Other	--	--	895	--	895	--	0
	SUB-TOTAL			7,952		18,756		10,804
240	3 Commercial Retail	TSF	--	--	181.00	14,181	181.00	14,181
	SUB-TOTAL			--		14,181		14,181
241	4 Commercial Office	TSF	--	--	1,228.00	13,198	1,228.00	13,198
	6 Other	--		--	--	1,128	--	1,128
	SUB-TOTAL			--		14,326		14,326
242	4 Commercial Office	TSF	--	--	368.00	3,910	368.00	3,910
	SUB-TOTAL			--		3,910		3,910
243	1 SF Residential	DU	--	--	211.00	2,089	211.00	2,089
	2 MF Residential	DU	--	--	816.00	6,099	816.00	6,099
	3 Commercial Retail	TSF	--	--	129.00	10,188	129.00	10,188
	4 Commercial Office	TSF	--	--	164.00	1,896	164.00	1,896
	SUB-TOTAL			--		20,272		20,272
244	1 SF Residential	DU	322.00	3,188	322.00	3,188	0.00	0
	SUB-TOTAL			3,188		3,188		0
245	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	6 Other	--	--	34	--	34	--	0
	SUB-TOTAL			232		232		0
246	5 Industrial Park	TSF	58.81	300	120.00	612	61.19	312
	SUB-TOTAL			300		612		312
247	3 Commercial Retail	TSF	71.37	3,858	500.00	20,030	428.63	16,172
	SUB-TOTAL			3,858		20,030		16,172
248	1 SF Residential	DU	2.00	20	2.00	20	0.00	0
	2 MF Residential	DU	4.00	32	4.00	32	0.00	0
	5 Industrial Park	TSF	882.09	5,293	1,200.00	7,200	317.91	1,907
	SUB-TOTAL			5,345		7,252		1,907

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
249	4 Commercial Office	TSF	--	--	250.00	2,890	250.00	2,890
	5 Industrial Park	TSF	291.68	1,488	291.68	1,488	0.00	0
	SUB-TOTAL			1,488		4,378		2,890
250	2 MF Residential	DU	--	--	450.00	3,435	450.00	3,435
	3 Commercial Retail	TSF	58.00	2,149	448.66	17,799	390.66	15,650
	4 Commercial Office	TSF	--	--	300.00	3,264	300.00	3,264
	SUB-TOTAL			2,149		24,498		22,349
251	5 Industrial Park	TSF	--	--	400.00	2,400	400.00	2,400
	SUB-TOTAL			--		2,400		2,400
252	4 Commercial Office	TSF	--	--	858.00	8,752	858.00	8,752
	SUB-TOTAL			--		8,752		8,752
253	1 SF Residential	DU	--	--	32.00	317	32.00	317
	SUB-TOTAL			--		317		317
254	3 Commercial Retail	TSF	8.71	323	116.21	6,134	107.50	5,811
	SUB-TOTAL			323		6,134		5,811
255	1 SF Residential	DU	2.00	20	20.00	198	18.00	178
	SUB-TOTAL			20		198		178
256	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	SUB-TOTAL			198		198		0
257	1 SF Residential	DU	103.00	1,020	170.00	1,683	67.00	663
	SUB-TOTAL			1,020		1,683		663
258	1 SF Residential	DU	54.00	535	130.00	1,287	76.00	752
	5 Industrial Park	TSF	--	--	125.00	638	125.00	638
	6 Other	--		--	--	3,324	--	3,324
	SUB-TOTAL			535		5,249		4,714
259	1 SF Residential	DU	--	--	10.00	99	10.00	99
	SUB-TOTAL			--		99		99
260	1 SF Residential	DU	27.00	267	402.00	3,980	375.00	3,713
	SUB-TOTAL			267		3,980		3,713
261	1 SF Residential	DU	10.00	99	25.00	247	15.00	148
	SUB-TOTAL			99		247		148
262	1 SF Residential	DU	346.00	3,425	790.00	7,821	444.00	4,396
	2 MF Residential	DU	--	--	100.00	800	100.00	800
	6 Other	--	--		1,088	--	1,088	--
	SUB-TOTAL			4,513		9,709		5,196

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
263	2 MF Residential	DU	--	--	200.00	1,600	200.00	1,600
	SUB-TOTAL			--		1,600		1,600
264	1 SF Residential	DU	63.00	624	63.00	624	0.00	0
	2 MF Residential	DU	264.00	2,026	264.00	2,026	0.00	0
	SUB-TOTAL			2,650		2,650		0
265	2 MF Residential	DU	670.00	4,975	670.00	4,975	0.00	0
	SUB-TOTAL			4,975		4,975		0
266	2 MF Residential	DU	200.00	742	200.00	742	0.00	0
	3 Commercial Retail	TSF	101.04	5,462	120.00	6,487	18.96	1,025
	5 Industrial Park	TSF	--	--	75.00	383	75.00	383
	SUB-TOTAL			6,204		7,612		1,408
267	3 Commercial Retail	TSF	100.00	5,406	200.00	10,812	100.00	5,406
	SUB-TOTAL			5,406		10,812		5,406
268	2 MF Residential	DU	180.00	1,440	180.00	1,440	0.00	0
	3 Commercial Retail	TSF	182.33	9,857	182.33	9,857	0.00	0
	5 Industrial Park	TSF	75.00	383	112.00	571	37.00	188
	SUB-TOTAL			11,680		11,868		188
269	1 SF Residential	DU	173.00	1,713	266.00	2,633	93.00	920
	2 MF Residential	DU	--	--	25.00	93	25.00	93
	6 Other	--	--	8	--	737	--	729
	SUB-TOTAL			1,721		3,463		1,742
270	1 SF Residential	DU	8.00	79	308.00	3,049	300.00	2,970
	2 MF Residential	DU	--	--	75.00	278	75.00	278
	SUB-TOTAL			79		3,327		3,248
271	2 MF Residential	DU	--	--	171.00	1,180	171.00	1,180
	3 Commercial Retail	TSF	--	--	630.00	25,238	630.00	25,238
	SUB-TOTAL			--		26,418		26,418
272	1 SF Residential	DU	819.00	8,108	967.00	9,573	148.00	1,465
	2 MF Residential	DU	180.00	1,440	180.00	1,440	0.00	0
	3 Commercial Retail	TSF	8.12	691	8.12	691	0.00	0
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			11,327		12,792		1,465
273	1 SF Residential	DU	6.00	59	101.00	1,000	95.00	941
	SUB-TOTAL			59		1,000		941
274	1 SF Residential	DU	--	--	80.00	792	80.00	792
	4 Commercial Office	TSF	--	--	110.06	1,123	110.06	1,123
	SUB-TOTAL			--		1,915		1,915

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
275	1 SF Residential	DU	225.00	2,228	225.00	2,228	0.00	0
	SUB-TOTAL			2,228		2,228		0
276	1 SF Residential	DU	75.00	743	75.00	743	0.00	0
	2 MF Residential	DU	539.00	4,312	539.00	4,312	0.00	0
	3 Commercial Retail	TSF	98.01	8,337	98.01	8,337	0.00	0
	6 Other	--	--	73	--	73	--	0
	SUB-TOTAL			13,465		13,465		0
277	3 Commercial Retail	TSF	7.91	656	73.00	4,175	65.09	3,519
	4 Commercial Office	TSF	--	--	110.00	3,536	110.00	3,536
	5 Industrial Park	TSF	--	--	150.00	765	150.00	765
	SUB-TOTAL			656		8,476		7,820
278	2 MF Residential	DU	757.00	6,056	757.00	6,056	0.00	0
	3 Commercial Retail	TSF	81.89	6,966	81.89	6,966	0.00	0
	6 Other	--	--	398	--	398	--	0
	SUB-TOTAL			13,420		13,420		0
279	1 SF Residential	DU	313.00	2,160	313.00	2,160	0.00	0
	3 Commercial Retail	TSF	19.33	1,644	26.33	2,240	7.00	596
	4 Commercial Office	TSF	0.20	2	0.20	2	0.00	0
	5 Industrial Park	TSF	--	--	58.00	348	58.00	348
	SUB-TOTAL			3,806		4,750		944
280	4 Commercial Office	TSF	--	--	38.18	389	38.18	389
	SUB-TOTAL			--		389		389
281	2 MF Residential	DU	--	--	150.00	1,200	150.00	1,200
	SUB-TOTAL			--		1,200		1,200
282	2 MF Residential	DU	486.00	3,888	700.00	5,600	214.00	1,712
	3 Commercial Retail	TSF	17.90	968	17.90	968	0.00	0
	SUB-TOTAL			4,856		6,568		1,712
283	1 SF Residential	DU	161.00	1,594	175.00	1,732	14.00	138
	2 MF Residential	DU	400.00	3,200	667.00	5,336	267.00	2,136
	6 Other	--	--	1,618	--	1,740	--	122
	SUB-TOTAL			6,412		8,808		2,396
284	1 SF Residential	DU	2.00	20	2.00	20	0.00	0
	2 MF Residential	DU	254.00	2,032	254.00	2,032	0.00	0
	SUB-TOTAL			2,052		2,052		0
285	1 SF Residential	DU	--	--	80.00	792	80.00	792
	3 Commercial Retail	TSF	--	--	246.99	9,894	246.99	9,894
	4 Commercial Office	TSF	--	--	150.00	1,530	150.00	1,530
	SUB-TOTAL			--		12,216		12,216

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
286	1 SF Residential	DU	--	--	182.00	1,802	182.00	1,802
	SUB-TOTAL			--		1,802		1,802
287	1 SF Residential	DU	--	--	35.00	347	35.00	347
	2 MF Residential	DU	--	--	120.00	960	120.00	960
	SUB-TOTAL			--		1,307		1,307
288	1 SF Residential	DU	--	--	167.00	1,653	167.00	1,653
	6 Other	--		--	--	4,475	--	4,475
	SUB-TOTAL			--		6,128		6,128
289	1 SF Residential	DU	--	--	166.00	1,643	166.00	1,643
	2 MF Residential	DU	--	--	350.00	2,415	350.00	2,415
	4 Commercial Office	TSF	--	--	57.17	583	57.17	583
	SUB-TOTAL			--		4,641		4,641
290	1 SF Residential	DU	64.00	634	104.00	1,030	40.00	396
	2 MF Residential	DU	93.00	744	93.00	744	0.00	0
	SUB-TOTAL			1,378		1,774		396
291	1 SF Residential	DU	--	--	74.00	733	74.00	733
	2 MF Residential	DU	--	--	350.00	2,415	350.00	2,415
	4 Commercial Office	TSF	8.60	88	181.63	1,853	173.03	1,765
	SUB-TOTAL			88		5,001		4,913
292	1 SF Residential	DU	140.00	1,386	140.00	1,386	0.00	0
	SUB-TOTAL			1,386		1,386		0
293	1 SF Residential	DU	133.00	1,317	180.00	1,782	47.00	465
	2 MF Residential	DU	368.00	2,944	684.00	5,217	316.00	2,273
	SUB-TOTAL			4,261		6,999		2,738
294	2 MF Residential	DU	--	--	276.00	1,904	276.00	1,904
	3 Commercial Retail	TSF	124.35	6,722	155.00	8,379	30.65	1,657
	5 Industrial Park	TSF	210.00	1,260	300.00	1,800	90.00	540
	SUB-TOTAL			7,982		12,083		4,101
295	4 Commercial Office	TSF	--	--	56.00	647	56.00	647
	5 Industrial Park	TSF	666.67	3,400	1,020.58	5,205	353.91	1,805
	6 Other	--	--	56	--	156	--	100
	SUB-TOTAL			3,456		6,008		2,552
296	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			--		1,701		1,701
297	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			--		1,701		1,701

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
298	2 MF Residential	DU	830.00	5,727	830.00	5,727	0.00	0
	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			5,727		7,428		1,701
299	3 Commercial Retail	TSF	184.00	9,947	184.00	9,947	0.00	0
	SUB-TOTAL			9,947		9,947		0
300	3 Commercial Retail	TSF	272.00	10,896	300.00	12,018	28.00	1,122
	SUB-TOTAL			10,896		12,018		1,122
301	3 Commercial Retail	TSF	49.24	1,825	49.24	1,825	0.00	0
	6 Other	--	--	7,904	--	8,635	--	731
	SUB-TOTAL			9,729		10,460		731
302	3 Commercial Retail	TSF	30.00	2,552	30.00	2,552	0.00	0
	6 Other	--	--	3,750	--	3,750	--	0
	SUB-TOTAL			6,302		6,302		0
303	6 Other	--	--	5,625	--	5,625	--	0
	SUB-TOTAL			5,625		5,625		0
304	3 Commercial Retail	TSF	48.00	3,739	48.00	3,739	0.00	0
	6 Other	--	--	3,113	--	3,113	--	0
	SUB-TOTAL			6,852		6,852		0
305	2 MF Residential	DU	--	--	76.00	524	76.00	524
	3 Commercial Retail	TSF	202.65	11,364	202.65	11,364	0.00	0
	5 Industrial Park	TSF	--	--	100.00	510	100.00	510
	SUB-TOTAL			11,364		12,398		1,034
306	2 MF Residential	DU	--	--	250.00	1,863	250.00	1,863
	3 Commercial Retail	TSF	80.50	4,352	143.90	7,779	63.40	3,427
	4 Commercial Office	TSF	--	--	50.00	1,710	50.00	1,710
	6 Other	--	--	336	--	336	--	0
	SUB-TOTAL			4,688		11,688		7,000
307	3 Commercial Retail	TSF	132.80	9,301	132.80	9,301	0.00	0
	SUB-TOTAL			9,301		9,301		0
308	2 MF Residential	DU	200.00	1,380	200.00	1,380	0.00	0
	3 Commercial Retail	TSF	175.11	14,895	175.11	14,895	0.00	0
	5 Industrial Park	TSF	29.40	150	45.00	230	15.60	80
	SUB-TOTAL			16,425		16,505		80
309	3 Commercial Retail	TSF	3.00	111	3.00	111	0.00	0
	SUB-TOTAL			111		111		0
310	6 Other	--	--	45	--	4,208	--	4,163
	SUB-TOTAL			45		4,208		4,163

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
311	1 SF Residential	DU	132.00	1,307	132.00	1,307	0.00	0
	2 MF Residential	DU	63.00	504	63.00	504	0.00	0
	SUB-TOTAL			1,811		1,811		0
312	3 Commercial Retail	TSF	164.40	8,887	180.00	9,731	15.60	844
	6 Other	--	--	200	--	200	--	0
	SUB-TOTAL			9,087		9,931		844
313	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	SUB-TOTAL			2,112		2,112		0
314	3 Commercial Retail	TSF	178.00	9,623	178.00	9,623	0.00	0
	SUB-TOTAL			9,623		9,623		0
315	1 SF Residential	DU	56.00	554	56.00	554	0.00	0
	2 MF Residential	DU	168.00	1,344	168.00	1,344	0.00	0
	SUB-TOTAL			1,898		1,898		0
316	1 SF Residential	DU	121.00	1,198	121.00	1,198	0.00	0
	SUB-TOTAL			1,198		1,198		0
317	6 Other	--	--	1,135	--	1,135	--	0
	SUB-TOTAL			1,135		1,135		0
318	1 SF Residential	DU	21.00	208	21.00	208	0.00	0
	2 MF Residential	DU	252.00	2,016	252.00	2,016	0.00	0
	SUB-TOTAL			2,224		2,224		0
319	3 Commercial Retail	TSF	--	--	130.00	7,028	130.00	7,028
	6 Other	--		--	--	292	--	292
	SUB-TOTAL			--		7,320		7,320
320	1 SF Residential	DU	125.00	1,238	125.00	1,238	0.00	0
	SUB-TOTAL			1,238		1,238		0
321	1 SF Residential	DU	155.00	1,535	155.00	1,535	0.00	0
	2 MF Residential	DU	66.00	528	66.00	528	0.00	0
	SUB-TOTAL			2,063		2,063		0
322	1 SF Residential	DU	87.00	861	87.00	861	0.00	0
	SUB-TOTAL			861		861		0
323	1 SF Residential	DU	161.00	1,594	161.00	1,594	0.00	0
	2 MF Residential	DU	132.00	1,056	132.00	1,056	0.00	0
	SUB-TOTAL			2,650		2,650		0
325	1 SF Residential	DU	--	--	205.00	2,029	205.00	2,029
	SUB-TOTAL			--		2,029		2,029

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
326	1 SF Residential	DU	101.00	1,000	101.00	1,000	0.00	0
	SUB-TOTAL			1,000		1,000		0
327	1 SF Residential	DU	105.00	1,040	105.00	1,040	0.00	0
	SUB-TOTAL			1,040		1,040		0
328	1 SF Residential	DU	110.00	1,089	110.00	1,089	0.00	0
	SUB-TOTAL			1,089		1,089		0
329	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			1,088		1,088		0
330	1 SF Residential	DU	143.00	1,416	143.00	1,416	0.00	0
	SUB-TOTAL			1,416		1,416		0
331	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	SUB-TOTAL			1,653		1,653		0
332	1 SF Residential	DU	114.00	1,129	114.00	1,129	0.00	0
	2 MF Residential	DU	102.00	816	102.00	816	0.00	0
	SUB-TOTAL			1,945		1,945		0
333	1 SF Residential	DU	803.00	7,950	803.00	7,950	0.00	0
	2 MF Residential	DU	360.00	2,880	360.00	2,880	0.00	0
	3 Commercial Retail	TSF	25.05	928	25.05	928	0.00	0
	6 Other	--	--	1,340	--	1,740	--	400
	SUB-TOTAL			13,098		13,498		400
334	1 SF Residential	DU	164.00	1,624	164.00	1,624	0.00	0
	SUB-TOTAL			1,624		1,624		0
335	1 SF Residential	DU	194.00	1,921	194.00	1,921	0.00	0
	SUB-TOTAL			1,921		1,921		0
336	1 SF Residential	DU	589.00	5,831	589.00	5,831	0.00	0
	6 Other	--	--	1,107	--	1,107	--	0
	SUB-TOTAL			6,938		6,938		0
337	1 SF Residential	DU	390.00	3,861	390.00	3,861	0.00	0
	SUB-TOTAL			3,861		3,861		0
338	3 Commercial Retail	TSF	92.00	4,974	92.00	4,974	0.00	0
	SUB-TOTAL			4,974		4,974		0
339	1 SF Residential	DU	289.00	2,861	289.00	2,861	0.00	0
	6 Other	--	--	1,106	--	1,106	--	0
	SUB-TOTAL			3,967		3,967		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
340	1 SF Residential	DU	394.00	3,901	394.00	3,901	0.00	0
	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	SUB-TOTAL			6,013		6,013		0
341	2 MF Residential	DU	325.00	2,243	325.00	2,243	0.00	0
	6 Other	--	--	1,175	--	1,175	--	0
	SUB-TOTAL			3,418		3,418		0
342	2 MF Residential	DU	168.00	1,344	168.00	1,344	0.00	0
	SUB-TOTAL			1,344		1,344		0
343	1 SF Residential	DU	179.00	1,772	179.00	1,772	0.00	0
	2 MF Residential	DU	132.00	1,056	132.00	1,056	0.00	0
	SUB-TOTAL			2,828		2,828		0
344	1 SF Residential	DU	415.00	4,109	415.00	4,109	0.00	0
	3 Commercial Retail	TSF	--	--	40.00	2,162	40.00	2,162
	SUB-TOTAL			4,109		6,271		2,162
345	1 SF Residential	DU	23.00	228	81.00	802	58.00	574
	SUB-TOTAL			228		802		574
346	1 SF Residential	DU	--	--	10.00	99	10.00	99
	SUB-TOTAL			--		99		99
347	1 SF Residential	DU	313.00	3,099	313.00	3,099	0.00	0
	SUB-TOTAL			3,099		3,099		0
348	1 SF Residential	DU	517.00	5,118	517.00	5,118	0.00	0
	SUB-TOTAL			5,118		5,118		0
349	2 MF Residential	DU	83.00	664	388.00	3,104	305.00	2,440
	3 Commercial Retail	TSF	8.00	680	8.00	680	0.00	0
	6 Other	--	--	226	--	226	--	0
	SUB-TOTAL			1,570		4,010		2,440
350	6 Other	--	--	1,010	--	1,860	--	850
	SUB-TOTAL			1,010		1,860		850
352	1 SF Residential	DU	440.00	4,356	592.00	5,861	152.00	1,505
	6 Other	--		--	--	1,363	--	1,363
	SUB-TOTAL			4,356		7,224		2,868
353	1 SF Residential	DU	259.00	2,564	259.00	2,564	0.00	0
	6 Other	--		--	--	26	--	26
	SUB-TOTAL			2,564		2,590		26

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
355	1 SF Residential	DU	--	--	500.00	4,950	500.00	4,950
	6 Other	--		--	--	1,101	--	1,101
	SUB-TOTAL			--		6,051		6,051
356	1 SF Residential	DU	385.00	3,811	385.00	3,811	0.00	0
	3 Commercial Retail	TSF	--	--	60.00	5,104	60.00	5,104
	SUB-TOTAL			3,811		8,915		5,104
357	1 SF Residential	DU	--	--	90.00	891	90.00	891
	SUB-TOTAL			--		891		891
358	1 SF Residential	DU	105.00	1,040	275.00	2,723	170.00	1,683
	2 MF Residential	DU	121.00	968	121.00	968	0.00	0
	6 Other	--	--	970	--	1,138	--	168
	SUB-TOTAL			2,978		4,829		1,851
359	1 SF Residential	DU	570.00	5,643	570.00	5,643	0.00	0
	2 MF Residential	DU	192.00	1,536	192.00	1,536	0.00	0
	SUB-TOTAL			7,179		7,179		0
360	1 SF Residential	DU	538.00	5,326	538.00	5,326	0.00	0
	2 MF Residential	DU	248.00	1,984	248.00	1,984	0.00	0
	3 Commercial Retail	TSF	119.00	10,122	135.00	11,483	16.00	1,361
	6 Other	--	--	938	--	1,088	--	150
	SUB-TOTAL			18,370		19,881		1,511
361	1 SF Residential	DU	188.00	1,861	601.00	5,407	413.00	3,546
	6 Other	--		--	--	28	--	28
	SUB-TOTAL			1,861		5,435		3,574
362	1 SF Residential	DU	173.00	1,713	173.00	1,713	0.00	0
	SUB-TOTAL			1,713		1,713		0
363	1 SF Residential	DU	6.00	59	44.00	436	38.00	377
	SUB-TOTAL			59		436		377
364	1 SF Residential	DU	199.00	1,970	199.00	1,970	0.00	0
	SUB-TOTAL			1,970		1,970		0
365	1 SF Residential	DU	201.00	1,990	201.00	1,990	0.00	0
	2 MF Residential	DU	102.00	816	102.00	816	0.00	0
	3 Commercial Retail	TSF	11.00	936	11.00	936	0.00	0
	SUB-TOTAL			3,742		3,742		0
366	1 SF Residential	DU	600.00	5,940	600.00	5,940	0.00	0
	SUB-TOTAL			5,940		5,940		0
367	1 SF Residential	DU	437.00	4,326	437.00	4,326	0.00	0
	SUB-TOTAL			4,326		4,326		0

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
368	1 SF Residential	DU	1,070.00	10,593	1,070.00	10,593	0.00	0
	3 Commercial Retail	TSF	--	--	35.00	2,977	35.00	2,977
	6 Other	--	--	1,174	--	1,629	--	455
	SUB-TOTAL			11,767		15,199		3,432
369	1 SF Residential	DU	202.00	2,000	202.00	2,000	0.00	0
	SUB-TOTAL			2,000		2,000		0
370	1 SF Residential	DU	1,080.00	10,692	1,080.00	10,692	0.00	0
	6 Other	--	--	4,475	--	4,475	--	0
	SUB-TOTAL			15,167		15,167		0
371	1 SF Residential	DU	673.00	6,663	673.00	6,663	0.00	0
	6 Other	--	--	996	--	1,088	--	92
	SUB-TOTAL			7,659		7,751		92
372	1 SF Residential	DU	287.00	2,841	287.00	2,841	0.00	0
	2 MF Residential	DU	230.00	1,840	230.00	1,840	0.00	0
	3 Commercial Retail	TSF	80.00	4,325	80.00	4,325	0.00	0
	SUB-TOTAL			9,006		9,006		0
373	1 SF Residential	DU	236.00	2,336	236.00	2,336	0.00	0
	6 Other	--	--	889	--	1,307	--	418
	SUB-TOTAL			3,225		3,643		418
374	1 SF Residential	DU	--	--	300.00	2,970	300.00	2,970
	2 MF Residential	DU	--	--	304.00	2,098	304.00	2,098
	3 Commercial Retail	TSF	150.00	8,109	150.00	8,109	0.00	0
	6 Other	--		--	--	78	--	78
	SUB-TOTAL			8,109		13,255		5,146
375	3 Commercial Retail	TSF	5.00	2,481	45.00	5,883	40.00	3,402
	SUB-TOTAL			2,481		5,883		3,402
377	3 Commercial Retail	TSF	57.50	2,131	57.50	2,131	0.00	0
	SUB-TOTAL			2,131		2,131		0
378	1 SF Residential	DU	332.00	2,291	332.00	2,291	0.00	0
	2 MF Residential	DU	--	--	407.00	3,256	407.00	3,256
	3 Commercial Retail	TSF	41.00	1,519	51.00	1,890	10.00	371
	4 Commercial Office	TSF	56.00	571	56.00	571	0.00	0
	5 Industrial Park	TSF	--	--	110.00	660	110.00	660
	SUB-TOTAL			4,381		8,668		4,287
380	1 SF Residential	DU	--	--	125.00	1,238	125.00	1,238
	2 MF Residential	DU	--	--	400.00	2,760	400.00	2,760
	SUB-TOTAL			--		3,998		3,998

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
381	6 Other	--	--	130	--	223	--	93
	SUB-TOTAL			130		223		93
382	6 Other	--	--	180	--	180	--	0
	SUB-TOTAL			180		180		0
383	1 SF Residential	DU	231.00	2,287	266.00	2,633	35.00	346
	3 Commercial Retail	TSF	8.71	323	8.71	323	0.00	0
	SUB-TOTAL			2,610		2,956		346
384	1 SF Residential	DU	354.00	3,505	354.00	3,505	0.00	0
	SUB-TOTAL			3,505		3,505		0
385	1 SF Residential	DU	--	--	75.00	743	75.00	743
	SUB-TOTAL			--		743		743
387	1 SF Residential	DU	304.00	3,010	800.00	7,920	496.00	4,910
	2 MF Residential	DU	180.00	1,440	700.00	5,600	520.00	4,160
	SUB-TOTAL			4,450		13,520		9,070
388	1 SF Residential	DU	--	--	99.00	980	99.00	980
	2 MF Residential	DU	--	--	400.00	3,200	400.00	3,200
	6 Other	--		--	--	2,320	--	2,320
	SUB-TOTAL			--		6,500		6,500
389	1 SF Residential	DU	1,187.00	11,751	1,236.00	12,236	49.00	485
	6 Other	--	--	766	--	1,088	--	322
	SUB-TOTAL			12,517		13,324		807
390	1 SF Residential	DU	150.00	1,485	150.00	1,485	0.00	0
	SUB-TOTAL			1,485		1,485		0
391	3 Commercial Retail	TSF	16.33	605	16.33	605	0.00	0
	5 Industrial Park	TSF	376.36	1,919	446.36	2,339	70.00	420
	SUB-TOTAL			2,524		2,944		420
392	1 SF Residential	DU	723.00	5,958	757.00	6,193	34.00	235
	3 Commercial Retail	TSF	20.80	771	102.48	5,187	81.68	4,416
	5 Industrial Park	TSF	--	--	500.00	2,550	500.00	2,550
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			7,817		15,018		7,201
393	1 SF Residential	DU	162.00	1,604	162.00	1,604	0.00	0
	2 MF Residential	DU	100.00	800	100.00	800	0.00	0
	3 Commercial Retail	TSF	52.27	4,446	52.27	4,446	0.00	0
	6 Other	--	--	350	--	679	--	329
	SUB-TOTAL			7,200		7,529		329

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
394	1 SF Residential	DU	325.00	3,217	325.00	3,217	0.00	0
	6 Other	--	--	5,527	--	5,571	--	44
	SUB-TOTAL			8,744		8,788		44
395	2 MF Residential	DU	185.00	1,277	185.00	1,277	0.00	0
	3 Commercial Retail	TSF	165.53	8,949	165.53	8,949	0.00	0
	6 Other	--	--	1,740	--	1,740	--	0
	SUB-TOTAL			11,966		11,966		0
396	3 Commercial Retail	TSF	76.23	6,484	110.00	9,357	33.77	2,873
	SUB-TOTAL			6,484		9,357		2,873
397	1 SF Residential	DU	220.00	1,665	549.00	3,935	329.00	2,270
	2 MF Residential	DU	579.00	4,558	579.00	4,558	0.00	0
	3 Commercial Retail	TSF	310.98	16,812	384.98	23,106	74.00	6,294
	6 Other	--		--	--	1,084	--	1,084
	SUB-TOTAL			23,035		32,683		9,648
398	1 SF Residential	DU	1,120.00	11,088	1,120.00	11,088	0.00	0
	2 MF Residential	DU	120.00	960	120.00	960	0.00	0
	3 Commercial Retail	TSF	261.13	22,465	261.13	22,465	0.00	0
	6 Other	--	--	2,533	--	2,533	--	0
	SUB-TOTAL			37,046		37,046		0
399	1 SF Residential	DU	859.00	8,504	880.00	8,712	21.00	208
	6 Other	--	--	790	--	1,228	--	438
	SUB-TOTAL			9,294		9,940		646
400	1 SF Residential	DU	--	--	12.00	119	12.00	119
	SUB-TOTAL			--		119		119
401	1 SF Residential	DU	--	--	835.00	8,267	835.00	8,267
	2 MF Residential	DU	--	--	482.00	3,856	482.00	3,856
	SUB-TOTAL			--		12,123		12,123
402	1 SF Residential	DU	300.00	2,970	1,129.00	11,177	829.00	8,207
	3 Commercial Retail	TSF	--	--	150.00	8,109	150.00	8,109
	6 Other	--	--	951	--	2,027	--	1,076
	SUB-TOTAL			3,921		21,313		17,392
403	1 SF Residential	DU	111.00	1,099	111.00	1,099	0.00	0
	2 MF Residential	DU	--	--	300.00	2,070	300.00	2,070
	3 Commercial Retail	TSF	12.00	1,021	46.00	3,913	34.00	2,892
	SUB-TOTAL			2,120		7,082		4,962
404	1 SF Residential	DU	10.00	99	177.00	1,752	167.00	1,653
	SUB-TOTAL			99		1,752		1,653

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
405	1 SF Residential	DU	24.00	238	296.00	2,930	272.00	2,692
	SUB-TOTAL			238		2,930		2,692
406	1 SF Residential	DU	38.00	376	353.00	3,495	315.00	3,119
	SUB-TOTAL			376		3,495		3,119
407	1 SF Residential	DU	--	--	47.00	465	47.00	465
	SUB-TOTAL			--		465		465
408	1 SF Residential	DU	47.00	465	380.00	3,762	333.00	3,297
	SUB-TOTAL			465		3,762		3,297
409	1 SF Residential	DU	--	--	77.00	762	77.00	762
	SUB-TOTAL			--		762		762
410	1 SF Residential	DU	25.00	247	249.00	2,162	224.00	1,915
	5 Industrial Park	TSF	--	--	44.00	264	44.00	264
	SUB-TOTAL			247		2,426		2,179
411	1 SF Residential	DU	--	--	675.00	6,682	675.00	6,682
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			--		7,770		7,770
412	1 SF Residential	DU	120.00	1,188	120.00	1,188	0.00	0
	3 Commercial Retail	TSF	--	--	40.00	2,162	40.00	2,162
	SUB-TOTAL			1,188		3,350		2,162
413	1 SF Residential	DU	29.00	287	146.00	1,325	117.00	1,038
	2 MF Residential	DU	246.00	1,697	514.00	3,547	268.00	1,850
	3 Commercial Retail	TSF	26.94	2,292	44.60	3,794	17.66	1,502
	4 Commercial Office	TSF	36.59	423	36.59	423	0.00	0
	5 Industrial Park	TSF	45.21	231	93.75	522	48.54	291
	SUB-TOTAL			4,930		9,611		4,681
414	1 SF Residential	DU	265.00	1,874	290.00	2,121	25.00	247
	2 MF Residential	DU	1,358.00	10,864	1,635.00	12,860	277.00	1,996
	3 Commercial Retail	TSF	95.83	3,551	175.00	6,486	79.17	2,935
	SUB-TOTAL			16,289		21,467		5,178
415	1 SF Residential	DU	75.00	743	75.00	743	0.00	0
	3 Commercial Retail	TSF	--	--	63.71	3,444	63.71	3,444
	5 Industrial Park	TSF	27.80	142	27.80	142	0.00	0
	SUB-TOTAL			885		4,329		3,444

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
416	1 SF Residential	DU	496.00	4,250	496.00	4,250	0.00	0
	2 MF Residential	DU	57.00	456	57.00	456	0.00	0
	3 Commercial Retail	TSF	15.00	556	15.00	556	0.00	0
	4 Commercial Office	TSF	--	--	100.00	1,156	100.00	1,156
	6 Other	--	--	39	--	225	--	186
	SUB-TOTAL			5,301		6,643		1,342
417	1 SF Residential	DU	662.00	6,554	950.00	9,405	288.00	2,851
	2 MF Residential	DU	240.00	1,920	255.00	2,040	15.00	120
	3 Commercial Retail	TSF	--	--	10.00	851	10.00	851
	6 Other	--	--	1,088	--	16,488	--	15,400
	SUB-TOTAL			9,562		28,784		19,222
418	1 SF Residential	DU	90.00	621	90.00	621	0.00	0
	2 MF Residential	DU	706.00	5,393	1,229.00	9,002	523.00	3,609
	3 Commercial Retail	TSF	128.43	6,943	228.00	12,326	99.57	5,383
	SUB-TOTAL			12,957		21,949		8,992
419	2 MF Residential	DU	1,834.00	14,672	1,834.00	14,672	0.00	0
	SUB-TOTAL			14,672		14,672		0
420	2 MF Residential	DU	40.00	320	56.00	448	16.00	128
	SUB-TOTAL			320		448		128
421	1 SF Residential	DU	--	--	250.00	2,475	250.00	2,475
	2 MF Residential	DU	752.00	6,016	1,500.00	12,000	748.00	5,984
	3 Commercial Retail	TSF	--	--	400.00	21,624	400.00	21,624
	4 Commercial Office	TSF	--	--	600.00	6,936	600.00	6,936
	6 Other	--		--	--	1,677	--	1,677
	SUB-TOTAL			6,016		44,712		38,696
422	1 SF Residential	DU	100.00	750	100.00	750	0.00	0
	3 Commercial Retail	TSF	4.00	340	10.00	851	6.00	511
	6 Other	--	--	1,185	--	1,523	--	338
	SUB-TOTAL			2,275		3,124		849
423	1 SF Residential	DU	353.00	3,495	464.00	4,324	111.00	829
	3 Commercial Retail	TSF	98.01	8,337	98.01	8,337	0.00	0
	4 Commercial Office	TSF	10.89	126	10.89	126	0.00	0
	SUB-TOTAL			11,958		12,787		829
424	1 SF Residential	DU	86.00	851	350.00	3,465	264.00	2,614
	SUB-TOTAL			851		3,465		2,614
425	1 SF Residential	DU	39.00	386	114.00	1,129	75.00	743
	2 MF Residential	DU	--	--	80.00	640	80.00	640
	6 Other	--		--	--	81	--	81
	SUB-TOTAL			386		1,850		1,464

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
426	1 SF Residential	DU	100.00	990	630.00	6,237	530.00	5,247
	5 Industrial Park	TSF	39.60	202	39.60	202	0.00	0
	SUB-TOTAL			1,192		6,439		5,247
427	1 SF Residential	DU	249.00	2,465	249.00	2,465	0.00	0
	SUB-TOTAL			2,465		2,465		0
428	1 SF Residential	DU	540.00	5,346	1,313.00	12,999	773.00	7,653
	3 Commercial Retail	TSF	--	--	86.60	5,896	86.60	5,896
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			5,346		19,983		14,637
429	1 SF Residential	DU	42.00	416	55.00	545	13.00	129
	SUB-TOTAL			416		545		129
430	1 SF Residential	DU	2.00	20	2.00	20	0.00	0
	SUB-TOTAL			20		20		0
431	1 SF Residential	DU	3.00	30	3.00	30	0.00	0
	SUB-TOTAL			30		30		0
433	1 SF Residential	DU	8.00	79	155.00	1,535	147.00	1,456
	SUB-TOTAL			79		1,535		1,456
434	1 SF Residential	DU	25.00	247	25.00	247	0.00	0
	SUB-TOTAL			247		247		0
437	4 Commercial Office	TSF	--	--	250.00	2,550	250.00	2,550
	6 Other	--		--	--	1,284	--	1,284
	SUB-TOTAL			--		3,834		3,834
438	1 SF Residential	DU	--	--	10.00	99	10.00	99
	4 Commercial Office	TSF	--	--	250.00	2,550	250.00	2,550
	SUB-TOTAL			--		2,649		2,649
439	1 SF Residential	DU	164.00	1,624	175.00	1,732	11.00	108
	3 Commercial Retail	TSF	--	--	41.65	2,252	41.65	2,252
	SUB-TOTAL			1,624		3,984		2,360
440	5 Industrial Park	TSF	--	--	50.00	300	50.00	300
	SUB-TOTAL			--		300		300
441	1 SF Residential	DU	150.00	1,485	490.00	4,371	340.00	2,886
	3 Commercial Retail	TSF	--	--	30.00	1,112	30.00	1,112
	6 Other	--	--	522	--	1,088	--	566
	SUB-TOTAL			2,007		6,571		4,564
442	1 SF Residential	DU	288.00	2,851	328.00	3,247	40.00	396
	SUB-TOTAL			2,851		3,247		396

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			2004		OVOV Buildout		Difference	
Zone	Land Use Category	Units	Amount	ADT	Amount	ADT	Amount	ADT
443	1 SF Residential	DU	499.00	4,940	763.00	7,554	264.00	2,614
	3 Commercial Retail	TSF	30.00	1,112	30.00	1,112	0.00	0
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			7,140		9,754		2,614
444	2 MF Residential	DU	440.00	3,520	440.00	3,520	0.00	0
	3 Commercial Retail	TSF	--	--	200.00	10,812	200.00	10,812
	6 Other	--	--	37	--	37	--	0
	SUB-TOTAL			3,557		14,369		10,812
445	1 SF Residential	DU	29.00	287	41.00	406	12.00	119
	SUB-TOTAL			287		406		119
446	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	SUB-TOTAL			198		198		0
447	1 SF Residential	DU	--	--	300.00	2,970	300.00	2,970
	6 Other	--	--	1,194	--	1,194	--	0
	SUB-TOTAL			1,194		4,164		2,970
448	1 SF Residential	DU	606.00	5,999	691.00	6,841	85.00	842
	SUB-TOTAL			5,999		6,841		842
449	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	SUB-TOTAL			198		198		0
450	1 SF Residential	DU	--	--	27.00	267	27.00	267
	SUB-TOTAL			--		267		267
451	1 SF Residential	DU	40.00	396	140.00	1,386	100.00	990
	5 Industrial Park	TSF	--	--	47.00	282	47.00	282
	SUB-TOTAL			396		1,668		1,272
452	1 SF Residential	DU	6.00	59	38.00	376	32.00	317
	SUB-TOTAL			59		376		317
453	1 SF Residential	DU	172.00	1,703	1,020.00	10,098	848.00	8,395
	3 Commercial Retail	TSF	--	--	16.00	593	16.00	593
	6 Other	--	--	711	--	1,088	--	377
	SUB-TOTAL			2,414		11,779		9,365
454	1 SF Residential	DU	116.00	1,148	650.00	6,435	534.00	5,287
	3 Commercial Retail	TSF	6.14	228	40.28	2,074	34.14	1,846
	6 Other	--	--	3,779	--	5,482	--	1,703
	SUB-TOTAL			5,155		13,991		8,836
455	1 SF Residential	DU	80.00	792	100.00	990	20.00	198
	SUB-TOTAL			792		990		198

Land Use and Trip Generation Comparison – 2004 and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
1.	SF Residential	DU	48,251.00	471,153	81,395.00	795,563	33,144.00	324,410
2.	MF Residential	DU	24,387.00	191,023	67,679.00	514,809	43,292.00	323,786
3.	Commercial Retail	TSF	9,157.63	515,716	23,585.06	1,230,042	14,427.43	714,326
4.	Commercial Office	TSF	2,072.12	25,996	17,311.53	205,851	15,239.41	179,855
5.	Industrial Park	TSF	18,332.42	107,565	40,735.96	240,697	22,403.54	133,132
6.	Other	--	--	176,541	--	301,424	--	124,883
TOTAL				**1,487,994**		**3,288,386**		**1,800,392**

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
1	1 SF Residential	DU	567.00	5,613	567.00	5,613	0.00	0
	5 Industrial Park	TSF	--	--	275.00	1,650	275.00	1,650
	SUB-TOTAL			5,613		7,263		1,650
2	1 SF Residential	DU	535.00	5,297	535.00	5,297	0.00	0
	SUB-TOTAL			5,297		5,297		0
3	1 SF Residential	DU	3,753.00	37,155	3,313.00	32,799	-440.00	-4,356
	2 MF Residential	DU	648.00	5,184	1,288.00	9,600	640.00	4,416
	3 Commercial Retail	TSF	320.00	17,299	320.00	17,299	0.00	0
	5 Industrial Park	TSF	334.28	1,936	334.29	1,936	0.01	0
	6 Other	--	--	9,942	--	1,088	--	-8,854
	SUB-TOTAL			71,516		62,722		-8,794
4	5 Industrial Park	TSF	389.00	2,334	--	--	-389.00	-2,334
	SUB-TOTAL			2,334		--		-2,334
5	1 SF Residential	DU	651.00	6,445	229.00	2,267	-422.00	-4,178
	2 MF Residential	DU	100.00	800	--	--	-100.00	-800
	3 Commercial Retail	TSF	27.01	2,201	27.01	2,201	0.00	0
	6 Other	--	--	233		--	--	-233
	SUB-TOTAL			9,679		4,468		-5,211
6	1 SF Residential	DU	330.00	3,267	409.00	4,049	79.00	782
	2 MF Residential	DU	141.00	1,128	--	--	-141.00	-1,128
	SUB-TOTAL			4,395		4,049		-346
7	1 SF Residential	DU	714.00	7,069	722.00	7,148	8.00	79
	SUB-TOTAL			7,069		7,148		79
8	1 SF Residential	DU	70.00	693	97.00	960	27.00	267
	SUB-TOTAL			693		960		267
9	1 SF Residential	DU	166.00	1,643	320.00	3,168	154.00	1,525
	SUB-TOTAL			1,643		3,168		1,525
10	1 SF Residential	DU	12.00	119	12.00	119	0.00	0
	2 MF Residential	DU	184.00	1,472	184.00	1,472	0.00	0
	3 Commercial Retail	TSF	33.64	3,440	300.00	12,018	266.36	8,578
	SUB-TOTAL			5,031		13,609		8,578
11	1 SF Residential	DU	108.00	1,070	108.00	1,070	0.00	0
	2 MF Residential	DU	237.00	1,817	237.00	1,817	0.00	0
	3 Commercial Retail	TSF	62.97	5,589	62.97	5,589	0.00	0
	4 Commercial Office	TSF	1.23	14	1.23	14	0.00	0
	5 Industrial Park	TSF	41.82	251	41.82	251	0.00	0
	6 Other	--	--	5	--	5	--	0
	SUB-TOTAL			8,746		8,746		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
12	1 SF Residential	DU	252.00	2,495	252.00	2,495	0.00	0
	6 Other	--	--	996	--	996	--	0
	SUB-TOTAL			3,491		3,491		0
13	1 SF Residential	DU	641.00	6,346	641.00	6,346	0.00	0
	2 MF Residential	DU	54.00	432	54.00	432	0.00	0
	3 Commercial Retail	TSF	114.56	6,193	25.00	2,127	-89.56	-4,066
	4 Commercial Office	TSF	21.82	252	--	--	-21.82	-252
	5 Industrial Park	TSF	32.93	198	--	--	-32.93	-198
	SUB-TOTAL			13,421		8,905		-4,516
14	1 SF Residential	DU	291.00	2,881	117.00	1,158	-174.00	-1,723
	6 Other	--	--	1,194		--	--	-1,194
	SUB-TOTAL			4,075		1,158		-2,917
15	1 SF Residential	DU	294.00	2,911	370.00	3,663	76.00	752
	SUB-TOTAL			2,911		3,663		752
16	1 SF Residential	DU	14.00	139	291.00	2,881	277.00	2,742
	SUB-TOTAL			139		2,881		2,742
17	1 SF Residential	DU	248.00	2,455	380.00	3,762	132.00	1,307
	SUB-TOTAL			2,455		3,762		1,307
18	1 SF Residential	DU	474.00	4,354	568.00	5,285	94.00	931
	2 MF Residential	DU	109.00	872	109.00	872	0.00	0
	3 Commercial Retail	TSF	50.00	4,253	21.00	1,786	-29.00	-2,467
	6 Other	--	--	18	--	18	--	0
	SUB-TOTAL			9,497		7,961		-1,536
19	1 SF Residential	DU	1,577.00	15,612	1,577.00	15,612	0.00	0
	6 Other	--	--	4,392	--	4,022	--	-370
	SUB-TOTAL			20,004		19,634		-370
20	1 SF Residential	DU	245.00	2,426	245.00	2,426	0.00	0
	2 MF Residential	DU	136.00	1,088	136.00	1,088	0.00	0
	5 Industrial Park	TSF	174.00	1,044	174.00	1,044	0.00	0
	SUB-TOTAL			4,558		4,558		0
21	1 SF Residential	DU	655.00	6,485	655.00	6,485	0.00	0
	3 Commercial Retail	TSF	70.00	5,954	70.00	5,954	0.00	0
	SUB-TOTAL			12,439		12,439		0
22	1 SF Residential	DU	350.00	3,465	350.00	3,465	0.00	0
	SUB-TOTAL			3,465		3,465		0
23	1 SF Residential	DU	373.00	3,693	373.00	3,693	0.00	0
	SUB-TOTAL			3,693		3,693		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
24	1 SF Residential	DU	422.00	4,178	422.00	4,178	0.00	0
	SUB-TOTAL			4,178		4,178		0
25	6 Other	--	--	725	--	1,088	--	363
	SUB-TOTAL			725		1,088		363
26	3 Commercial Retail	TSF	72.90	2,702	72.90	2,702	0.00	0
	SUB-TOTAL			2,702		2,702		0
27	2 MF Residential	DU	256.00	1,766	256.00	1,766	0.00	0
	SUB-TOTAL			1,766		1,766		0
28	1 SF Residential	DU	1,077.00	10,662	1,077.00	10,662	0.00	0
	6 Other	--	--	725	--	1,088	--	363
	SUB-TOTAL			11,387		11,750		363
29	2 MF Residential	DU	115.00	794	--	--	-115.00	-794
	6 Other	--		--	--	52	--	52
	SUB-TOTAL			794		52		-742
30	2 MF Residential	DU	275.00	2,200	275.00	2,200	0.00	0
	SUB-TOTAL			2,200		2,200		0
31	1 SF Residential	DU	65.00	644	65.00	644	0.00	0
	2 MF Residential	DU	200.00	1,600	200.00	1,600	0.00	0
	6 Other	--	--	2,175	--	1,740	--	-435
	SUB-TOTAL			4,419		3,984		-435
32	2 MF Residential	DU	94.00	752	94.00	752	0.00	0
	SUB-TOTAL			752		752		0
33	3 Commercial Retail	TSF	61.00	5,189	61.00	5,189	0.00	0
	SUB-TOTAL			5,189		5,189		0
34	3 Commercial Retail	TSF	107.10	9,110	107.10	5,790	0.00	-3,320
	SUB-TOTAL			9,110		5,790		-3,320
35	1 SF Residential	DU	616.00	6,098	616.00	6,098	0.00	0
	2 MF Residential	DU	260.00	1,860	260.00	1,860	0.00	0
	SUB-TOTAL			7,958		7,958		0
36	1 SF Residential	DU	483.00	4,782	190.00	1,881	-293.00	-2,901
	2 MF Residential	DU	268.00	2,144	268.00	2,144	0.00	0
	SUB-TOTAL			6,926		4,025		-2,901
37	1 SF Residential	DU	212.00	2,099	212.00	2,099	0.00	0
	2 MF Residential	DU	128.00	1,024	128.00	1,024	0.00	0
	6 Other	--	--	186	--	186	--	0
	SUB-TOTAL			3,309		3,309		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
38	2 MF Residential	DU	331.00	2,399	331.00	2,399	0.00	0
	3 Commercial Retail	TSF	50.00	4,253	50.00	4,253	0.00	0
	SUB-TOTAL			6,652		6,652		0
39	3 Commercial Retail	TSF	150.40	8,131	150.40	8,131	0.00	0
	5 Industrial Park	TSF	4,000.00	24,000	4,000.00	24,000	0.00	0
	SUB-TOTAL			32,131		32,131		0
40	1 SF Residential	DU	45.00	445	--	--	-45.00	-445
	3 Commercial Retail	TSF	--	--	200.00	10,812	200.00	10,812
	4 Commercial Office	TSF	116.70	1,190	116.70	1,190	0.00	0
	6 Other	--	--	24	--	24	--	0
	SUB-TOTAL			1,659		12,026		10,367
41	4 Commercial Office	TSF	177.60	2,053	177.60	2,053	0.00	0
	5 Industrial Park	TSF	685.94	4,116	685.94	4,116	0.00	0
	SUB-TOTAL			6,169		6,169		0
42	4 Commercial Office	TSF	696.85	8,056	696.85	8,056	0.00	0
	SUB-TOTAL			8,056		8,056		0
43	3 Commercial Retail	TSF	27.00	1,001	27.00	1,001	0.00	0
	4 Commercial Office	TSF	100.75	1,165	100.75	1,165	0.00	0
	SUB-TOTAL			2,166		2,166		0
44	1 SF Residential	DU	445.00	4,406	445.00	4,406	0.00	0
	3 Commercial Retail	TSF	35.00	2,498	35.00	2,498	0.00	0
	6 Other	--	--	1,087	--	1,450	--	363
	SUB-TOTAL			7,991		8,354		363
45	4 Commercial Office	TSF	464.93	5,375	464.94	5,375	0.01	0
	5 Industrial Park	TSF	1,215.00	7,290	1,215.00	7,290	0.00	0
	SUB-TOTAL			12,665		12,665		0
46	3 Commercial Retail	TSF	77.00	2,854	77.00	2,854	0.00	0
	5 Industrial Park	TSF	445.80	2,675	445.80	2,675	0.00	0
	SUB-TOTAL			5,529		5,529		0
47	5 Industrial Park	TSF	4,254.10	25,525	4,254.10	25,525	0.00	0
	SUB-TOTAL			25,525		25,525		0
48	5 Industrial Park	TSF	720.00	4,320	720.00	4,320	0.00	0
	SUB-TOTAL			4,320		4,320		0
49	5 Industrial Park	TSF	764.30	4,586	764.30	4,586	0.00	0
	SUB-TOTAL			4,586		4,586		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
50	1 SF Residential	DU	133.00	1,317	350.00	3,465	217.00	2,148
	6 Other	--	--	2,000	--	2,000	--	0
	SUB-TOTAL			3,317		5,465		2,148
51	5 Industrial Park	TSF	1,221.36	7,328	1,221.36	7,328	0.00	0
	SUB-TOTAL			7,328		7,328		0
52	1 SF Residential	DU	1,015.00	10,049	100.00	990	-915.00	-9,059
	SUB-TOTAL			10,049		990		-9,059
53	1 SF Residential	DU	250.00	2,475	35.00	347	-215.00	-2,128
	SUB-TOTAL			2,475		347		-2,128
54	1 SF Residential	DU	62.00	614	62.00	614	0.00	0
	2 MF Residential	DU	589.00	4,712	589.00	4,712	0.00	0
	SUB-TOTAL			5,326		5,326		0
55	1 SF Residential	DU	164.00	1,624	164.00	1,624	0.00	0
	2 MF Residential	DU	922.00	7,376	922.00	7,376	0.00	0
	6 Other	--	--	15	--	15	--	0
	SUB-TOTAL			9,015		9,015		0
56	1 SF Residential	DU	19.00	188	19.00	188	0.00	0
	2 MF Residential	DU	23.00	184	23.00	184	0.00	0
	SUB-TOTAL			372		372		0
57	3 Commercial Retail	TSF	55.40	4,712	55.40	4,712	0.00	0
	4 Commercial Office	TSF	1,274.60	13,144	1,274.60	13,144	0.00	0
	SUB-TOTAL			17,856		17,856		0
58	5 Industrial Park	TSF	1,123.00	6,738	1,123.00	6,738	0.00	0
	SUB-TOTAL			6,738		6,738		0
59	5 Industrial Park	TSF	764.00	3,820	764.00	3,820	0.00	0
	SUB-TOTAL			3,820		3,820		0
60	3 Commercial Retail	TSF	34.80	1,290	34.80	1,290	0.00	0
	4 Commercial Office	TSF	27.20	314	27.20	314	0.00	0
	5 Industrial Park	TSF	160.50	963	160.50	963	0.00	0
	SUB-TOTAL			2,567		2,567		0
61	4 Commercial Office	TSF	48.80	564	48.80	564	0.00	0
	5 Industrial Park	TSF	825.65	4,954	825.65	4,954	0.00	0
	SUB-TOTAL			5,518		5,518		0
62	3 Commercial Retail	TSF	19.50	723	19.50	723	0.00	0
	5 Industrial Park	TSF	430.64	2,584	430.64	2,584	0.00	0
	SUB-TOTAL			3,307		3,307		0
63	5 Industrial Park	TSF	575.00	3,450	575.00	3,450	0.00	0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	6 Other	--		--	--	2,444	--	2,444
	SUB-TOTAL			3,450		5,894		2,444
64	5 Industrial Park	TSF	3,161.48	18,969	3,161.48	18,969	0.00	0
	SUB-TOTAL			18,969		18,969		0
65	3 Commercial Retail	TSF	155.00	6,209	155.00	8,379	0.00	2,170
	5 Industrial Park	TSF	329.00	1,974	329.00	1,974	0.00	0
	SUB-TOTAL			8,183		10,353		2,170
66	3 Commercial Retail	TSF	170.45	6,828	170.45	9,215	0.00	2,387
	5 Industrial Park	TSF	329.00	1,974	329.00	1,974	0.00	0
	SUB-TOTAL			8,802		11,189		2,387
67	1 SF Residential	DU	163.00	1,614	163.00	1,614	0.00	0
	2 MF Residential	DU	90.00	720	90.00	720	0.00	0
	SUB-TOTAL			2,334		2,334		0
68	2 MF Residential	DU	208.00	1,435	208.00	1,435	0.00	0
	SUB-TOTAL			1,435		1,435		0
69	1 SF Residential	DU	76.00	752	76.00	752	0.00	0
	SUB-TOTAL			752		752		0
70	3 Commercial Retail	TSF	147.00	7,947	147.00	7,947	0.00	0
	5 Industrial Park	TSF	604.00	3,557	604.00	3,557	0.00	0
	6 Other	--	--	3,518	--	3,518	--	0
	SUB-TOTAL			15,022		15,022		0
71	6 Other	--	--	4,475	--	4,475	--	0
	SUB-TOTAL			4,475		4,475		0
72	3 Commercial Retail	TSF	60.00	2,224	60.00	2,224	0.00	0
	6 Other	--	--	508	--	508	--	0
	SUB-TOTAL			2,732		2,732		0
74	1 SF Residential	DU	153.00	1,515	153.00	1,515	0.00	0
	2 MF Residential	DU	147.00	1,176	147.00	1,176	0.00	0
	SUB-TOTAL			2,691		2,691		0
75	2 MF Residential	DU	149.00	1,192	149.00	1,192	0.00	0
	6 Other	--	--	9	--	46	--	37
	SUB-TOTAL			1,201		1,238		37
76	2 MF Residential	DU	188.00	1,297	188.00	1,297	0.00	0
	3 Commercial Retail	TSF	11.00	936	11.00	936	0.00	0
	SUB-TOTAL			2,233		2,233		0
78	5 Industrial Park	TSF	1,776.00	10,656	1,776.00	10,656	0.00	0
	SUB-TOTAL			10,656		10,656		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
79	5 Industrial Park	TSF	685.00	4,110	685.00	4,110	0.00	0
	SUB-TOTAL			4,110		4,110		0
80	5 Industrial Park	TSF	880.00	5,280	880.00	5,280	0.00	0
	SUB-TOTAL			5,280		5,280		0
81	5 Industrial Park	TSF	711.00	4,266	711.00	4,266	0.00	0
	SUB-TOTAL			4,266		4,266		0
82	5 Industrial Park	TSF	1,007.55	6,045	1,007.55	6,045	0.00	0
	SUB-TOTAL			6,045		6,045		0
83	5 Industrial Park	TSF	876.00	5,256	876.00	5,256	0.00	0
	SUB-TOTAL			5,256		5,256		0
84	5 Industrial Park	TSF	333.00	1,998	333.00	1,998	0.00	0
	SUB-TOTAL			1,998		1,998		0
86	1 SF Residential	DU	346.00	3,425	--	--	-346.00	-3,425
	3 Commercial Retail	TSF	82.76	8,257	82.76	8,196	0.00	-61
	6 Other	--	--	296	--	296	--	0
	SUB-TOTAL			11,978		8,492		-3,486
87	5 Industrial Park	TSF	1,274.13	7,645	--	--	-1,274.13	-7,645
	SUB-TOTAL			7,645		--		-7,645
89	6 Other	--	--	3,000	--	3,000	--	0
	SUB-TOTAL			3,000		3,000		0
90	2 MF Residential	DU	360.00	2,880	360.00	2,880	0.00	0
	3 Commercial Retail	TSF	1,305.35	57,648	1,305.35	57,648	0.00	0
	5 Industrial Park	TSF	163.88	983	163.88	983	0.00	0
	SUB-TOTAL			61,511		61,511		0
91	3 Commercial Retail	TSF	247.38	13,373	247.38	13,373	0.00	0
	SUB-TOTAL			13,373		13,373		0
92	2 MF Residential	DU	1,333.00	10,664	1,333.00	10,664	0.00	0
	3 Commercial Retail	TSF	618.00	24,757	618.00	24,757	0.00	0
	4 Commercial Office	TSF	629.00	7,271	629.00	7,271	0.00	0
	6 Other	--	--	2,469	--	2,469	--	0
	SUB-TOTAL			45,161		45,161		0
93	3 Commercial Retail	TSF	20.00	741	20.00	741	0.00	0
	6 Other	--	--	1,391	--	1,391	--	0
	SUB-TOTAL			2,132		2,132		0
94	6 Other	--	--	24,000	--	24,000	--	0
	SUB-TOTAL			24,000		24,000		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
96	1 SF Residential	DU	123.00	1,218	123.00	1,218	0.00	0
	2 MF Residential	DU	881.00	7,048	881.00	7,048	0.00	0
	SUB-TOTAL			8,266		8,266		0
97	6 Other	--	--	2,620	--	2,620	--	0
	SUB-TOTAL			2,620		2,620		0
98	3 Commercial Retail	TSF	6.20	527	6.20	527	0.00	0
	4 Commercial Office	TSF	691.50	7,053	691.50	7,053	0.00	0
	SUB-TOTAL			7,580		7,580		0
99	2 MF Residential	DU	470.00	3,760	470.00	3,760	0.00	0
	6 Other	--	--	53	--	53	--	0
	SUB-TOTAL			3,813		3,813		0
100	3 Commercial Retail	TSF	23.00	1,956	23.00	1,956	0.00	0
	4 Commercial Office	TSF	220.00	2,543	220.00	2,543	0.00	0
	SUB-TOTAL			4,499		4,499		0
101	3 Commercial Retail	TSF	491.60	19,693	491.60	19,693	0.00	0
	SUB-TOTAL			19,693		19,693		0
102	1 SF Residential	DU	38.00	376	38.00	376	0.00	0
	2 MF Residential	DU	460.00	3,510	460.00	3,510	0.00	0
	3 Commercial Retail	TSF	10.50	893	10.50	893	0.00	0
	4 Commercial Office	TSF	9.50	110	9.50	110	0.00	0
	SUB-TOTAL			4,889		4,889		0
103	1 SF Residential	DU	95.00	940	95.00	940	0.00	0
	2 MF Residential	DU	169.00	1,352	169.00	1,352	0.00	0
	3 Commercial Retail	TSF	48.00	3,627	48.00	3,627	0.00	0
	6 Other	--	--	1,130	--	1,130	--	0
	SUB-TOTAL			7,049		7,049		0
104	1 SF Residential	DU	175.00	1,732	175.00	1,732	0.00	0
	2 MF Residential	DU	363.00	2,737	363.00	2,737	0.00	0
	3 Commercial Retail	TSF	252.00	13,623	252.00	13,623	0.00	0
	4 Commercial Office	TSF	370.00	4,277	370.00	4,277	0.00	0
	SUB-TOTAL			22,369		22,369		0
105	2 MF Residential	DU	144.00	994	144.00	994	0.00	0
	3 Commercial Retail	TSF	27.10	2,305	27.10	2,305	0.00	0
	4 Commercial Office	TSF	315.90	3,652	315.90	3,652	0.00	0
	SUB-TOTAL			6,951		6,951		0
106	2 MF Residential	DU	520.00	3,588	520.00	3,588	0.00	0
	SUB-TOTAL			3,588		3,588		0
107	1 SF Residential	DU	461.00	4,564	461.00	4,564	0.00	0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	2 MF Residential	DU	326.00	2,608	326.00	2,608	0.00	0
	6 Other	--	--	6,089	--	6,268	--	179
	SUB-TOTAL			13,261		13,440		179
108	2 MF Residential	DU	2,189.00	17,512	2,189.00	17,512	0.00	0
	6 Other	--	--	1,328	--	1,111	--	-217
	SUB-TOTAL			18,840		18,623		-217
109	1 SF Residential	DU	38.00	376	38.00	376	0.00	0
	SUB-TOTAL			376		376		0
110	1 SF Residential	DU	184.00	1,822	184.00	1,822	0.00	0
	2 MF Residential	DU	548.00	4,384	548.00	4,384	0.00	0
	6 Other	--	--	1,329	--	1,112	--	-217
	SUB-TOTAL			7,535		7,318		-217
111	6 Other	--	--	238	--	238	--	0
	SUB-TOTAL			238		238		0
112	1 SF Residential	DU	246.00	2,435	246.00	2,435	0.00	0
	6 Other	--	--	1,433	--	1,433	--	0
	SUB-TOTAL			3,868		3,868		0
113	2 MF Residential	DU	354.00	2,832	354.00	2,832	0.00	0
	SUB-TOTAL			2,832		2,832		0
114	2 MF Residential	DU	560.00	4,480	560.00	4,480	0.00	0
	SUB-TOTAL			4,480		4,480		0
115	1 SF Residential	DU	603.00	5,970	603.00	5,970	0.00	0
	SUB-TOTAL			5,970		5,970		0
116	2 MF Residential	DU	1,262.00	10,096	1,262.00	10,096	0.00	0
	3 Commercial Retail	TSF	628.50	25,178	628.50	25,178	0.00	0
	SUB-TOTAL			35,274		35,274		0
117	2 MF Residential	DU	1,261.00	10,088	1,261.00	10,088	0.00	0
	3 Commercial Retail	TSF	628.50	25,178	628.50	25,178	0.00	0
	SUB-TOTAL			35,266		35,266		0
118	2 MF Residential	DU	161.00	1,288	161.00	1,288	0.00	0
	SUB-TOTAL			1,288		1,288		0
119	2 MF Residential	DU	1,679.00	11,585	1,679.00	11,585	0.00	0
	SUB-TOTAL			11,585		11,585		0
120	2 MF Residential	DU	2,425.00	19,400	2,425.00	19,400	0.00	0
	3 Commercial Retail	TSF	283.30	15,043	283.30	15,043	0.00	0
	4 Commercial Office	TSF	75.00	867	75.00	867	0.00	0
	6 Other	--	--	1,327	--	1,110	--	-217

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	SUB-TOTAL			36,637		36,420		-217
121	1 SF Residential	DU	168.00	1,663	168.00	1,663	0.00	0
	2 MF Residential	DU	418.00	3,344	418.00	3,344	0.00	0
	SUB-TOTAL			5,007		5,007		0
122	2 MF Residential	DU	176.00	1,408	176.00	1,408	0.00	0
	SUB-TOTAL			1,408		1,408		0
123	1 SF Residential	DU	452.00	4,475	452.00	4,475	0.00	0
	2 MF Residential	DU	272.00	2,176	272.00	2,176	0.00	0
	3 Commercial Retail	TSF	17.20	637	17.20	637	0.00	0
	SUB-TOTAL			7,288		7,288		0
124	2 MF Residential	DU	1,343.00	4,983	1,343.00	4,983	0.00	0
	SUB-TOTAL			4,983		4,983		0
125	6 Other	--	--	6,036	--	6,215	--	179
	SUB-TOTAL			6,036		6,215		179
126	3 Commercial Retail	TSF	150.00	8,109	150.00	8,109	0.00	0
	4 Commercial Office	TSF	336.00	3,884	336.00	3,884	0.00	0
	SUB-TOTAL			11,993		11,993		0
127	2 MF Residential	DU	888.00	7,104	888.00	7,104	0.00	0
	SUB-TOTAL			7,104		7,104		0
128	1 SF Residential	DU	450.00	4,455	450.00	4,455	0.00	0
	SUB-TOTAL			4,455		4,455		0
129	1 SF Residential	DU	177.00	1,752	177.00	1,752	0.00	0
	SUB-TOTAL			1,752		1,752		0
130	1 SF Residential	DU	708.00	7,009	708.00	7,009	0.00	0
	SUB-TOTAL			7,009		7,009		0
131	1 SF Residential	DU	14.00	139	14.00	139	0.00	0
	2 MF Residential	DU	1,273.00	10,184	1,273.00	10,184	0.00	0
	6 Other	--	--	249	--	249	--	0
	SUB-TOTAL			10,572		10,572		0
132	1 SF Residential	DU	436.00	4,316	436.00	4,316	0.00	0
	6 Other	--	--	1,347	--	1,130	--	-217
	SUB-TOTAL			5,663		5,446		-217
133	3 Commercial Retail	TSF	27.00	1,460	27.00	1,460	0.00	0
	SUB-TOTAL			1,460		1,460		0
134	1 SF Residential	DU	482.00	4,772	482.00	4,772	0.00	0
	SUB-TOTAL			4,772		4,772		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
135	1 SF Residential	DU	174.00	1,723	174.00	1,723	0.00	0
	2 MF Residential	DU	172.00	1,376	172.00	1,376	0.00	0
	6 Other	--	--	1,656	--	1,656	--	0
	SUB-TOTAL			4,755		4,755		0
137	4 Commercial Office	TSF	72.00	832	72.00	832	0.00	0
	SUB-TOTAL			832		832		0
138	3 Commercial Retail	TSF	120.00	6,487	120.00	6,487	0.00	0
	SUB-TOTAL			6,487		6,487		0
139	2 MF Residential	DU	474.00	3,271	474.00	3,271	0.00	0
	SUB-TOTAL			3,271		3,271		0
140	1 SF Residential	DU	428.00	4,237	428.00	4,237	0.00	0
	2 MF Residential	DU	1,266.00	10,128	1,266.00	10,128	0.00	0
	3 Commercial Retail	TSF	20.00	1,701	20.00	1,701	0.00	0
	4 Commercial Office	TSF	31.00	358	31.00	358	0.00	0
	6 Other	--	--	593	--	593	--	0
	SUB-TOTAL			17,017		17,017		0
141	3 Commercial Retail	TSF	30.40	7,657	30.40	7,657	0.00	0
	4 Commercial Office	TSF	--	--	50.00	578	50.00	578
	SUB-TOTAL			7,657		8,235		578
142	2 MF Residential	DU	670.00	5,360	670.00	5,360	0.00	0
	SUB-TOTAL			5,360		5,360		0
143	1 SF Residential	DU	578.00	5,722	578.00	5,722	0.00	0
	2 MF Residential	DU	160.00	1,280	160.00	1,280	0.00	0
	6 Other	--	--	1,251	--	2,846	--	1,595
	SUB-TOTAL			8,253		9,848		1,595
144	1 SF Residential	DU	6.00	59	6.00	59	0.00	0
	SUB-TOTAL			59		59		0
145	3 Commercial Retail	TSF	874.22	40,255	874.22	40,255	0.00	0
	5 Industrial Park	TSF	74.50	380	74.50	380	0.00	0
	SUB-TOTAL			40,635		40,635		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
146	1 SF Residential	DU	314.00	3,109	314.00	3,109	0.00	0
	2 MF Residential	DU	296.00	2,368	296.00	2,368	0.00	0
	SUB-TOTAL			5,477		5,477		0
147	1 SF Residential	DU	140.00	1,386	140.00	1,386	0.00	0
	2 MF Residential	DU	667.00	4,712	667.00	4,712	0.00	0
	6 Other	--	--	1,246	--	1,101	--	-145
	SUB-TOTAL			7,344		7,199		-145
148	3 Commercial Retail	TSF	196.58	13,426	196.58	13,426	0.00	0
	SUB-TOTAL			13,426		13,426		0
149	1 SF Residential	DU	535.00	5,297	535.00	5,297	0.00	0
	2 MF Residential	DU	500.00	4,000	500.00	4,000	0.00	0
	3 Commercial Retail	TSF	34.85	2,964	34.85	2,964	0.00	0
	SUB-TOTAL			12,261		12,261		0
150	1 SF Residential	DU	114.00	1,129	114.00	1,129	0.00	0
	SUB-TOTAL			1,129		1,129		0
151	1 SF Residential	DU	71.00	703	71.00	703	0.00	0
	SUB-TOTAL			703		703		0
152	1 SF Residential	DU	279.00	2,762	892.00	8,831	613.00	6,069
	6 Other	--	--	47	--	47	--	0
	SUB-TOTAL			2,809		8,878		6,069
153	1 SF Residential	DU	424.00	4,198	424.00	4,198	0.00	0
	SUB-TOTAL			4,198		4,198		0
158	1 SF Residential	DU	100.00	990	--	--	-100.00	-990
	SUB-TOTAL			990		--		-990
159	1 SF Residential	DU	4.00	40	4.00	40	0.00	0
	5 Industrial Park	TSF	--	--	16.00	80	16.00	80
	6 Other	--		--	--	233	--	233
	SUB-TOTAL			40		353		313
160	1 SF Residential	DU	95.00	940	95.00	940	0.00	0
	2 MF Residential	DU	95.00	352	95.00	352	0.00	0
	SUB-TOTAL			1,292		1,292		0
161	1 SF Residential	DU	667.00	6,603	640.00	6,336	-27.00	-267
	2 MF Residential	DU	650.00	5,200	650.00	5,200	0.00	0
	3 Commercial Retail	TSF	151.82	18,358	151.82	18,358	0.00	0
	4 Commercial Office	TSF	282.41	3,265	282.41	3,265	0.00	0
	6 Other	--	--	7,903	--	2,329	--	-5,574
	SUB-TOTAL			41,329		35,488		-5,841
162	1 SF Residential	DU	248.00	2,455	335.00	3,055	87.00	600

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	3 Commercial Retail	TSF	102.42	5,537	102.42	5,537	0.00	0
	5 Industrial Park	TSF	240.00	1,440	240.00	1,440	0.00	0
	SUB-TOTAL			9,432		10,032		600
163	5 Industrial Park	TSF	2,567.08	15,402	1,000.00	6,000	-1,567.08	-9,402
	SUB-TOTAL			15,402		6,000		-9,402
164	1 SF Residential	DU	204.00	2,020	204.00	2,020	0.00	0
	2 MF Residential	DU	--	--	86.00	319	86.00	319
	5 Industrial Park	TSF	--	--	30.00	180	30.00	180
	6 Other	--	--	1,154	--	73	--	-1,081
	SUB-TOTAL			3,174		2,592		-582
165	1 SF Residential	DU	86.00	851	86.00	851	0.00	0
	2 MF Residential	DU	80.00	640	287.00	2,296	207.00	1,656
	3 Commercial Retail	TSF	151.78	9,310	127.83	6,188	-23.95	-3,122
	4 Commercial Office	TSF	13.81	160	13.81	160	0.00	0
	5 Industrial Park	TSF	1,893.36	11,358	3,402.47	20,413	1,509.11	9,055
	6 Other	--	--	414	--	414	--	0
	SUB-TOTAL			22,733		30,322		7,589
166	1 SF Residential	DU	431.00	4,267	431.00	4,267	0.00	0
	2 MF Residential	DU	292.00	2,336	462.00	3,696	170.00	1,360
	3 Commercial Retail	TSF	74.36	5,495	74.36	7,082	0.00	1,587
	4 Commercial Office	TSF	30.10	348	30.10	348	0.00	0
	5 Industrial Park	TSF	11.00	56	11.00	56	0.00	0
	6 Other	--	--	648	--	242	--	-406
	SUB-TOTAL			13,150		15,691		2,541
167	1 SF Residential	DU	327.00	3,237	196.00	1,940	-131.00	-1,297
	SUB-TOTAL			3,237		1,940		-1,297
168	1 SF Residential	DU	247.00	2,445	247.00	2,445	0.00	0
	SUB-TOTAL			2,445		2,445		0
169	1 SF Residential	DU	127.00	1,257	127.00	1,257	0.00	0
	2 MF Residential	DU	94.00	752	94.00	752	0.00	0
	3 Commercial Retail	TSF	200.00	8,012	300.00	12,018	100.00	4,006
	4 Commercial Office	TSF	--	--	20.00	684	20.00	684
	6 Other	--		--	--	152	--	152
	SUB-TOTAL			10,021		14,863		4,842
170	1 SF Residential	DU	163.00	1,614	60.00	594	-103.00	-1,020
	SUB-TOTAL			1,614		594		-1,020
171	1 SF Residential	DU	32.00	317	60.00	594	28.00	277
	6 Other	--	--	979	--	1,088	--	109
	SUB-TOTAL			1,296		1,682		386
172	1 SF Residential	DU	185.00	1,831	185.00	1,831	0.00	0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
	SUB-TOTAL			1,831		1,831		0
173	1 SF Residential	DU	386.00	3,821	386.00	3,821	0.00	0
	SUB-TOTAL			3,821		3,821		0
174	2 MF Residential	DU	--	--	400.00	2,342	400.00	2,342
	3 Commercial Retail	TSF	337.20	18,229	350.00	18,535	12.80	306
	4 Commercial Office	TSF	--	--	350.00	4,046	350.00	4,046
	6 Other	--		--	--	2,469	--	2,469
	SUB-TOTAL			18,229		27,392		9,163
175	1 SF Residential	DU	162.00	1,604	380.00	3,108	218.00	1,504
	2 MF Residential	DU	160.00	1,280	210.00	1,625	50.00	345
	3 Commercial Retail	TSF	98.01	5,298	98.01	5,298	0.00	0
	6 Other	--	--	1,367	--	1,295	--	-72
	SUB-TOTAL			9,549		11,326		1,777
176	1 SF Residential	DU	762.00	7,544	762.00	7,544	0.00	0
	2 MF Residential	DU	135.00	1,080	270.00	2,012	135.00	932
	3 Commercial Retail	TSF	337.59	13,100	337.59	13,100	0.00	0
	6 Other	--		--	--	326	--	326
	SUB-TOTAL			21,724		22,982		1,258
177	1 SF Residential	DU	542.00	5,366	477.00	4,722	-65.00	-644
	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	3 Commercial Retail	TSF	97.57	5,275	97.57	5,275	0.00	0
	6 Other	--	--	776	--	1,264	--	488
	SUB-TOTAL			13,529		13,373		-156
178	1 SF Residential	DU	333.00	3,297	333.00	3,297	0.00	0
	3 Commercial Retail	TSF	28.31	1,419	28.31	1,419	0.00	0
	4 Commercial Office	TSF	50.81	587	50.81	587	0.00	0
	6 Other	--		--	--	102	--	102
	SUB-TOTAL			5,303		5,405		102
179	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	2 MF Residential	DU	--	--	209.00	775	209.00	775
	3 Commercial Retail	TSF	46.25	2,130	28.78	4,280	-17.47	2,150
	4 Commercial Office	TSF	24.83	849	52.00	1,778	27.17	929
	6 Other	--	--	207	--	207	--	0
	SUB-TOTAL			4,839		8,693		3,854
180	1 SF Residential	DU	428.00	4,237	428.00	4,237	0.00	0
	6 Other	--		--	--	653	--	653
	SUB-TOTAL			4,237		4,890		653

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
181	1 SF Residential	DU	282.00	2,792	282.00	2,792	0.00	0
	6 Other	--	--	1,124	--	1,088	--	-36
	SUB-TOTAL			3,916		3,880		-36
182	1 SF Residential	DU	514.00	4,374	276.00	2,732	-238.00	-1,642
	2 MF Residential	DU	229.00	1,832	238.00	1,904	9.00	72
	3 Commercial Retail	TSF	76.23	4,121	96.23	5,202	20.00	1,081
	6 Other	--	--	280	--	280	--	0
	SUB-TOTAL			10,607		10,118		-489
183	2 MF Residential	DU	634.00	5,072	634.00	5,072	0.00	0
	3 Commercial Retail	TSF	3.50	298	3.50	298	0.00	0
	6 Other	--	--	5,838	--	6,956	--	1,118
	SUB-TOTAL			11,208		12,326		1,118
184	4 Commercial Office	TSF	250.00	2,890	100.00	1,156	-150.00	-1,734
	6 Other	--		--	--	528	--	528
	SUB-TOTAL			2,890		1,684		-1,206
185	1 SF Residential	DU	344.00	3,406	344.00	3,406	0.00	0
	SUB-TOTAL			3,406		3,406		0
186	1 SF Residential	DU	150.00	1,485	150.00	1,485	0.00	0
	4 Commercial Office	TSF	308.90	10,564	402.00	13,748	93.10	3,184
	6 Other	--	--	4,244	--	5,720	--	1,476
	SUB-TOTAL			16,293		20,953		4,660
187	1 SF Residential	DU	111.00	1,099	111.00	1,099	0.00	0
	2 MF Residential	DU	307.00	2,456	426.00	2,897	119.00	441
	6 Other	--	--	554	--	36	--	-518
	SUB-TOTAL			4,109		4,032		-77
188	1 SF Residential	DU	72.00	713	72.00	713	0.00	0
	2 MF Residential	DU	216.00	1,728	216.00	1,728	0.00	0
	SUB-TOTAL			2,441		2,441		0
189	3 Commercial Retail	TSF	--	--	3.00	255	3.00	255
	4 Commercial Office	TSF	28.44	329	--	--	-28.44	-329
	6 Other	--	--	30,800	--	30,800	--	0
	SUB-TOTAL			31,129		31,055		-74
190	1 SF Residential	DU	171.00	1,693	171.00	1,693	0.00	0
	SUB-TOTAL			1,693		1,693		0
191	4 Commercial Office	TSF	78.56	2,687	78.56	2,687	0.00	0
	SUB-TOTAL			2,687		2,687		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
192	1 SF Residential	DU	164.00	1,624	164.00	1,624	0.00	0
	2 MF Residential	DU	660.00	5,280	660.00	5,280	0.00	0
	6 Other	--		--	--	520	--	520
	SUB-TOTAL			6,904		7,424		520
193	4 Commercial Office	TSF	250.00	2,550	250.00	2,550	0.00	0
	SUB-TOTAL			2,550		2,550		0
194	6 Other	--	--	796	--	796	--	0
	SUB-TOTAL			796		796		0
195	1 SF Residential	DU	76.00	752	--	--	-76.00	-752
	2 MF Residential	DU	--	--	76.00	608	76.00	608
	SUB-TOTAL			752		608		-144
196	2 MF Residential	DU	--	--	10.00	80	10.00	80
	3 Commercial Retail	TSF	16.00	593	2.50	93	-13.50	-500
	4 Commercial Office	TSF	--	--	34.55	399	34.55	399
	6 Other	--		--	--	1,646	--	1,646
	SUB-TOTAL			593		2,218		1,625
197	3 Commercial Retail	TSF	--	--	13.00	1,106	13.00	1,106
	4 Commercial Office	TSF	400.00	4,080	400.00	4,080	0.00	0
	SUB-TOTAL			4,080		5,186		1,106
198	1 SF Residential	DU	331.00	3,277	331.00	3,277	0.00	0
	SUB-TOTAL			3,277		3,277		0
199	3 Commercial Retail	TSF	5.00	652	5.00	652	0.00	0
	6 Other	--	--	1,951	--	1,951	--	0
	SUB-TOTAL			2,603		2,603		0
200	4 Commercial Office	TSF	578.00	5,896	578.00	5,896	0.00	0
	SUB-TOTAL			5,896		5,896		0
201	4 Commercial Office	TSF	250.00	2,550	160.00	1,632	-90.00	-918
	SUB-TOTAL			2,550		1,632		-918
202	2 MF Residential	DU	560.00	3,864	560.00	3,864	0.00	0
	3 Commercial Retail	TSF	22.00	815	22.00	815	0.00	0
	4 Commercial Office	TSF	13.00	150	13.00	150	0.00	0
	6 Other	--	--	4,218	--	4,218	--	0
	SUB-TOTAL			9,047		9,047		0
203	2 MF Residential	DU	--	--	450.00	3,105	450.00	3,105
	3 Commercial Retail	TSF	1,504.00	60,250	2,000.00	80,120	496.00	19,870
	4 Commercial Office	TSF	125.00	1,445	125.00	1,445	0.00	0
	SUB-TOTAL			61,695		84,670		22,975
204	3 Commercial Retail	TSF	62.00	2,298	62.00	2,298	0.00	0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	4 Commercial Office	TSF	400.00	4,624	400.00	4,624	0.00	0
	6 Other	--	--	5,808	--	5,808	--	0
	SUB-TOTAL			12,730		12,730		0
205	3 Commercial Retail	TSF	47.30	2,557	100.00	5,406	52.70	2,849
	4 Commercial Office	TSF	198.89	2,299	850.00	9,826	651.11	7,527
	6 Other	--	--	1,700	--	3,399	--	1,699
	SUB-TOTAL			6,556		18,631		12,075
206	3 Commercial Retail	TSF	187.61	11,782	187.61	11,782	0.00	0
	SUB-TOTAL			11,782		11,782		0
207	3 Commercial Retail	TSF	--	--	6.00	782	6.00	782
	4 Commercial Office	TSF	230.00	2,659	350.00	4,046	120.00	1,387
	SUB-TOTAL			2,659		4,828		2,169
208	2 MF Residential	DU	234.00	1,872	234.00	1,872	0.00	0
	SUB-TOTAL			1,872		1,872		0
209	1 SF Residential	DU	414.00	4,099	414.00	4,099	0.00	0
	2 MF Residential	DU	352.00	2,816	352.00	2,816	0.00	0
	6 Other	--	--	1,160	--	1,088	--	-72
	SUB-TOTAL			8,075		8,003		-72
210	1 SF Residential	DU	205.00	2,029	205.00	2,029	0.00	0
	2 MF Residential	DU	208.00	1,664	208.00	1,664	0.00	0
	3 Commercial Retail	TSF	148.10	8,006	148.10	8,006	0.00	0
	SUB-TOTAL			11,699		11,699		0
211	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	SUB-TOTAL			1,653		1,653		0
212	1 SF Residential	DU	252.00	2,495	252.00	2,495	0.00	0
	2 MF Residential	DU	272.00	2,176	272.00	2,176	0.00	0
	6 Other	--	--	179	--	179	--	0
	SUB-TOTAL			4,850		4,850		0
213	1 SF Residential	DU	275.00	2,723	275.00	2,723	0.00	0
	6 Other	--	--	233	--	233	--	0
	SUB-TOTAL			2,956		2,956		0
214	1 SF Residential	DU	--	--	49.00	485	49.00	485
	2 MF Residential	DU	307.00	2,118	181.00	1,330	-126.00	-788
	6 Other	--		--	--	74	--	74
	SUB-TOTAL			2,118		1,889		-229

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
215	1 SF Residential	DU	105.00	1,040	80.00	792	-25.00	-248
	2 MF Residential	DU	52.00	416	52.00	416	0.00	0
	3 Commercial Retail	TSF	143.56	7,020	143.56	7,020	0.00	0
	6 Other	--	--	5,822	--	6,027	--	205
	SUB-TOTAL			14,298		14,255		-43
216	1 SF Residential	DU	22.00	218	22.00	218	0.00	0
	2 MF Residential	DU	378.00	3,024	448.00	3,507	70.00	483
	3 Commercial Retail	TSF	204.96	11,080	204.96	11,080	0.00	0
	4 Commercial Office	TSF	65.45	757	65.45	757	0.00	0
	SUB-TOTAL			15,079		15,562		483
217	1 SF Residential	DU	202.00	2,000	202.00	2,000	0.00	0
	2 MF Residential	DU	316.00	2,528	386.00	3,011	70.00	483
	3 Commercial Retail	TSF	110.75	5,222	110.75	5,222	0.00	0
	4 Commercial Office	TSF	22.44	259	22.44	259	0.00	0
	5 Industrial Park	TSF	22.44	135	22.44	135	0.00	0
	6 Other	--	--	82		--	--	-82
	SUB-TOTAL			10,226		10,627		401
218	1 SF Residential	DU	511.00	4,606	511.00	4,606	0.00	0
	2 MF Residential	DU	641.00	5,128	810.00	6,414	169.00	1,286
	3 Commercial Retail	TSF	557.87	24,488	557.87	24,488	0.00	0
	6 Other	--	--	88	--	1,176	--	1,088
	SUB-TOTAL			34,310		36,684		2,374
219	1 SF Residential	DU	230.00	2,277	20.00	198	-210.00	-2,079
	2 MF Residential	DU	--	--	250.00	2,000	250.00	2,000
	4 Commercial Office	TSF	--	--	100.00	1,020	100.00	1,020
	SUB-TOTAL			2,277		3,218		941
220	1 SF Residential	DU	8.00	79	8.00	79	0.00	0
	4 Commercial Office	TSF	--	--	100.00	1,020	100.00	1,020
	6 Other	--	--	1,348	--	1,348	--	0
	SUB-TOTAL			1,427		2,447		1,020
221	1 SF Residential	DU	438.00	4,246	380.00	3,672	-58.00	-574
	2 MF Residential	DU	6.00	48	6.00	48	0.00	0
	4 Commercial Office	TSF	--	--	50.00	510	50.00	510
	5 Industrial Park	TSF	144.40	866	144.40	866	0.00	0
	6 Other	--	--	1,417	--	1,417	--	0
	SUB-TOTAL			6,577		6,513		-64
222	1 SF Residential	DU	105.00	1,040	55.00	545	-50.00	-495
	2 MF Residential	DU	112.00	896	--	--	-112.00	-896
	5 Industrial Park	TSF	124.15	745	--	--	-124.15	-745
	6 Other	--	--	3,861	--	3,861	--	0
	SUB-TOTAL			6,542		4,406		-2,136
223	1 SF Residential	DU	32.00	317	--	--	-32.00	-317

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	2 MF Residential	DU	641.00	5,128	--	--	-641.00	-5,128
	3 Commercial Retail	TSF	67.50	5,742	110.00	5,947	42.50	205
	4 Commercial Office	TSF	150.00	1,734	248.00	2,867	98.00	1,133
	5 Industrial Park	TSF	415.00	2,490	242.00	1,452	-173.00	-1,038
	6 Other	--	--	1,249	--	823	--	-426
	SUB-TOTAL			16,660		11,089		-5,571
224	1 SF Residential	DU	356.00	3,434	280.00	2,682	-76.00	-752
	2 MF Residential	DU	525.00	4,200	550.00	4,400	25.00	200
	3 Commercial Retail	TSF	116.68	4,324	116.68	4,324	0.00	0
	6 Other	--	--	3,970	--	4,011	--	41
	SUB-TOTAL			15,928		15,417		-511
225	1 SF Residential	DU	156.00	1,544	156.00	1,544	0.00	0
	2 MF Residential	DU	151.00	1,208	--	--	-151.00	-1,208
	6 Other	--	--	2,368	--	1,776	--	-592
	SUB-TOTAL			5,120		3,320		-1,800
226	1 SF Residential	DU	300.00	2,970	300.00	2,970	0.00	0
	2 MF Residential	DU	292.00	2,336	292.00	2,336	0.00	0
	3 Commercial Retail	TSF	85.38	3,431	85.38	3,917	0.00	486
	6 Other	--	--	74	--	354	--	280
	SUB-TOTAL			8,811		9,577		766
227	1 SF Residential	DU	172.00	1,703	118.00	1,168	-54.00	-535
	2 MF Residential	DU	184.00	1,472	786.00	6,288	602.00	4,816
	4 Commercial Office	TSF	563.56	5,748	--	--	-563.56	-5,748
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			8,923		8,544		-379
228	1 SF Residential	DU	358.00	3,544	385.00	3,811	27.00	267
	SUB-TOTAL			3,544		3,811		267
229	1 SF Residential	DU	178.00	1,763	178.00	1,763	0.00	0
	SUB-TOTAL			1,763		1,763		0
230	1 SF Residential	DU	10.00	99	10.00	99	0.00	0
	SUB-TOTAL			99		99		0
231	1 SF Residential	DU	5.00	50	5.00	50	0.00	0
	2 MF Residential	DU	51.00	408	51.00	408	0.00	0
	6 Other	--	--	69	--	69	--	0
	SUB-TOTAL			527		527		0
232	1 SF Residential	DU	10.00	99	10.00	99	0.00	0
	2 MF Residential	DU	--	--	850.00	5,865	850.00	5,865
	SUB-TOTAL			99		5,964		5,865
233	4 Commercial Office	TSF	569.47	5,809	--	--	-569.47	-5,809
	SUB-TOTAL			5,809		--		-5,809

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	ADT	Amount	ADT	Amount	ADT
234	3 Commercial Retail	TSF	100.00	5,406	100.00	5,406	0.00	0
	4 Commercial Office	TSF	470.24	4,796	470.24	4,796	0.00	0
	SUB-TOTAL			10,202		10,202		0
235	3 Commercial Retail	TSF	20.00	1,081	240.00	12,974	220.00	11,893
	4 Commercial Office	TSF	130.00	1,326	80.00	816	-50.00	-510
	SUB-TOTAL			2,407		13,790		11,383
236	1 SF Residential	DU	808.00	8,000	808.00	8,000	0.00	0
	6 Other	--	--	951	--	1,101	--	150
	SUB-TOTAL			8,951		9,101		150
237	1 SF Residential	DU	225.00	2,228	225.00	2,228	0.00	0
	2 MF Residential	DU	570.00	3,933	570.00	3,933	0.00	0
	4 Commercial Office	TSF	99.00	1,144	99.00	1,144	0.00	0
	6 Other	--	--	63	--	63	--	0
	SUB-TOTAL			7,368		7,368		0
238	1 SF Residential	DU	399.00	3,950	399.00	3,950	0.00	0
	2 MF Residential	DU	123.00	984	123.00	984	0.00	0
	3 Commercial Retail	TSF	184.00	12,575	184.00	12,479	0.00	-96
	4 Commercial Office	TSF	340.00	3,621	340.00	3,621	0.00	0
	5 Industrial Park	TSF	944.00	5,664	944.00	5,664	0.00	0
	6 Other	--	--	67	--	67	--	0
	SUB-TOTAL			26,861		26,765		-96
239	3 Commercial Retail	TSF	337.29	12,500	337.29	12,500	0.00	0
	4 Commercial Office	TSF	262.87	3,039	262.87	3,039	0.00	0
	5 Industrial Park	TSF	1,939.67	10,240	387.07	2,322	-1,552.60	-7,918
	6 Other	--	--	895	--	895	--	0
	SUB-TOTAL			26,674		18,756		-7,918
240	3 Commercial Retail	TSF	181.00	12,417	181.00	14,181	0.00	1,764
	SUB-TOTAL			12,417		14,181		1,764
241	3 Commercial Retail	TSF	44.00	2,665	--	--	-44.00	-2,665
	4 Commercial Office	TSF	--	--	1,228.00	13,198	1,228.00	13,198
	6 Other	--		--	--	1,128	--	1,128
	SUB-TOTAL			2,665		14,326		11,661
242	4 Commercial Office	TSF	368.00	3,910	368.00	3,910	0.00	0
	SUB-TOTAL			3,910		3,910		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
243	1 SF Residential	DU	211.00	2,089	211.00	2,089	0.00	0
	2 MF Residential	DU	816.00	6,099	816.00	6,099	0.00	0
	3 Commercial Retail	TSF	129.00	9,138	129.00	10,188	0.00	1,050
	4 Commercial Office	TSF	164.00	1,896	164.00	1,896	0.00	0
	SUB-TOTAL			19,222		20,272		1,050
244	1 SF Residential	DU	512.00	5,068	322.00	3,188	-190.00	-1,880
	2 MF Residential	DU	157.00	1,256	--	--	-157.00	-1,256
	SUB-TOTAL			6,324		3,188		-3,136
245	1 SF Residential	DU	--	--	20.00	198	20.00	198
	2 MF Residential	DU	148.00	1,184	--	--	-148.00	-1,184
	5 Industrial Park	TSF	406.74	2,385	--	--	-406.74	-2,385
	6 Other	--		--	--	34	--	34
	SUB-TOTAL			3,569		232		-3,337
246	3 Commercial Retail	TSF	36.00	3,062	--	--	-36.00	-3,062
	5 Industrial Park	TSF	58.81	300	120.00	612	61.19	312
	SUB-TOTAL			3,362		612		-2,750
247	3 Commercial Retail	TSF	71.37	3,858	500.00	20,030	428.63	16,172
	SUB-TOTAL			3,858		20,030		16,172
248	1 SF Residential	DU	2.00	20	2.00	20	0.00	0
	2 MF Residential	DU	4.00	32	4.00	32	0.00	0
	5 Industrial Park	TSF	882.09	5,293	1,200.00	7,200	317.91	1,907
	SUB-TOTAL			5,345		7,252		1,907
249	4 Commercial Office	TSF	150.00	1,734	250.00	2,890	100.00	1,156
	5 Industrial Park	TSF	291.68	1,488	291.68	1,488	0.00	0
	SUB-TOTAL			3,222		4,378		1,156
250	2 MF Residential	DU	--	--	450.00	3,435	450.00	3,435
	3 Commercial Retail	TSF	148.66	7,050	448.66	17,799	300.00	10,749
	4 Commercial Office	TSF	--	--	300.00	3,264	300.00	3,264
	SUB-TOTAL			7,050		24,498		17,448
251	5 Industrial Park	TSF	400.00	2,400	400.00	2,400	0.00	0
	SUB-TOTAL			2,400		2,400		0
252	4 Commercial Office	TSF	858.00	8,752	858.00	8,752	0.00	0
	SUB-TOTAL			8,752		8,752		0
253	1 SF Residential	DU	84.00	832	32.00	317	-52.00	-515
	SUB-TOTAL			832		317		-515
254	3 Commercial Retail	TSF	116.21	6,134	116.21	6,134	0.00	0
	SUB-TOTAL			6,134		6,134		0
255	1 SF Residential	DU	69.00	683	20.00	198	-49.00	-485

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	SUB-TOTAL			683		198		-485
256	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	SUB-TOTAL			198		198		0
257	1 SF Residential	DU	304.00	3,009	170.00	1,683	-134.00	-1,326
	2 MF Residential	DU	11.00	88	--	--	-11.00	-88
	SUB-TOTAL			3,097		1,683		-1,414
258	1 SF Residential	DU	97.00	960	130.00	1,287	33.00	327
	5 Industrial Park	TSF	125.00	638	125.00	638	0.00	0
	6 Other	--		--	--	3,324	--	3,324
	SUB-TOTAL			1,598		5,249		3,651
259	1 SF Residential	DU	14.00	139	10.00	99	-4.00	-40
	2 MF Residential	DU	237.00	1,896	--	--	-237.00	-1,896
	SUB-TOTAL			2,035		99		-1,936
260	1 SF Residential	DU	402.00	3,980	402.00	3,980	0.00	0
	SUB-TOTAL			3,980		3,980		0
261	1 SF Residential	DU	295.00	2,921	25.00	247	-270.00	-2,674
	SUB-TOTAL			2,921		247		-2,674
262	1 SF Residential	DU	790.00	7,821	790.00	7,821	0.00	0
	2 MF Residential	DU	--	--	100.00	800	100.00	800
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			8,909		9,709		800
263	2 MF Residential	DU	140.00	1,120	200.00	1,600	60.00	480
	SUB-TOTAL			1,120		1,600		480
264	1 SF Residential	DU	63.00	624	63.00	624	0.00	0
	2 MF Residential	DU	--	--	264.00	2,026	264.00	2,026
	SUB-TOTAL			624		2,650		2,026
265	2 MF Residential	DU	1,338.00	10,704	670.00	4,975	-668.00	-5,729
	SUB-TOTAL			10,704		4,975		-5,729
266	2 MF Residential	DU	--	--	200.00	742	200.00	742
	3 Commercial Retail	TSF	101.04	5,462	120.00	6,487	18.96	1,025
	5 Industrial Park	TSF	--	--	75.00	383	75.00	383
	SUB-TOTAL			5,462		7,612		2,150
267	3 Commercial Retail	TSF	100.00	5,406	200.00	10,812	100.00	5,406
	SUB-TOTAL			5,406		10,812		5,406

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
268	2 MF Residential	DU	400.00	3,200	180.00	1,440	-220.00	-1,760
	3 Commercial Retail	TSF	182.33	9,857	182.33	9,857	0.00	0
	5 Industrial Park	TSF	75.00	383	112.00	571	37.00	188
	SUB-TOTAL			13,440		11,868		-1,572
269	1 SF Residential	DU	687.00	6,801	266.00	2,633	-421.00	-4,168
	2 MF Residential	DU	--	--	25.00	93	25.00	93
	6 Other	--	--	2,735	--	737	--	-1,998
	SUB-TOTAL			9,536		3,463		-6,073
270	1 SF Residential	DU	8.00	79	308.00	3,049	300.00	2,970
	2 MF Residential	DU	--	--	75.00	278	75.00	278
	SUB-TOTAL			79		3,327		3,248
271	2 MF Residential	DU	155.00	1,070	171.00	1,180	16.00	110
	3 Commercial Retail	TSF	690.66	27,668	630.00	25,238	-60.66	-2,430
	SUB-TOTAL			28,738		26,418		-2,320
272	1 SF Residential	DU	967.00	9,573	967.00	9,573	0.00	0
	2 MF Residential	DU	823.00	6,584	180.00	1,440	-643.00	-5,144
	3 Commercial Retail	TSF	8.12	691	8.12	691	0.00	0
	6 Other	--	--	1,088	--	1,088	--	0
	SUB-TOTAL			17,936		12,792		-5,144
273	1 SF Residential	DU	101.00	1,000	101.00	1,000	0.00	0
	SUB-TOTAL			1,000		1,000		0
274	1 SF Residential	DU	362.00	3,584	80.00	792	-282.00	-2,792
	4 Commercial Office	TSF	110.06	1,123	110.06	1,123	0.00	0
	SUB-TOTAL			4,707		1,915		-2,792
275	1 SF Residential	DU	225.00	2,228	225.00	2,228	0.00	0
	SUB-TOTAL			2,228		2,228		0
276	1 SF Residential	DU	75.00	743	75.00	743	0.00	0
	2 MF Residential	DU	539.00	4,312	539.00	4,312	0.00	0
	3 Commercial Retail	TSF	98.01	8,337	98.01	8,337	0.00	0
	6 Other	--	--	73	--	73	--	0
	SUB-TOTAL			13,465		13,465		0
277	3 Commercial Retail	TSF	7.91	809	73.00	4,175	65.09	3,366
	4 Commercial Office	TSF	--	--	110.00	3,536	110.00	3,536
	5 Industrial Park	TSF	--	--	150.00	765	150.00	765
	SUB-TOTAL			809		8,476		7,667
278	2 MF Residential	DU	757.00	6,056	757.00	6,056	0.00	0
	3 Commercial Retail	TSF	81.89	6,966	81.89	6,966	0.00	0
	6 Other	--	--	398	--	398	--	0
	SUB-TOTAL			13,420		13,420		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
279	1 SF Residential	DU	313.00	2,160	313.00	2,160	0.00	0
	3 Commercial Retail	TSF	26.33	2,240	26.33	2,240	0.00	0
	4 Commercial Office	TSF	0.20	2	0.20	2	0.00	0
	5 Industrial Park	TSF	58.00	348	58.00	348	0.00	0
	SUB-TOTAL			4,750		4,750		0
280	4 Commercial Office	TSF	38.18	389	38.18	389	0.00	0
	SUB-TOTAL			389		389		0
281	2 MF Residential	DU	150.00	1,200	150.00	1,200	0.00	0
	SUB-TOTAL			1,200		1,200		0
282	2 MF Residential	DU	486.00	3,888	700.00	5,600	214.00	1,712
	3 Commercial Retail	TSF	17.90	968	17.90	968	0.00	0
	SUB-TOTAL			4,856		6,568		1,712
283	1 SF Residential	DU	161.00	1,594	175.00	1,732	14.00	138
	2 MF Residential	DU	400.00	3,200	667.00	5,336	267.00	2,136
	6 Other	--	--	1,618	--	1,740	--	122
	SUB-TOTAL			6,412		8,808		2,396
284	1 SF Residential	DU	392.00	2,842	2.00	20	-390.00	-2,822
	2 MF Residential	DU	--	--	254.00	2,032	254.00	2,032
	SUB-TOTAL			2,842		2,052		-790
285	1 SF Residential	DU	80.00	792	80.00	792	0.00	0
	3 Commercial Retail	TSF	246.99	9,894	246.99	9,894	0.00	0
	4 Commercial Office	TSF	--	--	150.00	1,530	150.00	1,530
	SUB-TOTAL			10,686		12,216		1,530
286	1 SF Residential	DU	82.00	812	182.00	1,802	100.00	990
	SUB-TOTAL			812		1,802		990
287	1 SF Residential	DU	111.00	1,099	35.00	347	-76.00	-752
	2 MF Residential	DU	--	--	120.00	960	120.00	960
	SUB-TOTAL			1,099		1,307		208
288	1 SF Residential	DU	--	--	167.00	1,653	167.00	1,653
	6 Other	--	--	4,475	--	4,475	--	0
	SUB-TOTAL			4,475		6,128		1,653
289	1 SF Residential	DU	166.00	1,643	166.00	1,643	0.00	0
	2 MF Residential	DU	--	--	350.00	2,415	350.00	2,415
	4 Commercial Office	TSF	57.17	583	57.17	583	0.00	0
	SUB-TOTAL			2,226		4,641		2,415

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
290	1 SF Residential	DU	64.00	634	104.00	1,030	40.00	396
	2 MF Residential	DU	93.00	744	93.00	744	0.00	0
	SUB-TOTAL			1,378		1,774		396
291	1 SF Residential	DU	74.00	733	74.00	733	0.00	0
	2 MF Residential	DU	--	--	350.00	2,415	350.00	2,415
	4 Commercial Office	TSF	181.63	1,853	181.63	1,853	0.00	0
	SUB-TOTAL			2,586		5,001		2,415
292	1 SF Residential	DU	161.00	1,594	140.00	1,386	-21.00	-208
	SUB-TOTAL			1,594		1,386		-208
293	1 SF Residential	DU	133.00	1,317	180.00	1,782	47.00	465
	2 MF Residential	DU	368.00	2,944	684.00	5,217	316.00	2,273
	SUB-TOTAL			4,261		6,999		2,738
294	2 MF Residential	DU	180.00	1,242	276.00	1,904	96.00	662
	3 Commercial Retail	TSF	364.00	19,678	155.00	8,379	-209.00	-11,299
	4 Commercial Office	TSF	349.98	3,570	--	--	-349.98	-3,570
	5 Industrial Park	TSF	210.00	1,260	300.00	1,800	90.00	540
	6 Other	--	--	99		--	--	-99
	SUB-TOTAL			25,849		12,083		-13,766
295	4 Commercial Office	TSF	56.00	647	56.00	647	0.00	0
	5 Industrial Park	TSF	1,020.58	5,205	1,020.58	5,205	0.00	0
	6 Other	--	--	56	--	156	--	100
	SUB-TOTAL			5,908		6,008		100
296	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			--		1,701		1,701
297	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			--		1,701		1,701
298	2 MF Residential	DU	830.00	5,727	830.00	5,727	0.00	0
	3 Commercial Retail	TSF	--	--	20.00	1,701	20.00	1,701
	SUB-TOTAL			5,727		7,428		1,701
299	3 Commercial Retail	TSF	184.00	9,947	184.00	9,947	0.00	0
	SUB-TOTAL			9,947		9,947		0
300	3 Commercial Retail	TSF	272.00	10,896	300.00	12,018	28.00	1,122
	SUB-TOTAL			10,896		12,018		1,122
301	3 Commercial Retail	TSF	49.24	1,825	49.24	1,825	0.00	0
	6 Other	--	--	7,904	--	8,635	--	731
	SUB-TOTAL			9,729		10,460		731

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
302	3 Commercial Retail	TSF	414.42	17,952	30.00	2,552	-384.42	-15,400
	6 Other	--	--	1,163	--	3,750	--	2,587
	SUB-TOTAL			19,115		6,302		-12,813
303	6 Other	--	--	5,625	--	5,625	--	0
	SUB-TOTAL			5,625		5,625		0
304	3 Commercial Retail	TSF	48.00	3,739	48.00	3,739	0.00	0
	6 Other	--	--	3,113	--	3,113	--	0
	SUB-TOTAL			6,852		6,852		0
305	2 MF Residential	DU	--	--	76.00	524	76.00	524
	3 Commercial Retail	TSF	202.65	11,364	202.65	11,364	0.00	0
	5 Industrial Park	TSF	100.00	510	100.00	510	0.00	0
	SUB-TOTAL			11,874		12,398		524
306	2 MF Residential	DU	--	--	250.00	1,863	250.00	1,863
	3 Commercial Retail	TSF	143.90	7,779	143.90	7,779	0.00	0
	4 Commercial Office	TSF	--	--	50.00	1,710	50.00	1,710
	6 Other	--	--	336	--	336	--	0
	SUB-TOTAL			8,115		11,688		3,573
307	3 Commercial Retail	TSF	132.80	9,301	132.80	9,301	0.00	0
	SUB-TOTAL			9,301		9,301		0
308	2 MF Residential	DU	245.00	1,691	200.00	1,380	-45.00	-311
	3 Commercial Retail	TSF	180.51	15,599	175.11	14,895	-5.40	-704
	5 Industrial Park	TSF	29.40	150	45.00	230	15.60	80
	SUB-TOTAL			17,440		16,505		-935
309	3 Commercial Retail	TSF	3.00	111	3.00	111	0.00	0
	SUB-TOTAL			111		111		0
310	6 Other	--	--	4,208	--	4,208	--	0
	SUB-TOTAL			4,208		4,208		0
311	1 SF Residential	DU	132.00	1,307	132.00	1,307	0.00	0
	2 MF Residential	DU	63.00	504	63.00	504	0.00	0
	SUB-TOTAL			1,811		1,811		0
312	3 Commercial Retail	TSF	180.00	9,731	180.00	9,731	0.00	0
	6 Other	--	--	200	--	200	--	0
	SUB-TOTAL			9,931		9,931		0
313	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	SUB-TOTAL			2,112		2,112		0
314	3 Commercial Retail	TSF	178.00	9,623	178.00	9,623	0.00	0
	SUB-TOTAL			9,623		9,623		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
315	1 SF Residential	DU	--	--	56.00	554	56.00	554
	2 MF Residential	DU	582.00	4,656	168.00	1,344	-414.00	-3,312
	SUB-TOTAL			4,656		1,898		-2,758
316	1 SF Residential	DU	121.00	1,198	121.00	1,198	0.00	0
	SUB-TOTAL			1,198		1,198		0
317	6 Other	--	--	1,387	--	1,135	--	-252
	SUB-TOTAL			1,387		1,135		-252
318	1 SF Residential	DU	21.00	208	21.00	208	0.00	0
	2 MF Residential	DU	252.00	2,016	252.00	2,016	0.00	0
	SUB-TOTAL			2,224		2,224		0
319	3 Commercial Retail	TSF	130.00	7,028	130.00	7,028	0.00	0
	6 Other	--	--	279	--	292	--	13
	SUB-TOTAL			7,307		7,320		13
320	1 SF Residential	DU	125.00	1,238	125.00	1,238	0.00	0
	SUB-TOTAL			1,238		1,238		0
321	1 SF Residential	DU	155.00	1,535	155.00	1,535	0.00	0
	2 MF Residential	DU	66.00	528	66.00	528	0.00	0
	SUB-TOTAL			2,063		2,063		0
322	1 SF Residential	DU	87.00	861	87.00	861	0.00	0
	SUB-TOTAL			861		861		0
323	1 SF Residential	DU	161.00	1,594	161.00	1,594	0.00	0
	2 MF Residential	DU	132.00	1,056	132.00	1,056	0.00	0
	SUB-TOTAL			2,650		2,650		0
325	1 SF Residential	DU	205.00	2,029	205.00	2,029	0.00	0
	SUB-TOTAL			2,029		2,029		0
326	1 SF Residential	DU	101.00	1,000	101.00	1,000	0.00	0
	SUB-TOTAL			1,000		1,000		0
327	1 SF Residential	DU	105.00	1,040	105.00	1,040	0.00	0
	SUB-TOTAL			1,040		1,040		0
328	1 SF Residential	DU	110.00	1,089	110.00	1,089	0.00	0
	SUB-TOTAL			1,089		1,089		0
329	1 SF Residential	DU	50.00	495	--	--	-50.00	-495
	6 Other	--	--	1,340	--	1,088	--	-252
	SUB-TOTAL			1,835		1,088		-747
330	1 SF Residential	DU	143.00	1,416	143.00	1,416	0.00	0
	SUB-TOTAL			1,416		1,416		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
331	1 SF Residential	DU	167.00	1,653	167.00	1,653	0.00	0
	SUB-TOTAL			1,653		1,653		0
332	1 SF Residential	DU	114.00	1,129	114.00	1,129	0.00	0
	2 MF Residential	DU	102.00	816	102.00	816	0.00	0
	SUB-TOTAL			1,945		1,945		0
333	1 SF Residential	DU	803.00	7,950	803.00	7,950	0.00	0
	2 MF Residential	DU	360.00	2,880	360.00	2,880	0.00	0
	3 Commercial Retail	TSF	25.05	928	25.05	928	0.00	0
	6 Other	--	--	1,340	--	1,740	--	400
	SUB-TOTAL			13,098		13,498		400
334	1 SF Residential	DU	164.00	1,624	164.00	1,624	0.00	0
	SUB-TOTAL			1,624		1,624		0
335	1 SF Residential	DU	194.00	1,921	194.00	1,921	0.00	0
	SUB-TOTAL			1,921		1,921		0
336	1 SF Residential	DU	589.00	5,831	589.00	5,831	0.00	0
	6 Other	--	--	1,359	--	1,107	--	-252
	SUB-TOTAL			7,190		6,938		-252
337	1 SF Residential	DU	390.00	3,861	390.00	3,861	0.00	0
	SUB-TOTAL			3,861		3,861		0
338	3 Commercial Retail	TSF	92.00	4,974	92.00	4,974	0.00	0
	SUB-TOTAL			4,974		4,974		0
339	1 SF Residential	DU	289.00	2,861	289.00	2,861	0.00	0
	6 Other	--	--	1,358	--	1,106	--	-252
	SUB-TOTAL			4,219		3,967		-252
340	1 SF Residential	DU	394.00	3,901	394.00	3,901	0.00	0
	2 MF Residential	DU	264.00	2,112	264.00	2,112	0.00	0
	SUB-TOTAL			6,013		6,013		0
341	2 MF Residential	DU	325.00	2,243	325.00	2,243	0.00	0
	6 Other	--	--	1,175	--	1,175	--	0
	SUB-TOTAL			3,418		3,418		0
342	2 MF Residential	DU	168.00	1,344	168.00	1,344	0.00	0
	SUB-TOTAL			1,344		1,344		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
343	1 SF Residential	DU	179.00	1,772	179.00	1,772	0.00	0
	2 MF Residential	DU	132.00	1,056	132.00	1,056	0.00	0
	SUB-TOTAL			2,828		2,828		0
344	1 SF Residential	DU	415.00	4,109	415.00	4,109	0.00	0
	3 Commercial Retail	TSF	40.00	2,162	40.00	2,162	0.00	0
	SUB-TOTAL			6,271		6,271		0
345	1 SF Residential	DU	23.00	228	81.00	802	58.00	574
	SUB-TOTAL			228		802		574
346	1 SF Residential	DU	--	--	10.00	99	10.00	99
	SUB-TOTAL			--		99		99
347	1 SF Residential	DU	313.00	3,099	313.00	3,099	0.00	0
	SUB-TOTAL			3,099		3,099		0
348	1 SF Residential	DU	517.00	5,118	517.00	5,118	0.00	0
	SUB-TOTAL			5,118		5,118		0
349	2 MF Residential	DU	83.00	664	388.00	3,104	305.00	2,440
	3 Commercial Retail	TSF	8.00	680	8.00	680	0.00	0
	6 Other	--	--	226	--	226	--	0
	SUB-TOTAL			1,570		4,010		2,440
350	6 Other	--	--	1,010	--	1,860	--	850
	SUB-TOTAL			1,010		1,860		850
352	1 SF Residential	DU	592.00	5,861	592.00	5,861	0.00	0
	6 Other	--		--	--	1,363	--	1,363
	SUB-TOTAL			5,861		7,224		1,363
353	1 SF Residential	DU	259.00	2,564	259.00	2,564	0.00	0
	6 Other	--		--	--	26	--	26
	SUB-TOTAL			2,564		2,590		26
355	1 SF Residential	DU	500.00	4,950	500.00	4,950	0.00	0
	6 Other	--	--	1,101	--	1,101	--	0
	SUB-TOTAL			6,051		6,051		0
356	1 SF Residential	DU	385.00	3,811	385.00	3,811	0.00	0
	3 Commercial Retail	TSF	--	--	60.00	5,104	60.00	5,104
	SUB-TOTAL			3,811		8,915		5,104
357	1 SF Residential	DU	90.00	891	90.00	891	0.00	0
	SUB-TOTAL			891		891		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
358	1 SF Residential	DU	421.00	4,168	275.00	2,723	-146.00	-1,445
	2 MF Residential	DU	255.00	2,040	121.00	968	-134.00	-1,072
	6 Other	--	--	993	--	1,138	--	145
	SUB-TOTAL			7,201		4,829		-2,372
359	1 SF Residential	DU	570.00	5,643	570.00	5,643	0.00	0
	2 MF Residential	DU	192.00	1,536	192.00	1,536	0.00	0
	SUB-TOTAL			7,179		7,179		0
360	1 SF Residential	DU	538.00	5,326	538.00	5,326	0.00	0
	2 MF Residential	DU	248.00	1,984	248.00	1,984	0.00	0
	3 Commercial Retail	TSF	119.00	10,122	135.00	11,483	16.00	1,361
	6 Other	--	--	938	--	1,088	--	150
	SUB-TOTAL			18,370		19,881		1,511
361	1 SF Residential	DU	250.00	2,475	601.00	5,407	351.00	2,932
	6 Other	--		--	--	28	--	28
	SUB-TOTAL			2,475		5,435		2,960
362	1 SF Residential	DU	173.00	1,713	173.00	1,713	0.00	0
	3 Commercial Retail	TSF	68.28	3,691	--	--	-68.28	-3,691
	SUB-TOTAL			5,404		1,713		-3,691
363	1 SF Residential	DU	44.00	436	44.00	436	0.00	0
	SUB-TOTAL			436		436		0
364	1 SF Residential	DU	199.00	1,970	199.00	1,970	0.00	0
	SUB-TOTAL			1,970		1,970		0
365	1 SF Residential	DU	201.00	1,990	201.00	1,990	0.00	0
	2 MF Residential	DU	102.00	816	102.00	816	0.00	0
	3 Commercial Retail	TSF	40.28	3,426	11.00	936	-29.28	-2,490
	SUB-TOTAL			6,232		3,742		-2,490
366	1 SF Residential	DU	600.00	5,940	600.00	5,940	0.00	0
	SUB-TOTAL			5,940		5,940		0
367	1 SF Residential	DU	437.00	4,326	437.00	4,326	0.00	0
	SUB-TOTAL			4,326		4,326		0
368	1 SF Residential	DU	1,070.00	10,593	1,070.00	10,593	0.00	0
	3 Commercial Retail	TSF	--	--	35.00	2,977	35.00	2,977
	6 Other	--	--	1,500	--	1,629	--	129
	SUB-TOTAL			12,093		15,199		3,106
369	1 SF Residential	DU	202.00	2,000	202.00	2,000	0.00	0
	SUB-TOTAL			2,000		2,000		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
370	1 SF Residential	DU	1,080.00	10,692	1,080.00	10,692	0.00	0
	6 Other	--	--	5,012	--	4,475	--	-537
	SUB-TOTAL			15,704		15,167		-537
371	1 SF Residential	DU	673.00	6,663	673.00	6,663	0.00	0
	6 Other	--	--	996	--	1,088	--	92
	SUB-TOTAL			7,659		7,751		92
372	1 SF Residential	DU	287.00	2,841	287.00	2,841	0.00	0
	2 MF Residential	DU	230.00	1,840	230.00	1,840	0.00	0
	3 Commercial Retail	TSF	153.55	8,301	80.00	4,325	-73.55	-3,976
	SUB-TOTAL			12,982		9,006		-3,976
373	1 SF Residential	DU	236.00	2,336	236.00	2,336	0.00	0
	6 Other	--	--	889	--	1,307	--	418
	SUB-TOTAL			3,225		3,643		418
374	1 SF Residential	DU	--	--	300.00	2,970	300.00	2,970
	2 MF Residential	DU	304.00	2,098	304.00	2,098	0.00	0
	3 Commercial Retail	TSF	150.00	8,109	150.00	8,109	0.00	0
	6 Other	--		--	--	78	--	78
	SUB-TOTAL			10,207		13,255		3,048
375	3 Commercial Retail	TSF	45.00	5,883	45.00	5,883	0.00	0
	SUB-TOTAL			5,883		5,883		0
376	1 SF Residential	DU	205.00	2,029	--	--	-205.00	-2,029
	6 Other	--	--	13		--	--	-13
	SUB-TOTAL			2,042		--		-2,042
377	3 Commercial Retail	TSF	57.50	2,131	57.50	2,131	0.00	0
	SUB-TOTAL			2,131		2,131		0
378	1 SF Residential	DU	332.00	2,291	332.00	2,291	0.00	0
	2 MF Residential	DU	437.00	3,496	407.00	3,256	-30.00	-240
	3 Commercial Retail	TSF	51.00	1,890	51.00	1,890	0.00	0
	4 Commercial Office	TSF	166.00	1,843	56.00	571	-110.00	-1,272
	5 Industrial Park	TSF	--	--	110.00	660	110.00	660
	SUB-TOTAL			9,520		8,668		-852
379	1 SF Residential	DU	214.00	2,119	--	--	-214.00	-2,119
	SUB-TOTAL			2,119		--		-2,119
380	1 SF Residential	DU	--	--	125.00	1,238	125.00	1,238
	2 MF Residential	DU	400.00	2,760	400.00	2,760	0.00	0
	SUB-TOTAL			2,760		3,998		1,238
381	6 Other	--	--	130	--	223	--	93
	SUB-TOTAL			130		223		93

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
382	6 Other	--	--	180	--	180	--	0
	SUB-TOTAL			180		180		0
383	1 SF Residential	DU	266.00	2,633	266.00	2,633	0.00	0
	3 Commercial Retail	TSF	8.71	323	8.71	323	0.00	0
	SUB-TOTAL			2,956		2,956		0
384	1 SF Residential	DU	354.00	3,505	354.00	3,505	0.00	0
	3 Commercial Retail	TSF	23.07	1,962	--	--	-23.07	-1,962
	SUB-TOTAL			5,467		3,505		-1,962
385	1 SF Residential	DU	75.00	743	75.00	743	0.00	0
	SUB-TOTAL			743		743		0
386	1 SF Residential	DU	162.00	1,604	--	--	-162.00	-1,604
	SUB-TOTAL			1,604		--		-1,604
387	1 SF Residential	DU	1,070.00	10,593	800.00	7,920	-270.00	-2,673
	2 MF Residential	DU	954.00	7,632	700.00	5,600	-254.00	-2,032
	SUB-TOTAL			18,225		13,520		-4,705
388	1 SF Residential	DU	312.00	3,089	99.00	980	-213.00	-2,109
	2 MF Residential	DU	187.00	1,496	400.00	3,200	213.00	1,704
	6 Other	--	--	2,320	--	2,320	--	0
	SUB-TOTAL			6,905		6,500		-405
389	1 SF Residential	DU	1,187.00	11,751	1,236.00	12,236	49.00	485
	6 Other	--	--	766	--	1,088	--	322
	SUB-TOTAL			12,517		13,324		807
390	1 SF Residential	DU	150.00	1,485	150.00	1,485	0.00	0
	SUB-TOTAL			1,485		1,485		0
391	3 Commercial Retail	TSF	16.33	605	16.33	605	0.00	0
	5 Industrial Park	TSF	446.36	2,339	446.36	2,339	0.00	0
	SUB-TOTAL			2,944		2,944		0
392	1 SF Residential	DU	723.00	5,958	757.00	6,193	34.00	235
	3 Commercial Retail	TSF	102.48	5,187	102.48	5,187	0.00	0
	5 Industrial Park	TSF	--	--	500.00	2,550	500.00	2,550
	6 Other	--	--	1,450	--	1,088	--	-362
	SUB-TOTAL			12,595		15,018		2,423
393	1 SF Residential	DU	162.00	1,604	162.00	1,604	0.00	0
	2 MF Residential	DU	100.00	800	100.00	800	0.00	0
	3 Commercial Retail	TSF	52.27	4,446	52.27	4,446	0.00	0
	6 Other	--	--	350	--	679	--	329
	SUB-TOTAL			7,200		7,529		329
394	1 SF Residential	DU	325.00	3,217	325.00	3,217	0.00	0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
	6 Other	--	--	7,317	--	5,571	--	-1,746
	SUB-TOTAL			10,534		8,788		-1,746
395	1 SF Residential	DU	185.00	1,831	--	--	-185.00	-1,831
	2 MF Residential	DU	--	--	185.00	1,277	185.00	1,277
	3 Commercial Retail	TSF	165.53	8,949	165.53	8,949	0.00	0
	6 Other	--	--	2,182	--	1,740	--	-442
	SUB-TOTAL			12,962		11,966		-996
396	3 Commercial Retail	TSF	76.23	6,484	110.00	9,357	33.77	2,873
	SUB-TOTAL			6,484		9,357		2,873
397	1 SF Residential	DU	220.00	1,665	549.00	3,935	329.00	2,270
	2 MF Residential	DU	579.00	4,558	579.00	4,558	0.00	0
	3 Commercial Retail	TSF	384.98	23,106	384.98	23,106	0.00	0
	6 Other	--		--	--	1,084	--	1,084
	SUB-TOTAL			29,329		32,683		3,354
398	1 SF Residential	DU	1,120.00	11,088	1,120.00	11,088	0.00	0
	2 MF Residential	DU	120.00	960	120.00	960	0.00	0
	3 Commercial Retail	TSF	261.13	22,465	261.13	22,465	0.00	0
	6 Other	--	--	2,634	--	2,533	--	-101
	SUB-TOTAL			37,147		37,046		-101
399	1 SF Residential	DU	859.00	8,504	880.00	8,712	21.00	208
	6 Other	--	--	790	--	1,228	--	438
	SUB-TOTAL			9,294		9,940		646
400	1 SF Residential	DU	12.00	119	12.00	119	0.00	0
	SUB-TOTAL			119		119		0
401	1 SF Residential	DU	835.00	8,267	835.00	8,267	0.00	0
	2 MF Residential	DU	482.00	3,856	482.00	3,856	0.00	0
	SUB-TOTAL			12,123		12,123		0
402	1 SF Residential	DU	1,129.00	11,177	1,129.00	11,177	0.00	0
	3 Commercial Retail	TSF	150.00	8,109	150.00	8,109	0.00	0
	6 Other	--	--	951	--	2,027	--	1,076
	SUB-TOTAL			20,237		21,313		1,076
403	1 SF Residential	DU	111.00	1,099	111.00	1,099	0.00	0
	2 MF Residential	DU	--	--	300.00	2,070	300.00	2,070
	3 Commercial Retail	TSF	46.00	3,913	46.00	3,913	0.00	0
	SUB-TOTAL			5,012		7,082		2,070
404	1 SF Residential	DU	177.00	1,752	177.00	1,752	0.00	0
	SUB-TOTAL			1,752		1,752		0
405	1 SF Residential	DU	296.00	2,930	296.00	2,930	0.00	0
	SUB-TOTAL			2,930		2,930		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
406	1 SF Residential	DU	353.00	3,495	353.00	3,495	0.00	0
	SUB-TOTAL			3,495		3,495		0
407	1 SF Residential	DU	47.00	465	47.00	465	0.00	0
	SUB-TOTAL			465		465		0
408	1 SF Residential	DU	648.00	6,415	380.00	3,762	-268.00	-2,653
	SUB-TOTAL			6,415		3,762		-2,653
409	1 SF Residential	DU	154.00	1,525	77.00	762	-77.00	-763
	SUB-TOTAL			1,525		762		-763
410	1 SF Residential	DU	349.00	3,152	249.00	2,162	-100.00	-990
	5 Industrial Park	TSF	44.00	264	44.00	264	0.00	0
	SUB-TOTAL			3,416		2,426		-990
411	1 SF Residential	DU	675.00	6,682	675.00	6,682	0.00	0
	6 Other	--	--	1,160	--	1,088	--	-72
	SUB-TOTAL			7,842		7,770		-72
412	1 SF Residential	DU	120.00	1,188	120.00	1,188	0.00	0
	3 Commercial Retail	TSF	--	--	40.00	2,162	40.00	2,162
	SUB-TOTAL			1,188		3,350		2,162
413	1 SF Residential	DU	106.00	1,049	146.00	1,325	40.00	276
	2 MF Residential	DU	614.00	4,912	514.00	3,547	-100.00	-1,365
	3 Commercial Retail	TSF	44.60	3,794	44.60	3,794	0.00	0
	4 Commercial Office	TSF	36.59	423	36.59	423	0.00	0
	5 Industrial Park	TSF	93.75	522	93.75	522	0.00	0
	SUB-TOTAL			10,700		9,611		-1,089
414	1 SF Residential	DU	290.00	2,121	290.00	2,121	0.00	0
	2 MF Residential	DU	1,358.00	10,864	1,635.00	12,860	277.00	1,996
	3 Commercial Retail	TSF	95.83	3,551	175.00	6,486	79.17	2,935
	4 Commercial Office	TSF	125.00	1,445	--	--	-125.00	-1,445
	SUB-TOTAL			17,981		21,467		3,486
415	1 SF Residential	DU	211.00	2,089	75.00	743	-136.00	-1,346
	3 Commercial Retail	TSF	63.71	3,444	63.71	3,444	0.00	0
	5 Industrial Park	TSF	153.25	895	27.80	142	-125.45	-753
	6 Other	--	--	12,320		--	--	-12,320
	SUB-TOTAL			18,748		4,329		-14,419

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
416	1 SF Residential	DU	579.00	5,732	496.00	4,250	-83.00	-1,482
	2 MF Residential	DU	148.00	1,184	57.00	456	-91.00	-728
	3 Commercial Retail	TSF	15.00	556	15.00	556	0.00	0
	4 Commercial Office	TSF	--	--	100.00	1,156	100.00	1,156
	6 Other	--	--	39	--	225	--	186
	SUB-TOTAL			7,511		6,643		-868
417	1 SF Residential	DU	579.00	5,732	950.00	9,405	371.00	3,673
	2 MF Residential	DU	149.00	1,192	255.00	2,040	106.00	848
	3 Commercial Retail	TSF	--	--	10.00	851	10.00	851
	6 Other	--	--	1,102	--	16,488	--	15,386
	SUB-TOTAL			8,026		28,784		20,758
418	1 SF Residential	DU	90.00	621	90.00	621	0.00	0
	2 MF Residential	DU	706.00	5,393	1,229.00	9,002	523.00	3,609
	3 Commercial Retail	TSF	128.43	6,943	228.00	12,326	99.57	5,383
	SUB-TOTAL			12,957		21,949		8,992
419	1 SF Residential	DU	1,018.00	10,078	--	--	-1,018.00	-10,078
	2 MF Residential	DU	1,834.00	14,672	1,834.00	14,672	0.00	0
	SUB-TOTAL			24,750		14,672		-10,078
420	2 MF Residential	DU	40.00	320	56.00	448	16.00	128
	SUB-TOTAL			320		448		128
421	1 SF Residential	DU	100.00	990	250.00	2,475	150.00	1,485
	2 MF Residential	DU	1,952.00	13,900	1,500.00	12,000	-452.00	-1,900
	3 Commercial Retail	TSF	100.00	5,406	400.00	21,624	300.00	16,218
	4 Commercial Office	TSF	100.00	1,156	600.00	6,936	500.00	5,780
	6 Other	--	--	1,659	--	1,677	--	18
	SUB-TOTAL			23,111		44,712		21,601
422	1 SF Residential	DU	76.00	752	100.00	750	24.00	-2
	2 MF Residential	DU	80.00	640	--	--	-80.00	-640
	3 Commercial Retail	TSF	136.00	7,476	10.00	851	-126.00	-6,625
	6 Other	--	--	1,185	--	1,523	--	338
	SUB-TOTAL			10,053		3,124		-6,929
423	1 SF Residential	DU	374.00	3,703	464.00	4,324	90.00	621
	3 Commercial Retail	TSF	98.01	8,337	98.01	8,337	0.00	0
	4 Commercial Office	TSF	10.89	126	10.89	126	0.00	0
	SUB-TOTAL			12,166		12,787		621
424	1 SF Residential	DU	189.00	1,871	350.00	3,465	161.00	1,594
	2 MF Residential	DU	194.00	1,552	--	--	-194.00	-1,552
	SUB-TOTAL			3,423		3,465		42

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
425	1 SF Residential	DU	241.00	2,386	114.00	1,129	-127.00	-1,257
	2 MF Residential	DU	80.00	640	80.00	640	0.00	0
	6 Other	--	--	81	--	81	--	0
	SUB-TOTAL			3,107		1,850		-1,257
426	1 SF Residential	DU	630.00	6,237	630.00	6,237	0.00	0
	5 Industrial Park	TSF	39.60	202	39.60	202	0.00	0
	SUB-TOTAL			6,439		6,439		0
427	1 SF Residential	DU	249.00	2,465	249.00	2,465	0.00	0
	SUB-TOTAL			2,465		2,465		0
428	1 SF Residential	DU	2,124.00	21,028	1,313.00	12,999	-811.00	-8,029
	3 Commercial Retail	TSF	86.60	5,896	86.60	5,896	0.00	0
	6 Other	--		--	--	1,088	--	1,088
	SUB-TOTAL			26,924		19,983		-6,941
429	1 SF Residential	DU	55.00	545	55.00	545	0.00	0
	SUB-TOTAL			545		545		0
430	1 SF Residential	DU	2.00	20	2.00	20	0.00	0
	SUB-TOTAL			20		20		0
431	1 SF Residential	DU	3.00	30	3.00	30	0.00	0
	SUB-TOTAL			30		30		0
433	1 SF Residential	DU	155.00	1,535	155.00	1,535	0.00	0
	SUB-TOTAL			1,535		1,535		0
434	1 SF Residential	DU	25.00	247	25.00	247	0.00	0
	SUB-TOTAL			247		247		0
437	1 SF Residential	DU	250.00	2,475	--	--	-250.00	-2,475
	2 MF Residential	DU	13.00	104	--	--	-13.00	-104
	4 Commercial Office	TSF	--	--	250.00	2,550	250.00	2,550
	6 Other	--	--	1,284	--	1,284	--	0
	SUB-TOTAL			3,863		3,834		-29
438	1 SF Residential	DU	568.00	5,623	10.00	99	-558.00	-5,524
	2 MF Residential	DU	13.00	104	--	--	-13.00	-104
	4 Commercial Office	TSF	--	--	250.00	2,550	250.00	2,550
	SUB-TOTAL			5,727		2,649		-3,078
439	1 SF Residential	DU	1,031.00	10,207	175.00	1,732	-856.00	-8,475
	3 Commercial Retail	TSF	41.65	2,252	41.65	2,252	0.00	0
	SUB-TOTAL			12,459		3,984		-8,475

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
440	1 SF Residential	DU	568.00	5,623	--	--	-568.00	-5,623
	5 Industrial Park	TSF	--	--	50.00	300	50.00	300
	SUB-TOTAL			5,623		300		-5,323
441	1 SF Residential	DU	284.00	2,812	490.00	4,371	206.00	1,559
	3 Commercial Retail	TSF	--	--	30.00	1,112	30.00	1,112
	6 Other	--	--	522	--	1,088	--	566
	SUB-TOTAL			3,334		6,571		3,237
442	1 SF Residential	DU	552.00	5,464	328.00	3,247	-224.00	-2,217
	SUB-TOTAL			5,464		3,247		-2,217
443	1 SF Residential	DU	763.00	7,554	763.00	7,554	0.00	0
	3 Commercial Retail	TSF	--	--	30.00	1,112	30.00	1,112
	4 Commercial Office	TSF	108.90	1,259	--	--	-108.90	-1,259
	6 Other	--	--	1,932	--	1,088	--	-844
	SUB-TOTAL			10,745		9,754		-991
444	1 SF Residential	DU	882.00	8,732	--	--	-882.00	-8,732
	2 MF Residential	DU	19.00	152	440.00	3,520	421.00	3,368
	3 Commercial Retail	TSF	110.00	5,947	200.00	10,812	90.00	4,865
	6 Other	--	--	37	--	37	--	0
	SUB-TOTAL			14,868		14,369		-499
445	1 SF Residential	DU	41.00	406	41.00	406	0.00	0
	SUB-TOTAL			406		406		0
446	1 SF Residential	DU	231.00	2,287	20.00	198	-211.00	-2,089
	SUB-TOTAL			2,287		198		-2,089
447	1 SF Residential	DU	125.00	1,238	300.00	2,970	175.00	1,732
	6 Other	--	--	1,194	--	1,194	--	0
	SUB-TOTAL			2,432		4,164		1,732
448	1 SF Residential	DU	691.00	6,841	691.00	6,841	0.00	0
	SUB-TOTAL			6,841		6,841		0
449	1 SF Residential	DU	20.00	198	20.00	198	0.00	0
	SUB-TOTAL			198		198		0
450	1 SF Residential	DU	27.00	267	27.00	267	0.00	0
	SUB-TOTAL			267		267		0
451	1 SF Residential	DU	67.00	663	140.00	1,386	73.00	723
	5 Industrial Park	TSF	47.00	282	47.00	282	0.00	0
	SUB-TOTAL			945		1,668		723
452	1 SF Residential	DU	38.00	376	38.00	376	0.00	0
	SUB-TOTAL			376		376		0

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
453	1 SF Residential	DU	875.00	8,663	1,020.00	10,098	145.00	1,435
	3 Commercial Retail	TSF	16.00	641	16.00	593	0.00	-48
	6 Other	--	--	711	--	1,088	--	377
	SUB-TOTAL			10,015		11,779		1,764
454	1 SF Residential	DU	625.00	6,188	650.00	6,435	25.00	247
	3 Commercial Retail	TSF	40.28	2,074	40.28	2,074	0.00	0
	6 Other	--	--	5,482	--	5,482	--	0
	SUB-TOTAL			13,744		13,991		247
455	1 SF Residential	DU	80.00	792	100.00	990	20.00	198
	SUB-TOTAL			792		990		198

Land Use and Trip Generation Comparison – Current General Plan and OVOV Buildout								
			Amount	**ADT**	**Amount**	**ADT**	**Amount**	**ADT**
1.	SF Residential	DU	89,373.00	877,112	81,395.00	795,563	-7,978.00	-81,549
2.	MF Residential	DU	62,543.00	481,988	67,679.00	514,809	5,136.00	32,821
3.	Commercial Retail	TSF	21,561.65	1,134,793	23,585.06	1,230,042	2,023.41	95,249
4.	Commercial Office	TSF	14,746.77	169,850	17,311.53	205,851	2,564.76	36,001
5.	Industrial Park	TSF	43,144.21	254,465	40,735.96	240,697	-2,408.25	-13,768
6.	Other	--	--	288,885	--	301,424	--	12,539
TOTAL				**3,207,093**		**3,288,386**		**81,293**

Appendix C

OVOV BUILDOUT TRIP GENERATION BY TAZ – AM, PM AND ADT

See Appendix D for Traffic Analysis Zone (TAZ) map and trip generation rates.

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
1.	2 Single Family (1-5du/ac)	367.00 DU	70	206	276	235	136	371	3,633
	3 Single Family (6-10du/ac)	200.00 DU	38	112	150	128	74	202	1,980
	30 Industrial Park	275.00 TSF	151	28	179	36	143	179	1,650
SUB-TOTAL			259	346	605	399	353	752	7,263
2.	2 Single Family (1-5du/ac)	535.00 DU	102	300	402	342	198	540	5,297
SUB-TOTAL			102	300	402	342	198	540	5,297
3.	2 Single Family (1-5du/ac)	3,313.00 DU	629	1,855	2,484	2,120	1,226	3,346	32,799
	4 Condominium/Townhouse	648.00 DU	65	311	376	305	168	473	5,184
	5 Apartment	640.00 DU	51	275	326	262	134	396	4,416
	11 Commercial Center(10-30a)	320.00 TSF	234	150	384	762	826	1,588	17,299
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	30 Industrial Park	256.80 TSF	141	26	167	33	134	167	1,541
	32 Manufacturing/Warehouse	77.49 TSF	43	13	56	21	36	57	395
SUB-TOTAL			1,358	2,780	4,138	3,563	2,592	6,155	62,722
5.	2 Single Family (1-5du/ac)	229.00 DU	44	128	172	147	85	232	2,267
	12 Commercial Center (<10ac)	25.00 TSF	27	17	44	83	90	173	2,127
	13 Commercial Shops	2.01 TSF	1	1	2	4	4	8	74
SUB-TOTAL			72	146	218	234	179	413	4,468
6.	2 Single Family (1-5du/ac)	409.00 DU	78	229	307	262	151	413	4,049
SUB-TOTAL			78	229	307	262	151	413	4,049
7.	1 Single Family (<1du/ac)	8.00 DU	2	5	7	7	3	10	79
	3 Single Family (6-10du/ac)	714.00 DU	136	400	536	457	264	721	7,069
SUB-TOTAL			138	405	543	464	267	731	7,148
8.	2 Single Family (1-5du/ac)	97.00 DU	18	54	72	62	36	98	960
SUB-TOTAL			18	54	72	62	36	98	960
9.	2 Single Family (1-5du/ac)	320.00 DU	61	179	240	205	118	323	3,168
SUB-TOTAL			61	179	240	205	118	323	3,168
10.	2 Single Family (1-5du/ac)	12.00 DU	2	7	9	8	4	12	119
	4 Condominium/Townhouse	184.00 DU	18	88	106	86	48	134	1,472
	10 Commercial Center (>30ac)	300.00 TSF	141	90	231	492	534	1,026	12,018
SUB-TOTAL			161	185	346	586	586	1,172	13,609
11.	2 Single Family (1-5du/ac)	24.00 DU	5	13	18	15	9	24	238
	3 Single Family (6-10du/ac)	84.00 DU	16	47	63	54	31	85	832
	4 Condominium/Townhouse	165.00 DU	17	79	96	78	43	121	1,320
	5 Apartment	72.00 DU	6	31	37	30	15	45	497
	12 Commercial Center (<10ac)	52.76 TSF	58	36	94	175	190	365	4,488
	13 Commercial Shops	2.46 TSF	2	1	3	4	4	8	91
	15 Sit-Down Restaurant	7.75 TSF	37	34	71	51	34	85	1,010
	30 Industrial Park	41.82 TSF	23	4	27	5	22	27	251
	40 Commercial Office	1.23 TSF	2	0	2	0	2	2	14
	51 Developed Park	2.00 AC	0	0	0	0	0	0	5
SUB-TOTAL			166	245	411	412	350	762	8,746
12.	2 Single Family (1-5du/ac)	213.00 DU	40	119	159	136	79	215	2,109
	3 Single Family (6-10du/ac)	39.00 DU	7	22	29	25	14	39	386
	14 Hotel	121.00 ROOM	41	27	68	39	35	74	996
SUB-TOTAL			88	168	256	200	128	328	3,491

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
13.	2 Single Family (1-5du/ac)	641.00 DU	122	359	481	410	237	647	6,346
	4 Condominium/Townhouse	54.00 DU	5	26	31	25	14	39	432
	12 Commercial Center (<10ac)	25.00 TSF	27	17	44	83	90	173	2,127
SUB-TOTAL			154	402	556	518	341	859	8,905
14.	2 Single Family (1-5du/ac)	117.00 DU	22	66	88	75	43	118	1,158
SUB-TOTAL			22	66	88	75	43	118	1,158
15.	2 Single Family (1-5du/ac)	370.00 DU	70	207	277	237	137	374	3,663
	SUB-TOTAL		70	207	277	237	137	374	3,663
16.	2 Single Family (1-5du/ac)	291.00 DU	55	163	218	186	108	294	2,881
	SUB-TOTAL		55	163	218	186	108	294	2,881
17.	2 Single Family (1-5du/ac)	380.00 DU	72	213	285	243	141	384	3,762
	SUB-TOTAL		72	213	285	243	141	384	3,762
18.	2 Single Family (1-5du/ac)	455.00 DU	86	255	341	291	168	459	4,505
	4 Condominium/Townhouse	109.00 DU	11	52	63	51	28	79	872
	6 Mobile Home	113.00 DU	9	36	45	40	24	64	780
	12 Commercial Center (<10ac)	21.00 TSF	23	14	37	70	76	146	1,786
	51 Developed Park	7.00 AC	0	0	0	0	0	0	18
	SUB-TOTAL		129	357	486	452	296	748	7,961
19.	2 Single Family (1-5du/ac)	1,577.00 DU	300	883	1,183	1,009	583	1,592	15,612
	20 Elementary/Middle School	1,950.00 STU	507	390	897	156	176	332	2,828
	50 Golf Course	150.00 AC	23	9	32	15	30	45	1,194
	SUB-TOTAL		830	1,282	2,112	1,180	789	1,969	19,634
20.	2 Single Family (1-5du/ac)	245.00 DU	47	137	184	157	91	248	2,426
	4 Condominium/Townhouse	136.00 DU	14	65	79	64	35	99	1,088
	30 Industrial Park	174.00 TSF	96	17	113	23	90	113	1,044
	SUB-TOTAL		157	219	376	244	216	460	4,558
21.	2 Single Family (1-5du/ac)	620.00 DU	118	347	465	397	229	626	6,138
	3 Single Family (6-10du/ac)	35.00 DU	7	20	27	22	13	35	347
	12 Commercial Center (<10ac)	70.00 TSF	76	48	124	232	252	484	5,954
	SUB-TOTAL		201	415	616	651	494	1,145	12,439
22.	2 Single Family (1-5du/ac)	350.00 DU	67	196	263	224	130	354	3,465
	SUB-TOTAL		67	196	263	224	130	354	3,465
23.	2 Single Family (1-5du/ac)	373.00 DU	71	209	280	239	138	377	3,693
	SUB-TOTAL		71	209	280	239	138	377	3,693
24.	2 Single Family (1-5du/ac)	422.00 DU	80	236	316	270	156	426	4,178
	SUB-TOTAL		80	236	316	270	156	426	4,178
25.	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		195	150	345	60	68	128	1,088
26.	13 Commercial Shops	72.90 TSF	52	35	87	131	131	262	2,702
	SUB-TOTAL		52	35	87	131	131	262	2,702
27.	5 Apartment	256.00 DU	20	110	130	105	54	159	1,766
	SUB-TOTAL		20	110	130	105	54	159	1,766

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
28.	3 Single Family (6-10du/ac)	1,077.00 DU	205	603	808	689	398	1,087	10,662
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		400	753	1,153	749	466	1,215	11,750
29.	51 Developed Park	20.00 AC	0	0	0	1	1	2	52
	SUB-TOTAL		0	0	0	1	1	2	52
30.	4 Condominium/Townhouse	275.00 DU	28	132	160	129	72	201	2,200
	SUB-TOTAL		28	132	160	129	72	201	2,200
31.	3 Single Family (6-10du/ac)	65.00 DU	12	36	48	42	24	66	644
	4 Condominium/Townhouse	200.00 DU	20	96	116	94	52	146	1,600
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	SUB-TOTAL		344	372	716	232	184	416	3,984
32.	4 Condominium/Townhouse	94.00 DU	9	45	54	44	24	68	752
	SUB-TOTAL		9	45	54	44	24	68	752
33.	12 Commercial Center (<10ac)	61.00 TSF	66	42	108	203	220	423	5,189
	SUB-TOTAL		66	42	108	203	220	423	5,189
34.	11 Commercial Center(10-30a)	107.10 TSF	78	50	128	255	276	531	5,790
	SUB-TOTAL		78	50	128	255	276	531	5,790
35.	3 Single Family (6-10du/ac)	616.00 DU	117	345	462	394	228	622	6,098
	4 Condominium/Townhouse	60.00 DU	6	29	35	28	16	44	480
	5 Apartment	200.00 DU	16	86	102	82	42	124	1,380
	SUB-TOTAL		139	460	599	504	286	790	7,958
36.	2 Single Family (1-5du/ac)	190.00 DU	36	106	142	122	70	192	1,881
	4 Condominium/Townhouse	268.00 DU	27	129	156	126	70	196	2,144
	SUB-TOTAL		63	235	298	248	140	388	4,025
37.	2 Single Family (1-5du/ac)	212.00 DU	40	119	159	136	78	214	2,099
	4 Condominium/Townhouse	128.00 DU	13	61	74	60	33	93	1,024
	25 Church	20.00 TSF	8	7	15	7	6	13	186
	SUB-TOTAL		61	187	248	203	117	320	3,309
38.	4 Condominium/Townhouse	105.00 DU	11	50	61	49	27	76	840
	5 Apartment	226.00 DU	18	97	115	93	47	140	1,559
	12 Commercial Center (<10ac)	50.00 TSF	55	35	90	166	180	346	4,253
	SUB-TOTAL		84	182	266	308	254	562	6,652
39.	11 Commercial Center(10-30a)	150.40 TSF	110	71	181	358	388	746	8,131
	30 Industrial Park	4,000.00 TSF	2,200	400	2,600	520	2,080	2,600	24,000
	SUB-TOTAL		2,310	471	2,781	878	2,468	3,346	32,131
40.	11 Commercial Center(10-30a)	200.00 TSF	146	94	240	476	516	992	10,812
	31 Business Park	116.70 TSF	140	27	167	35	116	151	1,190
	34 Utilities	10.00 TSF	0	0	0	0	0	0	24
	SUB-TOTAL		286	121	407	511	632	1,143	12,026
41.	30 Industrial Park	685.94 TSF	377	69	446	89	357	446	4,116
	40 Commercial Office	177.60 TSF	275	34	309	37	229	266	2,053
	SUB-TOTAL		652	103	755	126	586	712	6,169

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
42.	40 Commercial Office	696.85 TSF	1,080	132	1,212	146	899	1,045	8,056
	SUB-TOTAL		1,080	132	1,212	146	899	1,045	8,056
43.	13 Commercial Shops	27.00 TSF	19	13	32	49	49	98	1,001
	40 Commercial Office	100.75 TSF	156	19	175	21	130	151	1,165
	SUB-TOTAL		175	32	207	70	179	249	2,166
44.	2 Single Family (1-5du/ac)	445.00 DU	85	249	334	285	165	450	4,406
	12 Commercial Center (<10ac)	25.00 TSF	27	17	44	83	90	173	2,127
	13 Commercial Shops	10.00 TSF	7	5	12	18	18	36	371
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	26 Day Care	80.00 STU	34	30	64	32	37	69	362
	SUB-TOTAL		348	451	799	478	378	856	8,354
45.	30 Industrial Park	1,215.00 TSF	668	122	790	158	632	790	7,290
	40 Commercial Office	464.94 TSF	721	88	809	98	600	698	5,375
	SUB-TOTAL		1,389	210	1,599	256	1,232	1,488	12,665
46.	13 Commercial Shops	77.00 TSF	55	37	92	139	139	278	2,854
	30 Industrial Park	445.80 TSF	245	45	290	58	232	290	2,675
	SUB-TOTAL		300	82	382	197	371	568	5,529
47.	30 Industrial Park	4,254.10 TSF	2,340	425	2,765	553	2,212	2,765	25,525
	SUB-TOTAL		2,340	425	2,765	553	2,212	2,765	25,525
48.	30 Industrial Park	720.00 TSF	396	72	468	94	374	468	4,320
	SUB-TOTAL		396	72	468	94	374	468	4,320
49.	30 Industrial Park	764.30 TSF	420	76	496	99	397	496	4,586
	SUB-TOTAL		420	76	496	99	397	496	4,586
50.	2 Single Family (1-5du/ac)	350.00 DU	67	196	263	224	130	354	3,465
	58 Landfill	20.00 SG	60	40	100	80	120	200	2,000
	SUB-TOTAL		127	236	363	304	250	554	5,465
51.	30 Industrial Park	1,221.36 TSF	672	122	794	159	635	794	7,328
	SUB-TOTAL		672	122	794	159	635	794	7,328
52.	2 Single Family (1-5du/ac)	100.00 DU	19	56	75	64	37	101	990
	SUB-TOTAL		19	56	75	64	37	101	990
53.	1 Single Family (<1du/ac)	35.00 DU	10	23	33	29	13	42	347
	SUB-TOTAL		10	23	33	29	13	42	347
54.	3 Single Family (6-10du/ac)	62.00 DU	12	35	47	40	23	63	614
	4 Condominium/Townhouse	589.00 DU	59	283	342	277	153	430	4,712
	SUB-TOTAL		71	318	389	317	176	493	5,326
55.	3 Single Family (6-10du/ac)	164.00 DU	31	92	123	105	61	166	1,624
	4 Condominium/Townhouse	922.00 DU	92	443	535	433	240	673	7,376
	51 Developed Park	5.80 AC	0	0	0	0	0	0	15
	SUB-TOTAL		123	535	658	538	301	839	9,015

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
56.	2 Single Family (1-5du/ac)	19.00 DU	4	11	15	12	7	19	188
	4 Condominium/Townhouse	23.00 DU	2	11	13	11	6	17	184
	SUB-TOTAL		6	22	28	23	13	36	372
57.	12 Commercial Center (<10ac)	55.40 TSF	60	38	98	184	199	383	4,712
	31 Business Park	1,169.60 TSF	1,404	269	1,673	351	1,158	1,509	11,930
	40 Commercial Office	105.00 TSF	163	20	183	22	135	157	1,214
	SUB-TOTAL		1,627	327	1,954	557	1,492	2,049	17,856
58.	30 Industrial Park	1,123.00 TSF	618	112	730	146	584	730	6,738
	SUB-TOTAL		618	112	730	146	584	730	6,738
59.	35 Regional Post Office	764.00 TSF	153	115	268	115	115	230	3,820
	SUB-TOTAL		153	115	268	115	115	230	3,820
60.	13 Commercial Shops	34.80 TSF	25	17	42	63	63	126	1,290
	30 Industrial Park	160.50 TSF	88	16	104	21	83	104	963
	40 Commercial Office	27.20 TSF	42	5	47	6	35	41	314
	SUB-TOTAL		155	38	193	90	181	271	2,567
61.	30 Industrial Park	825.65 TSF	454	83	537	107	429	536	4,954
	40 Commercial Office	48.80 TSF	76	9	85	10	63	73	564
	SUB-TOTAL		530	92	622	117	492	609	5,518
62.	13 Commercial Shops	19.50 TSF	14	9	23	35	35	70	723
	30 Industrial Park	430.64 TSF	237	43	280	56	224	280	2,584
	SUB-TOTAL		251	52	303	91	259	350	3,307
63.	14 Hotel	297.00 ROOM	101	65	166	95	86	181	2,444
	30 Industrial Park	575.00 TSF	316	58	374	75	299	374	3,450
	SUB-TOTAL		417	123	540	170	385	555	5,894
64.	30 Industrial Park	3,161.48 TSF	1,739	316	2,055	411	1,644	2,055	18,969
	SUB-TOTAL		1,739	316	2,055	411	1,644	2,055	18,969
65.	11 Commercial Center(10-30a)	155.00 TSF	113	73	186	369	400	769	8,379
	30 Industrial Park	329.00 TSF	181	33	214	43	171	214	1,974
	SUB-TOTAL		294	106	400	412	571	983	10,353
66.	11 Commercial Center(10-30a)	170.45 TSF	124	80	204	406	440	846	9,215
	30 Industrial Park	329.00 TSF	181	33	214	43	171	214	1,974
	SUB-TOTAL		305	113	418	449	611	1,060	11,189
67.	3 Single Family (6-10du/ac)	163.00 DU	31	91	122	104	60	164	1,614
	4 Condominium/Townhouse	90.00 DU	9	43	52	42	23	65	720
	SUB-TOTAL		40	134	174	146	83	229	2,334
68.	5 Apartment	208.00 DU	17	89	106	85	44	129	1,435
	SUB-TOTAL		17	89	106	85	44	129	1,435
69.	3 Single Family (6-10du/ac)	76.00 DU	14	43	57	49	28	77	752
	SUB-TOTAL		14	43	57	49	28	77	752

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
70.	11 Commercial Center(10-30a)	147.00 TSF	107	69	176	350	379	729	7,947
	18 Health Club	71.00 TSF	68	45	113	153	102	255	2,840
	26 Day Care	150.00 STU	65	57	122	60	69	129	678
	30 Industrial Park	529.00 TSF	291	53	344	69	275	344	3,174
	32 Manufacturing/Warehouse	75.00 TSF	42	13	55	20	35	55	383
	SUB-TOTAL		573	237	810	652	860	1,512	15,022
71.	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	SUB-TOTAL		800	350	1,150	150	225	375	4,475
72.	13 Commercial Shops	60.00 TSF	43	29	72	108	108	216	2,224
	20 Elementary/Middle School	350.00 STU	91	70	161	28	32	60	508
	SUB-TOTAL		134	99	233	136	140	276	2,732
74.	3 Single Family (6-10du/ac)	153.00 DU	29	86	115	98	57	155	1,515
	4 Condominium/Townhouse	147.00 DU	15	71	86	69	38	107	1,176
	SUB-TOTAL		44	157	201	167	95	262	2,691
75.	4 Condominium/Townhouse	149.00 DU	15	72	87	70	39	109	1,192
	51 Developed Park	17.50 AC	0	0	0	1	1	2	46
	SUB-TOTAL		15	72	87	71	40	111	1,238
76.	5 Apartment	188.00 DU	15	81	96	77	39	116	1,297
	12 Commercial Center (<10ac)	11.00 TSF	12	8	20	37	40	77	936
	SUB-TOTAL		27	89	116	114	79	193	2,233
78.	30 Industrial Park	1,776.00 TSF	977	178	1,155	231	924	1,155	10,656
	SUB-TOTAL		977	178	1,155	231	924	1,155	10,656
79.	30 Industrial Park	685.00 TSF	377	69	446	89	356	445	4,110
	SUB-TOTAL		377	69	446	89	356	445	4,110
80.	30 Industrial Park	880.00 TSF	484	88	572	114	458	572	5,280
	SUB-TOTAL		484	88	572	114	458	572	5,280
81.	30 Industrial Park	711.00 TSF	391	71	462	92	370	462	4,266
	SUB-TOTAL		391	71	462	92	370	462	4,266
82.	30 Industrial Park	1,007.55 TSF	554	101	655	131	524	655	6,045
	SUB-TOTAL		554	101	655	131	524	655	6,045
83.	30 Industrial Park	876.00 TSF	482	88	570	114	456	570	5,256
	SUB-TOTAL		482	88	570	114	456	570	5,256
84.	30 Industrial Park	333.00 TSF	183	33	216	43	173	216	1,998
	SUB-TOTAL		183	33	216	43	173	216	1,998
86.	12 Commercial Center (<10ac)	15.00 TSF	16	10	26	50	54	104	1,276
	13 Commercial Shops	20.50 TSF	15	10	25	37	37	74	760
	14 Hotel	36.00 ROOM	12	8	20	12	10	22	296
	15 Sit-Down Restaurant	47.26 TSF	228	210	438	308	205	513	6,160
	SUB-TOTAL		271	238	509	407	306	713	8,492
89.	53 Wayside Honor Ranch	30.00 SG	90	60	150	120	180	300	3,000
	SUB-TOTAL		90	60	150	120	180	300	3,000

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
90.	4 Condominium/Townhouse	360.00 DU	36	173	209	169	94	263	2,880
	10 Commercial Center (>30ac)	1,093.35 TSF	514	328	842	1,793	1,946	3,739	43,800
	11 Commercial Center(10-30a)	135.00 TSF	99	63	162	321	348	669	7,298
	12 Commercial Center (<10ac)	77.00 TSF	84	53	137	256	277	533	6,550
	30 Industrial Park	163.88 TSF	90	16	106	21	85	106	983
	SUB-TOTAL		823	633	1,456	2,560	2,750	5,310	61,511
91.	11 Commercial Center(10-30a)	247.38 TSF	181	116	297	589	638	1,227	13,373
	SUB-TOTAL		181	116	297	589	638	1,227	13,373
92.	4 Condominium/Townhouse	1,333.00 DU	133	640	773	627	347	974	10,664
	10 Commercial Center (>30ac)	618.00 TSF	290	185	475	1,014	1,100	2,114	24,757
	14 Hotel	300.00 ROOM	102	66	168	96	87	183	2,469
	40 Commercial Office	629.00 TSF	975	120	1,095	132	811	943	7,271
	SUB-TOTAL		1,500	1,011	2,511	1,869	2,345	4,214	45,161
93.	13 Commercial Shops	20.00 TSF	14	10	24	36	36	72	741
	14 Hotel	169.00 ROOM	57	37	94	54	49	103	1,391
	SUB-TOTAL		71	47	118	90	85	175	2,132
94.	54 Six Flags Magic Mtn	240.00 SG	720	480	1,200	960	1,440	2,400	24,000
	SUB-TOTAL		720	480	1,200	960	1,440	2,400	24,000
96.	2 Single Family (1-5du/ac)	123.00 DU	23	69	92	79	46	125	1,218
	4 Condominium/Townhouse	881.00 DU	88	423	511	414	229	643	7,048
	SUB-TOTAL		111	492	603	493	275	768	8,266
97.	55 Travel Village	26.20 SG	79	52	131	105	157	262	2,620
	SUB-TOTAL		79	52	131	105	157	262	2,620
98.	12 Commercial Center (<10ac)	6.20 TSF	7	4	11	21	22	43	527
	31 Business Park	691.50 TSF	830	159	989	207	685	892	7,053
	SUB-TOTAL		837	163	1,000	228	707	935	7,580
99.	4 Condominium/Townhouse	470.00 DU	47	226	273	221	122	343	3,760
	51 Developed Park	20.20 AC	0	0	0	1	1	2	53
	SUB-TOTAL		47	226	273	222	123	345	3,813
100.	12 Commercial Center (<10ac)	23.00 TSF	25	16	41	76	83	159	1,956
	40 Commercial Office	220.00 TSF	341	42	383	46	284	330	2,543
	SUB-TOTAL		366	58	424	122	367	489	4,499
101.	10 Commercial Center (>30ac)	491.60 TSF	231	147	378	806	875	1,681	19,693
	SUB-TOTAL		231	147	378	806	875	1,681	19,693
102.	3 Single Family (6-10du/ac)	38.00 DU	7	21	28	24	14	38	376
	4 Condominium/Townhouse	305.00 DU	31	146	177	143	79	222	2,440
	5 Apartment	155.00 DU	12	67	79	64	33	97	1,070
	12 Commercial Center (<10ac)	10.50 TSF	11	7	18	35	38	73	893
	40 Commercial Office	9.50 TSF	15	2	17	2	12	14	110
	SUB-TOTAL		76	243	319	268	176	444	4,889

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
103.	3 Single Family (6-10du/ac)	95.00 DU	18	53	71	61	35	96	940
	4 Condominium/Townhouse	169.00 DU	17	81	98	79	44	123	1,352
	12 Commercial Center (<10ac)	38.50 TSF	42	27	69	128	139	267	3,275
	13 Commercial Shops	9.50 TSF	7	5	12	17	17	34	352
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	16.10 AC	0	0	0	0	1	1	42
	SUB-TOTAL		279	316	595	345	304	649	7,049
104.	3 Single Family (6-10du/ac)	175.00 DU	33	98	131	112	65	177	1,732
	4 Condominium/Townhouse	211.00 DU	21	101	122	99	55	154	1,688
	5 Apartment	152.00 DU	12	65	77	62	32	94	1,049
	11 Commercial Center(10-30a)	252.00 TSF	184	118	302	600	650	1,250	13,623
	40 Commercial Office	370.00 TSF	574	70	644	78	477	555	4,277
	SUB-TOTAL		824	452	1,276	951	1,279	2,230	22,369
105.	5 Apartment	144.00 DU	12	62	74	59	30	89	994
	12 Commercial Center (<10ac)	27.10 TSF	30	19	49	90	98	188	2,305
	40 Commercial Office	315.90 TSF	490	60	550	66	408	474	3,652
	SUB-TOTAL		532	141	673	215	536	751	6,951
106.	5 Apartment	520.00 DU	42	224	266	213	109	322	3,588
	SUB-TOTAL		42	224	266	213	109	322	3,588
107.	2 Single Family (1-5du/ac)	461.00 DU	88	258	346	295	171	466	4,564
	4 Condominium/Townhouse	326.00 DU	33	156	189	153	85	238	2,608
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	51 Developed Park	20.50 AC	0	0	0	1	1	2	53
	SUB-TOTAL		1,233	1,004	2,237	695	590	1,285	13,440
108.	4 Condominium/Townhouse	2,189.00 DU	219	1,051	1,270	1,029	569	1,598	17,512
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	8.70 AC	0	0	0	0	0	0	23
	SUB-TOTAL		414	1,201	1,615	1,089	637	1,726	18,623
109.	3 Single Family (6-10du/ac)	38.00 DU	7	21	28	24	14	38	376
	SUB-TOTAL		7	21	28	24	14	38	376
110.	2 Single Family (1-5du/ac)	184.00 DU	35	103	138	118	68	186	1,822
	4 Condominium/Townhouse	548.00 DU	55	263	318	258	142	400	4,384
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	9.40 AC	0	0	0	0	0	0	24
	SUB-TOTAL		285	516	801	436	278	714	7,318
111.	34 Utilities	100.00 TSF	0	0	0	0	0	0	238
	SUB-TOTAL		0	0	0	0	0	0	238
112.	2 Single Family (1-5du/ac)	90.00 DU	17	50	67	58	33	91	891
	3 Single Family (6-10du/ac)	156.00 DU	30	87	117	100	58	158	1,544
	50 Golf Course	180.00 AC	27	11	38	18	36	54	1,433
	SUB-TOTAL		74	148	222	176	127	303	3,868
113.	4 Condominium/Townhouse	354.00 DU	35	170	205	166	92	258	2,832
	SUB-TOTAL		35	170	205	166	92	258	2,832

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
114.	4 Condominium/Townhouse	560.00 DU	56	269	325	263	146	409	4,480
	SUB-TOTAL		56	269	325	263	146	409	4,480
115.	3 Single Family (6-10du/ac)	603.00 DU	115	338	453	386	223	609	5,970
	SUB-TOTAL		115	338	453	386	223	609	5,970
116.	4 Condominium/Townhouse	1,262.00 DU	126	606	732	593	328	921	10,096
	10 Commercial Center (>30ac)	628.50 TSF	295	189	484	1,031	1,119	2,150	25,178
	SUB-TOTAL		421	795	1,216	1,624	1,447	3,071	35,274
117.	4 Condominium/Townhouse	1,261.00 DU	126	605	731	593	328	921	10,088
	10 Commercial Center (>30ac)	628.50 TSF	295	189	484	1,031	1,119	2,150	25,178
	SUB-TOTAL		421	794	1,215	1,624	1,447	3,071	35,266
118.	4 Condominium/Townhouse	161.00 DU	16	77	93	76	42	118	1,288
	SUB-TOTAL		16	77	93	76	42	118	1,288
119.	5 Apartment	1,679.00 DU	134	722	856	688	353	1,041	11,585
	SUB-TOTAL		134	722	856	688	353	1,041	11,585
120.	4 Condominium/Townhouse	2,425.00 DU	243	1,164	1,407	1,140	631	1,771	19,400
	11 Commercial Center(10-30a)	267.30 TSF	195	126	321	636	690	1,326	14,450
	13 Commercial Shops	16.00 TSF	12	8	20	29	29	58	593
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	40 Commercial Office	75.00 TSF	116	14	130	16	97	113	867
	51 Developed Park	8.40 AC	0	0	0	0	0	0	22
	SUB-TOTAL		761	1,462	2,223	1,881	1,515	3,396	36,420
121.	2 Single Family (1-5du/ac)	168.00 DU	32	94	126	108	62	170	1,663
	4 Condominium/Townhouse	418.00 DU	42	201	243	196	109	305	3,344
	SUB-TOTAL		74	295	369	304	171	475	5,007
122.	4 Condominium/Townhouse	176.00 DU	18	84	102	83	46	129	1,408
	SUB-TOTAL		18	84	102	83	46	129	1,408
123.	2 Single Family (1-5du/ac)	452.00 DU	86	253	339	289	167	456	4,475
	4 Condominium/Townhouse	272.00 DU	27	131	158	128	71	199	2,176
	13 Commercial Shops	17.20 TSF	12	8	20	31	31	62	637
	SUB-TOTAL		125	392	517	448	269	717	7,288
124.	7 Senior (Active)	1,343.00 DU	107	161	268	215	134	349	4,983
	SUB-TOTAL		107	161	268	215	134	349	4,983
125.	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	SUB-TOTAL		1,112	590	1,702	246	333	579	6,215
126.	11 Commercial Center(10-30a)	150.00 TSF	110	71	181	357	387	744	8,109
	40 Commercial Office	336.00 TSF	521	64	585	71	433	504	3,884
	SUB-TOTAL		631	135	766	428	820	1,248	11,993
127.	4 Condominium/Townhouse	888.00 DU	89	426	515	417	231	648	7,104
	SUB-TOTAL		89	426	515	417	231	648	7,104
128.	3 Single Family (6-10du/ac)	450.00 DU	86	252	338	288	167	455	4,455
	SUB-TOTAL		86	252	338	288	167	455	4,455

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
129.	3 Single Family (6-10du/ac)	177.00 DU	34	99	133	113	65	178	1,752
	SUB-TOTAL		34	99	133	113	65	178	1,752
130.	2 Single Family (1-5du/ac)	708.00 DU	135	396	531	453	262	715	7,009
	SUB-TOTAL		135	396	531	453	262	715	7,009
131.	2 Single Family (1-5du/ac)	14.00 DU	3	8	11	9	5	14	139
	4 Condominium/Townhouse	1,273.00 DU	127	611	738	598	331	929	10,184
	25 Church	20.00 TSF	8	7	15	7	6	13	186
	51 Developed Park	24.20 AC	0	0	0	1	1	2	63
	SUB-TOTAL		138	626	764	615	343	958	10,572
132.	2 Single Family (1-5du/ac)	436.00 DU	83	244	327	279	161	440	4,316
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	16.00 AC	0	0	0	0	1	1	42
	SUB-TOTAL		278	394	672	339	230	569	5,446
133.	11 Commercial Center(10-30a)	27.00 TSF	20	13	33	64	70	134	1,460
	SUB-TOTAL		20	13	33	64	70	134	1,460
134.	2 Single Family (1-5du/ac)	482.00 DU	92	270	362	308	178	486	4,772
	SUB-TOTAL		92	270	362	308	178	486	4,772
135.	2 Single Family (1-5du/ac)	174.00 DU	33	97	130	111	64	175	1,723
	4 Condominium/Townhouse	172.00 DU	17	83	100	81	45	126	1,376
	50 Golf Course	208.00 AC	31	12	43	21	42	63	1,656
	SUB-TOTAL		81	192	273	213	151	364	4,755
137.	40 Commercial Office	72.00 TSF	112	14	126	15	93	108	832
	SUB-TOTAL		112	14	126	15	93	108	832
138.	11 Commercial Center(10-30a)	120.00 TSF	88	56	144	286	310	596	6,487
	SUB-TOTAL		88	56	144	286	310	596	6,487
139.	5 Apartment	474.00 DU	38	204	242	194	100	294	3,271
	SUB-TOTAL		38	204	242	194	100	294	3,271
140.	3 Single Family (6-10du/ac)	428.00 DU	81	240	321	274	158	432	4,237
	4 Condominium/Townhouse	1,266.00 DU	127	608	735	595	329	924	10,128
	12 Commercial Center (<10ac)	20.00 TSF	22	14	36	66	72	138	1,701
	20 Elementary/Middle School	400.00 STU	104	80	184	32	36	68	580
	40 Commercial Office	31.00 TSF	48	6	54	7	40	47	358
	51 Developed Park	5.00 AC	0	0	0	0	0	0	13
	SUB-TOTAL		382	948	1,330	974	635	1,609	17,017
141.	15 Sit-Down Restaurant	20.30 TSF	98	90	188	132	88	220	2,646
	16 Fast Food Restaurant	10.10 TSF	257	247	504	176	162	338	5,011
	40 Commercial Office	50.00 TSF	78	10	88	11	65	76	578
	SUB-TOTAL		433	347	780	319	315	634	8,235
142.	4 Condominium/Townhouse	670.00 DU	67	322	389	315	174	489	5,360
	SUB-TOTAL		67	322	389	315	174	489	5,360

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
143.	2 Single Family (1-5du/ac)	96.00 DU	18	54	72	61	36	97	950
	3 Single Family (6-10du/ac)	482.00 DU	92	270	362	308	178	486	4,772
	4 Condominium/Townhouse	160.00 DU	16	77	93	75	42	117	1,280
	20 Elementary/Middle School	1,950.00 STU	507	390	897	156	176	332	2,828
	51 Developed Park	7.00 AC	0	0	0	0	0	0	18
	SUB-TOTAL		633	791	1,424	600	432	1,032	9,848
144.	2 Single Family (1-5du/ac)	6.00 DU	1	3	4	4	2	6	59
	SUB-TOTAL		1	3	4	4	2	6	59
145.	10 Commercial Center (>30ac)	778.00 TSF	366	233	599	1,276	1,385	2,661	31,167
	12 Commercial Center (<10ac)	36.00 TSF	39	25	64	120	130	250	3,062
	13 Commercial Shops	45.74 TSF	33	22	55	82	82	164	1,695
	15 Sit-Down Restaurant	7.80 TSF	38	35	73	51	34	85	1,017
	16 Fast Food Restaurant	6.68 TSF	170	163	333	116	107	223	3,314
	32 Manufacturing/Warehouse	74.50 TSF	42	13	55	20	35	55	380
	SUB-TOTAL		688	491	1,179	1,665	1,773	3,438	40,635
146.	2 Single Family (1-5du/ac)	314.00 DU	60	176	236	201	116	317	3,109
	4 Condominium/Townhouse	296.00 DU	30	142	172	139	77	216	2,368
	SUB-TOTAL		90	318	408	340	193	533	5,477
147.	3 Single Family (6-10du/ac)	140.00 DU	27	78	105	90	52	142	1,386
	4 Condominium/Townhouse	100.00 DU	10	48	58	47	26	73	800
	5 Apartment	567.00 DU	45	244	289	232	119	351	3,912
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	5.00 AC	0	0	0	0	0	0	13
	SUB-TOTAL		277	520	797	429	265	694	7,199
148.	11 Commercial Center(10-30a)	183.88 TSF	134	86	220	438	474	912	9,941
	15 Sit-Down Restaurant	7.70 TSF	37	34	71	50	33	83	1,004
	16 Fast Food Restaurant	5.00 TSF	127	122	249	87	80	167	2,481
	SUB-TOTAL		298	242	540	575	587	1,162	13,426
149.	2 Single Family (1-5du/ac)	535.00 DU	102	300	402	342	198	540	5,297
	4 Condominium/Townhouse	500.00 DU	50	240	290	235	130	365	4,000
	12 Commercial Center (<10ac)	34.85 TSF	38	24	62	116	125	241	2,964
	SUB-TOTAL		190	564	754	693	453	1,146	12,261
150.	2 Single Family (1-5du/ac)	114.00 DU	22	64	86	73	42	115	1,129
	SUB-TOTAL		22	64	86	73	42	115	1,129
151.	1 Single Family (<1du/ac)	71.00 DU	21	48	69	60	26	86	703
	SUB-TOTAL		21	48	69	60	26	86	703
152.	2 Single Family (1-5du/ac)	892.00 DU	169	500	669	571	330	901	8,831
	51 Developed Park	18.00 AC	0	0	0	1	1	2	47
	SUB-TOTAL		169	500	669	572	331	903	8,878
153.	3 Single Family (6-10du/ac)	424.00 DU	81	237	318	271	157	428	4,198
	SUB-TOTAL		81	237	318	271	157	428	4,198
159.	2 Single Family (1-5du/ac)	4.00 DU	1	2	3	3	1	4	40
	25 Church	25.00 TSF	10	8	18	9	8	17	233
	35 Regional Post Office	16.00 TSF	3	2	5	2	2	4	80
	SUB-TOTAL		14	12	26	14	11	25	353

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
160.	3 Single Family (6-10du/ac)	95.00 DU	18	53	71	61	35	96	940
	7 Senior (Active)	95.00 DU	8	11	19	15	10	25	352
	SUB-TOTAL		26	64	90	76	45	121	1,292
161.	1 Single Family (<1du/ac)	60.00 DU	17	40	57	50	22	72	594
	2 Single Family (1-5du/ac)	580.00 DU	110	325	435	371	215	586	5,742
	4 Condominium/Townhouse	650.00 DU	65	312	377	306	169	475	5,200
	11 Commercial Center(10-30a)	48.00 TSF	35	23	58	114	124	238	2,595
	12 Commercial Center (<10ac)	54.22 TSF	59	37	96	180	195	375	4,612
	13 Commercial Shops	12.50 TSF	9	6	15	23	23	46	463
	14 Hotel	283.00 ROOM	96	62	158	91	82	173	2,329
	15 Sit-Down Restaurant	21.10 TSF	102	94	196	138	92	230	2,750
	16 Fast Food Restaurant	16.00 TSF	407	391	798	279	257	536	7,938
	40 Commercial Office	282.41 TSF	438	54	492	59	364	423	3,265
	SUB-TOTAL		1,338	1,344	2,682	1,611	1,543	3,154	35,488
162.	2 Single Family (1-5du/ac)	248.00 DU	47	139	186	159	92	251	2,455
	6 Mobile Home	87.00 DU	7	28	35	30	18	48	600
	11 Commercial Center(10-30a)	102.42 TSF	75	48	123	244	264	508	5,537
	30 Industrial Park	240.00 TSF	132	24	156	31	125	156	1,440
	SUB-TOTAL		261	239	500	464	499	963	10,032
163.	30 Industrial Park	1,000.00 TSF	550	100	650	130	520	650	6,000
	SUB-TOTAL		550	100	650	130	520	650	6,000
164.	2 Single Family (1-5du/ac)	204.00 DU	39	114	153	131	75	206	2,020
	7 Senior (Active)	86.00 DU	7	10	17	14	9	23	319
	30 Industrial Park	30.00 TSF	17	3	20	4	16	20	180
	52 Undeveloped Park	145.00 AC	0	0	0	0	0	0	73
	SUB-TOTAL		63	127	190	149	100	249	2,592
165.	2 Single Family (1-5du/ac)	86.00 DU	16	48	64	55	32	87	851
	4 Condominium/Townhouse	287.00 DU	29	138	167	135	75	210	2,296
	12 Commercial Center (<10ac)	30.23 TSF	33	21	54	100	109	209	2,571
	13 Commercial Shops	97.60 TSF	70	47	117	176	176	352	3,617
	23 Hospital	24.66 TSF	18	6	24	5	17	22	414
	30 Industrial Park	3,400.00 TSF	1,870	340	2,210	442	1,768	2,210	20,400
	32 Manufacturing/Warehouse	2.47 TSF	1	0	1	1	1	2	13
	40 Commercial Office	13.81 TSF	21	3	24	3	18	21	160
	SUB-TOTAL		2,058	603	2,661	917	2,196	3,113	30,322
166.	2 Single Family (1-5du/ac)	431.00 DU	82	241	323	276	159	435	4,267
	4 Condominium/Townhouse	462.00 DU	46	222	268	217	120	337	3,696
	12 Commercial Center (<10ac)	48.64 TSF	53	34	87	161	175	336	4,137
	13 Commercial Shops	21.38 TSF	15	10	25	38	38	76	792
	16 Fast Food Restaurant	4.34 TSF	110	106	216	76	70	146	2,153
	25 Church	26.00 TSF	10	9	19	9	8	17	242
	32 Manufacturing/Warehouse	11.00 TSF	6	2	8	3	5	8	56
	40 Commercial Office	30.10 TSF	47	6	53	6	39	45	348
	SUB-TOTAL		369	630	999	786	614	1,400	15,691
167.	2 Single Family (1-5du/ac)	196.00 DU	37	110	147	125	73	198	1,940
	SUB-TOTAL		37	110	147	125	73	198	1,940

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
168.	2 Single Family (1-5du/ac)	247.00 DU	47	138	185	158	91	249	2,445
	SUB-TOTAL		47	138	185	158	91	249	2,445
169.	2 Single Family (1-5du/ac)	127.00 DU	24	71	95	81	47	128	1,257
	4 Condominium/Townhouse	94.00 DU	9	45	54	44	24	68	752
	10 Commercial Center (>30ac)	300.00 TSF	141	90	231	492	534	1,026	12,018
	20 Elementary/Middle School	60.00 STU	16	12	28	5	5	10	87
	25 Church	7.00 TSF	3	2	5	3	2	5	65
	42 Medical Office	20.00 TSF	39	10	49	20	53	73	684
	SUB-TOTAL		232	230	462	645	665	1,310	14,863
170.	2 Single Family (1-5du/ac)	60.00 DU	11	34	45	38	22	60	594
	SUB-TOTAL		11	34	45	38	22	60	594
171.	2 Single Family (1-5du/ac)	60.00 DU	11	34	45	38	22	60	594
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		206	184	390	98	90	188	1,682
172.	2 Single Family (1-5du/ac)	185.00 DU	35	104	139	118	68	186	1,831
	SUB-TOTAL		35	104	139	118	68	186	1,831
173.	2 Single Family (1-5du/ac)	386.00 DU	73	216	289	247	143	390	3,821
	SUB-TOTAL		73	216	289	247	143	390	3,821
174.	4 Condominium/Townhouse	200.00 DU	20	96	116	94	52	146	1,600
	7 Senior (Active)	200.00 DU	16	24	40	32	20	52	742
	10 Commercial Center (>30ac)	300.00 TSF	141	90	231	492	534	1,026	12,018
	14 Hotel	300.00 ROOM	M 102	66	168	96	87	183	2,469
	15 Sit-Down Restaurant	50.00 TSF	241	222	463	326	217	543	6,517
	40 Commercial Office	350.00 TSF	543	67	610	74	452	526	4,046
	SUB-TOTAL		1,063	565	1,628	1,114	1,362	2,476	27,392
175.	2 Single Family (1-5du/ac)	162.00 DU	31	91	122	104	60	164	1,604
	4 Condominium/Townhouse	160.00 DU	16	77	93	75	42	117	1,280
	5 Apartment	50.00 DU	4	22	26	21	11	32	345
	6 Mobile Home	218.00 DU	17	70	87	76	46	122	1,504
	11 Commercial Center(10-30a)	98.01 TSF	72	46	118	233	253	486	5,298
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	34 Utilities	87.12 TSF	0	0	0	0	0	0	207
	SUB-TOTAL		335	456	791	569	480	1,049	11,326
176.	2 Single Family (1-5du/ac)	762.00 DU	145	427	572	488	282	770	7,544
	4 Condominium/Townhouse	135.00 DU	14	65	79	63	35	98	1,080
	5 Apartment	135.00 DU	11	58	69	55	28	83	932
	10 Commercial Center (>30ac)	196.02 TSF	92	59	151	321	349	670	7,853
	13 Commercial Shops	141.57 TSF	102	68	170	255	255	510	5,247
	25 Church	35.00 TSF	14	12	26	13	11	24	326
	SUB-TOTAL		378	689	1,067	1,195	960	2,155	22,982
177.	2 Single Family (1-5du/ac)	477.00 DU	91	267	358	305	176	481	4,722
	4 Condominium/Townhouse	264.00 DU	26	127	153	124	69	193	2,112
	11 Commercial Center(10-30a)	97.57 TSF	71	46	117	232	252	484	5,275
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	25 Church	17.00 TSF	7	6	13	6	5	11	158
	51 Developed Park	7.00 AC	0	0	0	0	0	0	18
	SUB-TOTAL		390	596	986	727	570	1,297	13,373

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
178.	2 Single Family (1-5du/ac)	333.00 DU	63	186	249	213	123	336	3,297
	11 Commercial Center(10-30a)	21.78 TSF	16	10	26	52	56	108	1,177
	13 Commercial Shops	6.53 TSF	5	3	8	12	12	24	242
	25 Church	11.00 TSF	4	4	8	4	3	7	102
	40 Commercial Office	50.81 TSF	79	10	89	11	66	77	587
	SUB-TOTAL		167	213	380	292	260	552	5,405
179.	2 Single Family (1-5du/ac)	167.00 DU	32	94	126	107	62	169	1,653
	7 Senior (Active)	209.00 DU	17	25	42	33	21	54	775
	13 Commercial Shops	21.78 TSF	16	10	26	39	39	78	807
	16 Fast Food Restaurant	7.00 TSF	178	171	349	122	112	234	3,473
	34 Utilities	87.12 TSF	0	0	0	0	0	0	207
	42 Medical Office	52.00 TSF	101	25	126	51	139	190	1,778
	SUB-TOTAL		344	325	669	352	373	725	8,693
180.	2 Single Family (1-5du/ac)	428.00 DU	81	240	321	274	158	432	4,237
	20 Elementary/Middle School	450.00 STU	117	90	207	36	41	77	653
	SUB-TOTAL		198	330	528	310	199	509	4,890
181.	3 Single Family (6-10du/ac)	282.00 DU	54	158	212	180	104	284	2,792
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		249	308	557	240	172	412	3,880
182.	3 Single Family (6-10du/ac)	276.00 DU	52	155	207	177	102	279	2,732
	4 Condominium/Townhouse	238.00 DU	24	114	138	112	62	174	1,904
	11 Commercial Center(10-30a)	96.23 TSF	70	45	115	229	248	477	5,202
	20 Elementary/Middle School	83.00 STU	22	17	39	7	7	14	120
	25 Church	17.25 TSF	7	6	13	6	5	11	160
	SUB-TOTAL		175	337	512	531	424	955	10,118
183.	4 Condominium/Townhouse	634.00 DU	63	304	367	298	165	463	5,072
	12 Commercial Center (<10ac)	3.50 TSF	4	2	6	12	13	25	298
	22 College	4,000.00 STU	520	40	560	280	560	840	6,160
	50 Golf Course	100.00 AC	15	6	21	10	20	30	796
	SUB-TOTAL		602	352	954	600	758	1,358	12,326
184.	17 Movie Theater	300.00 SEA	T 0	0	0	15	6	21	528
	40 Commercial Office	100.00 TSF	155	19	174	21	129	150	1,156
	SUB-TOTAL		155	19	174	36	135	171	1,684
185.	2 Single Family (1-5du/ac)	133.00 DU	25	74	99	85	49	134	1,317
	3 Single Family (6-10du/ac)	211.00 DU	40	118	158	135	78	213	2,089
	SUB-TOTAL		65	192	257	220	127	347	3,406
186.	3 Single Family (6-10du/ac)	150.00 DU	29	84	113	96	56	152	1,485
	23 Hospital	340.50 TSF	242	89	331	75	238	313	5,720
	42 Medical Office	402.00 TSF	780	197	977	398	1,073	1,471	13,748
	SUB-TOTAL		1,051	370	1,421	569	1,367	1,936	20,953
187.	2 Single Family (1-5du/ac)	111.00 DU	21	62	83	71	41	112	1,099
	4 Condominium/Townhouse	307.00 DU	31	147	178	144	80	224	2,456
	7 Senior (Active)	119.00 DU	10	14	24	19	12	31	441
	51 Developed Park	14.00 AC	0	0	0	0	1	1	36
	SUB-TOTAL		62	223	285	234	134	368	4,032

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
188.	2 Single Family (1-5du/ac)	72.00 DU	14	40	54	46	27	73	713
	4 Condominium/Townhouse	216.00 DU	22	104	126	102	56	158	1,728
	SUB-TOTAL		36	144	180	148	83	231	2,441
189.	12 Commercial Center (<10ac)	3.00 TSF	3	2	5	10	11	21	255
	22 College	20,000.00 STU	2,600	200	2,800	1,400	2,800	4,200	30,800
	SUB-TOTAL		2,603	202	2,805	1,410	2,811	4,221	31,055
190.	2 Single Family (1-5du/ac)	171.00 DU	32	96	128	109	63	172	1,693
	SUB-TOTAL		32	96	128	109	63	172	1,693
191.	42 Medical Office	78.56 TSF	152	38	190	78	210	288	2,687
	SUB-TOTAL		152	38	190	78	210	288	2,687
192.	2 Single Family (1-5du/ac)	164.00 DU	31	92	123	105	61	166	1,624
	4 Condominium/Townhouse	660.00 DU	66	317	383	310	172	482	5,280
	18 Health Club	13.00 TSF	12	8	20	28	19	47	520
	SUB-TOTAL		109	417	526	443	252	695	7,424
193.	31 Business Park	250.00 TSF	300	58	358	75	248	323	2,550
	SUB-TOTAL		300	58	358	75	248	323	2,550
194.	50 Golf Course	100.00 AC	15	6	21	10	20	30	796
	SUB-TOTAL		15	6	21	10	20	30	796
195.	4 Condominium/Townhouse	76.00 DU	8	36	44	36	20	56	608
	SUB-TOTAL		8	36	44	36	20	56	608
196.	4 Condominium/Townhouse	10.00 DU	1	5	6	5	3	8	80
	13 Commercial Shops	2.50 TSF	2	1	3	5	5	10	93
	14 Hotel	200.00 ROOM	68	44	112	64	58	122	1,646
	40 Commercial Office	34.55 TSF	54	7	61	7	45	52	399
	SUB-TOTAL		125	57	182	81	111	192	2,218
197.	12 Commercial Center (<10ac)	13.00 TSF	14	9	23	43	47	90	1,106
	31 Business Park	400.00 TSF	480	92	572	120	396	516	4,080
	SUB-TOTAL		494	101	595	163	443	606	5,186
198.	2 Single Family (1-5du/ac)	179.00 DU	34	100	134	115	66	181	1,772
	3 Single Family (6-10du/ac)	152.00 DU	29	85	114	97	56	153	1,505
	SUB-TOTAL		63	185	248	212	122	334	3,277
199.	14 Hotel	237.00 ROOM	81	52	133	76	69	145	1,951
	15 Sit-Down Restaurant	5.00 TSF	24	22	46	33	22	55	652
	SUB-TOTAL		105	74	179	109	91	200	2,603
200.	31 Business Park	578.00 TSF	694	133	827	173	572	745	5,896
	SUB-TOTAL		694	133	827	173	572	745	5,896
201.	31 Business Park	160.00 TSF	192	37	229	48	158	206	1,632
	SUB-TOTAL		192	37	229	48	158	206	1,632

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
202.	5 Apartment	560.00 DU	45	241	286	230	118	348	3,864
	13 Commercial Shops	22.00 TSF	16	11	27	40	40	80	815
	14 Hotel	250.00 ROOM	85	55	140	80	73	153	2,058
	18 Health Club	54.00 TSF	52	35	87	117	78	195	2,160
	40 Commercial Office	13.00 TSF	20	2	22	3	17	20	150
	SUB-TOTAL		218	344	562	470	326	796	9,047
203.	5 Apartment	450.00 DU	36	194	230	185	95	280	3,105
	10 Commercial Center (>30ac)	2,000.00 TSF	940	600	1,540	3,280	3,560	6,840	80,120
	40 Commercial Office	125.00 TSF	194	24	218	26	161	187	1,445
	SUB-TOTAL		1,170	818	1,988	3,491	3,816	7,307	84,670
204.	13 Commercial Shops	62.00 TSF	45	30	75	112	112	224	2,298
	17 Movie Theater	3,300.00 SEA	T 0	0	0	165	66	231	5,808
	40 Commercial Office	400.00 TSF	620	76	696	84	516	600	4,624
	SUB-TOTAL		665	106	771	361	694	1,055	12,730
205.	11 Commercial Center(10-30a)	100.00 TSF	73	47	120	238	258	496	5,406
	24 Library	40.00 TSF	30	12	42	136	148	284	3,399
	40 Commercial Office	850.00 TSF	1,318	162	1,480	179	1,097	1,276	9,826
	SUB-TOTAL		1,421	221	1,642	553	1,503	2,056	18,631
206.	11 Commercial Center(10-30a)	166.11 TSF	121	78	199	395	429	824	8,980
	15 Sit-Down Restaurant	21.50 TSF	104	96	200	140	93	233	2,802
	SUB-TOTAL		225	174	399	535	522	1,057	11,782
207.	15 Sit-Down Restaurant	6.00 TSF	29	27	56	39	26	65	782
	40 Commercial Office	350.00 TSF	543	67	610	74	452	526	4,046
	SUB-TOTAL		572	94	666	113	478	591	4,828
208.	4 Condominium/Townhouse	234.00 DU	23	112	135	110	61	171	1,872
	SUB-TOTAL		23	112	135	110	61	171	1,872
209.	2 Single Family (1-5du/ac)	414.00 DU	79	232	311	265	153	418	4,099
	4 Condominium/Townhouse	352.00 DU	35	169	204	165	92	257	2,816
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		309	551	860	490	313	803	8,003
210.	2 Single Family (1-5du/ac)	205.00 DU	39	115	154	131	76	207	2,029
	4 Condominium/Townhouse	208.00 DU	21	100	121	98	54	152	1,664
	11 Commercial Center(10-30a)	148.10 TSF	108	70	178	352	382	734	8,006
	SUB-TOTAL		168	285	453	581	512	1,093	11,699
211.	2 Single Family (1-5du/ac)	167.00 DU	32	94	126	107	62	169	1,653
	SUB-TOTAL		32	94	126	107	62	169	1,653
212.	2 Single Family (1-5du/ac)	252.00 DU	48	141	189	161	93	254	2,495
	4 Condominium/Townhouse	272.00 DU	27	131	158	128	71	199	2,176
	25 Church	18.03 TSF	7	6	13	6	5	11	168
	51 Developed Park	4.20 AC	0	0	0	0	0	0	11
	SUB-TOTAL		82	278	360	295	169	464	4,850
213.	2 Single Family (1-5du/ac)	275.00 DU	52	154	206	176	102	278	2,723
	25 Church	25.09 TSF	10	8	18	9	8	17	233
	SUB-TOTAL		62	162	224	185	110	295	2,956

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
214.	3 Single Family (6-10du/ac)	49.00 DU	9	27	36	31	18	49	485
	4 Condominium/Townhouse	74.00 DU	7	36	43	35	19	54	592
	5 Apartment	107.00 DU	9	46	55	44	22	66	738
	25 Church	8.00 TSF	3	3	6	3	2	5	74
	SUB-TOTAL		28	112	140	113	61	174	1,889
215.	2 Single Family (1-5du/ac)	80.00 DU	15	45	60	51	30	81	792
	4 Condominium/Townhouse	52.00 DU	5	25	30	24	14	38	416
	11 Commercial Center(10-30a)	100.00 TSF	73	47	120	238	258	496	5,406
	13 Commercial Shops	43.56 TSF	31	21	52	78	78	156	1,614
	20 Elementary/Middle School	350.00 STU	91	70	161	28	32	60	508
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	25 Church	100.00 TSF	39	33	72	36	30	66	930
	34 Utilities	47.92 TSF	0	0	0	0	0	0	114
	SUB-TOTAL		1,054	591	1,645	605	667	1,272	14,255
216.	3 Single Family (6-10du/ac)	22.00 DU	4	12	16	14	8	22	218
	4 Condominium/Townhouse	378.00 DU	38	181	219	178	98	276	3,024
	5 Apartment	70.00 DU	6	30	36	29	15	44	483
	11 Commercial Center(10-30a)	204.96 TSF	150	96	246	488	529	1,017	11,080
	40 Commercial Office	65.45 TSF	101	12	113	14	84	98	757
	SUB-TOTAL		299	331	630	723	734	1,457	15,562
217.	2 Single Family (1-5du/ac)	202.00 DU	38	113	151	129	75	204	2,000
	4 Condominium/Townhouse	316.00 DU	32	152	184	149	82	231	2,528
	5 Apartment	70.00 DU	6	30	36	29	15	44	483
	11 Commercial Center(10-30a)	65.75 TSF	48	31	79	156	170	326	3,554
	13 Commercial Shops	45.00 TSF	32	22	54	81	81	162	1,668
	30 Industrial Park	22.44 TSF	12	2	14	3	12	15	135
	40 Commercial Office	22.44 TSF	35	4	39	5	29	34	259
	SUB-TOTAL		203	354	557	552	464	1,016	10,627
218.	2 Single Family (1-5du/ac)	360.00 DU	68	202	270	230	133	363	3,564
	4 Condominium/Townhouse	750.00 DU	75	360	435	353	195	548	6,000
	5 Apartment	60.00 DU	5	26	31	25	13	38	414
	6 Mobile Home	151.00 DU	12	48	60	53	32	85	1,042
	10 Commercial Center (>30ac)	327.00 TSF	154	98	252	536	582	1,118	13,100
	11 Commercial Center(10-30a)	166.62 TSF	122	78	200	397	430	827	9,007
	13 Commercial Shops	64.25 TSF	46	31	77	116	116	232	2,381
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	25 Church	9.41 TSF	4	3	7	3	3	6	88
	SUB-TOTAL		681	996	1,677	1,773	1,572	3,345	36,684
219.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	4 Condominium/Townhouse	250.00 DU	25	120	145	118	65	183	2,000
	31 Business Park	100.00 TSF	120	23	143	30	99	129	1,020
	SUB-TOTAL		149	154	303	161	171	332	3,218
220.	2 Single Family (1-5du/ac)	8.00 DU	2	4	6	5	3	8	79
	31 Business Park	100.00 TSF	120	23	143	30	99	129	1,020
	34 Utilities	566.28 TSF	0	0	0	0	0	0	1,348
	SUB-TOTAL		122	27	149	35	102	137	2,447

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
221.	2 Single Family (1-5du/ac)	350.00 DU	67	196	263	224	130	354	3,465
	4 Condominium/Townhouse	6.00 DU	1	3	4	3	2	5	48
	6 Mobile Home	30.00 DU	2	10	12	11	6	17	207
	22 College	362.00 STU	47	4	51	25	51	76	557
	25 Church	92.52 TSF	36	31	67	33	28	61	860
	30 Industrial Park	144.40 TSF	79	14	93	19	75	94	866
	31 Business Park	50.00 TSF	60	12	72	15	50	65	510
	SUB-TOTAL		292	270	562	330	342	672	6,513
222.	2 Single Family (1-5du/ac)	55.00 DU	10	31	41	35	20	55	545
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	22 College	1,700.00 STU	221	17	238	119	238	357	2,618
	25 Church	16.70 TSF	7	6	13	6	5	11	155
	SUB-TOTAL		433	204	637	220	331	551	4,406
223.	11 Commercial Center(10-30a)	110.00 TSF	80	52	132	262	284	546	5,947
	14 Hotel	100.00 ROOM	34	22	56	32	29	61	823
	30 Industrial Park	242.00 TSF	133	24	157	31	126	157	1,452
	40 Commercial Office	248.00 TSF	384	47	431	52	320	372	2,867
	SUB-TOTAL		631	145	776	377	759	1,136	11,089
224.	2 Single Family (1-5du/ac)	250.00 DU	48	140	188	160	93	253	2,475
	4 Condominium/Townhouse	550.00 DU	55	264	319	259	143	402	4,400
	6 Mobile Home	30.00 DU	2	10	12	11	6	17	207
	13 Commercial Shops	116.68 TSF	84	56	140	210	210	420	4,324
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	24 Library	34.40 TSF	26	10	36	117	127	244	2,923
	SUB-TOTAL		410	630	1,040	817	647	1,464	15,417
225.	2 Single Family (1-5du/ac)	156.00 DU	30	87	117	100	58	158	1,544
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	51 Developed Park	14.00 AC	0	0	0	0	1	1	36
	SUB-TOTAL		342	327	669	196	167	363	3,320
226.	2 Single Family (1-5du/ac)	300.00 DU	57	168	225	192	111	303	2,970
	4 Condominium/Townhouse	292.00 DU	29	140	169	137	76	213	2,336
	12 Commercial Center (<10ac)	15.68 TSF	17	11	28	52	56	108	1,334
	13 Commercial Shops	69.70 TSF	50	33	83	125	125	250	2,583
	14 Hotel	34.00 ROOM	12	7	19	11	10	21	280
	25 Church	8.00 TSF	3	3	6	3	2	5	74
	SUB-TOTAL		168	362	530	520	380	900	9,577
227.	2 Single Family (1-5du/ac)	118.00 DU	22	66	88	76	44	120	1,168
	4 Condominium/Townhouse	786.00 DU	79	377	456	369	204	573	6,288
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		296	593	889	505	316	821	8,544
228.	2 Single Family (1-5du/ac)	385.00 DU	73	216	289	246	142	388	3,811
	SUB-TOTAL		73	216	289	246	142	388	3,811
229.	1 Single Family (<1du/ac)	74.00 DU	21	50	71	62	27	89	733
	2 Single Family (1-5du/ac)	104.00 DU	20	58	78	67	38	105	1,030
	SUB-TOTAL		41	108	149	129	65	194	1,763
230.	1 Single Family (<1du/ac)	10.00 DU	3	7	10	8	4	12	99
	SUB-TOTAL		3	7	10	8	4	12	99

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
231.	2 Single Family (1-5du/ac)	5.00 DU	1	3	4	3	2	5	50
	4 Condominium/Townhouse	51.00 DU	5	24	29	24	13	37	408
	34 Utilities	29.00 TSF	0	0	0	0	0	0	69
	SUB-TOTAL		6	27	33	27	15	42	527
232.	1 Single Family (<1du/ac)	10.00 DU	3	7	10	8	4	12	99
	5 Apartment	850.00 DU	68	366	434	349	179	528	5,865
	SUB-TOTAL		71	373	444	357	183	540	5,964
234.	11 Commercial Center(10-30a)	100.00 TSF	73	47	120	238	258	496	5,406
	31 Business Park	470.24 TSF	564	108	672	141	466	607	4,796
	SUB-TOTAL		637	155	792	379	724	1,103	10,202
235.	11 Commercial Center(10-30a)	240.00 TSF	175	113	288	571	619	1,190	12,974
	31 Business Park	80.00 TSF	96	18	114	24	79	103	816
	SUB-TOTAL		271	131	402	595	698	1,293	13,790
236.	2 Single Family (1-5du/ac)	204.00 DU	39	114	153	131	75	206	2,020
	3 Single Family (6-10du/ac)	604.00 DU	115	338	453	387	223	610	5,980
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	5.00 AC	0	0	0	0	0	0	13
	SUB-TOTAL		349	602	951	578	366	944	9,101
237.	2 Single Family (1-5du/ac)	225.00 DU	43	126	169	144	83	227	2,228
	5 Apartment	570.00 DU	46	245	291	234	120	354	3,933
	40 Commercial Office	99.00 TSF	153	19	172	21	128	149	1,144
	51 Developed Park	24.40 AC	0	0	0	1	1	2	63
	SUB-TOTAL		242	390	632	400	332	732	7,368
238.	2 Single Family (1-5du/ac)	163.00 DU	31	91	122	104	60	164	1,614
	3 Single Family (6-10du/ac)	236.00 DU	45	132	177	151	87	238	2,336
	4 Condominium/Townhouse	123.00 DU	12	59	71	58	32	90	984
	11 Commercial Center(10-30a)	82.00 TSF	60	39	99	195	212	407	4,433
	12 Commercial Center (<10ac)	50.00 TSF	55	35	90	166	180	346	4,253
	13 Commercial Shops	32.00 TSF	23	15	38	58	58	116	1,186
	15 Sit-Down Restaurant	20.00 TSF	96	89	185	130	87	217	2,607
	30 Industrial Park	944.00 TSF	519	94	613	123	491	614	5,664
	31 Business Park	227.00 TSF	272	52	324	68	225	293	2,315
	40 Commercial Office	113.00 TSF	175	21	196	24	146	170	1,306
	51 Developed Park	25.90 AC	0	0	0	1	1	2	67
	SUB-TOTAL		1,288	627	1,915	1,078	1,579	2,657	26,765
239.	13 Commercial Shops	337.29 TSF	243	162	405	607	607	1,214	12,500
	21 High School	500.00 STU	160	70	230	30	45	75	895
	30 Industrial Park	387.07 TSF	213	39	252	50	201	251	2,322
	40 Commercial Office	262.87 TSF	407	50	457	55	339	394	3,039
	SUB-TOTAL		1,023	321	1,344	742	1,192	1,934	18,756
240.	11 Commercial Center(10-30a)	126.00 TSF	92	59	151	300	325	625	6,812
	12 Commercial Center (<10ac)	40.00 TSF	44	28	72	133	144	277	3,402
	15 Sit-Down Restaurant	9.50 TSF	46	42	88	62	41	103	1,238
	16 Fast Food Restaurant	5.50 TSF	140	134	274	96	88	184	2,729
	SUB-TOTAL		322	263	585	591	598	1,189	14,181

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
241.	21 High School	500.00 STU	160	70	230	30	45	75	895
	25 Church	25.00 TSF	10	8	18	9	8	17	233
	31 Business Park	1,200.00 TSF	1,440	276	1,716	360	1,188	1,548	12,240
	42 Medical Office	28.00 TSF	54	14	68	28	75	103	958
	SUB-TOTAL		1,664	368	2,032	427	1,316	1,743	14,326
242.	31 Business Park	253.00 TSF	304	58	362	76	250	326	2,581
	40 Commercial Office	115.00 TSF	178	22	200	24	148	172	1,329
	SUB-TOTAL		482	80	562	100	398	498	3,910
243.	2 Single Family (1-5du/ac)	211.00 DU	40	118	158	135	78	213	2,089
	4 Condominium/Townhouse	426.00 DU	43	204	247	200	111	311	3,408
	5 Apartment	390.00 DU	31	168	199	160	82	242	2,691
	11 Commercial Center(10-30a)	75.00 TSF	55	35	90	179	194	373	4,055
	12 Commercial Center (<10ac)	20.00 TSF	22	14	36	66	72	138	1,701
	15 Sit-Down Restaurant	34.00 TSF	164	151	315	222	148	370	4,432
	40 Commercial Office	164.00 TSF	254	31	285	34	212	246	1,896
	SUB-TOTAL		609	721	1,330	996	897	1,893	20,272
244.	2 Single Family (1-5du/ac)	322.00 DU	61	180	241	206	119	325	3,188
	SUB-TOTAL		61	180	241	206	119	325	3,188
245.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	51 Developed Park	13.00 AC	0	0	0	0	1	1	34
	SUB-TOTAL		4	11	15	13	8	21	232
246.	32 Manufacturing/Warehouse	120.00 TSF	67	20	87	32	56	88	612
	SUB-TOTAL		67	20	87	32	56	88	612
247.	10 Commercial Center (>30ac)	500.00 TSF	235	150	385	820	890	1,710	20,030
	SUB-TOTAL		235	150	385	820	890	1,710	20,030
248.	2 Single Family (1-5du/ac)	2.00 DU	0	1	1	1	1	2	20
	4 Condominium/Townhouse	4.00 DU	0	2	2	2	1	3	32
	4 Condominium/Townhouse	156.00 DU	16	75	91	73	41	114	1,248
	5 Apartment	148.00 DU	12	64	76	61	31	92	1,021
	30 Industrial Park	1,200.00 TSF	660	120	780	156	624	780	7,200
	SUB-TOTAL		688	262	950	293	698	991	9,521
249.	32 Manufacturing/Warehouse	291.68 TSF	163	50	213	79	137	216	1,488
	40 Commercial Office	250.00 TSF	388	48	436	53	323	376	2,890
	SUB-TOTAL		551	98	649	132	460	592	4,378
250.	4 Condominium/Townhouse	300.00 DU	30	144	174	141	78	219	2,400
	5 Apartment	150.00 DU	12	65	77	62	31	93	1,035
	10 Commercial Center (>30ac)	390.66 TSF	184	117	301	641	695	1,336	15,650
	13 Commercial Shops	58.00 TSF	42	28	70	104	104	208	2,149
	41 High-Rise Office	300.00 TSF	411	57	468	75	372	447	3,264
	SUB-TOTAL		679	411	1,090	1,023	1,280	2,303	24,498
251.	30 Industrial Park	400.00 TSF	220	40	260	52	208	260	2,400
	SUB-TOTAL		220	40	260	52	208	260	2,400
252.	31 Business Park	858.00 TSF	1,030	197	1,227	257	849	1,106	8,752
	SUB-TOTAL		1,030	197	1,227	257	849	1,106	8,752
253.	1 Single Family (<1du/ac)	32.00 DU	9	21	30	27	12	39	317
	SUB-TOTAL		9	21	30	27	12	39	317

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
254.	11 Commercial Center(10-30a)	107.50 TSF	78	51	129	256	277	533	5,811
	13 Commercial Shops	8.71 TSF	6	4	10	16	16	32	323
	SUB-TOTAL		84	55	139	272	293	565	6,134
255.	1 Single Family (<1du/ac)	20.00 DU	6	13	19	17	7	24	198
	SUB-TOTAL		6	13	19	17	7	24	198
256.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	SUB-TOTAL		4	11	15	13	7	20	198
257.	2 Single Family (1-5du/ac)	170.00 DU	32	95	127	109	63	172	1,683
	SUB-TOTAL		32	95	127	109	63	172	1,683
258.	2 Single Family (1-5du/ac)	130.00 DU	25	73	98	83	48	131	1,287
	25 Church	15.00 TSF	6	5	11	5	5	10	140
	32 Manufacturing/Warehouse	125.00 TSF	70	21	91	34	59	93	638
	50 Golf Course	400.00 AC	60	24	84	40	80	120	3,184
	SUB-TOTAL		161	123	284	162	192	354	5,249
259.	3 Single Family (6-10du/ac)	10.00 DU	2	6	8	6	4	10	99
	SUB-TOTAL		2	6	8	6	4	10	99
260.	2 Single Family (1-5du/ac)	402.00 DU	76	225	301	257	149	406	3,980
	SUB-TOTAL		76	225	301	257	149	406	3,980
261.	2 Single Family (1-5du/ac)	25.00 DU	5	14	19	16	9	25	247
	SUB-TOTAL		5	14	19	16	9	25	247
262.	2 Single Family (1-5du/ac)	596.00 DU	113	334	447	381	221	602	5,900
	3 Single Family (6-10du/ac)	194.00 DU	37	109	146	124	72	196	1,921
	4 Condominium/Townhouse	100.00 DU	10	48	58	47	26	73	800
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		355	641	996	612	387	999	9,709
263.	4 Condominium/Townhouse	200.00 DU	20	96	116	94	52	146	1,600
	SUB-TOTAL		20	96	116	94	52	146	1,600
264.	3 Single Family (6-10du/ac)	63.00 DU	12	35	47	40	23	63	624
	4 Condominium/Townhouse	186.00 DU	19	89	108	87	48	135	1,488
	5 Apartment	78.00 DU	6	34	40	32	16	48	538
	SUB-TOTAL		37	158	195	159	87	246	2,650
265.	4 Condominium/Townhouse	320.00 DU	32	154	186	150	83	233	2,560
	5 Apartment	350.00 DU	28	151	179	144	74	218	2,415
	SUB-TOTAL		60	305	365	294	157	451	4,975
266.	7 Senior (Active)	200.00 DU	16	24	40	32	20	52	742
	11 Commercial Center(10-30a)	120.00 TSF	88	56	144	286	310	596	6,487
	32 Manufacturing/Warehouse	75.00 TSF	42	13	55	20	35	55	383
	SUB-TOTAL		146	93	239	338	365	703	7,612
267.	11 Commercial Center(10-30a)	200.00 TSF	146	94	240	476	516	992	10,812
	SUB-TOTAL		146	94	240	476	516	992	10,812

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
268.	4 Condominium/Townhouse	180.00 DU	18	86	104	85	47	132	1,440
	11 Commercial Center(10-30a)	182.33 TSF	133	86	219	434	470	904	9,857
	32 Manufacturing/Warehouse	112.00 TSF	63	19	82	30	53	83	571
	SUB-TOTAL		214	191	405	549	570	1,119	11,868
269.	2 Single Family (1-5du/ac)	250.00 DU	48	140	188	160	93	253	2,475
	3 Single Family (6-10du/ac)	16.00 DU	3	9	12	10	6	16	158
	7 Senior (Active)	25.00 DU	2	3	5	4	3	7	93
	20 Elementary/Middle School	500.00 STU	130	100	230	40	45	85	725
	51 Developed Park	4.50 AC	0	0	0	0	0	0	12
	SUB-TOTAL		183	252	435	214	147	361	3,463
270.	1 Single Family (<1du/ac)	8.00 DU	2	5	7	7	3	10	79
	3 Single Family (6-10du/ac)	300.00 DU	57	168	225	192	111	303	2,970
	7 Senior (Active)	75.00 DU	6	9	15	12	8	20	278
	SUB-TOTAL		65	182	247	211	122	333	3,327
271.	5 Apartment	171.00 DU	14	74	88	70	36	106	1,180
	10 Commercial Center (>30ac)	630.00 TSF	296	189	485	1,033	1,121	2,154	25,238
	SUB-TOTAL		310	263	573	1,103	1,157	2,260	26,418
272.	2 Single Family (1-5du/ac)	665.00 DU	126	372	498	426	246	672	6,583
	3 Single Family (6-10du/ac)	302.00 DU	57	169	226	193	112	305	2,990
	4 Condominium/Townhouse	180.00 DU	18	86	104	85	47	132	1,440
	12 Commercial Center (<10ac)	8.12 TSF	9	6	15	27	29	56	691
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		405	783	1,188	791	502	1,293	12,792
273.	2 Single Family (1-5du/ac)	101.00 DU	19	57	76	65	37	102	1,000
	SUB-TOTAL		19	57	76	65	37	102	1,000
274.	2 Single Family (1-5du/ac)	80.00 DU	15	45	60	51	30	81	792
	31 Business Park	110.06 TSF	132	25	157	33	109	142	1,123
	SUB-TOTAL		147	70	217	84	139	223	1,915
275.	2 Single Family (1-5du/ac)	225.00 DU	43	126	169	144	83	227	2,228
	SUB-TOTAL		43	126	169	144	83	227	2,228
276.	3 Single Family (6-10du/ac)	75.00 DU	14	42	56	48	28	76	743
	4 Condominium/Townhouse	539.00 DU	54	259	313	253	140	393	4,312
	12 Commercial Center (<10ac)	98.01 TSF	107	68	175	325	353	678	8,337
	25 Church	7.84 TSF	3	3	6	3	2	5	73
	SUB-TOTAL		178	372	550	629	523	1,152	13,465
277.	11 Commercial Center(10-30a)	70.00 TSF	51	33	84	167	181	348	3,784
	15 Sit-Down Restaurant	3.00 TSF	14	13	27	20	13	33	391
	32 Manufacturing/Warehouse	150.00 TSF	84	26	110	41	71	112	765
	40 Commercial Office	10.00 TSF	16	2	18	2	13	15	116
	42 Medical Office	100.00 TSF	194	49	243	99	267	366	3,420
	SUB-TOTAL		359	123	482	329	545	874	8,476
278.	4 Condominium/Townhouse	757.00 DU	76	363	439	356	197	553	6,056
	12 Commercial Center (<10ac)	81.89 TSF	89	57	146	272	295	567	6,966
	50 Golf Course	50.00 AC	8	3	11	5	10	15	398
	SUB-TOTAL		173	423	596	633	502	1,135	13,420

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
279.	6 Mobile Home	313.00 DU	25	100	125	110	66	176	2,160
	12 Commercial Center (<10ac)	26.33 TSF	29	18	47	87	95	182	2,240
	30 Industrial Park	58.00 TSF	32	6	38	8	30	38	348
	40 Commercial Office	0.20 TSF	0	0	0	0	0	0	2
	SUB-TOTAL		86	124	210	205	191	396	4,750
280.	31 Business Park	38.18 TSF	46	9	55	11	38	49	389
	SUB-TOTAL		46	9	55	11	38	49	389
281.	4 Condominium/Townhouse	150.00 DU	15	72	87	71	39	110	1,200
	SUB-TOTAL		15	72	87	71	39	110	1,200
282.	4 Condominium/Townhouse	700.00 DU	70	336	406	329	182	511	5,600
	11 Commercial Center(10-30a)	17.90 TSF	13	8	21	43	46	89	968
	SUB-TOTAL		83	344	427	372	228	600	6,568
283.	2 Single Family (1-5du/ac)	175.00 DU	33	98	131	112	65	177	1,732
	4 Condominium/Townhouse	667.00 DU	67	320	387	313	173	486	5,336
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	SUB-TOTAL		412	658	1,070	521	346	867	8,808
284.	2 Single Family (1-5du/ac)	2.00 DU	0	1	1	1	1	2	20
	4 Condominium/Townhouse	254.00 DU	25	122	147	119	66	185	2,032
	SUB-TOTAL		25	123	148	120	67	187	2,052
285.	2 Single Family (1-5du/ac)	80.00 DU	15	45	60	51	30	81	792
	10 Commercial Center (>30ac)	246.99 TSF	116	74	190	405	440	845	9,894
	31 Business Park	150.00 TSF	180	35	215	45	149	194	1,530
	SUB-TOTAL		311	154	465	501	619	1,120	12,216
286.	2 Single Family (1-5du/ac)	182.00 DU	35	102	137	116	67	183	1,802
	SUB-TOTAL		35	102	137	116	67	183	1,802
287.	2 Single Family (1-5du/ac)	35.00 DU	7	20	27	22	13	35	347
	4 Condominium/Townhouse	120.00 DU	12	58	70	56	31	87	960
	SUB-TOTAL		19	78	97	78	44	122	1,307
288.	3 Single Family (6-10du/ac)	167.00 DU	32	94	126	107	62	169	1,653
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	SUB-TOTAL		832	444	1,276	257	287	544	6,128
289.	2 Single Family (1-5du/ac)	166.00 DU	32	93	125	106	61	167	1,643
	5 Apartment	350.00 DU	28	151	179	144	74	218	2,415
	31 Business Park	57.17 TSF	69	13	82	17	57	74	583
	SUB-TOTAL		129	257	386	267	192	459	4,641
290.	2 Single Family (1-5du/ac)	104.00 DU	20	58	78	67	38	105	1,030
	4 Condominium/Townhouse	93.00 DU	9	45	54	44	24	68	744
	SUB-TOTAL		29	103	132	111	62	173	1,774
291.	2 Single Family (1-5du/ac)	74.00 DU	14	41	55	47	27	74	733
	5 Apartment	350.00 DU	28	151	179	144	74	218	2,415
	31 Business Park	181.63 TSF	218	42	260	54	180	234	1,853
	SUB-TOTAL		260	234	494	245	281	526	5,001

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
292.	2 Single Family (1-5du/ac)	140.00 DU	27	78	105	90	52	142	1,386
	SUB-TOTAL		27	78	105	90	52	142	1,386
293.	2 Single Family (1-5du/ac)	180.00 DU	34	101	135	115	67	182	1,782
	4 Condominium/Townhouse	452.00 DU	45	217	262	212	118	330	3,616
	5 Apartment	232.00 DU	19	100	119	95	49	144	1,601
	SUB-TOTAL		98	418	516	422	234	656	6,999
294.	5 Apartment	276.00 DU	22	119	141	113	58	171	1,904
	11 Commercial Center(10-30a)	155.00 TSF	113	73	186	369	400	769	8,379
	30 Industrial Park	300.00 TSF	165	30	195	39	156	195	1,800
	SUB-TOTAL		300	222	522	521	614	1,135	12,083
295.	32 Manufacturing/Warehouse	1,020.58 TSF	572	173	745	276	480	756	5,205
	40 Commercial Office	56.00 TSF	87	11	98	12	72	84	647
	51 Developed Park	60.00 AC	0	0	0	2	2	4	156
	SUB-TOTAL		659	184	843	290	554	844	6,008
296.	12 Commercial Center (<10ac)	20.00 TSF	22	14	36	66	72	138	1,701
	SUB-TOTAL		22	14	36	66	72	138	1,701
297.	12 Commercial Center (<10ac)	20.00 TSF	22	14	36	66	72	138	1,701
	SUB-TOTAL		22	14	36	66	72	138	1,701
298.	5 Apartment	830.00 DU	66	357	423	340	174	514	5,727
	12 Commercial Center (<10ac)	20.00 TSF	22	14	36	66	72	138	1,701
	SUB-TOTAL		88	371	459	406	246	652	7,428
299.	11 Commercial Center(10-30a)	184.00 TSF	134	86	220	438	475	913	9,947
	SUB-TOTAL		134	86	220	438	475	913	9,947
300.	10 Commercial Center (>30ac)	300.00 TSF	141	90	231	492	534	1,026	12,018
	SUB-TOTAL		141	90	231	492	534	1,026	12,018
301.	13 Commercial Shops	49.24 TSF	35	24	59	89	89	178	1,825
	19 Car Dealership	86.00 TSF	138	52	190	96	144	240	3,225
	43 Post Office	50.00 TSF	209	193	402	275	265	540	5,410
	SUB-TOTAL		382	269	651	460	498	958	10,460
302.	12 Commercial Center (<10ac)	30.00 TSF	33	21	54	100	108	208	2,552
	19 Car Dealership	100.00 TSF	161	60	221	112	168	280	3,750
	SUB-TOTAL		194	81	275	212	276	488	6,302
303.	19 Car Dealership	150.00 TSF	242	90	332	168	252	420	5,625
	SUB-TOTAL		242	90	332	168	252	420	5,625
304.	11 Commercial Center(10-30a)	33.00 TSF	24	16	40	79	85	164	1,784
	15 Sit-Down Restaurant	15.00 TSF	72	67	139	98	65	163	1,955
	19 Car Dealership	83.00 TSF	134	50	184	93	139	232	3,113
	SUB-TOTAL		230	133	363	270	289	559	6,852
305.	5 Apartment	76.00 DU	6	33	39	31	16	47	524
	11 Commercial Center(10-30a)	197.29 TSF	144	93	237	470	509	979	10,665
	15 Sit-Down Restaurant	5.36 TSF	26	24	50	35	23	58	699
	32 Manufacturing/Warehouse	100.00 TSF	56	17	73	27	47	74	510
	SUB-TOTAL		232	167	399	563	595	1,158	12,398

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
306.	4 Condominium/Townhouse	125.00 DU	13	60	73	59	33	92	1,000
	5 Apartment	125.00 DU	10	54	64	51	26	77	863
	11 Commercial Center(10-30a)	143.90 TSF	105	68	173	342	371	713	7,779
	25 Church	36.10 TSF	14	12	26	13	11	24	336
	42 Medical Office	50.00 TSF	97	25	122	50	134	184	1,710
	SUB-TOTAL		239	219	458	515	575	1,090	11,688
307.	11 Commercial Center(10-30a)	128.00 TSF	93	60	153	305	330	635	6,920
	16 Fast Food Restaurant	4.80 TSF	122	117	239	84	77	161	2,381
	SUB-TOTAL		215	177	392	389	407	796	9,301
308.	5 Apartment	200.00 DU	16	86	102	82	42	124	1,380
	12 Commercial Center (<10ac)	175.11 TSF	191	121	312	581	630	1,211	14,895
	32 Manufacturing/Warehouse	45.00 TSF	25	8	33	12	21	33	230
	SUB-TOTAL		232	215	447	675	693	1,368	16,505
309.	13 Commercial Shops	3.00 TSF	2	1	3	5	5	10	111
	SUB-TOTAL		2	1	3	5	5	10	111
310.	19 Car Dealership	111.00 TSF	179	67	246	124	186	310	4,163
	51 Developed Park	17.20 AC	0	0	0	1	1	2	45
	SUB-TOTAL		179	67	246	125	187	312	4,208
311.	3 Single Family (6-10du/ac)	132.00 DU	25	74	99	84	49	133	1,307
	4 Condominium/Townhouse	63.00 DU	6	30	36	30	16	46	504
	SUB-TOTAL		31	104	135	114	65	179	1,811
312.	11 Commercial Center(10-30a)	180.00 TSF	131	85	216	428	464	892	9,731
	34 Utilities	84.00 TSF	0	0	0	0	0	0	200
	SUB-TOTAL		131	85	216	428	464	892	9,931
313.	4 Condominium/Townhouse	264.00 DU	26	127	153	124	69	193	2,112
	SUB-TOTAL		26	127	153	124	69	193	2,112
314.	11 Commercial Center(10-30a)	178.00 TSF	130	84	214	424	459	883	9,623
	SUB-TOTAL		130	84	214	424	459	883	9,623
315.	3 Single Family (6-10du/ac)	56.00 DU	11	31	42	36	21	57	554
	4 Condominium/Townhouse	168.00 DU	17	81	98	79	44	123	1,344
	SUB-TOTAL		28	112	140	115	65	180	1,898
316.	2 Single Family (1-5du/ac)	121.00 DU	23	68	91	77	45	122	1,198
	SUB-TOTAL		23	68	91	77	45	122	1,198
317.	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	18.00 AC	0	0	0	1	1	2	47
	SUB-TOTAL		195	150	345	61	69	130	1,135
318.	2 Single Family (1-5du/ac)	21.00 DU	4	12	16	13	8	21	208
	4 Condominium/Townhouse	252.00 DU	25	121	146	118	66	184	2,016
	SUB-TOTAL		29	133	162	131	74	205	2,224

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
319.	11 Commercial Center(10-30a)	130.00 TSF	95	61	156	309	335	644	7,028
	25 Church	30.00 TSF	12	10	22	11	9	20	279
	51 Developed Park	5.00 AC	0	0	0	0	0	0	13
	SUB-TOTAL		107	71	178	320	344	664	7,320
320.	2 Single Family (1-5du/ac)	125.00 DU	24	70	94	80	46	126	1,238
	SUB-TOTAL		24	70	94	80	46	126	1,238
321.	3 Single Family (6-10du/ac)	155.00 DU	29	87	116	99	57	156	1,535
	4 Condominium/Townhouse	66.00 DU	7	32	39	31	17	48	528
	SUB-TOTAL		36	119	155	130	74	204	2,063
322.	3 Single Family (6-10du/ac)	87.00 DU	17	49	66	56	32	88	861
	SUB-TOTAL		17	49	66	56	32	88	861
323.	3 Single Family (6-10du/ac)	161.00 DU	31	90	121	103	60	163	1,594
	4 Condominium/Townhouse	132.00 DU	13	63	76	62	34	96	1,056
	SUB-TOTAL		44	153	197	165	94	259	2,650
325.	3 Single Family (6-10du/ac)	205.00 DU	39	115	154	131	76	207	2,029
	SUB-TOTAL		39	115	154	131	76	207	2,029
326.	2 Single Family (1-5du/ac)	101.00 DU	19	57	76	65	37	102	1,000
	SUB-TOTAL		19	57	76	65	37	102	1,000
327.	2 Single Family (1-5du/ac)	105.00 DU	20	59	79	67	39	106	1,040
	SUB-TOTAL		20	59	79	67	39	106	1,040
328.	2 Single Family (1-5du/ac)	110.00 DU	21	62	83	70	41	111	1,089
	SUB-TOTAL		21	62	83	70	41	111	1,089
329.	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		195	150	345	60	68	128	1,088
330.	2 Single Family (1-5du/ac)	143.00 DU	27	80	107	92	53	145	1,416
	SUB-TOTAL		27	80	107	92	53	145	1,416
331.	2 Single Family (1-5du/ac)	167.00 DU	32	94	126	107	62	169	1,653
	SUB-TOTAL		32	94	126	107	62	169	1,653
332.	2 Single Family (1-5du/ac)	114.00 DU	22	64	86	73	42	115	1,129
	4 Condominium/Townhouse	102.00 DU	10	49	59	48	27	75	816
	SUB-TOTAL		32	113	145	121	69	190	1,945
333.	2 Single Family (1-5du/ac)	803.00 DU	153	450	603	514	297	811	7,950
	4 Condominium/Townhouse	360.00 DU	36	173	209	169	94	263	2,880
	13 Commercial Shops	25.05 TSF	18	12	30	45	45	90	928
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	SUB-TOTAL		519	875	1,394	824	544	1,368	13,498
334.	2 Single Family (1-5du/ac)	164.00 DU	31	92	123	105	61	166	1,624
	SUB-TOTAL		31	92	123	105	61	166	1,624
335.	2 Single Family (1-5du/ac)	194.00 DU	37	109	146	124	72	196	1,921
	SUB-TOTAL		37	109	146	124	72	196	1,921

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
336.	2 Single Family (1-5du/ac)	589.00 DU	112	330	442	377	218	595	5,831
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	7.30 AC	0	0	0	0	0	0	19
	SUB-TOTAL		307	480	787	437	286	723	6,938
337.	2 Single Family (1-5du/ac)	390.00 DU	74	218	292	250	144	394	3,861
	SUB-TOTAL		74	218	292	250	144	394	3,861
338.	11 Commercial Center(10-30a)	92.00 TSF	67	43	110	219	237	456	4,974
	SUB-TOTAL		67	43	110	219	237	456	4,974
339.	2 Single Family (1-5du/ac)	128.00 DU	24	72	96	82	47	129	1,267
	3 Single Family (6-10du/ac)	161.00 DU	31	90	121	103	60	163	1,594
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	7.00 AC	0	0	0	0	0	0	18
	SUB-TOTAL		250	312	562	245	175	420	3,967
340.	2 Single Family (1-5du/ac)	270.00 DU	51	151	202	173	100	273	2,673
	3 Single Family (6-10du/ac)	124.00 DU	24	69	93	79	46	125	1,228
	4 Condominium/Townhouse	264.00 DU	26	127	153	124	69	193	2,112
	SUB-TOTAL		101	347	448	376	215	591	6,013
341.	5 Apartment	325.00 DU	26	140	166	133	68	201	2,243
	26 Day Care	260.00 STU	112	99	211	104	120	224	1,175
	SUB-TOTAL		138	239	377	237	188	425	3,418
342.	4 Condominium/Townhouse	168.00 DU	17	81	98	79	44	123	1,344
	SUB-TOTAL		17	81	98	79	44	123	1,344
343.	2 Single Family (1-5du/ac)	90.00 DU	17	50	67	58	33	91	891
	3 Single Family (6-10du/ac)	89.00 DU	17	50	67	57	33	90	881
	4 Condominium/Townhouse	132.00 DU	13	63	76	62	34	96	1,056
	SUB-TOTAL		47	163	210	177	100	277	2,828
344.	2 Single Family (1-5du/ac)	415.00 DU	79	232	311	266	154	420	4,109
	11 Commercial Center(10-30a)	40.00 TSF	29	19	48	95	103	198	2,162
	SUB-TOTAL		108	251	359	361	257	618	6,271
345.	2 Single Family (1-5du/ac)	81.00 DU	15	45	60	52	30	82	802
	SUB-TOTAL		15	45	60	52	30	82	802
346.	2 Single Family (1-5du/ac)	10.00 DU	2	6	8	6	4	10	99
	SUB-TOTAL		2	6	8	6	4	10	99
347.	2 Single Family (1-5du/ac)	313.00 DU	59	175	234	200	116	316	3,099
	SUB-TOTAL		59	175	234	200	116	316	3,099
348.	2 Single Family (1-5du/ac)	517.00 DU	98	290	388	331	191	522	5,118
	SUB-TOTAL		98	290	388	331	191	522	5,118
349.	4 Condominium/Townhouse	388.00 DU	39	186	225	182	101	283	3,104
	12 Commercial Center (<10ac)	8.00 TSF	9	6	15	27	29	56	680
	26 Day Care	50.00 STU	22	19	41	20	23	43	226
	SUB-TOTAL		70	211	281	229	153	382	4,010

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
350.	25 Church	200.00 TSF	78	66	144	72	60	132	1,860
	SUB-TOTAL		78	66	144	72	60	132	1,860
352.	2 Single Family (1-5du/ac)	592.00 DU	112	332	444	379	219	598	5,861
	20 Elementary/Middle School	924.00 STU	240	185	425	74	83	157	1,340
	51 Developed Park	9.00 AC	0	0	0	0	0	0	23
	SUB-TOTAL		352	517	869	453	302	755	7,224
353.	2 Single Family (1-5du/ac)	259.00 DU	49	145	194	166	96	262	2,564
	51 Developed Park	10.00 AC	0	0	0	0	0	0	26
	SUB-TOTAL		49	145	194	166	96	262	2,590
355.	2 Single Family (1-5du/ac)	500.00 DU	95	280	375	320	185	505	4,950
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	5.00 AC	0	0	0	0	0	0	13
	SUB-TOTAL		290	430	720	380	253	633	6,051
356.	2 Single Family (1-5du/ac)	385.00 DU	73	216	289	246	142	388	3,811
	12 Commercial Center (<10ac)	60.00 TSF	65	41	106	199	216	415	5,104
	SUB-TOTAL		138	257	395	445	358	803	8,915
357.	2 Single Family (1-5du/ac)	90.00 DU	17	50	67	58	33	91	891
	SUB-TOTAL		17	50	67	58	33	91	891
358.	2 Single Family (1-5du/ac)	275.00 DU	52	154	206	176	102	278	2,723
	4 Condominium/Townhouse	121.00 DU	12	58	70	57	31	88	968
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	19.20 AC	0	0	0	1	1	2	50
	SUB-TOTAL		259	362	621	294	202	496	4,829
359.	2 Single Family (1-5du/ac)	570.00 DU	108	319	427	365	211	576	5,643
	4 Condominium/Townhouse	192.00 DU	19	92	111	90	50	140	1,536
	SUB-TOTAL		127	411	538	455	261	716	7,179
360.	2 Single Family (1-5du/ac)	538.00 DU	102	301	403	344	199	543	5,326
	4 Condominium/Townhouse	248.00 DU	25	119	144	117	64	181	1,984
	12 Commercial Center (<10ac)	135.00 TSF	147	93	240	448	486	934	11,483
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		469	663	1,132	969	817	1,786	19,881
361.	2 Single Family (1-5du/ac)	420.00 DU	80	235	315	269	155	424	4,158
	6 Mobile Home	181.00 DU	14	58	72	63	38	101	1,249
	25 Church	3.00 TSF	1	1	2	1	1	2	28
	SUB-TOTAL		95	294	389	333	194	527	5,435
362.	2 Single Family (1-5du/ac)	173.00 DU	33	97	130	111	64	175	1,713
	SUB-TOTAL		33	97	130	111	64	175	1,713
363.	2 Single Family (1-5du/ac)	44.00 DU	8	25	33	28	16	44	436
	SUB-TOTAL		8	25	33	28	16	44	436
364.	3 Single Family (6-10du/ac)	199.00 DU	38	111	149	127	74	201	1,970
	SUB-TOTAL		38	111	149	127	74	201	1,970

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
365.	2 Single Family (1-5du/ac)	201.00 DU	38	113	151	129	74	203	1,990
	4 Condominium/Townhouse	102.00 DU	10	49	59	48	27	75	816
	12 Commercial Center (<10ac)	11.00 TSF	12	8	20	37	40	77	936
	SUB-TOTAL		60	170	230	214	141	355	3,742
366.	2 Single Family (1-5du/ac)	600.00 DU	114	336	450	384	222	606	5,940
	SUB-TOTAL		114	336	450	384	222	606	5,940
367.	3 Single Family (6-10du/ac)	437.00 DU	83	245	328	280	162	442	4,326
	SUB-TOTAL		83	245	328	280	162	442	4,326
368.	2 Single Family (1-5du/ac)	1,070.00 DU	203	599	802	685	396	1,081	10,593
	12 Commercial Center (<10ac)	35.00 TSF	38	24	62	116	126	242	2,977
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	25 Church	56.00 TSF	22	18	40	20	17	37	521
	51 Developed Park	7.50 AC	0	0	0	0	0	0	20
	SUB-TOTAL		458	791	1,249	881	607	1,488	15,199
369.	2 Single Family (1-5du/ac)	202.00 DU	38	113	151	129	75	204	2,000
	SUB-TOTAL		38	113	151	129	75	204	2,000
370.	2 Single Family (1-5du/ac)	1,080.00 DU	205	605	810	691	400	1,091	10,692
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	SUB-TOTAL		1,005	955	1,960	841	625	1,466	15,167
371.	2 Single Family (1-5du/ac)	673.00 DU	128	377	505	431	249	680	6,663
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		323	527	850	491	317	808	7,751
372.	2 Single Family (1-5du/ac)	287.00 DU	55	161	216	184	106	290	2,841
	4 Condominium/Townhouse	230.00 DU	23	110	133	108	60	168	1,840
	11 Commercial Center(10-30a)	80.00 TSF	58	38	96	190	206	396	4,325
	SUB-TOTAL		136	309	445	482	372	854	9,006
373.	2 Single Family (1-5du/ac)	236.00 DU	45	132	177	151	87	238	2,336
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	25 Church	23.52 TSF	9	8	17	8	7	15	219
	SUB-TOTAL		249	290	539	219	162	381	3,643
374.	2 Single Family (1-5du/ac)	300.00 DU	57	168	225	192	111	303	2,970
	5 Apartment	304.00 DU	24	131	155	125	64	189	2,098
	11 Commercial Center(10-30a)	150.00 TSF	110	71	181	357	387	744	8,109
	51 Developed Park	30.00 AC	0	0	0	1	1	2	78
	SUB-TOTAL		191	370	561	675	563	1,238	13,255
375.	12 Commercial Center (<10ac)	40.00 TSF	44	28	72	133	144	277	3,402
	16 Fast Food Restaurant	5.00 TSF	127	122	249	87	80	167	2,481
	SUB-TOTAL		171	150	321	220	224	444	5,883
377.	13 Commercial Shops	57.50 TSF	41	28	69	104	104	208	2,131
	SUB-TOTAL		41	28	69	104	104	208	2,131

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
378.	4 Condominium/Townhouse	407.00 DU	41	195	236	191	106	297	3,256
	6 Mobile Home	332.00 DU	27	106	133	116	70	186	2,291
	13 Commercial Shops	51.00 TSF	37	24	61	92	92	184	1,890
	30 Industrial Park	110.00 TSF	61	11	72	14	57	71	660
	31 Business Park	56.00 TSF	67	13	80	17	55	72	571
	SUB-TOTAL		233	349	582	430	380	810	8,668
380.	2 Single Family (1-5du/ac)	125.00 DU	24	70	94	80	46	126	1,238
	5 Apartment	400.00 DU	32	172	204	164	84	248	2,760
	SUB-TOTAL		56	242	298	244	130	374	3,998
381.	25 Church	10.00 TSF	4	3	7	4	3	7	93
	51 Developed Park	50.00 AC	0	0	0	2	2	4	130
	SUB-TOTAL		4	3	7	6	5	11	223
382.	34 Utilities	21.00 TSF	0	0	0	0	0	0	50
	51 Developed Park	50.00 AC	0	0	0	2	2	4	130
	SUB-TOTAL		0	0	0	2	2	4	180
383.	2 Single Family (1-5du/ac)	266.00 DU	51	149	200	170	98	268	2,633
	13 Commercial Shops	8.71 TSF	6	4	10	16	16	32	323
	SUB-TOTAL		57	153	210	186	114	300	2,956
384.	2 Single Family (1-5du/ac)	354.00 DU	67	198	265	227	131	358	3,505
	SUB-TOTAL		67	198	265	227	131	358	3,505
385.	2 Single Family (1-5du/ac)	75.00 DU	14	42	56	48	28	76	743
	SUB-TOTAL		14	42	56	48	28	76	743
387.	2 Single Family (1-5du/ac)	800.00 DU	152	448	600	512	296	808	7,920
	4 Condominium/Townhouse	700.00 DU	70	336	406	329	182	511	5,600
	SUB-TOTAL		222	784	1,006	841	478	1,319	13,520
388.	2 Single Family (1-5du/ac)	99.00 DU	19	55	74	63	37	100	980
	4 Condominium/Townhouse	400.00 DU	40	192	232	188	104	292	3,200
	20 Elementary/Middle School	1,600.00 STU	416	320	736	128	144	272	2,320
	SUB-TOTAL		475	567	1,042	379	285	664	6,500
389.	2 Single Family (1-5du/ac)	1,110.00 DU	211	622	833	710	411	1,121	10,989
	3 Single Family (6-10du/ac)	126.00 DU	24	71	95	81	47	128	1,247
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		430	843	1,273	851	526	1,377	13,324
390.	2 Single Family (1-5du/ac)	150.00 DU	29	84	113	96	56	152	1,485
	SUB-TOTAL		29	84	113	96	56	152	1,485
391.	13 Commercial Shops	16.33 TSF	12	8	20	29	29	58	605
	30 Industrial Park	70.00 TSF	39	7	46	9	36	45	420
	32 Manufacturing/Warehouse	376.36 TSF	211	64	275	102	177	279	1,919
	SUB-TOTAL		262	79	341	140	242	382	2,944

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
392.	2 Single Family (1-5du/ac)	323.00 DU	61	181	242	207	120	327	3,198
	6 Mobile Home	434.00 DU	35	139	174	152	91	243	2,995
	11 Commercial Center(10-30a)	81.68 TSF	60	38	98	194	211	405	4,416
	13 Commercial Shops	20.80 TSF	15	10	25	37	37	74	771
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	32 Manufacturing/Warehouse	500.00 TSF	280	85	365	135	235	370	2,550
	SUB-TOTAL		646	603	1,249	785	762	1,547	15,018
393.	3 Single Family (6-10du/ac)	162.00 DU	31	91	122	104	60	164	1,604
	4 Condominium/Townhouse	100.00 DU	10	48	58	47	26	73	800
	12 Commercial Center (<10ac)	52.27 TSF	57	36	93	174	188	362	4,446
	25 Church	73.00 TSF	28	24	52	26	22	48	679
	SUB-TOTAL		126	199	325	351	296	647	7,529
394.	2 Single Family (1-5du/ac)	325.00 DU	62	182	244	208	120	328	3,217
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	21 High School	2,500.00 STU	800	350	1,150	150	225	375	4,475
	51 Developed Park	3.20 AC	0	0	0	0	0	0	8
	SUB-TOTAL		1,057	682	1,739	418	413	831	8,788
395.	5 Apartment	185.00 DU	15	80	95	76	39	115	1,277
	11 Commercial Center(10-30a)	165.53 TSF	121	78	199	394	427	821	8,949
	20 Elementary/Middle School	1,200.00 STU	312	240	552	96	108	204	1,740
	SUB-TOTAL		448	398	846	566	574	1,140	11,966
396.	12 Commercial Center (<10ac)	110.00 TSF	120	76	196	365	396	761	9,357
	SUB-TOTAL		120	76	196	365	396	761	9,357
397.	3 Single Family (6-10du/ac)	49.00 DU	9	27	36	31	18	49	485
	4 Condominium/Townhouse	512.00 DU	51	246	297	241	133	374	4,096
	5 Apartment	67.00 DU	5	29	34	27	14	41	462
	6 Mobile Home	500.00 DU	40	160	200	175	105	280	3,450
	11 Commercial Center(10-30a)	310.98 TSF	227	146	373	740	802	1,542	16,812
	12 Commercial Center (<10ac)	74.00 TSF	81	51	132	246	266	512	6,294
	20 Elementary/Middle School	600.00 STU	156	120	276	48	54	102	870
	25 Church	23.00 TSF	9	8	17	8	7	15	214
	SUB-TOTAL		578	787	1,365	1,516	1,399	2,915	32,683
398.	2 Single Family (1-5du/ac)	1,120.00 DU	213	627	840	717	414	1,131	11,088
	4 Condominium/Townhouse	120.00 DU	12	58	70	56	31	87	960
	12 Commercial Center (<10ac)	250.00 TSF	273	173	446	830	900	1,730	21,265
	13 Commercial Shops	2.68 TSF	2	1	3	5	5	10	99
	15 Sit-Down Restaurant	8.45 TSF	41	38	79	55	37	92	1,101
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	24 Library	17.00 TSF	13	5	18	58	63	121	1,445
	SUB-TOTAL		749	1,052	1,801	1,781	1,518	3,299	37,046
399.	2 Single Family (1-5du/ac)	800.00 DU	152	448	600	512	296	808	7,920
	3 Single Family (6-10du/ac)	80.00 DU	15	45	60	51	30	81	792
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	25 Church	15.00 TSF	6	5	11	5	5	10	140
	SUB-TOTAL		368	648	1,016	628	399	1,027	9,940
400.	2 Single Family (1-5du/ac)	12.00 DU	2	7	9	8	4	12	119
	SUB-TOTAL		2	7	9	8	4	12	119

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
401.	2 Single Family (1-5du/ac)	835.00 DU	159	468	627	534	309	843	8,267
	4 Condominium/Townhouse	482.00 DU	48	231	279	227	125	352	3,856
	SUB-TOTAL		207	699	906	761	434	1,195	12,123
402.	2 Single Family (1-5du/ac)	1,129.00 DU	215	632	847	723	418	1,141	11,177
	11 Commercial Center(10-30a)	150.00 TSF	110	71	181	357	387	744	8,109
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	51 Developed Park	361.00 AC	0	0	0	11	14	25	939
	SUB-TOTAL		520	853	1,373	1,151	887	2,038	21,313
403.	2 Single Family (1-5du/ac)	111.00 DU	21	62	83	71	41	112	1,099
	5 Apartment	300.00 DU	24	129	153	123	63	186	2,070
	12 Commercial Center (<10ac)	46.00 TSF	50	32	82	153	166	319	3,913
	SUB-TOTAL		95	223	318	347	270	617	7,082
404.	2 Single Family (1-5du/ac)	177.00 DU	34	99	133	113	65	178	1,752
	SUB-TOTAL		34	99	133	113	65	178	1,752
405.	2 Single Family (1-5du/ac)	296.00 DU	56	166	222	189	110	299	2,930
	SUB-TOTAL		56	166	222	189	110	299	2,930
406.	2 Single Family (1-5du/ac)	353.00 DU	67	198	265	226	131	357	3,495
	SUB-TOTAL		67	198	265	226	131	357	3,495
407.	2 Single Family (1-5du/ac)	47.00 DU	9	26	35	30	17	47	465
	SUB-TOTAL		9	26	35	30	17	47	465
408.	2 Single Family (1-5du/ac)	380.00 DU	72	213	285	243	141	384	3,762
	SUB-TOTAL		72	213	285	243	141	384	3,762
409.	2 Single Family (1-5du/ac)	77.00 DU	15	43	58	49	28	77	762
	SUB-TOTAL		15	43	58	49	28	77	762
410.	2 Single Family (1-5du/ac)	148.00 DU	28	83	111	95	55	150	1,465
	6 Mobile Home	101.00 DU	8	32	40	35	21	56	697
	30 Industrial Park	44.00 TSF	24	4	28	6	23	29	264
	SUB-TOTAL		60	119	179	136	99	235	2,426
411.	2 Single Family (1-5du/ac)	675.00 DU	128	378	506	432	250	682	6,682
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		323	528	851	492	318	810	7,770
412.	1 Single Family (<1du/ac)	120.00 DU	35	80	115	101	43	144	1,188
	11 Commercial Center(10-30a)	40.00 TSF	29	19	48	95	103	198	2,162
	SUB-TOTAL		64	99	163	196	146	342	3,350
413.	2 Single Family (1-5du/ac)	106.00 DU	20	59	79	68	39	107	1,049
	5 Apartment	514.00 DU	41	221	262	211	108	319	3,547
	6 Mobile Home	40.00 DU	3	13	16	14	8	22	276
	12 Commercial Center (<10ac)	44.60 TSF	49	31	80	148	161	309	3,794
	30 Industrial Park	48.54 TSF	27	5	32	6	25	31	291
	32 Manufacturing/Warehouse	45.21 TSF	25	8	33	12	21	33	231
	40 Commercial Office	36.59 TSF	57	7	64	8	47	55	423
	SUB-TOTAL		222	344	566	467	409	876	9,611

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
414.	2 Single Family (1-5du/ac)	40.00 DU	8	22	30	26	15	41	396
	4 Condominium/Townhouse	1,435.00 DU	144	689	833	674	373	1,047	11,480
	5 Apartment	200.00 DU	16	86	102	82	42	124	1,380
	6 Mobile Home	250.00 DU	20	80	100	88	53	141	1,725
	13 Commercial Shops	175.00 TSF	126	84	210	315	315	630	6,486
	SUB-TOTAL		314	961	1,275	1,185	798	1,983	21,467
415.	2 Single Family (1-5du/ac)	75.00 DU	14	42	56	48	28	76	743
	11 Commercial Center(10-30a)	63.71 TSF	47	30	77	152	164	316	3,444
	32 Manufacturing/Warehouse	27.80 TSF	16	5	21	8	13	21	142
	SUB-TOTAL		77	77	154	208	205	413	4,329
416.	2 Single Family (1-5du/ac)	276.00 DU	52	155	207	177	102	279	2,732
	4 Condominium/Townhouse	57.00 DU	6	27	33	27	15	42	456
	6 Mobile Home	220.00 DU	18	70	88	77	46	123	1,518
	13 Commercial Shops	15.00 TSF	11	7	18	27	27	54	556
	25 Church	20.00 TSF	8	7	15	7	6	13	186
	40 Commercial Office	100.00 TSF	155	19	174	21	129	150	1,156
	51 Developed Park	15.00 AC	0	0	0	0	1	1	39
	SUB-TOTAL		250	285	535	336	326	662	6,643
417.	2 Single Family (1-5du/ac)	950.00 DU	181	532	713	608	352	960	9,405
	4 Condominium/Townhouse	255.00 DU	26	122	148	120	66	186	2,040
	12 Commercial Center (<10ac)	10.00 TSF	11	7	18	33	36	69	851
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	22 College	10,000.00 STU	1,300	100	1,400	700	1,400	2,100	15,400
	SUB-TOTAL		1,713	911	2,624	1,521	1,922	3,443	28,784
418.	4 Condominium/Townhouse	474.00 DU	47	228	275	223	123	346	3,792
	5 Apartment	755.00 DU	60	325	385	310	159	469	5,210
	6 Mobile Home	90.00 DU	7	29	36	32	19	51	621
	11 Commercial Center(10-30a)	228.00 TSF	166	107	273	543	588	1,131	12,326
	SUB-TOTAL		280	689	969	1,108	889	1,997	21,949
419.	4 Condominium/Townhouse	1,834.00 DU	183	880	1,063	862	477	1,339	14,672
	SUB-TOTAL		183	880	1,063	862	477	1,339	14,672
420.	4 Condominium/Townhouse	56.00 DU	6	27	33	26	15	41	448
	SUB-TOTAL		6	27	33	26	15	41	448
421.	3 Single Family (6-10du/ac)	250.00 DU	48	140	188	160	93	253	2,475
	4 Condominium/Townhouse	1,500.00 DU	150	720	870	705	390	1,095	12,000
	11 Commercial Center(10-30a)	400.00 TSF	292	188	480	952	1,032	1,984	21,624
	14 Hotel	200.00 ROOM	68	44	112	64	58	122	1,646
	40 Commercial Office	600.00 TSF	930	114	1,044	126	774	900	6,936
	51 Developed Park	12.00 AC	0	0	0	0	0	0	31
	SUB-TOTAL		1,488	1,206	2,694	2,007	2,347	4,354	44,712
422.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	6 Mobile Home	80.00 DU	6	26	32	28	17	45	552
	12 Commercial Center (<10ac)	10.00 TSF	11	7	18	33	36	69	851
	20 Elementary/Middle School	1,050.00 STU	273	210	483	84	95	179	1,523
	SUB-TOTAL		294	254	548	158	155	313	3,124

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
423.	2 Single Family (1-5du/ac)	353.00 DU	67	198	265	226	131	357	3,495
	3 Single Family (6-10du/ac)	21.00 DU	4	12	16	13	8	21	208
	6 Mobile Home	90.00 DU	7	29	36	32	19	51	621
	12 Commercial Center (<10ac)	98.01 TSF	107	68	175	325	353	678	8,337
	40 Commercial Office	10.89 TSF	17	2	19	2	14	16	126
	SUB-TOTAL		202	309	511	598	525	1,123	12,787
424.	2 Single Family (1-5du/ac)	350.00 DU	67	196	263	224	130	354	3,465
	SUB-TOTAL		67	196	263	224	130	354	3,465
425.	2 Single Family (1-5du/ac)	114.00 DU	22	64	86	73	42	115	1,129
	4 Condominium/Townhouse	80.00 DU	8	38	46	38	21	59	640
	51 Developed Park	31.00 AC	0	0	0	1	1	2	81
	SUB-TOTAL		30	102	132	112	64	176	1,850
426.	2 Single Family (1-5du/ac)	560.00 DU	106	314	420	358	207	565	5,544
	3 Single Family (6-10du/ac)	70.00 DU	13	39	52	45	26	71	693
	32 Manufacturing/Warehouse	39.60 TSF	22	7	29	11	19	30	202
	SUB-TOTAL		141	360	501	414	252	666	6,439
427.	2 Single Family (1-5du/ac)	249.00 DU	47	139	186	159	92	251	2,465
	SUB-TOTAL		47	139	186	159	92	251	2,465
428.	2 Single Family (1-5du/ac)	1,313.00 DU	249	735	984	840	486	1,326	12,999
	11 Commercial Center(10-30a)	47.40 TSF	35	22	57	113	122	235	2,562
	12 Commercial Center (<10ac)	39.20 TSF	43	27	70	130	141	271	3,334
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		522	934	1,456	1,143	817	1,960	19,983
429.	2 Single Family (1-5du/ac)	55.00 DU	10	31	41	35	20	55	545
	SUB-TOTAL		10	31	41	35	20	55	545
430.	2 Single Family (1-5du/ac)	2.00 DU	0	1	1	1	1	2	20
	SUB-TOTAL		0	1	1	1	1	2	20
431.	2 Single Family (1-5du/ac)	3.00 DU	1	2	3	2	1	3	30
	SUB-TOTAL		1	2	3	2	1	3	30
433.	2 Single Family (1-5du/ac)	155.00 DU	29	87	116	99	57	156	1,535
	SUB-TOTAL		29	87	116	99	57	156	1,535
434.	2 Single Family (1-5du/ac)	25.00 DU	5	14	19	16	9	25	247
	SUB-TOTAL		5	14	19	16	9	25	247
437.	31 Business Park	250.00 TSF	300	58	358	75	248	323	2,550
	59 Cemex	12.84 SG	46	48	94	26	29	55	1,284
	SUB-TOTAL		346	106	452	101	277	378	3,834
438.	2 Single Family (1-5du/ac)	10.00 DU	2	6	8	6	4	10	99
	31 Business Park	250.00 TSF	300	58	358	75	248	323	2,550
	SUB-TOTAL		302	64	366	81	252	333	2,649
439.	2 Single Family (1-5du/ac)	175.00 DU	33	98	131	112	65	177	1,732
	11 Commercial Center(10-30a)	41.65 TSF	30	20	50	99	107	206	2,252
	SUB-TOTAL		63	118	181	211	172	383	3,984

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
440.	30 Industrial Park	50.00 TSF	28	5	33	7	26	33	300
	SUB-TOTAL		28	5	33	7	26	33	300
441.	2 Single Family (1-5du/ac)	330.00 DU	63	185	248	211	122	333	3,267
	6 Mobile Home	160.00 DU	13	51	64	56	34	90	1,104
	13 Commercial Shops	30.00 TSF	22	14	36	54	54	108	1,112
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		293	400	693	381	278	659	6,571
442.	2 Single Family (1-5du/ac)	112.00 DU	21	63	84	72	41	113	1,109
	3 Single Family (6-10du/ac)	216.00 DU	41	121	162	138	80	218	2,138
	SUB-TOTAL		62	184	246	210	121	331	3,247
443.	2 Single Family (1-5du/ac)	763.00 DU	145	427	572	488	282	770	7,554
	13 Commercial Shops	30.00 TSF	22	14	36	54	54	108	1,112
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		362	591	953	602	404	1,006	9,754
444.	4 Condominium/Townhouse	440.00 DU	44	211	255	207	114	321	3,520
	11 Commercial Center(10-30a)	200.00 TSF	146	94	240	476	516	992	10,812
	25 Church	4.00 TSF	2	1	3	1	1	2	37
	SUB-TOTAL		192	306	498	684	631	1,315	14,369
445.	2 Single Family (1-5du/ac)	41.00 DU	8	23	31	26	15	41	406
	SUB-TOTAL		8	23	31	26	15	41	406
446.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	SUB-TOTAL		4	11	15	13	7	20	198
447.	2 Single Family (1-5du/ac)	300.00 DU	57	168	225	192	111	303	2,970
	50 Golf Course	150.00 AC	23	9	32	15	30	45	1,194
	SUB-TOTAL		80	177	257	207	141	348	4,164
448.	2 Single Family (1-5du/ac)	691.00 DU	131	387	518	442	256	698	6,841
	SUB-TOTAL		131	387	518	442	256	698	6,841
449.	2 Single Family (1-5du/ac)	20.00 DU	4	11	15	13	7	20	198
	SUB-TOTAL		4	11	15	13	7	20	198
450.	2 Single Family (1-5du/ac)	27.00 DU	5	15	20	17	10	27	267
	SUB-TOTAL		5	15	20	17	10	27	267
451.	2 Single Family (1-5du/ac)	140.00 DU	27	78	105	90	52	142	1,386
	30 Industrial Park	47.00 TSF	26	5	31	6	24	30	282
	SUB-TOTAL		53	83	136	96	76	172	1,668
452.	2 Single Family (1-5du/ac)	38.00 DU	7	21	28	24	14	38	376
	SUB-TOTAL		7	21	28	24	14	38	376
453.	2 Single Family (1-5du/ac)	1,020.00 DU	194	571	765	653	377	1,030	10,098
	13 Commercial Shops	16.00 TSF	12	8	20	29	29	58	593
	20 Elementary/Middle School	750.00 STU	195	150	345	60	68	128	1,088
	SUB-TOTAL		401	729	1,130	742	474	1,216	11,779

OVOV Buildout Land Use and Trip Generation by TAZ									
			AM Peak Hour			PM Peak Hour			
Zone	Land Use Type	Units	In	Out	Total	In	Out	Total	ADT
454.	2 Single Family (1-5du/ac)	650.00 DU	124	364	488	416	241	657	6,435
	11 Commercial Center(10-30a)	34.14 TSF	25	16	41	81	88	169	1,846
	13 Commercial Shops	6.14 TSF	4	3	7	11	11	22	228
	52 Undeveloped Park	745.00 AC	0	0	0	0	0	0	373
	57 Agua Dulce Airport	51.09 SG	153	102	255	204	307	511	5,109
	SUB-TOTAL		306	485	791	712	647	1,359	13,991
455.	2 Single Family (1-5du/ac)	100.00 DU	19	56	75	64	37	101	990
	SUB-TOTAL		19	56	75	64	37	101	990

OVOV Buildout - Land Use and Trip Generation Summary									
			AM Peak Hour			PM Peak Hour			
Land Use Type	Units		In	Out	Total	In	Out	Total	ADT
1. Single Family (<1du/ac)	448.00	DU	129	299	428	376	164	540	4,436
2. Single Family (1-5du/ac)	64,889.00	DU	12,331	36,339	48,670	41,526	24,005	65,531	642,412
3. Single Family (6-10du/ac)	12,638.00	DU	2,405	7,077	9,482	8,085	4,678	12,763	125,116
4. Condominium/Townhouse	50,296.00	DU	5,033	24,142	29,175	23,638	13,082	36,720	402,368
5. Apartment	15,031.00	DU	1,203	6,471	7,674	6,166	3,160	9,326	103,716
6. Mobile Home	3,420.00	DU	272	1,095	1,367	1,199	719	1,918	23,599
7. Senior (Active)	2,352.00	DU	189	281	470	376	237	613	8,725
10. Commercial Center (>30ac)	9,728.62	TSF	4,572	2,918	7,490	15,955	17,317	33,272	389,730
11. Commercial Center(10-30a)	8,933.07	TSF	6,522	4,200	10,722	21,263	23,045	44,308	482,923
12. Commercial Center (<10ac)	2,465.12	TSF	2,690	1,705	4,395	8,184	8,877	17,061	209,685
13. Commercial Shops	2,104.11	TSF	1,513	1,010	2,523	3,790	3,790	7,580	77,980
14. Hotel	2,527.00	ROOM	859	555	1,414	810	733	1,543	20,798
15. Sit-Down Restaurant	289.72	TSF	1,397	1,288	2,685	1,890	1,258	3,148	37,763
16. Fast Food Restaurant	64.42	TSF	1,638	1,573	3,211	1,123	1,033	2,156	31,961
17. Movie Theater	3,600.00	SEAT	0	0	0	180	72	252	6,336
18. Health Club	138.00	TSF	132	88	220	298	199	497	5,520
19. Car Dealership	530.00	TSF	854	319	1,173	593	889	1,482	19,876
20. Elementary/Middle School	51,667.00	STU	13,434	10,334	23,768	4,134	4,674	8,808	74,942
21. High School	18,500.00	STU	5,920	2,590	8,510	1,110	1,665	2,775	33,115
22. College	36,062.00	STU	4,688	361	5,049	2,524	5,049	7,573	55,535
23. Hospital	365.16	TSF	260	95	355	80	255	335	6,134
24. Library	91.40	TSF	69	27	96	311	338	649	7,767
25. Church	997.46	TSF	392	333	725	356	301	657	9,278
26. Day Care	540.00	STU	233	205	438	216	249	465	2,441
30. Industrial Park	36,687.27	TSF	20,179	3,670	23,849	4,769	19,077	23,846	220,124
31. Business Park	7,797.08	TSF	9,358	1,795	11,153	2,337	7,722	10,059	79,530
32. Manufacturing/Warehouse	3,268.69	TSF	1,830	557	2,387	884	1,536	2,420	16,673
34. Utilities	1,032.44	TSF	0	0	0	0	0	0	2,457
35. Regional Post Office	780.00	TSF	156	117	273	117	117	234	3,900
40. Commercial Office	8,483.89	TSF	13,154	1,615	14,769	1,784	10,947	12,731	98,072
41. High-Rise Office	300.00	TSF	411	57	468	75	372	447	3,264
42. Medical Office	730.56	TSF	1,417	358	1,775	724	1,951	2,675	24,985
43. Post Office	50.00	TSF	209	193	402	275	265	540	5,410
50. Golf Course	1,338.00	AC	202	80	282	134	268	402	10,651
51. Developed Park	1,040.20	AC	0	0	0	30	39	69	2,705
52. Undeveloped Park	890.00	AC	0	0	0	0	0	0	446
53. Wayside Honor Ranch	30.00	SG	90	60	150	120	180	300	3,000
54. Six Flags Magic Mtn	240.00	SG	720	480	1,200	960	1,440	2,400	24,000
55. Travel Village	26.20	SG	79	52	131	105	157	262	2,620
57. Agua Dulce Airport	51.09	SG	153	102	255	204	307	511	5,109
58. Landfill	20.00	SG	60	40	100	80	120	200	2,000
59. Cemex	12.84	SG	46	48	94	26	29	55	1,284
TOTAL			**114,799**	**112,529**	**227,328**	**156,807**	**160,316**	**317,123**	**3,288,386**

Appendix D

TRAFFIC MODEL DATA

SCVCTM 5.0 Traffic Analysis Zones

DRAFT

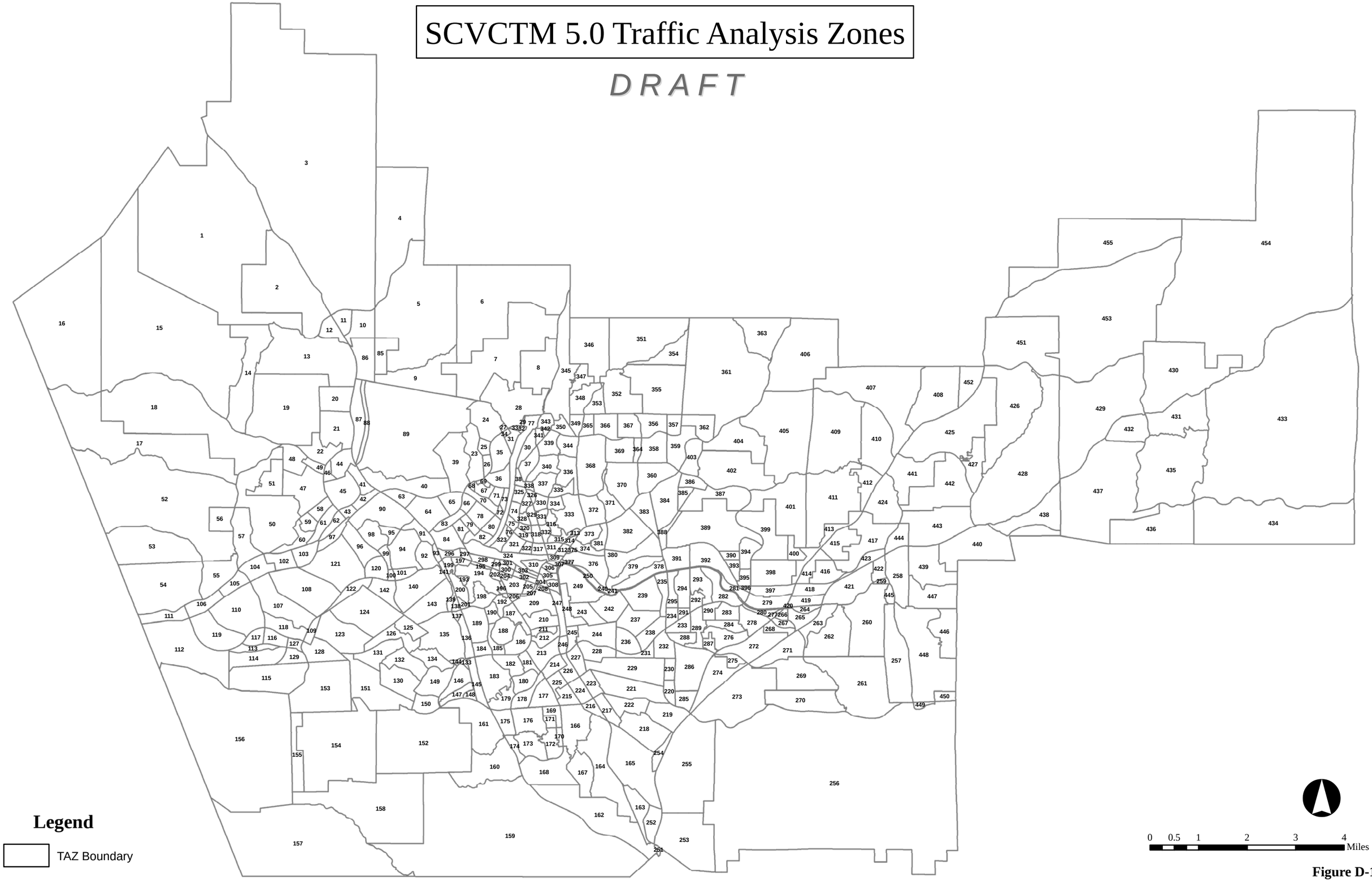

Figure D-1

Peak Hour and ADT Trip Rates

Zone	Land Use Type	Units	AM Peak Hour			PM Peak Hour			ADT
			Inbound	Outbound	Total	Inbound	Outbound	Total	
1.	Single Family (<1du/ac)	DU	.29	.67	.96	.84	.36	1.20	9.90
2.	Single Family (1-5du/ac)	DU	.19	.56	.75	.64	.37	1.01	9.90
3.	Single Family (6-10du/ac)	DU	.19	.56	.75	.64	.37	1.01	9.90
4.	Condominium/Townhouse	DU	.10	.48	.58	.47	.26	.73	8.00
5.	Apartment	DU	.08	.43	.51	.41	.21	.62	6.90
6.	Mobile Home	DU	.08	.32	.40	.35	.21	.56	6.90
7.	Senior (Active)	DU	.08	.12	.20	.16	.10	.26	3.71
10.	Commercial Center (>30ac)	TSF	.47	.30	.77	1.64	1.78	3.42	40.06
11.	Commercial Center(10-30a)	TSF	.73	.47	1.20	2.38	2.58	4.96	54.06
12.	Commercial Center (<10ac)	TSF	1.09	.69	1.78	3.32	3.60	6.92	85.06
13.	Commercial Shops	TSF	.72	.48	1.20	1.80	1.80	3.60	37.06
14.	Hotel	ROOM	.34	.22	.56	.32	.29	.61	8.23
15.	Sit-Down Restaurant	TSF	4.82	4.45	9.27	6.52	4.34	10.86	130.34
16.	Fast Food Restaurant	TSF	25.43	24.43	49.86	17.41	16.07	33.48	496.12
17.	Movie Theater	SEAT	.00	.00	.00	.05	.02	.07	1.76
18.	Health Club	TSF	.96	.64	1.60	2.16	1.44	3.60	40.00
19.	Car Dealership	TSF	1.61	.60	2.21	1.12	1.68	2.80	37.50
20.	Elementary/Middle School	STU	.26	.20	.46	.08	.09	.17	1.45
21.	High School	STU	.32	.14	.46	.06	.09	.15	1.79
22.	College	STU	.13	.01	.14	.07	.14	.21	1.54
23.	Hospital	TSF	.71	.26	.97	.22	.70	.92	16.80
24.	Library	TSF	.76	.30	1.06	3.40	3.69	7.09	84.98
25.	Church	TSF	.39	.33	.72	.36	.30	.66	9.30
26.	Day Care	STU	.43	.38	.81	.40	.46	.86	4.52
30.	Industrial Park	TSF	.55	.10	.65	.13	.52	.65	6.00
31.	Business Park	TSF	1.20	.23	1.43	.30	.99	1.29	10.20
32.	Manufacturing/Warehouse	TSF	.56	.17	.73	.27	.47	.74	5.10
33.	Science/Research	TSF	1.03	.21	1.24	.16	.92	1.08	10.20
34.	Utilities	TSF	.00	.00	.00	.00	.00	.00	2.38
35.	Regional Post Office	TSF	.20	.15	.35	.15	.15	.30	5.00
40.	Commercial Office	TSF	1.55	.19	1.74	.21	1.29	1.50	11.56
41.	High-Rise Office	TSF	1.37	.19	1.56	.25	1.24	1.49	10.88
42.	Medical Office	TSF	1.94	.49	2.43	.99	2.67	3.66	34.20
43.	Post Office	TSF	4.17	3.85	8.02	5.50	5.29	10.79	108.19
50.	Golf Course	AC	.15	.06	.21	.10	.20	.30	7.96
51.	Developed Park	AC	.00	.00	.00	.03	.04	.07	2.60
52.	Undeveloped Park	AC	.00	.00	.00	.00	.00	.00	.50
53.	Wayside Honor Ranch	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
54.	Six Flags Magic Mtn	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
55.	Travel Village	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
56.	CHP Office	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
57.	Agua Dulce Airport	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
58.	Landfill	SG	3.00	2.00	5.00	4.00	6.00	10.00	100.00
59.	Cemex	SG	3.60	3.75	7.35	2.00	2.25	4.25	100.00
Peak Hour Reduction Factors			12.0%	12.9%	--	12.5%	12.2%	--	--
Peak Period to Peak Hour Factors				.60			.35		--

DU = Dwelling Unit
TSF = Thousand Square Feet
STU = Student
AC = Acre
SG = Special Generator

ADT Trip Rates and P&A Splitting Factors

	Land Use Type	Units	ADT	Productions						Attractions					
				H-W	H-S	H-O	O-W	O-O	Total	H-W	H-S	H-O	O-W	O-O	Total
1.	Single Family (<1du/ac)	DU	9.90	.220	.100	.320	.020	.110	.770	.000	.000	.100	.020	.110	.230
2.	Single Family (1-5du/ac)	DU	9.90	.220	.100	.320	.020	.110	.770	.000	.000	.100	.020	.110	.230
3.	Single Family (6-10du/ac)	DU	9.90	.220	.100	.320	.020	.110	.770	.000	.000	.100	.020	.110	.230
4.	Condominium/Townhouse	DU	8.00	.200	.140	.370	.020	.090	.820	.000	.000	.070	.020	.090	.180
5.	Apartment	DU	6.90	.200	.140	.370	.020	.090	.820	.000	.000	.070	.020	.090	.180
6.	Mobile Home	DU	6.90	.200	.140	.370	.020	.090	.820	.000	.000	.070	.020	.090	.180
7.	Senior (Active)	DU	3.71	.050	.220	.410	.020	.100	.800	.000	.000	.080	.020	.100	.200
10.	Commercial Center (>30ac)	TSF	40.06	.000	.000	.000	.030	.300	.330	.090	.140	.110	.030	.300	.670
11.	Commercial Center(10-30a)	TSF	54.06	.000	.000	.000	.030	.300	.330	.090	.140	.110	.030	.300	.670
12.	Commercial Center (<10ac)	TSF	85.06	.000	.000	.000	.030	.340	.370	.060	.110	.090	.030	.340	.630
13.	Commercial Shops	TSF	37.06	.000	.000	.000	.030	.340	.370	.060	.110	.090	.030	.340	.630
14.	Hotel	ROOM	8.23	.000	.000	.000	.060	.180	.240	.120	.000	.400	.060	.180	.760
15.	Sit-Down Restaurant	TSF	130.34	.000	.000	.000	.060	.240	.300	.040	.000	.360	.060	.240	.700
16.	Fast Food Restaurant	TSF	496.12	.000	.000	.000	.070	.310	.380	.010	.000	.230	.070	.310	.620
17.	Movie Theater	SEAT	1.76	.000	.000	.000	.000	.310	.310	.080	.000	.300	.000	.310	.690
18.	Health Club	TSF	40.00	.000	.000	.000	.010	.250	.260	.060	.000	.420	.010	.250	.740
19.	Car Dealership	TSF	37.50	.000	.000	.000	.030	.250	.280	.080	.210	.150	.030	.250	.720
20.	Elementary/Middle School	STU	1.45	.000	.000	.000	.000	.030	.030	.100	.000	.840	.000	.030	.970
21.	High School	STU	1.79	.000	.000	.000	.000	.030	.030	.100	.000	.840	.000	.030	.970
22.	College	STU	1.54	.000	.000	.000	.000	.230	.230	.060	.000	.480	.000	.230	.770
23.	Hospital	TSF	16.80	.000	.000	.000	.000	.050	.050	.320	.000	.580	.000	.050	.950
24.	Library	TSF	84.98	.000	.000	.000	.090	.170	.260	.160	.000	.320	.090	.170	.740
25.	Church	TSF	9.30	.000	.000	.000	.050	.100	.150	.350	.000	.350	.050	.100	.850
26.	Day Care	STU	4.52	.000	.000	.000	.000	.030	.030	.100	.000	.840	.000	.030	.970
30.	Industrial Park	TSF	6.00	.000	.000	.000	.070	.210	.280	.390	.000	.050	.070	.210	.720
31.	Business Park	TSF	10.20	.000	.000	.000	.070	.210	.280	.390	.000	.050	.070	.210	.720
32.	Manufacturing/Warehouse	TSF	5.10	.000	.000	.000	.070	.210	.280	.390	.000	.050	.070	.210	.720
33.	Science/Research	TSF	10.20	.000	.000	.000	.070	.210	.280	.390	.000	.050	.070	.210	.720
34.	Utilities	TSF	2.38	.000	.000	.000	.090	.170	.260	.190	.000	.290	.090	.170	.740
35.	Regional Post Office	TSF	5.00	.000	.000	.000	.070	.210	.280	.390	.000	.050	.070	.210	.720
40.	Commercial Office	TSF	11.56	.000	.000	.000	.110	.180	.290	.270	.000	.150	.110	.180	.710
41.	High-Rise Office	TSF	10.88	.000	.000	.000	.110	.180	.290	.270	.000	.150	.110	.180	.710
42.	Medical Office	TSF	34.20	.000	.000	.000	.030	.260	.290	.140	.000	.280	.030	.260	.710
43.	Post Office	TSF	108.19	.000	.000	.000	.090	.220	.310	.150	.000	.230	.090	.220	.690
50.	Golf Course	AC	7.96	.000	.000	.000	.000	.270	.270	.080	.000	.380	.000	.270	.730
51.	Developed Park	AC	2.60	.000	.000	.000	.000	.120	.120	.010	.000	.750	.000	.120	.880
52.	Undeveloped Park	AC	.50	.000	.000	.000	.000	.120	.120	.010	.000	.750	.000	.120	.880
53.	Wayside Honor Ranch	SG	100.00	.000	.000	.000	.000	.170	.170	.330	.000	.330	.000	.170	.830
54.	Six Flags Magic Mtn	SG	100.00	.000	.000	.000	.010	.180	.190	.150	.000	.470	.010	.180	.810
55.	Travel Village	SG	100.00	.000	.000	.000	.010	.250	.260	.060	.000	.420	.010	.250	.740
56.	CHP Office	SG	100.00	.000	.000	.000	.110	.180	.290	.270	.000	.150	.110	.180	.710
57.	Agua Dulce Airport	SG	100.00	.000	.000	.000	.040	.180	.220	.160	.000	.400	.040	.180	.780
58.	Landfill	SG	100.00	.000	.000	.000	.110	.180	.290	.270	.000	.150	.110	.180	.710
59.	Cemex	SG	100.00	.000	.000	.000	.110	.180	.290	.270	.000	.150	.110	.180	.710

Peak Period to Peak Hour Factors	AM	.60	PM	.35

DU = Dwelling Unit
TSF = Thousand Square Feet
STU = Student
AC = Acre
SG = Special Generator

Network Speed and Capacity Table							
	Speed by Link Classification					One Hour	Off Peak
Facility Type	**1**	**2**	**3**	**4**	**5**	**Capacity**	**Capacity**
1 - Freeway	65	60	55	50	65	2,200	22,500
2 - Major Hwy (6+ Lanes)	40	35	30	45	50	1,000	9,000
3 - Secondary Hwy (4 Lanes)	35	30	25	40	45	850	8,000
4 - Limited Secondary Hwy (2 Lanes)	30	25	20	35	40	750	7,000
5 - Local/Industrial Collector (2-4 Lanes)	25	20	15	30	35	750	7,000
6 - Centroid Connector	15	15	15	15	15	unrestricted	unrestricted
7 - Expressway	45	40	35	50	55	1,400	14,000
8 - Freeway Ramp	30	30	30	30	30	1,500	12,000

Note: Capacities are per lane and are for one direction.

Appendix E

FREEWAY D/C CALCULATIONS

Table E-1: Freeway D/C Calculations - Existing Lanes

			Existing Conditions				Current GP Buildout				Proposed OVOV Buildout			
			AM		PM		AM		PM		AM		PM	
Segment	**Lanes**	**Capacity**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**
Northbound														
I-5 s/o Parker	4M	8,000	1,860	0.23	3,570	0.45	5,140	0.64	8,760	**1.10**	4,090	0.51	8,770	**1.10**
I-5 s/o Valencia	4M	8,000	5,430	0.68	6,050	0.76	8,540	**1.07**	9,730	**1.22**	7,860	0.98	9,190	**1.15**
I-5 s/o Calgrove	4M	8,000	5,600	0.70	6,970	0.87	8,710	**1.09**	10,530	**1.32**	7,540	0.94	8,700	**1.09**
SR-14 s/o Aqua Dulce	3M+1H	8,000	1,970	0.25	5,130	0.64	4,260	0.53	11,300	**1.41**	2,700	0.34	10,590	**1.32**
SR-14 s/o Sierra Hwy	4M+1H	10,000	2,510	0.25	7,500	0.75	5,020	0.50	15,430	**1.54**	3,900	0.39	13,580	**1.36**
SR-14 n/o I-5	5M+1H	12,000	2,950	0.25	8,430	0.70	6,320	0.53	16,250	**1.35**	5,100	0.43	13,390	**1.12**
Southbound														
I-5 s/o Parker	4M	8,000	2,190	0.27	3,070	0.38	6,950	0.87	7,980	1.00	6,770	0.85	7,640	0.96
I-5 s/o Valencia	4M	8,000	5,310	0.66	6,420	0.80	9,970	**1.25**	10,320	**1.29**	8,200	**1.03**	10,300	**1.29**
I-5 s/o Calgrove	4M	6,400	6,610	**1.03**	6,410	**1.00**	10,430	**1.63**	10,800	**1.69**	7,380	**1.15**	10,480	**1.64**
SR-14 s/o Aqua Dulce	3M+1H	8,000	5,580	0.70	2,810	0.35	11,970	**1.50**	5,190	0.65	11,780	**1.47**	3,350	0.42
SR-14 s/o Sierra Hwy	4M+1H	10,000	7,090	0.71	3,380	0.34	15,330	**1.53**	7,100	0.71	14,350	**1.44**	5,150	0.52
SR-14 n/o I-5	5M+1H	12,000	8,350	0.70	4,100	0.34	16,170	**1.35**	8,490	0.71	13,920	**1.16**	6,820	0.57

Capacities:

Mix-Flow Lane (M)	2,000 vphpl (1,600 vphpl for extended uphill grades)
HOV Lane (H)	2,000 vphpl
Truck Lane (T)	1,200 vphpl
Auxiliary Lane (A)	1,000 vphpl

Abbreviations:

Vol = Volume
D/C = Demand/Capacity Ratio
HOV = High Occupancy Vehicle

Table E-2: Freeway D/C Calculations - Future Lanes

			Existing Conditions				Current GP Buildout				Proposed OVOV Buildout			
			AM		PM		AM		PM		AM		PM	
Segment	**Lanes**	**Capacity**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**	**Vol**	**D/C**
Northbound														
I-5 s/o Parker	4M+1H	10,000	1,860	0.19	3,570	0.36	5,140	0.51	8,760	0.88	4,090	0.41	8,770	0.88
I-5 s/o Valencia	4M+1H	10,000	5,430	0.54	6,050	0.61	8,540	0.85	9,730	0.97	7,860	0.79	9,190	0.92
I-5 s/o Calgrove	4M+1H+1T	11,200	5,600	0.50	6,970	0.62	8,710	0.78	10,530	0.94	7,540	0.67	8,700	0.78
SR-14 s/o Aqua Dulce	3M+2H	10,000	1,970	0.20	5,130	0.51	4,260	0.43	11,300	**1.13**	2,700	0.27	10,590	**1.06**
SR-14 s/o Sierra Hwy	4M+2H	12,000	2,510	0.21	7,500	0.63	5,020	0.42	15,430	**1.29**	3,900	0.33	13,580	**1.13**
SR-14 n/o I-5	5M+2H	14,000	2,950	0.21	8,430	0.60	6,320	0.45	16,250	**1.16**	5,100	0.36	13,390	0.96
Southbound														
I-5 s/o Parker	4M+1H	10,000	2,190	0.22	3,070	0.31	6,950	0.70	7,980	0.80	6,770	0.68	7,640	0.76
I-5 s/o Valencia	4M+1H	11,000	5,310	0.48	6,420	0.58	9,970	0.91	10,320	0.94	8,200	0.75	10,300	0.94
I-5 s/o Calgrove	4M+1H+2T	12,400	6,610	0.53	6,410	0.52	10,430	0.84	10,800	0.87	7,380	0.60	10,480	0.85
SR-14 s/o Aqua Dulce	3M+2H	10,000	5,580	0.56	2,810	0.28	11,970	**1.20**	5,190	0.52	11,780	**1.18**	3,350	0.34
SR-14 s/o Sierra Hwy	4M+2H	12,000	7,090	0.59	3,380	0.28	15,330	**1.28**	7,100	0.59	14,350	**1.20**	5,150	0.43
SR-14 n/o I-5	5M+2H	14,000	8,350	0.60	4,100	0.29	16,170	**1.16**	8,490	0.61	13,920	0.99	6,820	0.49

Capacities:

Mix-Flow Lane (M)	2,000 vphpl (1,600 vphpl for extended uphill grades)
HOV Lane (H)	2,000 vphpl
Truck Lane (T)	1,200 vphpl
Auxiliary Lane (A)	1,000 vphpl

Abbreviations:

Vol = Volume
D/C = Demand/Capacity Ratio
HOV = High Occupancy Vehicle

APPENDIX 3.3

Air Quality Emission Calculations

Existing Operational Emissions

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Comm'l.urb924

Project Name: 112-23 OVOV Existing Commercial 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	57.33	59.72	57.44	0.00	0.13	0.13	71,575.84

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	4,089.43	6,218.14	54,530.90	57.76	9,513.24	1,850.80	5,638,883.05

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	4,146.76	6,277.86	54,588.34	57.76	9,513.37	1,850.93	5,710,458.89

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	4.33	59.64	50.10	0.00	0.11	0.11	71,564.80
Hearth - No Summer Emissions							
Landscape	0.64	0.08	7.34	0.00	0.02	0.02	11.04
Consumer Products	0.00						
Architectural Coatings	52.36						
TOTALS (lbs/day, unmitigated)	57.33	59.72	57.44	0.00	0.13	0.13	71,575.84

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	777.11	1,175.79	10,311.24	10.92	1,798.86	349.97	1,066,255.74
Comm'l Ctr 10-30 ac	1,989.47	3,026.35	26,540.01	28.11	4,630.06	900.78	2,744,425.53
Comm'l Ctr <10 ac	925.08	1,415.18	12,410.64	13.15	2,165.11	421.22	1,283,348.62
Comm'l Shops	397.77	600.82	5,269.01	5.58	919.21	178.83	544,853.16
TOTALS (lbs/day, unmitigated)	4,089.43	6,218.14	54,530.90	57.76	9,513.24	1,850.80	5,638,883.05

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	2,221.66	88,999.70	1,041,296.46
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	4,237.43	229,075.48	2,680,183.09
Comm'l Ctr <10 ac		85.06	1000 sq ft	1,259.35	107,120.31	1,253,307.56
Comm'l Shops		37.06	1000 sq ft	1,227.16	45,478.55	532,099.06
					470,674.04	5,506,886.17

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Comm'l.urb924

Project Name: 112-23 OVOV Existing Commercial 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	56.69	59.64	50.10	0.00	0.11	0.11	71,564.80

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	4,752.55	7,497.69	52,077.19	48.03	9,513.24	1,850.80	5,104,178.97

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	4,809.24	7,557.33	52,127.29	48.03	9,513.35	1,850.91	5,175,743.77

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	4.33	59.64	50.10	0.00	0.11	0.11	71,564.80
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	52.36						
TOTALS (lbs/day, unmitigated)	56.69	59.64	50.10	0.00	0.11	0.11	71,564.80

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	900.39	1,417.74	9,847.27	9.08	1,798.86	349.97	965,148.61
Comm'l Ctr 10-30 ac	2,312.67	3,649.10	25,345.80	23.38	4,630.06	900.78	2,484,186.84
Comm'l Ctr <10 ac	1,079.10	1,706.39	11,852.20	10.93	2,165.11	421.22	1,161,655.77
Comm'l Shops	460.39	724.46	5,031.92	4.64	919.21	178.83	493,187.75
TOTALS (lbs/day, unmitigated)	4,752.55	7,497.69	52,077.19	48.03	9,513.24	1,850.80	5,104,178.97

4/20/2009 6:35:30 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	2,221.66	88,999.70	1,041,296.46
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	4,237.43	229,075.48	2,680,183.09
Comm'l Ctr <10 ac		85.06	1000 sq ft	1,259.35	107,120.31	1,253,307.56
Comm'l Shops		37.06	1000 sq ft	1,227.16	45,478.55	532,099.06
					470,674.04	5,506,886.17

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Summary Report for Summer Emissions (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Institutional.urb924

Project Name: 112-23 OVOV Existing Institutional 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	221.96	324.17	285.04	0.00	0.61	0.61	388,864.18

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,332.06	1,378.03	12,174.61	12.82	2,105.37	409.73	1,249,903.26

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,554.02	1,702.20	12,459.65	12.82	2,105.98	410.34	1,638,767.44

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Institutional.urb924

Project Name: 112-23 OVOV Existing Institutional 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	220.83	324.04	272.19	0.00	0.58	0.58	388,844.86

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,246.32	1,661.73	11,614.55	10.65	2,105.37	409.73	1,131,578.16

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,467.15	1,985.77	11,886.74	10.65	2,105.95	410.31	1,520,423.02

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	23.53	324.04	272.19	0.00	0.58	0.58	388,844.86
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	197.30						
TOTALS (lbs/day, unmitigated)	220.83	324.04	272.19	0.00	0.58	0.58	388,844.86

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Elementary school	536.69	692.51	4,861.87	4.44	876.47	170.61	471,670.49
High school	223.63	299.75	2,091.99	1.92	379.91	73.93	204,105.67
Junior college (2 yrs)	344.37	451.07	3,138.65	2.89	572.09	111.31	307,097.30
Library	46.05	72.74	506.15	0.47	92.26	17.95	49,523.76
Place of worship	47.15	72.29	502.41	0.46	91.71	17.84	49,213.75
Hospital	26.07	40.25	283.43	0.26	50.91	9.91	27,419.51
Day Care	22.36	33.12	230.05	0.21	42.02	8.18	22,547.68
TOTALS (lbs/day, unmitigated)	1,246.32	1,661.73	11,614.55	10.65	2,105.37	409.73	1,131,578.16

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Elementary school		1.45	1000 sq ft	29,902.00	43,357.90	507,287.44
High school		1.79	students	10,500.00	18,795.00	219,901.49
Junior college (2 yrs)		1.54	students	18,379.00	28,303.66	331,152.81
Library		84.95	1000 sq ft	53.73	4,564.36	53,403.05
Place of worship		9.30	1000 sq ft	487.89	4,537.38	53,087.31
Hospital		16.80	1000 sq ft	149.90	2,518.32	29,464.34
Day Care		4.52	1000 sq ft	460.00	2,079.20	24,326.64
					104,155.82	1,218,623.08

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Elementary school				20.0	10.0	70.0
High school				10.0	5.0	85.0
Junior college (2 yrs)				5.0	2.5	92.5
Library				5.0	2.5	92.5

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Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Place of worship				3.0	1.5	95.5
Hospital				25.0	12.5	62.5
Day Care				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Res'l.urb924

Project Name: 112-23 OVOV Existing Residential 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	4,600.95	1,048.26	3,032.98	0.13	8.99	8.89	1,313,719.80

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	6,446.64	8,816.78	80,437.25	82.10	13,389.92	2,609.50	8,006,351.55

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	11,047.59	9,865.04	83,470.23	82.23	13,398.91	2,618.39	9,320,071.35

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	79.27	1,026.36	436.75	0.01	1.97	1.94	1,310,250.40
Hearth - No Summer Emissions							
Landscape	467.23	21.90	2,596.23	0.12	7.02	6.95	3,469.40
Consumer Products	3,838.12						
Architectural Coatings	216.33						
TOTALS (lbs/day, unmitigated)	4,600.95	1,048.26	3,032.98	0.13	8.99	8.89	1,313,719.80

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	4,411.74	6,073.02	55,405.32	56.55	9,223.00	1,797.43	5,514,788.17
Apartments mid rise	201.44	268.45	2,449.16	2.50	407.70	79.45	243,778.46
Condo/townhouse general	1,675.10	2,265.15	20,665.41	21.09	3,440.05	670.42	2,056,938.91
Mobile home park	150.28	200.28	1,827.23	1.87	304.17	59.28	181,874.41
Retirement community	8.08	9.88	90.13	0.09	15.00	2.92	8,971.60
TOTALS (lbs/day, unmitigated)	6,446.64	8,816.78	80,437.25	82.10	13,389.92	2,609.50	8,006,351.55

Operational Settings:

4/21/2009 1:17:23 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	15,357.00	9.90	dwelling units	46,071.00	456,102.88	5,336,403.64
Apartments mid rise	76.89	6.90	dwelling units	2,922.00	20,161.80	235,893.06
Condo/townhouse general	1,329.06	8.00	dwelling units	21,265.00	170,120.00	1,990,403.97
Mobile home park	363.33	6.90	dwelling units	2,180.00	15,042.00	175,991.40
Retirement community	40.00	3.71	dwelling units	200.00	742.00	8,681.40
					662,168.68	7,747,373.47

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:17:23 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

4/21/2009 1:17:45 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Res'l.urb924

Project Name: 112-23 OVOV Existing Residential 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	15,517.55	2,003.68	32,004.27	88.62	4,897.32	4,714.61	2,619,891.79

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	7,113.03	10,634.94	76,646.60	68.40	13,389.92	2,609.50	7,254,102.10

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	22,630.58	12,638.62	108,650.87	157.02	18,287.24	7,324.11	9,873,993.89

4/21/2009 1:17:45 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	79.27	1,026.36	436.75	0.01	1.97	1.94	1,310,250.40
Hearth	11,383.83	977.32	31,567.52	88.61	4,895.35	4,712.67	1,309,641.39
Landscaping - No Winter Emissions							
Consumer Products	3,838.12						
Architectural Coatings	216.33						
TOTALS (lbs/day, unmitigated)	15,517.55	2,003.68	32,004.27	88.62	4,897.32	4,714.61	2,619,891.79

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	4,886.56	7,325.36	52,794.30	47.12	9,223.00	1,797.43	4,996,637.50
Apartments mid rise	218.89	323.81	2,333.75	2.08	407.70	79.45	220,873.87
Condo/townhouse general	1,835.91	2,732.26	19,691.54	17.57	3,440.05	670.42	1,863,675.95
Mobile home park	163.31	241.59	1,741.12	1.55	304.17	59.28	164,786.12
Retirement community	8.36	11.92	85.89	0.08	15.00	2.92	8,128.66
TOTALS (lbs/day, unmitigated)	7,113.03	10,634.94	76,646.60	68.40	13,389.92	2,609.50	7,254,102.10

Operational Settings:

4/21/2009 1:17:45 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	15,357.00	9.90	dwelling units	46,071.00	456,102.88	5,336,403.64
Apartments mid rise	76.89	6.90	dwelling units	2,922.00	20,161.80	235,893.06
Condo/townhouse general	1,329.06	8.00	dwelling units	21,265.00	170,120.00	1,990,403.97
Mobile home park	363.33	6.90	dwelling units	2,180.00	15,042.00	175,991.40
Retirement community	40.00	3.71	dwelling units	200.00	742.00	8,681.40
					662,168.68	7,747,373.47

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:17:45 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

4/21/2009 1:41:20 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. SG.urb924

Project Name: 112-23 OVOV Existing Special Generator 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	32.71	0.09	9.18	0.00	0.02	0.02	13.80

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	207.25	317.41	2,783.59	2.94	485.61	94.47	287,842.10

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	239.96	317.50	2,792.77	2.94	485.63	94.49	287,855.90

4/21/2009 1:41:20 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth - No Summer Emissions							
Landscape	0.81	0.09	9.18	0.00	0.02	0.02	13.80
Consumer Products	0.00						
Architectural Coatings	31.90						
TOTALS (lbs/day, unmitigated)	32.71	0.09	9.18	0.00	0.02	0.02	13.80

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Wayside Honor Ranch	8.70	13.21	115.86	0.12	20.21	3.93	11,980.44
Six Flags Magic Mtn	137.97	211.38	1,853.71	1.96	323.39	62.92	191,687.07
Travel Village	22.59	34.61	303.55	0.32	52.96	10.30	31,388.76
Agua Dulce Airport	29.37	45.00	394.61	0.42	68.84	13.39	40,805.39
Landfill	8.62	13.21	115.86	0.12	20.21	3.93	11,980.44
TOTALS (lbs/day, unmitigated)	207.25	317.41	2,783.59	2.94	485.61	94.47	287,842.10

Operational Settings:

4/21/2009 1:41:20 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Wayside Honor Ranch		50.00	acres	20.00	1,000.00	11,700.00
Six Flags Magic Mtn		100.00	acres	160.00	16,000.00	187,200.00
Travel Village		100.00	acres	26.20	2,620.00	30,654.00
Agua Dulce Airport		100.00	acres	34.06	3,406.00	39,850.20
Landfill		100.00	acres	10.00	1,000.00	11,700.00
					24,026.00	281,104.20

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:41:20 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

4/21/2009 1:41:39 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. SG.urb924

Project Name: 112-23 OVOV Existing Special Generator 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	31.90	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	241.93	382.73	2,658.32	2.45	485.61	94.47	260,547.63

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	273.83	382.73	2,658.32	2.45	485.61	94.47	260,547.63

4/21/2009 1:41:39 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	31.90						
TOTALS (lbs/day, unmitigated)	31.90	0.00	0.00	0.00	0.00	0.00	0.00

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Wayside Honor Ranch	10.10	15.93	110.64	0.10	20.21	3.93	10,844.40
Six Flags Magic Mtn	161.09	254.87	1,770.30	1.63	323.39	62.92	173,510.45
Travel Village	26.38	41.74	289.89	0.27	52.96	10.30	28,412.34
Agua Dulce Airport	34.29	54.26	376.85	0.35	68.84	13.39	36,936.04
Landfill	10.07	15.93	110.64	0.10	20.21	3.93	10,844.40
TOTALS (lbs/day, unmitigated)	241.93	382.73	2,658.32	2.45	485.61	94.47	260,547.63

Operational Settings:

4/21/2009 1:41:39 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Wayside Honor Ranch		50.00	acres	20.00	1,000.00	11,700.00
Six Flags Magic Mtn		100.00	acres	160.00	16,000.00	187,200.00
Travel Village		100.00	acres	26.20	2,620.00	30,654.00
Agua Dulce Airport		100.00	acres	34.06	3,406.00	39,850.20
Landfill		100.00	acres	10.00	1,000.00	11,700.00
					24,026.00	281,104.20

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:41:39 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Non-Res'l.urb924

Project Name: 112-23 OVOV Existing Non-Residential 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	30.04	35.83	41.03	0.00	0.09	0.09	42,882.11

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	711.71	1,042.05	9,152.84	9.68	1,593.80	310.09	945,027.74

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	741.75	1,077.88	9,193.87	9.68	1,593.89	310.18	987,909.85

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	2.59	35.72	30.01	0.00	0.06	0.06	42,865.55
Hearth - No Summer Emissions							
Landscape	0.97	0.11	11.02	0.00	0.03	0.03	16.56
Consumer Products	0.00						
Architectural Coatings	26.48						
TOTALS (lbs/day, unmitigated)	30.04	35.83	41.03	0.00	0.09	0.09	42,882.11

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	43.76	66.08	580.76	0.61	101.06	19.66	59,930.65
High turnover (sit-down) rest.	184.89	283.29	2,489.65	2.63	433.24	84.29	256,915.67
Fast food rest. w/ drive thru	202.64	311.98	2,741.82	2.90	477.12	92.83	282,937.30
Hotel	75.84	106.05	932.03	0.99	162.19	31.56	96,179.71
Movie Theater	73.58	76.73	672.90	0.71	117.39	22.84	69,582.41
Car Dealership	131.00	197.92	1,735.68	1.84	302.80	58.91	179,482.00
TOTALS (lbs/day, unmitigated)	711.71	1,042.05	9,152.84	9.68	1,593.80	310.09	945,027.74

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	125.00	5,000.00	58,500.00
High turnover (sit-down) rest.		130.34	1000 sq ft	164.45	21,434.41	250,782.62
Fast food rest. w/ drive thru		496.12	1000 sq ft	47.58	23,605.39	276,183.06
Hotel		8.23	rooms	975.00	8,024.25	93,883.72
Movie Theater		1.76	1000 sq ft	3,300.00	5,808.00	67,953.60
Car Dealership		37.50	1000 sq ft	399.50	14,981.25	175,280.62
					78,853.30	922,583.62

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 11:53:12 AM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

4/21/2009 10:25:29 AM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Non-Res'l.urb924

Project Name: 112-23 OVOV Existing Non-Residential 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	29.07	35.72	30.01	0.00	0.06	0.06	42,865.55

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	808.57	1,256.51	8,739.05	8.05	1,593.80	310.09	855,447.29

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	837.64	1,292.23	8,769.06	8.05	1,593.86	310.15	898,312.84

4/21/2009 10:25:29 AM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	2.59	35.72	30.01	0.00	0.06	0.06	42,865.55
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	26.48						
TOTALS (lbs/day, unmitigated)	29.07	35.72	30.01	0.00	0.06	0.06	42,865.55

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	50.66	79.68	554.46	0.51	101.06	19.66	54,250.46
High turnover (sit-down) rest.	215.98	341.59	2,376.91	2.19	433.24	84.29	232,565.34
Fast food rest. w/ drive thru	237.42	376.19	2,617.65	2.41	477.12	92.83	256,120.65
Hotel	83.83	127.88	889.83	0.82	162.19	31.56	87,063.84
Movie Theater	69.04	92.52	642.62	0.59	117.39	22.84	62,984.29
Car Dealership	151.64	238.65	1,657.58	1.53	302.80	58.91	162,462.71
TOTALS (lbs/day, unmitigated)	808.57	1,256.51	8,739.05	8.05	1,593.80	310.09	855,447.29

4/21/2009 10:25:29 AM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	125.00	5,000.00	58,500.00
High turnover (sit-down) rest.		130.34	1000 sq ft	164.45	21,434.41	250,782.62
Fast food rest. w/ drive thru		496.12	1000 sq ft	47.58	23,605.39	276,183.06
Hotel		8.23	rooms	975.00	8,024.25	93,883.72
Movie Theater		1.76	1000 sq ft	3,300.00	5,808.00	67,953.60
Car Dealership		37.50	1000 sq ft	399.50	14,981.25	175,280.62
					78,853.30	922,583.62

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 10:25:29 AM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

4/21/2009 1:44:33 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Office.urb924

Project Name: 112-23 OVOV Existing Office 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	14.35	14.50	19.45	0.00	0.05	0.05	17,310.40

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	110.27	146.09	1,281.73	1.36	223.48	43.47	132,478.58

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	124.62	160.59	1,301.18	1.36	223.53	43.52	149,788.98

4/21/2009 1:44:33 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	1.05	14.42	12.11	0.00	0.03	0.03	17,299.36
Hearth - No Summer Emissions							
Landscape	0.64	0.08	7.34	0.00	0.02	0.02	11.04
Consumer Products	0.00						
Architectural Coatings	12.66						
TOTALS (lbs/day, unmitigated)	14.35	14.50	19.45	0.00	0.05	0.05	17,310.40

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	13.46	19.24	169.29	0.18	29.41	5.72	17,445.13
Regional Post Office	21.09	24.02	210.67	0.22	36.75	7.15	21,784.28
Post Office	14.98	22.59	198.12	0.21	34.56	6.72	20,486.56
Commercial Office	60.74	80.24	703.65	0.75	122.76	23.88	72,762.61
TOTALS (lbs/day, unmitigated)	110.27	146.09	1,281.73	1.36	223.48	43.47	132,478.58

Operational Settings:

4/21/2009 1:44:33 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	133.73	1,454.98	17,023.29
Regional Post Office		2.38	1000 sq ft	764.00	1,818.32	21,274.34
Post Office		34.20	1000 sq ft	50.00	1,710.00	20,007.00
Commercial Office		5.00	1000 sq ft	1,214.69	6,073.45	71,059.36
					11,056.75	129,363.99

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

4/21/2009 1:44:33 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0

4/21/2009 1:44:54 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Office.urb924

Project Name: 112-23 OVOV Existing Office 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	13.71	14.42	12.11	0.00	0.03	0.03	17,299.36

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	118.05	176.15	1,223.97	1.13	223.48	43.47	119,917.68

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	131.76	190.57	1,236.08	1.13	223.51	43.50	137,217.04

4/21/2009 1:44:54 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	1.05	14.42	12.11	0.00	0.03	0.03	17,299.36
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	12.66						
TOTALS (lbs/day, unmitigated)	13.71	14.42	12.11	0.00	0.03	0.03	17,299.36

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	15.08	23.19	161.59	0.15	29.41	5.72	15,792.21
Regional Post Office	20.74	28.97	201.19	0.19	36.75	7.15	19,718.60
Post Office	17.32	27.24	189.20	0.17	34.56	6.72	18,543.93
Commercial Office	64.91	96.75	671.99	0.62	122.76	23.88	65,862.94
TOTALS (lbs/day, unmitigated)	118.05	176.15	1,223.97	1.13	223.48	43.47	119,917.68

Operational Settings:

4/21/2009 1:44:54 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	133.73	1,454.98	17,023.29
Regional Post Office		2.38	1000 sq ft	764.00	1,818.32	21,274.34
Post Office		34.20	1000 sq ft	50.00	1,710.00	20,007.00
Commercial Office		5.00	1000 sq ft	1,214.69	6,073.45	71,059.36
					11,056.75	129,363.99

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

4/21/2009 1:44:54 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0

4/21/2009 1:36:45 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Recreation.urb924

Project Name: 112-23 OVOV Existing Recreation 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	225.08	0.06	5.51	0.00	0.01	0.01	8.28

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	612.98	927.34	8,132.48	8.61	1,418.76	276.02	840,957.13

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	838.06	927.40	8,137.99	8.61	1,418.77	276.03	840,965.41

4/21/2009 1:36:45 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth - No Summer Emissions							
Landscape	0.48	0.06	5.51	0.00	0.01	0.01	8.28
Consumer Products	0.00						
Architectural Coatings	224.60						
TOTALS (lbs/day, unmitigated)	225.08	0.06	5.51	0.00	0.01	0.01	8.28

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	566.87	869.02	7,621.02	8.07	1,329.53	258.66	788,067.75
Developed Park	19.87	27.75	243.37	0.26	42.46	8.26	25,166.64
Undeveloped Park	26.24	30.57	268.09	0.28	46.77	9.10	27,722.74
TOTALS (lbs/day, unmitigated)	612.98	927.34	8,132.48	8.61	1,418.76	276.02	840,957.13

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:36:46 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	608.00	65,779.52	769,620.39
Developed Park		7.96	acres	263.90	2,100.64	24,577.53
Undeveloped Park		2.60	acres	890.00	2,314.00	27,073.80
					70,194.16	821,271.72

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

4/21/2009 1:36:46 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

4/21/2009 1:37:10 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Recreation.urb924

Project Name: 112-23 OVOV Existing Recreation 2004 Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	224.60	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	710.17	1,118.17	7,766.55	7.16	1,418.76	276.02	761,213.82

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	934.77	1,118.17	7,766.55	7.16	1,418.76	276.02	761,213.82

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	224.60						
TOTALS (lbs/day, unmitigated)	224.60	0.00	0.00	0.00	0.00	0.00	0.00

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	662.11	1,047.85	7,278.10	6.71	1,329.53	258.66	713,339.64
Developed Park	21.94	33.46	232.42	0.21	42.46	8.26	22,780.23
Undeveloped Park	26.12	36.86	256.03	0.24	46.77	9.10	25,093.95
TOTALS (lbs/day, unmitigated)	710.17	1,118.17	7,766.55	7.16	1,418.76	276.02	761,213.82

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:37:11 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	608.00	65,779.52	769,620.39
Developed Park		7.96	acres	263.90	2,100.64	24,577.53
Undeveloped Park		2.60	acres	890.00	2,314.00	27,073.80
					70,194.16	821,271.72

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Ind'l.urb924

Project Name: 112-23 Existing 2004 Industrial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	113.25	12.46	10.47	0.00	0.02	0.02	14,950.01

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,292.36	1,926.78	13,659.25	12.36	2,433.01	473.85	1,312,918.34

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,405.61	1,939.24	13,669.72	12.36	2,433.03	473.87	1,327,868.35

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.90	12.46	10.47	0.00	0.02	0.02	14,950.01
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	112.35						
TOTALS (lbs/day, unmitigated)	113.25	12.46	10.47	0.00	0.02	0.02	14,950.01

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Industrial park	1,017.42	1,511.00	10,742.50	9.70	1,906.69	371.39	1,029,740.52
Manufacturing	103.08	151.40	1,080.42	0.97	190.87	37.19	103,195.13
Business Park	76.44	117.59	816.74	0.75	149.20	29.03	80,050.56
Utilities	95.42	146.79	1,019.59	0.94	186.25	36.24	99,932.13
TOTALS (lbs/day, unmitigated)	1,292.36	1,926.78	13,659.25	12.36	2,433.01	473.85	1,312,918.34

Operational Settings:

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Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Industrial park		6.00	1000 sq ft	15,717.43	94,304.58	1,103,363.55
Manufacturing		5.10	1000 sq ft	1,850.99	9,440.05	110,448.57
Business Park		10.20	1000 sq ft	723.70	7,381.74	86,366.36
Utilities		10.20	1000 sq ft	903.44	9,215.09	107,816.53
					120,341.46	1,407,995.01

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Industrial park				41.5	20.8	37.8
Manufacturing				48.0	24.0	28.0
Business Park				2.0	1.0	97.0
Utilities				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. Ind'l.urb924

Project Name: 112-23 Existing 2004 Industrial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	113.89	12.54	17.81	0.00	0.04	0.04	14,961.05

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,194.99	1,597.47	14,351.69	14.87	2,433.01	473.85	1,449,630.94

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,308.88	1,610.01	14,369.50	14.87	2,433.05	473.89	1,464,591.99

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.90	12.46	10.47	0.00	0.02	0.02	14,950.01
Hearth - No Summer Emissions							
Landscape	0.64	0.08	7.34	0.00	0.02	0.02	11.04
Consumer Products	0.00						
Architectural Coatings	112.35						
TOTALS (lbs/day, unmitigated)	113.89	12.54	17.81	0.00	0.04	0.04	14,961.05

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Industrial park	944.35	1,252.70	11,292.40	11.66	1,906.69	371.39	1,136,874.20
Manufacturing	96.94	125.51	1,136.43	1.17	190.87	37.19	113,919.40
Business Park	68.36	97.52	855.23	0.91	149.20	29.03	88,436.51
Utilities	85.34	121.74	1,067.63	1.13	186.25	36.24	110,400.83
TOTALS (lbs/day, unmitigated)	1,194.99	1,597.47	14,351.69	14.87	2,433.01	473.85	1,449,630.94

Operational Settings:

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Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Industrial park		6.00	1000 sq ft	15,717.43	94,304.58	1,103,363.55
Manufacturing		5.10	1000 sq ft	1,850.99	9,440.05	110,448.57
Business Park		10.20	1000 sq ft	723.70	7,381.74	86,366.36
Utilities		10.20	1000 sq ft	903.44	9,215.09	107,816.53
					120,341.46	1,407,995.01

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Industrial park				41.5	20.8	37.8
Manufacturing				48.0	24.0	28.0
Business Park				2.0	1.0	97.0
Utilities				2.0	1.0	97.0

Construction Air Emissions

for Existing General Plan and Area Plan

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Comm'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Commercial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	137.74	634.00	1,125.32	1.28	5,640.28	29.81	5,670.10	1,178.73	27.20	1,205.93
2010 TOTALS (lbs/day mitigated)	137.74	634.00	1,125.32	1.28	1,005.16	29.81	1,034.97	210.73	27.20	237.93
2011 TOTALS (lbs/day unmitigated)	131.44	587.90	1,051.02	1.28	5,640.28	27.52	5,667.80	1,178.73	25.09	1,203.82
2011 TOTALS (lbs/day mitigated)	131.44	587.90	1,051.02	1.28	1,005.16	27.52	1,032.68	210.73	25.09	235.82
2012 TOTALS (lbs/day unmitigated)	125.79	543.25	981.68	1.28	5,640.28	25.38	5,665.66	1,178.73	23.11	1,201.84
2012 TOTALS (lbs/day mitigated)	125.79	543.25	981.68	1.28	1,005.16	25.38	1,030.53	210.73	23.11	233.84
2013 TOTALS (lbs/day unmitigated)	120.98	500.94	916.12	1.28	5,640.28	23.44	5,663.72	1,178.73	21.31	1,200.04
2013 TOTALS (lbs/day mitigated)	120.98	500.94	916.12	1.28	1,005.16	23.44	1,028.60	210.73	21.31	232.04
2014 TOTALS (lbs/day unmitigated)	115.94	458.55	857.51	1.28	5,640.28	21.60	5,661.88	1,178.73	19.62	1,198.34
2014 TOTALS (lbs/day mitigated)	115.94	458.55	857.51	1.28	1,005.16	21.60	1,026.75	210.73	19.62	230.35
2015 TOTALS (lbs/day unmitigated)	110.95	416.73	802.48	1.28	5,640.28	19.93	5,660.21	1,178.73	18.09	1,196.81
2015 TOTALS (lbs/day mitigated)	110.95	416.73	802.48	1.28	1,005.16	19.93	1,025.09	210.73	18.09	228.81
2016 TOTALS (lbs/day unmitigated)	106.61	379.77	754.35	1.28	5,640.28	18.36	5,658.64	1,178.73	16.64	1,195.36
2016 TOTALS (lbs/day mitigated)	106.61	379.77	754.35	1.28	1,005.16	18.36	1,023.51	210.73	16.64	227.36
2017 TOTALS (lbs/day unmitigated)	102.78	345.86	708.60	1.28	5,640.28	16.82	5,657.11	1,178.73	15.23	1,193.95
2017 TOTALS (lbs/day mitigated)	102.78	345.86	708.60	1.28	1,005.16	16.82	1,021.98	210.73	15.23	225.95
2018 TOTALS (lbs/day unmitigated)	98.85	314.91	666.99	1.28	5,640.28	15.42	5,655.71	1,178.73	13.93	1,192.66
2018 TOTALS (lbs/day mitigated)	98.85	314.91	666.99	1.28	1,005.16	15.42	1,020.58	210.73	13.93	224.66
2019 TOTALS (lbs/day unmitigated)	95.66	287.13	628.30	1.28	5,640.28	14.07	5,654.36	1,178.73	12.69	1,191.42
2019 TOTALS (lbs/day mitigated)	95.66	287.13	628.30	1.28	1,005.16	14.07	1,019.23	210.73	12.69	223.42

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Comm'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Commercial

2020 TOTALS (lbs/day unmitigated)	92.30	262.08	592.44	1.28	5,640.28	12.99	5,653.27	1,178.73	11.69	1,190.41
2020 TOTALS (lbs/day mitigated)	92.30	262.08	592.44	1.28	1,005.16	12.99	1,018.14	210.73	11.69	222.41
2021 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2021 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2022 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2022 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2023 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2023 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2024 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2024 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2025 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2025 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2026 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2026 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2027 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2027 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2028 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2028 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2029 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2029 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2030 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2030 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Comm'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Commercial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	137.74	634.00	1,125.32	1.28	5,640.28	29.81	5,670.10	1,178.73	27.20	1,205.93
2010 TOTALS (lbs/day mitigated)	137.74	634.00	1,125.32	1.28	1,005.16	29.81	1,034.97	210.73	27.20	237.93
2011 TOTALS (lbs/day unmitigated)	131.44	587.90	1,051.02	1.28	5,640.28	27.52	5,667.80	1,178.73	25.09	1,203.82
2011 TOTALS (lbs/day mitigated)	131.44	587.90	1,051.02	1.28	1,005.16	27.52	1,032.68	210.73	25.09	235.82
2012 TOTALS (lbs/day unmitigated)	125.79	543.25	981.68	1.28	5,640.28	25.38	5,665.66	1,178.73	23.11	1,201.84
2012 TOTALS (lbs/day mitigated)	125.79	543.25	981.68	1.28	1,005.16	25.38	1,030.53	210.73	23.11	233.84
2013 TOTALS (lbs/day unmitigated)	120.98	500.94	916.12	1.28	5,640.28	23.44	5,663.72	1,178.73	21.31	1,200.04
2013 TOTALS (lbs/day mitigated)	120.98	500.94	916.12	1.28	1,005.16	23.44	1,028.60	210.73	21.31	232.04
2014 TOTALS (lbs/day unmitigated)	115.94	458.55	857.51	1.28	5,640.28	21.60	5,661.88	1,178.73	19.62	1,198.34
2014 TOTALS (lbs/day mitigated)	115.94	458.55	857.51	1.28	1,005.16	21.60	1,026.75	210.73	19.62	230.35
2015 TOTALS (lbs/day unmitigated)	110.95	416.73	802.48	1.28	5,640.28	19.93	5,660.21	1,178.73	18.09	1,196.81
2015 TOTALS (lbs/day mitigated)	110.95	416.73	802.48	1.28	1,005.16	19.93	1,025.09	210.73	18.09	228.81
2016 TOTALS (lbs/day unmitigated)	106.61	379.77	754.35	1.28	5,640.28	18.36	5,658.64	1,178.73	16.64	1,195.36
2016 TOTALS (lbs/day mitigated)	106.61	379.77	754.35	1.28	1,005.16	18.36	1,023.51	210.73	16.64	227.36
2017 TOTALS (lbs/day unmitigated)	102.78	345.86	708.60	1.28	5,640.28	16.82	5,657.11	1,178.73	15.23	1,193.95
2017 TOTALS (lbs/day mitigated)	102.78	345.86	708.60	1.28	1,005.16	16.82	1,021.98	210.73	15.23	225.95
2018 TOTALS (lbs/day unmitigated)	98.85	314.91	666.99	1.28	5,640.28	15.42	5,655.71	1,178.73	13.93	1,192.66
2018 TOTALS (lbs/day mitigated)	98.85	314.91	666.99	1.28	1,005.16	15.42	1,020.58	210.73	13.93	224.66
2019 TOTALS (lbs/day unmitigated)	95.66	287.13	628.30	1.28	5,640.28	14.07	5,654.36	1,178.73	12.69	1,191.42
2019 TOTALS (lbs/day mitigated)	95.66	287.13	628.30	1.28	1,005.16	14.07	1,019.23	210.73	12.69	223.42

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Comm'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Commercial

2020 TOTALS (lbs/day unmitigated)	92.30	262.08	592.44	1.28	5,640.28	12.99	5,653.27	1,178.73	11.69	1,190.41
2020 TOTALS (lbs/day mitigated)	92.30	262.08	592.44	1.28	1,005.16	12.99	1,018.14	210.73	11.69	222.41
2021 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2021 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2022 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2022 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2023 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2023 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2024 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2024 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2025 TOTALS (lbs/day unmitigated)	87.22	239.28	468.97	1.28	5,640.28	12.38	5,652.67	1,178.73	11.14	1,189.86
2025 TOTALS (lbs/day mitigated)	87.22	239.28	468.97	1.28	1,005.16	12.38	1,017.54	210.73	11.14	221.86
2026 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2026 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2027 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2027 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2028 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2028 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2029 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2029 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67
2030 TOTALS (lbs/day unmitigated)	84.43	229.71	402.11	1.28	5,640.28	12.17	5,652.45	1,178.73	10.94	1,189.67
2030 TOTALS (lbs/day mitigated)	84.43	229.71	402.11	1.28	1,005.16	12.17	1,017.33	210.73	10.94	221.67

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Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	537.94	3,917.09	5,027.69	8.63	14,614.03	167.27	14,781.30	3,056.70	153.00	3,209.69
2010 TOTALS (lbs/day mitigated)	537.94	3,917.09	5,027.69	8.63	2,620.68	167.27	2,787.95	552.01	153.00	705.00
2011 TOTALS (lbs/day unmitigated)	505.89	3,549.41	4,669.75	8.63	14,614.03	150.54	14,764.57	3,056.70	137.58	3,194.28
2011 TOTALS (lbs/day mitigated)	505.89	3,549.41	4,669.75	8.63	2,620.68	150.54	2,771.22	552.01	137.58	689.59
2012 TOTALS (lbs/day unmitigated)	475.11	3,190.40	4,330.51	8.63	14,614.03	134.82	14,748.84	3,056.70	123.09	3,179.79
2012 TOTALS (lbs/day mitigated)	475.11	3,190.40	4,330.51	8.63	2,620.68	134.82	2,755.50	552.01	123.09	675.10
2013 TOTALS (lbs/day unmitigated)	445.99	2,845.70	4,005.47	8.63	14,614.03	119.90	14,733.93	3,056.70	109.31	3,166.00
2013 TOTALS (lbs/day mitigated)	445.99	2,845.70	4,005.47	8.63	2,620.68	119.90	2,740.58	552.01	109.31	661.31
2014 TOTALS (lbs/day unmitigated)	417.81	2,521.74	3,710.03	8.63	14,614.03	106.92	14,720.95	3,056.70	97.38	3,154.07
2014 TOTALS (lbs/day mitigated)	417.81	2,521.74	3,710.03	8.63	2,620.68	106.92	2,727.60	552.01	97.38	649.38
2015 TOTALS (lbs/day unmitigated)	391.25	2,226.45	3,435.48	8.63	14,614.03	94.91	14,708.93	3,056.70	86.31	3,143.00
2015 TOTALS (lbs/day mitigated)	391.25	2,226.45	3,435.48	8.63	2,620.68	94.91	2,715.59	552.01	86.31	638.31
2016 TOTALS (lbs/day unmitigated)	369.17	1,981.58	3,199.15	8.63	14,614.03	85.25	14,699.28	3,056.70	77.42	3,134.11
2016 TOTALS (lbs/day mitigated)	369.17	1,981.58	3,199.15	8.63	2,620.68	85.25	2,705.93	552.01	77.42	629.42
2017 TOTALS (lbs/day unmitigated)	349.92	1,774.03	2,981.79	8.63	14,614.03	76.77	14,690.79	3,056.70	69.61	3,126.31
2017 TOTALS (lbs/day mitigated)	349.92	1,774.03	2,981.79	8.63	2,620.68	76.77	2,697.45	552.01	69.61	621.62
2018 TOTALS (lbs/day unmitigated)	332.37	1,596.95	2,785.06	8.63	14,614.03	69.76	14,683.79	3,056.70	63.15	3,119.84
2018 TOTALS (lbs/day mitigated)	332.37	1,596.95	2,785.06	8.63	2,620.68	69.76	2,690.45	552.01	63.15	615.15
2019 TOTALS (lbs/day unmitigated)	317.42	1,445.38	2,605.37	8.63	14,614.03	63.60	14,677.63	3,056.70	57.48	3,114.18
2019 TOTALS (lbs/day mitigated)	317.42	1,445.38	2,605.37	8.63	2,620.68	63.60	2,684.28	552.01	57.48	609.49

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

2020 TOTALS (lbs/day unmitigated)	303.47	1,316.00	2,440.46	8.63	14,614.03	58.61	14,672.64	3,056.70	52.89	3,109.58
2020 TOTALS (lbs/day mitigated)	303.47	1,316.00	2,440.46	8.63	2,620.68	58.61	2,679.29	552.01	52.89	604.89
2021 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2021 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2022 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2022 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2023 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2023 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2024 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2024 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2025 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2025 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2026 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2026 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2027 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2027 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2028 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2028 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2029 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2029 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2030 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2030 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	537.94	3,917.09	5,027.69	8.63	14,614.03	167.27	14,781.30	3,056.70	153.00	3,209.69
2010 TOTALS (lbs/day mitigated)	537.94	3,917.09	5,027.69	8.63	2,620.68	167.27	2,787.95	552.01	153.00	705.00
2011 TOTALS (lbs/day unmitigated)	505.89	3,549.41	4,669.75	8.63	14,614.03	150.54	14,764.57	3,056.70	137.58	3,194.28
2011 TOTALS (lbs/day mitigated)	505.89	3,549.41	4,669.75	8.63	2,620.68	150.54	2,771.22	552.01	137.58	689.59
2012 TOTALS (lbs/day unmitigated)	475.11	3,190.40	4,330.51	8.63	14,614.03	134.82	14,748.84	3,056.70	123.09	3,179.79
2012 TOTALS (lbs/day mitigated)	475.11	3,190.40	4,330.51	8.63	2,620.68	134.82	2,755.50	552.01	123.09	675.10
2013 TOTALS (lbs/day unmitigated)	445.99	2,845.70	4,005.47	8.63	14,614.03	119.90	14,733.93	3,056.70	109.31	3,166.00
2013 TOTALS (lbs/day mitigated)	445.99	2,845.70	4,005.47	8.63	2,620.68	119.90	2,740.58	552.01	109.31	661.31
2014 TOTALS (lbs/day unmitigated)	417.81	2,521.74	3,710.03	8.63	14,614.03	106.92	14,720.95	3,056.70	97.38	3,154.07
2014 TOTALS (lbs/day mitigated)	417.81	2,521.74	3,710.03	8.63	2,620.68	106.92	2,727.60	552.01	97.38	649.38
2015 TOTALS (lbs/day unmitigated)	391.25	2,226.45	3,435.48	8.63	14,614.03	94.91	14,708.93	3,056.70	86.31	3,143.00
2015 TOTALS (lbs/day mitigated)	391.25	2,226.45	3,435.48	8.63	2,620.68	94.91	2,715.59	552.01	86.31	638.31
2016 TOTALS (lbs/day unmitigated)	369.17	1,981.58	3,199.15	8.63	14,614.03	85.25	14,699.28	3,056.70	77.42	3,134.11
2016 TOTALS (lbs/day mitigated)	369.17	1,981.58	3,199.15	8.63	2,620.68	85.25	2,705.93	552.01	77.42	629.42
2017 TOTALS (lbs/day unmitigated)	349.92	1,774.03	2,981.79	8.63	14,614.03	76.77	14,690.79	3,056.70	69.61	3,126.31
2017 TOTALS (lbs/day mitigated)	349.92	1,774.03	2,981.79	8.63	2,620.68	76.77	2,697.45	552.01	69.61	621.62
2018 TOTALS (lbs/day unmitigated)	332.37	1,596.95	2,785.06	8.63	14,614.03	69.76	14,683.79	3,056.70	63.15	3,119.84
2018 TOTALS (lbs/day mitigated)	332.37	1,596.95	2,785.06	8.63	2,620.68	69.76	2,690.45	552.01	63.15	615.15
2019 TOTALS (lbs/day unmitigated)	317.42	1,445.38	2,605.37	8.63	14,614.03	63.60	14,677.63	3,056.70	57.48	3,114.18
2019 TOTALS (lbs/day mitigated)	317.42	1,445.38	2,605.37	8.63	2,620.68	63.60	2,684.28	552.01	57.48	609.49

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

2020 TOTALS (lbs/day unmitigated)	303.47	1,316.00	2,440.46	8.63	14,614.03	58.61	14,672.64	3,056.70	52.89	3,109.58
2020 TOTALS (lbs/day mitigated)	303.47	1,316.00	2,440.46	8.63	2,620.68	58.61	2,679.29	552.01	52.89	604.89
2021 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2021 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2022 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2022 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2023 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2023 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2024 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2024 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2025 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85
2025 TOTALS (lbs/day mitigated)	264.02	982.18	1,851.59	8.62	2,620.68	46.94	2,667.62	552.01	42.16	594.16
2026 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2026 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2027 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2027 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2028 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2028 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2029 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2029 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43
2030 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12
2030 TOTALS (lbs/day mitigated)	245.58	858.78	1,545.33	8.62	2,620.68	42.86	2,663.54	552.01	38.42	590.43

5/26/2009 01:49:41 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Instit'l.urb924

Project Name: 112-23 Construction Emissions Institutional Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	68.47	375.17	481.47	0.45	1,983.55	19.23	2,002.78	414.53	17.61	432.15
2010 TOTALS (lbs/day mitigated)	68.47	375.17	481.47	0.45	353.51	19.23	372.74	74.12	17.61	91.73
2011 TOTALS (lbs/day unmitigated)	64.99	349.66	452.01	0.45	1,983.55	17.84	2,001.40	414.53	16.34	430.87
2011 TOTALS (lbs/day mitigated)	64.99	349.66	452.01	0.45	353.51	17.84	371.36	74.12	16.34	90.45
2012 TOTALS (lbs/day unmitigated)	61.87	324.95	424.69	0.45	1,983.55	16.41	1,999.96	414.53	15.01	429.54
2012 TOTALS (lbs/day mitigated)	61.87	324.95	424.69	0.45	353.51	16.41	369.92	74.12	15.01	89.13
2013 TOTALS (lbs/day unmitigated)	59.26	301.60	398.87	0.45	1,983.55	15.12	1,998.67	414.53	13.82	428.35
2013 TOTALS (lbs/day mitigated)	59.26	301.60	398.87	0.45	353.51	15.12	368.63	74.12	13.82	87.94
2014 TOTALS (lbs/day unmitigated)	56.46	277.98	375.94	0.45	1,983.55	13.79	1,997.34	414.53	12.59	427.13
2014 TOTALS (lbs/day mitigated)	56.46	277.98	375.94	0.45	353.51	13.79	367.30	74.12	12.59	86.71
2015 TOTALS (lbs/day unmitigated)	53.65	253.69	354.33	0.45	1,983.55	12.71	1,996.26	414.53	11.60	426.13
2015 TOTALS (lbs/day mitigated)	53.65	253.69	354.33	0.45	353.51	12.71	366.22	74.12	11.60	85.72
2016 TOTALS (lbs/day unmitigated)	51.17	231.87	335.56	0.45	1,983.55	11.54	1,995.10	414.53	10.53	425.06
2016 TOTALS (lbs/day mitigated)	51.17	231.87	335.56	0.45	353.51	11.54	365.05	74.12	10.53	84.65
2017 TOTALS (lbs/day unmitigated)	48.96	211.62	317.71	0.45	1,983.55	10.49	1,994.05	414.53	9.57	424.10
2017 TOTALS (lbs/day mitigated)	48.96	211.62	317.71	0.45	353.51	10.49	364.01	74.12	9.57	83.68
2018 TOTALS (lbs/day unmitigated)	46.65	192.90	301.63	0.45	1,983.55	9.50	1,993.06	414.53	8.65	423.18
2018 TOTALS (lbs/day mitigated)	46.65	192.90	301.63	0.45	353.51	9.50	363.01	74.12	8.65	82.77
2019 TOTALS (lbs/day unmitigated)	44.79	176.01	286.65	0.45	1,983.55	8.53	1,992.08	414.53	7.75	422.29
2019 TOTALS (lbs/day mitigated)	44.79	176.01	286.65	0.45	353.51	8.53	362.04	74.12	7.75	81.87

5/26/2009 01:49:41 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Instit'l.urb924

Project Name: 112-23 Construction Emissions Institutional Existing General Plan

2020 TOTALS (lbs/day unmitigated)	42.84	160.73	272.95	0.45	1,983.55	7.80	1,991.36	414.53	7.09	421.62
2020 TOTALS (lbs/day mitigated)	42.84	160.73	272.95	0.45	353.51	7.80	361.31	74.12	7.09	81.20
2021 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2021 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2022 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2022 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2023 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2023 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2024 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2024 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2025 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2025 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2026 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2026 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2027 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2027 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2028 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2028 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2029 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2029 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2030 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2030 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94

5/26/2009 01:50:15 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Instit'l.urb924

Project Name: 112-23 Construction Emissions Institutional Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	68.47	375.17	481.47	0.45	1,983.55	19.23	2,002.78	414.53	17.61	432.15
2010 TOTALS (lbs/day mitigated)	68.47	375.17	481.47	0.45	353.51	19.23	372.74	74.12	17.61	91.73
2011 TOTALS (lbs/day unmitigated)	64.99	349.66	452.01	0.45	1,983.55	17.84	2,001.40	414.53	16.34	430.87
2011 TOTALS (lbs/day mitigated)	64.99	349.66	452.01	0.45	353.51	17.84	371.36	74.12	16.34	90.45
2012 TOTALS (lbs/day unmitigated)	61.87	324.95	424.69	0.45	1,983.55	16.41	1,999.96	414.53	15.01	429.54
2012 TOTALS (lbs/day mitigated)	61.87	324.95	424.69	0.45	353.51	16.41	369.92	74.12	15.01	89.13
2013 TOTALS (lbs/day unmitigated)	59.26	301.60	398.87	0.45	1,983.55	15.12	1,998.67	414.53	13.82	428.35
2013 TOTALS (lbs/day mitigated)	59.26	301.60	398.87	0.45	353.51	15.12	368.63	74.12	13.82	87.94
2014 TOTALS (lbs/day unmitigated)	56.46	277.98	375.94	0.45	1,983.55	13.79	1,997.34	414.53	12.59	427.13
2014 TOTALS (lbs/day mitigated)	56.46	277.98	375.94	0.45	353.51	13.79	367.30	74.12	12.59	86.71
2015 TOTALS (lbs/day unmitigated)	53.65	253.69	354.33	0.45	1,983.55	12.71	1,996.26	414.53	11.60	426.13
2015 TOTALS (lbs/day mitigated)	53.65	253.69	354.33	0.45	353.51	12.71	366.22	74.12	11.60	85.72
2016 TOTALS (lbs/day unmitigated)	51.17	231.87	335.56	0.45	1,983.55	11.54	1,995.10	414.53	10.53	425.06
2016 TOTALS (lbs/day mitigated)	51.17	231.87	335.56	0.45	353.51	11.54	365.05	74.12	10.53	84.65
2017 TOTALS (lbs/day unmitigated)	48.96	211.62	317.71	0.45	1,983.55	10.49	1,994.05	414.53	9.57	424.10
2017 TOTALS (lbs/day mitigated)	48.96	211.62	317.71	0.45	353.51	10.49	364.01	74.12	9.57	83.68
2018 TOTALS (lbs/day unmitigated)	46.65	192.90	301.63	0.45	1,983.55	9.50	1,993.06	414.53	8.65	423.18
2018 TOTALS (lbs/day mitigated)	46.65	192.90	301.63	0.45	353.51	9.50	363.01	74.12	8.65	82.77
2019 TOTALS (lbs/day unmitigated)	44.79	176.01	286.65	0.45	1,983.55	8.53	1,992.08	414.53	7.75	422.29
2019 TOTALS (lbs/day mitigated)	44.79	176.01	286.65	0.45	353.51	8.53	362.04	74.12	7.75	81.87
2020 TOTALS (lbs/day unmitigated)	42.84	160.73	272.95	0.45	1,983.55	7.80	1,991.36	414.53	7.09	421.62

5/26/2009 01:50:15 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Instit'l.urb924

Project Name: 112-23 Construction Emissions Institutional Existing General Plan

2020 TOTALS (lbs/day mitigated)	42.84	160.73	272.95	0.45	353.51	7.80	361.31	74.12	7.09	81.20
2021 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2021 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2022 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2022 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2023 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2023 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2024 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2024 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2025 TOTALS (lbs/day unmitigated)	41.03	152.68	228.90	0.45	1,983.55	7.59	1,991.14	414.53	6.89	421.42
2025 TOTALS (lbs/day mitigated)	41.03	152.68	228.90	0.45	353.51	7.59	361.10	74.12	6.89	81.01
2026 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2026 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2027 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2027 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2028 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2028 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2029 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2029 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94
2030 TOTALS (lbs/day unmitigated)	40.03	149.29	205.04	0.45	1,983.55	7.52	1,991.07	414.53	6.82	421.36
2030 TOTALS (lbs/day mitigated)	40.03	149.29	205.04	0.45	353.51	7.52	361.03	74.12	6.82	80.94

5/26/2009 01:52:29 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Non-Res'l.urb924

Project Name: 112-23 Construction Emissions Non Residential Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	24.06	152.61	124.23	0.06	245.07	9.01	254.08	51.22	8.28	59.50
2010 TOTALS (lbs/day mitigated)	24.06	152.61	124.23	0.06	43.70	9.01	52.71	9.17	8.28	17.44
2011 TOTALS (lbs/day unmitigated)	22.64	143.18	118.48	0.06	245.07	8.50	253.57	51.22	7.80	59.03
2011 TOTALS (lbs/day mitigated)	22.64	143.18	118.48	0.06	43.70	8.50	52.20	9.17	7.80	16.97
2012 TOTALS (lbs/day unmitigated)	21.37	134.10	113.26	0.06	245.07	7.78	252.86	51.22	7.15	58.37
2012 TOTALS (lbs/day mitigated)	21.37	134.10	113.26	0.06	43.70	7.78	51.49	9.17	7.15	16.32
2013 TOTALS (lbs/day unmitigated)	20.18	125.48	108.32	0.06	245.07	7.13	252.20	51.22	6.54	57.77
2013 TOTALS (lbs/day mitigated)	20.18	125.48	108.32	0.06	43.70	7.13	50.83	9.17	6.54	15.71
2014 TOTALS (lbs/day unmitigated)	18.99	116.71	103.87	0.06	245.07	6.42	251.50	51.22	5.90	57.12
2014 TOTALS (lbs/day mitigated)	18.99	116.71	103.87	0.06	43.70	6.42	50.13	9.17	5.90	15.06
2015 TOTALS (lbs/day unmitigated)	17.79	107.26	99.68	0.06	245.07	5.91	250.98	51.22	5.43	56.65
2015 TOTALS (lbs/day mitigated)	17.79	107.26	99.68	0.06	43.70	5.91	49.61	9.17	5.43	14.59
2016 TOTALS (lbs/day unmitigated)	16.72	98.61	96.03	0.06	245.07	5.36	250.43	51.22	4.92	56.14
2016 TOTALS (lbs/day mitigated)	16.72	98.61	96.03	0.06	43.70	5.36	49.06	9.17	4.92	14.09
2017 TOTALS (lbs/day unmitigated)	15.82	90.55	92.59	0.06	245.07	4.83	249.91	51.22	4.43	55.65
2017 TOTALS (lbs/day mitigated)	15.82	90.55	92.59	0.06	43.70	4.83	48.54	9.17	4.43	13.60
2018 TOTALS (lbs/day unmitigated)	14.80	83.05	89.49	0.06	245.07	4.33	249.40	51.22	3.97	55.19
2018 TOTALS (lbs/day mitigated)	14.80	83.05	89.49	0.06	43.70	4.33	48.03	9.17	3.97	13.13
2019 TOTALS (lbs/day unmitigated)	13.90	76.13	86.62	0.06	245.07	3.84	248.91	51.22	3.52	54.74
2019 TOTALS (lbs/day mitigated)	13.90	76.13	86.62	0.06	43.70	3.84	47.54	9.17	3.52	12.68

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Non-Res'l.urb924

Project Name: 112-23 Construction Emissions Non Residential Existing General Plan

2020 TOTALS (lbs/day unmitigated)	13.12	69.94	84.10	0.06	245.07	3.52	248.59	51.22	3.22	54.45
2020 TOTALS (lbs/day mitigated)	13.12	69.94	84.10	0.06	43.70	3.52	47.22	9.17	3.22	12.39
2021 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2021 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2022 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2022 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2023 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2023 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2024 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2024 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2025 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2025 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2026 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2026 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2027 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2027 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2028 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2028 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2029 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2029 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2030 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2030 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36

5/26/2009 01:53:14 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Non-Res'l.urb924

Project Name: 112-23 Construction Emissions Non Residential Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	24.06	152.61	124.23	0.06	245.07	9.01	254.08	51.22	8.28	59.50
2010 TOTALS (lbs/day mitigated)	24.06	152.61	124.23	0.06	43.70	9.01	52.71	9.17	8.28	17.44
2011 TOTALS (lbs/day unmitigated)	22.64	143.18	118.48	0.06	245.07	8.50	253.57	51.22	7.80	59.03
2011 TOTALS (lbs/day mitigated)	22.64	143.18	118.48	0.06	43.70	8.50	52.20	9.17	7.80	16.97
2012 TOTALS (lbs/day unmitigated)	21.37	134.10	113.26	0.06	245.07	7.78	252.86	51.22	7.15	58.37
2012 TOTALS (lbs/day mitigated)	21.37	134.10	113.26	0.06	43.70	7.78	51.49	9.17	7.15	16.32
2013 TOTALS (lbs/day unmitigated)	20.18	125.48	108.32	0.06	245.07	7.13	252.20	51.22	6.54	57.77
2013 TOTALS (lbs/day mitigated)	20.18	125.48	108.32	0.06	43.70	7.13	50.83	9.17	6.54	15.71
2014 TOTALS (lbs/day unmitigated)	18.99	116.71	103.87	0.06	245.07	6.42	251.50	51.22	5.90	57.12
2014 TOTALS (lbs/day mitigated)	18.99	116.71	103.87	0.06	43.70	6.42	50.13	9.17	5.90	15.06
2015 TOTALS (lbs/day unmitigated)	17.79	107.26	99.68	0.06	245.07	5.91	250.98	51.22	5.43	56.65
2015 TOTALS (lbs/day mitigated)	17.79	107.26	99.68	0.06	43.70	5.91	49.61	9.17	5.43	14.59
2016 TOTALS (lbs/day unmitigated)	16.72	98.61	96.03	0.06	245.07	5.36	250.43	51.22	4.92	56.14
2016 TOTALS (lbs/day mitigated)	16.72	98.61	96.03	0.06	43.70	5.36	49.06	9.17	4.92	14.09
2017 TOTALS (lbs/day unmitigated)	15.82	90.55	92.59	0.06	245.07	4.83	249.91	51.22	4.43	55.65
2017 TOTALS (lbs/day mitigated)	15.82	90.55	92.59	0.06	43.70	4.83	48.54	9.17	4.43	13.60
2018 TOTALS (lbs/day unmitigated)	14.80	83.05	89.49	0.06	245.07	4.33	249.40	51.22	3.97	55.19
2018 TOTALS (lbs/day mitigated)	14.80	83.05	89.49	0.06	43.70	4.33	48.03	9.17	3.97	13.13
2019 TOTALS (lbs/day unmitigated)	13.90	76.13	86.62	0.06	245.07	3.84	248.91	51.22	3.52	54.74
2019 TOTALS (lbs/day mitigated)	13.90	76.13	86.62	0.06	43.70	3.84	47.54	9.17	3.52	12.68

5/26/2009 01:53:14 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Non-Res'l.urb924

Project Name: 112-23 Construction Emissions Non Residential Existing General Plan

2020 TOTALS (lbs/day unmitigated)	13.12	69.94	84.10	0.06	245.07	3.52	248.59	51.22	3.22	54.45
2020 TOTALS (lbs/day mitigated)	13.12	69.94	84.10	0.06	43.70	3.52	47.22	9.17	3.22	12.39
2021 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2021 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2022 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2022 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2023 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2023 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2024 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2024 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2025 TOTALS (lbs/day unmitigated)	12.87	68.90	77.88	0.06	245.07	3.49	248.57	51.22	3.20	54.42
2025 TOTALS (lbs/day mitigated)	12.87	68.90	77.88	0.06	43.70	3.49	47.20	9.17	3.20	12.37
2026 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2026 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2027 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2027 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2028 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2028 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2029 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2029 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36
2030 TOTALS (lbs/day unmitigated)	12.74	68.46	74.51	0.06	245.07	3.48	248.56	51.22	3.19	54.41
2030 TOTALS (lbs/day mitigated)	12.74	68.46	74.51	0.06	43.70	3.48	47.19	9.17	3.19	12.36

5/26/2009 02:01:41 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Office.urb924
Project Name: 112-23 Construction Emissions Office Existing General Plan

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	18.04	115.24	86.12	0.04	128.16	6.96	135.12	26.79	6.40	33.18
2010 TOTALS (lbs/day mitigated)	18.04	115.24	86.12	0.04	22.87	6.96	29.82	4.80	6.40	11.19
2011 TOTALS (lbs/day unmitigated)	16.95	108.11	82.54	0.04	128.16	6.57	134.73	26.79	6.04	32.83
2011 TOTALS (lbs/day mitigated)	16.95	108.11	82.54	0.04	22.87	6.57	29.44	4.80	6.04	10.84
2012 TOTALS (lbs/day unmitigated)	15.97	101.25	79.32	0.04	128.16	6.02	134.18	26.79	5.53	32.32
2012 TOTALS (lbs/day mitigated)	15.97	101.25	79.32	0.04	22.87	6.02	28.89	4.80	5.53	10.33
2013 TOTALS (lbs/day unmitigated)	15.02	94.73	76.30	0.04	128.16	5.51	133.67	26.79	5.07	31.85
2013 TOTALS (lbs/day mitigated)	15.02	94.73	76.30	0.04	22.87	5.51	28.38	4.80	5.07	9.86
2014 TOTALS (lbs/day unmitigated)	14.10	88.10	73.54	0.04	128.16	4.96	133.12	26.79	4.56	31.35
2014 TOTALS (lbs/day mitigated)	14.10	88.10	73.54	0.04	22.87	4.96	27.83	4.80	4.56	9.36
2015 TOTALS (lbs/day unmitigated)	13.16	80.88	70.98	0.04	128.16	4.57	132.73	26.79	4.20	30.99
2015 TOTALS (lbs/day mitigated)	13.16	80.88	70.98	0.04	22.87	4.57	27.44	4.80	4.20	9.00
2016 TOTALS (lbs/day unmitigated)	12.34	74.24	68.76	0.04	128.16	4.12	132.28	26.79	3.79	30.57
2016 TOTALS (lbs/day mitigated)	12.34	74.24	68.76	0.04	22.87	4.12	26.99	4.80	3.79	8.59
2017 TOTALS (lbs/day unmitigated)	11.62	68.05	66.67	0.04	128.16	3.71	131.87	26.79	3.41	30.20
2017 TOTALS (lbs/day mitigated)	11.62	68.05	66.67	0.04	22.87	3.71	26.58	4.80	3.41	8.21
2018 TOTALS (lbs/day unmitigated)	10.83	62.31	64.79	0.04	128.16	3.32	131.48	26.79	3.05	29.84
2018 TOTALS (lbs/day mitigated)	10.83	62.31	64.79	0.04	22.87	3.32	26.19	4.80	3.05	7.85
2019 TOTALS (lbs/day unmitigated)	10.13	57.01	63.04	0.04	128.16	2.95	131.11	26.79	2.71	29.49
2019 TOTALS (lbs/day mitigated)	10.13	57.01	63.04	0.04	22.87	2.95	25.82	4.80	2.71	7.51

5/26/2009 02:01:41 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Office.urb924

Project Name: 112-23 Construction Emissions Office Existing General Plan

2020 TOTALS (lbs/day unmitigated)	9.51	52.29	61.52	0.04	128.16	2.68	130.84	26.79	2.46	29.25
2020 TOTALS (lbs/day mitigated)	9.51	52.29	61.52	0.04	22.87	2.68	25.55	4.80	2.46	7.26
2021 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2021 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2022 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2022 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2023 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2023 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2024 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2024 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2025 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2025 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2026 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2026 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2027 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2027 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2028 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2028 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2029 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2029 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2030 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2030 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24

5/26/2009 02:02:56 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Office.urb924
Project Name: 112-23 Construction Emissions Office Existing General Plan

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	18.04	115.24	86.12	0.04	128.16	6.96	135.12	26.79	6.40	33.18
2010 TOTALS (lbs/day mitigated)	18.04	115.24	86.12	0.04	22.87	6.96	29.82	4.80	6.40	11.19
2011 TOTALS (lbs/day unmitigated)	16.95	108.11	82.54	0.04	128.16	6.57	134.73	26.79	6.04	32.83
2011 TOTALS (lbs/day mitigated)	16.95	108.11	82.54	0.04	22.87	6.57	29.44	4.80	6.04	10.84
2012 TOTALS (lbs/day unmitigated)	15.97	101.25	79.32	0.04	128.16	6.02	134.18	26.79	5.53	32.32
2012 TOTALS (lbs/day mitigated)	15.97	101.25	79.32	0.04	22.87	6.02	28.89	4.80	5.53	10.33
2013 TOTALS (lbs/day unmitigated)	15.02	94.73	76.30	0.04	128.16	5.51	133.67	26.79	5.07	31.85
2013 TOTALS (lbs/day mitigated)	15.02	94.73	76.30	0.04	22.87	5.51	28.38	4.80	5.07	9.86
2014 TOTALS (lbs/day unmitigated)	14.10	88.10	73.54	0.04	128.16	4.96	133.12	26.79	4.56	31.35
2014 TOTALS (lbs/day mitigated)	14.10	88.10	73.54	0.04	22.87	4.96	27.83	4.80	4.56	9.36
2015 TOTALS (lbs/day unmitigated)	13.16	80.88	70.98	0.04	128.16	4.57	132.73	26.79	4.20	30.99
2015 TOTALS (lbs/day mitigated)	13.16	80.88	70.98	0.04	22.87	4.57	27.44	4.80	4.20	9.00
2016 TOTALS (lbs/day unmitigated)	12.34	74.24	68.76	0.04	128.16	4.12	132.28	26.79	3.79	30.57
2016 TOTALS (lbs/day mitigated)	12.34	74.24	68.76	0.04	22.87	4.12	26.99	4.80	3.79	8.59
2017 TOTALS (lbs/day unmitigated)	11.62	68.05	66.67	0.04	128.16	3.71	131.87	26.79	3.41	30.20
2017 TOTALS (lbs/day mitigated)	11.62	68.05	66.67	0.04	22.87	3.71	26.58	4.80	3.41	8.21
2018 TOTALS (lbs/day unmitigated)	10.83	62.31	64.79	0.04	128.16	3.32	131.48	26.79	3.05	29.84
2018 TOTALS (lbs/day mitigated)	10.83	62.31	64.79	0.04	22.87	3.32	26.19	4.80	3.05	7.85
2019 TOTALS (lbs/day unmitigated)	10.13	57.01	63.04	0.04	128.16	2.95	131.11	26.79	2.71	29.49
2019 TOTALS (lbs/day mitigated)	10.13	57.01	63.04	0.04	22.87	2.95	25.82	4.80	2.71	7.51

5/26/2009 02:02:56 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Office.urb924

Project Name: 112-23 Construction Emissions Office Existing General Plan

2020 TOTALS (lbs/day unmitigated)	9.51	52.29	61.52	0.04	128.16	2.68	130.84	26.79	2.46	29.25
2020 TOTALS (lbs/day mitigated)	9.51	52.29	61.52	0.04	22.87	2.68	25.55	4.80	2.46	7.26
2021 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2021 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2022 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2022 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2023 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2023 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2024 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2024 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2025 TOTALS (lbs/day unmitigated)	9.36	51.73	57.90	0.04	128.16	2.67	130.82	26.79	2.45	29.23
2025 TOTALS (lbs/day mitigated)	9.36	51.73	57.90	0.04	22.87	2.67	25.53	4.80	2.45	7.24
2026 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2026 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2027 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2027 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2028 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2028 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2029 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2029 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24
2030 TOTALS (lbs/day unmitigated)	9.29	51.48	55.94	0.04	128.16	2.66	130.82	26.79	2.44	29.23
2030 TOTALS (lbs/day mitigated)	9.29	51.48	55.94	0.04	22.87	2.66	25.53	4.80	2.44	7.24

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Rec.urb924

Project Name: 112-23 Construction Emissions Recreational Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	404.51	3,150.77	3,685.61	6.39	9,212.98	134.75	9,347.73	1,927.47	123.34	2,050.81
2010 TOTALS (lbs/day mitigated)	404.51	3,150.77	3,685.61	6.39	1,655.03	134.75	1,789.78	349.07	123.34	472.41
2011 TOTALS (lbs/day unmitigated)	379.57	2,858.36	3,423.39	6.39	9,212.98	121.28	9,334.26	1,927.47	110.94	2,038.40
2011 TOTALS (lbs/day mitigated)	379.57	2,858.36	3,423.39	6.39	1,655.03	121.28	1,776.31	349.07	110.94	460.00
2012 TOTALS (lbs/day unmitigated)	355.68	2,572.74	3,174.78	6.39	9,212.98	108.63	9,321.61	1,927.47	99.29	2,026.76
2012 TOTALS (lbs/day mitigated)	355.68	2,572.74	3,174.78	6.39	1,655.03	108.63	1,763.67	349.07	99.29	448.35
2013 TOTALS (lbs/day unmitigated)	333.19	2,298.66	2,936.35	6.39	9,212.98	96.66	9,309.64	1,927.47	88.23	2,015.70
2013 TOTALS (lbs/day mitigated)	333.19	2,298.66	2,936.35	6.39	1,655.03	96.66	1,751.69	349.07	88.23	437.30
2014 TOTALS (lbs/day unmitigated)	311.23	2,040.11	2,719.70	6.39	9,212.98	86.09	9,299.07	1,927.47	78.52	2,005.98
2014 TOTALS (lbs/day mitigated)	311.23	2,040.11	2,719.70	6.39	1,655.03	86.09	1,741.13	349.07	78.52	427.58
2015 TOTALS (lbs/day unmitigated)	290.44	1,803.77	2,518.45	6.39	9,212.98	76.42	9,289.40	1,927.47	69.61	1,997.08
2015 TOTALS (lbs/day mitigated)	290.44	1,803.77	2,518.45	6.39	1,655.03	76.42	1,731.46	349.07	69.61	418.68
2016 TOTALS (lbs/day unmitigated)	273.13	1,607.21	2,345.72	6.39	9,212.98	68.61	9,281.59	1,927.47	62.41	1,989.88
2016 TOTALS (lbs/day mitigated)	273.13	1,607.21	2,345.72	6.39	1,655.03	68.61	1,723.64	349.07	62.41	411.48
2017 TOTALS (lbs/day unmitigated)	258.05	1,440.05	2,187.35	6.39	9,212.98	61.69	9,274.67	1,927.47	56.05	1,983.52
2017 TOTALS (lbs/day mitigated)	258.05	1,440.05	2,187.35	6.39	1,655.03	61.69	1,716.73	349.07	56.05	405.12
2018 TOTALS (lbs/day unmitigated)	244.21	1,297.00	2,044.54	6.39	9,212.98	55.94	9,268.92	1,927.47	50.75	1,978.21
2018 TOTALS (lbs/day mitigated)	244.21	1,297.00	2,044.54	6.39	1,655.03	55.94	1,710.97	349.07	50.75	399.81
2019 TOTALS (lbs/day unmitigated)	232.47	1,174.32	1,914.30	6.39	9,212.98	50.86	9,263.84	1,927.47	46.07	1,973.54
2019 TOTALS (lbs/day mitigated)	232.47	1,174.32	1,914.30	6.39	1,655.03	50.86	1,705.89	349.07	46.07	395.14

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Rec.urb924

Project Name: 112-23 Construction Emissions Recreational Existing General Plan

2020 TOTALS (lbs/day unmitigated)	221.50	1,069.25	1,795.21	6.39	9,212.98	46.75	9,259.73	1,927.47	42.29	1,969.75
2020 TOTALS (lbs/day mitigated)	221.50	1,069.25	1,795.21	6.39	1,655.03	46.75	1,701.78	349.07	42.29	391.35
2021 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2021 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2022 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2022 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2023 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2023 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2024 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2024 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2025 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2025 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2026 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2026 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2027 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2027 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2028 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2028 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2029 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2029 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2030 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2030 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Rec.urb924

Project Name: 112-23 Construction Emissions Recreational Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	404.51	3,150.77	3,685.61	6.39	9,212.98	134.75	9,347.73	1,927.47	123.34	2,050.81
2010 TOTALS (lbs/day mitigated)	404.51	3,150.77	3,685.61	6.39	1,655.03	134.75	1,789.78	349.07	123.34	472.41
2011 TOTALS (lbs/day unmitigated)	379.57	2,858.36	3,423.39	6.39	9,212.98	121.28	9,334.26	1,927.47	110.94	2,038.40
2011 TOTALS (lbs/day mitigated)	379.57	2,858.36	3,423.39	6.39	1,655.03	121.28	1,776.31	349.07	110.94	460.00
2012 TOTALS (lbs/day unmitigated)	355.68	2,572.74	3,174.78	6.39	9,212.98	108.63	9,321.61	1,927.47	99.29	2,026.76
2012 TOTALS (lbs/day mitigated)	355.68	2,572.74	3,174.78	6.39	1,655.03	108.63	1,763.67	349.07	99.29	448.35
2013 TOTALS (lbs/day unmitigated)	333.19	2,298.66	2,936.35	6.39	9,212.98	96.66	9,309.64	1,927.47	88.23	2,015.70
2013 TOTALS (lbs/day mitigated)	333.19	2,298.66	2,936.35	6.39	1,655.03	96.66	1,751.69	349.07	88.23	437.30
2014 TOTALS (lbs/day unmitigated)	311.23	2,040.11	2,719.70	6.39	9,212.98	86.09	9,299.07	1,927.47	78.52	2,005.98
2014 TOTALS (lbs/day mitigated)	311.23	2,040.11	2,719.70	6.39	1,655.03	86.09	1,741.13	349.07	78.52	427.58
2015 TOTALS (lbs/day unmitigated)	290.44	1,803.77	2,518.45	6.39	9,212.98	76.42	9,289.40	1,927.47	69.61	1,997.08
2015 TOTALS (lbs/day mitigated)	290.44	1,803.77	2,518.45	6.39	1,655.03	76.42	1,731.46	349.07	69.61	418.68
2016 TOTALS (lbs/day unmitigated)	273.13	1,607.21	2,345.72	6.39	9,212.98	68.61	9,281.59	1,927.47	62.41	1,989.88
2016 TOTALS (lbs/day mitigated)	273.13	1,607.21	2,345.72	6.39	1,655.03	68.61	1,723.64	349.07	62.41	411.48
2017 TOTALS (lbs/day unmitigated)	258.05	1,440.05	2,187.35	6.39	9,212.98	61.69	9,274.67	1,927.47	56.05	1,983.52
2017 TOTALS (lbs/day mitigated)	258.05	1,440.05	2,187.35	6.39	1,655.03	61.69	1,716.73	349.07	56.05	405.12
2018 TOTALS (lbs/day unmitigated)	244.21	1,297.00	2,044.54	6.39	9,212.98	55.94	9,268.92	1,927.47	50.75	1,978.21
2018 TOTALS (lbs/day mitigated)	244.21	1,297.00	2,044.54	6.39	1,655.03	55.94	1,710.97	349.07	50.75	399.81
2019 TOTALS (lbs/day unmitigated)	232.47	1,174.32	1,914.30	6.39	9,212.98	50.86	9,263.84	1,927.47	46.07	1,973.54
2019 TOTALS (lbs/day mitigated)	232.47	1,174.32	1,914.30	6.39	1,655.03	50.86	1,705.89	349.07	46.07	395.14

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Rec.urb924

Project Name: 112-23 Construction Emissions Recreational Existing General Plan

2020 TOTALS (lbs/day unmitigated)	221.50	1,069.25	1,795.21	6.39	9,212.98	46.75	9,259.73	1,927.47	42.29	1,969.75
2020 TOTALS (lbs/day mitigated)	221.50	1,069.25	1,795.21	6.39	1,655.03	46.75	1,701.78	349.07	42.29	391.35
2021 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2021 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2022 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2022 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2023 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2023 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2024 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2024 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2025 TOTALS (lbs/day unmitigated)	191.97	810.35	1,375.62	6.38	9,212.98	37.60	9,250.59	1,927.47	33.88	1,961.35
2025 TOTALS (lbs/day mitigated)	191.97	810.35	1,375.62	6.38	1,655.03	37.60	1,692.64	349.07	33.88	382.95
2026 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2026 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2027 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2027 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2028 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2028 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2029 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2029 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03
2030 TOTALS (lbs/day unmitigated)	178.35	715.16	1,158.59	6.38	9,212.98	34.42	9,247.40	1,927.47	30.96	1,958.43
2030 TOTALS (lbs/day mitigated)	178.35	715.16	1,158.59	6.38	1,655.03	34.42	1,689.45	349.07	30.96	380.03

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Res'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Residential

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	708.35	3,639.26	10,892.08	15.30	160,208.47	160.80	160,369.26	33,467.42	145.41	33,612.83
2010 TOTALS (lbs/day mitigated)	708.35	3,639.26	10,892.08	15.30	28,476.11	160.80	28,636.90	5,956.43	145.41	6,101.84
2011 TOTALS (lbs/day unmitigated)	662.88	3,304.52	10,133.49	15.30	160,208.47	147.10	160,355.57	33,467.42	132.79	33,600.21
2011 TOTALS (lbs/day mitigated)	662.88	3,304.52	10,133.49	15.30	28,476.11	147.10	28,623.21	5,956.43	132.79	6,089.22
2012 TOTALS (lbs/day unmitigated)	619.90	2,980.55	9,419.94	15.30	160,208.47	134.32	160,342.79	33,467.42	120.95	33,588.37
2012 TOTALS (lbs/day mitigated)	619.90	2,980.55	9,419.94	15.30	28,476.11	134.32	28,610.43	5,956.43	120.95	6,077.38
2013 TOTALS (lbs/day unmitigated)	580.08	2,669.61	8,742.81	15.30	160,208.47	122.26	160,330.73	33,467.42	109.66	33,577.08
2013 TOTALS (lbs/day mitigated)	580.08	2,669.61	8,742.81	15.30	28,476.11	122.26	28,598.36	5,956.43	109.66	6,066.10
2014 TOTALS (lbs/day unmitigated)	542.45	2,379.60	8,130.70	15.30	160,208.47	113.35	160,321.82	33,467.42	101.49	33,568.91
2014 TOTALS (lbs/day mitigated)	542.45	2,379.60	8,130.70	15.30	28,476.11	113.35	28,589.46	5,956.43	101.49	6,057.92
2015 TOTALS (lbs/day unmitigated)	507.47	2,113.51	7,558.28	15.30	160,208.47	103.49	160,311.96	33,467.42	92.40	33,559.82
2015 TOTALS (lbs/day mitigated)	507.47	2,113.51	7,558.28	15.30	28,476.11	103.49	28,579.59	5,956.43	92.40	6,048.83
2016 TOTALS (lbs/day unmitigated)	477.88	1,892.18	7,055.41	15.30	160,208.47	95.57	160,304.04	33,467.42	85.11	33,552.53
2016 TOTALS (lbs/day mitigated)	477.88	1,892.18	7,055.41	15.30	28,476.11	95.57	28,571.67	5,956.43	85.11	6,041.54
2017 TOTALS (lbs/day unmitigated)	451.79	1,702.16	6,580.35	15.30	160,208.47	88.52	160,296.99	33,467.42	78.62	33,546.04
2017 TOTALS (lbs/day mitigated)	451.79	1,702.16	6,580.35	15.30	28,476.11	88.52	28,564.63	5,956.43	78.62	6,035.06
2018 TOTALS (lbs/day unmitigated)	427.54	1,537.93	6,142.08	15.30	160,208.47	82.79	160,291.26	33,467.42	73.26	33,540.68
2018 TOTALS (lbs/day mitigated)	427.54	1,537.93	6,142.08	15.30	28,476.11	82.79	28,558.89	5,956.43	73.26	6,029.70
2019 TOTALS (lbs/day unmitigated)	406.77	1,395.71	5,736.57	15.30	160,208.47	77.61	160,286.08	33,467.42	68.50	33,535.92
2019 TOTALS (lbs/day mitigated)	406.77	1,395.71	5,736.57	15.30	28,476.11	77.61	28,553.72	5,956.43	68.50	6,024.94

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Res'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Residential

2020 TOTALS (lbs/day unmitigated)	386.28	1,273.63	5,356.85	15.30	160,208.47	73.43	160,281.90	33,467.42	64.65	33,532.07
2020 TOTALS (lbs/day mitigated)	386.28	1,273.63	5,356.85	15.30	28,476.11	73.43	28,549.53	5,956.43	64.65	6,021.09
2021 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2021 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2022 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2022 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2023 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2023 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2024 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2024 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2025 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2025 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2026 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2026 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2027 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2027 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2028 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2028 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2029 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2029 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2030 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2030 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Res'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Residential

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	708.35	3,639.26	10,892.08	15.30	160,208.47	160.80	160,369.26	33,467.42	145.41	33,612.83
2010 TOTALS (lbs/day mitigated)	708.35	3,639.26	10,892.08	15.30	28,476.11	160.80	28,636.90	5,956.43	145.41	6,101.84
2011 TOTALS (lbs/day unmitigated)	662.88	3,304.52	10,133.49	15.30	160,208.47	147.10	160,355.57	33,467.42	132.79	33,600.21
2011 TOTALS (lbs/day mitigated)	662.88	3,304.52	10,133.49	15.30	28,476.11	147.10	28,623.21	5,956.43	132.79	6,089.22
2012 TOTALS (lbs/day unmitigated)	619.90	2,980.55	9,419.94	15.30	160,208.47	134.32	160,342.79	33,467.42	120.95	33,588.37
2012 TOTALS (lbs/day mitigated)	619.90	2,980.55	9,419.94	15.30	28,476.11	134.32	28,610.43	5,956.43	120.95	6,077.38
2013 TOTALS (lbs/day unmitigated)	580.08	2,669.61	8,742.81	15.30	160,208.47	122.26	160,330.73	33,467.42	109.66	33,577.08
2013 TOTALS (lbs/day mitigated)	580.08	2,669.61	8,742.81	15.30	28,476.11	122.26	28,598.36	5,956.43	109.66	6,066.10
2014 TOTALS (lbs/day unmitigated)	542.45	2,379.60	8,130.70	15.30	160,208.47	113.35	160,321.82	33,467.42	101.49	33,568.91
2014 TOTALS (lbs/day mitigated)	542.45	2,379.60	8,130.70	15.30	28,476.11	113.35	28,589.46	5,956.43	101.49	6,057.92
2015 TOTALS (lbs/day unmitigated)	507.47	2,113.51	7,558.28	15.30	160,208.47	103.49	160,311.96	33,467.42	92.40	33,559.82
2015 TOTALS (lbs/day mitigated)	507.47	2,113.51	7,558.28	15.30	28,476.11	103.49	28,579.59	5,956.43	92.40	6,048.83
2016 TOTALS (lbs/day unmitigated)	477.88	1,892.18	7,055.41	15.30	160,208.47	95.57	160,304.04	33,467.42	85.11	33,552.53
2016 TOTALS (lbs/day mitigated)	477.88	1,892.18	7,055.41	15.30	28,476.11	95.57	28,571.67	5,956.43	85.11	6,041.54
2017 TOTALS (lbs/day unmitigated)	451.79	1,702.16	6,580.35	15.30	160,208.47	88.52	160,296.99	33,467.42	78.62	33,546.04
2017 TOTALS (lbs/day mitigated)	451.79	1,702.16	6,580.35	15.30	28,476.11	88.52	28,564.63	5,956.43	78.62	6,035.06
2018 TOTALS (lbs/day unmitigated)	427.54	1,537.93	6,142.08	15.30	160,208.47	82.79	160,291.26	33,467.42	73.26	33,540.68
2018 TOTALS (lbs/day mitigated)	427.54	1,537.93	6,142.08	15.30	28,476.11	82.79	28,558.89	5,956.43	73.26	6,029.70
2019 TOTALS (lbs/day unmitigated)	406.77	1,395.71	5,736.57	15.30	160,208.47	77.61	160,286.08	33,467.42	68.50	33,535.92
2019 TOTALS (lbs/day mitigated)	406.77	1,395.71	5,736.57	15.30	28,476.11	77.61	28,553.72	5,956.43	68.50	6,024.94
2020 TOTALS (lbs/day unmitigated)	386.28	1,273.63	5,356.85	15.30	160,208.47	73.43	160,281.90	33,467.42	64.65	33,532.07

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP Res'l.urb924

Project Name: 112-23 Construction Emissions Existing General Plan Residential

2020 TOTALS (lbs/day mitigated)	386.28	1,273.63	5,356.85	15.30	28,476.11	73.43	28,549.53	5,956.43	64.65	6,021.09
2021 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2021 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2022 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2022 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2023 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2023 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2024 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2024 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2025 TOTALS (lbs/day unmitigated)	323.93	951.47	3,944.03	15.28	160,208.47	64.12	160,272.59	33,467.42	56.10	33,523.52
2025 TOTALS (lbs/day mitigated)	323.93	951.47	3,944.03	15.28	28,476.11	64.12	28,540.23	5,956.43	56.10	6,012.53
2026 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2026 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2027 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2027 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2028 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2028 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2029 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2029 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54
2030 TOTALS (lbs/day unmitigated)	290.62	820.81	3,182.62	15.28	160,208.47	60.86	160,269.32	33,467.42	53.11	33,520.53
2030 TOTALS (lbs/day mitigated)	290.62	820.81	3,182.62	15.28	28,476.11	60.86	28,536.96	5,956.43	53.11	6,009.54

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP SG.urb924

Project Name: 112-23 Construction Emissions Special Generator Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	95.51	743.46	733.51	1.07	1,531.79	34.53	1,566.32	320.47	31.66	352.14
2010 TOTALS (lbs/day mitigated)	95.51	743.46	733.51	1.07	275.20	34.53	309.73	58.05	31.66	89.71
2011 TOTALS (lbs/day unmitigated)	89.61	681.42	684.95	1.07	1,531.79	31.46	1,563.25	320.47	28.84	349.31
2011 TOTALS (lbs/day mitigated)	89.61	681.42	684.95	1.07	275.20	31.46	306.66	58.05	28.84	86.89
2012 TOTALS (lbs/day unmitigated)	84.08	620.90	639.23	1.07	1,531.79	28.43	1,560.22	320.47	26.04	346.52
2012 TOTALS (lbs/day mitigated)	84.08	620.90	639.23	1.07	275.20	28.43	303.63	58.05	26.04	84.09
2013 TOTALS (lbs/day unmitigated)	79.10	563.11	595.48	1.07	1,531.79	25.62	1,557.41	320.47	23.45	343.93
2013 TOTALS (lbs/day mitigated)	79.10	563.11	595.48	1.07	275.20	25.62	300.82	58.05	23.45	81.50
2014 TOTALS (lbs/day unmitigated)	74.03	507.42	556.02	1.07	1,531.79	22.93	1,554.72	320.47	20.98	341.45
2014 TOTALS (lbs/day mitigated)	74.03	507.42	556.02	1.07	275.20	22.93	298.13	58.05	20.98	79.02
2015 TOTALS (lbs/day unmitigated)	69.10	454.31	519.23	1.07	1,531.79	20.64	1,552.43	320.47	18.87	339.34
2015 TOTALS (lbs/day mitigated)	69.10	454.31	519.23	1.07	275.20	20.64	295.84	58.05	18.87	76.92
2016 TOTALS (lbs/day unmitigated)	64.90	408.89	487.79	1.07	1,531.79	18.52	1,550.31	320.47	16.92	337.39
2016 TOTALS (lbs/day mitigated)	64.90	408.89	487.79	1.07	275.20	18.52	293.72	58.05	16.92	74.97
2017 TOTALS (lbs/day unmitigated)	61.20	369.06	458.85	1.07	1,531.79	16.67	1,548.46	320.47	15.21	335.69
2017 TOTALS (lbs/day mitigated)	61.20	369.06	458.85	1.07	275.20	16.67	291.87	58.05	15.21	73.26
2018 TOTALS (lbs/day unmitigated)	57.60	333.95	432.98	1.07	1,531.79	15.02	1,546.81	320.47	13.70	334.17
2018 TOTALS (lbs/day mitigated)	57.60	333.95	432.98	1.07	275.20	15.02	290.22	58.05	13.70	71.75
2019 TOTALS (lbs/day unmitigated)	54.63	303.25	409.31	1.07	1,531.79	13.49	1,545.28	320.47	12.29	332.77
2019 TOTALS (lbs/day mitigated)	54.63	303.25	409.31	1.07	275.20	13.49	288.70	58.05	12.29	70.34

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP SG.urb924

Project Name: 112-23 Construction Emissions Special Generator Existing General Plan

2020 TOTALS (lbs/day unmitigated)	51.72	276.39	387.89	1.07	1,531.79	12.31	1,544.10	320.47	11.21	331.68
2020 TOTALS (lbs/day mitigated)	51.72	276.39	387.89	1.07	275.20	12.31	287.52	58.05	11.21	69.26
2021 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2021 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2022 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2022 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2023 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2023 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2024 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2024 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2025 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2025 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2026 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2026 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2027 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2027 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2028 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2028 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2029 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2029 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2030 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2030 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP SG.urb924

Project Name: 112-23 Construction Emissions Special Generator Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	95.51	743.46	733.51	1.07	1,531.79	34.53	1,566.32	320.47	31.66	352.14
2010 TOTALS (lbs/day mitigated)	95.51	743.46	733.51	1.07	275.20	34.53	309.73	58.05	31.66	89.71
2011 TOTALS (lbs/day unmitigated)	89.61	681.42	684.95	1.07	1,531.79	31.46	1,563.25	320.47	28.84	349.31
2011 TOTALS (lbs/day mitigated)	89.61	681.42	684.95	1.07	275.20	31.46	306.66	58.05	28.84	86.89
2012 TOTALS (lbs/day unmitigated)	84.08	620.90	639.23	1.07	1,531.79	28.43	1,560.22	320.47	26.04	346.52
2012 TOTALS (lbs/day mitigated)	84.08	620.90	639.23	1.07	275.20	28.43	303.63	58.05	26.04	84.09
2013 TOTALS (lbs/day unmitigated)	79.10	563.11	595.48	1.07	1,531.79	25.62	1,557.41	320.47	23.45	343.93
2013 TOTALS (lbs/day mitigated)	79.10	563.11	595.48	1.07	275.20	25.62	300.82	58.05	23.45	81.50
2014 TOTALS (lbs/day unmitigated)	74.03	507.42	556.02	1.07	1,531.79	22.93	1,554.72	320.47	20.98	341.45
2014 TOTALS (lbs/day mitigated)	74.03	507.42	556.02	1.07	275.20	22.93	298.13	58.05	20.98	79.02
2015 TOTALS (lbs/day unmitigated)	69.10	454.31	519.23	1.07	1,531.79	20.64	1,552.43	320.47	18.87	339.34
2015 TOTALS (lbs/day mitigated)	69.10	454.31	519.23	1.07	275.20	20.64	295.84	58.05	18.87	76.92
2016 TOTALS (lbs/day unmitigated)	64.90	408.89	487.79	1.07	1,531.79	18.52	1,550.31	320.47	16.92	337.39
2016 TOTALS (lbs/day mitigated)	64.90	408.89	487.79	1.07	275.20	18.52	293.72	58.05	16.92	74.97
2017 TOTALS (lbs/day unmitigated)	61.20	369.06	458.85	1.07	1,531.79	16.67	1,548.46	320.47	15.21	335.69
2017 TOTALS (lbs/day mitigated)	61.20	369.06	458.85	1.07	275.20	16.67	291.87	58.05	15.21	73.26
2018 TOTALS (lbs/day unmitigated)	57.60	333.95	432.98	1.07	1,531.79	15.02	1,546.81	320.47	13.70	334.17
2018 TOTALS (lbs/day mitigated)	57.60	333.95	432.98	1.07	275.20	15.02	290.22	58.05	13.70	71.75
2019 TOTALS (lbs/day unmitigated)	54.63	303.25	409.31	1.07	1,531.79	13.49	1,545.28	320.47	12.29	332.77
2019 TOTALS (lbs/day mitigated)	54.63	303.25	409.31	1.07	275.20	13.49	288.70	58.05	12.29	70.34
2020 TOTALS (lbs/day unmitigated)	51.72	276.39	387.89	1.07	1,531.79	12.31	1,544.10	320.47	11.21	331.68
2020 TOTALS (lbs/day mitigated)	51.72	276.39	387.89	1.07	275.20	12.31	287.52	58.05	11.21	69.26

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const Ex GP SG.urb924

Project Name: 112-23 Construction Emissions Special Generator Existing General Plan

2021 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2021 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2022 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2022 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2023 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2023 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2024 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2024 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2025 TOTALS (lbs/day unmitigated)	46.78	233.29	317.23	1.07	1,531.79	10.79	1,542.58	320.47	9.81	330.28
2025 TOTALS (lbs/day mitigated)	46.78	233.29	317.23	1.07	275.20	10.79	286.00	58.05	9.81	67.86
2026 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2026 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2027 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2027 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2028 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2028 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2029 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2029 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37
2030 TOTALS (lbs/day unmitigated)	44.49	217.43	280.66	1.07	1,531.79	10.26	1,542.05	320.47	9.32	329.80
2030 TOTALS (lbs/day mitigated)	44.49	217.43	280.66	1.07	275.20	10.26	285.47	58.05	9.32	67.37

Operational Air Emissions

for Existing General Plan and Area Plan

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Comm'l.urb924

Project Name: 112-23 Existing General Plan Commercial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	134.95	141.54	125.00	0.00	0.27	0.27	169,758.28

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,308.43	14,144.25	124,040.24	131.39	21,639.57	4,209.98	12,826,643.39

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,443.38	14,285.79	124,165.24	131.39	21,639.84	4,210.25	12,996,401.67

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	10.27	141.46	118.82	0.00	0.25	0.25	169,747.04
Hearth - No Summer Emissions							
Landscape	0.49	0.08	6.18	0.00	0.02	0.02	11.24
Consumer Products	0.00						
Architectural Coatings	124.19						
TOTALS (lbs/day, unmitigated)	134.95	141.54	125.00	0.00	0.27	0.27	169,758.28

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	3,038.96	4,598.01	40,322.99	42.71	7,034.59	1,368.58	4,169,683.85
Comm'l Ctr 10-30 ac	3,810.01	5,795.72	50,826.50	53.84	8,866.99	1,725.08	5,255,821.83
Comm'l Ctr <10 ac	1,840.38	2,815.40	24,690.11	26.15	4,307.34	837.99	2,553,133.54
Comm'l Shops	619.08	935.12	8,200.64	8.69	1,430.65	278.33	848,004.17
TOTALS (lbs/day, unmitigated)	9,308.43	14,144.25	124,040.24	131.39	21,639.57	4,209.98	12,826,643.39

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	8,687.99	348,040.90	4,072,078.47
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	8,115.06	438,700.16	5,132,791.76
Comm'l Ctr <10 ac		85.06	1000 sq ft	2,505.39	213,108.46	2,493,368.92
Comm'l Shops		37.06	1000 sq ft	1,909.94	70,782.38	828,153.80
					1,070,631.90	12,526,392.95

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Comm'l.urb924

Project Name: 112-23 Existing General Plan Commercial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	134.46	141.46	118.82	0.00	0.25	0.25	169,747.04

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	10,813.37	17,054.81	118,458.85	109.25	21,639.57	4,209.98	11,610,363.76

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	10,947.83	17,196.27	118,577.67	109.25	21,639.82	4,210.23	11,780,110.80

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	10.27	141.46	118.82	0.00	0.25	0.25	169,747.04
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	124.19						
TOTALS (lbs/day, unmitigated)	134.46	141.46	118.82	0.00	0.25	0.25	169,747.04

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	3,521.04	5,544.17	38,508.59	35.51	7,034.59	1,368.58	3,774,295.80
Comm'l Ctr 10-30 ac	4,428.98	6,988.35	48,539.48	44.77	8,866.99	1,725.08	4,757,441.33
Comm'l Ctr <10 ac	2,146.80	3,394.75	23,579.14	21.75	4,307.34	837.99	2,311,034.01
Comm'l Shops	716.55	1,127.54	7,831.64	7.22	1,430.65	278.33	767,592.62
TOTALS (lbs/day, unmitigated)	10,813.37	17,054.81	118,458.85	109.25	21,639.57	4,209.98	11,610,363.76

4/21/2009 1:15:30 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	8,687.99	348,040.90	4,072,078.47
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	8,115.06	438,700.16	5,132,791.76
Comm'l Ctr <10 ac		85.06	1000 sq ft	2,505.39	213,108.46	2,493,368.92
Comm'l Shops		37.06	1000 sq ft	1,909.94	70,782.38	828,153.80
					1,070,631.90	12,526,392.95

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

4/21/2009 1:15:30 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Institutional.urb924

Project Name: 112-23 Existing General Plan Institutional Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	67.96	98.16	93.16	0.00	0.22	0.21	117,647.30

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,277.66	2,305.39	20,363.35	21.43	3,522.38	685.49	2,091,051.71

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,345.62	2,403.55	20,456.51	21.43	3,522.60	685.70	2,208,699.01

4/21/2009 1:27:41 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	7.12	98.02	82.34	0.00	0.18	0.17	117,627.64
Hearth - No Summer Emissions							
Landscape	0.86	0.14	10.82	0.00	0.04	0.04	19.66
Consumer Products	0.00						
Architectural Coatings	59.98						
TOTALS (lbs/day, unmitigated)	67.96	98.16	93.16	0.00	0.22	0.21	117,647.30

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Day-care center	24.83	32.26	283.50	0.30	49.33	9.60	29,255.75
Elementary school	898.27	832.77	7,396.28	7.74	1,271.08	247.42	755,458.07
High school	514.79	530.21	4,676.18	4.93	810.33	157.69	480,894.99
Junior college (2 yrs)	681.59	678.51	5,962.96	6.30	1,037.65	201.89	615,337.26
Library	52.52	80.19	704.76	0.75	122.64	23.86	72,726.72
Place of worship	52.61	74.45	653.38	0.69	113.89	22.16	67,517.81
Hospital	53.05	77.00	686.29	0.72	117.46	22.87	69,861.11
TOTALS (lbs/day, unmitigated)	2,277.66	2,305.39	20,363.35	21.43	3,522.38	685.49	2,091,051.71

4/21/2009 1:27:41 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Day-care center		4.52	1000 sq ft	540.00	2,440.80	28,557.36
Elementary school		1.29	students	48,743.00	62,878.47	735,678.07
High school		1.71	students	23,444.00	40,089.24	469,044.11
Junior college (2 yrs)		1.54	students	33,336.00	51,337.44	600,648.02
Library		84.98	1000 sq ft	71.40	6,067.57	70,990.60
Place of worship		9.30	1000 sq ft	605.89	5,634.78	65,926.89
Hospital		16.80	1000 sq ft	345.84	5,810.11	67,978.31
					174,258.41	2,038,823.36

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Day-care center				5.0	2.5	92.5
Elementary school				20.0	10.0	70.0
High school				10.0	5.0	85.0
Junior college (2 yrs)				5.0	2.5	92.5

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Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Library				5.0	2.5	92.5
Place of worship				3.0	1.5	95.5
Hospital				25.0	12.5	62.5

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Institutional.urb924

Project Name: 112-23 Existing General Plan Institutional Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	67.10	98.02	82.34	0.00	0.18	0.17	117,627.64

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,107.08	2,780.04	19,427.22	17.83	3,522.38	685.49	1,893,087.35

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,174.18	2,878.06	19,509.56	17.83	3,522.56	685.66	2,010,714.99

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	7.12	98.02	82.34	0.00	0.18	0.17	117,627.64
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	59.98						
TOTALS (lbs/day, unmitigated)	67.10	98.02	82.34	0.00	0.18	0.17	117,627.64

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Day-care center	26.29	38.90	270.67	0.25	49.33	9.60	26,482.90
Elementary school	795.85	1,004.29	7,050.78	6.44	1,271.08	247.42	684,025.67
High school	480.40	639.36	4,462.17	4.10	810.33	157.69	435,352.05
Junior college (2 yrs)	624.63	818.15	5,692.92	5.24	1,037.65	201.89	557,015.93
Library	61.22	96.70	672.85	0.62	122.64	23.86	65,833.72
Place of worship	58.55	89.77	623.92	0.58	113.89	22.16	61,116.48
Hospital	60.14	92.87	653.91	0.60	117.46	22.87	63,260.60
TOTALS (lbs/day, unmitigated)	2,107.08	2,780.04	19,427.22	17.83	3,522.38	685.49	1,893,087.35

4/21/2009 1:28:08 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Day-care center		4.52	1000 sq ft	540.00	2,440.80	28,557.36
Elementary school		1.29	students	48,743.00	62,878.47	735,678.07
High school		1.71	students	23,444.00	40,089.24	469,044.11
Junior college (2 yrs)		1.54	students	33,336.00	51,337.44	600,648.02
Library		84.98	1000 sq ft	71.40	6,067.57	70,990.60
Place of worship		9.30	1000 sq ft	605.89	5,634.78	65,926.89
Hospital		16.80	1000 sq ft	345.84	5,810.11	67,978.31
					174,258.41	2,038,823.36

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8

4/21/2009 1:28:08 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Day-care center				5.0	2.5	92.5
Elementary school				20.0	10.0	70.0
High school				10.0	5.0	85.0
Junior college (2 yrs)				5.0	2.5	92.5

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Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Library				5.0	2.5	92.5
Place of worship				3.0	1.5	95.5
Hospital				25.0	12.5	62.5

4/20/2009 6:33:42 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 EX GP Res'l.urb924

Project Name: 112-23 Existing General Plan Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,332.01	2,120.42	4,943.48	0.20	14.71	14.58	2,655,006.27

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	12,369.01	16,785.22	153,134.91	156.32	25,491.48	4,967.93	15,242,339.04

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	21,701.02	18,905.64	158,078.39	156.52	25,506.19	4,982.51	17,897,345.31

4/20/2009 6:33:42 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	160.23	2,074.65	882.83	0.02	3.97	3.93	2,648,484.90
Hearth - No Summer Emissions							
Landscape	733.28	45.77	4,060.65	0.18	10.74	10.65	6,521.37
Consumer Products	8,006.75						
Architectural Coatings	431.75						
TOTALS (lbs/day, unmitigated)	9,332.01	2,120.42	4,943.48	0.20	14.71	14.58	2,655,006.27

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	8,056.59	11,061.48	100,916.06	103.01	16,798.91	3,273.87	10,044,716.72
Apartments mid rise	559.32	730.21	6,661.83	6.80	1,108.96	216.12	663,087.87
Condo/townhouse general	3,528.53	4,702.46	42,901.45	43.79	7,141.55	1,391.79	4,270,211.03
Mobile home park	150.28	200.28	1,827.23	1.87	304.17	59.28	181,874.41
Retirement community	74.29	90.79	828.34	0.85	137.89	26.87	82,449.01
TOTALS (lbs/day, unmitigated)	12,369.01	16,785.22	153,134.91	156.32	25,491.48	4,967.93	15,242,339.04

Operational Settings:

4/20/2009 6:33:42 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	28,936.00	9.57	dwelling units	86,808.00	830,752.53	9,719,804.48
Apartments mid rise	250.55	5.76	dwelling units	9,521.00	54,840.96	641,639.25
Condo/townhouse general	3,199.00	6.90	dwelling units	51,184.00	353,169.60	4,132,084.31
Mobile home park	363.33	6.90	dwelling units	2,180.00	15,042.00	175,991.40
Retirement community	367.60	3.71	dwelling units	1,838.00	6,818.98	79,782.07
					1,260,624.07	14,749,301.51

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/20/2009 6:33:42 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

4/20/2009 6:34:14 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 EX GP Res'l.urb924

Project Name: 112-23 Existing General Plan Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	32,345.27	4,089.37	66,725.95	184.71	10,214.28	9,833.16	5,349,798.83

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	13,584.80	20,246.59	145,918.32	130.22	25,491.48	4,967.93	13,810,220.89

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	45,930.07	24,335.96	212,644.27	314.93	35,705.76	14,801.09	19,160,019.72

4/20/2009 6:34:14 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	160.23	2,074.65	882.83	0.02	3.97	3.93	2,648,484.90
Hearth	23,746.54	2,014.72	65,843.12	184.69	10,210.31	9,829.23	2,701,313.93
Landscaping - No Winter Emissions							
Consumer Products	8,006.75						
Architectural Coatings	431.75						
TOTALS (lbs/day, unmitigated)	32,345.27	4,089.37	66,725.95	184.71	10,214.28	9,833.16	5,349,798.83

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	8,909.88	13,342.52	96,160.32	85.82	16,798.91	3,273.87	9,100,949.41
Apartments mid rise	600.52	880.79	6,347.89	5.67	1,108.96	216.12	600,786.40
Condo/townhouse general	3,834.29	5,672.17	40,879.69	36.48	7,141.55	1,391.79	3,868,996.58
Mobile home park	163.31	241.59	1,741.12	1.55	304.17	59.28	164,786.12
Retirement community	76.80	109.52	789.30	0.70	137.89	26.87	74,702.38
TOTALS (lbs/day, unmitigated)	13,584.80	20,246.59	145,918.32	130.22	25,491.48	4,967.93	13,810,220.89

Operational Settings:

4/20/2009 6:34:14 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	28,936.00	9.57	dwelling units	86,808.00	830,752.53	9,719,804.48
Apartments mid rise	250.55	5.76	dwelling units	9,521.00	54,840.96	641,639.25
Condo/townhouse general	3,199.00	6.90	dwelling units	51,184.00	353,169.60	4,132,084.31
Mobile home park	363.33	6.90	dwelling units	2,180.00	15,042.00	175,991.40
Retirement community	367.60	3.71	dwelling units	1,838.00	6,818.98	79,782.07
					1,260,624.07	14,749,301.51

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/20/2009 6:34:14 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP SG.urb924

Project Name: 112-23 OVOV Existing GP Special Generator Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	52.29	0.93	9.95	0.00	0.03	0.03	983.29

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	352.56	539.23	4,736.38	5.01	824.73	160.46	489,012.44

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	404.85	540.16	4,746.33	5.01	824.76	160.49	489,995.73

4/21/2009 1:42:17 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.06	0.81	0.68	0.00	0.00	0.00	966.44
Hearth - No Summer Emissions							
Landscape	0.74	0.12	9.27	0.00	0.03	0.03	16.85
Consumer Products	0.00						
Architectural Coatings	51.49						
TOTALS (lbs/day, unmitigated)	52.29	0.93	9.95	0.00	0.03	0.03	983.29

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Manufacturing	17.84	26.59	240.77	0.25	40.44	7.88	24,135.34
Wayside Honor Ranch	13.04	19.82	173.79	0.18	30.32	5.90	17,970.66
Six Flags Magic Mtn	206.96	317.07	2,780.57	2.95	485.09	94.37	287,530.61
Travel Village	22.59	34.61	303.55	0.32	52.96	10.30	31,388.76
Agua Dulce Airport	48.07	73.64	645.79	0.68	112.66	21.92	66,778.99
Landfill	44.06	67.50	591.91	0.63	103.26	20.09	61,208.08
TOTALS (lbs/day, unmitigated)	352.56	539.23	4,736.38	5.01	824.73	160.46	489,012.44

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Manufacturing		100.00	1000 sq ft	20.00	2,000.00	23,400.00
Wayside Honor Ranch		50.00	acres	30.00	1,500.00	17,550.00
Six Flags Magic Mtn		100.00	acres	240.00	24,000.00	280,800.00
Travel Village		100.00	acres	26.20	2,620.00	30,654.00
Agua Dulce Airport		100.00	acres	55.74	5,574.00	65,215.80
Landfill		100.00	acres	51.09	5,109.00	59,775.30
					40,803.00	477,395.10

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Manufacturing				48.0	24.0	28.0
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP SG.urb924

Project Name: 112-23 OVOV Existing GP Special Generator Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	51.55	0.81	0.68	0.00	0.00	0.00	966.44

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	411.35	650.19	4,522.22	4.17	824.73	160.46	442,658.63

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	462.90	651.00	4,522.90	4.17	824.73	160.46	443,625.07

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.06	0.81	0.68	0.00	0.00	0.00	966.44
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	51.49						
TOTALS (lbs/day, unmitigated)	51.55	0.81	0.68	0.00	0.00	0.00	966.44

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Manufacturing	20.63	32.08	228.90	0.21	40.44	7.88	21,863.26
Wayside Honor Ranch	15.15	23.89	165.97	0.15	30.32	5.90	16,266.60
Six Flags Magic Mtn	241.63	382.31	2,655.45	2.45	485.09	94.37	260,265.67
Travel Village	26.38	41.74	289.89	0.27	52.96	10.30	28,412.34
Agua Dulce Airport	56.12	88.79	616.73	0.57	112.66	21.92	60,446.70
Landfill	51.44	81.38	565.28	0.52	103.26	20.09	55,404.06
TOTALS (lbs/day, unmitigated)	411.35	650.19	4,522.22	4.17	824.73	160.46	442,658.63

4/21/2009 1:42:40 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Manufacturing		100.00	1000 sq ft	20.00	2,000.00	23,400.00
Wayside Honor Ranch		50.00	acres	30.00	1,500.00	17,550.00
Six Flags Magic Mtn		100.00	acres	240.00	24,000.00	280,800.00
Travel Village		100.00	acres	26.20	2,620.00	30,654.00
Agua Dulce Airport		100.00	acres	55.74	5,574.00	65,215.80
Landfill		100.00	acres	51.09	5,109.00	59,775.30
					40,803.00	477,395.10

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 1:42:40 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Manufacturing				48.0	24.0	28.0
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. GP Non-Res'l.urb924

Project Name: 112-23 Existing GP Non-Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	33.46	43.16	45.42	0.00	0.11	0.11	51,662.38

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	946.34	1,393.97	12,245.11	12.93	2,131.99	414.80	1,264,166.77

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	979.80	1,437.13	12,290.53	12.93	2,132.10	414.91	1,315,829.15

4/20/2009 6:36:08 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.12	43.04	36.15	0.00	0.08	0.08	51,645.53
Hearth - No Summer Emissions							
Landscape	0.74	0.12	9.27	0.00	0.03	0.03	16.85
Consumer Products	0.00						
Architectural Coatings	29.60						
TOTALS (lbs/day, unmitigated)	33.46	43.16	45.42	0.00	0.11	0.11	51,662.38

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	43.76	66.08	580.76	0.61	101.06	19.66	59,930.65
High turnover (sit-down) rest.	326.25	499.90	4,393.27	4.64	764.50	148.75	453,355.79
Fast food rest. w/ drive thru	226.07	348.05	3,058.76	3.23	532.28	103.56	315,643.37
Hotel	131.91	184.48	1,621.26	1.71	282.13	54.89	167,303.36
Movie Theater	73.58	76.73	672.90	0.71	117.39	22.84	69,582.41
Car Dealership	144.77	218.73	1,918.16	2.03	334.63	65.10	198,351.19
TOTALS (lbs/day, unmitigated)	946.34	1,393.97	12,245.11	12.93	2,131.99	414.80	1,264,166.77

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	125.00	5,000.00	58,500.00
High turnover (sit-down) rest.		130.34	1000 sq ft	290.19	37,823.36	442,533.35
Fast food rest. w/ drive thru		496.12	1000 sq ft	53.08	26,334.05	308,108.38
Hotel		8.23	rooms	1,696.00	13,958.08	163,309.52
Movie Theater		1.76	1000 sq ft	3,300.00	5,808.00	67,953.60
Car Dealership		37.50	1000 sq ft	441.50	16,556.25	193,708.12
					105,479.74	1,234,112.97

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/20/2009 6:36:08 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112-23 Ex. GP Non-Res'l.urb924

Project Name: 112-23 Existing GP Non-Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	32.72	43.04	36.15	0.00	0.08	0.08	51,645.53

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,079.10	1,680.85	11,691.32	10.77	2,131.99	414.80	1,144,337.67

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,111.82	1,723.89	11,727.47	10.77	2,132.07	414.88	1,195,983.20

4/21/2009 11:23:16 AM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.12	43.04	36.15	0.00	0.08	0.08	51,645.53
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	29.60						
TOTALS (lbs/day, unmitigated)	32.72	43.04	36.15	0.00	0.08	0.08	51,645.53

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	50.66	79.68	554.46	0.51	101.06	19.66	54,250.46
High turnover (sit-down) rest.	381.12	602.78	4,194.31	3.86	764.50	148.75	410,386.97
Fast food rest. w/ drive thru	264.87	419.68	2,920.24	2.69	532.28	103.56	285,726.86
Hotel	145.82	222.45	1,547.84	1.43	282.13	54.89	151,446.44
Movie Theater	69.04	92.52	642.62	0.59	117.39	22.84	62,984.29
Car Dealership	167.59	263.74	1,831.85	1.69	334.63	65.10	179,542.65
TOTALS (lbs/day, unmitigated)	1,079.10	1,680.85	11,691.32	10.77	2,131.99	414.80	1,144,337.67

4/21/2009 11:23:16 AM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	125.00	5,000.00	58,500.00
High turnover (sit-down) rest.		130.34	1000 sq ft	290.19	37,823.36	442,533.35
Fast food rest. w/ drive thru		496.12	1000 sq ft	53.08	26,334.05	308,108.38
Hotel		8.23	rooms	1,696.00	13,958.08	163,309.52
Movie Theater		1.76	1000 sq ft	3,300.00	5,808.00	67,953.60
Car Dealership		37.50	1000 sq ft	441.50	16,556.25	193,708.12
					105,479.74	1,234,112.97

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 11:23:17 AM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

4/21/2009 1:45:27 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Office.urb924

Project Name: 112-23 Existing General Plan Office Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	52.71	55.02	52.33	0.00	0.12	0.12	65,936.68

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	428.29	569.25	4,994.03	5.28	870.85	169.42	516,231.69

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	481.00	624.27	5,046.36	5.28	870.97	169.54	582,168.37

4/21/2009 1:45:27 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.99	54.94	46.15	0.00	0.10	0.10	65,925.44
Hearth - No Summer Emissions							
Landscape	0.49	0.08	6.18	0.00	0.02	0.02	11.24
Consumer Products	0.00						
Architectural Coatings	48.23						
TOTALS (lbs/day, unmitigated)	52.71	55.02	52.33	0.00	0.12	0.12	65,936.68

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	41.49	59.30	521.91	0.55	90.67	17.64	53,783.38
Regional Post Office	21.09	24.02	210.67	0.22	36.75	7.15	21,784.28
Post Office	14.98	22.59	198.12	0.21	34.56	6.72	20,486.56
Commercial Office	350.73	463.34	4,063.33	4.30	708.87	137.91	420,177.47
TOTALS (lbs/day, unmitigated)	428.29	569.25	4,994.03	5.28	870.85	169.42	516,231.69

Operational Settings:

4/21/2009 1:45:27 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	412.29	4,485.72	52,482.87
Regional Post Office		2.38	1000 sq ft	764.00	1,818.32	21,274.34
Post Office		34.20	1000 sq ft	50.00	1,710.00	20,007.00
Commercial Office		5.00	1000 sq ft	7,014.39	35,071.95	410,341.82
					43,085.99	504,106.03

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

4/21/2009 1:45:27 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Office.urb924

Project Name: 112-23 Existing General Plan Office Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	52.22	54.94	46.15	0.00	0.10	0.10	65,925.44

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	459.36	686.40	4,769.06	4.40	870.85	169.42	467,284.34

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	511.58	741.34	4,815.21	4.40	870.95	169.52	533,209.78

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.99	54.94	46.15	0.00	0.10	0.10	65,925.44
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	48.23						
TOTALS (lbs/day, unmitigated)	52.22	54.94	46.15	0.00	0.10	0.10	65,925.44

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	46.48	71.51	498.17	0.46	90.67	17.64	48,687.44
Regional Post Office	20.74	28.97	201.19	0.19	36.75	7.15	19,718.60
Post Office	17.32	27.24	189.20	0.17	34.56	6.72	18,543.93
Commercial Office	374.82	558.68	3,880.50	3.58	708.87	137.91	380,334.37
TOTALS (lbs/day, unmitigated)	459.36	686.40	4,769.06	4.40	870.85	169.42	467,284.34

Operational Settings:

4/21/2009 1:45:56 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	412.29	4,485.72	52,482.87
Regional Post Office		2.38	1000 sq ft	764.00	1,818.32	21,274.34
Post Office		34.20	1000 sq ft	50.00	1,710.00	20,007.00
Commercial Office		5.00	1000 sq ft	7,014.39	35,071.95	410,341.82
					43,085.99	504,106.03

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Recreation.urb924

Project Name: 112-23 Existing General Plan Recreational

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	325.84	0.06	4.64	0.00	0.02	0.02	8.43

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,214.06	1,847.18	16,199.14	17.15	2,826.04	549.81	1,675,106.19

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,539.90	1,847.24	16,203.78	17.15	2,826.06	549.83	1,675,114.62

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth - No Summer Emissions							
Landscape	0.37	0.06	4.64	0.00	0.02	0.02	8.43
Consumer Products	0.00						
Architectural Coatings	325.47						
TOTALS (lbs/day, unmitigated)	325.84	0.06	4.64	0.00	0.02	0.02	8.43

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	1,149.58	1,762.34	15,455.13	16.37	2,696.24	524.55	1,598,170.28
Developed Park	42.00	58.65	514.32	0.54	89.73	17.46	53,184.68
Undeveloped Park	22.48	26.19	229.69	0.24	40.07	7.80	23,751.23
TOTALS (lbs/day, unmitigated)	1,214.06	1,847.18	16,199.14	17.15	2,826.04	549.81	1,675,106.19

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:38:10 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	1,233.00	133,398.27	1,560,759.77
Developed Park		7.96	acres	557.70	4,439.29	51,939.72
Undeveloped Park		2.60	acres	762.50	1,982.50	23,195.25
					139,820.06	1,635,894.74

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Ex. GP Recreation.urb924

Project Name: 112-23 Existing General Plan Recreational

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	325.47	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,411.47	2,227.29	15,470.23	14.26	2,826.04	549.81	1,516,265.14

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,736.94	2,227.29	15,470.23	14.26	2,826.04	549.81	1,516,265.14

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	325.47						
TOTALS (lbs/day, unmitigated)	325.47	0.00	0.00	0.00	0.00	0.00	0.00

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	1,342.72	2,124.99	14,759.70	13.61	2,696.24	524.55	1,446,624.64
Developed Park	46.37	70.72	491.18	0.45	89.73	17.46	48,141.47
Undeveloped Park	22.38	31.58	219.35	0.20	40.07	7.80	21,499.03
TOTALS (lbs/day, unmitigated)	1,411.47	2,227.29	15,470.23	14.26	2,826.04	549.81	1,516,265.14

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:38:49 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	1,233.00	133,398.27	1,560,759.77
Developed Park		7.96	acres	557.70	4,439.29	51,939.72
Undeveloped Park		2.60	acres	762.50	1,982.50	23,195.25
					139,820.06	1,635,894.74

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

4/21/2009 1:38:49 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.7	11.7	11.7	11.7	11.7	11.7
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Constr Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2010 TOTALS (lbs/day unmitigated)	537.94	3,917.09	5,027.69	8.63	14,614.03	167.27	14,781.30	3,056.70	153.00	3,209.69	920,113.09
2011 TOTALS (lbs/day unmitigated)	505.89	3,549.41	4,669.75	8.63	14,614.03	150.54	14,764.57	3,056.70	137.58	3,194.28	920,051.10
2012 TOTALS (lbs/day unmitigated)	475.11	3,190.40	4,330.51	8.63	14,614.03	134.82	14,748.84	3,056.70	123.09	3,179.79	920,004.29
2013 TOTALS (lbs/day unmitigated)	445.99	2,845.70	4,005.47	8.63	14,614.03	119.90	14,733.93	3,056.70	109.31	3,166.00	919,984.22
2014 TOTALS (lbs/day unmitigated)	417.81	2,521.74	3,710.03	8.63	14,614.03	106.92	14,720.95	3,056.70	97.38	3,154.07	919,965.89
2015 TOTALS (lbs/day unmitigated)	391.25	2,226.45	3,435.48	8.63	14,614.03	94.91	14,708.93	3,056.70	86.31	3,143.00	919,958.05
2016 TOTALS (lbs/day unmitigated)	369.17	1,981.58	3,199.15	8.63	14,614.03	85.25	14,699.28	3,056.70	77.42	3,134.11	919,932.50

2017 TOTALS (lbs/day unmitigated)	349.92	1,774.03	2,981.79	8.63	14,614.03	76.77	14,690.79	3,056.70	69.61	3,126.31	919,923.13
2018 TOTALS (lbs/day unmitigated)	332.37	1,596.95	2,785.06	8.63	14,614.03	69.76	14,683.79	3,056.70	63.15	3,119.84	919,923.31
2019 TOTALS (lbs/day unmitigated)	317.42	1,445.38	2,605.37	8.63	14,614.03	63.60	14,677.63	3,056.70	57.48	3,114.18	919,929.75
2020 TOTALS (lbs/day unmitigated)	303.47	1,316.00	2,440.46	8.63	14,614.03	58.61	14,672.64	3,056.70	52.89	3,109.58	919,938.94
2021 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2022 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2023 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2024 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2025 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2026 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2027 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2028 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93

2029 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2030 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Constr Ex GP Ind'l.urb924

Project Name: 112-23 Construction Emissions Industrial Existing General Plan

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2010 TOTALS (lbs/day unmitigated)	537.94	3,917.09	5,027.69	8.63	14,614.03	167.27	14,781.30	3,056.70	153.00	3,209.69	920,113.09
2011 TOTALS (lbs/day unmitigated)	505.89	3,549.41	4,669.75	8.63	14,614.03	150.54	14,764.57	3,056.70	137.58	3,194.28	920,051.10
2012 TOTALS (lbs/day unmitigated)	475.11	3,190.40	4,330.51	8.63	14,614.03	134.82	14,748.84	3,056.70	123.09	3,179.79	920,004.29
2013 TOTALS (lbs/day unmitigated)	445.99	2,845.70	4,005.47	8.63	14,614.03	119.90	14,733.93	3,056.70	109.31	3,166.00	919,984.22
2014 TOTALS (lbs/day unmitigated)	417.81	2,521.74	3,710.03	8.63	14,614.03	106.92	14,720.95	3,056.70	97.38	3,154.07	919,965.89
2015 TOTALS (lbs/day unmitigated)	391.25	2,226.45	3,435.48	8.63	14,614.03	94.91	14,708.93	3,056.70	86.31	3,143.00	919,958.05
2016 TOTALS (lbs/day unmitigated)	369.17	1,981.58	3,199.15	8.63	14,614.03	85.25	14,699.28	3,056.70	77.42	3,134.11	919,932.50

2017 TOTALS (lbs/day unmitigated)	349.92	1,774.03	2,981.79	8.63	14,614.03	76.77	14,690.79	3,056.70	69.61	3,126.31	919,923.13
2018 TOTALS (lbs/day unmitigated)	332.37	1,596.95	2,785.06	8.63	14,614.03	69.76	14,683.79	3,056.70	63.15	3,119.84	919,923.31
2019 TOTALS (lbs/day unmitigated)	317.42	1,445.38	2,605.37	8.63	14,614.03	63.60	14,677.63	3,056.70	57.48	3,114.18	919,929.75
2020 TOTALS (lbs/day unmitigated)	303.47	1,316.00	2,440.46	8.63	14,614.03	58.61	14,672.64	3,056.70	52.89	3,109.58	919,938.94
2021 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2022 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2023 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2024 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2025 TOTALS (lbs/day unmitigated)	264.02	982.18	1,851.59	8.62	14,614.03	46.94	14,660.96	3,056.70	42.16	3,098.85	919,996.14
2026 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2027 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2028 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93

2029 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93
2030 TOTALS (lbs/day unmitigated)	245.58	858.78	1,545.33	8.62	14,614.03	42.86	14,656.89	3,056.70	38.42	3,095.12	920,063.93

Construction Air Emissions

for Existing General Plan and Area Plan

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Comm'l.urb924
Project Name: 112-23 OVOV Construction Emissions Commercial

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	150.79	665.81	1,173.27	1.30	6,564.35	30.77	6,595.13	1,371.72	28.05	1,399.77
2010 TOTALS (lbs/day mitigated)	150.79	665.81	1,173.27	1.30	1,169.16	30.77	1,199.93	244.99	28.05	273.03
2011 TOTALS (lbs/day unmitigated)	144.14	617.73	1,095.38	1.30	6,564.35	28.35	6,592.71	1,371.72	25.82	1,397.54
2011 TOTALS (lbs/day mitigated)	144.14	617.73	1,095.38	1.30	1,169.16	28.35	1,197.51	244.99	25.82	270.80
2012 TOTALS (lbs/day unmitigated)	138.22	571.11	1,022.66	1.30	6,564.35	26.18	6,590.54	1,371.72	23.81	1,395.53
2012 TOTALS (lbs/day mitigated)	138.22	571.11	1,022.66	1.30	1,169.16	26.18	1,195.34	244.99	23.81	268.80
2013 TOTALS (lbs/day unmitigated)	133.22	526.97	953.89	1.30	6,564.35	24.22	6,588.58	1,371.72	21.99	1,393.71
2013 TOTALS (lbs/day mitigated)	133.22	526.97	953.89	1.30	1,169.16	24.22	1,193.38	244.99	21.99	266.98
2014 TOTALS (lbs/day unmitigated)	127.94	482.50	892.48	1.30	6,564.35	22.35	6,586.71	1,371.72	20.27	1,391.99
2014 TOTALS (lbs/day mitigated)	127.94	482.50	892.48	1.30	1,169.16	22.35	1,191.51	244.99	20.27	265.26
2015 TOTALS (lbs/day unmitigated)	122.69	438.79	834.77	1.30	6,564.35	20.64	6,585.00	1,371.72	18.70	1,390.42
2015 TOTALS (lbs/day mitigated)	122.69	438.79	834.77	1.30	1,169.16	20.64	1,189.80	244.99	18.70	263.69
2016 TOTALS (lbs/day unmitigated)	118.12	400.10	784.29	1.30	6,564.35	19.04	6,583.40	1,371.72	17.23	1,388.95
2016 TOTALS (lbs/day mitigated)	118.12	400.10	784.29	1.30	1,169.16	19.04	1,188.20	244.99	17.23	262.21
2017 TOTALS (lbs/day unmitigated)	114.06	364.51	736.27	1.30	6,564.35	17.47	6,581.82	1,371.72	15.78	1,387.50
2017 TOTALS (lbs/day mitigated)	114.06	364.51	736.27	1.30	1,169.16	17.47	1,186.63	244.99	15.78	260.76
2018 TOTALS (lbs/day unmitigated)	109.91	331.97	692.67	1.30	6,564.35	16.03	6,580.38	1,371.72	14.44	1,386.16
2018 TOTALS (lbs/day mitigated)	109.91	331.97	692.67	1.30	1,169.16	16.03	1,185.19	244.99	14.44	259.43
2019 TOTALS (lbs/day unmitigated)	106.58	302.76	652.09	1.30	6,564.35	14.64	6,578.99	1,371.72	13.16	1,384.88
2019 TOTALS (lbs/day mitigated)	106.58	302.76	652.09	1.30	1,169.16	14.64	1,183.80	244.99	13.16	258.15

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Comm'l.urb924

Project Name: 112-23 OVOV Construction Emissions Commercial

2020 TOTALS (lbs/day unmitigated)	103.00	276.32	614.48	1.30	6,564.35	13.49	6,577.84	1,371.72	12.11	1,383.83
2020 TOTALS (lbs/day mitigated)	103.00	276.32	614.48	1.30	1,169.16	13.49	1,182.65	244.99	12.11	257.09
2021 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2021 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2022 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2022 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2023 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2023 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2024 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2024 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2025 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2025 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2026 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2026 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2027 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2027 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2028 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2028 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2029 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2029 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2030 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2030 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Comm'l.urb924

Project Name: 112-23 OVOV Construction Emissions Commercial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	150.79	665.81	1,173.27	1.30	6,564.35	30.77	6,595.13	1,371.72	28.05	1,399.77
2010 TOTALS (lbs/day mitigated)	150.79	665.81	1,173.27	1.30	1,169.16	30.77	1,199.93	244.99	28.05	273.03
2011 TOTALS (lbs/day unmitigated)	144.14	617.73	1,095.38	1.30	6,564.35	28.35	6,592.71	1,371.72	25.82	1,397.54
2011 TOTALS (lbs/day mitigated)	144.14	617.73	1,095.38	1.30	1,169.16	28.35	1,197.51	244.99	25.82	270.80
2012 TOTALS (lbs/day unmitigated)	138.22	571.11	1,022.66	1.30	6,564.35	26.18	6,590.54	1,371.72	23.81	1,395.53
2012 TOTALS (lbs/day mitigated)	138.22	571.11	1,022.66	1.30	1,169.16	26.18	1,195.34	244.99	23.81	268.80
2013 TOTALS (lbs/day unmitigated)	133.22	526.97	953.89	1.30	6,564.35	24.22	6,588.58	1,371.72	21.99	1,393.71
2013 TOTALS (lbs/day mitigated)	133.22	526.97	953.89	1.30	1,169.16	24.22	1,193.38	244.99	21.99	266.98
2014 TOTALS (lbs/day unmitigated)	127.94	482.50	892.48	1.30	6,564.35	22.35	6,586.71	1,371.72	20.27	1,391.99
2014 TOTALS (lbs/day mitigated)	127.94	482.50	892.48	1.30	1,169.16	22.35	1,191.51	244.99	20.27	265.26
2015 TOTALS (lbs/day unmitigated)	122.69	438.79	834.77	1.30	6,564.35	20.64	6,585.00	1,371.72	18.70	1,390.42
2015 TOTALS (lbs/day mitigated)	122.69	438.79	834.77	1.30	1,169.16	20.64	1,189.80	244.99	18.70	263.69
2016 TOTALS (lbs/day unmitigated)	118.12	400.10	784.29	1.30	6,564.35	19.04	6,583.40	1,371.72	17.23	1,388.95
2016 TOTALS (lbs/day mitigated)	118.12	400.10	784.29	1.30	1,169.16	19.04	1,188.20	244.99	17.23	262.21
2017 TOTALS (lbs/day unmitigated)	114.06	364.51	736.27	1.30	6,564.35	17.47	6,581.82	1,371.72	15.78	1,387.50
2017 TOTALS (lbs/day mitigated)	114.06	364.51	736.27	1.30	1,169.16	17.47	1,186.63	244.99	15.78	260.76
2018 TOTALS (lbs/day unmitigated)	109.91	331.97	692.67	1.30	6,564.35	16.03	6,580.38	1,371.72	14.44	1,386.16
2018 TOTALS (lbs/day mitigated)	109.91	331.97	692.67	1.30	1,169.16	16.03	1,185.19	244.99	14.44	259.43
2019 TOTALS (lbs/day unmitigated)	106.58	302.76	652.09	1.30	6,564.35	14.64	6,578.99	1,371.72	13.16	1,384.88
2019 TOTALS (lbs/day mitigated)	106.58	302.76	652.09	1.30	1,169.16	14.64	1,183.80	244.99	13.16	258.15

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Comm'l.urb924

Project Name: 112-23 OVOV Construction Emissions Commercial

2020 TOTALS (lbs/day unmitigated)	103.00	276.32	614.48	1.30	6,564.35	13.49	6,577.84	1,371.72	12.11	1,383.83
2020 TOTALS (lbs/day mitigated)	103.00	276.32	614.48	1.30	1,169.16	13.49	1,182.65	244.99	12.11	257.09
2021 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2021 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2022 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2022 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2023 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2023 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2024 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2024 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2025 TOTALS (lbs/day unmitigated)	97.55	253.02	485.59	1.30	6,564.35	12.88	6,577.23	1,371.72	11.54	1,383.26
2025 TOTALS (lbs/day mitigated)	97.55	253.02	485.59	1.30	1,169.16	12.88	1,182.04	244.99	11.54	256.53
2026 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2026 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2027 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2027 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2028 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2028 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2029 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2029 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33
2030 TOTALS (lbs/day unmitigated)	94.55	243.21	415.73	1.30	6,564.35	12.66	6,577.02	1,371.72	11.35	1,383.07
2030 TOTALS (lbs/day mitigated)	94.55	243.21	415.73	1.30	1,169.16	12.66	1,181.82	244.99	11.35	256.33

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Ind'l.urb924
Project Name: 112-23 OVOV Construction Emissions Industrial

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	461.90	3,201.21	4,139.35	6.89	13,612.73	137.07	13,749.81	2,846.64	125.27	2,971.90
2010 TOTALS (lbs/day mitigated)	461.90	3,201.21	4,139.35	6.89	2,437.37	137.07	2,574.44	512.77	125.27	638.04
2011 TOTALS (lbs/day unmitigated)	435.28	2,904.24	3,846.05	6.89	13,612.73	123.50	13,736.23	2,846.64	112.76	2,959.40
2011 TOTALS (lbs/day mitigated)	435.28	2,904.24	3,846.05	6.89	2,437.37	123.50	2,560.87	512.77	112.76	625.53
2012 TOTALS (lbs/day unmitigated)	409.81	2,614.32	3,568.21	6.89	13,612.73	110.76	13,723.49	2,846.64	101.02	2,947.66
2012 TOTALS (lbs/day mitigated)	409.81	2,614.32	3,568.21	6.89	2,437.37	110.76	2,548.13	512.77	101.02	613.79
2013 TOTALS (lbs/day unmitigated)	385.88	2,336.09	3,302.06	6.89	13,612.73	98.70	13,711.44	2,846.64	89.87	2,936.51
2013 TOTALS (lbs/day mitigated)	385.88	2,336.09	3,302.06	6.89	2,437.37	98.70	2,536.07	512.77	89.87	602.65
2014 TOTALS (lbs/day unmitigated)	362.59	2,073.83	3,060.28	6.89	13,612.73	88.14	13,700.88	2,846.64	80.16	2,926.80
2014 TOTALS (lbs/day mitigated)	362.59	2,073.83	3,060.28	6.89	2,437.37	88.14	2,525.51	512.77	80.16	592.94
2015 TOTALS (lbs/day unmitigated)	340.59	1,834.06	2,835.39	6.89	13,612.73	78.40	13,691.13	2,846.64	71.18	2,917.82
2015 TOTALS (lbs/day mitigated)	340.59	1,834.06	2,835.39	6.89	2,437.37	78.40	2,515.77	512.77	71.18	583.96
2016 TOTALS (lbs/day unmitigated)	322.23	1,634.65	2,641.59	6.89	13,612.73	70.52	13,683.26	2,846.64	63.94	2,910.57
2016 TOTALS (lbs/day mitigated)	322.23	1,634.65	2,641.59	6.89	2,437.37	70.52	2,507.89	512.77	63.94	576.71
2017 TOTALS (lbs/day unmitigated)	306.19	1,464.97	2,463.06	6.89	13,612.73	63.56	13,676.29	2,846.64	57.53	2,904.16
2017 TOTALS (lbs/day mitigated)	306.19	1,464.97	2,463.06	6.89	2,437.37	63.56	2,500.93	512.77	57.53	570.30
2018 TOTALS (lbs/day unmitigated)	291.47	1,319.69	2,301.46	6.89	13,612.73	57.77	13,670.51	2,846.64	52.18	2,898.82
2018 TOTALS (lbs/day mitigated)	291.47	1,319.69	2,301.46	6.89	2,437.37	57.77	2,495.14	512.77	52.18	564.96
2019 TOTALS (lbs/day unmitigated)	278.94	1,195.02	2,153.71	6.89	13,612.73	52.65	13,665.39	2,846.64	47.47	2,894.11

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Ind'l.urb924

Project Name: 112-23 OVOV Construction Emissions Industrial

2019 TOTALS (lbs/day mitigated)	278.94	1,195.02	2,153.71	6.89	2,437.37	52.65	2,490.02	512.77	47.47	560.25
2020 TOTALS (lbs/day unmitigated)	267.20	1,088.24	2,018.08	6.89	13,612.73	48.51	13,661.25	2,846.64	43.66	2,890.30
2020 TOTALS (lbs/day mitigated)	267.20	1,088.24	2,018.08	6.89	2,437.37	48.51	2,485.88	512.77	43.66	556.44
2021 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2021 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2022 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2022 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2023 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2023 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2024 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2024 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2025 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2025 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2026 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2026 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2027 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2027 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2028 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2028 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2029 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2029 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2030 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2030 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01

5/26/2009 03:05:51 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Ind'l.urb924

Project Name: 112-23 OVOV Construction Emissions Industrial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	461.90	3,201.21	4,139.35	6.89	13,612.73	137.07	13,749.81	2,846.64	125.27	2,971.90
2010 TOTALS (lbs/day mitigated)	461.90	3,201.21	4,139.35	6.89	2,437.37	137.07	2,574.44	512.77	125.27	638.04
2011 TOTALS (lbs/day unmitigated)	435.28	2,904.24	3,846.05	6.89	13,612.73	123.50	13,736.23	2,846.64	112.76	2,959.40
2011 TOTALS (lbs/day mitigated)	435.28	2,904.24	3,846.05	6.89	2,437.37	123.50	2,560.87	512.77	112.76	625.53
2012 TOTALS (lbs/day unmitigated)	409.81	2,614.32	3,568.21	6.89	13,612.73	110.76	13,723.49	2,846.64	101.02	2,947.66
2012 TOTALS (lbs/day mitigated)	409.81	2,614.32	3,568.21	6.89	2,437.37	110.76	2,548.13	512.77	101.02	613.79
2013 TOTALS (lbs/day unmitigated)	385.88	2,336.09	3,302.06	6.89	13,612.73	98.70	13,711.44	2,846.64	89.87	2,936.51
2013 TOTALS (lbs/day mitigated)	385.88	2,336.09	3,302.06	6.89	2,437.37	98.70	2,536.07	512.77	89.87	602.65
2014 TOTALS (lbs/day unmitigated)	362.59	2,073.83	3,060.28	6.89	13,612.73	88.14	13,700.88	2,846.64	80.16	2,926.80
2014 TOTALS (lbs/day mitigated)	362.59	2,073.83	3,060.28	6.89	2,437.37	88.14	2,525.51	512.77	80.16	592.94
2015 TOTALS (lbs/day unmitigated)	340.59	1,834.06	2,835.39	6.89	13,612.73	78.40	13,691.13	2,846.64	71.18	2,917.82
2015 TOTALS (lbs/day mitigated)	340.59	1,834.06	2,835.39	6.89	2,437.37	78.40	2,515.77	512.77	71.18	583.96
2016 TOTALS (lbs/day unmitigated)	322.23	1,634.65	2,641.59	6.89	13,612.73	70.52	13,683.26	2,846.64	63.94	2,910.57
2016 TOTALS (lbs/day mitigated)	322.23	1,634.65	2,641.59	6.89	2,437.37	70.52	2,507.89	512.77	63.94	576.71
2017 TOTALS (lbs/day unmitigated)	306.19	1,464.97	2,463.06	6.89	13,612.73	63.56	13,676.29	2,846.64	57.53	2,904.16
2017 TOTALS (lbs/day mitigated)	306.19	1,464.97	2,463.06	6.89	2,437.37	63.56	2,500.93	512.77	57.53	570.30
2018 TOTALS (lbs/day unmitigated)	291.47	1,319.69	2,301.46	6.89	13,612.73	57.77	13,670.51	2,846.64	52.18	2,898.82
2018 TOTALS (lbs/day mitigated)	291.47	1,319.69	2,301.46	6.89	2,437.37	57.77	2,495.14	512.77	52.18	564.96
2019 TOTALS (lbs/day unmitigated)	278.94	1,195.02	2,153.71	6.89	13,612.73	52.65	13,665.39	2,846.64	47.47	2,894.11
2019 TOTALS (lbs/day mitigated)	278.94	1,195.02	2,153.71	6.89	2,437.37	52.65	2,490.02	512.77	47.47	560.25

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Ind'l.urb924

Project Name: 112-23 OVOV Construction Emissions Industrial

2020 TOTALS (lbs/day unmitigated)	267.20	1,088.24	2,018.08	6.89	13,612.73	48.51	13,661.25	2,846.64	43.66	2,890.30
2020 TOTALS (lbs/day mitigated)	267.20	1,088.24	2,018.08	6.89	2,437.37	48.51	2,485.88	512.77	43.66	556.44
2021 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2021 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2022 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2022 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2023 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2023 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2024 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2024 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2025 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82
2025 TOTALS (lbs/day mitigated)	234.93	823.42	1,535.53	6.88	2,437.37	39.29	2,476.66	512.77	35.19	547.96
2026 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2026 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2027 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2027 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2028 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2028 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2029 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2029 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01
2030 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87
2030 TOTALS (lbs/day mitigated)	219.70	725.29	1,283.90	6.88	2,437.37	36.07	2,473.44	512.77	32.24	545.01

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Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Insti'l.urb924

Project Name: 112-23 OVOV Construction Emissions Institutional

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	70.26	372.40	475.91	0.44	2,183.07	19.10	2,202.17	456.19	17.48	473.67
2010 TOTALS (lbs/day mitigated)	70.26	372.40	475.91	0.44	388.84	19.10	407.94	81.48	17.48	98.97
2011 TOTALS (lbs/day unmitigated)	66.78	347.17	446.86	0.44	2,183.07	17.73	2,200.80	456.19	16.22	472.41
2011 TOTALS (lbs/day mitigated)	66.78	347.17	446.86	0.44	388.84	17.73	406.57	81.48	16.22	97.70
2012 TOTALS (lbs/day unmitigated)	63.65	322.71	419.92	0.44	2,183.07	16.30	2,199.37	456.19	14.90	471.09
2012 TOTALS (lbs/day mitigated)	63.65	322.71	419.92	0.44	388.84	16.30	405.14	81.48	14.90	96.38
2013 TOTALS (lbs/day unmitigated)	61.03	299.62	394.45	0.44	2,183.07	15.02	2,198.09	456.19	13.72	469.91
2013 TOTALS (lbs/day mitigated)	61.03	299.62	394.45	0.44	388.84	15.02	403.86	81.48	13.72	95.20
2014 TOTALS (lbs/day unmitigated)	58.23	276.23	371.82	0.44	2,183.07	13.70	2,196.77	456.19	12.50	468.69
2014 TOTALS (lbs/day mitigated)	58.23	276.23	371.82	0.44	388.84	13.70	402.54	81.48	12.50	93.98
2015 TOTALS (lbs/day unmitigated)	55.41	252.15	350.49	0.44	2,183.07	12.62	2,195.69	456.19	11.52	467.70
2015 TOTALS (lbs/day mitigated)	55.41	252.15	350.49	0.44	388.84	12.62	401.46	81.48	11.52	93.00
2016 TOTALS (lbs/day unmitigated)	52.93	230.49	331.95	0.44	2,183.07	11.47	2,194.54	456.19	10.45	466.64
2016 TOTALS (lbs/day mitigated)	52.93	230.49	331.95	0.44	388.84	11.47	400.31	81.48	10.45	91.93
2017 TOTALS (lbs/day unmitigated)	50.71	210.39	314.31	0.44	2,183.07	10.42	2,193.49	456.19	9.49	465.68
2017 TOTALS (lbs/day mitigated)	50.71	210.39	314.31	0.44	388.84	10.42	399.26	81.48	9.49	90.97
2018 TOTALS (lbs/day unmitigated)	48.40	191.79	298.42	0.44	2,183.07	9.44	2,192.51	456.19	8.58	464.77
2018 TOTALS (lbs/day mitigated)	48.40	191.79	298.42	0.44	388.84	9.44	398.28	81.48	8.58	90.06
2019 TOTALS (lbs/day unmitigated)	46.53	175.00	283.61	0.44	2,183.07	8.47	2,191.54	456.19	7.69	463.88
2019 TOTALS (lbs/day mitigated)	46.53	175.00	283.61	0.44	388.84	8.47	397.31	81.48	7.69	89.17

5/26/2009 03:10:41 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Insti'l.urb924

Project Name: 112-23 OVOV Construction Emissions Institutional

2020 TOTALS (lbs/day unmitigated)	44.57	159.81	270.07	0.44	2,183.07	7.74	2,190.81	456.19	7.02	463.21
2020 TOTALS (lbs/day mitigated)	44.57	159.81	270.07	0.44	388.84	7.74	396.58	81.48	7.02	88.50
2021 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2021 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2022 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2022 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2023 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2023 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2024 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2024 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2025 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2025 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2026 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2026 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2027 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2027 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2028 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2028 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2029 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2029 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2030 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2030 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25

5/26/2009 03:11:27 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Insti'l.urb924
Project Name: 112-23 OVOV Construction Emissions Institutional

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	70.26	372.40	475.91	0.44	2,183.07	19.10	2,202.17	456.19	17.48	473.67
2010 TOTALS (lbs/day mitigated)	70.26	372.40	475.91	0.44	388.84	19.10	407.94	81.48	17.48	98.97
2011 TOTALS (lbs/day unmitigated)	66.78	347.17	446.86	0.44	2,183.07	17.73	2,200.80	456.19	16.22	472.41
2011 TOTALS (lbs/day mitigated)	66.78	347.17	446.86	0.44	388.84	17.73	406.57	81.48	16.22	97.70
2012 TOTALS (lbs/day unmitigated)	63.65	322.71	419.92	0.44	2,183.07	16.30	2,199.37	456.19	14.90	471.09
2012 TOTALS (lbs/day mitigated)	63.65	322.71	419.92	0.44	388.84	16.30	405.14	81.48	14.90	96.38
2013 TOTALS (lbs/day unmitigated)	61.03	299.62	394.45	0.44	2,183.07	15.02	2,198.09	456.19	13.72	469.91
2013 TOTALS (lbs/day mitigated)	61.03	299.62	394.45	0.44	388.84	15.02	403.86	81.48	13.72	95.20
2014 TOTALS (lbs/day unmitigated)	58.23	276.23	371.82	0.44	2,183.07	13.70	2,196.77	456.19	12.50	468.69
2014 TOTALS (lbs/day mitigated)	58.23	276.23	371.82	0.44	388.84	13.70	402.54	81.48	12.50	93.98
2015 TOTALS (lbs/day unmitigated)	55.41	252.15	350.49	0.44	2,183.07	12.62	2,195.69	456.19	11.52	467.70
2015 TOTALS (lbs/day mitigated)	55.41	252.15	350.49	0.44	388.84	12.62	401.46	81.48	11.52	93.00
2016 TOTALS (lbs/day unmitigated)	52.93	230.49	331.95	0.44	2,183.07	11.47	2,194.54	456.19	10.45	466.64
2016 TOTALS (lbs/day mitigated)	52.93	230.49	331.95	0.44	388.84	11.47	400.31	81.48	10.45	91.93
2017 TOTALS (lbs/day unmitigated)	50.71	210.39	314.31	0.44	2,183.07	10.42	2,193.49	456.19	9.49	465.68
2017 TOTALS (lbs/day mitigated)	50.71	210.39	314.31	0.44	388.84	10.42	399.26	81.48	9.49	90.97
2018 TOTALS (lbs/day unmitigated)	48.40	191.79	298.42	0.44	2,183.07	9.44	2,192.51	456.19	8.58	464.77
2018 TOTALS (lbs/day mitigated)	48.40	191.79	298.42	0.44	388.84	9.44	398.28	81.48	8.58	90.06
2019 TOTALS (lbs/day unmitigated)	46.53	175.00	283.61	0.44	2,183.07	8.47	2,191.54	456.19	7.69	463.88
2019 TOTALS (lbs/day mitigated)	46.53	175.00	283.61	0.44	388.84	8.47	397.31	81.48	7.69	89.17

5/26/2009 03:11:27 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Insti'l.urb924

Project Name: 112-23 OVOV Construction Emissions Institutional

2020 TOTALS (lbs/day unmitigated)	44.57	159.81	270.07	0.44	2,183.07	7.74	2,190.81	456.19	7.02	463.21
2020 TOTALS (lbs/day mitigated)	44.57	159.81	270.07	0.44	388.84	7.74	396.58	81.48	7.02	88.50
2021 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2021 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2022 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2022 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2023 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2023 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2024 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2024 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2025 TOTALS (lbs/day unmitigated)	42.74	152.03	226.62	0.44	2,183.07	7.54	2,190.61	456.19	6.83	463.02
2025 TOTALS (lbs/day mitigated)	42.74	152.03	226.62	0.44	388.84	7.54	396.38	81.48	6.83	88.32
2026 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2026 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2027 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2027 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2028 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2028 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2029 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2029 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25
2030 TOTALS (lbs/day unmitigated)	41.73	148.75	203.06	0.44	2,183.07	7.47	2,190.54	456.19	6.77	462.96
2030 TOTALS (lbs/day mitigated)	41.73	148.75	203.06	0.44	388.84	7.47	396.31	81.48	6.77	88.25

5/26/2009 03:31:54 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Non-Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Non Residential

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	35.31	213.40	202.11	0.13	625.76	12.27	638.03	130.77	11.27	142.03
2010 TOTALS (lbs/day mitigated)	35.31	213.40	202.11	0.13	111.47	12.27	123.75	23.36	11.27	34.63
2011 TOTALS (lbs/day unmitigated)	33.41	199.54	192.18	0.13	625.76	11.57	637.33	130.77	10.62	141.38
2011 TOTALS (lbs/day mitigated)	33.41	199.54	192.18	0.13	111.47	11.57	123.04	23.36	10.62	33.98
2012 TOTALS (lbs/day unmitigated)	31.59	186.28	183.18	0.13	625.76	10.56	636.32	130.77	9.69	140.46
2012 TOTALS (lbs/day mitigated)	31.59	186.28	183.18	0.13	111.47	10.56	122.04	23.36	9.69	33.05
2013 TOTALS (lbs/day unmitigated)	29.99	173.72	174.66	0.13	625.76	9.70	635.46	130.77	8.90	139.66
2013 TOTALS (lbs/day mitigated)	29.99	173.72	174.66	0.13	111.47	9.70	121.18	23.36	8.90	32.26
2014 TOTALS (lbs/day unmitigated)	28.37	161.16	166.92	0.13	625.76	8.72	634.48	130.77	8.00	138.76
2014 TOTALS (lbs/day mitigated)	28.37	161.16	166.92	0.13	111.47	8.72	120.20	23.36	8.00	31.36
2015 TOTALS (lbs/day unmitigated)	26.68	147.30	159.66	0.13	625.76	8.03	633.79	130.77	7.36	138.13
2015 TOTALS (lbs/day mitigated)	26.68	147.30	159.66	0.13	111.47	8.03	119.51	23.36	7.36	30.72
2016 TOTALS (lbs/day unmitigated)	25.23	134.68	153.31	0.13	625.76	7.23	632.99	130.77	6.62	137.39
2016 TOTALS (lbs/day mitigated)	25.23	134.68	153.31	0.13	111.47	7.23	118.70	23.36	6.62	29.98
2017 TOTALS (lbs/day unmitigated)	23.99	122.88	147.34	0.13	625.76	6.53	632.28	130.77	5.97	136.74
2017 TOTALS (lbs/day mitigated)	23.99	122.88	147.34	0.13	111.47	6.53	118.00	23.36	5.97	29.34
2018 TOTALS (lbs/day unmitigated)	22.60	111.96	141.89	0.13	625.76	5.85	631.61	130.77	5.36	136.12
2018 TOTALS (lbs/day mitigated)	22.60	111.96	141.89	0.13	111.47	5.85	117.33	23.36	5.36	28.72
2019 TOTALS (lbs/day unmitigated)	21.37	102.04	136.86	0.13	625.76	5.20	630.95	130.77	4.75	135.51
2019 TOTALS (lbs/day mitigated)	21.37	102.04	136.86	0.13	111.47	5.20	116.67	23.36	4.75	28.11

5/26/2009 03:31:54 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Non-Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Non Residential

2020 TOTALS (lbs/day unmitigated)	20.28	93.17	132.35	0.13	625.76	4.77	630.52	130.77	4.35	135.12
2020 TOTALS (lbs/day mitigated)	20.28	93.17	132.35	0.13	111.47	4.77	116.24	23.36	4.35	27.72
2021 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2021 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2022 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2022 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2023 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2023 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2024 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2024 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2025 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2025 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2026 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2026 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2027 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2027 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2028 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2028 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2029 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2029 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2030 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2030 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64

5/26/2009 03:33:54 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Non-Res'l.urb924
Project Name: 112-23 OVOV Construction Emissions Non Residential

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	35.31	213.40	202.11	0.13	625.76	12.27	638.03	130.77	11.27	142.03
2010 TOTALS (lbs/day mitigated)	35.31	213.40	202.11	0.13	111.47	12.27	123.75	23.36	11.27	34.63
2011 TOTALS (lbs/day unmitigated)	33.41	199.54	192.18	0.13	625.76	11.57	637.33	130.77	10.62	141.38
2011 TOTALS (lbs/day mitigated)	33.41	199.54	192.18	0.13	111.47	11.57	123.04	23.36	10.62	33.98
2012 TOTALS (lbs/day unmitigated)	31.59	186.28	183.18	0.13	625.76	10.56	636.32	130.77	9.69	140.46
2012 TOTALS (lbs/day mitigated)	31.59	186.28	183.18	0.13	111.47	10.56	122.04	23.36	9.69	33.05
2013 TOTALS (lbs/day unmitigated)	29.99	173.72	174.66	0.13	625.76	9.70	635.46	130.77	8.90	139.66
2013 TOTALS (lbs/day mitigated)	29.99	173.72	174.66	0.13	111.47	9.70	121.18	23.36	8.90	32.26
2014 TOTALS (lbs/day unmitigated)	28.37	161.16	166.92	0.13	625.76	8.72	634.48	130.77	8.00	138.76
2014 TOTALS (lbs/day mitigated)	28.37	161.16	166.92	0.13	111.47	8.72	120.20	23.36	8.00	31.36
2015 TOTALS (lbs/day unmitigated)	26.68	147.30	159.66	0.13	625.76	8.03	633.79	130.77	7.36	138.13
2015 TOTALS (lbs/day mitigated)	26.68	147.30	159.66	0.13	111.47	8.03	119.51	23.36	7.36	30.72
2016 TOTALS (lbs/day unmitigated)	25.23	134.68	153.31	0.13	625.76	7.23	632.99	130.77	6.62	137.39
2016 TOTALS (lbs/day mitigated)	25.23	134.68	153.31	0.13	111.47	7.23	118.70	23.36	6.62	29.98
2017 TOTALS (lbs/day unmitigated)	23.99	122.88	147.34	0.13	625.76	6.53	632.28	130.77	5.97	136.74
2017 TOTALS (lbs/day mitigated)	23.99	122.88	147.34	0.13	111.47	6.53	118.00	23.36	5.97	29.34
2018 TOTALS (lbs/day unmitigated)	22.60	111.96	141.89	0.13	625.76	5.85	631.61	130.77	5.36	136.12
2018 TOTALS (lbs/day mitigated)	22.60	111.96	141.89	0.13	111.47	5.85	117.33	23.36	5.36	28.72
2019 TOTALS (lbs/day unmitigated)	21.37	102.04	136.86	0.13	625.76	5.20	630.95	130.77	4.75	135.51

5/26/2009 03:33:54 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Non-Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Non Residential

2019 TOTALS (lbs/day mitigated)	21.37	102.04	136.86	0.13	111.47	5.20	116.67	23.36	4.75	28.11
2020 TOTALS (lbs/day unmitigated)	20.28	93.17	132.35	0.13	625.76	4.77	630.52	130.77	4.35	135.12
2020 TOTALS (lbs/day mitigated)	20.28	93.17	132.35	0.13	111.47	4.77	116.24	23.36	4.35	27.72
2021 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2021 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2022 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2022 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2023 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2023 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2024 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2024 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2025 TOTALS (lbs/day unmitigated)	19.73	90.91	119.33	0.13	625.76	4.71	630.46	130.77	4.30	135.07
2025 TOTALS (lbs/day mitigated)	19.73	90.91	119.33	0.13	111.47	4.71	116.18	23.36	4.30	27.66
2026 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2026 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2027 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2027 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2028 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2028 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2029 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2029 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64
2030 TOTALS (lbs/day unmitigated)	19.43	89.95	112.28	0.13	625.76	4.69	630.44	130.77	4.28	135.05
2030 TOTALS (lbs/day mitigated)	19.43	89.95	112.28	0.13	111.47	4.69	116.16	23.36	4.28	27.64

5/26/2009 03:36:27 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Office.urb924
Project Name: 112-23 OVOV Construction Emissions Office

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	103.51	515.22	745.24	0.75	3,760.00	24.96	3,784.96	785.71	22.81	808.52
2010 TOTALS (lbs/day mitigated)	103.51	515.22	745.24	0.75	669.70	24.96	694.66	140.33	22.81	163.14
2011 TOTALS (lbs/day unmitigated)	98.66	479.46	697.77	0.75	3,760.00	23.11	3,783.11	785.71	21.11	806.82
2011 TOTALS (lbs/day mitigated)	98.66	479.46	697.77	0.75	669.70	23.11	692.81	140.33	21.11	161.44
2012 TOTALS (lbs/day unmitigated)	94.34	444.84	653.62	0.75	3,760.00	21.29	3,781.29	785.71	19.43	805.14
2012 TOTALS (lbs/day mitigated)	94.34	444.84	653.62	0.75	669.70	21.29	690.99	140.33	19.43	159.76
2013 TOTALS (lbs/day unmitigated)	90.68	412.13	611.90	0.75	3,760.00	19.66	3,779.66	785.71	17.92	803.63
2013 TOTALS (lbs/day mitigated)	90.68	412.13	611.90	0.75	669.70	19.66	689.36	140.33	17.92	158.25
2014 TOTALS (lbs/day unmitigated)	86.80	378.92	574.70	0.75	3,760.00	18.01	3,778.01	785.71	16.40	802.11
2014 TOTALS (lbs/day mitigated)	86.80	378.92	574.70	0.75	669.70	18.01	687.71	140.33	16.40	156.73
2015 TOTALS (lbs/day unmitigated)	82.89	345.42	539.70	0.75	3,760.00	16.62	3,776.62	785.71	15.12	800.83
2015 TOTALS (lbs/day mitigated)	82.89	345.42	539.70	0.75	669.70	16.62	686.32	140.33	15.12	155.45
2016 TOTALS (lbs/day unmitigated)	79.48	315.47	509.16	0.75	3,760.00	15.24	3,775.24	785.71	13.85	799.56
2016 TOTALS (lbs/day mitigated)	79.48	315.47	509.16	0.75	669.70	15.24	684.94	140.33	13.85	154.18
2017 TOTALS (lbs/day unmitigated)	76.48	287.70	480.10	0.75	3,760.00	13.90	3,773.90	785.71	12.62	798.33
2017 TOTALS (lbs/day mitigated)	76.48	287.70	480.10	0.75	669.70	13.90	683.60	140.33	12.62	152.95
2018 TOTALS (lbs/day unmitigated)	73.31	262.17	453.83	0.75	3,760.00	12.66	3,772.66	785.71	11.47	797.19
2018 TOTALS (lbs/day mitigated)	73.31	262.17	453.83	0.75	669.70	12.66	682.36	140.33	11.47	151.81
2019 TOTALS (lbs/day unmitigated)	70.74	239.11	429.37	0.75	3,760.00	11.46	3,771.46	785.71	10.37	796.08
2019 TOTALS (lbs/day mitigated)	70.74	239.11	429.37	0.75	669.70	11.46	681.16	140.33	10.37	150.70

5/26/2009 03:36:27 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Office.urb924

Project Name: 112-23 OVOV Construction Emissions Office

2020 TOTALS (lbs/day unmitigated)	68.08	218.23	406.85	0.75	3,760.00	10.52	3,770.52	785.71	9.50	795.21
2020 TOTALS (lbs/day mitigated)	68.08	218.23	406.85	0.75	669.70	10.52	680.22	140.33	9.50	149.83
2021 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2021 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2022 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2022 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2023 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2023 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2024 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2024 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2025 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2025 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2026 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2026 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2027 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2027 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2028 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2028 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2029 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2029 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2030 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2030 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40

5/26/2009 03:37:10 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Office.urb924
Project Name: 112-23 OVOV Construction Emissions Office

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	103.51	515.22	745.24	0.75	3,760.00	24.96	3,784.96	785.71	22.81	808.52
2010 TOTALS (lbs/day mitigated)	103.51	515.22	745.24	0.75	669.70	24.96	694.66	140.33	22.81	163.14
2011 TOTALS (lbs/day unmitigated)	98.66	479.46	697.77	0.75	3,760.00	23.11	3,783.11	785.71	21.11	806.82
2011 TOTALS (lbs/day mitigated)	98.66	479.46	697.77	0.75	669.70	23.11	692.81	140.33	21.11	161.44
2012 TOTALS (lbs/day unmitigated)	94.34	444.84	653.62	0.75	3,760.00	21.29	3,781.29	785.71	19.43	805.14
2012 TOTALS (lbs/day mitigated)	94.34	444.84	653.62	0.75	669.70	21.29	690.99	140.33	19.43	159.76
2013 TOTALS (lbs/day unmitigated)	90.68	412.13	611.90	0.75	3,760.00	19.66	3,779.66	785.71	17.92	803.63
2013 TOTALS (lbs/day mitigated)	90.68	412.13	611.90	0.75	669.70	19.66	689.36	140.33	17.92	158.25
2014 TOTALS (lbs/day unmitigated)	86.80	378.92	574.70	0.75	3,760.00	18.01	3,778.01	785.71	16.40	802.11
2014 TOTALS (lbs/day mitigated)	86.80	378.92	574.70	0.75	669.70	18.01	687.71	140.33	16.40	156.73
2015 TOTALS (lbs/day unmitigated)	82.89	345.42	539.70	0.75	3,760.00	16.62	3,776.62	785.71	15.12	800.83
2015 TOTALS (lbs/day mitigated)	82.89	345.42	539.70	0.75	669.70	16.62	686.32	140.33	15.12	155.45
2016 TOTALS (lbs/day unmitigated)	79.48	315.47	509.16	0.75	3,760.00	15.24	3,775.24	785.71	13.85	799.56
2016 TOTALS (lbs/day mitigated)	79.48	315.47	509.16	0.75	669.70	15.24	684.94	140.33	13.85	154.18
2017 TOTALS (lbs/day unmitigated)	76.48	287.70	480.10	0.75	3,760.00	13.90	3,773.90	785.71	12.62	798.33
2017 TOTALS (lbs/day mitigated)	76.48	287.70	480.10	0.75	669.70	13.90	683.60	140.33	12.62	152.95
2018 TOTALS (lbs/day unmitigated)	73.31	262.17	453.83	0.75	3,760.00	12.66	3,772.66	785.71	11.47	797.19
2018 TOTALS (lbs/day mitigated)	73.31	262.17	453.83	0.75	669.70	12.66	682.36	140.33	11.47	151.81
2019 TOTALS (lbs/day unmitigated)	70.74	239.11	429.37	0.75	3,760.00	11.46	3,771.46	785.71	10.37	796.08
2019 TOTALS (lbs/day mitigated)	70.74	239.11	429.37	0.75	669.70	11.46	681.16	140.33	10.37	150.70

5/26/2009 03:37:10 PM

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Office.urb924

Project Name: 112-23 OVOV Construction Emissions Office

2020 TOTALS (lbs/day unmitigated)	68.08	218.23	406.85	0.75	3,760.00	10.52	3,770.52	785.71	9.50	795.21
2020 TOTALS (lbs/day mitigated)	68.08	218.23	406.85	0.75	669.70	10.52	680.22	140.33	9.50	149.83
2021 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2021 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2022 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2022 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2023 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2023 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2024 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2024 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2025 TOTALS (lbs/day unmitigated)	64.94	204.86	332.52	0.75	3,760.00	10.17	3,770.17	785.71	9.18	794.89
2025 TOTALS (lbs/day mitigated)	64.94	204.86	332.52	0.75	669.70	10.17	679.87	140.33	9.18	149.51
2026 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2026 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2027 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2027 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2028 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2028 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2029 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2029 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40
2030 TOTALS (lbs/day unmitigated)	63.21	199.22	292.22	0.75	3,760.00	10.04	3,770.05	785.71	9.07	794.78
2030 TOTALS (lbs/day mitigated)	63.21	199.22	292.22	0.75	669.70	10.04	679.74	140.33	9.07	149.40

5/26/2009 03:44:14 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Recreation.urb924
Project Name: 112-23 OVOV Construction Emissions Recreation

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	578.17	4,306.12	5,252.23	9.14	15,098.87	183.25	15,282.12	3,158.14	167.55	3,325.70
2010 TOTALS (lbs/day mitigated)	578.17	4,306.12	5,252.23	9.14	2,708.05	183.25	2,891.29	570.45	167.55	738.00
2011 TOTALS (lbs/day unmitigated)	543.31	3,899.90	4,877.28	9.14	15,098.87	164.73	15,263.60	3,158.14	150.49	3,308.64
2011 TOTALS (lbs/day mitigated)	543.31	3,899.90	4,877.28	9.14	2,708.05	164.73	2,872.78	570.45	150.49	720.94
2012 TOTALS (lbs/day unmitigated)	509.74	3,503.07	4,521.43	9.14	15,098.87	147.31	15,246.18	3,158.14	134.44	3,292.58
2012 TOTALS (lbs/day mitigated)	509.74	3,503.07	4,521.43	9.14	2,708.05	147.31	2,855.36	570.45	134.44	704.88
2013 TOTALS (lbs/day unmitigated)	477.89	3,121.99	4,180.00	9.14	15,098.87	130.78	15,229.65	3,158.14	119.17	3,277.31
2013 TOTALS (lbs/day mitigated)	477.89	3,121.99	4,180.00	9.14	2,708.05	130.78	2,838.83	570.45	119.17	689.61
2014 TOTALS (lbs/day unmitigated)	447.10	2,764.10	3,869.26	9.14	15,098.87	116.33	15,215.20	3,158.14	105.88	3,264.02
2014 TOTALS (lbs/day mitigated)	447.10	2,764.10	3,869.26	9.14	2,708.05	116.33	2,824.37	570.45	105.88	676.32
2015 TOTALS (lbs/day unmitigated)	418.10	2,438.31	3,580.61	9.14	15,098.87	103.03	15,201.90	3,158.14	93.62	3,251.77
2015 TOTALS (lbs/day mitigated)	418.10	2,438.31	3,580.61	9.14	2,708.05	103.03	2,811.08	570.45	93.62	664.07
2016 TOTALS (lbs/day unmitigated)	394.01	2,168.46	3,332.51	9.14	15,098.87	92.36	15,191.23	3,158.14	83.80	3,241.94
2016 TOTALS (lbs/day mitigated)	394.01	2,168.46	3,332.51	9.14	2,708.05	92.36	2,800.41	570.45	83.80	654.24
2017 TOTALS (lbs/day unmitigated)	372.99	1,940.18	3,104.99	9.14	15,098.87	83.02	15,181.89	3,158.14	75.21	3,233.35
2017 TOTALS (lbs/day mitigated)	372.99	1,940.18	3,104.99	9.14	2,708.05	83.02	2,791.07	570.45	75.21	645.65
2018 TOTALS (lbs/day unmitigated)	353.92	1,745.76	2,899.36	9.14	15,098.87	75.33	15,174.20	3,158.14	68.11	3,226.25
2018 TOTALS (lbs/day mitigated)	353.92	1,745.76	2,899.36	9.14	2,708.05	75.33	2,783.38	570.45	68.11	638.55
2019 TOTALS (lbs/day unmitigated)	337.63	1,579.58	2,711.81	9.14	15,098.87	68.58	15,167.45	3,158.14	61.90	3,220.04
2019 TOTALS (lbs/day mitigated)	337.63	1,579.58	2,711.81	9.14	2,708.05	68.58	2,776.63	570.45	61.90	632.34

5/26/2009 03:44:14 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Recreation.urb924

Project Name: 112-23 OVOV Construction Emissions Recreation

2020 TOTALS (lbs/day unmitigated)	322.54	1,437.93	2,540.01	9.14	15,098.87	63.10	15,161.97	3,158.14	56.86	3,215.00
2020 TOTALS (lbs/day mitigated)	322.54	1,437.93	2,540.01	9.14	2,708.05	63.10	2,771.15	570.45	56.86	627.30
2021 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2021 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2022 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2022 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2023 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2023 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2024 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2024 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2025 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2025 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2026 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2026 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2027 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2027 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2028 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2028 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2029 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2029 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2030 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2030 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12

5/26/2009 03:47:12 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Recreation.urb924
Project Name: 112-23 OVOV Construction Emissions Recreation

Project Location: South Coast AQMD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:
CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	578.17	4,306.12	5,252.23	9.14	15,098.87	183.25	15,282.12	3,158.14	167.55	3,325.70
2010 TOTALS (lbs/day mitigated)	578.17	4,306.12	5,252.23	9.14	2,708.05	183.25	2,891.29	570.45	167.55	738.00
2011 TOTALS (lbs/day unmitigated)	543.31	3,899.90	4,877.28	9.14	15,098.87	164.73	15,263.60	3,158.14	150.49	3,308.64
2011 TOTALS (lbs/day mitigated)	543.31	3,899.90	4,877.28	9.14	2,708.05	164.73	2,872.78	570.45	150.49	720.94
2012 TOTALS (lbs/day unmitigated)	509.74	3,503.07	4,521.43	9.14	15,098.87	147.31	15,246.18	3,158.14	134.44	3,292.58
2012 TOTALS (lbs/day mitigated)	509.74	3,503.07	4,521.43	9.14	2,708.05	147.31	2,855.36	570.45	134.44	704.88
2013 TOTALS (lbs/day unmitigated)	477.89	3,121.99	4,180.00	9.14	15,098.87	130.78	15,229.65	3,158.14	119.17	3,277.31
2013 TOTALS (lbs/day mitigated)	477.89	3,121.99	4,180.00	9.14	2,708.05	130.78	2,838.83	570.45	119.17	689.61
2014 TOTALS (lbs/day unmitigated)	447.10	2,764.10	3,869.26	9.14	15,098.87	116.33	15,215.20	3,158.14	105.88	3,264.02
2014 TOTALS (lbs/day mitigated)	447.10	2,764.10	3,869.26	9.14	2,708.05	116.33	2,824.37	570.45	105.88	676.32
2015 TOTALS (lbs/day unmitigated)	418.10	2,438.31	3,580.61	9.14	15,098.87	103.03	15,201.90	3,158.14	93.62	3,251.77
2015 TOTALS (lbs/day mitigated)	418.10	2,438.31	3,580.61	9.14	2,708.05	103.03	2,811.08	570.45	93.62	664.07
2016 TOTALS (lbs/day unmitigated)	394.01	2,168.46	3,332.51	9.14	15,098.87	92.36	15,191.23	3,158.14	83.80	3,241.94
2016 TOTALS (lbs/day mitigated)	394.01	2,168.46	3,332.51	9.14	2,708.05	92.36	2,800.41	570.45	83.80	654.24
2017 TOTALS (lbs/day unmitigated)	372.99	1,940.18	3,104.99	9.14	15,098.87	83.02	15,181.89	3,158.14	75.21	3,233.35
2017 TOTALS (lbs/day mitigated)	372.99	1,940.18	3,104.99	9.14	2,708.05	83.02	2,791.07	570.45	75.21	645.65
2018 TOTALS (lbs/day unmitigated)	353.92	1,745.76	2,899.36	9.14	15,098.87	75.33	15,174.20	3,158.14	68.11	3,226.25
2018 TOTALS (lbs/day mitigated)	353.92	1,745.76	2,899.36	9.14	2,708.05	75.33	2,783.38	570.45	68.11	638.55
2019 TOTALS (lbs/day unmitigated)	337.63	1,579.58	2,711.81	9.14	15,098.87	68.58	15,167.45	3,158.14	61.90	3,220.04
2019 TOTALS (lbs/day mitigated)	337.63	1,579.58	2,711.81	9.14	2,708.05	68.58	2,776.63	570.45	61.90	632.34

5/26/2009 03:47:12 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Recreation.urb924

Project Name: 112-23 OVOV Construction Emissions Recreation

2020 TOTALS (lbs/day unmitigated)	322.54	1,437.93	2,540.01	9.14	15,098.87	63.10	15,161.97	3,158.14	56.86	3,215.00
2020 TOTALS (lbs/day mitigated)	322.54	1,437.93	2,540.01	9.14	2,708.05	63.10	2,771.15	570.45	56.86	627.30
2021 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2021 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2022 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2022 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2023 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2023 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2024 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2024 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2025 TOTALS (lbs/day unmitigated)	279.27	1,067.06	1,927.77	9.12	15,098.87	50.04	15,148.91	3,158.14	44.85	3,203.00
2025 TOTALS (lbs/day mitigated)	279.27	1,067.06	1,927.77	9.12	2,708.05	50.04	2,758.09	570.45	44.85	615.30
2026 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2026 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2027 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2027 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2028 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2028 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2029 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2029 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12
2030 TOTALS (lbs/day unmitigated)	259.17	930.49	1,610.45	9.12	15,098.87	45.48	15,144.35	3,158.14	40.68	3,198.82
2030 TOTALS (lbs/day mitigated)	259.17	930.49	1,610.45	9.12	2,708.05	45.48	2,753.53	570.45	40.68	611.12

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Residential

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	620.83	3,122.56	9,047.85	12.46	134,100.91	137.81	134,238.72	28,013.30	124.44	28,137.73
2010 TOTALS (lbs/day mitigated)	620.83	3,122.56	9,047.85	12.46	23,834.17	137.81	23,971.98	4,985.19	124.44	5,109.63
2011 TOTALS (lbs/day unmitigated)	581.65	2,837.84	8,418.92	12.46	134,100.91	126.04	134,226.95	28,013.30	113.59	28,126.88
2011 TOTALS (lbs/day mitigated)	581.65	2,837.84	8,418.92	12.46	23,834.17	126.04	23,960.21	4,985.19	113.59	5,098.78
2012 TOTALS (lbs/day unmitigated)	544.65	2,562.10	7,827.07	12.46	134,100.91	115.07	134,215.98	28,013.30	103.41	28,116.71
2012 TOTALS (lbs/day mitigated)	544.65	2,562.10	7,827.07	12.46	23,834.17	115.07	23,949.24	4,985.19	103.41	5,088.61
2013 TOTALS (lbs/day unmitigated)	510.47	2,297.58	7,265.07	12.46	134,100.91	104.74	134,205.64	28,013.30	93.74	28,107.04
2013 TOTALS (lbs/day mitigated)	510.47	2,297.58	7,265.07	12.46	23,834.17	104.74	23,938.90	4,985.19	93.74	5,078.93
2014 TOTALS (lbs/day unmitigated)	478.04	2,050.08	6,756.78	12.46	134,100.91	96.92	134,197.82	28,013.30	86.56	28,099.86
2014 TOTALS (lbs/day mitigated)	478.04	2,050.08	6,756.78	12.46	23,834.17	96.92	23,931.08	4,985.19	86.56	5,071.75
2015 TOTALS (lbs/day unmitigated)	447.82	1,822.51	6,281.20	12.46	134,100.91	88.44	134,189.34	28,013.30	78.75	28,092.04
2015 TOTALS (lbs/day mitigated)	447.82	1,822.51	6,281.20	12.46	23,834.17	88.44	23,922.61	4,985.19	78.75	5,063.94
2016 TOTALS (lbs/day unmitigated)	422.21	1,632.76	5,863.25	12.46	134,100.91	81.60	134,182.51	28,013.30	72.45	28,085.75
2016 TOTALS (lbs/day mitigated)	422.21	1,632.76	5,863.25	12.46	23,834.17	81.60	23,915.77	4,985.19	72.45	5,057.64
2017 TOTALS (lbs/day unmitigated)	399.57	1,469.45	5,468.48	12.46	134,100.91	75.48	134,176.38	28,013.30	66.82	28,080.11
2017 TOTALS (lbs/day mitigated)	399.57	1,469.45	5,468.48	12.46	23,834.17	75.48	23,909.64	4,985.19	66.82	5,052.01
2018 TOTALS (lbs/day unmitigated)	378.48	1,328.04	5,104.41	12.46	134,100.91	70.48	134,171.38	28,013.30	62.13	28,075.43
2018 TOTALS (lbs/day mitigated)	378.48	1,328.04	5,104.41	12.46	23,834.17	70.48	23,904.64	4,985.19	62.13	5,047.33
2019 TOTALS (lbs/day unmitigated)	360.41	1,205.41	4,767.52	12.46	134,100.91	65.94	134,166.84	28,013.30	57.96	28,071.26
2019 TOTALS (lbs/day mitigated)	360.41	1,205.41	4,767.52	12.46	23,834.17	65.94	23,900.10	4,985.19	57.96	5,043.15

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Residential

2020 TOTALS (lbs/day unmitigated)	342.62	1,099.89	4,452.19	12.46	134,100.91	62.27	134,163.18	28,013.30	54.59	28,067.88
2020 TOTALS (lbs/day mitigated)	342.62	1,099.89	4,452.19	12.46	23,834.17	62.27	23,896.44	4,985.19	54.59	5,039.78
2021 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2021 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2022 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2022 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2023 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2023 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2024 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2024 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2025 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2025 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2026 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2026 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2027 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2027 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2028 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2028 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2029 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2029 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2030 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2030 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Residential

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	620.83	3,122.56	9,047.85	12.46	134,100.91	137.81	134,238.72	28,013.30	124.44	28,137.73
2010 TOTALS (lbs/day mitigated)	620.83	3,122.56	9,047.85	12.46	23,834.17	137.81	23,971.98	4,985.19	124.44	5,109.63
2011 TOTALS (lbs/day unmitigated)	581.65	2,837.84	8,418.92	12.46	134,100.91	126.04	134,226.95	28,013.30	113.59	28,126.88
2011 TOTALS (lbs/day mitigated)	581.65	2,837.84	8,418.92	12.46	23,834.17	126.04	23,960.21	4,985.19	113.59	5,098.78
2012 TOTALS (lbs/day unmitigated)	544.65	2,562.10	7,827.07	12.46	134,100.91	115.07	134,215.98	28,013.30	103.41	28,116.71
2012 TOTALS (lbs/day mitigated)	544.65	2,562.10	7,827.07	12.46	23,834.17	115.07	23,949.24	4,985.19	103.41	5,088.61
2013 TOTALS (lbs/day unmitigated)	510.47	2,297.58	7,265.07	12.46	134,100.91	104.74	134,205.64	28,013.30	93.74	28,107.04
2013 TOTALS (lbs/day mitigated)	510.47	2,297.58	7,265.07	12.46	23,834.17	104.74	23,938.90	4,985.19	93.74	5,078.93
2014 TOTALS (lbs/day unmitigated)	478.04	2,050.08	6,756.78	12.46	134,100.91	96.92	134,197.82	28,013.30	86.56	28,099.86
2014 TOTALS (lbs/day mitigated)	478.04	2,050.08	6,756.78	12.46	23,834.17	96.92	23,931.08	4,985.19	86.56	5,071.75
2015 TOTALS (lbs/day unmitigated)	447.82	1,822.51	6,281.20	12.46	134,100.91	88.44	134,189.34	28,013.30	78.75	28,092.04
2015 TOTALS (lbs/day mitigated)	447.82	1,822.51	6,281.20	12.46	23,834.17	88.44	23,922.61	4,985.19	78.75	5,063.94
2016 TOTALS (lbs/day unmitigated)	422.21	1,632.76	5,863.25	12.46	134,100.91	81.60	134,182.51	28,013.30	72.45	28,085.75
2016 TOTALS (lbs/day mitigated)	422.21	1,632.76	5,863.25	12.46	23,834.17	81.60	23,915.77	4,985.19	72.45	5,057.64
2017 TOTALS (lbs/day unmitigated)	399.57	1,469.45	5,468.48	12.46	134,100.91	75.48	134,176.38	28,013.30	66.82	28,080.11
2017 TOTALS (lbs/day mitigated)	399.57	1,469.45	5,468.48	12.46	23,834.17	75.48	23,909.64	4,985.19	66.82	5,052.01
2018 TOTALS (lbs/day unmitigated)	378.48	1,328.04	5,104.41	12.46	134,100.91	70.48	134,171.38	28,013.30	62.13	28,075.43
2018 TOTALS (lbs/day mitigated)	378.48	1,328.04	5,104.41	12.46	23,834.17	70.48	23,904.64	4,985.19	62.13	5,047.33
2019 TOTALS (lbs/day unmitigated)	360.41	1,205.41	4,767.52	12.46	134,100.91	65.94	134,166.84	28,013.30	57.96	28,071.26
2019 TOTALS (lbs/day mitigated)	360.41	1,205.41	4,767.52	12.46	23,834.17	65.94	23,900.10	4,985.19	57.96	5,043.15

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Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV Res'l.urb924

Project Name: 112-23 OVOV Construction Emissions Residential

2020 TOTALS (lbs/day unmitigated)	342.62	1,099.89	4,452.19	12.46	134,100.91	62.27	134,163.18	28,013.30	54.59	28,067.88
2020 TOTALS (lbs/day mitigated)	342.62	1,099.89	4,452.19	12.46	23,834.17	62.27	23,896.44	4,985.19	54.59	5,039.78
2021 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2021 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2022 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2022 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2023 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2023 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2024 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2024 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2025 TOTALS (lbs/day unmitigated)	289.24	830.43	3,281.61	12.44	134,100.91	54.45	134,155.36	28,013.30	47.40	28,060.70
2025 TOTALS (lbs/day mitigated)	289.24	830.43	3,281.61	12.44	23,834.17	54.45	23,888.62	4,985.19	47.40	5,032.59
2026 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2026 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2027 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2027 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2028 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2028 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2029 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2029 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08
2030 TOTALS (lbs/day unmitigated)	260.69	721.34	2,650.50	12.44	134,100.91	51.70	134,152.61	28,013.30	44.89	28,058.19
2030 TOTALS (lbs/day mitigated)	260.69	721.34	2,650.50	12.44	23,834.17	51.70	23,885.87	4,985.19	44.89	5,030.08

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Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV SG.urb924

Project Name: 112-23 OVOV Construction Emissions Special Generator

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	74.35	561.29	533.60	0.72	1,173.20	26.89	1,200.09	245.40	24.66	270.05
2010 TOTALS (lbs/day mitigated)	74.35	561.29	533.60	0.72	210.45	26.89	237.34	44.34	24.66	68.99
2011 TOTALS (lbs/day unmitigated)	69.84	515.88	499.55	0.72	1,173.20	24.63	1,197.83	245.40	22.57	267.97
2011 TOTALS (lbs/day mitigated)	69.84	515.88	499.55	0.72	210.45	24.63	235.08	44.34	22.57	66.91
2012 TOTALS (lbs/day unmitigated)	65.60	471.67	467.60	0.72	1,173.20	22.29	1,195.50	245.40	20.42	265.82
2012 TOTALS (lbs/day mitigated)	65.60	471.67	467.60	0.72	210.45	22.29	232.74	44.34	20.42	64.76
2013 TOTALS (lbs/day unmitigated)	61.80	429.48	437.04	0.72	1,173.20	20.15	1,193.35	245.40	18.44	263.84
2013 TOTALS (lbs/day mitigated)	61.80	429.48	437.04	0.72	210.45	20.15	230.59	44.34	18.44	62.78
2014 TOTALS (lbs/day unmitigated)	57.92	388.64	409.44	0.72	1,173.20	18.03	1,191.24	245.40	16.50	261.90
2014 TOTALS (lbs/day mitigated)	57.92	388.64	409.44	0.72	210.45	18.03	228.48	44.34	16.50	60.84
2015 TOTALS (lbs/day unmitigated)	54.12	349.04	383.70	0.72	1,173.20	16.29	1,189.50	245.40	14.90	260.29
2015 TOTALS (lbs/day mitigated)	54.12	349.04	383.70	0.72	210.45	16.29	226.74	44.34	14.90	59.23
2016 TOTALS (lbs/day unmitigated)	50.87	314.90	361.68	0.72	1,173.20	14.62	1,187.83	245.40	13.36	258.76
2016 TOTALS (lbs/day mitigated)	50.87	314.90	361.68	0.72	210.45	14.62	225.07	44.34	13.36	57.70
2017 TOTALS (lbs/day unmitigated)	48.01	284.70	341.38	0.72	1,173.20	13.16	1,186.36	245.40	12.01	257.41
2017 TOTALS (lbs/day mitigated)	48.01	284.70	341.38	0.72	210.45	13.16	223.61	44.34	12.01	56.35
2018 TOTALS (lbs/day unmitigated)	45.18	257.90	323.25	0.72	1,173.20	11.85	1,185.05	245.40	10.80	256.20
2018 TOTALS (lbs/day mitigated)	45.18	257.90	323.25	0.72	210.45	11.85	222.29	44.34	10.80	55.14
2019 TOTALS (lbs/day unmitigated)	42.81	234.32	306.64	0.72	1,173.20	10.61	1,183.82	245.40	9.67	255.07
2019 TOTALS (lbs/day mitigated)	42.81	234.32	306.64	0.72	210.45	10.61	221.06	44.34	9.67	54.00

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV SG.urb924

Project Name: 112-23 OVOV Construction Emissions Special Generator

2020 TOTALS (lbs/day unmitigated)	40.52	213.63	291.65	0.72	1,173.20	9.69	1,182.89	245.40	8.82	254.21
2020 TOTALS (lbs/day mitigated)	40.52	213.63	291.65	0.72	210.45	9.69	220.13	44.34	8.82	53.15
2021 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2021 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2022 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2022 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2023 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2023 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2024 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2024 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2025 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2025 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2026 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2026 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2027 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2027 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2028 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2028 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2029 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2029 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2030 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2030 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV SG.urb924

Project Name: 112-23 OVOV Construction Emissions Special Generator

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5
2010 TOTALS (lbs/day unmitigated)	74.35	561.29	533.60	0.72	1,173.20	26.89	1,200.09	245.40	24.66	270.05
2010 TOTALS (lbs/day mitigated)	74.35	561.29	533.60	0.72	210.45	26.89	237.34	44.34	24.66	68.99
2011 TOTALS (lbs/day unmitigated)	69.84	515.88	499.55	0.72	1,173.20	24.63	1,197.83	245.40	22.57	267.97
2011 TOTALS (lbs/day mitigated)	69.84	515.88	499.55	0.72	210.45	24.63	235.08	44.34	22.57	66.91
2012 TOTALS (lbs/day unmitigated)	65.60	471.67	467.60	0.72	1,173.20	22.29	1,195.50	245.40	20.42	265.82
2012 TOTALS (lbs/day mitigated)	65.60	471.67	467.60	0.72	210.45	22.29	232.74	44.34	20.42	64.76
2013 TOTALS (lbs/day unmitigated)	61.80	429.48	437.04	0.72	1,173.20	20.15	1,193.35	245.40	18.44	263.84
2013 TOTALS (lbs/day mitigated)	61.80	429.48	437.04	0.72	210.45	20.15	230.59	44.34	18.44	62.78
2014 TOTALS (lbs/day unmitigated)	57.92	388.64	409.44	0.72	1,173.20	18.03	1,191.24	245.40	16.50	261.90
2014 TOTALS (lbs/day mitigated)	57.92	388.64	409.44	0.72	210.45	18.03	228.48	44.34	16.50	60.84
2015 TOTALS (lbs/day unmitigated)	54.12	349.04	383.70	0.72	1,173.20	16.29	1,189.50	245.40	14.90	260.29
2015 TOTALS (lbs/day mitigated)	54.12	349.04	383.70	0.72	210.45	16.29	226.74	44.34	14.90	59.23
2016 TOTALS (lbs/day unmitigated)	50.87	314.90	361.68	0.72	1,173.20	14.62	1,187.83	245.40	13.36	258.76
2016 TOTALS (lbs/day mitigated)	50.87	314.90	361.68	0.72	210.45	14.62	225.07	44.34	13.36	57.70
2017 TOTALS (lbs/day unmitigated)	48.01	284.70	341.38	0.72	1,173.20	13.16	1,186.36	245.40	12.01	257.41
2017 TOTALS (lbs/day mitigated)	48.01	284.70	341.38	0.72	210.45	13.16	223.61	44.34	12.01	56.35
2018 TOTALS (lbs/day unmitigated)	45.18	257.90	323.25	0.72	1,173.20	11.85	1,185.05	245.40	10.80	256.20
2018 TOTALS (lbs/day mitigated)	45.18	257.90	323.25	0.72	210.45	11.85	222.29	44.34	10.80	55.14
2019 TOTALS (lbs/day unmitigated)	42.81	234.32	306.64	0.72	1,173.20	10.61	1,183.82	245.40	9.67	255.07
2019 TOTALS (lbs/day mitigated)	42.81	234.32	306.64	0.72	210.45	10.61	221.06	44.34	9.67	54.00
2020 TOTALS (lbs/day unmitigated)	40.52	213.63	291.65	0.72	1,173.20	9.69	1,182.89	245.40	8.82	254.21
2020 TOTALS (lbs/day mitigated)	40.52	213.63	291.65	0.72	210.45	9.69	220.13	44.34	8.82	53.15

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: Z:\Alan Sako\112.23 OVOV\112-23 URBEMIS FILES\112.23 Const OVOV SG.urb924

Project Name: 112-23 OVOV Construction Emissions Special Generator

2021 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2021 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2022 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2022 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2023 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2023 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2024 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2024 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2025 TOTALS (lbs/day unmitigated)	37.13	184.77	243.22	0.72	1,173.20	8.67	1,181.88	245.40	7.88	253.28
2025 TOTALS (lbs/day mitigated)	37.13	184.77	243.22	0.72	210.45	8.67	219.12	44.34	7.88	52.22
2026 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2026 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2027 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2027 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2028 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2028 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2029 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2029 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89
2030 TOTALS (lbs/day unmitigated)	35.55	174.13	218.09	0.72	1,173.20	8.32	1,181.52	245.40	7.56	252.96
2030 TOTALS (lbs/day mitigated)	35.55	174.13	218.09	0.72	210.45	8.32	218.76	44.34	7.56	51.89

Operational Air Emissions

for Proposed General Plan and Area Plan

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Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Comm'l.urb924

Project Name: 112-23 OVOV Commercial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	147.70	154.95	136.27	0.00	0.30	0.30	185,858.61

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,040.49	13,525.00	118,669.43	124.32	20,448.00	3,979.99	12,139,727.56

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,188.19	13,679.95	118,805.70	124.32	20,448.30	3,980.29	12,325,586.17

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	11.24	154.87	130.09	0.00	0.28	0.28	185,847.37
Hearth - No Summer Emissions							
Landscape	0.49	0.08	6.18	0.00	0.02	0.02	11.24
Consumer Products	0.00						
Architectural Coatings	135.97						
TOTALS (lbs/day, unmitigated)	147.70	154.95	136.27	0.00	0.30	0.30	185,858.61

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	3,050.50	4,542.81	39,859.00	41.76	6,868.13	1,336.81	4,077,523.29
Comm'l Ctr 10-30 ac	3,757.32	5,629.11	49,390.22	51.74	8,510.46	1,656.47	5,052,555.00
Comm'l Ctr <10 ac	1,621.17	2,444.14	21,445.08	22.47	3,695.21	719.24	2,193,803.36
Comm'l Shops	611.50	908.94	7,975.13	8.35	1,374.20	267.47	815,845.91
TOTALS (lbs/day, unmitigated)	9,040.49	13,525.00	118,669.43	124.32	20,448.00	3,979.99	12,139,727.56

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	9,728.62	389,728.54	3,975,230.99
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	8,933.07	482,921.79	4,925,802.20
Comm'l Ctr <10 ac		85.06	1000 sq ft	2,465.12	209,683.11	2,138,767.69
Comm'l Shops		37.06	1000 sq ft	2,104.11	77,978.32	795,378.88
					1,160,311.76	11,835,179.76

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Comm'l.urb924

Project Name: 112-23 OVOV Commercial Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	147.21	154.87	130.09	0.00	0.28	0.28	185,847.37

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	10,265.87	16,298.82	113,954.82	103.42	20,448.00	3,979.99	10,990,562.91

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	10,413.08	16,453.69	114,084.91	103.42	20,448.28	3,980.27	11,176,410.28

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	11.24	154.87	130.09	0.00	0.28	0.28	185,847.37
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	135.97						
TOTALS (lbs/day, unmitigated)	147.21	154.87	130.09	0.00	0.28	0.28	185,847.37

Area Source Changes to Defaults

Percentage of residences with wood stoves changed from 10% to 0%

Percentage of residences with wood fireplaces changed from 5% to 0%

Percentage of residences with natural gas fireplaces changed from 85% to 0%

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Comm'l Ctr >30 ac	3,454.40	5,474.49	38,275.44	34.74	6,868.13	1,336.81	3,691,538.88
Comm'l Ctr 10-30 ac	4,270.26	6,783.57	47,428.00	43.04	8,510.46	1,656.47	4,574,272.64
Comm'l Ctr <10 ac	1,849.53	2,945.40	20,593.09	18.69	3,695.21	719.24	1,986,134.67
Comm'l Shops	691.68	1,095.36	7,658.29	6.95	1,374.20	267.47	738,616.72
TOTALS (lbs/day, unmitigated)	10,265.87	16,298.82	113,954.82	103.42	20,448.00	3,979.99	10,990,562.91

4/21/2009 1:16:37 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Comm'l Ctr >30 ac		40.06	1000 sq ft	9,728.62	389,728.54	3,975,230.99
Comm'l Ctr 10-30 ac		54.06	1000 sq ft	8,933.07	482,921.79	4,925,802.20
Comm'l Ctr <10 ac		85.06	1000 sq ft	2,465.12	209,683.11	2,138,767.69
Comm'l Shops		37.06	1000 sq ft	2,104.11	77,978.32	795,378.88
					1,160,311.76	11,835,179.76

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Comm'l Ctr >30 ac				2.0	1.0	97.0
Comm'l Ctr 10-30 ac				2.0	1.0	97.0
Comm'l Ctr <10 ac				2.0	1.0	97.0
Comm'l Shops				2.0	1.0	97.0

4/21/2009 1:34:58 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Institutional.urb924

Project Name: 112-23 OVOV Institutional Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	70.80	102.30	96.64	0.00	0.22	0.22	122,617.22

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,243.68	2,208.83	19,541.79	20.30	3,334.32	649.23	1,983,078.59

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,314.48	2,311.13	19,638.43	20.30	3,334.54	649.45	2,105,695.81

4/21/2009 1:34:58 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	7.42	102.16	85.82	0.00	0.18	0.18	122,597.56
Hearth - No Summer Emissions							
Landscape	0.86	0.14	10.82	0.00	0.04	0.04	19.66
Consumer Products	0.00						
Architectural Coatings	62.52						
TOTALS (lbs/day, unmitigated)	70.80	102.30	96.64	0.00	0.22	0.22	122,617.22

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Day-care center	22.62	28.46	250.35	0.26	43.02	8.37	25,550.68
Elementary school	956.05	875.73	7,794.75	8.06	1,320.47	257.18	786,375.63
High school	389.01	386.49	3,412.86	3.55	583.62	113.63	346,967.06
Junior college (2 yrs)	687.11	647.65	5,696.22	5.95	978.72	190.52	581,354.24
Library	60.20	90.58	796.67	0.83	136.88	26.65	81,308.00
Place of worship	78.22	108.15	949.64	0.99	163.48	31.82	97,071.43
Hospital	50.47	71.77	641.30	0.66	108.13	21.06	64,451.55
TOTALS (lbs/day, unmitigated)	2,243.68	2,208.83	19,541.79	20.30	3,334.32	649.23	1,983,078.59

4/21/2009 1:34:58 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Day-care center		4.52	1000 sq ft	540.00	2,440.80	24,896.16
Elementary school		1.45	students	51,667.00	74,917.15	764,154.94
High school		1.79	students	18,500.00	33,115.00	337,772.99
Junior college (2 yrs)		1.54	students	36,062.00	55,535.48	566,461.87
Library		84.98	1000 sq ft	91.40	7,767.17	79,225.16
Place of worship		9.30	1000 sq ft	997.46	9,276.38	94,619.06
Hospital		16.80	1000 sq ft	365.16	6,134.69	62,573.81
					189,186.67	1,929,703.99

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8

4/21/2009 1:34:58 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.3	10.3	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Day-care center				5.0	2.5	92.5
Elementary school				20.0	10.0	70.0
High school				10.0	5.0	85.0
Junior college (2 yrs)				5.0	2.5	92.5

4/21/2009 1:34:58 PM

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Library				5.0	2.5	92.5
Place of worship				3.0	1.5	95.5
Hospital				25.0	12.5	62.5

4/21/2009 1:35:24 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Institutional.urb924

Project Name: 112-23 OVOV Institutional Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	69.94	102.16	85.82	0.00	0.18	0.18	122,597.56

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,024.54	2,662.11	18,742.43	16.91	3,334.32	649.23	1,795,709.44

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,094.48	2,764.27	18,828.25	16.91	3,334.50	649.41	1,918,307.00

4/21/2009 1:35:24 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	7.42	102.16	85.82	0.00	0.18	0.18	122,597.56
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	62.52						
TOTALS (lbs/day, unmitigated)	69.94	102.16	85.82	0.00	0.18	0.18	122,597.56

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Day-care center	23.23	34.30	240.32	0.22	43.02	8.37	23,133.33
Elementary school	833.46	1,055.53	7,469.25	6.71	1,320.47	257.18	712,178.21
High school	352.51	465.79	3,274.17	2.96	583.62	113.63	314,170.20
Junior college (2 yrs)	606.11	780.49	5,467.96	4.95	978.72	190.52	526,352.29
Library	68.64	109.16	764.75	0.69	136.88	26.65	73,615.44
Place of worship	84.77	130.33	911.81	0.83	163.48	31.82	87,884.17
Hospital	55.82	86.51	614.17	0.55	108.13	21.06	58,375.80
TOTALS (lbs/day, unmitigated)	2,024.54	2,662.11	18,742.43	16.91	3,334.32	649.23	1,795,709.44

4/21/2009 1:35:24 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Day-care center		4.52	1000 sq ft	540.00	2,440.80	24,896.16
Elementary school		1.45	students	51,667.00	74,917.15	764,154.94
High school		1.79	students	18,500.00	33,115.00	337,772.99
Junior college (2 yrs)		1.54	students	36,062.00	55,535.48	566,461.87
Library		84.98	1000 sq ft	91.40	7,767.17	79,225.16
Place of worship		9.30	1000 sq ft	997.46	9,276.38	94,619.06
Hospital		16.80	1000 sq ft	365.16	6,134.69	62,573.81
					189,186.67	1,929,703.99

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8

4/21/2009 1:35:24 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.3	10.3	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Day-care center				5.0	2.5	92.5
Elementary school				20.0	10.0	70.0
High school				10.0	5.0	85.0
Junior college (2 yrs)				5.0	2.5	92.5

4/21/2009 1:35:24 PM

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Library				5.0	2.5	92.5
Place of worship				3.0	1.5	95.5
Hospital				25.0	12.5	62.5

4/21/2009 1:18:35 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Res'l.urb924

Project Name: 112-23 OVOV Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	9,121.97	2,046.86	4,597.69	0.19	13.74	13.62	2,565,140.88

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	11,558.30	15,333.31	140,672.65	141.35	22,989.35	4,483.48	13,785,528.12

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	20,680.27	17,380.17	145,270.34	141.54	23,003.09	4,497.10	16,350,669.00

4/21/2009 1:18:35 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	154.83	2,004.65	853.04	0.02	3.84	3.80	2,559,126.91
Hearth - No Summer Emissions							
Landscape	676.16	42.21	3,744.65	0.17	9.90	9.82	6,013.97
Consumer Products	7,876.92						
Architectural Coatings	414.06						
TOTALS (lbs/day, unmitigated)	9,121.97	2,046.86	4,597.69	0.19	13.74	13.62	2,565,140.88

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	6,768.73	9,078.35	83,287.64	83.69	13,611.23	2,654.52	8,161,957.00
Apartments mid rise	942.41	1,219.70	11,189.92	11.24	1,828.71	356.64	1,096,580.99
Condo/townhouse general	3,598.06	4,731.94	43,412.36	43.62	7,094.64	1,383.63	4,254,290.83
Mobile home park	161.93	200.70	1,841.27	1.85	300.91	58.68	180,438.98
Retirement community	87.17	102.62	941.46	0.95	153.86	30.01	92,260.32
TOTALS (lbs/day, unmitigated)	11,558.30	15,333.31	140,672.65	141.35	22,989.35	4,483.48	13,785,528.12

Operational Settings:

4/21/2009 1:18:35 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	25,991.67	9.90	dwelling units	77,975.00	771,952.47	7,873,915.05
Apartments mid rise	395.55	6.90	dwelling units	15,031.00	103,713.90	1,057,881.77
Condo/townhouse general	3,143.50	8.00	dwelling units	50,296.00	402,368.00	4,104,153.52
Mobile home park	570.00	4.99	dwelling units	3,420.00	17,065.80	174,071.15
Retirement community	470.40	3.71	dwelling units	2,352.00	8,725.92	89,004.38
					1,303,826.09	13,299,025.87

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:18:35 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

4/21/2009 1:18:59 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Res'l.urb924

Project Name: 112-23 OVOV Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	31,806.54	3,973.53	65,622.94	181.63	10,047.53	9,672.60	5,199,821.47

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	12,391.54	18,485.68	134,708.09	117.85	22,989.35	4,483.48	12,494,227.90

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	44,198.08	22,459.21	200,331.03	299.48	33,036.88	14,156.08	17,694,049.37

4/21/2009 1:18:59 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	154.83	2,004.65	853.04	0.02	3.84	3.80	2,559,126.91
Hearth	23,360.73	1,968.88	64,769.90	181.61	10,043.69	9,668.80	2,640,694.56
Landscaping - No Winter Emissions							
Consumer Products	7,876.92						
Architectural Coatings	414.06						
TOTALS (lbs/day, unmitigated)	31,806.54	3,973.53	65,622.94	181.63	10,047.53	9,672.60	5,199,821.47

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Single family housing	7,303.11	10,944.76	79,756.22	69.78	13,611.23	2,654.52	7,397,420.68
Apartments mid rise	996.03	1,470.46	10,715.46	9.37	1,828.71	356.64	993,863.47
Condo/townhouse general	3,838.08	5,704.78	41,571.67	36.37	7,094.64	1,383.63	3,855,788.38
Mobile home park	166.98	241.96	1,763.20	1.54	300.91	58.68	163,537.14
Retirement community	87.34	123.72	901.54	0.79	153.86	30.01	83,618.23
TOTALS (lbs/day, unmitigated)	12,391.54	18,485.68	134,708.09	117.85	22,989.35	4,483.48	12,494,227.90

Operational Settings:

4/21/2009 1:18:59 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	25,991.67	9.90	dwelling units	77,975.00	771,952.47	7,873,915.05
Apartments mid rise	395.55	6.90	dwelling units	15,031.00	103,713.90	1,057,881.77
Condo/townhouse general	3,143.50	8.00	dwelling units	50,296.00	402,368.00	4,104,153.52
Mobile home park	570.00	4.99	dwelling units	3,420.00	17,065.80	174,071.15
Retirement community	470.40	3.71	dwelling units	2,352.00	8,725.92	89,004.38
					1,303,826.09	13,299,025.87

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 1:18:59 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			

% of Trips - Commercial (by land use)

4/21/2009 1:43:21 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV SG.urb924

Project Name: 112-23 OVOV Special Generator Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	46.96	0.81	0.68	0.00	0.00	0.00	966.44

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	322.22	513.04	3,590.85	3.26	643.48	125.25	345,965.96

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	369.18	513.85	3,591.53	3.26	643.48	125.25	346,932.40

4/21/2009 1:43:21 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.06	0.81	0.68	0.00	0.00	0.00	966.44
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	46.90						
TOTALS (lbs/day, unmitigated)	46.96	0.81	0.68	0.00	0.00	0.00	966.44

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Manufacturing	11.63	18.18	130.99	0.12	22.64	4.41	12,274.15
Wayside Honor Ranch	13.27	21.07	147.32	0.13	26.43	5.15	14,208.12
Six Flags Magic Mtn	211.56	337.13	2,357.05	2.14	422.95	82.32	227,329.86
Travel Village	23.09	36.80	257.31	0.23	46.17	8.99	24,816.84
Agua Dulce Airport	45.04	71.77	501.76	0.46	90.04	17.52	48,392.84
Landfill	17.63	28.09	196.42	0.18	35.25	6.86	18,944.15
TOTALS (lbs/day, unmitigated)	322.22	513.04	3,590.85	3.26	643.48	125.25	345,965.96

4/21/2009 1:43:21 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Manufacturing		100.00	1000 sq ft	12.84	1,284.00	13,096.80
Wayside Honor Ranch		50.00	acres	30.00	1,500.00	15,300.00
Six Flags Magic Mtn		100.00	acres	240.00	24,000.00	244,800.00
Travel Village		100.00	acres	26.20	2,620.00	26,724.00
Agua Dulce Airport		100.00	acres	51.09	5,109.00	52,111.80
Landfill		100.00	acres	20.00	2,000.00	20,400.00
					36,513.00	372,432.60

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 1:43:21 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Manufacturing				48.0	24.0	28.0
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

4/21/2009 1:43:43 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV SG.urb924

Project Name: 112-23 OVOV Special Generator Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	46.96	0.81	0.68	0.00	0.00	0.00	966.44

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	322.22	513.04	3,590.85	3.26	643.48	125.25	345,965.96

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	369.18	513.85	3,591.53	3.26	643.48	125.25	346,932.40

4/21/2009 1:43:43 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.06	0.81	0.68	0.00	0.00	0.00	966.44
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	46.90						
TOTALS (lbs/day, unmitigated)	46.96	0.81	0.68	0.00	0.00	0.00	966.44

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Manufacturing	11.63	18.18	130.99	0.12	22.64	4.41	12,274.15
Wayside Honor Ranch	13.27	21.07	147.32	0.13	26.43	5.15	14,208.12
Six Flags Magic Mtn	211.56	337.13	2,357.05	2.14	422.95	82.32	227,329.86
Travel Village	23.09	36.80	257.31	0.23	46.17	8.99	24,816.84
Agua Dulce Airport	45.04	71.77	501.76	0.46	90.04	17.52	48,392.84
Landfill	17.63	28.09	196.42	0.18	35.25	6.86	18,944.15
TOTALS (lbs/day, unmitigated)	322.22	513.04	3,590.85	3.26	643.48	125.25	345,965.96

4/21/2009 1:43:43 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Manufacturing		100.00	1000 sq ft	12.84	1,284.00	13,096.80
Wayside Honor Ranch		50.00	acres	30.00	1,500.00	15,300.00
Six Flags Magic Mtn		100.00	acres	240.00	24,000.00	244,800.00
Travel Village		100.00	acres	26.20	2,620.00	26,724.00
Agua Dulce Airport		100.00	acres	51.09	5,109.00	52,111.80
Landfill		100.00	acres	20.00	2,000.00	20,400.00
					36,513.00	372,432.60

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 1:43:43 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Manufacturing				48.0	24.0	28.0
Wayside Honor Ranch				2.0	1.0	97.0
Six Flags Magic Mtn				2.0	1.0	97.0
Travel Village				2.0	1.0	97.0
Agua Dulce Airport				2.0	1.0	97.0
Landfill				2.0	1.0	97.0

4/21/2009 1:19:52 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Non-Res'l.urb924

Project Name: 112-23 OVOV Non-Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	39.00	52.63	53.38	0.00	0.12	0.12	63,024.87

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	988.43	1,425.51	12,531.36	13.11	2,154.44	419.38	1,279,587.15

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,027.43	1,478.14	12,584.74	13.11	2,154.56	419.50	1,342,612.02

4/21/2009 1:19:52 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.81	52.51	44.11	0.00	0.09	0.09	63,008.02
Hearth - No Summer Emissions							
Landscape	0.74	0.12	9.27	0.00	0.03	0.03	16.85
Consumer Products	0.00						
Architectural Coatings	34.45						
TOTALS (lbs/day, unmitigated)	39.00	52.63	53.38	0.00	0.12	0.12	63,024.87

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	43.31	64.37	566.18	0.59	97.28	18.94	57,784.24
High turnover (sit-down) rest.	291.57	440.38	3,873.22	4.05	665.49	129.55	395,299.72
Fast food rest. w/ drive thru	245.46	372.71	3,278.11	3.43	563.24	109.64	334,562.89
Hotel	177.74	242.53	2,133.15	2.23	366.52	71.35	217,708.49
Movie Theater	74.54	73.85	648.01	0.68	111.66	21.73	66,290.21
Car Dealership	155.81	231.67	2,032.69	2.13	350.25	68.17	207,941.60
TOTALS (lbs/day, unmitigated)	988.43	1,425.51	12,531.36	13.11	2,154.44	419.38	1,279,587.15

4/21/2009 1:19:52 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	138.00	5,520.00	56,304.00
High turnover (sit-down) rest.		130.34	1000 sq ft	289.72	37,762.10	385,173.45
Fast food rest. w/ drive thru		496.12	1000 sq ft	64.42	31,960.05	325,992.50
Hotel		8.23	rooms	2,527.00	20,797.21	212,131.53
Movie Theater		1.76	1000 sq ft	3,600.00	6,336.00	64,627.20
Car Dealership		37.50	1000 sq ft	530.00	19,875.00	202,725.00
					122,250.36	1,246,953.68

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 1:19:52 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

4/21/2009 1:20:17 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Non-Res'l.urb924

Project Name: 112-23 OVOV Non-Residential Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	38.26	52.51	44.11	0.00	0.09	0.09	63,008.02

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,098.45	1,717.92	12,030.11	10.89	2,154.44	419.38	1,158,511.24

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	1,136.71	1,770.43	12,074.22	10.89	2,154.53	419.47	1,221,519.26

4/21/2009 1:20:17 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	3.81	52.51	44.11	0.00	0.09	0.09	63,008.02
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	34.45						
TOTALS (lbs/day, unmitigated)	38.26	52.51	44.11	0.00	0.09	0.09	63,008.02

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Racquetball/health	49.02	77.58	543.49	0.49	97.28	18.94	52,317.27
High turnover (sit-down) rest.	333.18	530.71	3,718.01	3.37	665.49	129.55	357,900.39
Fast food rest. w/ drive thru	281.40	449.17	3,146.75	2.85	563.24	109.64	302,909.88
Hotel	191.21	292.28	2,047.67	1.85	366.52	71.35	197,111.08
Movie Theater	67.37	89.00	622.26	0.56	111.66	21.73	60,015.08
Car Dealership	176.27	279.18	1,951.93	1.77	350.25	68.17	188,257.54
TOTALS (lbs/day, unmitigated)	1,098.45	1,717.92	12,030.11	10.89	2,154.44	419.38	1,158,511.24

4/21/2009 1:20:17 PM

Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Racquetball/health		40.00	1000 sq ft	138.00	5,520.00	56,304.00
High turnover (sit-down) rest.		130.34	1000 sq ft	289.72	37,762.10	385,173.45
Fast food rest. w/ drive thru		496.12	1000 sq ft	64.42	31,960.05	325,992.50
Hotel		8.23	rooms	2,527.00	20,797.21	212,131.53
Movie Theater		1.76	1000 sq ft	3,600.00	6,336.00	64,627.20
Car Dealership		37.50	1000 sq ft	530.00	19,875.00	202,725.00
					122,250.36	1,246,953.68

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8

4/21/2009 1:20:17 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Racquetball/health				5.0	2.5	92.5
High turnover (sit-down) rest.				5.0	2.5	92.5
Fast food rest. w/ drive thru				5.0	2.5	92.5
Hotel				5.0	2.5	92.5
Movie Theater				2.0	1.0	97.0
Car Dealership				2.0	1.0	97.0

4/21/2009 2:53:59 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Office.urb924

Project Name: 112-23 OVOV Office Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	66.16	69.06	65.66	0.00	0.15	0.15	82,769.64

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	514.16	669.17	5,874.67	6.14	1,011.61	196.91	600,645.65

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	580.32	738.23	5,940.33	6.14	1,011.76	197.06	683,415.29

4/21/2009 2:53:59 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	5.01	68.96	57.93	0.00	0.12	0.12	82,755.60
Hearth - No Summer Emissions							
Landscape	0.61	0.10	7.73	0.00	0.03	0.03	14.04
Consumer Products	0.00						
Architectural Coatings	60.54						
TOTALS (lbs/day, unmitigated)	66.16	69.06	65.66	0.00	0.15	0.15	82,769.64

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	66.33	92.72	816.83	0.85	140.08	27.27	83,236.23
Regional Post Office	19.85	21.64	189.86	0.20	32.72	6.37	19,422.53
Post Office	13.44	19.93	174.89	0.18	30.14	5.87	17,890.82
Commercial Office	385.85	494.46	4,338.40	4.54	747.55	145.50	443,812.22
High-Rise Office	28.69	40.42	354.69	0.37	61.12	11.90	36,283.85
TOTALS (lbs/day, unmitigated)	514.16	669.17	5,874.67	6.14	1,011.61	196.91	600,645.65

Operational Settings:

4/21/2009 2:53:59 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	730.56	7,948.49	81,074.63
Regional Post Office		2.38	1000 sq ft	780.00	1,856.40	18,935.28
Post Office		34.20	1000 sq ft	50.00	1,710.00	17,442.00
Commercial Office		5.00	1000 sq ft	8,483.89	42,419.45	432,678.36
High-Rise Office		11.56	1000 sq ft	300.00	3,468.00	35,373.60
					57,402.34	585,503.87

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 2:53:59 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0
High-Rise Office				2.0	1.0	97.0

4/21/2009 2:54:21 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Office.urb924

Project Name: 112-23 OVOV Office Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	65.55	68.96	57.93	0.00	0.12	0.12	82,755.60

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	538.03	806.42	5,640.80	5.12	1,011.61	196.91	543,794.79

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	603.58	875.38	5,698.73	5.12	1,011.73	197.03	626,550.39

4/21/2009 2:54:21 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	5.01	68.96	57.93	0.00	0.12	0.12	82,755.60
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	60.54						
TOTALS (lbs/day, unmitigated)	65.55	68.96	57.93	0.00	0.12	0.12	82,755.60

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Medical office building	72.40	111.75	783.91	0.71	140.08	27.27	75,364.10
Regional Post Office	18.84	26.08	182.32	0.17	32.72	6.37	17,583.97
Post Office	15.18	24.02	167.94	0.15	30.14	5.87	16,197.25
Commercial Office	400.18	595.86	4,166.04	3.78	747.55	145.50	401,800.30
High-Rise Office	31.43	48.71	340.59	0.31	61.12	11.90	32,849.17
TOTALS (lbs/day, unmitigated)	538.03	806.42	5,640.80	5.12	1,011.61	196.91	543,794.79

Operational Settings:

4/21/2009 2:54:21 PM

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Medical office building		10.88	1000 sq ft	730.56	7,948.49	81,074.63
Regional Post Office		2.38	1000 sq ft	780.00	1,856.40	18,935.28
Post Office		34.20	1000 sq ft	50.00	1,710.00	17,442.00
Commercial Office		5.00	1000 sq ft	8,483.89	42,419.45	432,678.36
High-Rise Office		11.56	1000 sq ft	300.00	3,468.00	35,373.60
					57,402.34	585,503.87

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0

4/21/2009 2:54:21 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Medical office building				7.0	3.5	89.5
Regional Post Office				2.0	1.0	97.0
Post Office				2.0	1.0	97.0
Commercial Office				2.0	1.0	97.0
High-Rise Office				2.0	1.0	97.0

4/21/2009 1:39:36 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Recreation.urb924

Project Name: 112-23 OVOV Recreation Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	416.98	0.06	4.64	0.00	0.02	0.02	8.43

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	2,963.22	4,481.14	39,317.93	41.19	6,774.90	1,318.67	4,022,173.48

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	3,380.20	4,481.20	39,322.57	41.19	6,774.92	1,318.69	4,022,181.91

4/21/2009 1:39:36 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth - No Summer Emissions							
Landscape	0.37	0.06	4.64	0.00	0.02	0.02	8.43
Consumer Products	0.00						
Architectural Coatings	416.61						
TOTALS (lbs/day, unmitigated)	416.98	0.06	4.64	0.00	0.02	0.02	8.43

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	1,116.56	1,687.35	14,804.96	15.51	2,551.05	496.54	1,514,528.64
Developed Park	70.85	96.51	846.83	0.89	145.92	28.40	86,629.17
Undeveloped Park	1,775.81	2,697.28	23,666.14	24.79	4,077.93	793.73	2,421,015.67
TOTALS (lbs/day, unmitigated)	2,963.22	4,481.14	39,317.93	41.19	6,774.90	1,318.67	4,022,173.48

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:39:36 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 80 Season: Summer

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	1,338.00	144,758.22	1,476,533.85
Developed Park		7.96	acres	1,040.20	8,279.99	84,455.91
Undeveloped Park		260.00	acres	890.00	231,400.00	2,360,279.96
					384,438.21	3,921,269.72

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

4/21/2009 1:39:36 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

4/21/2009 1:40:03 PM

Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 OVOV Recreation.urb924

Project Name: 112-23 OVOV Recreation Emissions

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	416.61	0.00	0.00	0.00	0.00	0.00	0.00

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	3,386.90	5,400.18	37,755.88	34.26	6,774.90	1,318.67	3,641,428.55

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	3,803.51	5,400.18	37,755.88	34.26	6,774.90	1,318.67	3,641,428.55

4/21/2009 1:40:03 PM

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hearth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping - No Winter Emissions							
Consumer Products	0.00						
Architectural Coatings	416.61						
TOTALS (lbs/day, unmitigated)	416.61	0.00	0.00	0.00	0.00	0.00	0.00

Area Source Changes to Defaults

The number of persons per household for consumer product use changed from 3 persons to 3.09 persons

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Winter Pounds Per Day, Unmitigated

Source	ROG	NOX	CO	SO2	PM10	PM25	CO2
Golf Course	1,275.67	2,033.41	14,216.78	12.90	2,551.05	496.54	1,371,161.10
Developed Park	76.11	116.31	813.18	0.74	145.92	28.40	78,428.72
Undeveloped Park	2,035.12	3,250.46	22,725.92	20.62	4,077.93	793.73	2,191,838.73
TOTALS (lbs/day, unmitigated)	3,386.90	5,400.18	37,755.88	34.26	6,774.90	1,318.67	3,641,428.55

Operational Settings:

Does not include correction for passby trips

4/21/2009 1:40:03 PM

Does not include double counting adjustment for internal trips

Analysis Year: 2010 Temperature (F): 60 Season: Winter

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Golf Course		108.19	acres	1,338.00	144,758.22	1,476,533.85
Developed Park		7.96	acres	1,040.20	8,279.99	84,455.91
Undeveloped Park		260.00	acres	890.00	231,400.00	2,360,279.96
					384,438.21	3,921,269.72

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	51.7	1.2	98.6	0.2
Light Truck < 3750 lbs	7.3	2.7	94.6	2.7
Light Truck 3751-5750 lbs	22.9	0.4	99.6	0.0
Med Truck 5751-8500 lbs	10.6	0.9	99.1	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.6	0.0	81.2	18.8
Lite-Heavy Truck 10,001-14,000 lbs	0.5	0.0	60.0	40.0
Med-Heavy Truck 14,001-33,000 lbs	0.9	0.0	22.2	77.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.5	0.0	0.0	100.0
Other Bus	0.1	0.0	0.0	100.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	2.8	67.9	32.1	0.0
School Bus	0.1	0.0	0.0	100.0

4/21/2009 1:40:03 PM

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Motor Home	0.9	0.0	88.9	11.1

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.2	10.2	10.2	10.2	10.2	10.2
Rural Trip Length (miles)	17.6	12.1	14.9	15.4	9.6	12.6
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
Golf Course				2.0	1.0	97.0
Developed Park				2.0	1.0	97.0
Undeveloped Park				2.0	1.0	97.0

4/21/2009 1:25:10 PM

Urbemis 2007 Version 9.2.4

Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Constr OVOV Ind'l.urb924

Project Name: 112-23 OVOV Construction Emissions Industrial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2010 TOTALS (lbs/day unmitigated)	461.90	3,201.21	4,139.35	6.89	13,612.73	137.07	13,749.81	2,846.64	125.27	2,971.90	742,758.88
2011 TOTALS (lbs/day unmitigated)	435.28	2,904.24	3,846.05	6.89	13,612.73	123.50	13,736.23	2,846.64	112.76	2,959.40	742,704.54
2012 TOTALS (lbs/day unmitigated)	409.81	2,614.32	3,568.21	6.89	13,612.73	110.76	13,723.49	2,846.64	101.02	2,947.66	742,662.83
2013 TOTALS (lbs/day unmitigated)	385.88	2,336.09	3,302.06	6.89	13,612.73	98.70	13,711.44	2,846.64	89.87	2,936.51	742,642.91
2014 TOTALS (lbs/day unmitigated)	362.59	2,073.83	3,060.28	6.89	13,612.73	88.14	13,700.88	2,846.64	80.16	2,926.80	742,624.91
2015 TOTALS (lbs/day unmitigated)	340.59	1,834.06	2,835.39	6.89	13,612.73	78.40	13,691.13	2,846.64	71.18	2,917.82	742,615.60
2016 TOTALS (lbs/day unmitigated)	322.23	1,634.65	2,641.59	6.89	13,612.73	70.52	13,683.26	2,846.64	63.94	2,910.57	742,592.48

2017 TOTALS (lbs/day unmitigated)	306.19	1,464.97	2,463.06	6.89	13,612.73	63.56	13,676.29	2,846.64	57.53	2,904.16	742,582.58
2018 TOTALS (lbs/day unmitigated)	291.47	1,319.69	2,301.46	6.89	13,612.73	57.77	13,670.51	2,846.64	52.18	2,898.82	742,580.59
2019 TOTALS (lbs/day unmitigated)	278.94	1,195.02	2,153.71	6.89	13,612.73	52.65	13,665.39	2,846.64	47.47	2,894.11	742,583.83
2020 TOTALS (lbs/day unmitigated)	267.20	1,088.24	2,018.08	6.89	13,612.73	48.51	13,661.25	2,846.64	43.66	2,890.30	742,589.44
2021 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2022 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2023 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
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2025 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2026 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2027 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2028 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20

2029 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2030 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20

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Urbemis 2007 Version 9.2.4

Combined Winter Emissions Reports (Pounds/Day)

File Name: C:\Documents and Settings\rmamaghani\Application Data\Urbemis\Version9a\Projects\112.23 Constr OVOV Ind'l.urb924

Project Name: 112-23 OVOV Construction Emissions Industrial

Project Location: South Coast AQMD

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

CONSTRUCTION EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10 Dust	PM10 Exhaust	PM10	PM2.5 Dust	PM2.5 Exhaust	PM2.5	CO2
2010 TOTALS (lbs/day unmitigated)	461.90	3,201.21	4,139.35	6.89	13,612.73	137.07	13,749.81	2,846.64	125.27	2,971.90	742,758.88
2011 TOTALS (lbs/day unmitigated)	435.28	2,904.24	3,846.05	6.89	13,612.73	123.50	13,736.23	2,846.64	112.76	2,959.40	742,704.54
2012 TOTALS (lbs/day unmitigated)	409.81	2,614.32	3,568.21	6.89	13,612.73	110.76	13,723.49	2,846.64	101.02	2,947.66	742,662.83
2013 TOTALS (lbs/day unmitigated)	385.88	2,336.09	3,302.06	6.89	13,612.73	98.70	13,711.44	2,846.64	89.87	2,936.51	742,642.91
2014 TOTALS (lbs/day unmitigated)	362.59	2,073.83	3,060.28	6.89	13,612.73	88.14	13,700.88	2,846.64	80.16	2,926.80	742,624.91
2015 TOTALS (lbs/day unmitigated)	340.59	1,834.06	2,835.39	6.89	13,612.73	78.40	13,691.13	2,846.64	71.18	2,917.82	742,615.60
2016 TOTALS (lbs/day unmitigated)	322.23	1,634.65	2,641.59	6.89	13,612.73	70.52	13,683.26	2,846.64	63.94	2,910.57	742,592.48

2017 TOTALS (lbs/day unmitigated)	306.19	1,464.97	2,463.06	6.89	13,612.73	63.56	13,676.29	2,846.64	57.53	2,904.16	742,582.58
2018 TOTALS (lbs/day unmitigated)	291.47	1,319.69	2,301.46	6.89	13,612.73	57.77	13,670.51	2,846.64	52.18	2,898.82	742,580.59
2019 TOTALS (lbs/day unmitigated)	278.94	1,195.02	2,153.71	6.89	13,612.73	52.65	13,665.39	2,846.64	47.47	2,894.11	742,583.83
2020 TOTALS (lbs/day unmitigated)	267.20	1,088.24	2,018.08	6.89	13,612.73	48.51	13,661.25	2,846.64	43.66	2,890.30	742,589.44
2021 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2022 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2023 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2024 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2025 TOTALS (lbs/day unmitigated)	234.93	823.42	1,535.53	6.88	13,612.73	39.29	13,652.02	2,846.64	35.19	2,881.82	742,628.85
2026 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2027 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2028 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20

2029 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20
2030 TOTALS (lbs/day unmitigated)	219.70	725.29	1,283.90	6.88	13,612.73	36.07	13,648.80	2,846.64	32.24	2,878.87	742,679.20

CALINE4 CO Emissions

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 1: The Old Road & Rye Canyon
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	The Old Road	AT GRADE	4	5	5
East-West Roadway:	Rye Canyon	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

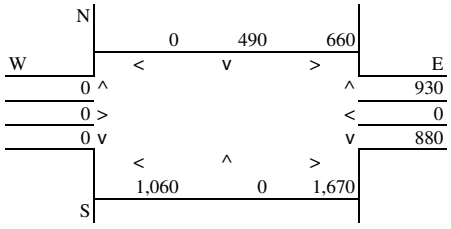
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

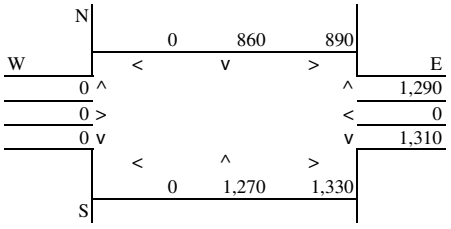
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	4,100	N-S Road	4,770

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 8: McBean Parkway & Magic Mountain Parkway
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	McBean Parkway	AT GRADE	4	5	5
East-West Roadway:	Magic Mountain Parkway	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak

	N				
		720	1,980	520	
W	<		v	>	E
470	^			^	350
1,660	>			<	690
140	v			v	70
		<	^	>	
		250	1,320	40	
	S				

P.M. Peak

	N				
		110	2,130	300	
W	<		v	>	E
420	^			^	640
1,830	>			<	1,420
410	v			v	220
		<	^	>	
		360	2,460	280	
	S				

Representative Traffic Volumes (Vehicles per Hour)

N-S Road	5,360	N-S Road	6,060

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 10: Orchard Village & McBean Parkway
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Orchard Village	AT GRADE	4	5	5
East-West Roadway:	McBean Parkway	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

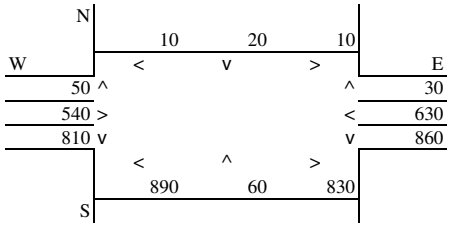
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

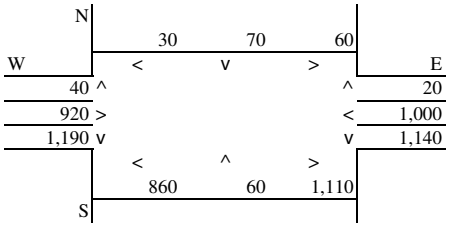
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	3,470	N-S Road	4,430

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 15: Bouquet Canyon Road & Soledad Canyon Road
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Bouquet Canyon Road	AT GRADE	4	5	5
East-West Roadway:	Soledad Canyon Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak

	N			
	1,370	1,860	390	
W	<	v	>	E
360	^		^	250
1,010	>		<	930
120	v		v	140
	<	^	>	
	20	620	190	
	S			

P.M. Peak

	N			
	890	1,390	420	
W	<	v	>	E
1,350	^		^	760
1,180	>		<	1,050
110	v		v	360
	<	^	>	
	100	1,750	490	
	S			

Representative Traffic Volumes (Vehicles per Hour)

N-S Road	4,850	N-S Road	6,560

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 3: The Old Road & Valencia Boulevard
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	The Old Road	AT GRADE	4	5	5
East-West Roadway:	Valencia Boulevard	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

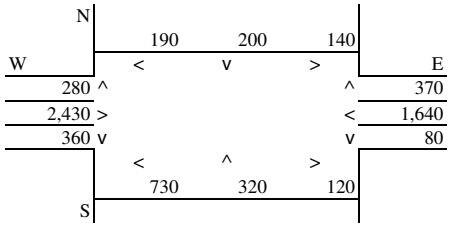
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

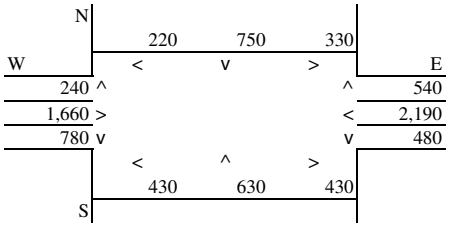
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	1,810	N-S Road	3,500

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 4: The Old Road & McBean Parkway
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	The Old Road	AT GRADE	4	5	5
East-West Roadway:	McBean Parkway	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

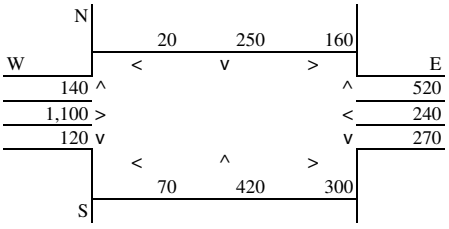
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

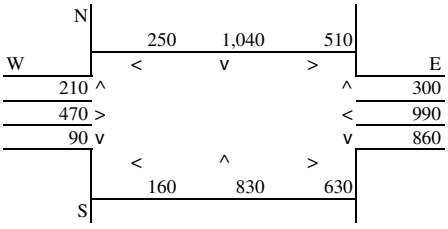
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	1,510	N-S Road	3,610

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 5: The Old Road & Pico Canyon Road
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	The Old Road	AT GRADE	4	5	5
East-West Roadway:	Pico Canyon Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

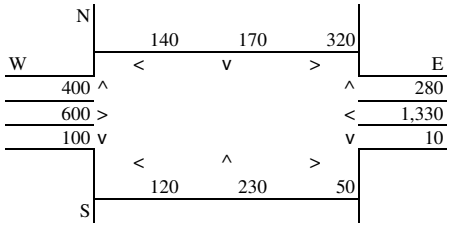
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

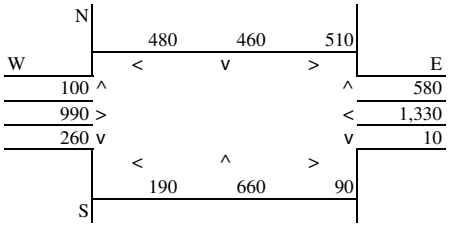
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	1,540	N-S Road	2,790

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 11: Orchard Village & Wiley Canyon Road
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Orchard Village	AT GRADE	4	5	5
East-West Roadway:	Wiley Canyon Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

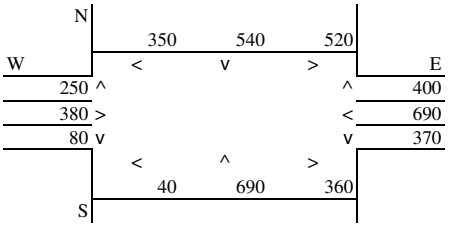
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

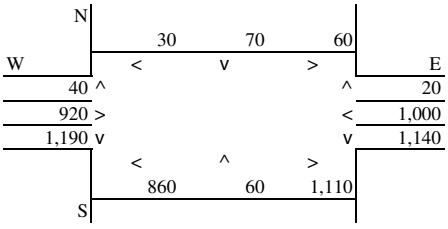
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	2,750	N-S Road	4,430

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 12: Valencia Boulevard & Magic Mountain Parkway
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Valencia Boulevard	AT GRADE	4	5	5
East-West Roadway:	Magic Mountain Parkway	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

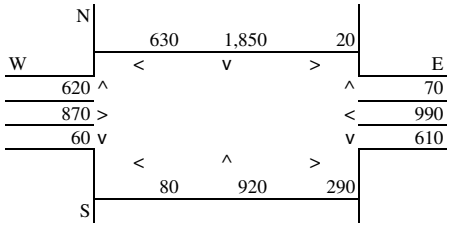
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

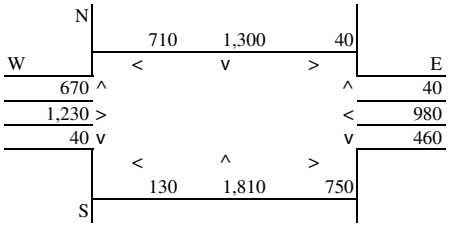
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	4,110	N-S Road	4,570

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 14: Bouquet Canyon Road & Newhall Ranch Road
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Bouquet Canyon Road	AT GRADE	4	5	5
East-West Roadway:	Newhall Ranch Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak

	N				
		790	2,190	100	
W	<	v	>	E	
240	^		^	80	
870	>		<	1,350	
800	v		v	660	
		<	^	>	
		500	530	320	
	S				

P.M. Peak

	N				
		420	1,470	70	
W	<	v	>	E	
660	^		^	100	
1,990	>		<	970	
1,060	v		v	160	
		<	^	>	
		880	2,480	650	
	S				

Representative Traffic Volumes (Vehicles per Hour)

N-S Road	5,000	N-S Road	6,700

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 17: Sierra Highway & Newhall Ranch Road
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Sierra Highway	AT GRADE	4	5	5
East-West Roadway:	Newhall Ranch Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

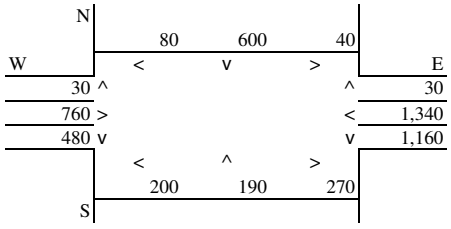
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

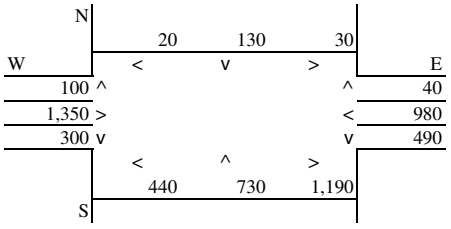
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	2,900	N-S Road	3,280

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 18: Whites Cyn Rd & Soledad Cyn Rd.
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Whites Canyon Road	AT GRADE	4	5	5
East-West Roadway:	Soledad Canyon Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

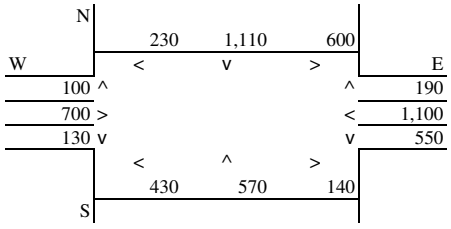
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

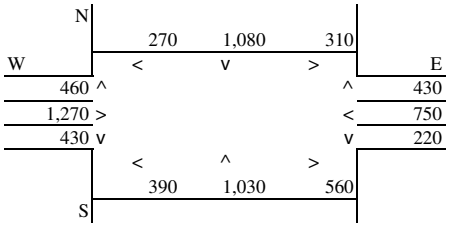
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	2,930	N-S Road	3,710

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 21: Pico Canyon Rd & Valencia Blvd
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Valencia Boulevard	AT GRADE	4	5	5
East-West Roadway:	Pico Canyon Road	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

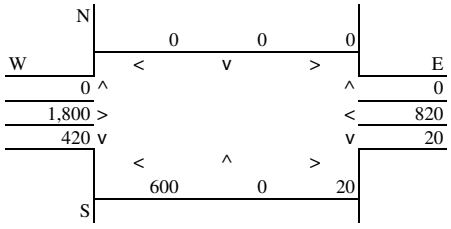
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

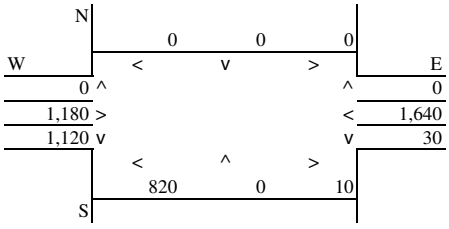
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	1,060	N-S Road	1,980

BAY AREA AQMD SIMPLIFIED CALINE4 ANALYSIS; UPDATED WITH EMFAC2007

Project Title:	One Valley One Vision Area Plan/General Plan Update
Intersection:	Intersection 23: Golden Valley & Via Princessa
Analysis Condition:	OVOV Area Plan/General Plan Buildout
Nearest Air Monitoring Station measuring CO:	Santa Clarita/Placerita Monitoring Station
Background 1-hour CO Concentration (ppm):	2.0
Background 8-hour CO Concentration (ppm):	1.6
Persistence Factor:	0.7
Analysis Year:	2030

		Roadway Type	No. of Lanes	Approach/Departure Speed A.M.	Approach/Departure Speed P.M.
North-South Roadway:	Golden Valley	AT GRADE	4	5	5
East-West Roadway:	Via Princessa	AT GRADE	4	5	5

EMFAC2007 COMPOSITE EMISSION FACTORS FOR CO

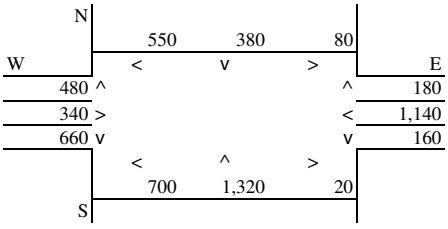
Air Basin: South Coast Air Basin County: Los Angeles

Assumes lowest mean wintertime temperature of 47 degrees F and 30% humidity.

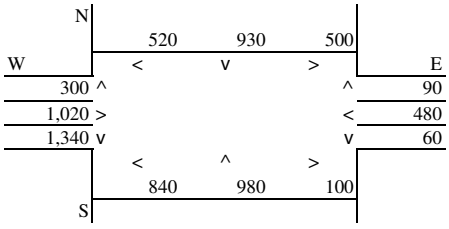
	Average Speed (miles per hour)									
Year	5	8	11	14	17	20	23	26	29	32
2007	10.404	9.093	8.058	7.231	6.563	6.024	5.588	5.23	4.936	4.7
2008	9.453	8.28	7.351	6.607	6.005	5.518	5.124	4.799	4.532	4.316
2009	8.51	7.471	6.646	5.984	5.448	5.012	4.66	4.367	4.126	3.929
2010	7.609	6.699	5.976	5.392	4.918	4.532	4.219	3.958	3.741	3.564
2011	6.831	6.032	5.393	4.877	4.456	4.113	3.833	3.599	3.404	3.243
2012	6.141	5.437	4.874	4.416	4.042	3.737	3.487	3.277	3.101	2.955
2013	5.528	4.909	4.411	4.005	3.673	3.4	3.177	2.988	2.83	2.697
2014	4.98	4.435	3.995	3.635	3.339	3.097	2.897	2.728	2.584	2.464
2015	4.502	4.021	3.63	3.311	3.047	2.829	2.65	2.497	2.368	2.258
2020	2.909	2.632	2.402	2.21	2.05	1.917	1.805	1.708	1.624	1.552
2025	2.144	1.95	1.789	1.653	1.539	1.444	1.364	1.294	1.233	1.181
2030	1.756	1.601	1.472	1.363	1.271	1.195	1.131	1.075	1.027	0.985

PEAK HOUR TURNING VOLUMES

A.M. Peak



P.M. Peak



Representative Traffic Volumes (Vehicles per Hour)

N-S Road	3,240	N-S Road	4,250

APPENDIX 3.4

Global Climate Change Documentation

Greenhouse Gas Emission Calculations

Greenhouse Gas Emissions Calculations

for Existing Conditions

Existing Conditions - OVOV Planning Area
Indirect GHG Emissions from Electrical Demand

Land Use	Units	Electrical Demand Factor[1] (kW-hr/unit/yr)	Annual Demand Factor (10^6 kW-hr/yr)	CO_2E Emission Factor[2] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Residential	72,638 Unit	5,656.50	410.88	399	**164,005.60**
FoodStore	1,341,840 Sq.Ft.	53.30	71.52	399	**28,547.95**
Restaurant	212,030 Sq.Ft.	47.45	10.06	399	**4,015.88**
Hospital	149,900 Sq.Ft.	21.70	3.25	399	**1,298.40**
Retail	2,576,562 Sq.Ft.	13.55	34.91	399	**13,935.64**
Movie Theater (3)	82,500 Sq.Ft.	13.55	1.12	399	**446.21**
College/University	459,475 Sq.Ft.	11.55	5.31	399	**2,118.32**
High School	262,500 Sq.Ft.	10.50	2.76	399	**1,100.18**
Elementary School	747,550 Sq.Ft.	5.90	4.41	399	**1,760.51**
Daycare	11,500 Sq.Ft.	5.90	0.07	399	**27.08**
Office	2,704,040 Sq.Ft.	12.95	35.02	399	**13,977.51**
Hotel/Motel	390,000 Sq.Ft.	9.95	3.88	399	**1,548.94**
Warehouse	0 Sq.Ft.	4.35	-	399	**-**
Miscellaneous	19,195,560 Sq.Ft.	10.50	201.55	399	**80,452.05**
				Projected GHG Emissions from Electrical Demand	**313,234.28**

Sources:
1. South Coast Air Quality Management District, *CEQA Air Quality Handbook*, (1993) Table A9-11-A.

2. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MT	Metric ton
yr	Year

Impact Sciences, Inc.
Prepared by R. Mamaghani
12 March 2009

JN 112-23

Existing Conditions - OVOV Planning Area
GHG Emissions from Solid Waste Generation

Land Use	Size	Unit	Rate (Tons/yr)	Solid Waste Generation (Tons/yr)	CO_2E Emission Factor[2] (MT CO_2E/MT waste)	Annual CO_2E Emissions (MT CO_2E/yr)
Single Family Detached	46,071	du	1.0200	46,992.42	0.11	**4,689.39**
Multi-Family or Attached	24,387	du	0.5850	14,266.40	0.11	**1,423.65**
Mobile Home	2,180	du	0.5850	1,275.30	0.11	**127.26**
General Retail	7,811,260	sq. ft.	0.0012	9,373.51	0.11	**935.39**
Eating/Drnkng Establ.	212,030	sq. ft.	0.0054	1,144.96	0.11	**114.26**
Food & Drug Stores	1,341,840	sq. ft.	0.0036	4,830.62	0.11	**482.05**
Auto Dlr/Service Sta.	399,500	sq. ft.	0.0026	1,018.73	0.11	**101.66**
Hotel & Motel	390,000	sq. ft.	0.0027	1,033.50	0.11	**103.13**
Warehouse	0	sq. ft.	0.0006	0.00	0.11	**-**
Medical Offices	133,730	sq. ft.	0.0014	180.54	0.11	**18.02**
Hospitals	149,900	sq. ft.	0.0028	412.23	0.11	**41.14**
Business Park	16,441,130	sq. ft.	0.0007	11,508.79	0.11	**1,148.47**
Office	2,162,420	sq. ft.	0.0007	1,513.69	0.11	**151.05**
Library 3	53,730	sq. ft.	0.0007	37.61	0.11	**3.75**
Education & Schools	1,021,550	sq. ft.	0.0007	664.01	0.11	**66.26**
College	459,475	sq. ft.	0.0007	298.66	0.11	**29.80**
Trans., Comm., Utilities	903,440	sq. ft.	0.0040	3,568.59	0.11	**356.11**
Special Generator 4	0	sq. ft.	0.0040	0.00	0.11	**-**
Golf Course/Park	872	acres	0.1000	87.19	0.11	**8.70**
Manufacturing	1,850,990	sq. ft.	0.0025	4,627.48	0.11	**461.78**
Church 3	487,890	sq. ft.	0.0007	341.52	0.11	**34.08**
				Projected GHG Emissions From Solid Waste Disposal		**10,295.94**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

Sources:

1. Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. Assumes 50% diversion.

2. US Environmental Protection Agency, Office of Solid Waste and Emergency Response, *Greenhouse Gas Emission Factors for Management of Selected Materials in Municipal Solid Waste (EPA-530-R-98-013)*, (1998). The factor is based on mixed municipal solid waste as disposed in landfills without landfill gas recovery.

Where:

CO_2E	Carbon dioxide equivalent
MT	Metric ton
yr	Year

3. Assumes same generation rate as for office.

4. Conservatively assumes same generation rate as utilities.

Existing Conditions - OVOV Planning Area
GHG Emission from Potable Water Treatment and Conveyance

Land Use	Action	Net Potable Water Needs Estimate[1] (MG/yr)	Electrical Demand Factor[2,3] (kW-hr/MG)	Annual Electrical Demand (10^6 kW-hr/year)	CO_2E Emission Factor[4] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	Supply & Conveyance	32,780.61	9,727	318.857	290	92,468.53
Net Project	Treatment	32,780.61	111	3.639	290	1,055.21
Net Project	Distribution	32,780.61	1,272	41.697	290	12,092.11
					Projected GHG Emissions From Water Demand	**105,615.85**

Sources:

1. Section 3.13, Water Services
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report (CEC-700-2005-011-SF)*, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*, (2006) 22. Prepared by Navigant Consulting, Inc.
4. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MG	Million gallons
MT	Metric ton
N_2O	Nitrous oxide
yr	Year

Existing Conditions, OVOV Planning Area
GHG Emission from Wastewater Collection and Treatment

Wasterwater Treatment Electrical Demand GHG Emissions

Land Use	Net Wastewater Generation Rate[1] (MG/yr)	Electrical Demand Factor[2] (kW-hr/MG)	Annual Demand Factor (10^b kW-hr/yr)	CO_2E Emision Factor[3] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	19,668.37	1,911	37.59	399	**15,002.93**

Sources:
1. Section 3.13, Water Service. Assumes that 60% of water demand would be wastewater.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared
3. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006),

Wastewater Treatment Process GHG Emissions[1]

Project	Maximum Population	Pounds BOD5 per Capita per Day[2] (lbs BOD5/capita/day)	Pounds CH_4 per Pound BOD5[3] (lbs CH_4/BOD5)	Fraction Anaerobically Digested[4]	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	252,000	0.13	0.22	0.15	**3,758.68**

Sources:
1. US Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I, Chapter 4.3.5*, (1998). Data is not available to determine CO_2
2. The US EPA recommends a default value of 0.13 lb BOD5/capita/day.
3. The US EPA recommends a default value of 0.22 lb CH_4/BOD5.
4. The US EPA recommends a default value of 15% for the fraction anaerobically digested for domestic wastewater.

Where:

BOD5	Biological oxygen demand using a standard 5 day test	18,761.61
CH_4	Methane	
CO_2	Carbon dioxide	
CO_2E	Carbon dioxide equivalent	
GWP	Global warming potential	
kW-hr	Kilowatt-hour	
lbs	Pounds	
MG	Million gallons	
MT	Metric ton	
N_2O	Nitrous oxide	
yr	Year	

Greenhouse Gas Emissions Calculations

for Existing General Plan and Area Plan

Existing General Plan
Indirect GHG Emissions from Electrical Demand

Land Use	Units	Electrical Demand Factor[1] (kW-hr/unit/yr)	Annual Demand Factor (10^6 kW-hr/yr)	CO_2E Emission Factor[2] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Residential	151,916 Unit	5,656.50	859.31	399	**343,003.32**
FoodStore	3,182,757 Sq.Ft.	53.30	169.64	399	**67,713.88**
Restaurant	343,270 Sq.Ft.	47.45	16.29	399	**6,501.58**
Hospital	345,840 Sq.Ft.	21.70	7.50	399	**2,995.59**
Retail	3,923,329 Sq.Ft.	13.55	53.16	399	**21,219.79**
Movie Theater (3)	82,500 Sq.Ft.	13.55	1.12	399	**446.21**
College/University	833,400 Sq.Ft.	11.55	9.63	399	**3,842.22**
High School	586,100 Sq.Ft.	10.50	6.15	399	**2,456.45**
Elementary School	1,218,575 Sq.Ft.	5.90	7.19	399	**2,869.80**
Daycare	13,500 Sq.Ft.	5.90	0.08	399	**31.79**
Office	8,917,970 Sq.Ft.	12.95	115.49	399	**46,098.07**
Hotel/Motel	678,400 Sq.Ft.	9.95	6.75	399	**2,694.36**
Warehouse	0 Sq.Ft.	4.35	-	399	**-**
Miscellaneous	50,950,550 Sq.Ft.	10.50	534.98	399	**213,542.93**
				Projected GHG Emissions from Electrical Demand	**713,415.99**

Sources:
1. South Coast Air Quality Management District, *CEQA Air Quality Handbook*, (1993) Table A9-11-A.

2. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MT	Metric ton
yr	Year

Impact Sciences, Inc.
Prepared by R. Mamaghani
12 March 2009

JN 112-23

Existing General Plan
GHG Emissions from Solid Waste Generation

Land Use	Size	Unit	Rate (Tons/yr)	Solid Waste Generation (Tons/yr)	CO_2E Emission Factor[2] (MT CO_2E/MT waste)	Annual CO_2E Emissions (MT CO_2E/yr)
Single Family Detached	86,808	du	1.0200	88,544.16	0.11	**8,835.85**
Multi-Family or Attached	62,543	du	0.5850	36,587.66	0.11	**3,651.09**
Mobile Home	2,565	du	0.5850	1,500.53	0.11	**149.74**
General Retail	18,243,123	sq. ft.	0.0012	21,891.75	0.11	**2,184.59**
Eating/Drnkng Establ.	343,270	sq. ft.	0.0054	1,853.66	0.11	**184.98**
Food & Drug Stores	3,182,757	sq. ft.	0.0036	11,457.93	0.11	**1,143.39**
Auto Dlr/Service Sta.	441,500	sq. ft.	0.0026	1,125.83	0.11	**112.35**
Hotel & Motel	678,400	sq. ft.	0.0027	1,797.76	0.11	**179.40**
Warehouse	0	sq. ft.	0.0006	0.00	0.11	**-**
Medical Offices	412,290	sq. ft.	0.0014	556.59	0.11	**55.54**
Hospitals	345,840	sq. ft.	0.0028	951.06	0.11	**94.91**
Business Park	45,656,650	sq. ft.	0.0007	31,959.66	0.11	**3,189.27**
Office	8,240,680	sq. ft.	0.0007	5,768.48	0.11	**575.64**
Library 3	71,400	sq. ft.	0.0007	49.98	0.11	**4.99**
Education & Schools	1,818,175	sq. ft.	0.0007	1,181.81	0.11	**117.93**
College	833,400	sq. ft.	0.0007	541.71	0.11	**54.06**
Trans., Comm., Utilities	1,250,240	sq. ft.	0.0040	4,938.45	0.11	**492.81**
Special Generator 4	0	sq. ft.	0.0040	0.00	0.11	**-**
Golf Course/Park	1,791	acres	0.1000	179.07	0.11	**17.87**
Manufacturing	4,043,660	sq. ft.	0.0025	10,109.15	0.11	**1,008.80**
Church 3	605,890	sq. ft.	0.0007	424.12	0.11	**42.32**
				Projected GHG Emissions From Solid Waste Disposal		**22,095.51**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

Sources:

1. Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. Assumes 50% diversion.

2. US Environmental Protection Agency, Office of Solid Waste and Emergency Response, *Greenhouse Gas Emission Factors for Management of Selected Materials in Municipal Solid Waste (EPA-530-R-98-013)*, (1998). The factor is based on mixed municipal solid waste as disposed in landfills without landfill gas recovery.

Where:

CO_2E	Carbon dioxide equivalent
MT	Metric ton
yr	Year

3. Assumes same generation rate as for office.

4. Conservatively assumes same generation rate as utilities.

OVOV
GHG Emissions from Solid Waste Generation

Land Use	Size	Unit	Rate (Tons/yr)	Solid Waste Generation (Tons/yr)	CO_2E Emission Factor[2] (MT CO_2E/MT waste)	Annual CO_2E Emissions (MT CO_2E/yr)
Single Family Detached	77,975	du	1.0200	79,534.50	0.11	**7,936.78**
Multi-Family or Attached	67,679	du	0.5850	39,592.22	0.11	**3,950.92**
Mobile Home	3,420	du	0.5850	2,000.70	0.11	**199.65**
General Retail	19,974,282	sq. ft.	0.0012	23,969.14	0.11	**2,391.89**
Eating/Drnkng Establ.	354,140	sq. ft.	0.0054	1,912.36	0.11	**190.83**
Food & Drug Stores	3,484,638	sq. ft.	0.0036	12,544.70	0.11	**1,251.84**
Auto Dlr/Service Sta.	530,000	sq. ft.	0.0026	1,351.50	0.11	**134.87**
Hotel & Motel	1,010,800	sq. ft.	0.0027	2,678.62	0.11	**267.30**
Warehouse	0	sq. ft.	0.0006	0.00	0.11	**-**
Medical Offices	730,560	sq. ft.	0.0014	986.26	0.11	**98.42**
Hospitals	365,160	sq. ft.	0.0028	1,004.19	0.11	**100.21**
Business Park	44,484,350	sq. ft.	0.0007	31,139.05	0.11	**3,107.38**
Office	10,344,450	sq. ft.	0.0007	7,241.12	0.11	**722.59**
Library 3	91,400	sq. ft.	0.0007	63.98	0.11	**6.38**
Education & Schools	1,767,675	sq. ft.	0.0007	1,148.99	0.11	**114.66**
College	901,550	sq. ft.	0.0007	586.01	0.11	**58.48**
Trans., Comm., Utilities	1,032,440	sq. ft.	0.0040	4,078.14	0.11	**406.96**
Special Generator 4	0	sq. ft.	0.0040	0.00	0.11	**-**
Golf Course/Park	2,378	acres	0.1000	237.82	0.11	**23.73**
Manufacturing	3,268,690	sq. ft.	0.0025	8,171.73	0.11	**815.46**
Church 3	997,460	sq. ft.	0.0007	698.22	0.11	**69.68**
				Projected GHG Emissions From Solid Waste Disposal		**21,848.02**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

Sources:

1. Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. Assumes 50% diversion.

2. US Environmental Protection Agency, Office of Solid Waste and Emergency Response, *Greenhouse Gas Emission Factors for Management of Selected Materials in Municipal Solid Waste (EPA-530-R-98-013)*, (1998). The factor is based on mixed municipal solid waste as disposed in landfills without landfill gas recovery.

Where:

CO_2E	Carbon dioxide equivalent
MT	Metric ton
yr	Year

3. Assumes same generation rate as for office.

4. Conservatively assumes same generation rate as utilities.

Existing General Plan
GHG Emission from Potable Water Treatment and Conveyance

Land Use	Action	Net Potable Water Needs Estimate[1] (MG/yr)	Electrical Demand Factor[2,3] (kW-hr/MG)	Annual Electrical Demand (10^6 kW-hr/year)	CO_2E Emission Factor[4] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	Supply & Conveyance	44,934.85	9,727	437.081	290	126,753.58
Net Project	Treatment	44,934.85	111	4.988	290	1,446.45
Net Project	Distribution	44,934.85	1,272	57.157	290	16,575.57
					Projected GHG Emissions From Water Demand	**144,775.60**

Sources:

1. Section 3.13, Water Services
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report (CEC-700-2005-011-SF)*, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*, (2006) 22. Prepared by Navigant Consulting, Inc.
4. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MG	Million gallons
MT	Metric ton
N_2O	Nitrous oxide
yr	Year

Existing General Plan
GHG Emission from Wastewater Collection and Treatment

Wasterwater Treatment Electrical Demand GHG Emissions

Land Use	Net Wastewater Generation Rate[1] (MG/yr)	Electrical Demand Factor[2] (kW-hr/MG)	Annual Demand Factor (10^6 kW-hr/yr)	CO_2E Emision Factor[3] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	26,960.91	1,911	51.52	399	**20,565.64**

Sources:
1. Section 3.13, Water Service. Assumes that 60% of water demand would be wastewater.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared
3. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006),

Wastewater Treatment Process GHG Emissions[1]

Project	Maximum Population	Pounds BOD5 per Capita per Day[2] (lbs BOD5/capita/day)	Pounds CH_4 per Pound BOD5[3] (lbs CH_4/BOD5)	Fraction Anaerobically Digested[4]	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	448,310	0.13	0.22	0.15	**6,686.73**

Sources:
1. US Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I, Chapter 4.3.5*, (1998). Data is not available to determine CO_2
2. The US EPA recommends a default value of 0.13 lb BOD5/capita/day.
3. The US EPA recommends a default value of 0.22 lb CH_4/BOD5.
4. The US EPA recommends a default value of 15% for the fraction anaerobically digested for domestic wastewater.

Where:

BOD5	Biological oxygen demand using a standard 5 day test
CH_4	Methane
CO_2	Carbon dioxide
CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MG	Million gallons
MT	Metric ton
N_2O	Nitrous oxide
yr	Year

27,252.37

Greenhouse Gas Emissions Calculations

for Proposed General Plan and Area Plan

OVOV
Indirect GHG Emissions from Electrical Demand

Land Use	Units	Electrical Demand Factor[1] (kW-hr/unit/yr)	Annual Demand Factor (10^6 kW-hr/yr)	CO_2E Emission Factor[2] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Residential	149,074 Unit	5,656.50	843.24	399	**336,586.51**
FoodStore	3,484,638 Sq.Ft.	53.30	185.73	399	**74,136.47**
Restaurant	354,140 Sq.Ft.	47.45	16.80	399	**6,707.46**
Hospital	365,160 Sq.Ft.	21.70	7.92	399	**3,162.93**
Retail	4,905,463 Sq.Ft.	13.55	66.47	399	**26,531.77**
Movie Theater (3)	90,000 Sq.Ft.	13.55	1.22	399	**486.78**
College/University	901,550 Sq.Ft.	11.55	10.41	399	**4,156.41**
High School	462,500 Sq.Ft.	10.50	4.86	399	**1,938.42**
Elementary School	1,291,675 Sq.Ft.	5.90	7.62	399	**3,041.95**
Daycare	13,500 Sq.Ft.	5.90	0.08	399	**31.79**
Office	11,133,310 Sq.Ft.	12.95	144.18	399	**57,549.44**
Hotel/Motel	1,010,800 Sq.Ft.	9.95	10.06	399	**4,014.54**
Warehouse	0 Sq.Ft.	4.35	-	399	**-**
Miscellaneous	48,785,480 Sq.Ft.	10.50	512.25	399	**204,468.73**
				Projected GHG Emissions from Electrical Demand	**722,813.21**

Sources:
1. South Coast Air Quality Management District, *CEQA Air Quality Handbook*, (1993) Table A9-11-A.

2. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MT	Metric ton
yr	Year

Impact Sciences, Inc.
Prepared by R. Mamaghani
12 March 2009

JN 112-23

OVOV
GHG Emission from Potable Water Treatment and Conveyance

Land Use	Action	Net Potable Water Needs Estimate[1] (MG/yr)	Electrical Demand Factor[2,3] (kW-hr/MG)	Annual Electrical Demand (10^6 kW-hr/year)	CO_2E Emission Factor[4] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	Supply & Conveyance	44,934.85	9,727	437.081	290	126,753.58
Net Project	Treatment	44,934.85	111	4.988	290	1,446.45
Net Project	Distribution	44,934.85	1,272	57.157	290	16,575.57
					Projected GHG Emissions From Water Demand	**144,775.60**

Sources:

1. Section 3.13, Water Services
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report (CEC-700-2005-011-SF)*, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*, (2006) 22. Prepared by Navigant Consulting, Inc.
4. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006), http://www.climateregistry.org/CARROT/public/Reports.aspx.

Where:

CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MG	Million gallons
MT	Metric ton
N_2O	Nitrous oxide
yr	Year

OVOV

GHG Emission from Wastewater Collection and Treatment

Wasterwater Treatment Electrical Demand GHG Emissions

Land Use	Net Wastewater Generation Rate[1] (MG/yr)	Electrical Demand Factor[2] (kW-hr/MG)	Annual Demand Factor (10^b kW-hr/yr)	CO_2E Emision Factor[3] (MT $CO_2E/10^6$ kW-hr)	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	26,960.91	1,911	51.52	399	**20,565.64**

Sources:

1. Section 3.13, Water Service. Assumes that 60% of water demand would be wastewater.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared
3. California Climate Action Registry, "Reporting Online Tool, Public Annual Entity Emissions," *Southern California Edison, PUP Report*, (2006),

Wastewater Treatment Process GHG Emissions[1]

Project	Maximum Population	Pounds BOD5 per Capita per Day[2] (lbs BOD5/capita/day)	Pounds CH_4 per Pound BOD5[3] (lbs CH_4/BOD5)	Fraction Anaerobically Digested[4]	Annual CO_2E Emissions (MT CO_2E/yr)
Net Project	439,923	0.13	0.22	0.15	**6,561.63**

Sources:

1. US Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I, Chapter 4.3.5*, (1998). Data is not available to determine CO_2
2. The US EPA recommends a default value of 0.13 lb BOD5/capita/day.
3. The US EPA recommends a default value of 0.22 lb CH_4/BOD5.
4. The US EPA recommends a default value of 15% for the fraction anaerobically digested for domestic wastewater.

Where:

BOD5	Biological oxygen demand using a standard 5 day test
CH_4	Methane
CO_2	Carbon dioxide
CO_2E	Carbon dioxide equivalent
GWP	Global warming potential
kW-hr	Kilowatt-hour
lbs	Pounds
MG	Million gallons
MT	Metric ton
N_2O	Nitrous oxide
yr	Year

27,127.28

Comparison of CAPCOA Greenhouse Gas Policies with One Valley One Vision

COMPARISON OF CAPCOA GREENHOUSE GAS MODEL POLICIES WITH ONE VALLEY ONE VISION:

KEY:

Boxes in RED = OVOV has similar policy language as strong as CAPCOA language.
Boxes in BLUE = OVOV has no similar policy but the City is currently implementing a similar policy or OVOV includes similar language in the body but has no similar policy.
Boxes in GREEN = OVOV has similar policy language with "should" or "encourage" based policies.
Boxes in PURPLE = OVOV has no similar language but an explanation or information has been provided.
Boxes in WHITE = OVOV has no similar language or policy.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
GHG-1 **pg. 70**	**Objective GHG-1:** By 2020, the City/County will reduce greenhouse gas emissions from within its boundaries to a level 30% less than the level that would otherwise occur if all activities continued under a "business as usual" scenario[1].	**CO 8.1** **pg. CO-92** **(Con/OS 8/09)**	**Objective CO 8.1:** Comply with the requirements of State law, including AB 32, SB 375 and implementing regulations, to reach targeted reductions of greenhouse gas (GHG) emissions.
GHG-1.1 & 1.2 **pg. 70**	**GHG-1.1 Emission Inventories:** The City/County will establish GHG emissions inventories including emissions from all sectors within the City/County, using methods approved by, or consistent with guidance from, the ARB; the City/County will update inventories every 3 years to incorporate improved methods, better data, and more accurate tools and methods, and to assess progress. **GHG-1.2 Climate Action Plans:** The City/County will establish plans to reduce or encourage reductions in GHG emissions from all sectors within the City/County.[2]	**CO 8.1.1** **pg. CO-92** **(Con/OS 8/09)**	**Policy CO 8.1.1:** Create and adopt a Climate Action Plan within 18 months of the OVOV adoption date that meets State requirements and includes the following components:
GHG-1.1.1 **pg. 70**	**1.1.1** The City/County will establish a baseline inventory of GHG emissions including municipal emissions, and emissions from all business sectors and the community.	***None***	*OVOV has no similar language, however establishing a GHG inventory is implied as part of the CAP process described in CO 8.1.1.*
GHG-1.1.2 **pg. 70**	**1.1.2** The City/county will define a "business as usual" scenario of municipal, economic, and community activities, and prepare a projected inventory for 2020 based on that scenario.	***None***	*OVOV has no similar language, however establishing a baseline is implied as part of the CAP process described in CO 8.1.1.*

[1] Note that the goal is not to reduce GHG emissions by 30% from the base year but at some time in the future - "if all activities continued under a 'business as usual' scenario." The CAPCOA provides two different alternatives for this goal. GHG 1.1A and 1.2A are below.
[2] The CAPCOA plan under GHG1.2 seems to define a need for three distinct elements of the CAP – a municipal, business and community plan.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
GHG-1.2.1 pg. 70	**1.2.1** The City/County will establish a Municipal Climate Action Plan which will include measures to reduce GHG emissions from municipal activities by at least 30% by 2020 compared to the "business as usual" municipal emissions.	**CO 8.1.1.a pg. CO-92 (Con/OS 8/09)**	a. Plans and programs to reduce GHG emissions to State-mandated targets, including enforceable reduction measures
GHG-1.2.2 pg. 70	**1.2.2** The City/County will, in collaboration with the business community, establish a Business Climate Action Plan, which will include measures to reduce GHG emissions from business activities, and which will seek to reduce emissions by at least 30% by 2020 compared to "business as usual" business emissions.	**CO 8.1.1.a pg. CO-92 (Con/OS 8/09)**	a. Plans and programs to reduce GHG emissions to State-mandated targets, including enforceable reduction measures
GHG 1.2.3 pg. 70	**1.2.3** The City/County will, in collaboration with the stakeholders from the community at large, establish a Community Climate Action Plan, which will include measures reduce GHG emissions from community activities, and which will seek to reduce emissions by at least 30% by 2020 compared to "business as usual" community emissions.	**CO 8.1.1.a pg. CO-92 (Con/OS 8/09)**	a. Plans and programs to reduce GHG emissions to State-mandated targets, including enforceable reduction measures
GHG 1.2.4 pg. 71	**1.2.4** Or: The City / County will, in collaboration with the stakeholders from the community at large, establish a CCAP, which will include measures to reduce GHG from community, municipal and business activities by at least 30% by 2020, compared to "business as usual".[3]	**CO 8.1.1.a-e pg. CO-92 (Con/OS 8/09)**	a. Plans and programs to reduce GHG emissions to State-mandated targets, including enforceable reduction measures b. Mechanisms to ensure regular review of progress towards the emission reduction targets established by the Climate Action Plan; c. Procedures for reporting on progress to officials and the public; d. Procedures for revising the plan as needed to meet GHG emissions reduction targets; e. Allocation of funding and staffing for Plan implementation;

[3] As an option to having three elements to the CAP (municipal, business and community), the CAPCOA document gives the option of having a single, all-encompassing element provided that collaboration with stakeholders occurs.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
GHG-2 **pg. 71**	**Objective GHG-2** The City/County will ensure that its local Climate Action, Land Use, Housing, and Transportation Plans are aligned with, support, and enhance any regional plans that have been developed consistent with state guidance to achieve reductions in GHG emissions.	**CO 8.1.2** **pg. CO-92** **(Con/OS 8/09)**	**Policy CO 8.1.2:** Participate in the preparation of a regional Sustainable Communities Strategy (SCS) Plan to meet regional targets for greenhouse gas emission reductions, as required by SB 375.
GHG-2.1 **pg. 71**	**GHG-2.1 Sustainable Communities Strategy/Regional Blueprint Planning:** The City/County will participate in the Sustainable Communities Strategy/Regional Blueprint Planning effort and will ensure that local plans are consistent with the Regional Plan.	**CO 8.1.2** **pg. CO-92** **(Con/OS 8/09)**	**Policy CO 8.1.2:** Participate in the preparation of a regional Sustainable Communities Strategy (SCS) Plan to meet regional targets for greenhouse gas emission reductions, as required by SB 375.
GHG-1.1A & 1.2A **pg. 71**	***GHG-1.1A Emission Inventories:*** *(Alternative form) The City/County will establish GHG emissions inventories including emissions from all sectors within the City/County, using methods approved by, or consistent with guidance from, the ARB; the City/County will update inventories every 4 years to incorporate improved methods, better data, and more accurate tools and methods, and to assess progress.* ***GHG-1.2A Climate Action Plans:*** *(Alternative form) The City/County will establish plans to reduce or encourage reductions in GHG emissions from all sectors within the City/County.*	**See CO 8.1.1 a-e above** **(Con/OS 8/09)**	See Above.
GHG-1.2.1A **pg. 71**	***1.2.1*** *The City/County will establish a Municipal Climate Action Plan which will include measures to reduce GHG emissions from municipal activities by at least 15% by 2020 compared to the baseline municipal emissions inventory (including any reductions required by ARB under AB 32).*	**See CO 8.1.1 a-e above** **(Con/OS 8/09)**	See Above.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
GHG-1.2.2A **pg. 71**	***1.2.2*** *The City/County will, in collaboration with the business community, establish a Business Climate Action Plan, which will include measures to incentivize and support reductions in GHG emissions from business activities, and which will seek to reduce emissions by at least 15% by 2020 compared to the baseline business emissions inventory (including any reductions required by ARB under AB-32).*	**See OC 8.1.1 a-e above (Con/OS 8/09)**	See Above .
GHG-1.2.3A **pg. 71**	***1.2.3*** *The City/County will, in collaboration with the stakeholders from the community at large, establish a Community Climate Action Plan, which will include measures to incentivize and support reductions in GHG emissions from community activities, and which will seek to reduce emissions by at least 15% by 2020 compared to the baseline community emissions inventory.*[4]	**See CO 8.1.1 a-e above (Con/OS 8/09)**	See Above
CAPCOA – Land Use and Urban Design		**OVOV**	
Reference	**Language**	**Reference**	**Language**
LU-1 pg. 73	**Objective LU-1:** The City/County will adopt and implement a development pattern that utilizes existing infrastructure; reduces the need for new roads, utilities and other public works in new growth areas; and enhances non-automobile transportation.	**LU 1.1 pg. L-70 (Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure.

[4] Note that there is no alternative language for 1.2.4.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-1.1 **pg. 73**	**LU-1.1 Urban Growth Boundary:** The City will establish an urban growth boundary (UBG) with related ordinances or programs to limit suburban sprawl; the City/County will restrict urban development beyond the UGB and streamline entitlement processes within the UGB for consistent projects.	**LU 1.1** **pg. L-70** **(Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure.
LU-1.1.1 **pg. 73**	**1.1.1** Urban development should occur only where urban public facilities and services exist or can be reasonably made available.	**LU 1.1** **pg. L-70** **(Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure.
LU-1.1.2 **pg. 73**	**1.1.2** The improvement and expansion of one urban public facility or service should not stimulate development that significantly precedes the City's, or other affected jurisdiction's, ability to provide all other necessary urban public facilities and services at adequate levels.	**LU 9.1** **pg. L-86** **(Land Use 8/09)**	**Objective LU 9.1:** Coordinate land use planning with provision of adequate public services and facilities to support development.
LU-1.2 **pg. 73**	**LU-1.2 Reserve Limits:** The City/County will redirect new growth into existing city/urban reserve areas.	**LU 1.1** **pg. L-70** **(Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure.
LU-1.3 **pg. 73**	**LU-1.3 Infill:** The City/County will encourage high-density, mixed-use, infill development and creative reuse of brownfield, under-utilized and/or defunct properties within the urban core.	**LU 1.1.5** **pg. L-70** **(Land Use 8/09)**	**Policy LU 1.1.5:** Promote infill development and re-use of underutilized sites within and adjacent to developed urban areas to achieve maximum benefit from existing infrastructure and minimize loss of open space, through redesignation of vacant sites for higher density or mixed uses, where appropriate.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-1.4 **pg. 73**	**LU-1.4 Urban Service Lines:** The City/County will maintain a one dwelling unit per 10 acre minimum lot size or lower density in areas outside designated urban service lines.	***None***	*OVOV has no similar policy, however the Non-Urban 1(NU 1) and Non-Urban 2 (NU 2) zones define a density of 1 unit per 10 acres and 1 unit per 20 acres respectively. These zones are proposed for the outermost, rural locations of the planning area.*[5]
LU-1.4.1 **pg. 73**	**1.4.1** Adopt an urban-rural transition zone along the urban service line to ensure that land uses within the City / County are compatible with adjacent open space and agricultural uses.		*OVOV has no similar policy, however the Non-Urban 1(NU 1) and Non-Urban 2 (NU 2) zones define a density of 1 unit per 10 acres and 1 unit per 20 acres respectively. These zones are proposed for the outermost, rural locations of the planning area.*
LU-1.5 **pg. 73**	**LU-1.5 Density:** The City/County will increase densities in urban core areas to support public transit.	**LU 5.2 & 5.2.1** **pg. L-80** **(Land Use 8/09)**[6]	**Objective LU 5.2:** Coordinate land use designations with support services and public transit in order to encourage vehicle trip reduction. **Policy LU 5.2.1:** Designate higher-density residential uses in areas served by public transit and a full range of support services.
LU-1.5.1 **pg. 73**	**1.5.1** Remove barriers to the development of accessory dwelling units in existing residential neighborhoods inside urban service lines.	**H 5.5** **pg. H-135** **(Housing 9/09)**	**H 5.5:** The City will amend the Unified Development Code to allow second dwelling units on individual residential lots with primary dwellings, provided that said lots are between 5,000 square feet and 19,999 square feet in area, subject to a conditional use permit. This action is in addition to the City's existing allowance for second dwelling units on lots of 20,000 square feet or larger, subject to an Administrative Permit.

[5] Land Use Element pp. 50-51 (Draft 8/09).
[6] OVOV defines several mixed use zones that range in density from a minimum of 6 units per acre to 50 units per acre. *The City Santa Clarita Green Team Report – Review of Policies and Programs* suggests an average density for Transit Oriented Development of 18 units per acre.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-1.6 **pg. 74**	**LU-1.6 Road Width:** The City/County will reduce required road width standards wherever feasible to calm traffic and encourage alternative modes of transportation.	**LU 2.3.5** **pg. L-75** **(Land Use 8/09)** **C 2.2.5** **pg. C-62** **(Circ 8/09)**	**Policy LU 2.3.5:** Mixed-use developments shall be designed to create a pedestrian-scale environment through appropriate street and sidewalk widths, block lengths, relationship of buildings to streets, and use of public spaces. **Policy C 2.2.5:** Adopt common standards for pavement width in consideration of capacity needs to serve projected travel demand, provided that a reduction in pavement width may be allowed in order to reduce traffic speeds, protect resources, enhance pedestrian mobility, or as otherwise deemed appropriate by the reviewing authority.
LU-1.7 **pg. 74**	**LU-1.7 Parking Spaces:** The City/County will reduce parking space requirements, unbundle parking from rents and charge for parking in new developments.	**LU 2.3.6** **pg. LU-75** **(Land Use 8/09)** **C 1.2.6 & 3.3.4** **pg. C-60, 65** **(Circ 8/09)**	**Policy LU 2.3.6:** Provide parking alternatives in mixed-use developments, including subterranean parking and structured parking to limit the amount of surface area devoted to vehicle storage. **Policy C 3.3.4:** Within transit-oriented development projects, provide incentives such as higher floor area ratio and/or lower parking requirements for commercial development that provides transit and ride-share programs. **Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
LU-1.8 **pg. 74**	**LU-1.8 Bicycle Facilities:** The City/County will add bicycle facilities to city streets and public spaces.	**C 1.1.6** **pg. C-59** **(Circ 8/09)**	**Policy C 1.1.6:** Provide adequate facilities, including but not limited to bicycle parking and storage, expansion of park-and-ride lots, and provision of adequate station and transfer facilities in appropriate locations.[7]

[7] Note that UDC Section 17.18.105 currently requires on-site bicycle parking for all commercial, office, industrial and multi-family uses.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-1.9 **pg. 74**	**LU-1.9 Levels of Service:** The City/County will discourage the extension of urban levels of service for new development beyond existing urban service lines, and, if necessary, use zoning to assure that development occurs only if public services are adequate.	**LU 1.1** **pg. L-70** **(Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure.
LU-2 **pg. 74**	**Objective LU-2**: Promote infill, mixed-use, and higher density development, and provide incentives to support the creation of affordable housing in mixed use zones.	**LU 1.1.5 & 3.1.5** **pg. L-70, 75** **(Land Use 8/09)**	**Policy LU 1.1.5:** Promote infill development and re-use of underutilized sites within and adjacent to developed urban areas to achieve maximum benefit from existing infrastructure and minimize loss of open space, through redesignation of vacant sites for higher density or mixed uses, where appropriate. **Policy LU 3.1.5:** Promote development of housing affordable to residents, including households with incomes in the very low, low, and moderate income classifications, through provision of adequate sites on the Land Use Map, density bonuses and other development incentives.
LU-2.1 **pg. 74**	**LU-2.1 Mixed-Use Development:** The City/County will plan for and create incentives for mixed-use development.	**LU 1.1.5** **pg. L-70** **(Land Use 8/09)**	**Policy LU 1.1.5:** Increase infill development and re-use of underutilized sites within and adjacent to developed urban areas to achieve maximum benefit from existing infrastructure and minimize loss of open space, through redesignation of vacant sites for higher density and mixed uses, where appropriate.[8]
LU-2.1.1 **pg. 74**	**2.1.1** The City/County will identify sites suitable for mixed-use development within an existing urban service line and will establish appropriate site specific standards to accommodate the mixed uses.	**LU 2.3** **pg. L-74** **(Land Use 8/09)**	**Objective LU 2.3:** Increase mixed-use development to create more livable neighborhoods, walkable business districts, and to reduce vehicle trips, while ensuring land use compatibility through mixed use zoning[9]

[8] Mixed use development under OVOV provides a variety of incentives. For example, the Mixed Use Urban Village Zone's minimum density is 19 units per acre and maximum density is 50 units per acre. This maximum density is 20 units per acre higher than the most dense residential zone, Urban Residential 5.
[9] A description of ideal locations for each mixed use zone is included in the body of the Land Use Element, pages L-57 and 58.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-2.1.1.1 pg. 74	**2.1.1.1** Increasing allowable building height or allowing height limit bonuses;	***None***	*OVOV has no similar policy, however both the Mixed Use Corridor and Mixed Use Urban Village zones have no maximum height. A maximum height of 50 feet has been established for the Mixed Use Neighborhood zone which is comparable with the Community Commercial (50 ft.) and Regional Commercial (55 ft.) zones and exceeds the Neighborhood Commercial (35 ft.) zone.*[10]
LU-2.1.1.2 pg. 74	**2.1.1.2** Allowing flexibility in applying development standards (such as FAR and lot coverage) based on the location, type, and size of the units, and the design of the development;	***None***	*OVOV has no similar policy, however the maximum floor area ratio allowed in a Mixed Use zone is 3.0. This exceeds the Regional Commercial and Business Park zone maximum floor area ratios of 2.0.*[11]
LU-2.1.1.3 pg. 74	**2.1.1.3** Allowing the residential component to be additive rather than within the established FAR for that zone, and eliminating maximum density requirements for residential uses in mixed use zones;	**LU 2.3.1 pg. L-75 (Land Use 8/09)**	**Policy LU 2.3.1:** In a mixed-use development, residential densities at the higher end of the allowed range should be allowed only if the development incorporates a robust mix of non-residential uses. *The residential density in MX districts shall range from a minimum of six (6) to a maximum of fifty (50) dwelling units per acre, and the maximum floor area ratio (FAR) for non-residential uses shall range from .5 to 3.0, depending on the location of the mixed-use project*[12]
LU-2.1.1.4 pg. 74	**2.1.1.4** Allowing reduced and shared parking based on the use mix, and establishing parking maximums where sites are located within 0.25 miles of a public transit stop;	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
LU-2.1.1.5 pg. 74	**2.1.1.5** Allowing for tandem parking, shared parking and off-site parking leases;	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.

[10] Land Use Element pp. 57-60 (draft 8/09).
[11] Land Use Element pp. 57-61 (draft 8/09).
[12] Land Use Element pg. 58 (draft 8/09).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-2.1.1.6 pg. 75	**2.1.1.6** Requiring all property owners in mixed-use areas to unbundle parking from commercial and residential leases;	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
LU-2.1.1.7 pg. 75	**2.1.1.7** Creating parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities;	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities wherever feasible.;
LU-2.1.1.8 pg. 75	**2.1.1.8** Establishing performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times.	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Establish performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times wherever feasible.
LU-2.1.2 pg. 75	**2.1.2** The City/County will seek funding to prepare specific plans and related environmental documents to facilitate mixed-use development at selected sites, and to allow these areas to serve as receiver sites for transfer of development rights away from environmentally sensitive lands and rural areas outside established urban growth boundaries.	***None***	*OVOV has no similar language.*
LU-2.1.3 pg. 75	**2.1.3** The City/County will enable prototype mixed-use structures for use in neighborhood center zones that can be adapted to new uses over time with minimal internal remodeling.	***None***	*OVOV has no similar language.*
LU-2.1.4 pg. 75	**2.1.4** The City/County will identify and facilitate the inclusion of complementary land uses not already present in local zoning districts, such as supermarkets, parks and recreational fields, schools in neighborhoods, and residential uses in business districts, to reduce the vehicle miles traveled and promote bicycling and walking to these uses.	**LU 2.3 pg. L-74 (Land Use 8/09)**	**Objective LU 2.3:** Provide mixed-use development where appropriate to create more livable neighborhoods, walkable business districts, and to reduce vehicle trips, while ensuring land use compatibility.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-2.1.5 pg. 75	**2.1.5** The City/County will work with employers developing larger projects to ensure local housing opportunities for their employees, and engage employers to find ways to provide housing assistance as part of their employee benefits packages; major projects in mixed-use areas should include work-force housing where feasible.	***None***	*OVOV has no similar language.*
LU-2.1.6 pg. 75	**2.1.6** The City/County will revise zoning ordinance(s) to allow local-serving businesses, such as childcare centers, restaurants, banks, family medical offices, drug stores, and other similar services near employment centers to minimize midday vehicle use.	**LU 2.3 & 4.5.4 pg. L-74, 81 (Land Use 8/09)**	**Objective LU 2.3:** Provide mixed-use development where appropriate to create more livable neighborhoods, walkable business districts, and to reduce vehicle trips, while ensuring land use compatibility **Policy LU 4.5.4:** Encourage the provision of support services for employees within business park areas, such as dining and personal services where appropriate, to reduce vehicle trips and promote pedestrian-friendly work environments.
LU-2.1.7 pg. 76	**2.1.7** The City / County will develop form-based community design standards to be applied to development projects and land use plans, using a comprehensive community outreach, for areas designated mixed-use	**LU 1.2.1 pg. L-72 (Land Use 8/09)**	**Policy LU 1.2.1:** In Newhall, provide opportunities for new business and housing by implementing the Downtown Newhall Specific Plan, provide incentives to promote infill development and re-use of underutilized sites, and continue to plan for the future development of North Newhall.
LU-2.1.8 pg. 76	**2.1.8** Mix affordable housing units with market rate units as opposed to building segregated affordable housing developments.	**LU 3.1.2 pg. L-75 (Land Use 8/09)**	**Policy LU 3.1.2:** Provide a mix of housing types within neighborhoods that accommodate households with varied income levels.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-3 **pg. 76**	**Objective LU-3**: Promote greater linkage between land uses and transit, as well as other modes of transportation.	**LU 5.2** **pg. L-80** **(Land Use 8/09)** **C 1.2.1** **pg. 59** **(Circ 8/09)**	**Objective LU 5.2:** Coordinate land use designations with support services and public transit in order to encourage vehicle trip reduction. **Policy C 1.2.1:** Develop coordinated plans for land use, circulation, and transit to promote transit-oriented development that concentrates higher density housing, employment, and commercial areas in proximity to transit corridors.
LU-3.1 **pg. 76**	**LU-3.1 Transit-Supportive Density:** The City/County will implement a Housing Overlay Zone for transit centers and corridors. This shall include average minimum residential densities of 25 units per acre within one quarter mile of transit centers; average minimum densities of 15 units per acre within one quarter mile of transit corridors; and minimum FAR of 0.5:1 for nonresidential uses within a quarter mile of transit centers or corridors.	***None***	*OVOV has no similar policy, however OVOV defines several mixed use zones that range in density from a minimum of 6 units per acre to 50 units per acre. Also, OVOV defines a range of FAR's allowed in Mixed Use zones between .5 and 3.0.*[13]
LU-3.2 **pg. 76**	**LU-3.2 Transit-Oriented Development:** The City/County will identify transit centers appropriate for mixed-use development, and will promote transit oriented, mixed use development within these targeted areas	**LU 2.3** **pg. L-74** **(Land Use 8/09)**	**Objective LU 2.3:** Provide mixed-use development where appropriate to create more livable neighborhoods, walkable business districts, and to reduce vehicle trips, while ensuring land use compatibility[14]

[13] Land Use Element pp. L-57-60 (draft 8/09).
[14] A description of ideal locations for each mixed use zone are included in the body of the Land Use Element, pages L-57 and 58.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-3.2.1 pg. 76	**3.2.1** Amending the Development Code to encourage mixed-use development within one-half mile of intermodal hubs and future rail stations; to offer flexible standards for affordable housing; and to establish minimum residential densities and non-residential FAR	**LU 5.2 pg. L-80 (Land Use 8/09)** **C 1.2.1 pg. 59 (Circ 8/09)**	**Objective LU 5.2:** Coordinate land use designations with support services and public transit in order to encourage vehicle trip reduction. **Policy C 1.2.1:** Develop coordinated plans for land use, circulation, and transit to promote transit-oriented development that concentrates higher density housing, employment, and commercial areas in proximity to transit corridors.
LU-3.2.2 pg. 76	**3.2.2** Rezoning commercial properties to residential and/or mixed-use where appropriate;	***None***	*OVOV has no similar policy, however the draft Land Use Map include in OVOV illustrates areas that have been rezoned pursuant to LU-3.2.2.*
LU-3.2.3 pg. 76	**3.2.3** Providing expanded zoning for multi-family housing;	**H 1 pg.H-121 (Housing 9/2009)**	**Objective H1:** Provide adequate sites at a range of densities to accommodate future housing needs.
LU-3.2.4 pg. 76	**3.2.4** Providing maximum parking standards and flexible building height limitations;	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate. *Both the Mixed Use Corridor and Mixed Use Urban Village zones have no maximum height. A maximum height of 50 feet (permitted by right) has been established for the Mixed Use Neighborhood zone which is comparable with the Community Commercial (50 ft.) and Regional Commercial (55 ft.) zones and exceeds the Neighborhood Commercial (35 ft.) zone. These heights can be exceeded with a conditional use permit.*[15]

[15] Land Use Element pp. 57-60 (draft 8/09).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-3.2.5 pg. 76	**3.2.5** Providing density bonus programs;	**LU 3.1.5 pg. L-75 (Land Use 8/09)**	**Policy LU 3.1.5:** Provide adequate sites on the Land Use Map, density bonuses and other development incentives,.
LU-3.2.6 pg. 76	**3.2.6** Establishing guidelines for private and public spaces;	***Land Use Element***	*OVOV has established numerous requirements and guidelines for the development of public and private spaces. These are described in detail in the draft Land Use Element.*
LU-3.2.7 pg. 76	**3.2.7** Providing incentives for redevelopment of underutilized areas, such as surface parking lots;	**LU 1.1.5 pg. L-70 (Land Use 8/09)**	**Policy LU 1.1.5:** Increase infill development and re-use of underutilized sites within and adjacent to developed urban areas to achieve maximum benefit from existing infrastructure and minimize loss of open space, through redesignation of vacant sites for higher density or mixed uses, where appropriate.
LU-3.2.8 pg. 76	**3.2.8** Establishing a minimum pedestrian and bicycle connectivity standard;	**LU 5.1.2 pg. L-80 (Land Use 8/09)**	**Policy LU 5.1.2:** Require connectivity between walkways and bikeways serving neighborhoods and nearby commercial areas, schools, parks, and other supporting services and facilities.
LU-3.2.9 pg. 76	**3.2.9** Creating parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities;	**NEW CIRC POLICY**	**NEW CIRC ELEMENT POLICY:** Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities wherever feasible.
LU-3.2.10 pg. 77	**3.2.10** Establishing performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times;	***None***	*OVOV has no similar language.*
LU-3.2.11 pg. 77	**3.2.11** Discouraging auto-oriented development.	**C 1 pg. C-58 (Circ 8/09)**	**Goal C 1:** An inter-connected network of circulation facilities that integrates all travel modes, provides viable alternatives to automobile use, and conforms with regional plans

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-3.3 pg. 77	**LU-3.3 Transit-oriented Brownfield Development:** The City/County will promote the development of brownfield sites and other underused or defunct properties near existing public transportation.	**LU 1.2.7 pg. L-71 (Land Use 8/09)**	**Policy LU 1.2.7:** On the Whittaker-Bermite site, continue to work with the property owner to facilitate master planning, remediation, and the economic re-use of the property to include roadway infrastructure and transit-oriented development around the Metrolink station.
LU-3.4 pg. 77	**LU-3.4 Public Transit Development Focus:** The City/County will ensure new development is designed to make public transit a viable choice for residents, including:	**C 1.1.1 pg. C-58 (Circ 8/09)**	**Policy C 1.1.1:** Reduce dependence on the automobile, particularly single-occupancy vehicle use, by providing safe and convenient access to transit, bikeways, and walkways.
LU-3.4.1 pg. 77	**3.4.1** Locating medium-high density development near activity centers that can be served efficiently by public transit and alternative transportation modes;	**LU 5.2.1 pg. L-80 (Land Use 8/09)**	**Policy LU 5.2.1:** Designate higher-density residential uses in areas served by public transit and a full range of support services.
LU-3.4.2 pg. 77	**3.4.2** Locating medium-high density development near streets served by public transit whenever feasible;	**LU 5.2.1 pg. L-80 (Land Use 8/09)**	**Policy LU 5.2.1:** Designate higher-density residential uses in areas served by public transit and a full range of support services.
LU-3.4.3 pg. 77	**3.4.3** Linking neighborhoods to bus stops by continuous sidewalks or pedestrian paths.	**C 1.2.2 pg. C-58 (Circ 8/09)**	**Policy C 1.2.2:** Create walkable communities, with paseos and walkways connecting residential neighborhoods to multi-modal transportation services such as bus stops and rail stations.
LU-3.5 pg. 77	**LU-3.5 City-centered Corridors:** The City/County will establish city-centered corridors, directing development to existing transportation corridors.	**LU 1.1 & 4.1.3 pp. L-70 & 77 (Land Use 8/09)**	**Objective LU 1.1:** Maintain an urban form for the Santa Clarita Valley that preserves an open space greenbelt around the developed portions of the Valley, protects significant resources from development, and directs growth to urbanized areas served with infrastructure. **Policy LU 4.1.3:** Direct business creation and expansion for larger companies within and adjacent to existing and planned business centers and major transportation corridors

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-3.6 **pg. 77**	**LU-3.6 Transit-oriented Development Design Standards:** The City / County will develop form-based community design standards to be applied to development projects and land use plans, using a comprehensive community outreach program, for areas designated mixed-use	**LU 1.2.1** **pg. L-72** **(Land Use 8/09)**	**Policy LU 1.2.1:** In Newhall, provide opportunities for new business and housing by implementing the Downtown Newhall Specific Plan, provide incentives to promote infill development and re-use of underutilized sites, and continue to plan for the future development of North Newhall.
LU-3.7 **pg. 77**	**LU-3.7 Affordable Housing:** Affordable housing will be located in transit-oriented development whenever feasible.	**C 1.2.1** **pg. C-59** **(Circ 8/09)**	**Policy C 1.2.1:** Develop coordinated plans for land use, circulation, and transit to promote transit-oriented development that concentrates higher density housing, employment, and commercial areas in proximity to transit corridors.
			Mixed residential densities will be allowed, to permit housing alternatives at all income levels and age preferences in proximity to transit jobs, and services. Through design of the Land Use Map in consideration of circulation patterns and needs, this General Plan will result in projected traffic impacts that are less significant than the previous General Plan, which was largely based on the separation of land uses.[16]
LU-4 **pg. 77**	**Objective LU-4:** Promote development and preservation of neighborhood characteristics that encourage walking and bicycle riding in lieu of automobile-based travel.	**LU 5.1.2** **pg. L-80** **(Land Use 8/09)**	**Policy LU 5.1.2:** Require connectivity between walkways and bikeways serving neighborhoods and nearby commercial areas, schools, parks, and other supporting services and facilities.

[16] Land Use Element, p. L-3 (draft 8/09).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-4.1 **pg. 77**	**LU-4.1 Pedestrian-oriented Character:** The City/County will create and preserve distinct, identifiable neighborhoods whose characteristics support pedestrian travel, especially within, but not limited to, mixed-use and transit-oriented development areas,	**LU 1.2, 2.1.3 & 5.1** **pg. L-71, 74 & 80** **(Land Use 8/09)**	**Objective LU 1.2:** Maintain the distinctive community character of villages and neighborhoods throughout the planning area by establishing uses, densities, and design guidelines appropriate to the particular needs and goals of each area **Policy LU 2.1.3:** Provide a range of land use types and densities to reflect the special characteristics, lifestyles, and opportunities that differentiate various communities and villages in the Santa Clarita Valley, including urban, suburban, and rural living environments. **Objective LU 5.1:** Provide for alternative travel modes linking neighborhoods, commercial districts, and job centers.
LU-4.1.1 **pg. 78**	**4.1.1** Designing or maintaining neighborhoods where the neighborhood center can be reached in approximately five minutes of walking;	***None***	*OVOV has no similar language, however neighborhood design is outlined in the Land Use Element in the description of Urban Residential zones.*[17]
LU-4.1.2 **pg. 78**	**4.1.2** Increasing housing densities from the perimeter to the center of the neighborhood;	***None***	*OVOV has no similar policy, however the proposed Land Use Map calls for greater central densities.*
LU-4.1.3 **pg. 78**	**4.1.3** Directing retail, commercial, and office space to the center of the neighborhood;	***None***	*OVOV has no similar policy, however the proposed Land Use Map calls for greater central densities.*
LU-4.1.4 **pg. 78**	**4.1.4** Encouraging pedestrian-only streets and/or plazas within developments, and destinations that may be reached conveniently by public transportation, walking, or bicycling;	**C 1.2.2, 1.2.3 & 7.1.7** **pg. C-59 & 70** **(Circ 8/09)**	**Policy C 1.2.2:** Create walkable communities, with paseos and walkways connecting residential neighborhoods to multi-modal transportation services such as bus stops and rail stations. **Policy C 1.2.3:** Require that new commercial and industrial development provide walkway connections to public sidewalks and transit stops, where available. **Policy C 7.1.7:** Use pedestrian-oriented scale and design features in areas intended for pedestrian use.

[17] Land Use Element pp. L-53 to L-55.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-4.1.5 pg. 78	**4.1.5** Allowing flexible parking strategies in neighborhood activity centers to foster a pedestrian-oriented streetscape;	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
LU-4.1.6 pg. 78	**4.1.6** Providing continuous sidewalks with shade trees and landscape strips to separate pedestrians from traffic;	**LU 3.4.9 pg. L-77 (Land Use 8/09)**	**Policy LU 3.4.9:** Encourage street cross-sections that locate landscaped parkways between the curb and the sidewalk to create a visually pleasing streetscape and provide pedestrian protection.
LU-4.1.7 pg. 78	**4.1.7** Encouraging neighborhood parks and recreational centers near concentrations of residential areas (preferably within one quarter mile) and include pedestrian walkways and bicycle paths that encourage nonmotorized travel.	**LU 5.1.2 pg. L-80 (Land Use 8/09)**	**Policy LU 5.1.2:** Require connectivity between walkways and bikeways serving neighborhoods and nearby commercial areas, schools, parks, and other supporting services and facilities.
LU-4.2 pg. 78	**LU-4.2 Pedestrian Access:** The City/County will ensure pedestrian access to activities and services, especially within, but not limited to, mixed-use and transit-oriented development areas,	**LU 5.1.2 & 7.1.7 pg. L-70, 80 (Land Use 8/09)**	**Policy LU 5.1.2:** Require connectivity between walkways and bikeways serving neighborhoods and nearby commercial areas, schools, parks, and other supporting services and facilities. **Policy C 7.1.7:** Use pedestrian-oriented scale and design features in areas intended for pedestrian use.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-4.2.1 pg. 78	**4.2.1** Ensuring new development that provides pedestrian connections in as many locations as possible to adjacent development, arterial streets, thoroughfares;	**C 1.2.2, 1.2.3, 1.2.5 & 1.2.7 pg. C-59, 60 (Circ 8/09)**	**Policy C 1.2.2:** Create walkable communities, with paseos and walkways connecting residential neighborhoods to multi-modal transportation services such as bus stops and rail stations. **Policy C 1.2.3:** Require that new commercial and industrial development provide walkway connections to public sidewalks and transit stops, where available. **Policy C 1.2.7:** In pedestrian-oriented areas, provide a highly connected circulation grid with relatively small blocks to encourage walking. **Policy C 1.2.5:** In mixed use projects, require compact development and mixed uses to locate housing, workplaces, and services within walking or bicycling distance of each other.
LU-4.2.2 pg. 78	**4.2.2** Ensuring a balanced mix of housing, workplaces, shopping, recreational opportunities, and institutional uses, including mixed-use structures;	**LU 2.1.2 pg. L-74 (Land Use 8/09)**	**Policy LU 2.1.2:** On the Land Use Map, integrate land use designations in a manner that promotes healthy, walkable communities, by providing an appropriate mix of residential and service uses in proximity to one another.
LU-4.2.3 pg. 78	**4.2.3** Locating schools in neighborhoods, within safe and easy walking distances of residences served;	**LU 5.1.2 pg. L-80 (Land Use 8/09)**	**Policy LU 5.1.2:** Require connectivity between walkways and bikeways serving neighborhoods and nearby commercial areas, schools, parks, and other supporting services and facilities.
LU-4.2.4 pg. 78	**4.2.4** For new development, primary entrances shall be pedestrian entrances, with automobile entrances and parking located to the rear;	**C 3.3.6 pg. C-65 (Circ 8/09)**	**Policy C 3.3.6:** In the development review process, prioritize direct pedestrian access between building entrances, sidewalks and transit stops, by placing parking behind buildings where possible, to the sides of buildings when necessary, and always away from street intersections.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-4.2.5 pg. 78	**4.2.5** Support development where automobile access to buildings does not impede pedestrian access, by consolidating driveways between buildings or developing alley access;	**C 7.1.5 pg. C-70 (Circ 8/09)**	**Policy C 7.1.5:** In new commercial development, provide for direct, clearly delineated, and preferably landscaped pedestrian walkways from transit stops and parking areas to building entries, and avoid placement of uses (such as drive-through facilities) in locations that would obstruct pedestrian pathways.
LU-4.2.6 pg. 79	**4.2.6** Street parking provided shall be utilized as a buffer between sidewalk pedestrian traffic and the automobile portion of the roadway;	**C 2.2.6 pg. C-70 (Circ 8/09)**	**Policy C 2.2.6:** Within residential neighborhoods, promote the design of "healthy streets" which may include reduced pavement width, shorter block length, provision of on-street parking, traffic-calming devices, bike routes and pedestrian connectivity, landscaped parkways, and canopy street trees.
LU-4.2.7 pg. 79	**4.2.7** Establish pedestrian and bicycle connectivity standards for new development, with block sizes between 1 and 2 acres;	**C 1.2.2 pg. C-59 (Circ 8/09)**	**Policy C 1.2.2:** Create walkable communities, with paseos and walkways connecting residential neighborhoods to multi-modal transportation services such as bus stops and rail stations.
LU-4.2.8 pg. 79	**4.2.8** For existing areas that do not meet established connectivity standards, prioritize the physical development of pedestrian connectors;	**C 7.1.2 pg. C-75 (Circ 8/09)**	**Policy C 7.1.2:** For existing walled subdivisions, extend pedestrian access to connect these neighborhoods to transit and services through public education and by facilitating retrofitted improvements where feasible.
LU-4.2.9 pg. 79	**4.2.9** Prioritizing grade-separated bicycle / pedestrian crossings where appropriate to enhance connectivity or overcome barriers such as freeways, railways and waterways.	**C 1.1.12** pg. C-60 (Circ 8/09)	**Policy C 1.1.12:** Implement recommendations of the City's Non-Motorized Transportation Plan to expand opportunities for alternative travel modes.
LU-5 pg. 79	**Objective LU-5:** Review fee structures and other opportunities to provide financial and administrative incentives to support desired land uses, development patterns, and alternative modes of transportation.	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Evaluate fee schedules on an ongoing basis to determine fee incentives to attract development
LU-5.1 pg. 79	**LU-5.1 Developer Fees:** The City/County will promote desired land uses by scaling developer fees based on desired criteria	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-5.1.1 pg. 79	**5.1.1** Increasing or reducing fees proportionally with distance from the city center or preferred transit sites;	***None***	*OVOV has no similar language.*
LU-5.1.2 pg. 79	**5.1.2** Increasing or reducing fees based on the degree to which mixed uses are incorporated into the project;	**None**	*OVOV has no similar language.*
LU-5.1.3 pg. 79	**5.1.3** Reducing fees for creative re-use of brownfield sites;	***None***	*OVOV has no similar language.*
LU-5.1.4 pg. 79	**5.1.4** Increasing fees for the use of greenfield sites.	***None***	*OVOV has no similar language.*
LU-5.2 pg. 79	**LU-5.2 Administrative Fees and Streamlining:** The City/County will provide fast-track permitting and reductions in processing fees for desired projects. The City/County will research and implement a program of incentives for development projects that are fully consistent with the Sustainable Communities Strategy / Regional Plan.	***None***	*OVOV has no similar language.*
LU-5.3 pg. 79	**LU-5.3 Incentives and Loans:** The City/County will provide incentive funding and/or infrastructure loans to support desired projects.	***None***	*OVOV has no similar language.*
LU-5.4 pg. 79	**LU-5.4 Infrastructure Preference:** The City/County will give preference for infrastructure improvements that support or enhance desired land uses and projects.	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-6 **pg. 79**	**Objective LU-6:** The City/County will mitigate climate change by decreasing heat gain from pavement and other hard surfaces associated with infrastructure.	**LU 7.1.1** **pg. L-99** **(Land Use 8/09)** **CO 3.1.8 & 8.1.3.d** **pg. CO-95, 106** **(Con/OS 8/09)**	**Policy LU 7.1.1:** Require shade trees within parking lots and adjacent to buildings to reduce the heat island effect, in consideration of Fire Department fuel modification restrictions. **Policy CO 3.1.8:** On development sites, require tree planting to provide habitat and shade to reduce the heat island effect caused by pavement and buildings. d. Encourage mitigation of the "heat island" effect through use of cool roofs, light-colored paving, and shading to reduce energy consumption for air conditioning.
LU-6.1 **pg. 80**	**LU-6.1 Hardscape Heat Gain:** The City/County will reduce heat gain from pavement and other hardscaping,	**LU 7.1.1** **pg. L-99** **(Land Use 8/09)** **CO 3.1.8 & 8.1.3.d** **pg. CO-95, 106** **(Con/OS 8/09)**	**Policy LU 7.1.1:** Require shade trees within parking lots and adjacent to buildings to reduce the heat island effect, in consideration of Fire Department fuel modification restrictions. **Policy CO 3.1.8:** On development sites, require tree planting to provide habitat and shade to reduce the heat island effect caused by pavement and buildings. d. Encourage mitigation of the "heat island" effect through use of cool roofs, light-colored paving, and shading to reduce energy consumption for air conditioning.
LU-6.1.1 **pg. 80**	**6.1.1** Reduce street rights-of-way and pavement widths to pre-World War II widths (typically 22 to 34 feet for local streets, and 30 to 35 feet for collector streets, curb to curb), unless landscape medians or parkway strips are allowed in the center of roadways;	**None**	*OVOV has no similar language. Local emergency services have been resistant to allowing a policy similar to LU 6.1.1.*
LU-6.1.2 **pg. 80**	**6.1.2** Reinstate the use of parkway strips to allow shading of streets by trees;	**CO 3.5.1 pg. CO-97** **(Con/OS 8/09)**	**Policy CO 3.5.1:** Continue to plant and maintain trees on public lands and within the public right-of-way to provide shade and walkable streets, incorporating measures to ensure that roots have access to oxygen at tree maturity, such as use of porous concrete.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
LU-6.1.3 pg. 80	**6.1.3** Include shade trees on south- and west-facing sides of structures;	**CO 8.3.6 pg. CO-108 (Con/OS 8/09)**	**Policy CO 8.3.6:** Require new development to use passive solar heating and cooling techniques in building design and construction, which may include but are not be limited to building orientation, clerestory windows, skylights, placement and type of windows, overhangs to shade doors and windows, and use of light colored roofs, shade trees and paving materials.
LU-6.1.4 pg. 80	**6.1.4** Include low-water landscaping in place of hardscaping around transportation infrastructure and in parking areas;	**CO 4.1.3 pg. CO-87 (Con/OS 8/09)**	**Policy CO 4.1.3:** Require low water use landscaping in new residential subdivisions and other private development projects, including a reduction in the amount of turf-grass.
LU-6.1.5 pg. 80	**6.1.5** Install cool roofs, green roofs, and use cool paving for pathways, parking, and other roadway surfaces;	**CO 8.1.3.d pg. CO-106 (Con/OS 8/09)**	d. Require mitigation of the "heat island" effect through use of cool roofs, light-colored paving, and shading to reduce energy consumption for air conditioning.
LU-6.1.6 pg. 80	**6.1.6** Establish standards that provide for pervious pavement options;	**CO 4.3 pg. CO-100 (Con/OS 8/09)**	**Objective CO 4.3:** Limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, and managing stormwater runoff at the source.
LU-6.1.7 pg. 80	**6.1.7** Remove obstacles to xeriscaping, edible landscaping and low-water landscaping.	**None**	*OVOV has no similar language.*
CAPCOA – Transportation Policies		**OVOV**	
Reference	**Language**	**Reference**	**Language**
TR-1 pg. 81	**Objective TR-1:** The City/County will reduce VMT-related emissions by encouraging the use of public transit through adoption of new development standards that will require improvements to the transit system and infrastructure, increase safety and accessibility, and provide other incentives.	**CO 8.1 pg. CO-92 (Con/OS 8/09)**	**Objective CO 8.1:** Comply with the requirements of State law, including AB 32, SB 375 and implementing regulations, to reach targeted reductions of greenhouse gas (GHG) emissions.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-1.1 **pg. 81**	**TR-1.1 Transportation Planning:** The City/County will ensure that new developments incorporate both local and regional transit measures into the project design that promote the use of alternative modes of transportation.	**C 1.1.12** **pg. C-60** **(Circ 8/09)**	**Policy C 1.1.12:** Implement recommendations of the City's Non-Motorized Transportation Plan to expand opportunities for alternative travel modes.
TR-1.1.1 **pg. 81**	**TR-1.1.1 Project Selection:** The City / County shall give priority to transportation projects that will contribute to a reduction in vehicle miles traveled per capita, while maintaining economic vitality and sustainability.	***None***	*OVOV has no similar policy. Refer to the Highway Plan Map. OVOV does not call for any new roads in the rural areas. Some roads are actually scheduled for removal.*
TR-1.1.2 **pg. 81**	**TR-1.1.2 Equal Pedestrian Access:** The City / County shall include sidewalks, separated sidewalks whenever possible, on both sides of all new street improvement projects, except where there are severe topographic or natural resource constraints.	***None***	*OVOV has no similar policy, however all but two of the standard roadway cross sections (excluding Rural Major and Rural Secondary Highway) included in the draft Circulation element require a sidewalk*[18].
TR-1.1.3 **pg. 81**	**TR-1.1.3 Public Involvement:** Carry out a comprehensive public involvement and input process that provides information about transportation issues, projects, and processes to community members and other stakeholders, especially to those traditionally underserved by transportation services.	**None**	*OVOV has no similar language, however the City's Traffic, CIP and Transit Divisions regularly engage the public on all transportation and circulation improvement projects.*
TR-1.2 **pg. 81**	**TR-1.2 System Interconnectivity:** The City/County will create an interconnected transportation system that allows a shift in travel from private passenger vehicles to alternative modes, including public transit, ride sharing, carsharing, bicycling and walking.	**C 1** **pg. C-58** **(Circ 8/09)**	**Goal C 1:** An inter-connected network of circulation facilities that integrates all travel modes, provides viable alternatives to automobile use, and conforms to regional plans.

[18] Circulation Element pp. C-28 to C-34 (draft 8/09).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-1.2.1 **pg. 81**	**1.2.1** Ensure transportation centers are multi-modal to allow transportation modes to intersect	**C 1.1.6** **pg. C-59** **(Circ 8/09)**	**Policy C 1.1.6:** Ensure multi-modal travel through provision of adequate facilities, including but not limited to bicycle parking and storage, expansion of park-and-ride lots, and provision of adequate station and transfer facilities in appropriate locations.
TR-1.2.2 **pg. 81**	**1.2.2** Provide adequate and affordable public transportation choices, including expanded bus routes and service, as well as other transit choices such as shuttles, light rail, and rail;	**C 1.1.1** **pg. C-59** **(Circ 8/09)**	**Policy C 1.1.1:** Reduce dependence on the automobile, particularly single-occupancy vehicle use, by providing safe and convenient access to transit, bikeways, and walkways.
TR-1.2.3 **pg. 81**	**1.2.3** To the extent feasible, extend service and hours of operation to underserved arterials and population centers or destinations such as colleges;	***None***	*OVOV has no similar language, however existing local bus service operates generally from as early as 5 AM to as late as 11 PM. The City is constantly evaluating demand and making adjustments to service provision.*[19]
TR-1.2.3A **pg. 82**	**1.2.3A** Focus transit resources on high-volume corridors and high-boarding destinations such as colleges, employment centers and regional destinations;	**C 5.3.1** **pg. C-68** **(Circ 8/09)**	**Policy C 5.3.1:** Continue to provide fixed route service to significant activity areas and neighborhoods with moderate to high density, and serve low-density and rural areas with dial-a-ride, flexible fixed routes, or other transit services as deemed appropriate.
TR-1.2.4 **pg. 82**	**1.2.4** Coordinate schedules and routes across service lines with neighboring transit authorities;	**C 1.1.3** **pg. C-58** **(Circ 8/09)**	**Policy C 1.1.3:** Work with local and regional agencies and employers to promote an integrated, seamless transportation system that meets access needs, including local and regional bus service, dial-a-ride, taxis, rail, van pools, car pools, bus pools, bicycling, walking, and automobiles.
TR-1.2.5 **pg. 82**	**1.2.5** Support programs to provide "station cars" for short trips to and from transit nodes (e.g., neighborhood electric vehicles);	***None***	*OVOV has no similar language.*
TR-1.2.6 **pg. 82**	**1.2.6** Study the feasibility of providing free transit to areas with residential densities of 15 dwelling units per acre or more, including options such as removing service from less dense, underutilized areas to do so;	***None***	*OVOV has no similar policy. The City will continue to analyze transit fees as a part of the Regional Transportation Plan analysis.*

[19] Schedules for Santa Clarita Transit are available at http://www.santaclaritatransit.com/Index.aspx?page=3

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-1.2.7 pg. 82	**1.2.7** Employ transit-preferential measures, such as signal priority and bypass lanes. Where compatible with adjacent land use designations, right-of-way acquisition or parking removal may occur to accommodate transit-preferential measures or improve access to transit. The use of access management should be considered where needed to reduce conflicts between transit vehicles and other vehicles;	**C 5.1.6 & C 1.1.8 pp. C-67 & 59 (Circ 8/09)**	**Policy 5.1.6:** Evaluate the feasibility of giving buses priority at signalized intersections to maintain transit service level standards, where appropriate. **Policy C 1.1.8:** Acquire and/or reserve adequate right-of-way in transportation corridors to accommodate multiple travel modes, including bus turnouts, bus rapid transit (BRT), bikeways, walkways, and linkages to trail systems.
TR-1.2.8 pg. 82	**1.2.8** Provide safe and convenient access for pedestrians and bicyclists to, across, and along major transit priority streets;	**C 1.1.7 & C 1.2.8 pp. C-59 & 60 (Circ 8/09)**	**Policy C 1.1.7:** Consider the safety and convenience of the traveling public, including pedestrians and cyclists, in design and development of all transportation systems. **Policy C 1.2.8:** Provide safe pedestrian connections across barriers, which may include but are not limited to major traffic corridors, drainage and flood control facilities, utility easements, grade separations, and walls.
TR-1.2.9 pg. 82	**1.2.9** Use park-and-ride facilities to access transit stations only at ends of regional transit-ways or where adequate feeder bus service is not feasible.	***None***	*OVOV has n o similar policy. Although the Circulation Element does discuss park-and-ride facilities at length, the intent of OVOV is to expand the number of park-and-rides throughout the planning area whereas the intent of TR-1.2.9 seems to be to limit them.*
TR-1.3 pg. 82	**TR-1.3 Transit System Infrastructure:** The City/County will upgrade and maintain transit system infrastructure to enhance public use,	***See Below***	*See Below.*
TR-1.3.1 pg. 82	**1.3.1** Ensure transit stops and bus lanes are safe, convenient, clean and efficient;	**C 5.2 pg. C-67 (Circ 8/09)**	**Objective C 5.2:** Maximize the accessibility, safety, convenience, and appeal of transit stops.
TR-1.3.2 pg. 82	**1.3.2** Ensure transit stops have clearly marked street-level designation, and are accessible;	**C 5.2.4 pg. C-67 (Circ 8/09)**	**Policy C 5.2.4:** Enhance way-finding signage along walkways and paseos to direct pedestrians to transit stops.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-1.3.3 pg. 82	**1.3.3** Ensure transit stops are safe, sheltered, benches are clean, and lighting is adequate;	**C 5.2.2 pg. C-67 (Circ 8/09)**	**Policy C 5.2.2:** Adopt and implement consistent design standards for use in both City and County areas for bus shelters, bus benches, trash receptacles, lighting, and other improvements for transit stops that are aesthetically pleasing and consistent with community character.
TR-1.3.4 pg. 82	**1.3.4** Place transit stations along transit corridors within mixed-use or transit-oriented development areas at intervals of three to four blocks, or no less than one-half mile.	***None***	*OVOV has no similar policy that requires transit stations at intervals of three to four blocks,, however Policy 5.1.4 does require a bus stop to be placed within ¼ mile of residential neighborhoods.*
TR-1.4 pg. 82	**TR-1.4 Customer Service:** The City/County will enhance customer service and system ease-of-use,	***None***	*OVOV has no similar language, however the City Council adopted the Transit Development Plan (TDP) in 2006. Several of the programs included in the TDP involve maximizing customer convenience to enhance ridership.*
TR-1.4.1 pg. 83	**1.4.1** Develop a Regional Pass system to reduce the number of different passes and tickets required of system users;	***None***	*OVOV has no similar language, however the City Council adopted the Transit Development Plan (TDP) in 2006. One of the programs included in the TDP which currently in the implementation process is the Transit Access Pass (TAP) program. This program will replace all existing passes into a single, paperless system. For more information visit the City of Santa Clarita's Transit website at http://santaclarita.taptogo.net/main.php?cn=santaclarita.*
TR-1.4.2 pg. 83	**1.4.2** Implement "Smart Bus" technology, using GPS and electronic displays at transit stops to provide customers with "real-time" arrival and departure time information (and to allow the system operator to respond more quickly and effectively to disruptions in service);	***None***	*OVOV has no similar language, however the City Council adopted the Transit Development Plan (TDP) in 2006. Several of the programs included in the TDP involve maximizing customer convenience to enhance ridership. A system of real-time, GPS based transit information similar to that described in TR-1.4.1 is currently being evaluated by the City.*
TR-1.4.3 pg. 83	**1.4.3** Investigate the feasibility of an on-line trip planning program.	***None***	*OVOV has no similar policy, however the City of Santa Clarita Transit Division currently operates an on-line trip planning program.*[20]

[20] The Trip Planner is available on the City of Santa Clarita's Transit Division website at http://www.santaclaritatransit.com/Index.aspx?page=27

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-1.5 **pg. 83**	**TR-1.5 Transit Funding:** The City/County will prioritize transportation funding to support a shift from private passenger vehicles to transit and other modes of transportation,	***None***	*OVOV has no similar policy that prioritizes funding to support transit over passenger vehicles, however Policy C 1.1.9 would Incorporate funding for all modes of transportation in the capital improvement program, and seek funding from all available sources for multi-modal system development.*
TR-1.5.1 **pg. 83**	**1.5.1** Give funding preference to improvements in public transit over other new infrastructure for private automobile traffic;	***None***	*OVOV has no similar language. It is inappropriate given the gaps in the existing right-of-way infrastructure to place public transit improvements as a higher priority in all cases than automobile traffic.*
TR-1.5.2 **pg. 83**	**1.5.2** Before funding transportation improvements that increase roadway capacity and VMT, evaluate the feasibility and effectiveness of funding projects that support alternative modes of transportation and reduce VMT, including transit, and bicycle and pedestrian access.	***None***	*OVOV has no similar language, however all cities in California will be subject to the priorities established by SB 375 for funding transportation projects.*
TR-1.6 **pg. 83**	**TR-1.6 Transit and Multimodal Impact Fees:** The City/County will assess transit and multimodal impact fees on new developments to fund public transportation infrastructure, bicycle infrastructure, pedestrian infrastructure and other multimodal accommodations.	**C 5.4.1** **pg. C-68** **(Circ 8/09)**	**Policy C 5.4.1:** Establish transit impact fee rates that are based on the actual impacts of new development on the transit system, and regularly monitor and adjust these fees as needed to ensure adequate mitigation.
TR-2 **pg. 83**	**Objective TR-2:** The City/County will implement traffic and roadway management strategies to improve mobility and efficiency, and reduce associated emissions.	**C 2.1** **pg. C-61** **(Circ 8/09)**	**Objective C 2.1:** Implement the Circulation Plan (as shown on Exhibit C-2) for streets and highways to meet existing and future travel demands for mobility, access, connectivity, and capacity.
TR-2.1 **pg. 83**	**TR-2.1 System Monitoring:** The City/County will monitor traffic and congestion to determine when and where the city needs new transportation facilities in order to increase access and efficiency.	**C 1.2** **pg. C-59** **(Circ 8/09)**	**Objective C 1.2:** Coordinate land use and circulation planning to achieve greater accessibility and mobility for users of all travel modes.
TR-2.2 **pg. 83**	**TR-2.2 Arterial Traffic Management:** The City/County will modify arterial roadways to allow more efficient bus operation, including bus lanes and signal priority/ preemption where necessary.	**C 5.1.6 &** **C 1.1.8** **pp. C-67 &** **59**	**Policy 5.1.6:** Evaluate the feasibility of giving buses priority at signalized intersections to maintain transit service level standards, where appropriate.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
		(Circ 8/09)	**Policy C 1.1.8:** Acquire and/or reserve adequate right-of-way in transportation corridors to accommodate multiple travel modes, including bus turnouts, bus rapid transit (BRT), bikeways, walkways, and linkages to trail systems.
TR-2.3 **pg. 83**	**TR-2.3 Signal Synchronization:** The City/County will expand signal timing programs where emissions reduction benefits can be demonstrated, including maintenance of the synchronization system, and will coordinate with adjoining jurisdictions as needed to optimize transit operation while maintaining a free flow of traffic.	**C 3.2.2** **pg. C-65** **(Circ 8/09)**	**Policy C 3.2.2:** Continue to enhance signal timing and synchronization to allow for free traffic flow, minimizing idling and vehicle emissions.
TR-2.4 **pg. 84**	**TR-2.4 HOV Lanes:** The City/County will encourage the construction of high occupancy vehicle (HOV) lanes or similar mechanisms whenever necessary to relieve congestion and reduce emissions.	***None***	*OVOV has no similar language.*
TR-2.5 **pg. 84**	**TR-2.5 Delivery Schedules:** The City/County will establish ordinances or land use permit conditions limiting the hours when deliveries can be made to off-peak hours in high traffic areas.	***None***	*OVOV has no similar language. However, the City does require all heavy commercial vehicles to receive a permit prior to entering or travelling through the City.*
TR-3 **pg. 84**	**Objective TR-3:** The City/County will reduce VMT related-emissions by implementing and supporting trip reduction programs.	**C 3** **pg. C-64** **(Circ 8/09)**	**Goal C 3:** Reduction of vehicle trips and emissions through effective management of travel demand, transportation systems, and parking.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-3.1 **pg. 84**	**TR-3.1 Ride-Share Programs:** The City/County will promote ride sharing programs,	**C 3.3.4, 3.1.4 & 3.1.5** **pg. C-65** **(Circ 8/09)**	**Policy C 3.3.4:** Within transit-oriented development projects, consider providing incentives such as higher floor area ratio and/or lower parking requirements for commercial development that provides transit and ride-share programs. **Policy C 3.1.4:** Promote the use of employee incentives to encourage alternative travel modes to work. **Policy C 3.1.5:** Promote the use of van pools, car pools, and shuttles to encourage trip reduction.
TR-3.1.1 **pg. 84**	**3.1.1** Designate a certain percentage of parking spaces for ride-sharing vehicles;	***None***	*OVOV has no similar language.*
TR-3.1.2 **pg. 84**	**3.1.2** Designate adequate passenger loading, unloading, and waiting areas for ride-sharing vehicles;	***None***	*OVOV has no similar language.*
TR-3.1.3 **pg. 84**	**3.1.3** Provide a web site or message board for coordinating shared rides;	***None***	*OVOV has no similar policy. However, the City of Santa Clarita's Environmental Services Division currently maintains rideshare information on its website: http://www.santa-clarita.com/cityhall/cmo/environment/get_involved_environmental.asp*
TR-3.1.4 **pg. 84**	**3.1.4** Encourage private, for-profit community car-sharing, including parking spaces for car share vehicles at convenient locations accessible by public transit;	***None***	*OVOV has no similar language.*
TR-3.1.5 **pg. 84**	**3.1.5** Hire or designate a rideshare coordinator to develop and implement ridesharing programs.	***None***	*OVOV has no similar language. However, a regular, full-time employee position is maintained in the City's Environmental Services Division to coordinate both in-house and community wide ride sharing programs.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-3.2 **pg. 84**	**TR-3.2 Employer-based Trip Reduction:** The City/County will support voluntary, employer-based trip reduction programs,	**C 3.1, 3.1.2, 3.1.4, 3.1.5** **pg. C-64 & 65** **(Circ 8/09)**	**Objective C 3.1:** Promote the use of travel demand management strategies to reduce vehicle trips. **Policy C 3.1.2:** Promote home-based businesses and live-work units as a means of reducing home-to-work trips. **Policy C 3.1.4:** Promote the use of employee incentives to encourage alternative travel modes to work. **Policy C 3.1.5:** Promote the use of van pools, car pools, and shuttles to encourage trip reduction.
TR-3.2.1 **pg. 84**	**3.2.1** Provide assistance to regional and local ridesharing organizations;	***None***	*OVOV has no similar language. OVOV has no similar language. However, a regular, full-time employee position is maintained in the City's Environmental Services Division to coordinate both in-house and community wide ride sharing programs.*
TR-3.2.2 **pg. 84**	**3.2.2** Advocate for legislation to maintain and expand incentives for employer ridesharing programs;	***None***	*OVOV has no similar language.*
TR-3.2.3 **pg. 84**	**3.2.3** Require the development of Transportation Management Associations for large employers and commercial/ industrial complexes;	***None***	*OVOV has no similar language, however the City of Santa Clarita Municipal Code Section 17.14.050.H.5 requires all development in Commercial and Industrial zones with 50 or more employees develop a Transportation Development Management Plan.*
TR-3.2.4 **pg. 84**	**3.2.4** Provide public recognition of effective programs through awards, top ten lists, and other mechanisms.	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-3.3 **pg. 84**	**TR-3.3 Ride Home Programs:** The City/County will implement a city/county wide "guaranteed ride home" program for those who commute by public transit, ride-sharing, or other modes of transportation, and encourage employers to subscribe to or support the program.	***None***	*OVOV has no similar policy, however the draft Circulation Element (August, 2009), page 36, discusses the concept of "Travel Demand Management"(TDM) at length. The discussion contains a number of examples of TDM programs include "Guaranteed Ride Home programs for employees who use alternative travel modes to work".*
TR-3.4 **pg. 85**	**TR-3.4 Local Area Shuttles:** The City/County will encourage and utilize shuttles to serve neighborhoods, employment centers and major destinations.	**C 5** **pg. C-64** **(Circ 8/09)**	**Goal C 5:** Bus transit service as a viable choice for all residents, easily accessible and serving destinations throughout the Valley.[21]
TR-3.4.1 **pg. 85**	**3.4.1** The City/County will create a free or low-cost local area shuttle system that includes a fixed route to popular tourist destinations or shopping and business centers;	**C 5** **pg. C-64** **(Circ 8/09)**	**Goal C 5:** Bus transit service as a viable choice for all residents, easily accessible and serving destinations throughout the Valley.
TR-3.4.2 **pg. 85**	**3.4.2** The City/County will work with existing shuttle service providers to coordinate their services.	***None***	*OVOV has no similar policy, however the City currently contracts with a private organization to provide all bus-related transit services.*[22]
TR-3.5 **pg. 85**	**TR-3.5 Low- and No-Travel Employment Opportunities:** The City/County will facilitate employment opportunities that minimize the need for private vehicle trips.	**C 1.2.1** **pg. C-65** **(Circ 8/09)**	**Policy C 1.2.1:** Develop coordinated plans for land use, circulation, and transit to promote transit-oriented development that concentrates higher density housing, employment, and commercial areas in proximity to transit corridors.
TR-3.5.1 **pg. 85**	**3.5.1** Amend zoning ordinances and the Development Code to include live/work sites and satellite work centers in appropriate locations;	***None***	*OVOV has no similar policy, however the UR4 and UR5 zones are proposed to include live work units.*[23]
TR-3.5.2 **pg. 85**	**3.5.2** Encourage telecommuting options with new and existing employers, through project review and incentives, as appropriate.	**C 3.1.3** **pg. C-70** **(Circ 8/09)**	**Policy C 3.1.3:** Promote the use of flexible work schedules and telecommuting to reduce home to work trips.

[21] The City currently operates a fixed route and dial-a-ride bus service to destinations throughout the Santa Clarita Valley. Ridership has increased almost 600% since 1991. Services are described in the Circulation Element (draft 8/09), pages C-42 through C-45.
[22] Services are described in the Circulation Element (draft 8/09), pages C-42 through C-45.
[23] Land Use Element (draft 8/09) pg LU-55.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-3.6 **pg. 85**	**TR-3.6 Congestion Pricing:** Advocate for a regional, market-based system to price or charge for auto trips during peak hours	***None***	*OVOV has no similar language.*
TR-4 **pg. 85**	**Objective TR-4:** The City/County will support bicycle use as a mode of transportation by enhancing infrastructure to accommodate bicycles and riders, and providing incentives.	**C 6** **pg. C-74** **(Circ 8/09)**	**Goal C 6:** A unified and well-maintained bikeway system with safe and convenient routes for commuting, recreational use and utilitarian travel, connecting communities and the region.
TR-4.1 **pg. 85**	**TR-4.1 Development Standards for Bicycles:** The City/County will establish standards for new development and redevelopment projects to support bicycle use.	**C 6.1** **pg. C-74** **(Circ 8/09)**	**Objective C 6.1:** Adopt and implement a coordinated master plan for bikeways for the Valley, including both City and County areas, to make cycling an attractive and feasible mode of transportation.[24]
TR-4.1.1 **pg. 85**	**4.1.1** Amending the Development Code to include standards for safe pedestrian and bicyclist accommodations.	**C 1.1.1** **pg. C-59** **(Circ 8/09)**	**Policy C 1.1.1:** Reduce dependence on the automobile, particularly single-occupancy vehicle use, by providing safe and convenient access to transit, bikeways, and walkways.
TR-4.1.1.1 **pg. 85**	**4.1.1.1** "Complete Streets" policies that foster equal access by all users in the roadway design	**C 1.1** **pg. C-59** **(Circ 8/09)**	**Objective C 1.1:** Provide multi-modal circulation systems that move people and goods efficiently while protecting environmental resources and quality of life.
TR-4.1.1.2 **pg. 85**	**4.1.1.2** Bicycle and pedestrian access internally and in connection to other areas through easements;	**C 1.2.8 & 6.1.3** **pp. C-65, 75** **(Circ 8/09)**	**Policy C 1.2.8:** Provide safe pedestrian connections across barriers, which may include but are not limited to major traffic corridors, drainage and flood control facilities, utility easements, grade separations, and walls. **Policy C 6.1.3:** Continue to acquire or reserve right-of-way and/or easements needed to complete the bicycle circulation system as development occurs.

[24] The City Council of the City of Santa Clarita adopted the *Non-Motorized Master Plan* in 2008.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-4.1.1.3 pg. 85	**4.1.1.3** Safe access to public transportation and other non-motorized uses through construction of dedicated paths;	**C 1.1.1 & 1.1.7 pp. C-64 (Circ 8/09)**	**Policy C 1.1.1:** Reduce dependence on the automobile, particularly single-occupancy vehicle use, by providing safe and convenient access to transit, bikeways, and walkways. **Policy C 1.1.7:** Consider the safety and convenience of the traveling public, including pedestrians and cyclists, in design and development of all transportation systems.
TR-4.1.1.4 pg. 86	**4.1.1.4** Safe road crossings at major intersections, especially for school children and seniors;	***None***	*OVOV has no similar policy, however the safety mechanisms and procedures currently used by the City are identified in the Circulation Element, page C-56 (draft 8/09).*
TR-4.1.1.5 pg. 86	**4.1.1.5** Adequate, convenient and secure bike parking at public and private facilities and destinations in all urban areas;	**C 1.1.6 pp. C-64 (Circ 8/09)**	**Policy C 1.1.6:** Ensure multi-modal travel through provision of adequate facilities, including but not limited to bicycle parking and storage, expansion of park-and-ride lots, and provision of adequate station and transfer facilities in appropriate locations.[25]
TR-4.1.1.6 pg. 86	**4.1.1.6** Street standards will include provisions for bicycle parking within the public right of way	**C 5.2.5 pp. C-74 (Circ 8/09)**	**Policy C 5.2.5:** Complementary transportation modes should be interconnected at intermodal transit centers, including provisions for bicycles on buses, bicycle parking at transit centers, and park-and-ride at transit stops.
TR-4.1.2 pg. 86	**4.1.2** Require new development and redevelopment projects to include bicycle facilities, as appropriate with the new land use.	**C 6.2.1 pp. C-75 (Circ 8/09)**	**Policy C 6.2.1:** Require bicycle parking, which can include bicycle lockers and sheltered areas at commercial sites and multi-family housing complexes for use by employees and residents, as well as customers and visitors.

[25] Note that UDC Section 17.18.105 currently requires on-site bicycle parking for all commercial, office, industrial and multi-family uses.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-4.1.2.1 **pg. 86**	**4.1.2.1** Construction of weatherproof bicycle facilities where feasible, and at a minimum, bicycle racks or covered, secure parking near the building entrances;	**C 6.2.1** **pp. C-75** **(Circ 8/09)**	**Policy C 6.2.1:** Require bicycle parking, which can include bicycle lockers and sheltered areas at commercial sites and multi-family housing complexes for use by employees and residents, as well as customers and visitors.
TR-4.1.2.2 **pg. 86**	**4.1.2.2** Provision and maintenance of changing rooms, lockers, and showers at large employers or employment centers.	**C 3.1.6** **pp. C-70** **(Circ 8/09)**	**Policy C 3.1.6:** Promote the provision of showers and lockers within businesses and employment centers, in order to encourage opportunities for employees to bicycle to work.[26]
TR-4.1.3 **pg. 86**	**4.1.3** Prohibit projects that impede bicycle and pedestrian access, such as large parking areas that cannot be safely crossed by non-motorized vehicles, and developments that block through access on existing or potential bicycle and pedestrian routes	**C 7.1.5** **pp. C-76** **(Circ 8/09)**	**Policy C 7.1.5:** In new commercial development, provide for direct, clearly delineated, and preferably landscaped pedestrian walkways from transit stops and parking areas to building entries, and avoid placement of uses (such as drive-through facilities) in locations that would obstruct pedestrian pathways.
TR-4.1.4 **pg. 86**	**4.1.4** Encourage the development of bicycle stations at intermodal hubs, with attended or "valet" bicycle parking, and other amenities such as bicycle rental and repair, and changing areas with lockers and showers;	**C 5.2.5** **pp. C-74** **(Circ 8/09)**	**Policy C 5.2.5:** Complementary transportation modes should be interconnected at intermodal transit centers, including provisions for bicycles on buses, bicycle parking at transit centers, and park-and-ride at transit stops. *OVOV has no similar language regarding "valet" parking, bicycle rental and repair.*

[26] Consider adding Metrolink or multi-modal hubs to the potential locations of shower facilities.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-4.1.5 pg. 86	**4.1.5** Conduct a connectivity analysis of the existing bikeway network to identify gaps, and prioritize bikeway development where gaps exist.	***None***	*OVOV has no similar policy, however within the Santa Clarita Valley, four gaps in the inter-jurisdictional bikeway network were identified by the Metro plan. These are summarized in Table C-4. Funds are available from the Bicycle Transportation Account program to help improve bicycle facilities, provided local agencies have adopted Bicycle Transportation Plans. The City of Santa Clarita's Non-Motorized Transportation Plan will fulfill this funding requirement.*[27] *The Non-Motorized Master Plan also examines gaps within the City and identifies strategies to fill them.*
TR-4.2 pg. 86	**TR-4.2 Bicycle and Pedestrian Trails:** The City/County will establish a network of multi-use trails to facilitate safe and direct off-street bicycle and pedestrian travel, and will provide bike racks along these trails at secure, lighted locations.		**Policy C 1.1.7:** Consider the safety and convenience of the traveling public, including pedestrians and cyclists, in design and development of all transportation systems.
TR-4.3 pg. 86	**R-4.3 Bicycle Safety Program:** The City/County will develop and implement a bicycle safety educational program to teach drivers and riders the laws, riding protocols, routes, safety tips, and emergency maneuvers.	***None***	*OVOV has no similar policy, however the City currently implements the Safe Routes to School program and a Share the Road program for bicycle safety.*
TR-4.4 pg. 86	**TR-4.4 Bicycle and Pedestrian Project Funding:** The City/County will pursue and provide enhanced funding for bicycle and pedestrian facilities and access projects, including, as appropriate.	***None***	*OVOV has no similar language, however the City's Non-Motorized Master Plan seeks to acquire funding for all potential non-motorized improvements. The City will continue to pursue regional funding for area wide transportation projects..*
TR-4.4.1 pg. 87	**4.4.1** Apply for regional, State, and federal grants for bicycle and pedestrian infrastructure projects;	***None***	**NEW CIRC ELEMENT POLICY**: Apply for regional, State, and federal grants for bicycle and pedestrian infrastructure projects
TR-4.4.2 pg. 87	**4.4.2** Establish development exactions and impact fees to fund bicycle and pedestrian facilities;	***None***	*OVOV has no similar language, however the City currently collects Bridge and Thoroughfare fees on new development. These fees pay for right-of-way improvements including bike paths.*

[27] Circulation Element, p. C-52 (draft 8/09).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-4.4.3 **pg. 87**	**4.4.3** Use existing revenues, such as state gas tax subventions, sales tax funds, and general fund monies for projects to enhance bicycle use and walking for transportation.	***None***	*OVOV has no similar language, however the City currently uses these types of funds to enhance bicycle us and walking transportation.*
TR-4.5 **pg. 87**	**TR-4.5 Bicycle Parking:** Adopt bicycle parking standards that ensure bicycle parking sufficient to accommodate 5 to 10% of projected use at all public and commercial facilities, and at a rate of at least one per residential unit in multiple-family developments *(suggestion: check language with League of American Bicyclists).*	**C 6.2.1** **pp. C-75** **(Circ 8/09)**	**Policy C 6.2.1:** Require bicycle parking, which can include bicycle lockers and sheltered areas at commercial sites and multi-family housing complexes for use by employees and residents, as well as customers and visitors. The current City of Santa Clarita Municipal Code Section 17.18.105 defines the requirement for bicycle parking as follows: Retail/Commercial Uses: 1 space per each 25 vehicle parking stalls Office Uses: 1 space per each 30 vehicle parking stalls Industrial Uses: 1 space per each 40 vehicle parking stalls Multifamily Residential Uses: 1 space per each 5 residential units
TR-5 **pg. 87**	**Objective TR-5:** The City/County will establish parking policies and requirements that capture the true cost of private vehicle use and support alternative modes of transportation.	***None***	*OVOV has no similar language.*
TR-5.1 **pg. 87**	**TR-5.1 Parking Policy:** The City/County will adopt a comprehensive parking policy to discourage private vehicle use and encourage the use of alternative transportation,	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-5.1.1 pg. 87	**5.1.1** Reduce the available parking spaces for private vehicles while increasing parking spaces for shared vehicles, bicycles, and other alternative modes of transportation;	***None***	*OVOV has no similar language.*
TR-5.1.2 pg. 87	**5.1.2** Eliminate or reduce minimum parking requirements for new buildings;	***None***	*OVOV has no similar language.*
TR-5.1.3 pg. 87	**5.1.3** "Unbundle" parking (require that parking is paid for separately and is not included in the base rent for residential and commercial space);	**C 1.2.6 pg. C-60 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
TR-5.1.4 pg. 87	**5.1.4** Use parking pricing to discourage private vehicle use, especially at peak times;	***None***	*OVOV has no similar policy, however the Circulation Element does address using pricing strategies on pages C-39 and C-40.*
TR-5.1.5 pg. 87	**5.1.5** Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities;	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities wherever feasible;
TR-5.1.6 pg. 87	**5.1.6** Establish performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times;	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Establish performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times wherever feasible.
TR-5.1.7 pg. 87	**5.1.7** Encourage shared parking programs in mixed-use and transit-oriented development areas.	**C 1.2.6 pp. C-65 (Circ 8/09)**	**Policy C 1.2.6:** Provide flexible standards for parking and roadway design in transit-oriented development areas to promote transit use, where appropriate.
TR-5.2 pg. 88	**TR-5.2 Event Parking Policies:** The City/County will establish policies and programs to reduce onsite parking demand and promote ride-sharing and public transit at large events	***None***	*OVOV has no similar language, however the City provides coordinated parking and shuttle services as needed for all major events.*
TR-5.2.1 pg. 88	**5.2.1** Promote the use of peripheral parking by increasing on-site parking rates and offering reduced rates for peripheral parking;	***None***	*OVOV has no similar language.*
TR-5.2.2 pg. 88	**5.2.2** Encourage special event center operators to advertise and offer discounted transit passes with event tickets;	**NEW CIRC POLICY**	**NEW CIRC ELEMENT POLICY:** Encourage special event center operators to advertise and offer discounted transit passes with event tickets

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-5.2.3 pg. 88	**5.2.3** Encourage special event center operators to advertise and offer discount parking incentives to carpooling patrons, with four or more persons per vehicle for on-site parking;	**NEW CIRC POLICY**	**NEW CIRC ELEMENT POLICY:** Encourage special event center operators to advertise and offer discount parking incentives to carpooling patrons, with four or more persons per vehicle for on-site parking
TR-5.2.4 pg. 88	**5.2.4** Promote the use of bicycles by providing space for the operation of valet bicycle parking service.	***None***	*OVOV has no similar language.*
TR-5.3 pg. 88	**TR-5.3 Parking "Cash-out" Program:** The City/County will require new office developments with more than 50 employees to offer a Parking "Cash-out" Program to discourage private vehicle use.	***None***	*OVOV has no similar language.*
TR-5.4 pg. 88	**TR-5.4 Electric/Alternative Fuel Vehicle Parking:** The City/County will require new commercial and retail developments to provide prioritized parking for electric vehicles and vehicles using alternative fuels.	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** The City/County will encourage new commercial and retail developments to provide prioritized parking for electric vehicles and vehicles using alternative fuels.
TR-6 pg. 88	**Objective TR-6:** The City/County will support and promote the use of low- and zero-emission vehicles, and alternative fuels, and other measures to directly reduce emissions from motor vehicles.	**C 3.2.3 pp. C-71 (Circ 8/09)**	**Policy C 3.2.3:** When available and feasible, provide opportunities and infrastructure to support use of alternative fuel vehicles and travel devices.
TR-6.1 pg. 88	**TR-6.1 Low and Zero Emission Vehicles:** The City/County will support and promote the use of low- and zero-emission vehicles,	**C 3.2.3 pp. C-71 (Circ 8/09)**	**Policy C 3.2.3:** When available and feasible, provide opportunities and infrastructure to support use of alternative fuel vehicles and travel devices.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
TR-6.1.1 pg. 88	**6.1.1** Develop the necessary infrastructure to encourage the use of zero-emission vehicles and clean alternative fuels, such as development of electric vehicle charging facilities and conveniently located alternative fueling stations;	**C 3.2.3 pp. C-71 (Circ 8/09)**	**Policy C 3.2.3:** When available and feasible, provide opportunities and infrastructure to support use of alternative fuel vehicles and travel devices.
TR-6.1.2 pg. 88	**6.1.2** Encourage new construction to include vehicle access to properly wired outdoor receptacles to accommodate ZEV and/or plug in electric hybrids (PHEV);	**C 3.2.3 pp. C-71 (Circ 8/09)**	**Policy C 3.2.3:** When available and feasible, provide opportunities and infrastructure to support use of alternative fuel vehicles and travel devices.
TR-6.1.3 pg. 88	**6.1.3** Encourage transportation fleet standards to achieve the lowest emissions possible, using a mix of alternate fuels, PZEV or better fleet mixes;	**CO 8.2.7 pp. CO-107 (Con/OS 8/09)**	**Policy CO 8.2.7:** Support the use of sustainable alternative fuel vehicles for machinery and fleets, where practical, by evaluating fuel sources, manufacturing processes, maintenance costs and vehicle lifetime use.
TR-6.1.4 pg. 89	**6.1.4** Establish incentives, as appropriate, to taxicab owners to use alternative fuel or gas-electric hybrid vehicles.	***None***	*OVOV has no similar language.*
TR-6.2 pg. 89	**TR-6.2 Vehicle Idling:** The City/County will enforce State idling laws for commercial vehicles, including delivery and construction vehicles.	***None***	*OVOV has no similar language, however the Los Angeles County Sheriff's Department is currently enforcing the existing State idling regulations.*
CAPCOA – Energy Efficiency Policies[28]		**OVOV**	
Reference	**Language**	**Reference**	**Language**
EE-1 pg. 90	**Objective EE-1** The City/County will establish green building requirements and standards for new development and redevelopment projects, and will work to provide incentives for green building practices and remove barriers that impede their use.	**CO 8.1.3 pg. CO-92 (Con/OS 8/09)**	**Policy CO 8.1.3**: Revise codes and ordinances as needed to address energy conservation.0

[28] The new California Green Building Standards Code Sections 406, 503, 504, and 511 deal with energy efficiency. Many of these sections may become mandatory in 2011.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-1.1 **pg. 90**	**EE-1.1 Green Building Ordinance:** The City/County will adopt a Green Building Ordinance that requires new development and redevelopment projects for both residential and commercial buildings to incorporate sufficient green building methods and techniques to qualify for the equivalent of a current LEED Certified rating, GreenPoints, or equivalent rating system.	**CO 8.1.3.a** **pg. CO-93** **(Con/OS 8/09)**	a. Strengthen building codes for new construction and renovation to achieve a higher level of energy efficiency, with a goal of exceeding energy efficiency beyond that required by Title 24;
EE-1.2 **pg. 90**	**EE-1.2 Green Building Flexibility:** The City/County will allow increased height limits and/or flexibility in other standards for projects that incorporate energy efficient green building practices.	***None***	*OVOV has no similar language, however OVOV generally requires increased building heights throughout the planning area although not as an incentive for green building projects.*
EE-1.3 **pg. 90**	**EE-1.3 Green Building Barriers:** The City/County will identify and remove regulatory or procedural barriers to implementing green building practices within its jurisdiction, such as updating codes, guidelines, and zoning, and will ensure that all plan review and building inspection staff are trained in green building materials, practices, and techniques.	**CO 8.1.3.b & CO 8.2.12** **pg. CO-93 & 94** **(Con/OS 8/09)**	b. Adopt a Green Building Program to encourage green building practices and materials, along with appropriate ordinances and incentives **Policy CO 8.2.12:** Provide ongoing training to appropriate City employees on sustainable planning, building, and engineering practices.
EE-1.4 **pg. 90**	**EE-1.4 Green Building Incentives:** The City/County will support the use of green building practices	**CO 8.1.3.b & CO 8.3.10** **pg. CO-93 & 95** **(Con/OS 8/09)**	b. Adopt a Green Building Program to encourage green building practices and materials, along with appropriate ordinances and incentives; **Policy CO 8.3.10:** Provide incentives and technical assistance for installation of energy-efficient improvements in existing and new buildings.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-1.4.1 pg. 90	**1.4.1** Providing information, marketing, training, and technical assistance about green building practices;	**CO 8.1.4 & CO 8.1.5 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.1.4:** Provide information and education to the public about energy conservation and local strategies to address climate change. **Policy CO 8.1.5:** Coordinate various activities within the community and appropriate agencies related to GHG emissions reduction activities.
EE-1.4.2 pg. 90	**1.4.2** Establishing guidelines for green building practices in residential and commercial development;	**CO 8.1.3.b pg. CO-93 (Con/OS 8/09)**	b. Adopt a Green Building Program to encourage green building practices and materials, along with appropriate ordinances and incentives;
EE-1.4.3 pg. 90	**1.4.3** Providing financial incentives, including reduction in development fees, administrative fees, and expedited permit processing for projects that use green building practices.	**OC 8.1.1.e & CO 8.3.10 pg. CO-92 & 95 (Con/OS 8/09)**	e. Allocation of funding and staffing for Plan implementation; **Policy CO 8.3.10:** Provide incentives and technical assistance for installation of energy-efficient improvements in existing and new buildings.
EE-2 pg. 90	**Objective EE-2** The City/County will establish policies and standards to increase energy efficiency at new developments.	**CO 8.1.3.a pg. CO-93 (Con/OS 8/09)**	a. Strengthen building codes for new construction and renovation to achieve a higher level of energy efficiency, with a goal of exceeding energy efficiency beyond that required by Title 24;
EE-2.1[29] **pg. 90**	**EE-2.1 Improved Building Standards:** The City/County will adopt energy efficiency performance standards for buildings that achieve a greater reduction in energy and water use than otherwise required by state law.	**CO 8.1.3.a & CO 4.1.1 pp. CO-93 & 86 (Con/OS 8/09)**	a. Strengthen building codes for new construction and renovation to achieve a higher level of energy efficiency, with a goal of exceeding energy efficiency beyond that required by Title 24; **Policy CO 4.1.1:** In coordination with applicable water suppliers, adopt and implement a water conservation strategy for public and private development.

[29] Items contained in EE-2.1 seem too specific for General Plan use. These appear to be more appropriate for either a green building program or a Climate Action Plan.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-2.1.1 pg. 91	**2.1.1** Standards for the installation of "cool roofs";	**CO 8.1.3.d & CO 8.2.9 pp. CO-93 & 94 (Con/OS 8/09)**	d. Encourage mitigation of the "heat island" effect through use of cool roofs, light-colored paving, and shading to reduce energy consumption for air conditioning. **Policy CO 8.2.9:** Reduce heat islands through installation of trees to shade parking lots and hardscapes, and use of light-colored reflective paving and roofing surfaces.
EE-2.1.2 pg. 91	**2.1.2** Performance standards for heat transfer across the building envelope that result in increased insulation and the use of low emissive windows;	**CO 8.2.1, 8.2.2, 8.3.1 & 8.3.2[30] pp. CO-93&94 (Con/OS 8/09)**	**Policy CO 8.2.1:** Ensure that all new City buildings, and all major renovations and additions, meet adopted green building standards, with a goal of achieving the LEED (Leadership in Energy and Environmental Design) Silver rating or above, or equivalent where appropriate. **Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012.[31] **Policy CO 8.3.1:** Evaluate site plans proposed for new development based on energy efficiency pursuant to LEED (Leadership in Energy and Environmental Design) standards for New Construction and Neighborhood Development, including the following: a) location efficiency; b) environmental preservation; c) compact, complete, and connected neighborhoods; and d) resource efficiency, including use of recycled materials and water.

[30] Improvements to the building envelope are included in LEED for New Development v.3.
[31] Note that CO 8.2 requires 8.2.1 and 8.2.2 of new public buildings.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
			Policy CO 8.3.2: Promote construction of energy efficient buildings through requirements for LEED certification or through comparable alternative requirements as adopted by local ordinance.[32]
EE-2.1.3 pg. 91	**2.1.3** Requirements to install high-efficiency plumbing fixtures and tankless water heaters;	**CO 4.1.5 & 4.1.6 pp. CO-87 (Con/OS 8/09)**	**Policy CO 4.1.5:** Promote the use of low-flow and/or waterless plumbing fixtures and appliances in all new residential and non-residential development and residential development of five or more dwelling units. **Policy CO 4.1.6:** Support amendments to the building code that would promote upgrades to water and energy efficiency when issuing permits for renovations or additions to existing buildings.
EE-2.1.4 pg. 91	**2.1.4** Performance standards that specify high-efficiency space heating and cooling systems;	***None***	*OVOV has no similar language and LEED does not require high-efficiency space heating but does have minimum energy standards.*
EE-2.1.5 pg. 91	**2.1.5** Requirements for improved overall efficiency of lighting systems;	**See CO 8.2.1, 8.2.2, 8.3.1 and 8.3.2 above**	*OVOV has no similar language and LEED does not require high-efficiency space heating but does have minimum energy standards..*[33]

[32] Note that 8.3 describes 8.3.1 and 8.3.2 as "encouraged" for private development.
[33] LEED does have minimum standards for Energy in new and existing buildings. EE-2.1.5 is unclear regarding whether the requirements defined by LEED will stratify their requirement for "improved overall efficiency of lighting systems."

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-2.1.6 pg. 91	**2.1.6** Requirements for the use of Energy Star® appliances and fixtures in discretionary new development;	**CO 8.3.8**	**Policy CO 8.3.8:** Encourage energy-conserving heating and cooling systems and appliances, and energy-efficiency in windows and insulation, in all new construction.
EE-2.1.7 pg. 91	**2.1.7** New lots shall be arranged and oriented to maximize effective use of passive solar energy.	**CO 8.1.3.c pg. CO-93 (Con/OS 8/09)**	c. Maximize orientation of buildings to maximize passive solar heating during cool seasons, avoid solar heat gain during hot periods, enhance natural ventilation, promote effective use of daylight, and optimize opportunities for on-site solar generation;
EE-2.2 pg. 91	**EE-2.2 Affordable Housing Energy Efficiency:** Affordable housing development shall incorporate energy efficient design and features to the maximum extent feasible.	*None*	*OVOV has no similar policy, however all policies included in OVOV regarding green building apply to all types of housing, including affordable housing.*
EE-2.2.1 pg. 91	**2.2.1** The City/County will target local funds, including redevelopment and community development block grant resources, to assist affordable housing developers in meeting the energy efficiency requirements.	*None*	*OVOV has no similar language.*
EE-2.3[34] **pg. 91**	**EE-2.3 Outdoor Lighting:** The City/County will establish outdoor lighting standards in the Zoning Ordinance	**CO 8.3.9 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.3.9:** Limit excessive lighting levels, and encourage a reduction of lighting when businesses are closed to a level required for security.
EE-2.3.1 pg. 91	**2.3.1** Requirements that all outdoor lighting fixtures be energy efficient	**CO 8.3.9 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.3.9:** Limit excessive lighting levels, and encourage a reduction of lighting when businesses are closed to a level required for security.
EE-2.3.1.1 pg. 91	**2.3.1.1** Full cut-off light fixtures at parking lots and on buildings;	***None***	*OVOV has no similar language.*
EE-2.3.1.2 pg. 91	**2.3.1.2** Photocells or astronomical time switches on all permanently installed exterior lighting;	***None***	*OVOV has no similar language.*

[34] Some items contained in EE-2.3 seem too specific for General Plan use. These appear to be more appropriate for either a green building program or a Climate Action Plan.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-2.3.1.3 pg. 91	**2.3.1.3** Directional and shielded LED lights for exterior lighting *(for example, see: www.nightwise.org)*, and install exterior and security lights with motion detectors.	***None***	*OVOV has no similar language.*
EE-2.3.2 pg. 91	**2.3.2** Requirements that light levels in all new development, parking lots, and street lighting not exceed state standards	**CO 8.3.9 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.3.9:** Limit excessive lighting levels, and encourage a reduction of lighting when businesses are closed to a level required for security.
EE-2.3.3 pg. 91	**2.3.3** Requirements that lighting at the urban-rural boundary be designed to provide one-half the light standard for urban areas;[35]	***None***	*OVOV has no similar language.*
EE-2.3.4 pg. 92	**2.3.4** Prohibition against continuous all-night outdoor lighting in sports stadiums, construction sites, and rural areas unless required for security reasons.	**CO 8.3.9 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.3.9:** Limit excessive lighting levels, and encourage a reduction of lighting when businesses are closed to a level required for security.
EE-3 pg. 92	**Objective EE-3:** The City/County will establish policies and standards to reduce exterior heat gain and heat island effects.	**CO 8.2.9 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.9:** Reduce heat islands through installation of trees to shade parking lots and hardscapes, and use of light-colored reflective paving and roofing surfaces.
EE-3.1[36] pg. 92	**EE-3.1 Exterior Heat Gain:** The City/County will establish standards for new development and for large redevelopment or rehabilitation (for example, additions of more than 25,000 square feet commercial or 100,000 square feet industrial), to reduce exterior heat gain for 50% of non-roof impervious site landscape (roads, sidewalks, courtyards, parking lots, and driveways)	***None***	*OVOV has no similar language.*

[35] This seems odd because, in the absence of a definite Urban Growth Boundary, the urban-rural boundary would not be a fixed location over time.
[36] Some items contained in EE-3.1 seem too specific for General Plan use. These appear to be more appropriate for either a green building program or a Climate Action Plan.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-3.1.1 pg. 92	**3.1.1** Achieving 50% paved surface shading with vegetation within 5 years, in consultation with city/county arborist	***None***	*Santa Clarita Unified Development Code Section 17.18.070.E.(10) states "The applicant shall be required to plant tree species that will achieve a parking lot coverage canopy to the satisfaction of the Director of Community Development…". In general the City's standard has been 50% at 5 years.*
EE-3.1.2 pg. 92	**3.1.2** Use of paving materials with a Solar Reflective Index (SRI) of at least 29, or open grid paving systems	**NEW CON/OS POLICY**	**NEW CON/OS ELEMENT POLICY:** Reduce extensive heat gain from paved surfaces wherever feasible.
EE-3.1.3 pg. 92	**3.1.3** Covered parking (underground, beneath decking or roofs, or beneath a building), where any roof-covered parking uses roofing material with SRI of at least 29.	**NEW CON/OS POLICY**	**NEW CON/OS ELEMENT POLICY:** Reduce extensive heat gain from paved surfaces wherever feasible.
EE-3.2 pg. 92	**EE-3.2 Heat Island Mitigation:** The City/County will adopt a Heat Island Mitigation Plan that requires cool roofs, cool pavements, and strategically placed shade trees, and will actively inspect and enforce	**NEW CON/OS POLICY**	**NEW CON/OS ELEMENT POLICY:** Reduce extensive heat gain from paved surfaces wherever feasible.
EE-4 pg. 92	**Objective EE-4:** The City/County will pursue policies and programs to improve energy efficiency of existing buildings.	**CO 8.2.2 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012.[37]
EE-4.1 pg. 92	**EE-4.1 Energy Audits:** The City/County will require the performance of energy audits for residential and commercial buildings prior to completion of sale, and that audit results and information about opportunities for energy efficiency improvements be presented to the buyer.	***None***	*OVOV has no similar language.*

[37] Note that 8.2.2 only refers to Public buildings. There is no similar language for private structures.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-4.2 **pg. 93**	**EE-4.2 Energy Efficiency Funding:** The City/County will pursue incentives, grants, and creative financing for projects that improve energy efficiency, including, for example, the option for property owners to pay for such improvements through long-term assessments on their property tax bills.	**CO 8.3.10** **pg. CO-95** **(Con/OS 8/09)**	**Policy CO 8.3.10:** Provide incentives and technical assistance for installation of energy-efficient improvements in existing and new buildings.
EE-4.3 **pg. 93**	**EE-4.3 Community Energy Program:** The City/County will implement an outreach and incentive program to promote energy efficiency and conservation in the community	**CO 8.1.4 & CO 8.1.5** **pg. CO-93** **(Con/OS 8/09)**	**Policy CO 8.1.4:** Provide information and education to the public about energy conservation and local strategies to address climate change. **Policy CO 8.1.5:** Coordinate various activities within the community and appropriate agencies related to GHG emissions reduction activities.
EE-4.3.1 **pg. 93**	**4.3.1** Launch an "energy efficiency challenge" campaign for community residents;	***None***	*OVOV has no similar language. However, a program such as this could easily be implemented through the City's green website, www.greensantaclarita.com.*
EE-4.3.2 **pg. 93**	**4.3.2** Implement a low-income weatherization assistance program;	***None***	*OVOV has no similar language. However, the City currently advertises the existing Federal weatherization assistance program on the City's green website, http://www.greensantaclarita.com/resEnergyefficiency.asp.*
EE-4.3.3 **pg. 93**	**4.3.3** Implement conservation campaigns specifically targeted to residents, and separately to businesses;	***None***	*OVOV has no similar language. However, the City currently promotes energy efficiency for residents and business on the City's green website: http://www.greensantaclarita.com/resEnergyefficiency.asp and http://www.greensantaclarita.com/businessEnergyEffeciency.asp*
EE-4.3.4 **pg. 93**	**4.3.4** Promote the purchase of Energy Star® appliances, including, where feasible, incentive grants and vouchers	***None***	*OVOV has no similar language. However, a Energy Star products are currently advertised on the City's green website, http://greensantaclarita.com/energystar.asp*
EE-4.3.5 **pg. 93**	**4.3.5** Promote participation in the local "Green Business" program;	***None***	*OVOV has no similar language. However, several programs exist that encourage the local green economy at the "Green Store" on the City's green website, http://greensantaclarita.com/*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EE-4.3.6 pg. 93	**4.3.6** Distribute free CFL bulbs or other efficiency fixtures to community members;	***None***	*OVOV has no similar language. However, the City partners with Southern California Edison and the Energy Coalition to provide community members with free CFL's and other upgrades. Information is available on the City's green website, http://www.greensantaclarita.com/resEnergyefficiency.asp*
EE-4.3.7 pg. 93	**4.3.7** Offer exchange programs for high-energy-use items, such as halogen torchiere lamps;	***None***	*OVOV has no similar language. However, the City partners with Southern California Edison and the Energy Coalition to exchange high-energy-use items for more efficient ones.. Information is available on the City's green website, http://www.greensantaclarita.com/resEnergyefficiency.asp*
EE-4.3.8 pg. 93	**4.3.8** Adopt an ordinance requiring energy upgrades at time of property sale.	***None***	*OVOV has no similar language.*
CAPCOA – Alternative Energy Policies		**OVOV**	
Reference	**Language**	**Reference**	**Language**
AE-1.1 pg. 94	**Objective AE-1:** The City/County will establish policies and programs that facilitate the siting of new renewable energy generation.	**CO 10.1.17 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.1.17:** Allow alternative energy projects in areas designated for open space, where consistent with other uses and values.
AE-1.1.1 pg. 94	**1.1.1** Designate suitable sites to prioritize their development for renewable energy generation;	**CO 10.1.17 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.1.17:** Allow alternative energy projects in areas designated for open space, where consistent with other uses and values.
AE-1.1.2 pg. 94	**1.1.2** Evaluate potential land use, environmental, economic, and other constraints on that use, and mitigate such constraints, as feasible;	**CO 10.1.17 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.1.17:** Allow alternative energy projects in areas designated for open space, where consistent with other uses and values.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-1.1.3 pg. 94	**1.1.3** Adopt measures to protect the renewable energy use of the sites and their resources, such as utility easements, rights-of-way, and land setasides.	**CO 10.1.17 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.1.17:** Allow alternative energy projects in areas designated for open space, where consistent with other uses and values.
AE-1.2 pg. 94	**AE-1.2 Removing Barriers:** The City/County will identify and remove or otherwise address barriers to renewable energy production	**NEW LU POLICY**	**NEW LU ELEMENT POLICY:** Work with existing utilities, agencies and renewable energy companies to remove barriers to renewable energy production.
AE-1.2.1 pg. 94	**1.2.1** Review and revise building and development codes, design guidelines, and zoning ordinances to remove such barriers	***None***	*OVOV has no similar language. In addition, the City of Santa Clarita may not have the authority to establish such protocols.*
AE-1.2.2 pg. 94	**1.2.2** Work with related agencies, such as fire, water, health and others that may have policies or requirements that adversely impact the development or use of renewable energy technologies;	**NEW LU POLICY**	**NEW LU ELEMENT POLICY:** Work with existing utilities, agencies and renewable energy companies to remove barriers to renewable energy production.
AE-1.2.3 pg. 94	**1.2.3** Develop protocols for safe storage of renewable and alternative energy products with the potential to leak, ignite or explode, such as biodiesel, hydrogen, and/or compressed air.	**S 4.2.2 pg. S-45 (Safety 8/09)**	**Policy S 4.2.2:** Through the development review process, ensure that any new development proposed in the vicinity of a use that stores or generates large amounts of hazardous materials provides adequate design features, setbacks, and buffers to mitigate impacts to sensitive receptors in the event of a hazardous materials incident.
AE-1.3 pg. 94	**AE-1.3 Zoning Flexibility:** The City/County will allow renewable energy projects in areas zoned for open space, where consistent with the Open Space element, and other uses and values.	**CO 10.1.17 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.1.17:** Allow alternative energy projects in areas designated for open space, where consistent with other uses and values.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-2 **pg. 94**	**Objective AE-2** The City/County will promote and require renewable energy generation, and co-generation projects where feasible and appropriate.	**CO 8.3.4 & 8.3.5** **pg. CO-94** **(Con/OS 8/09)**	**Policy CO 8.3.4:** Encourage new residential development to include on-site solar photovoltaic systems, or pre-wiring, in at least 50% of the residential units, in concert with other significant energy conservation efforts. **Policy CO 8.3.5:** Encourage on-site solar generation of electricity in new retail and office commercial buildings and associated parking lots, carports, and garages, in concert with other significant energy conservation efforts.
AE-2.1 **pg. 94**	**AE-2.1 On-site Renewable Energy Generation:** The City/County will require that new office/retail/commercial or industrial development, or major rehabilitation (e.g., additions of 25,000 square feet commercial, or 100,000 square feet industrial) incorporate renewable energy generation either on-or off-site to provide 15% or more of the project's energy needs.	**CO 8.3.5.** **pg. CO-94** **(Con/OS 8/09)**	**Policy CO 8.3.5:** Encourage on-site solar generation of electricity in new retail and office commercial buildings and associated parking lots, carports, and garages, in concert with other significant energy conservation efforts.
AE-2.2 **pg. 94**	**AE-2.2 Co-generation Projects:** The City/County will promote and encourage cogeneration projects for commercial and industrial facilities, provided they meet all applicable air quality standards and provide a net reduction in GHG emissions associated with energy production.	**NEW CON/OS POLICY**	**NEW CON/OS ELEMENT POLICY:** Promote and encourage cogeneration projects for commercial and industrial facilities, provided they meet all applicable air quality standards and provide a net reduction in GHG emissions associated with energy production.
AE-2.3 **pg. 94**	**AE-2.3 Green Utilities:** The City/County will promote and support green utilities, and will evaluate the creation of a locally or regionally owned green utility, perhaps in coordination with other regional strategies.	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-3 **pg. 95**	**Objective AE-3:** The City/County will promote, support, and require, as appropriate, the development of solar energy.	**CO 8.3.4 & 8.3.5** **pg. CO-94** **(Con/OS 8/09)**	**Policy CO 8.3.4:** Encourage new residential development to include on-site solar photovoltaic systems, or pre-wiring, in at least 50% of the residential units, in concert with other significant energy conservation efforts. **Policy CO 8.3.5:** Encourage on-site solar generation of electricity in new retail and office commercial buildings and associated parking lots, carports, and garages, in concert with other significant energy conservation efforts.
AE-3.1 **pg. 95**	**AE-3.1 Solar-ready Buildings:** The City/County will require that, where feasible, all new buildings be constructed to allow for easy, cost-effective installation of solar energy systems in the future, using such "solar-ready" features as:	***See above***	*See above*.
AE-3.1.1 **pg. 95**	**3.1.1** Designing the building to include optimal roof orientation (between 20 to 55 degrees from the horizontal), with sufficient south-sloped roof surface;	***None***	*OVOV has no similar language, however in order for homes to satisfy CO 8.3.4 they would need to have the proper orientation to take advantage of a photovoltaic system.*
AE-3.1.2 **pg. 95**	**3.1.2** Clear access without obstructions (chimneys, heating and plumbing vents, etc.) on the south sloped roof;	***None***	*OVOV has no similar language, however in order for homes to satisfy CO 8.3.4 they would need to be built without these obstructions.*
AE-3.1.3 **pg. 95**	**3.1.3** Designing the roof framing to support the addition of solar panels;	***None***	*OVOV has no similar language.*
AE-3.1.4 **pg. 95**	**3.1.4** Installation of electrical conduit to accept solar electric system wiring;	**CO 8.3.4** **pg. CO-94** **(Con/OS 8/09)**	**Policy CO 8.3.4:** Encourage new residential development to include on-site solar photovoltaic systems, or pre-wiring, in at least 50% of the residential units, in concert with other significant energy conservation efforts.
AE-3.1.5 **pg. 95**	**3.1.5** Installation of plumbing to support a solar hot water system and provision of space for a solar hot water storage tank.	***None***	*OVOV has no similar language.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-3.2 **pg. 95**	**AE-3.2 Solar Homes Partnership:** The City/County will require that residential projects of 6 units or more participate in the California Energy Commission's New Solar Homes Partnership, which provides rebates to developers who offer solar power in at least 50% of new units, or a program with similar provisions.	**CO 8.3.4** **pg. CO-94** **(Con/OS 8/09)**	**Policy CO 8.3.4:** Encourage new residential development to include on-site solar photovoltaic systems, or pre-wiring, in at least 50% of the residential units, in concert with other significant energy conservation efforts.
AE-3.3 **pg. 95**	**AE-3.3 Passive Solar Design:** The City/County will require that any building constructed in whole or in part with City/County funds incorporate passive solar design features, such as daylighting and passive solar heating, where feasible.	**CO 8.3.6** **pg. CO-95** **(Con/OS 8/09)**	**Policy CO 8.3.6:** Encourage new development to use passive solar heating and cooling techniques in building design and construction, which may include but are not be limited to building orientation, clerestory windows, skylights, placement and type of windows, overhangs to shade doors and windows, and use of light colored roofs and paving materials.
AE-3.4 **pg. 96**	**AE-3.4 Protection of Solar Elements:** The City/County will protect active and passive solar design elements and systems from shading by neighboring structures and trees, as consistent with existing tree shading requirements.[38]	***None***	*OVOV has no similar language.*
AE-4 **pg. 96**	**Objective AE-4:** The City/County will pursue and provide economic incentives and creative financing for renewable energy projects, as well as other support for community members or developers seeking funding for such projects.	**CO 8.3.10** **pg. CO-95** **(Con/OS 8/09)**	**Policy CO 8.3.10:** Provide incentives and technical assistance for installation of energy-efficient improvements in existing and new buildings.

[38] It is unclear what "existing tree shading requirements" are in relation to AE-3.4. Public administration of a tree trimming program on private property would be challenging.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-4.1 **pg. 96**	**AE-4.1 Renewable Energy Incentives:** The City/County will provide, where possible, grants, rebates, and incentives for renewable energy projects, including reduced fees and expedited permit processing.	**CO 8.3.10** **pg. CO-95** **(Con/OS 8/09)**	**Policy CO 8.3.10:** Provide incentives and technical assistance for installation of energy-efficient improvements in existing and new buildings.
AE-4.2 **pg. 96**	**AE-4.2 Creative Financing:** The City/County will provide, where feasible, creative financing for renewable energy projects, including subsidized or other low-interest loans, and the option to pay for system installation through long-term assessments on individual property tax bills.	***None***	*OVOV has no similar language. However, the City is participating in the ongoing County AB811 program.*
AE-4.3 **pg. 96**	**AE-4.3 Partnerships:** The City/County will pursue partnerships with other governmental entities and with private companies and utilities to establish incentive programs for renewable energy.	***None***	*OVOV has no similar language. However, the City is participating in the ongoing County AB811 program.*
AE-4.4 **pg. 96**	**AE-4.4 Information and Support:** The City/County will establish and maintain a clearinghouse of information on available funding alternatives for renewable energy projects, rates of return, and other information to support developers and community members interested in pursuing renewable energy projects.	***None***	*OVOV has no similar language. However, several programs to assist local developers, businesses and residents with finding funding support exist on the City's green website, http://greensantaclarita.com/*
AE-5 **pg. 96**	**Objective AE-5:** The City/County will implement measures to support the purchase and use of renewable and alternative energy.	**CO 8.2.3** **pg. CO-93** **(Con/OS 8/09)**	**Policy CO 8.2.3:** Support purchase of renewable energy for public buildings, which may include installing solar photovoltaic systems to generate electricity for city buildings and operations and other methods as deemed appropriate and feasible, in concert with significant energy conservation efforts.[39]

[39] CO 8.2.3 applies to public buildings only.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
AE-5.1 **pg. 96**	**AE-5.1 Green Electricity Purchasing:** The City/County will establish targets for the purchase of renewable energy, in excess of the state Renewable Portfolio Standards, using such mechanisms as green tags or renewable energy certificates.	***None***	*OVOV has no similar language.*
AE-5.2 **pg. 96**	**AE-5.2 Community Choice Aggregation:** The City/County will evaluate the feasibility and effectiveness of using Community Choice Aggregation as a model for providing renewable energy to meet the community's electricity needs, including potential partnerships with other jurisdictions.	***None***	*OVOV has no similar language, however the City conducted a study on aggregation in 2002 and decided not to pursue it.*
CAPCOA – Municipal Operations Policies		**OVOV**	
Reference	**Language**	**Reference**	**Language**
MO-1 **pg. 97**	**Objective MO-1:** The City/County will enhance the energy efficiency of its facilities.	**CO 8.2** **pg. CO-93** **(Con/OS 8/09)**	**Objective 8.2:** Reduce energy and materials consumption and greenhouse gas emissions in public uses and facilities.
MO-1.1 **pg. 97**	**MO-1.1 Energy Efficiency Plan:** The City/County will prepare and implement a comprehensive plan to improve energy efficiency of municipal facilities	***None***	*OVOV has no similar language, however the City Council has adopted an Environmentally Preferable Purchasing Plan that captures many elements of what MO-1.1 refers to as an "Energy Efficiency Plan".*
MO-1.1.1 **pg. 97**	**1.1.1** Conduct energy audits for all municipal facilities;	**CO 8.2.2** **pg. CO-93** **(Con/OS 8/09)**	**Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-1.1.2 pg. 97	**1.1.2** Retrofit facilities for energy efficiency where feasible and when remodeling or replacing components, including increased insulation, installing green or reflective roofs and low-emissive window glass;	**CO 8.2.2 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012.
MO-1.1.3 pg. 97	**1.1.3** Implement an energy tracking and management system;	***None***	*OVOV has no similar language, however the Environmentally Preferable Purchasing Policy generates an annual report that tracks the progress of each element within the plan, including the installation and retrofit of energy efficient products.*
MO-1.1.4 pg. 97	**1.1.4** Install energy-efficient exit signs, street signs, and traffic lighting;	**CO 8.2.10 pg. CO-94 (Con/OS 8/09) and C 3.2.2 pg. C-65 (Circ 8/09)**	**Policy CO 8.2.10:** Support installation of energy-efficient traffic control devices, street lights, and parking lot lights. *The City has been transitioning to LED lighting in all traffic signals since 2007 and will be 100% LED by the end of 2010.* **Policy C 3.2.2:** Continue to enhance signal timing and synchronization to allow for free traffic flow, minimizing idling and vehicle emissions.
MO-1.1.5 pg. 97	**1.1.5** Install energy-efficient lighting retrofits and occupancy sensors, and institute a "lights out at night" policy;	**CO 8.2.2 & 8.2.4 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012. **Policy CO 8.2.4:** Establish maximum lighting levels for public facilities, and encourage reduction of lighting levels to the level needed for security purposes after business hours, in addition to use of downward-directed lighting and use of low-reflective paving surfaces.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-1.1.6 pg. 97	**1.1.6** Retrofit heating and cooling systems to optimize efficiency (e.g., replace chillers, boilers, fans, pumps, belts, etc.);	**CO 8.2.2 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.2:** Ensure energy efficiency of existing public buildings through energy audits and repairs, and retrofit buildings with energy efficient heating and air conditioning systems and lighting fixtures, with a goal of completing energy repairs in City facilities by 2012.
MO-1.1.7 pg. 97	**1.1.7** Install Energy Star® appliances and energy-efficient vending machines;	**CO 8.2.8 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.8:** Promote the purchase of energy-efficient and recycled products, and vendors and contractors who use energy-efficient vehicles and products, consistent with adopted purchasing policies.
MO-1.1.8 pg. 97	**1.1.8** Improve efficiency of water pumping and use at municipal facilities, including a schedule to replace or retrofit system components with high-efficiency units (i.e., ultra-low-flow toilets, fixtures, etc.);	**CO 8.2.1 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.1:** Ensure that all new City buildings, and all major renovations and additions, meet adopted green building standards, with a goal of achieving the LEED (Leadership in Energy and Environmental Design) Silver rating or above, or equivalent where appropriate.[40]
MO-1.1.9 pg. 97	**1.1.9** Provide chilled, filtered water at water fountains and taps in lieu of bottled water;[41]	***None***	*OVOV has no similar language.*
MO-1.1.10 pg. 97	**1.1.10** Install a central irrigation control system and time its operation for off-peak use;	**CO 4.1.2 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.2:** Provide examples of water conservation in landscaping through use of low water use landscaping in public spaces such as parks, landscaped medians and parkways, plazas, and around public buildings.
MO-1.1.11 pg. 97	**1.1.11** Adopt an accelerated replacement schedule for energy inefficient systems and components.	***None***	*Although CO 8.2.2 does call for a retrofit program, there is no similar language in OVOV regarding an "accelerated replacement schedule."*
MO-1.2 pg. 97	**MO-1.2 Efficiency Requirement for New Facilities:** The City/County will require that any newly constructed, purchased, or leased municipal space meet minimum standards as appropriate,	***See below***	*See Below.*

[40] Note that LEED Silver certification requires a variety of efficient water fixtures.
[41] MO-1.1.10 is another example, similar to Notes 11 and 13, of items that seem too specific for General Plan use.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-1.2.1 pg. 98	**1.2.1** Requirements for new commercial buildings to meet LEED criteria established by the U.S. Green Building Council;	**CO 8.2.1 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.1:** Ensure that all new City buildings, and all major renovations and additions, meet adopted green building standards, with a goal of achieving the LEED (Leadership in Energy and Environmental Design) Silver rating or above, or equivalent where appropriate.
MO-1.2.2 pg. 98	**1.2.2** Requirements for new residential buildings to meet criteria of the Energy Star® New Homes Program established by U.S. EPA;	**CO 8.2.8 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.8:** Promote the purchase of energy-efficient and recycled products, and vendors and contractors who use energy-efficient vehicles and products, consistent with adopted purchasing policies.[42]
MO-1.2.3 pg. 98	**1.2.3** Incorporation of passive solar design features in new buildings, including daylighting and passive solar heating;	***None***	*Although OVOV has similar language for privately owned buildings (CO 8.3.6), there is no similar language for public buildings. However, new city buildings are required to meet LEED Sliver standards.*
MO-1.2.4 pg. 98	**1.2.4** Retrofitting of existing buildings to meet standards under Title 24 of the California Building Energy Code, or to achieve a higher performance standard as established by the City/County;	***None***	*OVOV has no similar language for the retrofit of existing buildings other than that included in CO 8.2.2.*
MO-1.2.5 pg. 98	**1.2.5** Retrofitting of existing buildings to decrease heat gain from non-roof impervious surfaces with cool paving, landscaping, and other techniques.	**CO 8.2.9 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.9:** Reduce heat islands through installation of trees to shade parking lots and hardscapes, and use of light-colored reflective paving and roofing surfaces.[43]
MO-1.3 pg. 98	**MO-1.3 Training & Support:** The City/County will ensure that staff receives appropriate training and support to implement objectives and policies to reduce GHG emissions	***See Below***	*See Below.*

[42] CO 8.2.8 implies that energy efficient products should be purchased for all publicly-owned buildings, residential or otherwise.
[43] Note that 8.2.9 does not specify if this item is for new or existing (or both).

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-1.3.1 pg. 98	**1.3.1** Provide energy efficiency training to design, engineering, building operations, and maintenance staff;	**CO 8.2.12 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.2.12:** Provide ongoing training to appropriate City employees on sustainable planning, building, and engineering practices.
MO-1.3.2 pg. 98	**1.3.2** Provide information on energy use and management, including data from the tracking and management system, to managers and others making decisions that influence energy use;	**CO 8.2.12 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.2.12:** Provide ongoing training to appropriate City employees on sustainable planning, building, and engineering practices.
MO-1.3.3 pg. 98	**1.3.3** Provide energy design review services to departments undertaking new construction or renovation projects, to facilitate compliance with LEED standards.	**CO 8.2.12 pg. CO-95 (Con/OS 8/09)**	**Policy CO 8.2.12:** Provide ongoing training to appropriate City employees on sustainable planning, building, and engineering practices.
MO-2 pg. 98	**Objective MO-2:** The City/County will improve efficiency at municipal systems and reduce GHG emissions from vehicle and equipment engines.	***See Below***	*See Below.*
MO-2.1 pg. 98	**MO-2.1 Wastewater System Efficiency:** The City/County will maximize efficiency of wastewater treatment and pumping equipment.	***None***	*OVOV has no similar language. The City does not handle wastewater treatment. However, two water pipelines that run through Santa Clarita to service LA City are gravity fed and use no pumping equipment.*
MO-2.2 pg. 98	**MO-2.2 Drinking Water System Efficiency:** The City/County will maximize efficiency at drinking water treatment, pumping, and distribution facilities, including development of off-peak demand schedules for heavy commercial and industrial users.	***None***	*OVOV has no similar language. The City does not handle water treatment or distribution facilities.*
MO-2.3 pg. 98	**MO-2.3 Fleet Replacement:** The City/County will establish a replacement policy and schedule to replace fleet vehicles and equipment with the most fuel-efficient vehicles practical, including gasoline	**CO 8.2.7 pg. CO-94 (Con/OS 8/09) and**	**Policy CO 8.2.7:** Support the use of sustainable alternative fuel vehicles for machinery and fleets, where practical, by evaluating fuel sources, manufacturing processes, maintenance costs and vehicle lifetime use.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
	hybrid and alternative fuel or electric models.	**C 3.2.1 pg. C-65 (Circ 8/09)**	**Policy C 3.2.1:** Adopt clean vehicle purchase policies for City and County fleets.[44]
MO-2.4 pg. 99	**MO-2.4 Small Tools and Equipment:** Install outdoor electrical outlets on buildings to support the use of electric lawn and garden equipment, and other tools that would otherwise be run with small gas engines or portable generators.	***None***	*OVOV has no similar language.*
MO-3 pg. 99	**Objective MO-3:** The City/County will implement measures to reduce employee vehicle trips and to mitigate emissions impacts from municipal travel.	**CO 8.2.13 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.13:** Support trip reduction strategies for employees as described in the Circulation Element.
MO-3.1 pg. 99	**MO-3.1 Trip Reduction Program:** The City/County will implement a program to reduce vehicle trips by employees	***See Below***	*See Below.*
MO-3.1.1 pg. 99	**3.1.1** Providing incentives and infrastructure for vanpooling and carpooling, such as pool vehicles, preferred parking, and a website or bulletin board to facilitate ride-sharing;	**C 1.1.3 & 1.1.6 Pg. C-59 (Circ 8/09)**	**Policy C 1.1.3:** Work with local and regional agencies and employers to promote an integrated, seamless transportation system that meets access needs, including local and regional bus service, dial-a-ride, taxis, rail, van pools, car pools, bus pools, bicycling, walking, and automobiles. **Policy C 1.1.6:** Encourage multi-modal travel through provision of adequate facilities, including but not limited to bicycle parking and storage, expansion of park-and-ride lots, and provision of adequate station and transfer facilities in appropriate locations.
MO-3.1.2 pg. 99	**3.1.2** Providing subsidized passes for mass transit;	***None***	*OVOV has no similar language, however any City employee is able to access local bus service free of charge, and employees who ride the train receive a $60 monthly voucher, good for approximately 10 rides.*

[44] The City of Santa Clarita has already adopted an alternative fuel vehicle purchasing program as part of its Environmentally Preferable Purchasing Policy.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-3.1.3 pg. 99	**3.1.3** Offering compressed work hours, off-peak work hours, and telecommuting, where appropriate;	**C 3.1.3 pg. C-64 (Circ 8/09)**	**Policy C 3.1.3:** Promote the use of flexible work schedules and telecommuting to reduce home to work trips.
MO-3.1.4 pg. 99	**3.1.4** Offer a guaranteed ride home for employees who use alternative modes of transportation to commute.	**C 3.1 pg. C-64 (Circ 8/09)**	**Objective C 3.1:** Promote the use of travel demand management strategies to reduce vehicle trips.[45]
MO-3.2 pg. 99	**MO-3.2 Bicycle Transportation Support:** The City/County will promote and support the use of bicycles as transportation	***See Below***	*See Below.*
MO-3.2.1 pg. 99	**3.2.1** Providing bicycle stations with secure, covered parking, changing areas with storage lockers and showers, as well as a central facility where minor repairs can be made;	**C 3.1.6 pg. C-65 (Circ 8/09)**	**Policy C 3.1.6:** Promote the provision of showers and lockers within businesses and employment centers, in order to encourage opportunities for employees to bicycle to work.
MO-3.2.2 pg. 99	**3.2.2** Providing bicycles, including electric bikes, for employees to use for short trips during business hours;	***None***	*OVOV has no similar language.*
MO-3.2.3 pg. 99	**3.2.3** Implementing a police-on-bicycles program;	***None***	*OVOV has no similar language. Program implementation would require an agreement with the Los Angeles County Sheriff's Department, who already operate a police-on-bicycles program.*
MO-3.2.4 pg. 99	**3.2.4** Providing a bicycle safety program, and information about safe routes to work.	***None***	*OVOV has no similar language, however the City currently operates a Share the Road safety program and OVOV will be consistent with the safety guidelines in the Non-Motorized Master Plan.*
MO-3.3 pg. 99	**MO-3.3 Municipal Parking Management:** The City/County will implement a Parking Management Program to discourage private vehicle use,	**C 3.3 pg. C-65 (Circ 8/09)**	**Objective C 3.3:** Make more efficient use of parking and maximize economic use of land, while decreasing impervious surfaces in urban areas, through parking management strategies.
MO-3.3.1 pg. 99	**3.3.1** Encouraging carpools and vanpools with preferential parking and a reduced parking fee;	**C 3.1.5 pg. C-65 (Circ 8/09)**	**Policy C 3.1.5:** Promote the use of van pools, car pools, and shuttles to encourage trip reduction.[46]

[45] The draft Circulation Element (August, 2009), page 36, discusses the concept of "Travel Demand Management"(TDM) at length. The discussion contains a number of examples of TDM programs include "Guaranteed Ride Home programs for employees who use alternative travel modes to work".

[46] Preferential parking and a reduced parking fee could be included within these programs, although C 3.1.5 does not specifically identify them.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-3.3.2 pg. 100	**3.3.2** Institute a parking cash-out program;	***None***	*OVOV has no similar language.*
MO-3.3.3 pg. 100	**3.3.3** Renegotiate employee contracts, where possible, to eliminate parking subsidies;	***None***	*OVOV has no similar language. The City does not use employee contracts.*
MO-3.3.4 pg. 100	**3.3.4** Install on-street parking meters with fee structures designed to discourage private vehicle use;	**NEW LU POLICY**	**NEW LAND USE ELEMENT POLICY:** Establish performance pricing of street parking, so that it is expensive enough to promote frequent turnover and keep 15 percent of spaces empty at all times wherever feasible.
MO-3.3.5 pg. 100	**3.3.5** Establish a parking fee for all single-occupant vehicles.	***None***	*OVOV has no similar language.*
MO-3.4 pg. 100	**MO-3.4 Travel Mitigation:** The City/County will mitigate business-related travel, especially air travel, through the annual purchase of verified carbon offsets.	***None***	*OVOV has no similar language.*[47]
MO-3.5 pg. 100	**MO-3.5 Transit Access to Municipal Facilities:** Municipal employment and service facilities shall be located on major transit corridors, unless their use is plainly incompatible with other uses located along major transit corridors.	***None***	*OVOV has no similar language, although most City buildings are already located on major transit corridors (City Hall on Valencia Blvd, etc).*
MO-4 pg. 100	**Objective MO-4:** The City/County will enhance renewable energy generation, and implement programs for load management and demand response.	***None***	*OVOV has no similar language. The City is not a utility and does not control energy generation, load management, or demand response programs.*

[47] CO 8.3.11 states that carbon offsets should be considered as mitigation for large development projects, but there is no language about using carbon offsets to mitigate for municipal business travel.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-4.1 pg. 100	**MO-4.1 Load Management and Demand Response:** The City/County will design and implement peak load management and demand response programs for water pollution control, supply and treatment, and distribution, including interface with existing automated systems for building energy management and SCADA systems.	***None***	*OVOV has no similar language. The City is not a utility and does not control load management or demand response programs.*
MO-4.2 pg. 100	**MO-4.2 Renewable Energy Installation:** The City/County will install renewable energy systems at its facilities where feasible	***See Below***	*See Below.*
MO-4.2.1 pg. 100	**4.2.1** Solar collection systems on municipal roofs;	**CO 8.2.3 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.3:** Support purchase of renewable energy for public buildings, which may include installing solar photovoltaic systems to generate electricity for city buildings and operations and other methods as deemed appropriate and feasible, in concert with significant energy conservation efforts.
MO-4.2.2 pg. 100	**4.2.2** Solar water heating for municipal pools;	**CO 8.2.5 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.2.5:** Support installation of photovoltaic and other renewable energy equipment on public facilities, in concert with significant energy conservation efforts.
MO-4.2.3 pg. 100	**4.2.3** Waste-to-energy systems at waste handling operations.	***None***	*OVOV has no similar language. The City does not operate waste handling facilities and none exist in the city.*
MO-5 pg. 100	**Objective MO-5:** The City/County will manage its stock of vegetation to reduce GHG emissions.	***See Below***	*See below.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
MO-5.1 pg. 100	**MO-5.1 Urban Tree Management:** The City/County will conduct a comprehensive inventory and analysis of the urban forest, and coordinate tree maintenance responsibilities with all responsible departments, consistent with best management practices.	**CO 3.5 pg. CO-85 (Con/OS 8/09)**	**Objective CO 3.5:** Maintain, enhance, and manage the urban forest throughout developed portions of the Santa Clarita Valley to provide habitat, reduce energy consumption, and create a more livable environment.
MO-5.2 pg. 100	**MO 5.2 Landscaping:** The City/County will evaluate existing landscaping and options to convert reflective and impervious surfaces to landscaping, and will install or replace vegetation with drought-tolerant, low-maintenance native species or edible landscaping that can also provide shade and reduce heat-island effects.	**CO 4.1.2 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.2:** Provide examples of water conservation in landscaping through use of low water use landscaping in public spaces such as parks, landscaped medians and parkways, plazas, and around public buildings.[48]
MO-6 pg. 101	**Objective MO-6:** The City/County will use its purchasing power to promote reductions in GHG emissions by the suppliers of its goods and services.	***See Below***	*See below.*
MO-6.1 pg. 101	**MO-6.1 Purchasing Practices:** The City/County will adopt purchasing practices and standards to support reductions in GHG emissions, including preferences for energy-efficient office equipment, and the use of recycled materials and manufacturers that have implemented green management practices.	**CO 8.2.8 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.8:** Promote the purchase of energy-efficient and recycled products, and vendors and contractors who use energy-efficient vehicles and products, consistent with adopted purchasing policies.
MO-6.2 pg. 101	**MO-6.2 Contracting Practices:** The City/County will establish bidding standards and contracting practices that encourage GHG emissions reductions, including preferences or points for the use of low or zero emission vehicles and equipment, recycled materials, and provider implementation of other green management practices.	**CO 8.2.8 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.8:** Promote the purchase of energy-efficient and recycled products, and vendors and contractors who use energy-efficient vehicles and products, consistent with adopted purchasing policies.
CAPCOA – Waste Reduction Policies		**OVOV**	

[48] The City, and all cities and counties throughout California, will be subject to the requirements of AB1881 on January 1, 2010.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
Reference	**Language**	**Reference**	**Language**
WRD-1 **pg. 102**	**Objective WRD-1:** The City/County will improve emissions control at waste handling facilities.	***None***	*OVOV has no similar language. There are no waste-handling facilities in the city.*
WRD-1.2 **pg. 102**	**WRD-1.1 Methane Recovery:** The City/County will establish methane recovery at all wastewater and solid waste treatment facilities.	***None.***	*OVOV has no similar language, however Chiquita Canyon Landfill presently operates a methane recovery system.*[49]
WRD-1.3 **pg. 102**	**WRD-1.3 Best Management Practices:** The City/County will utilize best management practices at all waste handling facilities.	***None***	*OVOV has no similar language. The City does not operate waste handling facilities. Currently, franchisees are required to recycle 50% or more of what they collect, however the City does not tell them how to accomplish this requirement.*
WRD-2 **pg. 102**	**Objective WRD-2:** The City/County will implement enhanced programs to divert solid waste from landfill operations.	***See Below***	*See below.*
WRD-2.1 **pg. 102**	**WRD-2.1 Diversion Targets:** The City/County will achieve a solid waste diversion of 75% of the waste stream by 2020.	***None***	*OVOV has no similar language.*
WRD-2.2 **pg. 102**	**WRD-2.2 Diversion Services:** The City/County will expand jurisdiction-wide waste diversion services to include, for example, single stream curbside recycling, and curbside recycling of food and greenwaste.	**CO 8.4.2** **pg. CO-95** **(Con/OS 8/09)**	**Policy CO 8.4.2:** Adopt mandatory residential recycling programs for all residential units, including single-family and multi-family dwellings. *The City of Santa Clarita currently offers residential and commercial/industrial recycling programs including requiring C&D recycling and greenwaste collection as part of the Construction and Demolition Ordinance.*
WRD-2.3 **pg. 102**	**WRD-2.3 Construction and Demolition Waste:** The City/County will adopt a Construction and Demolition Waste Recovery Ordinance, requiring building projects to recycle or reuse a minimum percentage of unused or leftover building materials	***See Below***	*See below.*

[49] Chiquita Canyon Landfill is located within the unincorporated Los Angeles County.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
WRD-2.3.1 pg. 102	**2.3.1** Require all new development and major rehabilitation projects (additions of 25,000 square feet commercial or 100,000 square feet industrial) to recycle or salvage XX% of non-hazardous construction and demolition debris (excluding excavated soil and land-clearing debris);	***None***	*The City currently requires C&D recycling as part of the Construction and Demolition Ordinance.*
WRD-2.3.2 pg. 102	**2.3.2** Require preparation of a construction waste management plan identifying materials to be diverted from disposal, and how material will be stored and handled;	***See above***	*See above.*
WRD-2.3.3 pg. 102	**2.3.3** Establish clear and consistent guidelines for calculation methods, recordkeeping, and reporting to document compliance with the plan;	***See above***	*See above.*
WRD-2.3.4 pg. 103	**2.3.4** Establish clear and consistent guidelines for how and when used construction materials can be used in new or remodel construction.	***See above***	*See above.*
WRD-2.4 pg. 103	**WRD-2.4 Reuse Center:** The City/County will establish a reuse/recycling center where furniture, appliances, building materials, and other useful, nonhazardous items may be dropped off or purchased for a nominal fee.	***None***	*OVOV has no similar language.*
WRD-2.5 pg. 103	**WRD-2.5 Program Promotion:** The City/County will promote and expand recycling programs, purchasing policies, and employee education to reduce the amount of waste produced.	**CO 8.2.8 & 8.2.11 pg. CO-94 (Con/OS 8/09)**	**Policy CO 8.2.8:** Promote the purchase of energy-efficient and recycled products, and vendors and contractors who use energy-efficient vehicles and products, consistent with adopted purchasing policies. **Policy CO 8.2.11:** Implement recycling in all public buildings, parks, and public facilities, including for special events.
WRD-3 pg. 103	**Objective WRD-3:** The City/County will enhance regional coordination on waste management.	***None***	*OVOV has no similar language, however the City does participate in the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
WRD-3.1 pg. 103	**WRD-3.1 Regional Coordination:** The City/County will coordinate with other agencies in its region to develop and implement effective waste management strategies and waste-to-energy technologies.	***None***	*OVOV has no similar language, however the City does participate in the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force.*
CAPCOA – Conservation & Open Space Policies		**OVOV**	
Reference	**Language**	**Reference**	**Language**
COS-1 pg. 104	**Objective COS-1:** The City/County will adopt and implement a comprehensive strategy to increase water conservation and the use of recycled water.	***None***	*OVOV has no similar language, however the City, and all cities and counties throughout California, will be subject to the requirements of AB1881 on January 1, 2010.*[50]
COS-1.1 pg. 104	**COS-1.1 Water Consumption Reduction Target:** The City/County will reduce per capita water consumption by 20% by 2020.	***None***	*OVOV has no similar language, however the City, and all cities and counties throughout California, will be subject to the requirements of AB1881 on January 1, 2010.*
COS-1.2 pg. 104	**COS-1.2 Water Conservation Plan:** The City/County will establish a water conservation plan that may include such policies and actions as:	**CO 4.1.1 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.1:** In coordination with applicable water suppliers, adopt and implement a water conservation strategy for public and private development.

[50] *In 2008 the Governor called for the State Water Resources Control Board to develop a plan that will reduce the statewide consumption of water by 20% by 2020 (called "20x2020"). The State Model Water Efficient Landscape Ordinance (AB1881) represents only a portion of this plan.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
COS-1.2.1 pg. 104	**1.2.1** Tiered rate structures for water use;	**CO 4.1.1 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.1:** In coordination with applicable water suppliers, adopt and implement a water conservation strategy for public and private development.
COS-1.2.2 pg. 104	**1.2.2** Restrictions on time of use for landscape watering, and other demandmanagement strategies;	**CO 4.1.1 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.1:** In coordination with applicable water suppliers, adopt and implement a water conservation strategy for public and private development.
COS-1.2.3 pg. 104	**1.2.3** Performance standards for irrigation equipment and water fixtures;	**CO 4.1.1 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.1:** In coordination with applicable water suppliers, adopt and implement a water conservation strategy for public and private development.[51]
COS-1.3 pg. 104	**COS-1.3 Recycled Water Use:** The City/County will establish programs and policies to increase the use of recycled water	**CO 4.2.1 pg. CO-87 (Con/OS 8/09)**	**Policy CO 4.2.1:** In cooperation with the Sanitation District and other affected agencies, expand opportunities for use of recycled water for the purposes of landscape maintenance, construction, water recharge, and other uses as appropriate.
COS-1.3.1 pg. 104	**1.3.1** Create an inventory of non-potable water uses within the jurisdiction that could be served with recycled water;	***None***	*OVOV has no similar language, however the Urban Water Management Plan does address "historical water usage" and identifies potential future users of recycled water.*
COS-1.3.2 pg. 104	**1.3.2** Produce and promote the use of recycled water for agricultural, industrial, and irrigation purposes, including grey water systems for residential irrigation;	**CO 4.2.3 pg. CO-88 (Con/OS 8/09)**	**Policy CO 4.2.3:** Promote the installation of rainwater capture and gray water systems in new development for irrigation, where feasible and practicable.
COS-1.3.3 pg. 104	**1.3.3** Produce and promote the use of treated, recycled water for potable uses where GHG emissions from producing such water are lower than from other potable sources.	***None***	*OVOV has no similar language, however the UWMP comprehensively addresses water conservation and recycling opportunities and includes a recycled water comparison.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
COS-1.4 **pg. 104**	**COS-1.4 Water Conservation Outreach:** The City/County will implement a public education and outreach campaign to promote water conservation, and will highlight specific water-wasting activities to discourage, such as the watering of non-vegetated surfaces and using water to clean sidewalks and driveways.	**CO 4.1.4** **pg. CO-86** **(Con/OS 8/09)**	**Policy CO 4.1.4:** Provide informational materials to applicants and contractors on the Castaic Lake Water Agency's Landscape Education Program, and/or other information on xeriscape, native California plants, and water-conserving irrigation techniques as materials become available.[52]
COS-2 **pg. 105**	**Objective COS-2:** The City/County will ensure that building standards and permit approval processes promote and support water conservation.[53]	***See below***	*See below.*
COS-2.1 **pg. 105**	**COS-2.1 Water-Efficient Design:** The City/County will establish building design guidelines and criteria to promote water-efficient building design, including minimizing the amount of non-roof impervious surfaces around the building(s).	**CO 4.1.5, 4.1.6, 4.1.7 & 4.2.3** **pg. CO-87** **(Con/OS 8/09)**	**Policy CO 4.1.5:** Promote the use of low-flow and/or waterless plumbing fixtures and appliances in all new residential and non-residential development and residential development of five or more dwelling units. **Policy CO 4.1.6:** Support amendments to the building code that would promote upgrades to water and energy efficiency when issuing permits for renovations or additions to existing buildings. **Policy CO 4.2.3:** Promote the installation of rainwater capture and gray water systems in new buildings for irrigation, where feasible and practicable.
			Policy CO 4.1.7: Apply water conservation policies to all pending development projects, including approved tentative subdivision maps to the extent permitted by law; where precluded from adding requirements by vested entitlements, encourage water conservation in construction and landscape design.

[52] Note that a public outreach campaign on water efficiency exists at the City of Santa Clarita's green website, http://www.greensantaclarita.com/greenfriendlytips.asp#water. Additional resources can be found at the CLWA website http://www.clwa.org/ .

[53] The new California Green Building Standards Code Sections 603 and 604 deal with indoor and outdoor water use. These sections may become mandatory in 2011.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
COS-2.2 pg. 105	**COS-2.2 Water-Efficient Infrastructure and Technology:** The City/County will establish menus and check-lists for developers and contractors to ensure water-efficient infrastructure and technology are used in new construction, including low-flow toilets and shower heads, moisture-sensing irrigation, and other such advances.	**CO 4.1.5 pg. CO-87 (Con/OS 8/09)**	**Policy CO 4.1.5:** Promote the use of low-flow and/or waterless plumbing fixtures and appliances in all new residential and non-residential development and residential development of five or more dwelling units.
COS-2.2 pg. 105	**COS-2.3 Gray Water System Standards:** The City/County will establish criteria and standards to permit the safe and effective use of gray water (on-site water recycling), and will review and appropriately revise, without compromising health and safety, other building code requirements that might prevent the use of such systems.	**CO 4.2.3 pg. CO-88 (Con/OS 8/09)**	**Policy CO 4.2.3:** Promote the installation of rainwater capture and gray water systems in new development for irrigation, where feasible and practicable.
COS-3 pg. 105	**Objective COS-3:** The City/County will establish programs and policies to ensure landscaping and forests are installed and managed to optimize their climate benefits.	***See Below***	*See Below.*
COS-3.1 pg. 105	**COS-3.1 Water-Efficient Landscapes:** The City/County will install water efficient landscapes and irrigation.[54]	**CO 4.1.3 pg. CO-87 (Con/OS 8/09)**	**Policy CO 4.1.3:** Promote low water use landscaping in new residential subdivisions and other private development projects, including a reduction in the amount of turf-grass. *For any landscape review process, the city employs a consultant who reviews all landscape plans for water efficiency and vegetation suitability, among other criteria.*
COS-3.1.1 pg. 105	**3.1.1** Planting drought-tolerant and native species, and covering exposed dirt with moisture-retaining mulch;	**CO 10.2.1 pg. CO-100 (Con/OS 8/09)**	**Policy CO 10.2.1:** Encourage provision of vegetated open space on a development project's site, which may include shallow wetlands and ponds, drought tolerant landscaping, and pedestrian hardscape that includes vegetated areas.

[54] The City, and all cities and counties throughout California, will be subject to the requirements of AB1881 on January 1, 2010.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
			For any landscape review process, the city employs a consultant who reviews all landscape plans for water efficiency and vegetation suitability, among other criteria.
COS-3.1.2 pg. 105	**3.1.2** Installing water-efficient irrigation systems and devices, including advanced technology such as moisture-sensing irrigation controls;	***None***	*OVOV has no similar language, however this kind of technology is required as part of AB1881.*
COS-3.1.3 pg. 105	**3.1.3** Installing edible landscapes that provide local food.	***None***	*OVOV has no similar language.*
COS-3.2 pg. 105	**COS-3.2 Shade Tree Planting:** The City/County will promote the planting of shade trees and will establish shade tree guidelines and specifications	**CO 3.6.2.d pg. CO-86 (Con/OS 8/09)**	**Policy CO 3.6.2:** Reduce impervious surfaces and provide more natural vegetation to enhance microclimates and provide habitat. In implementing this policy, consider the following design concepts: d. Breaking up large expanses of paving with natural landscaped areas planted with shade trees to reduce the heat island effect, along with shrubs and groundcover to provide diverse vegetation for habitat.
COS-3.2.1 pg. 105	**3.2.1** Recommendations for tree planting based on the land use (residential, commercial, parking lots, etc.);	***None***	*OVOV has no similar language, however the City currently has design standards for tree planting based on land use in the Community Character and Design Guidelines.*
COS-3.2.2 pg. 105	**3.2.2** Recommendations for tree types based on species size, branching patterns, whether deciduous or evergreen, whether roots are invasive, etc.	***None***	*OVOV has no similar language, however the City currently has design standards for tree types in the Community Character and Design Guidelines.*
COS-3.2.3 pg. 106	**3.2.3** Recommendations for placement, including distance from structures, density of planting, and orientation relative to structures and the sun.	***None***	*OVOV has no similar language.*
COS-3.3 pg. 106	**COS-3.3 Urban Forestry Management:** The City/County will develop an Urban Forestry Program to consolidate policies and ordinances regarding tree planting, maintenance, and removal.	**CO 3.5 pg. CO-85 (Con/OS 8/09)**	**Objective CO 3.5:** Maintain, enhance, and manage the urban forest throughout developed portions of the Santa Clarita Valley to provide habitat, reduce energy consumption, and create a more livable environment.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
COS-3.3.1 pg. 106	**3.3.1** Establish a tree-planting target and schedule to support the goals of the California Climate Action Team to plant 5 million trees in urban areas by 2020;	***None***	*OVOV has no similar language; however the City of Santa Clarita has been recognized as a Tree City USA since 1990.*
COS-3.3.1 pg. 106	**3.3.2** Establish guidelines for tree planting, including criteria for selecting deciduous or evergreen trees low-VOC-producing trees, and emphasizing the use of drought-tolerant native trees and vegetation.	***None***	*OVOV has no similar language; however, the City, and all cities and counties throughout California, will be subject to the requirements of AB1881 on January 1, 2010.*
COS-4 pg. 106	**Objective COS-4:** The City/County will establish policies and programs to develop and preserve conservation areas, including forested areas, agricultural lands, wildlife habitat and corridors, wetlands, watersheds, and groundwater recharge areas, that remove and sequester carbon from the atmosphere.	**CO 10.1.3 pg. CO-98 (Con/OS 8/09)**	**Policy CO 10.1.3:** Through dedications and acquisitions, obtain open space needed to preserve and protect wildlife corridors and habitat, which may include land within SEA's, wetlands, woodlands, water bodies, and areas with threatened or endangered flora and fauna.
COS-4.1 pg. 106	**COS-4.1 Conservation Area Development:** The City/County will establish programs and funding mechanisms to create protected conservation areas,	**CO 10.1.3 pg. CO-98 (Con/OS 8/09)**	**Policy CO 10.1.3:** Through dedications and acquisitions, obtain open space needed to preserve and protect wildlife corridors and habitat, which may include land within SEA's, wetlands, woodlands, water bodies, and areas with threatened or endangered flora and fauna.
COS-4.1.1 pg. 106	**4.1.1** Imposing mitigation fees for development on lands that would otherwise be conservation areas, and use the funds generated to protect other areas from development;	***None***	*OVOV has no similar language.*
COS-4.1.2 pg. 106	**4.1.2** Proposing for voter approval a small tax increment (e.g., a quarter cent sales tax, perhaps for a finite time period that could be renewed) to fund the purchase of development rights in conservation areas, or purchase of the land outright.	**CO 10.1.10 pg. CO-99 (Con/OS 8/09)**	**Policy CO 10.1.10:** Ensure that the open space acquisition plan developed pursuant to the 2007 Open Space District formation conforms to General Plan goals and objectives.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
COS-4.1.2 pg. 106	**COS-4.2 Conservation Area Preservation:** The City/County will establish policies to preserve existing conservation areas, and to discourage development in those areas.	**CO 10.1.3 pg. CO-98 (Con/OS 8/09)**	**Policy CO 10.1.3:** Through dedications and acquisitions, obtain open space needed to preserve and protect wildlife corridors and habitat, which may include land within SEA's, wetlands, woodlands, water bodies, and areas with threatened or endangered flora and fauna.
CAPCOA – Education & Outreach Policies		**OVOV**	
Reference	**Language**	**Reference**	**Language**
EO-1 pg. 107	**Objective EO-1:** The City/County will establish a coordinated, creative public outreach campaign, including publicizing the importance of reducing GHG emissions and steps community members can take to reduce their individual impacts.	**CO 1.2.1 & 1.5.4 pg. CO-78, 80 (Con/OS 8/09)**	**Policy CO 1.2.1:** Improve the community's understanding of renewable resource systems that occur naturally in the Santa Clarita Valley, including systems related to hydrology, energy, ecosystems, and habitats, and the interrelationships between these systems. **Policy CO 1.5.4:** Seek ways to discourage human behavior that may be detrimental to natural systems and to encourage environmental responsibility, through education, incentives, removing barriers, enforcement, and other means as practicable and feasible.
EO-1.1 pg. 107	**EO-1.1 Outreach Methods:** The City/County will use a variety of media and methods to promote climate awareness and GHG reduction	**CO 8.1.5 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.1.5:** Coordinate various activities within the community and appropriate agencies related to GHG emissions reduction activities
EO-1.1.1 pg. 107	**1.1.1** TV and radio spots with local celebrities and community leaders;	***None***	*OVOV has no similar language, however the City currently uses KHTS (local AM radio) and SCTV (local cable) as outreach platforms.*
EO-1.1.2 pg. 107	**1.1.2** Advertising "Green Tips" in the local paper;	***None***	*OVOV has no similar language, however the City already promotes "Green Tips" in the local newspaper.*
EO-1.1.3 pg. 107	**1.1.3** Collaborating with utilities, business associations, civic groups, and nonprofits to place tips and articles in billing materials or newsletters;	***None***	*OVOV has no similar language, however the City could use its existing green website, www.greensantaclarita.com. as a platform.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EO-1.1.4 pg. 107	**1.1.4** Designing and maintaining an interactive Climate Protection website and collaborating with other organizations to link to the website.	***None***	*OVOV has no similar language, however the City currently maintains a green website that addresses climate change prevention at http://www.greensantaclarita.com/climatechange.asp*
EO-1.2 pg. 107	**EO-1.2 Outreach Topics:** The City/County will coordinate with other agencies and outreach efforts to align messages on topics	**CO 8.1.5 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.1.5:** Coordinate various activities within the community and appropriate agencies related to GHG emissions reduction activities
EO-1.2.1 pg. 107	**1.2.1** Energy efficiency and conservation, and green energy;	**CO 8.1.4 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.1.4:** Provide information and education to the public about energy conservation and local strategies to address climate change.
EO-1.2.2 pg. 107	**1.2.2** Trip reduction, public transit, carpooling, vanpooling, and alternative modes of transportation;	**C 1.1.3 pg. C-59 (Circ 8/09)**	**Policy C 1.1.3:** Work with local and regional agencies and employers to promote an integrated, seamless transportation system that meets access needs, including local and regional bus service, dial-a-ride, taxis, rail, van pools, car pools, bus pools, bicycling, walking, and automobiles.
EO-1.2.3 pg. 107	**1.2.3** Green building and energy-efficient design;	**CO 8.1.4 pg. CO-93 (Con/OS 8/09)**	**Policy CO 8.1.4:** Provide information and education to the public about energy conservation and local strategies to address climate change.
EO-1.2.4 pg. 107	**1.2.4** Waste reduction, recycling, and composting;	**CO 8.4.7 pg. CO-96 (Con/OS 8/09)**	**Policy CO 8.4.7:** Provide information to the public on recycling opportunities and facilities, and support various locations and events to promote public participation in recycling.
EO-1.2.5 pg. 107	**1.2.5** Water conservation and water-efficient design and products;	**CO 4.1.4 pg. CO-86 (Con/OS 8/09)**	**Policy CO 4.1.4:** Provide informational materials to applicants and contractors on the Castaic Lake Water Agency's Landscape Education Program, and/or other information on xeriscape, native California plants, and water-conserving irrigation techniques as materials become available.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EO-1.2.6 pg. 107	**1.2.6** The benefits of buying local, and information about locally grown, prepared, and manufactured goods and local services.	**LU 4.2.2 – 4.2.5 pg. LU-78 (Land Use 8/09)**	**Policy LU 4.2.2:** Achieve a balanced ratio of jobs to housing through business expansion and economic development programs, with a goal of at least 1.5 jobs per household. **Policy LU 4.2.3:** Encourage businesses to locate in all appropriate areas of the community to encourage job creation in closer proximity to workforce housing. **Policy LU 4.2.4:** Coordinate with local colleges to promote job training programs for Santa Clarita Valley residents. **Policy LU 4.2.5:** Promote development of uses that create job opportunities for residents through the Santa Clarita Enterprise Zone and other business assistance programs as appropriate.
EO-2 pg. 107	**Objective EO-2:** The City/County will work with local businesses and energy providers on specific, targeted outreach campaigns and incentive programs.	**CO 1.5.4 pg. CO-80 (Con/OS 8/09)**	**Policy CO 1.5.4:** Seek ways to discourage human behavior that may be detrimental to natural systems and to encourage environmental responsibility, through education, incentives, removing barriers, enforcement, and other means as practicable and feasible.
EO-2.1 pg. 107	**EO-2.1 Energy Efficiency Campaigns:** The City/County will collaborate with local energy suppliers and distributors to establish energy conservation programs, Energy Star® appliance change-out programs, rebates, vouchers, and other incentives to install energy-efficient technology and products and to cooperate on advertising.	***None***	*OVOV has no similar language, however the City could use its existing green website, www.greensantaclarita.com as a platform. The site currently advertises Energy Star products and appliance change-out programs.*
EO-2.2 pg. 108	**EO-2.2 Pedestrian and Bicycle Promotion:** The City/County will work with local community groups and downtown business associations to organize and publicize walking tours and bicycle events, and to encourage pedestrian and bicycle modes of transportation.	***None***	*OVOV has no similar language, however the City currently runs the annual Bike to Work Day event, and operates more than 60 miles of trails and paseos designed for commuting and recreational use, including walking, running, biking, and skating. The City promotes these programs across city websites, including on www.greensantaclarita.com.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EO-3 **pg. 108**	**Objective EO-3:** The City/County will organize events and workshops to promote GHG-reducing activities.	**CO 8.1.5** **pg. CO-93** **(Con/OS 8/09)**	**Policy CO 8.1.5:** Coordinate various activities within the community and appropriate agencies related to GHG emissions reduction activities
EO-3.1 **pg. 108**	**EO-3.1 Waste Reduction:** The City/County will organize workshops on waste reduction activities for the home or business, such as backyard composting, or office paper recycling, and will schedule recycling dropoff events and neighborhood chipping/mulching days.	**CO 8.4.7** **pg. CO-96** **(Con/OS 8/09)**	**Policy CO 8.4.7:** Provide information to the public on recycling opportunities and facilities, and support various locations and events to promote public participation in recycling.
EO-3.2 **pg. 108**	**EO-3.2 Water Conservation:** The City/County will organize workshops on water conservation activities, such as selecting and planting drought-tolerant, native plants in landscaping, and installing advanced irrigation systems.	**CO 4.1.4** **pg. CO-86** **(Con/OS**	**Policy CO 4.1.4:** Provide informational materials to applicants and contractors on the Castaic Lake Water Agency's Landscape Education Program, and/or other information on xeriscape, native California plants, and water-conserving irrigation techniques as materials become available.
EO-3.3 **pg. 108**	**EO-3.3 Energy Efficiency:** The City/County will organize workshops on steps to increase energy efficiency in the home or business, such as weatherizing the home or building envelope, installing smart lighting systems, and how to conduct a self-audit for energy use and efficiency.	**CO 8.1.4** **pg. CO-93** **(Con/OS 8/09)**	**Policy CO 8.1.4:** Provide information and education to the public about energy conservation and local strategies to address climate change.
EO-3.4 **pg. 108**	**EO-3.4 Climate Protection Summit/Fair:** The City/County will organize an annual Climate Protection Summit or Fair, to educate the public on current climate science, projected local impacts, and local efforts and opportunities to reduce GHG emissions, including exhibits of the latest technology and products for conservation and efficiency.	***None***	*OVOV has no similar language, however the City's annual Earth Day, River Rally, and Arbor Day events do address climate change.*

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EO-3.5 **pg. 108**	**EO-3.5 Schools Programs:** The City/County will develop and implement a program to present information to school children about climate change and ways to reduce GHG emissions, and will support school-based programs for GHG reduction, such as school based trip reduction and the importance of recycling.	***None***	*OVOV has no similar language, however the City's existing green website does have information on climate change for school children at http://www.greensantaclarita.com/climatechange.asp*
EO-4 **pg. 108**	**Objective EO-4:** The City/County will sponsor competitions and awards to encourage GHG reductions and recognize success.[55]	***None***	*OVOV has no similar language. However, a program such as this could easily be implemented through the City's green website, www.greensantaclarita.com.*
EO-4.1 **pg. 108**	**EO-4.1 Climate Champions Awards:** The City/County will establish a Climate Champions Awards program to acknowledge outstanding private and public efforts to reduce GHG emissions.	***None***	*OVOV has no similar language.*
EO-4.2 **pg. 109**	**EO-4.2 GHG Reduction / Climate Protection Competitions:** The City/County will sponsor competitions and contests with prizes for promoting climate protection and reducing GHG emissions, including such contests as:	***None***	*OVOV has no similar language.*
EO-4.2.1 **pg. 109**	**4.2.1** Poster contests at schools, with winning entrants receiving scholarship grants and recognition at the Climate Protection Summit/Fair, and posters used in outreach campaigns or compiled in calendars;	***None***	*OVOV has no similar language, however the Transit Department is currently running one annual student art competition relating to the environmental benefits of public transportation and one "recycled work of art" competition.*

[55] Items contained in EO-4 seem too specific for General Plan use. These appear to be more appropriate for either a green building program or a Climate Action Plan.

CAPCOA – GHG Reduction Policies		OVOV	
Reference	**Language**	**Reference**	**Language**
EO-4.2.2 pg. 109	**4.2.2** Waste diversion contests between schools, businesses, civic organizations, and Scout troops or other groups, with prizes for the greatest percent waste diverted and recognition at the Climate Protection Summit/Fair, and similar contests for planting trees, reducing vehicle trips, or other desired behaviors;	***None***	*OVOV has no similar language.*
EO-4.2.3 pg. 109	**4.2.3** Walkathons, relays, or other similar fundraising challenges, with funds raised to support community climate protection programs and activities.	***None***	*OVOV has no similar language.*

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APPENDIX 3.9

Soil Types and Characteristics of the County's Planning Area

SOIL TYPES AND CHARACTERISTICS OF THE COUNTY'S PLANNING AREA

The following is a short description of each of the soils that are found within the County's Planning Area. Additionally, **Table 1, Soil Characteristics of the County's Planning Area,** further describes the types of soils and their characteristic types within the County's Planning Area.

Agua Dulce stony loam, 30 to 50 percent slopes (AgF)

This soil is located in mountainous areas in the southern part of Agua Dulce Canyon. Permeability is moderately slow in this soil. Available water-holding capacity is 3 to 4 inches. Fertility is moderate, runoff is rapid, and the erosion hazard is high. Roots can penetrate to a depth between 36 and 60 inches. Thin lenses of sandstone conglomerate generally limit the depth to which plant roots can penetrate. Agua Dulce stony loam, 30 to 50 percent slopes, is used for range, wildlife habitat, and watershed. Capability unit VIIe-1 (19) dryland; range site 2. There are approximately 6,118 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Amargosa rocky coarse sandy loam, 9 to 55 percent slopes, eroded (AmF2)

This soil is located on hilly uplands. In most places about 25 to 40 percent of the original surface soil has been removed through moderate sheet and rill erosion. Rock outcrops cover 2 to 20 percent of the surface, and many areas are cut by shallow gullies. Permeability is moderately rapid in this soil. Available water-holding capacity is 1 to 1.5 inches. Fertility is very low, runoff is medium to rapid, and the hazard of water erosion is moderate to high. In most places roots can penetrate to a depth of about 14 to 20 inches. Amargosa rocky coarse sandy loam, 9 to 55 percent slopes, eroded, is used as range and for recreation, wildlife, and water supply purposes. Capability Class VIIe-1 (19) dryland; range site 4. There are approximately 4,271 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Anaverde loam, 15 to 30 percent slopes (AnE)

Some of this soil is located on Pelona Ridge, and others are located along the upper reaches of Cottonwood Creek, west and south of White Oak Lodge. Permeability is moderate in this soil. Available water-holding capacity is 5.5 to 9 inches, depending on soil depth. Fertility is high, runoff is medium, and the erosion hazard is moderate. This Anaverde soil is used for range, wildlife, and recreation. Capability Class VIe-1 (20) dryland; range site 2. There are approximately 2 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Anaverde rocky loam, 30 to 50 percent slopes (ApF)

Some of this soil is located along the upper reaches of Cottonwood Creek and others are on Pelona Ridge. Slopes are dominantly 35 to 45 percent, and outcrops of bedrock cover from 5 to 10 percent of the areas. Runoff is rapid, and the erosion hazard is high. This Anaverde soil is used for range, wildlife, habitat, and watershed. Capability Class VIIe-1 (20) dryland; range site 2. There are approximately 10 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Castaic silty clay loam, 2 to 9 percent slopes (CkC)

This soil is located on toe slopes. Some areas are along Davenport Road and others are near the communities of Vincent and Acton. Fertility is low in this soil. Available water holding capacity is 5 to 7.5 inches. Roots extend to a depth of 30 to 44 inches. Runoff is slow to medium, and the erosion hazard is slight to moderate. This soil is used only for limited grazing. Dryland farming has not been successful. A few areas are used as homesites. Capability Class IIIe-1 (19) irrigated. There are approximately 130 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Castaic silty clay loam, 9 to 15 percent slopes (CkD)

On this soil, runoff is medium, and the erosion hazard is moderate. This soil is used for range and as homesites. Capability Class IIIe-1 irrigated. There are approximately 196 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Castaic-Balcom silty clay loams, 9 to 15 percent slopes (CmD)

This complex is on toe slopes in Romero Canyon. Runoff is medium, and the erosion hazard is moderate. In most places, slopes range from 12 to 14 percent. Included with these soils are a few areas less than 10 acres in size where sheet and rill erosion is moderate. Also included are small areas of Saugus loam and Millsholm rocky loam. This complex is used primarily for Dryland small grains and pasture and for range. Capability unit IIIe-1 irrigated. There are approximately 172 acres of this soil located within the Los Angeles County portion of the OVOV Planning Area.

Castaic-Balcom silty clay loams, 15 to 30 percent slopes (CmE)

The soils in this complex are less sloping and less eroded than Castaic-Balcom silty clay loams, 30 to 50 percent slopes, eroded (CmF2), but otherwise they are similar. Slopes are commonly about 25 percent. Runoff is medium to rapid, and the hazard of further erosion is moderate to high. Landslips are common. Included with this soil some areas 10 to 20 acres in size where sheet and rill erosion are moderate. Also included are small areas of Saugus loam, Gazos clay loam, and Millsholm rocky loam. This complex is

used for range as wildlife habitat. Capability unit IVe-1 irrigated. There are approximately 2,642 acres of this soil located within the Los Angeles County portion of the OVOV Planning Area.

Castaic-Balcom silty clay loams, 30 to 50 percent slopes (CmF)

These soils are slightly eroded, and their surface layer is 10 to 12 inches thick. Included with these soils areas 10 to 20 acres in size where rill and sheet erosion are moderate. Also included are small areas of Saugus loam. Areas of this complex are used for range, wildlife habitat, and watershed. Capability unit VIe-1 dryland. There are approximately 9,160 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Castaic-Balcom silty clay loams, 30 to 50 percent slopes, eroded (CmF2)

This complex is in the area near Castaic Junction. It is 60 percent Castaic silty clay loam and 40 percent Balcom silty clay loam. Permeability is moderately slow in these soils. Available water-holding capacity is 5 to 7 inches. Fertility is moderate, runoff is rapid, and the hazard of erosion is high. Plant roots generally penetrate to a depth of about 26 to 36 inches, but can reach a depth of 40 inches in some places. The Balcom soil, not the Castaic soil, contains lime at a depth of 10 to 20 inches. Included with these soils are small areas of Gazos clay loam, of Saugus loam, and of Gaviota sandy loam. Also included are narrow areas of soils that have a reddish-brown surface layer. Castaic-Balcom silty clay loams, 30 to 50 percent eroded, are used chiefly for range. They also are used for watershed purposes and for wildlife habitat and recreation. Capability unit VIe-1 dryland. There are approximately 11,897 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Castaic-Balcom silty clay loams, 50 to 65 percent slopes, eroded (CmG2)

This soil is located on mountainous uplands northwest of Castaic Junction, adjacent to the boundaries of Los Angeles and Ventura Counties. Moderate sheet and rill erosion have occurred in nearly all places where this soil is located. Runoff is very rapid, and the hazard of further erosion is very high. This soil is used mainly for wildlife habitat and watershed purposes, but some areas are grazed. Capability Class VIIe-1 dryland. There are approximately 2,669 acres of this soil located within the Los Angeles County portion of the OVOV Planning Area.

Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded (CnG3)

This undifferentiated group of soils is 35 percent Castaic silty clay loam and 30 percent Saugus loam. Included in mapping this unit are exposed areas of soft shale and conglomerate that make up as much as 10 percent of the unit and areas of Balcom silty clay loam that make up as much as 25 percent. Areas of this unit are cut by many intermittent, very deep drainage channels that have narrow v-shaped valleys and between them sharp, tortuous divides. Soil slipping is common, and geological erosion is active. During heavy rainstorms much silt is washed away from these soils. Because of repeated burning of brush, the vegetation on these soils now consists mainly of thick stands of chamise. The Castaic soil in this unit is steeper and more eroded than the Castaic soil in Cataic-Balcom silty clay loams, 30 to 50 percent slopes, eroded (CmF2), but otherwise is similar. Also, depth to soft shale generally is less, about 20 to 30 inches. The Saugus soil is steeper and more eroded than Saugus loam, 30 to 50 percent slopes, eroded (ScF2), but otherwise it is similar. In addition, depth to weakly consolidated sediment is 24 to 44 inches. Slopes are dominantly 45 to 65 percent. Available water-holding capacity is 4 to 6 inches in the Castaic soil, and 4 to 7 inches in the Saugus soil. In both soils, fertility is very low, runoff is very rapid, and the hazard of further erosion is very high. Most of this unit is inaccessible to man and livestock because the brush is dense, the soils are steep or very steep, and the valleys are narrow and v-shaped. These soils are used for watershed and for wildlife habitat. Capability unit VIIIe-1 dryland. There are approximately 8,136 acres of this soil within the Los Angeles County portion of the OVOV Planning Area.

Chino loam (Co)

This soil is nearly level and generally is located in the Leona Valley, but many areas are located along the Tehachapi Range. Permeability is moderately slow. Available water-holding capacity is 10 to 12 inches. Present fertility is moderate, but when the soil is reclaimed, fertility is high. Runoff is very slow, and the soil is likely to be ponded in places in spring. The hazard of erosion is none to slight. Roots can penetrate to a depth of 60 inches or more, depending on the height of the fluctuating water table. Chino loam is wet and is in meadow. It is used only as pasture. Capability Class IIw-2 irrigated. There are approximately 57 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Cortina sandy loam, 0 to 2 percent slopes (CyA)

This soil occupies narrow alluvial fans in side canyons along tributaries of the Santa Clara River. The surface layer lacks cobblestones, but the soil otherwise is similar to Cortina cobbly sandy loam, 2 to 9 percent slopes (CzC). Thickness of the surface layer ranges from 12 to 16 inches. In most places, slopes range from about 3 to 5 percent and are quite long. A few stones and pebbles are in the soil, but they do not interfere with tillage. Runoff is slow, and the hazard of erosion is moderate. Included with this soil in

mapping are small areas of Cortina cobbly sandy loam, Metz loamy sand, and Sorrento loam. Also included are small areas that have a surface layer of loam, which are mainly the result of land leveling and smoothing. In the past, loamy soil material from adjacent uplands was moved onto the areas to square fields and eliminate point rows. This Cortina soil is used for range and for dryland small grains. It is also used for irrigated alfalfa, small grains, and pasture. Capability unit IVs-0. There are approximately 888 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Cortina sandy loam, 2 to 9 percent slopes (CyC)

This soil occupies narrow alluvial fans in side canyons along tributaries of the Santa Clara River. The surface layer lacks cobblestones, but the soil is otherwise similar to Cortina cobbly sandy loam, 2 to 9 percent slopes (CzC). Thickness of the surface layer ranges from 12 to 16 inches. In most places, slopes range from about 3 to 5 percent and are quite long. A few stones and pebbles are in the soil, but they do not interfere with tillage. Runoff is slow, and the hazard of erosion is moderate. Included with this soil are small areas of Cortina cobbly sandy loam, Metz loamy sand, and Sorrento loam. Also included are small areas that have a surface layer of loam, which are mainly the result of land leveling and smoothing. In the past, loamy soil material from adjacent uplands was moved onto the areas to square fields and eliminate point rows. This Cortina soil is used for range and for dryland small grains. It is also used for irrigated alfalfa, small grains, and pasture. Capability unit IVs-0. There are approximately 646 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Cortina cobbly sandy loam, 2 to 9 percent slopes (CzC)

This soil is on narrow alluvial fans along Castaic Creek, in Agua Dulce Canyon, and in Mint Canyon. Permeability is rapid in this Cortina soil. Available water-holding capacity is 2 to 3 inches. Runoff is slow, and the hazard of erosion is slight. Fertility is low. Roots can penetrate to a depth of 60 inches or more. Included with this soil type are small areas of Cortina sandy loam and Metz sandy loam. This Cortina soil is used for range, as wildlife habitat, and for watershed purposes. The areas are likely to be flooded for a short period after a heavy rain. Capability unit VIIs-7 dryland. There are approximately 562 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Gaviota rocky sandy loam, 15 to 30 percent slopes, eroded (GaE2)

This soil is well drained. Permeability is moderately rapid. Available water-holding capacity is 1 to 2 inches. Runoff is medium, and the hazard of erosion is moderate. Fertility is low. Roots can penetrate to a depth of 14 to 20 inches. This soil is used for range, wildlife habitat, and watershed. Capability Class

VIIe-1 dryland. There are approximately 29 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Gaviota rocky sandy loam, 30 to 50 percent slopes, eroded (GaF2)

This soil is on mountains. Some areas located south of Castaic Junction are fairly large. Smaller areas are south of Solemint and northeast of Quail Lake. Slopes commonly are 45 percent. In most places sheet and rill erosion is moderate, and a few areas are cut by deep gullies. Outcrops of rock cover from about 5 to 10 percent of the total area. The dominant vegetation is chamise brush and an understory of annual grasses. Runoff is rapid on this soil, and the hazard of erosion is high. Drainage is somewhat excessive. Included with this soil in mapping are small areas of Millsholm rocky loam and Saugus loam. Also included are about 500 acres of a very rocky Gaviota soil near Vasquez Rocks. This Gaviota soil is used for range, wildlife, and watershed. Capability unit VIIe-1 dryland. There are approximately 6,128 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Gazos clay loam, 30 to 50 percent slopes (GbF)

Permeability of this soil is moderately slow. Available water-holding capacity is 3 to 6 inches. Runoff is rapid, and the hazard from erosion is high. Fertility is moderate. This soil is used mainly for grazing. Capability Class VIe-1 dryland. There are approximately 512 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Godde rocky loam, 30 to 50 percent slopes (GdF)

This soil occupies mountainous areas on Pelona Ridge and in other areas of the Leona Valley. In places, outcrops of rock occupy 5 to 10 percent of the area covered by this soil. Permeability of this soil is moderate. Available water-holding capacity is 2 to 3 inches. Fertility is low. Runoff is rapid, and the hazard of erosion is high. This soil is used for range, as wildlife habitat, and for recreation and watershed purposes. Capability Class VIIe-1 dryland. There are approximately 1,970 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Greenfield sandy loam, 0 to 2 percent slopes (GsA)

This soil is on long, smooth, broad alluvial fans near Fairmont. In places, the surface layer is coarse sandy loam. Runoff is very slow, and the hazard of erosion is slight. This soil is used for irrigated crops, dryland small grains, and pasture and range. Capability Class I-1 irrigated and IVec-1 dryland. There are approximately 24 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Greenfield sandy loam, 2 to 9 percent slopes (GsC)

This soil is on alluvial fans near Fairmont. Permeability is moderately rapid in this soil. Available water-holding capacity is 7.5 to 9 inches. Fertility is moderate. Roots can penetrate to a depth of 60 inches or more. Runoff is slow to medium, and the hazard of erosion is slight to moderate. This soil is used for irrigated crops, dryland small grains, and pasture and range. Capability Class IIe-1 irrigated and IVec-1 dryland. There are approximately 459 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Greenfield sandy loam, 9 to 15 percent slopes, eroded (GsD2)

This soil occupies narrow fans and terraces near Fairmont. Slopes commonly range from 10 to 14 percent. Runoff is medium to rapid, and the hazard of further erosion is moderate to high. This soil is used for dryland small grains, dryland pasture, and range. Capability Class IIIe-1 irrigated and IVec-1 dryland. There are approximately 277 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Hanford coarse sandy loam, 2 to 9 percent slopes (HbC)

In most places, this soil ranges from 2 to 5 percent slopes. Runoff is slow to medium, and the hazard of erosion is slight to moderate. This soil is used for irrigated crops, dryland small grains, and range. Capability Class IIe-1 irrigated and IVec-1 dryland. There are approximately 723 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Hanford coarse sandy loam, 9 to 15 percent slopes (HbD)

This soil occupies alluvial fans in narrow side canyons along Portal Ridge. Sheet and rill erosion are slight. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight to moderate. This soil is used for dryland small grains, dryland pasture, and range. Capability Class IIIe-1 irrigated and IVec-1 dryland. There are approximately 50 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Hanford sandy loam, 0 to 2 percent slopes (HcA)

This soil occurs throughout the area near Fairmont. It is dominantly sandy loam and fine sandy loam throughout, but otherwise it is similar to Hanford coarse sandy loam, 0 to 2 percent slopes (HbC). Runoff is slow on this soil, and the hazard of erosion is slight. Available water-holding capacity is 6 to 7.5 inches. Fertility is moderate. Roots can penetrate to a depth of 60 inches or more. Included with this soil in mapping are small areas of Hanford coarse sandy loam and of Greenfield sandy loam. This Hanford soil

is used for irrigated crops, pasture, and range. Capability unit IIs-4 irrigated and IVec-1 dryland. There are approximately 1,227 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Hanford sandy loam, 2 to 9 percent slopes (HcC)

This soil is on alluvial fans near Fairmont. It is dominantly sandy loam and fine sandy loam throughout, but it is otherwise similar to Hanford coarse sandy loam, 0 to 2 percent slopes, though with more pronounced slopes. In most places slopes range from 2 to 6 percent. Runoff is slow to medium on this soil, and the hazard of erosion is slight to moderate. Available water-holding capacity is 6 to 7.5 inches. Fertility is moderate. Included with this soil are small areas of Greenfield coarse sandy loam and of Hanford coarse sandy loam. Also included are small areas where rill and sheet erosion are moderate. Other included small areas are on fans where slopes range from 10 to 12 percent. This Hanford soil is used for purposed similar to those of Hanford coarse sandy loam, 0 to 2 percent slopes. Capability unit IIe-1 irrigated and IVec-1 dryland. There are approximately 3,960 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Hanford sandy loam, calcareous variant, 2 to 9 percent slopes (HeC)

Slopes for this soil are dominantly about 2 to 4 percent. Permeability is moderately rapid in this soil. Available water holding capacity is 7.5 to 9.9 inches. Fertility is moderate. Runoff is slow, and the hazard of erosion is slight. This soil is used for dryland small grains and range. Capability Class IIe-1 irrigated and IVec-1 dryland. There are approximately 46 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Las Posas loam, 9 to 30 percent slopes (LaE)

This soil occupies toe slopes and foothills west of Agua Dulce. Slopes are fairly long and smooth. Runoff is medium to rapid on this soil. The hazard of erosion is moderate to high. Available water-holding capacity is 4 to 7 inches. This soil is used for range in spring. Capability Class IVe-1 irrigated. There are approximately 348 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Las Posas-Toomes rocky loams, 30 to 50 percent slopes (LdF)

Some areas of this soil are on steep mountains, and other areas are on moderately steep foothills. The soils are most prevalent near Acton, Agua Dulce, and Vincent. Permeability is moderately slow. Runoff is rapid, and the hazard of erosion is high. Available water-holding capacity is 4 to 7 inches. Fertility is low.

This soil is used for range and as wildlife habitat. Capability Class VIIe-1 dryland. There are approximately 3,403 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Metz loamy sand, 0 to 2 percent slopes (MfA)

This soil is on alluvial fans near Castaic Junction. Permeability of this soil is rapid. Available water-holding capacity is 4 to 5 inches. Fertility is low. Runoff is very slow, and the hazard of water erosion is slight to moderate. Roots can penetrate to a depth of 60 inches or more. Included with this soil in mapping are small areas of Sorrento sandy loam and of Yolo sandy loam. Also included are a few small areas of Metz soils in lower-lying areas that are subject to occasional flooding. This Metz soil is used for irrigated crops, dryland farming, and wildlife habitat. Capability unit IIIs-4 irrigated. There are approximately 302 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Metz loamy sand, 2 to 9 percent slopes (MfC)

This soil is on alluvial fans along the Santa Clara River and its major tributaries. In most places slopes range from 2 to 5 percent. Runoff is slow, and the hazard of erosion is slight. Included with this soil in mapping are some areas at the head of narrow canyons that have slopes of 12 to 14 percent. Also included are small areas of Cortina sandy loam, Cortina cobbly sandy loam, and Yolo loam. In many places in Sand Canyon, the soil has been mixed, leveled, and shaped by earthmoving equipment. In these places much of the soil has been roughly bench terraced. This Metz soil is used for purposed similar to those of Metz loamy sand, 0 to 2 percent slopes (MfA). Capability unit IIIs-4 irrigated. There are approximately 828 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Metz loam, 0 to 2 percent slopes (MgA)

This soil is on flood plains north of Saugus. The surface layer is loam about 8 to 16 inches thick, but otherwise this soil is similar to Metz loamy sand, 0 to 2 percent slopes (MfA). In many places, reaction is mildly alkaline. Runoff is very slow on this soil, and the hazard of erosion is slight to none. Available water-holding capacity is 5 to 6 inches. Fertility is moderate. Included with this soil in mapping are small areas of Metz loamy sand. This Metz soil is used mainly for alfalfa and for row crops. Capability unit IIs-4 irrigated. There are approximately 31 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Metz loam, 2 to 5 percent sloes (MgB)

The surface layer of this soil is loam that is about 8 to 10 inches thick. Slopes range from 2 to 3 percent in most places. Sheet and rill erosion are minor. Runoff is slow on this soil, and the hazard of erosion is slight. Fertility is moderate. Included with this soil in mapping are small areas of Metz loamy sand. This Metz soil is used for irrigated alfalfa and small grains. Capability unit IIs-4 irrigated. There are approximately 271 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Millsholm rocky loam, 15 to 30 percent slopes, eroded (MhE2)

Slopes of this soil range from about 20 to 24 percent in most places. Sheet and rill erosion are moderate in most of the area. Runoff is medium to rapid, and the hazard of further erosion is moderate to high. This soil is used for range, wildlife, and recreation. Capability Class VIIe-1 dryland. There are approximately 816 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Millsholm rocky loam, 30 to 50 percent slopes, eroded (MhF2)

This soil is moderately permeable. Available water-holding capacity is 2 to 3 inches. Fertility is low. Runoff is rapid, and the hazard of erosion is high. This soil is used for range, wildlife, and watershed purposes. Capability Class VIIe-1 dryland. There are approximately 6,591 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Mocho sandy loam, 0 to 2 percent slopes (MoA)

This soil is near Castaic Junction. The surface layer is brown sandy loam that generally is massive and slightly hard. It is 10 to 12 inches thick. The hazard of erosion is slight on this soil, and runoff is very slow. Available water-holding capacity is 7.5 to 9.5 inches. Included with this soil are small areas of Metz loamy sand, Sorrento loam, and Yolo loam. This Mocho soil is used for purposed similar to those of Mocho loam, 0 to 2 percent slopes (MpA). Capability unit I-1 irrigated. There are approximately 37 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Mocho loam, 0 to 2 percent slopes (MpA)

This soil is on alluvial fans south of Castaic Junction. This soil is moderately permeable. Available water-holding capacity is 8 to 10 inches. Fertility is high. Runoff is very slow, and the hazard of erosion is none to slight. Roots can penetrate to a depth of 60 inches or more. Included with this soil are small areas of Metz loamy sand, Sorrento loam, and Yolo loam. This soil is used for dryland and irrigated crops.

Capability unit I-1 irrigated. There are approximately 304 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Mocho sandy loam, 2 to 9 percent slopes (MpC)

This soil occupies fairly narrow alluvial fans near Castaic Junction. In most places slopes range from 2 to 5 percent. In places at the heads of fans, a few pebbles or cobblestones are on the surface. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Included with this soil are small areas of Metz loamy sand, Sorrento loam, and Yolo loam. Also included are areas 5 to 10 acres in size where sheet and rill erosion are moderate. This Mocho soil is used about the same as Mocho loam, 0 to 2 percent slopes (MpA). Capability unit IIe-1 irrigated. There are approximately 603 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Oak Glen sandy loam, 2 to 9 percent slopes (ObC)

This soil is typically found on long, smooth alluvial fans. Permeability is moderately rapid in this soil. Available water-holding capacity is 6 to 7.5 inches. Fertility is high. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Roots penetrate to a depth of 60 inches or more. This soil is used for dryland small grains and range. Capability Classification is IIIe-1 dryland. There are approximately 5 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Oak Glen gravelly sandy loam, 2 to 9 percent slopes (OcC)

Except that this soil is gravelly throughout, it is similar to Oak Glen sandy loam, 2 to 9 percent slopes (ObC). The gravel consists of rounded granitic material that is about 2 inches or less in diameter, which makes up from 15 to about 35 percent, by volume, of the mass. Because of the gravel, available water-holding capacity is less than in Oak Glen sandy loam, 2 to 9 percent slopes, and tillage is more difficult. Runoff is slow to medium on this soil, and the hazard of erosion is slight to moderate. Available water-holding capacity is about 4 to 6 inches. Included with this soil are small areas of Oak Glen sandy loam. Also included are areas of unnamed soil in which the content of gravel ranges from 35 to 65 percent, by volume. This unnamed soil occupies up to 15 or 20 percent of each soil area. A few areas of a soil that has slopes of 12 to 14 percent are also included. This Oak Glen soil is used for range and as wildlife habitat. Capability unit IIIe-1 dryland. There are approximately 54 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Oak Glen loam, 0 to 2 percent slopes (OdA)

Most areas of this soil are in Oso Canyon. The surface layer is dark-gray light loam about 46 inches thick. The substratum is pale brown and ranges from heavy sandy loam to heavy coarse sandy loam and light loam. It is less than 18 percent clay. This soil is moderately permeable. Available water-holding capacity is high, but the growing season is shorter than in other areas of Oak Glen soils. Runoff is very slow, and the hazard of erosion is none to slight. Roots can penetrate to a depth of 60 inches or more. Included with this soil are small areas of Oak Glen sandy loam. Here cattle have trampled the surface, and the soil is hard and massive when dry. This Oak Glen soil is used for range and as wildlife habitat. Capability unit IIIc-1 dryland. There are approximately 4 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, 2 to 9 percent slopes (OgC)

This soil is on terraces near Saugus. This soil has moderately slow permeability. Available water-holding capacity is 9 to 11 inches. Fertility is low. Tilth is poor. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Roots can penetrate to a depth of about 60 inches. Included with this soil in mapping are small areas of Ojai loam, 9 to 15 percent slopes (OgD). Also included are small areas of Zamora loam. This Ojai soil is used for irrigated alfalfa, row crops, and range. It also is increasingly being used as site for homes and industries. Some areas on terraces northwest of Solemint and south of the Saugus-Ventura Road near the power substation have been shaped and altered by earthmoving equipment. These areas now have houses on them or are used as golf courses. Capability unit IIIe-1 irrigated. There are approximately 451 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, 9 to 15 percent slopes (OgD)

This soil is on foothills. Most areas are strongly sloping, but some areas are rolling. Slopes range from 10 to 15 percent in most places. Runoff is medium, and the hazard of erosion is moderate. Included with this soil in mapping are small areas where sheet and rill erosion are moderate. Also included are a few deep gullies. Other included small areas consist of Ojai loam, 15 to 30 percent slopes (OgE). This Ojai soil is used mostly for range, but some areas are used for dryland small grains. The areas also provide habitat for wildlife. Capability unit IVe-1 irrigated. There are approximately 181 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, 15 to 30 percent slopes (OgE)

This soil is on foothills near Solemint. Slopes range from 20 to 26 percent in most places. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Included with this soil in mapping are some areas 10 to 20 acres in size where sheet and rill erosions are moderate. Also included are a few deep loam, thin surface variant, 30 to 50 percent slopes, and Ojai loam, 30 to 50 percent slopes, eroded (OgF2). This Ojai soil is used for range, wildlife habitat, and watershed. The slopes severely limit suitability for cultivation. Capability unit VIe-1 dryland. There are approximately 157 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, 30 to 50 percent slopes (OgF)

This soil is on foothills near Castaic, Saugus, and Solemint. Slopes generally range from 35 to 45 percent. Runoff is rapid, and the hazard of erosion is high. Included with this soil are small areas of Ojai loam, 15 to 30 percent slopes (OgE). Also included are about 280 acres at the head of Plum Canyon that consist of Ojai soils and have a surface layer of clay loam. Small areas cut by sheet and rill erosion are also included. This Ojai soil is used for range, wildlife habitat, and watershed. Capability unit VIIe-1 dryland. There are approximately 2,516 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, 30 to 50 percent slopes, eroded (OgF2)

Much of the original surface layer of this soil has been removed through sheet and rill erosion. The present surface layer is 16 to 18 inches thick in most places. Slopes commonly are about 40 percent. The areas are cut by a few deep gullies and by many shallow gullies. Runoff is rapid, and the hazard of further erosion is high. This Ojai soil is suitable for range, wildlife, habitat, and watershed purposes. Capability unit VIIe-1 dryland. There are approximately 18 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai loam, thin surface variant, 30 to 50 percent slopes (OhF)

This is the only variant from this type of normal Ojai soil series. It is found on terraces. Permeability is moderately slow in this soil. Runoff is rapid, and the hazard of erosion is high. Available water-holding capacity is 8 to 10 inches. Fertility is low. Included with this soil in mapping are some small areas of Agua Dulce stony loam. Ojai loam, thin surface variant, 30 to 50 percent slopes, is used only for range. Capability unit VIIe-1 dryland. There are approximately 1,791 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ojai-Zamora loams, 15 to 30 percent slopes (OzE)

This soil is under grasses and oaks on short, hilly side slopes near Saugus. Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is used for range. Capability Class is VIe-1 dryland. There are approximately 314 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona coarse sandy loam, 2 to 5 percent slopes (RcB)

This type of soil is found on long, broad, smooth terraces. Soil blowing is a slight to moderate hazard. Runoff is slow, and the hazard of water erosion is slight. This soil is used for dryland crops and range, dryland and irrigated orchards, and wildlife habitat. Capability Class is IIIe-1 irrigated and IVec-1 dryland. There are approximately 168 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona coarse sandy loam, 5 to 9 percent slopes (RcC)

This type of soil is found on terraces. Permeability is moderately slow in this soil. Available water-holding capacity is 8 to 10 inches. Fertility is moderate, runoff is slow to medium, and the hazard of erosion is slight to moderate. Roots can penetrate to a depth of 60 inches. This soil is used for dryland crops and range, dryland and irrigated orchards, and wildlife habitat. Capability Class is IIIe-1 irrigated and IVec-1 dryland. There are approximately 461 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona coarse sandy loam, 9 to 15 percent slopes (RcD)

This soil is found on terraces. In many places, the topography is rolling. Soil blowing is a slight to moderate hazard. Runoff is medium, and the hazard of water erosion is moderate. This soil is used for dryland small grains and range. Because rainfall is unreliable, growth of dryland crops is poor. Capability Class is IVe-1 irrigated and IVec-1 dryland. There are approximately 611 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona sandy loam, 9 to 30 percent slopes, eroded (RdE2)

This soil is formed in old granitic alluvium laid down in a series of fairly narrow fingerlike rides that face northeast. Runoff is medium to rapid on this soil, and the hazard of erosion is moderate to high. This soil is used for range, wildlife habitat, and watershed. Capability Class is VIe-1 dryland. There are approximately 197 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona gravelly sandy loam, 9 to 30 percent slopes (ReE)

The available water-holding capacity of this soil is 5.5 to 7.5 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is used only for range and wildlife habitat. Capability Class is VIe-1 dryland. There are approximately 258 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona loam, 2 to 5 percent slopes (RfB)

Runoff for this soil is slow, and the hazard of erosion is slight. This soil is used for dryland small grains. Capability Class is IIe-1 irrigated and IVec-1 dryland. There are approximately 99 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Ramona loam, 5 to 9 percent slopes (RfC)

Runoff for this soil is slow to medium, and the hazard of erosion is slight to moderate. This soil is used for dryland crops and range, dryland and irrigated orchards, and wildlife habitat. Capability Class IIIe-1 irrigated and IVec-1 dryland. There are approximately 41 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Riverwash (Rg)

Riverwash consists of sandy material in the beds of intermittent streams. Narrow stringers of gravelly sand occupy many of the areas. During each flood, fresh deposits of alluvium are laid down and removed as a result of stream-bank erosion. The hazard of soil blowing is slight to moderate. Little or no vegetation is on the areas. This land type has no value for farming. The areas are used for wildlife and watershed purposes. Capability unit VIIIw-4 dryland. There are approximately 1,308 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Sandy Alluvial Land (Sa)

Sandy alluvial land (Sa) is mostly on flood plains along the Santa Clara River and its larger tributaries. It consists of unconsolidated alluvium that generally is stratified and ranges in texture from sand to loamy sand. The soil material has been recently deposited by streams. Flooding is frequent and, during each flood, resorting of the soil material occurs. The plant cover is willows and cottonwoods that have an understory of annual grasses and forbs. Soil blowing is a moderate hazard. This land type is used for grazing, wildlife habitat, and watershed purposes. Frequent flooding severely limits use for cultivated crops. Protection from flooding is needed. Capability unit VIIw-4. There are approximately 2,127 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Saugus loam, 15 to 30 percent slopes (ScE)

In most places this soil has slopes that range from 20 to 24 percent. Runoff is medium, and the hazard of erosion is moderate. Included with this slope are small areas on toe slopes that have slopes of 5 to 15 percent. Also included are areas 5 to 10 acres in size where sheet and rill erosion are moderate. Other included small areas consist of Balcom silty clay loams and of Saugus loam, 30 to 50 percent slopes (ScF). Thus, Saugus soil is used mainly for range. Some areas are used for homesites and subdivisions, though much grading is required. Capability unit VIe-1. There are approximately 652 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Saugus loam, 30 to 50 percent slopes (ScF)

In most places, the slope of this soil is about 45 percent, though on north slopes the slope may be as steep as 55 percent. Runoff is rapid, and the hazard of erosion is high. Included with this soil in mapping are small areas of Castaic-Balcom silty clay loams, 30 to 50 percent slopes (CmF), and of Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded (CnG3). Also included are small areas cut by sheet and gully erosion. This Saugus soil is used mainly for range. Many areas, however, have been reshaped and graded by earthmoving equipment for use as homesites and subdivisions. Capability unit VIIe-1 dryland. There are approximately 3,080 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Saugus loam, 30 to 50 percent slopes, eroded (ScF2)

This soil is on uplands in Romero Canyon and in other places near Castaic Junction. Permeability is moderate in this soil. Available water-holding capacity is 5 to 7.5 inches. Fertility is low, runoff is rapid, and the hazard of erosion is high. Included with this soil in mapping are small areas of Castaic-Balcom silty clay loams and of Castaic and Saugus soils. Also included are small areas of Gaviota rocky sandy loam and of Rough broken land. This Saugus soil is used for range, wildlife habitat, and watershed. Capability unit VIIe-1 dryland. There are approximately 22,781 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Sorrento loam, 0 to 2 percent slopes (SsA)

This soil is on alluvial fans along the Santa Clara River and its major tributaries. Runoff is very slow, and the hazard of erosion is slight. Included with this soil in mapping are small areas that have a surface layer of sandy loam. Also included are small areas of Metz loamy sand, Mocho loam, and Yolo loam. This Sorrento soil is used for many kinds of irrigated crops. Capability unit I-1 irrigated. There are

approximately 181 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Sorrento loam, 2 to 5 percent slopes (SsB)

This soil is on long, smooth alluvial fans along drainage ways of the Santa Clara River, near Castaic Junction. Permeability of this soil is moderate. Available water-holding capacity is 8.5 to 10 inches. Fertility is high. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 60 inches or more. Included with this soil in mapping are small areas of Metz loamy sand, Mocho loam, and Yolo loam. Also included are small areas that have a surface of sandy loam. This Sorrento soil is used for such irrigated crops as alfalfa, green onions, carrots, walnuts, and pasture. Capability unit IIe-1. There are approximately 802 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Temescal-Rock land complex, 30 to 50 percent slopes (TrF)

The permeability of this soil is moderate. Available water-holding capacity is 2 to 3 inches. Fertility is low, runoff is rapid, and the hazard of erosion is high. In most places roots can penetrate to a depth of 14 to 20 inches. This soil is used for range, wildlife, and watershed. Capability unit for the Temescal part is VIIe-1 dryland, and for the Rock land, VIIIs-1 dryland. There are approximately 140 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Terrace Escarpments (TsF)

Terrace escarpments is a type of land that consists of short, moderately steep to steep faces or breaks that separate the terraces from the lower-lying alluvial fans. The surface layer is generally coarse sandy loam. Slopes generally are about 35 percent, but they range from 15 to 45 percent. Annual grasses and forbs make up the vegetation. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Included with this land type are small areas where rill and gully erosion are severe. Also included are a few large, deep gullies that are actively eroding. Terrace escarpments are used for grazing. The areas are used mainly to provide cover for wildlife. Capability Class is VIIe-1 dryland. There are approximately 1,829 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Vernalis loam, 2 to 5 percent slopes (VbB)

This soil is more sloping, but it otherwise is similar to Vernalis clay loam, 0 to 2 percent slopes (VcA). The dominant slope ranges from 2 to 4 percent. Runoff is slow on this soil, and the hazard of erosion is slight. Available water-holding capacity is 9 to 10 inches. This soil is used for irrigated crops and dryland crops.

It is also used for range. Capability Class is I-1 irrigated and IVec-1 dryland. There are approximately 77 acres of this soil within the County of Los Angeles portion of the OVOV Planning Area.

Vernalis clay loam, 0 to 2 percent slopes (VcA)

Runoff is very slow in this soil, and the hazard of erosion is none to slight. Available water-holding capacity is 9.5 to 10.5 inches. This soil is used for sugar beets, irrigated small grains, dryland small grains, and range. Capability Class is I-1 irrigated and IVec-1 dryland. There are approximately 15 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Vista coarse sandy loam, 15 to 30 percent slopes (VsE)

This soil is located on hilly uplands. Slopes commonly range from 18 to 26 percent. Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is used for range, wildlife habitat, and watershed. Capability Class VIe-1 dryland. There are approximately 214 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Vista coarse sandy loam, 30 to 50 percent slopes (VsF)

This soil is located in the uplands on Pelona Ridge. The permeability of this soil is moderately rapid. Available water-holding capacity is 2.5 to 3.5 inches. Fertility is low. Runoff is rapid, and the hazard of erosion is high. In most places, roots can penetrate to a depth of about 28 to 38 inches. This soil is used for range, wildlife habitat, and watershed. Capability Class is VIIe-1 dryland. There are approximately 1,456 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Vista coarse sandy loam, 30 to 50 percent slopes, eroded (VsF2)

Much of the original surface layer of this soil has been removed through sheet and rill erosion. Many areas are cut by shallow gullies, and a few areas are cut by deep gullies. The present surface layer is 8 to 12 inches thick. Slopes range from 35 to 45 percent in most places, but they are as steep as 55 percent in a few places. Runoff is rapid, and the hazard of further erosion is high. Included with this soil are small areas that have a surface layer of sandy loam. Also included are small, slightly eroded areas. Other included small areas consist of Amargosa rocky coarse sandy loam. This Vista soil is used for range, wildlife habitat, and watershed. Capability Class is VIIe-1 dryland. There are approximately 402 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Water (W)

These are areas that are covered by water. These areas include lakes, rivers, streams, ponds, wetland areas, etc. These areas have no use in agricultural activity. There are approximately 2,159 acres of this type of land located within the County of Los Angeles portion of the OVOV Planning Area.

Wyman gravelly loam, 2 to 9 percent slopes (WgC)

This soil is located on terraces near Acton and Vincent. Permeability of this soil is moderate. Available water holding capacity is 8.5 to 9.5 inches. Fertility is moderate. The gravel in the soil does not significantly interfere with tillage, but it reduces the available water-holding capacity somewhat. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Roots can penetrate to a depth of 60 inches or more. This soil is used for dryland small grains and range. It is also used for wildlife habitat. Capability Class is IIe-1 irrigated and IVec-1 dryland. There are approximately 1,283 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Wyman gravelly loam, 9 to 15 percent slopes (WgD)

This soil is located on alluvial fans and terraces. Slopes range from 10 to 14 percent in most places. Runoff is medium, and the hazard of erosion is moderate. This soil is used for dryland small grain and range. It is also used for wildlife habitat. Capability Class is IIIe-1 irrigated and IVec-1 dryland. There are approximately 157 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Wyman cobbly loam, 5 to 9 percent slopes (WoC)

Runoff is slow to medium on this soil, and the hazard of erosion is slight to moderate. Available water holding capacity is 5.5 to 7 inches. Fertility is low. This soil is used for range in spring and for wildlife habitat year round. Capability Class VIe-7 dryland. There are approximately 252 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Yolo loam, 0 to 2 percent slopes (YoA)

This soil occurs on alluvial fans near Newhall and Saugus. Permeability is moderate in this soil. Available water-holding capacity is 8.5 to 10.5 inches. Fertility is high. Runoff is very low, and the hazard of erosion is none to slight. Roots can penetrate to a depth of 60 inches or more. Included with this soil are small areas of Metz loamy sand and of Sorrento loam. Also included are small areas that have a surface layer of sandy loam. This Yolo soil is used for irrigated crops. Capability unit I-1 irrigated. There are

approximately 645 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Yolo loam, 2 to 9 percent slopes (YoC)

This soil occurs on fairly narrow alluvial fans near Newhall and Saugus. Slopes range from 2 to 6 percent in most places. Runoff is slight to moderate, and the hazard of erosion is slow to medium. Included with this soil are areas at the upper edge of the alluvial fans that have slopes as steep as 10 to 12 percent, by volume, and fine gravel throughout. Also included are small areas that have a surface layer of sandy loam or that have a few pebbles and stones on the surface. Other included small areas consist of Metz loamy sand and of Sorrento loam. This Yolo soil is used mainly for irrigated crops and for range, but use for homesites is rapidly increasing. Capability unit IIe-1 irrigated. There are approximately 2,195 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Zamora Loam, 2 to 9 percent slopes (ZaC)

This soil is on long, smooth, convex terraces near Castaic Junction. Permeability of this soil is moderately slow. Available water-holding capacity is 10 to 11 inches. Fertility is moderate. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Roots can penetrate to a depth of 60 inches of more. Included with this soil mapping are small areas that have a surface layer of sandy loam or clay loam. Also included are about 75 acres where slopes are 0 to 2 percent. This Zamora soil is used for dryland grains and range. It also is used for wildlife habitat. Capability unit IIe-1 irrigated. There are approximately 592 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Zamora loam, 9 to 15 percent slopes (ZaD)

This soil is located on strongly sloping to nearly rolling terraces. In most places, slopes range from 10 to 14 percent. Runoff is medium, and the hazard of erosion is moderate. This soil is used for range. It is also used as pump sites for oil fields, which occupy a large part of this soil. Capability Class is IIIe-1 irrigated. There are approximately 94 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

Zamora clay loam, 2 to 9 percent slopes (ZcC)

In most places where this soil is located, slopes range from 5 to 7 percent. Runoff is slow to medium on this soil, and the hazard of erosion is slight to moderate. Available water-holding capacity is 10.5 to 11.5 inches. Fertility is moderate. This soil is used primarily for range. It also is used as pump sites for oil

fields, which occupy much of the acreage. Capability Class is IIe-1 irrigated. There are approximately 8 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

129 – Saugus loam, 30 to 50 percent slopes

The Saugus component makes up 85 percent of this soil. Slopes are 30 to 50 percent. This component occurs on mountains. The parent material consists of soft residuum weathered sandstone and shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement is moderately high. Available water to depth of 60 inches is low. Nonirrigated land capability classification is VIe. There are approximately 285 acres of this soils located within the County of Los Angeles portion of the OVOV Planning Area.

143 – Xerorthents – Urban Land – Saugus Complex, 15 to 30 percent slopes

The Xerorthents component makes up 45 percent of this soil complex. Slopes are usually 15 to 30 percent, and this soil is found on hills. The parent material consists of human-altered residuum. Depth to a root restrictive layer, bedrock, lithic, is 10 to 60 inches. Well drained. Available water depth of 60 inches is very low. Nonirrigated land capability classification is VIII.

The Saugus component makes up 15 percent of this soil. Slopes are 15 to 30 percent. The parent material consists of residuum weathered sandstone and shale. Depth to a root restrictive layer is 40 to 60 inches. Well drained. Water movement is moderately high. Available water to a depth of 60 inches is low. Land Capability Class IVe nonirrigated and IVe irrigated. There are approximately 61 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

19 – Trigo family – Calcixerollic Xerochrepts-Vista family complex, 30 to 70 percent slopes

The Trigo family component makes up to 35 percent of this soil complex. Slopes are 30 to 70 percent. This component occurs on mountains. The parent material consists of residuum weathered from sandstone and shale. Depth to a root restrictive layer is 3 to 19 inches. Drainage is excessive. Available water to a depth of 60 inches is very low. Capability class VIIe nonirrigated.

The Calcixerollic Xerochrepts component of this soil makes up 30 percent. Slopes are 30 to 70 percent. This complex is found on mountains. The parent material consists of residuum weathered sandstone and shale. Depth to a restrictive layer is 15 to 42 inches. Water movement is relatively high. Available water to a depth of 60 inches is moderate. Capability class VIIe nonirrigated.

The Vista family component makes up 20 percent of unit. Slopes are 30 to 70 percent. Found on mountains. The parent material consist of residuum weathered sandstone and shale. Depth to a root restrictive layer is 60 inches. Well drained. Water movement is high. Available water to a depth of 60 inches is moderate. Capability unit VIIe nonirrigated. There are approximately 200 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

54 – Caperton-Trigo, granitic substratum – Lodo families complex, 50 to 85 percent slopes

The Caperton family component makes up 45 percent of this soil complex. This component occurs on mountains. The parent material consists of residuum weathered from gneiss. Depth to a root restrictive layer is 4 to 20 inches. Well drained. Water movement is relatively high. Available water to a depth of 60 inches is very low. Capability class is VIIe nonirrigated.

The Trigo family, granitic substratum component makes up 25 percent. Slopes are 50 to 85 percent. Found on mountains. Parent material consists of residuum weathered from granodiorite. Depth to a root restrictive layer is 3 to 19 inches. Natural drainage is excessively drained. Water movement is high. Available water to a depth of 60 inches is very low. Capability unit VIIe nonirrigated.

The Lodo family component makes up 15 percent of this soil complex. Slopes are 50 to 85 percent. Found on mountains. Parent material consists of residuum weathered from schist. Depth to a root restrictive layer is 6 to 19 inches. Excessively drained. Water movement is moderately high. Available water to a depth of 60 inches is very low. Capability unit VIIe non-irrigated. There are approximately 220 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

1 – Exchequer family, 30 to 60 percent slopes

This soil is located on mountains. Slopes are 30 to 60 percent. The parent material consists of residuum weathered from granite. Depth to a root restrictive layer, bedrock, lithic, is 5 to 18 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded or ponded. There is no zone of water saturation within a depth of 72 inches. Capability Classification VIIe nonirrigated. There are approximately 20 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

102 – Badland

This type of soil is not used for agricultural activities. There are approximately 46 acres of this type located within the County of Los Angeles portion of the OVOV Planning Area.

115 – Friant fine sandy loam, 50 to 75 percent slopes

This soil is located on mountains and has slopes of 50 to 75 percent. The parent material consists of residuum weathered from slate. Depth to a root restrictive layer, bedrock, lithic, is 6 to 20 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is very low. Shrink-well potential is low. This soil is not flooded. There is no zone of water saturation within a depth of 72 inches. Land Capability Class VIIe nonirrigated. There are approximately 58 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

117 – Gaviota sandy loam, 30 to 50 percent slopes

This soil is found on mountains and slopes are 30 to 50 percent. The parent material consists of residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, lithic, is 10 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded or ponded. There is no zone of water saturation within a depth of 72 inches. Land Capability Class VIIe nonirrigated. There are approximately 9 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

122 – Millsholm loam, 30 to 50 percent slopes

This soil is located on hills and have slopes between 30 to 50 percent. The parent material consists of residuum weathered from sandstone and shale. Depth to a root restrictive layer, bedrock, lithic, is 10 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. The soil is not flooded nor is it ponded. There is no zone of water saturation within a depth of 72 inches. Land Capability Class VIIe nonirrigated. There are approximately 126 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

125 – Rock outcrop-Friant complex, 50 to 75 percent

The rock outcrop portion of this soil is not used in any agricultural activities. It is composed mostly of rocky, boulder areas along steep hilly, mountainous areas. The Friant portion of this soil is usually found on slopes that are 50 to 75 percent. The parent material consists of residuum weathered from metamorphic and sedimentary rock. Depth to a root restrictive layer is 6 to 20 inches. The natural drainage class is somewhat excessively drained. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. The soil is not flooded or ponded. There is no zone of water saturation within a depth of 72 inches. Nonirrigated land Capability Class is VIIe. There are approximately 24 acres of this soil located within the County of Los Angeles portion of the OVOV Planning Area.

128 – Saugus loam, 15 to 30 percent slopes

This soil is found on mountains in areas with slopes of 15 to 30 percent. The parent material consists of soft residuum weather from sandstone and shale. Depth to a root restrictive layer, bedrock, lithic is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded or ponded.

Table 1
On-Site Soil Characteristics

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Soil Survey of the Antelope Valley Area, California[1]								
Agua Dulce stony loam, 30 to 50 percent slopes	Ojai-Agua Dulce Association/Agua Dulce Series	rapid	high	30 to 50	range, wildlife habitat, and watershed	VIIe-1	moderately slow	moderate
Amargosa rocky coarse sandy loam, 9 to 55 percent slopes	Vista-Amargosa Association/Amargosa Series	medium to rapid	moderate to high	9 to 55	range, recreation, wildlife, and water supply purposes	VIIe-1	moderately rapid	very low
Anaverde loam, 15 to 30 percent slopes	Anaverde-Godde Association/Anaverde Series	medium	moderate	15 to 30	range, wildlife, and recreation.	VIe-1	moderate/ 5.5 to 9 inches	high
Anaverde rocky loam, 30 to 50 percent slopes	Anaverde-Godde Association/Anaverde Series	rapid	high	35 to 45	range, wildlife habitat, watershed	VIIe-1	NA	NA
Castaic silty clay loam, 2 to 9 percent slopes	Saugus-Castaic-Balcom Association/Castaic Series	slow to medium	slight to moderate	2 to 9	limited grazing, homesites	IIIe-1 irrigated	NA/ 5 to 7.5 inches	NA
Castaic silty clay loam, 9 to 15 percent slopes	Saugus-Castaic-Balcom Association/Castaic Series	medium	moderate	9 to 15	range and homesites	IIIe-1	NA	NA
Castaic-Balcom silty clay loams, 9 to 15 percent slopes	Saugus-Castaic-Balcom Association/Castaic Series	medium	moderate	12 to 14	dryland small grains/pasture/range	IIIe-1 irrigated	NA	NA
Castaic-Balcom silty clay loams, 15 to 30 percent slopes	Saugus-Castaic-Balcom Association/Castaic Series	medium to rapid	moderate to high	25	range as wildlife habitat	IVe-1 irrigated	NA	NA

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Castaic-Balcom silty clay loams, 30 to 50 percent slopes	Saugus-Castaic-Balcom Association/Castaic Series	NA	moderate	NA	range/wildlife habitat/watershed	VIe-1 dryland	NA	NA
Castaic-Balcom silty clay loams, 30 to 50 percent slopes, eroded	Saugus-Castaic-Balcom Association/Castaic Series	rapid	high	30 to 50	range/watershed/ wildlife habitat/ recreation	VIe-1 dryland	Slow/5 to 7 inches	moderate
Castaic-Balcom silty clay loams, 50 to 65 percent slopes, eroded	Saugus-Castaic-Balcom Association/Castaic Series	very rapid	very high	50 to 65	wildlife habitat, watershed purposes, and graze land	VIIe-1	NA	NA
Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded	Saugus-Castaic-Balcom Association/Castaic Series	rapid	very high	45 to 65	watershed/wildlife habitat	VIIIe-1 dryland	NA / 4 to 6 inches (Castaic soil) and 4 to 7 inches (Saugus soil)	low
Chino loam	Hanford-Ramona-Greenfield Association/Chino Series	very slow	none to slight	NA	wet and in meadow, used for pasture	IIw-2 irrigated	moderately slow/ 10 to 12 inches	moderate, but high when reclaimed
Cortina sandy loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Cortina Series	slow	moderate	3 to 5	dryland small grains/irrigated alfalfa/pasture	IVs-0	NA	NA
Cortina sandy loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Cortina Series	slow	moderate	3 to 5	dryland small grains/irrigated alfalfa/pasture	IVs-0	NA	NA
Cortina cobbly sandy loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Cortina Series	slow	slight	2 to 9	range, wildlife habitat, and watershed purposes	VIIs-7	rapid/2 to 3 inches	low
Gaviota rocky sandy loam, 15 to 30 percent slopes, eroded	Gaviota-Millsholm Association/Gaviota Series	medium	moderate	15 to 30	range, wildlife habitat, and watershed	VIIe-1	moderately rapid/ 1 to 2 inches	low

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Gaviota rocky sandy loam, 30 to 50 percent slopes, eroded	Gaviota-Millsholm Association/Gaviota Series	rapid	high	45	range, wildlife, and watershed	VIIe-1 dryland	NA	NA
Gazos clay loam, 30 to 50 percent slopes	Gaviota-Millsholm Association/Gazos Series	rapid	high	30 to 50	grazing	VIe-1	moderately slow/ 3 to 6 inches	moderate
Godde rocky loam, 30 to 50 percent slopes	Anaverde-Godde Association/Godde Series	rapid	high	30 to 50	range, wildlife habitat, recreation, watershed purposes	VIIe-1	moderate/ 2 to 3 inches	low
Greenfield sandy loam, 0 to 2 percent slopes	Hanford-Ramona-Greenfield Association/Greenfield Series	slow	slight	0 to 2	irrigated crops, dryland small grains, pasture, and range	IIe-1 irrigated	NA	NA
Greenfield sandy loam, 2 to 9 percent slopes	Hanford-Ramona Greenfield Association/Greenfield Series	slow to medium	slight to moderate	2 to 9	irrigated crops, dryland small grains, pasture, and range	IIe-1 irrigated	moderately rapid/7.5 to 9 inches	moderate
Greenfield sandy loam, 9 to 15 percent slopes, eroded	Hanford-Ramona-Greenfield Association/Greenfield Series	medium to rapid	moderate to high	10 to 14	dryland small grains, dryland pasture, range	IIIe-1 irrigated	NA	NA
Hanford coarse sandy loam, 9 to 15 percent slopes	Hanford-Ramona-Greenfield Association/Hanford Series	medium	moderate	9 to 15	dryland small grains, dryland pasture, range	IIIe-1 irrigated	NA	NA
Hanford sandy loam, 0 to 2 percent slopes	Hanford-Ramona-Greenfield Association/Hanford Series	slow	slight	0 to 2	irrigated crops/pasture/range	IIs-4 irrigated/ IVec-1 dryland	NA / 6 to 7.5 inches	moderate

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Hanford sandy loam, 2 to 9 percent slopes	Hanford-Ramona-Greenfield Association/Hanford Series	slow to medium	slight to moderate	2 to 6	irrigated crops/pasture/range	IIe-1 irrigated/IVec-1 dryland	NA / 6 to 7.5 inches	moderate
Hanford sandy loam, calcareous variant, 2 to 9 percent slopes	Hanford-Ramona-Greenfield Association/Hanford Series	slow	slight	2 to 9	dryland small grains and range	IIe-1 irrigated	moderately rapid/ 7.5 to 9.9 inches	moderate
Las Posas loam, 9 to 30 percent slopes	Las Posas-Toomes-Temescal Association/Las Posas Series	medium to rapid	moderate to high	9 to 30	range in spring	IVe-1	NA/4 to 7 inches	NA
Las Posas-Toomes rocky loams, 30 to 50 percent slopes	Las Posas-Toomes-Temescal Association/Las Posas Series	rapid	high	30 to 50	range and wildlife habitat	VIIe-1	moderately slow/ 4 to 7 inches	low
Metz loamy sand, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Metz Series	slow	slight to moderate	0 to 2	irrigated crops/dryland farming/wildlife habitat	IIIs-4 irrigated	rapid/ 4 to 5 inches	low
Metz loamy sand, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Metz Series	slow	slight	2 to 5	irrigated crops	IIIs-4 irrigated	NA / NA	NA
Metz loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Metz Series	slow	slight to none	0 to 2	alfalfa/row crops	IIs-4 irrigated	NA / 5 to 6 inches	moderate
Metz loam, 2 to 5 percent slopes	Yolo-Metz-Cortina Association/Metz Series	slow	slight	2 to 3	irrigated alfalfa/small grains	IIs-4 irrigated	NA / NA	moderate
Millsholm rocky loam, 15 to 30 percent slopes, eroded	Gaviota-Millsholm Association/Millsholm Series	medium to rapid	moderate to high	20 to 24	range, wildlife, and recreation.	VIIe-1	NA	NA
Millsholm rocky loam, 30 to 50 percent slopes, eroded	Gaviota-Millsholm Association/Millsholm Series	rapid	high	30 to 50	range, wildlife, and watershed	VIIe-1	moderate/ 2 to 3 inches	NA

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Mocho sandy loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Mocho Series	slow	slight	0 to 2	dryland/irrigated crops	I-1 irrigated	NA/ 7.5 to 9.5 inches	NA
Mocho loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Mocho Series	slow	none to slight	0 to 2	dryland/irrigated crops	I-1 irrigated	moderate/ 8 to 10 inches	high
Mocho loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Mocho Series	slow to medium	slight to moderate	2 to 5	dryland/irrigated crops	IIe-1 irrigated	NA / NA	NA
Oak Glen sandy loam, 2 to 9 percent slopes	Oak Glen-Gorman Association/Oak Glen Series	slow to medium	slight to moderate	2 to 9	dryland small grains, and range	IIIe-1	moderately rapid/ 6 to 7.5 inches	high
Oak Glen gravelly sandy loam, 2 to 9 percent slopes	Oak Glen-Gorman Association/Oak glen Series	slow to medium	slight to moderate	2 to 9	range/wildlife habitat	IIIe-1 dryland	NA/ 4 to 6 inches	NA
Oak Glen loam, 0 to 2 percent slopes	Oak Glen-Gorman Association/Oak Glen Series	very slow	none to slight	0 to 2	range/wildlife habitat	IIIc-1 dryland	moderate/ high	NA
Ojai loam, 2 to 9 percent slope	Ojai-Agua Dulce Association/Ojai Series	slow to medium	slight to moderate	2 to 9	irrigated alfalfa/row crops/ range/home sites/industry sites	IIIe-1 irrigated	moderate/ 9 to 11 inches	low
Ojai loam, 9 to 15 percent slopes	Ojai-Agua Dulce Association/Ojai Series	medium	moderate	10 to 15	range/dryland small grains/wildlife habitat	IVe-1 irrigated	NA / NA	NA
Ojai loam, 15 to 30 percent slopes	Ojai-Agua Dulce Association/Ojai Series	medium to rapid	moderate to high	20 to 26	range/wildlife habitat/watershed/severely limit suitability for cultivation	VIe-1 dryland	NA / NA	NA
Ojai loam, 30 to 50 percent slopes	Ojai-Agua Dulce Association/Ojai Series	rapid	high	35 to 45	range/wildlife habitat/watershed	VIIe-1 dryland	NA / NA	NA

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Ojai loam, 30 to 50 percent slopes, eroded	Ojai-Agua Dulce Association/Ojai Series	rapid	high	40	range/wildlife habitat/watershed	VIIe-1 dryland	NA / NA	NA
Ojai loam, thin surface variant, 30 to 50 percent slopes	Ojai-Agua Dulce Association/Ojai Series	rapid	high	30 to 50	range	VIIe-1 dryland	moderate/ 8 to 10 inches	low
Ojai-Zamora loams, 15 to 30 percent slopes	Ojai-Agua Dulce Association/Ojai Series	medium to rapid	moderate	15 to 30	range	VIe-1	NA	NA
Ramona coarse sandy loam, 2 to 5 percent slopes	Hanford-Ramona-Greenfield Association/Ramona Series	slow	slight	2 to 5	dryland crops, dryland and irrigated orchards, and wildlife habitat	IIe-1 irrigated	NA	NA
Ramona coarse sandy loam, 5 to 9 percent	Hanford-Ramona-Greenfield Association/Ramona Series	slow to medium	slight to moderate	5 to 9	dryland crops, dryland and irrigated orchards, and wildlife habitat	IIIe-1 irrigated	moderately slow/ 8 to 10 inches	moderate
Ramona coarse sandy loam, 9 to 15 percent	Hanford-Ramona-Greenfield Association/Ramona Series	medium	moderate	9 to 15	small grains and range	IVe-1	NA	NA
Ramona sandy loam, 9 to 30 percent slopes, eroded	Hanford-Ramona-Greenfield Association/Ramona Series	medium to rapid	moderate to high	25	range, wildlife habitat, and watershed	VIe-1	NA	NA
Ramona gravelly sandy loam, 9 to 30 percent slopes	Hanford-Ramona-Greenfield Association/Ramona Series	medium to rapid	moderate to high	9 to 30	range and wildlife habitat	VIe-1	NA/ 5.5 to 7.5 inches	NA
Ramona loam, 2 to 5 percent slopes	Hanford-Ramona-Greenfield Association/Ramona Series	slow	slight	2 to 5	dryland small grains	IIe-1 irrigated	NA	NA

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Ramona loam, 5 to 9 percent slopes	Hanford-Ramona-Greenfield Association/Ramona Series	slow to medium	slight to moderate	5 to 9	dryland crops, range, dryland and irrigated orchards, and wildlife habitat	IIIe-1 irrigated	NA	NA
Riverwash	N/A	NA	moderate	NA	wildlife habitat/watershed/no value for farming	VIIIw-4 dryland	NA / NA	NA
Sandy alluvial land	N/A	NA	moderate	NA	grazing/wildlife habitat/watershed/limited use for cultivated crops	VIIw-4	NA / NA	NA
Saugus loam, 15 to 30 percent slopes	Saugus-Castaic-Balcom Association/Saugus Series	medium	moderate	20 to 24	range/homesites and subdivisions	VIe-1	NA / NA	NA
Saugus loam, 30 to 50 percent slopes	Saugus-Castaic-Balcom Association/Saugus Series	rapid	high	45 to 55	range/homesites and subdivisions	VIIe-1 dryland	NA / NA	NA
Saugus loam, 30 to 50 percent slopes, eroded	Saugus-Castaic-Balcom Association/Saugus Series	rapid	high	30 to 50	range/wildlife habitat/watershed	VIIe-1 dryland	moderate/ 5 to 7.5 inches	low
Sorrento loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Sorrento Series	slow	slight	0 to 2	many kinds of irrigated crops	I-1 irrigated	NA / NA	NA
Sorrento loam, 2 to 5 percent slopes	Yolo-Metz-Cortina Association/Sorrento Series	slow	slight	2 to 5	irrigated crops such as alfalfa/green onions/carrots/walnuts/ pasture	IIe-1	moderate/ 8.5 to 10 inches	high
Temescal-Rock land complex, 30 to 50 percent slopes	Las Posas-Toomes-Temescal Association/Temescal Series	rapid	high	30 to 50	range, wildlife and watershed	Temescal part: VIIe-1 Rock Land: VIIIs-1	moderate/ 2 to 3 inches	low

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Terrace Escarpments	N/A	medium to rapid	moderate to high	35	incidentally for grazing. Cover for wildlife	VIIe-1	NA	NA
Vernalis loam, 2 to 5 percent slopes	Hanford-Ramona-Greenfield Association/Vernalis Series	slow	slight	2 to 5	irrigated crops, dryland crops, range	IIe-1 irrigated	NA/ .5 to 9.5 inches	NA
Vernalis clay loam, 0 to 2 percent slopes	Hanford-Ramona-Greenfield Association/Vernalis Series	very slow	none to slight	0 to 2	sugar beets, irrigated small grains, dryland small grains, and range	I-1 irrigated	NA/ 9.5 to 10.5 inches	NA
Vista coarse sandy loam, 15 to 30 percent slopes	Vista-Amargosa Association/Vista Series	medium to rapid	moderate to high	15 to 30	range, wildlife habitat, and watershed	VIe-1	NA	NA
Vista coarse sandy loam, 30 to 50 percent slopes	Vista-Amargosa Association/Vista Series	rapid	high	30 to 50	range, wildlife habitat, watershed	VIIe-1	moderately rapid/ 2.5 to 3.5 inches	low
Vista coarse sandy loam, 30 to 50 percent slopes, eroded	Vista-Amargosa Association/Vista Series	rapid	high	35 to 45	range/wildlife habitat/watershed	VIIe-1 dryland	NA / NA	NA
Wyman gravelly loam, 2 to 9 percent slopes	Las Posas-Toomes-Temescal Association/Wyman Series	slow to medium	slight to moderate	2 to 9	dryland small grains and range, and wildlife habitat	IIe-1 irrigated	moderate/ 8.5 to 9.5 inches	moderate
Wyman gravelly loam, 9 to 15 percent slopes	Las Posas-Toomes-Temescal Association/Wyman Series	medium	moderate	9 to 15	dryland small grain, range, and wildlife habitat	IIIe-1 irrigated	NA	NA
Wyman cobbly loam, 5 to 9 percent slopes	Las Posas-Toomes-Temescal Association/Wyman Series	slow to medium	slight to moderate	5 to 9	range in spring, and wildlife habitat	VIe-7	NA/5.5 to 7 inches	NA

Soil	Association and Series	Runoff	Erosion Hazard	Slope (percent)	Soil Use	Capability Classification	Permeability/ Water-Holding Capacity	Fertility
Yolo loam, 0 to 2 percent slopes	Yolo-Metz-Cortina Association/Yolo Series	very low	none to slight	0 to 2	irrigated crops	I-1 irrigated	moderate/ 8.5 to 10.5 inches	high
Yolo loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Yolo Series	slight to moderate	slow to medium	2 to 6	irrigated crops/range/homesites	IIe-1 irrigated	NA / NA	NA
Zamora loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Zamora Series	slow to medium	slight to moderate	2 to 9	dryland grains/range/wildlife habitat	IIe-1 irrigated	moderate/ 10 to 11 inches	moderate
Zamora loam, 9 to 15 percent slopes	Yolo-Metz-Cortina Association/Zamora Series	medium	moderate	9 to 15	range and pump-sites for oil fields	IIIe-1	NA	NA
Zamora clay loam, 2 to 9 percent slopes	Yolo-Metz-Cortina Association/Zamora Series	slow to medium	slight to moderate	5 to 7	range and pump-sites for oil fields	IIe-1 irrigated	NA/10.5 to 11.5 inches	NA

Soil	Depth to a Restrictive Layer, Bedrock or Lithic (inches)	Water Movement	Drainage	Available Water Depth of 60 inches	Capability Class	Parent Material	Slopes (Percent)
Soil Survey of Los Angeles County, California, West San Fernando Valley Area[2]							
102 – Badland[4]	NA	NA	NA	NA	NA	NA	NA
115 – Friant fine sandy loam, 50 to 75 percent slopes	6 to 20	high	somewhat excessively drained	very low	VIIe	residuum weathered from slate	50 to 75
117 – Gaviota sandy loam, 30 to 50 percent slopes	10 to 20	high	well drained	very low	VIIe	residuum weathered from sandstone	30 to 50
122 – Millsholm loam, 30 to 50 percent slopes	10 to 20	moderately high	well drained	very low	VIIe	residuum weathered from sandstone and shale	30 to 50

Soil	Depth to a Restrictive Layer, Bedrock or Lithic (inches)	Water Movement	Drainage	Available Water Depth of 60 inches	Capability Class	Parent Material	Slopes (Percent)
125 – Rock-outcrop[4]-Friant complex, 50 to 75 percent slopes	Rock: NA Friant: 6 to 20	Rock: NA Friant: NA	Rock: NA Friant: excessively drained	Rock: NA Friant: very low	Rock: NA Friant: VIIe	Rock: NA Friant: residuum weathered from metamorphic and sedimentary rock	Rock: NA Friant: 50 to 75
Soil Survey of Los Angeles County, California, West San Fernando Valley Area[2] (continued)							
128 – Saugus loam, 15 to 30 percent slopes	40 to 60	moderately high	well drained	low	IVe	soft residuum weathered from sandstone and shale	30 to 50
129 – Saugus loam, 30 to 50 percent slopes	40 to 60	NA	well drained	low	VIe non-irrigated	soft residuum, weathered sandstone, shale	30 to 50
143 – Xerorthents-Urban land-Saugus complex, 15 to 30 percent slopes	10 to 60 (Xerorthents) 40 to 60 (Saugus)	moderately high (Saugus)	well drained (Xerorthents and Saugus)	very low (Xerorthents) low (Saugus)	VIII non-irrigated (Xerorthents), IVe non-irrigated and IVe irrigated (Saugus)	human-altered residuum (Xerorthents), residuum weathered sandstone and shale (Saugus)	15 to 30

Soil	Depth to a Restrictive Layer, Bedrock or Lithic (inches)	Water Movement	Drainage	Available Water Depth of 60 inches	Capability Class	Parent Material	Slopes (Percent)
Soil Survey of the Angeles National Forest Area, California[3]							
1-Exchequer family, 30 to 60 percent slopes	5 to 18	moderately high	excessively drained	very low	VIIe	residuum weathered granite	30 to 60
19 – Trigo family-Calcixerollic Xerochrepts-Vista family complex, 30 to 70 percent slopes	3 to 19 (Trigo) 15 to 42 (Calcixerollic Xerochrepts), 60 (Vista)	relatively high (Calcixerollic Xerochrepts), high (Vista)	Excessive (Trigo Family), well drained (Vista)	very low (Trigo), moderate (Calcixerollic Xerochrepts), moderate (Vista)	VIIe non-irrigated (Trigo), VIIe non-irrigated (Calcixerollic Xerochrepts), VIIe (Vista)	residuum weathered sandstone and shale (all three components)	30 to 70
Soil Survey of the Angeles National Forest Area, California[3] (continued)							
54 – Caperton-Trigo, granitic substratum-Lodo families complex, 50 to 85 percent slopes	4 to 20 (Caperton), 3 to 19 (Trigo), 6 to 19 (Lodo)	moderately high (Caperton), high (Trigo), moderately high (Lodo)	well drained (Caperton), excessively drained (Trigo), excessively drained (Lodo)	very low (Caperton), very low (Trigo), very low (Lodo)	VIIe non-irrigated (Caperton), VIIe non-irrigated (Trigo), VIIe non-irrigated (Lodo)	residuum weathered from gneiss (Caperton), residuum weathered from granodiorite (Trigo), residuum weathered from schist (Lodo)	50 to 85

[1] *United States Department of Agriculture Soil Conservation Service In Cooperation with University of California Agricultural Experiment Station, Soil Survey Antelope Valley Area, California, January 1970.*

[2] *United States Department of Agriculture Soil Conservation Service In Cooperation with University of California Agricultural Experiment Station, Soil Survey Los Angeles County, California, West San Fernando Valley Area.*

[3] *United States Department of Agriculture Soil Conservation Service In Cooperation with University of California Agricultural Experiment Station, Soil Survey Angeles National Forest Area, California.*

[4] *Generated brief soil descriptions are created for major soil components. The Badland and Rock outcrop is a miscellaneous area.*

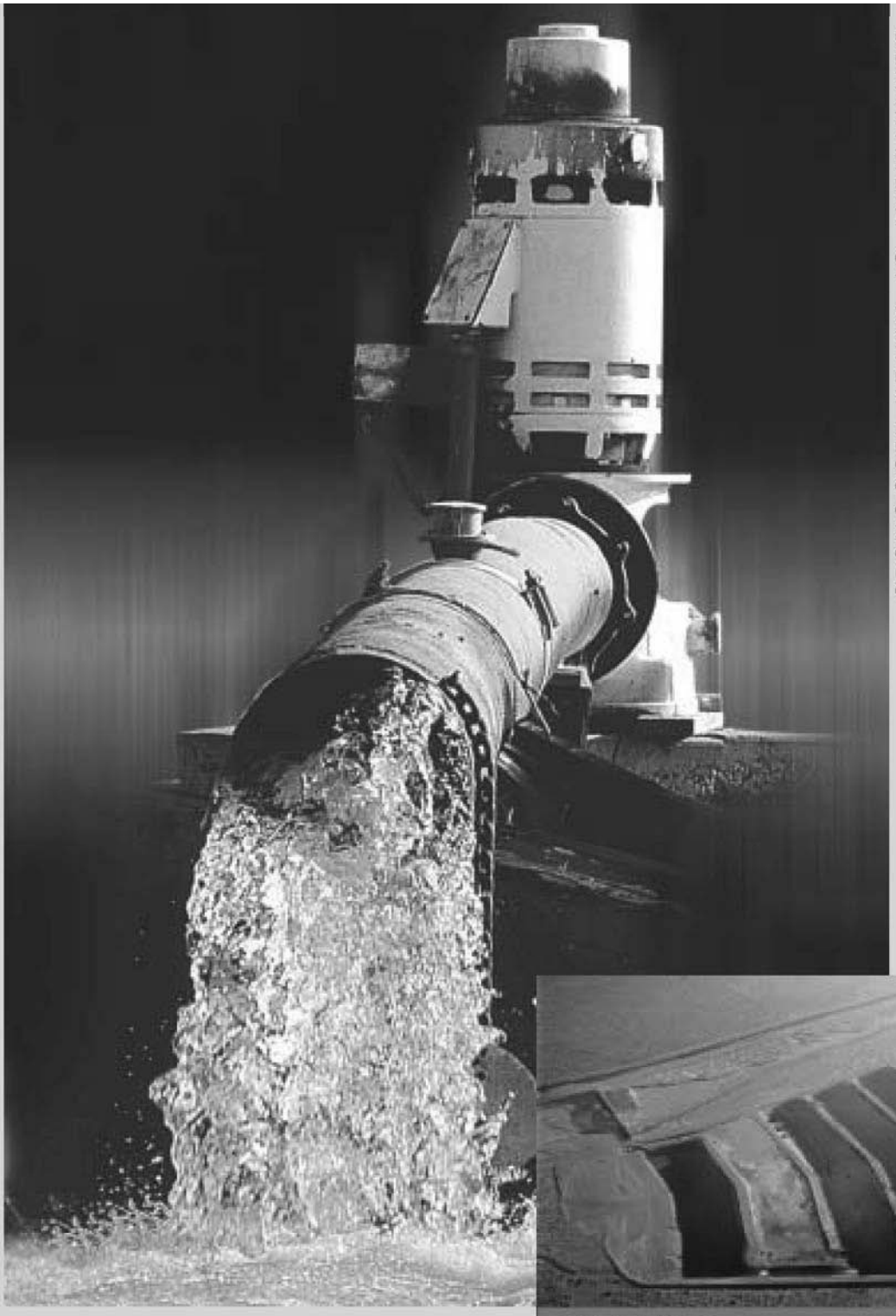
APPENDIX 3.13

Water Service Information

APPENDIX 3.13

Water Service Information (continued)

DEPARTMENT OF WATER RESOURCES



BULLETIN 118 - UPDATE 2003

CALIFORNIA'S GROUNDWATER

Cover photograph:
A typical agricultural well with the water discharge pipe and the electric motor that drives the pump.

Inset photograph:
Groundwater recharge ponds in the Upper Coachella Valley near the Whitewater River that use local and imported water. Recharge ponds are also called spreading basins or recharge basins.

State of California
The Resources Agency
Department of Water Resources

CALIFORNIA'S
GROUNDWATER

BULLETIN 118 *Update 2003*

October 2003

GRAY DAVIS
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State of California

MARY D. NICHOLS
Secretary of Resources
The Resources Agency

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If you need this publication in an alternate form, contact the Department's Office of Water Education at 1-800-272-8869.

Foreword

Groundwater is one of California's greatest natural resources. In an average year, groundwater meets about 30 percent of California's urban and agricultural water demands. In drought years, this percentage increases to more than 40 percent. In 1995, an estimated 13 million Californians, nearly 43 percent of the State's population, were served by groundwater. The demand on groundwater will increase significantly as California's population grows to a projected 46 million by the year 2020. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality impacts, or limited by a lack of data, management, and coordination between agencies.

Over the last few years, California voters and the Legislature have provided significant funding to local agencies for conjunctive use projects, groundwater recharge facilities, groundwater monitoring, and groundwater basin management activities under Proposition 13 and the Local Groundwater Management Assistance Act of 2000. Most recently, the 2002 passage of Proposition 50 will result in additional resources to continue recent progress toward sustaining our groundwater resources through local agency efforts. We are beginning to see significant benefits from these investments.

The State Legislature recognizes the need for groundwater data in making sound local management decisions. In 1999, the Legislature approved funding and directed the Department of Water Resources (DWR) to update the inventory of groundwater basins contained in Bulletin 118 (1975), *California's Ground Water* and Bulletin 118-80 (1980), *Ground Water Basins in California.* In 2001, the Legislature passed AB 599, requiring the State Water Resources Control Board to establish a comprehensive monitoring program to assess groundwater quality in each groundwater basin in the State and to increase coordination among agencies that collect groundwater contamination information. In 2002, the Legislature passed SB 1938, which contains new requirements for local agency groundwater management plans to be eligible for public funds for groundwater projects.

Effective management of groundwater basins is essential because groundwater will play a key role in meeting California's water needs. DWR is committed to assisting local agencies statewide in developing and implementing effective, locally planned and controlled groundwater management programs. DWR is also committed to federal and State interagency efforts and to partnerships with local agencies to coordinate and expand data monitoring activities that will provide necessary information for more effective groundwater management. Coordinated data collection at all levels of government and local planning and management will help to ensure that groundwater continues to serve the needs of Californians.

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Acknowledgments

Successful completion of this update and continued implementation of this program would not be possible without the dedicated efforts of the Central, Northern, San Joaquin, and Southern District Offices of the California Department of Water Resources. The information in this report is the result of contributions from many local, state, and federal agencies outside DWR. We would like to acknowledge the contributions of the following agencies.

California Department of Pesticide Regulation
California Department of Toxic Substances Control
California Department of Health Services
California State Water Resources Control Board
California Regional Water Quality Control Boards
United States Geological Survey
United States Bureau of Reclamation

We also wish to thank numerous reviewers who provided valuable comments on the April 2003 public review draft of this bulletin.

Acronyms and abbreviations

AB Assembly Bill
BMO Basin management objective
CAS California Aquifer Susceptibility
CVP Central Valley Project
DBCP Dibromochloropropane
DCE Dichloroethylene
DHS California Department of Health Services
DPR California Department of Pesticide Regulation
DTSC California Department of Toxic Substances Control
DWR California Department of Water Resources
DWSAP Drinking Water Source Assessment Program
EDB Ethylene dibromide
EC Electrical conductivity
EMWD Eastern Municipal Water District
EWMP Efficient water management
EPA U.S. Environmental Protection Agency
ESA Federal Endangered Species Act
ET Evapotranspiration
ETAW Evapotranspiration of applied water
EWA Environmental Water Account
GAMA Groundwater Ambient Monitoring and Assessment
GIS Geographic information system
GMA Groundwater Management Agency
gpm Gallons per minute
GRID Groundwater Resources Information Database
GRIST Groundwater Resources Information Sharing Team
H & S Health and Safety Code
HR Hydrologic region
ISI Integrated Storage Investigations
ITF Interagency Task Force
JPA Joint powers agreement
maf Million acre-feet
MCL Maximum contaminant level
mg/L Milligrams per liter
MOU Memorandum of understanding
MTBE Methyl tertiary-butyl ether
OCWD Orange County Water District
PAC Public Advisory Committee
PCE Tetrachloroethylene
PCA Possible contaminating activity
PPIC Public Policy Institute of California
ROD Record of Decision
RWQCB Regional Water Quality Control Board
SB Senate Bill
SGA Sacramento Groundwater Authority
SVOC Semi-volatile organic compound
SVWD Scotts Valley Water District
SWRCB State Water Resources Control Board

taf Thousand acre-feet
TCE Trichloroethylene
TDS Total dissolved solids
UWMP Urban water management plan
USACE U.S. Army Corps of Engineers
USBR U.S. Bureau of Reclamation
USC United States Code
USGS U.S. Geological Survey
VOC Volatile organic compound
WQCP Water Quality Control Plan

Contents

Contents

Findings **1**
Recommendations **7**

Introduction **13**
History of Bulletin 118 15
The Need for Bulletin 118 Update 2003 16
Report Organization 17

Chapter 1 Groundwater–California's Hidden Resource **19**
California's Hydrology 20
California's Water Supply System 24
Recent Groundwater Development Trends 27
The Need for Groundwater Monitoring and Evaluation 28

Chapter 2 Groundwater Management in California **31**
How Groundwater is Managed in California 33
Groundwater Management through Authority Granted to Local Water Agencies 33
Local Groundwater Ordinances 36
Adjudicated Groundwater Basins 40
How Successful Have Groundwater Management Efforts Been? 44
Future Groundwater Management in California 49

Chapter 3 Groundwater Management Planning and Implementation **53**
Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components ... 54
Required Components of Local Groundwater Management Plans 54
Recommended Components of Groundwater Management Plans 55
Model Groundwater Management Ordinance 62

Chapter 4 Recent Actions Related to Groundwater Management **65**
Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13) 66
California Bay-Delta Record of Decision 66
Local Groundwater Management Assistance Act of 2000 (AB 303, Water Code Section 10795 et seq.) . 67
Groundwater Quality Monitoring Act of 2001 (AB 599, Water Code Section 10780 et seq.) 67
Water Supply Planning 68
Emergency Assistance to the Klamath Basin 68
Governor's Drought Panel 68
Sacramento Valley Water Management Agreement 69
Groundwater Management Water Code Amendments 69
Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50) 69

Chapter 5 The Roles of State and Federal Agencies in California Groundwater Management **71**
Local Groundwater Management Assistance from DWR 72
Conjunctive Water Management Program 72

Assistance from Other State and Federal Agencies 75
State Water Resources Control Board and Regional Water Quality Control Boards 75
California Department of Health Services 76
California Department of Pesticide Regulation 76
California Department of Toxic Substances Control 77
California Bay-Delta Authority 78
U.S. Environmental Protection Agency 78
U.S. Geological Survey 78
U.S. Bureau of Reclamation 78

Chapter 6 Basic Groundwater Concepts 79
Origin of Groundwater 80
Occurrence of Groundwater 80
Groundwater and Surface Water Interconnection 81
Physical Properties That Affect Groundwater 83
Aquifer 85
Aquitard 85
Unconfined and Confined Aquifers 87
Groundwater Basin 88
Groundwater Subbasin 90
Groundwater Source Areas 90
Movement of Groundwater 92
Quantity of Groundwater 93
Groundwater Storage Capacity 93
Usable Groundwater Storage Capacity 95
Available Groundwater Storage Capacity 95
Groundwater Budget 95
Change in Groundwater Storage 96
Overdraft 96
Safe Yield 99
Subsidence 100
Conjunctive Management 100
Quality of Groundwater 101
Beneficial Uses 101
Public Drinking Water Supply 101
Agricultural Supply 101
Contaminant Groups 103

Chapter 7 Inventory of California's Groundwater Information 105
Statewide Groundwater Information 106
Groundwater Basins 106
Groundwater Budgets 106
Active Monitoring 111
Groundwater Quality 112
Regional Groundwater Use 113

North Coast Hydrologic Region 119
Description of the Region 122
Groundwater Development 122
Groundwater Quality 124
Changes from Bulletin 118-80 125
San Francisco Bay Hydrologic Region 129
Description of the Region 131
Groundwater Development 131
Groundwater Quality 132
Changes from Bulletin 118-80 134
Central Coast Hydrologic Region 137
Description of the Region 140
Groundwater Development 140
Groundwater Quality 140
Changes from Bulletin 118-80 142
South Coast Hydrologic Region 145
Description of the Region 148
Groundwater Development 149
Conjunctive Use 149
Groundwater Quality 149
Changes from Bulletin 118 - 80 150
Sacramento River Hydrologic Region 155
Description of the Region 158
Groundwater Development 159
Groundwater Quality 160
Changes from Bulletin 118-80 161
San Joaquin River Hydrologic Region 167
Description of the Region 169
Groundwater Development 169
Conjunctive Use 170
Groundwater Quality 170
Changes from Bulletin 118-80 170
Tulare Lake Hydrologic Region 175
Description of the Region 177
Groundwater Development 177
Groundwater Quality 178
Changes from Bulletin 118-80 180
North Lahontan Hydrologic Region 183
Description of the Region 185
Groundwater Development 186
Groundwater Quality 187
Changes from Bulletin 118-80 188
South Lahontan Hydrologic Region 191
Description of the Region 194
Groundwater Development 194
Groundwater Quality 194
Changes from Bulletin 118-80 196

Colorado River Hydrologic Region 201
Description of the Region 204
Groundwater Development 204
Groundwater Quality 204
Changes from Bulletin 118-80 206

References 209
Glossary 213

Appendices

Appendix A Obtaining Copies of Supplemental Material 224
Appendix B The Right to Use Groundwater in California 225
Appendix C Required and Recommended Components of Local Groundwater Management Plans 230
Appendix D Groundwater Management Model Ordinance 232
Appendix E SWRCB Beneficial Use Designations 239
Appendix F Federal and State MCLs and Regulation Dates for Drinking Water Contaminants 241
Appendix G Development of Current Groundwater Basin/Subbasin Map 245

Tables

Table 1 Groundwater management methods 33
Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management 34
Table 3 Special act districts with groundwater management authority in California 35
Table 4 Counties with ordinances addressing groundwater management 39
Table 5 List of adjudicated basins 42
Table 6 Scotts Valley Water District's Groundwater Monitoring Plan 58
Table 7 Porosity (in percent) of soil and rock types 85
Table 8 Types and boundary characteristics of groundwater basins 88
Table 9 Examples of factors that limit development of a groundwater basin 94
Table 10 Range of TDS values with estimated suitability for agricultural uses 102
Table 11 Range of boron concentrations with estimated suitability on various crops 102
Table 12 Annual agricultural and municipal water demands met by groundwater 113
Table 13 Most frequently occurring contaminants by contaminant group in the North Coast Hydrologic Region 125
Table 14 Modifications since Bulletin 118-80 of groundwater basins in North Coast Hydrologic Region 125
Table 15 North Coast Hydrologic Region groundwater data 127
Table 16 Most frequently occurring contaminants by contaminant group in the San Francisco Bay Hydrologic Region 133
Table 17 Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Francisco Bay Hydrologic Region 134
Table 18 San Francisco Bay Hydrologic Region groundwater data 135
Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region 141

Table 20 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region 142
Table 21 Central Coast Hydrologic Region groundwater data 143
Table 22 Most frequently occurring contaminants by contaminant group in the South Coast Hydrologic Region 151
Table 23 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Coast Hydrologic Region 152
Table 24 South Coast Hydrologic Region groundwater data 153
Table 25 Most frequently occurring contaminants by contaminant group in the Sacramento River Hydrologic Region 161
Table 26 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Sacramento River Hydrologic Region 161
Table 27 Sacramento River Hydrologic Region groundwater data 163
Table 28 Most frequently occurring contaminants by contaminant group in the San Joaquin River Hydrologic Region 171
Table 29 Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Joaquin River Hydrologic Region 172
Table 30 San Joaquin River Hydrologic Region groundwater data 173
Table 31 Most frequently occurring contaminants by contaminant group in the Tulare Lake Hydrologic Region 179
Table 32 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Tulare Lake Hydrologic Region 180
Table 33 Tulare Lake Hydrologic Region groundwater data 181
Table 34 Most frequently occurring contaminants by contaminant group in the North Lahontan Hydrologic Region 188
Table 35 North Lahontan Hydrologic Region groundwater data 189
Table 36 Most frequently occurring contaminants by contaminant group in the South Lahontan Hydrologic Region 196
Table 37 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Lahontan Hydrologic Region 196
Table 38 South Lahontan Hydrologic Region groundwater data 198
Table 39 Most frequently occurring contaminants by contaminant group in the Colorado River Hydrologic Region 205
Table 40 Modifications since Bulletin 118-80 of groundwater basins in Colorado River Hydrologic Region 206
Table 41 Colorado River Hydrologic Region groundwater data 207

Figures

Figure 1 Shaded relief map of California 21
Figure 2 Mean annual precipitation in California, 1961 to 1990 22
Figure 3 Groundwater basins, subbasins, and hydrologic regions..... 23
Figure 4 Water projects in California 25
Figure 5 Well completion reports filed with DWR from 1987 through 2000..... 27
Figure 6 Well completion reports filed annually from 1987 through 2000 28
Figure 7 Process of addressing groundwater management needs in California 32
Figure 8 Counties with groundwater ordinances..... 37
Figure 9 Scotts Valley Water District's Groundwater Management Plan monitoring locations..... 60

Figure 10 Broad distribution of grant and loan awardees for 2001 through 2003 74
Figure 11 The Hydrologic Cycle 81
Figure 12 Examples of porosity in sediments and rocks 84
Figure 13 Hydraulic conductivity ranges of selected rocks and sediments 86
Figure 14 Interbedded aquifers with confined and unconfined conditions 87
Figure 15 Groundwater basin near the coast with the aquifer extending beyond the surface basin boundary 89
Figure 16 Significant volcanic groundwater source areas 91
Figure 17 Schematic of total, usable, and available groundwater storage capacity 94
Figure 18 Hydrograph indicating overdraft 97
Figure 19 Photograph of extensometer 100
Figure 20 Groundwater basins and subbasins 108
Figure 21 Basin and subbasin groundwater budget types 109
Figure 22 California's 10 hydrologic regions 114
Figure 23 Agricultural and urban demand supplied by groundwater in each hydrologic region 115
Figure 24 Regional Water Quality Control Board regions and Department of Water Resources hydrologic regions 117
Figure 25 North Coast Hydrologic Region 120
Figure 26 MCL exceedances in public supply wells in the North Coast Hydrologic Region 124
Figure 27 San Francisco Bay Hydrologic Region 130
Figure 28 MCL exceedances in public supply wells in the San Francisco Bay Hydrologic Region 133
Figure 29 Central Coast Hydrologic Region 138
Figure 30 MCL exceedances in public supply wells in the Central Coast Hydrologic Region 141
Figure 31 South Coast Hydrologic Region 146
Figure 32 MCL exceedances in public supply wells in the South Coast Hydrologic Region 150
Figure 33 Sacramento River Hydrologic Region 156
Figure 34 MCL exceedances in public supply wells in the Sacramento River Hydrologic Region 160
Figure 35 San Joaquin River Hydrologic Region 168
Figure 36 MCL exceedances in public supply wells in the San Joaquin River Hydrologic Region 171
Figure 37 Tulare Lake Hydrologic Region 176
Figure 38 MCL exceedances by contaminant group in public supply wells in the Tulare Lake Hydrologic Region 179
Figure 39 North Lahontan Hydrologic Region 184
Figure 40 MCL exceedances in public supply wells in the North Lahontan Hydrologic Region 187
Figure 41 South Lahontan Hydrologic Region 192
Figure 42 MCL exceedances in public supply wells in the South Lahontan Hydrologic Region 195
Figure 43 Colorado River Hydrologic Region 202
Figure 44 MCL exceedances in public supply wells in the Colorado River Hydrologic Region 205

Sidebars

Box A Which Bulletin 118 Do You Mean? 16
Box B Will Climate Change Affect California's Groundwater? 26
Box C What About Overdraft? 29
Box D Basin Management Objectives for Groundwater Management 38
Box E Adjudication of Groundwater Rights in the Raymond Basin 41
Box F Managing through a Joint Powers Agreement 45
Box G Managing a Basin through Integrated Water Management 46

Box H Managing Groundwater Using both Physical and Institutional Solutions 47
Box I Impediments to Conjunctive Management Programs in California 48
Box J Managing Groundwater Quantity and Quality 50
Box K What are Management Objectives? 61
Box L Providing Data: The Internet Makes Groundwater Elevation Data Readily Accessible to the Public 73
Box M Improving Coordination of Groundwater Information 77
Box N One Resource, Two Systems of Law 82
Box O Critical Conditions of Overdraft 98
Box P Focused on Nitrates: Detailed Study of a Contaminant 103
Box Q How Does the Information in This Report Relate to the Recently Enacted Laws Senate Bill 221 and Senate Bill 610 (2002)? 107
Box R Explanation of Groundwater Data Tables 110
Box S What Happens When an MCL Exceedance Occurs? 112

Findings

Major Findings

1. **Groundwater provides about 30% of the State's water supply in an average year, yet in many basins the amount of groundwater extracted annually is not accurately known.**
   - In some regions, groundwater provides 60% or more of the supply during dry years.
   - Many small- to moderate-sized towns and cities are entirely dependent on groundwater for drinking water supplies.
   - 40% to 50% of Californians rely on groundwater for part of their water supply.
   - In many basins, groundwater use is indirectly estimated by assuming crop evapotranspiration demands and surveying the acreage of each crop type.

2. **Opportunities for local agencies to manage their groundwater resources have increased significantly since the passage of Assembly Bill 3030 in 1992. (Water Code § 10750 et seq.). In the past several years more agencies have developed management programs to facilitate conjunctive use, determine the extent of the resource, and protect water quality.**
   - The act provides the authority for many local agencies to manage groundwater.
   - The act has resulted in more than 200 local agencies adopting groundwater management plans to date.
   - The act encourages regional cooperation in basins and allows private water purveyors to participate in groundwater management through memoranda of understanding with public agencies.
   - Many local agencies are recognizing their responsibility and authority to better manage groundwater resources.

3. **Agencies in some areas have not yet developed groundwater management plans.**
   - Concerns about cooperative management, governance, and potential liabilities have kept some agencies from developing management plans.
   - Development of management programs to maintain a sustainable groundwater supply for local use has not been accomplished throughout the State.

4. **A comprehensive assessment of overdraft in the State's groundwater basins has not been conducted since Bulletin 118-80, but it is estimated that overdraft is between 1 million and 2 million acre-feet annually.**
   - Historical overdraft in many basins is evident in hydrographs that show a steady decline in groundwater levels for a number of years.
   - Other basins may be subject to overdraft in the future if current water management practices are continued.
   - Overdraft can result in increased water production costs, land subsidence, water quality impairment, and environmental degradation.
   - Few basins have detailed water budgets by which to estimate overdraft.
   - While the most extensively developed basins tend to have information, many basins have insufficient data for effective management or the data have not been evaluated.
   - The extent and impacts of overdraft must be fully evaluated to determine whether groundwater will provide a sustainable water supply.
   - Modern computer hardware and software enable rapid manipulation of data to determine basin conditions such as groundwater storage changes or groundwater extraction, but a lack of essential data limits the ability to make such calculations.
   - Adequate statewide land use data for making groundwater extraction estimates are not available in electronic format.

5. **Surface water and groundwater are connected and can be effectively managed as integrated resources.**
   - Groundwater originates as surface water.
   - Groundwater extraction can affect flow in streams.
   - Changes in surface water flow can affect groundwater levels.
   - Legal systems for surface water and groundwater rights can make coordinated management complex.

6. **Groundwater quality and groundwater quantity are interdependent and are increasingly being considered in an integrated manner.**
   - Groundwater quantity and groundwater quality are inseparable.
   - Groundwater in some aquifers may not be usable because of contamination with chemicals, either from natural or human sources.
   - Unmanaged groundwater extraction may cause migration of poor quality water.
   - Monitoring and evaluating groundwater quality provides managers with the necessary data to make sound decisions regarding storage of water in the groundwater basin.
   - State agencies conduct several legislatively mandated programs to monitor different aspects of groundwater quality.
   - California Department of Water Resources (DWR) monitors general groundwater quality in many basins throughout the State for regional evaluation.

7. **Land use decisions affecting recharge areas can reduce the amount of groundwater in storage and degrade the quality of that groundwater.**
   - In many basins, little is known about the location of recharge areas and their effectiveness.
   - Protection and preservation of recharge areas are seldom considered in land use decisions.
   - If recharge areas are altered by paving, channel lining, or other land use changes, available groundwater will be reduced.
   - Potentially contaminating activities can degrade the quality of groundwater and require wellhead treatment or aquifer remediation before use.
   - There is no coordinated effort to inform the public that recharge areas should be protected against contamination and preserved so that they function effectively.

Additional Important Findings

8. **Funding to assist local groundwater management has recently been available in unprecedented amounts.**
   - Proposition 13 (Water Code, § 79000 et seq.) authorized $230 million in loans and grants for local groundwater programs and projects, almost all of which has been allocated.
   - The Local Groundwater Management Assistance Act of 2000 (Water Code, § 10795) has resulted in more than $15 million in grants to local agencies in fiscal years 2001, 2002, and 2003.
   - Proposition 50 (Water Code, § 79500 et seq) will provide funding for many aspects of water management, including groundwater management and groundwater recharge projects.
   - Funding for the California Bay-Delta program has provided technical and facilitation assistance to numerous local groundwater planning efforts.

9. **Local governments are increasingly involved in groundwater management.**
   - Twenty-four of the 27 existing county groundwater management ordinances have been adopted since 1990.
   - Most ordinances require the proponents of groundwater export to demonstrate that a proposed project will not cause subsidence, degrade groundwater quality, or deplete the water supply before the county will issue an export permit.
   - While the ordinances generally require a permit for export of groundwater, most do not require a comprehensive groundwater management plan designed to ensure a sustainable water resource for local use.
   - Some local governments are coordinating closely with local water agencies that have adopted groundwater management plans.
   - Many local governments are monitoring and conducting studies in an effort to better understand groundwater resources.

10. **Despite the increased groundwater management opportunities and activities, the extent of local efforts is not well known.**
   - There is no general requirement that groundwater management plans be submitted to DWR, so the number of adopted plans and status of groundwater management throughout the State are not currently known.
   - There are no requirements for evaluating the effectiveness of adopted plans, other than during grant proposal review.
   - No agency is responsible for tracking implementation of adopted plans.
   - Unlike urban water management plans, groundwater management plans are not required to be submitted to DWR, making the information unavailable for preparing the California Water Plan.

11. **Despite the fact that several agencies often overlie each groundwater basin, there are few mechanisms in place to support and encourage agencies to manage the basin cooperatively.**
   - Some local agencies have recognized the benefits of initiating basinwide and regional planning for groundwater management and have recorded many successes.
   - Regional cooperation and coordination depends on the ability of local agencies to fund such efforts.
   - There is no specific State or federal program to fund and support coordination efforts that would benefit all water users in a region and statewide.

12. **The State Legislature has recognized the need to consider water supplies as part of the local land use planning process.**
   - Three bills—Senate Bill 221[1], SB 610[2], and AB 901[3]—were enacted in 2001 to improve the assessment of water supplies. The new laws require the verification of sufficient water supply as a condition for approving certain developments and compel urban water suppliers to provide more information on the reliability of groundwater as an element of supply.
   - The Government Code does not specifically require local governments to include a water resources element in their general plans.

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[1] Business and Professions Code Section 11010, Government Code Sections 65867.5, 66455.3, and 66473.7.
[2] Public Resources Code Section 21151.9, Water Code Sections 10631, 10656, 10657, 10910-10912, 10915.
[3] Water Code Sections 10610.2, 10631, 10634.

13. **The need to monitor groundwater quality and contamination of groundwater continues to grow.**
    - As opportunities for developing additional surface water supplies become more limited, subsequent growth will increasingly rely on groundwater.
    - Human activities are likely the cause of more than half the exceedances of maximum contaminant levels in public water supply wells.
    - New contaminants are being regulated and standards are becoming more stringent for others, requiring increased monitoring and better management of water quality.

14. **Monitoring networks for groundwater levels and groundwater quality have not been evaluated in all basins to ensure that the data accurately represent conditions in the aquifer(s).**
    - Groundwater levels are monitored in about 10,000 active wells including those basins where most of the groundwater is used.
    - Groundwater levels are not monitored in approximately 200 basins, where population is sparse and groundwater use is generally low.
    - Groundwater quality monitoring networks are most dense near population centers and may not be representative of the basin as a whole.
    - Many of the wells being monitored are not ideally constructed to provide water level or water quality information that is representative of a specific aquifer.
    - Many wells are too deep to monitor changes in the unconfined (water table) portion of basins.

15. **The coordination of groundwater data collection and evaluation by local, State, and federal agencies is improving.**
    - The State Water Resources Control Board (SWRCB) recently formed the Groundwater Resources Information Sharing Team (GRIST) consisting of several State and federal agencies with groundwater-related programs.
    - DWR established a website in 1996 that has provided water-level data and hydrographs for more than 35,000 active and inactive wells monitored by DWR and cooperating agencies.
    - DWR collects and maintains water level data in part through partnerships with local agency cooperators.
    - DWR staff collaborated with many local, State, and federal agencies in developing this update of Bulletin 118.
    - SWRCB recently formed an interagency task force to develop a comprehensive groundwater quality monitoring program for assessing every groundwater basin in the State as required by the Groundwater Quality Monitoring Act of 2001 (AB 599; Water Code, § 10780 et seq.).
    - Water purveyors have concerns about balancing public access to data with water supply security.

16. **Boundaries of groundwater basins have been determined using the best available geologic and hydrologic information. These boundaries are important in determining the availability of local water supplies.**
    - Basin boundaries were derived primarily by identifying alluvial sediments on geologic maps using the best available information, but are subject to change when new information becomes available.
    - The Water Code requires the use of basin boundaries defined in Bulletin 118 in groundwater management plans and urban water management plans.
    - The location of basin boundaries will become more critical as the demand for water continues to increase.
    - Subbasin boundaries may be delineated for management convenience rather than based on hydrogeologic conditions.

17. **Little is known about the stream-aquifer interaction in many groundwater basins.**
    - Groundwater and surface water are closely linked in the hydrologic cycle.
    - The relationship between streamflow and extraction of groundwater is not fully understood in most basins and is generally not monitored.
    - Groundwater extraction in many basins may affect streamflow.
    - Interaction of groundwater flow and surface water may affect environmental resources in the hyporheic zone.
    - An understanding of stream-aquifer interaction will be essential to evaluating water transfers in many areas of the State.

18. **Although many new wells are built in fractured rock areas, insufficient hydrogeologic information is available to ensure the reliability of groundwater supplies.**
    - Population is increasing rapidly in foothill and mountain areas in which groundwater occurs in fractured rock.
    - The cumulative effect of groundwater development may reduce the yield of individual wells, lower the flow of mountain streams, and impact local habitat.
    - Characterization of groundwater resources in fractured rock areas can be very expensive and complex.
    - Many groundwater users in these areas have no other water supply alternatives.
    - Recent dry years have seen many wells go dry in fractured rock areas throughout the State.
    - Groundwater management in these areas is beginning, but there is insufficient data to support quantitative conclusions about the long-term sustainable yield.

19. **When new wells are built, drillers are required to file a Well Completion Report with DWR. That report contains a lithologic log, the usability of which varies considerably from driller to driller.**
    - The Well Completion Reports are confidential and not available to the public, as stipulated by the Water Code, unless the owner's permission is obtained.
    - The usefulness of the information in Well Completion Reports varies but is not fully realized.
    - Public access to Well Completion Reports would increase understanding of groundwater conditions and issues.
    - There is no provision in the Water Code that requires submission of geophysical logs, which would provide an accurate log of the geologic materials within the aquifer.
    - Geophysical logs would provide a greatly improved database for characterization of aquifers.

Recommendations

Major Recommendations

1. **Local or regional agencies should develop groundwater management plans if groundwater constitutes part of their water supply. Management objectives should be developed to maintain a sustainable long-term supply for multiple beneficial uses. Management should integrate water quantity and quality, groundwater and surface water, and recharge area protection.**
   - Groundwater management in California is a local agency responsibility.
   - In basins where there is more than one management agency, those agencies should coordinate their management objectives and program activities.
   - A water budget should be completed that includes recharge, extraction and change in storage in the aquifer(s).
   - Changes in groundwater quality should be monitored and evaluated.
   - Stakeholders should be identified and included in development of groundwater management plans.

2. **The State of California should continue programs to provide technical and financial assistance to local agencies to develop monitoring programs, management plans, and groundwater storage projects to more efficiently use groundwater resources and provide a sustainable supply for multiple beneficial uses. DWR should:**
   - Post information about projects that have successfully obtained funding through various grant and loan programs.
   - Provide additional technical assistance to local agencies in the preparation of grant and loan applications.
   - Continue outreach efforts to inform the public and water managers of grant and loan opportunities.
   - Participate, when requested, in local efforts to develop and implement groundwater management plans.
   - Continue to assess, develop, and modify its groundwater programs to provide the greatest benefit to local agencies.
   - Develop grant criteria to ensure funding supports local benefits as well as Statewide priorities, such as development of the California Water Plan and meeting Bay-Delta objectives.

3. **DWR should continue to work with local agencies to more accurately define historical overdraft and to more accurately predict future water shortages that could result in overdraft.**
   - A water budget should be developed for each basin.
   - The annual change in storage should be determined for each basin.
   - The amount of annual recharge and discharge, including pumping, should be determined.
   - Changes in groundwater quality that make groundwater unusable or could allow additional groundwater to be used should be included in any evaluation of overdraft.

4. **Groundwater management agencies should work with land use agencies to inform them of the potential impacts various land use decisions may have on groundwater, and to identify, prioritize, and protect recharge areas.**
   - Local planners should consider recharge areas when making land use decisions that could reduce recharge or pose a risk to groundwater quality.
   - Recharge areas should be identified and protected from land uses that limit recharge rates, such as paving or lining of channels.

- Both local water agencies and local governments should pursue education and outreach to inform the public of the location and importance of recharge areas.
- DWR should inform local agencies of the availability of grant funding and technical assistance that could support these efforts.

5. **DWR should publish a report by December 31, 2004 that identifies those groundwater basins or subbasins that are being managed by local or regional agencies and those that are not, and should identify how local agencies are using groundwater resources and protecting groundwater quality.**
   - Such information will be necessary to confirm whether agencies are meeting the requirements of SB 1938 (Water Code Section 10753.7).
   - Collection and summary of existing groundwater management plans will provide a better understanding of the distribution and coordination of groundwater management programs throughout the State.
   - Successful strategies employed by specific local agencies should be highlighted to assist others in groundwater management efforts.
   - Similarly, the impact of groundwater management ordinances throughout the State should be evaluated to provide a better understanding of the effect of ordinances on groundwater management.

6. **Water managers should include an evaluation of water quality in a groundwater management plan, recognizing that water quantity and water quality are inseparable.**
   - Local water managers should obtain groundwater quality data from federal, state, and local agencies that have collected such data in their basin.
   - Local agencies should evaluate long-term trends in groundwater quality.
   - Local agencies should work closely with the SWRCB and DWR in evaluating their groundwater basins.
   - Local agencies should establish management objectives and monitoring programs that will maintain a sustainable supply of good quality groundwater.

7. **Water transfers that involve groundwater (or surface water that will be replaced with groundwater) should be consistent with groundwater management in the source area that will assure the long term sustainability of the groundwater resource.**

8. **Continue to support coordinated management of groundwater and surface water supplies and integrated management of groundwater quality and groundwater quantity.**
   - Future bond funding should be provided for conjunctive use facilities to improve water supply reliability.
   - Funding for feasibility and pilot studies, in addition to construction of projects will help maximize the potential for conjunctive use.
   - DWR should continue and expand its efforts to form partnerships with local agencies to investigate and develop locally controlled conjunctive use programs.

9. **Local, State, and federal agencies should improve data collection and analysis to better estimate groundwater basin conditions used in Statewide and local water supply reliability planning. DWR should:**
   - Assist local agencies in the implementation of SB 221, SB 610, and AB 901 to help determine water supply reliability during the local land use planning process.
   - Provide and continue to update information on groundwater basins, including basin boundaries, groundwater levels, monitoring data, aquifer yield, and other aquifer characteristics.

- Identify areas of rapid development that are heavily reliant on groundwater and prioritize monitoring activities in these areas to identify potential impacts on these basins.
- Evaluate the existing network of wells monitored for groundwater elevations, eliminate wells of questionable value from the network, and add wells where data are needed.
- Work cooperatively with local groundwater managers to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts, beginning with the most heavily used basins.
- Expand DWR and local agency monitoring programs to provide a better understanding of the interaction between groundwater and surface water.
- Work with SWRCB to investigate temporal trends in water quality to identify areas of water quality degradation that should receive additional attention.
- Estimate groundwater extraction using a land use based method for over 200 basins with little or no groundwater budget information.
- Integrate groundwater budgets into the California Water Plan Update process.

10. **Increase coordination and sharing of groundwater data among local, State, and federal agencies and improve data dissemination to the public. DWR should:**
    - Use the established website to continually update new groundwater basin data collected after the publication of California's Groundwater (Bulletin 118-Update 2003).
    - Publish a summary update of Bulletin 118 every five years coincident with the California Water Plan (Bulletin 160).
    - Publish, in cooperation with SWRCB, a biennial groundwater report that addresses current groundwater quantity and quality conditions.
    - Coordinate the collection and storage of its groundwater quality monitoring data with programs of SWRCB and other agencies to ensure maximum coverage statewide and reduce duplication of effort.
    - Make groundwater basin information more compatible with other Geographic Information System-based resource data to improve local integrated resources planning efforts.
    - Compile data collected by projects funded under grant and loan programs and make data available to the public on the DWR website.
    - Encourage local agency cooperators to submit data to the DWR database.
    - Maximize the accuracy and usefulness of data and develop guidelines for quality assurance and quality control, consistency, and format compatibility.
    - Expand accessibility of groundwater data by the public after considering appropriate security measures.
    - State, federal and local agencies should expand accessibility of groundwater data by the public after considering appropriate security measures.
    - Local agencies should submit copies of adopted groundwater management plans to DWR.

Additional Important Recommendations

11. **Local water agencies and local governments should be encouraged to develop cooperative working relationships at basinwide or regional levels to effectively manage groundwater. DWR should:**
    - Provide technical and financial assistance to local agencies in the development of basinwide groundwater management plans.
    - Provide a preference in grant funding for groundwater projects for agencies that are part of a regional or basinwide planning effort.
    - Provide Proposition 50 funding preferences for projects that are part of an integrated regional water management plan.

12. **Groundwater basin boundaries identified in Bulletin 118 should be updated as new information becomes available and the basin becomes better defined. DWR should:**
    - Identify basin boundaries that are based on limited data.
    - List the kind of information that is necessary to better define basin boundaries.
    - Develop a systematic procedure to obtain and evaluate stakeholder input on groundwater basin boundaries.

13. **Improve the understanding of groundwater resources in fractured rock areas of the State.**
    - DWR, in cooperation with local and federal agencies, should conduct studies to determine the amount of groundwater that is available in fractured rock areas, including water quality assessment, identification of recharge areas and amounts, and a water budget when feasible.
    - Local agencies and local governments should conduct studies in their areas to quantify the local demands on groundwater and project future demands.
    - The Legislature should consider expanding the groundwater management authority in the Water Code to include areas outside of alluvial groundwater basins
    - DWR should include information on the most significant fractured rock groundwater sources in future updates of Bulletin 118.

14. **Develop a program to obtain geophysical logs in areas where additional data are needed.**
    - DWR should encourage submission of geophysical logs, when they are conducted, as a part of the Well Completion Report.
    - The geophysical logs would be available for use by public agencies to better understand the aquifer, but would be confidential as stipulated by the Water Code.
    - DWR should seek funding to work with agencies and property owners to obtain geophysical logs of new wells in areas where additional data are needed.
    - Geophysical logs would be used to better characterize the aquifers within each groundwater basin.

15. **Educate the public on the significance of groundwater resources and on methods of groundwater management.**
    - DWR should continue to educate the public on statewide groundwater issues and assist local agencies in their public education efforts.
    - Local agencies should expand their outreach efforts during development of groundwater management plans under AB 3030 and other authority.
    - DWR should develop educational materials to explain how they quantify groundwater throughout the State, as well as the utility and limitations of the information.
    - DWR should continue its efforts to educate individual well owners and small water systems that are entirely dependent on groundwater.

Introduction

Introduction

Groundwater is one of California's greatest natural resources. In an average water supply year, groundwater meets about 30 percent of California's urban and agricultural demand. In drought years, this percentage increases to 40 percent or even higher (DWR 1998). Some cities, such as Fresno, Davis, and Lodi, rely solely on groundwater for their drinking water supply. In 1995, an estimated 13 million Californians (nearly 43 percent of the State's population) used groundwater for at least a portion of their public supply needs (Solley and others 1998). With a projected population of nearly 46 million by the year 2020, California's demand on groundwater will increase significantly. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality, or limited by a lack of data, lack of management, and coordination between agencies.

In the last few years, California has provided substantial funds to local agencies for groundwater management. For example, the nearly $2 billion Water Bond 2000 (Proposition 13) approved by California voters in March 2000 specifically authorizes funds for two groundwater programs: $200 million for grants for feasibility studies, project design, and the construction of conjunctive use facilities; and $30 million for loans for local agency acquisition and construction of groundwater recharge facilities and grants for feasibility studies for recharge projects. Additionally, the Local Groundwater Management Assistance Act of 2000 (AB 303) resulted in $15 million in fiscal years 2001, 2002, and 2003 for groundwater studies and data collection intended to improve basin and subbasin groundwater management. These projects focus on improving groundwater monitoring, coordinating groundwater basin management, and conducting groundwater studies.

The State Legislature has increasingly recognized the importance of groundwater and the need for monitoring in making sound groundwater management decisions. Significant legislation was passed in 2000, 2001 and 2002. AB 303 authorizes grants to help local agencies develop better groundwater management strategies. AB 599 (2001) requires, for the first time, that the State Water Resources Control Board (SWRCB), in cooperation with other agencies, develop a comprehensive monitoring program capable of assessing groundwater quality in every basin in the State with the intent of maintaining a safe groundwater supply. SB 610 (2001) and SB 901 (2001) together require urban water suppliers, in their urban water management plans, to determine the adequacy of current and future supplies to meet demands. Detailed groundwater information is required for those suppliers that use groundwater. SB 221 (2001) prohibits approval of certain developments without verification of an available water supply. These bills are significant with respect to groundwater because much of California's new development will rely on groundwater for its supply.

Finally, SB 1938 (2002) was enacted to provide incentives to local agencies for improved groundwater management. The legislation modified the Water Code to require that specific elements be included in a groundwater management plan for an agency to be eligible for certain State funding administered by the Department of Water Resources for groundwater projects. AB 303 is exempt from that requirement.

History of Bulletin 118

DWR has long recognized the need for collection, summary, and evaluation of groundwater data as tools in planning optimal use of the groundwater resource. An example of this is DWR's Bulletin 118 series. Bulletin 118 presents the results of groundwater basin evaluations in California. The Bulletin 118 series was preceded by Water Quality Investigations Report No. 3, *Ground Water Basins in California* (referred to in this bulletin as Report No. 3), published in 1952 by the Department of Public Works, Division of Water Resources (the predecessor of DWR). The purpose of Report No. 3 was to create a base index map of the "more important ground water basins" for carrying out DWR's mandate in Section 229 of the Water Code. Section 229 directed Public Works to:

> …investigate conditions of the quality of all waters within the State, including saline waters, coastal and inland, as related to all sources of pollution of whatever nature and shall report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters.

Report No. 3 identified 223 alluvium-filled valleys that were believed to be basins with usable groundwater in storage. A statewide numbering system was created in cooperation with the State Water Pollution Control Board (now the State Water Resources Control Board) based on the boundaries of the nine Regional Water Quality Control Boards. In 1992, Water Code Section 229 was amended, resulting in the elimination of the annual reporting requirements.

In 1975, DWR published Bulletin 118, *California's Ground Water*, (referred to in this report as Bulletin 118-75). Bulletin 118-75 summarized available information from DWR, U.S. Geological Survey, and other agencies for individual groundwater basins to "help those who must make decisions affecting the protection, additional use, and management of the State's ground water resources."

Bulletin 118-75 contains a summary of technical information for 248 of the 461 identified groundwater basins, subbasins, and what were referred to as "areas of potential ground water storage" in California as well as maps showing their location and extent. The Bulletin 118-75 basin boundaries were based on geologic and hydrogeologic conditions except where basins were defined by a court decision.

In 1978, Section 12924 was added to the California Water Code:

> The Department shall, in conjunction with other public agencies, conduct an investigation of the State's groundwater basins. The Department shall identify the State's groundwater basins on the basis of geologic and hydrogeologic conditions and consideration of political boundary lines whenever practical. The Department shall also investigate existing general patterns of groundwater pumping and groundwater recharge within such basins to the extent necessary to identify basins which are subject to critical conditions of overdraft.

DWR published the report in 1980 as *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924* (referred to in this report as Bulletin 118-80). The bulletin included 36 groundwater basins with boundaries different from Bulletin 118-75. The changed boundaries resulted by combining several basins based on geologic or political considerations and by dividing the San Joaquin Valley groundwater basin into many smaller subbasins based primarily on political boundaries. These changes resulted in the identification of 447 groundwater basins, subbasins, and areas of potential groundwater storage. Bulletin 118-80 also identified 11 basins as subject to critical conditions of overdraft.

Box A Which Bulletin 118 Do You Mean?

Mention of an update to Bulletin 118 causes some confusion about which Bulletin 118 the California Department of Water Resources (DWR) has updated. In addition to the statewide Bulletin 118 series (Bulletin 118-75, Bulletin 118-80, and Bulletin 118-03), DWR released several other publications in the 118 series that evaluate groundwater basins in specific areas of the State. Region-specific Bulletin 118 reports are listed below.

- Bulletin 118-1. Evaluation of Ground Water Resources: South San Francisco Bay
  Appendix A. Geology, 1967
  Volume 1. Fremont Study Area, 1968
  Volume 2. Additional Fremont Study Area, 1973
  Volume 3. Northern Santa Clara County, 1975
  Volume 4. South Santa Clara County, 1981
- Bulletin 118-2. Evaluation of Ground Water Resources: Livermore and Sunol Valleys, 1974
  Appendix A. Geology, 1966
- Bulletin 118-3. Evaluation of Ground Water Resources: Sacramento County, 1974
- Bulletin 118-4. Evaluation of Ground Water Resources: Sonoma County
  Volume 1. Geologic and Hydrologic Data, 1975
  Volume 2. Santa Rosa Plain, 1982
  Volume 3. Petaluma Valley, 1982
  Volume 4. Sonoma Valley, 1982
  Volume 5. Alexander Valley and Healdsburg Area, 1983
- Bulletin 118-5. Bulletin planned but never completed.
- Bulletin 118-6. Evaluation of Ground Water Resources: Sacramento Valley, 1978

The Need for Bulletin 118 Update 2003

Despite California's heavy reliance on groundwater, basic information for many of the groundwater basins is lacking. Particular essential data necessary to provide for both the protection and optimal use of this resource is not available. To this end, the California Legislature mandated in the Budget Act of 1999 that DWR prepare:

> ...the statewide update of the inventory of groundwater basins contained in Bulletin 118-80, which includes, but is not limited to, the following: the review and summary of boundaries and hydrographic features, hydrogeologic units, yield data, water budgets, well production characteristics, and water quality and active monitoring data; development of a water budget for each groundwater basin; development of a format and procedures for publication of water budgets on the Internet; development of the model groundwater management ordinance; and development of guidelines for evaluating local groundwater management plans.

The information on groundwater basins presented in Bulletin 118 Update 2003 is mostly limited to the acquisition and compilation of existing data previously developed by federal, State, and local water agencies. While this bulletin is a good starting reference for basic data on a groundwater basin, more recent data and more information about the basin may be available in recent studies conducted by local water management agencies. Those agencies should be contacted to obtain the most recent data.

Report Organization

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual descriptions and a Geographic Information System-compatible map of each of the delineated groundwater basins in California. The basin descriptions will be updated as new information becomes available, and can be viewed or downloaded at http://www.waterplan.water.ca.gov/groundwater/118index.htm (Appendix A). Basin descriptions will not be published in hard copy.

This report is organized into the following topics:

- Groundwater is one of California's most important natural resources, and our reliance on it has continued to grow (Chapter 1).
- Groundwater has a complex legal and institutional framework in California that has shaped the groundwater management system in place today (Chapter 2).
- Groundwater management occurs primarily at the local water agency level, but may also be instituted at the local government level. At the request of the Legislature, DWR has developed some recommendations for a model groundwater management ordinance and components for inclusion in a groundwater management plan (Chapter 3).
- Groundwater has had a flurry of activity in the Legislature and at the ballot box in recent years that will affect the way groundwater is managed in California (Chapter 4).
- Groundwater programs with a variety of objectives exist in many State and federal agencies (Chapter 5).
- Groundwater concepts and definitions should be made available to a wide audience (Chapter 6).
- Groundwater basins with a wide range of characteristics and concerns exist in each of California's 10 hydrologic regions (Chapter 7).

Chapter 1
Groundwater – California's Hidden Resource

Chapter 1
Groundwater – California's Hidden Resource

In 1975, *California's Ground Water – Bulletin 118* described groundwater as "California's hidden resource." Today, those words ring as true as ever. Because groundwater cannot be directly observed, except under a relatively few conditions such as at a spring or a wellhead, most Californians do not give much thought to the value that California's vast groundwater supply has added to the State. It is unlikely that California could have achieved its present status as the largest food and agricultural economy in the nation and fifth largest overall economy in the world without groundwater resources. Consider that about 43 percent of all Californians obtain drinking water from groundwater. California is not only the single largest user of groundwater in the nation, but the estimated 14.5 million acre-feet (maf) of groundwater extracted in California in 1995 represents nearly 20 percent of all groundwater extracted in the entire United States (Solley and others 1998).

California's Hydrology

California's climate is dominated by the Pacific storm track. Numerous mountain ranges cause orographic lifting of clouds, producing precipitation mostly on the western slopes and leaving a rain shadow on most eastern slopes (Figure 1 and Figure 2). These storms also leave tremendous accumulations of snow in the Sierra Nevada during the winter months. While the average annual precipitation in California is about 23 inches (DWR 1998), the range of annual rainfall varies greatly from more than 140 inches in the northwestern part of the State to less than 4 inches in the southeastern part of the State.

Snowmelt and rain falling in the mountains flow into creeks, streams, and rivers. The average annual runoff in California is approximately 71 maf (DWR 1998). As these flows make their way into the valleys, much of the water percolates into the ground. The vast majority of California's groundwater that is accessible in significant amounts is stored in alluvial groundwater basins. These alluvial basins, which are the subject of this report, cover nearly 40 percent of the geographic area of the State (Figure 3).

This bulletin focuses on groundwater resources, but in reality groundwater and surface water are inextricably linked in the hydrologic cycle. As an example, groundwater may be recharged by spring runoff in streams, but later in the year the base flow of a stream may be provided by groundwater. So, although the land surface is a convenient division for categorizing water resources, it is a somewhat arbitrary one. It is essential that water managers recognize and account for the relationship between groundwater and surface water in their planning and operations.

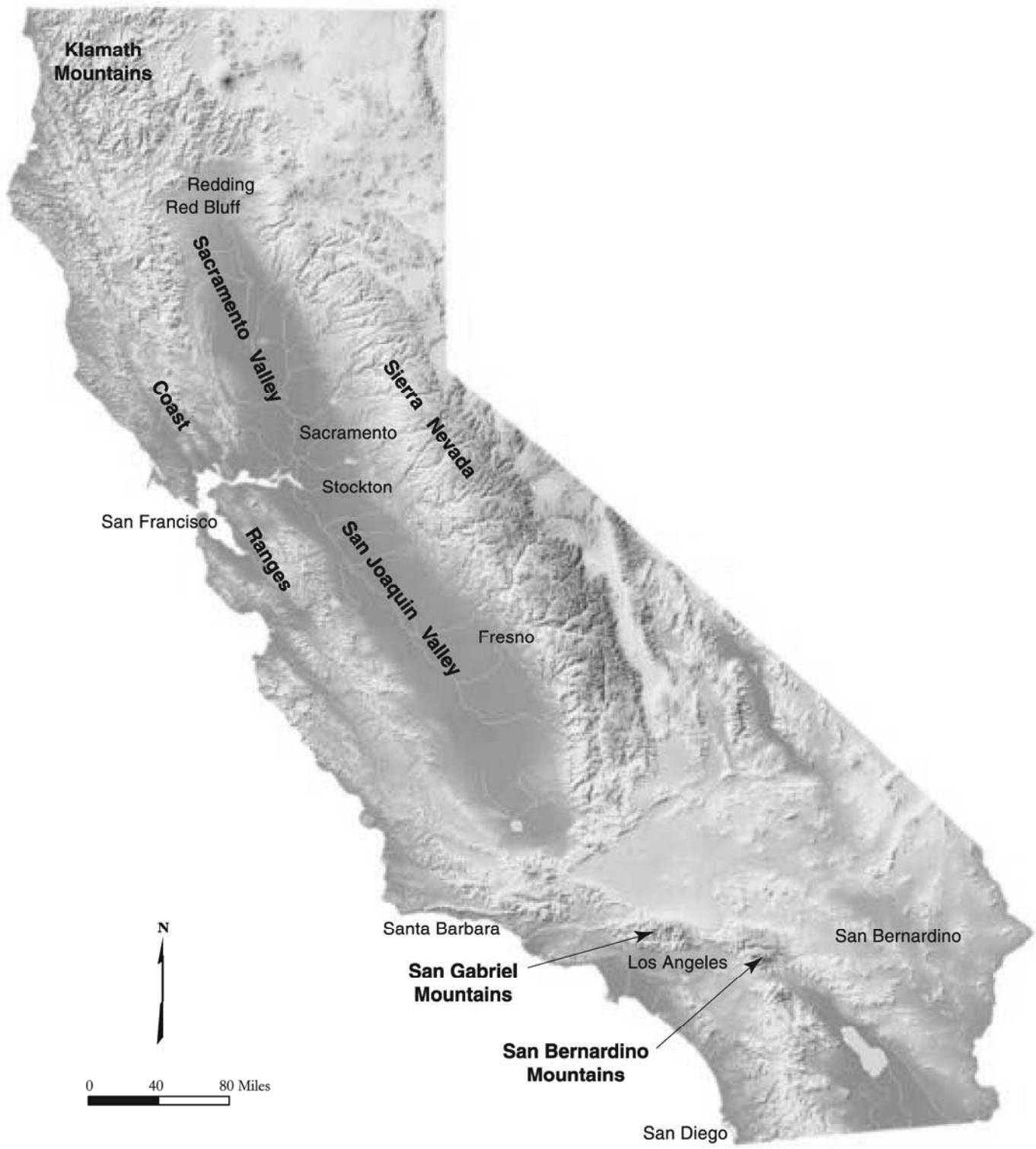

Figure 1 Shaded relief map of California

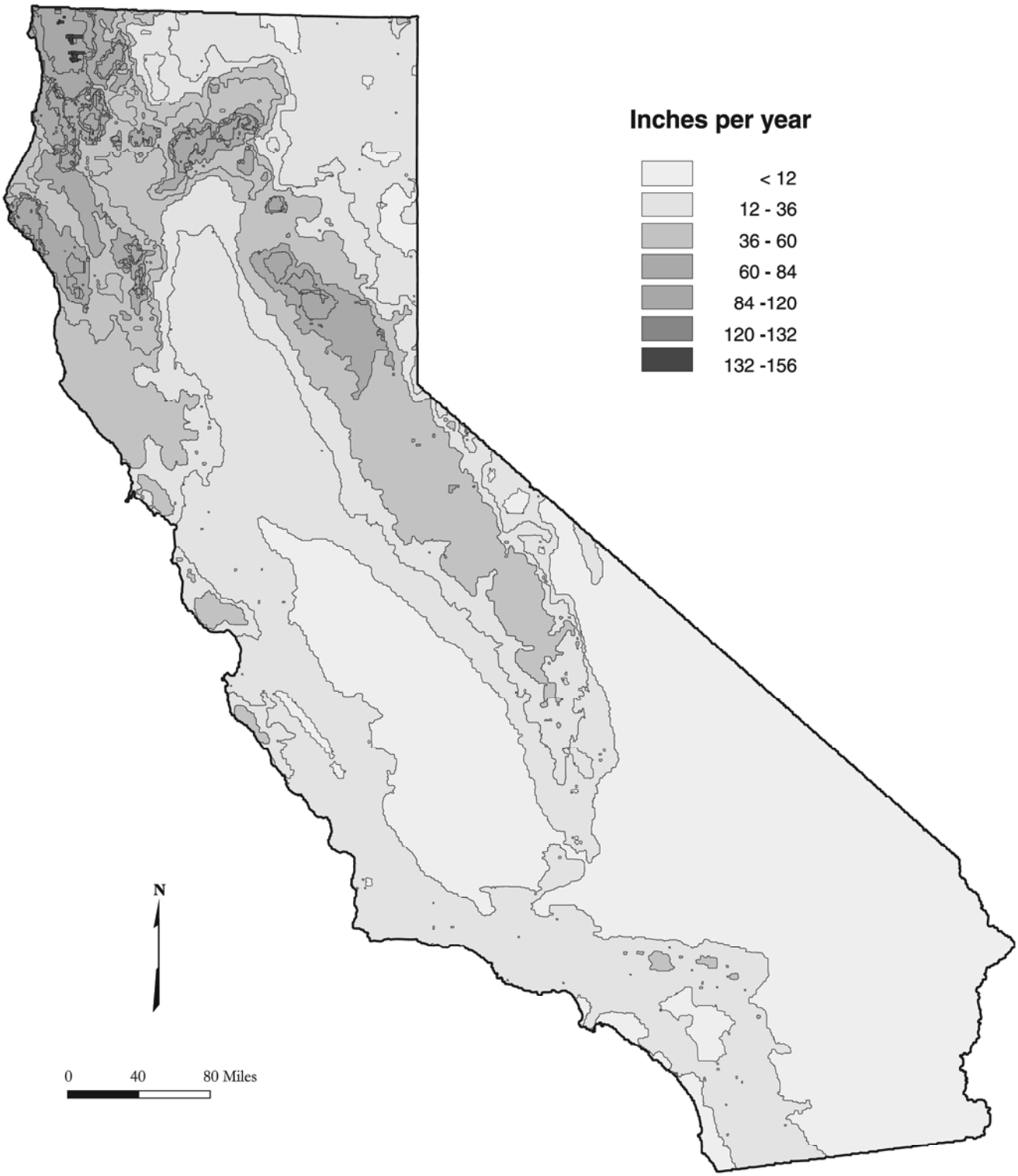

Figure 2 Mean annual precipitation in California, 1961 to 1990

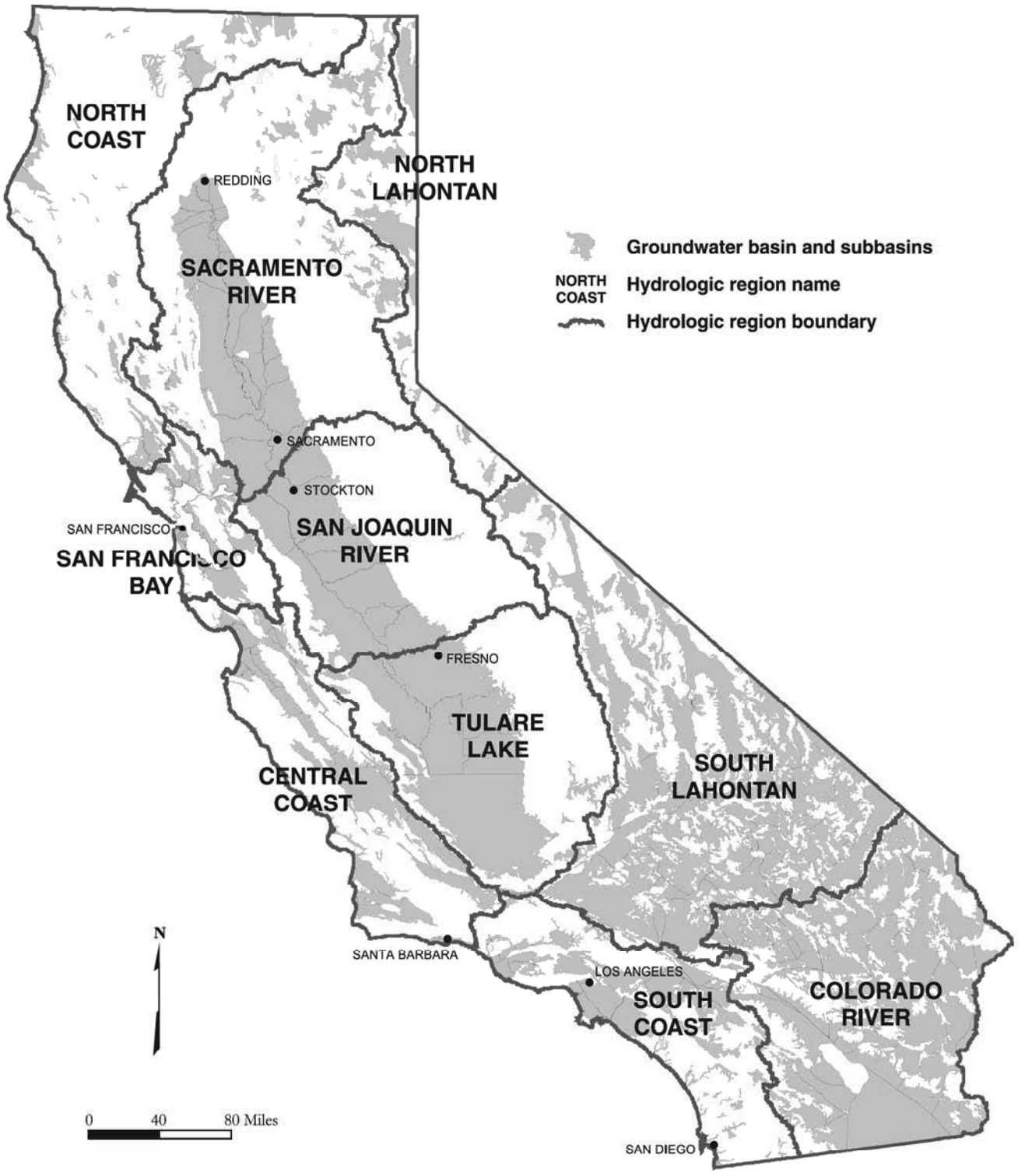

Figure 3 Groundwater basins, subbasins and hydrologic regions

California's Water Supply System

The economic success achieved in California could not have been foreseen a century ago. California's natural hydrologic system appeared too limited to support significant growth in population, industry, and agriculture. The limitations revolved around not only the relative aridity of the State, but the geographic, seasonal, and climatic variability that influence California's water supply. Approximately 70 percent of the State's average annual runoff occurs north of Sacramento, while about 75 percent of the State's urban and agricultural water needs are to the south. Most of the State's precipitation falls between October and April with half of it occurring December through February in average years. Yet, the peak demand for this water occurs in the summer months. Climatic variability includes dramatic deviations from average supply conditions by way of either droughts or flooding. In the 20th century alone, California experienced multiyear droughts in 1912–1913, 1918–1920, 1922–1924, 1929–1934, 1947–1950, 1959–1961, 1976–1977, and 1987–1992 (DWR 1998).

California has dealt with the limitations resulting from its natural hydrology and achieved its improbable growth by developing an intricate system of reservoirs, canals, and pipelines under federal, State and local projects (Figure 4). However, a significant portion of California's water supply needs is also met by groundwater. Typically, groundwater supplies about 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to about 40 percent statewide and 60% or more in some regions.

The importance of groundwater to the State's development may have been underestimated at the beginning of the 20th century. At that time, groundwater was seen largely as just a convenient resource that allowed for settlement in nearly any part of the State, given groundwater's widespread occurrence. Significant artesian flow from confined aquifers in the Central Valley allowed the early development of agriculture. When the Water Commission Act defined the allocation of surface water rights in 1914, it did not address allocation of the groundwater resource. In the 1920s, the development of the deep-well turbine pump and the increased availability of electricity led to a tremendous expansion of agriculture, which used these high-volume pumps and increased forever the significance of groundwater as a component of water supply in California.

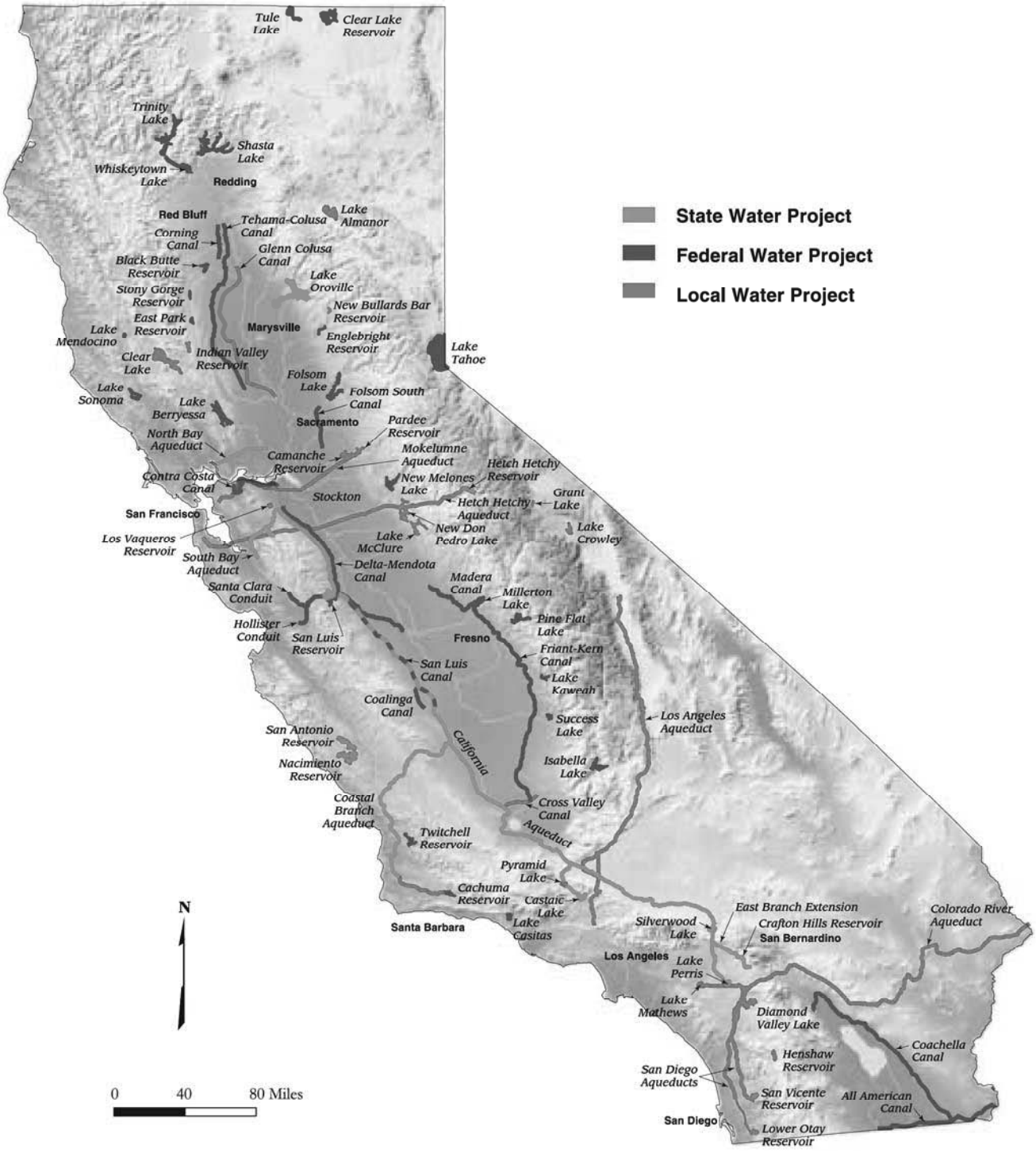

Figure 4 Water projects in California

Box B Will Climate Change Affect California's Groundwater?

California's water storage and delivery system can be thought of as including three reservoir systems—the snowpack of the Sierra Nevada, an extensive system of dams, lakes, and conveyance systems for surface water, and finally the aquifers that store groundwater. Precipitation in the form of snow is stored in the Sierra in winter and early spring and under ideal conditions melts in a manner that allows dams to capture the water for use during California's dry season. When snow melts faster, the dams act as flood control structures to prevent high runoff from flooding lowland areas. Water storage and delivery infrastructure—dams and canals—has been designed largely around the historical snowpack, while aquifers have played a less formal and less recognized role.

What will be the effect of climate change on California's water storage system? How will groundwater basins and aquifers be affected?

The latest report of the Intergovernmental Panel on Climate Change (2001) reaffirms that climate is changing in ways that cannot be accounted for by natural variability and that "global warming" is occurring. Studies by the National Water Assessment Team for the U.S. Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change identify potential changes that could affect water resources systems. For California, these include higher snow levels leading to more precipitation in the form of rain, earlier runoff, a rise in sea level, and possibly larger floods. In addition to affecting the balance between storage and flood control of our reservoirs, such changes in hydrology would affect wildlands, resulting in faunal and floral displacement and resulting in changes in vegetative water consumption. These changes would also affect patterns of both irrigated and dryland farming.

A warmer, wetter winter would increase the amount of runoff available for groundwater recharge; however, this additional runoff in the winter would be occurring at a time when some basins, particularly in Northern California, are either being recharged at their maximum capacity or are already full. Conversely, reductions in spring runoff and higher evapotranspiration because of warmer temperatures could reduce the amount of water available for recharge and surface storage.

The extent to which climate will change and the impact of that change are both unknown. A reduced snowpack, coupled with increased seasonal rainfall and earlier snowmelt may require a change in the operating procedures for existing dams and conveyance facilities. Furthermore, these changes may require more active development of successful conjunctive management programs in which the aquifers are more effectively used as storage facilities. Water managers might want to evaluate their systems to better understand the existing snowpack-surface water-groundwater relationship, and identify opportunities that may exist to optimize groundwater and other storage capability under a new hydrologic regime that may result from climate change. If more water was stored in aquifers or in new or reoperated surface storage, the additional water could be used to meet water demands when the surface water supply was not adequate because of reduced snowmelt.

Recent Groundwater Development Trends

While development of California's surface water storage system has slowed significantly, groundwater development continues at a strong pace. A review of well completion reports submitted to the California Department of Water Resources (DWR) provides data on the number and type of water wells drilled in California since 1987. For the 14-year period, DWR received 127,616 well completion reports for water supply wells that were newly constructed, reconditioned, or deepened—an average of 9,115 annually[1]. Of these, 82 percent were drilled for individual domestic uses; 14 percent for irrigation; and about 4 percent for a combined group of municipal and industrial uses (Figure 5). Although domestic wells predominate, individual domestic use makes up a small proportion of total groundwater use in the State.

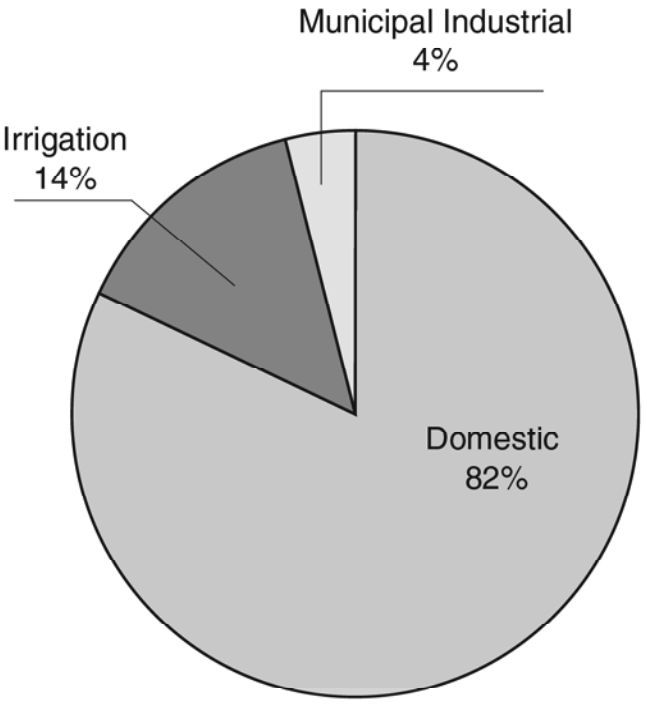

Figure 5 Well completion reports filed with DWR from 1987 through 2000

The most evident influence on the number of wells constructed is hydrologic conditions. The number of wells constructed and modified increases dramatically with drought conditions (Figure 6). The number of wells constructed and modified annually from 1987 through 1992 is more than double the annual totals for 1995 through 2000. Each year from 1987 through 1992 was classified as either dry or critically dry; water years 1995 through 2000 were either above normal or wet, based on measured unimpaired runoff in the Sacramento and San Joaquin valleys. In addition to providing an indication of the growth of groundwater development, well completion reports are a valuable source of information on groundwater basin conditions.

[1] DWR also received an average of 4,225 well completion reports for monitoring, which were not included above because they do not extract groundwater for supply purposes.

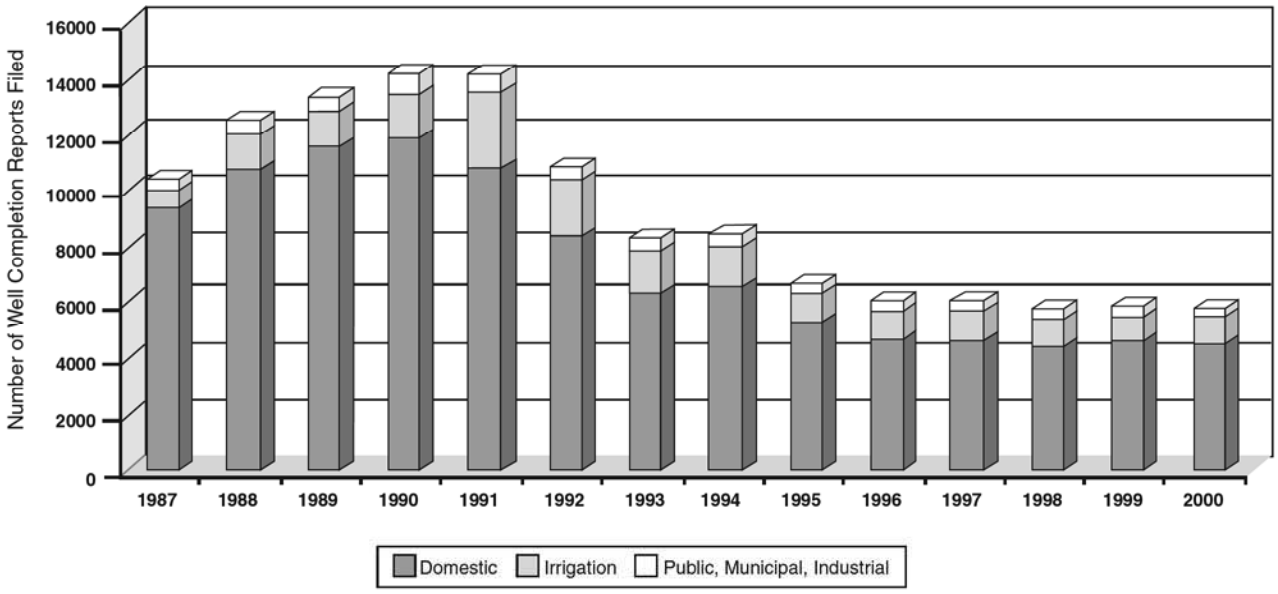

Figure 6 Well completion reports filed annually from 1987 through 2000

The Need for Groundwater Monitoring and Evaluation

Some 34 million people called California their home in the year 2000, and a population of nearly 46 million is expected by 2020. The increased population and associated commercial, industrial, and institutional growth will bring a substantially greater need for water. This need will be met in part by improved water use efficiency, opportunities to reoperate or expand California's surface water system, and increased desalination and recycling of water sources not currently considered usable. This need will also be met by storing and extracting additional groundwater. However, the sustainability of the groundwater resource, both in terms of what is currently used and future increased demand, cannot be achieved without effective groundwater management. In turn, effective groundwater management cannot be achieved without a program of groundwater data collection and evaluation.

Perhaps surprising to many, California does not have a comprehensive monitoring network for evaluating the health of its groundwater resource, including quantity and quality of groundwater. The reasons for this are many with the greatest one being that information on groundwater levels and groundwater quality is primarily obtained by drilling underground, which is relatively expensive. Given that delineated groundwater basins cover about 40 percent of the State's vast area, the cost of a dedicated monitoring network would be prohibitive. The other important reason for the lack of a comprehensive network is that, as will be discussed later in this report, groundwater is a locally controlled resource. State and federal agencies become involved only when a groundwater issue is directly related to the mission of a particular agency or if a local agency requests assistance. For these and other reasons, California lacks a cohesive, dedicated monitoring network.

Box C What about Overdraft?

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts.

The California Water Plan Update, Bulletin 160-98 (DWR 1998) estimated that groundwater overdraft in California in 1995 was nearly 1.5 million acre-feet annually, with most of the overdraft occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions. The regional and statewide estimates of overdraft are currently being revised for the 2003 update of Bulletin 160. While these estimates are useful from a regional and statewide planning perspective, the basin water budgets calculated for this update of Bulletin 118 clearly indicate that information is insufficient in many basins to quantify overdraft that has occurred, project future impacts on groundwater in storage, and effectively manage groundwater. Further technical discussion of overdraft is provided in Chapter 6 of this bulletin.

When DWR and other agencies involved in groundwater began to collect data in the first half of the 20th century, it quickly became evident that there were insufficient funds to install an adequate number of monitoring wells to accurately determine changes in the condition of groundwater basins. Consequently, to create a serviceable monitoring network, the agencies asked owners of irrigation or domestic wells for permission to measure water levels and to a lesser extent to monitor water quality. These have been called "wells of opportunity." In many areas, this approach has led to a network of wells that provide adequate information to gain a general understanding of conditions in the subsurface and to track changes through time. In some areas, groundwater studies were conducted and often included the construction of a monitoring well network. These studies have gradually contributed to a more detailed understanding of some of California's groundwater basins, particularly the most heavily developed basins.

Given the combination of monitoring wells of opportunity and dedicated monitoring wells, it might be assumed that an adequate monitoring network in California will eventually accumulate. However, several factors contribute to reducing the effectiveness of the monitoring network for data collection and evaluation: (1) The funding for data programs in many agencies, which was generally insufficient in the first place, has been reduced significantly. (2) When private properties change ownership, some new owners rescind permission for agency personnel to enter the property and measure the well. (3) The appropriateness of using these private wells is questionable because they are often screened over long intervals encompassing multiple aquifers in the subsurface, and in some cases construction details for the well are unknown. (4) Some wells with long-term records actually reach the end of their usefulness because the casing collapses or something falls into the well, making it unusable. In some cases, groundwater levels may drop below the well depth. (5) As water quality or water quantity conditions change, the monitoring networks may no longer be adequate to provide necessary data to manage groundwater.

The importance of long-term monitoring networks cannot be overstated. Sound groundwater management decisions require observation of trends in groundwater levels and groundwater quality. Only through these long-term evaluations can the question of sustainability of groundwater be answered. For example, this report contains a summary of groundwater contamination in public water supply wells throughout the State collected from 1994 through 2000. While this provides a "snapshot" of the suitability of the groundwater currently developed for public supply needs, it does not address sustainability of groundwater for public uses. Sustainability can only be determined by observing groundwater quality over time. If conditions worsen, local managers will need to take steps to prevent further harm to groundwater quality. Long-term groundwater records require adequate funding and staff to develop groundwater monitoring networks and to collect, summarize, and evaluate the data.

Chapter 2
Groundwater Management in California

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Groundwater management, as defined in this report, is the planned and coordinated monitoring, operation, and administration of a groundwater basin or portion of a groundwater basin with the goal of long-term sustainability of the resource. Throughout the history of water management in California, local agencies have practiced an informal type of groundwater management. For example, since the early 20th century, when excess surface water was available, some agencies intentionally recharged groundwater to augment their total water supply. In 1947, the amount of groundwater used was estimated at 9 million to 10 million acre-feet. By the beginning of the 21st century, the amount of groundwater used had increased to an estimated 15 million acre-feet. Better monitoring would provide more accurate information. This increased demand on California's groundwater resources, when coupled with estimates of population growth, has resulted in a need for more intensive groundwater management.

In 1914, California created a system of appropriating surface water rights through a permitting process (Stats 1913, ch. 586), but groundwater use has never been regulated by the State. Though the regulation of groundwater has been considered on several occasions, the California Legislature has repeatedly held that groundwater management should remain a local responsibility (Sax 2002). Although they are treated differently legally, groundwater and surface water are closely interconnected in the hydrologic cycle. Use of one resource will often affect the other, so that effective groundwater management must consider surface water supplies and uses.

Figure 7 depicts the general process by which groundwater management needs are addressed under existing law. Groundwater management needs are identified at the local water agency level and may be directly resolved at the local level. If groundwater management needs cannot be directly resolved at the local agency level, additional actions such as enactment of ordinances by local governments, passage of laws by the Legislature, or decisions by the courts may be necessary to resolve the issues. Upon implementation, local agencies evaluate program success and identify additional management needs. The State's role is to provide technical and financial assistance to local agencies for their groundwater management efforts, such as through the Local Groundwater Assistance grant program (see Chapter 4, AB 303).

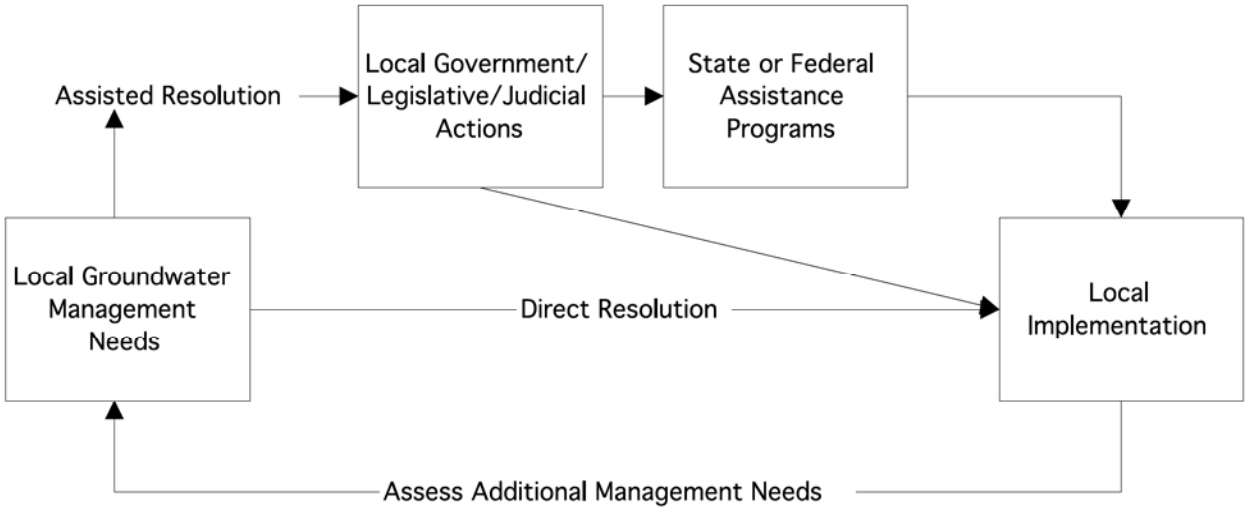

Figure 7 Process of addressing groundwater management needs in California

How Groundwater is Managed in California

There are three basic methods available for managing groundwater resources in California: (1) management by local agencies under authority granted in the California Water Code or other applicable State statutes, (2) local government groundwater ordinances or joint powers agreements, and (3) court adjudications. Table 1 shows how often each of these methods has been used, and each method is discussed briefly below. No law requires that any of these forms of management be applied in a basin. Management is often instituted after local agencies or landowners recognize a specific groundwater problem. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand.

Table 1 Groundwater management methods

Method	Frequency of use[a]
Local water agencies	Undetermined number of agencies with authority to manage some aspect of groundwater under general powers associated with a particular type of district. Thirteen agencies with specially legislated authority to limit or regulate extraction. Seven agencies with adopted plans under authority from Water Code Section 10750 et seq.[b] (AB 255 of 1991). More than 200 agencies with adopted plans under authority from Water Code Section 10750 et seq. (AB 3030 of 1992).
Local groundwater management ordinances	Currently adopted in 27 counties.
Court adjudication	Currently decided in 19 groundwater basins, mostly in Southern California. Three more basins are in court.

a. The numbers for some methods are unknown because reporting to the California Department of Water Resources is not required.
b. Section 10750 *et seq*. was amended in 1992.

Groundwater Management through Authority Granted to Local Water Agencies

More than 20 types of local agencies are authorized by statute to provide water for various beneficial uses. Many of these agencies also have statutory authority to institute some form of groundwater management. For example, a Water Replenishment District (Water Code, § 60000 et seq.) is authorized to establish groundwater replenishment programs and collect fees for that service. A Water Conservation District (Water Code, § 75500 et seq.) can levy groundwater extraction fees. Table 2 lists these and other types of local agencies that deliver water and may have authority to institute some form of groundwater management. Most of these agencies are identified in the Water Code, but their specific authority related to groundwater management varies. The Water Code does not require that the agencies report their activities to the California Department of Water Resources (DWR).

Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management

Local agency	Authority	Number of agencies[a]
Community Services District	Gov. Code § 61000 et seq.	313
County Sanitation District	Health and Safety Code § 4700 et seq.	91
County Service Area	Gov. Code § 25210.1 et seq.	897
County Water Authority	Water Code App. 45.	30
County Water District	Water Code § 30000 et seq.	174
County Waterworks District	Water Code § 55000 et seq.	34
Flood Control and Water Conservation District	Water Code App. 38.	39
Irrigation District	Water Code § 20500 et seq.	97
Metropolitan Water District	Water Code App 109.	1
Municipal Utility District	Pub. Util. Code § 11501 et seq.	5
Municipal Water District	Water Code § 71000 et seq.	40
Public Utility District	Pub. Util. Code § 15501 et seq.	54
Reclamation District	Water Code § 50000 et seq.	152
Recreation and Park District	Pub. Resources Code § 5780 et seq.	110
Resort Improvement District	Pub. Resources Code § 13000 et seq.	-
Resource Conservation District	Pub. Resources Code § 9001 et seq.	99
Water Conservation District	Water Code App. 34; Wat. Code § 74000 et seq.	13
Water District	Water Code § 34000 et seq.	141
Water Replenishment District	Water Code § 60000 et seq.	1
Water Storage District	Water Code § 39000 et seq.	8

a. From State Controller's Office Special Districts Annual Report, 49th Edition.

Greater authority to manage groundwater has been granted to a small number of local agencies or districts created through special acts of the Legislature. For example, the Sierra Valley Groundwater Basin Act of 1980 (Water Code, App. 119) created the first two groundwater management districts in California. Currently, 13 local agencies have specific groundwater management authority as a result of being special act districts. The specific authority of each agency varies, but they can generally be grouped into two categories. Most of the agencies formed since 1980 have the authority to limit export and even control some in-basin extraction upon evidence of overdraft or the threat of overdraft. These agencies can also generally levy fees for groundwater management activities and for water supply replenishment. Agencies formed prior to 1980 do not have authority to limit extraction from a basin. However, the groundwater users in these areas are generally required to report extractions to the agency, and the agency can levy fees for groundwater management or water supply replenishment. Some of these agencies have effectively used a tiered fee

structure to discourage excessive groundwater extraction in the basin. Table 3 lists the names of special act districts with legislative authority to manage groundwater.

Table 3 Special act districts with groundwater management authority in California

District or agency	Water Code citation[a]	Year agency established in Code[b]
Desert Water Agency	App. 100	1961
Fox Canyon Groundwater Management Agency	App. 121.	1982
Honey Lake Groundwater Management District	App. 129.	1989
Long Valley Groundwater Management District	App. 119.	1980
Mendocino City Community Services District	Section 10700 et seq.	1987
Mono County Tri-Valley Groundwater Management District	App. 128.	1989
Monterey Peninsula Water Management District	App. 118.	1977
Ojai Groundwater Management Agency	App. 131.	1991
Orange County Water District	App. 40.	1933
Pajaro Valley Water Management Agency	App. 124.	1984
Santa Clara Valley Water District	App. 60.	1951
Sierra Valley Groundwater Management District	App. 119.	1980
Willow Creek Groundwater Management Agency	App. 135.	1993

a. From West's Annotated California Codes (1999 update)
b. This represents the year the agency was established in the Water Code. Specific authorities, such as those for groundwater management activities, may have been granted through later amendments.

In 1991, AB 255 (Stats. 1991, Ch. 903) was enacted authorizing local agencies overlying basins subject to critical conditions of overdraft, as defined in DWR's Bulletin 118-80, to establish programs for groundwater management within their service areas. Water Code section 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality. Seven local agencies adopted plans under this authority.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation was significant in that it greatly increased the number of local agencies authorized to develop a groundwater management plan and set forth a common framework for management by local agencies throughout California. AB 3030, which is codified in Water Code section 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by Bulletin 118-75 (DWR 1975) and updates. Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3). More than 200 agencies have adopted an AB 3030 groundwater management plan. None of these agencies is known to have exercised the authority of a Water Replenishment District.

Water Code section 10755.2 expands groundwater management opportunities by encouraging coordinated plans and by authorizing public agencies to enter into a joint powers agreement or memorandum of understanding with public or private entities that provide water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

Local Groundwater Ordinances

A second general method of managing groundwater in California is through ordinances adopted by local governments such as cities or counties. Twenty-seven counties have adopted groundwater ordinances, and others are being considered (Figure 8). The authority of counties to regulate groundwater has been challenged, but in 1995 the California Supreme Court declined to review an appeal of a lower court decision *Baldwin v. County of Tehama* (1994) that holds that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. However, the precise nature and extent of the police power of cities and counties to regulate groundwater is uncertain.

The Public Policy Institute of California recently performed a study of California's water transfer market, which included a detailed investigation of the nature of groundwater ordinances by counties in California. The report found that 22 counties had adopted ordinances requiring a permit to export groundwater. In all but three cases, restricting out-of-county uses appears to be the only purpose (Hanak 2003). One ordinance, adopted recently in Glenn County (Box D, "Basin Management Objectives for Groundwater Management"), takes a comprehensive approach by establishing management objectives for the county's groundwater basins. Several other counties in Northern California are considering adopting similar management objective based ordinances.

Ordinances are mostly a recent trend in groundwater management, with 24 of the 27 ordinances enacted since 1990. Local ordinances passed during the 1990s have significantly increased the potential role of local governments in groundwater management. The intent of most ordinances has been to hold project proponents accountable for impacts that may occur as a result of proposed export projects. Because adoption of most of these ordinances is recent, their effect on local and regional groundwater management planning efforts is not yet fully known. However, it is likely that future groundwater development will take place within the constraints of local groundwater management ordinances. Table 4 lists counties with groundwater management ordinances and their key elements.

Figure 8 Counties with groundwater ordinances

Box D Basin Management Objectives for Groundwater Management

Most county groundwater management ordinances require that an export proponent prove the project will not deplete groundwater, cause groundwater quality degradation, or result in land subsidence. Although these factors could be part of any groundwater management plan, these ordinances do not require that a groundwater management plan be developed and implemented.

The only ordinance requiring development and adoption of objectives to be accomplished by management of the basin was adopted by the Glenn County Board of Supervisors in 2000. The action came after a citizens committee spent five years working with stakeholders. The process of developing a groundwater management ordinance for Glenn County began in 1995 when local landowners and county residents became concerned about plans to export groundwater or substitute groundwater for exported surface water. Control of exports was the focus of early ordinance discussions.

After long discussions and technical advice from groundwater specialists, the committee realized that goals and objectives must be identified for effective management of groundwater in the county. What did the county want to accomplish by managing groundwater within the county? What did groundwater management really mean?

The concept of establishing basin management objectives emerged (BMOs). BMOs would establish threshold values for groundwater levels, groundwater quality, and land surface subsidence. When a threshold level is reached, the rules and regulations require that groundwater extraction be adjusted or stopped to prevent exceeding the threshold.

The Glenn County Board of Supervisors has adopted BMOs, which were developed by an advisory committee, for groundwater levels throughout the county. While currently there are 17 BMOs representing the 17 management areas in the county, the goal is to begin managing the entire county in a manner that benefits each of the local agencies and their landowners, as well as landowners outside of an agency boundary. The committee is now developing BMOs for groundwater quality and land surface subsidence.

There is no single set of management objectives that will be successful in all areas. Groundwater management must be adapted to an area's political, institutional, legal, and technical constraints and opportunities. Groundwater management must be tailored to each basin or subbasin's conditions and needs. Even within a single basin, the management objectives may change as more is learned about managing the resource within that basin. Flexibility is the key, but that flexibility must operate within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement.

Table 4 Counties with ordinances addressing groundwater management

County	Year enacted	Key elements (refer to ordinances for exemptions and other details)
Butte	1996	Export permit required (extraction & substitute pumping), Water Commission and Technical Advisory Committee, groundwater planning reports (county-wide monitoring program)
Calaveras	2002	Export permit required (extraction & substitute pumping)
Colusa	1998	Export permit required (extraction & substitute pumping)
Fresno	2000	Export permit required (extraction & substitute pumping)
Glenn	1990 rev. 2000	Water Advisory Committee and Technical Advisory Committee, basin management objectives and monitoring network, export permit required (1990)
Imperial	1996	Commission established to manage groundwater, including controlling exports (permit required), overdraft, artificial recharge, and development projects
Inyo	1998	Regulates (1) water transfers pursuant to Water Code Section 1810, (2) sales of water to the City of Los Angeles from within Inyo Co., (3) transfer or transport of water from basins within Inyo County to another basin with the County, and (4) transfers of water from basins within Inyo Co. to any area outside the County.
Kern	1998	Conditional use permit for export to areas both outside county and within watershed area of underlying aquifer in county. Only applies to southeastern drainage of Sierra Nevada and Tehachapi mountains.
Lake	1999	Export permit required (extraction & substitute pumping)
Lassen	1999	Export permit required (extraction & substitute pumping)
Madera	1999	Permit required for export, groundwater banking, and import for groundwater banking purposes to areas outside local water agencies
Mendocino	1995	Mining of groundwater regulated for new developments in Town of Mendocino
Modoc	2000	Export permit required for transfers out of basin
Mono	1988	Permit required for transfers out of basin
Monterey	1993	Water Resources Agency strictly regulates extraction facilities in zones with groundwater problems
Napa	1996	Permits for local groundwater extractions; exemptions for single parcels and agricultural use
Sacramento	1952 rev. 1985	Water Agency established to manage and protect groundwater management zones; replenishment charges
San Benito	1995	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use, injecting imported water; influence of well pumping restrictions
San Bernardino	2002	Permit required for any new groundwater well within the desert region of the county
San Diego	1991	Provides for mapping of groundwater impacted basins (defined); projects within impacted basins require groundwater investigations
San Joaquin	1996	Export permit required (extraction & substitute pumping)
Shasta	1997	Export permit required (extraction & substitute pumping)
Sierra	1998	Export permit required or for off-parcel use
Siskiyou	1998	Permit required for transfers out of basin
Tehama	1992	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use; influence of well pumping restrictions
Tuolumne	2001	Export permit required (extraction & substitute pumping)
Yolo	1996	Export permit required (extraction & substitute pumping)

Adjudicated Groundwater Basins

A third general form of groundwater management in California is court adjudication. In some California groundwater basins, as the demand for groundwater exceeded supply, landowners and other parties turned to the courts to determine how much groundwater can rightfully be extracted by each user. The courts study available data to arrive at a distribution of the groundwater that is available each year, usually based on the California law of overlying use and appropriation. This court-directed process can be lengthy and costly. As noted in Table 5, the longest adjudication took 24 years. Many of these cases have been resolved with a court-approved negotiated settlement, called a stipulated judgment. Unlike overlying and non-overlying rights to groundwater, such decisions guarantee to each party a proportionate share of the groundwater that is available each year. The intense technical focus on the groundwater supply and restrictions on groundwater extraction for all parties make adjudications one of the strongest forms of groundwater management in California.

There are 19 court adjudications for groundwater basins in California, mostly in Southern California (see Table 5). Eighteen of the adjudications were undertaken in State Superior Court and one in federal court. For each adjudicated groundwater basin, the court usually appoints a watermaster to oversee the court judgment. In 15 of these adjudications, the court judgment limits the amount of groundwater that can be extracted by all parties based on a court-determined safe yield of the basin. The basin boundaries are also defined by the court. The Santa Margarita Basin was adjudicated in federal court. That decision requires water users to report the amount of surface water and groundwater they use, but groundwater extraction is not restricted.

Most basin adjudications have resulted in either a reduction or no increase in the amount of groundwater extracted. As a result, agencies often import surface water to meet increased demand. The original court decisions provided watermasters with the authority to regulate extraction of the quantity of groundwater; however, they omitted authority to regulate extraction to protect water quality or to prevent the spread of contaminants in the groundwater. Because water quantity and water quality are inseparable, watermasters are recognizing that they must also manage groundwater quality.

Box E Adjudication of Groundwater Rights in the Raymond Basin

The first basin-wide adjudication of groundwater rights in California was in the Raymond Basin in Los Angeles County in 1949 (*Pasadena v. Alhambra*). The first water well in Raymond Basin was drilled in 1881; 20 years later, the number of operating wells grew to about 140. Because of this pumping, the City of Pasadena began spreading water in 1914 to replenish the groundwater, and during the next 10 years the city spread more than 20,000 acre-feet.

Pumping during 1930 through 1937 caused water levels to fall 30 to 50 feet in wells in Pasadena. After attempting to negotiate a reduction of pumping on a cooperative basis, the City of Pasadena, on September 23, 1937, filed a complaint in Superior Court against the City of Alhambra and 29 other pumpers to quiet title to the water rights within Raymond Basin. The court ruled that the city must amend its complaint, making defendants of all entities pumping more than 100 acre-feet per year, and that it was not a simple quiet title suit but, a general adjudication of the water rights in the basin.

In February 1939, a court used the reference procedure under the State Water Code to direct the State Division of Water Resources, Department of Public Works (predecessor to the Department of Water Resources) as referee to review all physical facts pertaining to the basin, determine the safe yield, and ascertain whether there was a surplus or an overdraft. The study took 2-1/2 years to complete and cost more than $53,000, which was paid by the parties. The resulting Report of Referee submitted to the court in July 1943 found that the annual safe yield of the basin was 21,900 acre-feet but that the actual pumping and claimed rights were 29,400 acre-feet per year.

Most parties agreed to appoint a committee of seven attorneys and engineers to work out a stipulated agreement. In 1944, the court designated the Division of Water Resources to serve as watermaster for the stipulated agreement, which all but one of the parties supported. On December 23, 1944, the judge signed the judgment that adopted the stipulation.

The stipulation provided that (1) the water was taken by each party openly, notoriously, and under a claim of right, which was asserted to be, and was adverse to each and all other parties; (2) the safe yield would be divided proportionally among the parties; and (3) each party's right to a specified proportion of the safe yield would be declared and protected. It also established an arrangement for the exchange of pumping rights among parties.

Based on the stipulation, the court adopted a program of proportionate reductions. In so doing, the court developed the doctrine of mutual prescription, whereby the rights were essentially based on the highest continual amount of pumping during the five years following the beginning of the overdraft, and under conditions of overdraft, all of the overlying and appropriative water users had acquired prescriptive rights against each other, that is, mutual prescription.*

In 1945, one party appealed the judgment, and in 1947, the District Court of Appeals reversed and remanded *Pasadena v. Alhambra.* However, on June 3, 1949, the State Supreme Court overturned the appellate court's decision and affirmed the original judgment. In 1950, the court granted a motion by the City of Pasadena that there be a review of the determination of safe yield, and in 1955, the safe yield and the total decreed rights were increased to 30,622 acre-feet per year. In 1984, watermaster responsibilities were assigned to the Raymond Basin Management Board.

*In City of Los Angeles v. City of San Fernando (1975) the California Supreme Court rejected the doctrine of mutual prescription and held that a groundwater basin should be adjudicated based on the correlative rights of overlying users and prior appropriation among non-overlying users. For further discussion, see Appendix B.

Table 5 List of adjudicated basins

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
1—Scott River Stream System	Scott River Valley; Siskiyou	1-5	1970	1980	Two local irrigation districts
2—Santa Paula Basin	Subbasin of Santa Clara River; Ventura	4-4	1991	1996	Three-person technical advisory committee from United Water CD, City of Ventura, and Santa Paula Basin Pumpers Association; www.unitedwater.org
3—Central Basin	Northeast part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1962	1965	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
4—West Coast Basin	Southwest part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1946	1961	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
5—Upper Los Angeles River Area	San Fernando Valley Basin (entire watershed); Los Angeles	4-12	1955	1979	Superior Court appointee
6—Raymond Basin	Northwest part of San Gabriel Valley Basin; Los Angeles	4-13	1937	1944	Raymond Basin Management Board
7—Main San Gabriel Basin	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1968	1973	Water purveyors and water districts elect a nine-member board; www.watermaster.org/
Puente Narrows, *Addendum to Main San Gabriel Basin decision*			1972	1972	Two consulting engineers
8—Puente	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1985	1985	Three consultants
9—Cummings Basin	Cummings Valley Basin; Kern	5-2	1966	1972	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
10—Tehachapi Basin	Tehachapi Valley West Basin and Tehachapi Valley East Basin; Kern	5-28 6-45	1966	1973	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
11—Brite Basin	Brite Valley; Kern	5-80	1966	1970	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm

Table 5 List of adjudicated basins (continued)

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
12—Mojave Basin Area Adjuducation	Lower, Middle & Upper Mojave River Valley Basins; El Mirage & Lucerne valleys; San Bernardino	6-40, 6-41, 6-42	1990	1996	Mojave Water Agency; www.mojavewater.org/mwa700.htm
13—Warren Valley Basin	Part of Warren Valley Basin; San Bernardino	7-12	1976	1977	Hi-Desert Water District; www.mojavewater.org
14—Chino Basin	Northwest part of Upper Santa Ana Valley Basin; San Bernardino and Riverside	8-2	1978	1978	Nine people, recommended by producers and appointed by the court; www.cbwm.org/
15—Cucamonga Basin	North central part of Upper Santa Ana Valley Basin; San Bernardino	8-2	1975	1978	Not yet appointed, operated as part of Chino Basin
16—San Bernardino Basin Area	Northeast part of Upper Santa Ana Basin; San Bernardino and Riverside	8-2	1963	1969	One representative each from Western Municipal Water District of Riverside County & San Bernardino Valley Municipal Water District
17—Six Basins	Six subbasins in northwest upper Santa Ana Valley; Upper & Lower Claremont Heights, Canyon, Pomona, Live Oak & Ganesha; Los Angeles. Small portions of Upper Claremont Heights and Canyon are in San Bernardino County	4-14, 8-2	1998	1998	Nine-member board representing all parties to the judgment
18—Santa Margarita River watershed	The Santa Margarita River watershed, including 3 groundwater basins: Santa Margarita Valley, Temecula Valley and Cahuilla Valley Basins; San Diego and Riverside.	9-4, 9-5, 9-6	1951	1966	U.S. District Court appointee
19—Goleta	Goleta Central Basin; judgment includes North Basin; Santa Barbara	3-16	1973	1989	No watermaster appointed; the court retains jurisdiction

How Successful Have Groundwater Management Efforts Been?

This chapter describes the opportunities for local agencies to manage their groundwater resources. Many have questioned whether these opportunities have led to an overall successful system of groundwater management throughout California. How successful groundwater management has been throughout the State is a difficult question and cannot be answered at present. While there are many examples of local agency successes (see Box F, "Managing through a Joint Powers Agreement," Box G, "Managing a Basin through Integrated Water Management," and Box H, "Managing Groundwater Using both Physical and Institutional Solutions"), there are neither mandates to prepare groundwater management plans nor reporting requirements when plans are implemented, so a comprehensive assessment of local planning efforts is not possible. Additionally, many plans have been adopted only recently, during a period of several consecutive wet years, so many of the plan components are either untested or not implemented.

At a minimum, successful groundwater management should be defined as maintaining and maximizing long-term reliability of the groundwater resource, focused on preventing significant depletion of groundwater in storage over the long term and preventing significant degradation of groundwater quality. A review of some of the groundwater management plans prepared under AB 3030 reveals that some plans are simply brief recitations about continuing the agency's existing programs. Not all agencies that enacted groundwater management plans under AB 3030 are actively implementing the plan.

Despite this apparent lack of implementation of groundwater management plans prepared under AB 3030, the bill has certainly increased interest in more effective groundwater management. With more than 200 agencies participating in plans and more than 120 of those involved in coordinated plans with other agencies, AB 3030 has resulted in a heightened awareness of groundwater management. Additionally, annual reports published by a few water agencies indicate that they are indeed moving toward better coordination throughout the basin and more effective management of all water supplies. Given the history of groundwater management in California, these seemingly small steps toward better management may actually represent giant strides forward.

More recently, financial incentives have played a large role in driving groundwater management activities. For example, under grant and loan programs resulting from Proposition 13 of 2000 (see description in Chapter 4), local agencies submitted applications proposing a total increase in annual water yield of more than 300,000 acre-feet through groundwater storage projects. Additional projects and programs would be developed with sufficient funding for feasibility and pilot studies. Unfortunately, not enough funding exists for all of the proposed projects, and many other legal and institutional barriers remain (see Box I, "Impediments to Conjunctive Management Programs in California"). It is clear, however, that further incentives would help agencies move ahead more aggressively in their groundwater management planning efforts.

Additional progress in groundwater management is reflected by passage of amendments to the Water Code (§§ 10753.4 and 10795.4 as amended, §§ 10753.7, 10753.8, and 10753.9 as amended and renumbered, and §§ 10753.1 and 10753.7 as added) through SB 1938 of 2002. The amendments require that groundwater management plans include specific components for agencies to be eligible for some public funds for groundwater projects. The provisions of SB 1938 (2001) are fully described in Chapters 3 and 4.

This evaluation of groundwater management success has not really considered ordinances and adjudications. Adjudications have been successful at maintaining the groundwater basin conditions, often restricting pumping for all basin users. In some cases, adjudication provides the necessary framework for more proactive management as well. Ordinances have successfully restricted exports from basins, but have not

Box F Managing through a Joint Powers Agreement

In 1993, representatives from business, environmental, public, and water purveyor interests formed the Sacramento Area Water Forum to develop a plan to protect the region's water resources from the effects of prolonged drought as the demand for water continues to grow. The Water Forum was founded on two co-equal objectives: (1) to provide a reliable and safe water supply for the region's economic health and planned development to the year 2030 and (2) to preserve the fishery, wildlife, recreational and aesthetic values of the lower American River.

After a six-year consensus-based process of education, analysis and negotiation, the participants signed a Water Forum agreement to meet these objectives. The agreement provides a framework for avoiding future water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity.

The Sacramento Groundwater Authority (SGA) was formed to fulfill a key Water Forum goal of protecting and managing the north-area groundwater basin. The SGA is a joint powers authority formed for the purpose of collectively managing the region's groundwater resources. This authority permits SGA to make contractual arrangements required to implement a conjunctive use program, and also provides potential partners with the legal and political certainty for entering into long-term agreements.

SGA's regional banking and exchange program is designed to provide long-term supply benefits for local needs, but also will have the potential to provide broader statewide benefits consistent with American River environmental needs. Water stored in Folsom Lake would be conjunctively used with groundwater in order to reduce surface water diversions in dry years and to achieve in-lieu recharge of the basin in wet years. The conjunctive use program participants include 16 water providers in northern Sacramento and southern Placer counties that serve water to more than half a million people.

Two of three implementation phases of the program are complete. In the first phase, program participants identified long-term water supply needs and conducted an inventory of existing infrastructure that could be used to implement the program. In the second phase, SGA completed two pilot banking and exchange projects, demonstrating the technical, legal, and institutional viability of a regional conjunctive use program. In the first pilot study, water agencies worked with the U.S. Bureau of Reclamation and the Sacramento Area Flood Control Agency to bank 2,100 acre-feet of groundwater, providing additional flood storage capacity in Folsom Lake. In the second pilot study, Citrus Heights and Fair Oaks water districts and the city of Sacramento extracted and used 7,143 acre-feet of groundwater, forgoing a portion of their rights to surface water, making this water available to the Environmental Water Account. The third phase of the SGA program is to further solidify the institutional framework and construct facilities to implement a full-scale regional conjunctive use program. These facilities, that will result in an average annual yield of 21,400 acre-feet, are currently under construction, funded in part by a $21.6 million grant under Proposition 13 of 2000.

Box G Managing a Basin through Integrated Water Management

Orange County Water District (OCWD) was established in 1933 by an uncodified Act (Water Code App. 40) to manage Orange County's groundwater basin and protect the Santa Ana River rights of water users of north-central Orange County. The district manages the groundwater basin, which provides as much as 75 percent of the water supply for its service area. The district strives for a groundwater-based water supply with enough reserves to provide a water supply through drought conditions. An integrated set of water management practices helps achieve this, including the use of recharge, alternative sources, and conservation.

Recharge

The Santa Ana River provides the main natural recharge source for the county's groundwater basin. Increased groundwater use and lower-than-average rainfall during the late 1980s and early 1990s forced the district to rely on an aggressive program to enhance recharge of the groundwater basin. Programs used today to optimize water use and availability include:

- Construction of levees in the river channel to increase infiltration.
- Construction of artificial recharge basins within the forebay.
- Development of an underwater basin cleaning vehicle that removes a clogging layer at the bottom of the recharge basin and extends the time between draining the basin for cleaning by a bulldozer.
- Use of storm water captured behind Prado Dam that would otherwise flow to the ocean.
- Use of imported water from the State Water Project and Colorado River.
- Injection of treated recycled water to form a seawater intrusion barrier.

Alternative Water Use and Conservation

OCWD has successfully used nontraditional sources of water to help satisfy the growing need for water in Orange County. Projects that have added to the effective supply of groundwater are:

- Use of treated recycled water for irrigation and industrial use.
- In-lieu use to reduce groundwater pumping.
- Change to low-flow toilets and showerheads.
- Participation of 70 percent of Orange County hotels and motels in water conservation programs.
- Change to more efficient computerized irrigation.

Since 1975, Water Factory 21 has provided recycled water that meets all primary and secondary drinking water standards set by the California Department of Health Services. OCWD has proposed a larger, more efficient membrane purification project called the Groundwater Replenishment System (GWRS), which is scheduled to begin operating at 70,000 acre-feet per year in 2007. By 2020 the system will annually supply 121,000 acre-feet of high quality water for recharge, for injection into the seawater intrusion barrier, and for direct industrial uses.

This facility will use a lower cost microfiltration and reverse osmosis treatment process that produces water of near distilled quality, which will help reverse the trend of rising total dissolved solids (TDS) in groundwater caused by the recharge of higher TDS-content Santa Ana River and Colorado River waters. The facility will use about half the energy required to import an equivalent amount of water to Orange County from Northern California. The GWRS will be funded, in part, by a $30 million grant under Proposition 13 of 2000.

Source: Orange County Water District

Box H Managing Groundwater using both Physical and Institutional Solutions

Four agencies share responsibility for groundwater management in Ventura County. Coordination and cooperation between these agencies focus on regular meetings, attendance at each other's board meetings, joint projects, watershed committees, and ongoing personal contacts to discuss water-related issues. The agencies and their areas of responsibility are:

- United Water Conservation District – physical solutions, monitoring, modeling, reporting, administering management plans and adjudication;
- Fox Canyon Groundwater Management Agency – pumping allocations, credits and penalties, abandoned well destruction, data for irrigation efficiency;
- County of Ventura – well permits, well construction regulations, tracking abandoned wells; and
- Calleguas Municipal Water District – groundwater storage of imported water.

In Ventura County 75% to 80% of the extracted groundwater is for agriculture; the remainder is for municipal and industrial use. Seawater intrusion into the aquifers was recognized in the 1940s and was the driving force behind a number of groundwater management projects and policies in the county's groundwater basins. As groundwater issues became more complicated at the end of the 20th century, these groundwater management projects and policies were useful in solving a number of problems.

Physical Solutions

Physical solutions substitute supplemental surface water for groundwater pumping near coastal areas, increase basin recharge, and increase the reliability of imported water. Projects include:

- Winter flood-flow storage for dry season release
- Wells and pipelines to move pumping for drinking water away from the coast
- Diversion structures to supply surface water to spreading grounds and irrigation
- Pipelines to convey surface water to coastal areas
- Las Posas Basin Aquifer Storage and Recovery project

Institutional Solutions

Institutional solutions focus on developing and implementing effective groundwater management programs, reducing pumping demands, tracking groundwater levels and water quality, managing groundwater pumping patterns, and destroying abandoned wells to prevent cross-contamination of aquifers. Solutions include:

- Creation of Fox Canyon Groundwater Management Agency (GMA), which represents each major pumping constituency
- Use of irrigation efficiency (agriculture), water conservation, and alternative sources of water (urban) to reduce pumping by 25%
- Manage outside the GMA area through an AB 3030 plan and a court adjudication
- Limit new permits for wells in specific aquifers to avoid seawater intrusion
- Creation of a program to destroy abandoned wells
- Creation of a database of historical groundwater levels and quality information collected since the 1920s
- Development of a regional groundwater flow model and a regional master plan for groundwater projects
- Creation of an irrigation weather station to assist in irrigation efficiency

Implementation of these physical and institutional management tools has resulted in the reversal of seawater intrusion in key coastal monitoring wells. These same tools are being used to mitigate saline intrusion (not seawater) in two inland basins and to reduce seasonal nitrate problems in the recharge area. Work is being expanded to help reduce loading of agricultural pesticides and nutrients. Without close coordination and cooperation of the county's water-related agencies, municipalities, and landowners, it would have been very difficult to implement most of these solutions. Although such coordination takes time, the investment has paid off in solutions that help provide a sustainable water supply for all water users in Ventura County.

Source: United Water Conservation District

necessarily improved groundwater management. The primary intent of most ordinances is to ensure that proponents of projects are held accountable for potential impacts of the proposed export projects. As studies lead to a better understanding of local water resources, development of pilot export and transfer projects, with appropriate monitoring, may lead to greater certainty in managing groundwater resources. Areas managed under adjudications and ordinances will continue to develop more active management approaches. Population growth and its accompanying increased demand on the resources is a certainty. Most geographic areas in California are not immune to this growth, so strategies for more than just maintaining existing groundwater supply through extraction or export restrictions need to be implemented.

Box I Impediments to Conjunctive Management Programs in California

In 1998 the National Water Research Institute, in cooperation with the Association of Ground Water Agencies and the Metropolitan Water District of Southern California, conducted a workshop to determine the biggest impediments to implementing a cost-effective conjunctive water management program in California.

Since that time, some steps have been taken to overcome those impediments, but several important barriers remain. Workshop participants identified the 10 most significant obstacles:

1) Inability of local and regional water management governance entities to build trust, resolve differences (internally and externally), and share control.
2) Inability to match benefits and funding burdens in ways that are acceptable to all parties, including third parties.
3) Lack of sufficient federal, State, and regional financial incentives to encourage groundwater conjunctive use to meet statewide water needs.
4) Legal constraints that impede conjunctive use, regarding storage rights, basin judgments, area of origin, water rights, and indemnification.
5) Lack of statewide leadership in the planning and development of conjunctive use programs as part of comprehensive water resources plans, which recognize local, regional, and other stakeholders' interests.
6) Inability to address quality difference in "put" versus "take"; standards for injection, export, and reclaimed water; and unforeseeable future groundwater degradation.
7) Risk that water stored cannot be extracted when needed because of infrastructure, water quality or water level, politics, and institutional or contractual provisions.
8) Lack of assurances to prevent third-party impacts and assurances to increase willingness of local citizens to participate.
9) Lack of creativity in developing lasting "win-win" conjunctive use projects, agreements, and programs.
10) Supplemental suppliers and basin managers have different roles and expectations in relation to conjunctive use.

[**Editor's note**: The California Department of Water Resources' Conjunctive Water Management program has taken significant steps to overcome several of these impediments, using a combination of California Bay-Delta Authority, DWR, Proposition 13, and AB 303 funds to promote locally planned and controlled conjunctive use programs.]

Future Groundwater Management in California

Trying to predict what will happen with groundwater management in California is difficult given that actions by all of the involved groups—landowners, local governments, local, State, and federal agencies, and the courts—will continue to shape groundwater management in the future. However, the increasing population and its demands on California's water supply will accelerate the rate at which groundwater management issues become critical and require resolution. Some general conclusions are:

- Groundwater management will continue to be a local responsibility with increasing emphasis on how actions in one part of a basin impact groundwater resources throughout the basin. Regional cooperation and coordination of groundwater management activities will increase.

- As the State's population continues to grow, the increased reliance on groundwater will keep the topic of groundwater management at the forefront of legislative interest.

- Coordinated management of groundwater and surface water resources, through further development of conjunctive water management programs and projects, will become increasingly important.

- The increased reliance on groundwater in the future will necessitate a more direct link between land use planning, watershed management, floodplain management, and groundwater management plans.

- Current trends indicate that financial incentives in the form of loans and grants are increasing groundwater management planning and implementation at the local level. These successes will only continue at the current pace with increased funding to local agencies.

- Management of groundwater will increasingly include consideration of groundwater quality and groundwater quantity.

- Groundwater will be an important element in the trend toward an integrated water management approach that considers the full range of demand management and supply alternatives.

- Understanding of the relationship of groundwater and surface water and the role of groundwater in the environment will continue to grow.

Box J Managing Groundwater Quantity and Quality

When people hear the words "groundwater monitoring"' they may think either of measuring groundwater levels or of analyzing for groundwater quality. In reality, monitoring and management of groundwater quantity and groundwater quality are inseparable components of a management plan.

Although the primary focus of the California Department of Water Resources (DWR) is on groundwater quantity and the measures taken by local agencies to manage supply, management must also consider groundwater quality. Natural or anthropogenic contamination and pumping patterns that are not managed to protect groundwater quality may limit the quantity of groundwater that is available for use in a basin.

Several State programs provide useful data as well as regulatory direction on groundwater quality that managers can use in managing their groundwater supply. One program is the Drinking Water Source Assessment and Protection Program prepared by the California Department of Health Services in response to 1996 amendments to the federal Safe Drinking Water Act. The DWSAP requires water purveyors to assess sources of drinking water, develop zones indicating time of travel of groundwater, and identify potentially contaminating activities around supply wells. The goal is to ensure that the quality of drinking water sources is maintained and protected. Other useful water quality data for groundwater managers is collected by the agencies within the California Environmental Protection Agency, including the State Water Resources Control Board, Department of Pesticide Regulation and the Department of Toxic Substances Control, which are discussed in more detail in Chapter 5. Each of these agencies has a specific statutory responsibility to collect groundwater quality information and protect water quality.

Protection of Recharge Areas

Groundwater recharge areas, and the human activities that can render them unusable, are an example of the need to coordinate land use activities to protect both groundwater quality and quantity. Protection of recharge areas, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Existing and potential recharge areas must be protected so that they remain functional, that is they continue to provide recharge to the aquifer and they are not contaminated with chemical or microbial constituents. Land-use practices should be implemented so that neither the quantity nor quality of groundwater is reduced. A lack of protection of recharge areas could decrease the availability of usable groundwater and require the substitution of a more expensive water supply.

Many potentially contaminating activities have routinely been practiced in recharge areas, leading to the presence of contaminants in groundwater. In many areas, groundwater obtained from aquifers now requires remediation. Recent studies in some areas show that recharge areas are contaminated, but down-gradient wells are not, indicating that it is only a matter of time before contaminants in wells reach concentrations that require treatment of the groundwater.

In addition to quality impacts, urban development, consisting of pavement and buildings on former agricultural land, lining of flood control channels, and other land use changes have reduced the capacity of recharge areas to replenish groundwater, effectively reducing the safe yield of some basins.

Box J Managing Groundwater Quantity and Quality (continued)

To ensure that recharge areas continue to replenish high quality groundwater, water managers and land use planners should work together to:

- Identify recharge areas so the public and local zoning agencies are aware of the areas that need protection from paving and from contamination;
- Include recharge areas in zoning categories that eliminate the possibility of contaminants entering the subsurface;
- Standardize guidelines for pre-treatment of the recharge water, including recycled water;
- Build monitoring wells to collect data on changes in groundwater quality that may be caused by recharge; and
- Consider the functions of recharge areas in land use and development decisions.

Chapter 3
Groundwater Management Planning and Implementation

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The 1990s were a very important decade in the history of groundwater management in California. In 1992, the State Legislature provided an opportunity for more formal groundwater management with the passage of AB 3030 (Water Code § 10750 et seq.). More than 200 agencies have adopted an AB 3030 groundwater management plan. Additionally, 24 of the 27 counties with ordinances related to groundwater management adopted those laws during the 1990s. Plans prepared under AB 3030 certainly brought unprecedented numbers of water agencies into the groundwater management arena, and counties are now heavily involved in groundwater management, primarily through ordinances. However, many plans prepared under AB 3030 have had little or no implementation, and many counties focus primarily on limiting exports rather than on a comprehensive management program. As a result, the California Budget Act of 1999 (Stats. 1999, ch. 50), which authorized this update to Bulletin 118, directed the California Department of Water Resources (DWR) to complete several tasks, including developing criteria for evaluating groundwater management plans and developing a model groundwater management ordinance. This chapter presents the results of these directives. The intent is to provide a framework that will assist local agencies in proactively planning and implementing effective groundwater management programs.

Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components

In 2002, the Legislature passed SB 1938 (Stats 2002, ch 603), which amended Water Code section 10750 et seq to require that groundwater management plans adopted by local agencies include certain components to be eligible for public funds administered by DWR for construction of groundwater projects; the statute applies to funds authorized or appropriated after September 1, 2002. In addition to the required components, DWR worked with representatives from local water agencies to develop a list of additional recommended components that are common to effective groundwater management.

Both the "required" and the "recommended" components are tools that local agencies can use either to institute a groundwater management plan for the first time or to update existing groundwater management plans. These components are discussed below and listed in Appendix C, which can be used as a checklist by local agencies to assess whether their groundwater management plans are addressing these issues.

Required Components of Local Groundwater Management Plans

As of January 1, 2003, amendments to Water Code Section 10750 et seq., resulting from the passage of SB 1938, require new groundwater management plans prepared under section 10750, commonly referred to as AB 3030 plans, to include the first component listed below.

Groundwater management plans prepared under any statutory authority must include components 2 through 7 to be eligible for the award of public funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These requirements apply to funds authorized or appropriated after September 1, 2002. Funds appropriated under Water Code section 10795 et seq. (AB 303 – Local Groundwater Assistance Fund) are specifically excluded.

1) Documentation that a written statement was provided to the public "describing the manner in which interested parties may participate in developing the groundwater management plan" (Water Code, § 10753.4 (b)).

2) Basin management objectives (BMOs) for the groundwater basin that is subject to the plan (Water Code, § 10753.7 (a)(1)).
3) Components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping (Water Code, § 10753.7 (a)(1)).
4) A plan by the managing entity to "involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin" (Water Code, § 10753.7 (a)(2)). A local agency includes "any local public agency that provides water service to all or a portion of its service area" (Water Code, § 10752 (g)).
5) Adoption of monitoring protocols (Water Code, § 10753.7 (a)(4)) for the components in Water Code section 10753.7 (a)(1). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting BMOs.
6) A map showing the area of the groundwater basin as defined by DWR Bulletin 118 with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code, § 10753.7 (a)(3)).
7) For local agencies not overlying groundwater basins, plans shall be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code, § 10753.7 (a)(5)).

Recommended Components of Groundwater Management Plans

Although the seven components listed above are required only under certain conditions, they should always be considered for inclusion in any groundwater management planning process. In addition to the required components of a groundwater management plan resulting from the passage of SB 1938, it is recommended that the components listed below be included in any groundwater management plan adopted and implemented by a local managing entity. These additional components were developed in accord with the Budget Act of 1999 and with the assistance of stakeholder groups. The components should be considered and developed for specific application within the basin, subbasin, or agency service area covered by the plan. Additional components will likely be needed in specific areas. The level of detail for each component will vary from agency to agency. None of the suggested data reporting in the components should be construed to require disclosure of information that is confidential under State law. Local agencies should consider both the benefits of public dissemination of information and water supply security in developing reporting requirements.

Manage with the Guidance of an Advisory Committee

The managing entity should establish an advisory committee of interested parties that will help guide the development and implementation of the plan. The committee can benefit management in several ways. First, the committee can bring a variety of perspectives to the management team. As the intent of local groundwater management is to maintain and expand local benefits from the availability of the resource, it makes sense that the intended beneficiaries are a part of the management process. Second, the committee is free to focus on the specifics of groundwater management without being distracted by the many operational activities that the managing entity (such as a water district) must complete. Third, some parties could be negatively impacted by certain groundwater management decisions, and these actions and potential adverse impacts should be a part of the decision-making process to help reduce future conflicts. Finally, the advisory committee helps the managing entity gain the confidence of the local constituency by providing the opportunity for interested parties to participate in the management process.

Many managing entities have already elected to use advisory committees for implementation of their groundwater management plans. The composition of these committees varies widely. Some groups consist entirely of stakeholders, others add local or State government representatives or academic members as impartial third parties, and some have included consultants as technical advisers. Some plans use multiple advisory committees to manage unique subareas. Some plans appoint advisory committees with different objectives, such as one that deals with technical issues and another that deals with policy issues. There is no formula for the composition of an advisory committee because it should ultimately be based on local management needs and should include representation of diverse local interests.

The Tulare Lake Bed Coordinated Management Plan provides an example of the benefit of an advisory committee. The plan includes nine groups of participants, making coordination and communication a complicated issue. To allow for greater communication, an executive committee was established consisting of one voting member from each public agency participating in the plan and one voting member representing a combined group of private landowner plan participants. The committee administers groundwater management activities and programs for the plan (TLBWSD 2002).

Describe the Area to Be Managed under the Plan

The plan should include a description of the physical setting and characteristics of the aquifer system underlying the plan area in the context of the overall basin. The summary should also include a description of historical data, including data related to groundwater levels, groundwater quality, subsidence, and groundwater-surface water interaction; known issues of concern with respect to the above data; and a general discussion of historical and projected water demands and supplies. All of these data are critical to effective groundwater management because they demonstrate the current understanding of the system to be managed and serve as a point of departure for monitoring activities as part of plan implementation.

Create a Link Between Management Objectives and Goals and Actions of the Plan

The major goal of any groundwater management plan is to maintain a reliable supply of groundwater for long-term beneficial uses of groundwater in the area covered by the plan. The plan should clearly describe how each of the adopted management objectives helps attain that goal. Further, the plan should clearly describe how current and planned actions by the managing entity help meet the adopted management objectives. The plan will have a greater chance of success by developing an understanding of the relationship between each action, management objectives, and the goal of the groundwater management plan.

For example, prevention of contamination of groundwater from the land surface is a management objective that clearly supports the goal of groundwater sustainability. Management actions that could help support this objective include (1) educating the public through outreach programs that explain how activities at the surface ultimately impact groundwater, (2) developing wellhead protection programs or re-evaluating existing programs, (3) working with the local responsible agency to ensure that permitted wells are constructed, abandoned, and destroyed according to State well standards, (4) investigating whether local conditions necessitate higher standards than those adopted by the local permitting agency for the construction, abandonment, or destruction of wells, and (5) working with businesses engaged in practices that might impact groundwater to reduce the risks of contamination.

The concept of having a management objective is certainly not new. While many existing plans do not clearly include management objectives nor specifically identify actions to achieve objectives, some plans indirectly include these components. As an example, Eastern Municipal Water District's (EMWD) Groundwater Management Plan states that its goal includes maximizing "the use of groundwater for all beneficial uses in such a way as to lower the cost of water supply and to improve the reliability of the total

water supply for all users." To achieve this goal, EMWD has listed several issues to be addressed. One is the prevention of long-term depletion of groundwater. This can be defined as a management objective even though it is not labeled as such. Where this management objective is currently unmet in the North San Jacinto watershed portion of the plan area, EMWD has identified specific actions to achieve that objective including the reduction of groundwater extraction coupled with pursuing the construction of a pipeline to act as an alternative source of surface water for the impacted area (EMWD 2002).

Describe the Plan Monitoring Program

The groundwater management plan should include a map indicating the locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence, stream gaging, and other applicable monitoring. The groundwater management plan should summarize the type of monitoring (for example, groundwater level, groundwater quality, subsidence, streamflow, precipitation, evaporation, tidal influence), type of measurements, and the frequency of monitoring for each location. Site specific monitoring information should be included in each groundwater management plan. The plan should include the well depth, screened interval(s) and aquifer zone(s) monitored and the type of well (public, irrigation, domestic, industrial, monitoring). These components will serve as a tool for the local managing entity to assess the adequacy of the existing monitoring network in tracking the progress of plan activities.

The groundwater management plan developed for the Scotts Valley Water District (SVWD) provides a detailed description of the monitoring program in Santa Cruz County (Todd Engineers 1994) Table 6 is SVWD's monitoring table, which serves as an example of the level of detail that is useful in a plan (Todd Engineers 2003a). Figure 9 shows the locations and types of monitoring points for each monitoring site. The monitoring table specifies in detail the data available and the planned monitoring. These serve as useful tools for SVWD to visualize the types and distribution of data available for their groundwater management activities. In addition to the minimum types of monitoring, SVWD summarizes other types of data that are relevant to their groundwater management effort.

Describe Integrated Water Management Planning Efforts

Water law in California treats groundwater and surface water as two separate resources with the result that they have largely been managed separately. Such management does not represent hydrologic reality. Recently, managers of a number of resources are becoming increasingly aware of how their planning activities could impact or be impacted by the groundwater system. Because of this, the local managing entity should describe any current or planned actions to coordinate with other land use, zoning, or water management planning entities.

Integrated management is addressed in existing groundwater management plans in several ways, including conjunctively managing groundwater with surface water supplies, recharging water from municipal sewage treatment plants, and working with local planning agencies to provide comments when a project is proposed that could impact the groundwater system.

Examples of planning efforts that should be integrated with groundwater management may include watershed management, protection of recharge areas, agricultural water management, urban water management, flood management, drinking water source assessment and protection, public water system emergency and disaster response, general plans, urban development, agricultural land preservation, and environmental habitat protection or restoration. Another example that may appear insignificant is transportation infrastructure. However, local impacts on smaller aquifers could be significant when landscaping of medians and interchanges requires groundwater pumping for irrigation or when paved areas are constructed over highly permeable sediments that act as recharge zones for the underlying aquifer.

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Precipitation	El Pueblo Yard	15-minute recording	Feb-85	Daily/District, Monthly/City	Other historic gages:(1) Blair site on Granite Ck. Rd. (Jan. 1975 - Dec. 1980)
	WWTP	5-minute recording	1990	Daily/City	(2) Hacienda Dr. (Jul. 1974 - Mar. 1979) (3) El Pueblo Yard bucket gage (Jan. 1981 - Jan. 1985)
Evaporation	El Pueblo Yard	Pan	Jan-86	Daily/District	Evaporation pan raw data not compiled after July 1990
Evapotranspiration	De Laveaga Park, Santa Cruz	Automated active weather station	Sep-90	California Irrigation Management Information System/Monthly	Data available on-line through CIMIS
Streamflow	Carbonera Ck at Scotts Valley @ Cabonera Way Bridge (#111613000)	15-minute recording	Jan-85	USGS/ Daily	Other historic gages: (1) Carbonera Ck @ Santa Cruz (#11161400) 150 feet upstream from mouth (1974-1976 partial data)
	Bean Ck near Scotts Valley @ Hermon Crossing (#11160430)	15-minute recording	Dec-88	USGS/ Daily	(2) Bean Ck near Felton (#11160320) (1973-1978 partial data), low flows at same location (1983-1988)
	Eagle Creek In Henry Cowell Redwoods State Park	Bucket-Fall, Flow Meter-Spring	Mar-01	Semi-annually/ Todd Engineers	(3) Carbonera Creek @ Glen Canyon (1990-1994?)
Well Inventory	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36	Over 400 wells: location, log, type, capacity, etc. stored in GIS, and Access database	1950s	Logs from DWR maintained by Todd Engineers	
Groundwater Levels	~34 Santa Magarita aquifer and ~14 Lompico formation wells	Depth to water	1968	Quarterly/ District and cooperators	Data from over 75 wells, as early as 1968, bi-monthly 1983-1989
Pumpage	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36 District wells in production and on standby	Metered	1975	Monthly/ Scotts Valley Water District, Mt. Hermon Association, Hanson Aggregates West, San Lorenzo Valley Water District	Other historic pumpage data: Manana Woods (1988-1996 partial data)

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan (continued)

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Groundwater Quality	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14,23-26, 36 District wells in production	Title 22 constituents	1963	At least semi-annual/ District and others	Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program
	North Scotts Valley 3 shallow monitoring wells	Metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Surface Water Quality	4 sites on Carbonera and 3 sites on Bean Creek	Grab samples - metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Wastewater Outflows	City of Scotts Valley WWTP @ Lundy Lane	Wastewater outflow volume and effluent quality	1965	Daily/City of Scotts Valley	Plant operational in 1965 (septic systems pre-1965)
Recycled Water Production	Scotts Valley WWTP	Recycled water quantity and quality	2002	At least quarterly/ WWTP	

Source: Todd Engineering 2003a

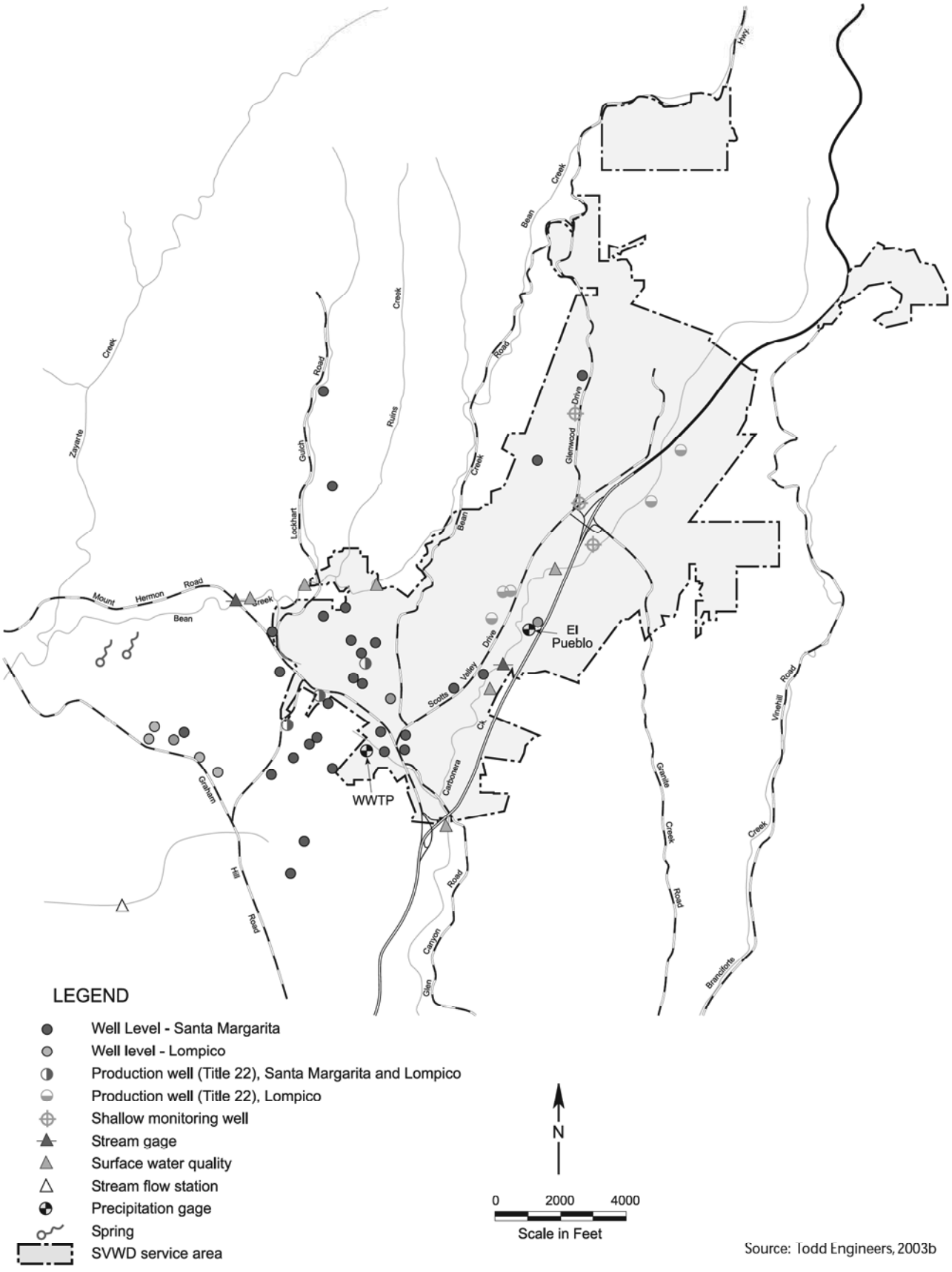


Figure 9 Scotts Valley Water District's Groundwater Management Plan monitoring locations

Box K What are Management Objectives?

Management objectives are the local managing entity's way of identifying the most important issues in meeting local resource needs; they can be seen as establishing a "value system" for the plan area. There is no fixed set of management objectives for any given plan area. Some of the more commonly recognized management objectives include the monitoring and managing of groundwater levels, groundwater quality, inelastic land subsidence, and changes in streamflow and surface water quality where they impact or are impacted by groundwater pumping. Management objectives may range from being entirely qualitative to strictly quantified.

Each management objective would have a locally determined threshold value associated with it, which can vary greatly. For example, in establishing a management objective for groundwater quality, one area may simply choose to establish an average value of total dissolved solids as the indicator of whether a management objective is met, while another agency may choose to have no constituents exceeding the maximum contaminant level for public drinking water standards. While there is great latitude in establishing management objectives, local managers should remember that the objectives should serve to support the goal of a sustainable supply for the beneficial use of the water in their particular area.

An example of an alternative management objective is Orange County Water District's (OCWD) objective of maintaining available storage space in its management area at 200,000 acre-feet. The objective does not require that groundwater elevations be fixed at any particular location, although managing to this objective would likely have the net benefit of stabilizing water levels. Groundwater storage is a dynamic value, so attempting to meet this management objective is an ongoing challenge. OCWD has implemented many management actions directly aimed at managing the basin to meet this objective.

The Deer Creek and Tule River Authority provides an excellent example of how groundwater management activities can be coordinated with other resources. The authority, in conjunction with the U.S. Bureau of Reclamation, has constructed more than 200 acres of recharge basins as part of its Deer Creek Recharge-Wildlife Enhancement Project. When available, the project takes surplus water during winter months and delivers it to the basins, which serve as winter habitat for migrating waterfowl, creating a significant environmental benefit. Most of the water also recharges into the underlying aquifer, thereby benefiting the local groundwater system.

Report on Implementation of the Plan

The managing entity should produce periodic reports—annually or at other frequencies determined by the local managing entity—summarizing groundwater basin conditions and groundwater management activities. For the period since the previous update, the reports should include:

- A summary of monitoring results, including historical trends,
- A summary of actual management actions,
- A summary, supported by monitoring results, of whether management actions are achieving progress in meeting management objectives,
- A summary of proposed management actions, and
- A summary of any plan component changes, including addition or modification of management objectives.

Unfortunately, many plans were prepared in the mid-1990s with little or no follow-up documentation of whether the plan is actually being implemented. This makes it difficult to determine what progress has been achieved in managing the groundwater resource. Periodic reports will serve as a tool for the managing entity to organize its many activities to implement the plan, act as a driving force for plan implementation, and help interested parties understand the progress made by local entities in managing their groundwater resource.

Progress reports on SVWD (Todd Engineers 2002) and EMWD (2002) groundwater management plans serve as excellent examples of the value of such an exercise. Both reports effectively portray the results of management actions: progress toward achieving objectives and specific recommendations for future management actions. An example of reporting on the modification of a management objective for water quality can be found in EMWD's 2000 Annual Report (EMWD 2001). A task force of more than 20 water suppliers and wastewater agencies, including EMWD, worked to update the Regional Water Quality Control Board's Region 5 Basin Plan objectives for nitrogen and total dissolved solids in water, effectively changing EMWD's management objectives for those constituents.

Evaluate the Plan Periodically

The managing entity and advisory committee should re-evaluate the entire plan. Periodic evaluation of the entire management plan is essential to define successes and failures under the plan and identify changes that may be needed. Additionally, re-evaluation of the plan should include assessment of changing conditions in the basin that may warrant modification of the plan or management objectives. Adjustment of components in the plan should occur on an ongoing basis if necessary. The re-evaluation of the plan should focus on determining whether the actions under the plan are meeting the management objectives and whether the management objectives are meeting the goal of sustaining the resource.

While there are several examples of existing groundwater management plans that demonstrate ongoing changes to plan activities, there are no known examples of such an approach to entirely re-evaluate an existing plan. This is likely due in part to the occurrence of several consecutive wet years in the mid- and late-1990s. The abundant surface water supplies reduced the need to actively manage groundwater supplies in many cases. More recent dry conditions and the recent passage of SB 1938 will create an excellent opportunity for managing entities to begin a re-evaluation of existing plans.

Model Groundwater Management Ordinance

As discussed in the previous chapter, ordinances are groundwater management mechanisms enacted by local governments through exercise of their police powers to protect the health and safety of their citizens. In Baldwin v. Tehama County (1994), the appellate court declared that State law does not preempt the field of groundwater management.

In the mid- to late-1990s, many counties adopted ordinances that effectively prevented export of groundwater from the county, even though none specifically prohibited export. The intent of each of these ordinances is to sustain groundwater as a viable local resource. To ensure that goal, an export project proponent is required by most of the ordinances to show that the proposed project will not cause depletion of the groundwater, degradation of groundwater quality, or subsidence before a permit to export groundwater can be issued. Although these ordinances do not specifically require threshold limits for each of these potential negative impacts, a project proponent can really only show that these negative effects will not occur if the proponent develops a groundwater management plan.

Many of these ordinances were developed in response to the plans of some agencies or landowners to export groundwater or develop a groundwater substitution project where surface water is exported and groundwater is substituted for local use. In some cases, short-term export actually took place, leading to a number of claims of negative third party impacts. Residents of some counties became concerned because no one knew how much groundwater was available for local use and how much groundwater was available for export. In short, details of the hydrology of the basin, including surface water and groundwater availability, water quality, and the interaction of surface water and groundwater were not known. This lack of detailed knowledge about the operating potential of their groundwater resources led counties to take what they viewed as protective action, which consisted of requiring a permit before anyone could export groundwater from the county.

From the perspective of DWR, groundwater should be managed in a manner that ensures long-term sustainability of the resource for beneficial uses. Those beneficial uses are to be decided by the local stakeholders within the basin. In some areas, there may be an ample supply of water, so groundwater exports or substitution projects are feasible while local beneficial uses of the water supply are maintained. In other areas, limiting exports may be necessary to maintain local beneficial uses. Such determinations can be made only after the data are collected and evaluated and the results are used to develop management objectives for the basin.

While developing both the criteria for evaluating groundwater management plans and the model groundwater management ordinance, DWR staff has borne two principles in mind. First, the goal of groundwater management, whether accomplished by a plan or by an ordinance, is to sustain and often expand a groundwater resource. Second, groundwater management, whether accomplished by a plan or by an ordinance, requires that local agencies address and resolve the same or similar issues within the boundaries of the agencies. To say it in different words, whether it is a plan or an ordinance, good groundwater management should address the same issues and problems and arrive at the same conclusions and solutions to satisfy the needs of the local area. While some areas may allow or promote exports, others may not.

As stated above, the Legislature required a model ordinance as one of the elements of this update of Bulletin 118. The model ordinance is included as Appendix D and can be used by local governments that have identified a need to adopt a groundwater management ordinance. The model is an example of what a local ordinance might include. Local conditions will require some additions, modifications, or deletions. The variety of political, institutional, legal, technical, and economic opportunities and constraints throughout California guarantees that there will be differences to which the model will have to be adapted. Local governments interested in adopting a groundwater management ordinance are encouraged to consider all components included in the model.

Water Code section 10753.7(b)(1)(A) allows an agency to participate in or consent to be subject to a groundwater management plan, a basin-wide management plan, or other integrated regional water management plan in order to meet the funding eligibility requirements that resulted from passage of SB 1938 (2001). A local government that adopts an ordinance should consider whether or not it will have local agencies that do not have their own groundwater management plan, but consent to be managed under the ordinance. If this situation is anticipated, the ordinance should include the required components described in the Water Code so State funding can be pursued.

Chapter 4

Recent Actions Related to Groundwater Management

Chapter 4
Recent Actions Related to Groundwater Management

The past few years have seen significant actions that impact groundwater management in California. Below are several examples of recent actions including legislation, ballot measures, and executive orders that show the State Legislature and the citizens of California clearly recognize the importance of groundwater and its appropriate management in meeting the present and future water supply needs of the State.

Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)

On March 7, 2000, California voters approved a $1.97-billion general obligation bond known as the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13). Of the nearly $2 billion, $230 million was earmarked for groundwater programs. The act authorizes $200 million for grants for feasibility studies, project design, and construction of conjunctive use facilities (Water Code, § 79170 et seq.) and $30 million in loans for local agency acquisition and construction of groundwater recharge facilities and feasibility study grants for projects potentially eligible for the loan program (Water Code, § 79161 et seq.). More than $120 million have been awarded in grants and loans to local agencies in the first two years of implementation of these programs.

California Bay-Delta Record of Decision

The goal of the California Bay-Delta (formerly CALFED) program is to restore ecosystem health and improve water management in the Bay-Delta system. The program has four primary objectives:

- Provide good water quality for all beneficial uses
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species
- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system
- Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees

The Record of Decision (ROD), released in August 2000, sets forth a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta system. The ROD lays out specific actions and investments over the first seven years to meet program goals. Most important, with respect to groundwater is the California Bay-Delta program's commitment to local groundwater management. The ROD states, "CALFED will work with local governments and affected stakeholders to develop legislation to strengthen AB 3030 and provide technical and financial incentives to encourage more effective basin-wide groundwater management plans…" (CALFED 2000). The ROD encourages basin management that is developed at the subbasin level so that it addresses local needs, but is coordinated at the basin-wide level so that it considers impacts to other users in the basin. The ROD also commits Bay-Delta agencies to "facilitate and fund locally supported, managed, and controlled groundwater and conjunctive use projects with a total of 500,000 acre-feet to 1 million acre-feet (maf) of additional storage capacity by 2007" (CALFED 2000).

Local Groundwater Management Assistance Act of 2000 (AB 303, Water Code Section 10795 et seq.)

The goal of the Local Groundwater Management Assistance Act is to help local agencies better understand how to manage groundwater resources effectively to ensure the safe production, quality, and proper storage of groundwater in the State. The act created the Local Groundwater Assistance Fund, which must be appropriated annually. In three years, more than $15 million in grants were awarded for 71 projects. Grants went to local agencies for groundwater studies and projects that contribute to basin and subbasin management objectives, including but not limited to groundwater monitoring and groundwater basin management. Grants are available to all geographic areas of the State. This act serves to emphasize that groundwater is recognized as an important local resource and, to the extent that groundwater is properly managed at the local level, serves to benefit all Californians.

Groundwater Quality Monitoring Act of 2001 (AB 599, Water Code Section 10780 et seq.)

Assembly Bill 599, known as the Groundwater Quality Monitoring Act of 2001, set a goal to establish comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public. The objective of the program is to highlight those basins in which contamination has occurred or is likely to occur and provide information that will allow local managers to develop programs to curtail, treat, or avoid additional contamination. The act required the State Water Resources Control Board (SWRCB), in coordination with an Interagency Task Force (ITF) and a Public Advisory Committee (PAC), to integrate existing monitoring programs and design new program elements, as necessary, to establish a comprehensive statewide groundwater quality monitoring program.

Through the ITF and PAC, the Comprehensive Groundwater Quality Monitoring Program was developed. The program will seek to:

- Accelerate the monitoring and assessment program already established by the SWRCB,
- Implement monitoring and assessment in accordance with a prioritization of basins/subbasins,
- Increase coordination and data sharing among groundwater agencies, and
- Maintain groundwater data in a single repository to provide useful access by the public while maintaining appropriate security measures.

The Comprehensive Groundwater Quality Monitoring Program is expected to provide the following key benefits:

- A common base communications medium for agencies to utilize and supply groundwater quality data at multiple levels,
- A mechanism to unite local, regional and statewide groundwater programs in a common effort,
- Better understanding of local, regional and statewide water quality issues and concerns that in turn can provide agencies at all levels with better information to deal with the concerns of consumers and consumer advocate groups,
- Groundwater agencies with trend and long-term forecasting information, essential for groundwater management plan preparation and implementation, and
- The motivation for small- and medium-sized agencies to begin or improve their own groundwater monitoring and management programs.

Water Supply Planning

Three bills enacted by the Legislature to improve water supply planning processes at the local level became effective January 1, 2002. In general, the new laws are intended to improve the assessment of water supplies during the local planning process before land use projects that depend on water are approved. The new laws require the verification of sufficient water supplies as a condition for approving developments, and they compel urban water suppliers to provide more information on the reliability of groundwater if used as a supply.

SB 221 (Bus. and Prof. Code, § 11010 as amended; Gov. Code, § 65867.5 as amended; Gov. Code, §§ 66455.3 and 66473.7) prohibits approval of subdivisions consisting of more than 500 dwelling units unless there is verification of sufficient water supplies for the project from the applicable water supplier(s). This requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 service connections. The law defines criteria for determining "sufficient water supply," such as using normal, single-dry, and multiple-dry year hydrology and identifying the amount of water that the supplier can reasonably rely on to meet existing and future planned uses. Rights to extract additional groundwater must be substantiated if used for the project.

SB 610 (Water Code, §§ 10631, 10656, 10910, 10911, 10912, and 10915 as amended; Pub. Resources Code, § 21151.9 as amended) and AB 901 (Water Code, §§ 10610.2 and 10631 as amended; Water Code § 10634) make changes to the Urban Water Management Planning Act to require additional information in Urban Water Management Plans (UWMP) if groundwater is identified as a source available to the supplier. Required information includes a copy of any groundwater management plan adopted by the supplier, proof that the developer or agency has rights to the groundwater, a copy of the adjudication order or decree for adjudicated basins, and if not adjudicated, whether the basin has been identified as being overdrafted or projected to be overdrafted in the most current DWR publication on the basin. If the basin is in overdraft, the UWMP must include current efforts to eliminate any long-term overdraft. A key provision in SB 610 requires that any project subject to the California Environmental Quality Act supplied with water from a public water system be provided a water supply assessment, except as specified in the law. AB 901 requires the plan to include information relating to the quality of existing sources of water available to an urban water supplier over given periods and include the manner in which water quality affects water management strategies and supply reliability.

Emergency Assistance to the Klamath Basin

On May 4, 2001, the Governor proclaimed a State of Emergency in the Klamath Basin in Siskiyou and Modoc counties. The proclamation included disaster assistance of up to $5 million under authority of the State Natural Disaster Assistance Act. This assistance went directly into constructing wells to extract groundwater for use on cover crops to avoid loss of critical topsoil. The Governor's proclamation also included $1 million for a study of the Klamath River Basin to determine the long-term water supply in the California portion of the basin.

Governor's Drought Panel

The Governor's Advisory Drought Planning Panel was formed in 2000 to develop a contingency plan to address the impacts of critical water shortages in California. The panel formed with the recognition that critical water shortages may severely impact the health, welfare, and economy of California. Panel recommendations included securing funding for the Local Groundwater Management Assistance Act (described above), continued support of critical groundwater monitoring in basins with inadequate data, and the formation of a technical assistance and education program for "rural homeowners and small domestic water systems relying on self-supplied groundwater" (GADPP 2000).

Sacramento Valley Water Management Agreement

On May 22, 1995, SWRCB adopted the "Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary" (the 1995 WQCP). Following this action, SWRCB initiated a water rights hearing process with the intent of allocating responsibility for meeting the standards of the 1995 WQCP among water right holders in areas tributary to the Delta. The water rights hearing was conducted in phases with all phases being resolved with the exception of Phase 8, which involved water rights holders in the Sacramento Valley.

Proceeding with Phase 8 may have involved litigation and judicial review for years. That extended process could have resulted in adverse impacts to the environment and undermined progress on other statewide water management initiatives. To avoid the consequences of delay, the Sacramento Valley Water Users, DWR, the U.S. Bureau of Reclamation (USBR), and export water users developed the Sacramento Valley Water Management Agreement. The agreement became effective April 20, 2001. At that time SWRCB issued an order staying the Phase 8 hearing for 18 months. The parties negotiated a short-term settlement agreement that obligated DWR and USBR to continue to fully meet the Bay-Delta water quality standards while providing for the development of conjunctive use and system improvement projects by participating upstream water rights holders that would make water available to help meet water quality standards while improving the reliability of local water supplies. SWRCB has subsequently dismissed the Phase 8 proceedings, and work is being undertaken on both short-term and long-term activities included in the Sacramento Valley Water Management Agreement.

Groundwater Management Water Code Amendments

In September 2002, SB 1938 (Water Code, § 10753.4 and § 10795.4 as amended; Water Code, § 10753.7, § 10753.8 and § 10753.9 as amended and renumbered; Water Code, § 10753.1 and § 10753.7 as added) was signed into law. The act amends existing law related to groundwater management by local agencies. The law requires any public agency seeking State funds administered through DWR for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan with certain specified components. Prior to this, there were no required plan components. New requirements include establishing basin management objectives, preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management. The requirements apply to agencies that have already adopted groundwater management plans as well as agencies that do not overlie groundwater basins identified in Bulletin 118 and its updates when these agencies apply for state funds. The requirements do not apply to funds administered through the AB 303-Local Groundwater Management Assistance Act (Water Code, § 10795 et seq.) or to funds authorized or appropriated prior to September 1, 2002. Further discussion of the requirements is included in Chapter 3 and Appendix C.

Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)

California voters approved the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50; Water Code, § 79500 et seq.) in the November 2002 elections. The initiative provides for more than $3.4 billion of funding, subject to appropriation by the Legislature, for a number of land protection and water management activities.

Several chapters of Proposition 50 allocate funds for specified water supply and water quality projects, including:

- Chapter 3 Water Security. Provides $50 million to protect State, local, and regional drinking water systems from terrorist attack or deliberate acts of destruction or degradation.

- Chapter 4 Safe Drinking Water. Provides $435 million for grants and loans for infrastructure improvements to meet safe drinking water standards.
- Chapter 5 Clean Water and Water Quality. Provides $390 million for a number of water quality and environmental improvements.
- Chapter 6 Contaminant and Salt Removal Technologies. Provides $100 million for desalination of ocean or brackish waters as well as treatment and removal of contaminants.
- Chapter 7 California Bay-Delta program. Provides $825 million for continuing implementation of all elements of the program.
- Chapter 8 Integrated Regional Water Management. Provides $500 million for many categories of water management projects that will protect communities from drought, protect and improve water quality, and reduce dependence on imported water supplies.
- Chapter 9 Colorado River. Provides $70 million for canal-lining projects necessary to reduce water use and to meet commitments related to California's allocation of water from the Colorado River.

Chapter 5

The Roles of State and Federal Agencies in California Groundwater Management

Chapter 5
The Roles of State and Federal Agencies in California Groundwater Management

Even though groundwater management is a local responsibility and mostly voluntary, several State and federal agencies have key roles in California groundwater management. Some of these roles may not be immediately recognized, but because they work toward the goal of maintaining a reliable groundwater supply, they are closely related to groundwater management. Some of the programs available through the California Department of Water Resources (DWR) and other agencies that assist local agencies in managing groundwater resources are described below.

Local Groundwater Management Assistance from DWR

DWR's role in groundwater management begins with the fundamental understanding that groundwater management is locally driven and management programs should respond to local needs and concerns. DWR recognizes that when groundwater is effectively managed at the local level, benefits are realized at a statewide level.

DWR has historically maintained many programs that directly benefit local groundwater management efforts including:

- Providing assistance to local agencies to assess basin hydrogeologic characteristics,
- Assisting local agencies to identify opportunities to develop additional groundwater supply,
- Monitoring groundwater levels and quality,
- Providing watermaster services for court-adjudicated basins,
- Providing standards for well construction and destruction,
- Managing the State's extensive collection of well completion reports, and
- Reviewing proposals and distributing grant funds and low-interest loans for conjunctive use projects, as well as local groundwater management and monitoring programs.

Conjunctive Water Management Program

DWR's Conjunctive Water Management Program consists of a number of integrated efforts to assist local agencies in improving groundwater management and increasing water supply reliability.

One goal of the Integrated Storage Investigations (ISI) Program, an element of the Bay-Delta program, is to increase water supply reliability statewide through the planned, coordinated management and use of groundwater and surface water resources. The effort emphasizes forming working partnerships with local agencies and stakeholders to share technical data and costs for planning and developing locally controlled and managed conjunctive water management projects.

Toward that end, the Conjunctive Water Management Program has:

- Developed a vision in which DWR would assist local agencies throughout the State so that these agencies can effectively manage groundwater resources,
- Adopted a set of working principles to ensure local planning; local control, operation, and management of conjunctive use projects; voluntary implementation of projects; and local benefits from the proposed projects,
- Executed memoranda of understanding with 30 local agency partners and provided technical and financial assistance to study groundwater basins and assess opportunities for conjunctive water management,

- Provided technical assistance in the form of groundwater monitoring, groundwater modeling, and local water management planning, as well as a review of numerous regional and statewide planning efforts on a variety of water issues, and
- Provided facilitation assistance to promote broad stakeholder involvement in regional water management planning processes.

DWR staff review proposals and distribute grants pursuant to the Local Groundwater Management Assistance Act of 2000 (AB 303). To date, DWR has awarded more than $15 million to local agencies to fund 71 projects dealing with groundwater investigation, monitoring, or management.

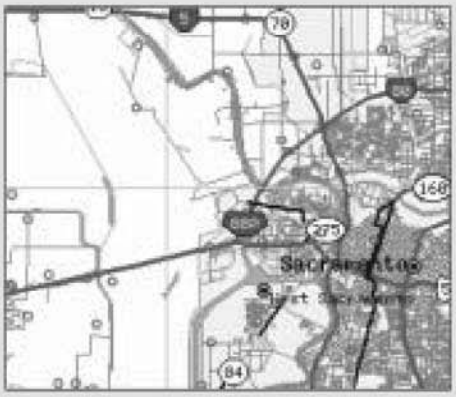
With funds provided under Proposition 13, DWR has awarded more than $170 million in loans and grants for groundwater recharge and storage studies and projects to local agencies throughout the State. Applicant estimates of the water supply reliability increases that will be realized from these projects exceeds 150 thousand acre-feet annually. Recipients of loans and grants must provide progress reports to allow an evaluation of the successes of the various programs. Figure 10 shows the distribution of loan and grant awardees throughout the State.

Both grant programs have active outreach efforts to inform and to assist agencies in preparation of applications. Selection of projects for funding relies in part on input from advisory committees composed of stakeholders from throughout the State.

Box L Providing Data:

The Internet Makes Groundwater Elevation Data Readily Accessible to the Public

In 1996, the California Department of Water Resources (DWR) began providing Internet access to groundwater level data and hydrographs for wells in groundwater basins throughout California. The website, which distributes historical data for more than 35,000 wells monitored by DWR and its many cooperators, has proven very popular, with more than 60,000 visits to date. Options include a form or map interface to locate wells with water level data and the ability to download long-term water levels for specific wells or seasonal measurements for specific areas to create groundwater contour maps. The accessibility of this data makes it a significant resource for local agencies in making sound groundwater management decisions. The address of the site is http://wdl.water.ca.gov/.



Wells can be located with a map interface. By clicking on a well, a hydrograph with the latest data available is automatically generated.

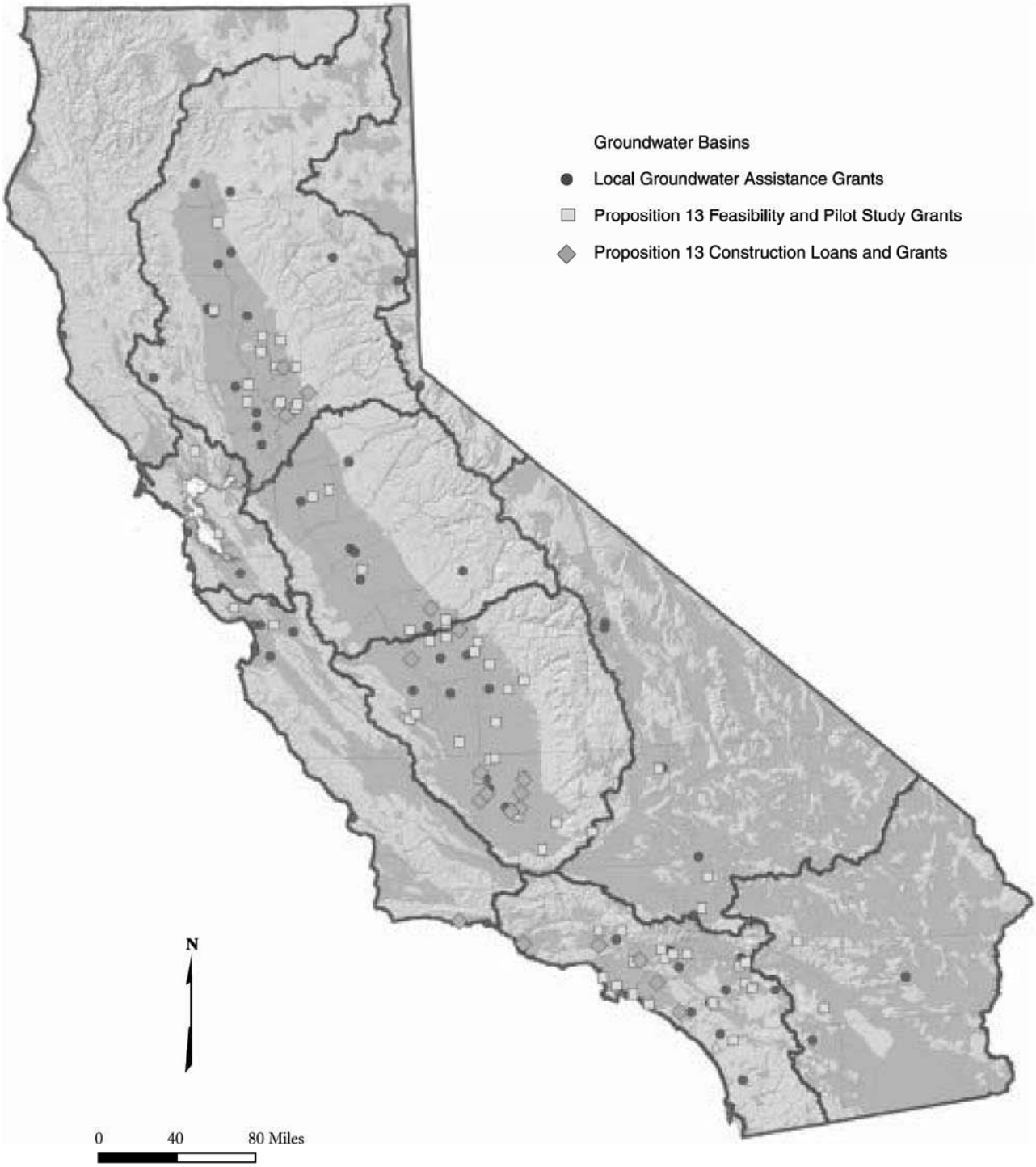


Figure 10 Broad distribution of grant and loan awardees for 2001 through 2003

Assistance from Other State and Federal Agencies

Many other State and federal agencies provide groundwater management assistance to local agencies. Some of those roles are described below. For more information on the roles of various agencies in protecting the groundwater resource, see the California Department of Health Services' Drinking Water Source Assessment and Protection Program Document (DHS 2000), California Groundwater Management (Bachman and others 1997), or the individual agency websites.

State Water Resources Control Board and Regional Water Quality Control Boards

http://www.swrcb.ca.gov The mission of the State Water Resources Control Board (SWRCB) is to ensure the highest reasonable quality of waters of the State, while allocating those waters to achieve the optimum balance of beneficial uses. In turn, the nine Regional Water Quality Control Boards (RWQCB) develop and enforce water quality objectives and implement plans to protect the beneficial uses of the State's waters, recognizing differences in climate, topography, geology, and hydrology.

SWRCB has many responsibilities regarding the protection of the groundwater resource. One of the more notable is the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA is a recently enacted program that will provide a comprehensive assessment of water quality in water wells throughout the state. GAMA has two main components: the California Aquifer Susceptibility (CAS) Assessment and the Voluntary Domestic Well Assessment Project.

The CAS combines age dating of water and sampling for low-level volatile organic compounds (VOCs), such as methyl tertiary-butyl ether (MTBE), to assess the relative susceptibility of all of approximately 16,000 public supply wells throughout the State. Age dating provides a general assessment of how quickly groundwater is moving through the system, while the sampling of low-level VOCs allows greater reaction time for potential remediation strategies before contaminants reach action levels. Sampling is being conducted by staff from the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The CAS Assessment was developed cooperatively with DHS and DWR.

The Voluntary Domestic Well Assessment Project will provide a previously unavailable sampling of water quality in domestic wells, which will assist in assessing the relative susceptibility of California's groundwater. Because water quality in individual domestic wells is unregulated, the program is voluntary and will focus, as resources permit, on specific areas of the state. Constituents to be analyzed include nitrate, total and fecal coliform bacteria, MTBE, and minerals. Additional constituents will be added in areas with known water quality problems.

Other SWRCB/RWQCB activities related to groundwater protection include developing basin plans that identify existing and potential beneficial uses of marine water, groundwater, and surface waters; regulating the discharge of waste that may affect water quality in California; monitoring of landfills and hazardous waste facilities; establishing standards for the construction and monitoring of underground storage tanks; establishing management plans for control of nonpoint source pollutants; and issuing cleanup and abatement orders that require corrective actions by the responsible party for a surface water or groundwater pollution problem or nuisance.

The Groundwater Quality Monitoring Act of 2001 (AB599, Water Code, § 10780 et seq.) required the SWRCB to develop a comprehensive monitoring program in a report to the Legislature. See Chapter 4 for details.

California Department of Health Services

http://www.dhs.ca.gov/ps/ddwem The DHS Drinking Water Program, part of the Division of Drinking Water and Environmental Management, is responsible for DHS implementation of the federal Safe Drinking Water Act, as well as California statutes and regulations related to drinking water. As part of this responsibility, DHS inspects and provides regulatory oversight of approximately 8,500 public water systems (and approximately 16,000 drinking water wells) to assure delivery of safe drinking water to all California consumers.

Public water system operators are required to regularly monitor their drinking water sources for microbiological, chemical and radiological contaminants to show that drinking water supplies meet regulatory requirements (called primary maximum contaminant levels–MCLs). Among these contaminants are approximately 80 specific inorganic and organic chemical contaminants and six radiological contaminants that reflect the natural environment as well as human activities.

Public water system operators also monitor their water for a number of other contaminants and characteristics that deal with the aesthetic properties of drinking water (known as secondary MCLs). They are also required by regulation to analyze for certain unregulated contaminants (to allow DHS to collect information on emerging contaminants, for example), and to report findings of other contaminants that may be detected during routine monitoring. The DHS water quality monitoring database contains the results of analyses since 1984. These data, collected for purposes of regulatory compliance with drinking water laws, also provide an extensive body of information on the quality of groundwater throughout the State.

California Department of Pesticide Regulation

http://www.cdpr.ca.gov/dprprograms.htm The California Department of Pesticide Regulation (DPR) protects human health and the environment by regulating pesticide sales and use and by promoting reduced-risk pest management. DPR plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the groundwater resource.

DPR conducts six types of groundwater monitoring:

1) Monitoring for pesticides on a DPR-determined Ground Water Protection List, which lists pesticides with the potential to pollute groundwater;
2) Four-section survey monitoring to verify a reported detection and to help determine if a detected pesticide resulted from legal agricultural use;
3) Areal extent monitoring to identify the extent of contaminated wells;
4) Adjacent section monitoring to identify additional areas sensitive to pesticide movement to groundwater;
5) Monitoring to repeatedly sample a network of wells to determine whether pesticide residues are declining; and
6) Special project monitoring.

When pesticides are found in groundwater, they are normally regulated in one-square mile areas identified in regulation as sensitive to groundwater pollution. These pesticides are subject to permitting by the county agricultural commissioner and to use restrictions specified in regulation. DPR maintains an extensive database of pesticide sampling in groundwater and reports a summary of annual sampling and detections to the State Legislature.

California Department of Toxic Substances Control

http://www.dtsc.ca.gov The California Department of Toxic Substances Control (DTSC) has two programs related to groundwater resources protection: the Hazardous Waste Management Program and the Site Mitigation Program. These programs are authorized under Division 20 of the California Health and Safety Code, and implementing regulations are codified in Title 22 of the California Code of Regulations.

A critical element of both programs is maintaining environmental quality and economic vitality through the protection of groundwater resources. This is accomplished through hazardous waste facility permitting and design; oversight of hazardous waste handling, removal, and disposal; oversight of remediation of hazardous substances releases; funding of emergency removal actions involving hazardous substances, including the cleanup of illegal drug labs; cleanup of abandoned hazardous waste sites; oversight of the closure of military bases; and pollution prevention.

If groundwater is threatened or impacted by a hazardous substance release, DTSC provides technical oversight for the characterization and remediation of soil and groundwater contamination. DTSC and the nine RWQCBs coordinate regulatory oversight of groundwater remediation. To ensure site-specific groundwater quality objectives are met, DTSC consults with RWQCB staff and appropriate groundwater basin plans.

Box M Improving Coordination of Groundwater Information

California's groundwater resources are addressed by an array of different State and federal agencies. Each agency approaches groundwater from a unique perspective, based on its individual statutory mandate. As a result, each agency collects different types of groundwater data and information. To facilitate the effective and efficient exchange of groundwater resource information, the State Water Resources Control Board (SWRCB) is coordinating the Groundwater Resources Information Sharing Team (GRIST), which is composed of representatives from various groundwater agencies. Agencies currently participating in GRIST are:

- State Water Resources Control Board
- Department of Health Services
- Department of Water Resources
- Department of Pesticide Regulation
- Lawrence Livermore National Laboratory
- U.S. Geological Survey

One of the tasks of the GRIST is to identify data relevant to California groundwater resources. A listing of the data, along with the appropriate agency contacts and Internet links, will be maintained by SWRCB on the Groundwater Resources Information Database. In addition, to facilitate effective information sharing and communication among stakeholders, groundwater data will be made available on the SWRCB GeoTracker system. GeoTracker is a geographic information system that provides Internet access to environmental data. The centralization of environmental data through GeoTracker will enable more in-depth geospatial and statistical analyses of groundwater data in the future. For more information about GeoTracker, visit the GeoTracker Internet site at http://geotracker.arsenautlegg.com.

California Bay-Delta Authority

http://calwater.ca.gov The California Bay-Delta program was initiated in 1994 to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Sacramento-San Joaquin Bay-Delta System. The partnership currently consists of more than 20 State and federal agencies. An important element of the program is to increase storage by developing an additional 500,000 acre-feet to 1.0 million acre-feet of groundwater storage capacity by the year 2007 (CALFED 2000).

Effective January 1, 2003, a newly formed State agency assumed responsibility for overseeing implementation of the Bay-Delta program. The California Bay-Delta Authority provides a permanent governance structure for the collaborative state-federal effort. The authority was established by enactment of Senate Bill 1653 in 2002. The legislation calls for the authority to sunset on January 1, 2006, unless federal legislation has been enacted authorizing the participation of appropriate federal agencies in the authority.

U.S. Environmental Protection Agency

http://www.epa.gov/safewater The U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water, together with states, tribes, and many partners, protects public health by ensuring safe drinking water and protecting groundwater. The EPA's role in California groundwater is primarily related to protection of the resource and comes in the form of administering several federal programs in close coordination with State agencies such as SWRCB, DHS, and DTSC.

U.S. Geological Survey

http://ca.water.usgs.gov USGS has published results of many studies of California groundwater basins. USGS maintains an extensive groundwater level and groundwater quality monitoring network and has compiled this data in a database. The California District is working on cooperative programs with local, State, and other federal agencies. The most notable programs include three regional studies of the San Joaquin-Tulare Basin, the Sacramento River Basin, and the Santa Ana River basin under the National Water Quality Assessment Program. Results were published for the San Joaquin-Tulare Basin in 1995 and the Sacramento River Basin in 2000. The Santa Ana River basin study is in progress.

U.S. Bureau of Reclamation

http://www.usbr.gov The U.S. Bureau of Reclamation (USBR) operates the Central Valley Project (CVP), an extensive network of dams, canals, and related facilities that delivers about 7 maf during normal years for agricultural, urban, and wildlife use. USBR's role with respect to groundwater is generally limited to monitoring for impacts to the groundwater systems adjacent to its CVP facilities. Through the cooperative efforts of USBR, DWR, irrigation districts, farmers, and other local entities, groundwater level data have been collected continuously since project conception in the 1930s and 1940s.

In addition to CVP monitoring, USBR monitors groundwater levels to identify potential impacts as a result of two other projects in California. That monitoring includes the Santa Ynez basin as part of the Cachuma Project on the central coast, and the Putah Creek Cone as part of the Solano Project in the southwest Sacramento Valley. Both monitoring efforts are required as part of permitting for the projects.

USBR is planning to implement a groundwater information system to collect and distribute to the public the large volume of historical groundwater level data associated with its projects.

Chapter 6
Basic Groundwater Concepts

Chapter 6
Basic Groundwater Concepts

This chapter presents general concepts relating to the origin, occurrence, movement, quantity, and quality of groundwater. The concepts will be useful in providing the nontechnical reader with a basic understanding of groundwater. For more experienced readers, many topics are discussed specifically as they apply to California or as the terms are used in this report. A glossary of terms is included at the end of this report. For additional reading on basic groundwater concepts see *Basic Ground-Water Hydrology* (Heath 1983).

Origin of Groundwater

Groundwater is a component of the hydrologic cycle (Figure 11), which describes locations where water may occur and the processes by which it moves or is transformed to a different phase. In simple terms, water or one of its forms—water vapor and ice—can be found at the earth's surface, in the atmosphere, or beneath the earth's surface. The hydrologic cycle is a continuum, with no beginning or end; however, it is often thought of as beginning in the oceans. Water evaporates from a surface water source such as an ocean, lake, or through transpiration from plants. The water vapor may move over the land and condense to form clouds, allowing the water to return to the earth's surface as precipitation (rain or snow). Some of the snow will end up in polar ice caps or in glaciers. Most of the rain and snowmelt will either become overland flow in channels or will infiltrate into the subsurface. Some of the infiltrated water will be transpired by plants and returned to the atmosphere, while some will cling to particles surrounding the pore spaces in the subsurface, remaining in the vadose (unsaturated) zone. The rest of the infiltrated water will move gradually under the influence of gravity into the saturated zone of the subsurface, becoming groundwater. From here, groundwater will flow toward points of discharge such as rivers, lakes, or the ocean to begin the cycle anew. This flow from recharge areas to discharge areas describes the groundwater portion of the hydrologic cycle.

The importance of groundwater in the hydrologic cycle is illustrated by considering the distribution of the world's water supply. More than 97 percent of all earth's water occurs as saline water in the oceans (Fetter 1988). Of the world's fresh water, almost 75 percent is in polar ice caps and glaciers, which leaves a very small amount of fresh water readily available for use. Groundwater accounts for nearly all of the remaining fresh water (Alley and others 1999). All of the fresh water stored in the world's rivers and lakes accounts for less than 1 percent of the world's fresh water.

Occurrence of Groundwater

Groundwater is the water occurring beneath the earth's surface that completely fills (saturates) the void space of rocks or sediment. Given that all rock has some open space (voids), groundwater can be found underlying nearly any location in the State. Several key properties help determine whether the subsurface environment will provide a significant, usable groundwater resource. Most of California's groundwater occurs in material deposited by streams, called alluvium. Alluvium consists of coarse deposits, such as sand and gravel, and finer-grained deposits such as clay and silt. The coarse and fine materials are usually coalesced in thin lenses and beds in an alluvial environment. In this environment, coarse materials such as sand and gravel deposits usually provide the best source of water and are termed aquifers; whereas, the finer-grained clay and silt deposits are relatively poor sources of water and are referred to as aquitards. California's groundwater basins usually include one or a series of alluvial aquifers with intermingled aquitards. Less frequently, groundwater basins include aquifers composed of unconsolidated marine sediments that have been flushed by fresh water. We include the marine-deposited aquifers in the discussion of alluvial aquifers in this bulletin.

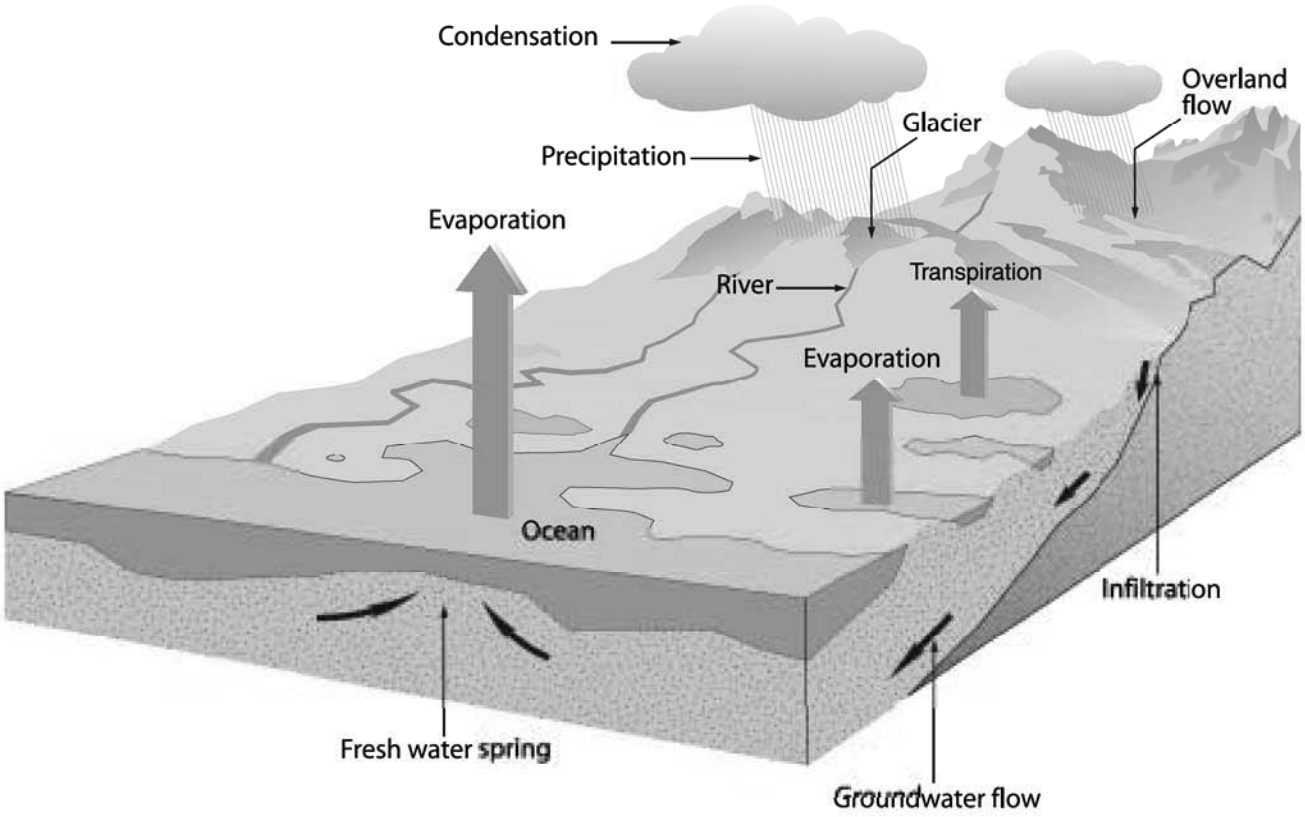


Figure 11 The Hydrologic Cycle

Although alluvial aquifers are most common in California, other groundwater development occurs in fractured crystalline rocks, fractured volcanics, and limestones. For this report, these nonalluvial areas that provide groundwater are referred to as "groundwater source areas," while the alluvial aquifers are called groundwater basins. Each of these concepts is discussed more fully below.

Groundwater and Surface Water Interconnection

Groundwater and surface water bodies are connected physically in the hydrologic cycle. For example, at some locations or at certain times of the year, water will infiltrate the bed of a stream to recharge groundwater. At other times or places, groundwater may discharge, contributing to the base flow of a stream. Changes in either the surface water or groundwater system will affect the other, so effective management requires consideration of both resources. Although this physical interconnection is well understood in general terms, details of the physical and chemical relationships are the topic of considerable research.

These details are the subject of significant recent investigations into the hyporheic zone, the zone of sand and gravel that forms the channel of a stream. As surface water flows downstream it may enter the gravels in the

Box N One Resource, Two Systems of Law

In California, two distinct legal regimes govern the appropriation of surface water and subterranean streams, and percolating groundwater. The California Water Code requires that water users taking water for beneficial use from surface watercourses and "subterranean streams flowing through known and definite channels" obtain water right permits or licenses from the State Water Resources Control Board (SWRCB) (Water Code § 1200 et seq.). Groundwater classified as percolating groundwater is not subject to the Water Code provisions concerning the appropriation of water, and a water user can take percolating groundwater without having a State-issued water right permit or license. Current Water Code section 1200 is derived from a provision in the Water Commission Act of 1913, which became effective on December 19, 1914.

The SWRCB developed a test to identify groundwater that is in a subterranean stream flowing through a known and definite channel and is therefore subject to the SWRCB's permitting authority. The physical conditions that must be present in a subterranean stream flowing in a known and definite channel are: (1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel. Whether groundwater is subject to the SWRCB's permitting authority under this test is a factual determination. Water that does not fit this test is "percolating groundwater" and is not subject to the SWRCB's permitting authority.

The SWRCB has issued decisions that find that groundwater under the following streams constitutes a "subterranean stream flowing through known and definite channels" and is therefore subject to the SWRCB's permitting authority (Murphey 2003 pers com):

Los Angeles River in Los Angeles County
Sheep Creek in San Bernardino County
Mission Basin of the San Luis Rey River in San Diego County
Bonsall Basin of the San Luis Rey River in San Diego County
Pala Basin of the San Luis Rey River in San Diego County
Carmel River in Monterey County
Garrapata Creek in Monterey County
Big Sur River in Monterey County
Russian River
Chorro Creek in San Luis Obispo County
Morro Creek in San Luis Obispo County
North Fork Gualala River in Mendocino County

Contact the SWRCB, Division of Water Rights for specific stream reaches and other details of these decisions.

hyporheic zone, mix with groundwater, and re-enter the surface water in the stream channel. The effects of this interchange between surface water and groundwater can change the dissolved oxygen content, temperature, and mineral concentrations of the water. These changes may have a significant effect on aquatic and riparian biota.

Significantly, the physical and chemical interconnection of groundwater and surface water is not well represented in California's water rights system (see Box N "One Resource, Two Systems of Law").

Physical Properties That Affect Groundwater

The degree to which a body of rock or sediments will function as a groundwater resource depends on many properties, some of which are discussed here. Two of the more important physical properties to consider are porosity and hydraulic conductivity. Transmissivity is another important concept to understand when considering an aquifer's overall ability to yield significant groundwater. Throughout the discussion of these properties, keep in mind that sediment size in alluvial environments can change significantly over short distances, with a corresponding change in physical properties. Thus, while these properties are often presented as average values for a large area, one might encounter different conditions on a more localized level. Determination of these properties for a given aquifer may be based on lithologic or geophysical observations, laboratory testing, or aquifer tests with varying degrees of accuracy.

Porosity

The ratio of voids in a rock or sediment to the total volume of material is referred to as porosity and is a measure of the amount of groundwater that may be stored in the material. Figure 12 gives several examples of the types of porosity encountered in sediments and rocks. Porosity is usually expressed as a percentage and can be classified as either primary or secondary. Primary porosity refers to the voids present when the sediment or rock was initially formed. Secondary porosity refers to voids formed through fracturing or weathering of a rock or sediment after it was formed. In sediments, porosity is a function of the uniformity of grain size (sorting) and shape. Finer-grained sediments tend to have a higher porosity than coarser sediments because the finer-grained sediments generally have greater uniformity of size and because of the tabular shape and surface chemistry properties of clay particles. In crystalline rocks, porosity becomes greater with a higher degree of fracturing or weathering. As alluvial sediments become consolidated, primary porosity generally decreases due to compaction and cementation, and secondary porosity may increase as the consolidated rock is subjected to stresses that cause fracturing.

Porosity does not tell the entire story about the availability of groundwater in the subsurface. The pore spaces must also interconnect and be large enough so that water can move through the ground to be extracted from a well or discharged to a water body. The term "effective porosity" refers to the degree of interconnectedness of pore spaces. For coarse sediments, such as the sand and gravel encountered in California's alluvial groundwater basins, the effective porosity is often nearly equal to the overall porosity. In finer sediments, effective porosity may be low due to water that is tightly held in small pores. Effective porosity is generally very low in crystalline rocks that are not highly fractured or weathered.

While porosity measures the total amount of water that may be contained in void spaces, there are two related properties that are important to consider: specific yield and specific retention. Specific yield is the fractional amount of water that would drain freely from rocks or sediments due to gravity and describes the portion of the groundwater that could actually be available for extraction. The portion of groundwater that is retained either as a film on grains or in small pore spaces is called specific retention. Specific yield and specific retention of the aquifer material together equal porosity. Specific retention increases with decreasing

grain size. Table 7 shows that clays, while having among the highest porosities, make poor sources of groundwater because they yield very little water. Sand and gravel, having much lower porosity than clay, make excellent sources of groundwater because of the high specific yield, which allows the groundwater to flow to wells. Rocks such as limestone and basalt yield significant quantities of groundwater if they are well-weathered and highly fractured.

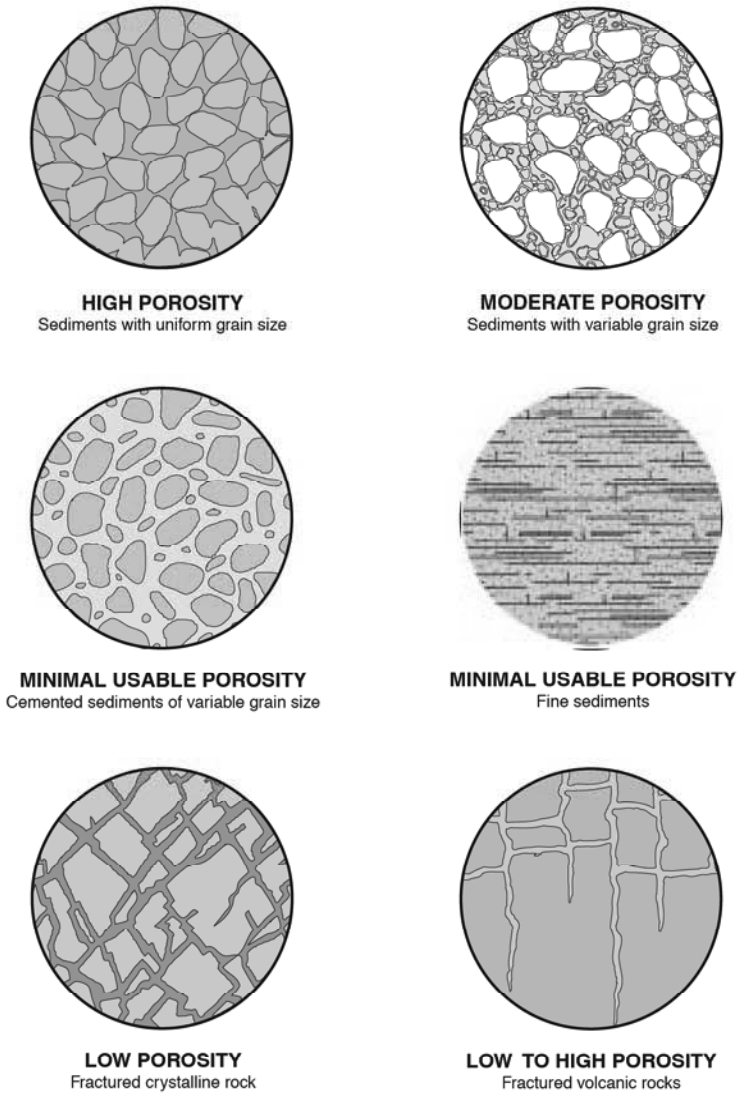


Figure 12 Examples of porosity in sediments and rocks

Table 7 Porosity (in percent) of soil and rock types

Material	Porosity	Specific yield	Specific retention
Clay	50	2	48
Sand	25	22	2
Gravel	20	19	1
Limestone	20	18	2
Sandstone (semiconsolidated)	11	6	5
Granite	0.1	0.09	0.01
Basalt (young)	11	8	3

Modified from Heath (1983)

Hydraulic Conductivity

Another major property related to understanding water movement in the subsurface is hydraulic conductivity. Hydraulic conductivity is a measure of a rock or sediment's ability to transmit water and is often used interchangeably with the term permeability. The size, shape, and interconnectedness of pore spaces affect hydraulic conductivity (Driscoll 1986).

Hydraulic conductivity is usually expressed in units of length/time: feet/day, meters/day, or gallons/day/square-foot. Hydraulic conductivity values in rocks range over many orders of magnitude from a low permeability unfractured crystalline rock at about 10^{-8} feet/day to a highly permeable well-sorted gravel at greater than 10^{4} feet/day (Heath 1983). Clays have low permeability, ranging from about 10^{-3} to 10^{-7} feet/day (Heath 1983). Figure 13 shows hydraulic conductivity ranges of selected rocks and sediments.

Transmissivity

Transmissivity is a measure of the aquifer's ability to transmit groundwater through its entire saturated thickness and relates closely to the potential yield of wells. Transmissivity is defined as the product of the hydraulic conductivity and the saturated thickness of the aquifer. It is an important property to understand because a given area could have a high value of hydraulic conductivity but a small saturated thickness, resulting in limited overall yield of groundwater.

Aquifer

An aquifer is a body of rock or sediment that yields significant amounts of groundwater to wells or springs. In many definitions, the word "significant" is replaced by "economic." Of course, either term is a matter of perspective, which has led to disagreement about what constitutes an aquifer. As discussed previously, coarse-grained sediments such as sands and gravels deposited in alluvial or marine environments tend to function as the primary aquifers in California. These alluvial aquifers are the focus of this report. Other aquifers, such as those found in volcanics, igneous intrusive rocks, and carbonate rocks are described briefly in the section Groundwater Source Areas.

Aquitard

An aquitard is a body of rock or sediment that is typically capable of storing groundwater but does not yield it in significant or economic quantities. Fine-grained sediments with low hydraulic conductivity, such as clays and silts, often function as aquitards. Aquitards are often referred to as confining layers because they retard the vertical movement of groundwater and under the right hydrogeologic conditions confine groundwater that is under pressure. Aquitards are capable of transmitting enough water to allow some flow between adjacent aquifers, and depending on the magnitude of this transfer of water, may be referred to as leaky aquitards.

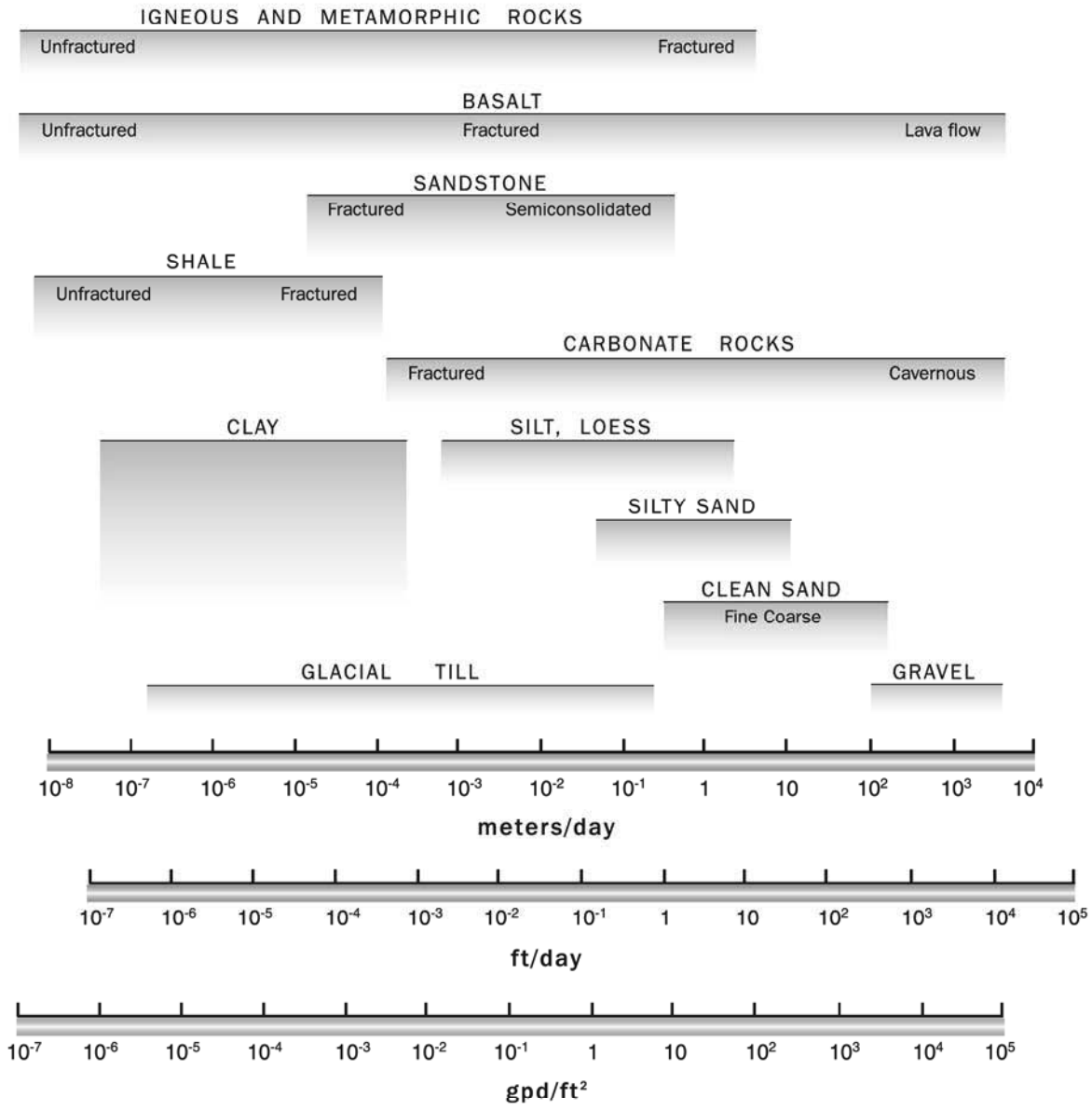


Figure 13 Hydraulic conductivity ranges of selected rocks and sediments

Unconfined and Confined Aquifers

In most depositional environments, coarser-grained deposits are interbedded with finer-grained deposits creating a series of aquifers and aquitards. When a saturated aquifer is bounded on top by an aquitard (also known as a confining layer), the aquifer is called a confined aquifer (Figure 14). Under these conditions, the water is under pressure so that it will rise above the top of the aquifer if the aquitard is penetrated by a well. The elevation to which the water rises is known as the potentiometric surface. Where an aquifer is not bounded on top by an aquitard, the aquifer is said to be unconfined. In an unconfined aquifer, the pressure on the top surface of the groundwater is equal to that of the atmosphere. This surface is known as the water table, so unconfined aquifers are often referred to as water table aquifers. The arrangement of aquifers and aquitards in the subsurface is referred to as hydrostratigraphy.

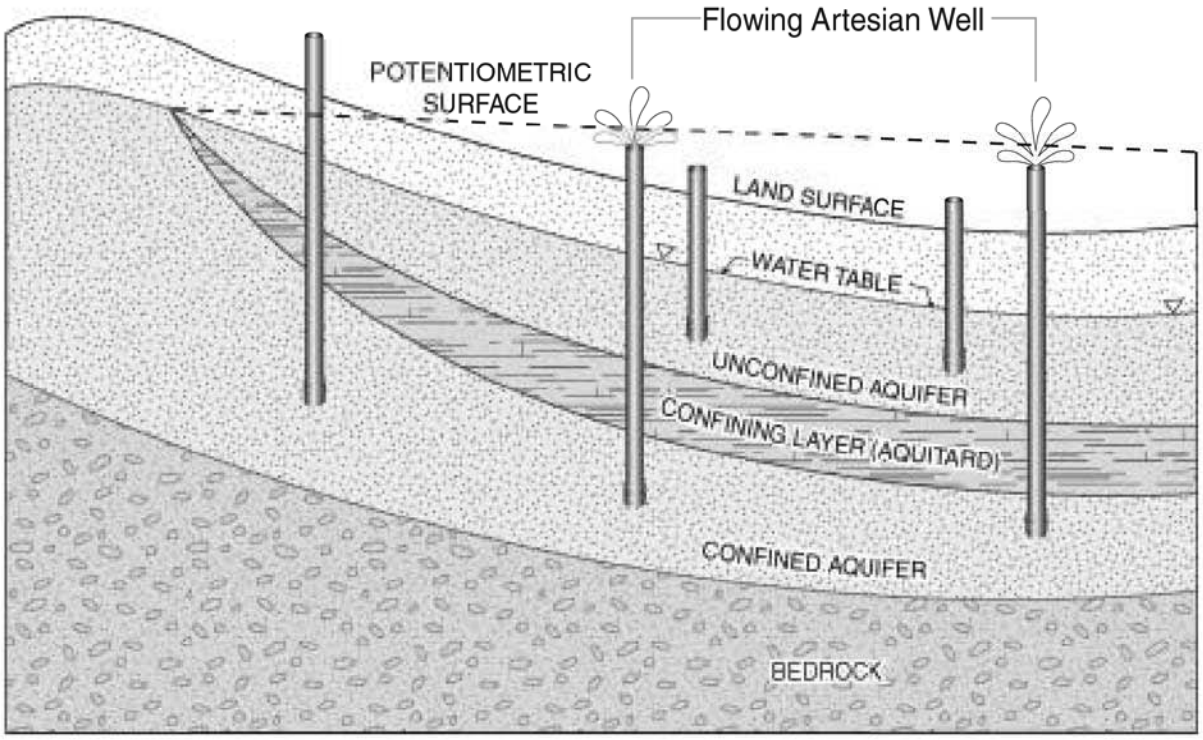


Figure 14 Interbedded aquifers with confined and unconfined conditions

With the notable exception of the Corcoran Clay of the Tulare Formation in the San Joaquin Valley and the aquitard in West Coast Basin in Los Angeles County, there are no clearly recognizable regional aquitards in California alluvial basins. Instead, due to the complexity of alluvial environments, it is the cumulative effect of multiple thin lenses of fine-grained sediments that causes increasing confinement of groundwater with increasing depth, creating what is often referred to as a semiconfined aquifer.

In some confined aquifers groundwater appears to defy gravity, but that is not the case. When a well penetrates a confined aquifer with a potentiometric surface that is higher than land surface, water will flow naturally to the surface. This is known as artesian flow, and results from pressure within the aquifer. The pressure results when the recharge area for the aquifer is at a higher elevation than the point at which discharge is occurring (Figure 14). The confining layer prevents the groundwater from returning to the surface until the confining layer is penetrated by a well. Artesian flow will discontinue as pressure in the aquifer is reduced and the potentiometric surface drops below the land surface elevation.

Groundwater Basin

A groundwater basin is defined as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Lateral boundaries are features that significantly impede groundwater flow such as rock or sediments with very low permeability or a geologic structure such as a fault. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin. In some cases, such as in the San Joaquin and Sacramento Valleys, the base of fresh water is considered the bottom of the groundwater basin. Table 8 is a generalized list of basin types and the features that define the basin boundaries.

Table 8 Types and boundary characteristics of groundwater basins

Characteristics of groundwater basins	
Groundwater basin	An aquifer or an aquifer system that is bounded laterally and at depth by one or more of the following features that affect groundwater flow: • Rocks or sediments of lower permeability • A geologic structure, such as a fault • Hydrologic features, such as a stream, lake, ocean, or groundwater divide
Types of basins and their boundaries	
Single simple basin	Basin surrounded on all sides by less permeable rock. Higher permeability near the periphery. Clays near the center. Unconfined around the periphery. Confined near the center. May have artesian flow near the center.
Basin open at one or more places to other basins	Many desert basins. Merged alluvial fans. Topographic ridges on fans. Includes some fault-bounded basins.
Basin open to Pacific Ocean	260 basins along the coast. Water-bearing materials extend offshore. May be in contact with sea water. Vulnerable to seawater intrusion.
Single complex basin	Basin underlain or surrounded by older water-bearing materials and water-bearing volcanics. Quantification is difficult because of unknown contacts between different rock types within the basin.
Groundwater in areas of volcanic rocks	Basin concept is less applicable in volcanic rocks. Volcanic rocks are highly variable in permeability.
Groundwater in weathered crystalline rocks (fractured hard rock)—not considered a basin	Small quantities of groundwater. Low yielding wells. Most wells are completed in the crystalline rock and rely on fractures to obtain groundwater.
Political boundaries or management area boundaries	Usually not related to hydrogeologic boundaries.Formed for convenience, usually to manage surface water storage and delivery.

Although only the upper surface of a groundwater basin can be shown on a map, the basin is three-dimensional and includes all subsurface fresh water-bearing material. These boundaries often do not extend straight down, but are dependent on the spatial distribution of geologic materials in the subsurface. In fact, in a few cases near California's coastal areas, aquifers in the subsurface are known to extend beyond the mapped surface of the basin and may actually be exposed under the ocean. Under natural conditions, fresh water flows from these aquifers into the ocean. If groundwater levels are lowered, sea water may flow into the aquifer. This has occurred in Los Angeles, Orange, Ventura, Santa Cruz and Monterey Counties, and some areas around San Francisco Bay. Depiction of a groundwater basin in three dimensions requires extensive subsurface investigation and data evaluation to delineate the basin geometry. Figure 15 is a cross-section showing how a coastal basin might appear in the subsurface.

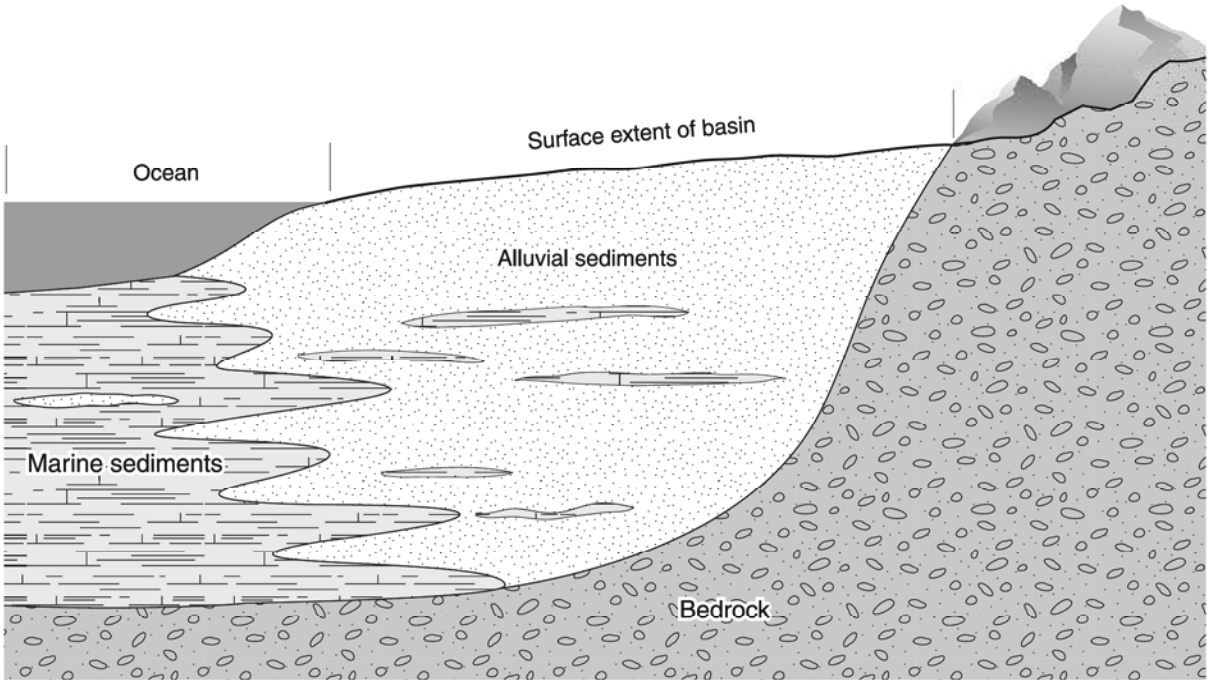


Figure 15 Groundwater basin near the coast with the aquifer extending beyond the surface basin boundary

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated. In many other basins where much less is known and understood about the basin, boundaries will probably change as a better understanding of the basin is developed. A procedure for collecting information from all the stakeholders should be developed for use statewide so that agreement on basin boundaries can be achieved.

Groundwater Subbasin

A subbasin is created by dividing a groundwater basin into smaller units using geologic and hydrologic barriers or, more commonly, institutional boundaries (see Table 8). These subbasins are created for the purpose of collecting and analyzing data, managing water resources, and managing adjudicated basins. As the definition implies, the designation of a subbasin boundary is flexible and could change in the future. The limiting rule for a subbasin is that it should not cross over a groundwater basin boundary.

An example of a hydrologic subbasin boundary would be a river or stream that creates a groundwater divide. While hydrologic boundaries may limit groundwater flow in the shallow subsurface, data indicate significant groundwater flow may occur across the boundary at greater depths. In addition, the location of the boundary may change over time if pumping or recharge patterns change. Institutional subbasin boundaries could be based on a political boundary, such as a county line or a water agency service area, or a legally mandated boundary such as a court adjudicated basin.

Groundwater Source Areas

Groundwater in California is also found outside of alluvial groundwater basins. Igneous extrusive (volcanic), igneous intrusive, metamorphic, and sedimentary rocks are all potential sources of groundwater. These rocks often supply enough water for domestic use, but in some cases can also yield substantial quantities. In this report the term groundwater source area is used for rocks that are significant in terms of being a local groundwater source, but do not fit the category of basin or subbasin. The term is not intended to imply that groundwater actually originates in these rocks, but that it is withdrawn from rocks underlying a generally definable area. Because of the increased difficulty in defining and understanding the hydrogeologic properties of these rocks, the limited data available for the areas in which these rocks occur, and the relatively small, though rapidly growing, segment of the population served by these water supplies, they are discussed separately from groundwater basins.

Volcanics

Groundwater in volcanics can occur in fractures that result from cooling or changes in stress in the crust of the Earth, lava tubes, tree molds, weathering surfaces, and porous tuff beds. Additionally, the volcanics could overlie other deposits from an alluvial environment. Flow in the fractures may approach the same velocities as that of surface water, but there is often very limited storage potential for groundwater. The tuff beds can act similarly to alluvial aquifers.

Some of the most productive volcanic rocks in the State include the Modoc Plateau volcanics in the northeast and the Napa-Sonoma volcanics northeast of San Francisco Bay (Figure 16). Wells in Modoc Plateau volcanics are commonly reported to yield between 100 and 1,000 gallons per minute, with some yields of 4,000 gpm (Planert and Williams 1995). Bulletin 118-75 assigned identification numbers to these volcanic rocks throughout the State (for example, Modoc Plateau Recent Volcanic Areas, 1-23). The numbers led some to interpret them as being groundwater basins. In this update, the numbers corresponding to the volcanics are being retired to eliminate this confusion.

Figure 16 Significant volcanic groundwater source areas

Igneous Intrusive, Metamorphic, and Sedimentary Rocks

Groundwater in igneous intrusive, metamorphic, and consolidated sedimentary rocks occurs in fractures resulting from tectonism and expansion of the rock as overburden pressures are relieved. Groundwater is extracted from fractured rock in many of the mountainous areas of the State, such as the Sierra Nevada, the Peninsular Range, and the Coast Ranges. Rocks in these areas often yield only enough supply for individual domestic wells, stock water wells, or small community water systems. Availability of groundwater in such formations can vary widely, even over a distance of a few yards. Areas of groundwater production from consolidated rocks were not defined in previous versions of Bulletin 118 and are not included in this update.

As population grows in areas underlain by these rocks, such as the foothills of the Sierra Nevada and southern California mountains, many new wells are being built in fractured rock. However, groundwater data are often insufficient to accurately estimate the long term reliability of groundwater supplies in these areas. Additional investigation, data evaluation, and management will be needed to ensure future sustainable supplies. The Legislature recognized both the complexity of these areas and the need for management in SB 1938 (2002), which amended the Water Code to require groundwater management plans with specific components be adopted for agencies to be eligible for certain funding administered by DWR for construction of groundwater projects. Water Code section 10753.7(a)(5) states:

> Local agencies that are located in areas outside the groundwater basins delineated on the latest edition of the department's groundwater basin and subbasin map shall prepare groundwater management plans incorporating the components in this subdivision, and shall use geologic and hydrologic principles appropriate to those areas.

In carbonate sedimentary rocks such as limestone, groundwater occurs in fractures and cavities formed as a result of dissolution of the rock. Flow in the largest fractures may approach the velocities of surface water, but where these rocks occur in California there is limited storage potential for groundwater. Carbonate rocks occur mostly in Inyo County near the Nevada border (USGS 1995), in the Sierra Nevada foothills, and in some parts of the Sacramento River drainage north of Redding. The carbonates near the Nevada state border in Inyo County are part of a regional aquifer that extends northeastward into Nevada. Springs in Nevada and in the Death Valley region in California are dependent on groundwater flow in this regional aquifer. In other parts of the country, such as Florida, carbonate rocks constitute significant sources of groundwater.

Movement of Groundwater

The movement of groundwater in the subsurface is quite complex, but in simple terms it can be described as being driven by potential energy. At any point in the saturated subsurface, groundwater has a hydraulic head value that describes its potential energy, which is the combination of its elevation and pressure. In an unconfined aquifer, the water table elevation represents the hydraulic head, while in a confined aquifer the potentiometric surface represents the hydraulic head (Figure 14). Water moves in response to the difference in hydraulic head from the point of highest energy toward the lowest. On a regional scale this results in flow of groundwater from recharge areas to discharge areas. In California, pumping depressions around extraction wells often create the discharge points to which groundwater flows. Groundwater may naturally exit the subsurface by flowing into a stream, lake, or ocean, by flowing to the surface as a spring or seep, or by being transpired by plants.

The rate at which groundwater flows is dependent on the hydraulic conductivity and the rate of change of hydraulic head over some distance. In the mid-19th century, Henry Darcy found through his experiments on sand filters that the amount of flow through a porous medium is directly proportional to the difference

between hydraulic head values and inversely proportional to the horizontal distance between them (Fetter 1988). His conclusions extend to flow through aquifer materials. The difference between hydraulic heads divided by the distance between them is referred to as the hydraulic gradient. When combined with the hydraulic conductivity of the porous medium and the cross-sectional area through which the groundwater flows, Darcy's law states:

$$Q = KA(dh/dl) \text{ (volume/time)}$$

Where:

Q = flow discharging through a porous medium
K = hydraulic conductivity (length/time)
A = cross-sectional area (length^2)
dh = change in hydraulic head between two points (length)
dl = distance between two points (length)

This version of Darcy's law provides a volumetric flow rate. To calculate the average linear velocity at which the water flows, the result is divided by the effective porosity. The rate of movement of groundwater is very slow, usually less than 1,000 feet per year because of the great amount of friction resulting from movement through the spaces between grains of sand and gravel.

Quantity of Groundwater

Because groundwater is a precious resource, the questions of how much there is and how more can be made available are important. There are many terms and concepts associated with the quantity of groundwater available in a basin, and some controversy surrounding their definition. Some of these include groundwater storage capacity, usable storage capacity, groundwater budget, change in storage, overdraft, and safe yield. This section discusses some of the more common terms used to represent groundwater quantity in California.

Groundwater Storage Capacity

The groundwater storage capacity of an individual basin or within the entire State is one of the questions most frequently asked by private citizens, water resource planners, and politicians alike. Total storage capacity seems easy to understand. It can be seen as how much physical space is available for storing groundwater. The computation of groundwater storage capacity is quite simple if data are available: capacity is determined by multiplying the total volume of a basin by the average specific yield. The total storage capacity is constant and is dependent on the geometry and hydrogeologic characteristics of the aquifer(s) (Figure 17).

Estimates of total groundwater storage capacity in California are staggering. Previous estimates of total storage range from 850 million acre-feet (maf) to 1.3 billion acre-feet (DWR 1975, DWR 1994). However, due to incomplete information about many of the groundwater basins, there has never been an accurately quantified calculation of total storage capacity statewide. Even if such a calculation were possible, the utility of such a number is questionable because total storage capacity might lead to overly optimistic estimates of how much additional groundwater development can contribute to meeting future demands.

Total groundwater storage capacity is misleading because it only takes into account one aspect of the physical character of the basin. Many other factors limit the ultimate development potential of a groundwater basin. These limiting factors may be physical, chemical, economic, environmental, legal, and institutional (Table 9). Some of these factors, such as the economic and institutional ones, can change with time. However, there may remain significant physical and chemical constraints that will limit groundwater development.

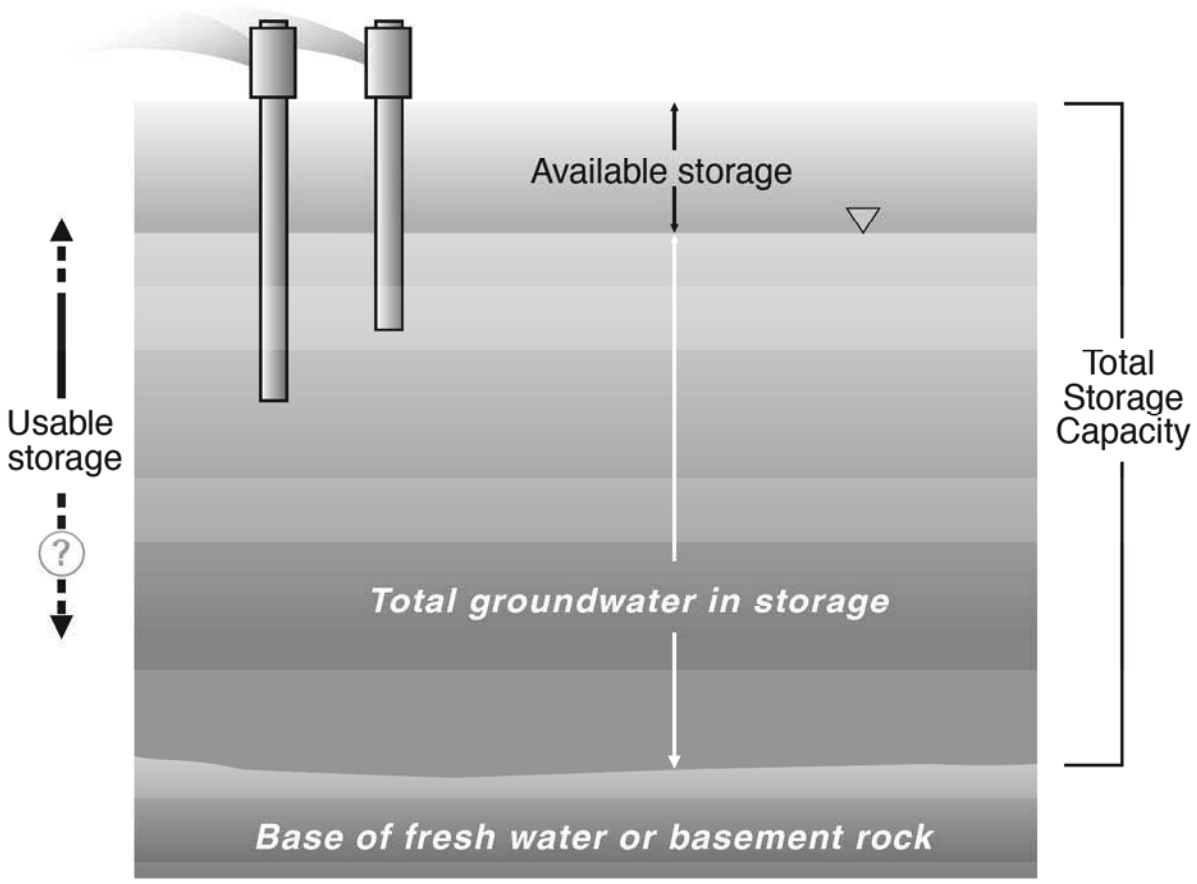


Figure 17 Schematic of total, usable, and available groundwater storage capacity

Table 9 Examples of factors that limit development of a groundwater basin

Limiting factor	Examples
Physical	Basin recharge area not adequate to sustain development; pumping too concentrated in a portion of basin; well yields too low for intended use.
Quality	Water quality not suitable for intended use; increased potential for seawater intrusion in coastal areas; upwelling of poorer quality water in deeper parts of basin.
Economic	Excessive costs associated with increased pump lifts and deepening of wells; cost of treating water if it does meet requirements for intended use.
Environmental	Need to maintain groundwater levels for wetlands, stream base flow, or other habitat.
Institutional	Local groundwater management plans or ordinances restricting use; basin adjudication; impacts on surface water rights of others.

Usable Groundwater Storage Capacity

Usable storage capacity is defined as the amount of groundwater of suitable quality that can be economically withdrawn from storage. It is typically computed as the product of the volume of the basin to some basin-specific depth that is considered economically available and the average specific yield of the basin (see Figure 17).

As more groundwater is extracted, groundwater levels may fall below some existing wells, which may then require replacement or deepening. This may be a consideration in management of the basin and will depend on the cost of replacement, the cost of pumping the water from deeper zones, and whether managers are willing to pay that cost. Other impacts that may increase the cost include subsidence and groundwater quality degradation. The usable storage may change because of changes in economic conditions.

Estimates of usable storage represent only the total volume of groundwater assumed to be usable in storage, not what would be available for sustained use on an annual basis. Previous estimates of usable groundwater storage capacity range from 143 to 450 maf (DWR 1975, DWR 1994). Unfortunately, the term "usable storage" is often used to indicate the amount of water that can be used from a basin as a source of long-term annual supply. However, the many limitations associated with total groundwater storage capacity discussed above may also apply to usable storage.

Available Groundwater Storage Capacity

Available storage capacity is defined as the volume of a basin that is unsaturated and capable of storing additional groundwater. It is typically computed as the product of the empty volume of the basin and the average specific yield of the unsaturated part of the basin (see Figure 17). The available storage capacity does not include the uppermost portion of the unsaturated zone in which saturation could cause problems such as crop root damage or increased liquefaction potential. The available storage will vary depending on the amount of groundwater taken out of storage and the recharge. The total groundwater in storage will change inversely as the available storage changes.

Available storage has often been used as a number to represent the potential for additional yield from a particular basin. Unfortunately, many of the limitations that exist in developing existing supply discussed above also limit taking advantage of available storage. Although limitations exist, looking only at available groundwater storage capacity may underestimate the potential for groundwater development. Opportunities to use groundwater already in storage and create additional storage space would be overlooked by this approach.

Groundwater Budget

A groundwater budget is an analysis of a groundwater basin's inflows and outflows to determine the change in groundwater storage. Alternatively, if the change in storage is known, the value of one of the inflows or outflows could be determined. The basic equation can be expressed as:

INFLOWS – OUTFLOWS = CHANGE IN STORAGE

Typical inflows include:

- natural recharge from precipitation;
- seepage from surface water channels;
- intentional recharge via ponds, ditches, and injection wells;
- net recharge of applied water for agricultural and other irrigation uses;
- unintentional recharge from leaky conveyance pipelines; and
- subsurface inflows from outside basin boundaries.

Outflows include:

- groundwater extraction by wells;
- groundwater discharge to surface water bodies and springs;
- evapotranspiration; and
- subsurface outflow across basin or subbasin boundaries.

Groundwater budgets can be useful tools to understand a basin, but detailed budgets are not available for most groundwater basins in California. A detailed knowledge of each budget component is necessary to obtain a good approximation of the change in storage. Absence or inaccuracy of one or more parameters can lead to an analysis that varies widely from a positive to a negative change in storage or vice versa. Since much of the data needed requires subsurface exploration and monitoring over a series of years, the collection of detailed field data is time-consuming and expensive. A management plan should develop a monitoring program as soon as possible.

Change in Groundwater Storage

As stated above, a groundwater budget is one potential way of estimating the change in storage in a basin, although it is limited by the accuracy and availability of data. There is a simpler way—by determining the average change in groundwater elevation over the basin, multiplied by the area overlying the basin and the average specific yield (or storativity in the case of a confined aquifer). The time interval over which the groundwater elevation change is determined is study specific, but annual spring-to-spring changes are commonly used. A change in storage calculation does not attempt to determine the volume of water in storage at any time interval, but rather the change from a previous period or baseline condition.

A change in storage calculation is a relatively quick way to represent trends in a basin over time. If change in storage is negligible over a representative period, the basin is in equilibrium under current use. Changes in storage calculations are more often available for a groundwater basin than groundwater budgets because water level measurements are available in many basins. Specific yield and storativity are readily estimated based on knowledge of the hydrogeologic setting and geologic materials or through aquifer pumping tests. Although simple, change in storage calculations have potential sources of error, so it is important to treat change in storage as just one of many tools in determining conditions in a groundwater basin. Well data sets must be carefully evaluated before use in these calculations. Mixing of wells constructed in confined and unconfined portions of the basin and measurement of different well sets over time can result in significant errors.

Although the change in storage calculation is a relatively quick and inexpensive method of observing changes in the groundwater system, the full groundwater budget is preferable. A detailed budget describes an understanding of the physical processes affecting storage in the basin, which the simple change in storage calculation does not. For example, the budget takes into account the relationship between the surface water and the groundwater system. If additional groundwater extraction induced additional infiltration of surface water, the calculated change in storage could be minimal. However, if the surface water is used as a source of supply downstream, the impact of reduced flows could be significant.

Overdraft

Groundwater overdraft is defined as the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions (DWR 1998). Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts.

Despite its common usage, the term overdraft has been the subject of debate for many years. Groundwater management is a local responsibility, therefore, the decision whether a basin is in a condition of overdraft is the responsibility of the local groundwater or water management agency. In some cases local agencies may choose to deliberately extract groundwater in excess of recharge in a basin (known as "groundwater mining") as part of an overall management strategy. An independent analysis of water levels in such a basin might conclude that the basin is in overdraft. In other cases, where basin management is less active or nonexistent, declining groundwater levels are not considered a problem until levels drop below the depth of many wells in the basin. As a result, overdraft may not be reported for many years after the condition began.

Water quality changes and subsidence may also indicate that a basin has been overdrafted. For example, when groundwater levels decline in coastal aquifers, seawater fills the pore spaces in the aquifer that are vacated by the groundwater, indicating that the basin is being overdrafted. Overdraft has historically led to as much as 30 feet of land subsidence in one area of the State and lesser amounts in other areas.

The word "overdraft" has been used to designate two unrelated types of water shortages. The first is "historical overdraft" similar to the type illustrated in Figure 18, which shows that ground water levels began to decline in the mid 1950s and then leveled off in the mid 1980s, indicating less groundwater extraction or more recharge. The second type of shortage is "projected overdraft" as used in the *California Water Plan Update* (DWR 1998). In reality, this is an estimate of future water shortages based on an assumed management program within the basin, including projected supply and projected demand. If water management practices change in those basins in which a water shortage is projected, the amount of projected shortage will change.

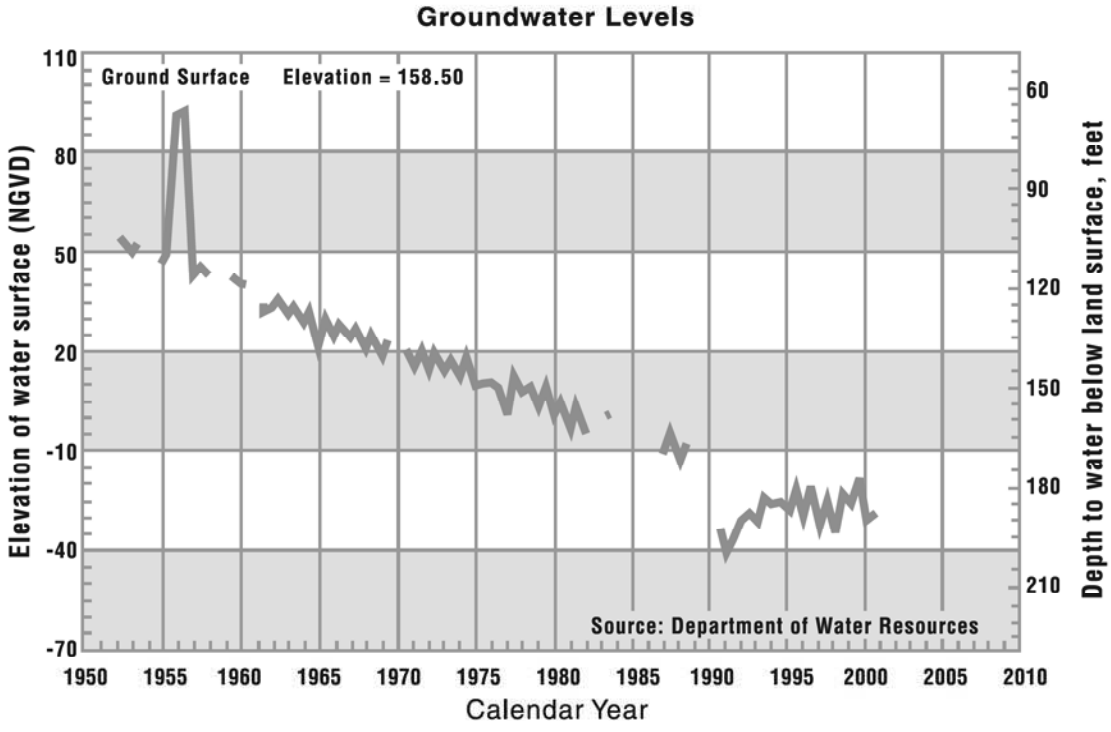


Figure 18 Hydrograph Indicating Overdraft

In some basins or subbasins, groundwater levels declined steadily over a number of years as agricultural or urban use of groundwater increased. In response, managing agencies developed surface water import projects to provide expanded water supplies to alleviate the declining groundwater levels. Increasing groundwater levels, or refilling of the aquifer, demonstrate the effectiveness of this approach in long-term water supply planning. In some areas of the State, the past overdraft is now being used to advantage. When the groundwater storage capacity that is created through historical overdraft is used in coordination with surface water supplies in a conjunctive management program, local and regional water supplies can be augmented.

In 1978 DWR was directed by the legislature to develop a definition of critical overdraft and to identify basins that were in a condition of critical overdraft (Water Code § 12924). The process that was followed and the basins that were deemed to be in a condition of critical overdraft are discussed in Box O, "Critical Conditions of Overdraft." This update to Bulletin 118 did not include similar direction from the legislature, nor funding to undertake evaluation of the State's groundwater basins to determine whether they are in a state of overdraft.

Box O Critical Conditions of Overdraft

In 1978 DWR was directed by the legislature to develop a definition of critical overdraft and to identify those basins in a critical condition of overdraft (Water Code §12924). DWR held public workshops around the state to obtain public and water managers' input on what the definition should include, and which basins were critically overdrafted. Bulletin 118-80, *Ground Water Basins in California* was published in 1980 with the results of that local input. The definition of critical overdraft is:

> *A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.*

No time is specified in the definition. Definition of the time frame is the responsibility of the local water managers, as is the definition of significant adverse impacts, which would be related to the local agency's management objectives.

Eleven basins were identified as being in a critical condition of overdraft. They are:

- Pajaro Basin
- Ventura Central Basin
- Chowchilla Basin
- Kings Basin
- Tulare Lake Basin
- Kern County Basin
- Cuyama Valley Basin
- Eastern San Joaquin County Basin
- Madera Basin
- Kaweah Basin
- Tule Basin

The task was not identified by the Legislature, nor was the funding for this update (2003) sufficient to consult with local water managers and fully re-evaluate the conditions of the 11 critically overdrafted basins. Funding and duration were not sufficient to evaluate additional basins with respect to conditions of critical overdraft.

If a basin lacks existing information, the cost of a thorough evaluation of overdraft conditions in a single basin could exceed $1 million. In this update of Bulletin 118, DWR has included groundwater budget information for each basin description, where available. In most cases, however, sufficient quantitative information is not available, so conditions of overdraft or critical overdraft were not reported.

While this bulletin does not specifically identify overdrafted basins (other than the 11 basins from Bulletin 118-80), the negative effects of overdraft are occurring or may occur in the future in many basins throughout the State. Declining water levels, diminishing water quality, and subsidence threaten the availability of groundwater to meet current and future demands. A thorough understanding of overdraft can help local groundwater managers minimize the impacts and take advantage of the opportunity created by available groundwater storage capacity. Local groundwater managers and DWR should seek funding and work cooperatively to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts. Beginning with the most heavily used basins and relying to the extent possible on available data collected by DWR and through local groundwater management programs, current or projected conditions of critical overdraft should be identified. If local agencies take the lead in collecting and analyzing data to fully understand groundwater basin conditions, DWR can use the information to update the designations of critically overdrafted basins. This can be a cost effective approach since much of the data needed to update the overdraft designations are the same data that agencies need to effectively manage groundwater.

Safe Yield

Safe yield is defined as the amount of groundwater that can be continuously withdrawn from a basin without adverse impact. Safe yield is commonly expressed in terms of acre-feet per year. Depending on how it is applied, safe yield may be an annual average value, or may be calculated based on changed conditions each year. Although safe yield may be indicated by stable groundwater levels measured over a period of years, a detailed groundwater budget is needed to accurately estimate safe yield. Safe yield has commonly been determined in groundwater basin adjudications.

Proper application of the safe yield concept requires that the value be modified through time to reflect changing practices within the basin. One of the common misconceptions is that safe yield is a static number. That is, once it has been calculated, the amount of water can be extracted annually from the basin without any adverse impacts. An example of a situation in which this assumption could be problematic is when land use changes. In some areas, where urban development has replaced agriculture, surface pavement, storm drains, and sewers have increased runoff and dramatically reduced recharge into the basin. If extraction continued at the predetermined safe yield of the basin, water level decline and other negative impacts could occur.

Figure 19 Photograph of extensometer

An extensometer is a well with a concrete bench mark at the bottom. A pipe extends from the concrete to the land surface. If compaction of the finer sediments occurs, leading to land surface subsidence, the pipe in the well will appear to rise out of the well casing. When this movement is recorded, the data show how much the land surface has subsided.

Subsidence

When groundwater is extracted from some aquifers in sufficient quantity, compaction of the fine-grained sediments can cause subsidence of the land surface. As the groundwater level is lowered, water pressure decreases and more of the weight of the overlying sediments is supported by the sediment grains within the aquifer. If these sediments have not previously been surcharged with an equivalent load, the overlying load will compact them. Compaction decreases the porosity of the sediments and decreases the overall volume of the finer grain sediments, leading to subsidence at the land surface. While the finer sediments within the aquifer system are compacted, the usable storage capacity of the aquifer is not greatly decreased.

Data from extensometers (Figure 19) show that as groundwater levels decline in an aquifer, the land surface falls slightly. As groundwater levels rise, the land surface also rises to its original position. This component of subsidence is called elastic subsidence because it recovers. Inelastic subsidence, the second component of subsidence, is what occurs when groundwater levels decline to the point that the finer sediments are compacted. This compaction is not recoverable.

Conjunctive Management

Conjunctive management in its broadest definition is the coordinated and combined use of surface water and groundwater to increase the overall water supply of a region and improve the reliability of that supply. Conjunctive management may be implemented to meet other objectives as well, including reducing groundwater overdraft and land subsidence, protecting water quality, and improving environmental conditions. Although surface water and groundwater are sometimes considered to be separate resources, they are connected in the hydrologic cycle. By using or storing additional surface water when it is plentiful, and relying more heavily on groundwater during dry periods, conjunctive management can change the timing and location of water so it can be used more efficiently.

Although a specific project or program may be extremely complex, there are several components common to conjunctive management projects. The first is to recharge surplus surface water when it is available to increase groundwater in storage. Recharge may occur through surface spreading, by injection wells, or by reducing groundwater use by substituting surface water. The surplus surface water used for recharge may be local runoff, imported water, stored surface water, or recycled water. The second component is to reduce surface water use in dry years or dry seasons by switching to groundwater. This use of the stored groundwater may take place through direct extraction and use, pumping back to a conveyance facility, or through exchange of another water supply. A final component that should be included is an ongoing monitoring program to evaluate operations and allow water managers to respond to changes in groundwater, surface water, or environmental conditions that could violate management objectives or impact other water users.

Quality of Groundwater

All water contains dissolved constituents. Even rainwater, often described as being naturally pure, contains measurable dissolved minerals and gases. As it moves through the hydrologic cycle, water dissolves and incorporates many constituents. These include naturally occurring and man-made constituents.

Most natural minerals are harmless up to certain levels. In some cases higher mineral content is preferable to consumers for taste. For example, minerals are added to many bottled drinking waters after going through a filtration process. At some level, however, most naturally occurring constituents, along with those introduced by human activities, are considered contaminants. The point at which a given constituent is considered a contaminant varies depending on the intended use of the groundwater and the toxicity level of the constituents.

Beneficial Uses

For this report, water quality is a measure of the suitability of water for its intended use, with respect to dissolved solids and gases and suspended material. An assessment of water quality should include the investigation of the presence and concentration of any individual constituent that may limit the water's suitability for an intended use.

The SWRCB has identified 23 categories of water uses, referred to as beneficial uses. The beneficial use categories and a brief description of each are presented in Appendix E. The actual criteria that are used to evaluate water quality for each of the beneficial uses are determined by the nine Regional Water Quality Control Boards, resulting in a range of criteria for some of the uses. These criteria are published in each of the Regional Boards' Water Quality Control Plans (Basin Plans)[1].

A summary of water quality for all of the beneficial uses of groundwater is beyond the scope of this report. Instead, water quality criteria for two of the most common uses—municipal supply (referred to as public drinking water supply in this report) and agricultural supply—are described below.

Public Drinking Water Supply

Standards for maximum contaminant levels (MCLs) of constituents in drinking water are required under the federal Safe Drinking Water Act of 1974 and its updates. There are primary and secondary standards. Primary standards are developed to protect public health and are legally enforceable. Secondary standards are generally for the protection of aesthetic qualities such as taste, odor, and appearance, and cosmetic qualities, such as skin or tooth discoloration, and are generally non-enforceable guidelines. However, in California secondary standards are legally enforceable for all new drinking water systems and new sources developed by existing public water suppliers (DWR 1997). Under these primary and secondary standards, the U.S. Environmental Protection Agency regulates more than 90 contaminants, and the California Department of Health Services regulates about 100. Federal and State primary MCLs are listed in Appendix F.

Agricultural Supply

An assessment of the suitability of groundwater as a source of agricultural supply is much less straightforward than that for public water supply. An evaluation of water supply suitability for use in agriculture is difficult because the impact of an individual constituent can vary depending on many factors, including soil chemical and physical properties, crop type, drainage, and irrigation method. Elevated levels of constituents usually do not result in an area being taken entirely out of production, but may lower crop yields. Management decisions will determine appropriate land use and irrigation methods.

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[1] Digital versions of these plans are available online at http://www.swrcb.ca.gov/plnspols/index.html

There are no regulatory standards for water applied on agriculture. Criteria for crop water have been provided as guidelines. Many constituents have the potential to negatively impact agriculture, including more than a dozen trace elements (Ayers and Westcot 1985). Two constituents that are commonly considered with respect to agricultural water quality are salinity—expressed as total dissolved solids (TDS)—and boron concentrations.

Increasing salinity in irrigation water inhibits plant growth by reducing a plant's ability to absorb water through its roots (Pratt and Suarez 1996). While the impact will depend on crop type and soil conditions, it is useful to look at the TDS of the applied water as a general assessment tool. A range of values for TDS with their estimated suitability for agricultural uses is presented in Table 10. These ranges are modified from criteria developed for use in the San Joaquin Valley by the San Joaquin Valley Drainage Program. However, they are similar to values presented in Ayers and Westcot (1985).

Table 10 Range of TDS values with estimated suitability for agricultural uses

Range of TDS (mg/L)	Suitability
<500	Generally no restrictions on use
500 – 1,250	Generally slight restrictions on use
1,250 – 2,500	Generally moderate restrictions on use
>2,500	Generally severe restrictions on use

Modified from SJVDP (1990)
TDS = total dissolved solids

High levels of boron can present toxicity problems in plants by damaging leaves. The boron is absorbed through the root system and transported to the leaves. Boron then accumulates during plant transpiration, resulting in leaf burn (Ayers and Westcot 1985). Boron toxicity is highly dependent on a crop's sensitivity to the constituent. A range of values of dissolved boron in irrigation water, with their estimated suitability on various crops is presented in Table 11. These ranges are modified from Ayers and Westcot (1985).

Table 11 Range of boron concentrations with estimated suitability on various crops

Range of dissolved boron (mg/L)	Suitability
<0.5	Suitable on all but most highly boron sensitive crops
0.5 – 1.0	Suitable on most boron sensitive crops
1.0 – 2.0	Suitable on most moderately boron sensitive crops
>2.0	Suitable for only moderately to highly boron tolerant crops

Source: Modified from Ayers and Westcot 1985

Contaminant Groups

Because there are so many potential individual constituents to evaluate, researchers have often summarized contaminants into groups depending on the purpose of the study. Recognizing that there are exceptions to any classification scheme, this update considered groups according to their common sources of contamination—those naturally occurring and those caused by human activities (anthropogenic). Each of these sources includes more than one contaminant group. A listing of the contaminant groups and the individual constituents belonging to those groups, summarized in this report, is included in Appendix F.

Naturally Occurring Sources

In this report, naturally occurring sources include three primary groups: (1) inorganic constituents with primary MCLs, (2) inorganic constituents with secondary MCLs, and (3) radiological constituents. Inorganics primarily include naturally occurring minerals such as arsenic or mercury, although human activities may certainly contribute to observed concentrations. Radiological constituents include primarily naturally occurring constituents such as radon, gross alpha, and uranium. Although radioactivity is not considered a significant contaminant statewide, it can be locally important, particularly in communities in the Sierra Nevada.

Anthropogenic Sources

Anthropogenic contaminants include pesticides, volatile organic compounds (VOCs), and nitrates. Pesticides and VOCs are often grouped together into an organic contaminant group. However, separating the two gives a general idea of which contaminants are primarily from agricultural activities (pesticides) and which are primarily from industrial activities (VOCs). One notable exception to the groupings is dibromochloropropane (DBCP). Even though this compound is a VOC, DBCP is a soil fumigant and is included with pesticides. Nitrates are a surprising anthropogenic class to some observers. Nitrogen is certainly a naturally occurring inorganic constituent. However, because most nitrates are associated with agriculture (see Box P, "Focused on Nitrates: Detailed Study of a Contaminant") and nitrates are among California's leading contaminants, it is appropriate to consider them separately from inorganics.

Box P Focused on Nitrates: Detailed Study of a Contaminant

Because water has so many potential uses, the study of water quality means different things to different people. Thomas Harter, a professor at the University of California at Davis, has chosen to focus on nitrates as one of his research interests. Harter's monitoring network consists of 79 wells on 5 dairies in the San Joaquin Valley.

A common result of dairy activities is the release of nitrogen into the surroundings, which changes to nitrate in groundwater. Nitrates are notorious for their role in interfering with oxygen transport in babies, a condition commonly referred to as "blue baby syndrome." Nitrates are also of interest because more public supply wells have been closed due to nitrate contamination than from any other contaminant (Bachman and others 1997).

Harter's study has focused on two primary activities. The first is a meticulous examination of nitrogen at the surface and nitrates in the uppermost 25 feet of the subsurface. This monitoring has been ongoing since 1993, and has shown that a significant amount of nitrate can reach shallow groundwater. The second focus of the study has been to change management practices to reduce the amount of nitrogen available to reach groundwater, along with continued monitoring. This has occurred since 1998. Results of the study are better management practices that significantly reduce the amount of nitrogen available to groundwater. This will help minimize the potential adverse impacts to groundwater quality from nitrates.

Chapter 7

Inventory of California's Groundwater Information

Chapter 7
Inventory of California's Groundwater Information

The groundwater information in this chapter summarizes the available information on statewide and regional groundwater issues. For more detailed information on specific groundwater basins see the supplement to this report that is available on the California Department of Water Resources (DWR) website, http://www.waterplan.water.ca.gov/groundwater/118index.htm. See Appendix A for information on accessing individual basin descriptions and the map delineating California's groundwater basins.

Statewide Groundwater Information

There is a large amount of data available for many of the State's most heavily developed groundwater basins. Conversely, there is relatively little data available on groundwater in the undeveloped areas. The information in this report is generally limited to a compilation of the information readily available to DWR staff and may not include the most up-to-date data generated by studies that have been completed recently by water management agencies. For this reason, the collection of additional, more recent data on groundwater basins should be continued and integrated into the basin descriptions. Statewide summaries are included below.

Groundwater Basins

There are currently 431 groundwater basins delineated, underlying about 40 percent of the surface area of the State. Of those, 24 basins are subdivided into a total of 108 subbasins, giving a total of 515 distinct groundwater systems described in this report (Figure 20). Basin delineation methods are described in Appendix G. Additionally, many of the subbasin boundaries were developed or modified with public input, but little physical data. These boundaries should not be considered as precisely defining a groundwater basin boundary; the determination of whether any particular area lies within a groundwater basin boundary should be determined only after detailed local study.

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated.

Groundwater Budgets

Rather than simply providing all groundwater budget data collected during this update, the budget information was classified into one of three categories indicating the relative level of detail of information available. These categories, types A, B, and C, are discussed in Box R, "Explanation of Groundwater Data Tables." A type A budget indicates that much of the information needed to characterize the groundwater budget for the basin or subbasin was available. DWR staff did not verify these type A budgets, so DWR cannot address the accuracy of the data provided by them. Type B indicates that enough data are available to estimate the groundwater extraction to meet local water use needs. This is useful in understanding the reliance of a particular area on groundwater. Type C indicates a low level of knowledge of any of the budget components for the area.

Figure 21 depicts where these type A, B, and C budgets occur. In general, there is a greater level of understanding (type A or B) in the more heavily developed areas in terms of groundwater use. These include the Central Valley and South Coast. The lowest level of knowledge of groundwater budget data is in the southeast desert area. A discussion of groundwater use in each region is included below.

Box Q How Does the Information in This Report Relate to the Recently Enacted Laws Senate Bill 221 and Senate Bill 610 (2002)?

Recently enacted legislation requires developers of certain new housing projects to demonstrate an available water supply for that development. If a part of that proposed water supply is groundwater, urban water suppliers must provide additional information on the availability of an adequate supply of groundwater to meet the projected demand and show that they have the legal right to extract that amount of groundwater. SB 610 (2002) amended the Water Code to require, among other things, the following information (Section 10631(b)(2)):

> *For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.*

The hydrogeologic information contained in the basin descriptions that supplement this update of Bulletin 118 includes only the information that was available in California Department of Water Resources (DWR) files through reference searches and through limited contact with local agencies. Local agencies may have conducted more recent studies that have generated additional information about water budgets and aquifer characteristics. Unless the agency notified DWR, or provided a copy of the recent reports to DWR staff, that recent information has not been included in the basin descriptions. Therefore, although SB 610 refers to groundwater basins identified as overdrafted in Bulletin 118, it would be prudent for local water suppliers to evaluate the potential for overdraft of any basin included as a part of a water supply assessment.

Persons interested in collecting groundwater information in accordance with the Water Code as amended by SB 221 and SB 610 may start with the information in Bulletin 118, but should follow up by consulting the references listed for each basin and contacting local water agencies to obtain any new information that is available. Otherwise, evaluation of available groundwater resources as mandated by SB 221 and SB 610 may not be using the most complete and recent information about water budgets and aquifer characteristics.

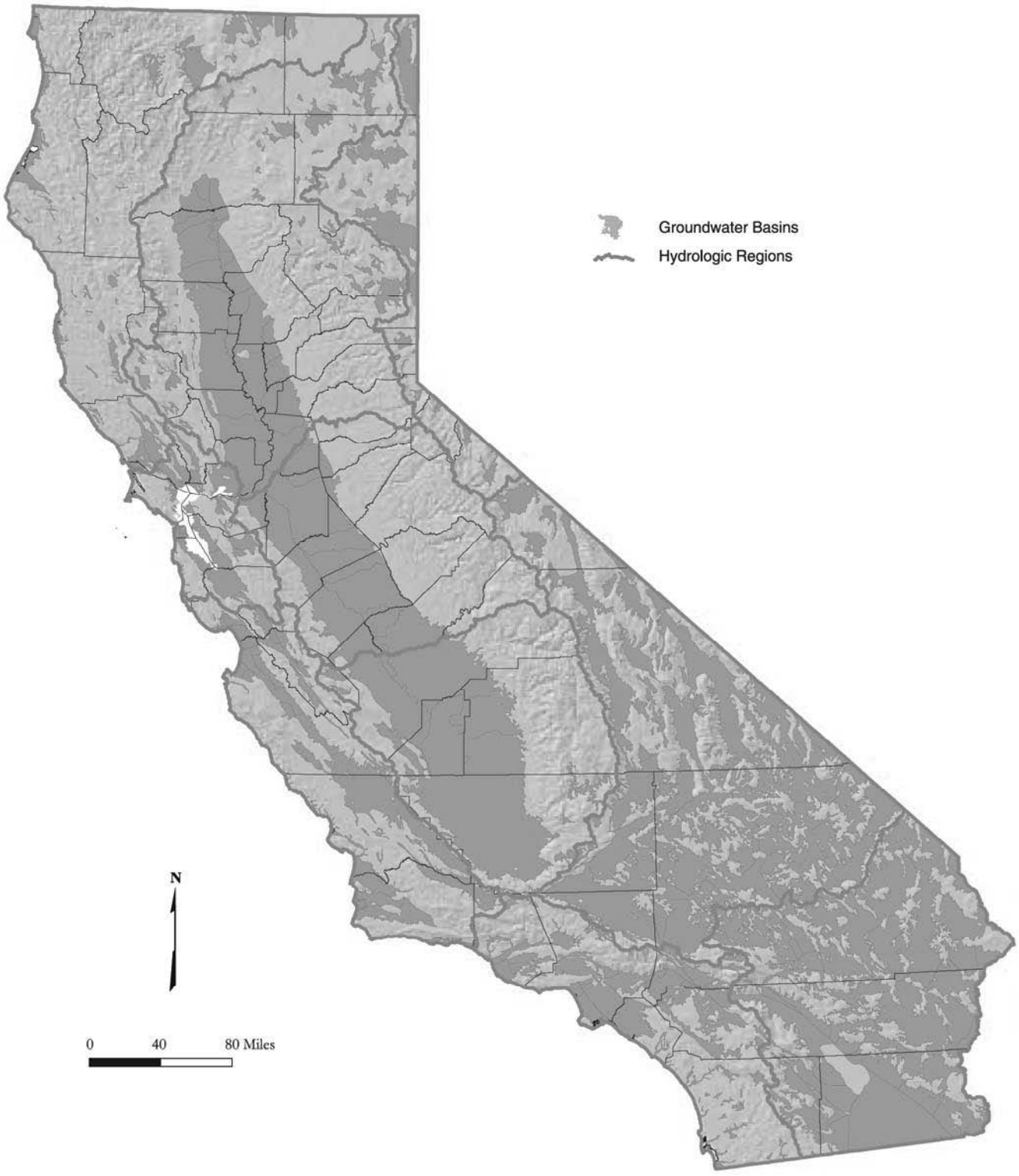

Figure 20 Groundwater basins and subbasins

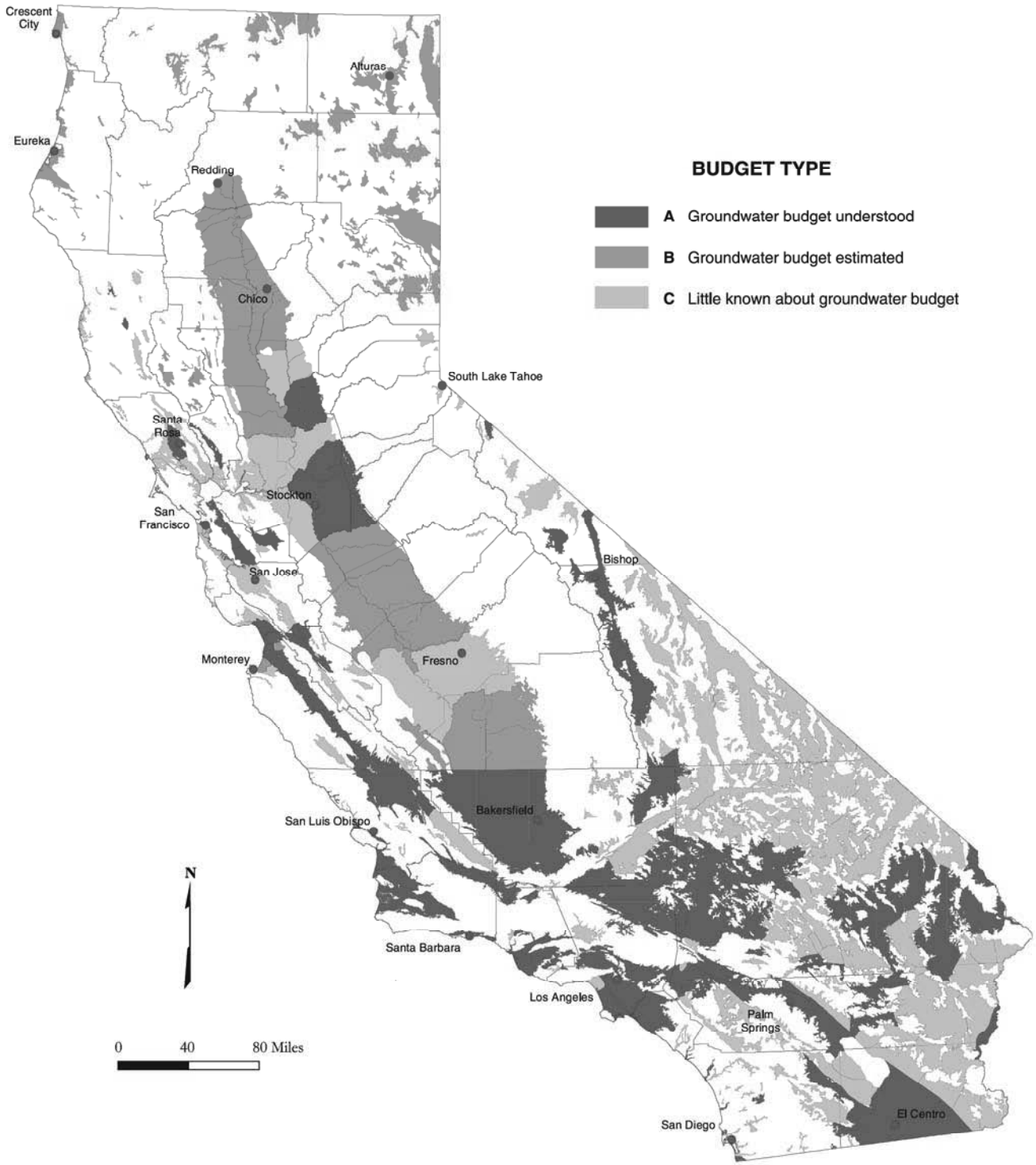

Figure 21 Basin and subbasin groundwater budget types

Box R Explanation of Groundwater Data Tables

A groundwater data table for each hydrologic region is included at the end of each hydrologic region section in Chapter 7. The tables include the following information:

Basin/Subbasin Number. The basin numbering format is x-xxx.xx. The first number in the sequence assigns the basin to one of the nine Regional Water Quality Control Board boundaries. The second number is the groundwater basin number. Any number following the decimal identifies that the groundwater basin has been further divided into subbasins. Reevaluation of available hydrogeologic information resulted in the deletion of some basins and subbasins identified in Bulletins 118-75 and 118-80. Because of this, there are some gaps in the sequence of basin numbers in this report. The methods used for developing the current groundwater basin maps are discussed in Appendix H. The names and numbers of the basins deleted, along with any comments related to their elimination are included in the appropriate region in Chapter 7. Previously unidentified groundwater basins or subbasins that were delineated during this update are assigned new identification numbers that sequentially follow the last number used in Bulletin 118-80 for groundwater basins or subbasins.

Basin or Subbasin Name. Basin names are based on published and unpublished reports, topographic maps, and local terminology. Names of more recently delineated basins or subbasins are based on the principal geographic feature, which in most cases corresponds to the name of a valley. In the case of a subbasin, its formal name should include the name of the basin (for example, Sacramento Valley Groundwater Basin, North American Subbasin). However, both locally and informally, the term subbasin is used interchangeably with basin (for example, North American Basin).

Area. The area for each basin or subbasin is presented in acres rounded to three significant figures (for example, 147,148 acres was rounded to 147,000 acres). The area describes only the upper surface or map view of a basin. The basin underlies the area and may extend beyond the surface expression (discussed in Chapter 6).

Groundwater Budget Type. The type of groundwater budget information available was classified as Type A, B, or C based on the following criteria:

Type A – indicates one of the following: (1) a groundwater budget exists for the basin or enough components from separate studies could be combined to give a general indication of the basin's groundwater budget, (2) a groundwater model exists for the basin that can be used to calculate a groundwater budget, or (3) actual groundwater extraction data exist for the basin.

Type B – indicates that a use-based estimate of groundwater extraction is calculated for the basin. The use-based estimate is determined by calculating the overall use from California Department of Water Resources land use and urban water use surveys. Known surface water supplies are then subtracted from the total demand leaving the rest of the use to be met by groundwater extraction.

Type C – indicates that there are not enough data to provide either an estimate of the basin's groundwater budget or groundwater extraction from the basin.

Well Yields. Maximum and average well yields in gallons per minute (gpm) are reported for municipal supply and agricultural wells where available. Most of the values reported are from initial tests reported during construction of the well, which may not be an accurate indication of the long-term production capacity of the wells.

Box R continued on next page

Box R Explanation of Groundwater Data Tables (continued)

Types of Monitoring. This includes monitoring of both groundwater levels and quality. "Levels" indicate the number of wells actively monitored without consideration of frequency. Most wells are monitored semi-annually, but many are monitored monthly. "Quality" indicates the number of wells monitored for various constituents; these could range from a grab sample taken for a field specific conductance measurement to a full analysis of organic and inorganic constituents. "Title 22" indicates the number of public water system wells that are actively sampled and monitored under the direction of California Department of Health Services (DHS) Title 22 Program.

Total Dissolved Solids. This category includes range and average values of total dissolved solids (TDS). This data primarily represents data from published reports. In some cases, a range of average TDS values is presented.

Active Monitoring

The summary of active monitoring includes wells that are monitored for groundwater elevation or groundwater quality within the delineated groundwater basins as of 1999. Groundwater elevation data collected by DWR and cooperators are available online at http://wdl.water.ca.gov. Most of the water quality data are for public supply wells and were provided by the California Department of Health Services (DHS). Other groundwater level and water quality monitoring activities were reported by local agencies during this update. The summary indicates that there are nearly 14,000 wells monitored for groundwater levels, 10,700[1] wells monitored under DHS water quality monitoring program, and 4,700 wells monitored for miscellaneous water quality by other agencies.

[1] These numbers include the wells in basins and subbasins only; throughout the entire state, DHS has responsibility for more than 16,000 public supply wells.

Box S What Happens When an MCL Exceedance Occurs?

All suppliers of domestic water to the public are subject to regulations adopted by the U.S. Environmental Protection Agency under the Safe Drinking Water Act (42 U.S.C. 300f et seq.) as well as by the California Department of Health Services under the California Safe Drinking Water Plan Act (Health and Safety Code §§ 116270-116750).

These regulations include primary drinking water standards that establish maximum contaminant levels (MCLs) for inorganic and organic chemicals and radioactivity. MCLs are based on health protection, technical feasibility, and economic factors.

California requires public water systems to sample their drinking water sources, analyze for regulated contaminants, and determine compliance with the MCLs on a regular basis. Sampling frequency depends on the contaminant, type of water source, and previous sampling results; frequency can range from monthly to once every nine years, or none at all if sampling is waived because the source is not vulnerable to the contaminant.

Primary MCLs are enforceable standards. In California, compliance is usually determined at the wellhead or the surface water intake. To meet water quality standards and comply with regulations, a water system with a contaminant exceeding an MCL must notify the public and remove the source from service or initiate a process and schedule to install treatment for removing the contaminant.

Notification requirements reflect the severity of the associated health risks; immediate health concerns prompt immediate notice to consumers. Violations that do not pose a significant health concern may use a less immediate notification process. In addition to consumer notification, a water system is required by statute to notify the local governing body (for example, city council or county board of supervisors) whenever a drinking water well exceeds an MCL, even if the well is taken out of service.

Detections of regulated contaminants (and certain unregulated contaminants) must also be reported to consumers in the water system's annual Consumer Confidence Report.

Groundwater Quality

The summary of water quality relied heavily on data from the DHS Title 22 water quality monitoring program. The assessment consisted of querying the DHS database for active wells that have constituents exceeding the maximum contaminant level (MCL) for drinking water. Summaries of this assessment for each of the State's hydrologic regions (HRs) are discussed in this chapter.

DHS data are the most comprehensive statewide water quality data set available, but this data set should not be used as a sole indicator of the groundwater quality in California. Data from these wells are not necessarily representative of any given basin; it only represents the quality of groundwater where a public water supply is extracted.

The Natural Resources Defense Council (NRDC 2001) issued a report that concludes California's groundwater resources face a serious long-term threat from contamination. Despite heavy reliance on groundwater, no comprehensive statewide assessments of groundwater quality were available. In response to the NRDC report, the State Water Resources Control Board (SWRCB) is planning a comprehensive assessment of the State's groundwater quality. This program is discussed in Chapter 4, in the section titled "Groundwater Quality Monitoring Act of 2001 (AB 599)."

Regional Groundwater Use

The importance of groundwater as a resource varies regionally throughout the State. For planning purposes, DWR divides California into 10 hydrologic regions (HRs), which correspond to the State's major drainage areas. HR boundaries are shown in Figure 22. A review of average water year supplies from the California Water Plan (DWR 1998) shows the importance of groundwater as a local supply for agricultural and municipal use throughout the State and in each of California's 10 HRs (Table 12 and Figure 23).

Table 12 Annual agricultural and municipal water demands met by groundwater

Hydrologic region	Total Demand Volume (TAF)	Demand met by Groundwater (TAF)	Demand met by Groundwater (%)
North Coast	1063	263	25
San Francisco Bay	1353	68	5
Central Coast	1263	1045	83
South Coast	5124	1177	23
Sacramento River	8720	2672	31
San Joaquin River	7361	2195	30
Tulare Lake	10556	4340	41
North Lahontan	568	157	28
South Lahontan	480	239	50
Colorado River	4467	337	8

Source: DWR 1998

With more than 80 percent of demand met by groundwater, the Central Coast HR is heavily reliant on groundwater to meet its local needs. The Tulare Lake and South Lahontan HRs meet more than 40 percent of their local demand from groundwater. The South Coast, North Coast, North Lahontan, San Joaquin River, and Sacramento River HRs take between 20 and 40 percent of their supply from groundwater. Groundwater is a relatively minor source of supply in the San Francisco Bay and Colorado River HRs.

Of all the groundwater extracted annually in the state, an estimated 35 percent is produced from the Tulare Lake HR. More than 70 percent of groundwater extraction occurs in the Central Valley (Tulare Lake, San Joaquin River, and Sacramento River HRs combined). Nearly 20 percent is extracted in the highly urbanized South Coast and Central Coast HRs, while less than 10 percent is extracted in the remaining five HRs combined.

Figure 22 California's 10 hydrologic regions

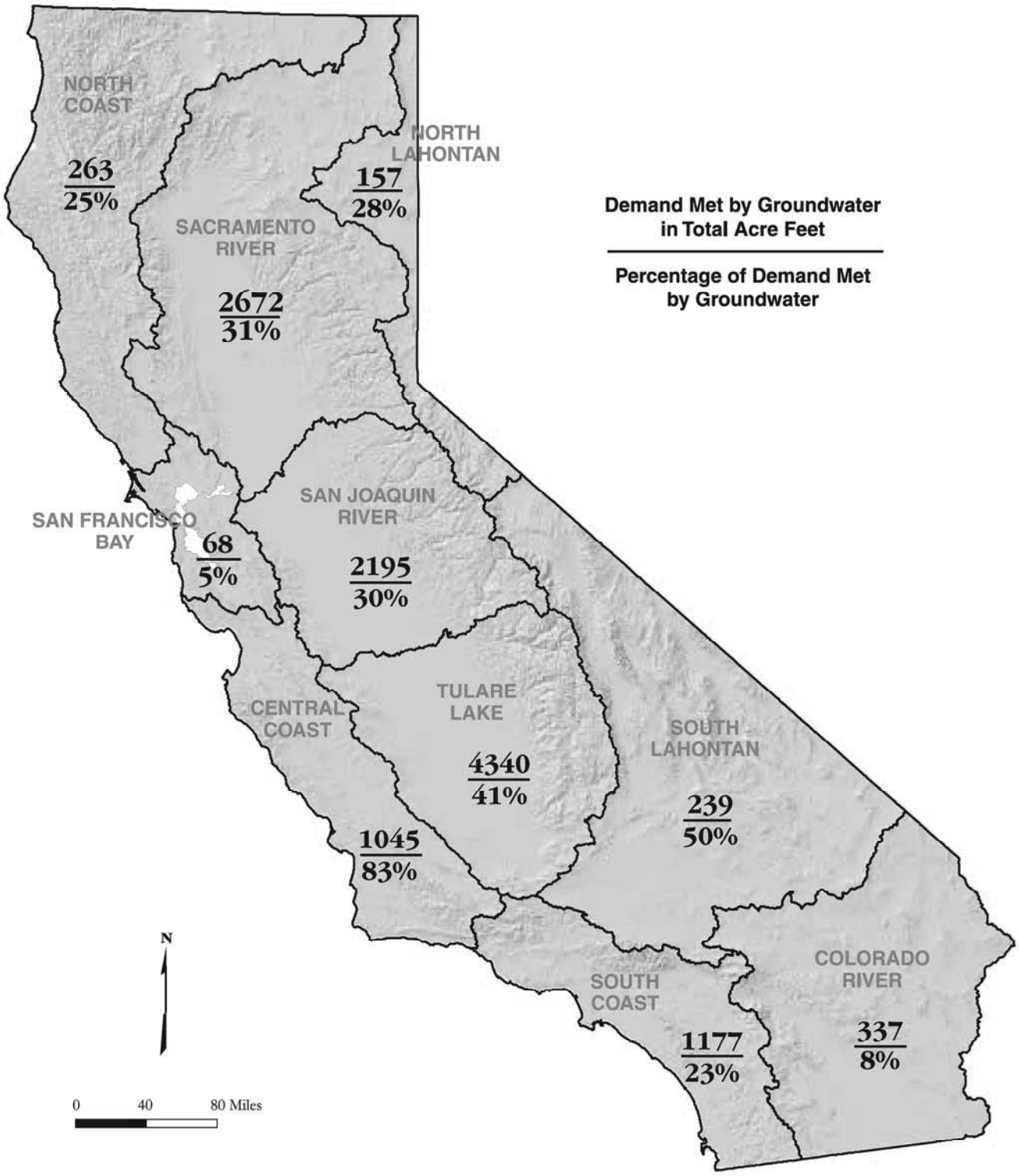

Figure 23 Agricultural and urban demand supplied by groundwater in each hydrologic region

The remainder of this chapter provides a summary of each of the 10 HRs. A basin location map for each HR is followed by a brief discussion of groundwater occurrence and groundwater conditions. A summary tabulation of groundwater information for each groundwater basin within the HR is provided. Greater detail for the data presented in these tables, including a bibliography, is provided in the individual basin/subbasin descriptions in the supplemental report (see Appendix A). Because the groundwater basin numbers are based on the boundaries of the State's nine Regional Water Quality Control Boards (RWQCB), Figure 24 shows the relationship between the Regional Board boundaries and DWR's HR boundaries.

The groundwater basin tabulations give an overview of available data. Where a basin is divided into subbasins, only the information for the subbasins is provided. The data for each subbasin generally come from different sources, so it is inappropriate to sum the data into a larger basin summary. An explanation of each of the data items presented in the summary table is provided in Box R.

Figure 24 Regional Water Quality Control Board regions and Department of Water Resources hydrologic regions

North Coast Hydrologic Region

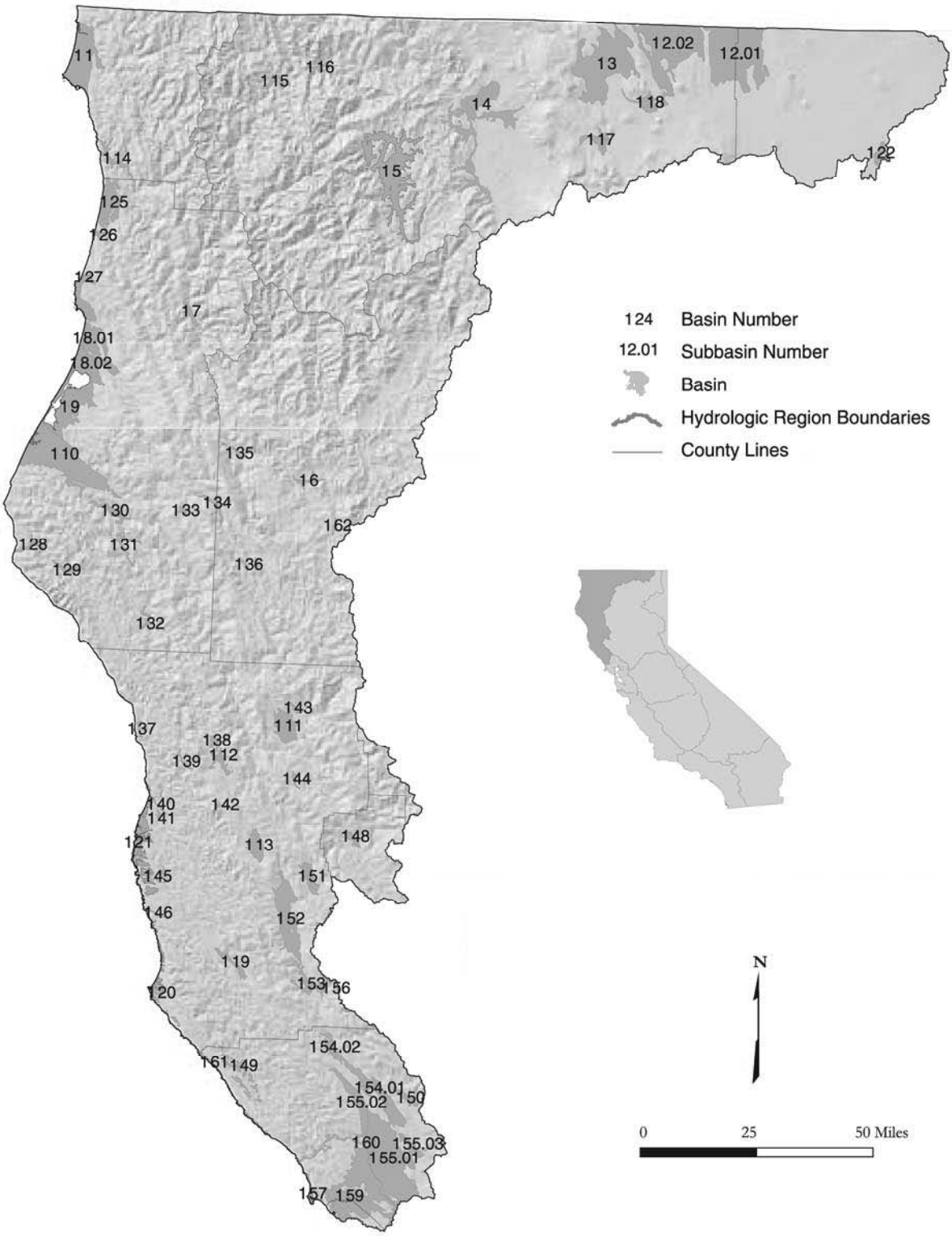

Figure 25 North Coast Hydrologic Region

Basins and Subbasins of the North Coast Hydrologic Region

Basin/subbasin	Basin name
1-1	Smith River Plain
1-2	Klamath River Valley
1-2.01	Tule Lake
1-2.02	Lower Klamath
1-3	Butte Valley
1-4	Shasta Valley
1-5	Scott River Valley
1-6	Hayfork Valley
1-7	Hoopa Valley
1-8	Mad River Valley
1-8.01	Mad River Lowland
1-8.02	Dows Prairie School Area
1-9	Eureka Plain
1-10	Eel River Valley
1-11	Covelo Round Valley
1-12	Laytonville Valley
1-13	Little Lake Valley
1-14	Lower Klamath River Valley
1-15	Happy Camp Town Area
1-16	Seiad Valley
1-17	Bray Town Area
1-18	Red Rock Valley
1-19	Anderson Valley
1-20	Garcia River Valley
1-21	Fort Bragg Terrace Area
1-22	Fairchild Swamp Valley
1-25	Prairie Creek Area
1-26	Redwood Creek Area
1-27	Big Lagoon Area
1-28	Mattole River Valley
1-29	Honeydew Town Area
1-30	Pepperwood Town Area
1-31	Weott Town Area
1-32	Garberville Town Area
1-33	Larabee Valley
1-34	Dinsmores Town Area
1-35	Hyampom Valley
1-36	Hettenshaw Valley
1-37	Cottoneva Creek Valley
1-38	Lower Laytonville Valley
1-39	Branscomb Town Area
1-40	Ten Mile River Valley
1-41	Little Valley
1-42	Sherwood Valley
1-43	Williams Valley
1-44	Eden Valley
1-45	Big River Valley
1-46	Navarro River Valley
1-48	Gravelley Valley
1-49	Annapolis Ohlson Ranch Formation Highlands
1-50	Knights Valley
1-51	Potter Valley
1-52	Ukiah Valley
1-53	Sanel Valley
1-54	Alexander Valley
1-54.01	Alexander Area
1-54.02	Cloverdale Area
1-55	Santa Rosa Valley
1-55.01	Santa Rosa Plain
1-55.02	Healdsburg Area
1-55.03	Rincon Valley
1-56	McDowell Valley
1-57	Bodega Bay Area
1-59	Wilson Grove Formation Highlands
1-60	Lower Russian River Valley
1-61	Fort Ross Terrace Deposits
1-62	Wilson Point Area

Description of the Region

The North Coast HR covers approximately 12.46 million acres (19,470 square miles) and includes all or portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake, and Sonoma counties (Figure 25). Small areas of Shasta, Tehama, Glenn, Colusa, and Marin counties are also within the region. Extending from the Oregon border south to Tomales Bay, the region includes portions of four geomorphic provinces. The northern Coast Range forms the portion of the region extending from the southern boundary north to the Mad River drainage and the fault contact with the metamorphic rocks of the Klamath Mountains, which continue north into Oregon. East of the Klamath terrane along the State border are the volcanic terranes of the Cascades and the Modoc Plateau. In the coastal mountains, most of the basins are along the narrow coastal strip between the Pacific Ocean and the rugged Coast Range and Klamath Mountains and along inland river valleys; alluviated basin areas are very sparse in the steep Klamath Mountains. In the volcanic terrane to the east, most of the basins are in block faulted valleys that once held Pleistocene-age lakes. The North Coast HR corresponds to the boundary of RWQCB 1. Significant geographic features include basin areas such as the Klamath River Basin, the Eureka/Arcata area, Hoopa Valley, Anderson Valley, and the Santa Rosa Plain. Other significant features include Mount Shasta, forming the southern border of Shasta Valley, and the rugged north coastal shoreline. The 1995 population of the entire region was about 606,000, with most being centered along the Pacific Coast and in the inland valleys north of the San Francisco Bay Area.

The northern mountainous portion of the region is rural and sparsely populated, primarily because of the rugged terrain. Most of the area is heavily forested. Some irrigated agriculture occurs in the narrow river valleys, but most occurs in the broader valleys on the Modoc Plateau where pasture, grain and alfalfa predominate. In the southern portion of the region, closer to urban centers, crops like wine grapes, nursery stock, orchards, and truck crops are common.

A majority of the surface water in the North Coast HR goes to environmental uses because of the "wild and scenic" designation of most of the region's rivers. Average annual precipitation ranges from 100 inches in the Smith River drainage to 29 inches in the Santa Rosa area and about 10 inches in the Klamath drainage; as a result, drought is likely to affect the Klamath Basin more than other portions of the region. Communities that are not served by the area's surface water projects also tend to experience shortages. Surface water development in the region includes the U.S. Bureau of Reclamation (USBR) Klamath Project, Humboldt Bay Municipal Water District's Ruth Lake, and U.S. Army Corps of Engineer's Russian River Project. An important factor concerning water demand in the Klamath Project area is water allocation for endangered fish species in the upper and lower basin. Surface water deliveries for agriculture in 2001, a severe drought year, were only about 20 percent of normal.

Groundwater Development

Groundwater development in the North Coast HR occurs along the coast, near the mouths of some of the region's major rivers, on the adjacent narrow marine terraces, or in the inland river valleys and basins. Reliability of these supplies varies significantly from area to area. There are 63 groundwater basins/subbasins delineated in the region, two of which are shared with Oregon. These basins underlie approximately 1.022 million acres (1,600 square miles).

Along the coast, most groundwater is developed from shallow wells installed in the sand and gravel beds of several of the region's rivers. Under California law, the water produced in these areas is considered surface water underflow. Water from Ranney collectors installed in the Klamath River, Rowdy Creek, the Smith

River, and the Mad River supply the towns of Klamath, Smith River and Crescent City in Del Norte County and most of the Humboldt Bay area in Humboldt County. Except on the Mad River, which has continuous supply via releases from Ruth Reservoir, these supplies are dependent on adequate precipitation and flows throughout the season. In drought years when streamflows are low, seawater intrusion can occur causing brackish or saline water to enter these systems. This has been a problem in the town of Klamath, which in 1995 had to obtain community water from a private well source. Toward the southern portion of the region, along the Mendocino coast, the Town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers. Groundwater supply is limited by the aquifer storage capacity, and surveys done in the Town of Mendocino in the mid-1980s indicate that about 10 percent of wells go dry every year and up to 40 percent go dry during drought years.

Groundwater development in the inland coastal valleys north of the divide between the Russian and Eel Rivers is generally of limited extent. Most problems stemming from reliance on groundwater in these areas is a lack of alluvial aquifer storage capacity. Many groundwater wells rely on hydrologic connection to the rivers and streams of the valleys. The City of Rio Dell has experienced water supply problems in community wells and, as a result, recently developed plans to install a Ranney collector near the Eel River. South of the divide, in the Russian River drainage, a significant amount of groundwater development has occurred on the Santa Rosa Plain and surrounding areas. The groundwater supplies augment surface supplies from the Russian River Project.

In the north-central part of the North Coast HR, the major groundwater basins include the Klamath River Valley, Shasta Valley, Scott River Valley, and Butte Valley. The Klamath River Valley is shared with Oregon. Of these groundwater basins, Butte Valley has the most stable water supply conditions. The historical annual agricultural surface water supply has been about 20,000 acre-feet. As farming in the valley expanded from the early 1950s to the early 1990s, bringing nearly all the arable land in the valley into production, groundwater was developed to farm the additional acres. It has been estimated that current, fully developed demands are only about 80 percent of the available groundwater supply. By contrast, water supply issues in the other three basins are contingent upon pending management decisions regarding restoration of fish populations in the Klamath River and the Upper Klamath Basin system. The Endangered Species Act (ESA) fishery issues include lake level requirements for two sucker fish species and in-stream flow requirements for coho salmon and steelhead trout. Since about 1905, the Klamath Project has provided surface water to the agricultural community, which in turn has provided water to the wildlife refuges. Since the early 1990s, it has been recognized that surface water in the Klamath Project is over-allocated, but very little groundwater development had occurred. In 2001, which was a severe drought year, USBR delivered a total of about 75,000 acre-feet of water to agriculture in California, about 20 percent of normal. In the Klamath River Groundwater Basin this translated to a drought disaster, both for agriculture and the wildlife refuges. In addition, there were significant impacts for both coho salmon and sucker fisheries in the Klamath River watershed. As a result of the reduced surface water deliveries, significant groundwater development occurred, and groundwater extraction increased from an estimated 6,000 acre-feet in 1997 to roughly 60,000 acre-feet in 2001. Because of the complexity of the basin's water issues, a long-term Klamath Project Operation plan has not yet been finalized. Since 1995, USBR has issued an annual operation plan based on estimates of available supply. The Scott River Valley and Shasta Valley rely to a significant extent on surface water diversions. In most years, surface water supplies the majority of demand, and groundwater extraction supplements supply as needed depending on wet or dry conditions. Discussions are under way to develop strategies to conjunctively use surface water and groundwater to meet environmental, agricultural, and other demands.

Groundwater Quality

Groundwater quality characteristics and specific local impairments vary with regional setting within the North Coast HR. In general, seawater intrusion and nitrates in shallow aquifers are problems in the coastal groundwater basins; high total dissolved solids (TDS) content and general alkalinity are problems in the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese can be problems in the inland basins of Mendocino and Sonoma counties.

Water Quality in Public Supply Wells

From 1994 through 2000, 584 public supply water wells were sampled in 32 of the 63 basins and subbasins in the North Coast HR. Analyzed samples indicate that 553 wells, or 95%, met the state primary Maximum Contaminant Levels (MCL) for drinking water. Thirty-one wells, or 5%, sampled have constituents that exceed one or more MCL. Figure 26 shows the percentage of each contaminant group that exceeded MCLs in the 31 wells.

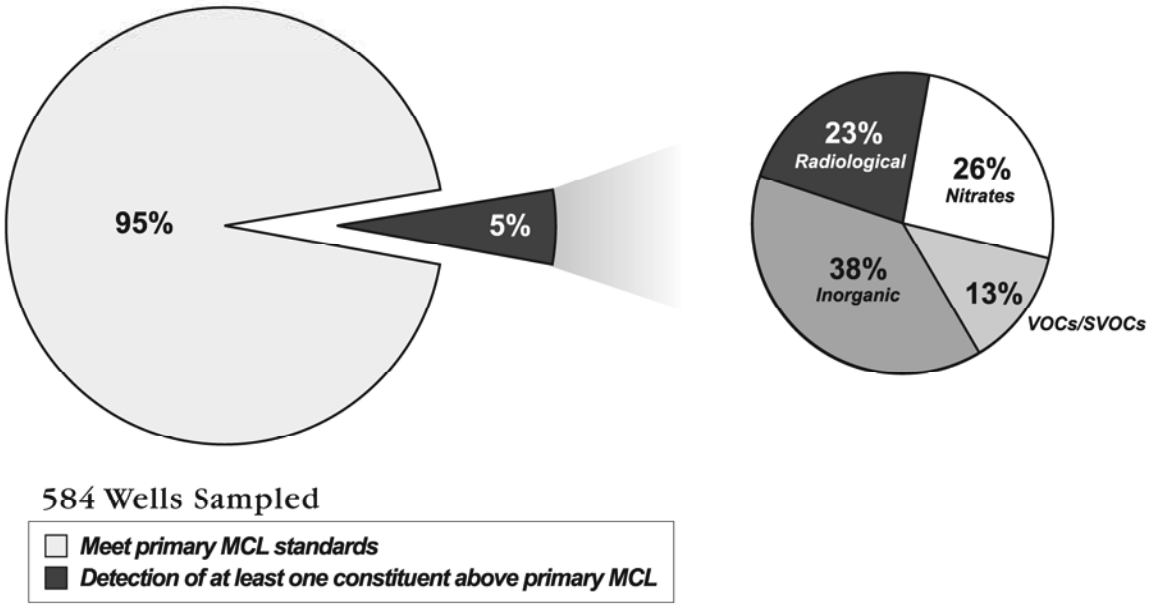

Figure 26 MCL exceedances in public supply wells in the North Coast Hydrologic Region

Table 13 lists the three most frequently occurring individual contaminants in each of the five contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 13 Most frequently occurring contaminants by contaminant group in the North Coast Hydrologic Region

Contaminant group wellsInorganics – Primary exceedance	Contaminant - # of wells Aluminum – 4	Contaminant - # of wells Arsenic – 4	Contaminant - # of 4 tied at 1
Inorganics – Secondary	Manganese – 150	Iron – 108	Copper – 2
Radiological	Radium 228 – 3	Combined RA226 + RA228 – 3	Radium 226 – 1
Nitrates	Nitrate(as NO_3) – 7	Nitrite(as N) – 1	
VOCs/SVOCs	TCE – 2	3 tied at 1 exceedance	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 14, along with other modifications to North Coast HR.

Table 14 Modifications since Bulletin 118-80 of groundwater basins in North Coast Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21
Modoc Plateau Recent Volcanic Area	deleted	1-23
Modoc Plateau Pleistocene Volcanic Area	deleted	1-24
Gualala River Valley	deleted	1-47
Wilson Grove Formation Highlands	1-59	2-25
Fort Ross Terrace Deposits	1-61	
Wilson Point Area	1-62	

Fort Ross Terrace Deposits (1-61) and Wilson Point Area (1-62) have been defined since B118-80 and are included in this update. Mad River Valley Groundwater Basin (1-8) has been subdivided into two subbasins. Sebastopol Merced Formation (2-25) merged into Basin 1-59 and was renamed Wilson Grove Formation Highlands.

There are a couple of deletions of groundwater basins from Bulletin 118-80. The Modoc Plateau Recent Volcanic Area (1-23) and the Modoc Plateau Pleistocene Volcanic Area (1-24) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6. Gualala River Valley (1-47) was deleted because the State Water Resources Control Board determined the water being extracted in this area as surface water within a subterranean stream.

Table 15 North Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-1	SMITH RIVER PLAIN	40,450	B	500	50	7	10	33	164	32 - 496
1-2	KLAMATH RIVER VALLEY									
1-2.01	UPPER KLAMATH LAKE BASIN - Tule Lake	85,930	B	3,380	1,208	40	8	5	721	140 - 2,200
1-2.02	UPPER KLAMATH LAKE BASIN - Lower Klamath	73,330	B	2,600	1,550	4	-	-	-	-
1-3	BUTTE VALLEY	79,700	B	5,000	2,358	28	13	9	310	55 - 1,110
1-4	SHASTA VALLEY	52,640	B	1,200	273	9	15	24	-	-
1-5	SCOTT RIVER VALLEY	63,900	B	3,000	794	6	10	5	258	47 - 1,510
1-6	HAYFORK VALLEY	3,300	B	200	-	-	5	-	-	-
1-7	HOOPA VALLEY	3,900	B	300	-	-	4	-	125	95 - 159
1-8	MAD RIVER VALLEY									
1-8.01	MAD RIVER VALLEY LOWLAND	25,600	B	120	72	4	9	2	184	55 - 280
1-8.02	DOWS PRAIRIE SCHOOL AREA	14,000	B	-	-	-	3	-	-	-
1-9	EUREKA PLAIN	37,400	B	1,200	-	4	4	6	177	97 - 460
1-10	EEL RIVER VALLEY	73,700	B	1,200	-	8	11	29	237	110 - 340
1-11	COVELO ROUND VALLEY	16,400	C	850	193	9	5	29	239	116 - 381
1-12	LAYTONVILLE VALLEY	5,020	A	700	7	4	3	-	149	53 - 251
1-13	LITTLE LAKE VALLEY	10,000	A	1,000	45	7	7	-	340	97 - 1,710
1-14	LOWER KLAMATH RIVER VALLEY	7,030	B	-	-	-	-	-	-	43 - 150
1-15	HAPPY CAMP TOWN AREA	2,770	B	-	-	-	-	17	-	-
1-16	SEIAD VALLEY	2,250	B	-	-	-	2	2	-	-
1-17	BRAY TOWN AREA	8,030	B	-	-	-	-	-	-	-
1-18	RED ROCK VALLEY	9,000	B	-	-	-	-	-	-	-
1-19	ANDERSON VALLEY	4,970	C	300	30	7	5	7	-	80 - 400
1-20	GARCIA RIVER VALLEY	2,240	C	-	-	-	-	-	-	-
1-21	FORT BRAGG TERRACE AREA	24,100	C	75	14	-	-	51	185	26 - 650
1-22	FAIRCHILD SWAMP VALLEY	3,300	B	-	-	-	-	-	-	-
1-25	PRAIRIE CREEK AREA	20,000	B	-	-	-	-	1	106	-
1-26	REDWOOD CREEK AREA	2,000	B	-	-	1	0	4	-	102 - 332
1-27	BIG LAGOON AREA	13,400	B	-	-	1	0	31	174	-
1-28	MATTOLE RIVER VALLEY	3,150	B	-	-	-	-	2	-	-
1-29	HONEYDEW TOWN AREA	2,370	B	-	-	-	-	1	-	-
1-30	PEPPERWOOD TOWN AREA	6,290	B	-	-	-	-	1	-	-
1-31	WEOTT TOWN AREA	3,650	B	-	-	-	-	2	-	-
1-32	GARBERVILLE TOWN AREA	2,100	B	-	-	-	-	5	-	-
1-33	LARABEE VALLEY	970	B	-	-	-	-	-	-	-
1-34	DINSMORES TOWN AREA	2,300	B	-	-	-	-	3	-	-
1-35	HYAMPOM VALLEY	1,350	B	-	-	-	-	1	-	-
1-36	HETTENSHAW VALLEY	850	B	-	-	-	-	-	-	-
1-37	COTTONEVA CREEK VALLEY	760	C	-	-	-	-	-	118	118
1-38	LOWER LAYTONVILLE VALLEY	2,150	C	-	-	-	-	-	-	-
1-39	BRANSCOMB TOWN AREA	1,320	C	-	-	-	-	-	130	80 - 179
1-40	TEN MILE RIVER VALLEY	1,490	C	-	-	-	-	-	-	-
1-41	LITTLE VALLEY	810	C	-	-	-	-	-	-	-

Table 15 North Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-42	SHERWOOD VALLEY	1,150	C	-	-	-	-	-	-	-
1-43	WILLIAMS VALLEY	1,640	C	-	-	-	-	-	-	-
1-44	EDEN VALLEY	1,380	C	-	-	-	-	-	140	140
1-45	BIG RIVER VALLEY	1,690	C	-	-	-	-	2	-	-
1-46	NAVARRO RIVER VALLEY	770	C	-	-	-	-	-	-	-
1-48	GRAVELLEY VALLEY	3,000	C	-	-	-	-	3	-	-
1-49	ANAPOLIS OHLSON RANCH FOR. HIGHLANDS	8,650	C	36	-	-	0	1	260	260
1-50	KNIGHTS VALLEY	4,090	C	-	-	-	-	-	-	-
1-51	POTTER VALLEY	8,240	C	100	-	2	0	1	-	140 - 395
1-52	UKIAH VALLEY									
1-53	SANEL VALLEY	5,570	C	1,250	-	5	8	6	-	174 - 306
1-54	ALEXANDER VALLEY									
1-54.01	ALEXANDER AREA									
1-54.02	CLOVERDALE AREA	6,500	C	-	500	3	-	13	-	130 - 304
1-55	SANTA ROSA VALLEY									
1-55.01	SANTA ROSA PLAIN	80,000	A	1,500	-	43	-	155	-	-
1-55.02	HEALDSBURG AREA	15,400	C	500	-	8	-	28	-	90 - 500
1-55.03	RINCON VALLEY	5,600	C	-	-	2	-	12	-	-
1-56	McDOWELL VALLEY	1,500	C	1,200	-	-	-	-	145	143 - 146
1-57	BODEGA BAY AREA	2,680	A	150	-	-	-	6	-	-
1-59	WILSON GROVE FORMATION HIGHLANDS	81,500	C	-	-	14	-	68	-	-
1-60	LOWER RUSSIAN RIVER VALLEY	6,600	C	500 +	-	1	-	32	-	120 - 210
1-61	FORT ROSS TERRACE DEPOSITS	8,490	C	75	27	-	-	13	320	230 - 380
1-62	WILSON POINT AREA	700	B	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS = total dissolved solids

San Francisco Bay Hydrologic Region

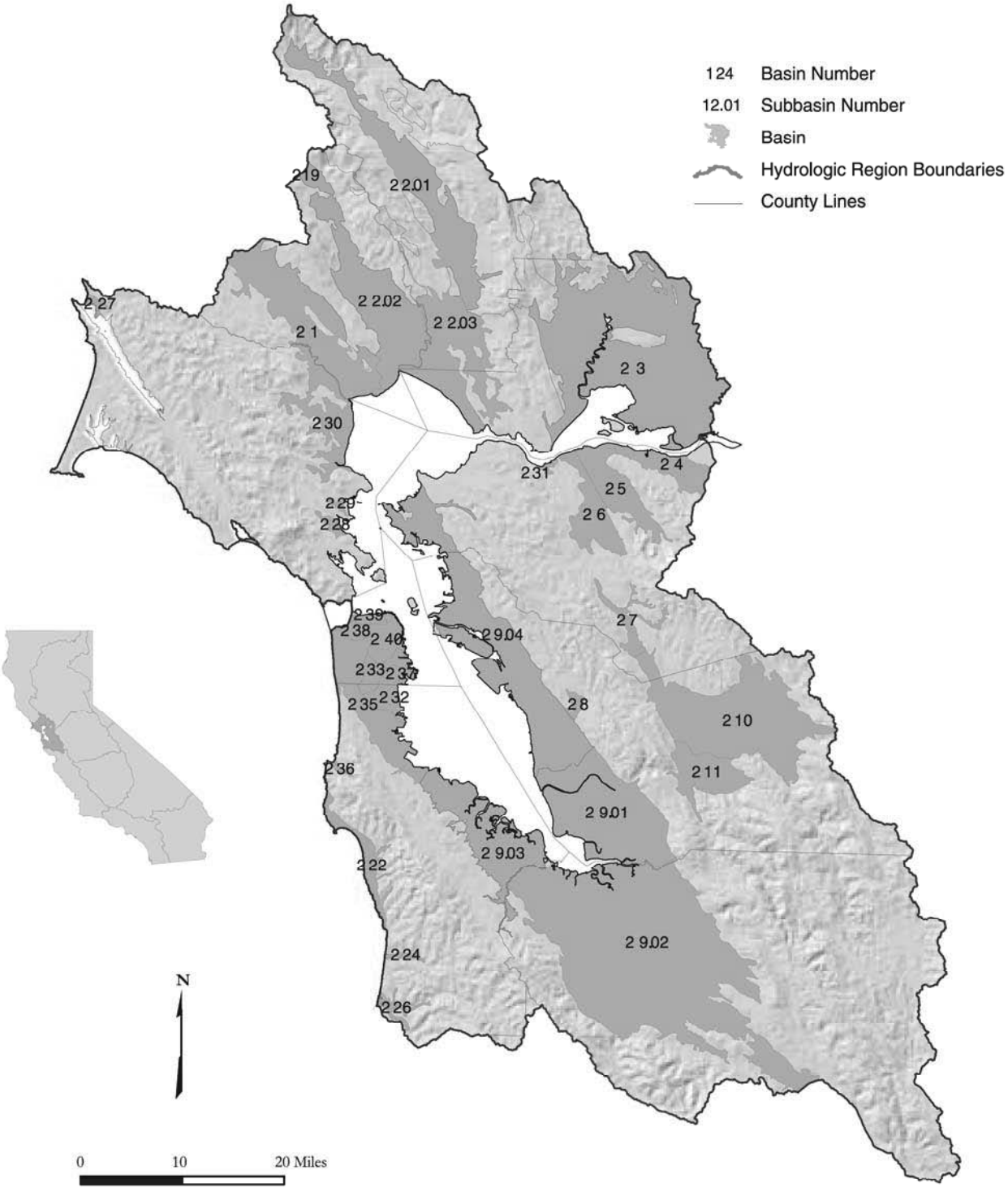

Figure 27 San Francisco Bay Hydrologic Region

Basins and Subbasins of the San Francisco Bay Hydrologic Region

Basin/subbasin	Basin name
2-1	Petaluma Valley
2-2	Napa-Sonoma Valley
2-2.01	Napa Valley
2-2.02	Sonoma Valley
2-2.03	Napa-Sonoma Lowlands
2-3	Suisun-Fairfield Valley
2-4	Pittsburg Plain
2-5	Clayton Valley
2-6	Ygnacio Valley
2-7	San Ramon Valley
2-8	Castro Valley
2-9	Santa Clara Valley
2-9.01	Niles Cone
2-9.02	Santa Clara
2-9.03	San Mateo Plain
2-9.04	East Bay Plain
2-10	Livermore Valley
2-11	Sunol Valley
2-19	Kenwood Valley
2-22	Half Moon Bay Terrace
2-24	San Gregorio Valley
2-26	Pescadero Valley
2-27	Sand Point Area
2-28	Ross Valley
2-29	San Rafael Valley
2-30	Novato Valley
2-31	Arroyo Del Hambre Valley
2-32	Visitacion Valley
2-33	Islais Valley
2-35	Merced Valley
2-36	San Pedro Valley
2-37	South San Francisco
2-38	Lobos
2-39	Marina
2-40	Downtown San Francisco

Description of the Region

The San Francisco Bay HR covers approximately 2.88 million acres (4,500 square miles) and includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties (Figure 27). The region corresponds to the boundary of RWQCB 2. Significant geographic features include the Santa Clara, Napa, Sonoma, Petaluma, Suisun-Fairfield, and Livermore valleys; the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Range. While being the smallest in size of the 10 HRs, the region has the second largest population in the State at about 5.8 million in 1995 (DWR 1998). Major population centers include the cities of San Francisco, San Jose and Oakland.

Groundwater Development

The region has 28 identified groundwater basins. Two of those, the Napa-Sonoma Valley and Santa Clara Valley groundwater basins, are further divided into three and four subbasins, respectively. The groundwater basins underlie approximately 896,000 acres (1,400 square miles) or about 30 percent of the entire HR.

Despite the tremendous urban development in the region, groundwater use accounts for only about 5 percent (68,000 acre-feet) of the region's estimated average water supply for agricultural and urban uses, and accounts for less than one percent of statewide groundwater uses.

In general, the freshwater-bearing aquifers are relatively thin in the smaller basins and moderately thick in the more heavily utilized basins. The more heavily utilized basins in this region include the Santa Clara Valley, Napa-Sonoma Valley, and Petaluma Valley groundwater basins. In these basins, the municipal and irrigation wells have average depths ranging from about 200 to 500 feet. Well yields in these basins range from less than 50 gallons per minute (gpm) to approximately 3,000 gpm. In the smaller basins, most municipal and irrigation wells have average well depths in the 100- to 200-foot range. Well yields in the smaller and less utilized basins are typically less than 500 gpm.

Land subsidence has been a significant problem in the Santa Clara Valley Groundwater Basin in the past. An extensive annual monitoring program has been set up within the basin to evaluate changes in an effort to maintain land subsidence at less than 0.01 feet per year (SCVWD 2001). Additionally, groundwater recharge projects have been implemented in the Santa Clara Valley to ensure that groundwater will continue to be a viable water supply in the future.

Groundwater Quality

In general, groundwater quality throughout most of the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, boron, and organic compounds.

The areas of high TDS (and chloride) concentrations are typically found in the region's groundwater basins that are situated close to the San Francisco Bay, such as the northern Santa Clara, southern Sonoma, Petaluma, and Napa valleys. Elevated levels of nitrate have been detected in a large percentage of private wells tested within the Coyote Subbasin and Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (in the Central Coast HR) located to the south of the Santa Clara Valley (SCVWD 2001). The shallow aquifer zone within the Petaluma Valley also shows persistent nitrate contamination. Groundwater with high TDS, iron, and boron levels is present in the Calistoga area of Napa Valley, and elevated boron levels in other parts of Napa Valley make the water unfit for agricultural uses. Releases of fuel hydrocarbons from leaking underground storage tanks and spills/leaks of organic solvents at industrial sites have caused minor to significant groundwater impacts in many basins throughout the region. Methyl tertiary-butyl ether (MTBE) and chlorinated solvent releases to soil and groundwater continue to be problematic. Environmental oversight for many of these sites is performed either by local city and county enforcement agencies, the RWQCB, the Department of Toxic Substances Control, and/or the U.S. Environmental Protection Agency.

Water Quality in Public Supply Wells

From 1994 through 2000, 485 public supply water wells were sampled in 18 of the 33 basins and subbasins in the San Francisco Bay HR. Analyzed samples indicate that 410 wells, or 85 percent, met the state primary MCLs for drinking water standards. Seventy-five wells, or 15 percent, have constituents that exceed one or more MCL. Figure 28 shows the percentages of each contaminant group that exceeded MCLs in the 75 wells.

Table 16 lists the three most frequently occurring contaminants in each contaminant group and the number of wells in the HR that exceeded the MCL for those contaminants.

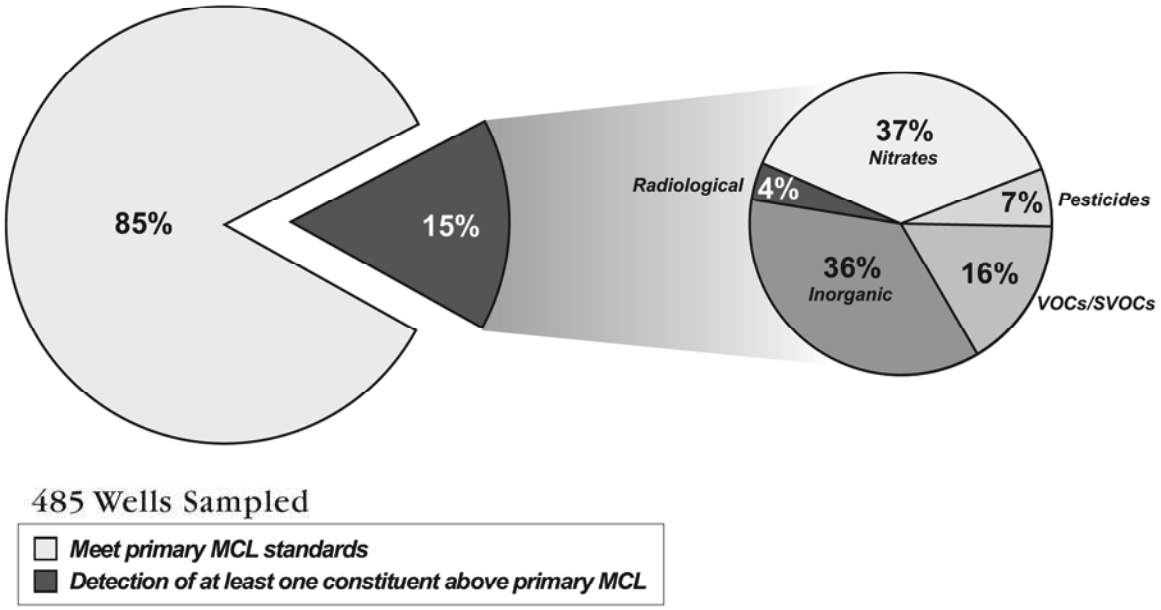

Figure 28 MCL exceedances in public supply wells in the San Francisco Bay Hydrologic Region

Table 16 Most frequently occurring contaminants by contaminant group in the San Francisco Bay Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics	Iron – 57	Manganese – 57	Fluoride – 7
Radiological	Gross Alpha – 2	Radium 226 – 1	
Nitrates	Nitrate (as NO_3) – 27	Nitrate + Nitrite – 3	Nitrite (as N) – 1
Pesticides	Di(2-Ethylhexyl)phthalate – 4	Heptachlor – 1	
VOCs/SVOCs	PCE – 4	Dichloromethane – 3	TCE– 2 Vinyl Chloride – 2

TCE = Trichloroethylene
PCE = Tetrachloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Coumpound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 17.

Table 17 Modifications since Bulletin 118-80 of groundwater basins in San Francisco Bay Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21

No additional basins were assigned to the San Francisco Bay HR in this revision. However, the Santa Clara Valley Groundwater Basin (2-9) has been subdivided into four subbasins instead of two, and the Napa-Sonoma Valley Groundwater Basin is now three subbasins instead of two.

There are several deletions of groundwater basins from Bulletin 118-80. The San Francisco Sand Dune Area (2-34) was deleted when the San Francisco groundwater basins were redefined in a USGS report in the early 1990s. The Napa-Sonoma Volcanic Highlands (2-23) is a volcanic aquifer and was not assigned a basin number in this bulletin. This is considered to be a groundwater source area as discussed in Chapter 6. Bulletin 118-80 identified seven groundwater basins that were stated to differ from 118-75: Sonoma County Basin, Napa County Basin, Santa Clara County Basin, San Mateo Basin, Alameda Bay Plain Basin, Niles Cone Basin, and Livermore Basin. They were created primarily by combining several smaller basins and subbasins within individual counties. This report does not consider these seven as basins. There is no change in numbering because the basins were never assigned a basin number.

Table 18 San Francisco Bay Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
2-1	PETALUMA VALLEY	46,100	C	100	-	16	7	24	347	58-650
2-2	NAPA-SONOMA VALLEY									
2-2.01	NAPA VALLEY	45,900	A	3,000	223	19	10	23	272	150-370
2-2.02	SONOMA VALLEY	44,700	C	1,140	516	18	9	35	321	100-550
2-2.03	NAPA-SONOMA LOWLANDS	40,500	C	300	98	0	6	9	185	50-300
2-3	SUISUN-FAIRFIELD VALLEY	133,600	C	500	200	21	17	35	410	160-740
2-4	PITTSBURG PLAIN	11,600	C	-	-	-	-	9	-	-
2-5	CLAYTON VALLEY	17,800	C	-	-	-	-	48	-	-
2-6	YGNACIO VALLEY	15,500	C	-	-	-	-	-	-	-
2-7	SAN RAMON VALLEY	7,060	C	-	-	-	-	-	-	-
2-8	CASTRO VALLEY	1,820	C	-	-	-	-	-	-	-
2-9	SANTA CLARA VALLEY									
2-9.01	NILES CONE	57,900	A	3,000	2,000	350	120	20	-	-
2-9.02	SANTA CLARA	190,000	C	-	-	-	10	234	408	200-931
2-9.03	SAN MATEO PLAIN	48,100	C	-	-	-	2	14	407	300-480
2-9.04	EAST BAY PLAIN	77,400	A	1,000	UNK	29	16	7	638	364-1,420
2-10	LIVERMORE VALLEY	69,500	A	-	-	-	-	36	-	-
2-11	SUNOL VALLEY	16,600	C	-	-	-	-	2	-	-
2-19	KENWOOD VALLEY	3,170	C	-	-	-	-	13	-	-
2-22	HALF MOON BAY TERRACE	9,150	C	-	-	5	-	9	-	-
2-24	SAN GREGORIO VALLEY	1,070	C	-	-	-	-	-	-	-
2-26	PESCADERO VALLEY	2,900	C	-	-	3	-	4	-	-
2-27	SAND POINT AREA	1,400	C	-	-	-	-	6	-	-
2-28	ROSS VALLEY	1,770	C	-	-	-	-	-	-	-
2-29	SAN RAFAEL VALLEY	880	C	-	-	-	-	-	-	-
2-30	NOVATO VALLEY	20,500	C	-	-	-	-	1	-	-
2-31	ARROYO DEL HAMBRE VALLEY	790	C	-	-	-	-	-	-	-
2-32	VISITACION VALLEY	880	C	-	-	-	-	-	-	-
2-33	ISLAIS VALLEY	1,550	C	-	-	-	-	-	-	-
2-35	MERCED VALLEY	10,400	C	-	-	-	-	10	-	-
2-36	SAN PEDRO VALLEY	880	C	-	-	-	-	-	-	-
2-37	SOUTH SAN FRANCISCO	2,170	C	-	-	-	-	-	-	-
2-38	LOBOS	2,400	A	-	-	-	-	-	-	-
2-39	MARINA	220	A	-	-	-	-	-	-	-
2-40	DOWNTOWN SAN FRANCISCO	7,600	C	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS - total dissolved solids

Central Coast Hydrologic Region

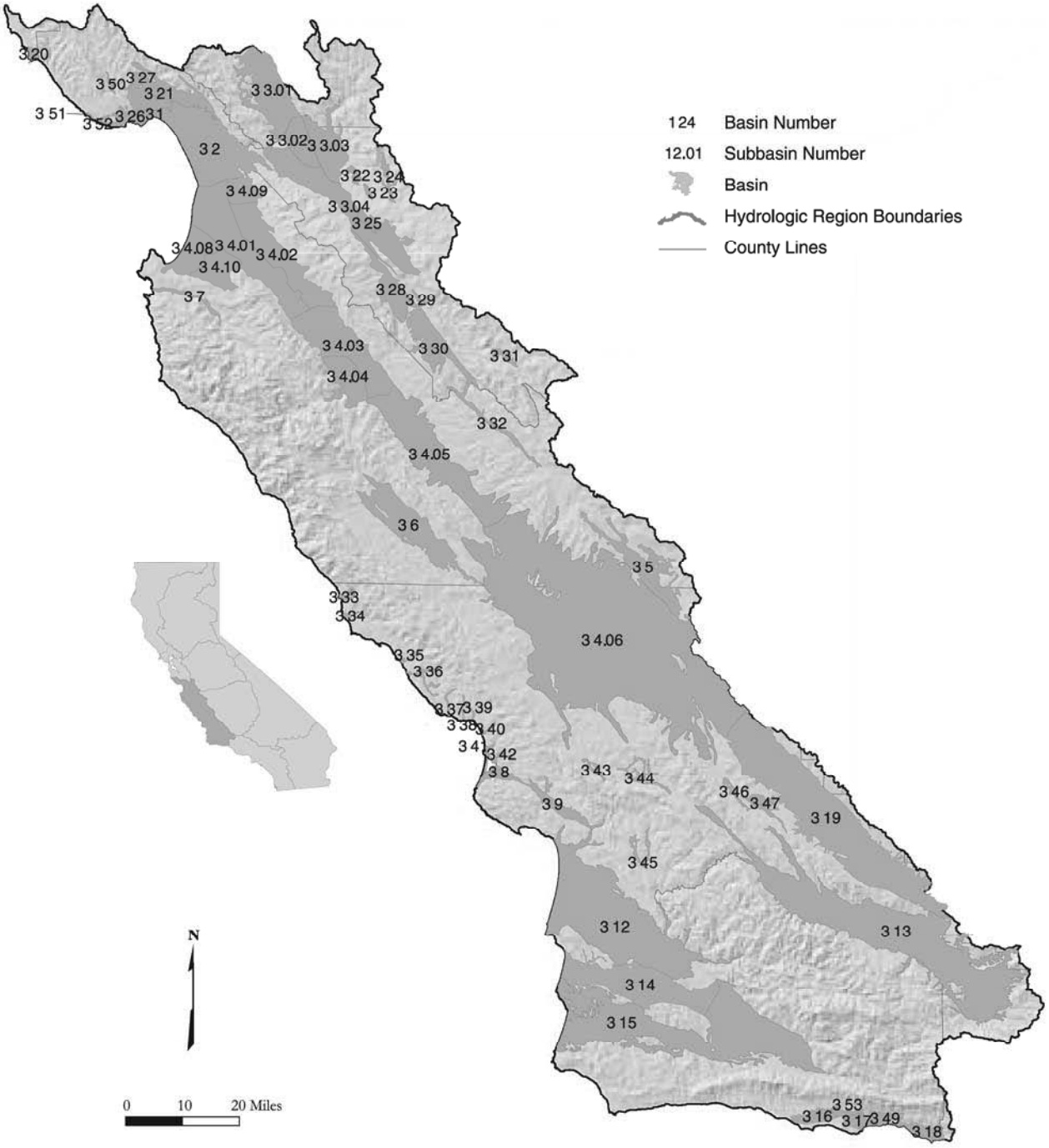

Figure 29 Central Coast Hydrologic Region

Basins and Subbasins of Central Coast Hydrologic Region

RegionBasin/ subbasin	Basin name
3-1	Soquel Valley
3-2	Pajaro Valley
3-3	Gilroy-Hollister Valley
3-3.01	Llagas Area
3-3.02	Bolsa Area
3-3.03	Hollister Area
3-3.04	San Juan Bautista Area
3-4	Salinas Valley
3-4.01	180/400 Foot Aquifer
3-4.02	East Side Aquifer
3-4.04	Forebay Aquifer
3-4.05	Upper Valley Aquifer
3-4.06	Paso Robles Area
3-4.08	Seaside Area
3-4.09	Langley Area
3-4.10	Corral de Tierra Area
3-5	Cholame Valley
3-6	Lockwood Valley
3-7	Carmel Valley
3-8	Los Osos Valley
3-9	San Luis Obispo Valley
3-12	Santa Maria River Valley
3-13	Cuyama Valley
3-14	San Antonio Creek Valley
3-15	Santa Ynez River Valley
3-16	Goleta
3-17	Santa Barbara
3-18	Carpinteria
3-19	Carrizo Plain
3-20	Ano Nuevo Area
3-21	Santa Cruz Purisima Formation
3-22	Santa Ana Valley
3-23	Upper Santa Ana Valley
3-24	Quien Sabe Valley
3-25	Tres Pinos Valley
3-26	West Santa Cruz Terrace
3-27	Scotts Valley
3-28	San Benito River Valley
3-29	Dry Lake Valley
3-30	Bitter Water Valley
3-31	Hernandez Valley
3-32	Peach Tree Valley
3-33	San Carpoforo Valley
3-34	Arroyo de la Cruz Valley
3-35	San Simeon Valley
3-36	Santa Rosa Valley
3-37	Villa Valley
3-38	Cayucos Valley
3-39	Old Valley
3-40	Toro Valley
3-41	Morro Valley
3-42	Chorro Valley
3-43	Rinconada Valley
3-44	Pozo Valley
3-45	Huasna Valley
3-46	Rafael Valley
3-47	Big Spring Area
3-49	Montecito
3-50	Felton Area
3-51	Majors Creek
3-52	Needle Rock Point
3-53	Foothill

Description of the Region

The Central Coast HR covers approximately 7.22 million acres (11,300 square miles) in central California (Figure 29). This HR includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura counties. Significant geographic features include the Pajaro, Salinas, Carmel, Santa Maria, Santa Ynez, and Cuyama valleys; the coastal plain of Santa Barbara; and the Coast Range. Major drainages in the region include the Salinas, Cuyama, Santa Ynez, Santa Maria, San Antonio, San Lorenzo, San Benito, Pajaro, Nacimiento, Carmel, and Big Sur Rivers.

Population data from the 2000 Census suggest that about 1.4 million people or about 4 percent of the population of the State live in this HR. Major population centers include Santa Barbara, Santa Maria, San Luis Obispo, Gilroy, Hollister, Morgan Hill, Salinas, and Monterey.

The Central Coast HR has 50 delineated groundwater basins. Within this region, the Gilroy-Hollister Valley and Salinas Valley groundwater basins are divided into four and eight subbasins, respectively. Groundwater basins in this HR underlie about 2.390 million acres (3,740 square miles) or about one-third of the HR.

Groundwater Development

Locally, groundwater is an extremely important source of water supply. Within the region, groundwater accounted for 83 percent of the annual supply used for agricultural and urban purposes in 1995. For an average year, groundwater in the region accounts for about 8.4 percent of the statewide groundwater supply and about 1.3 percent of the total state water supply for agricultural and urban needs. In drought years, groundwater in this region is expected to account for about 7.2 percent of the statewide groundwater supply and about 1.9 percent of the total State water supply for agricultural and urban needs (DWR 1998).

Aquifers are varied and range from large extensive alluvial valleys with thick multilayered aquifers and aquitards to small inland valleys and coastal terraces. Several of the larger basins provide a dependable and drought-resistant water supply to coastal cities and farms.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Several reservoirs including Hernandez, Twitchell, Lake San Antonio, and Lake Nacimiento are operated primarily for the purpose of groundwater recharge. The concept is to maintain streamflow over a longer period than would occur without surface water storage and thus provide for increased recharge of groundwater. Seawater intrusion is a major problem throughout much of the region. In the Salinas Valley Groundwater Basin, seawater intrusion was first documented in the 1930s and has been observed more than 5 miles inland.

Groundwater Quality

Much of the groundwater in the region is characterized by calcium sulfate to calcium sodium bicarbonate sulfate water types because of marine sedimentary rock in the watersheds. Aquifers intruded by seawater are typically characterized by sodium chloride to calcium chloride, and have chloride concentrations greater than 500 mg/L. In several areas, groundwater exceeds the MCL for nitrate.

Water Quality in Public Supply Wells

From 1994 through 2000, 711 public supply water wells were sampled in 38 of the 60 basins and subbasins in the Central Coast HR. Analyzed samples indicate that 587 wells, or 83 percent, met the state primary MCLs for drinking water. One-hundred-twenty-four wells, or 17 percent, have constituents that exceed one or more MCL. Figure 30 shows the percentages of each contaminant group that exceeded MCLs in the 124 wells.

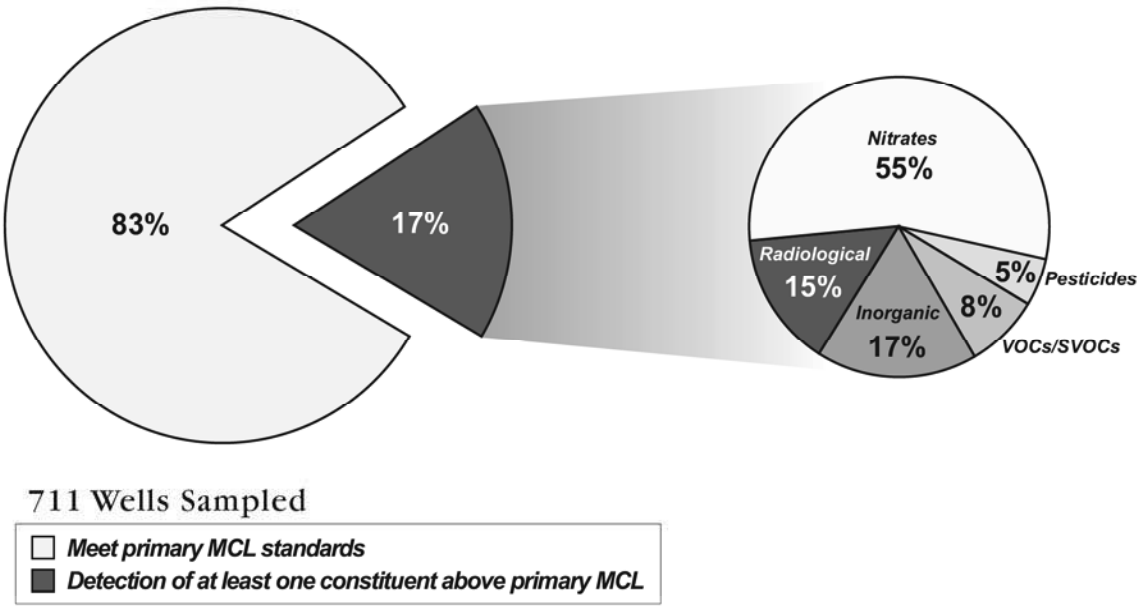

Figure 30 MCL exceedances in public supply wells in the Central Coast Hydrologic Region

Table 19 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region

Contaminant group wells	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of
Inorganics – Primary	Antimony – 6	Aluminum – 4	Chromium (Total) – 4
Inorganics – Secondary	Iron – 145	Manganese – 135	TDS – 11
Radiological	Gross Alpha – 15	Radium 226 – 3	Uranium – 3
Nitrates	Nitrate (as NO_3) – 69	Nitrate + Nitrite – 24	
Pesticides	Heptachlor – 4	Di (2-Ethylhexyl) phthalate – 2	
VOCs/SVOCs	TCE – 3	3 are tied at 2 exceedances	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC= Semivolatile Organic Compound

Changes from Bulletin 118-80

Four new basins have been defined since Bulletin 118-80. They are Felton Area, Majors Creek, Needle Rock Point, and Foothill groundwater basins. Additionally, new subbasins have been broken out in both the Gilroy-Hollister Valley Groundwater Basin (3-3) and the Salinas Valley Groundwater Basin (3-4) (Table 20).

Table 20 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region

Subbasin name	New number	Old number
Llagas Area	3-3.01	3-3
Bolsa Area	3-3.02	3-3
Hollister Area	3-3.03	3-3
San Juan Bautista Area	3-3.04	3-3
180/400 Foot Aquifer	3-4.01	3-4
East Side Aquifer	3-4.02	3-4
Upper Forebay Aquifer	3-4.04	3-4
Upper Valley Aquifer	3-4.05	3-4
Pismo Creek Valley Basin	3-12	3-10
Arroyo Grande Creek Basin	3-12	3-11
Careaga Sand Highlands Basin	3-12 and 3-14	3-48
Felton Area	3-50	
Majors Creek	3-51	
Needle Rock Point	3-52	
Foothill	3-53	

Pismo Creek Valley Basin (3-10) and Arroyo Grande Creek Basin (3-11) have been merged into the Santa Maria River Valley Basin (3-12). Careaga Sand Highlands Basin (3-48) has been merged into the Santa Maria River Valley Basin (3-12) and San Antonio Creek Valley Basin (3-14).

Table 21 Central Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-1	SOQUEL VALLEY	2,500	C	1,421	665	6	6	16	482	270-990
3-2	PAJARO VALLEY	76,800	A	2,000	500	185	185	149	580-910	300-30,000
3-3	GILROY-HOLLISTER VALLEY									
3-3.01	LLAGAS AREA	55,600	C	-	-	-	-	95	-	-
3-3.02	BOLSA AREA	21,000	A	-	400	11	<11	3	-	400-1800
3-3.03	HOLLISTER AREA	32,700	A	-	400	42	<42	35	-	400-1600
3-3.04	SAN JUAN BAUTISTA AREA	74,300	A	-	400	37	<37	40	-	460-1700
3-4	SALINAS VALLEY									
3-4.01	180/400 FOOT AQUIFER	84,400	A	-	-	166	218	82	478	223-1,013
3-4.02	EAST SIDE AQUIFER	57,500	A	-	-	74	67	53	450	168-977
3-4.04	FOREBAY AQUIFER	94,100	A	-	-	89	91	35	624	300-1,100
3-4.05	UPPER VALLEY AQUIFER	98,200	A	4,000	-	36	37	17	443	140-3,700
3-4.06	PASO ROBLES AREA	597,000	A	3,300	-	183	-	58	614	165-3,868
3-4.08	SEASIDE AREA	25,900	B	3,500	1,000		7	24	400	200-900
3-4.09	LANGLEY AREA	15,400	B	1,570	450	-	-	52	-	52-348
3-4.10	CORRAL DE TIERRA AREA	22,300	C	948	450	-	3	26	-	355-679
3-5	CHOLAME VALLEY	39,800	C	3,000	1,000	1	-	1	-	-
3-6	LOCKWOOD VALLEY	59,900	C	1,500	100	-	-	9	-	-
3-7	CARMEL VALLEY	5,160	C	1,000	600	50	23	12	260-670	220-1,200
3-8	LOS OSOS VALLEY	6,990	A	700	230	-	-	10	354	78-33,700
3-9	SAN LUIS OBISPO VALLEY	12,700	A	600	300	-	-	11	583	278-1,949
3-12	SANTA MARIA RIVER VALLEY	184,000	A	2,500	1,000	286	10	108	598	139-1,200
3-13	CUYAMA VALLEY	147,000	A	4,400	1,100	17	2	8	-	206-3,905
3-14	SAN ANTONIO CREEK VALLEY	81,800	A	-	400	30	-	9	415	129-8,040
3-15	SANTA YNEZ RIVER VALLEY	204,000	A	1,300	750	163	21	76	507	400-700
3-16	GOLETA	9,210	A	800	500	49	11	17	755	617-929
3-17	SANTA BARBARA	6,160	A	625	560	75	36	5	-	217-385
3-18	CARPINTERIA	8,120	A	500	300	41	41	4	557	317-1,780
3-19	CARRIZO PLAIN	173,000	C	1,000	500	-	-	1	-	-
3-20	ANO NUEVO AREA	2,032	C	-	-	-	-	2	-	-
3-21	SANTA CRUZ PURISIMA FORMATION	40,200	C	200	20	-	-	39	440	380-560
3-22	SANTA ANA VALLEY	2,720	C	130	-	-	-	-	-	-
3-23	UPPER SANTA ANA VALLEY	1,430	C	-	-	-	-	-	-	-
3-24	QUIEN SABE VALLEY	4,710	C	122	122	-	-	-	-	-
3-25	TRES PINOS VALLEY	3,390	C	1,225	-	-	-	3	-	-
3-26	WEST SANTA CRUZ TERRACE	7,870	C	550	200	-	-	7	480	378-684
3-27	SCOTTS VALLEY	774	C	410	100-900	26	7	7	360	100-980
3-28	SAN BENITO RIVER VALLEY	24,200	C	2,000	-	-	-	3	-	-
3-29	DRY LAKE VALLEY	1,420	C	-	-	-	-	-	-	-
3-30	BITTER WATER VALLEY	32,200	C	-	-	-	-	-	-	-
3-31	HERNANDEZ VALLEY	2,860	C	160	58	-	-	-	-	-

Table 21 Central Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-32	PEACH TREE VALLEY	9,790	C	117	84	-	-	-	-	-
3-33	SAN CARPOFORO VALLEY	200	C	-	-	-	-	-	-	217-385
3-34	ARROYO DE LA CRUZ VALLEY	750	C	-	-	-	-	-	-	211-381
3-35	SAN SIMEON VALLEY	620	A	170	100	-	-	4	413	46-2,210
3-36	SANTA ROSA VALLEY	4,480	A	708	400	-	-	2	-	298-2,637
3-37	VILLA VALLEY	980	C	-	-	-	-	-	-	260-1,635
3-38	CAYUCOS VALLEY	530	C	166	100	-	-	-	-	815-916
3-39	OLD VALLEY	750	C	335	200	-	-	-	-	346-2,462
3-40	TORO VALLEY	721	C	500	0	-	-	-	-	458-732
3-41	MORRO VALLEY	1,200	C	442	300	-	-	6	1150	469-5,100
3-42	CHORRO VALLEY	3,200	C	700	200	-	-	6	656	60-3,606
3-43	RINCONADA VALLEY	2,580	C	0	0	-	-	-	-	-
3-44	POZO VALLEY	6,840	C	230	100	-	-	5	-	287-676
3-45	HUASNA VALLEY	4,700	C	0	0	-	-	-	-	-
3-46	RAFAEL VALLEY	2,990	C	0	0	-	-	-	-	-
3-47	BIG SPRING AREA	7,320	C	0	0	-	-	-	-	-
3-49	MONTECITO	6,270	A	1,000	750	88	2	4	700	600-1,100
3-50	FELTON AREA	1,160	C	825	244	6	-	2	-	69-400
3-51	MAJORS CREEK	364	C	50	38	-	-	-	-	-
3-52	NEEDLE ROCK POINT	480	C	450	320	-	-	-	-	-
3-53	FOOTHILL	3,120	A	-	-	-	8	7	828	554-1,118

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

South Coast Hydrologic Region

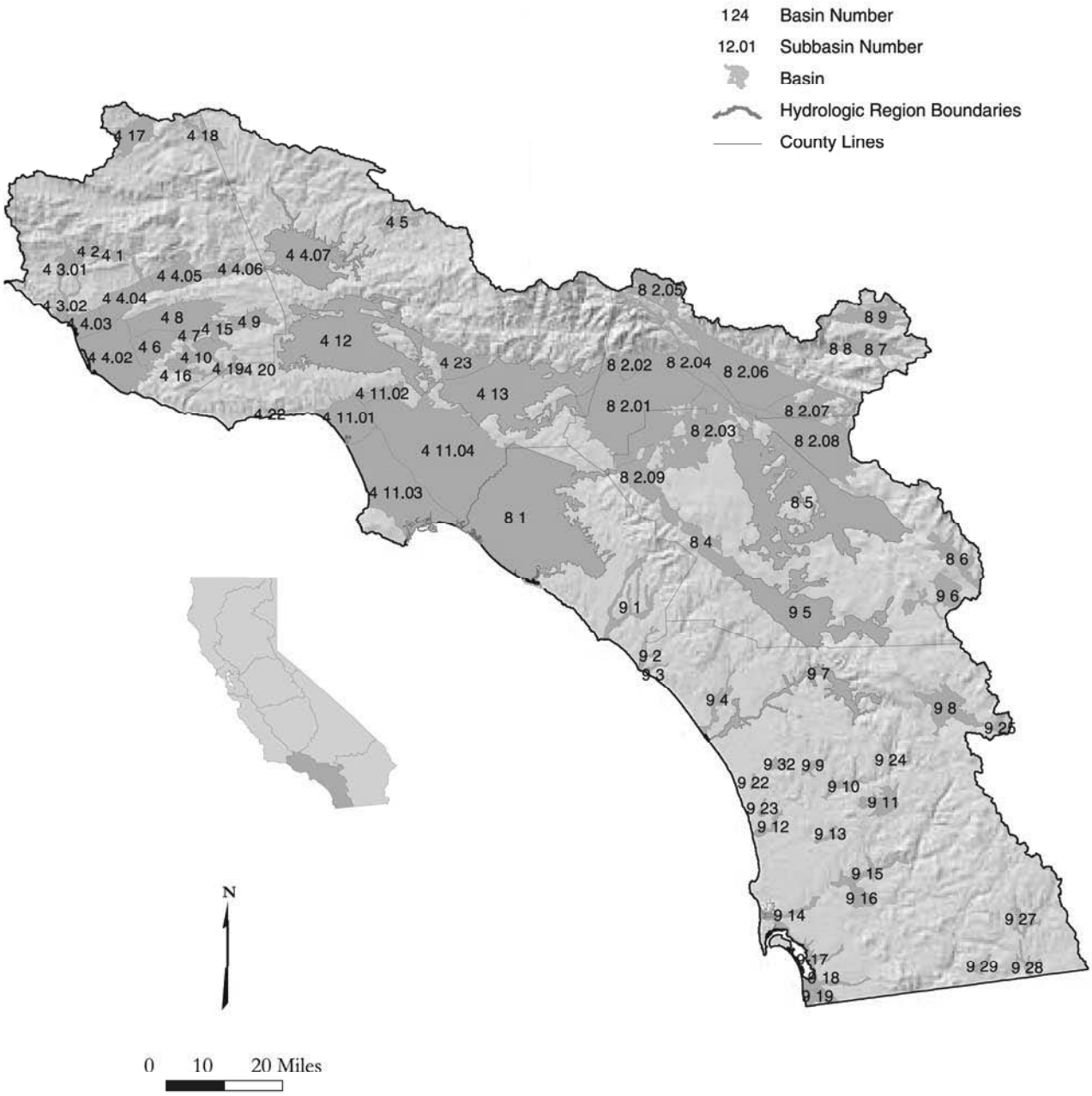

Figure 31 South Coast Hydrologic Region

Basins and Subbasins of the South Coast Hydrologic Region

Basin/subbasin	Basin name
4-1	Upper Ojai Valley
4-2	Ojai Valley
4-3	Ventura River Valley
4-3.01	Upper Ventura River
4-3.02	Lower Ventura River
4-4	Santa Clara River Valley
4-4.02	Oxnard
4-4.03	Mound
4-4.04	Santa Paula
4-4.05	Fillmore
4-4.06	Piru
4-4.07	Santa Clara River Valley East
4-5	Acton Valley
4-6	Pleasant Valley
4-7	Arroyo Santa Rosa Valley
4-8	Las Posas Valley
4-9	Simi Valley
4-10	Conejo Valley
4-11	Coastal Plain of Los Angeles
4-11.01	Santa Monica
4-11.02	Hollywood
4-11.03	West Coast
4-11.04	Central
4-12	San Fernando Valley
4-13	San Gabriel Valley
4-15	Tierre Rejada
4-16	Hidden Valley
4-17	Lockwood Valley
4-18	Hungry Valley
4-19	Thousand Oaks Area
4-20	Russell Valley
4-22	Malibu Valley
4-23	Raymond
8-1	Coastal Plain of Orange County
8-2	Upper Santa Ana Valley
8-2.01	Chino
8-2.02	Cucamonga
8-2.03	Riverside-Arlington
8-2.04	Rialto-Colton
8-2.05	Cajon
8-2.06	Bunker Hill
8-2.07	Yucaipa
8-2.08	San Timoteo
8-2.09	Temescal
8-4	Elsinore
8-5	San Jacinto
8-6	Hemet Lake Valley
8-7	Big Meadows Valley
8-8	Seven Oaks Valley
8-9	Bear Valley
9-1	San Juan Valley
9-2	San Mateo Valley
9-3	San Onofre Valley
9-4	Santa Margarita Valley
9-5	Temecula Valley
9-6	Coahuila Valley
9-7	San Luis Rey Valley
9-8	Warner Valley
9-9	Escondido Valley
9-10	San Pasqual Valley
9-11	Santa Maria Valley
9-12	San Dieguito Creek
9-13	Poway Valley
9-14	Mission Valley
9-15	San Diego River Valley
9-16	El Cajon Valley
9-17	Sweetwater Valley
9-18	Otay Valley
9-19	Tijuana Basin
9-22	Batiquitos Lagoon Valley
9-23	San Elijo Valley
9-24	Pamo Valley
9-25	Ranchita Town Area
9-27	Cottonwood Valley
9-28	Campo Valley
9-29	Potrero Valley
9-32	San Marcos Area

Description of the Region

The South Coast HR covers approximately 6.78 million acres (10,600 square miles) of the southern California watershed that drains to the Pacific Ocean (Figure 31). The HR is bounded on the west by the Pacific Ocean and the watershed divide near the Ventura-Santa Barbara County line. The northern boundary corresponds to the crest of the Transverse Ranges through the San Gabriel and San Bernardino mountains. The eastern boundary lies along the crest of the San Jacinto Mountains and low-lying hills of the Peninsular Range that form a drainage boundary with the Colorado River HR. The southern boundary is the international boundary with the Republic of Mexico. Significant geographic features include the coastal plain, the central Transverse Ranges, the Peninsular Ranges, and the San Fernando, San Gabriel, Santa Ana River, and Santa Clara River valleys.

The South Coast HR includes all of Orange County, most of San Diego and Los Angeles Counties, parts of Riverside, San Bernardino, and Ventura counties, and a small amount of Kern and Santa Barbara Counties. This HR is divided into Los Angeles, Santa Ana and San Diego subregions, RWQCBs 4, 8, and 9 respectively. Groundwater basins are numbered according to these subregions. Basin numbers in the Los Angeles subregion are preceded by a 4, in Santa Ana by an 8, and in San Diego by a 9. The Los Angeles subregion contains the Ventura, Santa Clara, Los Angeles, and San Gabriel River drainages, Santa Ana encompasses the Santa Ana River drainage, and San Diego includes the Santa Maria River, San Luis Rey River and the San Diego River and other drainage systems.

According to 2000 census data, about 17 million people live within the boundaries of the South Coast HR, approximately 50 percent of the population of California. Because this HR amounts to only about 7 percent of the surface area of the State, this has the highest population density of any HR in California (DWR 1998). Major population centers include the metropolitan areas surrounding Ventura, Los Angeles, San Diego, San Bernardino, and Riverside.

The South Coast HR has 56 delineated groundwater basins. Twenty-one basins are in subregion 4 (Los Angeles), eight basins in subregion 8 (Santa Ana), and 27 basins in subregion 9 (San Diego).

The Los Angeles subregion overlies 21 groundwater basins and encompasses most of Ventura and Los Angeles counties. Within this subregion, the Ventura River Valley, Santa Clara River Valley, and Coastal Plain of Los Angeles basins are divided into subbasins. The basins in the Los Angeles subregion underlie 1.01 million acres (1,580 square miles) or about 40 percent of the total surface area of the subregion.

The Santa Ana subregion overlies eight groundwater basins and encompasses most of Orange County and parts of Los Angeles, San Bernardino, and Riverside counties. The Upper Santa Ana Valley Groundwater Basin is divided into nine subbasins. Groundwater basins underlie 979,000 acres (1,520 square miles) or about 54 percent of the Santa Ana subregion.

The San Diego subregion overlies 27 groundwater basins, encompasses most of San Diego County, and includes parts of Orange and Riverside counties. Groundwater basins underlie about 277,000 acres (433 square miles) or about 11 percent of the surface of the San Diego subregion.

Overall, groundwater basins underlie about 2.27 million acres (3,530 square miles) or about 33 percent of the South Coast HR.

Groundwater Development

Groundwater has been used in the South Coast HR for well over 100 years. High demand and use of groundwater in Southern California has given rise to many disputes over management and pumping rights, with the resolution of these cases playing a large role in the establishment and clarification of water rights law in California. Raymond Groundwater Basin, located in this HR, was the first adjudicated basin in the State. Of the 16 adjudicated basins in California, 11 are in the South Coast HR. Groundwater provides about 23 percent of water demand in normal years and about 29 percent in drought years (DWR 1998).

Groundwater is found in unconfined alluvial aquifers in most of the basins of the San Diego subregion and the inland basins of the Santa Ana and Los Angeles subregions. In some larger basins, typified by those underlying the coastal plain, groundwater occurs in multiple aquifers separated by aquitards that create confined groundwater conditions. Basins range in depth from tens or hundreds of feet in smaller basins, to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this HR depending on aquifer characteristics and well location, size, and use. Some aquifers are capable of yielding thousands of gallons per minute to municipal wells.

Conjunctive Use

Conjunctive use of surface water and groundwater is a long-standing practice in the region. At present, much of the potable water used in Southern California is imported from the Colorado River and from sources in the eastern Sierra and Northern California. Several reservoirs are operated primarily for the purpose of storing surface water for domestic and irrigation use, but groundwater basins are also recharged from the outflow of some reservoirs. The concept is to maintain streamflow over a longer period of time than would occur without regulated flow and thus provide for increased recharge of groundwater basins. Most of the larger basins in this HR are highly managed, with many conjunctive use projects being developed to optimize water supply.

Coastal basins in this HR are prone to intrusion of seawater. Seawater intrusion barriers are maintained along the Los Angeles and Orange County sections of the coastal plain. In Orange County, recycled water is injected into the ground to form a mound of groundwater between the coast and the main groundwater basin. In Los Angeles County, imported and recycled water is injected to maintain a seawater intrusion barrier.

Groundwater Quality

Groundwater in basins of the Los Angeles subregion is mainly calcium sulfate and calcium bicarbonate in character. Nitrate content is elevated in some parts of the subregion. Volatile organic compounds (VOCs) have created groundwater impairments in some of the industrialized portions of the region. The San Gabriel Valley and San Fernando Valley groundwater basins both have multiple sites of contamination from VOCs. The main constituents in the contamination plumes are trichloroethylene (TCE) and tetrachloroethylene (PCE). Some of the locations have been declared federal Superfund sites. Contamination plumes containing high concentrations of TCE and PCE also occur in the Bunker Hill Subbasin of the Upper Santa Ana Valley Groundwater Basin. Some of these plumes are also designated as Superfund sites. Perchlorate is emerging as an important contaminant in several areas in the South Coast HR.

Groundwater in basins of the Santa Ana subregion is primarily calcium and sodium bicarbonate in character. Local impairments from excess nitrate or VOCs have been recognized. Groundwater and surface water in the Chino Subbasin of the Santa Ana River Valley Groundwater Basin have elevated nitrate concentrations, partly derived from a large dairy industry in that area. In Orange County, water from the Santa Ana River provides a large part of the groundwater replenishment. Wetlands maintained along the Santa Ana River near the boundary of the Upper Santa Ana River and Orange County Groundwater Basins provide effective removal of nitrate from surface water, while maintaining critical habitat for endangered species.

Groundwater in basins of the San Diego subregion has mainly calcium and sodium cations and bicarbonate and sulfate anions. Local impairments by nitrate, sulfate, and TDS are found. Camp Pendleton Marine Base, in the northwestern part of this subregion, is on the EPA National Priorities List for soil and groundwater contamination by many constituents.

Water Quality in Public Supply Wells

From 1994 through 2000, 2,342 public supply water wells were sampled in 47 of the 73 basins and subbasins in the South Coast HR. Analyzed samples indicate that 1,360 wells, or 58 percent, met the state primary MCLs for drinking water. Nine-hundred-eighty-two wells, or 42 percent, have constituents that exceed one or more MCL. Figure 32 shows the percentages of each contaminant group that exceeded MCLs in the 982 wells.

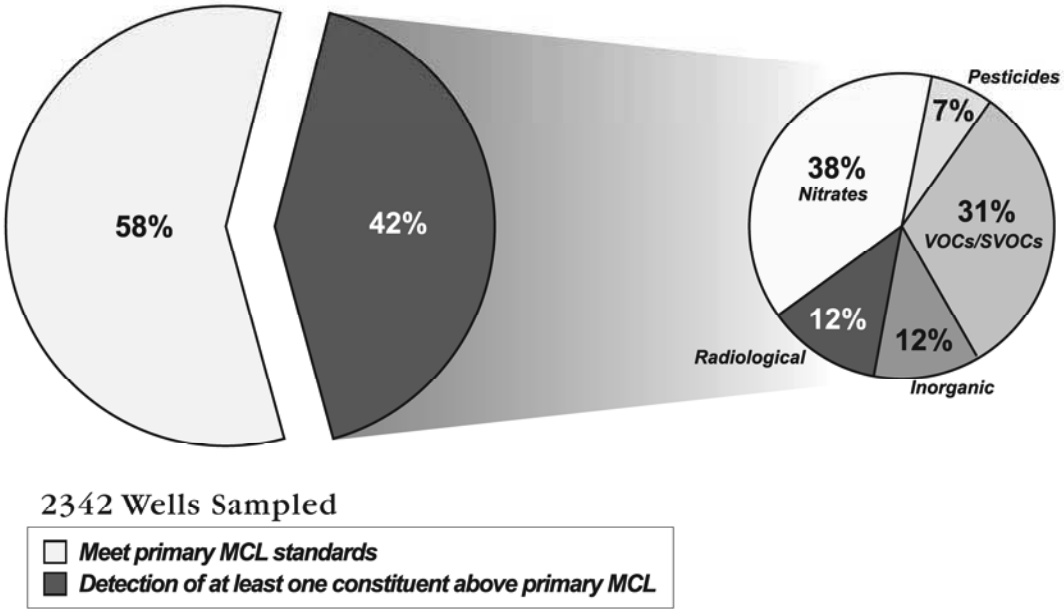

Figure 32 MCL exceedances in public supply wells in the South Coast Hydrologic Region

Table 22 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 23). The Cajalco Valley (8-3), Jamul Valley (9-20), Las Pulgas Valley (9-21), Pine Valley (9-26), and Tecate Valley (9-30) Groundwater Basins have been deleted in this report because they have thin deposits of alluvium and well completion reports indicate that groundwater production is from underlying fractured bedrock. The Conejo Tierra Rejada Volcanic (4-21) is a volcanic aquifer and was not assigned a basin number in this bulletin. This is considered to be groundwater source area as discussed in Chapter 6.

Table 22 Most frequently occurring contaminants by contaminant group in the South Coast Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 56	Thallium – 13	Aluminum – 12
Inorganics – Secondary	Iron – 337	Manganese – 335	TDS – 36
Radiological	Gross Alpha – 104	Uranium – 40	Radium 226 – 9 Radium 228 – 9
Nitrates	Nitrate (as NO_3) – 364	Nitrate + Nitrite – 179	Nitrate Nitrogen (NO_3-N) – 14
Pesticides	DBCP – 61	Di(2-Ethylhexyl)phthalate –5	Heptachlor – 2 EDB – 2
VOCs/SVOCs	TCE – 196	PCE – 152	1,2 Dichloroethane – 89

DBCP = Dibromochloropropane
EDB = Ethylene Dibromide
VOCs = Volatile Organic Compounds
SVOCs = Semivolatile Organic Compounds

The Ventura River Valley (4-3), Santa Clara River Valley (4-4), Coastal Plain of Los Angeles (4-11), and Upper Santa Ana Valley (8-2) Groundwater Basins have been divided into subbasins in this report. The extent of the San Jacinto Groundwater Basin (8-5) has been decreased because completion of Diamond Valley Reservoir has inundated the valley. Paloma Valley has been removed because well logs indicate groundwater production is solely from fractured bedrock. The Raymond Groundwater Basin (4-23) is presented as an individual basin instead of being incorporated into the San Gabriel Valley Groundwater Basin (4-13) because it is bounded by physical barriers and has been managed as a separate and individual groundwater basin for many decades. In Bulletin 118-75, groundwater basins in two different subregions were designated the Upper Santa Ana Valley Groundwater Basin (4-14 and 8-2). To alleviate this confusion, basin 4-14 has been divided, with parts of the basin incorporated into the neighboring San Gabriel Valley Groundwater Basin (4-13) and the Chino subbasin of the Upper Santa Ana Valley Groundwater Basin (8-2.01). The San Marcos Area Groundwater Basin (9-32) in central San Diego County is presented as a new basin in this report.

Table 23 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Coast Hydrologic Region

Basin/subbasin name	Number	Old number
Upper Ventura River	4-3.01	4-3
Lower Ventura River	4-3.02	4-3
Oxnard	4-4.02	4-4
Mound	4-4.03	4-4
Santa Paula	4-4.04	4-4
Fillmore	4-4.05	4-4
Piru	4-4.06	4-4
Santa Clara River Valley East	4-4.07	4-4
Santa Monica	4-11.01	4-11
Hollywood	4-11.02	4-11
West Coast	4-11.03	4-11
Central	4-11.04	4-11
Upper Santa Ana Valley	Incorporated into 8-2.01 and 4-13	4-14
Conejo-Tierra Rejada Volcanic	deleted	4-21
Raymond	4-23	4-13
Chino	8-2.01	8-2
Cucamonga	8-2.02	8-2
Riverside-Arlington	8-2.03	8-2
Rialto-Colton	8-2.04	8-2
Cajon	8-2.05	8-2
Bunker Hill	8-2.06	8-2
Yucaipa	8-2.07	8-2
San Timoteo	8-2.08	8-2
Temescal	8-2.09	8-2
Cajalco Valley	deleted	8-3
Tijuana Basin	9-19	
Jamul Valley	deleted	9-20
Las Pulgas Valley	deleted	9-21
Batiquitos Lagoon Valley	9-22	
San Elijo Valley	9-23	
Pamo Valley	9-24	
Ranchita Town Area	9-25	
Pine Valley	deleted	9-26
Cottonwood Valley	9-27	
Campo Valley	9-28	
Potrero Valley	9-29	
Tecate Valley	deleted	9-30
San Marcos Area	9-32	Not previously identified

Table 24 South Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
4-1	UPPER OJAI VALLEY	3,800	A	200	50	4	-	1	707	438-1,249
4-2	OJAI VALLEY	6,830	A	600	383	24	-	22	640	450-1,140
4-3	VENTURA RIVER VALLEY									
4-3.01	UPPER VENTURA RIVER	7,410	C	-	600	17	-	18	706	500-1,240
4-3.02	LOWER VENTURA RIVER	5,300	A	-	20	-	-	2	-	760-3,000
4-4	SANTA CLARA RIVER VALLEY									
4-4.02	OXNARD	58,000	A	1,600	-	127	127	69	1,102	160-1,800
4-4.03	MOUND	14,800	A	-	700	11	11	4	1,644	1,498-1,908
4-4.04	SANTA PAULA	22,800	A	-	700	60	50	10	1,198	470-3,010
4-4.05	FILLMORE	20,800	A	2,100	700	23	-	10	1,100	800-2,400
4-4.06	PIRU	8,900	A	-	800	19	-	3	1,300	608-2,400
4-4.07	SANTA CLARA RIVER VALLEY EAST	66,200	C	-	-	-	-	62	-	-
4-5	ACTON VALLEY	8,270	A	1,000	140	-	-	7	-	-
4-6	PLEASANT VALLEY	21,600	A	-	1,000	9	-	12	1,110	597-3,490
4-7	ARROYO SANTA ROSA VALLEY	3,740	A	1,200	950	6	-	7	1,006	670-1,200
4-8	LAS POSAS VALLEY	42,200	A	750	-	-	-	24	742	338-1,700
4-9	SIMI VALLEY	12,100	A	-	394	13	-	1	-	1,580
4-10	CONEJO VALLEY	28,900	A	1,000	100	-	-	3	631	335-2,064
4-11	COASTAL PLAIN OF LOS ANGELES									
4-11.01	SANTA MONICA	32,100	C	4,700	-	-	-	12	916	729-1,156
4-11.02	HOLLYWOOD	10,500	A	-	-	5	5	1	-	526
4-11.03	WEST COAST	91,300	A	1,300	-	67	58	33	456	-
4-11.04	CENTRAL	177,000	A	11,000	1,730	302	64	294	453	200-2,500
4-12	SAN FERNANDO VALLEY	145,000	A	3,240	1,220	1398	2385	126	499	176-1,16
4-13	SAN GABRIEL VALLEY	154,000	A	4,850	1,000	67	296	259	367	90-4,288
4-15	TIERRA REJADA	4,390	A	1,200	172	4	1	-	-	619-930
4-16	HIDDEN VALLEY	2,210	C	-	-	-	-	1	453	289-743
4-17	LOCKWOOD VALLEY	21,800	A	350	25	-	-	1	-	-
4-18	HUNGRY VALLEY	5,310	C	-	28	-	-	-	<350	-
4-19	THOUSAND OAKS AREA	3,110	C	-	39	2	-	-	1,410	1,200-2,300
4-20	RUSSELL VALLEY	3,100	A	-	25	-	-	-	-	-
4-22	MALIBU VALLEY	613	C	1,060	1,030	-	-	-	-	-
4-23	RAYMOND	26,200	A	3,620	1,880	88	-	70	346	138-780
8-1	COASTAL PLAIN OF ORANGE COUNTY	224,000	A	4,500	2,500	521	411	240	475	232-661
8-2	UPPER SANTA ANA VALLEY									
8-2.01	CHINO	154,000	A	1,500	1,000	12	8	187	484	200-600
8-2.02	CUCAMONGA	9,530	C	4,400	2,115	1	1	21	-	-
8-2.03	RIVERSIDE-ARLINGTON	58,600	A	-	-	11	3	43	-	370-756
8-2.04	RIALTO-COLTON	30,100	A	5,000	545	50	5	41	337	
8-2.05	CAJON	23,200	C	200	60	-	-	5	-	-
8-2.06	BUNKER HILL	89,600	A	5,000	1,245	398	169	204	-	150-550
8-2.07	YUCAIPA	25,300	A	2,800	206	19	3	45	334	-

Table 24 South Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
8-2.08	SAN TIMOTEO	73,100	A	-	-	67	12	36	-	-
8-2.09	TEMESCAL	23,500	C	-	-	2	2	20	753	373-950
8-4	ELSINORE	25,700	C	5,400	-	1	1	18	-	
8-5	SAN JACINTO	188,000	C	-	-	150	115	56	463	160-12,000
8-6	HEMET LAKE VALLEY	16,700	C	820	196	-	-	9	-	-
8-7	BIG MEADOWS VALLEY	14,200	C	120	34	-	-	8	-	-
8-8	SEVEN OAKS VALLEY	4,080	C	-	-	-	-	1	-	-
8-9	BEAR VALLEY	19,600	A	1,000	500	57	57	52	-	-
9-1	SAN JUAN VALLEY	16,700	C	1,000	-	-	-	8	760	430-12,880
9-2	SAN MATEO VALLEY	2,990	A	-	-	-	-	5	586	490-770
9-3	SAN ONOFRE VALLEY	1,250	A	-	-	-	-	2	-	600-1,500
9-4	SANTA MARGARITA VALLEY	626	A	1,980	-	4	-	-	-	337-9,030
9-5	TEMECULA VALLEY	87,800	C	1,750	-	140	4	67	476	220-1,500
9-6	COAHUILA VALLEY	18,200	C	500	-	2	-	1	-	304-969
9-7	SAN LUIS REY VALLEY	37,000	C	2,000	500	-	-	28	1,258	530-7,060
9-8	WARNER VALLEY	24,000	C	1,800	800	-	-	4	-	263
9-9	ESCONDIDO VALLEY	2,890	C	190	50	-	-	1	-	250-5,000
9-10	SAN PASQUAL VALLEY	4,540	C	1,700	1,000	-	-	2	-	500-1,550
9-11	SANTA MARIA VALLEY	12,300	A	500	36	3	-	2	1,000	324-1,680
9-12	SAN DIEGUITO CREEK	3,560	A	1,800	700	-	-	-	-	2,000
9-13	POWAY VALLEY	2,470	C	200	100	-	-	1	-	610-1,500
9-14	MISSION VALLEY	7,350	C	-	1,000	-	-	-	-	-
9-15	SAN DIEGO RIVER VALLEY	9,890	C	2,000	-	-	-	5	-	260-2,870
9-16	EL CAJON VALLEY	7,160	C	300	50	1	-	2,340		
9-17	SWEETWATER VALLEY	5,920	C	1,500	300	7	7	9	2,114	300-50,000
9-18	OTAY VALLEY	6,830	C	1,000	185	-	-	-	-	500->2,000
9-19	TIJUANA BASIN	7,410	A	2,000	350	-	-	-	-	380-3,620
9-22	BATIQUITOS LAGOON VALLEY	741	C	-	-	-	-	-	1,280	788-2,362
9-23	SAN ELIJO VALLEY	883	C	1,800	-	-	-	-	-	1,170-5,090
9-24	PAMO VALLEY	1,500	C	-	-	-	-	-	369	279-455
9-25	RANCHITA TOWN AREA	3,130	C	125	22	-	-	-	-	283-305
9-27	COTTONWOOD VALLEY	3,850	C	-	-	-	-	1	-	-
9-28	CAMPO VALLEY	3,550	C	-	<40	-	-	4	-	800
9-29	POTRERO VALLEY	2,020	C	-	-	-	-	4	-	-
9-32	SAN MARCOS VALLEY	2,130	C	60	-	-	-	-	-	500-700

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Sacramento River Hydrologic Region

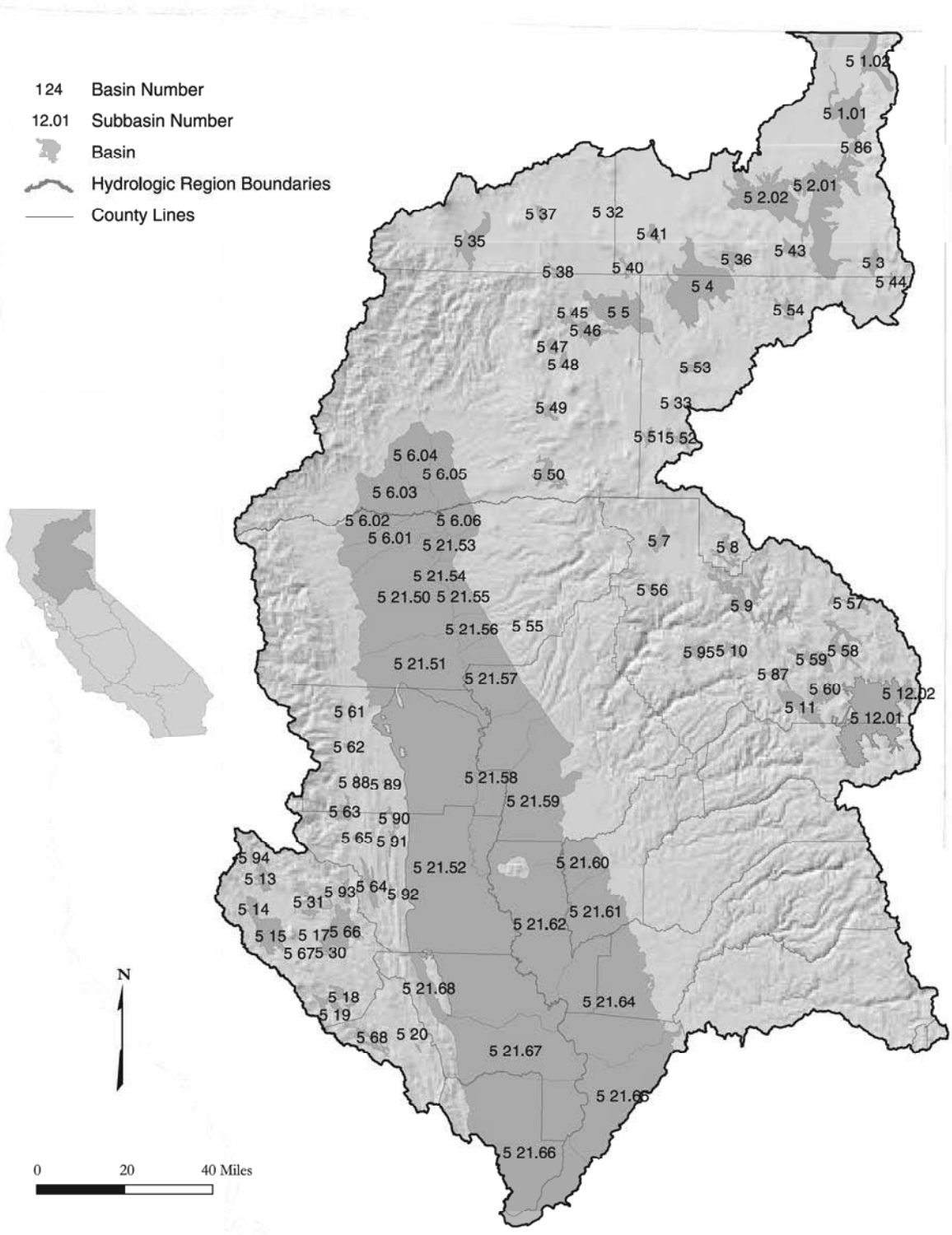

Figure 33 Sacramento River Hydrologic Region

Basins and Subbasins of the Sacramento River Hydrologic Region

Basin/subbasins	Basin name
5-1	Goose Lake Valley
5-1.01	Lower Goose Lake Valley
5-1.02	Fandango Valley
5-2	Alturas Area
5-2.01	South Fork Pitt River
5-2.02	Warm Springs Valley
5-3	Jess Valley
5-4	Big Valley
5-5	Fall River Valley
5-6	Redding Area
5-6.01	Bowman
5-6.02	Rosewood
5-6.03	Anderson
5-6.04	Enterprise
5-6.05	Millville
5-6.06	South Battle Creek
5-7	Lake Almanor Valley
5-8	Mountain Meadows Valley
5-9	Indian Valley
5-10	American Valley
5-11	Mohawk Valley
5-12	Sierra Valley
5-12.01	Sierra Valley
5-12.02	Chilcoot
5-13	Upper Lake Valley
5-14	Scotts Valley
5-15	Big Valley
5-16	High Valley
5-17	Burns Valley
5-18	Coyote Valley
5-19	Collayomi Valley
5-20	Berryessa Valley
5-21	Sacramento Valley
5-21.50	Red Bluff
5-21.51	Corning
5-21.52	Colusa
5-21.53	Bend
5-21.54	Antelope
5-21.55	Dye Creek
5-21.56	Los Molinos
5-21.57	Vina
5-21.58	West Butte
5-21.59	East Butte
5-21.60	North Yuba
5-21.61	South Yuba
5-21.62	Sutter
5-21.64	North American
5-21.65	South American
5-21.66	Solano
5-21.67	Yolo
5-21.68	Capay Valley

Basin/subbasins	Basin name
5-30	Lower Lake Valley
5-31	Long Valley
5-35	Mccloud Area
5-36	Round Valley
5-37	Toad Well Area
5-38	Pondosa Town Area
5-40	Hot Springs Valley
5-41	Egg Lake Valley
5-43	Rock Prairie Valley
5-44	Long Valley
5-45	Cayton Valley
5-46	Lake Britton Area
5-47	Goose Valley
5-48	Burney Creek Valley
5-49	Dry Burney Creek Valley
5-50	North Fork Battle Creek
5-51	Butte Creek Valley
5-52	Gray Valley
5-53	Dixie Valley
5-54	Ash Valley
5-56	Yellow Creek Valley
5-57	Last Chance Creek Valley
5-58	Clover Valley
5-59	Grizzly Valley
5-60	Humbug Valley
5-61	Chrome Town Area
5-62	Elk Creek Area
5-63	Stonyford Town Area
5-64	Bear Valley
5-65	Little Indian Valley
5-66	Clear Lake Cache Formation
5-68	Pope Valley
5-86	Joseph Creek
5-87	Middle Fork Feather River
5-88	Stony Gorge Reservoir
5-89	Squaw Flat
5-90	Funks Creek
5-91	Antelope Creek
5-92	Blanchard Valley
5-93	North Fork Cache Creek
5-94	Middle Creek
5-95	Meadow Valley

Description of the Region

The Sacramento River HR covers approximately 17.4 million acres (27,200 square miles). The region includes all or large portions of Modoc, Siskiyou, Lassen, Shasta, Tehama, Glenn, Plumas, Butte, Colusa, Sutter, Yuba, Sierra, Nevada, Placer, Sacramento, El Dorado, Yolo, Solano, Lake, and Napa counties (Figure 33). Small areas of Alpine and Amador counties are also within the region. Geographically, the region extends south from the Modoc Plateau and Cascade Range at the Oregon border, to the Sacramento-San Joaquin Delta. The Sacramento Valley, which forms the core of the region, is bounded to the east by the crest of the Sierra Nevada and southern Cascades and to the west by the crest of the Coast Range and Klamath Mountains. Other significant features include Mount Shasta and Lassen Peak in the southern Cascades, Sutter Buttes in the south central portion of the valley, and the Sacramento River, which is the longest river system in the State of California with major tributaries the Pit, Feather, Yuba, Bear and American rivers. The region corresponds approximately to the northern half of RWQCB 5. The Sacramento metropolitan area and surrounding communities form the major population center of the region. With the exception of Redding, cities and towns to the north, while steadily increasing in size, are more rural than urban in nature, being based in major agricultural areas. The 1995 population of the entire region was 2.372 million.

The climate in the northern, high desert plateau area of the region is characterized by cold snowy winters with only moderate precipitation and hot dry summers. This area depends on adequate snowpack to provide runoff for summer supply. Annual precipitation ranges from 10 to 20 inches. Other mountainous areas in the northern and eastern portions of the region have cold wet winters with large amounts of snow, which typically provide abundant runoff for summer supplies. Annual precipitation ranges from 40 to more than 80 inches. Summers are generally mild in these areas. The Coast Range and southern Klamath Mountains receive copious amounts of precipitation, but most of the runoff flows to the coast in the North Coastal drainage. Sacramento Valley comprises the remainder of the region. At a much lower elevation than the rest of the region, the valley has mild winters with moderate precipitation. Annual precipitation varies from about 35 inches in Redding to about 18 inches in Sacramento. Summers in the valley are hot and dry.

Most of the mountainous portions of the region are heavily forested and sparsely populated. Three major national forests (Mendocino, Trinity, and Shasta) make up the majority of lands in the Coast Range, southern Klamath Mountains, and the southern Cascades; these forests and the region's rivers and lakes provide abundant recreational opportunities. In the few mountain valleys with arable land, alfalfa, grain and pasture are the predominant crops. In the foothill areas of the region, particularly adjacent to urban centers, suburban to rural housing development is occurring along major highway corridors. This development is leading to urban sprawl and is replacing the former agricultural production on those lands. In the Sacramento Valley, agriculture is the largest industry. Truck, field, orchard, and rice crops are grown on approximately 2.1 million acres. Rice represents about 23 percent of the total irrigated acreage.

The Sacramento River HR is the main water supply for much of California's urban and agricultural areas. Annual runoff in the HR averages about 22.4 maf, which is nearly one-third of the State's total natural runoff. Major water supplies in the region are provided through surface storage reservoirs. The two largest surface water projects in the region are USBR's Shasta Lake (Central Valley Project) on the upper Sacramento River and Lake Oroville (DWR's State Water Project) on the Feather River. In all, there are more than 40 major surface water reservoirs in the region. Municipal, industrial, and agricultural supplies to the region are about 8 maf, with groundwater providing about 2.5 maf of that total. Much of the remainder of the runoff goes to dedicated natural flows, which support various environmental requirements, including in-stream fishery flows and flushing flows in the Delta.

Groundwater Development

Groundwater provides about 31 percent of the water supply for urban and agricultural uses in the region, and has been developed in both the alluvial basins and the hard rock uplands and mountains. There are 88 basins/subbasins delineated in the region. These basins underlie 5.053 million acres (7,900 square miles), about 29 percent of the entire region. The reliability of the groundwater supply varies greatly. The Sacramento Valley is recognized as one of the foremost groundwater basins in the State, and wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. Many of the mountain valleys of the region also provide significant groundwater supplies to multiple uses.

Geologically, the Sacramento Valley is a large trough filled with sediments having variable permeabilities; as a result, wells developed in areas with coarser aquifer materials will produce larger amounts of water than wells developed in fine aquifer materials. In general, well yields are good and range from one-hundred to several thousand gallons per minute. Because surface water supplies have been so abundant in the valley, groundwater development for agriculture primarily supplement the surface supply. With the changing environmental laws and requirements, this balance is shifting to a greater reliance on groundwater, and conjunctive use of both supplies is occurring to a greater extent throughout the valley, particularly in drought years. Groundwater provides all or a portion of municipal supply in many valley towns and cities. Redding, Anderson, Chico, Marysville, Sacramento, Olivehurst, Wheatland, Willows, and Williams rely to differing degrees on groundwater. Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater.

In the mountain valleys and basins with arable land, groundwater has been developed to supplement surface water supplies. Most of the rivers and streams of the area have adjudicated water rights that go back to the early 1900s, and diversion of surface water has historically supported agriculture. Droughts and increased competition for supply have led to significant development of groundwater for irrigation. In some basins, the fractured volcanic rock underlying the alluvial fill is the major aquifer for the area. In the rural mountain areas of the region, domestic supplies come almost entirely from groundwater. Although a few mountain communities are supplied in part by surface water, most rely on groundwater. These groundwater supplies are generally quite reliable in areas that have sufficient aquifer storage or where surface water replenishes supply throughout the year. In areas that depend on sustained runoff, water levels can be significantly depleted in drought years and many old, shallow wells can be dewatered. During 2001, an extreme drought year on the Modoc Plateau, many well owners experienced problems with water supply.

Groundwater development in the fractured rocks of the foothills of the southern Cascades and Sierra Nevada is fraught with uncertainty. Groundwater supplies from fractured rock sources are highly variable in terms of water quantity and water quality and are an uncertain source for large-scale residential development. Originally, foothill development relied on water supply from springs and river diversions with flumes and ditches for conveyance that date back to gold mining era operations. Current development is primarily based on individual private wells, and as pressures for larger scale development increase, questions about the reliability of supply need to be addressed. Many existing foothill communities have considerable experience with dry or drought year shortages. In Butte County residents in Cohasset, Forest Ranch, and Magalia have had to rely on water brought up the ridges in tanker trucks. The suggested answer has been the development of regional water supply projects. Unfortunately, the area's development pattern of small, geographically dispersed population centers does not lend itself to the kind of financial base necessary to support such projects.

Groundwater Quality

Groundwater quality in the Sacramento River HR is generally excellent. However, there are areas with local groundwater problems. Natural water quality impairments occur at the north end of the Sacramento Valley in the Redding subbasin, and along the margins of the valley and around the Sutter Buttes, where Cretaceous-age marine sedimentary rocks containing brackish to saline water are near the surface. Water from the older underlying sediments mixes with the fresh water in the younger alluvial aquifer and degrades the quality. Wells constructed in these areas typically have high TDS. Other local natural impairments are moderate levels of hydrogen sulfide in groundwater in the volcanic and geothermal areas in the western portion of the region. In the Sierra foothills, there is potential for encountering uranium and radon-bearing rock or sulfide mineral deposits containing heavy metals. Human-induced impairments are generally associated with individual septic system development in shallow unconfined portions of aquifers or in fractured hard rock areas where insufficient soil depths are available to properly leach effluent before it reaches the local groundwater supply.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,356 public supply water wells were sampled in 51 of the 88 basins and subbasins in the Sacramento River HR. Samples analyzed indicate that 1,282 wells, or 95 percent, met the state primary MCLs for drinking water. Seventy-four wells, or 5 percent, have constituents that exceed one or more MCL. Figure 34 shows the percentages of each contaminant group that exceeded MCLs in the 74 wells.

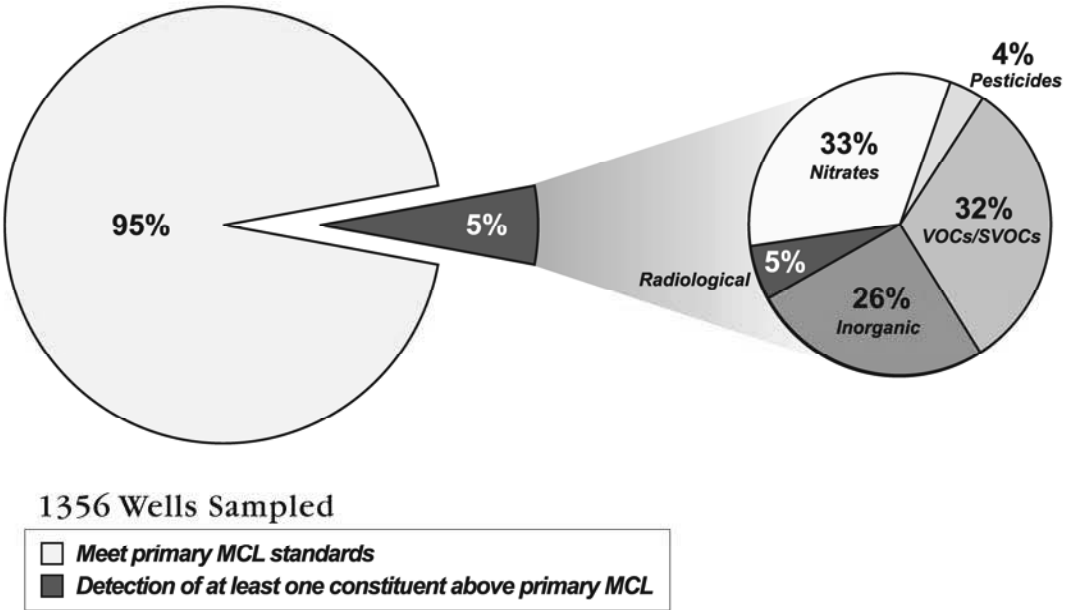

Figure 34 MCL exceedances in public supply wells in the Sacramento River Hydrologic Region

Table 25 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 25 Most frequently occurring contaminants by contaminant group in the Sacramento River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Cadmium – 4	Chromium (Total) – 3	3 tied at 2
Inorganics – Secondary	Manganese – 221	Iron – 166	Specific Conductance – 3
Radiological	Gross Alpha – 4		
Nitrates	Nitrate (as NO_3) – 22	Nitrate + Nitrite – 5	Nitrate Nitrogen (NO_3-N) – 2
Pesticides	Di(2-Ethylhexyl)phthalate – 4		
VOCs/SVOCs	PCE – 11	TCE – 7	Benzene – 4

PCE = Tetrachloroethylene
TCE = Trichloroethylene
VOC = Volatile Organic Compounds
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Some modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report. These are listed in Table 26.

Table 26 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Sacramento River Hydrologic Region

Basin name	New number	Old number
Fandango Valley	5-1.02	5-39
Bucher Swamp Valley	deleted	5-42
Modoc Plateau Recent Volcanic Areas	deleted	5-32
Modoc Plateau Pleistocene Volcanic Areas	deleted	5-33
Mount Shasta Area	deleted	5-34
Sacramento Valley Eastside Tuscan Formation Highlands	deleted	5-55
Clear Lake Pleistocene Volcanics	deleted	5-67

No additional basins were assigned to the Sacramento River HR in this revision. However, four basins have been divided into subbasins. Goose Lake Valley Groundwater Basin (5-1) has been subdivided into two subbasins, Fandango Valley (5-39) was modified to be a subbasin of Goose Lake Valley. Redding Area Groundwater Basin has been subdivided into six subbasins, Sierra Valley Groundwater Basin has been subdivided into two subbasins, and the Sacramento Valley Groundwater Basin has been subdivided into 18 subbasins.

There are several deletions of groundwater basins from Bulletin 118-80. Bucher Swamp Valley Basin (5-42) was deleted due to a thin veneer of alluvium over rock. Modoc Plateau Recent Volcanic Areas (5-32), Modoc Plateau Pleistocene Volcanic Areas (5-33), Mount Shasta Area (5-34), Sacramento Valley Eastside Tuscan Formation Highlands (5-55), and Clear Lake Pleistocene Volcanics (5-67) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6.

Table 27 Sacramento River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-1	GOOSE LAKE VALLEY									
5-1.01	LOWER GOOSE LAKE	36,000	B	-	400	9	9	-	183	68 - 528
5-1.02	FANDANGO VALLEY	18,500	B	2,000	-	3	-	-	-	-
5-2	ALTURAS AREA								357	180 - 800
5-2.01	SOUTH FORK PITT RIVER	114,000	B	5,000	1,075	9	-	8	-	-
5-2.02	WARM SPRINGS VALLEY	68,000	B	400	314	3	-	11	-	-
5-3	JESS VALLEY	6,700	B		3,000	-	-	-	-	-
5-4	BIG VALLEY	92,000	B	4,000	880	19	9	10	260	141 - 633
5-5	FALL RIVER VALLEY	54,800	B	1,500	266	16	7	3	174	115 - 232
5-6	REDDING AREA									
5-6.01	BOWMAN	85,330	B	2,000	589	8	2	13	-	70 - 247
5-6.02	ROSEWOOD	45,320	B	-	-	4	-	-	-	118 - 218
5-6.03	ANDERSON	98,500	B	1,800	46	11	10	69	194	109-320
5-6.04	ENTERPRISE	60,900	B	700	266	11	3	43	-	160 - 210
5-6.05	MILLVILLE	67,900	B	500	254	6	5	4	140	-
5-6.06	SOUTH BATTLE CREEK	32,300	B	-	-	0	0	0	360	-
5-7	LAKE ALMANOR VALLEY	7,150	B	-	-	10	4	4	105	53 - 260
5-8	MOUNTAIN MEADOWS VALLEY	8,150	B	-	-	-	-	-	-	-
5-9	INDIAN VALLEY	29,400	B	-	-	-	4	9	-	-
5-10	AMERICAN VALLEY	6,800	B	40	40		4	11	-	-
5-11	MOHAWK VALLEY	19,000	B	-	500	1	2	15	248	210 - 285
5-12	SIERRA VALLEY									
5-12.01	SIERRA VALLEY	117,700	B	1,500	640	34	15	9	312	110 - 1,620
5-12.02	CHILCOOT	7,550	B	-	-	15	-	8	-	-
5-13	UPPER LAKE VALLEY	7,260	B	900	302	12	3	6	-	-
5-14	SCOTTS VALLEY	7,320	B	1,200	171	9	1	9	158	140 - 175
5-15	BIG VALLEY	24,210	B	1,470	475	49	11	7	535	270 - 790
5-16	HIGH VALLEY	2,360	B	100	37	5	2	-	598	480 - 745
5-17	BURNS VALLEY	2,900	B	-	30	1	5	-	335	280 - 455
5-18	COYOTE VALLEY	6,530	B	800	446	6	3	3	288	175 - 390
5-19	COLLAYOMI VALLEY	6,500	B	1,000	121	10	4	3	202	150 - 255
5-20	BERRYESSA VALLEY	1,400	C	-	-	0	-	0	-	-
5-21	SACRAMENTO VALLEY									
5-21.50	RED BLUFF	266,750	B	1,200	363	30	10	56	207	120 - 500
5-21.51	CORNING	205,640	B	3,500	977	29	7	30	286	130 - 490
5-21.52	COLUSA	918,380	B	5,600	984	98	30	134	391	120 - 1,220
5-21.53	BEND	20,770	B	-	275	0	3	9		334-360
5-21.54	ANTELOPE	18,710	B	800	575	4	5	22	296	-
5-21.55	DYE CREEK	27,730	B	3,300	890	8	1	3	240	159 - 396
5-21.56	LOS MOLINOS	33,170	B	1,000	500	3	3	9	217	
5-21.57	VINA	125,640	B	3,850	1,212	23	5	69	285	48 - 543
5-21.58	WEST BUTTE	181,600	B	4,000	1,833	32	8	36	293	130 - 676

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-21.59	EAST BUTTE	265,390	B	4,500	1,019	43	4	44	235	122 - 570
5-21.60	NORTH YUBA	100,400	C	4,000	-	21	-	32	-	-
5-21.61	SOUTH YUBA	107,000	C	4,000	1,650	56	-	6	-	-
5-21.62	SUTTER	234,000	C	-	-	34	-	115	-	-
5-21.64	NORTH AMERICAN	351,000	A	-	800	121	-	339	300	150 - 1,000
5-21.65	SOUTH AMERICAN	248,000	C	-	-	105	-	247	221	24-581
5-21.66	SOLANO	425,000	C	-	-	123	23	136	427	150 - 880
5-21.67	YOLO	226,000	B	4,000+	1,000	127	20	185	880	480 - 2,060
5-21.68	CAPAY VALLEY	25,000	C	-	-	11	-	3	-	-
5-30	LOWER LAKE VALLEY	2,400	B	100	37		3	5	568	290 - 1,230
5-31	LONG VALLEY	2,600	B	100	63	-	-	-	-	-
5-35	MCCLOUD AREA	21,320	B	-	380	-	-	1	-	-
5-36	ROUND VALLEY	7,270	B	2,000	800	2				148 - 633
5-37	TOAD WELL AREA	3,360	B	-	-	-	-	-	-	-
5-38	PONDOSA TOWN AREA	2,080	B	-	-	-	-	-	-	-
5-40	HOT SPRINGS VALLEY	2,400	B	-	-	-	-	-	-	-
5-41	EGG LAKE VALLEY	4,100	B	-	20	-	-	-	-	-
5-43	ROCK PRAIRIE VALLEY	5,740	B	-	-	-	-	-	-	-
5-44	LONG VALLEY	1,090	B	-	-	-	-	-	-	-
5-45	CAYTON VALLEY	1,300	B	-	400	-	-	-	-	-
5-46	LAKE BRITTON AREA	14,060	B	-	-	-	-	2	-	-
5-47	GOOSE VALLEY	4,210	B	-	-	-	-	-	-	-
5-48	BURNEY CREEK VALLEY	2,350	B	-	-	-	-	2	-	-
5-49	DRY BURNEY CREEK VALLEY	3,070	B	-	-	-	-	-	-	-
5-50	NORTH FORK BATTLE CREEK VALLEY	12,760	B	-	-	-	-	3	-	-
5-51	BUTTE CREEK VALLEY	3,230	B	-	-	-	-	-	-	-
5-52	GRAYS VALLEY	5,440	B	-	-	-	-	-	-	-
5-53	DIXIE VALLEY	4,870	B	-	-	-	-	-	-	-
5-54	ASH VALLEY	6,010	B	3,000	2,200	-	-	-	-	-
5-56	YELLOW CREEK VALLEY	2,310	B	-	-	-	-	-	-	-
5-57	LAST CHANCE CREEK VALLEY	4,660	B	-	-	-	-	-	-	-
5-58	CLOVER VALLEY	16,780	B	-	-	-	-	-	-	-
5-59	GRIZZLY VALLEY	13,400	B	-	-	-	-	1	-	-
5-60	HUMBUG VALLEY	9,980	B	-	-	-	-	8	-	-
5-61	CHROME TOWN AREA	1,410	B	-	-	-	-	-	-	-
5-62	ELK CREEK AREA	1,440	B	-	-	-	-	-	-	-
5-63	STONYFORD TOWN AREA	6,440	B	-	-	-	-	-	-	-
5-64	BEAR VALLEY	9,100	B	-	-	-	-	-	-	-
5-65	LITTLE INDIAN VALLEY	1,270	B	-	-	-	-	-	-	-
5-66	CLEAR LAKE CACHE FORMATION	30,000	B	245	52		-	4	-	-
5-68	POPE VALLEY	7,180	C	-	-	-	-	1	-	-
5-86	JOSEPH CREEK	4,450	B	-	-	-	-		-	-

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-87	MIDDLE FORK FEATHER RIVER	4,340	B	-	-	-	-	2	-	-
5-88	STONY GORGE RESERVOIR	1,070	B	-	-	-	-	-	-	-
5-89	SQUAW FLAT	1,300	C	-	-	-	-	-	-	-
5-90	FUNKS CREEK	3,000	C	-	-	-	-	-	-	-
5-91	ANTELOPE CREEK	2,040	B	-	-	-	-	-	-	-
5-92	BLANCHARD VALLEY	2,200	B	-	-	-	-	-	-	-
5-93	NORTH FORK CACHE CREEK	3,470	C	-	-	-	-	-	-	-
5-94	MIDDLE CREEK	700	B	-	75	-	-	1	-	-
5-95	MEADOW VALLEY	5,730	B	-	-	-	-	1	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

San Joaquin River Hydrologic Region

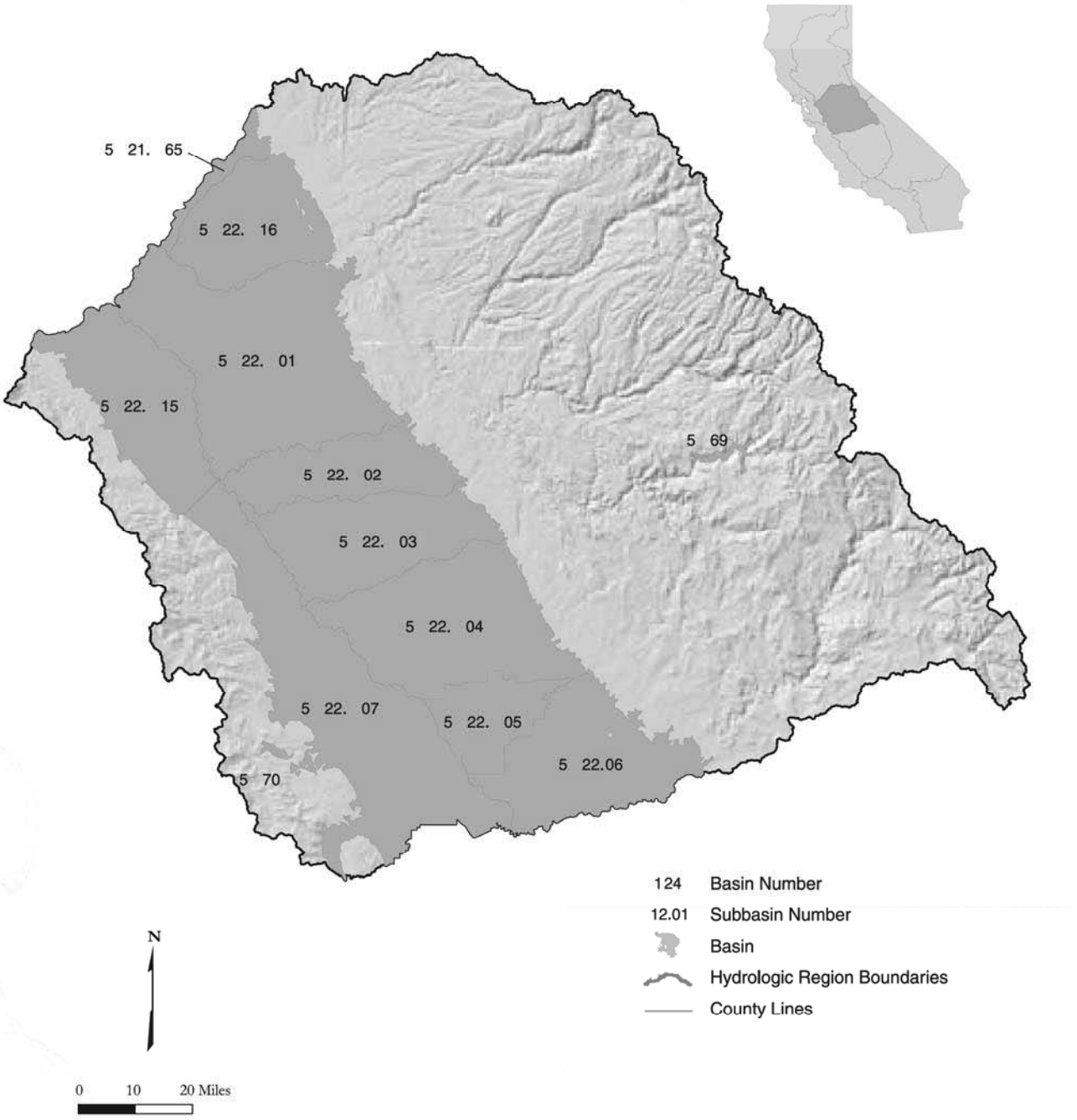

Figure 35 San Joaquin River Hydrologic Region

Basins and Subbasins of the San Joaquin River Hydrologic Region

Basin/subbasin	Basin name
5-22	San Joaquin Valley
5-22.01	Eastern San Joaquin
5-22.02	Modesto
5-22.03	Turlock
5-22.04	Merced
5-22.05	Chowchilla
5-22.06	Madera
5-22.07	Delta-Mendota
5-22.15	Tracy
5-22.16	Cosumnes
5-69	Yosemite Valley
5-70	Los Banos Creek Valley

Description of the Region

The San Joaquin River HR covers approximately 9.7 million acres (15,200 square miles) and includes all of Calaveras, Tuolumne, Mariposa, Madera, San Joaquin, and Stanislaus counties, most of Merced and Amador counties, and parts of Alpine, Fresno, Alameda, Contra Costa, Sacramento, El Dorado, and San Benito counties (Figure 35). The region corresponds to a portion near the middle of RWQCB 5. Significant geographic features include the northern half of the San Joaquin Valley, the southern part of the Sacramento-San Joaquin Delta, the Sierra Nevada and Diablo Range. The region is home to about 1.6 million people (DWR 1998). Major population centers include Merced, Modesto, and Stockton. The Merced area is entirely dependent on groundwater for its supply, as will be the new University of California at Merced campus.

Groundwater Development

The region contains two entire groundwater basins and part of the San Joaquin Valley Groundwater Basin, which continues south into the Tulare Lake HR. The San Joaquin Valley Groundwater Basin is divided into nine subbasins in this region. The basins underlie 3.73 million acres (5,830 square miles) or about 38 percent of the entire HR area.

The region is heavily groundwater reliant. Within the region groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes. Groundwater use in the region accounts for about 18 percent of statewide groundwater use for agricultural and urban needs. Groundwater use in the region accounts for 5 percent of the State's overall supply from all sources for agricultural and urban uses (DWR 1998).

The aquifers are generally quite thick in the San Joaquin Valley subbasins, with groundwater wells commonly extending to depths of up to 800 feet. Aquifers include unconsolidated alluvium and consolidated rocks with unconfined and confined groundwater conditions. Typical well yields in the San Joaquin Valley range from 300 to 2,000 gpm with yields of 5,000 gpm possible. The region's only significant basin located outside of San Joaquin Valley is Yosemite Valley. Yosemite Valley Basin supplies water to Yosemite National Park and has substantial well yields.

Conjunctive Use

Since near the beginning of the region's agricultural development, groundwater has been used conjunctively with surface water to meet water needs. Groundwater was and is used when and where surface water is unable to fully meet demands either in time or area. For several decades, this situation was more of an incidental conjunctive use than a formal one. Historical groundwater use has resulted in some land subsidence in the southwest portion of the region.

Groundwater Quality

In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are TDS, nitrate, boron, chloride, and organic compounds. The Yosemite Valley Groundwater Basin has exceptionally high quality groundwater.

Areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. The high TDS content of west-side groundwater is due to recharge of streamflow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley is the result of concentration of salts due to evaporation and poor drainage. Nitrates may occur naturally or as a result of disposal of human and animal waste products and fertilizer. Boron and chloride are likely a result of concentration from evaporation near the valley trough. Organic contaminants can be broken into two categories, agricultural and industrial. Agricultural pesticides and herbicides have been detected in groundwater throughout the region, but primarily along the east side of the San Joaquin Valley where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is dibromochloropropane (DBCP), a now-banned soil fumigant and known carcinogen once used extensively on grapes and cotton. Industrial organic contaminants include TCE, dichloroethylene (DCE), and other solvents. They are found in groundwater near airports, industrial areas, and landfills.

Water Quality in Public Supply Wells

From 1994 through 2000, 689 public supply water wells were sampled in 10 of the 11 basins and subbasins in the San Joaquin River HR. Samples analyzed indicate that 523 wells, or 76 percent, met the state primary MCLs for drinking water. One-hundred-sixty-six wells, or 24 percent, have constituents that exceed one or more MCL. Figure 36 shows the percentages of each contaminant group that exceeded MCLs in the 166 wells.

Table 28 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Changes from Bulletin 118-80

The subbasins of the San Joaquin Valley, which were delineated as part of the 118-80 update, are given their first numeric designation in this report. Additionally, the Cosumnes Subbasin has been added to the subbasins within the San Joaquin River HR. It is worth noting that the southern portion of the South American Subbasin of the Sacramento Valley Groundwater Basin is also included as part of this HR. The subbasin names and numbers within the region are listed in Table 29.

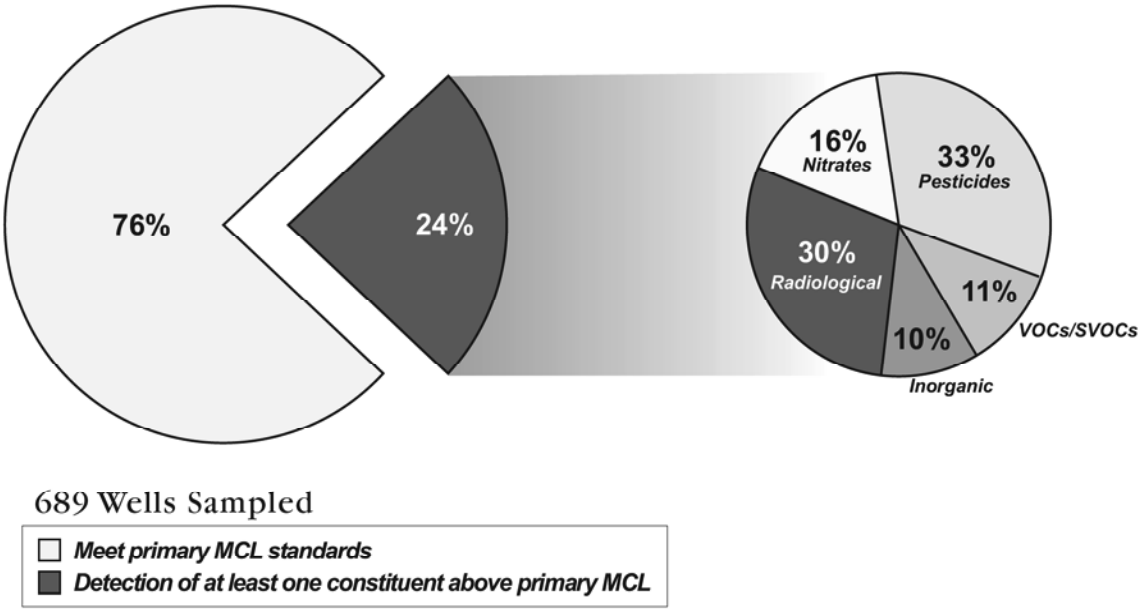

Figure 36 MCL exceedances in public supply wells in the San Joaquin River Hydrologic Region

Table 28 Most frequently occurring contaminants by contaminant group in the San Joaquin River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Aluminum – 4	Arsenic – 4	4 tied at 2 exceedances
Inorganics – Secondary	Manganese – 123	Iron – 102	TDS – 9
Radiological	Uranium – 33	Gross Alpha – 26	Radium 228 – 6
Nitrates	Nitrate (as NO_3) – 23	Nitrate + Nitrite – 6	Nitrate Nitrogen (NO_3-N) – 3
Pesticides	DBCP – 44	Di(2-Ethylhexyl)phthalate – 11	EDB – 6
VOCs	PCE – 8	Dichloromethane – 3	TCE – 3

DBCP = Dibromochloropropane
EDB = Ethylenedibromide
PCE = Tetrachloroethylene
TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Table 29 Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Joaquin Hydrologic Region

Subbasin name	New number	Old number
Eastern San Joaquin	5-22.01	5-22
Modesto	5-22.02	5-22
Turlock	5-22.03	5-22
Merced	5-22.04	5-22
Chowchilla	5-22.05	5-22
Madera	5-22.06	5-22
Delta-Mendota	5-22.07	5-22
Tracy	5-22.15	5-22
Cosumnes	5-22.16	5-22

Table 30 San Joaquin River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-22	SAN JOAQUIN VALLEY									
5-22.01	EASTERN SAN JOAQUIN	707,000	A	1,500	-	345	69	540	310	30 - 1,632
5-22.02	MODESTO	247,000	B	4,500	1000-2000	230	15	209	60-500	200-8300
5-22.03	TURLOCK	347,000	B	4,500	1000-2000	307	0	163	200-500	100-8300
5-22.04	MERCED	491,000	B	4,450	1500-1900	378	0	142	200-400	100-3600
5-22.05	CHOWCHILLA	159,000	B	4,750	750-2000	203	0	28	200-500	120-6400
5-22.06	MADERA	394,000	B	4,750	750-2000	378	0	127	200-400	100-6400
5-22.07	DELTA-MENDOTA	747,000	B	5,000	800-2000	816	0	120	770	210-86,000
5-22.15	TRACY	345,000	C	3,000	500-3,000	18	14	183	1,190	210-7,800
5-22.16	COSUMNES	281,000	A	1,500	-	75	13	72	218	140-438
5-69	YOSEMITE VALLEY	7,500	C	1,200	900	0	0	3	54	43-73
5-70	LOS BANOS CREEK VALLEY	4,840	C	-	-	0	0	0	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Tulare Lake Hydrologic Region

Figure 37 Tulare Lake Hydrologic Region

Basins and Subbasins of Tulare Lake Hydrologic Region

Basin/subbasin	Basin name
5-22	San Joaquin Valley
5-22.08	Kings
5-22.09	Westside
5-22.10	Pleasant Valley
5-22.11	Kaweah
5-22.12	Tulare Lake
5-22.13	Tule
5-22.14	Kern County
5-23	Panoche Valley
5-25	Kern River Valley
5-26	Walker Basin Creek Valley
5-27	Cummings Valley
5-28	Tehachapi Valley West
5-29	Castaic Lake Valley
5-71	Vallecitos Creek Valley
5-80	Brite Valley
5-82	Cuddy Canyon Valley
5-83	Cuddy Ranch Area
5-84	Cuddy Valley
5-85	Mil Potrero Area

Description of the Region

The Tulare Lake HR covers approximately 10.9 million acres (17,000 square miles) and includes all of Kings and Tulare counties and most of Fresno and Kern counties (Figure 37). The region corresponds to approximately the southern one-third of RWQCB 5. Significant geographic features include the southern half of the San Joaquin Valley, the Temblor Range to the west, the Tehachapi Mountains to the south, and the southern Sierra Nevada to the east. The region is home to more than 1.7 million people as of 1995 (DWR, 1998). Major population centers include Fresno, Bakersfield, and Visalia. The cities of Fresno and Visalia are entirely dependent on groundwater for their supply, with Fresno being the second largest city in the United States reliant solely on groundwater.

Groundwater Development

The region has 12 distinct groundwater basins and 7 subbasins of the San Joaquin Valley Groundwater Basin, which crosses north into the San Joaquin River HR. These basins underlie approximately 5.33 million acres (8,330 square miles) or 49 percent of the entire HR area.

Groundwater has historically been important to both urban and agricultural uses, accounting for 41 percent of the region's total annual supply and 35 percent of all groundwater use in the State. Groundwater use in the region represents about 10 percent of the State's overall supply for agricultural and urban uses (DWR 1998).

The aquifers are generally quite thick in the San Joaquin Valley subbasins with groundwater wells commonly exceeding 1,000 feet in depth. The maximum thickness of freshwater-bearing deposits (4,400 feet) occurs at the southern end of the San Joaquin Valley. Typical well yields in the San Joaquin Valley range from 300 gpm to 2,000 gpm with yields of 4,000 gpm possible. The smaller basins in the mountains surrounding the San Joaquin Valley have thinner aquifers and generally lower well yields averaging less than 500 gpm.

The cities of Fresno, Bakersfield, and Visalia have groundwater recharge programs to ensure that groundwater will continue to be a viable water supply in the future. Extensive groundwater recharge programs are also in place in the south valley where water districts have recharged several million acre-feet for future use and transfer through water banking programs.

The extensive use of groundwater in the San Joaquin Valley has historically caused subsidence of the land surface primarily along the west side and south end of the valley.

Groundwater Quality

In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, arsenic, and organic compounds.

The areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. High TDS content of west-side water is due to recharge of stream flow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley is the result of concentration of salts because of evaporation and poor drainage. In the central and west-side portions of the valley, where the Corcoran Clay confining layer exists, water quality is generally better beneath the clay than above it. Nitrates may occur naturally or as a result of disposal of human and animal waste products and fertilizer. Areas of high nitrate concentrations are known to exist near the town of Shafter and other isolated areas in the San Joaquin Valley. High levels of arsenic occur locally and appear to be associated with lakebed areas. Elevated arsenic levels have been reported in the Tulare Lake, Kern Lake and Buena Vista Lake bed areas. Organic contaminants can be broken into two categories, agricultural and industrial. Agricultural pesticides and herbicides have been detected throughout the valley, but primarily along the east side where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is DBCP, a now-banned soil fumigant and known carcinogen once used extensively on grapes. Industrial organic contaminants include TCE, DCE, and other solvents. They are found in groundwater near airports, industrial areas, and landfills.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,476 public supply water wells were sampled in 14 of the 19 groundwater basins and subbasins in the Tulare Lake HR. Evaluation of analyzed samples shows that 1,049 of the wells, or 71 percent, met the state primary MCLs for drinking water. Four-hundred-twenty-seven wells, or 29 percent, exceeded one or more MCL. Figure 38 shows the percentages of each contaminant group that exceeded MCLs in the 427 wells.

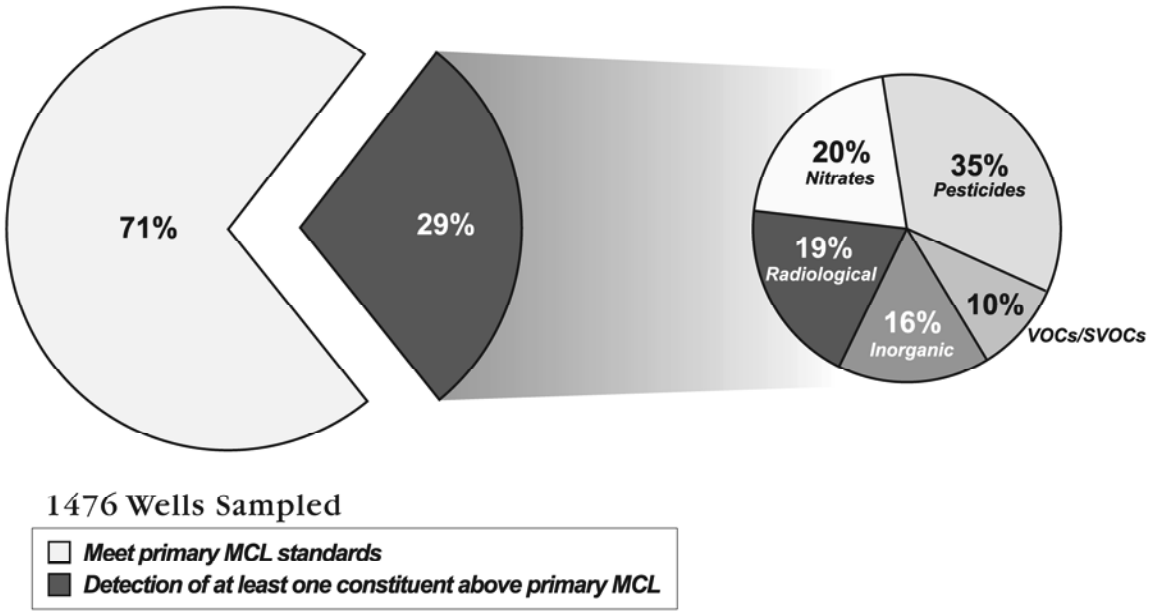

Figure 38 MCL exceedances by contaminant group in public supply wells in the Tulare Lake Hydrologic Region

Table 31 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 31 Most frequently occurring contaminants by contaminant group in the Tulare Lake Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics - Primary	Fluoride – 32	Arsenic – 16	Aluminum – 13
Inorganics - Secondary	Iron – 155	Manganese – 82	TDS – 9
Radiological	Gross Alpha – 74	Uranium – 24	Radium 228 – 8
Nitrates	Nitrate(as NO_3) – 83	Nitrate + Nitrite – 14	Nitrite(as N) – 3
Pesticides	DBCP – 130	EDB – 24	Di(2-Ethylhexyl)phthalate – 7
VOCs/SVOCs	TCE – 17	PCE – 16	Benzene – 6 MTBE – 6

DBCP = Dibromochloropropane
EDB = Ethylenedibromide
TCE = Trichloroethylene
PCE = Tetrachloroehylene
VOC = Volatile organic compound
SVOC = Semivolatile organic compound

Changes from Bulletin 118-80

There are no newly defined basins since Bulletin 118-80. However, the subbasins of the San Joaquin Valley, which were delineated as part of the 118-80 update, are given their first numeric designation in this report (Table 32).

Table 32 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Tulare Lake Hydrologic Region

Subbasin name	New number	Old number
Kings	5-22.08	5-22
Westside	5-22.09	5-22
Pleasant Valley	5-22.10	5-22
Kaweah	5-22.11	5-22
Tulare Lake	5-22.12	5-22
Tule	5-22.13	5-22
Kern County	5-22.14	5-22
Squaw Valley	deleted	5-24
Cedar Grove Area	deleted	5-72
Three Rivers Area	deleted	5-73
Springville Area	deleted	5-74
Templeton Mountain Area	deleted	5-75
Manache Meadow Area	deleted	5-76
Sacator Canyon Valley	deleted	5-77
Rockhouse Meadows Valley	deleted	5-78
Inns Valley	deleted	5-79
Bear Valley	deleted	5-81

Several basins have been deleted from the Bulletin 118-80 report. In Squaw Valley (5-24) all 118 wells are completed in hard rock. Cedar Grove Area (5-72) is a narrow river valley in Kings Canyon National Park with no wells. Three Rivers Area (5-73) has a thin alluvial terrace deposit but 128 of 130 wells are completed in hard rock. Springville Area (5-74) is this strip of alluvium adjacent to Tule River and all wells are completed in hard rock. Templeton Mountain Area (5-75), Manache Meadow Area (5-76), and Sacator Canyon Valley (5-77) are all at the crest of mountains with no wells. Rockhouse Meadows Valley (5-78) is in wilderness with no wells. Inns Valley (5-79) and Bear Valley (5-81) both have all wells completed in hard rock.

Table 33 Tulare Lake Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-22	SAN JOAQUIN VALLEY									
5-22.08	KINGS	976,000	C	3,000	500-1,500	909	-	722	200-700	40-2000
5-22.09	WESTSIDE	640,000	C	2,000	1,100	960	-	50	520	220-35,000
5-22.10	PLEASANT VALLEY	146,000	B	3,300	-	151	-	2	1,500	1000-3000
5-22.11	KAWEAH	446,000	B	2,500	1,000-2,000	568	-	270	189	35-580
5-22.12	TULARE LAKE	524,000	B	3,000	300-1,000	241	-	86	200-600	200-40,000
5-22.13	TULE	467,000	B	3,000	-	459	-	150	256	200-30,000
5-22.14	KERN COUNTY	1,950,000	A	4,000	1,200-1,500	2,258	249	476	400-450	150-5000
5-23	PANOCHE VALLEY	33,100	C	-	-	48	-	-	1,300	394-3530
5-25	KERN RIVER VALLEY	74,000	C	3,650	350	-	-	92	378	253-480
5-26	WALKER BASIN CREEK VALLEY	7,670	C	650	-	-	-	1	-	-
5-27	CUMMINGS VALLEY	10,000	A	150	56	51	-	15	344	-
5-28	TEHACHAPI VALLEY WEST	14,800	A	1,500	454	64	-	19	315	280-365
5-29	CASTAC LAKE VALLEY	3,600	C	400	375	-	-	3	583	570-605
5-71	VALLECITOS CREEK VALLEY	15,100	C	-	-	-	-	0	-	-
5-80	BRITE VALLEY	3,170	A	500	50	-	-	-	-	-
5-82	CUDDY CANYON VALLEY	3,300	C	500	400	-	-	3	693	695
5-83	CUDDY RANCH AREA	4,200	C	300	180	-	-	4	550	480-645
5-84	CUDDY VALLEY	3,500	A	160	135	3	-	3	407	325-645
5-85	MIL POTRERO AREA	2,300	C	3,200	240	7	-	7	460	372-657

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

North Lahontan Hydrologic Region

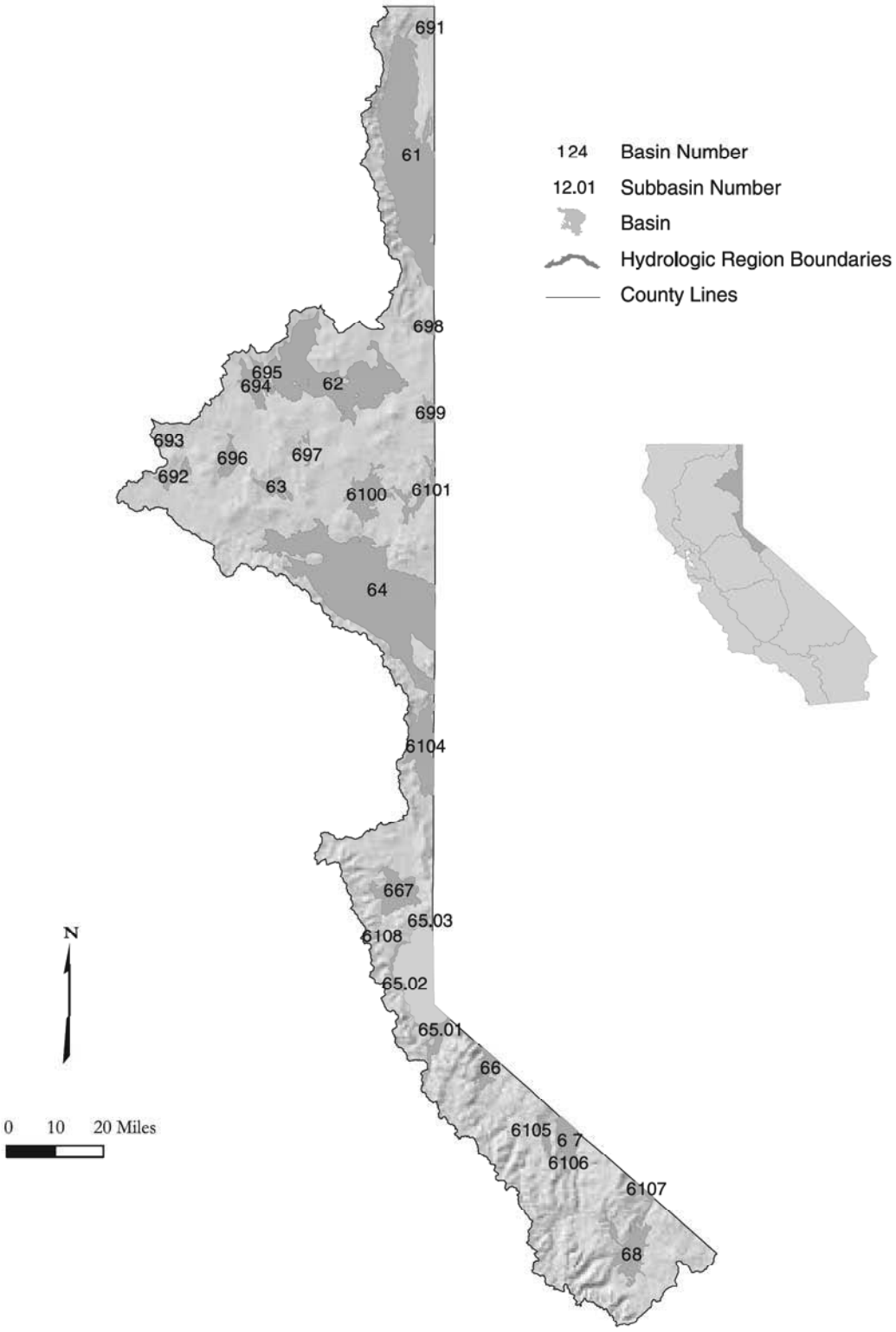

Figure 39 North Lahontan Hydrologic Region

Basins and Subbasins of the North Lahontan Hydrologic Region

Basin/subbasin	Basin name
6-1	Surprise Valley
6-2	Madeline Plains
6-3	Willow Creek Valley
6-4	Honey Lake Valley
6-5	Tahoe Valley
6-5.01	Tahoe Valley South
6-5.02	Tahoe Valley West
6-5.03	Tahoe Valley North
6-6	Carson Valley
6-7	Antelope Valley
6-8	Bridgeport Valley
6-67	Martis (Truckee) Valley
6-91	Cow Head Lake Valley
6-92	Pine Creek Valley
6-93	Harvey Valley
6-94	Grasshopper Valley
6-95	Dry Valley
6-96	Eagle Lake Area
6-97	Horse Lake Valley
6-98	Tuledad Canyon
6-99	Painters Flat
6-100	Secret Valley
6-101	Bull Flat
6-104	Long Valley
6-105	Slinkard Valley
6-106	Little Antelope Valley
6-107	Sweetwater Flat
6-108	Olympic Valley

Description of the Region

The North Lahonton HR covers approximately 3.91 million acres (6,110 square miles) and includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, Mono, and Tuolumne counties (Figure 39). Reaching south from the Oregon border almost to Mono Lake on the east side of the Sierra, this region encompasses portions of two geomorphic provinces. From Long Valley north, most of the groundwater basins of the region were formed by basin and range block faulting near the western extent of the province. South from Long Valley, most of the basins are in the alpine valleys of the Sierra Nevada or are at the foot of the Sierra along the California-Nevada border where streams and rivers draining the eastern Sierran slopes terminate in desert sinks or lakes. The region corresponds to approximately the northern half of RWQCB 6. Significant geographic features include the Sierra Nevada, the volcanic terrane of the Modoc Plateau, Honey Lake Valley, and Lake Tahoe. The latter two areas are the major population centers in the region. The 1995 population of the entire region was about 84,000 people (DWR, 1998).

The northern portion of the region is rural and sparsely populated. Cattle ranching and associated hay cropping are the predominant land uses in addition to some pasture irrigation. Less than 4 percent of the entire region is irrigated. About 75 percent of the irrigated lands are in Modoc and Lassen counties, and most of the remainder is in Alpine and Mono counties. Much of the southern portion of the region is federally owned and managed as national forest lands where tourism and recreation constitute much of the economic base.

Much of the North Lahontan HR is chronically short of water due to the arid, high desert climate, which predominates in the region. Throughout the northern portion of the region where annual precipitation can be as low as 4 inches, runoff is typically scant and streamflows decrease rapidly during the irrigation season as the snowpack in the higher elevations melts. In the southern portion of the region, annual precipitation ranges from more than 70 inches (mostly snow in the higher elevations of the mountains) to as little as 8 inches in the low elevation valleys. In wet years, surface water can meet much of the agricultural demand, but in dry years, most of the region relies heavily on groundwater to meet water supply needs.

Groundwater Development

There are 24 groundwater basins in the region, one of which is divided into three subbasins. Thirteen of these basins are shared with Nevada and one with Oregon. These basins underlie approximately 1.03 million acres (1,610 square miles) or about 26 percent of the entire region. Although the groundwater basins were delineated based on mapped alluvial fill, much of the groundwater produced in many of them actually comes from underlying fractured rock aquifers. This is particularly true in the volcanic areas of Modoc and Lassen counties where, in many basins, volcanic flows are interstratified with lake sediments and alluvium. Wells constructed in the volcanics commonly produce large amounts of groundwater, whereas wells constructed in fine-grained lake deposits produce less. Because the thickness and lateral extent the of the hard rocks outside of the defined basin are generally not known, actual groundwater in storage in these areas is unknown.

Locally, groundwater is an important resource accounting for about 28 percent of the annual supply for agricultural and urban uses. Groundwater use in the region represents less than 1 percent of the State's overall supply for agricultural and urban uses (DWR 1998).

In the northern portion of the region, a sizable quantity of groundwater (nearly 130,000 acre-feet) is extracted annually for agricultural and municipal purposes. Groundwater extracted from the Honey Lake Valley Basin accounts for 41,900 acre-feet of the agricultural supply and 12,000 acre-feet of the municipal supply (based on normalized data from 1990). An additional 3,100 acre-feet is extracted to meet the demands of the Honey Lake Wildlife Area, which provides habitat for several threatened species (Bald Eagle, Sandhill Crane, Bank Swallow, and Peregrine Falcon).

Well yields in the Honey Lake Valley Basin are greatest in alluvial and volcanic deposits. Wells drawing from these deposits may have yields that vary from 10 gpm to more than 2,000 gpm, but drawdown in these cases is generally high. Eight wells in the Honey Lake Wildlife Area have an average yield of between 1,260 and 2,100 gpm. Depths of completed wells in the region range from 20 to 720 feet.

The Honey Lake Valley Basin is very close to exceeding prudent perennial yield, and future development could come at the expense of water for agriculture. A 1987 agreement between DWR, the state of Nevada, and the U.S. Geological Survey resulted in a study of the groundwater flow system in eastern Honey Lake Valley. Upon conclusion of the study in September 1990, a Nevada state engineer ruled that only about 13,000 acre-feet could be safely transferred from the basin.

No major changes in water use are anticipated in the near future in the northern portion of the region. Irrigated agriculture is already constrained by economically available water supplies. A small amount of agricultural expansion is expected but only in areas that can support minor additional groundwater development. Likewise, the modest need for additional municipal and irrigation supplies can be met by minor expansion of present surface systems or by increased use of groundwater.

The principal drainages in the southern portion of the region are the Truckee, Walker and Carson rivers. Water rights in these drainages historically have been heavily contested, and allocations are limited by interstate agreements with Nevada, in-stream environmental requirements, and miscellaneous private rights holders. In the Lake Tahoe Basin, further development is strictly limited because of concerns regarding water quality in the lake. Surface water storage developed in the region's drainages provides urban and agricultural supply to the Reno/Sparks area and to the many smaller communities in the eastern Sierra and at the foot of the mountain slopes. Most communities rely on a combination of surface water and groundwater supply.

In the upper Truckee drainage, the primary groundwater basins underlie the areas around Lake Tahoe and Martis Valley, where the Town of Truckee is located. Both areas use surface water and groundwater for urban and surrounding rural domestic supplies.

Little is known about the small groundwater basins developed along the foot of the eastern Sierra. Most communities overlying these basins are along the streams and rivers flowing down the mountains, and groundwater is extracted from the underlying alluvium. Groundwater augments surface supplies for agricultural purposes and supports municipal and rural domestic supplies.

Groundwater Quality

In basins in the northern portion of the region, groundwater quality ranges widely from excellent to poor. Wells that obtain their water supply from lake deposits can have high concentrations of boron, arsenic, fluoride, nitrate, and TDS. TDS content generally increases toward the central portions of these basins where concentrations have accumulated over time. The groundwater quality along the margins of most of these basins tends to be of much better quality. There is a potential for future groundwater pollution occurring in urban/suburban areas where single-family septic systems have been installed, especially in hard rock areas. Groundwater quality in the alpine basins is good to excellent; but, as in any area where single-family septic systems have been installed, there is potential for degradation of groundwater quality.

Water Quality in Public Supply Wells

From 1994 through 2000, 169 public supply water wells were sampled in 8 of the 26 basins and subbasins in the North Lahontan HR. Evaluation of the analyzed samples indicates that 147 wells, or 87 percent, met the state primary MCLs for drinking water. Twenty-two wells, or 13 percent, have constituents that exceed one or more MCL. Figure 40 shows the percentages of each contaminant group that exceeded MCLs in the 22 wells.

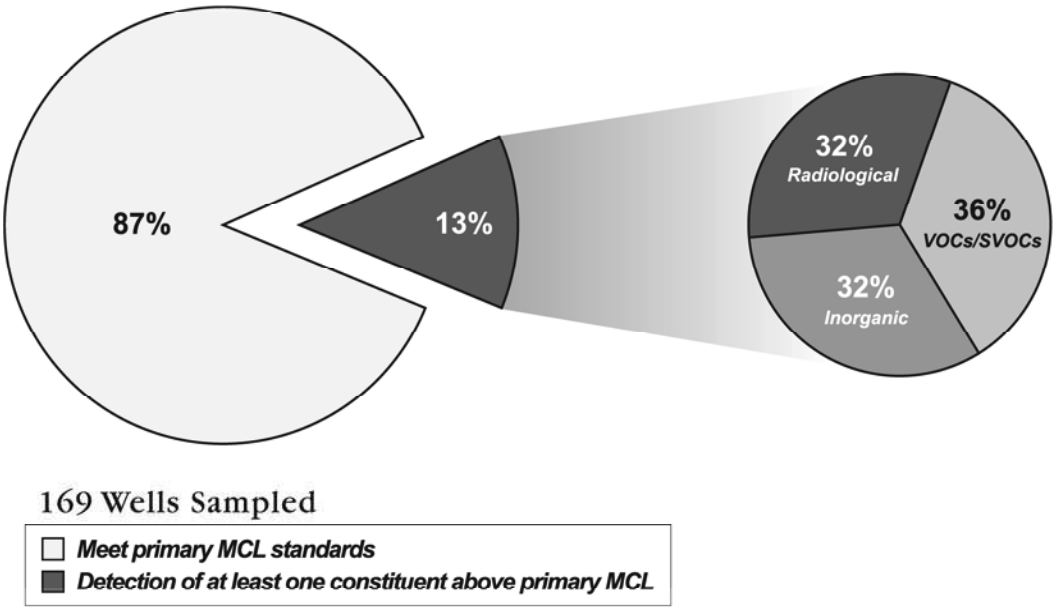

Figure 40 MCL exceedances in public supply wells in the North Lahontan Hydrologic Region

Table 34 lists the three most frequently occurring contaminants in each contaminant group and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 34 Most frequently occurring contaminants by contaminant group in the North Lahontan Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 3	Thallium – 3	3 tied at 1 exceedance
Inorganics – Secondary	Iron – 14	Manganese – 13	TDS – 1
Radiological	Gross Alpha – 7	Uranium – 5	Radium 226 – 1
VOCs/SVOCs	1,2 Dichloroethane – 8	TCE – 2	MTBE – 1

TCE = Trichloroethylene
MTBE = Methyltertiarybutylether
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

There are no newly defined basins since Bulletin 118-80. The only delineated areas removed from the list of region basins are the Recent and Pleistocene volcanic areas of the Modoc Plateau, previously numbered 6-102 and 6-103, respectively.

Table 35 North Lahontan Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-1	SURPRISE VALLEY	228,000	B	2,500	1,383	16	11	4	224	87 - 1,800
6-2	MADELINE PLAINS	156,150	B	-	450	2	6	-	402	81 - 1,790
6-3	WILLOW CREEK VALLEY	11,700	B	-	-	7	4	-	401	90 - 1,200
6-4	HONEY LAKE VALLEY	311,150	B	2,500	784	39	24	49	518	89 - 2,500
6-5	TAHOE VALLEY									
6-5.01	TAHOE SOUTH	14,800	C	4,000	-	6	-	54	-	59 - 206
6-5.02	TAHOE WEST	6,000	C	-	-	-	9	3	103	68 - 128
6-5.03	TAHOE VALLEY NORTH	2,000	C	900	-	-	-	-	141	-
6-6	CARSON VALLEY	10,700	C	-	-	-	-	-	-	-
6-7	ANTELOPE VALLEY	20,100	A	-	-	-	-	12	-	-
6-8	BRIDGEPORT VALLEY	32,500	C	-	-	-	-	6	-	-
6-67	MARTIS VALLEY	35,600	C	-	-	-	-	-	-	-
6-91	COW HEAD LAKE VALLEY	5,600	B	-	-	-	-	-	-	-
6-92	PINE CREEK VALLEY	9,530	B	-	-	-	-	1	-	-
6-93	HARVEY VALLEY	4,500	B	-	-	-	-	-	-	-
6-94	GRASSHOPPER VALLEY	17,670	B	-	-	-	-	-	-	-
6-95	DRY VALLEY	6,500	B	-	-	-	-	-	-	-
6-96	EAGLE LAKE AREA	-	B	-	-	-	4	4	-	-
6-97	HORSE LAKE VALLEY	3,800	B	-	-	-	-	-	-	-
6-98	TULEDAD CANYON	5,200	B	-	-	-	-	-	-	-
6-99	PAINTERS FLAT	6,400	B	-	-	-	-	-	-	-
6-100	SECRET VALLEY	33,680	B	-	-	2	2	-	-	125 - 3,200
6-101	BULL FLAT	18,100	B	-	-	-	-	-	-	-
6-104	LONG VALLEY	46,840	B	-	-	31	4		302	127 - 570
6-105	SLINKARD VALLEY	4,500	C	-	-	-	-	-	-	-
6-106	LITTLE ANTELOPE VALLEY	2,500	C	-	-	-	-	-	-	-
6-107	SWEETWATER FLAT	4,700	C	-	-	-	-	-	-	-
6-108	OLYMPIC VALLEY	700	C	600	330	-	-	2	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

South Lahontan Hydrologic Region

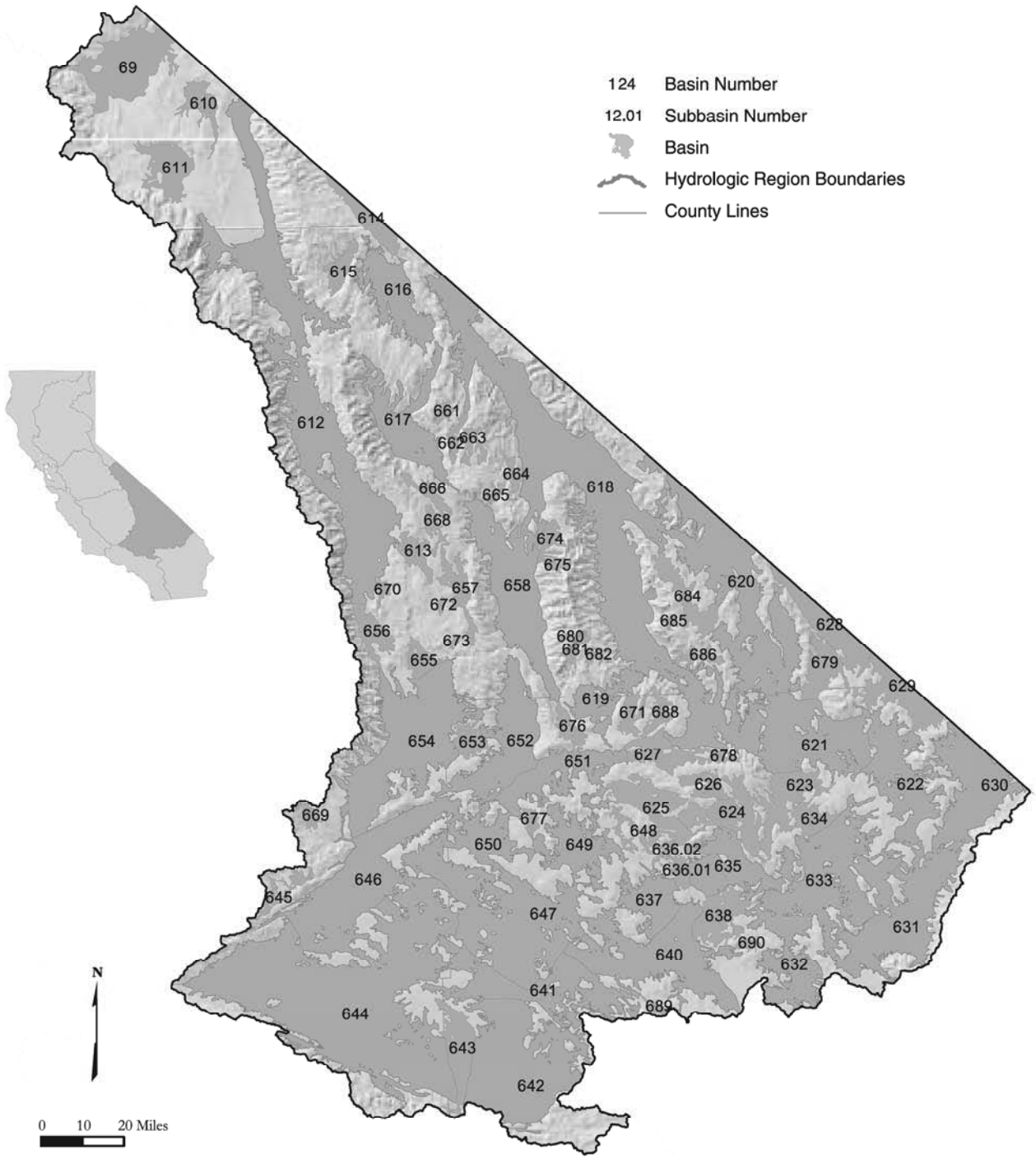

Figure 41 South Lahontan Hydrologic Region

Basins and Subbasins of the South Lahontan Hydrologic Region

Basin/subbasin	Basin name
6-9	Mono Valley
6-10	Adobe Lake Valley
6-11	Long Valley
6-12	Owens Valley
6-13	Black Springs Valley
6-14	Fish Lake Valley
6-15	Deep Springs Valley
6-16	Eureka Valley
6-17	Saline Valley
6-18	Death Valley
6-19	Wingate Valley
6-20	Middle Amargosa Valley
6-21	Lower Kingston Valley
6-22	Upper Kingston Valley
6-23	Riggs Valley
6-24	Red Pass Valley
6-25	Bicycle Valley
6-26	Avawatz Valley
6-27	Leach Valley
6-28	Pahrump Valley
6-29	Mesquite Valley
6-30	Ivanpah Valley
6-31	Kelso Valley
6-32	Broadwell Valley
6-33	Soda Lake Valley
6-34	Silver Lake Valley
6-35	Cronise Valley
6-36	Langford Valley
6-36.01	Langford Well Lake
6-36.02	Irwin
6-37	Coyote Lake Valley
6-38	Caves Canyon Valley
6-40	Lower Mojave River Valley
6-41	Middle Mojave River Valley
6-42	Upper Mojave River Valley
6-43	El Mirage Valley
6-44	Antelope Valley
6-45	Tehachapi Valley East
6-46	Fremont Valley
6-47	Harper Valley
6-48	Goldstone Valley
6-49	Superior Valley
6-50	Cuddeback Valley
6-51	Pilot Knob Valley
6-52	Searles Valley
6-53	Salt Wells Valley
6-54	Indian Wells Valley
6-55	Coso Valley
6-56	Rose Valley
6-57	Darwin Valley
6-58	Panamint Valley
6-61	Cameo Area
6-62	Race Track Valley
6-63	Hidden Valley
6-64	Marble Canyon Area
6-65	Cottonwood Spring Area
6-66	Lee Flat
6-68	Santa Rosa Flat
6-69	Kelso Lander Valley
6-70	Cactus Flat
6-71	Lost Lake Valley
6-72	Coles Flat
6-73	Wild Horse Mesa Area
6-74	Harrisburg Flats
6-75	Wildrose Canyon
6-76	Brown Mountain Valley
6-77	Grass Valley
6-78	Denning Spring Valley
6-79	California Valley
6-80	Middle Park Canyon
6-81	Butte Valley
6-82	Spring Canyon Valley
6-84	Greenwater Valley
6-85	Gold Valley
6-86	Rhodes Hill Area
6-88	Owl Lake Valley
6-89	Kane Wash Area
6-90	Cady Fault Area

Description of the Region

The South Lahontan HR covers approximately 21.2 million acres (33,100 square miles) in eastern California. This region includes about 21 percent of the surface area of California and both the highest (Mount Whitney) and lowest (Death Valley) surface elevations of the contiguous United States. The HR is bounded on the west by the crest of the Sierra Nevada and on the north by the watershed divide between Mono Lake and East Walker River drainages; on the east by Nevada and the south by the crest of the San Gabriel and San Bernardino mountains and the divide between watersheds draining south toward the Colorado River and those draining northward. This HR includes the Owens, Mojave, and Amargosa River systems, the Mono Lake drainage system, and many other internally drained basins. Average annual precipitation is about 7.9 inches, and runoff is about 1.3 maf per year (DWR 1994).

The South Lahontan HR includes Inyo County, much of Mono and San Bernardino counties, and parts of Kern and Los Angeles counties (Figure 41). National forests, national and state parks, military bases and other public lands comprise most of the land in this region. The Los Angeles Department of Water and Power is also a major landowner in the northern part of the HR and controls rights to much of the water draining the eastern Sierra Nevada.

According to 2000 census data, the South Lahontan HR is home to about 530,000 people, or 1.6 percent of the state's population. The major population centers are in the southern part of the HR and include Palmdale, Lancaster, Victorville, Apple Valley, and Hesperia.

Groundwater Development

In this report, 76 groundwater basins are delineated in the South Lahontan HR, and the Langford Valley Groundwater Basin (6-36) is divided into two subbasins. The groundwater basins underlie about 11.60 million acres (18,100 square miles) or about 55 percent of the HR.

Most of the groundwater production is concentrated, along with the population, in basins in the southern part of this region. Groundwater provides 41 percent of water supply for agriculture and urban uses (DWR 1998). Much of this HR is public land with very low population density, within these areas there has been little groundwater development and little is known about the basins.

In most smaller basins, groundwater is found in unconfined alluvial aquifers; however, in some of the larger basins, or near dry lakes, aquifers may be separated by aquitards that cause confined groundwater conditions. Depths of the basins range from tens or hundreds of feet in smaller basins to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this region depending on aquifer characteristics and well location, size, and use.

Conjunctive use of surface water and groundwater is practiced in the more heavily pumped basins. Some water used in the southern part of the HR is imported from Northern California by the State Water Project. Some of this imported water is used to recharge groundwater in the Mojave River Valley basins (6-40, 6-41, and 6-42). Surface water and groundwater are exported from the South Lahontan HR to the South Coast HR by the Los Angeles Department of Water and Power.

Groundwater Quality

The chemical character of the groundwater varies throughout the region, but most often is calcium or sodium bicarbonate. Near and beneath dry lakes, sodium chloride and sodium sulfate-chloride water is common. In general, groundwater near the edges of valleys contains lower TDS content than water beneath the central part of the valleys or near dry lakes.

Drinking water standards are most often exceeded for TDS, fluoride, and boron content. The EPA lists 13 sites of contamination in this HR. Of these, three military installations in the Antelope Valley and Mojave River Valley groundwater basins are federal Superfund sites because of VOCs and other hazardous contaminants.

Water Quality in Public Supply Wells

From 1994 through 2000, 605 public supply water wells were sampled in 19 of the 77 basins and subbasins in the South Lahontan HR. Analyzed samples indicate that 506 wells, or 84 percent, met the state primary MCLs for drinking water. Ninety-nine wells, or 16 percent, have constituents that exceed one or more MCL. Figure 42 shows the percentages of each contaminant group that exceeded MCLs in the 99 wells.

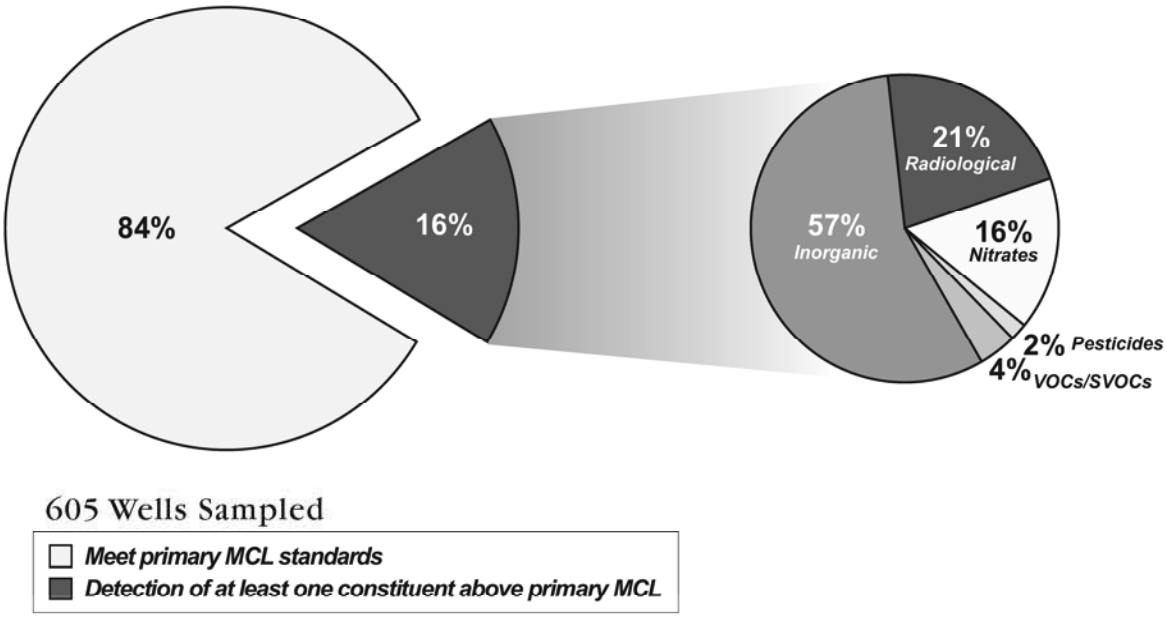

Figure 42 MCL exceedances in public supply wells in the South Lahontan Hydrologic Region

Table 36 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 36 Most frequently occurring contaminants by contaminant group in the South Lahontan Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 30	Arsenic – 19	Antimony – 5
Inorganics – Secondary	Iron – 82	Manganese – 36	Specific Conductance – 5 TDS – 5
Radiological	Gross Alpha – 18	Uranium – 7	Radium 228 – 2
Dissolved Nitrogen	Nitrate (as NO_3) – 12	Nitrate + Nitrite–6	Nitrite (as N) – 4
Pesticides	Di(2-Ethylhexyl)phthalate) – 2		
VOCs/SVOCs	MTBE – 2	TCE – 2	Carbon Tetrachloride – 2

TCE = Trichloroethylene
MTBE = Methyltertiarybutylether
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 37). Langford Valley Groundwater Basin (6-36) has been divided into two subbasins. Granite Mountain Area (6-59) and Fish Slough Valley (6-60) groundwater basins have been deleted because no information was found concerning wells or groundwater in these basins or because well completion reports indicate that groundwater production is derived from fractured rocks beneath the basin. Furnace Creek Area Groundwater Basin (6-83) has been incorporated into Death Valley Groundwater Basin (6-18), and Butterbread Canyon Valley Groundwater Basin (6-87) has been incorporated into Lost Lake Valley Groundwater Basin (6-71).

Table 37 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Lahontan Hydrologic Region

Basin/subbasin name	New number	Old number
Langford Well Lake	6-36.01	6-36
Irwin	6-36.02	6-36
Troy Valley	Incorporated into 6-40 and 7-14.	6-39
Granite Mountain Area	Deleted	6-59
Fish Slough Valley	Deleted	6-60
Furnace Creek Area	Deleted – incorporated into 6-18	6-83
Butterbread Canyon Valley	Deleted – incorporated into 6-71	6-87

Troy Valley Groundwater Basin (6-39) has been split at the Pisgah fault, which is a groundwater barrier, and has been incorporated into Lower Mojave River Valley (6-40) and Lavic Valley (7-14) groundwater basins. This change incorporates part of the South Lahontan HR into a basin in the Colorado River HR[1]. The Middle Mojave River Valley Groundwater Basin (6-41) has changed boundaries along the north (Harper Valley; 6-47) and east sides (Lower Mojave River Valley; 6-40). The new boundaries are along the Camp Rock-Harper Lake fault zone, Waterman fault, and Helendale fault. Groundwater level elevations indicate that these faults are likely strong barriers to groundwater movement.

The boundary between the Upper Mojave River Valley Groundwater Basin (6-42) and the Lucerne Valley Groundwater Basin (7-19) was changed from the regional surface divide to the southern part of the Helendale fault, which is a groundwater barrier. This change incorporates part of the Colorado Desert HR into a basin in the South Lahontan HR[2].

[1] The boundaries of the hydrologic regions are defined by surface drainage patterns. In this case, faults impede groundwater flow causing it to flow beneath the surface drainage divide into the adjacent hydrologic region.
[2] See previous note.

Table 38 South Lahontan Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-09	MONO VALLEY	173,000	A	800	480	-	-	-	-	2060
6-10	ADOBE LAKE VALLEY	39,800	C	-	-	-	-	-	-	-
6-11	LONG VALLEY	71,800	A	250	90	20	-	5	-	-
6-12	OWENS VALLEY	661,000	A	8,100	1,870	700	7	89	-	300-450,000
6-13	BLACK SPRINGS VALLEY	30,800	C	-	-	-	-	-	-	-
6-14	FISH LAKE VALLEY	48,100	C	-	-	-	-	-	-	-
6-15	DEEP SPRINGS VALLEY	29,900	C	700	390	-	-	-	-	-
6-16	EUREKA VALLEY	129,000	C	-	-	-	-	1	-	-
6-17	SALINE VALLEY	146,000	C	-	-	-	-	-	-	-
6-18	DEATH VALLEY	921,000	C	-	-	28	-	6	-	-
6-19	WINGATE VALLEY	71,400	C	-	-		-		-	-
6-20	MIDDLE AMARGOSA VALLEY	390,000	C	3,000	2,500	2	-	4	-	-
6-21	LOWER KINGSTON VALLEY	240,000	C	-	-	-	-	-	-	-
6-22	UPPER KINGSTON VALLEY	177,000	C	24	-	-	-	5	-	-
6-23	RIGGS VALLEY	87,700	C	-	-	-	-	-	-	-
6-24	RED PASS VALLEY	96,500	C	-	-	-	-	-	-	-
6-25	BICYCLE VALLEY	89,600	C	710	-	-	12	6	618	508-810
6-26	AVAWATZ VALLEY	27,700	C	-	-	-	-	-	-	-
6-27	LEACH VALLEY	61,300	C	-	-	-	-	-	-	-
6-28	PAHRUMP VALLEY	93,100	C	300	150	-	-	-	-	-
6-29	MESQUITE VALLEY	88,400	C	1,500	1,020	-	-	-	-	-
6-30	IVANPAH VALLEY	199,000	C	600	400	-	-	9	-	-
6-31	KELSO VALLEY	255,000	C	370	290	-	-		-	-
6-32	BROADWELL VALLEY	92,100	C	-	-	-	-	1	-	-
6-33	SODA LAKE VALLEY	381,000	C	2,100	1,100	-	-	3	-	-
6-34	SILVER LAKE VALLEY	35,300	C	-	-	-	-		-	-
6-35	CRONISE VALLEY	127,000	C	600	340	-	-	-	-	-
6-36	LANGFORD VALLEY									
6-36.01	LANGFORD WELL LAKE	19,300	C	1,700	410	11	7	3	498	440-568
6-36.02	IRWIN	10,500	C	550	-	40	-	3	528	496-598
6-37	COYOTE LAKE VALLEY	88,200	A	1,740	660	5	-	-	-	300-1000
6-38	CAVES CANYON VALLEY	73,100	A	300	-	4	1	4	-	300-1000
6-40	LOWER MOJAVE RIVER VALLEY	286,000	A	2,700	770	70	21	52	300	-
6-41	MIDDLE MOJAVE RIVER VALLEY	211,000	A	4,000	1,000	74	3	14	500	-
6-42	UPPER MOJAVE RIVER VALLEY	413,000	A	5,500	1,030	120	22	153	500	1105
6-43	EL MIRAGE VALLEY	75,900	A	1,000	230	50	3	21	-	-
6-44	ANTELOPE VALLEY	1,110,000	A	7,500	286	262	10	248	300	200-800
6-45	TEHACHAPI VALLEY EAST	24,000	C	150	31	31	-	9	361	298-405
6-46	FREMONT VALLEY	2,370,000	C	4,000	500	23	-	13	596	350-100,000
6-47	HARPER VALLEY	410,000	A	3,000	725	11	3	19	-	179-2391
6-48	GOLDSTONE VALLEY	28,100	C	-	-	-	-	-	-	-
6-49	SUPERIOR VALLEY	120,000	C	450	100	-	-	-	-	-

Table 38 South Lahontan Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-50	CUDDEBACK VALLEY	94,900	C	500	300	-	-	-	-	-
6-51	PILOT KNOB VALLEY	139,000	C	-	-	-	-	1	-	-
6-52	SEARLES VALLEY	197,000	C	1,000	300	-	-	-	-	-
6-53	SALT WELLS VALLEY	29,500	C	-	-	-	-	-	-	-
6-54	INDIAN WELLS VALLEY	382,000	A	3,800	815	116	20	63	312	110-1620
6-55	COSO VALLEY	25,600	C	-	-	-	-	-	-	-
6-56	ROSE VALLEY	42,500	C	-	-	-	-	1	-	-
6-57	DARWIN VALLEY	44,200	C	130	43	-	-	-	-	-
6-58	PANAMINT VALLEY	259,000	C	35	30	-	-	-	-	-
6-61	CAMEO AREA	9,310	C	-	-	-	-	-	-	-
6-62	RACE TRACK VALLEY	14,100	C	-	-	-	-	-	-	-
6-63	HIDDEN VALLEY	18,000	C	-	-	-	-	-	-	-
6-64	MARBLE CANYON AREA	10,400	C	-	-	-	-	-	-	-
6-65	COTTONWOOD SPRING AREA	3,900	C	-	-	-	-	-	-	-
6-66	LEE FLAT	20,300	C	-	-	-	-	-	-	-
6-68	SANTA ROSA FLAT	312	C	-	-	-	-	-	-	-
6-69	KELSO LANDER VALLEY	11,200	C	-	-	-	-	-	-	-
6-70	CACTUS FLAT	7,030	C	-	-	-	-	-	-	-
6-71	LOST LAKE VALLEY	23,300	C	-	-	-	-	-	-	-
6-72	COLES FLAT	2,950	C	-	-	-	-	-	-	-
6-73	WILD HORSE MESA AREA	3,320	C	-	-	-	-	-	-	-
6-74	HARRISBURG FLATS	24,900	C	-	-	-	-	1	-	-
6-75	WILDROSE CANYON	5,160	C	-	-	-	-	-	-	-
6-76	BROWN MOUNTAIN VALLEY	21,700	C	-	-	-	-	-	-	-
6-77	GRASS VALLEY	9,980	C	-	-	-	-	-	-	-
6-78	DENNING SPRING VALLEY	7,240	C	-	-	-	-	-	-	-
6-79	CALIFORNIA VALLEY	58,300	C	-	-	-	-	-	-	-
6-80	MIDDLE PARK CANYON	1,740	C	-	-	-	-	-	-	-
6-81	BUTTE VALLEY	8,810	C	-	-	-	-	-	-	-
6-82	ANVIL SPRING CANYON VALLEY	4,810	C	-	-	-	-	-	-	-
6-84	GREENWATER VALLEY	59,900	C	-	-	-	-	-	-	-
6-85	GOLD VALLEY	3,220	C	-	-	-	-	-	-	-
6-86	RHODES HILL AREA	15,600	C	-	-	-	-	-	-	-
6-88	OWL LAKE VALLEY	22,300	C	-	-	-	-	-	-	-
6-89	KANE WASH AREA	5,960	C	60	-	-	-	-	-	-
6-90	CADY FAULT AREA	7,960	C	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Colorado River Hydrologic Region

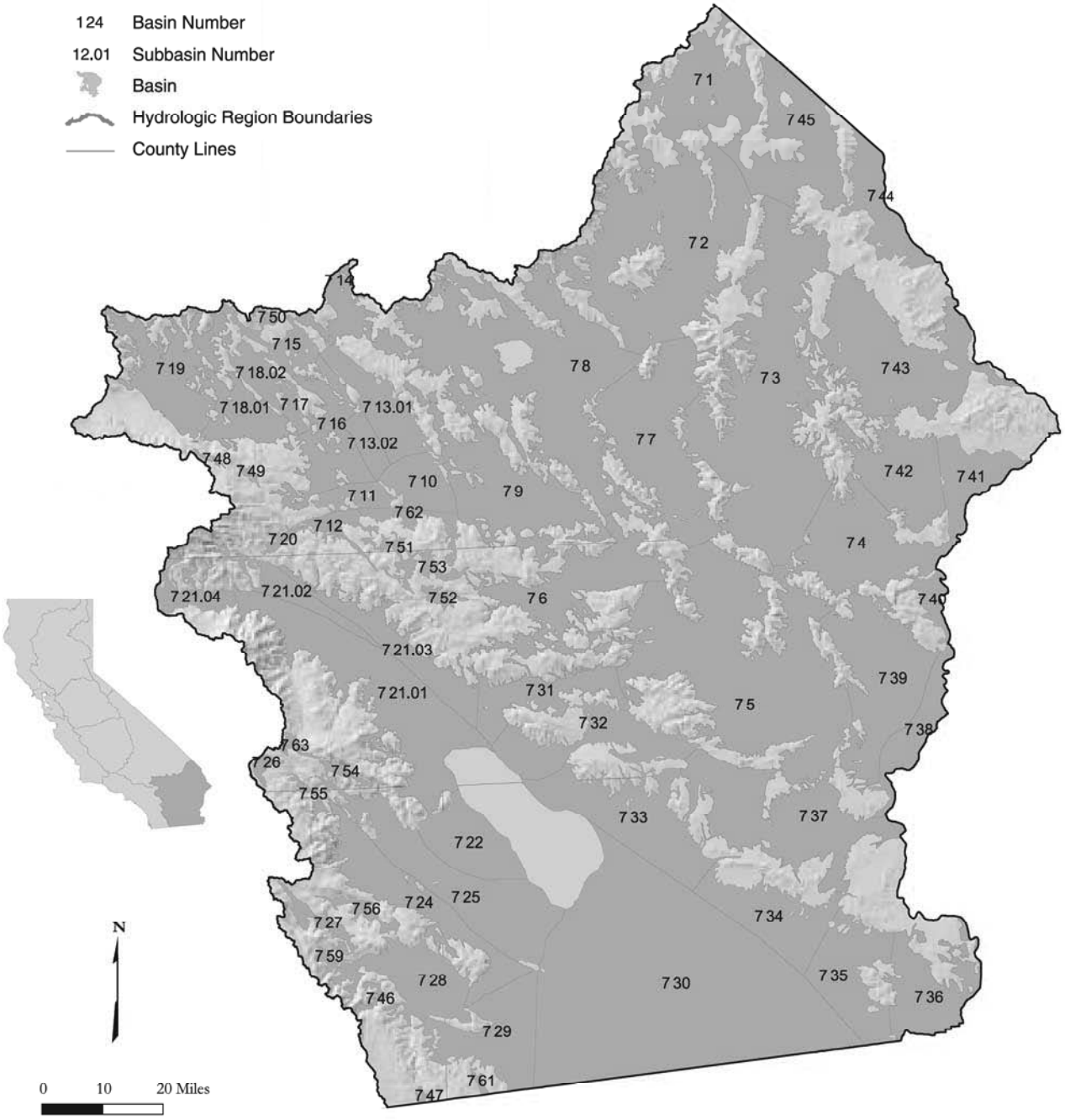

Figure 43 Colorado River Hydrologic Region

Basins and Subbasins of Colorado River Hydrologic Region

Basin/subbasin	Basin name
7-1	Lanfair Valley
7-2	Fenner Valley
7-3	Ward Valley
7-4	Rice Valley
7-5	Chuckwalla Valley
7-6	Pinto Valley
7-7	Cadiz Valley
7-8	Bristol Valley
7-9	Dale Valley
7-10	Twentynine Palms Valley
7-11	Copper Mountain Valley
7-12	Warren Valley
7-13	Deadman Valley
7-13.01	Deadman Lake
7-13.02	Surprise Spring
7-14	Lavic Valley
7-15	Bessemer Valley
7-16	Ames Valley
7-17	Means Valley
7-18	Johnson Valley Area
7-18.01	Soggy Lake
7-18.02	Upper Johnson Valley
7-19	Lucerne Valley
7-20	Morongo Valley
7-21	Coachella Valley
7-21.01	Indio
7-21.02	Mission Creek
7-21.03	Desert Hot Springs
7-21.04	San Gorgonio Pass
7-22	West Salton Sea
7-24	Borrego Valley
7-25	Ocotillo-Clark Valley
7-26	Terwilliger Valley
7-27	San Felipe Valley
7-28	Vallecito-Carrizo Valley
7-29	Coyote Wells Valley
7-30	Imperial Valley
7-31	Orocopia Valley
7-32	Chocolate Valley
7-33	East Salton Sea
7-34	Amos Valley
7-35	Ogilby Valley
7-36	Yuma Valley
7-37	Arroyo Seco Valley
7-38	Palo Verde Valley
7-39	Palo Verde Mesa
7-40	Quien Sabe Point Valley
7-41	Calzona Valley
7-42	Vidal Valley
7-43	Chemehuevi Valley
7-44	Needles Valley
7-45	Piute Valley
7-46	Canebrake Valley
7-47	Jacumba Valley
7-48	Helendale Fault Valley
7-49	Pipes Canyon Fault Valley
7-50	Iron Ridge Area
7-51	Lost Horse Valley
7-52	Pleasant Valley
7-53	Hexie Mountain Area
7-54	Buck Ridge Fault Valley
7-55	Collins Valley
7-56	Yaqui Well Area
7-59	Mason Valley
7-61	Davies Valley
7-62	Joshua Tree
7-63	Vandeventer Flat

Description of the Region

The Colorado River HR covers approximately 13 million acres (20,000 square miles) in southeastern California. It is bounded on the east by Nevada and Arizona, the south by the Republic of Mexico, the west by the Laguna, San Jacinto, and San Bernardino mountains, and the north by the New York, Providence, Granite, Old Dad, Bristol, Rodman, and Ord Mountain ranges. An average annual precipitation of 5.5 inches and average annual runoff of only 200,000 acre-feet makes this the most arid HR of California (DWR 1994). Surface runoff drains to many closed basins or to the Colorado River.

This HR includes all of Imperial, most of Riverside, much of San Bernardino, and part of San Diego counties (Figure 43). Many of the alluvial valleys in the region are underlain by groundwater aquifers that are the sole source of water for local communities.

About 533,000 people live within the Colorado River HR (DWR, 1998). The largest population centers are Palm Springs, Palm Desert, Indio, Coachella, and El Centro.

Groundwater Development

The earliest groundwater development in California may have been prehistoric water wells dug by the Cahuilla Indians in Coachella Valley of the Colorado River HR. In this report, 64 groundwater basins/subbasins are delineated in this HR. The Deadman Valley, Johnson Valley Area, and Coachella Valley groundwater basins have been divided into subbasins. Groundwater basins underlie about 8.68 million acres or about 26 percent of this HR.

In the Colorado River HR, groundwater provides about 8 percent of the water supply in normal years for agricultural and urban uses (DWR 1998). In most smaller basins, groundwater is found in unconfined alluvial aquifers. In some of the larger basins, particularly near dry lakes, aquifers may be separated by aquitards that create confined groundwater conditions. Depths of basins range from tens or hundreds of feet in smaller basins and along arms of ephemeral rivers to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this region depending on aquifer characteristics and well location, size, and use. Some aquifers are capable of yielding thousands of gallons per minute to municipal wells.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Water is imported from the Colorado River for irrigation in Imperial, Coachella, and Palo Verde Valleys and from groundwater recharge in Coachella Valley. Water imported from Northern California is used to replenish Warren and Joshua Tree groundwater basins. Many agencies have erected systems of barriers to allow more efficient percolation of ephemeral runoff from surrounding mountains. The concept of utilizing groundwater basins in this sparsely populated HR for storing water that would be pumped during drought years is getting much attention.

Groundwater Quality

The chemical character of groundwater in the Colorado River HR is variable. Cation concentration is dominated by sodium with calcium common and magnesium appearing less often. Bicarbonate is usually the dominant anion, although sulfate and chloride waters are also common. In basins with closed drainages, water character often changes from calcium-sodium bicarbonate near the margins to sodium chloride or chloride-sulfate beneath a dry lake. It is not uncommon for concentrations of dissolved constituents to rise dramatically toward a dry lake where saturation of mineral salts is reached. An example of this is found at Bristol Valley Groundwater Basin, where the mineral halite (sodium chloride) is formed and then mined by

evaporation of groundwater in trenches in Bristol (dry) Lake. The TDS content of groundwater is high in many of the basins in this region. High fluoride content is common; sulfate content occasionally exceeds drinking water standards; and high nitrate content is common, especially in agricultural areas.

Two of the primary challenges in the Colorado River HR are overdraft in the Coachella Valley and leaking underground storage tanks. The EPA has not yet placed any contamination sites in this HR on the Superfund National Priorities List; however, one site is under consideration because of high pesticide levels.

Water Quality in Public Supply Wells

From 1994 through 2000, 314 public supply water wells were sampled in 23 of the 64 basins and subbasins in the Colorado River HR. Analyzed samples indicate that 270 wells, or 86 percent, met the state primary MCLs for drinking water standards. Forty-four wells, or 14 percent, have constituents that exceed one or more MCL. Figure 44 shows the percentages of each contaminant group that exceeded MCLs in the 44 wells.

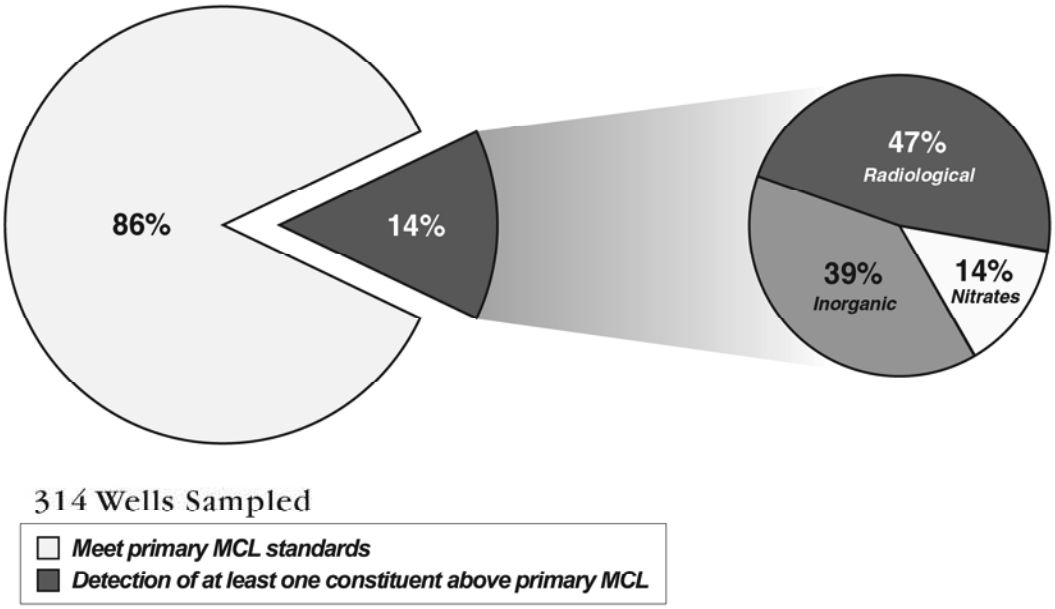

Figure 44 MCL exceedances in public supply wells in the Colorado River Hydrologic Region

Table 39 lists the three most frequently occurring contaminants in each contaminant group and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 39 Most frequently occurring contaminants by contaminant group in the Colorado River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 17		
Inorganics – Secondary	Iron – 38	Manganese – 26	TDS – 5
Radiological	Radium 228 – 3	Combined RA226 + RA228 – 3	Radium 226 – 1
Nitrates	Nitrate (as NO_3) – 6	Nitrate + Nitrite – 1	

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 40). Jacumba Valley East Groundwater Basin (7-60) has been deleted because of lack of information about groundwater in this basin. The Pinyon Wash Area (7-57) and Whale Peak Area (7-58) groundwater basin names have been deleted because they are now incorporated into other larger basins. Similarly, Clark Valley (7-23) and Ocotillo Valley (7-25) groundwater basins are now the combined Ocotillo-Clark Valley Groundwater Basin (7-25). The Deadman Valley (7-13), Johnson Valley Area (7-18), and Coachella Valley (7-21) groundwater basins have been subdivided into subbasins in this report. The western boundary of Lucerne Valley Groundwater Basin (7-19) has been moved eastward from the HR boundary to the Helendale fault. Groundwater level elevations indicate that this fault is a groundwater barrier and that groundwater flows westward back under the surface divide into the Upper Mojave River Groundwater Basin (6-42). The boundary between Lucerne Valley (7-19) and Johnson Valley Area (7-18) groundwater basins is delineated in this report.

The boundaries of Twentynine Palms Valley (7-10), Copper Mountain Valley (7-11), Warren Valley (7-12), Deadman Lake (7-13), and Ames Valley (7-16) groundwater basins have been redrawn in light of newer groundwater level data. These data indicate that the Pinto Mountain fault is a groundwater barrier. Joshua Tree Groundwater Basin (7-62) is a new basin that has been delineated from parts of Copper Mountain Valley and Twentynine Palms Valley Groundwater Basins because the Pinto Mountain fault is such a strong barrier. Buck Ridge Fault Valley Groundwater Basin (7-54) was presented in Bulletin 118-80 as two unconnected deposits of water-bearing alluvium separated by outcrop of nonwater-bearing rocks. These water-bearing deposits have been designated as separate groundwater basins in this report, with the Buck Ridge Fault Valley Groundwater Basin (7-54) as the northern basin and Vandeventer Flat Groundwater Basin (7-63) presented as the southern basin.

Table 40 Modifications since Bulletin 118-80 of groundwater basins in Colorado River Hydrologic Region

Basin name	New number	Old number
Clark Valley	Delete – combined with 7-25	7-23
Ocotillo-Clark Valley	7-25 (now combined)	7-25
Pinyon Wash Area	Incorporated into 7-56	7-57
Whale Peak Area	Incorporated into 7-28	7-58
Jacumba Valley East	Deleted	7-60
Joshua Tree	7-62 (new)	
Vandeventer Flat	7-63 (new)	

Table 41 Colorado River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
7-1	LANFAIR VALLEY	157,000	C	70	16	-	-	9	515	173-2,260
7-2	FENNER VALLEY	454,000	A	200	100	-	-	4	515	173-2,260
7-3	WARD VALLEY	961,000	A	260	180	-	-	1	-	327-589
7-4	RICE VALLEY	189,000	C	65	-	-	-	-	-	-
7-5	CHUCKWALLA VALLEY	604,000	C	3,900	1,800	12	-	10	-	424
7-6	PINTO VALLEY	183,000	A	1,480	900	-	-	1	-	-
7-7	CADIZ VALLEY	270,000	C	167	66	-	-	-	400	300-3000
7-8	BRISTOL VALLEY	498,000	A	3,000	-	-	-	-		300-298,000
7-9	DALE VALLEY	213,000	C	380	275	-	-	2	-	-
7-10	TWENTYNINE PALMS VALLEY	62,400	C	3,000	540	27	-	2	640	-
7-11	COPPER MOUNTAIN VALLEY	30,300	A	2,450	250	2	-	2	-	180-214
7-12	WARREN VALLEY	17,200	A	4,000	350	27	18	17	196	129-269
7-13	DEADMAN VALLEY									
7-13.01	DEADMAN LAKE	89,200	C	2,000	-	28	3	1	-	311-985
7-13.02	SURPRISE SPRING	29,300	C	1,370	680	26	6	9	177	141-1,050
7-14	LAVIC VALLEY	102,000	C	140	80	-	-	-	-	-
7-15	BESSEMER VALLEY	39,100	C	0	-	-	-	-	-	-
7-16	AMES VALLEY	110,000	C	2,000	-	19	3	11	459	-
7-17	MEANS VALLEY	15,000	C	0	-	1	-	-	-	-
7-18	JOHNSON VALLEY AREA									
7-18.01	SOGGY LAKE	76,800	C	-	-	6	-	1	-	300-2,000
7-18.02	UPPER JOHNSON VALLEY	34,800	C	-	-	-	-	-	-	3,000
7-19	LUCERNE VALLEY	148,000	A	1,000	-	22	9	21	301	200-5,000
7-20	MORONGO VALLEY	7,240	C	600	90	-	-	5	-	-
7-21	COACHELLA VALLEY									
7-21.01	INDIO	336,000	A	1,880	650	30	-	204	300	-
7-21.02	MISSION CREEK	49,000	A	3,500	715	5	-	15	<500	-
7-21.03	DESERT HOT SPRINGS	101,000	C	2,500	985	10	-	2	-	800-1,000
7-21.04	SAN GORGONIO PASS	38,700	A	1,000	0	17	8	5	-	106-205
7-22	WEST SALTON SEA	106,000	C	540	400	v	-	-	-	-
7-24	BORREGO VALLEY	153,000	A	2,000	0	10	10	25	-	300-2,440
7-25	OCOTILLO-CLARK VALLEY	223,000	C	3,500	1,760	1	-	2	-	-
7-26	TERWILLIGER VALLEY	8,030	C	100	-	-	-	1	-	500
7-27	SAN FELIPE VALLEY	2,340	C	500	30	-	-	1	-	-
7-28	VALLECITO-CARRIZO VALLEY	122,000	C	2,500	260	-	-	1	-	-
7-29	COYOTE WELLS VALLEY	146,000	A	-	-	25	6	9	-	-
7-30	IMPERIAL VALLEY	961,000	A	1,000	-	19	-	45	1088	498-7,280
7-31	OROCOPIA VALLEY	96,500	A	210	165	0	-	1	-	-
7-32	CHOCOLATE VALLEY	130,000	C	0	0	0	-	-	-	-
7-33	EAST SALTON SEA	196,000	C	0	0	1	-	4	-	-
7-34	AMOS VALLEY	130,000	C	100	50	3	-	1	-	-
7-35	OGILBY VALLEY	134,000	C	4,000	50	27	1	3	-	-

Table 41 Colorado River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
7-36	YUMA VALLEY	3,780	C	100	40	59	0	15	-	-
7-37	ARROYO SECO VALLEY	258,000	C	-	-	2	0	0	-	-
7-38	PALO VERDE VALLEY	73,400	A	-	-	11	-	19	840	658-1,030
7-39	PALO VERDE MESA	226,000	C	2,750	1,650	20	-	13	-	-
7-40	QUIEN SABE POINT VALLEY	25,300	C	25	-	-	-	3	-	-
7-41	CALZONA VALLEY	81,000	C	2,340	500	0	0	0	-	
7-42	VIDAL VALLEY	138,000	C	1,800	675	-	-	1	-	-
7-43	CHEMEHUEVI VALLEY	273,000	A	0	0	1	0	1	-	-
7-44	NEEDLES VALLEY	88,400	A	1,500	980	34	-	11	-	-
7-45	PIUTE VALLEY	176,000	C	1,500	200	-	-	-	-	-
7-46	CANEBRAKE VALLEY	5,420	C	125	-	-	-	-	-	-
7-47	JACUMBA VALLEY	2,450	A	1,000	-	-	-	3		296-6,100
7-48	HELENDALE FAULT VALLEY	2,620	C	-	-	-	-	-	-	-
7-49	PIPES CANYON FAULT VALLEY	3,390	C	-	-	-	-	-	-	-
7-50	IRON RIDGE AREA	5,250	C	-	-	-	-	-	-	-
7-51	LOST HORSE VALLEY	17,300	C	-	-	-	-	-	-	-
7-52	PLEASANT VALLEY	9,670	C	-	-	-	-	-	-	-
7-53	HEXIE MOUNTAIN AREA	11,200	C	-	-	-	-	-	-	-
7-54	BUCK RIDGE FAULT VALLEY	6,930	C	-	-	-	-	-	-	-
7-55	COLLINS VALLEY	7,080	C	1,500	-	-	-	-	-	-
7-56	YAQUI WELL AREA	15,000	C	0	-	-	-	1	-	-
7-59	MASON VALLEY	5,530	C	0	0	0	0	1	-	-
7-61	DAVIES VALLEY	3,570	C	0	0	0	0	-	-	-
7-62	JOSHUA TREE	33,800	A	2,200	1,110	25	5	14	180	117-185
7-63	VANDEVENTER FLAT	6,750	C	50	17	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

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Glossary

Glossary

A

acre-foot (af) The volume of water necessary to cover one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

adjudication A case that has been heard and decided by a judge. In the context of an adjudicated groundwater basin, landowners or other parties have turned to the courts to settle disputes over how much groundwater can be extracted by each party to the decision.

alluvial Of or pertaining to or composed of alluvium.

alluvium A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi sorted sediment in the bed of the stream or on it's floodplain or delta, as a cone or fan at the base of a mountain slope.

anthropogenic Of human origin or resulting from human activity.

appropriative right The right to use water that is diverted or extracted by a nonriparian or nonoverlying party for nonriparian or nonoverlying uses. In California, surface water appropriative rights are subject to a statutory permitting process while groundwater appropriation is not.

aquitard A confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores ground water.

aquifer A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

aridity A term describing a climate or region in which precipitation is so deficient in quantity or occurs so infrequently that intensive agricultural production is not possible without irrigation.

artesian aquifer A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure; that is, a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer.

artesian pressure Hydrostatic pressure of artesian water, often expressed in terms of pounds per square inch; or the height, in feet above the land surface, of a column of water that would be supported by the pressure.

artificial recharge The addition of water to a groundwater reservoir by human activity, such as putting surface water into dug or constructed spreading basins or injecting water through wells.

available groundwater storage capacity The volume of a groundwater basin that is unsaturated and capable of storing groundwater.

average annual runoff The average value of total annual runoff volume calculated for a selected period of record, at a specified location, such as a dam or stream gage.

average year water demand Demand for water under average hydrologic conditions for a defined level of development.

B

basin management objectives (BMOs) See management objectives

beneficial use One of many ways that water can be used either directly by people or for their overall benefit. The State Water Resources Control Board recognizes 23 types of beneficial use with water quality criteria for those uses established by the Regional Water Quality Control Boards.

borehole geophysics The general field of geophysics developed around the lowering of a variety of probes into a boring or well. Borehole logging provides additional information concerning physical, electrical, acoustic, nuclear and chemical aspects of the soils and rock encountered during drilling.

C

community water system A public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 year-long residents (DHS 2000).

confined aquifer An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined ground water. See artesian aquifer.

conjunctive use The coordinated and planned management of both surface and groundwater resources in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average surface water supply.

contaminant Any substance or property preventing the use or reducing the usability of the water for ordinary purposes such as drinking, preparing food, bathing washing, recreation, and cooling. Any solute or cause of change in physical properties that renders water unfit for a given use. (Generally considered synonymous with pollutant).

critical conditions of overdraft A groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts. The definition was created after an extensive public input process during the development of the Bulletin 118-80 report.

D

deep percolation Percolation of water through the ground and beyond the lower limit of the root zone of plants into groundwater.

desalination A process that converts seawater or brackish water to fresh water or an otherwise more usable condition through removal of dissolved solids.

domestic well A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer service connections.

drinking water system See public water system

drought condition Hydrologic conditions during a defined period when rainfall and runoff are much less than average.

drought year supply The average annual supply of a water development system during a defined drought period.

E

electrical conductivity (EC) The measure of the ability of water to conduct an electrical current, the magnitude of which depends on the dissolved mineral content of the water.

effective porosity The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

environmental water Water serving environmental purposes, including instream fishery flow needs, wild and scenic river flows, water needs of fresh-water wetlands, and Bay-Delta requirements.

evapotranspiration (ET) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces.

G

groundwater basin An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and having a definable bottom.

groundwater budget A numerical accounting, the *groundwater equation*, of the recharge, discharge and changes in storage of an aquifer, part of an aquifer, or a system of aquifers.

groundwater in storage The quantity of water in the zone of saturation.

groundwater management The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

groundwater management plan A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or statutory authority.

groundwater mining The process, deliberate or inadvertent, of extracting groundwater from a source at a rate in excess of the replenishment rate such that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

groundwater monitoring network A series of monitoring wells at appropriate locations and depths to effectively cover the area of interest. Scale and density of monitoring wells is dependent on the size and complexity of the area of interest, and the objective of monitoring.

groundwater overdraft The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.

groundwater quality See water quality

groundwater recharge facility A structure that serves to conduct surface water into the ground for the purpose of replenishing groundwater. The facility may consist of dug or constructed spreading basins, pits, ditches, furrows, streambed modifications, or injection wells.

groundwater recharge The natural or intentional infiltration of surface water into the zone of saturation.

groundwater source area An area where groundwater may be found in economically retrievable quantities outside of normally defined groundwater basins, generally referring to areas of fractured bedrock in foothill and mountainous terrain where groundwater development is based on successful well penetration through interconnecting fracture systems. Well yields are generally lower in fractured bedrock than wells within groundwater basins.

groundwater storage capacity volume of void space that can be occupied by water in a given volume of a formation, aquifer, or groundwater basin.

groundwater subbasin A subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

groundwater table The upper surface of the zone of saturation in an unconfined aquifer.

groundwater Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

H

hazardous waste Waste that poses a present or potential danger to human beings or other organisms because it is toxic, flammable, radioactive, explosive or has some other property that produces substantial risk to life.

hydraulic barrier A barrier created by injecting fresh water to control seawater intrusion in an aquifer, or created by water injection to control migration of contaminants in an aquifer.

hydraulic conductivity A measure of the capacity for a rock or soil to transmit water; generally has the units of feet/day or cm/sec.

hydrograph A graph that shows some property of groundwater or surface water as a function of time.

hydrologic cycle The circulation of water from the ocean through the atmosphere to the land and ultimately back to the ocean.

hydrologic region A study area consisting of multiple planning subareas. California is divided into 10 hydrologic regions.

hydrostratigraphy A geologic framework consisting of a body of rock having considerable lateral extent and composing a reasonably distinct hydrologic system.

hyporheic zone The region of saturated sediments beneath and beside the active channel and that contain some proportion of surface water that was part of the flow in the surface channel and went back underground and can mix with groundwater.

I

infiltration The flow of water downward from the land surface into and through the upper soil layers.

infiltration capacity The maximum rate at which infiltration can occur under specific conditions of soil moisture.

in-lieu recharge The practice of providing surplus surface water to historic groundwater users, thereby leaving groundwater in storage for later use.

ISI Integrated Storage Investigations Program, an element of the CALFED Bay Delta initiative.

J

joint powers agreement (JPA) An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the California Government Code.

L

land subsidence The lowering of the natural land surface due to groundwater (or oil and gas) extraction.

leaky confining layer A low-permeability layer that can transmit water at sufficient rates to furnish some recharge from an adjacent aquifer to a well.

lithologic log A record of the lithology of the soils, sediments and/or rock encountered in a borehole from the surface to the bottom.

lithology The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

losing stream A stream or reach of a stream that is losing water by seepage into the ground.

M

management objectives Objectives that set forth the priorities and measurable criteria of local groundwater basin management. For example, one management objective could be to minimize degradation of groundwater quality with a criteria set that groundwater will not be degraded by more than 100 mg/l in terms of TDS.

maximum contaminant level (MCL) The highest drinking water contaminant concentration allowed under federal and State Safe Drinking Water Act regulations.

N

natural recharge Natural replenishment of an aquifer generally from snowmelt and runoff; through seepage from the surface.

nonpoint source Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, etc., carried to lakes and streams by surface runoff.

O

operational yield An optimal amount of groundwater that should be withdrawn from an aquifer system or a groundwater basin each year. It is a dynamic quantity that must be determined from a set of alternative groundwater management decisions subject to goals, objectives, and constraints of the management plan.

ordinance A law set forth by a governmental authority.

overdraft See groundwater overdraft

overlying right Property owners above a common aquifer possess a mutual right to the reasonable and beneficial use of a groundwater resource on land overlying the aquifer from which the water is taken. Overlying rights are correlative (related to each other) and overlying users of a common water source must share the resource on a pro rata basis in times of shortage. A proper overlying use takes precedence over all non-overlying uses.

P

perched groundwater Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

perennial yield The maximum quantity of water that can be annually withdrawn from a groundwater basin over a long period of time (during which water supply conditions approximate average conditions) without developing an overdraft condition.

perforated interval The depth interval where slotted casing or screen is placed in a well to allow entry of water from the aquifer formation.

permeability The capability of soil or other geologic formations to transmit water. See hydraulic conductivity.

pesticide Any of a class of chemicals used for killing insects, weeds or other undesirable entities. Most commonly associated with agricultural activities, but has significant domestic use in California.

point source A specific site from which wastewater or polluted water is discharged into a water body.

pollution (of water) The alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

porosity The ratio of the voids or open spaces in alluvium and rocks to the total volume of the alluvium or rock mass.

possible contaminating activity (PCA) Human activities that are actual or potential origins of contamination for a drinking water source. PCAs include sources of both microbiological and chemical contaminants that could have an adverse effect upon human health (DHS 2000).

potentiometric surface The surface to which the water in a confined aquifer will rise in a tightly cased well.

prescriptive right rights obtained through the open and notorious adverse use of another's water rights. By definition, adverse use is not use of a surplus, but the use of non-surplus water to the direct detriment of the original rights holder.

primary porosity Voids or open spaces that were present when alluvium and rocks were originally deposited or formed.

public supply well A well used as a part of a public water system.

public water system A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. (DHS 2000).

pueblo right A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, entitled to the beneficial use of all needed, naturally-occurring surface and groundwater of the original pueblo watershed Pueblo rights are paramount to all other claims.

R

recharge Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gain from precipitation, or artificially as the result of human influence. See artificial recharge.

recharge basin A surface facility constructed to infiltrate surface water into a groundwater basin.

riparian right A right to use surface water, such right derived from the fact that the land in question abuts upon the banks of streams.

runoff The volume of surface flow from an area.

S

safe yield The maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect.

salinity Generally, the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water. See also total dissolved solids.

saline intrusion The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies.

saturated zone The zone in which all interconnected openings are filled with water, usually underlying the unsaturated zone.

seawater intrusion barrier A system designed to retard, cease or repel the advancement of seawater intrusion into potable groundwater supplies along coastal portions of California. The system may be a series of specifically placed injection wells where water is injected to form a hydraulic barrier.

secondary porosity Voids in a rock formed after the rock has been deposited; not formed with the genesis of the rock, but later due to other processes. Fractures in granite and caverns in limestone are examples of secondary openings.

seepage The gradual movement of water into, through or from a porous medium. Also the loss of water by infiltration into the soil from a canal, ditches, laterals, watercourse, reservoir, storage facilities, or other body of water, or from a field.

semi-confined aquifer A semi-confined aquifer or leaky confined aquifer is an aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer depending on the direction of the hydraulic gradient.

service area The geographic area served by a water agency.

specific conductance See electrical conductivity

specific retention The ratio of the volume of water a rock or sediment will retain against the pull of gravity to the total volume of the rock or sediment.

specific yield the ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil**.**

spring a location where groundwater flows naturally to the land surface or a surface water body.

stakeholders Any individual or organization that has an interest in water management activities. In the broadest sense, everyone is a stakeholder, because water sustains life. Water resources stakeholders are typically those involved in protecting, supplying, or using water for any purpose, including environmental uses, who have a vested interest in a water-related decision.

stratigraphy The science of rocks. It is concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties—all characters and attributes of rocks as strata—and their interpretation in terms of environment and mode of origin and geologic history.

subsidence See land subsidence

subterranean stream Subterranean streams "flowing through known and definite channels" are regulated by California's surface water rights system.

surface supply Water supply obtained from streams, lakes, and reservoirs.

sustainability Of, relating to, or being a method of using a resource so that the resource is not depleted or permanently damaged.

T

total dissolved solids (TDS) a quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter. See also salinity

toxic Poisonous, relating to or caused by a poison. Toxicity is determined for individual contaminants or for mixtures of contaminants as found in waste discharges.

transmissivity The product of hydraulic conductivity and aquifer thickness; a measure of a volume of water to move through an aquifer. Transmissivity generally has the units of ft^2/day or gallons per day/foot. Transmissivity is a measure of the subsurface's ability to transmit groundwater horizontally through its entire saturated thickness and affects the potential yield of wells.

transpiration An essential physiological process in which plant tissues give off water vapor to the atmosphere.

U

unconfined aquifer An aquifer which is not bounded on top by an aquitard. The upper surface of an unconfined aquifer is the water table.

underground stream Body of water flowing as a definite current in a distinct channel below the surface of the ground, usually in an area characterized by joints or fissures. Application of the term to ordinary aquifers is incorrect.

unsaturated zone The zone below the land surface in which pore space contains both water and air.

urban water management plan (UWMP) An UWMP is required for all urban water suppliers having more than 3,000 connections or supplying more than 3,000 acre-feet of water. The plans include discussions on water supply, supply reliability, water use, water conservation, and water shortage contingency and serve to assist urban water suppliers with their long-term water resources planning to ensure adequate water supplies for existing and future demands.

usable storage capacity The quantity of groundwater of acceptable quality that can be economically withdrawn from storage.

V

vadose zone See unsaturated zone

volatile organic compound (VOC) A manmade organic compound that readily vaporizes in the atmosphere. These compounds are often highly mobile in the groundwater system and are generally associated with industrial activities.

W

water quality Description of the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

water table See groundwater table

water year A continuous 12-month period for which hydrologic records are compiled and summarized. Different agencies may use different calendar periods for their water years.

watershed The land area from which water drains into a stream, river, or reservoir.

well completion report A required, confidential report detailing the construction, alteration, abandonment, or destruction of any water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well. The reports were called *Water Well Drillers' Report* prior to 1991 and are often referred to as "driller's logs." The report requirements are described in the California Water Code commencing with Section 13750.

WQCP Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary.

Metric Conversions

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm2)	square inches (in2)	0.00155	645.16
	square meters (m2)	square feet (ft2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km2)	square miles (mi2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters	million gallons (10*)	0.26417	3.7854
	cubic meters (m3)	cubic feet (ft3)	36.315	0.028317
	cubic meters (m3)	cubic yards (yd3)	1.308	0.76455
	cubic dekameters (dam3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m3/s)	cubic feet per second (ft3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (k/W)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	eet head of water	0.32456	2.989
Specific Capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimeter (µS/cm)	micromnos per centermeter	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8X°C)+32	(°F-321/18

Appendices

Appendix A
Obtaining Copies of Supplemental Material

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual basin descriptions and a GIS-compatible map of each of the delineated groundwater basins in California. The supplemental material will be updated as new information becomes available and can be viewed or downloaded at http://www.waterplan.water.ca.gov/groundwater/118index.htm

Appendix B
The Right to Use Groundwater in California

California does not have a statewide management program or statutory permitting system for groundwater. Some local agencies have adopted groundwater ordinances under their police powers, or have adopted groundwater management programs under a variety of statutory authorities.

Prior to a discussion of groundwater management, it is helpful to understand some of the laws governing the right to use groundwater in California. When the Water Commission Act of 1913 (Stats. 1913, Ch. 586) became effective in 1914, appropriative surface water rights became subject to a statutory permitting process. This appropriation procedure can be found in Water Code Section 1200 *et seq*. Groundwater classified as underflow of a surface stream, a "subterranean stream flowing through a known and definite channel," was made subject to the State permit system. However, most groundwater in California is presumed to be "percolating water," that is, water in underground basins and groundwater which has escaped from streams. This percolating water is not subject to a permitting process. As a result, most of the body of law governing groundwater use in California today has evolved through a series of court decisions beginning in the early 20th century. Key cases are listed in Table B-1, and some of the most significant are discussed below.

Table B-1 Significant court cases related to the right to use groundwater in California

Case	Issues addressed
Katz v. Walkinshaw, 141 Cal. 116 (1903)	Established Correlative Rights Doctrine. Correlative rights of overlying users, and surplus supply available for appropriation among non-overlying users.
Peabody v. City of Vallejo, 2 Cal. 2d 351 (1935)	Limited riparian rights under the reasonable and beneficial use requirement of the 1928 constitutional amendment; requirement of reasonable and beneficial use.
Pasadena v. Alhambra, 33 Cal. 2d 908 (1949)	First basin adjudication in California; established Doctrine of Mutual Prescription.
Niles Sand and Gravel Co. v. Alameda County Water District, 37 Cal. App. 3d 924 (1974)	Established right to store water underground as a servitude.
Techachapi-Cummings County Water District v. Armstrong, 49 Cal. App. 3d 992 (1975)	Modified the Mutual Prescription Doctrine articulated in Pasadena v. Alhambra. Overlying owners' water rights must be quantified on the basis of current, reasonable and beneficial need, not past use. By analogy to riparian rights, factors to be considered include: the amount of water available, the extent of ownership in the basin, and the nature of projected use.
Los Angeles v. San Fernando, 14 Cal. 3d 199 (1975)	Significantly modified Mutual Prescription Doctrine by disallowing it against public entities (Civil Code section 1007); established pueblo right above overlying owner right; established right to store imported water underground and recapture when needed above the right of overlying landowner.
Wright v. Goleta Water District, 174 Cal. App. 3d 74 (1985)	The unexercised water rights of overlying owners are protected from appropriators; notice and opportunity must be given to overlying owners to resist any interference with their rights.
Hi-Desert County Water District v. Blue Skies Country Club,	Retention of overlying right; no acquisition of prescriptive
23 Cal. App. 4th 1723 (1994)	right by overlying owner.
Baldwin v. Tehama County, 31 Cal. App. 4th 166 (1994)	City and County regulation of groundwater through police power. County limitations on export upheld.
City of Barstow v. Mojave Water Agency,	Held that in considering a stipulated physical solution
23 Cal. 4th 1224 (2000)	involving equitable apportionment, court must consider correlativerights of parties that did not join the stipulation.

This table modified from Bachman and others 1997

Katz v. Walkinshaw (141 Cal. 116)

In the 1903 decision, *Katz v. Walkinshaw*, the California Supreme Court rejected the English Common Law doctrine of groundwater rights and established the Doctrine of Correlative Rights. Prior to the *Katz* decision, California had followed the doctrine articulated in the 1843 English decision of *Acton v. Blundell* (12 M. & W. 324, 152 Eng. Rep. 1223), which established that landowners enjoyed absolute ownership of groundwater underneath their property. The 1903 decision rejected the English Common Law approach as unsuitable for the "natural conditions" in California, and instead established the Correlative Rights Doctrine analogous to a riparian right. Each overlying landowner was entitled to make reasonable beneficial use of groundwater with a priority equal to all other overlying users. Water in excess of the needs of the overlying owners could be pumped and used on nonoverlying lands on a first-in-time, first-in-right basis under what is known as an appropriative right. An appropriative groundwater right, unlike its surface water counterpart, is not subject to a permitting process. Where overlying owners made full use of available supplies, appropriative rights were extinguished. Where there was insufficient water to meet even the needs of the overlying owners, the court applied the Correlative Rights Doctrine to apportion the available groundwater among the overlying landowners. Figure B-1 depicts the rights to use groundwater established in *Katz v. Walkinshaw*.

City of Pasadena v. City of Alhambra (33 Cal. 2d 908)

The 1949 decision, *Pasadena v. Alhambra*, added significant complexity to the right to use groundwater in California. This decision, involving the adjudication of the Raymond Basin, established the doctrine of mutual prescription. Groundwater levels in the basin had been declining for many years by the time court action was initiated. Most substantial pumpers, both overlying and appropriators, were joined in the action. Previously, appropriators only had a right to water surplus to the needs of overlying users. However, based upon a stipulation by most of the parties, the court in *Pasadena* adopted a program of proportionate reductions. These appropriators had each effectively gained a prescriptive right, similar to that of surface water rights, in which they had taken the water in an open, notorious, and hostile manner for at least five years. Mutual prescription provided groundwater rights to both overlying users and appropriators in depleted groundwater basins by prorating their rights based on the highest continuous amount of pumping during the five years following commencement of the overdraft. All of the users in the Raymond Basin were thus entitled to extract their portion of the court-approved safe yield of the basin.

City of Los Angeles v. City of San Fernando (14 Cal. 3d 199)

In 1975, in *Los Angeles v. San Fernando*, the California Supreme Court significantly limited the Mutual Prescription Doctrine introduced in Pasadena v. Alhambra. This opinion had far-reaching impacts on both the right to use groundwater and the practice of conjunctive use of groundwater and surface water to manage a basin. The case began in 1955, when the City of Los Angeles sued the cities of San Fernando, Glendale, Burbank and other pumpers, asserting a prior right to the San Fernando Valley groundwater basins in the northern part of the City of Los Angeles. The court, relying on Civil Code Section 1007, held that public agencies and public utilities cannot lose their groundwater rights by prescription. This holding effectively ruled out any future "mutual prescription" settlements or judgments involving rights held by public entities.

With respect to the native water supply of the San Fernando Basin, the court found that the City of Los Angeles had prior rights to all of this supply pursuant to its "pueblo right." Pueblo rights are traceable to rights recognized by the Spanish crown and the Mexican government. Under the Spanish/Mexican system, water rights were held in trust by pueblos for the benefit of all of its inhabitants. Under the Treaty of Guadalupe Hidalgo executed by Mexico and the United States in 1848, the municipal successors to Spanish/Mexican pueblos retained their pueblo rights upon the cession of California. In the San Fernando decision, the court confirmed Los Angeles' pueblo right, finding it superior to the rights of all overlying landowners. While a pueblo right is rare, it is an example of the complexity of the rights to use groundwater in California.

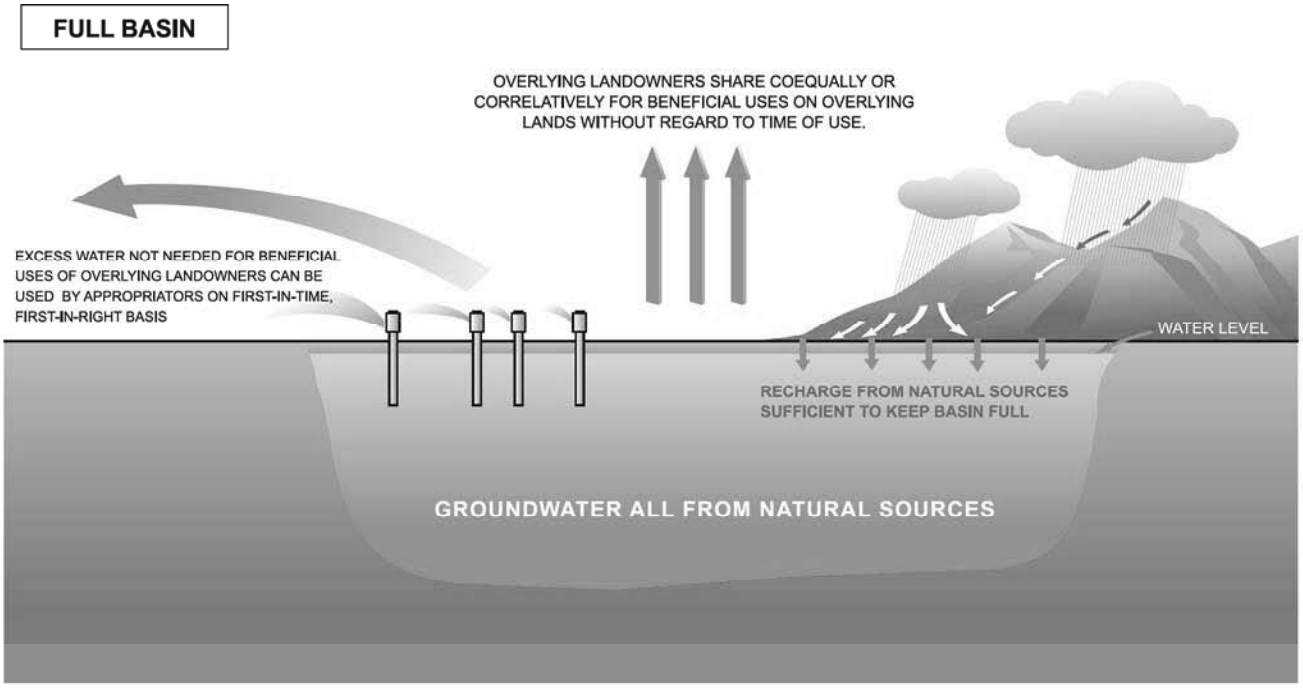


Figure B-1 Rights to groundwater use in full basin established in Katz v. Walkinshaw

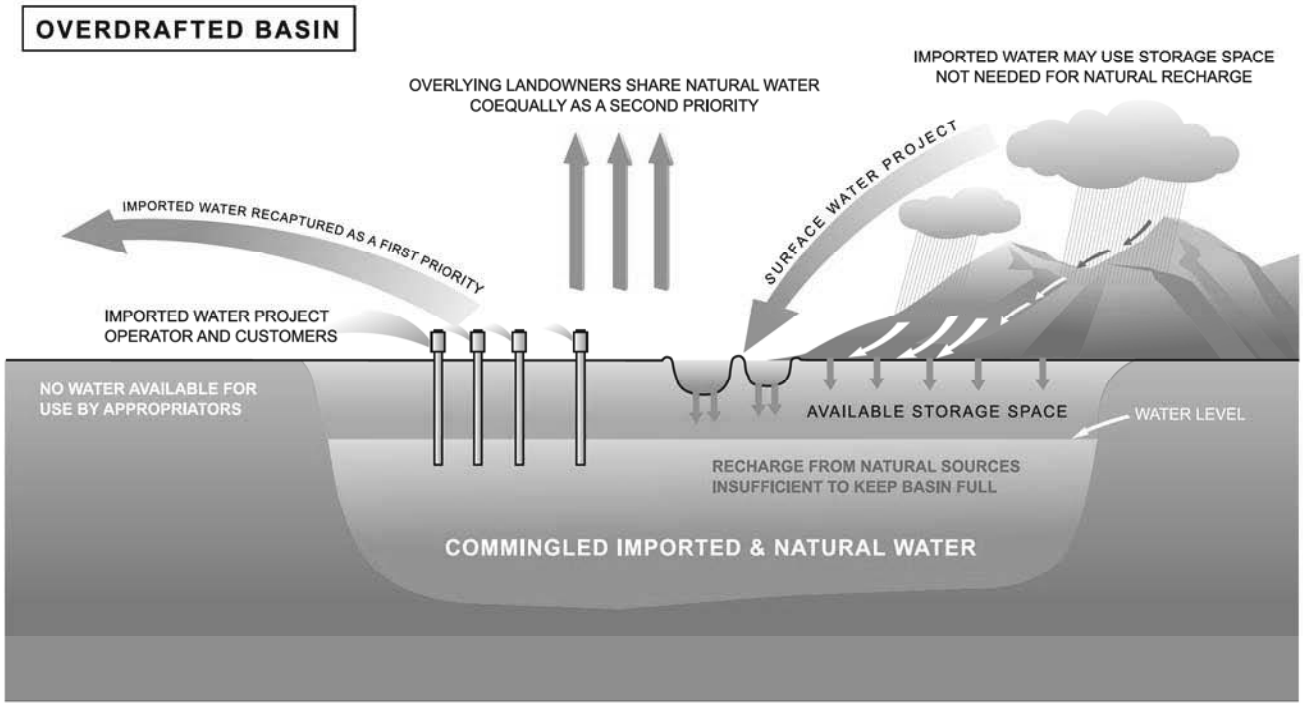


Figure B-2 Rights to groundwater use in overdrafted basin established in Los Angeles v. San Fernando

For the future of conjunctive use of groundwater basins, the court's holding with respect to the rights to available storage space in the Basin is significant. The court upheld the right of public agencies – namely the cities of San Fernando, Los Angeles, Burbank, and Glendale–to recapture the imported water they added to the Basin. The court held that the rights of the respective public agencies to recover such imported water are of equal priority to the City of Los Angeles' pueblo right, and that all such public agency rights are "prior to the rights dependent on ownership of overlying land or based solely upon appropriation of groundwater from the basin." The court remanded the case, directing the trial court to apportion the safe yield of the Basin accordingly.

The court noted that there did not appear to be any shortage of underground storage space in relation to the demand and, hence, the court did not find it necessary to determine priorities as to the future use of such space. The Judgment issued by the trial court on remand, however, provided: "To the extent of any future spreading or in lieu storage of import water or reclaimed water by Los Angeles, Glendale, Burbank or San Fernando, the party causing said water to be so stored shall have a right to extract an equivalent amount of ground water from the San Fernando Basin." Pursuant to the Judgment, a court-appointed Watermaster now manages the groundwater extraction and storage rights within the ULARA. Figure B-2 depicts the rights to use groundwater established in Los Angeles v. San Fernando in an overdrafted basin where water has been stored.

City of Barstow v. Mojave Water Agency (23 Cal. 4th 1224)

In 2000, the California Supreme Court partially overturned the 1995 adjudication of the Mojave River Basin. The trial court had approved a negotiated settlement (or stipulated agreement) that failed to include a well-by-well determination of water rights. The trial court held the negotiated settlement to be binding on all users in the basin, including some pumpers who had not agreed to the settlement. The lower court decision was based on the doctrine of "equitable apportionment," in which the available water is shared based on concepts of equity and fairness. The Court of Appeal had partially reversed the lower court, and held that the trial court did not have the authority to ignore California's traditional water rights doctrine giving overlying users a priority right to beneficial and reasonable use of the groundwater. The Court of Appeal affirmed the trial court's negotiated settlement except as it applied to two of the parties. First, the Court of Appeal reversed the holding against a non-negotiating party since the trial court had ignored that party's existing overlying water rights. Secondly, the Court of Appeal reversed the trial court's judgment as it applied to a company, where the negotiated agreement did not give the company a water-allowance equal to its actual water use. The Supreme Court affirmed the Court of Appeal decision, but reversed the judgment applying to the company's water-allowance. The Supreme Court also affirmed that the trial court could not apply the doctrine of equitable apportionment when overlying water users had already established a prior water right. The Court stated that, while the trial court could impose a physical solution (such as the negotiated settlement), the court could not simply ignore affected owners' legal water rights. Equitable apportionment, thus, remains a tool for adjudicating basin groundwater rights, but only if all parties stipulate to its use.

Appendix C
Required and Recommended Components of Local Groundwater Management Plans

Section 10750 et seq. of the Water Code, commonly referred to as Assembly Bill 3030, stipulates certain procedures that must be followed in adopting a groundwater management plan under this section.

Amendments to Section 10750 et seq. added the requirement that new groundwater management plans prepared under Section 10750 et seq. must include component 1 below (SB1938 (Stats 2002, Ch 603)).

In addition, the amendments mandate that if the agency preparing the groundwater management plan intends to apply for funding administered by the California Department of Water Resources (DWR) for groundwater or groundwater quality projects, the agency must prepare and implement a groundwater management plan that includes components 2, 3, 6, 7 and 9 below. DWR recommends that all the components below be included in any groundwater management plan to be adopted and implemented by a local managing entity.

Consideration and development of these components for the specific conditions of the basin to be managed under the plan will help to ensure effective groundwater management. In developing these criteria, DWR recognizes that the goal of a groundwater management plan and the goal of an ordinance to manage groundwater should be the same—assurance of a long-term, sustainable, reliable, good quality groundwater supply. Such efforts can benefit greatly from cooperative management within the basin or region.

None of the suggested data reporting in the components below should be construed as recommending disclosure of information that is confidential under State law.

1. Include documentation that a written statement was provided to the public "describing the manner in which interested parties may participate in developing the groundwater management plan," which may include appointing a technical advisory committee (Water Code § 10753.4 (b)).
2. Include a plan by the managing entity to "involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin." (Water Code § 10753.7 (a)(2)). A local agency includes "any local public agency that provides water service to all or a portion of its service area"
(Water Code § 10752 (g)).
3. Provide a map showing the area of the groundwater basin, as defined by DWR Bulletin 118, with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code § 10753.7 (a)(3)).
4. Establish an advisory committee of stakeholders (interested parties) within the plan area that will help guide the development and implementation of the plan and provide a forum for resolution of controversial issues.
5. Describe the area to be managed under the plan, including:
    a. The physical structure and characteristics of the aquifer system underlying the plan area in the context of the overall basin.

b. A summary of the availability of historical data including, but not limited to, the components in Section 7 below.

c. Issues of concern including, but not limited to, issues related to the components in Section 7 below.

d. A general discussion of historical and projected water demands and supplies.

6. Establish management objectives (MOs) for the groundwater basin that is subject to the plan. (Water Code § 10753.7 (a)(1)).

7. Include components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping. (Water Code § 10753.7 (a)(1)). Consider additional components listed in Water Code § 10753.8 (a) through (l).

8. For each MO, describe how meeting the MO will contribute to a more reliable supply for long-term beneficial uses of groundwater in the plan area, and describe existing or planned management actions to achieve MOs.

9. Adopt monitoring protocols for the components in Section 7 (Water Code § 10753.7 (a)(4)). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting MOs.

10. Describe the monitoring program, including:

a. A map indicating the general locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence stations, or stream gages.

b. A summary of monitoring sites indicating the type (groundwater level, groundwater quality, subsidence, stream gage) and frequency of monitoring. For groundwater level and groundwater quality wells, indicate the depth interval(s) or aquifer zone monitored and the type of well (public, irrigation, domestic, industrial, monitoring).

11. Describe any current or planned actions by the local managing entity to coordinate with other land use, zoning, or water management planning agencies or activities (Water Code § 10753.8 (k), (l)).

12. Provide for periodic report(s) summarizing groundwater basin conditions and groundwater management activities. The report(s), prepared annually or at other frequencies as determined by the local management agency, should include:

a. Summary of monitoring results, including a discussion of historical trends.

b. Summary of management actions during the period covered by the report.

c. A discussion, supported by monitoring results, of whether management actions are achieving progress in meeting MOs.

d. Summary of proposed management actions for the future.

e. Summary of any plan component changes, including addition or modification of MOs, during the period covered by the report.

f. Summary of actions taken to coordinate with other water management and land use agencies, and other government agencies.

13. Provide for the periodic re-evaluation of the entire plan by the managing entity.

14. For local agencies not overlying groundwater basins, plans should be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code § 10753.7 (a)(5)).

Appendix D
Groundwater Management Model Ordinance

In developing this model ordinance, the California Department of Water Resources recognizes that the goal of a groundwater management plan and the goal of an ordinance to manage groundwater should be the same—assurance of a long-term, sustainable, reliable, good quality groundwater supply. Such efforts require cooperative management within the region or sub-region.

Chapter X

Groundwater Management Ordinance

Sections:

X.01 Declaration of Findings
X.02 Purpose
X.03 Declaration of Intent
X.04 Definitions
X.05 Groundwater Management Program
X.06 Management Objectives
X.07 Monitoring Program Network
X.08 Monitoring Frequency
X.09 Changes in Monitoring
X.10 Review of Technical Data
X.11 Data Dissemination
X.12 Actions when MO Noncompliance is Reported
X.13 Regional Coordination
X.14 Integrated Resource Management
X.15 Data Relating to Export and Substitution of Groundwater

X.01 Declaration of Findings - The Board finds that:

A. The protection of the groundwater resource for its use within the County is of major concern to the residents of the County for the protection of their health, welfare, and safety.
B. The reliability and sustainability of the groundwater supply for all beneficial uses are of critical importance to the economic, social, and environmental well-being of the County.
C. A lack of effective groundwater management may have significant negative impacts, including, but not limited to:
    1. Lower groundwater levels leading to additional expenses from:
        a) Increased energy consumption.
        b) The need to deepen existing wells.
        c) The need to build new wells.
        d) The need to destroy non-functioning wells.
    2. Costly damage to public roads, bridges, canals, and other structures caused by land subsidence.
    3. Reduction of surface and subsurface flows leading to the potential loss of critical riparian and wetland habitat.
    4. Degradation of groundwater quality.

D. It is essential for management purposes to adopt a monitoring program addressing groundwater levels, groundwater quality, land subsidence, and surface water flow and quality where it directly impacts or is impacted by groundwater.

X.02 Purpose - In support of the findings above, the County has determined that this groundwater management ordinance is necessary to ensure that:

A. Groundwater continues to be a reliable and sustainable resource.
B. The extraction of groundwater does not result in significant adverse economic, environmental, or social impacts.
C. Groundwater quality is protected.
D. Excessive land surface subsidence from groundwater extraction is prevented.

X.03 Declaration of Intent

A. The County intends to foster prudent groundwater management practices by establishing a policy that encourages appropriate management of the resource based on recommendations by a committee of stakeholders.
B. The County intends that its groundwater management activities occur as an open and public process that considers input from all stakeholders in the County.
C. The County intends to work cooperatively with interested local agencies to further develop and implement joint groundwater management activities.
D. The County does not intend to regulate, in any manner, the use of groundwater, except as a last resort to protect the groundwater resource.
E. The County intends to act as an enforcing agency should the local resource become threatened.
F. The County does not intend to infringe upon the rights of surface water users in the managed area.
G. The County does not intend to limit other authorized means of managing groundwater within the County.

X.04 Definitions

A. "Aquifer" means a geologic formation that stores groundwater and transmits and yields significant quantities of water to wells and springs. Significant quantity is an amount that that satisfies local needs and may range from thousands of gallons per minute to less than 5 gpm, depending on rock type and intended use.
B. "Board" means the Board of Supervisors of the County.
C. "District" means a district or municipality, located wholly or partially within the boundaries of the County, that is a purveyor of water for agricultural, domestic, or municipal use.
D. "Enforcement Agency" means the Board as the enforcement agency under this chapter.
E. "Groundwater" means all water beneath the surface of the earth below the zone of saturation, but does not include subterranean streams flowing in known and definite channels.
F. "Groundwater Basin" means an aquifer or series of aquifers with a reasonably defined lateral and vertical extent, as defined in Bulletin 118 by Department of Water Resources. "Non-basin areas" are outside defined groundwater basins and contain smaller amounts of groundwater in consolidated sediments or fractured hard rock.
G. "Groundwater Export" means the conveyance of groundwater outside of the boundaries of the County and outside of the boundaries of any district that is partially within the County.
H. "Groundwater Substitution" means the voluntary use of an available groundwater supply instead of surface water for the purposes of using the surface water outside the County and outside the boundaries of any district that is partially within the County.

I. "Land Subsidence" means the lowering of the ground surface caused by the inelastic consolidation of clay beds in the aquifer system.
J. "Management Objective"(MO) means a condition identified for each subunit to ensure that the groundwater supply is reliable and sustainable. The MOs set acceptable conditions with respect to groundwater levels, groundwater quality, inelastic land surface subsidence, and surface water flows and quality. Compliance with the MO is tracked by a monitoring program and threshold values that are adopted for each Management Objective.
K. "Recharge" means flow to groundwater storage from precipitation, and infiltration from streams, irrigation, spreading basins, injection wells, and other sources of water.
L. "Reliability" means having an available, predictable, and usable groundwater supply at any given point in time.
M. "Stakeholder" means an individual or an entity, such as a water supplier or a county resident, with a permanent interest in the availability of the groundwater resource.
N. "Subunit" means any subdivision of a groundwater basin or non-basin area in the County created for the purposes of representation of stakeholders and the establishment of local area management objectives.
O. "Sustainable" means the groundwater resource is maintained for use by residents in the basin over a prolonged period of time.
P. "Technical Advisory Committee" means a committee of persons knowledgeable in groundwater management, hydrology, and hydrogeology established for the purpose of providing technical guidance to the Water Advisory Committee.
Q. "Threshold values" mean the limits established by the WAC for groundwater levels, groundwater quality, land surface subsidence, and surface water flow and quality that are not to be exceeded if the MOs are to be met.
R. "Water Advisory Committee" (WAC) means a multimember advisory body established for the purpose of aiding the Board in providing effective management of the groundwater resources in the County, and representing all of the subunits that are identified.
S. "Water Management Entities" means any local agency, or group of agencies, authorized to manage groundwater.

X.05 Groundwater Management Program

A. The County recognizes that effective groundwater management is key to maintaining a reliable and sustainable resource. For the purposes of establishing an effective groundwater management program, the Board shall appoint a WAC to establish MOs and make recommendations to the Board to ensure that MOs are met.
B. For purposes of establishing a WAC, the groundwater basins and non-basin areas of the County will be divided into subunits based on hydrogeologic principles and institutional boundaries. These subunits shall be established by the Board based on public input to address the groundwater management needs of the County. The WAC shall consist of members that represent each subunit. Upon establishment of the subunits, the Board shall appoint a member to represent each subunit on the WAC.
C. The WAC shall have the following responsibilities to the Board:
    1. Recommend MOs for each groundwater management subunit.
    2. Recommend a groundwater monitoring network for purposes of tracking MOs.
    3. Recommend the frequency of monitoring.
    4. Propose changes in monitoring.
    5. Ensure monitoring data receive technical review.
    6. Ensure that monitoring data are made available to the public.

7. Recommend actions to resolve noncompliance with MOs.

D. For the purposes of providing technical advice to the WAC in carrying out its responsibilities, a technical advisory committee (TAC) shall be established. The TAC shall consist of local experts or a combination of local expertise and technical consultants from private and public organizations that are nominated by the WAC and approved by the Board. Individuals appointed to the TAC should be highly knowledgeable in groundwater management, hydrology, and hydrogeology. The TAC shall review technical data collected by monitoring programs within the County and advise the WAC.

X.06 Management Objectives

A. To ensure that the County maintains a reliable and sustainable groundwater supply, MOs for groundwater levels, groundwater quality, land subsidence, and surface water flow and quality shall be adopted for each subunit. Threshold values that are not to be exceeded shall be defined for each MO.
B. Compliance with the MOs will be determined by evaluation of data collected from groundwater level, groundwater quality, land subsidence, and surface water flow and quality monitoring networks. Evaluation of these data with respect to threshold values shall be the basis for determining compliance with the MOs.
C. Each WAC member shall recommend MOs for their subunit. The WAC shall develop a comprehensive set of recommendations for all subunits, and the Board shall adopt these MOs for the County. MOs may differ from subunit to subunit, but the established MOs shall be consistent with the overall goal of supply reliability for the County.
D. Groundwater management practices based on the established MOs for one subunit of the County shall not adversely impact adjacent subunits.

X.07 Monitoring Program Network

The WAC shall develop County-wide monitoring programs to collect representative data on groundwater levels, groundwater and surface water quality, land surface subsidence, and stream flow and quality. Each subunit shall propose its own monitoring program, and the WAC shall adopt a comprehensive monitoring program for the County. The data collected, showing current conditions and changes over time as a result of groundwater extraction, shall be evaluated by the WAC in consultation with the TAC. The WAC will recommend policies and actions to ensure that MOs for each subunit are met. The collection and evaluation of the data shall be based on scientifically sound principles, and shall incorporate appropriate quality assurance and quality control protocols.

A. Groundwater levels: The groundwater level monitoring network shall be proposed by the WAC and approved by the Board. The intent of the groundwater level monitoring network is to measure water levels in selected wells that can adequately determine representative conditions in the aquifer system for determination of compliance with the MOs. The network will include selected municipal, domestic, and irrigation wells owned by water districts, private parties, and municipal and industrial water suppliers. Where needed, dedicated monitoring wells may be installed. Participation by well owners will be voluntary.
B. Water Quality: The groundwater quality monitoring network shall be proposed by the WAC and approved by the Board. The intent of the groundwater quality monitoring network is to monitor selected wells that can adequately determine representative groundwater quality conditions in the aquifer system for identification of compliance with the MOs. The network will include selected municipal, domestic, and irrigation wells owned by water districts, private parties, and municipal

and industrial water suppliers. Where needed, dedicated monitoring wells may be installed. Participation by well owners will be voluntary.

C. Land Subsidence: The land subsidence program and network shall be proposed by the WAC and approved by the Board. The intent of the land subsidence monitoring is to detect land subsidence for determination of compliance with the MOs. The network may include benchmarks that are surveyed for changes in elevation throughout the County, based on the judgment of the WAC of the need for such a program.

D. Surface Water Flow and Quality: The surface water flow and quality network shall be proposed by the WAC and approved by the Board. The intent of this network is to detect changes in surface water flow or surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping for evaluation of compliance with MOs.

X.08 Monitoring Frequency

The recommended frequency of collection of data for each of the parameters listed above shall be determined by the WAC. Initially, each parameter should be measured at the frequencies outlined below, unless the WAC notes upon evaluation of existing data that more frequent monitoring or additional analyses are called for.

A. Groundwater levels should be measured at least three times during the year: one measurement prior to the period of highest groundwater use, one measurement during peak groundwater use, and one measurement following the period of highest groundwater use (approximately the months of _____, _____, and _____).

B. Groundwater quality measurements of electrical conductivity, temperature, and pH should be obtained at least twice annually during the periods of highest and lowest groundwater use (approximately the months of _____ and _____). Upon evaluation of the data, the WAC may propose analyses for other constituents.

C. Selected benchmarks in the County land subsidence monitoring network should be surveyed every five years at a minimum. These surveys should be conducted following aquifer recovery and prior to the period of highest groundwater extraction (approximately the month of_____).

D. Measurement of surface water flow and quality in areas determined to directly affect groundwater levels or quality or that are affected by groundwater pumping shall be obtained at least ___ times per month as long as there are flows in the channel.

X.09 Changes in Monitoring

If evaluation of the groundwater level, groundwater quality, land subsidence, surface water flow, or surface water quality data indicates a need for more or less frequent measurements or analyses, the WAC may propose a change in the monitoring frequency. Similarly, if evaluation of the data indicates that additional monitoring sites are necessary, the WAC may propose an additional or a reduced number of sites for data collection. The Board shall adopt these changes when supported by credible evidence.

X.10 Review of Technical Data

A. The TAC shall propose and the WAC shall adopt standard methods using scientifically sound principles for review and analysis of the collected data. The TAC will meet, as needed and requested by the WAC, to evaluate the technical data and shall report their findings at appropriate meetings of the WAC. The WAC shall meet at least __ times per month during the period of maximum groundwater use (months of _____ through _____) and quarterly during the off season (months of _____ through _____), or as necessary.

B. During the period of highest groundwater use, the WAC meetings will focus on data review and analysis with respect to compliance with the current MOs. During the period of low

groundwater use, the WAC meetings will focus on a review of compliance with MOs for the previous period of high groundwater use and consideration of the need for changes to the MOs.

X.11 Data Dissemination

The WAC, in addition to establishing methods for data collection and evaluation, shall establish methods for data storage and dissemination. The WAC shall disseminate the monitoring data and evaluation reports through public presentations and through a County-maintained groundwater Internet site. At a minimum, the WAC shall publicly present findings from the monitoring program to the Board twice annually.

X.12 Actions when MO Noncompliance is Reported

A. Action by Technical Advisory Committee. In the event that the TAC identifies an area that is not in compliance with the MOs, or if noncompliance is reported by any other means, the TAC shall report to the WAC on the regional extent and magnitude of the noncompliance. This information shall also be released to the public no later than ___ days from the time that noncompliance with MOs was identified. The TAC shall then collect all available pertinent hydrologic data, investigate possible causes for noncompliance with MOs, and recommend actions to the WAC to bring the area into compliance. These recommendations shall be made no later than ___ days after the report of noncompliance is released to the public. The TAC shall first make recommendations that focus on correcting the noncompliance through negotiations with all parties in the affected area.

B. Action by Water Advisory Committee. The WAC shall act as lead negotiator in re-establishing compliance with the MO. If negotiations with parties in the affected area do not result in timely and positive action to re-establish compliance with MOs for the basin, the WAC may recommend a plan to the Board to modify, reduce or terminate groundwater extraction in the affected area or take other necessary actions. Such a plan will be recommended to the Board only after the WAC has thoroughly reviewed the recommendations of the TAC at a public meeting. The modification, reduction, or termination of groundwater extraction in the affected area shall first be applied to wells involved in any export or substitution programs, and then to other wells if necessary. Domestic wells shall not be considered for any modification, reductions, or termination of groundwater extraction.

C. Action by Board of Supervisors. The Board of Supervisors, using its police powers, shall act as the enforcement agency for this ordinance. Any recommendation of the WAC may be appealed to the Board within __ working days.

X.13 Regional Coordination

Management decisions recommended by the WAC and adopted by the Board shall not deleteriously affect groundwater resources in any portions of groundwater basins or non-basin areas that share a common groundwater resource in adjacent counties. To accomplish this goal, the WAC shall meet and coordinate with water management entities outside the County that overlie a common groundwater basin at least twice per year once prior to the period of highest groundwater use and once following the period of highest groundwater use.

X.14 Integrated Resource Management

A. To ensure integration of planning activities within the County, the WAC shall inform County departments involved with groundwater related activities, including but not limited to Land Use or Zoning, Planning, Public Works, Utilities, and Environmental Health, of all WAC meetings and actions regarding MOs. In turn, these County departments shall take into consideration the

adopted MOs when approving development or zoning changes or construction projects that may rely on or affect groundwater quantity or quality.

B. To the greatest extent practicable, the WAC should also integrate resource management planning with other agencies within the basin. Resource activities that could benefit from integrated planning with groundwater management include, but are not limited to:
   - Groundwater management planning by other agencies—agricultural, municipal, industrial, local government
   - Watershed management plans
   - Urban water management plans
   - Management and disposal of municipal solid waste and municipal sewage
   - Drinking water source assessment and protection programs
   - Public water system emergency and disaster response plans
   - Surface water and groundwater conjunctive management programs
   - Expansion of surface and groundwater facilities
   - Water efficiency programs
   - Water recycling programs
   - Environmental habitat construction or restoration programs
   - Water quality protection programs
   - Recharge programs
   - Transportation infrastructure planning

X.15 Data Relating to Export and Substitution of Groundwater

A. Districts, persons, or contractors intending to operate a groundwater export or groundwater substitution program shall submit the following data to the WAC __ working days prior to commencing the program:
   1. A description of the project with the total amount of groundwater to be exchanged or substituted
   2. The dates over which the project will take place.
   3. A statement of the anticipated impacts of the project relative to adopted MOs.
   4. A discussion of possible contingencies in the event of MO noncompliance.
   5. A map showing the location of the wells to be used by the program.
   6. A summary of any monitoring program proposed.
   7. All required environmental documentation.

B. While the program is in operation, the following information shall be provided to the WAC at least ___ times per month:
   1. All static and pumping groundwater level measurements made in the pumping well during the period of extraction for the export or substitution program.
   2. The amount of groundwater extracted from each well per week.
   3. Static groundwater level measurements in at least __ of the most proximal wells to the project pumping wells that can be practicably monitored.

C. All costs for providing such information to the WAC shall be borne by the project participants.

Note: Although the terms “County” and “Board” are used throughout the model ordinance for clarity, the model could be used by any local government or agency with appropriate authority or powers.

Appendix E
SWRCB Beneficial Use Designations[1]

Agricultural Supply (AGR) – Uses of water for farming, horticulture, or ranching including, but not limited to irrigation, stock watering, or support of vegetation for ranch grazing.

Aquaculture (AQUA) – Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Cold Freshwater Habitat (COLD) – Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) – Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Freshwater Replenishment (FRSH) – Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Groundwater Recharge (GWR) – Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Hydropower Generation (POW) – Uses of water for hydropower generation.

Industrial Process Supply (PRO) – Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND) – Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Inland Saline Water Habitat (SAL) – Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Marine Habitat (MAR) – Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Migration of Aquatic Organisms (MIGR) – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Municipal and Domestic Supply (MUN) – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Navigation (NAV) – Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Noncontact Water Recreation (REC-2) – Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Ocean Commercial and Sport Fishing (COMM) – Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

[1] From SWRCB 2000

Preservation of Biological Habitats of Special Significance (BIOL) – Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) – Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance or plant or animal species established under State or federal law as rare, threatened or endangered.

Shellfish Harvesting (SHELL) – Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Spawning, Reproduction, and/or Early Development (SPWM) – Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Warm Freshwater Habitat (WARM) – Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Water Contact Recreation (REC-1) – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Wildlife Habitat (WILD) – Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Appendix F
Federal and State MCLs and Regulation Dates for Drinking Water Contaminants

	U.S. Environmental Protection Agency		California Department of Health Services	
Contaminant	**MCL (mg/L)**	**Date[a]**	**MCL (mg/L)**	**Effective date**
Inorganics				
Aluminum	0.05 to 2[b]	1/91	1 0.2[b]	2/25/89 9/8/94
Antimony	0.006	7/92	0.006	9/8/94
Arsenic	0.05 0.01	eff: 6/24/77 2001	0.05	77
Asbestos	7 MFL[c]	1/91	7 MFL[c]	9/8/94
Barium	1 2	eff: 6/24/77 1/91	1	77
Beryllium	0.004	7/92	0.004	9/8/94
Cadmium	0.010 0.005	eff: 6/24/77 1/91	0.010 0.005	77 9/8/94
Chromium	0.05 0.1	eff: 6/24/77 1/91	0.05	77
Copper	1.3[d]	6/91	1[b] 1.3[d]	77 12/11/95
Cyanide	0.2	7/92	0.2 0.15	9/8/94 6/12/03
Fluoride	4 2[b]	4/86 4/86	2	4/98
Lead	0.05[e] 0.015[d]	eff: 6/24/77 6/91	0.05[e] 0.015[d]	771 2/11/95
Mercury	0.002	eff: 6/24/77	0.002	77
Nickel	Remanded	0.1	9/8/94	
Nitrate	(as N)10	eff: 6/24/77	(as N03) 45	77
Nitrite (as N)	1	1/91	1	9/8/94
Total Nitrate/Nitrite (as N)	10	1/91	10	9/8/94
Selenium	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Thallium	0.002	7/92	0.002	9/8/94
Radionuclides				
Uranium	30 g/L	12/7/00	20 pCi/L	1/1/89
Combined radium-226 & 228	5 pCi/L	eff: 6/24/77	5 pCi/L	77
Gross Alpha particle activity	15 pCi/L	eff: 6/24/77	15 pCi/L	77
Gross Beta particle activity	dose of 4 millirem/yr	eff: 6/24/77	50 pCi/L[f]	77

Contaminant	U.S. Environmental Protection Agency MCL (mg/L)	Date[a]	California Department of Health Services MCL (mg/L)	Effective date
Strontium-90	8 pCi/L	eff: 6/24/77 now covered by Gross Beta	8 pCi/L[f]	77
Tritium	20,000 pCi/L	eff: 6/24/77 now covered by Gross Beta	20,000 pCi/L[f]	77
VOCs				
Benzene	0.005	6/87	0.001	2/25/89
Carbon Tetrachloride	0.005	6/87	0.0005	4/4/89
1,2-Dichlorobenzene	0.6	1/91	0.6	9/8/94
1,4-Dichlorobenzene	0.075	6/87	0.005	4/4/89
1,1-Dichloroethane	- -	- -	0.005	6/24/90
1,2-Dichloroethane	0.005	6/87	0.0005	4/4/89
1,1-Dichloroethylene	0.007	6/87	0.006	2/25/89
cis-1,2-Dichloroethylene	0.07	1/91	0.006	9/8/94
trans-1,2-Dichloroethylene	0.1	1/91	0.01	9/8/94
Dichloromethane	0.005	7/92	0.005	9/8/94
1,3-Dichloropropene	- -	- -	0.0005	2/25/89
1,2-Dichloropropane	0.005	1/91	0.005	6/24/90
Ethylbenzene	0.7	1/91	0.68 0.7 0.3	2/25/89 9/8/94 6/12/03
Methyl-tert-butyl ether (MTBE)	- -	- -	0.005[b] 0.013	1/7/99 5/17/00
Monochlorobenzene	0.1	1/91	0.03 0.07	2/25/89 9/8/94
Styrene	0.1	1/91	0.1	9/8/94
1,1,2,2-Tetrachloroethane	- -	- -	0.001	2/25/89
Tetrachloroethylene	0.005	1/91	0.005	5/89
Toluene	1	1/91	0.15	9/8/94
1,2,4 Trichorobenzene	0.07	7/92	0.07	9/8/94
1,1,1-Trichloroethane	0.200	6/87	0.200	2/25/89
1,1,2-Trichloroethane	0.005	7/92	0.032 0.005	4/4/89 9/8/94
Trichloroethylene	0.005	6/87	0.005	2/25/89
Trichlorofluoromethane	- -	- -	0.15	6/24/90
1,1,2-Trichloro-1,2,2- Trifluoroethane	- -	- -	1.2	6/24/90
Vinyl chloride	0.002	6/87	0.0005	4/4/89
Xylenes	10	1/91	1.750	2/25/89

Contaminant	U.S. Environmental Protection Agency MCL (mg/L)	Date[a]	California Department of Health Services MCL (mg/L)	Effective date
SVOC's				
Alachlor	0.002	1/91	0.002	9/8/94
Atrazine	0.003	1/91	0.003 0.001	4/5/89 6/12/03
Bentazon	- -	- -	0.018	4/4/89
Benzo(a) Pyrene	0.0002	7/92	0.0002	9/8/94
Carbofuran	0.04	1/91	0.018	6/24/90
Chlordane	0.002	1/91	0.0001	6/24/90
Dalapon	0.2	7/92	0.2	9/8/94
Dibromochloropropane	0.0002	1/91	0.0001 0.0002	7/26/89 5/3/91
Di(2-ethylhexyl)adipate	0.4	7/92	0.4	9/8/94
Di(2-ethylhexyl)phthalate	0.006	7/92	0.004	6/24/90
2,4-D	0.10.07	eff: 6/24/77 1/91	0.1 0.07	77 9/8/94
Dinoseb	0.007	7/92	0.007	9/8/94
Diquat	0.02	7/92	0.02	9/8/94
Endothall	0.1	7/92	0.1	9/8/94
Endrin	0.0002 0.002	eff: 6/24/77 7/92	0.0002 0.002	77 9/8/94
Ethylene Dibromide	0.00005	1/91	0.00002 0.00005	2/25/89 9/8/94
Glyphosate	0.7	7/92	0.7	6/24/90
Heptachlor	0.0004	1/91	0.00001	6/24/90
Heptachlor Epoxide	0.0002	1/91	0.00001	6/24/90
Hexachlorobenzene	0.001	7/92	0.001	9/8/94
Hexachlorocyclopentadiene	0.05	7/92	0.05	9/8/94
Lindane	0.004 0.0002	eff: 6/24/77 1/91	0.004 0.0002	77 9/8/94
Methoxychlor	0.1 0.04	eff: 6/24/77 1/91	0.1 0.04 0.03	77 9/8/94 6/12/03
Molinate	- -	- -	0.02	4/4/89
Oxamyl	0.2	7/92	0.2 0.05	9/8/94 6/12/03
Pentachlorophenol	0.001	1/91	0.001	9/8/94
Picloram	0.5	7/92	0.5	9/8/94
Polychlorinated Biphenyls	0.0005	1/91	0.0005	9/8/94
Simazine	0.004	7/92	0.010 0.004	4/4/89 9/8/94

Contaminant	U.S. Environmental Protection Agency MCL (mg/L)	Date[a]	California Department of Health Services MCL (mg/L)	Effective date
Thiobencarb	- -	- -	0.07 0.001[b]	4/4/89 4/4/89
Toxaphene	0.005 0.003	eff: 6/24/77 1/91	0.005 0.003	77 9/8/94
2,3,7,8-TCDD (Dioxin)	$3x10^{-8}$	7/92	$3x10^{-8}$	9/8/94
2,4,5-TP (Silvex)	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Disinfection Byproducts				
Total trihalomethanes	0.10 0.080	11/29/79 eff: 11/29/83 eff: 1/1/02[g]	0.10	3/14/83
Total haloacetic acids	0.060	eff: 1/1/02[g]		
Bromate	0.010	eff: 1/1/02[g]		
Chlorite	1.0	eff: 1/1/02[g]		
Treatment Technique				
Acrylamide	TT[h]	1/91	TT[h]	9/8/94
Epichlorohydrin	TT[h]	1/91	TT[h]	9/8/94

Source: http://www.dhs.ca.gov/ps/ddwem/chemicals/MCL/EPAandDHS.pdf

a. "eff." indicates the date the MCL took effect; any other date provided indicates when EPA established (that is, published) the MCL.

b. Secondary MCL.

c. MFL = million fibers per liter, with fiber length > 10 microns.

d. Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.

e. The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote d.

f. MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

g. Effective for surface water systems serving more than 10,000 people; effective for all others 1/1/04.

h. TT = treatment technique, because an MCL is not feasible.

Federal and State MCLs – updated 05/23/03

Appendix G
Development of Current Groundwater Basin/Subbasin Map

This Bulletin 118 update represents the first time that groundwater basin boundaries have been released as a digital coverage. The basin boundaries for the revised groundwater basin map were primarily defined using geologic contacts and hydrogeologic barriers. Specifically the identification of the groundwater basins was initially based on the presence and areal extent of unconsolidated alluvial sediments identified on 1:250,000 scale, geologic maps published by the California Department of Conservation, Division of Mines and Geology. The identified groundwater basin areas were then further evaluated through review of relevant geologic and hydrogeologic reports and well completion reports, and using the basin definition criteria listed in Table 8. Basin boundaries that are specified in each of the court decisions has been used for the boundaries of adjudicated basins.

Well completion reports for wells present in basin areas that were identified from the geologic map were reviewed to identify the depth to the top of the water table and the top of impermeable bedrock. If there was less than 25 feet of permeable material present or if there was no groundwater present within the permeable material, the area was eliminated from the map. The well completion reports were also reviewed to determine if water supply wells located within the delineated basin area were extracting groundwater from the permeable materials underlying the area or from the bedrock beneath the permeable material. If the wells only extracted groundwater from the bedrock, the area was eliminated from the map. This resulted in the elimination of some areas identified as basins in previous Bulletin 118 publications. If there were no wells present in basin areas identified from the geologic map and no other information on the geology underlying these areas, the areas were retained in the current version of the map. Additional hydrogeologic information might or might not verify that these areas should be retained as groundwater basins.

Groundwater basins were delineated and separated from each other by the following restrictions on groundwater flow. For more detail on the types of basins and the flow boundaries of those basins, see Table 8.

Impermeable Bedrock. Impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock.

Constrictions in Permeable Materials. A lower permeability material, even with openings that are filled with more permeable stream channel materials, generally forms a basin boundary for practical purposes. While groundwater may flow through the sediment-filled gaps, the flow is restricted to those gaps.

Fault. A fault that crosses permeable materials may form a barrier to groundwater movement if movement along the fault plane has created fine material that impedes groundwater movement or juxtaposed low permeability material adjacent to an aquifer. This is usually indicated by noticeable difference in water levels in wells and/or flow patterns on either side of the fault. Not all faults act as barriers to groundwater flow.

Low Permeability Zone. Areas of clay or other fine-grained material that have significant areal or vertical extent generally form a barrier to groundwater movement within the basin but do not form basin boundaries.

Groundwater Divide. A groundwater divide is generally considered a barrier to groundwater movement from one basin to another for practical purposes. Groundwater divides have noticeably divergent groundwater flow directions on either side of the divide with the water table sloping away from the divide. The location of the divide may change as water levels in either one of the basins change, making such a "divide" less useful. Such a boundary is often used for subbasins.

Adjudicated Basin Boundaries. The basin boundaries established by court order were used for all adjudicated basins. These court-decided boundaries affect the location of natural boundaries of adjoining basins. Some adjudicated basins are represented as subbasins in this bulletin.

Available reports on the geologic and hydrogeologic conditions in the delineated basin areas were also reviewed to determine if there was information that would further define the boundaries of the basin areas. This review resulted in changes to some of the basin boundaries identified in previous versions of Bulletin 118.

Several of the larger groundwater basins were further subdivided into groundwater subbasins in Bulletin 118-80 and additional large groundwater basins were subdivided during this 2003 revision. The subbasin boundaries were also primarily defined using geologic contacts and hydrogeologic divides where possible. If this was not possible, political or institutional boundaries were used.

The hydrogeologic information contained in the basin descriptions that supplement this update of Bulletin 118 includes only the information that was available in California Department of Water Resources (DWR) files through reference searches and through limited contact with local agencies. Local agencies may have conducted more recent studies that have generated additional information about water budgets and aquifer characteristics. Unless the agency notified DWR or provided a copy of the recent reports to DWR staff that recent information has not been included in the basin descriptions. Therefore, although Senate Bill 610 refers to groundwater basins identified as overdrafted in Bulletin 118, it would be prudent for local water suppliers to evaluate the potential for overdraft of any basin included as a part of a water supply assessment.

Persons interested in collecting groundwater information in accordance with the Water Code as amended by SB 221 and SB 610 may start with the information in Bulletin 118, but should follow up by consulting the references listed for each basin and contacting local water agencies to obtain any new information that is available. Otherwise, evaluation of available groundwater resources as mandated by SB 221 and SB 610 may not be using the most complete and recent information about water budgets and aquifer characteristics.

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated.

In many other basins where much less is known and understood about the basin, boundaries will probably change as a better understanding of the basin is developed. A procedure for collecting information from all the stakeholders should be developed for use statewide so that agreement on basin boundaries can be achieved.

2005
URBAN WATER MANAGEMENT PLAN

Prepared for:

Castaic Lake Water Agency (CLWA)
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company
(Los Angeles County Waterworks District No. 36/Cooperating Agency)

Prepared by:

Black & Veatch :: Nancy Clemm :: Kennedy/Jenks Consultants :: Jeff Lambert :: Luhdorff & Scalmanini Consulting Engineers :: Reiter/Lowry Consultants :: Richard Slade and Associates, L.L.C.

November 2005

TABLE OF CONTENTS

SUMMARY **S-1**

1.0 INTRODUCTION **1-1**
1.1 Overview 1-1
1.2 Purpose 1-1
1.3 Implementation of the Plan 1-2
1.3.1 Joint Preparation of the Plan 1-2
1.3.2 Public Outreach 1-3
1.3.3 Resources Maximization 1-5
1.4 The Water Agencies of the Santa Clarita Valley 1-5
1.4.1 Castaic Lake Water Agency 1-5
1.4.2 Retail Water Purveyors 1-6
1.5 Climate 1-8
1.6 Potential Effects of Global Warming 1-8
1.7 Other Demographic Factors 1-9
1.8 List of Acronyms 1-9

2.0 WATER USE **2-1**
2.1 Overview 2-1
2.2 Historic Water Use 2-2
2.3 Projected Water Use 2-3
2.3.1 Purveyor Projections 2-3
2.3.2 Projections Based on Historical Use 2-5
2.3.2.1 Linear Regression Method 2-5
2.3.2.2 Comparison to City and County Planning 2-7
2.4 Other Factors Affecting Water Usage 2-9
2.4.1 Weather Effects on Water Usage 2-9
2.4.2 Conservation Effects on Water Usage 2-11

3.0 WATER RESOURCES **3-1**
3.1 Overview 3-1
3.2 Wholesale (Imported) Water Supplies 3-2
3.2.1 Imported Water Supplies 3-2
3.2.2 Litigation Effects on Availability of Imported Water 3-6
3.3 Groundwater 3-7
3.3.1 Santa Clara River Groundwater Basin – East Subbasin 3-7
3.3.2 Adopted Groundwater Management Plan 3-7
3.3.2.1 Available Groundwater Supplies 3-10
3.3.2.1.1 Alluvium 3-12
3.3.2.1.2 Saugus Formation 3-16
3.3.3 Potential Supply Inconsistency 3-19
3.4 Transfers, Exchanges, and Groundwater Banking Programs 3-20
3.4.1 Transfers and Exchanges 3-20

3.4.1.1 Core Transfers 3-20
3.4.1.2 Spot Market Transfers 3-20
3.4.1.3 Option Contracts 3-21
3.4.1.4 Future Market Transfers 3-21
3.4.2 Groundwater Banking Programs 3-21
3.4.2.1 Semitropic Water Banking 3-22
3.4.2.2 Rosedale-Rio Bravo Water Bank 3-23
3.4.2.3 Other Opportunities 3-23
3.5 Planned Water Supply Projects and Programs 3-24
3.6 Development of Desalination 3-24
3.6.1 Opportunities for Brackish Water and/or Groundwater Desalination 3-25
3.6.2 Opportunities for Seawater Desalination 3-25

4.0 RECYCLED WATER 4-1
4.1 Overview 4-1
4.2 Recycled Water Master Plan 4-1
4.3 Potential Sources of Recycled Wastewater 4-2
4.3.1 Existing and Planned Wastewater Treatment Facilities 4-2
4.3.1.1 Existing Facilities 4-2
4.3.2 Planned Improvements and Expansions 4-3
4.3.3 Water Rights 4-3
4.3.4 Other Potential Sources of Recycled Water 4-5
4.3.4.1 Newhall Ranch Water Reclamation Plant 4-5
4.3.4.2 Oilfield Produced Water 4-5
4.3.5 Summary of Available Source Water Flows 4-6
4.4 Recycled Water Demand 4-6
4.4.1 Current Use 4-6
4.4.2 Potential Users 4-7
4.4.3 Potential Recycled Water Demand 4-8
4.4.4 Recycled Water Comparison 4-8
4.5 Methods To Encourage Recycled Water Use 4-8
4.6 Optimization Plan 4-9

5.0 WATER QUALITY 5-1
5.1 Overview 5-1
5.2 Imported Water Quality 5-1
5.3 Groundwater Quality 5-3
5.3.1 Groundwater Quality - Alluvium 5-3
5.3.2 Groundwater Quality – Saugus Formation 5-4
5.4 Aquifer Protection 5-5
5.4.1 Alluvium 5-5
5.4.2 Saugus Formation 5-8
5.5 Water Quality Impacts on Reliability 5-8
5.5.1 Groundwater Contamination (Perchlorate) 5-8
5.5.2 Perchlorate Impacted Water Purveyor Wells 5-10

5.5.3 Restoration of Perchlorate Impacted Water Supply 5-10

6.0 RELIABILITY PLANNING 6-1
6.1 Overview 6-1
6.2 Reliability of Water Supplies 6-1
6.3 Normal, Single-Dry, and Multiple-Dry Year Planning 6-2
6.3.1 Groundwater 6-2
6.3.2 Recycled Water 6-3
6.3.3 State Water Project Table A Supply 6-3
6.3.3.1 Flexible Storage Account 6-3
6.3.3.2 Semitropic Water Bank 6-4
6.3.4 Buena Vista-Rosedale 6-4
6.3.5 Rosedale-Rio Bravo Bank 6-4
6.3.6 Additional Planned Banking 6-5
6.4 Supply and Demand Comparisons 6-5
6.4.1 Normal Water Year 6-5
6.4.2 Single-Dry Year 6-6
6.4.3 Multiple-Dry Year 6-6
6.4.4 Summary of Comparisons 6-6

7.0 DEMAND MANAGEMENT MEASURES 7-1
7.1 Overview 7-1
7.2 Water Demand Management Measures and Best Management Practices 7-1
7.3 Implementation Levels of DMMs/BMPs 7-2
7.4 Summary of Conservation 7-3

8.0 WATER SHORTAGE CONTINGENCY PLANNING 8-1
8.1 Overview 8-1
8.2 Coordinated Planning 8-1
8.2.1 CLWA and the Water Purveyors 8-1
8.2.2 City of Santa Clarita Drought Committee 8-1
8.3 Stages of Action To Respond to Water Shortages 8-2
8.4 Minimum Water Supply Available During Next Three Years 8-3
8.5 Actions To Prepare for Catastrophic Interruption 8-4
8.5.1 General 8-4
8.5.2 SWP Emergency Outage Scenarios 8-5
8.5.3 Regional Power Outage Scenarios 8-12
8.6 Mandatory Prohibitions During Shortages 8-13
8.7 Consumptive Reduction Methods During Restrictions 8-14
8.7.1 Supply Shortage Triggering Levels 8-14
8.7.2 Consumption Limits 8-14
8.7.3 New Demand 8-15
8.8 Penalties for Excessive Use 8-15
8.8.1 CLWA Santa Clarita Water Division 8-15
8.8.2 Newhall County Water District 8-15
8.8.3 Valencia Water Company 8-16

8.9 Financial Impacts of Actions During Shortages 8-17
8.9.1 CLWA Santa Clarita Water Division 8-17
8.9.2 Newhall County Water District 8-17
8.9.3 Valencia Water Company 8-18
8.10 Water Shortage Contingency Resolution 8-18
8.11 Mechanism To Determine Reductions in Water Use 8-18

LIST OF TABLES

1-1 Agency Coordination Summary
1-2 Public Participation Timeline
1-3 Retail Water Service Connections
1-4 Climate Data for the Santa Clarita Valley
2-1 Historical Accounts and Deliveries by Retail Purveyor
2-2 Projected Water Demands
2-3 Past, Current, and Projected Water Deliveries (by customer type) CLWA SCWD
2-4 Past, Current, and Projected Water Deliveries (by customer type) LACWWD #36
2-5 Past, Current, and Projected Water Deliveries (by customer type) NCWD
2-6 Past, Current, and Projected Water Deliveries (by customer type) VWC
2-7 Adjusted Santa Clarita Valleywide General Plan
2-8 Projected Household Water Use
2-9 Comparison of Purveyor and OVOV Projections
3-1 Summary of Current and Planned Water Supplies and Banking Programs
3-2 Historical Total SWP Deliveries to Purveyors
3-3 CLWA Demand Projections Provided to Wholesale Supplier (DWR)
3-4 Wholesaler Identified and Quantified Existing and Planned Sources of Water Available to CLWA for Average/Normal Years
3-5 Wholesale Supply Reliability
3-6 Groundwater Operating Plan for the Santa Clarita Valley
3-7 Historical Groundwater Production by the Retail Water Purveyors
3-8 Projected Groundwater Production (Normal Year)
3-9 Active Municipal Groundwater Source Capacity – Alluvial Aquifer Wells
3-10 Active Municipal Groundwater Source Capacity – Saugus Formation Wells
3-11 Recommended Schedule for Water Banking Capacity
3-12 Future Reliability Enhancement Programs
3-13 Transfer and Exchange Opportunities
3-14 Existing Seawater Desalination Facilities Along the California Coast
3-15 Proposed Seawater Desalination Facilities Along the California Coast
4-1 Participating Agencies
4-2 Wastewater Collection and Capacity
4-3 Use of Native Water vs. Foreign Water
4-4 Disposal of Wastewater (non-recycled)
4-5 Summary of Available Source Water Flows
4-6 Actual Recycled Water Uses
4-7 Potential Recycled Water Uses
4-8 Projected Future Use of Recycled Water in Service Area
4-9 Recycled Water Uses – 2000 Projection Compared with 2004 Actual

4-10 Methods To Encourage Recycled Water Use
6-1 Basis of Water Year Data
6-2 Projected Average/Normal Year Supplies and Demands
6-3 Projected Single-Dry Year Supplies and Demands
6-4 Projected Multiple-Dry Year Supplies and Demands
8-1 Rationing and Reduction Goals
8-2 Per Capita Health and Safety Water Quantity Calculations
8-3 Estimate of Minimum Supply for the Next Three Years
8-4 Projected Supplies and Demands During Six-Month Disruption of Imported Supply System
8-5 Water Deficiency Triggering Levels

LIST OF FIGURES

1-1 Castaic Lake Water Agency Service Area
2-1 Historical Annual Total Demand
2-2 Historical vs. Projected Annual Demand (Includes Agricultural Demand/Private Uses)
2-3 Historical vs. Projected Annual Demand
2-4 Weather Effects on Water Usage
2-5 Comparison of Regional Indoor/Outdoor Water Use
3-1 Santa Clara River Valley East Groundwater Subbasin
3-2 Municipal Alluvial Well Locations
3-3 Saugus Well Locations
5-1 Forecasted Two-Year Groundwater Capture Zones for Active Alluvial Production Wells Located Closest to the Whittaker-Bermite Property
5-2 Forecasted Two-Year Groundwater Capture Zones for Active Saugus Production Wells Located Closest to the Whittaker-Bermite Property
5-3 Preliminary 97-005 Implementation Schedule Castaic Lake Water Agency
8-1 Primary SWP Facilities

LIST OF APPENDICES

A UWMP Checklist
B Public Outreach Materials
C Groundwater Resources and Yield in the Santa Clarita Valley
D Perchlorate Contamination and Impact on Groundwater Supplies in the Santa Clarita Valley
E Project Description Excerpt from August 2005 “CLWA Groundwater Containment, Treatment, and Restoration Project” Mitigated Negative Declaration
F Best Management Practices
G Draft Water Shortage Contingency Resolution/Ordinance
H Reference List

SUMMARY

SUMMARY

The California Urban Water Planning Act (Act) requires most water utilities to update and submit an Urban Water Management Plan (UWMP) every five years. An UWMP is required in order for a water supplier to be eligible for the California Department of Water Resources (DWR) administered State grants and loans and drought assistance. This document presents the 2005 UWMP (Plan) for the Castaic Lake Water Agency (Agency, CLWA) service area, which includes four local retail water purveyors. This regional Plan builds upon previous documents, specifically CLWA's 2000 UWMP and an amendment to the 2000 Plan. Following a general discussion of Plan preparation and general project rationale, information is provided on water use, water resources, recycled water, water quality, reliability planning, demand management measures (DMMs), best management practices (BMPs), and water shortage contingency planning. This summary chapter presents an overview of each chapter in the Plan.

1.0 INTRODUCTION

CLWA's service area includes the service areas of four local retail water agencies. This regional Plan has been prepared for CLWA and three of the purveyors: CLWA Santa Clarita Water Division (SCWD), Newhall County Water District (NCWD), and Valencia Water Company (VWC). The fourth purveyor, Los Angeles County Waterworks District No. 36 (LACWWD #36), does not prepare a plan because it does not provide water to more than 3,000 customers or supply more than 3,000 acre-feet (af) of water annually – the minimum requirements for plan preparation. However, LACWWD #36 participated in the development of the Plan on an "ad-hoc" basis. Chapter 1 describes the purpose of the Plan, discusses Plan implementation, and provides general information about CLWA, the retail water purveyors, and service area characteristics. In response to new documents by DWR, this Plan also acknowledges the potential effects of global warming as a component of water management planning.

2.0 WATER USE

Chapter 2 describes historic and current water usage and the methodology used to project future demands within CLWA's service area. Water usage is divided into sectors such as residential, industrial, institutional, landscape, agricultural, and other purposes. To undertake this evaluation, existing land use data and new housing construction information were compiled from each of the retail water purveyors and projections prepared by "One Valley One Vision" (OVOV), a joint planning effort by the City of Santa Clarita and Los Angeles County Department of Regional Planning (LACDRP). This information was then compared to historical trends for new water service connections and customer water usage. In addition, weather and water conservation effects on historical water usage were factored into the evaluation.

3.0 WATER RESOURCES

Chapter 3 describes the water resources available to CLWA and the retail water purveyors from 2005 to 2030 – the 25-year period covered by the Plan. Resources include: (1) wholesale (imported) water supplies from the State Water Project (SWP), (2) local groundwater supplies from the Alluvium and Saugus Formation aquifers, and (3) transfers, exchanges, and

groundwater banking programs. Also described are planned water supply projects and programs and the development of desalination. Current and future imported water supplies are discussed, including "Table A" water supplies, CLWA's Flexible Storage Accounts, and reliability issues associated with SWP supplies. CLWA's Groundwater Management Plan (GWMP) is described, and available groundwater supplies are assessed. The adequacy of groundwater supplies and the emergence of perchlorate contamination issues are introduced and discussed in more detail in subsequent chapters. The role of water transfers and groundwater banking is described, and recent and proposed cooperative agreements to maximize local supplies through these progressive water management strategies are also discussed.

4.0 RECYCLED WATER

State water policy identifies water recycling as a beneficial use of water, and recycled water is an important component of water management planning. Chapter 4 describes the existing and future recycled water opportunities available to the CLWA service area. Currently, CLWA serves recycled water to VWC for the Westridge Golf Course and miscellaneous landscape irrigation. This Plan presents estimates of potential supply and demand for 2005 to 2030 in five year increments, as well as CLWA's proposed incentives and optimization plan.

5.0 WATER QUALITY

Chapter 5 describes the water quality of both groundwater and imported water supplies and discusses potential water quality impacts on supply reliability. As mentioned above, perchlorate contamination control is a major issue in CLWA's service area. The contamination is associated with the former Whittaker-Bermite site. Extensive investigations, management plans, and control actions to address this issue have been undertaken and are described in detail in this Plan. It has been determined that the programs underway should restore the impaired wells during 2006.

6.0 RELIABILITY PLANNING

The Act requires urban water suppliers to assess water supply reliability that compares total projected water used with the expected water supply over the next twenty years in five year increments. The Act also requires an assessment for a single dry year and multiple dry years. Chapter 6 presents the reliability assessment for CLWA's service area.

It is the stated goal of CLWA and the retail water purveyors to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions over the next 25 years in combination with conservation of non-essential demand during certain dry years, the Plan successfully achieves this goal.

The organization of the reliability tables presented in this Plan varies from those presented in the 2000 Plan Amendment to follow more closely with the recommended tables provided in the DWR "Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan," dated January 18, 2005.

7.0 WATER DEMAND MANAGEMENT MEASURES AND BEST MANAGEMENT PRACTICES

Establishing goals and choosing water conservation measures is a continuing planning process. Goals are developed, adopted, and then evaluated periodically. Specific conservation measures are phased in and then evaluated for their effectiveness, achievement of desired results, and customer satisfaction. Chapter 7 of this plan summarizes DMMs and BMPs in both the implementation and development stages. CLWA and the retail water purveyors have been aggressively implementing DMM and BMP programs even though implementation is voluntary. Activities include water audits/repairs, public outreach, conservation pricing, residential plumbing retrofit, residential ultra low flush toilet replacement, large landscape conservation, and conservation programs for commercial, industrial, and institutional accounts. CLWA and the retail purveyors continue development and implementation of a comprehensive program.

8.0 WATER SHORTAGE CONTINGENCY PLANNING

Water supplies may be interrupted or reduced significantly in a number of ways, such as a drought which limits supplies, an earthquake which damages water delivery or storage facilities, or a toxic spill that affects water quality. Chapter 8.0 of this Plan describes how CLWA and the retail water purveyors plan to respond to such emergencies so that customer needs are met promptly and equitably.

Chapter 1
INTRODUCTION

Chapter 1.0
INTRODUCTION

1.1 OVERVIEW

This volume presents the Urban Water Management Plan 2005 (Plan) for the Castaic Lake Water Agency (Agency, CLWA) service area, which includes four retail water purveyors. This chapter describes the general purpose of the Plan, discusses Plan implementation, and provides general information about CLWA, retail purveyors, and service area characteristics. A list of acronyms and abbreviations is also provided.

1.2 PURPOSE

An Urban Water Management Plan (UWMP) is a planning tool that generally guides the actions of water management agencies. It provides managers and the public with a broad perspective on a number of water supply issues. It is not a substitute for project-specific planning documents, nor was it intended to be when mandated by the State Legislature. For example, the Legislature mandated that a plan include a section which "describes the opportunities for exchanges or water transfers on a short-term or long-term basis." (California Urban Water Planning Act, Article 2, Section 10630(d).) The identification of such opportunities, and the inclusion of those opportunities in a general water service reliability analysis, neither commits a water management agency to pursue a particular water exchange/transfer opportunity, nor precludes a water management agency from exploring exchange/transfer opportunities not identified in the plan. When specific projects are chosen to be implemented, detailed project plans are developed, environmental analysis, if required, is prepared, and financial and operational plans are detailed.

In short, this Plan is a management tool, providing a framework for action, but not functioning as a detailed project development or action. It is important that this Plan be viewed as a long-term, general planning document, rather than as an exact blueprint for supply and demand management. Water management in California is not a matter of certainty, and planning projections may change in response to a number of factors. From this perspective, it is appropriate to look at the Plan as a general planning framework, not a specific action plan. It is an effort to generally answer a series of planning questions including:

- What are the potential sources of supply and what is the reasonable probable yield from them?
- What is the probable demand, given a reasonable set of assumptions about growth and implementation of good water management practices?
- How well do supply and demand figures match up, assuming that the various probable supplies will be pursued by the implementing agency?

Using these "framework" questions and resulting answers, the implementing agency will pursue feasible and cost-effective options and opportunities to meet demands. CLWA and the retail water purveyors will explore enhancing basic supplies from traditional sources such as the State Water Project (SWP) as well as other options. These include groundwater extraction, water

exchanges, recycling, desalination, and water banking/conjunctive use. Specific planning efforts will be undertaken in regard to each option, involving detailed evaluations of how each option would fit into the overall supply/demand framework, how each option would impact the environment, and how each option would affect customers. The objective of these more detailed evaluations would be to find the optimum mix of conservation and supply programs that ensure that the needs of the customers are met.

The California Urban Water Management Planning Act (Act) requires preparation of a plan that:

- Accomplishes water supply planning over a 20-year period in five year increments. (CLWA and the purveyors are going beyond the requirements of the Act by developing a plan which spans 25 years.)
- Identifies and quantifies adequate water supplies, including recycled water, for existing and future demands, in normal, single-dry, and multiple-dry years.
- Implements conservation and efficient use of urban water supplies.

A checklist to ensure compliance of this Plan with the Act requirements is provided in Appendix A.

In short, the Plan answers the question: *Will there be enough water for the Santa Clarita Valley community in future years, and what mix of programs should be explored for making this water available?*

It is the stated goal of CLWA and the retail water purveyors to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions over the next 25 years in combination with conservation of non-essential demand during certain dry years, the Plan successfully achieves this goal.

1.3 IMPLEMENTATION OF THE PLAN

The CLWA service area includes the service areas of four local retail water agencies. This Plan has been prepared for the CLWA and three of the purveyors: CLWA Santa Clarita Water Division (SCWD), Newhall County Water District (NCWD), and Valencia Water Company (VWC). The fourth purveyor, Los Angeles County Waterworks District No. 36 (LACWWD #36), is not required to prepare a Plan because the District does not provide water to more than 3,000 customers or supply more than 3,000 acre-feet (af) of water annually; however, LACWWD #36 participated in the development of the Plan on an "ad-hoc" basis. This subsection provides the cooperative framework within which the Plan will be implemented including agency coordination, public outreach, and resources maximization.

1.3.1 Joint Preparation of the Plan

Water agencies are permitted by the State to work together to develop a cooperative regional plan. This approach has been adopted by the water agencies in the Santa Clarita Valley (Valley), which are jointly sponsoring the current Plan. Water resource specialists with expertise in water resource management were retained to assist the local water agencies in preparing the details of the Plan. Agency coordination for this Plan is summarized in Table 1-1.

Table 1-1
Agency Coordination Summary

	Participated in UWMP Development	Received Copy of Draft	Commented on Draft	Attended Public Meetings	Contacted for Assistance	Sent Notice of Intent to Adopt	Not Involved
Antelope Valley-East Kern Water Agency					✓		
California Department of Water Resources	✓				✓		
Castaic Lake Water Agency	✓	✓	✓	✓	✓		
Castaic Town Council		✓	✓	✓	✓		
City of Santa Clarita Department of Planning and Building Services		✓		✓	✓	✓	
CLWA Santa Clarita Water Division	✓	✓	✓	✓	✓		
LA County Department of Regional Planning		✓			✓	✓	
Los Angeles County Supervisor Mike Antonovich (representatives)				✓	✓		
LA County Waterworks District No. 36	✓	✓	✓	✓	✓		
Metropolitan Water District of Southern California		✓			✓		
Newhall County Water District	✓	✓	✓	✓	✓		
Valencia Water Company	✓	✓	✓	✓	✓		
Ventura County Resource Management Agency		✓			✓	✓	
Westranch Town Council					✓		

1.3.2 Public Outreach

The water agencies have encouraged community participation in water planning. For the current Plan, public sessions were held for review and to solicit input on the Draft Plan before its adoption. Interested groups were informed about the development of the Plan along with the schedule of public activities. Notices of public meetings were published in the local press. Copies of the Draft Plan were made available at the water agencies' offices, local public libraries and sent to the City of Santa Clarita, the County of Los Angeles, and the County of Ventura, as well as interested parties. Water agencies also convened meetings with various interests to gather data concerning planned development and the probable implementation of approved development. Such informed data gathering on important issues is a means of checking the short-term "reality" of official projections and understanding the concerns of various groups.

CLWA contracted with a local public relations firm to coordinate preparation of the Plan with the local community. CLWA notified the cities and counties within its service area of the opportunity to provide input regarding the Plan. Table 1-2 presents a timeline for public participation during the development of the Plan. A copy of the public outreach materials,

including paid advertisements, newsletter covers, website postings, and invitation letters are attached in Appendix B.

Table 1-2
Public Participation Timeline

April 7, 2005	Kick-off Community Workshop	Describe UWMP requirements and process
June 27, 2005	Preliminary Draft UWMP	Preliminary Draft released to solicit input
June 29, 2005	Community Workshop	Review UWMP and solicit input
August 31, 2005	Follow-up Community Workshop	Release Draft UWMP and review contents
September 28, 2005	First CLWA Public Hearing	Review contents of Draft UWMP and take comments
October 26, 2005	Second CLWA Public Hearing	UWMP considered for approval by the CLWA Board and NCWD Board (at a joint meeting)

The components of public participation include:

Local Media

- Paid advertisements in local newspapers
- Meeting(s) with local editorial boards (Daily News and Signal)

Community-based Outreach

- Building Industry Association
- Castaic Town Council
- Chamber of Commerce
- Friends of the Santa Clara River
- Santa Clarita Valley Well Owners Association
- Santa Clarita Organization for Planning the Environment (SCOPE)
- Sierra Club
- Valencia Industrial Association
- Westranch Town Council

Water Agencies Public Participation

- Presentation(s) to NCWD Board – March, May, September, and October
- Presentation(s) to CLWA Board – March, May, July, September, and October

City/County Outreach

- Meeting with City Planning Division – March, May, and July

- Meeting with Los Angeles County Department of Regional Planning – March, May, and July
- Meeting with Supervisor Antonovich representative(s) Millie Jones, Paul Novak – May and July

Public Availability of Documents

- Water Agencies' websites
- City Hall
- Local libraries

1.3.3 Resources Maximization

Several documents were developed to enable CLWA to maximize the use of available resources and minimize use of imported water, including the Groundwater Management Plan (GWMP), Santa Clara River Valley Memorandum of Understanding, Water Supply Reliability Plan Draft Report, and the 2004 Santa Clarita Valley Water Report. Chapter 3 of this Plan describes in detail the water resources available to CLWA and the retail purveyors for the 25-year period covered by the Plan. Additional discussion regarding documents developed to maximize resources is included in Section 3.3.2 and Chapter 6.

1.4 THE WATER AGENCIES OF THE SANTA CLARITA VALLEY

1.4.1 Castaic Lake Water Agency

CLWA was formed in 1962 for the purpose of contracting with the California Department of Water Resources (DWR) to provide a supplemental supply of imported water to the water purveyors in the Valley. CLWA serves an area of 195 square miles in Los Angeles and Ventura Counties.

CLWA is a SWP contractor with an annual contractual Table A Amount of 95,200 af. Table A Amount (formerly referred to as "entitlement") is named for the "Table A" in each SWP contractor's Water Supply Contract. It contains an annual buildup in Table A Amounts of SWP water, from the first year of the Water Supply Contract through a specific year, based on growth projections made before the Water Supply Contract was executed. For most contractors, the maximum annual Table A Amount was reached in 1990. The total of all SWP contractors' maximum Table A Amounts is currently about 4.17 million af.

CLWA's original SWP Water Supply Contract with DWR was amended in 1966 for a maximum annual Table A Amount of 41,500 af. In 1991, CLWA purchased 12,700 af of annual Table A Amount from a Kern County water district and in 1999 purchased 41,000 af of annual Table A Amount from another Kern County water district, for a current total annual Table A Amount of 95,200 af.[1] CLWA wholesales this imported water to each of the local retail water purveyors through an extensive transmission pipeline system.

Though the reliability of SWP water is variable due to weather-related issues and environmental factors, SWP water remains an important supplemental water supply source for the Valley in the long-term. An important element to enhancing the long-term water supply reliability of SWP supplies is the effective use of water banking/conjunctive-use programs, such as those described in this Plan.

1.4.2 Retail Water Purveyors

Four retail purveyors provide water service to most residents of the Valley.

SCWD's service area includes portions of the city of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Canyon Country, Newhall, and Saugus. SCWD supplies water from local groundwater and CLWA imported water.

LACWWD #36's service area includes the Hasley Canyon area in the unincorporated community of Val Verde. During most years, the District obtains its water supply from CLWA.

NCWD's service area includes portions of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Newhall, Canyon Country, Saugus, and Castaic. The District supplies water from local groundwater and CLWA imported water.

VWC's service area includes a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Castaic, Stevenson Ranch, and Valencia. VWC supplies water from local groundwater, CLWA imported water, and recycled water.

The service area for CLWA and the retail water purveyors is shown on Figure 1-1.

[1] CLWA's contract rights to SWP water total 95,200 acre feet per year ('afy"), including a water transfer of 41,000 afy approved in 1999 from Wheeler Ridge-Maricopa Water Storage District, a member unit of the Kern County Water Agency. CLWA's Environmental Impact Report ("EIR") prepared in connection with the 41,000 afy water transfer was challenged in *Friends of the Santa Clara River v. Castaic Lake Water Agency* (Los Angeles County Superior Court, Case Number BS056954) ("*Friends*"). That action was dismissed with prejudice (permanently) in February 2005. New challenges to CLWA's environmental review of the transfer were filed in January 2005 (*i.e., Planning and Conservation League v. Castaic Lake Water Agency*, Los Angeles County Superior Court Case Number BS098724). A more detailed discussion of these new challenges and the reasons the challenges will have no impact on the amount of water available to CLWA can be found at Section 3.2.2.

Castaic Lake Water Agency Service Area

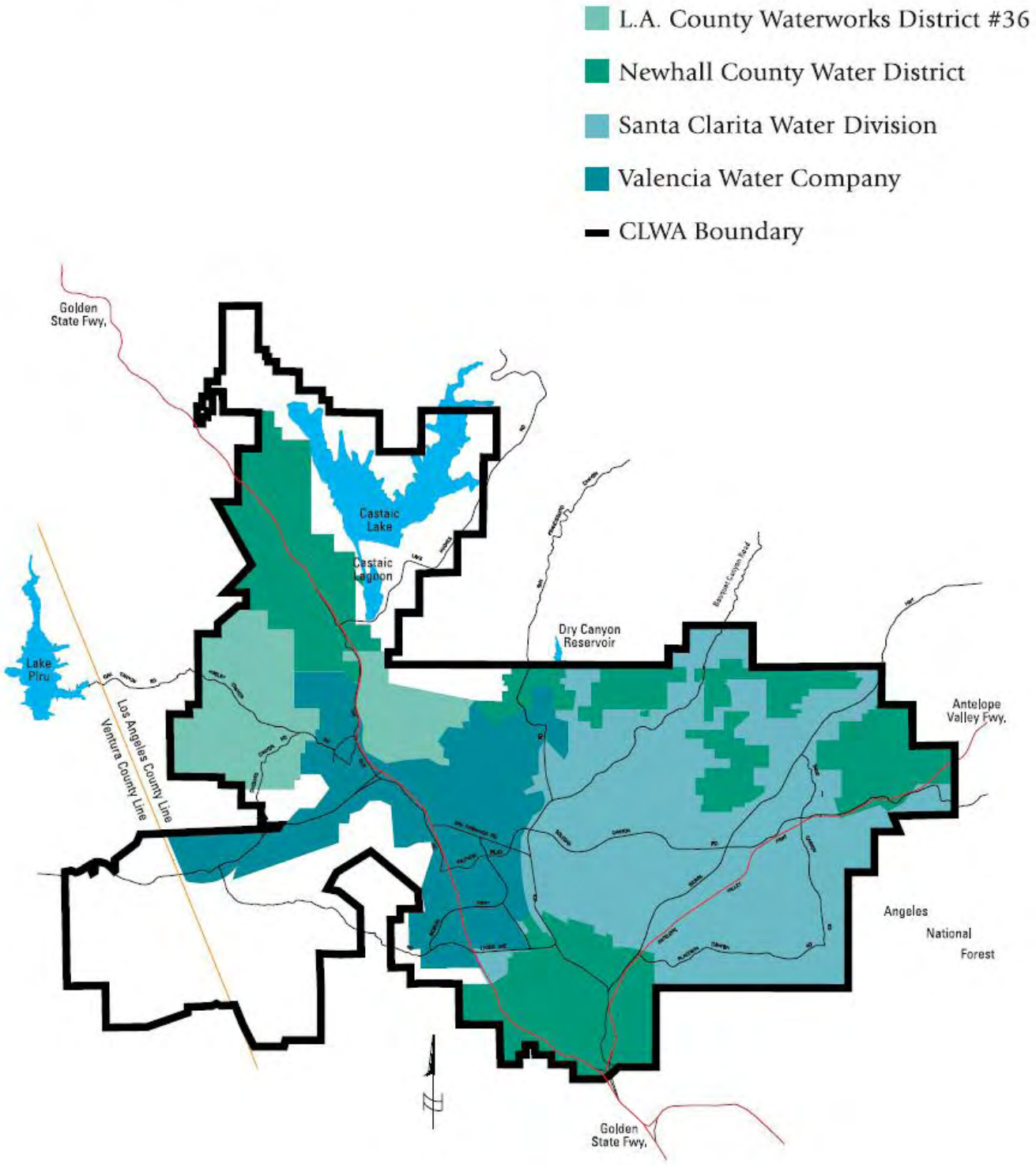


Figure 1-1
Castaic Lake Water Agency Service Area

As of mid-2005, the retail water purveyors served about 65,800 connections, as presented in Table 1-3.

Table 1-3
Retail Water Service Connections

Retail Water Purveyor	Connections
CLWA Santa Clarita Water Division (SCWD)	26,784
Los Angeles County Waterworks District No. 36 (LACWWD # 36)	1,311
Newhall County Water District (NCWD)	9,112
Valencia Water Company (VWC)	28,602
Total Connections	**65,809**

1.5 CLIMATE

The climate in CLWA's service area is generally semi-arid and warm. Summers are dry with temperatures as high as 110°F. Winters are somewhat cool with temperatures as low as 20°F. Average rainfall is about 17.64 inches per year in the flat areas and about 27 inches in the mountains. The region is subject to wide variations in annual precipitation and also experiences periodic wildfires. Table 1-4 presents the region's annual average climate data. Standard Monthly Average data was generated from 1996-2005 data. Average Monthly Rainfall data is provided for 1980-2004, and Average Maximum Temperature data is provided for 1971-2000.

Table 1-4
Climate Data for the Santa Clarita Valley

	Jan	Feb	Mar	Apr	May	Jun
Standard Monthly Average ETo[(1)]	2.20	2.45	3.64	4.74	5.31	6.06
Average Rainfall (inches) [(2)]	3.52	4.88	3.13	0.88	0.28	0.06
Average Max. Temperature (Fahrenheit) [(3)]	64.2	66.0	68.7	73.1	79.9	88.0

	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Standard Monthly Average ETo[(1)]	6.75	6.66	5.01	3.95	2.73	2.31	51.81
Average Rainfall (inches)[(2)]	0.03	0.05	0.15	0.88	1.29	2.49	17.64
Average Max. Temperature (Fahrenheit) [(3)]	94.9	94.9	89.4	81.3	69.1	65.2	78.1

Notes:
(1) ETo (evapotranspiration) data provided for Glendale region, http://wwwcimis.water.ca.gov/cimis/welcome.jsp
(2) Average Monthly Rainfall data gathered from long-term average precipitation records from Newhall-Soledad 32c gage during period 1980-2004.
(3) Temperature data provided for Dry Canyon Reservoir region, http://www.wrcc.dri.edu/CLIMATEDATA.html

1.6 Potential Effects of Global Warming

A topic of growing concern for water planners and managers is global warming and the potential impacts it could have on California's future water supplies. DWR's Draft California Water Plan Update 2005 contains the first-ever assessment of such potential impacts in a California Water Plan.

Volume 1, Chapter 4 of the California Water Plan, "Preparing for an Uncertain Future," lists some potential impacts of global warming, based on more than a decade of scientific studies on the subject:

- Could produce hydrologic conditions, variability, and extremes that are different from what current water systems were designed to manage
- May occur too rapidly to allow sufficient time and information to permit managers to respond appropriately
- May require special efforts or plans to protect against surprises or uncertainties

Should global warming increase over time, it may cause a number of changes impacting future water supplies, including changes in Sierra snowpack patterns (the source of the SWP's water supply in Lake Oroville), hydrologic patterns, sea level, rainfall intensity, and statewide water demand. Computer models (such as CALVIN) have been developed to show water planners how California water management might adapt to climate change. DWR has committed to continue to update and refine these models based on ongoing scientific data collection and to incorporate this information into future California Water Plans. As DWR develops more specific assessments of the potential effects of climate change on SWP delivery reliability and water demands, CLWA and the purveyors can update their plans accordingly.

1.7 OTHER DEMOGRAPHIC FACTORS

Water service is provided to residential, commercial, industrial, institutional, recreational, and agricultural customers and for environmental and other uses, such as fire protection and pipeline cleaning.

Recently, the Valley area (along with most of California) has experienced significant increases in both single family and multi-family residential construction, as well as in commercial and industrial construction. As the local population has increased, the demand for water has also increased.

1.8 LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this report.

AB	Assembly Bill
ACOE	U.S. Army Corps of Engineers
Act	California Urban Water Management Planning Act
af	acre-feet
afy	acre-feet per year
Agency	Castaic Lake Water Agency
AWWARF	American Water Works Association Research Foundation
Basin	Santa Clara River Valley Groundwater Basin, East Subbasin
BMPs	Best Management Practices

CCF	One Hundred Cubic Feet
CCR	Consumer Confidence Report
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLWA	Castaic Lake Water Agency
CUWCC	California Urban Water Conservation Council
CVP	Central Valley Project
DBP	Disinfection by-products
Delta	Sacramento-San Joaquin Delta
DHS	California Department of Health Services
DMM	Demand Management Measures
DOF	Department of Finance
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EC	Electrical conductivity
Edison	Southern California Edison
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GWMP	Groundwater Management Plan
KCWA	Kern County Water Agency
LACDRP	Los Angeles County Department of Regional Planning
LACSD	Sanitation Districts of Los Angeles County
LACWWD #36	Los Angeles County Waterworks District # 36
M&I	Municipal and Industrial
Metropolitan	Metropolitan Water District of Southern California
mgd	million gallons per day
mg/L	milligrams per liter
MOU	Memorandum of Understanding
NCWD	Newhall County Water District
NPDES	National Pollutant Discharge Elimination System
OVOV	One Valley One Vision
Plan	Urban Water Management Plan 2005
PUC	California Public Utilities Commission
RAP	Remedial Action Plan
RO	Reverse Osmosis
RTP	Regional Transportation Plan
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments

SCLLC	Santa Clarita LLC
SCOPE	Santa Clarita Organization for Planning the Environment
SCWC	Santa Clarita Water Company
SCWD	Santa Clarita Water Division
Semitropic	Semitropic Water Storage District
SWP	State Water Project
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
umhos/cm	Micromhos per centimeter
UWCD	United Water Conservation District
UWMP	Urban Water Management Plan
Valley	Santa Clarita Valley
VWC	Valencia Water Company
WRP	Waste Water Reclamation Plant

Chapter 2
WATER USE

Chapter 2.0
WATER USE

2.1 OVERVIEW

This chapter describes historic and current water usage and the methodology used to project future demands within CLWA's service area. Water usage is divided into sectors such as residential, industrial, institutional, landscape, agricultural, and other purposes. To undertake this evaluation, existing land use data and new housing construction information were compiled from each of the retail water purveyors and projections prepared by "One Valley One Vision" (OVOV), a joint planning effort by the City of Santa Clarita and Los Angeles County Department of Regional Planning (LACDRP). This information was then compared to historical trends for new water service connections and customer water usage information. In addition, weather and water conservation effects on historical water usage were factored into the evaluation.

The methodology used to project future demands within CLWA's service area included three steps: (1) obtain projected demands to 2030 from each water purveyor, (2) compare projections based on historical records to the totals developed by the purveyors, and (3) compare these results with the OVOV Plan for consistency with the General Plan.

This approach allowed the comparison of three different sources of data and projections to be evaluated. Several factors can affect demand projections, including:

- Land use revisions
- New regulations
- Consumer choice
- Economic conditions
- Transportation needs
- Highway construction
- Environmental factors
- Conservation programs
- Plumbing codes

The foregoing factors affect the amount of water needed, as well as the timing of when it is needed. Past experience in the Valley has indicated that the economy is the biggest factor in determining water demand projections. During an economic recession, there is a major downturn in development and a subsequent slowing of the projected demand for water. The projections in this Plan do not attempt to forecast recessions or droughts. Likewise, no speculation is made about future plumbing codes or other regulatory changes. However, the projections do include water conservation, which is projected to reduce overall water demand by 10 percent. There have been, and continue to be, major efforts statewide to conserve water, which have been successful.

2.2 HISTORIC WATER USE

Predicting future water supply requires accurate historic water use patterns and water usage records. Both the economy and entitlement process (compliance with the California Environmental Quality Act [CEQA]) are key factors impacting growth in population and demand. Figure 2-1 illustrates the steady increase in Valley water demand since 1980.

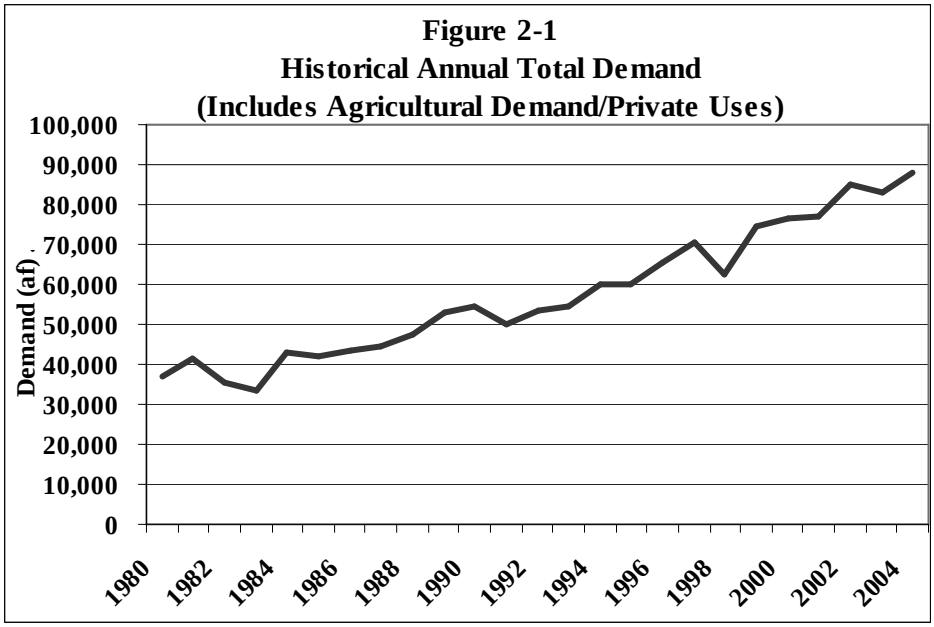


Table 2-1 presents the historical accounts and deliveries by retail purveyor since 1990. The type of customer accounts included in the table are single family homes, multi-family homes, commercial, industrial, institutional/government, and landscape.

Table 2-1
Historical Accounts and Deliveries by Retail Purveyor

Purveyor		1990	1992	1994	1996	1998	2000	2002	2004
CLWA	No. Accounts	18,550	19,000	19,400	19,650	20,300	21,970	24,175	26,161
SCWD	Deliveries (af)	18,503	17,551	19,911	22,006	20,319	25,280	28,434	29,191
LACWWD	No. Accounts	706	736	752	768	774	972	1,200	1,300
#36	Deliveries (af)	513	456	500	533	578	758	1,071	1,302
NCWD	No. Accounts	6,039	6,230	6,373	6,475	6,726	7,434	7,941	8,970
	Deliveries (af)	7,813	7,973	7,754	8,916	8,782	9,623	9,869	10,555
VWC	No. Accounts	13,965	14,520	15,359	17,009	19,389	21,661	24,453	27,238
	Deliveries (af)	16,572	15,338	17,390	19,721	19,874	25,190	28,360	30,682
Total	No. Accounts	39,260	40,486	41,884	43,902	47,189	52,037	57,769	63,669
	Deliveries (af)	43,401	41,318	45,555	51,176	49,553	60,851	67,734	71,730
	af/Account	1.11	1.02	1.09	1.17	1.05	1.17	1.17	1.13

2.3 PROJECTED WATER USE

2.3.1 Purveyor Projections

Each of the four retail water purveyors provided projected water demands based on the projects that are under evaluation, are in the planning process, or the result of its own water planning efforts for its service area. The purveyors maintain historical data, as well as work closely with property owners and developers in their service areas, to ensure they have an adequate water supply and the necessary infrastructure to provide water service.

Since there are only four purveyors in the service area, there is close coordination and exchange of data. SCWD's engineering department continually updates expected demands and infrastructure needs. NCWD prepared a "Water Supply Assessment" in 2004 that is the basis for NCWD's projected demand. VWC is a California Public Utilities Commission (PUC)-regulated water supplier and is required to regularly provide its service plan for rate increases and service area changes. Table 2-2 summarizes the purveyors' projected water demands through 2030.

Table 2-2
Projected Water Demands

Purveyor	Demand (af)						Annual Increase
	2005	2010	2015	2020	2025	2030	
CLWA SCWD	30,400	35,000	39,100	43,100	47,100	51,100	2.1%
LACWWD #36	1,300	1,600	1,800	2,000	2,400	2,800	3.1%
NCWD	11,800	14,400	16,000	17,700	19,300	21,000	2.4%
VWC	30,200	35,100	40,200	43,700	50,600	54,400	2.4%
Total Purveyor	**73,700**	**86,100**	**97,100**	**106,500**	**119,400**	**129,300**	2.2%
Agricultural/Private Uses	15,600	13,950	12,300	10,650	9,000	9,000	--
Total (w/o conservation)	**89,300**	**100,050**	**109,400**	**117,150**	**128,400**	**138,300**	**--**
Conservation (1)	(7,370)	(8,610)	(9,710)	(10,650)	(11,940)	(12,930)	--
Total (w/conservation)	81,930	91,440	99,690	106,500	116,460	125,370	1.3%

Notes:
(1) Assumes 10 percent reduction on urban portion of demand resulting from conservation best management practices (see Chapter 7).

Tables 2-3 through 2-6 present the past, current, and projected water deliveries by customer type for the CLWA SCWD, LACWWD #36, NCWD, and VWC, respectively.

Table 2-3
Past, Current, and Projected Water Deliveries (by customer type)
CLWA Santa Clarita Water Division

Year		Water Use Sectors	Single Family	Multi-Family	Comm-ercial	Industrial	Institutional/ Government	Landscape	Total
2000	metered	No. of accounts	16,906	3,784	537	48	83	612	21,970
		Deliveries (af)	15,966	2,669	930	1,096	893	3,726	25,280
2005	metered	No. of accounts	20,550	4,800	650	50	125	700	26,875
		Deliveries (af)	19,139	3,386	1,126	1,142	1,345	4,262	30,400
2010	metered	No. of accounts	23,575	5,800	750	60	175	800	31,160
		Deliveries (af)	21,486	4,091	1,299	1,370	1,883	4,871	35,000
2015	metered	No. of accounts	25,715	6,800	850	70	225	900	34,560
		Deliveries (af)	23,333	4,796	1,472	1,598	2,421	5,480	39,100
2020	metered	No. of accounts	27,855	7,800	950	80	275	1,000	37,960
		Deliveries (af)	25,080	5,501	1,645	1,826	2,959	6,089	43,100
2025	metered	No. of accounts	29,995	8,800	1,050	90	325	1,100	41,360
		Deliveries (af)	26,827	6,206	1,818	2,054	3,497	6,698	47,100
2030	metered	No. of accounts	32,135	9,800	1,150	100	375	1,200	44,760
		Deliveries (af)	28,574	6,911	1,991	2,282	4,035	7,307	51,100

Table 2-4
Past, Current, and Projected Water Deliveries (by customer type)
Los Angeles County Waterworks District No. 36

Year		Water Use Sectors	Single Family	Multi-Family	Comm-ercial	Const/ Industrial	Institutional/ Government	Landscape	Total
2000	metered	No. of accounts	948	5	0	10	5	4	972
		Deliveries (af)	643	29	0	54	20	12	758
2005	metered	No. of accounts	1,275	5	0	10	5	5	1,300
		Deliveries (af)	1,185	29	0	54	20	12	1,300
2010	metered	No. of accounts	1,575	5	0	10	5	4	1,600
		Deliveries (af)	1,480	30	0	56	21	12	1,600
2015	metered	No. of accounts	1,774	5	0	11	5	4	1,800
		Deliveries (af)	1,676	31	0	58	22	13	1,800
2020	metered	No. of accounts	1,973	6	0	11	6	4	2,000
		Deliveries (af)	1,872	32	0	60	22	13	2,000
2025	metered	No. of accounts	2,372	6	0	11	6	5	2,400
		Deliveries (af)	2,268	33	0	62	23	14	2,400
2030	metered	No. of accounts	2,772	6	0	12	6	5	2,800
		Deliveries (af)	2,665	34	0	63	23	14	2,800

Table 2-5
Past, Current, and Projected Water Deliveries (by customer type)
Newhall County Water District

Year		Water Use Sectors	Single Family	Multi-Family	Commercial	Construction/ Industrial	Institutional/ Government	Landscape	Total
2000	metered	No. of accounts	6,608	293	377	11	18	127	7,434
		Deliveries (af)	5,556	1,537	872	411	119	1,128	9,623
2005	metered	No. of accounts	8,047	293	399	35	59	232	9,065
		Deliveries (af)	7,243	1,969	891	207	133	1,357	11,800
2010	metered	No. of accounts	9,735	425	425	60	75	300	11,020
		Deliveries (af)	8,750	2,485	999	250	176	1,740	14,400
2015	metered	No. of accounts	10,730	450	450	85	90	425	12,230
		Deliveries (af)	9,475	2,595	1,038	315	212	2,365	16,000
2020	metered	No. of accounts	11,865	475	475	110	105	550	13,580
		Deliveries (af)	10,385	2,750	1,066	375	234	2,890	17,700
2025	metered	No. of accounts	12,620	500	500	135	120	675	14,550
		Deliveries (af)	11,000	2,900	1,114	425	261	3,600	19,300
2030	metered	No. of accounts	14,050	525	525	160	135	800	16,195
		Deliveries (af)	12,275	3,000	1,140	500	285	3,800	21,000

Table 2-6
Past, Current, and Projected Water Deliveries (by customer type)
Valencia Water Company

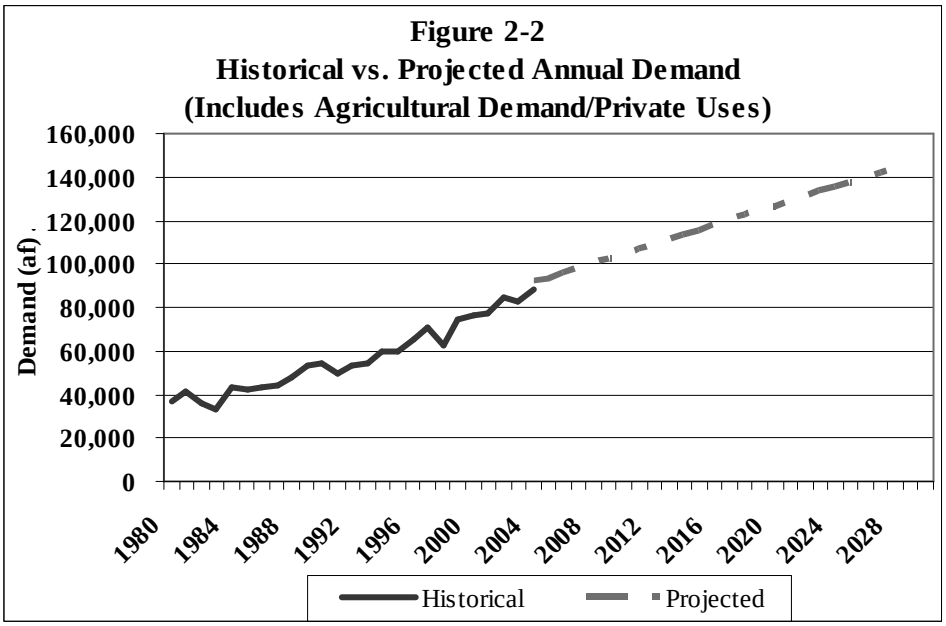
Year		Water Use Sectors	Single Family	Multi-Family	Comm-ercial	Industrial	Institutional/ Government	Landscape	Total
2000	metered	No. of accounts	19,805	191	876	382	406	1	21,661
		Deliveries (af)	12,112	1,373	5,798	1,759	3,711	437	25,190
2005	metered	No. of accounts	25,067	364	1,307	452	505	3	27,698
		Deliveries (af)	14,526	1,646	6,949	2,108	4,448	523	30,200
2010	metered	No. of accounts	29,405	2,035	1,615	558	624	3	34,240
		Deliveries (af)	17,147	2,186	8,611	2,399	4,465	292	35,100
2015	metered	No. of accounts	30,724	8,176	1,998	690	772	3	42,363
		Deliveries (af)	17,998	4,151	9,882	2,753	5,124	292	40,200
2020	metered	No. of accounts	31,234	13,203	2,282	788	882	3	48,392
		Deliveries (af)	18,326	5,760	10,752	2,995	5,575	292	43,700
2025	metered	No. of accounts	36,384	14,341	2,605	900	1,007	3	55,240
		Deliveries (af)	21,803	6,124	12,454	3,469	6,458	292	50,600
2030	metered	No. of accounts	39,484	14,391	2,767	956	1,069	3	58,670
		Deliveries (af)	23,909	6,140	13,388	3,729	6,942	292	54,400

2.3.2 Projections Based On Historical Use

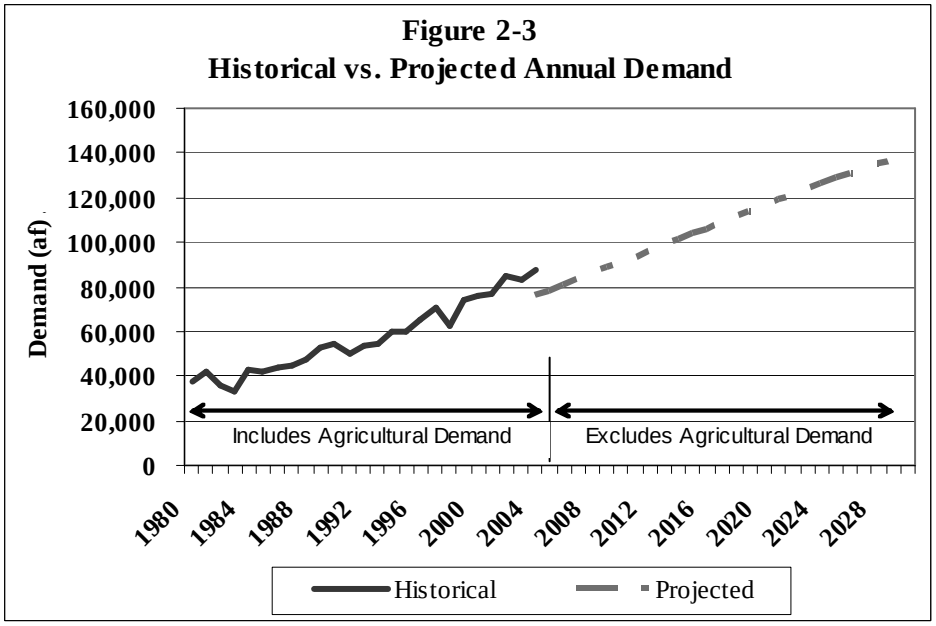
Another methodology to forecast demand involves projecting historical water use into the future. Mathematical methods are used to perform this projection. A correlation factor to the historical data of 1.0 would be considered the most exact. The ideal method results in a correlation of 0.9 or greater. For this Plan, a Linear Regression method was used to project demands, which resulted in a coefficient of correlation of 0.95.

2.3.2.1 Linear Regression Method

The Linear Regression method examines the historical growth in water demand and projects forward using linear regression. Figure 2-2 displays the growth in water demand since 1980 for the CLWA service area with a linear progression through the year 2030. Growth in demand has been relatively constant with some downturns that reflect either weather patterns or economic trends. The demand includes agricultural as well and municipal and industrial (M&I) uses.



On Figure 2-3, agricultural demand is removed to show M&I use only. As shown on Figure 2-3, results from the linear regression (after extracting the projected agricultural demands provided in Table 2-2) indicate a total 2030 demand of 137,100 af. This demand figure is comparable to the 129,300 af submitted by the purveyors (a six percent difference), as shown in Table 2-2.



2.3.2.2 Comparison to City and County Planning

The next step involved comparison of the purveyor-projected growth in water demand with the growth projections provided by local land use planning agencies. Table 2-7 is the result of the joint OVOV planning effort by the City of Santa Clarita and LACDRP.

Table 2-7
Adjusted Santa Clarita Valleywide General Plan [(1)(2)]
(SCAG 2004 RTP, Projections: Years 2000 to 2030)

Jurisdiction	2000 [(3)]	2005	2010	2015	2020	2025	2030	Change	Average Annual Growth
City of Santa Clarita									
Population	151,088	171,290	196,680	210,280	222,290	232,830	242,620	91,532	1.6%
Households	50,787	55,614	62,837	67,832	72,883	77,868	82,806	32,019	1.6%
Employment	51,380	59,640	68,820	73,240	77,490	81,460	85,190	33,810	1.7%
Jobs/Household ratio	*1.01*	*1.07*	*1.10*	*1.08*	*1.06*	*1.05*	*1.03*	0.02	
Persons per Household	*2.97*	*3.08*	*3.13*	*3.10*	*3.05*	*2.99*	*2.93*	(0.04)	
SCV Unincorporated Area									
Population	61,523	78,053	105,094	125,850	146,401	166,557	185,589	124,066	3.7%
Households	17,973	20,645	28,108	34,609	41,154	47,941	54,630	36,657	3.8%
Employment (estimated)	10,790	13,900	18,830	23,190	27,980	33,080	38,240	27,450	4.3%
Jobs/Household ratio	*0.60*	*0.67*	*0.67*	*0.67*	*0.68*	*0.69*	*0.70*	0.10	
Persons per Household	*3.42*	*3.78*	*3.74*	*3.64*	*3.56*	*3.47*	*3.40*	(0.03)	
SCV Planning Area[(4)]									
Population	212,611	249,343	301,774	336,130	368,691	399,387	428,209	215,598	2.4%
Households	68,760	76,259	90,945	102,441	114,037	125,809	137,436	68,676	2.3%
Employment	62,170	73,540	87,650	96,430	105,470	114,540	123,430	61,260	2.3%
Jobs/Household ratio	*0.90*	*0.96*	*0.96*	*0.94*	*0.92*	*0.91*	*0.90*	(0.01)	
Persons per Household	*3.09*	*3.27*	*3.32*	*3.28*	*3.23*	*3.17*	*3.12*	0.02	

Notes:
(1) Source: Stanley R. Hoffman Associates, Inc.; Southern California Association of Governments, 2004 Regional Transportation Plan (RTP).
(2) The SCAG population and household projections are used as control totals for the entire "One Valley One Vision" (OVOV) planning area while the allocation between the City and unincorporated areas is based on 2000-2003 Department of Finance (DOF) population and household trend data. The 1998-2003 Employment Development Department data is used to calibrate the 2005 base year for employment. However, the employment totals for the unincorporated area are allowed to exceed the SCAG RTP 2004 forecast based on local information from the County of Los Angeles Planning staff.
(3) 2000 Population and Household data is based on DOF estimates benchmarked to the 2000 U.S. Census Figures.
(4) The Santa Clarita Valley Planning Area estimates are the sum of the City and unincorporated area.
(5) On May 11, 2005, the OVOV Team agreed to use these adjusted RTP data for the OVOV General Plan Update.

The OVOV task force used the data provided by Southern California Association of Governments' (SCAG's) Regional Transportation Plan (RTP), the State Department of Finance (DOF), and the Employment Development Department. This joint effort was undertaken to ensure compatibility of planning efforts since the Valley is considered a realistic planning area with both City and County jurisdictions.

The annual rate of growth was examined to determine if the projected water demand was in accordance with the purveyors' projected growth shown in Table 2-2.

In Table 2-7, the OVOV projections indicate a 1.6 percent annual growth rate of population and households for the City of Santa Clarita, and 3.7 to 3.8 percent annual growth rates for the Valley Unincorporated Area. This results in a combined growth rate of 2.3 to 2.4 percent, which is

comparable to the purveyors' projected annual growth rate in water demand of 2.2 percent shown in Table 2-2.

Table 2-8 summarizes the projected Valley water use per household in af and in gallons per capita per day (gpcd). The data developed in this table is derived from the total annual demand projections provided in Table 2-2 divided by the projected annual populations and by the projected annual households provided in Table 2-7. Since the forecasted growth is based on households and population, it is not possible to obtain a direct match to number of service connections and water use per connection. However, based on 2005 population and water demand, the current estimated water use is 264 gpcd. The projected water use in 2030 of 270 gpcd remains very close to the 2005 water use of 264 gpcd, thus demonstrating that water demand and projected growth track closely. The term "household" is a term used by OVOV and does not equate to a single family residence.

Table 2-8
Projected Household Water Use

Projected Water Use	2005	2010	2015	2020	2025	2030
Water Use (af/household) (1)	0.97	0.95	0.95	0.93	0.95	0.94
Water Use (gpcd) (2)	264	255	258	258	267	270

Notes:

(1) Based on dividing the total annual demand projections provided in Table 2-2 by the projected annual households provided in Table 2-7.

(2) Based on dividing the total annual demand projections (converted from af to gpd) provided in Table 2-2 by the projected annual populations provided in Table 2-7.

An additional analysis was conducted by using actual 2004 water use (in gpcd) and multiplying that by the projected population from the OVOV population forecast (Table 2-7). 2004 actual water use was determined by taking the "2004 Santa Clarita Valley Water Report" M&I water use for 2004 and dividing that by the 2004 population. This resulted in an actual water use of 269 gpcd, which compares closely to the values presented in Table 2-8. Table 2-9 presents a summary of the comparison between the purveyors and OVOV demand projections. The projected demand by the purveyors varies from -0.20 percent to 5.62 percent of the water demand determined based on the OVOV population projections. This demonstrates that the purveyors' projections track closely with the anticipated growth projected by OVOV.

Table 2-9
Comparison of Purveyor and OVOV Demand Projections

Projection	Demand (af)					
	2005	2010	2015	2020	2025	2030
Purveyor (1)	73,700	86,100	97,100	106,500	119,400	129,300
OVOV (2)	75,136	90,936	101,288	111,100	120,350	129,035
Difference	1,436	4,836	4,188	4,600	950	(264)
Percent Difference	1.95%	5.62%	4.31%	4.32%	0.80%	-0.20%

Notes:

(1) Demand projections based on total puveyor projections provided in Table 2-2.

(2) Demand projections based on 269 gpcd multiplied by OVOV population projections provided in Table 2-7.

The data provided in Tables 2-3 through 2-6 indicates total estimated 2005 Valley water use to be (in af/connection) 1.13 for all connection types and 0.77 for a single family connection. These findings were compared with a study conducted by the American Water Works Association Research Foundation (AWWARF), Residential End Uses of Water (1999). This study compared residential water demand for several cities in the western United States. For comparison, the average annual water use (in af/connection) for a single family connection in Las Virgenes Municipal Water District and the City of San Diego are 0.87 and 0.47, respectively, which compare with the Valley water use of 0.77.

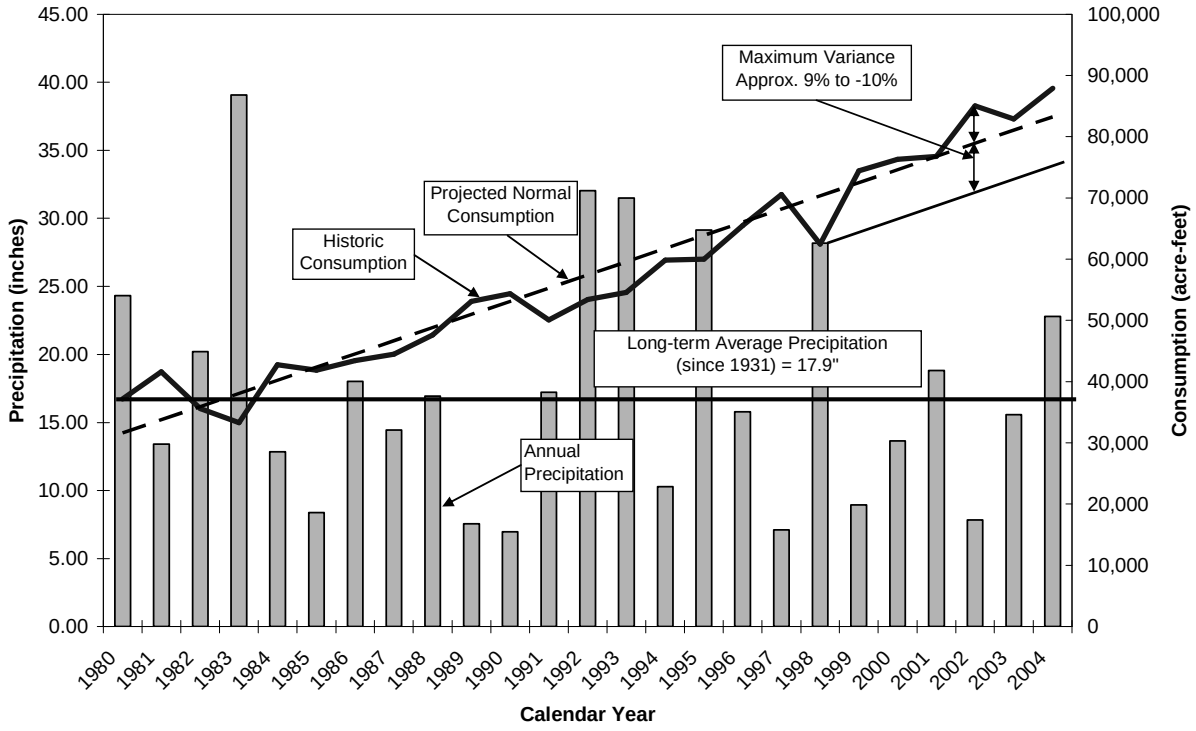
2.4 OTHER FACTORS AFFECTING WATER USAGE

Two major factors that affect water usage are weather and water conservation. Historically, when the weather is hot and dry, water usage increases. The amount of increase varies according to the number of consecutive years of hot, dry weather and the conservation activities imposed. During cool-wet years, historical water usage has decreased to reflect less water usage for external landscaping. Water conservation measures employed within the CLWA's and purveyors' service areas have a direct long-term effect on water usage. Both of these factors are discussed below in detail.

2.4.1 Weather Effects on Water Usage

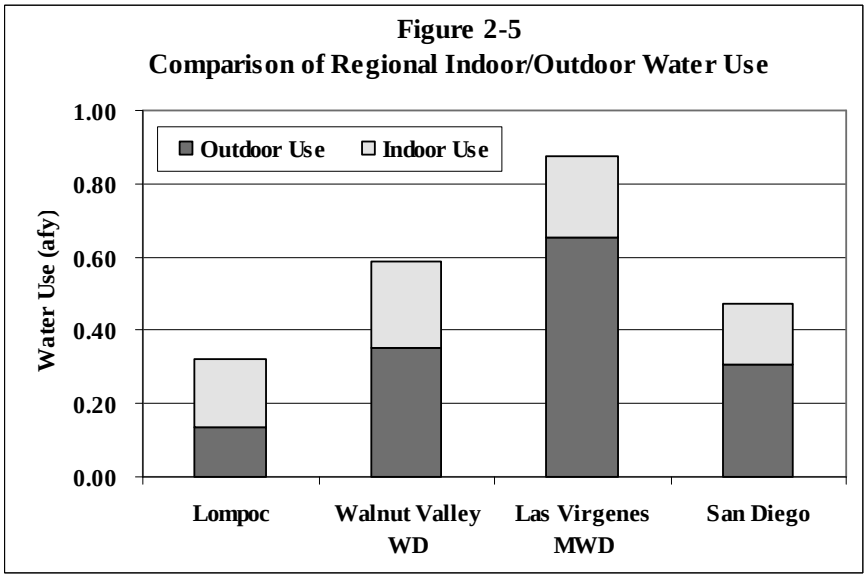
Historically, about 605 to 1,110 gallons of water are consumed daily for urban uses for every household in the CLWA's and purveyors' service areas. Most of this range in water use is due to seasonal weather variations. As presented on Figure 2-4, the historical water use from 1980 to 2004 fluctuated principally due to weather, with the maximum variance around the projected normal of approximately 9 percent higher use in hot, dry years to approximately 10 percent lower use in cool, wet years.

Figure 2-4
Weather Effects on Water Usage



The same AWWARF study described in Section 2.3.2.2 compared residential indoor and outdoor water use for several cities in the western United States. A comparison of the water use for four California locations is presented on Figure 2-5. As shown on the figure, indoor water use tracks closely among each of the four locations. However, outdoor use (landscaping), varies significantly among the locations. CLWA and the retail purveyors' water use correlates most closely with the data provided for Las Virgenes MWD.

Figure 2-5
Comparison of Regional Indoor/Outdoor Water Use



2.4.2 Conservation Effects on Water Usage

In recent years, water conservation has become an increasingly important factor in water supply planning in California. The California plumbing code has instituted requirements for new construction that mandate the installation of ultra low-flow toilets and low-flow showerheads. CLWA and the purveyors have developed water conservation measures that include public information and education programs. CLWA funds a toilet replacement program and, through its connection fee program, has provided financial incentives to developers for good water management practices.

During the 1987-1992 drought period, overall water requirements due to the effects of hot, dry weather were projected to increase by approximately 10 percent. As a result of extraordinary conservation measures enacted during the period, the overall water requirements actually decreased by more than 10 percent.

Residential, commercial, and industrial usage can be expected to decrease as a result of the implementation of more aggressive water conservation practices. As previously discussed, the greatest opportunity for conservation is in developing greater efficiency and reduction in landscape irrigation. The irrigation demand can represent as much as 50 percent of the water demand for residential customers depending upon lot size and amount of irrigated turf and plants. It is assumed that conservation will result in a long-term 10 percent reduction of demand.

Chapter 3
WATER RESOURCES

Chapter 3.0
WATER RESOURCES

3.1 OVERVIEW

This section describes the water resources available to CLWA and the purveyors for the 25-year period covered by the Plan. These are summarized in Table 3-1 and discussed in more detail below. Both currently available and planned supplies are discussed.

Table 3-1
Summary of Current and Planned Water Supplies and Banking Programs[1]

Water Supply Sources	Supply (af)					
	2005	2010	2015	2020	2025	2030
Existing Supplies						
Wholesale (Imported)	*70,380*	*73,660*	*75,560*	*76,080*	*77,980*	*77,980*
SWP Table A Supply (2)	65,700	67,600	69,500	71,400	73,300	73,300
Flexible Storage Account (CLWA) (3)	4,680	4,680	4,680	4,680	4,680	4,680
Flexible Storage Account (Ventura County) (3) (4)	0	1,380	1,380	0	0	0
Local Supplies						
Groundwater	*40,000*	*46,000*	*46,000*	*46,000*	*46,000*	*46,000*
Alluvial Aquifer	35,000	35,000	35,000	35,000	35,000	35,000
Saugus Formation	5,000	11,000	11,000	11,000	11,000	11,000
Recycled Water	1,700	1,700	1,700	1,700	1,700	1,700
Total Existing Supplies	112,080	121,360	123,260	123,780	125,680	125,680
Existing Banking Programs (3)						
Semitropic Water Bank (5)	50,870	50,870	0	0	0	0
Total Existing Banking Programs	50,870	50,870	0	0	0	0
Planned Supplies						
Local Supplies						
Groundwater	*0*	*10,000*	*10,000*	*20,000*	*20,000*	*20,000*
Restored wells (Saugus Formation)	0	10,000	10,000	10,000	10,000	10,000
New Wells (Saugus Formation)	0	0	0	10,000	10,000	10,000
Recycled Water (6)	0	0	1,600	6,300	11,000	15,700
Transfers						
Buena Vista-Rosedale (7)	0	11,000	11,000	11,000	11,000	11,000
Total Planned Supplies	0	21,000	22,600	37,300	42,000	46,700
Planned Banking Programs (3)						
Rosedale-Rio Bravo	0	20,000	20,000	20,000	20,000	20,000
Additional Planned Banking	0	0	20,000	20,000	20,000	20,000
Total Planned Banking Programs	0	20,000	40,000	40,000	40,000	40,000

Notes:

(1) The values shown under "Existing Supplies" and "Planned Supplies" are supplies projected to be available in average/normal years. The values shown under "Existing Banking Programs" and "Planned Banking Programs" are either total amounts currently in storage, or the maximum capacity of program withdrawals.

(2) SWP supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by percentages of average deliveries projected to be available, taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005).

(3) Supplies shown are total amounts that can be withdrawn, and would typically be used only during dry years.

(4) Initial term of the Ventura County entities' flexible storage account is ten years (from 2006 to 2015).

(5) Supplies shown are the total amount currently in storage, and would typically be used only during dry years. Once the current storage amount is withdrawn, this supply would no longer be available and in any event, is not available after 2013.

(6) Recycled water supplies based on projections provided in Chapter 4, Recycled Water.

(7) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

The term "dry" is used throughout this chapter and in subsequent chapters concerning water resources and reliability as a measure of supply availability. As used in this Plan, dry years are those years when supplies are the lowest, which occurs primarily when precipitation is lower than the long-term average precipitation. The impact of low precipitation in a given year on a particular supply may differ based on how low the precipitation is, or whether the year follows a high-precipitation year or another low-precipitation year. For the SWP, a low-precipitation year may or may not affect supplies, depending on how much water is in SWP storage at the beginning of the year. Also, dry conditions can differ geographically. For example, a dry year can be local to the Valley area (thereby affecting local groundwater replenishment and production), local to northern California (thereby affecting SWP water deliveries), or statewide (thereby affecting both local groundwater and the SWP). When the term "dry" is used in this Plan, statewide drought conditions are assumed, affecting both local groundwater and SWP supplies at the same time.

3.2 WHOLESALE (IMPORTED) WATER SUPPLIES

3.2.1 Imported Water Supplies

Imported water supplies consist primarily of SWP supplies, which were first delivered to CLWA in 1980. In addition, CLWA has access to water from Flexible Storage Accounts in Castaic Lake, which are planned for dry-year use, but are not strictly limited as such. CLWA wholesales these imported supplies to each of the local retail water purveyors.

The SWP is the largest state-built, multi-purpose water project in the country. It was authorized by the California State Legislature in 1959, with the construction of most initial facilities completed by 1973. Today, the SWP includes 28 dams and reservoirs, 26 pumping and generating plants, and approximately 660 miles of aqueducts. The primary water source for the SWP is the Feather River, a tributary of the Sacramento River. Storage released from Oroville Dam on the Feather River flows down natural river channels to the Sacramento-San Joaquin River Delta (Delta). While some SWP supplies are pumped from the northern Delta into the North Bay Aqueduct, the vast majority of SWP supplies are pumped from the southern Delta into the 444-mile-long California Aqueduct. The California Aqueduct conveys water along the west side of the San Joaquin Valley to Edmonston Pumping Plant, where water is pumped over the Tehachapi Mountains and the aqueduct then divides into the East and West Branches. CLWA takes delivery of its SWP water at Castaic Lake, a terminal reservoir of the West Branch. From Castaic Lake, CLWA delivers its SWP supplies to the local retail water purveyors through an extensive transmission pipeline system.

In the early 1960s, DWR began entering into individual SWP Water Supply Contracts with urban and agricultural public water supply agencies located throughout northern, central, and southern California for SWP water supplies. CLWA is one of 29 water agencies (commonly referred to as “contractors”) that have an SWP Water Supply Contract with DWR. Each SWP contractor’s SWP Water Supply Contract contains a “Table A,” which lists the maximum amount of water an agency may request each year throughout the life of the contract. Table A is used in determining each contractor’s proportionate share, or “allocation,” of the total SWP water supply DWR determines to be available each year. The total planned annual delivery capability of the SWP and the sum of all contractors’ maximum Table A amounts was originally

4.23 million af. The initial SWP storage facilities were designed to meet contractors' water demands in the early years of the SWP, with the construction of additional storage facilities planned as demands increased. However, essentially no additional SWP storage facilities have been constructed since the early 1970s. SWP conveyance facilities were generally designed and have been constructed to deliver maximum Table A amounts to all contractors. After the permanent retirement of some Table A amount by two agricultural contractors in 1996, the maximum Table A amounts of all SWP contractors now totals about 4.17 million af. Currently, CLWA's annual Table A Amount is 95,200 af.[1,2]

While Table A identifies the maximum annual amount of water an SWP contractor may request, the amount of SWP water actually available and allocated to SWP contractors each year is dependent on a number of factors and can vary significantly from year to year. The primary factors affecting SWP supply availability include hydrology, the amount of water in SWP storage at the beginning of the year, regulatory and operational constraints, and the total amount of water requested by SWP contractors. Urban SWP contractors' requests for SWP water, which were low in the early years of the SWP, have been steadily increasing over time, which increases the competition for limited SWP dry-year supplies.

Consistent with other urban SWP contractors, SWP deliveries to CLWA have increased as its requests for SWP water have increased. Tables 3-2 and 3-3 present historical total SWP deliveries to CLWA municipal purveyors and CLWA SWP demand projections provided to DWR (CLWA's wholesale supplier), respectively.

Table 3-2
Historical Total SWP Deliveries to Purveyors(1)

Year	Deliveries (af)	Year	Deliveries (af)
1980	1,125	1993	13,393
1981	5,816	1994	14,389
1982	9,659	1995	16,996
1983	9,185	1996	18,093
1984	10,996	1997	22,148
1985	11,823	1998	20,254
1986	13,759	1999	27,282
1987	16,285	2000	32,579
1988	19,033	2001	35,369
1989	21,618	2002	41,768
1990	21,613	2003	44,419
1991	7,968	2004	47,205
1992	13,911		

Notes:
(1) Includes CLWA SCWD, LACWWD 36, NCWD, and VWC.

[1] CLWA's original SWP Water Supply Contract with DWR was amended in 1966 for a maximum annual Table A Amount of 41,500 af. In 1991, CLWA purchased 12,700 af of annual Table A Amount from a Kern County water district, and in 1999 purchased an additional 41,000 af of annual Table A Amount from another Kern County water district, for a current total annual Table A Amount of 95,200 af.
[2] See Section 3.2.2.

Table 3-3
CLWA Demand Projections Provided to Wholesale Supplier (DWR) (af)

Wholesaler (Supply Source)	2010	2015	2020	2025	2030
DWR (SWP)	95,200	95,200	95,200	95,200	95,200

In an effort to assess the impacts of these varying conditions on SWP supply reliability, DWR issued its "State Water Project Delivery Reliability Report" in May 2003. The report assists SWP contractors in assessing the reliability of the SWP component of their overall supplies. DWR is in the process of updating this report and, on May 25, 2005, provided updated delivery reliability estimates to the SWP contractors in its "Excerpts from the Working Draft of 2005 State Water Project Delivery Reliability." In this update, DWR provided a recommended set of analyses for SWP contractors to use in preparing their 2005 UWMPs.[3] These updated analyses indicate that the SWP, using existing facilities operated under current regulatory and operational constraints, and with all contractors requesting delivery of their full Table A Amounts in most years, could deliver 77 percent of total Table A Amounts on a long-term average basis. These most recent analyses also project that SWP deliveries during multiple-year dry periods could average about 25 to 40 percent of total Table A Amounts and could possibly be as low as 5 percent during an unusually dry single year. During wetter years, or more than 25 percent of the time, 100 percent of full Table A Amounts is projected to be available.

The SWP supplies projected to be available for delivery to CLWA were determined based on the total SWP delivery percentages identified by DWR in its updated analyses. Table 3-4 shows SWP supplies projected to be available to CLWA in average/normal years (based on the average delivery over the study's historic hydrologic period from 1922-1994), i.e., long-term average basis. Table 3-5 summarizes estimated SWP supply availability in a single dry year (based on a repeat of the worst-case historic hydrologic conditions of 1977) and over a multiple dry year period (based on a repeat of the worst-case historic four-year drought of 1931-1934). Reliability and dry-year planning of water supplies are further described in Chapter 6, Reliability Planning.

[3]As part of the Monterey Settlement Agreement, DWR is to prepare an assessment every two years of SWP delivery reliability, which SWP contractors are to use in their water planning efforts. DWR has completed an update of its analysis of SWP delivery reliability and is currently updating this report. While DWR continues its drafting of the remainder of the report, it issued this updated reliability data to the SWP contractors early, so that they could use the most up-to-date SWP reliability data in preparation of their UWMPs. For this reason, DWR issued, in a Notice to Contractors, excerpts from its working draft of this report (available at www.swpao.water.ca.gov/pdfs/05-08.pdf). It is unlikely that the reliability data in DWR's final version of this updated report will differ from the draft.

Table 3-4
Wholesaler Identified and Quantified Existing and Planned Sources of Water Available to CLWA for Average/Normal Years (1)

Wholesaler (Supply Source)	2010	2015	2020	2025	2030
DWR (SWP)					
Table A Supply (af)	67,600	69,500	71,400	73,300	73,300
% of Table A Amount	71%	73%	75%	77%	77%

Notes:

(1) The percentages of Table A Amount projected to be available are taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005). Supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by these percentages.

Table 3-5
Wholesale Supply Reliability (1)

Wholesaler	Single Dry Year (2)	Multiple Dry Years (3)
DWR (SWP Supply)		
2005		
Table A Supply (af)	3,800	30,500
% of Table A Amount	4%	32%
2025/2030		
Table A Supply (af)	4,800	31,400
% of Table A Amount	5%	33%

Notes:

(1) The percentages of Table A Amount projected to be available are taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005). Supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by these percentages.

(2) Based on the worst case historic single dry year of 1977.

(3) Supplies shown are annual averages over four consecutive dry years, based on the worst case historic four-year dry period of 1931-1934.

As part of its Water Supply Contract with DWR, CLWA has access to a portion of the storage capacity of Castaic Lake. This Flexible Storage Account allows CLWA to borrow up to 4,684 af of the storage in Castaic Lake. Any of this amount that CLWA borrows must be replaced by CLWA within five years of its withdrawal. CLWA manages this storage by keeping the account full in normal and wet years and then delivering that stored amount (or a portion of it) during dry periods. The account is refilled during the next year that adequate SWP supplies are available to CLWA to do so. CLWA has recently negotiated with Ventura County water agencies to obtain the use of their Flexible Storage Account. This will allow CLWA access to another 1,376 af of storage in Castaic Lake. CLWA access to this additional storage will be available on a year-to-year basis for ten years, beginning in 2006.

While the primary supply of water available from the SWP is allocated Table A supply, SWP supplies in addition to Table A water may periodically be available, including “Article 21” water, Turnback Pool water, and DWR dry-year purchases. Article 21 water (which refers to the SWP contract provision defining this supply) is water that may be made available by DWR when

excess flows are available in the Delta (i.e., when Delta outflow requirements have been met, SWP storage south of the Delta is full, and conveyance capacity is available beyond that being used for SWP operations and delivery of allocated and scheduled Table A supplies). Article 21 water is made available on an unscheduled and interruptible basis and is typically available only in average to wet years, generally only for a limited time in the late winter. The Turnback Pool is a program where contractors with allocated Table A supplies in excess of their needs in a given year may turn back that excess supply for purchase by other contractors who need additional supplies that year. The Turnback Pool can make water available in all types of hydrologic years, although generally less excess water is turned back in dry years. As urban contractor demands increase in the future, the amount of water turned back and available for purchase will likely diminish. In critical dry years, DWR has formed Dry Year Water Purchase Programs for contractors needing additional supplies. Through these programs, water is purchased by DWR from willing sellers in areas that have available supplies and is then sold by DWR to contractors willing to purchase those supplies. Because the availability of these supplies is somewhat uncertain, they are not included as supplies in this UWMP. However, CLWA's access to these supplies when they are available may enable it to improve the reliability of its SWP supplies beyond the values used throughout this report.

3.2.2 Litigation Effects on Availability of Imported Water

Of CLWA's 95,2000 af annual Table A Amount, 41,000 afy was permanently transferred to CLWA in 1999 by Wheeler Ridge-Maricopa Water Storage District, a member unit of the Kern County Water Agency. CLWA's Environmental Impact Report ("EIR") prepared in connection with the 41,000 afy water transfer was challenged in Friends of the Santa Clara River v. Castaic Lake Water Agency (Los Angeles County Superior Court, Case Number BS056954) ("Friends"). On appeal, the Court of Appeal, Second Appellate District held that since the 41,000 afy EIR tiered off the Monterey Agreement EIR that was later decertified, CLWA would also have to decertify its EIR as well and prepare a revised EIR. As amplified in detail in the following sentences, Friends was dismissed with prejudice (permanently) in February 2005. CLWA has not been enjoined from using any water that is part of the 41,000 afy transfer.

Under the jurisdiction of the Los Angeles County Superior Court in Friends, CLWA prepared and circulated a revised Draft EIR for the transfer, received and responded to public comments regarding the revised Draft EIR, and held two separate public hearings concerning the revised Draft EIR. CLWA approved the revised EIR for the transfer on December 22, 2004 and lodged the revised EIR with the Los Angeles Superior Court as part of its Return to the Preemptory Writ of Mandate in Friends. Thereafter, Friends was dismissed with prejudice (permanently). In January 2005, two new challenges to CLWA's environmental review for the transfer were filed in the Ventura County Superior Court by the Planning and Conservation League and by the California Water Impact Network; these cases have been consolidated and transferred to Los Angeles County Superior Court.

These pending challenges to the EIR for the transfer do not affect the reliability of the transfer amount, and it is still appropriate to include the transfer amount as part of CLWA's 95,200 AFY Table A amount, for the following reasons. First, the transfer was completed in 1999, and DWR has allocated and annually delivered the water in accordance with the completed transfer. Second, the Court of Appeal held that the only defect in the 1999 EIR was that it tiered off the

Monterey Agreement EIR, which was later decertified. This defect has now been remedied by the preparation of a revised EIR that did not tier off the Monterey Agreement EIR. Third, the Monterey Amendments settlement agreement expressly authorizes the operation of the SWP in accordance with the Monterey Amendments, which authorized the transfer. Fourth, the Court of Appeal refused to enjoin the transfer, and instead required preparation of a revised EIR. Fifth, the transfer contracts remain in full force and effect, and no court has ever questioned their validity or enjoined the use of this portion of CLWA's Table A amount. It is, therefore, reasonable to conclude that if a court finds the revised EIR legally deficient, that court, like all others before it, will again refuse to enjoin the transfer, and will instead require further revisions to the EIR. Therefore, the pending challenges litigation should have no impact upon the amount of water available to CLWA as a result of the transfer.

3.3 GROUNDWATER

This section presents information about CLWA's and the purveyor's groundwater supplies, including a summary of the adopted GWMP.

3.3.1 Santa Clara River Groundwater Basin – East Subbasin

The sole source of local groundwater for urban water supply in the Valley is the groundwater Basin identified in the DWR Bulletin 118, 2003 Update as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin) (Basin No. 4-4.07). The Basin is comprised of two aquifer systems, the Alluvium and the Saugus Formation. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. There are also some scattered outcrops of Terrace deposits in the Basin that likely contain limited amounts of groundwater. Since these deposits are located in limited areas situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and consequently have not been developed for any significant water supply. Figure 3-1 illustrates the mapped extent of the Santa Clara River Valley East Subbasin in DWR Bulletin 118 (2003), which approximately coincides with the outer extent of the Alluvium and Saugus Formation. The service area for CLWA and the purveyors is also shown on Figure 3-1.

3.3.2 Adopted Groundwater Management Plan

As part of legislation authorizing CLWA to provide retail water service to individual municipal customers, Assembly Bill (AB) 134 (2001) included a requirement that CLWA prepare a groundwater management plan in accordance with the provisions of Water Code Section 10753, which was originally enacted by AB 3030. The general contents of CLWA's groundwater management plan were outlined in 2002, and a detailed plan was drafted and adopted in 2003 to satisfy the requirements of AB 134. The plan both complements and formalizes a number of existing water supply and water resource planning and management activities in CLWA's service area, which effectively encompasses the East Subbasin of the Santa Clara River Valley Groundwater Basin.

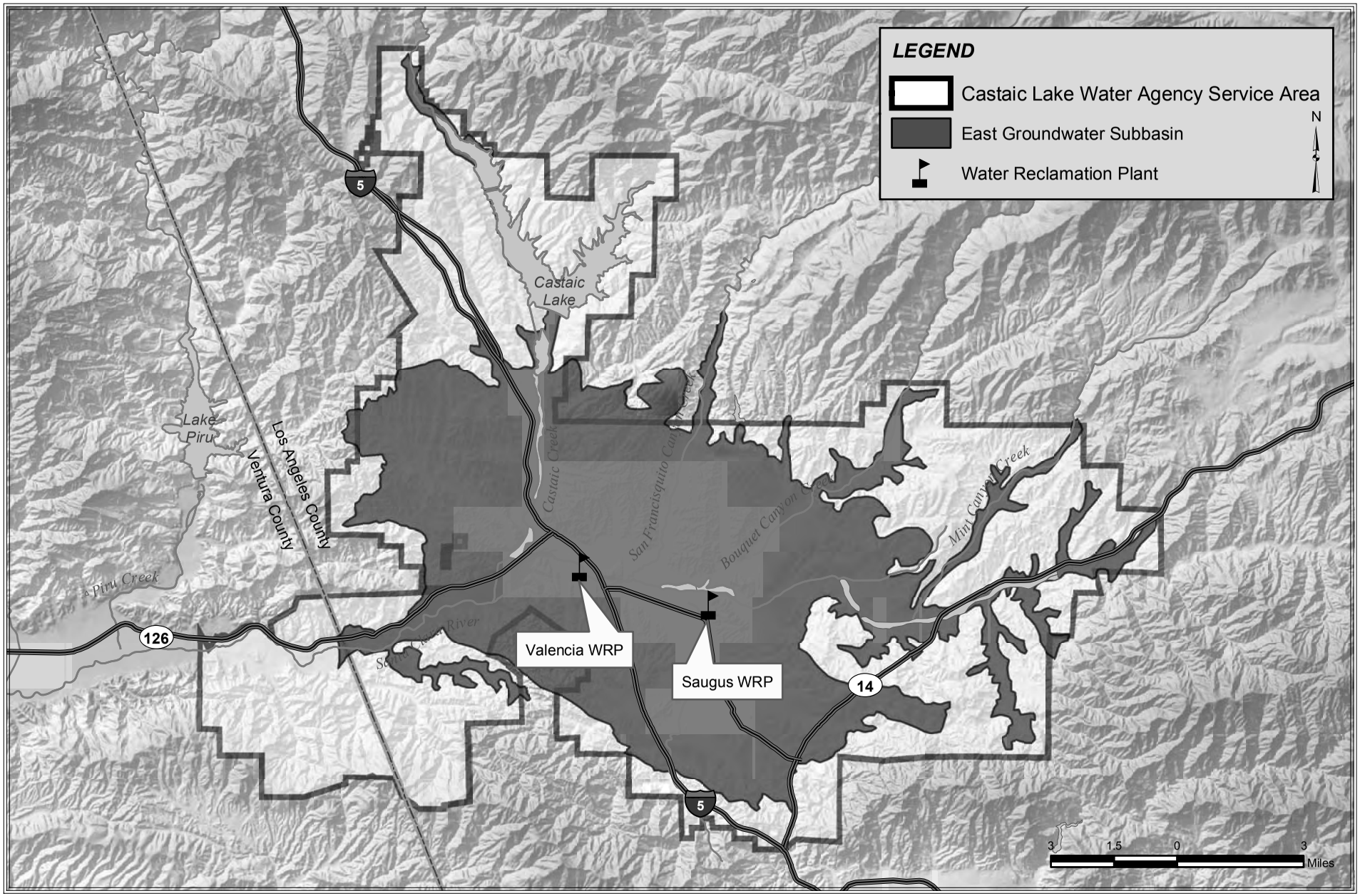


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Figure 3-1
Santa Clara River Valley
East Groundwater Subbasin

CLWA adopted the GWMP on December 10, 2003. The GWMP contains four management objectives, or goals, for the Basin including (1) development of an integrated surface water, groundwater, and recycled water supply to meet existing and projected demands for municipal, agricultural, and other water uses; (2) assessment of groundwater basin conditions to determine a range of operational yield values that use local groundwater conjunctively with supplemental SWP supplies and recycled water to avoid groundwater overdraft; (3) preservation of groundwater quality, including active characterization and resolution of any groundwater contamination problems; and (4) preservation of interrelated surface water resources, which includes managing groundwater to not adversely impact surface and groundwater discharges or quality to downstream basin(s).

Prior to preparation and adoption of the GWMP, a local Memorandum of Understanding (MOU) process among CLWA, the purveyors, and United Water Conservation District (UWCD) in neighboring Ventura County had produced the beginning of local groundwater management, now embodied in the GWMP. In 2001, out of a willingness to seek opportunities to work together and develop programs that mutually benefit the region as well as their individual communities, those agencies prepared and executed the MOU. The agreement is a collaborative and integrated approach to several of the aspects of water resource management included in the GWMP. UWCD manages surface water and groundwater resources in seven groundwater basins, all located in Ventura County, downstream of the East Subbasin of the Santa Clara River Valley (Basin). UWCD is a partner in cooperative management efforts to accomplish the objectives (goals) for the Basin, particularly as they relate to preservation of surface water resources that flow through the respective basins. As a result of the MOU, the cooperating agencies have undertaken the following measures: integrated their database management efforts, developed and utilized a numerical groundwater flow model for analysis of groundwater basin yield and containment of groundwater contamination, and continued to monitor and report on the status of Basin conditions, as well as on geologic and hydrologic aspects of the overall stream-aquifer system.

The adopted GWMP includes 14 elements intended to accomplish the Basin management objectives listed above. In summary, the plan elements include:

- Monitoring of groundwater levels, quality, production and subsidence
- Monitoring and management of surface water flows and quality
- Determination of Basin yield and avoidance of overdraft
- Development of regular and dry-year emergency water supply
- Continuation of conjunctive use operations
- Long-term salinity management
- Integration of recycled water
- Identification and mitigation of soil and groundwater contamination, including involvement with other local agencies in investigation, cleanup, and closure
- Development and continuation of local, state and federal agency relationships
- Groundwater management reports

- Continuation of public education and water conservation programs
- Identification and management of recharge areas and wellhead protection areas
- Identification of well construction, abandonment, and destruction policies
- Provisions to update the groundwater management plan

Work on a number of the GWMP elements had been ongoing for some time prior to the formal adoption of the GWMP and continues on an ongoing basis. The results of some of that work are reflected in this Plan.

3.3.2.1 Available Groundwater Supplies

The groundwater component of overall water supply in the Valley derives from a groundwater operating plan developed over the last 20 years to meet water requirements (municipal, agricultural, small domestic) while maintaining the Basin in a sustainable condition (i.e., no long-term depletion of groundwater or interrelated surface water). This operating plan also addresses groundwater contamination issues in the Basin, all consistent with both the MOU and the GWMP described above. The groundwater operating plan is based on the concept that pumping can vary from year to year to allow increased groundwater use in dry periods and increased recharge during wet periods and to collectively assure that the groundwater Basin is adequately replenished through various wet/dry cycles. As described in the MOU and subsequently formalized in the GWMP, the operating yield concept has been quantified as ranges of annual pumping volumes.

The ongoing work of the MOU has produced two formal reports. The first report, dated April 2004, documents the construction and calibration of the groundwater flow model for the Valley. The second report, dated August 2005, presents the modeling analysis of the purveyors' groundwater operating plan, described below. The primary conclusion of the modeling analysis is that the groundwater operating plan will not cause detrimental short or long term effects to the groundwater and surface water resources in the Valley and is therefore, sustainable[4]. The analysis of sustainability for groundwater and interrelated surface water is described in Appendix C.

The groundwater operating plan, summarized in Table 3-6, is as follows:

> **Alluvium** – Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the eastern Santa Clara River watershed. Pumping ranges between 30,000 and 40,000 afy during normal and above-normal rainfall years. However, due to hydrogeologic constraints in the eastern part of the Basin, pumping is reduced to between 30,000 and 35,000 afy during locally dry years.
>
> **Saugus Formation** – Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly from the SWP. During average-year conditions within the SWP system, Saugus pumping ranges between 7,500 and 15,000 afy. Planned dry-year pumping from the Saugus Formation ranges between

[4] From "Analysis of Groundwater Basin Yield, Upper Santa Clara River Basin, Eastern Subbasin, Los Angeles County, California," prepared by CH2M Hill and Luhdorff and Scalmanini Consulting Engineers, August 2005.

15,000 and 25,000 afy during a drought year and can increase to between 21,000 and 25,000 afy if SWP deliveries are reduced for two consecutive years and between 21,000 and 35,000 afy if SWP deliveries are reduced for three consecutive years. Such high pumping would be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 afy, to further enhance the effectiveness of natural recharge processes that would recover water levels and groundwater storage volumes after the higher pumping during dry years.

Table 3-6
Groundwater Operating Plan for the Santa Clarita Valley

Aquifer	Groundwater Production (af)			
	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	15,000 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**45,000 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**

Within the groundwater operating plan, three factors affect the availability of groundwater supplies: sufficient source capacity (wells and pumps); sustainability of the groundwater resource to meet pumping demand on a renewable basis; and protection of groundwater sources (wells) from known contamination, or provisions for treatment in the event of contamination. The first two factors are briefly discussed as follows, and more completely addressed in Appendix C. Protection of groundwater sources and provisions for treatment in the event of contamination are developed further in Chapter 5.

For reference to the Groundwater Operating Plan, recent historical and projected groundwater pumping by the retail water purveyors is summarized in Tables 3-7 and 3-8, respectively.

Table 3-7
Historical Groundwater Production by the Retail Water Purveyors[1]

Basin Name	Groundwater Pumped (af) [2]				
	2000	2001	2002	2003	2004
Santa Clara River Valley East Subbasin					
CLWA Santa Clarita Water Division	*11,529*	*9,896*	*9,513*	*6,424*	*7,146*
Alluvium	11,529	9,896	9,513	6,424	7,146
Saugus Formation	0	0	0	0	0
LA County Waterworks District 36	*0*	*0*	*0*	*0*	*380*
Alluvium	0	0	0	0	380
Saugus Formation	0	0	0	0	0
Newhall County Water District	*3,694*	*4,073*	*4,376*	*3,779*	*5,321*
Alluvium	1,508	1,641	981	1,266	1,582
Saugus Formation	2,186	2,432	3,395	2,513	3,739
Valencia Water Company	*13,186*	*11,353*	*12,568*	*12,775*	*11,824*
Alluvium	12,179	10,518	11,603	11,707	9,862
Saugus Formation	1,007	835	965	1,068	1,962
Total	*28,409*	*25,322*	*26,457*	*22,978*	*24,671*
Alluvium	25,216	22,055	22,097	19,397	18,970
Saugus Formation	3,193	3,267	4,360	3,581	5,701
% of Total Municipal Water Supply	**47%**	**42%**	**39%**	**34%**	**34%**

Notes:

(1) From 2004 Santa Clarita Valley Water Report (May 2005).

(2) Pumping for municipal and industrial uses only. Does not include pumping for agricultural and miscellaneous uses.

Table 3-8
Projected Groundwater Production (Normal Year)

Basin Name	Range of Groundwater Pumping (af) [1][2][3]				
	2010	2015	2020	2025	2030
Santa Clara River Valley East Subbasin					
CLWA Santa Clarita Water Division					
Alluvium	6,000-14,000	6,000-14,000	6,000-14,000	6,000-14,000	6,000-14,000
Saugus Formation	3,000	3,000	3,000	3,000	3,000
LA County Waterworks District 36					
Alluvium	0	0	0	0	0
Saugus Formation	500-1,000	500-1,000	500-1,000	500-1,000	500-1,000
Newhall County Water District					
Alluvium	1,500-3,000	1,500-3,000	1,500-3,000	1,500-3,000	1,500-3,000
Saugus Formation	3,000-6,000	3,000-6,000	3,000-6,000	3,000-6,000	3,000-6,000
Valencia Water Company					
Alluvium	12,000-20,000	12,000-20,000	12,000-20,000	12,000-20,000	12,000-20,000
Saugus Formation	2,500-5,000	2,500-5,000	2,500-5,000	2,500-5,000	2,500-5,000

Notes:

(1) The range of groundwater production capability for each purveyor varies based on a number of factors which include each purveyor's capacity to produce groundwater, the location of its wells within the Alluvium and Saugus Formation, local hydrology, availability of imported water supplies and water demands.

(2) To ensure sustainability, the purveyors have committed that the annual use of groundwater pumped collectively in any given year will not exceed the purveyors' operating plan as described in the Basin Yield Study and reported annually in the SCV Water Report. As noted in the discussion of the purveyors' operating plan for groundwater in Table 3-6 of this Plan, the "normal" year quantities of groundwater pumped from the Alluvium and Saugus Formation are 30,000 to 40,000 afy and 7,500 to 15,000 afy, respectively.

(3) Groundwater pumping shown for purveyor municipal and industrial uses only.

The groundwater operating plan recognizes ongoing Alluvial pumping for both municipal and agricultural water supply, as well as other small private domestic and related pumping. During preparation of this Plan, the Santa Clarita Valley Well Owners' Association submitted some limited information about the nature and magnitude of private well pumping. This included a detailed estimate of private well pumping in the San Francisquito Canyon portion of the Basin: a total of 85 afy by 73 individual private pumpers, or nearly 1.2 afy per private well pumper. As a result of that input, it is now better recognized that total private pumping is likely well within the 500 afy estimates of small private well pumping in recent annual Water Reports, or about 1 percent of typical Alluvial Aquifer pumping by the purveyors and other known private well owners, e.g. agricultural pumpers, combined. Thus, while the small private wells are not explicitly modeled in the Basin yield analysis described herein because their locations and operations are not known, their operation creates a pumping stress that is essentially negligible at the scale of the regional model. Ultimately, the intent to maintain overall pumping within the operating plan, including private pumping, will result in sustainable groundwater conditions to support the combination of municipal (purveyor), agricultural, and small private groundwater use on an ongoing basis.

3.3.2.1.1 Alluvium

Based on a combination of historical operating experience and recent groundwater modeling analysis, the Alluvial Aquifer can supply groundwater on a long-term sustainable basis in the overall range of 30,000 to 40,000 afy, with a probable reduction in dry years to a range of 30,000 to 35,000 afy. Both of those ranges include about 15,000 afy of Alluvial pumping for current agricultural water uses and an estimated pumping of up to about 500 afy by small private pumpers. The dry year reduction is a result of practical constraints in the eastern part of the Basin, where lowered groundwater levels in dry periods have the effect of reducing pumping capacities in that shallower portion of the aquifer.

Adequacy of Supply

For municipal water supply, with existing wells and pumps, the three retail water purveyors with Alluvial wells (NCWD, SCWD, and VWC) have a combined pumping capacity from active wells (not contaminated by perchlorate) of 36,120 gpm, which translates into a current full-time Alluvial source capacity of approximately 58,000 afy. Alluvial pumping capacity from all the active municipal supply wells is summarized in Table 3-9. The locations of the various municipal Alluvial wells throughout the Basin are illustrated on Figure 3-2. These capacities do not include one Alluvial Aquifer well that has been temporarily inactivated due to perchlorate contamination: the SCWD Stadium well, which represents another 800 gpm of pumping capacity, or full-time source capacity of about 1,290 afy.

In terms of adequacy and availability, the combined active Alluvial groundwater source capacity of municipal wells is approximatley 58,000 afy. This is more than sufficient to meet the municipal, or urban, component of groundwater supply from the Alluvium, which is currently 20,000 to 25,000 afy of the total planned Alluvial pumping of 30,000 to 40,000 afy. (The balance of Alluvial pumping in the operating plan is for agricultural and other, including small private, pumping.)

Sustainability

Until recently, the long-term renewability of Alluvial groundwater was empirically determined from approximately 60 years of recorded experience. Generally, it consists of long-term stability in groundwater levels and storage, with some dry period fluctuations in the eastern part of the Basin, over a historical range of total Alluvial pumpage from as low as about 20,000 afy to as high as about 43,000 afy. Those empirical observations have now been complemented by the development and application of a numerical groundwater flow model, which has been used to predict aquifer response to the planned operating ranges of pumping. The numerical groundwater flow model has also been used to analyze the control of perchlorate contaminant migration under selected pumping conditions that would restore, with treatment, pumping capacity inactivated due to perchlorate contamination detected in some wells in the Basin. The latter use of the model is described in Chapter 5, which addresses the Saugus Formation and the overall approach to the perchlorate contamination issue.

Table 3-9
Active Municipal Groundwater Source Capacity—Alluvial Aquifer Wells

Wells	Pump Capacity (gpm)	Max Annual Capacity (af)	Normal Year Production [1] (af)	Dry-Year Production (af)
Newhall CWD				
Castaic 1	600	960	385	345
Castaic 2	425	680	166	125
Castaic 4	270	430	100	45
Pinetree 1	300	480	164	N/A
Pinetree 3	550	880	545	525
Pinetree 4	500	800	300	N/A
NCWD Subtotal	2,645	4,230	1,660	1,040
Santa Clarita WD				
Clark	600	960	782	700
Guida	1,000	1,610	1,320	1,230
Honby	950	1,530	696	870
Lost Canyon 2	850	1,370	741	640
Lost Canyon 2A	825	1,330	1,034	590
Mitchell 5B	700	1,120	557	N/A
N. Oaks Central	1,000	1,610	822	1,640
N. Oaks East	950	1,530	1,234	485
N. Oaks West	1,400	2,250	898	N/A
Sand Canyon	750	1,200	930	195
Sierra	1,500	2,410	846	N/A
SCWD Subtotal	10,525	16,920	9,860	6,350
Valencia WC				
Well D	1,050	1,690	690	690
Well E-15	1,400	2,260	N/A	N/A
Well N	1,250	2,010	620	620
Well N7	2,500	4,030	1,160	1,160
Well N8	2,500	4,030	1,160	1,160
Well Q2	1,200	1,930	985	985
Well S6	2,000	3,220	865	865
Well S7	2,000	3,220	865	865
Well S8	2,000	3,220	865	865
Well T2	800	1,290	460	460
Well T4	700	1,120	460	460
Well U4	1,000	1,610	935	935
Well U6	1,250	2,010	825	825
Well W9	800	1,290	600	600
Well W10	1,500	2,410	865	865
Well W11	1,000	1,610	350	350
VWC Subtotal	22,950	36,950	11,705	11,705
Total Purveyors	**36,120**	**58,100** [2]	**23,225** [2]	**19,095** [2]

Notes:
(1) Based on recent annual pumping.
(2) Currently active wells only; capacity will slightly increase by restoration of contaminated wells.

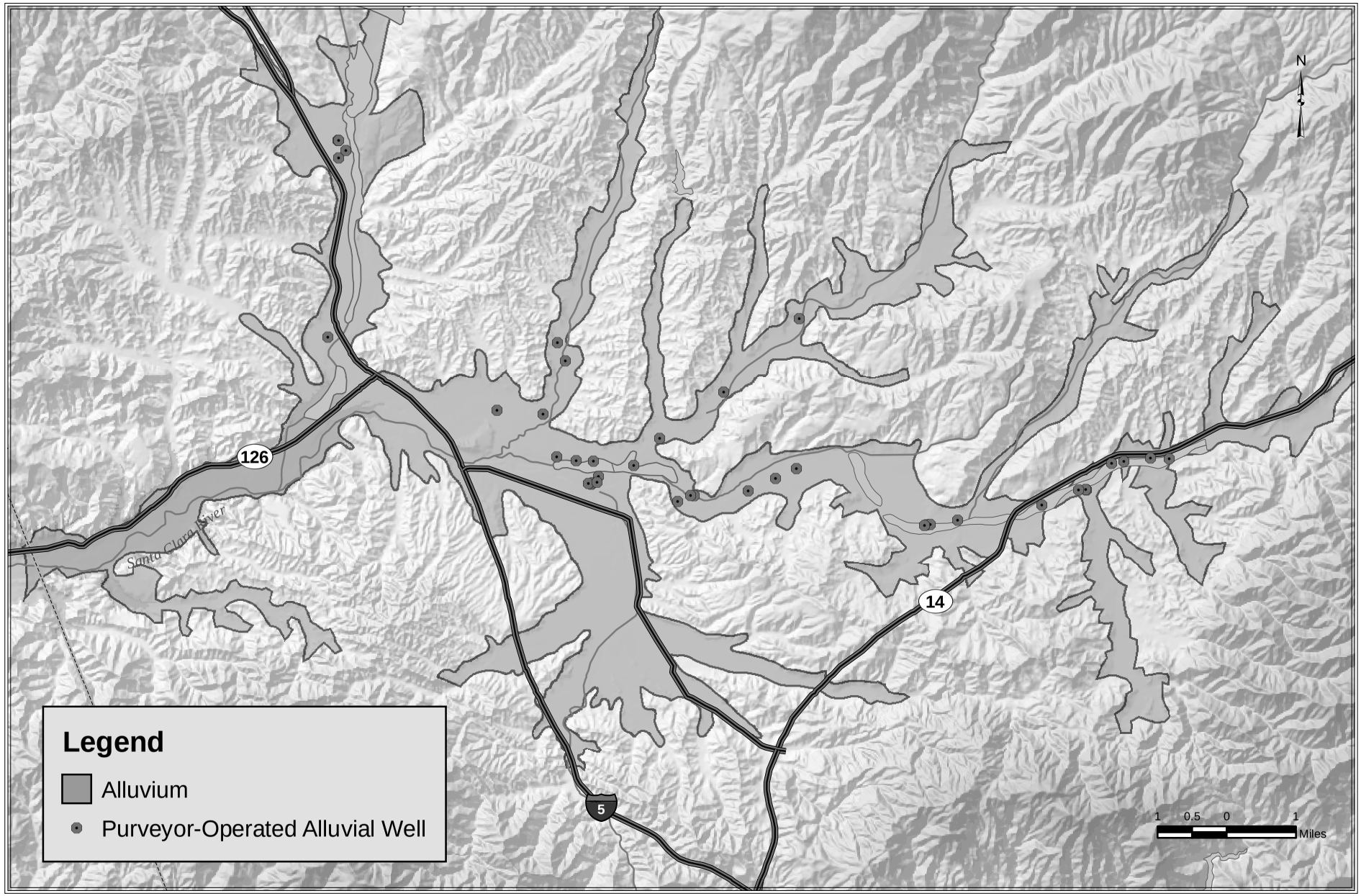

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Figure 3-2
Municipal Alluvial Well Locations
Santa Clara River Valley, East Groundwater Subbasin

To examine the yield of the Alluvium or, the sustainability of the Alluvium on a renewable basis, the groundwater flow model was used to examine the long-term projected response of the aquifer to pumping for municipal and agricultural uses in the 30,000 to 40,000 afy range under average/normal and wet conditions, and in the 30,000 to 35,000 afy range under locally dry conditions. To examine the response of the entire aquifer system, the model also incorporated pumping from the Saugus Formation in accordance with the normal (7,500-15,000 afy) and dry year (15,000-35,000 afy) operating plan for that aquifer. The model was run over a 78-year hydrologic period, which was selected from actual historical precipitation to examine a number of hydrologic conditions expected to affect both groundwater pumping and groundwater recharge. The selected 78-year simulation period was assembled from an assumed recurrence of 1980 to 2003 conditions, followed by an assumed recurrence of 1950 to 2003 conditions. The 78-year period was analyzed to define both local hydrologic conditions (normal and dry), which affect the rate of pumping from the Alluvium, and hydrologic conditions that affect SWP operations, which in turn affect the rate of pumping from the Saugus. The resultant simulated pumping cycles included the distribution of pumping for each of the existing Alluvial Aquifer wells, for normal and dry years respectively, as shown in Table 3-9.

Simulated Alluvial Aquifer response to the range of hydrologic conditions and pumping stresses is essentially a long-term repeat of the historical conditions that have resulted from similar pumping over the last several decades. The resultant response consists of: (1) generally constant groundwater levels in the middle to western portion of the Alluvium and fluctuating groundwater levels in the eastern portion as a function of wet and dry hydrologic conditions, (2) variations in recharge that directly correlate with wet and dry hydrologic conditions, and (3) no long-term decline in groundwater levels or storage. The Alluvial Aquifer is considered a sustainable water supply source to meet the Alluvial portion of the operating plan for the groundwater Basin. This is based on the combination of actual experience with Alluvial Aquifer pumping at capacities similar to those planned for the future and the resultant sustainability (recharge) of groundwater levels and storage, and further based on modeled projections of aquifer response to planned pumping rates that also show no depletion of groundwater.

3.3.2.1.2 Saugus Formation

Based on historical operating experience and extensive recent testing and groundwater modeling analysis, the Saugus Formation can supply water on a long-term sustainable basis in a normal range of 7,500 to 15,000 afy, with intermittent increases to 25,000 to 35,000 af in dry years. The dry-year increases, based on limited historical observation and modeled projections, demonstrate that a small amount of the large groundwater storage in the Saugus Formation can be pumped over a relatively short (dry) period. This would be followed by recharge (replenishment) of that storage during a subsequent normal-to-wet period when pumping would be reduced.

Adequacy of Supply

For municipal water supply with existing wells, the three retail water purveyors with Saugus wells (NCWD, SCWD, and VWC) have a combined pumping capacity from active wells (not contaminated by perchlorate) of 14,900 gpm, which translates into a full-time Saugus source capacity of 24,000 afy. Saugus pumping capacity from all the active municipal supply wells is summarized in Table 3-10; the locations of the various active municipal Saugus wells are illustrated on Figure 3-3. These capacities do not include the four Saugus wells contaminated by

perchlorate, although they indirectly reflect the capacity of one of the contaminated wells, VWC's Well 157, which has been sealed and abandoned, and replaced by VWC's Well 206 in a non-impacted part of the Basin. The four contaminated wells, one owned by NCWD and two owned by SCWD, in addition to the VWC well, represent a total of 7,900 gpm of pumping capacity (or full-time source capacity of about 12,700 afy) inactivated due to perchlorate contamination.

Table 3-10
Active Municipal Groundwater Source Capacity—Saugus Formation Wells

Wells	Pump Capacity (gpm)	Max Annual Capacity (af)	Normal Year Production [(1)] (af)	Dry-Year Production (af)
Newhall CWD				
12	2,300	3,700	1,315	2,044
13	2,500	4,030	1,315	2,044
NCWD Subtotal	4,800	7,730	2,630	4,088
Valencia WC				
159	500	800	50	50
160	2,000	3,220	1,000	1,330
201	2,400	3,870	100	3,577
205	2,700	4,350	1,000	3,827
206	2,500	4,030	1,175	3,500
VWC Subtotal	10,100	16,270	3,325	12,284
Total Purveyors	**14,900**	**24,000** [(2)]	**5,955** [(2)]	**16,372** [(2)]

Notes:
(1) Based on recent annual pumping.
(2) Currently active wells only; additional capacity to meet dry-year operating plan would be met by restoration of contaminated wells and new well construction.

In terms of adequacy and availability, the combined active Saugus groundwater source capacity of municipal wells of 24,000 afy, is more than sufficient to meet the planned use of Saugus groundwater in normal years of 7,500 to 15,000 afy. During the currently scheduled two-year time frame for restoration of impacted Saugus capacity (as discussed further in Chapter 5), this currently active capacity is more than sufficient to meet water demands, in combination with other sources, if both of the next two years are dry. At that time, the combination of currently active capacity and restored impacted capacity, through a combination of treatment at two of the impacted wells and replacement well construction, will provide sufficient total Saugus capacity to meet the planned use of Saugus groundwater during multiple dry-years of 35,000 af, if that third year is also a dry year.

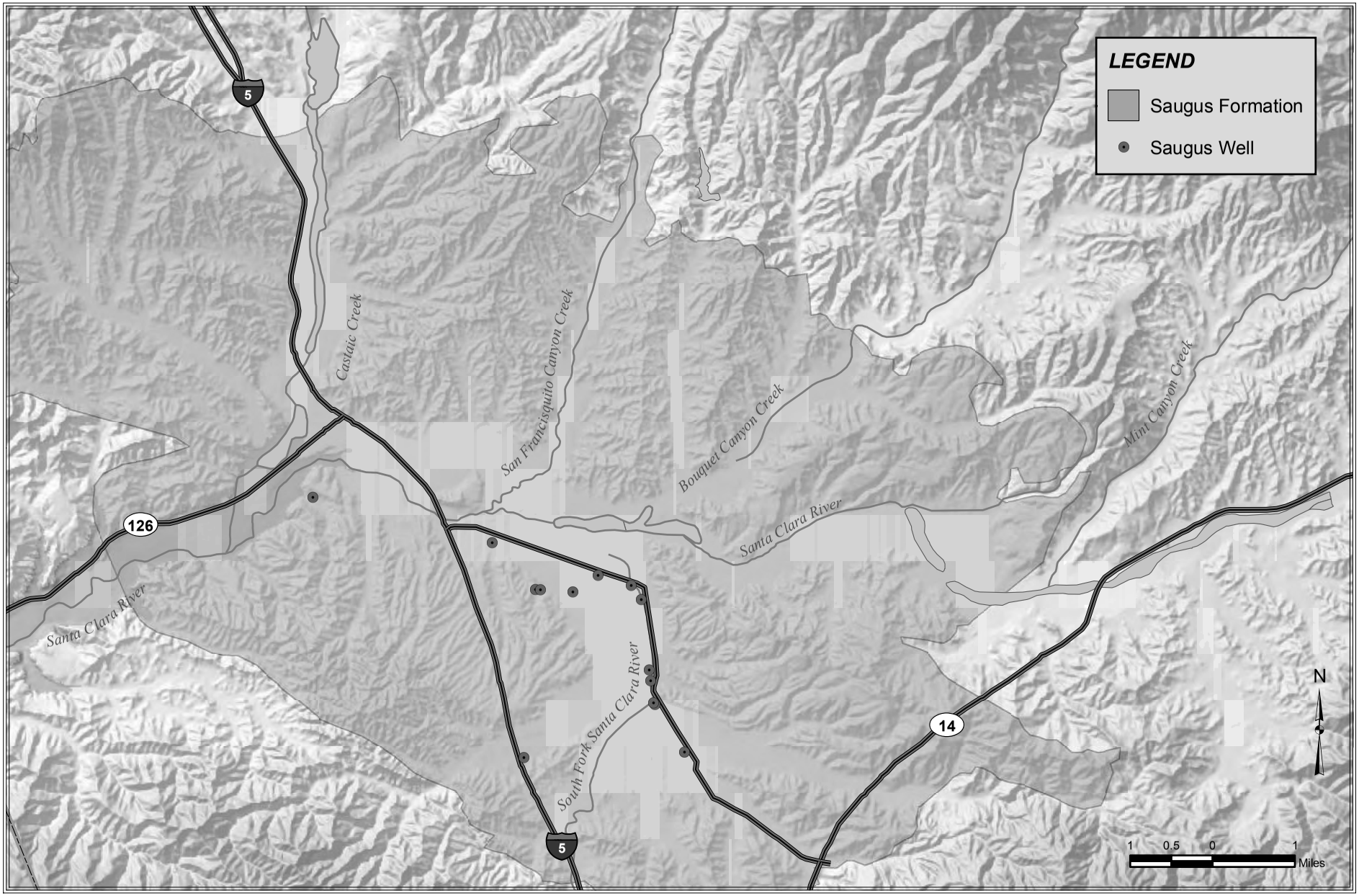

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Figure 3-3
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

Sustainability

Until recently, the long-term sustainability of Saugus groundwater was empirically determined from limited historical experience. The historical record shows fairly low annual pumping in most years, with one four-year period of increased pumping up to about 15,000 afy that produced no long-term depletion of the substantial groundwater storage in the Saugus. Those empirical observations have now been complemented by the development and application of the numerical groundwater flow model, which has been used to examine aquifer response to the operating plan for pumping from both the Alluvium and the Saugus and also to examine the effectiveness of pumping for both contaminant extraction and control of contaminant migration within the Saugus Formation. The latter aspects of Saugus pumping are discussed in Chapter 5.

To examine the yield of the Saugus Formation or, its sustainability on a renewable basis, the groundwater flow model was used to examine long-term projected response to pumping from both the Alluvium and the Saugus over the 78-year period of hydrologic conditions using alternating wet and dry periods as have historically occurred. The pumping simulated in the model was in accordance with the operating plan for the Basin. For the Saugus, simulated pumpage included the planned restoration of recent historic pumping from the perchlorate-impacted wells. In addition to assessing the overall recharge of the Saugus, that pumping was analyzed to assess the effectiveness of controlling the migration of perchlorate by extracting and treating contaminated water close to the source of contamination.

Simulated Saugus Formation response to the ranges of pumping under assumed recurrent historical hydrologic conditions is consistent with actual experience under smaller pumping rates. The response consists of (1) short-term declines in groundwater levels and storage near pumped wells during dry-period pumping, (2) rapid recovery of groundwater levels and storage after cessation of dry-period pumping, and (3) no long-term decreases or depletion of groundwater levels or storage. The combination of actual experience with Saugus pumping and recharge up to about 15,000 afy, now complemented by modeled projections of aquifer response that show long-term utility of the Saugus at 7,500 to 15,000 afy in normal years and rapid recovery from higher pumping rates during intermittent dry periods, shows that the Saugus Formation can be considered a sustainable water supply source to meet the Saugus portion of the operating plan for the groundwater Basin.

3.3.3 Potential Supply Inconsistency

A small group of wells that have been impacted by perchlorate represent a temporary loss of well capacity within CLWA's service area. Of the six wells that were initially removed from active water supply service upon the detection of perchlorate, four wells with a combined capacity of 10,000 af remain out of service, as discussed further in Chapter 5. However, CLWA and the purveyors have developed an implementation plan that would restore this well capacity. The implementation plan includes a combination of treatment facilities and replacement wells. Treatment facilities for several of the impacted wells will be operational in 2006 and the production restoration (replacement) wells will be operational by 2010. Additional information on the treatment technology and schedule for restoration of the impacted wells is provided in Chapter 5. Additional information concerning water quality issues and replacement capacity is also provided in Chapter 5.

3.4 TRANSFERS, EXCHANGES, AND GROUNDWATER BANKING PROGRAMS

Additional water supplies can be purchased from other water agencies and sources, and CLWA is currently exploring opportunities. An important element to enhancing the long-term reliability of the total mix of supplies currently available to meet the needs of the Valley is the use of transfers, exchanges, and groundwater banking programs, such as those described below.

3.4.1 Transfers and Exchanges

An opportunity available to CLWA to increase water supplies is to participate in voluntary water transfer programs. Since the drought of 1987-1992, the concept of water transfer has evolved into a viable supplemental source to improve supply reliability. The initial concept for water transfers was codified into law in 1986 when the California Legislature adopted the "Katz" Law (California Water Code, Sections 1810-1814) and the Costa-Isenberg Water Transfer Law of 1986 (California Water Code, Sections 470, 475, 480-483). These laws help define parameters for water transfers and set up a variety of approaches through which water or water rights can be transferred among individuals or agencies.

Up to 27 million af of water are delivered for agricultural use every year. Over half of this water use is in the Central Valley, and much of it is delivered by, or adjacent to, SWP and Central Valley Project (CVP) conveyance facilities. This proximity to existing water conveyance facilities could allow for the voluntary transfer of water to many urban areas, including CLWA, via the SWP. Such water transfers can involve water sales, conjunctive use and groundwater substitution, and water sharing and usually occur as a form of spot, option, or core transfers agreement. The costs of a water transfer would vary depending on the type, term, and location of the transfer. The most likely voluntary water transfer programs would probably involve the Sacramento or southern San Joaquin Valley areas.

One of the most important aspects of any resource planning process is flexibility. A flexible strategy minimizes unnecessary or redundant investments (or stranded costs). The voluntary purchase of water between willing sellers and buyers can be an effective means of achieving flexibility. However, not all water transfers have the same effectiveness in meeting resource needs. Through the resource planning process and ultimate implementation, several different types of water transfers could be undertaken.

3.4.1.1 Core Transfers

Core transfers are agreements to purchase a defined quantity of water every year. These transfers have the benefit of more certainty in costs and supply, but in some years can be surplus to imported water (available in most years) that is already paid for.

3.4.1.2 Spot Market Transfers

Spot market transfers involve water purchased only during the time of need (usually a drought). Payments for these transfers occur only when water is actually requested and delivered, but there is usually greater uncertainty in terms of costs and availability of supply. Examples of such transfers were the Governor's Drought Water Banks of 1991 and 1992. An additional risk of spot

market transfers is that the purchases may be subject to institutional limits or restricted access (e.g., requiring the purchasing agency to institute rationing before it is eligible to participate in the program).

3.4.1.3 Option Contracts

Option contracts are agreements that specify the amount of water needed and the frequency or probability that the supply will be called upon (an option). Typically, a relatively low up-front option payment is required and, if the option is actually called upon, a subsequent payment would be made for the amount called. These transfers have the best characteristics of both core and spot transfers. With option contracts, the potential for redundant supply is minimized, as are the risks associated with cost and supply availability.

3.4.1.4 Future Market Transfers

The most viable types of water transfers are core and option transfers and, as such, represent CLWA's long-term strategy. The costs for these types of transfers have been estimated to be about $60 to $110 per af (equivalent to $1,100 to $2,000 per af for Table A Amount) for core transfers and $250 per af for option transfers. Although the option transfer costs might seem high, the equivalent average annual cost is much less - about $65 to $112 per af. Average annual option transfer costs are much lower due to the variable likelihood that the transfers will be needed. Currently, CLWA is proceeding with environmental compliance to acquire a core transfer of an additional 11,000 afy of surface water from the Buena Vista Water Storage District and Rosedale-Rio Bravo Water Storage District, both located in Kern County.

3.4.2 Groundwater Banking Programs

With recent developments in conjunctive use and groundwater banking, significant opportunities exist to improve water supply reliability for CLWA. Conjunctive use is the coordinated operation of multiple water supplies to achieve improved supply reliability. Most conjunctive use concepts are based on storing groundwater supplies in times of surplus for use during dry periods and drought when surface water supplies would likely be reduced.

Groundwater banking programs involve storing available SWP surface water supplies during wet years in groundwater basins in, for example, the San Joaquin Valley. Water would be stored either directly by surface spreading or injection, or indirectly by supplying surface water to farmers for their use in lieu of their intended groundwater pumping. During water shortages, the stored water could be pumped out and conveyed through the California Aqueduct to CLWA as the banking partner, or used by the farmers in exchange for their surface water allocations, which would be delivered to CLWA as the banking partner through the California Aqueduct. Several conjunctive use and groundwater banking opportunities are available to CLWA.

In 2003, CLWA produced a Draft Water Supply Reliability Plan. The plan outlines primary elements that CLWA should include in its water supply mix to obtain maximum overall supply reliability enhancement. These elements include both conjunctive use and groundwater banking programs, as well as water acquisitions. The Plan also contains a recommended implementation plan and schedule.

The reliability plan recommends that CLWA obtain total banking storage capacity of 50,000 af, with pumpback capacity of 20,000 af per year, by 2005. For the long-term, CLWA should obtain a total of 183,000 af of storage capacity, with total pumpback capacity of 70,000 af per year by 2050. Table 3-11, taken from the 2003 Draft Water Supply Reliability Report, presents an implementation schedule recommended for both storage and pumpback capacity beginning in 2005 and incrementally increasing through 2050.

Table 3-11
Recommended Schedule for Water Banking Capacity(1)

Year	Total Pumpback (afy)	Total Storage (afy)
2005	20,000	50,000
2010	20,000	50,000
2020	40,000	100,000
2030	60,000	150,000
2040	70,000	183,000
2050	70,000	183,000

Notes:
(1) Reference "Draft Report – CLWA Water Supply Reliability Plan", Kennedy/Jenks Consultants, 2003.

3.4.2.1 Semitropic Water Banking

Semitropic Water Storage District (Semitropic) provides SWP water to farmers for irrigation. Semitropic is located in the San Joaquin Valley in the northern part of Kern County immediately east of the California Aqueduct. Using its available groundwater storage capacity (approximately one million af), Semitropic has developed a groundwater banking program, which it operates by taking available SWP supplies in wet years and returning the water in dry years. As part of this dry-year return, Semitropic can leave its SWP water in the Aqueduct for delivery to a banking partner and increase its groundwater production for its farmers. Semitropic constructed facilities so that groundwater can be pumped into a Semitropic canal and, through reverse pumping plants, be delivered to the California Aqueduct. Semitropic currently has six banking partners: the Metropolitan Water District of Southern California (Metropolitan), Santa Clara Valley Water District, Alameda County Water District, Alameda County Flood Control and Water Conservation District Zone 7, Vidler Water Company, and The Newhall Land and Farming Company. The total amount of storage under contract is approximately 1 million af.

In 2002, CLWA stored an available portion of its Table A Amount (24,000 af) in an account in Semitropic's program.[5] In 2004, 32,522 af of available 2003 Table A Amount water was stored in a second Semitropic account.[6] In accordance with the terms of CLWA's storage agreements with Semitropic, 90 percent of the banked amount, or a total of 50,870 af, is recoverable through 2013 to meet CLWA water demands when needed. Each account has a term of ten years for the

[5] CLWA's approval of this project and of its negative declaration was challenged under the California Environmental Quality Act ("CEQA") in the Ventura County Superior Court (i.e., California Water Network v. Castaic Lake Water Agency [Ventura County Superior Court Case No. CIV 215327]). Finding that CLWA's approval of this project and of its negative declaration did not violate CEQA, the trial entered judgment in favor of CLWA. Petitioners have, however, filed an appeal with the California Court of Appeal, Second Appellate District, Division 6 Court of Appeal Case No. B177978.
[6] No legal challenge was made to CLWA's approval of this project or to the negative declaration for this project.

water to be withdrawn and delivered to CLWA.[7] Current operational planning includes use of the water stored in Semitropic for dry-year supply. Accordingly, it is reflected in the available supplies delineated in this section, and it is also reflected in contributing to short-term (prior to 2013) reliability in Chapter 6.

3.4.2.2 Rosedale-Rio Bravo Water Storage District Water Banking

Also located in Kern County, immediately adjacent to the Kern Water Bank, Rosedale-Rio Bravo Water Storage District has completed environmental documentation for a Water Banking and Exchange Program. The initial offering from the program is storage and pumpback capacity of 20,000 afy, with up to 100,000 af of storage capacity. This banking program would meet the total pumpback and exceed the total storage capacity in 2010 recommended in the implementation schedule provided in the 2003 Draft Water Supply Reliability Report. This program is available for subscription and, in 2004, CLWA signed an MOU with Rosedale-Rio Bravo to begin preliminary non-binding negotiations on the possible terms for participation in the program. Such terms would define a project that would then be subject to subsequent environmental analysis. In April 2005, CLWA and Rosedale-Rio Bravo executed a deposit agreement for the exclusive right to negotiate, and CLWA approved an EIR in October 2005. This project is a water management program to improve the reliability of CLWA's existing dry-year supplies; it is not, and should not be considered, an annual supply that could support growth. CLWA anticipates that, upon completion of CEQA documentation, this program will be operational by 2006.

3.4.2.3 Other Opportunities

The Draft Water Supply Reliability Plan recommends water banking storage and pumpback capacity both north and south of CLWA's service area, the latter of which would provide an emergency supply in case of catastrophic outage along the California Aqueduct. With short-term storage now existing in the Semitropic program and negotiations underway with Rosedale-Rio Bravo, CLWA is assessing southern water banking opportunities. These include potential programs with the Chino Basin Watermaster (with whom CLWA signed an MOU in 2003), Calleguas Municipal Water District, and San Gorgonio Pass Water Agency.

Groundwater banking and conjunctive-use programs enhance the reliability of both the existing and future supplies. Table 3-12 summarizes CLWA's future reliability enhancement programs.

Table 3-12
Future Reliability Enhancement Programs

Project Name	Year Available	Proposed Quantities (af)		
		Average/ Normal Year	Single Dry Year	Multiple Dry Years (1)
Rosedale-Rio Bravo Water Banking Program	2006	0	20,000	20,000
Additional Planned Banking Programs	2014	0	20,000	20,000

Notes:
(1) Supplies shown are maximum withdrawal capacity for each of four consecutive dry years.

[7] Thereafter, the remaining amount of project water is forfeited from the account.

3.5 PLANNED WATER SUPPLY PROJECTS AND PROGRAMS

The 2003 Draft Water Supply Reliability Plan also discusses the potential for acquiring additional water supplies to meet future demands (the plan refers to these as "water transfer opportunities"). Table 3-13 summarizes CLWA's transfer and exchange opportunities.

Table 3-13
Transfer and Exchange Opportunities

Source Transfer Agency	Transfer/ Exchange	Year Available	Short/Long Term	Proposed Quantity (afy)
Buena Vista-Rosedale (1)	Transfer	2006	Long Term	11,000

Notes:
(1) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

Buena Vista Water Storage District/Rosedale-Rio Bravo Water Storage District Water Storage and Recovery Program

These two districts, both located in Kern County, have joined together to develop a program that provides both a firm water supply and a water banking component. Both districts are member agencies of the Kern County Water Agency (KCWA), an SWP contractor, and both districts have contracts with KCWA for SWP Table A Amounts. Environmental documentation has been completed for this program, which envisions a single partner purchasing a firm annual water supply, which can then be banked in years when it is not needed for withdrawal and delivery in later years. The supply is based on existing long-standing Kern River water rights, which would be delivered by exchange of SWP Table A Amount. In 2004, CLWA signed an MOU with both districts to begin preliminary non-binding negotiations on the possible terms for participation in the program. Such terms would define a project subject to subsequent environmental analysis. The initial offering from the program is up to 11,000 afy of firm supply. In December 2004, CLWA, Buena Vista, and Rosedale-Rio Bravo executed a deposit agreement for the exclusive right to negotiate, and CLWA started preparing an EIR. CLWA anticipates that, upon completion of CEQA documentation, this program will be operational during 2006.

3.6 DEVELOPMENT OF DESALINATION

The California UWMP Act requires a discussion of potential opportunities for use of desalinated water (Water Code Section 10631[i]). CLWA has explored such opportunities, and they are described in the following section, including opportunities for desalination of brackish water, groundwater, and seawater. However, at this time, none of these opportunities is practical or economically feasible for CLWA, and CLWA has no current plans to pursue them. Therefore, desalinated supplies are not included in the supply summaries in this Plan (e.g., Tables 3-1, 6-2, 6-3, and 6-4).

3.6.1 Opportunities for Brackish Water and/or Groundwater Desalination

As discussed in Chapter 5, the two sources of groundwater in the Valley are water drawn from the Alluvial Aquifer and from the Saugus Formation. Neither of these supplies can be considered brackish in nature, and desalination is not required.

However, CLWA and the retail water purveyors could team up with other SWP contractors and provide financial assistance in construction of other regional groundwater desalination facilities in exchange for SWP supplies. The desalinated water would be supplied to users in communities near the desalination plant, and a similar amount of SWP supplies would be exchanged and allocated to CLWA from the SWP contractor. A list summarizing the groundwater desalination plans of other SWP contractors is not available; however, CLWA would begin this planning effort should the need arise.

In addition, should an opportunity emerge with a local agency other than an SWP contractor, an exchange of SWP deliveries would most likely involve a third party, such as Metropolitan. Most local groundwater desalination facilities would be projects implemented by retailers of SWP contractors and, if an exchange program was implemented, would involve coordination and wheeling of water through the contractor's facilities to CLWA.

3.6.2 Opportunities for Seawater Desalination

Because the Valley is not in a coastal area, it is neither practical nor economically feasible for CLWA and its purveyors to implement a seawater desalination program. However, similar to the brackish water and groundwater desalination opportunities described above, CLWA and the purveyors could provide financial assistance to other SWP contractors in the construction of their seawater desalination facilities in exchange for SWP supplies.

CLWA and the purveyors have been following the existing and proposed seawater desalination projects along California's coast. In March 2004, the California Coastal Commission released the "Seawater Desalination and the California Coastal Act." This Act provides a summary and status of the existing and proposed seawater desalination plants along California's coast. Tables 3-14 and 3-15 provide a summary of several of California's existing and proposed municipal/domestic seawater desalination facilities, respectively.

As shown in the tables, most of the existing and proposed seawater desalination facilities are/would be operated by agencies that are not SWP contractors. However, in these cases as described above, an exchange for SWP deliveries would most likely involve a third party (SWP contractor), the local water agency (retailer), and CLWA.

Table 3-14
Existing Seawater Desalination Facilities Along the California Coast[1]

Operator/Location	Maximum Capacity (gpd/afy[2])	Status
City of Morro Bay	830,000/930	Intermittent Use
City of Santa Barbara	N/A	Inactive
Marina Coast Water District	300,000/335	Active

Notes:
(1) Reference "Seawater Desalination and the California Coastal Act," California Coastal Commission, March 2004.
(2) gpd = gallons per day; afy = acre-feet per year

Although not listed in Table 3-15, the Bay Area Regional Desalination Partnership, made up of four agencies collaborating on a Regional Desalination Project in the San Francisco Bay Area, is working to develop desalination as a water supply for the region. This partnership, comprised of San Francisco Public Utilities Commission, Santa Clara Valley Water District, East Bay Municipal Utilities District, and Contra Costa Water District, is in the process of planning regional seawater/brackish water desalination facilities. This regional desalination project is an example of the type of project that CLWA could participate in on an exchange basis.

Table 3-15
Proposed Seawater Desalination Facilities Along the California Coast[1]

Operator/Location	Maximum Capacity (gpd/afy[2])	Status
Cambria Community Services District	500,000/560	Planning
City of Santa Cruz	2,500,000/2,800	Planning
Marina Coast Water District/Fort Ord	2,680,000/3,000	Planning
Long Beach	10,000,000/11,000	Planning
Los Angeles Dept. of Water & Power	10,000,000/11,000	Planning
Monterey Peninsula Water Mgmt. District/Sand City	7,500,000/8,400	Planning
Cal-Am/Moss Landing Power Plant	9,000,000/10,000	Planning
Municipal Water District of Orange County/Dana Point	27,000,000/30,000	Planning
Poseidon Resources/Huntington Beach	50,000,000/55,000	Draft EIR Complete
San Diego County Water Authority/San Onofre	TBD	Planning
San Diego County Water Authority/South County	50,000,000/55,000	Planning
San Diego County Water authority/Poseidon/Carlsbad	50,000,000/55,000	Planning
West Basin Municipal Water District	20,000,000/22,000	Planning

Notes:
(1) Reference "Seawater Desalination and the California Coastal Act," California Coastal Commission, March 2004.
(2) gpd = gallons per day; afy = acre-feet per year

Chapter 4
WATER RECYCLING

Chapter 4.0
RECYCLED WATER

4.1 OVERVIEW

This section of the Plan describes the existing and future recycled water opportunities available to the CLWA service area. The description includes estimates of potential supply and demand for 2005 to 2030 in five year increments, as well as CLWA's proposed incentives and optimization plan.

4.2 RECYCLED WATER MASTER PLAN

The four retail water purveyors provide water to M&I customers. In normal years, approximately 60 percent of the M&I demand within CLWA's service area is met with imported water. However, the reliability of the imported SWP supply is variable (due to its dependence on current year hydrology in northern California and prior year storage in SWP reservoirs). When sufficient imported water is not available, the balance is met with local groundwater provided by the purveyors.

It is anticipated that water demands will continue to increase. Accordingly, additional reliable sources of water are necessary to meet projected water demands. CLWA recognizes that recycled water is an important and reliable source of additional water. Recycled water would enhance reliability in that it would provide an additional source of supply and allow for more effective utilization of CLWA's water supplies. A Draft Reclaimed Water System Master Plan for the CLWA service area was completed in 1993, and a Draft Recycled Water Master Plan update was completed in 2002. Table 4-1 provides a list of the agencies that participated in the Recycled Water Master Plan update.

Table 4-1
Participating Agencies

Participating Agencies	Role in Plan Development
Castaic Lake Water Agency	Wholesale water provider
Newhall County Water District	Retail water purveyor
Santa Clarita Water Division	Retail water purveyor
Valencia Water Company	Retail water purveyor
Los Angeles County Waterworks District 36	Retail water purveyor
Los Angeles County Sanitation District 26	Recycled water supplier
Los Angeles County Sanitation District 32	Recycled water supplier
Berry Petroleum	Potential recycled water supplier

The Sanitation Districts of Los Angeles County (LACSD) own and operate two water reclamation plants (WRPs): Saugus WRP and Valencia WRP, within the CLWA service area. The water is treated to tertiary levels and discharged to the Santa Clara River. The Newhall Ranch development is also planning to construct a water recycling facility, and non-potable

water from this source may be incorporated into the CLWA's recycled water system. Additionally, Berry Petroleum has expressed interest in treating oilfield produced water from the Placerita Oilfield for sale to CLWA for non-potable uses. Oilfield produced water is a by-product of petroleum extraction, however, and would only be available on a short-term basis. By utilizing the effluent from the WRPs and oilfield produced water for irrigation and other non-potable purposes, CLWA can more efficiently allocate its potable water and increase the overall reliability of water supplies in the Valley.

4.3 POTENTIAL SOURCES OF RECYCLED WASTEWATER

LACSD provides wastewater collection, treatment, and disposal services to residents of two sanitation districts in the Valley: District Nos. 26 and 32, which serve the eastern and western portions of the Valley, respectively. The majority of the two districts' service areas lies within the City of Santa Clarita.

4.3.1 Existing and Planned Wastewater Treatment Facilities

4.3.1.1 Existing Facilities

LACSD's Saugus and Valencia WRPs operated independently until 1980, at which time the two plants were linked by a bypass interceptor. The interceptor was installed to transfer a portion of flows received at the Saugus WRP to the Valencia WRP. In order to improve operating efficiencies and because a shortage of space at the Saugus WRP limits future expansion of wastewater facilities in District No. 26, a joint powers agreement was enacted in 1984, creating the Santa Clarita Valley Joint Sewerage System. Through use of wastewater and sludge connecting lines, future expansions of treatment works, including sludge handling and disposal operations, will be provided at the larger Valencia WRP.

The primary sources of wastewater to the Saugus and Valencia WRPs are domestic. Both plants are tertiary treatment facilities and produce high quality effluent. Historically, the effluent from the two WRPs has been discharged to the Santa Clara River. The Saugus WRP effluent outfall is located approximately 400 feet downstream (west) of Bouquet Canyon Road. Effluent from the Valencia WRP is discharged to the Santa Clara River at a point approximately 2,000 feet downstream (west) of The Old Road Bridge.

Together, the Valencia and Saugus WRPs have a design capacity of 28.1 million gallons per day (mgd). In fiscal year 2002-2003 (FY 02/03), they produced an average of 18.33 mgd, none of which was used for recycled water purposes.

Located within District No. 26, the Saugus WRP, completed in 1962, is southeast of the intersection of Bouquet Canyon Road and Soledad Canyon Road. Two subsequent expansions and flow equalization facilities brought its current design capacity to 6.5 mgd. The treatment process was brought up to a tertiary level with the addition of dual-media pressure filters in 1987. However, no future expansions are possible due to space limitations at the site. In FY 02/03, the Saugus WRP produced an average effluent flow of 5.28 mgd (5,914 afy). Use of recycled water from this facility is permitted under Regional Water Quality Control Board (RWQCB) Order No. 87-49; however, LACSD staff has expressed concern about diverting these discharges due to potential impacts to downstream habitat. Until more detailed habitat

investigations are conducted, it is assumed that only recycled water from the Valencia WRP will be used.

The Valencia WRP is located within District No. 32 and is on The Old Road near Magic Mountain Amusement Park. The Valencia WRP was completed in 1967. The existing capacity is 21.6 mgd following three subsequent expansions: construction of a 4.4 million gallon flow equalization tank in February 1995, the Stage 4 expansion completed in June 1996, and the Joint Sewerage System Phase I expansion of 9 mgd in 2002. In FY 02/03, the Valencia WRP produced an average effluent flow of 13.05 mgd (14,628 afy). Use of recycled water from the Valencia WRP is permitted under RWQCB Order No. 87-48. On July 24, 1996, CLWA executed an agreement with LACSD to purchase up to 1,700 afy of recycled water from the Valencia WRP. In 2002, CLWA constructed the facilities to utilize this supply and initiated deliveries in 2003 to the Westridge Golf Course.

Recycled water from Valencia WRP has been used in the past by the City of Santa Clarita for landscape irrigation and by Pacific Pipeline and Oberg Construction for construction applications, delivered via tanker truck. In April 2000, a contract was signed with TransCoast Financial for use of up to 20,000 gallons per day (gpd) for dust control at a nearby composting facility. When recycled water is requested, it is transported via tanker truck.

4.3.2 Planned Improvements and Expansions

To accommodate anticipated growth in the Valley and to ensure compliance with discharge requirements from the RWQCB, LACSD has begun an expansion of the Valencia WRP as part of the 2015 Joint Sewerage System Facilities Plan. The ultimate capacity of the WRP is planned to be 27.6 mgd. The Phase I expansion (9 mgd increase) was completed in 2002. Phase 2 is expected to be completed in 2010 and involves an additional 6 mgd increase. No expansion is planned at the Saugus WRP. Thus, the ultimate total capacity for both WRPs is 34.1 mgd (38,200 afy). Table 4-2 provides the projected wastewater flow for the combined Valencia and Saugus WRP planning area.

Table 4-2
Wastewater Collection and Capacity

Type of Wastewater	Capacity (af)						
	2002	2005	2010	2015	2020	2025	2030
Wastewater Collected and Treated in Service Area	20,542	31,500	38,200	38,200	38,200	38,200	38,200
Quantity that Meets Recycled Water Standard	20,542	31,500	38,200	38,200	38,200	38,200	38,200

Note:
(1) Information collected from LACSD and Draft 2002 Recycled Water Master Plan.

4.3.3 Water Rights

The ability of CLWA to use recycled water is constrained by its rights to use the water available. While there are few regulatory limitations on the use of oilfield produced water, the use of wastewater effluent is limited by various state water laws, codes, and court decisions. These

regulatory limitations are described in greater detail in the 2002 Draft Recycled Water Master Plan.

CLWA has been approved to use 1,700 afy, but the ultimate recycled water use is governed by the availability of native versus foreign water as shown in Table 4-3. According to the Water Code Section 1211, downstream water rights holders are protected if the source of return flow is "native water." Native water is water that under natural conditions would contribute to a given stream or other body of water (i.e., surface water or percolating groundwater). Thus, if the source of water is "foreign" (e.g., imported or SWP water), downstream water rights holders are not protected under the code. Groundwater extracted from and used in the Valley and then discharged to the Santa Clara River as wastewater effluent may be considered a "native water" to the river; whereas, SWP water imported into and used in the Valley and then discharged to the Santa Clara River as wastewater effluent may be considered a "foreign water." Furthermore, while existing discharges may have a permanent public use (i.e., habitat), only the "foreign water" percentage within the effluent flows can be diverted for recycling purposes.

In 2005, the Valley's potable water supply is projected to consist of approximately 36 percent groundwater (native water) and 64 percent imported water (foreign water). Projected potable water demand for the year 2030 is approximately 112,500 af, 65 percent derived from foreign water and 35 percent derived from native sources. The projected recycled water component would consist of approximately 65 percent (72,800 af foreign / 112,500 total) of projected wastewater generation. Therefore, CLWA's future recycled water system is limited to the foreign water portion of wastewater. This volume is determined by multiplying the percentage of foreign water by the wastewater flow. As shown in Table 4-3, the future foreign water portion of wastewater is 24,830 afy (65 percent times 38,200 afy). It is important to note that these percentages are of potable water demand (i.e., they do not include the use of recycled water in the calculation) and as such are not percentages of total water demand. Although the foreign water percentage of potable water demand only increases by one percent from 2005 to 2030, actual use of foreign water increases by approximately 58 percent.

Table 4-3
Use of Native Water vs. Foreign Water

	Native Water Demand (afy)	Foreign Water Demand (afy)[(1)]	Recycled Water Demand (afy)	Potable Water Demand Total (afy)	Wastewater Flow[(2)] (afy)	Foreign Water Percentage of Potable Water Demand	Foreign Water Portion of Wastewater (afy)
Projected (2005)	25,500	46,100	800	71,600	31,500	64%	20,100
Future (2030)	39,700	72,800	17,391	112,500	38,200	65%	24,830

Note:
(1) Foreign water includes SWP water, water transfers, and desalination.
(2) From Table 4-2.

In order to maintain native water rights, and assuming the ultimate capacities and recycled water demand (as discussed in Section 4.3), the existing and planned methods of wastewater effluent discharge and use are as summarized in Table 4-4.

Table 4-4
Disposal of Wastewater (non-recycled)

Method of Disposal	Treatment Level	Wastewater Discharge and Use (af)					
		2005	2010	2015	2020	2025	2030
Discharge to Santa Clara River	Disinfected, tertiary	30,700	36,600	34,900	30,200	25,500	20,800
Recycled Water Users	Disinfected Tertiary	800	1,600	3,300	8,000	12,700	17,400
Total		**31,500**	**38,200**	**38,200**	**38,200**	**38,200**	**38,200**

4.3.4 Other Potential Sources of Recycled Water

4.3.4.1 Newhall Ranch Water Reclamation Plant

A third Valley reclamation plant is proposed as part of the Newhall Ranch project. This proposed facility would be located near the western edge of the development project along the south side of State Route 126. The plant will be constructed in stages, with an ultimate capacity of 7.7 mgd. Effluent from the proposed water reclamation plant would be used to meet non-potable water demand within the development area. According to the Newhall Ranch Draft Additional Analyses, this plant is projected to produce 5,344 afy on average. During the dry months, all of the recycled water would be used for non-potable uses within Newhall Ranch, supplemented by additional recycled water from CLWA. During the wet winter months when demands are low, the Newhall Ranch WRP would on average have approximately 286 afy excess recycled water. In order for the WRP to be non-discharging (i.e., have production equal demand), this recycled water would be transferred into CLWA's recycled water system for use and/or storage. Any excess demand would need a National Pollutant Discharge Elimination System (NPDES) permit prior to discharge. NPDES permits could place stricter regulatory limitation on the effluent, which may increase treatment costs. Furthermore, the discharge could be subject to additional environmental review prior to approval.

4.3.4.2 Oilfield Produced Water

Oilfield produced water is a by-product of oil production generated when oil is extracted from the oil reservoir. It is generally of poor quality and unsuitable for potable, industrial, or irrigation use without treatment. Because of the poor water quality, reinjection has often been the most cost-effective disposal option.

Treatment processes can produce potable quality water; yet, because of the poor initial water quality and the organic constituents, it is often more appropriate for treated oilfield produced water to be used for irrigation or industrial purposes to offset potable water demand. Pilot studies performed at the Placerita Oilfield have indicated that, even with reverse osmosis (RO) treatment, some organic compounds such as naphthalene, 2-butanone, and ethylbenzene, can be detected in the RO effluent.

The economics of oil production are market-driven and are different from those of drinking water supplies. As oil prices rise or drop, oilfields go into and out of production depending on the costs of production. Also, oilfields are eventually depleted of supply and abandoned. Therefore, while oilfield produced water should be considered as long-term, it is not a completely firm supply and is not permanent.

Studies of the potential reuse of treated oilfield produced water from the Placerita Oilfield have indicated that approximately 44,000 barrels per day (1.8 mgd) of treated oilfield produced water may be available. For irrigation reuse, the produced water would need to be cooled and treated to remove hardness, silica, total dissolved solids (TDS), boron, ammonia, and total organic carbon (TOC).

4.3.5 Summary of Available Source Water Flows

As discussed previously, the non-potable water system has four potential sources of water. The flows projected to be available are shown in Table 4-5. For planning purposes, only recycled water from LACSD is considered available to meet the projected recycled water demands due to the level of evaluation still needed on the alternative sources.

Table 4-5
Summary of Available Source Water Flows

Source	Current Capacity (mgd)	Projected Capacity (mgd)	Projected to be Available for Non-Potable Use (afy)
LACSD Total	28.1	34.1	19,995
Valencia WRP	*21.6*	*27.6*	*19,995*
Saugus WRP	*6.5*	*6.5*	*0*
Oilfield Produced Water	0	1.8	1,980
Newhall Ranch WRP	0	7.7	5,344
Total			**27,319**

4.4 RECYCLED WATER DEMAND

In this section, current recycled water use is discussed, and potential recycled water users within CLWA's service area are identified as determined from the 2002 Draft Recycled Water Master Plan. For each potential user, estimates are provided for annual demand, peak monthly demand, peak daily demand, and the hourly distribution of water demand during peak months. The requirements for potential users to convert their existing water potable systems to recycled water are also discussed.

4.4.1 Current Use

Currently, Recycled water is served to landscape irrigation customers, including the Westridge Golf Course. Table 4-6 provides a summary of existing recycled water use.

Table 4-6
Actual Recycled Water Uses

Type of Use	Treatment Level	Actual 2004 Use (af)
Landscape	Disinfected tertiary	448
Total		**448**

4.4.2 Potential Users

Potential recycled water users were identified through a number of sources including:

- 1993 Recycled Water Master Plan
- Water consumption records for LACWD No. 36, NCWD, SCWD, and VWC
- Land use maps
- General Plans and Specific Plans for the City of Santa Clarita and County of Los Angeles
- Discussions with City, County, water purveyor, and land developer staff
- "Windshield" survey of CLWA service area
- Draft 2002 Recycled Water Master Plan

In order to be considered as a potential recycled water user, the user had to be located within CLWA's service area and have a potential non-potable water demand of at least 4 afy. A total potential demand for existing and future recycled water users is 34,500 afy as identified in the Draft 2002 Recycled Water Master Plan for 2015. As this volume is already greater than the anticipated source of recycled water supply, additional future recycled users were not identified at this time. However, CLWA may reevaluate the list of recycled users after 2015 to consider future users not included in the Draft Master Plan. Table 4-7 provides a summary of the demands by user type.

Table 4-7
Potential Recycled Water Uses

Type of Use	Treatment Level	Potential Use (af)				
		2010	2015	2020	2025	2030
Landscape	Disinfected tertiary	34,500	34,500	34,500	34,500	34,500
Total		**34,500**	**34,500**	**34,500**	**34,500**	**34,500**

The initial list of potential recycled water users was reduced by evaluating the potential users that would be most expensive to serve until potential uses were approximately 17,000 afy. The unit cost to serve each user was calculated using the capital costs for pipelines, reservoirs, and pump stations as well as operational costs for pumping. The areas retained for recycled water service have costs per af ranging from $120 to $5,000. Areas eliminated from service had costs as high as $13,000/af. However, only two of the proposed phases in the Draft Master Plan had costs above $1,000 per af. The resulting proposed recycled water service area encompasses a large portion of CLWA's western service area.

4.4.3 Potential Recycled Water Demand

Potential annual recycled water demands were estimated from historical water use records for existing users and the proposed irrigated area and expected water use per acre for future users. Demands for recycled water are seasonal, with the highest demands occurring during the hot, dry summer months when irrigation requirements are greatest.

The total potential annual recycled water demand that is cost effective to serve is approximately 17,400 afy. Implementation of the recycled water system is expected to occur over the next 25 years. Table 4-8 summarizes the projected future use by user type.

Table 4-8
Projected Potential Future Use of Recycled Water in Service Area

Type of Use	Projected Use (af)				
	2010	2015	2020	2025	2030
Landscape	1,600	3,300	8,000	12,700	17,400
Total	1,600	3,300	8,000	12,700	17,400

4.4.4 Recycled Water Comparison

CLWA's 2000 UWMP projected a total recycled water demand of 19,612 afy by the year 2010. Although it did not specifically state a projected 2005 demand, CLWA had approval for 1,700 afy of recycled water use and was in the process of constructing the necessary facilities to deliver this amount at the time the 2000 UWMP was written. Approximately 448 afy was served in 2004 to landscape irrigation customers, including the Westridge Golf Course. Current demand is lower than originally predicted due to delays in the necessary environmental documentation and funding availability to expand the recycled water distribution system. Table 4-9 provides a comparison of the 2000 projected demand versus the actual 2004 demand.

Table 4-9
Recycled Water Uses - 2000 Projection Compared with 2004 Actual

User Type	2000 Projection for 2005 (af)	2004 Actual Use (af)
Landscape	1,700	448
Total	**1,700**	**448**

4.5 METHODS TO ENCOURAGE RECYCLED WATER USE

In order to provide an incentive to recycled water users, it was recommended in the Draft 2002 Recycled Water Master Plan that the CLWA issue a monthly rebate directly to each recycled water user. However, CLWA is currently considering utilizing a two-fold approach to encourage recycled water use. CLWA plans on making recycled water available at a reduced rate and to work with the City of Santa Clarita and Los Angeles County to adopt a Recycled Water Ordinance, mandating recycled use for certain applications. A Draft Ordinance is currently

being developed and is anticipated to be ready for review in late 2005. The recycled water incentives are summarized in Table 4-10.

Table 4-10
Methods To Encourage Recycled Water Use

Actions	Use Projected to Result From This Action [(1)] (af)				
	2010	2015	2020	2025	2030
Reduced Rate/Recycled Water Ordinance	800	1,600	3,980	6,340	8,700
Total	800	1,600	3,980	6,340	8,700

Note:
(1) Estimated as the projected use due to future customers and assuming future customer use is half of projected recycled water demand for the given years.

CLWA may consider providing financial assistance to retail water providers to offset the costs of extending the recycled water conveyance system or to existing customers to cover a portion of or all of the costs to convert their potable water system to receive recycled water.

4.6 OPTIMIZATION PLAN

Production from the WRPs is not anticipated to be adequate to meet the total demands of the system. However, as potable water demands increase and, consequently, recycled water production increases, the water available to meet system demands would also increase. Therefore, it is recommended that construction of the recycled water system be phased to utilize the increases in plant production.

Oilfield produced water would also not be available immediately, nor would it be available as a permanent source of supply. Instead, this alternative water source would be used as an interim supply when the field is in operation and inadequate recycled water is available from Valencia WRP. Oilfield produced water is anticipated to be available as a long-term supply, available for approximately the next 20 years. The phasing considers when this water source would be available. A detailed discussion of the recommended phasing plan is provided in the Draft Master Plan.

Phasing implementation of the recycled water system is recommended for the following reasons:

- A number of the potential recycled water users are future users that do not yet need recycled water.
- The current flow of the Valencia WRP is not adequate to meet the total demands of the recycled water users.
- Capital requirements would be spread over CLWA's current planning period through 2030.
- Oilfield produced water is not immediately (nor permanently) available.
- Demand is increasing due to development of Newhall Ranch

The recycled water system is divided into implementation phases based primarily on service zone boundaries.

In general, the following factors were considered in developing a phasing plan:

- Ease or willingness of customers to connect to recycled water
- Retrofit costs
- Regulatory requirements
- Community impacts and development requirements
- Water utility involvement/cooperation
- Funding availability
- Reliability and operational costs considerations
- System flexibility

The implementation phases are prioritized based on the status of the users (existing or future), the anticipated construction schedule of future users, and the proximity of the users to the non-potable water source (e.g., Valencia WRP, Placerita Oilfield).

Chapter 5
WATER QUALITY

Chapter 5.0
WATER QUALITY

5.1 OVERVIEW

The quality of any natural water is dynamic in nature. This is true for the SWP and the local groundwater of the Basin. During periods of intense rainfall or snowmelt, routes of surface water movement are changed; new constituents are mobilized and enter the water while other constituents are diluted or eliminated. The quality of water changes over the course of a year. These same basic principles apply to groundwater. Depending on water depth, groundwater will pass through different layers of rock and sediment and leach different materials from those strata. Water depth is a function of local rainfall and snowmelt. During periods of drought, the mineral content of groundwater increases. Water quality is not a static feature of water, and these dynamic variables must be recognized.

Water quality regulations also change. This is the result of the discovery of new contaminants, changing understanding of the health effects of previously known as well as new contaminants, development of new analytical technology, and the introduction of new treatment technology. All water purveyors are subject to drinking water standards set by the Federal Environmental Protection Agency (EPA) and the California Department of Health Services (DHS). Additionally, investor-owned water utilities, such as VWC, are also subject to water quality regulation by the PUC. CLWA provides surface water from the SWP while local retail water purveyors combine local groundwater with treated SWP water from CLWA for delivery to their customers. (LACWWD #36 is an exception and during most years receives water from SWP.) An annual Consumer Confidence Report (CCR) is provided to all Valley residents who receive water from CLWA and one of the four retail water purveyors. That report includes detailed information about the results of quality testing of the water supplied during the preceding year (CCR, 2005).

The quality of water received by individual customers will vary depending on whether they receive SWP water, groundwater, or a blend. Some will receive only SWP water at all times, while others will receive only groundwater. Others may receive water from one well at one time, water from another well at a different time, different blends of well and SWP water at other times, and only SWP water at yet other times. These times may vary over the course of a day, a week, or a year.

This section provides a general description of the water quality of both imported water and groundwater supplies. A discussion of potential water quality impacts on the reliability of these supplies is also provided.

5.2 IMPORTED WATER QUALITY

CLWA provides SWP water to the Valley. The source of SWP water is rain and snow of the Sierra Nevada, Cascade, and Coastal mountain ranges. This water travels to the Delta through a series of rivers and various SWP structures. There it is pumped into a series of canals and reservoirs, which provides water to urban and agricultural users throughout the San Francisco

Bay Area and central and southern California. The most southern reservoir on the West Branch of the SWP California Aqueduct is Castaic Lake. CLWA receives water from Castaic Lake and distributes it to the purveyors following treatment.

Perhaps the most important difference in quality between surface water and groundwater is the presence of microbes in surface water. Surface water is exposed to a variety of microbial contaminants while groundwater in general is not. As a result, there are considerably more water quality regulations for surface water providers. CLWA has two surface water treatment plants, the Rio Vista Water Treatment Plant and the Earl Schmidt Water Filtration Plant, whose function is to ensure the safety of the water by eliminating microbial contaminants. Both of these plants have a multi-barrier strategy. The first barrier is the application of ozone, a powerful disinfectant, which has the ability to kill a broad range of microbes. The second barrier is the addition of chemicals to remove particles from the water, which can hide and protect microbes. Removing particles improves the anti-microbial action of the disinfectants. The water is then passed through two sets of filters, and chloramines are then added to the water. Chloramines are similar to chlorine and prevent the growth of bacteria in the distribution system, which delivers water from the treatment plants to the retail water purveyors.

An important property of SWP water is the chemical make up caused by its passage through the Delta. The Delta is basically a very large marsh (or estuary) with large masses of plants and peat soils. These contribute organic materials (TOC) to the water. Salt water can also move into the Delta from San Francisco Bay and the Pacific Ocean. This brings in salts, notably bromide and chloride. None of these chemicals are harmful in and of themselves; however, when bromide and TOC react with disinfectants such as ozone, chlorine, or chloramines, a reaction occurs forming substances known as disinfection by-products (DBPs). A variety of health-based concerns are associated with DBPs (CCR, 2005).

Another important property of SWP water is the mineral content. SWP water is generally low in dissolved minerals, such as calcium, magnesium, sodium, potassium, iron, manganese, nitrate, and sulfate. Most of these minerals do not have health based concerns, but “hard” water (water high in calcium, magnesium, and iron) can cause a number of problems for consumers, such as the formation of white crusts in plumbing fixtures, water spots, damage to water heaters, and excess use of soaps. Nitrate is the main exception, as it has significant health effects for infants; however, the nitrate content of SWP water is very low. Also of significance is the chloride content. Although not a human health risk, chloride can have a negative impact on agricultural activities and regulatory compliance for local sanitation agencies. The chloride content of SWP water varies widely from well over 100 milligrams per liter (mg/L) to below 40 mg/L, depending on Delta conditions.

All surface waters can have taste and odor problems caused by the growth of algae in reservoirs, such as Castaic Lake. Under certain conditions, algae can grow in large mats, which then die, releasing foul smelling chemicals. Although harmless, the taste and odor causing chemicals can generally be very unpleasant for consumers.

5.3 GROUNDWATER QUALITY

The Basin has two sources of groundwater. Most local wells draw water from the Alluvial Aquifer. A smaller portion of the Valley's water supply is drawn from the Saugus Formation, a much deeper aquifer than the Alluvial Aquifer. The quality components of these aquifers differ with changing rainfall conditions. The two aquifers' water quality changes at different rates and much more slowly than surface water.

Local groundwater generally does not have microbial water quality problems. Parasites, bacteria, and viruses are filtered out as the water percolates through the soil, sand, and rock on its way to the aquifer. Even so, disinfectants are added to local groundwater when it is pumped by wells to protect public health. Local groundwater has very little TOC and generally has very low concentrations of bromide, minimizing potential for DPB formation. Taste and odor problems from algae are not an issue with groundwater.

The mineral content of local groundwater is very different from SWP water. The groundwater is very "hard," that is, it has high concentrations of calcium and magnesium (approximately 250-600 mg/L, as developed in the CLWA et al 2005 Annual Water Quality Report). Groundwater may also contain higher concentrations of nitrates and chlorides when compared to SWP water. However, all groundwater meets or exceeds drinking water standards.

The following sections describe the groundwater quality of the Alluvium and Saugus Formation.

5.3.1 Groundwater Quality – Alluvium

Groundwater quality is a key factor in assessing the Alluvial Aquifer as a municipal and agricultural water supply. In terms of the aquifer system, there is no convenient long-term record of water quality, i.e., water quality data in one or more single wells that spans several decades and continues to the present. Thus, in order to examine a long-term record of water quality in the Alluvium, individual records have been integrated from several wells completed in the same aquifer materials and in close proximity to each other to examine historical trends in general mineral groundwater quality throughout the Basin. Based on these records of groundwater quality, wells within the Alluvium have experienced historical fluctuations in general mineral content, as indicated by specific conductance (or electrical conductivity [EC]), which correlates with fluctuations of individual constituents that contribute to EC. The historic water quality data indicates that, on a long-term basis, there has not been a notable trend and, specifically, there has not been a decline in water quality within the Alluvium.

Specific conductance within the Alluvium exhibits a westward gradient, corresponding with the direction of groundwater flow in the Alluvium. EC is lowest in the easternmost portion of the Basin and highest in the west. Water quality in the Alluvium generally exhibits an inverse correlation with precipitation and streamflow, with a stronger correlation in the easternmost portion of the Basin, where groundwater levels fluctuate the most. Wet periods have produced substantial recharge of higher quality (low EC) water, and dry periods have resulted in declines in groundwater levels, with a corresponding increase in EC (and individual contributing constituents) in the deeper parts of the Alluvium.

Specific conductance throughout the Alluvium is currently below the Secondary (aesthetic) Upper Maximum Contaminant Level of 1,600 micromhos per centimeter (umhos/cm). The presence of long-term consistent water quality patterns, although intermittently affected by wet and dry cycles, supports the conclusion that the Alluvial aquifer is a viable ongoing water supply source in terms of groundwater quality.

The most notable groundwater quality issue in the Alluvium is perchlorate contamination. In 2002, one Alluvial well located near the former Whittaker-Bermite facility was inactivated for municipal water supply due to detection of perchlorate slightly below the Notification Level. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. In response, VWC removed the well from active service and commissioned an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. Sections 5.4 and 5.5 present additional information on the results of the Q2 analysis and report and VWC's response plan for Well Q2 to pursue permitting and installation of wellhead treatment, which resulted in returning the well to water supply service in October 2005.

5.3.2 Groundwater Quality – Saugus Formation

Similar to the Alluvium, groundwater quality in the Saugus Formation is a key factor in assessing that aquifer as a municipal and agricultural water supply. As with groundwater level data, long-term Saugus groundwater quality data is not sufficiently extensive (few wells) to permit any basin-wide analysis or assessment of pumping-related impacts on quality. As with the Alluvium, EC has been chosen as an indicator of overall water quality, and records have been combined to produce a long-term depiction of water quality. Water quality in the Saugus Formation has not historically exhibited the precipitation-related fluctuations seen in the Alluvium. Based on the historical record over the last 50 years, groundwater quality in the Saugus has exhibited a slight overall increase in EC. More recently, several wells within the Saugus Formation have exhibited an additional increase in EC similar to that seen in the Alluvium. In 2004, monthly data collected by VWC for two Saugus wells shows that the overall level of EC remained fairly stable during the year. Levels of EC in the Saugus Formation remain below the Secondary (aesthetic) Upper Maximum Contaminant Level for EC. Groundwater quality within the Saugus will continue to be monitored to ensure that degradation that presents concern relative to the long-term viability of the Saugus as an agricultural or municipal water supply does not occur.

As with the Alluvium, the most notable groundwater quality issue in the Saugus Formation is prechlorate contamination. Perchlorate was originally detected in four Saugus wells operated by the retail water purveyors in the eastern part of the Saugus Formation in 1997, near the former Whittaker-Bermite facility. Since then, the four Saugus municipal supply wells have been out of water supply service due to the presence of perchlorate. While the inactivation of those wells does not limit the ability of the purveyors to meet water requirements, there is an ongoing effort to restore impacted pumping capacity and contain potential perchlorate migration in the Saugus Formation by 2006 as discussed in Sections 5.4 and 5.5.

The local retail water purveyors continue to test for perchlorate in active water supply wells near the Whittaker-Bermite site, and there has been no additional detection of perchlorate in any other municipal Saugus well. Details are provided below on the various aspects of ongoing

perchlorate-related work, including investigation of the extent of contamination, development of an interrelated program for control and extraction of perchlorate by restoring impacted capacity (wells), treatment technology and its planned application for restoration of impacted wells, regulatory aspects of utilizing impacted wells with treatment for domestic water supply, and the current state of planning and implementation of perchlorate control and clean-up, including restoration of contaminated municipal water supply as part of that control and clean-up.

5.4 AQUIFER PROTECTION

As introduced in Chapter 3, three factors affect the availability of groundwater: sufficient source capacity (wells and pumps); sustainability of the groundwater resource to meet pumping demand on a renewable basis; and protection of groundwater sources (wells) from known contamination, or provisions for treatment in the event of contamination. The first two of those factors are addressed in Chapter 3. The third factor, the impact and resolution of contamination, is being addressed in the Valley's two aquifers as follows.

5.4.1 Alluvium

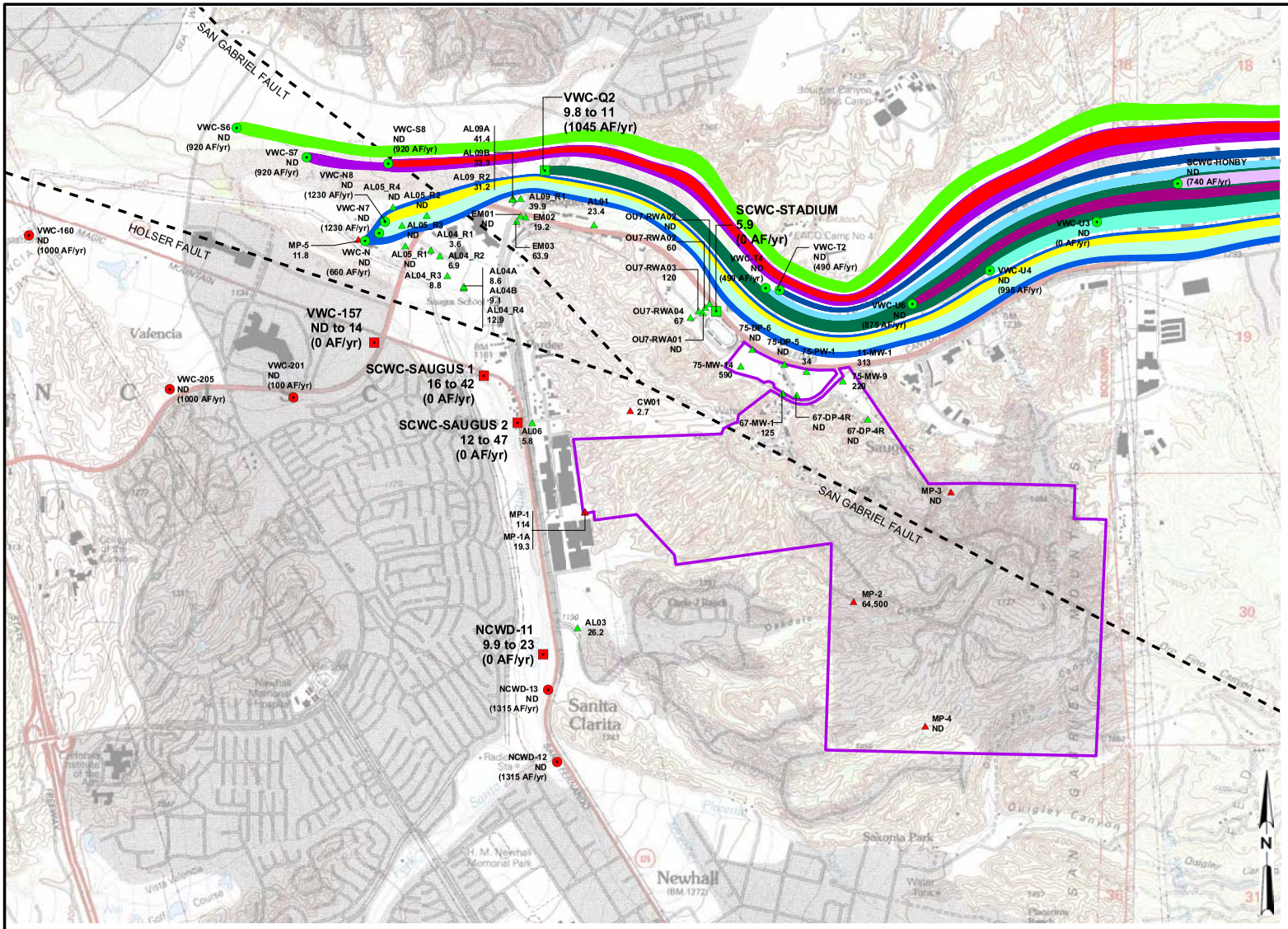
Details of the overall perchlorate contamination issue, which has had a larger impact on the Saugus Formation (four impacted wells with a total pumping capacity of 7,900 gpm) than on the Alluvium (one impacted well with a total pumping capacity of 800 gpm), are discussed in Appendix D of this Plan. As detailed in that Appendix, there has been extensive investigation of the extent of perchlorate contamination which, in combination with the groundwater modeling previously described, has led to the current plan for integrated control of contamination migration and restoration of impacted pumping (well) capacity in 2006. While most of the perchlorate contamination control and restoration plan is focused on the Saugus Formation, part of that plan includes potential capture of contaminated groundwater in the Alluvium by pumping of selected Saugus wells. Specific long-term resolution of perchlorate contamination in the Alluvium, which impacted two water supply wells, is focused on a combination of wellhead treatment at one well, the VWC's Well Q2, and several source control methods such as on-site pumping and treatment in the northern Alluvium (at the northerly portion of the former Whittaker-Bermite site) and subsequent restoration of the impacted Stadium well. In the interim, i.e., through 2006, a key challenge is protection of active Alluvial wells that could be impacted, including what effect that might have on adequacy of Alluvial groundwater pumping capacity and what response will be taken.

In April 2005, perchlorate was detected in VWC's Well Q2. VWC's response was to remove the well from active water supply service and to rapidly seek approval for installation of wellhead treatment and return of the well to service. As part of outlining its plan for treatment and return of the well to service, VWC analyzed the impact of the temporary inactivation of the well on its water supply capability; the analysis determined that VWC's other sources are sufficient to meet demand and that the inactivation of Well Q2 thus had no impact on VWC's water supply capability (LSCE, 2005). VWC proceeded through mid-2005 to gain approval for installation of wellhead treatment (ion-exchange as described below), including environmental review, and completed the installation of the wellhead treatment facilities in September 2005. Well Q2 was returned to active water supply service in October 2005.

Ongoing monitoring of all active municipal wells near the Whittaker-Bermite site has shown no detections of perchlorate in any active Alluvial wells. However, based on a combination of proximity to the Whittaker-Bermite site and prevailing groundwater flow directions, complemented by findings in the ongoing on-site and off-site investigations by Whittaker-Bermite and the Army Corps of Engineers (ACOE) (See Appendix D), there is logical concern that perchlorate could impact nearby, downgradient Alluvial wells. As a result, provisions are in place to respond to perchlorate contamination if it should occur. The groundwater model was used to examine capture zones around Alluvial wells under planned operating conditions (pumping capacities and volumes) for the time period through currently scheduled restoration of impacted wells in 2006 (Technical Memorandum "Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property (Santa Clarita, California)", CH2M Hill, November 2004). The capture zone analysis of Alluvial wells generally near the Whittaker-Bermite site, shown on Figure 5-1, suggests that inflow to those wells will either be upgradient of the contamination site, or will be from the Alluvium beyond where perchlorate is most likely to be transported, with the possible exception of the VWC's Pardee wellfield, which includes Wells N, N7, and N8. Although the capture zone analysis does not show the Pardee wells to be impacted, they are considered to be at some potential risk due to the proximity of their capture zone to the Whittaker-Bermite site.

The combined pumping capacity of VWC's Pardee wells is 6,200 gpm, which equates to about 10,000 af of maximum annual capacity. However, in the operating plan for both normal and dry-year Alluvial pumping, the planned use of those wells represents 2,940 afy of the total 30,000 to 40,000 afy Alluvial groundwater supply. Thus, if the wells were to become contaminated with perchlorate, they would represent an amount of the total Alluvial supply that could be readily replaced, on a short-term interim basis, by utilizing an equivalent amount of imported water from CLWA or by utilizing existing capacity from other Alluvial wells (see Table 3-9 in Chapter 3.0). However, if the Pardee wells were to become contaminated by perchlorate contamination, VWC has made site provisions at its Pardee wellfield for installation of wellhead treatment. Such treatment would be the same methodology as installed at its Well Q2.

In addition to the preceding, on-site investigation by Whittaker-Bermite since late 2003 has resulted in the completion, in June 2005, of a Workplan for a Pilot Remediation Pumping Program in the Northern Alluvium and certain on-site sub-areas east/southeast, or generally upgradient, of the impacted Stadium well. That program basically involves the establishment of containment, generally along the northern boundary of the Whittaker-Bermite site, upgradient of the Stadium well, by continuous pumping of a former Whittaker-Bermite facility well, at a continuous low capacity, complemented by pumping at several groundwater "hot spots" also generally upgradient of the Stadium well. Due to the low conductivity nature of the aquifer materials at the various "hot spots," pumping for containment at those locations would be from several wells at low pumping capacities. Extracted water would be treated at Whittaker-Bermite's existing on-site treatment system. Generally consistent with the Saugus restoration concept, the Northern Alluvium pumping program would have the concurrent objectives of preventing site-related contaminants from leaving the site and removing some contamination from groundwater such that it can be removed in the on-site treatment process prior to discharge of the water back to the groundwater Basin.



LEGEND

CONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELL
- ALLUVIUM
- SAUGUS

TWO-YEAR GROUNDWATER CAPTURE ZONE
- SCWC-HONBY
- VWC-N
- VWC-N7
- VWC-N8
- VWC-Q2
- VWC-S6
- VWC-S7
- VWC-S8
- VWC-T2
- VWC-T4
- VWC-U4
- VWC-U6
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. PUMPING VALUES IN PARENTHESES ARE ANNUAL PUMPING VOLUMES
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; AF/yr = acre feet per year
5. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND 0.05 IN THE SAUGUS FORMATION.

FIGURE 5-1
FORECASTED TWO-YEAR GROUNDWATER CAPTURE ZONES FOR ACTIVE ALLUVIAL PRODUCTION WELLS LOCATED CLOSEST TO THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

CH2MHILL

5.4.2 Saugus Formation

Details of the overall nature and extent of perchlorate contamination are discussed in Appendix D. The program and schedule involves the ultimate installation of treatment facilities to both extract contaminated water and control migration in the aquifer, such that the impacted capacity is restored and perchlorate migration is controlled in 2006.

In the interim, the question of whether existing active Saugus wells are likely to be contaminated by perchlorate migration prior to the installation of treatment and pumping for perchlorate contamination control has been evaluated by using the groundwater flow model to analyze capture zones of existing active wells through 2006, the scheduled period for permitting, installation of treatment, and restoration of impacted capacity. For that analysis, recognizing current hydrologic conditions and available supplemental SWP supplies, the rate of Saugus pumping was conservatively projected to be in the normal range (7,500 to 15,000 afy) for the near-term. The results of the capture zone analysis, illustrated on Figure 5-2, were that the two nearest downgradient Saugus wells, VWC's Wells 201 and 205, would draw water from very localized areas around the wells and would not draw water from locations where perchlorate has been detected in the Saugus. As shown on the figure, the capture zone analysis projected Well 201 would potentially draw Saugus groundwater from areas located up to 450 feet east of the well, but was unlikely to draw water from areas farther to the east through that time period. During the same time, Well 205 would potentially draw Saugus groundwater from areas as much as 650 feet to the east and northeast of this well.

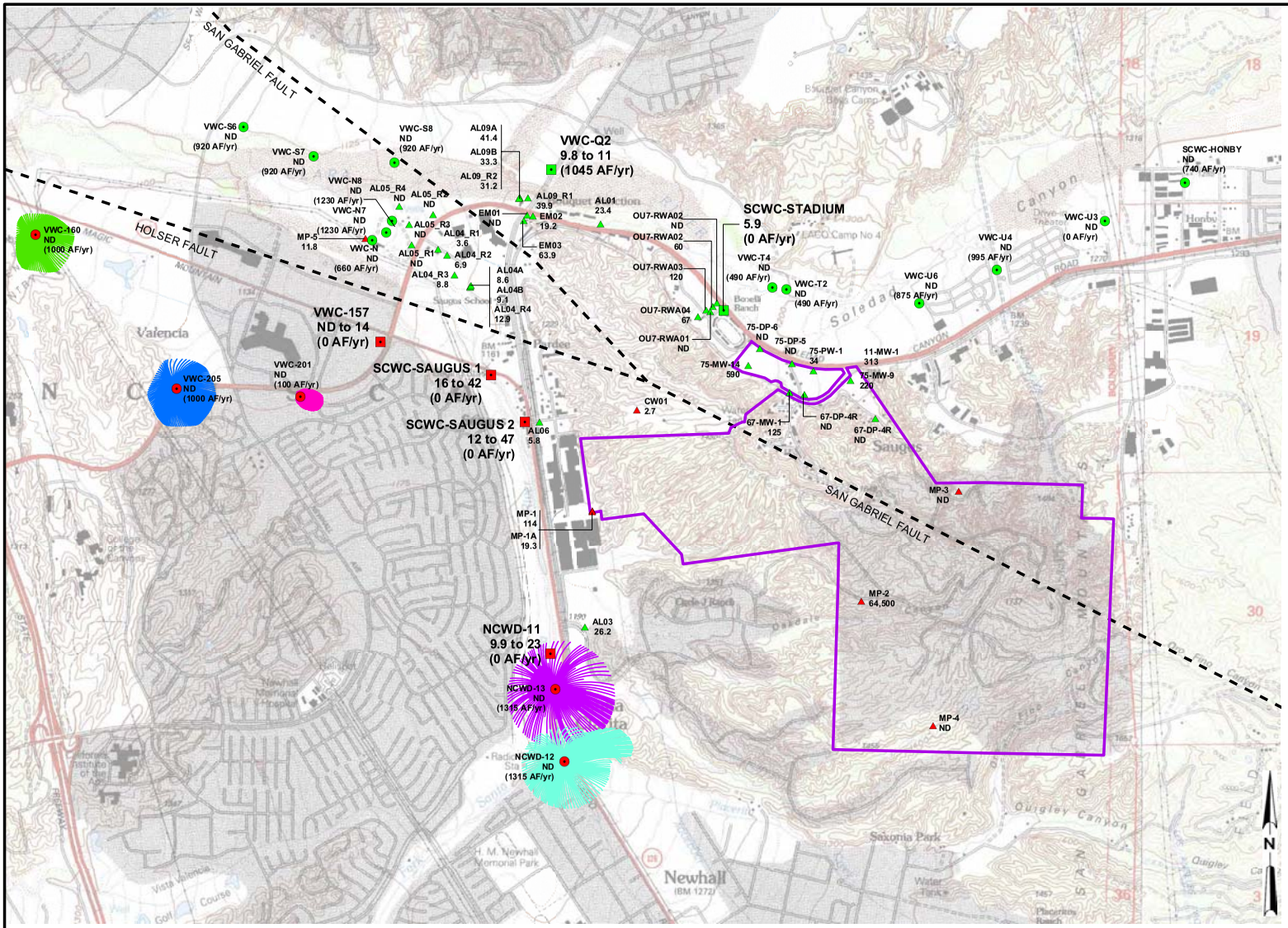
As a result, the currently active downgradient Saugus wells are expected to remain active as sources of water supply in accordance with the overall operating plan for the Saugus Formation, given the generally low planned pumping from the nearest downgradient Saugus wells in the operating plan through 2006, after which restored capacity and resultant aquifer hydraulic control are scheduled to be in place.

5.5 WATER QUALITY IMPACTS ON RELIABILITY

5.5.1 Groundwater Contamination (Perchlorate)

The detection of perchlorate in Valley groundwater supplies has raised concerns over the reliability of those supplies, in particular the Saugus Formation, where four wells have been removed from active service as a result of perchlorate. As discussed below and in Appendix D, planning for remediation of the perchlorate and restoration of the impacted well capacity is substantially underway. While that work is being completed, non-impacted production facilities can be relied upon for the quantities of water projected to be available from the Alluvial Aquifer and Saugus Formation during the time necessary to restore perchlorate-impacted wells. CLWA, the local retail water purveyors, the California Department of Toxic Substances Control (DTSC), and the ACOE continue to work closely on the perchlorate contamination issue.

The following is a summary of the status of perchlorate remediation and restoration of perchlorate-impacted groundwater supply. A more detailed discussion of pertinent events related



LEGEND

CONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELL
- ALLUVIUM
- SAUGUS

TWO-YEAR GROUNDWATER CAPTURE ZONE
- NC-12
- NC-13
- VWC-160
- VWC-201
- VWC-205
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. PUMPING VALUES IN PARENTHESES ARE ANNUAL PUMPING VOLUMES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; AF/yr = acre feet per year
5. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND 0.05 IN THE SAUGUS FORMATION.

FIGURE 5-2
FORECASTED TWO-YEAR GROUNDWATER CAPTURE ZONES FOR ACTIVE SAUGUS PRODUCTION WELLS LOCATED CLOSEST TO THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

CH2MHILL

to perchlorate contamination, containment, remediation, and water supply restoration is included in Appendix D. These discussions are provided to illustrate that work toward the ultimate remediation of the perchlorate contamination, including the reactivation of impacted groundwater supply wells, has progressed on several integrated fronts over the last five years.

5.5.2 Perchlorate Impacted Water Purveyor Wells

As introduced above, perchlorate was detected in four Saugus Formation production wells near the former Whittaker-Bermite site in 1997. As a result, these wells (SCWD's Wells Saugus 1 and Saugus 2, NCWD's Well NC-11, and VWC's Well V-157) were removed from service. In 2002, perchlorate was detected in the SCWD Stadium well located directly adjacent to the Whittaker-Bermite site. This Alluvial well also has been removed from service.

Since the detection of perchlorate and resultant inactivation of impacted wells, the purveyors have been conducting regular monitoring of active wells near the Whittaker-Bermite site. In April 2005, that monitoring detected the presence of perchlorate in VWC's Well Q2, an Alluvial well located immediately northwest of the confluent of Bouquet Creek and the Santa Clara River. The location of this well is also shown on Figures 5-1 and 5-2. As a result of the detection and confirmation of perchlorate in its Well Q2, VWC removed the well from active service and pursued rapid permitting and installation of wellhead treatment in order to return the well to water supply service as described in Section 5.4.1.

In January 2005, VWC permanently closed well V-157 and in September 2005 completed the construction of new Saugus well V-206 located in an area of the Saugus Formation not impacted by perchlorate. VWC's V-206 is operational and replaces the pumping capacity temporarily impacted by the detection of perchlorate at V-157. In October 2005, VWC restored the pumping capacity of well Q2 with the start-up of wellhead treatment designed to effectively remove perchlorate. In summary, four wells (Saugus 1 and 2, NC-11, and Stadium well) remain temporarily offline due to perchlorate contamination.

Locations of the impacted wells, and other nearby non-impacted wells, relative to the Whittaker-Bermite site are shown on Figures 5-1 and 5-2.

5.5.3 Restoration of Perchlorate Impacted Water Supply

Since the detection of perchlorate in the four Saugus wells in 1997, CLWA and the retail water purveyors have recognized that one element of an overall remediation program would most likely include pumping from impacted wells, or from other wells in the immediate area, to establish hydraulic conditions that would control the migration of contamination from further impacting the aquifer in a downgradient (westerly) direction. Thus, CLWA and the retail water purveyors expect that the overall perchlorate remediation program could include dedicated pumping from some or all of the impacted wells, with appropriate treatment, such that two objectives could be achieved. The first objective is control of subsurface flow and protection of downgradient wells, and the second is restoration of some or all of the contaminated water supply. Not all impacted capacity is required for control of groundwater flow. The remaining capacity would be replaced by construction of replacement wells at non-impacted locations.

In cooperation with state regulatory agencies and investigators working for Whittaker-Bermite, CLWA and the local retail water purveyors developed an off-site plan that focuses on the concepts of groundwater flow control and restored pumping capacity and is compatible with on-site and possibly other off-site remediation activities. Specifically relating to water supply, the plan includes the following:

- Constructing and operating a water treatment process that removes perchlorate from two impacted wells such that the produced water can be used for municipal supply.
- Hydraulically containing the perchlorate contamination that is moving from the Whittaker-Bermite site toward the impacted wells by pumping the wells at rates that will capture water from all directions around them.
- Protecting the downgradient non-impacted wells through the same hydraulic containment that results from pumping two of the impacted wells.
- Restoring the annual volumes of water pumped from the impacted wells before they were inactivated and also restoring the wells' total capacity to produce water in a manner consistent with the retail water purveyors' operating plan for groundwater supply described above.

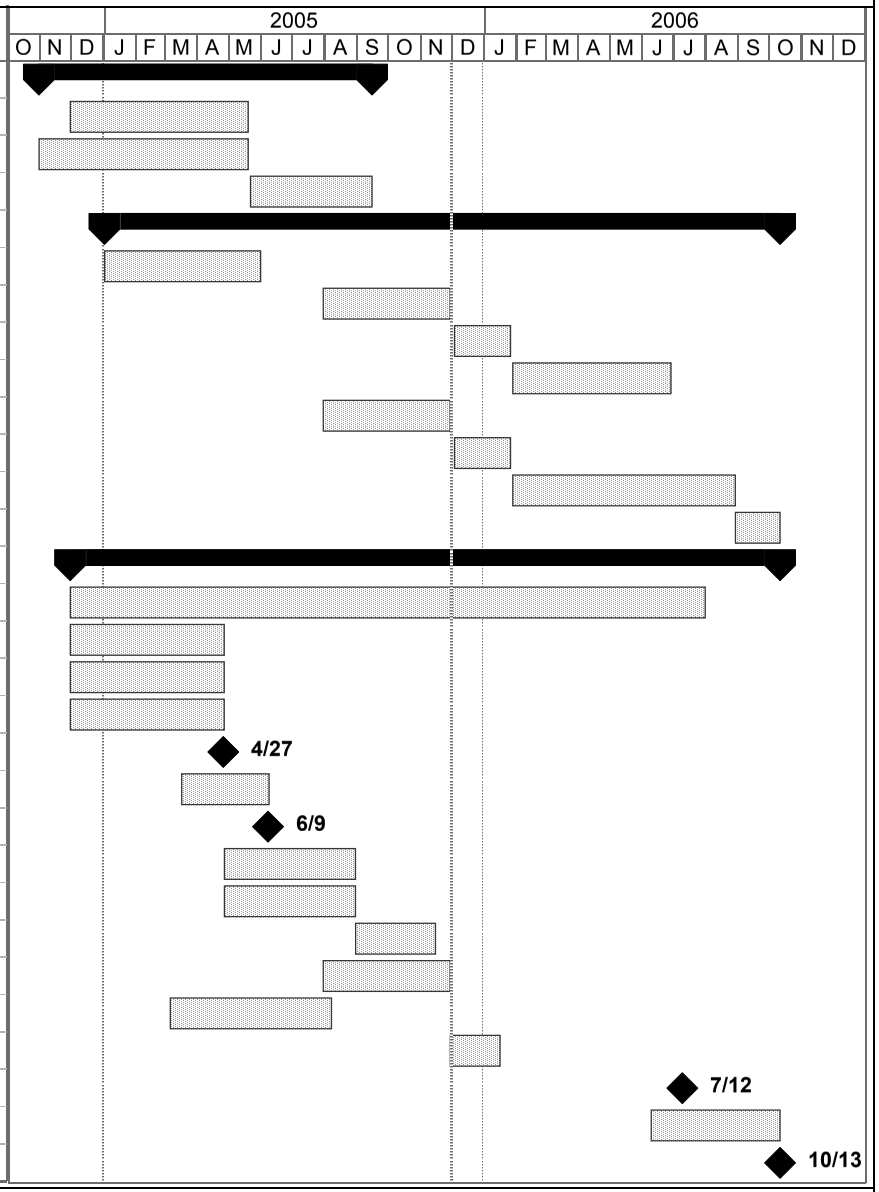
The current schedule for implementation of the plan to restore contaminated water supply (wells) is illustrated on Figure 5-3. Included in the schedule is a planned extended test of the wells that will be returned to service as part of restoring contaminated water supply and that will also be operated to extract contaminated water and control the migration of contamination in the aquifer. Concurrent with the testing of the wells, several specific ion exchange resins will also be tested to evaluate their performance and longevity. The two key activities that comprise the majority of effort required for implementation of the plan are general facilities-related work (design and construction of well facilities, treatment equipment, pipelines, etc.) and permitting work. Both activities are planned and scheduled concurrently, resulting in planned completion (i.e., restoration of all impacted capacity) in 2006. Notable recent accomplishments toward implementation include completion of the Final Draft Interim Remedial Action Plan (RAP) in August 2005 and completion of environmental review with the adoption of a Mitigated Negative Declaration in September 2005.

In light of the preceding, with regard to the adequacy of groundwater as the local component of water supply in this Plan, the impacted capacity will remain unavailable through early to mid-2006, during which time the non-impacted groundwater supply will be sufficient to meet near-term water requirements as described in Chapter 3, Water Resources. Afterwards, the total groundwater capacity will be sufficient to meet the full range of normal and dry-year conditions as provided in the operating plan for groundwater supply.

Returning the contaminated Saugus wells to municipal water supply service by installing treatment requires issuance of permits from DHS before the water can be considered potable and safe for delivery to customers. The permit requirements are contained in DHS Policy Memo 97-005 for direct domestic use of impaired water sources.

Figure 5-3
Preliminary 97-005 Implementation Schedule
Castaic Lake Water Agency

ID	Task Name	Duration	Start	Finish
1	**DTSC Approval Activities**	**230 days**	**Mon 11/1/04**	**Fri 9/16/05**
2	Feasibility Study	6.15 mons	Wed 12/1/04	Fri 5/20/05
3	Draft RAP	29 wks	Mon 11/1/04	Fri 5/20/05
4	Final RAP	4.25 mons	Mon 5/23/05	Fri 9/16/05
5	**Implementation Activities**	**465 days**	**Mon 1/3/05**	**Fri 10/13/06**
6	Easements and ROW	5.4 mons	Mon 1/3/05	Wed 6/1/05
7	Treatment Design	4.4 mons	Mon 8/1/05	Wed 11/30/05
8	Treatment Bidding & Contracting	2 mons	Mon 12/5/05	Fri 1/27/06
9	Treatment Construction	5.5 mons	Mon 1/30/06	Fri 6/30/06
10	Pipeline Design	4.4 mons	Mon 8/1/05	Wed 11/30/05
11	Pipeline Bidding & Contracting	2 mons	Mon 12/5/05	Fri 1/27/06
12	Pipeline Construction	7.7 mons	Mon 1/30/06	Thu 8/31/06
13	System Startup	1.55 mons	Fri 9/1/06	Fri 10/13/06
14	**DHS Approval Activities (97-005)**	**488 days**	**Wed 12/1/04**	**Fri 10/13/06**
15	DHS Coordination	21.8 mons	Wed 12/1/04	Wed 8/2/06
16	TM1: Source Water Assessment	5.3 mons	Wed 12/1/04	Wed 4/27/05
17	TM2: Raw Water Quality Characterization	5.3 mons	Wed 12/1/04	Wed 4/27/05
18	TM3: Source Water Protection	5.3 mons	Wed 12/1/04	Wed 4/27/05
19	DHS Workshop No. 1	0 days	Wed 4/27/05	Wed 4/27/05
20	TM4: Effective Monitoring & Treatment	3 mons	Fri 3/18/05	Thu 6/9/05
21	DHS Workshop No. 2	0 days	Thu 6/9/05	Thu 6/9/05
22	TM5: Human Health Risk Assessment	4.5 mons	Thu 4/28/05	Wed 8/31/05
23	TM6: Alternative Source Assessment	4.5 mons	Thu 4/28/05	Wed 8/31/05
24	DHS Review of TMs 5 & 6	2.75 mons	Thu 9/1/05	Wed 11/16/05
25	Prepare 97-005 Engineer's Report	4.4 mons	Mon 8/1/05	Wed 11/30/05
26	CEQA Initial Study and Draft MND	5.55 mons	Mon 3/7/05	Mon 8/8/05
27	Permit Application	1.7 mons	Thu 12/1/05	Tue 1/17/06
28	Public Hearing	0 days	Wed 7/12/06	Wed 7/12/06
29	DHS Evaluation	4.5 mons	Mon 6/12/06	Fri 10/13/06
30	Obtain DHS Permit	0 days	Fri 10/13/06	Fri 10/13/06



Project: CLWA 97-005_r2
Date: Thu 12/1/05

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

Before issuing a permit to a water utility for use of an impaired source as part of the utility's overall water supply permit, DHS requires that studies and engineering work be performed to demonstrate that pumping the wells and treating the water will be protective of public health for users of the water. The 97-005 Policy Memo requires that DHS review the local retail water purveyor's plan, establish appropriate permit conditions for the wells and treatment system, and provide overall approval of returning the impacted wells to service for potable use. Ultimately, CLWA's and the local retail water purveyor's plan and the DHS requirements are intended to ensure that the water introduced to the potable water distribution system has no detectable concentration of perchlorate.

The DHS 97-005 Policy Memo requires, among other things, the completion of a source water assessment for the impacted wells intended to be returned to service. The purpose of the assessment is to determine the extent to which the aquifer is vulnerable to continued migration of perchlorate and other contaminants of interest from the Whittaker-Bermite site. The assessment includes the following:

- Delineation of the groundwater capture zone caused by operating the impacted wells
- Identification of contaminants found in the groundwater at or near the impacted wells
- Identification of chemicals or contaminants used or generated at the Whittaker-Bermite facility
- Determination of the vulnerability of pumping the impacted wells to these contaminant sources

CLWA is currently working directly with the retail water purveyors and its consultants on development of the DHS 97-005 Policy Memo permit application. Two coordination workshops have already been held with DHS. Drafts of all six elements of the 97-005 Policy Memo have been submitted to DHS and the retail purveyors for review, including: the Source Water Assessment, Raw Water Quality Characterization, Source Protection Plan, Effective Monitoring and Treatment Evaluation, Human Health Risk Assessment, and the Alternatives Sources Evaluation. The Engineer's Report, which summarizes these six elements for the 97-005 process, is anticipated to be complete by the end of November 2005.

The CEQA process for the "CLWA Groundwater Containment, Treatment, and Restoration Project," for which the 97-005 process is being conducted, was completed in August 2005. The Project Description from the project's CEQA Initial Study is included in Appendix E.

As listed above, DHS 97-005 Policy Memo requires an analysis to demonstrate contaminant capture and protection of other nearby water supply wells. The development and calibration of a numerical groundwater flow model of the entire basin had been initiated as a result of a 2001 MOU among the Upper Basin Water Purveyors (CLWA, CLWA SCWD, LACWWD #36, NCWD, and VWC) and the United Water Conservation District in Ventura County.

The groundwater model was initially intended for use in analyzing the operating yield and sustainability of groundwater in the Basin. Use of the model for that analysis is described in Chapter 3. However, the model was adaptable to analyze both the sustainability of groundwater under an operational scenario that includes full restoration of perchlorate-contaminated supply

and the containment of perchlorate near the Whittaker-Bermite property (i.e., by pumping some of the contaminated wells). In 2004, DTSC reviewed and approved the construction and calibration of the regional model as described in the final model report, "Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration" (CH2M Hill, April 2004).

After DTSC approval, the model was used to simulate the capture and control of perchlorate by restoring impacted wells, with treatment. The results of that work are summarized in a second report, "Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California" (CH2M Hill, December 2004). The modeling analysis indicates that the pumping of impacted wells SCWD-Saugus 1 and SCWD-Saugus 2 on a nearly continual basis will effectively contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property. The analysis also indicates that (1) no new production wells are needed in the Saugus Formation to meet the perchlorate containment objective, (2) impacted well NCWD-11 is not a required component of the containment program, and (3) pumping at SCWD-Saugus 1 and SCWD-Saugus 2 is necessary to prevent migration of perchlorate to other portions of the Saugus Formation.

The perchlorate containment report also includes the general design of a sentinel groundwater monitoring network and program required by DHS as part of its 97-005 Policy Memo permitting. The perchlorate containment report was approved by DTSC in November 2004. With that approval, the model is now being used to support the source water assessment and the balance of the permitting process required by DHS under its 97-005 Policy Memo.

Chapter 6
RELIABILITY PLANNING

Chapter 6.0
RELIABILITY PLANNING

6.1 OVERVIEW

The Act requires urban water suppliers to assess water supply reliability that compares total projected water used with the expected water supply over the next twenty years in five year increments. The Act also requires an assessment for a single dry year and multiple dry years. This chapter presents the reliability assessment for CLWA's service area.

It is the stated goal of CLWA and the retail water purveyors to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions over the next 25 years in combination with conservation of non-essential demand during certain dry years, the Plan successfully achieves this goal.

6.2 RELIABILITY OF WATER SUPPLIES

Each water supply source has its own reliability characteristics. In any given year, the variability in weather patterns around the state may affect the availability of supplies to the Valley differently. For example, from 2000 through 2002, southern California experienced dry conditions in all three years. During the same period, northern California experienced one dry year and two normal years. The Valley is typical in terms of water management in southern California; local groundwater supplies are used to a greater extent when imported supplies are less available due to dry conditions in the north, and larger amounts of imported water supplies are used during periods when northern California has wetter conditions. This pattern of "conjunctive use" has been in effect since SWP supplies first came to the Valley in 1980. SWP supplies have supplemented the overall supply of the Valley, which previously depended solely on local groundwater supplies.

To supplement these local groundwater supplies, CLWA contracted with DWR for delivery of SWP water, providing an imported water supply to the Valley. However, the variability in SWP supplies affects the ability of the agencies to meet the overall water supply needs for the service area. While each of the Valley's available supply sources has some variability, the variability in SWP supplies has the largest effect on overall supply reliability.

As discussed in Section 3.2 of Chapter 3, each SWP contractor's Water Supply Contract contains a Table A Amount that identifies the maximum amount of water that contractor may request. However, the amount of SWP water actually allocated to contractors each year is dependent on a number of factors than can vary significantly from year to year. The primary factors affecting SWP supply availability include hydrologic conditions in northern California, the amount of water in SWP storage reservoirs at the beginning of the year, regulatory and operational constraints, and the total amount of water requested by the contractors. The availability of SWP supplies to CLWA and the other SWP contractors is generally less than their full Table A amounts in many years and can be significantly less in very dry years.

DWR's SWP Delivery Reliability Report, issued in May 2003, assists SWP contractors in assessing the reliability of the SWP component of their overall supplies. DWR is currently in the process of updating this report and, on May 25, 2005, provided excerpts from this update that includes updated reliability analyses and a recommendation for which set of analyses to use in preparation of 2005 UWMPs. DWR provided these updated delivery reliability estimates to the SWP contractors in its "Excerpts from the Working Draft of 2005 State Water Project Delivery Reliability."

The amount of SWP water projected to be available to CLWA in this Plan is based on DWR's draft reliability report update. In its report, DWR presents the results of its analysis of the reliability of SWP supplies, based on model studies of SWP operations. In general, DWR model studies show the anticipated amount of SWP supply that would be available for a given SWP water demand, given an assumed set of physical facilities and operating constraints, based on 73 years of historic hydrology. The results are interpreted as the capability of the SWP to meet the assumed SWP demand, over a range of hydrologic conditions, for that assumed set of physical facilities and operating constraints.

DWR's draft report presents the results of model studies for years 2005 and 2025. In these model studies, DWR assumed existing SWP facilities and operating constraints for both the 2005 and 2025 studies. The primary differences between the two studies are an increase in projected SWP contractor demands and an increase in projected upstream demands (which affects SWP supplies by reducing the amount of inflows available for the SWP). In the report, DWR presents the SWP delivery capability resulting from these studies as a percent of full contractor Table A Amounts. To estimate supply capability in intermediate years between 2005 and 2025, DWR interpolates between the results of those studies.

6.3 NORMAL, SINGLE-DRY, AND MULTIPLE-DRY YEAR PLANNING

CLWA has various water supplies available to meet demands during normal, single-dry, and multiple-dry years. The following sections elaborate on the different supplies available to CLWA including groundwater, recycled water, and SWP supplies.

6.3.1 Groundwater

Supplies from the Alluvial Aquifer are projected to be 30,000 to 40,000 afy in average years and 30,000 to 35,000 afy in dry years; supplies from the Saugus Formation are projected to be 7,500 to 15,000 afy in average years and 15,000 to 35,000 afy in dry years. Groundwater modeling of the aquifers has shown that short-term, dry-year supply from the Saugus Formation could increase to up to 35,000 afy. This amount of Saugus Formation pumping can be achieved through pumping from a combination of existing wells at about 15,000 afy, restored capacity from perchlorate-impacted wells of about 10,000 afy, and new wells at 10,000 afy.

The projected groundwater supplies used in this Plan are generally the midpoints of the ranges mentioned above, with the exception of dry-period pumping from the Saugus Formation. Given the large amount of groundwater storage within the Saugus Formation, it was assumed that single-dry year pumping on an intermittent basis would be limited primarily by well capacity, to 35,000 afy. For the multiple-dry year period, it was assumed that pumping from the Saugus

Formation would be governed by the groundwater operating plan summarized in Table 3-6, with average pumping over the 4-year dry period of about 21,500 afy.

6.3.2 Recycled Water

Recycled water is available from two existing water reclamation plants operated by LACSD. CLWA has completed environmental review on the construction of Phase I of its Reclaimed Water System Master Plan, a multi-phased program to deliver recycled water in the Valley. As described in Chapter 4, the ability of CLWA to use recycled water is constrained by its rights to use the water available. CLWA currently has rights to use 1,700 afy of recycled water, and Phase I provides for the delivery of this amount. While actual use of recycled water currently totals approximately 500 afy, the amount of this supply currently available is 1,700 afy. In this Plan, the existing supply of recycled water assumed to be available is 1,700 afy in an average year, a single-dry year, and in each year of a multiple-dry year period. CLWA projects an increase of 15,700 afy in the supply of recycled water by 2030, for a total of 17,400 afy. Similar to the existing recycled water supply, the 15,700 afy of planned recycled water supply is assumed to be available in an average year, a single-dry year, and in each year of a multiple-dry year period.

6.3.3 State Water Project Table A Supply

For this Plan, the availability of SWP supplies to CLWA was estimated by multiplying CLWA's 95,200 afy of Table A Amount by the delivery percentages from DWR's draft report.[1] For the three hydrologic conditions evaluated, the delivery percentages used were taken from DWR's report based on the 73-year average, 1977, and the 1931-1934 average, for the average year, single-dry year, and multiple-dry year conditions, respectively.

In DWR's 73-year model studies, the lowest single-year SWP delivery results from 1977 hydrologic conditions, and the lowest delivery over any four-year period results from the hydrologic conditions from 1931 to 1934. Thus, the estimates of SWP dry-year supply availability used in this assessment were based on the worst case hydrologic conditions in DWR's report.

6.3.3.1 Flexible Storage Account

Under the Water Supply Contracts with DWR for SWP water, the contractors that share in the repayment of Castaic Lake may access a portion of the storage in that reservoir. This accessible storage is referred to as "flexible storage." The contractors may withdraw water from flexible storage, in addition to their allocated Table A supplies, on an as-needed basis. A contractor must replace any water it withdraws from this storage within five years. As one of the three contractors sharing in the repayment of Castaic Lake, CLWA has access to this flexible storage. Its share of the total flexible storage is currently 4,684 af. After recent negotiations with Ventura

[1] Of CLWA's 95,2000 af annual Table A Amount, 41,000 afy was permanently transferred to CLWA in 1999 by Wheeler Ridge-Maricopa Water Storage District, a member unit of the Kern County Water Agency. CLWA's Environmental Impact Report ("EIR") prepared in connection with the 41,000 afy water transfer was challenged in *Friends of the Santa Clara River v. Castaic Lake Water Agency* (Los Angeles County Superior Court, Case Number BS056954) ("*Friends*"). A more detailed discussion of these new challenges and the reasons the challenges will have no impact on the amount of water available to CLWA can be found at Section 3.2.2.

County water agencies, CLWA has gained access to an additional 1,376 af of flexible storage for ten years beginning in 2006.

CLWA plans to use this supply only in dry years. For the single-dry year condition, it was assumed the entire amount would be used. For the multiple-dry year condition, it was assumed that the entire amount would be used sometime during the four-year period, so the average annual supply during that period would be one fourth of the total. Any water withdrawn was assumed to be replaced in intervening average and wet years and would be available again for use in the next dry year.

6.3.3.2 Semitropic Water Bank

In 2002, CLWA stored 24,000 af of its allocated SWP Table A supply through a groundwater banking agreement with Semitropic. In 2004, CLWA stored 32,522 af of its 2003 allocated SWP Table A supply in a second Semitropic storage account. Under the terms of these agreements, and after consideration for losses within the groundwater basin, CLWA may withdraw up to 50,870 af when needed within ten years of when the water was stored. In addition to this short-term storage for CLWA, Semitropic has a long-term groundwater banking program with several other partners. The facilities that Semitropic may use in the return of CLWA's banked water supply are the same facilities that Semitropic may use to return banked water to its long-term banking program partners. As a result, there may be competition for use of those facilities in a particularly dry year, which could limit CLWA's ability to access the water in that year.

CLWA plans to use this supply only in dry years. For the single dry year, it was assumed that competition among Semitropic's banking partners for use of return facilities would limit CLWA's supply to about one third of the storage available, or about 17,000 af. For the multiple-dry year period, it was assumed that the entire amount would be accessible and used sometime during the four-year period, so the average annual supply during that period would be one fourth of the total available, or about 12,700 af. Since the stored water must be withdrawn within ten years of when it was stored, it was assumed that this supply is available only through 2013.

6.3.4 Buena Vista-Rosedale

The Buena Vista Water Storage District and the Rosedale-Rio Bravo Water Storage District, both member districts of KCWA, have jointly developed a program that provides both a firm water supply and a water banking component. This planned supply program would provide a firm annual water supply based on existing and long-standing Kern River water rights, which would be delivered by exchange of their SWP Table A supplies. In years when this supply is not needed, it can be banked for withdrawal and delivery in later years. The supply from this program is up to 11,000 afy of firm supply, which will be available in every year.

6.3.5 Rosedale-Rio Bravo Bank

Rosedale-Rio Bravo Water Storage District has also developed a water banking and exchange program. The initial offering from the program is for storage and withdrawal capacity of 20,000 afy, with up to 100,000 af of storage capacity. Withdrawals from the program can be made by exchange of Rosedale's Table A supply, or by pumpback into the California Aqueduct. CLWA issued a draft EIR on its participation in this program in August 2005, and plans to use this

supply only in dry years. For the single-dry year, supplies were assumed at the program's maximum withdrawal capacity of 20,000 af. For the multiple-dry year period, it was assumed in the first five-year increment the program is available that supplies would be limited to an average of 5,000 afy and that 20,000 af of water would be stored in one wet year prior to the dry period. In later years, it was assumed that supplies would average at least 15,000 afy over the dry period and that additional supplies would be banked during wetter years to allow withdrawal of at least this amount.

6.3.6 Additional Planned Banking

CLWA's Draft Water Supply Reliability Plan identifies a need for additional banking programs to firm up the dry-year reliability of service area supplies. While a specific banking program has not yet been identified, the amount of the additional dry-year supply needed was estimated as equivalent to the storage and withdrawal capacity of the Rosedale-Rio Bravo Bank. The supply amounts needed from this additional banking program were assumed to be the same as for the Rosedale-Rio Bravo Bank, with the exception that the program was not assumed to be available until 2015.

6.4 SUPPLY AND DEMAND COMPARISONS

The available supplies and water demands for CLWA's service area were analyzed to access the region's ability to satisfy demands during three scenarios: a normal water year, single-dry year, and multiple-dry years. The tables in this section present the supplies and demands for the various drought scenarios for the projected planning period of 2010-2030 in five year increments. Table 6-1 presents the base years for the development of water year data. Tables 6-2, 6-3, and 64 at the end of this section summarize, respectively, Normal Water Year, Single-Dry Water Year, and Multiple-Dry Year supplies.

Table 6-1
Basis of Water Year Data

Water Year Type	Base Years	Historical Sequence
Normal Water Year	Average	1922-1994
Single-Dry Water Year	1977	--
Multiple-Dry Water Years	1931-1934	--

6.4.1 Normal Water Year

Table 6-2 summarizes CLWA's water supplies available to meet demands over the 20-year planning period during an average/normal year. As presented in the table, CLWA's water supply is broken down into existing and planned water supply sources, including wholesale (imported) water, local supplies, transfers, and banking programs. Demands are shown with and without the effects of an assumed 10 percent urban demand reduction resulting from conservation best management practices.

6.4.2 Single-Dry Year

The water supplies and demands for CLWA's service area over the 20-year planning period were analyzed in the event that a single-dry year occurs, similar to the drought that occurred in California in 1977. Table 6-3 summarizes the existing and planned supplies available to meet demands during a single-dry year. Demand during dry years was assumed to increase by 10 percent.

6.4.3 Multiple-Dry Year

The water supplies and demands for CLWA's service area over the 20-year planning period were analyzed in the event that a four-year multiple-dry year event occurs, similar to the drought that occurred during the years 1931 to 1934. Table 6-4 summarizes the existing and planned supplies available to meet demands during multiple-dry years. Demand during dry years was assumed to increase by 10 percent.

6.4.4 Summary of Comparisons

As shown in the analyses above, CLWA and the retail purveyors have adequate supplies to meet demands during normal, single-dry, and multiple-dry years throughout the 20-year planning period.

Table 6-2
Projected Average/Normal Year Supplies and Demands

Water Supply Sources	Supply (af)				
	2010	2015	2020	2025	2030
Existing Supplies					
Wholesale (Imported)	*67,600*	*69,500*	*71,400*	*73,300*	*73,300*
SWP Table A Supply (1)	67,600	69,500	71,400	73,300	73,300
Flexible Storage Account (CLWA) (2)	0	0	0	0	0
Flexible Storage Account (Ventura County) (2)	0	0	0	0	0
Local Supplies					
Groundwater	*46,000*	*46,000*	*46,000*	*46,000*	*46,000*
Alluvial Aquifer	35,000	35,000	35,000	35,000	35,000
Saugus Formation	11,000	11,000	11,000	11,000	11,000
Recycled Water	1,700	1,700	1,700	1,700	1,700
Total Existing Supplies	115,300	117,200	119,100	121,000	121,000
Existing Banking Programs					
Semitropic Water Bank (2)	0	0	0	0	0
Total Existing Banking Programs	0	0	0	0	0
Planned Supplies					
Local Supplies					
Groundwater	*0*	*0*	*0*	*0*	*0*
Restored wells (Saugus Formation) (2)	0	0	0	0	0
New Wells (Saugus Formation) (2)	0	0	0	0	0
Recycled Water (3)	0	1,600	6,300	11,000	15,700
Transfers					
Buena Vista-Rosedale (4)	11,000	11,000	11,000	11,000	11,000
Total Planned Supplies	11,000	12,600	17,300	22,000	26,700
Planned Banking Programs					
Rosedale-Rio Bravo (2)	0	0	0	0	0
Additional Planned Banking (2)	0	0	0	0	0
Total Planned Banking Programs	0	0	0	0	0
Total Existing and Planned Supplies and Banking	126,300	129,800	136,400	143,000	147,700
Total Estimated Demand (w/o conservation) (5)	100,050	109,400	117,150	128,400	138,300
Conservation (6)	(8,600)	(9,700)	(10,700)	(11,900)	(12,900)
Total Adjusted Demand	91,450	99,700	106,450	116,500	125,400

Notes:

(1) SWP supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by percentages of average deliveries projected to be available (71% in 2010 and 77% in 2025/2030), taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005).

(2) Not needed during average/normal years.

(3) Recycled water supplies based on projections provided in Chapter 4, Recycled Water.

(4) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

(5) Demands are for uses within the existing CLWA service area. Demands for any annexations to the CLWA service area will be added if and when such annexations are approved. Currently proposed annexations have a demand for about 4,000 afy and, given supplies CLWA is in the process of acquiring, potential future annexations with demands up to an additional 7,000 afy could eventually be approved (see Footnote 4).

(6) Assumes 10 percent reduction on urban portion of total demand resulting from conservation best management practices, as discussed in Chapter 7.

Table 6-3
Projected Single-Dry Year Supplies and Demands

Water Supply Sources	Supply (af)				
	2010	2015	2020	2025	2030
Existing Supplies					
Wholesale (Imported)	*9,860*	*9,860*	*8,480*	*9,480*	*9,480*
SWP Table A Supply (1)	3,800	3,800	3,800	4,800	4,800
Flexible Storage Account (CLWA)	4,680	4,680	4,680	4,680	4,680
Flexible Storage Account (Ventura County) (2)	1,380	1,380	0	0	0
Local Supplies					
Groundwater	*47,500*	*47,500*	*47,500*	*47,500*	*47,500*
Alluvial Aquifer	32,500	32,500	32,500	32,500	32,500
Saugus Formation	15,000	15,000	15,000	15,000	15,000
Recycled Water	1,700	1,700	1,700	1,700	1,700
Total Existing Supplies	59,060	59,060	57,680	58,680	58,680
Existing Banking Programs					
Semitropic Water Bank (3)	17,000	0	0	0	0
Total Existing Banking Programs	17,000	0	0	0	0
Planned Supplies					
Local Supplies					
Groundwater	*10,000*	*10,000*	*20,000*	*20,000*	*20,000*
Restored wells (Saugus Formation)	10,000	10,000	10,000	10,000	10,000
New Wells (Saugus Formation)	0	0	10,000	10,000	10,000
Recycled Water (4)	0	1,600	6,300	11,000	15,700
Transfers					
Buena Vista-Rosedale (5)	11,000	11,000	11,000	11,000	11,000
Total Planned Supplies	21,000	22,600	37,300	42,000	46,700
Planned Banking Programs					
Rosedale-Rio Bravo (6)	20,000	20,000	20,000	20,000	20,000
Additional Planned Banking (7)	0	20,000	20,000	20,000	20,000
Total Planned Banking Programs	20,000	40,000	40,000	40,000	40,000
Total Existing and Planned Supplies and Banking	117,060	121,660	134,980	140,680	145,380
Total Estimated Demand (w/o conservation) (8) (9)	110,100	120,300	128,900	141,200	152,100
Conservation (10)	(9,500)	(10,700)	(11,700)	(13,100)	(14,200)
Total Adjusted Demand	100,600	109,600	117,200	128,100	137,900

Notes:

(1) SWP supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by percentages of single dry deliveries projected to be available for the worst case single dry year of 1977 (4% in 2010 and 5% in 2025/2030), taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005).

(2) Initial term of the Ventura County entities' flexible storage account is ten years (from 2006 to 2015).

(3) The total amount of water currently in storage is 50,870 af, available through 2013. Withdrawals of up to this amount are potentially available in a dry year, but given possible competition for withdrawal capacity with other Semitropic banking partners in extremely dry years, it is assumed here that about one third of the total amount stored could be withdrawn.

(4) Recycled water supplies based on projections provided in Chapter 4, Recycled Water.

(5) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

(6) Rosedale-Rio Bravo Water Banking and Recovery Program online in 2006, based on completing CEQA and subsequent adoption by CLWA Board of Directors.

(7) Assumes additional planned banking supplies available by 2014.

(8) Assumes increase in total demand of 10 percent during dry years.

(9) Demands are for uses within the existing CLWA service area. Demands for any annexations to the CLWA service area will be added if and when such annexations are approved. Currently proposed annexations have a demand for about 4,000 afy and, given supplies CLWA is in the process of acquiring, potential future annexations with demands up to an additional 7,000 afy could eventually be approved (see Footnote 5).

(10) Assumes 10 percent reduction on urban portion of total normal year demand resulting from conservation best management practices ([urban portion of total normal year demand x 1.10] * 0.10), as discussed in Chapter 7.

Table 6-4
Projected Multiple-Dry Year Supplies and Demands [1]

Water Supply Sources	2010	2015	2020	2025	2030
Existing Supplies					
Wholesale (Imported)	*32,010*	*32,910*	*32,570*	*32,570*	*32,570*
SWP Table A Supply (2)	30,500	31,400	31,400	31,400	31,400
Flexible Storage Account (CLWA) (3)	1,170	1,170	1,170	1,170	1,170
Flexible Storage Account (Ventura County) (3)	340	340	0	0	0
Local Supplies					
Groundwater	*47,500*	*47,500*	*47,500*	*47,500*	*47,500*
Alluvial Aquifer	32,500	32,500	32,500	32,500	32,500
Saugus Formation (4)	15,000	15,000	15,000	15,000	15,000
Recycled Water	1,700	1,700	1,700	1,700	1,700
Total Existing Supplies	81,210	82,110	81,770	81,770	81,770
Existing Banking Programs					
Semitropic Water Bank (3)	12,700	0	0	0	0
Total Existing Banking Programs	12,700	0	0	0	0
Planned Supplies					
Local Supplies					
Groundwater	*6,500*	*6,500*	*6,500*	*6,500*	*6,500*
Restored wells (Saugus Formation) (4)	6,500	6,500	5,000	5,000	5,000
New Wells (Saugus Formation) (4)	0	0	1,500	1,500	1,500
Recycled Water (5)	0	1,600	6,300	11,000	15,700
Transfers					
Buena Vista-Rosedale (6)	11,000	11,000	11,000	11,000	11,000
Total Planned Supplies	17,500	19,100	23,800	28,500	33,200
Planned Banking Programs					
Rosedale-Rio Bravo (7) (8)	5,000	15,000	15,000	15,000	15,000
Additional Planned Banking (8) (9)	0	5,000	15,000	15,000	15,000
Total Planned Banking Programs	5,000	20,000	30,000	30,000	30,000
Total Existing and Planned Supplies and Banking	116,410	121,210	135,570	140,270	144,970
Total Estimated Demand (w/o conservation) (10) (11)	110,100	120,300	128,900	141,200	152,100
Conservation (12)	(9,500)	(10,700)	(11,700)	(13,100)	(14,200)
Total Adjusted Demand	100,600	109,600	117,200	128,100	137,900

Notes:

(1) Supplies shown are annual averages over four consecutive dry years (unless otherwise noted).

(2) SWP supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by percentages of deliveries projected to be available for the worst case four-year drought of 1931-1934 (32% in 2010 and 33% in 2025/2030), taken from Table 6-5 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005).

(3) Based on total amount of storage available divided by 4 (4-year dry period). Initial term of the Ventura County entities' flexible storage account is ten years (from 2006 to 2015).

(4) Total Saugus pumping is the average annual amount that would be pumped under the groundwater operating plan, as summarized in Table 3-6 ([11,000+15,000+25,000+35,000]/4).

(5) Recycled water supplies based on projections provided in Chapter 4, Recycled Water.

(6) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

(7) Rosedale-Rio Bravo Water Banking and Recovery Program online in 2006, assuming CEQA complete and adoption by CLWA Board of Directors.

(8) Average dry year period supplies could be up to 20,000 af for each program depending on storage amounts at the beginning of the dry period.

(9) Assumes additional planned banking supplies available by 2014.

(10) Assumes increase in total demand of 10 percent during dry years.

(11) Demands are for uses within the existing CLWA service area. Demands for any annexations to the CLWA service area will be added if and when such annexations are approved. Currently proposed annexations have a demand for about 4,000 afy and, given supplies CLWA is in the process of acquiring, potential future annexations with demands up to an additional 7,000 afy could eventually be approved (see Footnote 6).

(12) Assumes 10 percent reduction on urban portion of total normal year demand resulting from conservation best management practices ([urban portion of total normal year demand x 1.10] * 0.10), as discussed in Chapter 7.

Chapter 7
DEMAND MANAGEMENT MEASURES

Chapter 7.0
WATER DEMAND MANAGEMENT MEASURES

7.1 OVERVIEW

This section describes the water Demand Management Measures (DMMs) and the Best Management Practices (BMPs) implemented by CLWA as a part of water conservation programs to result in quantifiable water savings for the Valley.

7.2 WATER DEMAND MANAGEMENT MEASURES AND BEST MANAGEMENT PRACTICES

Establishing goals and choosing water conservation measures is a continuing planning process. Goals are developed, adopted, and then evaluated periodically. Specific conservation measures are phased in and then evaluated for their effectiveness, achievement of desired results, and customer satisfaction. Water conservation can achieve a number of goals such as:

- Meeting legal mandates
- Reducing average annual potable water demands
- Reducing wastewater flows
- Reducing urban runoff
- Reducing demands during peak seasons
- Meeting drought restrictions

The Act specifies 14 DMMs. The Act was revised in 2000 to relate the DMMs to the 14 BMPs of the California Urban Water Conservation Council (CUWCC).

The CUWCC was formed in 1991 through the "Memorandum of Understanding Regarding Urban Water Conservation in California." The urban water conservation BMPs included in the MOU are intended to reduce California's long-term urban water demands. The BMPs are currently implemented by the signatories to the MOU on a voluntary basis. However, the CALFED Bay-Delta Program (now the California Bay-Delta Authority) included mandatory implementation of the BMPs and certification of water use efficiency programs in its final Environmental Impact Statement/Report and Record of Decision. Work toward this certification requirement has taken place during the five year planning period since 2000, but to date a final decision on such a requirement has not been made by the Bay-Delta Authority. Therefore, implementation of the BMPs/DMMs continues to be voluntary.

After adoption of the 2000 UWMP, CLWA signed the urban MOU in February 2001 on its own behalf as a water wholesaler and on behalf of the local retail water purveyors, thus meeting one of the recommendations of the 2000 UWMP. NCWD signed the MOU separately on its own behalf in September 2002. Los Angeles County signed the MOU prior to the 2000 UWMP on

behalf of all its Waterworks Districts. The retail purveyors have voluntarily complied with those BMPs considered locally cost-effective, as discussed in Section 7.3.

7.3 IMPLEMENTATION LEVELS OF DMMs/BMPs

The CUWCC is composed of over 150 urban water suppliers and 30 environmental organizations, as well as other interested companies and organizations. It has spent much of its existence determining the methodology by which savings from various water conservation measures (BMPs) can be quantified. The CUWCC has published "Guidelines to Preparing Cost-effectiveness Analysis" and a "BMP Cost and Savings Study," which assigns the water savings that can be ascribed to specific devices and activities when making cost-effectiveness evaluations for specific BMPs.

The BMP Cost and Savings Study recognizes two categories of BMPs: device-based and activity-based. Device-based BMPs, such as showerhead and toilet replacement programs, are intended to alter water use patterns through the actual installation of water-saving appliances. Activity-based BMPs, such as school education and public information programs, are intended to modify social behaviors to encourage people to save water. The savings from device-based BMPs can be directly quantified and attributed, whereas savings from activity-based BMPs are usually not possible to quantify. Device-based BMPs will result in quantifiable water savings for the Valley.

CLWA has been implementing the following BMPs, which pertain to wholesalers and retailers (with the exception of BMP 10), for the past several years (both prior to and after signing the urban MOU):

BMP 3	System Water Audits, Leak Detection and Repair
BMP 7	Public Information
BMP 8	School Education
BMP 10	Wholesale Agency Assistance
BMP 11	Conservation Pricing
BMP 12	Conservation Coordinator

CLWA implements BMP 8 on behalf of all the retailers.

In addition, since signing the urban MOU, CLWA has been assisting the purveyors by implementing BMPs 2 (Residential Plumbing Retrofit) and 14 (Residential Ultra Low Flush Toilet Replacement Programs). CLWA and VWC also undertook a pilot program to assess the cost-effectiveness of BMP 5 (Large Landscape Conservation Programs and Incentives) and BMP 9 (Conservation Programs for Commercial, Industrial, and Institutional Accounts). These two BMPs will see increased focus during the next five year planning period of this Plan. NCWD has been implementing all cost-effective BMPs since it signed the MOU.

Three BMPs are undergoing revision by the CUWCC and their implementation will be re-assessed during this planning period.

Signatories to the urban MOU are allowed by Water Code Section 10631(j) to include their biennial CUWCC BMP reports in an UWMP to meet the requirements of the DMMs sections of the UWMP Act. As a wholesaler MOU signatory, CLWA assists with BMP implementation and reporting for two retail purveyors: SCWD and VWC. NCWD, as a separate MOU signatory, is responsible for BMP implementation and reporting for its own retail service area. LACWWD #36 BMP implementation and reporting is done by the County of Los Angeles on behalf of all its Waterworks Districts. For the purposes of this Plan, the most recent BMP reports (2003 and 2004) as required by the urban MOU are attached as Appendix F. This appendix includes the reports for CLWA (wholesale), SCWD, and VWC. NCWD's separate report is also included in Appendix F.

7.4 SUMMARY OF CONSERVATION

CLWA will continue to implement the BMPs applicable to a wholesale water agency (BMPs 3, 7, 8, 10, 11, and 12), as well as other BMPs found to be locally cost-effective. NCWD will continue to implement all locally cost-effective BMPs for its service area. VWC, while not a signatory, will also continue to implement all cost-effective BMPs in its service territory.

CLWA, in cooperation with the retail purveyors, continues development and implementation of a comprehensive water conservation program. The program will expand existing water conservation activities and BMP implementation. These efforts will be tied to water conservation programs in adjoining urban areas making appropriate improvements to meet the unique conditions of the Valley.

Chapter 8
WATER SHORTAGE CONTINGENCY PLANNING

Chapter 8.0
WATER SHORTAGE CONTINGENCY PLANNING

8.1 OVERVIEW

Water supplies may be interrupted or reduced significantly in a number of ways, such as a drought which limits supplies, an earthquake which damages water delivery or storage facilities, a regional power outage, or a toxic spill that affects water quality. This chapter of the Plan describes how CLWA and the retail water purveyors plan to respond to such emergencies so that emergency needs are met promptly and equitably.

To date, both a Water Shortage Contingency Plan and a Drought Emergency Water Sharing Agreement have been prepared by CLWA and the retail purveyors. Prohibitions, penalties and financial impacts of shortages have recently been developed by CLWA SCWD, NCWD, and VWC and are summarized in this chapter.

8.2 COORDINATED PLANNING

CLWA and the purveyors have coordinated efforts in the past to meet water shortages. During 1991 (the fifth year of a six-year drought), the purveyors and CLWA prepared a Water Shortage Contingency Plan. Since this plan was first prepared, the Valley has experienced two water shortages: in 1991-1992 due to the continuation of the 1987-1992 drought and in 1994 due to the January 17, 1994, Northridge earthquake. The plan worked extremely well in both instances, and minor updates were made to incorporate what was actually experienced during these two periods. It is envisioned that the Water Shortage Contingency Plan will be implemented whenever needed on a contingency basis.

8.2.1 CLWA and the Water Purveyors

During times of normal supply, the water agencies meet periodically to review total water supply and demand in the Valley and any new regulations affecting the water industry.

During 1991, the local agencies met about once per month. Monthly water production and demand reports were produced and shared with the City of Santa Clarita Drought Committee. Also, after the 1987-1992 drought, CLWA and the retail purveyors cooperated in sharing available water from all sources without regard to contractual or other water rights for the duration of the emergency, and to facilitate among themselves water transfers, exchanges, and arrangements to use each others distribution facilities. Should water shortage conditions similar to the 1987-1992 drought occur again, it is expected that similar coordinated planning between the local agencies would be conducted.

8.2.2 City of Santa Clarita Drought Committee

The City of Santa Clarita Drought Committee was created by the City's Ordinance No. 91-16, adopted on March 13, 1991. The committee was made up of five appointees representing the

public, a representative of the City Staff, purveyor representatives, and a representative from CLWA. The function was to:

- Review all available data on water consumption, water supply and groundwater conditions
- Evaluate the level of compliance with the terms of the ordinance
- Evaluate the level of achievement of the stated water consumption reductions
- Make recommendations to the City Council concerning the timing of and need for implementation of future additional water restrictions as may be developed
- Make recommendations to the water purveyors serving the City of Santa Clarita concerning additional measures to encourage water conservation

From its inception and through the crucial summer months of 1991, the group met twice monthly. In the event of another drought or water shortage crisis, such a committee could be reinstituted. The 1991 ordinances, resolutions and agreements in Appendix G will be used as the model for the water shortage contingency resolution/ordinance package.

8.3 STAGES OF ACTION TO RESPOND TO WATER SHORTAGES

The Saugus Formation has underground storage of approximately 1.65 million acre-feet. In times of continued drought, the Saugus Formation can be pumped for temporary periods above its normal-year production. During an extended drought, the purveyors would consider upgrading the pumping capacity of their wells in the Saugus Formation and possibly drill additional wells to enable temporary pumping above the normal-year production of 7,500 to 15,000 afy. As developed in the Valley's groundwater operating plan and presented in Table 3-6, production in the Saugus Formation can be as high as 25,000-35,000 afy during multiple-dry year periods.

The Alluvium would be most affected by a continued local drought. As developed in the Valley's groundwater operating plan and further presented in Table 3-6, sustainable production during normal years can range from 30,000 to 40,000 afy. However, due to operational constraints in the eastern part of the Basin, production would be reduced to approximately 30,000 to 35,000 afy during locally dry years.

Table 8-1 presents the four-stage rationing and demand reduction goals for the Valley.

Table 8-1
Rationing and Reduction Goals

Deficiency	Stage	Demand Reduction Goal	Type of Program
Up to 15%	1	15% reduction	Voluntary
15-25%	2	25% reduction	Mandatory
25-35%	3	35% reduction	Mandatory
35-50%	4	50+% reduction	Mandatory

Priorities for use of available water, based on Chapter 3 of the California Water Code, are:

- Health and Safety—Interior residential, sanitation and fire protection
- Commercial, Industrial, and Governmental—Maintain jobs and economic base
- Existing Landscaping—Especially trees and shrubs
- New Demand—Projects with permits when shortage declared

Water quantity calculations used to determine the interior household gpcd requirements for health and safety are provided in Table 8-2. As developed in Table 8-2, the California Water Code Stage 2, 3, and 4 health and safety allotments are 68 gpcd, or 33 ccf (100 cubic feet) per person per year. When considering this allotment and the 2005 Valley Planning Area population of 249,343, as presented in Table 2-7, the total annual water supply required to meet the first priority use during a water shortage is approximately 19,000 afy.

Table 8-2
Per Capita Health and Safety Water Quantity Calculations

	Non-Conserving Fixtures		Habit Changes		Conserving Fixtures	
Toilets	5 flushes x 5.5 gpf =	27.5	3 flushes x 5.5 gpf =	16.5	5 flushes x 1.6 gpf =	8.0
Showers	5 min x 4.0 gpm =	20.0	4 min x 3.0 gpm =	12.0	5 min x 2.0 gpm =	10.0
Washers	12.5 gpcd (1/3 load) =	12.5	11.5 gpcd (1/3 load) =	11.5	11.5 gpcd (1/3 load) =	11.5
Kitchens	4 gpcd =	4.0	4 gpcd =	4.0	4 gpcd =	4.0
Other	4 gpcd =	4.0	4 gpcd =	4.0	4 gpcd =	4.0
Total gpcd		68.0		48.0		37.5
CCF per capita per year		33.0		23.0		18.0

8.4 MINIMUM WATER SUPPLY AVAILABLE DURING NEXT THREE YEARS

The minimum water supply available during the next three years would occur during a three-year multiple-dry year event between the years 2006 and 2008. As shown in Table 8-3, the total supplies and banking range from approximately 103,500 afy to 120,500 afy during the next three years. When comparing these supplies to the demand projections provided in Chapters 2 and 6 of this Plan, CLWA and the purveyors have adequate supplies available to meet projected demands should a multiple-dry year period occur during the next three years.

Table 8-3
Estimate of Minimum Supply for the Next Three Years

Source	Supply (af)		
	2006	2007	2008
Wholesale Imported	*29,620*	*29,620*	*29,620*
SWP Table A Supply (1)	27,600	27,600	27,600
Flexible Storage Account (CLWA) (2)	1,560	1,560	1,560
Flexible Storage Account (Ventura County) (2)	460	460	460
Local Supply			
Groundwater	*37,500*	*54,500*	*54,500*
Alluvial Aquifer	32,500	32,500	32,500
Saugus Formation	5,000	22,000	22,000
Recycled Water	1,700	1,700	1,700
Transfers			
Buena Vista-Rosedale (3)	11,000	11,000	11,000
Banking Programs	*23,600*	*23,600*	*23,600*
Semitropic Water Bank (4)	16,900	16,900	16,900
Rosedale-Rio Bravo (5) (6)	6,700	6,700	6,700
Total Supplies	**103,420**	**120,420**	**120,420**

Notes:

(1) SWP supplies are calculated by multiplying CLWA's Table A Amount of 95,200 af by percentages of total deliveries projected to be available for the worst case three-year drought of 1990-1992, calculated from data in Table B-8 of DWR's "Excerpts from Working Draft of 2005 State Water Project Delivery Reliability Report" (May 2005). The average of total SWP deliveries over this three year period was 29 percent of total Table A Amounts.

(2) Based on total amount of storage available divided by 3 (3-year dry period).

(3) CLWA is in the process of acquiring this supply, primarily to meet the potential demands of future annexations to the CLWA service area. This acquisition is consistent with CLWA's annexation policy under which it will not approve potential annexations unless additional water supplies are acquired. Currently proposed annexations have a demand for about 4,000 afy of this supply which, if approved, would leave the remaining 7,000 afy available for potential future annexations. Unless and until any such annexations are actually approved, this supply will be available to meet demands within the existing CLWA service area.

(4) Based on total amount of storage available (50,870 af) divided by 3 (3-year dry period) and rounded down to the nearest 100.

(5) Assumes Rosedale-Rio Bravo Water Banking and Recovery Program on line in 2006, based on completion of CEQA and subsequent adoption by CLWA Board of Directors.

(6) Based on total amount of storage available (20,000 af) divided by 3 (3-year dry period).

8.5 ACTIONS TO PREPARE FOR CATASTROPHIC INTERRUPTION

8.5.1 General

The Valley is located approximately 20 miles southwest of the San Andreas Fault. A major earthquake along the southern portion of the San Andreas Fault would affect the Valley. The California Division of Mines and Geology has stated two of the aqueduct systems that import

water to southern California could be ruptured by displacement on the San Andreas Fault, and supply may not be restored for a three to six week period. The situation would be further complicated by physical damage to pumping equipment and local loss of electrical power.

DWR has a contingency aqueduct outage plan for restoring the California Aqueduct to service should a major break occur, which it estimates would take approximately four months to repair.

Experts agree it may be at least three days after the earthquake before outside help could get to the Valley. Extended supply shortages of both groundwater and imported water, due to power outages and/or equipment damage, would be severe until the water supply could be restored.

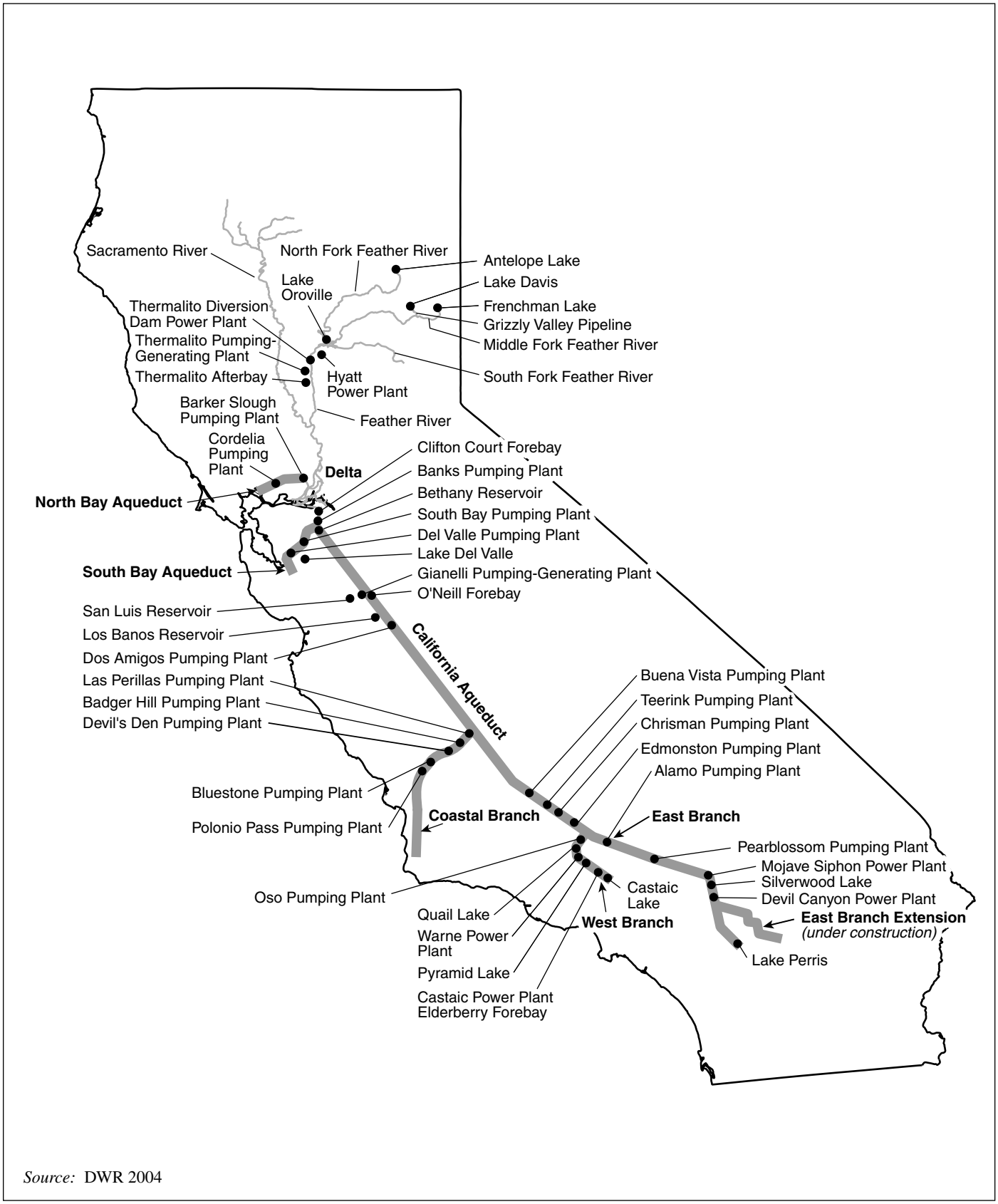
Combined water storage of the local agencies totals approximately 190 million gallons of water in storage tanks, which can be gravity fed to Valley residences, even if there is a power outage. In addition, since the 1994 Northridge earthquake, storage tanks have been fitted with flexible couplings, which should reduce damage to local storage facilities. The public would be asked to reduce consumption to minimum health and safety levels, extending the supply to seven days. This would provide sufficient time to restore a significant amount of groundwater production. After the groundwater supply is restored, the pumping capacity of the four retail purveyors, along with CLWA's proportionate share of storage from Pyramid and Castaic Lakes, could meet the reduced demand until such time that the imported water supply was reestablished. Updates on the water situation would be made as often as necessary.

The Valley's water sources are generally of good quality, and no insurmountable problems resulting from industrial or agricultural contamination are foreseen. If contamination did result from a toxic spill or similar accident, the contamination would be isolated and should not significantly impact the total water supply. In addition, such an event would be covered by the purveyors' emergency response plan. The recent detection of perchlorate in the Saugus Formation and Alluvial Aquifer is an example of prior contamination due to industrial chemical processes. The few affected wells have been shut down; design of the treatment process to remove the perchlorate is near completion; and the wells are expected to return to service in 2006.

8.5.2 SWP Emergency Outage Scenarios

In addition to earthquakes, the SWP could experience other emergency outage scenarios. Past examples include slippage of aqueduct side panels into the California Aqueduct near Patterson in the mid-1990s, the Arroyo Pasajero flood event in 1995 (which also destroyed part of Interstate 5 near Los Banos), and various subsidence repairs needed along the East Branch of the Aqueduct since the 1980s. All these outages were short-term in nature (on the order of weeks), and DWR's Operations and Maintenance Division worked diligently to devise methods to keep the Aqueduct in operation while repairs were made. Thus, the SWP contractors experienced no interruption in deliveries.

One of the SWP's important design engineering features is the ability to isolate parts of the system. The Aqueduct is divided into "pools." Thus, if one reservoir or portion of the California Aqueduct is damaged in some way, other portions of the system can still remain in operation. The Primary SWP facilities are shown on Figure 8-1.



Source: DWR 2004

Figure 8-1. Primary SWP Facilities

Other events could result in significant outages and potential interruption of service. Examples of possible nature-caused events include a levee breach in the Delta near the Harvey O. Banks Pumping Plant, a flood or earthquake event that severely damaged the Aqueduct along its San Joaquin Valley traverse, or an earthquake event along either the West or East Branches. Such events could impact some or all SWP contractors south of the Delta.

The response of DWR, CLWA, and other SWP contractors to such events would be highly dependent on the type and location of any such event. In typical SWP operations, water flowing through the Delta is diverted at the SWP's main pumping facility, located in the southern Delta, and is pumped into the California Aqueduct. During the relatively heavier runoff period in the winter and early spring, Delta diversions generally exceed SWP contractor demands, and the excess is stored in San Luis Reservoir. Storage in SWP aqueduct terminal reservoirs, such as Pyramid and Castaic Lakes, is also refilled during this period. During the summer and fall, when diversions from the Delta are generally more limited and less than contractor demands, releases from San Luis Reservoir are used to make up the difference in deliveries to contractors. The SWP share of maximum storage capacity at San Luis Reservoir is 1,062,000 af.

CLWA receives its SWP deliveries through the West Branch of the California Aqueduct at Castaic Lake. The only other contractors receiving deliveries from the West Branch are Metropolitan and Ventura County Watershed Protection District (formerly known as the Ventura County Flood Control District). The West Branch has two terminal reservoirs, Pyramid Lake and Castaic Lake, which were designed to provide emergency storage and regulatory storage (i.e., storage to help meet peak summer deliveries) for CLWA and the other two West Branch contractors. Maximum operating capacity at Pyramid and Castaic lakes is 169,900 af and 323,700 af, respectively.

In addition to SWP storage south of the Delta in San Luis and the terminal reservoirs, a number of contractors have stored water in groundwater banking programs in the San Joaquin Valley, and many also have surface and groundwater storage within their own service areas.

Three scenarios that could impact the delivery to CLWA of its SWP supply, previously banked supplies, or other supplies delivered to it through the California Aqueduct are described below. For each of these scenarios, it was assumed that an outage of six months could occur. CLWA's ability to meet demands during the worst of these scenarios is presented following the scenario descriptions.

Scenario 1: Levee Breach Near Banks Pumping Plant

As demonstrated by the June 2004 Jones Tract levee breach and previous levee breaks, the Delta's levee system is fragile. The SWP's main pumping facility, Banks Pumping Plant, is located in the southern Delta. Should a major levee in the Delta near these facilities fail catastrophically, salt water from the eastern portions of San Francisco Bay would flow into the Delta, displacing the fresh water runoff that supplies the SWP. All pumping from the Delta would be disrupted until water quality conditions stabilized and returned to pre-breach conditions. The re-freshening of Delta water quality would require large amounts of additional Delta inflows, which might not be immediately available, depending on the timing of the levee

breach. The Jones Tract repairs took several weeks to accomplish and months to complete; a more severe breach could take much longer, during which time pumping from the Delta might not be available on a regular basis.

Assuming that the Banks Pumping Plant would be out of service for six months, DWR could continue making at least some SWP deliveries to all southern California contractors from water stored in San Luis Reservoir. The water available for such deliveries would be dependent on the storage in San Luis Reservoir at the time the outage occurred and could be minimal if it occurred in the late summer or early fall when San Luis Reservoir storage is typically low. In addition to supplies from San Luis Reservoir, water from the West Branch terminal reservoirs would also be available to the three West Branch contractors, including CLWA. CLWA water stored in groundwater banking programs in the San Joaquin Valley may also be available for withdrawal and delivery to CLWA.

Scenario 2: Complete Disruption of the California Aqueduct in the San Joaquin Valley

The 1995 flood event at Arroyo Pasajero demonstrated vulnerabilities of the California Aqueduct (the portion that traverses the San Joaquin Valley from San Luis Reservoir to Edmonston Pumping Plant). Should a similar flood event or an earthquake damage this portion of the aqueduct, deliveries from San Luis Reservoir could be interrupted for a period of time. DWR has informed the SWP contractors that a four-month outage could be expected in such an event. CLWA's assumption is a six-month outage.

Arroyo Pasajero is located downstream of San Luis Reservoir and upstream of the primary groundwater banking programs in the San Joaquin Valley. Assuming an outage at a location near Arroyo Pasajero that resulted in the California Aqueduct being out of service for six months, supplies from San Luis Reservoir would not be available to those SWP contractors located downstream of that point. However, CLWA water stored in groundwater banking programs in the San Joaquin Valley could be withdrawn and delivered to CLWA, and water from the West Branch terminal reservoirs would also be available to the three West Branch contractors, including CLWA. Assuming an outage at a location on the California Aqueduct south of the groundwater banking programs in the San Joaquin Valley, these supplies would not be available to CLWA, but water from the West Branch terminal reservoirs would be available to the three West Branch contractors, including CLWA.

Scenario 3: Complete Disruption of the West Branch of the California Aqueduct

The West Branch of the California Aqueduct begins at a bifurcation of the Aqueduct south of Edmonston Pumping Plant, which pumps SWP water through and across the Tehachapi Mountains. From the point of bifurcation, the West Branch is an open canal through Quail Lake, a small flow regulation reservoir, to the Peace Valley Pipeline, which carries water into Pyramid Lake. From Pyramid Lake, water is released into the Angeles Tunnel, through Castaic Powerplant into Elderberry Forebay, and then into Castaic Lake.

If a major earthquake (an event similar to or greater than the 1994 Northridge earthquake) were to damage a portion of the West Branch, deliveries could be interrupted. The exact location of

such damage along the West Branch would be key to determining emergency operations by DWR and the three West Branch SWP contractors. For this scenario, it was assumed that the West Branch would suffer a single-location break and deliveries of SWP water from north of the Tehachapi Mountains or of CLWA water stored in groundwater banking programs in the San Joaquin Valley would not be available. It was also assumed that Pyramid and Castaic dams would not be damaged by the event and that water in Pyramid and Castaic Lakes would be available to the three West Branch SWP contractors, including CLWA.

In any of these three SWP emergency outage scenarios, DWR and the SWP contractors would coordinate operations to minimize supply disruptions. Depending on the particular outage scenario or outage location, some or all of the SWP contractors south of the Delta might be affected. But even among those contractors, potential impacts would differ given each contractor's specific mix of other supplies and available storage. During past SWP outages, the SWP contractors have worked cooperatively to minimize supply impacts among all contractors. Past examples of such cooperation have included certain SWP contractors agreeing to rely more heavily on alternate supplies, allowing more of the outage-limited SWP supply to be delivered to other contractors; and exchanges among SWP contractors, allowing delivery of one contractor's SWP or other water to another contractor, with that water being returned after the outage was over.

Of these three SWP outage scenarios, the West Branch outage scenario presents the worst-case scenario for CLWA. In this scenario, CLWA would rely on local supplies and water available from Pyramid and Castaic Lakes. An assessment of the supplies available to meet demands in CLWA's service area during a six-month West Branch outage and the additional levels of conservation projected to be needed are presented in Table 8-4 for 2005 through 2030.

During an outage, the local supplies available would consist of groundwater from the Alluvial Aquifer and the Saugus Formation, as well as recycled water. It was assumed that local well production would be unimpaired by the outage and that the outage would occur during a year when average/normal supplies would be available from the Alluvial Aquifer. Pumping from the Saugus was assumed to be one-half of the annual supplies available in a single dry year. Note that adequate well and aquifer capacity exists to pump at levels higher than those assumed in this assessment, particularly during a temporary period such as an outage. However, to be conservative, groundwater production was assumed to be one-half of annual supplies. Based on the assumption that additional voluntary conservation could reduce the amount of waste discharge, and therefore the amount of recycled water available, the amount of recycled water assumed to be available would be reduced by 25 percent.

The water available to CLWA from Pyramid and Castaic Lakes includes flexible storage available to CLWA at Castaic Lake and emergency and potentially regulatory storage available in both Pyramid and Castaic Lakes. Regulatory storage, which is used to help meet high peak summer deliveries, may or may not be available depending on what time of year an outage occurs. For this assessment, regulatory storage was assumed to be unavailable. The amount of emergency storage assumed to be available to CLWA was based on CLWA's proportionate share of usable storage in each reservoir, where usable storage is maximum operating storage, less regulatory and dead pool storage. At Castaic Lake, this usable storage determination also

excludes the three West Branch contractors' total flexible storage. CLWA's proportionate share of usable storage was assumed to be slightly less than three percent, based on its share of capital cost repayment at each reservoir. On this cost repayment basis, the proportionate shares of the Metropolitan and Ventura County Flood Control District are about 96 percent and one percent, respectively.

Table 8-4 shows that, for a six-month emergency outage, additional conservation beyond the conservation BMPs described in Chapter 7 would be required, with the additional demand reductions ranging from three to 16 percent of the urban portion of total demand. It is likely that potential cooperation among SWP contractors and/or temporarily increased purveyor groundwater production during such an outage could increase supplies so that lower amounts, or even no amount, of additional conservation would be needed. However, even without such supply increases, these levels of additional conservation would be readily achievable. In an emergency such as this, these levels of additional conservation would likely be achieved through voluntary conservation, but mandatory measures would be enacted if needed.

Table 8-4
Projected Supplies and Demands During
Six-Month Disruption of Imported Supply System [1]

	Supply / Demand (af)					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Local Supplies						
Existing Supplies						
Groundwater						
Alluvial Aquifer (2)	17,500	17,500	17,500	17,500	17,500	17,500
Saugus Formation (3)	5,000	7,500	7,500	7,500	7,500	7,500
Recycled Water (4) (5)	190	600	640	640	640	640
Planned Supplies						
Groundwater (3)						
Restored wells (Saugus Formation)	0	5,000	5,000	5,000	5,000	5,000
New Wells (Saugus Formation)	0	0	0	5,000	5,000	5,000
Recycled Water (5)	0	0	600	2,360	4,130	5,890
Total Existing and Planned Local Supplies	22,690	30,600	31,240	38,000	39,770	41,530
SWP West Branch Storage Available						
Flexible Storage (at Castaic Lake)						
Existing (CLWA)	4,680	4,680	4,680	4,680	4,680	4,680
Existing (Ventura County) (6)	0	1,380	1,380	0	0	0
Emergency Storage						
Pyramid Lake (7)	4,370	4,370	4,370	4,370	4,370	4,370
Castaic Lake (8)	3,370	3,370	3,370	3,370	3,370	3,370
Total West Branch Storage	12,420	13,800	13,800	12,420	12,420	12,420
Total Local Supplies and West Branch Storage	35,110	44,400	45,040	50,420	52,190	53,950
Demands (9)						
Total Estimated Demand (w/o Conservation) (10)	44,700	50,000	54,700	58,600	64,200	69,100
Conservation (11)	(3,700)	(4,300)	(4,900)	(5,300)	(6,000)	(6,500)
Total Demand (w/ Conservation)	41,000	45,700	49,800	53,300	58,200	62,600
Additional Conservation Required	5,900	1,300	4,800	2,900	6,000	8,700
Additional Conservation as Percent of Demand (12)	16%	3%	10%	5%	10%	13%

Notes:

(1) Assumes complete disruption in SWP supplies and in deliveries through the California Aqueduct for six months.

(2) Pumping from the Alluvial Aquifer is assumed to be one-half of average/normal year supplies (see Table 6-2).

(3) Pumping from the Saugus Formation is assumed to be one-half of single dry year supplies (see Table 6-3).

(4) Existing recycled water supply is based on one-half of current actual use of about 500 af for 2005, projected demand of 1,600 af for 2010, and existing supply of 1,700 af from 2015 on, as adjusted for the reduction described in Footnote 5.

(5) Assumes 25 percent reduction in waste discharge, and therefore in recycled water availability, due to additional voluntary conservation.

(6) Initial term of the Ventura County entities' flexible storage account is ten years (from 2006 to 2015).

(7) CLWA's share of usable storage at Pyramid Lake, based on its 2.817 percent proportionate share of capital cost repayment of the reservoir. Usable storage is assumed to be 165,100 af (maximum operating storage of 169,900 af, less regulatory storage of 10,000 af for making peak summer deliveries and dead pool storage of 4,800 af).

(8) CLWA's share of usable storage at Castaic Lake, based on its 2.927 percent proportionate share of capital cost repayment of the reservoir. Usable storage is assumed to be 115,100 af (maximum operating storage of 323,700 af, less regulatory storage of 30,000 af for making peak summer deliveries, total SWP contractor flexible storage of 160,000 af, and dead pool storage of 18,600 af).

(9) Demands are assumed to be one-half of average/normal year demands (see Table 2-2).

(10) Demands are for uses within the existing CLWA service area. Demands for any annexations to the CLWA service area will be added if and when such annexations are approved. During a six-month outage, currently proposed annexations would have a demand for about 2,000 afy and, given supplies CLWA is in the process of acquiring, potential future annexations with demands up to an additional 3,500 afy could eventually be approved.

(11) Assumes 10 percent reduction on urban portion of total demand resulting from conservation best management practices, as discussed in Chapter 7.

(12) Additional Conservation is expressed as percent of urban portion of total demand, since an outage would result in shortfall only to purveyors' customers (i.e., urban users).

8.5.3 Regional Power Outage Scenarios

For a major emergency such as an earthquake, Southern California Edison (Edison) has declared that in the event of an outage, power would be restored within a 24 hour period. Following the Northridge earthquake, Edison was able to restore power within 19 hours. Edison experienced extensive damage to several key power stations, yet was still able to recover within a 24 hour timeframe.

CLWA

To specifically address the concern of water outages due to loss of power, CLWA has equipped its two treatment plants with generators to produce power for treating water to comply with the State of California Safe Drinking Water Act and the Health and Safety Code. The Rio Vista Water Treatment Plant and Intake Pump Station emergency generator system provides electrical power to treat 30 mgd for 72 hours without fuel replacement. The Earl Schmidt Filtration Plant emergency generator system provides electrical power to treat 33 mgd for 72 hours without fuel replacement.

CLWA SCWD

SCWD is committed to providing regular service and meeting the needs of the community during any emergency situation. SCWD is obligated to respond to emergencies by using all available resources in the most effective way possible. SCWD has prepared an Emergency Response Plan that provides emergency operations procedures for the effective use of resources during various emergency situations. Emergency situations include but are not limited to: earthquakes, major fire emergencies, water outages due to loss of power, localized flooding, water contamination, and acts of sabotage.

To specifically address the concerns of water outages due to loss of power, SCWD has purchased and maintains one mobile generator and has the ability to obtain emergency access to others. The current generator is trailer mounted and has the capability of supplying 180 Kilovolt-Amperes (KVA). This capacity provides the capability to run any facility within the service area of SCWD. Most primary pumping facilities are equipped with emergency transfer switches, and SCWD employees are trained regularly to install and operate the generators in the most efficient and safe manner. The generator's run time is only limited by the amount of available diesel fuel. SCWD has an above ground diesel fuel storage tank with a capacity of 1,000 gallons located at its Warehouse at 21110 West Golden Triangle Road in the City of Santa Clarita. SCWD maintains one carrier truck, which is equipped with the capability of dispensing 100 gallons of diesel as necessary in refilling the generators. In addition, SCWD maintains a trailer-mounted 100 gallon diesel tank that will be deployed as required to preserve services. SCWD will respond to power outages on a prioritized basis and will continue its response to the power emergency as long as necessary. In addition to the generators, SCWD has a gas driven pump capable of delivering a maximum 2,000 gallons per minute (gpm). This pump can be installed at select facilities and run as required.

NCWD

NCWD fully understands its role in providing a vital service to the community. NCWD is obligated to respond to emergencies by using all available resources in the most effective way possible. NCWD has prepared an Emergency Response Plan that provides emergency operations procedures for the effective use of NCWD resources during various emergency situations. Emergency situations meant to be addressed by this plan are: earthquakes, major fire emergencies, water outages due to loss of power, localized flooding, water contamination, and acts of sabotage. To specifically address the concerns of water outages due to loss of power, NCWD has purchased and maintains three mobile generators. The generators are trailer mounted and have the following capacities: 600 KVA; 300 KVA; and 180 KVA.

These capacities provide the capability to run any facility within NCWD's service area. All primary pumping facilities are equipped with emergency transfer switches, and NCWD employees are trained regularly to maximize the speed to install and operate the generators. The generator run time is only limited by the amount of available diesel fuel. NCWD has an above ground diesel fuel storage tank with a capacity of 1,000 gallons located at its main office at 23780 N. Pine Street in the City of Santa Clarita. Multiple crew trucks are equipped with 100 gallon diesel tanks and the necessary fueling equipment to refill the generators. NCWD would respond to power outages on a prioritized basis and would continue its response to the power emergency as long as necessary. In addition to the generators, NCWD has a gas driven pump capable of delivering 600 gpm. This pump can be installed at select facilities as needed.

The NCWD Emergency Response Plan should be referenced for a more detailed description of specific actions NCWD plans to take in the event of a major power failure.

VWC

In the event that a power outage occurs, VWC has one mobile generator capable of powering either one of VWC's Saugus wells or two Alluvial wells that are in close proximity to one another. VWC would use the generator as a back-up to ensure water service remained until Edison was able to restore power. For regional power outages, VWC would rely on Edison's reliability criteria for restoring service with the longest outage assumed not to exceed 24 hours. This length of outage would not have a significant impact on water service.

The VWC Emergency Response Plan should be referenced for a more detailed description of specific actions VWC plans to take in the event of a major power failure.

8.6 MANDATORY PROHIBITIONS DURING SHORTAGES

All Valley residents live within the boundaries of the City of Santa Clarita or Los Angeles County. Several ordinances were passed in 1991, during the last long-term drought, by the various governmental entities in the Santa Clarita Valley outlawing wasteful water practices. It is expected that, if the Valley experienced another dry-year period, the same ordinances would be reactivated.

On February 11, 1991, the CLWA Board of Directors adopted Resolution No. 804 mandating a program of water conservation in the Santa Clarita Valley.

On February 14, 1991, the NCWD Board of Directors adopted Resolution No. 101 outlawing wasteful water practices. The ordinance was amended on October 15, 1991, with the adoption of Ordinance No. 102 and further amended on July 14, 2005, with the adoption of Ordinance No. 112.

On March 13, 1991, the City of Santa Clarita adopted Ordinance No. 91-16 outlawing wasteful water practices and calling for voluntary water conservation. The ordinance was amended on October 8, 1991 by the adoption of Ordinance No. 91-48.

On March 21, 1991, the Los Angeles County Board of Supervisors adopted Ordinance No. 91-0046U, which prohibits wasteful water practices.

Most of the ordinances mentioned above had sunset provisions that were effective January 1, 1992; however, these ordinances could be reinstituted as needed.

8.7 CONSUMPTIVE REDUCTION METHODS DURING RESTRICTIONS

8.7.1 Supply Shortage Triggering Levels

The agencies will manage water supplies to minimize the social and economic impact of water shortages. The Plan is designed to provide a minimum 50 percent of normal supply during a severe or extended water shortage.

Demand reduction stages may be triggered by a shortage in any one of the water sources in the Valley or by shortages in a combination of supplies. The guidelines for triggering the stages are listed in Table 8-5. However, circumstances may arise where the purveyors may deviate from these guidelines, such as in a case where the Governor declares a water shortage emergency and/or institutes a statewide rationing program.

Table 8-5
Water Deficiency Triggering Levels

Stage	Percent Shortage
1	Up to 15 percent water deficiency
2	15 to 25 percent water deficiency
3	25 to 35 percent water deficiency
4	35 to 50+ percent water deficiency

8.7.2 Consumption Limits

The Valley-wide consumption allocation method for each customer type is as follows:

Single Family	Hybrid of Per-capita and Percentage Reduction
Multi Family	Hybrid of Per-capita and Percentage Reduction

Commercial	Percentage Reduction
Industrial	Percentage Reduction
Governmental	Percentage Reduction
Recreational	Percentage Reduction
Irrigation	Percentage Reduction

The percentage reductions at each stage and for each customer type correspond to the figures listed in Table 8-4. In a drought situation (multiple-dry year period), individual customer allotments will be based on a normal year consumption table. The water agencies will classify each customer and calculate each customer's allotment according to Table 8-4. Each customer will be notified of its classification and allotment by mail before the implementation of a mandatory program. New customers and connections will be notified at the time service commences if a mandatory program is in effect. Any customer may appeal its classification on the basis of use or the allotment on the basis of incorrect calculation.

In a disaster, prior notice of allotment may not be possible. Notice will be provided by the most efficient means available, if necessary, through the terms of the CLWA's Emergency Response Plan.

8.7.3 New Demand

During any declared water shortage emergency requiring mandatory rationing, the retail purveyors recommend that the City and County building departments continue to process applications for grading and building permits, but not issue the actual permits until mandatory rationing is rescinded. In Stages 3 and 4, it may be necessary to discontinue all use of grading water, even if permits have been issued, and consider banning all use of water for non-essential uses, such as new landscaping and pools.

8.8 PENALTIES FOR EXCESSIVE USE

The following section provides a summary of the penalties, if any, that are implemented for excessive water use for CLWA SCWD, NCWD, and VWC.

8.8.1 CLWA Santa Clarita Water Division

The SCWD has one commodity rate for all customer classes, so no excessive use penalties are in place.

8.8.2 Newhall County Water District

In July 2005, NCWD's Board of Directors adopted Ordinance No. 112, which addresses water conservation, shortage, drought, and emergency response procedures. NCWD's Water Conservation Action Plan states that no water user shall waste water or make, cause, or permit the use of water for any purpose contrary to any provision of Ordinance No. 112, or in quantities in excess of the use permitted by the conservation stage in effect. If excessive use (water leaks and/or waste) is detected from any water user, the following enforcement plan will be followed:

Efficient Water Use and Stage 1 Enforcement:

- Any sign of water leaks and/or waste will be documented.
- NCWD will then determine the appropriate level of action to inform the water user of the guidelines in Ordinance No. 112 and will encourage more efficient water use.

Stages 2, 3, and 4 Enforcement:

- First Violation: NCWD shall issue a verbal warning to the water user and recommend corrective action.
- Second Violation: NCWD shall issue a written warning to the water user, and a fine of $40 shall be added to the water user's bill if the corrective action is not taken within 30 days after receiving the written warning.
- Third Violation: A fine of $100 shall be added to the water user's bill if the corrective action is not taken within 30 days after receiving the written warning. In addition, the NCWD Board or General Manager may require installation of a flow-restricting device on the water user's service connection.
- Fourth Violation: For the fourth and any additional violations, a fine of $250 shall be added to the water user's bill at the property where the violation occurred. NCWD may also discontinue the water user's water service at the property where the violation occurred. Reconnection shall be permitted only when there is reasonable protection against future violations, such as a flow-restricting device on the customer's service connection, as determined at NCWD's discretion.

NCWD Enforcement Costs: NCWD shall be reimbursed for its costs and expenses in enforcing the provisions of Ordinance No. 112, including costs incurred for staff to investigate and monitor the water user's compliance with the terms of the Ordinance. Charges for installation of flow-restricting devices or for discontinuing or restoring water service, as NCWD incurs those charges, shall be added to the water user's bill at the property where the enforcement costs were incurred.

8.8.3 Valencia Water Company

VWC is regulated by the PUC. During times of threatened or actual water shortage, the PUC will require that VWC apportion its available water supply among its customers. In the absence of direction from the PUC, VWC will apportion the supply in the manner that appears most equitable under circumstances then prevailing and with the cooperation of the Valley water purveyors with due regard to public health and safety.

The PUC's methodology for water utilities to implement Water Conservation Plans is documented in Standard Practice U-40-W, "Instructions for Water Conservation, Rationing, and Service Connection Moratoria." Water shortage contingency plans must be approved by the PUC prior to implementation by VWC. As stated in the Standard Practice U-40-W, the PUC shall

authorize mandatory conservation and rationing by approving Schedule No. 14.1, Mandatory Water Conservation and Rationing. Schedule No. 14.1 sets forth water use violation fines, charges for removal of flow restrictors, and the period during which mandatory conservation and rationing measures will be in effect.

8.9 FINANCIAL IMPACTS OF ACTIONS DURING SHORTAGES

The following section addresses the financial impacts of actions during water shortages for CLWA SCWD, NCWD, and VWC.

8.9.1 CLWA Santa Clarita Water Division

Approximately 45 percent of SCWD's expenses are variable and will be reduced proportionately with any reduction in sales due to voluntary or mandatory conservation. The remaining 55 percent of expenses are fixed and will not decrease as a result of reduced sales. Also, only 50 percent of the fixed expenses are included in the meter charge, and 70 percent of SCWD's revenues are generated by the commodity and energy charge.

As a result of the 1987-1992 drought, the Valley's retail water purveyors asked their retail customers to voluntarily reduce water use in 1992. The customers temporarily achieved a 25 percent reduction in usage. Approximately 70 percent of SCWD's revenues are derived from the commodity charge. A reduction of 25 percent could dramatically affect the financial stability of SCWD and impact its ability to meet its payment obligations and fund its capital program. Rather than being faced with the necessity of raising rates during a drought period, the Board directed staff to establish and maintain a Water Conservation Rate Stabilization Fund to be used in years when actual consumption drops 10 percent or more below average consumption. The Rate Stabilization Fund, established to address the financial impacts of water shortages, was approved by the Board in 2004.

8.9.2 Newhall County Water District

NCWD's rates are designed with the intent that NCWD will generate adequate revenues to meet the costs of operating the water system. For the 2005-06 budget year, it is expected that 26 percent of NCWD's total water revenues will come from the service charge and about 74 percent of the total revenues will come from the commodity charge. The service charge is based on meter size and the commodity charge is based on the quantity of water consumed.

The nature of NCWD's operation (as with any water utility) is that the majority of the operating costs are "fixed" in nature and do not increase or decrease in direct proportion with increases or decreases in water use by customers. For example, if water availability issues or shortages cause NCWD to request a voluntary reduction in the customer's water use, two-thirds of the operating costs will remain the same even though less water is sold. This would result in a major revenue shortfall.

In an effort to address this shortfall, NCWD established a reserve policy (Resolution 2005-26), that includes a "rate stabilization" fund to be used in situations where actual consumption of

water is reduced as a direct result of a water shortage situation as defined in Table 8-1 of this Plan.

In the event of a declaration of a water shortage situation, NCWD's Board of Directors will consider options and actions intended to replenish the rate stabilization reserve to its ideal level. These actions may include but are not limited to rate increases or surcharges, per customer assessments, and utilization of other reserve funds.

8.9.3 Valencia Water Company

The PUC allows the investor owned water utilities it regulates to track and seek recovery of lost revenues and expense increases due to mandatory or voluntary water rationing during a drought. PUC regulated utilities' rates are set based on an assumed level of customer water usage during normal weather conditions. Therefore, when a drought occurs and customers conserve water, a utility's revenue declines, and it is difficult for the utility to fund its operating expenses. In order to provide an incentive for utilities to promote water conservation during periods of drought, the PUC developed a mechanism whereby utilities can track lost revenues as well as increases in expenses due to drought. Utilities can then recover a portion of their lost revenues and expense increases via a surcharge to customers. This reduces the financial strain conservation programs place on investor owned utilities while furthering the statewide goal of water conservation during periods of drought.

8.10 WATER SHORTAGE CONTINGENCY RESOLUTION

If a water shortage crisis reoccurs, such as the 1987-1992 drought, the water agencies will call a public hearing to declare a water shortage pursuant to Sections 351 and 352 of the California Water Code.

The Los Angeles County Board of Supervisors (on behalf of LACWWD #36) and NCWD's and CLWA's respective Boards of Directors would adopt ordinances, similar to those adopted in 1991, implementing the Water Shortage Contingency Plan. As stated in Section 8.6, in February 1991, the CLWA Board of Directors adopted Resolution No. 804, which recognized reductions in requested delivery of SWP supply and mandated water conservation in the Valley.

VWC would file an advice letter with the CPUC implementing the Water shortage Contingency Plan.

8.11 MECHANISM TO DETERMINE REDUCTIONS IN WATER USE

Demand

NCWD, SCWD, and VWC bill their customers on a monthly basis. The prior year's consumption is included on most customer bills. This allows comparison of the total consumption from each billing period to the same billing period from the prior year.

Production

Under normal conditions, CLWA, NCWD, SCWD, and VWC prepare monthly production reports, which are reviewed and compared to production reports and pumping statistics from the same period of the prior year. Under water shortage conditions, these production reports could be prepared as often as daily.

Stage 1 and 2 Water Shortages

During Stage 1 and 2 Water Shortages, retail purveyors will review selected production reports on a daily basis, and CLWA will provide each retail purveyor with a copy of its daily production report. The water agencies will meet on a more frequent basis to review water supply and demand in the Valley. Billing reports will be reviewed to identify users who are not abiding by the plan.

Stage 3 and 4 Water Shortages

During Stage 3 and 4 Water Shortages, the retail purveyors will review all production reports and pumping statistics on a daily basis. The water agencies will continue to monitor the supply and demand in the Valley. Water transfers and agreements to use each other's distribution facilities will be implemented as needed. Billing reports will be reviewed to identify users who are not abiding by the plan.

Disaster Shortage

During a disaster shortage, management will continually monitor production figures. The water agencies will work to transfer water and use each other's distribution facilities where feasible.

Appendix A
UWMP Checklist

Appendix A
2005 Urban Water Management Plan Checklist

Yes	No			
Coordination with Appropriate Agencies				**(Water Code §10620 (d)(1)(2))**
✓		Participated in area, regional, watershed or basin wide plan		1-2 Page or Chapter
✓		Describe the coordination of the plan preparation and anticipated benefits.		1-2 thru 1-4 Page or Chapter
Describe resource maximization / import minimization plan				**(Water Code §10620 (f))**
✓		Describe how water management tools / options maximize resources & minimize need to import water		1-5 Page or Chapter
Plan Updated in Years Ending in Five and Zero				**(Water Code § 10621(a))**
✓		Date updated and adopted plan received	*Adopted Nov. 9th, 2005*	1-2 thru 1-4 Page or Chapter
City and County Notification and Participation				**(Water Code § 10621(b))**
✓		Notify any city or county within service area of UWMP of plan review & revision		1-3 thru 1-5 Page or Chapter
✓		Consult and obtain comments from cities and counties within service area		1-3 thru 1-5 Page or Chapter
Service Area Information				**(Water Code § 10631 (a))**
✓		Include current and projected population		2-7 Page or Chapter
✓		Population projections were based on data from state, regional or local agency		2-7 Page or Chapter
✓		Describe climate characteristics that affect water management		1-8; 1-9; 2-9; 2-10 Page or Chapter
✓		Describe other demographic factors affecting water management		1-9 Page or Chapter
Water Sources				**(Water Code § 10631 (b))**
✓		Identify existing and planned water supply sources		3-1; chapter 3 Page or Chapter
✓		Provide current water supply quantities		3-1; chapter 3 Page or Chapter
✓		Provide planned water supply quantities		3-1; chapter 3 Page or Chapter
If Groundwater identified as existing or planned source				**(Water Code §10631 (b)(1-4))**
✓		Has management plan		3-6 thru 3-9 Page or Chapter
✓		Attached management plan (b)(1)		[attached to adopted plan] Page or Chapter
✓		Description of basin(s) (b)(2)		3-6 Page or Chapter
		Basin is adjudicated		-- Page or Chapter
		If adjudicated, attached order or decree (b)(2)		-- Page or Chapter
		Quantified amount of legal pumping right (b)(2)		-- Page or Chapter
✓		Analysis of location, amount & sufficiency, last five years (b)(3)		3-9 thru 3-18 Page or Chapter
✓		Analysis of location & amount projected, 20 years (b)(4)		3-9 thru 3-18 Page or Chapter
Reliability of Supply				**(Water Code §10631 (c) (1-3)**
✓		Describes the reliability of the water supply and vulnerability to seasonal or climatic shortage		Chapter 6 Page or Chapter
Water Sources Not Available on a Consistent Basis				**(Water Code §10631 (c))**
✓		Describe the reliability of the water supply due to seasonal or climatic shortages		3-3, 3-8, Chapter 6 Page or Chapter
✓		Describe the vulnerability of the water supply to seasonal or climatic shortages		1-8; 1-9; Chapter 6 Page or Chapter
✓		Describe plans to supplement/replace inconsistent sources with alternative sources/DMMs		3-17; 5-5; 5-10 Page or Chapter
Transfer or Exchange Opportunities				**(Water Code §10631 (d))**
✓		Describe short term and long term exchange or transfer opportunities		3-19; 3-23 Page or Chapter
Water Use Provisions				**(Water Code §10631 (e) (1-2))**
✓		Quantify past water use by sector		2-4; 2-5 Page or Chapter
✓		Quantify current water use by sector		2-4; 2-5 Page or Chapter
✓		Project future water use by sector		2-4; 2-5 Page or Chapter
✓		Identify and quantify sales to other agencies		3-2, 3-3 Page or Chapter
✓		Identify and quantify additional water uses		Chapter 3 & 4 Page or Chapter
Demand Management Measures				**(Water Code §10631 (f)(g))**
✓		Agency is a CUWCC member		Chapter 7 Page or Chapter
✓		Annual BMP reports provided and considered completed by CUWCC website		Appendix F Page or Chapter
Planned Water Supply Projects and Programs				**(Water Code §10631 (h))**
✓		Detailed description of expected future supply projects & programs		3-22; 3-23 Page or Chapter
✓		Timeline for each proposed project		3-20 thru 3-23 Page or Chapter
✓		Quantification of each projects normal yield (AFY)		3-22; 3-23 Page or Chapter
✓		Quantification of each projects single dry-year yield (AFY)		3-22; 3-23 Page or Chapter
✓		Quantification of each projects multiple dry-year yield (AFY)		3-22; 3-23 Page or Chapter

Appendix A
2005 Urban Water Management Plan Checklist

Yes	No			
Opportunities for development of desalinated water			**(Water Code §10631 (i))**	
✓		Describes opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply	3-23 thru 3-25	Page or Chapter
If Supplier receives or projects receiving water from a wholesale supplier			**(Water Code §10631 (k))**	
✓		Agency receives, or projects receiving, wholesale water	3-2 thru 3-6	Page or Chapter
✓		Agency provided written demand projections to wholesaler, 20 years	3-3	Page or Chapter
✓		Wholesaler provided written water availability projections, by source, to agency, 20 years (if agency served by more than one wholesaler, duplicate this table and provide the source availability for each wholesaler)	3-4	Page or Chapter
✓		Reliability of wholesale supply provided in writing by wholesale agency (if agency served by more than one wholesaler, duplicate this table and provide the source availability for each wholesaler)	3-5; chapter 6	Page or Chapter
Water Shortage Contingency Plan Section			**(Water Code § 10632)**	
Stages of Action			**(Water Code § 10632 (a))**	
✓		Provide stages of action	8-2	Page or Chapter
✓		Provide the water supply conditions for each stage	8-2	Page or Chapter
✓		Includes plan for 50 percent supply shortage	8-2	Page or Chapter
Three-Year Minimum Water Supply			**(Water Code §10632 (b))**	
✓		Identifies driest 3-year period	8-3; 8-4	Page or Chapter
✓		Minimum water supply available by source for the next three years	8-3	Page or Chapter
Preparation for catastrophic water supply interruption			**(Water Code §10632 (c))**	
✓		Provided catastrophic supply interruption plan	8-4 thru 8-13	Page or Chapter
Prohibitions			**(Water Code § 10632 (d))**	
✓		List the mandatory prohibitions against specific water use practices during water shortages	8-13; 8-14	Page or Chapter
Consumption Reduction Methods			**(Water Code § 10632 (e))**	
✓		List the consumption reduction methods the water supplier will use to reduce water use in the most restrictive stages with up to a 50% reduction.	8-14; 8-15	Page or Chapter
Penalties			**(Water Code § 10632 (f))**	
✓		List excessive use penalties or charges for excessive use	8-15 thru 8-17	Page or Chapter
Revenue and Expenditure Impacts			**(Water Code § 10632 (g))**	
✓		Describe how actions and conditions impact revenues	8-17; 8-18	Page or Chapter
✓		Describe how actions and conditions impact expenditures	8-17; 8-18	Page or Chapter
✓		Describe measures to overcome the revenue and expenditure impacts	8-17; 8-18	Page or Chapter
Water Shortage Contingency Ordinance/Resolution			**(Water Code § 10632 (h))**	
✓		Attach a copy of the draft water shortage contingency resolution or ordinance.	Appendix G	Page or Chapter
Reduction Measuring Mechanism			**(Water Code § 10632 (i))**	
✓		Provided mechanisms for determining actual reductions	8-18	Page or Chapter
Recycling Plan Agency Coordination			**(Water Code § 10633)**	
✓		Describe the coordination of the recycling plan preparation information to the extent available.	4-1	Page or Chapter
Wastewater System Description			**(Water Code § 10633 (a))**	
✓		Describe the wastewater collection and treatment systems in the supplier's service area	4-2; 4-3	Page or Chapter
✓		Quantify the volume of wastewater collected and treated	4-3	Page or Chapter
Wastewater Disposal and Recycled Water Uses			**(Water Code § 10633 (a - d))**	
✓		Describes methods of wastewater disposal	4-5	Page or Chapter
✓		Describe the current type, place and use of recycled water	4-6; 4-7	Page or Chapter
✓		Describe and quantify potential uses of recycled water	4-7; 4-8	Page or Chapter
✓		Determination of technical and economic feasibility of serving the potential uses	4-7; 4-8	Page or Chapter
Projected Uses of Recycled Water			**(Water Code § 10633 (e))**	
✓		Projected use of recycled water, 20 years	4-8	Page or Chapter
✓		Compare UWMP 2000 projections with UWMP 2005 actual (§ 10633 (e))	4-8	Page or Chapter

Appendix A
2005 Urban Water Management Plan Checklist

Yes	No			
Plan to Optimize Use of Recycled Water			**(Water Code § 10633 (f))**	
✓		Describe actions that might be taken to encourage recycled water uses	4-8, 4-9	Page or Chapter
✓		Describe projected results of these actions in terms of acre-feet of recycled water used per year	4-9	Page or Chapter
✓		Provide a recycled water use optimization plan which includes actions to facilitate the use of recycled water (dual distribution systems, promote recirculating uses)	4-9, 4-10	Page or Chapter
Water quality impacts on availability of supply			**(Water Code §10634)**	
✓		Discusses water quality impacts (by source) upon water management strategies and supply reliability	Chapter 5	Page or Chapter
Supply and Demand Comparison to 20 Years			**(Water Code § 10635 (a))**	
✓		Compare the projected normal water supply to projected normal water use over the next 20 years, in 5-year increments.	6-7	Page or Chapter
Supply and Demand Comparison: Single-dry Year Scenario			**(Water Code § 10635 (a))**	
✓		Compare the projected single-dry year water supply to projected single-dry year water use over the next 20 years, in 5-year increments.	6-8	Page or Chapter
Supply and Demand Comparison: Multiple-dry Year Scenario			**(Water Code § 10635 (a))**	
✓		Project a multiple-dry year period (as identified in Table 9) occurring between 2006-2010 and compare projected supply and demand during those years	6-9	Page or Chapter
✓		Project a multiple-dry year period (as identified in Table 9) occurring between 2011-2015 and compare projected supply and demand during those years	6-9	Page or Chapter
✓		Project a multiple-dry year period (as identified in Table 9) occurring between 2016-2020 and compare projected supply and demand during those years	6-9	Page or Chapter
✓		Project a multiple-dry year period (as identified in Table 9) occurring between 2021-2025 and compare projected supply and demand during those years	6-9	Page or Chapter
Provision of Water Service Reliability section to cities/counties within service area			**(Water Code § 10635(b))**	
✓		Provided Water Service Reliability section of UWMP to cities and counties within which it provides water supplies within 60 days of UWMP submission to DWR	[to be complied w/ adopted Plan]	Page or Chapter
Does the Plan Include Public Participation and Plan Adoption			**(Water Code § 10642)**	
✓		Attach a copy of adoption resolution	[attached to adopted Plan]	Page or Chapter
✓		Encourage involvement of social, cultural & economic community groups	1-3 thru 1-5; Appendix B	Page or Chapter
✓		Plan available for public inspection	1-3 thru 1-5; Appendix B	Page or Chapter
✓		Provide proof of public hearing	1-3 thru 1-5; Appendix B	Page or Chapter
✓		Provided meeting notice to local governments	1-3 thru 1-5; Appendix B	Page or Chapter
Review of implementation of 2000 UWMP			**(Water Code § 10643)**	
✓		Reviewed implementation plan and schedule of 2000 UWMP	Chapter 1	Page or Chapter
✓		Implemented in accordance with the schedule set forth in plan	Chapter 1	Page or Chapter
Provision of 2005 UWMP to local governments			**(Water Code § 10644 (a))**	
✓		Provide 2005 UWMP to DWR, and cities and counties within 30 days of adoption	[to be complied w/ upon adoption of Plan]	Page or Chapter
Does the plan or correspondence accompanying it show where it is available for public review			**(Water Code § 10645)**	
✓		Does UWMP or correspondence accompanying it show where it is available for public review	1-3	Page or Chapter

Appendix B
Public Outreach Materials

UWMP 2005 Workshop and Public Hearing Schedule	
Date	**Meeting**
April 7, 2005	Community Workshop #1
June 29, 2005	Community Workshop #2
August 31, 2005	Community Workshop #3
September 28, 2005	First Joint Public Hearing
October 26, 2005	Second Joint Public Hearing

UWMP 2005 Outreach Meeting Schedule	
Date	**Meeting**
May 17, 2005	City of Santa Clarita Planning and Government Relations Staff
July 13, 2005	Building Industry Association Executive Director
August 3, 2005	Building Industry Association Government Affairs Committee
August 9, 2005	Santa Clarita Valley Government Affairs Committee
September 20, 2005	Santa Clarita Valley Chamber of Commerce Board
September 21, 2005	Castaic Town Council
September 22, 2005	Santa Clarita Valley Chamber of Commerce Environmental Committee

The Signal
3/29/05

SANTA CLARITA VALLEY

URBAN WATER MANAGEMENT PLAN

2005

CASTAIC LAKE WATER AGENCY AND THE SANTA CLARITA VALLEY WATER COMMUNITY ANNOUNCE THE PREPARATION OF THE 2005 URBAN WATER MANAGEMENT PLAN

The Urban Water Management Plan, mandated by the State of California, presents a picture of the Valley's water situation through the year 2030. It describes the long-range water needs of the community, and the means that will be used to supply the necessary water. We encourage your interest and involvement.

Kick-Off Community Workshop

Date: Thursday, April 7, 2005

Time: 6:00 pm

Location: Castaic Lake Water Agency,
Administration Building,
27234 Bouquet Canyon Road

Purpose: At this Kick-Off Community Workshop we will present an overview of the state requirements and an outline of the contents of the 2005 Urban Water Management Plan. Our team of experts will provide an overview and answer any questions. We will also provide an overview of the many opportunities for public comment during the preparation of the 2005 Urban Water Management Plan.

CASTAIC LAKE WATER AGENCY

Please call (661) 297-1600
for information.

Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company

Daily News
3/31/05

SANTA CLARITA VALLEY

URBAN WATER MANAGEMENT PLAN

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CASTAIC LAKE WATER AGENCY

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Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company

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The Signal
Daily News
6/22/05

SANTA CLARITA VALLEY
URBAN WATER MANAGEMENT PLAN
2005

CASTAIC LAKE WATER AGENCY AND
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2005 URBAN WATER MANAGEMENT PLAN

The Urban Water Management Plan, mandated by the State of California, presents a picture of the Valley's water situation through the year 2030. It describes the long-range water needs of the community, and the means that will be used to supply the necessary water. We encourage your interest and involvement.

YOU ARE CORDIALLY INVITED TO ATTEND OUR NEXT WORKSHOP
JUNE 29, 2005
5:30 P.M.

June 2005	Preliminary Draft UWMP release for public comment
June 2005	Community Workshop to review UWMP and seek input
August 2005	Follow up Community Workshop – release Draft UWMP, review contents with the public
September 2005	First CLWA Public Hearing
October 2005	Second CLWA Public Hearing
October 2005	Final UWMP considered for approval by the CLWA Board and NCWD Board (at a joint meeting)

CASTAIC LAKE WATER AGENCY

All meetings will be held at
Castaic Lake Water Agency, Administration Building
27234 Bouquet Canyon Road, at times TBA.
Please call (661) 297-1600 for information.

Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company

Breakfast, Lunch and Dinner only $175.00.
All Golfers get a chance at the Hole In One contest for a car sponsored by Frontier Toyota as well as many other raffles and prizes.
Musical sendoff provided by Canyon High Marching Band and Happy Hour Jazz, by the Canyon High Jazz Band.
Register online at www.goldstarbrigade.org or call (661) 252-7076.
This is a Non-Profit event. For sponsorship information log onto our website or call the number above.

SANTA CLARITA VALLEY
URBAN WATER MANAGEMENT PLAN
2005

CASTAIC LAKE WATER AGENCY AND
THE SANTA CLARITA VALLEY WATER COMMUNITY
ANNOUNCE THE PREPARATION OF THE
2005 URBAN WATER MANAGEMENT PLAN

The Urban Water Management Plan, mandated by the State of California, presents a picture of the Valley's water situation through 2030. It describes the long-range water needs of the community, and the means that will be used to supply the necessary water. We encourage your interest and involvement.

YOU ARE CORDIALLY INVITED TO ATTEND
OUR NEXT WORKSHOP
AUGUST 31, 2005
6:30 P.M.

June 2005	Preliminary Draft UWMP release for public comment
June 2005	Community Workshop to review UWMP and seek input
August 2005	Follow up Community Workshop – release Draft UWMP, review contents with the public
September 2005	First CLWA Public Hearing
October 2005	Second CLWA Public Hearing - UWMP considered for approval by the CLWA Board and NCWD Board (at a joint meeting)

CASTAIC LAKE WATER AGENCY

All meetings will be held at
Castaic Lake Water Agency, Administration Building
27234 Bouquet Canyon Road, at times TBA.
Please call (661) 297-1600 for information.

Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company

SANTA CLARITA VALLEY
URBAN WATER MANAGEMENT PLAN
2005

CASTAIC LAKE WATER AGENCY AND
THE SANTA CLARITA VALLEY WATER COMMUNITY
ANNOUNCE THE PREPARATION OF THE
2005 URBAN WATER MANAGEMENT PLAN

The Urban Water Management Plan, mandated by the State of California, presents a picture of the Valley's water situation through 2030. It describes the long-range water needs of the community, and the means that will be used to supply the necessary water. We encourage your interest and involvement.

YOU ARE CORDIALLY INVITED TO ATTEND OUR NEXT WORKSHOP

AUGUST 31, 2005
6:30 P.M.

June 2005	Preliminary Draft UWMP release for public comment
June 2005	Community Workshop to review UWMP and seek input
August 2005	Follow up Community Workshop – release Draft UWMP, review contents with the public
September 2005	First CLWA Public Hearing
October 2005	Second CLWA Public Hearing - UWMP considered for approval by the CLWA Board and NCWD Board (at a joint meeting)

CASTAIC LAKE WATER AGENCY

All meetings will be held at
Castaic Lake Water Agency, Administration Building
27234 Bouquet Canyon Road, at times TBA.
Please call (661) 297-1600 for information.

Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company

The Signal
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3 of 3

SANTA CLARITA VALLEY
URBAN WATER MANAGEMENT PLAN
2005

CASTAIC LAKE WATER AGENCY AND
THE SANTA CLARITA VALLEY WATER COMMUNITY
ANNOUNCE THE PREPARATION OF THE
2005 URBAN WATER MANAGEMENT PLAN

The Urban Water Management Plan, mandated by the State of California, presents a picture of the Valley's water situation through 2030. It describes the long-range water needs of the community, and the means that will be used to supply the necessary water. We encourage your interest and involvement.

YOU ARE CORDIALLY INVITED TO ATTEND OUR NEXT PUBLIC HEARING

OCTOBER 26, 2005

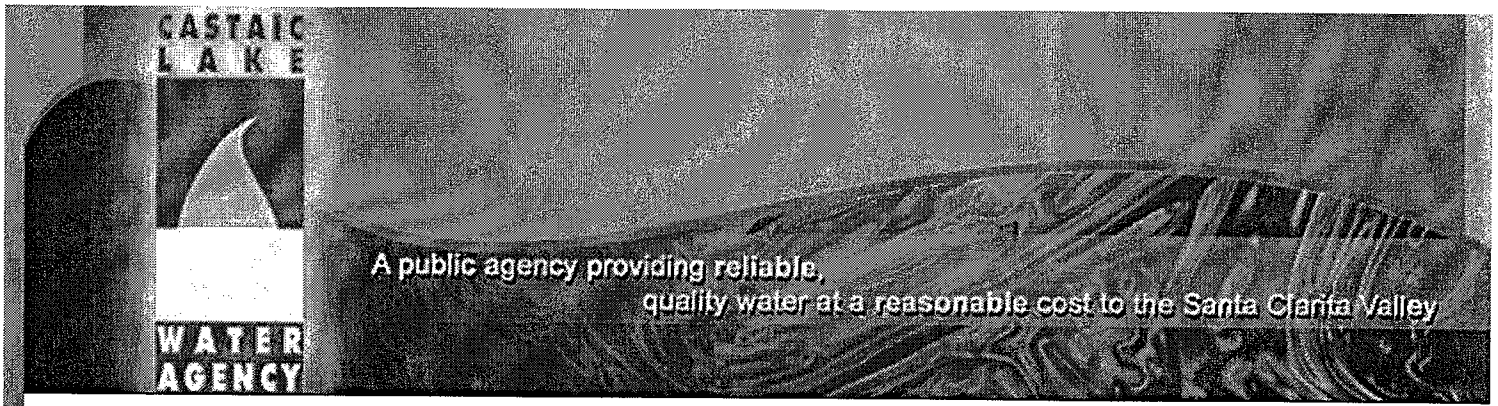
7:00 P.M.

June 2005	Preliminary Draft UWMP release for public comment
June 2005	Community Workshop to review UWMP and seek input
August 2005	Follow up Community Workshop – release Draft UWMP, review contents with the public
September 23, 2005	First CLWA Public Hearing
October 26, 2005	Second CLWA Public Hearing - UWMP considered for approval by the CLWA Board and NCWD Board (at a joint meeting)

CASTAIC LAKE WATER AGENCY

Hearing will be held at
Castaic Lake Water Agency, Administration Building
27234 Bouquet Canyon Road
Please call (661) 297-1600 for information.

Castaic Lake Water Agency
CLWA Santa Clarita Water Division
Newhall County Water District
Valencia Water Company



Publications (Newsletters, etc.)

Important Notices

This is where new items, important notices and information on upcoming events are posted.

IMPORTANT: The Draft 2005 Urban Water Management Plan for the Santa Clarita Valley is available for review. PLEASE SCROLL TO THE BOTTOM OF THIS PAGE FOR MORE INFORMATION.

Draft 2005 Urban Water Management Plan for the Santa Clarita Valley

The Draft 2005 Urban Water Management Plan is prepared in accordance with the requirements of the Urban Water Management Planning Act (Water Code sections 10630 et seq.). Every five years, in years ending in "5" and "0," water suppliers having more th 3,000 service connections or selling at least 3,000 acre-feet of water per year must prepare a plan.

Castaic Lake Water Agency, CLWA Santa Clarita Water Division, Newhall County Water District and Valencia Water Company ha prepared a joint regional plan for the Santa Clarita Valley, as encouraged by the Act. Los Angeles County Waterworks District No. 36 is participating on an ad hoc basis.

Two public hearings will be held to review the plan. Both hearings will he held during joint meetings of the CLWA and NCWD Boar of Directors, and will take place in the CLWA Board Room at the address shown below.

Wednesday, September 28, 2005 7:00 p.m.

Wednesday, October 26, 2005 7:00 p.m.

Written comments should be submitted to CLWA by 5:00 p.m., Wednesday, October 21, 2005. Comments should be directed to:

Mary Lou Cotton
Water Resources Manager
CLWA
27234 Bouquet Canyon Road
Santa Clarita, CA 91350
Fax: 661/297-1611

- Draft 2005 UWMP Introduction and Table of Contents
- Draft 2005 UWMP Chapters 1 through 4
- Draft 2005 UWMP Chapters 5 through 8
- Draft 2005 UWMP Appendix A
- Draft 2005 UWMP Appendix B
- Draft 2005 UWMP Appendix C
- Draft 2005 UWMP Appendix D
- Draft 2005 UWMP Appendix E

CASTAIC LAKE

Vital News About Water Issues in the Santa Clarita Valley Summer 2005

Water Currents

Urban Water Management Plan to Address SCV Water Demand and Supply

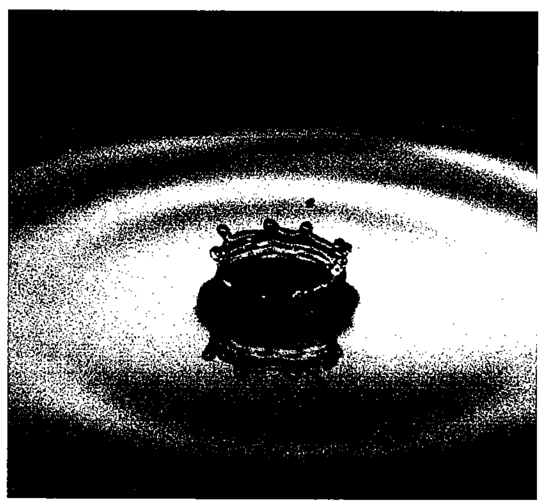
CLWA and the local water retailers are preparing a draft of the Santa Clarita Valley 2005 Urban Water Management Plan (UWMP) for review this summer and fall. All California urban water suppliers having more than 3,000 service connections or selling more than 3,000 acre-feet of water annually are required by the California Water Code to prepare a UWMP every five years. About 450 water suppliers statewide are affected. CLWA, CLWA Santa Clarita Water Division, Newhall County Water District (NCWD), and Valencia Water Company are working jointly to prepare a draft of a 2005 plan for the Santa Clarita Valley. Los Angeles County Waterworks District No. 36 is participating on an *ad hoc* basis, as the Los Angeles County Department of Public Works must prepare its own UWMP.

A UWMP must consider projected demands and supplies for a 20-year period, in five-year increments. It must also assess water supply and demand scenarios for average/normal water years (i.e., periods of normal precipitation), a single dry year, and multiple dry years.

The draft 2005 UWMP for the Santa Clarita Valley will identify current local and imported water supply sources, as well as potential future sources. Current sources include the State Water Project, local groundwater and recycled water. Future potential sources include all of these plus water transfers, additional recycled water, groundwater banking, water conservation and desalination.

The plan will identify future demand based on growth projections. By assessing projected demand along with projected supply, the 2005 UWMP will show how the Santa Clarita Valley will meet its water needs through 2030.

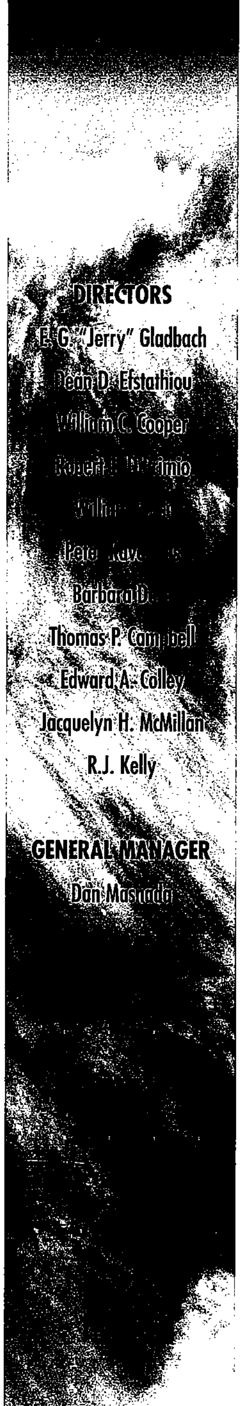
CLWA and the retailers published an amended 2000 UWMP this past January, which addresses in detail the issue of perchlorate contamination first detected in 1997 in certain groundwater wells adjacent to the former Whittaker-Bermite site. It describes plans for returning the contaminated wells to service.



Years of negotiations between CLWA, the local water retailers and the current and former owners of the site, in an effort to reach agreement on clean-up, were unproductive. In November 2000 CLWA and the retailers filed suit to compel the

Continued, page 4

WATER AGENCY



CASTAIC LAKE WATER AGENCY

Vital News About Water Issues in the Santa Clarita Valley Fall 2005

Water Currents

CLWA and Retailers Seek Public Comment on 2005 Urban Water Management Plan

The California Urban Water Planning Act requires water utilities to update and submit an Urban Water Management Plan (UWMP) every five years. CLWA is one of California's approximately 450 water suppliers now preparing such a plan. CLWA, CLWA Santa Clarita Water Division, Newhall County Water District (NCWD), and Valencia Water Company have worked together to prepare a draft of a 2005 plan for the Santa Clarita Valley. (Los Angeles County Waterworks District No. 36 is participating on an *ad hoc* basis, as the Los Angeles County Department of Public Works must prepare its own UWMP.)

A UWMP must consider projected demands and supplies for a 20-year period, in five-year increments. It must also assess water supply and demand scenarios for average/normal water years (i.e., periods of normal precipitation), a single dry year, and multiple dry years.

The draft 2005 UWMP for the Santa Clarita Valley is available for public review and comment. The Plan identifies current local and imported water supply sources, as well as potential future sources. Current sources include the State Water Project, local ground- water and recycled water. Future potential sources include all of these sources plus water transfers, additional recycled water, groundwater banking, water conservation and desalination.

The Plan identifies future demand based on growth projections. By assessing projected demand along with projected supply, the 2005 UWMP shows how the Santa Clarita Valley will meet its water needs through 2030.

Two public hearings to discuss the 2005 UWMP have been scheduled, the first of which was held on Wednesday, September 28, 2005, during a joint meeting of the CLWA and NCWD Boards of Directors . A second public hearing is scheduled for 7 p.m. on Wednesday, October 26, 2005. The hearing will be held in the CLWA Boardroom at 27234 Bouquet Canyon Road, Santa Clarita, CA 91350.

DIRECTORS
E. G. "Jerry" Gladbach
Dean D. Efstathiou
William C. Cooper
Robert J. DiPrimio
William [illegible]
Peter [illegible]
Barbara [illegible]
Thomas P. Campbell
Edward A. Colley
Jacquelyn H. McMillan
R.J. Kelly
GENERAL MANAGER
Dan Masnada

JEFFREY LAMBERT, AICP
Planning / Government Relations

March 26, 2005

Sand Canyon Area Well Owners Association
c/o 27363 Sand Canyon Road
Santa Clarita, CA 91387-3632

Subject: 2005 Santa Clarita Valley Urban Water Manager Plan

Dear Sand Canyon Well Owners Association:

We have begun to prepare the 2005 Santa Clarita Valley Urban Water Management Plan. In an effort to ensure all interested parties are fully informed and involved in our process, we have scheduled the first of many community workshops.

Date:	Thursday, April 7, 2005
Time:	6:00 pm
Location:	Castaic Lake Water Agency, Administration Building, 27234 Bouquet Canyon Road

The purpose of this Kick-Off Community Workshop is to present an overview of the state requirements and an outline of the contents of the 2005 Santa Clarita Valley Urban Water Management Plan.

I have enclosed a flyer for this workshop and encourage you to attend.

Sincerely,

Jeffrey Lambert, AICP
Public Outreach Manager, 2005 SCV UWMP

4603 Morse Avenue, Sherman Oaks, CA 91423, (818) 907-0294
Jeffrey@Jeffrey-Lambert.com

Ms. Dana Wisehart
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060

Stephan C. Volker
436 14th Street, Suite 1300
Oakland, California 94612

Sierra Club Angeles Chapter
3435 Wilshire Boulevard, Suite 320
Los Angeles, California 90010-1904

Friends of the Santa Clara River
660 Randy Drive
Newbury Park, California 91320-4323

Mr. Steve Cole
Acting General Manager
Newhall Country Water District
P.O. Box 220970
Newhall, California 91322-0970

Mr. Dennis Slivinski, Assistant County Counsel
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1830

Mr. David Todd
Office of Water Use Efficiency
CA Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Mr. Gerald Johns, Deputy Director
CA Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Jeffrey M. Smith, AICP
Southern CA Association of Governments
818 West Seventh Street, 12th Floor
Los Angeles, CA 90017-3435

McCormick, Kidman & Behrens, LLP
Russ Behrens, Esq.
695 Town Center Drive
Suite 400
Costa Mesa, California 92626-7187

Mr. Chris Stephens, Planning Director
Resource Management Agency
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1600

Mr. James Hartl
Director, Regional Planning
County of Los Angeles
320 West Temple Street
Los Angeles, CA 90012

Mr. Michael Murphy
Inter-Government Relations Officer
City of Santa Clarita
23920 Valencia Blvd.
Santa Clarita, CA 91355

Ms. Judy Reinsma, President
Santa Clarita Valley Well Owners Association
P.O. Box 800085
Santa Clarita, CA 91380

Sand Canyon Area Well Owners Association
c/o 27363 Sand Canyon Road
Santa Clarita, CA 91387-3632

Paul Fancett
Castaic Area Town Council
P.O. Box 325
Castaic, CA 91310

Paul Ash, President
Westranch Town Council
Hanger, Levine and Steinberg
21031 Ventura Blvd., Suite 800
Woodland Hills, CA 91364

Santa Clarita Sierra Club
21827 Parvin Dr.
Saugus, CA 91350

Santa Clarita Organization for Planning the Environment **SCOPE**
P.O. Box 1182
Canyon Country, CA
91386-1182

NOTE:
Those shaded addresses were sent Return Receipt (only Judy Reinsma was returned without evidence of receipt)

JEFFREY LAMBERT, AICP
Planning / Government Relations

June 21, 2005

Subject: 2005 Santa Clarita Valley Urban Water Management Plan

Dear:

As you know, we are preparing the 2005 Santa Clarita Valley Urban Water Management Plan. In an effort to ensure all interested parties are fully informed and involved in the process, we have scheduled the second community workshop.

Date:	Wednesday, June 29, 2005
Time:	5:30 pm
Location:	Castaic Lake Water Agency, Administration Building, 27234 Bouquet Canyon Road

The purpose of this Community Workshop is to present the Preliminary Draft 2005 UWMP and to seek your feedback. The Draft 2005 UWMP is scheduled to be released in August with public hearings scheduled for September and October.

I encourage you to attend and learn more about the 2005 Santa Clarita Valley Urban Water Management Plan.

Sincerely,

Jeffrey Lambert, AICP
Public Outreach Manager, 2005 SCV UWMP

4603 Morse Avenue, Sherman Oaks, CA 91423, (818) 907-0294
Jeffrey@Jeffrey-Lambert.com

JEFFREY LAMBERT, AICP
Planning / Government Relations
4603 Morse Avenue, Sherman Oaks, CA 91423, (818) 907-0294
Jeffrey@Jeffrey-Lambert.com

August 22, 2005

Subject: 2005 Santa Clarita Valley Urban Water Management Plan

Dear Interested Party:

As you know, the Santa Clarita Valley water suppliers are preparing the 2005 Santa Clarita Valley Urban Water Management Plan. This letter is intended to provide you with advanced information on upcoming public meetings. We have scheduled the third community workshop and have tentatively scheduled two public hearings at joint meetings of the Castaic Lake Water Agency and Newhall County Water District Boards of Directors. These meetings have been scheduled as follows:

What:	**Third Community Workshop**
Date:	Wednesday, August 31, 2005
Time:	6:30 pm
Location:	Castaic Lake Water Agency, Administration Building, 27234 Bouquet Canyon Road

What:	**Joint Public Hearing**
Date:	Wednesday, September 28, 2005 (tentative)
Time:	7:00 pm
Location:	Castaic Lake Water Agency, Administration Building, 27234 Bouquet Canyon Road

What:	**Joint Public Hearing (Second)**
Date:	Wednesday, October 26, 2005 (tentative)
Time:	7:00 pm
Location:	Castaic Lake Water Agency, Administration Building, 27234 Bouquet Canyon Road

The Draft 2005 UWMP is scheduled for release in mid- to late-August. The Draft 2005 UWMP will be available on the CLWA and NCWD web sites.

I encourage you to attend and be involved in the review and adoption of the 2005 Santa Clarita Valley Urban Water Management Plan.

Sincerely,

Jeffrey Lambert, AICP
Public Outreach Manager, 2005 SCV UWMP

Ms. Dana Wisehart
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060

Stephan C. Volker
436 14th Street, Suite 1300
Oakland, California 94612

Sierra Club Angeles Chapter
3435 Wilshire Boulevard, Suite 320
Los Angeles, California 90010-1904

Friends of the Santa Clara River
660 Randy Drive
Newbury Park, California 91320-4323

Mr. Steve Cole
Acting General Manager
Newhall Country Water District
P.O. Box 220970
Newhall, California 91322-0970

Mr. Dennis Slivinski, Assistant County Counsel
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1830

Mr. David Todd
Office of Water Use Efficiency
CA Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Mr. Gerald Johns, Deputy Director
CA Department of Water Resources
P.O. Box 942836
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Mr. Chris Stephens, Planning Director
Resource Management Agency
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1600

Mr. James Hartl
Director, Regional Planning
County of Los Angeles
320 West Temple Street
Los Angeles, CA 90012

Mr. Michael Murphy
Inter-Government Relations Officer
City of Santa Clarita
23920 Valencia Blvd.
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Ms. Judy Reinsma, President
Santa Clarita Valley Well Owners Association
P.O. Box 800085
Santa Clarita, CA 91380

Sand Canyon Area Well Owners Association
c/o 27363 Sand Canyon Road
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Paul Fancett
Castaic Area Town Council
P.O. Box 325
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Paul Ash, President
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Hanger, Levine and Steinberg
21031 Ventura Blvd., Suite 800
Woodland Hills, CA 91364

Santa Clarita Sierra Club
21827 Parvin Dr.
Saugus, CA 91350

Santa Clarita Organization for Planning the Environment SCOPE
P.O. Box 1182
Canyon Country, CA
91386-1182

NOTE:
Those shaded addresses were sent Return Receipt (only Judy Reinsma was returned without evidence of receipt)

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Santa Clarita Organization for Planning the Environment **SCOPE**
P.O. Box 1182
Canyon Country, CA
91386-1182

Dear SCOPE:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

With this in mind, I am requesting an opportunity to meet with you at your convenience. We would like to present the most recent version of the 2005 UWMP and answer any questions you may have.

I look forward to meeting with you. Please contact me via my cell phone at (818) 605-1506 to arrange a meeting.

Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Santa Clarita Sierra Club
21827 Parvin Dr.
Saugus, CA 91350

Dear Santa Clarita Sierra Club:

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Sincerely,

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Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Paul Ash, President
Westranch Town Council
Hanger, Levine and Steinberg
21031 Ventura Blvd., Suite 800
Woodland Hills, CA 91364

Dear Mr. Ash:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Paul Fancett
Castaic Area Town Council
P.O. Box 325
Castaic, CA 91310

Dear Mr. Fancett:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Sand Canyon Area Well Owners Association
c/o 27363 Sand Canyon Road
Santa Clarita, CA 91387-3632

Dear Sand Canyon Area Well Owners Association:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Ms. Judy Reinsma, President
Santa Clarita Valley Well Owners Association
P.O. Box 800085
Santa Clarita, CA 91380

Dear Ms. Reinsma:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Mr. Michael Murphy
Inter-Government Relations Officer
City of Santa Clarita
23920 Valencia Blvd.
Santa Clarita, CA 91355

Dear Mr. Murphy:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Mr. James Hartl
Director, Regional Planning
County of Los Angeles
320 West Temple Street
Los Angeles, CA 90012

Dear Mr. Hartl:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Mr. Chris Stephens, Planning Director
Resource Management Agency
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1600

Dear Mr. Stephens:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Jeffrey M. Smith, AICP
Southern CA Association of Governments
818 West Seventh Street, 12th Floor
Los Angeles, CA 90017-3435

Dear Mr. Smith:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

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CA Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Dear Mr. Johns:

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Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Mr. David Todd
Office of Water Use Efficiency
CA Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Mr. Dennis Slivinski, Assistant County Counsel
County of Ventura
800 South Victoria Avenue
Ventura, California 93009-1830

Dear Mr. Slivinski:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Friends of the Santa Clara River
660 Randy Drive
Newbury Park, California 91320-4323

Dear Friends of the Santa Clara River:

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Sierra Club Angeles Chapter
3435 Wilshire Boulevard, Suite 320
Los Angeles, California 90010-1904

Dear Sierra Club:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Stephan C. Volker
436 14th Street, Suite 1300
Oakland, California 94612

Dear Mr. Volker:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Sincerely,

Jeffrey Lambert, AICP

Jeffrey Lambert, AICP
Planning / Government Relations

July 20, 2005

Ms. Dana Wisehart
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060

Dear Ms Wisehart:

As you know, the Santa Clarita Valley water agencies are preparing the 2005 Urban Water Management Plan. I have been asked to manage the public outreach component of this effort. This includes seeking opportunities to talk with interested community groups about the 2005 UWMP. We released the Preliminary Draft 2005 UWMP on June 27, 2005 and are working toward the release of the Draft 2005 UWMP in August.

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Planning / Government Relations

July 20, 2005

Paul Ash, President
Westranch Town Council
Hanger, Levine & Steinberg
21031 Ventura Blvd, Suite 800
Woodland Hills, CA 91364-6512

Dear Mr. Ash:

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Sincerely,

Jeffrey Lambert, AICP

Appendix C
Groundwater Resources and Yield In the Santa Clarita Valley

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Groundwater Resources and Yield in the Santa Clarita Valley

Introduction

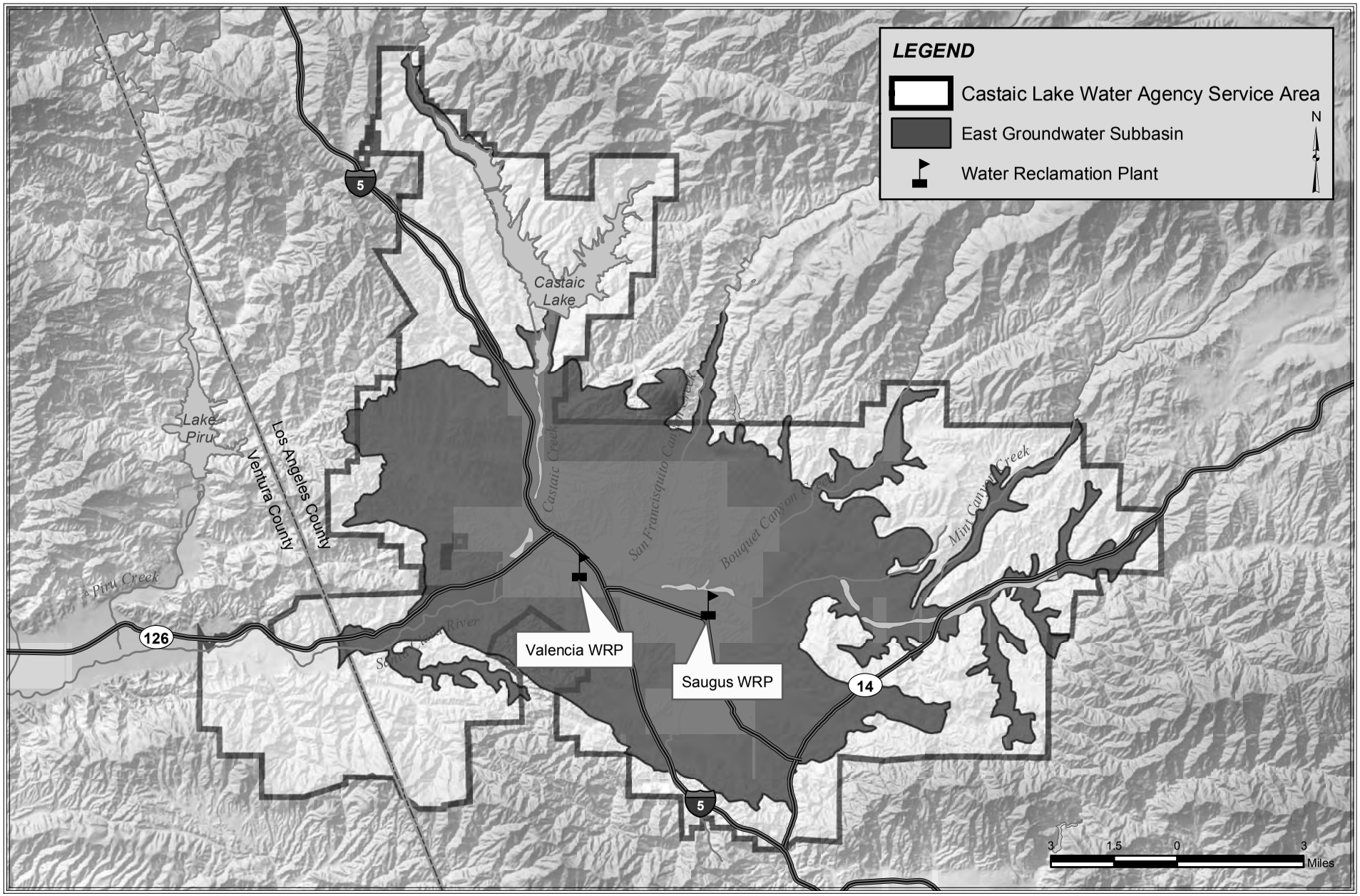
Beginning in the early part of the twentieth century, and continuing through the 1970s, local groundwater extracted from the two aquifers that comprise the local groundwater basin was the Santa Clarita Valley's sole source of water supply. Since 1980, local groundwater supplies have been supplemented with imported surface water from the State Water Project (SWP). In 2003, augmentation of those water supplies began with the initiation of deliveries from Castaic Lake Water Agency's (CLWA) recycled water system, which is anticipated to increase with time.

Santa Clara River Valley Groundwater Basin – East Subbasin

The groundwater basin generally beneath the Santa Clarita Valley, identified in the California Department of Water Resources' (DWR) Bulletin 118, 2003 Update as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin) (Basin No. 4-4.07), is comprised of two aquifer systems. The Alluvium generally underlies the Santa Clara River and its several tributaries and the Saugus Formation underlies practically the entire Upper Santa Clara River area. There are also some scattered outcrops of Terrace deposits in the Basin that likely contain limited amounts of groundwater; however, since these deposits are located in limited areas that are situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and consequently have not been developed for any significant water supply. Figure C-1 illustrates the mapped extent of the Basin in DWR Bulletin 118 (2003), which approximately coincides with the outer extent of the Alluvium and Saugus Formation, and its relationship to the extent of the CLWA service area.

A 2001 Update Report on both the Alluvium and Saugus Formation Aquifers was completed by Richard C. Slade and Associates, Consulting Groundwater Geologists (Slade, 2002). That report updated the analyses and interpretation of hydrogeologic conditions from earlier reports (Slade, 1986 and 1988), including extensive detail on major aspects of the groundwater Basin. Notable parts of the 2001 Update Report includes:

- Description of the extensive additional data available since the original Alluvium and Saugus Formation reports were prepared in 1986 and 1988, respectively
- Organization of historic data into a Geographic Information System (GIS) database
- Description of the overall groundwater basin in conformance with that being mapped by the Department of Water Resources in Bulletin 118 (2003)



LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Figure C-1
Santa Clara River Valley
East Groundwater Subbasin

- Analysis of historical groundwater levels and production, and conclusions that there have been no conditions that would be illustrative of groundwater overdraft
- Suggestion that utilization of operational yield (as opposed to perennial yield) as a basis for managing groundwater production would be more applicable in this basin to reflect
- Fluctuating utilization of groundwater in conjunction with utilization of imported SWP water
- Conclusion that operational yield of the Alluvium is 30,000 to 40,000 acre-feet per year (afy) for wet and average/normal rainfall years, with an expected reduction into the range of 30,000 to 35,000 afy in dry years
- Conclusion that operational yield of the Saugus Formation would be in the range of 7,500 to 15,000 afy on a long-term basis, with short-term increases during dry periods into a range of 15,000 to 25,000 afy, and to 35,000 afy if dry year conditions continue

Groundwater Management Plan

As part of legislation authorizing CLWA to provide retail water service to individual municipal customers in addition to its ongoing wholesale water supply, Assembly Bill 134 (2001) included a requirement that CLWA prepare a groundwater management plan in accordance with the provisions of Water Code Section 10753, which was originally enacted by, and is commonly known as, Assembly Bill 3030. The general contents of CLWA's groundwater management plan were outlined in 2002, and a detailed plan was drafted and adopted in 2003 to satisfy the requirements of AB 134. The plan both complements and formalizes a number of existing water supply and water resource planning and management activities in CLWA's service area, which effectively encompasses the East Subbasin of the Santa Clara River Valley Groundwater Basin.

CLWA adopted the Groundwater Management Plan (GWMP) in December 2003. As part of the GWMP, four management objectives, or goals, were established for the Basin including: (1) development of an integrated surface water, groundwater, and recycled water supply to meet existing and projected demands for municipal, agricultural, and other water uses; (2) assessment of groundwater Basin conditions to determine a range of operational yield values that will make use of local groundwater conjunctively with supplemental SWP supplies and recycled water to avoid groundwater overdraft, (3) preservation of groundwater quality, including active characterization and solution of any groundwater contamination problems, and (4) preservation of interrelated surface water resources, which includes managing groundwater to not adversely impact surface and groundwater discharges or quality to downstream basin(s).

The adopted GWMP includes 14 elements that are intended to accomplish the Basin management objectives listed above. In summary, the plan elements include:

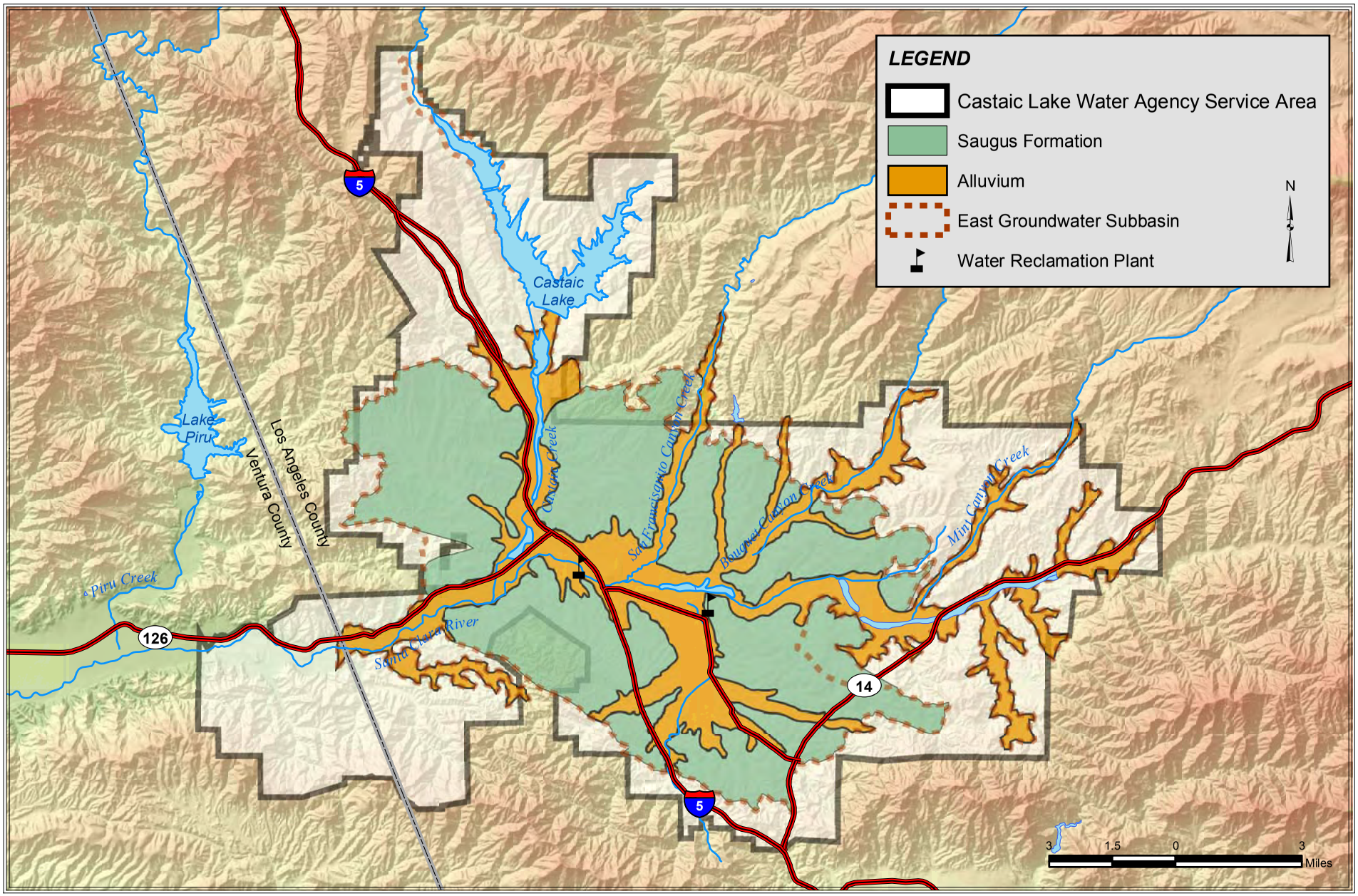
- Monitoring of groundwater levels, quality, production and subsidence
- Monitoring and management of surface water flows and quality
- Determination of Basin yield and avoidance of overdraft

- Development of regular and dry-year emergency water supply
- Continuation of conjunctive use operations
- Long-term salinity management
- Integration of recycled water
- Identification and mitigation of soil and groundwater contamination, including involvement with other local agencies in investigation, cleanup, and closure
- Development and continuation of local, state and federal agency relationships
- Groundwater management reports
- Continuation of public education and water conservation programs
- Identification and management of recharge areas and wellhead protection areas
- Identification of well construction, abandonment, and destruction policies
- Provisions to update the groundwater management plan

Alluvium – General

The Alluvial Aquifer system, of Quaternary to Holocene (recent) geologic age, consists primarily of stream channel and flood plain deposits of the Santa Clara River and its tributaries. The Alluvium is deepest along the center of the present river channel, with a maximum thickness of about 200 feet near the Saugus area. It thins toward the flanks of the adjoining hills and toward the eastern and western boundaries of the Basin and, in the tributaries, becomes a mere veneer in their upper reaches. The spatial extent of the Alluvium throughout the Basin is illustrated in Figure C-2.

Groundwater generally moves westward toward the outlet of the Basin, which is also the outlet of the Upper Santa Clara River Hydrologic Area. Thus, groundwater movement in the Alluvium beneath the tributaries is toward their confluence with the Santa Clara River and then westward in the Alluvium. From about Castaic Junction to Blue Cut, the Alluvium thins and narrows. This configuration forces groundwater to rise, keeping the depth to water at or close to the land surface. As discussed in more detail below, the general groundwater flow direction has remained unchanged whether groundwater levels are high or intermittently depressed. The San Gabriel and Holser faults traverse the Basin but neither fault measurably affects groundwater levels or flows in the Alluvium.



LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Figure C-2
Alluvial and Saugus Formations
Santa Clara River Valley East Groundwater Subbasin

Alluvial wells are distributed throughout the basin along the Santa Clara River and its southwest draining tributaries. Figure C-3 illustrates the location of the wells operated by retail water purveyors and other known Alluvial wells in the Basin. The Alluvium is the most permeable of the local aquifer units. Based on well yields and aquifer testing, estimated transmissivity values of 50,000 to 500,000 gallons per day per foot have been reported for the Alluvium, with the higher values where the Alluvium is thickest in the center of the Valley and generally west of Bouquet Canyon. The amount of groundwater in storage in the Alluvium can vary because of the effects of recharge, discharge, and pumping from the aquifer. The maximum storage capacity of the Alluvium has been estimated to be 240,000 acre-feet (af).

Consistent with the 2001 Update Report (Slade, 2002), the current management practice of the local retail water purveyors is to continue a groundwater operating plan that generally results in total Alluvial pumping in the range of 30,000 to 40,000 afy, slightly reduced to 30,000 to 35,000 afy in dry periods. This operating plan maximizes use of the Alluvium because of the aquifer's ability to store and produce good quality water on a perennial basis, and because the Alluvium is capable of rapid recovery of water levels and storage in wet periods. As with many groundwater basins, it is possible to intermittently exceed the long-term average yield for one or more years without long-term adverse effects. In the eastern part of the Alluvial Aquifer system, pumping during dry periods results in intermittently lower water levels in that portion of the aquifer. However, management of pumping during dry periods limits the lowering of water levels, and normal-to-wet period recharge results in a rapid return of groundwater levels to historic highs. Historical groundwater data collected from the Alluvium over many hydrologic cycles provides assurance that groundwater elevations return to normal in average or wet years following periods during which the groundwater elevations have declined. In addition, high rainfall totals in only one to two years generally will cause water levels within the Alluvium to rise quickly and by a relatively large amount. Such water level response to rainfall is a significant characteristic of permeable, porous, alluvial aquifer systems that occur within large watersheds.

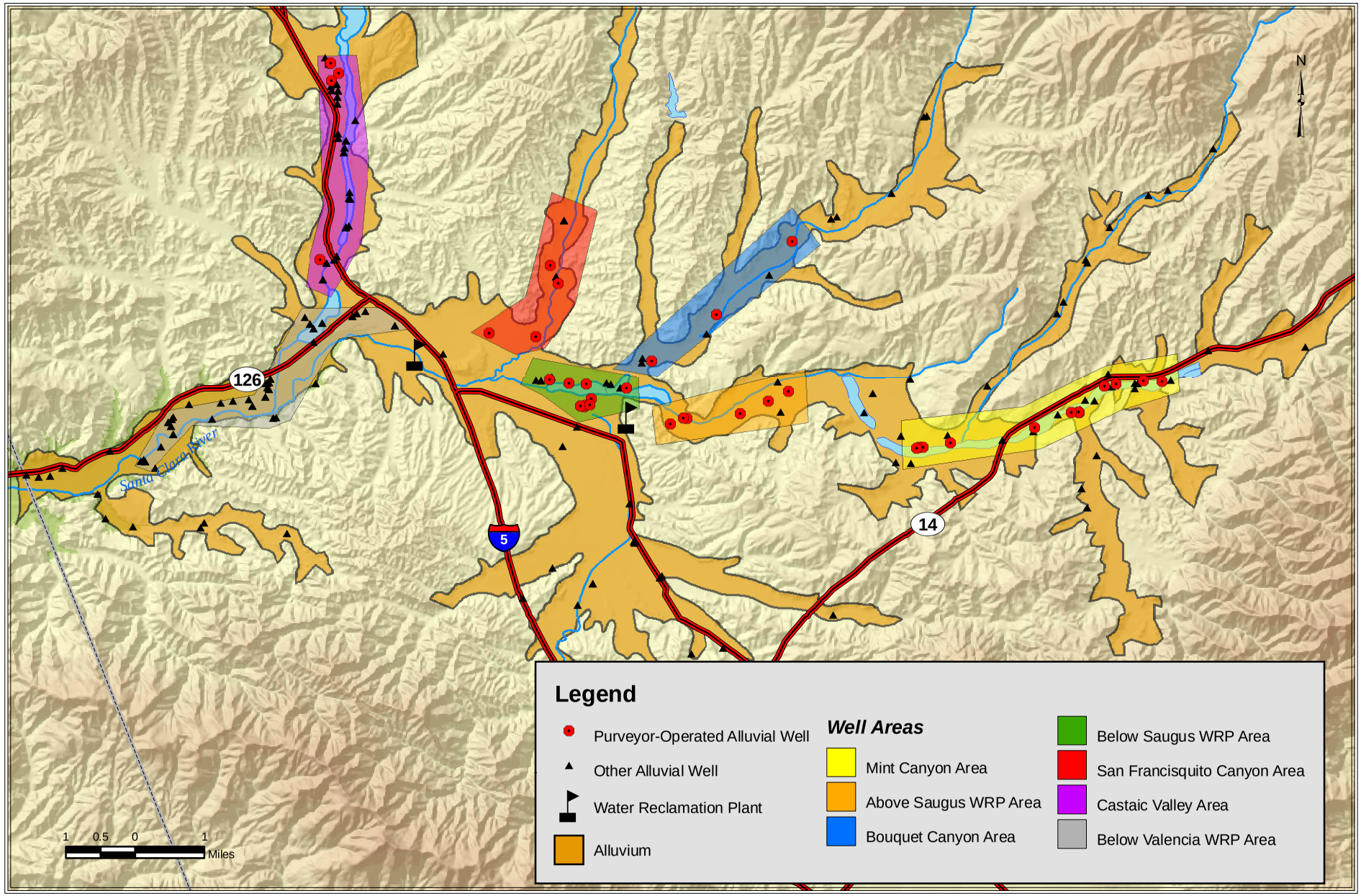


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Figure C-3
Alluvial Well Locations
Santa Clara River Valley, East Groundwater Subbasin

Alluvium – Historical and Current Conditions

Total pumpage from the Alluvium in 2004 was about 33,800 af, of which about 56 percent (19,000 af) was for municipal water supply, and the balance, about 44 percent (14,800 af), was for agriculture and other (minor) miscellaneous uses.

Alluvial pumpage has been recorded intermittently since the mid-1940s, and consistently since 1980. When pumpage records are unavailable (e.g., in the 1970s), data has been approximated to obtain a continuous historic record (Figure C-4). Alluvial pumpage from private wells, estimated to be at most 500 afy, has been included in the total Alluvial pumpage. Since the inception of SWP deliveries to CLWA in 1980, total pumpage from the Alluvium has ranged from a low of about 20,000 afy (in 1983) to slightly more than 43,000 afy (in 1999). Agricultural pumpage remained stable from the mid-1940's through about 1960, generally ranging from 33,000 to 37,000 afy, with annual pumpage as high as 41,000 af. From 1960 through the late 1970's, agricultural pumpage declined in a nearly linear trend, and has fluctuated slightly since then, between approximately 10,000 and 16,000 afy. As agricultural pumpage declined, municipal pumpage from the Alluvium increased from less than 4,000 afy in the 1950s to approximately 17,000 af in 1980. Beginning in 1980 with the importation of SWP water, municipal pumpage from the Alluvium declined to about 12,500 afy and remained stable throughout the 1980's. Municipal pumpage has subsequently increased to the current range of approximately 20,000 to 25,000 afy. Overall, there has been a change in municipal/agricultural pumping distribution since 1980, toward a slightly higher fraction for municipal water supply (from about 50 percent to nearly 60 percent of Alluvial pumpage), which reflects the general land use changes in the Valley.

The most recent analysis of the Alluvium (Slade, 2002) suggested that the operational yield of the Alluvium is 30,000 to 40,000 afy in average/normal and wet years, with a reduction to 30,000 to 35,000 afy in dry years. On a long-term basis since the importation of SWP water, total Alluvial pumpage has been about 30,500 afy (31,300 af in years with less than average precipitation, and 29,400 af in years with greater than average precipitation). These amounts are at the lower end of the range of operational yield of the Alluvium.

Groundwater Production - Alluvium

Santa Clara River Valley, East Groundwater Subbasin

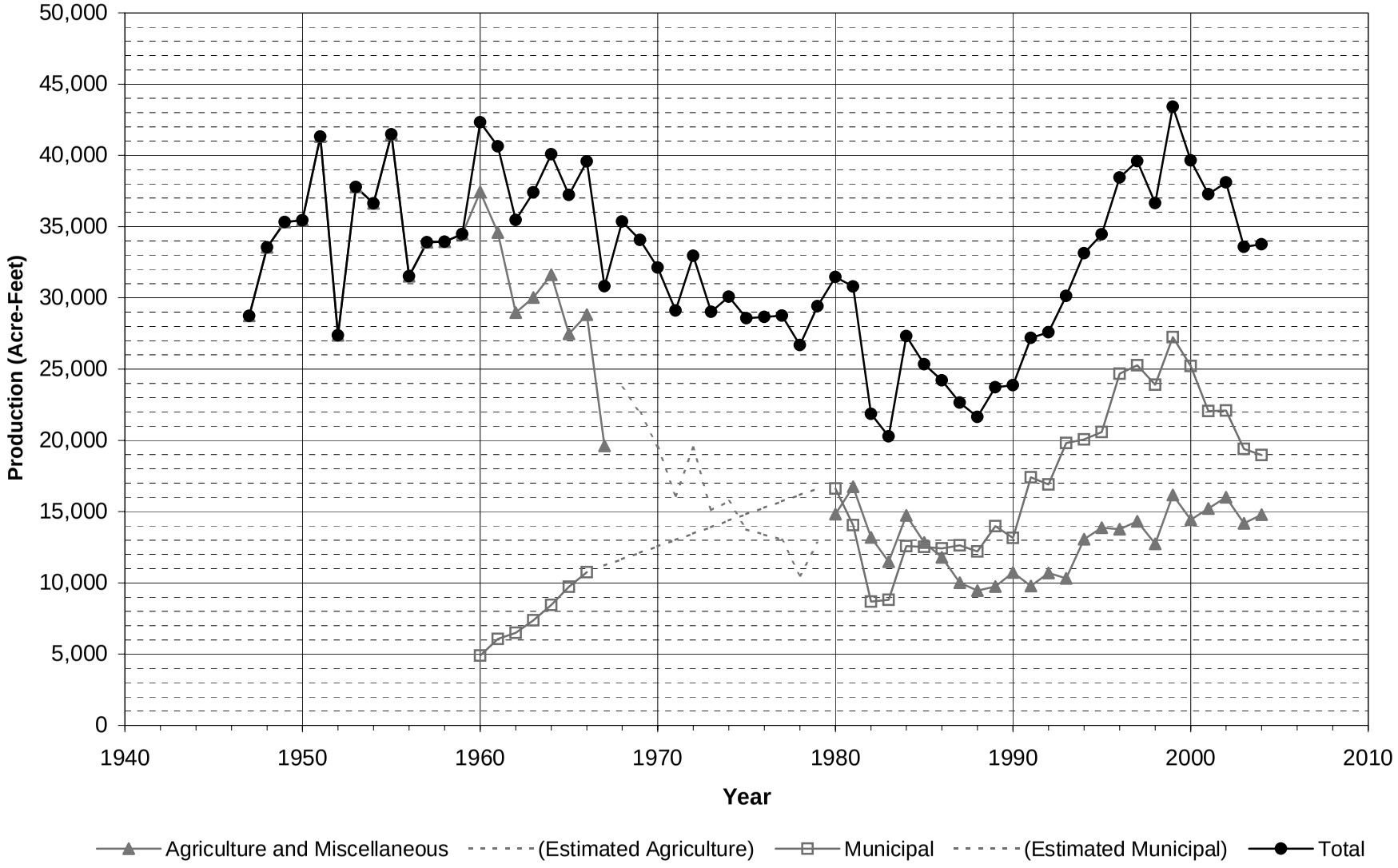


Figure C-4

Groundwater levels in various parts of the Basin have historically exhibited different responses to both pumpage and climatic fluctuations. During the last 20 to 30 years, in essentially all the alluvial portions of the Basin, groundwater levels have fluctuated from near the ground surface when the Basin is full, to as much as 100 feet lower when the Basin is pumped during intermittent dry periods of reduced recharge. Figure C-3 groups the Alluvial wells into areas with similar groundwater level fluctuations. Figures C-5 and C-6 present historical groundwater levels organized into hydrograph form (groundwater elevation vs. time) for four of these areas in the Basin. The other areas shown in Figure C-3 exhibit groundwater level responses similar to those in these four areas.

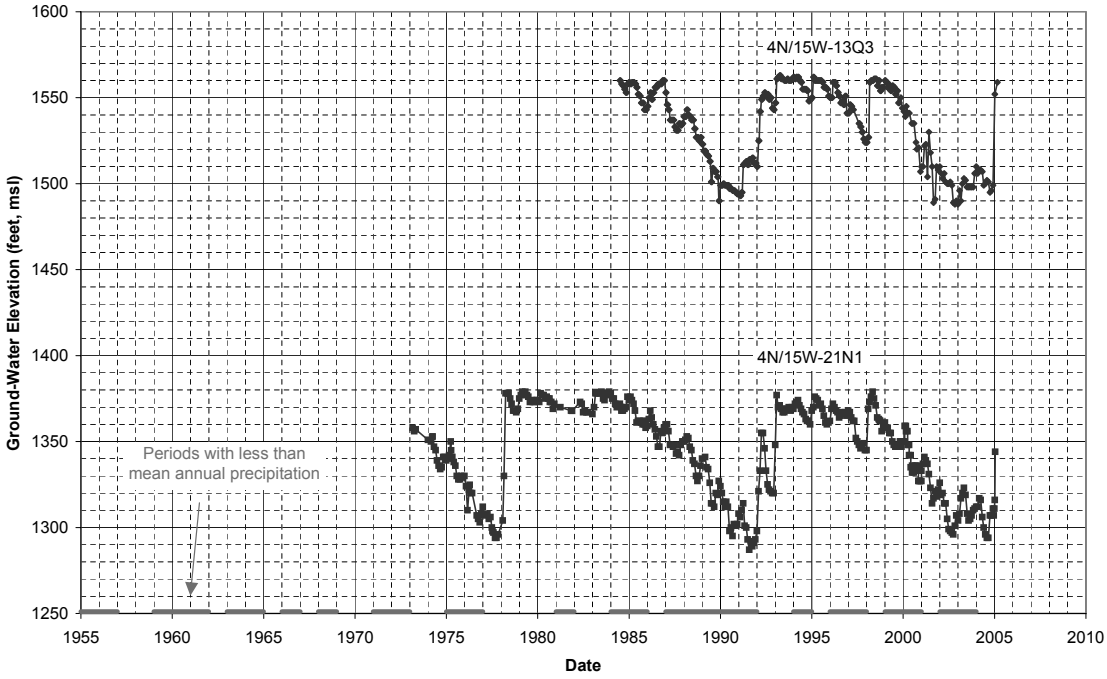
The 'Mint Canyon' area is located at the far eastern end of the Basin along the Santa Clara River. In this area, the Alluvium is shallower than in the western parts of the Basin; consequently, the area has historically exhibited the most dramatic responses to climatic fluctuations. The 'Above Saugus WRP' and 'Bouquet Canyon' areas generally exhibit groundwater level responses that are similar to those in the 'Mint Canyon' area.

The 'Below Saugus WRP' area is located along the Santa Clara River immediately downstream of the Saugus Water Reclamation Plant (WRP). This area has shown a dramatic increase in groundwater levels (30 to 60 feet) since the 1960s. The area now receives recharge from the treated wastewater discharged from the Saugus WRP to the Santa Clara River, and is located in one of the thickest areas of the Alluvium. The 'Below Saugus WRP' area exhibits groundwater level responses to climatic fluctuations, but these responses are much smaller than those further east in the Basin. The 'San Francisquito Canyon' area generally exhibits groundwater level responses that are similar to those in the 'Below Saugus WRP' area.

The 'Castaic Valley' area is located along Castaic Creek below Castaic Lake. Groundwater levels in this area have remained fairly constant, with slight responses to climatic fluctuations, since the 1950s.

The 'Below Valencia' WRP area is located along the Santa Clara River downstream of the Valencia WRP, and receives recharge from the treated wastewater discharged from the Valencia WRP to the Santa Clara River. Groundwater levels in this area exhibit slight, if any, response to climatic fluctuations, and have remained fairly constant since the 1950s.

Groundwater Elevation for 'Mint Canyon' Area Alluvial Wells
(lowest and highest for area shown)



Groundwater Elevation for 'Below Saugus WRP' Area Alluvial Wells
(lowest and highest for area shown)

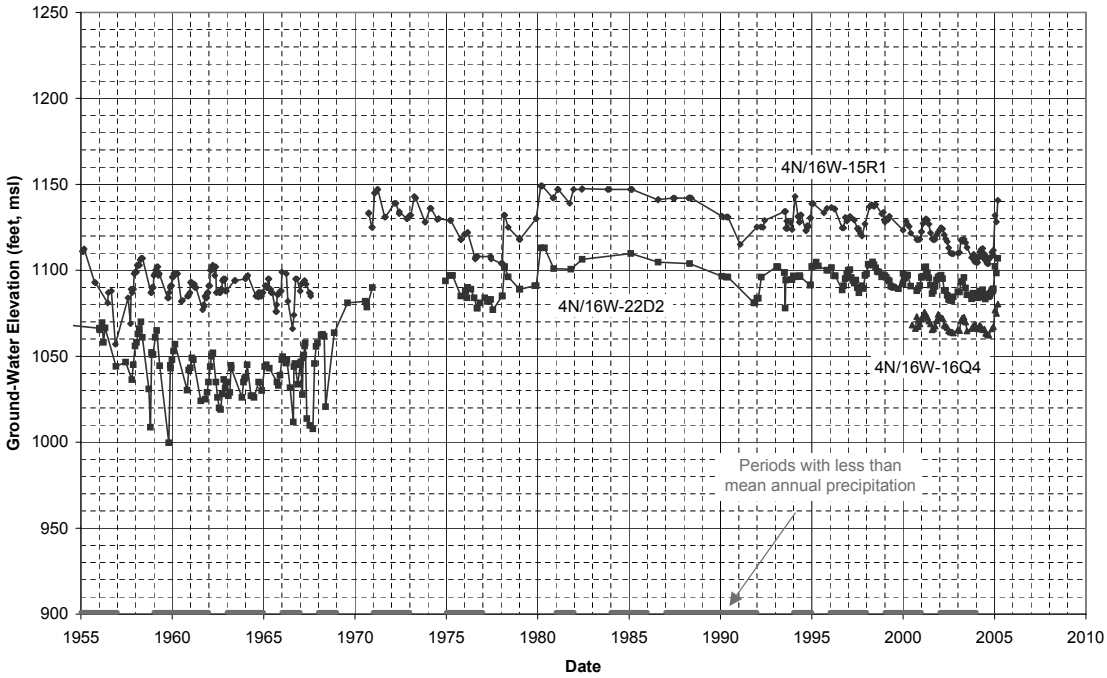
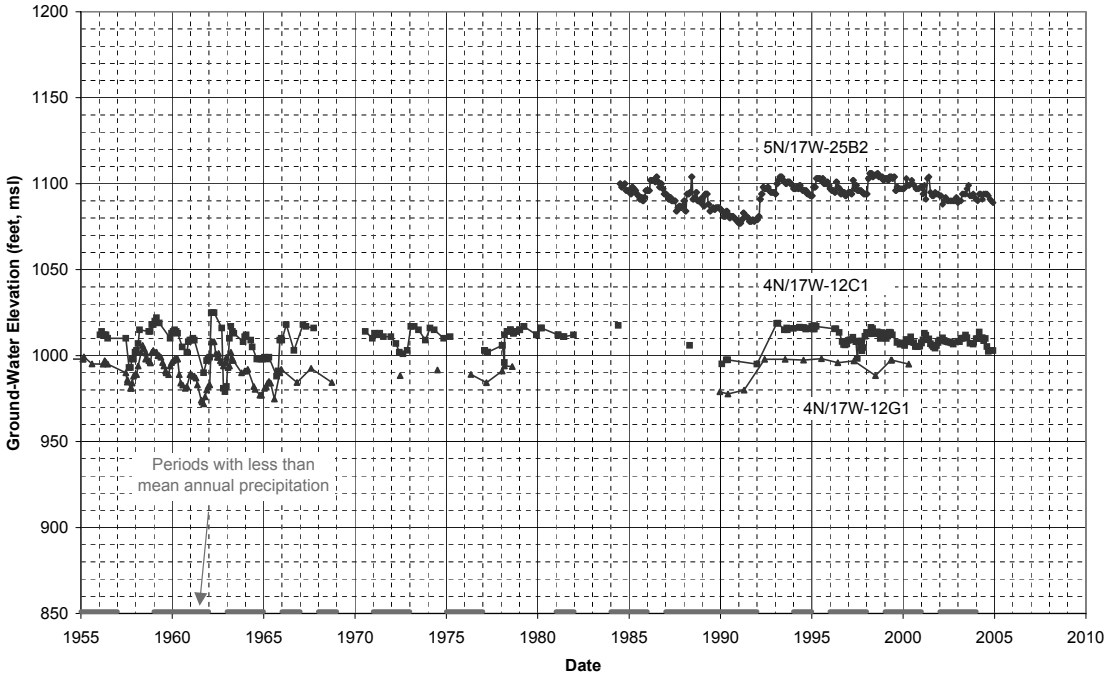


Figure C-5

Groundwater Elevation for 'Castaic Valley' Area Alluvial Wells
(lowest and highest for area shown)



Groundwater Elevation for 'Below Valencia WRP' Area Alluvial Wells
(lowest and highest for area shown)

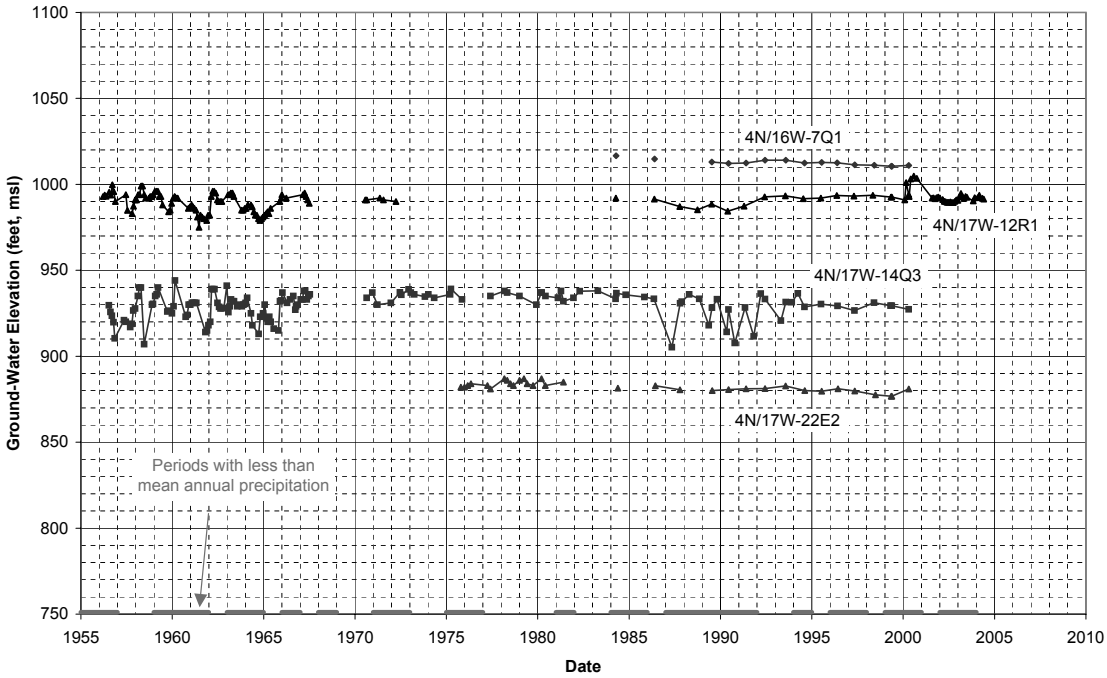


Figure C-6

Groundwater fluctuations in the 'Mint Canyon' area (illustrated in Figure C-5) represent the most substantial intermittent changes in the Basin. As described and discussed above, the Alluvium has historically experienced a number of alternating wet and dry hydrologic conditions during which groundwater level declines are followed by returns to historic highs. Since the Alluvium is thinner to the east, the resulting groundwater fluctuations are most dramatic in this area, up to 75 to 100 feet. When water levels are low, well yields and pumping capacities in this area can be impacted. The affected retail water purveyors respond by decreasing pumping and increasing use of Saugus Formation and imported SWP supplies. The purveyors also shift a fraction of the Alluvial pumpage that would normally be supplied by 'Mint Canyon' area wells to areas further west, where well yields and pumping capacities remain fairly constant because of smaller groundwater level fluctuations. As shown in Figure C-7, the purveyors have decreased the percent of total Alluvial pumpage from the 'Mint Canyon' area steadily beginning in 2000, and have offset these decreases by increasing pumpage in the 'Below Saugus WRP' and 'Below Valencia WRP' areas. This allows the purveyors to maximize the available supply from the Alluvium during dry periods to best meet demand. In spite of the current period of below average precipitation, groundwater levels in the 'Mint Canyon' area have ceased to decline in the last two years. This is illustrative of the purveyors' integrated use of surface water and groundwater to maintain local groundwater resources within their overall yield.

Depending on the period of available data, all the hydrographs of groundwater levels in the Alluvium show the same general picture: recent (last 30 years) groundwater levels have exhibited historic highs; in some locations, there are intermittent dry-period declines (and an associated use of some groundwater from storage) followed by wet-period recoveries (and associated natural refilling of storage space). On a long-term basis, the Alluvium shows no signs of water level-related overdraft (i.e., no trend toward decreasing water levels and storage). Since there is no evidence of any historic or recent trend toward permanent groundwater level or storage decline, pumpage from the Alluvium has been, and continues to be, within the operational yield of that aquifer.

As previously mentioned, it is possible to intermittently pump the aquifer by exceeding its average yield for one or more years without long-term impacts. This utilizes some water from storage in the aquifer, and is evidenced by lowered groundwater levels, which subsequently recover during periods of reduced pumpage or higher than average precipitation. Records of groundwater levels, pumpage and precipitation suggest that declines and subsequent rises in groundwater levels are influenced more by fluctuations in the availability of water for recharge than by pumpage. When less water is available for recharge, during periods of lower than average precipitation and streamflow, groundwater levels decline even when pumpage remains

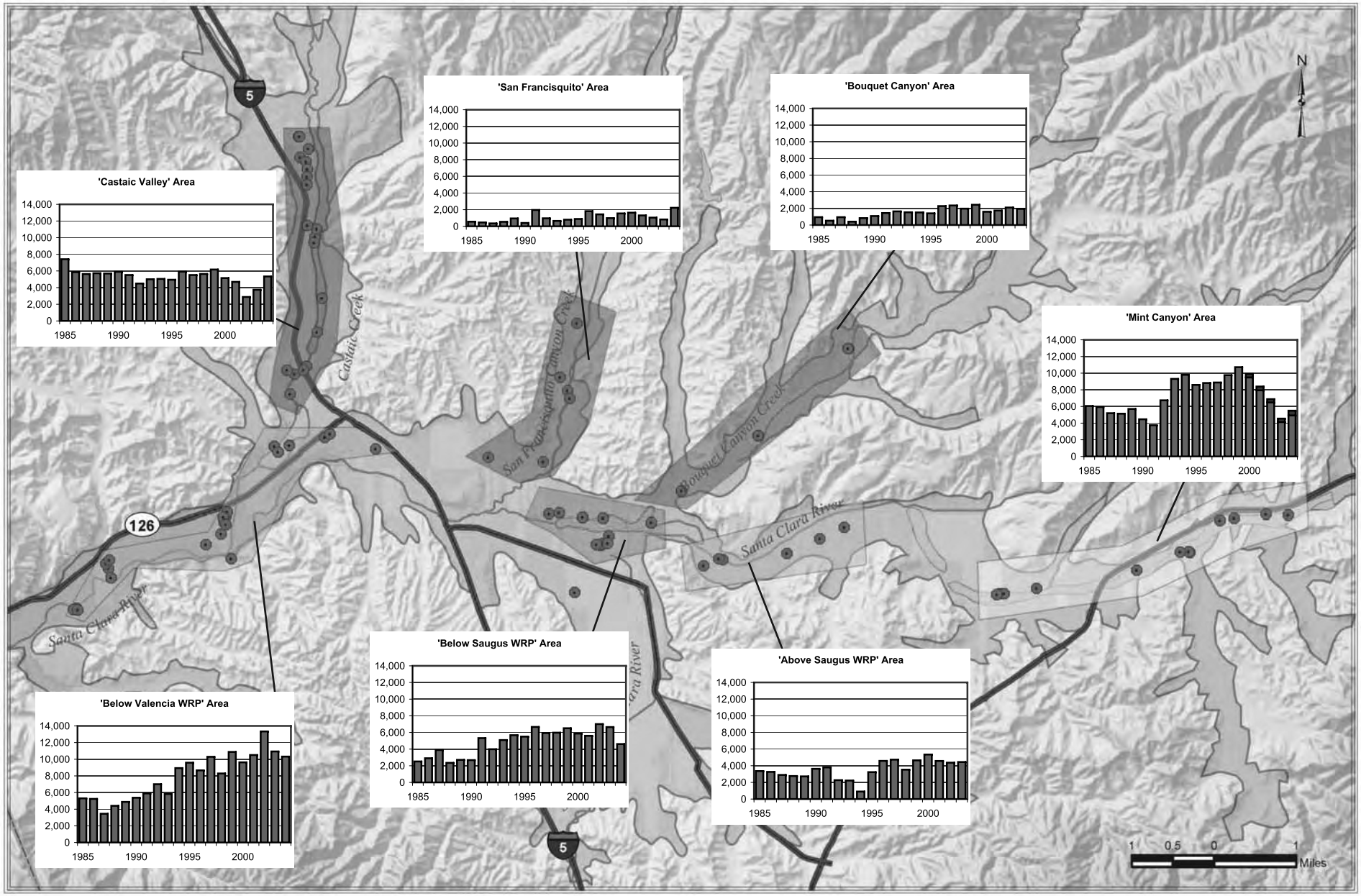


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Figure C-7
Annual Groundwater Production from Alluvium by Area (Acre-feet)
Santa Clara River Valley, East Groundwater Subbasin

constant. Conversely, when an abundance of water is available for recharge because of wet conditions, pumpage can increase significantly without affecting groundwater levels. Overall, long-term experience with Alluvial Aquifer response to pumping in the ranges now considered to be its operational yield shows that such ranges can be considered reliable components of future supply. Recently completed numerical groundwater flow modeling, discussed in detail below, has been used to project Alluvial Aquifer response to the same ranges of pumping over multiple decades of varying hydrologic conditions; groundwater levels are projected to essentially repeat what has historically occurred since the importation of supplemental SWP water.

Saugus Formation – General

The Saugus Formation, of Pliocene to Pleistocene geologic age, has traditionally been divided into two stratigraphic units: the lowermost, geologically older Sunshine Ranch Member, which is of mixed marine to terrestrial (non-marine) origin; and the overlying, or upper, portion of the Formation which is entirely terrestrial in origin. The Sunshine Ranch Member of the Saugus Formation has a maximum thickness of about 3,000 to 3,500 feet in the central part of the Valley; however, due to its marine origin and fine-grained nature, it is not considered to be a viable source of groundwater for municipal or other water supply. Above the Sunshine Ranch Member, the upper portion of the Saugus Formation is coarser grained, consisting mainly of lenticular beds of sandstone and conglomerate that are interbedded with lesser amounts of sandy mudstone, which were deposited in stream channels, flood plains, and alluvial fans by one or more ancestral drainage systems in the Valley. The sand and gravel units that represent aquifer materials in the upper part of the Saugus Formation are generally located between depths of about 300 and 2,500 feet. The spatial extent of the Saugus Formation throughout the Basin is illustrated on Figure C-8.

The Saugus Formation is much thicker and more spatially extensive throughout the Basin when compared to the Alluvium. It is also significant in terms of groundwater storage and individual well capacity. However, the Saugus Formation has typically lower values of transmissivity, in the range of 80,000 to 160,000 gpd/ft, with the higher values in the upper portions of the Formation. The storage capacity of the Saugus has most recently been estimated to be 1.65 million af between depths of 300 feet and approximately 2,500 feet (to the base of the Saugus, or to the base of fresh water if shallower than 2,500 feet). Groundwater in the Saugus Formation generally moves north along the South Fork of the Santa Clara River, towards the Santa Clara River and the outlet of the Basin. Saugus wells operated by the retail water purveyors (shown in Figure C-8) are located in the southern portion of the Basin, south of the Santa Clara River.

For long-term planning purposes, the operating plan includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years, a conservative estimate in light of historical estimates of potential recharge to the Saugus complemented by observations of high groundwater levels in the overlying Alluvium over the last 30 years. The operating plan also

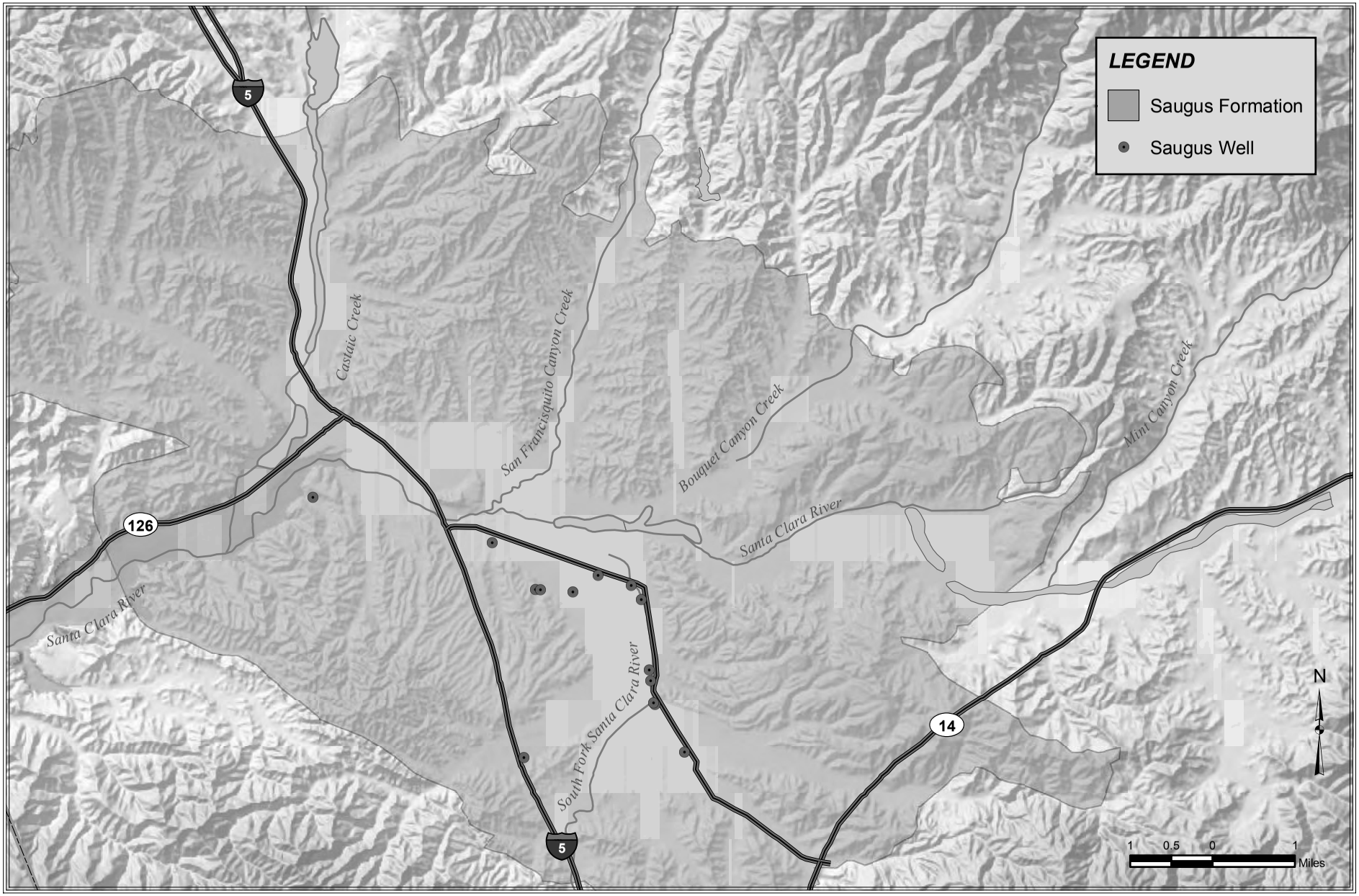

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Figure C-8
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

includes planned dry-year pumping of 15,000 to 35,000 afy for one to three consecutive dry years, when shortages to other water supplies could occur. Such high pumping would be followed by periods of lower pumpage (7,500 to 15,000 afy in average/normal years as noted above) to allow recharge to recover water levels and storage in the Saugus. Maintaining the substantial volume of water in the Saugus Formation is an important strategy to help provide water supplies in the Valley during dry periods.

Saugus Formation – Historical and Current Conditions

Total pumpage from the Saugus Formation in 2004 was 6,500 af, of which most (5,700 af) was for municipal water supply, and the balance (800 af) was for agricultural and other (minor) uses. Historically, groundwater pumpage from the Saugus peaked in the early 1990s and then declined steadily. Pumpage has remained generally stable, at an average of about 4,600 afy, since 1998.

Historical pumpage records for the Saugus Formation are limited prior to 1980, but suggest that pumpage from the Saugus was minimal at that time. When pumpage records are unavailable, data have been approximated to obtain a continuous historic record (Figure C-9). The records indicate that there was almost no pumping from the Saugus prior to 1960 (about 100 af in most years, beginning in 1948), and that some increased pumping for agricultural water supply (about 900 af) began in about 1962. The largest amount of agricultural pumping from the Saugus was during the mid-1960s, when annual pumpage was about 3,000 af. Agricultural pumping from the Saugus declined to near zero by the late 1970s, but has generally ranged from 500 to 1,000 afy since 1982. Municipal pumping records from the Saugus are incomplete prior to 1980. There was no Saugus pumpage for municipal supply in the early 1960s. Despite the lack of pre-1980 records, post-1980 data suggests that municipal pumping from the Saugus began in the 1970s, and reached nearly 5,000 afy by 1980-81.

The first historical investigation of the Saugus (Slade, 1988) suggested that the recharge potential of the Saugus was in the range of 11,000 to 22,000 afy, depending on precipitation and groundwater levels in the partially overlying Alluvium. Recent updating of that original work (Slade, 2002) suggested that the operational yield of the Saugus Formation is in the range of 7,500 to 15,000 afy in average years, with an increase to as much as 35,000 afy in multiple dry year periods. On a long-term average basis since the importation of SWP water, total pumpage from the Saugus Formation has ranged from a low of about 3,700 afy (in 1999) to a high of nearly 15,000 afy (in 1991); average pumpage from 1980 to present has been about 6,700 afy. These numbers are at the lower end of the estimated range of the operational yield of the Saugus Formation.

Unlike the Alluvium, which has an abundance of wells with extensive water level records, the water level data for the Saugus Formation is limited by the distribution of the wells in this Formation and the periods of record. The wells that do have water level records extending back

Groundwater Production - Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin

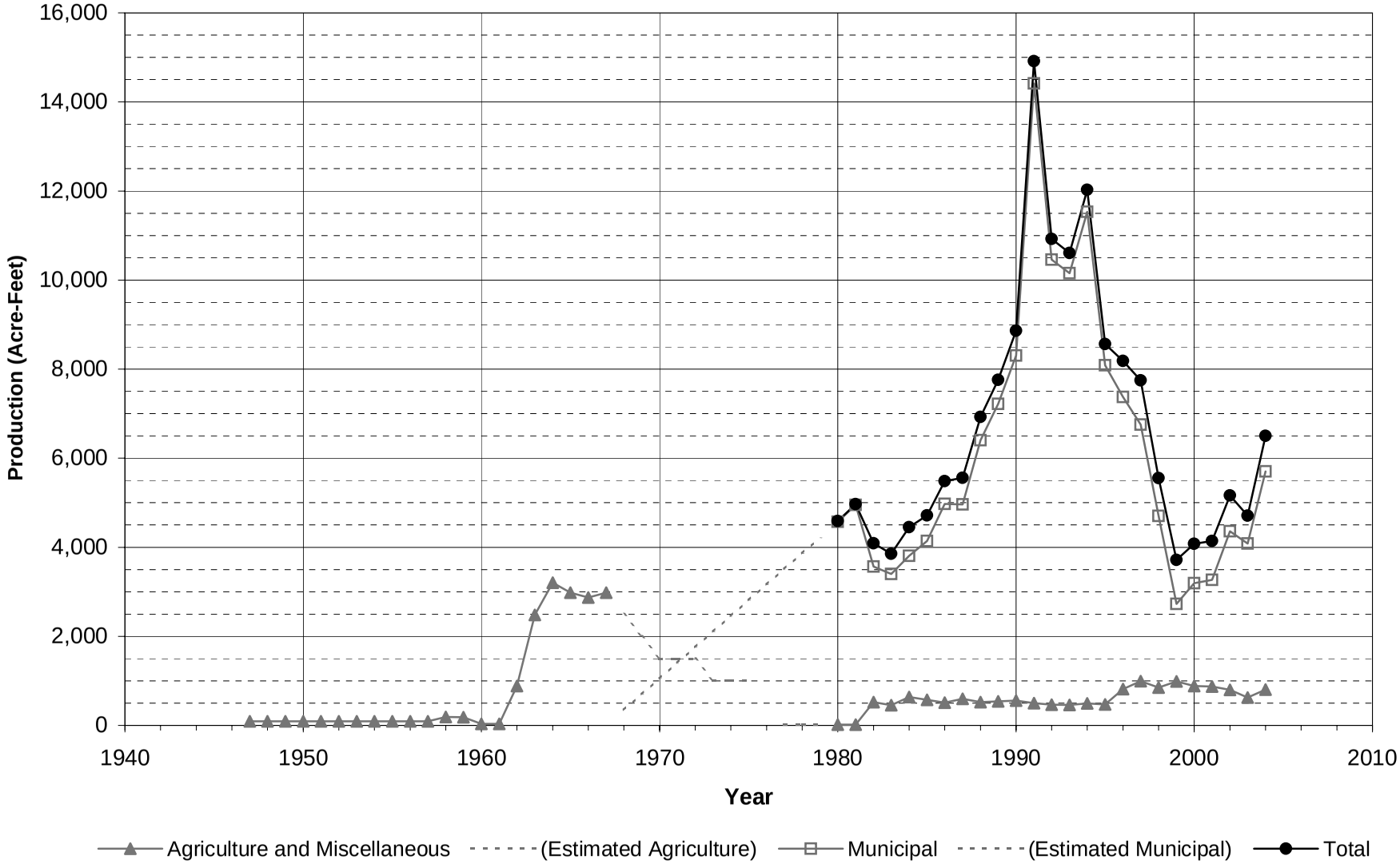


Figure C-9

to the mid-1960s indicate that groundwater levels in the Saugus Formation were highest in the mid-1980s and are currently higher than they were in the mid-1960s (Figure C-10). Based on these data, there is no evidence of any historic or recent trend toward permanent water level or storage decline.

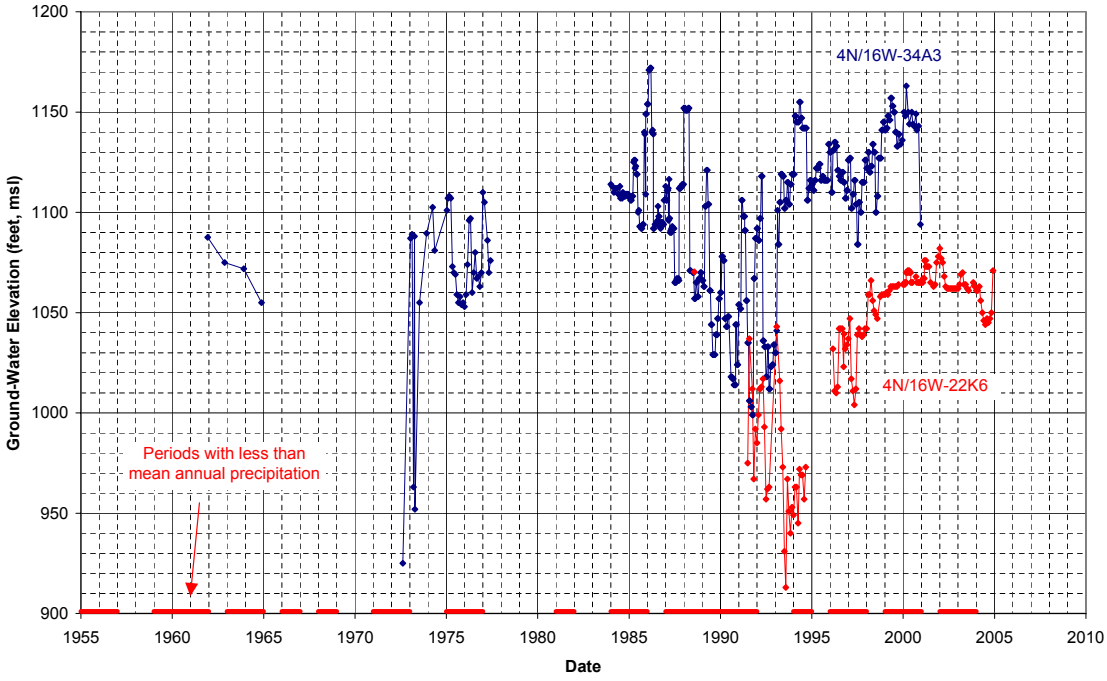
Records of groundwater levels, pumpage and precipitation suggest that declines and subsequent rises in groundwater levels in the Saugus Formation are more influenced by pumpage than by climatic fluctuations. Water levels in wells in the Saugus Formation are highly dependent on pumping in the respective wells. As opposed to the Alluvium, where pumpage is fairly evenly distributed among a number of wells in a given area, there are fewer active wells in the Saugus Formation. Consequently, pumping at one well can create a localized pumping depression that is evident in groundwater level hydrographs. Water levels in the Saugus Formation also exhibit stronger seasonal pumping fluctuations over a year than in the Alluvium (generally more than 20 feet in active Saugus wells, as opposed to generally less than ten feet in Alluvial wells). These responses to pumping are characteristic of the lower transmissivity of the Saugus Formation.

During the period from 1985 through 1991, which experienced consecutive years of lower than average precipitation (with one average year in the middle), pumpage from the Saugus increased from 4,700 afy to nearly 15,000 afy, and groundwater levels declined more than 100 feet in some cases. The subsequent rise in water levels at an individual well depended on pumping at that well. For example (as illustrated on Figure C-10), pumping of Saugus wells declined dramatically beginning between 1993 and 1995, and water levels in individual wells subsequently rose when pumping decreased. Since 1999, water levels in the Saugus have been stable and have exhibited very slight, if any, response to current less-than-average precipitation. A slight pumping depression is evident around active wells. Water levels in the Saugus remain at or above historic levels, and there is no trend toward a sustained decline in Saugus water levels or storage that would be indicative of overdraft.

Consistent with the 2001 Update Report (Slade, 2002), the current management practice of the retail water purveyors is to preserve the Saugus Formation so this supply is available during drought periods, when Alluvial groundwater and SWP supplies are anticipated to decrease. The period of increased pumpage during the late 1980s and early 1990s is a good example of this management strategy. Most notably, in 1991, when SWP deliveries were substantially reduced, increased pumpage from the Saugus made up almost half of the decrease in SWP deliveries. This increased Saugus pumpage resulted in a short-term decline in water levels reflecting the use of stored water. However, the water levels subsequently rose when pumping was reduced, reflecting recovery of groundwater storage in the Saugus Formation.

As with the Alluvial aquifer as introduced above, the response of the Saugus Formation to pumping in the operational yield ranges has been projected by use of a recently completed numerical groundwater flow model. Results of those projections, discussed in detail below,

Groundwater Elevation for Saugus Wells
(lowest and highest shown)



Groundwater Elevation for Saugus Wells
(long-term record)

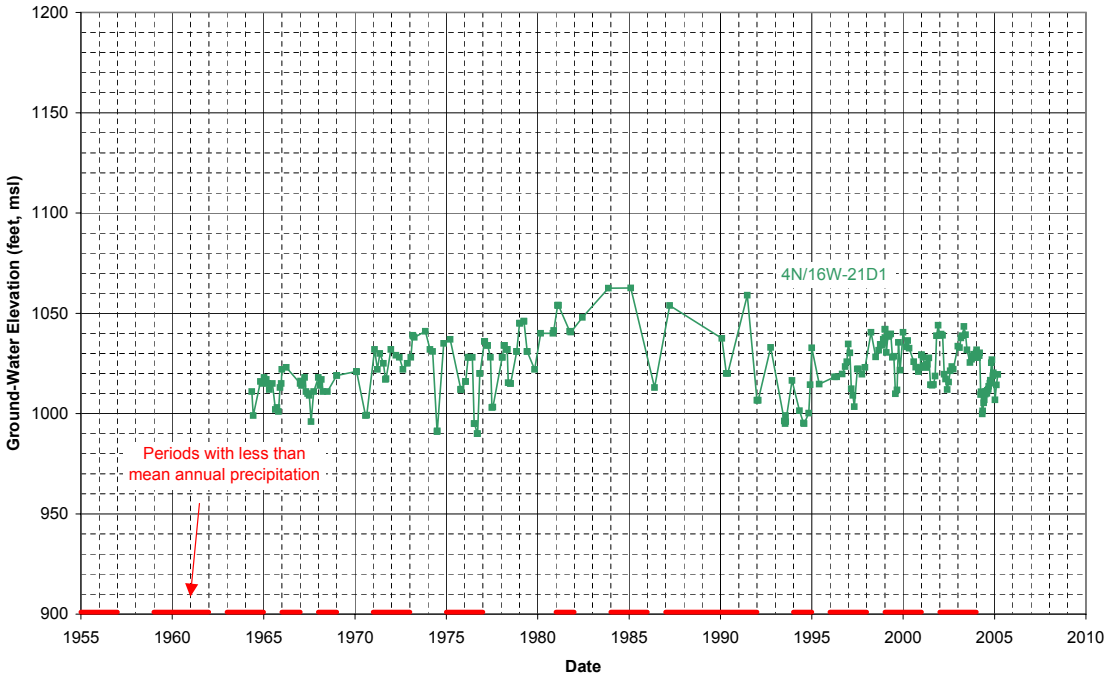


Figure C-10

show that fluctuations in pumping over multiple decades of varying hydrologic conditions will cause fluctuations in groundwater levels similar to what has historically occurred. Short-term declines during dry periods when Saugus pumping is temporarily increased are followed by recovery of water levels when pumping is reduced during wet/normal periods. The lack of any projected permanent decline in Saugus groundwater levels supports the reliability of the Saugus Formation as a long-term water supply at the capacities included in its operational yield.

Sustainability of Groundwater Supplies

Alluvial Aquifer – Based in part on historical operating experience, complemented by recent groundwater modeling work as described herein, it is planned that the Alluvial Aquifer can supply water on a long-term sustainable basis in the overall range of 30,000 to 40,000 afy, with a probable reduction in dry years to a range of 30,000 to 35,000 afy. Both of those ranges include about 15,000 afy of Alluvial pumping for current agricultural water uses and about 500 afy for small private water supply. The dry year reduction is a result of practical constraints in the eastern part of the Basin where lowered groundwater levels in dry periods have the effect of reducing pumping capacities in that shallower portion of the aquifer.

Until recently, the long-term renewability of Alluvial groundwater was empirically determined from approximately 60 years of recorded experience as previously described: long-term stability in groundwater levels and storage, with some dry period fluctuations in the eastern part of the Basin, over a historical range of Alluvial pumpage from as low as about 20,000 afy to as high as about 43,000 afy. Over the last couple of years, those empirical observations have been complemented by the development and application of a numerical groundwater flow model, has been used to predict aquifer response to the planned operating ranges of pumping. The numerical groundwater flow model has also been used to analyze the control of contaminant migration under selected pumping conditions that would restore, with treatment, pumping capacity that has been inactivated due to perchlorate contamination detected in some wells in the Basin.

To examine the yield of the Alluvium or, in other words, the sustainability of Alluvium on a renewable basis, the groundwater flow model was used to examine long-term projected response of the aquifer to pumping for municipal and agricultural uses in the 30,000 to 40,000 afy range under average/normal and wet conditions, and in the 30,000 to 35,000 afy range under locally dry conditions. To examine the response of the entire aquifer system, the model also incorporated pumping from the Saugus Formation in accordance with the normal (7,500-15,000 afy) and dry year (15,000-35,000 afy) operating plan for that aquifer. The model was run over a 78 year hydrologic period which was selected from actual historical hydrology (i.e., precipitation) to examine a number of hydrologic conditions that would be expected to affect both groundwater pumping and groundwater recharge. The selected 78-year simulation period was assembled from an assumed recurrence of 1980 to 2003 conditions, followed by an assumed

recurrence of 1950 to 2003 conditions. The 78-year period was analyzed to define both local hydrologic conditions (normal vs. dry), which affect the rate of pumping from the Alluvium, and hydrologic conditions that affect SWP operations, which in turn affect the rate of pumping from the Saugus. The resultant simulated pumping cycles included the distribution of pumping around the Basin for each of the existing wells, for normal and dry years respectively, shown in Tables C-1 and C-2.

The resultant pumping cycles are summarized as follows:

- Twenty-four years of dry year Alluvial pumping at 30,000 to 35,000 afy
- One drought of four consecutive dry years of Alluvial pumping at 30,000 to 35,000 afy
- Two droughts of three consecutive dry years each, with Alluvial pumping at 30,000 to 35,000 afy
- Three selected years with assigned dry-year Alluvial pumping despite near-normal or above-normal rainfall because each selected year was preceded by a multi-year drought
- Eighteen years of dry-year pumping from the Saugus, or an average of one dry year approximately every four years
- Two droughts lasting three years, plus (in both cases) a dry year that occurs two years before the beginning of each three-year drought and another dry year that begins one year after each three-year drought has ended; Saugus pumping was increased into the 15,000 to 35,000 afy range in all those years
- Two droughts lasting two years; Saugus pumping was increased into the 15,000 to 25,000 afy range in those years
- Sixty years of normal-year Saugus pumping, 7,500 to 15,000 afy

Simulated Alluvial aquifer response to the preceding range of hydrologic conditions and pumping stresses was essentially a long-term repeat of the historical conditions that have resulted from similar pumping over the last several decades. The resultant response consisted of (1) generally constant groundwater levels in the middle to western portion of the Alluvium, and fluctuating groundwater levels in the eastern portion of the Alluvium as a function of wet and dry hydrologic conditions, (2) variations in recharge that directly correlate with wet and dry hydrologic conditions, and (3) no long-term decline in groundwater levels or storage. Examples of projected groundwater levels and storage in various parts of the basin are illustrated in Figures C-11 through C-15. Based on the combination of actual experience with Alluvial aquifer pumping at capacities similar to those planned for the future and the resultant sustainability (recharge) of groundwater levels and storage, complemented by modeled projections of aquifer response to planned pumping rates that also show no depletion of groundwater, the Alluvial Aquifer is considered a sustainable water supply source to meet the Alluvial portion of the operating plan for the groundwater Basin.

TABLE C-1

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location[a]**	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
NCWD-Castaic 1	Castaic Valley	345	385	561	385	345
NCWD-Castaic 2	Castaic Valley	166	0	123	166	125
NCWD-Castaic 3	Castaic Valley	0	0	0	0	0
NCWD-Castaic 4	Castaic Valley	100	47	56	100	45
NCWD-Pinetree 1	Mint Canyon	164	0	0	164	0
NCWD-Pinetree 2	Mint Canyon	0	0	0	0	0
NCWD-Pinetree 3	Mint Canyon	566	544	525	545	525
NCWD-Pinetree 4	Mint Canyon	300	5	0	300	0
NCWD Total		**1,641**	**981**	**1,265**	**1,660**	**1,040**
NLF-161	Downstream of Valencia WRP	496	485	2,021	485	485
NLF-B10	Downstream of Valencia WRP	1,240	534	344	344	344
NLF-B11	Downstream of Valencia WRP	205	232	271	232	232
NLF-B5	Downstream of Valencia WRP	1,680	2,280	1,582	1,582	1,582
NLF-B6	Downstream of Valencia WRP	1,312	2,175	1,766	1,766	1,766
NLF-B7	Downstream of Valencia WRP	474	584	402	584	584
NLF-C	Downstream of Valencia WRP	1,319	1,720	1,373	1,373	1,373
NLF-C3	Downstream of Valencia WRP	93	192	186	192	192
NLF-C4	Downstream of Valencia WRP	1,028	809	764	809	809
NLF-C5	Downstream of Valencia WRP	680	850	622	850	850
NLF-C6	Downstream of Valencia WRP	231	241	108	241	241
NLF-C7	Downstream of Valencia WRP	741	866	443	866	866
NLF-C8	Downstream of Valencia WRP	293	594	408	594	594
NLF-E	Castaic Valley	1,691	16	28	16	16
NLF-E2	Castaic Valley	141	55	14	55	55
NLF-E4	Downstream of Valencia WRP	0	0	0	0	0
NLF-E5	Downstream of Valencia WRP	172	679	537	679	679
NLF-E9	Downstream of Valencia WRP	238	814	47	814	814
NLF-G45	Downstream of Valencia WRP	291	283	60	283	283
NLF-W4	San Francisquito Canyon[b]	46	1	0	0	0
NLF-W5	San Francisquito Canyon	276	104	23	107	107
NLF-X3	Downstream of Valencia WRP	12	0	0	0	0
NLF Total		**12,659**	**13,514**	**10,999**	**11,872**	**11,872**
SCWD-Clark	Bouquet Canyon	696	782	712	782	700
SCWD-Guida	Bouquet Canyon	1,047	1,320	1,230	1,320	1,230
SCWD-Honby	Above Saugus WRP	721	696	874	696	870
SCWD-Lost Canyon 2	Mint Canyon	741	730	644	741	640
SCWD-Lost Canyon 2A	Mint Canyon	1,034	905	593	1,034	590
SCWD-Mitchell #5A	Mint Canyon	407	143	19	0	0
SCWD-Mitchell #5B	Mint Canyon	0	150	0	557	0
SCWD-N. Oaks Central	Mint Canyon	822	1,646	1,641	822	1,640
SCWD-N. Oaks East	Mint Canyon	1,234	448	485	1,234	485
SCWD-N. Oaks West	Mint Canyon	898	1,123	31	898	0
SCWD-Sand Canyon	Mint Canyon	930	705	195	930	195
SCWD-Sierra	Mint Canyon	846	87	0	846	0
SCWD-Stadium	Above Saugus WRP	565	778	0	800	800
SCWD Total		**9,941**	**9,513**	**6,424**	**10,660**	**7,150**

TABLE C-1

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location[a]**	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
VWC-D	Castaic Valley	645	772	687	690	690
VWC-I	San Francisquito Canyon	0	0	0	0	0
VWC-K2	Downstream of Saugus WRP[c]	669	955	364	0	0
VWC-L2	Downstream of Saugus WRP[d]	349	490	71	0	0
VWC-N	Downstream of Saugus WRP	591	700	622	620	620
VWC-N3	Downstream of Saugus WRP[e]	226	857	255	0	0
VWC-N4	Downstream of Saugus WRP[f]	458	909	248	0	0
VWC-N7	Downstream of Saugus WRP				1,160	1,160
VWC-N8	Downstream of Saugus WRP				1,160	1,160
VWC-Q2	Downstream of Saugus WRP	923	1,167	1,451	985	985
VWC-S6	Downstream of Saugus WRP	1,490	1,320	2,134	865	865
VWC-S7	Downstream of Saugus WRP	564	419	1,095	865	865
VWC-S8	Downstream of Saugus WRP	327	190	409	865	865
VWC-T2	Above Saugus WRP	900	696	1,014	460	460
VWC-T4	Above Saugus WRP	690	831	799	460	460
VWC-U3	Above Saugus WRP[g]	956	572	823	0	0
VWC-U4	Above Saugus WRP	942	796	934	935	935
VWC-U6	Above Saugus WRP	0	0	0	825	825
VWC-W10	San Francisquito Canyon	182	0		0	0
VWC-W11	San Francisquito Canyon	806	939	764	600	600
VWC-W6	San Francisquito Canyon[h]	0	0	36	865	865
VWC-W9	San Francisquito Canyon				350	350
VWC Total		**10,718**	**11,613**	**11,706**	**11,705**	**11,705**
Robinson Ranch	Mint Canyon				932	400
WHR (All Wells)	Castaic Valley	1,604	1,602	2,273	1,600	1,600
Total Alluvial Aquifer Pumping		**36,563**	**37,223**	**32,667**	**38,429**	**33,767**

[a]See Figure 2-4 for well locations.

[b]Former well NLF-W4 was located approximately 900 feet west of existing production well VWC-11.

[c]Former well VWC-K2 was located approximately 210 feet south of existing production well VWC-N7.

[d]Former well VWC-L2 was located approximately 150 feet southeast of existing production well VWC-N7.

[e]Former well VWC-N3 was located approximately 440 feet northeast of existing production well VWC-N8.

[f]Former well VWC-N4 was located approximately 430 feet southeast of existing production well VWC-N8.

[g]Former well VWC-U3 was located approximately 2,300 feet northeast of existing production well VWC-U4.

[h]Former well VWC-W6 was located approximately 575 feet northeast of existing production well VWC-11.

Notes:

All pumping volumes are listed in AF/yr. Blank entries for historical pumping indicate that the well did not exist at that time.

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

UWMP = Urban Water Management Plan

VWC = Valencia Water Company

WHR = Wayside Honor Rancho, whose wells are owned by the Los Angeles County Waterworks District No. 36

TABLE C-2

Simulated Annual Groundwater Pumping from the Saugus Formation for the 78-year Simulation

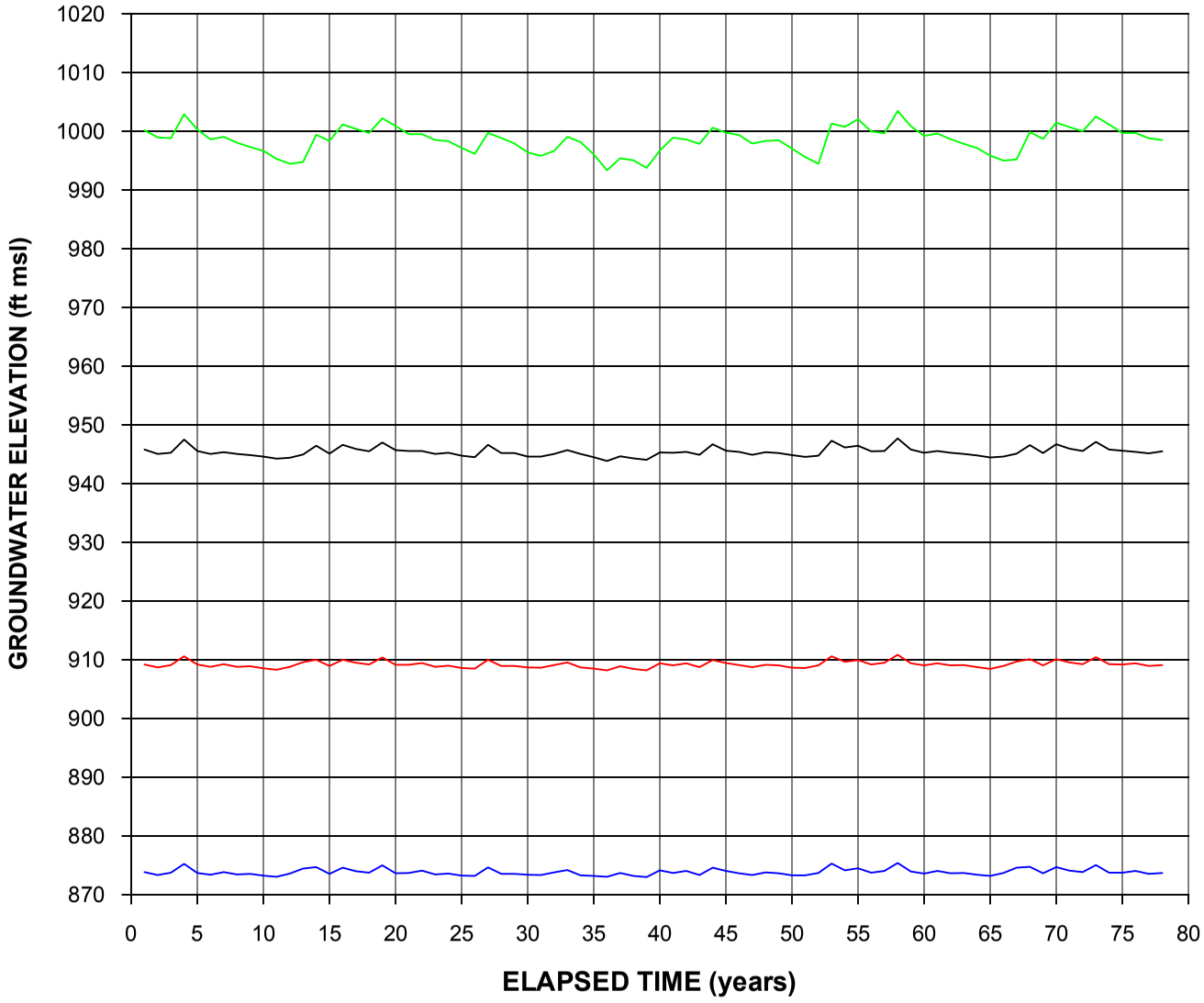
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Owner	Well Name	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
NCWD	11	811	811	811	811
	12	1,315	2,044	2,044	2,044
	13	1,315	2,044	2,044	2,044
Total Pumping (NCWD)		**3,441**	**4,899**	**4,899**	**4,899**
NLF	156	369	369	369	369
Total Pumping (NLF)		**369**	**369**	**369**	**369**
SCWC	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
Total Pumping (SCWC)		**3,544**	**3,544**	**3,544**	**3,544**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Valencia Country Club)	500	500	500	500
	201	100	100	3,577	3,577
	205	1,000	2,734	3,827	3,827
	206	1,175	2,734	3,500	3,500
Total Pumping (VWC)		**3,325**	**6,948**	**12,284**	**12,284**
To Be Determined	Future #1	0	0	3,250	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
	Future #4	0	0	0	3,250
Total Pumping (Future)		**0**	**0**	**3,250**	**13,000**
Total Saugus Formation Pumping		**10,679**	**15,760**	**24,346**	**34,096**

Notes:

All pumping volumes are listed in acre-feet.

Wells VWC-157 and NCWD-7, 8, 9, and 10 are assumed to no longer operate in the future.



NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS. WELL NLF-TOPCO1 IS LOCATED 210 feet SOUTHWEST OF WELL NLF-B11.

FIGURE C-11
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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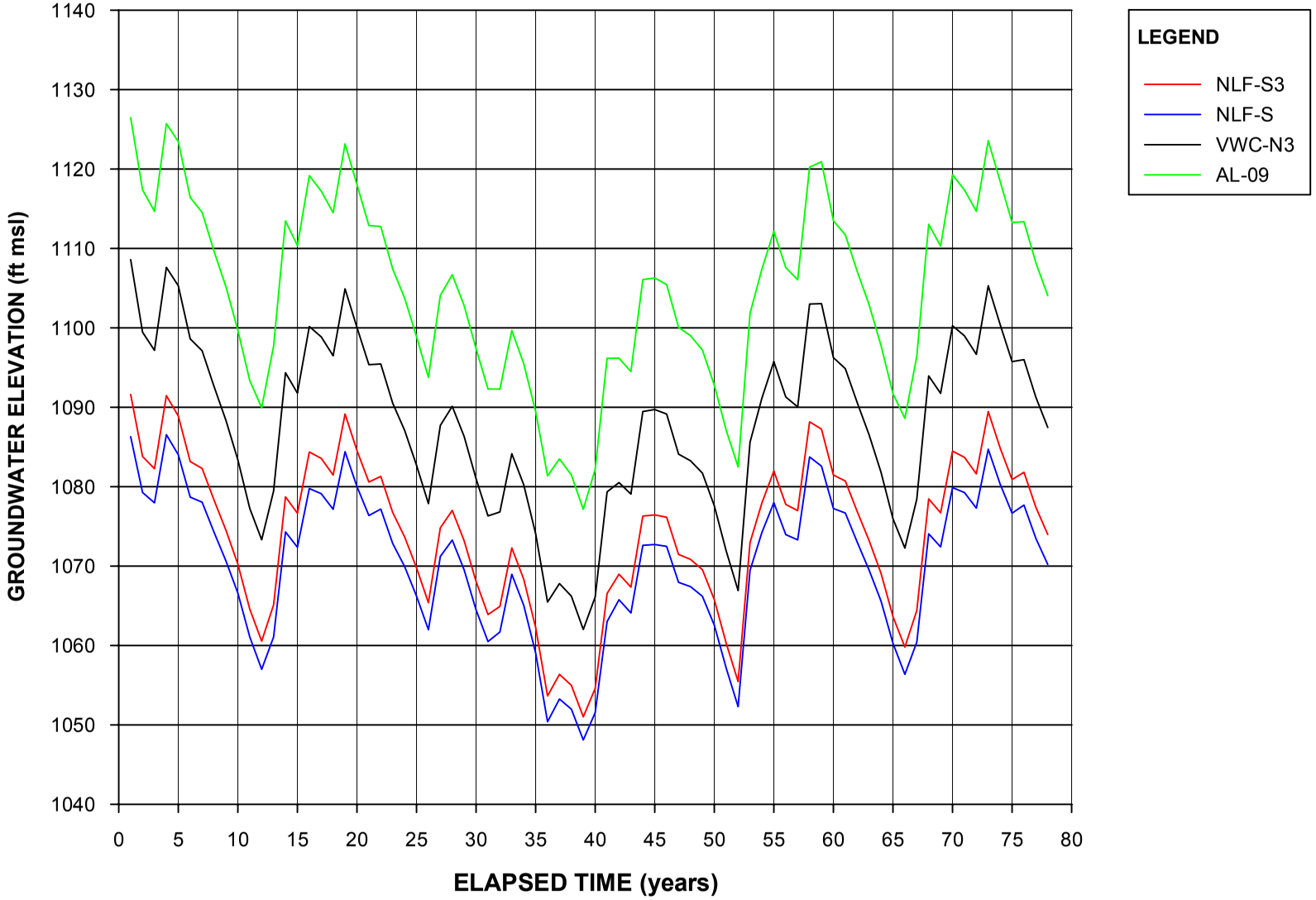

NOTES:

1. AL09 IS A CLUSTER OF OBSERVATION WELLS LOCATED 845 feet SOUTHWEST OF PRODUCTION WELL VWC-Q2.

2. THE REMAINING HYDROGRAPHS REPRESENT FORMER ALLUVIAL AQUIFER WELLS THAT HAVE BEEN ABANDONED AND THEREFORE ARE NOT PUMPED IN THE MODEL SIMULATIONS. RELATIVE TO EXISTING WELLS SHOWN ON FIGURE 2-4, THESE FORMER WELLS WERE LOCATED AS FOLLOWS:

   – WELL NLF-S3 WAS LOCATED 305 feet EAST OF WELL VWC-S6
   – WELL NLF-S WAS LOCATED 940 feet SOUTHWEST OF WELL VWC-S6
   – WELL VWC-N3 WAS LOCATED 435 feet NORTHEAST OF WELL VWC-N8

FIGURE C-12
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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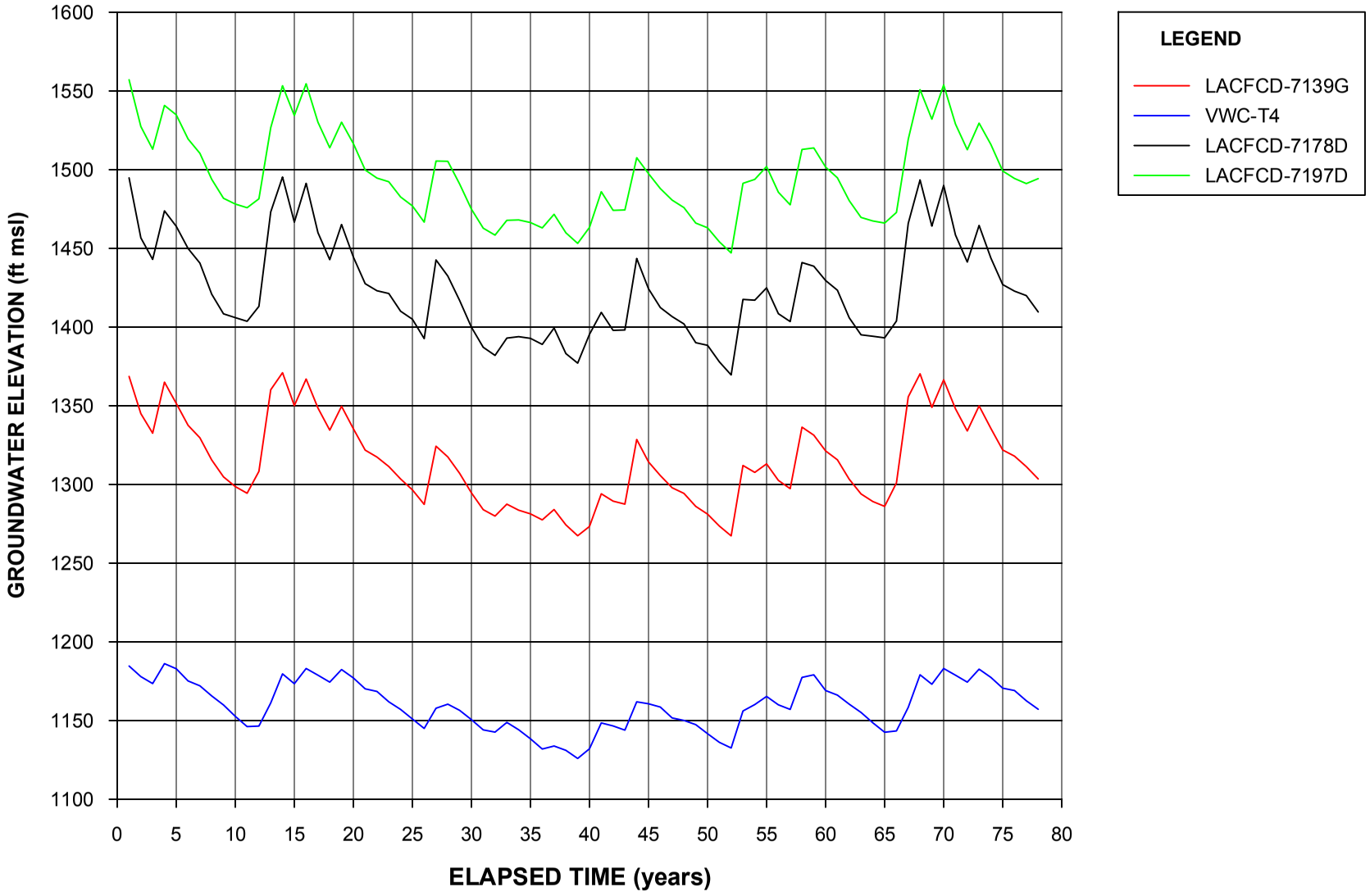

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR VWC- T4 = 1101 ft msl; ALLUVIUM BOTTOM ELEVATION ~1050 TO 1065 ft msl.
3. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7139G = 1289 ft msl; ALLUVIUM BOTTOM ELEVATION ~1256 ft msl OR LOWER.
4. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7178D = 1463 ft msl; ALLUVIUM BOTTOM ELEVATION ~1398 TO 1425 ft msl.
5. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7197D = 1474 ft msl; ALLUVIUM BOTTOM ELEVATION ~1423 TO 1447 ft msl.

FIGURE C-13
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER IN SOLEDAD CANYON
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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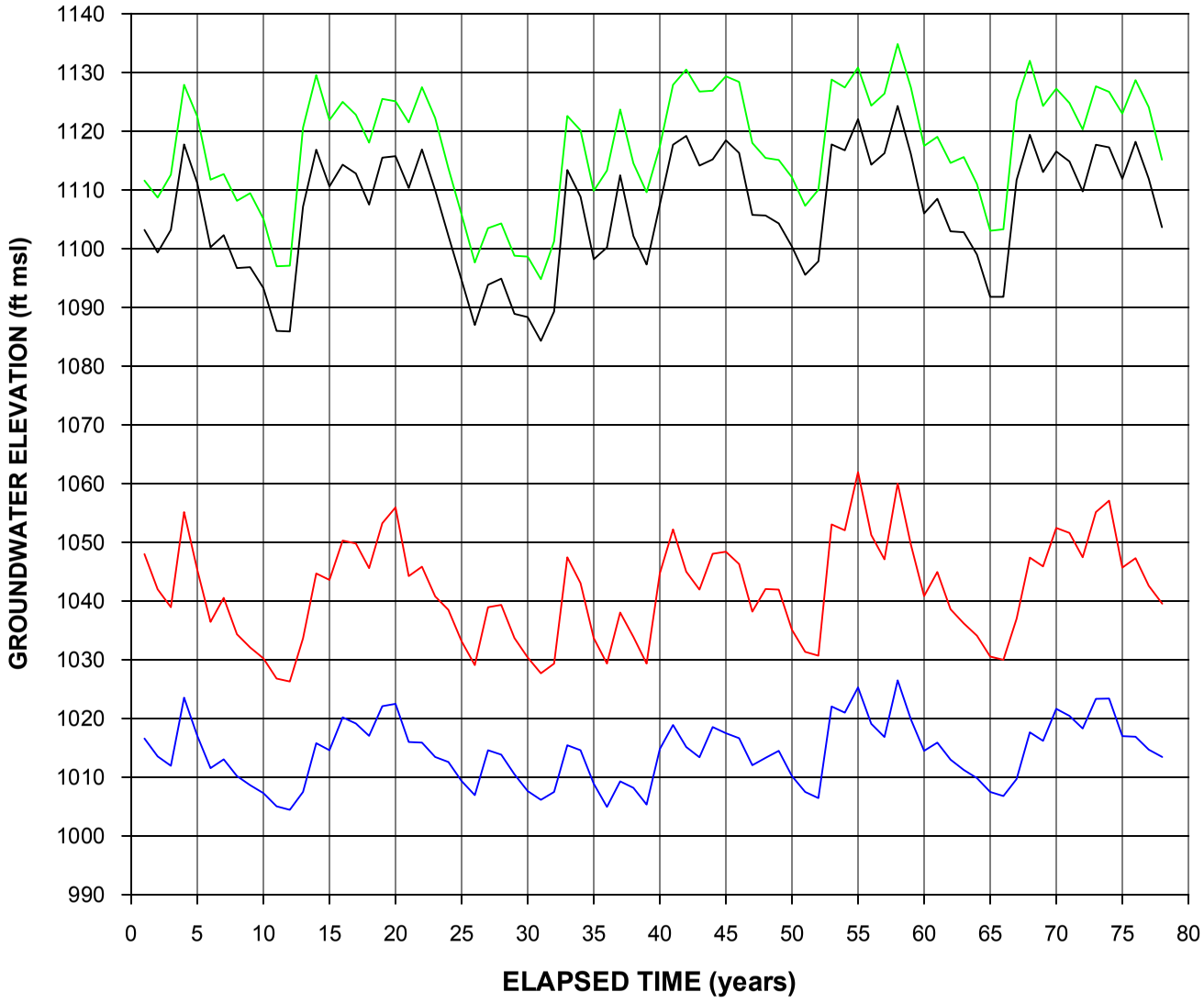

NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE C-14
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG CASTAIC CREEK
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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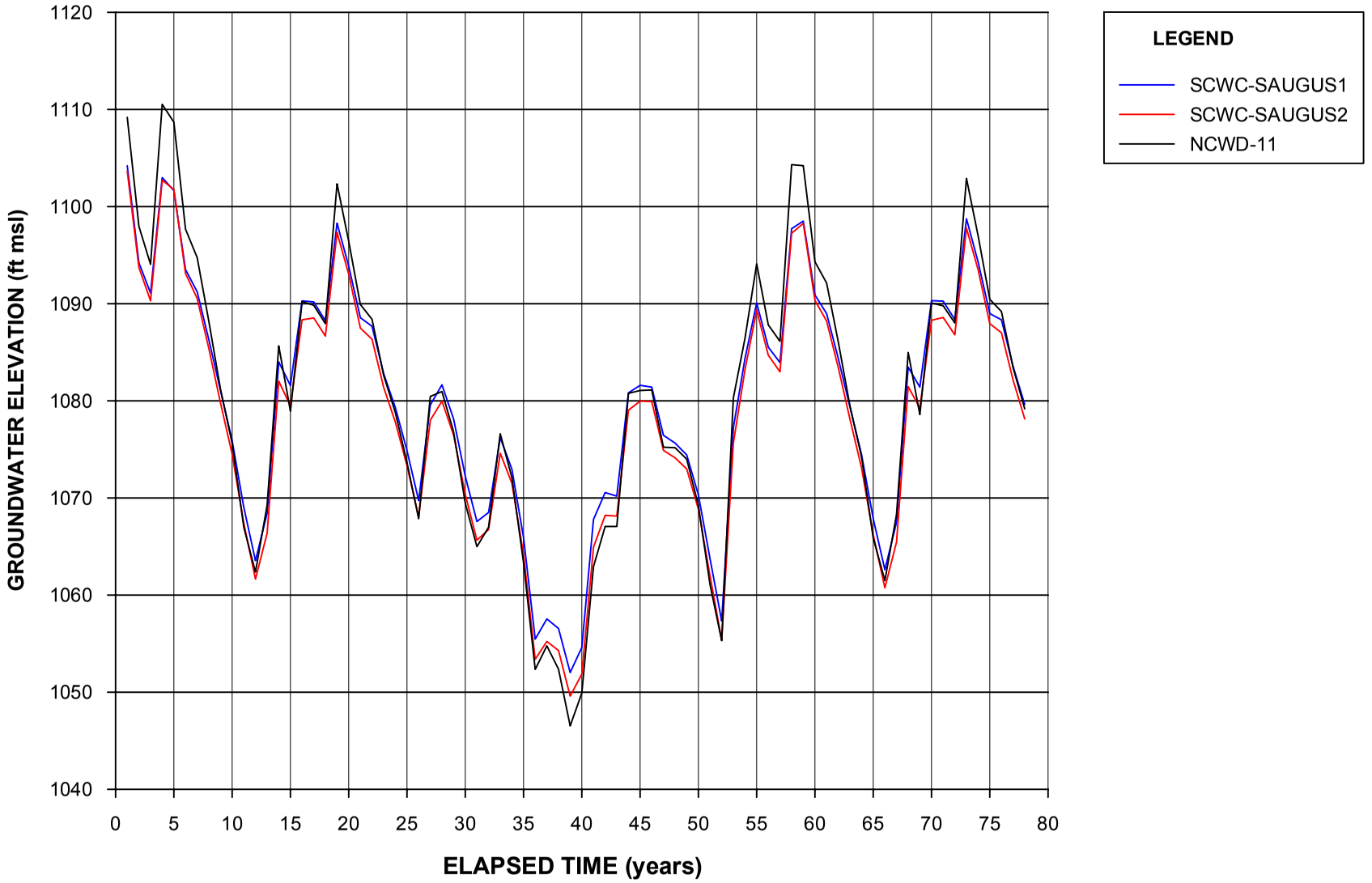

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. THESE WELLS ARE CONSTRUCTED IN THE SAUGUS FORMATION AND ARE NOT OPEN TO THE ALLUVIAL AQUIFER. THE SIMULATED HYDROGRAPHS AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE ALLUVIAL AQUIFER, ABOVE THE OPEN INTERVALS OF THESE WELLS.

FIGURE C-15
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG THE SOUTH FORK SANTA CLARA RIVER
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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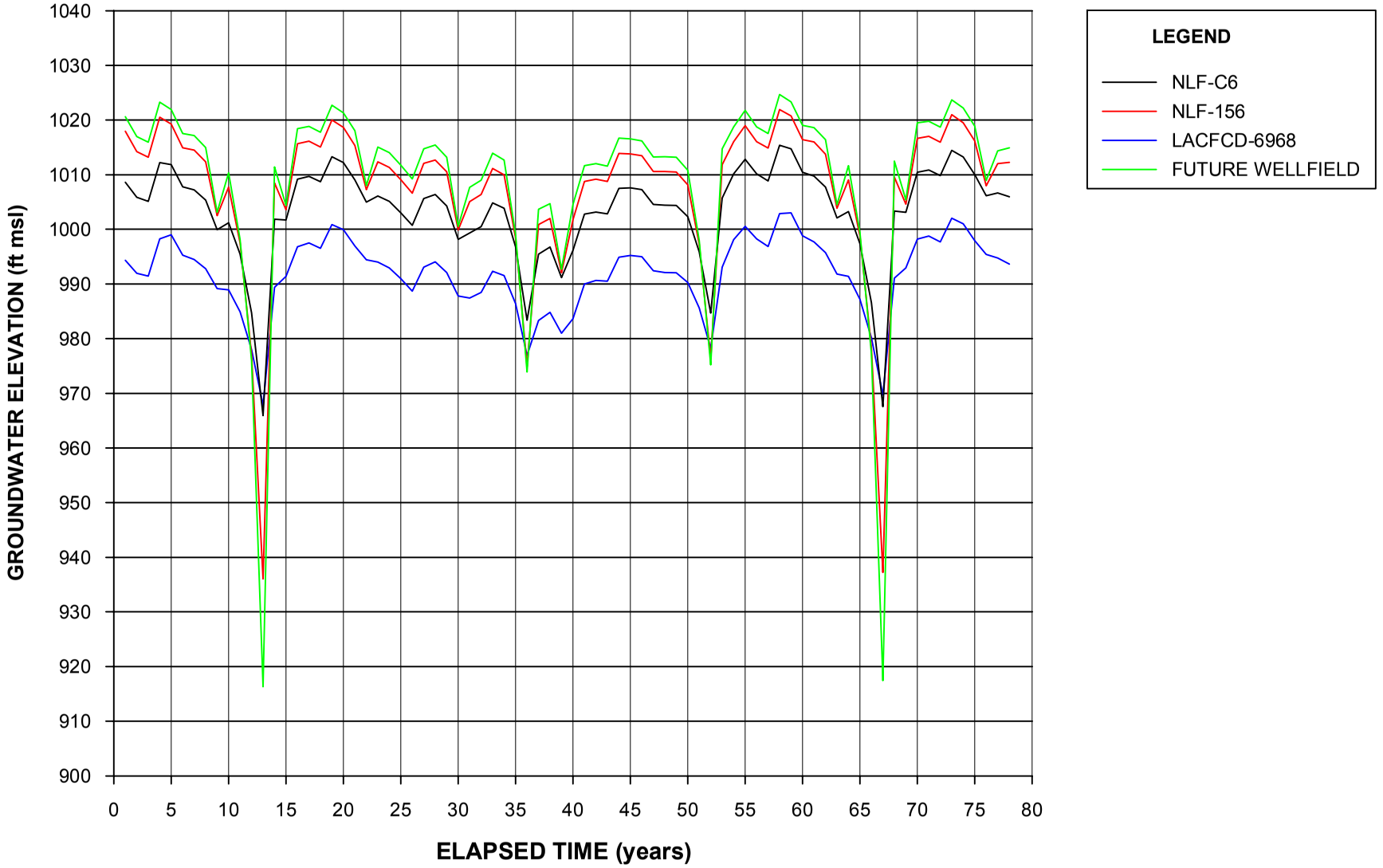
Saugus Formation – Based partially on historical operating experience, complemented by extensive recent testing and groundwater modeling work as described herein, it is planned that the Saugus Formation aquifer can supply water on a long-term sustainable basis in a normal range of 7,500 to 15,000 afy, with intermittent increases to 25,000 to 35,000 af in multiple dry years. The dry-year increases result from limited historical observation, now complemented by modeled projections, that a small amount of the large groundwater storage in the Saugus Formation can be pumped over a relatively short (dry) period, followed by recharge (replenishment) of that storage during a subsequent wet to normal period when pumping would be reduced.

Until recently, the long-term sustainability of Saugus groundwater was empirically determined from limited historical experience. The historical record shows fairly low annual pumping in most years, with one four-year period of increased pumping up to about 15,000 afy, that produced no long-term depletion of the substantial groundwater storage in the Saugus. As with the Alluvium, those empirical observations have now been complemented by the development and application of the numerical groundwater flow model. The model has been used to examine aquifer response to the operating plan for pumping from both the Alluvium and the Saugus, and to examine the effectiveness of pumping for both contaminant extraction and control of contaminant migration within the Saugus Formation.

To examine the yield of the Saugus Formation or, in other words, its sustainability on a renewable basis, the groundwater flow model was used to examine long-term projected response to pumping from both the Alluvium and the Saugus, over the 78-year period of hydrologic conditions to introduce alternating wet and dry periods as have historically occurred. The pumping simulated in the model was in accordance with the operating plan for the Basin. For the Saugus, simulated pumpage included the planned restoration of recent historic pumping from the perchlorate-impacted wells. That pumping was analyzed to assess, in addition to the overall recharge of the Saugus, the effectiveness of controlling the migration of perchlorate by extracting and treating contaminated water close to the source of contamination.

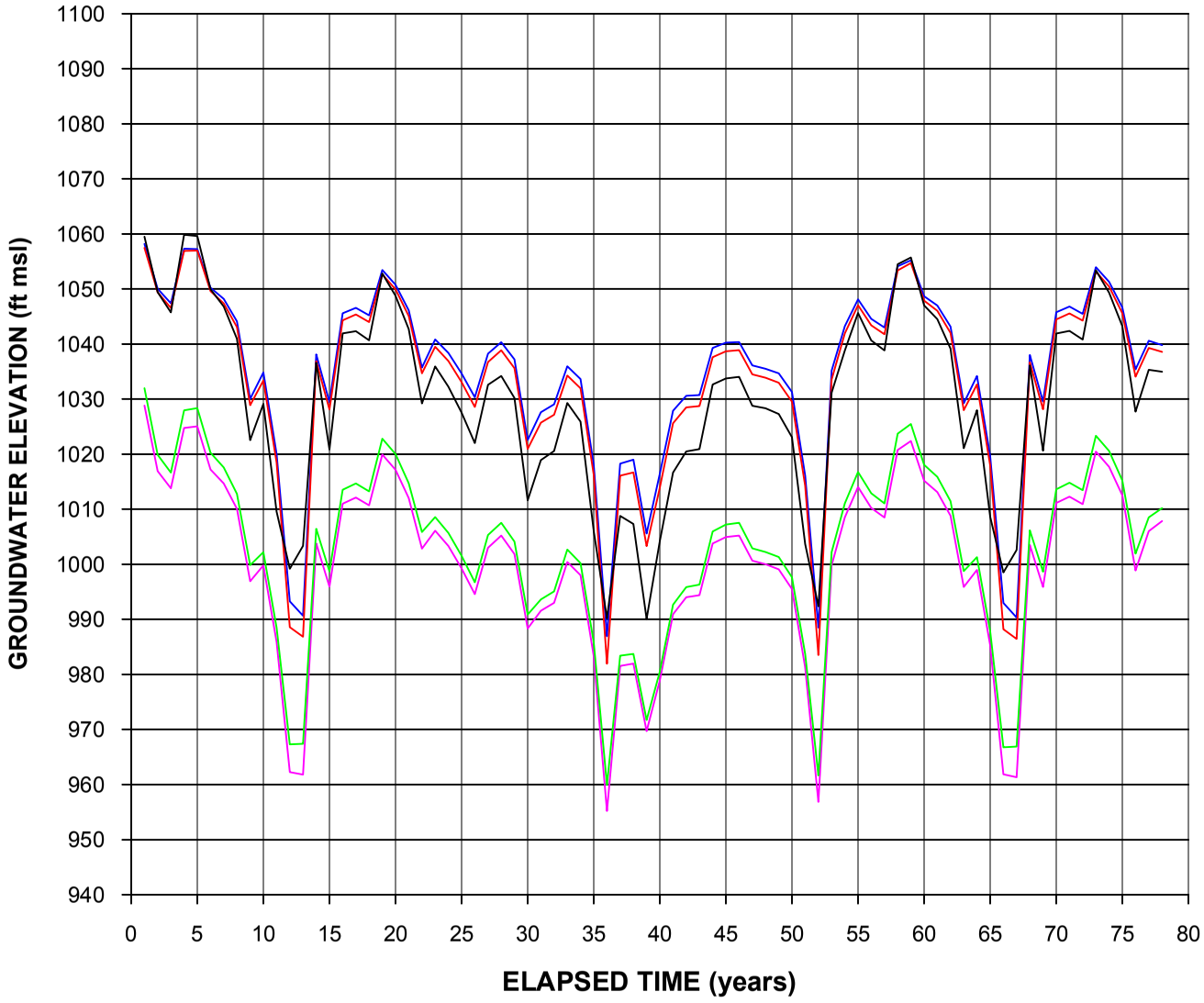
Simulated Saugus Formation response to the ranges of pumping under assumed recurrent historical hydrologic conditions was consistent with actual experience under smaller pumping rates. The response consisted of (1) short-term declines in groundwater levels and storage near pumped wells during dry-period pumping, (2) rapid recovery of groundwater levels and storage after cessation of dry-period pumping, and (3) no long-term decreases or depletion of groundwater levels or storage. Examples of projected groundwater levels and storage around the planned Saugus pumping areas are illustrated in Figures C-16 and C-17. The combination of actual experience with Saugus pumping and recharge up to about 15,000 afy, now complemented by modeled projections of aquifer response that show long-term utility of the Saugus at 7,500 to 15,000 afy in normal years and rapid recovery from higher pumping rates during intermittent dry periods, shows that the Saugus Formation can be considered a sustainable water supply source to meet the Saugus portion of the operating plan for the groundwater Basin.



NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WELLS NLF-C6 AND LACFCD-6968 ARE CONSTRUCTED IN THE ALLUVIAL AQUIFER AND ARE NOT OPEN TO THE SAUGUS FORMATION. THE SIMULATED HYDROGRAPHS SHOWN AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE SAUGUS FORMATION, BELOW THE OPEN INTERVALS OF THESE WELLS.
3. THE SIMULATED HYDROGRAPH FOR THE FUTURE WELLFIELD IS FOR A MODEL NODE WITH NO ASSIGNED PUMPING, LOCATED INSIDE THE WELLFIELD NEAR VWC-206.

FIGURE C-16
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA



NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE C-17
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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Appendix D

Contamination and Impact on Groundwater Supplies in the Santa Clarita Valley

Appendix D

Perchlorate Contamination and Impact on Groundwater Supplies in the Santa Clarita Valley

Introduction

The detection of perchlorate in Santa Clarita Valley groundwater supplies has raised concerns over the reliability of those supplies, in particular the Saugus Formation where four wells have been removed from active service as a result of perchlorate. As discussed below, planning for remediation of the perchlorate and restoration of the impacted well capacity is substantially underway. While that work is being completed, non-impacted production facilities can be relied upon for the quantities of water projected to be available from the Alluvial Aquifer and Saugus Formation during the time necessary to restore perchlorate-impacted wells. CLWA, the local retail water purveyors, the California Department of Toxic Substances Control (DTSC), and the U.S. Army Corps of Engineers (ACOE) continue to work closely on the perchlorate contamination issue, which reasonably ensures a prompt response to any significant changes in conditions.

The following is a discussion of pertinent events related to perchlorate contamination. This discussion is provided to illustrate that work toward the ultimate remediation of the perchlorate contamination, including the reactivation of impacted groundwater supply wells, has progressed on several integrated fronts over the last four years. The following discussion is organized into a section which summarizes the on-site investigations and clean-up activities which are under the regulatory control of DTSC, followed by several sections that focus on various aspects of the off-site impacts of perchlorate on water supply wells, and the ongoing activities to remediate that problem and restore the impacted water supply.

On-Site Investigations and Clean-up

On-site investigation is substantially underway and clean-up is in the planning stages at the former Whittaker-Bermite facility. The on-site investigation and clean-up activities at the source of the contamination are under the regulatory authority and control of DTSC.

Brief History[1]

The Whittaker-Bermite site is located in the center of the Santa Clarita Valley and was operated as an explosives and munitions manufacturing, testing, and storage facility since the late 1930's. It was first owned by the Los Angeles Powder Company and later by Golden State Fireworks, the Halifax Explosives Company, the Bermite Powder Company, and the Whittaker Corporation (Whittaker), which assumed ownership of the site in 1967. Under contracts with the U.S. Department of Defense, Whittaker Corporation used perchlorate in the manufacture of solid propellants for rockets and missiles until operations ceased in 1987. There is a long history of

[1] See, "General Site History," Whittaker Bermite Clean-Up, http://www.whittaker-bermite.com/history.html, pp. 1-3.

perchlorate use and other chemical use at the site, and recent surface and subsurface investigations at the site have revealed the presence of perchlorate and other contaminants in soil and groundwater.

The contaminants found in the soil that require clean-up are perchlorate and volatile organic compounds (VOCs). These chemicals were used in the manufacturing and testing of fireworks, dynamite, oil-field explosives, and munitions. The site consists of about 996 acres, with actual production facilities occupying approximately 50 acres. The property is characterized by chaparral covering the undisturbed portions of the site, fire breaks, dirt roads and remnants of facility foundations and buildings. The surrounding areas include commercial, light industrial, and residential land uses. The facility was closed in 1987 and most of the structures on the property were removed at or about that time.

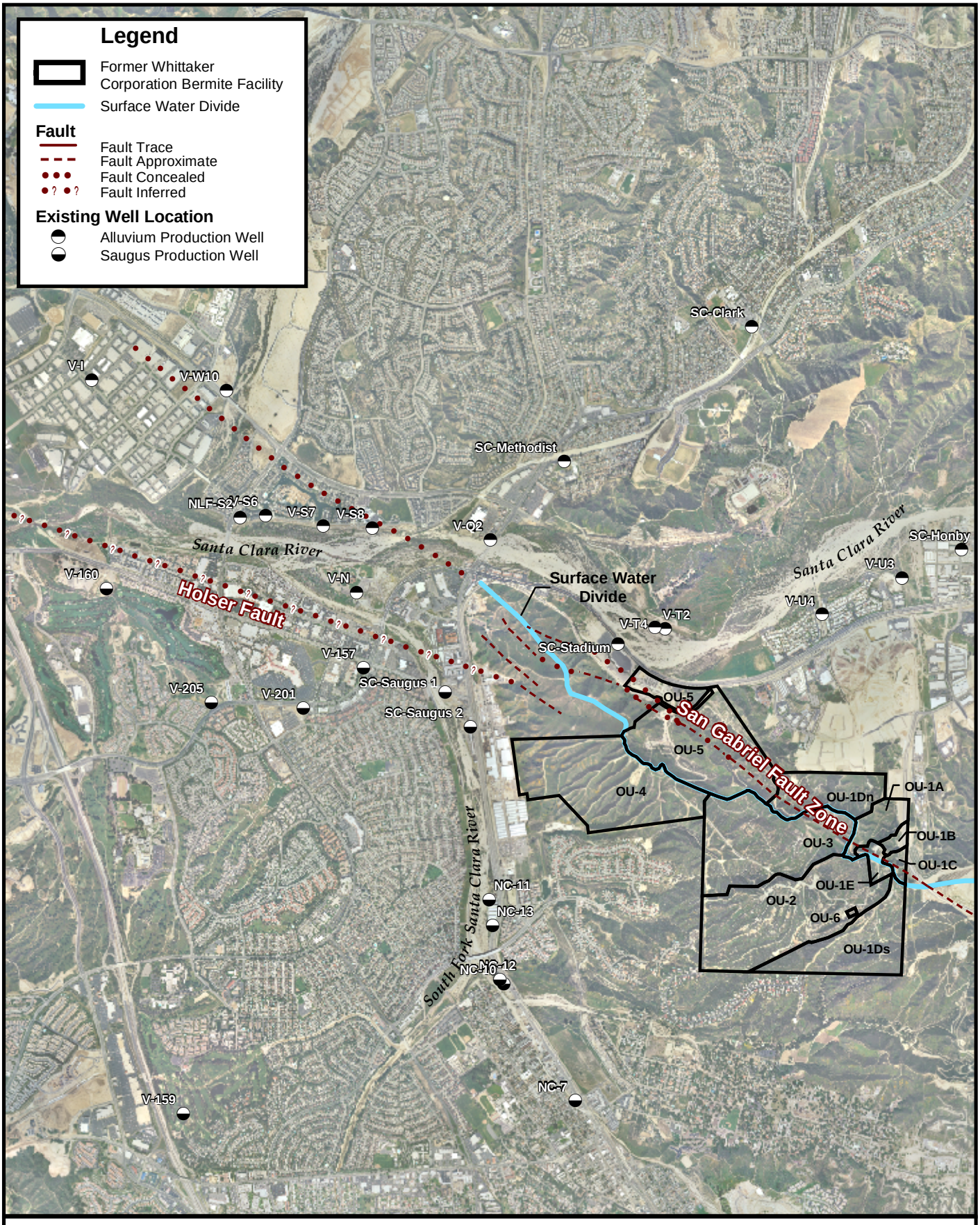
Between 1987 and 1998, Whittaker conducted environmental investigations and clean-up activities under the supervision of DTSC and its predecessor agency. In 1994, Whittaker entered into an enforceable agreement with DTSC to conduct a comprehensive site-wide investigation of areas of concern. In early 1997, with the remedial investigations underway, DTSC informed Whittaker that the soils, groundwater, and surface runoff would have to be reassessed for the presence of perchlorate, a compound that had been unregulated during the entire period of manufacturing at the site.

In 1998, Whittaker sold the property to Santa Clarita LLC, a brownfield development company. In addition to assuming all clean-up responsibilities, Santa Clarita LLC acquired the right to develop the property contingent upon the full cleanup and certification of the property's reuse by DTSC. Between 1999 and 2001, Santa Clarita LLC continued and expanded the site investigation and clean-up programs that had been initiated by Whittaker under the 1994 agreement. In 2002, however, with Santa Clarita LLC unable to fund additional site work due to financial difficulties, DTSC opened negotiations with Whittaker to resume site investigation and clean-up work. In November 2002, DTSC issued an Order that required Whittaker to complete the site investigations and feasibility studies for all contaminants of concern under a tight time schedule.

Recent Site Activities[2]

Because the site is so large, DTSC has divided the property into separate and distinct areas called Operable Units (OUs), which are defined largely by topographic features as shown in Figure D-1. OUs 1 through 6 comprise soils and perched groundwater zones from the ground surface to 200 feet below grade. OU-7 comprises soils below 200 feet from grade and site-wide groundwater and surface water, including any off-site migration of contaminants.

[2] See, "Recent Site Activities," http://www.whittaker-bermite.com/recent.html, pp. 1-5; see also, letter from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 20, 2004, pp. 1-20; and letters from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 25 and 26, 2004.



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0 3,500 7,000 Feet

Figure D-1
Site Location
Former Whittaker-Bermite Facility

SCO \\GALT\GIS2\SNTA_CLRTA\PLOTS\FIGURE_121404\FIGURE_2-16.MXD 12/14/2004

In complying with DTSC's Order, Whittaker consultants and contractors have conducted a significant amount of work since December 2002. The work has been performed pursuant to workplans submitted to and approved by DTSC. The principal activities, summarized by OU, include (1) additional remedial investigations, including soil samples, borings, exploratory trenching, and groundwater monitoring wells, (2) feasibility reports, treatability studies, and pilot tests, and (3) remedial action plans.[3] These efforts have included expediting the final remedial investigation reports, feasibility studies and remedial action plan for OU-1 soils. The final draft remedial action plan for OU-1 was submitted to DTSC in May 2004, and represents the results of efforts to initiate soil remediation work this year in some of the key source areas.[4]

In October 2004, DTSC issued a second public notice requesting comments on DTSC's proposal to clean-up perchlorate and other contaminants in the soil at OU-1.[5] Because of the different chemical and physical properties of the contaminants and the different types of soils in the impacted areas, DTSC has evaluated seven soil remediation alternatives that would protect human health and the environment. DTSC proposes to clean up perchlorate and VOCs in the soil by using a combination of the identified remediation alternatives.[6]

In addition, remedial investigation field work for the soil in OUs 2, 3, 4, 5 and 6 is almost complete, with the investigation results indicating it would be most expedient to conduct the remaining remedial response work for soils by modifying DTSC's Order to allow Whittaker to prepare and submit comprehensive site-wide documents for soil clean-up (e.g., remedial investigation, feasibility study, baseline risk assessment, and remedial action plan), rather than OU-specific documents.[7]

Whittaker also recently submitted a letter to DTSC requesting modifications to DTSC's Order, as it relates to the groundwater remedial response work for the area designated OU-7.[8] Although substantial progress has been made in OU-7, the remedial investigation and feasibility study field work for OU-7 is still ongoing.[9] Whittaker has proposed a tentative schedule for completing site-wide investigation and groundwater remediation work. The work is scheduled to be completed in 2005.[10]

In OU-7, in close coordination with the ACOE, CLWA, and local retail water purveyors, Whittaker has been conducting remedial investigation and clean-up work with respect to production wells impacted by the perchlorate contamination.[11] As part of that effort, ACOE has

[3] See, "Recent Site Activities," http://www.whittaker-bermite.com/recent.html, pp. 1-4.
[4] See, letter from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 20, 2004, p. 1.
[5] See, DTSC: Site Cleanup, Whittaker-Bermite Facility (former), Fact Sheet - October 2004, http://www.dtsc.ca.gov/SiteCleanup/Whittaker_Bermite/, p. 2.
[6] See, DTSC: Site Cleanup, Whittaker-Bermite Facility (former), Fact Sheet - May 2004, http://www.dtsc.ca.gov/SiteCleanup/Whittaker_Bermite/, p. 2.
[7] See, letter from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 25, 2004, pp. 1-2.
[8] See, letter from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 26, 2004, pp. 1-2.
[9] *Id.*
[10] *Id.*
[11] See, "Recent Site Activities," http://www.whittaker-bermite.com/recent.html, p. 4.

been investigating the nature and extent of the perchlorate contamination impacting the production wells. In OU-7, Whittaker, CLWA, the local retail water purveyors, and ACOE have conducted the following remedial investigation and feasibility study work in 2002-2004:

- Installed and sampled approximately 30 temporary Alluvial Aquifer monitoring wells
- Installed 12 permanent Alluvial Aquifer monitoring wells
- Installed and sampled six temporary Saugus monitoring wells on and off the site
- Installed five deep multi-port Saugus monitoring wells, four within the site boundaries and one off-site
- Installed one deep single-port Saugus monitoring well within the site boundaries
- Installed cluster wells at four locations to monitor discrete Saugus Formation zones, two within and two outside the site boundaries
- Conducted several rounds of groundwater monitoring for new and existing wells
- Constructed and calibrated a computer model capable of simulating aquifer conditions for development and evaluation of plume containment and treatment strategies
- Conducted aquifer pumping and permeability tests
- Conducted sampling of some of the impacted production wells
- Conducted pilot-scale testing of above-ground treatment options for removing perchlorate from drinking water, including ion exchange and bioremediation.[12]

Remedial response actions for groundwater is continuing through 2005. The schedule contemplates additional remedial investigations, feasibility studies, interim remedial measures, and a remedial action plan for groundwater. The remedial action plan will include the design, construction, and commencement of treatment of perchlorate-contaminated groundwater from two of the retail water purveyors' impacted production wells, which would concurrently provide treated potable water and contain and capture the OU-7 perchlorate plume along its downgradient edges. [13]

For contaminated surface waters on site, Whittaker updated the site-wide surface water sampling plan subject to the approval of DTSC and the Regional Water Quality Control Board (RWQCB).[14] Whittaker collected surface water samples from the primary site drainages during winter storm events in 2003 and 2004. In addition, Whittaker updated the site's stormwater pollution plan and devised and implemented erosion control measures in various areas of the site. Whittaker also conducted a sediment sampling program for the principal drainage areas.[15]

[12] *Id.* at pp. 4-5.
[13] See, letter from Hassan Amini, Ph.D., C.HG., Geomatrix Consultants, Inc., to Sayareh Amir, DTSC, dated August 20, 2004, pp. 16-19.
[14] See, "Recent Site Activities," http://www.whittaker-bermite.com/recent.html, p. 5.
[15] *Id.*

In short, the investigation of on-site sources of the perchlorate contamination and evaluation of clean-up options are substantially underway and closely monitored by DTSC (soils and groundwater), RWQCB (surface water), and ACOE (groundwater).

Perchlorate Impacted Water Purveyor Wells

As previously noted, in 1997, perchlorate was detected in four Saugus Formation production wells operating near the former Whittaker-Bermite site. These wells, CLWA Santa Clarita Water Division's (SCWD) Wells Saugus 1 and Saugus 2, Newhall County Water District's (NCWD) Well NC-11 and Valencia Water Company's (VWC) Well V-157, were removed from service. In 2002, perchlorate was detected in the SCWD Stadium well located directly adjacent to the Whittaker-Bermite site. This Alluvial well was also removed from service. Locations of the impacted wells, and other nearby non-impacted wells, relative to the Whittaker-Bermite site are shown on Figure D-1.

Since the detection of perchlorate and resultant inactivation of impacted wells, the retail water purveyors have been conducting regular monitoring of active wells near the Whittaker-Bermite site. In late March 2005, that monitoring detected the presence of perchlorate in VWC's Well Q2, an Alluvial well located immediately northwest of the confluent of Bouquet Creek and the Santa Clara River. As a result of the detection and confirmation of perchlorate in its Well Q2, VWC removed the well from active service and pursued rapid permitting and installation of wellhead treatment. The well was returned to water supply service in October 2005.

Regulatory Standards for Perchlorate

Perchlorate is a chemical salt and is very soluble in water. It is also very mobile in water and is persistent (i.e., doesn't degrade) under typical environmental conditions. The applicable drinking water standards for perchlorate are summarized below.

On December 6, 2002, the California Office of Environmental Health Hazard Assessment (OEHHA) proposed a public health goal (PHG) for the amount of perchlorate present in drinking water. OEHHA's proposal suggested a range of 2 to 6 micrograms per liter (µg/l). A proposed PHG is a theoretical calculation that initiates a thorough, multi-year standard-setting process by DHS. An adopted PHG reflects a very stringent health standard and is not an enforceable drinking water standard. A final PHG contributes to DHS' development of a Maximum Contaminant Level (MCL), which is an enforceable drinking water standard. DHS is required to establish an MCL at a level as close as is technically and economically feasible to the PHG.

In addition to OEHHA's proposal, DHS was required to adopt an MCL for perchlorate by January 1, 2004. However, this date has been extended into 2005 to allow additional review and study by DHS. Presently, there is no drinking water standard, or MCL, for perchlorate, only a provisional limit called an "action level". The perchlorate advisory action level is currently 6 µg/l, and is not an enforceable standard.

When perchlorate was first discovered in California drinking water supplies in 1997, DHS set the advisory action level at 18 µg/l. It was revised to 4 µg/l in January 2002 and then finally to its current level of 6 µg/l in March 2004. In September 2004, Assembly Bill 2528 was signed into law by Governor Schwarzenegger. This bill eliminates the term "action level" and replaces it with two new terms, "notification level" and "response level". This new terminology became

effective January 2005. However, DHS has advised public water systems that they may use the new terminology in advance of the effective date. Using this new approach, the term "notification level" is the same as the "action level". With respect to perchlorate, the notification level would be 6 µg/l and DHS recommends that the utility provide information to its customers about the presence of the contaminant using its annual consumer confidence report. The response level for perchlorate is 10 times the notification level, or 60 µg/l. At this level, DHS recommends the source be removed from service. At perchlorate levels greater than ten times the action level (or 60 µg/l), DHS recommends (or may require) that a water system remove the source(s) of supply with that concentrations from service. However, with the primary interest of protecting public health from those contaminants regulated by an action level, water utilities normally employ conservative operations by limiting use of the contaminated source, or elect to deliver an alternate source of supply until DHS establishes an enforceable drinking water standard (i.e., MCL). Accordingly, the local retail water purveyors removed all the perchlorate-impacted wells from active water supply service. At present, while prepared to comply with evolving terms, the retail water purveyors have adopted an intended goal in restoring impacted capacity to utilize groundwater for water supply at non-detect concentrations of perchlorate. This goal is consistent with the DHS Policy 97-005 for use of impaired water sources.

Water Purveyor Litigation and Interim Settlement

On November 29, 2000, CLWA and the local retail water purveyors filed suit against the current and prior owners of the Whittaker-Bermite facility. The lawsuit includes causes of action relating to payment of all necessary costs of response, removal of the perchlorate contamination, payment of remediation action costs, and compensation for other damages associated with the perchlorate contamination. CLWA and the local retail water purveyors have incurred substantial response costs and other expenses as a result of production lost on account of the contamination. As a result, CLWA's purveyors have used SWP water to make up for lost groundwater production.

In late summer 2003, CLWA, the local retail water purveyors, Whittaker and Remediation Financial, Inc. (RFI) and Santa Clarita LLC (SCLLC) entered into an interim settlement agreement, in which the parties agreed to work cooperatively for a minimum of one year to further define long-term costs and possibly achieve a long-term settlement. The interim settlement agreement specifies that Whittaker, RFI, and SCLLC and/or their insurers will reimburse certain past costs as well as fund studies and prepare cost estimates for the clean-up plan that will restore water production and capacity of the impacted wells and protect other wells from future contamination. The interim settlement provided for a one-year stay of the lawsuit between the parties and was subsequently amended to extend the stay through January 31, 2005. This has allowed the parties to focus on the final elements of the clean-up plan, which will be submitted to the regulatory agencies in early 2005. The parties continue negotiations to reach a complete settlement.

United States Army Corps of Engineers (ACOE) Groundwater Study

In early 2002, the owner of the Whittaker-Bermite property and CLWA initiated efforts to obtain federal assistance to conduct onsite and off-site groundwater investigations. Through Congressman McKeon, an initial federal authorization of seven million dollars was provided in the form of participation by the ACOE.

Toward that end, on April 11, 2002, ACOE and CLWA entered into a Feasibility Cost-Sharing Agreement to study and locate the source of perchlorate contamination, and other contaminants of interest (COI), in the groundwater in the Santa Clarita Valley. The main objective of the ACOE/CLWA study is to sufficiently characterize the existing groundwater conditions, develop and evaluate both interim and long-term solutions to the contamination and address the contaminated groundwater in the study area, which includes the former Whittaker-Bermite facility and areas adjacent to the property. The project is being implemented pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and in October 2004, the ACOE issued its report entitled, "Draft Final Conceptual Hydrology Memorandum, Eastern Santa Clara Subbasin Study, Santa Clarita, California".[16]

ACOE is actively testing the groundwater in the region in two major phases. ACOE completed five rounds of groundwater sampling in the Saugus Formation and the Alluvial Aquifer between October 2002 and April 2004.[17] ACOE drilled over 8,500 linear feet in the study area, and installed 41 groundwater monitoring wells at 11 different locations. Groundwater sampling was performed at all 41 wells, collecting a total of 149 groundwater samples. The testing began with an initial baseline assessment of each well[18] and was followed by additional groundwater sampling events of each well.[19] As a result of the testing program, ACOE identified the concentrated source areas, began tracing and understanding the contaminant plume, and developed two-dimensional geologic cross-sectional drawings of the study area.[20]

As a result of the sampling program, ACOE determined that perchlorate appears to be one of the primary COIs in the groundwater.[21] Perchlorate was detected in a monitoring well and reconnaissance sampling points in the Alluvial Aquifer approximately one mile west of the former Whittaker-Bermite facility at Bouquet Junction.[22] Additionally, ACOE found perchlorate in a monitoring well in the Alluvial Aquifer at the mouth of Oakdale Canyon in the South Fork of the Santa Clara River, apparently caused by surface water runoff from the former Whittaker-Bermite facility.[23] Testing at this monitoring well has revealed that perchlorate may have migrated vertically into the Saugus Formation at this location, which may have caused the contamination of the NC-11 well, one of the wells that has been inactivated.[24]

[16] See, ACOE, Los Angeles District, Draft Final Conceptual Hydrogeology Technical Memorandum (Memorandum), October, 2004, p.ES-1.
[17] See, Memorandum, p.ES-2; see also, ACOE, Los Angeles District, Citizens Advisory Group Update on City of Santa Clarita Eastern Santa Clara Subbasin Groundwater Study (Update), June 9, 2004, p.6.
[18] The initial baseline sampling tested for perchlorate, volatile organic compounds (VOCs), explosive compounds, nitrosamines and other contaminants of interest (COIs) (i.e., 1,4-dioxane, semivolatile organic compounds (SVOCs), chlorate, gross alpha and gross beta, cyanide and hexavalent chromium). The wells were also tested for metals (including major cations), major anions, alkalinity, total Kjedahl nitrogen (TKN), nitrate, ammonia, total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total organic compound (TOC). See, Memorandum, p.ES-3.
[19] See, Memorandum, p.ES-3; Section 6.1.
[20] See, Update, p.7.
[21] See, Memorandum, p.ES-5; Section 6.1.
[22] See, Memorandum, p.ES-5; Section 6.1; see also, Update, p.15.
[23] See, Memorandum, p. ES-5; see also, Update, p.16.
[24] See, Memorandum, p.ES-5; Section 6.1.

In the Saugus Formation, ACOE found perchlorate in a monitoring well west of Bouquet Junction, over two miles from the former Whittaker-Bermite facility.[25] However, it appears that the impact on groundwater in this area of the Saugus Formation may be limited to the upper portions of the Saugus Formation, as the contamination was not detected below hydrostratigraphic unit (HSU) SIII. The contamination of the V-157 and SC-Saugus 1 and 2 wells, which also have been deactivated, appears to be caused by the vertical downward migration of perchlorate in HSU SIII, and lateral migration away from the source areas. It also appears that the NC-11 well also may have been impacted by this contaminant plume.[26]

As a result of ACOE's work to date, the extent of perchlorate contamination in the Santa Clara region is better understood. Further work will continue to define the lateral and vertical extent of the contaminated groundwater in the Saugus Formation and Alluvial Aquifer, and evaluate potential changes in groundwater contaminants over time.[27] Therefore, ACOE plans to continue integrating its current study results with other ongoing investigations in the area, including the remedial investigation by the Whittaker Company and the response activities undertaken by CLWA and the local retail water purveyors for impacted production wells.[28] ACOE also intends to complete further focused sampling programs and prepare follow-up technical memoranda of those test results.[29]

Based on the knowledge obtained by its testing and analysis, ACOE plans to implement interim remedial measures at selected locations to reduce the perchlorate concentration before it can disperse and/or interfere with the known transportation pathways. By these efforts, ACOE, in coordination with response actions of the property with oversight from DTSC, anticipates preventing further contamination and establishing source control.[30]

DTSC/CLWA/Purveyor Environmental Oversight Agreement

In February 2003, DTSC and CLWA, NCWD, SCWD, and VWC entered into an Environmental Oversight Agreement (Agreement) whereby DTSC provides review and oversight of the response activities being undertaken by CLWA and the local retail water purveyors relating to the detection of perchlorate in the five impacted wells.

The significance of the Agreement lies in the response actions to be undertaken in its "Scope of Work" (Exhibit B to the Agreement). Under the Scope of Work, CLWA and the retail water purveyors will prepare (1) Well Characterization Reports, (2) a Health-Based Risk Assessment, (3) a Regional Groundwater Flow Model, and (4) a Treatment Technology Evaluation Report. The regional groundwater flow model and the treatment technology evaluation are key inputs to the permitting for restoring the impacted wells by returning them to water supply service as described below. Both have been completed and are being utilized in conjunction to control contamination migration and restore impacted water supply well capacity. Most importantly, under the Scope of Work, CLWA and the retail water purveyors will prepare and implement a

[25] See, Memorandum, P.ES-5; see also, Update, p.9.
[26] See, Memorandum, p. ES-5; Section 6.1.
[27] See, Memorandum, p.ES-6; Section 6.2.
[28] See, Memorandum, p.ES-1.
[29] See, Update, p.17.
[30] See, ACOE, Los Angeles District, "Citizens Advisory Group Update on City of Santa Clarita Eastern Santa Clara Subbasin Groundwater Study," June 9, 2004, p.18.

Remedial Action Plan (RAP) that will be used in connection with water treatment programs and/or well relocation. The RAP is important to the retail water purveyors, who have been working cooperatively with DTSC to implement the groundwater clean-up. CLWA is planning to submit the RAP to DTSC for its review in early 2005.

Treatment Technology

A number of full scale perchlorate treatment systems have been implemented in California and other states. In an effort to evaluate the various available treatment technologies, CLWA commissioned an investigation to identify and evaluate alternative treatment processes effective in removing perchlorate. The scope of that investigation includes resolving permitting issues pertaining to the construction and certification of a treatment facility, conducting bench-scale and pilot-scale tests to determine treatment process performance, and preparing preliminary capital and operations and maintenance cost estimates.

Three treatment technologies, an ion exchange system and two biological systems, were selected for study. The report "Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer, TM 3 Bench and Pilot Test Results" (Carollo Engineers, February 2004), concluded that all three systems were effective in removing perchlorate. However, there was considerable uncertainty with respect to the capital and operations and maintenance costs associated with each process. Therefore, a technical group comprised of representatives from CLWA, the retail water purveyors, and consultants retained by Whittaker-Bermite agreed to solicit competitive bids for the design, construction, and operation of both ion exchange and biological treatment systems. After thorough evaluation of several bids, the technical group determined that ion exchange is the preferred technology based upon treatment performance, ease of regulatory compliance, and comparison of costs associated with construction and operations and maintenance.

The preferred single-pass ion exchange treatment technology does not generate a concentrated perchlorate waste stream that would require additional treatment before discharge to a sanitary sewer or a brine line (if one is available). This technology incorporates an active resin (a material that attracts perchlorate molecules) that safely removes the perchlorate from water. The resin is contained in pressure vessels and the water is pumped through the vessel. The resin is eventually replaced with new resin after a period of time. The old resin is removed and transported by truck to an approved waste disposal site where it is safely destroyed. This technology is robust and reliable for use in drinking water systems. DHS has approved operation of the perchlorate treatment plants currently in operation at the following locations:

- La Puente Valley Water District (2,500 gpm)
- San Gabriel Valley Water Company, El Monte (7,800 gpm)
- California Domestic Water Company, Whittier (5,000 gpm)
- City of Riverside (2,000 gpm)
- West San Bernardino Water District, Rialto (2,000 gpm)
- City of Rialto (2,000 gpm)
- City of Colton (3,500 gpm)
- Fontana Union WC (5,000 gpm)
- City of Pomona (10,000 gpm)

Based on (1) the results of CLWA's investigation of perchlorate removal technologies, (2) the technical group's evaluation, and (3) DHS' approval of single-pass ion exchange for treatment in other settings, CLWA and the local retail water purveyors are planning single-pass ion exchange for the treatment technology for restoration of impacted capacity (wells) in accordance with the permitting, testing, and installation process as currently scheduled and described in the next section. The wellhead treatment installed at VWC Well Q2 is the same single-pass ion exchange as is planned for restoration of impacted Saugus well capacity.

Restoration of Perchlorate Impacted Water Supply

Since the detection of perchlorate in the four Saugus wells in 1997, CLWA and the retail water purveyors have recognized that one element of an overall remediation program would most likely include pumping from impacted wells, or from other wells in the immediate area, to establish hydraulic conditions that would control the migration of contamination from further impacting the aquifer in a downgradient (westerly) direction. Thus, CLWA and the retail water purveyors expect that the overall perchlorate remediation program could include dedicated pumping from some or all of the impacted wells, with appropriate treatment, such that two desirable objectives could both be achieved. The first objective is control of subsurface flow and protection of downgradient wells and the second is restoration of some or all of the contaminated water supply. Not all impacted capacity is required for control of groundwater flow. The remaining capacity would be replaced by construction of replacement wells at other non-impacted locations.

In cooperation with state regulatory agencies and investigators working for Whittaker-Bermite, CLWA and the local retail water purveyors developed an off-site plan that focuses on the above concepts of groundwater flow control and restored pumping capacity and is compatible with on-site and possibly other off-site remediation activities. Specifically relating to water supply, the plan includes the following:

- Constructing and operating a water treatment process that removes perchlorate from two impacted wells such that the produced water can be used for municipal supply
- Hydraulically containing the perchlorate contamination moving from the Whittaker-Bermite site toward the impacted wells by pumping the wells at rates that will capture water from all directions around them
- Protecting the downgradient non-impacted wells through the same hydraulic containment that results from pumping two of the impacted wells
- Restoring the annual volumes of water that were pumped from the impacted wells before they were inactivated, and also restoring the wells' total capacity to produce water in a manner consistent with the retail water purveyor's operational plan for groundwater supply

The current schedule for implementation of the plan to restore contaminated water supply (wells) is illustrated in Figure D-2. Included in the schedule is a planned extended test of the wells that will be returned to service as part of restoring contaminated water supply and that will also be operated to extract contaminated water and control the migration of contamination in the aquifer. Concurrent with the testing of the wells, several specific ion exchange resins will also be tested to evaluate their performance and longevity. The two key activities that comprise the majority of

effort required for implementation of the plan are general facilities-related work (design and construction of well facilities, treatment equipment, pipelines, etc.) and permitting work. Both activities are planned and scheduled concurrently resulting in planned completion (i.e., restoration of all impacted capacity) in 2006. Notable recent accomplishments toward implementation include completion of the Final Draft Interim Remedial Action Plan (RAP) in August 2005 and completion of environmental review with the adoption of a Mitigated Negative Declaration in September 2005.

In light of the preceding, with regard to the adequacy of groundwater as the local component of water supply in this UWMP, the impacted capacity will remain unavailable into 2006, during which time the non-impacted groundwater supply will be sufficient to meet near-term water requirements. Afterwards, the total groundwater capacity will be sufficient to meet the full range of normal and dry-year conditions as provided in the operating plan for groundwater supply, as described in Chapter 3 of this UWMP.

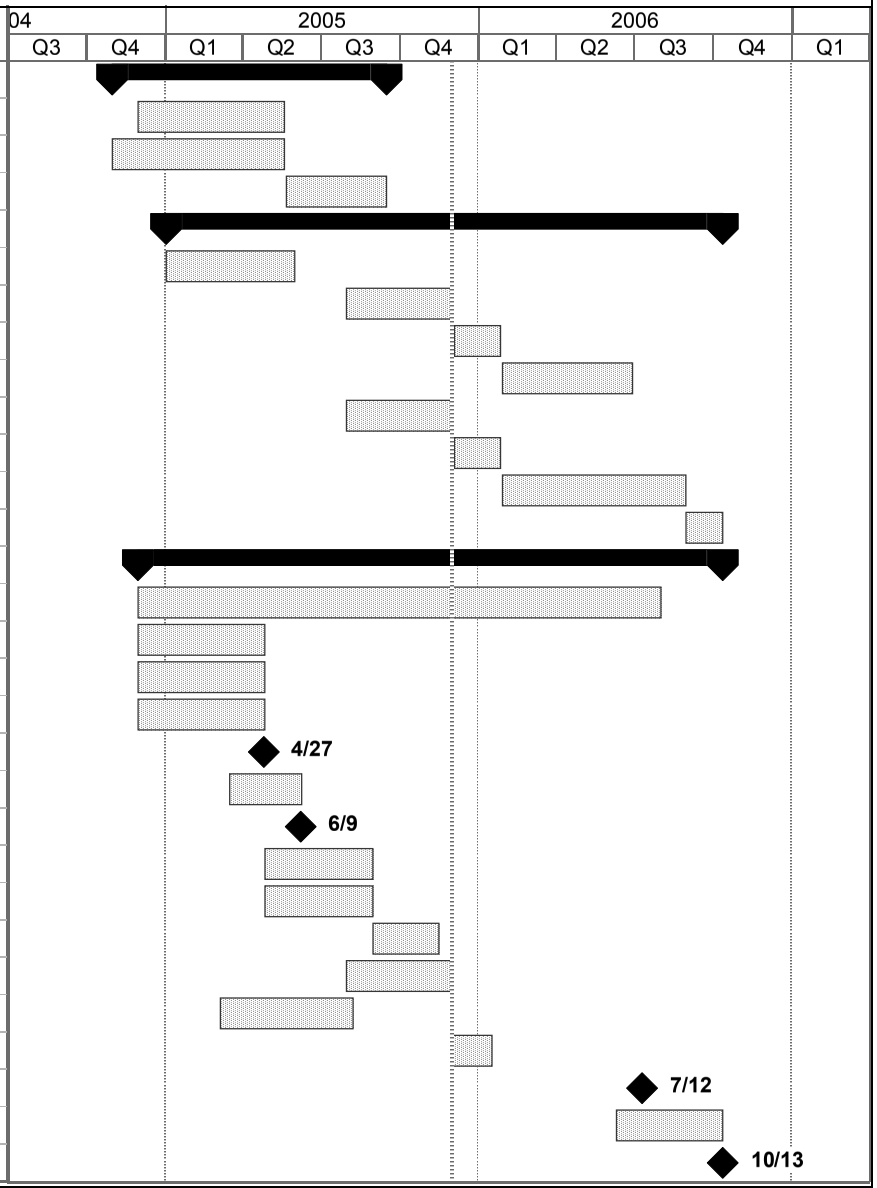
Returning contaminated wells to municipal water supply service by installing treatment requires issuance of permit from DHS before the water can be considered potable and safe for delivery to customers. The permit requirements are contained in DHS Policy Memo 97-005 for direct domestic use of impaired water sources. Before issuing a permit to a water utility for use of an impaired source as part of the utility's overall water supply permit, DHS requires that studies and engineering work be performed to demonstrate that pumping the wells and treating the water will be protective of public health for users of the water. The Policy Memo requires that DHS review the local retail water purveyor's plan, establish appropriate permit conditions for the wells and treatment system, and provide overall approval of returning the impacted wells to service for potable use. Ultimately, CLWA and the local retail water purveyor's plan and the DHS requirements are intended to ensure that the water introduced to the potable water distribution system has no detectable concentration of perchlorate.

The DHS 97-005 Policy Memo requires, among other things, the completion of a source water assessment for the impacted wells intended to be returned to service. The purpose of the assessment is to determine the extent to which the aquifer is vulnerable to continued migration of perchlorate and other contaminants of interest from the Whittaker-Bermite site. The assessment will include the following:

- Delineation of the groundwater capture zone caused by operating the impacted wells
- Identification of contaminants found in the groundwater at or near the impacted wells
- Identification of chemicals or contaminants used or generated at the Whittaker-Bermite facility
- Determination of the vulnerability of pumping the impacted wells to these contaminant sources

Figure D-2
Preliminary 97-005 Implementation Schedule
Castaic Lake Water Agency

ID	Task Name	Duration	Start	Finish
1	**DTSC Approval Activities**	**230 days**	**Mon 11/1/04**	**Fri 9/16/05**
2	Feasibility Study	6.15 mons	Wed 12/1/04	Fri 5/20/05
3	Draft RAP	29 wks	Mon 11/1/04	Fri 5/20/05
4	Final RAP	4.25 mons	Mon 5/23/05	Fri 9/16/05
5	**Implementation Activities**	**465 days**	**Mon 1/3/05**	**Fri 10/13/06**
6	Easements and ROW	5.4 mons	Mon 1/3/05	Wed 6/1/05
7	Treatment Design	4.4 mons	Mon 8/1/05	Wed 11/30/05
8	Treatment Bidding & Contracting	2 mons	Mon 12/5/05	Fri 1/27/06
9	Treatment Construction	5.5 mons	Mon 1/30/06	Fri 6/30/06
10	Pipeline Design	4.4 mons	Mon 8/1/05	Wed 11/30/05
11	Pipeline Bidding & Contracting	2 mons	Mon 12/5/05	Fri 1/27/06
12	Pipeline Construction	7.7 mons	Mon 1/30/06	Thu 8/31/06
13	System Startup	1.55 mons	Fri 9/1/06	Fri 10/13/06
14	**DHS Approval Activities (97-005)**	**488 days**	**Wed 12/1/04**	**Fri 10/13/06**
15	DHS Coordination	21.8 mons	Wed 12/1/04	Wed 8/2/06
16	TM1: Source Water Assessment	5.3 mons	Wed 12/1/04	Wed 4/27/05
17	TM2: Raw Water Quality Characterization	5.3 mons	Wed 12/1/04	Wed 4/27/05
18	TM3: Source Water Protection	5.3 mons	Wed 12/1/04	Wed 4/27/05
19	DHS Workshop No. 1	0 days	Wed 4/27/05	Wed 4/27/05
20	TM4: Effective Monitoring & Treatment	3 mons	Fri 3/18/05	Thu 6/9/05
21	DHS Workshop No. 2	0 days	Thu 6/9/05	Thu 6/9/05
22	TM5: Human Health Risk Assessment	4.5 mons	Thu 4/28/05	Wed 8/31/05
23	TM6: Alternative Source Assessment	4.5 mons	Thu 4/28/05	Wed 8/31/05
24	DHS Review of TMs 5 & 6	2.75 mons	Thu 9/1/05	Wed 11/16/05
25	Prepare 97-005 Engineer's Report	4.4 mons	Mon 8/1/05	Wed 11/30/05
26	CEQA Initial Study and Draft MND	5.55 mons	Mon 3/7/05	Mon 8/8/05
27	Permit Application	1.7 mons	Thu 12/1/05	Tue 1/17/06
28	Public Hearing	0 days	Wed 7/12/06	Wed 7/12/06
29	DHS Evaluation	4.5 mons	Mon 6/12/06	Fri 10/13/06
30	Obtain DHS Permit	0 days	Fri 10/13/06	Fri 10/13/06



Project: CLWA 97-005_r2
Date: Thu 12/1/05

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

CLWA is currently working directly with the retail water purveyors and its consultants on development of the DHS 97-005 Policy Memo permit application. Two coordination workshops have already been held with DHS. Drafts of all six elements of the 97-005 Policy Memo have been submitted to DHS and the retail purveyors for review, including: the Source Water Assessment, Raw Water Quality Characterization, Source Protection Plan, Effective Monitoring and Treatment Evaluation, Human Health Risk Assessment, and the Alternatives Sources Evaluation. The Engineer's Report, which summarizes these six elements for the 97-005 process, is anticipated to be complete by the end of November 2005.

As noted above, CLWA and the local retail water purveyors have recognized the probable need for some form of pumping in or near the impacted wells to extract contamination and protect downgradient non-impacted wells. As part of the permitting for use of impacted wells with treatment, DHS 97-005 Policy Memo requires an analysis to demonstrate contaminant capture and protection of other nearby water supply wells. The development and calibration of a numerical groundwater flow model of the entire basin was initiated as a result of a 2001 Memorandum of Understanding among the Upper Basin Water Purveyors (CLWA, CLWA SCWD, LACWWD #36, NCWD, and VWC) and the United Water Conservation District in Ventura County.

The groundwater model was initially intended for use in analyzing the yield and sustainability of groundwater in the Basin. Use of the model for that analysis is described in Chapter 3. The model was adaptable to analyze both the sustainability of groundwater under an operational scenario that includes full restoration of perchlorate-contaminated supply and the containment of perchlorate near the Whittaker-Bermite property (i.e., by pumping some of the contaminated wells), including preventing movement of perchlorate contamination to other portions of the aquifer system. DTSC reviewed and approved the construction and calibration of the regional model as described in the final model report "Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration" (CH2M Hill, April 2004).

After DTSC's approval of the model, it was used to simulate the capture and control of perchlorate by restoring impacted wells, with treatment, as described above. The results of that work were summarized in a second report "Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California" (CH2M Hill, December 2004). The modeling analysis indicate that the pumping of impacted wells SCWD-Saugus 1 and SCWD-Saugus 2 at rates of 1,200 gpm each on a nearly continual basis will effectively contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property. The analysis also indicates that (1) no new production wells are needed in the Saugus Formation to meet the perchlorate containment objective, (2) impacted well NCWD-11 is not a required component of the containment program, and (3) pumping at SCWC-Saugus 1 and SCWC-Saugus 2 is necessary to prevent migration of perchlorate to other portions of the Saugus Formation.

This report also includes the general design of a sentinel groundwater monitoring network and program required by DHS as part of its 97-005 Policy Memo permitting. The perchlorate containment report was approved by DTSC in November 2004. With that approval, the model is now being used to support the source water assessment and the remainder of the permitting process required by DHS under its 97-005 Policy Memo.

Somewhat independent of the focus on impacted Saugus wells and restoration of that impacted water supply has been the Alluvial Stadium well. On-site investigations by Whittaker-Bermite since late 2003 have resulted in the completion, in June 2005, of a Workplan for a Pilot Remediation Pumping Program in the Northern Alluvium and certain on-site sub-areas that are east/southeast, or generally upgradient, of the impacted Stadium well. That program basically involves the establishment of containment, generally along the northern boundary of the Whittaker-Bermite site, upgradient of the Stadium well, by continuous pumping of a former Whittaker-Bermite facility well, at a continuous low capacity, complemented by pumping at several groundwater "hot spots" that are also generally upgradient of the Stadium well. Due to the low conductivity nature of the aquifer materials at the various "hot spots", pumping for containment at those locations would be from several wells at low pumping capacities. Extracted water would be treated at Whittaker-Bermite's existing on-site treatment system. Generally consistent with the Saugus restoration concept, the Northern Alluvium pumping program would have the concurrent objectives of preventing site-related contaminants from leaving the site and removing some contamination from groundwater such that it can be removed in the on-site treatment process prior to discharge of the water back to the groundwater Basin.

Appendix E

Project Description Excerpt from August 2005 "CLWA Groundwater Containment, Treatment, and Restoration Project" Mitigated Negative Declaration

Appendix E

Project Description Excerpt from August 2005 "CLWA Groundwater Containment, Treatment, and Restoration Project" Mitigated Negative Declaration

Containment/Treatment Facilities

The Proposed Project for containment/treatment is based on analysis of temporal and spatial variations in groundwater flow patterns using the Regional Groundwater Flow Model for Santa Clarita Valley ("*Draft Interim Feasibility Study*," Kennedy/Jenks 2005). Model development and calibration are described in the "*Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration*," CH2M HILL 2004. Based on the model, the movement of contaminated water from the Whittaker-Bermite Property in the Saugus Formation was in a westerly direction. The San Gabriel Fault Zone, which runs east-west through the northern portion of the Whittaker-Bermite Property, was determined to provide a partial barrier to northward migration of the perchlorate-contaminated groundwater, and perchlorate-contaminated water could therefore be intercepted at the existing Saugus 1 and Saugus 2 wells, which are located near the intersection of Magic Mountain Parkway and San Fernando Road. Pumping of groundwater along the leading edge of the plume at these wells would effectively create a cone of depression adjacent to the wells. Perchlorate-contaminated water would then flow into this cone of depression where it would be extracted. The volume of extraction was evaluated to match it to the inflow of perchlorate-contaminated water, thereby maintaining a cone of depression that does not induce migration of better quality groundwater from the Alluvial Aquifer into the cone of depression. An extraction rate of from 1,100 gpm to 1,250 gpm is proposed.

Once extracted, the contaminated water would then be treated to remove the perchlorate and utilized. Over time, this interception of the contaminated plume would (a) reduce downstream migration of the plume and (b) collect the perchlorate and permanently remove it from the groundwater basin. Given that no new contamination would occur up-gradient from the interceptor wells, this strategy should eventually remediate the perchlorate problem.

The primary elements of the Containment Facilities to be constructed and operated (Figure 4 [not included]; Table E-1) are new pumps for existing production wells, new monitoring wells, new pipelines, and a new treatment plant for perchlorate removal. In addition, several existing wells would be removed. These facilities would provide for extraction of contaminated groundwater, conveyance of this water to a treatment facility, and treatment to remove perchlorates. The treatment plant would be tied into existing CLWA distribution pipelines to deliver treated water. Containment facility elements and specifications are shown on Table E-1.

Table E-1
Proposed Project Perchlorate Containment Facilities

FACILITY	SITE	DESCRIPTION (SEE FIGURE 4 [Not Included])
New pumps	Saugus-1 and Saugus-2 wells	**New** variable speed up to 1200 gpm each, installed at existing well site.
Network of monitoring wells	North of Saugus-2 and adjacent to alluvial basin	**New** Small-diameter wells not used for production, located to characterize the contaminant plume and to monitor program effectiveness; included up gradient wells managed in cooperation with other entities.
Conveyance to Treatment Plant	Road rights of way and bike trail	**Segment 1: New** 10" pipeline from Saugus-2, along San Fernando Road to connect with an existing 14-21 inch pipeline on the east side of the South Fork of the Santa Clara River.
		Segment 2: **Connection** of segment 1 to an existing 14-21" pipeline under the Santa Clara River, along Magic Mountain Parkway, and north along Valencia Blvd. to the bridge at the South Fork of the Santa Clara River.
		Segment 3. **New** 16" pipeline under the Valencia Blvd. bridge at the South Fork of the Santa Clara River, along the north/west right-of-way of Valencia Boulevard, along a bike path around the gas station at Bouquet Canyon Bridge, suspended on the west side of Bouquet Canyon Bridge, then west along a bike path to the Rio Vista Intake Pump Station.
Treatment Plant	At Rio Vista Intake Pump Station	**New** one-train, two vessel ion exchange system using Amberlite PWA2 strong-base anion exchange resin followed by chloramination disinfection with a rated capacity of 2400 gpm.
Conveyance from Treatment Plant	West of Treatment Plant	**Connect new Treatment Plant to existing Rio Vista Intake Pump Plant** and CLWA's existing treated water pipeline.

Containment Facility Operation

Containment wells would initially be operated at 1,100 gpm, and then adjusted based on monitoring well data to achieve effective containment of perchlorates. Adjustments would be made in consultation with the Department of Toxic Substance Control (DTSC). Contaminants would be treated in accordance with DHS requirements.

The containment treatment facility utilizes disposable filters to remove perchlorates (US Filter). The dual vessel design of the facility would provide for continuous operation. Primary filtration would occur in Vessel 1, with Vessel 2 providing a final "polishing." When the filter in Vessel 1 requires replacement, primary filtration would switch to Vessel 2 while the filter in Vessel 1 is removed and replaced. Filters would then be collected from the facility and transported off site to an approved commercial disposal facility. The perchlorate treatment plant would be monitored on a continuous 24-hour basis at the adjacent Rio Vista Intake Pump Station using a Supervisory Control and Data Acquisition (SCADA) program.

Facilities for Restoration of Service

The containment element of the Proposed Project would restore up to 43% of production from the Saugus-1 and Saugus-2 wells. The permanent closure of VWC's V-157 well (V-157), NCWD's well number 11 (NC 11), and the Stadium well operated by CLWA's Santa Clara Water Division has created a deficit in local groundwater production of 6,300 gpm capacity, or about 3,838 afy. The containment project would also convert several existing pipelines from treated water use for conveyance of perchlorate-contaminated water to the treatment plant.

To restore local well production to pre-contamination levels and to restore service affected by conversion of existing facilities to carry untreated water, CLWA proposes to relocate production wells to areas outside of the zone of perchlorate contamination and to construct new conveyance facilities to replace the existing treated water pipelines that will be converted to convey water from Saugus 1 and Saugus 2 to the new treatment plant. This involves two elements (Figures 5 and 6 [not included]).

First, to replace lost production east of the confluence of the Santa Clara River and the South Fork of the Santa Clara River from closure of the Stadium Well, CLWA would relocate the Stadium Well from its location adjacent to the Stadium along the south bank of the Santa Clara River to a location about 0.6 miles upstream from the Stadium site to an existing CLWA facility at Furnivall Avenue and Santa Clara Street and would construct a short (50-100 foot) pipeline from the well to an existing 8-inch distribution line.

Second, in addition to VWC's new 2,500 gpm well northwest of Magic Mountain Amusement Park (hereafter MMA Park), CLWA would:

- Construct a new multiple-well 4,000 gpm facility (with chloramination facilities) along a dirt road to the west of the MMA Park), with wells connected via a 12-inch pipeline;
- Construct a new 18-inch treated water pipeline from CLWA's 48-inch pipeline at the McBean Parkway Bridge to a site opposite from NC 11; and
- Construct a new 18-inch groundwater pipeline along new road alignments that would connect these new wells directly to CLWA's existing 42-inch pipeline.

Long-term planning for CLWA's water storage and conveyance facilities includes potential development of a regulating reservoir southwest of the two proposed new wells. The regulating reservoir and the pipelines, which may be developed to connect it to the Proposed Project, are shown on Figure 6 [not included] for informational purposes and because they are addressed in the cumulative impacts discussion in this Initial Study. However, this reservoir facility and the pipelines needed to connect it to the Proposed Project are not a part of the Proposed Project and the Proposed Project does not depend upon them.

The wells, 12-inch connecting pipeline, chloramination facility, and 12-inch to 18-inch pipeline would be constructed within the road alignments of future planned roads. CLWA facilities would be constructed following the initial grading for these roads and the adjacent development. In combination with yield from the Saugus-1 and Saugus-2 wells and associated treatment plant, these actions would restore production lost due to perchlorate contamination and would restore service to areas previously served by the NC-11, V-157, and Stadium wells. Siting and details of the proposed restoration-of-service facilities are summarized on Table E-2. Note that the planned reservoir is not a part of the Proposed Project.

Chloramination Facilities

Chloramination facilities would be constructed at two sites: (a) at the new perchlorate treatment facility and (b) at the new well field west of MMA Park. Chloramines are formed by mixing sodium hypochlorate and ammonia, which are produced or stored in separate areas prior to mixing into the water stream. Several types of facilities would be considered during final design. Regardless of facility type, these facilities would be fully contained, and storage of water treatment chemicals would be within double-walled containers with separate containment back-up systems capable of holding 1.5 times the capacity of each chemical tank.

Table E-2
Proposed Project facilities for Restoration of Service

FACILITY	SITE	DESCRIPTION (SEE FIGURES 5 AND 6 [Not Included])
To replace Stadium Well		
New alluvial well	Furnivall Ave. & Santa Clara St.	**New** 800 gpm well and up to 100 foot long pipeline to connect to existing 8" pipeline.
To replace pumping capacity from contaminated wells to restore local dry year water supplies		
Well field and chloramination facility	West of MMA Park	**New** wells with a combined capacity of 4,000 gpm to be constructed along the unpaved perimeter road on the west boundary of the MMA Park, with a chloramination facility located at the last well along the 12" to 18" pipeline connecting these wells.
Pipeline from new wells to Existing 42" CLWA	West Magic Mountain Parkway to I-5	**Segment 4: New** 18" pipeline from the chloramination facility to Magic Mountain Parkway and then east along Magic Mountain Parkway to the terminus of CLWA's 42" pipeline at I-5.
Pipeline to serve area west of McBean Parkway	McBean Parkway to NC-11	**Segment 5. New** 33" pipeline along bikeway on south levee of the South Fork of the Santa Clara River to Valencia Boulevard; **Segment 6. New** 39" pipeline along Valencia Blvd. and Magic Mountain Parkway with a turnout west of San Fernando Road. **Segment 7. New** 18" pipeline from the Segment 5 turnout to San Fernando Road; and **Segment 8. New** turnout, connection to the CLWA existing 21" pipeline along the west side of the South Fork of the Santa Clara River, and 18" pipeline from the turnout parallel to CLWA's existing 21" pipeline along an access road to a site opposite NC-11, connecting to existing turnouts.

Appendix F
Best Management Practices

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	yes
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	44418
b. Determine other system verifiable uses (AF)	0
c. Determine total supply into the system (AF)	44838
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.99
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	yes
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	yes
a. If yes, describe the leak detection program:	
monthly review of metered sales vs. supply	

B. Survey Data

1. Total number of miles of distribution system line.	26
2. Number of miles of distribution system line surveyed.	26

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	5000	6000
2. Actual Expenditures	5000	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

Agency provides a quarterly community newsletter to approx. 2,000 people/organizatioms/elected officials. Utilize paid advertising, public and media events and Agency conservation garden to promote water conservation in service area.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	10
b. Public Service Announcement	yes	0
c. Bill Inserts / Newsletters / Brochures	yes	4
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	15
f. Special Events, Media Events	yes	10
g. Speaker's Bureau	yes	3
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	147102	100000
2. Actual Expenditures	144283	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

A2d. Retailers are billed based on usage and are shown last year's usage of Agency wholesale production. B1 and B2. After 2003, began new accounting system, also re-organized personnel.

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2003**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	147	3033	0
Grades 4th-6th	yes	67	2421	0
Grades 7th-8th	yes	0	0	0
High School	yes	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 09/01/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	114670	115000
2. Actual Expenditures	110979	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Have expanded program to include more workshops, career days and job fairs. PROBLEM: increased school district emphasis on testing has made entry into Grades 7-12 very difficult.

Reported as of 5/7/05

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit: **Castaic Lake Water Agency**

BMP Form Status: **100% Complete**

Year: **2003**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No	0	0	8	yes	165852	162161
2	yes	10000	10000	9	No		
3	No			10	yes	93659	72659
4	No			11	No		
5	No			12	yes	58000	58000
6	No			13	No		
7	yes	147102	144283	14	yes	20000	20000

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	yes
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	yes
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	yes
2) Residential retrofits	yes
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	.5	8	yes	10
2	yes	.5	9	yes	.5
3	yes	1	10	yes	2
4	yes	.5	11	yes	.5
5	yes	2.5	12	yes	2
6	yes	.5	13	yes	.5
7	yes	3	14	yes	.5

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	yes	9	yes
3	No	10	yes
4	No	11	No
5	yes	12	yes
6	No	13	No
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	494613	500000
2. Actual Expenditures	467103	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$6049713
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3264000
2. Commercial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
3. Industrial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
4. Institutional / Government	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
5. Irrigation	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
6. Other	
a. Water Rate Structure	

b. Sewer Rate Structure

c. Total Revenue from Volumetric Rates $

d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources $

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator? yes
2. Is this a full-time position? no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ? no
4. Partner agency's name:
5. If your agency supplies the conservation coordinator:
   - a. What percent is this conservation coordinator's position? 50%
   - b. Coordinator's Name Mary Lou Cotton
   - c. Coordinator's Title Water Resources Manager
   - d. Coordinator's Experience and Number of Years 11
   - e. Date Coordinator's position was created (mm/dd/yyyy) 02/15/2001
6. Number of conservation staff, including Conservation Coordinator. 3

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	68497	59000
2. Actual Expenditures	68497	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no
   - a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

One position filled for only part of calendar year.

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	yes
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	46669
b. Determine other system verifiable uses (AF)	0
c. Determine total supply into the system (AF)	47088
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.99
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	yes
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	yes
a. If yes, describe the leak detection program:	
monthly review of metered sales vs. supply	

B. Survey Data

1. Total number of miles of distribution system line.	26
2. Number of miles of distribution system line surveyed.	26

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	6000	6000
2. Actual Expenditures	6000	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

Agency provides a quarterly community newsletter to approx. 50,000 people/organizatioms/elected officials. Utilize paid advertising, public and media events and Agency conservation garden to promote water conservation in service area.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	15
b. Public Service Announcement	yes	0
c. Bill Inserts / Newsletters / Brochures	yes	5
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	15
f. Special Events, Media Events	yes	3
g. Speaker's Bureau	yes	8
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	235163	200000
2. Actual Expenditures	241461	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

A2d. Retailers are billed based on usage and are shown last year's usage of Agency wholesale production. B1 and B2. Relects new accounting process and reorganization.

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2004**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	54	1080	0
Grades 4th-6th	yes	21	732	0
Grades 7th-8th	yes	0	0	0
High School	yes	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 09/01/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	207270	200000
2. Actual Expenditures	219362	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Continuing difficulty gaining entry into Grades 7-12. B1 and B2. Reflects additonal staff hired in 2004.

Reported as of 5/7/05

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit: **Castaic Lake Water Agency**

BMP Form Status: **100% Complete**

Year: **2004**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No			8	yes	235163	241461
2	yes	20000	21000	9	No		
3	No			10	yes	88659	86621
4	No			11	No		
5	No			12	yes	58000	58000
6	No			13	No		
7	yes	207270	219362	14	yes	25000	25000

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	yes
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	yes
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	yes
2) Residential retrofits	yes
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	.5	8	yes	10
2	yes	.5	9	yes	.5
3	yes	1	10	yes	2
4	yes	.5	11	yes	.5
5	yes	2.5	12	yes	2
6	yes	.5	13	yes	.5
7	yes	3	14	yes	.5

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	yes	9	yes
3	No	10	yes
4	No	11	No
5	yes	12	yes
6	No	13	No
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	634092	650000
2. Actual Expenditures	651444	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

all budget numbers reflect new accounting process started in 2004.

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$8561300
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$0
2. Commercial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
3. Industrial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
4. Institutional / Government	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
5. Irrigation	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
6. Other	
a. Water Rate Structure	

b. Sewer Rate Structure

c. Total Revenue from Volumetric Rates $

d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources $

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Castaic Lake Water Agency	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator? yes
2. Is this a full-time position? no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ? no
4. Partner agency's name:
5. If your agency supplies the conservation coordinator:
   - a. What percent is this conservation coordinator's position? 50%
   - b. Coordinator's Name Mary Lou Cotton
   - c. Coordinator's Title Water Resources Manager
   - d. Coordinator's Experience and Number of Years 11
   - e. Date Coordinator's position was created (mm/dd/yyyy) 02/18/2001
6. Number of conservation staff, including Conservation Coordinator. 3

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	80503	80000
2. Actual Expenditures	80503	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no
   - a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

CUWCC

Best Management Practices Report Filing

Base Year Data

Reporting Unit: **Santa Clarita Water Division**	**Submitted to CUWCC** 04/19/2003

INSTRUCTIONS: This form MUST BE completed and submitted to the CUWCC prior to filing any BMP reports. The data provided on this form is used in determining coverage requirements for specific BMPs as indicated. If some of the data requested is not available, make reasonable estimates. You can update and edit values, if more precise information becomes available in the future.

For Customer Classification Definitions (i.e. Single Family, Multi-Family) click HERE.

	1. Your **BASE YEAR is 2001**. NOTE: Many calculations in determining credit history and coverage requirements are contingent on your BASE YEAR, which is calculated based on the following criteria. If a Signatory signed the MOU in 1997 or earlier, then the Base Year is 1997. If a Signatory signed the MOU after 1997, then the Base Year is the year the MOU was signed. The same holds true for USBR Contractors, except the date their Base Year is calculated from is the date that their Plan was noticed in the Federal Register.	
	BMP 1	
	2. Number of single-family customers in 2001	20802
	3. Number of multi-family units in 2001	1892
	BMPs 2 and 14	
	4. Number of single-family housing units constructed prior to 1992	14457
	5. Number of multi-family units prior to 1992	3401
	BMP 4	
	6. Number of unmetered accounts in 2001	0
	BMPs 5 and 9	
	7. Number of commercial accounts in 2001	582
	8. Number of industrial accounts in 2001	19
	9. Number of institutional accounts in 2001	89
	10. Total water use (AF) by commercial, industrial and institutional accounts in 2001	2850
	BMP 14	
	11. Average number of toilets per single-family household	2
	12. Average number of toilets per multi-family household	2
	13. Five-year average resale rate of single-family households	10.6

	14. Five-year average resale rate of multi-family households	19.1
	15. Average persons per single-family household	3.3
	16. Average persons per multi-family household	3.3

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Webmaster

Reported as of 5/7/05

Accounts & Water Use

Reporting Unit Name:
Santa Clarita Water Division

Submitted to CUWCC
02/15/2005

Year:
2003

A. Service Area Population Information:

1. Total service area population 82200

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	21754	16006	0	0
2. Multi-Family	4216	2594	0	0
3. Commercial	617	888	0	0
4. Industrial	19	135	0	0
5. Institutional	95	764	0	0
6. Dedicated Irrigation	731	4231	0	0
7. Recycled Water	0	0	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	0	NA	0
Total	27432	24618	0	0
	Metered		**Unmetered**	

Reported as of 5/7/05

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Based on your signed MOU date, 02/07/2001, your Agency STRATEGY DUE DATE is:	02/07/2003
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	

B. Water Survey Data

Survey Counts:	Single Family Accounts	Multi-Family Units
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	no	no
a. If yes, in what form are surveys tracked?		None

b. Describe how your agency tracks this information.

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Waiting on BMP revision before beginning implementation.

Reported as of 5/7/05

BMP 02: Residential Plumbing Retrofit

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? — no

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? — no

3. Estimated percent of single-family households with low-flow showerheads: — %

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? — no

5. Estimated percent of multi-family households with low-flow showerheads: — %

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? — yes

   a. If YES, when did your agency begin implementing this strategy? — 5/12/2002

   b. Describe your targeting/ marketing strategy.

   Newspaper ads, flyers and newsletter notifications of distrbution events.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	83	4
3. Number of toilet-displacement devices distributed:	0	0
4. Number of toilet flappers distributed:	0	0
5. Number of faucet aerators distributed:	25	15

6. Does your agency track the distribution and cost of low-flow devices? — yes

   a. If YES, in what format are low-flow devices tracked? — Manual Activity

   b. If yes, describe your tracking and distribution system :

   Keep records of which account addresses received low-flow devices.

C. Low-Flow Device Distribution Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0

2. Actual Expenditures 0

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

All funding provided by CLWA on behalf of retailers.

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	yes
a. If yes, describe the leak detection program:	
Visual inpsections/response to customers.	

B. Survey Data

1. Total number of miles of distribution system line.	286
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

Reported as of 5/7/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use?	yes
2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use?	no
a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed?	
b. Describe the program:	
3. Number of previously unmetered accounts fitted with meters during report year.	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	
b. Describe the feasibility study:	
2. Number of CII accounts with mixed-use meters.	700
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

All connections are metered.

Reported as of 5/7/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	731
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	
b. Description of marketing / targeting strategy:	
2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve	no

landscape water use efficiency?

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates			
b. Loans			
c. Grants			

5. Do you provide landscape water use efficiency information to new customers and customers changing services? yes

a. If YES, describe below:

Information and training provided by Castaic Lake WA

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? no

8. Do you provide customer notices at the end of the irrigation season? no

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

F. Comments

Reported as of 5/7/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? no

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers? no
3. What is the level of the rebate? 0
4. Number of rebates awarded. 0

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? no

a. If YES, describe the program and how it's organized.

CLWA as wholesaler runs program for retailers. See CLWA form.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	no	
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	no	
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	no	
f. Special Events, Media Events	no	
g. Speaker's Bureau	no	
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program provided by Castaic Lake WA.

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? no

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd				
Grades 4th-6th				
Grades 7th-8th				
High School				

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program?

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program provided by CLWA on behalf of retailers.

Reported as of 5/7/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? no

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered			
b. Number of New Surveys Completed			
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)			
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)			

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	no	no	no
f. Evaluation of all water-using apparatus and processes	no	no	no
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	no	no	no

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	no
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Not implementing BMP.

Reported as of 5/7/05

BMP 09a: CII ULFT Water Savings

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

1. Did your agency implement a CII ULFT replacement program in the reporting year? If No, please explain why on Line B. 10. — No

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

2. How does your agency advertise this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.)

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency?

3. What is the total number of customer accounts participating in the program during the last year ?

CII Subsector	Number of Toilets Replaced			
4.	**Standard Gravity Tank**	**Air Assisted**	**Valve Floor Mount**	**Valve Wall Mount**
a. Offices				
b. Retail / Wholesale				
c. Hotels				
d. Health				
e. Industrial				
f. Schools: K to 12				
g. Eating				
h. Govern-ment				
i. Churches				
j. Other				

5. Program design.

6. Does your agency use outside services to implement this program?

a. If yes, check all that apply.

7. Participant tracking and follow-up.

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business

b. Inadequate payback

c. Inadequate ULFT performance

d. Lack of funding

e. American's with Disabilities Act

f. Permitting

g. Other. Please describe in B. 9.

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and budgeting?

Not implementing BMP.

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor	0	0
b. Materials	0	0
c. Marketing & Advertising	0	0
d. Administration & Overhead	0	0
e. Outside Services	0	0
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution	
b. State agency contribution	
c. Federal agency contribution	
d. Other contribution	
e. Total	0

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$6968914
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$2740750
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$337293
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$122163
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$51278
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$9310
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$290286
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$42691
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1606562
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$215115
6. Other	
a. Water Rate Structure	Service Not Provided

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$0
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$0

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

2003 revenues reflect new accounting process.

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator?	no
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Castaic Lake WA
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	%
b. Coordinator's Name	
c. Coordinator's Title	
d. Coordinator's Experience and Number of Years	
e. Date Coordinator's position was created (mm/dd/yyyy)	
6. Number of conservation staff, including Conservation Coordinator.	0

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

D. Comments

Reported as of 5/7/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? — no

   a. If YES, describe the ordinance:

2. Is a copy of the most current ordinance(s) on file with CUWCC? — no

   a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

   a. Gutter flooding — no

   b. Single-pass cooling systems for new connections — no

   c. Non-recirculating systems in all new conveyor or car wash systems — yes

   d. Non-recirculating systems in all new commercial laundry systems — no

   e. Non-recirculating systems in all new decorative fountains — yes

   f. Other, please name — no

2. Describe measures that prohibit water uses listed above:

   Recirculating systems required in all car washes and fountains (city/san district ordinance).

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

   a. Allow the sale of more efficient, demand-initiated regenerating DIR models. — no

   b. Develop minimum appliance efficiency standards that:

      i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. — no

      ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. — no

   c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. — no

4. Does your agency include water softener checks in home water audit programs? — no

5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models? no

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Agency supported San District water softener ban ordinance adopted in 2003.

Reported as of 5/7/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2003**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	60	9
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**60**	**9**

6. Describe your agency's ULFT program for single-family residences.

publicly advertised rebate program

7. Describe your agency's ULFT program for multi-family residences.

publicly advertised rebate program

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

B. Residential ULFT Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	10000	20000
2. Actual Expenditures	10000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program run by CLWA on behalf of retailers

Reported as of 5/7/05

Accounts & Water Use

Reporting Unit Name:
Santa Clarita Water Division

Submitted to CUWCC
02/15/2005

Year:
2004

A. Service Area Population Information:

1. Total service area population 85300

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	22404	16922	0	0
2. Multi-Family	4351	2538	0	0
3. Commercial	627	917	0	0
4. Industrial	19	127	0	0
5. Institutional	97	790	0	0
6. Dedicated Irrigation	773	4828	0	0
7. Recycled Water	0	0	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	0	NA	0
Total	28271	26122	0	0
	Metered		**Unmetered**	

Reported as of 5/7/05

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Based on your signed MOU date, 02/07/2001, your Agency STRATEGY DUE DATE is:	02/07/2003
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	

B. Water Survey Data

Survey Counts:	Single Family Accounts	Multi-Family Units
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	no	no
a. If yes, in what form are surveys tracked?		None

b. Describe how your agency tracks this information.

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Waiting on BMP revision before beginning implementation.

Reported as of 5/7/05

BMP 02: Residential Plumbing Retrofit

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? no

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? no

3. Estimated percent of single-family households with low-flow showerheads: %

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? no

5. Estimated percent of multi-family households with low-flow showerheads: %

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? yes

   a. If YES, when did your agency begin implementing this strategy? 5/12/2002

   b. Describe your targeting/ marketing strategy.

   Newspaper ads, flyers and newsletter notifications of distrbution events.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	41	3
3. Number of toilet-displacement devices distributed:	0	0
4. Number of toilet flappers distributed:	0	0
5. Number of faucet aerators distributed:	25	10

6. Does your agency track the distribution and cost of low-flow devices? yes

   a. If YES, in what format are low-flow devices tracked? Manual Activity

   b. If yes, describe your tracking and distribution system :

   Keep records of which account addresses received low-flow devices.

C. Low-Flow Device Distribution Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0

2. Actual Expenditures 0

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

All funding provided by CLWA on behalf of retailers.

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	yes
a. If yes, describe the leak detection program:	
Visual inpsections/response to customers.	

B. Survey Data

1. Total number of miles of distribution system line.	299
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

Reported as of 5/7/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use?	yes
2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use?	no
a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed?	
b. Describe the program:	
3. Number of previously unmetered accounts fitted with meters during report year.	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	
b. Describe the feasibility study:	
2. Number of CII accounts with mixed-use meters.	715
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

All connections are metered.

Reported as of 5/7/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	773
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	
b. Description of marketing / targeting strategy:	
2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve	no

landscape water use efficiency?

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates			
b. Loans			
c. Grants			

5. Do you provide landscape water use efficiency information to new customers and customers changing services? yes

a. If YES, describe below:

Information and training provided by Castaic Lake WA

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? no

8. Do you provide customer notices at the end of the irrigation season? no

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

F. Comments

Reported as of 5/7/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? — no

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers? — no
3. What is the level of the rebate? — 0
4. Number of rebates awarded. — 0

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — no

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? no

a. If YES, describe the program and how it's organized.

CLWA as wholesaler runs program for retailers. See CLWA form.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	no	
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	no	
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	no	
f. Special Events, Media Events	no	
g. Speaker's Bureau	no	
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program provided by Castaic Lake WA.

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? no

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd				
Grades 4th-6th				
Grades 7th-8th				
High School				

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program?

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program provided by CLWA on behalf of retailers.

Reported as of 5/7/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option?	no

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered			
b. Number of New Surveys Completed			
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)			
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)			

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	no		no
f. Evaluation of all water-using apparatus and processes	no	no	no
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	no	no	no

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	no
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Not implementing BMP.

Reported as of 5/7/05

BMP 09a: CII ULFT Water Savings

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

1. Did your agency implement a CII ULFT replacement program in the reporting year? If No, please explain why on Line B. 10. — No

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

2. How does your agency advertise this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.)

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency?

3. What is the total number of customer accounts participating in the program during the last year ?

CII Subsector	Number of Toilets Replaced			
4.	**Standard Gravity Tank**	**Air Assisted**	**Valve Floor Mount**	**Valve Wall Mount**
a. Offices				
b. Retail / Wholesale				
c. Hotels				
d. Health				
e. Industrial				
f. Schools: K to 12				
g. Eating				
h. Govern-ment				
i. Churches				
j. Other				

5. Program design.

6. Does your agency use outside services to implement this program?

a. If yes, check all that apply.

7. Participant tracking and follow-up.

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business

b. Inadequate payback

c. Inadequate ULFT performance

d. Lack of funding

e. American's with Disabilities Act

f. Permitting

g. Other. Please describe in B. 9.

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and budgeting?

Not implementing BMP.

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor		
b. Materials		
c. Marketing & Advertising		
d. Administration & Overhead		
e. Outside Services		
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution	
b. State agency contribution	
c. Federal agency contribution	
d. Other contribution	
e. Total	0

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$8082631
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3716432
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$374628
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$166423
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$52330
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$12265
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$339935
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$57314
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$2072553
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$299384
6. Other	
a. Water Rate Structure	Service Not Provided

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$0
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$0

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

CII revenues are combined and shown in Commercial

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator? no
2. Is this a full-time position? no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ? yes
4. Partner agency's name: Castaic Lake WA
5. If your agency supplies the conservation coordinator:
   - a. What percent is this conservation coordinator's position? %
   - b. Coordinator's Name
   - c. Coordinator's Title
   - d. Coordinator's Experience and Number of Years
   - e. Date Coordinator's position was created (mm/dd/yyyy)
6. Number of conservation staff, including Conservation Coordinator. 0

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no
   - a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? — no

   a. If YES, describe the ordinance:

2. Is a copy of the most current ordinance(s) on file with CUWCC? — no

   a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

   a. Gutter flooding — no

   b. Single-pass cooling systems for new connections — no

   c. Non-recirculating systems in all new conveyor or car wash systems — no

   d. Non-recirculating systems in all new commercial laundry systems — no

   e. Non-recirculating systems in all new decorative fountains — no

   f. Other, please name — no

2. Describe measures that prohibit water uses listed above:

   Recirculating systems required in all car washes and fountains (city/san district ordinance).

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

   a. Allow the sale of more efficient, demand-initiated regenerating DIR models. — no

   b. Develop minimum appliance efficiency standards that:

      i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. — no

      ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. — no

   c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. — no

4. Does your agency include water softener checks in home water audit programs? — no

5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models? no

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Agency supported San District water softener ban ordinance adopted in 2003.

Reported as of 5/7/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Santa Clarita Water Division	**100% Complete**	**2004**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	125	10
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**125**	**10**

6. Describe your agency's ULFT program for single-family residences.

publicly advertised rebate program

7. Describe your agency's ULFT program for multi-family residences.

publicly advertised rebate program

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

B. Residential ULFT Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	20000	20000
2. Actual Expenditures	20000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program run by CLWA on behalf of retailers

CUWCC

Best Management Practices Report Filing

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Logout

Memorandum of Understanding

Base Year Data

Reporting Unit: **Valencia Water Company**	**Submitted to CUWCC** 04/19/2003

INSTRUCTIONS: This form MUST BE completed and submitted to the CUWCC prior to filing any BMP reports. The data provided on this form is used in determining coverage requirements for specific BMPs as indicated. If some of the data requested is not available, make reasonable estimates. You can update and edit values, if more precise information becomes available in the future.

For Customer Classification Definitions (i.e. Single Family, Multi-Family) click HERE.

	1. Your **BASE YEAR is 2001.** NOTE: Many calculations in determining credit history and coverage requirements are contingent on your BASE YEAR, which is calculated based on the following criteria. If a Signatory signed the MOU in 1997 or earlier, then the Base Year is 1997. If a Signatory signed the MOU after 1997, then the Base Year is the year the MOU was signed. The same holds true for USBR Contractors, except the date their Base Year is calculated from is the date that their Plan was noticed in the Federal Register.	
	BMP 1	
	2. Number of single-family customers in 2001	19565
	3. Number of multi-family units in 2001	219
	BMPs 2 and 14	
	4. Number of single-family housing units constructed prior to 1992	12871
	5. Number of multi-family units prior to 1992	152
	BMP 4	
	6. Number of unmetered accounts in 2001	0
	BMPs 5 and 9	
	7. Number of commercial accounts in 2001	567
	8. Number of industrial accounts in 2001	901
	9. Number of institutional accounts in 2001	52
	10. Total water use (AF) by commercial, industrial and institutional accounts in 2001	6650
	BMP 14	
	11. Average number of toilets per single-family household	2
	12. Average number of toilets per multi-family household	2
	13. Five-year average resale rate of single-family households	8.6

	14. Five-year average resale rate of multi-family households	8.9
	15. Average persons per single-family household	3.3
	16. Average persons per multi-family household	3.3

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Webmaster

Reported as of 5/7/05

Accounts & Water Use

Reporting Unit Name:
Valencia Water Company

Submitted to CUWCC
02/15/2005

Year:
2003

A. Service Area Population Information:

1. Total service area population 89000

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	23365	14191	0	0
2. Multi-Family	277	1186	0	0
3. Commercial	854	5110	0	0
4. Industrial	441	1825	0	0
5. Institutional	59	1101	0	0
6. Dedicated Irrigation	400	2952	0	0
7. Recycled Water	1	96	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	0	NA	0
Total	25397	26461	0	0
	Metered		**Unmetered**	

Reported as of 5/7/05

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Based on your signed MOU date, 02/07/2001, your Agency STRATEGY DUE DATE is:	02/07/2003
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	

B. Water Survey Data

Survey Counts:	**Single Family Accounts**	**Multi-Family Units**
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	no	no
a. If yes, in what form are surveys tracked?		None

b. Describe how your agency tracks this information.

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

waiting on BMP revision

Reported as of 5/7/05

BMP 02: Residential Plumbing Retrofit

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? — no

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? — no

3. Estimated percent of single-family households with low-flow showerheads: — %

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? — no

5. Estimated percent of multi-family households with low-flow showerheads: — %

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? — yes

   a. If YES, when did your agency begin implementing this strategy? — 5/12/2002

   b. Describe your targeting/ marketing strategy.

   Distribution at public events, paid advertising.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	25	6
3. Number of toilet-displacement devices distributed:	0	0
4. Number of toilet flappers distributed:	0	0
5. Number of faucet aerators distributed:	30	5

6. Does your agency track the distribution and cost of low-flow devices? — yes

   a. If YES, in what format are low-flow devices tracked? — Database

   b. If yes, describe your tracking and distribution system :

   Names and address of recipient.

C. Low-Flow Device Distribution Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0

2. Actual Expenditures 0

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

CLWA provides program and funding on behalf of retailers.

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	yes
4. Did your agency complete a full-scale audit during this report year?	yes
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	yes
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	310
2. Number of miles of distribution system line surveyed.	310

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	yes
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	
see 2002 explanation	

E. Comments

Reported as of 5/7/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use?	yes
2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use?	no
a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed?	
b. Describe the program:	
3. Number of previously unmetered accounts fitted with meters during report year.	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	
b. Describe the feasibility study:	
2. Number of CII accounts with mixed-use meters.	0
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

All connections are metered.

Reported as of 5/7/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit: **Valencia Water Company**

BMP Form Status: **100% Complete**

Year: **2003**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	400
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	
b. Description of marketing / targeting strategy:	
2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve	no

landscape water use efficiency?

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates	0	0	0
b. Loans	0	0	0
c. Grants	0	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services? No

a. If YES, describe below:

CLWA provides training and information on behalf of retailers

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? no

8. Do you provide customer notices at the end of the irrigation season? no

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

F. Comments

Reported as of 5/7/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? — no

    a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers? — no

3. What is the level of the rebate?

4. Number of rebates awarded.

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — no

    a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

Newlsetters, bill inserts, website, coordination with wholesaler.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	3
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	yes	4
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	2
f. Special Events, Media Events	yes	3
g. Speaker's Bureau	no	
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Coordinate public outreach with CLWA programs/part of CLWA budget

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? no

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd				
Grades 4th-6th				
Grades 7th-8th				
High School				

3. Did your Agency's materials meet state education framework requirements? no

4. When did your Agency begin implementing this program?

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program is run by CLWA on behalf of retailers

Reported as of 5/7/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? yes

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	16	4	4
b. Number of New Surveys Completed	12	2	4
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	0	0	0
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	0	0	0

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	yes	yes	yes
f. Evaluation of all water-using apparatus and processes	yes	yes	yes
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	yes	yes	yes

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	no
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	0
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	40000	45000
2. Actual Expenditures	40000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Operating a pilot survey program while waiting on BMP revision.

Reported as of 5/7/05

BMP 09a: CII ULFT Water Savings

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

1. Did your agency implement a CII ULFT replacement program in the reporting year? No

If No, please explain why on Line B. 10.

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program?
Check all that apply.

a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

2. How does your agency advertise this program? Check all that apply.

a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.)

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency?

3. What is the total number of customer accounts participating in the program during the last year ?

CII Subsector	Number of Toilets Replaced			
4.	**Standard Gravity Tank**	**Air Assisted**	**Valve Floor Mount**	**Valve Wall Mount**
a. Offices				
b. Retail / Wholesale				
c. Hotels				
d. Health				
e. Industrial				
f. Schools: K to 12				
g. Eating				
h. Govern-ment				
i. Churches				
j. Other				

5. Program design.

6. Does your agency use outside services to implement this program?

a. If yes, check all that apply.

7. Participant tracking and follow-up.

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business

b. Inadequate payback

c. Inadequate ULFT performance

d. Lack of funding

e. American's with Disabilities Act

f. Permitting

g. Other. Please describe in B. 9.

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and budgeting?

ULFTs are part of a pilot CII survey program. Seemed well-accepted by those entities that accepted surveys

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor		
b. Materials		
c. Marketing & Advertising		
d. Administration & Overhead		
e. Outside Services		
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution

b. State agency contribution

c. Federal agency contribution

d. Other contribution

e. Total	0

D. Comments

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$5886000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3181000
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1984000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$468000
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$708000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$262000
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$426000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$426000
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1152000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$238000
6. Other	
a. Water Rate Structure	Uniform

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$33000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$1000

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

"Other" is recycled water service initiated in 2003.

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator?	no
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Castaic Lake WA
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	%
b. Coordinator's Name	
c. Coordinator's Title	
d. Coordinator's Experience and Number of Years	
e. Date Coordinator's position was created (mm/dd/yyyy)	
6. Number of conservation staff, including Conservation Coordinator.	2

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

D. Comments

Reported as of 5/7/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? — no

   a. If YES, describe the ordinance:

2. Is a copy of the most current ordinance(s) on file with CUWCC? — no

   a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

   a. Gutter flooding — no

   b. Single-pass cooling systems for new connections — no

   c. Non-recirculating systems in all new conveyor or car wash systems — yes

   d. Non-recirculating systems in all new commercial laundry systems — no

   e. Non-recirculating systems in all new decorative fountains — yes

   f. Other, please name — no

2. Describe measures that prohibit water uses listed above:

   Local planning rules.

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

   a. Allow the sale of more efficient, demand-initiated regenerating DIR models. — yes

   b. Develop minimum appliance efficiency standards that:

      i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. — yes

      ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. — yes

   c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. — yes

4. Does your agency include water softener checks in home water audit programs? — no

5. Does your agency include information about DIR and exchange-

type water softeners in educational efforts to encourage replacement of less efficient timer models? no

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Reported as of 5/7/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2003**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	40	7
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**40**	**7**

6. Describe your agency's ULFT program for single-family residences.

publicly-advertised rebate program

7. Describe your agency's ULFT program for multi-family residences.

publicly-advertised rebate program

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

B. Residential ULFT Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	10000	20000
2. Actual Expenditures	10000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program run by CLWA on behalf of retailers

Reported as of 5/7/05

Water Supply & Reuse

Reporting Unit:

Year:
2004

Water Supply Source Information

Supply Source Name	Quantity (AF) Supplied	Supply Type

Total AF:

Reported as of 5/7/05

Accounts & Water Use

Reporting Unit Name:
Valencia Water Company

Submitted to CUWCC
02/15/2005

Year:
2004

A. Service Area Population Information:

1. Total service area population 93000

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	24297	15522	0	0
2. Multi-Family	293	1288	0	0
3. Commercial	928	5827	0	0
4. Industrial	442	1957	0	0
5. Institutional	63	928	0	0
6. Dedicated Irrigation	405	3193	0	0
7. Recycled Water	8	420	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	0	NA	0
Total	26436	29135	0	0
	Metered		**Unmetered**	

Reported as of 5/7/05

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Based on your signed MOU date, 02/07/2001, your Agency STRATEGY DUE DATE is:	02/07/2003
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	

B. Water Survey Data

Survey Counts:	**Single Family Accounts**	**Multi-Family Units**
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	no	no
a. If yes, in what form are surveys tracked?		None

b. Describe how your agency tracks this information.

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

waiting on BMP revision

Reported as of 5/7/05

BMP 02: Residential Plumbing Retrofit

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? — no

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? — no

3. Estimated percent of single-family households with low-flow showerheads: — %

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? — no

5. Estimated percent of multi-family households with low-flow showerheads: — %

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? — yes

   a. If YES, when did your agency begin implementing this strategy? — 5/12/2002

   b. Describe your targeting/ marketing strategy.

   Distribution at public events, paid advertising.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	20	5
3. Number of toilet-displacement devices distributed:	0	0
4. Number of toilet flappers distributed:	0	0
5. Number of faucet aerators distributed:	25	5

6. Does your agency track the distribution and cost of low-flow devices? — yes

   a. If YES, in what format are low-flow devices tracked? — Database

   b. If yes, describe your tracking and distribution system :

   Names and address of recipient.

C. Low-Flow Device Distribution Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0

2. Actual Expenditures 0

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

CLWA provides program and funding on behalf of retailers.

Reported as of 5/7/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	yes
4. Did your agency complete a full-scale audit during this report year?	yes
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	yes
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	323
2. Number of miles of distribution system line surveyed.	323

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	yes
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	
see 2002 explanation	

E. Comments

Reported as of 5/7/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use?	yes
2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use?	no
a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed?	
b. Describe the program:	
3. Number of previously unmetered accounts fitted with meters during report year.	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	
b. Describe the feasibility study:	
2. Number of CII accounts with mixed-use meters.	0
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

Reported as of 5/7/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit: **Valencia Water Company**

BMP Form Status: **100% Complete**

Year: **2004**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	1119
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	
b. Description of marketing / targeting strategy:	
2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve	no

landscape water use efficiency?

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates	0	0	0
b. Loans	0	0	0
c. Grants	0	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services? No

a. If YES, describe below:

CLWA provides training on behalf of retailers

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? no

8. Do you provide customer notices at the end of the irrigation season? no

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

F. Comments

Reported as of 5/7/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? — no

    a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers? — no

3. What is the level of the rebate?

4. Number of rebates awarded.

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — no

    a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 5/7/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

Newlsetters, bill inserts, website, coordination with wholesaler.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	3
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	yes	4
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	2
f. Special Events, Media Events	yes	3
g. Speaker's Bureau	no	
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Coordinate public outreach with CLWA programs/part of CLWA budget

Reported as of 5/7/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? no

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd				
Grades 4th-6th				
Grades 7th-8th				
High School				

3. Did your Agency's materials meet state education framework requirements? no

4. When did your Agency begin implementing this program?

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program is run by CLWA on behalf of retailers

Reported as of 5/7/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? yes

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	7	3	0
b. Number of New Surveys Completed	7	3	0
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	0	0	0
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	0	0	0

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	yes	yes	yes
f. Evaluation of all water-using apparatus and processes	yes	yes	yes
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	yes	yes	yes

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	no
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	0
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	40000	40000
2. Actual Expenditures	45000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Operating a pilot survey prorgam while waiting on BMP revision.

Reported as of 5/7/05

BMP 09a: CII ULFT Water Savings

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

1. Did your agency implement a CII ULFT replacement program in the reporting year? If No, please explain why on Line B. 10. — No

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

2. How does your agency advertise this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.)

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency?

3. What is the total number of customer accounts participating in the program during the last year ?

CII Subsector	Number of Toilets Replaced			
4.	Standard Gravity Tank	Air Assisted	Valve Floor Mount	Valve Wall Mount
a. Offices				
b. Retail / Wholesale				
c. Hotels				
d. Health				
e. Industrial				
f. Schools: K to 12				
g. Eating				
h. Govern-ment				
i. Churches				
j. Other				

5. Program design.

6. Does your agency use outside services to implement this program?

a. If yes, check all that apply.

7. Participant tracking and follow-up.

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business

b. Inadequate payback

c. Inadequate ULFT performance

d. Lack of funding

e. American's with Disabilities Act

f. Permitting

g. Other. Please describe in B. 9.

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and budgeting?

ULFTs are part of a pilot CII survey program. Seemed well-accepted by those entities that accepted surveys

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor		
b. Materials		
c. Marketing & Advertising		
d. Administration & Overhead		
e. Outside Services		
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution

b. State agency contribution

c. Federal agency contribution

d. Other contribution

e. Total	0

D. Comments

Reported as of 5/7/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$6504000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3190000
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$2420000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$489000
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$813000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$245000
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$385000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$58000
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1331000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$231000
6. Other	
a. Water Rate Structure	Service Not Provided

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$143000
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$7000

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

"Other" is recycled water

Reported as of 5/7/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator?	no
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Castaic Lake WA
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	%
b. Coordinator's Name	
c. Coordinator's Title	
d. Coordinator's Experience and Number of Years	
e. Date Coordinator's position was created (mm/dd/yyyy)	
6. Number of conservation staff, including Conservation Coordinator.	2

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

D. Comments

Reported as of 5/7/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? — no

   a. If YES, describe the ordinance:

2. Is a copy of the most current ordinance(s) on file with CUWCC? — no

   a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

   a. Gutter flooding — no

   b. Single-pass cooling systems for new connections — no

   c. Non-recirculating systems in all new conveyor or car wash systems — yes

   d. Non-recirculating systems in all new commercial laundry systems — no

   e. Non-recirculating systems in all new decorative fountains — yes

   f. Other, please name — no

2. Describe measures that prohibit water uses listed above:

   Local planning rules.

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

   a. Allow the sale of more efficient, demand-initiated regenerating DIR models. — yes

   b. Develop minimum appliance efficiency standards that:

      i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. — yes

      ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. — yes

   c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. — yes

4. Does your agency include water softener checks in home water audit programs? — no

5. Does your agency include information about DIR and exchange-

type water softeners in educational efforts to encourage replacement of less efficient timer models? no

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Reported as of 5/7/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Valencia Water Company	**100% Complete**	**2004**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	90	4
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**90**	**4**

6. Describe your agency's ULFT program for single-family residences.

publicly-advertised rebate program

7. Describe your agency's ULFT program for multi-family residences.

publicly-advertised rebate program

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

B. Residential ULFT Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	20000	20000
2. Actual Expenditures	20000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Program run by CLWA on behalf of retailers

CUWCC

Best Management Practices Report Filing

Base Year Data

Reporting Unit: **Newhall County Water District**	**Submitted to CUWCC** 08/21/2003

INSTRUCTIONS: This form MUST BE completed and submitted to the CUWCC prior to filing any BMP reports. The data provided on this form is used in determining coverage requirements for specific BMPs as indicated. If some of the data requested is not available, make reasonable estimates. You can update and edit values, if more precise information becomes available in the future.

For Customer Classification Definitions (i.e. Single Family, Multi-Family) click HERE.

	1. Your **BASE YEAR is 2002.** NOTE: Many calculations in determining credit history and coverage requirements are contingent on your BASE YEAR, which is calculated based on the following criteria. If a Signatory signed the MOU in 1997 or earlier, then the Base Year is 1997. If a Signatory signed the MOU after 1997, then the Base Year is the year the MOU was signed. The same holds true for USBR Contractors, except the date their Base Year is calculated from is the date that their Plan was noticed in the Federal Register.	
	BMP 1	
	2. Number of single-family customers in 2002	6662
	3. Number of multi-family units in 2002	4812
	BMPs 2 and 14	
	4. Number of single-family housing units constructed prior to 1992	5522
	5. Number of multi-family units prior to 1992	4756
	BMP 4	
	6. Number of unmetered accounts in 2002	0
	BMPs 5 and 9	
	7. Number of commercial accounts in 2002	323
	8. Number of industrial accounts in 2002	8
	9. Number of institutional accounts in 2002	71
	10. Total water use (AF) by commercial, industrial and institutional accounts in 2002	2289.66
	BMP 14	
	11. Average number of toilets per single-family household	2.5
	12. Average number of toilets per multi-family household	1.2
	13. Five-year average resale rate of single-family households	4.46

	14. Five-year average resale rate of multi-family households	9.02
	15. Average persons per single-family household	3.35
	16. Average persons per multi-family household	2.51

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Accounts & Water Use

Reporting Unit Name:	Submitted to	Year:
Newhall County Water District	CUWCC **11/30/2004**	**2003**

A. Service Area Population Information:

1. Total service area population 32000

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	6807	5687	0	0
2. Multi-Family	384	1803	0	0
3. Commercial	267	562	0	0
4. Industrial	7	76	0	0
5. Institutional	64	632	0	0
6. Dedicated Irrigation	70	945	0	0
7. Recycled Water	0	0	0	0
8. Other	72	130.4	0	0
9. Unaccounted	NA	21.55	NA	12.48
Total	7671	9856.95	0	12.48
	Metered		**Unmetered**	

Accounts & Water Use

Reporting Unit Name:	Submitted to	Year:
Newhall County Water District	CUWCC **11/30/2004**	**2004**

A. Service Area Population Information:

1. Total service area population 35000

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	7544	6054	0	0
2. Multi-Family	367	1682	0	0
3. Commercial	283	524	0	0
4. Industrial	7	116	0	0
5. Institutional	63	613	0	0
6. Dedicated Irrigation	77	1457	0	0
7. Recycled Water	0	0	0	0
8. Other	81	54	0	0
9. Unaccounted	NA	6.62	NA	826.23
Total	8422	10506.62	0	826.23
	Metered		**Unmetered**	

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Based on your signed MOU date, 03/05/2002, your Agency STRATEGY DUE DATE is:	03/04/2004
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	N/A
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	N/A

B. Water Survey Data

Survey Counts:	Single Family Accounts	Multi-Family Units
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	no	no
a. If yes, in what form are surveys tracked?		None

b. Describe how your agency tracks this information.

NCWD did not have a residential survey program from 7/2002 - 6/2003. However, in Fiscal Year 2002/2003 NCWD updated their database system

to Inhance which allowed for customer service to more easily identify and log customers based on their class code. Single-family and multi-family customers were classified in separate classes and homeowner association accounts, neighborhood recreation facilities, and other common irrigated areas were coded as landscape for future BMP 5 programs. The Inhance system also allowed NCWD to electronically sort residential customers by parcel groupings or books. From the listed books/groups, Customer Service was able to calculate the estimated number of single and multi-family dwelling units built before 1992. This data information can then be used for the development and marketing BMP 2 (Residential Plumbing Retrofit) and 14 (ULFT Rebate Program).

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

NCWD signed the MOU in 3/2002 and therefore was not required to implement a Residential Water Use Survey Program until 7/2003 which is the start of the 2004 reporting period. Although a residential water use survey program was not implemented in FY 2002/03, NCWD offered residential customers informative material and guidebooks to help them identify water waste or inefficiency and how they could conserve. All new residential customers were given Conservation Packets with information on water conservation for indoor and outdoor residential water usage. These packets included irrigation and gardening guidebooks (Sunset Magazine), 55 Quick Tips, recommendations to identify and prevent leaks, how to complete a self audit of your home, and other useful pamphlets and material.

Reported as of 5/18/05

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Based on your signed MOU date, 03/05/2002, your Agency STRATEGY DUE DATE is:	03/04/2004
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	N/A
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	no
a. If YES, when was it implemented?	N/A

B. Water Survey Data

Survey Counts:	Single Family Accounts	Multi-Family Units
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	no	no
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	no	no
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	no	no
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	yes	yes
a. If yes, in what form are surveys tracked?		database

b. Describe how your agency tracks this information.

A tracking system for monitoring participation in BMP 1 and other programs was created in NCWD's Inhance database in 2002/03 which is

connected to the customer service and billing database. In 2003/04, NCWDÌs Customer Service staff began connecting the BMP data to the district's GIS mapping software. With the GIS, NCWD is able to map out pre and post 1992 residential accounts so that the district could have additional information such as lot size, topographic conditions and other issues essential to identify ideal customers for a residential survey program. Furthermore, a new detailed BMP data section was added to the Inhance system to log customer participation in each of the BMP programs including residential surveys. Combining the new BMP data section and the GIS capabilities, NCWD was able to determine trends in customer behavior/participation so that BMP 1 and other programs can be better marketed and implemented. Specific data and information related to BMP 1 is also tracked in an excel database.

C. Water Survey Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

NCWD filed a late exemption in November 2004 for the District's first year (2003/04 reporting period) for implementing BMP 1. NCWD did not have the staff or budgeted funds to implement a residential survey program. NCWD has begun development of a pilot survey program in late FY 2003/04 to evaluate the effectiveness (resulting water savings and cost savings achieved) of a district managed residential survey program. The pilot survey program is expected to begin in 2005. After the completion of 30-50 surveys and post-survey monitoring and assessments, NCWD will determine the most cost-effective method for reducing residential water usage out of the listed options below: 1. In-house (staff operated and maintained) survey program. 2. Outsourced (to outside consulting firm) large scale residential survey program. 3. Valley-wide survey program (with other local retailers and CLWA assistance). 4. Discontinuation of any and all residential survey programs. Although a residential water use survey program was not implemented in FY 2003/04, NCWD continued to offer residential customers informative material and guidebooks to help them identify water waste or inefficiency and how they could conserve. All new residential customers were given Conservation Packets with information on water conservation for indoor and outdoor residential water usage. These packets included irrigation and gardening guidebooks (Sunset Magazine), 55 Quick Tips, recommendations to identify and prevent leaks, how to complete a self audit of your home, and other useful pamphlets and material.

Reported as of 5/18/05

BMP 02: Residential Plumbing Retrofit

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? no

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

   The City of Santa Clarita requires the replacement of high flow plumbing fixtures and devices in high stage drought conditions only. No other local ordinance or code requiring installation or retrofit of low flow plumbing devices (for residential customers) is in place for NCWDís service area in the Santa Clarita Valley. NCWD is creating a Water Use Efficiency Ordinance (effective 12/2004) with listed recommendations to be water efficient including the installation of low flow plumbing devices. NCWD is considering requiring that customers/residents follow these recommendations during a DWR declared drought.

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? no

3. Estimated percent of single-family households with low-flow showerheads: 1.3%

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? no

5. Estimated percent of multi-family households with low-flow showerheads: .15%

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

   N/A

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? yes

   a. If YES, when did your agency begin implementing this strategy? 01/01/2003

   b. Describe your targeting/ marketing strategy.

   Showerheads and aerators were provided by the wholesaler (CLWA) to give out to customers at local events (i.e. Open House, River Rally, Emergency Expo). The program was mainly marketed by CLWA; however NCWD advertised the program in the quarterly newsletter and at the front office desk. In 2003/04 NCWD expanded the BMP 2 program to also include all pre-1992 multi-family homes in addition to the (pre-1992) single-family homes. This includes several mobile home parks and small apartment buildings built prior to 1992. Customers were allocated up to 4 devices per household unless they could prove additional low flow devices were necessary.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	21	4
3. Number of toilet-displacement devices distributed:	0	0
4. Number of toilet flappers distributed:	0	0
5. Number of faucet aerators distributed:	29	27

6. Does your agency track the distribution and cost of low-flow devices? yes

a. If YES, in what format are low-flow devices tracked? Database

b. If yes, describe your tracking and distribution system :

In 2003/04 NCWD staff added data box in the customer service and billing database (Inhance) in order to accurately track customer participation. BMP participation was categorized by program and tracked based on the status or level of a customer's participation as follows: 1. Call or email of interest 2. Received Application Form (for rebate programs) 3. Participated in designated BMP program (example: received showerhead) 4. Customer on waiting list 5. Post program follow up completed For BMP 2, each low flow device (i.e. showerheads, faucet aerators and garden hose spray nozzles) was tracked as well. Using the database, NCWD was able to map the distribution of participation throughout the four service areas and easily identify patterns and trends. For example, participation in BMP 2 was clumped in neighborhoods most likely due to communication between neighbors regarding the programs.

C. Low-Flow Device Distribution Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	2228.4	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

In June of 2/004, NCWD offered the free devices to both single and multi-family customers to increase distribution and meet the requirements of BMP 2. NCWD also started providing the low flow devices to customers at the district's front office rather than strictly at public events. The estimated expenditures are for approximately 60 hours of staff time invested at $37.14/hour. Staff hours includes the time necessary to created the tracking database and maps, coordinating with CLWA, assisting customers, stocking front office inventory, and logging customer participation.

Reported as of 5/18/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year? yes

2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:

   a. Determine metered sales (AF) 9840.96

   b. Determine other system verifiable uses (AF) 0

   c. Determine total supply into the system (AF) 9869.43

   d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required. 1.00

3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production? yes

4. Did your agency complete a full-scale audit during this report year? no

5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit? no

6. Does your agency operate a system leak detection program? no

   a. If yes, describe the leak detection program:

   Although NCWD does not have a proactive leak detection program, the district monitors key data to quickly identify leaks and other necessary repairs in the distribution system. Monthly records of total water purchased from CLWA and water supply obtained through district wells (groundwater), as well as the total water sales and other verifiable usage for all 4 service areas is logged. The percent water loss is tracked to determine potential leaks or system misreads throughout the 4 service areas. The total (annual) water loss for the entire district averages around 7.5 to 9.0 percent.

B. Survey Data

1. Total number of miles of distribution system line. 134.93

2. Number of miles of distribution system line surveyed. 0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	500000	382.343
2. Actual Expenditures	567444.49	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

   N/A

E. Comments

The listed budget and expenditures [Section C (1,2)] include all maintenance, leak and general repairs, upgrades and replacement of the distribution system in the four service areas. NCWD investigates

potential leaks and system damages as needed and monitors the collected data to detect major leaks and other irregularities in the system. The investigation of system leaks is classified under system maintenance in the 2002-03 Budget. A detailed breakdown of the budget and expenditures for Leak Detection, Repair and Distribution System Maintenance is attached (submitted separately to CUWCC).

Reported as of 5/18/05

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year? — no

2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:

a. Determine metered sales (AF)	10507.16
b. Determine other system verifiable uses (AF)	-4.04
c. Determine total supply into the system (AF)	11332.85
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.93

3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production? — yes

4. Did your agency complete a full-scale audit during this report year? — yes

5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit? — no

6. Does your agency operate a system leak detection program? — no

a. If yes, describe the leak detection program:

Refer to 2002-03 Submission

B. Survey Data

1. Total number of miles of distribution system line.	147.41
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	382343	500000
2. Actual Expenditures	358475.08	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

The listed budget and expenditures [Section C (1,2)] include all maintenance, leak and general repairs, upgrades and replacement of the distribution system in the four service areas. NCWD investigates potential leaks and system damages as needed and monitors the collected data to detect major leaks and other irregularities in the system. The investigation of system leaks is classified under system maintenance in the 2002-03 Budget. A detailed breakdown of the budget and expenditures for Leak Detection, Repair and Distribution System Maintenance is attached (submitted separately to CUWCC).

Reported as of 5/18/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use? yes

2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use? no

   a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed? Always Metered

   b. Describe the program:

   All existing accounts are metered and have been for several years. All new connections are required to install the appropriate size meter and type (i.e. CII mixed or dedication irrigation meter) as determined necessary by the district's engineering department and approved by management.

3. Number of previously unmetered accounts fitted with meters during report year. 0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters? no

   a. If YES, when was the feasibility study conducted? (mm/dd/yy) N/A

   b. Describe the feasibility study:

   N/A - NCWD has an "at least as effective" district policy to assess the benefits of installing a dedicated irrigation meter on a case by case basis [see Section D(b)].

2. Number of CII accounts with mixed-use meters. 341

3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period. 0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? yes

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

   NCWD meets the requirements under BMP 4 Sections A(a), C, and D as described in the BMP. A dedicated irrigation meter retrofit program [Section A(b)] and a feasibility study [Section a(c)] on the merits of an incentive program to switch mixed meters to dedicated landscape (irrigation) meters has not been completed. These two requirements have been meet through NCWD*s new water service connection policies and procedures. Currently, dedicated irrigation meters have been installed in all appropriate CII properties within the district and therefore there are no retrofit opportunities available. Like all CII and other meters, the dedicated irrigation meters are

billed based on monthly usage. The irrigation meters are also separately billed from a property*s main meter with a separate monthly service fee (based on the size of the meter), energy and water availability fees, and other standard monthly charges. Instead of a feasibility study to determine the potential merits of an incentive program, NCWD requires developers to install dedicated irrigation meters when appropriate (as determined by the district). NCWD evaluates the cost/benefits of installing a dedicated irrigation meter during a new projects* (or customer*s) water service application and installation process. The engineering staff work with the developer/customer to determine if a dedicated irrigation meter is necessary and will benefit the customer and the district to help conserve water. If the NCWD*s engineering department determines a dedicated irrigation meter is necessary, the developer/customer is required to install the separate meter and incur any related installation costs. As a result of these policies, NCWD has a significant number of dedicated irrigation meters in the CII sectors that will allow the district to better audit these accounts and establish water budgets (for BMP 5 requirements) to reduce district water usage.

E. Comments

NCWD has met the requirements stated under BMP 4 requiring meters for all existing and new customers. Furthermore, dedicated irrigation meters are installed at the time of initial service connection (when appropriate) to reduce water usage and minimize costs to the district and the customer. NCWD will assist any property owners in retrofitting their property with a dedicated irrigation meter if there is an increase in the landscape area(s) or other circumstance to constitute the need for a separate landscape/irrigation meter. However, NCWD does not offer any incentive for customers to retrofit and the associated installation costs are the responsibility of the customers.

Reported as of 5/18/05

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Does your agency require meters for all new connections and bill by volume-of-use? — yes

2. Does your agency have a program for retrofitting existing unmetered connections and bill by volume-of-use? — no

   a. If YES, when was the plan to retrofit and bill by volume-of-use existing unmetered connections completed? — N/A

   b. Describe the program:

   All existing accounts are metered and have been for several years. All new connections are required to install the appropriate size meter and type (i.e. CII mixed, residential, dedication irrigation meter, etc.) as determined necessary by the district's engineering department.

3. Number of previously unmetered accounts fitted with meters during report year. — 0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters? — no

   a. If YES, when was the feasibility study conducted? (mm/dd/yy) — N/ A

   b. Describe the feasibility study:

   N/A

2. Number of CII accounts with mixed-use meters. — 358

3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period. — 0

C. Meter Retrofit Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — yes

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

   N/A ñ NCWD has an "at least as effective" district policy to assess the benefits of installing a dedicated irrigation meter on a case by case basis [see Section D(a) 2002-03 submission].

E. Comments

NCWD continues to meet the requirements under BMP 4 Sections A(a), C, D as described in the BMP, as well as Section A(b) (retrofit program) and Section A(c) (feasibility study) under the district*s úat least as effectiveî program in place. These two requirements are met through NCWD*s new water service connection policies and procedures. The incentives of installing a dedicated irrigation meter are evaluated during the initial service application process for each individual service application.

Dedicated irrigation meters are installed in all appropriate CII properties during the initial service connection to minimize retrofit costs to the district and the customer (refer to BMP 4 2002-03 Comment submission).

Reported as of 5/18/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	118
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	N/A
b. Description of marketing / targeting strategy:	

N/A

2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	

N/A

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	no
4. Does your agency offer financial incentives to improve landscape water use efficiency?	no

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded

a. Rebates	0	0	0
b. Loans	0	0	0
c. Grants	0	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services? yes

a. If YES, describe below:

NCWD offers basic landscape design manuals (published by AWWA) to help customers incorporate native and drought tolerant plants with consideration to the unique conditions found in the Santa Clarita Valley. Information on efficient gardening is also provided to children in the Culver and AWWA published coloring and activity books provided to customers at events and the NCWD office. The local water wholesaler (CLWA) also provides NCWD and the other local retailers with several sources and opportunities for all customers to learn more about water efficient landscape irrigation. Residents and businesses in the valley have access to an extensive list of plants and key information on planting and maintaining the recommended species on CLWAls website. CLWA also offers training courses to all Santa Clarita Valley residents (including NCWD customers), gardeners and business owners on creating and maintaining a water efficient landscape. Classes include organic gardening, drip irrigation, native and drought tolerant plants, among other classes available. NCWD further promotes water efficient landscape design and irrigation through newsletter articles, local newspaper articles and through the districtls Ordinance 101 (Water Conservation) that lists recommended watering hours and outdoor (and indoor) water wasting activities.

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? yes

8. Do you provide customer notices at the end of the irrigation season? yes

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

F. Comments

There are no listed expenditures for BMP 5 for 2002/03 since any costs for landscape /irrigation educational material and guidebooks were included in expenditures for BMP 7 (Public Information Programs). Estimated expenditures specifically for educational material on water efficient landscape/irrigation are approximately $400 ordered from AWWA. Staff hours and miscellaneous costs are also calculated under BMP 7. NCWD signed the MOU in 3/2002 and therefore was not

required to implement a Landscape Survey Program until 7/2004 which is the start of the 2005 reporting period.

Reported as of 5/18/05

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	133
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	0
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	no

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	no
a. If YES, when did your agency begin implementing this strategy?	N/A
b. Description of marketing / targeting strategy:	
N/A	
2. Number of Surveys Offered.	0
3. Number of Surveys Completed.	0
4. Indicate which of the following Landscape Elements are part of your survey:	
a. Irrigation System Check	no
b. Distribution Uniformity Analysis	no
c. Review / Develop Irrigation Schedules	no
d. Measure Landscape Area	no
e. Measure Total Irrigable Area	no
f. Provide Customer Report / Information	no
5. Do you track survey offers and results?	no
6. Does your agency provide follow-up surveys for previously completed surveys?	no
a. If YES, describe below:	
N/A	

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve landscape water use efficiency?	no

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded

a. Rebates	0	0	0
b. Loans	0	0	0
c. Grants	0	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services? yes

a. If YES, describe below:

In 2003/04 NCWD expanded its library of water conservation information and resources to include more landscape and irrigation guidebooks, references and other helpful material for customers. The District provided the Sunset Magazine series to all new homeowners and made them available to customers attending public events and to customers at the NCWD office. The Sunset magazine series included; ìSmart Water & Energy Use in the West,î ìHow to Water Your Garden,î and ìWater-Wise Gardening for California.î NCWD also offers basic landscape design manuals (published by AWWA) to help customers incorporate native and drought tolerant plants with consideration to the unique conditions found in the Santa Clarita Valley. Information on efficient gardening is also provided to children in the Culver and AWWA published coloring and activity books provided to customers at events and the NCWD office. The local wholesaler (CLWA) continues to provide a list of native and drought tolerant vegetation on their website and offer various courses on water efficient landscape design and irrigation. The resources provided by CLWA are available to all NCWD customers and other residents of the Santa Clarita Valley. NCWD will continue to expand its efforts to promote water efficient landscape and irrigation practices throughout the district. At the end of 2003/04, The Engineering and Conservation Department began applying customer data to the districtís GIS mapping system to start gathering necessary information and data to establish water budgets. The information will also help the district in identify ideal candidates for landscape surveys and/or water budgets based on their lot size, location, topographic features and water usage history.

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? yes

8. Do you provide customer notices at the end of the irrigation season? yes

D. Landscape Conservation Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

E. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

F. Comments

There are no listed expenditures for BMP 5 for 2002/03 since any costs for landscape /irrigation educational material and guidebooks was included in expenditures for BMP 7 (Public Information Programs). Estimated expenditures specifically for educational material on water

efficient landscape/irrigation are $2,343.30 for the 3 Sunset Magazine guidebooks, and approximately $1,500 to $2,000 for various education materials from AWWA and the Culver Company. Staff hours and miscellaneous costs are also calculated under BMP 7. NCWD is investigating installing a CIMIS weather station for district customers to use to obtain accurate (local) ET values to improve the efficiency of their irrigation systems. The district will be increasing its efforts to promote water efficient irrigation and will be developing a landscape survey program targeting top water using meters (per square foot landscape area). NCWD filed a late exemption in November 2004 for the District's second reporting period (2005/06) for implementing BMP 5. The exemption was filed since NCWD currently does not have the staff or budgeted funds to implement a landscape survey program, however the district will actively seek funding sources for such a program.

Reported as of 5/18/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? — no

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

   NCWD did not offer a rebate program in 2002-03. Los Angeles County Sanitation Districts 32 & 26 (LACSD) and Southern California Edison did not offer any type of rebate for water efficient clothes washers.

2. Does your agency offer rebates for high-efficiency washers? — no
3. What is the level of the rebate? — 0
4. Number of rebates awarded. — 0

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — no

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

   N/A

D. Comments

N/A

Reported as of 5/18/05

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers? — no

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

   Los Angeles County Sanitation Districts or LACSD, (specifically 32 & 26) offer a cost reduction of 20%, 40% or 60% for customers that reduce their wastewater (sewer) discharge by 20% or more. The reduction is calculated based on a 12 month comparison of water usage as shown on the customer's water bill (from NCWD). If they reduced their bill 20%, they receive a 20% reduction on their fees. Customers must reduce their water usage (and thus discharge) by at least 20% in order to qualify for the financial incentives. Installing a water efficient clothes washer could generate 20% water savings and therefore qualify the customer for a reduction. However, neither LACSD nor Southern California Edison offers a rebate specifically for high efficiency clothes washers. Thus, at this time NCWD is not offering a complementing rebate to customers.

2. Does your agency offer rebates for high-efficiency washers? — no
3. What is the level of the rebate? — 0
4. Number of rebates awarded. — 0

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — no

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

   N/A

D. Comments

NCWD currently does not have the staff or funds to implement a water efficient clothes washer rebate program. NCWD will reassess the cost-effectiveness of such a program as funding sources change and/or Southern California Edison or LACSD implement a specific clothes washer rebate program.

Reported as of 5/18/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

NCWD has a comprehensive public outreach and education program to promote water conservation and water use efficiency. The district efforts are designed to target the various classes of customers including (single & multi-family) residential, CII and large landscape. For several years the district has been releasing a quarterly newsletter to the entire customer base to inform customers on district upgrades and additions to improve the water quality and service, recognition of employee excellence, and education on new district policies and programs. Most importantly, the newsletter includes a "Water Awareness" section that provides customers with useful tips and recommendations to be water efficient and to reduce water waste. The newsletters also include a seasonal article describing how to increase water efficiency such as how to set your summer irrigation schedule or how to protect pipes from freezing temperatures in the winter. In addition to the newsletter, NCWD includes a bill notice (or by-line) with important reminders and water conservation tips. For example, the bill notice in May 2003 reminded customers to change out their old toilets and receive a ULFT rebate voucher from the district. NCWD also includes bill stuffers in the customer*s monthly water bill several times a year to promote conservation programs and/or to provide general information on conservation. NCWD participates in 4 major community events (River Rally, CLWA Open House, Emergency Expo and The Street Fair) to further reach out to the customers and the general public. At these events and at the district office, customers can obtain pamphlets, guidebooks, conservation promo items and children*s coloring and activities books on water conservation, and other informative material. NCWD maintains an extensive inventory of information resource material on conservation, leak detection, water safety, district operations, water quality (annual reports), and more. In FY 2002-03 NCWD expanded its website to include a úWater Conservationî section which includes easy tips for conserving water. NCWD continues to expand all areas of public outreach and education

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	no	0
b. Public Service Announcement	no	0
c. Bill Inserts / Newsletters / Brochures	yes	5
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	1
f. Special Events, Media Events	yes	4
g. Speaker's Bureau	no	
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	14930.85	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

In 2002/03 the BMP 7 (Public Information Programs) budget was not separately defined and therefore only actual expenditures are provided. Expenditures were taken from a general account that is used for various uses including public outreach and education, employee supplies and uniforms, and other marketing uses. The expenditures were calculated based on the development and production (printing, mailing, etc.) costs associated with the PR material and events, as well as the employee time expended. Various levels of staff participated in public outreach efforts including management, customer service, accounting, and technical field staff. Therefore, an average hourly employee rate of $37.14 was used which includes auxiliary costs such as insurance, worker*s compensation, taxes and other fees. With a total of 7,715 meter accounts and an estimated population of 28,000, NCWD expended $1.94 per meter account or $0.53 per person.

Reported as of 5/18/05

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

NCWD continued to maintain a comprehensive public outreach and education program to promote water conservation and water use efficiency in FY 2003/04. In 2003/04 NCWD identified that irrigation constituted a significant portion of the districtÌs water usage and therefore added new information material to educate and promote water efficient irrigation (to residential customers). The District provided the Sunset Magazine series to all new homeowners and made them available to customers attending public events and to customers at the NCWD office. The Sunset magazine series included; ÌSmart Water & Energy Use in the West,Ó ÌHow to Water Your Garden,Ó and ÌWater-Wise Gardening for California.Ó NCWD continued to release a quarterly newsletter to the entire customer base to inform customers on district upgrades and additions to improve the water quality and service, recognition of employee excellence, education on new district policies and programs and water conservation. The newsletters also continued to include seasonal articles describing how to increase water efficiency for indoor and outdoor water usage. In May of 2003, NCWD included a bill notice (or by-line) in the customerÌs monthly water bill to remind customers to change out their old toilets and receive a ULFT rebate voucher from the district. A separate postcard was also sent to advertise the valley wide Residential ULFT Rebate Program sponsored and organized by the local wholesaler (CLWA). The district works with the wholesaler and the other local water retailers in the Santa Clarita Valley to promote water efficiency and conservation through various PR campaigns, advertising and newspaper articles. Since the annual city Street Fair was not held September 2003, NCWD only participated in 3 major community events (River Rally, CLWA Open House, and the Emergency Expo) to further reach out to the customers and the general public. At these events and at the district office, customers can obtain pamphlets, guidebooks, conservation promo items and childrenÌs coloring and activities books on water conservation, and other informative material. NCWD maintains an extensive inventory of information resource material on conservation, leak detection, water safety, district operations, water quality (annual reports), and more. NCWD continued to expand the ÌWater ConservationÓ section of the district website adding new easy tips for conserving water and links to useful information sites.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	no	0
b. Public Service Announcement	no	0
c. Bill Inserts / Newsletters / Brochures	yes	6
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	yes	1
f. Special Events, Media Events	yes	3

g. Speaker's Bureau	no	0
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	10000
2. Actual Expenditures	25692.01	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

In mid 2003/04 a separate BMP budget account was created to better record expenses related to the BMP programs. Therefore, the expenditures for BMP 7 in 2003/04 are recorded under two separate accounts in the districtÌs budget and expenditures report. Most of the recorded BMP expenses were for BMP 7 (Public Information Programs) such as design and printing costs, educational and promotional item purchases and other related costs. The expenditures were calculated based on the development and production (printing, mailing, etc.) costs associated with the PR material and events, as well as the employee time expended. Various levels of staff participated in public outreach efforts including management, customer service, accounting, and technical field staff. Therefore, an average hourly employee rate of $37.14 was used which includes auxiliary costs such as insurance, workerÌs compensation, taxes and other fees. With a total of 8,531 meter accounts and an estimated population of 32,000, NCWD expended $3.01 per meter account or $0.80 per person.

Reported as of 5/18/05

BMP 08: School Education Programs

Reporting Unit:
Newhall County Water District

BMP Form Status:
100% Complete

Year:
2003

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	47	1410	0
Grades 4th-6th	yes	23	700	0
Grades 7th-8th	yes	0	0	0
High School	yes	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 01/01/1993

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

The education program is provided entirely by our wholesaler (CLWA) on our behalf since 1993 for K-6 and 7-12, however the program has been unsuccessful at reach students and teachers in grades 7-12. Students travel to CLWA for their workshops and presentations which include a tour of CLWA's drought tolerant and native vegetation garden and classes how water science, conservation and composting. The actual number of workshops held was not provided to NCWD, therefore an estimated value is provided in this report. The estimated number of presentations was based on the total number of participating students assuming 30 students per workshop or presentation. Currently, CLWA does not offer curriculum workshops teachers on water conservation and related topics.

Reported as of 5/18/05

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	29	844	0
Grades 4th-6th	yes	22	650	0
Grades 7th-8th	yes	0	0	0
High School	yes	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 01/01/1993

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

CLWA continues to organize and implement a school education program on our behalf of NCWD and the other water retailers in the Santa Clarita Valley since 1993 for K-6. In 2003-04, grades and 7-12 students and teachers did not participate. CLWA is working on developing a program in 2005 specifically targeted at grades 7-12. The actual number of workshops held was not provided to NCWD for 2003-04, therefore an estimated value is provided in this report. The estimated number of presentations was based on the total number of participating students assuming 30 students per workshop or presentation. Currently, CLWA does not offer curriculum workshops teachers on water conservation and related topics.

Reported as of 5/18/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? no

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	0	0	0
b. Number of New Surveys Completed	0	0	0
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	0	0	0
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	0	0	0

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	no	no	no
f. Evaluation of all water-using apparatus and processes	no	no	no
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	no	no	no

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water no

savings for the purpose of complying with BMP 9 under this option?	
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	0
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

Based on NCWD signatory date of the MOU, the district does not need to implement a CII conservation program until FY 2004-05. NCWD's Customer Service staff began preparations for a CII program in 2002-03 by sorting accounts by the BMP class codes such as commercial, industrial, large landscape, etc. The class codes were applied to the Inhance (customer service and billing database) System to use for future CII programs.

Reported as of 5/18/05

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? no

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	0	0	0
b. Number of New Surveys Completed	0	0	0
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	0	0	0
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	0	0	0

CII Survey Components	Commercial Accounts	Industrial Accounts	Institutional Accounts
e. Site Visit	no	no	no
f. Evaluation of all water-using apparatus and processes	no	no	no
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	no	no	no

Agency CII Customer Incentives	Budget ($/Year)	No. Awarded to Customers	Total $ Amount Awarded
h. Rebates	0	0	0
i. Loans	0	0	0
j. Grants	0	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water no

savings for the purpose of complying with BMP 9 under this option?	
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	no
7. Estimated annual savings (AF/yr) from site-verified actions taken by agency since 1991.	0
8. Estimated annual savings (AF/yr) from non-site-verified actions taken by agency since 1991.	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

NCWD did not have a CII Survey program in 2003-04 as the MOU was signed in March 2002. During 2003-04, NCWD began gather necessary data and information to implement a CII Survey or conservation program for the next reporting period (2005-06) as scheduled.

Reported as of 5/18/05

BMP 09a: CII ULFT Water Savings

Reporting Unit: **Newhall County Water District** | BMP Form Status: **100% Complete** | Year: **2003**

1. Did your agency implement a CII ULFT replacement program in the reporting year? If No, please explain why on Line B. 10. — No

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program? Check all that apply.

Consumption ranking
Potential savings
Oldest meter

a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

NCWD did not implement a CII ULFT program during the 2003-04 reporting period, however a program is in potential development (as part of a CII survey program) for the 2004-05 that will identify target customers based on the facilities water usage (consumption) volume, water savings potential and if the site has plumbing fixtures installed or replaced prior to January 1992.

2. How does your agency advertise this program? Check all that apply.

Direct letter
Bill insert
Bill message
Newsletter
Telephone
Web page
Radio PSAs
Newspapers
Trade publications
Other print media
Trade shows and events
Telemarketing

a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

All BMP programs are advertised in our district newsletter, through newspaper articles, our website, customer calls, bill inserts and other applicable and other cost effective means. Although a CII toilet rebate program was not implemented in 2003-04 reporting period, the above marked advertising efforts were included for the residential ULFT rebate program (5/2003 & 5/2004).

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.) — Yes

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency? — Yes

3. What is the total number of customer accounts participating in the program during the last year ? — 0

CII Subsector	Number of Toilets Replaced			
4.	Standard	Air	Valve Floor	Valve Wall

	Gravity Tank	Assisted	Mount	Mount
a. Offices	0	0	0	0
b. Retail / Wholesale	0	0	0	0
c. Hotels	0	0	0	0
d. Health	0	0	0	0
e. Industrial	0	0	0	0
f. Schools: K to 12	0	0	0	0
g. Eating	0	0	0	0
h. Govern-ment	0	0	0	0
i. Churches	0	0	0	0
j. Other	0	0	0	0

5. Program design.

Rebate or voucher
Direct installation
Direct installation with customer co-payment
Direct distribution
Direct distribution with customer co-payment
Retrofit on resale

6. Does your agency use outside services to implement this program? Yes

a. If yes, check all that apply.

Community Based Organization
Plumbing contractors/subcontracts

7. Participant tracking and follow-up.

Letter
Telephone

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business	4
b. Inadequate payback	5
c. Inadequate ULFT performance	2
d. Lack of funding	4
e. American's with Disabilities Act	1
f. Permitting	2
g. Other. Please describe in B. 9.	3

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

Although a specific program has not been implemented, several CII customers have been informally surveyed during customer service phone calls and at public events. regarding participation in district programs. From the provided customer input, the above rankings were determined for reasons for not participating in conservation and rebate programs.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and

budgeting?

N/A - CII ULFT Retrofit program was not implemented in NCWD.

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor	0	0
b. Materials	0	0
c. Marketing & Advertising	0	0
d. Administration & Overhead	0	0
e. Outside Services	0	0
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution	0
b. State agency contribution	0
c. Federal agency contribution	0
d. Other contribution	0
e. Total	0

D. Comments

N/A - CII ULFT Retrofit program was not implemented in NCWD.

Reported as of 5/18/05

BMP 09a: CII ULFT Water Savings

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

1. Did your agency implement a CII ULFT replacement program in the reporting year? If No, please explain why on Line B. 10. — No

A. Targeting and Marketing

1. What basis does your agency use to target customers for participation in this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

   N/A

2. How does your agency advertise this program? Check all that apply.

   a. Describe which method you found to be the most effective overall, and which was the most effective per dollar expended.

   N/A

B. Implementation

1. Does your agency keep and maintain customer participant information? (Read the Help information for a complete list of all the information for this BMP.)

2. Would your agency be willing to share this information if the CUWCC did a study to evaluate the program on behalf of your agency? — Yes

3. What is the total number of customer accounts participating in the program during the last year ? — 0

CII Subsector	Number of Toilets Replaced			
4.	Standard Gravity Tank	Air Assisted	Valve Floor Mount	Valve Wall Mount
a. Offices	0	0	0	0
b. Retail / Wholesale	0	0	0	0
c. Hotels	0	0	0	0
d. Health	0	0	0	0
e. Industrial	0	0	0	0
f. Schools: K to 12	0	0	0	0
g. Eating	0	0	0	0
h. Govern-ment	0	0	0	0
i. Churches	0	0	0	0
j. Other	0	0	0	0

5. Program design.

6. Does your agency use outside services to implement this program? — No

a. If yes, check all that apply.

7. Participant tracking and follow-up.

8. Based on your program experience, please rank on a scale of 1 to 5, with 1 being the least frequent cause and 5 being the most frequent cause, the following reasons why customers refused to participate in the program.

a. Disruption to business	4
b. Inadequate payback	5
c. Inadequate ULFT performance	2
d. Lack of funding	4
e. American's with Disabilities Act	1
f. Permitting	2
g. Other. Please describe in B. 9.	3

9. Please describe general program acceptance/resistance by customers, obstacles to implementation, and other isues affecting program implementation or effectiveness.

N/A - NCWD did not implement a CII ULFT Rebate program in 2003/04. Refer to BMP 9(a) 2002/03 regarding general acceptance/resistance by customers for all BMP and other conservation programs within in NCWD.

10. Please provide a general assessment of the program for this reporting year. Did your program achieve its objectives? Were your targeting and marketing approaches effective? Were program costs in line with expectations and budgeting?

N/A

C. Conservation Program Expenditures for CII ULFT

1. CII ULFT Program: Annual Budget & Expenditure Data

	Budgeted	Actual Expenditure
a. Labor	0	0
b. Materials	0	0
c. Marketing & Advertising	0	0
d. Administration & Overhead	0	0
e. Outside Services	0	0
f. Total	0	0

2. CII ULFT Program: Annual Cost Sharing

a. Wholesale agency contribution	0
b. State agency contribution	0
c. Federal agency contribution	0
d. Other contribution	0
e. Total	0

D. Comments

A CII ULFT Rebate Program was not implemented in 2003/04. The district is reviewing the cost-effectiveness of incorporating a ULFT Rebate program with the CII Survey project.

Reported as of 5/18/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$2610115.2
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$4971003.58
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$195845.76
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$426019.58
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$26484.48
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$37008.69
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$220239.36
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$0
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$468008.64
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$605189.36
6. Other	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided

c. Total Revenue from Volumetric Rates	$48438.72
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$490129.57

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

All NCWD customers are metered and billed based on their usage and standard monthly fees and other miscellaneous charges. NCWD received $6,704,884.61 in revenue for volumetric and non-volumetric charges (as a total for all classes). Non-volumetric revenue collected from institutional customers is incorporated in the commercial class non-volumetric revenue. The volumetric revenue for each class was calculated using the flat rate of $0.80/ccf and the class usage values as provided in the Customer Account and Usage Worksheet.

Reported as of 5/18/05

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$2695841.28
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$5672106.46
2. Commercial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$182603.52
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$458349.06
3. Industrial	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$40423.68
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$67094.02
4. Institutional / Government	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$213618.24
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$0
5. Irrigation	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$507735.36
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$809294.6
6. Other	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric	

Rates	$18817.92
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$462445.13

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	30000
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

All NCWD customers are metered and billed based on their usage and standard monthly fees and other miscellaneous charges. NCWD received $7,603,691.87 in revenue for volumetric and non-volumetric charges (as a total for all classes). Non-volumetric revenue collected from institutional customers is incorporated in the commercial class non-volumetric revenue. The volumetric revenue for each class was calculated using the flat rate of $0.80/ccf and the class usage values as provided in the Customer Account and Usage Worksheet. NCWD budgeted for a water rate structure study to identify the most effective rate structure for residential customers to increase water conservation while meeting revenue goals. The study evaluated several water districts' and other retailers' rate structures based on the impact on conservation, revenue, customer service and satisfaction, and implementation and maintenance time and effort. The NCWD Board voted to implement a tiered rate structure for individually metered residential customers starting January 2005.

Reported as of 5/18/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Castaic Lake Water Agency (Wholesaler)
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	35%
b. Coordinator's Name	Paula Forsberg
c. Coordinator's Title	Customer Service Manager
d. Coordinator's Experience and Number of Years	Customer Service 22 years
e. Date Coordinator's position was created (mm/dd/yyyy)	03/01/2002
6. Number of conservation staff, including Conservation Coordinator.	5

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	30000	30000
2. Actual Expenditures	27000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

The budget and expenditures are strictly estimates based on the number of estimated staff hours used for BMP programs including gathering the Base Year data for the BMP reporting requirements. An estimated 535-550 hours of staff time went into BMP programs for 2002-03. An average employee per hour estimated cost including benefits and other miscellaneous charges is approximately $37.14, however management and supervisory level staff also participated in BMP efforts.

Reported as of 5/18/05

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	yes
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	no
4. Partner agency's name:	Castaic Lake Water Agency (CLWA)
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	85%
b. Coordinator's Name	Melinda Weinrich
c. Coordinator's Title	Environmental Conservation Specialist
d. Coordinator's Experience and Number of Years	Conservation/Program Management/Consulting 10 years
e. Date Coordinator's position was created (mm/dd/yyyy)	05/10/2004
6. Number of conservation staff, including Conservation Coordinator.	6

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	30000	60000
2. Actual Expenditures	35000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

A new position was created in May of 2004 in order to address the conservation issues within the district and to meet the requirements of the BMP under CUWCC. The Conservation Coordinator works with the Customer Service staf, field team, engineering and other departments as needed. As a small district, the entire staff works on some aspect of the BMP and other water conservation programs at the district such as working at public events, providing data and reports, mapping participation, etc.

Reported as of 5/18/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? yes

a. If YES, describe the ordinance:

NCWD's Ordinance (Water Conservation) was adopted in 2/1991 due to water supply conditions in the district's service area. The purpose of the ordinance is to provide a water conservation plan to minimize the effect of shortage of water supplies on the customers of the district. The ordinance sets parameters or irrigation hours and schedules to optimize water efficiency and prevent water waste. The ordinance also states that it is the duty of all persons to inspect for leaks and damages to indoor and outdoor plumbing and fixtures and to repair as necessary as soon as possible. The ordinance also lists prohibited use of water for washing vehicles, for cleaning and operating decorative fountains and for serving water in restaurants, cafeterias and other food service locations. A copy of the complete ordinance was submitted to the CUWCC as an attachment to this BMP report.

2. Is a copy of the most current ordinance(s) on file with CUWCC? no

a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

1. LA County Sanitation District (32 & 26) 2. City of Santa Clarita 3. County of Los Angeles	1. Ordinance Prohibiting the Installation of Certain Water Softening Appliances 2. City Code, Title 9 Health & Safety, Chapter 9.38 (Water Conservation & Water Waste), Chapter 10.04 Runoff Water & Pollution 3. County Code, Title 11 Health & Safety, Chapter 11.38 (Water & Sewer) * All the above listed ordinances and codes were submitted to the CUWCC for reference.

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

a. Gutter flooding	yes
b. Single-pass cooling systems for new connections	no
c. Non-recirculating systems in all new conveyor or car wash systems	no
d. Non-recirculating systems in all new commercial laundry systems	no
e. Non-recirculating systems in all new decorative fountains	yes
f. Other, please name See listed measures below (B2) & in attached Ordinance 101	yes

2. Describe measures that prohibit water uses listed above:

1. Watering lawns and landscaped areas more than once a day. 2.

Watering lawns and landscaped areas between 10am through 5pm 3. Causing water to runoff into the street, storm drains, gutters, parking lots, etc. 4. Not repairing leaks or broken indoor and outdoor plumbing and fixtures. 5. Serving water to customers in restaurants, cafeterias or other food service location unless the customer specifically request water

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

a. Allow the sale of more efficient, demand-initiated regenerating DIR models. yes

b. Develop minimum appliance efficiency standards that:

i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. yes

ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. yes

c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. yes

4. Does your agency include water softener checks in home water audit programs? no

5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models? yes

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

Copies of NCWD's Ordinance 101 as well as the LA County, Los Angeles County Sanitation District (LACSD) and city of Santa Clarita's ordinances and codes related to water waste were submitted to the CUWCC as an attachment to these 2003-04 BMP reports.

Reported as of 5/18/05

BMP 13: Water Waste Prohibition

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? yes

a. If YES, describe the ordinance:

NCWD's Ordinance (Water Conservation) was adopted in 2/1991 due to water supply conditions in the district's service area. The purpose of the ordinance is to provide a water conservation plan to minimize the effect of shortage of water supplies on the customers of the district. The ordinance sets parameters or irrigation hours and schedules to optimize water efficiency and prevent water waste. The ordinance also states that it is the duty of all persons to inspect for leaks and damages to indoor and outdoor plumbing and fixtures and to repair as necessary as soon as possible. The ordinance also lists prohibited use of water for washing vehicles, for cleaning and operating decorative fountains and for serving water in restaurants, cafeterias and other food service locations. A copy of the complete ordinance was submitted to the CUWCC as an attachment to this BMP report.

2. Is a copy of the most current ordinance(s) on file with CUWCC? yes

a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

1. City of Santa Clarita 2. County of Los Angeles	1. Title 9 Health & Safety, Chapter 9.38 & Chapter 10.4 Stormwater & Urban Runoff Pollution Control (see submitted documents) 2. County Codes, Title 11 Health & Safety, Chapter 11.38 (Water & Sewers)

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

a. Gutter flooding	yes
b. Single-pass cooling systems for new connections	no
c. Non-recirculating systems in all new conveyor or car wash systems	no
d. Non-recirculating systems in all new commercial laundry systems	no
e. Non-recirculating systems in all new decorative fountains	yes
f. Other, please name See list of measures below & in Ordinance 101 (attached)	yes

2. Describe measures that prohibit water uses listed above:

1. Watering lawns and landscaped areas more than once a day. 2. Watering lawns and landscaped areas between 10am through 5pm 3. Causing water to runoff into the street, storm drains, gutters, parking lots, etc. 4. Not repairing leaks or broken indoor and outdoor plumbing and fixtures. 5. Serving water to customers in restaurants, cafeterias or other food service location unless the customer specifically request water.

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

a. Allow the sale of more efficient, demand-initiated regenerating DIR models. yes

b. Develop minimum appliance efficiency standards that:

i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used. yes

ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced. yes

c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply. yes

4. Does your agency include water softener checks in home water audit programs? no

5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models? yes

C. Water Waste Prohibition Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

E. Comments

Copies of NCWD's Ordinance 101 as well as the LA County and city of Santa ClaritaÃs ordinances and codes related to water waste were submitted to the CUWCC as an attachment to these 2003-04 BMP reports.

Reported as of 5/18/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2003**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	no

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	69	0
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**69**	**0**

6. Describe your agency's ULFT program for single-family residences.

The ULFT (residential) Rebate program was conducted by the area wholesaler (CLWA) for pre-1993 single family homes in the Santa Clarita Valley. All the local retailers participated including Valencia Water Company, Santa Clarita Water District and LA County District 36. CLWA promoted the program in the local paper and throughout the community. NCWD released additional PR notices to district customers in the quarterly newsletter, on the monthly water bill (by-line) and with a postcard notices regarding the program. The program started May 1, 2003. Customers were required to contact the district (by phone or in person) to receive a rebate form to complete. NCWD made a copy of the rebate form for district records and to log which customers received rebates and those who also returned the voucher forms. Customers had 30 days upon receiving their voucher sheet and rebate number to purchase a ULFT and return the voucher form and their receipt to NCWD or the wholesaler. NCWD forwarded all forms to CLWA for final processing. Santa Clarita Water District coordinated the processing of the rebate checks and tallied participation. Once a customer returned their voucher form and ULFT receipt, they were mailed a rebate check for either $20 or $40. Customers who purchased ULFT between $50 and $75 received a $20 rebate and $40 for ULFT above $75. There was no limit on the number of rebates allocated per customers, however no customer took more than 3 voucher forms. The program lasted until the end of May 2003 with NCWD customers receiving 69 total rebates.

7. Describe your agency's ULFT program for multi-family residences.

CLWA selected to only target single-family residents for the 2003 ULFT Rebate Program.

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

1. City of Santa Clarita 2. Los Angeles County	There is currently no ordinance requiring retrofit of toilets (to ULFT) upon resale in the Santa Clarita Valley.

B. Residential ULFT Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	5000
2. Actual Expenditures	3946.57	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

The 2003-03 ULFT Rebate Program Budget was based on the employee time and effort, program marketing and PR efforts and miscellaneous supplies and costs. The costs are as follows: 1. Printing cost for ULFT Rebate Program notification postcard - $393.21 2. Postcard Postage to 3,500 qualified customers (at $0.23/postcard) - $805.00 3. Staff Time of 74 hours at $37.14/hour (average wage with benefit costs) - $2,748.36 Total Costs $3,946.57

Reported as of 5/18/05

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Newhall County Water District	**100% Complete**	**2004**

A. Implementation

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes

Number of Toilets Replaced by Agency Program During Report Year

Replacement Method	SF Accounts	MF Units
2. Rebate	104	5
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**104**	**5**

6. Describe your agency's ULFT program for single-family residences.

CLWA coordinated a residential ULFT rebate program for all the local retailers in the Santa Clarita Valley (including NCWD). The rebate program starts on May 1st offering rebates to eligible customers (with toilets installed prior to 1992) to receive a rebate for purchasing a ULFT. Customers received a $30 rebate for ULFT from $50 to $75, and $60 rebate for ULFTs over $75. Retailers receive a percentage of the available rebate funds ($20,000 for entire program) based on their customer population or eligible residents. Customers had 30 days to return their voucher form with their ULFT receipt in order to receive their rebate check. NCWD had such a high demand from customers that a waiting list had to be created. Over 135 customers were signed up on the waiting list to receive a voucher form if additional program funding became available.

7. Describe your agency's ULFT program for multi-family residences.

NCWD allowed multi-family residents to receive a rebate for the purchase of a ULFT through the CLWA. Previously, the rebate was only offered to single-family residents. Two landlords (or property owners) received rebates to update their rental facilities and two tenants received rebates. There was no limit on the number of rebates allocated per person; however District staff confirmed the number of toilets needed for any customers who request more than 3 rebates.

8. Is a toilet retrofit on resale ordinance in effect for your service area? no

9. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

City of Santa Clarita & LA County	There is no retrofit on resale ordinance in the Santa Clarita Valley.

B. Residential ULFT Program Expenditures

	This Year	Next Year

1. Budgeted Expenditures	5000	3000
2. Actual Expenditures	4417.31	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

N/A

D. Comments

Budget for Residential ULFT Rebate Program includes the following calculated costs: 1. Staff time (approximately 50 hours) - Preparation & implementation - Planning meetings - PR efforts, mail outs, bill stuffers, etc. - Creating rebate forms and database - Translating program documents into Spanish 2. Printing and postage cost for postcard notice to customers 3. Creating & incorporating bill stuffers 4. Miscellaneous Costs (supplies & materials & other costs)

Reported as of 5/18/05

Appendix G
Draft Water Shortage Contingency Resolution/Ordinance

(This appendix contains examples that were adopted in 1991 to address water shortage conditions and will be used as the model for future water shortage contingency ordinance.)

Appendix I

DROUGHT EMERGENCY WATER SHARING AGREEMENT

1. Parties. The parties to this agreement are: Valencia Water Company, Santa Clarita Water Company, Los Angeles County Waterworks District No. 36-Val Verde, Newhall County Water District, and the Castaic Lake Water Agency.

2. Critical Water Shortage Conditions. The State of California is experiencing a fifth year of drought, which has caused critical water shortages in many areas of the state, including the service area of the Castaic Lake Water Agency. The Agency has recently been informed that the State Water Project will have insufficient water to meet its demands for the coming year.

3. Water Sharing Agreement. In order to alleviate the emergency water shortage caused by the Drought and by insufficient agency water to meet demands, the undersigned parties agree to cooperate in sharing available water from all sources among themselves without regard to water, contractual or other rights for the duration of the emergency, and to facilitate among themselves water transfers, exchanges, and wheeling arrangements.

4. Preservation of Rights. By entering into this emergency water pooling and transfer, the parties do not waive their individual claims to water rights, or to contractual or other claims to water or the use of water. Each party agrees that no party hereto will lose any water right, contract right, or other entitlement to water by entering into this agreement,

nor shall any party attempt to use this agreement or the emergency exchange of water as a basis for a claim against any other party of a continued right to the use of that water. This agreement shall not be construed as constituting any alteration in the respective priorities or terms of any of the rights held by any party, nor as an admission with respect to any rights or claims. Each party further agrees that no party hereto will lose any water or other right by a claim of non-use by another party, prescription, or dedication to public use by entering into this agreement.

5. Termination. This agreement shall terminate upon the cessation of drought conditions affecting the service area of the Castaic Lake Water Agency, or January 1, 1992, whichever is sooner, but may be extended by mutual consent of all the parties.

6. Counterparts. This agreement shall be executed in counterparts, each of which shall be deemed an original.

7. Effective Date. The effective date of this agreement shall be that date upon which all the parties hereto have executed the agreement.

Valencia Water Company

Date: FEBRUARY 13, 1991

Attest:

by

Santa Clarita Water Company

Date: February 26, 1991

by W. J. Manthey

Attest:

Benjamin L. Borelli

Los Angeles County Waterworks
District No. 36

Date: 8/27/91

by ORIGINAL SIGNED BY

Attest:

~~Pg~~ 21

Newhall County Water District

Date: 2/19/91

by ORIGINAL SIGNED BY

Attest:

~~Pg~~ 22

Castaic Lake Water Agency

Date: 2/28/91

by ORIGINAL SIGNED BY

Attest:

~~Pg~~ 23

s/Los Angeles County Waterworks District No. 36

Date: AUG 27 1991

by Michael D. Antonovich

Attest:
ATTEST: LARRY J. MONTEILH
EXECUTIVE OFFICER —
CLERK OF THE BOARD OF SUPERVISORS
By Lynne C. Valle, Deputy

s/Newhall County Water District

Date:

Attest:

by

s/Castaic Lake Water Agency

Date: 2/28/91

Attest:

by

APPROVED AS TO FORM
DE WITT W. CLINTON, County Counsel

BY
DEPUTY

ADOPTED
BOARD OF SUPERVISORS
COUNTY OF LOS ANGELES

S 9 1 AUG 27 1991

LARRY J. MONTEILH
EXECUTIVE OFFICER

s/ Newhall County Water District Date: 2/19/71

Attest:

by [signature] President [signature] Secy

s/ Castaic Lake Water Agency Date: _____

Attest:

by _____ _____

s/Los Angeles County Waterworks
District No. 36

Date:

Attest:

by

s/Newhall County Water District

Date:

Attest:

by

s/Castaic Lake Water Agency

Date: 2/28/91

Attest:

by

Appendix II

RESOLUTION NO.804

RESOLUTION OF THE BOARD OF DIRECTORS OF CASTAIC LAKE WATER AGENCY RECOGNIZING REDUCTIONS IN REQUESTED DELIVERY OF STATE WATER PROJECT SUPPLY FOR YEAR 1991 AND MANDATING A PROGRAM OF WATER CONSERVATION IN THE SANTA CLARITA VALLEY

WHEREAS, the Castaic Lake Water Agency is a public entity organized and operating pursuant to the California Water Code, Appendix, Chapter 103, and is primarily empowered to supply water at wholesale to retail water distributors within the Santa Clarita Valley; and

WHEREAS, the Agency's source of water is by contract with the State Water Project of the California Department of Water Resources; and

WHEREAS, the State Water Project, and the entire State of California is experiencing protracted drought conditions of unprecedented recent duration; and

WHEREAS, the California Department of Water Resources in a letter dated February 2, 1991 advised the Agency to plan for "severe reductions" in its State Water Project supply; and

WHEREAS, the letter further reported, "there is a 50% probability that the Department will only be able to deliver about half of the water requested for municipal and industrial use in 1991"; and

WHEREAS, half of the requested State Water Project supply of the Castaic Lake Water Agency would be 13,050 acre feet: and

WHEREAS, the retail water distributors within the Santa Clarita Valley operate ground water production facilities that have been planned to make up some portion of the delivery reductions in State Project Water; and

WHEREAS, the retail water distributors and the Agency, have pursuant to Water Code, Sections 10610 through 10656, adopted a URBAN WATER MANAGEMENT PROGRAM for retail sales which contains water conservation measures including, metering, leak detection, public education, public information, home retrofit devices, drip and sprinkler irrigation restrictions, and a landscape suggestion for use of drought tolerant plantings; and

WHEREAS, heretofore, the Castaic Lake Water Agency adopted Resolution No. 667 relating to a voluntary water conservation program to reduce water consumption by 10 percent; and

WHEREAS, it is now essential to enact a mandatory program;

NOW, THEREFORE, BE IT RESOLVED that this Agency's Board of Directors does hereby find and determine the following:

1. That the General Manager of the Agency be authorized to execute a "Drought Emergency Water Sharing Agreement" with the local water purveyors to make it clear that emergency drought sharing of Agency water supplies during year 1991 not result in any waiver of contractual or other right to use of Agency water.

2. That the General Manager confer with the retail water purveyors to coordinate the distribution and use of the limited State Project Water supply to maximize the distribution of the ground water production capacity of the combined facilities operated by the retail water purveyors.

3. That the Agency request both the City of Santa Clarita and the County of Los Angeles to adopt mandatory water use ordinances with terms generally as follows:

I. A WATER CONSERVATION ORDINANCE WHICH SHALL TERMINATE ON JANUARY 1, 1992 UNLESS RENEWED OR TERMINATED EARLIER

A. Hose Watering-Prohibition.

No person shall hose-water or wash down any sidewalks, walkways, driveways, parking areas, or other paved surfaces. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infraction.

B. Watering of Lawns and Landscaping

1. No person shall water or cause to be watered any lawn or landscaping between the hours of 10:00 a.m. and 5:00 p.m.

2. No person shall water or cause to be watered any lawn or landscaping more than once a day.

3. No person shall water or cause to be watered any lawn or landscaping to such an extent that runoff into adjoining streets, parking lots or alleys occurs due to incorrectly directed or maintained sprinklers or excessive watering.

4. It shall be the duty of all persons to inspect all hoses, faucets and sprinkling systems for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

5. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

C. Indoor Plumbing and Fixtures.

1. It shall be the duty of all persons to inspect all accessible indoor plumbing and faucets for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

2. Any new or replacement toilets installed in any residence or business shall be of a low-flow variety.

3. Willful violation hereof shall be an infraction punishable by a fine of $500.00.

D. Washing Vehicles

No vehicle of any type may be washed, except at a commercial car wash, unless such vehicle is washed by using a hand-held bucket or a water-hose equipped with an automatic shutoff nozzle. No person shall leave a water hose running while washing a vehicle or at any other time. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infraction.

E. Public Eating Places

No restaurant, cafeteria, coffee shop, or other public place where food is sold or served shall serve drinking water to any customer unless specifically requested to do so by such customer. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

F. Decorative Fountains

No person shall use water to clean, fill, or maintain levels in decorative fountains unless such water flows through a recycling system. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

4. That the above cited three paragraphs are deemed appropriate as PHASE ONE of the Agency's mandatory conservation program with recognition of the possibility that the California Department of Water Resources may declare deeper finite reductions for the municipal and industrial water supplies of the State Water Project. Residents of the Agency are put on notice that further and additional phases of the mandatory conservation program may be enacted by the Agency and could include the following:

A. Odd/Even landscape irrigation restriction, based upon address

B. A financial penalty of say triple the water rate for metered water service that exceeds historic use

C. Complete prohibition of landscape irrigation

I, the undersigned, hereby certify: That I am the duly appointed and acting Secretary of the Castaic Lake Water Agency, and that at a special meeting of the Board of Directors of said Agency held on Monday, February 11, 1991, the foregoing Resolution No. 804 was duly and regularly adopted by said Board, and that said resolution has not been rescinded or amended since the date of its adoption, and that it is now in full force and effect.

Betty L. Castleberry
Secretary

DATED: 2/12/91

Appendix III

ORDINANCE NO. 101

WATER CONSERVATION ORDINANCE OF
NEWHALL COUNTY WATER DISTRICT

* * * * * * * * * * * * * * *

BE IT ORDAINED BY THE BOARD OF DIRECTORS OF NEWHALL COUNTY WATER DISTRICT, LOS ANGELES COUNTY, CALIFORNIA AS FOLLOWS:

Section 1: Because of the water supply conditions prevailing within the District's service area, the general welfare requires that water resources available to the District be put to the maximum beneficial use to the extent to which they are capable, and that the waste or unreasonable use, or unreasonable method of use of water be prevented, and that the conservation of such water be practiced with the view to the reasonable and beneficial use thereof in the interest of the people of the District, and for the public welfare. The purpose of this Ordinance is to provide a water conservation plan to minimize the effect of a shortage of water supplies on the customers of the District.

Section 2: No customer of the District shall make, cause, use or permit the use of water from the District in a manner contrary to any provision of this Ordinance.

Section 3: Watering of Lawns or Landscaping.

(a) No person shall water or cause to be watered any lawn or landscaping between the hours of 10:00 a.m. and 5:00 p.m.

(b) No person shall water or cause to be watered any lawn or landscaping more than once a day.

(c) No person shall water or cause to be watered any lawn or landscaping to such an extent that runoff into adjoining streets, parking lots or alleys occurs due to incorrectly directed or maintained sprinklers or excessive watering.

(d) It shall be the duty of all persons to inspect all hoses, faucets and sprinkling systems for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

Section 4: Indoor Plumbing and Fixtures.

(a) It shall be the duty of all persons to inspect all accessible indoor plumbing and faucets for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

(b) For new or replacement toilets installed in any residence or business, local low-flow types are recommended.

Section 5: Washing Vehicles. No vehicle of any type may be washed, except at a commercial car wash, unless such vehicle is washed by using a hand-held bucket or a water-hose equipped with an automatic shutoff nozzle. No person shall leave a water hose running while washing a vehicle or at any other time.

Section 6: Public Eating Places. No restaurant, cafeteria, coffee shop or other public place where food is sold or served shall serve drinking water to any customer unless specifically requested to do so by such customer.

Section 7: No person shall use water to clean, fill or maintain levels in decorative fountains unless such water flows through a recycling system.

Section 8: Water Conservation Kits. Water conservation kits are available without charge to the District's customers at the District's office. In most cases, the kits include a plastic displacement bag, two sets of shower flow restrictors, two dye tablets to check for toilet leaks and a brochure which explains the use of the kit. The kits are to be installed by the District's customers.

Section 9: Effective Date. The water use restrictions of this Ordinance are effective immediately. Other provisions of this Ordinance are effective on March 21, 1991.

ADOPTED, SIGNED AND APPROVED by the Board of Directors of NEWHALL COUNTY WATER DISTRICT this 19th day of February, 1991.

MARY JUNE HERRINGTON, President
of the Board of Directors of the
NEWHALL COUNTY WATER DISTRICT

A T T E S T:

JAMES E. JINKS, Secretary of
the Board of Directors of the
NEWHALL COUNTY WATER DISTRICT

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I hereby certify that the foregoing Ordinance No. 101 was duly and regularly adopted and passed by the Board of Directors of the NEWHALL COUNTY WATER DISTRICT at a regular meeting thereof on the 19th day of February, 1991 by the following vote of the members thereof:

AYES:	DIRECTORS:	Herrington, Hayes, Wade, Agajanian and Whiteside
NOES:	DIRECTORS:	None
ABSENT:	DIRECTORS:	None
ABSTAINED:	DIRECTORS:	None

JAMES E. JINKS, Secretary of
the Board of Directors of the
NEWHALL COUNTY WATER DISTRICT

ORDINANCE NO. 102

ORDINANCE AMENDING SECTION 3 OF ORDINANCE NO. 101 OF NEWHALL COUNTY WATER DISTRICT RE WATER CONSERVATION

* * * * * * * * * * * * * * *

BE IT ORDAINED BY THE BOARD OF DIRECTORS OF NEWHALL COUNTY WATER DISTRICT, LOS ANGELES COUNTY, CALIFORNIA AS FOLLOWS:

Section 1: Section 3 of Ordinance No. 101 is amended to provide as follows:

"Section 3: Watering of Lawns or Landscaping.

(a) No person shall water or cause to be watered any lawn or landscaping between the hours of 8:00 a.m. and 6:00 p.m.

(b) No person shall water or cause to be watered any lawn or landscaping more than once a day, or for a period of time not to exceed ten minutes per watering station or cycle.

(c) No person shall water or cause to be watered any lawn or landscaping to such an extent that runoff into adjoining streets, parking lots or alleys occurs due to incorrectly directed or maintained sprinklers or excessive watering.

(d) It shall be the duty of all persons to inspect all hoses, faucets and sprinkling systems for leaks and to cause all leaks to be repaired as soon as is reasonably practicable."

Section 2: The provisions of this Ordinance shall be effective on November 19, 1991.

ADOPTED, SIGNED AND APPROVED by the Board of Directors of NEWHALL COUNTY WATER DISTRICT this 15th day of October, 1991.

MARY JUNE HERRINGTON, President of the Board of Directors of the NEWHALL COUNTY WATER DISTRICT

A T T E S T:

JAMES E. JINKS, Secretary of the Board of Directors of the NEWHALL COUNTY WATER DISTRICT

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I hereby certify that the foregoing Ordinance No. 102 was duly and regularly adopted and passed by the Board of Directors of the NEWHALL COUNTY WATER DISTRICT at a regular meeting thereof on the 15th day of October, 1991 by the following vote of the members thereof:

AYES:	DIRECTORS:	Herrington, Hayes, Wade, Agajanian and Whiteside
NOES:	DIRECTORS:	None
ABSENT:	DIRECTORS:	None
ABSTAINED:	DIRECTORS:	None

JAMES E. JINKS, Secretary of the Board of Directors of the NEWHALL COUNTY WATER DISTRICT

Appendix IV

ORDINANCE NO. 91-16

AN ORDINANCE OF THE CITY OF SANTA CLARITA
ADDING CHAPTER 9.38 TO TITLE 9
OF THE SANTA CLARITA MUNICIPAL CODE

WHEREAS, the State of California is experiencing a prolonged drought; and

WHEREAS, the delivery of State Project Water to the Castaic Lake Water Agency has been reduced by 90% of the requested delivery levels.

THE CITY COUNCIL OF THE CITY OF SANTA CLARITA DOES HEREBY ORDAIN AS FOLLOWS:

Section 1. The Santa Clarita Municipal Code is amended adding Chapter 9.38 to Title 9 relating to water conservation to read as follows:

CHAPTER 9.38

WATER CONSERVATION

Sections:

9.38.010 Drought Committee
9.38.015 Water Conservation Regulations
9.38.020 Penalties
9.38.025 Termination of Ordinance
9.38.030 Ordinance 91-16 Amended

9.38.010 Drought Committee

A. A drought committee shall be established, whose function shall be:

1. to review all available data on water consumption, water supply and ground water conditions;

2. to evaluate the level of compliance with the terms of this Ordinance;

3. to evaluate the level of achievement of the stated water consumption reductions;

4. to make recommendations to the City Council concerning the timing of and need for implementation of future additional water restrictions as may be developed; and

5. to make recommendations to the water purveyors in the City of Santa Clarita concerning additional measures to encourage water conservation, including but not limited to; conservation goals for individual water accounts, surcharges for excessive water use and the installation of flow restriction devices in water services.

B. The members of the Drought Committee shall include representatives from the staff of the City of Santa Clarita, the Upper Santa Clara Water Committee, other appointees as the City Council deems appropriate, and the staff of the Castaic Lake Water Agency.

9.38.015 Water Conservation Regulations

A. Water conservation shall be achieved through the restriction and/or prohibition of various types of water use. The restrictions and prohibitions shall be implemented immediately.

B. The following conditions and restrictions shall apply to the use of water within the City of Santa Clarita:

1. Hose Water Prohibition.

a. No person shall hose-water or wash down any sidewalks, walkways, driveways, parking areas, or other paved surface.

2. Watering of Lawns and Landscaping.

a. No person shall water or cause to be watered any lawn or landscaping between the hours of 8:00 a.m. and 6:00 p.m. except as provided in Section 9.38.015.B.2.e.

b. Lawns and landscaping shall be watered no more frequently than every other day.

c. No person shall water or cause to be watered any lawn or landscaping to such an extent that runoff into adjoining streets, parking lots or alleys occurs due to incorrectly directed or maintained sprinklers or to excessive watering.

d. It shall be the duty of all persons to inspect all hoses, faucets and sprinkling systems for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

e. Commercial gardeners and landscapers, municipal water uses, commercial nurseries, golf courses and other water-dependent industries shall not water or cause to be watered any lawn of landscaping between the hours of 10:00 a.m. and 3:00 p.m., and no more frequently than every other day, unless reclaimed water is used.

f. The maintenance and testing of irrigation systems may be performed without the restrictions specified in Section 9.38.015.B.2.a and 9.38.015.B.2.e.

3. Indoor Plumbing.

   a. Accessible indoor plumbing and fixtures must be inspected for leaks and repaired as soon as reasonably practicable.

   b. New and replacement toilets, showers and faucets shall be of a low-flow type. New or replacement faucets shall be equipped with aerators.

4. Washing Vehicles.

   a. Vehicles must be washed by hand-held bucket or with a hose equipped with automatic shutoff nozzle. Hoses may not be left running.

   b. These restrictions shall not be applied to commercial vehicle washing facilities and operations.

5. Public Eating Places.

   a. Water may be served only upon request by the customer.

6. Decorative Fountains.

   a. Water may not be used to clean, fill or maintain levels in decorative fountains unless the fountain has a water recycling system.

7. Landscaping and Irrigation Plans.

   a. All new landscaping and irrigation improvements shall be approved by the City of Santa Clarita Director of Parks and Recreation prior to construction.

   b. No person or entity shall be required to implement any landscaping requirements of any association, developer or governing agency until the termination of this ordinance.

C. Conservation Goal

1. The goal of this Water Conservation Ordinance is to achieve at least 25% reduction of overall water consumption within the City of Santa Clarita.

9.38.020 Penalties.

A. Willful violations of the terms of this Ordinance shall be subject to written warnings and/or citations. A written warning shall be issued upon the first violation of any part of this Ordinance. The second violation shall result in a fine of $50.00. The third violation shall result in a fine of $100.00, and all subsequent violations shall result in a fine of $300.00 for each violation.

9.38.025 Termination of Ordinance.

A. This Ordinance shall terminate on January 1, 1992, unless renewed or termination earlier by ordinance.

Section 2. The City Council hereby declares that the provisions of this Ordinance are severable and if for any reason a court or competent jurisdiction shall hold any sentence, paragraph or section of this Ordinance to be invalid, such decision shall not affect the validity of the remaining parts of this Ordinance.

Section 3. This Ordinance is adopted as an urgency measure. The facts of the urgency are these: The State of California is currently suffering from the effects of a five-year drought, and the deliveries of State Project water to local water agencies are being reduced. This Ordinance restricts or prohibits certain types of water usage. The immediate enactment of this Ordinance is therefore necessary to ensure the adequacy of the water supply for the City of Santa Clarita and is thereby directly related to public health, safety and welfare. Therefore, this Ordinance shall be effective immediately upon adoption.

Section 4. The City Clerk shall certify to the passage of this Ordinance and shall cause it to be published in the manner prescribed by law.

9.38.030 Ordinance 91-12 Amended

A. Ordinance 91-12 is hereby amended, deleting Section 9.38.015.b.8 in its entirety.

PASSED, APPROVED AND ADOPTED this 13th day of March, 1991.

Carl Boyer
CARL BOYER, MAYOR

ATTEST:

Donna M. Grindey
DONNA GRINDEY, CITY CLERK

STATE OF CALIFORNIA)
COUNTY OF LOS ANGELES) ss.
CITY OF SANTA CLARITA)

I, Donna M. Grindey, City Clerk of the City of Santa Clarita, do hereby certify that the foregoing Ordinance No. 91-16 was duly adopted as an urgency ordinance at a regular meeting of the City Council on the 13th day of March, 1991, by the following four-fifths vote, to wit:

AYES: COUNCILMEMBERS Darcy, Heidt, McKeon, Boyer

NOES: COUNCILMEMBERS Klajic

ABSENT: COUNCILMEMBERS None

Donna M. Grindey
CITY CLERK

AGN:gmm-394

ORDINANCE NO. 91-48

AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF SANTA CLARITA, CALIFORNIA, AMENDING CHAPTER 9.38 OF THE SANTA CLARITA MUNICIPAL CODE RELATING TO WATER CONSERVATION

THE CITY COUNCIL OF THE CITY OF SANTA CLARITA, CALIFORNIA, DOES ORDAIN AS FOLLOWS:

SECTION 1. The Santa Clarita Municipal Code is hereby amended at Subsection 9.38.015.B.2.b to read as follows:

b. Lawns and landscaping shall be watered no more than 10 minutes per watering station or cycle per day.

SECTION 2. The Santa Clarita Municipal Code at Subsection 9.38.015.B.2.e is hereby amended to read as follows:

e. Commercial gardeners and landscapers, municipal water uses, commercial nurseries, golf courses and other water-dependent industries shall not water or cause to be watered any lawn or landscaping between the hours of 10:00 a.m. and 3:00 p.m., and no more than 10 minutes per watering station or cycle per day unless reclaimed water is used. This subsection does not apply to residential lawns which are subject to the time limitations indicated in the other subsections of this Ordinance.

SECTION 3. Section 9.38.015.C.1 is hereby amended to read as follows:

1. The goal of this Water Conservation Ordinance is to achieve a significant reduction of overall water consumption within the City of Santa Clarita.

SECTION 4. This Ordinance is adopted as an urgency measure. The facts of the urgency are these: The State of California is currently suffering from the effects of a five-year drought, and the deliveries of State Project water to local water agencies are being reduced. This Ordinance restricts or prohibits certain types of water usage. The immediate enactment of this Ordinance is therefore necessary to ensure the adequacy of the water supply for the City of Santa Clarita and is thereby directly related to public health, safety and welfare. Therefore, this Ordinance shall be effective immediately upon adoption.

SECTION 5. The City Clerk shall certify to the passage of this Ordinance and shall cause it to be published in the manner prescribed by law.

PASSED, APPROVED AND ADOPTED this 8th day of October, 1991.

Carl Boyer

Carl Boyer, Mayor

ATTEST:

Donna M. Grindey

Donna M. Grindey, City Clerk

STATE OF CALIFORNIA)
COUNTY OF LOS ANGELES) ss
CITY OF SANTA CLARITA)

I, Donna M. Grindey, City Clerk of the City of Santa Clarita, do hereby certify that the foregoing Ordinance No. 91-48 was duly adopted as an urgency ordinance at a regular meeting of the City Council on the 8th day of October, 19 91 by the following four-fifths vote, to wit:

AYES: COUNCILMEMBERS: Darcy, Heidt, McKeon, Boyer

NOES: COUNCILMEMBERS: Klajic

ABSENT: COUNCILMEMBERS: None

Donna M. Grindey

Donna M. Grindey, City Clerk

Appendix V

ORDINANCE NO. 91-0046U

An urgency ordinance amending Title 11, Chapter 11.38 of the Los Angeles County Code relating to Water and Sewers to add Part 4, Water Conservation.

The Board of Supervisors of the County of Los Angeles ordains as follows:

Section 1. Title 11, Chapter 11.38 of the County Code is amended by adding Part 4, to read:

Part 4. Water Conservation Requirements For The Unincorporated Los Angeles County Area.

Section 11.38.620 Hose Watering Prohibition. No person shall hose water or wash down any sidewalks, walkways, driveways, parking areas or other paved surfaces, except as is required for the benefit of public health and safety. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

Section 11.38.630 Watering of Lawns and Landscaping.

a). No person shall water or cause to be watered any lawn or landscaping between the hours of 10:00 a.m. and 5:00 p.m.

b). No person shall water or cause to be watered any lawn or landscaping more than once a day.

c). No person shall water or cause to be watered any lawn or landscaping to such an extent that runoff into adjoining streets, parking lots or alleys occurs due to incorrectly directed or maintained sprinklers or excessive watering.

d). It shall be the duty of all persons to inspect all hoses, faucets and sprinkling systems for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

e). Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

Section 11.38.640 Indoor Plumbing and Fixtures.

a). It shall be the duty of all persons to inspect all accessible indoor plumbing and faucets for leaks and to cause all leaks to be repaired as soon as is reasonably practicable.

b). Willful violation hereof shall be an infraction punishable by a fine of $500.00.

Section 11.38.650 Washing Vehicles.
No motor vehicle, boat, trailer or other type of mobile equipment may be washed, except at a commercial car wash or with reclaimed water, unless such vehicle is washed by using a hand-held bucket or a water-hose equipped with an automatic shutoff nozzle. No person shall leave a water hose running while washing a vehicle or at any other time. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

Section 11.38.660 Public Eating Places.
No restaurant, hotel, cafeteria, cafe or other public place where food is sold or served shall serve drinking water to any customer unless specifically requested to

do so by such customer. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

Section 11.38.670 Decorative Fountains.
No person shall use water to clean, fill or maintain levels in decorative fountains, ponds, lakes, or other similar aesthetic structures unless such water flows through a recycling system. Willful violation hereof shall be an infraction punishable by a fine of $100.00 for the first infraction and $500.00 each for subsequent infractions.

Section 2. This ordinance shall terminate on January 1, 1993, unless renewed or terminated earlier by ordinance.

Section 3. Due to the severity of the drought in the State of California, there is an immediate need to prohibit the wasting of water in the Los Angeles County unincorporated area to better utilize the available water supplies. This ordinance is urgently needed for the preservation of the public health, safety and general welfare and shall take effect immediately.

Section 4. This ordinance shall be published in

Metropolitan News Enterprise

a newspaper printed and published in the County of Los Angeles.

Michael D. Antonovich
Chairman

ATTEST:

Executive Officer
Board of Supervisors
of the County of Los Angeles

I hereby certify that at its meeting of March 21, 1991, the foregoing ordinance was adopted by the Board of Supervisors of said County of Los Angeles by the following vote, to wit:

Ayes:	Noes:
Supervisors Gloria Molina	Supervisors None
Edmund D. Edelman	
Deane Dana	
Michael D. Antonovich	

Executive Officer
Board of Supervisors
of the County of Los Angeles

Effective Date: March 21, 1991

Operative Date: _____

I hereby certify that pursuant to Section 25103 of the Government Code, delivery of this document has been made.
LARRY J. MONTEILH
Executive Officer
Clerk of the Board of Supervisors
By _____ DEPUTY

APPROVED AS TO FORM:
DE WITT W. CLINTON
County Counsel
By _____
GERALD F. CRUMP
Chief Assistant County Counsel

44

. . . S A M P L E N O T I C E . . .

LOS ANGELES COUNTY WATER WASTING ORDINANCE
NOTICE OF WARNING

Date _____

Address: _____
_____
_____
_____

Dear Customer:

Due to the severity of the current drought, the County Board of Supervisors, on March 21, 1991, adopted an Ordinance that specifies a number of water saving measures. The Ordinance applies to the unincorporated areas of the County and includes the following provisions:

__ Washing down of paved surfaces is prohibited, except as required for public health and safety.

__ Lawn and landscape watering is prohibited between the hours of 10:00 a.m. and 5:00 p.m.

__ Landscape watering that results in runoff into adjoining streets, parking lots or alleys due to misdirected sprinklers or excessive watering is prohibited.

__ Leaking hoses, faucets and sprinkling systems must be repaired as soon as is reasonably practicable.

__ Leaks to indoor plumbing systems must be repaired as soon as is reasonably practicable.

__ Washing of a motor vehicle, boat or trailer is prohibited except at a commercial car wash or with a hand-held bucket or water hose equipped with an automatic shutoff nozzle.

__ Serving drinking water to customers at public eating places is prohibited unless specifically requested by such customers.

__ Water cannot be used in decorative fountains, ponds, lakes and other similar aesthetic structures unless the water flows through a recycling system.

We observed the violation(s) of the above noted provisions on your property. We request your support in complying with the provisions of this ordinance so that we can avoid unnecessary waste and stretch our limited water supplies for the duration of the drought. Violation of this Ordinance is punishable by a fine of up to $500. If you have any questions regarding this ordinance or its enforcement please contact (your office and phone number).

(WW3901)

Appendix VI

RESOLUTION

ADOPTING A WATER SHORTAGE CONTINGENCY PLAN
FOR THE SANTA CLARITA WATER COMPANY

WHEREAS, the California Legislature enacted Assembly Bill 11X during the 1991 Extraordinary Session of the California Legislature (an act to amend the California Water Code Sections 10620, 10621, 10631, and 10652, and to add Section 10656 to the California Water Code, relating to water); and

WHEREAS, AB 11X mandates that every urban water supplier providing municipal water directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre feet of water annually to develop a Water Shortage Contingency Plan; and

WHEREAS, AB 11X mandates that said Plan be filed with the California Department of Water Resources by January 31, 1992; and

WHEREAS, the Santa Clarita Water Company is an urban supplier of water providing water to more than 3,000 customers, and has therefore prepared and circulated for public review a Draft Water Shortage Contingency Plan, in compliance with the requirements of AB 11X, has held a properly noticed public hearing on January 29, 1992, regarding said Draft Plan, and has thereafter prepared a Final Water Shortage Contingency Plan;

NOW, THEREFORE, BE IT RESOLVED by the Santa Clarita Water Company's Board as follows:

1. A Final Water Shortage Contingency Plan is hereby adopted and is attached hereto as Exhibit "A" hereof, which exhibit is hereby incorporated herein;

2. The President is hereby authorized and directed to file the Plan with the California Department of Water Resources;

3. The President is hereby also authorized to follow lawful procedures to declare a Water Shortage Emergency and to implement this Water Shortage Contingency Plan; and

4. The President shall recommend to the Santa Clarita Water Company's Board additional procedures, rules, and regulations to carry out effective and equitable allocation of water resources during a water shortage.

Appendix VI

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3. The President is hereby also authorized to follow lawful procedures to declare a Water Shortage Emergency and to implement this Water Shortage Contingency Plan; and

4. The President shall recommend to the Santa Clarita Water Company's Board additional procedures, rules, and regulations to carry out effective and equitable allocation of water resources during a water shortage.

ORDINANCE NO. 112
AN ORDINANCE AMENDING ORDINANCE 101
WATER CONSERVATION, SHORTAGE, DROUGHT AND
EMERGENCY RESPONSE
ORDINANCE OF
NEWHALL COUNTY WATER DISTRICT

* * * * * * * * * * * * * * * * * ** * * * * * * * *

Be it ordained by The Board of Directors of Newhall County Water District, Los Angeles County, California, Ordinance No. 101 is amended to read as follows:

Section 1: ***PURPOSE*****:** The specific provisions of this Ordinance are necessary and proper to conserve water resources and minimize cost to the District and its customers. The District requires that water resources available to the District be put to the maximum beneficial use, and that water efficient practices be used to reach this objective. The District further finds that its water supplies may be reduced because of drought, failure of facilities, or catastrophic events such as earthquakes and regional power failures. Anti-waste and water conservation requirements are necessary to achieve demand reduction without unneeded hardship.

Section 2: ***DEFINITIONS AND TERMS:***

A. ***Water efficient practices****:* Cost-effective practices that require the least amount of water to generate the greatest benefit (water and cost savings) to the customer.

B. ***Water Waste:*** To use or expend water carelessly or needlessly.

C. ***Water User:*** Business or residential customer of the District.

D. ***Water Conservation Stages:*** The General Manager shall determine the conservation stage, except that the Board shall determine any conservation stage more restrictive than Stage 1. A water deficiency occurs when the current or near-term water demand exceeds the current or near-term water supply.

Stage 1. Water deficiencies range between 1 and 15 percent.

Stage 2. Water deficiencies range from more than 15 and up to 25 percent.

Stage 3. Water deficiencies range from more than 25 and up to 35 percent.

Stage 4. Water deficiencies are more than 35 percent.

E. ***Water Deficiency:*** A water deficiency occurs when the current or near-term water demand exceeds the current or near-term water supply, based on a yearly assessment. (Percent or deficiency = (1 – water supply/water demand) x 100

Section 3: ***WATER CONSERVATION ACTION PLAN:*** This plan establishes water conservation measures to be taken in response to current and anticipated levels of deficiency in State and/or local water supplies. No Water User shall waste water or make, cause, or permit the use of water for any purpose contrary to any provision of this Ordinance, or in quantities in excess of the use permitted by the conservation stage in effect pursuant to this Ordinance.

3.1 Efficient Water Use. *Because more severe effects of a water shortage are often brought about due to wasteful water use habits carried over from times of sufficient supply, certain voluntary water-use practices are encouraged at all times.*

3.1.1 Outdoor Water Use Efficiency Guidelines and Recommendations:

a) Sprinklers should be maintained and adjusted so that overspray, runoff, and water waste is avoided. The most effective and water-efficient irrigation should be used, and drip irrigation should be considered where appropriate.

b) All leaks in plumbing and irrigation systems should be repaired promptly

c) Vehicles should be washed using a hose equipped with automatic shutoff nozzle.

d) Sidewalks, walkways, driveways, parking lots or any other hard-surfaced areas should not be washed down, except for health and safety purposes.

e) Low-water-use native or drought-tolerant vegetation should be used to minimize the need for irrigation. Plants and trees with similar water needs should be grouped together for most efficient irrigation. (Please see our website ncwd.org for more information and links to other websites listing drought tolerant plants.)

f) Landscape should be installed in a manner that will reduce the amount of water needed for irrigation. For example, the use of mulches and watering basins is encouraged where appropriate.

g) Irrigation should occur during optimal watering hours, avoiding wind and heat. The following hours are considered the most efficient hours for NCWD customers to effectively irrigate lawns and landscaped areas:

Winter/Fall (November through April) – 6 PM to 10 AM

Spring/Summer (May through October) –8 PM to 9 AM

h) Water usage on any decorative fountains, ponds or other types of water streams should be minimized by incorporating a water recycling system so the water is continually recovered and reused.

i) Pool and spa safety covers or evaporation-reducing water treatments should be considered if safe and appropriate for the situation. These will help minimize water loss due to evaporation. Pool and spa chemistry should be balanced and maintained to help reduce the frequency of pool/spa draining and refilling.

3.1.2 Indoor Water Use Efficiency Guidelines and Recommendations:

a) All leaks and/or damage to faucets, toilets, and indoor pipes should be repaired immediately.

b) Low flow devices for indoor plumbing fixtures including faucets, kitchen spray nozzles, toilets, and showers should be used where possible.

c) Install 1.0 gallon per flush (gpf) ultra low-flow toilets or dual-flush toilets.

d) Water-efficient Energy Star® approved appliances including, but not limited to, clothes washers and dishwashers should be used.

e) Clothes washers and dishwashers should be run using full loads to maximize water efficiency.

f) A source specific hot water dispenser or a whole house hot water recirculation system should be considered. These devices generate hot water within seconds, minimizing running the water until it is hot.

g) All commercial establishments where food or beverages are provided should encourage the serving of water to their customers only when specifically requested by the customer.

3.1.3 ***New Construction Water Efficiency Guidelines:*** As new technology advances, builders of new structures or persons retrofitting existing facilities should consider options such as evapotranspiration-controlled sprinkler systems, grey water or non-potable water systems (where legally acceptable), storm water cisterns, and landscape designs minimizing the use of turf and water-intensive plants. Businesses should review industry-specific guidance for ways to reduce water usage and should consider programs such as multi-pass cooling towers and process water recycling.

3.2 ***Water Conservation Stage 1 –:*** *At this stage of water deficiency, the Water Users are strongly encouraged to adhere to all the guidelines in section 3.1, Water Use Efficiency Guidelines. The following practice is also strongly suggested during Stage 1 water deficiencies:*

a) Outdoor irrigation of all vegetation including lawns and landscaping is limited to three times per week and no more than 10 minutes per watering station. Irrigation should occur during the following hours:

Winter/Fall (November through April) – 6 PM to 10 AM

Spring/Summer (May through October) – 8 PM to 9 AM

3.3 ***Water Conservation Stage 2:*** *At this stage of water deficiency, Efficient Water Use Guidelines (3.1.1-3.1.2 above) and Stage 1 practices (3.2 above) become mandatory requirements. Further mandatory practices during Stage 2 are as follows:*

a) All new landscaping shall be limited to widely accepted drought-tolerant plants requiring less than typical water requirements.

b) No new lawns, whether by seed or sod, shall be installed.

c) No filling of pools or spas. Water levels may be maintained.

3.4 Water Conservation Stage 3: *At this stage of water deficiency, Efficient Water Use Guidelines (3.1.1-3.1.2 above), Stage 1 practices (3.2 above), and Stage 2 practices (3.3 above) become mandatory requirements. Further mandatory practices during Stage 3 are as follows:*

a) No new applications for service will be accepted.

b) No water for grading will be allowed.

c) Washing vehicles is prohibited, except at commercial facilities that recycle water.

d) Street cleaning with potable water is prohibited.

3.5 Water Conservation Stage 4: *At this stage of water deficiency, Efficient Water Use Guidelines (3.1.1- 3.1.2 above), Stage 1 practices (3.2 above), Stage 2 practices (3.3 above), and Stage 3 practices (3.4 above) become mandatory requirements. Further mandatory practices during Stage 4 are as follows:*

a) Outdoor irrigation of all vegetation including lawns and landscaping is prohibited. Existing trees and larger shrubs will be exempt.

b) No new landscaping shall be permitted.

Section 4: ENFORCEMENT:

4.1 Efficient Water Use and Stage 1 Enforcement:

a) Any notification to the District of signs or indications of water leaks or water waste will be documented. The District will confirm the water waste prior to any further action.

b) The District shall determine the action to be taken to inform the Water User of the guidelines in this Ordinance and to encourage more efficient and cost-effective water use.

4.2 Stage 2, 3 and 4 Enforcement. *The General Manager, and other District authorized representatives have the duty and are authorized to enforce provisions of Stage 2, 3, and 4 of this Ordinance. If a violation is ongoing, the District may disconnect service until the violation is corrected.*

4.2.1 First Violation. For a first violation, the District shall issue a verbal warning to the Water User and recommend corrective action.

4.2.2 Second Violation. For a second violation, the District shall issue a written warning to the Water User, and a fine of $40 shall be added to the Water User's bill at the property where the violation occurred if the corrective action is not taken within 30 days after receiving the written warning.

4.2.3 Third Violation. For a third violation, a fine of $100 shall be added to the Water User's bill at the property where the violation occurred if the corrective action is not taken within 30 days after receiving the written warning. In addition to the fine, the Board or the General Manager may require installation of a flow-restricting device on the Water User's service connection.

4.2.4 ***Fourth Violation.*** For the fourth and any additional violations, a fine of $250 shall be added to the Water User's bill at the property where the violation occurred. The District may also discontinue the Water User's water service at the property where the violation occurred. Re-connection shall be permitted only when there is reasonable protection against future violations, such as a flow-restricting device on the customer's service connection, as determined at the District's discretion.

4.3 ***District Enforcement Costs.*** District shall be reimbursed for its costs and expenses in enforcing the provisions of this Ordinance, including such costs as District incurs for District staff to investigate and monitor the Water User's compliance with the terms of this Ordinance. Charges for installation of flow-restricting devices or for discontinuing or restoring water service, as the District incurs those charges, shall be added to the Water User's bill at the property where the enforcement costs were incurred.

Section 5: ***ADMINISTRATION:***

5.1 ***General.*** The provisions of this Ordinance shall be administered and enforced by the District through the General Manager, who may delegate such enforcement to one or more employees or contractors of the District. The District may implement additional demand reduction practices, including surcharges, rationing, and specific water allocations, in times of severe shortage or emergency situations.

5.1.1 ***Water Utility Accounts.*** Accounts shall not be established for new customers, including the transfer of accounts upon change of ownership, until the customer agrees to comply with the provisions of this Ordinance. In pursuing the objectives of this Ordinance, the General Manager shall seek the cooperation of other water purveyors within the District's service area. The District will request that other water purveyors not permit the establishment of new accounts until the customer agrees to comply with the provisions of this Ordinance.

5.1.2 ***Discretionary Exemptions.*** The Board may, in its discretion, exempt Water Users and individual facilities of Water Users from the provisions of this Ordinance, or impose reasonable conditions in lieu of compliance with this Ordinance, if the Board finds that any of the following conditions exist:

a) Hardship. The requirements of this Ordinance would cause an unnecessary and undue hardship upon the Water User, the Water User facility or the public.

b) Health and Safety. Strict compliance with the requirements of this Ordinance would create an emergency condition, as determined by the Board or other governmental entity with appropriate jurisdiction, affecting the health, protection or safety of the Water User or the public.

c) No Impact on Water Use. The granting of the exemption or imposition of reasonable conditions in lieu of compliance with this Ordinance would not increase the quantity of water consumed by the Water User or otherwise adversely affect service to other Water Users. In other words, the Water User will create an offset. In granting any such relief, the departure from the requirements of this Ordinance shall be limited to the minimum necessary to address the circumstances upon which such departure is required by a Water User.

5.1.3 ***Appeals.*** Any customer or applicant for a water service may appeal any decision under this Ordinance to the Board whose decision shall be final.

ADOPTED, APPROVED AND SIGNED by the Board of Directors of NEWHALL COUNTY WATER DISTRICT this 14th day of July, 2005.

_____
MARIA GUTZEIT, President of the
Board of Directors of
NEWHALL COUNTY WATER DISTRICT

ATTEST:

_____
Karin J. Russell, Secretary of the
Board of Directors of
NEWHALL COUNTY WATER DISTRICT

Appendix H
References

Appendix H
REFERENCE LIST

The following documents were used in the preparation of the 2005 Urban Water Management Plan for the Santa Clarita Valley:

2000 Urban Water Management Plan, Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Company, Valencia Water Company, December 2000, prepared by SA Associates, Reiter/Lowry/Consultants, and Black & Veatch.

2000 Urban Water Management Plan Groundwater Perchlorate Contamination Amendment and Other Amendments, Castaic Lake Water Agency, CLWA Santa Clarita Water Division, Newhall County Water District, Valencia Water Company, January 2005, prepared by Luhdorff & Scalmanini Consulting Engineers.

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2004b. Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, presented in Support of the 97-005 Permit Application, prepared for the Upper Basin Water Purveyors (Castaic Lake Water Agency, Santa Clarita Water Division of CLWA, Newhall County Water District, and Valencia Water Company), December, prepared by CH2M HILL.

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Castaic Lake Water Agency Draft Report, Recycled Water Master Plan, May 2002, prepared by Kennedy/Jenks Consultants.

Castaic Lake Water Agency Final Environmental Impact Report – Supplemental Water Project Transfer of 41,000 Acre-Feet of State Water Project Table A Amount, December 2004, prepared by Science Applications International Corporation.

Castaic Lake Water Agency Groundwater Containment, Treatment, and Restoration Project, Mitigated Negative Declaration, August 2005, prepared by Black & Veatch.

Castaic Lake Water Agency Groundwater Management Plan – Santa Clara River Valley Groundwater Basin, East Subbasin, December 2003, prepared by Luhdorff & Scalmanini Consulting Engineers.

Castaic Lake Water Agency Recycled Water Master Plan Program Environmental Impact Report Notice of Preparation and Initial Study, April 2005, prepared by BonTerra Consulting.

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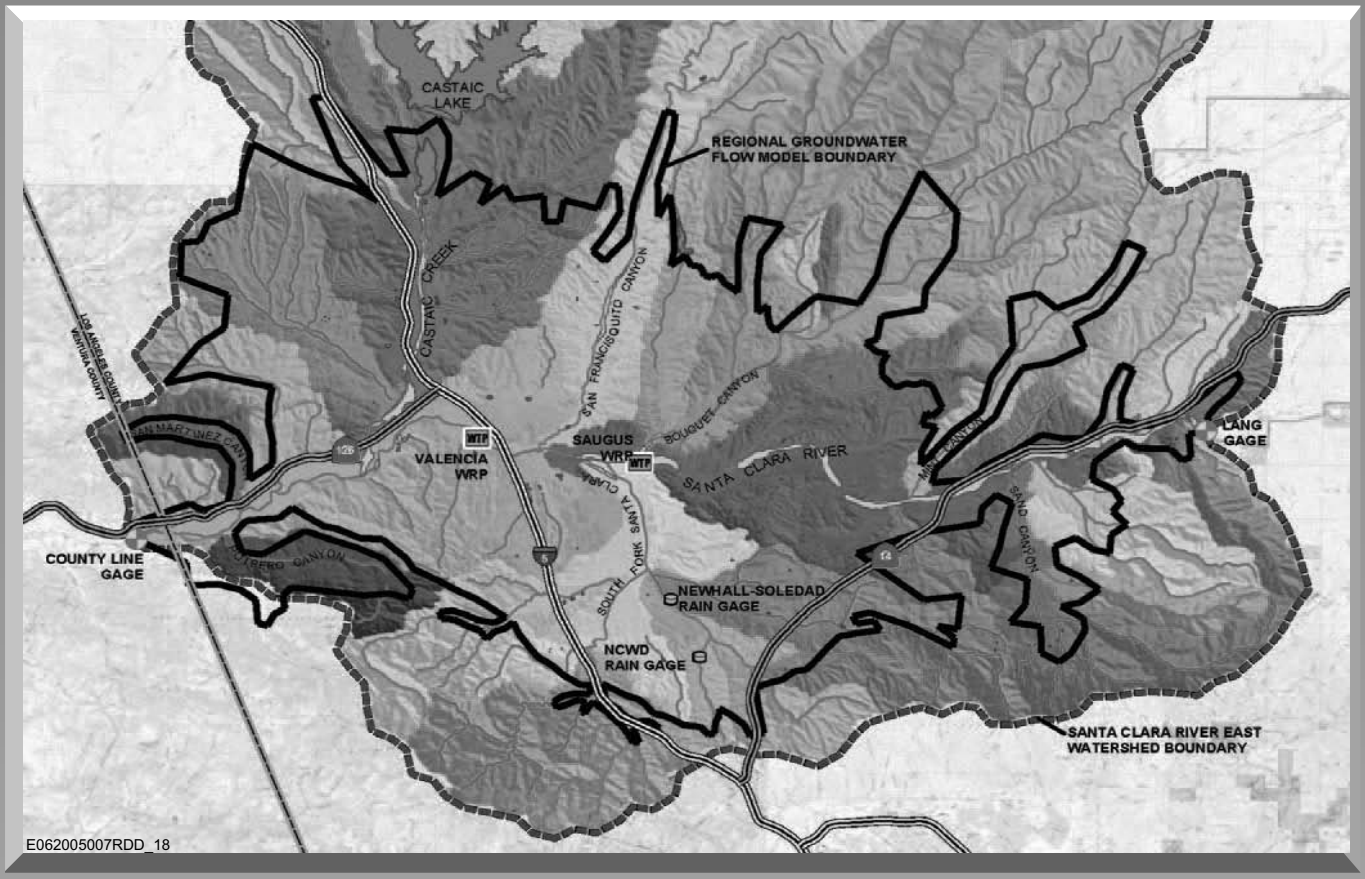
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Prepared in Support of the August 2001 Memorandum of Understanding between the Upper Basin Water Purveyors and the United Water Conservation District



Prepared by

CH2MHILL

In cooperation with
Luhdorff & Scalmanini Consulting Engineers

August 2005

Prepared for
Upper Basin Water Purveyors:
Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
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September 23, 2005

178973.A4.02

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Mr. William Manetta
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Mr. Steve Cole
Newhall County Water District
P.O. Box 220970
23780 North Pine Street
Santa Clarita, California 91322-0970

Subject: Submittal of Report on Basin Yield Analysis

Dear Mr. DiPrimio, Mr. Masnada, Mr. Manetta, and Mr. Cole:

CH2M HILL is pleased to submit the enclosed report titled *Analysis of Groundwater Basin Yield, Upper Santa Clara River Basin, East Subbasin, Los Angeles County, California*. This report has been developed for the Upper Basin Water Purveyors and is the second of two reports that present and evaluate the groundwater operating plan for water supply wells completed in the Alluvial Aquifer and the Saugus Formation. This work has been performed as part of the August 2001 Memorandum of Understanding between the Santa Clara River Valley Upper Basin Water Purveyors and the United Water Conservation District. The first report, dated April 2004, documented the construction and calibration of a groundwater flow model for the Santa Clarita Valley. The enclosed report presents a modeling analysis of the groundwater operating plan and concludes that the groundwater operating plan is a reliable long-term component of water supply for the valley.

It has been our pleasure to serve the Upper Basin Water Purveyors on this important project. Please call me at 503/235-5022 if you have any questions.

Sincerely,

CH2M HILL

John J. Porcello
Project Manager

Nathan R. Brown, P.G.
Hydrogeologist

RDD/051860005 (CAH3130.doc)
Enclosures

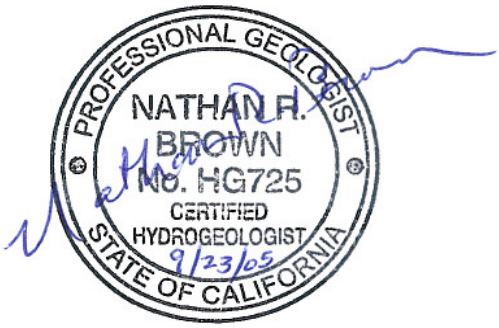
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Prepared in Support of the August 2001 Memorandum of Understanding between the Upper Basin Water Purveyors and the United Water Conservation District

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water Company



Prepared by

CH2MHILL

In cooperation with

Luhdorff & Scalmanini Consulting Engineers

August 2005

Contents

Page

Section

Acronyms and Abbreviations xi

1 Introduction 1-1
1.1 Background 1-1
1.2 Report Organization 1-4

2 Groundwater Hydrology and Operating Plan 2-1
2.1 Basin Hydrogeology 2-1
2.2 Groundwater Operating Plan 2-2
2.2.1 Historical Groundwater Conditions 2-2
2.2.2 Historical Estimates of Basin Yield 2-7
2.2.3 Development of Current Operating Plan 2-9

3 Modeling Approach for Analyzing Basin Yield 3-1
3.1 Model Description 3-1
3.2 Modeling Approach 3-2
3.3 Simulation Period 3-3
3.3.1 Selection of Simulation Period 3-3
3.3.2 Relationship of Simulation Period to Variations in Alluvial Aquifer Pumping 3-4
3.3.3 Relationship of Simulation Period to Variations in Saugus Pumping 3-5
3.4 Assignment of Pumping Rates 3-5
3.4.1 Variations in Alluvial Aquifer Pumping 3-6
3.4.2 Variations in Saugus Formation Pumping 3-7
3.4.3 Monthly Allocation of Pumping 3-7
3.4.4 Influence of Perchlorate Contamination on Groundwater Pumping 3-7
3.5 Simulation Methods for Other Local Hydrologic Processes 3-10
3.5.1 Recharge from Urban Irrigation 3-10
3.5.2 Recharge from Agricultural Irrigation 3-10
3.5.3 Precipitation Recharge 3-11
3.5.4 Stormwater Flows and Recharge from Streams 3-11
3.5.5 WRP Discharges to the Santa Clara River 3-11
3.5.6 Monthly Assignment and Tracking of Surface Water Budget 3-12
3.6 Running the Model and Evaluating Results 3-12

4 Model Results 4-1
4.1 Groundwater Elevations 4-1
4.2 Groundwater Recharge, Discharge, and Storage 4-1

Contents, Continued

Page

4.3 River Flows 4-2
4.4 Relationship of Simulation Results to Future Conditions 4-3

5 Conclusions 5-1
5.1 Principal Findings 5-1
5.2 Implications for Long-term Water Management 5-2

6 References 6-1

Appendices

A Memorandum of Understanding
B Description of the Santa Clarita Valley Regional Groundwater Flow Model

Tables—Located at the end of each section.

2-1 Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin

2-2 Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999

2-3 Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999

2-4 Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 versus 1975 through 1999

2-5 Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974

2-6 Annual Pumping Rates Specified by the Operating Plan for the Santa Clarita Valley's Groundwater Resources

2-7 CALSIM II Calculated State Water Project Municipal and Industrial Allocations

3-1 Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003

3-2 Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation

3-3 State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation

3-4 Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Contents, Continued

Tables, continued

3-5 Simulated Annual Groundwater Pumping from the Saugus Formation for the 78-year Simulation

3-6 Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

3-7 Allocation of Pumping, by Month, for Agricultural and Urban Production Wells

3-8 Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

3-9 Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

3-10 Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

3-11 Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)

3-12 Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

3-13 Simulated Monthly Treated Wastewater Discharge from Santa Clarita Valley WRPs under Full Build-out Conditions

4-1 Simulated Annual Groundwater Budget

Contents, Continued

Figures—Located at the end of each section.

1-1 Map of Study Area

2-1 Groundwater Basins in the Santa Clara River Drainage

2-2 Basin Geologic Map

2-3 Santa Clarita Valley Hydrology

2-4 Regional Well Location Map

2-5 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage

2-6 Annual Precipitation at the Newhall-Soledad and NCWD Rain Gages since 1950

2-7 Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

2-8 Alluvial Groundwater Elevations versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-9 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-10 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

2-11 Saugus Groundwater Elevations along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-12 Saugus Groundwater Elevations along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

2-13 Groundwater Elevations in Adjacent Alluvial and Saugus Wells versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-14 Historical Castaic Creek Flood Flows Available to Downstream Users

3-1 Subwatersheds within the Santa Clara Valley East Watershed

3-2 Regional Model Grid

3-3 Schematic Diagram of Model's Representation of Stratigraphy in the Middle of the Basin

3-4 Schematic Cross Sections

Contents, Continued

Figures, continued

3-5 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage for the 78-year Simulation Period

3-6 Well Locations and Perchlorate Concentrations near the Whittaker-Bermite Property

3-7 Simulated Land Use within the Regional Model Boundary under Full Build-out Conditions

4-1 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer West of Interstate 5

4-2 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer East of Interstate 5

4-3 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer in Soledad Canyon

4-4 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer along Castaic Creek

4-5 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer along the South Fork Santa Clara River

4-6 Simulated Average Annual Groundwater Elevations in the Saugus Formation West of Interstate 5

4-7 Simulated Average Annual Groundwater Elevations in the Saugus Formation East of Interstate 5

4-8 Simulated Annual Groundwater Inflows

4-9 Simulated Annual Groundwater Outflows

4-10 Simulated Annual and Cumulative Change in Groundwater Storage

4-11 Simulated Santa Clara River Flow at County Line

4-12 Simulated Groundwater Discharge to Santa Clara River

Acronyms and Abbreviations

µg/L	micrograms per liter
AF/yr	acre-feet per year
AL	State of California's Action Level
Amended 2000 UWMP	2000 Urban Water Management Plan and 2005 amendments
CLWA	Castaic Lake Water Agency
DWR	California Department of Water Resources
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
in/yr	inches per year
Kh	horizontal hydraulic conductivity
LACSD	Los Angeles County Sanitation District
LADPW	Los Angeles County Department of Public Works
LSCE	Luhdorff & Scalmanini Consulting Engineers
MOU	Memorandum of Understanding
msl	mean sea level
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
OCAP	Operating Criteria and Plan
Purveyors	Upper Basin Water Purveyors
RCS	Richard C. Slade and Associates, LLC
Regional Model	Santa Clarita Valley Regional Groundwater Flow Model
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
T	transmissivity
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
UWMP	Urban Water Management Plan

VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
UWCD	United Water Conservation District

SECTION 1

Introduction

This report presents an evaluation of the long-term sustainability of existing groundwater management practices in the Santa Clarita Valley, located in northwestern Los Angeles County, California. The groundwater system in the Santa Clarita Valley is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07) and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Groundwater in the basin is pumped from a shallow Alluvial Aquifer and deeper groundwater resources that are present in an older, underlying unit called the Saugus Formation. Most groundwater pumping is by the local water purveyors (the Upper Basin Water Purveyors [herein referred to as the Purveyors[1]]) for municipal uses (in the range of approximately 23,000 to 28,000 acre-feet per year [AF/yr] in recent years), with some continuing pumping by private landowners, primarily for irrigation uses (approximately 15,000 to 16,000 AF/yr in recent years). The Purveyors also have access to other sources of water, including imported State Water Project (SWP) water, groundwater banking outside the basin, recycled water, short-term water exchanges, and dry-year water purchase programs (Luhdorff & Scalmanini Consulting Engineers [LSCE], 2005a). The water management practices of the Purveyors call for maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, and limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus Formation pumping during years when supplemental imported water supplies are significantly reduced because of drought conditions.

The evaluation of the Purveyors' current groundwater management practices has been performed using a detailed numerical groundwater flow model of the basin. The model, called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. The Regional Model has been developed for the Purveyors as a tool for the analysis of groundwater management options in the context of future water demands and water supply conditions in the valley. Among the objectives in developing the model were (1) to be able to evaluate the long-term sustainability (yield) of the Alluvial and Saugus aquifer systems under a range of existing and potential future water resource management conditions, and (2) to facilitate general management of water quantity and water quality issues. Figure 1-1 is a map showing the area simulated by the model (tables and figures are located at the end of each section).

1.1 Background

The Regional Model has been developed as part of the work scope contained in an August 2001 Memorandum of Understanding (MOU) that was entered into by the

[1]The Purveyors consist of the Castaic Lake Water Agency (CLWA), the Newhall County Water District, the Santa Clarita Water Division of CLWA, and the Valencia Water Company. The Santa Clarita Water Division of CLWA was acquired by CLWA in 1999. It was formerly called the Santa Clarita Water Company (SCWC).

Purveyors and the United Water Conservation District (UWCD), located downstream in Ventura County. The MOU, which is provided in Appendix A, is a commitment by the Purveyors to expand on previous analyses of groundwater conditions such that the adequacy of the local groundwater supply can be better understood and questions about surface water and groundwater resources can be more readily addressed. The MOU initiated a collaborative and integrated approach to data collection; database management; evaluating groundwater conditions and the sustainability of the Purveyors' operating plan; groundwater flow modeling; annual reporting on basin conditions; and technical reporting focused on geologic and hydrologic aspects of the overall stream-aquifer system.

In 2003, subsequent to the MOU, CLWA prepared and adopted a formal Groundwater Management Plan (CLWA, 2003), which includes 14 elements intended to achieve four management objectives, or goals, for the groundwater basin that were identified in the plan. Those four management objectives were development of local groundwater for water supply; avoidance of overdraft and associated undesirable effects; preservation of groundwater quality; and preservation of interrelated surface water resources. The intent of the Groundwater Management Plan is to ensure that ongoing utilization of local groundwater continues to result in acceptable aquifer conditions, specifically avoidance of overdraft (Element 3 of the plan), no degradation of quality (Element 6 of the plan), no adverse impacts to surface waters (Element 2 of the plan). The plan identified these objectives and elements as being accomplished via continued conjunctive use operations that have been ongoing since the initial importation of supplemental surface water in 1980 (Element 5 of the plan) and via monitoring and interpretation of surface water and groundwater conditions on an ongoing basis (Elements 1 and 2 of the plan).

Both the MOU and the Groundwater Management Plan contain several technical components, including the development and calibration of a regional-scale groundwater flow model and the application of the model to evaluate the sustainability of the Purveyors' current groundwater operating plan. The development and calibration of the model was documented in detail in April 2004 in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a). A summary of the Regional Model's construction and calibration is presented in Appendix B. The analysis of the sustainability of the Purveyor's current groundwater operating plan began in 2004 and is the subject of this report. Consequently, this report and the earlier report on the development and calibration of the model represent the accomplishment of two of the key technical work components that were described in the MOU and in several elements of the Groundwater Management Plan.

The Purveyors prepared the first Urban Water Management Plan (UWMP) for the Santa Clarita Valley in 1985. At about that same time, the Purveyors began studying the local water resources to assess the condition, hydrogeologic character, storage capacity, water budgets, and water quality of the local groundwater aquifers. Some of that work involved evaluating the potential for conjunctive use of groundwater and imported water resources, specifically artificial recharge of the Alluvial Aquifer using spreading basins, and aquifer storage and recovery in the Saugus Formation. An update of the UWMP in December 2000 projected water demands in the valley through 2020 and delineated a number of local and other water supplies, in conjunction with SWP water, to meet those projected water demands. The UWMP also identified a water supply plan that consisted of using alternate

supplies and/or development of future supplies from groundwater storage projects, short-term transfers, local groundwater, and other sources to offset potentially reduced deliveries of SWP water, while meeting demands in a manner that would not cause overdraft conditions in the local aquifer systems. In 2005, CLWA amended the 2000 UWMP to address the adequacy of groundwater supplies in light of perchlorate contamination that had caused the inactivation of five municipal water supply wells. Included in the amendments to the 2000 UWMP (CLWA et al., 2005; hereafter referred to, together with the 2000 UWMP [Black & Veatch, 2000], as the Amended 2000 UWMP) was discussion of the plan currently being implemented to install treatment and restore impacted wells for water supply by 2006. In accordance with the California Urban Water Management Planning Act, the UWMP is currently undergoing a 5-year update that will be completed in late 2005.

The Purveyors and UWCD initially agreed in the MOU, and the Purveyors subsequently committed in the Groundwater Management Plan, to develop and use the Regional Model for the sustainability evaluation of the local groundwater operating plan, in part because (1) the available data showed that no long-term lowering of the water table or degradation of water quality had occurred during the 50 to 60 years of historical groundwater development in the valley, and (2) the various studies and water planning efforts performed up to that time had resulted in a local groundwater operating plan that places future pumping of the Alluvial Aquifer in the same range as historical pumping. However, although the MOU recognized a need to formally analyze the Alluvial Aquifer, it identified that the primary question to evaluate with the Regional Model would be the operational yield of the Saugus Formation, given that the Purveyors' operating plan called for dry-year pumping at rates higher than historically had been pumped. For that reason, the MOU identified that the model would evaluate the effect of the current groundwater operating plan on groundwater conditions in both the Alluvial Aquifer and the Saugus Formation over a multi-year wet/dry cycle. The operational yield was defined in the MOU as an operating plan for the local groundwater basin that would allow continued pumping from the Alluvial Aquifer and Saugus Formation while assuring that groundwater supplies would be adequately replenished from one wet/dry cycle to the next.

Together, the historical development of these plans and the evaluation of their sustainability that is described in this report are grounded in the following objectives, which have been identified by the Purveyors for local groundwater resource management:

1. Prepare a groundwater operating plan for the basin (locations of wells, pumping capacities, and variations in annual pumping volumes) that is integrated with SWP and other imported supplies and recycled water to meet local water demands.

2. Analyze the groundwater operating plan to quantify possible basin responses to the plan, in terms of temporal variations that could occur in groundwater levels, groundwater storage, and Santa Clara River streamflows. This includes evaluating the rate of recovery of Saugus Formation groundwater levels after 1 or more years of increased pumping in the Saugus Formation.

3. Evaluate the range of basin responses to the groundwater operating plan to determine whether the plan will result in sustainable groundwater resources and supplies. This includes evaluating the following:

    a. Whether groundwater level declines during future drought periods will continue to arise primarily from local drought conditions, instead of from the groundwater operating plan for the basin; and, more importantly, whether groundwater levels and storage will recover (recharge) in wet periods following dry or drought conditions

    b. Whether groundwater discharges to the Santa Clara River will continue to be relatively stable over time, compared to the year-to-year variations in groundwater recharge that occur in the rest of the basin

To meet these objectives, the Purveyors developed the Regional Model to be an evolving tool for local groundwater resource management. As discussed in the model development report (CH2M HILL, 2004a), specific objectives identified for the Regional Model were as follows:

1. To evaluate the long-term sustainability (yield) of the two aquifer systems in the valley, the Alluvial Aquifer and the Saugus Formation, under a range of existing and potential future water resource management conditions

2. To evaluate artificial recharge for the purpose of increasing the long-term sustainability of the aquifer system, particularly in conjunction with the availability of imported surface water supplies

3. To evaluate the influences of future water management plans and alternatives on groundwater conditions in the valley and on the flows of water into the downstream basins in Ventura County

4. To facilitate general management of water quantity and water quality issues

This report focuses on the application of the Regional Model to meet the first objective.

1.2 Report Organization

The remainder of this report is organized as follows:

- **Section 2** discusses the hydrogeology of the basin and describes the groundwater operating plan.
- **Section 3** describes the process that was used to simulate the groundwater operating plan with the Regional Model and evaluate the modeling results.
- **Section 4** discusses the results of the simulated groundwater operating plan.
- **Section 5** discusses the principal findings from the analyses of historical data and numerical modeling results, and the implications of these findings for long-term water management in the Santa Clarita Valley.
- **Section 6** is the reference list.

Figure

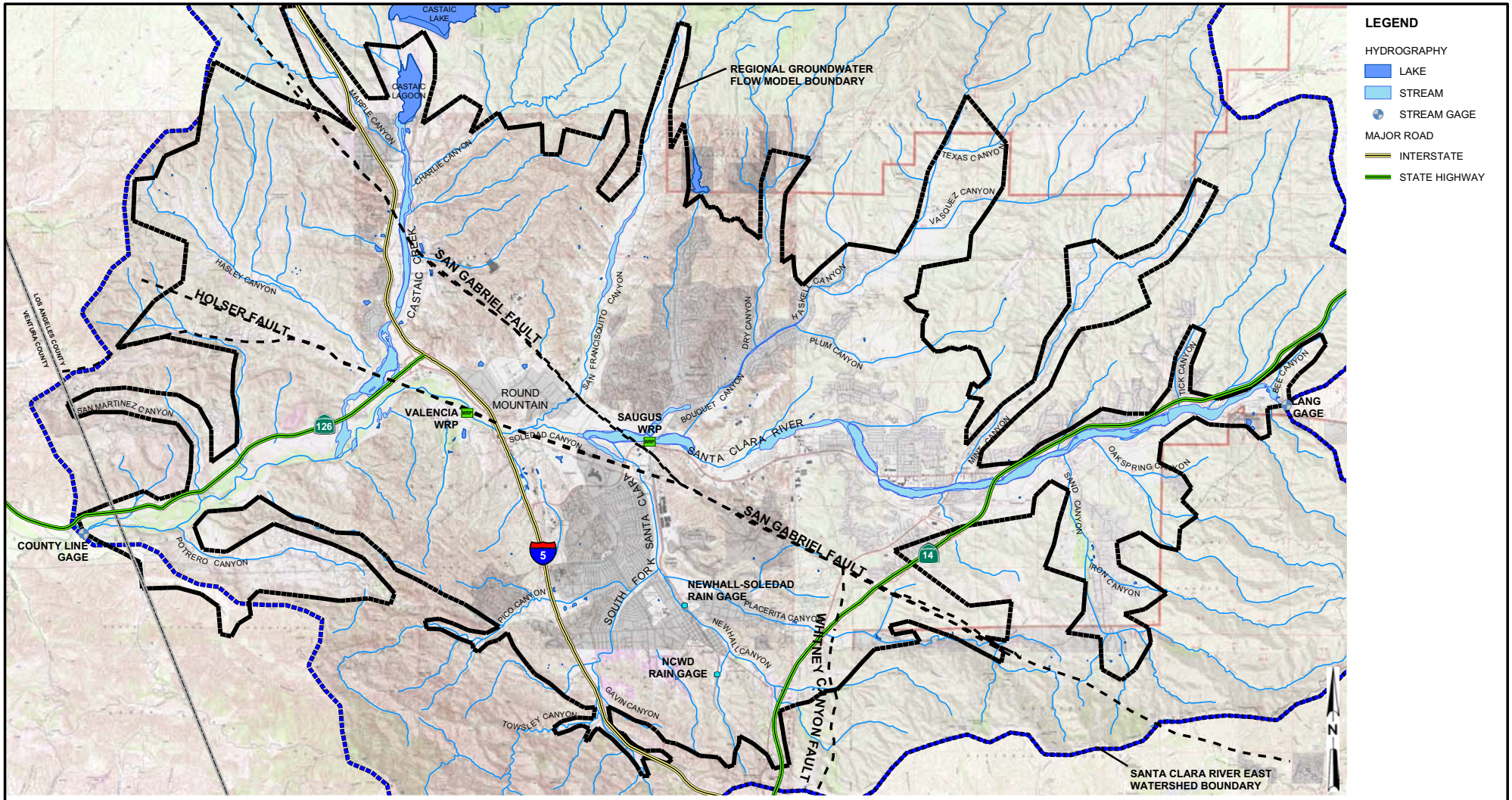


FIGURE 1-1
MAP OF STUDY AREA
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 2

Groundwater Hydrology and Operating Plan

2.1 Basin Hydrogeology

The groundwater system in the Santa Clarita Valley is identified by DWR as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Figure 2-1 shows the location of this groundwater basin. The basin contains two aquifer systems: the Alluvial Aquifer and the Saugus Formation. Figure 2-2 is a geologic map showing the geographical extent of these and other rock units in and around the basin.

In general, natural groundwater recharge occurs in the eastern portion and at the northern and southern limits of the basin, and natural groundwater discharge occurs in the west-central portion of the basin, in the alluvial valley occupied by the Santa Clara River. Groundwater pumping is an additional groundwater discharge mechanism that occurs in discrete portions of the basin. A schematic representation of the regional-scale geology and hydrologic cycle in the Santa Clarita Valley is shown on Figure 2-3, and the components of the hydrologic cycle for the basin's groundwater and surface water resources are listed in Table 2-1. As indicated by the diagram and the table, groundwater is exchanged between the Alluvial Aquifer and the Saugus Formation, with the Alluvial Aquifer recharging the Saugus Formation in certain portions of the regional recharge areas, and the Alluvial Aquifer receiving groundwater from the Saugus Formation in the regional groundwater discharge areas. Additionally, the aquifer systems are affected by direct rainfall; stream-flows in the Santa Clara River and its tributaries; evapotranspiration (ET) by riparian vegetation along portions of the river; and human influences, which consist of pumping, agricultural and urban irrigation, discharge of treated water into the Santa Clara River from two water reclamation plants (WRP), and occasional releases of water into Castaic Creek from Castaic Lake and Castaic Lagoon.

The Santa Clarita Valley obtains its water supply from local groundwater sources and from imported water supplies. Total water use in the valley is largely for municipal and industrial uses and, to a lesser extent, for agricultural uses. In 2004, approximately 61 percent of groundwater pumping was by the Purveyors (for municipal uses) and 39 percent was by private land owners, primarily for irrigation. Figure 2-4 is a map showing the locations of production wells that are currently present in the Alluvial Aquifer and the Saugus Formation. Prior to the 1960s, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during much of the 1950s and early 1960s ranged between approximately 35,000 and 44,000 AF/yr. Pumping from the Alluvial Aquifer dropped gradually from approximately 40,000 AF/yr in the mid-1960s to less than 30,000 AF/yr through the 1980s, and did not rise above 30,000 AF/yr until 1993. Since then, it has ranged between 30,000 and nearly 44,000 AF/yr. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. As a

result of statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available.

2.2 Groundwater Operating Plan

The water management practices of the Purveyors call for maximizing the use of Alluvial Aquifer groundwater and SWP water during years of normal or above-normal availability of SWP water supplies and local Alluvial Aquifer groundwater resources. These practices recognize ongoing Alluvial pumping for agricultural water supply as well as other smaller (private) domestic and related water supply, and are intended to maintain overall pumping within sustainable rates. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. These water management practices are based, in part, on observations about the historical hydrology of the basin (described in Section 2.2.1) and form the groundwater operating plan for the basin (described in Section 2.2.2).

2.2.1 Historical Groundwater Conditions

Long-term water level data have been collected over the years at agricultural wells and Purveyor-owned wells in the City of Santa Clarita and along the South Fork Santa Clara River. The data have been collected in pumping wells, and the hydrographs of these wells are steep at certain times, suggesting that the measured water levels are influenced, to a certain degree, by pumping at the well. Nonetheless, the data show general relationships between groundwater elevation trends and changes in groundwater recharge and pumping over time. These relationships have been identified by examining the 50-year period from 1950 through 1999. During this period, the average rainfall was close to the long-term average rainfall observed since 1883. Consequently, long-term changes in the basin's hydrology arising from other factors could be more easily identified because rainfall was near normal for the 50-year period as a whole.

Following are discussions of the observed hydrologic trends in the basin, including rainfall, groundwater elevations in the Alluvial Aquifer and the Saugus Formation, and flows in the Santa Clara River.

2.2.1.1 Historical Trends in Rainfall

Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. The average rainfall at this gage was 17.95 inches from 1883 through 2000 and 17.84 inches from 1950 through 2000[2]. Figure 2-5 shows the annual rainfall at the Newhall-Soledad gage for calendar years 1950 through 2000. Figure 2-5 also shows the cumulative departure from the average annual precipitation since 1950. Cumulative departure refers to the cumulative amount of rainfall that is greater than or less than the long-term average rainfall. The slope of the cumulative departure plot shows the temporal trends in rainfall

[2]Annual rainfall values for the Newhall-Soledad gage were derived from monthly values reported by the National Climate Data Center and LADPW.

over successive years. The figure shows the following trends in precipitation within the Santa Clarita Valley:

1. 1950 through 1964: Dry conditions except for single wet years in 1952, 1957, 1958, and 1962 (a nearly continuous decrease in cumulative departure values)
2. 1965 through 1970: Wet conditions (increase in cumulative departure values)
3. 1971 through 1977: Average to dry conditions (flat or declining cumulative departure values)
4. 1978 through 1983: Wet conditions (increase in cumulative departure values)
5. 1984 through 1991: Dry conditions (decrease in cumulative departure values)
6. 1992 through 1999: Highly variable conditions from year to year, but overall increase in cumulative departure values

A second rain gage is located approximately 1.3 miles to the south, at the Newhall County Water District (NCWD) office (see Figure 1-1). Figure 2-6 compares the annual rainfall at the Newhall-Soledad and NCWD gages for calendar years 1950 through 2000. Rainfall at the NCWD gage is usually greater than at the Newhall-Soledad gage, because the NCWD gage is located closer to the hills that form the southern boundary of the watershed and receive a greater amount of orographic precipitation, as shown on Figure 2-7.

2.2.1.2 Historical Trends in Alluvial Aquifer Groundwater Elevations

Figure 2-8 shows trends in groundwater elevations in two Alluvial Aquifer wells located in the basin interior (wells VWC-N and NLF-S, near the mouth of the South Fork Santa Clara River) and two Alluvial Aquifer wells located near the regional groundwater discharge zone at the western end of the basin (wells NLF-C5 and NLF-C7). The figure also shows trends in the following other components of the hydrologic cycle:

1. Precipitation at the Newhall-Soledad rain gage (plotted as the cumulative departure from the average precipitation)
2. Annual pumping volumes from the Alluvial Aquifer and the Saugus Formation
3. Total discharges to the Santa Clara River from two WRPs (which are discussed further in Section 2.2.1.5)
4. Measured flow volume in the Santa Clara River during the lowest flow month of each year

Observations from Figure 2-8 are as follows:

1. Alluvial Aquifer groundwater elevations show greater variability over time within the basin interior (wells VWC-N and NLF-S) than near the basin outlet (wells NLF-C5 and NLF-C7). The range in water levels during the 50-year period of record is approximately 100 feet at the interior wells, but only 20 to 30 feet in the two wells near the basin outlet.
2. The effect of reduced pumping from the Alluvial Aquifer from 1967 through 1989 was to minimize seasonal fluctuations in Alluvial Aquifer water levels near the aquifer's regional discharge zone at the western end of the valley. In this area, fluctuations in

Alluvial Aquifer pumping over time affected Alluvial groundwater elevations only seasonally; year-to-year variations in groundwater elevations were small. This indicates that water levels in this area are controlled less by pumping than by the discharge of Alluvial Aquifer groundwater to the Santa Clara River in the area downstream of Interstate 5.

3. As with the western portion of the Alluvial Aquifer, the central portion of the Alluvial Aquifer has not shown long-term water level declines. During the 1950s and early 1960s, total pumping from the Alluvial Aquifer ranged between approximately 35,000 and 44,000 AF/yr during all but 1 year, and long-term (year-to-year) groundwater elevations were relatively stable (see the hydrographs for wells VWC-N and NLF-S). When pumping from the Alluvial Aquifer decreased beginning in 1967, Alluvial groundwater elevations in this area quickly rose and have been relatively stable since about 1970, despite an increase in Alluvial Aquifer pumping during the 1990s. The hydrographs indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above-normal rainfall patterns return.

4. The seasonal low flow in the Santa Clara River at the County Line gage has shown a long-term increase since the mid-1970s and, to some degree, since the late 1960s. Figure 2-5 shows that this increase in flow coincides with increases in the annual discharges of treated water to the Santa Clara River from the two WRPs. Although Alluvial Aquifer pumping increased during the 1980s and 1990s, the seasonal low river flow did not show a long-term decrease during this period. The increases in WRP and Santa Clara River flows and the fluctuations in Alluvial Aquifer pumping have not caused long-term changes in Alluvial Aquifer groundwater elevations at the two wells near the basin outlet.

2.2.1.3 Historical Trends in Saugus Formation Groundwater Elevations

Figures 2-9 and 2-10 compare groundwater elevation trends in the Saugus Formation near the Santa Clara River, below the mouth of the South Fork Santa Clara River, with the same hydrologic components displayed on Figure 2-8. Figure 2-9 shows this information for the period 1950 through 1999, and Figure 2-10 shows this information during the 1990s, when groundwater levels rose in the Saugus Formation. Figures 2-11 and 2-12 show the same information, but for groundwater elevations at Saugus Formation wells located farther away from the Santa Clara River, along the tributary valley containing the South Fork Santa Clara River.

In examining the four Saugus Formation figures, it is difficult to distinguish between the influences of precipitation and pumping trends on changes in Saugus water levels. Although a slight rise in water levels might have occurred at wells VWC-157 and VWC-160 during the late 1960s and early 1970s, it appears to follow the trends in Saugus pumping volumes more closely than the precipitation trends. The data at VWC-157 also suggest that a succession of above-normal precipitation years (e.g., 1978 through 1983) or a year of precipitation that is substantially above normal (e.g., 1983) might have some influence on Saugus water levels. However, the data are limited, and the periods of increased precipitation tend to coincide with periods of decreased pumping, making it difficult to identify the effect of precipitation or pumping on Saugus water levels.

Another observation is that the rise in Saugus Formation water levels in the late 1960s and early 1970s occurred despite an increase in annual pumping volumes from the Alluvial Aquifer. During the late 1980s and 1990s, Saugus pumping increased from slightly less than 6,000 AF/yr (in 1986 and 1987) to approximately 15,000 AF/yr in 1991. When SWP deliveries were substantially reduced in 1991, pumping from the Saugus Formation made up for almost half of the reduction that year. This increased Saugus pumping resulted in short-term declines in groundwater elevations at the pumping wells, particularly from 1991 through 1994, reflecting the use of naturally-stored Saugus groundwater. However, as shown on Figures 2-9 and 2-10, the water levels subsequently rose when pumping declined. This indicates that Saugus water levels are controlled by precipitation and/or Saugus pumping trends, and not by pumping trends in the Alluvial Aquifer.

2.2.1.4 Comparison of Historical Trends in Alluvial and Saugus Groundwater Elevations

Figure 2-13 compares groundwater elevations at Alluvial Aquifer and Saugus Formation wells located near each other along the Santa Clara River, just below the mouth of the South Fork Santa Clara River. At this location, the trends in Alluvial groundwater elevations show no clear relationship with the trends in Saugus groundwater elevations. A moderate overall increase in groundwater elevations was observed in both the Alluvial Aquifer and the Saugus Formation during the late 1960s. However, this similarity in the water level trends might be a coincidence arising from reduced pumping in both aquifers. During the early 1970s, water levels in Saugus well VWC-157 decreased while water levels in the nearby Alluvial Aquifer well (VWC-N) generally increased. During the 1990s, the Alluvial Aquifer groundwater elevations at well VWC-N were generally stable despite (1) increased pumping from the Alluvial Aquifer and (2) a sharp decrease, then increase, in Saugus groundwater elevations, which correlated with the trends in Saugus pumping. In summary, although there might be a relationship between Alluvial and Saugus groundwater elevations near the margins of the groundwater basin, where folding of Saugus beds has brought permeable zones in contact with the alluvium, Figure 2-13 indicates that there is general independence between the Alluvial and Saugus water level trends at this location, which is near the center of the bowl-shaped Saugus Formation structure shown on Figure 2-3.

2.2.1.5 Historical Trends in Santa Clara River Baseflow

Long-term records of flows in the Santa Clara River are available for the eastern and western ends of the basin. The locations of the two gages are shown on Figure 1-1 and Figure 2-3. At the western end of the basin, the County Line gage has recorded Santa Clara River flows leaving the basin for most of the period since 1952, except for a 1-year period during water year 1969 (October 1968 through September 1969). At the eastern end of the basin, the Lang gage has recorded Santa Clara River flows entering the basin from October 1949 through September 1989 and from April 2003 to the present.

Baseflow in the Santa Clara River is perennial in the western portion of the Santa Clarita Valley. The following sources of water contribute to the river's baseflow:

1. **Groundwater discharge from the Alluvial Aquifer to the riverbed.** Groundwater in the Alluvial Aquifer seeps into the riverbed near, and downstream of, Round Mountain (which is located just below the mouth of San Francisquito Canyon).

2. **Discharges from two WRPs.** Treated water is discharged to the Santa Clara River from two Los Angeles County Sanitation District (LACSD) WRPs in the valley. The Saugus WRP (Plant No. 26) is located along the south side of the river near Bouquet Canyon, just above the mouth of the South Fork Santa Clara River. The Valencia WRP (Plant No. 32) is located along the north side of the river, just west of Interstate 5.

3. **Flood Flows in Castaic Creek.** DWR stores SWP water in Castaic Lake. In some years, DWR releases flood flows from Castaic Dam/Lagoon into Castaic Creek during the winter or spring months. Depending on the magnitude of the releases, some of these flows enter the Santa Clara River downstream of the Valencia WRP. As shown on Figure 2-14, these releases have occurred during many, though not all, years since the release program began in the late 1970s.

Hydrograph separation techniques were applied to the daily streamflow data for the County Line gage to estimate historical groundwater discharges (baseflow) to the Santa Clara River within the Santa Clarita Valley. The hydrograph separation was performed for calendar years 1953 through 1999 using the following five steps:

1. For each day, the average daily flow at the County Line gage, in cubic feet per second (cfs), was converted to acre-feet of volumetric flow for the day.

2. The daily flows from Castaic Dam and at the Castaic Creek South gage (located near the mouth of Castaic Creek) were subtracted from the flow at the County Line gage. These data reflect surface water flow from tributaries. Data from the Castaic Creek South gage were used through June 1977. Beginning in July 1977, operational data for Castaic Lagoon, presented in annual reports by DWR, were used to estimate surface flow contributions from Castaic Creek.

3. The discharges of treated water from the two WRPs were subtracted. This step was performed for calendar years 1975 and later, because 1975 was the first year that such records were available.

4. The resulting day-to-day trends in streamflows were scrutinized for days when notably elevated flows occurred suddenly. These days were assumed to be dominated by storm flow. In some cases, the elevated flows lasted for only 2 to 5 days. In other cases, flows remained elevated for several days, but showed steady declines, indicating that only the beginning of the elevated-flow period was dominated by surface runoff.

5. On all other days, storm flow was considered to be minimal or zero, and the flow values calculated for days not dominated by storm flow were assumed to represent river base-flow (that is, groundwater discharge to the river). For each month, an average flow was calculated for these non-storm days. The average flow was then converted to a total flow for the month, and the monthly flow volumes were summed to come up with the total flow for each year.

Table 2-2 presents the annual calculations from the hydrograph separation analysis. Table 2-3 presents summary statistics for the entire 47-year period that was analyzed, as well as for shorter time frames. Tables 2-4 and 2-5 show dry-year, normal-year, and

wet-year statistics for the entire period of record and the shorter time frames. The shorter time frames are as follows:

1. Calendar years 1953 through 1965, which were years of primarily agricultural water use prior to urbanization and construction of WRPs. This 13-year period was also characterized by 5 years of below-normal rainfall.

2. Calendar years 1975 through 1999, which represent 25 years of significant urbanization, including SWP water importation and WRP operations. This 25-year period was characterized by 6 years of below-normal rainfall, although rainfall volumes in general were somewhat higher (19.4 inches per year [in/yr] average, versus 15.5 in/yr average for 1953 through 1965).

3. Calendar years 1953 through 1999, but excluding 8 years (1966 through 1974) when WRP discharges occurred but were not recorded.

The daily streamflow data and the hydrograph separation technique indicate the following:

1. Summary statistics in Table 2-3 for all types of rainfall years (dry, normal, and wet) show that average groundwater discharges to the river from 1953 through 1965 were approximately 2,500 AF/yr (3.5 cfs). Groundwater discharges to the river were typically 14,000 to 22,000 AF/yr (19 to 31 cfs) from 1975 through 1999 because of more rainfall, increasing urbanization, and increasing importation of water from outside the valley.

2. For normal rainfall years only, median and average groundwater discharges to the river were approximately 4,000 and 3,600 AF/yr (5.5 and 5.0 cfs), respectively, from 1953 through 1965 (see Table 2-4); and approximately 12,500 and 14,300 AF/yr (17 and 20 cfs), respectively, during 1975 through 1999 (see Table 2-4).

3. For drought years only, Table 2-4 shows that groundwater discharges to the river ranged from 400 to 4,900 AF/yr (0.5 to 7 cfs) between 1953 and 1965, and from 5,200 to 14,500 AF/yr (7 to 20 cfs) between 1975 and 1999. Table 2-4 also shows that median and average groundwater discharges to the river during drought years were 600 and 1,700 AF/yr (1 and 2 cfs), respectively, from 1953 through 1965, and typically 9,600 and 10,200 AF/yr (13 and 14 cfs), respectively, from 1975 through 1999.

In summary, significant increases in the baseflow of the Santa Clara River have occurred since urbanization of the Santa Clarita Valley began during the late 1960s and early 1970s. Water imports began in 1980, and have increased in volume as urbanization has continued. The imported water has reached the river through releases from Castaic Dam/Lagoon and, more significantly, discharges of treated water into the river. As a result, water is now present in the Santa Clara River on a continuous basis in the western portion of the basin, even during dry years. This is a sharp contrast to conditions prior to the 1970s, when the river would become dry during drought periods.

2.2.2 Historical Estimates of Basin Yield

During the late 1980s, Richard C. Slade, Consulting Groundwater Geologist, now known as Richard C. Slade and Associates, LLC (both hereafter referred to as RCS), conducted hydrogeologic assessments of the two aquifer systems in the basin. RCS performed separate

evaluations for the Alluvial Aquifer in 1986 and the Saugus Formation in 1988, then updated this work in 2002.

The first study of the Alluvial Aquifer (RCS, 1986) identified a "practical or perennial yield" of 31,600 to 32,600 AF/yr. RCS derived these values using the so-called "Pumpage and Change-In-Storage" method, a commonly used method at the time that compares groundwater pumping volumes with changes in the volume of groundwater in storage during a multi-year period when cumulative rainfall is close to average. As RCS discussed in a more recent report (2002), this method works best in aquifers that are fully developed or in overdraft, and where recharge does not play an important role in determining the amount of groundwater in storage. Consequently, as discussed by RCS (2002), this method is not well suited to estimating sustainable pumping rates in this setting because natural recharge and water importation are major influences on the groundwater basin in the Santa Clarita Valley, and the local groundwater resources are not fully developed or in overdraft.

The first study of the Saugus Formation (RCS, 1988) did not identify a practical or perennial yield or a range of pumping rates that were estimated to be sustainable on a long-term basis. Instead, this study first estimated the "usable groundwater in storage," which was defined as the volume of Saugus Formation groundwater that is economically obtainable and of satisfactory quality for beneficial use. RCS estimated the usable groundwater in storage to be 1.41 million acre-feet. Then, using precipitation records and calculations of the exposed area of the Saugus Formation and overlying terrace deposits, and also considering the hydraulic potential for inter-aquifer flow from the overlying Alluvial Aquifer, RCS estimated that the Saugus Formation potentially receives between approximately 11,000 and 22,000 AF/yr of recharge from a combination of direct rainfall and inter-aquifer flow in any given year, depending on local hydrologic conditions. However, RCS did not discuss the relationship of these estimates to long-term pumping from the Saugus Formation. In fact, RCS noted that these assessments "…should not be construed as a rigorous determination of the perennial yield of the Saugus…."

In the *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems* (RCS, 2002), RCS concluded that groundwater levels in the Alluvial Aquifer and Saugus Formation have fluctuated over time, but have shown no long-term progressive declines in the amount of groundwater storage that could be considered indicative of overdraft conditions. From the long-term pumping and water level data, the report concluded that the Alluvial Aquifer can be pumped at rates between 30,000 and 40,000 AF/yr over the long term, and suggested that pumping be between 30,000 and 35,000 AF/yr during local droughts. For the Saugus Formation, the report concluded that pumping can occur at rates between 7,500 and 15,000 AF/yr on a long-term basis, with short-term increases to as much as 35,000 AF/yr toward the end of a multi-year period of reduced availability of imported water supplies.

RCS (2002) referred to these pumping rates for the Alluvial and Saugus aquifer systems as the "operational yield" of both aquifers, a term that was previously described in the August 2001 MOU. The term perennial yield is often interpreted as a "not-to-exceed" volume, with a related potential for pumping above the perennial yield value in any given year to be incorrectly interpreted as "overdraft." Consequently, the MOU advanced the concept of operational yield to deal with the misinterpretations commonly associated with the concept of perennial yield. In the Santa Clarita Valley, operational yield is used today to describe the

flexible use of groundwater that allows increased pumping during dry periods and subsequent recharge (direct or in-lieu) in wet/normal rainfall periods, performed in a manner that protects the aquifer by assuring that groundwater supplies are adequately replenished on a long-term basis from one wet/dry cycle to the next. This concept is the basis for the development of the current groundwater operating plan for the local groundwater basin, which is discussed in the following section.

2.2.3 Development of Current Operating Plan

The groundwater operating plan for the Santa Clarita Valley's groundwater resources has been defined in the Amended 2000 UWMP for the Santa Clarita Valley (Black & Veatch, 2000; CLWA et al., 2005) and in annual water reports that discuss the water demands, water supplies, and surface water and groundwater resources of the valley (including the *Santa Clarita Valley Water Report 2004* [LSCE, 2005a]). These reports provide ranges of values for groundwater extractions from the Alluvial Aquifer and the Saugus Formation during wet/normal years and dry years. The Purveyors have developed the operating plan by considering the water supply needs of the valley, the availability of imported water supplies, and knowledge of the historical recovery of both aquifers (following the peak pumping years that occurred prior to the mid-1960s in the Alluvial Aquifer and during the early 1990s in the Saugus Formation). The plan is summarized in Table 2-6 and is as follows:

1. Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the eastern part of the basin. Under the operating plan, pumping ranges between 30,000 and 40,000 AF/yr during normal and above-normal rainfall years, but, because of operational constraints in the eastern part of the basin, is reduced to between 30,000 and 35,000 AF/yr during locally dry years.

2. Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly imported water from the SWP system. For the Saugus Formation, the operating plan consists of pumping between 7,500 and 15,000 AF/yr during average-year conditions within the SWP system. Planned dry-year pumping from the Saugus Formation ranges between 15,000 and 25,000 AF/yr during a drought year, and increases to between 21,000 and 25,000 AF/yr if SWP deliveries are reduced for 2 consecutive years, and between 21,000 and 35,000 AF/yr if SWP deliveries are reduced for 3 consecutive years. Such high pumping would be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 AF/yr, to further enhance the effectiveness of natural recharge processes that would rapidly recover water levels and groundwater storage volumes in the Saugus Formation, as has been historically experienced.

The Purveyors have developed this plan as part of an overall water supply strategy designed to meet increasing water demands in the Santa Clarita Valley while assuring a reasonable degree of water supply reliability[3] and not exceeding the operational yield of the local aquifer systems on a long-term basis. In particular, this plan employs an integrated use

[3]As discussed in Section ES.5 of the *2004 Santa Clarita Valley Water Report* (LSCE, 2005a), the Purveyors are in the process of establishing a water reliability policy, for planning purposes, sufficient for meeting projected demands 95 percent of the time over each 20-year period. In the remaining 5 percent of the time, it is planned that the maximum supply shortage will be 10 percent of demand, a level that is based on past experience that a 10 percent water demand reduction is feasible during a drought. (During the last drought, in the early 1990s, voluntary conservation efforts by area residents resulted in a reduction in water demands of approximately 20 percent below demands in preceding years.)

of the Alluvial Aquifer and the Saugus Formation that recognizes the fundamental differences in the hydrogeologic characteristics of these two units[4]. Maintaining the substantial volume of water in the Saugus Formation is an important part of this strategy, to help maintain local groundwater supplies on a long-term basis. In implementing this operating plan, the Purveyors blend groundwater and imported water for area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and any given location in the valley is an operational decision, which varies over time according to source availability and the operational capacities of Purveyor-owned facilities. In years when SWP supplies are reduced because of regulatory factors and/or dry weather conditions in the watersheds that provide SWP water supplies, the water demands in the Santa Clarita Valley can be met through a combination of the following alternate supplies:

1. Local groundwater pumping (increased short-term Saugus pumping)
2. Deliveries from CLWA's groundwater banking programs, such as the Semitropic Groundwater Storage Program in Kern County, where CLWA has banked excess SWP water in recent years
3. Deliveries from CLWA's flexible storage account in Castaic Lake Reservoir
4. Participation in DWR dry-year water purchase programs
5. Short-term water exchanges

The Purveyors have emphasized developing water supplies that add diversity in water supply options, especially in years of dry conditions in the Santa Clarita Valley (which can reduce Alluvial Aquifer supplies) and/or reduced availability of SWP imports. Drought periods, local or in the SWP system, can affect water supplies in single and multiple years. Details concerning the nature of local hydrologic variations, which govern Alluvial Aquifer pumping, are presented in Section 2.2.3.1. Section 2.2.3.2 discusses variations in imported water availability, which governs pumping from the Saugus Formation.

2.2.3.1 Variations in Local Hydrology and Alluvial Aquifer Pumping

The rate of pumping from the Alluvial Aquifer in a given year is partly affected by groundwater elevations in the eastern portion of the basin, which is the primary groundwater recharge area for the local groundwater systems. Historically, during dry years, decreases in Alluvial Aquifer pumping occur in the eastern-most Alluvial Aquifer production wells, which are located adjacent to the Santa Clara River in Soledad Canyon, upstream of the mouth of Bouquet Canyon. Reduced groundwater pumping occurs in these areas because of declines in groundwater elevations resulting from reduced groundwater recharge by the Santa Clara River during dry years. Groundwater levels in this area have historically decreased between approximately 50 and 100 feet during multi-year periods of below-normal rainfall and Santa Clara River streamflows. Consequently, the approximate

[4]As discussed in this report and other documents (RCS, 2002; CH2M HILL, 2004a; LSCE, 2005a), the Alluvial Aquifer is more permeable and much thinner than the Saugus Formation. The eastern portion of the Alluvial Aquifer also shows considerably greater short-term (month-to-month) and long-term (year-to-year) fluctuations in groundwater levels than the rest of the Alluvial Aquifer and the Saugus Formation.

5,000 AF/yr reduction in Alluvial Aquifer pumping in dry years that is called for under the operating plan occurs primarily as reduced pumping from wells in eastern Soledad Canyon.

Elsewhere in the Alluvial Aquifer, where groundwater elevations have fluctuated much less during single-year or multi-year dry periods, reductions in pumping rates have been unnecessary. Throughout the Alluvial Aquifer, groundwater elevations have historically recovered fully in response to the normal and above-normal rainfall and stream flows that mark the end of each dry period.

The historical record of rainfall and pumping indicates that the 5,000 AF/yr of dry-year reduction in Alluvial Aquifer pumping typically occurs when rainfall is below 12 in/yr, as measured at the Newhall-Soledad rain gage. Annual rainfall at this gage was below 12 in/yr during 14 years of this 50-year period, as shown on Figure 2-5.

2.2.3.2 Variations in State Water Project Hydrology and Saugus Formation Pumping

The rate of pumping from the Saugus Formation in a given year is governed by the availability of imported water supplies, particularly imported water from the SWP system. CLWA has performed a statistical evaluation of SWP deliveries (Kennedy/Jenks Consultants, 2003) using the 2021B scenario from the CALSIM II model, which was developed by DWR for its SWP Delivery Reliability Report (DWR, 2003). The CALSIM II model and the SWP Delivery Reliability Report were developed to support (1) the preparation of urban water management plans by the water agencies that are SWP contractors, (2) analyses required to comply with Senate Bills 221 and 610, and (3) other water supply planning activities that include the SWP as a supply component. The 2021B scenario simulates the anticipated deliveries of water to the 29 SWP contractors using an historical hydrologic record and anticipated operating and regulatory conditions for the SWP system in 2021. The U.S. Bureau of Reclamation (USBR) has also used CALSIM II to perform biological assessment studies for the Operating Criteria and Plan (OCAP) for the SWP (USBR, 2004). Both the CLWA and the USBR studies, which were made public for review in February 2004, include evaluations of the role and function of an Environmental Water Account (EWA), which consists of water purchased to mitigate the water supply impacts of protection measures for endangered species. These CALSIM II simulations have been performed for the SWP system at a present-day level of development and for the anticipated level of development in 2020. Table 2-7 compares the municipal and industrial water use allocations calculated by CALSIM II for the SWP Reliability Report (DWR, 2003) and for the OCAP (USBR, 2004) for the hydrology that occurred from 1950 through 1993.

CLWA's evaluation reached the following conclusions regarding the deliveries it will receive under this scenario (Kennedy/Jenks Consultants, 2003):

1. A regression analysis indicates that there is a weak relationship between the SWP delivery in a given year and the previous year's delivery.

2. SWP deliveries will equal or exceed 70 percent of CLWA's 95,200 AF/yr Table A water amount during approximately 75 percent of the simulated years. During the remaining years, the deliveries will vary between 20 and 70 percent.

3. A Monte Carlo analysis of projected deliveries during 73 consecutive years indicated that at a 95 percent confidence level, 4 years of a 7-year drought period in the SWP

system (such as was observed from 1988 through 1994) will have sufficiently low deliveries to require short-term pumping of increased groundwater volumes to meet local water demands. This includes a period of 3 consecutive years of increased pumping.

Section 3.3.3 of this report discusses the relationship between SWP hydrology, SWP allocations to the 29 SWP contractors, and corresponding pumping from the Saugus Formation, and how this relationship was built into the modeling analysis of the groundwater operating plan.

Tables

TABLE 2-1
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges to the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam, Lang gage)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial Aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow into the Santa Clarita Valley occurs beneath Castaic Creek through water seepage beneath Castaic Dam.

TABLE 2-2
Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Calendar Year	Total Flow at Mouth of Castaic Creek (acre-feet)[a]	Total Gaged Flow at County Line (acre-feet)[b]	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[c]	Local Rainfall Condition[d]
1953	0	4,986	4,943	0	4,943	4.88	Dry
1954	977	7,316	5,554	0	5,554	15.82	Normal
1955	134	4,795	4,122	0	4,122	13.91	Normal
1956	311	5,429	3,803	0	3,803	14.21	Normal
1957	559	4,782	2,410	0	2,410	22.85	Wet
1958	21,204	38,756	5,344	0	5,344	23.14	Wet
1959	473	3,277	2,206	0	2,206	9.81	Dry
1960	1	777	586	0	586	11.64	Dry
1961	79	804	410	0	410	8.82	Dry
1962	5,101	28,460	2,433	0	2,433	21.22	Wet
1963	32	1,884	1,058	0	1,058	12.79	Normal
1964	1	1,030	646	0	646	10.09	Dry
1965	3,702	35,614	996	0	996	32.28	Wet
1966	5,780	10,101	2,332	No data	---	14.57	Normal
1967	27,819	40,480	8,640	No data	---	23.23	Wet
1968	4,381	7,216	3,895	No data	---	6.90	Dry
1969	46,461	258,660	29,395	No data	---	32.42	Wet
1970	6,597	31,066	14,924	No data	---	23.19	Wet
1971	2,310	15,883	10,843	No data	---	13.75	Normal
1972	2,205	16,027	12,975	No data	---	4.15	Dry
1973	12,671	52,631	26,115	No data	---	19.79	Wet
1974	7,288	25,265	11,918	No data	---	18.04	Wet
1975	2,027	14,770	10,806	5,534	5,272	10.92	Dry
1976	156	10,162	9,754	6,095	3,659	14.02	Normal
1977	1,380	13,454	9,359	6,004	3,355	20.87	Wet
1978	35,378	129,187	60,955	6,982	53,973	42.17	Wet
1979	13,626	57,594	42,448	7,397	35,051	21.47	Wet
1980	16,785	95,211	57,593	7,372	50,221	27.00	Wet
1981	6,519	24,232	21,172	7,949	13,223	13.42	Normal
1982	9,102	36,488	32,531	8,436	24,095	20.20	Wet
1983	67,058	131,236	55,878	9,420	46,458	39.07	Wet

TABLE 2-2
Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Calendar Year	Total Flow at Mouth of Castaic Creek (acre-feet)[a]	Total Gaged Flow at County Line (acre-feet)[b]	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[c]	Local Rainfall Condition[d]
1984	13,787	39,279	35,215	9,512	25,703	12.86	Normal
1985	2,619	24,466	24,089	9,614	14,475	8.37	Dry
1986	4,945	48,024	31,327	10,822	20,505	18.02	Wet
1987	911	26,198	23,663	11,844	11,819	14.45	Normal
1988	2,415	36,611	24,934	12,363	12,571	16.92	Wet
1989	Unavailable	24,799	23,453	13,560	9,893	7.56	Dry
1990	0	23,472	21,772	14,006	7,766	6.98	Dry
1991	65	34,901	18,702	14,108	4,594	17.21	Wet
1992	4,450	68,577	23,601	15,703	7,898	32.03	Wet
1993	7,725	152,783	65,054	17,179	47,875	32.72	Wet
1994	Unavailable	32,039	31,239	16,946	14,293	10.27	Dry
1995	5,611	82,409	51,001	17,824	33,177	29.15	Wet
1996	5,632	47,930	36,366	16,831	19,535	15.88	Normal
1997	9,885	36,780	27,521	15,778	11,743	13.35	Normal
1998	47,803	205,139	81,744	17,695	64,049	30.73	Wet
1999	5,830	32,382	27,176	17,847	9,329	8.96	Dry

[a]Values through June 1977 are from the former Castaic Creek South gage (U.S. Geologic Survey [USGS] Gage Station 11108145). Values after June 1977 are derived from records of releases from Castaic Dam/Lagoon into Castaic Creek, as provided by DWR.

[b]Values through September 30, 1996, are from USGS Gage Station 11108500. This gage was located immediately downstream of the Los Angeles-Ventura County Line and was taken permanently out of service after October 21, 1996. Data beginning on October 1, 1996, are from new USGS gage station 11109000, located approximately 2.5 miles farther downstream, near Piru Junction, at the Las Brisas Bridge.

[c]Annual rainfall values are based on monthly records for this gage, as reported by the National Climate Data Center and LADPW.

[d]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-3
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	311	4,795	2,410	0	2,410	13.91
Average	2,506	10,608	2,655	0	2,655	15.50
Maximum	21,204	38,756	5,554	0	5,554	32.28
Statistics for 1975 through 1999						
Minimum	0	10,162	9,359	5,534	3,355	6.98
Median	5,632	36,611	27,521	11,844	14,293	16.92
Average	11,466	57,125	33,894	11,873	22,021	19.38
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	3,161	30,250	22,613	11,844	8,613	15.14
Average	8,230	41,211	23,207	11,873	15,396	18.05
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	4,450	28,460	18,702	11,844	8,613	15.82
Average	9,151	43,050	21,338	11,873	15,396	17.92
Maximum	67,058	258,660	81,744	17,847	64,049	42.17

TABLE 2-4
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 versus 1975 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 5 Dry Years during 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	1	1,030	646	0	646	9.81
Average	111	2,175	1,758	0	1,758	9.05
Maximum	473	4,986	4,943	0	4,943	11.64
Statistics for 4 Normal Years during 1953 through 1965						
Minimum	32	1,884	1,058	0	1,058	12.79
Median	222	5,112	3,963	0	3,963	14.06
Average	363	4,856	3,634	0	3,634	14.18
Maximum	977	7,316	5,554	0	5,554	15.82
Statistics for 4 Wet Years during 1953 through 1965						
Minimum	559	4,782	996	0	996	21.22
Median	4,402	32,037	2,421	0	2,421	23.00
Average	7,641	26,903	2,796	0	2,796	24.87
Maximum	21,204	38,756	5,344	0	5,344	32.28
Statistics for 6 Dry Years during 1975 through 1999						
Minimum	0	14,770	10,806	5,534	5,272	6.98
Median	2,323	24,633	23,771	13,783	9,611	8.67
Average	2,619	25,322	23,089	12,918	10,171	8.84
Maximum	5,830	32,382	31,239	17,847	14,475	10.92
Statistics for 6 Normal Years during 1975 through 1999						
Minimum	156	10,162	9,754	6,095	3,659	12.86
Median	6,076	31,489	25,592	10,678	12,521	13.72
Average	6,148	30,763	25,615	11,335	14,280	14.00
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 13 Wet Years during 1975 through 1999						
Minimum	65	13,454	9,359	6,004	3,355	16.92
Median	7,725	68,577	42,448	10,822	33,177	27.00
Average	16,642	83,970	42,702	11,639	31,063	26.74
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-5
Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 13 Dry Years during 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	473	14,770	10,806	13,783	5,272	8.82
Average	1,601	14,311	12,630	12,918	6,347	8.41
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 12 Normal Years during 1953 through 1999						
Minimum	0	7,316	2,433	6,004	2,433	13.35
Median	5,101	26,198	21,172	11,844	11,743	16.92
Average	5,238	27,883	16,963	10,788	8,671	17.10
Maximum	12,671	52,631	27,521	15,778	13,223	21.22
Statistics for 22 Wet Years during 1953 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	7,507	44,252	25,525	10,822	20,505	23.17
Average	15,807	73,060	29,877	11,639	24,412	25.62
Maximum	67,058	258,660	81,744	17,824	64,049	42.17
Statistics for 11 Dry Years during 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	79	14,770	10,806	13,783	5,272	8.96
Average	1,226	14,800	13,393	12,918	6,347	8.94
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 10 Normal Years during 1953 through 1965 and 1975 through 1999						
Minimum	32	1,884	1,058	6,095	1,058	12.79
Median	944	17,197	15,463	10,678	8,649	13.97
Average	3,834	20,400	16,823	11,335	10,022	14.07
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 17 Wet Years during 1953 through 1965 and 1975 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	5,611	48,024	31,327	10,822	20,505	23.14
Average	14,524	70,543	33,312	11,639	24,412	26.30
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-6
Annual Pumping Rates Specified by the Operating Plan for Santa Clarita Valley Groundwater Resources
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Aquifer	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
Operating Plan Pumping				
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	15,000 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**45,000 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**
Modeled Pumping				
Alluvium	38,429	33,767	33,767	33,767
Saugus	10,679	15,760	24,346	34,096
Total	**49,108**	**49,527**	**58,113**	**67,863**

Notes:

All pumping volumes are listed in acre-feet.

The operating plan is defined in the Amended 2000 UWMP (Black & Veatch, 2000; CLWA et al., 2005).

In the model simulations, total pumping is different than listed in this table when dry-year pumping conditions in one aquifer coincide with normal-year pumping conditions in the other aquifer (because of differences in the timing of dry conditions locally versus reduced deliveries of SWP water imports).

TABLE 2-7
CALSIM II Calculated State Water Project Municipal and Industrial Allocations
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	OCAP Current EWA[a]	OCAP Future EWA[a]	2020 SWP Reliability[b]
1950	0.88	0.91	0.79
1951	1.00	1.00	0.96
1952	1.00	1.00	1.00
1953	1.00	1.00	0.95
1954	1.00	1.00	0.96
1955	0.44	0.45	0.43
1956	1.00	1.00	1.00
1957	0.94	0.91	0.75
1958	1.00	1.00	1.00
1959	0.84	0.88	0.83
1960	0.51	0.55	0.56
1961	0.68	0.72	0.76
1962	0.93	0.98	0.87
1963	1.00	1.00	1.00
1964	0.84	0.74	0.73
1965	0.87	0.81	0.77
1966	1.00	1.00	0.92
1967	1.00	1.00	1.00
1968	0.89	0.90	0.85
1969	1.00	1.00	1.00
1970	1.00	1.00	0.95
1971	1.00	1.00	1.00
1972	0.76	0.75	0.65
1973	1.00	1.00	0.91
1974	1.00	1.00	1.00
1975	1.00	1.00	1.00
1976	0.78	0.75	0.65
1977	0.03	0.04	0.20
1978	1.00	1.00	1.00
1979	1.00	0.94	0.89
1980	1.00	0.91	0.85
1981	0.90	0.92	0.84
1982	1.00	1.00	1.00
1983	1.00	1.00	1.00
1984	0.66	1.00	0.99
1985	0.97	0.91	0.83
1986	0.74	0.70	0.78
1987	0.70	0.77	0.71
1988	0.12	0.17	0.23
1989	0.96	0.95	0.83
1990	0.24	0.27	0.28
1991	0.24	0.29	0.25
1992	0.39	0.43	0.29
1993	1.00	1.00	1.00

[a]Source: USBR, 2004

[b]Source: DWR, 2003

Figures

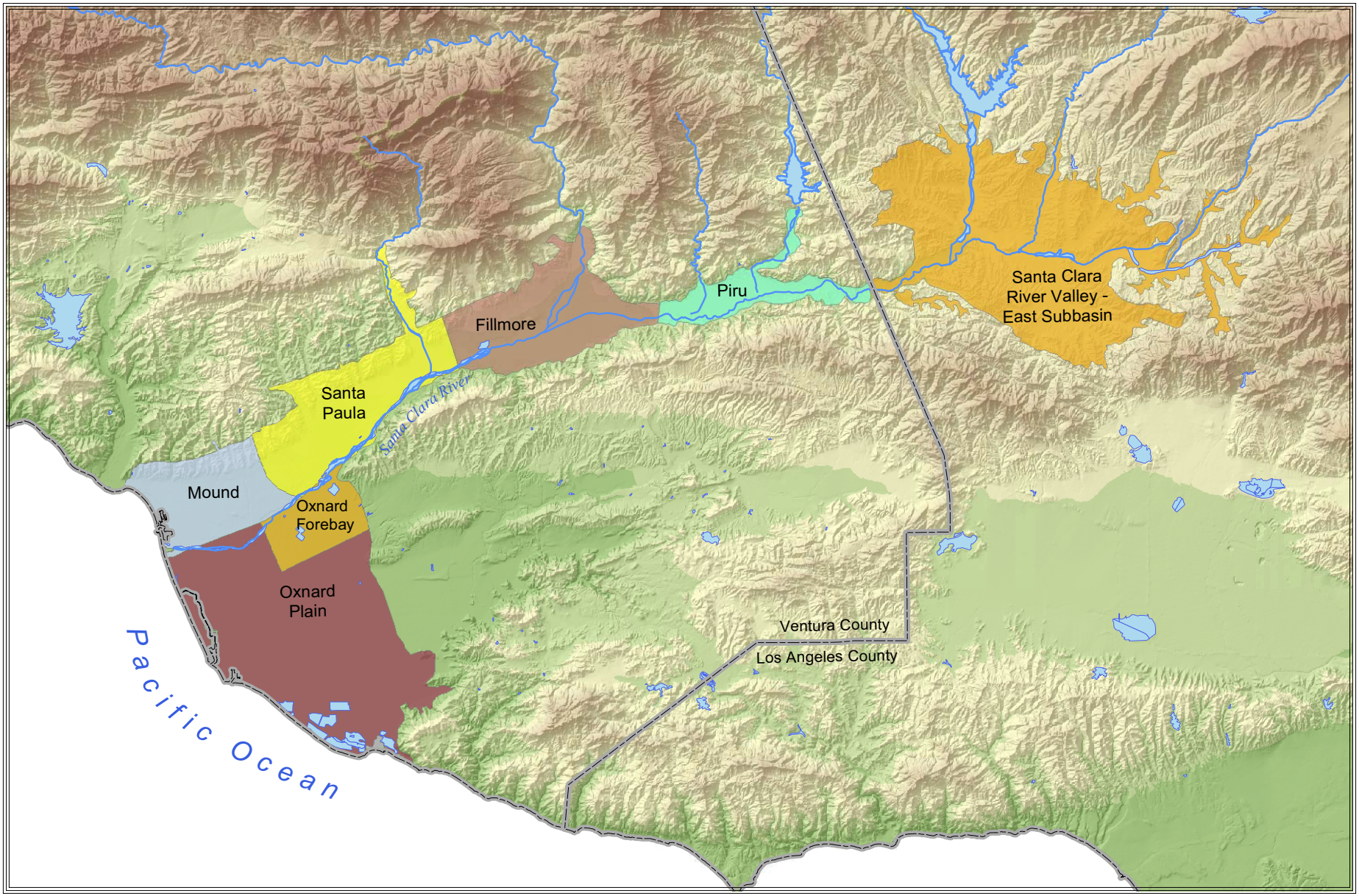

FIGURE 2-1
GROUNDWATER BASINS IN THE SANTA CLARA RIVER DRAINAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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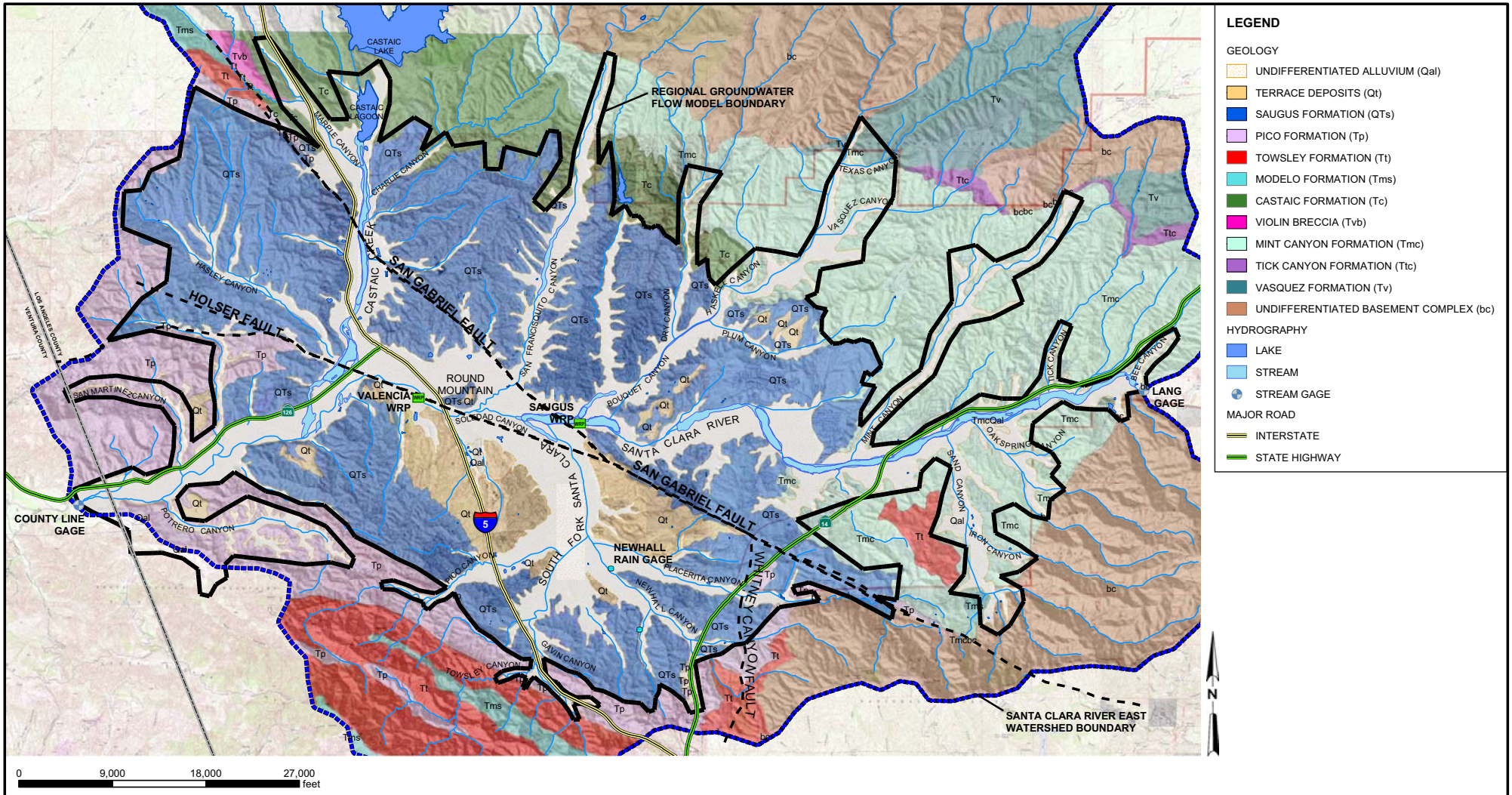

LEGEND

GEOLOGY
- UNDIFFERENTIATED ALLUVIUM (Qal)
- TERRACE DEPOSITS (Qt)
- SAUGUS FORMATION (QTs)
- PICO FORMATION (Tp)
- TOWSLEY FORMATION (Tt)
- MODELO FORMATION (Tms)
- CASTAIC FORMATION (Tc)
- VIOLIN BRECCIA (Tvb)
- MINT CANYON FORMATION (Tmc)
- TICK CANYON FORMATION (Ttc)
- VASQUEZ FORMATION (Tv)
- UNDIFFERENTIATED BASEMENT COMPLEX (bc)

HYDROGRAPHY
- LAKE
- STREAM
- STREAM GAGE

MAJOR ROAD
- INTERSTATE
- STATE HIGHWAY

FIGURE 2-2
BASIN GEOLOGIC MAP
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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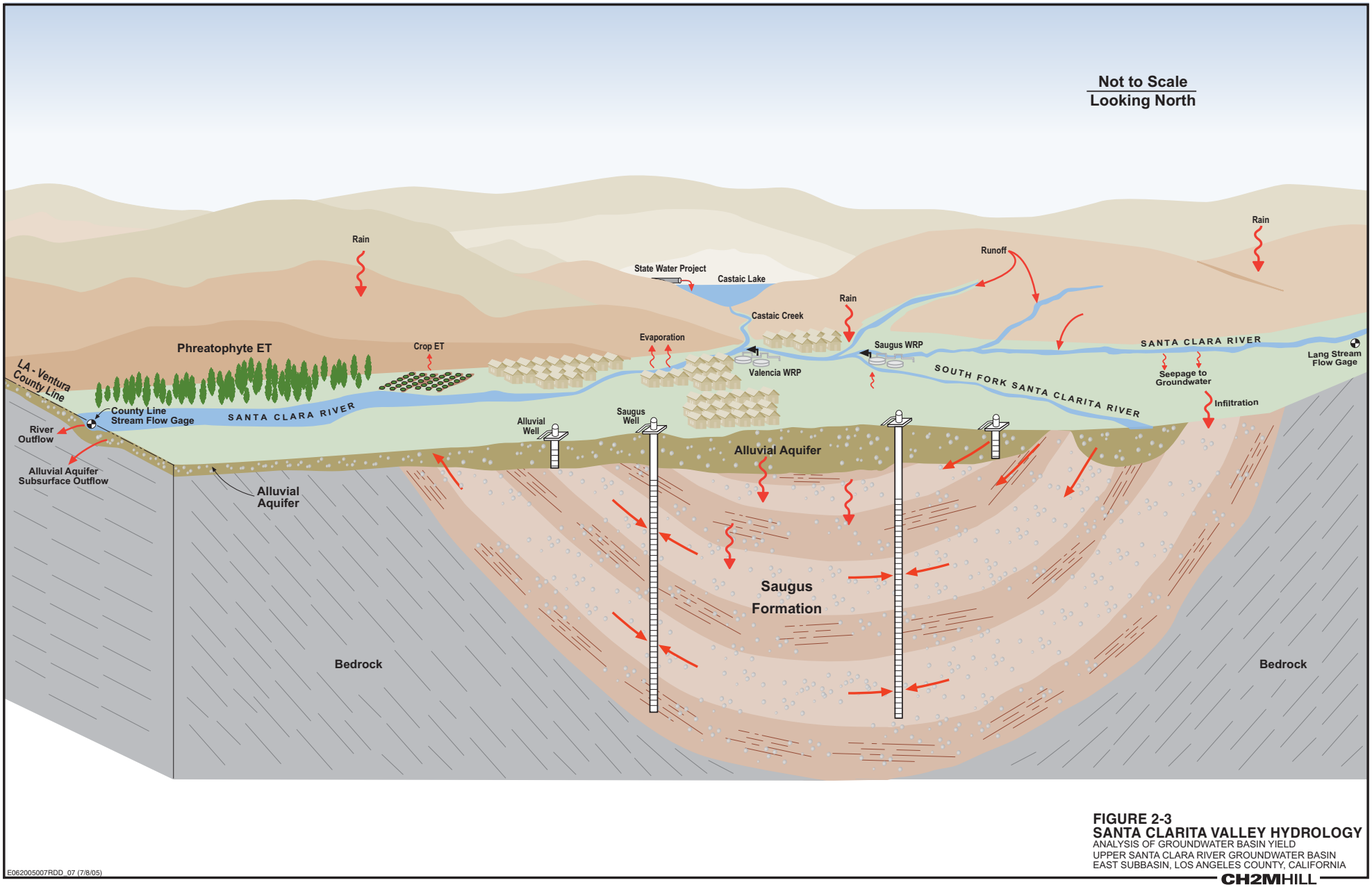

FIGURE 2-3
SANTA CLARITA VALLEY HYDROLOGY
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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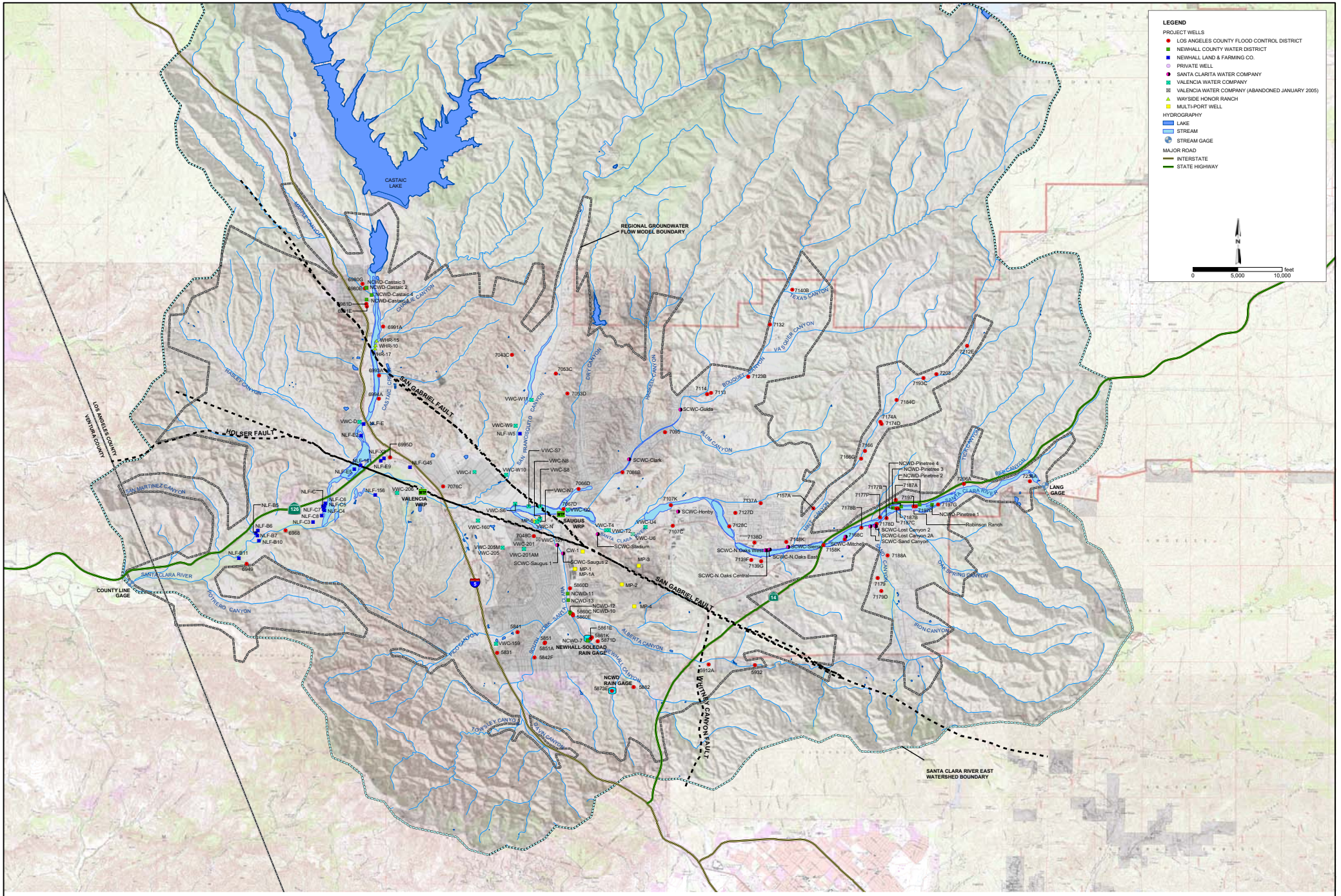

FIGURE 2-4
REGIONAL WELL LOCATION MAP
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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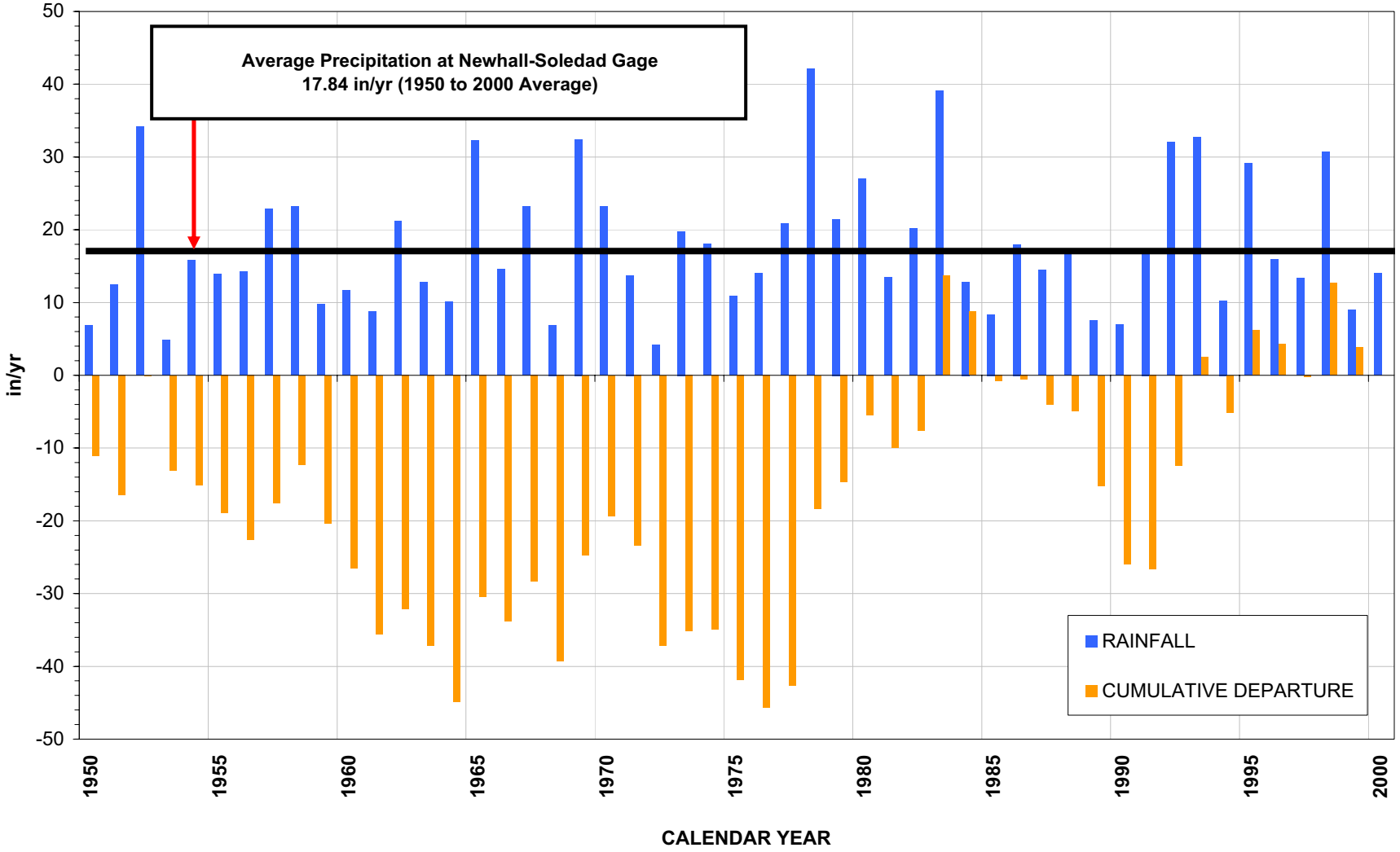

FIGURE 2-5
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE

ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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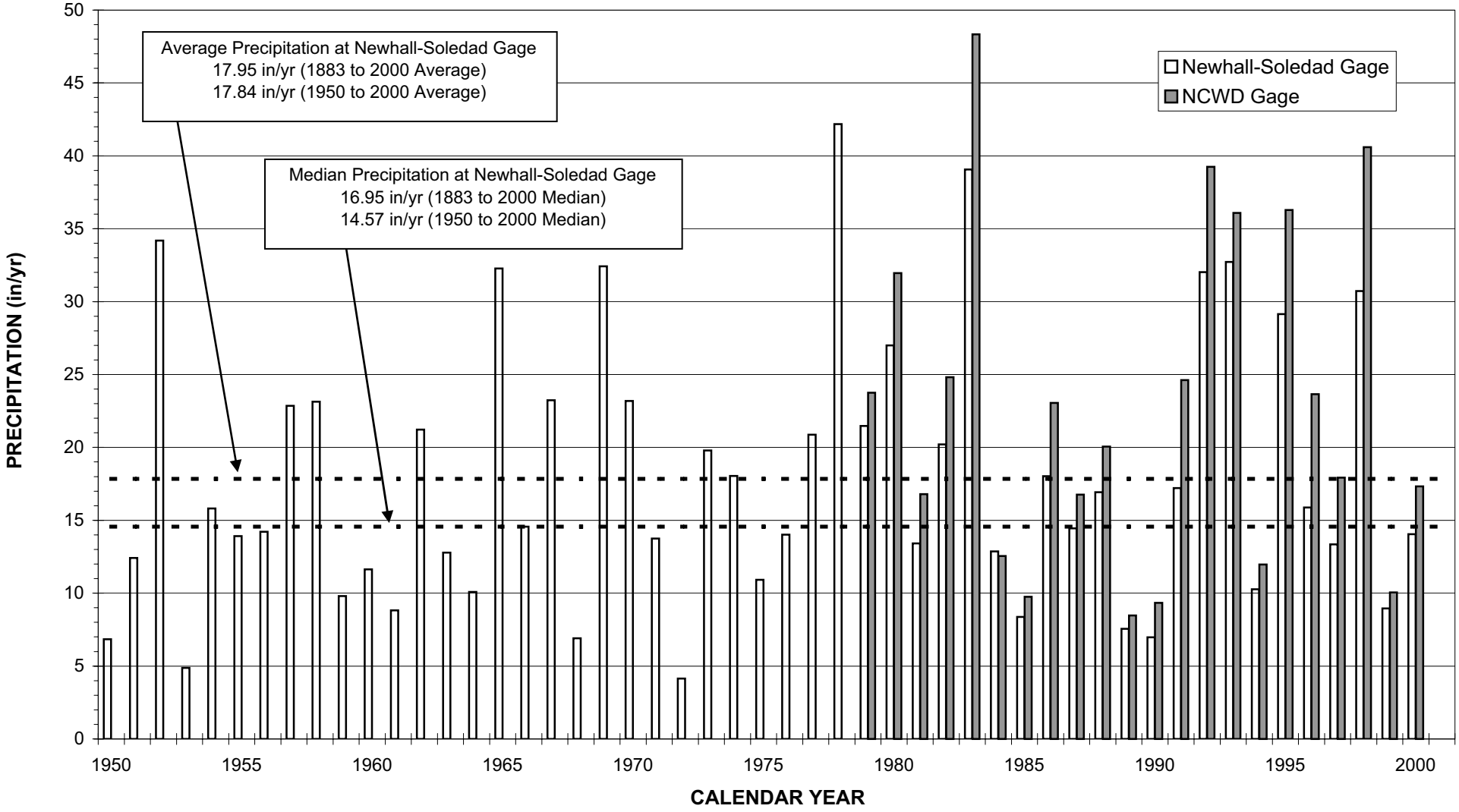

FIGURE 2-6
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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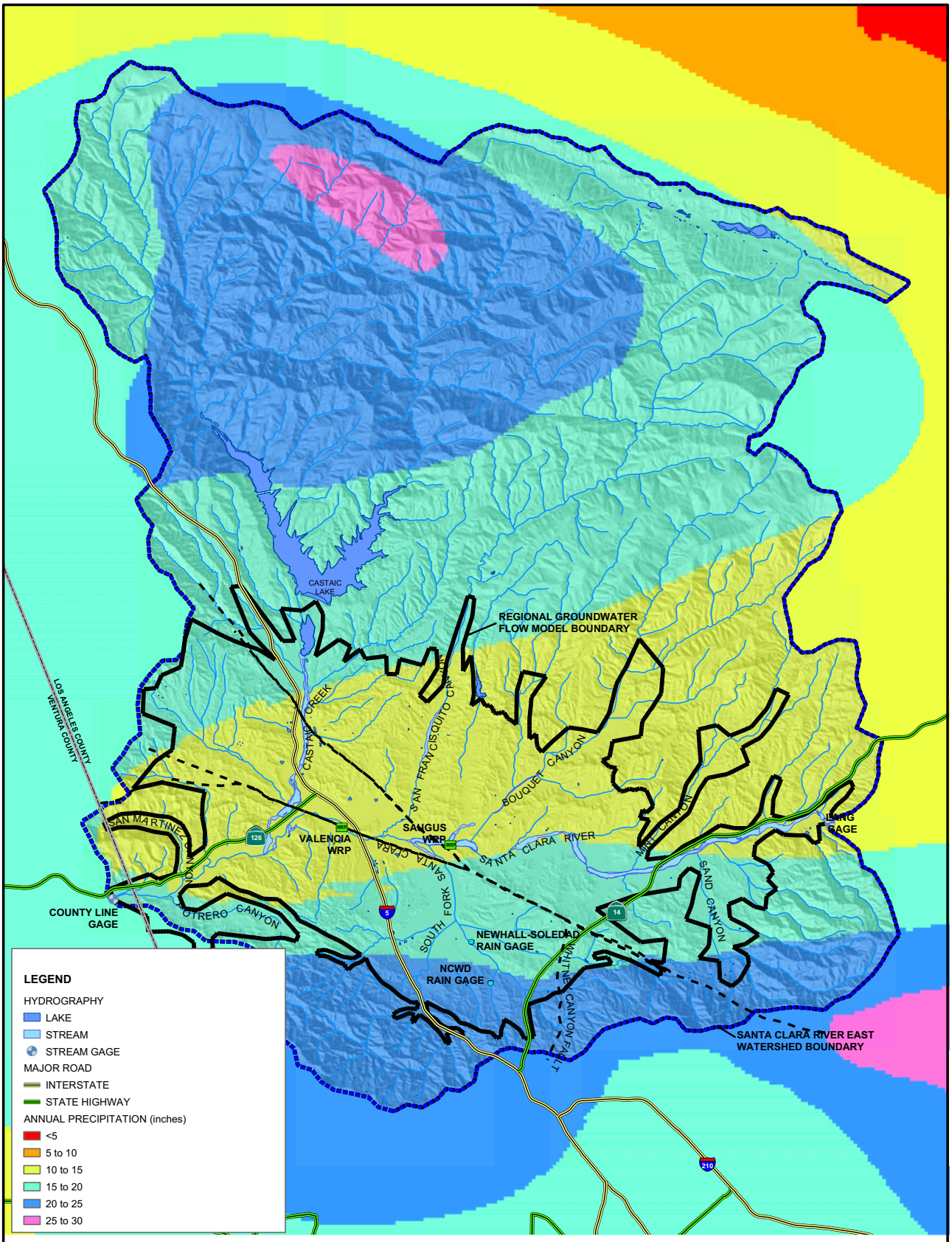

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

N

0 2.5 5 miles

FIGURE 2-7
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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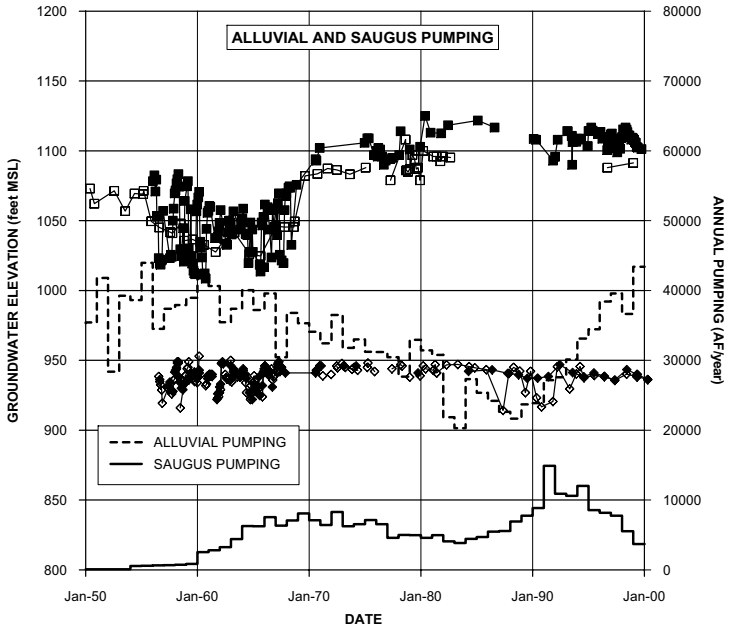

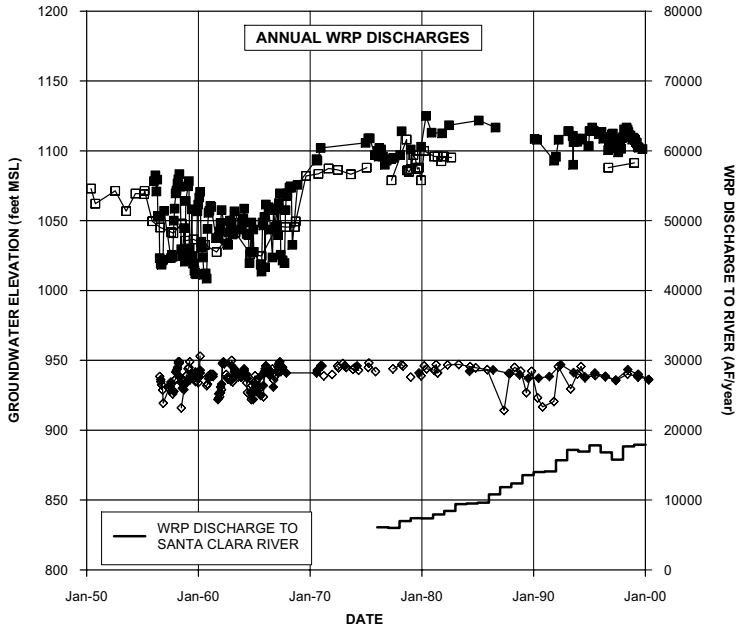

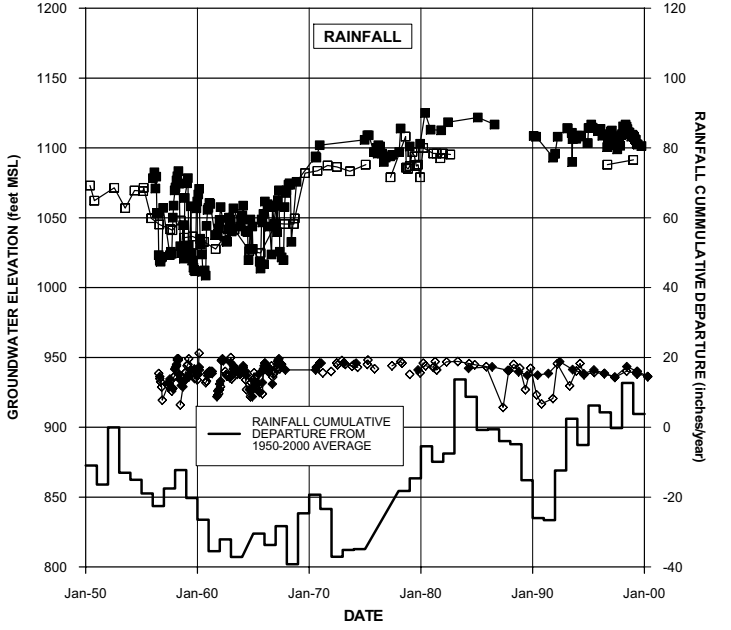

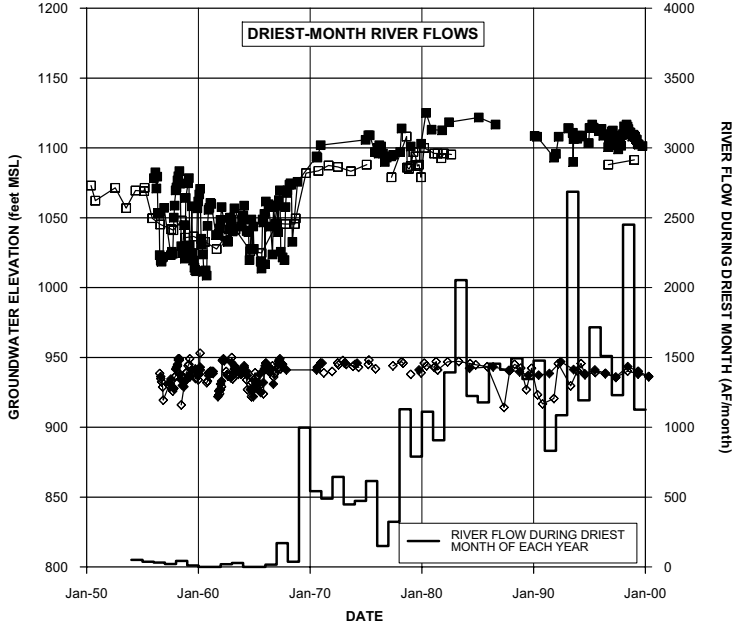

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N
- ELEVATION OF GROUNDWATER IN NLF-S
- ELEVATION OF GROUNDWATER IN NLF-C5
- ELEVATION OF GROUNDWATER IN NLF-C7

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS. FORMER WELL NLF-S WAS LOCATED 940 feet SOUTHWEST OF WELL VWC-S6.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-8
ALLUVIAL GROUNDWATER ELEVATIONS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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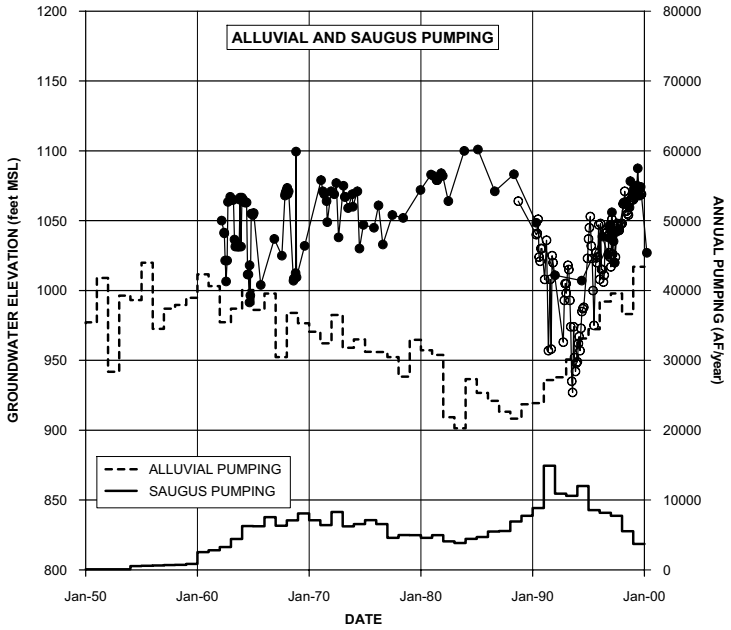

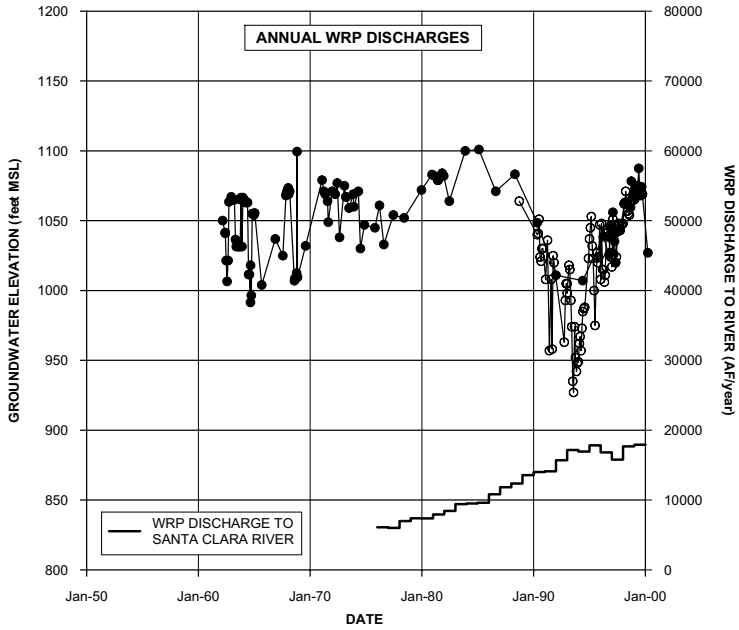

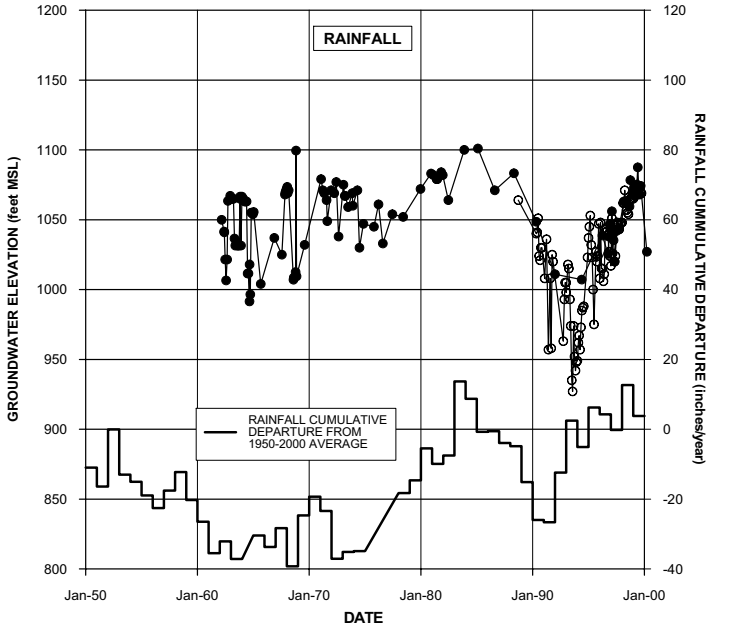

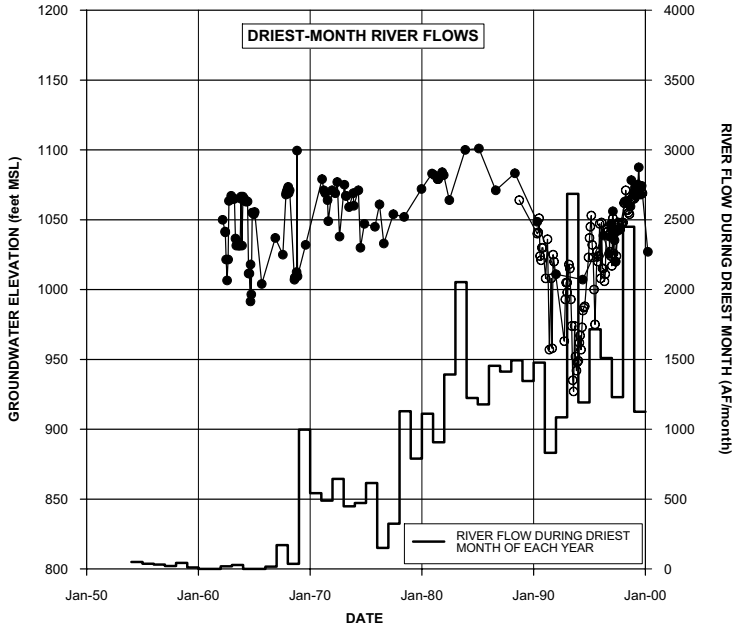

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157 (DESTROYED JANUARY 2005)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-9
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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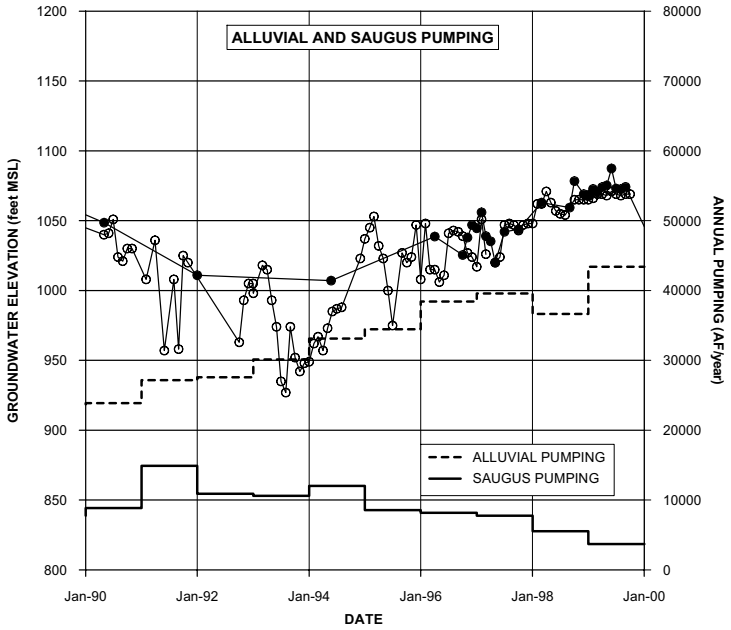

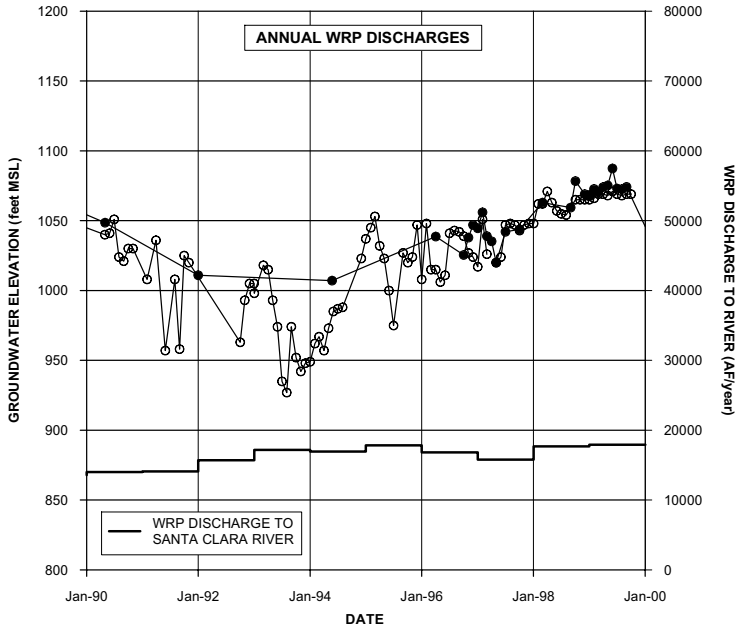

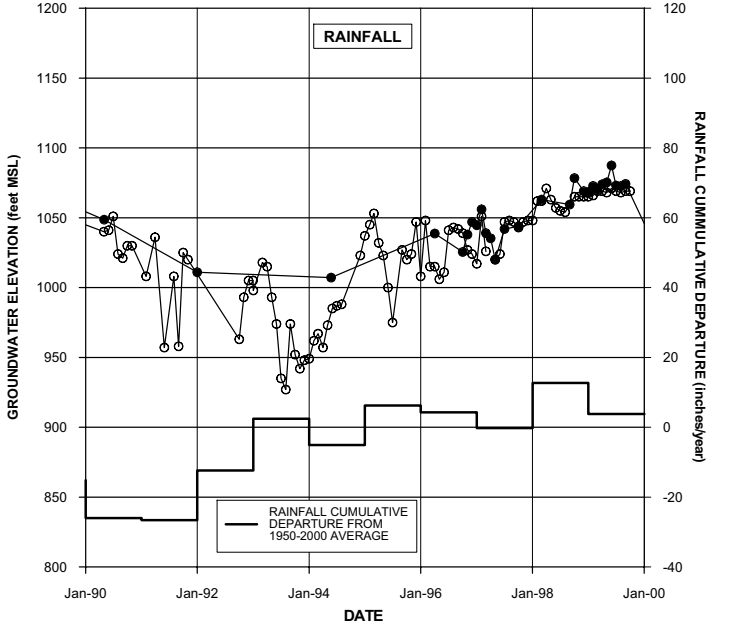

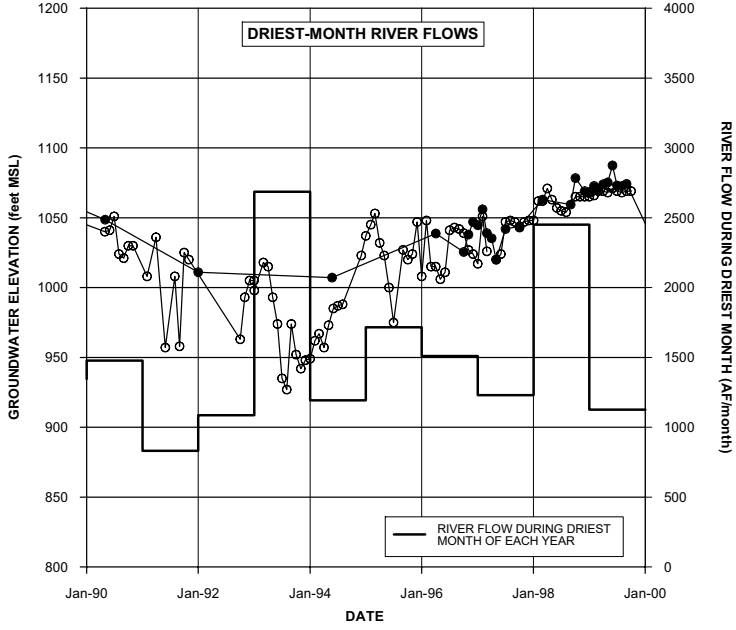

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157 (ABANDONED JANUARY 2005)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-10
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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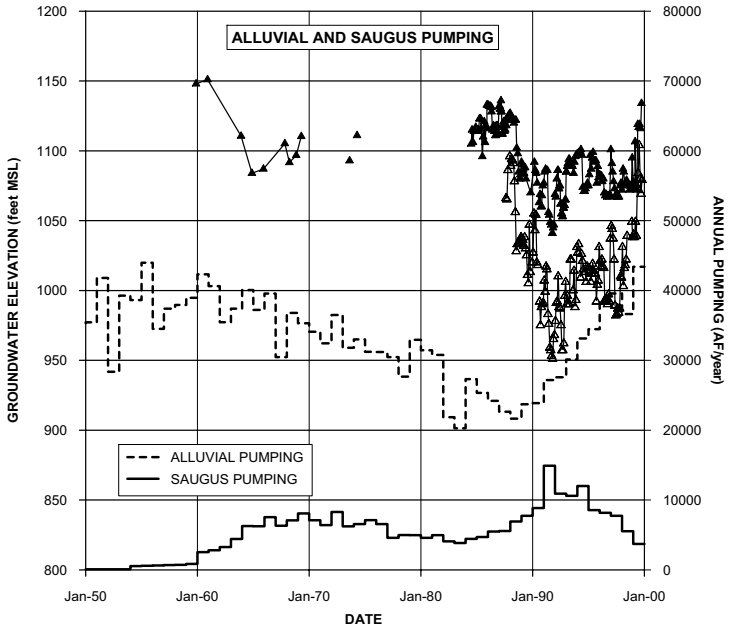

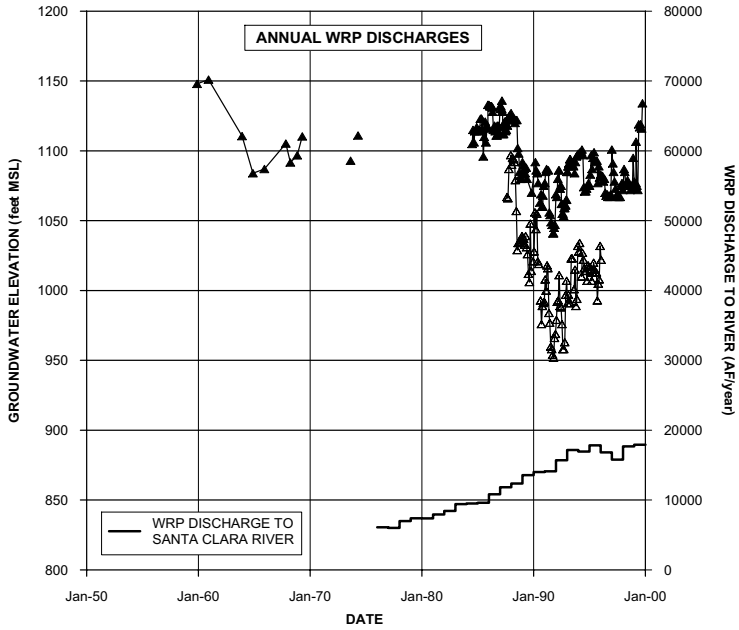

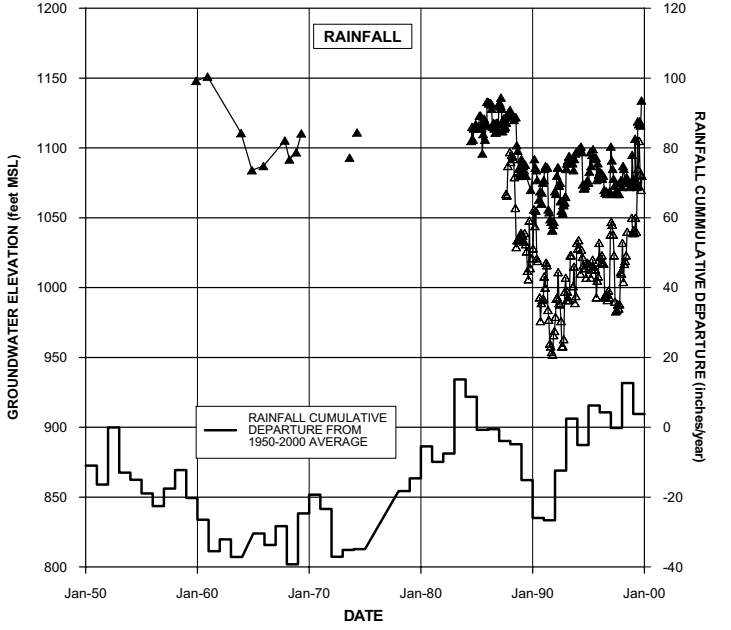

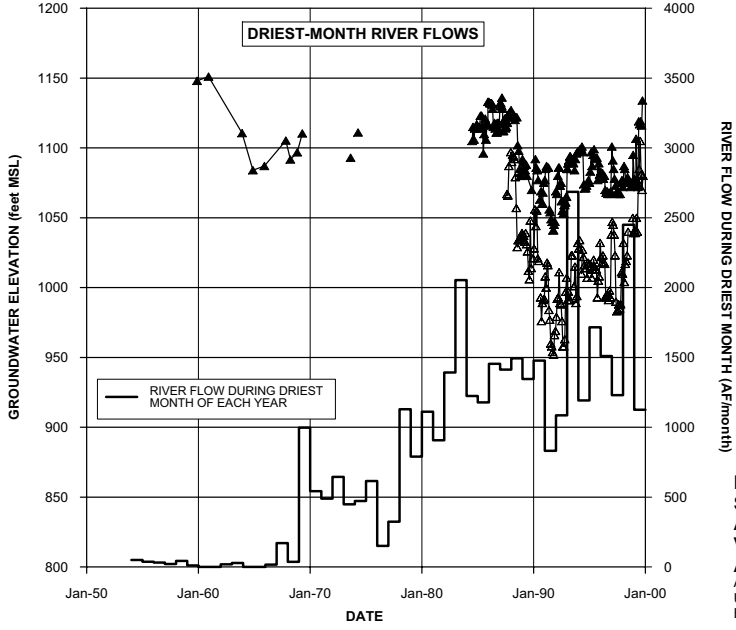

LEGEND

- ELEVATION OF GROUNDWATER IN NCWD-7
- ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-11
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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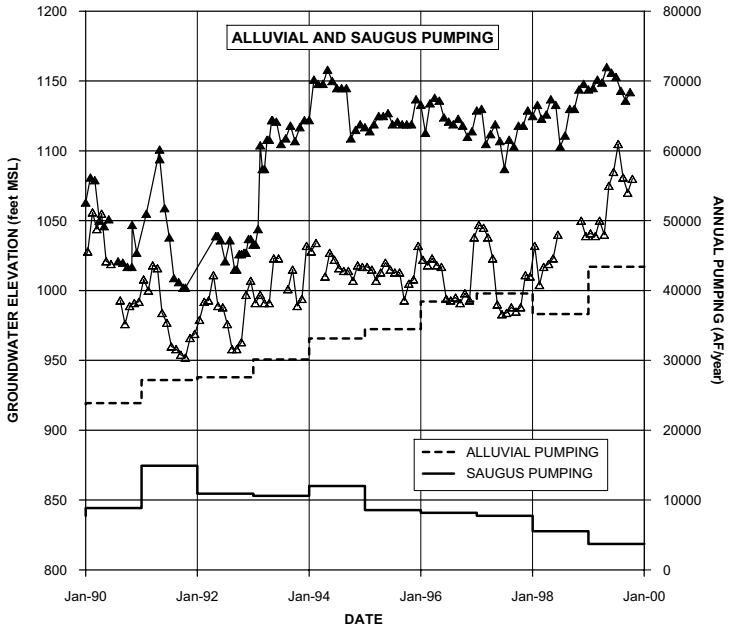

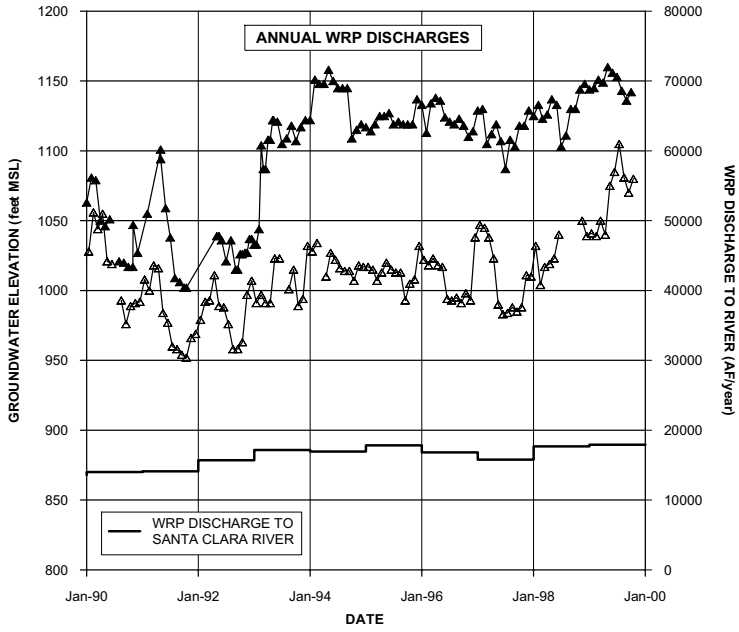

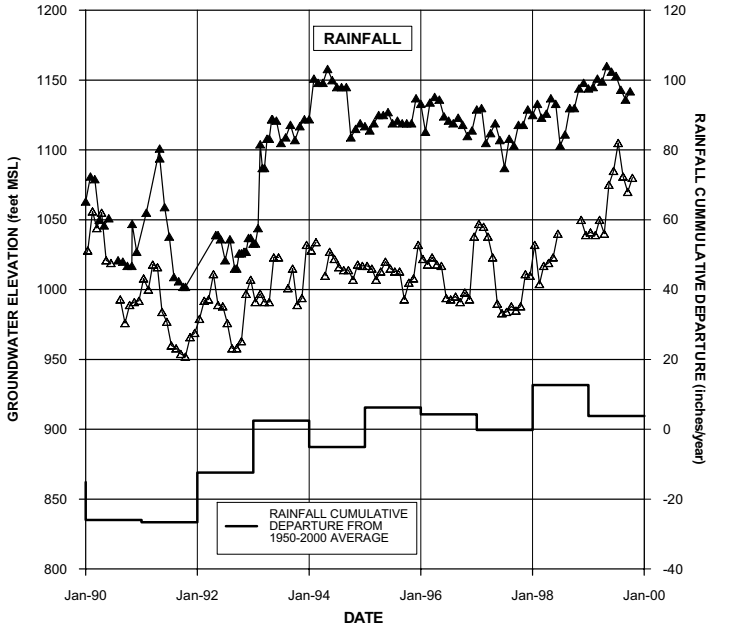

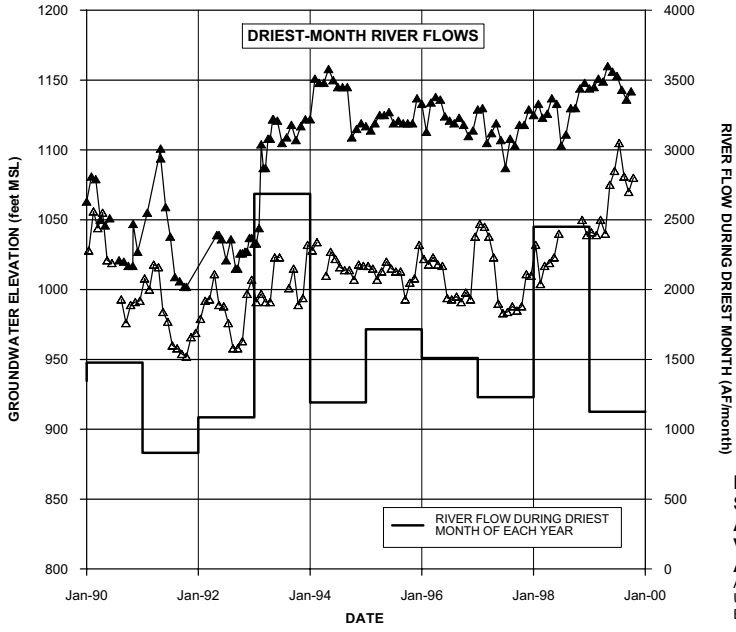

LEGEND

ELEVATION OF GROUNDWATER IN NCWD-10
ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-12
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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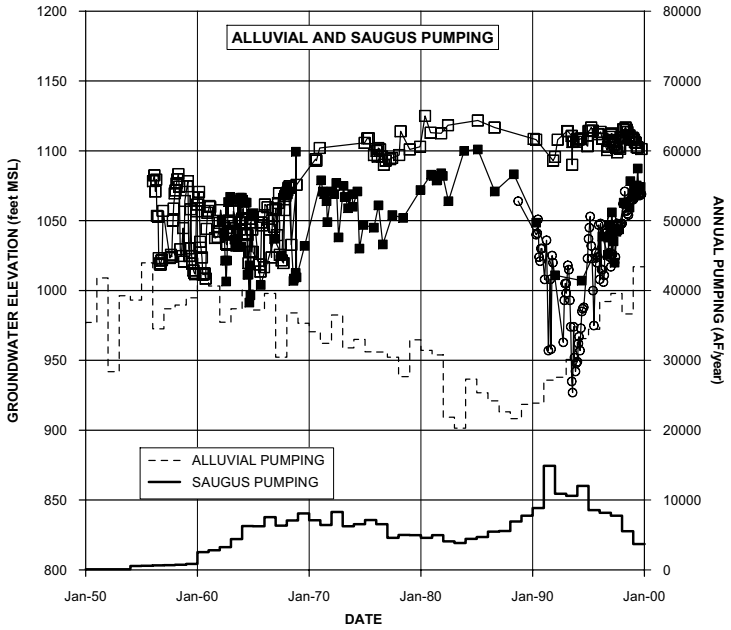

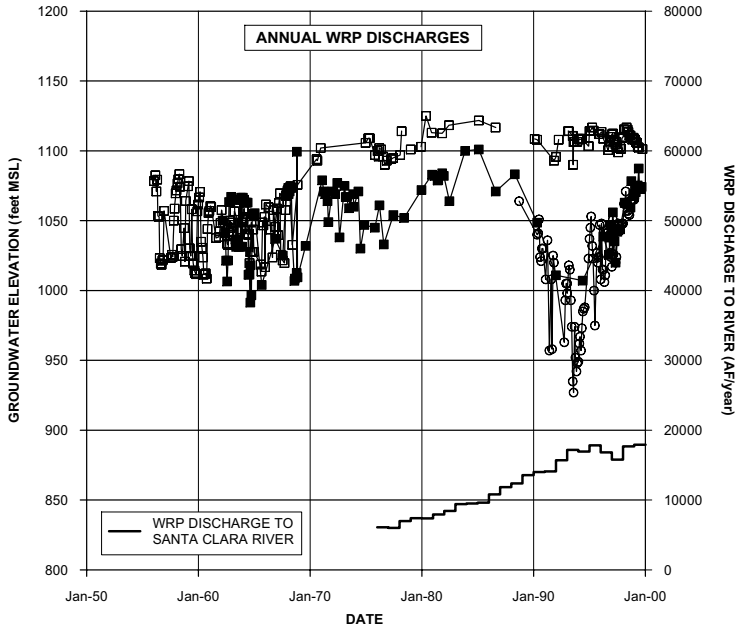

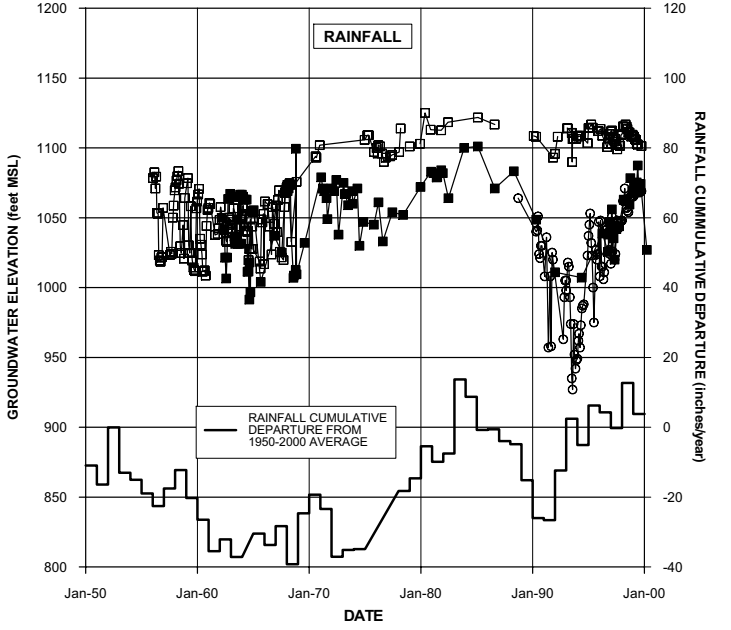

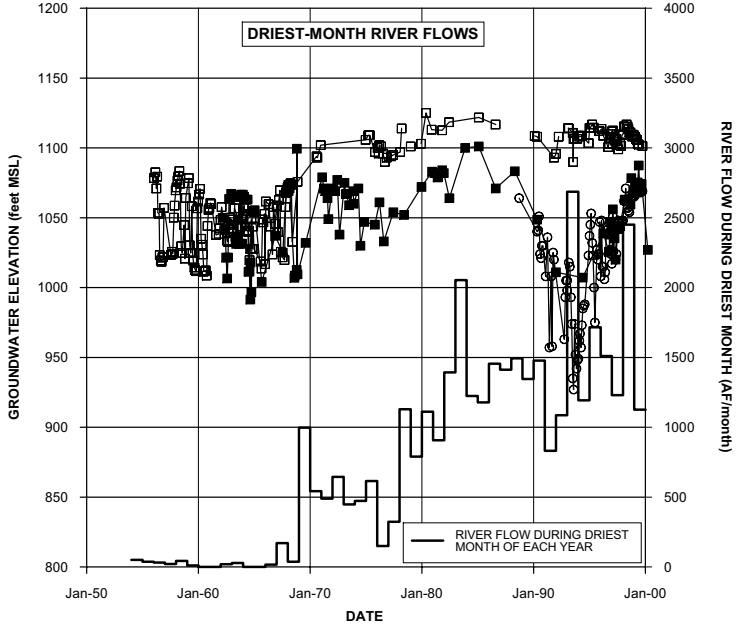

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N (ALLUVIUM)
- ELEVATION OF GROUNDWATER IN VWC-157 (SAUGUS)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2 (SAUGUS)

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-13
GROUNDWATER ELEVATIONS IN ADJACENT ALLUVIAL AND SAUGUS WELLS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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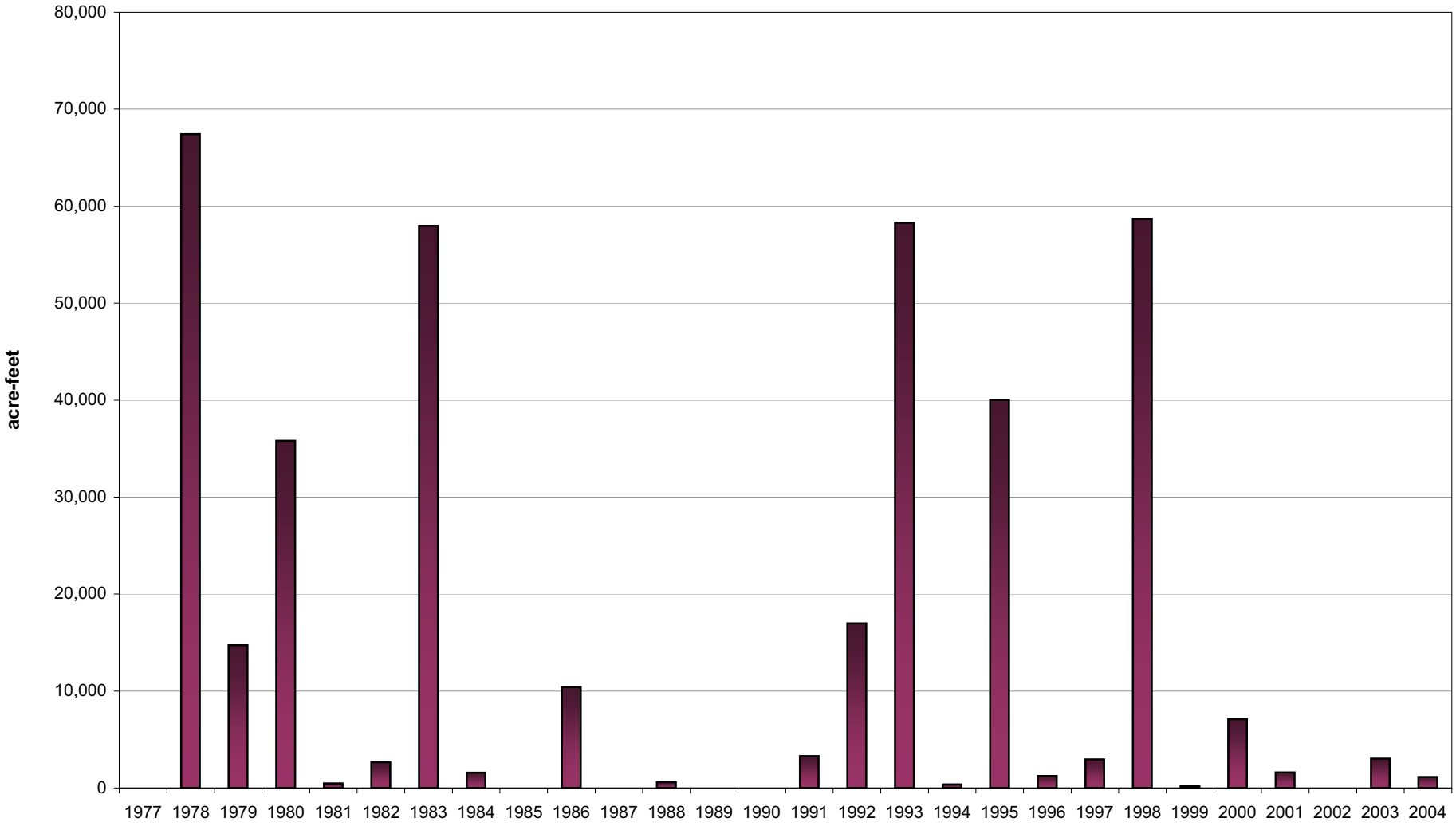

Note:
This chart shows the potential Flood Flows available during water years 1977 through 2004. Water Year 1977 is defined as October 1, 1976, through September 30, 1977, but the water is generally available only from October 1 through April 30.

FIGURE 2-14
HISTORICAL CASTAIC CREEK FLOOD FLOWS AVAILABLE TO DOWNSTREAM USERS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 3

Modeling Approach for Analyzing Basin Yield

The approach to using the Regional Model for the basin yield analysis began with identifying a simulation period spanning several decades to capture short-term (year-to-year) and longer-term (multi-year) variations in pumping from both aquifer systems. Pumping was then assigned in the Regional Model in accordance with historical and current uses of each production well, and in consideration of how the pumping rate assignments are currently impacted by the presence of perchlorate in groundwater in specific areas. Regional Model simulation results were then studied to evaluate short-term and long-term trends in groundwater elevations, groundwater budgets, and river flows. This section presents the design details of this modeling evaluation.

3.1 Model Description

The Regional Model is a three-dimensional, numerical model that uses MicroFEM® finite-element software (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. Figure 3-1 shows the model domain, along with its location relative to the upstream watersheds that contribute runoff into the model study area. The Regional Model's construction and calibration is summarized in Appendix B and discussed in detail in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a).

The Regional Model area largely coincides with the Santa Clara River Valley Groundwater Basin, East Subbasin, delineated by DWR, extending from the Lang stream gage at the eastern end of the valley to the County Line stream gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. Figure 3-2 shows the spacing of the individual nodes that make up the grid. The upper model layer simulates the Alluvial Aquifer and also the upper portion of the Saugus Formation where the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and its Sunshine Ranch Member. The layer representation is summarized schematically on Figure 3-3. Figure 3-4 shows the model layering in three cross-sectional views.

The boundary conditions in the model consist of the following:

1. Specified flux boundaries for the following:

    a. Precipitation
    b. Irrigation
    c. Recharge from ephemeral streams
    d. Pumping
    e. Underflow from beneath Castaic Dam

2. Head-dependent flux boundaries for the following:
    a. Groundwater discharges to the perennial reach of the Santa Clara River
    b. Residual drainage of groundwater to the Santa Clara River in the ephemeral reach under high water table conditions
    c. Evapotranspiration (ET) by phreatophyte plants, which extract groundwater from the shallow water table that lies along riparian river corridors
3. Constant-head boundaries for the following:
    a. Subsurface inflow in the Alluvial Aquifer at the eastern end of the valley, at the Lang gage[5]
    b. Subsurface outflow in the Alluvial Aquifer at the western end of the valley, at the County Line gage

Groundwater recharge rates are estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates are calculated using a detailed Surface Water Routing Model (SWRM), which was written specifically to provide time-dependent, spatially varying recharge rates as input to the Regional Model. The SWRM relies on streamflow records at the Lang and County Line gages; historical records of rainfall data from the NCWD rain gage (see Figure 1-1 for the location of this gage); spatial variations in rainfall across the basin (see Figure 2-7); and, for the basin yield analysis, the rates and locations of future WRP discharges to the Santa Clara River and irrigation from agricultural and urban water uses.

The depths from which production wells obtain water are defined in the Regional Model from well construction records. The rates and locations of pumping are based on the Purveyors' operating plan for the basin and on the surveyed location of each production well.

3.2 Modeling Approach

The process of designing the modeling analysis of the operating plan for the basin consisted of the following five activities:

1. Selecting a period over which to simulate groundwater conditions resulting from various pumping configurations
2. Defining pumping rates and schedules for each production well in the Santa Clarita Valley, considering the variability in pumping demands that occur due to cycles of drought and nondrought conditions and year-to-year variations in the availability of other water supplies
3. Defining the variation in local hydrology (rainfall, streamflows, and groundwater recharge) on a month-to-month basis throughout the simulation period

[5]A constant-head boundary was established in the Regional Model at this location using recent field conditions that were observed after the model calibration report (CH2M HILL, 2004a) was published. This change improved the Regional Model's calibration in the Alluvial Aquifer in the upper reaches of Soledad Canyon and did not appreciably change the calibration quality elsewhere. See CH2M HILL (2005) for further details.

4. Running the model to calculate time-varying (monthly) groundwater elevations and groundwater discharge terms throughout the multi-year simulation period
5. Evaluating the modeling results by examining forecasted time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the effects of the operating plan in the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River

These activities are described in further detail below.

3.3 Simulation Period

The locations and temporal variation in pumping from the Alluvial Aquifer were defined in the model from the operating plan and from historical records of the year-to-year variability in local hydrology. Simulated pumping from the Saugus Formation was defined from the operating plan, historical pumping records, and operational constraints and historical patterns of SWP water supply availability.

3.3.1 Selection of Simulation Period

Because the operating plan for the Saugus Formation is linked to the hydrology and operational constraints for the SWP system, the year-to-year variability in Saugus Formation pumping is, to a great extent, dependent on the hydrology outside the valley (i.e., in northern California). As shown in Table 3-1, local hydrology is often not a good indicator of local pumping conditions in the Saugus Formation, because local droughts and SWP droughts frequently do not coincide with each other. The following are examples:

1. In 1955, dry conditions in the SWP system coincided with approximately 14 inches of rainfall at the Newhall-Soledad rain gage, which is similar to the long-term median rainfall recorded at this gage.
2. In 1976 and 1977, the SWP system hydrology was critical, while the local hydrology during those years was near normal (1976) and wetter than normal (1977).
3. In 1987 and 1988, the SWP system hydrology was dry (1987) and critical (1988), while the local hydrology during those years was near normal (1987) and wetter than normal (1988).
4. In 1991 and 1992, the SWP system hydrology was in its fifth and sixth consecutive years of dry or critical hydrology, while the local hydrology was wetter than normal both years.
5. In 2001, dry conditions in the SWP system coincided with wetter-than-normal local conditions.

Consequently, it was decided that the model would need to be run over several decades to capture the year-to-year variability in the hydrology of each system, as well as the less frequent times when both systems experience similar hydrologic conditions (as occurred

periodically during the 1960s and in 1994). Historical records were then analyzed to identify a synthetic simulation period that would meet the following criteria:

1. The simulation time should be long enough to include an historical period that accounts for the year-to-year variations in local hydrology that have been observed in the past.
2. The period should be long enough to include longer-term (i.e., on the order of decades) periods of relatively dry conditions and relatively wet conditions.
3. The average rainfall during the simulation period should be similar to the average rainfall of 17.84 in/yr that was observed from 1950 through 2000 at the Newhall-Soledad gage.
4. The period should be sufficiently long to allow simulation of two occurrences of reduced SWP water supplies during the period 1990 through 1992, which corresponds to periods of increased pumping from the Saugus Formation under the operating plan.
5. The frequency of dry-year occurrences in the SWP system, corresponding to increased pumping from the Saugus Formation, should be similar to the historical frequency.
6. If necessary to meet other criteria, the simulation should repeat parts of this sequence before and/or after the historical sequence.

Examination of historical local hydrology and independent simulations of SWP deliveries resulted in the selection of a 78-year period over which the model was run, with monthly time steps. The 78-year period replicates the historical hydrology of the following years:

1. Years 1 through 24 = 1980 through 2003
2. Years 25 through 78 = 1950 through 2003

3.3.2 Relationship of Simulation Period to Variations in Alluvial Aquifer Pumping

Figure 3-5 shows the year-to-year rainfall in the valley and the cumulative departure from average rainfall for each year during the 78-year simulation period. The figure also shows each simulation year's corresponding historical year. The cumulative departure from average rainfall is plotted to show the occurrence of relatively wet versus relatively dry periods. A year-to-year decline in the slope of the cumulative departure curve indicates that conditions are dry, whereas a year-to-year increase indicates that rainfall is above normal. Also plotted are the occurrences of SWP droughts. The figure shows the following:

1. The first 19 years of the simulation period are generally wet, as a whole, though a multi-year drought occurs in years 5 through 12 (1984 through 1991).
2. A prolonged dry period begins in year 20, as indicated by the downward slope in the cumulative departure curve. This period lasts through year 39, as the curve starts to slope upward to the right beginning in year 40[6]. This 20-year period of generally dry conditions corresponds to the historical period 1999 through 2003, followed by 1950 through 1964.

[6]Year 40 is equivalent to historical year 1965, when rainfall was over 32 inches, or 2.2 times the long-term median rainfall and 1.8 times the long-term average rainfall.

3. Rainfall was generally at or above normal from years 40 through 45 (historical years 1965 through 1970), before a drought ensued from years 46 through 51 (historical years 1971 through 1976).

4. Rainfall was then generally above normal during years 52 through 58 (1977 through 1983), followed by the drought years 59 through 66 (1984 through 1991), the wetter-than-normal years 67 through 76 (1992 through 2001), and dry years 77 and 78 (2002 and 2003).

Table 3-2 shows the sequence of local hydrologic conditions and resulting valleywide pumping volumes for the Alluvial Aquifer that have been defined from the groundwater operating plan for the valley. The 78-year simulation period contains the following:

1. Twenty-four years of sporadic dry-year pumping, which is approximately 30 percent of the simulated 78-year period.

2. One drought consisting of 4 consecutive years of below-normal pumping (in years 34 through 37, based on historical hydrology from 1959 through 1962).

3. Two droughts consisting of 3 consecutive years of below-normal pumping (in years 10 through 12 and 64 through 66, both of which are based on historical hydrology from 1989 through 1991).

4. Three years (years 12, 37, and 66) when rainfall is near or above normal, but pumping is assigned at a dry-year rate because the year was preceded by a multi-year local drought.

3.3.3 Relationship of Simulation Period to Variations in Saugus Pumping

Table 3-3 shows the sequence of SWP droughts, SWP allocations, and resulting pumping volumes for the Saugus Formation that have been defined based on the CLWA and USBR analyses. With respect to Saugus Formation pumping, the 78-year period contains the following:

1. Two droughts lasting 2 years
2. Two droughts lasting 3 years
3. A dry year that occurs 2 years before the beginning of each 3-year drought
4. A dry year that begins 1 year after each 3-year drought has ended
5. A total of 18 dry years, or an average of 1 dry year approximately every 4 years
6. Sixty years of normal-year pumping from the Saugus Formation

3.4 Assignment of Pumping Rates

Pumping rates for Purveyor-owned wells and known private pumping wells (owned by the Newhall Land & Farming Company (NLF), the Wayside Honor Rancho, and Robinson Ranch) were assigned in accordance with the groundwater operating plan for the Santa Clarita Valley, which defines ranges of valleywide annual pumping, given the water supply needs of the Purveyors. Pumping rates at individual wells were also assigned using the recent and planned production schedules for each well, information on the depths and lengths of the intake sections (open intervals) of each well, and by incorporating current

plans addressing the presence of perchlorate in specific portions of the Saugus Formation and the Alluvial Aquifer.

As noted in the discussion of the groundwater operating plan in Section 2.2, the water management practices of the Purveyors recognize ongoing Alluvial Aquifer pumping for agricultural water supply, as well as other smaller private domestic and related pumping. For the last 7 years of formal annual water report preparation in the Santa Clarita Valley, those reports have included estimates of the latter private pumping. In recent years, that estimate has been 500 AF/yr. Initially in 2003, during the preparation of the Groundwater Management Plan (CLWA, 2003), and recently, during ongoing preparation of the 2005 UWMP, the Santa Clarita Valley Well Owners' Association submitted limited information about the nature and magnitude of private well pumping. The most notable input from the Well Owners' Association was its detailed estimate of private well pumping in the San Francisquito Canyon portion of the basin: a total of 85 AF/yr by 73 individual private pumpers, or an average of approximately 1.2 AF/yr per private well (equivalent to approximately 0.7 gallon per minute). As a result of that information, there is increased confidence that total private pumping in the basin by smaller users is within the 500 AF/yr estimate presented in recent annual water reports and is, therefore, approximately 1 percent of typical Alluvial Aquifer pumping by the Purveyors and other known private well owners (including agricultural pumpers) combined. However, the small private wells are not explicitly modeled in the basin yield analysis described herein because their locations and operations are not known, and their operation creates a pumping stress that is essentially negligible at the scale of the regional model. Ultimately, as discussed throughout this report, the intent to maintain overall pumping within the operating plan, including private pumping, will result in sustainable groundwater conditions to support the combination of municipal (Purveyor), agricultural, and private groundwater use on an ongoing basis. Thus, private well owners in the basin, like the large municipal and agricultural pumpers, can expect groundwater supplies to continue to be available as they have been in the past, with some fluctuations in water levels through wet and dry periods, but no long-term depletion of supply.

Details of pumping rate assignments for Purveyor-owned wells and known private pumping wells are discussed for the Alluvial Aquifer in Section 3.4.1 and for the Saugus Formation in Section 3.4.2. Section 3.4.3 discusses the monthly distribution of pumping for each well. Section 3.4.4 discusses how the pumping rate assignments relate to the presence of perchlorate in groundwater.

3.4.1 Variations in Alluvial Aquifer Pumping

Pumping rates at specific wells were assigned for normal and dry years using the operating plan and information on the capacity, recent and planned use, and location of each well. Figure 2-4 shows the locations of these wells and other wells in the valley. Table 3-4 compares recent annual pumping volumes at each Alluvial Aquifer well with the assumed future production rates at each well under normal and dry-year conditions. Most Alluvial Aquifer wells were specified to operate at similar rates regardless of year type. However, there were two exceptions, as follows:

1. Wells in the eastern portion of the basin (the NCWD-Pinetree wells, nine wells owned by SCWC, and the privately owned Robinson Ranch well) were assumed to have lower

pumping capacities during dry years than nondrought years because of lower groundwater elevations during dry periods. This assumption was based on historical observations indicating that the eastern portion of the Alluvial Aquifer, in contrast to other parts of the valley, experiences declines in water levels during dry periods.

2. Pumping was also reduced at NCWD's three operating wells in Castaic Valley, in accordance with recent pumping records from those wells.

3.4.2 Variations in Saugus Formation Pumping

Pumping rates at specific Saugus Formation production wells were assigned for each type of year (normal, dry year 1, dry year 2, and dry year 3) using the operating plan for the valley and information on the capacity, recent and planned use, and location of each well. Table 3-5 summarizes the annual pumping volumes at each Saugus Formation well[7]. Significant aspects of the pumping rate selection at each well are as follows:

1. Pumping from most existing Saugus Formation production wells was based on recent and planned use of these wells, as defined by the Purveyors. The simulation included increased dry-year pumping from the Saugus Formation in the western portion of the basin, where it is anticipated that future wells will be installed.

2. Each Saugus Formation production well has an intake section (open interval) that is significantly longer in vertical extent than the thicknesses of the individual layers that represent the Saugus Formation in the Regional Model. Consequently, the Saugus pumping rates were assigned to multiple layers in the model by considering the depths of the intake section of each well and the transmissivity of each model layer. Table 3-6 shows the allocation of pumping in each model layer for each Saugus Formation production well, along with the intake sections of each well and the model-simulated transmissivity in each layer at each well location.

3.4.3 Monthly Allocation of Pumping

Table 3-7 shows the allocation of pumping, by month, for agricultural and urban production wells in both the Saugus Formation and the Alluvial Aquifer. Separate distributions were used because agricultural demands are for exclusively outdoor uses, whereas urban demands are for both indoor and outdoor uses. As discussed in the model development report (CH2M HILL, 2004a), the monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining historical monthly flow records for the two LACSD WRPs and monthly demand distributions recorded by the Purveyors during the past several years.

3.4.4 Influence of Perchlorate Contamination on Groundwater Pumping

In 1997, two Saugus Formation production wells owned by CLWA's Santa Clarita Water Division (formerly SCWC) (wells SCWC-Saugus1 and SCWC-Saugus2), one Saugus Formation production well owned by the Newhall County Water District (NCWD)

[7]Table 3-5 only lists wells that are anticipated to be operating in the future. Existing wells that are not listed in this table (such as NCWD-7 and NCWD-10) are currently not in service or pump very limited quantities of groundwater, and, therefore, are not expected to provide significant quantities of water in the future.

(well NCWD-11), and one Saugus Formation production well owned by VWC (well VWC-157) were shut down because perchlorate was detected in groundwater at these wells[8]. In 2002, an Alluvial Aquifer production well owned by SCWC (well SCWC-Stadium) was shut down because of perchlorate detection. In March 2005, an Alluvial Aquifer production well owned by VWC (well VWC-Q2) was shut down because of perchlorate detection. The locations of the six impacted production wells and nearby nonimpacted production wells are shown on Figure 3-6, along with the locations of monitoring wells and exploratory borings that have been installed to investigate the extent of perchlorate contamination. Figure 3-6 also shows perchlorate concentrations at locations where perchlorate has been detected in groundwater. At each of the six production wells, the detected perchlorate concentrations exceeded the State of California's Action Level (AL) for perchlorate at the time of the detection[9].

In 2003, the Purveyors entered into a voluntary cleanup agreement with the California Department of Toxic Substances Control whereby the Department of Toxic Substances Control provides review and oversight of the activities of the Purveyors in response to the perchlorate detections. The Purveyors have also initiated a process for approval by the California Department of Health Services, in accordance with its Policy 97-005, for restoration of water supply from "severely impaired" water sources, such as the perchlorate-impacted wells. Also in 2003, the Purveyors and the responsible party (the Whittaker Corporation) entered into an Interim Settlement Agreement. Activities since execution of the Interim Settlement Agreement have consisted of developing the elements of a remedial strategy that will entail pumping of two impacted wells for containment of perchlorate migration; treatment and subsequent use of the pumped water for water supply; and installation of replacement wells in non-impacted portions of the basin to restore the remainder of groundwater supply impacted by perchlorate. A noteworthy detail of these activities is that the Regional Model was used to identify the design of a pumping scheme that would meet the Purveyors' objectives for perchlorate containment in the Saugus Formation (CH2M HILL, 2004b).

With respect to perchlorate presence in the Alluvial Aquifer, the selection of pumping rates for the basin yield analysis was as follows:

1. Well SCWC-Stadium was simulated as pumping during each year of the 78-year simulation period. The Whittaker Corporation is developing plans to mitigate the source of perchlorate to the portion of the Alluvial Aquifer immediately north and downgradient of the Whittaker-Bermite property. The modeled pumping scenario simulates the possibility that the well will be returned to service in the future and pump at a rate similar to historical volumes after source mitigation activities have reduced perchlorate concentrations to undetectable levels in the Alluvial Aquifer at and near this well.

[8]As part of the ongoing implementation of perchlorate containment and restoration of impacted capacity, well VWC-157 was abandoned in January 2005 and replaced by new well VWC-206. Thus, this analysis includes planned pumping from replacement well VWC-206.

[9]The AL has varied over time. The California Department of Health Services initially established an AL of 18 micrograms per liter (μg/L) in 1997, at the same time the four impacted Saugus Formation production wells were taken offline. In 2002, the Department of Health Services revised the AL to 4 μg/L based on studies by the U.S. Environmental Protection Agency. In March 2004, the AL was revised to 6 μg/L based on a public health goal published by the Office of Environmental Health Hazard Assessment. See http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/actionlevel.htm for further details.

2. Well VWC-Q2 was simulated as pumping during each year of the 78-year simulation period. VWC and the Whittaker Corporation are currently implementing plans to install perchlorate treatment (ion exchange) facilities at the wellhead to remove perchlorate so that the well can be returned to service (LSCE, 2005b). VWC is working with USFilter to install and maintain this treatment and is preparing an application to amend its water supply permit to allow treatment at this well, which is expected to be returned to service by fall 2005. The perchlorate detected in well VWC-Q2 does not significantly impact the water supplies used to meet demand in the Santa Clarita Valley during the time required to respond to the contamination at this well (LSCE, 2005b).

With respect to perchlorate presence in the Saugus Formation, the Purveyors have developed a hydraulic containment plan for the Saugus Formation that consists of pumping from the SCWC-Saugus1 and SCWC-Saugus2 production wells. The three Saugus wells impacted by perchlorate had produced a combined average of 4,186 AF/yr of water during the 5 years preceding the detection of perchlorate. Restoration of that volume of water is currently planned to be achieved by reactivating wells SCWC-Saugus1 and SCWC-Saugus2, with treatment for removal of perchlorate, and by constructing replacement wells in other parts of the Saugus Formation not impacted by perchlorate. Full restoration of impacted water supply, including implementation of the containment plan, is currently scheduled for 2006. The containment plan will consist of (1) pumping groundwater on a nearly continual basis from production wells SCWC-Saugus1 and SCWC-Saugus2 production wells; (2) treating the pumped water using ion exchange resins followed by chlorine and ammonia disinfection; and (3) pumping the treated water to CLWA's Rio Vista Intake Pump Station for subsequent distribution for municipal water supply. This containment plan was developed to meet the following objectives, which were identified by the Purveyors:

1. Hydraulically contain perchlorate that is migrating westward in the Saugus Formation from the Whittaker-Bermite property toward the impacted production wells
2. Hydraulically contain perchlorate that is present at monitoring well MP-5 and production well VWC-157, which are located downgradient of the impacted wells
3. Protect downgradient production wells that are currently not impacted
4. Restore the annual volumes of water that were pumped from the impacted wells before they were shut down
5. Operate the impacted wells in a manner that is consistent with the groundwater operating plan
6. If possible, pump one or more of the impacted Saugus Formation production wells in a manner that also contains perchlorate migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property

A detailed analysis of this perchlorate containment plan in the Saugus Formation is presented in *Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property* (CH2M HILL, 2004b). The pumping plan described in that report for the SCWC-Saugus1 and SCWC-Saugus2 production wells was also used in the basin yield modeling evaluation. These wells were assumed to operate on a continuous basis to contain perchlorate in this portion of the Saugus Formation. The analysis assumed each well

would be offline 1 month each year for routine maintenance, but would otherwise operate on a continuous basis.

Additionally, for the previous evaluations of the containment plan and for the basin yield analysis, the third impacted production well (NCWD-11) was assumed to operate at a yield of 1,200 gallons per minute for a period of 5 months during the peak-demand season, providing a volume of 811 acre-feet that would be treated prior to entering the distribution system. Consequently, total pumping from the three perchlorate-impacted Saugus Formation production wells that will be returned to service (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11) was simulated as 4,355 AF/yr. Total pumping from NCWD wells completed in the Saugus Formation was simulated as 3,441 AF/yr in normal years and 4,899 AF/yr in dry years, with pumping occurring from NCWD-11 and nearby production wells NCWD-12 and NCWD-13. Because they are closely spaced geographically, the three wells together form a pumping center in the Saugus Formation. Thus, although NCWD may choose to no longer use well NCWD-11, this analysis includes a pumping distribution that examines the sustainability of the Saugus Formation with a conservatively high pumping capacity at this pumping center.

3.5 Simulation Methods for Other Local Hydrologic Processes

In addition to groundwater pumping, infiltration from irrigation (from urban and agricultural lands), precipitation, and streamflows (stormwater and WRP discharges) were also modeled. These other local hydrologic processes were defined using the Surface Water Routing Model (SWRM), which is described in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Key aspects of the derivation of these terms are described in the following sections.

3.5.1 Recharge from Urban Irrigation

Under existing land use and water use conditions, the estimated long-term infiltration rates of applied irrigation water beneath urban areas, under full build-out conditions in the valley, were estimated to be 1.0 in/yr for industrial and retail lands, 2.2 in/yr for residential developments and parks, and 4.6 in/yr for golf courses. These rates were applied during each year (and each month) of the 78-year simulation period. The areas over which these rates were applied were larger than under current conditions. The areas were defined from existing land use data and from LACSD mapping of projected future land uses in the rest of the Santa Clarita Valley under full build-out conditions[10]. Figure 3-7 shows the land use that was simulated in the model for full build-out conditions.

3.5.2 Recharge from Agricultural Irrigation

As discussed in the *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002), irrigation of lands owned by NLF results in existing agricultural return flows. The source of most irrigation water is groundwater pumping from the Alluvial Aquifer, with some limited pumping occurring from one Saugus Formation well (NLF-156).

[10]LACSD land use mapping indicates that, including Newhall Ranch, approximately 14,000 acres of currently undeveloped land will be urbanized in the future within the Regional Model simulation area. Additional urbanization will also occur in areas that are within the watershed, but outside the Regional Model's boundaries.

Under full valley build-out conditions, the currently irrigated lands will no longer be irrigated because their water source will be used as part of the water supply for Newhall Ranch. Therefore, under full build-out conditions, no agricultural irrigation will occur within the area simulated by the Regional Model.

3.5.3 Precipitation Recharge

Infiltration from direct precipitation within the Regional Model domain was defined using data from the Newhall-Soledad and NCWD rain gages, an isohyet map of rainfall throughout the watershed, and a power-function equation developed by Turner (1986) that describes the relationship between annual rainfall and ET rates within the valley. Details concerning the derivation of precipitation infiltration rates from these data are contained in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Table 3-8 lists the simulated monthly precipitation at the NCWD rain gage for the 78-year model period[11].

3.5.4 Stormwater Flows and Recharge from Streams

For each month of the simulation, the SWRM calculated the amounts of stormwater flow and groundwater recharge in all streams, plus the amount of flow and groundwater recharge arising from projected future WRP discharges to the Santa Clara River. For the Santa Clara River, the volume of streamflow was defined from measured and estimated streamflow data at the Lang gage (Table 3-9). For Castaic Creek, the volume of streamflow was defined from historical DWR operations and consideration of the hydrologic year type (Table 3-10). For the remaining Santa Clara River tributaries, streamflow volumes were defined by the SWRM using monthly rainfall data and the Turner (1986) relationship between rainfall, ET, and the subsequent yield from each watershed.

3.5.5 WRP Discharges to the Santa Clara River

Treated water is discharged to the Santa Clara River from two LACSD WRPs. As shown on Figure 1-1, the Saugus WRP discharges to the river immediately above the mouth of the South Fork Santa Clara River, and the Valencia WRP discharges to the river just west of Interstate 5.

Under full valley build-out conditions, future flows into and from WRPs will be higher than historical flows because of increased development and the associated increase in indoor water use volumes. Additionally, a portion of the future treated water will be reclaimed, as described in CLWA's recycled water master plan (Kennedy/Jenks Consultants, 2002). Future inflows to the Saugus and Valencia WRPs were estimated from projected future water demands and from comparisons of historical water use and measured inflows to both WRPs. Table 3-11 shows the derivation of urban water demands outside the Newhall Ranch development (which will be served by a new, separate WRP). Table 3-12 shows the total amount of treated water generated by the Saugus and Valencia WRPs, and the amount of this water that is reclaimed and discharged to the river, by month. The analysis assumes that the reclaimed water volume will be no more than 16,000 AF/yr, to maintain existing flow volumes in the Santa Clara River. For the Newhall Ranch WRP, discharges to the river

[11]The simulated monthly precipitation was defined from measurements at the NCWD gage from 1979 through 2003, as well as by combining the isohyet map with measurements at the Newhall-Soledad gage from 1950 through 1978.

will be 286 AF/yr, occurring primarily in December and January, when demands for reclaimed water are at their seasonal low. The total combined volumes of treated water discharged to the Santa Clara River under full valley build-out conditions (including Newhall Ranch) are summarized, by month, in Table 3-13. These rates were used in each year of the 78-year simulation.

3.5.6 Monthly Assignment and Tracking of Surface Water Budget

The month-by-month assignment of the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system was performed by the SWRM using the procedures described in Section C.8.5 of Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Streambed infiltration capacities were the same as those used in the calibrated model. For each of the 78 years in the model simulation, the streambed infiltration capacity values were selected by matching the year to 1 of the 20 years (1980 through 1999) from the model calibration runs, using rainfall and streamflow data to select the corresponding streambed infiltration rates.

The SWRM also tracked the volume of surface water in each simulated stream that does not infiltrate during each month because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage was calculated to remain as surface water in the Santa Clara River and to eventually exit the Regional Model at the west end of the valley, at the County Line gage.

3.6 Running the Model and Evaluating Results

As discussed in the previous sections, the modeling evaluations were performed by simulating conditions on a monthly basis for the 78-year simulation period. The first step in this process consisted of running the SWRM to calculate the monthly distribution of recharge to the Alluvial Aquifer system (from rainfall, streamflow, irrigation, and WRP discharges) and recharge to the Saugus Formation (from rainfall and irrigation) in areas where the Alluvial Aquifer is not present. The output from the SWRM consisted of monthly files that assigned recharge to each node in the model grid.

The Regional Model was then run using monthly time steps, in which pumping and recharge terms were varied each month. The model was run by solving the groundwater flow equations for three time intervals during each month to improve the accuracy of the calculations. For each sub-interval of time, the model was run with a convergence criterion of 0.0001 foot for groundwater elevations and a water budget convergence criterion of 1 cubic foot per day. The model results were then evaluated by generating time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the potential effects of the groundwater operating plan across the basin. The hydrographs were used to evaluate whether the operating plan is consistent with the objective of operating the basin in a manner that maintains long-term stability in groundwater levels and river flows. This analysis and its findings are presented in Section 4.

Tables

TABLE 3-1
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1950	Below Normal	6.84
1951	Above Normal	12.42
1952	Wet	34.19
1953	Wet	4.88
1954	Above Normal	15.82
1955	Dry	13.91
1956	Wet	14.21
1957	Above Normal	22.85
1958	Wet	23.14
1959	Below Normal	9.81
1960	Dry	11.64
1961	Dry	8.82
1962	Below Normal	21.22
1963	Wet	12.79
1964	Dry	10.09
1965	Wet	32.28
1966	Below Normal	14.57
1967	Wet	23.23
1968	Below Normal	6.90
1969	Wet	32.42
1970	Wet	23.19
1971	Wet	13.75
1972	Below Normal	4.15
1973	Above Normal	19.79
1974	Wet	18.04
1975	Wet	10.92
1976	Critical	14.02
1977	Critical	20.87
1978	Above Normal	42.17
1979	Below Normal	21.47
1980	Above Normal	27.00
1981	Dry	13.42
1982	Wet	20.20
1983	Wet	39.07
1984	Wet	12.86

TABLE 3-1
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1985	Dry	8.37
1986	Wet	18.02
1987	Dry	14.45
1988	Critical	16.92
1989	Dry	7.56
1990	Critical	6.98
1991	Critical	17.21
1992	Critical	32.03
1993	Above Normal	32.72
1994	Critical	10.27
1995	Wet	29.15
1996	Wet	15.88
1997	Wet	13.35
1998	Wet	30.73
1999	Wet	8.96
2000	Above Normal	14.04
2001	Dry	22.24
2002	Dry	7.90
2003	Above Normal	15.70

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest.

[b]Records are for the Newhall-Soledad rain gage (Station No. FC32CE), in inches. As shown on Figure 2-6, the median and average rainfall at this gage from 1950 through 2002 were 14.57 in/yr and 17.84 in/yr, respectively.

TABLE 3-2
Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Model Year	Based on Historical Year	Local Rainfall (inches)[a]	Alluvial Aquifer Pumping under the Groundwater Operating Plan[b,c] (AF/yr)
1	1980	27.00	35,000-40,000
2	1981	13.42	35,000-40,000
3	1982	20.20	35,000-40,000
4	1983	39.07	35,000-40,000
5	1984	12.86	35,000-40,000
6	1985	8.37	30,000-35,000
7	1986	18.02	35,000-40,000
8	1987	14.45	35,000-40,000
9	1988	16.92	35,000-40,000
10	1989	7.56	30,000-35,000
11	1990	6.98	30,000-35,000
12	1991	17.21	30,000-35,000
13	1992	32.03	35,000-40,000
14	1993	32.72	35,000-40,000
15	1994	10.27	30,000-35,000
16	1995	29.15	35,000-40,000
17	1996	15.88	35,000-40,000
18	1997	13.35	35,000-40,000
19	1998	30.73	35,000-40,000
20	1999	8.96	30,000-35,000
21	2000	14.04	35,000-40,000
22	2001	22.24	35,000-40,000
23	2002	7.90	30,000-35,000
24	2003	15.70	35,000-40,000
25	1950	6.84	30,000-35,000
26	1951	12.42	35,000-40,000
27	1952	34.19	35,000-40,000
28	1953	4.88	30,000-35,000
29	1954	15.82	35,000-40,000
30	1955	13.91	35,000-40,000
31	1956	14.21	35,000-40,000
32	1957	22.85	35,000-40,000
33	1958	23.14	35,000-40,000
34	1959	9.81	30,000-35,000
35	1960	11.64	30,000-35,000
36	1961	8.82	30,000-35,000
37	1962	21.22	30,000-35,000
38	1963	12.79	35,000-40,000
39	1964	10.09	30,000-35,000
40	1965	32.28	35,000-40,000
41	1966	14.57	35,000-40,000

TABLE 3-2
Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Model Year	Based on Historical Year	Local Rainfall (inches)[a]	Alluvial Aquifer Pumping under the Groundwater Operating Plan[b,c] (AF/yr)
42	1967	23.23	35,000-40,000
43	1968	6.90	30,000-35,000
44	1969	32.42	35,000-40,000
45	1970	23.19	35,000-40,000
46	1971	13.75	35,000-40,000
47	1972	4.15	30,000-35,000
48	1973	19.79	35,000-40,000
49	1974	18.04	35,000-40,000
50	1975	10.92	30,000-35,000
51	1976	14.02	35,000-40,000
52	1977	20.87	35,000-40,000
53	1978	42.17	35,000-40,000
54	1979	21.47	35,000-40,000
55	1980	27.00	35,000-40,000
56	1981	13.42	35,000-40,000
57	1982	20.20	35,000-40,000
58	1983	39.07	35,000-40,000
59	1984	12.86	35,000-40,000
60	1985	8.37	30,000-35,000
61	1986	18.02	35,000-40,000
62	1987	14.45	35,000-40,000
63	1988	16.92	35,000-40,000
64	1989	7.56	30,000-35,000
65	1990	6.98	30,000-35,000
66	1991	17.21	30,000-35,000
67	1992	32.03	35,000-40,000
68	1993	32.72	35,000-40,000
69	1994	10.27	30,000-35,000
70	1995	29.15	35,000-40,000
71	1996	15.88	35,000-40,000
72	1997	13.35	35,000-40,000
73	1998	30.73	35,000-40,000
74	1999	8.96	30,000-35,000
75	2000	14.04	35,000-40,000
76	2001	22.24	35,000-40,000
77	2002	7.90	30,000-35,000
78	2003	15.70	35,000-40,000

[a]From records at Newhall-Soledad rain gage (Station No. FC32CE).

[b]Alluvial Aquifer pumping rates listed in this column will occur under the operating plan for the valley if the 1950 through 2003 local hydrology repeats itself in the future.

[c]Alluvial Aquifer pumping is set at the dry-year rate in years 12, 37, and 66 because each of these years is the first nondrought year that occurs after a multi-year drought ends.

TABLE 3-3
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
1	Above Normal	90	Normal (7,500-15,000)
2	Dry	90	Normal (7,500-15,000)
3	Wet	100	Normal (7,500-15,000)
4	Wet	100	Normal (7,500-15,000)
5	Wet	100	Normal (7,500-15,000)
6	Dry	95	Normal (7,500-15,000)
7	Wet	70	Normal (7,500-15,000)
8	Dry	75	Normal (7,500-15,000)
9	Critical	15	Dry Year 1 (15,000)
10	Dry	95	Normal (7,500-15,000)
11	Critical	25	Dry Year 1 (15,000)
12	Critical	30	Dry Year 2 (25,000)
13	Critical	45	Dry Year 3 (35,000)
14	Above Normal	100	Normal (7,500-15,000)
15	Critical	50	Dry Year 1 (15,000)
16	Wet	80	Normal (7,500-15,000)
17	Wet	100	Normal (7,500-15,000)
18	Wet	100	Normal (7,500-15,000)
19	Wet	100	Normal (7,500-15,000)
20	Wet	100	Normal (7,500-15,000)
21	Above Normal	90	Normal (7,500-15,000)
22	Dry	39	Dry Year 1 (15,000)
23	Dry	70	Normal (7,500-15,000)
24	Above Normal	90	Normal (7,500-15,000)
25	Below Normal	90	Normal (7,500-15,000)
26	Above Normal	100	Normal (7,500-15,000)
27	Wet	100	Normal (7,500-15,000)
28	Wet	100	Normal (7,500-15,000)
29	Above Normal	100	Normal (7,500-15,000)
30	Dry	45	Dry Year 1 (15,000)
31	Wet	100	Normal (7,500-15,000)
32	Above Normal	90	Normal (7,500-15,000)
33	Wet	100	Normal (7,500-15,000)
34	Below Normal	85	Normal (7,500-15,000)
35	Dry	55	Dry Year 1 (15,000)
36	Dry	70	Dry Year 2 (25,000)
37	Below Normal	95	Normal (7,500-15,000)
38	Wet	100	Normal (7,500-15,000)
39	Dry	75	Dry Year 1 (15,000)
40	Wet	80	Normal (7,500-15,000)
41	Below Normal	100	Normal (7,500-15,000)
42	Wet	100	Normal (7,500-15,000)

TABLE 3-3
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
43	Below Normal	90	Normal (7,500-15,000)
44	Wet	100	Normal (7,500-15,000)
45	Wet	100	Normal (7,500-15,000)
46	Wet	100	Normal (7,500-15,000)
47	Below Normal	75	Normal (7,500-15,000)
48	Above Normal	100	Normal (7,500-15,000)
49	Wet	100	Normal (7,500-15,000)
50	Wet	100	Normal (7,500-15,000)
51	Critical	75	Dry Year 1 (15,000)
52	Critical	4	Dry Year 2 (25,000)
53	Above Normal	100	Normal (7,500-15,000)
54	Below Normal	95	Normal (7,500-15,000)
55	Above Normal	90	Normal (7,500-15,000)
56	Dry	90	Normal (7,500-15,000)
57	Wet	100	Normal (7,500-15,000)
58	Wet	100	Normal (7,500-15,000)
59	Wet	100	Normal (7,500-15,000)
60	Dry	95	Normal (7,500-15,000)
61	Wet	70	Normal (7,500-15,000)
62	Dry	75	Normal (7,500-15,000)
63	Critical	15	Dry Year 1 (15,000)
64	Dry	95	Normal (7,500-15,000)
65	Critical	25	Dry Year 1 (15,000)
66	Critical	30	Dry Year 2 (25,000)
67	Critical	45	Dry Year 3 (35,000)
68	Above Normal	100	Normal (7,500-15,000)
69	Critical	50	Dry Year 1 (15,000)
70	Wet	80	Normal (7,500-15,000)
71	Wet	100	Normal (7,500-15,000)
72	Wet	100	Normal (7,500-15,000)
73	Wet	100	Normal (7,500-15,000)
74	Wet	100	Normal (7,500-15,000)
75	Above Normal	90	Normal (7,500-15,000)
76	Dry	39	Dry Year 1 (15,000)
77	Dry	70	Normal (7,500-15,000)
78	Above Normal	90	Normal (7,500-15,000)

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest.

[b]Defined from simulations performed by CLWA (Kennedy/Jenks Consultants, 2003) and USBR (2004) using the CALSIM II model. This condition is for the year 2020 level of development. In any given year, the allocation may be made up, in part, of carryover water from the prior year.

TABLE 3-4

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location**[a]	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
NCWD-Castaic 1	Castaic Valley	345	385	561	385	345
NCWD-Castaic 2	Castaic Valley	166	0	123	166	125
NCWD-Castaic 3	Castaic Valley	0	0	0	0	0
NCWD-Castaic 4	Castaic Valley	100	47	56	100	45
NCWD-Pinetree 1	Mint Canyon	164	0	0	164	0
NCWD-Pinetree 2	Mint Canyon	0	0	0	0	0
NCWD-Pinetree 3	Mint Canyon	566	544	525	545	525
NCWD-Pinetree 4	Mint Canyon	300	5	0	300	0
NCWD Total		**1,641**	**981**	**1,265**	**1,660**	**1,040**
NLF-161	Downstream of Valencia WRP	496	485	2,021	485	485
NLF-B10	Downstream of Valencia WRP	1,240	534	344	344	344
NLF-B11	Downstream of Valencia WRP	205	232	271	232	232
NLF-B5	Downstream of Valencia WRP	1,680	2,280	1,582	1,582	1,582
NLF-B6	Downstream of Valencia WRP	1,312	2,175	1,766	1,766	1,766
NLF-B7	Downstream of Valencia WRP	474	584	402	584	584
NLF-C	Downstream of Valencia WRP	1,319	1,720	1,373	1,373	1,373
NLF-C3	Downstream of Valencia WRP	93	192	186	192	192
NLF-C4	Downstream of Valencia WRP	1,028	809	764	809	809
NLF-C5	Downstream of Valencia WRP	680	850	622	850	850
NLF-C6	Downstream of Valencia WRP	231	241	108	241	241
NLF-C7	Downstream of Valencia WRP	741	866	443	866	866
NLF-C8	Downstream of Valencia WRP	293	594	408	594	594
NLF-E	Castaic Valley	1,691	16	28	16	16
NLF-E2	Castaic Valley	141	55	14	55	55
NLF-E4	Downstream of Valencia WRP	0	0	0	0	0
NLF-E5	Downstream of Valencia WRP	172	679	537	679	679
NLF-E9	Downstream of Valencia WRP	238	814	47	814	814
NLF-G45	Downstream of Valencia WRP	291	283	60	283	283
NLF-W4	San Francisquito Canyon[b]	46	1	0	0	0
NLF-W5	San Francisquito Canyon	276	104	23	107	107
NLF-X3	Downstream of Valencia WRP	12	0	0	0	0
NLF Total		**12,659**	**13,514**	**10,999**	**11,872**	**11,872**
SCWD-Clark	Bouquet Canyon	696	782	712	782	700
SCWD-Guida	Bouquet Canyon	1,047	1,320	1,230	1,320	1,230
SCWD-Honby	Above Saugus WRP	721	696	874	696	870
SCWD-Lost Canyon 2	Mint Canyon	741	730	644	741	640
SCWD-Lost Canyon 2A	Mint Canyon	1,034	905	593	1,034	590
SCWD-Mitchell #5A	Mint Canyon	407	143	19	0	0
SCWD-Mitchell #5B	Mint Canyon	0	150	0	557	0
SCWD-N. Oaks Central	Mint Canyon	822	1,646	1,641	822	1,640
SCWD-N. Oaks East	Mint Canyon	1,234	448	485	1,234	485
SCWD-N. Oaks West	Mint Canyon	898	1,123	31	898	0
SCWD-Sand Canyon	Mint Canyon	930	705	195	930	195
SCWD-Sierra	Mint Canyon	846	87	0	846	0
SCWD-Stadium	Above Saugus WRP	565	778	0	800	800
SCWD Total		**9,941**	**9,513**	**6,424**	**10,660**	**7,150**

TABLE 3-5
Simulated Annual Groundwater Pumping from the Saugus Formation for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Owner	Well Name	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
NCWD	11	811	811	811	811
	12	1,315	2,044	2,044	2,044
	13	1,315	2,044	2,044	2,044
Total Pumping (NCWD)		**3,441**	**4,899**	**4,899**	**4,899**
NLF	156	369	369	369	369
Total Pumping (NLF)		**369**	**369**	**369**	**369**
SCWC	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
Total Pumping (SCWC)		**3,544**	**3,544**	**3,544**	**3,544**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Valencia Country Club)	500	500	500	500
	201	100	100	3,577	3,577
	205	1,000	2,734	3,827	3,827
	206	1,175	2,734	3,500	3,500
Total Pumping (VWC)		**3,325**	**6,948**	**12,284**	**12,284**
To Be Determined	Future #1	0	0	3,250	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
	Future #4	0	0	0	3,250
Total Pumping (Future)		**0**	**0**	**3,250**	**13,000**
Total Saugus Formation Pumping		**10,679**	**15,760**	**24,346**	**34,096**

Notes:

All pumping volumes are listed in acre-feet.

Wells VWC-157 and NCWD-7, 8, 9, and 10 are assumed to no longer operate in the future.

TABLE 3-6

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-11	2	200	1,075	300	10	3,000	72.3
	3			500	2	1,000	24.1
	4			75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
	3			500	2	1,000	58.5
	4			280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
	3			250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
	3			500	6.5	3,250	39.4
	4			500	4	2,000	24.2
	5			300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
	3			500	6.5	3,250	59.9
	4			500	4	2,000	36.8
	5			20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.7
	3			500	6.5	3,250	56.9
	4			500	4	2,000	35.0
	5			91	4	364	6.4
VWC-159	3	662	1,900	338	0.025	8.45	27.3
	4			500	0.025	12.5	40.4
	5			400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.6
	4			500	4	2,000	46.2
	5			500	4	2,000	46.2
VWC-201	3	540	1,670	460	6.5	2,990	52.7
	4			500	4	2,000	35.3
	5			170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
	4			500	4	2,000	40.9
	5			430	4	1,720	35.2
VWC-206	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6

TABLE 3-6

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
Future Wells	3	820	1,930	180	6.5	1,170	23.9
Near VWC-206	4			500	4	2,000	40.9
(Assumed)	5			430	4	1,720	35.2

Notes:

Existing wells NCWD-7 and NCWD-10 are assumed to no longer operate in the future.

Kh = horizontal hydraulic conductivity
T = transmissivity
ft/day = feet per day
ft^2/day = square feet per day

TABLE 3-7
Allocation of Pumping, by Month, for Agricultural and Urban Production Wells
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Month	Percent of Annual Water Use, Agricultural	Percent of Annual Water Use, Urban	Percent of May through October Water Use, Urban
January	3.75	5.2	
February	5.10	3.7	
March	6.60	5.2	
April	9.10	6.6	
May	10.55	8.7	13.2
June	11.40	10.4	15.8
July	14.10	13.0	19.7
August	12.95	13.6	20.6
September	10.20	10.9	16.6
October	7.50	9.3	14.1
November	5.00	7.1	
December	3.75	6.3	
Total	**100.0**	**100.0**	**100.0**

TABLE 3-8

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
2	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
3	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
4	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
5	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
6	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
7	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
8	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
9	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
10	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
11	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
12	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
13	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
14	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
15	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
16	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
17	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
18	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
19	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
20	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
21	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
22	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
23	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
24	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47
25	2.58	1.69	1.27	0.86	0.01	0.00	0.00	0.00	0.32	0.36	0.73	0.21	8.03
26	2.96	0.93	1.16	1.69	0.09	0.00	0.00	0.05	0.00	0.49	1.33	5.88	14.57
27	17.68	0.61	10.30	1.80	0.00	0.00	0.00	0.00	0.12	0.00	4.52	5.09	40.12
28	0.80	0.02	0.21	1.64	0.69	0.00	0.00	0.00	0.00	0.00	2.32	0.04	5.73
29	6.38	3.36	4.86	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.38	1.47	18.56
30	5.69	1.69	0.21	3.38	1.91	0.00	0.00	0.00	0.00	0.00	1.43	2.01	16.32
31	7.55	1.00	0.00	5.90	1.82	0.00	0.11	0.00	0.00	0.15	0.00	0.15	16.68
32	7.22	2.71	3.05	1.16	1.06	0.25	0.00	0.00	0.00	2.68	0.40	8.30	26.81
33	2.11	10.42	5.82	7.18	0.00	0.00	0.00	0.00	0.04	1.35	0.23	0.00	27.15
34	3.70	5.47	0.00	0.59	0.00	0.00	0.00	0.00	0.08	0.00	0.00	1.68	11.51
35	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
36	1.88	0.00	0.76	0.33	0.09	0.00	0.07	0.00	0.11	0.00	4.12	2.99	10.35
37	3.86	19.44	1.53	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.00	24.90
38	0.99	3.63	4.10	2.23	0.06	0.43	0.00	0.00	0.77	0.50	2.29	0.01	15.01
39	2.95	0.00	1.88	2.41	0.04	0.12	0.00	0.00	0.00	0.52	1.47	2.48	11.84
40	0.25	0.07	1.65	9.14	0.00	0.02	0.26	0.16	0.95	0.00	17.49	7.89	37.88
41	1.42	1.55	0.33	0.00	0.09	0.00	0.00	0.00	0.09	0.11	7.56	5.95	17.10

TABLE 3-8

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	6.76	0.22	3.23	5.41	0.19	0.00	0.00	0.00	0.50	0.00	9.36	1.58	27.26
43	0.86	0.93	2.91	0.97	0.07	0.00	0.00	0.38	0.00	0.39	0.35	1.24	8.10
44	19.53	13.89	0.82	1.16	0.05	0.05	0.18	0.00	0.00	0.00	2.32	0.05	38.04
45	0.94	6.63	4.33	0.00	0.00	0.00	0.00	0.00	0.00	0.13	8.86	6.33	27.21
46	1.23	1.41	0.48	0.94	0.15	0.00	0.00	0.00	0.47	0.50	0.38	10.57	16.14
47	0.00	0.12	0.00	0.02	0.05	0.05	0.00	0.06	0.00	0.05	3.45	1.08	4.87
48	5.19	11.74	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.83	1.03	23.22
49	10.58	0.02	4.30	0.06	0.00	0.00	0.02	0.00	0.00	1.17	0.12	4.89	21.17
50	0.28	3.02	6.04	2.96	0.00	0.00	0.00	0.00	0.00	0.39	0.04	0.09	12.81
51	0.00	7.39	1.47	0.46	0.15	0.35	0.01	0.00	3.40	0.22	2.09	0.90	16.45
52	5.75	0.12	2.15	0.00	5.27	0.00	0.00	2.68	0.02	0.05	0.06	8.40	24.49
53	10.74	13.23	17.10	2.72	0.00	0.00	0.00	0.00	1.23	0.01	2.70	1.76	49.49
54	12.44	3.20	6.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.89	1.19	23.75
55	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
56	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
57	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
58	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
59	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
60	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
61	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
62	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
63	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
64	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
65	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
66	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
67	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
68	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
69	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
70	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
71	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
72	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
73	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
74	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
75	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
76	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
77	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
78	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47

TABLE 3-9

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
2	594	98	339	240	107	18	18	12	338	321	258	394	2,739
3	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
4	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
5	0	596	405	240	143	166	228	411	154	220	904	578	4,044
6	483	461	274	215	77	0	0	0	12	179	221	301	2,224
7	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
8	117	117	65	31	12	0	0	0	0	0	258	516	1,116
9	222	209	506	117	77	68	0	0	0	0	12	25	1,236
10	50	111	60	25	6	0	0	0	102	94	34	18	499
11	212	276	230	46	46	5	0	0	0	27	36	147	1,025
12	162	775	879	736	145	142	14	0	45	69	62	263	3,291
13	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
14	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
15	388	493	497	319	163	80	20	7	37	102	193	941	3,239
16	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
17	666	896	730	315	151	46	7	0	54	154	307	510	3,836
18	517	346	140	85	33	5	4	50	66	240	566	809	2,859
19	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
20	92	85	204	224	197	107	80	46	52	54	31	80	1,252
21	117	117	65	31	12	0	0	0	0	0	258	516	1,116
22	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
23	50	111	60	25	6	0	0	0	102	94	34	18	499
24	666	896	730	315	151	46	7	0	54	154	307	510	3,836
25	83	198	184	126	105	83	51	54	56	53	43	42	1,078
26	49	40	66	91	98	84	79	72	57	71	47	53	807
27	9,629	636	7,091	2,114	895	326	153	138	86	97	178	313	21,656
28	300	282	271	237	165	134	102	86	85	83	74	68	1,888
29	145	278	404	356	181	108	110	99	91	90	80	75	2,017
30	103	156	157	128	153	99	78	76	74	68	66	62	1,220
31	69	85	130	137	139	98	86	80	77	76	67	69	1,113
32	67	55	78	90	93	80	78	78	76	79	66	71	910
33	66	329	743	4,550	825	283	130	108	95	145	146	116	7,536
34	246	351	189	127	111	92	84	86	83	69	68	68	1,575
35	68	67	70	69	70	68	65	65	60	58	316	164	1,140
36	124	91	38	38	36	32	28	33	22	19	19	119	597
37	139	1,904	791	449	329	169	97	82	80	84	82	82	4,287
38	85	142	145	131	104	86	79	74	66	65	62	58	1,096
39	69	50	51	62	66	54	53	53	54	45	43	41	640
40	30	23	25	46	43	36	31	34	37	35	1,305	3,300	4,944
41	1,765	1,014	778	450	308	115	68	54	45	63	91	523	5,274

TABLE 3-9

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	757	489	1,028	2,295	1,880	729	212	104	89	73	255	487	8,397
43	300	247	276	180	72	32	32	30	25	133	208	851	2,384
44	13,797	2,856	1,005	489	320	147	98	98	46	318	392	399	19,966
45	461	550	1,168	465	290	169	74	60	58	27	501	1,338	5,161
46	614	524	556	397	262	167	70	25	5	30	200	420	3,270
47	332	250	131	90	50	22	32	6	0	0	11	58	983
48	153	1,717	950	471	226	71	18	12	8	3	8	44	3,679
49	608	229	392	190	129	49	17	6	0	3	19	87	1,728
50	53	90	228	181	104	31	15	3	0	0	0	0	704
51	0	110	63	39	33	12	0	0	1	0	0	0	258
52	28	7	28	19	60	5	0	0	0	0	0	0	147
53	744	9,486	11,412	1,696	2,736	1,154	418	209	101	264	422	86	28,730
54	1,254	433	1,113	506	246	190	178	111	125	90	120	558	4,925
55	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
56	594	98	339	240	107	18	18	12	338	321	258	394	2,739
57	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
58	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
59	0	596	405	240	143	166	228	411	154	220	904	578	4,044
60	483	461	274	215	77	0	0	0	12	179	221	301	2,224
61	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
62	117	117	65	31	12	0	0	0	0	0	258	516	1,116
63	222	209	506	117	77	68	0	0	0	0	12	25	1,236
64	50	111	60	25	6	0	0	0	102	94	34	18	499
65	212	276	230	46	46	5	0	0	0	27	36	147	1,025
66	162	775	879	736	145	142	14	0	45	69	62	263	3,291
67	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
68	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
69	388	493	497	319	163	80	20	7	37	102	193	941	3,239
70	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
71	666	896	730	315	151	46	7	0	54	154	307	510	3,836
72	517	346	140	85	33	5	4	50	66	240	566	809	2,859
73	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
74	92	85	204	224	197	107	80	46	52	54	31	80	1,252
75	117	117	65	31	12	0	0	0	0	0	258	516	1,116
76	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
77	50	111	60	25	6	0	0	0	102	94	34	18	499
78	666	896	730	315	151	46	7	0	54	154	307	510	3,836

TABLE 3-10

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
2	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
3	0	0	0	0	0	667	842	735	0	0	0	0	2,244
4	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
8	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
9	0	0	809	341	900	0	0	0	0	0	0	0	2,050
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	66	66
13	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
14	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
15	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
16	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
17	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
18	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
19	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
20	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
21	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
22	0	0	0	0	0	667	842	735	0	0	0	0	2,244
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
30	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
31	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
32	0	0	0	0	0	667	842	735	0	0	0	0	2,244
33	0	0	0	0	0	667	842	735	0	0	0	0	2,244
34	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
35	0	0	0	0	0	0	0	0	0	0	0	0	0
36	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
37	0	0	0	0	0	667	842	735	0	0	0	0	2,244
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
40	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
41	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853

TABLE 3-10

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	0	0	0	0	0	667	842	735	0	0	0	0	2,244
43	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
45	0	0	0	0	0	667	842	735	0	0	0	0	2,244
46	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
47	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	667	842	735	0	0	0	0	2,244
49	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
50	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
51	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
52	0	0	0	0	0	667	842	735	0	0	0	0	2,244
53	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
54	0	0	0	0	0	667	842	735	0	0	0	0	2,244
55	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
56	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
57	0	0	0	0	0	667	842	735	0	0	0	0	2,244
58	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
59	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0
61	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
62	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
63	0	0	809	341	900	0	0	0	0	0	0	0	2,050
64	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	66	66
67	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
68	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
69	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
70	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
71	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
72	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
73	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
74	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
75	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
76	0	0	0	0	0	667	842	735	0	0	0	0	2,244
77	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632

TABLE 3-11
Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year 2000 Actual (AF/yr)	Full Build-out Conditions (AF/yr)	Comments
Annual Urban Water Use Outside Newhall Ranch		
60,988	123,038	Year 2000 value is retail purveyor demand plus other demands in Table II-6 of the *2004 Santa Clarita Valley Water Report* (LSCE, 2005a). Year 2045 value is from Table 2.5-4 of the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2001). Consists of 89,805 AF/yr Development Monitoring System[a] demand, plus 55,995 AF/yr additional urban demand, minus 14,480 AF/yr conservation, minus 5,193 AF/yr agricultural uses and 3,089 AF/yr "other" uses. Does not include 4,500 AF/yr for aquifer storage and recovery or 17,680 AF/yr of demand for the Newhall Ranch Specific Plan.
Annual Indoor Water Use Outside Newhall Ranch (Equal to LACSD WRP Influent Volumes)		
18,723	40,313 (average year)	The year 2000 volume is from the Saugus and Valencia WRPs for the period January 2000 through December 2000. The long-term current generated effluent volume is based on the influent volume estimated from water balance calculations performed for the chloride mass balance analysis. The effluent volume is 32.8 percent of the total urban water production of 123,038 AF/yr, which includes other uses.

[a]Development Monitoring System water demands are demands associated with future build-out of developments identified in Los Angeles County's Development Monitoring System for the Santa Clarita Valley.

TABLE 3-12

Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Month	Treated Water Volume (2000)[a]	Treated Water Volume (Full Build-out Conditions)[b]	Percent of Annual Outdoor Demand	Reclaimed Volume under Full Build-out Conditions (Before Maintaining Existing Streamflows)	Reclaimed Volume under Full Build-out Conditions (After Maintaining Existing Streamflows)	WRP Discharges to River under Full Build-out Conditions[c]	Month
January	1,503	3,237	3.75	637	637	2,600	January
February	1,443	3,106	5.10	867	867	2,239	February
March	1,528	3,290	6.60	1,122	1,122	2,168	March
April	1,505	3,240	9.10	1,547	1,547	1,693	April
May	1,569	3,379	10.55	1,794	1,794	1,585	May
June	1,543	3,322	11.40	1,938	1,781	1,541	June
July	1,606	3,459	14.10	2,397	1,854	1,605	July
August	1,649	3,550	12.95	2,202	1,902	1,648	August
September	1,593	3,430	10.20	1,734	1,734	1,696	September
October	1,631	3,512	7.50	1,275	1,275	2,237	October
November	1,546	3,329	5.00	850	850	2,479	November
December	1,607	3,459	3.75	637	637	2,822	December
Total Annual	**18,723**	**40,313**	**100.0**	**17,000**	**16,000**	**24,313**	**Total Annual**

[a]Values shown are the actual volumes of treated water discharged to the Santa Clara River from the Saugus and Valencia WRPs during calendar year 2000. (See also Table 3-11.)

[b]Values shown are the combined treated water volumes estimated to be produced by the Saugus and Valencia WRPs for full build-out conditions in the Santa Clarita Valley. These values do not include the future Newhall Ranch WRP, which will be operated by LACSD.

[c]Values shown do not include discharges of treated water to the river from the future Newhall Ranch WRP. These volumes are 10 acre-feet in November, 138 acre-feet in December, and 138 acre-feet in January. During the other nine months of the year, this WRP will not discharge treated water to the river (see the *Newhall Ranch Draft Additional Analysis* [Impact Sciences, Inc., 2001] for further details). The combined total discharge from the Saugus, Valencia, and Newhall Ranch WRPs is summarized in Table 3-13.

Note:
All units are in acre-feet.

TABLE 3-13

Simulated Monthly Treated Wastewater Discharges from Santa Clarita Valley WRPs under Full Build-out Conditions

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

WRP	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Saugus	493	487	500	490	503	466	457	508	586	555	514	596	6,155
Valencia	2,107	1,752	1,668	1,203	1,082	1,075	1,148	1,140	1,110	1,682	1,965	2,226	18,158
Newhall	138	0	0	0	0	0	0	0	0	0	10	138	286
Total	**2,738**	**2,239**	**2,168**	**1,693**	**1,585**	**1,541**	**1,605**	**1,648**	**1,696**	**2,237**	**2,489**	**2,960**	**24,599**

Note:

Wastewater discharge volumes are listed in acre-feet.

Figures

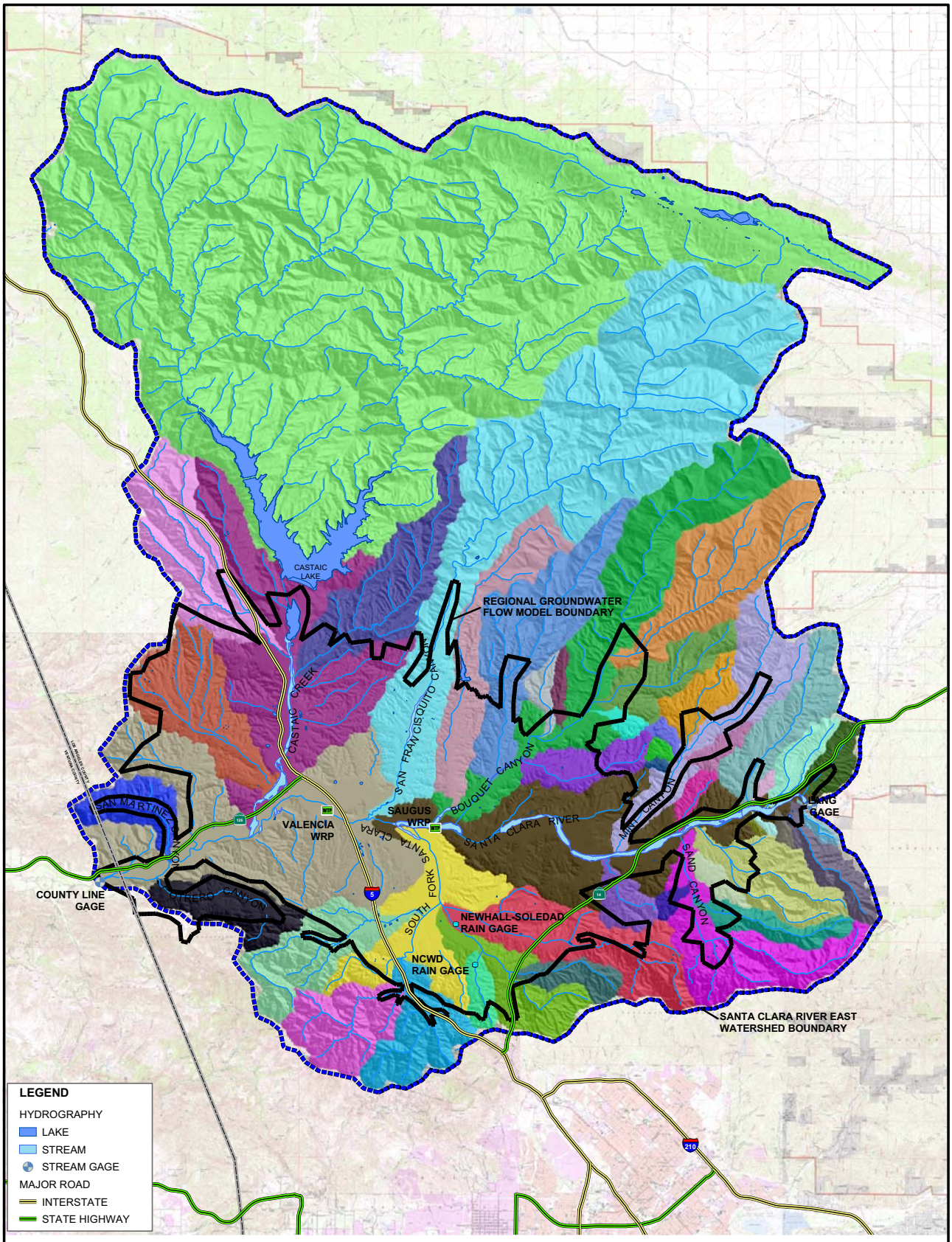

FIGURE 3-1
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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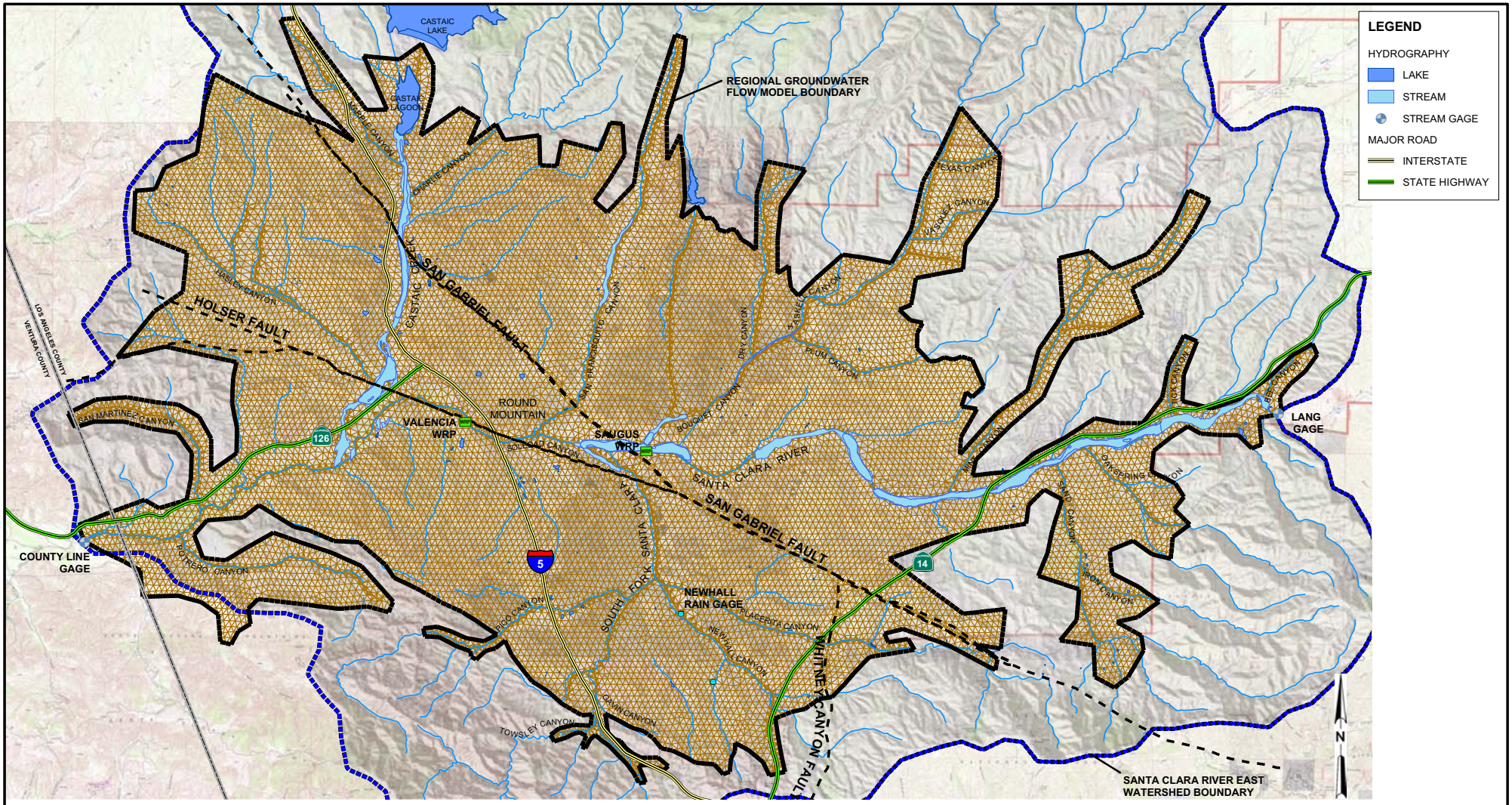

FIGURE 3-2
REGIONAL MODEL GRID
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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	Stratigraphy		Model Layer	Thickness (feet)
Saugus	Alluvium	Saugus	1	500
Saugus	Saugus	Saugus	2	
Saugus	Saugus	Saugus	3	500
Saugus	Saugus	Saugus	4	500
Saugus	Saugus	Saugus	5	500
Saugus	Saugus	Saugus	6	500
Sunshine	Sunshine	Sunshine	7	Variable

FIGURE 3-3
SCHEMATIC DIAGRAM OF THE MODEL'S REPRESENTATION OF STRATIGRAPHY IN THE MIDDLE OF THE BASIN
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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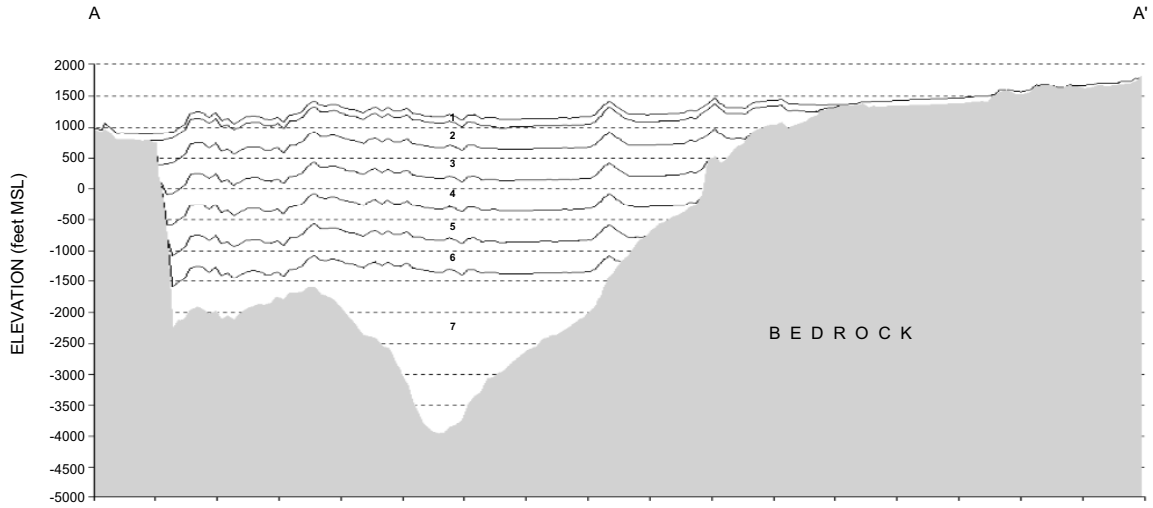
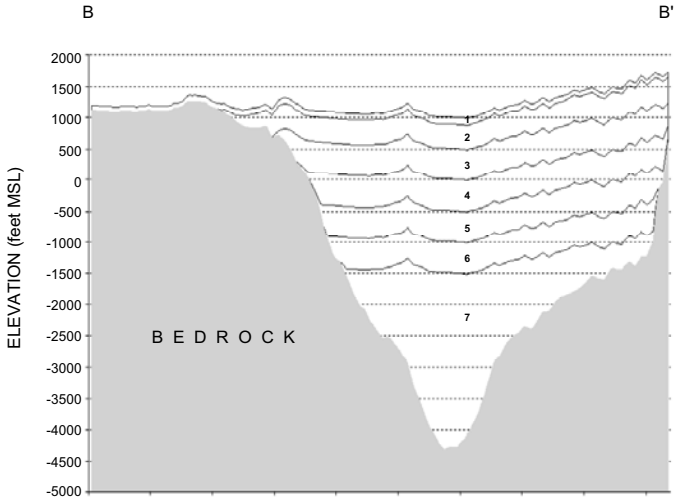
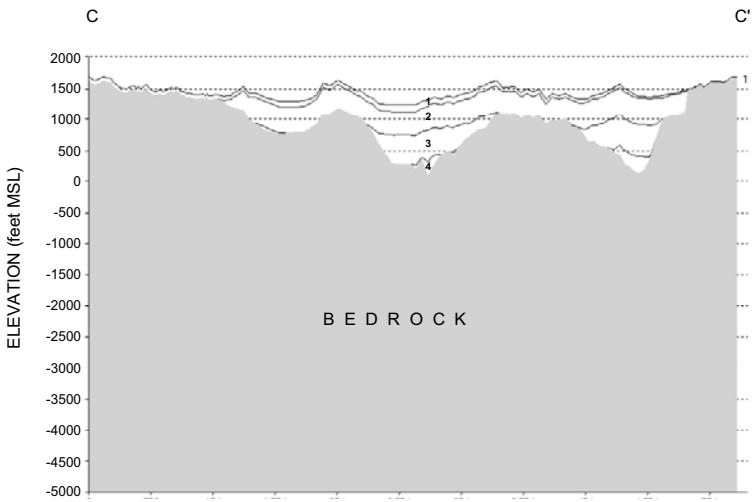
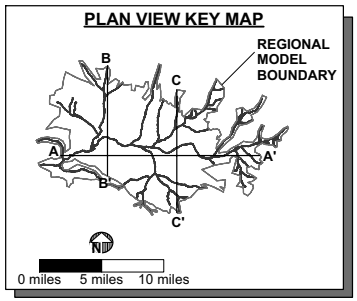
178973-414.xls\FIG3-3









LEGEND

1 = MODEL LAYER 1

2 = MODEL LAYER 2

3 = MODEL LAYER 3

4 = MODEL LAYER 4

5 = MODEL LAYER 5

6 = MODEL LAYER 6

7 = MODEL LAYER 7

HORIZONTAL CROSS SECTION SCALE

0 feet 10,000 feet 20,000 feet

5x VERTICAL EXAGGERATION

FIGURE 3-4
SCHEMATIC CROSS SECTIONS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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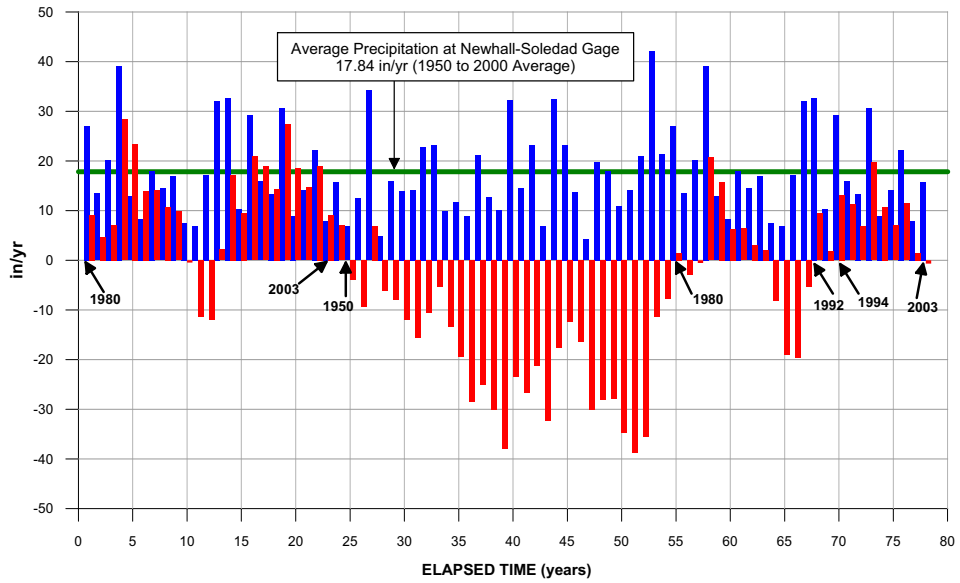

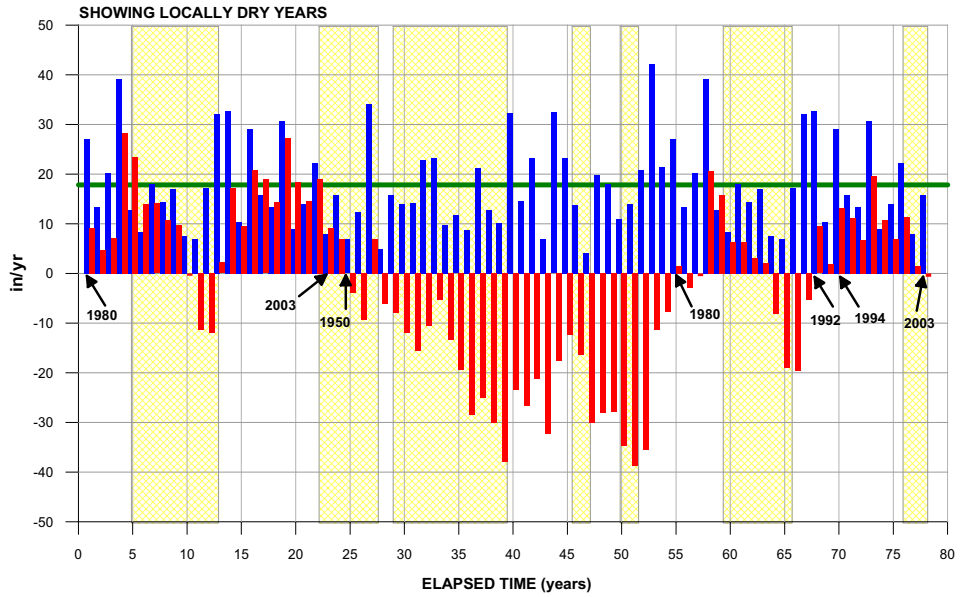

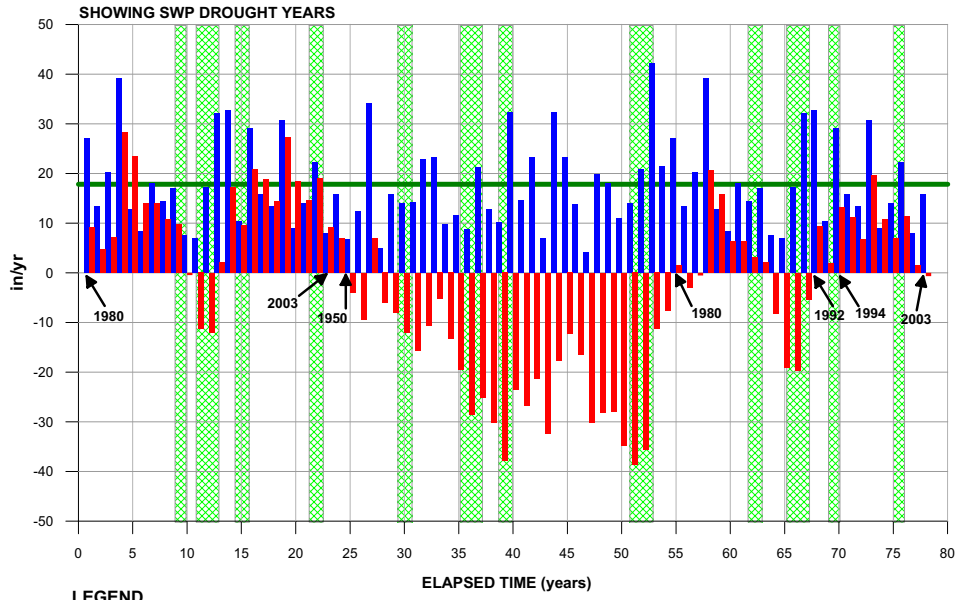

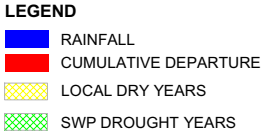

FIGURE 3-5
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE FOR THE 78-YEAR SIMULATION PERIOD
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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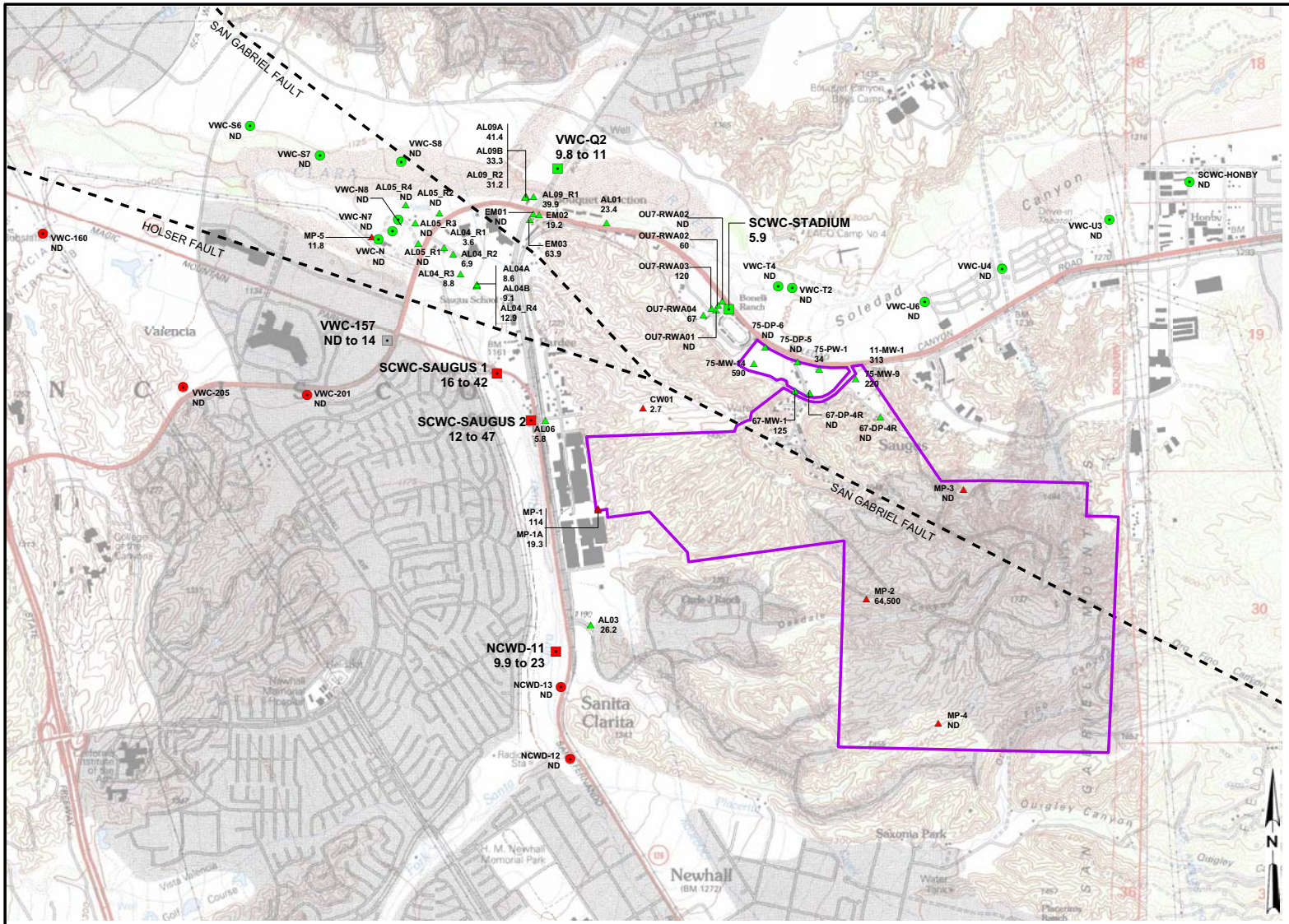

LEGEND

CONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS
- SAUGUS (DESTROYED JANUARY 2005)

UNCONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELL

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE 3-6
WELL LOCATIONS AND PERCHLORATE CONCENTRATIONS NEAR THE WHITTAKER-BERMITE PROPERTY
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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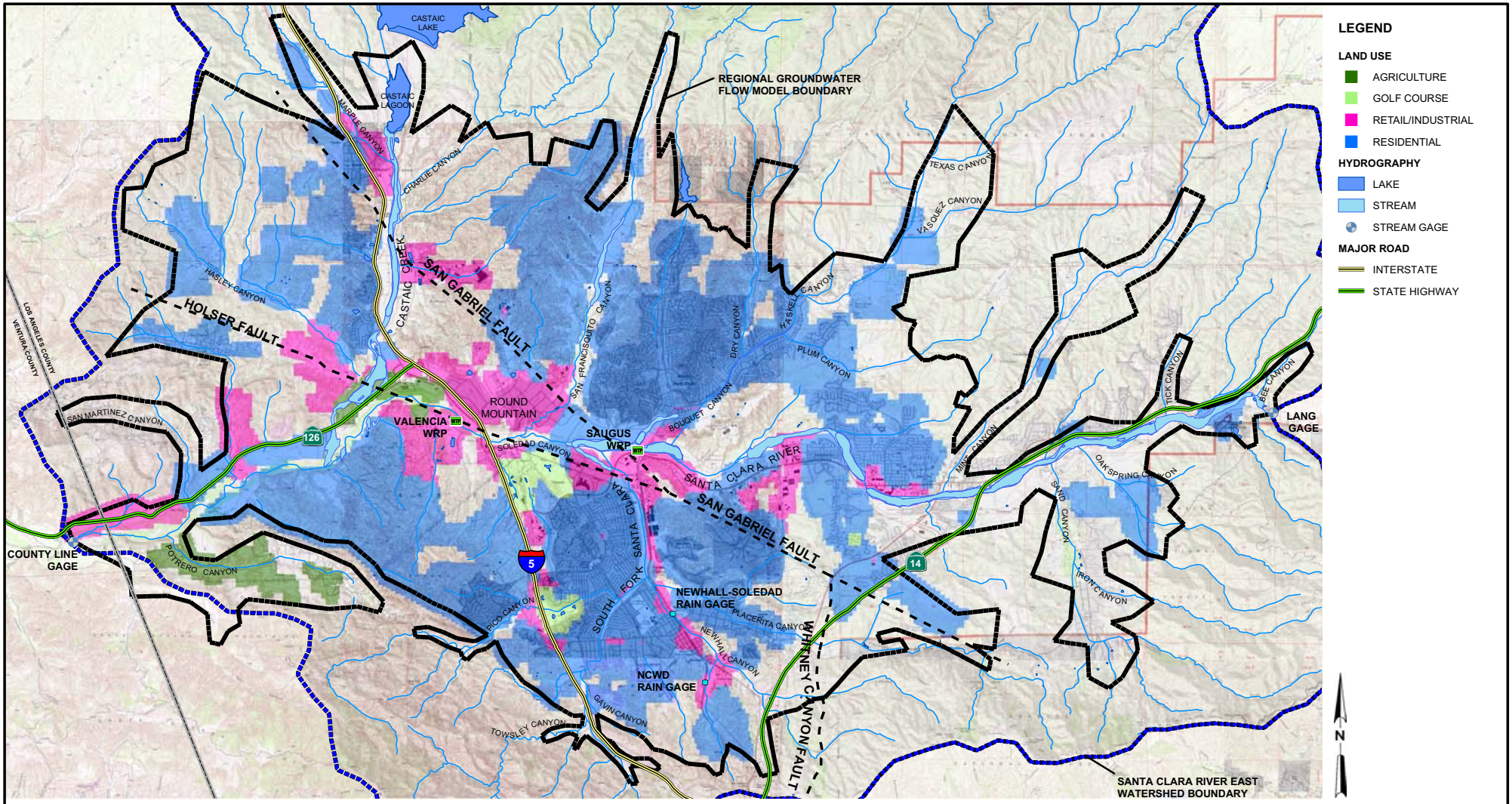


NOTE:
LAND USES UNDER FULL BUILD-OUT CONDITIONS ARE SHOWN ONLY INSIDE THE MODEL BOUNDARY, AND ARE NOT SHOWN OUTSIDE THE MODEL BOUNDARY.

FIGURE 3-7
SIMULATED LAND USE WITHIN THE REGIONAL MODEL BOUNDARY UNDER FULL BUILD-OUT CONDITIONS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

SECTION 4

Model Results

This section of the report presents and discusses hydrographs of simulated groundwater elevations, groundwater budget terms, and Santa Clara River flows for the 78-year modeling period.

4.1 Groundwater Elevations

Groundwater elevation hydrographs for different portions of the Alluvial Aquifer are presented on Figures 4-1 through 4-5. Hydrographs for different portions of the Saugus Formation are presented on Figures 4-6 and 4-7. Each figure shows the monthly groundwater elevations simulated for the 78-year modeling period.

These figures show that the spatial distribution and temporal variation of pumping are not expected to cause a long-term decline in groundwater levels in the Alluvial Aquifer or the Saugus Formation. The Regional Model simulates distinct multi-year periods of overall declining or overall increasing groundwater elevations resulting from cycles of below-normal and above-normal rainfall periods. This variation is consistent with historical observations of the relationship between rainfall and groundwater level fluctuations (CH2M HILL, 2004a). The Regional Model also simulates short-term declines in Saugus Formation groundwater elevations that arise from the increased Saugus pumping that occurs during the second and third years of reduced water imports. The model simulates water level recovery within a few years after Saugus pumping returns to normal-year pumping rates, a finding that is consistent with historical observations following a peak pumping period in the early 1990s (see Figures 2-9 and 2-10).

4.2 Groundwater Recharge, Discharge, and Storage

Figures 4-8 and 4-9 show the annual valleywide variations in groundwater recharge and discharge, respectively, throughout the 78-year simulation period. These groundwater recharge and discharge rates are also listed in Table 4-1. Figure 4-10 shows the annual and cumulative changes in groundwater storage volumes. Figures 4-8 through 4-10 and Table 4-1 together show the following:

1. Groundwater recharge rates (see Figure 4-8) vary greatly from year to year, because of variations in (a) precipitation within the groundwater basin and (b) precipitation and stormwater generation in the watersheds lying upstream of the groundwater basin. In contrast, total groundwater discharge (see Figure 4-9) is much less variable from year to year, with the more limited variations arising from increased pumping during drought years and increased ET and groundwater discharge to the Santa Clara River during wet years.
2. Year-to-year and cumulative changes in groundwater storage during the 78-year simulation period (see Figure 4-10) provide insights as to the manner in which the basin is

functioning hydrologically under the groundwater operating plan for the valley. The cumulative change in groundwater storage is a measure of the longer-term trends in the amount of groundwater in storage, and is plotted on a monthly basis. Table 4-1 tabulates the annual water budget for each year of the 78-year simulation, and shows the cumulative change on an annual basis (in contrast to the monthly basis shown on Figure 4-10). Figure 4-10 and Table 4-1 together show the following:

a. The cumulative change in total groundwater storage volume, which measures the continuous change in storage in the combined Alluvial-Saugus aquifer system since the beginning of the simulation, ranges between approximately a 150,000-acre-foot decline and a 260,000-acre-foot increase. The change in groundwater storage during a single year ranges from approximately an 80,000-AF/yr decline to a 170,000-AF/yr increase.

b. A nearly 20-year period of overall decline in the cumulative groundwater storage volume occurs between years 19 and 39, as shown on Figure 4-10. Beginning in year 40, the cumulative change in storage shows a generally upward trend, with occasional downward trends during specific drought periods.

3. Implementation of the groundwater operating plan will not cause permanent declines in groundwater storage volumes. This is shown by the forecasted recovery of groundwater storage volumes after periods of continued decline, such as after the 20-year period of groundwater declines that occurs during years 19 through 39.

4. Based on the previous observations, changes in groundwater storage volumes, particularly over a period of many years, are governed significantly by variations in local hydrologic conditions. Local precipitation and streamflows are the primary recharge mechanisms in the valley and therefore have a direct influence on year-to-year and longer-term changes in groundwater storage volumes.

4.3 River Flows

Figure 4-11 shows the total flows estimated by the model for the Santa Clara River at the County Line gage, which is located at the western end of the valley. The figure contains both a linear plot and a semi-logarithmic plot, to better illustrate the flows during low-flow periods. As shown by both plots, the total streamflows vary considerably over time at this location, due primarily to variations in rainfall.

The influences of the local hydrology and the groundwater operating plan on the Santa Clara River are also shown by Figure 4-12, which displays the model-calculated volumes of monthly groundwater discharge to the river. Groundwater discharges to the river occur along the river reach lying downstream of the mouth of San Francisquito Canyon. The figure shows that the groundwater discharge rates to the river also vary over time, both seasonally and over multi-year periods. Additionally, the figure shows that the Regional Model simulates a period of relatively low groundwater discharge to the river from years 23 through 39 (historical years 2002 through 2003, followed by 1950 through 1964), which corresponds to the prevailing below-normal rainfall conditions in those years. The figure also shows higher volumes of groundwater discharge to the river in years of above-normal

rainfall, particularly the very wet periods years 1 through 4, 13 through 19, 52 through 58, and 67 through 72.

The similarity between rainfall and groundwater discharges to the river indicates that local hydrology is the primary influence on these discharges. Additionally, the groundwater discharge hydrographs do not show any marked short-term declines in flows when Saugus Formation groundwater levels decrease during years of increased Saugus Formation pumping. The Regional Model, therefore, indicates that the operating plan for the groundwater system is not expected to adversely affect river flows.

4.4 Relationship of Simulation Results to Future Conditions

The curves presented on Figures 4-1 through 4-12 provide a general indication of the types of fluctuations in groundwater conditions that could be expected to occur in the future in the Santa Clarita Valley over a period of many years. However, these curves have been derived using an assumed sequence of local hydrologic conditions that is based on the sequence of rainfall and streamflow volumes that were measured during the past several decades. In the future, the year-to-year volumes and trends in rainfall and streamflow could vary from those observed in the past. Consequently, actual future trends in rainfall and streamflow might differ from those presented in this simulation on a short-term basis. However, over a period of several years or decades, the model-simulated recharge values and basin responses are more likely to reflect actual long-term average basin conditions under this operating plan.

The modeling simulation described in this report meets the intended objectives of quantifying possible basin responses to the operating plan, in terms of temporal variations that could occur in groundwater levels, groundwater storage, and Santa Clara River streamflows; and using the quantified responses to evaluate the sustainability of the operating plan with respect to potential trends in groundwater levels and Santa Clara River flows. The principal conclusions about the groundwater operating plan that have been drawn from the historical analyses and modeling simulations presented in this report are discussed in Section 5.

Table

TABLE 4-1

Simulated Annual Groundwater Budget

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year			Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
0	to	1	41,053	13,970	39,953	17,871	112,847	49,119	21,649	17,524	18,464	106,756	6,091	6,091
1	to	2	11,601	13,970	3,373	18,632	47,576	49,035	10,147	10,469	18,136	87,788	-40,212	-34,120
2	to	3	51,672	13,970	28,415	18,444	112,501	49,035	10,925	12,319	18,585	90,863	21,638	-12,483
3	to	4	181,820	13,970	89,448	16,985	302,223	49,035	36,265	29,506	19,056	133,861	168,361	155,879
4	to	5	687	13,970	527	18,253	33,437	49,119	16,665	23,150	18,225	107,158	-73,721	82,158
5	to	6	2	13,970	535	18,927	33,434	44,372	9,497	13,286	18,171	85,326	-51,891	30,266
6	to	7	42,574	13,970	19,998	18,619	95,161	49,035	11,479	14,376	18,568	93,458	1,703	31,969
7	to	8	11,415	13,970	2,484	19,419	47,288	49,035	7,923	10,419	18,277	85,654	-38,366	-6,397
8	to	9	27,363	13,970	10,507	19,743	71,583	54,214	6,664	10,234	18,507	89,618	-18,036	-24,433
9	to	10	0	13,970	523	20,113	34,606	44,372	4,739	8,041	18,359	75,510	-40,904	-65,336
10	to	11	0	13,970	1,472	20,347	35,789	49,446	2,584	5,612	18,354	75,996	-40,208	-105,544
11	to	12	50,580	13,970	28,173	19,613	112,336	58,025	3,061	8,476	18,563	88,125	24,211	-81,334
12	to	13	130,074	13,970	80,760	17,850	242,654	72,600	14,234	18,462	18,728	124,024	118,630	37,296
13	to	14	112,433	13,970	51,561	17,509	195,472	49,035	24,221	29,084	18,797	121,137	74,335	111,632
14	to	15	414	13,970	1,979	18,575	34,939	49,446	7,788	16,616	18,157	92,007	-57,068	54,563
15	to	16	113,543	13,970	60,100	17,636	205,250	49,035	29,255	26,983	18,745	124,018	81,232	135,795
16	to	17	45,609	13,970	21,594	18,204	99,376	49,119	15,122	21,342	18,635	104,218	-4,842	130,954
17	to	18	16,967	13,970	5,320	18,758	55,015	49,035	11,851	16,757	18,242	95,885	-40,870	90,084
18	to	19	137,727	13,970	59,717	17,397	228,810	49,035	27,143	31,249	18,923	126,350	102,460	192,544
19	to	20	13	13,970	4,717	18,586	37,286	49,035	14,305	20,865	18,200	102,405	-65,119	127,425
20	to	21	14,095	13,970	4,962	19,294	52,321	49,119	11,194	14,485	18,342	93,139	-40,818	86,607
21	to	22	58,364	13,970	35,154	18,639	126,127	54,116	12,710	19,337	18,655	104,818	21,309	107,917
22	to	23	0	13,970	523	19,557	34,050	44,372	8,105	13,129	18,311	83,916	-49,866	58,051
23	to	24	19,602	13,970	5,065	19,867	58,504	49,035	8,138	10,710	18,375	86,258	-27,754	30,297
24	to	25	0	13,970	524	20,258	34,752	44,441	5,486	7,896	18,418	76,240	-41,489	-11,192
25	to	26	3,053	13,970	518	20,406	37,947	49,035	4,033	6,132	18,386	77,587	-39,639	-50,832
26	to	27	135,033	13,970	73,747	18,014	240,763	49,035	16,024	17,254	18,639	100,951	139,812	88,980
27	to	28	0	13,970	536	18,764	33,270	44,372	9,238	15,229	18,125	86,963	-53,693	35,287
28	to	29	20,048	13,970	4,960	19,518	58,496	49,119	7,646	10,808	18,326	85,898	-27,402	7,885
29	to	30	9,397	13,970	2,999	19,929	46,296	54,116	4,726	8,252	18,339	85,433	-39,138	-31,253
30	to	31	11,022	13,970	2,348	20,308	47,647	49,035	4,024	7,140	18,409	78,609	-30,962	-62,215
31	to	32	62,138	13,970	37,429	19,568	133,105	49,035	6,854	11,497	18,820	86,205	46,900	-15,315
32	to	33	63,939	13,970	36,375	18,890	133,174	49,119	11,471	19,025	18,678	98,293	34,881	19,566
33	to	34	244	13,970	2,395	20,199	36,808	44,372	6,943	11,585	18,375	81,275	-44,466	-24,900
34	to	35	1,555	13,970	524	20,530	36,579	49,446	3,767	7,507	18,404	79,124	-42,545	-67,445
35	to	36	32	13,970	4,852	20,690	39,543	58,025	303	5,882	18,401	82,610	-43,067	-110,512
36	to	37	52,098	13,970	24,510	19,931	110,509	44,441	4,564	10,236	18,620	77,860	32,648	-77,864
37	to	38	4,170	13,970	616	20,483	39,239	49,035	2,503	6,237	18,378	76,152	-36,913	-114,777
38	to	39	362	13,970	2,463	20,816	37,610	49,446	719	4,966	18,418	73,549	-35,938	-150,716
39	to	40	122,459	13,970	74,037	19,276	229,741	49,035	8,546	10,468	18,766	86,814	142,927	-7,789
40	to	41	12,997	13,970	4,096	19,066	50,129	49,119	8,998	13,953	18,220	90,290	-40,161	-47,950
41	to	42	64,499	13,970	40,945	18,797	138,210	49,035	10,243	16,890	18,577	94,745	43,465	-4,484
42	to	43	0	13,970	536	19,752	34,258	44,372	6,577	12,461	18,301	81,711	-47,454	-51,938
43	to	44	123,377	13,970	53,751	18,022	209,121	49,035	17,543	21,442	18,640	106,660	102,461	50,523
44	to	45	64,250	13,970	39,379	18,423	136,022	49,119	13,271	20,449	18,544	101,383	34,639	85,163
45	to	46	8,541	13,970	2,217	19,103	43,830	49,035	10,232	18,196	18,249	95,712	-51,882	33,281
46	to	47	0	13,970	533	19,897	34,399	44,372	6,746	10,372	18,334	79,823	-45,424	-12,143

TABLE 4-1

Simulated Annual Groundwater Budget

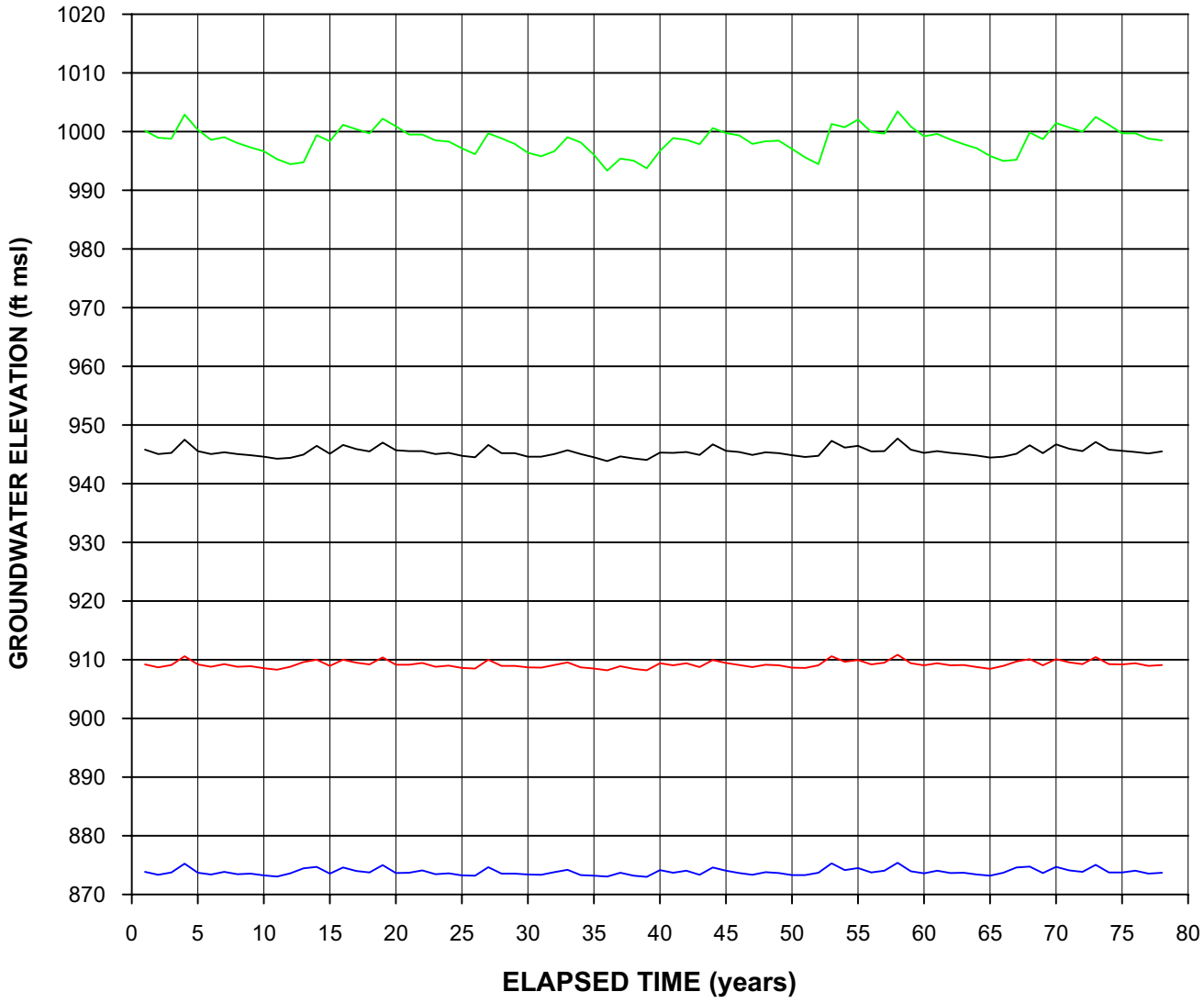
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
47 to 48	43,414	13,970	18,560	19,505	95,448	49,035	8,927	12,755	18,638	89,355	6,094	-6,050
48 to 49	32,966	13,970	13,527	19,953	80,416	49,119	8,497	12,634	18,666	88,916	-8,499	-14,549
49 to 50	839	13,970	1,856	20,451	37,117	44,372	5,528	8,992	18,434	77,326	-40,209	-54,758
50 to 51	9,990	13,970	2,645	20,684	47,289	54,116	3,517	6,845	18,455	82,933	-35,643	-90,401
51 to 52	49,961	13,970	25,027	20,153	109,112	62,702	3,319	9,913	18,755	94,689	14,423	-75,978
52 to 53	188,493	13,970	69,633	17,584	289,679	49,119	22,292	27,398	18,933	117,742	171,937	95,959
53 to 54	46,125	13,970	20,155	18,290	98,539	49,035	15,148	24,661	18,522	107,366	-8,827	87,132
54 to 55	89,718	13,970	39,953	17,979	161,620	49,035	20,589	29,655	18,624	117,903	43,716	130,848
55 to 56	11,601	13,970	3,373	19,267	48,211	49,035	11,347	18,242	18,316	96,940	-48,729	82,119
56 to 57	51,672	13,970	28,415	19,203	113,260	49,119	11,982	18,862	18,806	98,769	14,491	96,610
57 to 58	181,820	13,970	89,448	17,106	302,343	49,035	32,399	38,747	19,048	139,229	163,114	259,725
58 to 59	687	13,970	527	18,350	33,534	49,035	16,623	29,046	18,213	112,917	-79,383	180,342
59 to 60	2	13,970	535	19,266	33,773	44,372	10,576	17,223	18,266	90,437	-56,664	123,678
60 to 61	42,574	13,970	19,998	18,987	95,529	49,119	12,553	18,152	18,704	98,527	-2,998	120,680
61 to 62	11,415	13,970	2,484	19,754	47,622	49,035	9,005	13,268	18,366	89,674	-42,052	78,628
62 to 63	27,363	13,970	10,507	20,014	71,853	54,116	7,752	12,812	18,539	93,219	-21,366	57,262
63 to 64	0	13,970	523	20,416	34,909	44,372	5,755	10,119	18,437	78,683	-43,774	13,488
64 to 65	0	13,970	1,472	20,680	36,121	49,522	3,569	7,254	18,475	78,820	-42,698	-29,210
65 to 66	50,580	13,970	28,173	19,854	112,576	58,025	4,004	10,335	18,623	90,989	21,588	-7,622
66 to 67	130,074	13,970	80,760	17,898	242,702	72,452	13,502	21,223	18,686	125,863	116,839	109,216
67 to 68	112,433	13,970	51,561	17,536	195,499	49,035	23,462	32,532	18,803	123,833	71,667	180,883
68 to 69	414	13,970	1,979	18,661	35,024	49,522	8,596	18,842	18,226	95,186	-60,162	120,721
69 to 70	113,543	13,970	60,100	17,647	205,261	49,035	29,552	30,176	18,761	127,523	77,737	198,459
70 to 71	45,609	13,970	21,594	18,166	99,339	49,035	15,740	23,534	18,602	106,911	-7,572	190,886
71 to 72	16,967	13,970	5,320	18,777	55,034	49,035	12,551	18,552	18,264	98,402	-43,368	147,518
72 to 73	137,727	13,970	59,717	17,442	228,856	49,119	28,296	34,847	19,001	131,263	97,592	245,111
73 to 74	13	13,970	4,717	18,592	37,292	49,035	14,986	23,059	18,220	105,299	-68,007	177,103
74 to 75	14,095	13,970	4,962	19,254	52,281	49,035	11,783	15,930	18,311	95,059	-42,779	134,324
75 to 76	58,364	13,970	35,154	18,654	126,142	54,116	13,385	20,958	18,673	107,132	19,010	153,334
76 to 77	0	13,970	523	19,646	34,139	44,441	8,624	14,082	18,380	85,527	-51,388	101,946
77 to 78	19,602	13,970	5,065	19,899	58,536	49,035	8,607	11,515	18,393	87,550	-29,014	72,932
Minimum	0	13,970	518	16,985	33,270	44,372	303	4,966	18,125	73,549	-79,383	-150,716
Maximum	188,493	13,970	89,448	20,816	302,343	72,600	36,265	38,747	19,056	139,229	171,937	259,725
Average	42,498	13,970	21,480	19,092	97,040	49,823	11,520	16,262	18,498	96,105	935	44,866
Median	19,602	13,970	5,193	19,153	58,500	49,035	9,822	14,430	18,446	92,573	-28,384	36,292

Note:

All flow volumes are listed in AF/yr.

Figures



NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS. WELL NLF-TOPCO1 IS LOCATED 210 feet SOUTHWEST OF WELL NLF-B11.

FIGURE 4-1
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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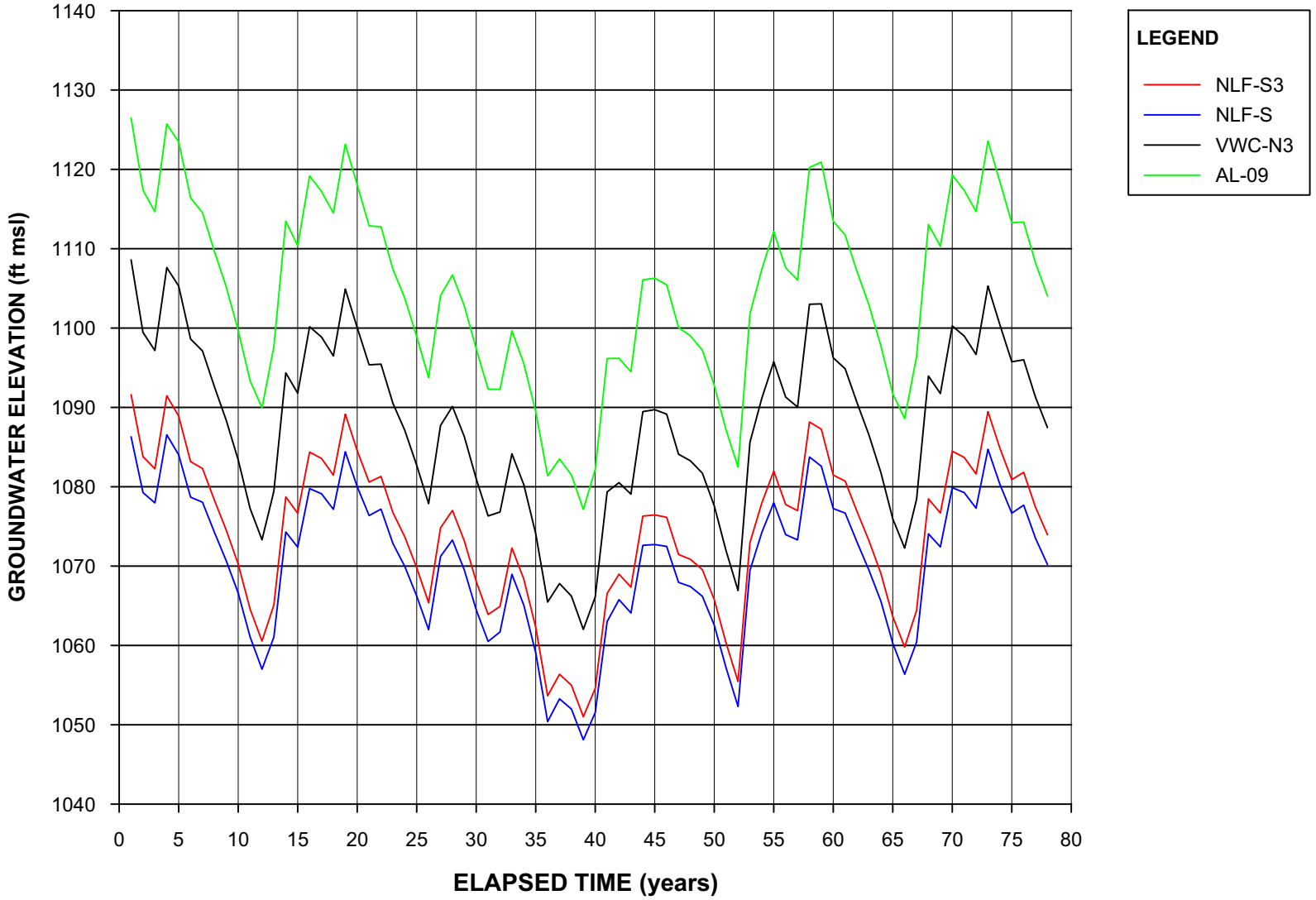

NOTES:

1. AL09 IS A CLUSTER OF OBSERVATION WELLS LOCATED 845 feet SOUTHWEST OF PRODUCTION WELL VWC-Q2.

2. THE REMAINING HYDROGRAPHS REPRESENT FORMER ALLUVIAL AQUIFER WELLS THAT HAVE BEEN ABANDONED AND THEREFORE ARE NOT PUMPED IN THE MODEL SIMULATIONS. RELATIVE TO EXISTING WELLS SHOWN ON FIGURE 2-4, THESE FORMER WELLS WERE LOCATED AS FOLLOWS:

   – WELL NLF-S3 WAS LOCATED 305 feet EAST OF WELL VWC-S6
   – WELL NLF-S WAS LOCATED 940 feet SOUTHWEST OF WELL VWC-S6
   – WELL VWC-N3 WAS LOCATED 435 feet NORTHEAST OF WELL VWC-N8

FIGURE 4-2
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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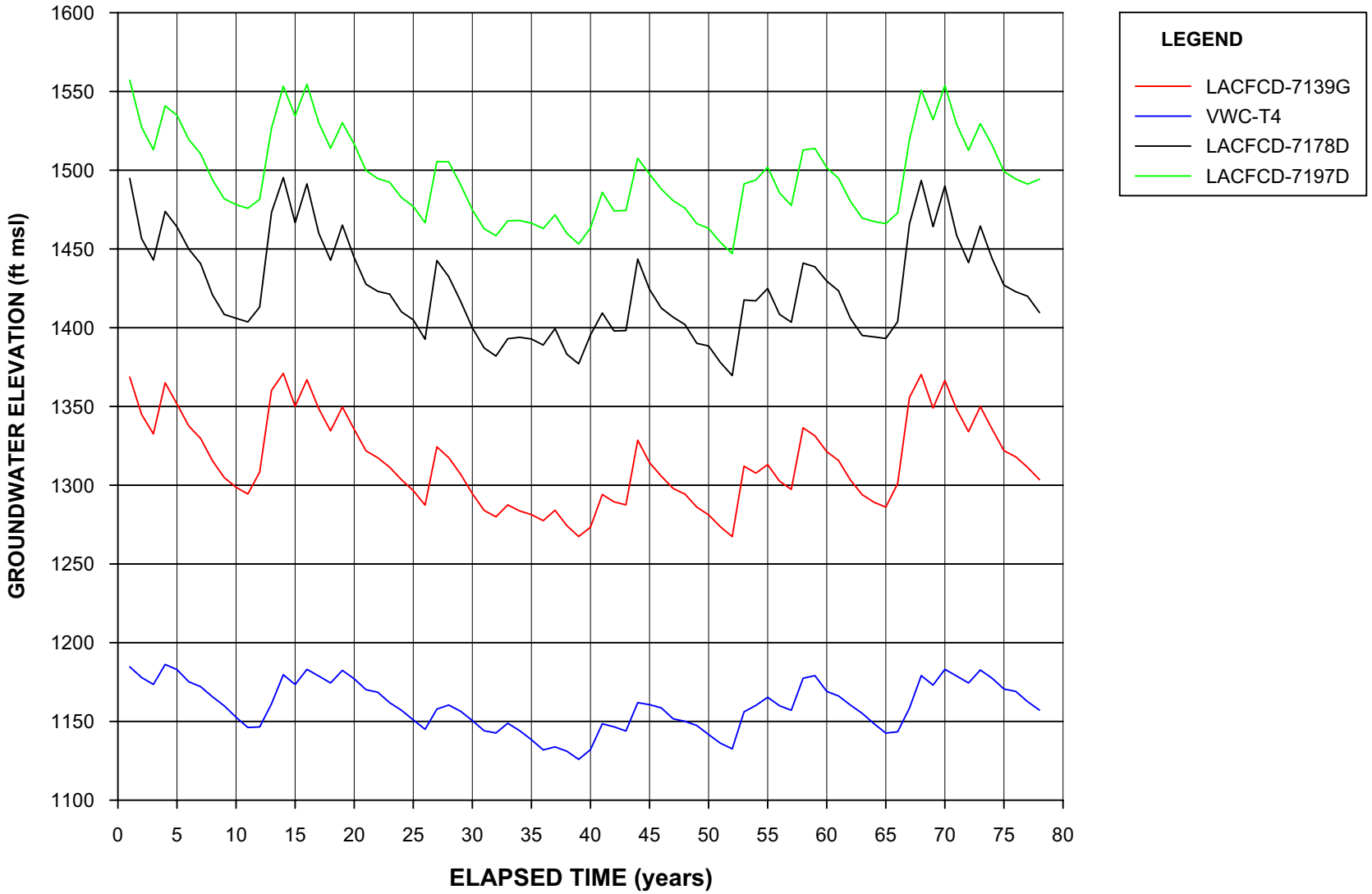

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR VWC- T4 = 1101 ft msl; ALLUVIUM BOTTOM ELEVATION ~1050 TO 1065 ft msl.
3. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7139G = 1289 ft msl; ALLUVIUM BOTTOM ELEVATION ~1256 ft msl OR LOWER.
4. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7178D = 1463 ft msl; ALLUVIUM BOTTOM ELEVATION ~1398 TO 1425 ft msl.
5. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7197D = 1474 ft msl; ALLUVIUM BOTTOM ELEVATION ~1423 TO 1447 ft msl.

FIGURE 4-3
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER IN SOLEDAD CANYON
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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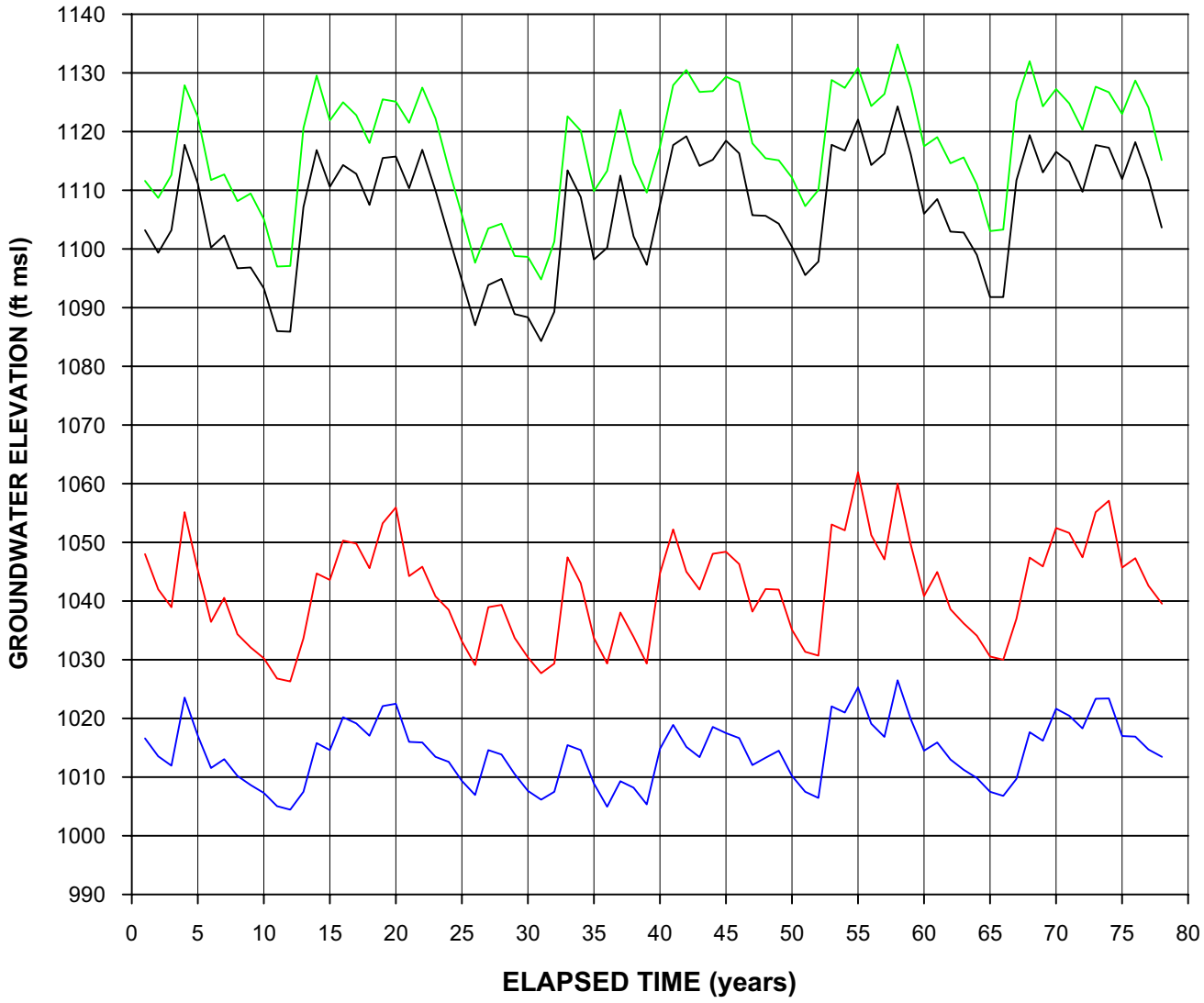

NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE 4-4
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG CASTAIC CREEK
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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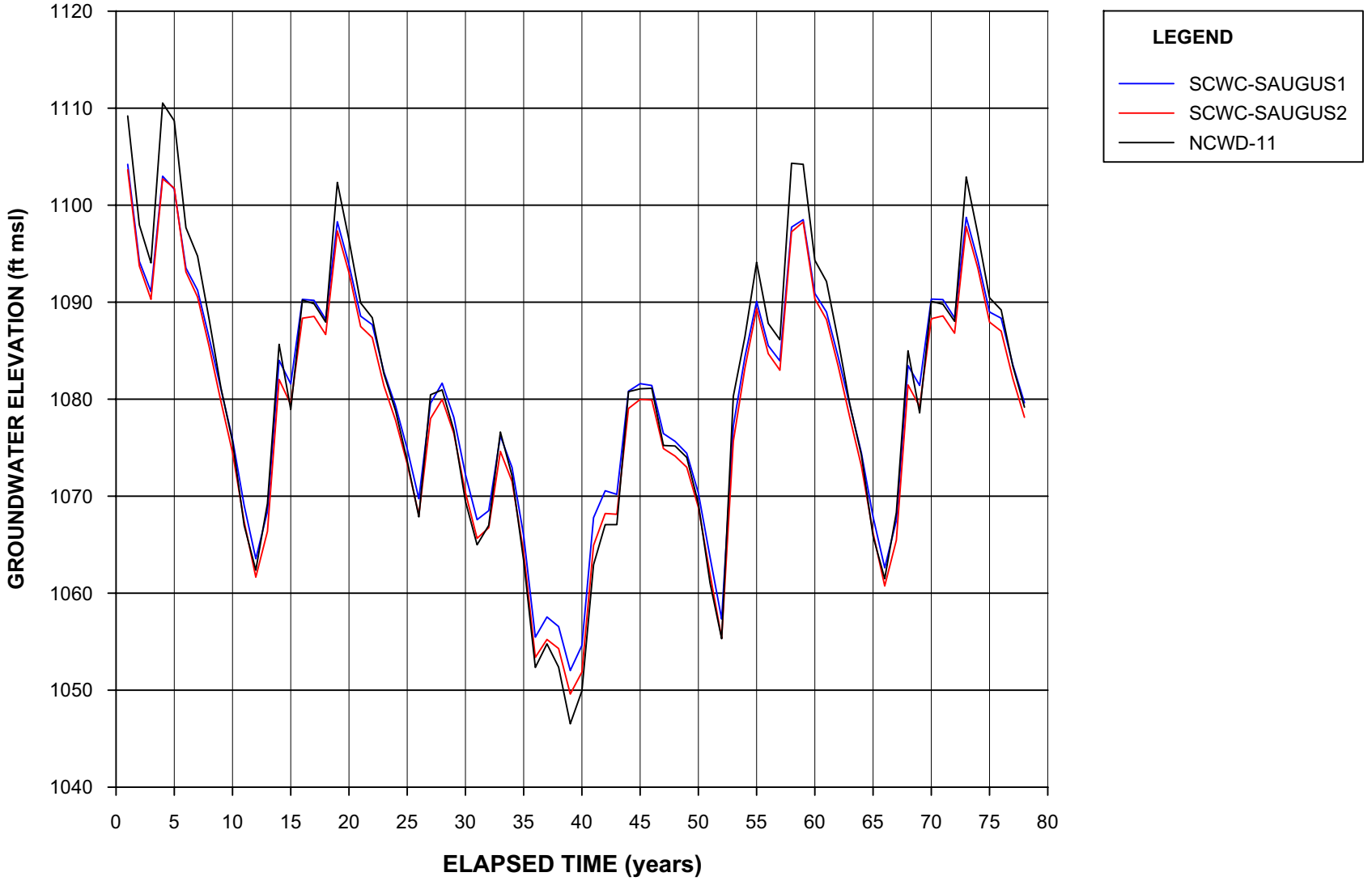

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

2. THESE WELLS ARE CONSTRUCTED IN THE SAUGUS FORMATION AND ARE NOT OPEN TO THE ALLUVIAL AQUIFER. THE SIMULATED HYDROGRAPHS AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE ALLUVIAL AQUIFER, ABOVE THE OPEN INTERVALS OF THESE WELLS.

FIGURE 4-5
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG THE SOUTH FORK SANTA CLARA RIVER
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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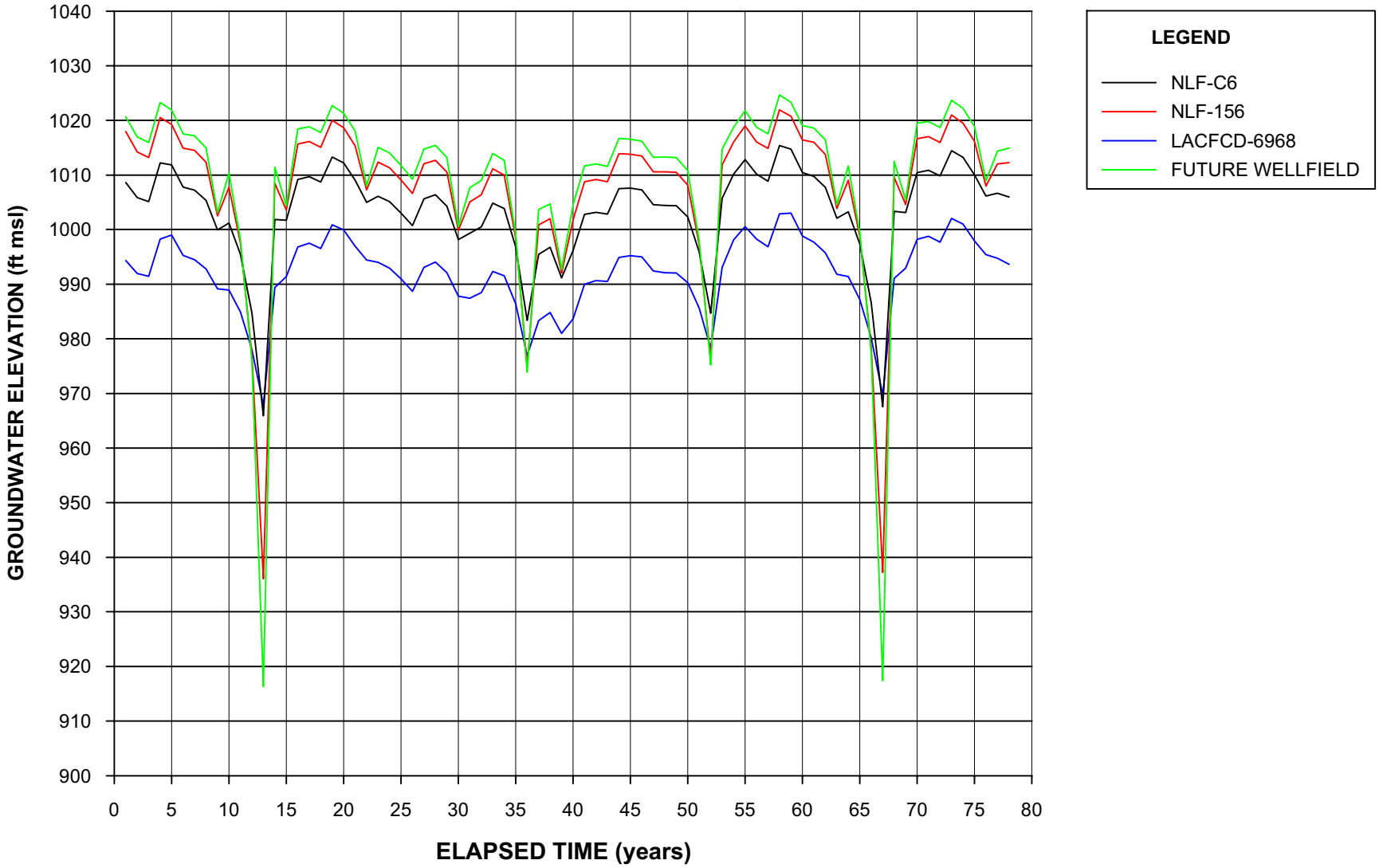

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WELLS NLF-C6 AND LACFCD-6968 ARE CONSTRUCTED IN THE ALLUVIAL AQUIFER AND ARE NOT OPEN TO THE SAUGUS FORMATION. THE SIMULATED HYDROGRAPHS SHOWN AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE SAUGUS FORMATION, BELOW THE OPEN INTERVALS OF THESE WELLS.
3. THE SIMULATED HYDROGRAPH FOR THE FUTURE WELLFIELD IS FOR A MODEL NODE WITH NO ASSIGNED PUMPING, LOCATED INSIDE THE WELLFIELD NEAR VWC-206.

FIGURE 4-6
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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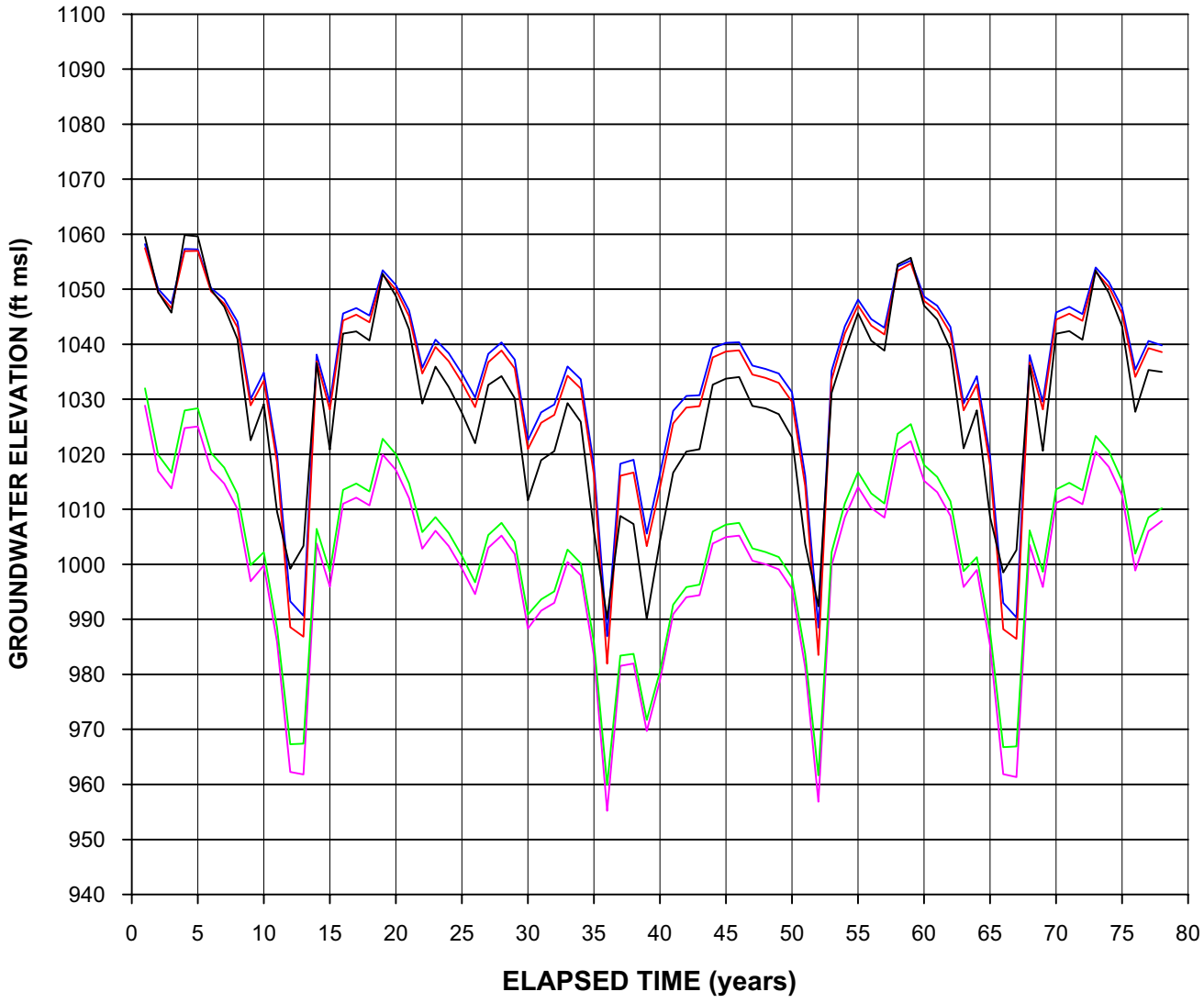

NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE 4-7
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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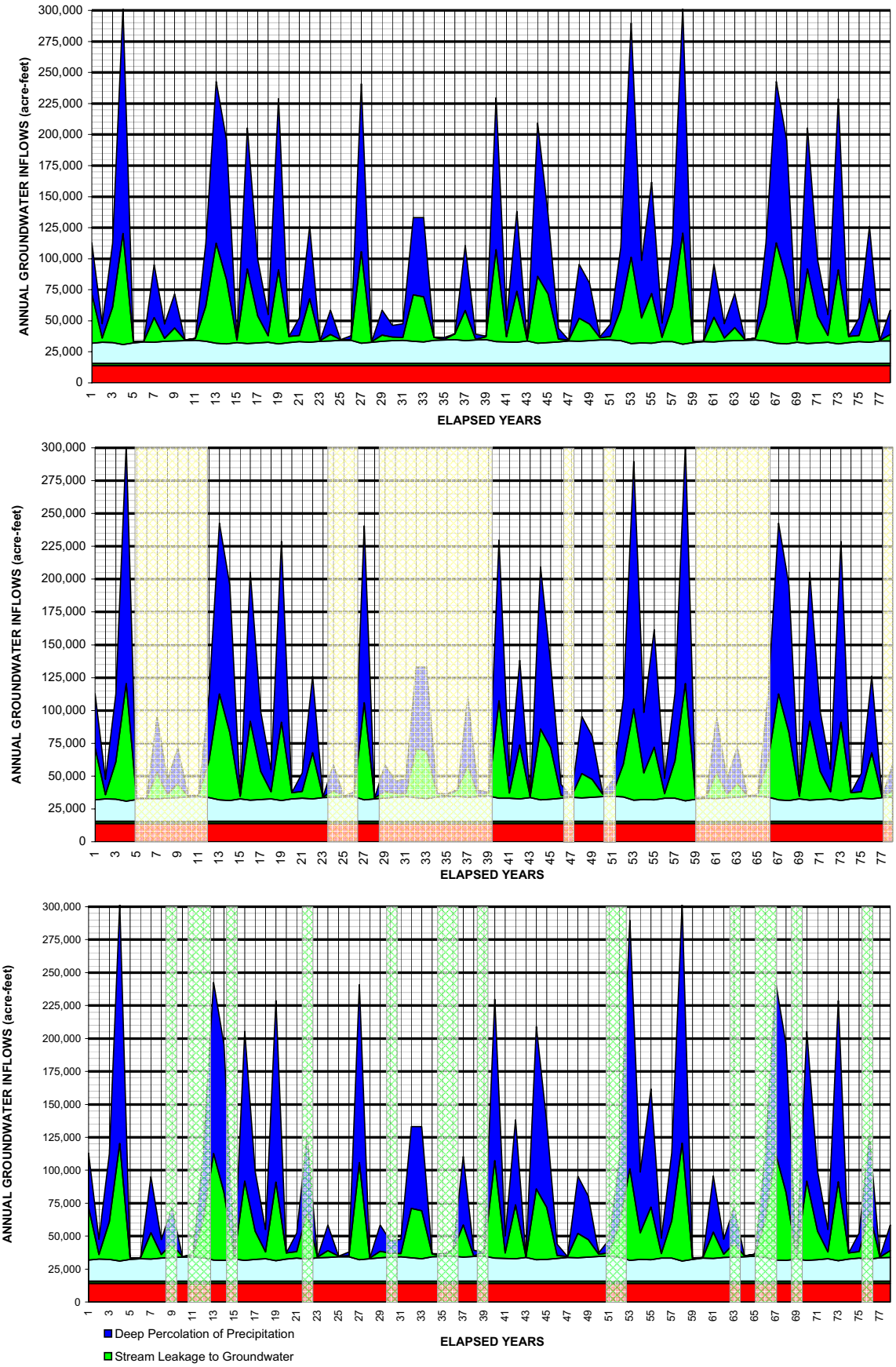

Note:

The deep percolation of applied water is calculatedfor full build-out conditions within the Regional Model boundary, as shown on Figure 3-7 and discussed in Section 3.5.

FIGURE 4-8
SIMULATED ANNUAL GROUNDWATER INFLOWS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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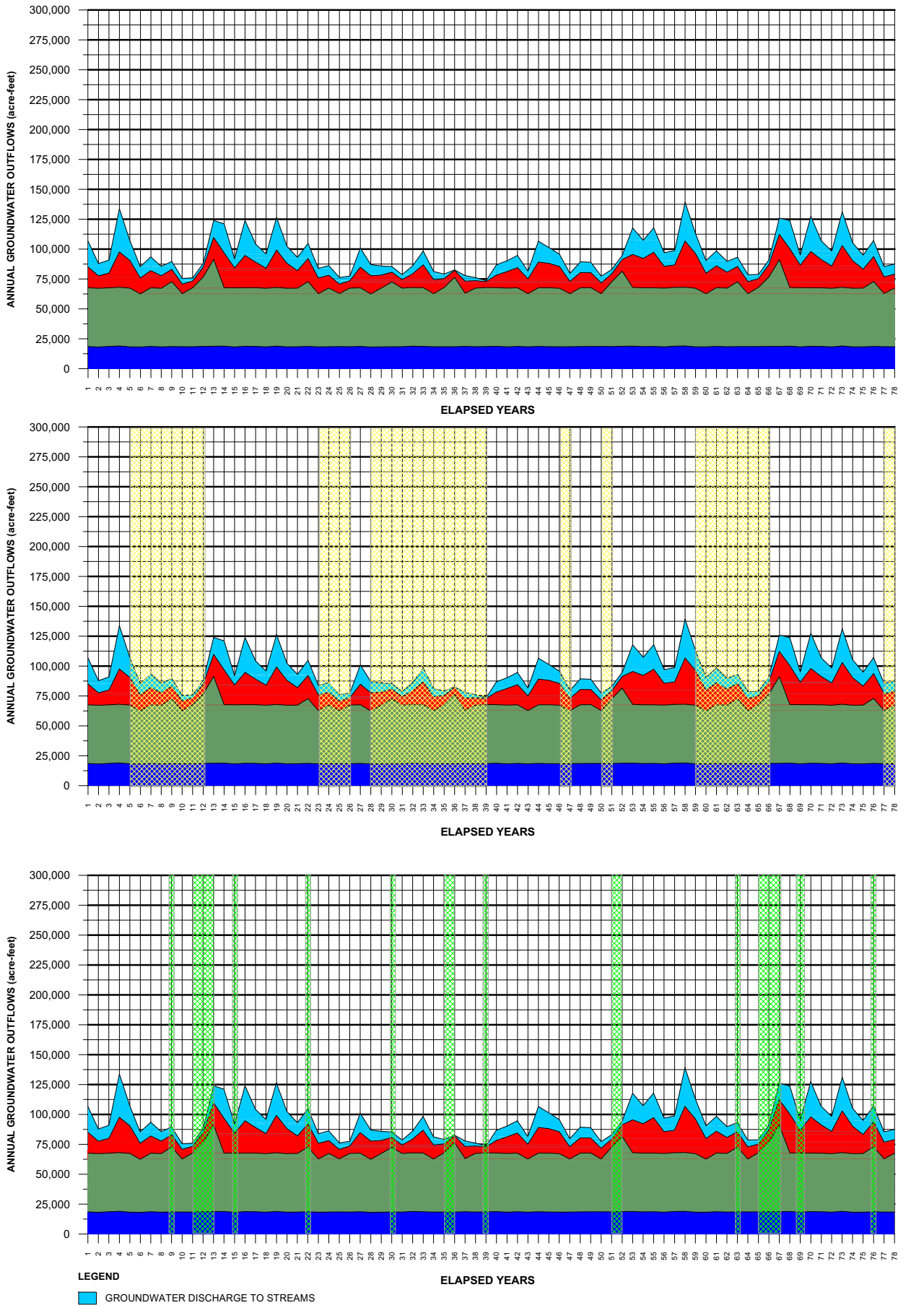

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FIGURE 4-9
SIMULATED ANNUAL GROUNDWATER OUTFLOWS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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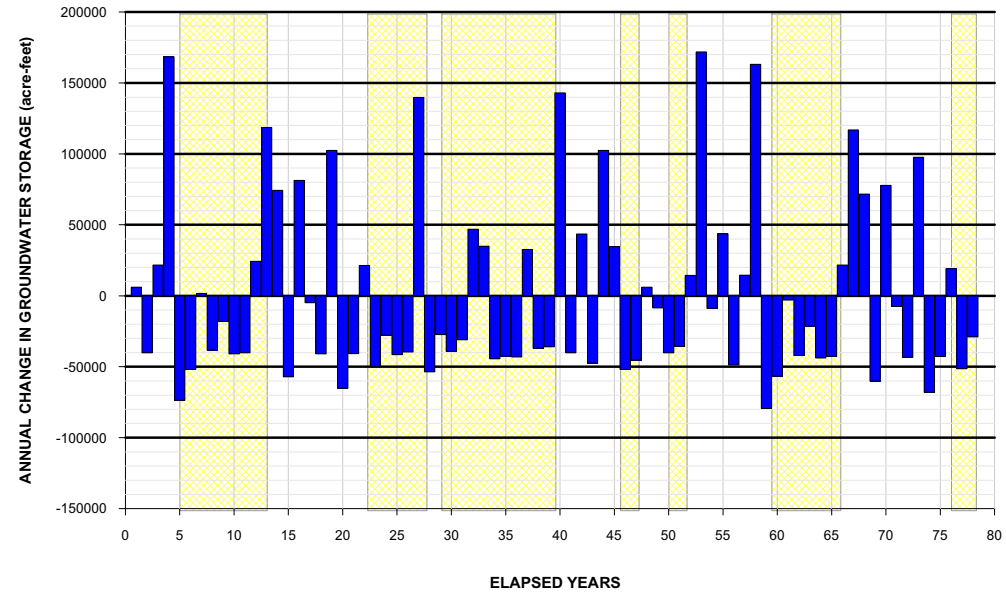

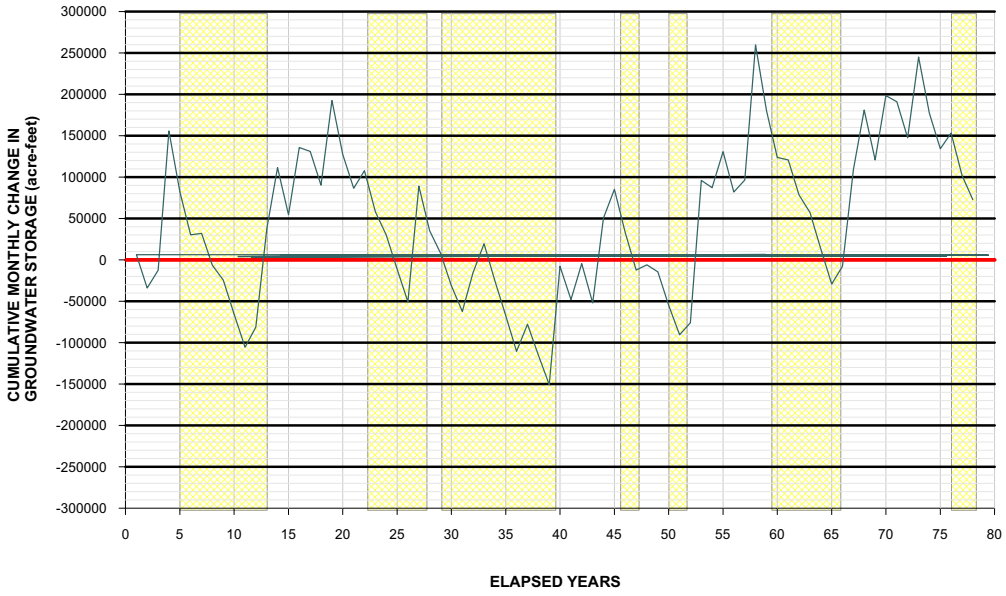

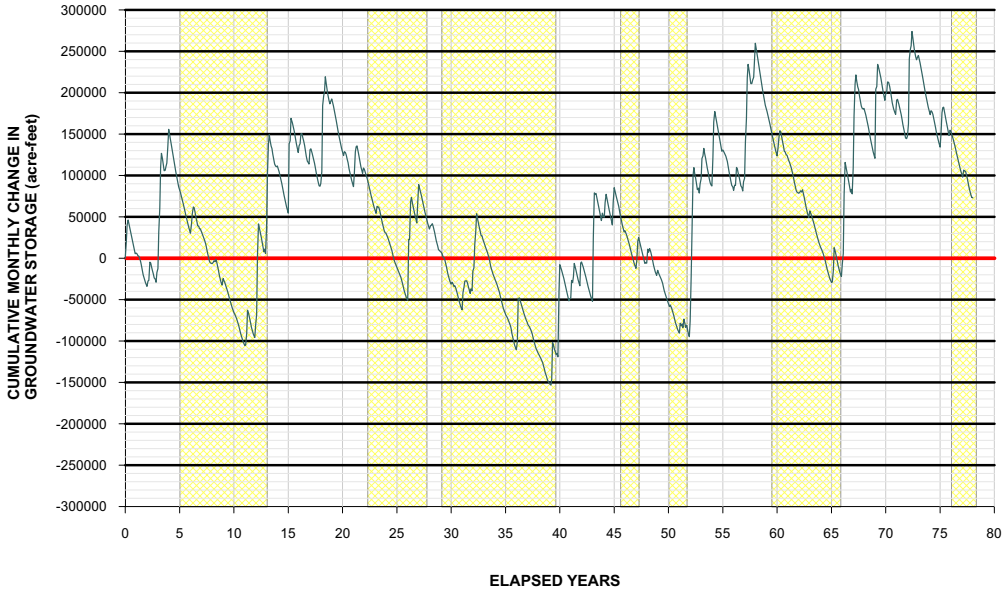

LOCAL DRY YEARS

FIGURE 4-10 (PAGE 1 OF 2)
ANNUAL AND CUMULATIVE CHANGE IN SIMULATED GROUNDWATER STORAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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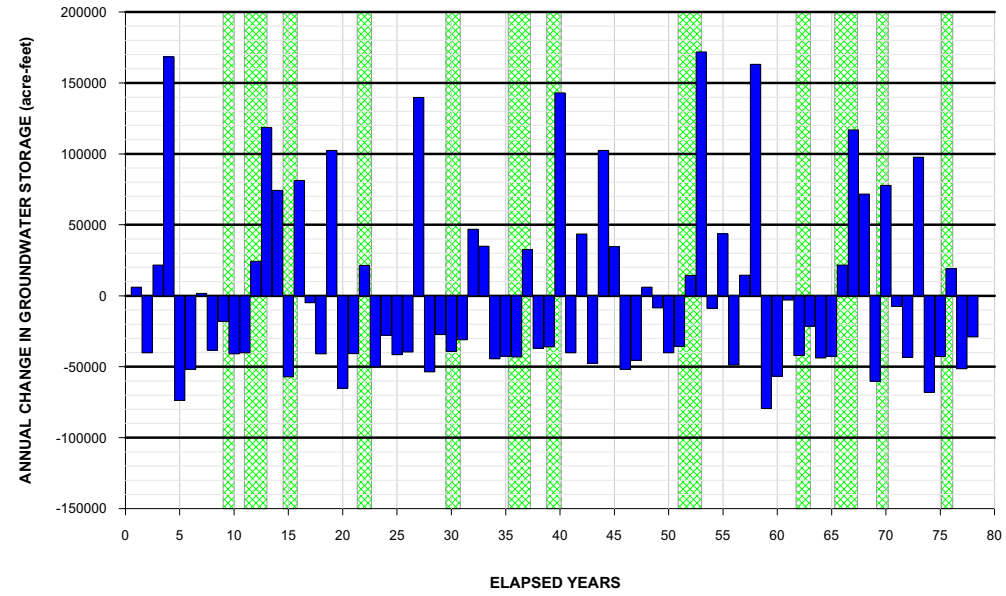

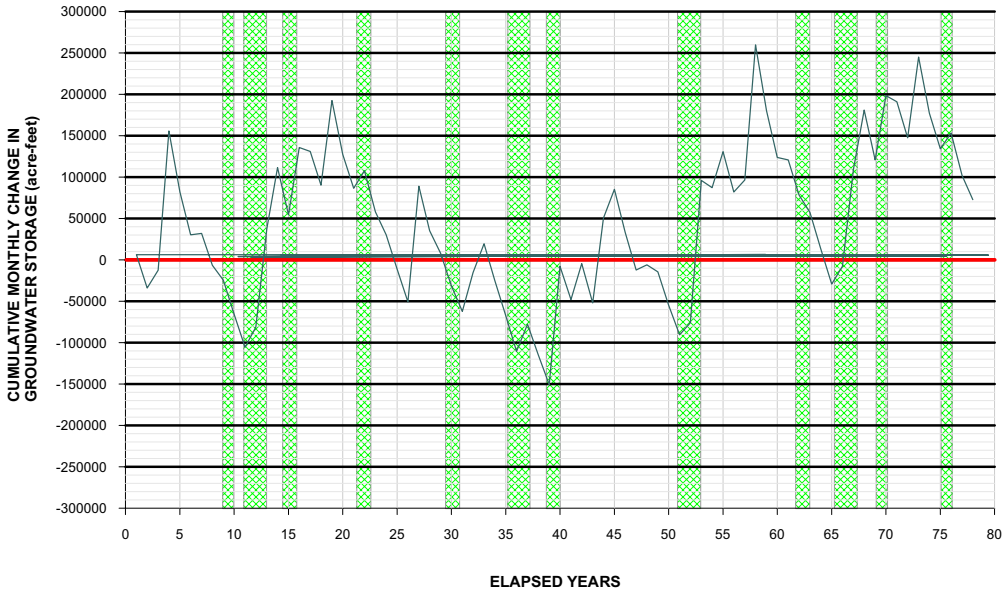

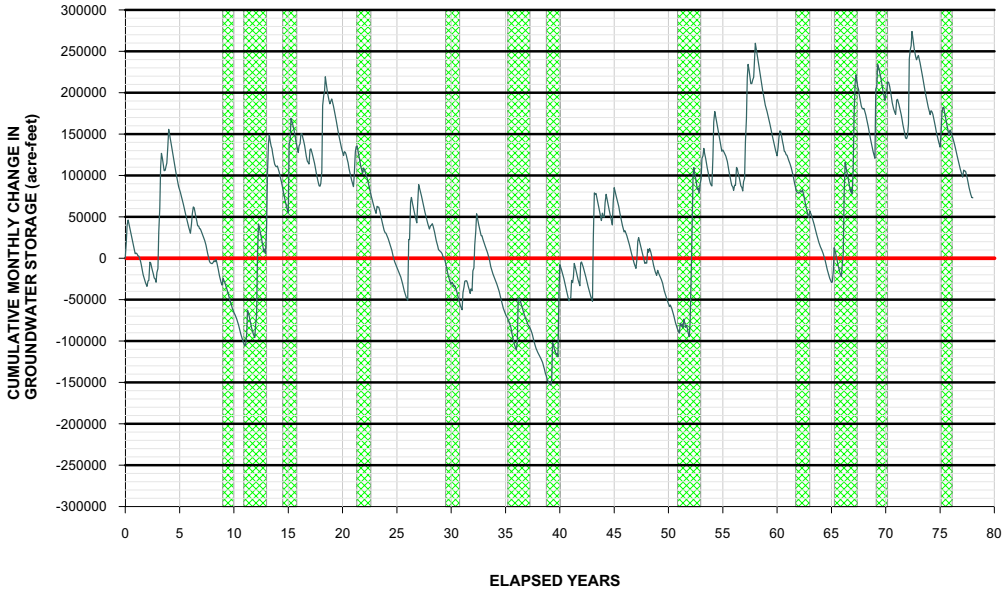

FIGURE 4-10 (PAGE 2 OF 2)
ANNUAL AND CUMULATIVE CHANGE IN SIMULATED GROUNDWATER STORAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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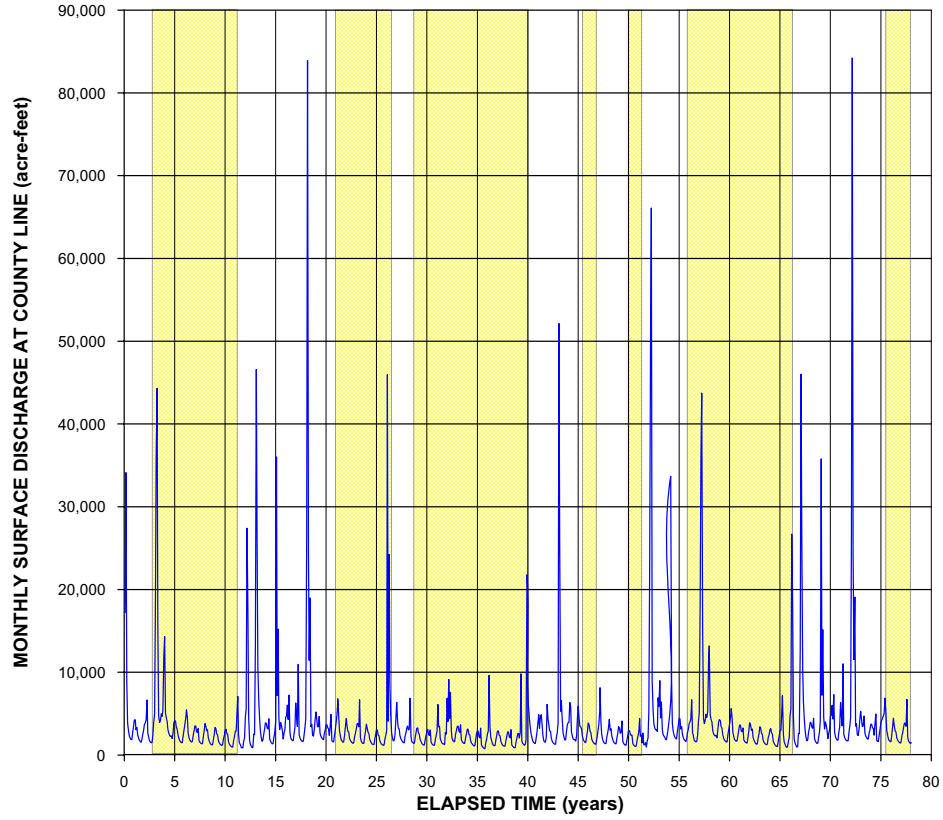

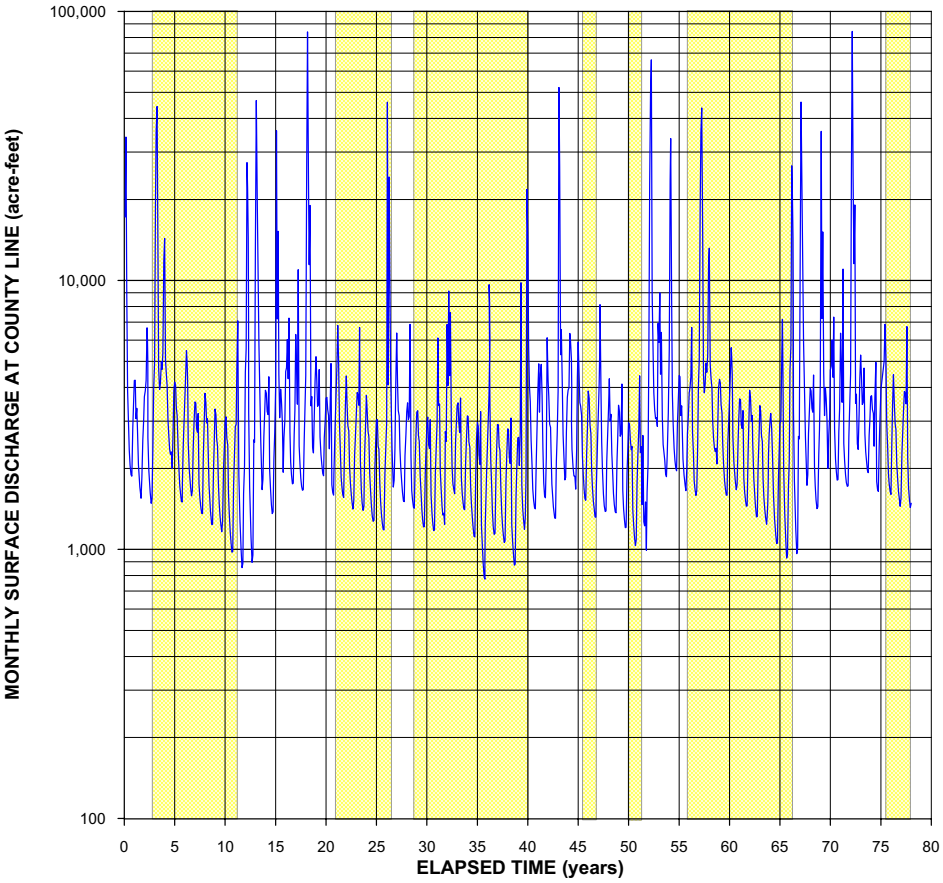

LEGEND

LOCAL DRY YEARS

FIGURE 4-11
SIMULATED SANTA CLARA RIVER FLOW AT COUNTY LINE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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CH2MHILL

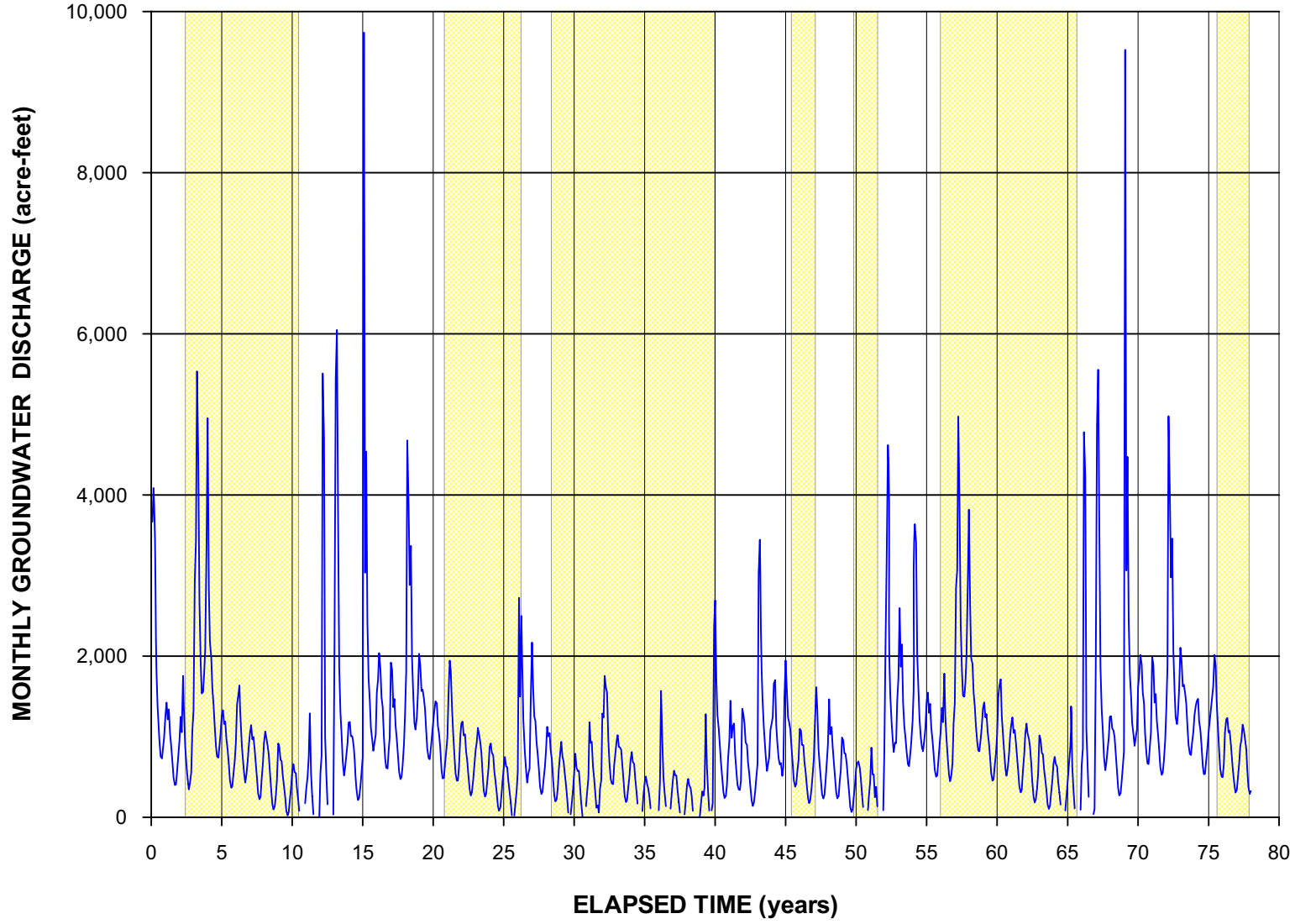

FIGURE 4-12
SIMULATED GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 5

Conclusions

This section discusses the principal findings from the analyses of historical data and numerical modeling results and the implications of these findings for both groundwater management and water supply in the Santa Clarita Valley.

5.1 Principal Findings

The primary objective of the groundwater basin yield evaluation was to use the Regional Model to examine the groundwater operating plan under a range of potential hydrologic conditions to determine whether the groundwater resources in the valley could be expected to respond to such operations in a sustainable fashion. For the purposes of this evaluation, as in other settings, sustainability is defined in terms of renewability (recharge) of groundwater as reflected by the following indicators:

1. Lack of chronic, or sustained, depletion of groundwater storage, as indicated by projected groundwater levels, over a reasonable range of wet, normal, and dry hydrologic conditions

2. Maintenance of surface water flows in the western portion of the basin (which are partially maintained by groundwater discharge) and surface water outflow to downstream basins over the same range of hydrologic conditions

Regarding maintenance of surface water flows, although the development and use of groundwater in a sustainable manner necessitates the inducement of recharge from surface water, sustainability, in this case, does not rely on inducing groundwater recharge by eliminating surface water flows. Rather, it retains and, as supported by increased supplemental water importation, generally increases surface water outflow. Regarding both indicators of sustainability, the range of analyzed hydrologic conditions is a long-term period that includes anticipated occurrences of the types of years and groups of year types that have historically occurred in the basin.

The primary conclusion from the modeling analysis is that the current operating plan for the groundwater basin in the Santa Clarita Valley will not cause detrimental short- or long-term effects to the groundwater and surface water resources in the valley and is, therefore, sustainable. The modeling analysis, along with the historical data described in this report, result in the following specific conclusions regarding the sustainability of the operating plan:

1. The groundwater basin has historically been, and continues to be, in good operating condition and not in overdraft conditions, as indicated by historical data.

2. The operating plan is sustainable over varying hydrologic conditions, because it is feasible to intermittently exceed a long-term average yield for 1 or more years without

creating long-term adverse impacts to the groundwater system and the Santa Clara River.

3. Yields from the Alluvial Aquifer and the Saugus Formation during wet and dry years can be used for long-term water supply planning purposes. In particular, although increased pumping from the Saugus Formation during years of reduced SWP deliveries can be expected to cause short-term declines in groundwater levels during such pumping, it is not projected to cause permanent declines in groundwater discharges or streamflow. Additionally, Saugus groundwater levels will rapidly recover to pre-drought conditions.

4. The strategy around which the plan was designed (maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, while limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus pumping during years when SWP supplies are significantly reduced because of drought conditions) is viable on a long-term basis.

5. The historical observations of basin conditions and the model simulations together support the historical and ongoing confidence that groundwater can continue to be a sustainable source of water supply under the current groundwater operating plan described in the Amended 2000 UWMP (Black & Veatch, 2000; CLWA et al., 2005), the Groundwater Management Plan (CLWA, 2003), and the annual water reports (LSCE, 2005a).

In summary, the groundwater basin can be expected to respond to the operating plan in a manner similar to what has been experienced over approximately the last 50 years: use of water from groundwater storage during drier periods, mostly reflected by small to large fluctuations in Alluvial Aquifer groundwater levels from the middle to the eastern part of the basin, followed by full to near-full recovery in wet years or periods of years. A notable difference from historically experienced conditions is in the Saugus Formation. Greater Saugus pumping during periods of significantly reduced imported water supplies is projected to cause larger fluctuations in groundwater levels during such pumping, with full to near-full recovery of Saugus water levels in subsequent years, when the availability of imported water supplies returns to normal.

5.2 Groundwater Management and Water Supply Implications

The primary focus of the MOU and a key focus of the Groundwater Management Plan is basin yield; specifically, whether a groundwater operating yield could be developed whereby some defined amount of groundwater could be pumped on a sustainable basis. The evaluation described in this report addresses that question. The MOU did not envision impacts from groundwater contamination such as have recently impacted a number of municipal water supply wells. Fortunately, the Regional Model could be used, and has been used, to also examine the effectiveness of the operating plan in containing groundwater contaminants while concurrently pumping (with appropriate treatment at contaminated wells) for municipal water supply (CH2M HILL, 2004b). Thus, in addition to the water supply and groundwater management findings derived from the original intent of the MOU, as discussed below, an additional significant finding derived from the

development and application of the model is that groundwater supply and the control of groundwater contamination migration can be concurrently accomplished without having to modify or, more importantly, compromise the operating yield of the basin.

In addition to the preceding contamination-related findings, there are other findings that directly relate to the original intent of the MOU and can be classified as findings related to the yield of the basin and/or the long-term water supply in the valley. First, the long-term yield of the basin can be considered, for the present, to be equivalent to the operating plan for the basin, based on the simulated projections of groundwater levels, storage, and stream flows. In other words, with the existing and planned distribution of wells and pumping capacities in the operating plan, the basin can be expected to sustainably yield the annual volumes of groundwater in the operating plan for ongoing municipal and agricultural water supply. Additionally, other pumpers in the basin, such as small private well owners, can expect to experience Alluvial Aquifer groundwater conditions generally similar to what they have experienced in the past. This expression of basin yield, based on the existing and planned distribution of wells and pumping capacities, should not be considered or interpreted as a limit to the yield of the basin. It is possible that some alternate configurations of well locations and pumping capacities, potentially complemented by other management actions (e.g., artificial recharge activities), could increase the yield of the basin in the future. The Regional Model, developed for analysis of the current operating plan, can be used to examine potential changes in the operating plan and associated changes in basin yield if that is ever desirable. For the present, however, the main finding of the current groundwater operating plan is that basin conditions can be expected to generally repeat what has been experienced over the last several decades, with some increase in Saugus groundwater level fluctuations if dry-year increases in pumping are actually needed as planned, all resulting in no long-term depletion of groundwater.

From a water supply perspective, the main finding of the operational yield analysis is that it supports the groundwater component of overall water supply for the Santa Clarita Valley as described in the 2000 UWMP, and as expected to be carried forward in the 2005 UWMP.

As discussed in Section 5.1, the Saugus Formation has not been historically pumped at the dry-year rates described in the operating plan. Consistent with the ongoing water resource management, data collection, data management, data evaluation, and reporting activities that have been ongoing in the basin for the past several years, the Purveyors will closely monitor the effects of the greater-than-historical Saugus Formation pumping when it occurs. Depending on the findings from monitoring activities during the first period of increased Saugus pumping, the conjunctive use program that currently relies on SWP deliveries could potentially expand to include artificial recharge activities to enhance Saugus water level recovery after periods of increased Saugus pumping.

In conclusion, through the UWMP, the MOU, the Groundwater Management Plan, and other related water resource management activities, the Purveyors have developed an ongoing process for groundwater resource management in the Santa Clarita Valley that results in a sustainable operating plan for the local groundwater basin. As discussed in the annual water reports (including LSCE, 2005a), the ongoing process of groundwater management relies not only on the historical evaluations and numerical modeling analyses, but also on other program elements identified in the MOU—data gathering, database maintenance, and annual reporting—as well as other activities, such as implementing

conservation measures, increasing the use of recycled water, planning for water reliability, updating the UWMP on a regular schedule, and administering the Groundwater Management Plan. The development and implementation of the UWMP, the MOU, and the Groundwater Management Plan have resulted in a significantly improved understanding of the local water resources, and, in particular, have demonstrated that the current groundwater operating plan results in a reliable, long-term component of water supply for the valley. Ongoing monitoring and interpretation of actual groundwater conditions, as discussed in the MOU and the Groundwater Management Plan, will allow (1) continued assessment of basin responses to future pumping; (2) verification that, as public and private development increase with time, both within and adjacent to the basin, the groundwater basin responds in the same general manner as described herein; and (3) identification of whether adjustments to the operating plan might be warranted to achieve its primary objective of a sustainable groundwater resource.

SECTION 6

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Appendix A
Memorandum of Understanding

Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation**. The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights**. Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By _____
General Manager

Castaic Lake Water Agency

By _____
General Manager

Newhall County Water District

By _____
General Manager

Valencia Water Company

By _____
President

Santa Clarita Water Company

By _____
President

Los Angeles County Waterworks District No. 36

By _____
County of Los Angeles

United Water Conservation District Boundary

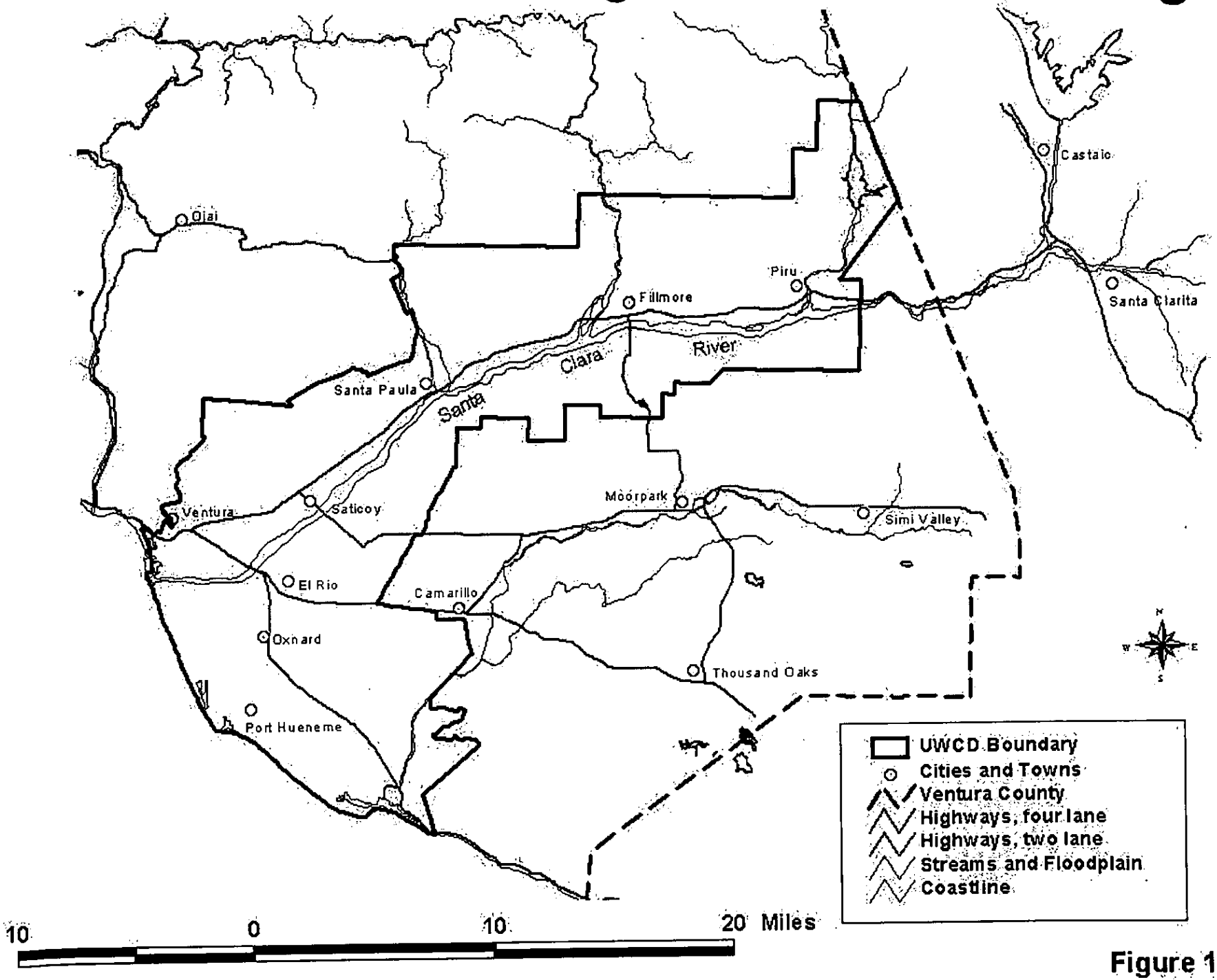


Figure 1-1

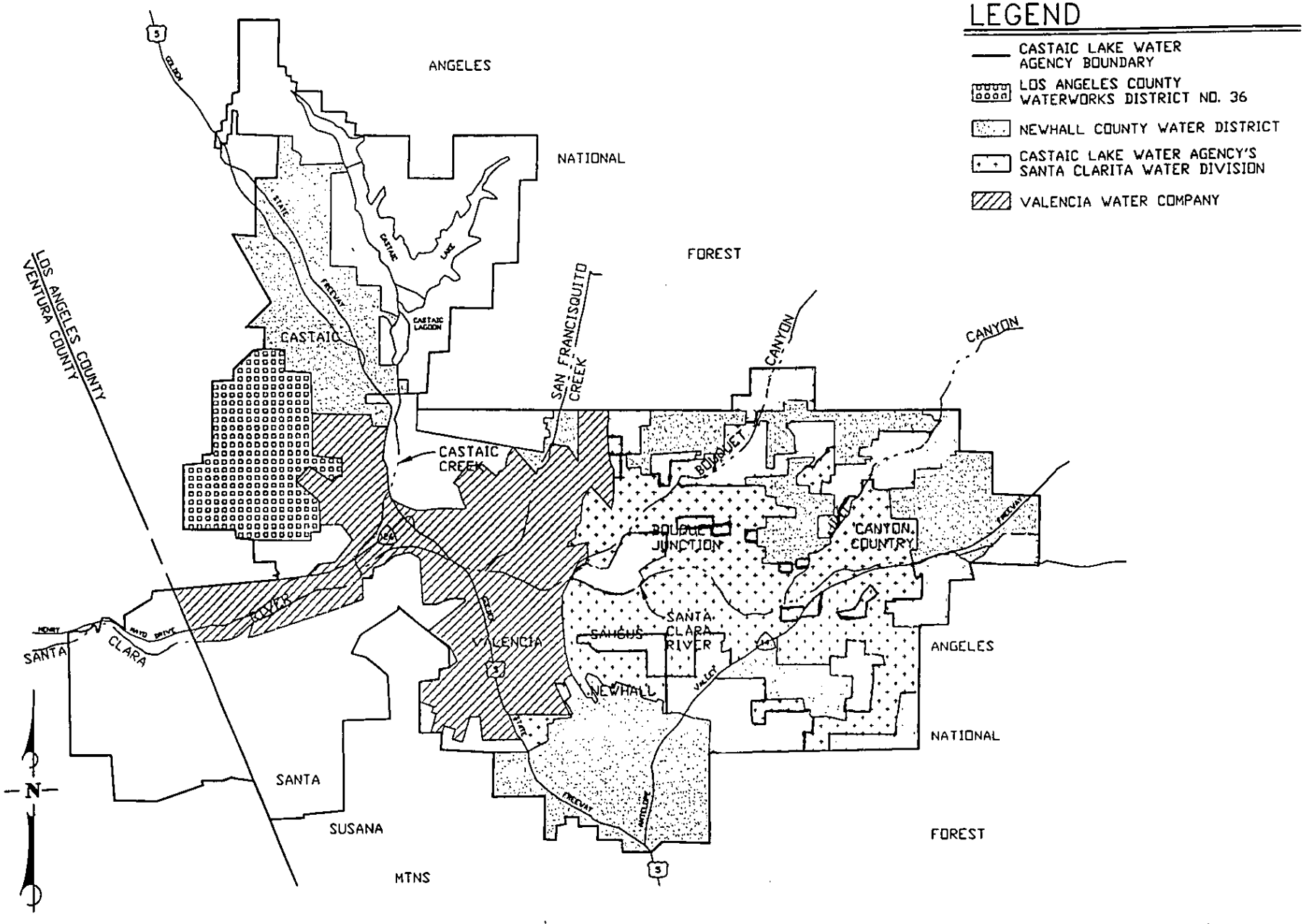


FIGURE 1-2

CLWA AND WATER PURVEYOR SERVICE AREAS

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the

area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the

gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is

available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

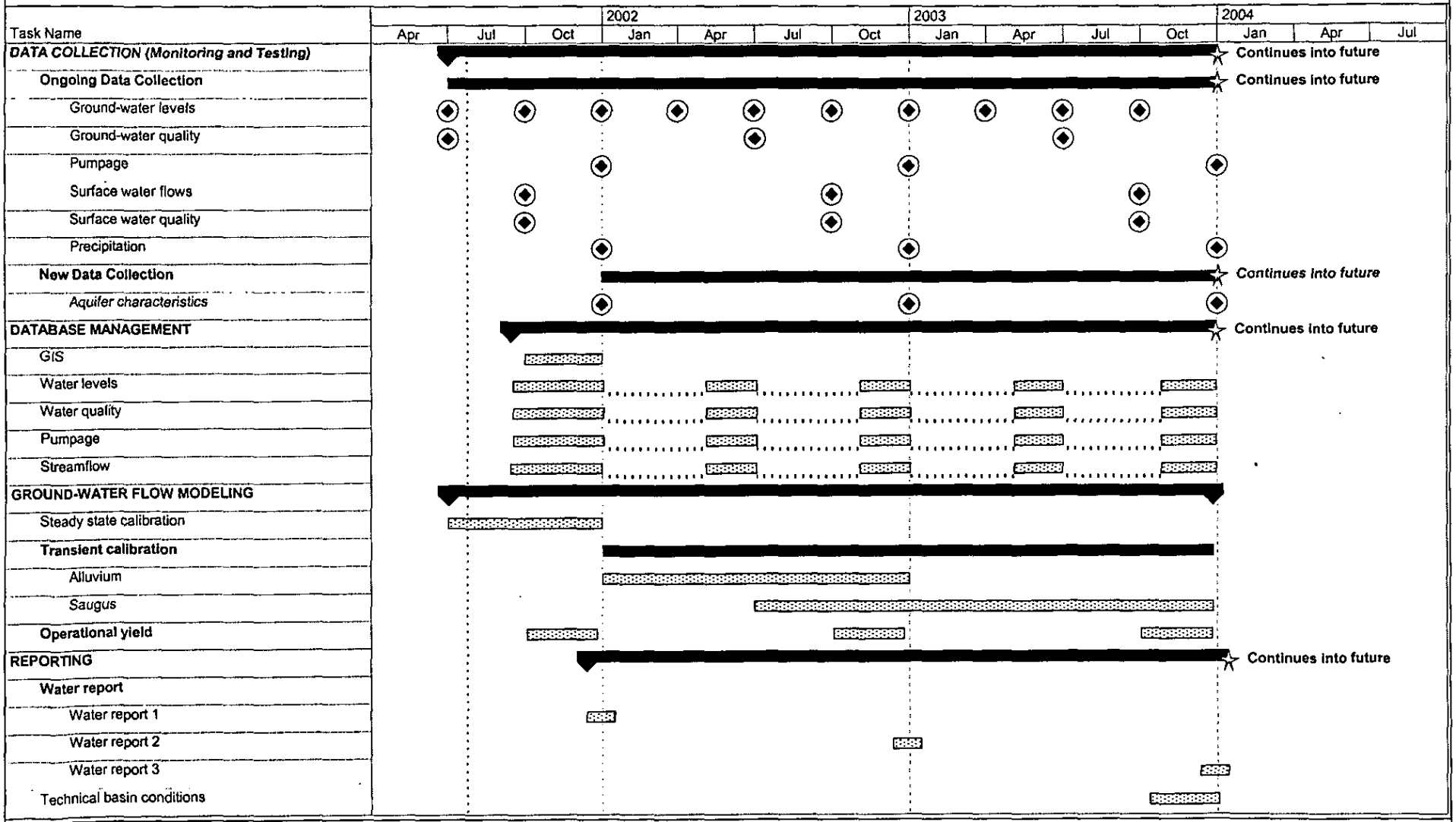
REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as

well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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Appendix B
Description of the Santa Clarita Valley Regional Groundwater Flow Model

APPENDIX B

Description of the Santa Clarita Valley Regional Groundwater Flow Model

B.1 Introduction

The Santa Clarita Valley Regional Groundwater Flow Model (hereafter referred to as the Regional Model) is a three-dimensional, numerical model of groundwater flow that covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. A Surface Water Routing Model (SWRM) was also developed specifically for this basin as a pre- and post-processor for the Regional Model.

The approach to developing the Regional Model included the following steps:

1. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system
2. Creating a variety of data sets to conduct steady-state and transient calibrations
3. Constructing the Regional Model using the MicroFEM® finite-element groundwater flow code (Hemker and de Boer, 2003), and also using the available database and geographic information system (GIS) information for the Santa Clarita Valley
4. Calibrating the Regional Model
5. Performing sensitivity tests on the Regional Model

This appendix provides an overview of the Regional Model's construction and calibration. The construction and calibration of the Regional Model and the SWRM are described in detail in the *Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California* (CH2M HILL, 2004a).

B.2 Model Construction

B.2.1 Software

The Regional Model was constructed using the three-dimensional, finite-element groundwater modeling software MicroFEM® (Hemker and de Boer, 2003). MicroFEM® operates in a Windows™ environment and can be used to solve groundwater flow problems for unconfined, semi-confined, or confined aquifer systems. This software simulates steady-state or transient flow conditions in up to a 20-layer aquifer system; the finite-element mesh may contain as many as 50,000 nodes in each model layer. The software contains several different methods for simulating groundwater/surface water interactions. MicroFEM® is based on software developed in the Netherlands during the 1980s for use in evaluating the effects of groundwater pumping in areas with complicated meandering rivers. Further

details regarding this software's design, capabilities, and functionality can be found on the Internet at www.microfem.com and in two reviews of the software by Diodato (1997, 2000).

B.2.2 Model Grid

The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The nodes are spaced 500 feet apart in the majority of the modeled area. However, a finer node spacing (150 feet) was used along the Santa Clara River and its tributaries to allow a more exact simulation of surface water/ groundwater exchanges. Additionally, specific nodes were placed within this regional grid at the locations of production and monitoring wells.

B.2.3 Layering

The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation wherever the Alluvial Aquifer is not present. The six underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member. The northern and southern edges of the model domain are defined by the geologic contacts mapped by Richard C. Slade and Associates, LLC (2002), formerly known as Richard C. Slade, Consulting Groundwater Geologist (both hereafter referred to as RCS), for the Alluvial Aquifer and the Saugus Formation.

The saturated thickness of the Alluvial Aquifer was defined from the average base elevation of the aquifer and the water level elevations measured during the fall of 1985 and the spring of 2000, as described by RCS (1986 and 2002). Along the Santa Clara River, the typical saturated thickness of the Alluvial Aquifer is as much as 130 feet in the western (down-gradient) portion of the basin and between 80 and 90 feet in the eastern (upgradient) portion of the basin, though it can be notably less in this area during droughts. Saturated thicknesses can be less than 60 feet in some tributary canyons, particularly along the South Fork Santa Clara River, where all production wells are constructed in the Saugus Formation, rather than the alluvium (RCS, 2002).

The Saugus Formation is generally a bowl-shaped structure that thins at its margins and has its greatest thickness (about 5,500 feet) in the center of the basin. The upper, freshwater-bearing portion of the Saugus Formation was simulated using 500-foot-thick model layers to depths as great as 2,500 feet in the center of the basin (RCS, 1988 and 2002). The deepest active model layer at any given location represented the Sunshine Ranch Member of the Saugus Formation, which is of marine origin and is, therefore, more saline and thought to have lower water-bearing potential than the overlying Saugus Formation deposits that are terrestrial in origin.

B.2.4 Boundary Conditions

The following boundary conditions were used in the Regional Model:

1. **Specified flux for precipitation within the model grid.** Deep percolation of precipitation was simulated using the precipitation top-system package contained in MicroFEM®.
2. **Specified flux for irrigation.** Deep percolation of agricultural irrigation and urban irrigation in developed areas was simulated using the precipitation top-system package contained in MicroFEM®.

3. **Specified flux and head-dependent flux along ephemeral streams**. With respect to groundwater discharges to streams, the Santa Clara River was modeled as an ephemeral, predominantly losing stream at and upstream of the mouth of San Francisquito Canyon, and as a perennial, predominantly gaining stream downstream of San Francisquito Canyon. The tributaries to the Santa Clara River were modeled as ephemeral streams, using the precipitation top-system package to specify stream leakage to groundwater. For these tributaries and the ephemeral reach of the Santa Clara River, groundwater recharge rates were estimated from precipitation records, stream-flow records, watershed maps, topographic maps, and aerial photography using the SWRM, which was developed specifically to calculate time-varying recharge at each stream node from these data. Aerial photos and historical observations indicated that under high water table conditions, groundwater can locally discharge into Castaic Creek and the ephemeral reach of the Santa Clara River wherever Alluvial groundwater levels rise above the riverbed elevation. Consequently, the drain package in MicroFEM® was used in these streams to allow for drainage of any groundwater that was calculated by MicroFEM® to be above the riverbed elevation in any given river node at any given time step.

4. **Specified flux and head-dependent flux along perennial Santa Clara River**. The perennial reach of the Santa Clara River was modeled using the wadi top-system package contained in MicroFEM®. The wadi package allows groundwater to discharge to the river whenever groundwater elevations are higher than the specified river stage. When groundwater levels are below the river stage, the river recharges the Alluvial Aquifer. The rate of recharge is proportional to the difference between the river stage elevation and the model-calculated groundwater elevation. However, after the groundwater elevation drops below the streambed sediments, the rate of leakage from the stream is constant (i.e., does not vary as the groundwater elevation fluctuates). For the Regional Model, each node along the perennial reach of the Santa Clara River was assigned a river stage 1 foot higher than the mapped bed elevation of the river. The riverbed permeability, or conductance, which helps control the model-calculated groundwater/surface water exchange rates, was adjusted during model calibration by calibrating to streamflow data collected at the County Line gage.

5. **Specified flux for pumping**. Pumping rates and locations for wells completed in the Alluvial Aquifer and the Saugus Formation were directly imported into the Regional Model from the Upper Santa Clara River Groundwater Basin database. For model calibration, pumping rates were assigned from water use records maintained by the Upper Basin Water Purveyors; estimates of monthly water demand for urban water use and agricultural water use; and well construction records, which were needed to determine which model layers at each individual well should be assigned pumping

6. **Specified flux at upgradient Alluvial Aquifer boundaries.** Where there is Alluvial groundwater flow into the study area from beneath Castaic Dam, the magnitude of the specified flux was adjusted during the model calibration process using groundwater elevations and gradients published by RCS (1986 and 2002).

7. **Specified groundwater elevation in the Alluvial Aquifer at the county line.** The groundwater elevation (805 feet) was obtained from water level contour maps for the

Alluvial Aquifer prepared by RCS (1986, 2002). (See Figure 2-7 in the main text for groundwater elevation contours during Spring 2000, as mapped by RCS [2002].)

8. **Specified groundwater elevation in the Alluvial Aquifer at the Lang gage.** The groundwater elevation (1,746 feet) was derived from topographic maps of the elevation of the Santa Clara River bed. As discussed in CH2M HILL in *Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property* (2004b), the boundary condition at this location was converted to a constant-head boundary shortly after completion of the model development report. This change was made based on results from field reconnaissance that was performed in April and May of 2004, when the Santa Clara River was dry at the Lang gage. At that time, groundwater was locally discharging from the bed of the Santa Clara River in isolated locations where the riverbed intersects the water table, then seeping back into the riverbed nearby. Significant phreatophyte growth was also present along the riverbed in this same area (just downstream of the Lang gage). Additionally, water was present and actively flowing in the river east (upstream) of the Santa Clarita Valley (in the area between the Santa Clarita Valley and the upstream Acton Basin). Based on these observations, a specified groundwater elevation of 1,746 feet was established in the Alluvial Aquifer at the eastern boundary of the Regional Model to simulate subsurface flow beneath the channel of the Santa Clara River at the Lang gage. This specified elevation was held constant throughout the simulation period.

9. **Head-dependent flux for evapotranspiration (ET).** ET from the water table by riparian vegetation was simulated using the evaporation top-system package contained in MicroFEM®. This package requires specification of the maximum rooting depth for the riparian vegetation, the maximum potential ET rate, and the ground surface elevation.

10. **No-flow boundaries**. In general, the outermost line of nodes that form the model boundary and the bottom of the model are no-flow boundaries. The exceptions are the western model boundary (specified head) and the specified-flux nodes representing underflow into the Alluvial Aquifer from beneath Castaic Dam. Also, all nodes on the model boundary are assigned specified fluxes due to precipitation and, in some cases, ephemeral streamflow.

B.2.5 Aquifer Parameters

The selection of the aquifer parameter values (horizontal and vertical hydraulic conductivity, storage coefficients, streambed conductance, and ET parameters) is described in detail in Sections 4 and 5 of the Regional Model development report (CH2M HILL, 2004a). Initial estimates of, and ranges of values for, these parameters were defined during initial model development and adjusted on an as-needed basis, and within certain limits, during model calibration. Additionally, the calibration process adjusted the coefficients for an empirical power-function equation (Turner, 1986) that was used in the SWRM to define the relationship between precipitation, stormwater flow, and the amount of stormwater flow available for potential infiltration to groundwater.

B.3 Model Calibration

B.3.1 Calibration Process

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation. The steady-state calibration was performed for calendar years 1980 through 1985, and the transient calibration was performed for calendar years 1980 through 1999. The goals of the initial calibration process were generally to match groundwater flow directions, groundwater gradients, and groundwater elevations that were measured throughout the 20-year simulation period at wells across the valley. An additional calibration goal was to match the patterns of total flow in the Santa Clara River and estimated groundwater discharge rates to the river. The Alluvial Aquifer and the Saugus Formation were each subdivided into zones to facilitate parameter selection and model calibration. Model variables were adjusted in a manner that sought to honor independent estimates of parameter values while resulting in the best possible calibration.

B.3.2 Calibration Quality

The Regional Model meets most of the qualitative and quantitative goals that were established for the calibration process. For the steady-state model, statistical goals for the head residuals, which are equal to the modeled minus measured groundwater elevations, were easily met for the Alluvial Aquifer and adequately met for the Saugus Formation. For the transient model, trends in groundwater elevations were generally well matched, and groundwater discharges to the river were simulated well for both the steady-state and transient models. However, during the middle and late 1990s, the model tended to simulate too much decline in Alluvial Aquifer groundwater elevations in the eastern-most portion of the valley. This is the area where local droughts have the greatest effect on the Upper Basin Water Purveyors' ability to pump groundwater, so this deviation is acceptable because predictive simulations of various groundwater pumping strategies will not overestimate the degree to which groundwater can be pumped from the Alluvial Aquifer in this area during periods of below-normal rainfall.

The groundwater budget for the 20-year transient calibration period showed that recharge from precipitation and streamflows varied considerably from year to year, ranging from less than 15,000 acre-feet per year (AF/yr) in the driest years to as much as 270,000 AF/yr in the wettest years. In contrast, total groundwater discharges were less variable, ranging from approximately 61,000 AF/yr at the end of the late 1980s/early 1990s drought to 116,000 AF/yr during 1998. This variability in groundwater discharge did not follow the year-to-year pumping patterns, but instead was caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlated well with groundwater recharge patterns. During the 20-year transient calibration period, changes in the volume of groundwater stored in the combined Alluvial-Saugus aquifer system varied primarily according to year-to-year variations in regional rainfall. No long-term decline in groundwater storage was observed in the field or simulated by the Regional Model during the calibration period.

B.3.3 Calibration Update

In a recent technical memorandum (CH2M HILL, 2005), the calibration of the Regional Model was extended an additional 62 months (from January 2000 through February 2005) to update and test the model's calibration against an independent data set consisting of recently observed hydrologic and pumping conditions in the basin. Examination of groundwater elevation hydrographs for the Alluvial Aquifer and the Saugus Formation indicated that the model showed a similar overall ability to simulate conditions during the recent 5-year period, as was the case for the preceding 20-year period to which the model was originally calibrated.

B.4 Model Sensitivity

Sensitivity analyses were performed to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the Regional Model. Variables that were tested were the hydraulic properties (horizontal and vertical hydraulic conductivities and storage coefficients) for the Alluvial Aquifer and the Saugus Formation, the riverbed leakage terms for the Santa Clara River and Castaic Creek, and the ET parameters. The sensitivity analysis indicated that the Regional Model is calibrated well and that it is sensitive to the choices of horizontal hydraulic conductivity in both aquifers and the vertical hydraulic conductivity values in the Saugus Formation. The model is also sensitive to the surface water parameters, specifically the choice of empirical coefficients used by the Turner (1986) equation to estimate stormwater flows from rainfall data and the riverbed leakage terms in both the eastern (groundwater recharge) and western (groundwater discharge) portions of the basin. The model is relatively insensitive to the choice of ET parameters.

B.5 Model Applicability

The process of developing the conceptual model of the local groundwater basin, developing a detailed numerical model, calibrating the model to a 20-year period of groundwater elevation and streamflow data, and independently testing the calibration against a recent set of basin conditions has resulted in a groundwater flow model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary design and calibration attributes that make the Regional Model appropriate for its intended uses are as follows:

1. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased State Water Project water imports (from outside the valley), and associated changes in land use and water use
2. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property)
3. Its use of an integrated model of the watershed to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system

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California Department of Water Resources, "State Water Project Delivery Reliability Report 2007" (August 2008)

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The State Water Project Delivery Reliability Report 2007

August 2008

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Foreword

The water delivery reliability of the State Water Project (SWP) is at a crossroads. Future water deliveries to millions of Californians throughout the state will be affected by many factors, including two significant changes: Delta pumping restrictions and climate change.

This report provides a glimpse of our current path if no action is taken to address these and other factors. The report also identifies many other factors that could be changed to positively affect our water future.

Estimating the delivery reliability of the SWP depends on many issues, including possible future regulatory standards in the Delta, population growth, water conservation and recycling efforts, and water transfers. The impact of climate change on hydrology, consumptive use of water, fisheries and sea level rise must also be considered. This report evaluates the impacts of potential changes in hydrology of climate change. These other factors, also need to be considered: the stability of Delta levees, and therefore, SWP water deliveries, are threatened by earthquakes, land subsidence and floods.

On the positive side, there are significant and promising processes under way that could take us to a much more reliable and sustainable Delta water conveyance system for the SWP.

In this report, a possible future for these factors is presented. However, to the extent that these factors can be and are changed by actions over the next few years, this estimate of water delivery reliability will also change.

In spring 2007, the state saw the first voluntary shutdown of the SWP pumps in the Delta to protect fish. Delta smelt and some other pelagic (open water) fishes have been in decline since the early 2000s for reasons that likely include the presence of invasive species, which have altered the basic food web in the Delta, and the impacts of toxics and water project operations. In 2007, water project operations changes in the Delta costing over 500,000 acre-feet were taken to help protect the endangered Delta smelt with the use of the Environmental Water Account. Unfortunately, these actions did not result in an increase in the abundance of Delta smelt in the fall of 2007 suggesting that more than just water project operational changes in the Delta are needed to increase Delta smelt abundance. In addition, another pelagic fish, the long-fin smelt, is now also being considered for listing under the State Endangered Species Act. Clearly, a more comprehensive approach to address the decline in pelagic fish is needed.

In December 2007, a federal court imposed interim rules that will significantly restrict the operations of both the SWP and the Central Valley Project while a new federal biological opinion for Delta smelt is written in 2008.

During 2007, new Delta planning efforts — including Delta Vision established by Gov. Arnold Schwarzenegger and the Bay-Delta Conservation Planning process — have reached important conclusions about the need to change the way water is conveyed across or around the Delta to better protect fish and provide a

sustainable and reliable water supply for the state. Those efforts will continue into 2008.

This report on water delivery reliability of the SWP represents the current state of water affairs and future delivery scenarios if no action is taken. It shows a continued eroding of SWP water delivery reliability under the current method of moving water through the Delta and assumed near-term effects of climate change.

The estimates for current deliveries show that, when compared to the estimates in the *2005 State Water Project Delivery Reliability Report,* total annual SWP deliveries decrease in 93 percent of the years based on the historical data used in the analysis. Water deliveries estimated for 20 years into the future are also presented as a range of values to capture the variability in the results of the climate change studies.

When compared to the future estimates in the 2005 report, total annual deliveries for 2027 show even greater decreases in most of years if no action is taken to address the factors causing this decrease in water delivery reliability. That is why DWR is, and will continue to be, at the forefront of efforts to improve conditions in the Delta that will protect the ecosystem and water supply reliability for 25 million Californians.

Lester A. Snow
Director
California Department of Water Resources
December 2007

Contents

Chapters

5 Foreword
13 Chapter 1: Introduction
14 Background
14 Purpose
14 Reporting Requirements
14 Previous Reports
15 Context
15 The State Water Project
16 The Sacramento-San Joaquin Delta
19 Chapter 2: Water Delivery Reliability
19 Calculating SWP Delivery Reliability
19 Factors Affecting Water Delivery Reliability
19 Availability of Source Water
19 Factors of Uncertainty
20 Treating Availability of Source Water Issues in CalSim II Studies
20 Ability to Convey Source Water to the Desired Point of Delivery
20 Factors of Uncertainty
21 Treating SWP Conveyance Issues in CalSim II Simulations
22 Demand for System Water
22 Factors of Uncertainty
22 Treating Water Demand Issues in CalSim II Simulations
23 Limitations to Estimating Future Water Delivery Reliability
23 Studies Must Rely on Assumptions
23 Studies Assume Repeating Historical Weather Patterns
23 Other Important Assumptions
25 Chapter 3: Status of Planning Activities That May Affect SWP Delivery Reliability
25 Delta Vision
26 Delta Risk Management Strategy
26 CALFED Ecosystem Restoration Program Conservation Strategy
29 Chapter 4: Areas of Significant Uncertainty for SWP Delivery Reliability
29 Pelagic Organism Decline
29 Environmental Water Account and POD

30 Biological Assessment of the SWP and CVP Operating Criteria and Plan
30 Assessment of Possible POD Impacts on SWP Delivery Reliability
30 Climate Change and Sea Level Rise
31 Assessment of Possible Climate Change Impacts on SWP Delivery Reliability
32 Vulnerability of Delta Levees for Failure
33 Delta Risk Management Strategy
34 Potential Interruption/Disruption of SWP Deliveries Due to Earthquakes
35 Potential Interruption/Disruption of SWP Deliveries Due to "Sunny Day" Event
35 Combined Potential Interruption/Disruption of SWP Deliveries
36 Emergency Operations Plan
37 Chapter 5: General Approach for Assessing SWP Delivery Reliability
37 General Solution Techniques and Incorporating Operational Constraints
37 Hydrology
38 Demands
38 Meeting Delta Water Quality Standards
38 CalSim II Priorities in Water Deliveries
38 SWP Table A and Article 21 Deliveries
39 CalSim II Performance
40 Recent Improvements to CalSim II Simulations
41 Chapter 6: Assessment of Present and Future SWP Delivery Reliability
42 Assessment of SWP Delivery Reliability under Current (2007) Conditions
42 Availability of Source Water
42 Demand for Delta Water
42 Ability to Convey Source Water to the Desired Point of Delivery
43 Presentation of CalSim II Results
43 SWP Table A Deliveries under Different Hydrologic Scenarios
45 Article 21 Deliveries under Different Hydrologic Scenarios
46 SWP Table A Delivery Probability
47 Impact on Total SWP Deliveries under Current (2007) Conditions Due to Flow Restrictions to Protect Delta Smelt
49 Assessment of SWP Delivery Reliability under Future (2027) conditions
49 Availability of Source Water
50 Demand for Delta Water
50 Ability to Convey Source Water to the Desired Point of Delivery
51 Presentation of CalSim II Results
51 SWP Table A Deliveries under Different Hydrologic Scenarios
52 Article 21 Deliveries under Different Hydrologic Scenarios
54 SWP Table A Delivery Probability
55 Comparing Current and Future SWP Delivery Reliability
55 SWP Table A Deliveries under Different Hydrologic Scenarios
55 Article 21 Deliveries under Different Hydrologic Scenarios
58 SWP Table A Delivery Probability
61 Chapter 7: Interpreting and Applying the Results for Local Planning Use

61 Example 1
62 How to Calculate Supplies
62 Example 2
62 Where to Find the Data
62 How to Calculate Supplies
67 Appendix A. 2007 Delivery Reliability Report
67 CalSim II Modeling Assumptions
75 Appendix B. Results of Report CalSim II Studies
77 Study Results
119 Appendix C. State Water Project SWP Table A Amounts
121 Appendix D. Recent State Water Project Deliveries
121 SWP Contract Water Types
121 SWP Table A Water
121 Article 21 Water
121 Turnback Pool Water
121 Carryover Water
121 Updated Historical Deliveries
133 Appendix E. Comment Letters on the Draft Report and the Department's Responses
321 References

Tables

28 - **Table 3.1** Overall comparison of BDCP options by criteria category (rank)
34 - **Table 4.1** Expected impact on Delta exports due to salinity intrusion from various seismic events
38 - **Table 5.1** CalSim II water use prioritization
42 - **Table 6.1** SWP Table A demands from the Delta under Current Conditions
42 - **Table 6.2** Article 21 demands from the Delta under Current Conditions
43 - **Table 6.3** Old and Middle River flow target scenarios assumed in CalSim II studies
44 - **Table 6.4** SWP Table A delivery from the Delta under Current Conditions
44 - **Table 6.5** Average and dry period SWP Table A deliveries from the Delta under Current Conditions
45 - **Table 6.6** Average and wet years SWP Table A delivery from the Delta under Current Conditions
45 - **Table 6.7** Annual SWP Article 21 delivery from the Delta under Current Conditions
46 - **Table 6.8** Average and dry year SWP Article 21 delivery under Current Conditions
46 - **Table 6.9** Average and wet year SWP Article 21 delivery under Current Conditions
47 - **Table 6.10** Highlighted SWP Table A delivery percent exceedence values under Current Conditions
50 - **Table 6.11** SWP Table A demands from the Delta under Future Conditions
50 - **Table 6.12** Article 21 demands from the Delta under Future Conditions
51 - **Table 6.13** SWP Table A delivery from the Delta under Future Conditions
52 - **Table 6.14** Average and dry period SWP Table A deliveries from the Delta under Future Conditions
52 - **Table 6.15** Average and wet period SWP Table A deliveries from the Delta under Future Conditions
52 - **Table 6.16** Annual SWP Article 21 delivery from the Delta under Future Conditions
53 - **Table 6.17** Average and dry year SWP Article 21 delivery under Future Conditions
53 - **Table 6.18** Average and wet year SWP Article 21 delivery under Future Conditions

54 - **Table 6.19** Highlighted SWP Table A delivery percent exceedence values under Future Conditions
55 - **Table 6.20** SWP Table A delivery from the Delta under current and Future Conditions
56 - **Table 6.21** Average and dry period SWP Table A deliveries from the Delta under current and Future Conditions
56 - **Table 6.22** Average and wet period SWP Table A deliveries from the Delta under current and Future Conditions
56 - **Table 6.23** Annual SWP Article 21 delivery from the Delta under current and Future Conditions
57 - **Table 6.24** Average and dry year SWP Article 21 delivery under current and Future Conditions
57 - **Table 6.25** Average and wet year SWP Article 21 delivery under Current and Future Conditions
59 - **Table 6.26** Highlighted SWP Table A delivery percent exceedence values under Current and Future Conditions
62 - **Table 7.1** SWP average and dry year SWP Table A delivery from the Delta in five-year intervals for studies 2007 and 2027
63 - **Table 7.2** Average annual SWP deliveries assuming a maximum SWP Table A amount of 100,000 acre-feet
63 - **Table 7.3** Single dry year SWP delivery (1977 conditions)
assuming a maximum SWP Table A amount of 100,000 acre-feet
63 - **Table 7.4** Average SWP Delivery over a multiple dry year period
assuming a maximum SWP Table A amount of 100,000 acre-feet 1931-1934 conditions
64 - **Table 7.5** Annual SWP delivery over single dry year (1988 conditions)
assuming a maximum Table A amount of 100,000 acre-feet
64 - **Table 7.6** Annual SWP delivery over multiple dry year period 1990-1992
assuming a maximum Table A amount of 100,000 acre-feet 1990 conditions
64 - **Table 7.7** Annual SWP delivery over multiple dry year period 1990-1992
assuming a maximum SWP Table A amount of 100,000 acre-feet 1991 conditions
65 - **Table 7.8** Annual SWP delivery over multiple dry year period 1990-1992
assuming a maximum SWP Table A amount of 100,000 acre-feet 1992 conditions
68 - **Table A.1** 2007 Delivery Reliability Report CalSim II modeling assumption
71 - **Table A.2** 2007 Study American River demand assumptions
72 - **Table A.3** 2027 Study American River demand assumptions
76 - **Table B.1** Summary of CalSim II simulations used to update SWP delivery estimates
78 - **Table B.2** SWP average and dry year SWP Table A delivery from the Delta (in percent of maximum SWP Table A amounts)
79 - **Table B.3** SWP Table A deliveries under Current (2007) Conditions
Derived values for estimating probability curve
80 - **Table B.3 cont.** SWP water delivery from the Delta under Current (2007) Conditions
Derived values for estimating probability curve
81 - **Table B.4** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and less restrictive Old River and Middle River flow targets
82 - **Table B.4 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and less restrictive Old River and Middle River flow targets
83 - **Table B.5** SWP Table A from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and more restrictive Old River and Middle River flow targets
84 - **Table B.5 cont** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and more restrictive Old River and Middle River flow targets
85 - **Table B.6** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and less restrictive Old River and Middle River flow targets
86 - **Table B.6 cont** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and less restrictive Old River and Middle River flow targets

87 - **Table B.7** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and more restrictive Old River and Middle River flow targets
88 - **Table B.7 cont** SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and more restrictive Old River and Middle River flow targets
89 - **Table B.8** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and less restrictive Old River and Middle River flow targets
90 - **Table B.8 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and less restrictive Old River and Middle River flow targets
91 - **Table B.9** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and more restrictive Old River and Middle River flow targets
92 - **Table B.9 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and more restrictive Old River and Middle River flow targets
93 - **Table B.10** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and less restrictive Old River and Middle River flow targets
94 - **Table B.10 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and less restrictive Old River and Middle River flow targets
95 - **Table B.11** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and more restrictive Old River and Middle River flow targets
96 - **Table B.11 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and more restrictive Old River and Middle River flow targets
97 - **Table B.12** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curveGFDL Model with A2 emissions
98 - **Table B.12 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curveGFDL Model with A2 emissions
99 - **Table B.13** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curve GFDL Model with B1 Emissions
100 - **Table B.13 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curve GFDL Model with B1 Emissions
101 - **Table B.14** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curve PCM Model with A2 Emissions
102 - **Table B.14 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curvePCM Model with A2 Emissions
103 - **Table B.15** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curvePCM Model with B1 Emissions
104 - **Table B.15 cont.** SWP Table A deliveries from the Delta under Future (2027) Conditions,
derived values for estimating probability curvePCM Model with B1 Emissions
105 - **Table B.16** *SWP Article 21* deliveries under Current (2007) Conditions
106 - **Table B.16 cont.** *SWP Article 21* deliveries under Current (2007) Conditions
107 - **Table B.17** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with A2 emissions
108 - **Table B.17 cont.** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with A2 emissions
109 - **Table B.18** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with B1 emissions

110 - **Table B.18 cont.** *SWP Article 21* deliveries under Future (2027) ConditionsClimate change scenario GFDL with B1 emissions
111 - **Table B.19** *SWP Article 21* deliveries under Future (2027) ConditionsClimate change scenario PCM with A2 emissions
112 - **Table B.19 cont.** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with A2 emissions
113 - **Table B.20** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with B1 emissions
114 - **Table B.20 cont.** *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with B1 emissions
115 - **Figure B.1** SWP Table A delivery probability under Current Conditions
115 - **Figure B.2** SWP Table A delivery probability under Future Conditions
116 - **Figure B.3** SWP Table A delivery probability under Future Conditions for climate change scenarios with A2 emissions
116 - **Figure B.4** SWP Table A delivery probability under Future Conditions for climate change scenarios with B1 emissions
117 - **Table B.21** Highlighted SWP Table A delivery percent exceedence values under Current and Future Conditions
118 - **Table B.22** Comparing total SWP deliveries under Current Conditions from updated studies to deliveries from 2005 Report
120 - **Table C.1** Maximum annual SWP Table A amounts
122 - **Table D.1** Historical State Water Project Deliveries: 1997
123 - **Table D.2** Historical State Water Project Deliveries: 1998
124 - **Table D.3** Historical State Water Project Deliveries: 1999
125 - **Table D.4** Historical State Water Project Deliveries: 2000
126 - **Table D.5** Historical State Water Project Deliveries: 2001
127 - **Table D.6** Historical State Water Project Deliveries: 2002
128 - **Table D.7** Historical State Water Project Deliveries: 2003
129 - **Table D.8** Historical State Water Project Deliveries: 2004
130 - **Table D.9** Historical State Water Project Deliveries: 2005
131 - **Table D.10** Historical State Water Project Deliveries: 2006

Figures

47 - **Figure 6.1** SWP Delta Table A delivery probability under Current Conditions
48 - **Figure 6.2** Distribution of changes in total annual SWP deliveries under Current Conditions
due to implementation of flow restrictions to protect delta smelt
48 - **Figure 6.3** Distribution of percent changes in total annual SWP deliveries under Current Conditions
due to implementation of flow restrictions to protect delta smelt
54 - **Figure 6.4** SWP Delta Table A delivery probability under Future Conditions
58 - **Figure 6.5** Current and future SWP Delta Table A delivery probability from the *2005 SWP Delivery Reliability Report*
58 - **Figure 6.6** Updated current and future SWP Delta Table A delivery probability
115 - **Figure B.1** SWP Delta Table A delivery probability under Current Conditions
115 - **Figure B.2** SWP Delta Table A delivery probability under Future Condition
116 - **Figure B.3** SWP Delta Table A delivery probability under Future Conditions
Climate change scenarios with A2 emissions
116 - **Figure B.4** SWP Delta Table A delivery probability under Future Conditions
Climate change scenarios with B1 emissions

Introduction 1

The State Water Project (SWP) is primarily a water storage and delivery system intended to help close the gap in California between when and where precipitation primarily falls and when and where most water demands occur. Water from the SWP is a critical component of water supply for the 29 state water contractors, who may also receive water from other sources. While each of the water supply contracts defines the maximum amount of water to be delivered annually, the amount of water actually delivered may be less due to such factors as variable precipitation and runoff, physical and institutional limits on storage and conveyance, and contractors' variable water demands. For communities receiving SWP water, the reliability of SWP water deliveries is a key factor for local planners and government officials estimating their own water supply reliability.

Since the *2005 SWP Delivery Reliability Report*, DWR has updated its estimate of current (2007) and future (2027) SWP delivery reliability and has expanded the conditions under which reliability is quantified. The additional conditions are changes in hydrology due to potential climate change and restrictions on SWP and CVP pumping in accordance with the interim operation rules imposed by the December 2007 federal court order.

This report first briefly describes the SWP and the Sacramento-San Joaquin Delta (Delta), the hub of water deliveries in California. Next, it discusses the general topic of water delivery reliability and how DWR calculates delivery reliability for the SWP. Then it summarizes key planning activities that may affect future SWP delivery reliability. These activities are Delta Vision, the Bay Delta Conservation Plan, the Delta Risk Management Strategy, and the CALFED Ecosystem Restoration Program Conservation Strategy. The report presents three areas of significant uncertainty to SWP delivery reliability: the recent and significant decline in pelagic organisms in the Delta (open-water fish such as delta smelt and striped bass), climate change and sea level rise, and the vulnerability of Delta levees' to failure. Next, the report discusses the general approach to simulating SWP operations by CALSIM II for this report.

The report presents results of CALSIM II studies that assume future climate change scenarios and SWP operations under high and low flow restrictions in the Delta. The assumed flow restrictions are designed to estimate the operation restrictions to be put in place by the federal court to protect delta smelt for water year 2008 and until replaced by new federal biological opinions.

Finally, the report provides guidance on how to apply the delivery estimates to water management plans. Presented in appendixes are detailed CALSIM II simulation assumptions and results and recent SWP deliveries.

This report does not include analyses of how specific water agencies should integrate SWP water supply into their water supply equation. This topic requires extensive information about local facilities, local water resources, and local water use, which is beyond the scope of this report.

Moreover, such an analysis would require decisions about water supply and use that traditionally have been made locally. DWR believes that local officials should continue to fill this role.

Background

Purpose

This report on SWP delivery reliability is intended to help local agencies, cities, and counties that use SWP water while planning integrated water resources management to develop adequate and affordable water supplies for their communities. These activities are usually conducted in the course of preparing a water management plan such as the Urban Water Management Plans required by Water Code Section 10610. The information in this report can be used by local agencies in preparing or amending their water management plans and identifying the new facilities or programs that may be necessary to meet future water demands. Local agencies and governments will also find in this report useful information for conducting analyses mandated by laws requiring water retailers to demonstrate whether their water supplies are sufficient for certain proposed subdivisions and development projects subject to the California Environmental Quality Act.

This report can be used with published guidelines that explain how to integrate SWP supply information with supply information from other sources to develop an overall reliability assessment of each contractor's total water portfolio. DWR has published two documents addressing this topic. *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001* (October 2003) includes suggestions on how local water suppliers can integrate supplies from various sources, such as the SWP, into their analyses. Another document is *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan* (January 2005). Both documents can be found on DWR's Office of Water Use Efficiency home page at **http://www.owue.water.ca.gov**.

Reporting Requirements

As a result of a court-approved settlement agreement executed by the Planning and Conservation League, DWR, state water contractors and other entities in the wake of the 3rd Circuit Court of Appeal's ruling in the "Monterey Amendments" case in 2000, DWR has a legal duty to prepare State Water Project delivery reliability reports every two years. In that agreement, DWR committed to the following:

> Commencing in 2003, and every two years thereafter, the Department of Water Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public. (Settlement Agreement Attachment B).

Previous Reports

The *2007 SWP Delivery Reliability Report* is the third report of this type. The previous reports in 2003 and 2005 defined and calculated delivery reliability the same manner as in this report with output from DWR's CALSIM II model. This report differs from those earlier reports because it includes estimates of reductions to SWP delivery reliability due to the pelagic organism decline (POD) and future climate changes. This report also discusses the risk of conveyance disruption due to Delta levee failure.

Context

The State Water Project

The SWP is a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants that extends for more than 600 miles. Its main purpose is to divert and store surplus water during wet periods and distribute it to areas in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California. It is also used for recreation and to control floods, generate power, protect fish and wildlife, and manage water quality in the Sacramento-San Joaquin Delta.

The keystone of the SWP is Lake Oroville, which conserves water from the Feather River watershed. It is the SWP's largest storage facility with a capacity of about 3.5 million acre-feet. Releases from Lake Oroville flow down the Feather River into the Sacramento River, which drains the northern portion of California's Central Valley. The Sacramento River flows into the Sacramento-San Joaquin Delta, comprised of 738,000 acres of land interlaced with channels that receive runoff from about 40 percent of the state's land area. The SWP and the federal Central Valley Project (CVP) rely on Delta channels as a conduit to move water from the Sacramento River inflow to the points of diversion in the south Delta. Thus, the Delta is actually part of the SWP conveyance system, making the Delta a key component in SWP deliveries. The significance of the Delta to SWP deliveries is described in more detail below.

From the northern Delta, Barker Slough Pumping Plant diverts water for delivery to Napa and Solano counties through the North Bay Aqueduct. Near Byron in the southern Delta, the SWP diverts water into Clifton Court Forebay for delivery south of the Delta. Banks pumping plant lifts water from Clifton Court Forebay into the California Aqueduct, which channels the water to Bethany Reservoir. The water delivered to Bethany Reservoir from Banks Pumping Plant is either delivered into the South Bay Aqueduct for use in the San Francisco Bay Area or continues down the California Aqueduct to O'Neil Forebay, Gianelli Pumping-Generating Plant, and San Luis Reservoir.

San Luis Reservoir is jointly operated by DWR and the Bureau of Reclamation and has a storage capacity of more than 2 million acre-feet (maf). DWR's share of gross storage in the reservoir is about 1.062 maf. Generally, water is pumped into San Luis Reservoir during late fall through early spring, and is temporarily stored for release back to the California Aqueduct to meet summertime peaking demands for SWP and CVP contractors.

SWP water not stored in San Luis Reservoir and water eventually released from San Luis continues to flow south through the San Luis Canal, a portion of the California Aqueduct jointly owned by DWR and the Bureau of Reclamation. As water flows through the San Joaquin Valley, deliveries of CVP water are made through numerous turnouts to farmlands in the service areas of the CVP. Near Kettleman City, the Coastal Branch Aqueduct splits from the California Aqueduct for water delivery to agricultural areas to the west and municipal and industrial water users in San Luis Obispo and Santa Barbara counties.

The remaining water conveyed by the California Aqueduct travels farther in the San Joaquin Valley to agriculture users such as Kern County Water Agency before reaching Edmonston Pumping Plant, which raises the water high enough to travel across the Tehachapi Mountains into Antelope Valley. In Antelope Valley, the Aqueduct divides into the East and West Branches. The East Branch carries water into Silverwood Lake and Lake Perris. Water in the West Branch flows to Quail Lake, Pyramid Lake, and Castaic Lake.

Twenty-nine state water contractors have signed long-term water supply contracts with DWR for 4.173 million acre-feet (maf) per year. Signed in the 1960s, all contracts are in effect to at least 2035 and are essentially uniform. Each contract contains a schedule of the maximum amount of water the

contractor can receive annually. This schedule is contained in SWP Table A. The annual amount was designed to increase each year, with most contractors reaching their maximum amount in 1990. In most cases, SWP water is an important component of local water supplies. Five contractors use SWP water primarily for agricultural purposes and the remaining 24 contractors use SWP water primarily for municipal purposes. All available water is allocated annually in proportion to each contractor's annual SWP Table A amount. Appendix C contains additional information about SWP Table A.

The Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta is a network of natural and artificial channels and reclaimed islands at the confluence of the Sacramento and San Joaquin rivers. The Delta forms the eastern portion of the San Francisco estuary, receiving runoff from more than 40 percent of the state's land area. It is a low-lying region where over the years sediment from the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers mingled with organic matter deposited by marsh plants. Covering 738,000 acres interlaced with hundreds of miles of waterways, much of the land is below sea level and relies on more than 1,100 miles of rather fragile levees for protection against flooding.

Because the SWP and the CVP use Delta channels to convey water to the southern Delta for diversion, the Delta is the focal point for water distribution throughout the state. In fact, the Delta is one of the few estuaries in the world that is used as a major source of drinking water supply: about one-quarter of California's drinking water comes from the Delta; two-thirds of Californians get some portion of their drinking water from the Delta. The Delta also provides a unique estuarine habitat for many resident and migratory fish and birds, some of which are listed as threatened or endangered. Most of the native fish either migrate through the Delta or move into it for spawning. Resident native fish are mainly present in areas strongly influenced by the Sacramento River inflows.

The CVP pumps at Jones Pumping Plant have a capacity of 4,600 cubic feet per second (cfs) and divert water directly from Old River. The CVP has contracts to divert 3.3 maf annually from the Delta for primarily agricultural use south of the Delta. The SWP pumps at Banks Pumping Plant have a combined pumping capacity of 10,300 cfs; however, diversions into the buffering Clifton Court Forebay are restricted to 13,870 acre-feet (af) daily and 13,250 af per day over a three-day average. A rate of 13,250 af per day equates to an average pumping of 6,680 cfs.

CVP and SWP reservoir releases and Delta exports are coordinated according to the Coordinated Operating Agreement (COA), which sets guidelines for the sharing of supply and responsibility for meeting water quality standards in the Delta. Most of the water exported by the SWP depends on water rights derived from Lake Oroville storage; however, the SWP can also divert water considered in excess in the Delta. These excess conditions in the Delta usually result when there is sufficient inflow to meet all beneficial needs and the SWP is not required to make supporting releases from Lake Oroville. Diversions during excess Delta conditions are still governed by various determinations and rules.

In addition to the state and federal projects' diversions, irrigation water for use in the Delta is taken from channels and sloughs through approximately 1,800 diversions which can total more than 5,000 cfs in July and August.

Delta water quality is primarily governed by the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta (1995 Bay-Delta Plan). This plan established beneficial uses, associated water quality objectives, and an implementation program. The State Water Resources Control Board (SWRCB) in Water Rights Decision 1641 assigned primary responsibility for meeting many of the Delta water quality objectives to the SWP and CVP. Key factors in determining water quality in the western Delta are the quality of important Delta inflows and the intrusion of

ocean-derived salts associated with daily tides. The extent of this intrusion is primarily determined by the magnitude of Delta inflows, export pumping rates, and operation of the Delta Cross Channel. Delta inflows are normally at least partially regulated by upstream reservoir operations.

The water flowing in Delta channels is constrained by an extensive levee system that protects Delta islands from flooding. This protection is critical because land subsidence in the Delta, primarily due to the consuming oxidation of aerated peat soils, has placed most of the land in the Delta below sea level. In fact, the elevation of Delta islands can be more than 20 feet below sea level. The resulting difference between the elevations of Delta lands and the water surface in adjacent channels makes Delta levees vulnerable to failure. Land subsidence in the Delta is expected to continue, which will increase the vulnerability of levees to failure and subsequent island flooding.

Water Delivery Reliability

2

As mentioned in the Introduction, estimates of SWP delivery reliability are intended to help local SWP water users assess their water supply reliability, a key measure of a system's ability to match water supplies with demand. Just how water delivery reliability is assessed is critical to whether it is a meaningful guide for such an analysis. This chapter presents DWR's method for calculating SWP delivery reliability, the factors affecting SWP delivery reliability, and the limitations to estimating future water delivery reliability.

Calculating SWP Delivery Reliability

For this report, "water delivery reliability" is defined as the annual amount of water that can be expected to be delivered with a certain numeric frequency. SWP delivery reliability is calculated using computer simulations based on 82 years of historical data. The annual amounts of SWP water deliveries are ranked from smallest to largest and a probability is calculated for each amount. These results are often displayed as a graph, commonly referred to as an exceedence plot. They can also be presented in a table.

Factors Affecting Water Delivery Reliability

The amount of the SWP water supply delivered to the state water contractors in a given year depends on the demand for the supply, amount of rainfall, snowpack, runoff, and water in storage, pumping capacity from the Delta, and legal constraints on SWP operation. Expressed in more general terms, water delivery reliability depends on three general factors: the availability of water at the source, the ability to convey water from the source to the desired point of delivery, and the magnitude of demand for the water.

Availability of Source Water

The availability of water at the source depends on the amount of rain and snow and water use in the source areas. For the SWP, the size of the April 1 snowpack in the Feather River watershed and the storage in Lake Oroville are key components of the annual estimation of the SWP's delivery capabilities from April through September.

Factors of Uncertainty The inherent yearly variable location, timing, amount, and form of precipitation in California introduce some uncertainty to the availability of future SWP source water and hence future SWP deliveries. The approach of analysis of SWP deliveries by simulating an 82-year sequence based on historical weather patterns restricts the subsequent simulation to no more extreme droughts or severe storms than have historically occurred. However, the 82-year sequence of weather patterns does produce a wide range of hydrologic events with which to evaluate the ability of the SWP to deliver water.

The second source of uncertainty in source water is due to climate change. Current literature suggests that global warming is likely to significantly

affect the hydrologic cycle, changing California's precipitation pattern and amount from that shown by the record. In fact, there is evidence that some changes have already occurred, such as an earlier beginning of snowmelt in the Sierra, an increase in winter runoff as a fraction of the total runoff, and an increase in winter flooding frequency. More variability in rainfall, wetter at times and drier at other times, would place more stress on the reliability of existing flood management and water supply systems, such as the SWP.

Treating Availability of Source Water Issues in CalSim II Studies The State Water Project operation analyses contained in this report are based upon operation simulations under an extended record of historical precipitation and adjusted historical runoff. The 82-year record of 1922-2003 runoff patterns in the studies simulating 2007 and 2027 levels of development have been adjusted as needed to reflect the current and future levels of development in the source areas by analyzing land use patterns and projecting future land and water use. These series of data are then used to forecast the amount of water available to the SWP under Current and Future (2027) conditions.

Potential changes in climate patterns are becoming better defined and studies have been done on potential impacts to SWP deliveries due to associated changing hydrology. In a 2006 DWR report, *Progress on Incorporating Climate Change into Management of California's Water Resources*, broad-brush estimates are made of the potential impact upon the SWP around the year 2050 if no additional conveyance facilities or upstream reservoirs are built. These climate change studies adjusted the 73-year historical record (1922-1994) of rainfall and runoff according to four scenarios: weak temperature warming and weak precipitation increase in California under model PCM; modest warming and modest drying under model PCM; modest warming and modest drying under model GFDL v. 2.0; and weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0. These studies have been updated for this report by expanding the simulation period to 82 years (1922-2003).

DWR has estimated potential deliveries at the 2027 level. However, these estimates are based on the assumption that no changes will be made in either the way water is conveyance across the Delta or in the interim operating rules defined by the recent court order to protect delta smelt. These assumptions are not a prediction of the future but an assessment of the future if these factors do not change. In addition, these estimates must be viewed with caution given the uncertainty of the effects of climate change in the future and the simplifying assumptions required for the analyses.

Ability to Convey Source Water to the Desired Point of Delivery

The ability to convey source water to the desired point of delivery refers to the availability of facilities to capture and convey water and any institutional limitations placed upon the facilities. Uncertainty in SWP deliveries may be in part due to uncertainty in the ability to convey water. For the SWP, this uncertainty centers on the Delta.

Factors of Uncertainty In general, SWP operations are closely regulated by Delta water quality standards established by the State Water Resources Control Board (SWRCB) and set forth in Water Rights Decision 1641. Even in the times SWP operations are left to the discretion of DWR, actions often require consultation with federal and state fish and wildlife agencies under its Endangered Species Act provisions. The evolving response to the continuing unexplained decline in many pelagic fish species since the early 2000's, and the legal challenges to SWP operation and ongoing planning activities related to the Delta's future are sources of uncertainty for SWP delivery reliability related to water conveyance.

On May 25, 2007, a federal judge found that the 2005 USFWS Biological Opinion for delta smelt was not consistent with the requirements of the Federal Endangered Species Act and must be

rewritten. On Aug. 31, 2007, the same judge established interim operating rules to protect delta smelt until USFWS rewrites the biological opinion. The interim operating rules set in-Delta flow targets in Old and Middle rivers from late December through June that will restrict CVP and SWP pumping in 2008 and until the delta smelt biological opinion is rewritten. In Chapter 4, this report discusses the process used to rewrite this biological opinion.

Another potential uncertainty for SWP water conveyance through the Delta is the risk of interruptions in SWP diversions from the Delta due to levee failure. SWP source water enters the Delta through the Sacramento River and is conveyed to Banks Pumping Plant via Delta channels lined with fragile levees. If a levee fails, depending on the location and the size of the adjacent island, the flow of water from nearby channels onto the affected island can draw saline water from Suisun and San Pablo bays into the central Delta. In such an incident, SWP pumping at Banks Pumping Plant may have to be curtailed or ceased for a period to prevent drawing saline water into the south Delta. Additional releases from Lake Oroville may also be necessary to flush the Delta of the saline water. As discussed in Chapter 4, the likelihood of levee failures in the future is expected to increase.

Finally, future sea level rise associated with climate change could increase the salinity in the Delta as higher ocean tides push saline water farther inland. If Delta water quality standards remain the same, SWP pumping could become more restricted, at least under some hydrologic conditions.

Treating SWP Conveyance Issues in CalSim II Simulations The 2007 base study in this report assumes current facilities and institutional limitations, which include Water Rights Decision 1641, export curtailments for the Vernalis Adaptive Management Plan (VAMP) as described in a 2004 new Operating Criteria and Plan (OCAP) developed by DWR and U.S. Bureau of Reclamation for the SWP and Central Valley Project, and court-ordered in-Delta flow targets in Old and Middle rivers to protect delta smelt. This report examines two levels of Old River and Middle River flow targets. Chapter 6 has a more detailed description of these assumptions. For comparison, the 2027 studies in this report assume the same institutional limitations as the 2007 simulations regarding Delta water quality requirements, fish protection, and Delta flows will be in place 20 years in the future; no facility improvements, expansions, or additions will be made to the SWP; and conveying water through the Sacramento-San Joaquin Delta will not be significantly interrupted by levee failures. These assumptions are not a prediction of the future but an assessment of the future if these conditions are not changed. As discussed in Chapter 3, there are several processes under way to further the discussion on the need for changes in water conveyance around the Delta to address many of the issues. The 2027 studies also incorporate assumptions about climate change, but do not account for sea level rise or the expected accompanying increase in Delta salinity because the tools to evaluate this impact of climate change have not yet been completed.

Also not included in this report are CALSIM II studies that reflect risk of levee failure. The impact on SWP deliveries due to a single or multiple levee failure is highly dependent on where the levees fail and the Delta conditions at the time. As the Draft DRMS Phase 1 Summary Report indicates, the effect on SWP deliveries can range from relatively minor to catastrophic for a large earthquake with extensive levee failures, depending on whether the earthquake occurs under dry or wet Delta conditions. However, the same report points out that if multiple Delta islands are left flooded with openings to adjacent channels after a large-scale levee failure, the volume of water that would move into and out of the Delta over a tidal cycle could actually increase, resulting in higher salinities in the west Delta. If Delta water quality standards remain unchanged, releases from Lake Oroville would then most likely need to increase above current levels to enable the same level of SWP pumping. The DRMS

report also indicates that multiple levee failures and Delta island flooding due to flood flows may not significantly affect SWP deliveries due to the fresh water Delta-wide conditions that would exist at the time of flood flows. Chapter 4 addresses Delta levee vulnerability to failure in detail.

Demand for System Water

Water demand in the delivery service area is affected by such factors as the magnitude and types of water demands, the extent of water conservation measures, local weather patterns, and water costs. Supply from a water system may be sufficiently reliable at a low level of demand but become less reliable as the demand increases. In other cases, the reliability of a water supply system to meet a higher demand may be maintained at its past level because new facilities have been added or the operation of the system has been changed. In general, the higher and the more time-concentrated the water demands, the more need for storage and conveyance capacity to achieve the same delivery reliability. For example, if the demand occurs only three months in the summer, a water system with a sufficient annual supply but insufficient water storage may not be able to reliably meet the demand. If, however, the same total amount of demand is distributed over the year, the same system could more easily meet the demand because the need for water storage is reduced.

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors. Demand on the SWP is nearing the maximum contract amount (in other words, "Maximum SWP Table A amount"). Each SWP contract contains a SWP Table A, which states the maximum annual delivery amount over the period of the contract. These annual amounts usually increase over time. Most contractors' SWP Table A amounts reached a maximum in 1990. The total of all contractors' maximum SWP Table A amounts is 4.173 million acre-feet (maf) per year. SWP Table A is used to define each contractor's portion of the available water supply that DWR will allocate and deliver to that contractor. The SWP Table A amounts in any particular contract are not guarantees of annual delivery amounts but are used to allocate individual contractors' portion of the total delivery amount available. Estimates of each contractor's amount of water delivered are determined by the factors described in this report. (See Appendix C for additional explanation and listing of the maximum SWP Table A amounts).

Of the 29 SWP contractors, Yuba City, Butte County, and the Plumas County Flood Control and Water Conservation District are north of the Delta. Their total maximum SWP Table A amounts is 0.040 maf. The total maximum SWP Table A amounts for the remaining 26 contractors, who all receive their supply from the Delta, is 4.133 maf. This report focuses on SWP deliveries from the Delta because the amount of water pumped from the Delta by SWP facilities is the most significant component of the total amount of SWP deliveries. The results presented in this report in terms of estimated delivered water supplies as a percent of SWP Table A deliveries apply to contractors north of the Delta in the same manner as those contractors receiving supply from the Delta.

Factors of Uncertainty Estimating future demand for SWP water requires assumptions be made about population growth, water conservation, recycling efforts, other sources of supply available to the SWP contractors, and climate change. The estimates also depend on the cost to the SWP contractor for each of the components of their integrated water management plan. These factors are considered by the SWP contractors in the estimates of their current and future demands.

Treating Water Demand Issues in CalSim II Simulations SWP Table A and Article 21 demands in the 2007 studies were assumed the same as those in the 2005 study from the *2005 SWP Delivery Reliability Report*. SWP Table A and Article 21 demands in the 2027 studies were assumed the same as those in the 2025 study from the *2005 SWP Delivery Reliability Report*. The demand values are assumed

to vary from year to year depending on the weather. Specific values used in the CalSim II studies are contained in Appendix A.

Limitations to Estimating Future Water Delivery Reliability

Studies Must Rely on Assumptions

Actual, historical water deliveries cannot always be used with a significant degree of certainty to predict future water deliveries. As discussed earlier, there are continual, significant changes over time in the determinants of water delivery for a specific water supply system. These changes include water storage and delivery facilities, water use in the source areas, water demand in the receiving areas, and the regulatory constraints on the operation of facilities for the delivery of water. Given the highly significant changes that have occurred for the SWP over the past 40 years, past deliveries are not a good predictor of SWP current deliveries, much less of future deliveries.

For example, the demand 30 years ago for water from the SWP was lower than it is now or expected to be in the future. Past lower demand for SWP water resulted in less water transported through the SWP during normal and wet times than could have been—or would have been if the demand for water had been higher. Less water was delivered then because less water was needed; the amount of source water and conveyance capabilities weren't limiting factors for deliveries. Conversely, the recent court-ordered restriction on SWP exports from the Delta is estimated to reduce annual deliveries from what has been delivered in the recent past. Analyses estimating future SWP deliveries must include assumptions about future (2027) conditions. Some assumptions are very important to the analyses and are key to understanding the resulting estimates of annual water deliveries. A discussion of the important assumptions for the studies in this report follows.

Studies Assume Repeating Historical Weather Patterns

One of the most significant assumptions for water planning in general is how wet, dry and variable the weather will be. Until recently, assuming the future weather pattern would be similar to the past was sufficient for many planning purposes. Given the evolving information on the potential effects of global climate change in the future, this approach is no longer adequate. Incorporating climate change into future projections is difficult because of the many ways the patterns of rain, snow and temperature could shift. A way to measure some of the uncertainty is to analyze many potential climate change scenarios in order to capture the range of water supply impacts.

This report contains estimates of future SWP deliveries under four future climate change scenarios. The scenarios are variations based upon the historical record of precipitation information for the Central Valley for the period 1922 through 2003. The amount and timing of rainfall and runoff is adjusted but the sequence of dry years or wet years is the same for all scenarios. Evaluating how water management systems will respond under severely dry periods is limited to assuming the worst droughts in the period of historical record. The worst multiyear drought on record is 1928 through 1934, although the brief drought from 1976 through 1977 was more acutely dry.

Other Important Assumptions

To identify the assumptions with the most effect on the estimates of SWP deliveries, DWR conducted a sensitivity analysis for assumptions in CalSim II model studies. In a sensitivity analysis, an assumption such as the amount of water used in the watershed above Lake Oroville is varied over several studies and the results for SWP deliveries are compared. This is done to assess how each assumption affects study results. The *2005 SWP Delivery Reliability Report* presents and discusses the results of DWR's study. The parameters having the largest net impact on SWP Delta deliveries are SWP Table

A demands and Banks Pumping Plant limits. The most elastic parameters (i.e., parameters causing the most percent change in SWP deliveries per percent change in value) are SWP Table A demands and Lake Oroville inflow. The estimates for the future inflow to Lake Oroville depend on what is assumed for climate change. Legal limitations are one of the factors defining the rules for operating Banks Pumping Plant. Therefore, the assumptions for climate change and the court-ordered restrictions directly affecting Banks Pumping Plant operations will significantly affect SWP delivery estimates.

Status of Planning Activities That May Affect SWP Delivery Reliability

3

As discussed earlier, the Sacramento-San Joaquin Delta is an essential part of the conveyance system for the SWP. SWP pumping at Banks Pumping Plant is largely regulated to protect the many uses of the Delta. However, there is a growing recognition that today's uses in the Delta are not sustainable over the long term under current management practices and regulatory requirements. Four major concurrent Delta planning efforts are under way with objectives related to providing a sustainable Delta. These plans may propose changes to SWP operations which in turn could affect SWP delivery reliability. These efforts are Delta Vision, Delta Risk Management Strategy, the CALFED Ecosystem Restoration Program Conservation Strategy, and the Bay Delta Conservation Plan. Each could affect SWP and CVP operations in the Delta.

Delta Vision

On Sept. 28, 2006, in conjunction with the signing of SB 1574, Gov. Schwarzenegger signed an executive order to initiate Delta Vision and establish an independent Blue Ribbon Task Force to develop a durable vision for sustainable management of the Sacramento-San Joaquin Bay Delta. The Delta Vision process is looking more broadly at the sustainability of the Delta. The Blue Ribbon Task Force has prepared its vision for sustainable management of the Delta at **http://www.deltavision.ca.gov**. A strategic plan to implement the vision will be the focus of the Task Force during 2008.

Key points from the Task Force's vision are:

- The water system and the ecosystem of the Delta are co-equal values.
- The Delta is a unique place that has value in its own right.
- Future management must work with nature to achieve desired goals for the Delta.
- Design for resiliency by encouraging regional self sufficiency and developing alternative ways to move water among areas of the state.
- Separate water for human uses from water for the ecosystem.
- New storage and improved conveyance must be constructed to capture water at times least damaging to the environment.
- Over time, reliance on levees should be reduced. However, levees remain critical to the future of the Delta and new policies should match levels of protection provided to uses allowed.
- Assess dual conveyance systems as the preferred direction, to understand the optimal combination of through-Delta and isolated facility improvements against listed performance standards.

The Task Force also identified near-term actions that must be taken. These focus on preparing for disasters in or around the Delta, protecting the Delta ecosystem and water supply system

from urban encroachment, and quickly beginning work on short-term improvements to both the ecosystem and water supply system.

Delta Risk Management Strategy

The 2000 CALFED Record of Decision presented its Preferred Program Alternative describing actions, studies, and conditional decisions to help fix the Delta. Included in the Stage 1 implementation of the preferred alternative was the completion of a Delta Risk Management Strategy (DRMS) that would look at sustainability of the Delta and assess major risks to the Delta resources from floods, seepage, subsidence, and earthquakes. DRMS would also evaluate the consequences and develop recommendations to manage the risk.

In 2005, the Legislature passed and the governor signed AB 1200, which requires DWR to evaluate the potential impacts on water supply derived from the Delta based on 50-, 100-, and 200-year projections for possible impacts on the Delta due to subsidence, earthquakes, floods, climate change, and combinations of these. DWR and The Department of Fish and Game (DFG) must determine the principal options for the Delta. DWR must then evaluate each option for addressing those impacts for its ability to, among other things, prevent the disruption of water supplies derived from the Delta, improve the water quality of drinking water supplies from the Delta, and maintain Delta water quality for Delta users. DFG is to evaluate and comparatively rate each option for its ability to restore salmon and other fisheries that use the Delta. The study is to be completed by January 1, 2008. The DRMS Project was developed, in part, to address the provision in AB 1200 and is a major source of scientific and technical information on the Delta and Suisun Marsh levees for other major studies and initiatives including the Delta Vision initiative, the Bay Delta Conservation Plan, and the CALFED End of Stage 1 Assessment.

Prior to the initiation of the DRMS study, no other levee risk assessment had been as comprehensive and complex. Due to the relatively short time for the assessment, DRMS made the best estimates possible based on existing data and models. While data gaps exist, there were no opportunities to gather new data in the course of the DRMS effort. Results should be considered on a regional basis rather than for any individual island or levee reach. The results should be used for a gaining broad understanding of the condition in the entire Delta, and should not be used as a basis for design for any specific location.

The DRMS preliminary findings have been reviewed by a CALFED scientific panel. The review has lead to a reevaluation of some of the initial DRMS analyses. The results of the reevaluation will be incorporated into the final report and will be completed in April 2008. Delta Vision, the CALFED Ecosystem Restoration Program and the Bay-Delta Conservation Planning effort depend on the best available information from DRMS to support their own processes. The findings discussed in Chapter 4 should be viewed as a progress report that is subject to refinement. While specific numbers may change, the essence of the findings is expected to remain the same.

CALFED Ecosystem Restoration Program Conservation Strategy

The Ecosystem Restoration Program (ERP) implementing agencies are developing a Conservation Strategy to guide ecosystem restoration implementation based on evaluation of past actions, new information, and changing understanding of the ecosystem. The Conservation Strategy is non-regulatory and based on willing seller participation. To date, the effort has focused on the Delta due to the emphasis placed on the pelagic organism decline (POD) and other planning efforts. In future versions, comparable conservation strategies will be developed for the entire ERP focus area including the Sacramento and San Joaquin rivers' watersheds.

The Conservation Strategy is a biological view of where restoration of important habitat types could occur to restore ecosystem form and processes to the maximum extent. Areas have been identified in the Conservation Strategy with potential for various kinds of habitat restoration in the Delta-Suisun Marsh based upon existing elevations, habitat, and natural process requirements of pelagic organisms and other native fishes. Elevation and soil type are the drivers for this preliminary depiction, which does not consider the constraints of water conveyance options, infrastructure, or land use patterns and ownership. As noted in the BDCP discussion that follows, new conveyance focuses on new diversion(s) north of the Delta from the Sacramento River, which would divert water for export around the Delta, offers the greatest potential for meeting ecosystem restoration objectives. The Conservation Strategy is also incorporating information from other Delta-related planning efforts (e.g., Delta Risk Management Strategy, Suisun Marsh Implementation Plan, the ERP End of Stage 1 Assessment, and recovery plans for Federally-listed species) and technical and public input.

The draft of the strategy focuses on five broad habitat categories for restoration or management in the Delta. These categories include managed wetland and wildlife-friendly agriculture (primarily subsided islands), inter-tidal, floodplain, upland transition, and grassland/vernal pool transition corridor.

Information on ecosystem processes, such as hydrodynamics, temperature, salinity, residence times, and productivity is being developed. Details of restoration actions that address flow and river operations — the primary drivers of aquatic systems and habitats — will be incorporated once the Delta Regional Ecosystem Restoration Implementation Plan conceptual models (January 2008) and the anadromous fish recovery plans (Spring 2008) are completed and coordinated with the BDCP process.

Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) has a different and more specific purpose than do DRMS and Delta Vision. BDCP is being developed consistent with the federal Habitat Conservation Plan (HCP) and State Natural Community Conservation Planning (NCCP). The purpose of BDCP is to develop a conservation plan that resolves the conflict between fishery protection under state and federal Endangered Species acts and water operations of the State Water Project (SWP), Central Valley Project (CVP), and Mirant Power facilities in the legal Delta. The goal of BDCP is to develop a plan that satisfies both the conservation and water supply goals of the Planning Agreement signed in October 2006. The BDCP Steering Committee is composed of 19 groups that represent the state and federal water agencies and export contractors, non-governmental organizations representing environmental and farming interests, and Mirant Power, with state and federal fishery agencies serving as ex-officio members. BDCP is ultimately focused on satisfying permitting requirements for the water supply system in the Delta. Among other things, the plan will:

- Provide for conservation and management of at-risk fish species affected by the covered activities.
- Preserve, restore, and conserve aquatic, riparian, and associated terrestrial habitats.
- Provide clear expectations and regulatory assurances for Delta water operations and facilities (CVP, SWP, and Mirant Corp.).

The steering committee for BDCP has been actively working since April 2007 to set the scope and focus of this planning. The committee initially developed 10 options. These options were narrowed to four options for conveyance and opportunities that provide for habitat restoration and enhancement.

- **Option 1: Existing Through-Delta Conveyance.** This option includes use of existing through-Delta conveyance with physical habitat restoration in the north and west Delta and Suisun Marsh (about 28 percent of BDCP planning area).

- **Option 2: Improved Through-Delta Conveyance.** This option includes improving through-Delta conveyance with operable barriers on some channels, separating water supply conveyance flows from the San Joaquin River, and providing habitat restoration in the north, west, central, and south Delta and Suisun Marsh (about 35 percent of the BDCP planning area).

- **Option 3: Dual Conveyance.** This option is similar to Option 2 with the addition of an isolated conveyance facility from the Sacramento River to the south Delta export facilities.

- **Option 4: Peripheral Aqueduct.** This option includes construction of a peripheral aqueduct from the Sacramento River to the south Delta export facilities, which would allow habitat restoration throughout the Delta and Suisun Marsh (about 75 percent of the BDCP planning area).

Table 3.1 shows a summary of how a BDCP Steering Committee consultant ranked the options during the evaluations.

The BDCP plans to finish a draft of the conservation plan by the end of 2008 and the associated draft Environmental Impact Report/ Environmental Impact Statement available for public review at the end of calendar year 2009.

Table 3.1 Overall comparison of BDCP options by criteria category (rank)[1]

Evaluation Criteria Category	Conservation Strategy Option			
	Option 1 *Existing Through Delta*	**Option 2** *Improved Through Delta*	**Option 3** *Dual Conveyance*	**Option 4** *Peripheral Aqueduct*
Biological	★	★★	★★★	★★★★
Planning	★	★	★★★★	★★★★
Flexibility/Sustainability/Durability	★	★★	★★★	★★★★
Impacts on Other Resources	★★★★	★★★	★	★★

[1]/ Performance ranks are ★ (lowest-performing) to ★★★★ (best-performing). Some options receive equal rank.

Areas of Significant Uncertainty for SWP Delivery Reliability

4

Delta Vision's recognition that today's uses in the Delta are not sustainable in the long term is in large part based on three major growing concerns: the pelagic organism decline, possible impacts from climate change and sea level rise, and the vulnerability of Delta levees for failure. Each of these uncertainties for SWP delivery reliability is discussed below.

Pelagic Organism Decline

In late 2004 and early 2005, scientists became concerned about the numbers of many pelagic (open water) organisms including delta smelt that had been declining sharply since the early 2000s. Other pelagic fish with very low numbers in the Delta are striped bass, longfin smelt, and threadfin shad. By 2005, the decline was widely recognized as serious and became known as the Pelagic Organism Decline (POD). Hypothesized factors contributing individually or in concert to lower pelagic productivity are:

- toxic effects,
- exotic species effects, and
- water project effects.

Studies over the past three years are indicating that all these factors might be contributing to the decline in pelagic fishes, and their relative importance might vary depending on the year, season, and location in the Delta. Continued decline in the abundance of juvenile delta smelt led to a voluntary modification in 2007 in SWP and CVP operations to reduce the reversed flows in Middle and Old rivers — a modification made possible by the Environmental Water Account (discussed below). Subsequently on May 31, 2007, DWR ceased Delta pumping and the U.S. Bureau of Reclamation reduced pumping to the minimum operating level of 850 cubic feet per second (cfs). SWP pumping resumed on June 10 at a minimal level of 90 cfs and slowly ramped up to 5,000 cfs by July 1.

In 2007, the Pelagic Fish Action Plan (Resources Agency 2007), developed jointly by DWR and DFG, made several recommendations related to actions that could be taken to improve protection of pelagic fish, including delta smelt. These actions included ways to increase primary productivity in the Delta, reduce the effects of toxics, and possible changes in water project operations. The actions related to SWP and CVP operations guided the voluntary actions taken by DWR and USBR in 2007 as part of the Environmental Water Account.

Environmental Water Account and POD

The POD is occurring despite the operation since 2001 of the Environmental Water Account (EWA). This CALFED water management tool was created to provide added protection to at-risk fish species at no uncompensated costs to SWP and CVP water deliveries. The purpose of the EWA is to enable modifying water project operations in the Delta to provide protection for fish while also compensating for any water supply lost to SWP and CVP water users. Under EWA, fish protection is achieved by periodic curtailment of SWP and CVP water diversion from the Delta to water users south of the

Delta and later replacing any lost water supply. EWA achieves this through buying water from willing sellers or diverting surplus water when safe for fish, then banking, storing, transferring, and releasing the water as needed to protect fish and compensate water users. In its simplest terms, the EWA is aimed at adding flexibility to the state's water delivery system by providing water at critical times to meet environmental needs without reducing SWP and CVP water deliveries. Funding for the EWA is expected to continue through 2008. Without the compensation for the supply effects due to restricted pumping, SWP water supply reliability will be reduced. The studies in this report assume no EWA will be in place under the current and future scenarios.

Biological Assessment of the SWP and CVP Operating Criteria and Plan

In 2004, Reclamation and DWR developed a new Operating Criteria and Plan (OCAP) for the SWP and Central Valley Project (CVP). This plan documented many aspects of the SWP and CVP through: detailing project descriptions, explaining regulatory and legal requirements, listing changes in project operations since the last OCAP in 1992, and analyzing the present and proposed operations using computer simulations. OCAP provided the project descriptions required for a comprehensive biological assessment of SWP and CVP. The biological assessment analyzed existing and potential effects of SWP and CVP operations on listed species and led to Endangered Species Act (ESA) consultation with the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) to update biological opinions (BO) for delta smelt, winter-run salmon, and other species listed under the ESA. In 2004, USFWS issued a non-jeopardy BO with regards to impacts on delta smelt caused by revised operations of the CVP and SWP. This opinion was updated in 2005. USFWS concluded that any adverse effects from the CVP and SWP operations would be avoided or minimized by conservation and adaptive management measures included in the OCAP.

The USFWS's 2005 BO for delta smelt was challenged in U.S. District Court. This court ruled in May of 2007 that the OCAP BO for delta smelt was inconsistent with the Federal Endangered Species Act and needed to be rewritten. On Dec. 14, 2007, the court established interim operating rules to protect delta smelt while USFWS rewrites the BO. These interim operating rules are similar to the 2007 Pelagic Action Plan in that they include in-Delta flow limits in Old and Middle rivers that have the effect of restricting CVP and SWP pumping.

Assessment of Possible POD Impacts on SWP Delivery Reliability

As previously discussed in Chapter 2, a crucial impact of POD upon SWP delivery reliability is to cause additional restrictions on SWP operations. These constraints introduce uncertainty in the ability to convey SWP source water to the desired point of delivery. This uncertainty can be somewhat addressed in analyses by assuming two levels of restrictions. The 2007 and 2027 studies in this report assume constraints to Old and Middle rivers flow in accordance to the August 2007 court ruling on interim actions to protect delta smelt. These simulations are described in more detail in Chapter 6.

Climate Change and Sea Level Rise

Climate change is identified in the 2005 update of the *California Water Plan (Bulletin 160-05)* as a key consideration in planning for the state's future water management. This is because climate change may seriously affect the state's water resources, particularly the SWP's ability to deliver water. In fact, the 2005 report by the University of California, Berkeley, for the California Energy Commission, *Climate Change and Water Supply Reliability*, asserts that climate change in California "is likely to affect water users primarily through its impact on supply reliability and uncertainty" (p. 4).

For the SWP, climate change has the potential to simultaneously affect the availability of source water,

the ability to convey water, and users' demands for water. These potential changes are described below.

Three climate warming scenarios prepared by the California Climate Change Center predict slightly warmer winters with less winter snowpack. Some changes in hydrology due to climate change may already be noticeable, such as an earlier beginning of snowmelt in the Sierra, an increase in winter runoff as a fraction of the total runoff, and an increase in winter flooding frequency. Also, spring and summer runoff in the Sacramento River and San Joaquin River watersheds may be declining due to reduced snowpack.

In the future, average winter flood flows to the Delta are likely to become larger due to more intense storms with more precipitation occurring as rain instead of snow. This shift from snow to rain, particularly in the northern Sierra Nevada, is expected to shift the timing of the peak runoff toward the winter. This in turn may require adjustments to reservoir flood control operations — water managers may be forced to make changes in reservoir operations and flood-control rule curves — resulting in less spring and summer Delta inflows and an increase in Delta salinity.

Climate change experts believe that the timing and quantity of available water supplies in the coming decades may be less predictable due to changing climatic conditions (DWR's 2006 report, *Progress on Incorporating Climate Change into Management of California's Water Resources*). This may exacerbate the existing mismatch in California between where and when precipitation occurs and where and when people use water.

The sea level has been rising at an average rate of 0.08 inches per year and is now about 0.6 feet higher at the Golden Gate than it was in 1920. The Intergovernmental Panel on Climate Change estimates that sea level will rise by about 0.6 to 1.9 feet over the next 100 years (Intergovernmental Panel on Climate Change 2007). Even if Delta levees are fully upgraded, sea level rise could negatively affect water supply reliability through increased salinity intrusion in the Delta. A further tightening of drinking water quality standards or increases in salinity or other constituents could significantly increase the cost of treating Delta water for municipal use. Increased salinity in the Delta reduces the opportunity for exporters to blend the less saline Delta water with other sources higher in salinity. If current in-Delta water quality standards are maintained, re-operation of upstream reservoirs would be needed to provide more water for controlling the seasonal salinity intrusion in the Delta. This would likely result in generally lower reservoir levels, perhaps reducing the ability to meet water supply and water quality needs during dry periods.

Assessment of Possible Climate Change Impacts on SWP Delivery Reliability

As previously discussed in Chapter 2, climate change can potentially affect SWP delivery reliability by altering the timing and amount of source water. In 2006, DWR released a report on climate change and its potential impact on California's water resources. Entitled *Progress on Incorporating Climate Change into Management of California's Water Resources*, the report summarizes recent research into changes in precipitation, air temperatures, snow levels, and rainfall and snowmelt runoff. The report also evaluates possible future impact on California water supply through CalSim II simulations with hydrologic sequences, which reflect different scenarios of climate change. In order to account for the uncertainty in future climate change, four scenarios are examined:

1. weak temperature warming and weak precipitation increase in California under model PCM;
2. modest warming and modest drying under model PCM;
3. modest warming and modest drying under model GFDL v. 2.0; and
4. weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0.

Some of the main results of the 2006 climate change report related to estimated impacts on the SWP and Delta around the year 2050 are:

- Estimated changes in annual average SWP south-of-Delta SWP Table A deliveries range from a slight increase of about 1 percent for a wetter scenario to about a 10 percent reduction for one of the drier climate change scenarios.
- Estimated increased winter runoff and lower SWP Table A allocations result in slightly higher annual average Article 21[1] deliveries in the three drier climate change scenarios. However, the boosts in Article 21 do not offset losses to SWP Table A. The wetter scenario with higher SWP Table A allocations result in fewer Article 21 delivery opportunities and slightly lower annual average Article 21 deliveries.
- Estimated SWP carryover storage is reduced in the drier climate change scenarios and is somewhat increased in the wetter climate change scenario.

Sea level rise effects on water project operations to repulse a greater salt water intrusion under these conditions were not examined due to lack of existing tools for that type of analysis.

For this report, the Calsim II simulations were updated to incorporate an extension of the hydrologic simulation sequence to 2003 and operation of the SWP to meet the interim operating rules of the August 31, 2007, court order related to delta smelt. The same four scenarios of future climate change were simulated. It should be noted that these scenarios assume greenhouse emissions for 2050, not at the 2027 level assumed for Future Conditions. This report estimates climate change impact to SWP deliveries by interpolating between future studies that assume no climate change and studies that assume 2050 emissions. This approach is detailed in Appendix B. These studies are the best available estimates for future SWP water deliveries. Chapter 6 describes these simulations along with all other simulations presented in this report.

[1] Article 21 water is interruptible water allocated under certain conditions: SWP's share of San Luis Reservoir is full or projected to fill in the near term; other SWP reservoirs are full or at their storage targets, or conveyance capacity to fill these reservoirs is maximized; releases from upstream reservoirs plus unregulated inflow exceed the water supply needed to meet Sacramento Valley in-basin uses; SWP Table A deliveries are being fully met; and Banks Pumping Plant has spare capacity.

Vulnerability of Delta Levees for Failure

Delta levees provide constant protection from flooding because most lands in the Delta are below sea level. Most of the Delta's levees, however, do not meet modern engineering standards and are highly susceptible to failure. Levees are subject to failure at times of high flood flows, but also at any time of the year due to seepage or the piping of water through the levee, slippage or sloughing of levee material, or sudden failure due to an earthquake. According to the URS Corp./Jack R. Benjamin & Associates report, *Draft Summary Report, Phase 1: Risk Analysis, Delta Risk Management Strategy (DRMS)*, June 2007, the risk of levee failure in the Delta is significant, as shown by the fact that virtually all levees in the Delta have failed at least once over the past 100 years, with about half failing at least twice. Since 1900, there have been 166 levee failures.

A breach of one or more levees and island flooding will affect Delta water quality and water operations. Depending on the hydrology and the size and locations of the breaches and flooded islands, a significant amount of saline water may be drawn into the interior Delta from Suisun and San Pablo bays. At the time of island flooding, exports may be drastically reduced or ceased to evaluate the salinity distribution in the Delta and to avoid drawing higher saline water toward the pumps. The introduced salinity then could become dispersed and degrade Delta water quality for a prolonged period because of complex relationships between Delta inflows, tidal mixing, and the time taken to repair the breaches.

A large earthquake in the Delta causing signifi-

cant levee failures and island flooding could lead to multiyear disruptions in water supply, significant water quality degradation, as well as permanent flooding of several islands. Such permanent multi-island flooding would probably lead to increased salt water intrusion into the Delta during seasonal low inflows. Maintaining Delta water quality when several islands are flooded and breaches are open would require additional Delta inflow because the volume of water coming into the Delta on the flood tide would increase, requiring more fresh water from the rivers to prevent the saline water from extending into the Delta. When SWP and CVP pumping is restarted, Delta inflow would need to increase again beyond the pumping amount in order to prevent water quality degradation in the Delta. This chain of events would significantly affect water supply reliability by limiting pumping and requiring additional reservoir releases to generate the needed higher Delta inflows. A worst case scenario for water supply impacts would be a moderate or large earthquake causing extensive levee failure in the late summer or fall of a dry year.

The levee break on Middle River and subsequent flooding of Upper Jones Tract in 2004 is a small-scale example of this phenomenon. Following the break, Delta pumping was curtailed for several days to prevent seawater intrusion. Water shipments down the California Aqueduct were continued through unscheduled releases from San Luis Reservoir. Also, Shasta and Oroville reservoir releases were increased to provide for salinity control in the Delta.

A growing concern about the long-term viability of the Delta's levee system led to the initiation of the Delta Risk Management Strategy (DRMS).

Delta Risk Management Strategy

The 2000 CALFED Record of Decision presented its Preferred Program Alternative to help fix the Delta that described actions, studies, and decisions contingent upon subsequent environmental and engineering analyses. Included in the Stage 1 implementation of the preferred alternative was the completion of a Delta Risk Management Strategy (DRMS) that would look at sustainability of the Delta and assess major risks to the Delta resources from floods, seepage, subsidence, and earthquakes. DRMS would also evaluate the consequences and develop recommendations to manage the risk.

Assembly Bill 1200, passed in 2005, directs DWR to evaluate the potential effects of subsidence, earthquakes, floods, and climate change to Delta-based water supply. After determining principal options for the Delta, DWR must then evaluate each option according to its ability to prevent the disruption of water supplies from the Delta, improve the water quality of drinking water supplies from the Delta, and maintain Delta water quality for Delta users. By providing important information on levees in the Delta and Suisun Marsh, the DRMS Project is intended to support other major studies and initiatives including the Delta Vision initiative, the Bay Delta Conservation Plan, and the CALFED End of Stage 1 Assessment.

DWR defined Phase 1 of DRMS as the risk analysis of levee failures and associated potential economic, environmental, and public health and safety impacts and Phase 2 as the development and evaluation of strategies to reduce risks from levee failures. Risk analysis includes the likely occurrence of earthquakes of varying magnitudes in the region, future rates of subsidence given continued farming practices, the likely magnitude and frequency of storms, and the potential effects associated with global climate change (sea level rise, climate change, temperature change). Estimated risks to the Delta were made for 50-, 100-, and 200-year projections since risk can be expected to increase with time.

One reason for conducting a risk analysis is to quantitatively consider the uncertainties that relate to the performance of levees. Sources of uncertainty that affect any analysis can be fundamentally different. Events in nature such as precipitation are inherently random and this uncertainty cannot be reduced by simply collect-

ing more information; rather, this uncertainty can be predicted in terms of probability.

The Draft DRMS Phase 1 Report looked at several hazards to levees: seismic events that cause levee failures, flood flows that can overtop levees or cause levee failure by increased pressure and seepage, undetected problems during non-flood flow periods, and erosion due to high wind waves. The level of risk of failure of Delta levees was determined by considering: the frequency of different magnitudes of hazards that can challenge the integrity of Delta levees, how vulnerable different levee reaches are to hazards, how hazards and levee vulnerabilities combine to produce levee failure, and the economic and ecosystem impacts due to levee failure. The analysis assumes that existing regulatory and management practices will continue.

Potential Interruption/Disruption of SWP Deliveries Due to Earthquakes A strong earthquake affecting the Delta could cause simultaneous levee failures on several islands, and there is a real possibility of several simultaneous island flooding. DRMS considered scenarios that consisted of different combinations of flooded islands, ranging from one island to 30 islands flooded. **Table 4.1** summarizes impacts of various scenarios of island flooding associated with a single seismic event as presented in the URS/Jack R. Benjamin & Associates report, *Draft Summary Report, Phase 1: Risk Analysis, Delta Risk Management Strategy (DRMS)*, June 2007.

Preliminary analysis indicates that some water may not be treatable by municipal agencies for many months beyond those listed in **Table 4.1** due to high organic carbon concentrations. This would extend the period that Delta water supply would be unavailable for urban users.

Key findings of the Draft Phase 1 DRMS report on possible impacts on SWP deliveries due to earthquakes are:

- When the probability of all seismic levee breaches under existing conditions is considered, about 115 levee failures can be expected during 100 years.
- There is about a 28 percent chance of 30 or more islands simultaneously failing during a major earthquake in the next 25 years.
- A moderate to large earthquake capable of causing multiple levee failures could happen in the next 25 years. Under such an earthquake, extensive levee failure would most likely occur in the west and central Delta. Levee repairs could take up to 6.5 years and exports from the Delta could be disrupted for up to two years with a loss of up to 9.3 maf of water.
- By 2050, the frequency of island flooding from seismic events is expected to increase by 12 percent over 2005 conditions, if a seismic event has not occurred.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Table 4.1 Expected impact on Delta exports due to salinity intrusion from various seismic events

Seismic Case	Flooded islands	Months to repair levees	Months without pumping	Water not exported (maf)
1	1	up to 20	up to 2	up to 0.7
2	3	19	1 to 3	0.1 to 1.0
3	3	23	1 to 4	0.1 to 1.2
4	10	45	2 to 10	0.7 to 2.5
5	20	62	11 to 21	6.3 to 6.5
6	30	81	16 to 23	6.5 to 9.3

Potential Interruption/Disruption of SWP Deliveries Due to Floods During an average year, about 85 percent and 10 percent of the total Delta inflow comes from the Sacramento and San Joaquin rivers respectively. The remaining Delta inflow primarily comes from three eastside tributaries. Inflow from the Sacramento and San Joaquin rivers depends on reservoir releases, precipitation, and snowmelt. Over the long-term, many different combinations of high flood flows in the Sacramento and San Joaquin rivers are possible because of the large geographical extent of the two rivers' watersheds and the variability in storm paths. DRMS considered magnitude and frequency of flooding in different parts of the Delta from different sources to evaluate the probability of these high flows. This approach allows the inclusion in the risk analysis of floods that, while possible, are larger than have been historically recorded. The DRMS report views an analysis which relies only on historical data as likely to underestimate risk.

Potential disruption of Delta exports due to floods and levee failures would depend on the number of flooded islands, the timing and size of the flood flows, and the water quality in the Delta and Suisun Bay at the time of the flood. However, during such high flows, there would normally be little or no impact on water quality on the exports due to levee failures and DRMS assumes no significant effect on Delta exports.

Key findings of the Draft Phase 1 DRMS report on possible impacts on SWP deliveries due to flood flows are:

- By 2050, Delta flood hazard is expected to increase 200 percent due to sea level rise and more frequent high flows.
- By 2050, the frequency of island flooding from floods is expected to increase over 2005 conditions.
- By 2050, flood fragility of levees is expected to increase 10 percent due to subsidence, and overall Delta island flood frequency is expected to increase 230 percent.
- By 2050, the frequency of floods is expected to increase by 50 percent and levees are expected to become 20 percent more vulnerable to flooding due to increased seepage and stability problems associated with more subsidence and sea level rise.
- By 2050, the combined effects of increased levee vulnerability and flood flows indicates an 80 percent expected increase in island flooding from flood flows.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Potential Interruption/Disruption of SWP Deliveries Due to "Sunny Day" Event A "sunny day" levee failure is a failure that occurs during non-flood times and is not caused by an earthquake. Possible causes of levee failure include wave action, animal activity, and seepage. DRMS reports that, on average, there will be about 5.4 sunny-day breaches with 50 years of exposure in the Delta. These types of levee failures are not expected to involve the potential of simultaneous multilevee events as could happen with high flood flows and a large earthquake.

Combined Potential Interruption/Disruption of SWP Deliveries DRMS evaluated combined risk of levee failure due to earthquakes, floods, and "sunny day events" as well as how risks may change in the future. Key findings by DRMS are:

- Taking into account the probability of all levee breaches from all hazards under 2005 conditions, the number of levee failures in the Delta can be expected to about double over the next 100 years.
- Levee hazards are expected to grow in the future due to such factors as sea level rise and more frequent flood flows that will put more pressure on the levees.

- The overall likelihood of a major Delta event causing extensive levee failure is increasing as is the magnitude of the consequences from a given event.
- There is a possible range of sea level rise of from 0.7 to 4.6 feet over the next 100 years, depending on the assumed future greenhouse gas emissions and the forecast model used. Current estimates by the Intergovernmental Panel on Climate Change indicate that sea level will rise from 0.6 to 1.9 feet over the next 100 years. The CALFED Independent Science Board (ISB) has recommended that planning that incorporates sea level rise, should use the full range of variability of 20-55 inches.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Emergency Operations Plan

As part of its efforts to reduce impacts to the SWP should a levee failure occur, DWR has initiated the development of an Emergency Operations Plan (EOP). This plan will provide procedures for emergency preparedness and incident management typically necessary for a jurisdiction or organization with emergency response roles and responsibilities. While DWR has current general procedures for emergency response, the EOP will ultimately enhance the state's ability to prepare for, respond to, and recover from a Delta levee failure disaster and will provide DWR with a plan focused specifically on a catastrophic levee failure disaster. The EOP will be a blueprint for coordinating the protection of life and property with its local, state, and federal partners in taking the steps necessary to protect the state's water system.

DWR has completed the first of two phases of engineering design work intended to enhance the state's ability to respond to large-scale levee failures or floods in the Delta. In the first phase, DWR conducted a discovery process to analyze previously developed plans and procedures and to identify current DWR capabilities for response to emergencies and disasters in the Delta. This phase included: developing plans to determine the quantity and gradation of rock needed to repair several levee breaches and block certain river channels to minimize salinity intrusion into the interior of the Delta, securing strategic joint stockpile-transfer facilities, completing design requirements and contracting for the construction of a new belt conveyor system, and establishing new procurement contracts for rock to be placed at the stockpile-transfer facilities. Through this process, DWR has categorized response actions that can be taken to reduce the impact of a Delta levee failure disaster. The first phase, now complete, has resulted in a DWR report, *Delta Emergency Operations Plan Concept Paper April 2007*. This report can be accessed at **http://www.dfm.water.ca.gov/er/**.

In the second phase, DWR will engage its partners in local, state, and federal government, and in the private sector, to develop a detailed EOP for responding to levee failure events, stabilizing the system, and facilitating recovery. The EOP will be consistent with and in compliance with California's Standardized Emergency Management System (SEMS)[2] and with the National Incident Management System (NIMS)[2]. By developing the EOP, DWR will improve preparedness capabilities for response and recovery.

[2]/ SEMS is an emergency management system required by California Government Code Section 8607(a) for managing incidents involving multiple jurisdictions and agencies. NIMS is a nationwide, federal emergency management approach, for managing incidents with all levels of government, private-sector, and nongovernmental organizations working together. For more SEMS/NIMS information, please visit: **www.oes.ca.gov.**

General Approach for Assessing SWP Delivery Reliability

5

CalSim II, a computer model jointly developed by DWR and U.S. Bureau of Reclamation, simulates much of the water resources infrastructure in the Central Valley and Delta region of California. CalSim II models all areas that contribute flow to the Delta. The geographical coverage includes the Sacramento River Valley, the San Joaquin River Valley, the Sacramento-San Joaquin Delta, the Upper Trinity River, and the CVP and SWP service areas. CalSim II simulates operation of the CVP-SWP system using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period.

General Solution Techniques and Incorporating Operational Constraints

CalSim II routes water through a CVP-SWP system network representation. The network includes more than 300 nodes and over 900 arcs, representing 24 surface reservoirs and the interconnected flow system. The physical description of the system is expressed through a user interface with tables outlining the system characteristics. CalSim II uses logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty and standardized rule curves (i.e., Water Supply Index versus Demand Index Curve). The rule curves relate forecasted water supplies to deliverable demand, and then use deliverable demand to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP system-wide delivery and south-of-Delta delivery are also determined using water supply parameters and operational constraints with specific consideration for export constraints.

Hydrology

The historical flow record is adjusted for the influence of land-use change and upstream flow regulation in order to represent the possible range of water supply conditions. The hydrology used by CalSim II was developed jointly by DWR and U.S. Bureau of Reclamation. Water diversion requirements (demands), stream accretions and depletions, rim basin inflows, irrigation efficiency, return flows, non-recoverable losses, and groundwater operation are components that make up the hydrology used by CalSim II. Sacramento Valley and tributary basin hydrologies are developed using a process designed to adjust the historical sequence of monthly stream flows to represent a sequence of flows at a future level of development. Adjustments to historical water supplies are determined by imposing future level land use on historical meteorological and

hydrologic conditions. San Joaquin River basin hydrology is developed using fixed annual demands and regression analysis to develop flow accretions and depletions. The resulting hydrology represents the water supply available from Central Valley streams to the CVP and SWP at a future level of development. Groundwater has only limited representation in CalSim II. This resource is modeled as a series of interconnected lumped-parameter basins. Groundwater pumping, recharge from irrigation, stream-aquifer interaction and interbasin flow are calculated dynamically by the model.

Demands

SWP demands are preprocessed independent of CalSim II and vary according to the specified scenario (e.g., 2007, 2027) and according to hydrologic conditions. Agricultural land-use-based demands are calculated from an assumed cropping pattern and a soil moisture budget. Urban demands are typically set to contract amount, but with reductions in wet years based on recent historical data. Both land-use-based demands and estimated contract amounts serve as upper bounds on deliveries. Environmental demands such as minimum reservoir storage requirements, minimum in-stream flows and deliveries to national wildlife refuges, and wildlife management areas are as stipulated in current regulatory requirements and discretionary interagency agreements.

Meeting Delta Water Quality Standards

CalSim II uses DWR's Artificial Neural Network (ANN) model to simulate the flow-salinity relationships for the Delta. The ANN model correlates DSM2 model-generated salinity at key locations in the Delta with Delta inflows, Delta exports, and Delta Cross Channel operations. The ANN flow-salinity model estimates electrical conductivity at the following four locations for modeling Delta water quality standards: Old River at Rock Slough, San Joaquin River at Jersey Point, Sacramento River at Emmaton, and Sacramento River at Collinsville. In its estimates, the ANN model considers antecedent conditions up to 148 days, and considers a "carriage-water" type of effect associated with Delta exports.

CalSim II Priorities in Water Deliveries

CalSim II allocates water according to the four priorities shown in **Table 5.1**. Highest priority is given to prior-right water users, minimum in-stream flow requirements and water quality requirements. While CVP and SWP contractor deliveries take precedence over next year's storage, a balance between the two is struck in the allocation decision to ensure that enough water is left in storage at the end of the year in case of impending drought.

SWP Table A and Article 21 Deliveries

The CalSim II simulations in this report estimate SWP delivery amounts for SWP Table A and Article 21. As mentioned in Chapter 2, SWP Table A is the contractual method for allocating available supply, and the total of all maximum SWP Table A amounts for deliveries from the Delta is 4.133 million acre-feet (maf) per year. Article 21 refers to a provision in the contract for delivering water that is available in addition to SWP Table A amounts. (See Appendices A and B for more discussion.) Article 21

Table 5.1 CalSim II water use prioritization

1	Prior-right water users, minimum in-stream flow requirements, water quality requirements
2	SWP Table A contractors, CVP contractors
3	Reservoir storage for the next year (carryover)
4	SWP Article 21 deliveries

of SWP contracts allows contractors to receive additional water deliveries only under specific conditions. These conditions are:

1. The water is available only when it does not interfere with SWP Table A allocations and SWP operations;
2. The water is available only when excess water is available in the Delta;
3. The water is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and
4. The water cannot be stored in the SWP system. In other words, the contractors must be able to use the Article 21 water directly or be able to store it in their own system.

Water supply under Article 21 becomes available only during wet months of the year, generally December through March. Because an SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, not all SWP contractors can take advantage of this additional supply.

The importance of Article 21 water to local water supply is tied to how each contractor uses its SWP supply. For those SWP contractors who are able to store their wet weather supplies, Article 21 supply can be stored by being put directly into a reservoir or by offsetting other water that would have been withdrawn from storage, such as local groundwater. In the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required. This report presents information on Article 21 water separately so local agencies can determine whether it is appropriate to incorporate this supply into their analyses.

CalSim II Performance

Some of the comments to the *Draft 2003 SWP Delivery Reliability Report* expressed concern about the accuracy of CalSim II and the credibility of conclusions about SWP delivery reliability that are based on CalSim II simulations. In order to respond to these concerns, DWR conducted several CalSim II studies. In one study, results from a CalSim II simulation using historical input from 1975 to 1998 were compared to historical operations. This study is documented in the report, *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report, November 2003* and was provided in Appendix E of the *2005 SWP Delivery Reliability Report*. In a second study, a sensitivity analysis was performed to quantify the effects of various inputs on CalSim II results. Two performance measures were used, a Sensitivity Index and Elasticity Index, to quantify the sensitivity of 12 model output responses to 12 different model input parameters. This sensitivity study was also provided in Appendix E of the *2005 SWP Delivery Reliability Report*.

In a follow-up study, DWR staff conducted a more detailed analysis of the sensitivity results, focusing on the delivery reliability of SWP system. The results of this analysis are documented in an internal memorandum report, dated April 30, 2007. The purpose of this analysis was to assist SWP contractors and other interested parties in evaluating the impact of model input parameters on SWP deliveries (SWP Delta deliveries, SWP north-of-Delta deliveries, and SWP deliveries under Article 21) with respect to a selected subset of input parameters. This memorandum report is available via the internet at **http://baydeltaoffice.water.ca.gov/** by clicking on the announcement of the *Draft 2007 SWP Delivery Reliability Report* under "Items of Interest."

Recent Improvements to CalSim II Simulations

The SWP operation simulations in this report use the CalSim II model developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP) that was then modified specifically for these studies. In addition to the modifications needed for the 2007 U.S. District Court Judge Oliver Wanger's decision, the 2004 OCAP version was modified to include the improvements listed below. A complete list of model assumptions is included in Appendix A. The new enhancements to CalSim II are:

- **Improved representation of the San Joaquin River Basin** The previous San Joaquin River Basin representation was replaced by the San Joaquin River Water Quality Module version 1.00 (SJRWQM) developed by U.S. Bureau of Reclamation Mid-Pacific Region. The SJRWQM is an update to previous versions that has gone through extensive agency review and a formal peer review.

- **Improved modeling of flow-salinity relationships in the Delta** The previous Artificial Neural Network (ANN) used to estimate flow-salinity relationships has been replaced with a newer more accurate version. The new ANN and its accompanying implementation to the CalSim II model produces salinities that match more closely the Delta Simulation Model 2 (DSM2) salinities.

- **An extended hydrologic sequence** The Hydrologic sequence of 74 simulated years has been extended to 82 years, from water years 1922 through 1994 to water years 1922 through 2003.

Assessment of Present and Future SWP Delivery Reliability

6

CalSim II simulations were conducted to evaluate current (2007) SWP delivery reliability and incorporate actions to protect delta smelt defined by the 2007 federal court ruling. Simulations to evaluate future (2027) SWP delivery reliability incorporate the current interim court-ordered operating rules related to delta smelt and a range of possible climate change impacts to hydrology in the Central Valley. The interim operating rules for delta smelt are simulated at both a more-restricted level and a less-restricted level for Delta exports to provide a range of estimated water deliveries. Therefore, for 2007, two studies are conducted. For 2027, 10 simulations are used to reflect the four assumed scenarios for climate change and the two levels of operation rules. By using these interim court-ordered operating rules in the studies, DWR is not making an assumption about the results of the ongoing discussions to revise the delta smelt Biological Opinion. The studies are simply an indication of the near-term impacts of these interim operating rules. An update of this report for 2009 will be done using operating rules defined by the revised delta smelt Biological Opinion.

Results of these updated CalSim II simulations are presented alongside results from the *2005 SWP Delivery Reliability Report* to help identify and explain impacts to delivery reliability due to actions to protect delta smelt and future climate change. At the end of the chapter, the information is presented in a way to easily compare the estimated SWP deliveries under Current (2007) Conditions to those under Future (2027) Conditions.

This chapter contains tables summarizing the updated estimated delivery amounts of the studies for the entire study period (1922-2003), dry years, and wet years and presents information on the estimated probability of SWP Table A delivery amounts currently and 20 years in the future. While two CalSim II simulations were made to estimate current delivery reliability (bookends for delta smelt protection) and 10 simulations were made to estimate future delivery reliability (combinations of flow constraints and climate change scenarios), simulation results in this chapter for Future (2027) Conditions are presented in terms of ranges in values for ease of analysis. The annual values for SWP deliveries estimated by all the CalSim II simulations are listed in tables in Appendix B. These tables also show the annual SWP Table A demands assumed for each study.

The results indicate potentially significant differences between the updated studies and studies done for the 2005 report under both current and future conditions for estimated deliveries during multiple-year dry periods. In general, updated estimates of both current and future SWP Table A deliveries are less than the deliveries presented in the 2005 report, particularly during multiple dry years. For a given probability of exceedence, current and future SWP Table A deliveries are also less than were presented in the 2005 report. For future conditions, the probability of an annual SWP Table A delivery exceeding 1.7 maf is substantially less than was presented in the 2005 report. The updated studies show generally higher SWP Table A deliveries under Future (2027)

Conditions compared to Current (2007) Conditions, but decreases in deliveries in the future are possible during multiple dry year periods, depending on which climate change scenario is assumed. In comparison, the 2005 report showed more frequent and greater increases in future deliveries.

Assessment of SWP Delivery Reliability under Current (2007) Conditions

Current Conditions refer to those conditions believed in effect in 2007. These conditions, described below, include Old River and Middle River flow targets from the current court-ordered interim operating rules. Results from CalSim II simulations for the *2005 SWP Delivery Reliability Report* under the 2005 study are presented throughout this section for comparison. Appendix A presents a detailed list of the study assumptions for this report.

Availability of Source Water

The 2005 level of development (level of water use in the source areas) is assumed representative of 2007. The hydrologic sequence of simulated years is based on historical precipitation and runoff patterns and is from water years 1922 through 2003. The hydrologic sequence for the 2005 report is shorter, from water years 1922 through 1994. For comparison purposes, these differences are not significant.

Demand for Delta Water

The SWP Table A demands for deliveries from the Delta assumed for 2007 are shown in **Table 6.1**. The assumed demands for the studies were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with DWR's 2007 document, *Draft Environmental Impact Report: Monterey Amendment to the State Water Project Contracts (Including Kern Water Bank Transfer) and Associated Actions as Part of a Settlement Agreement (Monterey Plus)*. A range in SWP Table A demands is shown because the demand is assumed to vary each year with the weather.

Table 6.1 presents key demand values. Differences between the values in updated studies and the 2005 study in the 2005 report are due to the longer simulation period for the current report. SWP Article 21 demands for water are the same as assumed in the *2005 SWP Delivery Reliability Report* and are shown in **Table 6.2**.

Ability to Convey Source Water to the Desired Point of Delivery

The CalSim II simulations assume that current Delta water quality regulations (contained in the

Table 6.1 SWP Table A demands from the Delta under Current Conditions

Study of Current Conditions	Average Demand		Maximum Demand		Minimum Demand	
	taf /year	maximum SWP Table A[1]	taf /year	maximum SWP Table A[1]	taf /year	maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2005	3290	80%	3862	93%	2321	56%
Updated Studies (2007)	3308	80%	3864	94%	2323	56%

[1]/ 4,133 taf /year.

Table 6.2 Article 21 demands from the Delta under Current Conditions

Study of Current Conditions	Average Article 21 demand (taf)		Total (taf/year)
	December - March	April - November	
2005 SWP Delivery Reliability Report, Study 2005	704	607	1311
Updated Studies (2007)	699	598	1297

State Water Resources Control Board's Decision 1641) are in place for the 2007 studies. The simulations also incorporate flow restrictions of the recent court-ordered interim operating rules related to delta smelt. Two CalSim II simulations were run to evaluate a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The specific rules for these flows are contained in **Table 6.3**. The lower- and higher-level restrictions are the same for Dec. 25 through Feb. 20 and April 15 through May 15. They are significantly different during Feb. 21 through April 14 and May 16 through June 30. Additional information on the characterization of the potential court decision in the model is found in Appendix A. The amount of exports allowed while achieving the Old River and Middle River flow targets are assumed shared equally between the CVP and the SWP. Combined CVP and SWP exports also are assumed constrained according to the June 30, 2004, Long-Term Central Valley Project Operations Criteria and Plan during April 15 to May 15. This operation is part of the Vernalis Adaptive Management Plan. The specific rules for this restriction are included in Appendix A.

The simulation of Current Conditions in the 2005 report also assumed D-1641 Delta standards and combined SWP and CVP pumping restrictions according to the 2004 Long-Term Central Valley Project Operations Criteria and Plan. However, the 2005 report assumed no Old River and Middle River flow targets.

Presentation of CalSim II Results

For the purpose of describing SWP deliveries under Current (2007) Conditions in this chapter, the annual deliveries from the two CalSim II simulations, which assumed a higher and a lower level of Old River and Middle River flow targets, are averaged. The annual SWP Table A and Article 21 deliveries for the two 2007 simulations are presented in Appendix B.

SWP Table A Deliveries under Different Hydrologic Scenarios

Table 6.4 contains the average, maximum, and minimum estimates of SWP Table A deliveries from the Delta under Current Conditions from the *2005 SWP Delivery Reliability Report* and under 2007 assumptions that include Old River and Middle River flow targets. As previously mentioned, SWP deliveries under 2007 conditions are the result of averaging annual deliveries from two scenarios of Old River and Middle River flow targets. The estimated probabilities for a given amount of annual SWP delivery under Current (2007) Conditions are presented in **Figure 6.1**.

Table 6.4 shows that under updated Current (2007) Conditions, average SWP delivery amounts may decrease 5 percent of maximum SWP Table A when compared to the earlier estimate, from 68 percent to 63 percent. Since SWP Table A demands are the same between the earlier and updated studies, this decrease in deliveries is primarily due to the Old River and Middle River flow targets to

Table 6.3 Old and Middle River flow target scenarios assumed in CalSim II studies

Period	Combined Average Old River and Middle River flow[1]	
	Less Restrictive	More Restrictive
Dec 25 – Jan 3	Less than 2,000 cfs flow upstream	Less than 2,000 cfs flow upstream
Jan 4 – Feb 20	Less than 5,000 cfs flow upstream	Less than 5,000 cfs flow upstream
Feb 21 – April 14	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream
Apr 15 – May 15	No Old and Middle River flow constraint; VAMP controls exports	No Old and Middle River flow constraint; VAMP controls exports
May 16 – May 31	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream
Jun 1 – Jun 30	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream

[1]/ Where: OMR flow = (0.58 * flow at Vernalis) – (0.913 * total export)

protect delta smelt reducing the amount of Delta water available for export by the SWP. The maximum delivery of 93 percent for the 2005 study is reduced to 90 percent for the updated study. The estimate of minimum SWP Table A delivery actually increases slightly. This is primarily due to the larger amount of storage available in Lake Oroville at the beginning of the year. The higher amount of storage is due to the fish-protection restrictions on SWP Delta pumping for the previous year reducing the need to release water from Lake Oroville.

Table 6.5 includes estimates of SWP Table A deliveries for Current (2007) Conditions under an assumed repetition of historical drought periods. The years are identified as dry by the Eight River Index, a good indicator of the relative amount of water supply available to the SWP. The Eight River Index is the sum of the unimpaired runoff from the four rivers in the Sacramento Basin used to define water conditions in the basin plus the four rivers in the San Joaquin Basin, which correspondingly define water conditions in that basin. The eight rivers are the Sacramento, Feather, Yuba, American, Stanislaus, Tuolumne, Merced, and San Joaquin. **Table 6.5** also includes the average deliveries for comparison purposes. Once again, deliveries under Current (2007) Conditions are the result of averaging annual deliveries from two scenarios of Old River and Middle River flow targets.

Table 6.5 shows that estimates of updated SWP deliveries under Current (2007) Conditions during dry periods are less than were earlier estimated. SWP deliveries may be reduced to 34 percent of maximum SWP Table A during the two-year drought of 1976-1977. The six-year drought of 1987-1992 is estimated to provide 35 percent of maximum SWP Table A, a reduction of 289 taf/year when compared to the 2005 estimate. The four-year drought of 1931-1934 is an exception with SWP deliveries estimated to increase 3 percent of maximum SWP Table A, from 32 percent to 35 percent.

Table 6.6 summarizes SWP Table A deliveries under an assumed repetition of historical wet periods under Current (2007) Conditions. As with drought years, the Eight River Index is used to identify wet years. **Table 6.6** shows that estimates of SWP

Table 6.4 SWP Table A delivery from the Delta under Current Conditions

Study of Current Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2005	2818	68%	3848	93%	159	4%
Updated Studies (2007)[3]	2595	63%	3711	90%	243	6%

[1]/ 4,133 taf /year
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[3]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3.

Table 6.5 Average and dry period SWP Table A deliveries from the Delta under Current Conditions

Study of Current Conditions	SWP Table A delivery from the Delta (in percent of maximum SWP Table A[1])					
	Long-term Average[2]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report, Study 2005	68%	4%	41%	32%	42%	37%
Updated Studies (2007)[3]	63%	6%	34%	35%	35%	34%

[1]/ 4,133 taf /year
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[3]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

deliveries under updated Current (2007) Conditions do not significantly change from earlier estimates during wet years. Decreases in SWP deliveries for these wet periods generally range from 0 to 2 percent of maximum SWP Table A (0 to 83 taf/year).

Article 21 Deliveries under Different Hydrologic Scenarios

State Water Project water delivery is a combination of both SWP Table A deliveries and the use of Article 21 by some contractors to store water locally at times when extra water and capacity is available beyond that needed by normal SWP operations. **Table 6.7** contains the average, maximum, and minimum SWP Article 21 deliveries over the 1922-1994 period for the earlier study and the 1922-2003 period for the updated simulations. Comparing the estimates of SWP Article 21 deliveries, the updated estimates show significantly less delivery amounts on average and for maximum delivery over the simulation period. Estimated average Article 21 deliveries are 175 taf less under the updated Current (2007) Conditions than was estimated in the 2005 report. Estimated maximum Article 21 delivery is reduced 520 taf. These reductions are primarily due to the storage in San Luis Reservoir being lower in the 2007 studies. The reservoir is lower because Delta pumping is restricted by the court-ordered operation rules for delta smelt. To assure SWP Table A deliveries for the coming year are not reduced, the SWP portion of San Luis Reservoir must be very close to full, if not completely full, before Article 21 deliveries are made.

As noted above, water available for Article 21 occurs only in wet periods and it is difficult to evaluate impacts except to look at specific years. **Table 6.8** shows the updated and earlier estimates of Article 21 deliveries by year during dry periods. Under the updated current (2007) conditions, Article 21 deliveries are estimated to be significantly reduced during the dry periods 1929-1934, 1976-1977, and 1987-1992.

Table 6.9 shows the updated and earlier estimates of Article 21 deliveries by year during the 1978-1987 wet period. Under Current (2007) Conditions, updated estimated Article 21 delivery can decrease up to 550 taf in an individual year, compared to earlier estimates. In only one year, 1980, does the estimated Article 21 deliveries increase when compared to earlier estimates.

Table 6.6 Average and wet years SWP Table A delivery from the Delta under Current Conditions

Study of Current Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report, Study 2005	68%	60%	65%	69%	75%	72%
Updated Studies (2007)[2]	63%	60%	66%	68%	73%	71%

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

Table 6.7 Annual SWP Article 21 delivery from the Delta under Current Conditions

Study of Current Conditions	Average delivery[1] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report, Study 2005	260	1110	0
Updated Studies (2007)[2]	85	590	0

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for Current (2007) Conditions in **Figure 6.1**. Results from the *2005 SWP Delivery Reliability Report* and updated estimates for 2007 are shown. Updated estimates of probability for Current (2007) Conditions are shown as a single line which results from ranking the averaged deliveries from the two scenarios of Old River and Middle

Table 6.8 Average and dry year SWP Article 21 delivery under Current Conditions (taf per year)

Year	*2005 SWP Reliability Report*, Study 2005	Updated Studies (2007)[2]
1929	0	0
1930	120	0
1931	0	0
1932	240	0
1933	510	40
1934	210	0
1976	190	5
1977	0	0
1987	550	0
1988	0	0
1989	0	0
1990	0	0
1991	0	0
1992	0	0
Long-term average[1]	260	85

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

Table 6.9 Average and wet year SWP Article 21 delivery under Current Conditions (taf per year)

Year	*2005 SWP Reliability Report*, Study 2005	Updated Studies (2007)[2]
1978	300	100
1979	160	0
1980	140	190
1981	550	0
1982	800	490
1983	400	400
1984	550	460
1985	0	0
1986	120	30
1987	550	0
1978-87 Average	360	170
Long-term Average[1]	260	85

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

River flow targets. Probability values for each of these two scenarios are presented in Appendix B. To use **Figure 6.1**, one would first locate the percent exceedence of interest along the horizontal axis (x-axis) of the graph, move vertically upward to the curve, then horizontally to the vertical axis (y-axis) and read the annual delivery. For example, for an 80 percent exceedence, corresponding annual SWP Delta deliveries would be 2,277 taf from previous estimates and 1,990 taf for the updated estimates. The numerical data for this figure is included in Appendix B and should be referenced for specific values corresponding to specific exceedences.

Figure 6.1 shows that under Current (2007) Conditions, for probabilities of exceedence above 40 percent, updated annual SWP Table A deliveries can be 250 taf to 500 taf less than the earlier estimates. Annual SWP Table A deliveries associated with exceedences below 40 percent are much less different than the 2005 study. **Table 6.10** contains the values for SWP Delta deliveries corresponding to 25 percent, 50 percent, and 75 percent exceedence. The information in **Table 6.10** can be stated as follows: For any given year,

- There is a 25 percent chance that SWP deliveries will be at or above 3,218 taf.
- There is an equal chance that SWP deliveries will be above or below 2,976 taf.
- There is 75 percent chance that SWP deliveries will be above 2,168 taf. Another way to state this is that there is a 25 percent chance that deliveries will be below this value.

Impact on Total SWP Deliveries under Current (2007) Conditions Due to Flow Restrictions to Protect Delta Smelt

As previously discussed, the updated estimates of current SWP deliveries in this report incorporate

Figure 6.1 Average and wet years SWP Table A delivery from the Delta under Current Conditions

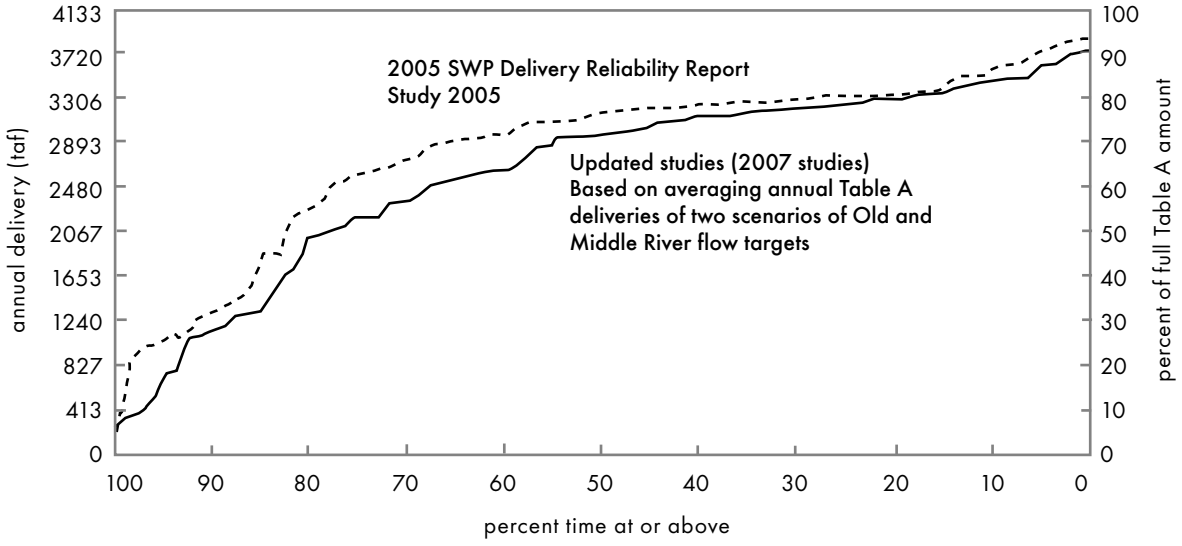


Table 6.10 Highlighted SWP Table A delivery percent exceedence values under Current Conditions

Exceedence	Annual SWP Table A Delivery (taf)		Reduction in delivery compared to 2005 report (taf)
	2005 SWP Reliability Report, Study 2005	Updated Studies (2007)[1]	
25%	3323	3218	105 (3%)
50%	3173	2976	197 (6%)
75%	2588	2168	420 (16%)

[1]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3.

effects on SWP deliveries caused by new restrictions in Old River and Middle River flows ordered by the federal court in December 2007. **Tables 6.4, 6.5, 6.7, and 6.8** indicate that both SWP Table A and Article 21 deliveries under the updated studies tend to be less overall and in particular during dry periods compared to the results presented in the previous 2005 report. This section further characterizes the change in combined SWP Table A and Article 21 SWP deliveries due to the federal court order.

For the updated delivery estimates, CalSim II simulations were run assuming a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The lower- and higher-level restrictions are significantly different during Feb. 21 through April

Figure 6.2 Distribution of changes in total annual SWP deliveries under Current Conditions due to implementation of flow restrictions to protect delta smelt

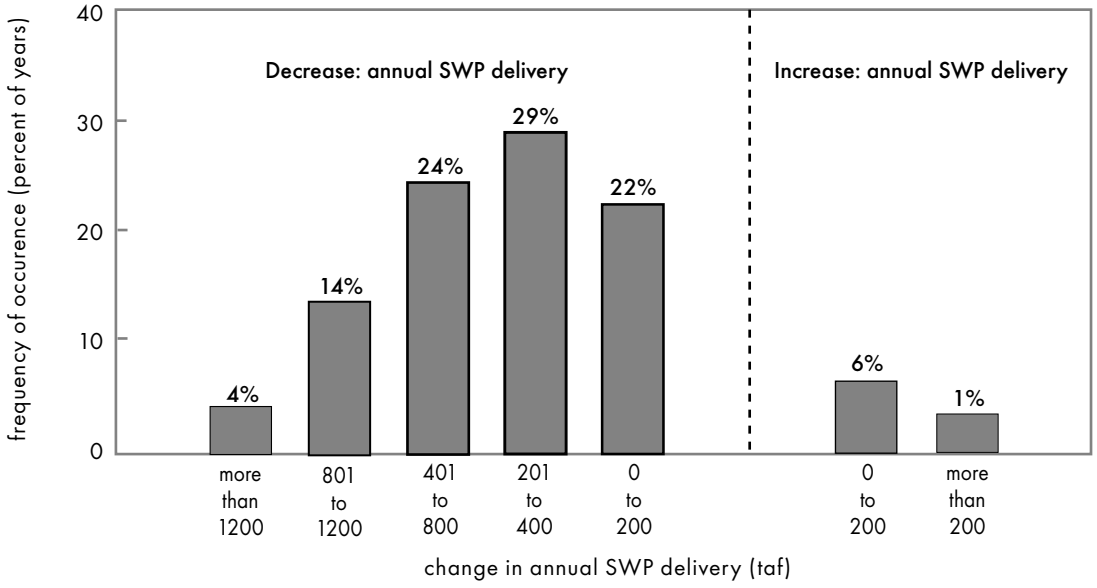
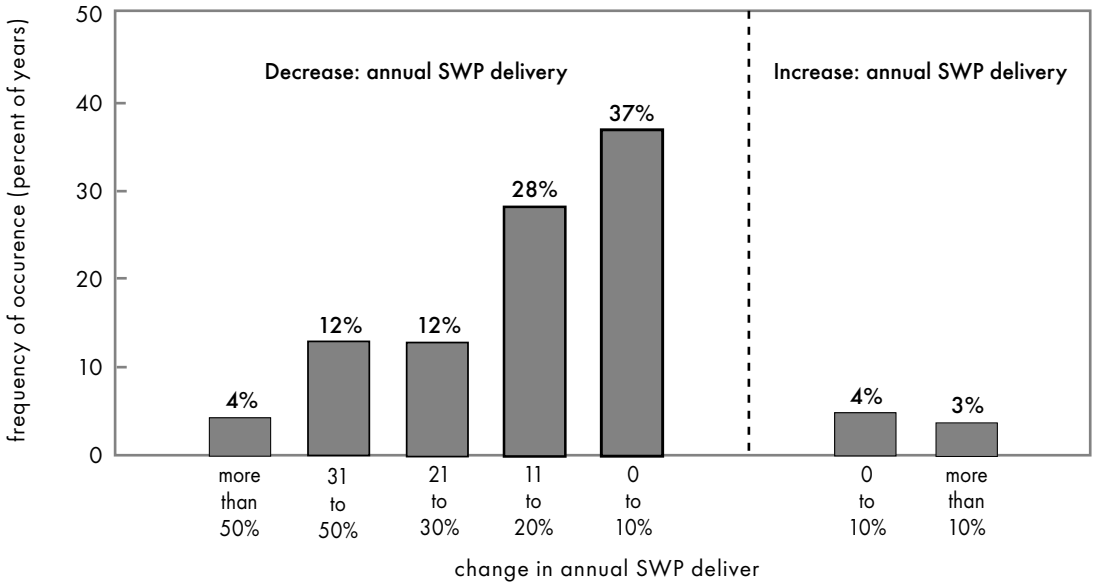


Figure 6.3 Distribution of percent changes in total annual SWP deliveries under Current Conditions due to implementation of flow restrictions to protect delta smelt



14 and May 16 through June 30. The specific rules for these flows are contained in **Table 6.3**. For presentation of combined SWP deliveries, annual SWP Table A and Article 21 deliveries from the two simulations are averaged.

Figures 6.2 and 6.3 show the distribution of changes in total annual SWP deliveries between updated estimates and estimates from the 2005 report over the common 1922 through 1994 simulation period. **Figure 6.2** shows the distribution of changes in total annual delivery in terms of thousand acre-feet and frequency of occurrence while **Figure 6.3** shows the distribution of changes in terms of percent change from the 2005 report estimates and frequency of occurrence. Any differences in SWP deliveries are nearly entirely due to the new flow restrictions for delta smelt in the updated studies. The total annual SWP deliveries which are used to generate **Figures 6.2 and 6.3** are presented in **Table B.22**.

Figures 6.2 and 6.3 show that out of the 73 years of simulation (1922-1994), total annual SWP deliveries decrease 93 percent of the time under the updated estimates. Annual deliveries decrease from 0 to 400 taf over 50 percent of the time and from 401 taf to 1,200 taf 38 percent of the time. In terms of percent decrease in deliveries, total annual SWP deliveries decrease more than 30 percent 16 percent of the time.

Table 6.7 shows that, on average, Article 21 delivery is about 175 taf less under the 2007 study than under the 2005 study. When this is combined with the difference in average SWP Table A delivery projections presented in **Table 6.4**, the difference in total average SWP delivery is about 400 taf, for an overall decrease of about 13 percent in delivery capability from the 2005 to the 2007 study

Assessment of SWP Delivery Reliability under Future (2027) conditions

Future Conditions refer to conditions that are assumed in effect in the year 2027. These conditions as described below include effects of climate change and the same Old River and Middle River flow targets that are assumed under Current (2007) Conditions. Results from the CalSim II simulation for the *2005 SWP Delivery Reliability Report* under 2025 future scenario (Study 2025) are presented throughout this section for comparison purposes. A detailed list of the study assumptions for this report is presented in Appendix A.

Availability of Source Water

DWR's 2006 report, *Progress on Incorporating Climate Change into Management of California's Water Resources*, evaluates possible future impact on California water supply through CalSim II simulations with hydrologic sequences that reflect different scenarios of climate change. The four climate change scenarios consist of two greenhouse gas emissions scenarios, A2 and B1, and two global climate models, the Geophysical Fluid Dynamic Lab model (GFDL) and the Parallel Climate model (PCM). The A2 emissions scenario assumes high growth in population, regional based economic growth, and slow technological changes, which collectively result in significantly higher greenhouse gas emissions. The B1 scenario represents low growth in population, global based economic growth, and sustainable development all of which results in a low increase in greenhouse gas emissions. Both the GFDL model and PCM predict future warming although the GFDL model indicates a greater warming trend than does the PCM. These four scenarios are assumed for the analysis in this report in order to generate the 82-year hydrologic sequence. It should be noted that these scenarios, although focusing on potential water supply conditions in 2050, include the assumption that water use in the water supply basins is at a 2020 level of development, not a 2050 level of development. In this respect, the studies span assumed temporal points of reference. They are, however, the best available estimates for future SWP water deliveries.

Demand for Delta Water

The SWP contractors' SWP Table A demands for deliveries from the Delta assumed for 2027 are shown in **Table 6.11**. The assumed demands for the studies were developed through discussions with SWP water contractors and stakeholders involved in the development of DWR's *Draft Environmental Impact Report (Draft EIR) for the Monterey Amendment to the State Water Project Contracts, including the Kern Water Bank Transfer and associated actions as part of a Settlement Agreement (Monterey Plus)*. Maximum and minimum SWP Table A demand is shown because the demand is assumed to vary each year with the weather. SWP Article 21 demands for water are the same as assumed in the 2005 SWP Delivery Reliability Report and are shown in **Table 6.12**.

Ability to Convey Source Water to the Desired Point of Delivery

One of the most significant assumptions regarding SWP conveyance is that the rules and facilities related to Delta conveyance will remain at the status quo. That is, no new facilities are assumed to be in place to convey water through, around, or through and around the Delta. As noted in Chapter 3, there are several processes under way to identify modifications to the existing method of conveying water through the Delta to reduce the conflict between fishery concerns and water supply reliability. However, these programs are not at a stage where such changes can be used in this report. The CalSim II simulations for 2027 scenarios assume the current Delta water quality regulations (contained in the State Water Resources Control Board's Decision 1641) are in place as well as the flow restrictions for Old River and Middle rivers set forth in the federal court-ordered interim action related to delta smelt. The studies evaluate a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The specific rules for these flows are contained in **Table 6.3**. The exports resulting from meeting Old River and Middle River flow targets related to delta smelt are again assumed shared equally between the CVP and the SWP.

The simulation of Future Conditions in the 2005 report (Study 2025) also assumed D-1641 Delta water quality requirements and combined SWP and CVP pumping restrictions according to the 2004 Long-Term Central Valley Project Operations Criteria and Plan. It did not assume the flow restrictions for Old River and Middle Rivers were in place.

To simulate the assumed 2027 conditions, 10 CalSim II simulations are needed: the two levels of flow restrictions combined with four climate change scenarios and a scenario assuming no climate change. SWP deliveries derived from these 10 simulations were modified as explained below before

Table 6.11 SWP Table A demands from the Delta under Future Conditions

Study of Future Conditions	Average Demand		Maximum Demand		Minimum Demand	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2025	4110	99%	4133	100%	3898	94%
Updated Studies (2027)	4111	99%	4133	100%	3935	95%

[1]/ 4,133 taf /year.

Table 6.12 Article 21 demands from the Delta under Future Conditions

Study of Future Conditions	Average Article 21 demand (taf)		Total (taf)
	December - March	April - November	
2005 SWP Delivery Reliability Report, Study 2025	704	607	1311
Updated Studies (2027)	699	598	1297

being used to describe Future (2027) Conditions.

Presentation of CalSim II Results

For the purpose of describing SWP deliveries under Future Conditions in this chapter, the annual deliveries under the four scenarios of climate change simulated by CalSim II were adjusted to better estimate deliveries reflecting 2027 conditions. As previously mentioned, the climate change scenarios for Future Conditions assume projections of climate and hydrology for 2050. Currently, 2027 climate change projections are not available. In order to estimate SWP deliveries 20 years in the future with potential changes in climate, annual SWP deliveries were interpolated between deliveries from a CalSim II simulation of a particular climate change scenario under the low or high operation restrictions for Old River and Middle River flows and deliveries from the corresponding CalSim II simulation which assumes no climate change. All CalSim II simulations for Future Conditions assume a 2027 SWP demand level.

Each climate change scenario then consists of two sequences of modified (interpolated) SWP deliveries, one sequence for each of the two levels of Old River and Middle River flow targets. For each climate change scenario, these two sequences of annual deliveries were then averaged to yield a single sequence designed to reflect a climate change projection to 2027 with an averaged Old River and Middle River flow target operation. The following tables and graph of SWP Table A delivery probability are based on these four sequences of annual SWP deliveries. The annual SWP Table A and Article 21 deliveries for the 10 simulations on which the information in this section is based are presented in Appendix B.

SWP Table A Deliveries under Different Hydrologic Scenarios

Table 6.13 contains the average, maximum, and minimum estimates of SWP Table A deliveries from the Delta under Future Conditions from Study 2025 from the *2005 SWP Delivery Reliability Report* and under updated 2027 assumptions. The deliveries under 2027 conditions are shown as a range to account for the four climate change scenarios. The estimated probabilities for a given amount of annual SWP delivery under Future (2027) Conditions are presented in **Figure 6.4**.

Table 6.13 shows that under the updated Future (2027) Conditions, average SWP delivery amounts may decrease from 8 to 11 percent of maximum SWP Table A amounts compared to earlier estimates. Since SWP Table A demands are the same in the earlier and updated studies, this decrease in deliveries is primarily due to the incorporation of the Old River and Middle River flow targets related to delta smelt reducing the amount of Delta water available for export by SWP and the assumed hydrologic changes associated with climate change. The estimate of minimum annual SWP Table A delivery for the updated study ranges from 6 to 7 percent of maximum SWP Table A amounts.

Table 6.14 includes estimates of SWP Table A deliveries for a single-year and multiyear droughts. It also includes the average of the SWP Table A

Table 6.13 SWP Table A delivery from the Delta under Future Conditions

Study of Future Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2025	3178	77%	4133	100%	187	5%
Updated Studies (2027)[3]	2724–2850	66 – 69%	4133	100%	255–293	6 – 7%

[1]/ 4,133 taf /year
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[3]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

deliveries for comparison purposes. Estimates of updated SWP deliveries under Future (2027) Conditions during dry periods can range 5 percent of maximum SWP Table A (32 percent to 37 percent for 1931-1934). This is a range of almost 210 taf/year. With the period 1931-1934 being the exception, all other multiyear droughts show reduced deliveries. The reductions range from 2 percent to 13 percent of maximum SWP Table A amounts, or from 83 taf/yr to 540 taf/yr.

Table 6.15 summarizes SWP Table A deliveries under an assumed repetition of historical wet periods under Future Conditions. As with drought years, the Eight River Index is used to identify wet years. The estimated deliveries for the updated future (2027) condition during wet periods do not generally range as much as those for the dry periods. The maximum range is 3 percent of maximum SWP Table A for the six-year and 10-year wet periods. This equates to a range of 120 taf/yr. Reductions in delivery amounts are significant for the four-, six-, and 10-year wet periods. For example, average annual SWP Table A deliveries decrease to a range of 86 to 87 percent of maximum SWP Table A for the 1980-1983 period. The estimate for the 2025 study for this period is 93 percent. This corresponds to a reduction of 250 taf/yr to 290 taf/yr.

Article 21 Deliveries under Different Hydrologic Scenarios

Table 6.16 contains the average, maximum, and minimum SWP Article 21 deliveries over the

Table 6.14 Average and dry period SWP Table A deliveries from the Delta under Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report, Study 2025	77%	5%	40%	33%	42%	38%
Updated Studies (2027)[2]	66 – 69%	7%	26 – 27%	32 – 37%	33 – 35%	33 – 36%

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.15 Average and wet period SWP Table A deliveries from the Delta under Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report, Study 2025	77%	95%	97%	93%	93%	89%
Updated Studies (2027)[2]	66 – 69%	94%	97%	86 – 87%	84 – 87%	80 – 83%

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.16 Annual SWP Article 21 delivery from the Delta under Future Conditions

Study of Current Conditions	Average delivery[1] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report, Study 2025	120	550	0
Updated Studies (2027)[2]	30	410 – 420	0

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

1922-1994 period for earlier studies and the 1922-2003 period for the updated simulations of Future (2027) Conditions. Comparing the estimates of SWP Article 21 deliveries, the updated estimates show less delivery amounts on average and for the maximum annual delivery over the simulation period. Estimated average Article 21 deliveries are 90 taf less under updated Future (2027) Conditions than was estimated in the *2005 SWP Delivery Reliability Report*. Estimated maximum

Table 6.17 Average and dry year SWP Article 21 delivery under Future Conditions (taf per year)

Year	2005 SWP Reliability Report, Study 2025	Updated Studies (2007)[2]
1929	0	0
1930	140	0
1931	0	0
1932	110	0 – 40
1933	550	20 – 90
1934	240	0 – 10
1976	0	0
1977	0	0 - 10
1987	180	0
1988	0	0
1989	90	0
1990	0	0
1991	0	0
1992	100	0
Long-term Average[1]	120	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.18 Average and wet year SWP Article 21 delivery under Future Conditions (taf per year)

Year	*2005 SWP Reliability Report*, Study 2025	Updated Studies (2027)[2]
1978	300	40 - 150
1979	140	0
1980	90	90 - 130
1981	70	0
1982	170	0
1983	360	270 – 290
1984	490	410 – 420
1985	0	0
1986	80	0 – 10
1987	180	0
1978-87 Average	190	90 – 100
Long-term Average[1]	120	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Article 21 delivery is reduced 120 to 130 taf.

Table 6.17 contains the estimates for Article 21 deliveries during historical dry periods. No Article 21 delivery is estimated for the lower range of the updated Future (2027) Conditions for any of the years. For the higher range, some Article 21 deliveries are shown for 1932 through 1934 and 1977. The availability of Article 21 deliveries during dry periods is greatly reduced in the analysis of the updated future (2027) condition.

Table 6.18 shows updated and earlier estimates of Article 21 deliveries by year during the 1978-1987 wet period. The availability of Article 21 deliveries is also reduced for this wet period. The average Article 21 delivery for the 1978 - 1987 period under Future (2027) Conditions ranges from 90 taf/yr to 100 taf/yr, compared to 190 taf/yr for the 2025 study.

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for Future (2027) Conditions in **Figure 6.4**. Results from both the 2025 study from the *2005 SWP Delivery Reliability Report* and the updated 2027 studies are shown. Probabilities for 2027 conditions are shown as a shaded area to reflect the range in SWP Table A deliveries resulting from the four climate change scenarios analyzed.

Figure 6.4 shows that under Future (2027) Conditions, for probabilities of exceedence under 80 percent, updated annual SWP Table A deliveries can be significantly less than the earlier estimates. For example, given a 60 percent time at or above, an earlier estimate of about 3,400 taf annually decreases to about 2,670 taf to 2,890 taf annually for the updated estimates. Displaying delivery

Figure 6.4 *SWP Table A* delivery probability under future conditions

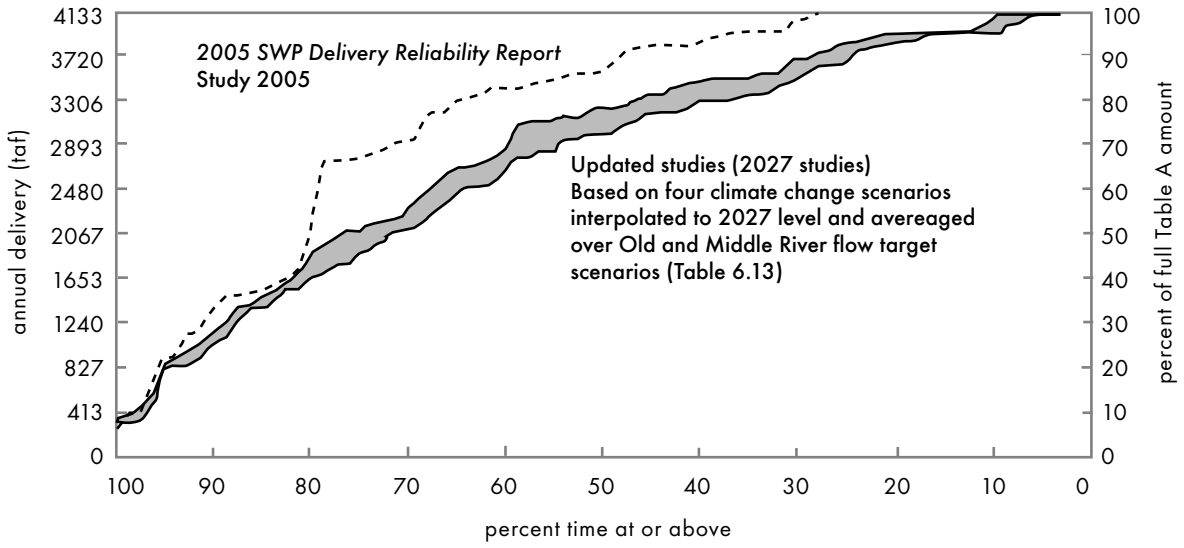


Table 6.19 Highlighted SWP Table A delivery percent exceedence values under Future Conditions

Exceedence	Annual SWP Table A Delivery (taf)		Reduction in delivery in updated studies compared to 2005 report (taf)
	2005 SWP Delivery Reliability Report, Study 2025	Updated Studies (2027)[1]	
25%	4133	3687 - 3815	318 - 446 (8 - 11%)
50%	3565	2967 - 3205	360 - 598 (10 - 17%)
75%	2738	1860 - 2077	661 - 878 (24 - 32%)

[1]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets

probabilities as a shaded area on **Figure 6.4** shows the impact of uncertainty on probabilities associated with a given future SWP Table A delivery. The information on which **Figure 6.4** is based is contained in **Tables B.12 through B.15** in Appendix B.

Table 6.19 presents the SWP Table A annual deliveries associated with 25, 50, and 75 percent exceedence from **Figure 6.4**. The information in this table can be stated as follows: For any given year,

- There is 1 chance in 4 that SWP deliveries will be at or above the range of 3,687 taf to 3,815 taf.
- There is an equal chance that SWP deliveries will be above or below the range of 2,967 taf to 3,205 taf.
- There is 75 percent chance that SWP deliveries will be above the range of 1,860 taf to 2,077 taf. Another way to state this is that there is a 25 percent chance that deliveries will be below this range.

Comparing Current and Future SWP Delivery Reliability

CalSim II simulation-based results presented earlier in this chapter compare updated delivery projections with those contained in the *2005 SWP Delivery Reliability Report* and generally show that deliveries are projected to be less than projected in the 2005 report due to adding flow restrictions for Old River and Middle rivers set forth in the recent federal court-ordered interim action related to delta smelt and potential climate change scenarios. This section presents the same CalSim II simulation-based results in a way to facilitate comparing current reliability to future reliability. Results from the *2005 SWP Delivery Reliability Report* are presented as a reference.

SWP Table A Deliveries under Different Hydrologic Scenarios

Tables 6.20, 6.21, and 6.22 contain summaries and highlights of estimated SWP Table A deliveries from the Delta under current and Future (2027) Conditions from the *2005 SWP Delivery Reliability Report* and as derived from updated CalSim II simulations for this report. In the 2005 report, future SWP deliveries on average tended to increase over current deliveries. The updated estimates of future SWP deliveries also tend to increase compared to updated estimated current deliveries. An exception is for dry periods. The 2005 report indicated that future SWP Table A deliveries for dry periods would be approximately the same as for current dry periods. The updated estimates indicate that future SWP Table A deliveries under a two-year drought condition (1976-1977) could be lower by as much as 8 percent of maximum SWP Table A than under Current (2007) Conditions (**Table 6.21**).

Article 21 Deliveries under Different Hydrologic Scenarios

Tables 6.23, 6.24, and 6.25 contain summaries and highlights of estimated SWP Article 21 deliveries

Table 6.20 SWP Table A delivery from the Delta under current and Future Conditions

Study of Future Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf /year	SWP Table A[1] maximum	taf /year	SWP Table A[1] maximum	taf /year	SWP Table A[1] maximum
2005 SWP Delivery Reliability Report						
Current (2005)	2818	68%	3848	93%	159	4%
Future (2025)	3178	77%	4133	100%	187	5%
Update Studies						
Current (2007)	2595	63%	3711	90%	243	6%
Future (2027)[3]	2724–2850	66 – 69%	4133	100%	255 – 293	6 – 7%

[1]/ 4,133 taf /year

from the Delta under current and Future Conditions from the *2005 SWP Delivery Reliability Report* and as derived from updated CalSim II simulations for this report. Overall, the CalSim II simulations from the 2005 report and the updated simulations for 2007 and 2027 conditions tend to show less Article 21 deliveries in the future. Depending on the climate change scenario, updated estimates of future SWP Article 21 deliveries may increase over updated current values for specific years; however, the long-

Table 6.21 Average and dry period SWP Table A deliveries from the Delta under current and Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[2]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report						
Current (2005)	68%	4%	41%	32%	42%	37%
Future (2025)	77%	5%	40%	33%	42%	38%
Update studies						
Current (2007)	63%	6%	34%	35%	35%	34%
Future (2027)[3]	66 – 69%	7%	26 – 27%	32 – 37%	33 – 35%	33 – 36%

Table 6.22 Average and wet period SWP Table A deliveries from the Delta under current and Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[2]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report						
Current (2005)	68%	60%	65%	69%	75%	72%
Future (2025)	77%	95%	97%	93%	93%	89%
Update studies						
Current (2007)	63%	60%	66%	68%	73%	71%
Future (2027)[3]	66 – 69%	94%	97%	86 – 87%	84 – 87%	80 – 83%

Table 6.23 Annual SWP Article 21 delivery from the Delta under current and Future Conditions

Study of Current Conditions	Average delivery[2] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report			
Current (2005)	260	1110	0
Future (2025)	120	550	0
Update studies			
Current (2007)	90	590	0
Future (2027)[3]	30	410 – 420	0

For Tables 6.20 - 6.23:
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[3]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.24 Average and dry year SWP Article 21 delivery under current and Future Conditions (taf per year)

Year	*2005 SWP Delivery Reliability Report*		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Current (2027)[2]
1929	0	0	0	0
1930	120	140	0	0
1931	0	0	0	0
1932	240	110	0	0 – 40
1933	510	550	40	20 – 90
1934	210	240	0	0 - 10
1976	190	0	5	0
1977	0	0	0	0 - 10
1987	550	180	0	0
1988	0	0	0	0
1989	0	90	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	100	0	0
Long-term Average[1]	260	120	85	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.25 Average and wet year SWP Article 21 delivery under Current and Future Conditions (taf per year)

Year	*2005 SWP Delivery Reliability Report*		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Current (2027)[2]
1978	300	300	100	40 - 150
1979	160	140	0	0
1980	140	90	190	90 - 130
1981	550	70	0	0
1982	800	170	490	0
1983	400	360	400	270 – 290
1984	550	490	460	410 – 420
1985	0	0	0	0
1986	120	80	30	0 – 10
1987	550	180	0	0
1978-87 Average	360	190	170	90 – 100
Long-term Average[1]	260	120	85	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual *Table A* deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

term average future Article 21 delivery is less than half of the estimate for the current (2007) scenario.

SWP Table A Delivery Probability

The current and future probability that a given level of SWP Table A amount will be delivered from the Delta is shown in **Figure 6.5** from the *2005 SWP Delivery Reliability Report* and in **Figure 6.6** for update studies for this report. In the 2005 report, future SWP Table A deliveries exceeded current deliveries at the 80 percent exceedence level. Under the updated simulations for this report, future SWP Table A deliveries exceed current deliveries at approximately the 60 percent exceedence level. Above this exceedence, future deliveries are larger than current deliveries,

Figure 6.5 Current and future *SWP Table A* delivery probability from the *2005 SWP Delivery Reliability Report*

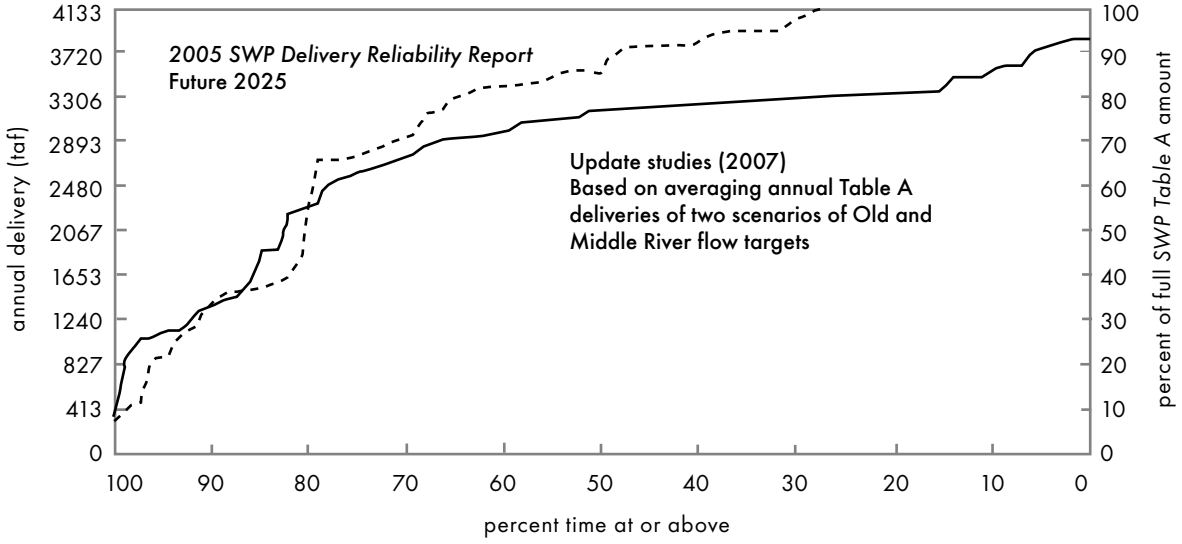
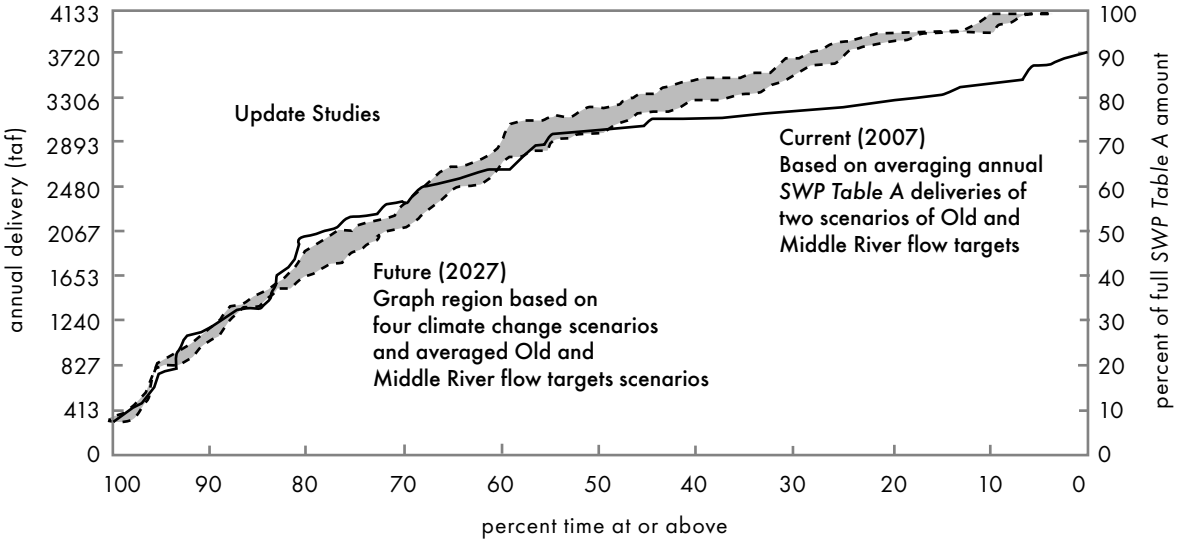


Figure 6.6 Updated current and future *SWP Table A* delivery probability



with the difference in delivery amount depending upon which climate change scenario is assumed.

Table 6.26 presents SWP Table A delivery values which correspond to 25, 50, and 75 percent exceedence for Current and Future Conditions. Previously in the 2005 report, future annual SWP deliveries were estimated to be larger than current deliveries by approximately 900 taf, 400 taf, and 150 taf for 25 percent, 50 percent, and 75 percent exceedences respectively. For the updated studies, future SWP Table A deliveries associated with a given percent exceedence may also be higher than for the deliveries at the current level (2007), but this difference is significantly less. In fact, future deliveries associated with an exceedence level of above 50 percent may be less than under Current (2007) Conditions for certain climate change scenarios.

Table 6.26 Highlighted SWP Table A delivery percent exceedence values under Current and Future Conditions

Exceedence	Annual SWP Table A Delivery (taf)			
	2005 SWP Delivery Reliability Report		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Future (2027)[1]
25%	3323	4133	3218	3687 – 3815
50%	3173	3565	2976	2967 – 3205
75%	2588	2738	2168	1860 – 2077

[1] Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Interpreting and Applying the Results for Local Planning Use

7

Chapter 6 presents a single set of estimates for current-level deliveries and a range of results for deliveries 20 years in the future. Chapter 6 and Appendix B explain how these estimates are developed. This chapter provides guidance on how to apply the delivery estimates to water management plans.

All results in this report are presented as percentages of the maximum SWP Table A amount for SWP deliveries from the Delta of 4.133 maf/yr. Estimates of deliveries for a specific SWP contractor can be converted to acre-feet/year by multiplying the percentages by that contractor's maximum SWP Table A amount. It is possible that the SWP Table A amount for a specific contractor may not be at the ultimate maximum value, but it should be very close to it. The Delta SWP Table A value for 2007 is 4.127 maf/yr, 99.9 percent of the maximum Delta SWP Table A value of 4.133 maf/yr. Therefore, for almost all purposes, this approach should be sufficient for these analyses. In addition, the percentages may also be used to estimate the SWP Table A deliveries to SWP contractors in Butte and Plumas counties and Yuba City. The deliveries to these contractors would be calculated using the same method.

The following two examples are taken from Chapter 6 of the *2005 State Water Project Delivery Reliability Report* and updated with the data from this report. These examples are developed for a hypothetical SWP contractor with a maximum SWP Table A amount of 100,000 acre-feet per year. Hypothetical examples illustrating applications of the delivery probability curves and adjustments to the data for a SWP contractor that cannot convey its maximum SWP Table A amount are provided in *The State Water Project Delivery Reliability Report 2002*. Questions regarding the use of the information contained in these reports may be directed to the Department of Water Resources' Bay-Delta Office at (916) 653-1099.

Example 1

This example uses data directly from **Table 6.21** for updated current and future estimates of SWP Table A deliveries during dry periods and employs allocation methods that provide a simple means of estimating supplies to each contractor. The analysis includes high and low estimates of the range of values for year 2027. In order to estimate deliveries between current (2007) and Future (2027) Conditions, the data in the table is interpolated for five-year increments and contained in **Table 7.1**. **Table 7.1** shows the average percentage of maximum Delta SWP Table A deliveries for average, single-dry year, and two-, four- and six-year multiple dry year scenarios from 2007 to 2027 in five-year increments.

The maximum SWP Table A amounts of each contractor are listed in Appendix C. SWP Table A amounts can be amended and a contractor's SWP Table A amount over the next 20 years may be less than its maximum over some or all of this period. In this case, the contractor should use the amended SWP Table A amounts for the corresponding years during this period. To use dry years other than those presented in **Table 7.1**, or

to show year-to-year supplies instead of averages over a multiple-dry year period, see Example 2.

How to Calculate Supplies

In order to estimate delivery amount for the average and drought periods for each five-year increment from 2007 to 2027, multiply the contractor's SWP Table A amount for a particular year by the corresponding delivery percentages for that year from **Table 7.1**.

Tables 7.2 through 7.4 show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum SWP Table A amount of 100,000 af, on average and for the various drought periods. For this example, the supplies shown for the multiple-dry year period are average supplies over the four-year drought from 1931-1934. Data from other year types, although not required in an urban water management plan, could also be presented this way.

Example 2

This example is similar to Example 1 but allows a contractor to select alternative single-year or multiple-dry year sequences other than those presented in **Table 7.1**. This option might be selected if analyzing different hydrologic year(s) makes more sense given a contractor's other supply sources, or given the locally acceptable risk level for water delivery shortages.

This example can also be used to identify supplies projected to be available in each year of a multiple-dry year period. While the Water Code does not specifically require this, the *Urban Water Management Plan Guidebook* suggests showing year-to-year supplies (see the *UWMP Guidebook*, Section 7, Step 3).

Where to Find the Data

Choose a single-year or multiple-year sequences from **Tables B.3 and B.12 through B.15** to represent single-dry year and multiple-dry year scenarios. **Table B.3** contains the percent of maximum SWP Table A deliveries under all 82 hydrologic years in the updated model study for 2007. **Tables B.12 through B.15** contains the percent of maximum SWP Table A deliveries under all 82 hydrologic years in the updated model studies for 2027.

How to Calculate Supplies

Multiply the contractor's SWP Table A amount for a particular year by the percent of maximum SWP Table A deliveries for the selected years, to get an estimated delivery amount for the years selected, for 2007 and 2027. Values for years between 2007 and 2027 can be linearly interpolated.

Tables 7.5 through 7.8 show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum SWP Table A amount of 100,000 af, in a single dry year and year-to-year over a multiple dry-year period. For this example, the single dry year selected is for 1988 conditions, and the multiple dry-year period selected is the three-year period from 1990-1992. In showing year-to-year supplies for the multiple-dry year period, these year-to-year supplies should be shown for each five-year increment during the 20-year projection period.

Table 7.1 SWP average and dry year SWP Table A delivery from the Delta in five-year intervals for studies 2007 and 2027

Year	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Average 1922 -2003	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2007	63%	6%	34%	35%	35%	34%
2012	64 - 65%	6%	32%	34 - 36%	35%	34 - 35%
2017	65 - 66%	7%	30 - 31%	34 - 36%	34 - 35%	34 - 35%
2022	66 - 68%	7%	28 - 29%	33 - 37%	34 - 35%	33 - 36%
2027	66 - 69%	7%	26 - 27%	32 - 37%	33 - 35%	33 - 36%

Table 7.2 Average annual SWP deliveries assuming a maximum SWP Table A amount of 100,000 acre-feet (acre-feet)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	63,000	64,000 – 65,000	64,000 - 66,000	65,000 - 68,000	66,000 - 69,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.3 Single dry year SWP delivery (1977 conditions) assuming a maximum SWP Table A amount of 100,000 acre-feet (acre-feet)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	6,000	6,000	7,000	7,000	7,000
State Water Project (Article 21)[1]	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.4 Average SWP Delivery over a multiple dry year period assuming a maximum SWP Table A amount of 100,000 acre-feet 1931-1934 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	35,000	34,000 – 36,000	34,000 – 36,000	33,000 – 37,000	32,000 – 37,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.5 Annual SWP delivery over single dry year (1988 conditions), assuming a maximum Table A amount of 100,000 acre-feet (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	11,540	11,490 – 12,000	11,440 – 12,460	11,370 – 12,920	11,320 – 13,380
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.6 Annual SWP delivery over multiple dry year period 1990-1992, assuming a maximum Table A amount of 100,000 acre-feet 1990 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	8,710	8,080 – 8,590	7,450 – 8,470	6,800 – 8,320	6,170 – 8,200
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.7 Annual SWP delivery over multiple dry year period 1990-1992, assuming a maximum SWP Table A amount of 100,000 acre-feet 1991 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	17,640	17,980 – 18,485	18,290 – 19,360	18,630 – 20,200	18,950 – 21,050
State Water Project (Article 21)[1]	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.8 Annual SWP delivery over multiple dry year period 1990-1992, assuming a maximum SWP Table A amount of 100,000 acre-feet 1992 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	26,300	26,180 – 26,880	26,030 – 27,460	25,910 – 28,040	25,770 – 28,620
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Appendix A. 2007 Delivery Reliability Report

CalSim II Modeling Assumptions

The CalSim II model developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP) was modified specifically for the studies in this report. The model for this report assumes a D-1641 regulatory environment and implements the 2007 federal court decision on remedy actions for the Delta smelt. Two of the proposed actions in that decision, actions 6 and 8, specify a range in upstream flow targets for Old River and Middle River (OMR). The model studies for this report consider both the high and low remedy actions for actions 6 and 8 to book-end the potential effects. The assumptions for the remedy actions are shown in the following table.

The remedy actions incorporate the Vernalis Adaptive Management Plan (VAMP) export curtailments for the period April 15 – May 15 with impacts borne by the projects. The VAMP criteria applied in the model are as follows:

Vernalis flow (cfs)	Combined exports (cfs)
< 5700	< 1500
= 5700	< 2250
> 5700 and = < 8600	< 1500 or < 3000 (alternating standard)
> 8600	< 0.5 * flow at Vernalis

Action	Period	OMR Standard (flow upstream in cfs)	
		Remedy Action High	Remedy Action Low
4	December 25 – January 3	< 2000	< 2000
5	January 4 – February 20	< 5000	< 5000
6	February 21 – April 14	< 750	< 2000
7	April 15 – May 15	No OMR standard. VAMP controls export.	No OMR standard. VAMP controls export.
8	May 16 – June 30	< 750	< 5000

Where: OMR flow = (0.58 * flow at Vernalis) – (0.913 * total export)

The 2004 OCAP model version was also modified to include the three improvements listed below.

1. The previous San Joaquin River Basin representation was replaced by the San Joaquin River Water Quality Module version 1.00 (SJRWQM) developed by U.S. Bureau of Reclamation Mid-Pacific Region. The SJRWQM is an update to previous versions that has gone through extensive agency review and a formal peer review.

2. The previous Artificial Neural Network (ANN) used to estimate flow-salinity relationships has been replaced with a newer more accurate version. The new ANN, and its accompanying implementation to the CalSim II model, produces salinities that match more closely to Delta Simulation Model 2 (DSM2) salinities.

3. The Hydrologic sequence of simulated years has been extended to include the water years 1995 – 2003. The new simulation period spans water years 1922 – 2003 whereas the previous sequence covered water years 1922- 1994.

All studies assume current SWP Delta diversion limits (often referred to as "Banks Pumping Plant capacity"), existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements. **Table A.1** lists key study assumptions. **Table A.2** presents the assumptions behind American River demands.

Table A.1 2007 Delivery Reliability Report CalSim II modeling assumptions

	Period of Simulation: 82 years (1922-2003)	
	Updated Studies (2007)	**Updated Studies (2027)**
HYDROLOGY		
Level of Development (Land Use)	2005 Level, *DWR Bulletin 160-98*[1]	2020 Level, *DWR Bulletin 160-98*[2]
North of Delta (except American River) Demands		
CVP	Land Use based, limited by Full Contract	
SWP (FRSA)	Land Use based, limited by Full Contract	
Non-Project	Land Use based	
CVP Refuges	Firm Level 2	
American River Basin Demands		
Water rights	2001 Level[3]	2020 Level[4]
CVP	2001 Level[3]	2020 Level[4]
San Joaquin River Basin Demands		
Friant Unit	Limited by contract amounts, based on current allocation policy	
Lower Basin	Land-use based, based on district level operations and constraints.	
Stanislaus River Basin	Land-use based, based on New Melones Interim Operations Plan	
South of Delta Demands		
CVP	Full Contract	
CCWD	151 taf/yr	
SWP (with North Bay Aqueduct)	2.3-3.9 maf/yr	3.9-4.1 maf/yr
SWP Article 21 Demand	MWDSC up to 100 taf/month, Dec-Mar, others up to 84 taf/month	
FACILITIES		
Freeport Regional Water Project	None	Included
Banks Pumping Capacity	6680 cfs	
Tracy Pumping Capacity	4200 cfs + deliveries upstream of DMC constriction	

	Period of Simulation: 82 years (1922-2003)	
	Updated Studies (2007)	**Updated Studies (2027)**
REGULATORY STANDARDS		
Trinity River		
Minimum Flow below Lewiston Dam	369-453 taf/yr	Trinity EIS Preferred Alternative (369-815 taf/yr)
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 taf as able)	
Clear Creek		
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to FWS and NPS, and FWS use of CVPIA 3406(b)(2) water	
Upper Sacramento River		
Shasta Lake End-of-September Minimum Storage	SWRCB WR 1993 Winter-run Biological Opinion (1900 taf)	
Minimum Flow below Keswick Dam	Flows for SWRCB WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and FWS use of CVPIA 3406(b)(2) water	
Feather River		
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 cfs)	
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750 – 1700 cfs)	
Yuba River		
Minimum flow below Daguerre Point Dam	Interim D-1641 operations	Lower Yuba River Accord
American River		
Minimum Flow below Nimbus Dam	SWRCB D-893 (see accompanying Operations Criteria), and FWS use of CVPIA 3406(b)(2) water	
Minimum Flow at H Street Bridge	SWRCB D-893	
Lower Sacramento River		
Minimum Flow near Rio Vista	SWRCB D-1641	
Mokelumne River		
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100 – 325 cfs)	
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25 – 300 cfs)	
Stanislaus River		
Minimum Flow below Goodwin Dam	1987 USBR, DFG agreement , and FWS use of CVPIA 3406(b)(2) water	
Minimum Dissolved Oxygen	SWRCB D-1422	
Merced River		
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180 – 220 cfs, Nov – Mar), and Cowell Agreement	
Minimum Flow at Shaffer Bridge	FERC 2179 (25 – 100 cfs)	
Tuolumne River		
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94 – 301 taf/yr)	
San Joaquin River		
Maximum Salinity near Vernalis	SWRCB D-1641	
Minimum Flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Program per San Joaquin River Agreement	
Sacramento River-San Joaquin River Delta		
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	
Delta Cross Channel Gate Operation	SWRCB D-1641	
Delta Exports	SWRCB D-1641, FWS use of CVPIA 3406(b)(2) water and CALFED Fisheries Agencies use of EWA assets	

	Period of Simulation: 82 years (1922-2003)	
	Updated Studies (2007)	**Updated Studies (2027)**
OPERATIONS CRITERIA		
Subsystem		
Upper Sacramento River		
Flow Objective for Navigation (Wilkins Slough)	3,250 – 5,000 cfs based on CVP Ag allocation levels	
American River		
Folsom Dam Flood Control	SAFCA, Interim re-operation of Folsom Dam, Variable 400/670 (without outlet modifications)	
Flow below Nimbus Dam	Operations criteria corresponding to SWRCB D-893 required minimum flow	
Sacramento Water Forum Mitigation Water	None	Sacramento Water Forum (up to 47 taf/yr in dry years)
Feather River		
Flow at Mouth	Maintain the DFG/DWR flow target above Verona or 2800 cfs for Apr– Sep dependent on Oroville inflow and FRSA allocation	
Stanislaus River		
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	
San Joaquin River		
Flow near Vernalis	San Joaquin River Agreement in support of the Vernalis Adaptive Management Program	
System-wide		
CVP Water Allocation		
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	
CVP Refuges	100% (75% in Shasta Critical years)	
CVP Agriculture	100% - 0% based on supply (reduced by 3406(b)(2) allocation)	
CVP Municipal & Industrial	100% - 50% based on supply (reduced by 3406(b)(2) allocation)	
SWP Water Allocation		
North of Delta (FRSA)	Contract specific	
South of Delta	Based on supply; Monterey Agreement	
CVP/SWP Coordinated Operations		
Sharing of Responsibility for In-Basin-Use	1986 Coordinated Operations Agreement	
Sharing of Surplus Flows	1986 Coordinated Operations Agreement	
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641	
Transfers		
Dry Year Program	None	
Phase 8	None	
MWDSC/CVP Settlement Contractors	None	
CVP/SWP Integration		
Dedicated Conveyance at Banks	None	
NOD Accounting Adjustments	None	

[1]/ The 2005 Level of Development for the Sacramento Valley is defined by linearly interpolated values from the 1995 Level of Development and 2020 Level of Development from *DWR Bulletin 160-98*. The San Joaquin Valley hydrology reflects 2005 land-use assumptions developed by U.S. Bureau of Reclamation to support its studies.
[2]/ The 2020 Level of Development for the Sacramento Valley is from *DWR Bulletin 160-98*. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by U.S. Bureau of Reclamation to support its studies.
[3]/ Presented in attached table of 2007 Study American River Demand Assumptions.
[4]/ Presented in attached table of 2027 Study American River Demand Assumptions.
[5]/ CalSim II model representation for the Stanislaus River does not necessarily represent U.S. Bureau of Reclamation's current or future operational policies.
[6]/ Delta diversions include operations of Los Vaqueros Reservoir and represents average annual diversion.
[7]/ Includes modified EBMUD operations of the Mokelumne River.
[8]/ This is implemented only in the PCWA Middle Fork Project releases used in defining the CalSim II inflows to Folsom Lake.

Table A.2 2007 Study American River demand assumptions

Location / Purveyor	ALLOCATION TYPE (MAXIMUM)					
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total
Auburn Dam Site (D300)						
Placer County Water Agency	0	0	0	8,500	0	**8,500**
Total	**0**	**0**	**0**	**8,500**	**0**	**8,500**
Folsom Reservoir (D8)						
Sacramento Suburban	0	0	0	0	0	**0**
City of Folsom (includes P.L. 101-514)	0	0	0	20,000	0	**20,000**
Folsom Prison	0	0	0	2,000	0	**2,000**
San Juan Water District (Placer County)	0	0	0	10,000	0	**10,000**
San Juan Water District (Sac. County) (includes P.L. 101-514)	0	11,200	0	33,000	0	**44,200**
El Dorado Irrigation District	0	7,550	0	0	0	**7,550**
El Dorado Irrigation District (P.L. 101-514)	0	0	0	0	0	**0**
City of Roseville	0	32,000	0	0	0	**32,000**
Placer County Water Agency	0	0	0	0	0	**0**
Total	**0**	**50,750**	**0**	**65,000**	**0**	**115,750**
Folsom South Canal (D9)						
So. Cal WC/ Arden Cordova WC	0	0	0	3,500	0	**3,500**
California Parks and Recreation	0	100	0	0	0	**100**
SMUD (export)	0	0	0	15,000	0	**15,000**
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	**0**
Canal Losses	0	0	0	1,000	0	**1,000**
Total	**0**	**100**	**0**	**19,500**	**0**	**19,600**
Nimbus to Mouth (D302)						
City of Sacramento	0	0	0	63,335	0	**63,335**
Arcade Water District	0	0	0	2,000	0	**2,000**
Carmichael Water District	0	0	0	8,000	0	**8,000**
Total	**0**	**0**	**0**	**73,335**	**0**	**73,335**
Sacramento River (D162)						
Placer County Water Agency	0	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**	**0**
Sacramento River (D167/D168)						
City of Sacramento	0	0	0	38,665	0	**38,665**
Sacramento County Water Agency (SMUD transfer)	0	0	0	0	0	**0**
Sacramento County Water Agency (P.L. 101-514)	0	0	0	0	0	**0**
EBMUD (export)	0	0	0	0	0	**0**
Total	**0**	**0**	**0**	**38,665**	**0**	**38,665**
Total from the American River	**0**	**50,850**	**0**	**166,335**	**0**	**217,185**

Table A.3 2027 Study American River demand assumptions

Location / Purveyor	ALLOCATION TYPE (MAXIMUM)					
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total
Auburn Dam Site (D300)						
Placer County Water Agency	0	0	0	35,500	0	**35,500**
Total	**0**	**0**	**0**	**35,500**	**0**	**35,500**
Folsom Reservoir (D8)						
Sacramento Suburban	0	0	0	29,000	0	**29,000**
City of Folsom (includes P.L. 101-514)	0	7,000	0	27,000	0	**34,000**
Folsom Prison	0	0	0	2,000	0	**2,000**
San Juan Water District (Placer County)	0	0	0	25,000	0	**25,000**
San Juan Water District (Sac County) (includes P.L. 101-514)	0	24,200	0	33,000	0	**57,200**
El Dorado Irrigation District	0	7,550	0	0	0	**7,550**
El Dorado Irrigation District (P.L. 101-514)	0	7,500	0	0	0	**7,500**
City of Roseville	0	32,000	0	30,000	0	**62,000**
Placer County Water Agency	0	0	0	0	0	**0**
Total	**0**	**78,250**	**0**	**146,000**	**0**	**224,250**
Folsom South Canal (D9)						
So. Cal WC / Arden Cordova WC	0	0	0	5,000	0	**5,000**
California Parks and Recreation	0	5,000	0	0	0	**5,000**
SMUD (export)	0	15,000	0	15,000	0	**30,000**
South Sacramento County Agriculture (export, SMUD transfer)	35,000	0	0	0	0	**35,000**
Canal Losses	0	0	0	1,000	0	**1,000**
Total	**35,000**	**20,000**	**0**	**21,000**	**0**	**76,000**
Nimbus to Mouth (D302)						
City of Sacramento	0	0	0	96,300	0	**96,300**
Arcade Water District	0	0	0	11,200	0	**11,200**
Carmichael Water District	0	0	0	12,000	0	**12,000**
Total	**0**	**0**	**0**	**119,500**	**0**	**119,500**
Sacramento River (D162)						
Sacramento Suburban	0	0	0	29,000	0	**29,000**
Total	**0**	**0**	**0**	**29,000**	**0**	**29,000**
Sacramento River (D167/D168)						
City of Sacramento	0	0	0	34,300	0	**34,300**
Sacramento County Water Agency (SMUD transfer)	0	30,000	0	0	0	**30,000**
Sacramento County Water Agency (P.L. 101-514)	0	15,000	0	0	0	**15,000**
EBMUD (export)	0	133,000	0	0	0	**133,000**
Total	**0**	**178,000**	**0**	**34,300**	**0**	**212,300**
Total from the American River	**35,000**	**98,250**	**0**	**322,000**	**0**	**455,250**

Folsom Unimpaired Inflow (FUI) FUI = Total taf (Mar – Sep) + 60 taf			Notes
> 1600	**> 950**	**< 400**	
35,500	35,500	35,500	
35,500	**35,500**	**35,500**	
29,000	0	0	4,5,10
34,000	34,000	20,000	1,2,3
2,000	2,000	2,000	
25,000	25,000	10,000	
57,200	57,200	44,200	1,2,3
7,550	7,550	7,550	1,2,3
7,500	7,500	1,450	1,2,3
54,900	54,900	39,800	
0	0	0	10
217,150	**188,150**	**125,000**	
5,000	5,000	5,000	
5,000	5,000	5,000	
30,000	30,000	15,000	1,2,3
35,000	0	0	4,5
1,000	1,000	1,000	
76,000	**41,000**	**26,000**	
96,300	96,300	50,000	6,7,8
11,200	11,200	3,500	12
12,000	12,000	12,000	
119,500	**119,500**	**65,500**	
0	29,000	29,000	4,5
0	**29,000**	**29,000**	
34,300	34,300	80,600	8
0	0	0	9
0	0	0	9
0	0	0	
34,300	**34,300**	**80,600**	
448,150	**384,150**	**252,000**	

[1]/ Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 950,000 af.
[2]/ Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 950,000 af but greater than 400,000 af.
[3]/ Driest years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 400,000 af.
[4]/ Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 1,600,000 af.
[5]/ Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 1,600,000 af.
[6]/ Wet/average years as it applies to the City of Sacramento are time periods when the flows bypassing the E. A. Fairbairn Water Treatment Plant diversion exceed the "Hodge flows."
[7]/ Drier years are time periods when the flows bypassing the City's E.A. Fairbairn Water Treatment Plant diversion do not exceed the "Hodge flows."
[8]/ For modeling purposes, it is assumed that the City of Sacramento's total annual diversions from the American and Sacramento River in year 2030 would be 130,600 af.
[9]/ The total demand for Sacramento County Water Agency would be up to 78,000 af. The 45,000 af represents firm entitlements; the additional 33,000 af of demand is expected to be met by intermittent surplus supply. The intermittent supply is subject to Reclamation reduction (50%) in dry years.
[10]/ Water Rights Water provided by releases from PCWA's Middle Fork Project; inputs into upper American River model must be consistent with these assumptions.
[11]/ Demand requires "Replacement Water" as indicated below
[12]/ Arcade WD demand modeled as step function: one demand when FUI > 400, another demand when FUI < 400.

Appendix B. Results of Report CalSim II Studies

The supply reliability of the State Water Project is estimated in studies by using a computer program that simulates the operation of the SWP on a monthly basis over an 82-year historical record of rainfall and runoff (1922–2003). The simulation model integrates all the relevant water resource components and calculates key water management parameters, such as:

- the amount of water released from reservoirs in the Sacramento-San Joaquin valleys,
- the amount of water required to maintain Delta water quality standards,
- the amount of water to be pumped from the Delta by the SWP and the Central Valley Project (CVP), and
- the amount of water that can be delivered by each of these projects.

The information required to run the simulation is referred to as the "model input." The most significant categories of input are:

- the physical description of the water system facilities (maximum pumping or release capacity, maximum reservoir storages, etc.);
- institutional requirements (delivery contract requirements, Delta water quality standards, the operations agreement between the SWP and CVP, endangered species requirements, and other requirements of federal and state laws, etc);
- hydrology (river and stream flows adjusted for water use in the source areas); and
- the level of SWP water demand.

CalSim II is the current version of the computer simulation model used to estimate SWP delivery reliability. All versions of CalSim employ commercially available linear programming software as a solution device. The application of the software, graphical user interface, and input/output devices are discussed in the documentation for CalSim which is available at **http://baydeltaoffice.water.ca.gov/ modeling/hydrology/CalSimII/.**

The model studies selected for this report are intended to estimate current SWP delivery reliability and future SWP delivery reliability in the year 2027. Estimating current SWP delivery reliability assumes the SWP and CVP operate to meet Old River and Middle River flow targets specified in the 2007 federal court ruling on interim measures to protect delta smelt. Estimating future SWP delivery reliability in 2027 assumes an altered hydrology due to climate change, no new facilities or improvements to existing facilities, an increased SWP water demand, and existing institutional requirements, including the 2007 federal court ruling.

As listed in **Table B.1**, 12 CalSim II simulations were used in this report: two for estimating current (2007) SWP delivery reliability and 10 for estimating future (2027) SWP delivery reliability. Two simulations were needed for estimating current reliability due to uncertainty in which Old River

and Middle River flow target might apply. The 2007 proposed federal court ruling gave discretion to USFWS to determine whether at times a more or less restrictive flow target should be met based upon USFWS's assessment of the vulnerability of delta smelt at that time. The yearly annual SWP deliveries from these two studies were averaged to yield a single sequence of annual SWP deliveries to describe Current Conditions while incorporating average impacts to deliveries due to Old River and Middle River flow targets contained in the federal court ruling.

Ten CalSim II simulations were needed to estimate future (2027) reliability due to three factors:

1. uncertainty in how climate change may affect the source water for SWP,
2. the need to adjust CalSim II results to account for the climate change scenarios assuming a 2050 level of emissions, and
3. uncertainty in which Old River and Middle River flow target might apply.

The ten simulations consist of four climate change scenarios and a no-climate-change scenario which each assume two scenarios of Old River and Middle River flow targets. The four climate change scenarios are defined by the climate change model used and the assumed greenhouse gas emissions scenario. One emissions scenario, referred to as "A2," assumes high growth in population, regional based economic growth, and slow technological changes, which results in significantly higher greenhouse gas emissions. The other emissions scenario, "B1," represents low growth in population, global based economic growth and sustainable development that results in a low increase in greenhouse gas emissions. The climate change models used are the Geophysical Fluid Dynamic Lab model (GFDL) and the Parallel Climate model (PCM). Both models project future warming although the GFDL model indicates a greater warming tread than the PCM.

Table B.1 Summary of CalSim II simulations used to update SWP delivery estimates

Time Frame	Climate Change Model	Greenhouse Gas Emissions Scenario	Old River and Middle River flow target targets[1]
Current	None	None	Less restrictive
			More restrictive
Future	None	None	Less restrictive
			More restrictive
Future	Geophysical Fluid Dynamic Lab Model	A2	Less restrictive
			More restrictive
		B1	Less restrictive
			More restrictive
Future	Parallel Climate Model	A2	Less restrictive
			More restrictive
		B1	Less restrictive
			More restrictive

Note: The Geophysical Fluid Dynamic Lab model and PCM refers to the Parallel Climate model. The GFDL model indicates a greater warming tread than the PCM. A2 emissions scenario assumes high growth in population, regional based economic growth, and slow technological changes, which results in significantly higher greenhouse gas emissions. B2 emissions scenario represents low growth in population, global based economic growth and sustainable development that results in a low increase in greenhouse gas emissions.
1/ Less restrictive Old River and Middle River flow targets refer to combined Old River and Middle River flow not more than 5,000 cfs in upstream direction in February 21 – April 14; June 1-30. More restrictive Old River and Middle River flow targets refer to combined Old River and Middle River flow being not more than 750 cfs in upstream direction during February 21 – April 14 and June 1 – 30 (see Table 6.3). maf = million acre-feet; taf = thousand acre-feet

The climate change scenarios used in this report to describe future SWP delivery reliability then are:

1. A2 emissions scenario with the GFDL model,
2. B1 emissions with the GFDL model,
3. A2 emissions with the PCM model,
4. B1 emissions with the PCM model.

Each climate change scenario generates two sequences of future SWP deliveries due to each assuming two scenarios of Old River and Middle River flow targets.

The ten CalSim II simulations were used to generate four sequences of future (2027) SWP deliveries which are used to describe future SWP delivery reliability in Chapter 6 of this report. This process consisted of first interpolating between sequences to estimate SWP deliveries under climate change affects for 2027 instead of 2050, then averaging each pair of sequences differentiated by Old River and Middle River flow targets scenario. The A2 and B1 greenhouse gas emissions scenarios assume a 2050 level of emissions. Scenarios for 2027 were not available at the time of composing this report. A key assumption in estimating 2027 SWP delivery reliability for this report is that SWP deliveries for a CalSim II simulation which assumes 2027 SWP demands and 2027 climate change, would fall somewhere between CalSim II simulations which assume 2027 SWP demands and no climate change and 2027 SWP demands and climate change corresponding to 2050 emissions. Just where these SWP deliveries would fall is estimated in this report by interpolating between each sequence from a scenario which assumes 2050 emissions and a scenario which assumes no climate change. The interpolation is as follows:

Future (2027) annual SWP delivery = NCC + (20/43) (CC – NCC)

Where
NCC = annual SWP delivery for future, no climate change scenario
CC = annual SWP delivery for future with climate change scenario, which assumes 2050 emission levels

The ratio of 20/43 corresponds to the ratio of calendar years: (2027-2007)/(2050-2007)

The key study assumptions are described in detail in Chapter 3 and Appendix A. Additional discussions of the Operations Criteria and Plan (OCAP) studies are on the US Bureau of Reclamation's website at **http://www.usbr.gov/mp/cvo/ocap_page.html**.

Study Results

The annual delivery amounts estimated by the twelve CalSim II simulations are contained in **Tables B.3 through B.15**. The tables show the demand level, the amount of delivery from the Delta, and percent of maximum total SWP Table A amounts for the SWP contractors receiving water from the Delta. Of the 29 SWP contractors, 26 receive their deliveries from the Delta. The total maximum SWP Table A amount for all SWP contractors is 4.173 maf/year. Of this amount, 4,133 taf/yr is the maximum Delta SWP Table A amount. Also presented are the results of interpolating and averaging SWP delivery sequences which provide the information used in Chapter 6 in assessing current and future SWP delivery reliability. Current and future SWP deliveries are presented both in time sequence and by ranking to correspond to the data presented in the summary/highlight tables and used to generate the probability curves in Chapter 6.

These values must be interpreted within the context of the assumptions upon which they are calculated. For example, for the year 1958 in the 2027 study which assumes PCM model with high emissions and less restrictive Old River and Middle River flow targets, the annual delivery is calculated to be 4,133 taf or 100 percent of maximum Delta SWP Table A (see **Table B.8**). This result should be stated as follows under the assumptions of:

1. rainfall that was similar to what it was in 1958 but modified to reflect climate change effects as predicted by PCM model under assumed higher emissions;
2. the level of water use in the source area is increased to the level it would be in 2027;

3. SWP facilities and operation requirements are the same as they are today with less restrictive Old River and Middle River flow targets in effect;
4. SWP contractor demands are at their maximum Delta SWP Table A level, then SWP would deliver approximately 4,133 taf or 100 percent of the maximum Delta SWP Table A.

Actually, the conditional statement associated with the result for any particular year is even more complicated than this because the result is also dependent upon the rainfall that has occurred in previous years. For example, if the previous year (1957) was wet, runoff for 1958 for the same amount of rainfall would be greater than if 1957 were dry. In addition, reservoir storage for the beginning of 1958 varies depending upon the weather conditions in 1957. Thus, each year's simulation is dependent on the previous year's simulation and, hence, any year in the entire historical sequence is linked to all previous years.

Table B.2 summarizes the delivery estimates for the SWP for important dry sequences computed in the studies for current (2007) and Future (2027) Conditions. The percentages of maximum SWP Table A amounts are based on averaging current deliveries and interpolating and then averaging future annual SWP Table A deliveries as previously discussed. This information can be helpful in analyzing the delivery reliability of a specific water system that receives a portion of its water supply from the SWP. The series of data contained in **Tables B.3 through B.15** are also helpful in analyzing longer periods of time that contain not only dry periods but wetter periods which can replenish water supplies.

Table B.16 presents the annual SWP Article 21 deliveries under Current Conditions and **Tables B.17 through B.20** present annual SWP Article 21 deliveries under the four climate change scenarios under Future Conditions for both the higher and lower Old and Middle River flow targets.

Probability distribution curves derived from the CalSim II simulations used in this report are presented in **Figures B.1 through B.4** to visually show the estimated percentage of years a given annual delivery is equaled or exceeded. In this report, this value represents the probability of receiving at least a given level of delivery in any particular year. As a reference, probability distribution curves for the 2005 and 2025 studies from the 2005 State Water Project Delivery Reliability Report are presented along with the curves from the 2007 and 2027 studies in this report. SWP Table A delivery values for 25%, 50%, and 75% exceedences are shown for all scenarios in **Table B.21**.

Finally, the combined SWP Table A and Article 21 amounts under current conditions as calculated in the 2005 Reliability Report and the 2007 updated report are presented in **Table B.22** to show the estimated impact on total SWP deliveries due to flow restrictions to protect delta smelt.

Table B.2 SWP average and dry year SWP Table A delivery from the Delta (in percent of maximum SWP Table A amounts[1])

Time Frame	Climate Change Model	Emissions Scenario	Average 1922 - 2003	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
Current 2007	none	none	63%	6%	34%	35%	35%	34%
Future 2027	Geophysical Fluid Dynamic Lab Model	A2	66%	7%	26%	32%	34%	34%
		B1	66%	7%	27%	32%	33%	33%
	Parallel Climate Model	A2	67%	7%	26%	33%	33%	34%
		B1	69%	7%	27%	37%	35%	36%

[1]/ 4,133 taf/year

Table B.3 SWP Table A deliveries under Current (2007) Conditions
Derived values for estimating probability curve

Year	SWP Table A demands (taf)	SWP Table A deliveries for 2007 studies				Probability Curve[1]		
		lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Year	SWP Table A Delivery (taf)	Exceedence Frequency
1922	3,752	3,737	3,611	3,674	89%	1993	3,711	0%
1923	3,253	3,250	3,067	3,159	76%	1927	3,699	1%
1924	3,491	529	272	400	10%	1922	3,674	3%
1925	3,355	1,528	1,759	1,644	40%	1978	3,599	4%
1926	3,395	2,449	1,923	2,186	53%	1956	3,581	5%
1927	3,862	3,782	3,616	3,699	89%	1951	3,497	6%
1928	3,460	2,165	1,953	2,059	50%	1959	3,465	8%
1929	2,909	840	667	753	18%	2000	3,451	9%
1930	3,328	2,076	1,980	2,028	49%	1996	3,440	10%
1931	2,935	1,158	1,053	1,105	27%	1999	3,439	11%
1932	3,141	1,449	1,161	1,305	32%	1963	3,406	12%
1933	3,429	2,211	1,751	1,981	48%	1938	3,394	14%
1934	3,472	1,272	1,357	1,315	32%	1935	3,334	15%
1935	3,800	3,619	3,050	3,334	81%	1953	3,323	16%
1936	3,598	3,422	2,826	3,124	76%	1971	3,317	17%
1937	3,544	3,210	3,227	3,219	78%	1968	3,297	19%
1938	3,396	3,394	3,394	3,394	82%	1966	3,265	20%
1939	3,264	3,257	3,256	3,256	79%	1970	3,257	21%
1940	3,241	3,208	3,122	3,165	77%	1939	3,256	22%
1941	2,528	2,526	2,526	2,526	61%	1984	3,227	24%
1942	3,169	3,167	3,167	3,167	77%	1937	3,219	25%
1943	3,156	3,154	3,154	3,154	76%	1975	3,218	26%
1944	3,092	2,971	2,888	2,930	71%	1954	3,201	27%
1945	3,114	3,088	3,082	3,085	75%	1946	3,199	28%
1946	3,217	3,215	3,183	3,199	77%	1985	3,198	30%
1947	3,424	2,637	1,992	2,314	56%	1974	3,184	31%
1948	3,397	2,637	2,582	2,609	63%	1942	3,167	32%
1949	3,315	1,423	1,119	1,271	31%	1940	3,165	33%
1950	3,467	2,629	2,294	2,462	60%	1923	3,159	35%
1951	3,499	3,497	3,497	3,497	85%	1943	3,154	36%
1952	2,587	2,585	2,585	2,585	63%	1989	3,130	37%
1953	3,325	3,323	3,323	3,323	80%	1979	3,128	38%
1954	3,296	3,293	3,110	3,201	77%	1981	3,128	40%
1955	3,230	1,202	1,071	1,137	28%	1936	3,124	41%
1956	3,583	3,581	3,581	3,581	87%	1997	3,101	42%
1957	3,237	2,670	2,420	2,545	62%	1973	3,085	43%
1958	3,032	3,029	3,030	3,030	73%	1945	3,085	45%
1959	3,549	3,389	3,541	3,465	84%	1958	3,030	46%
1960	3,557	1,665	1,255	1,460	35%	1998	3,008	47%
1961	3,582	2,517	2,197	2,357	57%	1995	2,993	48%
1962	3,692	2,908	3,015	2,962	72%	1967	2,990	49%
1963	3,825	3,717	3,095	3,406	82%	1962	2,962	51%
1964	3,494	2,018	2,404	2,211	53%	2003	2,943	52%
1965	3,061	3,028	2,693	2,861	69%	1982	2,940	53%

Table B.3 (cont.) SWP water delivery from the Delta under Current (2007) Conditions
Derived values for estimating probability curve

Year	*SWP Table A* demands (taf)	SWP Table A deliveries for 2007 studies				Probability Curve[1]		
		lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Year	SWP Table A Delivery (taf)	Exceedence Frequency
1966	3,284	3,282	3,249	3,265	79%	1944	2,930	54%
1967	3,002	2,989	2,991	2,990	72%	1965	2,861	56%
1968	3,326	3,324	3,270	3,297	80%	1987	2,825	57%
1969	2,638	2,626	2,625	2,626	64%	1980	2,710	58%
1970	3,259	3,257	3,257	3,257	79%	1969	2,626	59%
1971	3,343	3,329	3,305	3,317	80%	1948	2,609	61%
1972	3,459	1,881	1,533	1,707	41%	1976	2,604	62%
1973	3,099	3,094	3,077	3,085	75%	1952	2,585	63%
1974	3,186	3,184	3,183	3,184	77%	1957	2,545	64%
1975	3,231	3,229	3,206	3,218	78%	1941	2,526	66%
1976	3,473	2,973	2,234	2,604	63%	1983	2,497	67%
1977	3,423	225	260	243	6%	1950	2,462	68%
1978	3,625	3,598	3,601	3,599	87%	1961	2,357	69%
1979	3,514	3,249	3,007	3,128	76%	1947	2,314	70%
1980	2,717	2,711	2,709	2,710	66%	1986	2,294	72%
1981	3,360	3,273	2,982	3,128	76%	1964	2,211	73%
1982	2,942	2,940	2,940	2,940	71%	1926	2,186	74%
1983	2,499	2,497	2,497	2,497	60%	2002	2,162	75%
1984	3,229	3,227	3,227	3,227	78%	1994	2,105	77%
1985	3,216	3,213	3,184	3,198	77%	1928	2,059	78%
1986	2,323	2,294	2,294	2,294	56%	1930	2,028	79%
1987	2,898	2,868	2,782	2,825	68%	1933	1,981	80%
1988	2,969	544	409	477	12%	1972	1,707	82%
1989	3,553	3,132	3,129	3,130	76%	1925	1,644	83%
1990	3,630	500	220	360	9%	1960	1,460	84%
1991	3,427	806	652	729	18%	1934	1,315	85%
1992	3,368	1,096	1,078	1,087	26%	1932	1,305	87%
1993	3,864	3,846	3,576	3,711	90%	1949	1,271	88%
1994	3,672	2,071	2,138	2,105	51%	2001	1,164	89%
1995	3,015	2,995	2,992	2,993	72%	1955	1,137	90%
1996	3,441	3,440	3,440	3,440	83%	1931	1,105	91%
1997	3,308	3,026	3,176	3,101	75%	1992	1,087	93%
1998	3,015	3,008	3,007	3,008	73%	1929	753	94%
1999	3,441	3,440	3,439	3,439	83%	1991	729	95%
2000	3,469	3,463	3,439	3,451	84%	1988	477	96%
2001	3,710	1,334	994	1,164	28%	1924	400	98%
2002	3,847	2,470	1,853	2,162	52%	1990	360	99%
2003	3,469	3,130	2,756	2,943	71%	1977	243	100%
Avg	**3,309**	**2,658**	**2,531**	**2,595**	**63%**		**2,595**	
Min	**2,323**	**225**	**220**	**243**	**6%**		**243**	
Max	**3,864**	**3,846**	**3,616**	**3,711**	**90%**		**3,711**	

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.4 SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	4,057	98%	4,068	98%	4,062	98%
1923	4,133	3,114	75%	2,056	50%	2,622	63%
1924	4,133	438	11%	750	18%	583	14%
1925	4,133	1,628	39%	1,470	36%	1,554	38%
1926	4,133	2,414	58%	2,149	52%	2,291	55%
1927	4,133	4,133	100%	3,816	92%	3,986	96%
1928	4,133	2,109	51%	2,160	52%	2,133	52%
1929	4,133	847	20%	881	21%	863	21%
1930	4,133	2,357	57%	2,470	60%	2,410	58%
1931	4,133	1,098	27%	1,066	26%	1,083	26%
1932	4,133	1,512	37%	1,352	33%	1,437	35%
1933	4,133	2,274	55%	1,357	33%	1,847	45%
1934	4,133	1,327	32%	1,312	32%	1,320	32%
1935	4,133	3,734	90%	3,205	78%	3,488	84%
1936	4,133	3,569	86%	3,682	89%	3,622	88%
1937	4,133	3,510	85%	2,292	55%	2,943	71%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,527	85%	2,488	60%	3,044	74%
1940	4,133	3,642	88%	3,749	91%	3,691	89%
1941	3,898	3,908	95%	3,907	95%	3,907	95%
1942	4,133	4,133	100%	3,633	88%	3,900	94%
1943	4,133	3,849	93%	3,535	86%	3,703	90%
1944	4,133	2,924	71%	2,131	52%	2,555	62%
1945	4,133	3,394	82%	3,354	81%	3,375	82%
1946	4,133	3,795	92%	3,283	79%	3,557	86%
1947	4,133	1,697	41%	2,004	48%	1,839	45%
1948	4,133	3,256	79%	2,393	58%	2,854	69%
1949	4,133	1,387	34%	1,504	36%	1,441	35%
1950	4,133	2,738	66%	2,569	62%	2,660	64%
1951	4,133	4,133	100%	3,983	96%	4,063	98%
1952	3,898	3,907	95%	3,907	95%	3,907	95%
1953	4,133	4,091	99%	3,164	77%	3,660	89%
1954	4,133	3,079	74%	2,795	68%	2,947	71%
1955	4,133	980	24%	967	23%	974	24%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	2,460	60%	2,002	48%	2,247	54%
1958	4,133	4,133	100%	4,132	100%	4,133	100%
1959	4,133	3,219	78%	2,268	55%	2,777	67%
1960	4,133	1,557	38%	2,077	50%	1,799	44%
1961	4,133	2,746	66%	2,092	51%	2,442	59%
1962	4,133	3,016	73%	2,962	72%	2,991	72%
1963	4,133	3,923	95%	3,629	88%	3,786	92%
1964	4,133	1,605	39%	1,557	38%	1,583	38%
1965	4,133	3,368	81%	3,285	79%	3,329	81%

Table B.4 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,476	84%	2,984	72%	3,247	79%
1967	4,133	4,133	100%	4,133	100%	4,133	100%
1968	4,133	2,988	72%	2,614	63%	2,814	68%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	3,971	96%	4,058	98%
1971	4,133	3,665	89%	3,456	84%	3,568	86%
1972	4,133	1,458	35%	1,563	38%	1,507	36%
1973	4,133	4,133	100%	3,571	86%	3,872	94%
1974	4,133	4,133	100%	4,133	100%	4,133	100%
1975	4,133	3,624	88%	3,179	77%	3,417	83%
1976	4,133	2,167	52%	1,720	42%	1,959	47%
1977	4,133	287	7%	332	8%	308	7%
1978	3,898	3,905	94%	3,904	94%	3,905	94%
1979	4,133	3,292	80%	2,937	71%	3,127	76%
1980	3,898	3,766	91%	3,492	84%	3,639	88%
1981	4,133	2,737	66%	2,535	61%	2,643	64%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,025	97%	4,083	99%
1985	4,133	3,226	78%	2,518	61%	2,897	70%
1986	3,898	2,863	69%	2,957	72%	2,907	70%
1987	4,133	2,679	65%	2,551	62%	2,619	63%
1988	4,133	450	11%	628	15%	533	13%
1989	4,133	3,486	84%	3,060	74%	3,288	80%
1990	4,133	281	7%	514	12%	389	9%
1991	4,133	889	22%	869	21%	880	21%
1992	4,133	1,124	27%	1,091	26%	1,109	27%
1993	4,133	4,036	98%	3,989	97%	4,014	97%
1994	4,133	1,866	45%	1,193	29%	1,553	38%
1995	3,898	3,903	94%	3,903	94%	3,903	94%
1996	4,133	4,133	100%	3,653	88%	3,910	95%
1997	4,133	3,301	80%	3,235	78%	3,271	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	3,777	91%	3,967	96%
2000	4,133	3,960	96%	3,264	79%	3,636	88%
2001	4,133	769	19%	872	21%	817	20%
2002	4,133	2,586	63%	2,387	58%	2,493	60%
2003	4,133	3,213	78%	3,224	78%	3,218	78%
Avg	**4,106**	**2,947**	**71%**	**2,729**	**66%**	**2,846**	**69%**
Min	**3,898**	**281**	**7%**	**332**	**8%**	**308**	**7%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.5 SWP Table A from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	3,664	89%	3,597	87%	3,633	88%
1923	4,133	2,991	72%	2,312	56%	2,676	65%
1924	4,133	125	3%	437	11%	270	7%
1925	4,133	1,565	38%	1,350	33%	1,465	35%
1926	4,133	1,968	48%	1,727	42%	1,856	45%
1927	4,133	3,706	90%	3,688	89%	3,697	89%
1928	4,133	1,895	46%	1,754	42%	1,829	44%
1929	4,133	646	16%	702	17%	672	16%
1930	4,133	2,114	51%	2,461	60%	2,275	55%
1931	4,133	1,046	25%	804	19%	934	23%
1932	4,133	1,165	28%	1,350	33%	1,251	30%
1933	4,133	1,915	46%	885	21%	1,436	35%
1934	4,133	1,427	35%	1,315	32%	1,375	33%
1935	4,133	3,087	75%	2,933	71%	3,015	73%
1936	4,133	2,959	72%	3,552	86%	3,235	78%
1937	4,133	3,774	91%	2,391	58%	3,131	76%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,158	76%	2,237	54%	2,730	66%
1940	4,133	3,136	76%	3,317	80%	3,220	78%
1941	3,898	3,798	92%	3,532	85%	3,674	89%
1942	4,133	3,626	88%	3,192	77%	3,424	83%
1943	4,133	3,466	84%	3,498	85%	3,481	84%
1944	4,133	2,550	62%	1,627	39%	2,121	51%
1945	4,133	3,315	80%	3,442	83%	3,374	82%
1946	4,133	3,430	83%	3,007	73%	3,233	78%
1947	4,133	1,819	44%	1,588	38%	1,711	41%
1948	4,133	2,891	70%	2,343	57%	2,636	64%
1949	4,133	1,096	27%	1,127	27%	1,110	27%
1950	4,133	2,232	54%	2,339	57%	2,282	55%
1951	4,133	4,133	100%	3,991	97%	4,067	98%
1952	3,898	3,907	95%	3,876	94%	3,893	94%
1953	4,133	3,163	77%	2,476	60%	2,843	69%
1954	4,133	3,034	73%	2,505	61%	2,788	67%
1955	4,133	998	24%	854	21%	931	23%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	1,991	48%	1,770	43%	1,888	46%
1958	4,133	4,133	100%	3,627	88%	3,898	94%
1959	4,133	2,933	71%	2,399	58%	2,684	65%
1960	4,133	1,237	30%	1,680	41%	1,443	35%
1961	4,133	2,492	60%	2,077	50%	2,299	56%
1962	4,133	3,124	76%	2,927	71%	3,033	73%
1963	4,133	3,119	75%	2,835	69%	2,987	72%
1964	4,133	2,189	53%	1,864	45%	2,038	49%
1965	4,133	2,979	72%	3,041	74%	3,008	73%

Table B.5 cont SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with A2 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,376	82%	2,624	63%	3,026	73%
1967	4,133	4,047	98%	4,133	100%	4,087	99%
1968	4,133	2,368	57%	2,083	50%	2,235	54%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	3,645	88%	3,906	95%
1971	4,133	3,124	76%	3,117	75%	3,121	76%
1972	4,133	1,487	36%	1,463	35%	1,476	36%
1973	4,133	3,455	84%	2,916	71%	3,204	78%
1974	4,133	3,748	91%	3,850	93%	3,795	92%
1975	4,133	3,232	78%	2,602	63%	2,939	71%
1976	4,133	1,632	39%	1,866	45%	1,741	42%
1977	4,133	278	7%	279	7%	278	7%
1978	3,898	3,905	94%	3,904	94%	3,904	94%
1979	4,133	3,044	74%	2,635	64%	2,853	69%
1980	3,898	3,905	94%	3,584	87%	3,756	91%
1981	4,133	2,545	62%	2,298	56%	2,430	59%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,119	100%	4,127	100%
1985	4,133	3,030	73%	2,314	56%	2,697	65%
1986	3,898	2,841	69%	2,964	72%	2,898	70%
1987	4,133	2,280	55%	2,067	50%	2,181	53%
1988	4,133	427	10%	738	18%	572	14%
1989	4,133	3,197	77%	2,811	68%	3,017	73%
1990	4,133	191	5%	293	7%	238	6%
1991	4,133	733	18%	700	17%	718	17%
1992	4,133	1,100	27%	1,078	26%	1,090	26%
1993	4,133	3,504	85%	3,684	89%	3,588	87%
1994	4,133	2,283	55%	1,237	30%	1,797	43%
1995	3,898	3,902	94%	3,903	94%	3,903	94%
1996	4,133	3,604	87%	3,383	82%	3,501	85%
1997	4,133	3,211	78%	3,344	81%	3,273	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	3,544	86%	3,859	93%
2000	4,133	3,316	80%	2,874	70%	3,110	75%
2001	4,133	982	24%	771	19%	884	21%
2002	4,133	2,063	50%	2,074	50%	2,068	50%
2003	4,133	2,836	69%	2,819	68%	2,828	68%
Avg	**4,106**	**2,734**	**66%**	**2,540**	**61%**	**2,643**	**64%**
Min	**3,898**	**125**	**3%**	**279**	**7%**	**238**	**6%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.6 SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	4,057	98%	3,945	95%	4,005	97%
1923	4,133	3,114	75%	2,000	48%	2,596	63%
1924	4,133	438	11%	797	19%	605	15%
1925	4,133	1,628	39%	1,455	35%	1,548	37%
1926	4,133	2,414	58%	1,893	46%	2,172	53%
1927	4,133	4,133	100%	3,772	91%	3,965	96%
1928	4,133	2,109	51%	2,098	51%	2,104	51%
1929	4,133	847	20%	997	24%	917	22%
1930	4,133	2,357	57%	2,055	50%	2,217	54%
1931	4,133	1,098	27%	1,099	27%	1,098	27%
1932	4,133	1,512	37%	1,367	33%	1,445	35%
1933	4,133	2,274	55%	1,219	29%	1,783	43%
1934	4,133	1,327	32%	1,452	35%	1,385	34%
1935	4,133	3,734	90%	3,366	81%	3,563	86%
1936	4,133	3,569	86%	3,125	76%	3,363	81%
1937	4,133	3,510	85%	2,225	54%	2,912	70%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,527	85%	2,620	63%	3,105	75%
1940	4,133	3,642	88%	3,565	86%	3,606	87%
1941	3,898	3,908	95%	3,907	95%	3,907	95%
1942	4,133	4,133	100%	3,494	85%	3,836	93%
1943	4,133	3,849	93%	3,567	86%	3,718	90%
1944	4,133	2,924	71%	2,070	50%	2,527	61%
1945	4,133	3,394	82%	2,823	68%	3,128	76%
1946	4,133	3,795	92%	3,449	83%	3,634	88%
1947	4,133	1,697	41%	1,910	46%	1,796	43%
1948	4,133	3,256	79%	2,427	59%	2,870	69%
1949	4,133	1,387	34%	1,397	34%	1,392	34%
1950	4,133	2,738	66%	2,514	61%	2,634	64%
1951	4,133	4,133	100%	4,012	97%	4,077	99%
1952	3,898	3,907	95%	3,907	95%	3,907	95%
1953	4,133	4,091	99%	3,136	76%	3,647	88%
1954	4,133	3,079	74%	2,965	72%	3,026	73%
1955	4,133	980	24%	954	23%	968	23%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	2,460	60%	1,973	48%	2,234	54%
1958	4,133	4,133	100%	4,132	100%	4,133	100%
1959	4,133	3,219	78%	2,330	56%	2,805	68%
1960	4,133	1,557	38%	1,809	44%	1,674	41%
1961	4,133	2,746	66%	2,308	56%	2,542	62%
1962	4,133	3,016	73%	2,937	71%	2,979	72%
1963	4,133	3,923	95%	3,710	90%	3,824	93%
1964	4,133	1,605	39%	1,554	38%	1,581	38%
1965	4,133	3,368	81%	3,277	79%	3,326	80%

Table B.6 cont SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,476	84%	2,895	70%	3,206	78%
1967	4,133	4,133	100%	4,133	100%	4,133	100%
1968	4,133	2,988	72%	2,570	62%	2,794	68%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	4,010	97%	4,076	99%
1971	4,133	3,665	89%	3,525	85%	3,600	87%
1972	4,133	1,458	35%	1,564	38%	1,507	36%
1973	4,133	4,133	100%	3,574	86%	3,873	94%
1974	4,133	4,133	100%	3,807	92%	3,981	96%
1975	4,133	3,624	88%	3,020	73%	3,343	81%
1976	4,133	2,167	52%	2,113	51%	2,142	52%
1977	4,133	287	7%	306	7%	296	7%
1978	3,898	3,905	94%	3,905	94%	3,905	94%
1979	4,133	3,292	80%	2,612	63%	2,976	72%
1980	3,898	3,766	91%	3,515	85%	3,649	88%
1981	4,133	2,737	66%	2,498	60%	2,626	64%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,057	98%	4,098	99%
1985	4,133	3,226	78%	2,471	60%	2,875	70%
1986	3,898	2,863	69%	2,976	72%	2,915	71%
1987	4,133	2,679	65%	2,378	58%	2,539	61%
1988	4,133	450	11%	602	15%	521	13%
1989	4,133	3,486	84%	3,225	78%	3,365	81%
1990	4,133	281	7%	484	12%	376	9%
1991	4,133	889	22%	924	22%	905	22%
1992	4,133	1,124	27%	1,014	25%	1,073	26%
1993	4,133	4,036	98%	3,975	96%	4,007	97%
1994	4,133	1,866	45%	1,169	28%	1,542	37%
1995	3,898	3,903	94%	3,903	94%	3,903	94%
1996	4,133	4,133	100%	3,579	87%	3,875	94%
1997	4,133	3,301	80%	3,244	78%	3,275	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	3,812	92%	3,984	96%
2000	4,133	3,960	96%	3,061	74%	3,542	86%
2001	4,133	769	19%	874	21%	818	20%
2002	4,133	2,586	63%	2,264	55%	2,436	59%
2003	4,133	3,213	78%	3,327	81%	3,266	79%
Avg	**4,106**	**2,947**	**71%**	**2,696**	**65%**	**2,830**	**68%**
Min	**3,898**	**281**	**7%**	**306**	**7%**	**296**	**7%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.7 SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	3,664	89%	3,556	86%	3,614	87%
1923	4,133	2,991	72%	2,293	55%	2,666	65%
1924	4,133	125	3%	301	7%	207	5%
1925	4,133	1,565	38%	1,363	33%	1,471	36%
1926	4,133	1,968	48%	1,561	38%	1,779	43%
1927	4,133	3,706	90%	3,632	88%	3,671	89%
1928	4,133	1,895	46%	1,757	43%	1,831	44%
1929	4,133	646	16%	768	19%	703	17%
1930	4,133	2,114	51%	2,048	50%	2,083	50%
1931	4,133	1,046	25%	889	22%	973	24%
1932	4,133	1,165	28%	1,352	33%	1,252	30%
1933	4,133	1,915	46%	892	22%	1,439	35%
1934	4,133	1,427	35%	1,181	29%	1,313	32%
1935	4,133	3,087	75%	2,839	69%	2,972	72%
1936	4,133	2,959	72%	2,894	70%	2,929	71%
1937	4,133	3,774	91%	2,132	52%	3,010	73%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,158	76%	2,358	57%	2,786	67%
1940	4,133	3,136	76%	3,075	74%	3,108	75%
1941	3,898	3,798	92%	3,433	83%	3,628	88%
1942	4,133	3,626	88%	3,107	75%	3,384	82%
1943	4,133	3,466	84%	3,499	85%	3,481	84%
1944	4,133	2,550	62%	1,547	37%	2,083	50%
1945	4,133	3,315	80%	3,018	73%	3,177	77%
1946	4,133	3,430	83%	3,166	77%	3,307	80%
1947	4,133	1,819	44%	1,484	36%	1,663	40%
1948	4,133	2,891	70%	2,426	59%	2,675	65%
1949	4,133	1,096	27%	1,085	26%	1,090	26%
1950	4,133	2,232	54%	2,162	52%	2,200	53%
1951	4,133	4,133	100%	3,928	95%	4,038	98%
1952	3,898	3,907	95%	3,841	93%	3,876	94%
1953	4,133	3,163	77%	2,539	61%	2,872	70%
1954	4,133	3,034	73%	2,683	65%	2,871	69%
1955	4,133	998	24%	838	20%	924	22%
1956	4,133	4,133	100%	4,040	98%	4,090	99%
1957	4,133	1,991	48%	1,796	43%	1,900	46%
1958	4,133	4,133	100%	3,720	90%	3,941	95%
1959	4,133	2,933	71%	2,347	57%	2,660	64%
1960	4,133	1,237	30%	1,291	31%	1,263	31%
1961	4,133	2,492	60%	2,313	56%	2,409	58%
1962	4,133	3,124	76%	2,786	67%	2,967	72%
1963	4,133	3,119	75%	3,101	75%	3,111	75%
1964	4,133	2,189	53%	1,676	41%	1,951	47%
1965	4,133	2,979	72%	3,063	74%	3,018	73%

Table B.7 cont SWP Table A deliveries from the Delta under Future (2027) Conditions
GFDL Model with B1 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,376	82%	2,551	62%	2,992	72%
1967	4,133	4,047	98%	4,006	97%	4,028	97%
1968	4,133	2,368	57%	2,121	51%	2,253	55%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	3,736	90%	3,948	96%
1971	4,133	3,124	76%	3,117	75%	3,121	76%
1972	4,133	1,487	36%	1,460	35%	1,475	36%
1973	4,133	3,455	84%	2,949	71%	3,219	78%
1974	4,133	3,748	91%	3,622	88%	3,689	89%
1975	4,133	3,232	78%	2,665	64%	2,968	72%
1976	4,133	1,632	39%	1,969	48%	1,789	43%
1977	4,133	278	7%	280	7%	279	7%
1978	3,898	3,905	94%	3,905	94%	3,905	94%
1979	4,133	3,044	74%	2,117	51%	2,613	63%
1980	3,898	3,905	94%	3,622	88%	3,773	91%
1981	4,133	2,545	62%	1,974	48%	2,280	55%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,013	97%	4,078	99%
1985	4,133	3,030	73%	2,281	55%	2,681	65%
1986	3,898	2,841	69%	3,046	74%	2,936	71%
1987	4,133	2,280	55%	1,865	45%	2,087	50%
1988	4,133	427	10%	689	17%	549	13%
1989	4,133	3,197	77%	3,064	74%	3,135	76%
1990	4,133	191	5%	198	5%	194	5%
1991	4,133	733	18%	681	16%	709	17%
1992	4,133	1,100	27%	1,010	24%	1,058	26%
1993	4,133	3,504	85%	3,614	87%	3,555	86%
1994	4,133	2,283	55%	1,154	28%	1,758	43%
1995	3,898	3,902	94%	3,903	94%	3,903	94%
1996	4,133	3,604	87%	2,991	72%	3,319	80%
1997	4,133	3,211	78%	3,352	81%	3,276	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	3,348	81%	3,768	91%
2000	4,133	3,316	80%	2,900	70%	3,123	76%
2001	4,133	982	24%	635	15%	821	20%
2002	4,133	2,063	50%	2,064	50%	2,063	50%
2003	4,133	2,836	69%	2,879	70%	2,856	69%
Avg	**4,106**	**2,734**	**66%**	**2,482**	**60%**	**2,617**	**63%**
Min	**3,898**	**125**	**3%**	**198**	**5%**	**194**	**5%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.8 SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	4,057	98%	4,062	98%	4,060	98%
1923	4,133	3,114	75%	2,377	58%	2,771	67%
1924	4,133	438	11%	568	14%	498	12%
1925	4,133	1,628	39%	1,473	36%	1,556	38%
1926	4,133	2,414	58%	1,907	46%	2,178	53%
1927	4,133	4,133	100%	4,107	99%	4,133	100%
1928	4,133	2,109	51%	1,909	46%	2,016	49%
1929	4,133	847	20%	970	23%	904	22%
1930	4,133	2,357	57%	1,974	48%	2,179	53%
1931	4,133	1,098	27%	1,164	28%	1,128	27%
1932	4,133	1,512	37%	1,353	33%	1,438	35%
1933	4,133	2,274	55%	1,378	33%	1,857	45%
1934	4,133	1,327	32%	1,381	33%	1,352	33%
1935	4,133	3,734	90%	3,527	85%	3,638	88%
1936	4,133	3,569	86%	3,562	86%	3,566	86%
1937	4,133	3,510	85%	2,518	61%	3,049	74%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,527	85%	2,997	73%	3,280	79%
1940	4,133	3,642	88%	3,834	93%	3,731	90%
1941	3,898	3,908	95%	3,906	95%	3,907	95%
1942	4,133	4,133	100%	3,805	92%	3,981	96%
1943	4,133	3,849	93%	3,587	87%	3,727	90%
1944	4,133	2,924	71%	2,058	50%	2,521	61%
1945	4,133	3,394	82%	3,896	94%	3,627	88%
1946	4,133	3,795	92%	3,080	75%	3,463	84%
1947	4,133	1,697	41%	1,704	41%	1,700	41%
1948	4,133	3,256	79%	2,786	67%	3,037	73%
1949	4,133	1,387	34%	1,370	33%	1,379	33%
1950	4,133	2,738	66%	2,810	68%	2,771	67%
1951	4,133	4,133	100%	4,133	100%	4,133	100%
1952	3,898	3,907	95%	3,907	95%	3,907	95%
1953	4,133	4,091	99%	3,373	82%	3,757	91%
1954	4,133	3,079	74%	2,962	72%	3,025	73%
1955	4,133	980	24%	929	22%	956	23%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	2,460	60%	1,945	47%	2,221	54%
1958	4,133	4,133	100%	4,133	100%	4,133	100%
1959	4,133	3,219	78%	2,489	60%	2,880	70%
1960	4,133	1,557	38%	1,874	45%	1,705	41%
1961	4,133	2,746	66%	2,627	64%	2,691	65%
1962	4,133	3,016	73%	2,902	70%	2,963	72%
1963	4,133	3,923	95%	3,687	89%	3,813	92%
1964	4,133	1,605	39%	1,535	37%	1,572	38%
1965	4,133	3,368	81%	3,225	78%	3,301	80%

Table B.8 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions PCM Model with A2 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,476	84%	3,208	78%	3,352	81%
1967	4,133	4,133	100%	4,133	100%	4,133	100%
1968	4,133	2,988	72%	2,743	66%	2,874	70%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	4,133	100%	4,133	100%
1971	4,133	3,665	89%	3,452	84%	3,566	86%
1972	4,133	1,458	35%	1,422	34%	1,441	35%
1973	4,133	4,133	100%	3,758	91%	3,959	96%
1974	4,133	4,133	100%	4,133	100%	4,133	100%
1975	4,133	3,624	88%	3,404	82%	3,521	85%
1976	4,133	2,167	52%	2,000	48%	2,089	51%
1977	4,133	287	7%	274	7%	281	7%
1978	3,898	3,905	94%	3,903	94%	3,904	94%
1979	4,133	3,292	80%	3,056	74%	3,182	77%
1980	3,898	3,766	91%	3,491	84%	3,638	88%
1981	4,133	2,737	66%	2,570	62%	2,659	64%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,133	100%	4,133	100%
1985	4,133	3,226	78%	2,581	62%	2,926	71%
1986	3,898	2,863	69%	3,004	73%	2,928	71%
1987	4,133	2,679	65%	2,567	62%	2,627	64%
1988	4,133	450	11%	446	11%	448	11%
1989	4,133	3,486	84%	3,424	83%	3,457	84%
1990	4,133	281	7%	377	9%	325	8%
1991	4,133	889	22%	875	21%	883	21%
1992	4,133	1,124	27%	1,090	26%	1,108	27%
1993	4,133	4,036	98%	4,057	98%	4,046	98%
1994	4,133	1,866	45%	1,494	36%	1,693	41%
1995	3,898	3,903	94%	3,903	94%	3,903	94%
1996	4,133	4,133	100%	3,813	92%	3,984	96%
1997	4,133	3,301	80%	3,199	77%	3,254	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	3,960	96%	4,052	98%
2000	4,133	3,960	96%	3,602	87%	3,794	92%
2001	4,133	769	19%	824	20%	795	19%
2002	4,133	2,586	63%	1,996	48%	2,312	56%
2003	4,133	3,213	78%	3,241	78%	3,226	78%
Avg	**4,106**	**2,947**	**71%**	**2,782**	**67%**	**2,870**	**69%**
Min	**3,898**	**281**	**7%**	**274**	**7%**	**281**	**7%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.9 SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with A2 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	3,664	89%	3,545	86%	3,609	87%
1923	4,133	2,991	72%	2,850	69%	2,925	71%
1924	4,133	125	3%	150	4%	137	3%
1925	4,133	1,565	38%	1,394	34%	1,485	36%
1926	4,133	1,968	48%	1,463	35%	1,733	42%
1927	4,133	3,706	90%	3,736	90%	3,720	90%
1928	4,133	1,895	46%	1,701	41%	1,805	44%
1929	4,133	646	16%	712	17%	677	16%
1930	4,133	2,114	51%	1,849	45%	1,991	48%
1931	4,133	1,046	25%	1,051	25%	1,049	25%
1932	4,133	1,165	28%	1,286	31%	1,222	30%
1933	4,133	1,915	46%	1,172	28%	1,569	38%
1934	4,133	1,427	35%	1,264	31%	1,351	33%
1935	4,133	3,087	75%	3,437	83%	3,250	79%
1936	4,133	2,959	72%	3,265	79%	3,101	75%
1937	4,133	3,774	91%	2,662	64%	3,257	79%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,158	76%	2,727	66%	2,958	72%
1940	4,133	3,136	76%	3,226	78%	3,178	77%
1941	3,898	3,798	92%	3,826	93%	3,811	92%
1942	4,133	3,626	88%	3,421	83%	3,531	85%
1943	4,133	3,466	84%	3,754	91%	3,600	87%
1944	4,133	2,550	62%	1,272	31%	1,955	47%
1945	4,133	3,315	80%	4,000	97%	3,634	88%
1946	4,133	3,430	83%	2,729	66%	3,104	75%
1947	4,133	1,819	44%	1,441	35%	1,643	40%
1948	4,133	2,891	70%	2,535	61%	2,726	66%
1949	4,133	1,096	27%	1,068	26%	1,083	26%
1950	4,133	2,232	54%	1,992	48%	2,120	51%
1951	4,133	4,133	100%	4,133	100%	4,133	100%
1952	3,898	3,907	95%	3,906	95%	3,906	95%
1953	4,133	3,163	77%	2,660	64%	2,929	71%
1954	4,133	3,034	73%	2,938	71%	2,989	72%
1955	4,133	998	24%	676	16%	848	21%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	1,991	48%	1,760	43%	1,883	46%
1958	4,133	4,133	100%	4,133	100%	4,133	100%
1959	4,133	2,933	71%	2,481	60%	2,722	66%
1960	4,133	1,237	30%	1,522	37%	1,370	33%
1961	4,133	2,492	60%	2,162	52%	2,339	57%
1962	4,133	3,124	76%	3,127	76%	3,126	76%
1963	4,133	3,119	75%	3,065	74%	3,094	75%
1964	4,133	2,189	53%	1,582	38%	1,907	46%
1965	4,133	2,979	72%	2,955	72%	2,968	72%

Table B.9 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions PCM Model with A2 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,376	82%	2,891	70%	3,150	76%
1967	4,133	4,047	98%	4,110	99%	4,077	99%
1968	4,133	2,368	57%	2,085	50%	2,236	54%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	4,133	100%	4,133	100%
1971	4,133	3,124	76%	3,090	75%	3,108	75%
1972	4,133	1,487	36%	1,408	34%	1,450	35%
1973	4,133	3,455	84%	3,275	79%	3,371	82%
1974	4,133	3,748	91%	3,684	89%	3,718	90%
1975	4,133	3,232	78%	3,000	73%	3,124	76%
1976	4,133	1,632	39%	1,558	38%	1,598	39%
1977	4,133	278	7%	248	6%	264	6%
1978	3,898	3,905	94%	3,904	94%	3,904	94%
1979	4,133	3,044	74%	2,768	67%	2,915	71%
1980	3,898	3,905	94%	3,893	94%	3,899	94%
1981	4,133	2,545	62%	2,169	52%	2,370	57%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,133	100%	4,133	100%
1985	4,133	3,030	73%	2,420	59%	2,746	66%
1986	3,898	2,841	69%	3,253	79%	3,032	73%
1987	4,133	2,280	55%	1,709	41%	2,014	49%
1988	4,133	427	10%	636	15%	524	13%
1989	4,133	3,197	77%	3,184	77%	3,191	77%
1990	4,133	191	5%	177	4%	184	4%
1991	4,133	733	18%	626	15%	683	17%
1992	4,133	1,100	27%	1,047	25%	1,075	26%
1993	4,133	3,504	85%	3,554	86%	3,527	85%
1994	4,133	2,283	55%	1,372	33%	1,859	45%
1995	3,898	3,902	94%	3,903	94%	3,903	94%
1996	4,133	3,604	87%	3,661	89%	3,631	88%
1997	4,133	3,211	78%	3,287	80%	3,246	79%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	4,112	99%	4,123	100%
2000	4,133	3,316	80%	3,237	78%	3,279	79%
2001	4,133	982	24%	617	15%	812	20%
2002	4,133	2,063	50%	1,845	45%	1,961	47%
2003	4,133	2,836	69%	2,831	69%	2,834	69%
Avg	**4,106**	**2,734**	**66%**	**2,592**	**63%**	**2,668**	**65%**
Min	**3,898**	**125**	**3%**	**150**	**4%**	**137**	**3%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	4,133	100%

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.10 SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	4,057	98%	4,132	100%	4,092	99%
1923	4,133	3,114	75%	3,064	74%	3,091	75%
1924	4,133	438	11%	295	7%	371	9%
1925	4,133	1,628	39%	1,821	44%	1,718	42%
1926	4,133	2,414	58%	2,070	50%	2,254	55%
1927	4,133	4,133	100%	4,032	98%	4,086	99%
1928	4,133	2,109	51%	2,273	55%	2,186	53%
1929	4,133	847	20%	1,058	26%	945	23%
1930	4,133	2,357	57%	2,233	54%	2,299	56%
1931	4,133	1,098	27%	1,167	28%	1,130	27%
1932	4,133	1,512	37%	1,638	40%	1,570	38%
1933	4,133	2,274	55%	2,415	58%	2,340	57%
1934	4,133	1,327	32%	1,323	32%	1,325	32%
1935	4,133	3,734	90%	3,831	93%	3,779	91%
1936	4,133	3,569	86%	3,649	88%	3,606	87%
1937	4,133	3,510	85%	3,137	76%	3,337	81%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,527	85%	3,283	79%	3,414	83%
1940	4,133	3,642	88%	3,929	95%	3,775	91%
1941	3,898	3,908	95%	3,907	95%	3,907	95%
1942	4,133	4,133	100%	4,133	100%	4,133	100%
1943	4,133	3,849	93%	3,682	89%	3,772	91%
1944	4,133	2,924	71%	2,964	72%	2,943	71%
1945	4,133	3,394	82%	3,743	91%	3,556	86%
1946	4,133	3,795	92%	3,494	85%	3,655	88%
1947	4,133	1,697	41%	1,817	44%	1,752	42%
1948	4,133	3,256	79%	3,345	81%	3,297	80%
1949	4,133	1,387	34%	1,559	38%	1,467	35%
1950	4,133	2,738	66%	2,896	70%	2,812	68%
1951	4,133	4,133	100%	4,133	100%	4,133	100%
1952	3,898	3,907	95%	3,907	95%	3,907	95%
1953	4,133	4,091	99%	3,727	90%	3,922	95%
1954	4,133	3,079	74%	3,306	80%	3,184	77%
1955	4,133	980	24%	1,074	26%	1,024	25%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	2,460	60%	2,424	59%	2,443	59%
1958	4,133	4,133	100%	4,133	100%	4,133	100%
1959	4,133	3,219	78%	3,175	77%	3,199	77%
1960	4,133	1,557	38%	1,911	46%	1,722	42%
1961	4,133	2,746	66%	2,540	61%	2,650	64%
1962	4,133	3,016	73%	3,519	85%	3,250	79%
1963	4,133	3,923	95%	3,314	80%	3,640	88%
1964	4,133	1,605	39%	2,055	50%	1,814	44%
1965	4,133	3,368	81%	3,325	80%	3,348	81%

Table B.10 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions PCM Model with B1 Emissions and less restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,476	84%	3,497	85%	3,486	84%
1967	4,133	4,133	100%	4,133	100%	4,133	100%
1968	4,133	2,988	72%	2,991	72%	2,990	72%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	4,133	100%	4,133	100%
1971	4,133	3,665	89%	3,651	88%	3,658	89%
1972	4,133	1,458	35%	1,525	37%	1,489	36%
1973	4,133	4,133	100%	3,847	93%	4,000	97%
1974	4,133	4,133	100%	4,133	100%	4,133	100%
1975	4,133	3,624	88%	3,776	91%	3,695	89%
1976	4,133	2,167	52%	2,296	56%	2,227	54%
1977	4,133	287	7%	315	8%	300	7%
1978	3,898	3,905	94%	3,905	94%	3,905	94%
1979	4,133	3,292	80%	3,462	84%	3,371	82%
1980	3,898	3,766	91%	3,596	87%	3,687	89%
1981	4,133	2,737	66%	2,745	66%	2,740	66%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,133	100%	4,133	100%
1985	4,133	3,226	78%	3,369	82%	3,293	80%
1986	3,898	2,863	69%	2,726	66%	2,799	68%
1987	4,133	2,679	65%	2,520	61%	2,605	63%
1988	4,133	450	11%	521	13%	483	12%
1989	4,133	3,486	84%	3,526	85%	3,504	85%
1990	4,133	281	7%	466	11%	367	9%
1991	4,133	889	22%	1,052	25%	965	23%
1992	4,133	1,124	27%	1,380	33%	1,243	30%
1993	4,133	4,036	98%	3,943	95%	3,993	97%
1994	4,133	1,866	45%	1,884	46%	1,874	45%
1995	3,898	3,903	94%	3,903	94%	3,903	94%
1996	4,133	4,133	100%	3,893	94%	4,021	97%
1997	4,133	3,301	80%	3,285	79%	3,294	80%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	4,068	98%	4,103	99%
2000	4,133	3,960	96%	3,858	93%	3,913	95%
2001	4,133	769	19%	1,017	25%	884	21%
2002	4,133	2,586	63%	2,605	63%	2,595	63%
2003	4,133	3,213	78%	3,188	77%	3,201	77%
Avg	**4,106**	**2,947**	**71%**	**2,962**	**72%**	**2,954**	**71%**
Min	**3,898**	**281**	**7%**	**295**	**7%**	**300**	**7%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.11 SWP Table A deliveries from the Delta under Future (2027) Conditions
PCM Model with B1 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,133	3,664	89%	3,626	88%	3,647	88%
1923	4,133	2,991	72%	3,082	75%	3,033	73%
1924	4,133	125	3%	178	4%	150	4%
1925	4,133	1,565	38%	1,789	43%	1,669	40%
1926	4,133	1,968	48%	1,966	48%	1,967	48%
1927	4,133	3,706	90%	3,650	88%	3,680	89%
1928	4,133	1,895	46%	1,952	47%	1,921	46%
1929	4,133	646	16%	824	20%	729	18%
1930	4,133	2,114	51%	1,886	46%	2,008	49%
1931	4,133	1,046	25%	1,140	28%	1,090	26%
1932	4,133	1,165	28%	1,457	35%	1,301	31%
1933	4,133	1,915	46%	1,979	48%	1,944	47%
1934	4,133	1,427	35%	1,343	32%	1,388	34%
1935	4,133	3,087	75%	3,170	77%	3,126	76%
1936	4,133	2,959	72%	3,222	78%	3,081	75%
1937	4,133	3,774	91%	3,385	82%	3,593	87%
1938	4,133	4,133	100%	4,133	100%	4,133	100%
1939	4,133	3,158	76%	2,893	70%	3,035	73%
1940	4,133	3,136	76%	3,327	81%	3,225	78%
1941	3,898	3,798	92%	3,887	94%	3,839	93%
1942	4,133	3,626	88%	3,653	88%	3,639	88%
1943	4,133	3,466	84%	3,547	86%	3,503	85%
1944	4,133	2,550	62%	2,449	59%	2,503	61%
1945	4,133	3,315	80%	3,641	88%	3,467	84%
1946	4,133	3,430	83%	3,288	80%	3,364	81%
1947	4,133	1,819	44%	1,907	46%	1,860	45%
1948	4,133	2,891	70%	2,837	69%	2,866	69%
1949	4,133	1,096	27%	1,417	34%	1,245	30%
1950	4,133	2,232	54%	2,726	66%	2,462	60%
1951	4,133	4,133	100%	3,757	91%	3,958	96%
1952	3,898	3,907	95%	3,907	95%	3,907	95%
1953	4,133	3,163	77%	3,050	74%	3,110	75%
1954	4,133	3,034	73%	3,080	75%	3,056	74%
1955	4,133	998	24%	1,053	25%	1,024	25%
1956	4,133	4,133	100%	4,133	100%	4,133	100%
1957	4,133	1,991	48%	1,959	47%	1,976	48%
1958	4,133	4,133	100%	4,133	100%	4,133	100%
1959	4,133	2,933	71%	2,962	72%	2,946	71%
1960	4,133	1,237	30%	1,651	40%	1,430	35%
1961	4,133	2,492	60%	2,312	56%	2,408	58%
1962	4,133	3,124	76%	3,230	78%	3,174	77%
1963	4,133	3,119	75%	2,936	71%	3,034	73%
1964	4,133	2,189	53%	2,240	54%	2,213	54%
1965	4,133	2,979	72%	2,774	67%	2,884	70%

Table B.11 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions PCM Model with B1 Emissions and more restrictive Old River and Middle River flow targets

Year	SWP Table A demands (taf)	No Climate Change Lower flow target scenario[1]		GFDL with A2 Emissions Lower flow target scenario[1]		Estimated Delivery Interpolated to 2027[2]	
		SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	4,133	3,376	82%	3,376	82%	3,376	82%
1967	4,133	4,047	98%	4,050	98%	4,048	98%
1968	4,133	2,368	57%	2,357	57%	2,363	57%
1969	3,898	3,903	94%	3,903	94%	3,903	94%
1970	4,133	4,133	100%	4,133	100%	4,133	100%
1971	4,133	3,124	76%	3,149	76%	3,136	76%
1972	4,133	1,487	36%	1,503	36%	1,495	36%
1973	4,133	3,455	84%	3,381	82%	3,420	83%
1974	4,133	3,748	91%	3,837	93%	3,789	92%
1975	4,133	3,232	78%	3,211	78%	3,222	78%
1976	4,133	1,632	39%	1,631	39%	1,631	39%
1977	4,133	278	7%	284	7%	281	7%
1978	3,898	3,905	94%	3,905	94%	3,905	94%
1979	4,133	3,044	74%	3,002	73%	3,024	73%
1980	3,898	3,905	94%	3,855	93%	3,881	94%
1981	4,133	2,545	62%	2,549	62%	2,547	62%
1982	4,133	4,133	100%	4,133	100%	4,133	100%
1983	3,898	3,903	94%	3,903	94%	3,903	94%
1984	4,133	4,133	100%	4,133	100%	4,133	100%
1985	4,133	3,030	73%	3,035	73%	3,032	73%
1986	3,898	2,841	69%	2,775	67%	2,810	68%
1987	4,133	2,280	55%	2,379	58%	2,326	56%
1988	4,133	427	10%	484	12%	454	11%
1989	4,133	3,197	77%	3,351	81%	3,269	79%
1990	4,133	191	5%	449	11%	311	8%
1991	4,133	733	18%	826	20%	776	19%
1992	4,133	1,100	27%	1,152	28%	1,124	27%
1993	4,133	3,504	85%	3,434	83%	3,471	84%
1994	4,133	2,283	55%	2,228	54%	2,258	55%
1995	3,898	3,902	94%	3,903	94%	3,902	94%
1996	4,133	3,604	87%	3,647	88%	3,624	88%
1997	4,133	3,211	78%	3,380	82%	3,289	80%
1998	3,898	3,908	95%	3,908	95%	3,908	95%
1999	4,133	4,133	100%	4,133	100%	4,133	100%
2000	4,133	3,316	80%	3,408	82%	3,359	81%
2001	4,133	982	24%	1,050	25%	1,014	25%
2002	4,133	2,063	50%	2,176	53%	2,115	51%
2003	4,133	2,836	69%	2,803	68%	2,820	68%
Avg	**4,106**	**2,734**	**66%**	**2,760**	**67%**	**2,746**	**66%**
Min	**3,898**	**125**	**3%**	**178**	**4%**	**150**	**4%**
Max	**4,133**	**4,133**	**100%**	**4,133**	**100%**	**4,133**	**100%**

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.12 SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve GFDL Model with A2 emissions

Year	SWP Table A demands (taf)	SWP Table A deliveries for 2027 studies				Probability Curve[1]		
		lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Year	SWP Table A Delivery (taf)	Exceedence Frequency
1922	4,062	3,633	3,848	93%	0%	1938	4,133	100%
1923	2,622	2,676	2,649	64%	1%	1956	4,133	100%
1924	583	270	427	10%	3%	1982	4,133	100%
1925	1,554	1,465	1,510	37%	4%	1967	4,110	99%
1926	2,291	1,856	2,074	50%	5%	1984	4,105	99%
1927	3,986	3,697	3,842	93%	6%	1951	4,065	98%
1928	2,133	1,829	1,981	48%	8%	1958	4,015	97%
1929	863	672	767	19%	9%	1970	3,982	96%
1930	2,410	2,275	2,343	57%	10%	1974	3,964	96%
1931	1,083	934	1,008	24%	11%	1999	3,913	95%
1932	1,437	1,251	1,344	33%	12%	1998	3,908	95%
1933	1,847	1,436	1,641	40%	14%	1978	3,905	94%
1934	1,320	1,375	1,348	33%	15%	1969	3,903	94%
1935	3,488	3,015	3,252	79%	16%	1983	3,903	94%
1936	3,622	3,235	3,428	83%	17%	1995	3,903	94%
1937	2,943	3,131	3,037	73%	19%	1952	3,900	94%
1938	4,133	4,133	4,133	100%	20%	1922	3,848	93%
1939	3,044	2,730	2,887	70%	21%	1927	3,842	93%
1940	3,691	3,220	3,456	84%	22%	1993	3,801	92%
1941	3,907	3,674	3,791	92%	24%	1941	3,791	92%
1942	3,900	3,424	3,662	89%	25%	1996	3,705	90%
1943	3,703	3,481	3,592	87%	26%	1980	3,697	89%
1944	2,555	2,121	2,338	57%	27%	1942	3,662	89%
1945	3,375	3,374	3,375	82%	28%	1943	3,592	87%
1946	3,557	3,233	3,395	82%	30%	1973	3,538	86%
1947	1,839	1,711	1,775	43%	31%	1940	3,456	84%
1948	2,854	2,636	2,745	66%	32%	1936	3,428	83%
1949	1,441	1,110	1,276	31%	33%	1946	3,395	82%
1950	2,660	2,282	2,471	60%	35%	1963	3,387	82%
1951	4,063	4,067	4,065	98%	36%	1945	3,375	82%
1952	3,907	3,893	3,900	94%	37%	2000	3,373	82%
1953	3,660	2,843	3,252	79%	38%	1971	3,344	81%
1954	2,947	2,788	2,867	69%	40%	1997	3,272	79%
1955	974	931	952	23%	41%	1953	3,252	79%
1956	4,133	4,133	4,133	100%	42%	1935	3,252	79%
1957	2,247	1,888	2,068	50%	43%	1975	3,178	77%
1958	4,133	3,898	4,015	97%	45%	1965	3,169	77%
1959	2,777	2,684	2,731	66%	46%	1989	3,153	76%
1960	1,799	1,443	1,621	39%	47%	1966	3,137	76%
1961	2,442	2,299	2,371	57%	48%	1937	3,037	73%
1962	2,991	3,033	3,012	73%	49%	2003	3,023	73%
1963	3,786	2,987	3,387	82%	51%	1962	3,012	73%
1964	1,583	2,038	1,810	44%	52%	1979	2,990	72%
1965	3,329	3,008	3,169	77%	53%	1986	2,902	70%

Table B.12 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve GFDL Model with A2 emissions

		SWP Table A deliveries for 2027 studies				Probability Curve[1]		
Year	SWP Table A demands (taf)	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Year	SWP Table A Delivery (taf)	Exceedence Frequency
1966	3,247	3,026	3,137	76%	54%	1939	2,887	70%
1967	4,133	4,087	4,110	99%	56%	1954	2,867	69%
1968	2,814	2,235	2,525	61%	57%	1985	2,797	68%
1969	3,903	3,903	3,903	94%	58%	1948	2,745	66%
1970	4,058	3,906	3,982	96%	59%	1959	2,731	66%
1971	3,568	3,121	3,344	81%	61%	1923	2,649	64%
1972	1,507	1,476	1,491	36%	62%	1981	2,536	61%
1973	3,872	3,204	3,538	86%	63%	1968	2,525	61%
1974	4,133	3,795	3,964	96%	64%	1950	2,471	60%
1975	3,417	2,939	3,178	77%	66%	1987	2,400	58%
1976	1,959	1,741	1,850	45%	67%	1961	2,371	57%
1977	308	278	293	7%	68%	1930	2,343	57%
1978	3,905	3,904	3,905	94%	69%	1944	2,338	57%
1979	3,127	2,853	2,990	72%	70%	2002	2,281	55%
1980	3,639	3,756	3,697	89%	72%	1926	2,074	50%
1981	2,643	2,430	2,536	61%	73%	1957	2,068	50%
1982	4,133	4,133	4,133	100%	74%	1928	1,981	48%
1983	3,903	3,903	3,903	94%	75%	1976	1,850	45%
1984	4,083	4,127	4,105	99%	77%	1964	1,810	44%
1985	2,897	2,697	2,797	68%	78%	1947	1,775	43%
1986	2,907	2,898	2,902	70%	79%	1994	1,675	41%
1987	2,619	2,181	2,400	58%	80%	1933	1,641	40%
1988	533	572	552	13%	82%	1960	1,621	39%
1989	3,288	3,017	3,153	76%	83%	1925	1,510	37%
1990	389	238	314	8%	84%	1972	1,491	36%
1991	880	718	799	19%	85%	1934	1,348	33%
1992	1,109	1,090	1,099	27%	87%	1932	1,344	33%
1993	4,014	3,588	3,801	92%	88%	1949	1,276	31%
1994	1,553	1,797	1,675	41%	89%	1992	1,099	27%
1995	3,903	3,903	3,903	94%	90%	1931	1,008	24%
1996	3,910	3,501	3,705	90%	91%	1955	952	23%
1997	3,271	3,273	3,272	79%	93%	2001	850	21%
1998	3,908	3,908	3,908	95%	94%	1991	799	19%
1999	3,967	3,859	3,913	95%	95%	1929	767	19%
2000	3,636	3,110	3,373	82%	96%	1988	552	13%
2001	817	884	850	21%	98%	1924	427	10%
2002	2,493	2,068	2,281	55%	99%	1990	314	8%
2003	3,218	2,828	3,023	73%	100%	1977	293	7%
Avg	**2,846**	**2,643**	**2,745**	**66%**			**2,745**	
Min	**308**	**238**	**293**	**7%**			**293**	
Max	**4,133**	**4,133**	**4,133**	**100%**			**4,133**	

[1]/ See Table 6.3 [2]/ Values used to describe Current Conditions in Capter 6 [3]/ 4,133 taf/year

Table B.13 SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve GFDL Model with B1 Emissions

Year	deliveries derived from interpolating between "no climate change" and "GFDL + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,005	3,614	3,810	92%	0%	1938	4,133	100%
1923	2,596	2,666	2,631	64%	1%	1956	4,133	100%
1924	605	207	406	10%	3%	1982	4,111	99%
1925	1,548	1,471	1,509	37%	4%	1984	4,088	99%
1926	2,172	1,779	1,975	48%	5%	1967	4,081	99%
1927	3,965	3,671	3,818	92%	6%	1951	4,057	98%
1928	2,104	1,831	1,967	48%	8%	1958	4,037	98%
1929	917	703	810	20%	9%	1970	4,012	97%
1930	2,217	2,083	2,150	52%	10%	1998	3,908	95%
1931	1,098	973	1,036	25%	11%	1978	3,905	94%
1932	1,445	1,252	1,348	33%	12%	1969	3,903	94%
1933	1,783	1,439	1,611	39%	14%	1983	3,903	94%
1934	1,385	1,313	1,349	33%	15%	1995	3,903	94%
1935	3,563	2,972	3,267	79%	16%	1952	3,892	94%
1936	3,363	2,929	3,146	76%	17%	1999	3,876	94%
1937	2,912	3,010	2,961	72%	19%	1974	3,835	93%
1938	4,133	4,133	4,133	100%	20%	1927	3,818	92%
1939	3,105	2,786	2,945	71%	21%	1922	3,810	92%
1940	3,606	3,108	3,357	81%	22%	1993	3,781	91%
1941	3,907	3,628	3,768	91%	24%	1941	3,768	91%
1942	3,836	3,384	3,610	87%	25%	1980	3,711	90%
1943	3,718	3,481	3,600	87%	26%	1942	3,610	87%
1944	2,527	2,083	2,305	56%	27%	1996	3,600	87%
1945	3,128	3,177	3,152	76%	28%	1943	3,597	87%
1946	3,634	3,307	3,471	84%	30%	1973	3,546	86%
1947	1,796	1,663	1,729	42%	31%	1946	3,471	84%
1948	2,870	2,675	2,773	67%	32%	1963	3,467	84%
1949	1,392	1,090	1,241	30%	33%	1971	3,361	81%
1950	2,634	2,200	2,417	58%	35%	1940	3,357	81%
1951	4,077	4,038	4,057	98%	36%	2000	3,332	81%
1952	3,907	3,876	3,892	94%	37%	1997	3,276	79%
1953	3,647	2,872	3,260	79%	38%	1935	3,267	79%
1954	3,026	2,871	2,949	71%	40%	1953	3,260	79%
1955	968	924	946	23%	41%	1989	3,250	79%
1956	4,133	4,090	4,111	99%	42%	1965	3,172	77%
1957	2,234	1,900	2,067	50%	43%	1975	3,156	76%
1958	4,133	3,941	4,037	98%	45%	1945	3,152	76%
1959	2,805	2,660	2,733	66%	46%	1936	3,146	76%
1960	1,674	1,263	1,468	36%	47%	1966	3,099	75%
1961	2,542	2,409	2,476	60%	48%	2003	3,061	74%
1962	2,979	2,967	2,973	72%	49%	1962	2,973	72%
1963	3,824	3,111	3,467	84%	51%	1937	2,961	72%
1964	1,581	1,951	1,766	43%	52%	1954	2,949	71%
1965	3,326	3,018	3,172	77%	53%	1939	2,945	71%

Table B.13 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve GFDL Model with B1 Emissions

Year	deliveries derived from interpolating between "no climate change" and "GFDL + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	3,206	2,992	3,099	75%	54%	1986	2,926	71%
1967	4,133	4,028	4,081	99%	56%	1979	2,794	68%
1968	2,794	2,253	2,523	61%	57%	1985	2,778	67%
1969	3,903	3,903	3,903	94%	58%	1948	2,773	67%
1970	4,076	3,948	4,012	97%	59%	1959	2,733	66%
1971	3,600	3,121	3,361	81%	61%	1923	2,631	64%
1972	1,507	1,475	1,491	36%	62%	1968	2,523	61%
1973	3,873	3,219	3,546	86%	63%	1961	2,476	60%
1974	3,981	3,689	3,835	93%	64%	1981	2,453	59%
1975	3,343	2,968	3,156	76%	66%	1950	2,417	58%
1976	2,142	1,789	1,965	48%	67%	1987	2,313	56%
1977	296	279	287	7%	68%	1944	2,305	56%
1978	3,905	3,905	3,905	94%	69%	2002	2,250	54%
1979	2,976	2,613	2,794	68%	70%	1930	2,150	52%
1980	3,649	3,773	3,711	90%	72%	1957	2,067	50%
1981	2,626	2,280	2,453	59%	73%	1926	1,975	48%
1982	4,133	4,133	4,133	100%	74%	1928	1,967	48%
1983	3,903	3,903	3,903	94%	75%	1976	1,965	48%
1984	4,098	4,077	4,088	99%	77%	1964	1,766	43%
1985	2,875	2,681	2,778	67%	78%	1947	1,729	42%
1986	2,915	2,936	2,926	71%	79%	1994	1,650	40%
1987	2,539	2,087	2,313	56%	80%	1933	1,611	39%
1988	521	549	535	13%	82%	1925	1,509	37%
1989	3,365	3,135	3,250	79%	83%	1972	1,491	36%
1990	376	194	285	7%	84%	1960	1,468	36%
1991	905	709	807	20%	85%	1934	1,349	33%
1992	1,073	1,058	1,065	26%	87%	1932	1,348	33%
1993	4,007	3,555	3,781	91%	88%	1949	1,241	30%
1994	1,542	1,758	1,650	40%	89%	1992	1,065	26%
1995	3,903	3,903	3,903	94%	90%	1931	1,036	25%
1996	3,875	3,319	3,597	87%	91%	1955	946	23%
1997	3,275	3,276	3,276	79%	93%	2001	819	20%
1998	3,908	3,908	3,908	95%	94%	1929	810	20%
1999	3,984	3,768	3,876	94%	95%	1991	807	20%
2000	3,542	3,123	3,332	81%	96%	1988	535	13%
2001	818	821	819	20%	98%	1924	406	10%
2002	2,436	2,063	2,250	54%	99%	1977	287	7%
2003	3,266	2,856	3,061	74%	100%	1990	285	7%
Avg	**2,830**	**2,617**	**2,723**	**66%**			**2,723**	
Min	**296**	**194**	**285**	**7%**			**285**	
Max	**4,133**	**4,133**	**4,133**	**100%**			**4,133**	

[1]/ See Table 6.3 [2]/ 4,133 taf/year

Table B.14 SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve PCM Model with A2 Emissions

Year	deliveries derived from interpolating between "no climate change" and "GFDL + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,060	3,609	3,834	93%	0%	1938	4,133	100%
1923	2,771	2,925	2,848	69%	1%	1951	4,133	100%
1924	498	137	317	8%	3%	1956	4,133	100%
1925	1,556	1,485	1,521	37%	4%	1958	4,133	100%
1926	2,178	1,733	1,956	47%...	5%	1970	4,133	100%
1927	4,121	3,720	3,920	95%	6%	1982	4,133	100%
1928	2,016	1,805	1,910	46%	8%	1984	4,133	100%
1929	904	677	790	19%	9%	1967	4,105	99%
1930	2,179	1,991	2,085	50%	10%	1999	4,088	99%
1931	1,128	1,049	1,089	26%	11%	1974	3,926	95%
1932	1,438	1,222	1,330	32%	12%	1927	3,920	95%
1933	1,857	1,569	1,713	41%	14%	1998	3,908	95%
1934	1,352	1,351	1,352	33%	15%	1952	3,907	95%
1935	3,638	3,250	3,444	83%	16%	1978	3,904	94%
1936	3,566	3,101	3,334	81%	17%	1969	3,903	94%
1937	3,049	3,257	3,153	76%	19%	1983	3,903	94%
1938	4,133	4,133	4,133	100%	20%	1995	3,903	94%
1939	3,280	2,958	3,119	75%	21%	1941	3,859	93%
1940	3,731	3,178	3,454	84%	22%	1922	3,834	93%
1941	3,907	3,811	3,859	93%	24%	1996	3,807	92%
1942	3,981	3,531	3,756	91%	25%	1993	3,787	92%
1943	3,727	3,600	3,664	89%	26%	1980	3,769	91%
1944	2,521	1,955	2,238	54%	27%	1942	3,756	91%
1945	3,627	3,634	3,630	88%	28%	1973	3,665	89%
1946	3,463	3,104	3,283	79%	30%	1943	3,664	89%
1947	1,700	1,643	1,672	40%	31%	1945	3,630	88%
1948	3,037	2,726	2,881	70%	32%	2000	3,537	86%
1949	1,379	1,083	1,231	30%	33%	1940	3,454	84%
1950	2,771	2,120	2,446	59%	35%	1963	3,453	84%
1951	4,133	4,133	4,133	100%	36%	1935	3,444	83%
1952	3,907	3,906	3,907	95%	37%	1953	3,343	81%
1953	3,757	2,929	3,343	81%	38%	1971	3,337	81%
1954	3,025	2,989	3,007	73%	40%	1936	3,334	81%
1955	956	848	902	22%	41%	1989	3,324	80%
1956	4,133	4,133	4,133	100%	42%	1975	3,323	80%
1957	2,221	1,883	2,052	50%	43%	1946	3,283	79%
1958	4,133	4,133	4,133	100%	45%	1966	3,251	79%
1959	2,880	2,722	2,801	68%	46%	1997	3,250	79%
1960	1,705	1,370	1,537	37%	47%	1937	3,153	76%
1961	2,691	2,339	2,515	61%	48%	1965	3,135	76%
1962	2,963	3,126	3,044	74%	49%	1939	3,119	75%
1963	3,813	3,094	3,453	84%	51%	1979	3,049	74%
1964	1,572	1,907	1,739	42%	52%	1962	3,044	74%
1965	3,301	2,968	3,135	76%	53%	2003	3,030	73%

Table B.14 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve PCM Model with A2 Emissions

Year	deliveries derived from interpolating between "no climate change" and "GFDL + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	3,352	3,150	3,251	79%	54%	1954	3,007	73%
1967	4,133	4,077	4,105	99%	56%	1986	2,980	72%
1968	2,874	2,236	2,555	62%	57%	1948	2,881	70%
1969	3,903	3,903	3,903	94%	58%	1923	2,848	69%
1970	4,133	4,133	4,133	100%	59%	1985	2,836	69%
1971	3,566	3,108	3,337	81%	61%	1959	2,801	68%
1972	1,441	1,450	1,446	35%	62%	1968	2,555	62%
1973	3,959	3,371	3,665	89%	63%	1961	2,515	61%
1974	4,133	3,718	3,926	95%	64%	1981	2,515	61%
1975	3,521	3,124	3,323	80%	66%	1950	2,446	59%
1976	2,089	1,598	1,843	45%	67%	1987	2,320	56%
1977	281	264	273	7%	68%	1944	2,238	54%
1978	3,904	3,904	3,904	94%	69%	2002	2,137	52%
1979	3,182	2,915	3,049	74%	70%	1930	2,085	50%
1980	3,638	3,899	3,769	91%	72%	1957	2,052	50%
1981	2,659	2,370	2,515	61%	73%	1926	1,956	47%
1982	4,133	4,133	4,133	100%	74%	1928	1,910	46%
1983	3,903	3,903	3,903	94%	75%	1976	1,843	45%
1984	4,133	4,133	4,133	100%	77%	1994	1,776	43%
1985	2,926	2,746	2,836	69%	78%	1964	1,739	42%
1986	2,928	3,032	2,980	72%	79%	1933	1,713	41%
1987	2,627	2,014	2,320	56%	80%	1947	1,672	40%
1988	448	524	486	12%	82%	1960	1,537	37%
1989	3,457	3,191	3,324	80%	83%	1925	1,521	37%
1990	325	184	255	6%	84%	1972	1,446	35%
1991	883	683	783	19%	85%	1934	1,352	33%
1992	1,108	1,075	1,092	26%	87%	1932	1,330	32%
1993	4,046	3,527	3,787	92%	88%	1949	1,231	30%
1994	1,693	1,859	1,776	43%	89%	1992	1,092	26%
1995	3,903	3,903	3,903	94%	90%	1931	1,089	26%
1996	3,984	3,631	3,807	92%	91%	1955	902	22%
1997	3,254	3,246	3,250	79%	93%	2001	804	19%
1998	3,908	3,908	3,908	95%	94%	1929	790	19%
1999	4,052	4,123	4,088	99%	95%	1991	783	19%
2000	3,794	3,279	3,537	86%	96%	1988	486	12%
2001	795	812	804	19%	98%	1924	317	8%
2002	2,312	1,961	2,137	52%	99%	1977	273	7%
2003	3,226	2,834	3,030	73%	100%	1990	255	6%
Avg	**2,870**	**2,668**	**2,769**	**67%**			**2,769**	
Min	**281**	**137**	**255**	**6%**			**255**	
Max	**4,133**	**4,133**	**4,133**	**100%**			**4,133**	

[1]/ See Table 6.3 [2]/ 4,133 taf/year

Table B.15 SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve PCM Model with B1 Emissions

Year	deliveries derived from interpolating between "no climate change" and "PCM + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1922	4,092	3,647	3,869	94%	0%	1938	4,133	100%
1923	3,091	3,033	3,062	74%	1%	1956	4,133	100%
1924	371	150	261	6%	3%	1958	4,133	100%
1925	1,718	1,669	1,693	41%	4%	1970	4,133	100%
1926	2,254	1,967	2,111	51%	5%	1982	4,133	100%
1927	4,086	3,680	3,883	94%	6%	1984	4,133	100%
1928	2,186	1,921	2,054	50%	8%	1999	4,118	100%
1929	945	729	837	20%	9%	1967	4,091	99%
1930	2,299	2,008	2,154	52%	10%	1951	4,046	98%
1931	1,130	1,090	1,110	27%	11%	1974	3,961	96%
1932	1,570	1,301	1,436	35%	12%	1998	3,908	95%
1933	2,340	1,944	2,142	52%	14%	1952	3,907	95%
1934	1,325	1,388	1,357	33%	15%	1978	3,905	94%
1935	3,779	3,126	3,452	84%	16%	1969	3,903	94%
1936	3,606	3,081	3,344	81%	17%	1983	3,903	94%
1937	3,337	3,593	3,465	84%	19%	1995	3,903	94%
1938	4,133	4,133	4,133	100%	20%	1942	3,886	94%
1939	3,414	3,035	3,224	78%	21%	1927	3,883	94%
1940	3,775	3,225	3,500	85%	22%	1941	3,873	94%
1941	3,907	3,839	3,873	94%	24%	1922	3,869	94%
1942	4,133	3,639	3,886	94%	25%	1996	3,823	92%
1943	3,772	3,503	3,637	88%	26%	1980	3,784	92%
1944	2,943	2,503	2,723	66%	27%	1993	3,732	90%
1945	3,556	3,467	3,511	85%	28%	1973	3,710	90%
1946	3,655	3,364	3,509	85%	30%	1943	3,637	88%
1947	1,752	1,860	1,806	44%	31%	2000	3,636	88%
1948	3,297	2,866	3,082	75%	32%	1953	3,516	85%
1949	1,467	1,245	1,356	33%	33%	1945	3,511	85%
1950	2,812	2,462	2,637	64%	35%	1946	3,509	85%
1951	4,133	3,958	4,046	98%	36%	1940	3,500	85%
1952	3,907	3,907	3,907	95%	37%	1937	3,465	84%
1953	3,922	3,110	3,516	85%	38%	1975	3,458	84%
1954	3,184	3,056	3,120	75%	40%	1935	3,452	84%
1955	1,024	1,024	1,024	25%	41%	1966	3,431	83%
1956	4,133	4,133	4,133	100%	42%	1971	3,397	82%
1957	2,443	1,976	2,210	53%	43%	1989	3,387	82%
1958	4,133	4,133	4,133	100%	45%	1936	3,344	81%
1959	3,199	2,946	3,073	74%	46%	1963	3,337	81%
1960	1,722	1,430	1,576	38%	47%	1997	3,291	80%
1961	2,650	2,408	2,529	61%	48%	1939	3,224	78%
1962	3,250	3,174	3,212	78%	49%	1962	3,212	78%
1963	3,640	3,034	3,337	81%	51%	1979	3,197	77%
1964	1,814	2,213	2,013	49%	52%	1985	3,163	77%
1965	3,348	2,884	3,116	75%	53%	1954	3,120	75%

Table B.15 cont. SWP Table A deliveries from the Delta under Future (2027) Conditions, derived values for estimating probability curve PCM Model with B1 Emissions

	deliveries derived from interpolating between "no climate change" and "PCM + B1 emissions"				ranking of calculated SWP Table A deliveries for probability curve			
Year	lower flow target[2] (taf)	higher flow target[2] (taf)	average flow targets (taf)	percent of max SWP Table A[3]	Exceedence Frequency	Year	SWP Table A Delivery (taf)	percent of max SWP Table A[3]
1966	3,486	3,376	3,431	83%	54%	1965	3,116	75%
1967	4,133	4,048	4,091	99%	56%	1948	3,082	75%
1968	2,990	2,363	2,676	65%	57%	1959	3,073	74%
1969	3,903	3,903	3,903	94%	58%	1923	3,062	74%
1970	4,133	4,133	4,133	100%	59%	2003	3,011	73%
1971	3,658	3,136	3,397	82%	61%	1986	2,805	68%
1972	1,489	1,495	1,492	36%	62%	1944	2,723	66%
1973	4,000	3,420	3,710	90%	63%	1968	2,676	65%
1974	4,133	3,789	3,961	96%	64%	1981	2,644	64%
1975	3,695	3,222	3,458	84%	66%	1950	2,637	64%
1976	2,227	1,631	1,929	47%	67%	1961	2,529	61%
1977	300	281	291	7%	68%	1987	2,465	60%
1978	3,905	3,905	3,905	94%	69%	2002	2,355	57%
1979	3,371	3,024	3,197	77%	70%	1957	2,210	53%
1980	3,687	3,881	3,784	92%	72%	1930	2,154	52%
1981	2,740	2,547	2,644	64%	73%	1933	2,142	52%
1982	4,133	4,133	4,133	100%	74%	1926	2,111	51%
1983	3,903	3,903	3,903	94%	75%	1994	2,066	50%
1984	4,133	4,133	4,133	100%	77%	1928	2,054	50%
1985	3,293	3,032	3,163	77%	78%	1964	2,013	49%
1986	2,799	2,810	2,805	68%	79%	1976	1,929	47%
1987	2,605	2,326	2,465	60%	80%	1947	1,806	44%
1988	483	454	468	11%	82%	1925	1,693	41%
1989	3,504	3,269	3,387	82%	83%	1960	1,576	38%
1990	367	311	339	8%	84%	1972	1,492	36%
1991	965	776	870	21%	85%	1932	1,436	35%
1992	1,243	1,124	1,183	29%	87%	1934	1,357	33%
1993	3,993	3,471	3,732	90%	88%	1949	1,356	33%
1994	1,874	2,258	2,066	50%	89%	1992	1,183	29%
1995	3,903	3,902	3,903	94%	90%	1931	1,110	27%
1996	4,021	3,624	3,823	92%	91%	1955	1,024	25%
1997	3,294	3,289	3,291	80%	93%	2001	949	23%
1998	3,908	3,908	3,908	95%	94%	1991	870	21%
1999	4,103	4,133	4,118	100%	95%	1929	837	20%
2000	3,913	3,359	3,636	88%	96%	1988	468	11%
2001	884	1,014	949	23%	98%	1990	339	8%
2002	2,595	2,115	2,355	57%	99%	1977	291	7%
2003	3,201	2,820	3,011	73%	100%	1924	261	6%
Avg	**2,954**	**2,746**	**2,850**	**69%**			**2,850**	
Min	**300**	**150**	**261**	**6%**			**261**	
Max	**4,133**	**4,133**	**4,133**	**100%**			**4,133**	

[1]/ See Table 6.3 [2]/ 4,133 taf/year

Table B.16 *SWP Article 21* deliveries under Current (2007) Conditions

Year	Article 21 demands (taf)	Article 21 deliveries		
		less restrictive flow targets (taf)[1]	more restrictive flow targets (taf) [1]	average of flow targets (taf) [1]
1922	1,408	0	0	0
1923	1,408	0	0	0
1924	1,408	0	0	0
1925	1,408	0	0	0
1926	1,408	0	0	0
1927	1,408	0	0	0
1928	1,408	0	0	0
1929	1,408	0	0	0
1930	1,408	0	0	0
1931	1,408	0	0	0
1932	1,408	0	0	0
1933	1,408	77	0	38
1934	1,408	0	0	0
1935	1,408	0	0	0
1936	1,408	0	0	0
1937	1,408	0	0	0
1938	1,408	589	586	587
1939	1,408	124	59	92
1940	1,408	0	0	0
1941	652	100	0	50
1942	1,408	672	324	498
1943	1,156	555	471	513
1944	1,408	0	0	0
1945	1,408	0	0	0
1946	1,408	0	0	0
1947	1,408	0	0	0
1948	1,408	0	0	0
1949	1,408	0	0	0
1950	1,408	0	0	0
1951	1,408	308	134	221
1952	652	100	100	100
1953	1,408	90	90	90
1954	1,156	0	0	0
1955	1,408	0	0	0
1956	1,408	319	194	256
1957	1,408	0	0	0
1958	1,408	563	154	359
1959	1,408	50	42	46
1960	1,408	0	0	0
1961	1,408	0	0	0
1962	1,408	0	0	0
1963	1,408	0	0	0
1964	1,408	0	0	0
1965	1,408	0	0	0

Table B.16 cont. *SWP Article 21* deliveries under Current (2007) Conditions

Year	Article 21 demands (taf)	Article 21 deliveries		
		less restrictive flow targets (taf)	more restrictive flow targets (taf)	average of flow targets (taf)
1966	1,408	0	0	0
1967	1,408	270	0	135
1968	1,408	165	0	82
1969	652	199	199	199
1970	1,408	552	368	460
1971	1,156	0	0	0
1972	1,408	0	0	0
1973	1,408	0	0	0
1974	1,408	96	0	48
1975	1,408	346	0	173
1976	1,408	10	0	5
1977	1,408	0	0	0
1978	652	200	0	100
1979	1,408	0	0	0
1980	400	189	188	189
1981	1,408	0	0	0
1982	1,156	527	453	490
1983	652	400	400	400
1984	1,408	552	368	460
1985	1,156	0	0	0
1986	652	53	0	27
1987	1,408	0	0	0
1988	1,156	0	0	0
1989	1,408	0	0	0
1990	1,408	0	0	0
1991	1,408	0	0	0
1992	1,408	0	0	0
1993	1,408	0	0	0
1994	1,408	0	0	0
1995	652	100	35	67
1996	1,408	423	387	405
1997	1,156	458	227	342
1998	652	178	100	139
1999	1,408	469	285	377
2000	1,156	0	0	0
2001	1,408	0	0	0
2002	1,408	0	0	0
2003	1,408	0	0	0
Avg	**1,297**	**106**	**63**	**85**
Min	**400**	**0**	**0**	**0**
Max	**1,408**	**672**	**586**	**587**

[1]/ See Table 6.3

Table B.17 *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with A2 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL-A2[2] (taf)*
		no climate change (taf)	GFDL with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	*no climate change* (taf)	GFDL with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	
1922	1,408	0	0	0	0	0	0	0
1923	1,408	0	0	0	0	0	0	0
1924	1,408	0	0	0	0	0	0	0
1925	1,408	6	5	6	22	116	66	36
1926	1,408	0	0	0	0	0	0	0
1927	1,408	0	0	0	0	0	0	0
1928	1,408	0	0	0	0	0	0	0
1929	1,408	0	0	0	0	0	0	0
1930	1,408	0	0	0	0	0	0	0
1931	1,408	0	0	0	0	0	0	0
1932	1,408	0	125	58	0	66	31	44
1933	1,408	87	0	47	0	0	0	23
1934	1,408	0	0	0	0	17	8	4
1935	1,408	0	273	127	0	121	56	92
1936	1,408	0	0	0	0	0	0	0
1937	1,408	0	22	10	0	0	0	5
1938	1,408	165	333	243	0	334	155	199
1939	1,408	0	0	0	0	0	0	0
1940	1,408	0	0	0	0	0	0	0
1941	652	0	0	0	0	0	0	0
1942	1,408	0	0	0	0	0	0	0
1943	1,156	17	0	9	0	0	0	4
1944	1,408	0	0	0	0	0	0	0
1945	1,408	0	0	0	0	0	0	0
1946	1,408	0	0	0	0	0	0	0
1947	1,408	0	0	0	0	0	0	0
1948	1,408	0	0	0	0	0	0	0
1949	1,408	0	0	0	0	0	0	0
1950	1,408	0	0	0	0	0	0	0
1951	1,408	171	264	214	115	115	115	164
1952	652	0	0	0	0	0	0	0
1953	1,408	0	0	0	0	0	0	0
1954	1,156	0	0	0	0	0	0	0
1955	1,408	0	0	0	0	0	0	0
1956	1,408	338	466	397	172	268	217	307
1957	1,408	0	0	0	0	0	0	0
1958	1,408	105	0	56	0	0	0	28
1959	1,408	0	0	0	0	0	0	0
1960	1,408	0	0	0	0	0	0	0
1961	1,408	0	0	0	0	0	0	0
1962	1,408	0	0	0	0	0	0	0
1963	1,408	0	0	0	0	0	0	0
1964	1,408	0	0	0	0	0	0	0
1965	1,408	0	203	94	0	0	0	47

[1]/ See Table 6-3 [2]/ As described in Appendix B

Table B.17 cont. *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with A2 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries GFDL-A2[2] (taf)
		no climate change (taf)	GFDL with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	*no climate change* (taf)	GFDL with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	
1966	1,408	0	0	0	0	0	0	0
1967	1,408	0	0	0	0	0	0	0
1968	1,408	0	0	0	0	0	0	0
1969	652	61	124	90	62	95	77	84
1970	1,408	444	31	252	294	0	157	204
1971	1,156	0	0	0	0	0	0	0
1972	1,408	0	0	0	0	0	0	0
1973	1,408	0	0	0	0	0	0	0
1974	1,408	0	0	0	0	0	0	0
1975	1,408	0	0	0	0	0	0	0
1976	1,408	0	0	0	0	0	0	0
1977	1,408	0	30	14	0	0	0	7
1978	652	106	300	196	0	200	93	145
1979	1,408	0	0	0	0	0	0	0
1980	400	131	155	142	63	97	78	110
1981	1,408	0	0	0	0	0	0	0
1982	1,156	0	0	0	0	0	0	0
1983	652	340	239	293	241	239	240	267
1984	1,408	491	491	491	341	371	355	423
1985	1,156	0	0	0	0	0	0	0
1986	652	0	49	23	0	0	0	12
1987	1,408	0	0	0	0	0	0	0
1988	1,156	0	0	0	0	0	0	0
1989	1,408	0	0	0	0	0	0	0
1990	1,408	0	0	0	0	0	0	0
1991	1,408	0	0	0	0	0	0	0
1992	1,408	0	0	0	0	0	0	0
1993	1,408	0	0	0	0	0	0	0
1994	1,408	0	0	0	0	0	0	0
1995	652	0	0	0	0	0	0	0
1996	1,408	38	0	20	0	0	0	10
1997	1,156	158	157	157	0	126	59	108
1998	652	0	0	0	0	0	0	0
1999	1,408	284	153	223	117	0	63	143
2000	1,156	0	0	0	0	0	0	0
2001	1,408	0	0	0	0	0	0	0
2002	1,408	0	0	0	0	0	0	0
2003	1,408	0	0	0	0	0	0	0
Avg	**1,297**	**36**	**42**	**39**	**17**	**26**	**22**	**30**
Min	**400**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Max	**1,408**	**491**	**491**	**491**	**341**	**371**	**355**	**423**

[1]/ See Table 6-3 [2]/ As described in Appendix B

Table B.18 *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with B1 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL*-B1[2] *(taf)*
		no climate change (taf)	GFDL with B1 emissions (taf)	*interpolated GFDL*-B1[2] *(taf)*	*no climate change* (taf)	GFDL with B1 emissions (taf)	*interpolated GFDL*-B1[2] *(taf)*	
1922	1,408	0	0	0	0	0	0	0
1923	1,408	0	0	0	0	0	0	0
1924	1,408	0	0	0	0	0	0	0
1925	1,408	6	20	13	22	65	42	27
1926	1,408	0	0	0	0	0	0	0
1927	1,408	0	0	0	0	0	0	0
1928	1,408	0	0	0	0	0	0	0
1929	1,408	0	0	0	0	0	0	0
1930	1,408	0	0	0	0	0	0	0
1931	1,408	0	0	0	0	0	0	0
1932	1,408	0	15	7	0	88	41	24
1933	1,408	87	0	47	0	0	0	23
1934	1,408	0	0	0	0	0	0	0
1935	1,408	0	142	66	0	225	105	85
1936	1,408	0	0	0	0	0	0	0
1937	1,408	0	112	52	0	0	0	26
1938	1,408	165	213	187	0	239	111	149
1939	1,408	0	0	0	0	0	0	0
1940	1,408	0	0	0	0	0	0	0
1941	652	0	0	0	0	0	0	0
1942	1,408	0	0	0	0	0	0	0
1943	1,156	17	35	25	0	0	0	13
1944	1,408	0	0	0	0	0	0	0
1945	1,408	0	0	0	0	0	0	0
1946	1,408	0	0	0	0	0	0	0
1947	1,408	0	0	0	0	0	0	0
1948	1,408	0	0	0	0	0	0	0
1949	1,408	0	0	0	0	0	0	0
1950	1,408	0	0	0	0	0	0	0
1951	1,408	171	259	212	115	54	86	149
1952	652	0	0	0	0	0	0	0
1953	1,408	0	0	0	0	0	0	0
1954	1,156	0	0	0	0	0	0	0
1955	1,408	0	0	0	0	0	0	0
1956	1,408	338	463	396	172	257	212	304
1957	1,408	0	0	0	0	0	0	0
1958	1,408	105	0	56	0	0	0	28
1959	1,408	0	0	0	0	0	0	0
1960	1,408	0	0	0	0	0	0	0
1961	1,408	0	0	0	0	0	0	0
1962	1,408	0	0	0	0	0	0	0
1963	1,408	0	0	0	0	0	0	0
1964	1,408	0	0	0	0	0	0	0
1965	1,408	0	22	10	0	0	0	5

[1]/ See Table 6.3 [2]/ As described in Appendix B

Table B.18 cont. *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario GFDL with B1 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL*-B1[2] *(taf)*
		no climate change (taf)	GFDL with B1 emissions (taf)	*interpolated GFDL*-B1[2] *(taf)*	*no climate change* (taf)	GFDL with B1 emissions (taf)	*interpolated GFDL*-B1[2] *(taf)*	
1966	1,408	0	0	0	0	0	0	0
1967	1,408	0	0	0	0	0	0	0
1968	1,408	0	0	0	0	0	0	0
1969	652	61	144	100	62	144	100	100
1970	1,408	444	43	257	294	0	157	207
1971	1,156	0	0	0	0	0	0	0
1972	1,408	0	0	0	0	0	0	0
1973	1,408	0	0	0	0	0	0	0
1974	1,408	0	0	0	0	0	0	0
1975	1,408	0	0	0	0	0	0	0
1976	1,408	0	0	0	0	0	0	0
1977	1,408	0	0	0	0	0	0	0
1978	652	106	247	171	0	54	25	98
1979	1,408	0	0	0	0	0	0	0
1980	400	131	174	151	63	168	112	131
1981	1,408	0	0	0	0	0	0	0
1982	1,156	0	0	0	0	0	0	0
1983	652	340	239	293	241	239	240	267
1984	1,408	491	491	491	341	326	334	413
1985	1,156	0	0	0	0	0	0	0
1986	652	0	54	25	0	0	0	13
1987	1,408	0	0	0	0	0	0	0
1988	1,156	0	0	0	0	0	0	0
1989	1,408	0	0	0	0	0	0	0
1990	1,408	0	0	0	0	0	0	0
1991	1,408	0	0	0	0	0	0	0
1992	1,408	0	0	0	0	0	0	0
1993	1,408	0	0	0	0	0	0	0
1994	1,408	0	0	0	0	0	0	0
1995	652	0	0	0	0	0	0	0
1996	1,408	38	0	20	0	0	0	10
1997	1,156	158	229	191	0	115	53	122
1998	652	0	0	0	0	0	0	0
1999	1,408	284	332	306	117	0	63	184
2000	1,156	0	0	0	0	0	0	0
2001	1,408	0	0	0	0	0	0	0
2002	1,408	0	0	0	0	0	0	0
2003	1,408	0	0	0	0	0	0	0
Avg	**1,297**	**36**	**39**	**38**	**17**	**24**	**20**	**29**
Min	**400**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Max	1,408	491	491	491	341	326	334	413

[1]/ See Table 6.3 [2]/ As described in Appendix B

Table B.19 *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with A2 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries GFDL-A2[2] (taf)
		no climate change (taf)	PCM with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	*no climate change* (taf)	PCM with A2 emissions (taf)	*interpolated GFDL-A2[2] (taf)*	
1922	1,408	0	0	0	0	0	0	0
1923	1,408	0	0	0	0	0	0	0
1924	1,408	0	0	0	0	0	0	0
1925	1,408	6	189	91	22	276	140	116
1926	1,408	0	0	0	0	0	0	0
1927	1,408	0	0	0	0	0	0	0
1928	1,408	0	0	0	0	0	0	0
1929	1,408	0	0	0	0	0	0	0
1930	1,408	0	0	0	0	0	0	0
1931	1,408	0	0	0	0	0	0	0
1932	1,408	0	80	37	0	0	0	19
1933	1,408	87	270	172	0	0	0	86
1934	1,408	0	59	28	0	0	0	14
1935	1,408	0	160	75	0	125	58	66
1936	1,408	0	0	0	0	0	0	0
1937	1,408	0	133	62	0	0	0	31
1938	1,408	165	320	237	0	282	131	184
1939	1,408	0	0	0	0	0	0	0
1940	1,408	0	0	0	0	0	0	0
1941	652	0	0	0	0	0	0	0
1942	1,408	0	0	0	0	0	0	0
1943	1,156	17	117	63	0	0	0	32
1944	1,408	0	0	0	0	0	0	0
1945	1,408	0	0	0	0	63	29	15
1946	1,408	0	0	0	0	0	0	0
1947	1,408	0	0	0	0	0	0	0
1948	1,408	0	0	0	0	0	0	0
1949	1,408	0	0	0	0	0	0	0
1950	1,408	0	0	0	0	0	0	0
1951	1,408	171	245	205	115	283	193	199
1952	652	0	0	0	0	0	0	0
1953	1,408	0	0	0	0	0	0	0
1954	1,156	0	0	0	0	0	0	0
1955	1,408	0	0	0	0	0	0	0
1956	1,408	338	455	392	172	268	217	304
1957	1,408	0	0	0	0	0	0	0
1958	1,408	105	82	94	0	0	0	47
1959	1,408	0	0	0	0	0	0	0
1960	1,408	0	0	0	0	0	0	0
1961	1,408	0	0	0	0	0	0	0
1962	1,408	0	0	0	0	0	0	0
1963	1,408	0	0	0	0	0	0	0
1964	1,408	0	0	0	0	0	0	0
1965	1,408	0	46	21	0	0	0	11

[1]/ See Table 6.3 [2]/ As described in Appendix B

Table B.19 cont. *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with A2 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL-A2*[2] *(taf)*
		no climate change (taf)	PCM with A2 emissions (taf)	*interpolated GFDL-A2* [2] *(taf)*	*no climate change* (taf)	PCM with A2 emissions (taf)	*interpolated GFDL-A2*[2] *(taf)*	
1966	1,408	0	0	0	0	0	0	0
1967	1,408	0	0	0	0	0	0	0
1968	1,408	0	0	0	0	0	0	0
1969	652	61	61	61	62	61	62	61
1970	1,408	444	279	367	294	114	210	289
1971	1,156	0	0	0	0	0	0	0
1972	1,408	0	0	0	0	0	0	0
1973	1,408	0	0	0	0	0	0	0
1974	1,408	0	0	0	0	0	0	0
1975	1,408	0	0	0	0	0	0	0
1976	1,408	0	0	0	0	0	0	0
1977	1,408	0	0	0	0	0	0	0
1978	652	106	300	196	0	200	93	145
1979	1,408	0	0	0	0	0	0	0
1980	400	131	100	116	63	60	61	89
1981	1,408	0	0	0	0	0	0	0
1982	1,156	0	0	0	0	0	0	0
1983	652	340	239	293	241	239	240	267
1984	1,408	491	491	491	341	341	341	416
1985	1,156	0	0	0	0	0	0	0
1986	652	0	49	23	0	0	0	11
1987	1,408	0	0	0	0	0	0	0
1988	1,156	0	0	0	0	0	0	0
1989	1,408	0	0	0	0	0	0	0
1990	1,408	0	0	0	0	0	0	0
1991	1,408	0	0	0	0	0	0	0
1992	1,408	0	0	0	0	0	0	0
1993	1,408	0	0	0	0	0	0	0
1994	1,408	0	0	0	0	0	0	0
1995	652	0	0	0	0	0	0	0
1996	1,408	38	0	20	0	0	0	10
1997	1,156	158	195	175	0	0	0	87
1998	652	0	0	0	0	0	0	0
1999	1,408	284	295	289	117	40	81	185
2000	1,156	0	0	0	0	0	0	0
2001	1,408	0	0	0	0	0	0	0
2002	1,408	0	0	0	0	0	0	0
2003	1,408	0	0	0	0	0	0	0
Avg	**1,297**	**36**	**51**	**43**	**17**	**29**	**23**	**33**
Min	**400**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Max	**1,408**	**491**	**491**	**491**	**341**	**341**	**341**	**416**

[1]/ See Table 6.3 [2]/ As described in Appendix B

Table B.20 *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with B1 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL*-B1 [2] *(taf)*
		no climate change (taf)	PCM with B1 emissions (taf)	*interpolated GFDL*-B1 [2] *(taf)*	*no climate change* (taf)	PCM with B1 emissions (taf)	*interpolated GFDL*-B1 [2] *(taf)*	
1922	1,408	0	0	0	0	0	0	0
1923	1,408	0	0	0	0	0	0	0
1924	1,408	0	0	0	0	0	0	0
1925	1,408	6	48	25	22	29	25	25
1926	1,408	0	0	0	0	0	0	0
1927	1,408	0	0	0	0	0	0	0
1928	1,408	0	0	0	0	0	0	0
1929	1,408	0	0	0	0	0	0	0
1930	1,408	0	0	0	0	0	0	0
1931	1,408	0	0	0	0	0	0	0
1932	1,408	0	0	0	0	0	0	0
1933	1,408	87	104	95	0	0	0	47
1934	1,408	0	0	0	0	0	0	0
1935	1,408	0	0	0	0	0	0	0
1936	1,408	0	0	0	0	0	0	0
1937	1,408	0	0	0	0	0	0	0
1938	1,408	165	0	88	0	0	0	44
1939	1,408	0	0	0	0	0	0	0
1940	1,408	0	0	0	0	0	0	0
1941	652	0	0	0	0	0	0	0
1942	1,408	0	0	0	0	0	0	0
1943	1,156	17	49	32	0	0	0	16
1944	1,408	0	0	0	0	0	0	0
1945	1,408	0	0	0	0	0	0	0
1946	1,408	0	0	0	0	0	0	0
1947	1,408	0	0	0	0	0	0	0
1948	1,408	0	0	0	0	0	0	0
1949	1,408	0	0	0	0	0	0	0
1950	1,408	0	0	0	0	0	0	0
1951	1,408	171	168	169	115	0	61	115
1952	652	0	0	0	0	0	0	0
1953	1,408	0	0	0	0	0	0	0
1954	1,156	0	0	0	0	0	0	0
1955	1,408	0	0	0	0	0	0	0
1956	1,408	338	325	331	172	176	174	253
1957	1,408	0	0	0	0	0	0	0
1958	1,408	105	122	113	0	0	0	57
1959	1,408	0	0	0	0	0	0	0
1960	1,408	0	0	0	0	0	0	0
1961	1,408	0	0	0	0	0	0	0
1962	1,408	0	0	0	0	0	0	0
1963	1,408	0	0	0	0	0	0	0
1964	1,408	0	0	0	0	0	0	0
1965	1,408	0	0	0	0	0	0	0

[1]/ See Table 6.3 [2]/ As described in Appendix B

Table B.20 cont. *SWP Article 21* deliveries under Future (2027) Conditions
Climate change scenario PCM with B1 emissions

Year	Article 21 demand (taf)	Article 21 deliveries under less restrictive flow targets[1]			Article 21 deliveries under more restrictive flow targets[1]			Averaged Article 21 deliveries *GFDL*-B1 [2] *(taf)*
		no climate change (taf)	PCM with B1 emissions (taf)	*interpolated GFDL*-B1 [2] *(taf)*	*no climate change* (taf)	PCM with B1 emissions (taf)	*interpolated GFDL*-B1 [2] *(taf)*	
1966	1,408	0	0	0	0	0	0	0
1967	1,408	0	0	0	0	0	0	0
1968	1,408	0	0	0	0	0	0	0
1969	652	61	75	67	62	62	62	65
1970	1,408	444	424	435	294	274	285	360
1971	1,156	0	0	0	0	0	0	0
1972	1,408	0	0	0	0	0	0	0
1973	1,408	0	0	0	0	0	0	0
1974	1,408	0	0	0	0	0	0	0
1975	1,408	0	0	0	0	0	0	0
1976	1,408	0	0	0	0	0	0	0
1977	1,408	0	0	0	0	0	0	0
1978	652	106	54	82	0	0	0	41
1979	1,408	0	0	0	0	0	0	0
1980	400	131	125	128	63	87	74	101
1981	1,408	0	0	0	0	0	0	0
1982	1,156	0	0	0	0	0	0	0
1983	652	340	340	340	241	239	240	290
1984	1,408	491	491	491	341	341	341	416
1985	1,156	0	0	0	0	0	0	0
1986	652	0	0	0	0	0	0	0
1987	1,408	0	0	0	0	0	0	0
1988	1,156	0	0	0	0	0	0	0
1989	1,408	0	0	0	0	0	0	0
1990	1,408	0	0	0	0	0	0	0
1991	1,408	0	0	0	0	0	0	0
1992	1,408	0	0	0	0	0	0	0
1993	1,408	0	0	0	0	0	0	0
1994	1,408	0	0	0	0	0	0	0
1995	652	0	0	0	0	0	0	0
1996	1,408	38	50	44	0	0	0	22
1997	1,156	158	255	203	0	0	0	102
1998	652	0	0	0	0	0	0	0
1999	1,408	284	310	296	117	115	116	206
2000	1,156	0	0	0	0	0	0	0
2001	1,408	0	0	0	0	0	0	0
2002	1,408	0	0	0	0	0	0	0
2003	1,408	0	0	0	0	0	0	0
Avg	**1,297**	**36**	**36**	**36**	**17**	**16**	**17**	**26**
Min	**400**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Max	**1,408**	**491**	**491**	**491**	**341**	**341**	**341**	**416**

[1]/ See Table 6.3 [2]/ As described in Appendix B

Figure B.1 SWP Table A delivery probability under Current Conditions

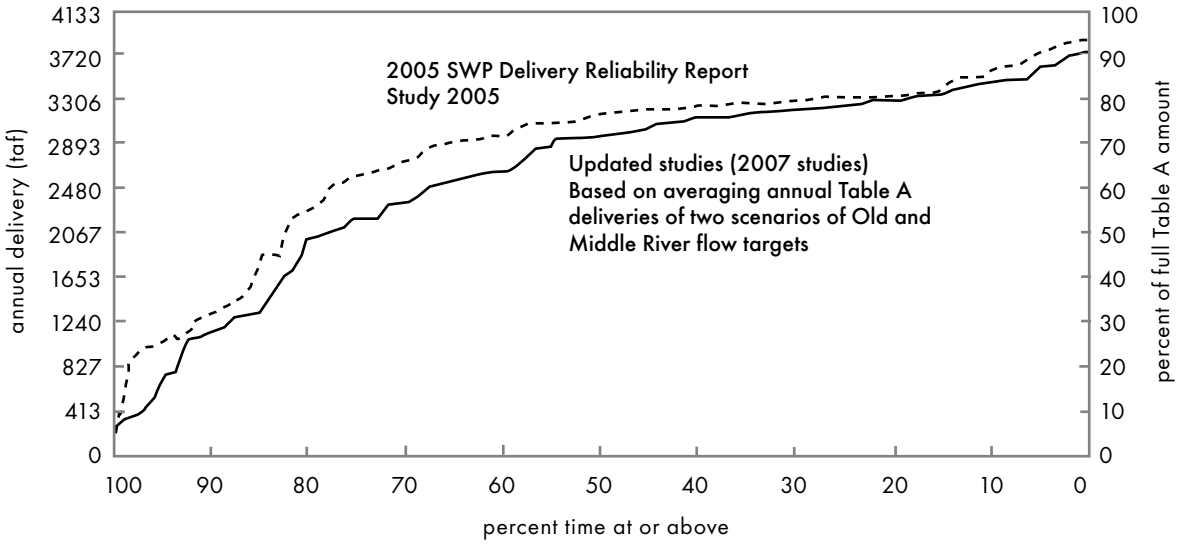


Figure B.2 SWP Table A delivery probability under Future Conditions

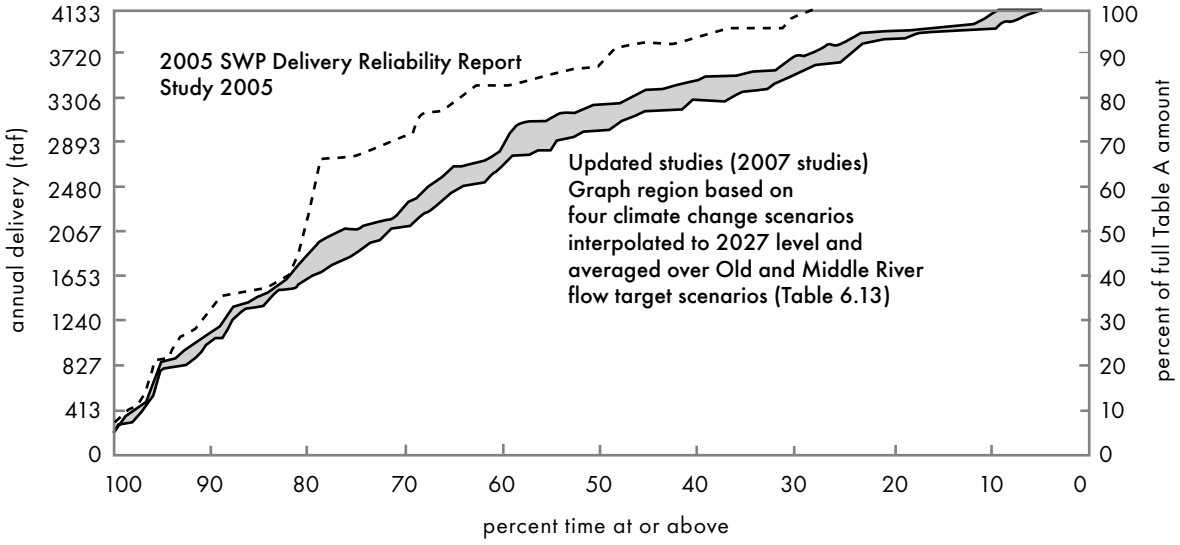


Figure B.3 SWP Table A delivery probability under Future Conditions for climate change scenarios with A2 emissions

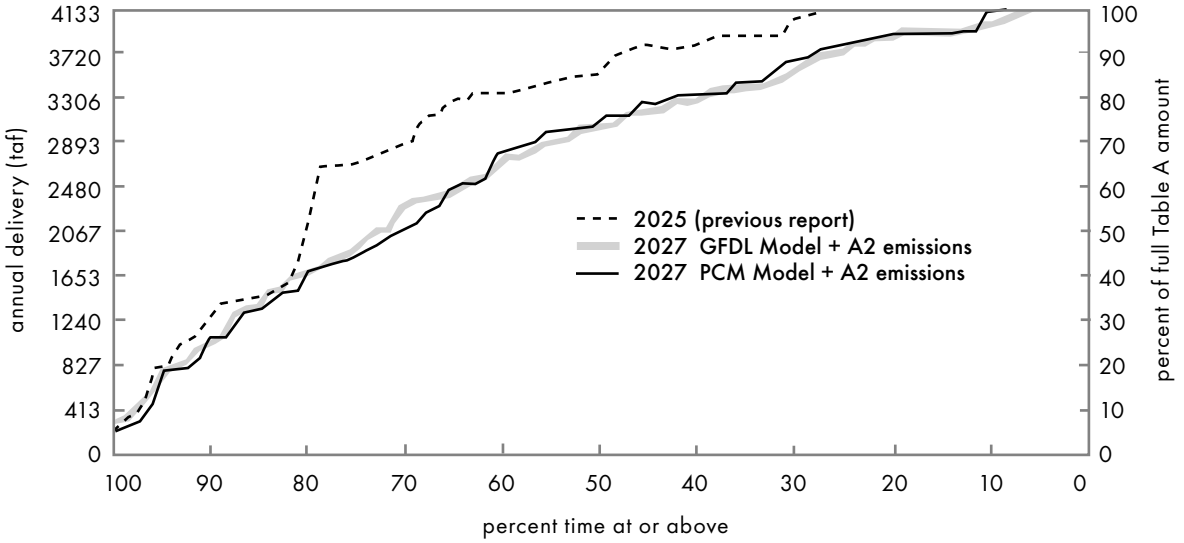


Figure B.4 SWP Table A delivery probability under Future Conditions for climate change scenarios with B1 emissions

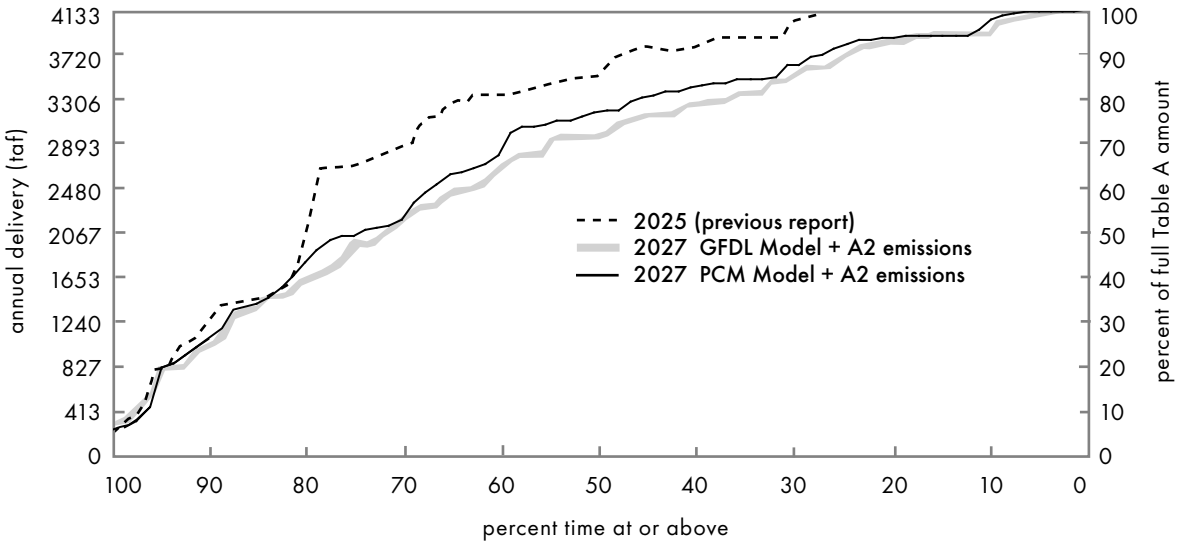


Table B.21 Highlighted SWP Table A delivery percent exceedence values under Current and Future Conditions

	Exceedence values (taf)		
	25%	**50%**	**75%**
2005 SWP Delivery Reliability Report			
Current (2005)	3323	3173	2588
Future (2025)	4133	3565	2738
Updated studies			
Current (2007)	3218	2976	2168
Future (2027)[1]			
GFDL+A2	3703	3017	1883
GFDL+B1	3686	2967	1966
PCM+A2	3782	3084	1860
PCM+B1	3813	3205	2077

1/ Based upon **SWP Table A** deliveries that have been interpolated between the "no climate change" scenario and the climate change scenarios determined by climate change model (GFDL or PCM) and greenhouse gas emissions scenario (A2 or B1). **SWP Table A** deliveries for two scenarios of Old River and Middle River flow targets were then averaged.

Table B.22 Comparing total SWP deliveries under Current Conditions from updated studies to deliveries from 2005 Report

Year	Total SWP Deliveries (Table A + Article 21)			Year	Total SWP Deliveries (Table A + Article 21)		
	study 2005 (2005 Report) (taf)	updated study 2007[1] (taf)	Change in total SWP deliveries (taf)		study 2005 (2005 Report) (taf)	updated study 2007[1] (taf)	Change in total SWP deliveries (taf)
1922	3,847	3,674	-173	**1963**	4,020	3,406	-614
1923	3,358	3,159	-199	**1964**	3,323	2,211	-1,113
1924	1,244	400	-844	**1965**	3,236	2,861	-376
1925	1,870	1,644	-226	**1966**	3,800	3,265	-534
1926	3,035	2,186	-849	**1967**	3,870	3,125	-745
1927	4,058	3,699	-359	**1968**	3,881	3,379	-501
1928	3,518	2,059	-1,459	**1969**	2,907	2,825	-82
1929	1,108	753	-355	**1970**	3,809	3,717	-92
1930	2,972	2,028	-944	**1971**	3,341	3,317	-24
1931	1,018	1,105	88	**1972**	3,756	1,707	-2,049
1932	1,649	1,305	-344	**1973**	3,476	3,085	-390
1933	1,842	2,019	177	**1974**	4,038	3,232	-806
1934	1,746	1,315	-432	**1975**	4,132	3,391	-741
1935	3,998	3,334	-663	**1976**	3,455	2,609	-846
1936	3,573	3,124	-449	**1977**	159	243	84
1937	3,442	3,219	-223	**1978**	3,903	3,699	-203
1938	4,058	3,982	-76	**1979**	3,661	3,128	-533
1939	3,612	3,348	-264	**1980**	2,847	2,898	52
1940	3,374	3,165	-209	**1981**	3,904	3,128	-777
1941	2,773	2,576	-197	**1982**	3,691	3,430	-260
1942	4,086	3,665	-420	**1983**	2,898	2,897	-1
1943	3,727	3,667	-60	**1984**	3,318	3,687	370
1944	3,091	2,930	-161	**1985**	3,214	3,198	-16
1945	3,460	3,085	-375	**1986**	2,417	2,321	-97
1946	3,464	3,199	-265	**1987**	3,442	2,825	-617
1947	3,292	2,314	-978	**1988**	856	477	-380
1948	2,942	2,609	-333	**1989**	3,174	3,130	-43
1949	2,264	1,271	-993	**1990**	1,099	360	-739
1950	3,199	2,462	-737	**1991**	1,052	729	-323
1951	3,886	3,718	-167	**1992**	1,426	1,087	-339
1952	2,863	2,685	-178	**1993**	4,007	3,711	-296
1953	3,836	3,413	-423	**1994**	3,306	2,105	-1,201
1954	3,817	3,201	-616	**1995**		3,061	
1955	2,207	1,137	-1,070	**1996**		3,845	
1956	3,911	3,838	-73	**1997**		3,443	
1957	3,492	2,545	-947	**1998**		3,147	
1958	4,086	3,388	-698	**1999**		3,816	
1959	3,846	3,511	-335	**2000**		3,451	
1960	1,865	1,460	-405	**2001**		1,164	
1961	2,756	2,357	-399	**2002**		2,162	
1962	3,262	2,962	-300	**2003**		2,943	

[1]/ Average of the two scenarios of Old River and Middle River flow targets described in Table 6-3.

Appendix C. State Water Project SWP Table A Amounts

The contracts between the Department of Water Resources and the 29 State Water Project water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. SWP Table A is an exhibit to these contracts. Comprehension of SWP Table A is important in understanding the information in this report. To understand the table, it is necessary to understand how the contracts work.

All water-supply related costs of the SWP are paid by the contractors, and SWP Table A serves as a basis for allocating some of the costs among the contractors. In addition, SWP Table A plays a key role in the annual allocation of available supply among contractors. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. This was referred to as the maximum project yield, and it was recognized that in some years the project would be unable to deliver that amount and in other years project supply could exceed that amount. The 4.2 maf number was used as the basis for apportioning available supply to each contractor and as a factor in calculating each contractor's share of the project's costs. This apportionment is accomplished by SWP Table A in each contract. SWP Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. Other contract provisions permit changes to an individual contractor's SWP Table A under special circumstances. The total of the maximums in all the contracts now equals 4.173 maf.

A copy of the consolidated SWP Table A from all the contracts is presented in **Table C.1**. The amounts listed in SWP Table A cannot be viewed as an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular time span. SWP Table A is simply a tool for apportioning available supply and cost obligations under the contract. In this report, reference to "SWP Table A amounts" means the amounts listed in SWP Table A. Contractors also receive other classifications of water from the project, as distinguished from SWP Table A (for example, Article 21 water, and turnback pool water). These other contract provisions are discussed in Appendix D.

Table C.1 Maximum annual SWP Table A amounts (af)

SWP Contractors	Maximum SWP Table A
North Bay	
Napa County FC&WCD	29,025
Solano County WA	47,756
Subtotal	**76,781**
South Bay	
Alameda County FC&WCD, Zone 7	80,619
Alameda County WD	42,000
Santa Clara Valley WD	100,000
Subtotal	**222,619**
San Joaquin Valley	
Oak Flat WD	5,700
County of Kings	9,305
Dudley Ridge WD	57,343
Empire West Side ID	3,000
Kern County WA	998,730
Tulare Lake Basin WSD	95,922
Subtotal	**1,170,000**
Central Coastal	
San Luis Obispo County FC&WCD	25,000
Santa Barbara County FC&WCD	45,486
Subtotal	**70,486**
Southern California	
Antelope Valley-East Kern WA	141,400
Castaic Lake WA	95,200
Coachella Valley WD	121,100
Crestline-Lake Arrowhead WA	5,800
Desert WA	50,000
Littlerock Creek ID	2,300
Mojave WA	75,800
Metropolitan WDSC	1,911,500
Palmdale WD	21,300
San Bernardino Valley MWD	102,600
San Gabriel Valley MWD	28,800
San Gorgonio Pass WA	17,300
Ventura County FCD	20,000
Subtotal	**2,593,100**
Delta Subtotal	**4,132,986**
Feather River	
County of Butte	27,500
Plumas County FC&WCD	2,700
City of Yuba City	9,600
Subtotal	**39,800**
Grand Total	**4,172,786**

Appendix D. Recent State Water Project Deliveries

SWP Contract Water Types

The State Water Project contracts define several classifications of water available for delivery to contractors under specific circumstances. All classifications are considered "project" water. Many contractors make frequent use of these additional water types to increase or decrease the amount available to them under SWP Table A.

SWP Table A Water

Each contract's SWP Table A amount is the value in acre-feet that is used to determine the portion of available supply to be delivered to that contractor. *Table A* water is water delivered according to this apportionment methodology and is given first priority for delivery.

Article 21 Water

Article 21 of the contracts permits delivery of water excess to delivery of SWP Table A and some other water types to those contractors requesting it. It is available under specific conditions discussed in Chapter 4. Article 21 water is apportioned to those contractors requesting it in the same proportion as their SWP Table A.

Turnback Pool Water

Contractors may choose to offer their allocated SWP Table A water in excess to their needs to other contractors through two pools in February and March. Contributing contractors receive a reduction in charges, and taking contractors pay extra.

Carryover Water

Pursuant to the long-term water supply contracts, the Department of Water Resources (DWR) has offered contractors the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next year. The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The water supply contracts state the criteria of carrying over SWP Table A water from one year to the next. Normally, carryover water is water that has been exported during the year, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir to be delivered during the following year. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Updated Historical Deliveries

Table D.1 through D.10 list annual historical deliveries by various water classifications for each contractor for 1997 through 2006. Similar delivery tables for years 1995 through 2004 are included in the *State Water Project Delivery Reliability Report 2005*. Amounts listed for 2004 are slightly different due to accounting adjustments made by DWR's State Water Project Analysis Office.

Table D.1 Historical State Water Project Deliveries: 1997

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	185	0	0	0	**185**
Plumas County FC&WCD	231	0	0	0	**231**
City of Yuba City	1,005	0	0	0	**1,005**
Napa County FC&WCD	4,341	0	0	0	**4,341**
Solano County WA	35,530	0	0	0	**35,530**
Alameda County FC&WCD, Zone 7	27,522	0	0	0	**27,522**
Alameda County WD	24,063	0	0	0	**24,063**
Santa Clara Valley WD	95,601	0	0	0	**95,601**
Oak Flat WD	5,238	0	0	0	**5,238**
Dudley Ridge WD	51,623	7,141	12,544	0	**71,308**
Kern County WA	1,092,543	10,264	0	0	**1,102,807**
Tulare Lake Basin WSD	21,156	1,213	0	0	**22,369**
San Luis Obispo County FC&WCD	1,199	0	0	0	**1,199**
Santa Barbara County FC&WCD	7,439	0	0	0	**7,439**
Antelope Valley-East Kern WA	61,752	641	0	0	**62,393**
Castaic Lake WA (+Rch 31A, 5 & 7)	27,712	0	0	0	**27,712**
Coachella Valley WD	23,100	0	35,000	0	**58,100**
Crestline-Lake Arrowhead WA	651	0	0	0	**651**
Desert WA	38,100	0	15,000	0	**53,100**
Littlerock Creeck ID	444	0	0	0	**444**
Mojave WA	10,374	0	0	0	**10,374**
Metropolitan WDSC	738,990	0	0	0	**738,990**
Palmdale WD	11,861	0	0	0	**11,861**
San Bernardino Valley MWD	9,654	0	0	0	**9,654**
San Gabriel Valley MWD	16,002	2,173	0	0	**18,175**
Ventura County FCD	1,850	0	0	0	**1,850**
Totals	**2,308,166**	**21,432**	**62,544**	**0**	**2,392,142**
Total South of Delta	**2,306,745**	**21,432**	**62,544**	**0**	**2,390,721**

Table D.2 Historical State Water Project Deliveries: 1998

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	527	0	0	0	**527**
City of Yuba City	1,054	0	0	0	**1,054**
Napa County FC&WCD	5,359	0	0	0	**5,359**
Solano County WA	21,377	9,982	0	407	**31,766**
Alameda County FC&WCD, Zone 7	17,941	0	0	0	**17,941**
Alameda County WD	19,075	0	0	0	**19,075**
Santa Clara Valley WD	62,526	0	0	884	**63,410**
Oak Flat WD	4,401	0	0	0	**4,401**
County of Kings	3	12	0	0	**15**
Dudley Ridge WD	52,919	984	0	1,747	**55,650**
Empire West Side ID	0	0	0	542	**542**
Kern County WA	856,906	0	0	1,684	**858,590**
Tulare Lake Basin WSD	11,367	9,310	0	0	**20,677**
San Luis Obispo County FC&WCD	3,592	0	0	0	**3,592**
Santa Barbara County FC&WCD	18,618	0	0	0	**18,618**
Antelope Valley-East Kern WA	52,926	0	0	0	**52,926**
Castaic Lake WA (+Rch 31A, 5 & 7)	20,093	0	0	0	**20,093**
Coachella Valley WD	23,100	0	55,000	0	**78,100**
Crestline-Lake Arrowhead WA	187	0	0	0	**187**
Desert WA	38,100	0	20,000	0	**58,100**
Littlerock Creek ID	404	0	0	0	**404**
Mojave WA	3,925	0	0	0	**3,925**
Metropolitan WDSC	359,213	0	0	33,672	**392,885**
Palmdale WD	8,752	0	0	0	**8,752**
San Bernardino Valley MWD	1,878	0	0	0	**1,878**
San Gabriel Valley MWD	9,310	0	0	0	**9,310**
Ventura County FCD	1,850	0	0	0	**1,850**
Totals	**1,595,403**	**20,288**	**75,000**	**38,936**	**1,729,627**
Total South of Delta	**1,593,822**	**20,288**	**75,000**	**38,936**	**1,728,046**

Table D.3 Historical State Water Project Deliveries: 1999

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	286	0	0	0	**286**
City of Yuba City	1,096	0	0	0	**1,096**
Napa County FC&WCD	4,550	754	0	0	**5,304**
Solano County WA	37,753	0	0	0	**37,753**
Alameda County FC&WCD, Zone 7	46,000	2,910	0	0	**48,910**
Alameda County WD	34,871	2,781	0	0	**37,652**
Santa Clara Valley WD	67,465	15,480	0	0	**82,945**
Oak Flat WD	4,871	0	0	0	**4,871**
County of Kings	4,000	0	0	0	**4,000**
Dudley Ridge WD	51,870	4,990	6,566	0	**63,426**
Empire West Side ID	3,000	176	0	0	**3,176**
Kern County WA	1,077,755	58,241	42,154	0	**1,178,150**
Tulare Lake Basin WSD	118,500	49,898	121,337	0	**289,735**
San Luis Obispo County FC&WCD	3,743	0	0	0	**3,743**
Santa Barbara County FC&WCD	20,137	0	0	0	**20,137**
Antelope Valley-East Kern WA	69,073	0	0	0	**69,073**
Castaic Lake WA (+Rch 31A, 5 & 7)	32,899	0	0	0	**32,899**
Coachella Valley WD	23,100	0	27,380	0	**50,480**
Crestline-Lake Arrowhead WA	1,132	0	0	0	**1,132**
Desert WA	38,100	0	20,000	0	**58,100**
Littlerock Creek ID	342	0	0	0	**342**
Mojave WA	5,144	0	0	0	**5,144**
Metropolitan WDSC	829,777	22,840	0	0	**852,617**
Palmdale WD	13,278	0	0	0	**13,278**
San Bernardino Valley MWD	12,874	0	0	0	**12,874**
San Gabriel Valley MWD	18,000	0	0	0	**18,000**
Ventura County FCD	1,850	0	0	0	**1,850**
Totals	**2,521,466**	**158,070**	**217,437**	**0**	**2,896,973**
Total South of Delta	**2,520,084**	**158,070**	**217,437**	**0**	**2,895,591**

Table D.4 Historical State Water Project Deliveries: 2000

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	586	0	0	0	**586**
City of Yuba City	901	0	0	0	**901**
Napa County FC&WCD	3,136	297	0	1,525	**4,958**
Solano County WA	32,882	1,040	0	1,417	**35,339**
Alameda County FC&WCD, Zone 7	53,877	3,740	0	0	**57,617**
Alameda County WD	33,598	2,380	0	0	**35,978**
Santa Clara Valley WD	70,433	18,381	0	13,174	**101,988**
Oak Flat WD	4,494	0	0	14	**4,508**
County of Kings	3,600	0	0	0	**3,600**
Dudley Ridge WD	38,673	7,454	12,193	2,884	**61,204**
Empire West Side ID	1,271	528	0	0	**1,799**
Kern County WA	825,856	78,908	233,202	13,193	**1,151,159**
Tulare Lake Basin WSD	98,595	56,818	27,073	15,827	**198,313**
San Luis Obispo County FC&WCD	3,962	0	0	0	**3,962**
Santa Barbara County FC&WCD	22,741	0	0	0	**22,741**
Antelope Valley-East Kern WA	83,577	0	0	0	**83,577**
Castaic Lake WA (+Rch 31A, 5 & 7)	40,680	0	0	0	**40,680**
Coachella Valley WD	20,790	17,820	3,713	0	**42,323**
Crestline-Lake Arrowhead WA	1,194	0	0	0	**1,194**
Desert WA	34,290	17,820	6,124	0	**58,234**
Mojave WA	9,135	0	0	0	**9,135**
Metropolitan WDSC	1,273,729	103,124	0	169,529	**1,546,382**
Palmdale WD	8,221	0	0	839	**9,060**
San Bernardino Valley MWD	18,399	0	0	0	**18,399**
San Gabriel Valley MWD	14,000	475	0	0	**14,475**
Ventura County FCD	4,050	0	0	0	**4,050**
Totals	**2,702,670**	**308,785**	**282,305**	**218,402**	**3,512,162**
Total South of Delta	**2,701,183**	**308,785**	**282,305**	**218,402**	**3,510,675**

Table D.5 Historical State Water Project Deliveries: 2001

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	513	0	0	0	**513**
City of Yuba City	1,065	0	0	0	**1,065**
Napa County FC&WCD	4,293	996	82	1,723	**7,094**
Solano County WA	17,756	2,304	0	1,021	**21,081**
Alameda County FC&WCD, Zone 7	22,307	0	308	5,990	**28,605**
Alameda County WD	13,695	10	107	4,192	**18,004**
Santa Clara Valley WD	35,689	0	0	12,233	**47,922**
Oak Flat WD	2,089	0	22	101	**2,212**
County of Kings	1,560	0	0	0	**1,560**
Dudley Ridge WD	18,467	933	347	6,815	**26,562**
Empire West Side ID	0	253	0	1,107	**1,360**
Kern County WA	363,204	23,233	6,502	92,052	**484,991**
Tulare Lake Basin WSD	40,830	8,755	769	7,889	**58,243**
San Luis Obispo County FC&WCD	4,184	0	99	0	**4,283**
Santa Barbara County FC&WCD	14,285	396	296	0	**14,977**
Antelope Valley-East Kern WA	45,071	0	899	0	**45,970**
Castaic Lake WA (+Rch 31A, 5 & 7)	30,471	850	618	0	**31,939**
Coachella Valley WD	9,009	0	91	0	**9,100**
Crestline-Lake Arrowhead WA	1,057	0	0	0	**1,057**
Desert WA	14,859	0	151	0	**15,010**
Mojave WA	4,433	0	0	0	**4,433**
Metropolitan WDSC	686,545	10,415	7,949	200,000	**904,909**
Palmdale WD	8,170	0	0	2,257	**10,427**
San Bernardino Valley MWD	26,488	0	0	0	**26,488**
San Gabriel Valley MWD	6,534	0	0	0	**6,534**
Ventura County FCD	1,850	0	0	0	**1,850**
Totals	**1,374,424**	**48,145**	**18,240**	**335,380**	**1,776,189**
Total South of the Delta	**1,372,846**	**48,145**	**18,240**	**335,380**	**1,774,611**

Table D.6 Historical State Water Project Deliveries: 2002

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	419	0	0	0	**419**
City of Yuba City	1,181	0	0	0	**1,181**
Napa County FC&WCD	2,022	827	283	3,743	**6,875**
Solano County WA	28,223	2,242	0	0	**30,465**
Alameda County FC&WCD, Zone 7	40,707	1,484	556	8,113	**50,860**
Alameda County WD	24,250	83	862	2,331	**27,526**
Santa Clara Valley WD	55,896	202	2,053	3,311	**61,462**
Oak Flat WD	3,841	50	76	134	**4,101**
County of Kings	2,800	0	54	0	**2,854**
Dudley Ridge WD	38,688	1,861	1,177	1,994	**43,720**
Empire West Side ID	1,278	26	0	101	**1,405**
Kern County WA	670,884	21,951	20,543	15,680	**729,058**
Tulare Lake Basin WSD	73,785	3,749	2,289	5,385	**85,208**
San Luis Obispo County FC&WCD	4,355	0	0	0	**4,355**
Santa Barbara County FC&WCD	24,166	436	324	3,455	**28,381**
Antelope Valley-East Kern WA	53,907	0	1,008	3,256	**58,171**
Castaic Lake WA (+Rch 31A, 5 & 7)	61,880	280	0	6,657	**68,817**
Coachella Valley WD	16,170	111	474	0	**16,755**
Crestline-Lake Arrowhead WA	2,189	0	0	0	**2,189**
Desert WA	26,670	189	781	0	**27,640**
Mojave WA	4,346	0	0	0	**4,346**
Metropolitan WDSC	1,273,205	9,624	14,335	97,940	**1,395,104**
Palmdale WD	8,359	0	437	0	**8,796**
San Bernardino Valley MWD	68,268	0	0	3,801	**72,069**
San Gabriel Valley MWD	18,353	0	0	4,698	**23,051**
Ventura County FCD	4,998	0	0	0	**4,998**
Totals	**2,510,840**	**43,115**	**45,252**	**160,599**	**2,759,806**
Total South of the Delta	**2,509,240**	**43,115**	**45,252**	**160,599**	**2,758,206**

Table D.7 Historical State Water Project Deliveries: 2003

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	551	0	0	0	**551**
City of Yuba City	1,324	0	0	0	**1,324**
Napa County FC&WCD	6,026	376	180	1,055	**7,637**
Solano County WA	25,135	2,280	0	1,918	**29,333**
Alameda County FC&WCD, Zone 7	30,695	0	656	13,099	**44,450**
Alameda County WD	31,086	0	354	5,150	**36,590**
Santa Clara Valley WD	90,620	936	841	14,104	**106,501**
Oak Flat WD	4,059	19	48	140	**4,266**
County of Kings	3,600	58	34	0	**3,692**
Dudley Ridge WD	49,723	1,928	482	1,452	**53,585**
Empire West Side ID	1,074	175	0	187	**1,436**
Kern County WA	841,697	27,891	8,419	22,380	**900,387**
Tulare Lake Basin WSD	94,376	6,243	938	4,284	**105,841**
San Luis Obispo County FC&WCD	4,417	36	0	0	**4,453**
Santa Barbara County FC&WCD	24,312	339	43	2,274	**26,968**
Antelope Valley-East Kern WA	52,730	0	250	7,049	**60,029**
Castaic Lake WA (+Rch 31A, 5 & 7)	49,895	991	90	4,760	**55,736**
Coachella Valley WD	14,045	204	194	0	**14,443**
Crestline-Lake Arrowhead WA	1,563	0	0	0	**1,563**
Desert WA	23,168	330	321	0	**23,819**
Mojave WA	10,907	0	0	3,528	**14,435**
Metropolitan WDSC	1,550,356	17,622	16,920	134,845	**1,719,743**
Palmdale WD	9,701	0	0	1,846	**11,547**
San Bernardino Valley MWD	25,371	200	0	1,844	**27,415**
San Gabriel Valley MWD	13,034	200	0	0	**13,234**
San Gorgonio Pass WA	116	0	0	0	**116**
Ventura County FCD	5,000	0	0	0	**5,000**
Totals	**2,964,581**	**59,828**	**29,770**	**219,915**	**3,274,094**
Total South of the Delta	**2,962,706**	**59,828**	**29,770**	**219,915**	**3,272,219**

Table D.8 Historical State Water Project Deliveries: 2004

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	1,440	0	0	0	**1,440**
City of Yuba City	1,434	0	0	0	**1,434**
Napa County FC&WCD	5,030	1,450	52	1,602	**8,134**
Solano County WA	17,991	7,787	0	47	**25,825**
Alameda County FC&WCD, Zone 7	39,898	0	0	11,466	**51,364**
Alameda County WD	20,956	0	214	6,714	**27,884**
Santa Clara Valley WD	52,867	2,983	508	0	**56,358**
Oak Flat WD	4,324	0	29	276	**4,629**
County of Kings	5,850	3,157	46	0	**9,053**
Dudley Ridge WD	36,377	7,393	291	2,185	**46,246**
Empire West Side ID	1,310	626	0	1,626	**3,562**
Kern County WA	640,190	86,513	5,075	40,120	**771,898**
Tulare Lake Basin WSD	58,575	15,299	489	5,638	**80,001**
San Luis Obispo County FC&WCD	4,096	69	0	0	**4,165**
Santa Barbara County FC&WCD	29,566	0	122	0	**29,688**
Antelope Valley-East Kern WA	50,532	0	0	9,199	**59,731**
Castaic Lake WA (+Rch 31A, 5 & 7)	46,358	1,618	0	35,785	**83,761**
Coachella Valley WD	8,631	0	89	6,745	**15,465**
Crestline-Lake Arrowhead WA	2,006	0	0	0	**2,006**
Desert WA	9,966	0	102	11,122	**21,190**
Mojave WA	11,176	0	0	0	**11,176**
Metropolitan WDSC	1,195,807	91,601	10,223	215,000	**1,512,631**
Palmdale WD	10,549	0	0	1,613	**12,162**
San Bernardino Valley MWD	35,522	0	0	20,631	**56,153**
San Gabriel Valley MWD	15,600	0	0	0	**15,600**
San Gorgonio Pass WA	841	0	0	0	**841**
Ventura County FCD	5,250	0	0	0	**5,250**
Totals	**2,312,142**	**218,496**	**17,240**	**369,769**	**2,917,647**
Total South of the Delta	**2,309,268**	**218,496**	**17,240**	**369,769**	**2,914,773**

Table D.9 Historical State Water Project Deliveries: 2005

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	527	0	0	0	**527**
City of Yuba City	1,894	0	0	0	**1,894**
Napa County FC&WCD	5,322	606	0	1,741	**7,669**
Solano County WA	24,515	10,421	0	83	**35,019**
Alameda County FC&WCD, Zone 7	38,388	0	275	7,849	**46,512**
Alameda County WD	36,469	846	943	6,341	**44,599**
Santa Clara Valley WD	89,476	6,298	342	11,899	**108,015**
Oak Flat WD	4,067	0	127	0	**4,194**
County of Kings	8,100	11,504	202	0	**19,806**
Dudley Ridge WD	51,609	28,197	1,286	821	**81,913**
Empire West Side ID	1,448	1,799	0	587	**3,834**
Kern County WA	893,439	453,078	22,397	9,851	**1,378,765**
Tulare Lake Basin WSD	86,604	47,267	2,158	3,973	**140,002**
San Luis Obispo County FC&WCD	4,006	245	0	0	**4,251**
Santa Barbara County FC&WCD	22,981	0	155	0	**23,136**
Antelope Valley-East Kern WA	57,205	0	0	2,626	**59,831**
Castaic Lake WA (+Rch 31A, 5 & 7)	54,303	2,451	0	2,702	**59,456**
Coachella Valley WD	26,984	0	2,716	12,819	**42,519**
Crestline-Lake Arrowhead WA	807	0	0	0	**807**
Desert WA	33,168	0	1,122	14,799	**49,089**
Mojave WA	10,360	0	0	1,201	**11,561**
Metropolitan WDSC	1,269,291	168,300	6,530	106,032	**1,550,153**
Palmdale WD	10,174	0	0	1,538	**11,712**
San Bernardino Valley MWD	31,211	56	0	283	**31,550**
San Gabriel Valley MWD	10,500	0	0	0	**10,500**
San Gorgonio Pass WA	677	15	0	0	**692**
Ventura County FCD	1,665	0	0	0	**1,665**
Totals	**2,775,190**	**731,083**	**38,253**	**185,145**	**3,729,671**
Total South of the Delta	**2,772,769**	**731,083**	**38,253**	**185,145**	**3,727,250**

Table D.10 Historical State Water Project Deliveries: 2006

	SWP Table A	Article 21	Turnback	Carryover	Total
County of Butte	468	0	0	0	**468**
City of Yuba City	4,148	1,194	0	0	**5,342**
Napa County FC&WCD	7,312	300	0	172	**7,784**
Solano County WA	12,070	18,195	0	390	**30,655**
Alameda County FC&WCD, Zone 7	50,785	0	491	2,252	**53,528**
Alameda County WD	0	2,375	39,373	1,331	**43,079**
Santa Clara Valley WD	47,344	26,769	0	524	**74,637**
Oak Flat WD	4,118	0	107	17	**4,242**
County of Kings	8,991	366	173	0	**9,530**
Dudley Ridge WD	55,343	18,515	1,068	0	**74,926**
Empire West Side ID	1,500	1,124	0	658	**3,282**
Kern County WA	961,882	256,634	18,610	5,418	**1,242,544**
Tulare Lake Basin WSD	48,361	59,424	1,787	0	**109,572**
San Luis Obispo County FC&WCD	3,382	827	0	0	**4,209**
Santa Barbara County FC&WCD	19,255	4,020	0	0	**23,275**
Antelope Valley-East Kern WA	76,623	0	0	3,761	**80,384**
Castaic Lake WA (+Rch 31A, 5 & 7)	56,758	2,089	0	3,905	**62,752**
Coachella Valley WD	121,100	0	0	0	**121,100**
Crestline-Lake Arrowhead WA	257	0	0	0	**257**
Desert WA	50,000	0	0	0	**50,000**
Mojave WA	32,496	0	0	1,518	**34,014**
Metropolitan WDSC	1,103,538	238,478	11,638	136,424	**1,490,078**
Palmdale WD	10,374	1,653	130	335	**12,492**
San Bernardino Valley MWD	31,902	0	0	3,427	**35,329**
San Gabriel Valley MWD	13,524	0	0	0	**13,524**
San Gorgonio Pass WA	4,262	0	0	0	**4,262**
Ventura County FCD	1,850	0	0	0	**1,850**
Totals	**2,727,643**	**631,963**	**73,377**	**160,132**	**3,593,115**
Total South of the Delta	**2,723,027**	**630,769**	**73,377**	**160,132**	**3,587,305**

Appendix E. Comment Letters on the Draft Report and the Department's Responses

Written comments from the public on the *Draft State Water Project Delivery Reliability Report* (December 2007) were accepted through March 13, 2008. These letters and the responses to them are contained in this appendix.

Index

135 California Water Impact Network
136 DWR response letter to California Water Impact Network
138 Delta Protection Commission
140 DWR response letter to Delta Protection Commission
142 DWR Transmission Planning
144 DWR response letter to DWR Transmission Planning
146 Metropolitan Water District of Southern California
148 DWR response letter to Metropolitan Water District of Southern California
150 Natural Resources Defense Council
198 DWR response letter to Natural Resources Defense Council
201 Bill Pennington
202 DWR response letter to Bill Pennington
203 Planning and Conservation League
297 DWR response letter to Planning and Conservation League
308 Stuart Robertson
309 DWR response letter to Stuart Robertson
311 State Water Contractors
315 DWR response letter to State Water Contractors

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Lloyd Carter
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Yvon Chouinard
director

Joan Hartmann
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Michael Jackson
director

Huey Johnson
director

Tom Stokely
director

March 11, 2008

California Department of Water Resources
SWP Delivery Reliability Report-Attn: Cynthia Pierson
PO Box 942836
Sacramento, CA 94236-0001

RE: Accuracy of SWP Delivery Reliability Report

Dear Sirs,

The California Water Impact Network (C-WIN) appreciates this opportunity to comment on the 2007 draft SWP Delivery Reliability Report. We believe the conclusion reached about the average reliability of the SWP at 66% is seriously misleading. Water agencies and planners will be relying on this number and could cause serious harm if this is not accurate.

How is the 66% reliability estimate in the draft Reliability Report, which purportedly takes the Wanger decision into consideration, consistent with assertions made in the most recent allocation estimate, which was issued just after snow surveys reported an above average snowpack.

The most recent estimates from DWR place the reliability of the SWP, even in this year's high snow pack scenario, at **35%**. In the DWR press release giving the 35% reliability figure for 2008, DWR also notes that without the Wanger decision, the figure from DWR would have been 50% delivery of Table A amounts.

C-WIN urges you to make sure that the final SWP Delivery Reliability Report accurately reflects the ability of the SWP to deliver water to the 29 SWP contractors who depend on it. The draft Reliability Report does not appear to be accurate.

Sincerely,

Carolee Krieger

Carolee Krieger, President

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 11, 2008

Ms. Carolee Krieger, President
California Water Impact Network
808 Romero Canyon Road
Santa Barbara, CA 93108

Dear Ms. Krieger:

This letter responds to your letter dated March 11, 2008 providing comments of the California Water Impact Network on the draft of the State Water Project Delivery Reliability Report—2007 (DRR2007).

In your letter, you express concern for the accuracy of the reliability of SWP deliveries presented in the DRR 2007. You state that the report concludes that the average reliability of the SWP under interim export restrictions to protect Delta smelt is 66 percent. You contrast this value with an estimate done in February 2008 by the Department of Water Resources that, despite above normal snowpack in 2008, SWP deliveries in 2008 would be 35 percent of SWP Contractors' 2008 Table A amounts and would be 50 percent if the federal court-ordered 2008 Delta export restrictions to protect Delta smelt were not in-place.

I believe the average SWP delivery reliability of 66 percent you refer to in your letter is actually listed as 63 percent in Tables 6-4, 6-5, 6-6, 6-20, 6-21, 6-22, and 7-1. This value is the average annual SWP Table A delivery under current conditions over the 82-year simulation period, expressed in terms of percent of maximum Table A amounts. The value of 63 percent is the mathematical average of 82 values which range from 6 percent to 90 percent (Table 6-4). As shown in Table 6-5, average SWP deliveries over several multiple-year dry periods range from 34 to 35 percent of maximum Table A amounts. Thus, there is considerable variability in the annual SWP Table A deliveries presented in the draft report under current conditions. Year-to-year variability in simulated deliveries is attributed to several factors including varying precipitation and the amount of water stored in SWP conservation reservoirs.

DWR estimates of actual SWP contractors deliveries depend in part upon existing storage in SWP reservoirs, SWP operational constraints, and contractor demands. The SWP started the 2008 water year (October 1, 2007) with storage amounts in its reservoirs that were well below normal. Thus, while the February 28, 2008 DWR news release, which estimated SWP contractor deliveries at 35 percent of full Table A amounts, pointed to a normal or above-normal Sierra snowpack, that same news release quoted a DWR manager in its Hydrology Branch as cautioning that "additional precipitation is still needed to alleviate the deficits to water supply conditions that existed at the start of the [water supply] season."

Thus, an estimate of SWP contractor deliveries for an individual water year with under near-normal snowpack conditions is not comparable to a long-term average of simulated deliveries, which incorporates a wide range of precipitation and reservoir storage conditions.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

March 13, 2008

California Department of Water Resources
PO Box 942836
Sacramento, California 94236-0001

Attn: Cynthia Pierson

Subject: State Water Project (SWP) Delivery Reliability Project

The Draft SWP Delivery Reliability Report 2007 (Report) updates the Department of Water Resources (DWR) estimate of current (2007) and future (2027) SWP delivery reliability and expands the conditions under which reliability is quantified. The report is produced every two years. 2027 potential deliveries are based on the assumption that no changes will be made in either the way water is conveyed across the Delta or in the interim operating rules to protect Delta smelt. It shows a continued eroding of SWP water delivery reliability under the current method of moving water through the Delta.

The staff of the Delta Protection Commission (Commission) has reviewed the subject document dated January 2008. From the information provided, staff has determined that the proposed project is located within the Primary Zone of the Legal Delta and a apportion of the Secondary Zone , and is therefore subject to consistency with the Land Use and Resource Management Plan for the Primary Zone (Management Plan) and appeal to the commission.

The Delta Protection Act (Act) was enacted in 1992 in recognition of the increasing threats to the resources of the Primary Zone of the Delta from urban and suburban encroachment having the potential to impact agriculture, wildlife habitat, and recreation uses. Pursuant to the Act, a Management Plan was completed and adopted by the Commission in 1995.

The Management Plan sets out findings, policies, and recommendations resulting from background studies in the areas of environment, utilities and infrastructure, land use, agriculture, water, recreation and access, levees, and marine patrol/boater education/safety programs.

The policy from the Management Plan that is relevant to this project includes, but is not limited to the following:

Water

- Policy 3: "Water agencies at local, State, and federal levels shall work together to ensure that adequate Delta water quality standards are set and met and that beneficial uses of State waters are protected consistent with the CALFED (see Water code Section 12310(f) Record of Decision dated August 8, 2000."

The Recommendations in the Management Plan which are intended to help achieve the Policies , which are relevant to this project are as follows:

- ."Recommendation 1: "The Delta waterways should continue to serve as a primary transportation system moving water to the State's natural and developed water systems."
- Recommendation 2:"Delta water rights should be respected and protected."
- Recommendation 3: " Programs to enhance the natural values of the State's aquatic habitats and water quality will benefit the Delta and should be supported."

A copy of the Management Plan and the Act are available at the Commission's web site www.delta.ca.gov for your reference. Please contact me at (916) 776-2292 or lindadpc@citlink.net if you have any questions regarding the Commission or the comments provided herein.

Sincerely,

Linda Fiack
Executive Director

Cc: Kathy Kelly,
Chief, Bay-Delta Office, DWR

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 11, 2008

Ms. Linda Fiack, Executive Director
Delta Protection Commission
14215 River Road
PO Box 530
Walnut Grove, CA 95690

Dear Ms. Fiack:

This letter responds to your letter dated March 13, 2008 providing comments of the Delta Protection Commission on the draft of the State Water Project Delivery Reliability Report—2007 (DRR(2007)).

In your letter, you state that the DRR (2007) is subject to consistency with the Delta Protection Commission's 1995 comprehensive long-term resource management plan, *Land Use and Resource Management Plan for the Primary Zone of the Delta.* As such, the DRR (2007) is subject to the Management Plan's Policy 3 which states that local,

State and federal water agencies "shall work together to ensure that adequate Delta water quality standards are set and met and that beneficial uses of State waters are protected consistent with CALFED." You also site three recommendations in the Management Plan for achieving its policies which you find to be relevant to the DRR (2007): Recommendation 1, which states that Delta waterways should continue to serve as a primary transportation system moving water to the State's natural and developed water systems; Recommendation 2, which states that Delta water rights should be respected and protected; and Recommendation 3, which states that programs to enhance the natural values of the State's aquatic habitats and water quality will benefit the Delta and should be supported.

The DRR (2007) is consistent with Policy 3 and Recommendations 1, 2, and 3 in the *1995 Land Use and Resource Management Plan for the Primary Zone of the Delta.* The SWP delivery reliability estimates in the DDR (2007) are based upon CalSim II simulations of both SWP and CVP operations. These simulations under both current and future conditions assume several factors including: existing Delta water quality standards protecting beneficial use of Delta water are met; existing Delta water rights continue; the 2007 federal court-ordered interim flow standards to protect delta smelt are in place; and Delta waterways and the means of conveying water to Banks and Jones Pumping Plants remain unchanged.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

Comments of the California Department of Water Resources'
Transmission Planning Branch
On the California Department of Water Resources'
"State Water Project Delivery Reliability Report 2007"
March 13, 2008

The Transmission Planning Branch of the California Department of Water Resources' Power Planning and Risk Management Office submits the following comments regarding the "State Water Project Delivery Reliability Report 2007":

The biennial report identifies factors that may impact water availability along with changes that can be made to improve future water supply reliability. The report updates DWR's estimate of the ability to maintain current (2007) and future (2027) State Water Project (SWP) delivery reliability.

The report identifies various factors that affect the SWP's ability to convey source water to the desired point of delivery. Among the factors identified as affecting Delta pumping operations were water quality constraints, fish and wildlife constraints, future sea level rise impacts associated with climate change, and levee failure impacts. However, the report did not, but should, address another important factor – potential restrictions on Banks Pumping Plant operation due to curtailment of energy transmission service to operate the pumps.

The SWP pumping plants in the Delta receive transmission service under the Comprehensive Agreement between DWR and Pacific Gas and Electric (PG&E). Under this agreement, which terminates on December 31, 2014, DWR has contractual rights for up to 275 megawatts (MW) of transmission service at the Banks Pumping Plant switchyard. However, only 157 MW is firm service; the remaining 118 MW is subject to curtailment by the California Independent System Operator (CAISO). Investor-owned utilities, such as PG&E, own most of the California high voltage transmission grid and, as a result of the electricity deregulation, has turned over the operation of these transmission facilities to the CAISO.

In June 2007, Banks Pumping Plant operation was severely restricted for much of the month to protect the Delta smelt. When the Delta smelt constraints were lifted in July 2007, DWR had intended to operate the plant continuously at full capacity to make up for June's pumping restriction. However, Banks Pumping Plant operation was curtailed due to curtailment of transmission service.

A recent operations study by DWR indicates that to make up for lost pumping opportunities and maximize water delivery reliability, Banks Pumping Plant and the expanded South Bay Pumping Plant will require a combined 305 MW of firm transmission service. To that end, DWR's Transmission Planning Branch is working with PG&E, CAISO, and the Western Area Power Administration to identify reinforcements needed to provide 305 MW of firm transmission service for these Delta

pumping facilities. It is anticipated that this level of service will occur no earlier than 2011 and could occur as late as 2015.

If you have any questions regarding the comments, please call Linda Quok, Chief of DWR's Transmission Planning Branch, at (916) 574-0617.

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 11, 2008

Ms. Linda Quok, Chief
Transmission Planning Branch
California Department of Water Resources
Joint Operations Center
3310 El Camino Avenue, Room LL90
Sacramento, CA 95821-9000

Dear Ms. Quok:

This letter responds to your letter dated March 13, 2008 providing comments on the draft of the State Water Project Delivery Reliability Report—2007.

In your email, you state that the draft report should address potential restrictions on Banks Pumping Plant operations due to the energy transmission service to operate the pumps being subject to curtailment by the California Independent System Operator (CAISO).

As you point out in your letter, SWP pumping at Banks Pumping Plant may at times be in effect curtailed by CAISO, a situation that may persist until sometime between 2011 and 2015. While this may be true, this level of detail of concern exceeds the level of analysis in the report. The analysis is based upon results from CalSim II studies which assume a monthly time step. Watershed runoff, reservoir storage, reservoir releases, Delta inflow, Delta consumptive use, Delta exports, Delta outflow, and SWP Table A and Article 21 deliveries are all calculated on a monthly average basis over the 82-year simulation period. Banks Pumping Plant restrictions due to water quality and flow standards are also based upon monthly average data. For presentation of CalSim II results in the report, monthly average SWP Table A and Article 21 deliveries are summed for each year to generate 82 values of total annual deliveries. Considering the level of detail inherent in the report, temporary curtailments of the energy transmission service needed to operate the pumps at Banks Pumping Plant is not viewed as significant.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Executive Office

March 12, 2008

Ms. Cynthia Pierson
California Department of Water Resources
SWP Delivery Reliability Report- Attn: Cynthia Pierson
P.O. Box 942836
Sacramento, CA 94236-0001

Dear Ms. Pierson:

State Water Project Delivery Reliability Report 2007—December 2007 Draft

The Metropolitan Water District of Southern California (Metropolitan) has reviewed the Department's December 2007 draft of the State Water Project Delivery Reliability Report. The report updates estimates of the current (2007) and future (2027) State Water Project delivery reliability and incorporates (i) the December 2007 Federal Court ruling for Delta exports and (ii) potential impacts of future climate change. The utility of the draft Reliability Report could be enhanced if it is amended to include a second future conditions analysis that omits the projected effects of climate change.

The draft Reliability Report presumes that the restrictions on exports from the Delta put in place by the Federal Court for water year 2008 to protect the delta smelt are similar to the operational requirements that will result from the adoption of new federal biological opinions. While the Court ruling is only applicable until September 2008, when the new biological opinion is due to be issued, Metropolitan believes this to be a prudent assumption at this time. The forthcoming incidental take permit will incorporate operational requirements that may or may not be more stringent than the Wanger interim operations rules. Regardless, the present decrease in supply reliability underscores the need to provide improvements to the conveyance of Project water across the Delta.

The incorporation of projected effects due to climate change introduces a level of uncertainty in the assessment of the reliability of the State Water Project through 2027. While the draft Reliability Report states that, "Potential changes in climate patterns are becoming better defined..." (second paragraph, page 7), it also states that the potential effects of climate change in the future are "evolving" and that, "Incorporating climate change into future projections is difficult because of the many ways the patterns of rain, snow and temperature could shift" (second full paragraph, page 10). The analysis made use of the results of a 2006 report from the Department in which "broad-brush estimates are made of the potential impact upon the SWP around the year 2050...". The analysis converted the year 2050 conclusions contained in the

2006 report to year 2027 through interpolation. Given the high degree of uncertainty, it is unclear how the results should be used.

Recently, Metropolitan has joined with other major water agencies within the United States to form the Water Utility Climate Alliance (WUCA). Top among WUCA's list of research needs is to reduce the uncertainty in projections related to how climate may change by improving and refining global climate models and applying them at the regional or local level. To facilitate incorporation of continued research and refinements of the projected effects of climate change, Metropolitan requests that the final version of the Reliability Report include a second analysis of future conditions without the climate change assumptions. This would provide a baseline analysis for future conditions to which refined projections of the effects of climate change could be applied.

Very truly yours,

Stephen N. Arakawa
Manager, Water Resource Management

JLS:tw
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STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 11, 2008

Mr. Steve Arakawa, Manager
Water Resource Management
The Metropolitan Water District of Southern California
700 N. Alameda Street
Los Angeles, CA 90012

Dear Mr. Arakawa:

This letter responds to your letter dated March 12, 2008 providing comments of the Metropolitan Water District of Southern California on the draft of the State Water Project Delivery Reliability Report—2007 (DRR 2007).

In your letter, you refer to the relative uncertainty in the assessment of the future reliability of State Water Project deliveries under climate change assumptions, and request that the DRR

The relative uncertainty of the effects of climate change on SWP delivery reliability are appreciated. However, Governor Schwarzenegger's Executive Order S-3-05, signed on June 1, 2005, directs the Secretary of the California Environmental Protection Agency to coordinate with State agencies to report every two years on the impacts to California of global warming, including impacts to water supply. The Department of Water Resources identifies climate change in the 2005 update of the California Water Plan (Bulletin 160-05) as a key consideration in planning for the State's future water management. This is because analysis has shown that climate change may in the future seriously affect the State's water resources, particularly SWP's ability to deliver water. The DRR (2007) recognizes the uncertainty of climate change projections by evaluating future State Water Project deliveries under four scenarios of climate change: weak temperature warming and weak precipitation increase in California under model PCM; modest warming and modest drying under model PCM; modest warming and modest drying under model GFDL v. 2.0; and weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0. Simulated deliveries under these scenarios of climate change were then interpolated to estimate deliveries in the year 2027.

The estimated future (2027) SWP Table A and Article 21 deliveries under the climate change scenarios in the DRR (2007) are based upon interpolations of SWP deliveries under future conditions without climate change and climate change at the 2050 level. The annual SWP deliveries under future conditions with and without climate change are presented in Appendix B (tables B-4 through B-11) and are available electronically via the DRR (2007) website if any reader wishes to perform further analysis.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

NATURAL RESOURCES DEFENSE COUNCIL

March 13, 2008

Ms. Cynthia Pierson
California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001
email: **comments-on-2007drr@water.ca.gov**

Re: Comments on the Draft State Water Project Delivery Reliability Report 2007 and OCAP Consultation

Dear Ms. Pierson:

We are writing on behalf of the Natural Resources Defense Council and its over 120,000 members and activists in California. We appreciate the opportunity to comment on the draft State Water Project Delivery Reliability Report 2007 ("Reliability Report" or "Report") and look forward to working cooperatively with the Department of Water Resources ("DWR") to address many of the issues raised by the Reliability Report, including improving conditions in the Delta to protect the ecosystem and water supply reliability for 25 million Californians. We also request that these comments and attachments be considered in the ongoing consultation regarding the Operating Criteria and Plan ("OCAP") for future joint operations of the State Water Project ("SWP") and Central Valley Project ("CVP").

We identify below some recommended changes to the final Report. Primary among these is the need for more discussion and analysis of demand management as a tool to improve reliability. Because reliability is a function of both water supply and water demand, reductions in demand can effectively improve reliability, as well as reduce the stresses on the Delta ecosystem caused by excessive water diversions. Governor Schwarzenegger recently released a new water plan, which includes a 20 percent reduction in per capita water use statewide by 2020. *See* Letter from Governor Schwarzenegger to Senators Perata, Steinberg, and Machado (February 28, 2008), appended as Attachment 1. This reduction in demand far exceeds the five percent reduction in average SWP Table A supplies that the Report projects for 2027. Report at 30. In fact, aggressive demand reduction measures could allow for far more significant reductions in SWP (and CVP) deliveries without adversely impacting reliability. We urge DWR to revise its modeling and analysis to address demand-side management for the final Report and in the ongoing OCAP consultations.

www.nrdc.org

111 Sutter Street
20th Floor
San Francisco, CA 94104
TEL 415 875-6100 FAX 415 875-6161

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I. THE REPORT SHOULD INCLUDE A DISCUSSION OF DEMAND MANAGEMENT

The draft Reliability Report recognizes that the concept of "reliability" measures "a system's ability to match water supplies with *demand*." Report at 6 (emphasis added). The Report asserts that reliability in the context of the SWP depends on three general factors: "the availability of water at the source, the ability to convey water from the source to the desired point of delivery, *and the magnitude of demand for the water*." *Id.* (emphasis added). Despite this recognition of the importance of water demand in the reliability equation, the draft Report omits any discussion of demand management, or the ability of SWP contractors to improve reliability by reducing their own demand, both overall and at different times of the year. Instead, the draft Report bases its analysis of reliability on demand values from previous years, which values are derived from historical data and information received from the SWP contractors. *Id.* at 9. This omission should be corrected in the final Report.

As explained in DWR's most recent State Water Plan update, and in the attached NRDC analysis and water district testimony, SWP contractors have considerable untapped capacity to improve the efficiency of their water use, to reduce their demand through improved groundwater management, and to reduce their demand through water recycling, stormwater capture, and other methods. Realizing this untapped capacity would reduce SWP contractor demand, reduce the need for diversions from the Delta, and improve SWP delivery reliability. *See* NRDC, *Effective Solutions to Meet California's Water Supply Reliability Needs* (February 25, 2008), appended as Attachment 2; Testimony of Jeffrey Kightlinger, General Manager, Metropolitan Water District of Southern California before the House Committee on Natural Resources, Subcommittee on Water and Power (January 29, 2008), appended as Attachment 3; Testimony of Richard W. Atwater, General Manager, Inland Empire Utilities Agency before the House Committee on Natural Resources, Subcommittee on Water and Power (January 29, 2008), appended as Attachment 4. The Report should be modified to include an analysis of the impact of these demand reduction measures on SWP reliability, as well as the impact of the Governor's call for a 20 percent reduction in per capita water use by 2020.

II. THERE IS NO EVIDENCE THAT NEW CONVEYANCE NORTH OF THE DELTA PROVIDES ECOSYSTEM BENEFITS

The draft Reliability Report picks up a refrain from the Bay Delta Conservation Plan ("BDCP") process that "a new North of Delta diversion(s) from the Sacramento River, which would divert water for export around the Delta, offers the greatest potential for meeting ecosystem restoration objectives." Report at 12. We are not aware of any specific proposal for a new North of Delta diversion(s), addressing such issues as proposed size, operational rules, total proposed diversions, governance and assurance mechanisms and mitigation plan. Nor are we aware of any analysis of the potential impacts of such a proposal. *See* Letter from NRDC to the Resources Agency Re: Comments on BDCP Points of Agreement (December 21, 2007), appended as

Attachment 5. In fact, there are myriad ways in which a new North of Delta diversion could cause greater harm to the Delta ecosystem than the management of the existing SWP and CVP conveyance facilities, including by increasing the amount of exports (either overall or seasonally), reducing downstream water quality, increasing migrating fish mortality (especially salmonids), increasing the relative concentration of toxic contaminants, increasing adverse Delta food web impacts, increasing the threat and growth of invasive species, reducing Delta agricultural productivity and more. If DWR has analyzed these potential impacts, we urge the agency to make that information publicly available. Otherwise, the statement that a theoretical North of Delta diversion(s) "offers the greatest potential for meeting ecosystem restoration objectives" (which objectives also remain undefined in the Report and the BDCP process) lacks any foundation and is premature.

III. THE ENVIRONMENTAL WATER ACCOUNT BENEFITS CONTRACTORS, NOT THE ENVIRONMENT

The draft Report incorrectly states that "decline in the abundance of juvenile delta smelt led to a voluntary modification in 2007 in SWP and CVP operations to reduce the reversed flows in Middle and Old Rivers – a modification made possible through the Environmental Water Account." Report at 15. In fact, the Environmental Water Account ("EWA") did not make this action "possible." Rather, DWR, the Bureau of Reclamation and the fisheries agencies are compelled to modify pumping operations when those operations adversely impact the survival, recovery and critical habitat of fish protected under the Endangered Species Act, such as the delta smelt. Indeed, a federal judge recently held, at DWR's urging, that "regardless of whether [EWA and similar 'environmental water'] programs are fully funded and/or remain functional mechanisms to provide water to the Delta, 'the burden … falls on the Projects, not the smelt.'" *NRDC v. Kempthorne*, case no. 05-CV-01207, Order on Summary Judgment, at 61 (May 25, 2007). If the fisheries agencies require the Projects to reduce pumping to protect listed fish, DWR and the Bureau must do so, whether or not EWA assets are available.

The history of the EWA demonstrates that, rather than aiding ecosystem recovery, the EWA has primarily functioned as an impediment to fish protection and recovery, by acting as an artificial constraint on the amount of water available for ecosystem needs. *See* Letter from NRDC to the Bureau of Reclamation Re: Comments on the Draft Supplemental EIS/EIR for Extending the Environmental Water Account and OCAP Consultations (December 10, 2007), appended as Attachment 6. The studies in the draft Report correctly assume that no EWA will be in place in the future. The text of the Report should be modified to correct the misconception that this outcome is bad for fish or constrains DWR's and the Bureau's ability and obligation to make sufficient water available for ecosystem protection.

IV. THE REPORT SHOULD CONFORM ITS SEA LEVEL RISE ASSUMPTIONS TO THE RECOMMENDATIONS OF THE CALFED INDEPENDENT SCIENCE BOARD

The draft Report estimates the effects of climate change on SWP delivery reliability by analyzing four different climate change scenarios developed in DWR's 2006 report entitled "Progress on Incorporating Climate Change into Management of California's Water Resources." Report at 18. However, the estimates of the impacts of climate change on California, and sea level rise in particular, have changed considerably since those four scenarios were developed. In particular, as the Report notes, the CALFED Independent Science Board has recommended that for planning purposes incorporating sea level rise, DWR should use the full range of variability of 50-140 cm (20-55 inches). Report at 22; *see also* Memorandum from Jeffrey Mount to Michael Healey re: Sea Level Rise and Delta Planning (Sep. 6, 2007), appended as Attachment 7. This range is considerably higher than DWR previously assumed in its 2006 report (a one-foot sea level rise), and will likely have considerably more significant water supply and ecosystem impacts. It is likely that other estimates of the impacts of climate change need to be updated as well, including projections of reduced Sierra snowpack and increased evaporation rates in watersheds and surface storage reservoirs. *See, e.g.,* NRDC, *In Hot Water, Water Management Strategies to Weather the Effects of Global Warming* (July, 2007), http://www.nrdc.org/globalWarming/hotwater/hotwater.pdf. The analysis should be redone incorporating the most recent sea level rise and other climate change analysis.

V. ARTICLE 21 WATER SHOULD BE OFFERED TO FISHERIES AGENCIES BEFORE BEING PROVIDED AS SURPLUS WATER TO CONTRACTORS

The Report assumes that DWR will continue to provide considerable amounts of Article 21 water to contractors in the future. It is within DWR's discretion whether or not to make Article 21 water available in any given year for delivery to SWP contractors. As we have urged DWR in the past, we request again that DWR implement a policy of foregoing Article 21 declarations and deliveries if state and federal fisheries agencies recommend that the water remain instream or available for ecosystem protection purposes. This small step to improve the Delta's ailing ecosystem would improve reliability for all water users by reducing the need for unplanned, emergency pumping restrictions to protect an ecosystem poised on the brink of collapse.

VI. REDUCED EXPORTS MEANS GREATER UPSTREAM RESERVOIR STORAGE

We note that one effect of reducing pumping from the historically high levels of recent years is that higher amounts of storage will be available in upstream reservoirs at the end of the year. Report at 30. Increased upstream reservoir storage should allow for improved coldwater management for salmon and steelhead below the dams. We urge DWR and the fisheries agencies to utilize the increase in carryover storage to increase

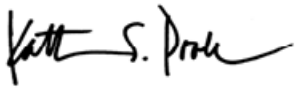
the protections for imperiled salmonids from the lessened protections in the most recent OCAP salmonid biological opinion, including the reduced Shasta carryover storage requirement and the more restrictive downstream temperature control point.

VII. REDUCED EXPORTS MEANS REDUCED YEILD FROM POTENTIAL SOUTH OF DELTA STORAGE

The current levels of Delta diversions, which are lower than those in the past, will also reduce the potential yield of proposed South of Delta storage facilities. This effect is due to the fact that there will be fewer times in the future when existing South of Delta storage is full. These reduced levels of diversion are likely to remain in place for the foreseeable future. The report should discuss the relationship between lower levels of diversions and proposed expansions in storage South of the Delta that would be dependant on Delta pumping as a water source.

Thank you again for the opportunity to comment. Please contact us with any questions.

Sincerely,



Katherine S. Poole
Senior Attorney

Barry Nelson
Senior Policy Analyst

Enc.

Cc: Cay Goude, USFWS
Maria Rea, NMFS

ATTACHMENT 1

Office of the Governor
ARNOLD SCHWARZENEGGER
THE PEOPLE'S GOVERNOR

PRESS RELEASE

02/29/2008 GAAS:112:08 FOR IMMEDIATE RELEASE

Governor Schwarzenegger Outlines Comprehensive Actions Needed to Fix Ailing Delta

Governor Schwarzenegger sent the following letter to Senators Perata, Steinberg, and Machado in response to their unfounded concerns that his administration is "unilaterally" beginning work on a so-called "peripheral canal." Consistent with the extensive work done by his administration over the last two years to gain consensus on a bipartisan legislative solution for a comprehensive plan to upgrade California's water infrastructure, Governor Schwarzenegger detailed his agenda in the following letter:

February 28, 2008

The Honorable Don Perata The Honorable Darrell Steinberg
President pro Tempore California State Senate
California State Senate State Capitol
State Capitol Room 4035
Room 205 Sacramento, California 95814
Sacramento, California 95814

The Honorable Mike Machado
California State Senate
State Capitol
Room 5066
Sacramento, California 95814

Dear Don, Mike and Darrell,

My administration has been working on solutions for addressing California's water supply and the environmental crisis in the Sacramento-San Joaquin Delta for more than two years. As you all have acknowledged during our negotiations on a comprehensive water infrastructure package over the last year, the heart of California's vital water supply system is in jeopardy of collapse without both immediate action and long term solutions to restore the ecosystem and protect water supplies.

I created the bipartisan Delta Vision Blue Ribbon Task Force by administrative action in 2006. The Task Force has issued its Vision and will develop a Strategic Plan to implement the Vision by the end of this year. In its recommendations, the Task Force identified a series of near-term actions that should be taken to protect the estuary, including studying the options for improving water transfer in the Delta. Far from acting unilaterally, my administration has been transparent in working with stakeholders and legislators on identifying both administrative and legislative actions that will be necessary to address the recommendations of the Task Force. As part of that effort, I will continue to negotiate in good faith with legislators on a comprehensive water infrastructure package.

To clarify the administrative actions we are considering as part of a comprehensive solution in the Delta, let me outline some of the key elements under development:

1. **A plan to achieve a 20 percent reduction in per capita water use statewide by 2020.** Conservation is one of the key ways to provide water for Californians and protect and improve the Delta ecosystem. A number of efforts are already underway to expand conservation programs, but I plan to direct state agencies to develop this more aggressive plan and implement it to the extent permitted by current law. I would welcome legislation to incorporate this goal into statute.
2. **Protection of floodplain in the Delta.** The Department of Water Resources (DWR) and other appropriate state agencies will expedite the evaluation and protection of critical floodplains. This action protects people and property, the existing water export system and the Delta ecosystem.
    - **Policy guidance on Delta land use.** The Blue Ribbon Task Force made it clear that changing land use patterns may limit our ability to address critical issues with the existing water export system and the Delta ecosystem. Accordingly, I will ask the Delta Protection Commission to update their Land Use and Resource Management Plan and direct the Governor's Office of Planning & Research and the State Architect to develop model Delta land use guidelines for distribution to local governments.
    - **Levee protection and standards.** DWR is actively involved in efforts to improve our flood protection and levee systems and, as part of this effort, should establish recommended standards for Delta levees.
3. **Multi-agency Delta disaster planning.** DWR, in coordination with the Office of Emergency Services, and other appropriate state agencies will develop and implement an emergency response plan and conduct a multi-agency disaster planning exercise in the Delta.
    - **Contract for emergency response equipment and services.** I will authorize DWR to continue its efforts to obtain equipment and services including barge services, sheet piling and other flood fighting materials to respond to disasters in the Delta. In addition to my previous orders, we must expedite the placement of materials and supplies in and near the Delta, to improve our emergency response capabilities.
4. **Expedite interim Delta actions.** The Resources Agency, DWR, Department of Fish and Game and the State Water Resources Control Board have already begun efforts to help protect and restore Delta habitat and help water users cope with supply interruptions.

I will direct the Resources Agency to expedite the completion of the Bay Delta Conservation Plan (BDCP), including the environmental review and permitting activities. Ongoing Delta actions, in conjunction with these efforts, will provide a foundation to help conserve at-risk species and improve water supply reliability.

5. **Water quality.** While additional storage and improved conveyance can allow greater control

of water flows that improve drinking water quality, more must be done. I will direct the State Water Resources Control Board to develop and implement a comprehensive program in the Delta to protect water quality.

6. **Improvements to Delta water conveyance.** DWR and other appropriate state agencies will soon begin the public process to study the alternatives available for improving the Delta water conveyance system. As part of this study, DWR must coordinate with BDCP efforts to recover at-risk species. DWR must also incorporate the issues of water supply reliability; seismic and flood durability; ecosystem health and resilience; water quality; and projected schedule, cost and funding in their options review, as suggested by the Task Force.

The Task Force recommended that we study a "dual conveyance facility" as a starting point. However I believe we must look at a full range of options for improving conveyance in the Delta.

Accordingly, I intend to direct DWR to proceed with the NEPA/CEQA analysis on at least four alternatives for Delta conveyance. They shall consider the following:

- The possibility of no new Delta conveyance facility;
- The possibility of a dual conveyance facility, as suggested by the Task Force;
- The possibility of an isolated facility;
- The possibility of substantial improvements and protections of the existing water export system, most often referred to as ‘armoring the Delta' or a "through-Delta" solution.

7. **Water storage.** DWR will complete the feasibility studies for the CALFED storage projects including Temperance Flat, Sites Reservoir, and the Los Vaqueros expansion. Each of these projects, depending on how they are built and operated, can provide substantial public benefits. Unlike in the past, when local entities built storage facilities for their own benefit and with little state investment, the current deteriorating condition of the Delta and the statewide water system demand public investment in exchange for the public benefit the entire state will realize.

In addition, I will direct DWR to expedite funding for groundwater storage projects throughout the state that will improve water supply reliability.

Please know that I will continue to work with the Legislature and all stakeholders to develop a comprehensive solution to the crisis in the Delta, and I will act on administrative measures in a transparent manner at the appropriate time.

California's history is filled with innovators and problem solvers. In 2006, with Democrats and Republicans working together for a common cause, we added to that legacy by building up our infrastructure. We showed leadership, not for the benefit of our own ambitions, but for the future of the state. That's something that Californians weren't used to, and they responded forcefully, approving all of the bonds. It's time for us to put the state first and add another chapter to the history books. It's time to secure a safe, clean and reliable water supply for the next generation of Californians. We have a great opportunity, and the people are counting on us. Let's not let it pass.

Sincerely,

Arnold Schwarzenegger

ATTACHMENT 2

EFFECTIVE SOLUTIONS TO MEET CALIFORNIA'S WATER SUPPLY RELIABILITY NEEDS

The Bay-Delta Estuary is facing a crisis. Numerous species are listed as threatened or endangered, or proposed for listing. The Delta smelt is on the verge of extinction. The status quo is not sustainable for any of the Delta's users, including farmers, commercial and sport fishermen, Delta residents and the 23 million Californians who rely on the Delta for a portion of their water supply. Investments to improve water supply reliability must also improve conditions in the Delta. By directing state funds to alternative water supplies, Delta flood protection and restoring a healthy ecosystem, the State will help improve water supply reliability, meet the needs of a growing population and protect imperiled fish species.

There is a broad consensus regarding the most effective tools to meet California's future water supply needs. The 2005 California Water Plan update contains extensive, detailed estimates of the water supply potential of a range of proven water supply tools. The bar chart below presents many of those totals, ranging from low to high yield estimates. We believe that the more ambitious estimates are realistic, and that aggressive targets and ambitious programs are required to assure Californians a reliable water future. DWR estimates that the three tools with the greatest potential – urban water conservation, wastewater recycling and improved groundwater management – could, together, produce more than six million acre-feet of new water. This represents approximately as much water as the CVP and SWP have diverted from the Delta in recent years, and more than enough to reduce Delta diversions and meet future growth needs.

NRDC believes that total Delta diversions must be reduced from the unsustainable record levels in recent years. We are working with other members of the environmental community to develop a science-based target for that reduction, which we will provide to the Task Force in the near future. Urban water use efficiency and other tools discussed below can provide the State with near-term and cost-effective supplies to offset any impacts from a reduction in Delta supplies.

Proven "Cornerstone" Water Supply Reliability Tools

Urban Water Use Efficiency: Currently, urban areas use over eight million acre-feet of water during a typical year. One-third or more of this water is used to irrigate urban landscapes. Urban water use efficiency could yield up to **3,500,000 acre-feet** of water per year according to the Pacific Institute's most recent projections. (This estimate is close to DWR's estimate of 3.1 million acre-foot high estimate of the potential of urban conservation at $230-522 per acre-foot.) Significant reductions in water use can be achieved through design, installation and maintenance of water efficient landscapes, along with indoor conservation measures in the commercial, industrial and residential sectors. These savings can be realized by investing in current, off-the-shelf technologies, reducing lost and unaccounted for water through system water audits, and increasing implementation of conservation pricing. New water efficient technologies will undoubtedly continue to emerge and contribute additional savings in the future.

Recycled Water: Recycling urban wastewater (also known as reclamation or re-use) is an important strategy to increase water supply. Recycled water is most frequently used for agricultural or landscape irrigation or groundwater recharge. DWR estimates water recycling can generate up to **1,500,000 acre-feet a year** by 2030 at average cost of $600 per acre-foot.

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Improved Groundwater Management: The Department of Water Resources estimates that improved groundwater management, such as the conjunctive use of surface and underground storage, has the potential to provide between 500,000 and 2 million acre-feet at costs ranging from $10-600. The average cost in a recent round of applications received by DWR for conjunctive use projects was $110 per acre-foot. The appropriate target for conjunctive use will be determined in part by decisions on water management in the Delta, which will influence potential yield from groundwater storage. Such investments are likely to yield greater benefits south of the Delta, where projects may be less constrained by Delta operations and provide greater independence from the Delta. This effort could also be coordinated with floodplain and habitat restoration efforts in the Central Valley.

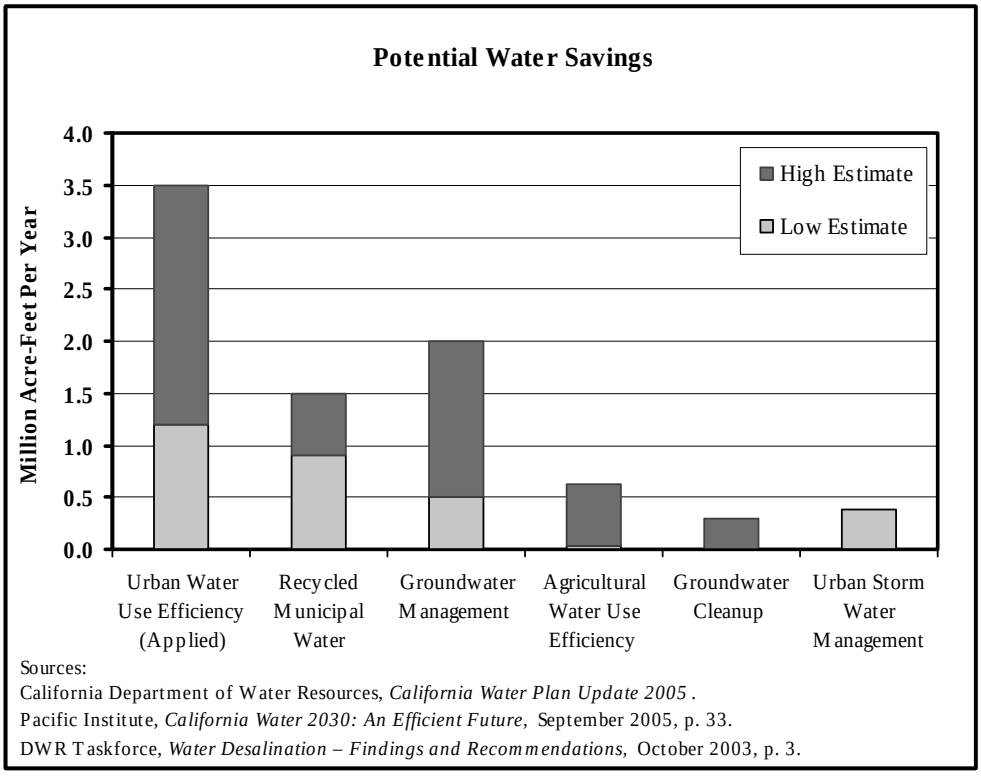
Additional Effective Strategies

In addition to the key tools discussed above, a number of additional water management tools can generate significant additional supplies.

Agricultural Water Use Efficiency: Eighty percent of California's annual water use goes to agriculture. Although in some areas considerable strides have been made in water use efficiency, farming methods are not as water-efficient as they can be. The California Bay-Delta Authority's Year Four report estimates up to **620,000 acre-feet** of water can be saved through agricultural water use efficiency, which includes installing micro-irrigation technology or other water management improvements, at a cost of $242 per acre-foot. We believe that these estimates understate the true potential of this tool.

Additionally, agricultural water is often highly subsidized. Pricing reform that sends clear, meaningful signals to agricultural water users can be very effective in encouraging increased water use efficiency.

Groundwater Clean-up: Removing salts, including nitrates, from groundwater can be a cost-effective means of producing clean water supplies, recharging stressed and contaminated aquifers, and increasing groundwater storage capacity without the need to build expensive surface storage projects. DWR estimates brackish groundwater desalination costs $250-500 per acre-foot, with a potential of yielding up to **290,000 acre-feet per year**.



Sources:
California Department of Water Resources, *California Water Plan Update 2005* .
Pacific Institute, *California Water 2030: An Efficient Future,* September 2005, p. 33.
DWR Taskforce, *Water Desalination – Findings and Recommendations,* October 2003, p. 3.

Urban Storm Water Management: Urban water agencies, particularly in Southern California, are increasingly recognizing the potential to provide multiple benefits by capturing, treating (where necessary), storing and using urban storm water. Use of low impact development techniques (LID) results in the diversion and capture of storm water and dry-weather runoff before it flows into surface waters. This water can then be used on- or off-site as an alternative water source for irrigation of parklands, sporting fields, cluster housing groups, or for fire-fighting. Such projects can provide water supply and flood management benefits, while reducing coastal pollution from urban runoff.

Nationally, research has repeatedly shown that LID has the potential to deliver vast quantities of useable water through recharge and infiltration, and that it is the most effective and cost-efficient means of managing storm water and abating water pollution. Further, LID uses common sense and simple technology – strategically placed beds of native plants, rain barrels, "green roofs," porous surfaces for parking lots and roads, and other tools – to retain rainfall on site or help rainfall soak into the ground, rather than polluting the nearest water body.

The Los Angeles Integrated Regional Water Management Plan indicates that proposed urban storm water management projects can generate **100,000 acre-feet** from urban storm water capture, and that the maximum potential is at least twice that amount. NRDC's preliminary estimate of the water savings from implementation of LID practices suggests that if LID were used in just 50% of all residential and commercial properties in Los Angeles, Riverside, and San Diego Counties, **377,000 acre-feet** annually could be infiltrated or otherwise reused. By offsetting energy-intensive imported water in like amounts, and after accounting for average energy requirements associated with pumping groundwater in these areas, LID could result in the reduction of up to 45,000 metric tons of CO_2 annually in Los Angeles County and an additional 55,000 metric tons of CO_2 in San Diego and Riverside Counties combined.

Transfers and Land Retirement. These tools must be carefully designed in order to avoid impacts to third parties. However, significant land retirement on the west side of the San Joaquin Valley is very likely and can generate significant water savings. For example, the Westlands Water District has advocated a land retirement program of up to 200,000 acres. Farming this land has historically required as much as 700,000 acre-feet of water.

Benefits of Alternative Water Management Strategies

A Healthier Bay-Delta and Other Ecosystems: Investments in surface storage could harm the Bay-Delta ecosystem by reducing flows to the Delta or increasing diversions from the Delta. In contrast, alternative water management tools would decrease our reliance on the Delta.

Energy Savings and Reduced Greenhouse Gas Emissions: Almost 20% of California's electricity use, and over 30% of its non-power plant natural gas use, is associated with the use of water. Water use efficiency and recycling can generate substantial energy savings and reductions in greenhouse gas emissions, and help the State meet AB 32 implementation targets.

Water Quality Benefits: Investing in water efficiency and groundwater cleanup will improve water quality by reducing urban runoff from lawns and gardens. In addition, investments in these tools will also help stretch limited state and federal funds available for water and wastewater treatment facility expansions and upgrades, by delaying or reducing the size of water system expansions. These investments will also improve drinking water quality, particularly for poorer communities in the Central Valley that rely on groundwater.

Reducing the Economic Risk from Delta Levee Failures: A massive levee failure in the Delta could jeopardize a critical water supply for 23 million Californians. Investments in alternative water management tools will reduce reliance on Delta diversions, thereby decreasing the risk to California's economy from potential Delta levee failures.

Strategies to Achieve Maximum Water Savings

This memo focuses on potential targets for a range of water management tools. The bullets below briefly outline key strategies that can maximize the water savings from these tools. We will present more details regarding these and other strategies in the future.

A Clear Conclusion Regarding Delta Diversion Totals: The single most effective thing the Delta Vision Task Force could do to encourage the development of alternative water supplies would be to make a clear, forceful recommendation regarding the need to reduce Delta diversions by a specified amount. Reducing Delta diversions will be a significant change from the trend over the last four decades. The likelihood that we will succeed in this transition will be greatly increased if the state has a clear goal to guide planning efforts and investments.

Learning from California's Energy Efficiency Success: California has emerged as a global leader in energy efficiency. We believe that the policy tools, such as a loading order and public benefits charges that have made this progress possible in the energy arena, can produce similar progress in encouraging water use efficiency. (See NRDC's white paper entitled: *Transforming Water Use: A California Water Efficiency Agenda for the 21st Century*.)

AB 32 Implementation: Reducing Delta diversions and investing in alternatives, such as water conservation, has the potential to significantly reduce energy use and greenhouse gas emissions. By integrating water planning with energy and climate change efforts, the state can take advantage of the synergies among these issues, including potential additional funding sources for less energy intensive alternatives to Delta diversions.

Integrated Regional Water Management: In recent years, IRWM has emerged as a key strategy to design water management solutions tailored to local needs, by considering local conditions, a full range of water management tools and a broad spectrum of potential benefits.

Credible Economics and Financing: Delta Vision should recommend that state and federal agencies carefully analyze the cost of alternative water supply strategies. Individual water agencies do this as a matter of course. However, state and federal agencies often fail to incorporate adequately basic economic analysis. For example, public funds dedicated to improving water supply reliability should be focused on the most cost-effective environmentally sound tools. The Delta Vision Task Force should develop recommendations to reduce water subsidies (e.g. by reforming renewed CVP contracts) and move toward real "beneficiary pays" financing.

ATTACHMENT 3

Testimony

Provided By

Jeffrey Kightlinger, General Manager
Metropolitan Water District of Southern California

On

The Immediate Federal and State Role in Addressing Uncertain Water Deliveries for California and Impacts on California Communities

Before the

Committee on Natural Resources
Subcommittee on Water and Power
United States House of Representatives

January 29, 2008

House Subcommittee on Water and Power
"The Immediate Federal and State Role in Addressing Uncertain Water Deliveries for California and Impacts on California Communities"

Oral Testimony by Jeffrey Kightlinger, General Manager
Metropolitan Water District of Southern California

Thank you Chairwoman Napolitano. I am pleased to give you and the subcommittee a brief survey of the impacts being felt throughout Southern California from the evolving water situation and Metropolitan's response. We face a new reality and new roles for Metropolitan and the state and federal governments to bringing more certainty to our water future.

At the moment we are roughly on track for an average rainfall year in both Southern California and Northern California. Traditionally this was good news. Traditionally this would mean that Metropolitan would likely receive enough water from the Sacramento-San Joaquin Delta to meet local demands and make modest additions to our storage reserves.

But not this year. Because of ongoing environmental problems in the Delta, there are court-ordered curtailments in water deliveries that started late last year and are expected to last into June. At the moment, the State Water Project has committed to delivering 25 percent of water supplies to its contractors throughout California. This percentage may increase, but Metropolitan is making preparations for a significant cutback in supplies. Metropolitan is responding by seeking to purchase additional supplies on the open market and funding a $6 million dollar water use efficiency outreach campaign to encourage conservation throughout our service area. In addition, Metropolitan's board of directors has approved over $30 million to aggressively implement water conservation and recycled hook-ups for public agencies and the commercial and industrial sectors.

Our tracking polls suggest that nearly half of the 18 million people in our service area have gotten the message and are taking steps to lower water use. This is helpful. Along with our efforts to creatively manage our resources, Metropolitan also invested in efforts to increase our storage capacity. In fact, today we have 10 times the amount of water in storage than we did during the last drought in the late 1980s and early 1990s. This includes a $2 billion capital investment in the building of Diamond Valley Lake, which alone nearly doubled the region's surface water storage capacity. Those reserves provide a cushion and give us some time. But, with the new restrictions in the Delta, we are now living on that borrowed time. That realization, and the uncertainties in the Delta, are beginning to create water supply impacts throughout the region.

Metropolitan, working with its member agencies, is developing a plan to equitably allocate our available State Water Project supplies from the Delta, the Colorado River Aqueduct and water stored in reserves. The primary objective of the plan is to minimize the impact on the overall regional economy. We are also striving to strike a balance recognizing needs from MWD, accounting for local supply and rewarding local districts that lower demands and increase supplies. A sterling example is Orange County. Last week it celebrated the opening of one of the largest water recycling facilities in the world. This facility will turn wastewater that used to drain into the Pacific Ocean into a reliable

high-quality drinking water supply that will help replenish the local groundwater basin. Metropolitan provided incentive funds to help make this project a reality. This is precisely the kind of strategic regional partnership that Metropolitan is working to replicate throughout our service area.

In the coming weeks and months, Metropolitan will review existing and new programs to lower demand and increase local supplies. We will be doing this despite rapidly rising costs from the State Water Project and other investments, which will likely require double-digit rate increases into the future. We continue to identify and implement new ways to lower demand and increase local supplies because we have seen the dramatic results of past efforts. And we are re-evaluating and updating our long-term water strategy, our Integrated Resources Plan, to determine if our conservation and local water supply targets should be even more ambitious.

To ensure our long-term plans are taking into account the impacts of climate change, Metropolitan has entered into a partnership with the RAND Corporation to develop appropriate planning models and protocols that would take into account long-term impacts on water supplies. The state has taken a leadership role with its energy policy, which is focused on landmark efforts to reduce greenhouse gases and working to ensure a better linkage between water and energy. Conserving water helps reduce the need to transport and treat water, which are energy-consumptive activities. Metropolitan is evaluating its carbon footprint in tandem with our water supply and planning efforts.

While there is much still to be done when it comes to water conservation, it is important to recognize how far Southern California has come. As an example, in the past 15 years Metropolitan has invested more than $200 million in water-conserving devices. These conservation investments, combined with plumbing code reforms, reduce our potential demands by about a million acre-feet per year. Had we not been this successful in lowering demand and simply expected the State Water Project to solve the region's problems, our demand on the Delta would be about 50 percent larger now. Given the multiple changing conditions due to climate change, endangered species rulings and other impacts in the Delta, Metropolitan has embarked upon a comprehensive update of its long-term Integrated Resources Plan. A renewed focus on the development of local resource projects will help decrease our dependency on the Delta. But we do need a more reliable supply from the Delta than the current system is providing. And we embrace the notion that restoring the health of this ecosystem is an essential ingredient to creating a more reliable water system.

How can the federal government help? We urge the federal agencies to remain active and engaged participants in the Delta. We need a new biological opinion from the U.S. Fish and Wildlife Service that will guide the operations of the State Water Project and the Central Valley Project. Metropolitan is actively seeking operational strategies that can help reduce conflicts between pumping operations and fish migration patterns. We also need the active participation of the federal wildlife agencies in coming up with a new Bay Delta Conservation Plan, which is exploring new and better ways to separate the movement of water supplies from the natural flows in the estuary. Yes, that may mean some form of a canal as one piece of a much larger solution. We need the feasibility studies and better science to understand new ways of moving water supplies. The deliberations ahead should be based on new facts and not old fears. Metropolitan has made a commitment to seek reliability from Delta supplies, and to find the water for new

growth from within our service area, a historic difference between the emerging Delta discussion and debates of the past. Metropolitan urges the federal government – our elected officials, federal agencies and staff – to support our local resource projects including recycling and other conservation programs.

As for assistance from the state, while we recognize the challenging fiscal situation, there are ways that the state can help. Metropolitan seeks to sponsor or support state legislation that would create a standard approach for regional water boards to authorize water recycling projects that seek to store supplies in groundwater basins. There are hundreds of millions of dollars from bonds that voters have already approved that are available to address parts of the Delta problem and to help regions become more self-sufficient.

Metropolitan remains a constructive and realistic participant to bring about dramatic and historic change in the Delta. We are very pleased to have the interest and involvement of both the state and federal governments to solve our problems and a collective recognition that the Delta as we know and manage it today is a broken ecosystem that needs fixing.

Thank you Chairwoman for today's hearing and I would be happy to respond to any questions.

ATTACHMENT 4

COMMITTEE ON RESOURCES
Subcommittee on Water and Power

"The Immediate Federal and State Role in
Addressing Waste Deliveries for California
and the Impacts in California Communities"
January 29, 2008

Testimony by
Richard W. Atwater
General Manager
Inland Empire Utilities Agency

I. Introduction

Thank you Chairwoman Grace Napolitano and members of the Subcommittee for Water and Power for the opportunity to testify before today regarding the water problems facing California. I am the General Manager of the Inland Empire Utilities Agency. The Subommittee has asked four important questions related to how address the critical water problems from Judge Wanger's court decision and how we develop regional and statewide strategies with the federal government to meet the challenges of having less water available from the Delta and the related issues with developing a sustainable ecosystem. The Inland Empire Utilities Agency in partnership with many other agencies in southern California and with financial assistance from the State of California and the Bureau of Reclamation is implementing a "Drought Proofing Strategy" that is a key element of a Delta Plan. We have recognized the challenges for a long time of meeting the statewide water needs in an environmentally responsible manner have committed over $500 million over the past seven years to implement projects that will develop new local supplies in southern California and reduce our need for Delta exports.

A. Inland Empire Utilities Agency/Chino Groundwater Basin

The Inland Empire Utilities Agency, a municipal water district under California law, was formed in 1950 by a popular vote of its residents. The service area of the Agency is entirely in San Bernardino County and has a current population of approximately 800,000. The IEUA service area is rapidly growing and will probably increase by 50 percent to 1.2 million within the next 20 years. The Chino Groundwater Basin was adjudicated in 1978 and is governed by a 9 member Watermaster Board. Overall water use is about 350,000 acre-feet annually, 70 percent of the supplies are from local sources within the Santa Ana Watershed. With the rapid growth, demand from MWD could increase from 70,000 acre-feet per year currently to 150,000 acre-feet in 2020 if we did business as usual! However IEUA, Chino

Basin Watermaster and in cooperation with many other agencies have developed a "Drought Proof Plan" that will develop over 100,000 acre-feet of new local supplies to minimize the need for additional imported water from MWD, thereby reduce our need for more Delta (SWP) water supplies.

B. History, Background and Interagency Relationships with CALFED Bay-Delta Program

The Agency has been a member agency of the Metropolitan Water District since 1950 and distributes about 70,000 acre-feet of imported water to the cities of Chino, Chino Hills, Fontana (through the Fontana Water Company), Ontario, Upland, Montclair, Rancho Cucamonga (through the Cucamonga County Water District), and the Monte Vista Water District. The Agency also provides wastewater treatment service (four regional water recycling plants that produce about 60 million gallons per day or 67,000 acre-feet per year). Excess recycled water flows downstream into the Santa Ana River where the Orange County Water District recharges that water into the Orange County groundwater basin for drinking water.

The Agency is also a member of the Santa Ana Watershed Project Authority (SAWPA) and is an active member of the Santa Ana River Watershed Group and the Chino Basin Watermaster. As a member agency of SAWPA, the Agency's water projects are closely coordinated with the SAWPA watershed wide planning and the funding of priority projects through the Water Bond Proposition 13 and Proposition 50 grants.

Public and Private Partnerships to Improve the Santa Ana Watershed

- Santa Ana Watershed Project Authority (SAWPA) has maintained an inclusive dialogue with all interested parties and is leading the update of the Santa Ana integrated regional watershed management plan through the "One Water-One Watershed" (OWOW) process;
- All local governments within the three counties (San Bernardino, Riverside and Orange) are working cooperatively together to manage growth and plan for the water/wastewater infrastructure needed to meet the needs of this rapidly urbanizing watershed;
- Partnerships with industry including dairies, manufacturing, and developers have resulted in creative solutions to local water quality problems (e.g. the Santa Ana brine sewer to the ocean) as well as producing new sources of renewable, cost effective energy;
- Industrial customers throughout the area are planning on using recycled water to reduce costs, ensure reliability, and to be excellent environmental stewards.

The Chino groundwater basin is one of the largest in Southern California. The Chino Basin Watermaster adopted an Optimum Basin Management Plan (OBMP) to protect the water

quality of the basin and to manage the local supplies effectively to the maximum benefit of the local ratepayers. A key element is the expansion of the conjunctive use operation of the Chino Basin to expand the storage and recovery by approximately 300,000 to 500,000 acre feet.

Other key components are the Inland Empire Utilities Agency regional water recycling project to develop new local supply of 100,000 acre-feet per year and the Chino Basin desalters that would develop an additional new local supply of 40,000 acre-feet per year.

The key benefits of the Chino Basin regional "OBMP" water plan are as follows:

Benefits

- *Provide a more dependable local water supply and reduce the likelihood of water rationing during future droughts and the impacts of climate change;*
- *Economic benefits of reliable water supply to industry and provide incentives to attract new industry and jobs in the Inland Empire region;*
- *Environmental protection – reduce wastewater discharges into Santa Ana River by 50 percent through local water recycling and protect Orange County drinking water supplies through implementation of comprehensive lower Chino Dairy area manure management strategy;*
- *Reduce imported water use in the rapidly growing Inland Empire region (upper Santa Ana River Watershed) and thereby contribute in a significant manner to the statewide CALFED Bay-Delta and Colorado River solutions through more efficient use of existing local supplies;*
- *Assist in solving multiple Endangered Species Act problems within the Santa Ana Watershed, the CALFED Bay-Delta program, and the Colorado River/Salton Sea;*
- *Implement a sustainable long-term water resources management program that maintains the salt balance of the Santa Ana River watershed;*
- *Reduce the energy intensity of the region's water supplies, helping to conserve energy and reduce greenhouse gas emissions that are contributing to climate change.*

II Chino Basin "Drought Proofing Strategy"

The IEUA Urban Water Management Plan, adopted in December 2005 and the Chino Basin Watermaster Optimum Basin Management Plan, document the overall strategy for improving the water supply reliability in the Chino Basin area.

- ✓ Water Conservation – 10% savings 35,000 AF
- ✓ Water Recycling – 100,000 AF
- ✓ Local Groundwater Storage and Conjunctive Use – 500,000 AF of new storage
- ✓ Chino Desalter 40,000 AF

- ✓ Stormwater – 25,000 acre-feet of new supplies
- ✓ Renewable Energy and Organics Recycling – Clean energy through biodigesters (using biosolids, dairy manure and food waste), solar power and wind power (goal of 15 megawatts)
- ✓ Water Quality Management – Establishment of Chino Creek Wetlands and Educational Park at IEUA and a continued partnership with Orange County Water District on Prado Wetlands implementation of the Chino Creek Integrated Watershed Plan.

A. Water Conservation- (35,000 acre-feet per year, 10 percent of overall use)

IEUA and its retail utilities are committed to implementing the Memorandum of Understanding (MOU) regarding Urban Water Conservation in California. IEUA is an active member of the California Urban Water Conservation Council (CUWCC). Currently, the Agency is expanding its conservation efforts to promote both water and *energy* conservation programs to our customers. IEUA's goal is to reduce water demands by 10 percent (35,000 acre-feet per year) through aggressive implementation of customer conservation programs. Innovative programs initiated by IEUA include the Inland Empire Landscape Alliance, in which elected officials from cities and water agencies within IEUA's service area are working to promote outdoor conservation including turf reduction rebates, use of California-friendly native plans and new regional model landscape ordinances that will promote water savings. Other programs include conservation rebates which are offered in partnership with the Metropolitan Water District of Southern California (ultra-low-flow toilets, weather-based irrigation controllers, synthetic turf, efficient sprinklers, water brooms X-Ray recirculation units and other water saving devices), landscape audits, and school education programs including the award-winning Garden In Every School program.

B. Water Recycling (50,000 acre-feet by 2010)

IEUA owns and operates four water recycling plants that produce high quality water that meets all state and federal requirements for non-potable landscape irrigation, industrial uses, and groundwater replenishment. Since 2000 the Agency has spent over $60 million expanding its recycled water distribution system and currently recycles about 15,000 acre-feet annually. Recently the IEUA Board approved an accelerated implementation plan to increase annual recycled water use to approximately 50,000 acre-feet within the next 3 years by constructing "purple" recycled water pipeline system to hookup existing large customers (schools, golf courses, city parks, groundwater recharge). IEUA's Board has approved a $140 million budget to expedite the construction of recycled water pipeline distribution system. The accelerated implementation plan was developed through a collaborative process with local cities, water districts, Chino Basin Watermaster and other stakeholders and represents a comprehensive evaluation of the infrastructure needed to maximize recycled water use in the region. In addition, IEUA and local cities have coordinated with developers to incorporate dual "purple" piping into new urban developments to maximize recycled water use for non-potable purposes.

The energy demands to produce and deliver recycled water are less than one third of the energy required to deliver water through the State Water Project. Additional energy savings are included in the plan by building new smaller water recycling plants in the northern part of our service area to provide recycled water to communities (Upland, Fontana, and Rancho Cucamonga) without the need to pump the water to them. The Cucamonga County Water District (CCWD) proposed satellite plant authorized by HR 2919 would be the prototype water recycling plant to reduce energy use of pumping recycled water to the higher elevations along the San Gabriel Mountains.

Approximately 25% of the recycled water will be used for groundwater replenishment within the Chino Groundwater basin to augment the potable water supply. IEUA and Chino Basin Watermaster recently got court approval to expand the artificial recharge of the Chino Basin Groundwater Basin. The plan is to blend recycled water with stormwater and imported water in a coordinated fashion with flood control district to ensure that all water sources are conserved in an optimal manner (targeted goal is an additional recharge of 80,000 acre-feet per year).

C. Local Groundwater Storage and Conjunctive Use (500,000 acre-feet of new storage)

The Chino Basin Watermaster is implementing an Optimum Basin Management Plan to enhance the conjunctive use storage of the Chino Basin. Today MWD has stored over 80,000 AF in the Basin and has funded $1.5 million in engineer feasibility studies to expand the storage to 150,000 AF. The Optimum Basin Management Program developed over the past two years by the Chino Basin Watermaster would implement a comprehensive water resources management strategy to drought proof the area and enhance the yield of the groundwater basin. The Chino Basin Watermaster has developed a conjunctive use program to store 300,000 – 500,000 acre-feet of imported water in wet years for drought year withdrawal for local, regional and statewide availability. In June, 2003 IEUA, Chino Basin Watermaster, Three Valleys MWD, Western MWD and the Metropolitan Water District executed an agreement for the initial 100,000 acre-feet of storage and recovery projects ($27.5 million funding from MWD and Calif. DWR). In June 2007 MWD agreed to fund studies to evaluate expanding this storage program.

D. Chino Desalination Projects (40,000 acre-feet annually by 2020)

Historically, Colorado River water (relatively high salinity) and "Route 66" agricultural practices have caused areas of the Chino Basin to have high salts that make the water unfit for domestic uses. To correct this problem and to recover this poor quality water, the Chino Basin Optimum Management Plan recommends implementation of groundwater cleanup projects to pump and treat poor quality groundwater to meet drinking water standards.
Additionally, the desalination projects of the lower Chino Basin area will protect and enhance the water quality of the Santa Ana River and the downstream use by Orange County. HR 813 (passed the House on October 22, 2007) would provide authorization under the Bureau of Reclamation's Title XVI program to provide funding for the third Chino desalter and brine line improvements with the SAWPA SARI brine system

recommended in the Southern California Comprehensive Water Reclamation and Reuse Study (USBR, 2003) and the joint MWD/USBR Salinity Management Study (1999). The third phase expansion is projected to cost $110 million and increase to approximately 40,000 AF.

E. Stormwater (25,000 acre-feet annual average of new stormwater capture percolation)

A critical issue facing the coastal plain of Southern California as the region continues to urbanize and hardscape our landscapes will be how to implement both small scale and larger scale projects for stormwater capture to allow percolation into our groundwater basins. IEUA in coordination with the Chino Basin Watermaster, the San Bernardino County Flood Control District and the Chino Basin Water Conservation District has developed an integrated recharge master plan to optimize the capture of stormwater with replenishment of imported water from MWD and our local recycled water to enhance the storage and recovery of water from the Chino Basin. During the past five years, IEUA has funded construction of over $50 million in improvements on the Groundwater Recharge Basin.

IEUA is also sponsoring innovative small scale, on-site (neighborhood development) storm water management projects to enhance percolation of rainfall to minimize runoff, reduce contamination of rainwater before it percolates into the ground and to cost effectively reduce flood control requirements while helping the cities and county meet regulatory requirements. This innovative program is being funded in partnership with the CALFED Bay-Delta Program, Metropolitan Water District of southern California, and the Southern California Concrete Association.

III. Climate Change Impacts on California Water Supplies

In the fall of 2006 IEUA collaborated with RAND on a study of the potential affects of Climate Change on the IEUA and Chino Basin area. This work has been recently completed and a Congressional briefing will held on January 31, 2008 to explain the findings of this report. Climate change will affect water supplies in California, but few water-management agencies in the state have formally included climate change in their water-management plans. RAND researchers have worked with Southern California's Inland Empire Utilities Agency to help it identify vulnerabilities related to climate change in its long-term water plans and to evaluate its most effective options for managing those risks. But in summary the RAND research project highlights the critical need to develop more local supplies in California (e.g., water recycling, local groundwater storage and stormwater replenishment programs, implement excellent water use efficiency/conservation programs) to avoid significant water shortages and economic impacts.

IV. Future Issues and Need for Federal Assistance

Southern California does have enormous water problems when you consider the following trends:

- ✓ *The current population is about 18.5 million and will likely double over the 50 years;*
- ✓ *The imported water infrastructure from MWD can optimistically only deliver 2.4 million acre-feet, assuming resolution State Water Project Delta issues and the Colorado River problems are successfully resolved;*
- ✓ *Climate change is expected to impact both amount and timing of future water supplies, increasing the likelihood of shortages during critical times;*
- ✓ *Importing water to southern California requires a large amount of electrical energy, substantially more than the alternative local supplies (recycled water, capturing stormwater, and groundwater recovery of poor quality water);*
- ✓ *The region faces significant shortages unless we develop a local supply strategy.*

The issue for the region as articulated in the MWD Integrated Water Resources Plan adopted in 2004, is to develop a balanced approach to multiple sources of supplies with a clear priority to local resources management and emphasis on less energy intensive uses of water that protect water quality and the wildlife habitats of the region.

Addressing the four questions asked in the letter inviting me to testify.? My response to these questions and suggestions are as follows:

The Committee should continue to examine the opportunities for State and Federal agency partnerships to promote water use efficiency programs recommended in the CALFED Bay-Delta Record of Decision (increase water conservation, water recycling and new local groundwater storage programs to reduce the need for Delta exports consistent with the California Water Plan.

The Committee has developed Views and Estimates in the past few years that strongly supports increased funding for the Bureau of Reclamation's Title XVI Program. For FY 2009 I recommend the Committee support an increase of $100 million increase in the funding of Title XVI Program expenditures.

A *coordinated approach to regional infrastructure planning for water supply, groundwater management, stormwater, wastewater reuse and recycling needs to be integrated on a watershed and regional scale. Regional leadership in the planning of flood control, wastewater and water facilities is an opportunity that can save billions over the next 5 decades as well as help address the serious challenge facing this nation through climate change. The federal government should be a partner in this process helping both to facilitate redirection of federal programs to support local planning and providing funding for projects that contribute to the nation's goals for water security and reduction of climate*

change impacts. EPA, Army Corps, US Bureau of Reclamation, the USDA Natural Resources and Conservation Service all have significant activities within the region.

A historic example of a state/federal partnership was the leadership of this committee in 1996 in drafting the CALEED Bay-Delta legislation that provided the authorization.

I would recommend that your Committee hold additional hearings on these opportunities to develop new regional, state and federal partnerships that address comprehensively watershed divide problems

In closing, thank you for the opportunity to testify. If I can provide any additional information on the current and future water problems facing California, please don't hesitate to contact me.

ATTACHMENT 5

NATURAL RESOURCES DEFENSE COUNCIL

December 21, 2007

Ms. Karen Scarborough
Resources Agency
1416 Ninth Street
Sacramento, CA 94814

Re: Comments on BDCP Points of Agreement

Dear Ms. Scarborough:

We are writing on behalf of the Natural Resources Defense Council ("NRDC") and its more than 120,000 members in California to express our concerns regarding the recent planning document approved by the Bay Delta Conservation Plan ("BDCP") Steering Committee: Points of Agreement for Continuing into the Planning Process (November 16, 2007) ("Points of Agreement"). These comments are supplementary to our previous comments. Unfortunately, with the one exception noted below, this document does not address the serious concerns we raised a year ago. *See* Letter from Barry Nelson and Katherine Poole to Scott Cantrell re Proposed Planning Agreement for the Bay Delta Conservation Plan (Oct. 2, 2006) (attached). In fact, in some areas, this document appears to be moving farther away from a balanced, legally sufficient and effective program.

I. PREMATURE DECISION REGARDING CONVEYANCE ISSUES

The Points of Agreement concludes that "the most promising approach for achieving the BDCP conservation and water supply goals involves a conveyance system with new points of diversion" including "the construction and operation of a new point (or points) of diversion in the north Delta on the Sacramento River and an isolated conveyance facility around the Delta" as well as "[m]odifications to existing south Delta facilities." *Id.* at 3. The document reaches this conclusion *before* the BDCP process has conducted the in-depth environmental review and comparison of alternatives under CEQA, NEPA, the ESA and the NCCPA that is necessary to support any scientifically-supportable and legally-defensible conservation plan. The BDCP has no basis for eliminating all other water conveyance and operations alternatives from serious consideration. This decision is premature, and should be revisited.

The Points of Agreement acknowledges that the Steering Committee has not yet begun the planning process for the development of the BDCP. Points of Agreement at 6. In fact, the BDCP has not yet defined the "preliminary biological goals and objectives to guide initial plan development." *Id.* at 7. If the goal of the BDCP process is truly to "develop a conservation plan for the Bay Delta pursuant to the Endangered Species Act (ESA) and the Natural Community Conservation Planning Act (NCCPA)", as the Points of Agreement asserts, then the biological goals and objectives should be driving the content of the plan, not water supply considerations. *Id.* at 1. For example, as in the

case of the Planning Agreement, this document does not commit to the recovery of listed species, and thus fails to meet the requirements of the NCCPA. That commitment should be one of the first and most fundamental commitments for a legitimate conservation plan.

Water conveyance facilities and their operations are one of the primary stressors on the Delta's ecosystem and aquatic species, and are ostensibly the focus of the BDCP. It stands to reason that the BDCP should consider the impacts of a wide array of alternative water conveyance facilities and operations on aquatic habitat, and consider alternative ways to revamp that water supply system to be compatible with fisheries conservation and recovery. The BDCP initially appeared to be pursuing this approach, identifying four "conservation strategy" options that would have allowed the agencies to analyze and compare the environmental impacts of a range of alternative water supply scenarios. Those options included:

- Option 1: use of existing facilities
- Option 2: improved through-Delta conveyance
- Option 3: dual conveyance
- Option 4: a new diversion on the Sacramento River

Points of Agreement at 5. By analyzing the benefits, costs and impacts of these alternative conveyance points, in combination with changes in operation that included various different diversion amounts, including significant reductions in total diversions, the BDCP could have garnered a great deal of useful data to inform a conservation plan.

Instead, the BDCP has prematurely narrowed its focus to Option 3, eliminating all other diversion and conveyance alternatives from consideration before fully analyzing the impacts of those alternatives. As explained in the Options Evaluation Report, this dual conveyance option will now "serve as the nucleus for the larger conservation plan and other major elements of the strategy will be formulated around it." BDCP Options Evaluations Report at ES-1 (Sept. 2007). As a result, any subsequent analysis will fail to provide decision makers with a meaningful comparison of critical policy alternatives, such as how the environmental impacts of reducing diversions from existing facilities would compare to the impacts of building a highly expensive new diversion facility on the Sacramento River.

Moreover, the BDCP's own Options Evaluation Report identified conveyance alternatives that it concluded were biologically preferable to the dual conveyance option, e.g. Option 4, but which the BDCP nevertheless rejected. While we do not endorse the analysis or conclusions of the Options Evaluation Report, it is telling that the BDCP stakeholders have already rejected an option that the federal fish agencies and their own internal analysis suggested was the biologically preferable option.

Simply put, we do not believe that it is justifiable to select a "plumbing" alternative without making any meaningful decisions regarding other key issues, such as endangered species recovery, ecosystem recovery goals, total diversions, annual operations, water quality impacts, impacts to Sacramento River fisheries, cost, financing, governance, and other issues central to the question of restoring the Delta. Some of these considerations could fundamentally affect decisions regarding conveyance strategies.

II. INCONSISTENCY WITH THE DELTA VISION BLUE RIBBON TASK FORCE VISION DOCUMENT

The imbalance in the Points of Agreement is particularly striking in comparison with the recently released Delta Vision document from the Delta Vision Blue Ribbon Task Force. The Delta Vision process was created through SB 1574 and Executive Order, representing an agreement between the legislature and the Governor. It is charged with developing a long term plan for the Delta that addresses more issues than are addressed by the BDCP process. Through the Stakeholder Coordination Group, this process also provides for the involvement of a broader range of stakeholders than the BDCP. Thus, the task force has broader support, broader involvement and a broader focus than the BDCP. Therefore, the BDCP should take care to ensure that its methodology, recommendations and timing are adapted to the Delta Vision process. Unfortunately, in the following respects, the Points of Agreement document is inconsistent with the Delta Vision document.

The Delta Vision document contradicts the conclusion of the BDCP regarding conveyance by recognizing that "not enough information is available at this point" to reach conclusions regarding conveyance. Instead, the Delta Vision document calls for an approach "recognizing the interdependence of all elements of a sustainable Delta vision and making decisions about conveyance and storage within that larger perspective." Delta Vision at 13. Unfortunately, the BDCP document has turned the sound approach of the Delta Vision document on its head, reaching a conclusion regarding the one issue for which the Task Force has most clearly recommended a cautious, comprehensive approach, and failing to reach conclusions regarding many other issues on which strong conclusions are clearly justified. The common thread among these decisions is an excessive focus on water supply issues, at the expense of other considerations.

The Delta Vision document is also far more direct in discussing the need for reductions in diversions, as well as the need for water in California to be managed "with significantly higher efficiency." Delta Vision at 2. This conclusion is supported by the CALFED Science Program, which recently stated that "opportunities for increasing supply to satisfy growing demand are becoming limited, and environmental problems are creating a growing need to reallocate water to the ecosystem. As California's population grows, increasing urban water needs will have to be met mainly by improving water management instead of by developing new supplies within the Sacramento-San Joaquin system." CALFED Science Program, State of the Science for the Bay-Delta System: Draft Summary for Policymakers and the Public at 9 *(*November 2007.) A reduction in diversions has also been mandated by the December 14 federal district court ruling regarding the protection of Delta smelt. The Points of Agreement should recognize this pressing need, which the Delta Vision document addresses more directly.

We recommend that the approach of the BDCP be modified to reflect the recommendations and approach of the Delta Vision Task Force.

III. LACK OF CONSIDERATION OF THE FAILURE OF THE ENVIRONMENTAL WATER ACCOUNT

The primary focus of this document appears to be to provide regulatory assurances for the CVP and SWP Delta facilities. Unfortunately, the Points of Agreement and the previous planning agreement do not clearly call for the analysis of the dramatic and fundamental failure of the previous assurances mechanism – the Environmental Water Account. We have described these failures in some detail. *See* Letter from Katherine Poole and Barry Nelson to Sammie Cervantes re the draft supplemental EIS/EIR for extending the EWA (Dec. 10, 2007) (attached). Indeed, the EWA has

contributed to the collapse of the Bay-Delta ecosystem and its fisheries. Clearly, this is a highly questionable tool for inclusion in a conservation plan for the Bay-Delta. It appears, however, based on the current proposal to extend the EWA, that state and federal agencies are attempting to extend temporarily this failed strategy until it can be made permanent by the BDCP. The BDCP can only avoid a full and fundamental evaluation of the EWA if this tool is permanently abandoned. The recovery of the Delta and listed species will require far more effective tools, including clear regulatory requirements and robust adaptive management measures that are not dependant on annual purchases and public funding, or on self-defeating increases in Delta pumping.

IV. ELIMINATION OF 8,500 AS AN INTERIM PROJECT

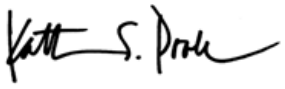
We are pleased that BDCP has responded to one of the recommendations in our previous letter – specifically by eliminating as an interim action the proposal to increase to 8,500 cfs the pumping limit for the SWP Delta pumps. Unfortunately however, other than this decision, the Points of Agreement document has not addressed the many fundamental concerns raised in that letter.

V. CONCLUSION

As you know, NRDC has reluctantly chosen not to participate in the BDCP process. We made this decision after raising concerns that the BDCP Planning Agreement failed to ensure that the final plan would conserve and recover affected listed species, while guaranteeing assurances to regulated entities "that neither the USFWS nor NMFS will require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for Covered Species, without the consent of the affected Potential Regulated Entities." Planning Agreement, pp. 10-11. Our concerns have not been addressed. Indeed, the recently-issued Points of Agreement heightens our previous concerns regarding this effort, which is not yet a credible "conservation plan."

We urge you to reconsider this approach, make the BDCP consistent with the Delta Vision process and refocus it on conservation as its first priority. Thank you in advance for considering our comments.

Sincerely,



Barry Nelson
Senior Policy Analyst

Katherine Poole
Senior Attorney

Cc: Senator Dianne Feinstein
Senator Barbara Boxer
Congresswoman Grace Napolitano
Congressman George Miller
Senate President pro tem Don Perata
Senator Mike Machado
Assemblywoman Lois Wolk
Assemblyman Jared Huffman
Lester Snow, DWR
John Davis, BOR
Steve Thompson, FWS
Maria Rea, NMFS
John McCamman, DFG

ATTACHMENT 6

NATURAL RESOURCES DEFENSE COUNCIL

December 10, 2007

Ms. Sammie Cervantes
Bureau of Reclamation
2800 Cottage Way, MP-140
Sacramento, CA 95825
scervantes@mp.usbr.gov

VIA ELECTRONIC AND U.S. MAIL

Re: Comments on the Draft Supplemental EIS/EIR for Extending the Environmental Water Account and OCAP Consultations

Dear Ms. Cervantes:

We are writing on behalf of the Natural Resources Defense Council ("NRDC") and its more than 120,000 members in California with regard to the draft supplemental EIS/EIR ("DSEIS/EIR") for the Environmental Water Account ("EWA"). The DSEIS/EIR proposes to extend the existing EWA program, which is currently set to expire at the end of 2007, for another four years, through 2011. The U.S. Bureau of Reclamation and the California Department of Water Resources, the co-lead agencies for the DSEIS/EIR, propose to take this action without providing any analysis of how the EWA has functioned since its inception in 2001 or whether the EWA has succeeded in achieving its stated fish protection purposes. In fact, the EWA has *not* functioned as envisioned and, by placing artificial restraints on the amount of water ostensibly available for fish protection, has contributed to the *decline* of imperiled fish in the Delta, most of which are in worse condition today than they were in 2001. For these reasons, we urge the agencies to discontinue the failed experiment of the EWA, and to devote the taxpayer resources currently dedicated to the EWA to actions that could provide a real benefit to imperiled fish.

In previous biological opinions on the joint operations of the Central Valley Project and State Water Project (i.e., the "Operating Criteria and Plan" or "OCAP"), the agencies have considered the EWA a central feature to mitigate the harmful impacts of the projects on listed fish. The Bureau has reinitiated consultation on those OCAP biological opinions, and those reconsultations are ongoing. Apparently, the agencies have not yet defined the "project" for this reconsultation and it is unclear whether the agencies are contemplating including the EWA in the new project description. Because the EWA has failed to function as a fish protective measure and should not be considered an effective mitigation or conservation tool in the new biological opinions, we seek consideration of these comments in those ongoing consultations as well. Likewise, we request that this information be incorporated, by DWR and DFG, into efforts to comply with the requirements of CESA.

I. THE EWA HAS NOT FUNCTIONED AS ENVISIONED

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There is no doubt that in past years the water promised for fish protection through both the Environmental Water Account and the CVPIA (b)(2) account has been significantly less than what was promised in the CALFED ROD. *Finding the Water: New Water Supply Opportunities to Revive the San Francisco Bay-Delta*, Environmental Defense, 2005 (appended as Exhibit 1). From 2001-2004, the EWA provided only 29% on average of the expected 195,000 acre-feet of operational assets. *Id.* at 12-13. Collectively, the EWA and b(2) have contributed as much as 500,000 acre-feet *less* water per year towards fish protection and restoration than anticipated in the CALFED ROD. These shortfalls have occurred while exports from the Delta have reached record high levels and the ecosystem has continued spiraling downward. Clearly, the EWA experiment has not performed as planned.

The failure of the EWA to function as envisioned is epitomized in the failure of the agencies to invoke Tier 3 this year – the intended backstop for any shortfall in EWA assets. EWA Tier 3 was supposed to ensure that if EWA was underfunded or failed to perform as anticipated (both of which have happened), sufficient water would be provided to ensure no jeopardy to listed fish. As explained in the Tier 3 Protocol, a copy of which is appended hereto as Exhibit 2:

> As part of the MSCS Conservation Agreement and the FWS and NMFS biological opinions, the CALFED agencies have provided a commitment, *subject to specified conditions and legal requirements,* that for the first four years of Stage 1, there will be no reductions, beyond existing regulatory levels, in CVP or SWP Delta exports resulting from measures to protect fish under FESA and CESA. *This commitment is based on the availability of three tiers of assets:*
> …
> Tier 3 is based upon the commitment and ability of the CALFED Agencies to make additional water available should it be needed.
> …
> Tier 3 is a fail-safe device, intended to be used only when Tier 1 and Tier 2 are insufficient to avoid jeopardy to the continued existence of an endangered or threatened species.
> …
> The State and Federal Projects will be responsible for making preparations for the activation of Tier 3.

(Emphasis added). This language makes clear that the assurances provided under CALFED, and the ESA and CESA compliance of the EWA, were dependent upon the existence and availability of these Tier 3 assets.

Unfortunately, when the time came to call upon this Tier 3 "fail-safe", the agencies failed to trigger it, ensuring that listed species rather than water users would suffer the consequences of the failure of the EWA to live up to its stated purpose. There can be no question that Tier 1 and Tier 2 have been and are insufficient to avoid jeopardy to the threatened delta smelt. A federal court held in May of this year that the "delta smelt is indisputably in jeopardy as to its survival and recovery." *NRDC v. Kempthorne*, Order on Summary Judgment at 119 (May 25, 2007). This finding echoes the findings of several expert fisheries biologists, including staff of many

state and federal agencies. *See, e.g.*, DSWG Briefing Statement (May 15, 2007) ("the species has become critically imperiled and an emergency response is warranted") (attached hereto as Exhibit 3); Statement Presented by Ryan Broddrick, Director, CDFG, to House Subcommittee on Water and Power (July 2, 2007) ("it is DFG's position that actions must be taken to protect as many individual smelt as can be through manipulation of the water projects. Each reproducing organism is important to the survival of the species.") (appended hereto as Exhibit 4). Despite these findings and the continued take of large numbers of delta smelt at the Project pumps this past summer, *see* delta smelt May, June and July take tables (appended hereto as Exhibit 5), the Project agencies obstinately refused to invoke Tier 3.

Inexplicably, the DSEIS/EIR makes no mention of this breakdown of the EWA's "fail-safe", nor does it describe or analyze the historical shortfalls of the EWA or the program's failure to function as envisioned. These shortcomings are far more relevant to the foreseeable impacts of extending the program than any of the purely hypothetical modeled impacts contained in the DSEIS/EIR. The DSEIS/EIR must be revised to address these issues. Further, these historical realities belie the statement in DSEIS/EIR that "[i]f pumping would be likely to put at risk the continued existence of a species listed as endangered or threatened under the Endangered Species Act (ESA), the Project Agencies would curtail pumping even if purchases already totaled 600,000 acre-feet and all assets were used." DSEIS/EIR at ES-5. This is precisely the situation that presented itself to the Project Agencies this summer, and the agencies failed to curtail pumping once EWA assets were depleted even though continued pumping threatened the continued existence of the delta smelt.

Moreover, the DSEIS/EIR seeks to utilize the ESA/CESA process for coverage of the EWA initially established in the CALFED ROD, without addressing any of these fundamental failures of the process to operate as envisioned and which were essential to the CALFED analysis. *See generally* DSEIS/EIR Appendix C.[1] For example, Tier 3 no longer exists as a viable "fail-safe device." Yet, the CALFED assurances were explicitly "based on the availability of three tiers of assets." Tier 3 Protocol. The DSEIS/EIR makes passing reference to this change, obliquely noting that "[b]ased on current circumstances, these three tiers are no longer an accurate way to describe EWA assets." DSEIS/EIR at 2-4. But the document fails to acknowledge the implications of omitting this critical "fail-safe device" or to describe the replacement structure of the EWA going forward.

In short, the DSEIS/EIR fails to adequately describe the project to decisionmakers and the public or to disclose the environmental impacts associated with the policy choice of extending the EWA. The document should be revised to correct these shortcomings. We believe that an accurate description and assessment of the EWA will demonstrate that the program should not be extended.

[1] The DSEIS/EIR also fails entirely to discuss the state court decision finding that DWR lacks the necessary CESA coverage for operation of the SWP, which also likely impacts the CESA analysis in Appendix C. It is unclear, for example, how EWA assets pumped through the SWP facilities at Clifton Court forebay and Banks pumping plant have CESA take authority when the court found that the SWP lacked any take authority for its pumping operations. The DSEIS/EIR must be revised to address this issue.

II. THE EWA HAS LIMITED, RATHER THAN EXPANDED, THE AMOUNT OF WATER AVAILABLE FOR IMPERILED FISH

Since shortly after the first EWA ROD was signed in 2004, the program has been used as an excuse by the agencies to deny needed water to imperiled fish rather than to help protect and recover imperiled fish. For example, in February 2005, when delta smelt populations were at then-record low levels, fishery biologists recommended that exports be curtailed to reduce entrainment. However, because EWA supplies were scarce, project managers did not curtail exports as much or as long as was requested. *Compare* "Data Assessment Team" call notes (Feb. 1, 2005) (recommending combined exports be reduced to 1500 cfs for one week) (appended hereto as Exhibit 6, without attachments) *with* CVO smelt report (February 2005) (showing much higher combined export levels) (appended as Exhibit 7). Hundreds of delta smelt were taken at the pumps as a result. *Id.* The lawful and proper course of action would have been for the agencies to fully implement the recommended action, and then use non-EWA project water to meet fish needs later in the year if EWA supplies ran short. Instead, the program has been implemented to turn this requirement on its head, and to short fish without any consideration given to imposing uncompensated reductions on project contractors and other water users.

Unfortunately, the agencies have continued this pattern of using limited EWA assets to deny needed fish protection actions. In 2006, as the delta smelt continued its unparalleled decline in abundance, the Delta Smelt Working Group ("DSWG") evaluated a range of protective actions that could be taken to lessen the impacts of water project operations. One action that was evaluated was to address fall (September-December) Delta salinity levels by making releases from upstream reservoirs to increase Delta outflows. The discussions and analyses of this proposed action are reported in DSWG notes for July 10 (see also the notes from August 21, and Sept 26 (appended hereto as Exhibits 8). The DSWG determined that the fall action had a high likelihood of being successfully implemented and that the scientific basis for the action was supported by statistically significant correlations.

Ultimately, the fall action was not taken because it was determined that "the amounts of water needed to demonstrably improve fall habitat quantity/quality [were] unavailable". Based on analyses provided by DWR, the amount of water necessary for maintaining net Delta outflows at 7000 cfs for the September-December period would range from only 170-433 TAF. DSWG notes (Aug. 21, 2006). As a result of not taking this action, Delta outflows steadily declined, falling below 6000 cfs in October, and salinity levels shifted upstream of 80 km, the critical threshold identified by the DSWG for delta smelt habitat quality and subsequent abundance. Delta smelt abundance plummeted to a new record low the following year, indicating that the fisheries agencies were not sufficiently addressing adverse habitat conditions in the Delta and other stressors to ensure the delta smelt's survival and recovery.

Perceived unavailability of water assets was also the reason behind the DSWG rejecting a protective action in winter 2006 intended to set net flows in Old and Middle Rivers to zero cfs to better protect pre-spawning adults. Low San Joaquin River inflows and negative flows on Old and Middle Rivers, concurrent with high export rates, are likely creating hydrodynamic conditions that draw greater numbers of fish to the pumps and correspond to significantly higher

salvage rates. Protection of these biologically valuable spawning adult fish is essential for recovery and sustainability of this at-risk species. Despite the expected benefit of taking this action, it was rejected because "DWR staff have derived estimates of the water costs of the potential actions in the Resources Agency POD Action Matrix and found that the proposed winter action could consume all available environmental water, leaving no assets for spring actions for larvae or juveniles." DSWG notes (Dec. 11, 2006) (appended as Exhibit 9); *see also* DSWG notes (Oct. 10, 2006) ("The Working Group notes that some of the weaknesses of the DFG plan included the potential to exhaust all EWA and B2 assets in winter, leaving nothing in reserve for spring actions") (appended as Exhibit 10).

More recently, NMFS' biologists testified against taking actions to protect delta smelt based on a similar misperception that the total amount of water available to protect imperiled salmonids was limited to a pot of "environmental water" defined by EWA and b(2) assets, and that water used to protect smelt would necessarily deplete the amount of water available to protect salmon. *See* Declaration of Bruce Oppenheim in *NRDC v. Kempthorne* ((June 15, 2007) (appended as Exhibit 11). For example, Mr. Oppenheim explained that "the use of environmental water after VAMP on the San Joaquin River may have consequences later in the year on the Sacramento River." *Id.* at 3. This statement is only true if there is a limited pot of "environmental water" available to meet all fisheries needs – a position that is contrary to numerous requirements of state and federal law.

All of these decisions are based on the incorrect assumption that the amount of water available to protect listed fish species is limited to the assets of the EWA, CVPIA b(2), and other sources of water "dedicated" to the environment. The Bureau has perpetuated this fallacy, asserting that it must meet the needs of CVP contractors before meeting the needs of listed fish species. *See* Declaration of Ronald Milligan in *NRDC v. Kempthorne* (June 21, 2007) ("Reclamation operates New Melones to meet … project needs of the East Side Division CVP contractors" which leaves "no additional water available for out of basin releases from New Melones Reservoir" even if needed to prevent jeopardy to listed delta smelt) (appended as Exhibit 12); *see also see also* Transcript of Hearing re Interim Remedies Day 7, *NRDC v. Kempthorne*, Testimony of Ronald Milligan at 1553-54 (Aug. 31, 2007) (explaining that the WOMT rejected some recommendations of the DSWG because of concerns regarding "the ability for the EWA to function in a manner that it could, in essence, pay back the projects for curtailments without impacting operations in the long term sense or allocations to contractors") (appended as Exhibit 13). Similarly, DWR has asserted that it has no additional water available for fish protection, while simultaneously making hundreds of thousands of acre-feet of surplus "Article 21" and "turnback pool" water available to water users and contractors.

This presumed EWA limitation on the amount of water available to protect fish is simply not correct. Numerous courts have made it abundantly clear that the Bureau and DWR must provide sufficient water to protect and recover listed fish species, whether it exceeds the amount of the water the agencies may have earmarked for that purpose or not. *See, e.g.*, *NRDC v. Kempthorne*, Order on Summary Judgment at 61 (May 25, 2007) ("The EWA is simply a means by which the SWP and CVP can obtain water by purchasing it from willing sellers. …If money is unavailable to fund the EWA, Defendants are nonetheless required to prevent smelt take from exceeding permissible take limits. … [I]f all else fails, [additional] assets may be brought to bear, which

include 'additional purchased or operational assets, funding to secure additional assets if needed, or project water if funding or assets are unavailable.'") (emphasis in original).

The agencies have turned the EWA on its head and, instead of using it to supplement the resources needed *and required* for fish protection, have used it as an excuse to short the environment and avoid committing those mandatory resources. Unless the agencies make very clear that limited EWA assets cannot be used as a reason not to take an action that would help protect or restore imperiled fish, it should be discontinued.

III. THE ANALYSIS FAILS TO DEMONSTRATE THAT THE EWA HELPS PROTECT AT-RISK FISH SPECIES AND CONTRIBUTE TO THEIR RECOVERY

In addition to the problems discussed above, the DSEIS/EIR fails to provide adequate support for its conclusion that extending the EWA would benefit fish protection and restoration.

First, the document recognizes in several places that a pumping "window" during which EWA assets may be pumped out of the Delta without increasing adverse impacts to listed fish no longer exists. The document explains that "[t]he EWA protects fish at the pumps by reducing pumping when it would help at-risk fish species, then transferring EWA assets across the Delta at other times to repay CVP and SWP users for water lost during pump reductions." DSEIS/EIR at 2-15. The DSEIS/EIR asserts that EWA assets should be used to reduce export pumping to protect fish from the months of December through July. DSEIS/EIR at 2-10 to 2-11. This proposal allows exports to increase to allow delivery of EWA water during the months of August through November. But several imperiled species are vulnerable to take at the pumps during this late summer/fall period. *See id.* at 2-13, 4-15. Moreover, the document notes that the alarming and continuing decline in four pelagic organisms in the Delta have corresponded to a period of "increased exports during June through December." DSEIS/EIR at 4-11. In addition, recent studies have indicated that decreased Delta inflows in late fall and winter may result in reductions in fall habitat quality and eastward movement of X2, which may result in adverse impacts to fish. DSEIS/EIR at 4-13. Thus, it is unclear when a safe pumping window exists for EWA to increase Delta exports. Instead, it is likely that an extended EWA would simply help sustain the current record high levels of exports pumped out of the Delta – export levels that have corresponded to many of the declining fish populations in the Delta. *See, e.g., id.* at B-3 to B-4 (Banks pumping would increase in July, August, and September to convey EWA assets).

Second, the DSEIS/EIR assumes with no support that "[w]hile the fish actions in … revised biological opinions [that are currently being developed for project operations] are unknown, they would likely be less than with the EWA program." DSEIS/EIR at ES-4. This statement reflects a fundamental misunderstanding of the nature of ESA and CESA requirements, which *mandate* that project operations cause no jeopardy to the existence *or recovery* of listed species, cause no adverse modification of critical habitat for survival *or recovery* of listed species, and that the impacts of project take be minimized and fully mitigated. In addition, Section 7 also imposes an affirmative obligation on federal agencies to "utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species listed" under the Act. 16 U.S.C. § 1536(a)(1). A program of "conservation" is one that brings the species to the point of recovery and delisting. *Id*. § 1532(3). In short, the

project agencies are obligated to protect, recover and conserve listed species, whether or not the EWA is in place.

Third, the DSEIS/EIR explicitly bases its analysis of fish actions on the invalidated, reinitiated, and discredited OCAP biological opinions, claiming that it "would be speculative to assume that the fish actions in the BO will be the same as those described by Judge Wanger because the BO will be based on a comprehensive review of all available information and science." DSEIS/EIR at 1-6. In reality, Judge Wanger's decision is based on a more comprehensive and current review of the science regarding the delta smelt than the invalidated BO, which failed even to acknowledge the precipitous decline of the delta smelt in recent years. In addition, the OCAP BO on listed salmonids has been discredited by more than three independent science reviews, including a CALFED review panel, which concluded that the BO was not based on the best available science. The DSEIS/EIR's reliance on the fish actions encompassed in these discredited BOs for the basis of its analysis lacks a reasonable basis.

Fourth, the Bureau has reinitiated consultation with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service on the OCAP. That consultation is ongoing. Until the Bureau meets the requirements of ESA §7 and, among other things, obtains a valid biological opinion at the conclusion of consultation, the ESA § 7(d) prohibition on making any irreversible and irretrievable commitment of resources applies to the Bureau's actions. Regional Director Kirk Rodgers has correctly recognized that reauthorization of the EWA during the pendency of the OCAP consultations would be a violation of §7(d), and has (twice) sworn to a federal court that such authorization would not occur before completion of the new BOs. *See* Declaration of Kirk Rodgers (Oct. 18, 2006), Declaration of Kirk Rodgers (July 9, 2007) (appended hereto as Exhibit 14). Reauthorization of the EWA as proposed in the DSEIS/EIR runs afoul of the 7(d) prohibition and contradicts Mr. Rodgers sworn statements in the pending OCAP lawsuits.

Finally, the DSEIS/EIR concludes that continuation of the EWA "would have a less than significant impact on X2 location during June through December." DSEIS/EIR at ES-9. However, as the document recognizes, emerging science indicates that moving X2 westward of its recent historic location in the fall could have a significant beneficial impact on listed species and their habitat. By reducing outflow in the fall, EWA could have a significantly detrimental impact on the ability of agencies to meet this new threshold.

IV. THE ANALYSIS FAILS TO EVALUATE THE EWA'S FAILURE TO ASSIST IN ECOSYTEM RESTORATION BEYOND ESA/CESA COMPLIANCE

To date, as discussed above, the EWA has primarily, even exclusively, been operated to limit protective ESA/CESA actions. However, the failure of the EWA extends even farther. The EWA was intended to "provide water for the protection and recovery of fish." CALFED Programmatic ROD at 54. Note that these benefits are not restricted to listed species. The ROD also states that the EWA will "acquire water for ecosystem and species recovery needs." CALFED ROD NCCP Determination at 21. Thus, the EWA was intended as a tool to provide restoration benefits beyond the requirements of ESA/CESA for listed species. These benefits were an important part of the Ecosystem Restoration Program and were the justification for

public funding for the EWA. The document does not analyze the failure of the EWA to provide these anticipated benefits.

Indeed, far from facilitating improved ecosystem health, by limiting ESA/CESA actions and by increasing diversions during the August to November period, the EWA has damaged ecosystem health. This failure is indicated by the fact that non-listed species, such as threadfin shad, are showing the same decline affecting listed species such as the delta smelt and that the Pelagic Organism Decline process has identified "water project operations" as a potential cause of the decline of Delta fishes. *See* Interagency Ecological Program 2006-2007 Work Plan to Evaluate the Decline of Pelagic Species in the Upper San Francisco Estuary (January 12, 2007) at 4 (appended hereto as Exhibit 15). The document does include one, inadequate mention of these impacts, by concluding that "(t)he entrainment indices for threadfin shad and American shad would be increase." DEIS/EIR at 4-36. Clearly, the EWA has undermined, rather than facilitated, the CALFED ecosystem restoration goal.

The document must be revised to fully and adequately evaluate the failure of the EWA to contribute to fisheries and ecosystem restoration beyond the requirements of ESA/CESA.

V. THE ANALYSIS FAILS TO EVALUATE THE EWA'S FUTURE USEFULNESS TO FACILITATE "REAL TIME" MANAGEMENT

The EWA was also intended to provide "real time diversion management" of Delta flows and the CVP and SWP Delta pumps. CALFED ROD NCCP Determination at 29. Such real time management assumes that the EWA has enough flexibility to modify Delta flows and the management of the projects beyond the relatively fixed prescriptive requirements of ESA/CESA compliance. The document fails to analyze the extent to which the EWA will provide such flexibility to achieve additional ecosystem or protective measures. Unless the management priorities or assets of the EWA are changed dramatically (a change that this document does not anticipate) it appears unlikely that the EWA will have much, if any, flexibility to provide additional protective measures. To the contrary, to the extent that the EWA provides real time management, this flexibility is designed to increase pumping, potentially causing additional impacts to the ecosystem, and designed solely to provide additional water supplies for South of Delta CVP and SWP contractors.

VI. THE FAILURE TO ANALYZE PAST PERFORMACE UNDERMINES A FUNDAMENTAL PURPOSE OF THE EWA -- TO FAILITATE ADAPTIVE MANAGEMENT

The CALFED ROD was designed with science-based adaptive management as a "central feature." CALFED Programmatic ROD at 4. This document repeats this assertion that "(a)daptive management is a key component of the EWA," and that "(a)daptive management provides a process to change fish actions or asset acquisitions." DSEIS/EIR at page 2-24. The careful evaluation of the past performance of management tools is the defining feature of adaptive management, in order to allow improved, adaptive future management. Indeed, the ROD explicitly commits CALFED agencies to "assess the success of EWA operations." CALFED ROD EWA Operating Principles Agreement at 4. Without such analysis, agencies

cannot "adapt" the management of the program in a manner that builds on past successes and responds to failures. The analysis of past performance of the EWA as an adaptive management tool is critical to the central purpose of this document – extending the EWA into the future. Such analysis is also important to agencies, such as the Delta Vision Task Force, the Bay-Delta Conservation Plan process, the Department of Fish and Game, NOAA Fisheries and the Fish and Wildlife Service, which may consider the merits of incorporating the EWA into future management for the Delta. Finally, such analysis is essential to the legislature and the Administration as they consider the justification for public funding for the EWA. An analysis of the past performance of the EWA will reveal that there is no justification for such continued public funding. As discussed above, the document fails to analyze past performance, a failure that cuts to the core of the purpose of the EWA as an adaptive management tool. The document must be revised to fully and accurately analyze the effectiveness of the EWA as an adaptive management tool.

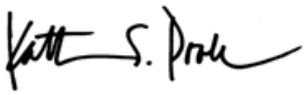
VII. THE DOCUMENT FAILS TO DESCRIBE ACCURATELY THE PROJECT PURPOSE

As discussed above, the document does not adequately analyze the EWA's failure to engage in real time management and adaptive management, to ensure ESA/CESA compliance and to contribute to broader ecosystem restoration. The document also does not include any meaningful provisions to address these failures. The document, however, largely maintains the old, inaccurate description of the purpose of the EWA. DSEIS/EIR at page 2-3. Thus, the document fails to adequately describe the purpose of the project. At the moment, the actual purpose of the EWA appears to be to limit protective actions under ESA and CESA, and to provide additional water supplies to south of Delta water contractors. The document should be revised to include an accurate description of the project.

VIII. CONCLUSION

In light of these many shortcomings in the operation of the EWA and the analysis of the DSEIS/EIR, we urge you to reject the proposal to extend the program beyond the end of 2007. In the alternative, we urge you to withdraw this document and issue a new, adequate draft that addresses the concerns outlined above.

Sincerely,



Katherine S. Poole
Senior Attorney

Barry Nelson
Senior Policy Analyst

Cc: Cay Goude, USFWS
Maria Rea, NMFS
John McCammon, DFG
Lester Snow, DWR

ATTACHMENT 7

Independent
Science
Board

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Montana State University

Paul Smith, Ph. D.
University of California, San Diego

September 6, 2007

TO: Michael Healey, Lead Scientist
CALFED Bay-Delta Program

FROM: Jeffrey Mount, Chair
CALFED Independent Science Board

RE: Sea Level Rise and Delta Planning

In July of this year, you asked that the Independent Science Board (ISB) examine the array of sea level rise projections available in published reports and, based on current scientific understanding, advise the Science Program about which projections are most appropriate for incorporating into on-going planning for the Delta. The ISB discussed this issue at their August, 2007 meeting and have developed recommendations detailed in this memo. It is important to note that this is not an assessment of the state of sea level rise science, but is intended to highlight the large uncertainty in sea level rise projections and recommend ways to incorporate this uncertainty into planning.

Background

Sea level plays a dominant role in the San Francisco Bay-Delta. Water surface elevations and associated fluctuations due to tides, meteorological conditions and freshwater inflows drive Bay-Delta hydrodynamics. Hydrodynamics, in turn, dictate the location and nature of physical habitat, the quantity and quality of water available for export, and the design of the flood control/water supply infrastructure. Change in sea level has the potential to substantially alter Bay-Delta conditions and to constrain future management options.

Global sea level rise is a well-documented phenomenon, both in the paleoclimatic record as well as the historical record. Tidal gage records indicate that sea level during the 20th century has risen an average of 2mm/yr (.08 in) during a period of 0.7^{o}C warming. Recent studies suggest that since 1990, global sea level has been rising at a rate of approximately 3.5 mm/yr (.14 in/yr)[1]. The cause of sea level rise stems from two processes: 1) thermal expansion of sea water as the surface layer warms, and 2) increase in mass of sea water associated with melting of land-based glaciers, snowfields and ice sheets.

Recent research supported by the California Energy Commission[2] (CEC) and continued under the CALFED-sponsored CaSCADE program, shows that sea level

[1] Church, J.A and N.J. White 2006 *A 20th Century Acceleration in Global Sea-Level Rise* Geophysical Research Letters, v. 33, article no. L01602

[2] Cayan, D. *et al*. 2006 *Projecting Future Sea Level* California Climate change Center White Paper CEC-500-2005-202-SF Accessed at http://www.climatechange.ca.gov/research/climate/projecting.html

rise will impact the Delta principally by increasing the frequency, duration and magnitude of water level extremes. These extreme events occur at various periodicities and are associated with high astronomical tides and Pacific climate disturbances, such as El Niño. The CEC study showed that under moderate climate warming and a sea level rise of 3 mm/year (12 in./century), extreme high water events in the Delta--those that exceed 99.99% of historical high water levels and severely impact levees--increases from exceptionally rare today to an average of around 600 hours/year by 2100. This work also showed that roughly 100 of these hours would coincide with very high runoff conditions, further amplifying the impacts of sea level rise. In sum, even under modest sea level rise and climate warming projections, extreme high water levels that are considered rare today will likely be very common by the end of this century.

Sea Level Rise Projections

Early in 2007, the Intergovernmental Panel on Climate Change (IPCC) released its latest assessment of the scientific basis for projections of future climate conditions, including global average sea level rise[3]. As noted in the press, in comparison with the IPCC's 2001 assessment, the latest sea level rise projections appear to have narrowed the range of potential sea level rise and lowered the magnitude of projected sea level rise. This was viewed by some outside of the IPCC as indication that: 1) uncertainty regarding sea level rise had decreased and 2) the problem of sea level rise itself appeared to be less than originally stated. However, both the methods used to derive the IPCC 2007 sea level projections, along with extensive new published research in 2007 suggest that this more optimistic view of future sea level rise may be unwarranted.

The IPCC projections are based on physical models that attempt to account for thermal expansion of the oceans and storage changes in land-based glaciers and ice fields. These models, by necessity, simplify the complex processes of ocean circulation and ice melting. The IPCC midrange projection for sea level rise this century is 20-43 cm (8-17 inches), with a full range of variability of 18-59 cm (7-23 inches). The range of variability reflects model differences and uncertainties as well as differences in greenhouse gas emission scenarios. The IPCC model effort is consensus-based, reflecting the agreement of numerous international scientists.

During the past year, there have been major advances in the science of sea level rise. Paradoxically, these advances have increased the uncertainty of projections in sea level rise, at least temporarily. These advances have also led to strong criticism of the approach that the IPCC used in establishing its projections[4]. One criticism is that the models used to project sea level rise tend to under-predict historical sea level rises, most notably failing to capture recent increases. Indeed, models that use empirical historical relationships between global temperatures and sea level rise perform better

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[3] IPCC 2007 *Climate Change 2007: The Physical Basis—Summary for Policymakers* Accessed at http://www.ipcc.ch/SPM2feb07.pdf

[4] summary in Kerr 2007 *Science NOW* Accessed at http://Sciencenow.sciencemag.org/cgi/content/full/2007/215/2

than the IPCC 2007 models[5]. When applied to the range of emission scenarios used by IPCC 2007, empirical models project a mid-range rise this century of 70-100 cm (28-39 in.) with a full range of variability of 50-140 cm (20-55 in.), substantially higher than IPCC 2007 projections. However, foremost among the criticisms is the failure of the IPCC to include dynamical instability of ice sheets on Greenland and Antarctica in their projections for sea level rise.

Melting of the ice sheets of Greenland and Antarctica has the potential to raise sea level 70 m. For most of the 20th century, the ice sheets have remained relatively stable, with melting contributing a minor fraction to sea level rise. However, during the past year numerous studies have demonstrated that the mass balance (input from snowfall versus losses due to melting or detachment) of these ice sheets is shifting toward more rapid loss, most likely in response to warming of the atmosphere and oceans[6]. The recent rate of mass loss in these ice sheets exceeds current physical model predictions. As many authors have pointed out, increased rates of ice sheet flow involving meltwater lubrication of the ice sheet bed or the removal of buttressing ice shelves, may be accelerating the rate of ice loss on Antarctica and Greenland. The IPCC 2007 report explicitly chose not to incorporate the uncertainty associated with this process into their sea level projections. Recent publications that have examined this issue suggest that, under business as usual emissions scenarios, dynamical instability of ice sheets may add as much as 1 m (39.4 in) to sea level rise by 2100[7].

Recommendations

The ability of current physical models to project sea level rise are limited. This stems in part from our poor understanding of and current inability to model the response of Greenland and Antarctic ice sheets to atmospheric and oceanic warming. Given the costs associated with levee failure in the Delta, the ISB feels it would be a mistake for the various planning processes now underway (BDCP, Delta Vision, DRMS) to base their planning on the conservative 2007 IPCC estimates of sea level rise. Although there is some disagreement about mechanisms of ice sheet disintegration, current advances in understanding coupled with new physical measurements all point toward the same conclusion: dynamical instability of ice sheets will likely contribute significantly to future sea level rise, with the potential for very rapid increases of up to a meter (39.4 in.) by 2100 from ice sheets alone. For this reason, the range of sea level projections based on greenhouse gas emission scenarios contained in the IPCC 2007 report should be viewed, at best, as minima for planning purposes.

The board recommends that planning efforts use three approaches to incorporate sea level rise uncertainty. First, given the inability of current physical models to accurately simulate historic and future sea level rise, until future model refinements

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[5] Rahmstorf, S 2007 *A Semi-Empirical Approach to Projecting Sea-Level Rise* Science v. 315, pp. 368-370.

[6] Shepherd, A. and D. Wingham 2007 *Recent Sea-Level Contributions of the Antarctic and Greenland Ice Sheets* Science, v. 315, pp. 1529-1532.

[7] Hansen J *et al* 2007 *Dangerous human-made interference with climate: a GISS modelE study* Atmospheric Chemistry and Physics, v. 7, pp.2287-2312.

are available, it is prudent to use existing empirically-based models for short to medium term planning purposes. The most recent empirical models project a mid-range rise this century of 70-100 cm (28-39 in.) with a full range of variability of 50-140 cm (20-55 in.). It is important to acknowledge that these empirical models also do not include dynamical instability of ice sheets and likely underestimate long term sea level rise. Second, we recommend adopting a concept that the scientific and engineering community has been advocating for flood management for some time. This involves developing a system that can not only withstand a design sea level rise, but also minimizes damages and loss of life for low-probability events or unforeseen circumstances that exceed design standards. Finally, the board recommends the specific incorporation of the potential for higher-than-expected sea level rise rates into long term infrastructure planning and design. In this way, options that can be efficiently adapted to the potential for significantly higher sea level rise over the next century will be favored over those that use “fixed” targets for design. After all, the current debates over uncertainty in sea level rise are less about how much rise is going to occur and more about when it is going to occur.

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 25, 2008

Ms. Katherine S. Poole, Senior Attorney
Mr. Barry Nelson, Senior Policy Analyst
Natural Resources Defense Council
111 Sutter Street
San Francisco, CA 94104

Dear Ms. Poole and Mr. Nelson:

This letter responds to your letter dated March 13, 2008 providing comments of the Natural Resources Defense Council on the draft of the State Water Project Delivery Reliability Report—2007 (DRR(2007)). Your letter addresses the water demands of the State Water Project (SWP) contractors used in the report, the characterization of modified SWP and CVP operations in 2007 to reduce reversed flows in Old and Middle Rivers, and a statement in the report concerning north-of-Delta diversions. Your letter also makes several recommendations for improving the report and urges changes in SWP operations.

You recommend that the Department include more discussion and analysis of demand management as a tool to improve reliability. The DRR (2007) estimates of SWP contractor demands are based on historical data and information received from the SWP contractors. Those demands are used in the CALSIM studies to obtain the estimates for annual water supply deliveries. The information in the report is presented as the amount of risk associated with an annual quantity of SWP supply. The information is not presented as the amount of risk associated with meeting the assumed SWP contractors' demand. This allows the results from the DRR—2007 to be directly incorporated into an SWP contractor's water management plan to estimate the overall reliability of the district's supply. The greater the ability of the district to draw upon other water supply sources and implement demand management programs, the greater the ability of the water management plan to meet the local water needs.

Providing guidance to SWP contractors on how local and overall water supply reliability could be improved is beyond the intended scope of the DRR (2007). The purpose of the report is to present the Department's current information regarding the annual water delivery reliability of the SWP for existing and future conditions. A key objective of the California Water Plan is to provide guidance to local agencies and governments and regional partnerships on ways to increase regional self sufficiency in meeting their future water demands. The Water Plan includes a diverse set of resource management strategies that can be implemented in

different combinations to provide water supply reliability and to meet other water related resource management needs in different regions of the state.

You state that the DRR (2007) should also include an analysis of the impact on SWP delivery reliability of implementing the Governor's call for a 20 percent reduction in per capita water use by 2020. The Department strongly supports aggressively reducing per capita water use however it is not clear how the reduction will affect the demand for Delta exports. SWP contractors should review their current water demands and future demand scenarios to help determine the mix and amounts of water supply sources they will need (including SWP supplies) to meet their water demands and other water resource objectives. It would be advisable for them to consider a future demand scenario that assumes a 20% reduction in per capita water use because it could change how much they decide to invest in different water supply sources. These evaluations, and their implications to the demand for imported water from the SWP and other sources, is a responsibility of the SWP contractors and can be a part of their 2010 Urban Water Management Plans. Urban Water Management Plans will be updated in 2010 and will incorporate this mandate. Those plans will help to define the anticipated demand on Delta water supply. This information will be incorporated into future reports as appropriate.

You state that the conclusion presented in the draft report (page 12) about a new North of Delta diversion from the Sacramento River offering the greatest potential for meeting ecosystem restoration objectives is premature. This statement has been removed from the final report. The Department is proceeding with an evaluation under NEPA and CEQA of the impacts and benefits of implementing the Bay-Delta Conservation Plan. As part of this effort, alternatives for Delta conveyance will be evaluated and the most promising conveyance alternative identified. At least four configurations will be considered: 1) no new Delta conveyance facilities; 2) dual Delta conveyance facilities; 3) an isolated conveyance facility; and 4) an improved through-Delta conveyance system.

You state that the draft report on page 15 incorrectly states that "decline in the abundance of juvenile delta smelt led to a voluntary modification in 2007 in SWP and CVP operations to reduce the reversed flows in Middle and Old Rivers—a modification made possible through the Environmental Water Account." You also make the point that DWR, the U. S. Bureau of Reclamation, and the fisheries agencies are compelled to modify pumping operations when those operations adversely impact the survival, recovery and critical habitat of fish such as delta smelt which are protected under the Endangered Species Act. The Department agrees that it is required to follow a directive by a fish regulatory agency to reduce exports if that agency has determined the action is needed to protect an endangered fish. In this circumstance, the Department had not been directed to reduce exports and chose to reduce them to protect delta smelt.

You state that the DRR (2007) should be redone in order to incorporate the full range of variability of sea level rise recommended by the CALFED Independent Science Board and incorporate updated projections of reduced Sierra snowpack and increased evaporation rates in watersheds and surface storage reservoirs. The Department is a leader in applying climate change factors to projections for water supply and we will continue to take a leadership role in this endeavor. The DRR is published every two years and we will use the best information and analytical methods available to develop the latest projections for delivery capability under potential climate change scenarios.

The remaining comments in your letter go beyond the scope of the DRR (2007). They include requesting DWR to implement a policy of foregoing Article 21 declarations and deliveries if state and federal agencies recommend that the water remain instream or available for ecosystem protection purposes; that DWR use increased carryover storage resulting from reduced pumping to increase the protection for imperiled salmonids; and that a discussion be included in the report of the relationship between lower levels of diversions and proposed expansions in storage south of the Delta that would be dependent on Delta pumping as a water source.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

cc: Cay Goude
U. S. Fish & Wildlife Service
3310 El Camino Avenue Suite 130
Sacramento, California 95821-6340

Maria Rea
Sacramento Area Office Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

From: Pennington, Bill
Sent: Tuesday, January 29, 2008 4:18 PM
To: 2007DRRComments
Cc: Fong, Frank C.; Waggoner, Michael G.; Wright, Jon
Subject: Reliability of Clifton Court Forebay

The reliability of the Forebay embankments and radial gates, etc., should be considered in the same manner as the reliability of the delta levees. Loss of control at the Forebay may be as likely as the expected levee failures over a 100-year period. Although the risk to individuals and real property might be small due to an embankment or gate failure at the Forebay, such failures may have a big, and long lasting, impact to delivery operations. Bill Pennington

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 11, 2008

Mr. Bill Pennington
California Energy Commission
1516 Ninth Street, MS28
Sacramento, California 95814

Dear Mr. Pennington:

This letter responds to your email of January 29, 2008 providing comments on the draft of the State Water Project Delivery Reliability Report—2007.

In your email, you state that the reliability of Clifton Court Forebay features, such as the intake gates and forebay embankment, should be considered in the same manner as the reliability of Delta levees. You express concern that the risk of the loss of control at the Forebay may be as likely as the risk of levee failure over a 100-year period and would significantly impact water deliveries.

While a failure of one or more of Clifton Court Forebay's intake gates or a portion of its embankment would potentially disrupt pumping at Banks Pumping Plant, the Department of Water Resources doesn't view this risk to State Water Project deliveries as comparable to the risk posed by the extensive levee system in the Delta. One of the strategic planning goals of the Department is to plan, design, construct, operate, and maintain the State Water Project to achieve maximum flexibility, safety, and reliability. In order to meet this goal, the Department is committed to the maintenance and effective operation of Clifton Court Forebay.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

President
Bill Center

President Emeritus
Sage Sweetwood
John Van De Kamp

Senior Vice President
Kevin Johnson

Secretary/Treasurer
Bill Leimbach

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Rick Hawley
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March 16, 2008

Katherine Kelly, Chief
Bay-Delta Office
California Department of Water Resources
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California Department of Water Resources
SWP Delivery Reliability Report – Attn: Cynthia Pierson
P.O. Box 942836
Sacramento, CA 94236-0001

via facsimile to: (916) 653-6077
via email to: comments-on-2007drr@water.ca.gov

Re: Comments on the *Draft State Water Project Delivery Reliability Report 2007*

Ms. Kelly:

The Planning and Conservation League (PCL) submits the following comments on DWR's Draft State Water Project Delivery Reliability Report 2007 (2007 DRR). As an organization that advocates for wise investment in and sustainable use of the state's water resources, as well as a party to the settlement agreement that calls for preparation of these biennial reliability reports, PCL urges DWR to substantively address the comments below so that the final report fully meets the rigorous reporting requirements specified in that agreement, and that local planning decisions can be made based on a clear and complete analysis of water delivery reliability.

1. The 2007 DRR must be sufficiently clear and accurate for use in the 2010 Urban Water Management Plans (UWMPS).

As recognized in the 2007 DRR, the Delivery Reliability Report is an important planning document used by many of the SWP contractors, and in turn local water districts as the basis for Urban Water Management Plans (UWMPs), water supply assessment and verifications.

Despite the importance of the DRR, DWR has tended to release the Delivery Reliability Report past the deadlines outlined in the settlement agreement. Per the settlement agreement the DRR is due to be updated biennially, beginning in 2003. The previous DRR was due in 2005; however the final was not issued until June 2006. As a result, all water agencies depending on the DRR were forced to rely on a May 2005 draft document for preparation of their 2005 UWMP. The 2007 Draft DRR was not released to the public until December of 2007, and the final

will not be issued until sometime in 2008. The late release of the report is a disservice to the many water agencies which receive water from the State Water Project, as well as the many cities and counties that need the information contained in the report to assess the adequacy of water supply assessments and verifications. Indeed, by releasing these reports in such a manner, local water agencies and local planning entities are forced to rely on draft materials or significantly dated materials as the basis for legally challengeable decisions. Such situations expose these entities to significant risk.

Should DWR continue the trend of late releases of the DRR, the next report, the 2009 DRR, will be issued too late to be useful to urban water agencies for the preparation of the 2010 urban water management plans. Therefore, the accuracy and clarity of the 2007 DRR is even more crucial to water managers and planner entities. PCL respectfully recommends that DWR revise the 2007 DRR to ensure it provides the level of reliable information necessary for the purposes in which it will be used. PCL further respectfully requests that DWR commit to releasing the Draft 2009 DRR in June 2008, and the Final 2009 DRR by February 2009 in order to ensure local water agencies will have sufficient time to incorporate DWR's information into the 2010 UWMPs.

2. The 2007 DRR should provide additional explanation and clarification of data and results to ensure information is presented in a readily understandable manner.

In referring to the Delivery Reliability Report, the settlement agreement specifically states that "The information presented in each report shall be presented in a manner readily understandable by the public." While we recognize that information about the reliability of the SWP is complex, clearer explanations and specific guidance from DWR on particular points are necessary to meet the intent of the settlement agreement and assist readers in deciphering this complex information. PCL proposes the following specific recommendations to develop a more reality understandable document.

A. The DRR must fully disclose the reliability associated with water supplied from the SWP and disclose the implications associated with various levels of reliability.

While the Draft DRR includes the results of many model runs, it fails to provide a significant discussion regarding the implications of the level of *reliability* associated with SWP deliveries. In particular, the Draft DRR fails to articulate how reliability should be factored into water planning, and the DRR fails to disclose the implications of reliance on water that cannot be reliably delivered.

For instance, the DRR includes a very cursory explanation of Article 21. Through out Chapter 7 of the Draft DRR, DWR has listed an "Article 21" category within the water supply source table examples. The Draft DRR does include a footnote stating that, "Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local water supply." This statement is woefully inadequate and dangerously misleading. Indeed, a study of the actual model outputs reveals that in one case, for example in table B-20 no Article 21 could be delivered for a period of

over 20 consecutive years. Article 21 is reported to be available in only 3 years between 1922 and 1966 in Table B-20. Even when Article 21 is available, in this case 22 thousand acre-feet in a year like 1925, it is not in a quantity that would result in a significant additional local supply even if storage where available.

Even in outputs for more recent conditions, such as in Table B-16, there are long periods of 8 and 10 years when no Article 21 water would be available. Most storage facilities in the state are not designed or operated to store water for a period or 8 to 20 years.

Yet, readers would have to study the many tables in the appendices of the DRR in order to find this information. Readers would then have to interpret those tables further to understand the significance of the listed numbers.

Because Article 21 cannot be delivered in quantities sufficient enough to enhance storage or annual water supply on a consistent basis, it is not reliable and is not an appropriate water supply for those that uses that require a high degree of reliability. In fact, relying on Article 21 for permanent supply is part of the "paper water" problem that was at the heart of the original Monterey Amendments litigation. By masking the dismal reliability of Article 21 with an understated and misleading footnote, DWR facilitates use inappropriate use of Article 21 for purposes that require a higher degree of reliability.

Beyond Article 21, the DRR fails to clearly disclose the reliability of all deliveries from SWP in a substantive manner. While the DRR does include modeling runs reporting the estimated delivery of water to SWP contractors, those runs omit important information, including risk factors in the Delta, and the need to respond to environmental, water quality and area of origin legal requirements. The DRR fails to inform readers that the model runs very likely overestimate the reliability of the SWP. Further, the DRR fails to provide guidance to SWP contractors on how local and overall water supply reliability could be improved.

To remedy this, PCL recommends that DWR include a full discussion regarding the reliability of all types of water delivered from the SWP. That discussion should include a full discussion of the implications of mismatching various levels of water supply reliability with the various intended uses (i.e. urban and agricultural use, or permanent and annual crops). In addition, the Final DRR should omit Article 21 from the list of Water Supply Sources in all tables. The final DRR may include Article 21 is a separate table of "interruptible and unreliable water sources." Such tables should include a footnote that reads, "Article 21 should not be used to support a permanent economy."

B. The DRR should include Water Supply Source tables for each SWP contractor.

DWR should include a clear and understandable forecast of how much water (both Table A and Article 21) the SWP can delivered under current and future conditions for each SWP contractors. Although some of this information is in the draft DRR, it is split up and scattered in many tables, figures, and graphs, and in some cases must be derived from information in

the DRR by means of additional calculations. Inclusion of separate tables for each contractor would allow readers to clearly find information affecting the specific area of interest.

C. The DRR should provide estimates of SWP delivery reliability for the period required by the next UWMP.

As noted in the 2007 Draft DRR, the primary use of the DRR is by SWP contractors and their customers for use within the regional and local UWMPs. California law requires the UWMPs, and also water supply assessments and verifications to assess water supplies for 20 years into the future. In order to be useful to those water planners, DWR should extend the analysis included in the DRR to the period required by the following UWMPs, which in this case would be 2030. While this seems to be a technical detail, failing to extend the range of the DRR could result in significant legal vulnerability for water and land use planners who rely on the DRR to make legally challengeable decisions.

3. The 2007 DRR should clearly disclose the limitations of modeling outputs and the implications of the modeling assumptions in CALSIM II, and provide recommendations to water agencies for appropriate use of modeling outputs.

CALSIM II is the primary analytic tool used in estimating current and future water delivery reliability, yet it has known weaknesses that are not disclosed or discussed in the 2007 DRR. Of particular concern to PCL is the fact that, although local agencies will be using this document as a basis for developing local UWMPs there is no acknowledgement of the potential for CALSIM II to *over*estimate delivery reliability. This is a critical flaw in the document that must be addressed.

As participants in the Monterey Plus EIR Committee process, PCL has previously submitted comments to DWR expressing our concerns regarding the adequacy of CALSIM II for use in water management planning and deliveries assessment. Rather than resubmit those comments, we incorporate them by reference here, and highlight some particular issues below.

The Draft DRR reports water availability to the SWP and SWP deliveries through 2027 based on CALSIM II runs. While CALSIM II may be a sophisticated and useful modeling tool for certain purposes, it is inappropriate for determining absolute numbers for export and deliveries. It has been criticized by a panel of expert reviewers for several weaknesses, including its lack of amenability to proper calibration. (*See* A. Close, *et al.*, *A Strategic Review of CALSIM II and its Use for Water Planning, Management and Operations in Central California* submitted to California Bay Delta Authority Science Program, December 4, 2003.

One flaw with CALSIM II is that it fails to reflect the bimodal distribution of water years in California. Currently, the DRR reports CALSIM II runs for average years, a critical dry year, a period of dry years and wet years. Given the presentation in the DRR, it would be reasonable for a reader to assume that average years are the most likely occurrences, and therefore average deliveries are the most reliable. However, based on California's fluctuating hydrology, average years are the least likely to occur, and periods of dry years and wet years are much for likely.

CALSIM II is ill-suited to address bimodal distribution of water years because the model produces an exceedence chart that hides this reality. Arve Sjovold has commented extensively on this point. Mr. Sjovold's most recent comments are incorporated by reference and attached to this letter.

Throughout the 2007 Draft DRR, modeled predictions are presented as though certain, and discussion of possible error or of ranges of possible outcomes is almost entirely absent. The models used cannot possibly produce such certainty. CALSIM II includes hundreds of assumptions. There is a reasonable likelihood that one or more of the assumptions incorporated into CALSIM II will be incorrect.. However, DWR does not disclose these limitations in a clear and understandable manner, and the Draft DRR fails to provide a reasonable strategy for addressing this issue.

Rather than the near certain results presented in the DRR, at best, the model runs can predict, given a certain set of data and assumptions, a range of possible outcomes, with some outcomes potentially more probable than others, and with all predictions limited by both known and unknown sources of error. An accurate discussion of the DRR's modeling results therefore cannot provide certain predictions, and instead should show the range of possible outcomes. By omitting both possible sources of error and potential outcome ranges, the DRR projects a false certainty that reported deliveries are likely.

Because CALSIM II is an optimization model that does not necessarily reflect options available to water operators, or options that water managers *would* choose, it may overestimates SWP deliveries. Despite the optimistic CALSIM II outputs, federal and state water quality and endangered species laws and regulations probably prohibit such high export levels due endangered species requirements, water quality requirements and other regulatory requirements. Indeed, at a recent Bay Delta Conservation Plan meeting on Delta conveyance options, DWR Deputy Director Jerry Johns, noted that CALSIM II and CALSIM Lite tend to deliver "optimistic" outputs, indicating that CALSIM II may maximize potential deliveries when such deliveries would be difficult or impossible to produce in the real world.

Based on CALSIM II outputs, the DRR assumes that future water exports from the Delta will be much higher than the historic average. This DRR prediction fails to recognize that DWR has chronically failed to meet water quality standards in the Delta under historic operations, and significant environmental degradation has taken place under such operations, resulting in new regulatory actions.

In light of the recent pelagic organism declines in the Bay Delta Estuary, and resulting rulings invalidating the biological opinion for Delta smelt, it is prudent to ensure that the Final 2007 DRR modeling assumptions and predictions are conservative, rather than "optimizing." Such revisions would provide a much more realistic and reliable estimate of deliveries that are more consistent with requirements of the Federal Clean Water Act, the Federal or California Endangered Species Acts, or any other environmental permit condition, regulation, standard, or law.

The DRR should also provide reasonable recommendations to water agencies for addressing these modeling faults. In order to increase the likelihood that the estimates used in planning documents will be reasonably accurate and reliable, the DRR could recommend that water agencies consider reducing the amount of deliveries predicted by CALSIM II by certain reasonable percentage, such as10 to 20 percent, when planning for water management.

4. The 2007 DRR should include a more comprehensive analysis of the impacts of climate change on water delivery reliability.

While the DRR recognizes that climate change will have very widespread impacts on the SWP. Yet, the DRR analyzes only one aspect associated with climate change, hydrology, for impact on the SWP deliveries. Climate change is anticipated to affect water quality in the Delta, consumptive use of water in both SWP watershed and the area of use, availability of hydropower and flood safety needs. None of these factors is analyzed for potential impact on SWP delivery reliability in the 2007 Draft DRR.

The Draft DRR proposes that some tools that may be necessary for broader analyses of climate change impacts are not yet available. For instance, the DRR states that current modeling cannot account for the impact on SWP deliveries that may result due to increasing salinity in Delta due to sea level rise. However, at a recent Bay Delta Conservation Plan meeting, DWR provided a summary of CALSIM Lite. During the presentation, it was indicated that the model is capable of assessing and responding to various salinity levels in the Delta. This implies that, at the very least, anticipated salinity increases should be taken into account along with hydrology impacts for all model runs and outputs included in the DRR. Beyond that, the DRR should clearly articulate the full range of impacts anticipated to occur under climate change. The DRR should further disclose which impacts are omitted from estimates of deliveries under climate change scenarios. Finally, the DRR should provide guidance to water agencies on how these omitted impacts are likely to affect deliveries (i.e. whether increased consumption is likely to increase or decrease the amount of water available to the SWP).

5. The 2007 DRR should evaluate variable levels of demand and in particular the 20% reduction in per capita consumption called for in Governor Schwarzenegger's recent letter.

The 2007 DRR assumes 2027 demand for supplies to be the very similar to those used in demand modeled in the 2005 DRR, an approach which neglects (a) the potential for changes in demand (for Article 21 supplies, in particular) due to changes to the SWP contracts that may result from DWR's upcoming decision on the Monterey Plus EIR (see also Section C-1 (p. 7) of the attached comments by PCL to DWR on the Draft Monterey Plus EIR), and (b) the potential for shifts in the amount and pattern of demand based on the ongoing Delta Vision and Bay Delta Conservation Plan processes.

In commenting on the 2006 DRR, PCL recommended that DWR incorporate various levels of demand into model runs. PCL repeats that comment for the 2007 DRR. Indeed, the 2007 Draft DRR, like the 2005 DRR identifies water demand in the delivery service area as one of three

primary components that determine SWP reliability. However, like the 2005 DRR, the 2007 Draft DRR does not examine a significantly varied range of possible demand. That omission is important, for such analysis would likely show that reliability is inversely proportional to the level of demand.

Rather, the 2007 Draft DRR provides no clear disclosure of the demand assumptions included in the CALSIM II outputs. The 2007 Draft DRR, instead, states that demand assumptions are based solely on information provided by contractors. PCL requests that in addition to analysis based on information provided by SWP contractors, DWR provide analysis of SWP reliability under the three demand scenarios included in DWR"s 2005 California Water Plan. In addition, the DRR should include analysis that anticipates full implementation of the Governor's recent call for a 20% reduction in per capita water use.

6. The 2007 DRR should consider operations not only under the Wanger decision, but also under operations consistent with the operational recommendations of the state and federal fishery agencies for protection of species listed as threatened or endangered under the federal or state Endangered Species Acts.

The 2007 DRR assumes that 2027 operations will be subject to the current limitations proscribed by the Wanger Interim Remedy Order and SWRCB water quality requirements. However, the re-consultation on the 2004 OCAP, the continued decline of currently listed species (such as Delta Smelt and Winter-run Chinook Salmon), as well as the potential listing of additional species (such as the Longfin Smelt) are just some of the factors that may require significant changes in operations with effects on delivery reliability well before 2027.

The 2007 DRR notes that assumptions regarding 2027 operations are not a prediction of the future, but rather an assessment of the future with consideration only of hydrological effects of climate change and projections of future land and water use. This caveat must be carried clearly throughout the report, making it clear that modeled reliability is likely to be an *over*estimate based on incomplete knowledge of future operational constraints. Furthermore, the DRR should include a discussion of how water agencies may increase water supply reliability within their own service area in order to reduce the risks associated with uncertainty of future SWP supplies.

7. The DRR must recognize that DWR has not yet issued a final decision and EIR for the Monterey Plus project.

DWR is in the process of responding to comments in the Draft Monterey Plus EIR. In response to those comments and upon further analyses, it is foreseeable that DWR may choose to make changes to the Monterey Plus project. The DRR must acknowledge this fact and recognize that the outcome of DWR's Monterey Amendments decision-making may well cause further impacts to SWP delivery reliability.

PCL appreciates the opportunity to comment on the DRR, and we look forward to working with DWR to improve future drafts of the 2007 report as well as future Delivery Reliability reports.

Sincerely,

Mindy McIntyre
Water Program Manager
Planning and Conservation League

Attachments

Cc:
Lester Snow, Director , Department of Water Resources
Antonio Rossmann, Rossmann & Moore, LLP
Roger Moore, Rossmann & Moore, LLP
Senator Perata
Senator Steinberg
Senator Kuehl,
Senator Machado
Senator Kehoe
Senator Ducheny
Assemblymember Wolk
Assemblymember Eng
Susan Kennedy, Chief of Staff
SWP Contractors

Attachment 1

Delores Brown January 1, 2008
California Department of Water Resources
Chief, Office of Environmental compliance
901 P Street
Sacramento, CA 95814

Re: Draft Environmental Impact Report, Monterey Amendment, SCH#: 200301118

Dear Ms. Brown:

Please accept the attached comments in behalf of the Citizens Planning Association of Santa Barbara County, one of the original plaintiffs in the matter of **PCL et al v. DWR.** The comments have been prepared by Mr. Arve R. Sjovold, our representative to the plaintiffs' committee and a participant in the EIR process. Although Mr. Sjovold participated in many of the EIR committee meetings, he is distressed that virtually none of the comments and suggestions made in the long tenure of this committee were recognized or adopted in the preparation of the document. Accordingly, he regrets that his name is listed as one of the committee responsible for preparing this document. Nonetheless, he will honor his pledge to be of service to the committee and to DWR in this matter.

The comments are divided up into several distinct sections. The first deals with what Mr. Sjovold shows are critical flaws in the CALSIM II model, which was used as the primary analytic tool for the impact analyses. Based on his review of the model CPA finds this Draft EIR is seriously deficient. The CALSIM II review presents several analytic findings that are seminal with regard to this model's flaws; they should be addressed by DWR before this process continues. The CALSIM II review also points to critical failures in the application of the CALSIM II results in the analysis.

The second section addresses other areas of the impact analyses while the third section is an attachment of comments and criticisms of the DWR paper on incorporating climate change in to CALSIM II. Since DWR made this report central to their analyses of climate change impacts in the EIR, it is entirely appropriate to include such comments.

Finally, there are two appendices which support the CALSIM II analysis presented by Mr. Sjovold. They point to constructive changes that should be included in CALSIM II before it is used again.

These comments do not reach all the analyses presented in the Draft; there was not sufficient time to do so. However, because of the central importance of CALSIM II to the Draft's analyses, the flaws that have been shown by Mr. Sjovold are sufficient to render the entire Draft as inadequate.

AN ANALYSIS OF CALSIM II AS USED IN THE DRAFT EIR

By: Arve R. Sjovold

Introduction

The draft EIR uses CALSIM II as its primary methodology in analyzing the impacts of the Monterey Amendments (with Settlement additions) and therefore deserves detailed scrutiny as to its accuracy and appropriateness as a tool for environmental impact analysis. The accuracy problem is paramount given that the Appellate Court found that the original Monterey EIR had not considered the ramifications of the SWP's inability to deliver anywhere near the full entitlement values prescribed in the SWP contracts. A consequence of this finding is the acknowledgement that any entity relying on full entitlements as actual deliveries that cannot be fulfilled is dealing with "paper water". To quantify how much water the project can deliver reliably requires a model with a high degree of absolute accuracy. And the degree to which the project falls short of delivering reliably against expected full entitlements is the measure of "paper water". DWR's analyses of reliability of delivery rely totally on the use of its CALSIM II model; thus the accuracy of CALSIM II is essential.

DWR has not properly calibrated CALSIM II so its accuracy is still in question. The EIR does not reference any calibration exercise of CALSIM II and assumes that it delivers accurate estimates of delivery given the assumptions that are made in its development and use.

CALSIM II is referred to as a "simulation model" though in fact it is an optimization model, which is designed to determine the maximum amount of water that can be exported given the constraints of hydrology and SWRCB rules that govern the project's operations. There are troubling features of CALSIM II, which in all likelihood render the model as unsuitable as an estimator of project deliveries. The troubling features include:

- Its water year indices
- The lack of statistical rigor in characterizing the hydrology
- The inability to use environmental parameters as inputs to study impacts
- The lack of calibrations

Model Suitability for Environmental Impact Analyses

The fact that the model is an optimization model and not a simulation as purported, misleads the analysis of environmental impact. This is particularly true considering that **the optimization objective is maximizing export of water from the Delta and not the maximizing of environmental qualities.** Admittedly, quantifying environmental qualities for a mathematical model is an extremely difficult task. However, the model should at least allow ready testing of various proposals to improve

the environmental health of the Delta. Instead, the model treats the existing set of water rights rules and regulations as hard-coded constraints within the model code such that it is very cumbersome to change them for use in environmental studies**. Furthermore, the constraints coded in the model are only those that the SWRCB has promulgated as regulations on the project that reflect the past history of the project and its observed impacts on the Delta. It is a tenuous proposition to pretend that those constraints are adequate to protect the environment as we move forward with this project.** For example, DWR admits that the model does not include within its code any sense of Endangered Species Act requirements, which given the current state of the Delta should be its primary focus. Furthermore, the last 12 months have seen several court rulings that acknowledge the inadequacy of the current operations and regulations to protect endangered species. As a result of these rulings, Delta exports have been dramatically reduced. As currently configured, CALSIM II is not well suited to help solve these problems.

The SWRCB constraints that are most limiting on exports are the salinity constraints in the Delta and these operate to control salinity mostly in the western Delta. **In fact, it is fair to say that the model assumes that as long as it meets the salinity constraints in the Delta it has met its requirement for environmental protection in the Delta.**

For example, there are no routines in the model to deal with reverse flows in the San Joaquin River and the consequent mortality of Delta Smelt in the project pumps. Yet there is sufficient data to provide a competent predictor based on flow and pumping conditions to predict when reverse flows are likely to occur. It could be used as a constraint on Delta pumping in order to protect the fish. (See Appendix A)

Even in the case of modeling the salinity, the model uses a predictive equation that relies on one position in the western Delta, is dependent only on Delta outflow, and is independent of project pumping. Yet the historical sense on this issue is the knowledge that heavy pumping in the South Delta can affect the position and variability of the salinity gradient in the Delta. With the relationship that presently exists in the model, the prediction of the salinity appears to be unaffected by export operations.

Furthermore, it is a tenuous scientific proposition that a single point for measuring the affects of the project on salinity in the Delta is sufficient given the magnitude and complexity of the Delta. For example, the Delta Smelt is a species that lives entirely within the brackish water of the Delta and its movements to and fro in the Delta are largely dependent on the salinity variations. DWR should use its modeling talents to predict salinity gradients throughout the Delta and how they vary under different hydrologic and pumping scenarios. The EIR is largely silent on this matter and yet it would seem, given the present dire state of the Delta, that analyses of this sort would be a primary focus of the EIR.

The presently used systems of modeling the Delta by DWR rely on CALSIM II in concert with DSM2, a more detailed model that is intended to calculate the flows throughout the myriad Delta channels. It depends on CALSIM II to provide the input and export flows to and from Delta using the CALSIM II calculations for the Sacramento and San Joaquin valleys; in effect CALSIM II provides the boundary conditions for the operation of DSM2. Thus, DSM2 is limited in the scope of its calculations by the CALSIM II constrained inputs. The limitations of CALSIM II as an export optimization

model are visited upon the DSM2 calculations independent of the capability of DSM2 to investigate salinity variations more broadly.

It would be extremely useful to the analysis of the environmental impacts of the project if first model calculations could be obtained for a scenario without regulation of input flows and no exports to establish the conditions in the Delta for which the Delta Smelt are adapted. From this baseline it may be possible to determine the degree to which project operations affect Delta habitat and hence the species that rely on it.

The Problem With Water Year Indices in CALSIM II

CALSIM II uses as a primary input to its calculations a designation called "Water Year Type", which can take on one of five discreet values corresponding to whether the year in question is "wet", "above normal", "below normal", "dry", or "critical". These designations are used as input data to govern project operations in the model (and in practice), particularly in setting environmental constraints and are developed from the historical record spanning 73 years, 1922-1994, the basic hydrologic record used to drive CALSIM II.

Water year type is derived from a "Water Year Index" which is in turn developed from a runoff index. There are two sets of runoff indices, one for the Sacramento Basin runoff and one for the San Joaquin basin runoff. The basin runoff indices are calculated from the measured runoffs from the four major rivers in the Sacramento Basin and the four major rivers in the San Joaquin. These major rivers capture about 80% of the total runoff in the respective basins and are believed to be reliable surrogates for runoff. This runoff data is available on a monthly basis.

For each water year (October through September) a water year index is calculated as the weighted sum of 40% of the current forecast for the upcoming April to July runoff, plus 30% of the current October through March runoff, plus 30% of the previous year's water index. Thus the weighted formulation necessarily spans parts of two water years although it purports to represent the current water year. Depending on the value of the index for a given water year an assignment into one of the water year types is made. For project operations, the index is set by the first of the month forecast beginning in February and continues until the final determination based on the May forecast of runoff.

For use in CALSIM II a water-year type and a water year index are provided as fixed assignments for a given year in a "look-up table" for use in the calculations. **Because of the way in which these two attributes are derived they in effect provide the simulation with "perfect" information as to the upcoming runoff season (December through May) for a given water year, a circumstance that is not possible for making decisions for real time operations.** Also there is the fundamental question posed by the derivation of the water year index in that it combines the runoff from two successive water years. **There is no scientific merit to the notion that the previous year's runoff should affect the subsequent year's runoff, which is precisely what the 40-30-30 weighting does.** A simple serial correlation of the annual runoff record shows that there is no significant correlation, meaning that the current water year's runoff is independent of the previous water year. The water index is without any scientific merit and it should not be used, as is the case for the dependent parameter, water year type.

How the use of these indices biases the CALSIM II calculations and the actual project operations is difficult to deduce, but it is sufficiently clear to state that none of the calculations can be considered useful in the analyses of the EIR.

The additional fact that the indices as they are used are provided to the calculations in a fashion that gives the calculations "perfect information" ahead of the unfolding water year run-off is also sufficient to discredit any claim that this model is a simulation of system hydrology. In a simulation, one tries to replicate the decision structure that faces the system in real time. Knowing how the water year is going to end well before it is experienced allows CALSIM II to begin pumping early in the water year when at times little runoff has materialized. In effect, the early pumping borrows water from the Delta in the knowledge that it will be made up during the spring runoff. However, in real time the system operators do not know that spring runoff will be ample and therefore must restrict early pumping until events on the ground dictate that it is safe to pump.

Environmental Inputs

The object of environmental impact analyses is to evaluate the degree to which project operations and requirements affect what is broadly referred to as the environment. Because environmental attributes are difficult to quantify a good approach is to develop quantitative methods that at least allow ready evaluation of various alternatives intended to both achieve environmental protection and project operations. The present form of CALSIM II focuses only on project operations. It limits its treatment of the environment to what can be hard coded into the model as purported environmental constraints. Even in this regard no attempt has been made to have the model address important environmental questions such as that posed by the dangerous declines in Delta fish species.

A peer review panel of nationally recognized experts was convened to review the CALSIM II model as a tool to support water planning (See Appendix G of the EIR). However, that panel "did not specifically address the manner in which CALSIM II represents the environmental regulations and objectives established for the Central Valley water system", as stated in a study(1) by the National Heritage Foundation. That study builds on the peer review study to examine just how CALSIM II treats environmental constraints and objectives in the model.

The NHI study found that CALSIM II and actual operations are not faithful to the constraints and requirements that have been levied on the projects to protect the environment and the Delta. The study also attempts to examine what would be required in terms of additional changes and requirements that might be necessary to restore Delta health. The EIR does not address the current lack of compliance nor what additional measures might be necessary to begin to restore the Delta. Given the current state of the Delta this deficiency is deplorable and the EIR is again deficient.

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(1) Jeffrey T. Payne et al, "**An Environmental Review of CalSim-II** : Defining "Full Environmental Compliance" and "Environmentally Preferred" Formulations of the CalSim-II Model, Natural Heritage Institute, November 2005

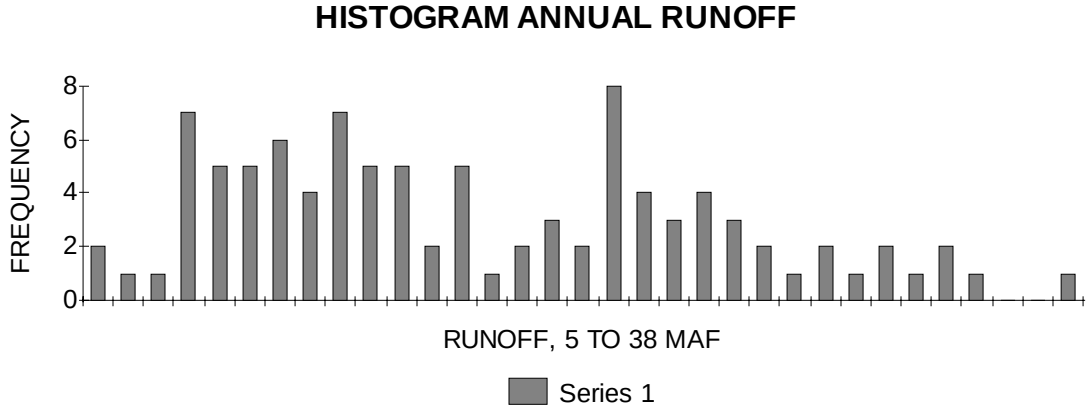
Lack of Statistical Rigor in Characterizing the Hydrology

CALSIM II uses a 73-year historical record of runoff as the primary input to the model. The variation evident in this record is assumed to be an accurate representation of the variation to be expected in the future and this assumption is relied on in characterizing the likelihood of the various output results. For the estimate of reliability of delivery, the model arranges the outputs in ascending order and ranks them in terms of the percentage of outputs exceeding a particular level of delivery. This percentage is used as an indicator of how well the project can meet its delivery requirements. Used in this way the frequency of occurrence takes on the quality of probability. But before any notion of probability can be assigned, the underlying stochastic character of the input variable, runoff, must be ascertained. In fact this information must be available to adequately design the model in the first place. This seems not to have taken place in the development of CALSIM II.

A careful examination of the statistical character of Central Valley runoff (using the 8-river runoff index--the combination of Sacramento and San Joaquin runoff) shows that runoff comprises two distinct groupings, a group that can be described as dry years and the other as wet years. Figure 1 presents a crude histogram of the 98-year runoff record for the 8-river index and it is quite clear that there are two distinct modes (central tendencies). These two tendencies

Figure 1

Runoff Distribution in the Central Valley
8-River Index
(Frequency of occurrence of annual flows-98 year record)



comprise two independent probability distributions and must be treated as such. The overall average runoff for the record (the 8-river index) is 18.04 million acre-feet, which is located in the minimum between the two central tendencies. Accordingly, the average is a relatively unlikely event, certainly not representative of what is normally referred to as “normal.” Thus to characterize individual water years as “normal”, “above normal”, or “below normal” conveys no real meaning. Another characteristic of the dry side

distribution is that the only sense of a threshold that could be described as “critical” are the lowest four years in the distribution, which are all 7 MAF or less.

There are 55 years (56% of the record) that comprise the dry year distribution and 43 years (44%) that are in the wet year distribution. These characterizations are based on total annual runoff. Since project operations cannot know at the beginning of the water year in September what the eventual runoff for the year will be, and the previous year is no indicator for what may happen in the current water year, it is of interest to examine the monthly runoff variations to establish when, in a given water year, a reliable conclusion can be drawn as to the likely amount of total runoff. This is where the look-up table of water year index and water year type bias the calculations by in effect telling CALSIM II what the water year will be before it is fully experienced. (Typically, runoff in the first few months of the water year is not very high and appreciable runoff does not occur until significant rain occurs.) **This is very important to the environmental management of the Delta because it could be extremely detrimental to the fisheries if massive pumping was initiated before a reasonable forecast could be made of the amount of water to be made available.** Since in general significant runoff seldom occurs before December, prudence would dictate reduced pumping rates in the fall until runoff is sufficient to provide exports and assure a healthy Delta habitat. Of necessity the project has to be operated this way because it cannot pump water that is not really available. **However, that level of early year pumping that can both protect the Delta environment and provide for exports has not been ascertained, either for operations or for CALSIM II calculations and the EIR fails to show as much.**

Significant runoff can occur in December and generally runoff increases going into winter and peaks in the spring when snowmelt becomes the major source of runoff. However, the record shows that December and even January and February have widespread variations in runoff. Figures 2, 3, and 4 present the histograms of runoff for those months respectively based on the 98-year runoff record. What is remarkable about these histograms is that they are highly skewed to dry months, so much so that the most likely (mode) runoff is approximately 1/3 of the average runoff for either December or January. More than half the data points in December are in the first three bars of the histogram, which means that for most of the years it is very unlikely that even modest export levels should be entertained. The same is true for January and even February. Again it must be observed that the average values of monthly runoff are not very representative of anything and can be very misleading. The likelihood of an average runoff is about 1/3 that of the most likely runoff. If pumping operational decisions were to be dictated by the average level of runoff, in most years there would be insufficient water for Delta health. This may in fact be the central reason in explaining the current declines in several of the threatened and endangered species in the Delta.

Given the above characteristics for monthly runoff, it is of great interest to establish when at the earliest the overall character of the year can be discerned. To this end some illuminating regression analyses have been performed to see how well earlier monthly runoff can predict total annual runoff (See Appendix B). A fairly good predictor is obtained by taking the sum of December and January runoff as an independent variable and regressing total runoff against that variable. Figure 5 is a scatter-plot of this data and shows distinctly that the Dec-Jan variable divides the data set into wet and dry domains. (There is a gap in the scatter-plot that demarks the two domains.) All the dry year totals

except one are delimited when the Dec-Jan sum is 3.9 MAF or less. That threshold also captures approximately 5 years that belong to the wet year group. The mean of the sum of December and January is 4.46 MAF so a sum of 3.9 or less signifies a dry winter as well. The average annual runoff (8-river index) is 18.04 MAF and the scatter-plot shows few data points surrounding this total, further confirmation that the average does not confer any sense of "normal."

CALSIM II needs to be revised to correctly account for the bi-modal statistical distribution of runoff. The analysis presented in Appendix B shows one possible direction. That direction would lead to a decision framework that would restrict pumping significantly in the fall and early winter until the amount of runoff that has materialized in combination with whatever snow-pack measurements indicate that more pumping can resume. And if that decision framework were put in place it would most likely eliminate the notion that there is any surplus water in January, February, and possibly March, to be used to implement Article 21, Carryover, or Turnback pool provisions in the Monterey Amendments.

Figure 2
Histogram of Dec Flow
Frequency vs. MAF

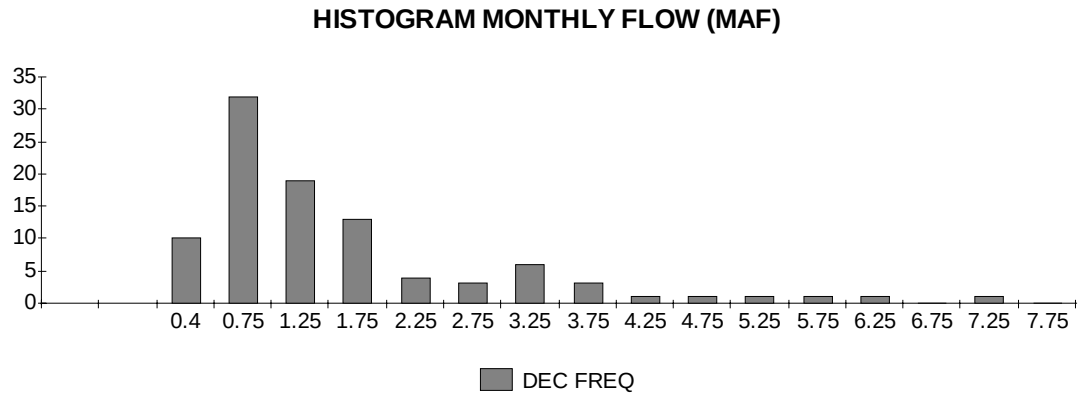


Figure 3
Histogram of Jan Flow
Frequency vs. MAF

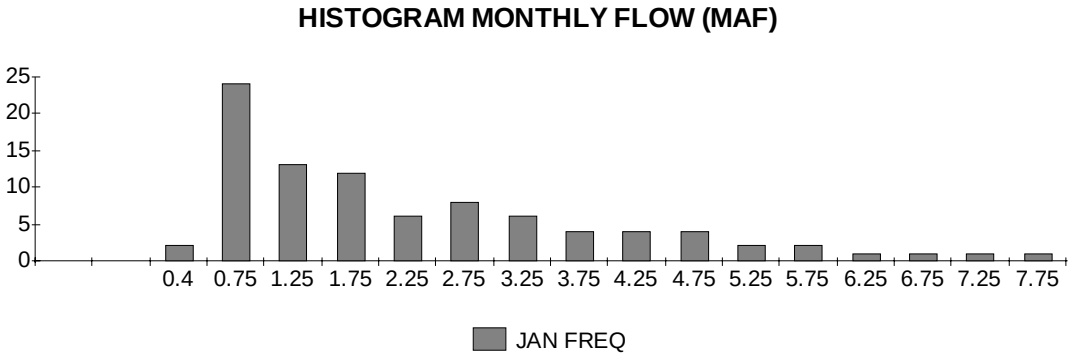


Figure 4
Histogram of Feb Flow
Frequency vs. MAF

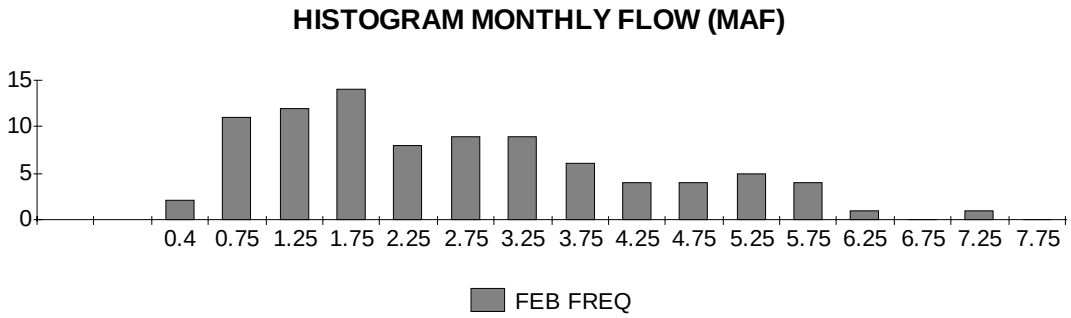
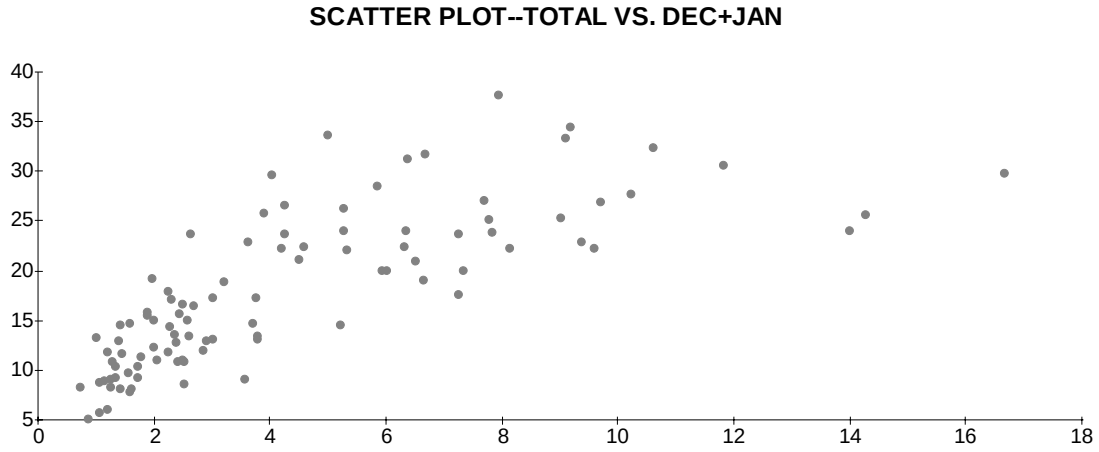


Figure 5

Total 8-River Flow vs. Dec+Jan, (MAF)



The Lack of Calibration of CALSIM II

It was stated above that it is necessary that CALSIM II be calibrated if it is to serve any useful function in environmental assessment or in assessing delivery reliability. DWR claims that its model gives reasonable answers and that it can be relied on for relative accuracy. A peer review of the model strongly recommended that the model be calibrated, especially if it is to be used where absolute accuracy is required and even if it is used for relative accuracy, as in comparisons of cases, given that it is an optimization model. **Calibrating an optimization model is essential in order to establish that whatever optima are calculated are real or possible solutions. This has not been done for CALSIM II and there can be no assurance of how well its calculated values represent reality.**

On the other hand, from the data at hand and with an understanding of how CALSIM II works it is possible to develop some estimates of its accuracy. What is required are CALSIM II estimates for a sequence of years for which there is also actual delivery data and which can be reasonably asserted are for the same conditions assumed for the CALSIM II estimates.

The EIR and the Reliability Report (Final 2005 Report) use CALSIM II estimates for a record that spans 1922-1994 and studies cases for levels of development corresponding to the years 2001, 2003, and 2021. The EIR reports in Table 6-7 the requests and subsequent actual Table A deliveries for the years 1996-2005, a period that spans the assumed level of development for year 2001 but there are no CALSIM II results for those years. The EIR also identifies the water year types associated with the actual deliveries.

Because the CALSIM II runs noted above do not include in its record the years 1996-2005 it is not possible to perform a direct comparison of estimates with deliveries. However, an examination of the CALSIM II results reported in the Reliability Report for the 73-year record shows two sequences of 10 years that are very similar to the 1996-2005 period, as judged by water year type. Those sequences are 1940-1949 and 1978-1987.

Table 1 presents the actual deliveries for the 1996-2005 period, along with the water year type and the contractor requests as reported in the EIR. Also shown are the reported actual deliveries as reported in the DWR reliability report, which show some disagreement from the EIR. Table 2 presents the water year type, assumed level of demand, and the CALSIM II deliveries for the selected 10-year sequences judged equivalent to the 1996-2005 period. The estimated deliveries are from Table B-3 of the reliability report as is the level of assumed demand, year 2001, or roughly the midpoint of the 10-year span. Water year types for these two sequences were taken from the input data file assembled for CALSIM II.

Table 1
SWP Actual Deliveries
Table A as reported (TAF)

		(From EIR)		(2005 Rel Rep)
YEAR	**YR TYPE**	**REQ**	**DEL**	**DEL**
1996	W	2676	2515	2206
1997	W	2976	2326	2308
1998	W	3335	1726	1595
1999	W	3147	2738	2521
2000	AN	3617	3201	2703
2001	D	4124	1547	1374
2002	D	3914	2573	2511
2003	AN	4126	2901	2964
2004	BN	4128	2600	2312
2005	AN	4127	2828	
	AVG	**3617**	**2495.5**	**2277.1**

It is assumed that “Requests” as reported in Table 6-7 of the EIR is a reasonable representation of the “demand” as used in the CALSIM II runs. Table 1 shows quite clearly that deliveries fall far short of requests. There is also the troubling observation that the EIR and Reliability Report do not agree; there is a little more than a 200 TAF difference in the averages. The EIR and the Reliability Report both profess to provide a detailed tabulation of actual deliveries. Since actual deliveries should be a matter of record there should be no discrepancy.

Table 2

Estimated CALSIM II Deliveries
Table A (TAF)
(From 2005 Reliability Report)

YEAR	TYPE	DEMAND	DEL	YEAR	TYPE	DEMAND	DEL
1940	AN	3713	3544	1978	AN	3126	3036
1941	W	3013	3036	1979	BN	3527	3509
1942	W	3583	3599	1980	AN	3197	3208
1943	W	3632	3545	1981	D	3834	3532
1944	D	3563	3449	1982	W	3451	3471
1945	BN	3612	3479	1983	W	3007	3036
1946	BN	3710	3724	1984	W	3692	3706
1947	D	3954	2652	1985	D	3753	3540
1948	BN	3959	2681	1986	W	3345	3023
1949	BN	3864	2568	1987	D	3905	2894
AVG		**3660**	**3227**			**3483.7**	**3295**

For both of the sequences presented in Table 2, looking at just the averages, CALSIM II estimates deliveries that are nearly equal to the assumed level of demand. For either sequence the level of demand is very nearly the same as the level of requests shown in Table 1 above. However, the level of estimated deliveries for each of these sequences is substantially higher than was shown as actual deliveries for the period 1996-2005. The estimated averages are roughly 700 TAF or 950 TAF above the actual average deliveries as reported by the EIR and the Reliability Report respectively for the period 1996-2005.

The two sequences are not perfect reproductions of the hydrologic sequence shown in Table 1 for the period 1996-2005. However, the balance of wetter than normal and drier than normal years is comparable. In fact, there are fewer drier years in the actual delivery sequence than in the two CALSIM II sequences. If there were to be any bias due to this difference it should reduce the estimated delivery level, which is already too high in comparison to the actual.

Based on these comparisons, one must conclude that either the level of demand assumed for the CALSIM II estimates is without foundation or that the model is seriously biased. In fact, until the source of this difference can be discovered and corrected the model is too inaccurate to be used for either absolute or relative accuracy in any study. It should be noted here that the list of contractor requests, which are used to drive

CALSIM II, does include some unrealistic requests. For example, a full Table A request of 25,000 acre-feet is shown for San Luis Obispo County which would be impossible to fulfill since the pipeline to San Luis Obispo County is sized to pass only 4800 acre-feet. What the model does with this excess water is a mystery.

One may conjecture that the bias is due to the difference between the operations implicit in an optimization model and the operations in actual practice. The model is given perfect information concerning the hydrology and only considers constraints that are promulgated by the SWRCB while actual operations must always be governed by the uncertainties of the hydrology ahead and environmental conditions as they materialize, of which the ESA actions are the most important. The optimization model is not really a good simulator of actual operations.

Other Comments on the Utility of CALSIM II in the EIR

Use of Averages in Reporting

Because the EIR relies so strongly on CALSIM II wherever it makes quantitative findings, it is questionable if such findings are of any merit given the deficiencies in the model. Even the methodology for reporting the model's calculations is misleading. First, because the model construction has ignored the underlying stochastic character of the input hydrology, the use of averages everywhere in the report give little insight as to the effects of project operations. For example, many lengthy tables are presented showing average flows throughout the system as calculated by CALSIM II. Table 7.1-2 of chapter 7 of the EIR presents tables that show average monthly flows for a number of stations over a fairly lengthy record. It is not certain what this table is intended to demonstrate since the record spans the period with CVP-only operations up to and including the period when both the SWP and the CVP are operating. What would be more interesting is to show the typical changes in these flows as the projects mature to maximum entitlements. **Furthermore, given the highly skewed character of the monthly flow distributions as shown above, it is more important to show what the flows are for the dry as well as wet domains. We have already shown that the average monthly flow is an uninteresting statistic and lends no meaning to the analysis.**

OTHER COMMENTS ON THE DRAFT MONTEREY + EIR

Use of Partial Hydrologic Records in Some Impact Analyses

In several instances the analysis relies on restricted hydrologic records in quantifying a particular point. The analysis of the effects of "borrowing" from lakes Castaic and Perris is a particular egregious example of distorting the impact by use of a restricted record. The analysis tries to show that the borrowing has little or no impact by comparing operations at these lakes before and after the Monterey amendments. Central to this analysis are the recorded data of operations from 1974 through 1994 for the before and the recorded data of operations from 1995 through 2003. The problem with this comparison is that the before record has an embedded 6-year drought and the after is an acknowledged wet period. Thus borrowing under Monterey occurred during a wet period while the basis for comparison has a mixed hydrologic record. Given the variations in lake parameters over ordinary operations those records are also too short to give confidence to the conclusions drawn.

If CALSIM II did not have so many flaws, this would have been a good example for its use to establish over the variation of a 98-year record the relative changes in lake levels due to borrowing. This would be standard practice for a study of this kind for which a large simulation had been developed. Unfortunately, CALSIM II is not a simulation and is not an appropriate tool. This leaves the analysis of the impact of borrowing resting on comparisons of a very restricted record.

In section 7.1, which characterizes the environmental setting in the major rivers and the Delta, data is presented which comprises significant variations in record lengths. Some data records span the period of SWP start-up but stop before full maturation of project contract entitlements. Only averages over these periods are reported so it is puzzling to discern just what the EIR is attempting to portray. Clearly, what would be much more informative would be to show the trends in stream flows as the project matures. Also, because the data represent several different sources, there are inconsistencies in the data. Inflows do not necessarily add up to Delta outflow (Table 7.1-2), as one would expect from the ensemble of rivers represented. The same can be said of the presentation of pre-project water quality data. If the environmental setting is to serve as a basis for comparison in impact analysis, the presentations leave much to be desired, especially when more informative presentations could have been prepared.

Use of frequency charts

Another reporting method is the use of the "frequency of return" charts that appear throughout the EIR. They purport to give the sense of probability of occurrence. However, because there are really two underlying probability distributions for the hydrology ("dry period" and "wet period" as we show above) the frequency charts are misleading and give an optimistic picture of the project's capabilities. They should not be used in the EIR

Article 21, Carryover, and Turn-back Pool Deliveries

These three categories of contractual water deliveries raise serious questions regarding pumping and Delta health. All are deliveries to be made in January, February, or March when certain conditions prevail. Article 21-water is termed surplus water but the only definition for it comes from the SWP contracts. There is certainly no test of whether it is surplus to the Delta. **DWR must develop a definition of surplus water that is properly constrained by considerations of Delta ecological health. This constraint must supersede the definition of surplus water in the master contract. The EIR must be considered deficient until such a requirement has been met.**

The Monterey Amendments eliminates all the conditions and constraints on delivery of surplus water that were in the original contract and substituted a new Article 21. One of the original provisions was the responsibility to determine that surplus water not be used in any manner that would constitute the development of a permanent-like economy due to its use. The new definition would seem to allow much more latitude to the use of surplus water for M&I uses that might not be allowed under the original contract. The EIR should analyze the impact of this provision in creating still more paper water.

Carryover and Turn-back Pool water are also contractual definitions and, together with Article 21 water, all three definitions have been modified by the Monterey Amendments. Carryover water is strictly a consequence of the difference between the definitions of contract year and water year. "Carryover" as used in the contract does not deal at all with reserving water in one water year to make it available in a subsequent water year, which is the normally intended meaning of the word. Instead, at the end of December when a new contract year starts, whatever Table A amounts that were scheduled but not delivered in the old year may be delivered in the new contract year even though it is in the same water year. The demand for this delivery occurs in the same months as for Article 21 water when, as we have shown, there is great uncertainty as to how the water year will turnout. The same is basically true for Turn-back Pool water. It too is a creation of the difference between contract and water years. Both "Carryover" and "Turn-back Pool" create opportunities for the contractors to "game" the system to get more Table A deliveries, all under the guise of strict adherence to the contracts. Because these categories are basically contractual creations of Monterey, invocation of them to cause deliveries in the first three months of the contract year should be carefully scrutinized in the EIR for impacts on Delta health. In fact, it would be extremely useful to examine project operations without these provisions. Furthermore, an alternative scenario for full EIR examination should be generated which requires the contract year to be coincident with the water year.

EWA operations

The EIR's discussions of the Environmental Water Account (EWA) do not help the reader understand how the EWA is supposed to work. On one hand it sounds like it is intended to reserve water to be made available for fish in the Delta when circumstances indicate that more flow into the Delta is necessary. On the other hand the EIR talks about

storing EWA water in the San Luis Reservoir. If it is in the San Luis Reservoir how is it made available to the fish when needed? The obvious question is could the water be kept above the Delta so that its release for fish is direct and to the point? Why must the water be delivered to San Luis Reservoir if it is anticipated that it will be needed for the EWA? Are those who are selling their water south of the Delta making a profit on it? And if it is a project obligation to adhere to the ESA why doesn't DWR act cautiously to make sure that it keeps enough water above the Delta to assure their ESA obligations? All of these questions should be addressed in the EIR.

Energy Impacts

Since the SWP is a very large net consumer of power, and given the present urgency about energy use and global warming, the analysis of the project's energy impacts is very important. Probably the most important direct energy effect of the Monterey Amendments per se is the transfer of 130 TAF of water from agriculture in the San Joaquin to urban users, most of which are outside the San Joaquin Valley. For those transfers to Southern California the transferred water must be pumped over the Tehachapi Mountains, which constitutes a net increase of pumping energy over and above that which would have been required if the water was used in the Southern San Joaquin as originally called for in the contracts. However, there are many more facets to the impacts of energy requirements associated with this project.

First and foremost, because the project has rarely delivered close to full Table A allotments, there is the question of how the energy required for pumping will be supplied when the project deliveries approach the full allotments. Since the SWP is at present a net energy consumer, any additional deliveries must be presumed to require more pumping energy, which must necessarily come from commercial power from the grid. Given the difficulties that California has in meeting peak demands in the most recent years, it is not at all certain that additional pumping energy can be had without significant impacts on the competing demands of California residents. It may be argued that this particular problem would attend the SWP without Monterey, but we should point out that all of DWR's calculations with CALSIM II predict increased deliveries, so much so that they have made those calculations the basis of their reliability analyses. The same CALSIM II calculations also are used to claim that the amended SWP now has much less "paper water". In any event, to make their calculations consistent they should assess the net increase in pumping energy demands associated with their claim that they can deliver more water than in the past.

A correct reckoning and portrayal of the energy impacts should use the actual record of deliveries as a basis for comparison instead of the CALSIM II generated numbers for year 2020. (There is particular concern in the period 2000 to 2005 when increased Delta pumping during December, January, and February occurred and a tabulation and comparison to prior years would be very informative.) The energy problem is how the additional energy to get to 2020 conditions is to be generated.

Another aspect of the Monterey Amendments that impacts energy demands is the transfer of the Kern Water Bank to the Kern Water Bank Authority (KWBA) combined with the Monterey created delivery categories of Article 21, Carryover, and Turn-back Pool. The combined effect allows the KWBA to request water from these various

accounts to put in the Kern Water Bank for the benefit of the KWBA, which incidentally comprises water entities that are not direct contract recipients of SWP. Thus a demand is placed on the SWP to pump water that would not have necessarily been pumped if KWBA had not been given the Kern Water Bank. The analysis must show how operations of the Kern Water Bank would have been expected to occur if it had remained as an SWP project facility. Also there is the question as to whether non-project participants, such as those comprising the KWBA, should benefit from project contractual provisions regarding the prices they pay for pumping energy. Given that additional energy increments above the previous baseline must come from commercial power, it seems that non-project participants should pay that marginal cost for pumping to fill the Kern water Bank. In other words all other legitimate SWP contractors must pay slightly more for their pumping energy needs because of costs imposed by operations of the KWBA.

In summary, the impact analyses must trace all the different flows that follow from the Monterey Amendments and accurately calculate the pumping energy differences and compare those differences to the previous actual baseline, and not to the year 2020 level of demand.

Land Use and Planning

In California one of the most important elements in land use planning is the availability of a reliable water supply. Because the first Monterey Agreement EIR failed to deal with the well-recognized inability of the SWP to deliver even close to full entitlements the EIR was held to be deficient. The Appellate Court made note that this lack of candid treatment in that EIR placed local planners in a difficult decision as to how much firm water they could count on in approving or rejecting development projects. Because the pre-Monterey contracts had provisions in them to allow DWR to bring entitlements into consonance with real capabilities to deliver and the Monterey Agreement made it a specific objective to eliminate those provisions, the Court stated that a new EIR must be drafted that analyses the consequences of utilizing the eliminated provisions to bring promises of delivery in accord with the project's capability to deliver. The current EIR has attempted to do this, relying on calculations with CALSIM II, but because of the total inadequacy of CALSIM II as presently configured those analyses are flawed. **This brings us to the point in the EIR impact analysis where a fundamental requirement promulgated by the Court of Appeals has not been fulfilled**. The present section of Land Use and Planning is therefore of little use. Nonetheless, there are some observations that can be made that may be useful in correcting the analysis in a future document.

The analysis of impacts on Land Use and Planning avoids the most obvious consequences of the project. Table 7.10-1 attempts to guide the reader to the most important impacts but ignores what must be considered the first order impacts. The table indicates that the only concern with the permanent transfers of water from agriculture to others is with the changes in land uses and agricultural practices of the land from which the water is transferred. However, it should be clear that any transfers to urban uses raises profound issues with changes in developed land use whenever additional water supplies

are make available. A prime example of this is the development now being pursued in the Castaic region solely because the Castaic Lake Water Agency claims to have reliable additional water supplies made available from transfers from Kern County Water Agency, all under the auspices of the Monterey Amendments. How the EIR can be silent on this matter is beyond comprehension.

Furthermore, the amounts of additional, reliable water claimed in the transfers is solely based on DWR's CALSIM II calculations as they are presented in the settlement-mandated provision requiring a reliability report. Because CALSIM II has already been shown to be a grossly inaccurate calculator of reliable water, its use in assessing how much water can be relied upon just continues the problem of "paper water", which the Appellate Court and the Settlement Agreement state must be eliminated from land use planning.

The table also misses the point on the Kern Water Bank transfer. By changing the water bank from a SWP facility to one owned and operated for the benefit of a limited set of water users, the SWP plans for delivery have been necessarily impacted and as a direct consequence the plans regarding the use of whatever water the water bank could have made available for all the SWP contractors are impacted.

Also the Reliability Report fails to account for the presence or absence of local water sources and its guidance to SWP contractors is too simple to be of any practical planning use. For example, many SWP contractors, taking their cue from the Reliability Report, assume a number around 75% reliability, which they apply to their Table A amount in reckoning their reliable supply. In truth, the way that the 75% is calculated depends on the project being able to deliver substantial amounts of Table A to Kern County Water Agency and the Metropolitan Water District because they have large reservoirs and can accept these large amounts in off-demand periods. By contrast, most other SWP contractors do not have such storage means and must take their Table A amounts during seasonal demands and the average amounts that can be relied on under those conditions is much less than 75%. Accordingly, a planner depending on water from one of these other SWP contractors would be misled. It is also an interesting observation that any development which is permitted solely on the basis of a SWP supply can really only depend on approximately 15% of whatever Table A allotment it may have because that is the lowest delivery level in the record. This has proven to be a realistic possibility in Santa Barbara County where transfers of SWP allotments among SWP subcontractors are being made to support developments outside existing water district boundaries. DWR needs to instruct its SWP contractors on how to use the information developed by them respecting each individual contractor's ability to receive SWP water in concert with whatever other water sources it has available.

In summary, the analysis in the EIR of impacts on Land Use and Planning is too superficial and limited to be of any use in prospective project decisions.

APPENDIX A

An Analysis of Reverse Flows at the South Delta Pumps

Recently, additional information on several factors was obtained that could explain the observed Pelagic Organism Decline (POD) in the Delta. It had been posited earlier that unusually high pumping by the SWP in the months of December, January, February, and March could be the cause. The additional information now focuses on the fact that high reverse flows in the Old San Joaquin River brought on by SWP/CVP pumping may explain the loss of the Delta Smelt. The investigations that brought this information to light also were concerned with the same four months (D,J,F,M). This information has been analyzed to relate the Old River flows to export pumping, river flows at Vernalis on the San Joaquin, and the Sacramento at Freeport. To date one quantitative relationship has been developed that explains the reverse flows quite well. The method used was multiple regression analysis and the best relationship so far is given below:

OLDSJ = 243-0.942*EXP+.533*SJVER

Where SJVER = San Joaquin flow at Vernalis, cfs
EXP = export pumping, cfs

Since export pumping is generally much greater than flows at Vernalis, this relationship yields negative flows for Old River in most instances.

The data set covered the years 1981 to 2006. Two data points appear as clear outliers, 1983 and 1997, which were very high run-off years. The standard error for this equation is 430 cfs while the corresponding percentage error of the fit is 18.5%. All coefficients are very significant ("t" values are respectively, 15.11 and 20.23).

What seems clear is that export pumping is a very strong variable; reverse (i.e. negative) Old River flows could be reduced by directly reducing exports. It seems also clear from perusing the input data that San Joaquin flows at Vernalis are not substantial enough to overcome the export reverse draw. This is probably due to the fact that in most years almost all of the San Joaquin is diverted for irrigation.

Another factor not yet analyzed is the magnitude of the exports compared to the volumes of water in the sloughs and Clifton Court forebay. When exports typically average 10,000 cfs for days at a time, the transit time through the sloughs may be quite short. (For example, 10,000 cfs equates to 20,000 acre-feet per day, which could be on the order of the volumetric capacity of Clifton Court forebay.) It seems that the biologists should look at what happens at all the levels of the aquatic food chain when that happens. Perhaps the reduction in smelt numbers and the observation of smaller smelt later in the spring are related to the reduction in biologically available food.

It might also be profitable to take a restricted look at the months of just December and January. Using all four months tends to obscure the fact that quite often river flows in the first two months of the four month period can be quite low, so much so that

exports would be even more devastating. The biologists should be asked to investigate the relationship of POD to just the pumping and flows in the first two months.

The sheer magnitude of the export flows is also interesting. There was a levy failure in one of the Jones tracts during a period when most observers would not have expected any stress on the levies. However, the maps show that the tracts in question are along the channels that lead directly to the pumps. Is it possible that the magnitude of the flows to the pumps was an important factor in the levy failure?

COMMENTS ON DWR'S TECHNICAL MEMORANDUM

"Progress on Incorporating Climate Change into Management of California's Water Resources", July 2006

By Arve R. Sjovold
September 2, 2006

In DWR'S year 2002 report on the "The State Water Project Delivery Reliability Report" it was explicitly acknowledged that climate change would affect the timing and amounts of snowfall and possibly precipitation and that sea level rise was likely. At that time the timing of these impacts was speculative. That report promised that more definitive studies of the impact on climate change would be provided, possibly as soon as the update of the California Water Plan Update 2003. Thus, it was with some anticipation that I looked forward to a comprehensive study of the affects of climate change on the SWP. The subject report fails to provide that comprehensive study. Although DWR did engage in some rather elaborate computerized calculations, the subject of those calculations studiously avoided the impacts, now more widely recognized, but clearly acknowledged in the 2002 Reliability Report. Any keenly interested observer of the debate on climate change would have expected a cogent and objective analysis of the effects of sea level rise and changed Sierra run-off patterns as first order effects.

The report devotes considerable of its quantitative analyses to the calculations of the effects of a very modest sea level rise of 15 inches on the ability of the Delta to deliver water to the pumps without severe violations of salinity thresholds. It does so based on assumptions that upstream reservoir operations are not changed and that sea level rise does not change the hydraulic network in the Delta. Another assumption for this analysis is that the salinity gradient in the western Delta does not change with this sea level rise. No supporting evidence or analysis is given as to why these assumptions are reasonable. In other words, a primary assumption is that the current system of Delta levies remains in tact with a 15 inch sea level rise. I won't argue that that level of sea level rise may indeed leave the levies operationally in tact, but it misses the first order question of what level of sea level rise will compromise the system of levies. There are good maps (produced by DWR, if I am not mistaken) of what the Delta may look like with 1, 2, 4, and 10-foot sea level rises. From these maps it is clear that somewhere between 2 and 4 feet of rise there is little assurance that the Delta can perform as a delivery network of fresh water to the South Delta pumps. Since the subject report acknowledges that 2.9 feet of sea level rise is likely under one of the scenarios studied by the International Panel on Climate Change (IPCC) by the end of the century, clearly the most important question to be addressed by DWR is to calculate at what level the Delta's levies cannot be relied upon. **The subject report does not do this and does not offer a qualitative discussion.**

The other major assumption underlying their quantitative calculations is that reservoir operations (that is, Oroville and Shasta) are not changed by climate change impacts. That this is an untenable assumption is apparent from the report's side study that shows, under 3 different scenarios, that peak discharge from the Feather River may be

substantially altered. In fact, the most severe scenario carefully quantifies that peak discharge for a "15 year event" may be 2 ½ times the current estimate of a 15-year peak discharge. Clearly, any inquiring mind would wonder how reservoir operations might be affected by such a finding. Curiously, the report does not inquire further. But that may be the most intriguing finding of the report. If as a matter of hydrology peak discharges at any return level are 2 ½ times higher, such a finding would call into question the ability of the dams to function as designed. First, 2 1/2 times peak discharge would probably tax the design limits of dam spillways. Second, flood pools in reservoirs would have to be enlarged compromising water conservation objectives. Third, passage of discharges 2 1/2 times as large would undoubtedly cause havoc below the dams. None of this is addressed in the report even though that is where it should logically lead.

In conclusion, the report shows no scientific curiosity concerning the very likely first order impacts of climate change. The detailed quantitative analyses that are performed are totally irrelevant to what are the major questions that are posed by climate change. The report should candidly state that the most reasonable forecasts of what climate change might produce would seriously compromise the project, to the extent that the SWP may be obsolete in its current configuration within the current century. This is certainly a different tone than that conveyed by this report.

Specific Criticisms

1) The report still relies on CALSIM II as a reliable model to study the impacts of climate change. First, as we have so many times stated in the past CALSIM II is a fatally flawed model. It has not been calibrated and is not a true simulation model, as it is commonly referred to. Second, the indices that are use to drive the model in certain of its calculations are without scientific or practical merit. They provide the so-called simulation with perfect information of stream flows in advance of simulated operational decisions and the indices are highly distorted representations of the true stochastic nature of the operational problem, simulating operations in the face of uncertain future stream flows. It is particularly noteworthy that the CALSIM II run labeled "Base" in the report does not resemble the CALSIM II 2021-runs performed for the Reliability Report for ostensibly the very same assumptions. In fact, the variance between these two case studies, the "2021" study in the reliability report and the "Base" in the climate change study, is roughly the same as the differences reported between the "Base" case in the climate change study and the alternative scenarios. (See Table 1 below.) In stark terms, we are using a measuring instrument that is too imprecise to reliably distinguish differences among the scenarios. Scientifically, the model is inappropriate just on that finding and DWR staff should be required to establish why there are such differences between these two reports.

2) Throughout a significant portion of the report detailing previous hydrologic history of the Central Valley, there are many regression analyses results that are portrayed to establish certain trends that may have some significance. The report does not state why they may be relevant. I find it difficult to see any

such relevance except if it is to acknowledge that some climate change may have already occurred. Even then, I fail to see the relevance absent any analysis that shows why it should be. Beyond that observation of relevance, there is the more important issue of deciding when a calculated trend is significant. It appears from the data presented in the report that many of the trends are statistically insignificant at normally accepted thresholds. Why such trends are reported as maybe "real" is puzzling.

3) The preoccupation with the affects of climate change on stream flow temperatures is probably misplaced. Given that current project operations are decimating species in the Delta, the concern seems an attempt to show that the species are doomed anyway and we shouldn't worry about what the projects are doing now. That is a very shortsighted view and seems to be extremely self-serving with respect to current operations. My view would show more emphasis on characterizing future overall stream flow amounts and timing rather than on speculations on stream-flow temperatures as if the basic stream flows are relatively unperturbed.

4) The report does provide a fairly decent summary of the extant scientific theories supporting global warming and the effects on climate. The report depends most strongly on the work reported by the IPCC and the scenarios they cast. However, other more recent work out of the Goddard Space Science Institute (GSSI) strongly suggests that ice sheet breakup of the Greenland and/or Antarctic ice sheets may accelerate sea level rise significantly, an event that is not a major factor in the IPCC scenarios. If the GSSI theory is more correct the integrity of the Delta in the nearer future may be in doubt. Neither the IPCC nor the GSSI can offer precise timelines as to when significant sea level rise may occur. Nonetheless, it is vitally important that DWR include a candid appraisal of the likelihood of sea level impacts on the Delta beyond the mere 15-inch rise assumed in their studies. Calculations can easily show that the generally accepted existing level of climate forcing, .85 watts/m^2, is sufficient to melt sufficient ice to raise sea level by 0.4 feet per year. What is not certain is how future climate forcing will divide between melting ice and warming the biosphere. It is very clear right now that the rate of sea level rise cannot be estimated precisely but the potential for rapid sea level rise is the most important feature of global warming. The report should candidly state so.

5) The report summarizes the past history that has been developed for global warming over the past 650,000 years which shows that within our recorded history the Earth is near a peak warm temperature for this interval. (See; James Hansen, "A Slippery Slope", Climatic Change, 68, 269-279, 2005). If the report had included the corresponding data on the coincidence of greenhouse gas concentrations and sea levels with temperature it would be quite clear that greenhouse gases are the most significant driver of temperature change and consequent sea level rise. The DWR report does

include a table of the existing concentrations of CO_2 and methane, corroborated in the attachment, which are higher than ever measured by the ice cores within the past 650,000 years. This remarkable finding should require the widest possible range of possible changes rather than the restricted ranges chosen by the report. In short, the authors of the report did not delve deeply enough into the current research being performed on climate change and the report cannot claim to have met its objective of "incorporating climate change into the SWP."

6) The analysis to incorporate climate change into CALSIM II involves an intricate attempt to translate IPCC climate change scenarios into specific quantitative changes in major Northern California river run-off as the basis of the computer calculations that form the major effort of the report. It is noted in the analysis that the climate change scenarios are based on global models that incorporate only six grid points to characterize expected rainfall for all of California. The analysis then proceeds to use the information developed for these six grid points to generate estimated changes for 10 of the major rivers. Another model, the Variable Infiltration Capacity (VIC) model, is used to calculate these estimated changes of rainfall into run-off. An important assumption in this exercise is the use of the VIC model to develop perturbation ratios due to climate change that can then be used to modify the characteristic run-off measurements for these rivers. The clear flaw in this methodology is the measured run-off used to characterize the rivers. The analysts chose the year 1976, a readily acknowledged drought year to characterize the average or "normal" run-off. Since 1976 was well below average for any river system in California, this choice necessarily biases the estimated changes low. 1976 run-off was probably less than half the average. Therefore, on translating changed rainfall into estimated run-off for the major rivers feeding the CVP and SWP, the use of 1976 as a basis to scale from as described in the report necessarily underestimates the run-offs under climate change by a significant amount. Accordingly, the entire exercise with the Delta model, DSM, is not even a reasonable estimate. Since this computer exercise seems to comprise the most substantive portion of the report, it calls into question any and all of its findings. DWR should be required to justify the choice of 1976 (although on its face it seems that this can't be done). A standard analysis of this type would have done so as a matter of course.

Table 1
Comparison of "Base" and 2021 CALSIM II Runs

(Million acre-feet per year)

Water Year	Climate Change Report SWP Exports	2002 Reliability Report SWP Exports Fixed Demand	Deviation
76	2.97	2.78	.19
77	1.00	0.83	.17
78	3.61	3.91	.30
79	3.70	3.49	.21
80	4.10	3.46	.64
81	3.33	3.40	.07
82	4.71	4.13	.58
83	3.68	4.13	.45
84	3.42	4.10	.68
85	3.52	3.32	.20
86	4.20	3.01	1.19
87	2.57	2.84	.27
88	1.54	0.99	.55
89	2.72	2.90	.18
90	1.60	1.15	.45
91	1.10	1.00	.10
Average Deviation			**0.39**

APPENDIX B

Development of a Preliminary Algorithm To Guide Pumping from the Delta In the Months of December and January

A look at monthly flows for the runoff record reveals that significant runoff begins in December and increases on through May. The highest runoff measurements generally occur in the spring. However, from time-to-time there are some early winter runoffs that are quite high. When looking at just the dry year portion of the record it is quite clear that the drier years are almost always characterized by runoff in both December and January that are much below average. Thus if the water year is going to produce reasonable runoff it must come from above average spring runoff. But the operators of the projects cannot safely assume that spring will be above average and must then adopt prudent operations when beginning export in the fall and winter. Therefore, an operational procedure must be developed that begins with the assumption that the water year will be dry until conditions show that it is likely to be wet. (We dismiss the notion that the previous water year has any useful information contained in its runoff record as is intimated by the "40-30-30" index.) The question is then, how can we establish with some certainty how much runoff is likely for the year?

To answer this question, we analyzed the relationship between total runoff recorded by the end of the water year to the measurements of monthly runoff as they occur. A perusal of the record shows that trying to rely on December runoff alone does not provide a reliable indicator. Next we examined the potential of the combined runoff of December and January to indicate the character of the impending water year.

We started by defining simple indicator variables. Since we desire to provide indicators that are most useful in the early part of the water year we concentrated on the months of December and January to see how much they could tell us. The indicators that seem to work reasonable well are as follows:

DRYWINTER, which takes on the value of either one or zero. If it is one, then it signifies a combined December-January runoff that is quite dry for that period. We first tried a combined runoff of less than 2.5 million acre-feet (MAF), which is just over half the average for this period. Later we tried a value of less than 2.25 MAF which is just about half.

WETWIN, which takes on the value of either one or zero. If it is one then it signifies a combined December-January runoff of greater than 4.24 MAF, which is the average for this period.

WETSPR, which takes on the value of either one or zero. If it is one then it signifies a combined April-May runoff of greater than 7.4 MAF, which is the average for these two months. Later we tried a threshold value of 6.5 MAF, or slightly less than the average. We felt that more precision in the spring runoff is not necessary since one must wait until spring to measure the runoff. So the role of this indicator variable is to establish explanatory power for the desired relationship for predicted total runoff.

Besides operations can be modified once we have passed beyond the months of December and January and the water year record unfolds.

The best relationship that we could find is given below:

TOTAL= 12.81- 2.99(DRWWINTER) + 7.22(WETWIN) + 5.17(WETSPR)
Where:

TOTAL = total water year runoff in MAF
DRYWINTER = 1,0 where 1 is sum of Dec-Jan when less than 2.25 MAF
WETWIN = 1,0 where 1 is sum of Dec-Jan when more than 4.24 MAF
WETSPR = 1,0 where 1 is sum of April-May runoff when Greater than 6.5 MAF

These variables were then tried in a linear multiple regression relationship to examine their explanatory power. All of the indicator variables were highly significant and the standard deviation of the fit was 3.27 MAF. Nine of the 98 data points in the sample were deleted from the regression calculation as probably too extreme on a probability basis. 7 of those 9 were for extremely high runoff years. Since the problem of export pumping is much less dependent on very high runoff years these deletions are not of prime importance and their inclusion only tends to skew the results. It is also noteworthy that the deletion of these data points appears not to affect the coefficients materially but does improve the precision of the relationship.

Conclusions

With three independent, stratifying variables that take on either of two possible values there are 6 independent outcomes. They are:

DRYWINTER and a dry spring (1,0,0), which produces an estimate of TOTAL of 9.82 MAF.

A winter (December-January runoff) that is greater than 2.25 but less than 4.24 MAF and a dry spring (0,0,0), which produces an estimated total runoff of 12.8 MAF.

DRYWINTER and a WETSPR (1,0,1), which produces an estimated total runoff of 15.0 MAF

A winter that is greater than 2.25 but less than 4.24 MAF and a WETSPR (0,0,1), which produces an estimated total runoff of 18.0 MAF.

WETWIN and a dry spring (0,1,0), which produces an estimated total runoff of 20.5 MAF.

WETWIN and WETSPR (0,1,1), which produces an estimated total runoff of 25.7 MAF.

Of the 98 years of the runoff record, nearly half the points(47) are included in the three categories that have estimated runoff less than the average for the total record. Twenty four (24) of the 47 points are associated with the estimate of 9.82 MAF. 15 are associated with the estimate of 12.8 MAF and 8 are associated with the estimate of 15.0 MAF. All three of these categories are determined by the combined monthly runoff of December and January and make no assumption that the spring will be wet. Accordingly, one may conclude that all December and January operations should assume that the water year is part of the dry period until spring runoff dictates otherwise. It is particularly important to note that for fully one quarter of the record (24 years), only 9.82 MAF can be relied upon. This should be the starting point for developing operations criteria for export pumping that take due care to preserve the Delta environment.

At present it appears that December and January pumping are little modified by the hydrologic indications to that time. Since project demands are low at this time of the year, these months are used to fill south of the Delta reservoirs. Only the constraints on Delta outflow and salinity may limit the pumping; and the restrictions here are highly skewed because of the influence of the erroneous “water year index” discussed in the body of the text. Questions that should be asked include: Should there be much of any export pumping if December and January runoff is below 2.25 MAF? Can the health of the Delta fisheries and its broader ecology be assured under such low flow conditions? Of those 24 years that comprise this condition three are for years that are extremely dry, averaging just under 6 MAF. What would be prudent operations under those conditions? The same questions must be answered for the other two dry year categories. The biologists should be asked to weigh in on what would be desirable under these drier conditions to assure Delta health.

It is possible that integration of snow-pack measurements might improve the ability to forecast more accurately or at least earlier with the same accuracy. However, reliable snow-pack measurements are usually not available until the end of March. Accordingly, early runoff is the most readily available and reliable indicator that can be useful.

Attachment 2

HOW CALSIM II DISTORTS ESTIMATES OF AVAILABLE SWP DELIVERIES

By: Arve R. Sjovold
March 2, 2008

In my comments on the Draft Monterey++ EIR I provided a rather thorough examination of significant flaws in the CALSIM II model. The comments were couched in statistical terms whose significance may not be readily discerned. In this essay I try to provide more commonplace analyses to show what the consequences of the flaws really are.

There are two structural flaws in CALSIM II, the methodology by which the water indices are constructed and the use of these indices in the model. In addition, there is the matter of how CALSIM II results as measures of probability are reported in the Reliability Report and how the results are reported in the EIR. Then there is the matter of the how the hydrology is represented in the model. Here I will attempt to show how each of these factors operate to produce faulty estimates.

Problem 1: Faulty Indices

Indices are sometimes useful in models to categorize certain information to facilitate calculations. In CALSIM II the indices that are used in this fashion are the water year indices. These are constructed from measures of runoff from the major rivers feeding the Central Valley and are used to characterized whether a year is "wet," "above normal," "below normal," "dry," or "critical." One of the problems in using this type of characterization is that there are two definitions of "year." There is the "contract year,' which is identical to the calendar year, and the "water year," which is a characterization developed on the basis of hydrology and is particularly pertinent in a climate that has summer drought. The "water year" is the period from October 1 through the following September 30. This definition follows from the recognition that because of summer drought little runoff is generated in the summer as the streams become increasingly lower until fall and winter rains generate significant runoff, which is later followed by the more important spring snowmelt. Actual project operations must respect both the "contract year" and the "water year."

The water indices that are used in CALSIM II try to span these two definitions by constructing an index that is a weighted average between the runoff from the preceding water year and runoff from the present water year. In so doing the index is made to represent a runoff from two water years that may have nothing to do with each other. It then becomes a flawed guide to operations and calculations.

I performed a correlation analysis on the series of annual measured runoffs (water year) in the Central Valley to find out whether a given water year is more likely to be wet (or dry) if the previous water year was wet (or dry). The result was that there is virtually no correlation, which means that each water year has to stand on its own. Thus the project should not base operational decisions on an index that is a composite of two water years in attempting to characterize the runoff. This is an important finding that has profound consequences on how much and when water can be delivered from the Delta.

First, there are several examples in both operations and in CALSIM II calculations where an erroneous index has led to a serious error in pumping. This circumstance occurs primarily every time a quite dry water year is preceded by a fairly wet water year. When this circumstance occurs, the flawed index indicates that the ensuing water year will be wetter than the actual case. If the quite dry year is followed by another quite dry year (the 1976 and 1977 years are a good example), more water will be pumped in the first of the two dry years with the result that the second dry year will be very short. The record shows that 531 kaf of surplus water was delivered in 1976, a year that delivered only about 30% of Table A entitlements. The following dry year, 1977, 323 kaf of surplus water was delivered while the project could only deliver about 15% of the Table A entitlements. Both of these years were well below average for runoff while the preceding year, 1975 was above normal. Clearly the project could have evened out the deliveries for the two years much better if it hadn't been misled by the erroneous index.

In my comments on the Draft EIR, I also analyzed how the projects should be prudently when each water year is treated independently. There I showed that until there was sufficient fall-winter runoff to indicate that the year would likely be average or better, that pumping should be curtailed. My analysis showed that that point wouldn't be reached until the end of January in most cases and could extend into February in a few cases. Because surplus water is declared available in the first three months of the calendar year, a reduction in pumping for any of these months would impact surplus water deliveries. The water index that is used by the project provides no such restriction.

The reverse case of a wet year following a dry year does not present an equivalent problem simply because project operations always respect the real time unfolding of the water year. Therefore, if the project operations begin in the fall with an index that is biased low, it soon becomes apparent in the actual runoff that conditions will be better than promised by the index. There is little risk that too little pumping will occur.

Problem 2: Perfect information in CALSIM II vs. Operations in the Face of Uncertainty

The next important flaw is with the use of the indices in the CALSIM II calculations. In CALSIM II a look-up table is created to store the water year type for use in the optimization calculations. The entries in this look-up table are single values for an entire year, including the unfolding water year. The indices are not modified in the course of the calculations. CALSIM II is structured to make water routing decisions based on the monthly runoff without knowing how the water year is unfolding except in the case of the indices which are used to set many important parameters in the calculation scheme. But the way the indices are used with respect to the parameters that depend on them is that they provide the advantage of knowing ahead of time the circumstances of the eventual water year. Thus, CALSIM II is armed with information that allows a calculation of the maximum amount of water that can be delivered from the Delta with near perfect knowledge, which must be contrasted with the operational decisions that actually unfold as the water year is experienced and is likely to result in decisions not to pump to avoid the risk that there will be insufficient water in the subsequent months. The difference is the amount that CALSIM II is in error, which can only be determined with a calibration.

Problem 3: Mischaracterization of the Central Valley Hydrology

Perhaps the worst flaw in the Draft EIR and the Reliability Report is the use of averages to describe impacts or outcomes. Most often in ordinary use the term "average" or "normal" connotes what is a most likely value, that which is expected more than any other value. These two terms are used extensively in both documents to depict impacts and outcomes. The problem is that if the "average" or "normal" is an unlikely event, is there any merit in presenting such values. An example will suffice to demonstrate the difficulty.

Say that the series of recorded annual runoff aggregates into two distinct sets, one set of years that we call "dry" which for argumentative purposes range between 5 and 15 MAF per year. The other set we shall call "wet" and they range between 20 and 38 MAF per year. Both sets have about the same number of years but of course they are randomly interspersed except for occasional drought sequences. The average of the entire record is about 18 MAF per year. Now from the way I constructed the two sets 18 MAF per year is an improbable event (actually it is more precisely an impossible event if my record is a precise recording of all the possibilities.) Recognizing this feature of the record we may ask is there any information disseminated by using the term "average," or as often is done "normal." The correct way to address the runoff record is to portray the data as two independent sets, a "dry" one with an average around 10 MAF per year and a "wet" one with an average around, say 25 MAF per year. It is entirely a different picture when one realizes that in any given year the runoff is either going to be 10 MAF +or – 5 MAF per year rather than 18 MAF or 25 MAF +13, -5 MAF.

The constructed runoff record above is fairly idealized but it is not far from the actual data for the Central Valley. According to the 8-river index the runoff indeed aggregates into two distinct sets, one with an average around 12 MAF and the other with an average around 25 MAF. (Please note that the 8-river index only captures about 80% of the total runoff when all the minor streams are accounted.) In the actual record the grand average seldom occurs. In other words, the so-called "normal" is not very normal and is certainly not a most likely event. Why is this important?

Misleading Results

In the reliability report the CALSIM II results over the entire record (93 years) are reported in a frequency diagram, which depicts how often the calculated delivery from the Delta is greater than a prescribed value. Remember delivery is driven by runoff. According to the reliability report the SWP can deliver 75% of Table A entitlement 50% of the time. This is a direct reading from the frequency diagram. However, if one looks at the likelihood of actually getting 75% +or -, it only occurs about 2 or 3 of 93 years. Hardly a likely result and certainly not what we mean when we refer to "normal."

The runoff record indicates that 56% of the time we can expect a runoff less than average and 44% of time it will be greater than average. The dry set (i.e. the 56% of runoff events) has an average runoff of about 12.5 MAF per year; the wet set about 25 MAF per year. The CALSIM II delivery record corresponding to the 93 runoff record used in driving CALSIM II mirrors the runoff record; slightly more than half the years

where delivery is constrained by the “dry” set runoff and slightly less than half the years where delivery is nearer the maximum due to above average runoff.

The problem occurs when the information calculated by CALSIM II is presented in the over simplified frequency diagram and read as probability of delivery. Even though almost half the years are calculated to deliver more than 75%, the actual likelihood of getting near 75% is very poor. When a local planner sees this information he is led to believe that he can rely on 75% most of the time. However, in reality more than half the time he will have to deal with deliveries much less than 75%. If he chooses the 75% level as the reliable delivery and allows new developments to hook up to water supplies on that basis there will be virtually no chance of avoiding a severe shortage in more than half the years. This is the epitome of “paper water.” The Reliability Report does report the calculated results for various drought sequences. For instance, it reports that for a six year drought, like the 1929-1934 and the 1987-1992 periods the average delivery will be somewhere around 37%. With this information the local planner can calculated his ability to compensate during a drought episode. If he has no other sources it will be difficult to promise any development a reliable supply greater than 75%. Even then he has to figure out how to balance the variations in delivery within the drought. For example, in the 1987-1992 drought only 15% was delivered in the worst year. The planner would have to have sufficient other sources to make up another 22% just to make the average for the drought. Because of the way the SWP is set up it is difficult for local planners to decide on a reliable level of delivery from the project. The overly simplified frequency diagram is almost totally useless for the type of analyses that a local planner should be doing.

Attachment 3

PLANNING AND CONSERVATION LEAGUE

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January 14, 2008

Delores Brown, Chief
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California Department of Water Resources
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RE: Planning and Conservation League comments on the Draft Environmental Impact Report, *Monterey Amendment to the State Water Project Contracts (Including the Kern Water Bank Transfer) and Associated Actions as Part of a Settlement Agreement (Monterey Plus)*, SCH# 2003011118 ("Draft Monterey Plus EIR")

Dear Ms. Brown:

This letter is to provide comments on the Department of Water Resources' Draft Monterey Plus EIR (DEIR), a document whose preparation PCL has actively sought and anticipated for more than a decade. When finalized, this EIR will be used as the decision-making document framing a decision by DWR on the so-called Monterey Amendments. If such amendments to the contracts governing the operations of the State Water Project were adopted and implemented, they would result in a drastic contractual restructuring of the State Water Project, now 47 years old. Our comments here do not speak extensively to the legality (or not) of this proposed decision to modify provisions of the contracts governing operations of the State Water Project, which are based on and carry out directions specifically adopted by the voters of California. This letter focuses on the environmental review document, and its adequacy.

In the litigation that compelled DWR's preparation of this EIR, PCL sought to ensure that DWR—the only entity with the statewide duty to manage and administer the State Water Project[1]—would correct the profound errors of process and substance that fatally infected the

[1] DWR's State Water Project duties, as envisioned by Governor Pat Brown and approved by the voters of California, are codified in the Burns-Porter Act, Wat. Code, §§12930, *et seq.* They also formed the basis for the prototype State Water Project validated by the California Supreme Court in *Metropolitan Water District v. Marquardt* (1963) 59 Cal. 2d 159. No Court has yet addressed the validity of the Monterey Amendments, whose final status necessarily awaits DWR's decision-making.

Central Coast Water Authority's review and approval of the 1995 EIR supporting the Monterey Amendments. In *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892 ("*PCL v. DWR*"), the Third District Court of Appeal unanimously vindicated PCL and its co-plaintiffs[2] on both grounds. Pointing to "the…contractors and the members of the public who were not invited to the table" in the negotiations that led to the Monterey Agreement, the Court held that "CEQA compels process…a meticulous process designed to ensure that the environment is protected." (83 Cal.App.4th at 905, 911.) Recognizing the "aura of unreality" surrounding discussions of the State Water Project, which has historically been unable to deliver even half the amounts referenced in Table A of the State Water Project contracts[3], the court found that CCWA's EIR "failed to meet the most important purpose of CEQA, to fully inform decision makers and the public of the environmental impacts of the choices before them." (*Id.* at pp. 913, 920.)

PCL entered into a 2003 Settlement Agreeement[4] with the expectation that DWR would counteract these historic errors and find "an effective way to cooperate" with the plaintiffs and other stakeholders in the preparation of an EIR fully complying with CEQA. DEIR, ex. D, and Exh. 3-A. Section III of the Settlement Agreement therefore confirmed, and elaborated on, DWR's EIR duties as previously recognized by the Court of Appeal. *Id.* at pp. 9-15.

The Settlement Agreement also made clear that the final outcome of the Monterey Amendments remains unwritten, so that DWR's new environmental review is not directed, even in part, at a *fait accompli.* While the Monterey Amendments are presently effective, they are effective only under an *interim* court order, made under Public Resources Code section 21168.9. The interim effectiveness of the Monterey Amendments will expire once DWR makes its new decision on all project components, recorded in new Notice of Determination, and files its return to the superior court's writ of mandate.[5] Once DWR completes an adequate environmental review, it is DWR's prerogative, and its duty as State Water Project manager, to render an entirely new final decision, and to choose which path to follow: the "Monterey Plus" project, the "no project" alternative, or one of the project alternatives reviewed in the EIR.

Since the Settlement Agreement went into effect (more than four years ago), PCL has participated in more than two dozen meetings of a Monterey Amendments EIR Committee, seeking to ensure that the EIR would produce a thorough and genuine CEQA analysis of the Monterey Plus actions. The EIR is the "heart and soul"[6] of both CEQA and the Settlement

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[2] The co-plaintiffs were Plumas County Flood Control and Water Conservation District, one of the 29 state water contractors, and the Citizens Planning Association of Santa Barbara County.

[3] See, e.g., DEIR, Appendix C (Long Term Water Supply Contract between DWR and Kern County Water Agency), § 6 and Table A.

[4] DEIR, Appendix D.

[5] DEIR, Appendix D, §§ II, V.F, VII.C; ex. 3-A.

[6] *PCL v. DWR,* 83 Cal. App. 4th at p. 911.

Agreement. Regrettably, DWR's Draft EIR falls far short of what CEQA requires from DWR. In short, the EIR is simply not adequate under CEQA. First, the DEIR does not adequately address specific concerns raised by the court in *PCL v. DWR*, including DWR's clear duty to analyze and disclose the consequences of implementing pre-Monterey article 18(b). That provision of the contract (which the Monterey Amendments would eliminate) requires DWR to reconcile contract amounts with the "humbler, leaner reality"[7] of deliverable supplies—prior to its elimination.

Second, the DEIR threatens a litany of potential new CEQA violations. To mention just several key problems:

- It improperly inserts key components of the Monterey Amendments into the project baseline, distorting the ability of the EIR to compare the project with the "no project" and project alternatives.
- It improperly uses an optimization model, CALSIM II, in a manner that effectively excludes the possibility of operating the project in a manner that would reduce rather than increase exports from the imperiled Bay-Delta Estuary, and fails to disclose project impacts to that estuary.
- It summarily rejects feasible alternatives and mitigation measures that would meaningfully address project objectives without requiring damaging and unlawful levels of new pumping.
- It fails to disclose the institutional and environmental consequences of transferring to local interests the ownership of a key part of the State Water Project—the Kern Water Bank, the world's largest underground storage facility—without any effective statewide accountability, and fails to study alternatives aimed at restoring that accountability.
- It evades, rather than engages, the "common-sense notion that land use decisions are appropriately predicated in some large part on the available water supply,"[8] thereby avoiding an analysis of the project's contributions to sprawl and environmentally destructive new growth.
- It avoids a required discussion of the project's creation of new "paper water" arising from a variety of sources, including the redefinition of article 21 "interruptible" water, administrative changes to the State Water Project, and overstatement of feasible deliveries in DWR's biennial Reliability Reports.[9]
- It fails to address the environmental consequences of the Monterey Amendments' financial restructuring of the State Water Project.

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[7] *Id.* at p. 914, n. 7.

[8] *PCL v. DWR*, 83 Cal. App. 4th at p. 915.

[9] PCL and its co-plaintiffs provided many of these comments to DWR in connection with its work on the Monterey EIR committee. Attachment A to these comments compiles some of these comments, which were not adequately addressed in the DEIR, or were simply ignored. These comment letters are therefore incorporated by reference in these comments, with the request that DWR specifically respond to them. We also incorporate comments made on behalf of PCL at public hearings.

• It recognizes the major problems that climate changes poses for the State Water Project generally, only to evade full assessment of project-related climate changes and defer the task to the very local decision-makers who will need to rely on DWR's programmatic assessment.

Finally, DWR must address these deficiencies at a critical juncture in California's water history, and make its final decision based on conditions as they exist in 2008, not 1995. The depth of the environmental crisis the State Water Project now faces deserves special emphasis. For the first time ever in 2007, the State Water Project's pumps were turned off temporarily to avoid an environmental catastrophe. Separate lawsuits have undercut DWR's ability to operate as in the past, without state permits and without federal biological opinions to justify continued pumping. Climate change, by the current estimations of DWR, could substantially cut project availability by mid-century. Moreover, California now faces the worst drought conditions it has experienced since the early 1990s.

These conditions underscore the crucial importance of delivering a Final EIR that fulfills, rather than avoids, the mandates of *PCL v. DWR* and the Settlement Agreement. In other settings, including Delta Vision, the California Water Plan, and recent reports and actions on climate change, California has commenced the difficult and necessary task of bringing to water policy a new era of realism that transcends the "build it and the water will follow" dictum of a previous generation.[10] Yet the DEIR seems conspicuously disconnected from the state's direction in other settings, to the point that "the plaintiffs" are chided for even suggesting alternatives that are sustainable and would not cause additional injury to the Delta.[11] To meet the hydrological, ecological and legal demands of our time, the Final EIR must rise to the occasion, rather than resorting to evasion.

Specific Comments

I. The DEIR evades key concerns raised by the Court in *PCL v. DWR*.

A. *PCL v. DWR* must serve as the starting point for DWR's EIR responsibilities.

As detailed below, the DEIR in key respects simply attempts to explain away, rather than directly address, the key holdings of the Court of Appeal in *PCL v. DWR.* The EIR must, as a starting point, analyze the substance of the court of appeal's decision in *PCL v. DWR* and ensure that its new project assessment is consistent with the Third District's analysis in that case. The key components of the ruling are as follows

• **Lead agency requirement**

[10] R. Kanouse, "Water Supply Planning and Smart Growth," in C. Davis, *et al.*, Navigating Rough Waters (American Water Works Association, 2001), p. 84. See also E. Rarick, CALIFORNIA RISING (2005), p. 213 (quoting Governor Pat Brown's statement that "I wanted to build a water project, and worry about the philosophy of land use later on").

[11] DEIR, pp. 11-6, 11-7.

Holding that CCWA erroneously acted as lead agency, the court ruled that CEQA required DWR, the only entity with the requisite "statewide perspective and expertise," to assume its proper role as lead agency in preparing a new EIR. (83 Cal. App. 4th at p. 907.) The Court noted the interconnected nature of the statewide project that the Monterey Amendments would transform: "[T]he allocation of water to one part of the state has potential implications for distribution throughout the system. DWR is painfully familiar with the problems plaguing the Delta and the possible impacts of the Delta Accord, an agreement between the federal and state governments on the Kern Fan Element." (*Id.)*[12]

- **"No project" alternative**

The court also held that the CCWA EIR was fatally defective under CEQA for failing to analyze implementation of pre-Monterey state water contract terms, and particularly the permanent shortage provisions of article 18(b), as part of the EIR's no-project alternative. Under the contracts that the Monterey Amendments would change , a permanent shortage occurs when the state is unable to reliably to deliver the full 4.23 million annual acre-feet (MAF) of previously-labeled "entitlements" listed in Table A of the project contracts. In that case, article 18(b) requires the state to make a proportional reduction of each contractor's amount listed in Table A, to match the available supply. The court held that an adequate EIR must analyze the impacts of eliminating these provisions.

- **"Paper water" problem**

The relationship between so-called "entitlements" and land-use planning was central to the court's holding that the EIR failed to address the "no project" alternative. The court connected this error to the risk of statewide land-use decisions made on the basis of "paper" water entitlements not grounded in real, deliverable water. The court openly criticized the false expectation that the State Water Project will deliver on its full "entitlement" level of 4.23 million acre-feet when the project's historic capability, evidenced in DWR's own data, has only been roughly half this level. The ruling therefore noted the "huge gap between what is promised and what can be delivered." (83 Cal.App.4th at 908.)[13]

- **Validation procedure**

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[12] As described in section V below, the Kern Fan Element is an approximately 20,000 acre-foot property on an alluvial fan, and the site of the Kern Water Bank, the world's largest groundwater storage facility. Article 52 of the Monterey Amendments call for DWR to relinquish control of the bank to the Kern Country Water Agency, which held the bank for only one day before retransferring it to a privately controlled joint powers agency, the Kern Water Bank Authority. Whether any statewide accountability will accompany the bank's operation is a key issue for DWR's new project decision.

[13] With respect to the "humbler, leaner reality" of project capability, the Court also noted the implicit assumption in the Monterey Amendments' financial restructuring of the State Water Project (article 51) that key facilities originally envisioned for the SWP will not be built. (*Id.* at 914.)

In addition to ruling for the plaintiffs on these CEQA claims, the court of appeal found that the plaintiffs had properly initiated a proceeding to question the substantive validity of the Monterey Amendments, including DWR's transfer of a 20,000-acre conservation and storage facility—the Kern Water Bank. . The court rejected a procedural challenge based on the theory that nonparty state water contractors were indispensable to the validation challenge. (83 Cal. App. 4th at pp. 920-926.)

- **Scope of the new EIR**

DWR must prepare an entirely new EIR as lead agency addressing the project as a whole. In *PCL v. DWR*, the Court of Appeal opined that it "need not hypothesize on the remaining issues" presented by the plaintiffs—such as the presence of a faulty project definition and the inadequate study of the Kern Water Bank's divestment—"because DWR, with its expertise on the statewide impacts of water transfers, may choose to address those issues in a *completely different and more comprehensive manner."* (83 Cal. App. 4th at p. 920 (emphasis added).)

B. Fundamental flaws in the DEIR undermine DWR's fulfillment of its lead agency duties recognized in *PCL v. DWR.*

As the court-directed lead agency with "principal responsibility " to carry out and approve the project (Pub. Res. Code, § 21067), DWR has an inherent responsibility to render a cohesive EIR that serves as the requisite environmental "alarm bell" in accordance with CEQA. The court recognized this obligation in *PCL v. DWR*, observing:

> The lead agency must independently participate, review, analyze and discuss the alternatives in good faith … Moreover, the agency's opinion on matters within its expertise is of particular value … As the process continues, "the lead agency may determine an environmentally superior alternative is more desirable or mitigation measures must be adopted … In sum, the lead agency plays a pivotal role in defining the scope of environmental review, lending its expertise in areas within its particular domain, and in ultimately recommending the most environmentally sound alternative.

(*PCL v. DWR*, 83 Cal. App. 4th at p. 904 (citing *Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal. App. 3d 692, 736-737).)

As elucidated further below, the current DEIR is not written in a way that will allow DWR to fulfill its lead agency obligations as required under CEQA. The DEIR consistently masks impacts and confuses readers. The DEIR obscures project impacts by presenting no project alternatives that include components of the proposed project. It fails, in other words, adequately to distinguish the proposed project from continued current conditions. The DEIR also limits options for decision makers by failing to provide alternatives distinguishable from the proposed action. These flaws prevent a sufficient analysis of the impacts and implications of moving forward with the proposed project. By limiting the outcomes of the alternatives included in the DEIR, and thus constraining the range of potential management decisions, the DEIR

attempts to absolve DWR of its decisional responsibilities as a lead agency. Therefore, the DEIR prevents DWR from fulfilling the lead agency role as defined and anticipated by the court in *PCL v. DWR*.

C. The DEIR fails to analyze the No Project Alternative as directed in *PCL v. DWR* and the Settlement Agreement

1. *PCL v. DWR* and the Settlement Agreement establish clear standards for the assessment and review of the no project alternative.

CEQA requires that the no project alternative address "existing conditions" as well as "what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services." (14 Cal. Code Regs. §15126(e)(2).) That requirement compels DWR in its new EIR fully to study the consequences of enforcing the terms of pre-Monterey water supply contracts prior to eliminating them.

To overcome the prejudicial error noted in the appellate ruling, DWR must "fulfill its mandate" in the new EIR "to present a complete analysis of the environmental consequences" of enforcing the pre-Monterey permanent shortage provision, article 18(b). (*PCL v. DWR*, 83 Cal.App.4th at 915.) Article 18(b) is the single most controversial aspect of the Monterey Amendments; controversy over its enforcement was the "driving force" behind the Monterey negotiations. (*Id.* at p. 908.) While the original contracts for the State Water Project (SWP) estimated the delivery capacity of the fully constructed SWP to be 4.23 million acre-feet of water, the contracts also anticipated the likelihood that this estimate could be wrong or fail to eventuate. The original contracts prudently included a safety valve in article 18(b), which would allow contracts to be reconciled with the "humbler, leaner reality" of SWP capacity. (*Id.* at p. 914, n.7.) The court of appeal recognized the need for such a safety valve, observing the "huge gap" between SWP entitlements and existing supplies connecting that holding to the risk of planning decisions grounded in "paper" rather than real, deliverable water.[14]

Because the Monterey Amendments, if adopted, would eliminate article 18(b), it is incumbent on DWR to come to terms with its "paper water" problem before finalizing that change to the project contracts. (*Id.*)The EIR must directly evaluate reduced Table A allocations resulting from application of that article. As a useful starting point, DWR should carefully review and perform the analysis requested in public comments referenced in the Third District's opinion. (*Id.* at 908, 915.)[15]

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[14] "Paper water," the court observed, was "always an illusion," steeped in the "unfulfilled dreams" of a water culture that had fostered an inflated expectation of what could be delivered. (*PCL v. DWR* (2000) 83 Cal. App. 4th 892, 914 fn. 7.)

[15] As one comment accurately suggested, the EIR "must include a parametric analysis of alternative levels of a lowered project yield tested by use of DWR's simulation model to establish which level of yield provides for the maximum reliability of deliveries given some tolerable threshold for failure to meet requests (i.e., with what frequency will Article 18(a) be

Section III.C.2 of the Settlement Agreement provides further guidance. It provides that the new EIR shall include "[a]s part of the CEQA-mandated 'no-project' alternative analysis, an analysis of the effect of pre-Monterey Amendment SWP contracts, including implementation of article 18 therein. This analysis shall address, at a minimum, (a) the impacts that might result from application of the provisions of article 18(b) of the SWP Contracts, as such provision existed prior to the Monterey Amendments, and (b) the related water delivery effects that might follow from any other provisions of the SWP Contracts." As PCL informed DWR in its March 28, 2003 scoping comments, two of the "other" contract provisions inevitably related to this assessment are articles 18(a) and 21, which prior to Monterey required, respectively, that agricultural contractors endure the first cutbacks in water allocations in times of temporary shortage and receive the first allocations in times of surplus.

The environmental effects of proportional reductions in Table A amounts, as calculated in the no project assessment, must be directly compared to those of the proposed project. As the court of appeal made clear in *PCL v. DWR*, neither claims of "infeasibility" nor purported legal disagreements can serve as an excuse for avoiding comparison of the environmental consequences of the no project alternative and the project. (*PCL v. DWR*, 83 Cal.App.4th at 918.

2. A dispositive error undermines the integrity of the DEIR's "no project" assessment.

The DEIR recognizes that if pre-Monterey article 18(b) were enforced, Table A amounts would be reduced to less than half their original levels—1.9 million acre-feet— to reflect the firm yield of the SWP. However, the DEIR assumes that this reduction in Table A would not tangibly reduce actual water deliveries, because water not delivered under Table A would be delivered as "surplus" water under article 21 of the pre-Monterey SWP contracts. In numerous passages, the DEIR offers variations on this same basic premise.[16]

This premise, the key to the DEIR's refusal to take article 18(b) reductions seriously, is startlingly close to reasoning in CCWA's decertified 1995 EIR that the Court of Appeal expressly rejected. CCWA's EIR posited that "[i]f Table A entitlements were adjusted, less entitlement water would be delivered and *more surplus water would be delivered pursuant to*

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invoked and with what consequences). All this can be accomplished without modification of the existing contracts." (83 Cal. App. 4th at 908.)

[16] See, e.g., DEIR, p. 2-16 (implementing article 18(b) "would not … have altered the amount of water that the Department delivered to the contractors in the many years when more than the minimum SWP yield was available in the SWP system. Instead, such water would have been delivered to contractors under Article 21"); p. 4-5 (with the elimination of article 18(a)'s agriculture-first shortage provision, "it no longer mattered whether a shortage was a temporary one or a permanent one, since the allocation of available supply would be the same in either situation"); p. 6-54 ("the altered allocation procedures provided for by Articles 18 and 21 result primarily in a shift in deliveries from one contractor to another and do not affect total deliveries").

Article 21. The total amount of water would be *essentially unchanged.*" (*PCL v. DWR*, 83 Cal. App. 4th at p. 929 (emphasis added).) The court specifically addressed this assumption, stating:

> This response does little more than acknowledge the paper commitment to build SWP facilities and the obvious fact that the hopes and dreams upon which the entitlements are based do not create a greater annual supply of water. None of the commenters suggested that implementation of article 18, subdivision (b), altered the contractual and political commitment to complete the SWP. They did, however, suggest that the elimination of paper water would impact land planning decisions that might reduce the need for as many SWP facilities. Under that scenario, article 18, subdivision (d), might not be invoked nor would surplus water under article 21 be tapped and exhausted.

(*PCL v. DWR*, 83 Cal. App. 4 h at p. 919.)

For multiple reasons, this premise in the DEIR is as baseless now as it was when the failure of DWR to address this key issue resulted in the judicial decertification of the 1995 EIR. First, the DEIR simply assumes as a foregone conclusion something that was very much in doubt. In 1994, prior to the initial enactment of the Monterey Amendments, the California Research Bureau (CRB) prepared a paper analyzing twenty options for changing the State Water Project's repayment system, one of which (Option 5) called for the implementation of pre-Monterey article 18(b) (CRB Report).[17] The report found that "[t]here is no guarantee" that implementing article 18(b) "would 'create' any surplus water. If the DWR implemented Article 18(b), they might also change how it operates the SWP reservoirs. They might decide, for example, not to distribute 'surplus' water and instead decide to store the water for distribution as entitlement water in another year."[18]

Second, the analysis incorrectly assumes that demand for SWP water in the Monterey and non-Monterey scenarios would be the same. That assumption is untenable, because The Monterey Amendments, if adopted, would fundamentally change the definition of Article 21 water. In particular, those amendments delete the pre-Monterey proviso in article 21(g)(1) that "the State shall refuse to deliver such surplus water to any contractor" to the extent that "the State determines that such delivery would tend to encourage the development of an economy within the area served by a contractor which would be dependent upon the sustained delivery which would be dependent upon the sustained delivery of water in excess of the contractor's maximum entitlement."[19]

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[17] Dennis O'Connor, FINANCING THE STATE WATER PROJECT: OPTIONS FOR CHANGE (CRB, August 1994). This CRB Report is included as Attachment B to these comments.

[18] Attachment B (CRB Report), p. 21.

[19] See DEIR, p. 2-17; DEIR, Appendix C (Amendment No. 1 to Kern Contract, p. 9). Metropolitan Water District's pre-Monterey contract included this language in Article 21(g)(1). The Monterey Amendments delete this language. DEIR, Appendix C (Amendment No. 23 to Kern contract, p. 13).

Third, other Monterey Amendments-related managerial changes also could profoundly affect the demand for article 21water. These include the removal of limitations on access to storage facilities, and the creation of a "turnback pool," which allows the contractors to sell their unused Table A amounts, acting as though the water resources of the state, which belong to the public, are actually the private property of the contractors. In short, the Monterey Amendments clearly removed constraints that would have limited demand for SWP water and capacity to accept SWP water. Yet the DEIR, recycling reasoning that discredited the 1995 EIR, assumes that these contract provisions are meaningless and have no bearing on demand or capacity to receive water.

Fourth, the DEIR fails to recognize that perceived and explicit disclosure of water reliability can impact demand for SWP water and the use of that water. The shortage provisions (article 18 (a) and 18 (b)) of the pre-Monterey SWP contracts recognized that the reliability of water fluctuates. The contracts also reflected the reality that the level of reliability necessary for certain uses also fluctuates. The pre-Monterey contracts attempted to reconcile water reliability and water allocation with article 18 (a) and 18 (b). The pre-Monterey SWP contracts recognized that water availability would fluctuate according to hydrology, area of origin demand, and environmental needs. Therefore, only a limited amount of water could be reliably delivered during drought and other shortages. The original contract provision of article 18(a) reflected that municipal contractors require a higher reliability of water than agricultural contractors. Thus, article 18(a) provided that level of reliability by providing municipal contractors a preference for water in drought and short term shortage.

In short, the existing (pre-Monterey) contracts recognized that article 21 water, the least reliable category of water under the contract, is unsuitable for use as a prolonged source of supply. Municipal contractors could not depend on sources of unreliable water in the same manner that they depend and use reliable sources, because doing so would put people, businesses and the environment at significant risk. Indeed, the risk that municipal contractors may inappropriately approve permanent development based on unreliable water is the essence of "paper water."[20] Like the invocation of article 18(b), article 21(g)(1)'s prohibition against founding permanent economies on vulnerable "surplus" water provided a powerful "safety valve" against paper water-based development. It provided decision-makers with a clear understanding that deliveries beyond the SWP's minimum yield are unreliable. In such a case, municipal water agencies would be legally and contractually restricted from relying on water in excess of the estimated minimum yield of water for development, as well as for prolonged supplies. By contrast, the Monterey Amendments—provisionally under the present implementation, and permanently under the proposed project—would remove these safeguards.

Yet the DEIR fails to analyze the impacts of these realities. Instead, the DEIR assumes that all water provided by the SWP, either Table A, article 21 or otherwise would be used in the same manner and would procure equal demand regardless of the explicit disclosure of reliability

[20] "Paper water always was an illusion. "Entitlements" is a misnomer, for contractors surely cannot be entitled to water nature refuses to provide or the body politic refuses to harvest, store and deliver." (*PCL v. DWR* (2000) 83 Cal. App. 4th at p. 914, n. 7.)

by the state. The DEIR is thereby assuming that SWP contractors are able to utilize very unreliable water[21] in the same way they demand very reliable water. This assumption is not supported by analysis and is not supported by law. In short, the current DEIR attempts to recycle the same skewed logic that led to the 1995 EIR's specious dismissal of the "paper water" problem.[22]

II. The DEIR fails to provide an accurate, stable and finite definition of the proposed project.

A. CEQA demands an accurate, stable and finite project definition that addresses the "whole of the action" under review.

Leading CEQA decisions have long since recognized that "an accurate, stable and finite project definition is the *sine qua non* of an informative and legally sufficient EIR." (*County of Inyo v. City of Los Angeles (III)* (1977) 71 Cal.App.3d 185, 199.) The CEQA process cannot "freeze the ultimate proposal in the precise mold of the initial project; indeed, new and unforeseen insights might emerge during the investigation, evoking revision of the original proposal." (*Id.*)

Precision and consistency in a lead agency's characterization of the project under review also reinforces related principles of CEQA: that the project must embrace the "whole of the action" (14 Cal. Code Regs., § 15378(a)); and that assessments in an EIR may not be used to justify a decision already made. In sum, CEQA "compels an interactive process of assessment of environmental impacts and responsive modification which must be genuine." (*County of Inyo v. City of Los Angeles* (*VI*) (1984) 160 Cal.App.3d 1178, 1185.)

B. The DEIR substantially understates the scope of the Monterey Amendments' proposed restructuring of the State Water project, and does not explain the source of authority for that proposed restructuring.

The description of the proposed project provides a very abbreviated summary of the changes in the SWP that would accompany the permanent adoption and implementation of the Monterey Amendments – in other words, those changes that would become permanent if the project were approved. Adopting what might be termed a "greatest hits" format, the analysis is limited to five bullet points, a few clarifying paragraphs, and a title line for all the remaining parts of these complex amendments. DEIR, §§ 4.3-4.4, pp. 4-2 to 4.8. Similarly, the background paper on the SWP is limited to a brief description of several articles, divorced from their legal and institutional context. DEIR, Ch. 2, pp. 2-1 to 2-19.

[21] See, e.g., DWR, 2005 RELIABILITY REPORT, p. 15 (article 21 water is "highly unpredictable and unreliable").

[22] *PCL v. DWR*, 83 Cal. App. 4th at p. 914.

These cursory discussions fail to illuminate critical aspects of the SWP that relate to the project's essential mission and statewide environmental accountability, and how this system would be fundamentally changed if the Monterey Amendments become permanent. In the deliberations that framed the SWP, the Governor, DWR, and the Legislature created a water project to enable the state to more evenly to distribute scarce water supplies, which the state controlled as a common good. To develop that resource, DWR and the Governor's office developed--and the Legislature and people approved--a system unique in the country. Unlike the federal Central Valley Water Project, where the federal government paid all project costs, the SWP focused upon water as a public good that belonged to the people.[23]

Authorization of the SWP therefore was premised on an understanding that the voters of California would therefore decide on whether they agreed to the distribution of water in the SWP. If they agreed to that redistribution, the voters would agree to back an issuance of bonds to construct the project with the provisos that (1) agencies contracting for the water would pay back the costs of constructing the project solely for the *right* to have water delivered to them through the project's facilities; and (2) although agencies would repay the costs of constructing the project, the facilities and the water would continue to belong to the State, as a *public* resource.[24]

The project framers also anticipated that the state water project would operate based upon long-term water service contracts that would remain in effect until the retirement of all water resources development bonds no sooner than 2035. These contracts would be unique, in that they were based upon: (1) DWR's inherent responsibility to manage the state's water resources fairly and equitably; (2) the principle that all contractors were to be treated equally; (3) the provision that any agency or district in California could contract with the department for water service; and (4) a trusteeship requiring the project to be constructed and managed for the good of the people of California.[25]

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[23] See P.A. Towner, *Brief History of the Negotiation of Water Supply Contracts for the State Water Project*, presented to the California Water Commission (Dec. 3, 1976).

[24] *Ibid.*

[25] The objective of the state water project to operate for the good of the people of California became part of the Bond Act. Once the Act was passed, it was incorporated into the Water Code (Wat. Code, §12930, *et seq.*) Governor Brown signed the prototype long-term water service contract with Metropolitan Water District just before the 1960 election. (Rarick, *supra*, at p. 221.) To further ensure that the people of California would not be responsible for repaying the bonds used to construct the facilities, DWR required agencies with which it contracted to have taxing authority, so that if the agency could not meet its payments to DWR, it would be required to tax residents to make these payments. (Wat. Code, §12937.) Conversely, if the SWP were "sold" into private ownership, it would potentially threaten the tax-exempt status of the project's general obligation bonds. Attachment B (CRB Report), p. 51.

To develop and secure approval of the state water project, DWR and the Governor first prepared a "statement of principles" for the long-term water service contractors.[26] These principles are derived from the "utility theory," which Governor Brown described to the Legislature as recognizing "our obligation to insure that water will be available to meet the proper demands of every part of the State."[27] These principles were the ones used to promote the project to California voters, and those principles reflected project sponsors' understanding that voters would not vote for project financing to support water facilities they did not own or control. Moreover, those principles specified that DWR would be acting as an agent and trustee of the people to manage water resources for the good of all Californians. After preparing these principles, the framers prepared and secured voter approval of the Burns-Porter Act.[28]

The SWP thus was premised on a fundamental *quid pro quo*: its contractors would benefit from project operation, but the public always would control the project itself, and the project's works truly were to be part of a "state" water project, which would be publicly owned and operated for public benefit. After securing passage of the Bond Act, DWR and the Governor determined the redistribution patterns of water throughout California based on estimated need and secured the water rights for those areas in the amount of estimated need until 2035, the end of the project repayment period. They also negotiated with agencies throughout California for water service contracts. The amount of water these agencies could expect to receive over the life of the project was subject to limitations, including limitations from water rights permits, climatological and environmental conditions. The contracts were to extend until 2035. The Department could not predict all conditions affecting water conditions until 2035. Consequently, state water service contracts were written so that DWR could not be held responsible for water it could not deliver provided that it made reasonable attempts to do so.[29]

On their face, key features of the Monterey Amendments, if made permanent, would differ sharply from the central tenets of the SWP contracts as originally framed, approved, and validated by the voters, shifting a substantial degree of control from SWP to the contractors. To name several examples:

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[26] Cal. State Senate Fact Finding Committee on Water Resources, Partial Report, *Contracts, Financing, Cost Allocations for State Water Development* (March 1960), pp. 51-52.

[27] E.G. Brown, Water Message to Legislature, Cal. Sen. J., Vol. 1 (1959) 222, 224-225. The Governor's principles constituted a "contemporary administrative directive, which was known to the voters at the time of the election," and were also accepted by the Legislature. (*Goodman v. County of Riverside*, (1983) 140 Cal. App. 3d 900, 907-908.)

[28] Wat. Code, § 12930, *et seq.*

[29] Under the state water project, contractors "are obligated to pay for their contractual entitlements of water" from the project, "*whether the water is delivered or not.*" (*PCL v. DWR*, 83 Cal. App. 4th at p. 899.)

- Major changes in article 18 would remove the temporary shortage provision requiring "agriculture first" cutbacks (article 18(a)) and the permanent shortage provision requiring Table A amounts to be reconciled with available supplies.
- Article 51 transforms the financial structure of the SWP, allowing the contractors "a rebate for the costs previously assessed for facilities that have never been built."[30]
- Article 52 facilitates the transfer of the Kern Water Bank property to local control, in exchange for the "retirement" of 45,000 acre-feet of Table A amount that two agricultural contractors-- Kern County Water Agency and Dudley Ridge Water District—had no assurance or reasonable expectation of ever receiving in deliverable water.
- Article 53 authorizes the transfer of 130,000 acre-feet in new agriculture-to-urban transfers, eases requirements for other transfers, and allows the transportation of water in state facilities to other contractors, or entities other than non-contractors.
- Article 54 provides for local control and management of the two terminal reservoirs.
- Article 55 allows contractors to transport non-project water in SWP facilities at the lower costs referenced in the SWP contracts.
- Article 56 allows contractors to sell water outside their service areas.

Collectively, these changes far exceed any other changes in the project's history. At present, the Monterey Amendments are proceeding under the authority of the Sacramento Superior Court's interim order under Public Resources Code section 21168.9.[31] But the DEIR never identifies the source of authority to make the amendments permanent. DWR should address these changes in light of Water Code section 12397(b)(4), the source of DWR's contracting authority, which provides that "[s]uch contracts shall not be impaired by subsequent acts of the Legislature during the time when any of the bonds authorized herein are outstanding and the state may be sued with respect to said contracts." DWR should indicate the source authority, if any, for the project as proposed to become permanent without the approval of the Legislature, or of the voters of California.

This issue of authority cannot be marginalized as a mere "legal" issue divorced from the environmental consequences of the project. Rather, on a host of environmental issues discussed in these comments, a foundational question is for whose benefit the project exists, the people of California or the State Water Contractors. The answer to this question may have profound consequences for the environment, particularly in times of water scarcity. DWR's clarification of its source of authority may therefore help illuminate whether its approach to managing the SWP can proceed consistently consistent with its duties as CEQA lead agency.[32]

C. The DEIR does not adequately clarify the "uses of the EIR."

[30] *PCL v. DWR*, 83 Cal. App. 4th at p. 914, n.7.

[31] Settlement Agreement, Appendix 3-A.

[32] *PCL v. DWR*, 83 cal. App. 4th at 903-907.

When finalized, the EIR will be used primarily by DWR, as lead agency, to decide whether to approve, modify, or disapprove the components of the proposed project: the Monterey Amendments and the further actions described in the Settlement Agreement. The DEIR summarizes the proposed project in Chapter 4, which also briefly describes the Monterey Amendments and the Settlement Agreement. As required by the writ of mandate issued by the Superior Court to implement the decision of the Court of Appeal in *PCL v. DWR*, "upon completion and certification of the new EIR, Respondent DWR shall make written findings and decisions and file a Notice of Determination identifying the components of the project analyzed in the EIR, all in the manner prescribed by sections 15091-15094 of the CEQA guidelines."[33]

Despite some helpful language, the DEIR's section of the "intended uses of this EIR (DEIR, § 1.2) contains one phrase that is ambiguous. It indicates that DWR as lead agency, and the State Water Contractors as responsible agencies, will use the EIR to "decide whether to *continue* operating under the proposed project: the Monterey Amendment and the Settlement Agreement, as described in Chapter 4, or to decide to implement one of the alternatives to the proposed project." (*Id.* at p. 1-1 (emphasis added).

The Monterey Amendments are presently proceeding only under an interim order that will expire following DWR's new Notice of Determination and return to the writ. The use of the word "continue" should not suggest that the default condition will be to make that interim operation permanent, or that DWR's approval decision on the "Monterey" part of the Monterey Plus project can be relegated to the past tense.

Instead, DWR must determine, based on its assessment of project impacts, alternatives, and mitigation measures, whether to (a) approve and execute the Monterey Amendments as initially proposed in 1994 and approved and executed in 1995; (b) approve and execute the Monterey Amendments and the further actions described in the Settlement Agreement; (c) approve and execute the Monterey Amendments as further modified in response in response to the analysis in and public comment on the present EIR; (d) approve and execute an alternative to the Monterey Amendments; or (e) approve no project at all. The EIR will also be used to determine whether or not to authorize the permanent transfer of the Kern Fan Element, and to proceed with the 41,000 acre-foot Kern/ Castaic transfer as part of the final project.

The Superior Court's writ of mandate requires DWR's *de novo* determinations and actions, because at present no project elements have been approved, except for the Superior Court's interim order under Public Resources Code section 21168.9. The exercise of that discretionary power cannot vitiate the fundamental CEQA duties of lead and responsible agencies to precede their final project decisions by the completion and certification of a valid EIR. The EIR will thus be used to DWR to meet these requirements of law and proceed once the section 21168.9 order ceases to be in effect.

PCL requests that the EIR specifically address each of the following questions, which it raised more than a year ago in a letter to the DWR Director:

[33] Settlement Agreement, Appendix 3-A.

1. Once DWR has completed and certified its EIR, will DWR make a new decision on all components of the project, recorded in a new notice of determination?

2. If DWR makes a new project decision, will that decision determine whether or not DWR will approve and execute the Monterey Amendments?

3. If DWR makes a new project decision to approve a project that includes the Monterey Amendments:

    a. Will the decision consider a no project alternative that includes no actions taken under the Monterey Amendments?
    b. Will the decision determine whether or not to adopt alternatives to the Monterey Amendments?
    c. Will the decision determine whether or not to adopt mitigation measures for any significant impacts of the Monterey Amendments?
    d. Will the decision determine whether to authorize the permanent transfer of the Kern Fan Element?
    e. Will the decision determine whether or not DWR approves of water deliveries under the 41,000 acre-foot Kern/Castaic transfer?[34]

III. The DEIR's "aura of unreality"[35] undermines its ability to meaningfully address the distinct environmental consequences of the project.

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[34] The 1999 contracts framing this agriculture-to-urban transfer were not the subject of a validation challenge. However, those transfer contracts were expressly based upon the Monterey Amendments, whose final authorization remains unknown, and DWR has never approved the transfer outside of the Monterey Amendments, which would subject it to the pre-Monterey agricultural deficiency provisions of article 18(a) and undermine its reliability to support urban uses. (See Attachment C (2002 letter of Castaic's counsel).) The Los Angeles Superior Court decertified Castaic's stand-alone 2004 EIR in May 2007 (*Planning and Conservation League v. Department of Water Resources* (LASC No. BS 098724.) While Los Angeles Superior Court Judge James Chalfant characterized the *1999* transfer contracts as "final," he recognized that DWR could still take actions that could "undermine" the ability of the transfer to deliver water. *Id.* at p. 13. He also relied partially on representations of DWR's counsel that DWR had the discretion to take steps that might curtail deliveries under the transfer. *Id.* at p.20 All parties except for DWR have appealed that decision, and it is pending in the Second District Court of Appeal. In addition to fully studying the Monterey-associated impacts of this sprawl-supportive transfer and appropriate mitigation, the EIR should fully consider PCL's proposed alternative that would consider alternative dispositions of its water. In a time of statewide water shortage, the need for DWR's careful evaluation is particularly acute.

[35] *PCL v. DWR*, 83 Cal. App. 4th at p. 912.

A. The DEIR analysis is predicated upon a defective environmental baseline.

Without the development of an adequate baseline condition, "analysis of impacts, mitigation measures and project alternatives becomes impossible." (*County of Amador v. El Dorado County Water Agency* (1999) 76 Cal. App. 4th 931, 953.)[36] The baseline for these assessments must be based on an analysis of "real conditions on the ground," rather than mere opinion or narrative. (*Save Our Peninsula Committee v. Monterey County Board of Supervisors* (2001) 87 Cal.App. 4th 99, 121.)

The DEIR accurately notes that that the baseline for assessment here is "complicated" by the implementation of the Monterey Amendments before 2003, when DWR issued its Notice of Preparation.[37] Nonetheless, a series of glaring errors undermine the baseline's integrity to serve as the basis for assessing the project's environmental impacts.

First, the DEIR states that the baseline has been "*adjusted to include events that are expected to occur over time"* that it assumes are "not related to the Monterey Amendment and the Settlement Agreement."[38] That "adjustment" constitutes an error of law under CEQA. It is the "no project" alternative, rather than the baseline, that, in addition to existing conditions, must account for "what would be reasonably expected to occur in the foreseeable future if the project were not approved, based upon current plans and consistent with available infrastructure and community services." CEQA Guidelines, § 15126.6(e)(2). But the "no project" alternative is "not the baseline for determining whether the project's proposed impacts may be significant, unless it is identical to the existing environmental setting analysis which does establish that baseline." *Id.*at 15126.6(e)(1). Here, where the "no project" analysis is much more complex, and by no means "identical" to the environmental setting, there is no basis for making these forecasting adjustments to the baseline, and the resulting mistake fatally infects the comparison between the baseline and impact assessment.

Second, the baseline does not accurately reflect pre-Monterey contract provisions that set limitations for contractors, and thus does not accurately reflect constrained demands or capacity

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[36] See also CEQA Guidelines, § 15125(a) (the environmental setting will "normally constitute baseline physical conditions by which a lead agency determines whether an impact is significant"); DEIR, p. 5-1.

[37] The DEIR inaccurately lists the Monterey Amendments' implementation date as 1995. DEIR, p. 5-2.

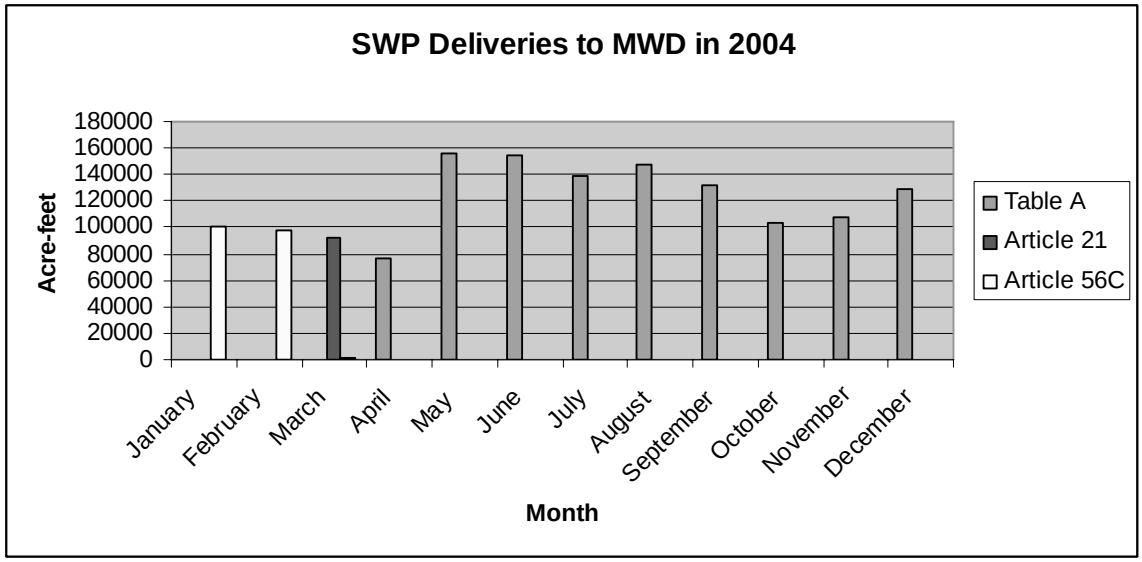
[38] DEIR, p. 5-2 (emphasis added); see also DEIR, p. 3 (postulating that "other changes and transfers" alleged to be "unrelated" to the Monterey Amendment, have occurred or are anticipated to occur by 2020). Although DWR attempts to project baseline and project conditions through 2020, the project involves changes to SWP project contracts that will remain effective until 2035. DWR's impact assessment does not demonstrate why it fails to make reasonable attempts to take account of the additional 15 years of project impacts.

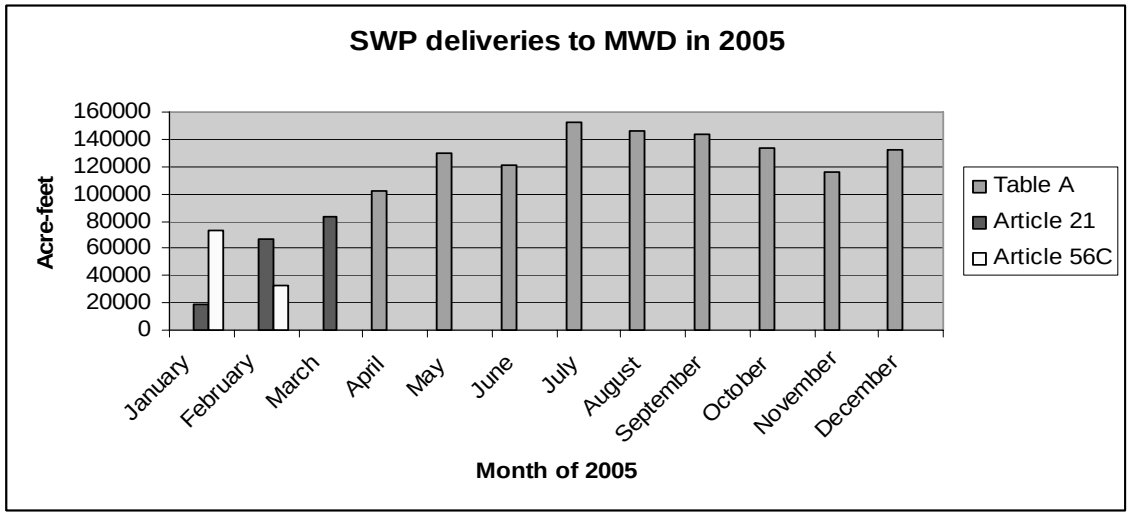
to accept SWP water under pre-Monterey contracts. These provisions, changed under Monterey as noted above, include the following:

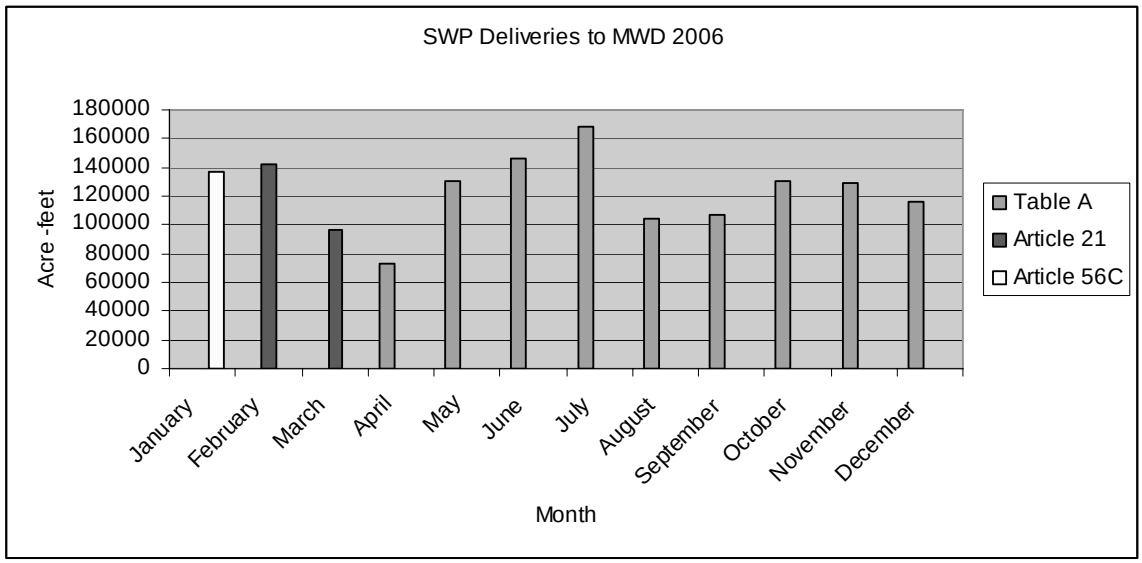
• The pre-Monterey contracts precluded SWP contractors from storing water outside of their own service areas. This provision limited contactors' capacity to accept SWP water to the real-time customer demands plus the amount of water that could be stored in facilities within the contractors' service areas. Eliminating this provision in the Monterey Amendments significantly expanded storage options available to contractors, and thereby enhanced contractors' capacity to take water. Yet the DEIR assumes that the baseline water demand is the same as demands when such limitations are not applied to contractors (as in the proposed project).

• The baseline also does not reflect how Article 21(g) (1) of the pre-Monterey contracts precluded the use and therefore demands for Article 21 water. As noted above, Article 21 (g) (1) prevents the state from delivering "surplus" water where it determines that it would contractor to the extent that the State determines that such delivery would tend to "encourage the development of an economy within the area served by sustained delivery of surplus water." This article established a specific limiting provision for delivery of Article 21 water, and the baseline should assume that DWR would implement it and withhold delivery of water where appropriate. By contrast, the Monterey Amendments have been in effect on an interim basis without that limitation. Several contractors now have economies that are dependent on continued delivery of Article 21 water. According to tables provided by DWR for water years 2004 and 2005, some urban contractors now take Article 21 and carry-over water in the winter months while taking little or no Table A supplies and take Table A supplies later in the year (see tables below). This indicates that some contractors are using Article 21 supplies to sustain the hard demands of their service area in winter months.[39]

[39] In fact, review of the historic deliveries of article 21 water demonstrates that municipal demands for Article 21 water supplies have *increased* since implementation of the Monterey project. Such use would have been prohibited under the pre-Monterey contracts. This increased demand for article 21 water should not be included in the baseline. The EIR should further analyze whether proposed contract amendments have indeed resulted in hardened demand for article 21 water, and corresponding shifts in delivery, demand, and request patterns for Table A supplies.


SWP Deliveries to MWD in 2004
Acre-feet
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
Table A
Article 21
Article 56C


SWP deliveries to MWD in 2005
Acre-feet
160000
140000
120000
100000
80000
60000
40000
20000
0
January
February
March
April
May
June
July
August
September
October
November
December
Month of 2005
Table A
Article 21
Article 56C


SWP Deliveries to MWD 2006
Acre -feet
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
Table A
Article 21
Article 56C

Source data provided electronically to Mindy McIntyre by DWR staff in 2007

Third, the baseline inappropriately excludes an accurate analysis of allowable operations under the current regulatory setting. The baseline does not include operational constraints of the federal Endangered Species Act (FESA) and the California Endangered Species Act (CESA). As detailed further in section III.B, *infra*, recent state and federal court rulings have determined that SWP operations as modeled in the DEIR do not comply with either CESA or FESA, and are therefore illegal.[40]

Fourth, the DEIR fails to recognize climate change in the baseline (and in the analysis of alternatives). The DEIR incorrectly states that too little is known about climate change to warrant incorporation of findings into the baseline and alternative. Rather, the DEIR provides a cursory discussion of climate change in a separate section of the EIR[41]. This assertion is contradicted by numerous studies and findings, including research published by DWR well before the release of the DEIR.

DWR has prepared and released significant information on climate change impacts to the SWP system and to California water resources. The Department's own "Progress on Incorporating Climate Change into Water Management," outlines several feasible scenarios for climate change. CEQA does not require definitive information prior to incorporation into analysis. Indeed, as noted by the Intergovernmental Panel on Climate Change, it is very unlikely that future California hydrology will be the same as past hydrology:

> The IPCC (2001) ranked the confidence limits of major impacts to water resources due to observed and projected climate change as very high (0.95-1.00), high (0.67-0.95), medium (0.33-0.67), low (0.05-0.33), and very low (0.00-0.05). There is high confidence that the timing and amount of runoff is changing, and very high confidence that watersheds with substantial snowpack will experience major changes as temperature continues to rise. The impacts of this trend are a decrease in available water resources in California, primarily during the summer months, and a potential increase in wintertime floods. There is high confidence that California's Sierra Nevada will experience a continued trend of decreased snow accumulation

[40] See, e.g., *Natural Resources Defense Council v. Kempthorne* (E.D. Cal. 2007), 2007 U.S. Dist. LEXIS 42263 (existing and planned future operations in the Central Valley Project and State Water Project may jeopardize the Delta Smelt, creating ESA compliance problems. While the baseline excludes compliance with these state and federal endangered species laws, the DEIR simultaneously relies on the FESA process to mitigate for many of the significant impacts of the proposed project. However, the DEIR provides no analysis to demonstrate that the FESA process is capable of mitigating these impacts.

[41] See DEIR, Ch. 12, addressed in section of these comments, *infra.*

and earlier snowmelt (e.g. Lettenmaier and Gan 1990; Jeton et al. 1996; Miller et al. 1999; Wilby and Dettinger 2000; Knowles and Cayan 2002; Miller et al. 2003).[42]

In fact, and as discussed fiurther below, widely available data demonstrate that climate change is already occurring in California, with trends of declining snowpack and earlier annual peak runoff.[43] Numerous studies, listed in attachment D to these comments, address climate change and its effects on water resources in California are available. Despite this overwhelming body of evidence of current and future climate change, the DEIR ignores climate change in the baseline and in all alternatives. Instead, the baseline and all alternatives are based on past hydrology.

In sum, the DEIR's baseline fails to provide an accurate basis for comparison of environmental impacts associated with the proposed project or other alternatives. The baseline must be adjusted to reflect the pre-Monterey SWP contracts, pre-Monterey SWP operations and the impacts of climate change. Without such adjustments, the baseline is an inadequate reference from which to determine the impacts of the proposed project and project alternatives.

B. The DEIR fails to reflect the current regulatory framework, and in particular the impact of the Delta Smelt/OCAP decision on the delivery reliability of the SWP.

DWR's final decision on the "Monterey Plus" must reflect and address SWP and environmental conditions as they exist now, rather than freezing them in 1995 or 2003. The recent ruling invalidating the biological opinion for the Delta Smelt is one of the most significant current environmental constraints for the SWP. Yet the DEIR fails to incorporate the impact of this decision in alternatives analysis or recognize this significant decision in Section 6.3 (Changes in SWP Operations Since 1995 Unrelated to the Proposed Project). The federal court's

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[42] *California Climate Change, Hydrologic Response, and Flood Forecasting* , Norman L. Miller Earth Sciences Division, Berkeley National Laboratory, Berkeley, California, USA . Presented at the International Expert Meeting on Urban Flood Management 20-21 November 2003, World Trade Center Rotterdam, The Netherlands April 30, 2004. http://www.lbl.gov/Science-Articles/Archive/assets/images/2004/Apr-30/California_Flooding.pdf

[43] *Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary*. Noah Knowles and Daniel R. Cayan, Geophysical Research Letters, VOL. 29, NO. 18, 1891, doi:10.1029/2001GL014339, 2002, http://natypete.andradedowns.googlepages.com/knowles2002.pdf; No. 119. Effects On Water Resources: Monitoring Snowmelt Runoff And Sea Level for Climate Change, Maurice Roos, California Department of Water Resources, presented at the U.S. Climate Change Science Program (CCSP) workshop on November 14-16, 2005, in Arlington, Virginia http://www.climatescience.gov/workshop2005/posters/P-WE2.8_Roos.pdf

summary judgment decision was issued on May 25, 2007, many months before the DEIR and the final ruling has now been issued.[44]

DWR has publicly recognized the impact of the Delta Smelt ruling outside of the DEIR. DWR's Chief of Project Operations Planning Branch, John Leahigh, stated that under the interim remedy actions proposed by the United States Fish and Wildlife Service (USFWS), SWP 2008 deliveries would be reduced anywhere between 8% (91,000 AF) to 27% (305,000 AF) from a baseline delivery of 1.15 MAFY in a dry year; and from between 8% (252,000 AF) and 31% (305,000) from a baseline of 3 MAFY in an average year. (Attachment F, *NRDC v. Kempthorne*, Doc. 398, Declaration of J. Leahigh, dated July 9, 2007, at ¶¶ 6. 36-37.)

While the ruling initially imposed an interim remedy only, it is reasonable to expect that the next biological opinion will impose permanent restrictions that are similar or more stringent to the interim remedy. It is very unlikely that the USFWS will issue a biological opinion significantly similar to the pre-ruling opinion. Given this likelihood, the EIR should reflect the operations imposed by the court in the Delta Smelt ruling. Indeed, the ruling demonstrates that existing operations, as modeled in the DEIR, are not lawful. The Delta Smelt ruling will alter the way the proposed project can be implemented. The interim remedy imposed by the court restricts winter and spring SWP pumping in the Delta. Such restrictions will necessarily impact deliveries of Article 21 water, as well as Turnback Pool transfers. Any conclusions included in the DEIR regarding deliveries of Article 21, Turnback Pool water and other water deliveries in the winter and spring are now inaccurate. The EIR must recognize the Delta Smelt ruling, and fully incorporate it into the environmental analysis for the project.[45]

C. The DEIR improperly uses CALSIM II as the principal tool to analyze baseline condition and environmental impacts.

The DEIR relies on CALSIM II to analyze the impacts of water allocation and deliveries under the baseline, the proposed project and the alternatives. CALSIM II results are relied upon to estimate SWP delivery and export impacts as well as to derive environmental impacts on the Delta and upstream tributaries. While CALSIM II may be a sophisticated and useful modeling tool for certain purposes, it is inappropriate for determining environmental impacts and for estimating impacts in export and deliveries. It has been criticized by a panel of expert reviewers for several weaknesses, including its lack of amenability to proper calibration. (*See* A. Close, *et al., A Strategic Review of CALSIM II and its Use for Water Planning, Management and Operations in Central California* submitted to California Bay Delta Authority Science Program, December 4, 2003.

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[44] Attachment E, *NRDC v. Kempthorne*, 1:05-cv-1207 (EDCA), Doc. 560, Interim Remedial Order Following Summary Judgment and Evidentiary Hearing, dated Dec. 14, 2007, Attachment F, *NRDC v. Kempthorne*, Doc. 323, Order Granting In Part and Denying In part Plaintiffs' Motion for Summary Judgment, dated May 25, 2007.

[45] The EIR also needs to discuss the *time of year* in which cutbacks of pumping will be necessary to achieve the restoration of the Delta Smelt. The timing of these cutbacks may well occur in spring and winter, ordinarily a heavy period for SWP pumping.

In addition, CALSIM II assumes foresight on the part of operators, and thus assumes that operators will not take actions that will result in later violations of environmental standards or other operating constraints. This assumption can lead to great underestimation of environmental impacts, for in the real world operators do not have such foresight and thus may make decisions without realizing the consequences ultimately resulting from those decisions.

Furthermore a recent analysis has revealed additional flaws in the statistical basis for CALSIM II. ("Analysis of CALSIM's Statistical Basis,"by Arve Sjovold, December 28, 2004, previously provided to DWR).

CALSIM II predictions are only as accurate as the data and assumptions that are plugged into the model. Here, those assumptions may be wrong; for example, the DEIR assumption that future water flow patterns will be similar to those that have occurred in the past is inconsistent with the ample literature on the substantial effects of global warming on California water flows. These input data errors and uncertainties further undermine the ability of the DEIR's modeling analysis to make the kind of predictions necessary to support a genuine analysis of impacts.

Because CALSIM II is an optimization model that does not necessarily reflect options available to water operators, it may predict levels of exports. However, federal and state water quality and endangered species laws and regulations probably would prohibit such high export levels for water quality problem. The DEIR assumes that future water exports from the Delta will be nearly twice the historic average. Yet this prediction fails to recognize that DWR has chronically failed to meet water quality standards in the Delta under historic operations, and significant environmental degradation has taken place under such conditions, resulting in new regulatory actions. In light of the recent pelagic organism declines in the Bay Delta Estuary, and resulting rulings invalidating the biological opinion for Delta smelt, it is prudent to ensure the DEIR modeling assumptions predictions are conservative, rather than "optimizing" to ensure assumed deliveries would not violate conditions of the Federal Clean Water Act, the Federal or California Endangered Species Acts, or any other environmental permit condition, regulation, standard, or law.

Finally, the DEIR's presentation of modeling results is flawed. Throughout the DEIR, modeled predictions—for example, statements that salmonid mortality will increase by a certain percentage—are presented as though certain, and discussion of possible error or of ranges of possible outcomes is almost entirely absent. The models used cannot possibly produce such certainty, however; at best, they can predict, given a certain set of data and assumptions, a range of possible outcomes, with some outcomes potentially more probable than others, and with all predictions limited by both known and unknown sources of error. An accurate discussion of the DEIR's modeling results therefore cannot provide certain predictions, and instead should show the range of possible outcomes. By omitting both possible sources of error and potential outcome ranges, the DEIR projects a false certainty that the impacts of the project will be relatively small. Indeed, if the modeling results were properly presented, with ranges of outcomes fully described, the study might show that the models actually predict that significantly larger impacts are entirely capable of occurring.

PCL does not argue that models should never have been used to inform the analysis in the DEIR. But the CALSIM II used cannot possibly provide a near-certain conclusion that significant environmental effects will not occur, or will be fully mitigated especially when both common sense, existing knowledge of the Delta system, and the analyses of other agencies all indicate the extremely high likelihood of such impacts. Indeed, PCL believes that if modeling results were properly reported, they would indicate the reasonable likelihood of significant impacts.

As participants in the EIR Committee process, PCL has previously submitted comments expressing our concerns regarding the adequacy of CALSIM II for analyzing baseline conditions and assessing environmental impacts. The DEIR has not adequately addressed our previous comments, and we resubmit those comments on CALSIM II by reference to the DEIR.

If DWR includes CALSIM II model analyses in future EIR drafts, we request clear explanations and justification of all assumptions made in the CALSIM II model runs. In addition, we request that DWR explicitly state when findings are based on post processing and when findings are based on direct model results. When findings are based on post processing, the rationale behind these post-processing decisions should be clearly articulated.

V. The DEIR fails in its duty to analyze the transfer, development and operation of the Kern Water Bank, and alternatives that would restore its public accountability.

A. DWR must independently study, and exercise its own judgment on, the "transfer, development and operation" of the Kern Water Bank.

As provided in the settlement agreement, "the new EIR shall include an independent study by DWR, as the lead agency, and the exercise of its judgment regarding the impacts related to the transfer, development and operation of the Kern Water Bank" in light of existing environmental permits. (Section III.F.) That study "shall identify SWP and any non-SWP sources of deliveries to the Kern Water Bank." (*Id.*) The EIR must provide this analysis to ensure compliance with the agreement and the requirements of CEQA.

The 2003 Settlement Agreement, which allows the Monterey Amendments to proceed on an interim basis, that "KWBA shall retain title to the KWBA lands. KWBA may continue to operate and administer the KWB lands including the water bank, subject to restrictions herein."[46] The agreement also provides that "[t]he restrictions in this Section V shall become final only upon (1) filing of the Notice of Determination following the completion of New EIR, (2) discharge of the writ of mandate in the underlying litigation as provided below, and (3) conclusion of all litigation in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction."[47]

[46] Settlement Agreement, § 5.A.

[47] Settlement Agreement, § V.F.

B. **The DEIR's study methods are too narrow to support DWR's independent judgment on the future of the Kern Water Bank.**

DWR's final decision addressing ownership and operation of the world's largest groundwater storage facility, the one million acre-foot capacity Kern Water Bank located west of Bakersfield, raises critical issues involving public trust accountability and environmental responsibility. The various stakes involved in the bank's operation—financial, institutional and environmental—are of immense importance to California's future. Built to capacity, the groundwater bank is capable of delivering 240,000 acre-feet of water per year, enough to supply the needs of roughly 500,000 households.[48]

The facility is also crucial because of its location, providing storage to the southern San Joaquin Valley.[49] When developed, the Kern Fan Element, in combination with the provisions of the proposed project allowing storage outside an SWP service area, significantly increase SWP contractors' capacity to accept water from the Delta.

But the DEIR's draft study on the Kern Water Bank (DEIR, Appendix E) says very little that would alert the reader to momentous environmental significance of DWR's forthcoming decision. The "methods" section of that study (DEIR, Appx. E, p. 5) suggests a possible reason for its benign assessment. Of the three sources of information noted in the study, the only information source that does not come directly from the Kern agencies, KCWA and KWBA, is that DWR contacted personnel from the California Department of Fish and Game and the United States Fish and Wildlife Service. That focus is far too narrow. The substantial environmental issues associated with the loss of statewide environmental accountability over the bank require a more probing analysis that could not be addressed simply by consulting wildlife and fisheries agencies, and it is DWR, as SWP manager, that must provide that analysis. As detailed below, even if the KWBA has been a responsible steward of the Kern Fan Element property that holds the bank, the concerns that arise from the decision for the bank to serve local rather than statewide interests would persist.

DWR's narrow study methods are surprising, because the broader issues surrounding the transfer, development and operation of the Kern Water Bank have been the subject of major public controversy, addressed in the media[50] and in reports that are referenced and discussed nowhere in the DEIR. One of those reports, prepared by Public Citizen, contends that while the

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[48] In August 1996, one day following DWR's transfer of the bank to Kern County Water Agency in its interim implementation of the Monterey Amendments in 1996, KCWA retransferred the bank to the Kern Water Bank Authority (KWBA), which consists of five local public water agencies and a private mutual water company.

[49] Sandino, *California's Groundwater Management Since the Governor's Commission Review: The Consolidation of Local Control* (2005) 36 MCGEORGE L. REV. 471, 489 n. 171.

[50] M. Arax, *Massive Farm Owned by L.A. Man Uses Water Bank Conceived for State Needs,* Los Angeles Times (online), December 19, 2003.

KWBA is formally public entity, it is effectively majority-controlled by one of the world's largest farming companies, Paramount Farming, and largely serves the interests of two corporations with large landholdings in the service area.[51] The Public Citizen report charges that the divestment of the bank from state authority has been environmentally destructive, raising issues that are nowhere addressed in the DEIR.[52] While we believe that DWR is very much aware of this report, and should thus have included a reaction to the report as part of the DEIR environmental analysis of the proposed transfer of the Kern Fan Element, we will attach the Public Citizen Report to these comments, so that DWR will have no excuse not to analyze its findings in connection with producing the final EIR.

Whether or not DWR concurs with them, it would be irresponsible not to address these well-known allegations before taking its final action on the proposed Kern Water Bank transfer.[53] Indeed, broad concerns about the lack of institutional and environmental accountability among Kern County's local water agencies have drawn the attention, not simply of environmental groups, but also some of the most respected scholars of California's water history. For example, Norris Hundley's discussion observes that such local districts "are ordinarily managed by boards of directors made up of a homogeneous, single interest body of people representing the large water users and guided by a rigid set of goals: maximization of water use at minimum cost with little or no regard for the environment or for the welfare of the people of California."[54] In short, the EIR will disserve decision-makers and the public unless DWR is able to step outside the mindset of the local Kern agencies, and address the Kern Water

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[51] J. Gibler, WATER HEIST (Public Citizen, December 2003)("Public Citizen report"), included as Attachment G to these comments. The EIR should specifically address the Public Citizen report as if it were set forth directly in these comments.

[52] See Public Citizen report, p. 2 (arguing that the bank should not "provide a handful of corporations with the keys to a virtual 'switchyard' for controlling water deals between agribusiness and real estate developers").

[53] To assist decision-makers and the public, PCL also requests that DWR include in the EIR a documentary appendix compiling key reference sources on the Kern Water Bank. The public should have an opportunity to directly review such key documents as (1) the 1987 DWR/ KCWA memorandum of understanding; (2) the purchase agreements framing the transfer of the Kern Fan Element from DWR to KCWA, and from KCWA to KWBA; (3) the 1995 KWBA Statement of Principles; (4) the 1995 KWBA Joint Powers Agreement; and (5) the 1995 KWBA Operations and Monitoring Memorandum of Understanding.

[54] N. Hundley, THE GREAT THIRST (2001), p. 536; see also R. Gottlieb and M. Fitzsimmons, THIRST FOR GROWTH (1991), pp. 96-97 ("With new purchases and related expansion of irrigated acreage becoming a speculative spiral, the Kern landowners raced to establish new water districts to contract for State Project water….The tendency toward concentration and overextension, already prevalent in the county from the days of *Lux v. Haggin*, was enormously magnified with the arrival of the aqueduct. A handful of landowners dominated the key water districts affiliated with the [Kern County Water Agency], and these districts, in turn, dominated the agency").

bank issues with the "statewide perspective and expertise" required in its stewardship of the State Water Project.[55]

C. The EIR fails to fully disclose how the transfer of the Kern Fan Element out of DWR's control alters the central purpose of the Kern Water Bank.

Although the DEIR briefly refers to the transfer of the Kern Fan Element out of state ownership, and its subsequent control by the KWBA (DEIR, p. 4-11), it never fully acknowledges how this transformation affected the fundamental purpose of the Kern Water Bank. The DEIR appendix on the transfer briefly references the 1987 Memorandum of Understanding (1987) between DWR and KCWA, which formed the basis for DWR's acquisition of the Kern property from Tenneco West.[56] But it never mentions how two key statewide and public protections referenced in the 1987 MOU were later removed:

- **Shift of bank purpose to serve local rather than statewide interests.**

The 1987 MOU clarified that the "primary purpose" of the Kern Water Bank is to "augment the dependable water supply of the State Water Project"; and that "[i]ncidental" to its primary purpose the bank will produce "local benefits." It defined the bank as a "SWP conservation facility" to be integrated with other SWP operations.

By contrast, the 1995 joint powers agreement for the KWBA reversed the priorities, ensuring that "the Authority will be operated and maintained "*for its benefit and the benefit of the Member Entities*."[57]

- **Failure to acknowledge statewide trust protection**

Although the MOU conferred upon the Agency a ten-year option to purchase the bank, it imposed conditions of that purchase that would have preserved DWR's trust responsibilities under the Water Code. Under the MOU, the Agency's purchase of the bank could only occur "[p]rovided that the *Department's right to use the area for project purposes* will be preserved. Consistent with section 11464 of the Water Code, the Department shall not sell facilities acquired for the Kern Water Bank."[58]

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[55] *PCL v. DWR*, 83 Cal. App. 4th at p. 907.

[56] DEIR, appx. E, p. 10.

[57] 1995 JPA for the KWBA, recitals at ¶ 5.

[58] The non-alienation provision in Water Code section 11464 provides that "no water right, reservoir, conduit, or facility for the generation, production, transmission, or distribution of electric power, acquired by the department shall ever be sold, granted, or conveyed by the department so that the department thereby is divested of the title to and ownership of it."

By contrast, neither article 52 of the Monterey Amendments, nor the conveyance agreements with the Kern agencies for the Kern Fan Element transfer, ever referenced or incorporated DWR's continuing authority, even in the context of local ownership, to use the bank as needed for SWP purposes. Instead, the transfer agreements took the form of unrestricted fee simple transfers, without any discussion of the state's underlying trust duties.

In its EIR, DWR must fully analyze the circumstances surrounding the removal of safeguards for the public and the state, and the environmental consequences of bank operation without these protections. It must also study alternatives that would not eliminate these protections, even in the context of local ownership and administration of the bank.

D. **The EIR must more fully describe DWR's experiences and purposes in attempting to develop the Kern Water Bank.**

The DEIR barely discusses DWR's original plans for the KWB and attempts to develop it. In a 1979 article, then-DWR director Ronald Robie described a variety of environmental advantages to DWR developing an underground storage facility for the SWP. He concluded that "an SWP ground water program will add flexibility to SWP operations and can be a hedge against earthquake or other disablement of the California Aqueduct."[59] Following the release of technical studies, DWR focused on the possibilities of developing SWP groundwater recharge operations in Kern County.

In 1986, DWR prepared an EIR for a state-run water bank, contemplating purchase of approximately 20,000 acres of land from Tenneco West, located on the Kern River's alluvial fan (the area that ultimately became the bank's site is sometimes referred to as the Kern Fan Element).[60] The present DEIR does not disclose that in its own environmental reviews, DWR recognized that operation of the bank might have an impact on the Bay-Delta.[61]

DWR made substantial investments in studies and other activities with the expectation of implementing the state-owned bank. Some estimates have placed the total amount DWR paid to develop the bank, including the initial purchase, over $70 million.[62] The EIR should disclose the full amount of that investment, including any investment in environmental study and mitigation.

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[59] *Id.* at 45.

[60] See also Kletzing, *Imported Groundwater Banking: The Kern Water Bank - A Case Study*, (1988). 19 PAC. L.J. 1225.

[61] DWR, First Stage Kern Fan Element Draft Supplemental Environmental Impact Report (1990). pp. 38-42.

[62] Public Citizen, p. 2.

E. The EIR does not fully disclose the circumstances that caused DWR to relinquish control of the KWB.

The EIR should more fully disclose the circumstances that caused DWR to stop developing the KWB. In this regard, several documents that PCL obtained from DWR, included as attachment H, are illuminating. During the early 1990s, KCWA, joined by other local water districts and the State Water Contractors organization, sought to have DWR cease all "planning, design and land acquisition" activities relating to the water bank, even requesting that it be "mothballed."[63] They also argued that since DWR would not be developing the bank, it should be transferred to local control. In response, DWR director David Kennedy ultimately endorsed divestment of the water bank to the Agency, which then became a key principle in the 1994 Monterey Agreement.[64]

Although DWR had earlier been trying to proceed with the state-run project, two factors--potential ESA impacts, and Kern non-cooperation—thwarted these efforts. The latter reflected both ESA impacts, which KCWA did not want to address, and partly KCWA's reluctance to allow DWR to protect statewide interests in the bank. DWR had reached a HCP addressing on-site impacts, and that HCP was satisfactory to everyone but the Kern interests. However, DWR staff reported that Kern "wanted to recharge and extract at their will and not pay for 'any stinking mitigation costs'. When DWR objected, Kern's Tom Clark responded, "if we think we must, we will buy it."[65]

F. The EIR inadequately addresses the details of DWR's purchase agreement with Kern County Water Agency.

The EIR identifies the agricultural contractors' retirement of 45,000 acre-feet of agricultural entitlement (almost all by KCWA) as the ostensible consideration (the price paid) for DWR's transfer of the Kern Water Bank. But it does not adequately analyze the circumstances surrounding that exchange:

• DWR estimated the bank's worth at just over $33 million. That figure was just two million more than the state had paid in 1988, despite the state's subsequent investment of approximately $40 million in the bank's development. The state apparently valued the element based upon its purchase piece of marginal agricultural land rather than its more important value—a capitalization of the land's highest and best use as a water bank.

[63] Attachment H (February 18, 1993 draft letter from SWC to DWR).

[64] Attachment H (1992 SWC action report; February 18, 1993 draft letter from SWC to DWR; February 9, 1993 and April 19, 1993 letters from DWR to SWC).

[65] Attachment H (Memorandum of Jack Erickson, DWR to John Pacheco, dated February 13, 1996).

• KCWA's retired agricultural "entitlements" existed only as an accounting tool, and Kern had no realistic expectation of receiving actual wet water under those entitlements. Nevertheless, KCWA was obligated—pursuant to the contracts it signed—to pay the state for that entitlement amount. By retiring those entitlements, KCWA therefore relieved itself of a substantial liability while losing little, if any, chance at wet water. The retired debit would appear to have a substantially higher value than the retired entitlements.

• DWR and KWBA have yet to provide a full accounting of the sources of water going into the Kern Water Bank, an issue that DWR is called upon to address in the Monterey settlement agreement within the Monterey Plus EIR. It seems likely that the other inexpensive sources of water made available to the Kern agencies through the Monterey Amendments—including "interruptible" (formerly surplus) water, carryover storage water, and turnback pool water—might have more than replaced the purported "loss" of KCWA's 45,000 acre-feet of paper entitlements with less expensive sources.

• The state's divestment also included some of its water. DWR conveyed title to half the water stored in the bank, as well as all the water stored during 1995. As the KWBA recognized in its financial statement, "the participants [in the KWBA] received Kern Water Bank land and facilities and 42,380 acre-feet of banked water. The 42,830 acre-feet of water subsequently was transferred to each of the participants in proportion to their ownership. This transaction was reflected as a contribution of capital in the amount of $27,858,500 by the respective participants."[66]

G. The DEIR fails to analyze key environmental consequences of the Kern Water Bank's operation without statewide trust accountability.

The DEIR fails to study the major environmental consequences of the Kern Water Bank, other than some smaller issues that centrally focus on KWBA's administration of the Kern Fan Element lands. Notably, the analysis fails to answer important questions about foreseeable trends in water marketing and groundwater banking due to the project.[67] Instead, the DEIR abruptly concludes that impacts are less than significant because multiple factors increased groundwater banking, and because of a beneficial impact on groundwater levels.[68]

The EIR must carefully study the following issues:

• **Pressures on the Delta**

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[66] KWBA, *Financial Statements* (December 31, 2000 and 1999).

[67] Neither Chapter 8 on growth-inducing impacts, nor Chapter 9 addressing water supply reliability and "paper water," address the transfer and operation of the Kern Water Bank. The effects of available storage and related transfers must be included in those analyses even if the bank is addressed separately in Appendix E.

[68] DEIR, appx. E, p. 49.

The transfer of the Kern Fan Element resulted in a shift in use of the facility. The state had intended to use the facility as a drought mitigation bank. In local control, it has become a new resource to maximize deliveries of SWP water and an economic resource. Local agencies now benefit from aggressively developing the Kern Fan Element. Under the Monterey Amendments, all contractors can use the Kern Water Bank to store SWP water. Therefore, the bank transfer has a significant potential to increase demand for and export of Delta water. The DEIR does not adequately analyze the impact on SWP demand and Delta export resulting from the transfer and development of the Kern Fan Element.

DWR's records, although not yet disclosed in the EIR, suggest a possible close connection between the Kern Water Bank, Delta pumping, and Delta environmental issues. The bank's relationship to Delta pumping and environmental conditions came up repeatedly in DWR's correspondence with other agencies,[69] as well as with the contractor constituencies represented in the Monterey negotiations.[70] In general, those records suggest DWR was well aware that operation of the Kern Bank could lead to increased Delta pumping, and that those increases could affect endangered species.

Additional research by PCL, previously brought to DWR's attention[71], also shows the Kern Bank's role in increased deliveries to southern contractors.[72] These documents highlight how filling the bank can impact the Delta. For example:

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[69] See, Attachment H, including: Letter from Wayne White, Department of Interior to David Kennedy, dated September 30, 1991 ("we are concerned about potential adverse effects of the project in the Sacramento-San Joaquin River Estuary (Delta) area in central California. The reason for this concern is that water storage capacity within the Kern Water Bank would be filled through additional water exports from the Delta averaging approximately 90,000 acre-feet per year"); *id.* (potential adverse effects on Delta smelt and winter-run Chinook salmon); Letter from John Turner, Department of Fish and Game, to Dan Masnada of CCWA, dated July 20, 1995 (development of storage facilities, along with other Monterey operational changes, "combine to create substantial potential for program effects in the Delta and upstream"); *id.* (full study of Kern Water Bank's "potential impacts on the Delta has never been completed").

[70] See Attachment H: MWD letter to Tom Clark dated May 29, 1992 (identifying relevance of Chinook impacts); Memorandum of Jack. A. Erickson, DWR, dated April 20, 1993 (acknowledging Delta issues associated with Kern Fan Element); DWR, Kern Fan Element Re-evaluation Study, February 1996 (acknowledging Kern-Delta link).

[71] See Appendix A.

[72] Several other provisions in the Monterey Amendments also facilitate increased pumping of KWB-bound water. These provisions include liberalized requirements for "interruptible" water, allowance of "carryover" water, and creation of a "turnback pool."

--A KCWA brochure reported that in 2001, the banking program had boosted local supplies by "almost 200,000 acre-feet" and urban Southern California supplies by 81,000 acre-feet.

--Numerous reports from the manager of KCWA member Lost Hills Water District document, among other things, Paramount Farming's use of water banking to obtain inexpensive sources of state water for future water transfers and sales.

--A Georgia State University paper on water sales from 1990-2001 recorded purchases from the Monterey Amendments turnback pool by KCWA, Dudley Ridge and other contractors at prices of $5.90 to $11.79 per acre.[73]

--The Urban Water Management Plan of the McAllister Ranch Irrigation District, a former agricultural area near Bakersfield that is turning to residential development with the assistance of the Kern Water Bank.

--KCWA's 1996 Water Supply report contradicts the assumption that Monterey provisions including the Kern Fan transfer have only had a minor effect on deliveries, reflecting an understanding that it expected the Kern water bank, along with Monterey managerial changes, to help increase its SWP yield.

- **Depleting the Environmental Water Account**

There appears to be significant evidence that effective possession of the Kern Water Bank enabled Paramount Farming subsidiary Westside Mutual and other interests within the KWBA to secure "surplus" water from the state, only to sell it back to the state's Environmental Water Account at a profit.[74] If DWR itself operated the bank, such privately-profitable sales would not have resulted in a transfer of money out of the state system; DWR could pump its own surplus water to the bank (rather than selling it at bargain-basement prices) and then at times of environmental need could pump that water, without paying marked-up prices for it, to users in lieu of Delta deliveries. By paying less for water, DWR thus could slow the depletion of EWA assets, which in turn would allow the EWA to take more protective actions. That change could become crucially important during a drought, for in times of scarcity the KWBA member agencies could charge far higher prices for their water, and the financial difference between a DWR-managed bank and a privately managed bank, and thus the difference in depletion of EWA funds, could be enormous.

- **Increasing the agribusiness footprint**

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[73] M. Czetwertynski, *The Sale and Lease of Water Rights in Western States: An Overview for the Period 1990-2001* (March 2002), pp. 16-17.

[74] The evidence is available at http://www.ewg.org/reports/CAWaterTakings/part4.php; http://www.watertransfers.water.ca.gov/water_trans/water_trans_index.cfm. Despite its prominent role in securing the divestment of the Kern Water Bank and benefiting from it, Paramount Farming—whose wholly owned subsidiary Westside Mutual Water Company owns more than 48 percent of the bank--is only cryptically referred to in the DEIR analysis of the Kern bank, and not by name. See DEIR, Appx. E, p. 17 (noting that Westside was formed by "a landowner").

The profit stream to Paramount Farming and other Roll International affiliates deserves further attention. The bank, which was intended to help balance out the state's water supply to cities, farms and fish, has instead allowed Paramount Farming to double its acreage of nuts and fruits since 1994."[75] If the Kern Bank has indeed allowed a private company to put substantial additional acreage to agricultural use, that change could have multiple environmental consequences, including local habitat loss, increased pollutant loading, and, perhaps more importantly, increasing and hardening overall south-of-Delta water demand, which in turn could increase Delta impacts in the next drought.

- **Constrained public uses**

Private operation of the bank outside DWR control would hamper the state's ability to manage water resources for a variety of public purposes, including drought storage for emergency preparedness, urban uses, environmental protection, river restoration, and water quality.[76] The specialty crops and urban uses supported by the bank, due to their inflexibility in times of drought, may increase pressure for water exports from the overburdened Bay Delta during times of critical shortage.

- **Supporting growth and development**

In KCWA's March 1995 newsletter, its general manager describes "our local groundwater basin" as "a multi-billion dollar resource."[77] The Public Citizen report alleged that the privately controlled water bank serves as "switchyard" for transactions between agribusiness and real estate interests in Southern California.[78] The DEIR must investigate these allegations, as well as suggestions that the bank may promote sprawl development.[79]

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[75] Arax, *supra*.

[76] "Water banking could be used as drought protection to statewide benefit and to help improve water quality in the heavily depleted San Joaquin Valley groundwater basin. Operating banks for water marketing will have the opposite effect, fueling increased dependence upon distant water supplies for new growth…." Public Citizen, *Water for People and Place* (Nov. 2005), p. 28.

[77] KCWA General *Manager* Jim Beck, quoted in *Water Age*, March 2005, p. 3.

[78] Public Citizen report, p. 2.

[79] See, e.g., V. Pollard, *Los Angeles Eyeing Kern Water Source*, Bakersfield Californian, March 24, 2002 (online) ("DWP officials have had early talks with representatives of Paramount Farming Co. and other participants in the about possible purchase of an as-yet-unspecified amount of water…The chairman of the Kern Water Bank Authority Board, Bill Phillimore, said sales from the water bank were contemplated from the time the bank was acquired by Kern County water agencies…."). The Public Citizen report asserts that Roll International affiliate WV Acquisitions has contracted with Lennar / LNR subsidiary Newhall Land and farming for

H. The DEIR fails to analyze alternatives that would restore state trust accountability to the Kern Water Bank's operation.

In light of the history and risks described above, it is essential that DWR develop and analyze a meaningful project alternative that would restore some measure of statewide accountability over the manner in which the KWB is operated. That alternative may even be compelled by the need to comply with Water Code section 11464 and other applicable laws.

Throughout its participation in this EIR review, PCL proposed two alternatives that would have addressed the Kern issues. The first was a "Kern Fan retention" alternative, which assumes state ownership and operation to enhance dry-year reliability. The second was a "Kern Fan Transfer with trust conditions" alternative that would allow the Kern Water Bank to remain in local control, subject to operational and financial criteria designed to maximize environmental benefits. It would require the bank to store environmental water in time of surplus and make it available at no cost to the state in time of drought, in exchange for allowing the asset to operate the rest of the time for local purposes. In sum, a variety of operating and financial arrangements must be explored to maximize the bank's contributions to the State's environment. CEQA requires a full analysis of these feasible alternatives, as part of the DEIR prepared on the proposed action.

Unfortunately, the DEIR summarily rejected the "Kern transfer with trust conditions" alternative with a cursory, untenable explanation. DEIR,§ 11.2.6, p. 11-16. The DEIR asserts that this alternative would fail to "meet the objectives" of the Monterey Amendment, but does not explain why. On the contrary, allowing local control of the bank to continue subject to the imposition of a state trust—which closely resembles the approach to local control of the bank already set forth in the 1987 DWR/ KCWA MOU—would be a balanced way to "[r]esolve legal and institutional issues related to storage of SWP water" in the county that would harmonize local and statewide interests.[80] In light of Water Code section 11464 and legal constraints

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sales of water entitlement. See http://www.hoovers.com/the-newhall-land-and-farming-company/--ID__11074--/free-co-factsheet.xhtml (describing Newhall as the "landing strip fot urban flight"). PCL has no independent knowledge of these accounts, but believes they deserve analysis.

[80] DEIR, p. 4-1 (listing project objectives). The "local control subject to DWR trust" approach does not appear incompatible with any of the other fundamental project objectives either. Moreover, the prospect that stakeholders might challenge the approach would provide no reason to summarily reject it as a project alternative. *PCL v. DWR*, 83 Cal. App. 4th at p. 915. Nor would the need for local agreement and funding be grounds to summarily dismiss this alternative from consideration (cf. DEIR, p. 11-6), particularly if DWR finds that it is the only lawful manner to proceed with local ownership of the bank.

related to conditions in the Delta, this alternative may well constitute the only lawful manner in which DWR can make a final decision that allows the bank to remain in local ownership.[81]

I. The EIR must answer additional questions about the Kern Water Bank's transfer, development and operation.

PCL requests that the EIR answer the following additional questions, each of which relates to potentially significant environmental impacts, as outlined in this comment letter, and each of which CEQA requires be addressed:

1. Does the KWBA actually acquire and sell water, or does it merely provide a facility that allows its member agencies to store and recover water that they acquire and sell?[82]

2. If the KWBA does actually acquire and sell water, how much water does it acquire and sell on a yearly basis?

3. How much water have each of the KWBA members, including Westside, bought and sold during each year of the Kern Bank's operations, using the Kern Bank in connection with such purchases and sales?

4. To whom has water stored in the Kern Bank been sold?

5. At what price has Kern Bank water been sold? Does that represent a markup beyond costs?

6. How much has the KWBA charged for storage in the Kern Bank ?

7. Has DWR purchased Kern Bank water? For what purpose and place of use? How much has come from the KWBA, and how much from particular agencies? At what price?

8. What are the sources of water that go to the Kern Bank? Each year, how much has come from: (a) SWP Table A allocations; (b) SWP Article 21 water; (c) CVP water; (d) surface runoff; (e) Kern River water?

9. Is there any evidence that DWR delivered water to the Kern Bank knowing it would later need to repurchase that water? Or is there evidence that DWR

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[81] The DEIR's premise that alternatives cannot be used here simply to improve "the health of the environment" (DEIR, 11-6) could not be more at odds with the elementary requirements of CEQA, which may be used to *mandate* feasible alternatives or mitigation measures. Pub. Res. Code, § 21002.

[82] Under the joint powers agreement, the KWBA is empowered to acquire and sell water, but it is less clear where it would get such water, or how it would access recharge or withdrawal facilities; the JPA appears to assign shares of facility use exclusively to the member agencies.

delivered water to the Kern Bank while simultaneously repurchasing earlier-delivered supplies?

10. Does the KWBA pay taxes on the land it owns?

11. Does the KWBA pay taxes on profits from water sales (if sales are above-cost)?

12. Does Westside profit from water sales, and if so does it pay taxes on those profits?

13. Have the KWBA member agencies obtained SWRCB approval for changing (either temporarily or long-term) the place or purpose of use of water stored in the Kern Bank and transferred to different users?

14. What are the KWBA member agencies doing with the profits from their sales, and what are the environmental consequences?

VI. The DEIR's assessment of alternatives is defective.

A. The DEIR presents multiple muddled versions of the No Project Alternative, blurring the distinction between "no project" and project alternatives.

CEQA defines the purpose of a No Project Alternative as, "to allow decision makers to compare the impacts of approving the proposed project with the impacts of not approving the proposed project" (CEQA Guidelines, § 15125).[83] Making up in quantity for what they lack in accuracy, the DEIR identifies multiple iterations of the No Project Alternative. As demonstrated here, each of these attempts is incoherent, and in some instances, they muddle the distinction between the No Project Alternative and project alternatives.

A brief synopsis of these attempts highlights their flaws:

• The No Project Alternative 1 (NPA1) assumes at the state would have developed the Kern Fan Element to a capacity of 350,000 acre-feet by 2003 and to 500,000 acre feet by 2020. The capacities used appear to be entirely arbitrary, and may well serve simply to narrow the distance between the no-project and the project without factual foundation. Moreover, the EIR appears to be internally inconsistent as the subject of how much state bank development was foreseeable.[84]

[83] PCL has already explained above why the no project assessment has not met the requirements of *PCL v. DWR*. This section describes, in addition, how the DEIR develops no project alternatives that are muddled with project alternatives.

[84] Inclusion in the No Project Alternative suggests a belief that state development could be "reasonably expected to occur in the foreseeable future," CEQA Guidelines, § 15126.6(c)(2); but

• The No Project Alternative 2 (NPA2) includes a number of the Table A transfers facilitated under the Monterey Agreements, conveyance of non-project water, and storage of contractor water outside of the contractors' service area-all key components and other provisions of the proposed project that were implemented as of 2003. The DEIR argues that these projects and policies would have been approved by the Department regardless of the Monterey project. However, that argument is entirely speculative, and in no way excuses the CEQA-mandated no project analysis. Each of these components was initiated as a direct result of the Monterey Amendments. As such, they are components of the very action under review and cannot be included in a no project alternative. [85]

• Court-Ordered No Project Alternative 3 (CNPA3) and Court-Ordered No Project Alternative 4 both contain significant flaws. As discussed above, neither of these alternatives provided the rigorous review anticipated by the court in *PCL v. DWR* and by plaintiffs in the settlement agreement.

• CNPA3 is also based on water allocation methods that were not in place at prior to the Monterey agreement. CPNA3 does not reflect the agricultural and groundwater replenishment priority for article 21 that was a specific requirement of the pre-Monterey contracts. Without the Monterey Amendment, this contract provision would remain in place. Therefore the only appropriate no project alternative is one which includes all pre-Monterey contract provisions, including the "agriculture first" and groundwater replenishment provisions of Article 21.

• The no project alternative must reflect the actual 'no project' condition. Rather than speculate that DWR might alter contract provisions, approve water transfers and overcome significant challenges to aggressively develop the Kern Fan Element, the no project alternative should assume that DWR would have implemented the pre-Monterey SWP contracts as written, including enforcement of all limitations and conditions.

B. The DEIR summarily rejected feasible alternatives to the project.

The DEIR must examine a range of reasonable alternatives that would feasibly obtain most of the project objectives, but avoid or substantially lessen any significant adverse effects of the project. (14 Cal. Code Regs. §15126.6.) In its screening and review of alternatives, the EIR must provide more than "cursory" analysis. (*PCL v. DWR*, 83 Cal. App. 4th at 919.) It should not construe project objectives so tautologically that only the proposed project could conceivably be capable of achieving them. Nor should the EIR allow the mere "threat of litigation" under a proposed alternative to prevent its environmental review. *Id.* at 914.

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in DWR's Kern study, it asserts that uncertainties made state bank development "infeasible." DEIR, Appendix E, p. 10

[85] Rather than include these components in the NPA2, subsequent drafts of the EIR must include this analysis of a limited set of policies (as opposed to the entire suite of Monterey Amendments) in the alternatives section of the EIR.

DEIR summarily eliminated *nine alternatives* that were suggested by PCL and the two other plaintiffs within the EIR committee process, each without any satisfactory explanation.[86] These alternatives were offered in order to provide a reasonable range of alternatives within the EIR analysis consistent with the requirements of CEQA. But the DEIR provides unjustified conclusions for each alternative that derailed any further review of them. Although increasing exports south of the Delta is notably (and properly) absent from the list of project objectives (DEIR, p. 4-1), the DEIR's alternatives analysis implicitly appears to assume that unless the contractors' pumping objectives are met, an alternative is infeasible.

The DEIR also gratuitously, and incoherently, chides "the plaintiffs" for seeking in proposed alternatives to improve the *environment.* (DEIR, pp. 11-5 to 11-7.) That reasoning would have been faulty if DWR's EIR had been done in 1995, but it particularly suspect in 2008, in light of the pelagic organism decline in the Delta and recent court rulings, discussed above, that will require constraints on pumping south of the Delta. Moreover, the summary exclusion of alternatives that attempt to balance contractors' and environmental objectives is entirely inconsistent with efforts the state is engaged in elsewhere, including Delta Vision and updates to the California Water Plan. Indeed, the state has long been aware of a variety of approaches that would serve the SWP's financial, management and operational goals while *also* considering environmental protection.[87] This context underscores the practicality of PCL's proposed alternatives.

A review of the grounds for dismissing the **"Improved Reliability through Environmental Enhancement" (IREE)**[88] alternative illustrates how the DEIR avoided analyzing a reasonable range of alternatives. Similar grounds were also used to reject other alternatives. The EIR's reasoning suggests that DWR views the project objectives so tautologically that seemingly only the Monterey Amendments (or a negligible variation on them) could feasibly accomplish them:

- The DEIR claims that the IREE "alternative was not considered in detail in the EIR because it would not meet any of the objectives of the Monterey Amendments. Furthermore, it would be in conflict with the basic terms of the long-term water supply contracts." DEIR, p. 11-6. But in summarily dismissing this alternative, the DEIR provides no substantiating evidence or analysis to demonstrate that the alternative would not meet any of the project objectives.

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[86] These alternatives, listed in PCL's December 18, 2006 comments on the last administrative draft EIR (Attachment A) pp. 12-15, are incorporated by reference. PCL proposes again that they be considered for full-fledged review rather than summary rejection.

[87] CRB report, attachment B to these comments.

[88] This alternative "would involve the Department reducing stress on fishery resources in the Delta by directly implementing water use efficiency measures, water recycling, storm water capture, and other local water system enhancements that stabilize water demand and improve SWP reliability." DEIR, p. 11-5.

• The assertion that IREE would not meet any of the project objectives is false. A key objective of the project provided in the DEIR is to increase the flexibility of the SWP. DEIR, p. 4-1. DWR specifically identifies environmental regulations as a primary limitation, in addition to hydrologic conditions, to delivery of water through the SWP. [Cite] [89] It is reasonable to expect that enhancements in the environment of the Delta would reduce the need for regulatory agencies to set new regulations or mandate actions to enforce existing regulations. Reduced regulatory actions would result in increased flexibility of the SWP. The DEIR does not provide any analysis which would indicate that such an assumption is unfounded or inaccurate.

• The DEIR's further claim that the IREE alternative is in conflict with the basic terms of the water supply contracts is also without merit. The proposed project is a set of contract amendments. It follows that alternatives to the proposed project would appropriately incorporate contract amendments. In fact, many of the provisions of the proposed project are in direct conflict with the basic terms of the pre-Monterey long-term water supply contracts. [90]

• The DEIR's rejection of IREE rests heavily on the notion that DWR already operates in compliance with Delta water quality and flow objectives "as constrained by the need to protect threatened and endangered fish species listed pursuant to federal and state Endangered Species Acts." DEIR, p. 11-6. As discussed above, the pelagic species crash and the *Kempthorne* decisions on the Delta Smelt shatter the foundations of this assertion, which must now be revisited. There is now a compelling legal, as well as environmental, reason not to summarily reject an alternative that could feasibly accomplish most of the project objectives, while also reducing injury to the Delta.

• The DEIR also rejects IREE on the preposterous theory that "the Monterey Amendment is not an appropriate tool for mandating that |SWP water be used to benefit the Delta environment. DEIR, p. 11-6. That is a remarkable assertion, considering that, as discussed elsewhere, the proposed project could result in increased pumping and thereby injure the Delta.

• Finally, the DEIR rejects IREE, as well as some other alternatives, based upon the legally erroneous theory that it would require action by local agencies; according to DWR, such agencies would have to propose water efficiency measures, which DWR recognizes it could

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[89] In fact, environmental problems in the Delta were contributing factors which led to the reductions in SWP deliveries in the early 1990's, and the contractor disputes that precipitated the Monterey Amendments. *PCL v. DWR*, 83 Cal. App. 4th at p. 908.

[90] For instance, eliminating the "agriculture first" reduction in article 18(a) of the contract, as is proposed in the proposed project, is in direct conflict with the pre-Monterey contracts. If such conditions were applied to all alternatives, then the proposed project would also have to be eliminated. Alternatives should not be held to a standard that is not imposed on the proposed project.

fund. DEIR, 11-5,11- 6. That misstates CEQA, which does not foreclose an alternatives assessment simply because other agency action may be required.[91]

C. The DEIR fails to analyze a reasonable range of alternatives to the project.

While unreasonably rejecting all of the alternatives proposed by plaintiffs, the DEIR remarkably provides *only one* project alternative to the DEIR. Alternative 5 "would be the same as the proposed project except that the Monterey water management practices would not be implemented." DEIR, p. 11-3. The DEIR's very limited range of alternatives is misleading and incomplete. In order to provide for reasonable comparison, alternatives to the proposed project must be distinguishable from the proposed project. However, alternative 5 (and NPA2) inappropriately includes significant portions of the proposed project. As a result the DEIR inappropriately concludes that all available courses of action have roughly similar impacts and outcomes.

The DEIR rationalizes this approach by suggesting that many of the actions taken under Monterey could have occurred under the original contracts. Prior to Monterey, however, these policies were not widely adopted by the SWP and they were not commonly practiced under the previous contract. Had DWR decided to implement these actions under a different hypothetical approach, DWR would still have had to complete CEQA review prior to taking those actions. Therefore, it is not appropriate to include these actions in Alternative 5 or NPA2. Since DWR has proposed to take these actions as part of the Monterey Amendments, these actions must be properly treated as potential decisions rather than assumed components of the no project alternative.

In sum, the EIR should include alternatives that are clearly distinguishable from the "no project" and proposed project. These alternatives should not include polices or actions that are being proposed for implementation as part of the proposed project.

VII. The DEIR contains faulty and legally unsupportable assessments of project impacts.

A. The DEIR uses inconsistent time periods for its analyses.

In the historical analysis provided in Chapter 6 the DEIR uses different time periods for analyses in various sections of the EIR. For instance, carryover in Dan Luis is analyzed from 1996 through 2004, while the flexible starage provisions are analyzed from 1996 through 2003 (see DEIR at 6-57 through 6-58).These variations make it impossible to determine the full impact of any of the proposed project and alternatives included in the DEIR. No explanation is provided as to why certain sections are analyzed under differing time periods. Subsequent draft EIR analyses must use a consistent time period throughout the EIR.

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[91] See, e.g., *Friends of the Eel River v. Sonoma County Water Agency* (2003) 108 Cal. App. 4th 859. 864-867. Similar grounds are improperly used to summarily reject other of PCL's proposed alternatives, such as the "urban preference and dry year reliability" and "no urban preference and dry year reliability" alternatives. DEIR, pp. 11-4, 11-5.

B. The DEIR inadequately analyzes impacts resulting from eliminating and changing contract provisions.

- **Altered Article 21 rules for "surplus"**

As extensively discussed in connection with the baseline, the DEIR failed to analyze the impact of eliminating article 21(g)(1), the prohibition on using "surplus water" (or post-Monterey, "interruptible" water) to build permanent local economies. The EIR must fully analyze how eliminating this provision and simultaneous transfer of the Kern Water Bank and allowance of water storage outside of the SWP service area has altered or will alter SWP contractor demand and ability to receive article 21 water.

The EIR must analyze the degree to which eliminating use provisions for article 21 and providing urban users with increased access to article 21 water resulted in new uses of that water, including serving new growth-fostering water transfers. Analyses should also identify the degree to which altered article 21 previsions have shifted scheduling and delivery of Table A water and whether such shifts have resulted in changes to SWP operations (including changes in the timing or amount of water released from Lake Oroville and San Luis Reservoir).

The proposed project would eliminate pre-Monterey allocation rules for article 21. The priority for agricultural use and groundwater replenishment would be removed, and a new allocation method allowing access to article 21 based on Table A amount percentages would be adopted. Eliminating pre-Monterey contract allocations allows more contractors, including municipal contractors that had not historically received significant deliveries of article 21, to access this water and put it to use for purposes that are much different than per-Monterey uses of Article 21.

The DEIR fails to disclose the implications of this potential change in allocation. In particular, the DEIR fails to clearly account for the impact resulting from allocating Article 21 to municipal contractors that may use the water for hardened demand and development. Subsequent versions of the EIR must include analysis and clear disclosure of the implications of altering Article 21 allocations.

- **Turnback Pool**

With the Monterey Amendments in place, all SWP contractors have an incentive to request their full contract amounts. In addition, the Turnback Pool provisions of the Monterey Amendments provide a new incentive for SWP contractors to maximize their annual demand for their full contract amounts. The DEIR recognizes that pre-Monterey some contractors could not use their full Table A amounts, and in some cases that resulted in reduced water deliveries through the SWP. That water which was not captured or delivered by the SWP would have thus been left instream for environmental benefit.

However, the Turnback Pools allow the contractors to benefit financially by requesting their full Table A amounts, even if that contractor does not require such water within its own service area. Other contractors who can make use of the water are encouraged under the

Monterey Amendments to purchase Turnback Pool water. It follows that under the proposed project, all contractors would request full contract allocations, regardless of need for that water. As PCL has long since noted, that tendency is likely to harden, and increase, the demand for Delta pumping.[92]

- **Storage Outside of Service Area**

In allowing SWP contractors to store SWP water outside of their service area, the proposed project significantly expands SWP contractors' ability to accept water, and increases the demand for water from the Delta. The DEIR obscures this fact by assuming that much of the water stored outside contractors' service areas under the provisional implementation of the Monterey Amendments *could* have been stored within the contractors' service area. This assumption is very speculative. It assumes that infrastructure including transport facilities was available; cost of delivery, water quality, access to the right to store water, and other factors impacting the availability of storage capacity within the service area would not have prevented storage of that water within the service area. None of these factors were analyzed when the lead agency determined that water delivered out of the service areas could have been received within the service areas. Rather, the DEIR explains that the assumption is based on, "a telephone survey of contractors conducted by DWR."[93]

The DEIR further seeks to reduce the perceived impact of water delivered to out of service area storage by assuming that such water would have instead been stored in San Luis Reservoir and delivered to other contractors via article 21 or increased Table A. Again, this assumption is purely speculative. It assumes that other contractors could have received the water and placed it within service area storage. These assumptions clearly seek to minimize the appearance of impacts. Indeed, through this methodology, the DEIR determines that of the 1,092,647 acre-feet of water delivered to out of service area storage between 1996 and 2003, only 44,000 acre feet are actually attributable to the proposed project. This is due to the multiple assumptions inappropriately incorporated into the baseline. However, as explained above, these assumptions do not belong in the baseline, and must be removed from the EIR.

- **Altered allocation under Articles 18 (a) and 21**

The DEIR fails to disclose the impacts of altered allocations under article 18(a). Specifically, the DEIR fails to how altered allocations that expose municipal contractors to reduced reliability could tend to encourage municipal contractors to increase demand for water in normal and wet years in order to restore dry year and shortage reliability.

The pre-Monterey article 18(a) provision requiring an agriculture-first reduction in the event of water shortages provided municipal contractors with a higher degree of drought reliability. Under the proposed project's alteration of article 18(a) this protection is eliminated. The proposed project thus exposes municipal contractors to reduced water reliability during

[92] See Attachment A (PCL comments on Draft Chapter 9, p. 6.)

[93] DEIR, p. 6-60 (No details of that survey are presented).

periods of shortage. Moreover, because the Monterey Amendments would, if finalized, permanently delete article 18(a)'s agriculture-first cutbacks, they would remove a major obstacle to agriculture-to-urban transfers that facilitate growth.[94]

It is reasonable and foreseeable to expect that municipal contractors will seek to mitigate the impact on their water reliability. In fact, the proposed project provides water management tools that would assist contractors in such an effort. The proposed project allows these contractors to greatly expand storage options, it provides these contractors with greater access to article 21 water and eliminates restrictions on use of that water, and it establishes the Turnback Pool giving these contractors greater access to water that would not be used by other contractors.

It is reasonable to assume that given the changes proposed, municipal contractors would have a greater incentive to maximize use of the tools provided in the proposed contract (maximizing Table A requests, utilizing article 21, Turnback Pool and carryover provisions to maximize water in newly available storage) in order restore their dry year and shortage reliability.

It is important to note that both Turnback Pool and article 21 water are usually available in the winter and the spring. SWP exports during these periods have been identified as a primary contributor to the Pelagic Organism Decline in the Delta Any action that would tend to encourage increased demand and increased export for these categories of water would therefore have a significant impact on the Delta.

The EIR must explicitly disclose the impact of eliminating the protections for municipal contractors under Article 18 (a), and the resulting impacts on the Delta. As elaborated below, the DEIR omits analysis of impacts or provides inadequate analysis of significant impacts associated with the proposed project.

- **Environmental consequences of financial restructuring under Article 51**

The DEIR briefly describes, but never analyzes the environmental consequences of article 51, one of the most important structural revisions in the SWP system that would be initiated by the Monterey Amendments, should they be adopted. DEIR, p. 4-8. Among other revisions, article 51 changes the way that DWR addresses revenues exceeding the cost of operating the SWP system.[95] As Environmental Defense documented years ago in legislative

[94] The record of such transfers during the interim enforcement of the Monterey Amendments deserves careful study. There is no evidence to support the speculative assertion that these Table A transfers would have occurred anyway in the absence of the Monterey Amendments. Rather, as the EIR correctly points out (DEIR 6-10), only one occurred previously (Devil's Den), and it was expressly subject to agriculture-first cutbacks even after transfer to urban use.

[95] In *PCL v. DWR*, the court of appeal recognized the interrelationship between revised articles 18 and 51 in the Monterey Amendments. The court "agree[d] with plaintiffs that inclusion of article 51 in the amended contracts implies that DWR and the contractors have forsaken their expectation that the SWP facilities will be built as planned and will deliver 4.23 MAF of water annually. Article 51 allows contractors a rebate for the costs previously assessed for facilities

testimony on the Monterey Amendments, appended as attachment I, the revenue stream returned to the contractors under article 51 is enormous over the life of the project contracts.

The new EIR must carefully analyze the environmental consequences of article 51 as an integral part of the Monterey Amendments, rather than summarily assuming that because this provision is "economic" in nature it would not contribute to such impacts. Although CEQA does not require analysis of purely economic or social changes, it requires analysis of environmental impacts that can be traced to such changes. (See, e.g., 14 Cal. Code Regs, § 15131; *San Franciscans Upholding the Downtown Plan v. City and County of San Francisco* (2002) 102 Cal.App.4th 656, 695-98.) Here, the EIR must analyze the relationship between articles 18 and 51, and must compare the project to the no-project scenario in which table A amounts are reduced *without* article 51 rebates. The EIR must also evaluate the environmental consequences of article 51's effect on water rates, and consider the financial adjustments made in article 51 when making its assessment of project alternatives and mitigation.

- **Reduction of state oversight of water transfers under Article 53**

Prior to the Monterey Amendments, DWR had contractual responsibility to oversee and approve transfers of water through the SWP. Under the proposed project, DWR largely excuses itself from this responsibility for certain transfers. Contractors are now permitted to transfer project and no project water at their convenience. DWR has essentially given up effective ability to control where and how water is used within the SWP.

This provision is particularly important for its implications on growth in California. As stated above, the pre-Monterey contracts recognized the difference between municipal reliability and agricultural reliability. Agricultural Table A amounts were explicitly conditioned by their reliability. Thus, it would be inappropriate to use agricultural water transfers for certain purposes, including development. However, provisions of the proposed project including elimination of article 18(b) and changes in 18(a) now imply that all water in the SWP has equal reliability. This new dynamic risks creating, rather than eliminating, a paper water problem. Under the proposed project, DWR would abandon its role in clearly articulating the difference in reliability of water and hand that responsibility to local agencies.

The proposed project implies that all water under the SWP has equal reliability, yet very little water has been removed from the total Table A amount. Given that the original contracts explicitly stated that Table A amounts for agriculture were not as reliable as municipal contracts, it is illogical to assume that suddenly, the SWP can reliably deliver water to all contractors. Yet under the proposed project, agricultural to municipal transfers will be more common and there will be no requirement to address the issue of reliability. This scenario risks inducing growth based on unrealistic assumptions of water reliability.

- **The DEIR fails to disclose impacts to the Bay Delta Estuary.**

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that have never been built. Indeed, fiscal and environmental pressures militate against completion of the project." (83 Cal.App.4th at p. 914, n. 7.)

As discussed above, the Bay Delta Estuary is in critical decline. Fisheries populations have declined dramatically since 2000. Several fish species, including the Delta Smelt, are now at historic low population indices. State and Federal scientist have determined that increased Delta exports, and in particular, exports occurring in the winter and spring are a significant contributor to these declines.

Yet many of the provisions of the proposed project would *increase* the amount of water exported by the SWP during times of "excess" in the Delta. Excess conditions usually occur in the winter and spring, the very time that delta smelt have become vulnerable to project operations. For instance, the DEIR admits that the Turnback Pool and Article 21 are both provisions that seek to capture water earlier in the year. Yet the DEIR fails to incorporate that timing factor into the analysis of impacts in the DEIR.

C. The DEIR fails to adequately growth-inducing impacts, and impermissibly defers the responsibility to analyze them.

The DEIR attempts to absolve DWR of fully analyzing and mitigating the growth inducing impacts of the proposed project. That evasion has profound environmental consequences, due to the stakes involved: as the DEIR concedes, the combination of new table A and article 21 deliveries in the project could support new populations ranging from 405,103 in the "more resource-intensive" scenario, and 561,684 in a "less resource-intensive" scenario. DEIR, p. 8-9. Yet the DEIR asserts in that DWR is *not* required to extensively analyze the growth inducing impacts of water delivered by DWR because DWR is not responsible for land-use decision. *Id.* at pp. 8-13, 14. The DEIR further holds that DWR is not responsible for differentiating between the impacts of water deliveries that stimulate new growth and the impacts of water deliveries used to enhance dry year reliability. *Id.*, p. 13.

This indifference to a major environmental consequence of the project, if finalized, would constitute a major evasion of CEQA responsibility. CEQA requires a lead agency, such as DWR, to analyze the full environmental consequences of its decisions. That responsibility creates a duty to analyze the consequences of removing an obstacle to growth, or accommodating growth. In this context, the DEIR's principal strategy—to defer the real analysis to post-decision *local* determination, is completely untenable.[96] None of these local decision-makers will have the opportunity to analyze the cumulative consequences of accommodating half a million Californians before the suite of growth-inducing changes in the Monterey Amendments become a *fait accompli.* Moreover, particularly given the decade-plus history with interim enforcement of the Monterey Amendments, there is no basis to support the EIR's premise that the consequences are speculative. Remarkably, the EIR does not even attempt to address the growth-inducing or growth-accommodating impacts of known projects that have relied, in whole or in part, on the Monterey Amendments.[97] The EIR must disclose the impacts associated with

[96] See DEIR, p. 8-14.

[97] The EIR should start by analyzing the documentary history of such projects as Dougherty Valley in Contra Costa County, as well as numerous projects in Los Angeles County: among

the decision to remove the state oversight of SWP water that was embodied in the original pre-Monterey contracts.[98]

While the DEIR argues that DWR does not have responsibility for how water is put to use, it is indisputable that DWR has specific and fundamental responsibilities for overseeing the use of SWP water. Under the Monterey Amendments, DWR has given local agencies increased flexibility, and therefore increased ability to use the water in a way that would potentially impact the environment. While DWR cannot be expected to predict with absolute certainty how contractors and land-use agencies will use the water in the future, DWR has a responsibility to disclose all *potential* significant impacts resulting from this decision and the proposed project. DWR simply cannot be excused from disclosing the impacts of eliminating previously held responsibilities.

The EIR must include adequate analysis of growth inducing impacts, including analysis of how, where and for what purpose water made available under the Monterey Amendments has been put to use, and will likely be used should DWR adopt the proposed project. This analysis must disclose the growth inducing implications of eliminating article 18(b) and article 21(g)(1) of the original contracts, facilitating transfers between agricultural and urban contractors, conveying non-project water, providing municipal contractors increased access to Article 21, permitting unlimited storage outside of the service area, and implementing the Turnback Pool. In addition, the EIR must fully disclose how these provisions may tend to increase the demand for such water and the resulting impacts on the Delta and upstream operations of delivery of such water.

The EIR must specifically state the percentage of water which contractors now have access to under the Monterey Amendments that is likely to be stored for dry year reliability and the percentage which will be used for new growth. Also, the EIR must disclose the degree to which water made available under the Monterey Amendments will be used for resource-intensive growth and urban sprawl. Impacts analysis should include a study of the impacts of the growth likely to be induced by the proposed project water deliveries (i.e. resource intensive sprawl or infill development). For instance, water made available to Castaic Lake Water Agency is likely to result in development of open space and agricultural lands (and require new annexations), whereas water made available to Los Angeles Department of Water and Power is likely to result in development in already developed areas.

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them, West Creek, Gate-King, Riverpark, Northlake, Mission Village, Soledad, River Valley, and Newhall Ranch.

[98] Prior to the Monterey amendment, DWR had explicit oversight of storage of SWP water, water transfers through the SWP, Table A transfers, use of article 21 water, and allocation of water in times of shortage. article 18(b) also required DWR to provide explicit information on the reliability of SWP water through determining the minimum yield of the Delta. Furthermore, under article 18(b), DWR has the authority to reconcile Table A amounts with that minimum yield. Such authority provided the State will direct discretion over the amount of water that could be determined to be reliable.

In addition, as discussed extensively in section V above, the EIR must analyze how the transfer of the Kern Water Bank to local control has facilitated growth-inducing uses of the facility, as compared to operations that would prioritize dry year reliability.

D. The DEIR's assessment of the reliability of water supplies and growth evades, rather than analyzes, the problem of "paper water."

Regrettably, the DEIR's chapter on the reliability of water supplies (Chapter 9) and growth virtually ignores everything that PCL submitted to DWR on the subject during years of EIR planning that preceded the public draft. PCL therefore references its previous submissions on this issue[99] and once again requests specific responses. In a case of "fighting the hypothetical," the DEIR does not seriously engage the "common sense" connection between water availability and growth identified in *PCL v. DWR*, and instead, undertakes to dispute the premise. Essentially, DWR argues that growth based upon paper water never existed, that its extent has been exaggerated, and that new measures (biennial reliability reports, Urban Water Management Plans, and SB 221/ 610) will prevent it from happening in the future. DEIR, pp. 9-2 to 9-11.

This analysis is fatally flawed. First, it asks the wrong question about the historical role of paper water, focusing on whether inflated water reliability estimates have subjectively motivated land-use decision-makers to approve projects. The DEIR answers the question in the negative, not because paper water isn't real, but because ignoring water reliability has been so pervasive that Table A amounts can't be considered uniquely responsible. DEIR, p, 9-10. But a "but for" causation test is not what CEQA requires. What matters is the following:

- Historically and recently, land use decision-makers in California have frequently approved projects with little regard for the availability of adequate water supplies to support the development. Many of these projects have involved State Water Project water resources.[100] Moreover, a consistent body of CEQA case law, from *Kings County* through *Vineyard*, underscores the depth of the problem of decision-makers ignoring the reliability of water supplies,

- The pre-Monterey Amendments SWP contracts had mechanisms that could have been used to take "paper water" out of the calculus regardless of decision-makers' subjective motivations where SWP water was involved: enforcement of article 18(b)'s permanent shortage provision, and article 21(g)(1)'s proscription on using "surplus" water to build permanent economies.

- If the Monterey Amendments become permanent, these safeguards will disappear from the SWP contracts, regardless of what local decision-makers may later do in review of specific projects.

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[99] See Attachment A, particularly the comments addressing the chapter on paper water and growth.

[100] See Attachment J (Kanouse/ EBMUD study).

The problem of "paper water"—stated in its simplest terms, of development decisions grounded in expectations of water supplies exceeding what can actually be delivered—emerged as one of the central themes in the Third District's ruling, and is perhaps the issue with which *PCL v. DWR* is most closely associated in both case law and in public discussion. [101] Rather than providing the thorough and candid assessment of "paper water" and development anticipated in the appellate ruling, the DEIR provides little more than a cursory historical summary, a description of planning laws and practices, and a superficial discussion of Urban Water Management Plans. Indeed, the analysis presented here bears more resemblance to arguments about "paper water" unsuccessfully presented to the court of appeal than the probing and comprehensive assessment anticipated in the appellate ruling and settlement.

A puzzling duality pervades the DEIR's discussion. The historical overview is dismissive of the notion that inflated expectations of SWP deliveries affected development decisions. But rather than debunking the notion that such inflated expectations were present in projects relying on SWP water, the chapter argues, if anything, that they were all too real; that decision-makers so pervasively failed to consider potential constraints on SWP water deliveries that they would have paid little attention to the amounts of "entitlement" referenced in the project contracts.

The core of this analysis posits that planners assume that *local water agencies* will obtain the supply necessary to meet the long-term water demand that results from planned growth. But far from "disproving" reliance on SWP paper water, this analysis points to planners and decision-makers trusting the water agencies; in other words, they are presumed to have relied upon the same pervasive "water culture" in which the court grounded its historical analysis of the "huge gap" between entitlements and available supplies. Instead of analyzing the historical paper water problem, the DEIR repackages it.

A similar circularity pervades the chapter's extremely cursory analysis of SWP water supply and urban planning in the future. From the historical position that planners and decision-makers rarely even considered water supply, the draft swings to a somewhat exaggerated faith that they now "get it," due in part to changes produced by the *PCL v. DWR* decision and settlement, and in part due to parallel legislative changes (notably, SB 610 and SB 221). But the DEIR does not even begin to show that the "modern" mechanisms, such as SB 610/ 221 and Urban Water Management Plans, have now made paper water disappear. [102] Notably, the DEIR does not even analyze two new sources of paper water that are specifically associated with this project. The first, extensively discussed above, is the growing reliance on article 21 water to support permanent developments. The second is that DWR's over-reliance on CALSIM in its reliability reports, which have induced local decision-makers to rely on estimates of SWP yield

[101] See, e.g., *Santa Clarita Organization for Planning the Environment v. County of Los Angeles* (2003) 106 Cal. App. 4th 715, 721; Kibel and Epstein, *Sprawl and 'Paper Water': A Reality Check for the California Courts* 20 CALIFORNIA REAL PROPERTY JOURNAL 22, 23 (Winter/ Spring 2002).

[102] Indeed, the DEIR has not yet addressed PCL's earlier criticisms of its analysis of Urban Water Management Plans, included in Attachment A,

that are vastly beyond historical deliveries. DWR still has yet to come to terms with this "cyber water" problem, which PCL identified in its scoping comments more than four years ago.[103]

D. The DEIR avoids, and impermissibly delegates to subsequent local review, project-related climate change impacts.

Climate change has been extensively addressed above in connection with baseline issues. The separate chapter on climate change in the DEIR (Chapter 12) creates additional CEQA problems, by systematically avoiding full and responsible discussion of project-related climate impacts. First, the analysis relies heavily on the dubious premise that, because DWR had concluded that the project would not affect *statewide* population growth, it would not affect growth-related greenhouse gas emissions "within the SWP service area as a whole." DEIR, p. 12-14. But DWR provides no support for the speculative premise that the location of development is inconsequential to greenhouse emissions. In fact, sprawling patterns of development cause considerably more greenhouse gas emissions than more compact forms of development that occur within existing urban areas. Turning "surplus" water into water that facilitates permanent new development in areas that are currently rural or agricultural will have a very significant impact on greenhouse gas emissions, and the DEIR needs to analyze how the proposed Monterey Amendments will affect that possibility.

Second, the DEIR does not study whether the elimination of pre-Monterey safeguards—including the permanent shortage provision in article 18(b) and the proscription on using "surplus" water to build permanent economies in article 21(g)(i)—may impact climate change by removing useful tools to reconcile supplies and deliveries in a climate-constrained project. The DEIR should study from a climate change perspective whether there is a difference between those pre-Monterey approaches and the post-Monterey approach (reliability reports and liberalized use of article 21).

Finally, the DEIR does not analyze whether would be a project-related difference in emissions due to the difference between serving urban and agricultural contractors. The elimination of the pre-Monterey "agriculture first" preference may make that distinction tangible.

E. The DEIR inadequately addresses cumulative impacts.

[103] As PCL observed in its March 2003 scoping comments (p. 8), a detailed analysis by Dennis O'Connor, then of the California Research Bureau, concluded that DWR's reliability report had no credible explanation for exceeding historic deliveries by around 50 percent. He concluded that the results were inconsistent with previous estimates and models, and recent deliveries were lower than the modeled conditions. His assessment also observes that CALSIM II is not calibrated or otherwise verified, and that the reliability report did not use the CALSIM II model as designed. O'Connor's analysis warns that DWR's assessments of reliability should not replace the "paper water" problem with a new, simulation-based "cyber water" problem. While O'Connor was addressing the draft 2002 report, the problems have never been corrected.

Although the cumulative impacts discussion (Chapter 10) mentions the Central Valley Project, it does not analyze the important question of how the project will affect the environment via CVP use of Delta export capacity. The DEIR analyzes the impact on the availability of water (DEIR, pp. 7-55 to 7-57), but the environmental impacts due to increased pumping from the Delta were not.

VII. Recommended mitigation of impacts

PCL expects that with the additional analysis suggested above, the Final EIR will determine that the proposed project has significant impacts on the environment. Therefore, we provide the following recommendations that could be utilized to mitigate for some, although not all, of the significant impacts identified in these comments.

- To partially prevent growth inducing impacts, the EIR can require DWR to provide a clear statement that Article 21, transfers of Article 21 and reliance on Turnback Pool water are not reliable sources of water and that such sources are not suitable for support of permanent economy, including development. To avoid any confusion, the EIR should commit DWR to excluding these sources of water from the Report on the Delivery Reliability of the State Water Project.

- To partially mitigate impacts associated with eliminating Article 18(b), the EIR should commit DWR to provide explicit guidance on how to interpret reliability curves included in the SWP Delivery Reliability Report.

- To partially mitigate potential impacts to the Delta from increased pumping of Article 21 water, the EIR can prohibit declaration of Article 21 when fish agencies determine that there would be threat to fish species from export of such water.

- To partially mitigate for the loss of statewide oversight of the use of SWP water, the EIR should commit DWR to providing full disclosure of accounting, pumping and delivery of SWP water to the public in a timely (weekly) basis.

- To partially mitigate for the loss of the Kern Fan Element as a public trust resource, the EIR should impose conditions requiring that public trust agencies will have priority for the capacity of the Kern Fan Element for the storage of water to protect public trust resources including the health of the Delta.

These measures would not fully mitigate the impacts of proposed project. Impacts such as increased demand for SWP water to offset dry year by municipal contractors would not be addressed by the proposed mitigation measures above. However, the final EIR would need to address all impacts of the proposed project.

As an original plaintiff in the Monterey Amendments litigation, PCL has an interest in ensuring that the final EIR provide the public and decision-makers with an accurate and thorough

analysis of the proposed Monterey Plus actions and a thorough comparison of viable and feasible alternatives, consistent with the original *PCL v. DWR* court decision.

We are distressed that despite the direction provided by the Court of Appeal, and despite our participation in the EIR process, and despite the significant events that have occurred since 1995, including the collapse of the Delta, the Monterey Plus DEIR is largely based on the same unfounded assumptions included in the CCWA EIR, and EIR rejected by the Court of Appeal.

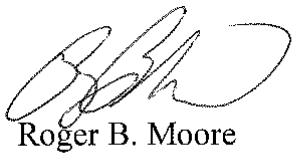
The current DEIR manifestly fails to provide the full review demanded by the Court – and by the California Environmental Quality Act – and that was anticipated by plaintiffs in the settlement agreement.

We urge DWR to remedy the significant flaws in the current DEIR by fully analyzing, disclosing and mitigating the impacts of the proposed project in future versions of the EIR, as CEQA most emphatically requires.

Thank you for taking our strongly felt comments into consideration.

Sincerely yours,

Gary A. Patton, Executive Director



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MWD Board
SWP contractors

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 25, 2008

Ms. Mindy McIntyre, Water Program Manager
Planning and Conservation League
1107 9th Street, Suite 360
Sacramento, CA 95814

Dear Ms. McIntyre:

This letter responds to your letter dated March 16, 2008 providing comments of the Planning and Conservation League (PCL) on the draft of the State Water Project Delivery Reliability Report—2007 (DRR(2007)). Your letter criticizes the timing of the release of the report, expresses concern about using CalSim II for determining absolute values of exports and deliveries, and makes several recommendations for improvement. Responses to your specific comments are included in the attachment.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department of Water Resources (DWR) responses.

Attached is a summary of your comments and DWR's responses that will appear in final of the 2007 Delivery Reliability Report.

Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

cc: See attached list

Lester A. Snow, Director
Department of Water Resources
Post Office Box 942836
Sacramento, California 95814

Antonio Rossmann
Rossmann & Moore, LLP
380 Hayes Street
San Francisco, California 94102

Roger Moore
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Senator Don Perata
State Capitol, Room 205
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Senator Darrell Steinberg
State Capitol, Room 4035
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Senator Sheila Kuehl
State Capitol, Room 5108
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SWP Contractors
Terry Erlewine
1121 L Street, Suite 1050
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Susan Kennedy, Chief of Staff
State Capitol Building
Sacramento, CA 94249

Attachment

Comment:
DWR should commit to releasing the Draft 2009 Delivery Reliability Report in June 2008 and the final report by February 2009 in order for local water agencies to have sufficient time to incorporate the information in the report into the 2010 Urban Water Management Plans (UWMPs).

Response:

DWR agrees with the goal of producing the 2009 Delivery Reliability Report according to a timeline which will allow for the information in the report to be incorporated into the 2010 UWMPs. The objectives of DWR for the report are to encourage public discussion and understanding of the estimation of the SWP delivery capability, meet the conditions of the settlement agreement, and provide the best available quantification of SWP deliveries. It is unfortunate that the DRR (2007) could not be finalized in 2007. Given the 2007 federal court order on new SWP operation criteria to protect delta smelt, DWR chose to delay the completion of the report until the impacts of this court order on SWP delivery reliability could be assessed. Re-consultation under the Endangered Species Act is underway for the SWP and CVP. The resulting biological opinions will define the operation rules for the water projects. The biological opinion from the U.S. Fish and Wildlife Service is expected to be completed this calendar year (2008). However, the biological opinion from the National Marine Fisheries Service will be completed in Spring 2009. The information contained in the next Delivery Reliability Report will incorporate these new rules and, therefore, the draft report is expected to be issued in mid-2009.

Comment:

The draft DRR (2007) fails to articulate how reliability should be factored into water planning.

Response:

Chapter 7 of the draft DRR (2007) presents two examples of how to use the information in the report to estimate SWP deliveries at 5-year increments between 2007 and 2027. Example 1 illustrates this process for calculating average annual supplies, a single dry year, and average deliveries over multiple dry years. Example 2 illustrates how to develop similar information for years or sequences selected by the individual SWP contractor.

By providing examples of a hypothetical contractor with Table A amounts of 100,000 af and using the delivery data in terms of percent of maximum Table A amount, the report makes the examples easy to apply by any contractor. Each SWP contractor has a

unique mix of local and imported water supplies, relies on SWP supplies for a different proportion of its needs, and has an individual conservation flexibility to accommodate supply variations. DWR believes that individual contractors can best determine under which conditions to rely upon current and future SWP deliveries, given a contractor's other supply sources or given the locally acceptable risk level for water delivery shortages.

Comment:

The draft DRR (2007) fails to disclose the implications of reliance on water that cannot be reliably delivered, in particular Article 21 water. Article 21 water should not be included in the list of water supply sources in any table.

Response:

The draft DRR (2007) clearly communicates the conditional availability of Article 21 deliveries. The first mention of Article 21 water in Chapter 4 includes a footnote which lists the limitations for the availability of this water. Chapter 5 includes a discussion of Article 21 of SWP contracts allowing contractors to receive additional water deliveries only under four specific conditions:

1. The water is available only when it does not interfere with Table A allocations and SWP operations;

2. The water is available only when excess water is available in the Delta;

3. The water is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and

4. The water cannot be stored within the SWP system. In other words, the contractors must be able to use the Article 21 water directly or be able to store it in non-SWP facilities.

Chapter 5 of the report also points out that in the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. In addition, Tables 6-8, 6-9, 6-17 and 6-18 compare the results of the annual amounts of Article 21 available during prolonged dry periods and wet periods for the DRR (2005) and the DRR (2007). The variability of the annual amounts and the reduction in the amounts estimated in the DRR (2007) clearly illustrate the uncertainty associated with Article 21 supplies.

DWR believes that the issue of incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required. Article 21 water is

presented separately in the report so local agencies can determine whether it is appropriate to incorporate this supply into their analyses. In many cases, water supplies available under Article 21 of the water supply contract are an important yet ephemeral source of water from SWP facilities that needs to be included in the DRR.

Comment:
The draft DRR (2007) fails to inform the reader that CalSim II model runs very likely overestimate the reliability of the SWP because the studies in the DRR do not account for Delta risk factors and the need to respond to environmental, water quality, and area of origin legal requirements.

Response:

"Delta risk factors" is an all inclusive term that has numerous components. It is not accurate to claim that CalSim-II simulations do not account for them. The simulations in the DRR (2007) account for restrictions due to potential protective measures for endangered fish, water quality requirements, and climate change. These potential impacts are extensively addressed in Chapter 4 of the DRR (2007). Implementation of potential limitations to exports from the Delta to protect delta smelt are represented in the current level study in the DRR (2007) by incorporating the interim decision of the federal Court. The future level studies incorporate climate change and these fish protection measures. CalSim II simulations do not account for a catastrophic levee failure but the potential interruptions to water supply are discussed in the report (ref. DRR 2007, P.8, PP.18-19). It is also inaccurate to claim that CalSim-II does not account for the "area of origin legal requirements." The estimates of water available from the source areas have been developed with assumptions on future population growth in upstream areas and the resulting consumptive demand, as well as projections of crop acreages in the valley floor and the resulting evapotranspiration demand.

Comment:

The draft DRR (2007) fails to provide guidance to SWP contractors on how local and overall water supply reliability could be improved.

Response:

Providing guidance to SWP contractors on how local and overall water supply reliability could be improved is beyond the intended scope of the DRR (2007). The purpose of the report is to present DWR's current information regarding the annual water delivery reliability of the State Water Project for existing and future conditions. A key objective of the California Water Plan is to provide guidance to local agencies and governments and regional partnerships on ways to increase regional self sufficiency in meeting their future water demands. The Water Plan includes a diverse set of resource management strategies that can be implemented in different combinations to provide water supply reliability and to meet other water related resource management needs in different regions of the state.

Comment:

The DRR (2007) should include a discussion regarding the reliability of all types of water delivered from the SWP.

Response:

The report provides information on the water supply categories most important to SWP water contractors, Table A and Article 21. The conditions associated with the supply under Article 21 are fully discussed in the report. More detail on the characterization of Article 21 supply is provided in the third response contained in this attachment.

Comment:

The DRR (2007) should include water supply source tables for each SWP contractor. DWR should include a clear and understandable forecast of how much water (both Table A and Article 21) the SWP can deliver under current and future conditions for each SWP contractor.

Response:

The DRR (2007) provides estimates of Table A supply for the entire range of delivery probabilities, zero to 100 percent. Calculating a Table A delivery amount for an individual contractor is a direct calculation based upon the maximum Table A amount in the contractor's water supply contract. The maximum Table A amounts for each contractor are contained in Appendix C, *State Water Project Table A Amounts*. Determining the acceptable level of risk associated with the estimated Table A delivery amount is a local decision based on specific local circumstances, facts, and level of water supply reliability required. Article 21 water is presented separately in the report so local agencies can determine whether it is appropriate to incorporate this supply into their analyses. Some SWP contractors will have no ability to receive Article 21 supplies. Estimating the amount of Article 21 deliveries for each SWP contractor is beyond the scope of the DRR (2007), as is developing an inventory of each SWP contractor's water supply sources.

Comment:

The DRR should provide estimates of SWP delivery reliability for the period required by the following UWMP (which would be 2030).

Response:

The DRR for 2009 will include estimates for 2009 and 2029 which can be used for the updated Urban Water Management Plans.

Comment:

The DRR should clearly disclose the limitations of modeling, the implications of modeling assumptions, and provide recommendations to water agencies for appropriate use of modeling results.

Response:

The points PCL includes in this comment are ones which were included in your letters commenting on the draft DRR (2002) and draft DRR (2005). The responses to these comments are included in the appendices of the corresponding final reports and referenced here. Disclosing the limitations of modeling is accomplished through clearly disclosing significant assumptions that are made in the modeling process, and that disclosure has been done fully and extensively in the DRR (2007). Chapter 7 of the report illustrates how to interpret and apply the results should local planning agencies choose to use these estimates as one of the components of their resource management decisions.

Comment:

The DRR should include a more comprehensive analysis of climate change impacts on water delivery reliability, including issues of Delta water quality and sea level rise, consumptive use of water in areas of origin, availability of hydropower, and flood safety. DRR should provide guidance to water agencies on how these omitted impacts are likely to affect deliveries.

Response:

DWR is a leader in applying climate change factors to projections for water supply and we will continue to take a leadership role in this endeavor. The DRR (2007) uses four climate change scenarios for rainfall and runoff to develop the range of delivery estimates for the future. The Department is investigating methods to estimate the effects of sea level rise on Delta water quality. The DRR is published every two years and we will use the best information and analytical methods available to develop the latest projections for delivery capability under potential climate change scenarios. Flood safety and hydropower effects are beyond the scope of the report.

Comment:

The DRR fails to evaluate variable levels of demands, including the goal of a 20% reduction in per capita consumption. The DRR should use the three demand scenarios presented in DWR's 2005 State Water Plan.

Response:

The DRR is intended to provide information on the amount of Table A and Article 21 water that can be delivered considering a variety of hydrologic conditions, climate change factors, regulatory constraints, and other factors. It also illustrates how that water would be allocated among contractors based on their Table A amounts. The DRR is not intended to evaluate how a comprehensive demand reduction might affect the demand for SWP supplies of individual municipal and agricultural contractors.

A reduction in per capita consumption may not affect SWP demands. If individual contractors can reduce their demand for SWP supplies as part of their total water supply portfolio, they could either offer any unneeded water to other contractors or request delivery of less water from the SWP than would otherwise be available to them. In the latter case, DWR could allocate the unclaimed amount to other contractors by increasing the percentage allocation of Table A supplies available to them. In other words, the same amount of water would continue to be allocated, but in different proportions to the contractors. In addition, factors such as water quality of the source supply and the costs associated with treating the supply for municipal use are significant considerations for SWP contractors. For some SWP contractors, the quality of the SWP supply is better than other sources and it is used to reduce treatment costs for municipal supply. In this situation, demand on another source of supply may be reduced due to conservation measures and the demand for SWP supplies would be unchanged.

SWP contractors should consider their current water demands and future demand scenarios to help determine the mix and amounts of water supply sources, including SWP supplies, they will need to meet their water demands and other water resource objectives. It would be advisable for local water agencies to consider a future demand scenario that assumes a reduction in per capita water use because it could change how much they decide to invest in different water supply sources. These evaluations, and their implications to the demand for imported water from the SWP and other sources, is a responsibility of the SWP contractors and can be a part of their 2010 Urban Water Management Plans.

Comment:

The DRR should consider operations beyond the Wanger decision to include those that are consistent with State and federal fishery agencies for protection of threatened or endangered species.

Response:

The estimates for delivery capability will be updated when the rules of operation to protect endangered fish are defined in the revised federal biological opinions for the operation of the SWP and Central Valley Project.

Comment:

The DRR must recognize that DWR has not yet issued a final decision and EIR for the Monterey Plus Project.

Response:

The DRR will be updated in 2009, and will include the most current information available regarding the status of the Monterey Plus Project and any relevant decisions of DWR regarding the project. It is not possible to predict at this time what those decisions might be and whether they would affect the reliability of SWP deliveries.

Comment:

As participants in the Monterey Plus EIR Committee process, PCL has previously submitted comments to DWR expressing our concerns regarding the adequacy of CALSIM II for use in water management planning and deliveries assessment. Rather than resubmit those comments, we incorporate them by reference here, and highlight some particular issues below.

Response:

Most of the comments PCL incorporates from comments submitted on the Monterey Agreement DEIR are ones that are addressed above or have been previously responded to as comments to the DRR (2002) or DRR (2005). We refer to those responses. Our response to the comment regarding bimodal distribution of water years follows.

Comment:

Exceedence charts in the DRR hide the bimodal distribution of water years in California. CalSim II is ill-suited to address bimodal distribution of water years because the model produces an exceedence chart that hides this reality.

Response:

Currently CalSim-II uses 82 years (water years 1922-2003) of historical flow records to reflect the hydrologic variations in Central California. The historical flow records are adjusted for the influence of land-use change and upstream flow regulation in order to represent the possible range of water supply conditions at a given level of development. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over the 82 years of study period. Using a monthly time step, CalSim II model simulates operation of CVP and SWP system storage and conveyance under specified operations rules. Model output provides project operations under a given level of development for the entire study period. One of the key model outputs is simulated SWP annual deliveries, which are ranked from low to high and plotted in an

exceedence chart. There is no intention to hide any inherent statistical properties of historically observed flow data.

Comment:

DRR fails to recognize that DWR has chronically failed to meet water quality standards in the Delta under historical operations and it fails to recognize the significant environmental degradation under the historical operations.

Response:

DWR operates the SWP to meet water quality objectives established by the State Water Resources Control Board (Board) and incorporated into DWR's water rights permits for the SWP. The water quality and fish flow requirements are contained in the Board's Decision 1641. In addition, the SWP is operated to meet requirements contained in the federal ESA biological opinions. Operation of the SWP has consistently met all water quality requirements except for those established for the south Delta, for which the salinity source is the San Joaquin River and not ocean-derived salts. The SWP does not contribute in any way to salt loads in the San Joaquin River and the southern Delta. The SWP is operated to help in achieving the south Delta salinity standards however, SWP operation cannot control south Delta water quality. This is because of the effects of the local flow and water quality conditions attributable to areas of stagnation, agricultural diversion and return flows, local wastewater discharges and lower quality water from the San Joaquin River. DWR is pursuing the installation of operable gates in the south Delta to improve circulation and, hence, water quality in the area.

Comment:

DRR should list potential sources of errors and show the range of possible outcomes due to these errors and provide recommendations to water agencies for addressing modeling faults-for example reduce the amount of deliveries predicted by CalSim II by some percent. By omitting both possible sources of errors and potential outcome ranges, the DRR projects a false certainty that reported deliveries are likely.

Response:

Quantifying the amount by which DRR estimates should be reduced or increased in order to achieve more accurate estimates of reliability requires a scientifically sound analysis of the uncertainties for numerous variables, each with their own error band, and developing a method to combine these uncertainties to get an estimate of the resultant uncertainty and its effect on the delivery reliability of the system. This is the approach that DWR is pursuing in conjunction with identifying and quantifying uncertainties associated with the system reliability in the face of the climate change phenomenon. However, until we can make reasonable and scientifically sound statements on uncertainties, we must rely on identifying a handful of variables that we know by experience could significantly affect SWP system reliability and provide the

users with a sense of how much over-estimation or under-estimation might be involved. An example would be reducing the input data on rim flows to major storage facilities of the system by a certain percentage and reporting the difference in simulation results. Such a study was done in the CalSim-II sensitivity analysis conducted in 2005 and presented in the 2005 Delivery Reliability Report.

From: Stuart Robertson [stuart@robertson-bryan.com]
Sent: Thursday, January 31, 2008 3:11 PM
To: 2007DRRComments
Subject: Comments

You are way off base to focus on climate change – this is more speculation than science as to timing and magnitude.

Delta conveyance is a far bigger, real and eminent threat. The weakness of the Delta levees is a known risk. One major failure due to a rodent, earthquake (quantifiable) or yes, global warming would catastrophically impair the SWP.

Get off the climate change and address something we can deal with within 20 years

Stuart Robertson, President
ROBERTSON-BRYAN, INC.
voice: (916) 687 - 7799
stuart@robertson-bryan.com

DEPARTMENT OF WATER RESOURCES
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(916) 653-5791

August 11, 2008

Mr. Stuart Robertson, President
Robertson-Bryan, Inc.
9888 Kent Street
Elk Grove, CA 95624

Dear Mr. Robertson:

This letter responds to your email of January 31, 2008 providing comments on the draft of the State Water Project Delivery Reliability Report—2007 (DRR(2007)).

In your email, you state that the draft DRR (2007) places too much focus on climate change and should instead focus on less speculative risks which can be addressed in the next 20 years, in particular the threat posed by weak Delta levees.

The relative uncertainty of the effects of climate change on SWP delivery reliability are appreciated. However, Governor Schwarzenegger's Executive Order S-3-05, signed on June 1, 2005, directs the Secretary of the California Environmental Protection Agency to coordinate with State agencies to report every two years on the impacts to California of global warming, including impacts to water supply. The Department of Water Resources identifies climate change in the 2005 update of the California Water Plan (Bulletin 160-05) as a key consideration in planning for the State's future water management. This is because analysis has shown that climate change may in the future seriously affect the State's water resources, particularly SWP's ability to deliver water. The DRR (2007) recognizes the uncertainty of climate change projections by evaluating future State Water Project deliveries under four scenarios of climate change: weak temperature warming and weak precipitation increase in California under model PCM; modest warming and modest drying under model PCM; modest warming and modest drying under model GFDL v. 2.0; and weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0. Simulated deliveries under these scenarios of climate change were then interpolated to estimate deliveries in the year 2027.

The draft DRR (2007) acknowledges the real threat of levee failure to State Water Project delivery reliability, citing key findings in the Draft Delta Risk Management Study (DRMS) Phase 1 Report. The draft DRMS Phase 1 report also points out that the impact of a levee failure on SWP deliveries would depend upon when and where the levee failure occurred. The draft DRR (2007) includes a discussion of DWR's development of an Emergency Operations Plan that will establish procedures for emergency preparedness and incident management activities to enhance the State's ability to prepare for, respond to, and recover from a Delta levee failure disaster and will provide DWR with a plan focused specifically on a catastrophic levee failure disaster.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

March 13, 2008

Department of Water Resources
SWP Delivery Reliability Report – Attn: Cynthia Pierson
P.O. Box 942836
Sacramento, CA 94236-0001

Re: Comments on Draft State Water Project Delivery Reliability Report, 2007

Dear Ms. Pierson:

On behalf of the State Water Contractors (SWC), I am writing to provide comments on the Department of Water Resources' (DWR) Draft State Water Project Delivery Reliability Report, 2007 (2007 Report). The SWC is a non-profit association of 27 public agencies from Northern, Central, and Southern California that purchase water under contract from the California State Water Project (SWP).[1] The SWP is the state's largest water delivery system, and collectively, members of the SWC deliver SWP water to more than 25 million residents throughout the state and more than 750,000 acres of highly productive agricultural land.

The SWC have reviewed the 2007 Report and found that it provides a reasonable assessment of current and future SWP delivery reliability, given the limitations and future uncertainty discussed in the report. We believe that the following comments will help improve the final 2007 Report and provide additional information that will be useful to the SWP Contractors in applying the delivery reliability results from the report into their own planning efforts.

[1] The members of the SWC are: Alameda County Flood Control and Water Conservation District Zone 7, Alameda County Water District, Antelope Valley-East Kern Water Agency, Casitas Municipal Water District, Castaic Lake Water Agency, Central Coast Water Authority, City of Yuba City, Coachella Valley Water District, County of Kings, Crestline-Lake Arrowhead Water Agency, Desert Water Agency, Dudley Ridge Water District, Empire-West Side Irrigation District, Kern County Water Agency, Littlerock Creek Irrigation District, Metropolitan Water District of Southern California, Mojave Water Agency, Napa County Flood Control and Water Conservation District, Oak Flat Water District, Palmdale Water District, San Bernardino Valley Municipal Water District, San Gabriel Valley Municipal Water District, San Gorgonio Pass Water Agency, San Luis Obispo County Flood Control and Water Conservation District, Santa Clara Valley Water District, Solano County Water Agency, Tulare Lake Basin Water Storage District.

STATE WATER CONTRACTORS
SWC
Served by the State Water Project
FOUNDED IN 1982

DIRECTORS

Dan Masnada
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Thomas Hurlbutt
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Tulare Lake Basin Water Storage District

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Joan Maher
Santa Clara Valley Water District

David Okita
Solano County Water Agency

Ray Stokes
Central Coast Water Authority

General Manager
Terry Erlewine

1. **Studies in 2007 Report are based on interim operations and will need updating with new OCAP operations**. The updated studies included in the 2007 Report all include the interim SWP and CVP operations rules imposed by the December 2007 Federal Court order. These interim operations rules are temporary and will be imposed only until a new Operations Criteria and Plan (OCAP) and biological opinion are issued, which is anticipated to occur in September 2008. In spite of the temporary nature of these interim operations rules, these rules are included as operational constraints in the 2007 Report's updated studies, not only for 2007 but for 2027 as well. This may provide the mistaken impression that the constraints are long-term, which is not the case.

   The new OCAP and biological opinions will most likely include operations rules that differ from those in the interim Court order. As a consequence, the results in the 2007 Report will be outdated as soon as the new OCAP is available in about six months. If DWR proceeds with finalizing this 2007 Report based on the interim operations rules, the final report should more clearly stress the interim operations upon which the 2007 Report studies are based and the limitations of the results presented, and DWR should commit to updating the report's studies based on new OCAP operations when it is available. Or alternatively, since there seems to be little value in finalizing a report that will almost immediately be outdated, DWR could delay finalization of this report until the new OCAP is finalized and studies can be updated (and in the interim, data from this draft 2007 Report would be available for use by anyone needing reliability data). This updated reliability information will be particularly important given that many agencies will begin preparation of their Urban Water Management Plan (UWMP) updates during 2009 (updates are due by December 31, 2010), and the final version of this 2007 Report will serve as guidance for their SWP supply analyses.

2. **Changes included in 2007 Report studies should be disaggregated.** A number of new factors are included in the 2007 report studies (i.e., modeling improvements, current interim operations, and climate change), each with a different degree of uncertainty. The CALSIM II modeling improvements should provide more accurate results, and presumably a corresponding improvement in certainty of results. However, the interim operations, which are in part based on real-time conditions that can produce a range of operational restrictions, introduce a new degree of uncertainty on delivery reliability. Further, the inclusion in the 2027 studies of a range of potential climate change impacts introduces an additional dimension of uncertainty. To provide readers with better information on which to make more informed judgments regarding the impacts on reliability of each of these factors and the varying levels of uncertainty associated with them, the final 2007 Report should present additional studies that separate out the effects of the new factors included, as discussed further below.

   a. **Effects of CALSIM II improvements since 2005 Report should be shown separately.** In the 2007 Report, results from studies in the 2005 Report are shown for comparative purposes along with results from the 2007 studies. The model studies in the 2007 Report were based on a version of CALSIM II that was modified from the CALSIM II version used in the 2005 Report to include several modeling improvements (i.e., improved San Joaquin River module, improved Artificial Neural Network to estimate Delta salinity, and

an extended hydrologic period used to simulate operations). The effects of these modeling improvements should be shown separately so that the changes in estimated delivery reliability resulting from this change alone can be ascertained. The SWC suggest including an additional study, under both 2007 and 2027 conditions, using the 2007 version of the model with its modeling improvements, but using the same SWP/CVP operational criteria as in the 2005 Report (i.e., based on 2004 OCAP operations). This comparison could be included as part of Appendix A, or possibly in Chapter 2 as part of the discussion of CALSIM II.

In the remainder of the 2007 Report, it is these added studies based on the 2007 version of the model and 2004 OCAP that should be used for comparative purposes to the 2007 Report studies presented, rather than the 2005 Report study results which are based on an earlier version of the model and a different hydrologic period. This would then provide an apples-to-apples study comparison, rather than the apples-to-oranges study comparison now included in the 2007 Report.

b. **Effects of changed operations (either interim or new OCAP operations) should be shown separately.** The SWC suggest that the effects on delivery reliability of the change in SWP/CVP operations rules since 2005, isolated from the modeling improvements, be presented. For the current conditions (2007) analysis in the 2007 Report, this could be shown by comparing the updated studies currently included in the 2007 Report, to the added study with the 2007 CALSIM II model version based on 2004 OCAP (described in Comment 2.a above). For the future conditions (2027) analysis, this could be shown by comparing studies that include just the change in SWP/CVP operations without the potential effects of climate change, to the added study with the 2007 CALSIM II model version based on 2004 OCAP (described in Comment 2.a above). Existing studies of future conditions that do not include the effects of climate change are currently included in Appendix B, but they are only used for interpolation purposes. The results of these studies should also be presented in the body of the report in Chapter 6, for comparative purposes alongside the other study results.

c. **Potential effects of climate change should be shown separately.** For the future conditions (2027) analysis, a comparison of the studies with climate change included in the 2007 Report to the existing studies without climate change (described in Comment 2.b above) would show a range of potential effects of climate change on SWP deliveries, isolated from the modeling improvements and change in SWP/CVP operations since 2005. Since there is a great degree of uncertainty associated with the broad-brush estimates of potential climate change included in the 2007 Report, it is appropriate to show these impacts separately from the better known and more certain effects of assumed future operations. This will also enable any refined estimates of potential climate change effects to more readily be compared to the range of delivery impacts included in the 2007 Report. In addition, separation of the potential climate change effects will be useful for UWMP preparation, as it will enable agencies to incorporate that information into their plans as a stand-alone analysis.

3. **Full range of future conditions scenarios should be shown.** In the 2007 Report, interim operations, which are based in part on real-time conditions that can produce a range of operational restrictions, are evaluated in two separate studies, one study with the high end of those restrictions the other with the low end. The results of these two studies are then averaged for each year and it is those average results that are presented. We agree that this average is a reasonable estimate of likely operations in a given year. For the future conditions, however, it would be informative to show the more complete range of potential deliveries by presenting the full range of non-averaged results.

We appreciate the opportunity to review and provide comments on the 2007 Report. If you have any questions about these comments, please contact me at (916) 447-7357.

Sincerely,

Terry L. Erlewine
General Manager

cc: SWC Member Agencies

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
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August 11, 2008

Mr. Terry L. Erlewine, General Manager
State Water Contractors
1121 L Street, Suite 1050
Sacramento, CA 95814

Dear Mr. Erlewine:

This letter responds to your letter dated March 13, 2008 providing comments of the State Water Contractors on the draft of the State Water Project Delivery Reliability Report—2007 (DRR(2007)). Your letter expresses concern that the SWP delivery reliability analysis in the DRR (2007) is based upon interim operation rules to protect delta smelt which may change in 2008 and requests that study results in the report be disaggregated and not averaged to provide readers better and more complete information. Responses to your detailed comments are provided below.

Comment: Studies in the 2007 Report are based on interim operations and will need updating with new Operations Criteria and Plan (OCAP) operations. DWR should either delay finalizing the report until the new OCAP is finalized and studies can be updated or DWR should more clearly stress the limitation of using interim operations in the report's studies and commit to updating the report's studies based on new OCAP operations when they are available.

Response: Your point about concern for the use of interim operation rules in estimating current and future SWP delivery reliability is well taken. The estimates of SWP delivery reliability in the DRR (2007) necessarily reflect the best information available at a point in time. It is recognized that operation rules under the new OCAP may differ from the interim rules assumed in the DRR (2007) and that estimated SWP delivery reliability could subsequently change. When the new OCAP and biological opinion are issued, DWR will update and make available the studies and analyses presented in the DRR (2007).

Comment: The final 2007 report should include studies in which the version of CalSim II used in the DDR (2007) evaluates SWP deliveries under the 2004 OCAP operation rules used in the 2005 report. Results of these studies should be compared to the results from the 2005 report and also be used for comparative purposes to the 2007 report studies presented.

Response: The updated estimates of SWP delivery reliability in each report reflect the use of the best available tools and information at the time of the report. The focus of the presentation of delivery reliability in each report are the updated estimates of current and future SWP deliveries not the effect of changes of the tools upon the estimates. The DDR (2007) includes a discussion of how the updated estimates compare to those in the previous report.

As you note in your comments, the version of CalSim II used in the 2007 draft report is different from the version used in the 2005 report because it uses an improved San Joaquin River water quality module, an improved Artificial Neural Network model to estimate Delta salinity, and an extended hydrologic period under which operations are simulated. DWR documented the improved Artificial Neural

Network model in CalSim II in Chapter 3 of the 2007 edition of its annual report, *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*. This report is accessible at http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/annualreports.cfm and selecting "Entire Report" under 2007. The San Joaquin River module in CalSim II was documented in U.S. Bureau of Reclamation's 2005 report, *CALSIM II San Joaquin River Module (DRAFT),* available at http://science.calwater.ca.gov/pdf/calsim/CALSIMSJR_DRAFT_072205.pdf. This module was subsequently reviewed by an expert panel in a 2006 report for CALFED titled, *Review Panel Report: San Joaquin River Valley CalSim II Model Review*. This report is available at http://science.calwater.ca.gov/pdf/calsim/calsim_II_final_report_011206.pdf

Comment: Since the estimates of effects of climate change have a great degree of uncertainty, potential effects to SWP delivery reliability due to climate change should be shown separately from the better know certain effects of assumed future operations.

Response: The relative uncertainty of the effects of climate change is appreciated. However, Governor Schwarzenegger's Executive Order S-3-05, signed on June 1, 2005, directs the Secretary of the California Environmental Protection Agency to coordinate with State agencies to biannually report on the impacts to California of global warming, including impacts to water supply. The Department of Water Resources identifies climate change in the 2005 update of the California Water Plan (Bulletin 160-05) as a key consideration in planning for the State's future water management. This is because analysis has shown that climate change may in the future seriously affect the State's water resources, particularly SWP's ability to deliver water. In DRR (2007), the Department recognizes the uncertainty of climate change projections by evaluating future State Water Project deliveries under four scenarios of climate change: weak temperature warming and weak precipitation increase in California under model PCM; modest warming and modest drying under model PCM; modest warming and modest drying under model GFDL v. 2.0; and weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0. Simulated deliveries under these scenarios of climate change were then interpolated to estimate deliveries in the year 2027. The annual SWP deliveries under future conditions with and without climate change are contained in Tables B-4 through B-11 in the Appendix B of DRR (2007).

Comment: For future conditions, it would be helpful if the full range of potential deliveries were presented that weren't averaged by simulations using higher and lower operational restrictions in accordance with the 2007 interim operations.

Response: Since the real-time conditions that would determine the extent of operation restrictions are unknown, we believe that averaging the deliveries under assumed higher and lower operation restrictions is reasonable. The annual Table A and Article 21 deliveries under both the higher and lower restrictions to operations are presented in Appendix B and have been made available electronically at the SWP Delivery Reliability Report website.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

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Potential Capture of Perchlorate Contamination Valencia Water Company's Wells E14 – E17

PREPARED FOR: Valencia Water Company

PREPARED BY: Joseph C. Scalmanini
William L. Halligan

DATE: April 26, 2006

PROJECT NUMBER: 06-2-008

Introduction

As part of its water supply planning in accordance with the overall groundwater operating plan in the Santa Clarita Valley Groundwater Basin, East Subbasin, Valencia Water Company is in the process of installing four new municipal water supply wells in the western part of its overall service area, generally near the mouth of Castaic Creek Canyon. Those four wells are intended to augment Valencia's groundwater source capacity and, in general, provide municipal pumping capacity in that part of the overall basin that will replace a number of agricultural supply wells in the same area as the latter are abandoned in concert with general land development in the area.

In light of general concerns about perchlorate contamination in the groundwater basin, despite the fact that the focus of that concern is several miles to the east of the new Valencia wells, Valencia commissioned the work reported herein to investigate the risk of perchlorate contamination on its new wells. As a result, the analysis described below was undertaken to examine the potential capture of perchlorate-impacted groundwater by the new Valencia wells, and the results have been interpreted to conclude regarding risk of perchlorate capture at the new wells.

In summary, the approach to investigating potential capture of perchlorate-impacted groundwater by the new wells involved three sequential steps: identification of local and regional groundwater flow patterns in the Alluvium, the aquifer in which all four wells are completed; application of a single layer groundwater flow model to examine the capture zone of the four-well "well field" under planned operating conditions; and interpretation of potential capture of perchlorate via examination of the wells' theoretical independent capture zone relative to known occurrence of perchlorate and its mobility in the Alluvium. The latter step was subsequently augmented by considering other factors, such as the locations and magnitude of pumping between the new wells and the known occurrence of perchlorate, that affect the potential capture of perchlorate by the new wells. Ultimately, conclusion regarding the risk of perchlorate contamination at the new wells was drawn from a combination of the theoretical independent

capture zone analysis and the other factors that affect the potential capture of known perchlorate in the basin.

Valencia Wells E14 – E17

Valencia's four new Alluvial wells are numbered E14 through E17. The locations of the new Valencia municipal wells are illustrated in Figure 1, which also shows other nearby wells.

As specified in Valencia's Water Supply Permit issued by the State Department of Health Services (DHS), Valencia's new municipal E wells are replacement wells for some of the nearby Newhall Land and Farming Company's agricultural E wells, e.g. Wells E, E2, E4 and E5, which are in the process of being permanently sealed and abandoned in accordance with the DHS Permit. As land development occurs in the general area of those wells, the need for irrigation water supply will progressively decrease and municipal water demands will correspondingly increase. Thus, in general, the new Valencia wells will generally produce water comparable to the historical production from the NLF wells, resulting in no substantial change in basin operation. Pumping from the basin will thus remain within the operating yield concept incorporated in the 2005 Urban Water Management Plan and analyzed in the 2005 Basin Yield Report.

The four new Valencia E wells are all generally similar in terms of aquifer completion and construction details. All four are completed solely in the Alluvium. All four well sites were explored via pilot hole drilling and logging to about 200 feet, and the four completed wells range in depth from 133 feet (Well E-15) to 170 feet (Well E-16). All four wells are similarly constructed with 18 inch nominal production casing from the ground surface to the top of a single perforated (louvered well screen) intake section. The depths of blank production casing range from 76 feet (Well E-14) to 92 feet (Well E-15). Louvered well screens range in length from 38 feet (Well E-14) to 63 feet (Well E-16). The bottom of the well intake sections ranges between depths of 114 feet (Well E-14) and 145 feet (Well E-16). All four wells have gravel envelopes extending from total depth to just above the top of the intake section, and are sealed above that depth, to the surface, with cement grout. Key well construction details for all four Valencia E wells are summarized in Table 1.

The four new Valencia E wells are intended to be equipped to pump between 1,000 and 1,400 gallons per minute (gpm). Three of the four wells (E-14 through 16) have comparable, high yields as indicated by their respective specific capacities (gpm per foot of drawdown) generally between about 62 and 66 gpm/ft. Well E-17, while still capable of its design capacity of 1,000 gpm, has a notably lower yield, about 34 gpm/ft. Well yield and design capacity details for all four wells are also summarized in Table 1.

At present, Valencia Well E-15 has been equipped with a permanent pump and appurtenant facilities to render it operational at its design capacity of 1,400 gpm. The other three wells have been approved by DHS for addition to Valencia's Water Supply Permit, but have not been equipped pending further development and associated increase in water demands.

Table 1
Design and Construction Features
Valencia Water Company Wells E14-E17

	Well			
	E14	**E15**	**E16**	**E17**
Test Hole/Pilot Hole Depth (ft.)	191	200	200	194
Production Borehole Depth (ft.)	150	180	184	160
Well Depth (ft.)	135	160	170	150
Well Diameter (ft.)	18	18	18	18
Well Casing Depth (ft.)	0-76 114-135	0-92 133-160	0-82 145-170	0-81 121-150
Well Screen Depth (ft.)	76-114	92-133	82-145	81-121
Design Capacity (gpm)	1,200	1,400	1,200	1,000
Specific Capacity (gpm/ft.)	65.9	62	61.8	34.1

Groundwater Flow

There is no known occurrence of perchlorate contamination in the Alluvium anywhere near the new Valencia E wells. Consequently, it is illogical to think that the E wells, regardless of design capacity or future operation, would induce the movement, or capture, of perchlorate-contaminated groundwater as a result of their pumping. However, to examine what might theoretically be captured by the new Valencia E wells, consideration was given to the limited detection of perchlorate in the Alluvium, about five miles east of those wells, and the general movement of groundwater in the Alluvium, both regionally and locally near the E wells.

In the Alluvium, groundwater flow is generally recognized to be aligned with the Santa Clara River and its tributaries. For the most part, groundwater levels west of Bouquet Canyon remain relatively constant over time, suggesting that both the direction and rate of groundwater flow do not vary widely in that part of the aquifer system. East of Bouquet Canyon, the Alluvium has experienced groundwater level fluctuations of varying magnitudes, generally increasing to the east, through wet and dry periods. Examination of the fluctuations suggests that the overall flow direction has remained westerly and southwesterly beneath the Santa Clara River and its main

tributaries respectively, although the rate of groundwater flow has fluctuated as groundwater levels have changed.

More specifically for purposes of this analysis, groundwater flow in the vicinity of the Valencia E wells, and upgradient from the vicinity of the E wells to the area where perchlorate has been detected in the Alluvium, was examined by preparing contour maps of equal groundwater elevation for both wet and dry climatic conditions, i.e. high and low groundwater levels. The resultant contour maps are illustrated in Figures 2 and 3. Unaffected by local groundwater level drawdown directly attributable to pumping operations, groundwater flow directions in the Alluvium, in both wet and dry periods, are generally westerly beneath the Santa Clara River from the vicinity of Bouquet Canyon where the only two Alluvial production wells ever impacted by perchlorate are located. Near the E wells themselves, there is a confluence of groundwater flow, with some southerly inflow beneath Castaic Creek joining the predominant westerly to southwesterly groundwater flow at the mouth of the Castaic Creek Canyon and its confluence with the main Santa Clara River Valley. The hydraulic gradient in both wet and dry periods is approximately 30 feet per mile. The lack of significant differences in groundwater flow directions and hydraulic gradients between the wet and dry periods is consistent with the generally stable groundwater level conditions in the westerly portion of the overall groundwater basin, west of the mouth of Bouquet Canyon.

Considering the locations of the E wells relative to the surrounding groundwater flow directions, a component of flow into the E wells can be expected to be from the upgradient easterly direction. Further considering the confluence of groundwater flow from the north (Castaic Canyon) with the regional flow from the east, it is also likely that a component of flow into the E wells will be from the upgradient northerly direction. Of course, pumping operations at the wells themselves will locally alter the gradient and associated flow directions, potentially resulting in inflow to the wells from cross-gradient and downgradient directions.

Capture Zone Simulation

The nature of drawdown around one or more pumped wells, and the resultant impact on local groundwater flow, i.e. "capture" of groundwater by the well(s), is directly affected by several factors related to the well(s) and the aquifer in which they are completed. Well parameters include pumping capacity and duration of pumping cycles (time). Aquifer parameters include hydraulic conductivity, transmissivity, and storage coefficient of the aquifer materials. Design capacities for all four E wells are listed in Table 1; in summary, they are 1,000 to 1,400 gpm. Pumping cycles for all the Valencia wells are variable as water requirements fluctuate through the year. During peak demand periods, some wells can operate as much as all day, or slightly longer. However, for all Valencia wells as a group, long-term average pumping cycles are about 8 hours per day. For the conservative analytical purposes described herein, drawdown due to pumping of the new Valencia E wells and the associated capture zone formation were based on hypothetical continuous pumping equivalent to intermittent pumping for an average of 8 hours per day. The duration of such hypothetical continuous pumping can be widely varied as a function of other water supply considerations. In light of other perchlorate-related activities in the Valley, with recognition of the plans to start construction later in 2006 for perchlorate control

and extraction from the Saugus Formation, the theoretical capture associated with assumed continuous pumping of the E wells was analyzed for a two year period.

In selecting the two year period for theoretical independent capture zone analysis, it should be recognized that there is no absolute nexus between the planned construction of perchlorate containment facilities in the Saugus Formation and any significant change in the Alluvial aquifer that would further protect the E wells. While previous analyses of Saugus containment have included a small component of containment-type capture of Alluvial groundwater, that ultimate effect will be a small incremental addition to the nature of "containment" that results from the regular operation of numerous high capacity Alluvial wells between the E wells and the limited detection of perchlorate in the Alluvium. The capture zone analysis described herein is theoretical and independent in the sense that it purposely ignores the containment and capture effects of all intervening pumping between the E wells and the area of perchlorate detection in the Alluvium. The two year capture zone time period was simply utilized to conservatively examine the potential capture of perchlorate in spite of the actual operation of intervening wells, through a time period until some additional control of migration would be added to the rest of ongoing Alluvial pumping.

A final comment on the two year time period selection is to recognize that, again ignoring the effects of all other Alluvial pumping, in particular the "containment" effects of intervening pumping between the E wells and the historical detection of perchlorate in the Alluvium, the capture zone of the new E wells could theoretically be extended incrementally farther upgradient by simply extending the simulated time period. Ultimately, a scenario could be crafted to show theoretical "capture" of groundwater from an area where perchlorate has been detected. However, such an interpretation would be unrealistic in light of a combination of actual pumping practices and natural processes in the aquifer system as discussed below. In summary, the two-year theoretical independent capture zone is presented for theoretical, conservative illustration purposes; however, it should not be interpreted as the probable real capture zone of the E wells for the collection of reasons discussed below.

Based on interpretation of aquifer tests, and consistent with hydraulic aquifer characteristics used in the recently completed numerical groundwater flow model of the basin, a theoretical, independent capture zone analysis was conducted using a steady-state, single-layer numerical flow model of the Alluvium. The model incorporated specific yield (storage coefficient) and hydraulic conductivity values consistent with the recently completed basin-wide groundwater flow model developed by CH2M Hill. The steady-state model incorporated a specific yield value of 0.1, hydraulic conductivity values that ranged from 105 to 550 feet per day, and transmissivity values that ranged from 200,000 to 600,000 gpd/ft. The model was calibrated to the contours of equal groundwater elevations in the Alluvium presented in the 2004 CH2M Hill regional flow model report. Assumptions incorporated into the model included no change in aquifer storage, which is supported by a review of Alluvium groundwater elevations and the minimal amount of storage change over the past several decades.

As discussed above, the theoretical, independent capture zone analysis simulated the extent of the E Wells capture of groundwater flow over a two-year period. In addition to the conservative nature of the capture zone analysis that ignored all other pumping and related capture or

"containment", the E well analysis was further conservative in that it assumed actual operation of all those wells, at their design capacities of 1,000 to 1,400 gpm, when in reality only one of the wells is currently equipped and operational, and the other three wells are not scheduled to become operational until water requirements increase.

Based on a combination of the aquifer characteristics and equivalent full time pumping for two years as described above, assuming all four Valencia E wells are operational, the theoretical independent capture zone for the new Valencia E wells would primarily extend upgradient in two directions: up to about 13,000 feet, or about 2.5 miles, northerly and easterly. The extent and shape of the integrated capture zones of all four E wells is illustrated in Figure 4. The outer bounds of the integrated individual capture zones of the individual wells are illustrated; each individual well's capture zone is a narrower, elongated zone, parallel to the overall integrated capture zone as illustrated in Figure 4.

Perchlorate Contamination in the Alluvium

The overall issue of perchlorate contamination of groundwater in the Santa Clarita Valley has primarily impacted the Saugus Formation, where four municipal wells have been out of service due to perchlorate since 1997. The Alluvium, on the other hand, has been impacted to a notably lesser extent. From the perspective of impacted municipal water supply wells, Santa Clarita Water Division's Stadium well was the first and, for a long time, the only Alluvial well impacted by perchlorate. The Stadium well is located on the south side of the Santa Clara River, upstream of its confluences with Bouquet Canyon and the South Fork of the Santa Clara River. The Stadium well is also located adjacent to the Northern Alluvium area on and immediately adjacent to the northern-most part of the Whittaker-Bermite site. The initial detection of perchlorate in that well was 5.9 g/l in 2002. The Stadium well has been removed from municipal service since the initial detection of perchlorate.

The only other detection of perchlorate in an Alluvial water supply well was in March and April 2005 when Valencia's Well Q2 was found to have low concentrations of perchlorate. Well Q2 is located on the north side of the Santa Clara River, on the west side of its confluence with Bouquet Creek. Initial detection and confirmation sampling of Well Q2 ranged between 9.8 and 11 g/l. After confirmation of perchlorate in April, Valencia temporarily removed the well from service and proceeded with a fast-track permitting and construction program to install wellhead treatment and return the well to service. That work was completed in September and Well Q2 has been in service, with wellhead treatment, since October 2005. Since then, however, the only indications of perchlorate at Well Q2 have been below the analytical detection limit of 4 g/l.

In addition to the limited detection of perchlorate in two municipal supply wells as described above, off-site investigation of perchlorate associated with the Whittaker-Bermite site has identified low concentrations (less than 10 g/l) in shallow Alluvium near Valencia's Pardee well field (Wells N, N7 and N8). Those detections have all been from sampling of shallow groundwater, above 50 feet and also above the intake (screened) sections of those wells. Despite those detections, however, there has been no detection of perchlorate in the nearby, deeper completed production wells.

Whittaker-Bermite has recently initiated actions to pump a production well, and to also extract from several small monitoring wells, as part of perchlorate containment efforts in the Northern Alluvium. The extracted water will be treated for perchlorate removal and then discharged to the Santa Clara River system. These pump and treat activities are intended to subsequently expand as necessary the remediation of perchlorate contamination in the Alluvium, immediately upgradient of the Stadium well, and also upgradient of the other municipal production wells in the vicinity of the Whittaker-Bermite site.

Potential Capture of Perchlorate by Valencia's E Wells

As illustrated in Figure 4, the theoretical independent capture zone of Valencia's new E wells, after an equivalent two year period of continuous pumping of all four wells, would extend toward the area where perchlorate has been detected in two Alluvial water supply wells (Stadium and Q2). However, the capture zone would not extend as far as any historical detection of perchlorate in the Alluvium, whether in production wells or as part of the off-site investigation of the Whittaker-Bermite site. Literal interpretation of the extent of the capture zone and the known detection of perchlorate would be that the E wells can be expected to not capture perchlorate-contaminated groundwater over the time period of analysis, which includes the period of construction and initial operation of facilities to contain and extract perchlorate from the Saugus Formation. However, as discussed above, such an expectation can be interpreted two ways: that the E wells are thus not a risk or, conversely, that the E wells could be at risk if the capture zone analysis were simply extended for sufficient time to encounter areas of perchlorate detection. As also discussed above, the planned containment and extraction of perchlorate in the Saugus Formation is expected to have a small effect on the Alluvium, but not to the extent that it will sufficiently contain perchlorate that downgradient wells can be considered to be protected. Thus, it could be reasoned that the capture zone should be analyzed for a longer pumping period, i.e. beyond the two years related to construction of the Saugus containment facilities. In simple summary, given the nature of groundwater flow direction and the hydraulic properties of the Alluvial aquifer, it is possible to model sets of conditions that would result in theoretical "capture" of groundwater from the area where perchlorate has been detected in the Alluvium. However, recognizing that such a result could be simulated, it should also be recognized that, for the reasons discussed below, such a result should not be interpreted to conclude that the E wells are at risk. In fact, it is logical to conclude, again for the reasons discussed below, that the E wells are likely not at risk.

Upgradient of the E wells in the direction of perchlorate detection in the Alluvium are several high capacity production wells, all of which are artificially removed from the simulated capture zone analysis, but all of which represent actual pumping locations that provide a combination of containment in the aquifer and potential capture of perchlorate if it were to mobilize that far from where it has been detected. For reference with regard to mobility, as discussed above, sampling of shallow portions of the Alluvium near the Pardee well field has detected low concentrations of perchlorate, but the nearby production wells have not detected any perchlorate. Ongoing pumping for water supply since the initial detections of perchlorate (in the Saugus Formation in 1997 and in the Alluvium in 2002) have resulted in only one additional Alluvial production well impact: Valencia's Well Q2 which was briefly impacted but has not detected perchlorate since it was equipped with wellhead treatment and returned to service in October 2005. All other

Alluvial wells between the Whittaker-Bermite site and the E wells have not been impacted despite closer proximity to detected perchlorate and regular water supply pumping for at least four years since perchlorate was first encountered.

The Alluvial production wells between the E wells and the area of detected perchlorate can be considered in three groups, progressively farther from the E wells: the S well field (Wells S6, S7, and S8); the Pardee well field (Wells N, N7 and N8); and Well Q2. Collectively, all those wells have a total pumping capacity of nearly 13,500 gpm, or nearly three times the total design capacity of the E well field. The S well field has existing pumping capacity of 6,000 gpm; the Pardee well field has existing pumping capacity of 6,250 gpm; and Well Q2 is equipped to pump and treat 1,200 gpm. Collectively and as individual wells or groups of wells, those various wells represent significant local pumping locations that provide a form of "containment", if perchlorate were to migrate to any of those areas, against further downgradient movement; and they represent significant extraction rates that would also extract perchlorate, again if it were to migrate to any of those areas. As described above, Well Q2 is already equipped to treat any perchlorate if it were to re-impact that well. The other intervening wells are not equipped with wellhead treatment; however, as is also the case at the E wells, all are designed with wellhead space and provisions for installation of treatment facilities, as was rapidly done at Well Q2 when perchlorate was detected, to enable their continued operation for perchlorate containment and extraction if they are impacted. Thus, the collective intervening wells represent a real pumping scenario that, in effect, produces pumping interruptions of the independent, theoretical capture zone of the E wells described and illustrated above.

In light of all the preceding, it can be concluded that, while a theoretical capture zone can be simulated to show that, with sufficient extended pumping, the new Valencia E wells might "capture" groundwater from areas where perchlorate has been detected in the Alluvium, such a capture zone analysis would necessarily be overly theoretical and conservative because it ignored the intervening effects of numerous other high capacity pumping. It also ignored the actual observations that have shown no detection of perchlorate in all but one of those intervening wells after at least four years of regular pumping operations since initial detection of perchlorate in the Alluvium. The presence of those wells, combined with the existing wellhead treatment at one of them and the provisions for installation of treatment at all the others if ever necessary, represents significant containment of potential perchlorate migration toward the E wells, again assuming perchlorate first migrates as far as the intervening wells. Thus, it can be concluded that the E wells are not at risk of capturing perchlorate from areas in the overall Alluvial aquifer system where it has previously been detected.

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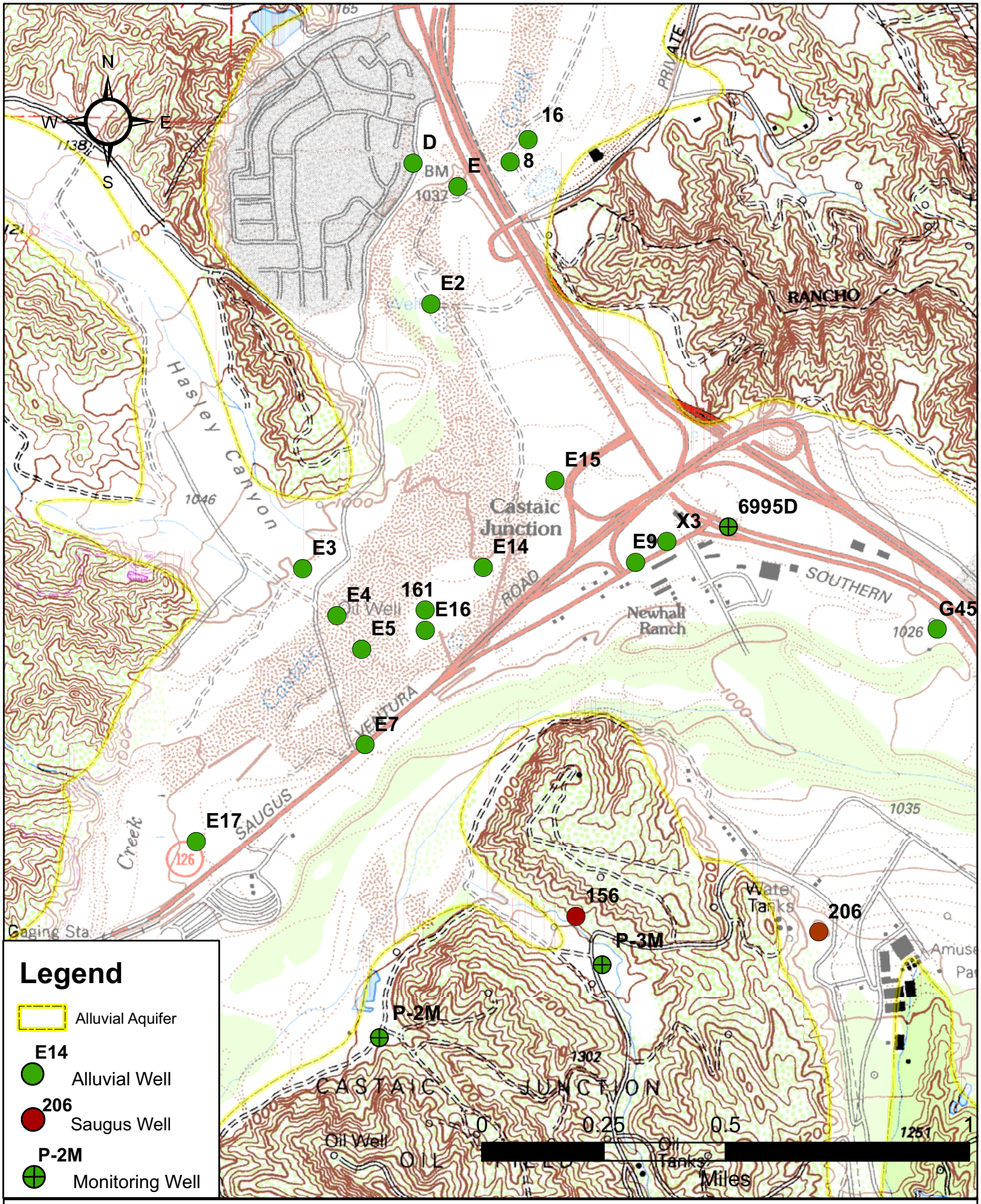
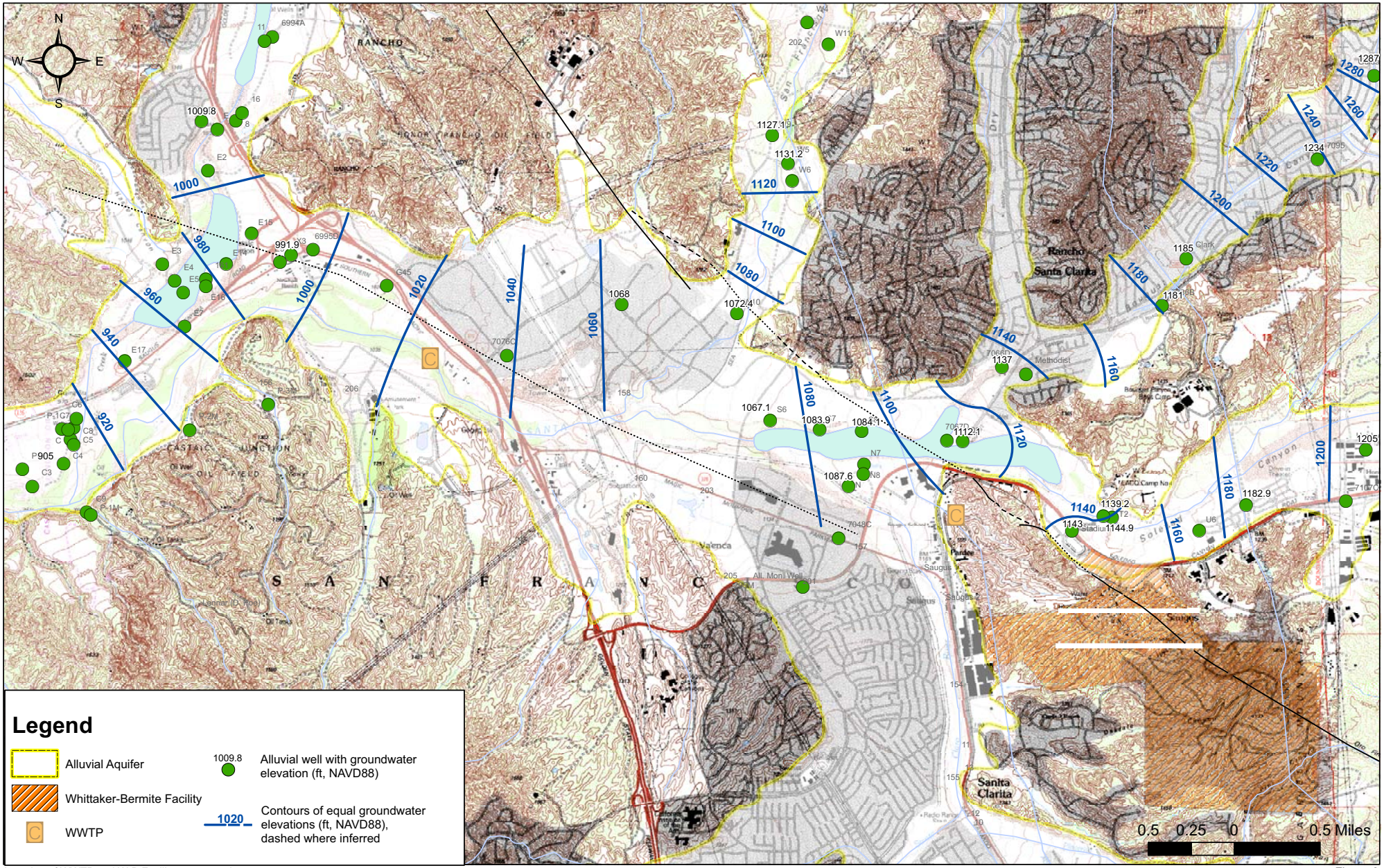


LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Figure 1
Well Location Map



Location of WWTP and W-B Facility are approximate.

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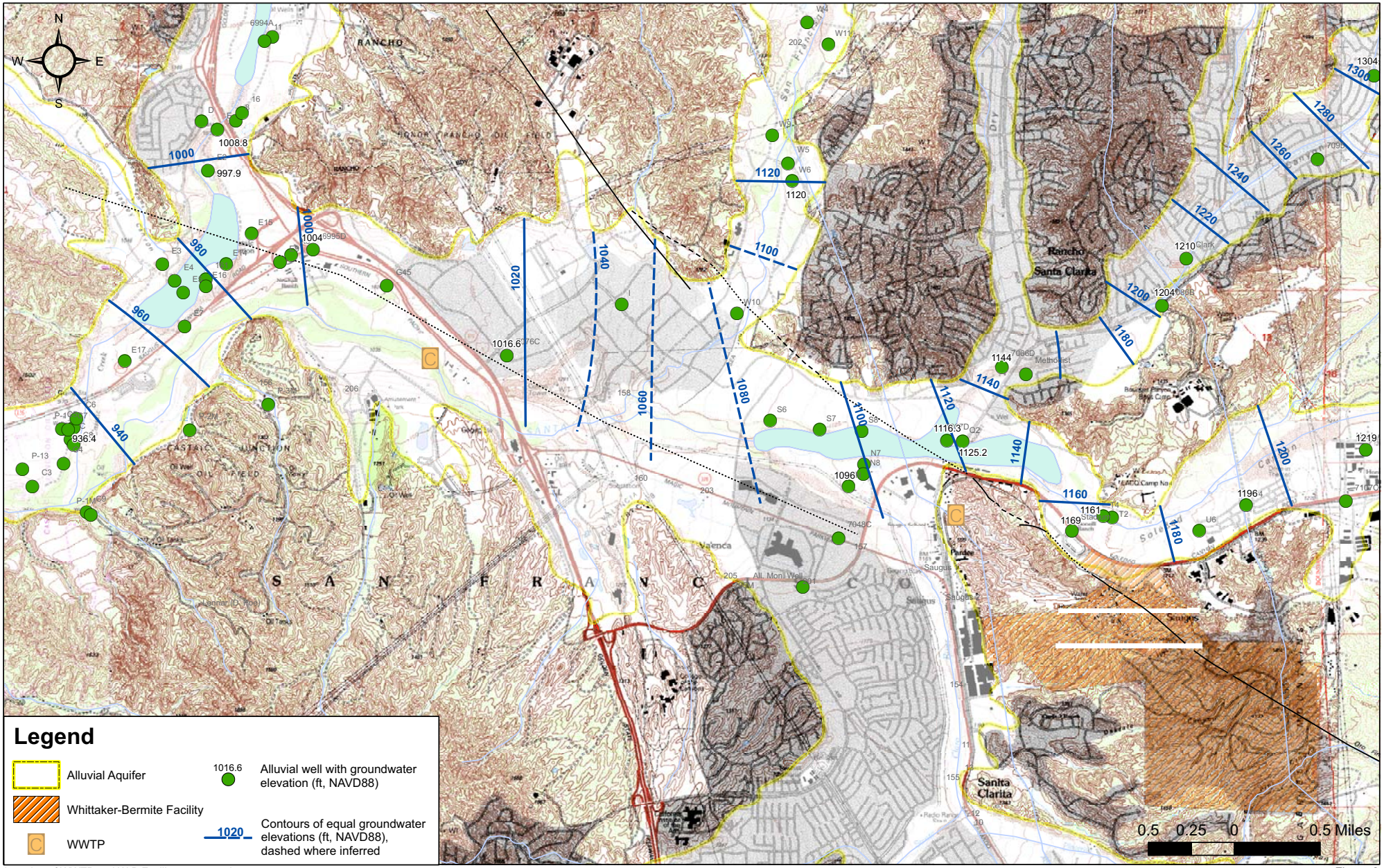
Figure 3
Contours of Equal Groundwater Elevation in Alluvium
Wet Period, Spring 2004



Location of WWTP and W-B Facility are approximate.

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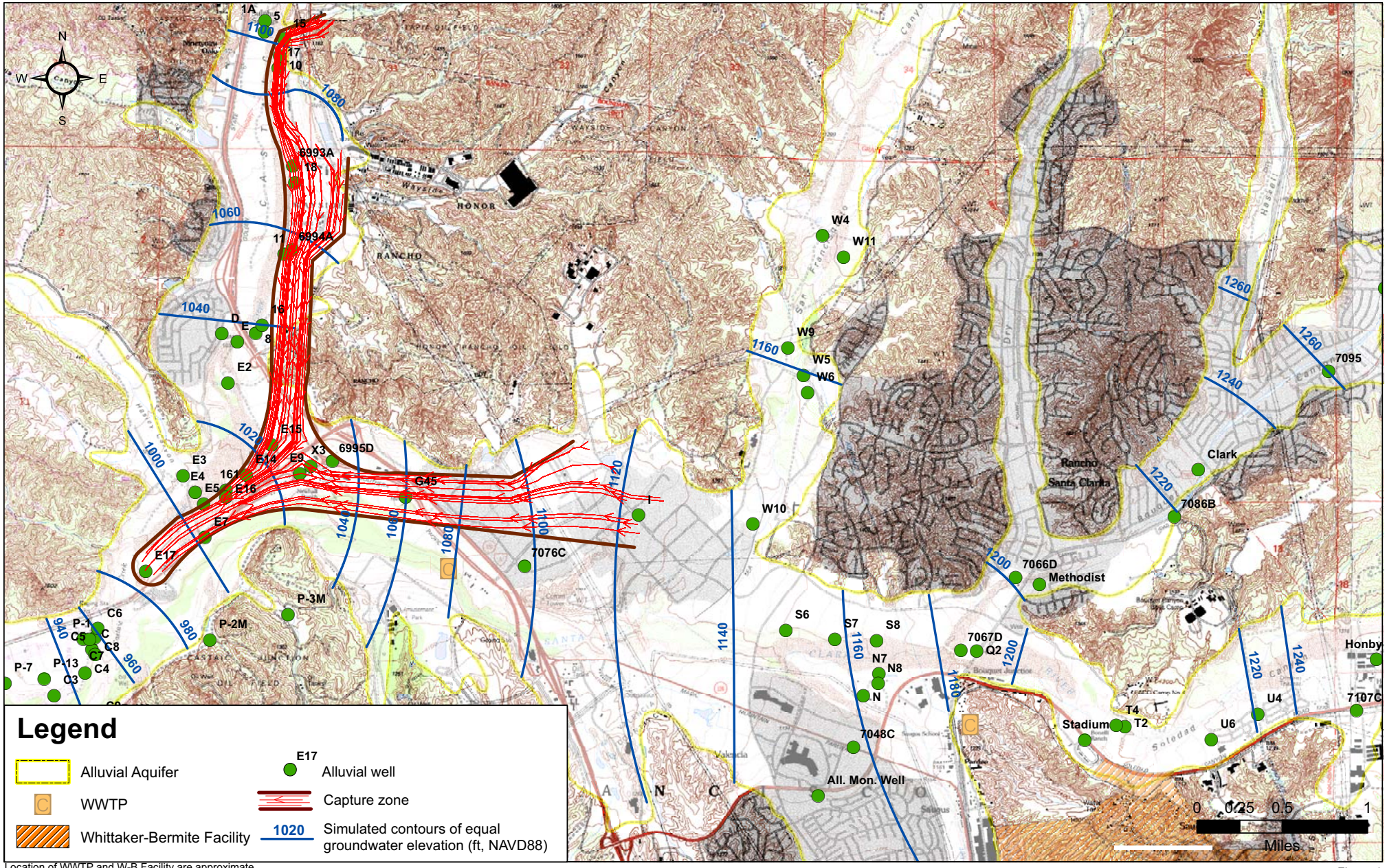
Figure 2
Contours of Equal Groundwater Elevation in Alluvium
Dry Period, Spring 1992



Legend

- Alluvial Aquifer
- WWTP
- Whittaker-Bermite Facility
- E17 — Alluvial well
- Capture zone
- 1020 — Simulated contours of equal groundwater elevation (ft, NAVD88)

Location of WWTP and W-B Facility are approximate.

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Figure 4
Valencia E Well Capture Zone
Two-Year Groundwater Travel Time Simulation

Water Supply Contracts Between the State of California Department of Water Resources and CLWA including Amendment No. 18 (41,000 Acre-Feet Water Transfer)

UPPER SANTA CLARA VALLEY WATER AGENCY

Location and Size

The Agency is located in Los Angeles County about 40 miles northwest of the city of Los Angeles. The Agency, as of July 1, 1964, encompassed an area of 86,100 acres and had an estimated population of 26,000.

Water Supply and Utilization

The entire water supply utilized within the Agency is obtained from underlying ground water basins. There are no streams within the Agency on which a dependable surface water supply could be developed. Water requirements in excess of the safe yield of the local ground water supply will be met with water from the State Water Project. Primary use of water in 1960 was for irrigated agriculture but by 1970 and thereafter the primary use is expected to be for municipal and industrial purposes.

Items of Contract Information Unique to Agency

Date of Contract - Preamble

April 30, 1963

Agency's Principal Place of Business - Preamble

Newhall

Estimated Year of Initial Water Delivery - Article 6(a)

1972

Date of Request as to Delivery Structures - Article 10(b)

June 30, 1963

Limit on Instantaneous Rate of Delivery - Article 12(c)

42 cfs (Increased by Amendment No. 2 to 48 cfs.)

E. SPECIAL PROVISIONS AND TABLES

45. SPECIAL PROVISIONS

(a) On or before June 30, 1963, the Agency shall furnish to the State its written request specifying the year in which the first delivery of project water from the West Branch Aqueduct as defined in Table H of this contract shall be made to the Agency. The timing of first deliveries of project water from said Branch Aqueduct shall be as so requested by the Agency: *Provided*, That in the event said request is, in the judgment of the State, incompatible with similar requests received from other contractors to be served from or through said Branch Aqueduct, which contractors have executed contracts with the State on or before June 30, 1963, the timing of first deliveries of project water to the Agency and such other contractors from said Branch Aqueduct shall be as established by mutual agreement among the State, the Agency, and said contractors: *Provided further*, That if such agreement has not been reached on or before December 31, 1963, the State may then construct said Branch Aqueduct in accordance with such construction schedules as, in the judgment of the State, will best serve the interests of all those contractors whose service areas are located south of the South Portal of the Tehachapi Tunnels and which have executed contracts with the State on or before June 30, 1963.

(b) The State shall provide sufficient capacity in the transportation facilities, subject to the provisions of Article 17(b), to deliver 11 percent of the Agency's annual entitlement in each of four months in each year. Subject to the foregoing limitation, in scheduling deliveries under Article 12(a) the State will provide for up to 1/9 of the Agency's annual entitlement to be delivered in excess of a rate of 8 1/3 percent of the annual entitlement per month.

(c) The annexations to the Agency, authorized by Ordinance No. 3 of the Agency dated March 13, 1963, are deemed to be approved by the department within the meaning of Article 15(b) and are generally described as the Val Verde--Hasley Canyon Area annexation, comprising approximately 7,280 acres, situated westerly of the Agency.

TABLE H

PROJECT TRANSPORTATION FACILITIES
UPPER SANTA CLARA VALLEY WATER AGENCY

A San Joaquin Valley–Southern California Aqueduct extending to Castaic Reservoir on the West Branch Aqueduct defined below, to the extent such aqueduct is determined by the State to be required for water transportation.

"West Branch Aqueduct" shall mean that portion of the San Joaquin Valley–Southern California Aqueduct specified in Section 12934(d) (2) of the Water Code extending from the junction of East and West Branches to a terminus in the vicinity of Newhall, Los Angeles County.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form and sufficiency:

P. G. Torres

Chief Counsel
Department of Water Resources
P. O. Box 388
Sacramento, California

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By Wm. E. Warne
Director

Attest:

Helen L. Thompson
Secretary
P.O. Box 328
Newhall, California

UPPER SANTA CLARA VALLEY WATER AGENCY

By M. E. Bonelli Jr.
President

Approved as to form and execution:

Stanley C. Logsdon
Counsel

By Everett W. Nichols
Director

By Earl Schmidt
Director

By [illegible]
Director

By Robert L. Essick
Director

By Roger C. Morey
Director

By E. Ray Fisher
Director

WHEREAS, the State and the Agency are desirous of making certain changes and additions to the above-mentioned contract, while otherwise continuing the contract in full force and effect;

NOW THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

Article 46 is added to the contract to read as follows:

46. Amendatory Provisions

a. Surplus Water

Notwithstanding other provisions of this contract, surplus water for agricultural and ground water replenishment use shall be offered to contractors on the following basis. Before surplus water is sold for other than agricultural and ground water replenishment use, each contractor shall have the right, subject to the ability of the State to deliver such water, to contract for agricultural and ground water replenishment use for a portion of the total amount of surplus water available in any year, in an amount which bears the same ratio to the total amount of surplus water available in that year as the sum of the annual entitlements delivered to the contractor for agricultural and ground water replenishment use during the preceding three years bears to the total amount of the annual entitlements delivered for agricultural and ground water replenishment use during the preceding three years of all contractors requesting surplus water: Provided, That if its proportion of such surplus water is not required by or cannot be delivered to any contractor, such amount of additional surplus water shall be offered to other contractors for agricultural and

under the provisions of Article 21.

As used in this subdivision "ground water replenishment use" shall mean the use of project water exclusively by direct application to spreading basins, streambeds, or through other means of direct artificial recharge for the purpose of replenishing overdrawn ground water basins.

b. Surcharge Credit

Notwithstanding other provisions of this contract, the State may include provisions in water supply contracts allowing a credit to a contractor not to exceed the surcharge to be paid by such contractor: Provided, That such credit shall be utilized to reduce the cost of water for agricultural use on other than excess land at a uniform rate per acre-foot not to exceed two dollars ($2) per acre-foot. Any contract including provisions pursuant to this subdivision shall assure that the reductions in the contractors' obligations authorized by this subdivision are made available exclusively for the benefit of agricultural use on land other than excess land and are not directly or indirectly made available for the benefit of agricultural use on excess land.

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 2 TO WATER SUPPLY
CONTRACT BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 22nd day of December 1964, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency, a public agency in the State of California, duly organized, existing, and acting pursuant to the laws thereof with its principal place of business in Newhall, California, herein referred to as the "Agency",

WITNESSETH, That:

WHEREAS, the State is authorized to construct and operate facilities for the storage and conveyance of water, certain of which facilities will make water available to the Agency; and

WHEREAS, the State and the Agency have entered into a water supply contract, dated April 30, 1963, as amended November 15, 1963, providing that the State shall supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

1. Subdivision (k) of Article 1 is amended to read as follows:

(k) Minimum Project Yield

"Minimum project yield" shall mean the dependable annual supply of project water to be made available, estimated to be 4,230,000 acre-feet per year, said amount to be determined by the State on the basis of coordinated operation studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon:

(1) The estimated relative proportion of deliveries for agricultural use to deliveries for municipal use for the year 1990, and the characteristic distributions of demands for these two uses throughout the year.

(2) An allowable reduction in the agricultural use portion of the minimum project yield, due to drought, of not to exceed fifty percent (50%) in any one year, nor a total of one hundred percent (100%) of one year's supply in any series of seven consecutive years.

(3) Agreements now in effect or as hereafter amended or supplemented between the State and the United States and others regarding the diversion or utilization of waters of the Delta or streams tributary thereto.

2. Table A of the contract entitled "Annual Entitlements Upper Santa Clara Valley Water Agency" is amended to read as follows:

4. Subdivision (a) of Article 16 is amended to read as follows:

(a) Limit on Total of All Maximum Annual Entitlements

The Agency's maximum annual entitlement hereunder, together with the maximum annual entitlements of all other contractors, shall aggregate no more than the minimum project yield as defined herein and in no event more than 4,230,000 acre-feet of project water.

5. Subdivision (b) of Article 45 is amended to read as follows:

(b) The State shall provide sufficient capacity in the transportation facilities, subject to the provisions of Article 17(b), to deliver 11 percent of the Agency's annual entitlement in each of eight and one half months in each year. Subject to the foregoing limitation, in scheduling deliveries under Article 12(a) the State will provide for up to 22 2/3 percent of the Agency's annual entitlement to be delivered in excess of a rate of 8 1/3 percent of the annual entitlement per month.

6. Article 46 is amended to read as follows:

46. Amendatory Provisions

(a) Surplus Water

Notwithstanding other provisions of this contract, surplus water for agricultural and ground water replenishment use shall be offered to contractors on the following basis. Before surplus water is sold for other than agricultural and ground water replenishment use, each contractor shall have the right, subject to the ability of the State to deliver such water and to the

contractor shall furnish certified copies of such records and data concerning the use of water within its boundaries as the State may request.

The provisions of this paragraph shall be applicable only to contractors in the San Joaquin Valley Service Area, contractors in the Southern California Service Area, and contractors in the Central Coastal Service Area. Before surplus water is sold for other than agricultural and ground water replenishment use, each such contractor shall have the right, subject to the ability of the State to deliver such water, to contract for agricultural and ground water replenishment use in accordance with the following formula: contractors in the San Joaquin Valley Service Area shall have a right to contract for sixty-nine percent (69%) of the surplus water available at the Mile 18 Pumping Plant; contractors in the Southern California Service Area shall have a right to contract for twenty-nine percent (29%) of such water; and contractors in the Central Coastal Service Area shall have a right to contract for two percent (2%) of such water: Provided, That within each of these service areas, each contractor shall have the right to contract for agricultural and ground water replenishment use for a portion of the total amount of surplus water available to that service area in any year, in an amount which bears the same ratio to the total amount of surplus water available to the service area in that year as the sum of the annual entitlements, set forth in Table A of this contract, delivered to the contractor for agricultural and ground water replenishment use during the preceding three years bears to the

and Ventura County Flood Control District; "contractors in the Central Coastal Service Area" shall mean: San Luis Obispo County Flood Control and Water Conservation District and Santa Barbara County Flood Control and Water Conservation District.

The provision of this paragraph shall be applicable only to a contractor to which the delivery of project water for municipal use as of 1990 is estimated by the State to be in excess of fifty percent (50%) of such contractor's maximum annual entitlement. For the purpose of fixing such contractor's right to delivery of surplus water, water from a watershed not tributary to the contractor's area which is delivered within the contractor's boundaries for agricultural or ground water replenishment use shall be deemed to be part of the contractor's annual entitlement delivered for such use in computing the quantity of surplus water to which the contractor is entitled under this subdivision: Provided, That the contractor shall not be deemed to have used more than its annual entitlement, as set forth in Table A, for such use. Surplus water shall be deemed to be used by the contractor for agricultural or ground water replenishment use if an equal quantity of water imported from a watershed not tributary to the contractor's area is delivered within the contractor's boundaries for such use.

In providing for the delivery of surplus water to contractors pursuant to this subdivision, the State shall refuse to deliver such surplus water to any contractor to the extent that the State determines that such delivery would tend to encourage the development of an economy within the area served by such contractor which would be dependent upon the sustained delivery of

under the provisions of Article 21. Nothing in this subdivision shall limit the right of the Agency to increase its annual entitlements as otherwise provided in this contract.

As used in this subdivision "ground water replenishment use" shall mean the use of project water exclusively by direct application to spreading basins, streambeds, or through other means of direct artificial recharge for the purpose of replenishing overdrawn ground water basins.

(b) Surcharge Credit

Notwithstanding other provisions of this contract, the State may allow a credit to each contractor not to exceed the surcharge paid by such contractor.

For the purpose of this contract, the surcharge credit shall be determined and applied in the following manner:

(1) The State shall, in each year after the year of initial water delivery, allow a credit to the Agency in the amount of the surcharge forwarded by the Agency to the State in the preceding year.

(2) The Agency shall not establish water rates, or tax or assessment rates, so as to cause the surcharge credit to be passed on to water users in a manner which will bring about a greater reduction in the cost per acre-foot of project water put to use on excess land than such cost of project water put to use on other than excess land.

This subdivision 46(b) shall be separable from all other provisions in this contract, and in the event that any or all of the provisions of this subdivision are in any manner or to any extent

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 3 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 24th day of January 1966, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency, a public agency in the State of California, duly organized, existing, and acting pursuant to the laws thereof with its principal place of business in Newhall, California, herein referred to as the "Agency",

WITNESSETH, That:

WHEREAS, the State is authorized to construct and operate facilities for the storage and conveyance of water, certain of which facilities will make water available to the Agency; and

WHEREAS, the State and the Agency have entered into a water supply contract, dated April 30, 1963, as amended

TABLE A
Annual Entitlements
Upper Santa Clara Valley Water Agency

Year	Total Annual Amount In Acre-Feet
1	1,600
2	3,700
3	5,700
4	7,500
5	9,500
6	11,400
7	13,400
8	15,300
9	17,700
10	20,100
11	22,100
12	24,600
13	26,900
14	29,100
15	30,900
16	32,900
17	35,300
18	37,400
19	39,300
20	41,500
And each succeeding year thereafter, for the term of this contract:	41,500

3. Subdivision (c) of Article 12 is amended to read as follows:

(c) Limit on Rate of Delivery to Agency

In no event shall the State be obligated to deliver water to the Agency through all delivery structures at a total combined instantaneous rate of flow exceeding seventy-six (76) cubic feet per second, except as this rate of flow may be revised by amendments of this article after submission to the State of the Agency's requests with respect to maximum flow capacities to be provided in said delivery structures, pursuant to Article 10.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 4 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 31st day of December, 1969, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency,

herein referred to as the "Agency";

WITNESSETH, That

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, Article 22(b) of such water supply contract provides that for each year through the year 1969 the Delta Water Charge shall be the product of $3.50 and the Agency's annual entitlement for the respective year and that beginning in the year 1970, the Delta Water Charge shall be the sum of the capital cost component, minimum operation, maintenance, power and replacement component, and

Thermalito power facilities through Central Valley Project Revenue Bonds and may finance other portions of the project facilities through additional revenue bond issues, bonds issued under other authority granted by the Legislature or the voters, bonds issued by other state agencies, advances from contractors, and other methods under which the financing costs relate to interest rates that may exceed the interest rate of the bonds issued under the Bond Act; and

WHEREAS, either the State or contractors making advances to the State may be subject to interest rates, or other financing costs that relate to interest rates, which will be greater than the "project interest rate" as presently defined in the contracts; and

WHEREAS, the parties desire that (1) the interest costs hereafter incurred by or on behalf of the State in financing the construction of project facilities by means other than the use of moneys provided under the Bond Act will be reflected in appropriate adjustments of the "project interest rate" (excepting the interest costs incurred for the Central Valley Project Revenue Bonds issued prior to the date of this amendment); (2) appropriate credit will be given to any contractor having made an advance of funds to the State corresponding to the bond service obligation payable by such contractor by reason of such advance or if bonds were not used to obtain funds for such advance, then to the net interest cost which would have resulted if the contractor had sold bonds for the purpose of funding the advance; and (3) if any sources of funds other than those provided under the Bond Act are employed to finance the construction of specific project facilities and the interest or other costs of such financing are greater than the cost would have been if bonds issued under the Bond Act had been used, appropriate

"Project interest rate" shall mean the weighted average interest rate of (1) through (6) below computed by dividing (i) the total interest cost required to be paid or credited by the State during the life of the indebtedness or advance by (ii) the total of the products of the various principal amounts and the respective terms in years of all such amounts:

(1) general obligation bonds issued by the State under the Bond Act,

(2) revenue bonds issued by the State under the Central Valley Project Act after May 1, 1969,

(3) bonds issued by the State under any other authority granted by the Legislature or the voters,

(4) bonds issued by any agency, district, political subdivision, public corporation, or non-profit corporation of this State,

(5) funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State, and

(6) funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing

construction of specific project facilities, any additional costs incurred because of such financing will not be charged to the contractors, except for adjustments to the "project interest rate".

Approved as to legal form and sufficiency:

C. Tanner

Chief Counsel
Department of Water Resources
P. O. Box 388
Sacramento, California

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

By W. E. Gianelli
Director

Approved as to form and execution:

Counsel

UPPER SANTA CLARA VALLEY
WATER AGENCY

By
Pres.

1971 the Delta Water Charge shall be the sum of the capital cost component, minimum operation, maintenance, power and replacement component, and variable operation, maintenance, power and replacement component computed in accordance with Articles 22(c) and (d) of the water supply contract; and

WHEREAS, Articles 22(e) and (g) of such water supply contract provide that the Delta Water Charge as computed in accordance with Articles 22(c) and (d) shall include all projected costs of additional project and supplemental conservation facilities commencing in the years in which the State first incurs capital costs for such facilities after the facilities are authorized; and

WHEREAS, the parties desire that all water supply contracts be amended to postpone inclusion of the projected costs of any authorized additional project and supplemental conservation facilities in the computation of the Delta Water Charge until after the year 1971 and to fix the rate for computing the Delta Water Charge for the year 1971 at $7.24;

NOW, THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. Subdivision (b) of Article 22 is amended to read as follows:

For each contractor receiving project water in any year through December 31, 1969, the Delta Water Charge shall be the product of $3.50 and the contractor's annual entitlement to project water for the respective year. For each contractor receiving project water in the year 1970, the Delta Water Charge shall be the

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 6 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made this 27th day of December, 1971, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, Article 22(b) of such water supply contract, as amended, provides that for each year through the year 1969 the Delta Water Charge shall be the product of $3.50 and the Agency's annual entitlement for the respective year, that for the year 1970 the Delta Water Charge shall be the product of $6.65 and the

the Delta Water Charge shall be determined on the basis of an allocation to project purposes, by the separable cost-remaining benefits method, of all actual and projected costs of all those initial project conservation facilities located in and above the Delta, and upon an allocation to the purposes of water conservation and water transportation, by the proportionate use of facilities method, of all actual and projected costs of the following project facilities located below the Delta: The aqueduct intake facilities at the Delta, Pumping Plant I (Delta Pumping Plant), the aqueduct from the Delta to San Luis Forebay (O'Neill Forebay), San Luis Forebay (O'Neill Forebay), and San Luis Reservoir: Provided, That all of the actual and projected costs properly chargeable to the generation and transmission of electrical energy in connection with operation of project conservation facilities shall be allocated to the purpose of water conservation in, above, and below the Delta: Provided further, That allocations to purposes the cost of which are to be paid by the United States shall be as determined by the United States.

Commencing in the year in which the State first awards a major construction contract for construction of a major feature of additional project conservation facilities, or first commences payments under a contract with a federal agency in the event a major feature of additional project conservation facilities is constructed by such federal agency under an agreement requiring the State to pay all or part of the costs of such construction, the Delta Water Charge shall be determined on the basis of the

which are allocated to the purpose of water conservation, in, above, and below the Delta pursuant hereto. Commencing in the year in which the State first awards a major construction contract for construction of a major feature of any supplemental conservation facilities, or first commences payments under a contract with a federal agency in the event a major feature of supplemental conservation facilities is constructed by such federal agency under an agreement requiring the State to pay all or part of the costs of such construction, the Delta Water Charge shall be determined on the basis of the allocations made pursuant to subdivision (e) of this article, and upon an allocation to project purposes, by the separable costs-remaining benefits method and subject to provisos corresponding to those contained in said subdivision (e), of all projected costs of such feature of the supplemental conservation facilities. Commencing in the same year, the computation of the rates to be used in determining the components of the Delta Water Charge shall include the annual entitlements to water under all contracts for supplemental water. If the repayment period of any bonds sold to construct supplemental conservation facilities or the repayment period under any agreement with a federal agency for repayment of the costs of supplemental conservation facilities constructed by such federal agency extends beyond the repayment period of the contract, the Delta Water Charge shall be determined and redetermined on the basis of such extended repayment period as the State determines to be appropriate: Provided, That if the agreement with such federal agency allows repayment of costs

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 7 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made as of the 15th day of October, 1972, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract, dated April 30, 1963 (herein referred to as the "Amended Contract") providing that the State shall supply certain quantities of water to the Agency, and that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, the Amended Contract provides for a surcharge equivalent to the power credit per acre-foot of water to be charged to water users, other than the United States or the State of California, for each acre-foot of project water determined to have been put to agricultural or manufacturing uses on excess land, for collection by the Agency either itself or through a

1. Article 30 entitled "Surcharge for Project Water Used on Excess Land".

2. The next-to-the-last sentence of the fifth paragraph of subdivision (a) of Article 46, entitled "Surplus Water", which sentence reads as follows:

> "A surcharge shall be added to the rate for surplus water furnished to excess land in an amount and under the conditions specified in Article 30 of this contract".

3. Subdivision (b) of Article 46 entitled "Surcharge Credit".

IN WITNESS WHEREOF, the parties hereto have executed this contract amendment on the date first above written.

Approved as to legal form and sufficiency:

By P. G. Turner
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By W. H. Gianella
Director

Attest:

By _____
(Title)

CASTAIC LAKE WATER AGENCY

By Earl Schmidt
(Title) President

Approved as to form and execution:

By _____
(Title)

interest rate, and all other factors which are determinative of such charges; and

WHEREAS, Article 28 also provides that each such redetermination shall include an adjustment of the components of the Transportation Charge to be paid by the Agency for succeeding years which shall account for differences, if any, between projections used by the State in determining the amounts of such components for all preceding years and actual costs incurred by the State during such years, but does not specify the computational details or the method of payment of such adjustments; and

WHEREAS, the State has been including such adjustments as "one-shot" credits or additional charges to be subtracted from or added to the Transportation Charge to be paid by the Agency in the year following the redetermination; and

WHEREAS, the magnitude of such adjustments together with changes in other determinants of charges may be significantly different in comparison with the amounts projected by the State under previous determinations and could impair the planned fiscal operations of the Agency, depending on the method of payment, and the parties desire to amend the contract to provide a method of amortizing the payment of the amounts of such differences over two or more years, depending on the magnitude of the differences; and

WHEREAS, bookkeeping will be simplified if the amortization of the payments of the amounts of such differences is

the State. Such adjustment shall be computed by the State and paid by the Agency or credited to the Agency's account in the manner described in (b) and (c) below.

(b) Adjustment: Transportation Charge-Capital Cost Component

Adjustments for prior underpayments or overpayments of the capital cost component of the Transportation Charge to the Agency, together with accrued interest charges or credits thereon computed at the then current project interest rate on the amount of the underpayment or overpayment and compounded annually for the number of years from the year the underpayment or overpayment occurred to and including the year following the redetermination, shall be paid in the year following the redetermination: Provided, That the Agency may elect to exercise the option whereby when the redetermined Transportation Charge for the following year, with adjustments, including adjustments of the operation, maintenance, power, and replacement components provided for in subdivision (c) of this article, is more or less than the last estimate of the Charge provided pursuant to Article 27 for the corresponding year, without adjustments, an amount equal to the total of such difference shall be deducted from or added to the adjusted capital cost component for that year and paid or credited in accordance with the following schedule:

Percent that Transportation Charge differs from last estimate (+ or -)	Period, in years, for amortizing the difference in indicated charge
for 10% or less	no amortization
more than 10%, but not more than 20%	2
more than 20%, but not more than 30%	3
more than 30%, but not more than 40%	4
more than 40%.	5

the Transportation Charge for the year in which the option is to become effective.

Such option, once having been exercised, shall be applicable for all of the remaining years of the project repayment period.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form and sufficiency:

By R. C. Turner
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By [illegible]
Director

Attest:

By Betty L. Castleberry
(Title) Secretary

CASTAIC LAKE WATER AGENCY

By [illegible]
(Title) President

Approved as to form and execution:

By [illegible]
(Title) Counsel

delivery of all of its annual entitlement for 1972 on a reasonable schedule; and

WHEREAS, the State has developed a proposed adjustment of the Agency's 1972 entitlement taking into consideration the monthly distribution of 1972 project water deliveries as requested in its five-year delivery schedule submitted to the State in 1967; and

WHEREAS, the Agency has requested that its annual entitlement for the first year of water deliveries be decreased accordingly; and

WHEREAS, the State has determined that a decrease from 1,600 acre-feet to 1,236 acre-feet is justified and that allowing such a decrease in the Agency's 1972 annual entitlement will not impair the financial feasibility of the project facilities;

NOW THEREFORE, it is mutually agreed as follows:

Table A entitled "Annual Entitlements Castaic Lake Water Agency" is amended to read as follows:

TABLE A

ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY

Year	Total Annual Amount in acre-feet
1	1,236
2	3,700
3	5,700
4	7,500
5	9,500
6	11,400
7	13,400
8	15,300
9	17,700
10	20,100
11	22,100
12	24,600
13	26,900

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 10 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made as of the 28th day of August, 1974, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency entered into a contract whereby the State will deliver and the Agency will purchase a supply of water to be made available from project facilities constructed by the State; and

WHEREAS, the State and the Agency included in such contract a subarticle, hereinafter referred to as the agricultural and ground water replenishment provision, which entitles the Agency to obtain from the State a supply of surplus water for agricultural and ground water replenishment use when available; and

WHEREAS, Article 21 of such contract also provides for the sale by the State of a supply of surplus water when available; and

(iii) Operational requirements regarding recreation and fish and wildlife uses;

(iv) Generation of power by the System or furnishing of project water required by power contracts;

(v) The exchange of water and the filling, retention, and release of storage in System reservoirs necessary for operational flexibility and to meet the requirements of paragraphs (i) through (iv) of this subdivision.

(vi) Losses of water due to evaporation, leakage, seepage, or other causes to meet the requirements of paragraphs (i) through (v) of this subdivision.

(3) "Ground water replenishment use" shall mean the use of project water exclusively for recharge of ground water basins by direct application to spreading basins, streambeds, or through other means of direct artificial recharge.

(4) "Contractors in the San Joaquin Service Area" shall mean those contractors which are furnished water through delivery structures from the California Aqueduct between Dos Amigos Pumping Plant and the South Portal of the Carley V. Porter Tunnel and from the Coastal Branch, California Aqueduct, from its junction with the California Aqueduct to the site for Devil's Den Pumping Plant.

(5) "Contractors in the Southern California Service Area" shall mean contractors for which water is delivered from the California Aqueduct downstream from the South Portal of the Carley V. Porter Tunnel.

(1) First, the quantity of surplus water to be delivered to noncontractors shall be limited to the quantity available in excess of the requests under the first priority and the second priority.

(2) Second, if there is not sufficient surplus water in excess of the requests under the first priority to meet the requests of contractors under the second priority, the quantity of water to be delivered under the second priority shall be limited to the quantity available in excess of the requests under the first priority and that quantity shall be apportioned in proportion to the amounts of the contractors' current annual entitlements that are to be used for purposes other than agricultural and ground water replenishment uses as determined by the State. If any contractor decides not to use the surplus water available to it under this provision, such surplus water shall be offered on a similar basis to other contractors for such uses.

(3) If there is not sufficient surplus water to meet the requests of contractors under the first priority, the quantity of water to be delivered under that priority shall be limited to the quantity available, and such quantity shall be apportioned to areas upstream and downstream from Dos Amigos Pumping Plant in proportion to the contractors' current annual entitlements that are to be used in such areas for agricultural and ground water replenishment purposes as determined by the State. The quantity of such water available upstream from Dos Amigos Pumping Plant shall be apportioned to contractors upstream from Dos Amigos Pumping Plant in proportion to the amounts of the contractors' current annual entitlements that are to be used for agricultural and ground water

in the judgment of the State to furnish surplus water to it, the contractor shall have a prior right to have such power utilized for furnishing surplus water otherwise available to it pursuant to this article at a cost no higher than that which the State is obligated to pay at the time it orders such power, but it shall have no greater right or priority to receive surplus water. A contractor's commitment may be for any part of the six-year period of its schedule, and the contractor will become bound by such commitment and become entitled to the prior right provided for in the preceding sentence only when the State, after consultation with the contractor, notifies the contractor in writing that it has ordered power based on the contractor's commitment.

(e) Rates.

(1) Surplus water (except further surplus water as described in subdivision (e)(4) of this article) shall be furnished to a contractor for agricultural use and for ground water replenishment use at rates which will return to the State all power costs as defined in subdivision (f) of this article and all incremental operation, maintenance, and replacement costs, and any other incremental costs, incurred in the conservation and transportation of such surplus water as determined by the State, which rates shall include an administrative charge to be determined by the State for each acre-foot of surplus water scheduled for delivery during the year. The amount of such administrative charge shall be credited to general operating costs of the System prior to the allocation of such costs. Incremental costs shall mean those costs which would not be incurred if surplus water were not scheduled for or delivered to the contractor.

article to any contractor which, under Table A of its contract, is scheduled to receive its maximum annual entitlement prior to 1978 and every year thereafter.

(5) Any revenues in excess of operation, maintenance, power and replacement costs and the administrative charge derived from sales of surplus water shall be credited as follows: The Delta water rate or portion thereof paid in accordance with subdivisions (e)(2), (e)(3), or (e)(4) of this article shall be credited to the cost of project conservation facilities, and the balance of such excess revenues, if any, shall be apportioned and credited, as appropriate, to the capital and to the minimum operation, maintenance, power and replacement costs of reaches of the transportation facilities of the System utilized for conveying such water to the purchasers.

(6) The rates and charges for surplus water shall be subject to redetermination by the State to reflect actual costs incurred and the difference shall be promptly credited or debited to the contractor that purchased such surplus water.

(f) Power Costs. Power costs for pumping surplus water shall consist of the cost of capacity, energy and additional transmission service required for the delivery of surplus water, including but not limited to the following:

(1) To the extent utilized for pumping surplus water:

(i) The cost of power purchased for pumping entitlement water,

(ii) The value of project recovery plant generation scheduled for pumping entitlement water, and

contract (disregarding any amendments reducing such Table A executed after July 1, 1974) is first scheduled and unless all of its deferred entitlements are first scheduled: Provided, That at the request of the contractor surplus water may be scheduled in lieu of deferred entitlements and the right to receive such deferred entitlements shall be reduced accordingly. If at the end of any year delivery of scheduled surplus water has prevented any annual entitlement or deferred entitlement from being delivered during that year, then for the purpose of charging for water delivered, deliveries during the year shall be considered first as annual entitlement water to the extent of the annual entitlement, and the balance as deferred entitlement or surplus water in accordance with the option of the contractor previously exercised pursuant to the first sentence of this subdivision.

(3) Before a contractor can receive surplus water under its contract in an amount greater than its annual entitlement for the year as shown in its Table A, it shall first increase its annual entitlement for such year to an amount equivalent to the surplus water scheduled, but it shall not be required to increase its annual entitlement to an amount in excess of 75 percent of its maximum annual entitlement.

(4) The State shall not sell surplus water to a contractor or noncontractor for use directly or indirectly within the boundaries of any other contractor without the written consent of such other contractor, nor shall the State authorize any contractor to supply surplus water for use outside such contractor's boundaries and within the boundaries of any other contractor without the written consent of such other contractor: Provided, That where

and data concerning the use of water within its boundaries as the State may request.

(j) Contracts.

(1) To obtain a supply of surplus water, any contractor or noncontractor shall execute a fuether contract with the State which shall be in conformity with this article and will include at least the following: Further provisions concerning the scheduling of surplus water and provisions as to times and methods of payment.

(2) The State shall not contract to sell surplus water to noncontractors for periods in excess of five years.

IN WITNESS WHEREOF, the parties hereto have executed this contract amendment as of the date first above written.

Approved as to legal form and sufficiency:

By _____
Acting Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By _____
Director

CASTAIC LAKE WATER AGENCY

By _____
(Title) PRESIDENT

(t) Project Repayment Period

"Project repayment period" shall mean that period of years commencing on January 1, 1961, and extending until December 31, 2035; Provided, that whenever construction of any project facilities is financed by a bond issue with maturity dates later than December 31, 2035, whether the bonds are issued pursuant to the Bond Act or other authority, repayment of the costs of such facilities shall be extended to end on the date of the latest maturities of the bonds with which construction of such facilities is financed.

2. Article 2 of the Agency's Water Supply Contract with the State is amended to read as follows:

(2) Term of Contract

This contract shall become effective on the date first above written and shall remain in effect for the longest of the following:

1. The project repayment period

2. 75 years

3. The period ending with the latest maturity date of any bond issue used to finance the construction costs of project facilities.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 12 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND THE
CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made this 12th day of January, 1983, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, the State and the Agency desire to make certain changes and additions to such contract, while otherwise continuing the contract in full force and effect;

NOW, THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. Article 1(e) is amended to read:

construction at the same time of alternative new water supply sources which are either reservoirs located north of the Delta or off-Aqueduct storage reservoirs located south or west of the Delta designed to supply water to the California Aqueduct. The following facilities and programs shall hereinafter be referred to as "Local Projects":

(A) On-stream and off-stream surface storage reservoirs not provided for in Section 12938 of the Water Code, that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(B) Ground water storage facilities that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(C) Waste water reclamation facilities that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(D) Water and facilities for delivering water purchased by the State for the System for a period of time agreed to by the sponsoring contractor; provided that the economic test specified herein shall be applied to the cost of these facilities together with the cost of the purchased water; and

(E) Future water conservation programs and facilities that will reduce demands by the sponsoring contractor for project water from the System for a period of time agreed to by the sponsoring contractor and will thereby have the effect of increasing project water available in the Delta for distribution.

(B) All contractors within whose boundaries any portion of such Local Project is located, and who are not sponsoring contractors for such Local Project give their written approval of such Local Project.

(5) "Sponsoring contractor" as used in this Article 1(h) shall mean the contractor or contractors who either will receive the yield from facilities described in 2(A), (B), (C), or (D) above, or agree to reduce demands for project water from the System pursuant to 2(E) above.

(6) In the event of a shortage in water supply within the meaning of Article 18(a), the determination of whether to count, in whole or in part, the yield from facilities described in 2(A), (B), (C), or (D) above, or the reduced demand from future conservation programs described in 2(E) above in the allocation of deficiencies among contractors will be based on a project-by-project evaluation taking into consideration such factors as any limitation on the use of the water from such facilities and whether the sponsoring contractor has access to project water from the Delta as an alternate to such facilities.

3. Article 1(i)(2) is amended to read:

(2) Facilities for the generation and transmission of electrical energy of the following types:

(A) Hydroelectric generating and transmission facilities, whose operation is dependent on the transportation of project water, or on releases to channels downstream of project facilities defined under (1) above. Such facilities shall be called "project aqueduct power recovery plants."

(5) funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State, and

(6) funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing by moneys in the Pooled Money Investment Account of such Treasury invested in securities,

to the extent the proceeds of any such bonds, advances or loans are for construction of the State Water Facilities defined in Section 12934(d) of the Water Code, the additional project conservation facilities, and the supplemental conservation facilities, (except off-aqueduct power facilities and advances for delivery structures, measuring devices and excess capacity) and without regard to any premiums received on the sale of bonds under item (1) above. The "project interest rate" shall be computed as a decimal fraction to five places.

5. Subdivision (h) is added to Article 22 to read:

(h) The determination of the rate for water under the Delta Water Charge shall be made by including the appropriate costs and quantities of water, calculated in accordance with subdivisions (c), (d) and (e) above, for all additional project conservation facilities as defined in Article 1(h) hereinabove. In the event a Local Project as defined in Article 1(h)(2) will,

(d) Notwithstanding the provisions of subdivisions (a) and (b) of this article, or of Article 1(s), the costs of off-aqueduct power facilities shall be determined and allocated as follows:

(1) The off-aqueduct power costs shall include all annual costs the State incurs for any off-aqueduct power facility, which shall include, but not be limited to, power purchases, any annual principal and interest payments on funds borrowed by or advanced to the State, annual principal and interest on bonds issued by the State or other agency, or under revenue bond financing contracts, any requirements for coverage, deposits to reserves, and associated operation and maintenance costs of such facility, less any credits, interest earnings, or other monies received by the State in connection with such facility. In the event the State finances all or any part of an off-aqueduct power facility directly from funds other than bonds or borrowed funds, in lieu of such annual principal and interest payments, the repayment of capital costs as to that part financed by such other funds shall be determined on the basis of the schedule that would have been required under Article 24.

(2) The annual costs of off-aqueduct power facilities as computed in (1) above shall initially be allocated among contractors in amounts which bear the same proportions to the total amount of such power costs that the total estimated electrical energy (kilowatt hours) required to pump through project transportation facilities the desired delivery amounts of annual entitlements for that year, as submitted pursuant to

reallocation shall include appropriate interest at the project interest rate.

9. Subdivision (e) is added to Article 25 to read:

(e) The total minimum operation, maintenance, power and replacement component due that year from each contractor shall be the sum of the allocations made under the proportionate use of facilities method provided in subdivision (b) of this article and the allocations made pursuant to subdivision (d) of this article for each contractor.

10. Subdivision (b) of Article 32 is amended to read:

(b) Interest on Overdue Payments

Upon every amount of money required to be paid by the Agency to the State pursuant to this contract which remains unpaid after it becomes due and payable, interest shall accrue at an annual rate equal to that earned by the Pooled Money Investment Fund, as provided in Government Code Sections 16480, et seq. calculated monthly on the amount of such delinquent payment from and after the due date until it is paid, and the Agency hereby agrees to pay such interest: provided, that no interest shall be charged to or be paid by the Agency unless such delinquency continues for more than thirty (30) days.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 13 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
CASTAIC LAKE WATER AGENCY

THIS CONTRACT is made this 6th day of June, 1987, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency".

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment;

WHEREAS, the State and the Agency wish to provide financing for project facilities with water system revenue bonds and provide for repayment of water system revenue bonds;

WHEREAS, the State and the Agency wish to clarify the definition of the project interest rate without changing the interpretation of Article 1(r), except for the addition of item (7), and to specify that financing costs of water system facilities and East Branch Enlargement facilities shall not be included in calculating the project interest rate; and

(2) Revenue bonds issued by the State under the Central Valley Project Act after May 1, 1969,

(3) Bonds issued by the State under any other authority granted by the Legislature or the voters,

(4) Bonds issued by any agency, district, political subdivision, public corporation, or nonprofit corporation of this State,

(5) Funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State,

(6) Funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing by moneys in the Surplus Money Investment Fund of such Treasury invested in securities, and

(7) Any other financing capability available in the Treasury of the State of California at whatever interest rate and other financing costs are provided in the law authorizing such borrowing. However, the use of other financing from the State Treasury is intended to involve only short term borrowing at interest rates and other financing costs no greater than those charged to other State agencies during the same period until such time as the Department can sell bonds and reimburse the source of the short term borrowing from the proceeds of the bond sale.

between the State and The Metropolitan Water District of Southern California, dated July 2, 1984, and May 15, 1985, which increased the East Branch Aqueduct capacity beyond that set forth in Table B-2 as shown in State Bulletin 132-70;

(5) That portion of Reach 24 (Silverwood Lake) to be determined by reallocation of Reach 24 to reflect the additional use to be made of that reach as a result of the East Branch Enlargement operation; and

(6) That portion of Reach 25 (San Bernardino Tunnel) to be determined by an allocation of total delivery capacity of Reach 25 between the basic East Branch facilities and the East Branch Enlargement as a result of East Branch Enlargement operation.

4. Article 1 (hh) is added to read:

(hh) "Water System Facilities" shall mean the following facilities to the extent that they are financed with water system revenue bonds or to the extent that other financing of such facilities is reimbursed with proceeds from water system revenue bonds:

(1) The North Bay Aqueduct,

(2) The Coastal Branch Aqueduct,

(3) Delta Facilities, including Suisun Marsh facilities, to serve the purposes of water conservation in the Delta, water supply in the Delta, transfer of water across the Delta, and mitigation of the environmental effects of project facilities, and to the extent presently authorized as project purposes, recreation and fish and wildlife enhancement,

(4) Local projects as defined in Article 1(h)(2) designed to develop no more than 25,000 acre-feet of project yield from each project,

shall be calculated in accordance with provisions in Article 5. of this contract.

6.5. Article 28(e) of the Agency's water supply contract with the State is added to read:

28(e) Notwithstanding the provisions of Article 28(b), adjustments for prior overpayments and underpayments shall be repaid beginning in the year following the redetermination by application of a unit rate per acre-foot which, when paid for the projected portion of the Agency's annual entitlement will return to the State, during the project repayment period, together with interest thereon computed at the project interest rate and compounded annually, the full amount of the adjustments resulting from financing after January 1, 1987, from all bonds, advances, or loans listed in Article 1(r) except for Article 1(r)(3) and except for bonds issued by the State under the Central Valley Project Act after January 1, 1987 for facilities not listed among the water system facilities in Article 1(hh). Notwithstanding the immediately preceding exception, such amortization shall also apply to any adjustments in this component charge resulting from a change in the project interest rate due to any refunding after January 1, 1986 of bonds issued under the Central Valley Project Act. However, amortization of adjustments resulting from items 1(r)(4) through (7) shall be limited to a period which would allow the Department to repay the debt service on a current basis until such time as bonds are issued to reimburse the source of such funding. In no event shall this amortization period be greater than the project repayment period.

credits are determined by the State to be available, such credits shall be promptly provided to the contractors and shall be in proportion to the payments under this article from each contractor. Reserves, bond debt service coverage, interest, and other earnings may be used in the last year to retire the bonds.

(b) Annual charges to recover water system revenue bond financing costs shall consist of two elements.

(1) The first element shall be an annual charge to the Agency for repayment of capital costs of water system facilities as determined under Articles 22 and 24 of this contract with interest at the project interest rate. For conservation facilities, the charge shall be a part of the capital cost component of the Delta Water Charge in accordance with Article 22. For transportation facilities, the charge shall be a part of the capital cost component of the Transportation Charge in accordance with Article 24.

(2) The second element shall be the Agency's share of a Water System Revenue Bond Surcharge to be paid in lieu of a project interest rate adjustment. The total annual amount to be paid by all contractors under this element shall be the difference between the total annual charges under the first element and the annual financing costs of the water system revenue bonds. The amount to be paid by each contractor shall be calculated annually as if the project interest rate were increased to the extent necessary to produce revenues from all contractors sufficient to pay such difference for that year. In making that calculation, adjustments in the Agency's Transportation capital cost component charges for prior overpayments and underpayments shall be determined as if amortized over the remaining years of the project repayment period.

of any water system revenue bond issuances and the form of any necessary resolutions or supplements.

(h) Defaults. (1) If a contractor defaults partially or entirely on its payment obligations calculated under this article and sufficient insurance or other security protecting the non-defaulting contractors is not provided under Article 50(f), the State shall allocate a portion of the default to each non-defaulting contractor. The Agency's share of the default shall be equal to an amount determined by multiplying the total default amount to be charged to all non-defaulting contractors by the ratio that the Agency's maximum Table A entitlement bears to the maximum Table A entitlements of all non-defaulting contractors. However, such amount shall not exceed in any year 25 percent of the Water System Revenue Bond financing costs that are otherwise payable by the Agency in that year. The amount of default to be charged to non-defaulting contractors shall be reduced by any receipts from insurance protecting non-defaulting contractors and bond debt service coverage from a prior year and available for such purpose.

(2) If a contractor defaults partially or entirely on its payment obligations under this article, the State shall also pursuant to Article 20, upon six months' notice to the defaulting contractor, suspend water deliveries under Article 20 to the defaulting contractor so long as the default continues. The suspension of water deliveries shall be proportional to the ratio of the default to the total water system revenue bond payments due from the defaulting contractor. However, the State may reduce, eliminate, or not commence suspension of deliveries pursuant to this subparagraph if it determines suspension in the amounts otherwise required is likely to impair the

coverage, such increase shall be handled in the same manner as provided in Article 50(a).

(7) Action taken pursuant to this subarticle shall not deprive the State of or limit any remedy provided by this contract or by law for the recovery of money due or which may become due under this contract.

(i) Power of Termination.

(1) The Department and the Agency agree to negotiate in good faith the development of a means to provide adequate protection for the Department's cash flow into priorities one and two for revenues under Water Code Section 12937(b) with the goal of obtaining agreement by April 1, 1987. The Department and the Agency agree to continue negotiations beyond April 1, 1987 if necessary to meet their common goal of arriving at agreement.

(2) If such an agreement has not been reached by April 1, 1987, and if the Director of Water Resources determines that adequate progress has not been made toward such an agreement, the Director may give notice to the Agency and other contractors that he intends to exercise the power to terminate provided in this subarticle 50(i). The Director's authority to give such a notice shall terminate on July 1, 1988.

(3) After six months from the date of issuing the notice of intent to terminate, but in no event later than January 1, 1989, the Director may terminate the authority of the Department to issue additional series of water system revenue bonds using the repayment provisions of Article 50. The Department shall promptly notify the Agency and other contractors that the Director has exercised the power of termination.

IN WITNESS WHEREOF, the parties have executed this contract on the date first above written.

Approved as to legal form and sufficiency:

By _____
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By _____
Director

Attest:

By _____
(Title)
Secretary

CASTAIC LAKE WATER AGENCY

By _____
General Manager

to the extent the proceeds of any such bonds, advances or loans are for construction of the State Water Facilities defined in Section 12934(d) of the Water Code, the additional project conservation facilities, and the supplemental conservation facilities, (except off-aqueduct power facilities and advances for delivery structures, measuring devices and excess capacity) and without regard to any premiums received on the sale of bonds under item (1) above. The "project interest rate" shall be computed as a decimal fraction to five places.

WHEREAS, the State and the Agency desire to amend the provisions of such contract related to the delivery and scheduling of entitlement water to allow, under certain conditions, the carry-over of a portion of the Agency's entitlement deliveries from a respective year into the first three months of the next calendar year.

WHEREAS, the carry-over of entitlement by the Agency is not intended to adversely impact current or future project operations.

WHEREAS, the State Water Project contractors and the Department are aware that the carry-over of entitlement water from one year into the next may increase or decrease the costs to other SWP contractors in either year. The tracking of those costs may be too complex and expensive and does not warrant special accounting procedures to be established; however, any significant identifiable cost shall be charged to those contractors causing such cost, as determined by the Department;

WHEREAS, the carry-over of entitlement water is not to affect the payment provisions of the contract.

NOW THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's Water Supply Contract with the State:

1. Article 1(ii) is added to read:

"Carry-over Entitlement Water" shall mean water from a contractor's annual entitlement for a respective year which is made available for delivery by the State in the next year pursuant to Article 12(e).

conditions consistent with this Article 12(e) that would govern the delivery of the Carry-over Entitlement Water.

The Agency agrees to pay all significant identifiable costs associated with its Carry-over Entitlement Water, as determined by the State.

All scheduling and delivery of Carry-over Entitlement Water shall be carried out pursuant to the provisions of this contract.

The Agency agrees to forego the delivery of any Carry-over Entitlement Water that is lost because of project operations or is not delivered by March 31 of the next year.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 15 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS AMENDMENT to the Water Supply Contract is made this 11th day of APRIL, 1991, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency".

RECITALS:

WHEREAS, the State and the Agency entered into a contract whereby the State will deliver and the Agency will purchase a supply of water to be made available from project facilities constructed by the State;

WHEREAS, the State and the Agency included in such contract an article which entitles the Agency to obtain from the State deliveries of surplus water when available;

WHEREAS, the State and the Agency desire to amend the provisions of such contract related to the deliveries of surplus water; and

3. Article 21(f) of the Agency's water supply contract with the State is amended to read:

(f) Power Costs.

(1) Beginning January 1, 1991, the Agency shall pay power charges for pumping surplus water as follows:

(A) If during a calendar month it is either not necessary to purchase power for pumping surplus water, or it is necessary to purchase power for pumping surplus water and the purchased power rate is less than or equal to the Melded Power Rate (defined as the average unit charge for pumping entitlement water during the calendar year for all power resources, including on-aqueduct power resources, off-aqueduct power resources, and any other power resources), then the monthly charges to the Agency for the Net Power (gross power used to pump the surplus water less power generated by the surplus water) used to pump surplus water to the Agency shall be determined using the Melded Power Rate.

(2) By receiving surplus or unscheduled water under this Article 21(f), the Agency accepts the responsibility to indemnify, defend, and hold harmless the State, its officers, employees and agents from all liability, expenses, defense costs, attorney fees, claims, actions, liens, and lawsuits of whatever kind, arising out of or related to this article.

(3) Effective January 1, 1991, power charges for delivery of unscheduled water to the Agency shall be calculated in the same manner as provided in this Article 21(f).

4. This Amendment shall take effect on January 1, 1991, only if, by January 31, 1991 an Amendment substantially the same as this one is executed by contractors that together have maximum annual entitlements totaling at least 3,796,007 acre-feet. By February 15, 1991, the State will inform the Agency of whether sufficient contractors had executed the Amendment to cause the Amendment to take effect.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AGREEMENT RELATING TO CONSOLIDATION AND TERMINATION OF THE WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA AND DEVIL'S DEN WATER DISTRICT BEING AMENDMENT NO. 16 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT is made this 3rd day of January, 1991, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency", and Devil's Den Water District, herein referred to as "Devil's Den".

RECITALS:

WHEREAS, the State and the Agency (formerly Upper Santa Clara Water Agency) have entered into and subsequently amended a water supply contract dated April 30, 1963, providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment;

WHEREAS, the State and the Agency desire to make certain changes to the Agency's mentioned contract, while otherwise continuing the Agency's contract in full force and effect.

AGREEMENT:

NOW, THEREFORE, the parties agree that the following changes are made to the Agency's water supply contract with the State, effective January 1, 1992.

1. Table A is amended to read as follows:

TABLE A
ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY

Calendar Year		Total Annual Amount in Acre-Feet
1968		3,700
1969		5,000
1970		5,700
1971		6,700
1972	1	8,936
1973	2	12,400
1974	3	15,400
1975	4	18,200
1976	5	21,200
1977	6	24,100
1978	7	24,762
1979	8	28,000
1980	9	30,400
1981	10	32,800
1982	11	34,800
1983	12	37,300
1984	13	39,600
1985	14	41,800
1986	15	43,600
1987	16	45,600
1988	17	48,000
1989	18	50,100
1990	19	52,000
1991	20	54,200
1992	21	54,200
And each succeeding year thereafter, for the term of this contract		54,200

4. Article 12(c) of the Agency's contract with the State is amended to read:

(c) **Limit on Rate of Delivery to Agency**

(1) In no event shall the State be obligated to deliver water to the Agency from Castaic Lake at a total combined instantaneous rate of flow exceeding ninety-nine (99) cubic feet per second, except as this rate of flow may be revised by amendment of this article after submission to the State of the Agency's requests with respect to maximum flow capacities to be provided in said delivery structures, pursuant to Article 10.

(2) In no event shall the State be obligated to deliver water to the Agency through the delivery structure at Devil's Den from Reach 31A at a total combined instantaneous rate of flow exceeding thirty-eight (38) cubic feet per second.

5. The proportionate use of facilities factors in the Agency's Table B will be revised to include:

(a) Additional capacity in the California Aqueduct from the Sacramento-San Joaquin Delta through Reach 31A of the Coastal Aqueduct for transporting 12,700 acre-feet with no more than a total amount in any one month of any year of project water greater than eighteen (18) percent of that portion of the Agency's annual entitlement for that year,

8. Pursuant to Article 15(a), the State consents to the Agency annually taking delivery of up to 12,700 acre-feet of the Agency's Table A annual entitlement water at the turnout to Devil's Den in Reach 31A consistent with Article 5(a) above. In any year when the Department determines that sufficient water is available, Article 12(d), surplus, and unscheduled water may also be delivered to the Agency in Reach 31A based upon the amount of the Agency's Table A annual entitlement requested for delivery in that reach.

9. The Agency agrees to indemnify, defend, and hold harmless the State from any liability, expenses, defense costs, attorney fees, claims, actions, liens and lawsuits of any kind arising out of or related to the actions implementing this amendment.

10. Covenants Between the State and Devil's Den:

The State and Devil's Den agree, in consideration of the assumption hereunder by the Agency and the State of new duties under the Castaic Lake Water Agency contract, that the Devil's Den Contract is terminated effective January 1, 1992, and the State and Devil's Den are discharged, effective January 1, 1992, from their respective duties under the Devil's Den Contract.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form and sufficiency:

Acting Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

for Director

CASTAIC LAKE WATER AGENCY

President E. B. "Jerry" Gladbach

Secretary Betty L. Castleberry

DEVIL'S DEN WATER DISTRICT

President Robert L. Larson

Secretary Laurie Foster

WHEREAS, the contractors and the State have negotiated an amendment to the water supply contracts to implement provisions of the Monterey Agreement (the "Monterey Amendment"); and

WHEREAS, the State and the Agency desire to implement such provisions by incorporating this Monterey Amendment into the water supply contract;

NOW, THEREFORE, IT IS MUTUALLY AGREED that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. **Article 1(d) is amended to read:**

(d) **Contractor**

"Contractor" shall mean any entity that has executed, or is an assignee of, a contract of the type published in Department of Water Resources Bulletin No. 141 dated November 1965, with the State for a dependable supply of water made available by the System, except such water as is made available by the facilities specified in Section 12934(d)(6) of the Water Code.

2. **Article 1(k) is amended to read:**

(k) **Minimum Project Yield**

"Minimum project yield" shall mean the dependable annual supply of project water to be made available, estimated to be 4,185,000 acre-feet per year, said amount to be determined by the State on the basis of coordinated operation studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon:

(5) Land acquisition prior to December 31, 1995, for the Kern Fan Element of the Kern Water Bank,

(6) Additional pumps at the Banks Delta Pumping Plant,

(7) The transmission line from Midway to Wheeler Ridge Pumping Plant,

(8) Repairs, additions, and betterments to conservation or transportation facilities existing as of January 1, 1987, and to all other facilities described in this subarticle (hh) except for item (5),

(9) A project facilities corporation yard, and

(10) A project facilities operation center.

4. Article 1(jj) is added to read:

(jj) **Interruptible water**

"Interruptible water" shall mean project water available as determined by the State that is not needed for fulfilling contractors' annual entitlement deliveries as set forth in their water delivery schedules furnished pursuant to Article 12 or for meeting project operational requirements, including storage goals for the current or following years.

5. Article 1(kk) is added to read:

(kk) **Nonproject water**

"Nonproject water" shall mean water made available for delivery to contractors that is not project water as defined in Article 1(j).

Other terms and conditions of the continued service shall be reasonable and equitable and shall be mutually agreed upon. In the event that said terms and conditions provide for continued service for a limited number of years only, the Agency shall have the same option to receive continued service here provided for upon the expiration of that and each succeeding period of continued service.

8. Article 7(a) is amended to read:

(a) **Changes in Annual Entitlements**

The Agency may, at any time or times during the term of this contract, by timely written notice furnished to the State, request that project water be made available to it thereafter in annual amounts greater or less than the annual entitlements designated in Table A of this contract. Subject to approval by the State of any such request, the State's construction schedule shall be adjusted to the extent necessary to satisfy the request, and the requested increases or decreases in said annual entitlements shall be incorporated in said Table A by amendment thereof. Requests for changes in annual entitlements for more than one year shall be approved by the State: *Provided*, That no change shall be approved if in the judgment of the State it would impair the financial feasibility of project facilities.

9. The title of Article 12 is amended to read "Priorities, Amounts, Times and Rates of Deliveries".

Fourth, project water previously stored pursuant to Articles 12(e) and 56.

Fifth, nonproject water to fulfill contractors' annual entitlements for that year not met by the first two priorities.

Sixth, additional interruptible water delivered to contractors in excess of their annual entitlements for that year.

Seventh, additional nonproject water delivered to contractors in excess of their annual entitlements for that year.

13. Article 14 is amended to read:

Curtailment of Delivery

(a) **State May Curtail Deliveries**

The State may temporarily discontinue or reduce the delivery of project water to the Agency hereunder for the purposes of necessary investigation, inspection, maintenance, repair, or replacement of any of the project facilities necessary for the delivery of project water to the Agency, as well as due to outages in, or reductions in capability of, such facilities beyond the State's control or unuseability of project water due to an emergency affecting project facilities. The State shall notify the Agency as far in advance as possible of any such discontinuance or reduction, except in cases of emergency, in which case notice need not be given.

(b) **Agency May Receive Later Delivery of Water Not Delivered**

In the event of any discontinuance or reduction of delivery of project water pursuant to subdivision (a) of this article, the Agency may elect to receive the amount of annual entitlement which otherwise would have been delivered to it during such period under

contractors for domestic supply, fire protection, or sanitation during the year. If a contractor is allocated more water than it requested, the excess water shall be reallocated among the other contractors in proportion to their annual entitlements as provided for above. The foregoing provisions of this subdivision shall be inoperative to the extent necessary to comply with subdivision (c) of this article and to the extent that a contractor's annual entitlement for the respective year reflects established rights under the area of origin statutes precluding a reduction in deliveries to such contractor.

(b) - Deleted

(c) **Permanent Shortage; Contracts for Areas-of-Origin**

In the event that the State, because of the establishment by a party of a prior right to water under the provisions of Sections 11460 through 11463 of the Water Code, enters into a contract with such party for a dependable supply of project water, which contract will cause a permanent shortage in the supply of project water to be made available to the Agency hereunder:

(1) The State shall: (i) equitably redistribute the costs of all transportation facilities included in the System among all contractors for project water, taking into account the diminution of the supply to the Agency and other prior contractors in accordance with the terms of their contracts, and (ii) revise the Agency's annual entitlements and maximum annual entitlement, by amendment of Table A of this contract to correspond to the reduced supply of project water to be made available to the Agency: *Provided*, That such redistribution of costs of transportation facilities shall not be made until there has been reasonable

(d) **Reinstatement of Entitlements**

If after any revision of annual entitlements and maximum annual entitlements pursuant to subdivision (c) of this article, circumstances arise which, in the judgment of the State, justify a revision upward of the same, the State shall, with the consent of the affected contractor, reinstate proportionately the previously reduced entitlements of such contractor to the extent deemed justified, and shall equitably redistribute the costs of the project transportation facilities if inequities would otherwise occur as a result of such reinstatement of entitlements.

(e) **Advance Notice of Delivery Reductions**

The State shall give the Agency written notice as far in advance as possible of any reduction in deliveries to it which is to be made under subdivision (a) of this article and, to the extent possible, shall give the Agency written notice five (5) years in advance of any reduction in its annual entitlements and maximum annual entitlement under subdivision (c) of this article. Reports submitted to the Agency pursuant to Article 16(c) may constitute such notices.

(f) **No Liability for Shortages**

Neither the State nor any of its officers, agents, or employees shall be liable for any damage, direct or indirect, arising from shortages in the amount of water to be made available for delivery to the Agency under this contract caused by drought, operation of area of origin statutes, or any other cause beyond its control.

off-aqueduct, and any other power) incurred in the transportation of such water as if such interruptible water were entitlement water, as well as all incremental operation, maintenance, and replacement costs, and any other incremental costs, as determined by the State. The State shall not include any administrative or contract preparation charge. Incremental costs shall mean those nonpower costs which would not be incurred if interruptible water were not scheduled for or delivered to the contractor. Only those contractors not participating in the repayment of the capital costs of a reach shall be required to pay any use of facilities charge for the delivery of interruptible water through that reach.

(c) **Contracts**

To obtain a supply of interruptible water, a contractor shall execute a further contract with the State which shall be in conformity with this article and shall include at least provisions concerning the scheduling of deliveries of interruptible water and times and methods of payment.

17. Article 22(j) is amended to read:

(j) Notwithstanding provisions of Article 22(a) through (i), the capital cost component and the minimum OMP&R component of the Delta Water Charge shall include an annual charge to recover the Agency's share of the conservation portion of the water system revenue bond financing costs. Charges to the Agency for these costs shall be calculated in accordance with provisions in Article 50 of this contract. Charges for the conservation portion of the water system revenue bond financing costs shall not be affected by any reductions in payments pursuant to Article 51.

subdivision shall be controlling as to allocations of capital costs to the Agency. Proportionate use of facilities factors for prior years shall not be adjusted by the State in response to changes or transfers of entitlement among contractors unless otherwise agreed by the State and the parties to the transfer and unless there is no impact on past charges or credits of other contractors.

19. Article 24(g) is amended to read:

(g) Notwithstanding provisions of Article 24(a) through (d), the capital cost component of the Transportation Charge shall include an annual charge to recover the Agency's share of the transportation portion of the water system revenue bond financing costs. Charges to the Agency for these costs shall be calculated in accordance with the provisions of Article 50 of this contract. Charges for the transportation portion of the water system revenue bond financing costs shall not be affected by any reductions in payments pursuant to Article 51.

20. Article 25(d)(3) is amended to read:

(3) An interim adjustment in the allocation of the power costs calculated in accordance with (2) above, may be made in May of each year based on April revisions in approved schedules of deliveries of project and nonproject water for contractors for such year. A further adjustment shall be made in the following year based on actual deliveries of project and nonproject water for contractors provided, however, in the event no deliveries are made through a pumping plant, the adjustments shall not be made for that year at that plant.

the charges for the year before that for obligations under subdivisions (c)(2)(ii) and (iii) of this article.

(b) **State Water Facilities Capital Account**

(1) The State shall establish a State Water Facilities Capital Account to be funded from revenues available under Water Code section 12937(b)(4). Through procedures described in this article and as limited by this article, the State may consider as a revenue need under subdivision (c)(2)(v) of this article and may deposit in the State Water Facilities Capital Account the amounts necessary to pay capital costs of the State Water Facilities for which neither general obligation bond nor revenue bond proceeds are available, including but not limited to planning, reconnaissance and feasibility studies, the San Joaquin Valley Drainage Program and, through the year 2000, the CALFED Bay-Delta Program.

(2) The Director of the Department of Water Resources shall fully consult with the contractors and consider any advice given prior to depositing funds into this account for any purposes. Deposits into this account shall not exceed the amounts specified in subdivision (c)(2)(v) of this article plus any amounts determined pursuant to subdivision (e)(1)(iii) of this article.

(3) The State shall use revenue bonds or other sources of moneys rather than this account to finance the costs of construction of any major capital projects.

(c) **Calculation of Financial Needs**

(1) Each year the State shall calculate in accordance with the timing provisions of Articles 29 and 31 the amounts that would have been charged (but for this article) to each contractor as provided in other provisions of this contract.

(3) Subject to the provisions of subdivision (e) of this article, the State shall reduce the annual charges in the aggregate for all contractors by the amounts by which the hypothetical charges calculated pursuant to subdivision (c)(1) above exceed the revenue needs determined pursuant to subdivision (c)(2) above. The reductions under this article shall be apportioned among the contractors as provided in subdivisions (d), (e), (f) and (g) of this article. Reductions to contractors shall be used to reduce the payments due from the contractors on each January 1 and July 1; *Provided*, however, that to the extent required pursuant to subdivision (h) of this article, each Agricultural Contractor shall pay to the Agricultural Rate Management Trust Fund an amount equal to the reduction allocated to such Agricultural Contractor. Any default in payment to the trust fund shall be subject to the same remedies as any default in payment to the State under this contract.

(4) The State may submit a supplemental billing to the Agency for the year in an amount not to exceed the amount of the prior reductions for such year under this article if necessary to meet unanticipated costs for purposes identified in Water Code section 12937(b)(1) and (2) for which the State can issue billings under other provisions of this contract. Any supplemental billing made to the Agency for these purposes shall be in the same proportion to the total supplemental billings to all contractors for these purposes as the prior reduction in charges to the Agency in that year bears to the total reductions in charges to all contractors in that year and shall be treated as reducing the amount of the reduction made available for that year to the Agency by the amount of the supplemental bill to the Agency.

Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(iii) In 1999 reductions in the amount of $32 million are projected to be available and shall be applied as follows: the first $10 million of reductions shall be apportioned among the Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(iv) In 2000 reductions in the amount of $33 million are projected to be available and shall be applied as follows: the first $10 million of reductions shall be apportioned among the Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(3)(i) In the event that the aggregate amount of reductions in any of the years 1997 through 2000 is less than the respective amount projected for such year in subdivision (d)(2) above, the shortfall shall be taken first from reductions that would have been provided to Urban Contractors. Only after all reductions to Urban Contractors have been eliminated in a given year shall the remaining shortfall be taken from reductions scheduled for Agricultural Contractors. Any projected reductions not made available due to such shortfalls in the years 1997 through 2000 shall be deferred with interest at the project interest rate to the earliest subsequent years when reductions in excess of those projected for those years are available. Such deferred reductions with interest at the project interest rate shall be applied to the charges of the contractors whose reductions have been deferred.

(ii) In the event that the aggregate amount of reductions available in any of the years 1997 through 2000 is

(5) Annual charges to a contractor shall only be reduced prospectively from and after the date it executes the Monterey Amendment to this contract. Apportionments of reductions shall be calculated on the assumption that all contractors have executed such amendment.

(e) **Review of Financial Requirements**

(1) In 2001 and every fifth year thereafter the Director of the Department of Water Resources, in full consultation with the contractors, will review the financial requirements of the State Water Resources Development System and determine the following:

(i) The amount of revenues that are needed for State Water Resources Development System purposes in addition to those needed for the purposes specified in subdivisions (c)(2)(i), (ii), (iii), and (iv) of this article;

(ii) If the aggregate amount that would have been charged to all contractors in any year but for this article exceeds the sum of (A) the amount of revenues needed for the purposes specified in subdivisions (c)(2)(i), (ii), (iii) and (iv), plus (B) $40.5 million, plus (C) the amount determined pursuant to subdivision (c)(2)(v) of this article, the amount of such excess.

(iii) The amount of the excess determined in subdivision (e)(1)(ii) above that should be collected by the State for additional State Water Resources Development System purposes and the amount of such excess that should be used for further annual charge reductions.

(2) After making the determinations required above, the State may collect the revenues for additional State Water Resources

account in excess of this requirement shall be returned to general project revenues.

(vi) Sixth, remaining amounts if any shall be used for reductions divided on a 24.7% - 75.3% basis between the Agricultural Contractors and the Urban Contractors respectively.

(f) **Apportionment of Reductions among Urban Contractors.** Reductions in annual charges apportioned to Urban Contractors under subdivisions (d) and (e) of this article shall be further allocated among Urban Contractors pursuant to this subdivision. The amount of reduction of annual charges for each Urban Contractor shall be based on each Urban Contractor's proportionate share of total allocated capital costs as calculated below, for both project conservation and project transportation facilities, repaid by all Urban Contractors over the project repayment period.

(1) The conservation capital cost component of the reduction allocation shall be apportioned on the basis of maximum annual entitlement. Each Urban Contractor's proportionate share shall be the same as the percentage of that contractor's maximum annual entitlement to the total of all Urban Contractors' maximum annual entitlements.

(2) The transportation capital cost component of the reduction allocation shall be apportioned on the basis of transportation capital cost component repayment obligations, including interest over the project repayment period. Each Urban Contractor's proportionate share shall be the same as the percentage that the contractor's total transportation capital cost component repayment obligation is of the total of all Urban Contractors' transportation capital cost component repayment obligations.

calculated in subdivision (f)(2) of this article by seventy percent (70%).

(iii) A total, weighted capital cost percentage shall be calculated for each Urban Contractor by adding the weighted conservation capital cost component percentage to their weighted transportation capital cost component percentage.

(4) The total amount of the annual charges to be reduced to Urban Contractors in each year shall be allocated among them by multiplying the total amount of annual charges to be reduced to the Urban Contractors by the total, weighted capital cost percentages for each such contractor. If the amount of the reduction to an Urban Contractor is in excess of that contractor's payment obligation to the Department for that year, such excess shall be reallocated among the other Urban Contractors.

(5) In the case of a permanent transfer of urban entitlement, the proportionate share of annual charge reductions associated with that entitlement shall be transferred with the entitlement to the buying contractor. In the case of an entitlement transfer by either Santa Barbara County Flood Control and Water Conservation District or San Luis Obispo County Flood Control and Water Conservation District, the reductions in annual charges to that agency shall be allocated (a) on the basis of that entitlement being retained by that agency which bears Coastal Branch Phase II transportation costs, (b) on the basis of that entitlement being retained by that agency which does not bear Coastal Branch Phase II transportation costs, and (c) on the basis of the balance of that agency's entitlement which also does not bear Coastal Branch Phase II transportation costs.

Transportation Charge (excluding off-aqueduct power charges) and Water Revenue Bond Surcharge shall be totaled for the years 1997 through 2035.

(iii) Kern County Water Agency and Dudley Ridge Water District totaled costs shall be reduced for the 45,000 acre-feet of annual entitlement being relinquished by them.

(iv) Any reductions in an Agricultural Contractor's totaled costs resulting from the transfer of any of the 130,000 acre-feet of annual entitlement shall be re-added to that contractor's costs.

(v) Each Agricultural Contractor's proportionate share shall be computed by dividing that contractor's total costs by the total costs for all Agricultural Contractors determined pursuant to subparagraphs (ii), (iii) and (iv) above.

(2) The reductions in annual charges, for 1997 through 2001, shall be calculated using the method described in subdivision (g)(1) of this article.

(3) The allocation shall be recalculated using the same method described in subdivision (g)(1) of this article every five years beginning in 2002, if any Agricultural Contractor requests such a recalculation. Any recalculation shall be based on project cost data beginning with the year that the recalculation is to become effective through 2035.

(h) **Agricultural Rate Management Trust Fund**

(1) **Establishment.** Through a trust agreement executed contemporaneously with this amendment, the State and the Agricultural Contractors that sign the Monterey Amendments shall

the percentage of the total of that contractor's statement of charges for that year, as redetermined by the State on or about May 15th of that year, for (a) the Delta Water Charge; (b) the capital cost and minimum operation, maintenance, power and replacement components of the Transportation Charge (including off-aqueduct power charges); and (c) the water system revenue bond surcharge, that is equal to the percentage of that contractor's annual entitlement for that year that was not allocated to it by the State by April 15th of that year.

(ii) In addition to the provisions of subdivision (h)(4)(i) of this article, if on April 15 of any year any of the irrigable land within the Tulare Lake Basin Water Storage District (Tulare) is flooded, and Tulare in writing requests the trustee to do so, the trustee shall, to the extent there are funds in Tulare's account, distribute to the State from such account for the benefit of Tulare an amount equal to the percentage of the total of Tulare's statement of charges for that year, as redetermined by the State on or about May 15th of that year, for (a) the Delta Water Charge; (b) the capital cost and minimum components of the Transportation Charge (including off-aqueduct power charges); and (c) the water system revenue bond surcharge, that is equal to the percentage of the irrigable land within Tulare that is flooded on April 15.

(iii) Each Agricultural Contractor shall remain obligated to make payments to the State as required by other articles in this contract. Any amount to be disbursed pursuant to subdivisions (h)(4)(i) and (h)(4)(ii) shall be paid by the trustee to the State on July 1 of the year involved and shall be credited by the State toward any amounts owed by such respective Agricultural

subdivision (d) of this article so long as the amount in that contractor's account is less than its share of the Cap.

(7) **Distribution of Funds in Excess of the Cap.** Whenever accumulated funds (including interest) in an Agricultural Contractor's account in the trust fund exceed that contractor's share of the Cap, or the estimated remaining payments the contractor is required to make to the State prior to the end of the project repayment period, that contractor may direct the trustee to pay such excess to the contractor.

(8) **Termination of Trust Fund.** At the end of the project repayment period, the Agricultural Rate Management Trust Fund shall be terminated and any balances remaining in the accounts for each of the Agricultural Contractors shall be disbursed to the respective Agricultural Contractors.

(i) **Definitions.** For the purposes of this article, the following definitions will apply:

(1) "Agricultural Contractor" shall mean the following agencies as they now exist or in any reorganized form:

(i) County of Kings,

(ii) Dudley Ridge Water District,

(iii) Empire West Side Irrigation District,

(iv) Kern County Water Agency for 993,300 acre-feet of its entitlement,

(v) Oak Flat Water District,

(vi) Tulare Lake Basin Water Storage District.

(2) "Urban Contractor" shall mean every other agency having a long term water supply contract with the State as they exist as of the date of this amendment or in any reorganized form as well as

24. Article 53 is added to read:

53. PERMANENT TRANSFERS AND REDUCTIONS OF ENTITLEMENT

(a) Article 41 provides that no assignment or transfer of a contract or any part thereof, rights thereunder or interest therein by a contractor shall be valid unless and until it is approved by the State and made subject to such reasonable terms and conditions as the State may impose. In accordance with State policy to assist water transfers, the State and the County of Kings, Dudley Ridge Water District (DRWD), Empire West Side Irrigation District, Kern County Water Agency (KCWA), Oak Flat Water District and Tulare Lake Basin Water Storage District (for the purposes of this article the "Agricultural Contractors") shall, subject to the conditions set forth in this article, expeditiously execute any necessary documents and approve all contracts between willing buyers and willing sellers until permanent transfers totaling 130,000 acre-feet of annual entitlements of the Agricultural Contractors and, to the extent provided in such contracts, rights in project transportation facilities related to such annual entitlement have been made to other contractors (the "Urban Contractors") or noncontractors in accordance with the provisions of this article. Such approval requirement shall apply to all contracts executed prior to January 1, 2011. KCWA shall be responsible for approval of such transfers for any portion of the 130,000 acre-feet not previously made available under this article by the other Agricultural Contractors. A contract between a willing buyer and a willing seller shall mean a contract between (1) a buyer which is an Urban Contractor or, to the extent provided in subdivision (e) of this article, a noncontractor and (2) a seller which is an Agricultural Contractor

entitlements as well as transportation rights in accordance with the following terms and procedure:

(1) The Agricultural Contractor shall provide the State a copy of a bona fide contract or Proposed Contract (the "Proposed Contract") and the State shall, within five working days of receipt, provide copies of such Proposed Contract to all Urban Contractors together with a Notice of Proposed Contract stating the date on or before which a Notice of Intent to Exercise a Right of First Refusal (NOI) must be delivered to both the State and the seller, which date shall be 90 days from the date the State mails the Notice of Proposed Contract.

(2) The Proposed Contract shall provide for the transfer of rights in project transportation facilities sufficient to deliver to the seller's service area in any one month eleven percent (11%) of the annual entitlement being transferred or such greater amount as the seller determines to sell; *Provided*, however, that sellers shall not be obligated to sell any transportation rights in the Coastal Aqueduct.

(3) To exercise the right of first refusal, an Urban Contractor shall deliver to the State and the seller its NOI within the time period stated in the Notice of Proposed Contract and shall proceed in good faith to try to complete the transfer to the Urban Contractor. If two or more Urban Contractors deliver NOI's to the State, the amount of annual entitlement and transportation rights being sold shall be allocated among those Urban Contractors that are prepared to perform the purchase by the Performance Date provided for herein in proportion to their maximum annual entitlements, or in another manner acceptable to the Urban Contractors delivering the

(5) If an Urban Contractor issuing a NOI fails to complete its exercise of the Right of First Refusal by the Performance Date, the seller shall be free to sell its entitlement in substantial conformance with the terms and conditions set forth in the Proposed Contract . An Urban Contractor issuing a NOI may assign its rights to exercise a right of first refusal to another Urban Contractor and the assignee shall have the same rights as the assignor to complete the purchase by the Performance Date.

(6) In exercising the Right of First Refusal, an Urban Contractor, at its option, may either agree to perform the Proposed Contract in its entirety, including all of its terms and conditions, or agree to pay the price offered under the Proposed Contract for the annual entitlement and transportation rights without condition and without being entitled to enforce or being subject to any other provisions of the Proposed Contract.

(e) As used in this article, "price" shall mean the dollar amount of consideration provided for in the Proposed Contract.

(f) Upon the effective date of any such transfer, the seller shall be relieved of and the buyer shall become liable to the State for all prospective Delta Water Charges, the related Transportation Charges and any other charges for the annual entitlements and associated transportation rights transferred unless the seller and buyer provide otherwise in the contract for the transfer and the State approves such other provisions. However, the contractor making the sale shall remain obligated to the State to make the payments if the buyer defaults on its payments to the State related to the water transferred and is not a party to a long term water supply contract of the type contained in Department of Water

impaired. The capital cost and minimum operation, maintenance, power and replacement components of the Transportation Charges shall then be reallocated among the other entities participating in repayment of costs of that reach. For the purposes of this determination, all payments received by the State from the seller relating to the annual entitlement sold shall be deemed to have been received from the buying contractor. Any increased Transportation minimum operation, maintenance, power and replacement component charges allocated to the buying contractor pursuant to this subdivision (g) shall begin January 1 of the year following the effective date of the transfer.

(h) Individual contractors may transfer entitlements among themselves in amounts in addition to those otherwise provided for in this article. The State shall expeditiously execute any necessary documents and approve all contracts involving permanent sales of entitlements among contractors, including permanent sales among Urban Contractors. Such sales shall be subject to the provisions of subdivisions (b), (f) and (g) of this article; *Provided*, however, that for a buying contractor needing transportation capacity in excess of the capacity factors on which its charges are based in any reach, reallocation of the Transportation capital cost component charges for transfers other than (i) the 130,000 acre-feet provided for in this article and (ii) the approximate 33,000 acre-feet of transfers proposed from contractors located in Santa Barbara or San Luis Obispo counties, shall be determined both prospectively and retroactively.

(i) On January 1 following the year in which such Monterey Amendments take effect and continuing every year thereafter until

25. Article 54 is added to read:

54. Usage of Lakes Castaic and Perris

(a) The State shall permit the contractors participating in repayment of the capital costs of Castaic Lake (Reach 30) and Lake Perris (Reach 28J) to withdraw water from their respective service connections in amounts in excess of deliveries approved pursuant to other provisions of the state water contracts. Each such contractor shall be permitted to withdraw up to a Maximum Allocation from the reach in which it is participating. The contractors participating in repayment of Castaic Lake may withdraw a collective Maximum Allocation up to 160,000 acre-feet pursuant to this article, which shall be apportioned among them pursuant to the respective proportionate use factors from the Department of Water Resources' Bulletin 132-94, Table B-1 upon which capital cost repayment obligations are based, as follows:

Castaic Lake

Participating Contractor	Proportionate Use Factor	Maximum Allocation (Acre Feet)
The Metropolitan Water District of Southern California	0.96212388	153,940
Ventura County Flood Control and Water Conservation District	0.00860328	1,376
Castaic Lake Water Agency	0.02927284	4,684
Total	**1.00000000**	**160,000**

delivery schedule at any time, and the modified schedule shall be subject to review in the same manner. If necessary, the State may modify the schedule after consultation with the contractor and other contractors participating in repayment of that reach but may not change the total quantity of water to be withdrawn. As part of the consultation, the State shall advise a contractor if it determines a withdrawal will adversely impact the rate of delivery provided for the contractor in this contract. The State shall not be responsible for any such impacts.

(c) A contractor may withdraw all or a portion of its Maximum Allocation. It shall restore any withdrawn portion of such allocation by furnishing an equivalent amount of replacement water to the reservoir from which the water was withdrawn within five years from the year in which the withdrawal takes place. The unused portion of the allocation, in addition to any replacement water furnished to the reservoir, shall remain available for subsequent withdrawal. The State shall keep an accounting of the contractor's storage withdrawals and replacements. In any year, the State shall permit a contractor to withdraw an amount equivalent to the contractor's Maximum Allocation minus remaining replacement water requirements due to previous withdrawals. If the contractor fails to schedule and replace the withdrawn water within the five-year return period, the State shall provide the replacement water from water scheduled for delivery to the contractor in the sixth year or as soon as possible thereafter. The total amount of scheduled annual entitlement which a contractor can use in any one year for restoring its Maximum Allocation and storing water in surface storage facilities

A contractor may use any of this total amount for replacement water but cannot use any more than that provided for in Article 56 to add to storage in project surface conservation facilities and in nonproject surface storage facilities. There shall be no limit under this article on the amount of scheduled annual entitlement a contractor can use to restore its Maximum Allocation in a year when its percentage of annual water supply allocation is one-hundred percent (100%), nor shall there be any limit under this article on the amount of interruptible water, nonproject water or water obtained through an exchange which a contractor can use to restore its Maximum Allocation.

(d) For any replacement water furnished to reservoir storage pursuant to this article, the responsible contractor shall pay the State charges for the conservation, if any, and transportation of such replacement water as are associated with the type of replacement water that is furnished, as if such water were delivered to the turnout at the reservoir to which the replacement water is furnished. Adjustments from estimated to actual costs shall be subject to provisions applicable to the type of replacement water. The State shall not charge contractors for water withdrawn pursuant to this article.

(e) The State shall operate capacity in Castaic and Perris Reservoirs, not required for purposes of Maximum Allocation deliveries, in compliance with the requirement of Article 17(b) of The Metropolitan Water District of Southern California's water supply contract with the State to maintain an amount of water reasonably sufficient to meet emergency requirements of the contractors participating in repayment of that reach. A

26. Article 55 is added to read:

55. Transportation of Nonproject Water

(a) Subject to the delivery priorities in Article 12(f), contractors shall have the right to receive services from any of the project transportation facilities to transport water procured by them from nonproject sources for delivery to their service areas and to interim storage outside their service areas for later transport and delivery to their service areas: *Provided,* that except to the extent such limitation in Section 12931 of the Water Code be changed, a contractor shall not use the project transportation facilities under this option to transport water the right to which was secured by the contractor through eminent domain unless such use be approved by the Legislature by concurrent resolution with the majority of the members elected to each house voting in favor thereof.

(b) For any nonproject water delivered pursuant to this article, contractors shall pay the State the same (including adjustments) for power resources (including on-aqueduct, off-aqueduct, and any other power) incurred in the conservation and transportation of such water as if such nonproject water were entitlement water, as well as all incremental operation, maintenance, and replacement costs, and any other incremental costs, which may include an administrative or contract preparation charge, all as determined by the State. Incremental costs shall mean those nonpower costs which would not be incurred if nonproject water were not scheduled for or delivered to contractors. Only those contractors not participating in the repayment of a reach shall be required to pay a use of facilities

limits and in accordance with the provisions provided for in this subdivision (c) and any applicable water right laws, by setting forth on the preliminary water delivery schedule submitted to the State on or before October 1 of each year pursuant to Article 12(a) the quantity of project water it wishes to store in the next succeeding year. There shall be no limit on the amount of project water a contractor can store outside its service area during any year in a then existing and operational groundwater storage program. The amount of project water a contractor can add to storage in project surface conservation facilities and in nonproject surface storage facilities located outside the contractor's service area each year shall be limited to the lesser of the percent of the contractor's Table A annual entitlement shown in column 2 or the acre-feet shown in column 3 of the following table, depending on the State's final water supply allocation percentage as shown in column 1. However, there shall be no limit to storage in nonproject facilities in a year in which the State's final water supply allocation percentage is one hundred percent. These limits shall not apply to water stored pursuant to Article 12(e).

(2) Storage capacity in project surface conservation facilities at any time in excess of that needed for project operations shall be made available to requesting contractors for storage of project and nonproject water. If such storage requests exceed the available storage capacity, the available capacity shall be allocated among contractors requesting storage in proportion to their annual entitlements designated in their Table A's for that year. A contractor may store water in excess of its allocated share of capacity as long as capacity is available for such storage.

(3) If the State determines that a reallocation of excess storage capacity is needed as a result of project operations or because of the exercise of a contractor's storage right, the available capacity shall be reallocated among contractors requesting storage in proportion to their annual entitlements designated in their Table A's for that year. If such reallocation results in the need to displace water from the storage balance for any contractor or noncontractor, the water to be displaced shall be displaced in the following order of priority:

First, water, if any, stored for noncontractors.

Second, water stored for a contractor that previously was in excess of that contractor's allocation of storage capacity.

Third, water stored for a contractor that previously was within that contractor's allocated storage capacity.

The State shall give as much notice as feasible of a potential displacement.

point of return to the aqueduct to the turn-out in the contractor's service area. In addition, the contractor shall pay all incremental operation, maintenance, and replacement costs, and any other incremental costs, as determined by the State, which shall not include any administrative or contract preparation charge. Incremental costs shall mean those nonpower costs which would not be incurred if such water were scheduled for or delivered to the contractor's service area instead of to interim storage outside the service area. Only those contractors not participating in the repayment of a reach shall be required to pay a use of facilities charge for use of a reach for the delivery of water to, or return of water from, interim storage.

(7) A contractor electing to store project water in a nonproject facility within the service area of another contractor shall execute a contract with that other contractor prior to storing such water which shall be in conformity with this article and will include at least provisions concerning the point of delivery and the time and method for transporting such water.

(d) **Sale of Project Water For Use Outside Service Area**

(1) If in any year a contractor has been allocated annual entitlement that it will not use within its service area, the contractor has not elected to store project water in accordance with the provisions of subdivision (c) of this article during that year, and the contractor has not elected to carry over entitlement water from the prior year pursuant to the provisions of Article 12(e), the contractor may sell such annual entitlement for use outside its service area in accordance with the following provisions.

(4) Each year the price per acre-foot to be paid by the State to contractors selling water remaining in the Pool or placed in the Pool after February 15, but on or before March 15 that is purchased by a contractor requesting such purchase by April 1 or by the State on April 1 shall be equal to twenty-five percent (25%) of the Delta water rate as of that date. The price per acre-foot to be paid to the State for the purchase of water from the Pool by a contractor placing a request for such purchase between March 2 and April 1 shall be equal to twenty-five percent (25%) of the Delta water rate as of the later date. Any water placed in the Pool on or before March 15 that is not purchased by a contractor or the State by April 1 may be withdrawn from the Pool by the selling contractor.

(5) If there are more requests from contractors to purchase water from the Pool than the amount in the Pool, the water in the Pool shall be allocated among those contractors requesting such water in proportion to their annual entitlements for that year up to the amount of their requests. If requests to purchase water from the Pool total less than the amount of water in the Pool, the sale of Pool water shall be allocated among the contractors selling such water in proportion to their respective amounts of water in the Pool.

(6) Any water remaining in the Pool after April 1 that is not withdrawn by the selling contractor shall be offered by the State to contractors and noncontractors and sold to the highest bidder: *Provided*, that if the highest bidder is a noncontractor, all contractors shall be allowed fifteen days to exercise a right of first refusal to purchase such water at the price offered by

Article 12(e) for carrying over water from the last three months of that year into the first three months of the succeeding year.

(f) **Bona Fide Exchanges Permitted**

Nothing in this article shall be deemed to prevent the Agency from entering into bona fide exchanges of project water for use outside the Agency's service area with other parties for project water or nonproject water if the State consents to the use of the project water outside the Agency's service area. Also, nothing in this article shall be deemed to prevent the Agency from continuing those exchange or sale arrangements entered into prior to September 1, 1995, which had previously received any required State approvals. A "bona fide exchange" shall mean an exchange of water involving a contractor and another party where the primary consideration for one party furnishing water to another is the return of a substantially similar amount of water, after giving due consideration to the timing or other nonfinancial conditions of the return. Reasonable payment for costs incurred in effectuating the exchange and reasonable deductions from water delivered, based on expected storage or transportation losses may be made. A "bona fide exchange" shall not include a transfer of water from one contractor to another party involving a significant payment unrelated to costs incurred in effectuating the exchange. The State, in consultation with the contractors, shall have authority to determine whether transfers of water constitute "bona fide exchanges" within the meaning of this paragraph and not disguised sales.

October 1, 1996 date and the January 1, 2000 date may be extended by unanimous agreement of the State, Kern County Water Agency and The Metropolitan Water District of Southern California.

(b) The State shall administer the water supply contracts of any contractors that do not execute the Monterey Amendment so that such contractors are not affected adversely or to the extent feasible beneficially by the Monterey Amendments of other contractors' water supply contracts.

(c) If a court of competent jurisdiction issues a final judgment or order determining that any part of a contractor's Monterey Amendment is invalid or unenforceable, all provisions of that amendment shall be of no force or effect as to such contractor, except as provided in subdivisions (e) and (f) of this paragraph.

(d) If any part of the Monterey Amendment of the Kern County Water Agency's or The Metropolitan Water District of Southern California's contracts or if the conveyance of the Kern Fan Element of the Kern Water Bank to the Kern County Water Agency provided for in Article 52 is determined by a court of competent jurisdiction in a final judgment or order to be invalid or unenforceable, the Monterey Amendments of all contractors and the Kern Water Bank Contract shall be of no force and effect except as provided in subdivisions (e) and (f) of this paragraph.

(e) Notwithstanding subdivisions (c), (d) and (f) of this paragraph, if any part of the Monterey Amendment of the Kern County Water Agency's or The Metropolitan Water District of Southern California's contract is determined by a court of competent jurisdiction in a final judgment or order to be invalid

District of Southern California. In cases arising under subdivision (c) or (d), the affected contractor whose Monterey Amendment has been determined to be partially invalid or unenforceable must first request the waiver.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment on the date first above written.

Approved as to legal form and sufficiency

Susan N. Weber
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Director

CASTAIC LAKE WATER AGENCY

ATTEST:

Robert H. Clark
ASSISTANT SECRETARY

GENERAL MANAGER

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 18 TO THE WATER SUPPLY CONTRACT
BETWEEN
THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
AND
CASTAIC LAKE WATER AGENCY

THIS AMENDMENT to the Water Supply Contract is made this 31st day of March, 1999, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State," and Castaic Lake Water Agency, herein referred to as the "Agency."

RECITALS:

A. The State and the Agency have entered into and subsequently amended a Water Supply Contract (the "Water Supply Contract") providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment.

B. The contractors and the State have amended the Water Supply Contracts to implement provisions of the Monterey Agreement (the "Monterey Amendment").

C. Among other things, Article 53 of the Water Supply Contract provides for the permanent transfer of up to 130,000 acre-feet of agricultural entitlement water to urban agencies.

D. The Agency and the Wheeler Ridge-Maricopa Water Storage District have entered into an Agreement to Purchase Wheeler Ridge-Maricopa Water Storage District State Water Project Entitlement to Water executed as of this date to provide for the sale by Kern County Water Agency, herein referred to as "KCWA", on behalf of Wheeler Ridge-Maricopa to the Agency of 41,000 acre-feet per year of KCWA's annual entitlement that has been allocated to Wheeler Ridge-Maricopa by KCWA under the contract between Wheeler Ridge-Maricopa and KCWA dated January 8, 1970 and all amendments thereto.

E. The State and Agency wish to set forth their agreement as to such matters as (i) the 41,000 acre-feet per year increase in the Agency's annual entitlement, (ii) the transfer of related transportation repayment obligations, and (iii) the revision of proportionate use of facilities factors set forth in the Water Supply Contract.

F. The State and KCWA are simultaneously with the execution and delivery of this Amendment, entering into Amendment No. 28 to KCWA's Water Supply Contract between KCWA and the State in order to reflect (i) the transfer of Table A Entitlement described herein, (ii) the transfer of related transportation repayment obligations, and (iii) the revision of proportionate use of facilities factors.

G. This Amendment is permitted by the terms of the Water Supply Contract, and except as amended herein, the provisions of the Water Supply Contract will remain in full force and effect.

NOW, THEREFORE, it is mutually agreed that the following changes are hereby made to the Agency's Water Supply Contract:

1. Article 53(j) is added to read:

(j) In accordance with Article 53(a) the Agency is increasing its Table A annual entitlements by 41,000 acre-feet beginning in year 2000 and each succeeding year thereafter for the term of the contract through a sale from Kern County Water Agency of 41,000 acre-feet of the 130,000 acre-feet made available to Urban Contractors. As a result of this sale, Table A as designated in Article 6(b) is amended as follows:

TABLE A

ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY
(Acre-feet)

Year		
1	(1968)	3,700
2	(1969)	5,000
3	(1970)	5,700
4	(1971)	6,700
5	(1972)	8,936
6	(1973)	12,400
7	(1974)	15,400
8	(1975)	18,200
9	(1976)	21,200
10	(1977)	24,100
11	(1978)	24,762
12	(1979)	28,000
13	(1980)	30,400
14	(1981)	32,800
15	(1982)	34,800
16	(1983)	37,300
17	(1984)	39,600
18	(1985)	41,800
19	(1986)	43,600
20	(1987)	45,600
21	(1988)	48,000
22	(1989)	50,100
23	(1990)	52,000
24	(1991)	54,200
25	(1992)	54,200
26	(1993)	54,200
27	(1994)	54,200
28	(1995)	54,200
29	(1996)	54,200
30	(1997)	54,200
31	(1998)	54,200
32	(1999)	54,200
~~33~~	~~(2000)~~	~~54,200~~
33	(2000)	**95,200**
And each succeeding year thereafter, for the term of this contract as an annual entitlement:		~~54,200~~ **95,200**

The following apply to this sale:

(1) Increases in the Agency's Delta Water and Transportation Charges and Water System Revenue Bond Surcharge resulting from the increase in the Agency's annual entitlements for 2000 and each year thereafter shall commence January 1, 2000, and be identified by the State and included in its annual Statement of Charges to the Agency.

(2) All future adjustments in charges and credits of past costs associated with the 41,000 acre-feet of annual entitlement (or applicable portion thereof) and the related transportation capacity in Reaches 1 through 16A of the California Aqueduct shall be attributable to the Agency as if the Agency's annual entitlement and the related transportation capacity had been increased by the 41,000 acre-feet of annual entitlement purchased from the KCWA in years prior to January 1, 2000.

(3) For cost allocation and repayment purposes, Exhibit A attached hereto shows entitlement and capacity amounts for each aqueduct reach in which the Agency participates. These redetermined values shall be used to derive the proportionate use of facilities factors as set forth in Table B as designated in Article 24(b). The capacity amounts shown in Exhibit A are estimated values. Actual values will be used by the State in implementing the terms of this Amendment and in redetermination of Table B of this Water Supply Contract under Article 28.

2. Article 12(c)(1) which defines the limits on the instantaneous rate of flow to the Agency from Castaic Lake based on peaking factors, is modified to delete "ninety-nine (99)" and replace it with "one hundred fifty (150)."

3. This Amendment is contingent upon the effectiveness of Water Supply Contract Amendment No. 28, between the State and the KCWA. If either amendment ceases to be effective, the State may identify the date on which the contract amendments shall be deemed inoperative, for the purpose of assuring timely repayment of contract obligations and orderly administration of the long-term water supply contracts.

4. The Agency agrees to indemnify, defend, and hold harmless the State and any of its officers, agents, or employees from any liability, expenses, defense costs, attorney fees, claims, actions, liens and lawsuits of any kind arising from or related to any and all actions implementing this Amendment and associated agreements.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment on the date first above written.

Approved as to legal form and sufficiency:

for Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

for Director

CASTAIC LAKE WATER AGENCY

ATTEST:

Robert H. Clark
Signature

Asst Secretary
Title

Signature

President, Board of Directors
Title

CASTAIC LAKE WATER AGENCY
ANNUAL ENTITLEMENT AND CAPACITY VALUES FOR EACH REACH FOR COST ALLOCATION AND REPAYMENT ONLY

The values related to this transfer are estimated to be as follows:

California Aqueduct [1]	Before Transfer		Entitlement Transferred from KCWA (AF) (3)	Capacity Transferred from KCWA (cfs) (4)	Additional Capacity Required (cfs) (5)	After Transfer	
	Annual Entitlement (AF) (1)	Capacity (cfs) (2)				Total Annual Entitlement (AF) (6)	Total Capacity (2)+(4)+(5) (cfs) (7)
Reach 1	54,200	95	41,000	122	0	95,200	217
Reach 2A	54,200	95	41,000	122	0	95,200	217
Reach 2B	54,200	95	41,000	122	0	95,200	217
Reach 3	54,200	95	41,000	122	0	95,200	217
Reach 4	54,200	95	41,000	122	0	95,200	217
Reach 5	54,200	95	41,000	122	0	95,200	217
Reach 6	54,200	95	41,000	122	0	95,200	217
Reach 7	54,200	95	41,000	122	0	95,200	217
Reach 8C	54,200	95	41,000	122	0	95,200	217
Reach 8D	54,200	95	41,000	122	0	95,200	217
Reach 9	54,200	75	41,000	122	0	95,200	197
Reach 10A	54,200	75	41,000	122	0	95,200	197
Reach 11B	54,200	75	41,000	122	0	95,200	197
Reach 12D	54,200	75	41,000	122	0	95,200	197
Reach 12E	54,200	75	41,000	122	0	95,200	197
Reach 13B	54,200	75	41,000	122	0	95,200	197
Reach 14A	54,200	75	41,000	120	0	95,200	195
Reach 14B	54,200	75	41,000	77	0	95,200	152
Reach 14C	54,200	75	41,000	46	11	95,200	132
Reach 15A	54,200	75	41,000	39	18	95,200	132
Reach 16A	54,200	75	41,000	25	32	95,200	132
Reach 17E	54,200	75	41,000	0	57	95,200	132
Reach 17F	54,200	75	41,000	0	57	95,200	132
West Branch							
Reach 29A	54,200	75	41,000	0	57	95,200	132
Reach 29F	54,200	75	41,000	0	57	95,200	132
Reach 29G	54,200	75	41,000	0	57	95,200	132
Reach 29H /2/	54,200	--	41,000	0	--	95,200	--
Reach 29J	54,200	75	41,000	0	57	95,200	132
Reach 30 /2/	54,200	--	41,000	0	--	95,200	--

[1] These numbers apply to the reaches as set forth in Bulletin 132, Figure B-4, "Repayment Reaches and Descriptions."

[2] Aqueduct capacity in cfs is not applicable to Pyramid Lake (Reach 29H) and Castaic Lake (Reach 30). The maximum instantaneous flow rate for deliveries to the Agency from Castaic Lake is 150 cfs.

California Court of Appeals, Second District, Division Four, "*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373" (2002)

H

FRIENDS OF THE SANTA CLARA RIVER, Plaintiff and Appellant, v. CASTAIC LAKE WATER AGENCY, Defendant and Respondent.
Cal.App.2.Dist.

FRIENDS OF THE SANTA CLARA RIVER,
Plaintiff and Appellant,
v.
CASTAIC LAKE WATER AGENCY, Defendant and Respondent.
No. B145283.

Court of Appeal, Second District, Division 4, California.
Jan. 10, 2002.

SUMMARY

A nonprofit environmental group filed a petition for a writ of mandate challenging a water agency's certification of an environmental impact report (EIR) as inadequate under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). The project analyzed in defendant's EIR was its purchase of entitlement to 41,000 acre-feet per year of state water from a water storage district. Defendant's EIR was tiered on an earlier EIR, which had been prepared in conjunction with a statewide agreement that equalized allocations of entitlements to water from the state water project between agricultural and urban contractors. The trial court entered judgment denying plaintiff's petition. (Superior Court of Los Angeles County, No. BS05694, David P. Yaffe, Judge.)

The Court of Appeal reversed, directing the trial court to issue a writ of mandate vacating the certification of defendant's EIR, and ordering the trial court to retain jurisdiction until defendant certified an EIR complying with CEQA. The court held that decertification of defendant's EIR was required, since another appellate court had found that the previous EIR, on which defendant's EIR was tiered, was inadequate and had decertified it. Pub. Resources Code, § 21094, subd. (a), authorizes tiering when the previous EIR has been certified. Defendant's EIR had a defect, since the previous EIR had been decertified. The court further held that defendant's tiering on the decertified EIR was prejudicial error, since defendant had not in its EIR addressed the environmental effects of its project absent the protections for agricultural contractors provided for in the statewide agreement that had been the subject of the decertified EIR. (Opinion by Vogel (C. S.), P. J., with Hastings and Curry, JJ., concurring.)

HEADNOTES

Classified to California Digest of Official Reports

(1a, 1b) Pollution and Conservation Laws § 2.3--California Environmental Quality Act--Environmental Impact Reports--Tiering--***1374** Effect of Decertification of Previous EIR.
The trial court erred in denying a nonprofit environmental group's mandamus challenge to a water agency's environmental impact report (EIR) on the ground it was inadequate under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). The project analyzed in defendant's EIR was its purchase of entitlement to 41,000 acre-feet per year of state water from a water storage district. Defendant's EIR was tiered on an earlier EIR, which had been prepared in conjunction with a statewide agreement that equalized allocations of entitlements to water from the state water project between agricultural and urban contractors. Decertification of defendant's EIR was required, since an appellate court had found that the previous EIR, on which defendant's EIR was tiered, was inadequate and had decertified it. Pub. Resources Code, § 21094, subd. (a), authorizes tiering when the previous EIR has been certified. Hence, defendant's EIR had a defect, since the previous EIR had been decertified. In addition, defendant's tiering on the decertified EIR was prejudicial error, since defendant had not in its EIR addressed the environmental effects of its project absent the protections for agricultural contractors provided for in the statewide agreement that had been the subject of the decertified EIR.
[See 4 Witkin, Summary of Cal. Law (9th ed. 1987) Real Property, § 59 et seq.; West's Key Digest System, Health and Environment k. 25.10(6.5).]
(2) Pollution and Conservation Laws § 2.3--California Environmental Quality Act--Environmental Impact Reports--Tiering.
The tiering provisions (Pub. Resources Code, § §

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21068.5, 21093, 21094) of the California Environmental Quality Act (Pub. Resources Code, § 21000 et seq.) enable a public agency to incorporate by reference and utilize a prior environmental impact report. Tiering is favored by the Legislature to streamline the regulatory process and avoid wasteful duplication of effort. Under CEQA Guidelines, the later EIR should state that the lead agency is using the tiering concept and that it is being tiered with the earlier EIR.

COUNSEL

Brandt-Hawley & Zoia and Susan Brandt-Hawley for Plaintiff and Appellant.

Robert H. Clark; Kane, Ballmer & Berkman and R. Bruce Tepper, Jr., for Defendant and Respondent.

***1375 VOGEL (C. S.), P. J.**

Introduction

In 1995, the California State Department of Water Resources (DWR) and water contractors of the State Water Project (SWP) reached a historic agreement, known as the Monterey Agreement, changing the allocations between agricultural and urban contractors of entitlements to SWP water. A major component of the Monterey Agreement was the transfer of entitlements up to 130,000 acre-feet per year from agricultural contractors to urban contractors, on a willing buyer-willing seller basis. Pursuant to the Monterey Agreement, respondent Castaic Lake Water Agency (respondent) purchased from the Kern County Water Agency (KCWA) and its member district the Wheeler Ridge-Maricopa Water Storage District (WRMWSD) entitlement to 41,000 acre-feet per year of SWP water.

Respondent approved this transfer after certifying a project environmental impact report (EIR) pursuant to the California Environmental Quality Act (CEQA), Public Resources Code section 21000 et seq. [FN1] In the present case appellant Friends of the Santa Clara River (appellant), a nonprofit California corporation, challenges the sufficiency of respondent's EIR.

> FN1 All further statutory references are to the Public Resources Code unless otherwise indicated. All references to "Guidelines" are to the CEQA regulations in title 14, California Code of Regulations.

Previously, the Central Coast Water Authority (CCWA) as lead agency prepared an EIR on the environmental effects statewide of implementing the Monterey Agreement (the Monterey Agreement EIR). Then the Belridge Water Storage District, one of the member districts of KCWA, as lead agency prepared an EIR on the environmental effects in Kern County of selling up to 130,000 acre-feet of SWP entitlements to then unidentified purchasers (the Belridge EIR). Then respondent's EIR "tiered" on the Monterey Agreement EIR and the Belridge EIR.

Appellant unsuccessfully petitioned the trial court in the present case for a writ of mandate compelling respondent to set aside the certification of respondent's EIR and approval of this project, on various grounds of alleged failure to comply with CEQA. Appellant appealed the judgment denying its petition for a writ of mandate.

While the present appeal was pending, the Court of Appeal for the Third Appellate District found the Monterey Agreement EIR inadequate and ordered it decertified. (***1376***Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892 [100 Cal.Rptr.2d 173], review den. Dec. 13, 2000, hereafter cited as *PCL*.) We conclude this requires decertifying respondent's tiered EIR.

Factual and Procedural Background

The Monterey Agreement

The SWP was constructed in the 1960's. It is a complex system of reservoirs, dams, power plants, pumping plants, canals, and aqueducts for storage and delivery of water. DWR manages the SWP. DWR has contracts with water contractors to deliver water to the contractors. Each such contract sets forth a maximum annual entitlement. DWR has historically delivered less water than the entitlements. The reliability of delivery is approximately 50 percent of entitlements.

Before the Monterey Agreement, shortfalls in deliveries due to prolonged droughts and other factors led to friction among the contractors over obtaining the available SWP water. Urban and agricultural contractors each believed the other was receiving preferential treatment. This friction was exacerbated by a provision in the SWP contracts that in years when shortfalls occurred, required agricultural contractors to incur the first delivery cutbacks. [FN2] Because contractors pay certain fixed costs to finance the SWP regardless of actual

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deliveries, agricultural contractors suffered severe delivery reductions with little relief from their financial obligations. Litigation was threatened. DWR, agricultural and urban water contractors met and negotiated the Monterey Agreement to avoid litigation and to increase the reliability of supply to all contractors. (*PCL, supra*, 83 Cal.App.4th at pp. 901-902.)

> FN2 Under article 18(a) of then existing contracts, deliveries to agricultural contractors were reduced by 50 percent in any one year or a total of 100 percent in seven consecutive years, before deliveries were reduced to other contractors. (*PCL, supra*, 83 Cal.App.4th at p. 899.)

Under the Monterey Agreement, all future allocations of SWP water are based on entitlements; when supply is insufficient to meet requests, deliveries to all contractors will be reduced in proportion to their entitlements; no longer will agricultural contractors be required to absorb the first reductions. This increases the reliability of supply to agricultural contractors.

Inferably in return, under the Monterey Agreement, agricultural contractors "will make available for permanent transfer to Urban Contractors on a willing buyer-willing seller basis 130,000 acre-feet of annual entitlements, ***1377** with [KCWA] being responsible for any portion of this amount not made available by other Ag Contractors." This will allow urban contractors to obtain additional entitlements, thereby slightly increasing their overall deliveries even in times of shortage.

In addition, the Kern Fan Element, a property acquired by DWR for water banking, will be transferred to agricultural contractors, 45,000 acre-feet of agricultural contractors' entitlements will be retired, and various operational changes will be made to improve efficiency and flexibility of the system.

The Monterey Agreement EIR

The parties to the Monterey Agreement determined that its implementation could have potential environmental consequences and therefore an EIR was required. They designated CCWA, one of the SWP contractors, as lead agency to prepare the Monterey Agreement EIR. CCWA prepared the draft and final EIR's on implementation of the Monterey Agreement in May and October 1995.

The introduction to the draft Monterey Agreement EIR stated it is a "program" EIR. Reiterating the criteria for a program EIR found in Guideline section 15168, it stated: "The purpose of a Program EIR is to document a series of actions so related that they can be characterized as one project. The actions may be related in one or more of the following ways: by geographical proximity; as logical parts in a chain of contemplated actions; in connection with the issuance of rules, regulations, plans, or other general criteria to govern the conduct of a continuing program; or as individual activities carried out under the same authorizing statutory or regulatory authority and having generally similar environmental effects that can be mitigated in similar ways. The proposal to implement the Monterey Agreement fulfills both the second and third criteria above, i.e., logical parts in a chain of contemplated actions, and a series of actions related to the issuance of rules, regulations, plans, and other general criteria to govern the conduct of a continuing program." Again reiterating matter in Guideline 15168, it stated the advantages of a program EIR are that it may: "provide an occasion for a more exhaustive consideration of effects and alternatives than would be practical in an EIR on an individual action; ensure consideration of cumulative actions that might be slighted in a case-by-case analysis; avoid duplicative reconsideration of basic policy considerations; allow the Lead Agency to consider broad policy alternatives and program-wide mitigation measures at an early time when the agency has greater flexibility to deal with basic problems or cumulative impacts; and allow reduction in paperwork." ***1378**

The Monterey Agreement EIR identified five major components of the Monterey Agreement with potential environmental effects: (1) revision of the methodology used to allocate water among contractors, (2) retirement of 45,000 acre-feet of agricultural entitlement, (3) transfer by sale between willing sellers and willing buyers of 130,000 acre-feet of entitlements from agricultural to urban contractors, (4) changes in the Kern Fan Element of the Kern Water Bank, and (5) changes in the manner Castaic Lake and Lake Perris terminal reservoirs may be operated. In general, the Monterey Agreement EIR determined the environmental effects that were capable of quantification at that time were negligible.

With regard to the change in the method of allocating entitlements, it summarized, "Changes in the method of allocating water become relevant only in years

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when demand exceeds available supply. During such years, following enactment of the principles contained in the Monterey Agreement, shortages will be shared proportionately by all contractors rather than be borne primarily by Agricultural Contractors as is the current practice. Thus, during future deficit years Agricultural Contractors can anticipate larger deliveries of water and Urban Contractors can expect smaller quantities of water than would have been the case in the past. These changes bring about a decrease in the variability of supplies delivered to Agricultural Contractors while increasing slightly that for the Urban Contractors. [¶] Added reliability of deliveries to Agricultural Contractors could increase the continuity of agricultural activities in these service areas. Added variability of water deliveries to Urban Contractors can, however, be offset by their acquisition of additional entitlement offered for sale by Agricultural Contractors as outlined below, and through other measures included in the program for increased water management flexibility."

With regard to the transfers of entitlements, it summarized: "The transfer of 130,000 AF of water entitlement from Agricultural Contractors to Urban Contractors and non-SWP Contractors has the potential to affect activities and land use patterns in those jurisdictions both relinquishing and acquiring the entitlement. Effects in those areas relinquishing water entitlement are likely to be centered on agricultural practices while those in areas acquiring water entitlement may relate to growth accommodation. The location of the eventual sellers and buyers of water entitlements is not known at this time." "SWP operations would not be adversely affected by the shift in deliveries among Contractors."

Belridge EIR

In contemplation of the transfer of up to 130,000 acre-feet of SWP entitlements from KCWA pursuant to the Monterey Agreement, the Belridge ***1379** Water Storage District as lead agency prepared a draft and final EIR in April and June of 1998 evaluating the effects in Kern County of such transfers. It evaluated the effects on the Belridge Water Storage District, the Lost Hills Water District, and the WRMWSD (all member districts of KCWA) of their transfer of SWP entitlements to yet undetermined purchasers.

The Belridge EIR repeatedly described the project being studied as a transfer of up to 130,000 acre-feet of entitlements *under the Monterey Agreement.* It stated: "The entitlement transfer would occur under the Monterey Agreement.... The benefits and impacts of the Monterey Agreement were evaluated in a separate environmental impact report [the Monterey Agreement EIR] which is discussed below and incorporated into this report by reference. However, to understand the potential benefits and impacts of the entitlement transfer, conditions that existed prior to the Monterey Agreement and after the Monterey Agreement are discussed."

The Belridge EIR then summarized how deliveries of SWP water differ before and after the Monterey Agreement. It also summarized in detail the Monterey Agreement EIR, which it incorporated by reference.

The Belridge EIR repeatedly stressed that under the changes made by the Monterey Agreement in allocating water during periods of shortage, agricultural contractors would not disproportionately suffer reduced deliveries, and therefore would enjoy increased reliability of deliveries even in times of shortage.

These assumptions enabled the Belridge EIR to conclude that the transfer of up to 130,000 acre-feet of entitlements from the member districts would not adversely affect at all the irrigated agricultural lands therein, because relinquishment of the entitlements would be compensated, on an average annual basis, by the increased reliability of SWP deliveries pursuant to the Monterey Agreement.

Respondent's EIR

The EIR in dispute in the present case is the EIR prepared by respondent in February 1999 on the proposed transfer to respondent of 41,000 acre-feet per year of SWP entitlement from KCWA and its member district WRMWSD.

The introduction section of respondent's EIR expressly stated, "*This EIR is a Project EIR that tiers from*" (1) a prior 1988 EIR by respondent, "Capital Program and Water Plan Including Acquisition of Supplemental Water and ***1380** of a Proposed Second Plant Site", (2) the Monterey Agreement EIR, and (3) the Belridge EIR. It stated the proposed transfer "is an example of the individual projects envisioned in the Monterey Agreement and evaluated on a programmatic basis in the Monterey Agreement

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EIR."

This introduction stated that "As a result of the recently adopted Monterey Agreement, [respondent] has the opportunity to purchase additional SWP entitlement beyond its current entitlement. The opportunity to acquire additional entitlement under the terms of the Monterey Agreement disappears when the subject entitlement (130,000 AFY) is transferred to [respondent] or other entities. A summary of the Monterey Agreement is presented below, and a more complete discussion of the SWP is included in the Monterey Agreement FEIR." A separate section of the introduction described "the Monterey Agreement/Amendment and its anticipated effect on historic water deliveries." After summarizing the major provisions of the Monterey Agreement, it concluded, "The Monterey Agreement has three primary objectives: (1) to increase the reliability of all SWP Contractors' water supplies; (2) to stabilize the rate structure to improve the financial viability of the SWP; and (3) to increase water management flexibility for all SWP Contractors. A permanent transfer of agricultural entitlement to an area with urban development potential such as that analyzed in this document is one of the ways that these objectives are intended to be met."

Respondent's EIR also discussed the Belridge EIR. It stated, "An independent EIR evaluating the environmental impacts of the sale of SWP entitlement within Kern County was completed by Belridge Water Storage District in June 1998. Issues identified in that EIR are not evaluated further in this EIR. Appropriate sections of the Belridge EIR ... are incorporated herein." It added that the proposed transfer would not significantly decrease water deliveries or irrigated acreage within KCWA or WRMWSD because, with implementation of the Monterey Agreement, "SWP deliveries to agricultural users will not be subject to absorbing the initial deficiencies during droughts and other unreliable delivery scenarios." The project description section acknowledged that this proposed transfer, "assuming it proceeds under the Monterey Agreement, will fulfill part of [KCWA's] commitment [under the Monterey Agreement to transfer up to 130,000 acre feet of entitlements to urban contractors]."

A commenter on respondent's draft EIR, Santa Clarita Organization for Planning the Environment, commented that the draft EIR was deficient in failing to analyze impacts on land in Kern County or on Castaic Lake as a terminal reservoir of the SWP. Respondent responded that those impacts had ***1381** already been evaluated in the Belridge EIR and the Monterey Agreement EIR and therefore were not required to be addressed in respondent's EIR.

Despite these numerous references relying on the Monterey Agreement and the Monterey Agreement EIR, respondent's EIR also asserted the proposed transfer of SWP entitlements could take place without the Monterey Agreement, under pre-Monterey Agreement contract law, with the consent of all parties and DWR. It acknowledged that the Monterey Agreement EIR was challenged in the *PCL* case, had been upheld by the Sacramento Superior Court, but was still challenged in the appeal then pending.

A comment from the Environmental Defense Center on the proposed final EIR complained that the EIR expressly tiers on the Monterey Agreement EIR, the status of which was questionable because it was in litigation in the Court of Appeal for the Third Appellate District; it also asserted the Belridge EIR was inappropriate for tiering. Respondent's consultant replied, "The proposed FEIR identifies that the proposed project may proceed either under the provisions of the Monterey Agreement or under the terms of the Kern County Water Agency Contract before it was modified by the Monterey Amendment .... The proposed final EIR identified the referenced litigation and Superior Court ruling .... [¶] The EIR does not tier from the Belridge ... EIR but incorporates appropriate sections by reference.... The inclusion of the reference to the Belridge 1998 EIR [as having been tiered on, as distinguished from having been incorporated by reference] is an error."

On the present appeal respondent admits that its EIR tiers on the Monterey Agreement EIR. Respondent states its EIR incorporates by reference the Belridge EIR.

Trial Proceedings in the Present Case

Appellant Friends of Santa Clara River filed a petition for a writ of mandate compelling respondent to set aside respondent's certification of its EIR and approval of the project, primarily on the ground respondent failed to comply with CEQA. Appellant alleged various defects in the EIR and respondent's findings. The alleged defects did not involve the Monterey Agreement EIR or the then pending *PCL* appeal. The trial court denied appellant's petition, finding that the EIR was adequate and that appellant's

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other contentions lacked merit. Appellant appealed from the judgment denying the petition. ***1382**

The PCL Case

In September 2000, after the trial court's judgment in the present case, the Court of Appeal for the Third Appellate District held the Monterey Agreement EIR prepared by CCWA was inadequate. (*PCL, supra*, 83 Cal.App.4th 892.) The Court of Appeal found two major defects. (1) The DWR, not CCWA, should have prepared the report as the lead agency; DWR has a statewide perspective and expertise on how allocation of water to another part of the state has implications for distribution throughout the system. (83 Cal.App.4th at pp. 903-907.) (2) The EIR did not adequately address the alternative of "no project"; it should have addressed the environmental implications of invoking article 18(b) of existing contracts, under which entitlements would be permanently reduced to reflect actual delivery patterns. (83 Cal.App.4th at pp. 908-920.) The court commented, "Perhaps the deficiencies in the EIR relate to the provincial experience of the lead agency, a topic we addressed earlier. We conclude the EIR failed to meet the most important purpose of CEQA, to fully inform the decision makers and the public of the environmental impacts of the choices before them. A new EIR must, therefore, be drafted. [¶] In view of our earlier conclusion that DWR must serve as lead agency under CEQA, we need not, as we ordinarily would, address the other alleged deficiencies in this EIR. (Pub. Resources Code, § 21005, subd. (c).) We need not hypothesize on the remaining issues because DWR, with its expertise on the statewide impacts of water transfers, may choose to address those issues in a completely different and more comprehensive manner." (83 Cal.App.4th at p. 920.)

The Court of Appeal reversed the judgment of the Sacramento Superior Court and remanded with directions to "issue a writ of mandate vacating the certification of the EIR," to "consider such orders it deems appropriate under Public Resources Code section 21168.9, subdivision (a)" and to "retain jurisdiction over this action until DWR certifies an EIR in accordance with CEQA standards and procedures that meets the substantive requirements of CEQA." (*PCL, supra*, 83 Cal.App.4th at p. 926.) It noted, "We earlier declined to stay implementation of the Monterey amendments and transfer of the Kern Fan Element. Consequently, the project was permitted to proceed pending disposition of this appeal. The record does not reflect the current status of the project and, in the absence of such information, we shall issue no orders concerning further implementation of the project. The trial court, acting under the authority provided by Public Resources Code section 21168.9, is the more appropriate forum to consider and rule upon requests to enjoin all or portions of the project pending completion of administrative and judicial proceedings necessitated by our opinion." (*Id.* at p. 926, fn. 16.) ***1383**

Expanded Issue on This Appeal

(1a) In its appellant's opening brief on the present appeal, appellant reasserted various arguments that appellant had unsuccessfully raised below concerning respondent's EIR and findings. Appellant's opening brief added, cursorily, that the decision in the *PCL* appeal, during pendency of this appeal, "completely shattered" respondent's EIR that was tiered on the EIR decertified in the *PCL* decision. Appellant more fully developed this argument in its appellant's reply brief. We requested and received supplemental briefs from the parties on this issue.

Legal Background: Tiering of EIR's

(2) Tiering "means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report." (§ 21068.5; Guidelines, § § 15152, 15385.)

Tiering is favored by the Legislature to streamline the regulatory process and avoid wasteful duplication of effort. (*Stanislaus Natural Heritage Project v. County of Stanislaus* (1996) 48 Cal.App.4th 182, 197-198 [55 Cal.Rptr.2d 625]; § § 21093, 21094; Guideline, § 15152, subd. (b).) "To achieve this purpose, environmental impact reports shall be tiered whenever feasible, as determined by the lead agency." (§ 21093, subd. (b).) "Where a prior environmental impact report has been prepared *and certified* for a program, plan, policy, or ordinance, the lead agency for a later project that meets the requirements of this section shall examine significant

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effects of the later project upon the environment by using a tiered environmental impact report ....” (§ 21094, subd. (a), italics added.) “All public agencies which propose to carry out or approve the later project may utilize the prior environmental impact report and the environmental impact report on the later project to fulfill the requirements of Section 21081 [which concerns findings necessary in order to approve a project if significant environmental effects have been identified]. [¶] When tiering is used pursuant to this section, an environmental impact report prepared for a later project shall refer to the prior environmental impact report and state where a copy of the prior environmental impact report may be examined.” (§ 21094, subds. (d), (e).) “The later EIR ... should state that the lead agency is using the tiering ***1384** concept and that it is being tiered with the earlier EIR.” (Guideline, § 15152, subd. (g).)

Discussion

(1b) Respondent's EIR expressly tiered on the Monterey Agreement EIR. Section 21094, subdivision (a) authorizes tiering where the previous EIR was certified. As a result of the *PCL* decision, the Monterey Agreement EIR is no longer certified. Respondent's EIR therefore has a defect. The question presented for us is whether that error was prejudicial. (§ 21005, subd. (b).)

Respondent contends that although its EIR tiered on the Monterey Agreement EIR, it did not expressly or specifically incorporate any substantive analysis from specific portions of the Monterey Agreement EIR. But respondent's reliance on the Monterey Agreement EIR is implicit in the concept of tiering, even without express reference to portions of the prior EIR's analysis. The express statement that respondent's EIR tiers on the prior EIR may be treated as an admission that respondent relied upon and needed to rely upon the Monterey Agreement EIR. (Guideline, § 15152, subd. (g).)

Aside from a few cursory statements that the present transfer could legally be accomplished under pre-Monterey Agreement contracts, a point we discuss later, respondent's EIR repeatedly referenced this project's part of the overall scheme envisioned by the Monterey Agreement. It stated this EIR was a project EIR tiered on the Monterey Agreement EIR, and that the project may be viewed as one of the projects “evaluated on a programmatic basis in the Monterey Agreement EIR.”

Respondent's EIR also expressly tiered on, or at least expressly incorporated and relied upon, the analysis in the Belridge EIR. Respondent's EIR acknowledged that the transfer would not affect irrigated lands in Kern County because of the increased reliability of deliveries to agricultural contractors under the Monterey Agreement, and that the present transfer would fulfill part of KCWA's commitment in the Monterey Agreement. The Belridge EIR, on which respondent relied, repeatedly stated that the potential transfers of up to 130,000 acre-feet would be made pursuant to the Monterey Agreement and would have no significant effect on the irrigated lands, due to the increased reliability of deliveries under the Monterey Agreement. Respondent's reliance on the Belridge EIR illustrates respondent's implied acknowledgement that the transfer in this case is part of an overall larger scheme, analyzed on a programmatic basis in the Monterey Agreement EIR. The *PCL* decision also emphasizes the importance of the statewide perspective in analyzing the implications of water entitlement transfers for the state ***1385** and SWP as a whole. We therefore find unpersuasive respondent's present argument that respondent did not rely on the Monterey Agreement EIR.

At oral argument respondent offered a variant of this contention. According to respondent: “the project” being analyzed in respondent's EIR was only the transfer of 41,000 acre-feet of entitlements from WRMWSD to respondent; respondent was only required, therefore, to analyze the environmental effects of that narrow project; respondent adequately evaluated the local environmental effects of the subject transfer; respondent was not *required* to analyze the effects of the transfer on irrigated lands in Kern County or on the SWP upstream from Kern County, and to any extent respondent relied on the Belridge EIR and Monterey Agreement EIR to do so, this was surplusage; therefore the tiering on the Monterey Agreement EIR was harmless and does not require setting aside respondent's EIR that was otherwise adequate, viewed as a stand-alone document evaluating the local environmental impacts of this specific project. Appellant answers that respondent was required to review “the whole of the project.” (Guideline, § 15378, subd. (a) [“ 'Project' means the whole of an action.”].)

Respondent's argument is not persuasive. The purpose of an EIR is to inform the public and the decision makers of the environmental effects of a project. Implicit in respondent's argument is an innuendo the public and decision makers in

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respondent's service area do not care about the upstream effects of this project. But in any event, this case does not squarely present that issue. This is not a case where (1) respondent neglectfully failed or deliberately refused to evaluate "upstream" environmental effects and (2) appellant challenged such an EIR as inadequate based on its failure to review upstream effects. Rather, respondent's EIR assumed the public and decision makers would want to know (1) that this project implements the Monterey Agreement, the environmental effects of which were analyzed in the Monterey Agreement EIR and found to be negligible, and (2) that the environmental effects in Kern County were studied in the Belridge EIR and found to be insignificant because of the increased reliability of water deliveries to agricultural contractors under the Monterey Agreement. The *PCL* decision undermined those premises by decertifying the Monterey Agreement EIR.

Respondent next contends the tiering on the Monterey Agreement EIR was not crucial because respondent and KCWA could legally have accomplished the transfer of entitlements under SWP contract law existing prior to the Monterey Agreement. Respondent cites the following portions of its EIR: section 1.3 of the introduction stated, "The SWP entitlement transfer analyzed in this document may proceed either under the provisions of the ***1386** Monterey Amendment [FN3] to KCWA water supply agreement with the DWR (Contract), or under the provisions of KCWA's Contract before it was modified by the Monterey Amendment," and again, "The entitlement transfer that is the subject of this EIR is of the type that falls within the provisions of the Monterey Amendment. However, this water transfer could occur without the Monterey Amendment with the consent of all affected parties." The project description section included, "This water transfer is expected to be subject to the conditions of the Monterey Amendment, but is not necessarily dependent upon the Monterey Amendment. With the cooperation of the participating agencies and the California Department of Water Resources (DWR), the transfer could occur in the absence of the Monterey Amendment." Finally, in response to comments from the Environmental Defense Center that tiering on the Monterey Agreement EIR was questionable in light of the *PCL* litigation, respondent's consultant stated, "The proposed FEIR identifies that the proposed project may proceed either under the provisions of the Monterey Agreement or under the terms of the Kern County Water Agency Contract before it was modified by the Monterey Amendment."

> FN3 By the Monterey "Amendment" respondent's EIR meant amendment of the SWP contracts between DWR and the approving contractors, to implement the principles of the Monterey Agreement.

These assertions are based on article 41, a standard provision of state water contracts, stating that "No assignment or transfer of this contract or any part hereof, rights hereunder, or interest herein by the Agency shall be valid unless and until it is approved by the State and made subject to such reasonable terms and conditions as the State may impose."

Respondent's argument is based on a straw man. The issue in this case is not the legal authority of KCWA to sell and of respondent to buy SWP water entitlements, but rather the adequacy of the evaluation of the environmental effects of doing so. The Belridge EIR evaluated those effects in Kern County pursuant to the Monterey Agreement, concluding that selling the entitlements would not have an effect on irrigated lands because, on average, it would be compensated by the increased reliability of deliveries to agricultural contractors under the Monterey Agreement. Neither the Monterey Agreement EIR, nor the Belridge EIR, nor respondent's EIR evaluated the environmental effects on the seller's irrigated lands of selling the entitlements under pre-Monterey-Agreement conditions, with agricultural contractors subject to the first and severest reductions in times of shortage.

Respondent contends this shortcoming is alleviated by the inclusion of discussions in the Belridge EIR and respondent's EIR of a "no project ***1387** alternative." This is incorrect. The no project alternative in the Belridge EIR was: not selling the entitlements. The no project alternative in respondent's EIR was: not buying the entitlements. Neither addressed the environmental effects of transferring the entitlements without the protections for agricultural contractors in the Monterey Agreement.

We conclude respondent's tiering on the now decertified Monterey Agreement EIR was prejudicial error. The judgment must be reversed because the certification of respondent's EIR must be vacated, based on the *PCL*/tiering problem. The question arises whether we should address the *other* alleged defects that were litigated below and raised in

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appellant's opening brief. We asked the parties to address whether these issues were moot if the judgment were reversed based on the *PCL*/tiering problem. Both parties remind us of section 21005, subdivision (c), which provides, "It is further the intent of the Legislature that any court, which finds, or, in the process of reviewing a previous court finding, finds, that a public agency has taken an action without compliance with this division, shall specifically address each of the alleged grounds for noncompliance." A treatise states, "This language, which courts may not treat as mandatory, is apparently intended to avoid situations in which a court, presented with numerous theories as to why a respondent agency purportedly violated CEQA, chooses to issue a writ based solely on one or a handful of theories, leaving the parties to wonder whether or not the unaddressed theories had merit. In such situations, where the respondent agency must conduct a second CEQA process to cure the problems identified by the court, the agency often does not know whether to modify its environmental document (or findings) to address concerns raised by the petitioners but ignored by the court." (Remy et al., Guide to the California Environmental Quality Act (10th ed. 1999) Judicial Review, pp. 646-647.)

Section 21005, subdivision (c) thus requires only that *if we find* other respects in which the EIR was defective we should describe them for the guidance of the parties. We have examined all of appellant's other contentions and find them to be *without merit.* If the *PCL*/tiering problem had not arisen, we would have affirmed the judgment. Section 21005, subdivision (c) does not require us to lengthen this opinion by addressing in detail why we *reject* appellant's other contentions. Appellant's supplemental reply brief so concedes: "The court's discussion of all aspects of CEQA noncompliance is respectfully requested, while areas of compliance are not required to be addressed."

This suggests that respondent may be able to cure the *PCL* problem by awaiting action by the DWR complying with the *PCL* decision, then issuing ***1388** a subsequent EIR, supplement to EIR, or addendum to EIR (Guidelines, § § 15162, 15163, 15164) tiering upon a newly certified Monterey Agreement EIR. Appellant itself so suggests.

Like the court in *PCL, supra,* 83 Cal.App.4th at page 926 and footnote 16, we leave to the trial court's discretion whether to enjoin all or portions of respondent's project pending completion of an adequate EIR. The trial court is in a better position than this court to determine factually the current status of the *PCL* litigation or of a new Monterey Agreement EIR.

Disposition

The judgment is reversed. The trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, and shall consider such orders it deems appropriate under section 21168.9. The parties shall bear their own costs on appeal.

Hastings, J., and Curry, J., concurred.
Respondent's petition for review by the Supreme Court was denied April 17, 2002. Baxter, J., was of the opinion that the petition should be granted. ***1389**

Cal.App.2.Dist.
Friends of Santa Clara River v. Castaic Lake Water Agency
95 Cal.App.4th 1373, 116 Cal.Rptr.2d 54, 02 Cal. Daily Op. Serv. 1246, 2002 Daily Journal D.A.R. 1477

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Los Angeles County Supreme Court, "Judgement Granting Preemptory Writ of Mandate, *Friends of the Santa Clara River v. Castaic Lake Water Agency*, Case No. BS056954" (October 25, 2002)

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SUPERIOR COURT OF THE STATE OF CALIFORNIA
IN AND FOR THE COUNTY OF LOS ANGELES

FRIENDS OF THE SANTA CLARA RIVER,

Petitioner,

v.

CASTAIC LAKE WATER AGENCY,

Respondent.

Case No. BS 056954

JUDGMENT GRANTING PEREMPTORY WRIT OF MANDATE

On Remand from the Court of Appeal

The hearing on the merits of the petition for writ of mandate was held on June 12, 2000, before the Honorable David P. Yaffe. Petitioner Friends of the Santa Clara River (Friends) was represented by attorney Susan Brandt-Hawley and respondent Castaic Lake Water Agency (CLWA) was represented by attorneys Robert H. Clark and R. Bruce Tepper. The court considered the briefs filed by the parties, the arguments of counsel, and the administrative record of proceedings, and took the case under submission.

On August 16, 2000, judgment was entered denying the petition in its entirety. An appeal was timely filed on October 16, 2000. The Fourth Division of the Second District Court of Appeal issued a slip opinion in Civil Case Number 145283 on January 10, 2002, and at the request of the National Audubon Society and the American Planning Association certified the opinion for publication on February 6, 2002. (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373.) The Court of Appeal reversed the judgment and ordered that "the trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, and shall consider such orders it deems appropriate under [Public Resources Code] section 21168.9."

CLWA filed a petition for review with the California Supreme Court on February 19, 2002, in Case Number S 104550, which was summarily denied on April 17, 2002. The remittitur issued from the Court of Appeal on May 3, 2002.

On September 24, 2002, at 9:30 a.m., the parties' proposed forms of judgment and writ on remand were considered by the Honorable David P. Yaffe. Friends was represented by attorney Susan Brandt-Hawley and CLWA was represented by attorneys Robert H. Clark and R. Bruce Tepper. The court considered the briefs filed by the parties and the arguments of counsel, and,

WHEREFORE, GOOD CAUSE APPEARING,

Susan Brandt-Hawley 707-576-0175 Oct 14 02 02:32p p.3

IT IS ORDERED THAT THE TENTATIVE RULING IS ADOPTED:

1. The judgment of this court denying the petition for writ of mandate, signed and filed on August 16, 2000, is vacated.

2. A peremptory writ of mandate shall issue ordering respondent Castaic Lake Water Agency to set aside its certification, made on March 29, 1999, of the Final Environmental Impact Report published in February 1999.

3. The Court retains jurisdiction until respondent Castaic Lake Water Agency certifies an Environmental Impact Report that complies with the California Environmental Quality Act and is consistent with the views expressed by the Court of Appeal Opinion filed January 10, 2002, Case No. B145283.

4. The Court finds that petitioner is the prevailing party in this proceeding.

5. The Court is informed that petitioner and respondent have fully and finally settled the outstanding issue of petitioner's claim for attorney fees and costs incurred in this action to date both in this Court and in the Court of Appeal, pursuant to CCP § 1021.5 and on all other bases whatsoever, for the compromise sum of $215,000.00, and the Court accepts said settlement.

6. Petitioner requests that the Court also prohibit respondent from using any of the 41,000 acre feet of additional water allotted to it from the subject State Water Project. Petitioner contends that the said water will be used to approve new development that will not be able to be reversed if a Final Environmental Impact Report is not certified. Respondent contends that such a prohibition would prevent it from meeting the existing water needs in the area it services. Both contentions appear to be speculative at this time. Respondent will not be prohibited from using the water to which it is entitled, but petitioner may renew its application for such prohibition based upon evidence of the actual use of such additional water for purposes it considers improper.

Approved as to form:

Date: October 7, 2002

Susan Brandt-Hawley
Attorney for Petitioner

Approved as to form:

Date: October 8, 2002

Robert H. Clark
Attorney for Respondent

IT IS SO ORDERED.

Date: OCT 25 2002

David P. Yaffe
Honorable David P. Yaffe
Judge of the Superior Court

Nov 14 02 02:33p Susan Brandt-Hawley 707-576-0175 p.5

Memorandum of Understanding Between the Santa Clara River Valley Upper Basin Water Purveyors and United Water Conservation District, August 2001

MEMORANDUM OF UNDERSTANDING
BETWEEN THE
SANTA CLARA RIVER VALLEY
UPPER BASIN WATER PURVEYORS
AND
UNITED WATER CONSERVATION DISTRICT

AUGUST 2001

COPY

Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation**. The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights**. Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By _____
General Manager

Castaic Lake Water Agency

By _____
General Manager

Newhall County Water District

By _____
General Manager

Valencia Water Company

By _____
President

Santa Clarita Water Company

By _____
President

Los Angeles County Waterworks District No. 36

By _____
County of Los Angeles

United Water Conservation District Boundary

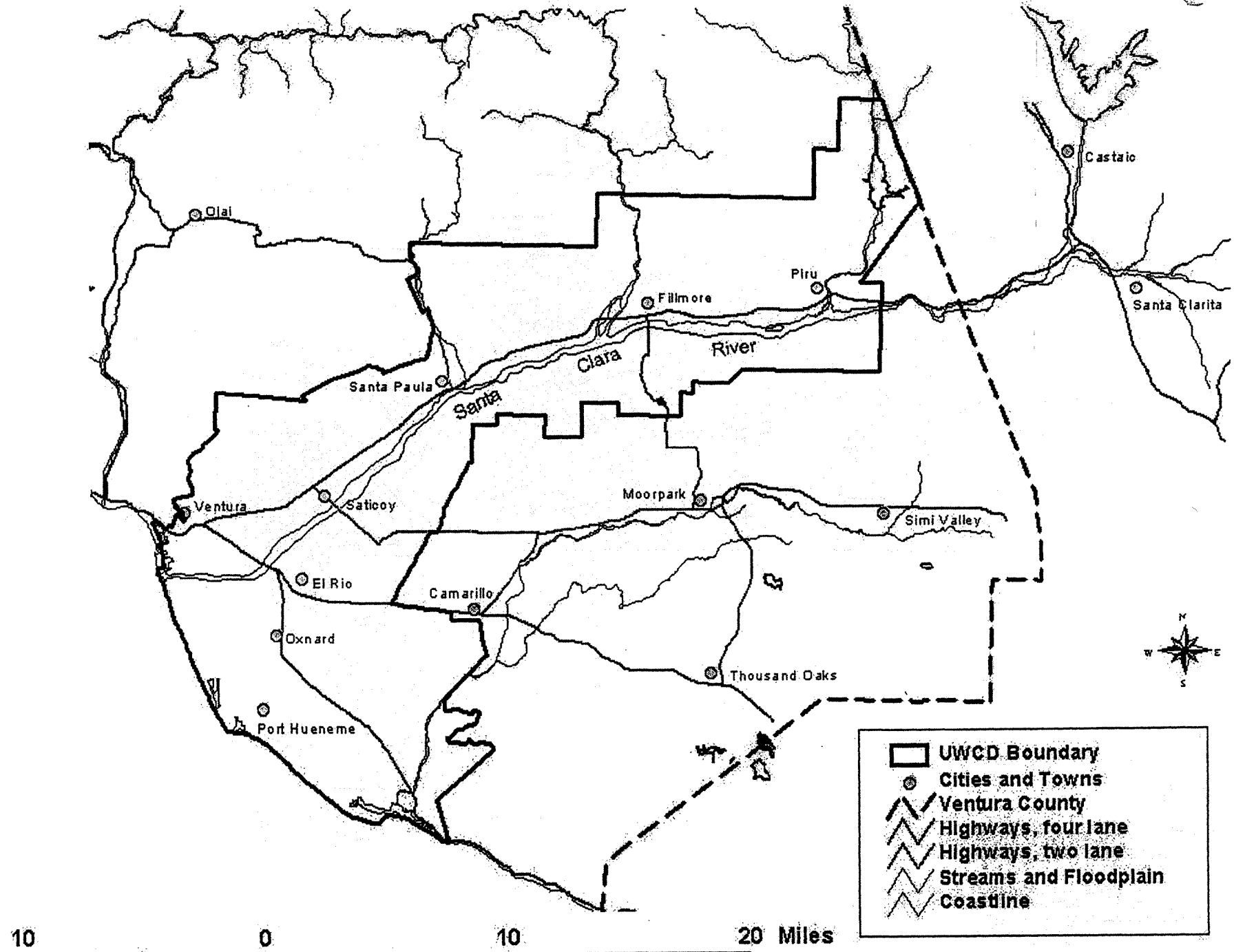
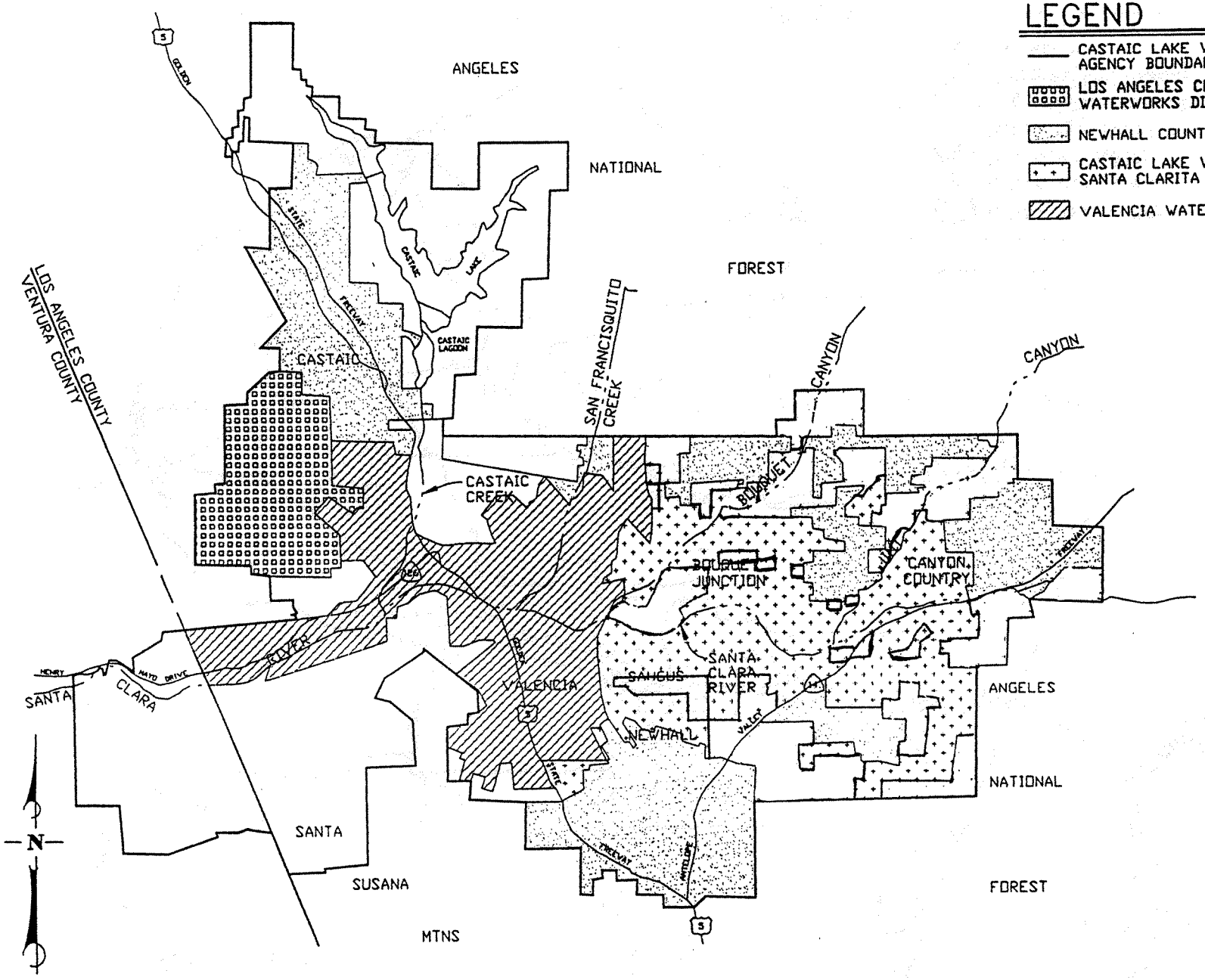


Figure 1-1



FIGUI 1-2

CLWA AND WATER PURVEYOR SERVICE AREAS

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the

area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the

gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is

available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

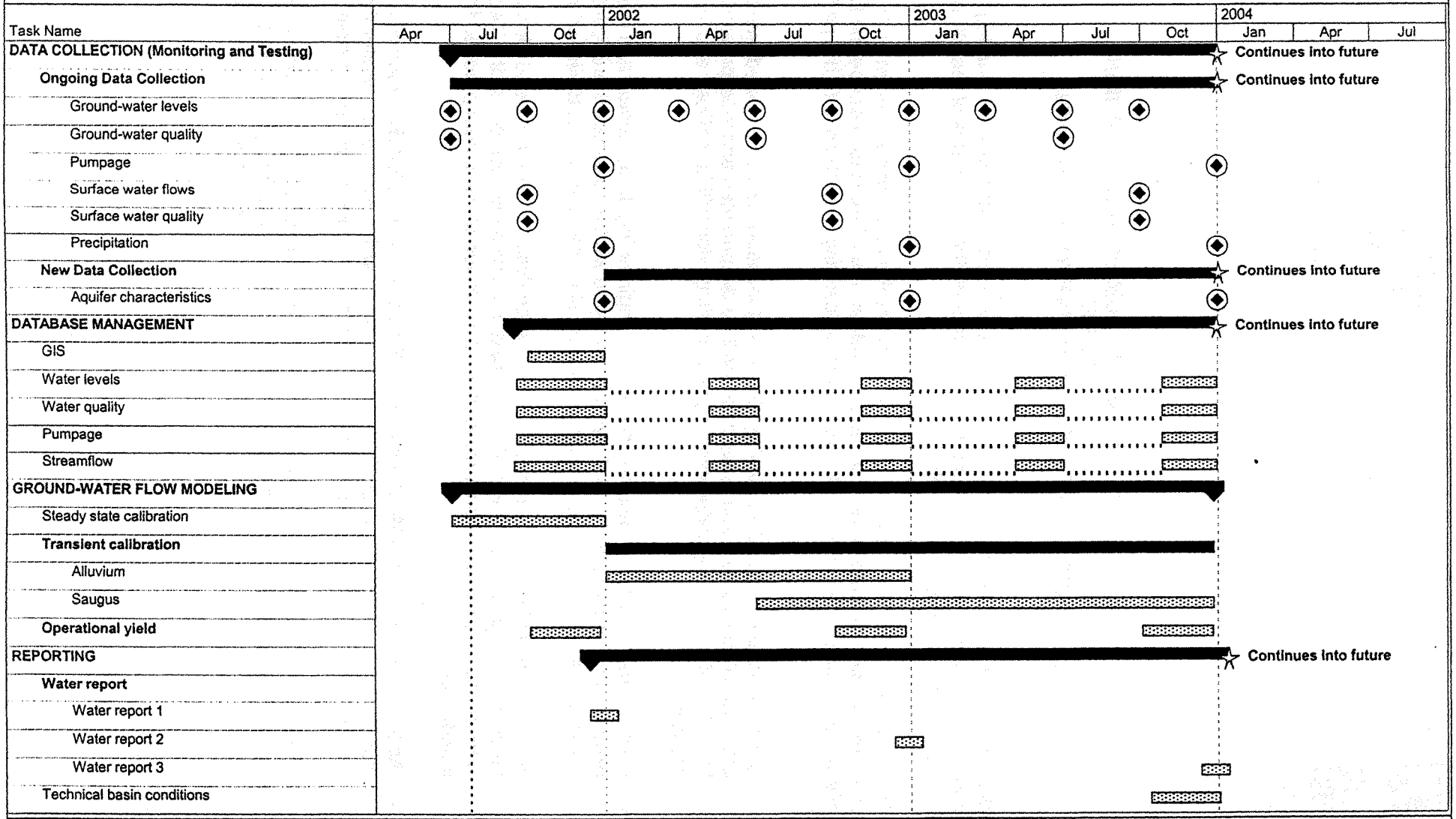
REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as

well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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NCWD

NEWHALL COUNTY WATER DISTRICT
23780 North Pine Street • P.O. Box 220970 • Santa Clarita, CA 91322-0970
(661) 259-3610 Phone • (661) 259-9673 Fax • email: mail@ncwd.org

Directors: RANDALL D. PFIESTER, *President* VALERIE THOMAS, *Vice President* BARBARA DORE LYNNE A. PLAMBECK DICK A. UNGER

ATTACHMENT TO MEMORANDUM OF UNDERSTANDING BETWEEN UPPER BASIN WATER PURVEYORS AND UWCD

NEWHALL COUNTY WATER DISTRICT strongly supports a cooperative working relationship and establishment of a joint monitoring program among the signatories of the attached Memorandum of Understanding (MOU).

This attachment shall not be construed to alter either the terms of agreement or the proposed activities that are the substance of the MOU. Rather, the intent is to describe the District's interpretation of the document and to convey their resulting expectations to the parties to the MOU.

- Subcommittee membership, meeting times, and locations will be finalized within six months. Subcommittee structure and organization will be documented and incorporated into the MOU by reference. Opportunities for public participation will be defined and included in the process.

- Cost estimates, activity plans and schedules, engineering data, models and modeling results, actual expenditures, and reports generated will be considered public information and made available under the terms and conditions of current law and established policies.

- Neutral technical expertise to ensure objective analyses and recommendations will be provided through inclusion of a USGS "expert" as a working member of the Technical Committee. Conclusions, proposals, and extrapolation of data must proceed from a credible foundation.

- As the provisions of the MOU are fulfilled, the parties will undertake regional water planning efforts to protect and enhance the water resources within the region. Water Code Sections 10750 through 10795 describe activities that may be included, where feasible.

- The Upper Basin Water Purveyors recognize the importance of the alluvial aquifer as a source of water supply for the residents of the Santa Clarita Valley, and will cooperatively encourage replenishment projects, particularly in the eastern reaches of the Santa Clara River.

August 16, 2001

California Court of Appeal, Second District, Division Four, "*Friends of the Santa Clara River v. Castaic Lake Water Agency*, Appellate No. B164027" (December 1, 2003)

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

California Rules of Court, rule 977(a), prohibits courts and parties from citing or relying on opinions not certified for publication or ordered published, except as specified by rule 977(b). This opinion has not been certified for publication or ordered published for purposes of rule 977.

IN THE COURT OF APPEAL OF THE STATE OF CALIFORNIA

SECOND APPELLATE DISTRICT

DIVISION FOUR

FRIENDS OF THE SANTA CLARA RIVER, Plaintiff and Appellant, v. CASTAIC LAKE WATER AGENCY, Defendant and Respondent.	B164027 (Los Angeles County Super. Ct. No. BS056954)

COURT OF APPEAL - SECOND DIST.
FILED
DEC 01 2003
JOSEPH A. LANE Clerk
Deputy Clerk

APPEAL from a judgment of the Superior Court of Los Angeles County, David P. Yaffe, Judge. Affirmed.

Law Office of Alyse M. Lazar and Alyse M. Lazar for Plaintiff and Appellant.

Rossmann and Moore, Antonio Rossmann and Roger B. Moore for Amici Curiae Planning and Conservation League and Citizens Planning Association of Santa Barbara County, Inc., in support of Plaintiff and Appellant.

Horvitz & Levy, Barry R. Levy, William N. Hancock; R. Bruce Tepper; and McCormick, Kidman & Behrens, Russell G. Behrens, H.L. (Mike) McCormick and David D. Boyer for Defendant and Respondent.

INTRODUCTION

This is the second time this case has been before us. On the first appeal we directed the trial court to issue a writ of mandate to set aside certification of respondent Castaic Lake Water Agency's Environmental Impact Report (EIR) because the EIR had been tiered upon a prior EIR that had been found to be infirm by an intervening appellate decision. Upon remand, respondent and appellant Friends of the Santa Clara River agreed a writ of mandate should issue to decertify the EIR but disagreed about whether the trial court should also enjoin the project pending certification of a new EIR. After consideration of documentary evidence and the presentation of written and oral arguments, the trial court rejected appellant's request for an injunction without prejudice to entertaining a renewed request founded on an adequate showing of entitlement to relief. This appeal follows entry of judgment in October 2002.

Appellant attacks the trial court's denial of its request for an injunction on two separate grounds. Appellant first contends the trial court's denial was in derogation of the directions contained in our earlier decision. The contention lacks merit. The clear and unambiguous dispositional language in our opinion granted the trial court the authority to deny in toto the request for an injunction. Appellant next contends the trial court erred on the merits in denying its request. Based upon the record, we find the trial court did not abuse its discretion in implicitly finding

appellant had failed to carry its burden of establishing the predicates for injunctive relief. We therefore affirm the judgment.

FACTUAL AND PROCEDURAL BACKGROUND

Respondent purchased from the Kern County Water Agency entitlement to 41,000 acre-feet per year of water. The purchase followed consummation of the Monterey Agreement which changed the allocation between agricultural and urban contractors of entitlements to State Water Project (SWP) water. Respondent approved this purchase after first certifying an EIR. This EIR was "tiered" upon an earlier EIR approving the Monterey Agreement.[1] The Legislature favors tiering to streamline the regulatory process and to avoid unnecessary duplication of effort.

Appellant filed a petition for a writ of mandate in the superior court to compel respondent to set aside its certification of the EIR for the purchase of 41,000 acre-feet per year of SWP water. Appellant advanced various grounds in support of its petition. The superior court denied the petition. Appellant appealed the adverse judgment to this court.

While that appeal was pending, our colleagues in the Third Appellate District concluded the EIR prepared for the Monterey Agreement was inadequate and therefore ordered it decertified. (*Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, review den. (*PCL*).)

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1 Tiering "means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report." (Pub. Res. Code, § 21068.5.)

We therefore concluded that in the appeal presented to us *PCL* required decertification of respondent's EIR because it had been tiered on the now-decertified EIR for the Monterey Agreement. (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1383-1388, review den. (*Friends I.*) We, however, rejected all of appellant's other challenges to respondent's EIR, finding "them to be *without merit.*" (*Id.* at p. 1387.) We noted: "[R]espondent may be able to cure the *PCL* problem by awaiting action by the [Department of Water Resources] complying with the *PCL* decision, then issuing a subsequent EIR, supplement to EIR, or addendum to EIR [citations] tiering upon a newly certified Monterey Agreement EIR." (*Id.* at pp. 1387-1388.)

In regard to further action in the trial court we wrote: "[W]e leave to the trial court's discretion whether to enjoin all or portions of respondent's project pending completion of an adequate EIR. The trial court is in a better position than this court to determine factually the current status of the *PCL* litigation or of a new Monterey Agreement EIR." (*Id.* at p. 1388.)

The dispositional paragraph of our decision read, in relevant part: "The judgment is reversed. The trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, and shall consider such orders it deems appropriate under [Public Resources Code] section 21168.9." (*Id.* at p. 1388.)

Upon remand, the parties agreed the trial court was required to issue a writ of mandate to decertify respondent's EIR. The bone of contention was whether the trial court should also enjoin respondent from proceeding with the project, e.g., the transferring of the entitlement to the 41,000 acre-feet of water per year, pending completion of the new EIR.

Appellant argued: "To allow [respondent] to use any portion of its unstudied 41,000 afy [acre feet per year] entitlement before the EIR analysis is complete will result in **new permanent water connections** that will not be able to be reversed. Once houses are in and the faucets are on, there is no way to turn back. Without the proven need for this water to serve existing users, there is no equitable justification for allowing the use of any portion of the 41,000 afy entitlement in the face of its clear consistency with CEQA policies against pre-approved projects. A fair EIR process requires that project approval not be up and running as a foregone conclusion."

The evidentiary support for this argument is found in a declaration executed in August 2002 by appellant's counsel. The declaration sought to establish respondent would have sufficient water from other sources to supply its existing customers without use of the entitlement. From these factual allegations, appellant argued any use by respondent of the entitlement would necessarily be for new customers and therefore subject to being enjoined. The declaration referenced several attached documents and included allegations grounded upon information and belief. In pertinent part it averred:

> "I am informed that [respondent] has utilized at most 3674 af [acre feet] of the subject 41,000 afy [acre feet per year] water transfer during the past year. Attached is a true copy of CLWA Production Report for 2000, 2001, and half of 2002, and also a DWR Notice to State Water Project Contractors dated May 2002. The reports speak for themselves, and reflect CLWA's use of State Water Project entitlements to its various purveyors. The allocation of SWP water was 65% in the last year, and *petitioner is informed and believes that CLWA expects an even larger allocation in the coming fiscal year to as much as 90%.* The report shows that water use is measured yearly from June to June. It is undisputed that CLWA has a 54,200 afy entitlement to SWP water that is not under any legal cloud and clearly available for use, aside from the 41,000 afy that is the subject of this litigation. Based on a 65% delivery of SWP water, CLWA's

> allocation of its undisputed 54,200 afy totals 35,230 af. The report reflects use of 38,974 af from June 2001 until June 2002; which appears to be only 3674 af more than can be supplied from the 54,200 afy entitlement. It thus appears that CLWA *may have utilized* 3674 af of its allocation from the subject 41,000 af entitlement in the past year. If the SWP allocations increase to 75% or greater, *as is apparently expected,* by doing the math it appears that the 41,000 af water transfer is not needed for existing customers of the CLWA water purveyors while the supplemental environmental review is pending." (Italics added.)

Appellant therefore sought an order enjoining respondent "from any and all use of the 41,000 afy water transfer under the current approvals."

In addition, appellant's counsel averred she had communicated with counsel in the *PCL* case and that as of August 22, 2002, "the *PCL* case remand has not yet been settled or otherwise resolved, and that the Monterey Agreement Implementation Draft EIR to be prepared by the Department of Water Resources (DWR) as required by the *PCL* decision has not yet been published." As for the status of respondent's EIR, the declaration averred that respondent's attorney had informed her "that the agency has not yet published its Draft Supplemental EIR in response to [the Court of Appeal's decision], but that it intends to prepare the EIR itself rather than await the new DWR Monterey Agreement Implementation EIR."

In opposition, respondent asked the trial court to "**issue an order allowing the Transfer of Entitlement to remain intact pending completion of a new EIR.**" In particular, respondent urged that the entitlement was "necessary to satisfy current existing and projected near-term water demand"; that a "decision to set aside the Transfer of Entitlement would cause immediate irreparable harm to the Agency and the water consumers"; and that the Transfer "has been in effect for more than three years, and there is no evidence that the Transfer has resulted in any new or increased significant adverse environmental effects."

Respondent's opposition was supported by a detailed eight-page declaration from Dan Masnada, respondent's general manager. Masnada averred that respondent had already retained consultants to prepare a new EIR and they planned to complete the process by March 2003. A portion of Masnada's declaration directly refuted the allegations made by appellant's counsel about respondent's projected water supply. In pertinent part, Masnada averred:

> "[Counsel's] declaration states that 'CLWA expects an even larger allocation made by DWR in the coming fiscal year to as much as 90%.' . . . *There is no factual basis for this statement.* There have been no indications that CLWA's SWP allocation made by DWR in the coming year will be anywhere near 90%. To the contrary, based on discussions with DWR Operations Control Office Personnel it is likely that the initial 2003 SWP allocation on December 1, 2002 will be approximately 20%, as it was last year. If dry conditions occur next year, the final SWP allocation for 2003 could remain as low as 20%.
>
> [Counsel's] Declaration also states that the CLWA Production Report 'shows that water use is measured yearly from June to June.' . . . This is incorrect. While annual water use can be measured from July to June, available SWP water supply is characterized on a calendar year basis because DWR allocates it on a calendar year basis. *[Her] accounting of water deliveries i[s] flawed.* She has utilized an approach that understates CLWA's current level of demand and projected deliveries to the retail purveyors during 2002. As discussed above, and shown in Exhibit A, CLWA's Final 2001 SWP allocation was 39%. Without the 41,000 AF in 2001, CLWA would have experienced a shortfall of 14,218 AF."

Appellant's reply to respondent's opposition did not include any additional declaration(s). Instead, its reply asserted respondent's "factual information" was "confusingly presented and misleading" and that a portion of Masnada's opinion about SWP allocations for 2003 was "complete conjecture and speculation."

After a hearing in which the parties presented argument and responded to questions from the bench, the trial court issued a writ of mandate ordering respondent to set aside its certification of the 1999 EIR and to certify a new EIR consistent with our opinion in *Friends I.* The trial court rejected appellant's request to enjoin any use of the water entitlement. It ruled: "Petitioner [appellant herein] requests that the Court also prohibit respondent from using any of the 41,000 acre feet of additional water allotted to it from the subject State Water Project. Petitioner contends that the said water will be used to approve new development that will not be able to be reversed if a Final Environmental Impact Report is not certified. Respondent contends that such a prohibition would prevent it from meeting the existing water needs in the area it services. *Both contentions appear to be speculative at this time. Respondent will not be prohibited from using the water to which it is entitled, but petitioner may renew its application for such prohibition based upon evidence of the actual use of such additional water for purposes it considers improper.*" (Italics added.)

This appeal follows.[2]

DISCUSSION

A. THE DIRECTIVE IN *FRIENDS I*

Appellant first contends the trial court misconstrued our directive in *Friends I.* Appellant's position is that our decision gave the trial court the power

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2 In July 2002, we denied respondent's motion to dismiss the appeal because denial of a *pendente lite* injunction is appealable pursuant to Code of Civil Procedure section 904.1, subdivision (a)(6).

to enjoin either all or part of the project pending certification of a new EIR but that it did not give it the power to decide, as it did in the proceedings it conducted following remand, not to enjoin any part of the project. Appellant relies upon the following language we now italicize from *Friends I*: "Like the court in *PCL, supra,* 83 Cal.App.4th at page 926 and footnote 16, we leave to the trial court's discretion whether to enjoin *all or portions* of respondent's project pending completion of an adequate EIR." (*Friends I, supra,* 95 Cal.App.4th 1373, 1388, italics added.) From that language, appellant argues "the Superior Court was not vested with the discretion to issue no injunction, but only with [the] discretion to issue a full or partial injunction."

Appellant's argument lacks merit because it ignores the clear dispositional language of our opinion which gave the trial court the authority to deny in toto a request for injunctive relief.

"Where a reviewing court has remanded a matter to the trial court with directions '. . . the trial court . . . is bound to specifically carry out the instructions of the reviewing court. . . . [A]ny material variance from the explicit directions of the reviewing court is unauthorized and void.'" (*Coffee-Rich, Inc. v. Fielder* (1975) 48 Cal.App.3d 990, 998.)

The appellate court's directions are determined by "look[ing] first to the dispositional language of the opinion--the language which constitutes the remittitur directions." (*Frankel v. Four Star International, Inc.* (1980) 104 Cal.App.3d 897, 902.) *Only if* the dispositional language is ambiguous and in need of interpretation will that language "be interpreted in light of the reasoning and holdings found in the body of the opinion. [Citations.]" (*Lesny Development Co. v. Kendall* (1985) 164 Cal.App.3d 1010, 1021.)

As set forth earlier, the pertinent portion of the dispositional language in *Friends I* read: "The judgment is reversed. The trial court shall issue a writ of

mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, *and shall consider such orders it deems appropriate under section 21168.9.*" (*Friends I, supra,* 95 Cal.App.4th 1373, 1388, italics added.) The statutory provision referenced--Public Resources Code section 21168.9--is lengthy and set forth in toto below in footnote 3.[3] The definitive

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3 The statute provides:

"(a) If a court finds, as a result of a trial, hearing, or remand from an appellate court, that any determination, finding, or decision of a public agency has been made without compliance with this division, the court shall enter an order that includes one or more of the following:

"(1) A mandate that the determination, finding, or decision be voided by the public agency, in whole or in part.

"(2) If the court finds that a specific project activity or activities will prejudice the consideration or implementation of particular mitigation measures or alternatives to the project, a mandate that the public agency and any real parties in interest suspend any or all specific project activity or activities, pursuant to the determination, finding, or decision, that could result in an adverse change or alteration to the physical environment, until the public agency has taken any actions that may be necessary to bring the determination, finding, or decision into compliance with this division.

"(3) A mandate that the public agency take specific action as may be necessary to bring the determination, finding, or decision into compliance with this division.

"(b) Any order pursuant to subdivision (a) shall include only those mandates which are necessary to achieve compliance with this division and only those specific project activities in noncompliance with this division. The order shall be made by the issuance of a peremptory writ of mandate specifying what action by the public agency is necessary to comply with this division. However, the order shall be limited to that portion of a determination, finding, or decision or the specific project activity or activities found to be in noncompliance only if a court finds that (1) the

(Fn. continued.)

construction of that statute is found in our Supreme Court's opinion in *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376. It concluded that the statute permits but does not require a court to enjoin a project while a new EIR is prepared. (*Id.* at pp. 423-425.) In deciding whether injunctive relief is appropriate, a court is to rely upon "traditional equitable principles." (*Id.* at p. 423.) Given this long-standing construction of section 21168.9,[4] it is clear our dispositional language granted the trial court the option to decline to grant any injunctive relief after it properly considered the pertinent equities. Appellant's argument that the trial court failed to follow our directions by declining to grant equitable relief is therefore without merit.

In any event, appellant engages in a crabbed interpretation of one phrase in our opinion to argue the trial court had no discretion to deny a request for

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> portion or specific project activity or activities are severable, (2) severance will not prejudice complete and full compliance with this division, and (3) the court has not found the remainder of the project to be in noncompliance with this division. The trial court shall retain jurisdiction over the public agency's proceedings by way of a return to the peremptory writ until the court has determined that the public agency has complied with this division.
>
> "(c) Nothing in this section authorizes a court to direct any public agency to exercise its discretion in any particular way. Except as expressly provided in this section, nothing in this section is intended to limit the equitable powers of the court."

4 See also *City of Santee v. County of San Diego* (1989) 214 Cal.App.3d 1438, 1456 ["Section 21168.9, as construed by the Supreme Court in *Laurel Heights,* merely grants a reviewing court the authority to stay all activity or use of a project until an agency certifies a proper EIR; it does not require it to do so. [Citation.] The court in *Laurel Heights* relied upon traditional equitable principles in deciding that injunctive relief there was not appropriate."].

injunctive relief. The sentence in which the phrase is found began with a specific reference to the *PCL* opinion: its dispositional language found at page 926, including footnote 16. That language included the same direction found in our dispositional language: the direction the trial court shall make any such orders it deems appropriate under section 21168.9. Footnote 16 read: "We earlier declined to stay implementation of the Monterey amendments and transfer of the Kern Fan Element. Consequently, the project was permitted to proceed pending disposition of this appeal. The record does not reflect the current status of the project and, in the absence of such information, we shall issue no orders concerning further implementation of the project. The trial court, acting under the authority provided by Public Resources Code section 21168.9, is the more appropriate forum to consider and rule upon requests *to enjoin all or portions of the project pending* the completion of administrative and judicial proceedings necessitated by our opinion." (*PCL, supra,* 83 Cal.App.4th 892, fn. 16 at p. 926, italics added.) Just as the *PCL* court did not intend to limit the trial court's authority by requiring it to enjoin at least a portion of the project, neither did we. We, as did the *PCL* court, were simply describing the types of requests that might be made, e.g., requests for a partial or full injunction. We did not intend to divest the trial court of its power to deny a request for injunctive relief if it either concluded that the moving party had failed to establish the predicates for relief or that, given the equities, relief was not required.

B. DENIAL OF INJUNCTIVE RELIEF

Appellant next contends: "The Superior Court's decision regarding injunctive relief was an abuse of discretion, because there is no factual basis to support the decision." (Bold omitted.) We disagree.

A decision to grant or deny a request for injunctive relief rests within the trial court's discretion. Its order will not be reversed on appeal unless an abuse of discretion is shown. It is, of course, the appellant's burden to establish an abuse of discretion. (*Cohen v. Board of Supervisors* (1985) 40 Cal.3d 277, 286.) "A trial court will be found to have abused its discretion only when it has exceeded the bounds of reason or contravened the uncontradicted evidence. [Citation.]" (*Lubavitch Congregation v. City of Long Beach* (1990) 217 Cal.App.3d 1388, 1391.)

It was appellant's burden as moving party in the trial court to establish the predicates for injunctive relief. In particular, Public Resources Code section 21168.9, subdivision (a)(2) requires the court to first find that a "specific project activity . . . will prejudice the consideration or implementation of particular mitigation measures or alternatives to the project" and that such activities "could result in an adverse change or alteration to the physical environment" before an injunction will issue. The trial court found appellant's claim of irreparable harm--new permanent water connections that will not be able to be reversed--to be speculative. In other words, it concluded appellant had failed to discharge its burden of proof.[5] However, it specifically left open the opportunity for appellant

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5 To a certain extent, appellant relies upon four documents not presented to the trial court to support its contention of abuse of discretion. Three of those documents were prepared after the trial court entered judgment in October 2002. Each document is a portion of a report prepared for respondent. Prior to the submission of briefing, we granted appellant's request to take judicial notice of these documents.

Appellant wants to use this information to show respondent is improperly representing to third parties it is entitled to the 41,000 acre-feet per year of water. Appellant argues this is proof of the irreparable harm it is suffering because the trial court declined to enjoin respondent.

Our prior grant of appellant's motion for judicial notice does not require us to consider these documents. "Although a reviewing court may take judicial notice of

(Fn. continued.)

to renew its claim "based upon evidence of the actual use of such additional water for purposes it considers improper."

Distilled to its essence, appellant's present position is nothing more than an argument the trial court was required to credit the allegations in its counsel's declaration which allegedly supported its request for injunctive relief. That is, appellant would have us find that no reasonable judge could have found its evidentiary showing insufficient. We cannot make that finding.

The evidence on this issue was conflicting. As set forth above, Masnada's declaration directly contradicted some of the allegations made by appellant's counsel. Given the (purported) deficiencies Masnada pointed out in counsel's declaration, the fact that much of counsel's declaration was based upon information and belief, and appellant's failure to file a reply declaration addressing those points with its reply memorandum, the trial court was well within its discretion to conclude that *at that point in time* appellant had failed to make the requisite showing.

Appellant argues such a conclusion is insupportable because the trial court also found respondent's trial court contention to be speculative. Not so. Appellant

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matters not before the trial court, . . . the reviewing court need not give effect to such evidence. 'Having taken judicial notice of such a matter, the reviewing court may or may not apply it in the particular case on appeal. The effect to be given to matters judicially noticed on appeal, where the question has not been raised below, depends on factors that are not evidentiary in character.' [Citation.]" (*Doers v. Golden Gate Bridge etc. Dist.* (1979) 23 Cal.3d 180, 184, fn. 1.)

In this instance, given that (1) these documents essentially constitute "new evidence" in support of appellant's request for injunctive relief and (2) the trial court explicitly anticipated appellant would renew its request before it, we decline to consider the documents on this appeal.

If appellant wishes to renew a request for injunctive relief, it can bring these documents to the trial court's attention.

is conflating two distinct points respondent made in the trial court. First, based upon a claim of irreparable harm, respondent had affirmatively sought an order that the transfer of entitlement remain in effect until the new EIR was completed. Second, respondent refuted the factual allegations about its water sources contained in the declaration executed by appellant's counsel. The trial court's finding of speculation was directed at the first point: respondent's claim it would suffer irreparable harm if the trial court denied its request for an order that the transfer remain in effect until the EIR was completed. The finding of speculation was not directed at the second point: respondent's discrete refutations of appellant's allegations. The trial court could reasonably find respondent had failed to meet its burden to establish the predicate for the relief it sought but could also reasonably find that the portions of Masnada's declaration set forth above were sufficient to show appellant's claim for relief was likewise subject to serious question and therefore grounded in speculation. We therefore reject appellant's claim that "[r]espondent's entire argument that there was no abuse of discretion is incorrectly based on evidence that the lower court determined was mere speculation, not fact."[6] (Fn. omitted.)

Lastly, we address an argument raised in the amici brief jointly filed by the Planning and Conservation League and the Citizens Planning Association of Santa

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6 Appellant cites to various comments the court made as well as questions it posed during the hearing as proof that the court grounded its decision either in facts unsupported by the evidence or on legal principles inapplicable to the case. This approach is in error. A contextual reading of the transcript of the hearing indicates the court's questions and comments were intended to gather information, to focus the parties' arguments, and to test the strength of the parties' respective positions. The "bottom line" is whether the trial court abused its discretion in finding appellant had failed to discharge its burden to establish the predicates for injunctive relief. As explained above, the court did not so abuse its discretion.

Barbara County, Inc. in support of appellant. Amici are two of the environmental organizations that were the prevailing parties in *PCL, supra,* 83 Cal.App.4th 892.

Amici first inform us that in May 2003--seven months after the trial court entered judgment in this matter--the superior court in Sacramento approved a settlement agreement entered into by the parties in the *PCL* case. Pursuant to that agreement, work has commenced on a new EIR in regard to the Monterey Agreement and related issues. The settlement agreement recognizes that the transfer underlying this lawsuit is "'subject to pending litigation in the Los Angeles Superior Court following remand from the Second District Court of Appeal'"; that "'jurisdiction with respect to that litigation should remain in the [Los Angeles Superior Court]'"; and that "'nothing in this settlement agreement is intended to predispose the remedies or other actions that may occur in that pending litigation.'"

Amici argue the trial court abused its discretion in denying appellant's request for injunctive relief because the court ignored "the specific directions of *Friends I*" that its determination on interim relief should be based upon the status of the *PCL* litigation and the new statewide EIR to be prepared for the Monterey Agreement.[7] As support for that proposition, Amici cites us to the last two paragraphs of our opinion in *Friends I.* There, after concluding that other than the *PCL*/tiering issue all of appellant's complaints about the EIR were meritless, we wrote: "This suggests that respondent may be able to cure the *PCL* problem by awaiting action by the DWR complying with the *PCL* decision, then issuing a subsequent EIR, supplement to EIR, or addendum to EIR [citations] tiering upon a newly certified Monterey Agreement EIR. Appellant itself so suggests. [¶] Like the court in *PCL, supra,* 83 Cal.App.4th at page 926 and footnote 16, we leave to

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7 Appellant raised this point in the trial court and its opening brief.

the trial court's discretion whether to enjoin all or portions of respondent's project pending completion of an adequate EIR. The trial court is in a better position than this court to determine factually the current status of the *PCL* litigation or of a new Monterey Agreement EIR." (*Friends I, supra,* 95 Cal.App.4th 1373, 1387-1388.)

Amici misapprehend our directions to the trial court. As explained above, those directions are found in the dispositional language of our opinion. That language directed the trial court, inter alia, to "consider such orders it deems appropriate under [Public Resources Code] section 21168.9." (*Ibid.*) That section grants the trial court broad powers to fashion equitable relief. (See fn. 3, *ante*, and accompanying text at pp. 10-12.) Amici's argument that the exercise of said discretion was to be based upon the status of either the *PCL* litigation or the new EIR for the Monterey Agreement is at odds with the clear dispositional language we employed. The two paragraphs in our opinion upon which amici rely were merely suggestions as to how respondent could proceed and a statement that in exercising its discretion whether to grant equitable relief pending completion of a new EIR for this project, the trial court could ascertain, and if it so chose, rely upon the status of the *PCL* litigation and new Monterey Agreement EIR.

In any event, the parties' papers in the trial court informed it of what was then the current status of both the *PCL* litigation and the new Monterey Agreement EIR and the issue was discussed at the hearing. Nothing in the record suggests the court did not consider those facts in rendering its decision, a decision that was properly framed by the specific prayers for relief each party advanced in the trial court. To a large extent, amici's position is nothing more than an attempt to reargue the motion and to do so based upon events that occurred after judgment was rendered. Because the *PCL* litigation settled *after* the trial court entered its judgment, that settlement and the status of the preparation of the new Monterey Agreement EIR are matters that can be brought to the attention of the trial court if

appellant seeks to renew its request for injunctive relief. Lastly, in order to forestall any unnecessary future litigation, we hasten to add that nothing stated in this opinion is to be construed to be an indication as to how the trial court should rule in any further proceeding(s) on any specific issue(s).

DISPOSITION

The judgment is affirmed.

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

VOGEL (C.S.), P.J.

We concur:

HASTINGS, J.

CURRY, J.

R. Bruce Tepper
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Suite 200
Los Angeles, CA 90067-1602

Division 4
Friends of the Santa Clara River
v.
Castaic Lake Water Agency
B164027

Los Angeles County Superior Court, "Statement of Decision, *California Water Impact Network v. Castaic Lake Water Agency*, Case No. BS098724" (April 2, 2007)

California Water Impact Network v. Castaic Lake Water Agency
BS 098724

Statement of Decision on Petition for Writ of Mandate

ORIGINAL FILED
APR 02 2007
LOS ANGELES SUPERIOR COURT

Petitioners California Water Impact Network ("CWIN") and Planning and Conservation League ("PCL") petition for writ of mandate under California Environmental Quality Act ("CEQA"). The court has read and considered the moving papers, oppositions, and reply, heard oral argument, and renders the following decision.

A. Statement of the Case

Petitioner CWIN commenced its petition for writ of mandate in Ventura County Superior Court on January 24, 2005. The petition alleges that on December 23, 2004, the Castaic Lake Water Agency ("Castaic"), a public water agency and water wholesaler that treats and delivers water to water retailers in Los Angeles and Ventura Counties, approved the permanent transfer of 41,000 acre feet per year from Real Party in Interest Kern County Water Agency ("Kern") and its member unit in Kern County, Wheeler Ridge-Maricopa Water Storage District ("Wheeler Ridge"), to Castaic (the "Kern water transfer," the "Kern transfer," or the "transfer"). Castaic also purported to certify the Environmental Impact Report ("EIR") for the project (the "2004 EIR" or the "EIR"). Petitioner claims the Kern water transfer "threatens to promote large-scale urban sprawl in Ventura and Los Angeles Counties, while diverting water from important environmental and agricultural uses in Kern County forever." Petitioner alleges that the 2004 EIR is premature, and fails to comply with CEQA.

The petition alleges a cause of action for violation of CEQA in that Real Party in Interest California Department of Water Resources ("DWR"), not Castaic, should have been the lead agency for the 2004 EIR, which does not adequately describe the background on which the project is based, fails to disclose a reliance on an invalid Urban Water Management Plan, fails to adequately describe alternatives to the project, including a "no project" alternative, fails to discuss growth inducement, and inaccurately states the availability of water availability.[1]

On January 24, 2005, PCL filed its own petition for writ of mandate against Castaic in Ventura County Superior Court. The PCL petition alleges a violation by Castaic in recording a Notice of Determination on December 23, 2004, certifying the 2004 EIR and rendering its approval of the Kern water transfer. The petition purports to allege five "causes of action" for violation of CEQA in the 2004 EIR based on Castaic stealing DWR's duty to be the lead agency for the EIR, certification of a defective EIR, approval of inadequate findings, erroneous presentation of the project as already complete, and "prejudicial abuse of discretion."

On June 22, 2005, upon motion by Castaic, the Ventura County Superior Court (the Honorable Frederick H. Bysshe, Jr.) ordered the transfer of both petitions, which had been consolidated, to Los Angeles. On March 27, 2006, the case was reassigned to this court.

On June 27, 2006, the court heard the demurrers of Castaic and Real Party in Interest Kern to the consolidated petitions. The court ruled that the petitions were timely filed and were

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[1]On CWIN's oral motion, the petition's second and third causes of action have been dismissed. As a result, CWIN's petition solely concerns Castaic's compliance with CEQA in the 2004 EIR.

not barred under the doctrine of *res judicata*. The court noted that the Kern water transfer agreements are valid. While principles of *collateral estoppel* barred Petitioners from re-raising issues resolved by the Second District with respect to the 1999 EIR, this conclusion did not foreclose the petitions and the demurrers were overruled.

On July 16, 2006, the court denied Castaic's motion for a legal determination under principles of *collateral estoppel* and party admission that Castaic is the proper lead agency for preparation of the EIR for the Kern water transfer. However, Petitioners are bound by their concession that Castaic may act as the lead agency at some point for an EIR on the Kern water transfer.

B. Preliminary Issues

1. Standing and Timeliness

Petitioner PCL alleges that it is a non-profit corporation devoted to environmental protection. PCL Pet. at ¶6-7. Some of PCL's members live in the area affected by the Kern water transfer. PCL Pet. at ¶8. Petitioner CWIN alleges that it is a nonprofit public benefit corporation the purpose of which is to protect California's environment. CWIN contends that it is impacted by the Kern water transfer because its members reside in and use the Santa Clara River watershed, which is impaired by the water transfer. CWIN Pet. at ¶9. Thus, Petitioners contend that they are impacted by the project and have standing to raise the issues herein. Respondents do not contest Petitioners' standing. *See* Waste Management of Alameda County, Inc. v. County of Alameda, (2000) 79 Cal.App.4th 1223, 1233-34.

The actions are timely on CEQA issues, each having been filed on January 24, 2005, within 30 days of Castaic's Notice of Determination that the 2004 EIR had been certified, filed in various counties between December 23 and December 27, 2004. *See* Pub. Res. Code §21167(c).

2. The Administrative Record

Castaic has certified the administrative record. Pub. Res. Code §21167.6; LASC 9.24(e). The record was received in evidence at trial.

Castaic and Kern, and DWR separately ask the court to judicially notice various records. Judicial notice is the acceptance by a court without formal proof of the existence of a matter of law or fact that is relevant to an issue in the case. People v. Rowland, (1992) 4 Cal.4th 238, 268, n.6. Certain documents are subject to judicial notice. Ev. Code §451, 452. Even where subject to judicial notice, however, a document must be relevant. Id.

The California Supreme Court decision in Western States Petroleum Assn. v. Superior Court, ("Western States") (1995) 9 Cal.4th 559, 573, n.4, provides that extrinsic evidence is generally not admissible for a traditional mandamus challenging a quasi-legislative agency action. The exclusion of extrinsic evidence in a traditional mandamus action is essentially the exclusion of irrelevant evidence. Extrinsic evidence is generally not admissible for a traditional mandamus challenging a quasi-legislative agency action. Id. Such evidence may be admissible in a narrowly construed exception in which (1) the evidence in question existed before the agency made the decision, and (2) the evidence could not have been presented to the agency in the first instance in the exercise of reasonable diligence. Id. at 578. The purpose of limiting extra-record evidence is that the free use of such evidence would invade the deference to which the legislative

branch is entitled under the constitutional separation of powers. If the courts freely considered extra-record evidence in mandamus cases, the highly deferential substantial evidence standard would be turned into a *de novo* standard where the courts in effect would decide not whether an administrative decision was supported by the evidence before the agency but instead whether it was the wisest and best decision according to the courts. Id. at 572.

Castaic asks the court to judicially notice: (1) the unpublished appellate decision in Friends of the Santa Clara River v. Castaic Lake Water Agency, 2003 Cal.App. Unpub. LEXIS 11239, dated December 1, 2003 ("Friends II"), and (2) the unpublished appellate decision in California Water Network v. Castaic Lake Water Agency, 2006 Cal.App. Unpub. LEXIS 2452, dated March 23, 2003.[2] The existence of these court decisions is subject to judicial notice. Ev. Code §452(d).[3]

DWR asks the court to judicially notice (1) Amendment No. 19 to the Water Supply Contract between it and Castaic dated May 28, 2003, and (2) Notice of Preparation of EIR for the Monterey Amendment dated January 24, 2003. DWR contends that these documents are official acts of a California agency subject to judicial notice under Ev. Code section 452(c) and (d). The Notice of Preparation is an official act of DWR and is judicially noticed. However, Amendment No. 19 is not. Official acts should be limited to regulations, public announcements, and other actions the existence of which is beyond dispute. A well informed person has no way of knowing whether Amendment No. 19 is authentic and valid. Nor is it a court record under section 452(d). DWR's request for judicial notice of Amendment No. 19 is denied.

C. Statement of Facts

1. SWP

In 1951, the Legislature authorized construction of a state water storage and delivery system. Planning & Conservation League v. Department of Water Resources, (2000) 83 Cal.App.4th 892, 898. The Legislature subsequently authorized the State Water Project ("SWP"), a complex system of 28 reservoirs and dams, 26 power and pumping plants, and 600 miles of canals and aqueducts to deliver 4.23 million acre-feet of water annually to Central and Southern California. The primary source for the SWP is the drainage of the Feather River, a tributary of the Sacramento River in Northern California (hereinafter, the "Delta").

DWR is the state agency charged with the statutory responsibility to build, manage, and operate the SWP. Essentially, DWR is the wholesale provider of water to middlemen agencies. In 1961, DWR entered into individual contracts with various agricultural and urban water suppliers in the State, referred to as State Water Contractors. *See* Water Code §12937. There are 29 agencies or districts that currently are State Water Contractors.

The SWP water contracts entitled the contractors to receive an annual amount of SWP

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[2]Castaic also supplied the court with copies of its decisions on demurrer and motion for legal determination in this case, which need not be judicially noticed.

[3]Real Party Wheeler purports to join in Castaic's request for judicial notice. In its ruling on the demurrers, the court informed Wheeler of the futility of a joinder as merely a cheerleading effort. No further discussion of the purported joinder is necessary.

water in exchange for a proportionate share of financing and maintaining the SWP facilities. Each water contract contains provisions for both allocation of the amount of water available each year and costs among the contractors. Each contract identifies a Table A amount, the annual maximum amount of water which DWR agrees to deliver, if available for delivery, to each SWP contractor on an annual basis. Delivery of the Table A amount is not assured, but rather provides the basis for proportional allocation of available water among contractors. The Table A amount is specified as either agricultural or urban (M&I). Each contract also includes Article 40, which permits water transfers between contractors, and Article 41, which requires DWR approval of any transfer subject to reasonable terms and conditions. AR 2356.

Each contractor annually submits a request to DWR for water delivery in the following year, up to the amount in Table A. In a year when DWR is unable to deliver the total of contractor requests, deliveries to all contractors will be reduced. The current Table A totals are 4.17 million acre-feet per year.[4] In fact, given existing facilities and contractor demands, the SWP can only deliver an average of 2.96 million acre-feet per year.

2. The Monterey Agreement

Historically, the delivery of less than Table A totals was not a significant problem because contractor demand was less than the Table A amounts. However, in the late 1980's and early 1990's, a drought led to SWP deliveries in amounts below that requested by contractors. Articles 18(a) and (b) of the SWP water contracts addressed DWR's temporary and permanent inability to deliver the water allocations listed in Table A of the contracts by requiring agricultural contractors to accept a reduction in water first before any remaining reduction was shared by urban contractors. In 1990, agricultural contractors received only half their requested water and none in 1991. Because contractors pay their proportionate share of fixed costs regardless of how much water is delivered, the agricultural contractors were paying for water they were not receiving and they were displeased. As a result, urban and agricultural water contractors clashed over DWR's delivery obligations and the proper interpretation of Article 18. AR 45-46.

In December 1994, five State Water Contractors and and DWR reached agreement on a broad set of fourteen principles (the "Monterey Agreement"). Among other things, the Monterey Agreement changed the allocation between agricultural and urban contractors of entitlements to SWP water. The Monterey Agreement eliminated Article 18 and specified that all SWP water was to be allocated in proportion to Table A amounts. Paragraph 24 of the Monterey Agreement provides for the permanent transfer of 130,000 acre-feet from certain willing agricultural contractors, including KWCA, to urban contractors, as implemented by individual agreement. AR 2515. It also provides that individual contractors may transfer entitlements among themselves beyond the 130,000 acre feet proposed, with DWR expeditiously executing any necessary documents and approving all such contracts. Other provisions of the Monterey Agreement include a revision of water allocations during shortages, eliminating the "agriculture first" provision, and retirement of 45,000 other acre-feet of entitlement by agricultural contractors.

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[4]An "acre-foot" is the amount of water that would cover one acre one foot deep.

The Monterey Agreement provides that individual SWP contracts could be amended to conform to it. Over the next two years, 27 of the 29 Water Contractors amended their SWP contracts to implement the principles of the Monterey Agreement (collectively, the "Monterey Amendments").

In 1995, a State Water Contractor, Central Coast Water Authority ("Central"), acted as lead agency and certified a program EIR analyzing the environmental impacts of the Monterey Agreement. This program EIR also addressed Paragraph 24 (Article 53 in the Monterey Amendments) water transfers, including the Kern water transfer. In late 1995, PCL filed a lawsuit in Sacramento Superior Court challenging the program EIR, Planning & Conservation League v. Department of Water Resources, ("PCL").

3. The Kern Water Transfer Agreement

Castaic is a State Water Contractor created by the California Legislature. Its mandate is to purchase and deliver sufficient supplies of water to serve the needs of the Santa Clarita Valley. *See* Swanson v. Marin Municipal Water District, (1976) 56 Cal.App.3d 512, 524 (water district has obligation to augment available water to meet increasing demands). Castaic diverts its SWP water from the West Branch of the California Aqueduct. Castaic is one of the Water Contractors entering into the Monterey Amendments (Amendment 17 to Castaic's SWP contract).

Kern County Water Agency ("KCWA") is a special district formed by the Legislature in 1961. Wheeler Ridge is a special district formed in 1959 to provide supplemental water to agricultural lands in Kern County and is located immediately north and east of Castaic. KCWA has contracts with Wheeler Ridge and other member agencies, for KCWA's SWP water.[5]

In March 1999, Castaic entered into an agreement to purchase from Wheeler Ridge, subject to KCWA's consent, 41,000 acre-feet per year of SWP water (the Kern water transfer). The price for the transfer was $47 million in debt instruments purchased by private investors. The purpose of the transfer is to permit Castaic to serve the water demands of existing users, as well as meet a portion of future water demand from anticipated growth within the Castaic service area. AR 16. The Kern water transfer is the largest transfer under Article 53 of the Monterey Amendments, and it counts towards the 130,000 acre-feet limit. In their transfer agreement, both sides warranted that there was no pending or threatened litigation other than PCL that could affect the 41,000 acre feet SWP entitlement. AR 2562-63.[6]

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[5]In 1998, another KCWA member, Belridge Water Storage District, certified an EIR on the environmental effects of transferring 130,000 acre-feet of SWP water to unidentified purchasers. This EIR was not challenged.

[6]Castaic has been planning since 1987 to increase the supply of water to Santa Clarita Valley. At that time, Los Angeles County General Plan forecast substantial population growth in the Santa Clarita Valley. In 1988, Castaic adopted a Capital Program and Water Plan (the "Capital Program") to address the purchases, construction, and improvements necessary to meet the anticipated water demand. The Capital Program called for the purchase of SWP water from districts willing to sell, including Wheeler Ridge, and the storage of water for later use during drought conditions at Semitropic Groundwater Storage District's ("Semitropic") basins. AR

DWR's approval of the Kern water transfer was required under Articles, 15, 41, and 56 of the SWP contracts. On March 31, 1999, DWR approved the transfer by entering into Amendment 18 of Castaic's SWP contract. Amendment 18 adds Article 53(j), which provides that "in accordance with Article 53(a)" of the Monterey Amendments, Castaic's Table A annual entitlements were increased by 41,000 acre-feet. AR 2545-47. DWR and KCWA, which consented to the transfer of its water, also entered into Amendment 28 to KCWA's SWP contract, an amendment which reduced KCWA's entitlement by 41,000 acre-feet. Based on these amendments, DWR has allocated SWP water to Castaic since 1999 based on a total Table A amount of 95,000 acre-feet -- Castaic's original Table A 54,000 acre-feet plus the 41,000 acre-feet from the Kern water transfer.

On March 29, 1999, Castaic, acting as lead agency, certified an EIR for the Kern water transfer. This 1999 EIR tiered off the 1995 Monterey Amendment program EIR, the Belridge EIR, and Castaic's own 1988 EIR for the Capital Program. In April 1999, Castaic's EIR for the Kern water transfer was challenged in Friends of the Santa Clara River v. Castaic Lake Water Agency, BS056954 ("Friends"). On August 16, 2000, the trial court entered judgment, denying the petition in its entirety.

4. The PCL and Friends Decisions

In September 2000, the Third Appellate District in PCL found that DWR was the only entity with the "statewide perspective and expertise" to serve as lead agency for the Monterey Agreement program EIR. Because "the allocation of water to one part of the state has potential implications for distribution throughout the system," the court recognized DWR's principal responsibility to "facilitate the water transfers allowed under the Monterey Agreement." 83 Cal.App.4th at 907. The use of Central as lead agency for the Monterey Agreement program EIR was inappropriate. Id. at 907.

This lead agency error was not harmless because the EIR also was defective. Perhaps as a consequence of Central's lack of statewide expertise, the EIR failed to properly discuss a "no project" alternative, including the environmental impact of implementing the pre-Monterey Agreement Article 18(b)'s permanent water shortage provision. Id. at 918. This was particularly important because local land use planners rely on the "paper water" entitlements in Table A

41845.

Pursuant to the Capital Program, Castaic permanently acquired 12,700 acre-feet of SWP Table A water in 1991 from Devil's Den Water District, a SWP contractor immediately north of Castaic. This transfer was subject to DWR approval, which per Article 41 of the SWP contracts could not be unreasonably withheld. DWR approved the transfer, noting that the transferred water remained labeled for "agricultural purposes" for purposes of delivery shortages.

Also pursuant to the Capital Program, in 2002 Castaic entered into a groundwater storage or "banking" agreement with Semitropic. This action was challenged under CEQA on the basis that the Monterey Agreement required DWR to conduct an environmental review. The challenge was rejected by the appellate court, which held that DWR had no jurisdiction over Castaic's management of water; DWR merely schedules SWP water delivery to Castaic. Cal. Water Network v. Castaic Lake Water Agency, (2006) 206 Cal.App. Unpub. LEXIS 2452, 9.

rather than real, deliverable water. The question was what impacts were reasonably foreseeable from eliminating Article 18(b)'s solution to permanent water shortage? Id. at 914-15. The PCL court held that the EIR, which lacked simulation models and projections relating to land use planning and demand for water, did not adequately address this issue. Id. at 919. It directed the Sacramento Superior Court to retain jurisdiction over the action until a new EIR was prepared and certified.

Based on the Third District's PCL decision, on January 10, 2002, the Second Appellate District reversed the judgment in Friends and directed the trial court to issue a writ of mandate compelling Castaic to set aside certification of its EIR. Friends, (2002) 95 Cal.App.4th 1373. The reversal was based solely on the fact that Castaic's EIR had been tiered upon the now inadequate Monterey Agreement program EIR. The Second District rejected all of the other challenges to Castaic's EIR, finding them to be without merit. The appellate court noted that Castaic may be able to cure the defect by waiting for DWR to comply with the Third District's directive in PCL by preparing a new program EIR. Castaic could issue a subsequent EIR, a supplement to EIR, or addendum to EIR, tiering upon the new Monterey Agreement EIR.

The Friends appellate decision concluded as follows: "The judgment is reversed. The trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until Respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, and shall consider such orders it deems appropriate under [Pub. Resources Code] section 21168.9."

On October 25, 2002, after remand from the court of appeal, the Friends trial court issued a Peremptory Writ of Mandate and Judgment on Remand, retaining jurisdiction until Castaic certifies an EIR that complies with CEQA and is consistent with the views expressed by the Second District. The trial court did not direct Castaic to set aside its approval of the Kern water transfer and denied the petitioner's request to enjoin Castaic from using any of the 41,000 acre feet of additional water allotted to it by the Kern water transfer. The trial court did state that the injunction request could be renewed upon a showing that the water was actually used for an improper purpose (irreversible new development).

5. Monterey Plus

On June 6, 2003, the Sacramento Superior Court approved a settlement between the parties in PCL. That settlement, known as "Monterey Plus," provides that the Monterey Agreement can proceed on an interim basis. In exchange, DWR agreed, among other things,[7] to prepare a new program EIR for implementation of the Monterey Agreement. This new EIR would include (1) information on water deliveries during the drought and recent historical period, (2) an analysis of a no project alternative, including the environmental impact of Article 18's water shortage provisions, (3) analysis of environmental impacts from changes in SWP operations and deliveries resulting from implementation of the Monterey Agreement, (4) analysis

[7]Some of the other provisions include biennial reports on project reliability, land use restrictions on the Kern Water Bank, new guidelines for permanent water transfers, new procedures for public involvement in contract changes, and funding for watershed restoration and new technical studies. AR 45048-49.

of environmental impacts of seven already completed water transfers from KWCA and member units totaling 70,000 acre-feet (Attachment E), which the parties recognized were "final," and of the Kern water transfer, which the parties acknowledged was being challenged in the pending Friends litigation in Los Angeles Superior Court, and (5) analysis of the environmental impacts from implementation of Monterey Plus. AR 48557-59. With respect to the Kern water transfer, the Monterey Plus parties agreed that "jurisdiction with respect to [Friends] should remain in that court and that nothing in this Settlement Agreement is intended to predispose the remedies or other actions that may occur in that pending litigation." The Monterey Plus did not require DWR to re-approve or disapprove any transfer.

6. The Friends II Decision

The Second District upheld the Friends trial court's decision not to grant injunctive relief for the Kern water transfer on December 1, 2003, in unpublished case no. B164027 ("Friends II"). PCL had filed an *amicus* brief supporting the petitioner in Friends II, pointing out that the Monterey Plus settlement now existed and arguing that the Friends decision required the trial court to rely on the status of PCL litigation, including the new Monterey Agreement program EIR DWR was to prepare, in deciding injunctive relief. The Friends II appellate court stated that PCL was wrong; it merely had suggested, not required, that the trial court could determine and rely on the status of the PCL case in deciding injunctive relief.

7. The 2004 EIR

After Friends, Castaic decided to prepare a revised EIR prior to DWR's preparation of a Monterey Amendment EIR. Castaic was driven by a concern that the Friends petitioner and others would use the decertification of its 1999 EIR to cloud its right to the transferred water, as well as Castaic's duty to its customers to complete the environmental documentation and finalize the Kern water transfer.

In June 2004, Castaic prepared and circulated a draft EIR that tiered only on Castaic's 1988 Capital Program EIR. Castaic concluded that it was the lead agency because it has the principal responsiblility for carrying out and implementing the project. Because the transfer is between neighboring SWP contractors, involving the withdrawal of water from a single branch of the Aqueduct, Castaic concluded that the transfer has no significant impacts on SWP operations or the water diverted from the Delta. *See* AR 13-14.

PCL served comments to the draft EIR on August 16, 2004. These comments criticized the use of Castaic as lead agency, arguing that Castaic's review was "premature" and "likely to operate at cross-purposes with DWR's statewide review." AR 1959. PCL contended that DWR, not Castaic, was required to be the lead agency under the PCL decision. Only DWR's expertise could analyze the changes in the amount of supplies available, the location and timing of deliveries, and changes in the SWP's conveyance and storage facilities for all of the proposed transfers, including the Kern water transfer. AR 1962. CWIN also timely expressed concern about Castaic's lack of authority to act as lead agency, and the potential for conflict with DWR's role. AR 578-580.

DWR, acting as a responsible agency under CEQA, commented on the draft EIR. It stated that the "document adequately and thoroughly discusses the proposed project and its

impacts. The [draft]EIR discusses the effects of the project on the environment and State Water Project (SW) and uses baseline conditions consistent with those being considered for inclusion in [DWR's EIR]. The draft also "adequately discusses the reliability of the SWP, pre- and post-Monterey Amendment conditions, future conditions, and SWP operations." DWR acknowledged that Castaic's EIR uses a model, DWRSIM, to assess the potential impact associated with the Kern transfer and that DWR's EIR will use a newer model, CALSIM II. DWR indicated that the use of a different computer model may cause slight changes in results, which may lead DWR to different conclusions than those made by Castaic in its EIR. Despite this fact, DWR concluded that the draft EIR adequately discusses the reliability of SWP, pre- and post- Monterey Amendments conditions, future conditions, and SWP operations. AR 564-65.

Castaic rejected Petitioners' concerns, and relied on DWR's comments to refute objections that its draft EIR will be inconsistent with the yet to be prepared DWR program EIR. AR 961-4. Castaic adopted findings, a mitigation monitoring program and statement of overriding considerations and certified a final EIR (the 2004 EIR).[8] The 2004 EIR describes Castaic's water program for the future needs of Santa Clarita Valley, the procedural history of the project (including the 1999 EIR), and the fact that the Kern water transfer has been implemented and ongoing since 1999. It uses two separate baselines for the project setting and evaluates environmental impacts of the Kern water transfer on the SWP, Castaic, and Wheeler Ridge. In discussing these impacts, the 2004 EIR considers three SWP scenarios: (a) with the Monterey Agreement, (b) without the Monterey Agreement, and (c) without the Monterey Agreement and with Article 18(b) permanent shortages. The EIR uses the DWRSIM model and concludes no significant direct environmental impacts will occur as a result of the project. There would, however, be indirect growth impacts as a result of water provided by the project.

8. The Petitioners Take Over from the Friends Petitioner

On January 24, 2005, CWIN and PCL filed separate petitions for writ of mandate in Ventura County concerning Castaic's compliance with CEQA in the 2004 EIR, and other issues.

On February 1, 2005, the Friends petitioner dismissed the action with prejudice. On February 7, 2005, the trial court in Friends held a hearing on Castaic's *ex parte* application to vacate the dismissal with prejudice and to discharge the writ of mandate. Castaic argued that, by dismissing, the petitioner was attempting to get the clerk, through ministerial act, to divest the court of its continuing jurisdiction over the 2004 EIR prepared in response to the court's peremptory writ of mandate. Instead, the Friends petitioner was passing the baton to CWIN and PCL for a challenge to the 2004 EIR. The trial court declined to set aside the dismissal, stating that whether the Ventura proceedings were a continuation of the Friends lawsuit was an issue of fact for the Ventura (now this) court.

On March 5, 2005, Castaic petitioned the Second Appellate District for a writ of mandate with respect to the trial court's refusal to vacate the dismissal, arguing that the trial court violated Pub. Resources Code section 21168.9 (stating that the trial court shall maintain jurisdiction over the agency's proceedings until the court has determined that the agency has complied with

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[8]On December 30, 2004, Castaic filed its return to the peremptory writ of mandate in Friends.

CEQA) because it had not yet determined that the 2004 EIR complied with CEQA Yet, under CEQA, a trial court that orders preparation of a new EIR must retain jurisdiction for a final determination of the EIR's validity.

On April 14, 2005, the Second Appellate District denied Castaic's petition for "failure to demonstrate that the 'retain jurisdiction' provision of Public Resources Code section 21168.9, subdivision (b), abrogates the entitlement to voluntary dismissal conferred by Code of Civil Procedure section 581, subdivision (b)(1)."[9]

D. CEQA

1. Standard of Review

A party may seek to set aside an agency decision for failure to comply with CEQA by petitioning for either a writ of administrative mandamus (CCP §1094.5) or of traditional mandamus. CCP §1085. A petition for administrative mandamus is appropriate when the party seeks review of a "determination, finding, or decision of a public agency, made as a result of a proceeding in which by law a hearing is required to be given, evidence is required to be taken and discretion in the determination of facts is vested in a public agency, on the grounds of noncompliance with [CEQA]." Pub. Res. Code §21168. This is generally referred to as an "adjudicatory" or "quasi-judicial" decision. Western States Petroleum Assn. v. Superior Court, ("Western States") (1995) 9 Cal.4th 559, 566-67. A petition for traditional mandamus is appropriate in all other actions "to attack, review, set aside, void or annul a determination, finding, or decision of a public agency on the grounds of noncompliance with [CEQA]." Where an agency is exercising a quasi-legislative function, such as by adopting a rule or entering into a contract, it is properly viewed as a petition for traditional mandamus. Id. at 567; Pub. Res. Code §21168.5.

At issue here is a CEQA challenge to a quasi-legislative action recorded by Castaic in a December 23, 2004 Notice of Determination approving the project, certifying the 2004 EIR, and adopting findings, a mitigation monitoring program, and a statement of overriding considerations. This procedural setting, where no administrative hearing was held or required, is governed by traditional mandamus. In determining whether to grant a petition for traditional mandamus in a CEQA case, the court may consider only whether there was a prejudicial abuse of discretion. Public entities abuse their discretion under CEQA if the agency has not proceeded in a manner required by law or if its determination or decision is not supported by substantial evidence. Western States, 9 Cal.4th at 568; Pub. Res. Code §21168.5.[10]

This requires "scrutiny of the alleged defect" depending on whether the claim is predominately "improper procedure or dispute over the facts." Vineyard Area Citizens for

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[9]The Second District later dismissed Castaic's appeal from the Friends dismissal, finding that the voluntary dismissal was not appealable. *See* H.D. Arnaiz, Ltd. v. County of San Joaquin, (2002) 96 Cal.App.4th 1357, 1364-67.

[10]The standard of review for traditional mandamus in a non-CEQA case is governed by an "arbitrary and capricious" standard, not a "prejudicial abuse of discretion" standard. The CEQA standard is the more stringent inquiry. Western States, 9 Cal.4th at 574.

Responsible Growth v. City of Rancho Cordova, ("Vineyard") (2007) 40 Cal.4th 412, 435. Whether Castaic is the proper lead agency is an procedural issue of law for the court. PCL, 83 Cal.App.4th at 905-06. Similarly, as Petitioners argue (Pet. Supp. Resp. Br. at 5), whether Castaic's 2004 EIR failed to provide certain required information and, as a result, presents uncertainties about the finality of the Kern water transfer is failing "to proceed in a manner required by CEQA" and an issue of law. Vineyard, 40 Cal.4th at 435. These issues require "a critical consideration, in a factual context, of legal principles and their underlying values." Harustak v. Wilkins, (2000) 84 Cal.App.4th 208, 212.

On the other hand, whether Castaic abused its discretion in the 2004 EIR's findings must be answered with reference to the evidence in the administrative record. This standard requires deference to the agency's factual and environmental conclusions based on conflicting evidence, but not to issues of law. Laurel Heights Improvement Assn. v. Regents of University of California, ("Laurel Heights") (1988) 47 Cal.3d 376, 393, 409. Argument, speculation, and unsubstantiated opinion or narrative will not suffice.[11] Guidelines, 15384(a), (b). The findings must be supported by "substantial evidence," defined as "enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached. CEQA Guidelines §15384(a). The question whether substantial evidence exists is a question of law. *See* California School Employees Association v. DMV, (1988) 203 Cal.App.3d 634, 644.

2. CEQA

The purpose of CEQA (Pub. Res. Code §21000 *et seq.*) is to maintain a quality environment for the people of California both now and in the future. Pub. Res. Code §21000(a). "[T]he overriding purpose of CEQA is to ensure that agencies regulating activities that may affect the quality of the environment give primary consideration to preventing environmental damage." Save Our Peninsula Committee v. Montery County Board of Supervisors, (2001) 87 Cal.App.4th 99, 117. CEQA must be interpreted "so as to afford the fullest, broadest protection to the environment within reasonable scope of the statutory language." Friends of Mammoth v. Board of Supervisors, (1972) 8 Cal.3d 247, 259. Public agencies must regulate both public and private projects so that "major consideration is given to preventing environmental damage, while providing a decent home and satisfying living environment for every Californian." Pub. Res. Code §21000(g).

The Legislature chose to accomplish its environmental goals through public environmental review processes designed to assist agencies in identifying and disclosing both environmental effects and feasible alternatives and mitigations. Pub. Res. Code §21002.

Under CEQA, a "project" is defined as any activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment (1) undertaken directly by any public agency, (2) supported through contracts, grants, subsidies, loans or other public assistance, or (3) involving the issuance of a lease, permit,

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[11] As an aid to carrying out the statute, the State Resources Agency has issued regulations called "Guidelines for the California Environmental Quality Act ("Guidelines"), contained in Code of Regulations, Title 14, Division 6, Chapter 3, beginning at section 15000.

license, certificate, or other entitlement for use by a public agency. Pub. Res. Code §21065. The word "may" in this context means a reasonable possibility. Citizen Action to Serve All Students v. Thornley, (1990) 222 Cal.App.3d 748, 753. "Environment" means the physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance. Guidelines, §21060.5.

The "project" is the whole of the action, not simply its constituent parts, which has the potential for resulting in either direct or reasonably foreseeable indirect physical change in the environment. Guidelines §15378. An indirect physical change must be considered if that change is a reasonably foreseeable impact which may be caused by the project. On the other hand, a change that is "speculative or unlikely to occur is not reasonably foreseeable." Guidelines §15064(d)(3). The term "project" may include several discretionary approvals by government agencies; it does not mean each separate government approval. Guidelines §15378(c).

The EIR is the "heart" of CEQA, providing agencies with in-depth review of projects with potentially significant environmental effects. Laurel Heights, 6 Cal.4th at 1123. An EIR describes the project and its environmental setting, identifies the potential environmental impacts of the project, and identifies and analyzes mitigation measures and alternatives that may reduce significant environmental impacts. Id. Using the EIR's objective analysis, agencies "shall mitigate or avoid the significant effects on the environment... whenever it is feasible to do so. Pub. Res. Code §21002.1. The EIR serves to "demonstrate to an apprehensive citizenry that the agency has in fact analyzed and considered the ecological implications of its actions." No Oil, Inc. v. City of Los Angeles, (1974) 13 Cal.3d 68, 86. It is not required to be perfect, merely that it be a good faith effort at full disclosure. Kings County Farm Bureau v. City of hanford, (1990) 221 Cal.App.3d 692, 711-12. A reviewing court passes only on its sufficiency as an informational document and not the correctness of its environmental conclusions. Laurel Heights, 47 Cal.3d at 392. An EIR will be upheld if it suffices as an informational document; mandate will issue only if it fails to include relevant information which precludes informed decision-making and informed public participation.

"Choosing the precise time for CEQA compliance involves a balancing of factors. EIRs... should be prepared as early as feasible in the planning process to enable environmental considerations to influence project program and design and yet late enough to provide meaningful information for environmental assessment." Guidelines, §15004(b). As a general rule, public agencies shall not undertake actions concerning a proposed project that would have a significant adverse effect or limit the choice of alternatives or mitigation measures before completion of CEQA compliance. Guidelines, §15004(b)(2). "[I]n order to achieve the salutary objectives of CEQA the determination of the earliest feasible time to [prepare the CEQA document] is to be made initially by the agency itself, which decision must be respected in the absence of manifest abuse." Mount Sutro Defense Committee v. Regents of University of California, (1978) 77 Cal.App.3d 20, 36, 40.

E. Analysis

CWIN and PCL argue that DWR is required to be the lead agency for the Monterey Amendments project EIR, which will examine all water transfers on a program level. The Kern

water transfer is part of the Monterey Amendments project. Therefore, DWR is the correct lead agency to conduct the environmental review of the Kern water transfer. According to Petitioners, while Castaic may not serve as the lead agency for "first-level" environmental review of the water transfer, it may serve as lead agency for a project level EIR for the Kern water transfer.

1. Validity of the Transfer

At the outset, the court must make clear an issue greatly discussed at hearing. Petitioners contend, and Castaic and Wheeler Ridge strongly dispute, that DWR may "invalidate" the Kern water transfer when it performs the program EIR.

Under contract and validation law, the Kern water transfer contract, entered into in 1999, is valid, has been approved by DWR, and Castaic has paid Wheeler Ridge for it. Neither the parties nor DWR can terminate the Kern transfer contract. Nothing in CEQA permits a public agency to void a contract.

In Kenneth Mebane Ranches v. Superior Court, (1992) 10 Cal.App.4th 276, a flood control district sought to condemn land outside its territory in order to mitigate the environmental impact of a project within its boundaries. The appellate court held that CEQA only requires mitigation of environmental impacts where it is feasible to do so. Where mitigation is infeasible, an agency can always approve a project notwithstanding environmental impacts if it issues a statement of overriding interests. But it cannot take actions that are not legal, and hence infeasible. 10 Cal.App. at 291-92.

Thus, in evaluating the environmental effects of the Monterey Agreement, DWR may impose mitigations that are legal. But it cannot invalidate the Kern transfer. The imposition of illegal mitigations would be infeasible. *See also* Pub. Res. Code §21004 (in mitigating significant environmental impact, agency may only employ powers provided by law).[12]

This does not mean that DWR's Monterey Amendments EIR cannot affect the Kern water transfer. DWR's EIR will consider the environmental impacts of the Kern water transfer in conjunction with the Attachment E transfers which the parties in Monterey Plus agreed were completed and final. DWR conceivably could conclude that these transfers have significant environmental impacts. As a consequence, DWR might have to impose feasible mitigation measures, adopt alternatives, or make a finding of infeasibility and adopt a statement of overriding considerations.[13] If mitigations/alternatives are adopted, they could significantly impact Castaic and Wheeler Ridge. As DWR states, "the contract amendments that effectuated the transfers under the Monterey Amendment[s] do not preclude DWR in its choice of

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[12]The parties disagree on whether the Monterey Amendments are valid and final. That is, they disagree on whether the amendments can be challenged in a reverse validation action separate and apart from CEQA. Resolution of this issue is unnecessary to the court's decision.

[13]At hearing, Petitioners' counsel stated that the parties to Monterey Agreement entered into a joint statement of the possible impacts from the Amendments, citing AR 48628-29. The joint statement at those pages of the record does not discuss possible mitigations; it merely summarizes the terms of Monterey Plus.

alternatives in the Monterey Amendment[s] EIR or mitigation measures that may need to be imposed to reduce significant impacts to less than significant." DWR Br. at 20. DWR gives an example of reducing the amount of SWP water to protect water quality standards for fish in the Delta. Id. at 20. These mitigations could undermine the Kern water transfer.[14] But DWR will not be considering whether the Kern water transfer is valid; it simply does not have the authority to void that transfer. *See* Kenneth Mebane Ranches v. Superior Court, (1994) 10 Cal.App.4th 276, 292.

2. Lead Agency Law

The lead agency under CEQA is the agency that carries out a project or has primary authority for approving a project. Pub. Res. Code 121067; Guidelines §15051; *see* PCL, 83 Cal.App.4th at 904 (DWR, not Central (a State Water Contractor), had principal responsibility for carrying out the Monterey Agreement and should have been lead agency for program EIR). The role and responsibility of the lead agency is "fundamental to the CEQA process as a whole." Guidelines §15050. The identification of the proper lead agency plays a "crucial role" in the division of responsibilities among public agencies reviewing a project. PCL, 83 Cal.App.4th at 903. When determining the appropriate lead agency, the courts look to determine which agency has principal responsibility for the core project activity. Friends of Cuyamaca Valley v. Lake Cuyamaca, (1994) 28 Cal.App.4th 419, 427. The lead agency responsibility is placed upon the agency with power to approve or disapprove the project. Lexington Hills v. State of California, (1988) 200 Cal.App.3d 415, 433. Though one agency has substantial responsibility for a project, it cannot act as lead agency if another agency bears final responsibility. *See* Fullerton Joint Union High School District v. Board of Education, (1982) 32 Cal.3d 779, 795, n.15 (State Board of Education, not county, had final responsibility for school district plan). Where the project is local, such as land use decisions, the agency that has general governmental power over a project is almost always the lead agency. Where two or more agencies are involved in a project, the agency that will carry out the project shall be the lead agency. Guidelines §15051(a).

3. The Impact of the PCL Decision

Petitioners contend that the PCL decision left no doubt that DWR is the appropriate lead agency for a program-level environmental review of the water transfers in the Monterey Agreement, contrasting DWR's statewide expertise with CCWA's "provincial experience." The Monterey Amendments restructure water distribution throughout the state, and the "allocation of water to one part of the state has potential implications for distribution throughout the system." Only DWR has principal responsibility for implementation of the Monterey Amendments. Op. Br. at 11-12; *see* PCL, 83 Cal.App.4th at 904, 908. Since the Kern water transfer is part of the Monterey Amendments, DWR must perform any EIR concerning the Kern water transfer.

Petitioners' argument is a *non-sequitur*. Nothing in PCL requires DWR to perform the environmental review for the Kern water transfer. Certainly, the PCL decision requires that DWR prepare the program EIR for the Monterey Amendments, now Monterey Plus. The

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[14]The close cooperation between DWR and Castaic on the 2004 EIR reduces, but does not eliminate, the prospect that DWR will impose alternatives or mitigations.

appellate court's reason for committing this task to DWR is that CEQA requires the lead agency to be the agency with principal responsibility for the project, the project is the environmental review of the Monterey Agreement, and DWR, not CCWA, has principal responsibility for implementing the Monterey Agreement. The decision pointed out that DWR manages the SWP, and has the statewide expertise and perspective to conduct the environmental review of the Monterey Agreement, which statewide project. While CCWA may have had a substantial stake in seeing the Monterey Agreement implemented, it did not have principal responsibility for it. DWR did, and DWR is required to perform the EIR for the Monterey Agreement. 83 Cal.App.4th at 906.

However, the PCL decision does not commit DWR to conduct the EIR for the Kern water transfer, or for any site specific project conducted pursuant to the Monterey Amendments. The PCL decision plainly requires DWR to prepare the program EIR for the Monterey Amendments, and its permanent transfer of 130,000 acre feet of SWP water. But it does not even mention the Kern water transfer, which is a local water transfer of Wheeler Ridge water to a point 60 miles further south in Santa Clarita Valley. The local nature of the project makes Castaic the logical choice to act as lead agency of this transfer, and nothing in PCL requires Castaic to wait for DWR's program EIR. The Kern water transfer is simply a different project from the Monterey Amendments.

Petitioners' concession that at some point Castaic can and should act as the lead agency for the Kern water transfer EIR undermines their argument that PCL committed this task to DWR. The concession shows that Petitioners really are concerned about the timing of this project specific EIR, and not whether it was committed to DWR in the PCL decision. Petitioners contend that Castaic must wait for DWR's Monterey Amendments program EIR and tier off of it for the Kern water transfer EIR. This argument is, as Castaic describes it, that Castaic "jumped the gun" by preparing the 2004 EIR. But the argument implicitly concedes that PCL did not commit the transfer EIR to DWR.

4. The Agency with Principal Responsibility

Even if PCL did not commit environmental review of the Kern water transfer to DWR, Petitioners argue that the Kern water transfer is an integral part of the Monterey Amendments project. This is shown by Monterey Plus, which excludes the Kern water transfer from the list of transfers designated as "final" and recognizes DWR's responsibility to assess its environmental impacts as part of the programmatic review. The Kern water transfer contract itself expressly relies on the Monterey Amendments, using its provisions as authority to accomplish the Kern water transfer. Even Wheeler Ridge's amendment to its SWP contract identifies the outcome of PCL as a factor that could impact the Kern water transfer's effectiveness. All of these facts, Petitioners argue, mean that the transfer is part of the Monterey Amendments environmental review.

Petitioners further argue that the nature of a program EIR supports their position. This purpose "is to document a series of actions so related they can be characterized as one project." Friends, 95 Cal.App.4th at 1377. The Monterey Amendments, including its transfer provisions, qualify as a "series of actions so related that they can be characterized as one project." An integrated review of the entire program may provide occasion for a more exhaustive

consideration of effects and alternatives than would be practical in an EIR on an individual action, ensure consideration of cumulative actions that might be slighted on a case-by-case analysis, avoid duplicative reconsideration of basic policy considerations, and allow the lead agency to consider broad policy alternatives and program-wide mitigation measures at an early time when the agency has greater flexibility to deal with basis problems or cumulative impacts. Id. at 1377. These factors are all borne out by the 2004 EIR, which presents a series of issues (the amount of supplies available to several water agencies, the location and timing of SWP deliveries, and use of SWP conveyance and storage facilities) on which DWR has superior expertise and greater accountability than Castaic. DWR may not delegate to Castaic its responsibility to prepare the environmental review for the Kern water transfer.

Under lead agency law, Castaic may act as lead agency and prepare an EIR for the Kern water transfer. The Kern water transfer is a project separate in time from the Monterey Amendments, now Monterey Plus. The core of the project is a local transfer of water between Castaic and Wheeler Ridge. Castiac alone had the responsibility to determine the water needs of its service area and to obtain the necessary water for those needs. Castaic negotiated and entered into the transfer contract with Wheeler Ridge. Castaic performed the contract by obtaining private investors who paid $47 million to Wheeler Ridge's water, and by taking delivery from DWR. The transfer is valid and cannot be challenged. Thus, Castaic has the general governmental power over the transfer, and is presumptively the lead agency for its own project. Bakman v. Dept. of Transportation, (1979) 99 Cal.App.3d 665, 678-79. Indeed, the environmental review of water transfers is generally performed by a local, not state, agency. County of Amador v. El Dorado County Water Agency, (1999) 76 Cal.App.4th 931 (local agency's analysis of water transfer project); Save Our Carmel River v. Monterey Peninsula Water Management District, (2006) 141 Cal.App.4th 677, 701 (city was lead agency as recipient of water transfer); Friends of the Eel River v. Sonoma County Water Agency, (2003) 108 Cal.Appp.4th 859 (local agency's EIR for plan to increase diversions of water from river); Sierra Club v. West Side Irrigation District, (2005) 128 Cal.App.4th 690 (local agency's environmental review of two projects to transfer water rights).[15]

It is true that DWR has an overall interest in promoting effective water management on a statewide basis. Pursuant to this interest, DWR had the right to approve the Kern water transfer, and it did so. This does not equate to principal responsibility, however. DWR is required by statute to "facilitate" the voluntary transfer of water between local agencies. Water Code §109.

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[15]The Friends court implicitly decided that Castaic may act as lead agency for the Kern water transfer. The Friends court acknowledged that it was required to address all deficiencies in the EIR unless it made a finding of improper lead agency. Pub. Res. Code §21005(c). If Castaic was the improper lead agency for the 1999 EIR, the appellate court was obligated to say so. The Friends court concluded that the 1999 EIR's only deficiency was that it tiered from the defective Monterey Agreement program EIR. Thus, the decision necessarily implied that Castaic was the proper lead agency for the 1999 EIR.

Of course, this case concerns the 2004 EIR, not the 1999 EIR, and the court previously held that Petitioners were not bound by the Friends court's implied determination. But the project is the same, and the implicit appellate determination is entitled to weight.

Per the SWP contracts, DWR's approval of the Kern water transfer could not be unreasonably withheld. Thus, DWR's involvement in the transfer is to facilitate the transfer by approving it and providing the SWP schedule delivery. Moreover, the SWP is intended as a supplement, not the exclusive supply, of water. Water supply decisions must be made by local Water Contractors, who obtain water both from SWP and other sources.[16]

Given that the decision to enter into the Kern water transfer belonged solely to Castaic and Wheeler-Ridge, and that DWR's approval is necessary merely to facilitate the transfer, Casataic had principal responsibility for the transfer.[17]

5. Project Definition

Petitioners contend for the first time in their Supplemental Vineyard Reply and at oral argument that the correct project definition is not the Kern water transfer, but is really the Monterey Amendments, citing the court's earlier ruling on Castaic's motion for legal determination that the key issue is whether the Amendments are a "series of actions (including the Kern water transfer) so related that they should be characterized as a single project." Pet. Supp. Reply at 5.

The correct definition of the project -- whether it is the Monterey Amendments or the Kern water transfer -- is a different issue than whether Castaic can act as lead agency for the project. Although the court did allude to project definition in ruling on the earlier motion, Petitioners never raised this issue in their opening brief or reply. Instead, they raise it for the first time in a reply brief on the application of Vineyard to this case. On appeal, an issue raised without analysis or authority lacks foundation and need not be addressed. City of Arcadia v. State Water Resources Control Board, ("Arcadia") (2006) 135 Cal.App.4th 1392, 1429, 1431. Similarly, an issue raised for the first time in supplemental reply deprives the opposing party of an opportunity to analyzing the issue and defend their position. Petitioners have waived the correct project definition as an issue by not raising it earlier.

Assuming *arguendo* that the issue has not been waived, a project under CEQA includes an activity directly undertaken by a public agency which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment. Pub. Res. Code §21065(a). The "project" must be broadly defined, so as to ensure against avoiding environmental review by "chopping a larger project into little ones" or "piecemealing." Bozung v. Local Agency Formation Commission, (1975) 13 Cal.3d 263, 283-84. The project includes "the whole of an action" that has a potential for resulting in a direct or indirect physical change in the environment. Guidelines §15378. An accurate project description is necessary for an intelligent evaluation of the potential environmental effects of a

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[16]As Wheeler Ridge points out, DWR was not the lead agency for the 1991 Devils Den transfer or any of the Attachment E transfers listed in the Monterey Agreement.

[17]Given that DWR's approval may not be unreasonably withheld, cases holding that a state agency should prepare the EIR where it has final authority to approve a project are simply inapposite. *See* Fullerton v. State Board of Education, (1982) 32 Cal.3d 779, 795, n.15 (State Board of Education had final authority to submit plan to voters for new unified school district).

proposed activity. Mcqueen v. Board of Directors, (1988) 202 cal.App.3d 1136, 1143. The agency must avoid "piecemealing" or splitting a project into two or more segments. Otherwise, the cumulative environmental impacts of each piece may not be fairly analyzed. Burbank-Glendale-Pasadena Airport Authority v Hensler, (1991) 233 Cal.App.3d 577, 592. On the other hand, CEQA was not intended to and cannot reasonably be construed to make a project of every activity of a public agency, regardless of the nature and objective of such activity...." Simi Valley Recreation & Park District v. Local Agency Formation Commission, (1975) 51 Cal.App.3d 648, 663.

In San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus, (1994) 27 Cal.App.4th 713, 731-32, the court held that the project description in an EIR was improperly restricted to a 633 single family residential units, a 40,500 square foot commercial center, and a 14 acre park, failing to include sewer expansion which the EIR acknowledged would be required as part of the development. Although a separate EIR was prepared for the sewer expansion, neither it nor the development project EIR referred to the growth-inducing effects of the two projects considered together. This failure to address cumulative impacts was a separate failure of the development EIR. 27 Cal.App.4h at 733. "[t]he danger of filing separate environmental documents for the same project is that considration of the cumulative impact on the environment of the two halves of the project may not occur. This danger was here realized." Id. at 734 (citation omitted). Because the EIR did not "adequately apprise all interested parties of the true scope of the project for intelligent weighing of the environmental consequences of the project" informed decision-making was precluded, the EIR was inadequate. Id.

The lesson from San Joaquin and other project definition cases is that the project should be defined broadly to ensure a complete analysis of impacts resulting from future expansion or continuation of other phases of the project.

In this case, DWR is the lead agency for the Monterey Amendments program EIR. DWR's description of its project is to improve the management of SWP supplies and operations through the Monterey Amendments. Thus, the Monterey Amendments EIR is broad in scope. The EIR will look at changing the allocation of all SWP water supplies (including deletion of agriculture first shortage provisions), retiring 45,000 acre feet of agricultural water, and establishing more efficient use of SWP facilities. As part of the analysis, it will analyze the potential impacts from permanently transferring 130,000 acre feet of water from agricultural to urban contractors per the Monterey Agreement. This analysis will look at the individual transfers, including the Kern water transfer, as they fit the entire Monterey Amendments. But DWR does not intend to consider each transfer individually; it intends to evaluate the impact of all the Attachment E transfers and the Kern water transfer as a whole. DWR Br. at 17.

Castaic's 2004 EIR project description concerns the impacts of the Kern water transfer alone. Castaic's EIR does look at cumulative impacts of the project with other projects, including the Monterey Amendments, but does not purport to assess the environmental impacts of the Monterey Amendments independent of the Kern water transfer. AR 141-42.

Castaic relies on the independent utility test to argue that the Kern water transfer is a separate project the environmental impact of which may be separately analyzed from the Monterey Amendments. The "independent utility" test has been developed in NEPA cases to determine whether multiple actions are connected so as to require an agency to consider them in

a single environmental review. Wetlands Action Network v. United Sates Army Corps. Engineers, (9th Cir. 2000) 222 F.3d 1105, 1118.[18] Pursuant to the independent utility test, where each of two projects would have taken place with or without the other, each has "independent utility" and the two are not considered so connected that an agency must consider them in a single environmental review. Native Ecosystems Council v. Dombeck, (9th Cir. 2002) 304 F.3d 886, 894. *See also* DelMar Terrace Conservancy, Inc. v. City Council of the City of San Diego, (1992) 10 Cal.App.4th 712 (freeway segment was separate project serving a viable purpose even if long-term, multi-segment plan to expand freeway never occurred, and had independent utility under CEQA).

Castaic argues that it has contemplated the Kern water transfer since 1988, when it included a transfer with Kern in its 1988 Capital Program for the Santa Clarita Valley's future water needs. For economic reasons, Wheeler Ridge, too, sought to transfer its SWP water rights since approximately 1985. Castaic concludes that the Kern water transfer would have occurred with or without the Monterey Amendments. Articles 40 and 41 of the SWP contract permitted transfers between Water Contractors, subject to DWR approval. Article 53, added to the SWP contracts by the Monterey Amendments and concerning the transfer of 130,000 acre-feet, did not "enlarge, restrict, or otherwise impact" Castaic's right to acquire water from Wheeler Ridge under Articles 40 and 41. Instead, it was merely a blanket approval of certain contemplated transfers. Castaic Op. Br. at 21. The Kern water transfer was completed, paid for, and operating since 1999. Nothing about it is tied to the outcome of the Monterey Amendments. Thus, while the transfer is part of a larger scheme (the Monterey Amendments), it is a long-planned site specific project with independent utility from the Monterey Amendments.

The court cannot conclude that the Kern water transfer would have taken place without the Monterey Amendments. True, Castaic has wanted Wheeler Ridge's SWP allocation of water since the late 1980's, and Wheeler Ridge was willing to provide it. Yet, it did not happen until after the Monterey Amendments. The contract between Castaic and Wheeler Ridge states that the transfer was taking place "in accordance with" Article 53 of the Monterey Amendments, and those Amendments change the way SWP water is allocated in California. It does not say that the transfer is being made under Article 41. Petitioners contend, and the court agrees, that only through conjecture can one conclude that Castaic and Wheeler Ridge would have entered into the transfer without the Monterey Amendments, and with Article 18's agriculture first provisions in place.[19]

Though the court cannot conclude that the Kern water transfer would have occurred without the Monterey Amendments, it can conclude that the transfer will remain in effect even if the Monterey Amendments are not approved or otherwise are mitigated under CEQA. The court

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[18]Since CEQA was modeled on the federal NEPA statute, federal decisions on NEPA are persuasive authority on CEQA issues. No Oil, Inc. v. Los Angeles, (1974) 13 Cal.3d 68, 86.

[19]When Petitioners commented on the draft EIR that any pre-Monterey Amendments transfer would be subject to Article 18's agriculture first provisions, Castaic did not say that the Kern transfer would have occurred without the Monterey Amendments. It merely responded that the transfer "could occur" either pre- or post- Monterey Amendments. AR 993.

already has indicated that the Kern water transfer is final. The parties to the transfer stated at hearing that they have no intention of rescinding it even if the Monterey Amendments are mitigated and Article 18's agriculture first provisions are in effect. This position is supported by the fact that the 2004 EIR evaluates the water supply impacts of just such a pre-Monterey Amendment Article 18 scenario. AR 186. As such, it is compelling evidence that the transfer will stand.[20]

Plainly, then, the Kern water transfer is final and will remain in place whatever happens to the Monterey Amendments. As such, the transfer has "independent utility" for purposes of environmental review. It is not so connected to the larger Monterey Amendments that the two must must be considered in a single environmental review. *See* Native Ecosystems Council v. Dombeck, 304 F.3d at 894.

6. EIR Timing

Petitioners' real argument seems to be that, whenever a program EIR is anticipated, the agency preparing an EIR for a specific project must wait for the program EIR.

This is not the law. Nothing in CEQA requires Castaic to wait for DWR's program EIR. Indeed, as a general proposition, the environmental review process should be undertaken early enough in the planning process to impact planning decisions, with the timing committed to the agency's discretion. City of Vernon v. Board of Harbor, (1988) 63 Cal.App.4th 677, 690-91. The Kern water transfer occurred almost eight years ago. It has been paid for and operating for a number of years. Castaic tried to conduct a timely environmental review, but that EIR was set aside in Friends. It is not an abuse of discretion for Castaic to want to complete the environmental review and obtain finality for the transfer without waiting for DWR's program EIR of the Monterey Amendments, now Monterey Plus.

Nor does this decision frustrate the law concerning program EIRs and tiering. The purpose of a program EIR is to document a series of actions so related that they can be characterized as one project. Friends, 95 Cal.App.4th at 1377. If the program EIR is sufficiently comprehensive, the lead agency may dispense with further environmental review for later activities within the program that are adequately covered in the program EIR. Guidelines §15618(c). Thus, the program EIR may be used to focus or simplify later environmental review, or as the basis of a tiered EIR. "Tiering" means the coverage of general matters and environmental effects in an EIR prepared for a policy, plan, program or ordinance, followed by narrower or site-specific EIRs which incorporate by reference the discussion in the prior report. *See* Pub. Resources Code §§ 21068.5, 21093 and Guideline §§ 15152, 15385. Tiering is favored "whenever feasible, as determined by the lead agency." Pub. Resources Code §21093(b). It is required where a prior EIR has been prepared and certified for a program, plan, or ordinance. Pub. Resources Code §21094(a). However, tiering is only required "where a prior environmental report has been prepared and certified for a program." Friends, 95 Cal.App.4th at 1383. It is not required, and in fact is prohibited, where the program EIR has yet to be prepared. Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova, ("Vineyard") (2007) 40 Cal.4th 412

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[20]Petitioners think so too, for their principal argument is premised on the 2004 EIR's assumption that the transfer is final for all purposes.

EIR cannot tier off of *future* environmental document).

7. Vineyard

In Vineyard, the Supreme Court addressed a county prepared EIR for a large land use development project known as "Sunrise Douglas." The principal issue was the availability of long-term water supply for the project, and the environmental impacts and mitigation for such supply. The Supreme Court analyzed the various water supply cases and distilled several principles. First, the EIR for a land use project must present sufficient facts to evaluate the pros and cons of supplying the amount of water the project will need, and not simply ignore or assume a water supply solution will be found for a development project. Second, an adequate EIR for a large project must show water supply for the entire project. It is not enough to show available water for early stages. While the agency may tier and defer analysis of certain details of later phases of long-term or complex projects, deferring analysis through tiering is appropriate when the impacts or mitigation measures are not determined by the first-tier approval and are specific to later phases. Third, the future water supplies identified and analyzed must bear a likelihood of actually being available. Finally, where there is some uncertainty about availability, CEQA requires some discussion of possible replacement sources or alternatives, and their environmental consequences.

Of particular use herein, the Supreme Court discussed the EIR's reliance on an anticipated local Water Board's master plan update, which would discuss the availability of long-term water supplies to the area and their environmental impact. The Court held that the county's EIR cannot tier from a *future* environmental document. If the environmental analysis from the Water Board's anticipated master plan update was important to understanding the long-term water supply for Sunrise Douglas, it should have been performed in the Sunrise Douglas EIR even though that might result in subsequent duplication by the Water Board's master plan update. Or, the county could have deferred analysis and approval of Sunrise Douglas until the Water Board's master plan update, then tiered the Sunrise Douglas EIR from the programmatic analysis performed by the Water Board.

The Vineyard decision shows that the timing of Castaic's project specific EIR in relation to DWR's program EIR is up to Castaic. It may either wait for DWR's program EIR and tier off of it, or prepare its own EIR for the Kern water transfer first. If it chooses the latter, Castaic may not tier off an environmental document that does not yet exist. Instead, Castaic must analyze all necessary environmental impacts and mitigations. If analysis of some portion of the Monterey Amendments is important to understanding the environmental impacts of the Kern water transfer, then analysis of that issue must be included in Castaic's EIR. But if Castaic's EIR does so, it is irrelevant that the document duplicates some of what DWR would do, or even that it may be inconsistent with DWR's analysis.[21] As DWR contends, CEQA's goal is to ensure sufficient information; it contains no prohibition against too much information. DWR Br. at 21. The timing of Castaic's EIR for the Kern water transfer is up to Castaic and Castaic alone.

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[21]As previously stated, the prospect of inconsistencies between Castaic's EIR and DWR's program EIR is diminished by Castaic's use of DWR modeling, DWR's comments and input into the 2004 EIR, and the general cooperation and coordination between the two agencies.

F. Contents of the 2004 EIR

Apart from the proper lead agency, Petitioners argue that the 2004 EIR is inadequate. Initially, the court believed that Castaic could have real problems on this issue. It is one thing for Castaic to act as lead agency on a water transfer before the program EIR is prepared; Vineyard and other case law say that Castaic may do so. But the EIR must be adequate and complete. Vineyard teaches that if analysis of some portion of the Monterey Amendments is important to understanding the environmental impacts of the Kern water transfer, then that analysis must be included in Castaic's EIR. PCL held that the "no project" alternative was particularly important for the Monterey Amendments, and the public was entitled to know what would happen if the Amendments were not approved and Article 18 was implemented in the event of water shortage. Commentators particularly wanted to know whether imposition of Article 18 might eliminate the "paper water" entitlements in the water contracts, reduce land planning decisions based on that paper water, and ultimately reduce growth and construction of additional SWP facilities. PCL, 83 Cal.App.4th at 892-3.

The court wondered whether Castaic would have the expertise to perform any analysis of the Monterey Amendments or the "no project" alternative that would be required in the 2004 EIR. However, the parties' briefs, and oral argument at hearing, have demonstrated that, with one exception, the 2004 EIR's contents are sufficiently presented. Indeed, Petitioners barely criticize the 2004 EIR's adequacy, except as it impacts the lead agency issue.

1. "Deception"

Petitioners' principal argument about content is that the 2004 EIR is deceptive in failing to make clear that the Kern water transfer is not "final." They contend that the 2004 EIR's project definition treats the Kern water transfer as an immutable *fait accompli* which fails to disclose that the "final status" of the transfer depends on the DWR's forthcoming review. According to Petitioners, the EIR improperly relies on the interim availability of the water to predict that DWR will "leave it in place," a point which the court in California Oak Foundation v. City of Santa Clarita, ("California Oak") (2005) 133 Cal.App.4th 1219, 1238, n.16 had no trouble dispatching, and also improperly states that it would be unnecessary and speculative to consider what the DWR might do to change the transfer (*See* AR 994). Pet. Op. Br. at 19-20. This false assumption that the transfer is immutable may result in land use decision-makers approving projects based on water availability "worth little more than a wish and a prayer." Id. at 20-21.

The court has determined that the transfer is final as a matter of law. Therefore, the EIR is not wrong in saying so. What Petitioners really contend is that the Kern water transfer, though final, can be affected by the DWR's program EIR through mitigations and imposition of alternatives. Yet, the EIR proceeds as if the transfer cannot be altered. As counsel described the issue at hearing, the 2004 EIR "talks about risk, but never directly informed the public about the fact that the transfer may be unwound through the Monterey Amendment EIR process." Thus, the EIR refers to the transfer as of an "*existing* 41,000 " acre feet of SWP Table A water (AR 15, 35) and states that "no permits or *other approvals* would be required other than" certification of the

EIR. AR 16.[22]

The EIR is the method for disclosure of environmental issues. Rural landowners Assn. V City Council, 43 Cal.App.3d 1013, 1020. CEQA's purpose is to compel agencies to make decisions with environmental consequences in mind, but CEQA does not and cannot guarantee that these decisions will always favor environmental concerns. Laurel Heights, 47 Cal.3d at 393. The EIR should provide sufficient analysis to allow decision-makers to make intelligent judgments about environmental consequences. Guidelines §15151. The evaluation of environmental effects need not be exhaustive, but the EIR's sufficiency is reviewed in the light of what is reasonably foreseeable. Id. Perfection is not required, but adequacy, completeness, and a good faith effort at full disclosure is. Id.

In California Oak, the court addressed the proposed development of a 584 acre industrial park project in the Santa Clarita. The City's EIR relied on the Kern water transfer for water supply, and the appellate court held that it did not adequately address the uncertainty in that water delivery. 133 Cal.App.4th at 1236. The City's comments "did little more than dismiss project opponents' concerns about water supply" and the EIR failed to discuss the adequacy and availability of water supply absent the Kern water transfer. Appendix K to the EIR did acknowledge uncertainty in the Kern water transfer, but this was insufficient in part because inforamtion "scattered here and there in EIR appendices" or a report "buried in an appendix" is not a substitute for good faith reasoned analysis. Id. at 1239 (citation omitted). Moreover, Appendix K contained no facts and analysis about the likelihood of deficit or alternative sources of supply, and was misleading about the fact that Castaic had an SWP "entitlement" without explaining that the entitlement consisted in part of "paper water." Id. at 1239-40. Hence the EIR failed as an informational document on water supply issues.

Castaic contends, and the other Respondents agree, that the 2004 EIR fully addresses the uncertainty of what DWR will do. At hearing, they contended that Petitioners really are arguing that the 2004 EIR is misleading because it does not anticipate Petitioners' argument.[23]

The EIR explains that planning for water supply to meet demands requires consideration of reliability of SWP supplies, because historical and statistical analysis show that the full Table A amount will not be available in some years. AR 41. The EIR explains that Castaic's Table A amount is the maximum SWP amount, and the amount of SWP water actually available to it varies from year to year. Id. The EIR acknowledges that DWR's allocations are based on that year's hydrological conditions, the amount of water stored in the SWP system, and contractor requests for water. AR 16. The EIR discusses the Monterey Agreement (AR 46-47), PCL and Monterey Plus. AR 17-18, 47. The EIR cautions land use planners who might rely on the EIR to predict future water supplies, that while Castaic will implement all feasible measures to obtain water "past water deliveries are not a guarantee of future delivery rates." AR 13.

The EIR considers the environmental impact of the project based on water allocation

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[22]At trial, Petitioners' counsel made plain that this issue of deception is distinct from the reliability of water delivery by DWR.

[23]Respondents' contention sounds like an argument that Petitioners failed to exhaust their administrative remedies. However, no failure to exhaust claim was made in their briefs.

scenarios of pre-Monterey Amendments without Article 18 cutbacks, pre-Monterey Amendments with Article 18 cutbacks, and post-Monterey Amendments. AR 56. The EIR argues that the project could have been authorized under Article 41, but instead was implemented under Article 53 of the Monterey Agreement. It adds that DWR is preparing a new EIR for the Monterey Amendment.

Since the Monterey Amendments change the way in which SWP water is allocated among contractors, the 2004 EIR provides three separate analyses of the project's impacts to water supply. AR 186-89. The EIR goes to great lengths to discuss the uncertainties in the Article 18 allocations. AR 187-89. For each scenario, the EIR estimates reliability based on wet, dry, and extended dry year conditions. AR 183-91. The EIR addresses direct impacts to water supply and water quality under the three water allocation scenarios. AR 202-05. It discusses indirect impacts from the growth-inducing effect of the project, and mitigations of these impacts through implementation of existing agency policies. AR 207-224. It discusses the cumulative impact of the project and other projects inside and outside the project area. AR 278-89. Finally, it addresses alternatives to the project, including a no project alternative. AR 293-300.

The EIR clearly demonstrates the variability of SWP deliveries, and covers what could happen as a result of the Monterey Amendments EIR. But Petitioners are correct that the EIR has a hole in it. The EIR does not directly explain that the project may be impacted by the outcome of the Monterey Amendments EIR. Instead, the 2004 EIR assumes there are three possible water delivery scenarios without any discussion of why or how they would occur: "Since the Monterey Amendments change the way in which SWP water is allocated among contractors, the 2004 EIR provides three separate analyses of the project's impacts to water supply." The reader is left to interpret how these allocations could come about, and must conclude on his or her own that they are three possible outcomes of challenges to the Monterey Amendments. Nor does the EIR explain how such challenges could cause these allocations to occur.

An EIR is an informational document which is supposed to provide the reader with the "analytic route the...agency traveled from evidence to action." Citizens of Goleta Valley v. Board of Supervisors, ("Goleta") (1990) 52 Cal.3d 553, 568. This means that the EIR must contain facts and analysis, not just the agency's bare conclusions or opinions. Castaic is not required to predict the outcome of litigation, and may not be able to discuss the likelihood of each of the three allocations. However, it should have at least explained why the three scenarios are relevant and how they would occur.[24] The failure to do so leaves the reader wondering why they are pertinent. Consequently, the 2004 EIR fails to provide the analytic route by which the three alternatives are relevant.

Non-compliance with the disclosure requirements of CEQA may constitute a prejudicial abuse of discretion regardless of whether the agency would have taken the same action had it complied with CEQA. Pub. Res. Code §21005(a). Still, CEQA is subject to the established principle that there is no presumption of prejudicial error. Pub. Res. Code §21005(b). Only if the manner in which the agency failed to follow the law is prejudicial must the decision be set aside. Sierra Club v. State Board of Forestry, (1994) 7 Cal.4th 1215, 1236.

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[24]For example, the court has no idea how a pre-Monterey Amendments without Article 18 cutbacks would occur.

The issue is whether Castaic's failure to supply the analytical route for its consideration of the three allocations is prejudicial. Prejudice depends on whether the failure to include this information makes "any meaningful assessment" of the project's environmental effects impossible, in which case prejudice is presumed. Sierra Club v. State Board of Forestry, (1994) 7 Cal.4th 1215, 1236 (agency approved timber harvesting plans without requiring necessary environmental information in them).[25] Even under this standard, not every CEQA failure is prejudicial. An EIR will be upheld if the error *de minimus* or clerical in nature (Save San Francisco Bay Association v. San Francisco Bay Conservation and Development Commission (1992) 10 Cal.App.4th 908, 935), the EIR analysis is comprehensive, if not perfect, despite the error (Schaeffer Land Trust v. San Jose City Council, (1989) 215 Cal.App.3d 612, 627-28), and information which should have been included to make the EIR accurate nonetheless has no material effect on informed decision-making or informed public participation (Al Larson Boat Shop, Inc. v. Board of Harbor Commissioners, (1993) 18 Cal.App.4th 729, 747-50).

The Vineyard court reiterated that the reviewing court must focus on the nature of the defect, depending on whether the claim is predominantly one of improper procedure or a dispute over facts. Where the agency has employed the correct procedures, greater deference is given to the agency's factual conclusions, which are reviewed for substantial evidence. 40 Cal.4th at 435.

The 2004 EIR's non-compliance concerns its analytic route – why and how the three allocations are pertinent. This is not a fact issue to be supported by substantial evidence. Instead, it is a failure affecting the public's ability to make a "meaningful assessment" of the project's environmental effects. As such, it is prejudicial. *See also* Rural Land Owners Assn. v. Lodi City Council, (1983) 143 Cal.App.3d 1013, 1023 (whenever failure to comply with CEQA results in a subversion of its purposes by omitting information from the environmental review process, the error is prejudicial).[26]

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[25]One appellate court, Resource Defense Fund v. Local Agency Formation Commission, (1987) 191 Cal.App.3d 886, 897-98 has stated that "[f]ailure to comply with CEQA is necessarily prejudicial." This does not appear to be the consensus approach. *See* Dusek v. Anaheim Redevelopment Agency, (1985) 173 Cal.App.3d 1029, 1040-42 ("a minor CEQA sin or two" constituting technical defects where the public had not been misled or defrauded is not enough for prejudice).

[26]Petitioners also argue that the 2004 EIR finesses the non-final nature of the project by jumping the gun and analyzing pre-Monterey Amendments. According to Petitioners, Castaic performed a "mini-programmatic review" at AR 155-06 and App. D (AR 468-550). The charts at AR 184 and 506 show this. According to Petitioners, this is not just factual overlap; this is usurpation of DWR's responsibilities.

DWR correctly points out that Petitioners are complaining about too much information, something that CEQA does not proscribe. Petitioners have no complaint about the content of the mini-program review. To the extent that Castaic performed a task that DWR is obligated to perform, DWR may either use Castaic's analysis or perform a new one. The cooperation of DWR and Castaiac suggests that the overlapping environmental analysis will be consistent. Even if inconsistent, DWR's analysis will control for the Monterey Amendments. There is no

2. Modeling

Petitioners contend that Castaic used an obsolete DWR model, DWRSIM, for making predictions about the amount of SWP water that could be available as a result of the Kern water transfer. DWR has used CALSIM II for modeling SWP deliveries since 2000. While the EIR uses CALSIM II to look at the environmental setting, it only uses DWRSIM to look at environmental impacts. According to Petitioners, Castaic's rationale for doing so -- that DWRSIM should be used for the 1998 environmental setting -- makes no sense. Modeling is for future results, not historical analysis.

Petitioners argue that Castaic's use of an old model prejudicially overstates the reliability of SWP water delivery. App.D, Table 2-2 compares the projected 2020 deliveries based on the two different models. AR 493. The graph shows a discrepancy between the two models, particularly in the 50-70% supply range, and most glaringly in the range of drought conditions. Although the EIR does not quantify these differences, Castaic's responses to public comments presents a table that does. The table shows that the two models can differ by as much as 5000 acre-feet. Pet. Op. Br. at 23. According to Petitioners, this is not the "slight discrepancy" DWR states it is.

When a challenge is brought to studies on which an EIR is based, "the issue is not whether the studies are irrefutable or whether they could have been better. The relevant issue is only whether the studies are sufficient credible to be considered as part of the total evidence that supports the" agency's decision. Laurel Heights, 47 Cal.3d at 409 (lead agency entitled to choose and rely on expert opinion even though others may disagree). Expert testimony constitutes substantial evidence and an agency is entitled to rely on it. Uhler v. City of Encinitas, (1991) 227 Cal.App.3d 795, 805. Even where experts disagree, the agency is entitled to choose one expert's opinion over another. Laurel Heights, 47 Cal.3d at 409. The party challenging the EIR bears the burden of demonstrating that the studies on which the EIR is based "are clearly inadequate or unsupported." State Water Resources Control Board Cases, (2006) 136 Cal.App.4th 674, 795.

CEQA requires Castaic to reasonably inform the reader about the amount of water available. The EIR states that all environmental impacts from the project are driven by the amount of water delivered and the timing of delivery. AR 55. Castaic analyzed the amount of SWP water available for delivery through hydrologic modeling with computer simulations that predict the amount of water available under various hydrologic conditions. To do so, the EIR, like all EIR's had to have an environmental setting for the project. This environmental setting describes the conditions of the project as they exist at the time the Notice of Preparation is published or, if there is none, at the time the environmental analysis is commenced. This setting will normally constitute the baseline physical conditions by which an agency determines whether an impact is significant. Guidelines §15125(a).

The 2004 EIR states that its baseline 1998 environmental setting used DWRSIM, which is a model simulating the operations of the SWP, "because this is the modeling tool that was available during 1998." AR 55. DWR had used DWRSIM in 2000 to conduct a reliability study for another project. The 2004 EIR does use CALSIM II for the current environmental setting of

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usurpation of responsibility.

the project. CALSIM II was available because DWR performed a SWP Delivery Reliability Report in 2003 using CALSIM II as its model. AR 56. Although the modeling tools are different, the criteria used to input into the computer simulation has not changed significantly. Id.

The question raised by Petitioners is why use an older computer simulation model (DWRSIM) for the 1998 baseline when a newer model (CALSIM II) was available? Appendix D of the 2004 EIR, entitled "Technical Data for Hydrologic Analysis," explains that Castaic had to do so because it did not perform any model analysis of its own. Instead, Castaic relied upon DWR's expertise, and its existing model studies. *See* AR 491. DWR used DWRSIM in its 2000 study and CALSIM II in its 2003 study; Castaic relied upon those same studies and same models.

Castaic's reliance on DWR's existing studies and its expertise is an explanation, but the issue becomes whether it is an adequate one.

The answer is in Appendix D, which explains that DWRSIM has a database of monthly runoff based on historic hydrologic data for a 73 year period from 1922-74. DWRSIM takes this data and, depending on the input variables of operating constraints and water contractor demand, estimates the amount of water SWP can deliver each month over that 75 year period. Assuming that hydrologic conditions repeat, the operator can predict the amount of water available under that particular hydrologic condition and with a particular demand and operating condition. AR 491.

Appendix D then shows that DWRSIM and CALSIM II predict similar outcomes, and that the differences in their predictions can be explained. In Figures 2-1 and 2-2 of Appendix D, Castaic compares the two models' prediction of SWP water deliveries at existing demand and at predicted 2020 demand levels. AR 493. The "existing demand" for the DWRSIM model is 1998 demand. The "existing demand" for the CALSIM II model is 2001 estimated demand. The 2001 demand is higher than the 2000 demand. Consistent with reality, the model will only show delivery up to the amount of demand; SWP will not deliver more water than is asked for even if it is available. This difference in demand explains why CALSIM II shows more delivery in wet years than DWRSIM; the lower demand in 1998 limits the amount of delivery.

The difference in demand also explains in part why CALSIM II predicts a higher delivery in extremely dry conditions; 1998's lower demand means more water is left in storage from the preceding year and is available for delivery in a dry year. Appendix D says that the proof is in the pudding: comparison of DWRSIM and CALSIM II in Figure 2-2, for the year 2020 with the same level of demand for each model, shows very close prediction of SWP delivery for both models. AR 492-93.

Castaic concludes that the two models predict "generally comparable" results and their differences are minimal. AR 491, 1003. Castaic argues that, if anything, the slightly higher supplies predicted by the DWRSIM model provide a worst case scenario for purposes of growth inducing impacts; the more water the more developers will grow the Santa Clarita Valley. AR 1003-04, 1009.

Contrary to Petitioners' argument, the use of DWRSIM and not CALSIM II in the 1998 baseline study does not affect the conclusion that the study constitutes substantial evidence. Petitioners do not present expert opinion that the use of DWRSIM results in any error. They merely rely on the differences in Figures 2-1 and 2-2 of Appendix D, and Appendix D explains

the reason for the differences. As Castaic points out, Petitioners cannot point to any environmental significance to the use of DWRSIM and not CALSIM II. Therefore, Petitioners have not met their burden of demonstrating that use of DWRSIM for the 1998 baseline in the 2004 EIR was "clearly inadequate or unsupported."[27]

3. Cumulative Impacts

Petitioners contend that the 2004 EIR attempts to assess the project's impacts on the SWP without discussion why Castaic is competent to do so. As an example, the EIR rejects any significant project impact on the Delta, even though it acknowledges that differences in timing in the use of water for urban (Castaic) rather than agricultural (Wheeler Ridge) purposes would change the timing of deliveries. AR 192. Petitioners argue that the Delta is "in crisis" and there is great potential for conflict between Castaic's and DWR's respective environmental analysis. Pet. Op. Br. at 23-4.

An EIR must contain a cumulative impacts analysis of the project's environmental impact when considered in conjunction with other projects (Guidelines §15130) in order to ensure that "the entire relevant environmental picture" has been adequately considered. Laupheimer v. State of California, (1988) 200 Cal.App.3d 440, 462. A cumulative impact consists of an impact which is created as a result of the combination of the project evaluated in the EIR together with other projects causing related impacts. Guidelines §15130(a)(1). The EIR should not discuss impacts which do not result at least in part from the project being evaluated. Id. The analysis should reflect the severity and likelihood of occurrence of the impact. Guidelines §15130(b). In every case, there should be at least a preliminary search for potential cumulative environmental effects and a preliminary assessment of their significance. Laupheimer, 200 Cal.App.3d at 462-63. The detail required in a cumulative impacts discussion need not be as great as provided for the environmental impacts attributable to the project alone. Guidelines §15130(b). Generally, the EIR should list the projects producing cumulative impacts or provide a summary of projections contained in a prior certified or adopted environmental document which describe the regional conditions contributing to the cumulative impact. Guidelines §15130(b)(1). The 2004 EIR uses the list approach to discuss cumulative impacts of the project's environmental impact when considered in conjunction with other projects. AR 241-289.

Castaic argues that everything that happens with respect to the Kern water transfer happens south of the Delta, and the EIR thoroughly discusses that, including the impact of the timing of deliveries. AR 193-06. Thus, the EIR's conclusion that the project will have no direct

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[27]Castaic does not have statewide expertise on SWP reliability, but its consultants and DWR do. In commenting on Castaic's draft EIR, DWR stated that the differences between CALSIM II and DWRSIM "may cause slight changes in results, which may lead DWR to different conclusions....[in DWR's Monterey Amendments EIR]" AR 564. However, DWR also found that the draft EIR adequately and thoroughly discussed the project and its impacts, including the effects of the project on the environment and the SWP, using appropriate baseline conditions, and had a good discussion of the relationship between the Kern water transfer and Monterey Plus. DWR concluded that the draft EIR a "adequately discusses the reliability of the SWP, pre- and post- Monterey Amendment conditions, and SWP operations." AR 564-65.

significant impact on the SWP or related facilities is fully supported. Castaic contends that Petitioners really are attacking its ability to act as lead agent for a local project if the project has the potential for statewide impact. According to Castaic, this argument goes to the lead agency issue, and is incorrect as a matter of law. Castaic is qualified and required by CEQA to assess impacts that occur outside of its borders in evaluating the Kern water transfer. Citizens of Goleta Valley v. Board of Supervisors, (1990) 52 Cal.3d 553, 573.

The court does not know whether Petitioners really are attacking Castaic's expertise or the adequacy of its assessment of SWP impacts from the Kern transfer. The reason is that Petitioners' arguments are conclusionary and unsupported by analysis, authority, or many facts. Petitioners' obligation was to point out what is wrong with the analysis, or what has been omitted that was required. An issue raised without analysis or authority lacks foundation and need not be addressed. Arcadia, 135 Cal.App.4th at 1429, 1431. The court has no obligation to search the EIR's cumulative analysis section to look for defects. Their general objection requires only a general response that Castaic's cumulative impacts analysis is adequate.

4. The "No Project" Alternative

Petitioners argue that the 2004 EIR fails to address the "no project" alternative, an issue particularly important because it was the principal defect in the PCL Monterey Agreement EIR. As the PCL court stated, a "no project" alternative must discuss "existing conditions" and "what would reasonably be expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services." 83 Cal.App.4th at 912. The Monterey Agreement EIR did not discuss the projections related to land planning, demand for water, and other impacts of reducing entitlements pursuant to Article 18(b). Id. at 919. Petitioners contend that the 2004 EIR does discuss the water supply reliability impacts of invoking Article 18(b), but not the statewide impacts the PCL court found so crucial.

The short answer to Petitioners contention is that 2004 EIR addresses a different project than the Monterey Amendments. The "no project" alternative for any EIR requires a comparison of the impacts of approving the project with the effect of not doing so. Guidelines §15126.6.(e)(1); Mira Mar Mobile Community v. City of Oceanside, (2004) 119 Cal.App.4th 477, 488-89. The only "no project alternative" that Castaic is obligated to consider is the alternative of "no Kern water transfer." Castaic has addressed this alternative by discussing groundwater sources of water and a possible moratorium. AR 291-4. Petitioners do not quibble with this analysis. But Castaic had no obligation to consider "no Monterey Amendments" as a no project alternative.[28] Indeed, it would make no sense to evaluate "no Monterey Amendments" as an alternative to the Kern water transfer.[29]

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[28]Of course, the 2004 EIR is obligated to consider invocation of Article 18(b) as a reasonably foreseeable environmental impact, and the adequacy of it doing so has been discussed.

[29]For a similar reason, Castaic need not analyze alternative uses of the SWP water in a "no project" alternative. CEQA does not require consideration of alternatives that do not meet the project objective; *i.e.*, delivery of water to Castaic's customers. *See* Guidelines §15126.6(c).

5. Post-Hoc Rationalization

Petitioners also suggest that the 2004 EIR is a post-hoc rationalization for "a decision already made." Pet. Op. Br. at 18. Pre-judging environmental decisions in order to accomplish a project is prohibited under CEQA. An agency may not commit to a project before CEQA review is completed because a fundamental purpose of an EIR is to provide decision-makers with information they can use in deciding whether to approve a project. Therefore, post-approval environmental review has been condemned. Laurel Heights, 47 Cal.3d at 394. *See* Residents Ad Hoc Stadium Com. v. Board of Trustees, (1979) 89 Cal.App.4th 274, 285. Of course, an agency contemplating a project may be presumed to favor the project, and CEQA assumes this to be inevitable. Therefore, it builds in procedural protections to insure that the decision-maker does not fail to note the facts and arguments by opponents to the EIR. Id. at 285.

Castaic had completed the transfer and performed under it for several years prior to preparing the 2004 EIR. Plainly, it desires to keep the transfer and not change it. When the 1999 was found deficient, Castaic was required under CEQA to perform a "fresh look" at the transfer's environmental impacts. With the exception of the analytical hole discussed above, it has done so. *See* City of Vernon v. Board of Harbor, (1998) 63 Cal.App.4th 677, 1523 (adequacy of EIR overcomes contention that it was a post-hoc rationalization).

G. Conclusion

Castaic may act as the lead agency for the Kern water transfer. The 2004 EIR was properly prepared except for one defect – it fails to show the analytic route as to how and why the three allocations of pre-Monterey Amendments, pre-Monterey Amendments without Article 18, and post-Monterey Amendments are relevant and would occur. The court offers no opinion on whether this failure must be rectified by addendum (Guidelines §15164), a subsequent EIR, a supplement to EIR, or a new EIR. That determination is Castaic's to make in the first instance.

The Petition for Writ of Mandate is granted in part. A writ shall issue commanding Castaic to set aside its approval of the 2004 EIR and comply with CEQA, either through the preparation of a new EIR or other environmental documentation, such as an addendum, addressing the analytic route of the three water allocations. Castaic is not directed to set aside the Kern water transfer. Judgment shall be entered in favor of Petitioners solely on this issue.

This shall serve as the court's proposed statement of decision in compliance with CRC 232(c). If there are no written objections filed, the statement shall be final. As Respondents have prevailed on all but one issue, Castaic's council is ordered to prepare a writ of mandate and judgment consistent with this decision, and serve it on all other counsel for approval as to form. After 10 days, Castaic may file the proposed writ and judgment with the court, along with a declaration stating the nature and extent of any objections received. An OSC re: judgment shall be set for April 23, 2007.

Dated: April 2, 2007

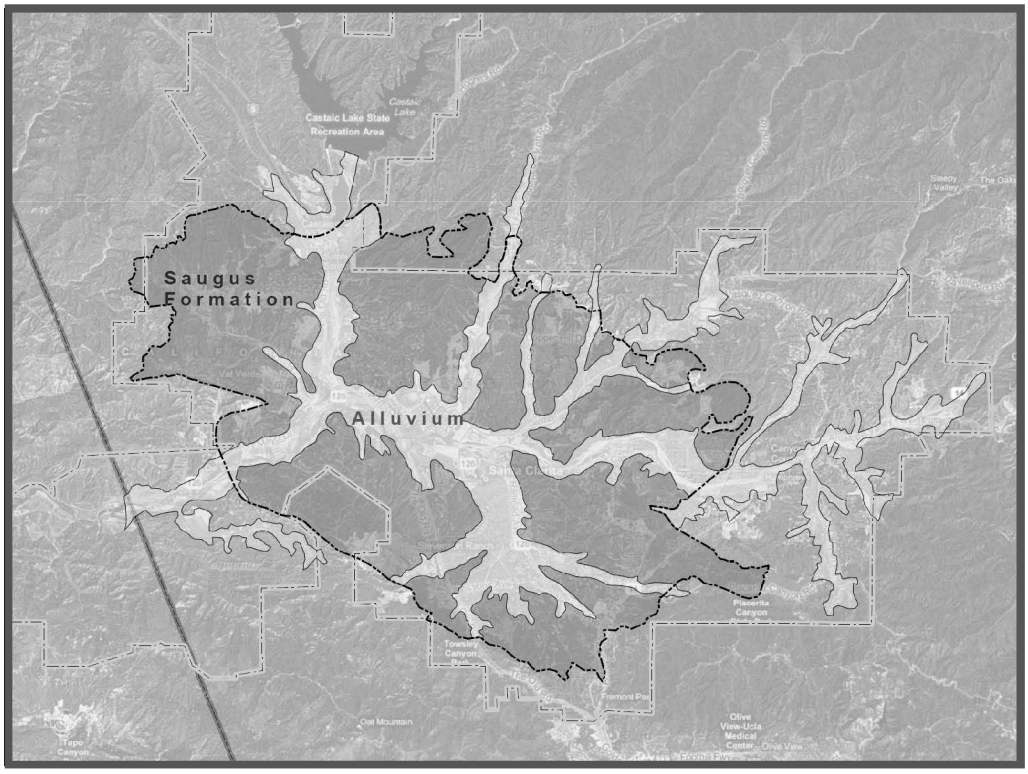
/s/ JAMES C. CHALFANT

Superior Court Judge

JAMES C. CHALFANT

Luhdorff & Scalmanini Consulting Engineers, "2009 Santa Clarita Valley Water Report" (May 2010)

2009
Santa Clarita Valley
Water Report



Castaic Lake Water Agency (CLWA)
CLWA Santa Clarita Water Division
Los Angeles County Waterworks District 36
Newhall County Water District
Valencia Water Company
May 2010

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

2009 Santa Clarita Valley Water Report

prepared for:

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CONSULTING ENGINEERS

Table of Contents

Page

Executive Summary ES-1
- ES.1 2009 Water Requirements and Supplies 1
- ES.2 Alluvial Aquifer 3
- ES.3 Saugus Formation 4
- ES.4 Imported Water 5
- ES.5 Recycled Water 6
- ES.6 2010 Water Supply Outlook 7

1. Introduction 1-1
- 1.1 Background 1
- 1.2 Purpose and Scope of the Report 2
- 1.3 Santa Clarita Valley Water Purveyors 3
- 1.4 The Upper Santa Clara River Hydrologic Area and East Groundwater Subbasin 3

2. 2009 Water Requirements and Supplies 2-1

3. Water Supplies 3-1
- 3.1 Groundwater Basin Yield 1
- 3.2 Alluvium – General 5
- 3.2.1 Alluvium – Historical and Current Conditions 7
- 3.3 Saugus Formation – General 9
- 3.3.1 Saugus Formation – Historical and Current Conditions 10
- 3.4. Imported Water 11
- 3.4.1 State Water Project Table A Supplies 12
- 3.4.2 Other Imported Water Supplies 13
- 3.4.3 Imported Water Supply Reliability 14
- 3.5 Water Quality – General 15
- 3.5.1 Groundwater Quality – Alluvium 19
- 3.5.2 Groundwater Quality – Saugus Formation 19
- 3.5.3 Imported Water Quality 20
- 3.6 Recycled Water 20
- 3.7 Santa Clara River 21

4. Summary of 2009 Water Supply and 2010 Outlook 4-1

5. Water Conservation 5-1

6. References 6-1

Figures

(all figures follow their respective sections)

1-1	CLWA and Purveyor Service Areas
1-2	Santa Clara River Groundwater Subbasins
1-3	Annual Precipitation and Cumulative Departure from Mean Annual Precipitation at Newhall-Soledad 32c Gage
2-1	Total Water Supply Utilization Santa Clarita Valley
3-1	Alluvium and Saugus Formation Santa Clara River Valley, East Groundwater Subbasin
3-2	Groundwater Production - Alluvium Santa Clara River Valley, East Groundwater Subbasin
3-3	Alluvial Well Locations By Area Santa Clara River Valley, East Groundwater Subbasin
3-4	Groundwater Elevations in Eastern Santa Clarita Valley Alluvial Wells
3-5	Groundwater Elevations in Western Santa Clarita Valley Alluvial Wells
3-6	Annual Groundwater Production from Alluvium by Area (Acre-feet) Santa Clara River Valley, East Groundwater Subbasin
3-7	Saugus Well Locations Santa Clara River Valley, East Groundwater Subbasin
3-8	Groundwater Production – Saugus Formation Santa Clara River Valley, East Groundwater Subbasin
3-9	Groundwater Elevations in Saugus Wells
3-10	Treated Water Distribution System Castaic Lake Water Agency

Figures, continued

(all figures follow their respective sections)

3-11	Groundwater Quality in Eastern Santa Clarita Valley Alluvial Wells
3-12	Groundwater Quality in Western Santa Clarita Valley Alluvial Wells
3-13	Groundwater Quality in Saugus Wells
3-14	Annual Stream Discharge Santa Clara River
4-1	Historical and Projected Water Use Santa Clarita Valley

Tables

		Page
ES-1	Santa Clarita Valley Summary of 2009 Water Supplies and Uses	ES-2
2-1	Water Supply Utilization by Municipal Purveyors	(after) 2-2
2-2	Individual Water Supply Utilization by Agricultural and Other Users	(after) 2-2
2-3	Total Water Supply Utilization for Municipal, Agricultural and Other Uses	(after) 2-2
3-1	Groundwater Operating Plan for the Santa Clarita Valley	3-3
3-2	2009 CLWA Imported Water Supply and Disposition	(after) 3-13
4-1	2010 Water Supply and Demand	(after) 4-2

Executive Summary

This annual report, which is the twelfth in a series that began to describe water supply conditions in 1998, provides current information about the water requirements and water supplies of the Santa Clarita Valley. The report was prepared for the imported water wholesaler, Castaic Lake Water Agency (CLWA), and for the four local retail water Purveyors that serve the Valley: CLWA Santa Clarita Water Division, Los Angeles County Waterworks District 36, Newhall County Water District, and Valencia Water Company. These entities and representatives from the City of Santa Clarita and the County of Los Angeles Department of Regional Planning meet as required to coordinate the management of imported water with local groundwater and recycled water to meet water requirements in the Valley.

This report provides information about local groundwater resources, State Water Project (SWP) and other imported water supplies, water conservation, and recycled water. The report reviews the sufficiency and reliability of supplies in the context of existing water demand, with focus on actual conditions in 2009, and it provides a short-term outlook of water supply and demand for 2010.

ES.1 2009 Water Requirements and Supplies

In 2009, total water requirements in the Santa Clarita Valley were about 86,600 acre-feet (af), of which about 70,000 af (81 percent) were for municipal use and the remainder (16,600 af) was for agricultural and other (miscellaneous) uses, including individual domestic uses. Total demand in 2009 was about 4.5 percent lower than in 2008, less than what was estimated in the 2008 Water Report, and water requirements in 2009 were also lower than the average projection in the 2005 Urban Water Management Plan (UWMP) (but closer to the projection in the 2005 UWMP with conservation). The majority of decreased water demand is attributable to a significant (8%) decrease in municipal water use from 2008. Total water requirements in 2009 were met by a combination of about 47,700 af from local groundwater resources (about 31,100 af for municipal and about 16,600 af for agricultural and other uses), about 38,600 af of SWP and other imported water, and about 300 af of recycled water.

Of the 47,700 af of total groundwater pumping in the Valley in 2009, about 40,000 af were pumped from the Alluvium and about 7,700 af were pumped from the underlying, deeper Saugus Formation. Alluvial pumping represented about a 1,750 af decrease from 2008, and Saugus pumping was slightly higher than in 2008, by about 750 af. Neither pumping volume resulted in any notable overall change in groundwater conditions (water levels, water quality, etc.) in either

aquifer system. Imported water deliveries to the Purveyors decreased by about 3,200 af from the previous year. Water uses and supplies in 2009 are summarized in the following Table ES-1.

Table ES-1
Santa Clarita Valley
Summary of 2009 Water Supplies and Uses
(acre-feet)

Municipal		
SWP and other Imported		38,546
Groundwater (Total)		31,100
Alluvium	*24,396*	
Saugus	*6,704*	
Recycled Water		328
Subtotal		**69,974**
Agriculture/Miscellaneous		
SWP and other Imported		-
Groundwater (Total)		16,564
Alluvium	*15,590*	
Saugus	*974*	
Subtotal		**16,564**
Total		***86,538***

In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was updated in 2005 to extend projected water demands through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project and other sources, local recycled water supplies, and other water supplies planned to meet those existing and projected water demands in the Valley. The 2005 UWMP describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand, including consideration of the impacts of perchlorate contamination on several municipal water supply wells. The 2005 UWMP also describes the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.

Notable details about each component of water supply in the Valley, and about the water supply outlook for 2010, include the following.

ES.2 Alluvial Aquifer

The groundwater operating plan in the 2005 UWMP includes Alluvial pumping in the range of 30,000 to 40,000 acre-feet per year (afy) following average/normal years, and slightly reduced pumping (30,000 to 35,000 afy) following dry years. An updated review of groundwater basin yield, completed in 2009, includes the same basic range of Alluvial pumping in the 2008 groundwater Operating Plan. Pumping from the Alluvium in 2009 was 40,000 af, which is at the upper end of the operating plan range for the Alluvium and had no adverse effects on groundwater levels and storage in the basin. On average, pumping from the Alluvium has been about 32,000 afy since supplemental imported water became available in 1980. That average rate remains near the lower end of the range of operational yield.

On a long-term basis, continuing through 2009, there is no evidence of any historic or recent trend toward permanent water level or storage decline. In general, throughout a large part of the basin, Alluvial groundwater levels have generally remained near historic highs during the last 30 years. Above average precipitation in late 2004 and 2005 resulted in significant water level recovery in the eastern part of the basin, continuing the overall trend of fluctuating groundwater levels within a generally constant range over the last 30 years. These ongoing data indicate that the Alluvium remains in good operating condition and can continue to support pumping in the operating range included in the 2005 UWMP, or slightly higher, without adverse results (e.g., long-term water level decline or degradation of groundwater quality.)

Based on an integration of water quality records from multiple wells completed in the Alluvium, there have been historical fluctuations in groundwater quality, typically associated with variations in precipitation and streamflow. However, like groundwater levels, there has been no long-term trend toward groundwater quality degradation; groundwater produced from the Alluvial aquifer remains a viable municipal and agricultural water supply.

In 2002, as part of ongoing monitoring of wells for perchlorate contamination, perchlorate was detected in one Alluvial well (the SCWD Stadium Well) located near the former Whittaker-Bermite facility. The detected concentration was slightly below the then-applicable Notification Level for perchlorate (6 μg/l, which was subsequently established as the Maximum Contaminant Level for perchlorate in October 2007), and the well has now been replaced to restore that component of municipal water supply that was impacted by perchlorate. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. After an interim period of wellhead treatment, that well has now been returned to regular water supply service. All other Alluvial wells operated by the Purveyors continue to be used for municipal water supply service;

those wells near the Whittaker-Bermite property are sampled in accordance with drinking water regulations and perchlorate has not been detected. As detailed in the 2005 UWMP, the ongoing inactivation of one Alluvial well due to perchlorate contamination does not limit the Purveyors' ability to produce groundwater from the Alluvium in accordance with the groundwater operating plan in the 2005 UWMP or the now updated 2008 groundwater Operating Plan.

The ongoing characterization and plan for control and cleanup of perchlorate in the Valley has focused on the Saugus Formation. In addition, however, on-site cleanup and control activities that began in 2006, and continued through 2009, include continuation of soil cleanup on the Whittaker-Bermite site, and continuation of pumping and treatment in the Northern Alluvium on the Whittaker-Bermite site. Expanded pumping and treatment, intended to effect perchlorate containment in the Northern Alluvium, became operational in October 2007. Under the direction of the State Department of Toxic Substances Control (DTSC), Whittaker has submitted a comprehensive site-wide remediation plan for the contaminants of concern in soil and groundwater detected on the site. A Draft Remedial Action Plan for Operable Units 2 through 6, focused on soil remediation, was submitted to DTSC in 2009. Whittaker has also completed a Draft Feasibility Study for Operable Unit 7 to identify and select treatment technologies for both on-site and off-site groundwater. Final approval of soil and groundwater clean-up plans by DTSC is expected by the end of 2010.

ES.3 Saugus Formation

The groundwater operating plan in the 2005 UWMP includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years; it also includes planned dry-year pumping from the Saugus of 21,000 to 35,000 afy for one to three consecutive dry years. The 2005 UWMP recognizes the results of basin yield analyses in 2004 and 2005 which found that such short-term pumping can be recharged during subsequent wet/normal years to allow groundwater levels and storage to recover, as it has in historical periods. The 2008 groundwater Operating Plan includes the same broad ranges by Saugus pumping.

Pumping from the Saugus Formation was about 7,700 af in 2009; on average, Saugus pumping has been about 6,800 afy since 1980. Both rates remain near the lower end of the ranges included in the groundwater operating plans and in the UWMP. As a result of long-term relatively low pumping from the Saugus Formation, groundwater levels in that aquifer have remained generally constant to slightly increasing over the last 35 to 40 years; those trends continued in 2009.

In 1997, ammonium perchlorate was discovered in four wells completed in the Saugus Formation in the vicinity of the former Whittaker-Bermite facility located generally toward the east, on the south side of the basin. All four of those impacted wells remain out of active supply service; one of them has been permanently sealed and destroyed. In 2006, a very low level of perchlorate was detected in another Saugus municipal well (NCWD's Well NC-13). That low level detection has been interpreted to not indicate anything new about the migration of perchlorate; however, it has also prompted additional monitoring well installation and a focused study of the Saugus Formation in that area. Results are being integrated with other groundwater remediation efforts and reviewed by the DTSC. All other Saugus wells owned and operated by the Purveyors are available for municipal water supply service. As part of regular operation, those wells are sampled in accordance with drinking water regulations and perchlorate has not been detected. Despite the inactivated Saugus wells, the Purveyors still have sufficient pumping capacity in other wells to meet the planned normal range of Saugus pumping in the 2005 UWMP.

Work toward the ultimate remediation of perchlorate contamination, including the restoration of impacted groundwater supply continued to progress in 2009, with focus on construction of facilities to implement a jointly developed plan to "pump and treat" contaminated water from two of the originally impacted wells to stop migration of the contaminant plume, and to deliver treated water for municipal supply to partially replace impacted well capacity. Environmental review of the project was completed with adoption of a Mitigated Negative Declaration in September 2005. The Final Interim Remedial Action Plan was completed and approved by DTSC in January 2006. Construction of facilities and pipelines necessary to implement the pump and treat program and to also restore inactivated well capacity began in November 2007. Construction was completed in spring 2010, and operational start-up is ongoing as this report is being written.

ES.4 Imported Water

Historically comprised of only its SWP Table A Amount, CLWA's imported water supplies now consist of a combination of SWP water and water acquired from the Buena Vista Water Storage District in Kern County. CLWA's contractual Table A Amount is 95,200 af of water from the SWP. Under the 2007 Water Acquisition Agreement with the Buena Vista Water Storage District (Buena Vista) and the Rosedale-Rio Bravo Water Storage District (Rosedale-Rio Bravo), Buena Vista's high flow Kern River entitlements (and other acquired waters that may become available) are captured and recharged within the Rosedale-Rio Bravo's service area on an ongoing basis. CLWA will receive 11,000 af of these supplies annually through either exchange

of Buena Vista's and Rosedale-Rio Bravo's SWP supplies or through direct delivery of water to the California Aqueduct via the Cross Valley Canal.

CLWA's final allocation of SWP water for 2009 was 40 percent of its Table A Amount, or 38,080 af. The total available imported water supply in 2009 was 67,050 af, comprised of the 38,080 af of Table A supply, 11,000 af purchased from Buena Vista/Rosedale Rio Bravo, 14,610 af of 2008 carryover delivered in 2009, 1,650 af recovered from the Semitropic Water Banking and Exchange Program, 52 af from the 2009 SWP Turnback Pool and 1,658 af through the Yuba Accord. CLWA deliveries to the Purveyors were 38,546 af. Following disposition of available water supplies in 2009, carryover of 28,303 af from 2008 and 2009 is available for 2010 water supply. No additional banking of imported water occurred in 2009.

CLWA has two groundwater banking agreements with the Semitropic Water Storage District in Kern County. In accordance with those agreements, over a ten-year period (until 2012/13), CLWA could withdraw up to 50,870 af of its Table A water that was stored in 2002 and 2003 to meet future Valley demands when needed. Following the withdrawal of 4,950 af in 2009 (1,650 af utilized in 2009 and 3,300 af planned to be utilized in 2010), that balance is 45,920 af. In addition to the banking in Semitropic, CLWA finalized an agreement with the Rosedale-Rio Bravo Water Storage District in 2005 and can now bank up to 100,000 afy of surplus Table A Amount in that District's Water Banking and Exchange Program. In addition to 20,000 af previously banked in both 2005 and 2006, CLWA banked 8,200 af of water in 2007. In accordance with the provisions of that agreement, CLWA can withdraw up to a total of 42,900 af of that water, at a rate up to 20,000 afy, to meet Valley water demands when needed. Additionally, as part of the Buena Vista Water Acquisition Agreement, CLWA is entitled to 22,000 af of water that was stored in the Rosedale Rio-Bravo Water Banking and Exchange Program in 2005 and 2006 on CLWA's behalf. As of 2010, CLWA maintains a recoverable total of 64,900 af in the Rosedale Rio-Bravo Water Banking and Exchange Program.

Since SWP water deliveries are subject to reduction when dry conditions occur in Northern California, the UWMP includes programs, like the Semitropic and Rosedale-Rio Bravo programs, for enhancing water supply reliability during such occurrences. A capital improvement program funded by CLWA has been established to provide facilities and additional water supplies needed to firm up SWP water supplies during times of drought.

ES.5 Recycled Water

Recycled water service was initiated in July 2003 in accordance with CLWA's Draft Reclaimed

Water System Master Plan (2002). The amount of recycled water used for irrigation purposes, at a golf course and in roadway median strips, was approximately 328 af in 2009. CLWA completed programmatic CEQA analysis in early 2007 for full implementation of the recycled water system as outlined in the Master Plan. CLWA is preparing the design of the second phase of the Recycled Water Master Plan that will take water from the Saugus Water Reclamation plant and distribute it to identified users to the north, across the Santa Clara River and then to the west and the east, which will include service to Santa Clarita Central Park. Another new phase of the recycled water system is in design to extend the system south from Magic Mountain Parkway. Collectively, these phases will have design capacity to increase recycled water deliveries by about 1,500 afy.

ES.6 2010 Water Supply Outlook

In 2010, total water demands are expected to be between 82,000-84,000 af, less than actual water use over the last three years, and below the water demand projections in the 2005 UWMP. It is expected that water demands in 2010 will continue to be met with a generally similar mix of water supplies comprised of local groundwater, supplemental SWP and other imported water, and recycled water.

Announced on May 20, 2010, the final allocation of water from the SWP is 45 percent of CLWA's Table A Amount, or 42,840 af. Combined with local groundwater from the two aquifer systems (48,000 af), total Flexible Storage Account (6,060 af), net carryover of SWP Table A allocation from 2008 and 2009 (28,303 af), annual acquisition through the Buena Vista Water/Rosedale Rio-Bravo Water Acquisition Agreement (11,000 af), delivery of water previously recovered but not used from the Semitropic Groundwater Storage Bank (3,300 af), and recycled water (500 af), the total available water supplies for 2010 are 140,000 af. As a result, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2010.

In August, 2007, a federal court ruled that certain operational changes were required of the SWP in order to protect the endangered Delta smelt. The court order resulted in the preparation of a new Biological Opinion (BO) requiring DWR to implement mitigation requirements with resultant impacts on SWP water supply reliability. Since then, DWR has prepared two updates to its 2005 Reliability Report, which is issued biennially to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies under varying hydrologic scenarios, e.g. normal and dry years. The current Draft SWP Delivery Reliability Report 2009 was issued in February, 2010. With the objective of protecting endangered fish such as the Delta

smelt and spring-run salmon, the Draft incorporates restrictions on SWP operations according to the Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fishery Service issued on December 15, 2008 and June 4, 2009, respectively. It also considers the impacts on SWP delivery reliability due to climate change, sea level rise, and vulnerability of the Delta's conveyance system and structure due to floods and earthquakes. The current Draft Reliability Report projects long-term reliability of 60 percent during normal year hydrology. CLWA staff has assessed the impact of the current Reliability Report on the CLWA reliability analysis contained in the Agency's 2005 UWMP and concluded that current and anticipated supplies are available to meet anticipated water supply needs.

CLWA, the retail water Purveyors, Los Angeles County and the City of Santa Clarita have formed the Santa Clarita Valley Water Committee. The specific purpose of the committee is to work collaboratively to ensure the progressive implementation of water use efficiency programs and ordinances in the Santa Clarita Valley. In terms of short-term water supply availability, CLWA has determined that, while current operational changes of the SWP are in effect, there are sufficient supplemental water supplies, including SWP water, to augment local groundwater and other water supplies such that overall water supplies will be sufficient to meet projected 2010 water requirements as reflected herein.

In any given year, SWP supplies may be reduced due to dry weather conditions or regulatory factors. During such an occurrence, the remaining water demands are planned to be met by a combination of alternate supplies such as returning water from CLWA's accounts in the Semitropic Groundwater Storage Program and the Rosedale-Rio Bravo Water Banking and Exchange Program, deliveries from CLWA's flexible storage account in Castaic Lake Reservoir, local groundwater pumping, short-term water exchanges, and participation in DWR dry-year water purchase programs in accordance with the 2005 Urban Water Management Plan. Following the recovery of 4,950 af in 2009, the banked excess 2002 and 2003 SWP Table A water in Semitropic represents nearly 46,000 af of recoverable water for drought water supply. In addition, the banked excess SWP Table A water in 2005 and 2006, augmented by banked water acquired through the Buena Vista/Rosedale-Rio Bravo Water Acquisition Agreement in 2005, 2006 and 2007, represent a total of 64,900 af of recoverable water for drought water supply from the Rosedale-Rio Bravo Banking and Exchange Program.

Drought periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and the

reverse situation can also occur (as it did in 2002 and 2003). For this reason, CLWA and the Purveyors have emphasized developing a water supply portfolio that is diverse, especially in dry years. Diversity of supply is considered a key element of reliability, giving Valley water Purveyors the ability to draw on multiple sources of supply to ensure reliable service during dry years, as well as during normal and wet years.

1. Introduction

1.1 Background

For most residents of the Santa Clarita Valley (Valley), domestic water service is provided by four retail water Purveyors: Castaic Lake Water Agency's Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LAWWD36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). Together, the Purveyors provide water to nearly 70,000 service connections. As a State Water Contractor, Castaic Lake Water Agency (CLWA) contracts for State Water Project water delivered from Castaic Lake, after which it is treated, filtered, and disinfected at two CLWA treatment plants before distribution to the Purveyors. Staff of these entities meet regularly to coordinate the supply of water in the Valley. Their respective service areas are shown in Figure 1-1.

While municipal water supply has grown to become the largest category of water use in the Valley, there remains an agricultural and other small private water demand that is predominately dependent on local groundwater for its water supply. Accordingly, ongoing agricultural water requirements and the use of local groundwater to meet those requirements are considered in analyses of water requirements and supplies such as reported herein. In addition to municipal and agricultural water uses in the Valley, water supply for a small fraction of Valley residents is provided by individual private water supply wells. The locations, construction details, annual pumping and other information about these private wells are not currently available. In the absence of detailed information about private wells and associated water use, pumping as reported herein necessarily includes an estimate of groundwater pumped from private wells; it is intended that this estimate will be refined in the future as more information about the private wells is obtained.

For more than 20 years, CLWA and the Purveyors have reviewed and reported on the availability of water supplies to meet all water requirements in the Valley. Those reports have also addressed local water resources, most notably groundwater, in the region. Past studies have assessed the condition of local groundwater aquifers, their hydrogeologic characteristics, aquifer storage capacity, operational yield and recharge rate, groundwater quality and contamination, and the ongoing conjunctive use of groundwater and imported water resources.

Other efforts have included developing drought contingency plans, coordinating emergency response procedures and implementing Valley-wide conservation programs. In 1985, the

Purveyors prepared the area's first Urban Water Management Plan (UWMP.) Information in the plan was coordinated among CLWA and the Purveyors to provide accurate, comprehensive and consistent water supply and demand information for long term planning purposes. In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was most recently updated in 2005 to extend water demand projections through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project, local recycled water supplies, and planned other water supplies to meet the existing and projected water demands in the Valley. The 2005 UWMP also describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet that component of overall water supply; and it also describes the impacts of perchlorate contamination on several municipal water supply wells, and the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.

In 2009, primarily in preparation for the next update of the UWMP in 2010, an updated analysis of groundwater basin yield was completed to guide the ongoing use of groundwater and the associated distribution of pumping to maintain groundwater use at a sustainable rate while also addressing localized issues such as restoration of groundwater contamination which has impacted local groundwater supplies since 1987. The results of the updated groundwater basin analysis are summarized in this Water Report.

1.2 Purpose and Scope of the Report

The purpose of this report, which is the twelfth in a series of annual water reports that began to describe water supply conditions in 1998, is to provide current information about water requirements and available water supplies to meet those demands in the Santa Clarita Valley. CLWA and the Purveyors began preparation of this series of reports in response to a request made by the Los Angeles County Board of Supervisors in 1998. Over the last few years, this series of reports has also served as an annual summary of groundwater conditions in the Valley in fulfillment of the commitment in the Santa Clarita Valley Groundwater Management Plan, adopted in 2003, to regularly report on implementation of that Plan.

This report was prepared for Castaic Lake Water Agency, for CLWA's Santa Clarita Water Division, and for Los Angeles County Waterworks District 36, Newhall County Water District, and Valencia Water Company. It continues a format for providing information regarding water uses and the availability of water supplies on an annual basis. It is intended to be a helpful resource for use by water planners and local land use planning agencies. This report is complemented by the more detailed Urban Water Management Plan for the area, which provides

longer-term water supply planning over a 25-year period, and by a number of other technical reports, some of which are specifically referenced herein.

1.3 Santa Clarita Valley Water Purveyors

As introduced above, four retail water Purveyors provide water service to most residents of the Santa Clarita Valley. Brief summary descriptions of those four Purveyors are as follows.

Castaic Lake Water Agency Santa Clarita Water Division has a service area that includes a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Saugus, Canyon Country, and Newhall. Water is supplied from both groundwater and CLWA turnouts to about 28,700 service connections.

Los Angeles County Waterworks District 36 has a service area that encompasses approximately 7,635 acres in the Hasley Canyon area and the unincorporated community of Val Verde. LAWWD 36 has nearly 1,400 service connections. The District has traditionally obtained its full water supply from a connection to the CLWA's Castaic Conduit and continued to do so in 2009.

Newhall County Water District's service area includes portions of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Newhall, Canyon Country, Valencia, and Castaic. NCWD supplies water from both groundwater and CLWA turnouts to approximately 9,600 service connections.

Valencia Water Company's service area serves nearly 30,000 service connections in a portion of the City of Santa Clarita and in the unincorporated communities of Castaic, Newhall, Saugus, Stevenson Ranch, and Valencia. VWC supplies water from both groundwater and CLWA turnouts; VWC also delivers recycled water for a small amount of non-potable use.

1.4 The Upper Santa Clara River Hydrologic Area and East Groundwater Subbasin

The Upper Santa Clara River Hydrologic Area (HA), as defined by the California Department of Water Resources (DWR), is located almost entirely in northwestern Los Angeles County. The area encompasses about 654 square miles comprised of flat valley land (about 6 percent of the total area) and hills and mountains (about 94 percent of the total area) that border the valley area. The mountains include the Santa Susana and San Gabriel Mountains to the south, and the Sierra

Pelona and Leibre-Sawmill Mountains to the north. Elevations range from about 800 feet on the valley floor to about 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of about 3,200 feet at the divide separating this hydrologic area from the Mojave Desert.

The Santa Clara River and its tributaries flow intermittently from Lang Station westward about 35 miles to Blue Cut, just west of the Los Angeles-Ventura County line, where the River is the outlet from the Upper Santa Clara River Hydrologic Area. The principal tributaries of the River in the Santa Clarita Valley are Castaic Creek, San Francisquito Creek, Bouquet Creek, and the South Fork of the Santa Clara River. In addition to tributary inflow, the Santa Clara River receives treated wastewater discharge from the Saugus and Valencia Water Reclamation Plants, which are operated by the Sanitation Districts of Los Angeles County.

The Santa Clara River Valley East Groundwater Subbasin, beneath the Santa Clarita Valley in the Upper Santa Clara River HA, is the source of essentially all local groundwater used for water supply in the Santa Clarita Valley. Below Blue Cut, the Santa Clara River continues westward through Ventura County to its mouth near Oxnard. Along that route, the River traverses all or parts of six groundwater basins in Ventura County (Piru, Fillmore, Santa Paula, Oxnard Forebay, Oxnard Plain, and Mound) as shown in Figure 1-2.

There are two primary precipitation gages in the Santa Clarita Valley, the Newhall-Soledad 32c gage and the Newhall County Water District gage (Figure 1-3). The National Climatic Data Center (NCDC) and Los Angeles County Department of Public Works (LADPW) have maintained records for the Newhall-Soledad 32c gage since 1931. Newhall County Water District has maintained records for the NCWD gage since 1979. The cumulative records from these two gages correlate very closely, with the NCWD gage recording approximately 25 percent more precipitation than the Newhall-Soledad 32c gage. This is likely due to the location of the NCWD gage, which is at the base of the mountains rimming the southern edge of the Santa Clarita Valley.

The Santa Clarita Valley is characterized as having an arid climate. Historically, intermittent periods of below-average precipitation have typically been followed by periods of above-average precipitation in a cyclical pattern, with each wetter or drier period typically lasting from one to five years. The longer-term precipitation records for the Newhall-Soledad 32c gage are illustrated in Figure 1-3. Long-term average precipitation at that gage is 17.9 inches (1931-2009). Figure 1-3 also shows the cumulative departure from mean annual precipitation. In general, periods of below-average precipitation have been longer and more moderate than

periods of above-average precipitation. Recently, the periods from 1971 to 1976, 1984 to 1991 and 1999 to 2003 have been drier than average; the periods from 1977 to 1983 and 1992 to 1996 have been wetter than average. More recently, wet conditions that began in late 2004, continued into early 2005, ultimately resulting in about 37 inches of measured precipitation, or slightly more than 200 percent of long-term average precipitation, in that year. Those significantly wet conditions contributed to substantial groundwater recharge and decreased water demand that year. Subsequently, total precipitation in 2006 and 2007 was slightly to significantly lower, 14 inches and 6 inches respectively, but water requirements in both years were still close to those projected in the 2005 UWMP, and there were no dramatic changes in groundwater conditions. With the exception of the average annual rainfall total in 2008, the dry conditions that began in 2006 have persisted through 2009. 2009 was a below-average year, with 11.6 inches of precipitation. However, water demand in 2009 was below that projected for average conditions in the 2005 UWMP, and below the short-term projection in the 2008 Water Report. Early year precipitation in 2010 was approximately 13.4 inches through April, or close to long-term average for that part of the year, but water use further decreased from last year for the same period. Combined with other water supply considerations, discussed in Chapter 4, those conditions are expected to result in 2010 water requirements being slightly lower than water use in 2009.

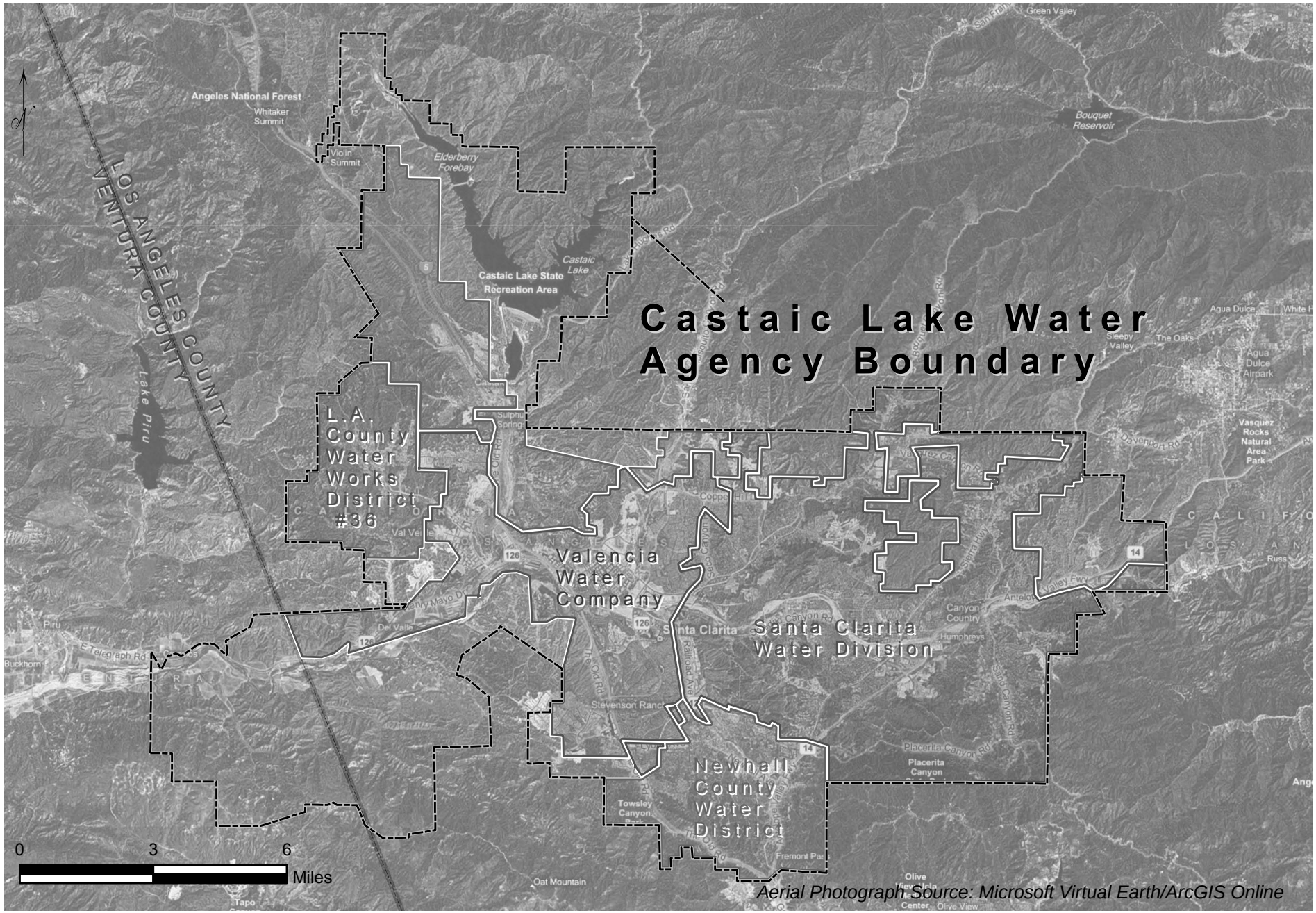

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Figure 1-1
CLWA and Purveyor Service Areas

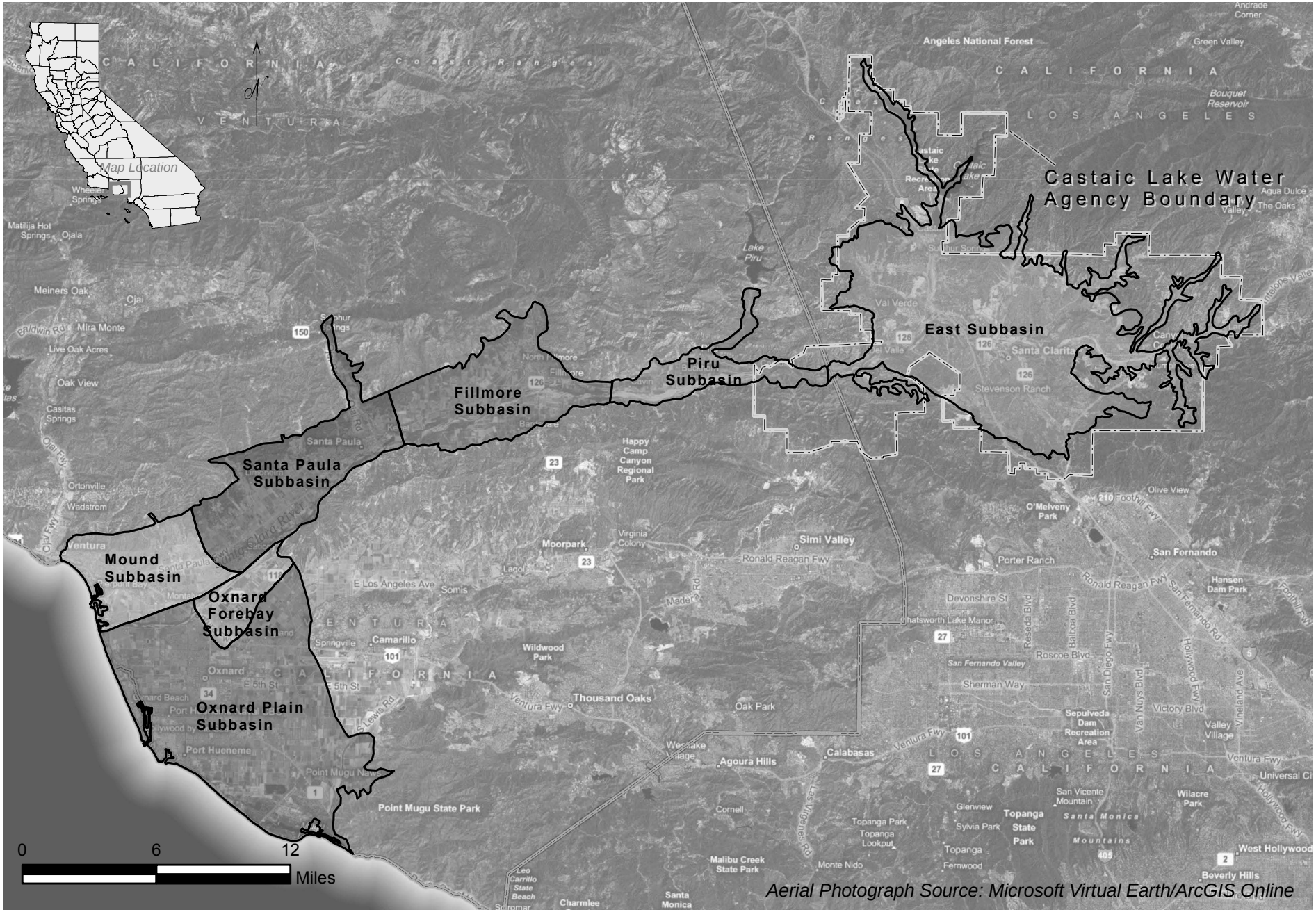

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Figure 1-2
Santa Clara River Groundwater Subbasins

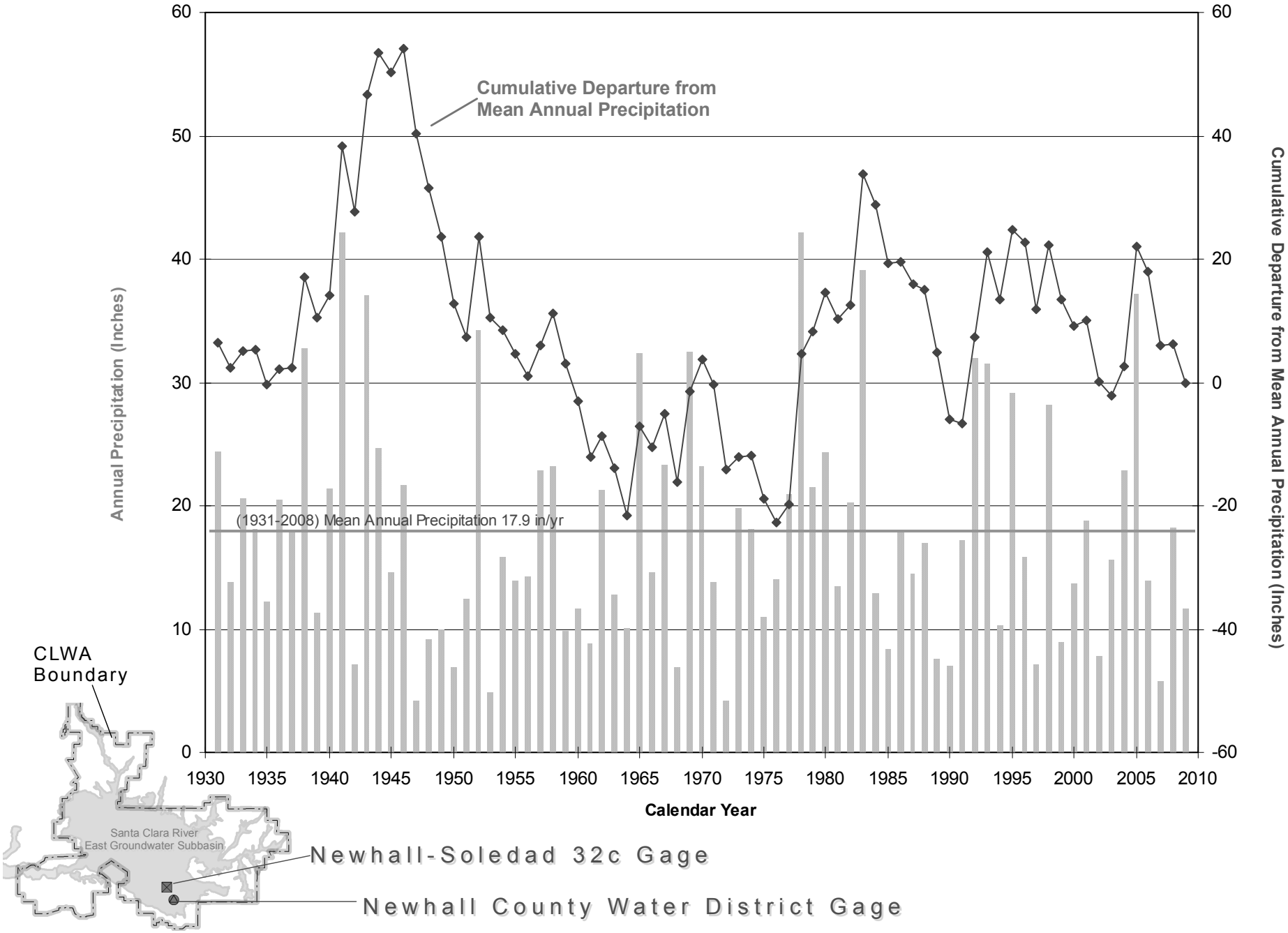

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Figure 1-3
Annual Precipitation and Cumulative Departure from Mean Annual Precipitation at Newhall-Soledad 32c Gage

2. 2009 Water Requirements and Supplies

Total water use in the Santa Clarita Valley was 86,600 af in 2009, a decrease of 4,100 af from the previous year. Of the total water demand, 70,000 af (81 percent) were for municipal use and the remaining 16,600 af (19 percent) were for agricultural and other (miscellaneous) uses, including estimated individual domestic uses. The majority of decreased water demand is attributable to a significant (8%) decrease in municipal water use from 2008. The total water demands were met by a combination of about 47,700 af from local groundwater resources (about 31,100 af for municipal supply and about 16,600 af for agricultural and other uses), about 38,600 af of SWP and other imported water, and about 300 af of recycled water.

Compared to the previous year, total water demand in the Santa Clarita Valley decreased by about 4.5 percent in 2009, and was less than the short-term projected water requirement presented in last year's Water Report. The decrease in water use in 2009 is attributed to ongoing very slow growth in the number of new service connections and continued water conservation awareness as a result of state-wide dry conditions and decreased deliveries of water from the State Water Project. Growth in each Purveyor service area was notably lower than in the preceding two years, with total additions of only about 300 new services connections in 2009, in notable contrast to the growth rate of about 1,000 connections per year over the preceding three years, and in even greater contrast to the predominant growth rate that was three times higher from the late 1990's through 2004. In addition, the Purveyors and the local community continued to be aware of the Governor's Alert in June, 2008 with regard to drought conditions and potential water supply shortages followed by the Governor's Drought Emergency Declaration in February, 2009. The widespread awareness of dry conditions throughout the state and the perceived effects on water supply availability are considered to be prime factors causing total water demand in 2009 to have continued to decline over each of the preceding two years, and to be well below the demand projections in the 2005 UWMP.

The uses of local groundwater, augmented by imported water supplies to meet municipal water requirements since 1980, when the importation of SWP water began, and also slightly augmented by the use of recycled water, are summarized in Table 2-1. Notable with regard to municipal water requirements is that, through 2009, total municipal demand (70,000 af) continues to be below (by about 11,000 af in 2009) the projections in the 2005 UWMP without conservation, and about equal to the projections in the UWMP with conservation.

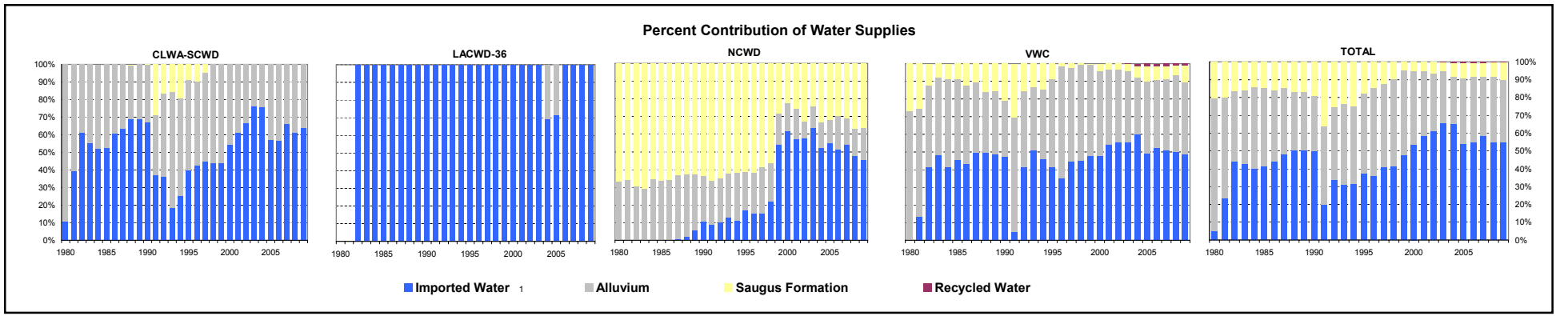
Water supply utilization for all agricultural and other non-municipal uses is summarized in Table 2-2. The category of Small Private Domestic, Irrigation and Golf Course Uses in Table 2-2 includes an estimated 500 af of small private pumping from the Alluvium.

Water supply utilization for all uses in the Santa Clarita Valley, again for the period 1980 to present, is summarized in Table 2-3. The trends in utilization of local groundwater and imported water, complemented by the recent addition of recycled water, are graphically illustrated in Figure 2-1. As can be seen by inspection of Table 2-2 and Figure 2-1, total water use in the Valley was nearly linearly increasing from the early 1980's through 2007, with some weather-related fluctuations in certain years. As discussed above, total water use has declined over the last two years, from a peak slightly above 92,000 af in 2007 to 86,600 af in 2009. Overall, the increase in total water demand since the inception of supplemental SWP importation has been from about 37,000 acre-feet in 1980 to the mid-80,000 acre-feet per year range through 2000-2005, to the short-term peak in the low-90,000 acre-feet per year range in 2006 through 2008.

The decreased demand in 2009 is comparable to the then-increasing demand in 2002. As can also be seen by inspection of Table 2-2 and Figure 2-1, most of the historical increase in water demand has been met with generally increasing importation of SWP water, most recently complemented by other imported water as discussed herein. Since the early 1990's, following a decade of decreased groundwater use during the initial period of SWP importation, total groundwater pumping has fluctuated from year to year, but has remained within a range between about 38,000 and 50,000 acre-feet per year through 2009.

Table 2-1
Water Supply Utilization by Municipal Purveyors
(Acre-Feet)

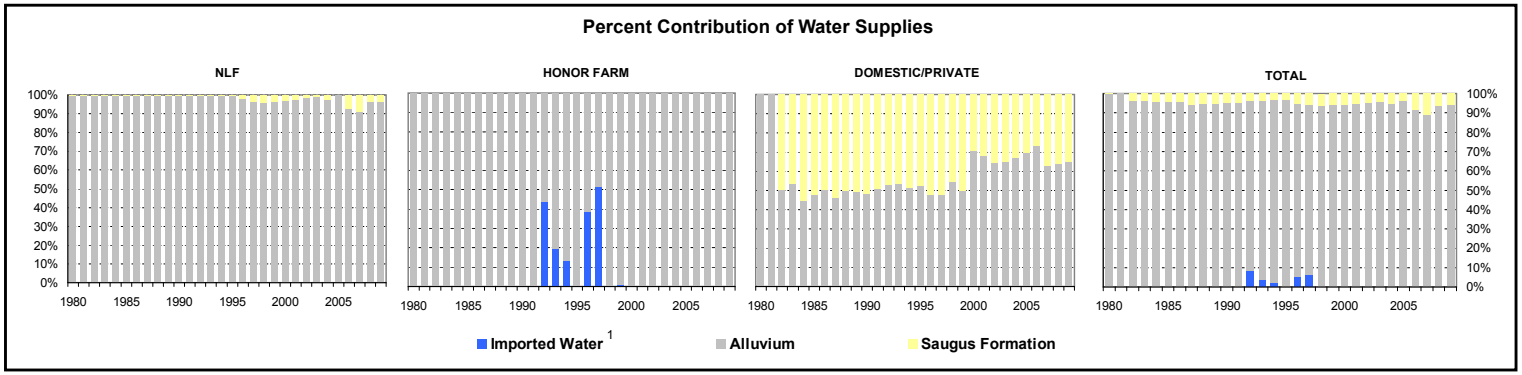
	CLWA Santa Clarita Water Division				Los Angeles County Waterworks District 36			Newhall County Water District				Valencia Water Company					All Municipal Purveyors				
Year	*Imported Water* [1]	*Alluvium*	*Saugus Formation*	**Total**	*Imported Water* [1]	*Alluvium* [2]	**Total**	*Imported Water* [1]	*Alluvium*	*Saugus Formation*	**Total**	*Imported Water* [1]	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**	*Imported Water* [1]	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	9,460	0	**10,585**	0	-	**0**	0	1,170	2,363	**3,533**	0	5,995	2,206	-	**8,201**	1,125	16,625	4,569	-	**22,319**
1981	4,602	7,109	0	**11,711**	0	-	**0**	0	1,350	2,621	**3,971**	1,214	5,597	2,329	-	**9,140**	5,816	14,056	4,950	-	**24,822**
1982	6,454	4,091	0	**10,545**	145	-	**145**	0	1,178	2,672	**3,850**	3,060	3,415	897	-	**7,372**	9,659	8,684	3,569	-	**21,912**
1983	5,214	4,269	0	**9,483**	207	-	**207**	0	1,147	2,787	**3,934**	3,764	3,387	611	-	**7,762**	9,185	8,803	3,398	-	**21,386**
1984	6,616	6,057	0	**12,673**	240	-	**240**	0	1,549	2,955	**4,504**	4,140	4,975	854	-	**9,969**	10,996	12,581	3,809	-	**27,386**
1985	6,910	6,242	0	**13,152**	272	-	**272**	0	1,644	3,255	**4,899**	4,641	4,633	885	-	**10,159**	11,823	12,519	4,140	-	**28,482**
1986	8,366	5,409	0	**13,775**	342	-	**342**	0	1,842	3,548	**5,390**	5,051	5,167	1,427	-	**11,645**	13,759	12,418	4,975	-	**31,152**
1987	9,712	5,582	0	**15,294**	361	-	**361**	22	2,127	3,657	**5,806**	6,190	4,921	1,305	-	**12,416**	16,285	12,630	4,962	-	**33,877**
1988	11,430	5,079	63	**16,572**	434	-	**434**	142	2,283	4,041	**6,466**	7,027	4,835	2,300	-	**14,162**	19,033	12,197	6,404	-	**37,634**
1989	12,790	5,785	0	**18,575**	457	-	**457**	428	2,367	4,688	**7,483**	7,943	5,826	2,529	-	**16,298**	21,618	13,978	7,217	-	**42,813**
1990	12,480	5,983	40	**18,503**	513	-	**513**	796	1,936	4,746	**7,478**	7,824	5,232	3,516	-	**16,572**	21,613	13,151	8,302	-	**43,066**
1991	6,158	5,593	4,781	**16,532**	435	-	**435**	675	1,864	4,994	**7,533**	700	9,951	4,642	-	**15,293**	7,968	17,408	14,417	-	**39,793**
1992	6,350	8,288	2,913	**17,551**	421	-	**421**	802	1,994	5,160	**7,956**	6,338	6,615	2,385	-	**15,338**	13,911	16,897	10,458	-	**41,266**
1993	3,429	12,016	2,901	**18,346**	465	-	**465**	1,075	1,977	5,068	**8,120**	8,424	5,815	2,182	-	**16,421**	13,393	19,808	10,151	-	**43,352**
1994	5,052	10,996	3,863	**19,911**	453	-	**453**	906	2,225	5,103	**8,234**	7,978	6,847	2,565	-	**17,390**	14,389	20,068	11,531	-	**45,988**
1995	7,955	10,217	1,726	**19,898**	477	-	**477**	1,305	1,675	4,775	**7,755**	7,259	8,698	1,586	-	**17,543**	16,996	20,590	8,087	-	**45,673**
1996	9,385	10,445	2,176	**22,006**	533	-	**533**	1,213	1,803	4,871	**7,887**	6,962	12,433	326	-	**19,721**	18,093	24,681	7,373	-	**50,147**
1997	10,120	11,268	1,068	**22,456**	785	-	**785**	1,324	2,309	5,168	**8,801**	9,919	11,696	516	-	**22,131**	22,148	25,273	6,752	-	**54,173**
1998	8,893	11,426	0	**20,319**	578	-	**578**	1,769	1,761	4,557	**8,087**	9,014	10,711	149	-	**19,874**	20,254	23,898	4,706	-	**48,858**
1999	10,772	13,741	0	**24,513**	654	-	**654**	5,050	1,676	2,622	**9,348**	10,806	11,823	106	-	**22,735**	27,282	27,240	2,728	-	**57,250**
2000	13,751	11,529	0	**25,280**	800	-	**800**	6,024	1,508	2,186	**9,718**	12,004	12,179	1,007	-	**25,190**	32,579	25,216	3,193	-	**60,988**
2001	15,648	9,896	0	**25,544**	907	-	**907**	5,452	1,641	2,432	**9,525**	13,362	10,518	835	-	**24,715**	35,369	22,055	3,267	-	**60,691**
2002	18,921	9,513	0	**28,434**	1,069	-	**1,069**	5,986	981	3,395	**10,362**	15,792	11,603	965	-	**28,360**	41,768	22,097	4,360	-	**68,225**
2003	20,668	6,424	0	**27,092**	1,175	-	**1,175**	6,572	1,266	2,513	**10,351**	16,004	11,707	1,068	50	**28,829**	44,419	19,397	3,581	50	**67,447**
2004	22,045	7,146	0	**29,191**	854	380	**1,234**	5,896	1,582	3,739	**11,217**	18,410	9,862	1,962	420	**30,654**	47,205	18,970	5,701	420	**72,296**
2005	16,513	12,408	0	**28,921**	857	343	**1,200**	5,932	1,389	3,435	**10,756**	14,732	12,228	2,513	418	**29,891**	38,034	26,368	5,948	418	**70,768**
2006	17,146	13,156	0	**30,302**	1,289	-	**1,289**	5,898	2,149	3,423	**11,470**	16,313	11,884	2,449	419	**31,065**	40,646	27,189	5,872	419	**74,126**
2007	20,669	10,686	0	**31,355**	1,406	-	**1,406**	6,478	1,806	3,691	**11,975**	16,779	13,140	2,367	470	**32,756**	45,332	25,632	6,058	470	**77,492**
2008	18,598	11,878	0	**30,476**	1,354	-	**1,354**	5,428	1,717	4,195	**11,340**	16,325	14,324	1,770	311	**32,730**	41,705	27,919	5,965	311	**75,900**
2009	17,739	10,077	0	**27,816**	1,243	-	**1,243**	4,832	1,860	3,868	**10,559**	14,732	12,459	2,836	328	**30,355**	38,546	24,396	6,704	328	**69,974**



1. Reflects State Water Project through 2006; includes imported water from State Water Project and Buena Vista WSD Agreement beginning in 2007.
2.Groundwater purchased from LA County Honor Farm.

Table 2-2
Individual Water Supply Utilization by Agricultural and Other Users
(Acre-Feet)

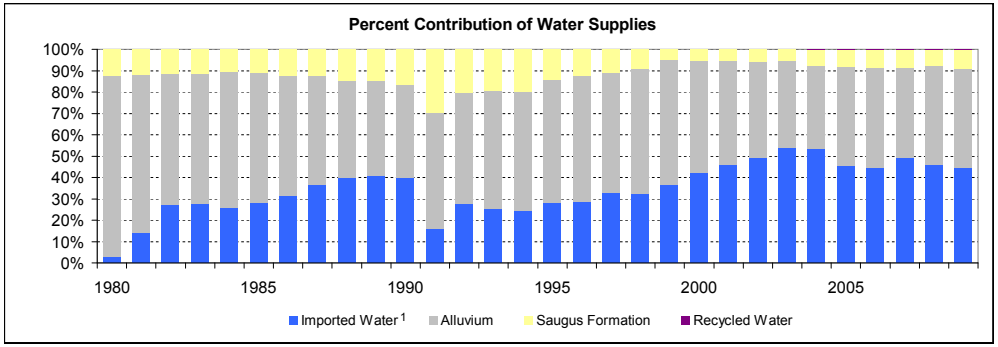
	Newhall Land and Farming			Los Angeles County Honor Farm			Small Private Domestic, Irrigation and Golf Courses Uses			All Agricultural and Other Users			
Year	*Alluvium*	*Saugus Formation*	**Total**	*Alluvium*	*Imported Water* [1]	**Total**	*Alluvium* [2]	*Saugus Formation* [3]	**Total**	*Imported Water* [1]	*Alluvium*	*Saugus Formation*	**Total**
1980	11,331	20	**11,351**	3,000	0	**3,000**	500	0	**500**	0	14,831	20	**14,851**
1981	13,237	20	**13,257**	3,000	0	**3,000**	500	0	**500**	0	16,737	20	**16,757**
1982	9,684	20	**9,704**	3,000	0	**3,000**	500	501	**1,001**	0	13,184	521	**13,705**
1983	7,983	20	**8,003**	3,000	0	**3,000**	500	434	**934**	0	11,483	454	**11,937**
1984	11,237	20	**11,257**	3,000	0	**3,000**	500	620	**1,120**	0	14,737	640	**15,377**
1985	9,328	20	**9,348**	3,000	0	**3,000**	500	555	**1,055**	0	12,828	575	**13,403**
1986	8,287	20	**8,307**	3,000	0	**3,000**	500	490	**990**	0	11,787	510	**12,297**
1987	6,512	20	**6,532**	3,000	0	**3,000**	500	579	**1,079**	0	10,012	599	**10,611**
1988	5,951	20	**5,971**	3,000	0	**3,000**	500	504	**1,004**	0	9,451	524	**9,975**
1989	6,243	20	**6,263**	3,000	0	**3,000**	500	522	**1,022**	0	9,743	542	**10,285**
1990	8,225	20	**8,245**	2,000	0	**2,000**	500	539	**1,039**	0	10,725	559	**11,284**
1991	7,039	20	**7,059**	2,240	0	**2,240**	500	480	**980**	0	9,779	500	**10,279**
1992	8,938	20	**8,958**	1,256	987	**2,243**	500	446	**946**	987	10,694	466	**12,147**
1993	8,020	20	**8,040**	1,798	443	**2,241**	500	439	**939**	443	10,318	459	**11,220**
1994	10,606	20	**10,626**	1,959	311	**2,270**	500	474	**974**	311	13,065	494	**13,870**
1995	11,174	20	**11,194**	2,200	6	**2,206**	500	453	**953**	6	13,874	473	**14,353**
1996	12,020	266	**12,286**	1,237	780	**2,017**	500	547	**1,047**	780	13,757	813	**15,350**
1997	12,826	445	**13,271**	1,000	1,067	**2,067**	500	548	**1,048**	1,067	14,326	993	**16,386**
1998	10,250	426	**10,676**	2,000	12	**2,012**	500	423	**923**	12	12,750	849	**13,611**
1999	13,824	479	**14,303**	1,842	20	**1,862**	500	509	**1,009**	20	16,166	988	**17,174**
2000	11,857	374	**12,231**	1,644	3	**1,647**	1,220	513	**1,733**	3	14,721	887	**15,611**
2001	12,661	300	**12,961**	1,604	0	**1,604**	1,224	573	**1,797**	0	15,489	873	**16,362**
2002	13,514	211	**13,725**	1,602	0	**1,602**	1,063	589	**1,652**	0	16,179	800	**16,979**
2003	10,999	122	**11,121**	2,273	0	**2,273**	931	504	**1,435**	0	14,203	626	**14,829**
2004	10,991	268	**11,259**	2,725	0	**2,725**	1,071	535	**1,606**	0	14,787	803	**15,590**
2005	8,648	6	**8,654**	2,499	0	**2,499**	1,133	499	**1,632**	0	12,280	505	**12,785**
2006	11,477	934	**12,411**	3,026	0	**3,026**	1,369	506	**1,875**	0	15,872	1,440	**17,312**
2007	9,968	971	**10,939**	2,085	0	**2,085**	1,088	656	**1,744**	0	13,141	1,627	**14,768**
2008	9,191	330	**9,521**	3,506	0	**3,506**	1,100	623	**1,723**	0	13,797	953	**14,750**
2009	11,061	379	**11,440**	3,432	0	**3,432**	1,097	595	**1,692**	0	15,590	974	**16,564**



1. *Reflects State Water Project through 2006; includes imported water from State Water Project and Buena Vista WSD Agreement beginning in 2007.*
2. *Robinson Ranch Golf Course irrigation and estimated private pumping.*
3. *Valencia Country Club and Vista Valencia Golf Course irrigation.*

Table 2-3
Total Water Supply Utilization for Municipal, Agricultural and Other Uses
(Acre-Feet)

Year	*Imported Water*[1]	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	31,456	4,589	-	**37,170**
1981	5,816	30,793	4,970	-	**41,579**
1982	9,659	21,868	4,090	-	**35,617**
1983	9,185	20,286	3,852	-	**33,323**
1984	10,996	27,318	4,449	-	**42,763**
1985	11,823	25,347	4,715	-	**41,885**
1986	13,759	24,205	5,485	-	**43,449**
1987	16,285	22,642	5,561	-	**44,488**
1988	19,033	21,648	6,928	-	**47,609**
1989	21,618	23,721	7,759	-	**53,098**
1990	21,613	23,876	8,861	-	**54,350**
1991	7,968	27,187	14,917	-	**50,072**
1992	14,898	27,591	10,924	-	**53,413**
1993	13,836	30,126	10,610	-	**54,572**
1994	14,700	33,133	12,025	-	**59,858**
1995	17,002	34,464	8,560	-	**60,026**
1996	18,873	38,438	8,186	-	**65,497**
1997	23,215	39,599	7,745	-	**70,559**
1998	20,266	36,648	5,555	-	**62,469**
1999	27,302	43,406	3,716	-	**74,424**
2000	32,582	39,937	4,080	-	**76,599**
2001	35,369	37,544	4,140	-	**77,053**
2002	41,768	38,276	5,160	-	**85,204**
2003	44,419	33,599	4,207	50	**82,276**
2004	47,205	33,757	6,503	420	**87,885**
2005	38,034	38,648	6,453	418	**83,553**
2006	40,646	43,061	7,312	419	**91,438**
2007	45,332	38,773	7,685	470	**92,260**
2008	41,705	41,716	6,918	311	**90,650**
2009	38,546	39,986	7,678	328	**86,538**



1. Reflects State Water Project through 2006; includes imported water from State Water Project and Buena Vista WSD Agreement beginning in 2007.

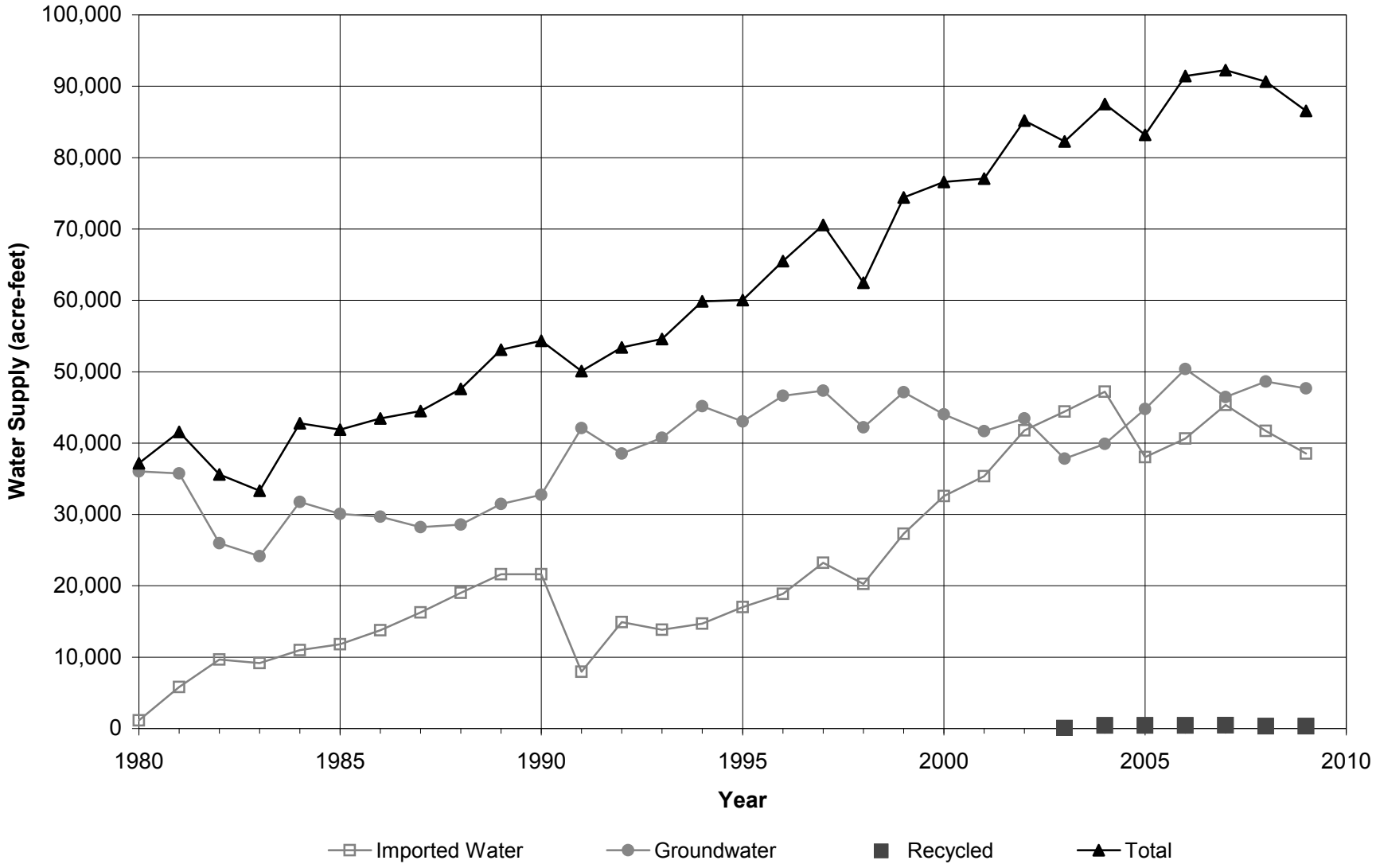


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Figure 2-1
Total Water Supply Utilization
Santa Clarita Valley

3. Water Supplies

Prior to 1980, local groundwater extracted from the Alluvium and the Saugus Formation was the sole source of water supply in the Santa Clarita Valley. Since 1980, local groundwater supplies have been supplemented with imported SWP water supplies, augmented in 2007 by acquisition of additional supplemental water from the Buena Vista Water Storage District. Those water supplies have also been slightly augmented by deliveries from CLWA's recycled water program since 2003. This section describes the groundwater resources of the Santa Clarita Valley, SWP and other imported water supplies, and CLWA's recycled water program.

3.1 Groundwater Basin Yield

The groundwater basin generally beneath the Santa Clarita Valley, identified in the State Department of Water Resources' Bulletin 118 as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), is comprised of two aquifer systems. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. The mapped extent of the Santa Clara River Valley East Subbasin in DWR Bulletin 118 and its relationship to the extent of the CLWA service area are illustrated in Figure 3-1. The mapped Subbasin boundary approximately coincides with the outer extent of the Alluvium and Saugus Formation.

A 2001 Update Report on both the Alluvium and Saugus Formation Aquifers (Slade, 2002), which updated analyses and interpretation of hydrogeologic conditions from earlier reports (Slade, 1986 and 1988), included extensive detail on major aspects of the groundwater basin. Notable parts of the Update Report relative to groundwater supply included findings that:

- Analysis of historical groundwater levels and production indicates that there have been no conditions that would be illustrative of groundwater overdraft.

- Utilization of operational yield (as opposed to perennial yield) as a basis for managing groundwater production would be more applicable in this basin to reflect fluctuating utilization of groundwater in conjunction with imported SWP water.

- Operational yield of the Alluvium would typically be 30,000 to 40,000 afy for wet and normal rainfall years, with an expected reduction into the range of 30,000 to 35,000 afy in dry years.

- Operational yield of the Saugus Formation would typically be in the range of 7,500 to 15,000 afy on a long-term basis, with possible short-term increases during dry periods into a range of 15,000 to 25,000 afy, and to 35,000 afy if dry conditions continue.

Following on the 2001 Update Report, the groundwater component of overall water supply in the Valley derives from a groundwater operating plan to meet water requirements (municipal, agricultural and other non-municipal, and small individual domestic) while maintaining the basin in a sustainable condition (i.e., no long-term depletion of groundwater or interrelated surface water). That operating plan also addresses groundwater contamination issues in the basin, all consistent with the Groundwater Management Plan adopted in 2003. The groundwater operating plan is based on the concept that pumping can vary from year to year to generally rely on increased groundwater use in dry periods and increased recharge during locally wet periods, and to collectively assure that the groundwater basin is adequately replenished through various wet/dry cycles.

The groundwater operating plan, summarized in Table 3-1, is as follows:

Alluvium – Pumping from the Alluvial Aquifer in a given year is related to local hydrologic conditions in the eastern Santa Clara River watershed. Pumping is expected to typically range between 30,000 and 40,000 afy following normal and above-normal rainfall years. Due to hydrogeologic constraints in the eastern part of the basin, pumping is expected to be typically reduced to between 30,000 and 35,000 afy following multiple locally dry years.

Saugus Formation – Pumping from the Saugus Formation in a given year is related to the availability of other water supplies, particularly from the SWP. During average-year conditions within the SWP system, Saugus pumping is expected to typically range between 7,500 and 15,000 afy. Planned dry-year pumping from the Saugus Formation is expected to range between 15,000 and 25,000 afy during a drought year and can increase to between 21,000 and 25,000 afy if SWP deliveries are reduced for two consecutive years, and between 21,000 and 35,000 afy if SWP deliveries are reduced for three consecutive years. Such high pumping is expected to typically be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 afy, to further enhance the effectiveness of natural recharge processes that would cause groundwater levels and storage volumes to recover after the higher pumping during dry years.

Table 3-1
Groundwater Operating Plan for the Santa Clarita Valley

Aquifer	Groundwater Production (af)			
	Normal Years	**Dry Year 1**	**Dry Year 2**	**Dry Year 3**
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	15,000 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**45,000 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**

In 2004, as part of analyzing the restoration of perchlorate-impacted groundwater supply in the Valley, a numerical groundwater flow model was developed and calibrated for use in analyzing the response of the groundwater basin to long-term operation at the operational yields noted above, with focus on perchlorate extraction and the control of perchlorate migration in the basin. That groundwater flow model was then utilized in 2005 to specifically analyze the sustainability of groundwater supplies in both the Alluvium and the Saugus Formation through a long-term (78 year) hydrologic period that was selected to examine groundwater basin response to variations in pumping in accordance with the operating plan. Resultant projections of groundwater levels, groundwater storage, and surface water flows showed the basin to respond in a long-term sustainable manner, with no chronic depletion of groundwater levels, storage, or stream flows. The analysis of groundwater sustainability was summarized in a Basin Yield Report (CH2M Hill and LSCE, 2005), which included the following findings:

- The groundwater basin has historically been, and continues to be, in good operating condition and not in overdraft, as indicated by historical data.

- The groundwater plan is sustainable over varying hydrologic conditions, because it is feasible to intermittently exceed a long-term average yield for one or more years without creating long-term adverse impacts to the groundwater system and the Santa Clara River.

- The groundwater operating plan for the Alluvium and the Saugus Formation can be used for long-term water supply planning purposes. In particular, although increased pumping from the Saugus Formation during dry periods can be expected to cause short-term declines in groundwater levels, it is not projected to cause permanent declines in groundwater discharges or streamflow. Saugus groundwater levels can be expected to recover to pre-drought conditions when pumping is reduced in subsequent wet to normal years.

- The strategy around which the groundwater operating plan was designed (maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, while limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus pumping during years when SWP supplies are significantly reduced because of drought conditions) is viable on a long-term basis.

- Together, the historical observations of basin conditions and the model simulations together support the historical and ongoing confidence that groundwater can continue to be a sustainable source of water supply under the groundwater operating plan.

In 2008, partly in preparation for the next UWMP in 2010, and in part because of recent events that can be expected to impact the future reliability of the supplemental water supply from the State Water Project, the Purveyors initiated an updated analysis to further assess groundwater development potential and possible augmentation of the groundwater operating plan. A further consideration in conducting an updated analysis of the basin was that global climate change could alter local rainfall and associated recharge patterns, thus affecting local groundwater supplies, i.e. the yield of the basin. Finally, the Los Angeles County Flood Control District (LACFCD) is planning a number of small flood control projects in the Santa Clarita Valley; estimated amounts of conservation/groundwater recharge potential were being included for each of the individual projects in the overall LACFCD planning, and the Purveyors had interest in whether that potential could appreciably augment the yield of the basin.

The updated basin yield analysis, completed in August, 2009, concluded the following (LSCE and GSI, 2009).

- The 2008 Operating Plan, with currently envisioned pumping rates and distribution comparable to the Operating Plan described above, will not cause detrimental short- or long-term effects to the groundwater and surface water resources in the Valley and is, therefore, sustainable. Further, local conditions in the Alluvium in the eastern end of the basin can be expected to repeat historical groundwater level declines during dry periods, necessitating a reduction in desired Alluvial aquifer pumping due to decreased well yield and associated actual pumping capacity during those periods. However, those reductions in pumping from the Alluvial aquifer can be made up by an equivalent amount of increased pumping in other parts of the basin without disrupting basin-wide sustainability or local pumping capacity in those other areas. For the Saugus Formation, the modeling analysis indicated that this aquifer can sustain the pumping that is imbedded the 2008 Operating Plan.

- A Potential Operating Plan (Alluvial pumping between 41,500 and 47,500 afy) would result in lower Alluvial groundwater levels, failure of the basin to fully recover (during wet hydrologic cycles) from depressed storage that would occur during dry periods, and generally declining trends in groundwater levels and storage. Long-term lowering of groundwater levels would also occur in the Saugus Formation (pumping between about 16,000 and nearly 40,000 afy) with only partial water level recovery occurring in the Saugus. Thus, the Potential Operating Plan would not be sustainable over a long-term period.

- Several climate change models were examined to estimate the potential impacts on local hydrology in the Santa Clarita Valley. The range of potential climate change impacts extends from a possible wet trend to a possible dry trend over the long term. The trends that range from an approximate continuation of historical average precipitation, to something wetter than that, would appear to result in continued sustainability of the 2008 Operating Plan, again with intermittent constraints on full pumping in the eastern part of the basin. The potential long-term dry trend arising out of climate change would be expected to decrease local recharge to the point that lower and declining groundwater levels would render the 2008 Operating Plan unsustainable. Ultimately it was recognized that a wide range of potential global climate change produces a range of non-unique results with respect to local hydrologic conditions and associated sustainable groundwater supply. Notable in the wide range of possibilities, however, was the output that, over 20 to 25 year planning horizon of the UWMP, the range of relatively wet to relatively dry hydrologic conditions would be expected to produce sustainable groundwater conditions under the 2008 groundwater Operating Plan.

Based on the preceding conclusions, groundwater utilization continues in accordance with the 2008 Operating Plan; and the Potential Operating Plan is not being considered for implementation.

3.2 Alluvium – General

The spatial extent of the aquifers used for groundwater supply in the Valley, the Alluvium and the Saugus Formation, are illustrated in Figure 3-1. Geologic descriptions and hydrogeologic details related to both aquifers are included in several technical reports including Slade (1986, 1988 & 2002), CH2M Hill (2005) and LSCE (2005), and in the 2005 Urban Water Management Plan.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), the 2005 UWMP, and the 2009 Updated Basin Yield Report (LSCE and GSI), the management practice of the Purveyors continues to be to rely on groundwater from the Alluvium for part of the overall municipal water supply, whereby total pumping from the Alluvium (by municipal, agricultural, and small private pumpers) is in accordance with the 2008 groundwater Operating Plan, 30,000 to 40,000 afy following wet and normal years, with possible reduction to 30,000 to 35,000 afy following multiple dry years. Such operation will maximize use of the Alluvium because of the aquifer's ability to store and produce good quality water on a sustainable basis, and because the Alluvium is capable of rapid recovery of groundwater storage in wet periods. As with many groundwater basins, it is possible to intermittently exceed a long-term average yield for one or more years without long-term adverse effects. Higher pumping for short periods may temporarily lower groundwater storage and related water levels, as has been the case in the Alluvium several times since the 1930's. However, subsequent decreases in pumping limit the amount of water level decline. Normal to wet-period recharge results in a rapid return of groundwater levels to historic highs. Historical groundwater data collected from the Alluvium over numerous hydrologic cycles continue to provide assurance that groundwater elevations, if locally lowered during dry periods, recover in subsequent average or wet years. Such water level response to rainfall is a significant characteristic of permeable, porous, alluvial aquifer systems that occur within large watersheds. In light of these historical observations, complemented by the long-term sustainability analysis using the numerical groundwater flow model, there is ongoing confidence that groundwater will continue to be a sustainable source of water supply at the rates of pumping described in the Basin Yield Report, as incorporated in the 2005 UWMP, and as described in the Updated Basin Yield Report, as expected to be incorporated in the 2010 UWMP.

Long-term adverse impacts to the Alluvium could occur if the amount of water extracted from the aquifer were to exceed the amount of water that recharges the aquifer over an extended period. However, the quantity and quality of water in the Alluvium and all significant pumping from the Alluvium are routinely monitored, and no long-term adverse impacts have ever been evident. Ultimately, the Purveyors have identified cooperative measures to be taken, if needed, to ensure sustained use of the aquifer. Such measures include but are not limited to the continuation of conjunctive use of SWP and other imported supplemental water with local groundwater, artificial recharge of the aquifer with local runoff or other surface water supplies, financial incentives discouraging extractions above a selected limit, expanded use of other water supplies such as recycled water, and expanded implementation of demand-side management, including conservation.

3.2.1 Alluvium – Historical and Current Conditions

Total pumping from the Alluvium in 2009 was about 40,000 af, a decrease of 1,750 af from the preceding year. Total Alluvium pumping was at the upper end of the groundwater Operating Plan range. Of the total Alluvial pumping in 2009, about 24,400 af (61 percent) was for municipal water supply, and the balance, about 15,600 af (39 percent), was for agriculture and other smaller uses, including individual domestic uses. In a longer-term context, there has been a change in municipal/agricultural pumping distribution since SWP deliveries began in 1980, toward a higher fraction for municipal water supply (from about 50 percent to more than 65 percent of Alluvial pumpage), which reflects the general land use changes in the area. Ultimately, on a long-term average basis since the beginning of imported water deliveries from the SWP, total Alluvial pumping has been about 32,000 afy, which is at the lower end of the range of operational yield of the Alluvium. That average has been higher over the last decade, about 38,500 afy, which remains within the range of operational yield of the Alluvium. The overall historic record of Alluvial pumping is illustrated in Figure 3-2.

Groundwater levels in various parts of the basin have historically exhibited different responses to both pumpage and climatic fluctuations. During the last 20 to 30 years, depending on location, Alluvial groundwater levels have remained nearly constant (generally toward the western end of the basin), or have fluctuated from near the ground surface when the basin is full, to as much as 100 feet lower during intermittent dry periods of reduced recharge (generally toward the eastern end of the basin). For illustration of the various groundwater level conditions in the basin, the Alluvial wells have been grouped into areas with similar groundwater level patterns, as shown in Figure 3-3. The groundwater level records have been organized into hydrograph form (groundwater elevation vs. time) as illustrated in Figures 3-4 and 3-5. Also shown on these plots is an annual marker indicating whether the year had a below-average amount of rainfall. The wells shown on these plots are representative of the respective areas, showing the range of values (highest to lowest elevation) through each area, and containing a sufficiently long-term record to illustrate trends over time.

Situated along the eastern upstream end of the Santa Clara River Channel, the ‘Mint Canyon’ area, located at the far eastern end of the groundwater basin, and the nearby ‘Above Saugus WRP’ area generally exhibit similar groundwater level responses (Figure 3-4) to hydrologic and pumping conditions. As shown in Figure 3-6, the Purveyors decreased total Alluvial pumping from the ‘Mint Canyon’ area steadily from 2000 through 2003, and correspondingly increased pumping in the ‘Below Saugus WRP’, and ‘Below Valencia WRP’ areas. In spite of a continued period of below-average precipitation from 1999 to 2003, that progressive decrease in pumping resulted in a cessation of groundwater level decline in the ‘Mint Canyon Area’. Subsequent wet

conditions in late 2004, continuing into 2005, resulted in full recovery of groundwater storage. With such high groundwater levels, pumping in the 'Mint Canyon' area was increased in 2005 and 2006, with no significant change in groundwater levels in 2005 and a slight decrease in 2006. Over the last four years, precipitation has been average to below-average. Accordingly, water levels have shown some decline, but this decline has been slowed by the reduction in pumpage in this easternmost part of the basin. Water levels remain within the historic range of levels over similar wet/dry periods. Just below the 'Mint Canyon' area, the 'Above Saugus WRP' has shown a similar decline, despite the steady rate of pumping over the last four years. Here the water levels also remain within the range of historical levels, as expected following a multi-year period without a significant wet year. These parts of the Valley have historically experienced a number of alternating wet and dry hydrologic conditions (Figure 3-4) during which groundwater level declines have been followed by returns to high or mid-range historic levels. This trend has continued over the last four years where below-average hydrologic conditions in 2009 followed three average to below-average years, and groundwater levels remain within mid-range levels.

In the 'Bouquet Canyon' area, pumping has remained relatively constant for the last ten years, and water levels have fluctuated with consecutive wet or dry years. During and since the most recent wet conditions of 2004 and 2005, water levels returned to within historic mid-range levels. During 2009, groundwater level trends either leveled off or showed some increase with the onset of precipitation at the end of the year. This groundwater level response to wet/dry years and pumping is typical for this area of the basin and, for 2009, levels have remained within the range of historical levels. When water levels are low, well yields and pumping capacities in this and other eastern areas can be impacted. The affected Purveyors typically respond by increasing use of Saugus Formation and imported (SWP) supplies, as shown in Table 2-3. The Purveyors also shift a fraction of the Alluvial pumping that would normally be supplied by the eastern areas to areas further west, where well yields and pumping capacities remain fairly constant because of smaller groundwater level fluctuations.

In the western parts and lower elevations of the Alluvium, groundwater levels respond to pumping and precipitation in a similar manner, but to an attenuated or limited extent compared to those situated in the eastern, higher elevation areas. As shown in the western group of hydrographs in Figure 3-5, groundwater level fluctuations become more subtle moving westward and lower in the Valley. The 'Below Saugus WRP' area, along the Santa Clara River immediately downstream of the Saugus Water Reclamation Plant, and the 'San Francisquito Canyon' area generally exhibit similar groundwater level trends. In this middle part of the basin, historical groundwater levels were lower in the 1950's and 60's than current levels. Groundwater levels in this area notably recovered as pumping declined through the 1960's and 1970's. They

have subsequently sustained generally high levels for much of the last 30 years, with three dry-period exceptions: mid-1970's, late 1980's to early 1990's, and the late 1990's to early 2000's. Recoveries to previous high groundwater levels followed both of the short dry-period declines in the 1970's and 1990's. More recently, groundwater levels recovered significantly in both areas, to historic highs, following a wetter-than-average year in 2004 and significantly wet 2005. Since 2005, pumping has been increasing in the 'Below Saugus WRP' area, while 'San Francisquito Canyon' area pumping approximately doubled in 2005, and has since gradually declined and leveled off over the last three years. Despite the current multi-year period of average to below-average precipitation, groundwater levels in these two areas remain in mid-range to high historical range.

The 'Castaic Valley' area is located along Castaic Creek below Castaic Lake. Below that and along the Santa Clara River, downstream of the Valencia Water Reclamation Plant, is the 'Below Valencia WRP' area, where discharges of treated effluent from the Valencia WRP to the Santa Clara River contribute to groundwater recharge. In the 'Castaic Valley' area, groundwater levels continue to remain fairly constant, with slight responses to climatic and other fluctuations, since the 1950's (Figure 3-5). Small changes in groundwater levels over the last four years are consistent with other short-term historical fluctuations. The long-term, generally constant trend remained through 2009. The 'Below Valencia WRP' area groundwater levels exhibit slight, if any, response to climatic fluctuations, and have remained fairly constant since the 1950's despite a notable increase in pumping through the 1990s that has since remained relatively steady over the last seven years, through 2009 (Figure 3-5 and 3-6).

In summary, depending on the period of available data, all the history of groundwater levels in the Alluvium shows the same general picture: recent (last 30 years) groundwater levels have exhibited historic highs; in some locations, there are intermittent dry-period declines (resulting from use of some groundwater from storage) followed by wet-period recoveries (and associated refilling of storage space). On a long-term basis, whether over the last 29 years since importation of supplemental SWP water, or over the last 40 to 50 years (since the 1950's - 60's), the Alluvium shows no chronic trend toward decreasing water levels and storage, and thus shows no symptoms of water level-related overdraft. Consequently, pumping from the Alluvium has been and continues to be sustainable, well within the operational yield of that aquifer on a long-term average basis, and also within the operating yield in almost every individual year.

3.3 Saugus Formation – General

Saugus wells operated by the Purveyors are located in the southern portion of the basin, south of the Santa Clara River (Figure 3-7). Consistent with the 2001 Update Report (Slade), the 2005

Basin Yield Report (CH2M Hill and LSCE), and the 2009 Basin Yield Update Report (LSCE and GSI), the Purveyors have utilized the Saugus in accordance with the original (and the 2008) groundwater Operating Plan, in the range of 7,500 to 15,000 afy in average/normal years, with planned dry-year pumping of 15,000 to 35,000 afy for one to three consecutive dry years, when shortages to CLWA's SWP water supplies could occur. Such high pumping would be followed by periods of lower pumping (7,500 to 15,000 afy in average/normal years as noted above) in order to allow recharge to recover water levels and storage in the Saugus. Maintaining the substantial volume of water in the Saugus Formation is an important strategy to help maintain water supplies in the Santa Clarita Valley during drought periods.

3.3.1 Saugus Formation – Historical and Current Conditions

Total pumping from the Saugus in 2009 was about 7,700 af, or about 750 af more than in the preceding year. Of the total Saugus pumping in 2009, most (about 6,700 af) was for municipal water supply, and the balance (1,000 af) was for agricultural and other irrigation uses. Historically, groundwater pumping from the Saugus peaked in the early 1990's and then steadily declined through the remainder of that decade. Since then, Saugus pumping had been in the range of about 4,000 to 6,500 afy, with the increase to almost 7,700 af in 2007 and again in 2009. Over the last five years, the municipal use of Saugus water has been relatively unchanged; almost all of the relatively small fluctuations from year to year have been related to non-municipal usage. On a long-term average basis since the importation of SWP water, total pumping from the Saugus Formation has ranged between a low of about 3,700 afy (in 1999) and a high of nearly 15,000 afy (in 1991); average pumping from 1980 to present has been about 6,800 afy. These pumping rates remain well within, and generally at the lower end of the range of Operating Yield of the Saugus Formation. The overall historic record of Saugus pumping is illustrated in Figure 3-8.

Unlike the Alluvium, which has an abundance of wells with extensive water level records, the water level data for the Saugus Formation are limited by both the distribution of the wells in that Formation and the periods of water level records. The wells that do have water level records extending back to the mid-1960's indicate that groundwater levels in the Saugus Formation were highest in the mid-1980's and are currently higher than they were in the mid-1960's (Figure 3-9). Based on these data, there is no evidence of any historic or recent trend toward permanent water level or storage decline. There continue to be seasonal fluctuations in groundwater levels but the prevalent longer-term trend is one of general stability.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), the 2005 UWMP, and the 2008 Updated Basin Yield Report (LSCE and GSI, 2009), the

Purveyors continue to maintain groundwater storage and associated water levels in the Saugus Formation so that supply is available during drought periods, when Alluvial pumping might be reduced and/or SWP or other supplemental supplies also decreased. The period of increased pumping during the early 1990's is a good example of this management strategy. Most notably, in 1991, when SWP deliveries were substantially reduced, increased pumping from the Saugus made up almost half of the decrease in SWP deliveries. The increased Saugus pumping over several consecutive dry years (1991-1994) resulted in short-term declining groundwater levels, reflecting the use of water from storage. However, groundwater levels subsequently recovered when pumping declined, reflecting recovery of groundwater storage in the Saugus Formation.

3.4 Imported Water

CLWA obtains the majority of its water supplies from the State Water Project (SWP), which is owned and operated by the California Department of Water Resources (DWR). CLWA is one of 29 contractors holding long-term SWP contracts with DWR. SWP water originates as rainfall and snowmelt in northern and central California. Runoff is stored in Lake Oroville, which is the project's largest storage facility. The water is then released from Lake Oroville down the Feather River to the Sacramento River and through the Sacramento-San Joaquin Delta. Water is diverted from the Delta into the Clifton Court Forebay, and then pumped into the 444-mile long California Aqueduct. SWP water is temporarily stored in San Luis Reservoir, which is jointly operated by DWR and the U.S. Bureau of Reclamation. Prior to delivery to CLWA, SWP supplies are stored in Castaic Lake, a terminal reservoir located at the end of the West Branch of the California Aqueduct.

CLWA's service area covers approximately 195 square miles (124,800 acres), including the City of Santa Clarita and surrounding unincorporated communities. SWP water from Castaic Lake is treated, filtered and disinfected at CLWA's Earl Schmidt Filtration Plant and Rio Vista Water Treatment Plant, which have a combined treatment capacity of 86 million gallons per day. Treated water is delivered from the treatment plants by gravity flow to each of the four Purveyors through a distribution network of pipelines and turnouts. At present, CLWA delivers water to the four Purveyors through 25 potable turnouts as schematically illustrated in Figure 3-10.

In 2009, CLWA fulfilled the following major accomplishments in order to enhance, preserve, and strengthen the quality and reliability of existing and future supplies:

- continued participation in a long-term water banking programs with Rosedale-Rio Bravo Water Storage District and the Semitropic Water Storage District. Water was not

withdrawn from the Rosedale-Rio Bravo Water Storage District, but 1,650 acre-feet was withdrawn from the Semitropic Water Storage District,

- continued implementation of the AB 3030 Groundwater Management Plan,
- continued implementation of the water conservation Best Management Practices,
- reconvened the Santa Clarita Valley Drought Committee, which has now changed its name to the Santa Clarita Valley Water Committee
- continued construction of treatment and distribution facilities for restoration of municipal well capacity impacted by perchlorate contamination,
- continued cooperative effort with the U.S. Army Corps of Engineers for characterization studies of the former Whittaker-Bermite site and in a task force effort with the City of Santa Clarita, local legislators, and state agencies to effect the cleanup and remediation of all aspects of the former Whittaker-Bermite site, including perchlorate contamination of local groundwater,
- began construction of the expansion of the Rio Vista Water Treatment Plant from 30 mgd to 60 mgd, and
- continued recycled water service.

3.4.1 State Water Project Table A Supplies

Each SWP contractor has a specified water supply amount shown in Table A of its contract that currently totals approximately 4.1 million af. The term of the CLWA contract is through 2038 and is renewable after that year. Although the SWP has not been fully completed, the SWP can deliver all 4.1 million af of Table A Amounts during certain wet years.

CLWA has a contractual Table A Amount of 95,200 af per year of water from SWP.[1] On October 30, 2008, the initial allocation for 2009 was announced as 15 percent. The allocation

[1] Of CLWA's 95,200 af annual Table A Amount, 41,000 afy was permanently transferred to CLWA in 1999 by Wheeler Ridge-Maricopa Water Storage District, a member unit of the Kern County Water Agency. CLWA's EIR prepared in connection with the 41,000 afy water transfer was challenged in Friends of the Santa Clara River v. Castaic Lake Water Agency (Los Angeles County Superior Court) ("Friends"). On appeal, the Court of Appeal held that since the 41,000 afy EIR tiered off the Monterey Agreement EIR that was later decertified, CLWA would also have to decertify its EIR as well and prepare a revised EIR. CLWA was not prevented from using any water that is part of the 41,000 afy transfer. Under the jurisdiction of the Los Angeles County Superior Court, CLWA prepared and circulated a revised Draft EIR for the transfer. CLWA approved the revised EIR in late 2004 ("2004 EIR") and lodged the EIR with the Los Angeles Superior Court. Thereafter, the case was dismissed with prejudice (i.e., permanently).

In January 2005, two new challenges to CLWA's 2004 EIR were filed in the Ventura County Superior Court by the Planning and Conservation League ("PCL") and by the California Water Impact Network ("CWIN"); these cases were consolidated and transferred to Los Angeles County Superior Court, Planning and Conservation League v. Castaic Lake Water Agency (Los Angeles County Superior Court,) ("PCL Action"). In May 2007, a final Statement of Decision was filed by the trial court in the PCL Action. It included a determination that the transfer is valid and cannot be terminated or unwound. The trial court did find one defect in the 2004 EIR, requiring Judgment to be entered against CLWA. The defect, however, did not relate to the environmental conclusions reached in the 2004 EIR. Notices of Appeal were filed by PCL and CWIN and the Agency, Kern County Water Agency, and Wheeler Ridge-Maricopa Water Storage District filed notices of cross-appeals. On December 17, 2009, the Court of Appeal issued a published opinion in which it reversed the trial court's Judgment, and found that the 41,000 afy EIR fully complied with CEQA, and remanded the matter to the trial court with directions to issue a new judgment denying PCL's and CWIN's challenges in their entirety. A petition for rehearing was filed by PCL and CWIN on January 4, 2010 but was denied on January 14, 2010. On January 26, 2010, PCL and CWIN filed a petition for review with the California Supreme Court, but the Court denied the petition on March 10, 2010.

was increased to 20 percent on March 18, 2009, and further increased to 30 percent on April 16, 2009; and then to 40 percent on May 20, 2009. The allocation was not subsequently changed. CLWA's final allocation of Table A Amount for 2009 was thus 40 percent, or 38,080 af.

In addition to its Table A Amount, CLWA has access to 4,684 af of "flexible storage" in Castaic Lake. In 2005, CLWA negotiated an agreement with the Ventura County SWP contractors to allow CLWA to utilize their flexible storage account of 1,376 af. In combination, this provides total flexible storage of 6,060 af, which is maintained in Castaic Lake for use in a future dry period or an emergency. This amount was available in 2009, but was not utilized due to other available supplies.

Also in 2005, CLWA completed an agreement to participate in a long-term water banking program with Rosedale-Rio Bravo Water Storage District in Kern County. CLWA delivered 20,000 af of its excess Table A water into storage in both 2005 and 2006. CLWA delivered another 8,200 af into that storage account in 2007 but did not contribute to or withdraw SWP water from the bank in 2008 or 2009. This long-term program will allow the storage up to 100,000 af at any one time, and will provide significant dry year reliability for the Santa Clarita Valley.

The other banking component of CLWA's imported water supply reliability program is comprised of two 10-year agreements with Semitropic Water Storage District whereby CLWA banked surplus Table A water supply in 2002 and 2003. Notable in 2009 was the first recovery of water from the 2002 account; of 4,950 af withdrawn in 2009, 1,650 af were delivered for water supply in the Valley, and the 3,300 af balance is intended to be delivered in 2010.

As delineated in Table 3-2, with the 40 percent Table A allocation and other imported water supplies, including 14,610 af of carryover from 2008, CLWA had total available supply of 67,050 af in 2009, most of which was delivered to the Purveyors (38,546 af), leaving 28,303 af of Table A Amount available for carryover to 2010.

3.4.2 Other Imported Water Supplies

In early 2007, CLWA finalized a Water Acquisition Agreement with the Buena Vista Water Storage District (Buena Vista) and the Rosedale-Rio Bravo Water Storage District (Rosedale-Rio Bravo) in Kern County. Under this Program, Buena Vista's high flow Kern River entitlements (and other acquired waters that may become available) are captured and recharged within

Table 3-2
2009 CLWA Imported Water Supply and Disposition
(acre-feet)

Supply		
Net 2008 SWP Carryover to 2009 [1]		14,610
Buena Vista/Rosedale Rio-Bravo		11,000
Yuba County Accord Water		1,658
2009 SWP Turnback Pool Water		52
Semitropic Water Banking and Exchange Program		1,650
2009 Final SWP Table A Allocation [2]		38,080
Total 2009 Imported Water Supply		**67,050**
Disposition		
Purveyor Deliveries (Total)		38,546
CLWA SCWD	*17,739*	
Valencia Water Company	*14,732*	
Newhall County Water District	*4,832*	
Los Angeles County WWD 36	*1,243*	
CLWA/DWR/Purveyor Metering[3]		201
Rosedale – Rio Bravo Water Banking and Exchange Program		0
2009 Table A Carryover to 2010[4]		28,303
Total 2009 Imported Water Disposition		**67,050**

1. Total 2009 carryover; amount used by CLWA, based on final DWR delivery accounting was 10,107 af.

2. Final 2009 allocation was 40% of contractual Table A amount of 95,200 acre-feet, which progressed as follows:

Initial allocation, October 30, 2008	15%
Allocation increase, March 18, 2009	20%
Allocation increase, April 16, 2009	30%
Final allocation, May 20, 2009	40%

3. Reflects meter reading differences.

4. Total 2009 Table A carryover to 2010.

Rosedale-Rio Bravo's service area on an ongoing basis.[2] CLWA receives 11,000 af of these supplies annually through either exchange of Buena Vista's and Rosedale-Rio Bravo's SWP supplies or through direct delivery of water to the California Aqueduct via the Cross Valley Canal.

In 2008, CLWA entered into the Yuba Accord Agreement, which allows for the purchase of water from the Yuba County Water Agency through the Department of Water Resources to 21 State Water Project contractors (including CLWA) and the San Luis and Delta-Mendota Water Authority. CLWA may purchase up to approximately 1,000 af per year and in 2009 received 1,658 af as part of the Agreement.

3.4.3 Imported Water Supply Reliability

The Department of Water Resources issued its Draft State Water Project Delivery Reliability Report 2009 in February 2010. The report is updated with new information and calculations of delivery reliability every two years and is intended to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies. The current Draft Reliability Report, with the objective of protecting endangered fish such as the Delta smelt and spring-run salmon, incorporates restrictions on SWP operations according to the Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fishery Service issued on December 15, 2008 and June 4, 2009, respectively. It also considers the impacts on SWP delivery reliability due to climate change, sea level rise, and vulnerability of the Delta's conveyance system and structure due to floods and earthquakes. The current Draft Reliability Report projects long-term reliability of 60 percent during normal year hydrology. In 2010, CLWA staff assessed the impact of the current Reliability Report on the CLWA reliability analysis contained in the Agency's 2005 UWMP. It concluded that current and anticipated supplies are available to meet anticipated water supply needs.

Groundwater banking and conjunctive use offer significant opportunities to improve water supply reliability for CLWA. Groundwater banking is the process of storing available supplies of water in groundwater basins during wet years or when supplemental water is otherwise available. During dry periods, or when imported water supply availability is reduced, banked water can be recovered from groundwater storage to replace, or firm up, the imported water supply deliveries.

[2] A CEQA action was filed by California Water Impact Network (CWIN) in November 2006 challenging the adequacy of CLWA's EIR on the acquisition of 11,000 af from the Buena Vista Water Storage District and Rosedale-Rio Bravo Water Storage District. In November 2007, a Los Angeles Superior Court ruled in favor of CLWA on all points. In January 2008, CWIN filed a notice of appeal. The case was argued before the appellate court March 2, 2009. On April 20, 2009, the Court of Appeal issued an opinion affirming the Superior Court's judgement.

As described herein, CLWA has entered into two groundwater banking programs and now has, in aggregate, more than 110,000 af of recoverable water in banked groundwater storage outside the local groundwater basin. The first component of CLWA's overall groundwater banking program is the result of two 10-year agreements between CLWA and Semitropic Water Storage District whereby, over the terms of the two agreements, CLWA can withdraw up to 45,920 af of SWP Table A water that it stored in Semitropic to meet Valley demands when needed in dry years (45,920 af is the net recoverable balance after originally banking 24,000 af in 2002 and 32,522 af in 2003, and withdrawing 4,950 af in 2009). The second component of the program, the long-term Rosedale-Rio Bravo Water Banking and Exchange Program in Kern County, has a recoverable total of 64,900 acre-feet in storage (i.e., 75,200 af originally banked less contractual losses).

Conjunctive use is the purposeful integrated use of surface water and groundwater supplies to maximize water supply from the two sources. CLWA and the Purveyors have been conjunctively utilizing local groundwater and imported surface water since the initial importation of SWP water in 1980. The groundwater banking programs described above allow CLWA to firm up the imported water component of conjunctive use in the Valley by storing surplus SWP and other water, in wet years, in groundwater basins outside the Valley. This allows recovery and importation of that water as needed in dry years to maintain a greater overall amount of imported surface water to be used conjunctively with local groundwater, further supporting the sustainable use of local groundwater at the rates in the groundwater operating plan.

3.5 Water Quality – General

Water delivered by the Purveyors consistently meets drinking water standards set by the Environmental Protection Agency (EPA) and the California Department of Public Health (DPH). An annual Water Quality Report is provided to all Santa Clarita Valley residents who receive water from one of the four water retailers. There is detailed information in that report about the results of quality testing of the groundwater and treated SWP water supplied to the residents of the Santa Clarita Valley during 2008. Several constituents of particular local interest are discussed in more detail below.

Total Trihalomethanes

In 2002, the United States Environmental Protection Agency implemented the new Disinfectants and Disinfection Byproducts Rule. In part, this rule established a new MCL of 80 μg/l (based on an annual running average) for Total Trihalomethanes (TTHM). TTHMs are byproducts created when chlorine is used as a means for disinfection. CLWA and the Purveyors implemented an alternative method of disinfection, chloramination, in 2005 to maintain compliance with the new

rule and future regulations relating to disinfection byproducts. TTHM concentrations have remained significantly below the MCL since implementation of alternative disinfection.

Perchlorate

Perchlorate has been a water quality concern in the Valley since 1997 when it was originally detected in four wells operated by the Purveyors in the eastern part of the Saugus Formation, near the former Whittaker-Bermite facility. In late 2002, perchlorate was detected in a fifth municipal well, in this case an Alluvial well (SCWD's Stadium Well) also located near the former Whittaker-Bermite site. In early 2005, perchlorate was detected in a second Alluvial well (VWC's Well Q2) near the former Whittaker-Bermite site. In 2006, a very low concentration of perchlorate was detected in another Saugus well (NCWD's Well NC-13), near one of the originally impacted wells. However, that detection has been interpreted to not be an indication of continued perchlorate migration in a westerly direction. Subsequent monitoring well installation has been completed and a focused study of the Saugus Formation has ultimately been incorporated into the overall groundwater remediation and removal actions submitted by Whittaker-Bermite and reviewed by the State Department of Toxic Substances Control (DTSC) as discussed below.

Wells with perchlorate concentrations exceeding the then-applicable Action Level (18 µg/l) or, more recently, the then-applicable Notification Level (6 µg/l)[3] were removed from active water supply service. One of the Alluvial wells (VWC's Well Q2) was returned to active water supply service, with treatment, in late 2005 as discussed below. The other impacted wells remain out of service; two wells (VWC's Well 157 and SCWD's Stadium Well) have been sealed and replaced by new wells, and two wells (SCWD's Saugus 1 & 2 Wells) are being returned to service as described below. The 2005 UWMP specifically addressed the adequacy of groundwater supply in light of the inactivation of the impacted Alluvial and Saugus wells; and it addressed the plan and schedule for restoration of perchlorate-impacted wells, including the protection of existing non-impacted wells. As summarized in the 2005 UWMP, the inactivation of the impacted wells does not constrain the ability to meet the groundwater component of total water supply in the Valley.

In 2000, CLWA and the impacted Purveyors filed a lawsuit against Whittaker Corporation (the former owner of the contaminated property) and Santa Clarita LLC and Remediation Financial, Inc. (the owners of record at that time). The lawsuit sought to have defendants pay all necessary costs of response, removal of the contaminant, remedial actions, and any liabilities or damages associated with the contamination. An Interim Settlement and Funding Agreement was reached

[3] The Maximum Contaminant Level (MCL) for perchlorate was set at 6 µg/l by the State Department of Public Health in October 2007.

in 2003. Although that Agreement expired in January 2005, the parties, under DTSC oversight, jointly developed a plan to "pump and treat" contaminated water from two of the Purveyors' impacted wells to stop migration of the contaminant plume and to partially restore the municipal well capacity that has been impacted by perchlorate. The parties also continued negotiations intended to achieve a long term settlement to the litigation through 2006, and a final settlement was completed and executed in April 2007.

Since 2007, the impacted Purveyors (SCWD, NCWD, and VWC) and CLWA continued working toward implementation of a jointly developed plan that will combine pumping from two of the impacted wells and a water treatment process to restore the impacted pumping capacity and control the migration of contamination in the aquifer. The development and implementation of a cleanup plan for the Whittaker-Bermite site and the impacted groundwater is being coordinated among CLWA, the impacted Purveyors, the State DTSC, and U.S. Army Corps of Engineers. DTSC is the lead agency responsible for regulatory oversight of the Whittaker-Bermite site.

In February 2003, DTSC and the impacted Purveyors entered into a voluntary cleanup agreement entitled *Environmental Oversight Agreement*. Under the Agreement, DTSC is providing review and oversight of the response activities being undertaken by the Purveyors related to the detection of perchlorate in the impacted wells. Under the Agreement's Scope of Work, the impacted Purveyors prepared a Work Plan for sampling the production wells, a report on the results and findings of the production well sampling, a draft Human Health Risk Assessment, a draft Remedial Action Workplan, an evaluation of treatment technologies and an analysis showing the integrated effectiveness of a project to restore impacted pumping capacity, extract perchlorate-impacted groundwater from two Saugus wells for treatment, and control the migration of perchlorate in the Saugus Formation. Environmental review of that project was completed in 2005 with adoption of a mitigated Negative Declaration. The Final Interim Remedial Action Plan for containment and extraction of perchlorate was completed and approved by DTSC in January 2006. Design of the treatment facilities and related pipelines is complete. Construction of those facilities and pipelines to implement the pump and treat program and to also restore inactivated municipal well capacity began in November 2007 and was completed, and in operational startup, as this report was being drafted (May, 2010).

Under the direction of DTSC, Whittaker has submitted a comprehensive site-wide remediation plan for the contaminants of concern in soil and groundwater detected on the property. A Draft Remedial Action Plan for Operable Units 2 through 6 that is focused on soil remediation was submitted to DTSC in 2009. The plan contains a number of recommended technologies to remove contaminants from the soil, in addition to a proposed clean-up schedule for the site. Whittaker has also completed a Draft Operable Unit 7 Feasibility Study to identify and select

treatment technologies for both on-site and off-site groundwater. Final approval by DTSC of soil and groundwater clean-up plans is expected by the end of 2010.

As noted above, perchlorate was detected in a second Alluvial well, VWC's Well Q2, in early 2005. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. Valencia's response for Well Q2 was to obtain permitting for installation of wellhead treatment, followed by installation of treatment facilities and returning the well to water supply service in October 2005. After nearly two years of operation with wellhead treatment, including regular monitoring specified by the State Department of Public Health (DPH), all of which resulted in no detection of perchlorate in Well Q2, Valencia requested that DPH allow treatment to be discontinued. DPH approved that request in August 2007, and treatment was subsequently discontinued. DPH-specified monitoring for perchlorate continues at Well Q2; there has been no detection of perchlorate since discontinuation of wellhead treatment.

On the Whittaker-Bermite site, soil remediation activities in operating unit subareas started in 2005. Groundwater "pump and treat" operations in the Northern Alluvium, which also started in 2005, continued through 2009. Expanded pumping, intended to effect perchlorate containment as well as to treat 'hot spots' in the Northern Alluvium, became operational in October 2007. Also on the Whittaker-Bermite site, remediation work in the Saugus Formation is underway. Additional objectives of this project include the reduction of further transport of contaminants to regional groundwater and reduction of the size of the contaminant mass in deep/perched zones.

Hardness

In 2008, the Valencia Water Company began a demonstration project delivering pre-softened groundwater from one of its wells to approximately 420 residents located in the Copperhill Community of Valencia. Hard water is the primary complaint from Valencia customers and it is estimated that more than 50 percent have installed individual water softening units at their homes. In addition to having high operating costs, many of these units are designed to discharge a brine (salt) solution to the sanitary sewer system that is eventually discharged to the Santa Clara River, or is part of the recycled water supply. The environmental impact of such discharges was the subject of a major Chloride Total Maximum Daily Load investigation which concluded with a commitment by the Purveyors to achieve surface water quality goals for in-stream discharge from the basin. Valencia's project is aimed at improving the quality of water for its customers to eliminate the need for home softening devices and to achieve the environmental benefits of reduced chloride discharge to the river.

The demonstration project utilizes softening technology that removes calcium and produces small calcium carbonate pellets which can be reused in a variety of industries. The demonstration project has now been operated for over a year and provides the water company with customer feedback and technical/financial information to assess potential future expansion of treatment to other well sites.

3.5.1 Groundwater Quality – Alluvium

Groundwater quality is, of course, a key factor in assessing the Alluvial aquifer as a municipal and agricultural water supply. Groundwater quality details and long-term conditions, examined by integration of individual records from several wells completed in the same aquifer materials and in close proximity to each other, have been discussed in previous annual Water Reports and in the 2005 UWMP. There were some changes in groundwater quality in 2009 that reflect fluctuations, trends, or other groundwater quality conditions as illustrated in Figures 3-11 and 3-12. These graphs show historical specific conductance values for representative wells in the Valley with the California Department of Public Health Secondary Maximum Levels included for reference. Most of the trends show a significant lowering of the specific conductance values by half following the wet years of 2004-2005. Since then, those trends have returned to 2004 levels but do not exceed historical levels. In summary, those conditions include: no long-term overall trend and, most notably, no long-term decline in Alluvial groundwater quality; a general groundwater quality "gradient" from east to west, with lowest dissolved mineral content to the east, increasing in a westerly direction; and periodic fluctuations in some parts of the basin, where groundwater quality has inversely varied with precipitation and stream flow. Those variations are typically characterized by increased mineral concentrations through dry periods of lower stream flow and lower groundwater recharge, such as is currently occurring, followed by lower mineral concentrations through wetter periods of higher stream flow and higher groundwater recharge.

The presence of long-term consistent water quality patterns, although intermittently affected by wet and dry cycles, supports the conclusion that the Alluvial aquifer remains a viable ongoing water supply source in terms of groundwater quality.

3.5.2 Groundwater Quality – Saugus Formation

As discussed above for the Alluvium, groundwater quality is a key factor in also assessing the Saugus Formation as a municipal and agricultural water supply. As with groundwater level data, long-term Saugus groundwater quality data are not sufficiently extensive to permit any sort of basin-wide analysis or assessment of pumping-related impacts on quality. However, integration

of individual records from several wells has been used to examine general water quality trends. Based on those records, water quality in the Saugus Formation has not historically exhibited the precipitation-related fluctuations seen in the Alluvium. Based on available data over the last 50 years, groundwater quality in the Saugus has exhibited a slight overall increase in dissolved mineral content as illustrated in Figure 3-13. More recently, several wells within the Saugus Formation have exhibited an additional increase in dissolved mineral content, similar to short-term changes in the Alluvium, possibly as a result of recharge to the Saugus Formation from the Alluvium. Since 2005, however, these levels have been steadily dropping or remaining constant. Dissolved mineral concentrations in the Saugus Formation remain below the Secondary (aesthetic) Upper Maximum Contaminant Level. Groundwater quality within the Saugus will continue to be monitored to ensure that degradation to the long-term viability of the Saugus as a component of overall water supply does not occur.

3.5.3 Imported Water Quality

CLWA operates two water treatment plants, the Earl Schmidt Filtration Plant located near Castaic Lake and the Rio Vista Water Treatment Plant located in Saugus. CLWA produces water that meets drinking water standards set by the U.S. EPA and DPH. SWP water has different aesthetic characteristics than groundwater with lower dissolved mineral concentrations (total dissolved solids) of approximately 250 to 360 mg/l, and lower hardness (as calcium carbonate) of about 105 to 135 mg/l.

Historically, the State Water Project (SWP) delivered only surface water from the Sacramento-San Joaquin River Delta. However, CLWA and other SWP users, in anticipation of drought, many years ago began “water banking” programs where SWP water could be stored or exchanged during wet years and withdrawn in dry years. The last three years have seen severe state-wide drought. As a result, water has been withdrawn from the water banking programs and pumped into the SWP system. During the period of 2008 through 2010, a greater portion of water in the SWP has been this “pumped-in” water. The “pumped-in” water has met all water quality standards established by DWR under its anti-degradation policy for the SWP.

3.6 Recycled Water

Recycled water is available from two water reclamation plants operated by the Sanitation Districts of Los Angeles County. In 1993, CLWA prepared a draft Reclaimed Water System Master Plan that outlined a multi-phase program to deliver recycled water in the Valley. CLWA previously completed environmental review on the construction of Phase I of the project, which will ultimately deliver 1,700 afy of recycled water. Deliveries of recycled water began in 2003

for irrigation water supply at a golf course and in roadway median strips. In 2009, recycled water deliveries were 328 af, generally consistent with recycled water deliveries that have ranged between 311 and 470 afy over the past six years.

Surveys conducted by CLWA indicate an interest for recycled water by existing water users as well as by future development as recycled water becomes available. In 2002, CLWA produced an updated Draft Recycled Water Master Plan. Overall, the program is expected to ultimately recycle up to 17,400 af of treated (tertiary) wastewater suitable for reuse on golf courses, landscaping and other non-potable uses, as set forth in the UWMP.

In 2007, CLWA completed California Environmental Quality Act (CEQA) analysis of the Recycled Water Master Plan (2002). This analysis consisted of a Program Environmental Impact Report (PEIR) covering the various options for a recycled water system as outlined in the Master Plan. The PEIR was certified by the CLWA Board in March 2007.

CLWA is preparing the design of the second phase of the Recycled Water Master Plan that will take water from the Saugus Water Reclamation plant and distribute it to identified users to the north, across the Santa Clara River and then to the west and the east, which will include service to Santa Clarita Central Park. There is also a new phase of the of the recycled water system in design that would extend the existing system southward from the intersection of Magic Mountain Parkway and the Old Road to the intersection of Orchard Village Road and Lyons Avenue, serving large irrigation customers along its proposed alignment. Collectively, these phases will have design capacity to increase recycled water deliveries by about 1,500 afy.

3.7 Santa Clara River

The Memorandum of Understanding (MOU) between the Santa Clarita Valley Purveyors and the United Water Conservation District, which manages surface and groundwater resources in seven groundwater basins in the Lower Santa Clara River Valley Area, was a significant accomplishment when it was prepared and executed in 2001. The MOU initiated a collaborative and integrated approach to data collection; database management; groundwater flow modeling; assessment of groundwater basin conditions, including determination of basin yield amounts; and preparation and presentation of reports, including continued annual reports such as this one for current planning and consideration of development proposals, and also including more technically detailed reports on geologic and hydrologic aspects of the overall stream-aquifer system. Meetings of the MOU participants have continued, and integration of the Upper (Santa Clarita Valley) and Lower (United WCD) Santa Clara River databases has been accomplished. As discussed above, a numerical groundwater flow model of the entire Santa Clarita groundwater

basin was developed and calibrated in 2002-2004. Subsequent to its initial use in 2004 for assessing the effectiveness of various operating scenarios to restore pumping capacity impacted by perchlorate contamination (by pumping and treating groundwater for water supply while simultaneously controlling the migration of contaminated groundwater), the model was used in 2005 for evaluation of basin yield under varying management actions and hydrologic conditions. The results completed the determination of sustainable operating yield values for both the Alluvium and the Saugus Formation, which were incorporated in the 2005 UWMP. The updated analysis of basin yield, completed in 2009, indicates that the 2008 Operating Plan will maintain river flows at higher levels than occurred prior to urbanization of the Valley.

On occasion, issues have been raised about whether use and management of groundwater in the Santa Clarita Valley have adversely impacted surface water flows into Ventura County. Part of the groundwater modeling work has addressed the surface water flow question as well as groundwater levels and storage. While the sustainability of groundwater has logically derived primarily from projected long-term stability of groundwater levels and storage, it has also derived in part from modeled simulations of surface water flows and the lack of streamflow depletion by groundwater pumping. In addition, the long-term history of groundwater levels in the western and central part of the basin, as illustrated in Figures 3-4 and 3-5, supports the modeled analysis and suggests that groundwater has not been lowered in such a way as to induce infiltration from the river and thus impact surface water flows.

Historical annual stream discharge in the Santa Clara River, into and out of the Santa Clarita Valley, is shown on Figure 3-14. The upstream gage at Lang Station was reinstated in 2002 and shows a wide range of average annual inflow over the last seven years. The downstream gage was moved in 1996 to its present location near Piru, about two miles downriver from the former County Line Gage. The combined record (1953-2009) of these two downstream gages indicates an annual stream discharge of about 47,000 afy. These data gaged near the County line show notably higher flows from the Santa Clarita Valley into the uppermost downstream basin, the Piru Basin, over the last 30 to 35 years.

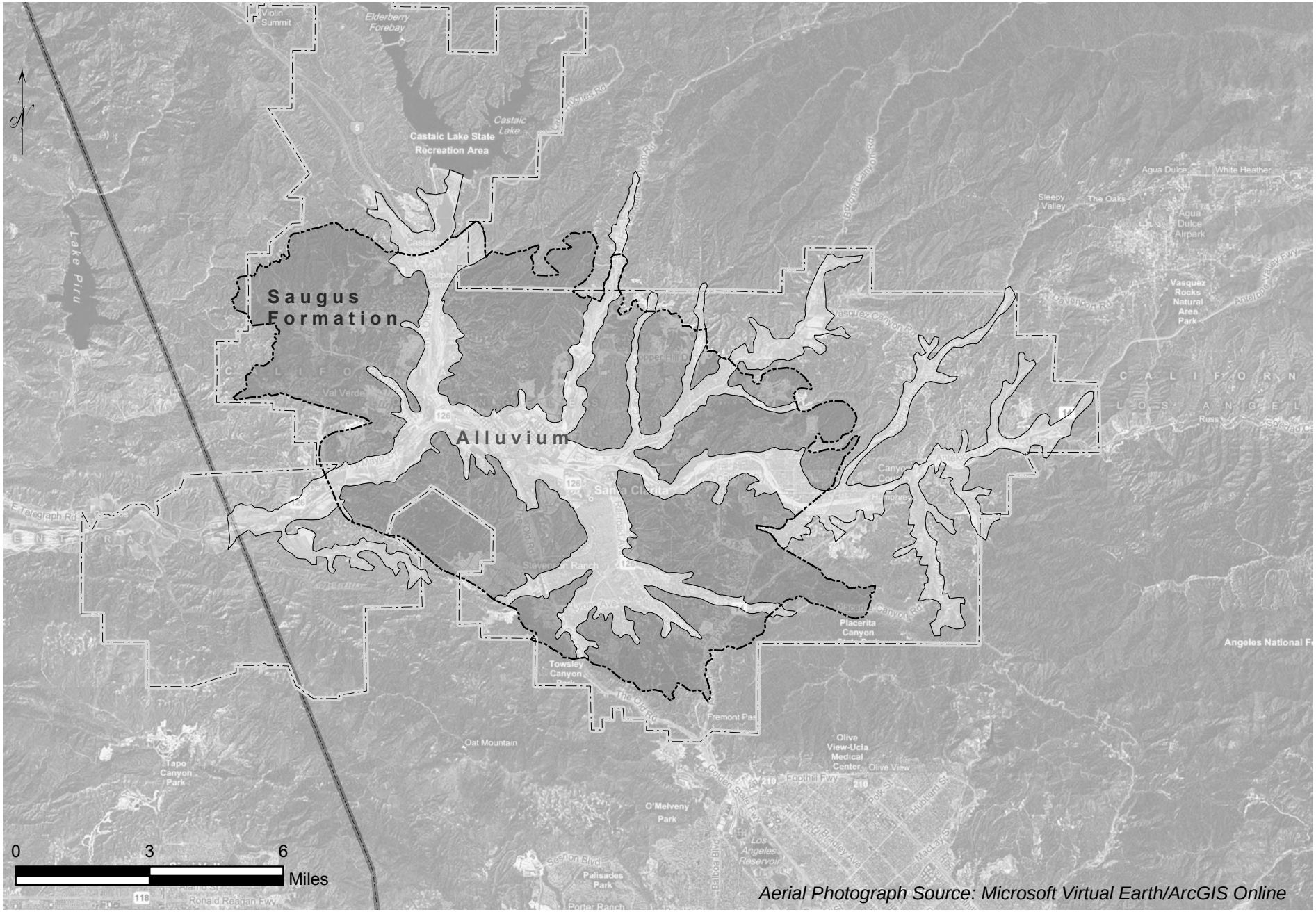

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Figure 3-1
Alluvium and Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin

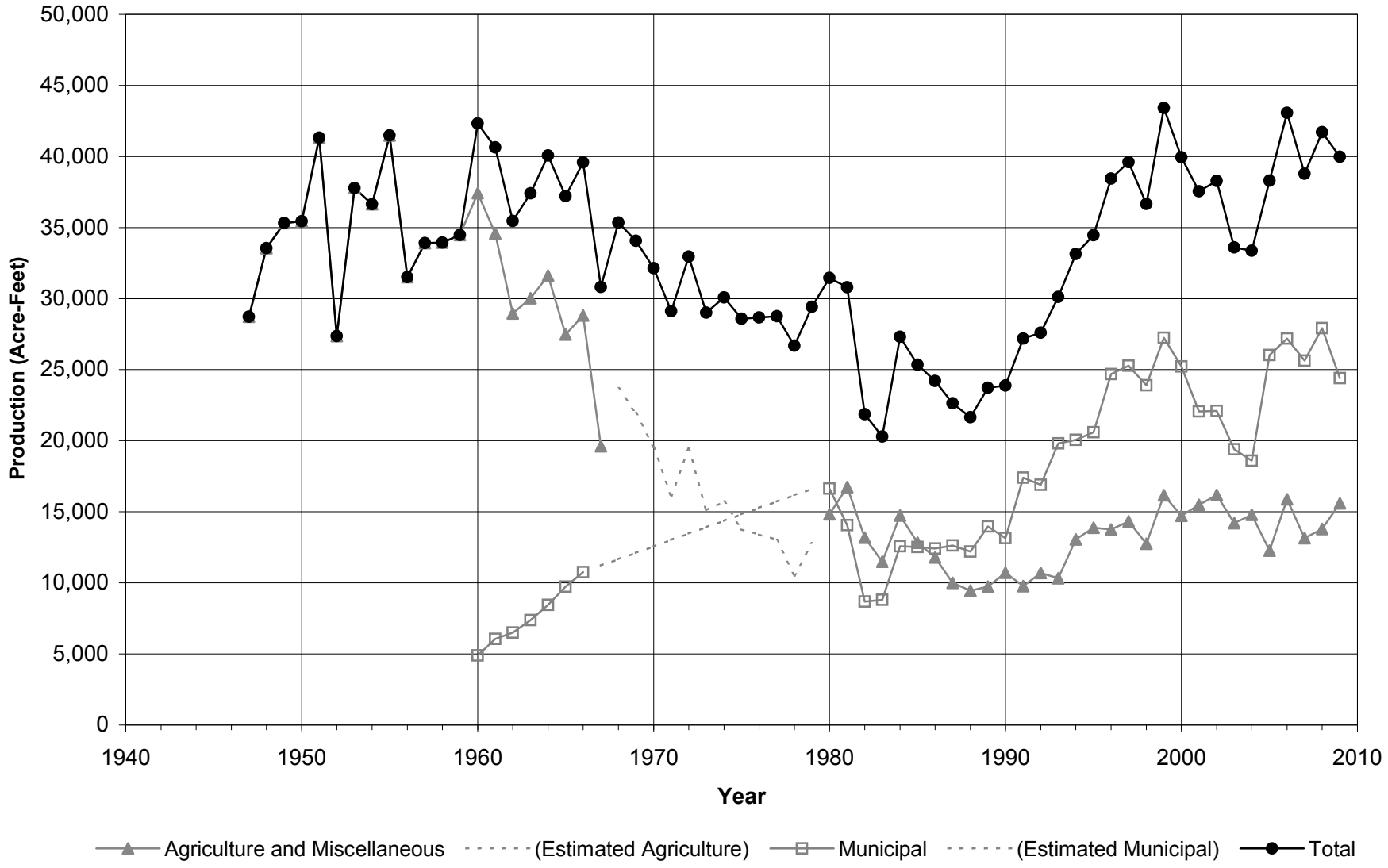

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Figure 3-2
Groundwater Production - Alluvium
Santa Clara River Valley, East Groundwater Subbasin

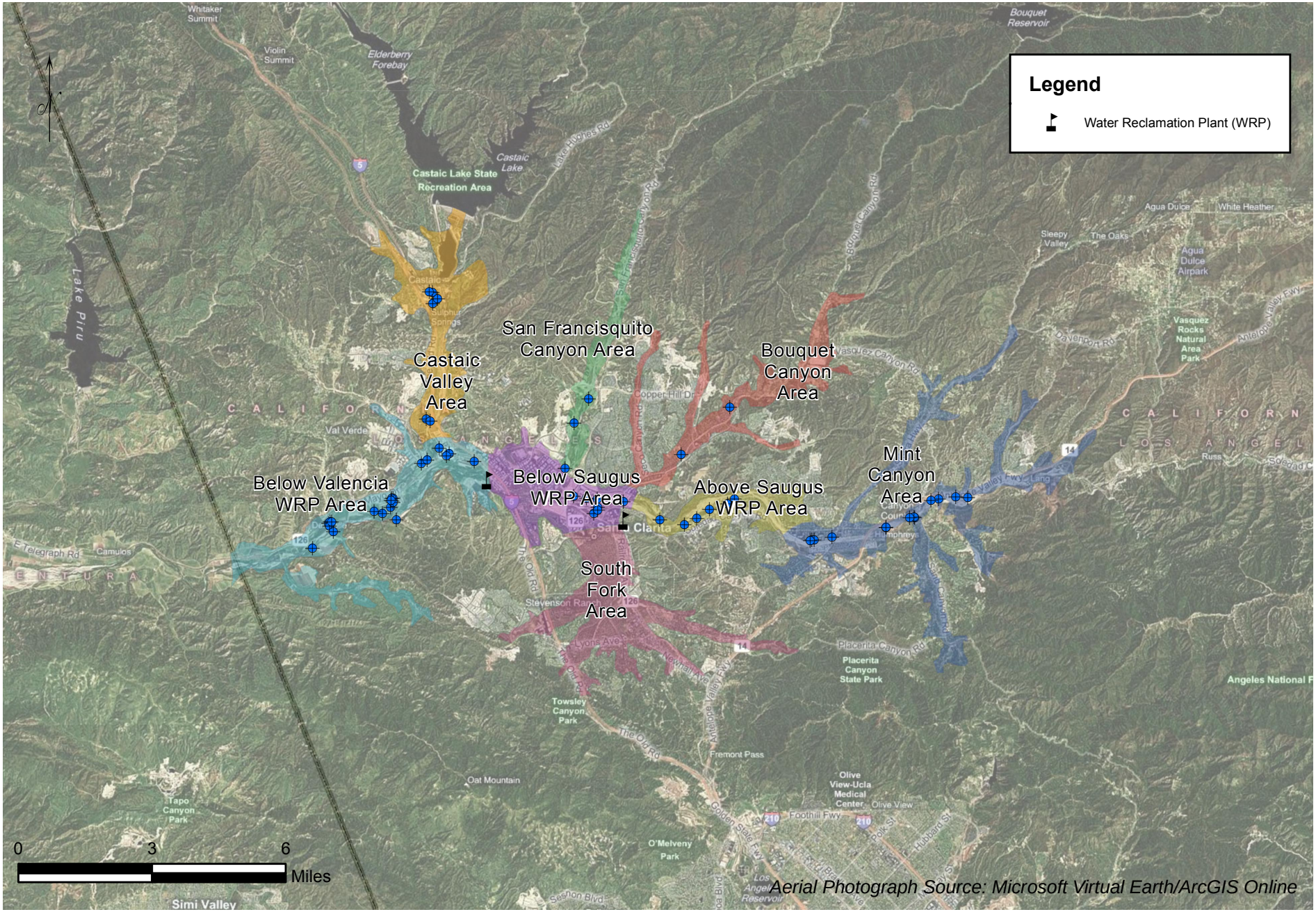

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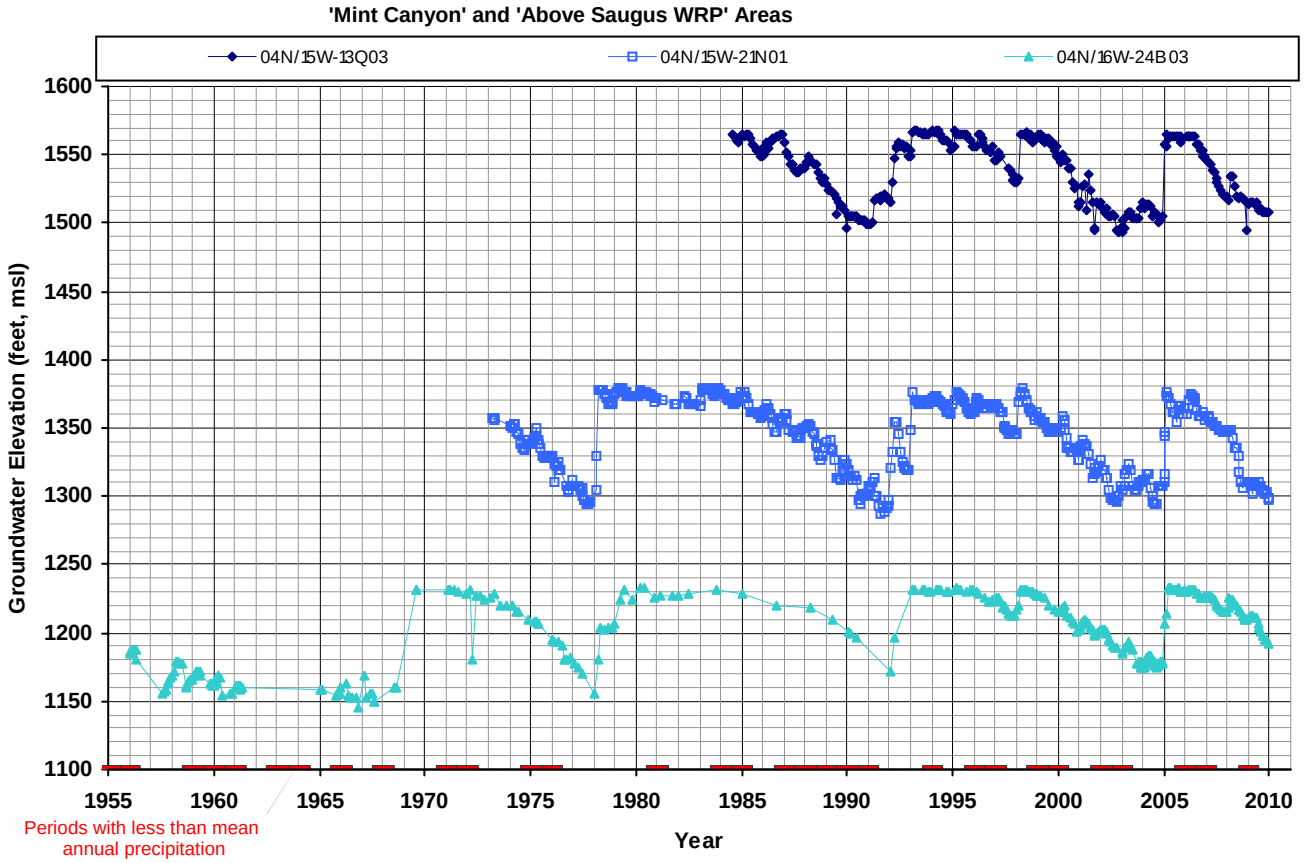
Figure 3-3
Alluvial Well Locations By Area
Santa Clara River Valley, East Groundwater Subbasin



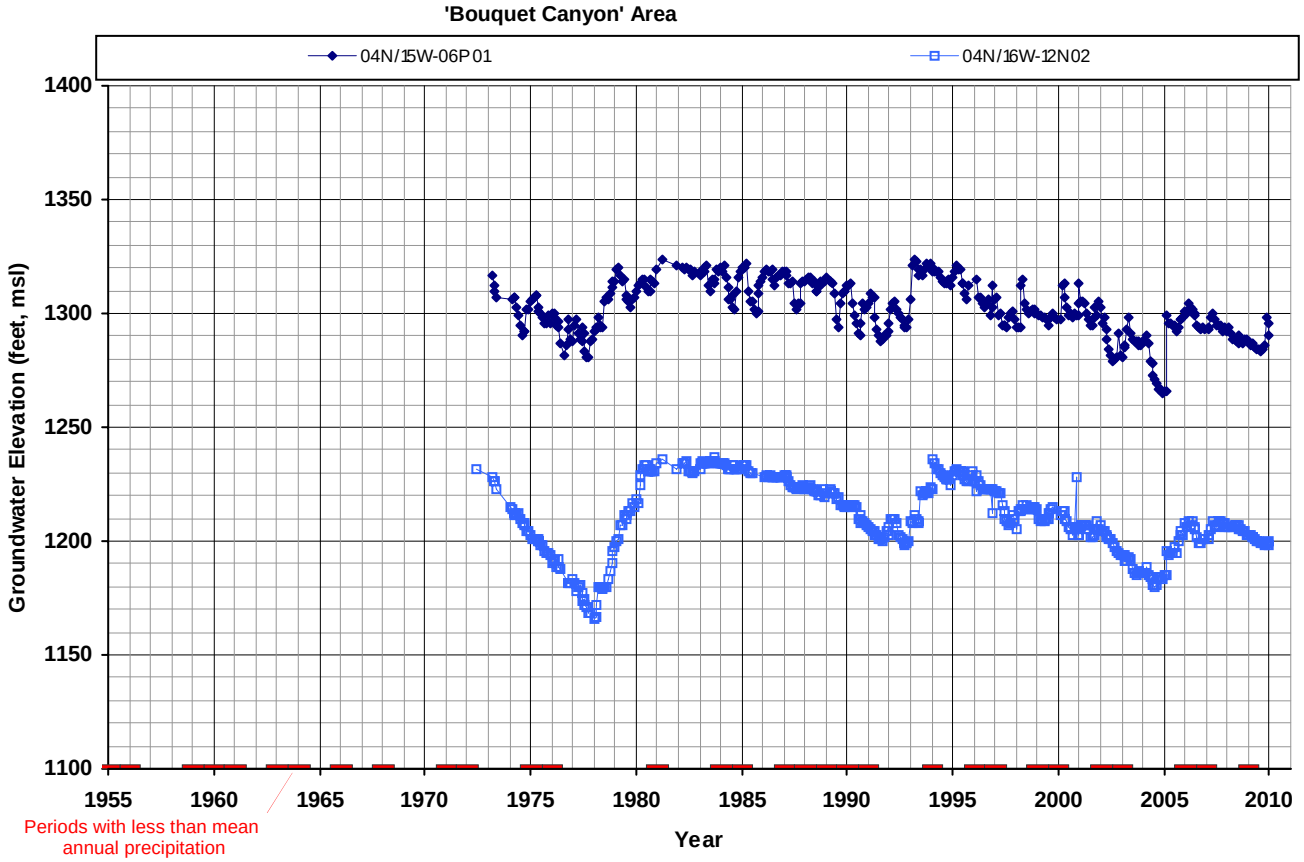


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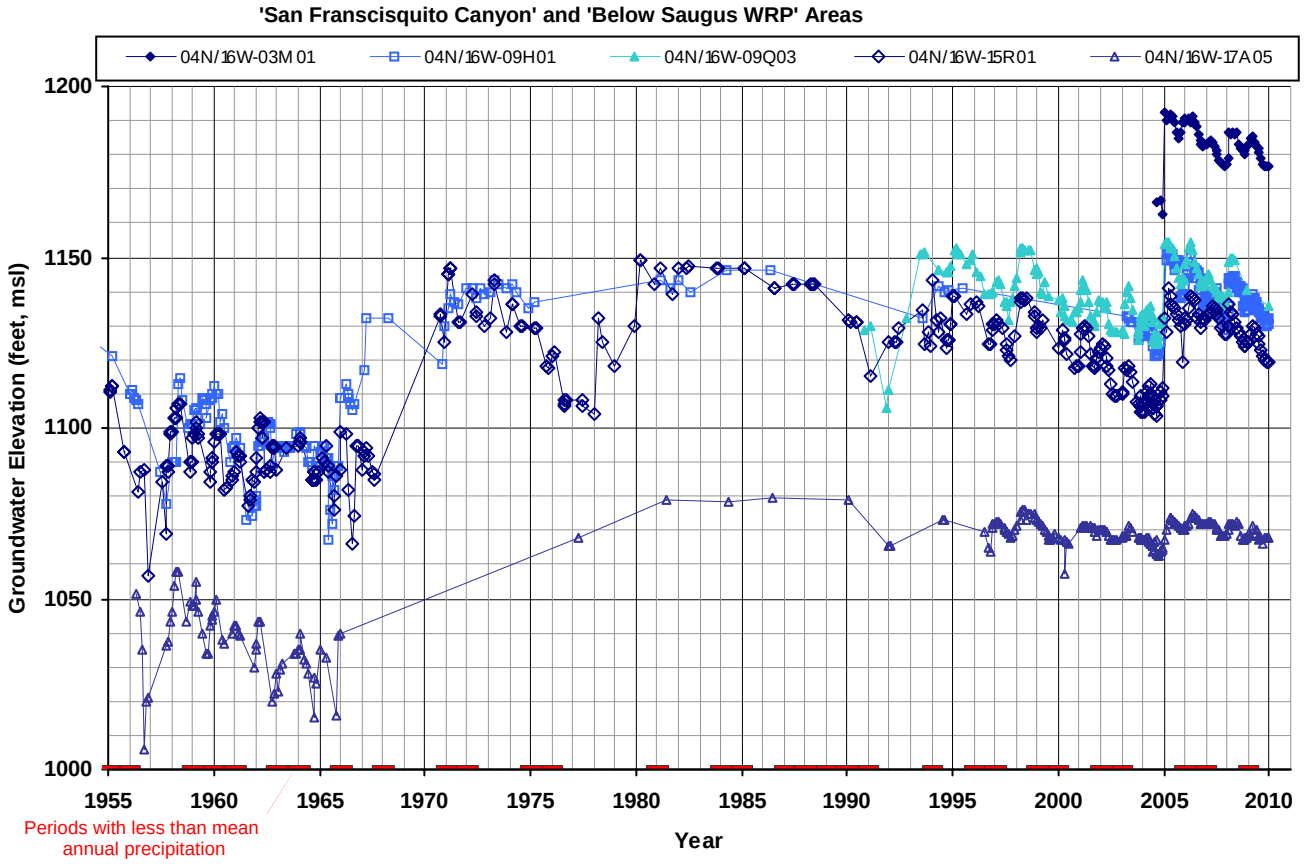
Figure 3-4
Groundwater Elevations in Eastern Santa Clarita Valley Alluvial Wells



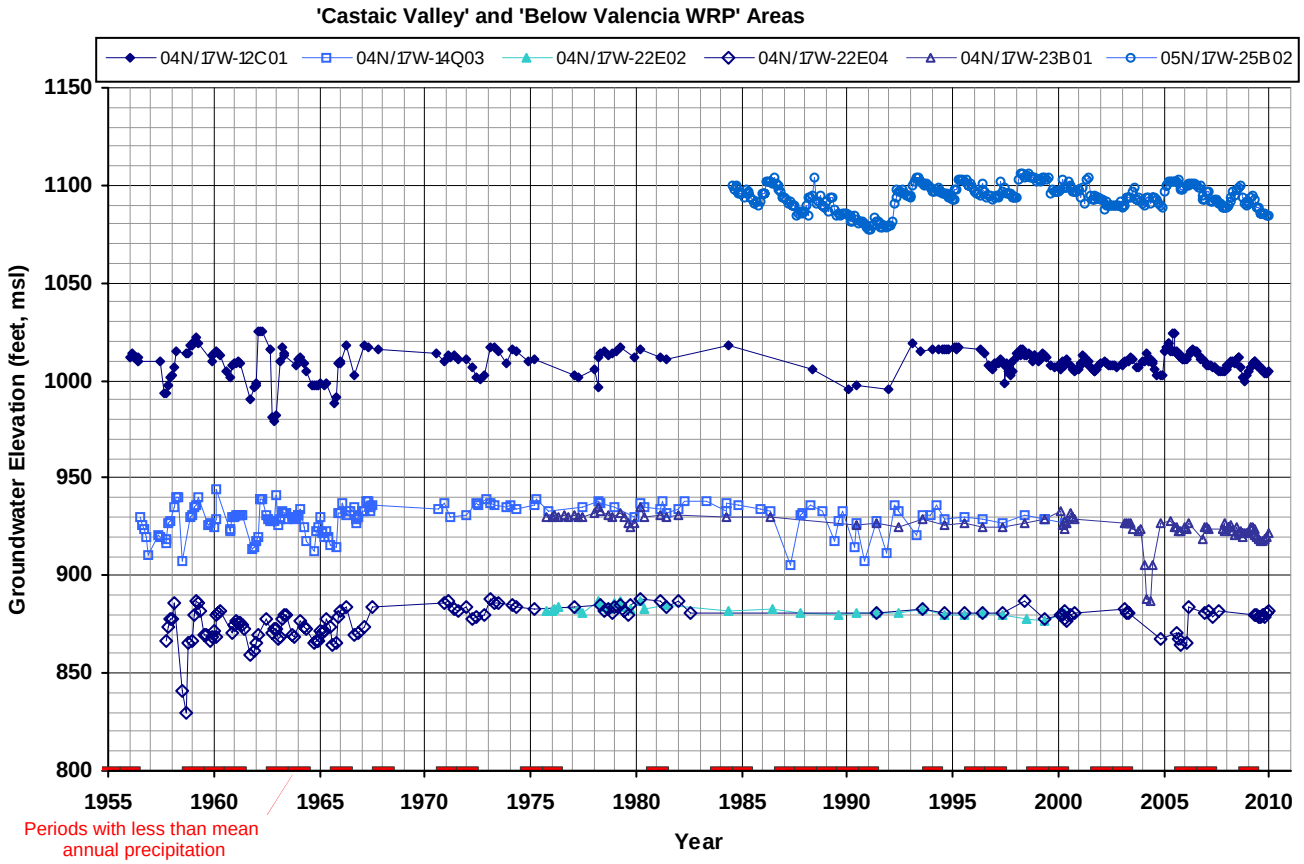


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Figure 3-5
Groundwater Elevations in Western Santa Clarita Valley Alluvial Wells

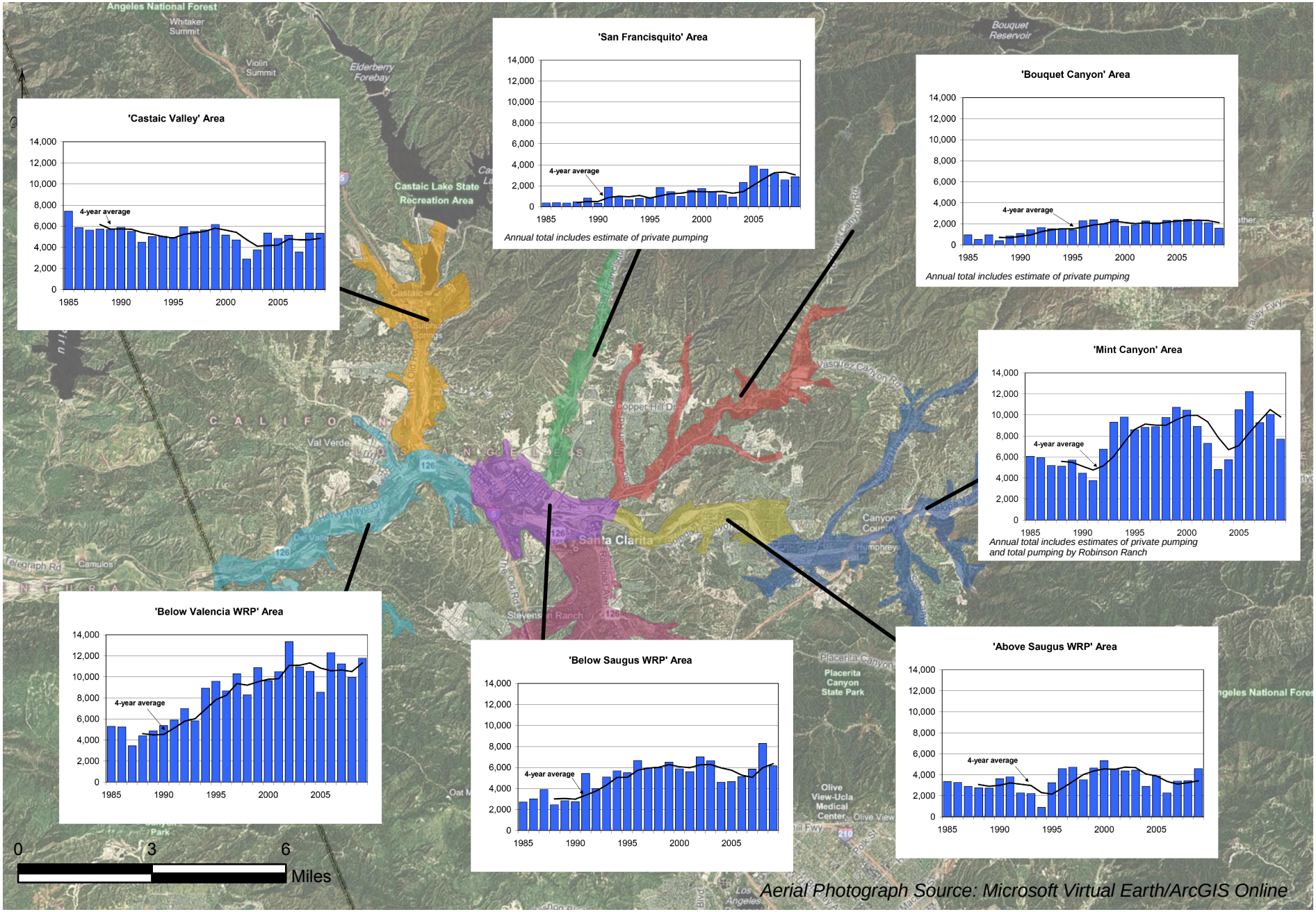

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Figure 3-6
Annual Groundwater Production from Alluvium by Area (Acre-feet)
Santa Clara River Valley, East Groundwater Subbasin

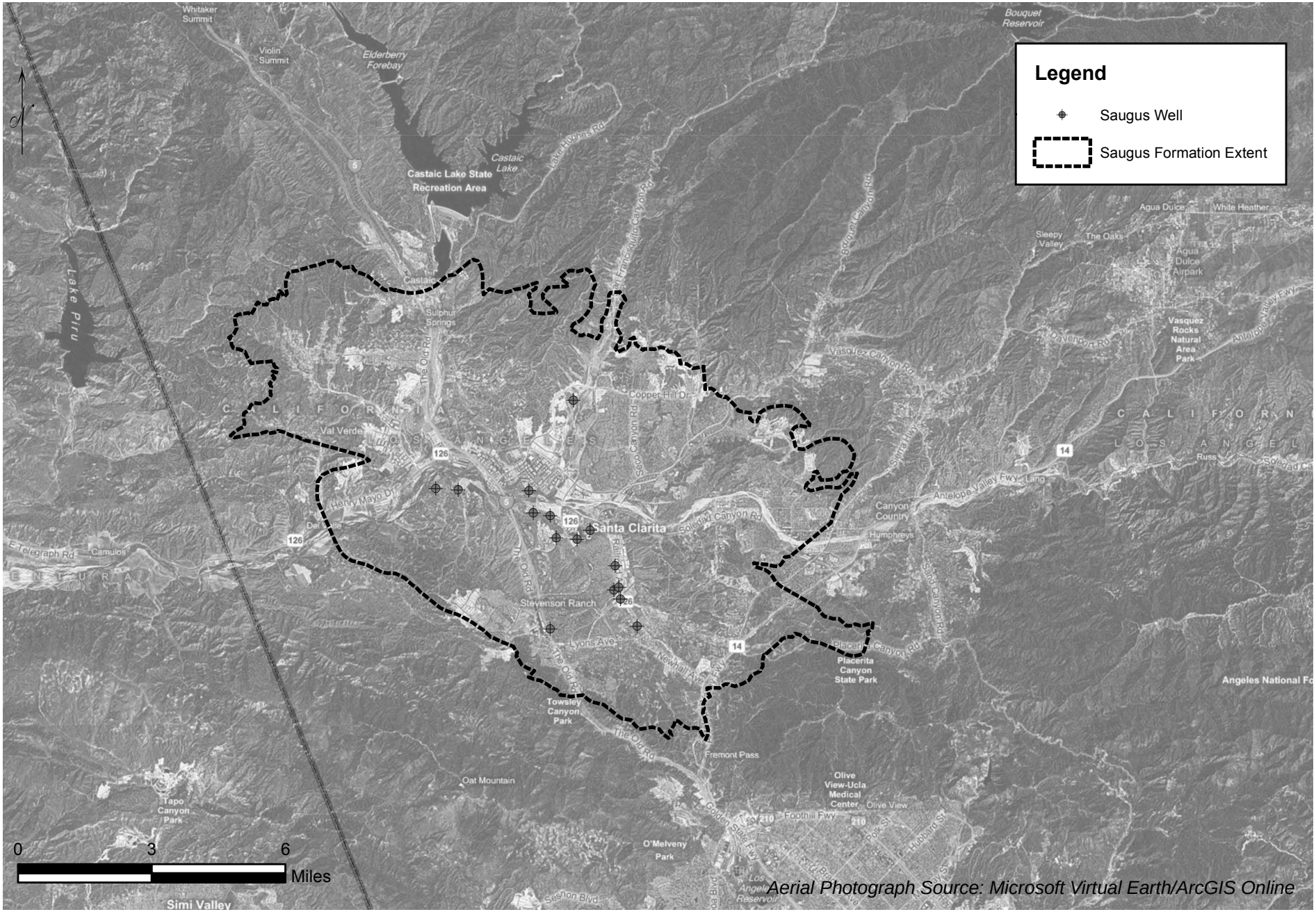

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Figure 3-7
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

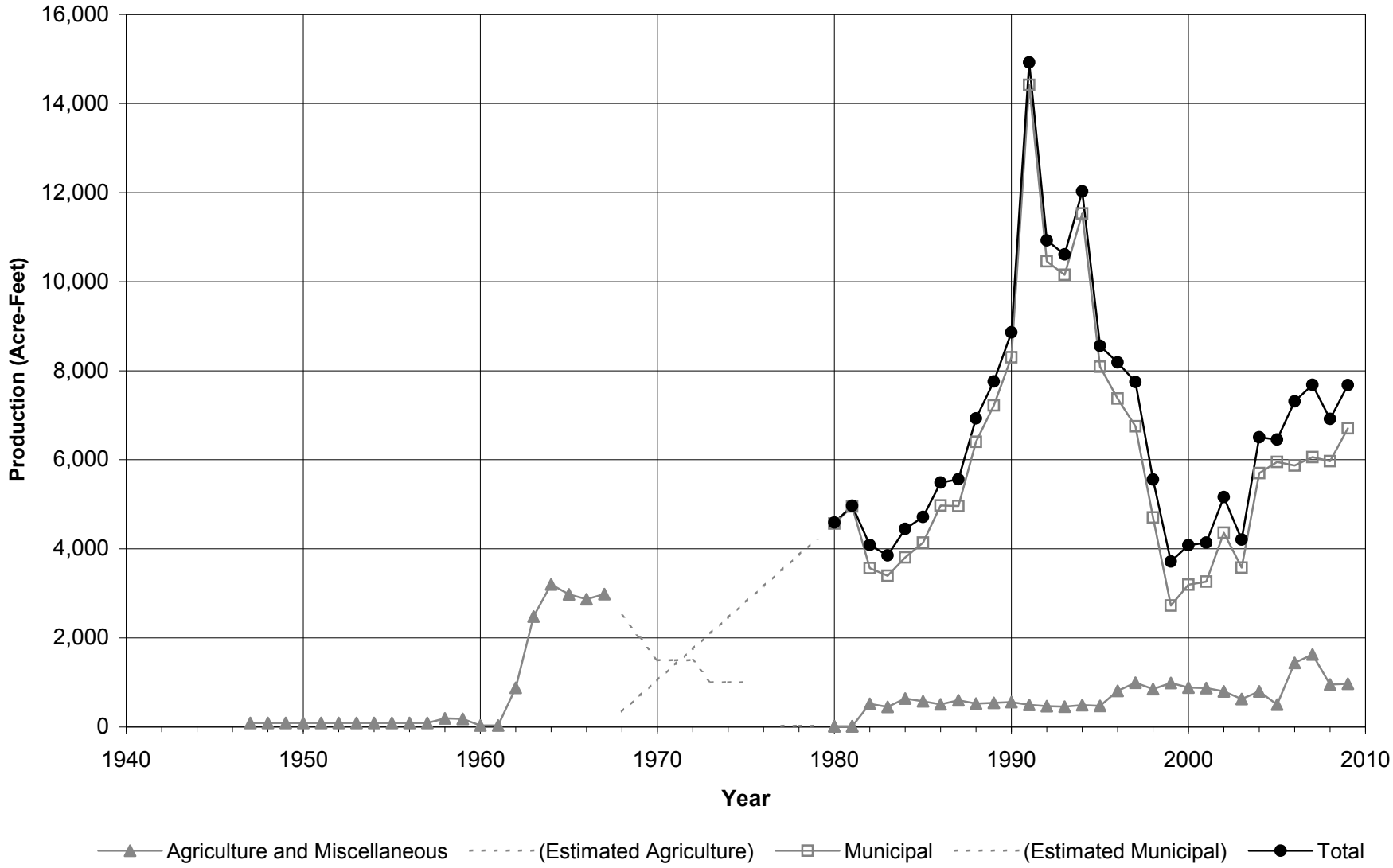

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Figure 3-8
Groundwater Production - Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin

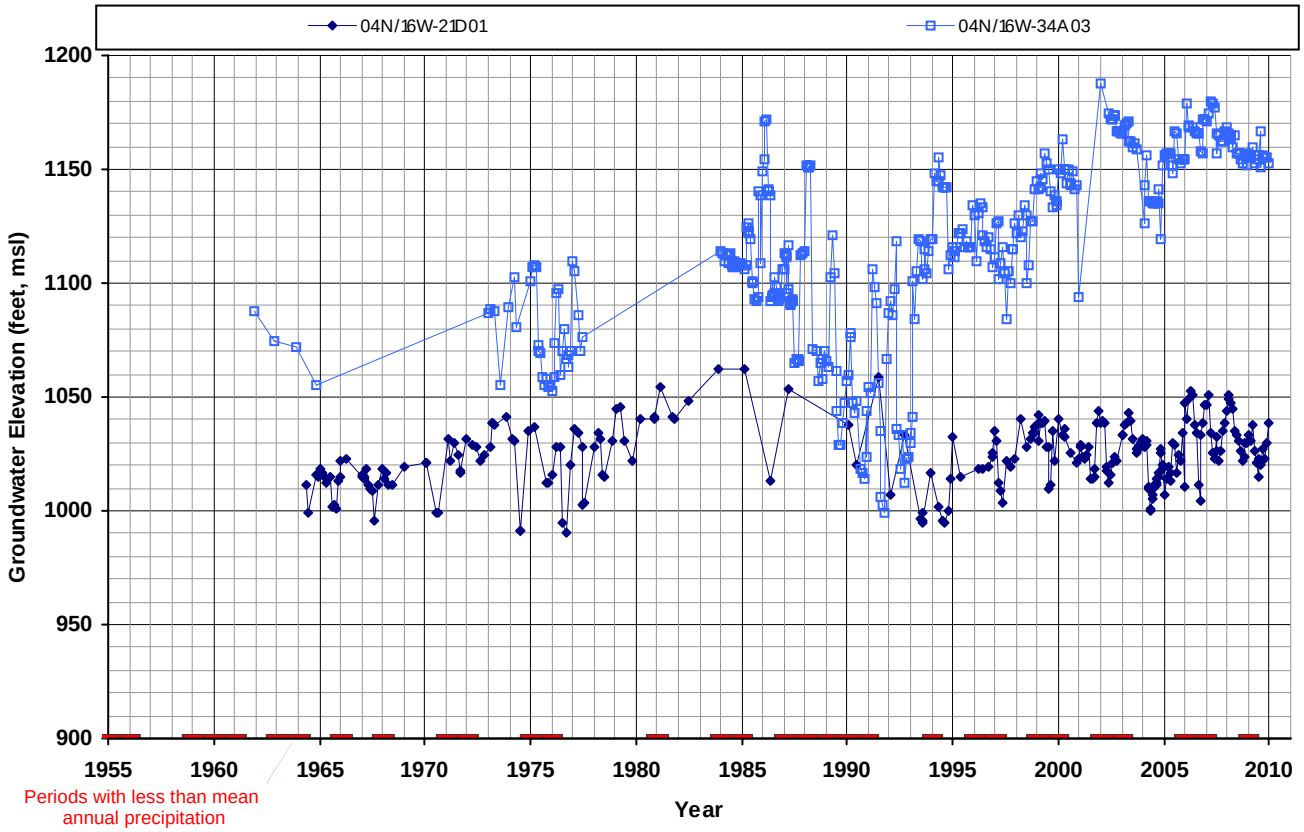

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Figure 3-9
Groundwater Elevations in Saugus Wells

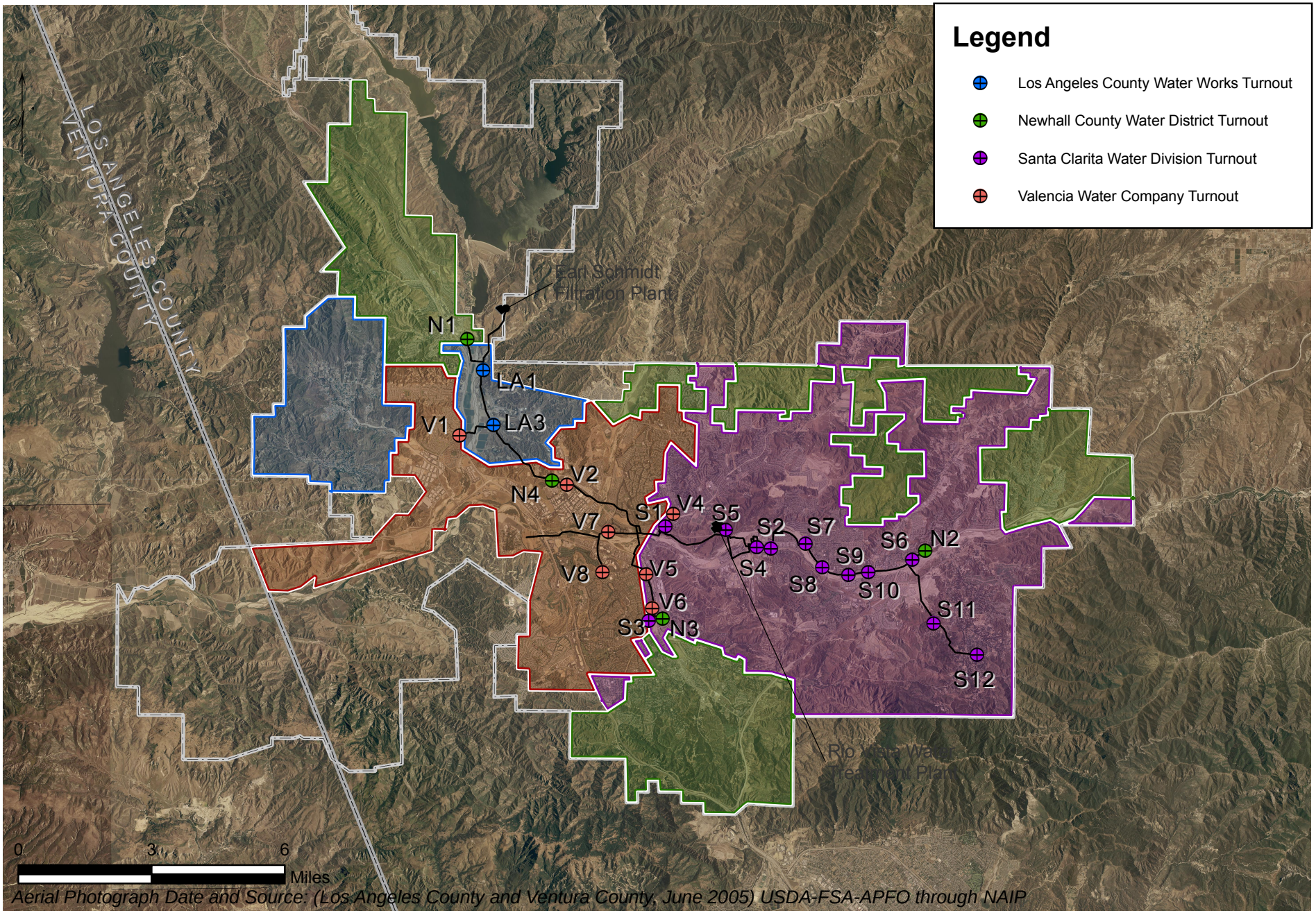

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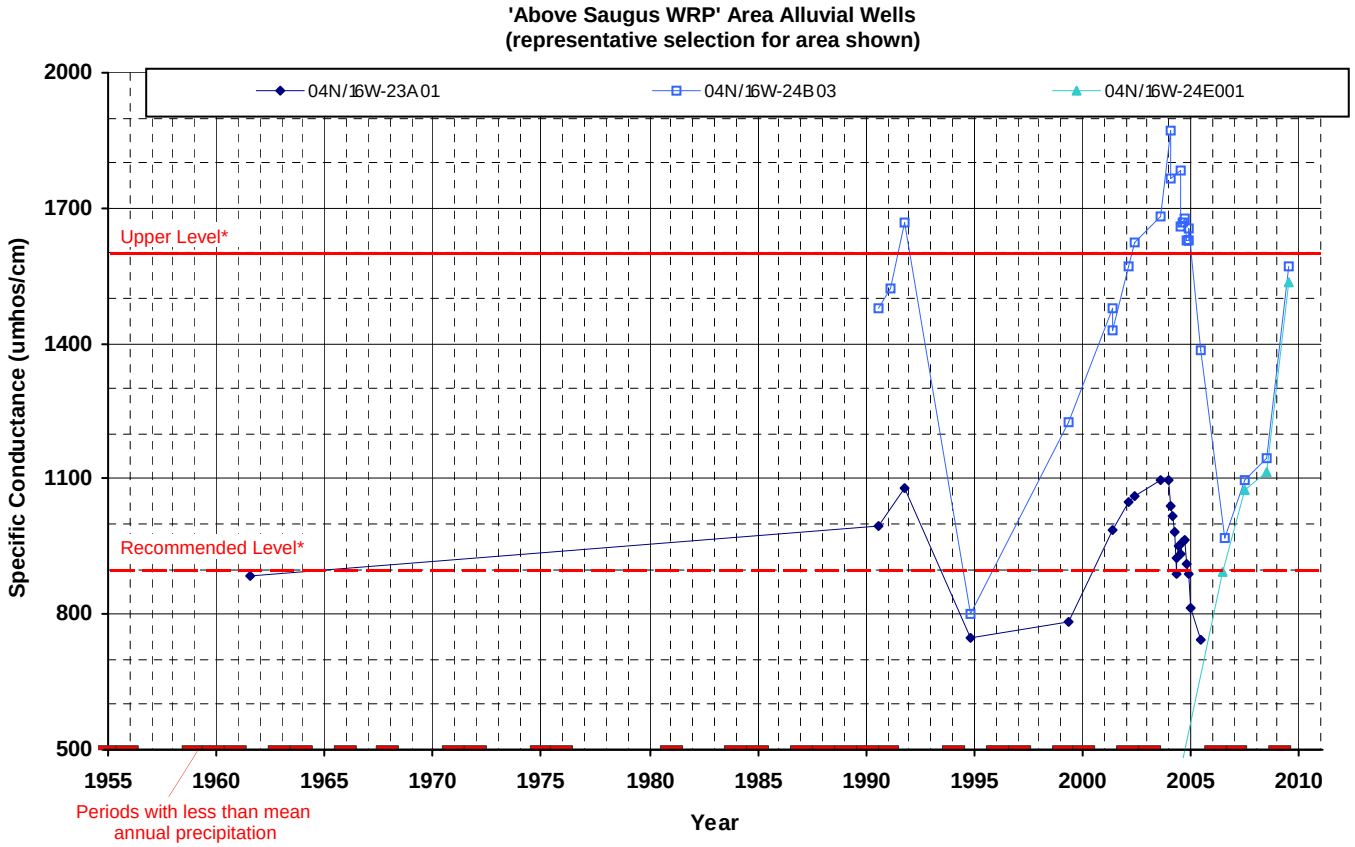
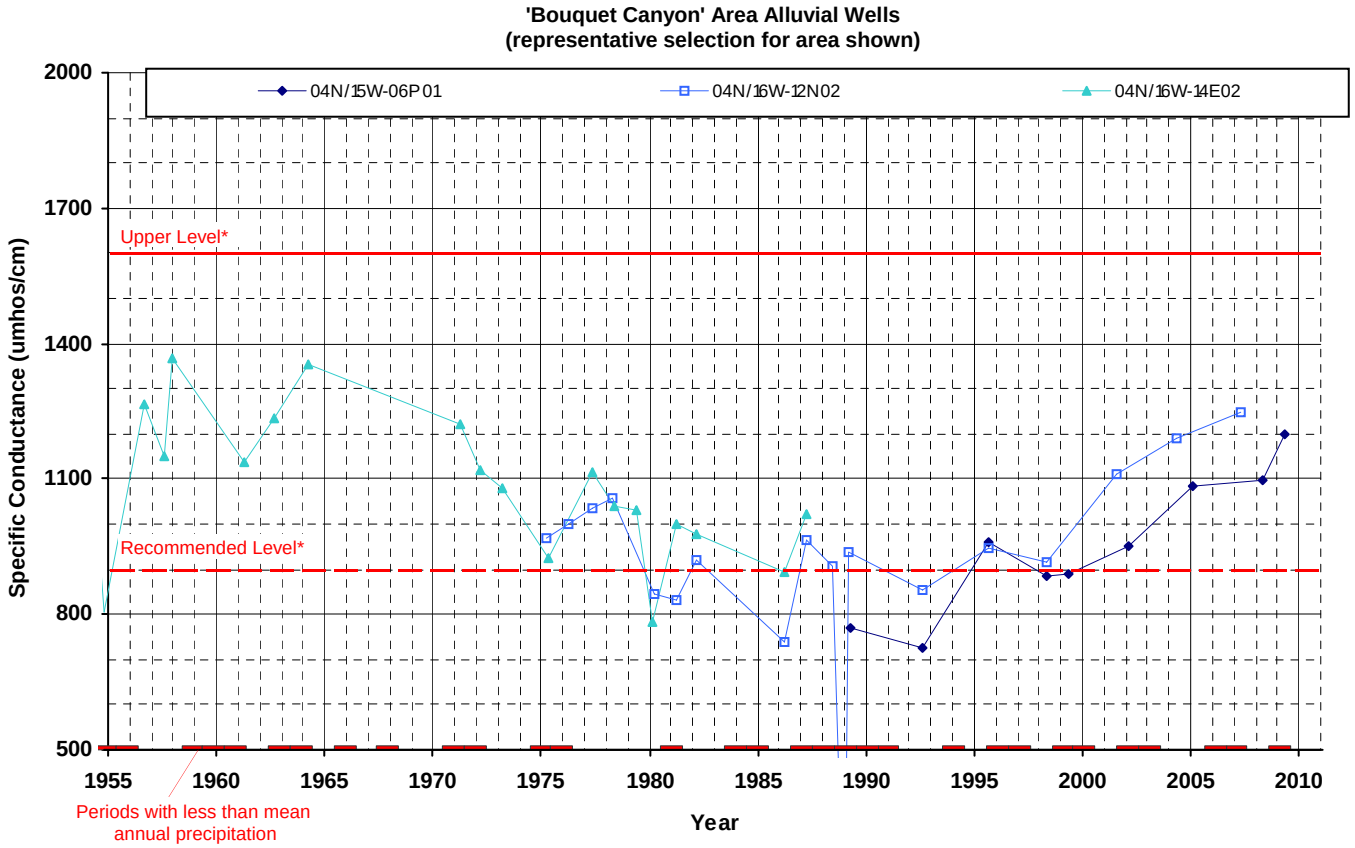
Figure 3-10
Treated Water Distribution System
Castaic Lake Water Agency





*California Department of Public Health Secondary Maximum Contaminant Level

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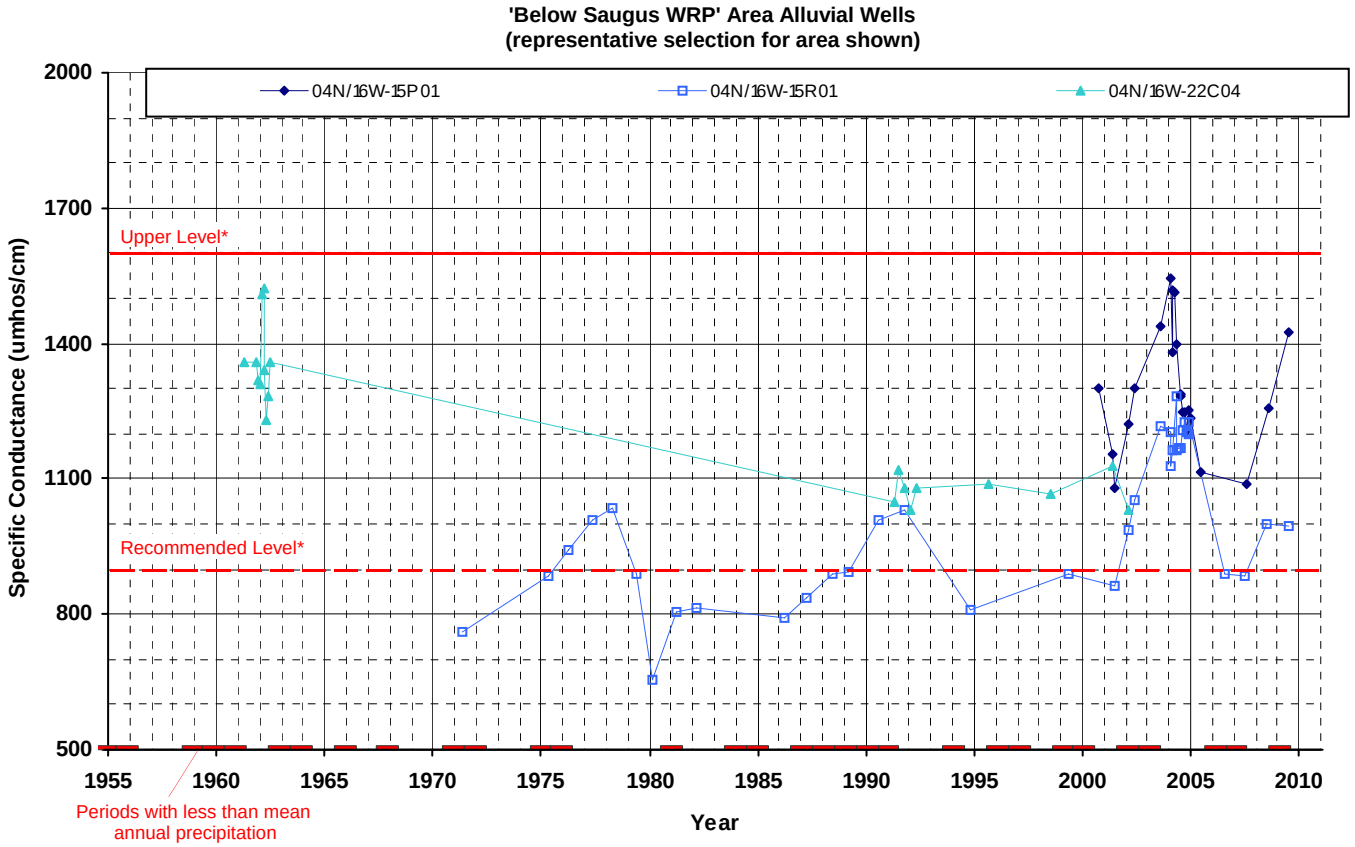
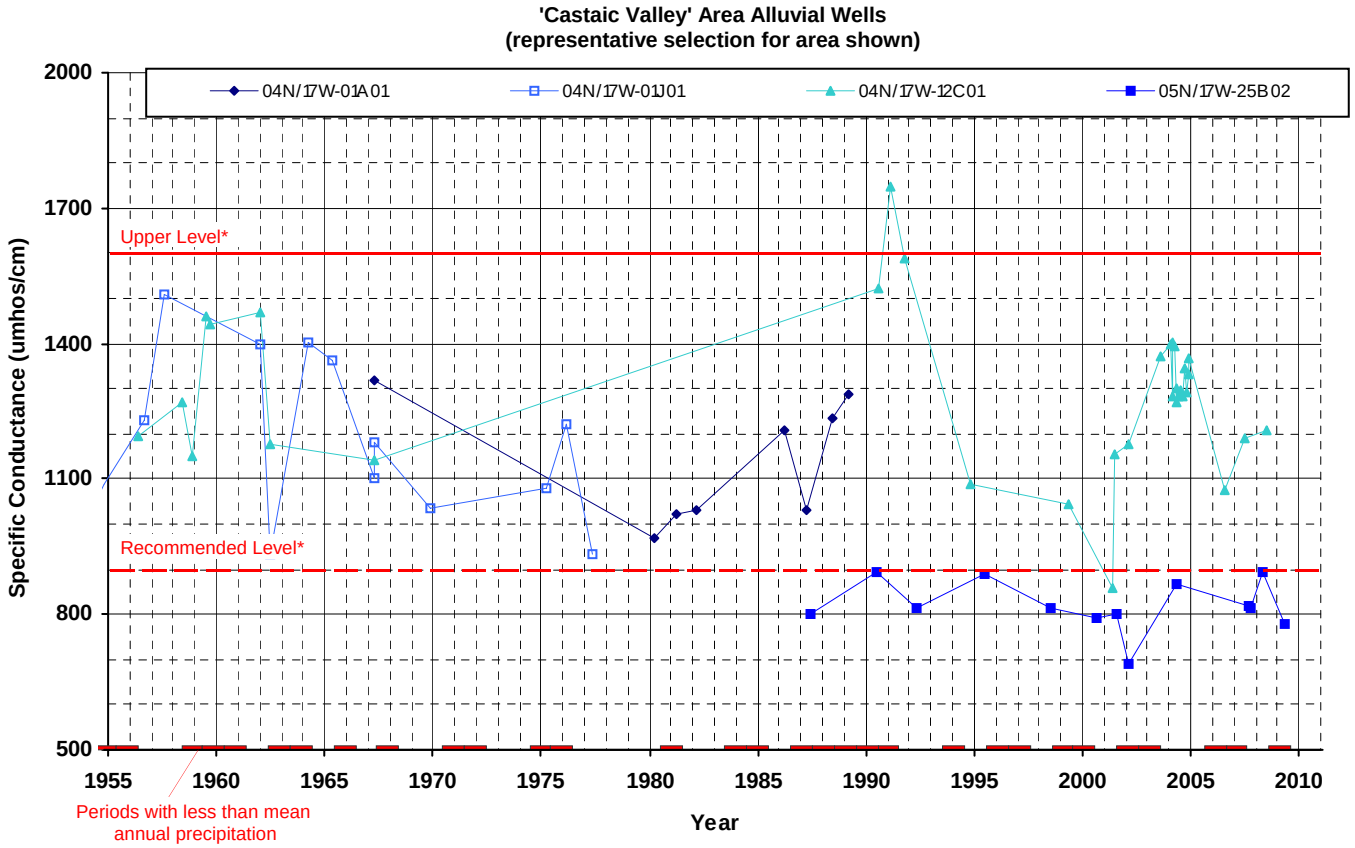
Figure 3-11
Groundwater Quality in Eastern Santa Clarita Valley Alluvial Wells





*California Department of Public Health Secondary Maximum Contaminant Level

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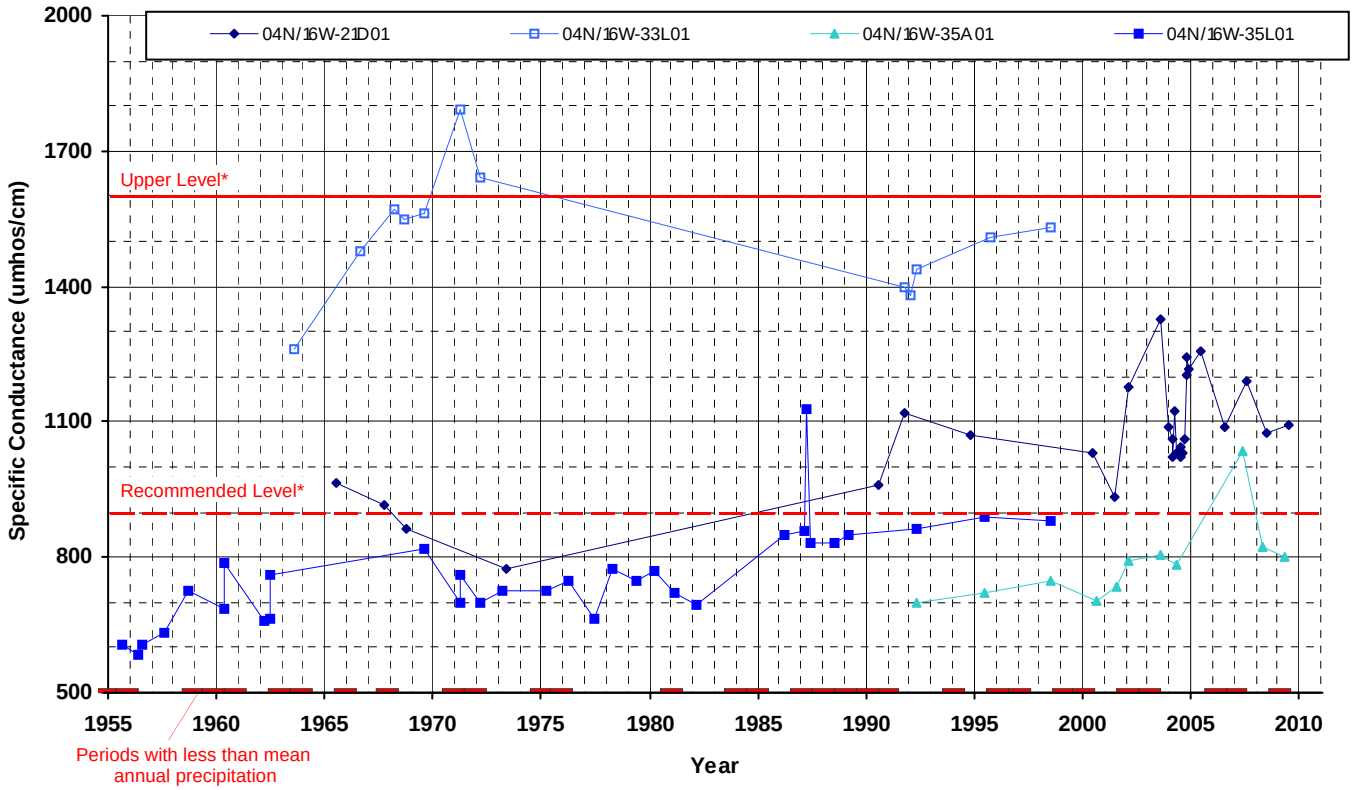
Figure 3-12
Groundwater Quality in Western Santa Clarita Valley Alluvial Wells



*California Department of Public Health Secondary Maximum Contaminant Level

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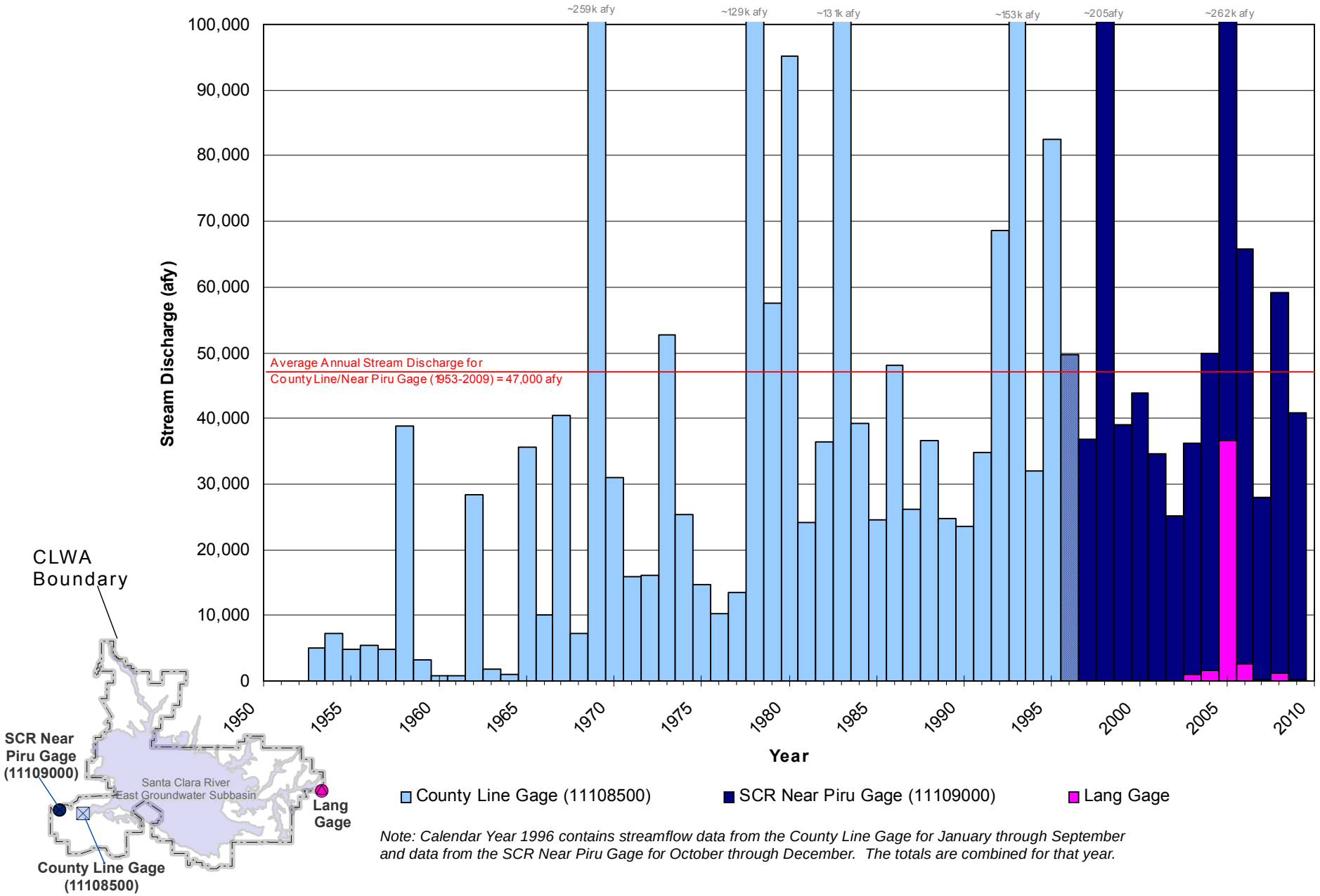
Figure 3-13
Groundwater Quality in Saugus Wells



Note: Calendar Year 1996 contains streamflow data from the County Line Gage for January through September and data from the SCR Near Piru Gage for October through December. The totals are combined for that year.

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Figure 3-14
Annual Stream Discharge
Santa Clara River

4. Summary of 2009 Water Supply and 2010 Outlook

As discussed in the preceding chapters, total water demands in the Santa Clarita Valley were 86,600 af in 2009. This represented a decrease of 4,100 af, or about 4.5 percent, from total demand in 2008 and continues a declining trend in total water demand over the last two years. Of the total demand in 2009, nearly 70,000 af were for municipal water supply, and the balance (16,600 af) was for agricultural and other uses, including estimated individual domestic uses. As detailed in Chapter 2, the total demand in 2009 was met by a combination of local groundwater, SWP and other imported water, and a small amount of recycled water.

The water demand in 2009 was notably lower than the average projection in the 2005 UWMP, (97,900 af), and also lower than the short-term projected demand that was estimated in the 2008 Water Report (91,000 af). For illustration, historical water use from 1980 through 2008 is plotted in Figure 4-1; also shown with that historical record are the projected total water demands in the 2005 UWMP through 2030. As discussed in the 2005 UWMP, year-to-year fluctuations in historical water demand have ranged from about ten percent below to about nine percent above the average or "normal" projection that would describe the long-term historical trend in the Valley's total water demand. The primary factor causing the year-to-year fluctuations is weather. In the short term, wetter years have typically resulted in decreased water demand, and drier years have typically resulted in higher water demand. Extended drier periods, however, have resulted in decreases in demand due to conservation and water shortage awareness. The decline in water demand toward the end of the 1987-92 drought is a good example of such reduced demand. A good recent example of wet-year effects on water demand was 2005, where extremely wet conditions resulted in total water requirements about six percent below the average projection in the 2005 UWMP.

Adding to the types of demand fluctuations described in the 2005 UWMP are the recently-observed effects of broad economic conditions on growth. As reflected by the numbers of service connections in each Purveyor service area, growth in 2009 further slowed, with addition of a total of only about 300 new service connections, in contrast to about 1,000 new connections in each of the preceding two years, and in notable contrast to the predominant growth rate nearly three times higher from the late 1990's through 2004. In addition, the Purveyors were informed by, and have conveyed to the local community, the Governor's Alert in June, 2008 regarding drought conditions and potential water supply shortages, and the Governor's subsequent Drought Emergency Declaration in February, 2009. The widespread awareness of dry conditions throughout the state, aggressive conservation messaging, and the decrease in local growth are

prime factors causing total water demand in 2009 to be notably less than each of the preceding two years, and well below the earlier estimated demand in the 2005 UWMP.

The preceding factors are expected to have a continuing effect in 2010, resulting in estimated total water demand that is again lower than last year. Total municipal water requirements in the first quarter of 2010 were about 16 percent lower than in 2009; that trend continued through April, at the end of which total municipal water requirements were about 19 percent lower than through the first four months of 2009. If municipal demand through the balance of the year tracks average or below average use over the same period through the last two years, and with agricultural and other water requirements comparable to previous years, total water demand in 2010 will be around 82,000 to 84,000 af. That range continues to be substantially below the 100,000 af demand projected for 2010 in the 2005 UWMP.

It is expected that both municipal and agricultural water demands in 2010 will continue to be met with a mix of water supplies as in previous years, notably local groundwater and imported SWP and other supplemental water, complemented by recycled water that will continue to supply a small fraction of total water demand.

On May 20, 2010, the final allocation of water from the SWP in 2010 was announced to be 45 percent; for CLWA, that equates to 42,840 af of its total Table A Amount, of 95,200 af. Combined with local groundwater from the two aquifer systems (48,000 af), total Flexible Storage Account water (6,060 af), net carryover SWP water from 2008 and 2009 (28,303 af), annual acquisition from Buena Vista Water/Rosedale-Rio Bravo Water Storage Districts (11,000 af), unused water previously withdrawn from the Semitropic Groundwater Storage Bank (3,300 af), and recycled water (500 af), the total available water supplies for 2010 are about 140,000 af. Consequently, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2010. Projected 2010 water supplies and demand are summarized in Table 4-1.

In August, 2007, a federal court ruled that certain operational changes were required of the SWP in order to protect the endangered Delta smelt. The court order resulted in the preparation of a new Biological Opinion (BO) requiring DWR to implement mitigation requirements with resultant impacts on SWP water supply reliability. Since then, DWR has prepared two updates to its 2005 Reliability Report, which is issued biennially to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies under varying hydrologic scenarios, e.g. normal and dry years. The current Draft SWP Delivery Reliability Report 2009 was issued in February, 2010. With the objective of protecting endangered fish such as the Delta

Table 4-1
2010 Water Supply and Demand
(acre-feet)

Projected 2010 Demand [1]		**82,000-84,000**
Available 2010 Water Supplies		
Local Groundwater		48,000
Alluvium [2]	*39,000*	
Saugus Formation [3]	*9,000*	
Imported Water		91,503
Table A Amount [4]	*42,840*	
Net Carryover from 2009 [5]	*28,303*	
Buena Vista/Rosedale-Rio Bravo[6]	*11,000*	
Flexible Storage Account (CLWA) [7]	*4,684*	
Flexible Storage Account (Ventura County) [7]	*1,376*	
Yuba Accord[8]	*0*	
Recovery of Banked Water		
Unused Semitropic 2002 Account withdrawal in 2009	*3,300*	
Recycled Water		500
Total Available 2010 Supplies		**140,003**
Additional Dry Year Supplies [9]		
Semitropic Groundwater Storage Bank		45,920
2002 Account[10]	*16,650*	
2003 Account[10]	*29,270*	
Rosedale-Rio Bravo Water Banking and Exchange Program		64,898
2005 and 2006 Buena Vista/Rosedale-Rio Bravo Water Acquisition Agreement[11]	*22,000*	
2005 Banking of Table A[12]	*17,800*	
2006 Banking of Table A[12]	*17,800*	
2007 Rosedale Rio-Bravo Banking[12]	*7,298*	
Total Additional Dry Year Supplies		**110,818**

1. Decreased from 2005 UWMP projections to reflect recent early 2010 actual water use, recent three-year trend, and economy-driven decrease in growth.

2. The Alluvium represents 30,000 – 40,000 afy of available supply under local wet-normal conditions, and 30,000 – 35,000 afy under local dry conditions. Available supply in 2010 is shown to be upper-range for average/wet conditions based on actual Alluvium conditions.

3. The Saugus Formation represents 7,500 – 15,000 afy of available water supply under non-drought conditions, and up to 35,000 afy under increasingly dry conditions. Available supply in 2010 is shown to be below mid-range for average/wet conditions, but above recent Saugus pumping in anticipation of perchlorate containment and cleanup pumping in the second half of 2010.

4. CLWA's SWP Table A amount is 95,200 af. The initial 2010 allocation was 15 percent (14,820 af). On March 17, 2010, the allocation was increased to 20 percent (19,040 af). On April 15, 2010 the allocation

was increased to 30 percent (28,560 af). On May 4, 2010 the allocation was increased to 40 percent (38,080 af). On May 20, 2010 the final allocation was increased to 45 percent (42,840 af).

5. Net amount available to CLWA in 2010; total carryover was 28,303 af.

6. 2010 annual supply from Buena Vista / Rosedale-Rio Bravo Water Acquisition Agreement.

7. CLWA can directly utilize up to 4,684 af of storage capacity in Castaic Lake. By agreement in 2005, CLWA can also utilize 1,376 af of Ventura County SWP contractors' flexible storage capacity in Castaic Lake.

8. Up to 850 af of non-SWP water supply is available to CLWA in critically dry years as a result of agreements among DWR, Yuba County Water Agency, and the U.S. Bureau of Reclamation regarding settlement of water rights issues on the Lower Yuba River (Yuba Accord). CLWA opted to not take any Yuba water in 2010.

9. Does not include other reliability measures available to CLWA and the retail water Purveyors. These measures include short-term exchanges, participation in DWR's dry-year water purchase programs, local dry-year supply programs and other future groundwater storage programs.

10. Net recoverable water after banking 24,000 af and 32,522 af in 2002 and 2003, respectively and recovering 4,950 af in 2009.

11. Water stored in Rosedale-Rio Bravo Water Banking and Exchange Program pursuant to the Buena Vista/Rosedale-Rio Bravo Water Acquisition Agreement.

12. Net recoverable water after banking 20,000 af in both 2005 and 2006, and banking 8,200 af in 2007.

smelt and spring-run salmon, the Draft incorporates restrictions on SWP operations according to the Biological Opinions of the U.S. Fish and Wildlife Service and the National Marine Fishery Service issued on December 15, 2008 and June 4, 2009, respectively. It also considers the impacts on SWP delivery reliability due to climate change, sea level rise, and vulnerability of the Delta's conveyance system and structure due to floods and earthquakes. The current Draft Reliability Report projects long-term reliability of 60 percent during normal year hydrology. CLWA staff has assessed the impact of the current Reliability Report on the CLWA reliability analysis contained in the Agency's 2005 UWMP and concluded that current and anticipated supplies are available to meet anticipated water supply needs. However, the preceding discussion of SWP supply should be considered by noting that, while the SWP Reliability Report represents a reasonable scenario with respect to long term reliability, recent reductions in supply reduce the difference between available supply and demand in the future, thereby making the CLWA service area more subject to shortages in certain dry years. Accordingly, the reduction in SWP supply reinforces the need to continue diligent efforts to conserve potable water and increase the use of recycled water, both to meet the goals in the 2005 UWMP and to maximize utilization of potable water supplies.

As discussed in Chapter 5, CLWA and the retail water purveyors have worked with Los Angeles County and the City of Santa Clarita in preparing a water conservation ordinance and the enforcement mechanisms to aggressively implement water conservation in the CLWA service area. In terms of short-term water supply availability, however, CLWA and the Purveyors have determined that, while current operational changes of the SWP are in effect, there are sufficient supplemental water supplies, including SWP water, to augment local groundwater and other water supplies such that overall water supplies will be sufficient to meet projected water requirements, as reflected herein, without the need for mandatory rationing though the summer of 2010. CLWA, the retail water Purveyors, Los Angeles County and the City of Santa Clarita have formed the Santa Clarita Valley Water Committee. The specific purpose of the committee is to work collaboratively to ensure the progressive implementation of water use efficiency programs and ordinances in the Santa Clarita Valley.

In addition to the regular and previously banked water supplies described above to meet projected demand in 2010, a residual of nearly 46,000 af of recoverable water remains stored in the Semitropic Groundwater Storage Bank in Kern County. Nearly 64,900 af of recoverable water are also stored in the long-term Rosedale-Rio Bravo Water Banking and Exchange Program, also in Kern County. After recovery of 4,950 af of banked water in 2009, 1,650 af of which were used in 2009 and 3,300 af of which are intended to be used in 2010, remaining recoverable water in all the Kern County storage banks slightly exceeds 110,000 af. That

component of overall water supply is separately reflected in Table 4-1 because it is intended for future dry-year supply and will not be used for 2010 water supply.

CLWA and the Purveyors have implemented a number of projects that are part of an overall program to provide facilities needed to firm up imported water supplies during times of drought. These involve water conservation, surface and groundwater storage, water transfers and exchanges, water recycling, additional short-term pumping from the Saugus Formation, and increasing CLWA's imported supply. This overall strategy is designed to meet increasing water demands while assuring a reasonable degree of supply reliability.

Part of the overall water supply strategy is to provide a blend of groundwater and imported water to area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and location in the Valley is an operational decision and varies over time due to source availability and operational capacity of Purveyor and CLWA facilities. The goal is to conjunctively use the available water resources so that the overall reliability of water supply is maximized while utilizing local groundwater at a sustainable rate.

For long-term planning purposes, water supplies and facilities are added on an incremental basis and ahead of need. It would be economically unsound to immediately, or in the short term, acquire all the facilities and water supplies needed for the next twenty to thirty years. This would unfairly burden existing customers with costs that should be borne by future customers. There are numerous ongoing efforts to produce an adequate and reliable supply of good quality water for Valley residents. Water consumers expect that their needs will continue to be met with a high degree of reliability and quality of service. To that end, CLWA's and the Purveyors' stated reliability goal is to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions contained in the 2005 UWMP for a planning horizon over the next 25 years, in combination with conservation of non-essential demand during certain dry years, CLWA and the Purveyors believe implementing their water plan will successfully achieve this goal.

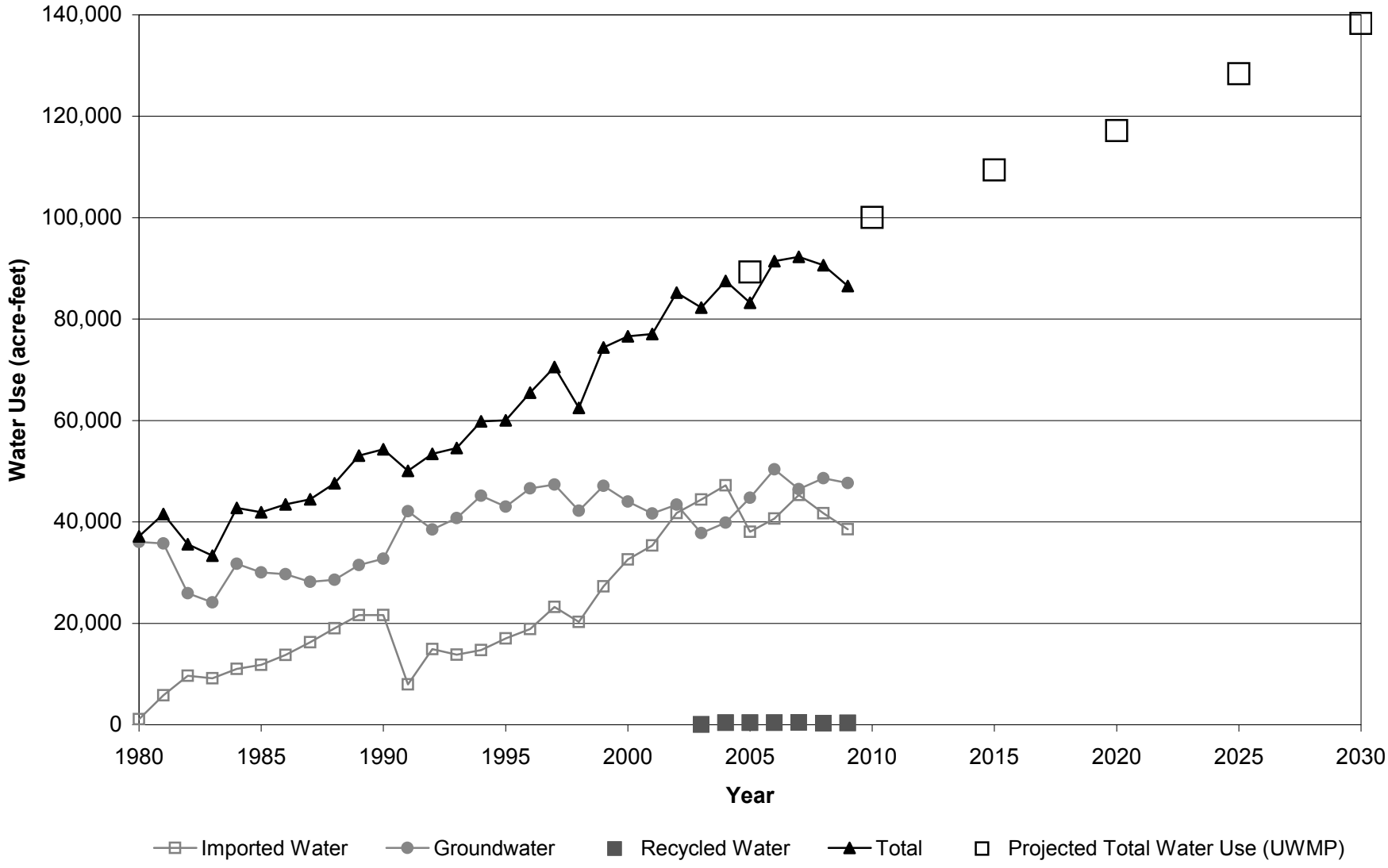

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Figure 4-1
Historical and Projected Water Use
Santa Clarita Valley

5. Water Conservation

The California Urban Water Conservation Council (CUWCC) was formed in 1991 through the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California. The urban water conservation Best Management Practices (BMPs) included in the MOU are intended to reduce California's long-term urban water demands. While the BMPs are currently implemented by the MOU signatories on a voluntary basis, they are specified as part of the Demand Management Measures section of the Urban Water Management Planning Act. Water conservation can achieve a number of goals, such as:

- meeting legal mandates
- reducing average annual potable water demands
- reducing sewer flows
- reducing demands during peak seasons
- meeting drought restrictions
- reducing carbon footprint, waste water flows and urban runoff.

CLWA signed the urban MOU in 2001 on behalf of its wholesale service area, and pledged to implement several BMPs at a wholesale support level (listed below). NCWD signed the MOU in 2002 and VWC signed the MOU in 2006, both on behalf of their respective retail service areas. As separate MOU signatories and in their respective roles as retailers, NCWD and VWC are committed to implementing all BMPs that are feasible and applicable in their service areas. Efforts are made to coordinate with CLWA and the other Purveyors wherever possible to maximize efficiency and ensure the cost effectiveness of NCWD's and VWC's conservation program.

In coordination with the Purveyors, CLWA has been implementing the following BMPs (which pertain to wholesalers) for several years (some prior to signing the MOU in 2001):

BMP 3	System Water Audits, Leak Detection and Repair
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 10	Wholesale Agency Programs
BMP 12	Water Conservation Coordinator

CLWA and the Purveyors have been implementing these BMPs valley-wide. Since 2001,

CLWA has also instituted implementation of BMP 2 (Residential Plumbing Retrofits) and BMP 14 (Residential Ultra Low Flush Toilet (ULFT) and High Efficiency Toilet (HET) Replacement Programs) on behalf of the Purveyors.

In addition to these efforts, in September 2006 CLWA installed a weather station at its headquarters adjacent to the Rio Vista Water Treatment Plant. This station became part a network of over 120 automated weather stations in the state of California that make up the California Irrigation Management Information System (CIMIS). The Department of Water Resources (DWR) manages the system which has a primary purpose of making available to the public, free of charge, information useful in estimating crop water use for irrigation scheduling.

NCWD, SCWD and VWC have initiated implementation of the remaining BMPs that are specific to retail water suppliers:

BMP 1	Water survey programs for single-family residential and multi-family residential customers
BMP 2	Residential plumbing retrofits (including Weather Based Irrigation Controllers)
BMP 3	System water audits, leak detection and repair
BMP 4	Metering with commodity rates for all new connections and retrofit of existing connections
BMP 5	Large landscape conservation programs and incentives
BMP 6	High-efficiency clothes washing machine financial incentive programs
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 9	Conservation programs for commercial, industrial, and institutional (CII) accounts
BMP 11	Conservation pricing
BMP 12	Conservation coordinator
BMP 13	Water waste prohibition
BMP 14	Residential High Efficiency Toilet (HET) Replacement Program

Reports to the CUWCC on BMP implementation by CLWA and the Purveyors were included in the 2005 UWMP and have been reported annually to the CUWCC since 2007.

Additional savings are occurring Valley-wide due to state interior plumbing code requirements that have been in effect since 1992, as well as due to changes in lot size and reduction in exterior square footage of new housing and commercial developments. The City of Santa Clarita and

County of Los Angeles have also taken a more active conservation role and have begun implementing water efficient devices and practices on the properties they own and manage. All of these efforts have begun to impact overall demand in the Valley, as can be seen in the significant decline in total water demand over the last two years and extending into early 2010. The Valley's water suppliers continue to monitor water demand trends through time to assess those factors that are accounting for the reduction, and to attempt to quantify them.

Most recently with regard to water conservation, CLWA and the retail water Purveyors entered into an MOU in 2007 to prepare a Santa Clarita Valley Water Use Efficiency Strategic Plan (the Plan). The purpose of the plan is to prepare a comprehensive long-term conservation plan for the Santa Clarita Valley by adopting objectives, policies and programs designed to promote proven and cost effective conservation practices. The Plan provides a detailed study of existing residential and commercial water use and recommends programs designed to reduce the overall Valley-Wide water demand by 10 percent by 2030. The programs are designed to provide Valley residents with the tools and education to use water more efficiently. The six programs identified in the Plan are:

- High Efficiency Toilet Rebate Program
- CII Audits & Customized Incentive Program
- Large Landscape Audits & Customized Incentive Program
- Landscape Contractor Certification and Weather Based Irrigation Controller Program
- High Efficiency Washer Rebate Program
- Public Information and Education Programs

In addition to the six programs designed for existing customers, the Plan also identifies three other key factors that will help reduce the valley's overall water demand; passive conservation, inflation, and new more water-efficient building ordinances.

Finally, the Plan includes an Appendix with more aggressive water use efficiency measures designed to meet a potential 20 percent reduction in water use by 2020. This includes funding more active conservation programs, retrofit on resale legislation, water rate reform, water budget based rates, and a more aggressive recycled water program.

Implementation of the majority of the programs identified in the Plan are beginning in 2010 through funding by CLWA on behalf of all the Purveyors.

In addition to this effort, the water Purveyors are working with City and County agencies to develop a landscape irrigation ordinance for the Santa Clarita Valley. This ordinance will focus primarily on new construction aimed at reducing overall water demands by requiring efficient landscape design and delivery systems. Implementation of the ordinance is expected in 2010, depending on review and adoption by the City and County.

Finally, in 2008, Governor Schwarzenegger issued a proclamation for all Californians to reduce their per capita water consumption by 20 percent by the year 2020. In November 2009, the Governor and California's legislature reached an historic agreement over ensuring long term water supply reliability for California, as well as restoring and protecting the Sacramento-San Joaquin Delta and other ecologically sensitive areas. The agreement is comprised of four policy bills and an $11.4 billion bond measure. One of the policy bills (SB 7X7) identifies reporting criteria and guidelines for water utilities to track and measure progress toward achieving the 20 percent per capita demand reduction goal. Water utilities are required to implement strategies and report progress in their Urban Water Management Plans. In 2010, DWR is expected to provide guidance and criteria for implementing the provisions of this new law; that guidance is expected to provide clarification regarding individual (per-capita) and broader (Valley-wide) conservation goals, which will be utilized in the preparation of the 2010 update of the UWMP for the Santa Clarita Valley.

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Groundwater Management Plan

Santa Clara River Valley Groundwater Basin, East Subbasin

Los Angeles County, California

CASTAIC LAKE WATER AGENCY

December, 2003

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Table of Contents

Page

I. Introduction 1
- Castaic Lake Water Agency 1
- Santa Clara River Valley Groundwater Basin, East Subbasin 1
- Overview of Water Requirements and Supplies 2
- Water Code Section 10753 2

II. Management Objectives (Goals) for the Basin 7

III. Groundwater Basin Conditions 10
- Occurrence of Groundwater 10
- Historical Groundwater Development 11
- Groundwater Monitoring Network and Program 12
- Groundwater Levels and Storage 13
- Groundwater Quality 15
- Areas of Concern and Identified Problems 17

IV. Historical and Projected Water Requirements and Supplies 19
- Historical Water Requirements 19
- Projected Water Requirements 20
- Existing and Projected Water Supplies 21

V. Elements of the Groundwater Management Plan 24
- Primary Element 1 - Monitoring of Groundwater Levels, Quality, Production, and Subsidence 26
- Primary Element 2 - Monitoring and Management of Surface Water Flows and Quality 27
- Primary Element 3 - Determination of Basin Yield and Avoidance of Overdraft 29
- Primary Element 4 - Development of Regular and Dry Year/Emergency Water Supply 30
- Primary Element 5 - Continuation of Conjunctive Use Operations 30
- Primary Element 6 - Long Term Salinity Management 32
- Primary Element 7 - Integration of Recycled Water 32

Table of Contents, cont.

Page

Primary Element 8 - Identification and Mitigation of Soil and Groundwater Contamination 33
Primary Element 9 - Development and Continuation of Local, State and Federal Agency Relationships 35
Primary Element 10 - Groundwater Management Reports 37
Secondary Element 1 - Continuation of Public Education and Water Conservation Programs 38
Secondary Element 2 - Identification and Management of Recharge Areas and Wellhead Protection Areas 39
Secondary Element 3 - Identification of Well Construction, Abandonment and Destruction Policies 42
Secondary Element 4 - Provisions to Update the Groundwater Management Plan 42

VI. References

Appendices

I. Groundwater and Surface Water Monitoring Protocols
II. Comments and Responses (separately bound)

Figures and Tables

Figures **Afer Page**

1-1 CLWA and Purveyors' Service Areas 1
1-2 Santa Clara River Valley East Ground-Water Subbasin 2
3-1 Alluvial and Saugus Formations 11
3-2 Historical Groundwater Elevations 13
3-3 Historical Groundwater Quality 14
4-1 Historical Groundwater Production 18
4-2 Historical and Projected Water Use 19
5-1 Water Level Monitoring Well Network 26
5-2 Water Quality Monitoring Network 26
5-3 Average of Daily Mean Streamflow over the Water Year 26
5-4 Historical and Projected Water Use 29

Tables **Page**

4-1 Projected Normal/Average Year Water Demands 21

I. Introduction

Castaic Lake Water Agency

Castaic Lake Water Agency (CLWA) was formed in 1962 as a State Water Project Contractor to provide wholesale water supply from the State Water Project (SWP) to retail water purveyors in the Upper Santa Clara River area, most notably to Newhall County Water District, Los Angeles County Waterworks District No. 36, Santa Clarita Water Company and Valencia Water Company. In 2001, as part of legislation authorizing CLWA to provide retail water service to individual municipal customers in addition to its ongoing wholesale water supply, Assembly Bill 134 included a requirement that CLWA prepare a groundwater management plan in accordance with the provisions of Water Code Section 10750 et seq., which was originally enacted by, and is commonly known as, Assembly Bill 3030. This groundwater management plan has been prepared to satisfy the requirements of AB 134 and to both complement and formalize a number of existing water supply and water resource planning and management activities in the CLWA service area.

The CLWA service area encompasses all of the existing and currently planned municipal water service areas of the Upper Santa Clara River area, i.e. the suburban areas generally proximate to the Santa Clara River in Los Angeles County, generally between hills of the San Gabriel Mountains and the Santa Susana Mountains on the north and south, and between the Los Angeles/Ventura County line and Lang Station on the west and east, respectively. The extent of the CLWA service area and the geographical locations of the individual water purveyors within the CLWA service area are illustrated in Figure 1-1.

Santa Clara River Valley Groundwater Basin, East Subbasin

The groundwater basin generally beneath the CLWA service area, identified in DWR Bulletin 118 as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), is comprised of two aquifer systems, the Alluvium generally underlying the Santa Clara River and its several tributaries, and the Saugus Formation which underlies much of the entire Upper Santa Clara River area. The mapped extent of the Santa Clara River Valley East Subbasin in Bulletin 118, which is approximately the outer extent of the Alluvium and the Saugus Formation, and its

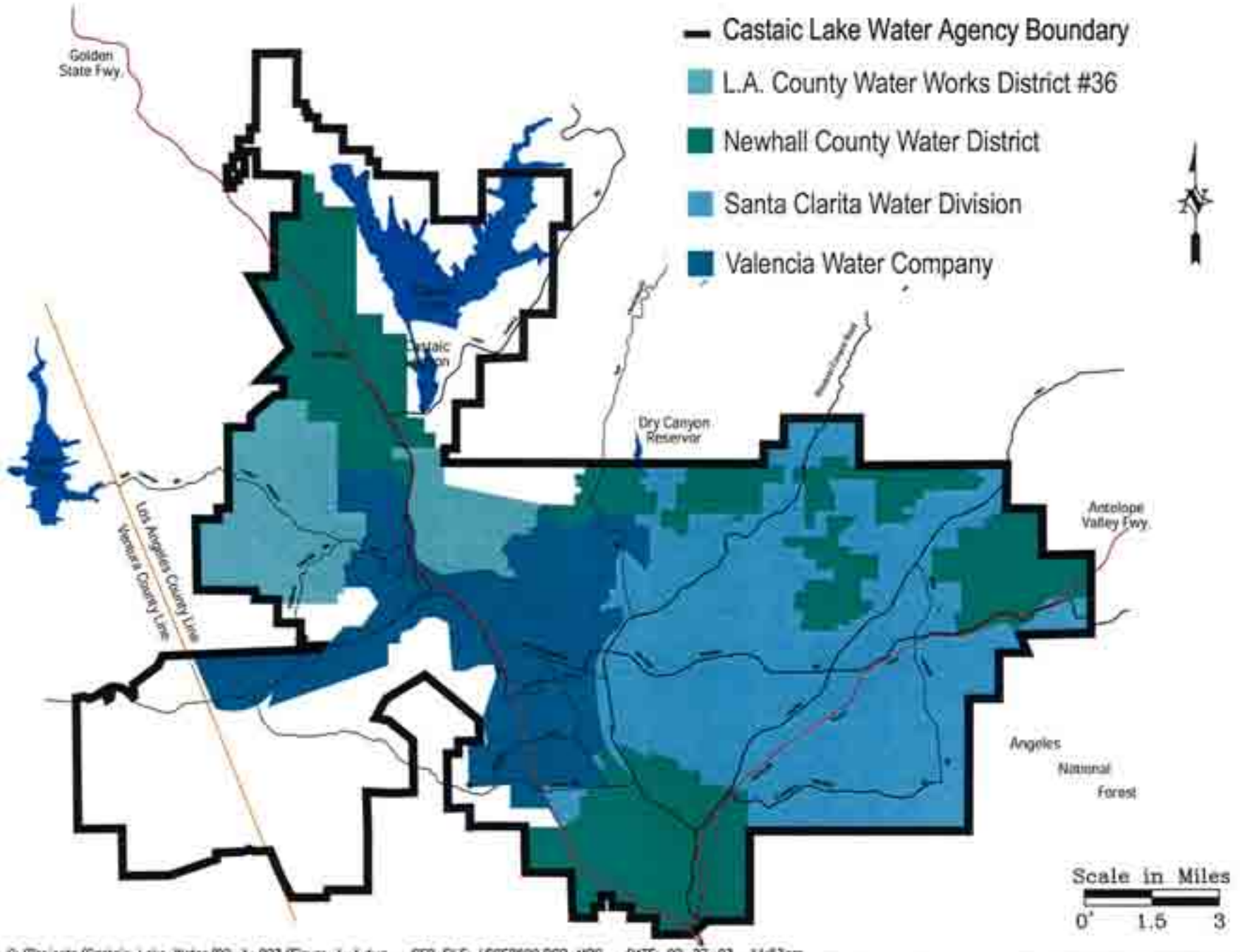

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Figure 1-1
CLWA and Purveyors' Service Areas

relationship to the extent of the CLWA service area are illustrated in Figure 1-2.

The two aquifer systems that comprise the groundwater basin are described in detail in this plan. For purposes of this plan, the groundwater basin is encompassed by the CLWA service area, and CLWA is the logical public water supply agency to prepare and implement a groundwater management plan for the Santa Clara River Valley East groundwater subbasin.

Overview of Water Requirements and Supplies

Historically, while development of local water supplies dates back at least 100 years, the earliest complete records of water use in the basin date from the late 1940's, when practically all water demand was for agricultural use. From that time through the early 1960's, agricultural water use, which was solely supplied by local groundwater, ranged from about 27,000 to about 42,000 acre-feet per year (afy). Over the succeeding three decades, agricultural water use progressively declined, into the range of about 8,000 to 10,000 afy, followed by a slight increase into the range of about 12,000 to 15,000 afy over the last ten years. Current projections are for agricultural water use to substantially decline, to about 7,000 afy, over the next 20 years.

Significant municipal water use in the basin did not begin until the early 1960's, when municipal uses, which were met exclusively at that time by local groundwater, were in the range of about 5,000 to 10,000 afy. By 1980, when supplemental surface water from the State Water Project (SWP) began to be imported to the basin, municipal water demands had increased to about 22,000 afy. Since then, municipal water demands have further increased, to their current level of about 61,000 afy, about 60 percent of which is supplied by SWP water, with the balance supplied by local groundwater. Current projections are for municipal water requirements to increase to about 106,000 afy over the next 20 years.

Historical and projected water requirements and supplies in the basin are discussed in more detail in Section IV of this Plan.

Water Code Section 10750 et. seq.

In 1992, the California State Legislature adopted Assembly Bill 3030 (AB 3030); that legislation was subsequently incorporated into the Water Code, Section 10750 et seq., to encourage local public agencies/water purveyors to adopt a formal plan to manage groundwater resources within

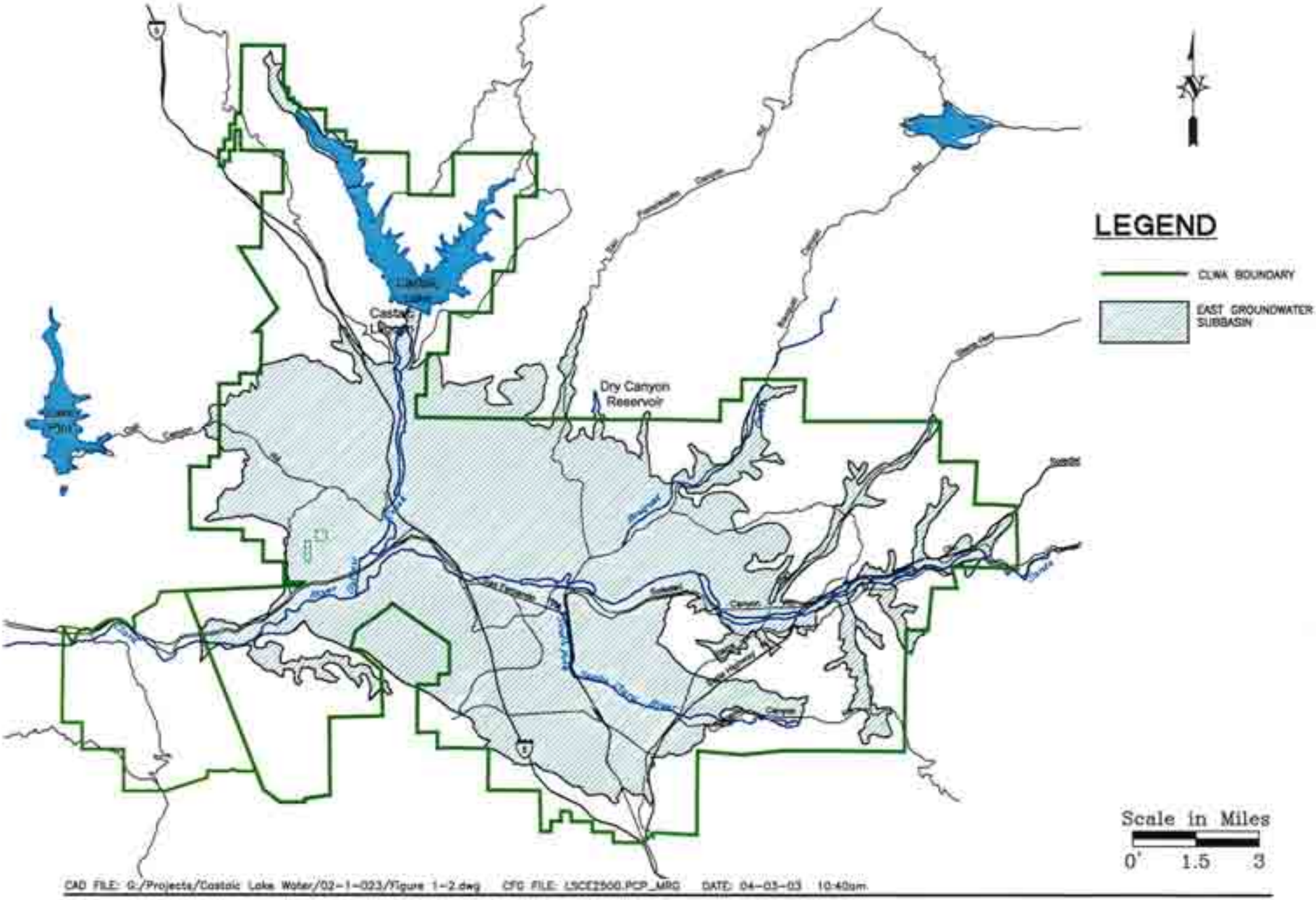

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Figure 1-2
Santa Clara River Valley
East Groundwater Subbasin

their jurisdictions. Within the scope of Water Code Section 10753.8, a local groundwater management plan can potentially include up to twelve specific components. Although the plan need not be restricted to those specific components, the listed components are quite broad and cover essentially all of the groundwater management elements which are part of this plan or are likely to be considered for implementation into this plan in the foreseeable future. To a considerable extent, a number of the groundwater management activities listed in Water Code Section 10753.8 have been implemented in the Santa Clara River Valley East groundwater subbasin as part of an organized effort by the local municipal water purveyors, including CLWA, to manage the groundwater basin within its sustainable yield for the benefit of local water supply, and also to integrate management of the basin with the management of surface and groundwater immediately downstream on the Santa Clara River, in this case specifically with United Water Conservation District in Ventura County, as discussed in more detail herein.

The potential components of a groundwater management plan listed in Water Code Section 10753.8 include:

- the control of saline water intrusion.
- identification and management of wellhead protection areas and recharge areas.
- regulation of the migration of contaminated groundwater.
- the administration of a well abandonment and well destruction program.
- mitigation of conditions of overdraft.
- replacement of groundwater extracted by water producers.
- monitoring of groundwater levels and storage.
- facilitating conjunctive use operations.
- identification of well construction policies.
- the construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- the development of relationships with state and federal regulatory agencies.
- the review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

In 2002, the Legislature adopted Senate Bill 1938 (SB 1938) to amend and add to Water Code Section 10750 et seq. regarding the implementation of local groundwater management plans. While the provisions of SB 1938 did not alter the potential components of a local groundwater management plan, as listed above, it did add the following notable provisions:

- The local agency, in preparing a groundwater management plan, shall make available to the public a written statement describing how interested parties may participate in developing the plan; for purposes of carrying out the preceding requirement, the local agency may appoint, and consult with, a technical advisory committee consisting of interested parties. AB 134 actually anticipated this last item by requiring CLWA to form an Advisory Committee to review its Plan. The membership of the Advisory Committee was specified to consist of one representative from each retail water purveyor within CLWA and one representative from each groundwater producer within CLWA who pumped more than 100 acre-feet in the preceding water year (2000). In conformance with that requirement, CLWA formed an Advisory Committee consisting of representatives from the following organizations, who collectively fulfill the description of the membership specified in AB134:

    - CLWA Santa Clarita Water Division
    - Los Angeles County Sheriff's Department
    - Los Angeles County Waterworks District No. 36
    - Newhall County Water District
    - Newhall Land and Farming Company
    - Robinson Ranch
    - Valencia Water Company

- In order to qualify for funding assistance for groundwater projects or groundwater quality projects, for funds administered by DWR, a local agency must accomplish all the following relative to groundwater management:

    - prepare and implement, or participate in, or consent to be subject to, a groundwater management plan, a basin-wide management plan, or other integrated regional water management program or plan that meets the provisions listed below.

    - include groundwater management components that address monitoring and management of water levels, groundwater quality degradation, inelastic land subsidence, and changes in surface flows and quality that either affect groundwater or are affected by groundwater pumping.

- include provisions to cooperatively work with other public (and presumably private) entities whose service area or boundary overlies the groundwater basin.

- include mapping of the groundwater basin, as defined in DWR's Bulletin 118, and the boundaries of the local agency subject to the plan, plus the boundaries of other local agencies that overlie the basin.

- adopt monitoring protocols designed to detect changes in groundwater levels, groundwater quality, inelastic land subsidence (for basins where subsidence has been identified as a potential problem), and flow and quality of surface water that either directly affect groundwater, or are directly affected by groundwater pumping.

Of the potential groundwater management activities listed in Water Code Section 10753.8, those already being investigated and actively implemented as part of less formal groundwater management by the purveyors include avoidance of overdraft, implementation of conjunctive use, monitoring of groundwater levels and quality, initiation of groundwater contamination control, analysis of basin yield for ongoing avoidance of overdraft, and annual analysis and reporting on basin conditions. The historic focus of informal groundwater management in the Santa Clara River Valley East groundwater subbasin has been on water supply, quantity and quality, to avoid conditions of overdraft, primarily by augmenting local groundwater supplies with a supplemental, imported surface water supply from the State Water Project. More recently, efforts have been added to include ongoing monitoring and the compilation of data into a data management system that is integrated with a comparable database system for the downstream surface water resources and groundwater basins on the Santa Clara River. Recent efforts have also included initiation of a process to develop a numerical groundwater flow model of the basin for analysis of basin response to various water supply, recharge, and conjunctive use management alternatives that might be applicable for the basin. The potential groundwater management provisions not historically implemented have been those more focused on groundwater contamination; however, very recent activities have added this component to local groundwater management as a result of impacts on several municipal water supply wells from a former munitions manufacturing site in the basin, as discussed in more detail herein.

In summary, in many respects, the local municipal water purveyors, including CLWA, have

already begun developing and implementing important parts of a formal local groundwater management program as part of developing reliable water supplies for in-basin needs. To ensure the reliability of the groundwater component of water supplies to meet existing and projected demands, those parts of local groundwater management planning already include monitoring, formulation of a data base, and integration with the database for adjoining downstream basins, analysis of groundwater conditions and annual reporting on water conditions in the basin, initiation of groundwater flow modeling, ongoing conjunctive use of local groundwater and imported SWP supplies, and initiation of investigation and control of localized groundwater contamination. The groundwater management plan described herein can be envisioned as a formalization, and some expansion, of those ongoing management efforts in the Santa Clara River Valley East groundwater subbasin.

The balance of this plan is organized to first establish a set of management objectives, or goals, for the basin; to then describe existing groundwater basin conditions, including areas of concern and identified problems; to present historical and projected water demands in the basin; and to finally present a set of groundwater management actions which, in aggregate, are the elements of this groundwater management plan.

II. Management Objectives (Goals) for the Basin

Prior to 1980, all water supplies in the Upper Santa Clara River Area were developed from local groundwater. Since 1980, the major water purveyors within the CLWA service area have developed their water supplies from a combination of local groundwater and imported supplemental surface water from the State Water Project (SWP). CLWA is the state SWP Contractor which holds the contract for SWP water. CLWA also operates the treatment and distribution system for delivery of SWP water to the local purveyors. Some imported SWP water has historically been delivered for non-municipal uses although, in aggregate, total non-municipal uses have been almost negligible (less than one percent).

A relatively small fraction of water supply in the area is still devoted to agricultural and other irrigation, and essentially all of that remains developed from groundwater. Over the last two decades, that use has been in a range between about 10,000 and 17,000 acre-feet per year.

The development and importation of a supplemental surface water supply from the State Water Project represents the first of a number of water resource and water supply management actions, all of which are formalized in this plan, aimed at what can be considered to be the overall goals or objectives for the basin. In no priority, those management objectives for the basin can be expressed as follows:

1. Development of an integrated surface water, groundwater, and recycled water supply to meet existing and projected demands for municipal, agricultural, and other water supply; since pumpage for other uses is from the same aquifer system, this objective includes agricultural, small community, non-agricultural irrigation, and individual domestic uses.

2. Assessment of groundwater basin conditions to determine a range of operational yield values that will make use of local groundwater conjunctively with SWP and recycled water to avoid groundwater overdraft and the undesirable effects associated with it. In effect, this objective equates to more detailed quantification of the yield of the basin in order to continue to avoid overdraft, consistent with what has historically been the case in the basin. In addition to avoiding the traditional overdraft symptoms

and effects, e.g. chronic water level decline, loss of groundwater storage, onset of land subsidence, groundwater quality degradation, a corresponding basin objective is to manage groundwater levels and associated groundwater discharge to the Santa Clara River at the west end of the basin, and thus not adversely impact surface and groundwater discharges to the downstream basin(s).

3. Preservation of groundwater quality for beneficial use in the basin, and for beneficial use of surface water and groundwater discharges from the basin. Included in this management goal will be the active characterization and solution of any groundwater contamination problems, through cooperation with responsible parties or through independent action if timely action by responsible parties is not forthcoming and the preceding management objectives are thereby impacted or constrained.

4. Preservation of interrelated surface water resources. Included in this management goal will be the maintenance of appropriate surface water flows and non-degradation of surface water quality as a result of managing groundwater conditions to meet the other management goals for the basin.

Quantitatively, the preceding goals translate into general preservation of groundwater levels and quality in the Alluvial aquifer system consistent with the last 30 years, including fluctuations through seasonal demands and local hydrologic variations (wet and dry periods). As discussed in more detail in the next chapter, the hydrogeologic setting in the area has resulted in smaller Alluvial groundwater level fluctuations toward the western half of the basin (generally west of Bouquet Canyon), and larger fluctuations to the east. However, largely due in part to the importation of supplemental surface water over the last 20 years, and the integrated or conjunctive use of that supplemental water with local groundwater, there has been no chronic decline in groundwater levels or storage. A continuation of such basin conditions, possibly complemented by management actions to decrease the historical water level fluctuations in the eastern part of the basin, will accomplish the second basin objective (continued avoidance of overdraft as has been the ongoing historical condition in the basin) while continuing to utilize local groundwater to meet part of projected water requirements. Corresponding management actions to sustain recharge and not overdraft groundwater storage will accomplish the third basin objective by replenishing the aquifer system with sufficient water to sustain what has been generally consistent quality of groundwater on a long-term basis.

In general, the same goals of preservation of groundwater levels and quality pertain to the Saugus Formation as well as to the Alluvium. However, while those goals are generally expected to equate to Alluvial pumping rates comparable to recent historical pumping, the Saugus Formation may be intermittently utilized at higher than historical pumping rates for dry-period and/or emergency water supply. Interpretation of historical pumping fluctuations and corresponding aquifer response suggests that such intermittent utilization of a small fraction of the Saugus' large storage capacity can successfully contribute to a firming of local water supplies while still accomplishing all the management objectives listed above, primarily via reduction in Saugus pumping during wet-normal conditions, possibly complemented by management actions to accelerate recharge of the Saugus.

III. Groundwater Basin Conditions

Occurrence of Groundwater

Groundwater in the Santa Clara River Valley East groundwater subbasin occurs in two aquifer systems, the Alluvium associated with the Santa Clara River and its tributaries, and the Saugus Formation. There are also some scattered outcrops of Terrace deposits in the basin that likely have the capacity to contain limited amounts of groundwater; however, since these deposits are located in limited areas that are situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and have consequently not been developed for water supply.

The Alluvial aquifer system, of Quaternary to Holocene (Recent) geologic age, consists primarily of stream channel and flood plain deposits of the Santa Clara River and its tributaries. The Alluvium is deepest along the center of the present river channel, with a maximum thickness of about 200 feet near the area known as Saugus. It thins toward the flanks of the adjoining hills and toward the eastern and western boundaries of the basin and, in the tributaries, becomes a mere veneer in their upper reaches. The spatial extent of the Alluvium throughout the basin is illustrated in Figure 3-1.

The Alluvium is the most permeable of the local aquifer units. Based on well yields and aquifer testing, transmissivity values in the range of 50,000 to 500,000 gallons per day per foot (gpd/ft) have been reported for the Alluvium, with the higher values where the Alluvium is thickest in the center of the valley and generally west of Bouquet Canyon (Slade 1986 and 2002). The amount of groundwater in storage can vary considerably because of the effects of recharge, discharge and pumping from the aquifer. The maximum storage capacity of the Alluvium has been estimated to be about 240,000 acre-feet (af) (Slade, 1986 and 2002).

The Saugus Formation, of Pliocene to Pleistocene geologic age, has traditionally been divided into two stratigraphic units: the lowermost, geologically older Sunshine Ranch member, which is of mixed marine to terrestrial (non-marine) origin; and the overlying, or upper, portion of the Formation which is entirely terrestrial in origin. The Sunshine Ranch Member of the Saugus Formation has a maximum thickness of about 3,000 to 3,500 feet in the central part of the valley;

however, due to its marine origin and fine-grained nature, it is not considered to be a viable source of groundwater for municipal or other comparable supply. Above the Sunshine Ranch Member, the Saugus Formation is coarser grained, consisting mainly of lenticular beds of sandstone and conglomerate that are interbedded with lesser amounts of sandy mudstone, which were deposited in stream channels, flood plains, and alluvial fans by one or more ancestral drainage systems in the valley. The sand and gravel units that represent aquifer materials in the upper part of the Saugus Formation are generally located between depths of about 300 and 2,500 feet. The spatial extent of the Saugus Formation throughout the basin is illustrated in Figure 3-1.

While much thicker and more spatially extensive throughout the basin when compared to the Alluvium, and while significant in terms of groundwater storage and individual well capacity, the Saugus Formation has typically lower values of transmissivity, in the range of 80,000 to 160,000 gpd/ft, with the higher values in the upper portions of the Formation (Slade, 1988 and 2002). The storage capacity of the Saugus has most recently been estimated to be 1.65 million acre-feet between depths of 300 feet and 2,500 feet (or the base of the Saugus or the base of fresh water if shallower than 2,500 ft.) (Slade, 2002).

Historical Groundwater Development

Of the two aquifer systems in the basin, the predominant development of groundwater for agricultural and municipal water supply has historically been from the Alluvium, a condition that remains the case at present. Prior to 1980, all water supply in the valley was developed from local groundwater; since 1980, local groundwater has been supplemented by imported surface water from the State Water Project. Details of historical water requirements, and water supplies to meet those requirements, are discussed and illustrated in Chapter IV of this Plan.

In general, over the last two decades, since the inception of SWP deliveries in 1980, total pumpage from the Alluvium has ranged from a low of about 20,000 afy (in 1983) to slightly more than 43,000 afy (in 1999). For comparison, agricultural pumpage from the Alluvium throughout the 1950's was consistently in the range of about 33,000 to 41,000 afy. During that same time, municipal pumpage was quite small, less than 4,000 afy. Overall, over the last two decades, there has been a change in municipal/agricultural pumping distribution, toward a slightly higher fraction for municipal water supply (from about 50% to nearly 60% of alluvial pumpage) which is indicative of the general land use changes in the area.

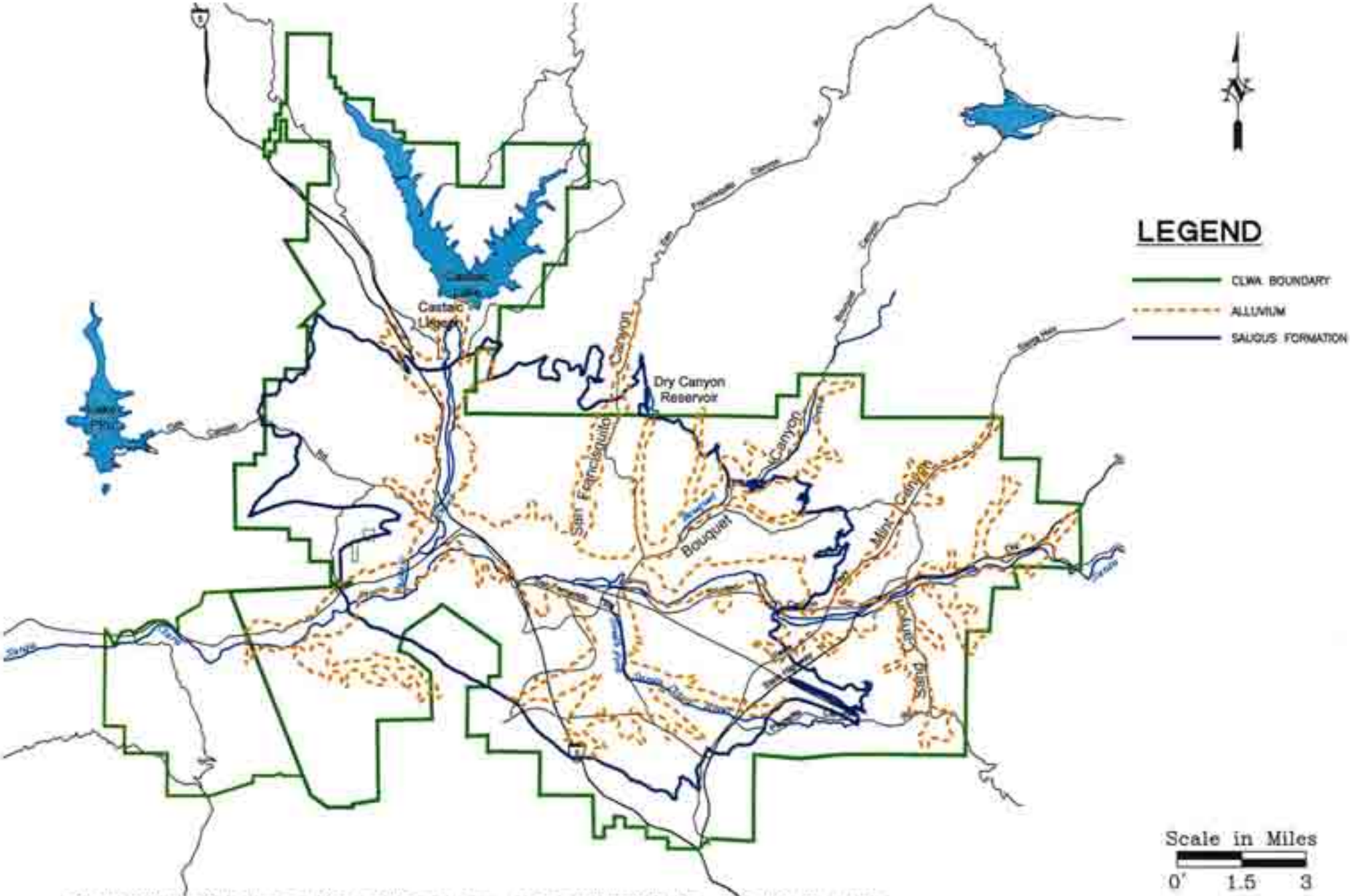

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Figure 3-1
Alluvial and Saugus Formations
Santa Clara River Valley East Groundwater Subbasin

Since 1980, total pumpage from the Saugus Formation has ranged between about 3,850 afy and nearly 15,000 afy; average pumpage over that period has been about 6,900 afy. The great majority of pumpage from the Saugus is for municipal supply (nearly 6,300 afy, or 92 percent, on average). For comparison, although historical Saugus pumping records prior to 1980 are limited, there appears to have been essentially no pumping from the Saugus prior to 1960 (on the order of about 100 af in most years, beginning in 1948), and some increased pumping for agricultural water supply beginning in about 1962 (about 900 af). The largest amount of agricultural pumping from the Saugus was during the mid-1960's, when annual Saugus pumpage was about 3,000 af. Agricultural pumping from the Saugus declined to near zero by the late 1970's, but has been generally in the 500 to 1,000 afy range since 1982. There was no Saugus pumpage for municipal supply in the early 1960's; limited data suggests that municipal pumping from the Saugus began in the 1970's, and reached nearly 5,000 afy by 1980-81. The most significant period of Saugus pumpage was 1991 through 1994, when pumpage ranged from 10,600 afy to nearly 15,000 afy and averaged over 12,000 afy, during which time SWP water deliveries were reduced at the end of extended drought conditions.

Groundwater Monitoring Network and Program

There is no formal groundwater monitoring network of wells for groundwater level measurements and/or groundwater quality sampling in the basin. Consequently, one component of this Plan is to formalize both a network of wells for groundwater monitoring and a program for water level measurements, water quality sampling, and other pertinent groundwater data collection (Primary Plan Element 1). Despite the lack of an existing formal groundwater monitoring network and program, however, there is a significant amount of historical groundwater data, some of which dates back into the 1940's, on which to base reasonable assessments of groundwater conditions in the basin. For example, groundwater level measurements have been made over varying periods of record in a total of 154 wells, mostly alluvial wells, throughout the basin. Similarly, groundwater quality data, consisting of varying numbers of constituents analyzed, are available from some wells, but a much smaller number than is the case for groundwater level data. These data, along with direct measurements or indirect estimates of pumpage, primarily from high capacity municipal and agricultural wells, allow for analysis of groundwater basin conditions, as discussed in this Plan, and also provide the bases on which a groundwater model can be developed (Primary Plan Element 3) and on which various management criteria such as operational yield, baseline groundwater quality, etc. can be determined (Primary Plan Elements 3, 6, etc.).

Groundwater Levels and Storage

Groundwater level data in various parts of the basin illustrate basin response to the historical pumpage from the Alluvium. Organized into hydrograph form (depth to groundwater or groundwater elevation vs. time), historical groundwater levels were lower in the 1950's and 60's than current levels in the middle to western part of the basin, logically in response to the higher pumpage of the 1950's before the importation of SWP water and the associated increase in return flows to the river that have augmented groundwater recharge in that part of the basin. Groundwater levels in those areas notably recovered as pumpage declined through the 1960's and 1970's. They have subsequently sustained generally high levels for much of the last 30 years, with two dry-period exceptions: mid-1970's and late 1980's - early 1990's; recoveries to previous high groundwater levels have followed both of those dry-period declines. Based on this data, there is no evidence of any historic or recent trend toward permanent water level or storage decline. In general, throughout the Alluvium, groundwater levels have been generally higher over the last 30 years than was consistently the case for the preceding 20 years (1950's - 60's).

During the last 20 to 30 years, in essentially all the alluvial portions of the basin, groundwater levels have fluctuated from near the ground surface when the basin is full, to as much as 100 feet lower during intermittent dry periods of reduced recharge. Selected hydrographs of groundwater elevations illustrate the above described conditions throughout the basin. Figure 3-2 illustrates groundwater level conditions and trends at multiple locations in the Alluvium along the main channel of the Santa Clara River, from east near the mouth of Sand Canyon, to the area between Mint Canyon and Bouquet Canyon, to farther west immediately below the mouth of Bouquet Canyon. Similar long-term conditions are evident in the tributary canyons.

A comment about some of the groundwater fluctuations illustrated in Figure 3-2 is appropriate since they are illustrative of the most substantial intermittent changes in the basin. As noted above, the Alluvium has historically experienced a number of alternating wet and dry hydrologic conditions as illustrated in Figure 3-2. Since the Alluvium is thinner to the east, the fluctuations in water levels of 75 to 100 feet impact well yields and pumping capacities when water levels are occasionally lower. When that occurs, as is currently the case due to locally dry hydrologic conditions, the affected purveyors shift a portion of their water demands to imported SWP water, thus reducing pumpage and reducing drawdown of water levels. Recovery of groundwater levels

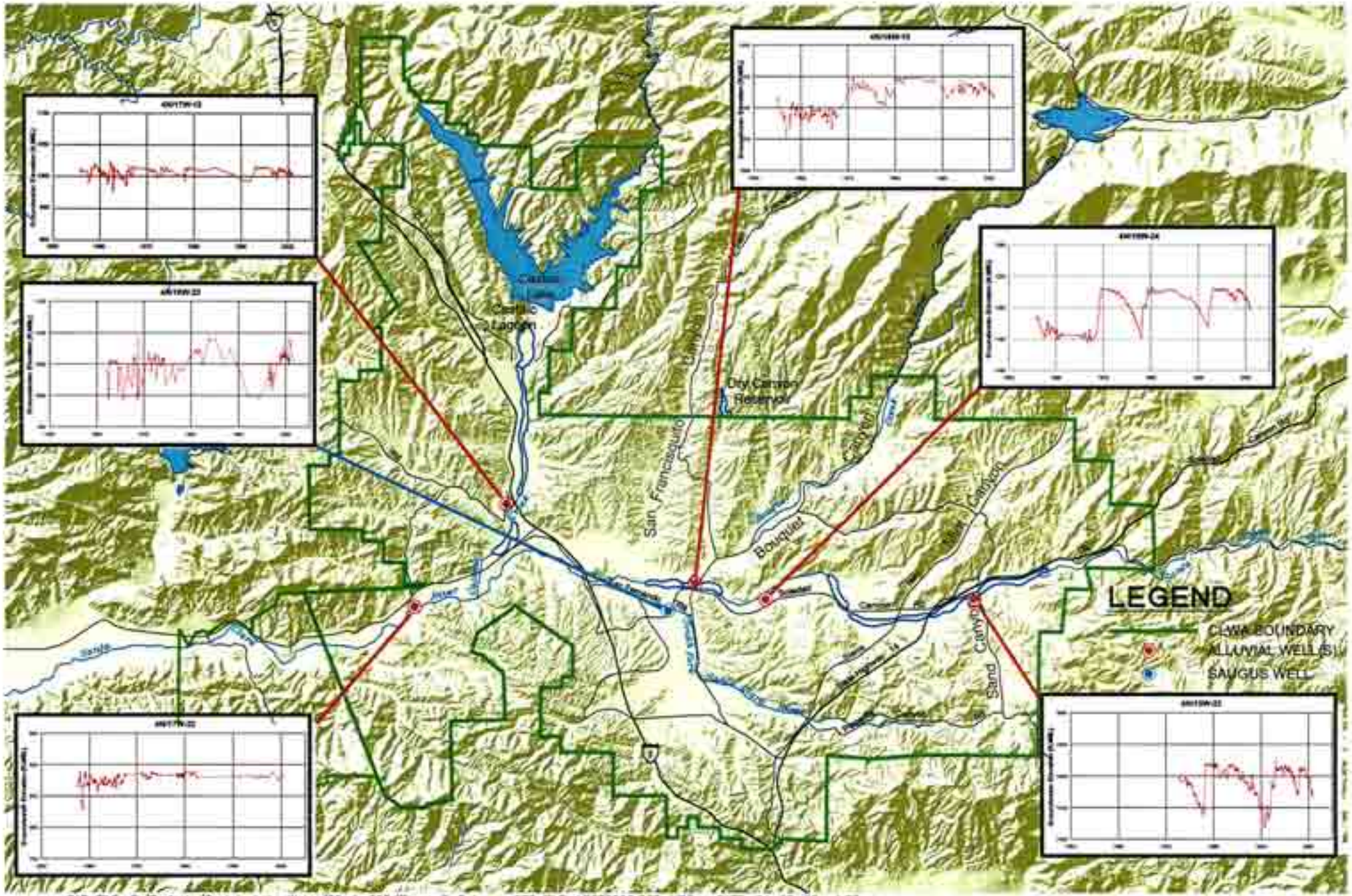

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Figure 3-2
Historical Groundwater Elevations
Santa Clara River Valley East Groundwater Subbasin

and storage occurs upon a return of stream flow to contribute to natural recharge.

Depending on the period of available data, all the hydrographs of alluvial groundwater levels show the same general picture: recent (last 30 years) groundwater levels are generally higher than over the preceding 20 years. In some locations, there are intermittent dry-period declines (and an associated use of some groundwater from storage) followed by wet-period recoveries (and associated refilling of storage space). On a long-term basis, whether over the last 20 years since the inception of conjunctive use via importation of SWP water, or over the last 40 to 50 years, the Alluvium shows no signs of water level-related overdraft, i.e., no trend toward decreasing groundwater levels and storage, a condition that is intended to be maintained via implementation of this Plan, e.g. via Primary Plan Elements 3 and 5.

Unlike the Alluvium, there are limited Saugus water level data; however, the limited data indicate that, although there have been seasonal water level changes in response to pumpage, the long-term trend in the Saugus (over the last 35 to 40 years) has been one of relative groundwater level stability (see, for example, Figure 3-2). There is no trend toward a sustained decline in Saugus water levels or storage that would be indicative of overdraft.

Land subsidence as a result of groundwater extractions is a concern in a number of groundwater basins in California. The potential for land subsidence caused by groundwater extractions derives from a combination of the geologic makeup of the aquifer materials and the history of groundwater level fluctuations. In the Santa Clara Valley East Subbasin, the most notable groundwater level fluctuations have occurred in the Alluvium to the east of Bouquet Canyon, with the greatest fluctuations (up to nearly 100 feet) recorded in the vicinity of Sand Canyon. Fortunately, those fluctuations have been intermittent, and have varied directly with local wet and dry conditions. From a subsidence perspective, they have also fluctuated in an unconfined aquifer that is comprised of essentially all coarse-grained material. The lack of any significant fine-grained material in the aquifer where groundwater levels have fluctuated results in two notable local conditions in regards to subsidence: there is no recorded historical subsidence or indirect evidence of its occurrence, i.e. subsidence-related impacts on surface structures, drainage facilities, etc.; and there is minimal potential for inelastic subsidence to occur in response to ongoing groundwater level fluctuations in the Alluvium.

The Saugus Formation contains a greater fraction of fine-grained material interbedded with the coarser aquifer materials that yield water to wells. Consequently, the Saugus has a greater

potential to undergo consolidation, with attenuant subsidence impacts at the ground surface, if groundwater levels are substantially lowered for long time periods. Historical Saugus pumping has not caused such conditions to occur. Current water supply planning, as described in this Plan, is to rely on the Saugus Formation for a relatively small component of water supply on an ongoing basis, with intermittent increased pumping during dry periods.

The long-term objective for groundwater management, as described in this Plan, is to not overdraft either the Alluvium or the Saugus, i.e. to not chronically lower groundwater levels. Satisfaction of the latter objective will have the correlative impact of minimizing the potential for inelastic land subsidence attributable to pumping from the Saugus Formation; combined with the lack of fine-grained material in the Alluvium, satisfaction of that objective will also have the correlative impact of ensuring the improbability of any subsidence attributable to pumping from that aquifer.

Groundwater Quality

Groundwater quality is, or course, a key factor in assessing both the Alluvial aquifer and the Saugus Formation as municipal and agricultural water supplies. At present, however, there is no convenient long-term record of water quality, i.e. water quality data in one or more wells that span several decades and continue to the present. Thus, in order to examine a long-term record of water quality in the Alluvium, an integration of individual records from several wells, completed in the same aquifer materials and in close proximity to each other, can be used to generally show long-term trends in groundwater quality. Figure 3-3 illustrates groundwater quality conditions and trends at multiple locations in the Alluvium along the main channel of the Santa Clara River from the area near the mouth of Mint Canyon, to areas immediately above and near the mouth of Bouquet Canyon, to the area below San Francisquito Canyon. Based on these records of groundwater quality, there have been historical fluctuations in concentrations of total dissolved solids (TDS), as well as corresponding fluctuations of individual constituents of TDS. In general, however, and similar to groundwater levels, there has been no long-term trend toward groundwater quality degradation.

Groundwater quality variations are common throughout the Alluvium and generally correlate inversely with precipitation and stream flow: wet periods have produced substantial recharge of higher quality (low TDS) water and dry periods have resulted in the notable declines in water levels described above, with a corresponding increase in TDS (and individual component

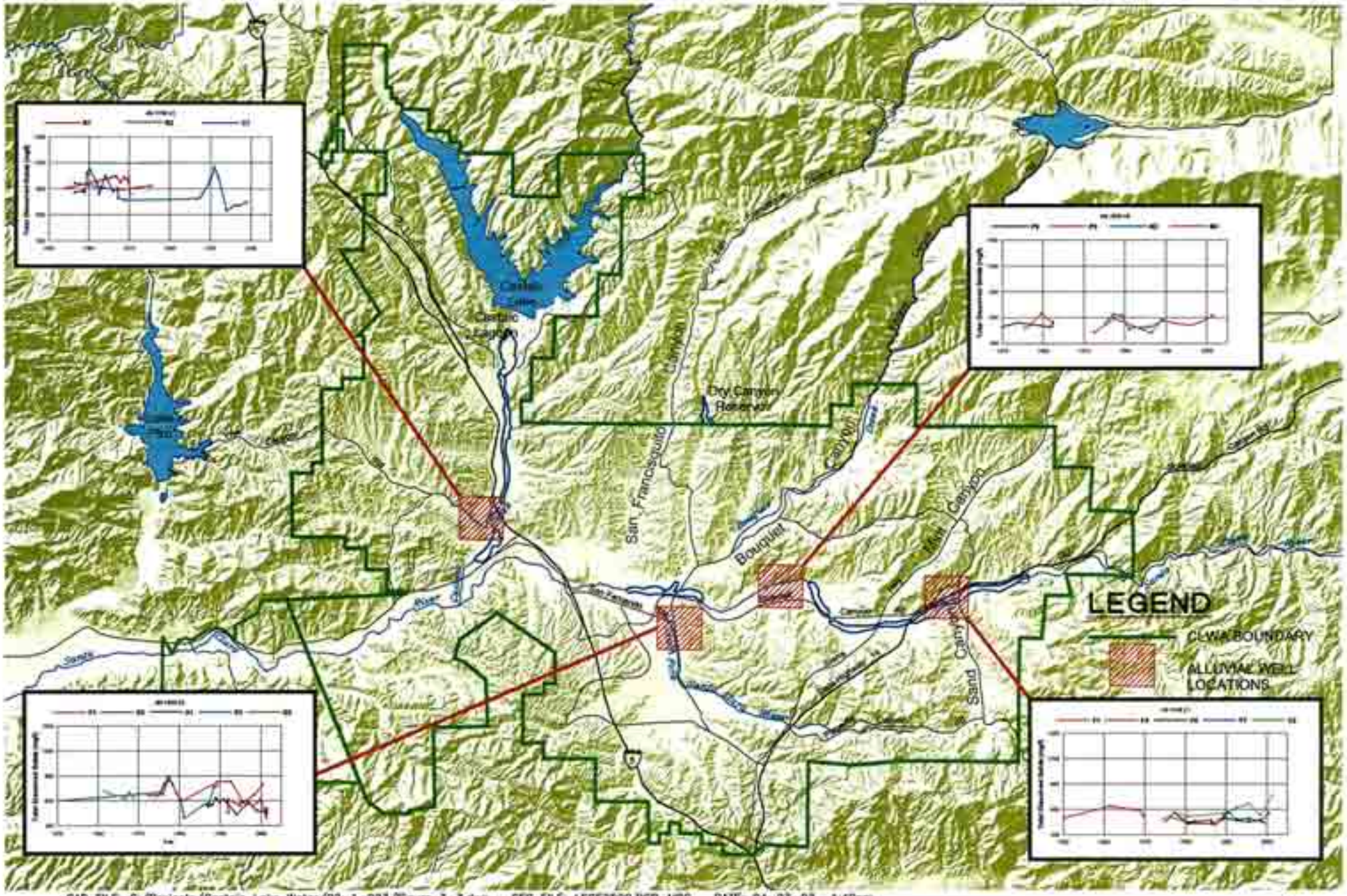

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Figure 3-3
Historical Groundwater Quality by Section
Santa Clara River Valley East Groundwater Subbasin

constituents) in the deeper parts of the Alluvium.

Due to a much more limited number of wells and the limited spatial extent of groundwater development in the Saugus Formation, long-term Saugus groundwater quality data are not sufficiently extensive to permit any sort of basin-wide analysis or assessment of pumping-related impacts on quality. Based on the most complete historical record, over the last 35 years, however, groundwater quality in the Saugus has remained generally constant. The Saugus Formation is, on a groundwater quality basis, a viable agricultural and municipal water supply.

The most notable groundwater quality issue in the basin centers around the detection and impact of perchlorate on several Saugus wells and one Alluvial well in the central part of the basin near the location of the former Whittaker Bermite facility, which is immediately southeast of the confluence of the main Santa Clara River and its South Fork tributary. In 1997, routine water quality sampling detected the presence of perchlorate in four municipal wells completed in the Saugus Formation (CLWA Santa Clarita Water Division Saugus Wells 1 and 2, Newhall County Water District Well 11, and Valencia Water Company Well 157). While there remains no primary or secondary drinking water standard for perchlorate, and although only some of the detected concentrations of perchlorate in the Saugus wells exceeded the Action Level established by the State Department of Health Services at that time (18 ug/l), all those wells were inactivated by their respective owners after detection of perchlorate; those wells remain out of municipal water supply service since then.

More recently, in late 2002, routine water quality sampling of Alluvial wells detected perchlorate in one of them (CLWA Santa Clarita Water Division Stadium Well) at a concentration which slightly exceeds the current Action Level (4 ug/l). This well has also been voluntarily inactivated, and remains removed from municipal water supply service.

This Plan, notably through Primary Plan Elements 1, 6 and 8, is intended to incorporate both short-term and long-term groundwater quality considerations in the management of the groundwater basin in order to formalize groundwater quality monitoring and assessment, to investigate and correct groundwater contamination problems, and to preserve or improve groundwater quality for ongoing water supply as well as for avoiding adverse water quality impacts on interconnected surface waters.

Areas of Concern and Identified Problems

A number of concerns have been expressed about groundwater conditions in the basin. While not all of the expressed concerns have been substantiated, they are listed and briefly discussed here, and they are addressed in the management objectives for the basin, intended to be achieved via implementation of the various primary and secondary elements in this Plan.

At present, the most notable concern in the basin is the impact of perchlorate contamination on a number of municipal water supply wells, thus affecting the available pumping capacity from some municipal wells. While perchlorate impacts on a few wells do not preclude the ability to pump groundwater in accordance with existing water supply plans, activities to characterize the contamination, and ultimately to control it and treat it, have been initiated in order to return the impacted wells' pumping capacity to water supply service. Primary Element 8 is included in this Plan to formalize the addressing of groundwater contamination issues in the basin.

Concern has also been expressed that groundwater development in the basin will adversely impact the quantity and/or quality of surface flows leaving the basin via the Santa Clara River. Such concern extends to the potential impact on groundwater in the next downstream basin, the Piru Basin in Ventura County. While there are no established provisions regarding surface flows out of the Santa Clara River Valley East subbasin, Primary Element 2 is included in this Plan to formally address the monitoring and management of surface water flows and quality within, and flowing out of, the basin. Some work is already ongoing related to this area of concern via a Memorandum of Understanding (MOU) among CLWA, other retail water purveyors within CLWA's service area, and United Water Conservation District, which manages surface water and groundwater in the downstream basins on the Santa Clara River in Ventura County. That cooperative effort, which is incorporated into this Plan via Primary Element 9, includes integration of databases, development of a numerical groundwater flow model, and interpretation and reporting on surface water and groundwater conditions.

A third expressed concern in the basin, is that groundwater is already overdrafted. Associated with that expressed concern is a related issue that reliance on overdrafted groundwater results in an overstated water supply in the basin. As discussed earlier in this section, long-term groundwater levels, storage, and quality all indicate the basin is in balance (i.e., no overdraft exists). As also discussed above, the importation of supplemental surface water over the last 23 years, and the associated initiation of conjunctive use operations have directly resulted in an

overall adequacy of water supplies while sustaining an undepleted groundwater supply. Primary Elements 3, 4 and 5 are key parts of this Plan to more formally quantify the yield of the groundwater basin, and to continue to meet overall water requirements via continuation of conjunctive use of local groundwater with imported supplemental surface water, ultimately complemented by integration of recycled water for non-potable water supply (Primary Element 7).

Finally with regard to areas of concern in the basin, the historically larger fluctuations in the eastern part of the basin have been highlighted for their impacts on private wells in that area. Some focused study has been done to address whether certain pumping directly affects private wells in Sand Canyon; its conclusions were that such direct effects were not occurring. Subsequently, a nearby development contracted for delivery of up to 120 acre-feet of imported SWP water from CLWA in order to reduce its use of groundwater for domestic and irrigation water supply. Primary Element 1 is partly intended to acquire site-specific data regarding private wells, their locations, the aquifers in which they are completed, their yields and pumping capacities as well as their quality, and their water level records. Primary Element 3 is partly intended to analyze such data in order to assess whether local aquifer depletion is occurring and, if so, what remedy is appropriate.

IV. Historical and Projected Water Requirements and Supplies

Historical Water Requirements

The initial development of water supplies in the Santa Clarita area began in the 1800's for irrigation on the San Francisquito Ranch after its purchase by Henry Mayo Newhall. While there are some records in the form of waterworks drawings that show early diversion and distribution facilities on the ranch in 1911 and some mapping of well locations in the 1930's, the earliest complete records of water use date from shortly after the end of World War II. From 1947 through the mid 1960's, groundwater pumping for agriculture ranged from about 27,000 to about 42,000 acre-feet per year (afy). For most of the same period, until 1960, there are no detailed records of water use for municipal supply. The first records of municipal water use begin in 1960, when municipal water requirements were about 5,000 afy; by the mid-1960's, municipal water requirements had increased to about 10,000 afy. Throughout that time, all municipal water supply was from local groundwater.

From the mid-1960's through about 1980, groundwater pumping for agricultural water supply declined into the range of about 10,000 to 15,000 afy. In the late 1980's through the early 1990's, agricultural groundwater pumping further declined into the range of about 8,000 to 10,000 afy; over about the last ten years, agricultural water requirements, which continue to be fully met by local groundwater pumping, have been in the range of about 12,000 to 15,000 afy. The history and trends of agricultural water use in the basin are illustrated in Figure 4-1.

Detailed records of municipal water use are not available from the mid-1960's through 1980, when imported surface water was first used in the basin for municipal water supply. However, the available municipal water use data at the beginning and at the end of that period, combined with estimated declining agricultural water use for the same period, suggest there was a generally steady increase in municipal water use from about 11,000 af in 1966 to about 22,000 af in 1980. Since then, municipal water use has increased to about 68,000 afy. With the addition of imported surface water from the State Water Project beginning in 1980, however, groundwater pumping for municipal supply declined in the early 1980's. Throughout the 1990's, municipal

pumping fluctuated between about 27,000 and 32,000 afy. The history and trend of municipal groundwater use in the basin are illustrated in Figure 4-1.

As noted above, until 1980, all water supply in the basin was from local groundwater. Imported surface water was first available from the State Water Project (SWP) in 1980, when a total of 1,125 af were imported into the basin. Since then, importations of SWP water have increased in two separate steady trends, interrupted by a notable decrease at the end of, and following, the 1987-1992 drought period: a steady increase beginning in 1980, to about 21,600 afy in each of 1989 and 1990, followed by a substantial decrease, to less than 8,000 af in 1991, and then a steady increase back to about 21,000 afy in 1997 and 1998, followed by further increases to nearly 42,000 af in 2002. The history and trends in importation of SWP water to the basin are illustrated in Figure 4-2, which also illustrates the historical trends in groundwater pumping and total water use in the basin since the importation of SWP water.

In the context of this groundwater management plan, the historical utilization of imported SWP water to augment local groundwater represents the initiation of conjunctive use of surface water and groundwater supplies, a groundwater management principle which is intended to be continued via adoption of Primary Element 5 of this plan.

Projected Water Requirements

Detailed projections of municipal water requirements were most recently completed as part of the Urban Water Management Plan prepared by CLWA and the municipal water purveyors (Newhall County Water District, Santa Clarita Water Company, and Valencia Water Company) in 2000. Those projections, which are forecast for a 20-year period, also recognize an ongoing but decreasing agricultural water demand over the same period, from about 15,000 afy in 2005 to about 7,000 afy by 2020. The municipal water demand projections in the Urban Water Management Plan are derived from utilization and interpretation of multiple projection methods, including per-capita water-use applied to population projections; extrapolation of number of service connections (using two different projection techniques, an average rate and an accelerated rate projection) applied to the rate of service connection additions since 1990; and land use projections combined with unit water use factors on multiple land use categories (urban, including residential, commercial, industrial and recreational; irrigated agricultural; and vacant and open space). The water demand projections in the Urban Water Management Plan also consider weather effects (variations due to hot-dry years vs. cool-wet years) and conservation

Historical Groundwater Production
Upper Santa Clara Valley Groundwater Basin
East Subbasin

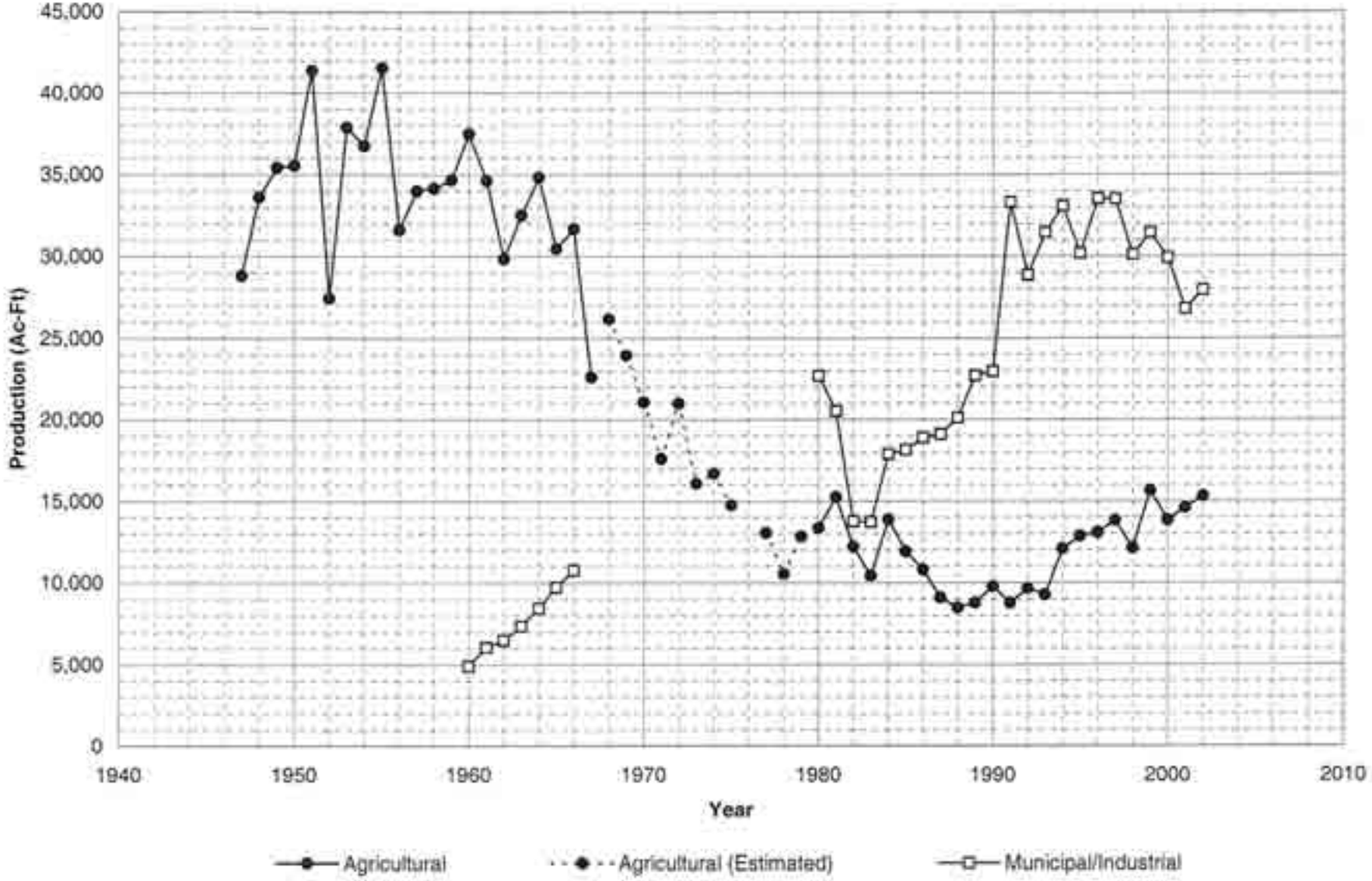


Figure 4-1

effects on water usage.

The net result of application and interpretation of the various water demand projection methods in the 2000 Urban Water Management Plan is summarized in Figure 4-2, which reflects projected urban and agricultural water demand through 2020, absent potential increased conservation savings, which are estimated to be ten percent of urban water demand. Numerically, urban water use without increased conservation savings is projected to increase to nearly 67,000 afy by 2005, and then continue to increase to 106,000 afy by 2020. As noted above, agricultural water use over the same period is projected to decrease to 15,000 afy by 2005, followed by an ongoing decrease to 7,100 afy by 2020. In addition to the graphical presentation of projected water demands in the basin through 2020 in Figure 4-2, projected water demands are tabulated, both with and without potential increased conservation savings, in Table 4-1.

Table 4-1
Projected Normal/Average Year Water Demands
(acre-feet per year)

	2005	**2010**	**2015**	**2020**
Urban Agriculture	66,600 15,100	77,700 12,400	90,900 9,800	106,000 7,100
Total Projected Demand	**81,700**	**90,100**	**100,700**	**113,100**
Increased Conservation Savings	6,600	7,700	9,100	10,600
Total Projected Demand *(with increased conservation)*	**75,100**	**82,400**	**91,600**	**102,500**

Existing and Projected Water Supplies

As noted above, existing water supplies to meet current water demands are comprised of local groundwater and imported SWP surface water. In 2001, for example, to meet a total water demand of nearly 76,800 af, local groundwater pumping amounted to 41,400 af, (about 54% of total demand) and imported SWP water amounted to 35,400 af (about 46% of total demand).

Water supplies to meet projected water demands are expected to continue to be primarily a combination of local groundwater and imported SWP surface water, augmented by local recycled

Historical and Projected Water Use
Upper Santa Clara Valley Groundwater Basin
East Subbasin

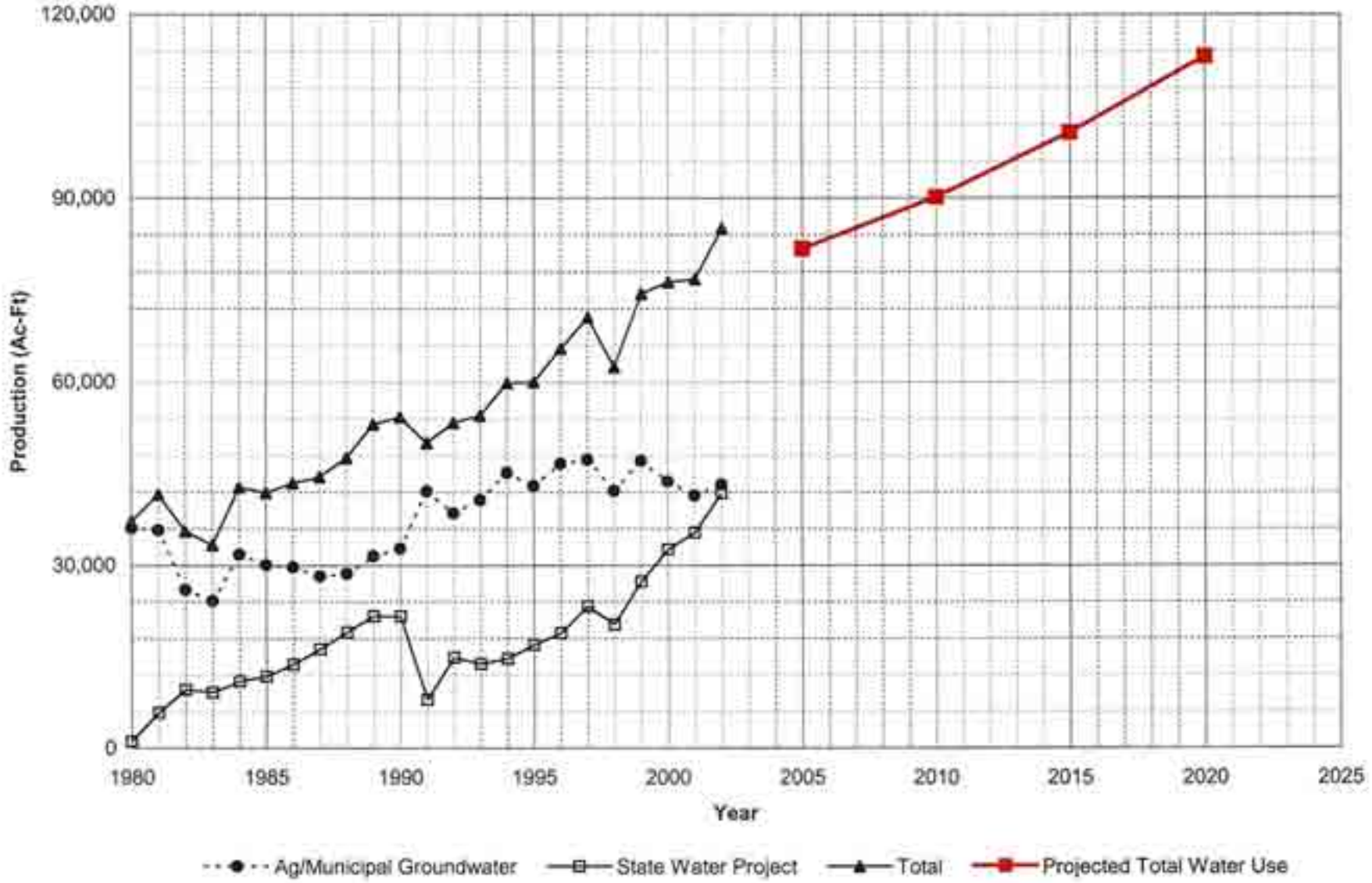


Figure 4-2

water and possibly some water supply derived from water transfers and desalination outside the basin.

Local Groundwater - Local groundwater has historically been developed from the two aquifers that comprise the groundwater basin, the Alluvium that underlies the Santa Clara River and its tributaries, and the Saugus Formation that underlies much of the CLWA service area. Those two aquifers, and the groundwater basin they comprise, are the focus of this groundwater management plan. Based on historical experience and observation of groundwater conditions, it is currently expected that ongoing utilization of local groundwater will continue to be in amounts that are generally comparable to what has historically been pumped, 30,000 to 40,000 afy from the Alluvium and 7,500 to 15,000 afy from the Saugus Formation. It is also expected that there is some additional development potential in the Saugus Formation, in the range of 10,000 to 20,000 af which might be intermittently extracted during one or more dry years when supplemental imported water supplies might be reduced. Ultimately, it is expected that local groundwater will continue to be a component of water supply in the basin at appropriate production levels from both aquifers. The intent of this groundwater management plan is to ensure that ongoing utilization of local groundwater continues to result in acceptable aquifer conditions, i.e. avoidance of overdraft (Primary Plan Element 3), no degradation of quality (Primary Plan Element 6), no adverse impacts to surface waters (Primary Plan Element 2), all via continuation of conjunctive use operations that have been ongoing since the initial importation of supplemental surface water in 1980 (Primary Plan Element 5) and via monitoring and interpretation of surface water and groundwater conditions on an ongoing basis (Primary Plan Elements 1 and 2).

Supplemental (SWP) Surface Water - CLWA has a Table A contract amount of 95,200 af of water from the SWP. CLWA's original contract, signed in 1963, was for 23,000 af; that Table A amount was later increased to 41,500 af. In 1988, CLWA purchased a Table A amount of 12,700 af from Devil's Den Water District, and it acquired another 41,000 af of Table A amount in 1999 from Kern County Water Agency and its member district, the Wheeler Ridge-Maricopa Water Storage District. There is ongoing CEQA-related litigation over the most recent acquisition of the 41,000 af Table A amount. However, there has been no invalidation of the completed agreement to transfer the 41,000 af Table A amount to CLWA and current water supply planning includes that Table A amount as CLWA corrects the CEQA technicality by preparing a new EIR to address the environmental consequences of the transfer.

Recycled Water - In 1993, CLWA prepared a draft Recycled Water System Master Plan that outlined a multi-phase program to integrate recycled water into the overall water supply system in the basin. Phase I of that project, which will deliver approximately 1,700 afy, began deliveries of recycled water for golf course irrigation in mid-2003. Overall, by 2020, recycled water is expected to ultimately reclaim up to 17,000 afy of treated waste water suitable for irrigation of golf courses, landscaping, and other non-potable uses.

V. Elements of the Groundwater Management Plan

As part of long-term water supply planning in the Santa Clara River Valley East groundwater subbasin, Castaic Lake Water Agency (CLWA) and the municipal water purveyors in the basin, in concert with other groundwater pumpers in the basin, began conjunctive use operations in 1980 by importing supplemental surface water from the State Water Project and integrating it with local groundwater to meet all the water requirements in the basin. Prior to that time, and continuing to the present, various groundwater pumpers and other entities in the basin, including CLWA, have collected groundwater and related data on which historical and ongoing analyses of groundwater basin conditions have been made. Those monitoring efforts and basin analyses have allowed CLWA and other entities in the basin to progressively define and understand basin conditions, and to continue to meet increasing water demands over the last 23 years. Information derived from the monitoring and management efforts to date has allowed the various public and private pumpers in the basin to continue to rely on the groundwater basin for some or all of their water supply without significant concern that the resource was either overdrafted or otherwise negatively impacted.

In light of the preceding, complemented most recently by the Memorandum of Understanding process that has initiated integrated management with United Water Conservation District, which serves as the manager of adjacent downstream basins on the Santa Clara River (as described in Primary Element 9), local groundwater management has already been initiated consistent with the opportunity provided by Water Code Section 10753. However, despite those ongoing accomplishments, CLWA recognizes the concerns and issues that are discussed herein relative to groundwater and the adequacy of water supplies in the basin. With that recognition, and in part prompted by the requirements of AB 134, CLWA has prepared this broader-based groundwater management plan.

To continue historical groundwater management activities and to address identified concerns and issues related to groundwater and water supply in the area, this Groundwater Management Plan has been developed to provide a framework for present and future actions. As has been the case for the groundwater management activities by CLWA and other local entities over the past 23 years, it is expected that this plan will be updated as new data are developed, particularly in light

of the key role that groundwater monitoring (water levels and quality) has played, and will continue to play, in defining groundwater conditions and aquifer response to management actions.

The management objectives, or goals, for the Santa Clara River East groundwater basin include the following:

Goal 1: Development of Local Groundwater for Water Supply
Goal 2: Avoidance of Overdraft and Associated Undesirable Effects
Goal 3: Preservation of Groundwater Quality
Goal 4: Preservation of Interrelated Surface Water Resources

To accomplish those goals, with recognition of the opportunities encouraged by Water Code Section 10750 et seq. for local agency management of groundwater resources, this plan incorporates a number of components which are divided into primary, or essential, elements and secondary, or potential, elements. In both categories, the elements formally recognize the effectiveness of a number of ongoing water resource management activities. They recognize the need for additional activity, such as expanded conjunctive use of supplemental surface water, and recycled water, with local groundwater. They also reflect the wider focus on local groundwater management, such as continuing cooperation with the municipal water purveyors and other pumpers in the basin, and with other water resource management entities on the Santa Clara River, most notably United Water Conservation District, to address the impacts of regional resource opportunities and/or challenges. In summary, this Groundwater Management Plan will enable CLWA, the retail water purveyors, and their neighbors to continue use of local groundwater for regular water supply, to expand their use of local groundwater during dry periods or emergencies, and to work with other agencies via implementation of the following management plan elements.

Primary (Essential) Plan Elements

1. Monitoring of Groundwater Levels, Quality, Production and Subsidence
2. Monitoring and Management of Surface Water Flows and Quality
3. Determination of Basin Yield and Avoidance of Overdraft
    - wet and dry period pumping
    - control of well field drawdown

4. Development of Regular and Dry Year/Emergency Water Supply
5. Continuation of Conjunctive Use Operations
6. Long Term Salinity Management
7. Integration of Recycled Water
8. Identification and Mitigation of Soil and Groundwater Contamination
    - involvement with other local agencies in investigation, cleanup, and closure
9. Development and Continuation of Local, State and Federal Agency Relationships
10. Groundwater Management Reports

Secondary (Potential) Elements

1. Continuation of Public Education and Water Conservation Programs
2. Identification and Management of Recharge Areas and Wellhead Protection Areas
    - involvement in land use planning process
3. Identification of Well Construction, Abandonment, and Destruction Policies
    - water quality protection
    - manage vertical distribution of pumpage
4. Provisions to Update the Groundwater Management Plan

Primary Element 1 - Monitoring of Groundwater Levels, Quality, Production, and Subsidence

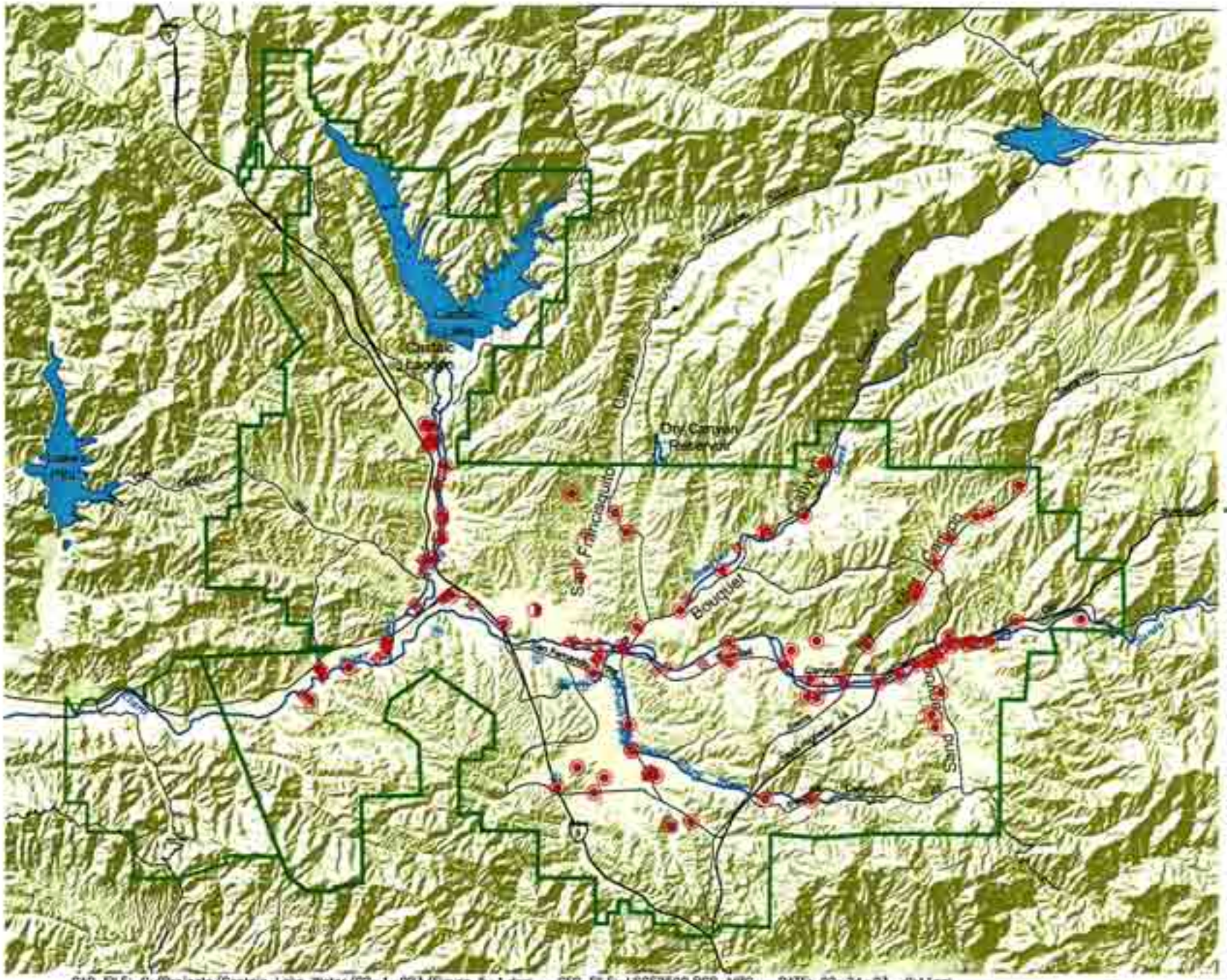
Prior to 1980, all water supply in the Upper Santa Clara River Area was developed from local groundwater; since 1980, imported surface water has become an increasing component of overall water supply in the area, but groundwater continues to meet all agricultural water demand and a significant part of municipal water demand. As a result of the long term development and use of groundwater in the area, there is a fairly substantial amount of historical groundwater level data, and a useful amount of groundwater quality data and groundwater pumping data that has been collected in the basin. All the available historical groundwater level, quality, and pumping data have been organized into a computerized data base for the Upper Santa Clara River Area. That data base, while separate, has been coordinated with an equivalent data base maintained by United Water Conservation District for the downstream basins on the Santa Clara River. The intent of database coordination has been to facilitate interpretation and reporting on groundwater and other water resource related issues by the respective agencies overlying the various basins along the river.

The networks of wells from which groundwater level and groundwater quality data have been collected are illustrated in Figures 5-1 and 5-2. The networks are comprised of a combination of active production wells, inactive production wells, and dedicated monitoring wells, shown on Figures 5-1 and 5-2. Data collection has historically varied from randomly infrequent to regularly scheduled but infrequent (e.g. semi-annual). The historical data collection efforts cannot be classified as an organized area-wide program of groundwater data collection, there are generally sufficient data available on which to interpret basin conditions. Ultimately, it is recognized that monitoring of existing wells, and expansion of the network of both production and monitoring wells, are key to accomplishing all the goals for the basin in this management plan. Monitored groundwater levels, quality, and pumping will collectively provide the basis for defining basin conditions and developing operational protocols that allow conjunctive use to support ongoing groundwater supply while avoiding undesirable conditions such as chronically depressed groundwater levels or degraded groundwater quality. Thus, a primary element of this plan is to develop and implement a groundwater monitoring program that is comprised of a network of wells, mostly as illustrated in Figures 5-1 and 5-2, but possibly expanded to include some dedicated monitoring wells as well as some potential new production wells. The frequencies and types of groundwater data collection will vary as a function of specific monitoring objectives in various parts of the basin. For initial implementation purposes , basin-wide groundwater monitoring protocols (locations and types of measurements, frequencies, etc.) are included in the Appendix to this Plan.

It should be noted, in light of the lack of historical subsidence and the low potential for it to occur as discussed in Section III above, that no formal subsidence monitoring is planned, i.e. no extensometers, fixed-point ground surveys or remote sensing. However, if the analysis of planned additional dry-year pumping indicates the potential for subsidence attributable to lower groundwater levels, monitoring or other appropriate action (e.g. re-distributed or reduced pumping) will be undertaken.

Primary Element 2 - Monitoring and Management of Surface Water Flows and Quality

The geologic and hydrologic configuration of the groundwater basin and the Santa Clara River system that overlies the aquifers in the basin is such that the River and the Alluvial aquifer can directly interact. Further, although the Saugus Formation has hydraulic characteristics that indicate it to be locally confined, groundwater can move between the Alluvium and the Saugus. The net result of the overall river-aquifer configuration is that groundwater is readily recharged



LEGEND

- ACTIVE ALLUVIAL WELL
- INACTIVE ALLUVIAL WELL
- ACTIVE SAUGUS WELL
- INACTIVE SAUGUS WELL
- SAUGUS MONITORING WEL
- UNKNOWN ALLUVIAL WELL
- CLWA BOUNDARY

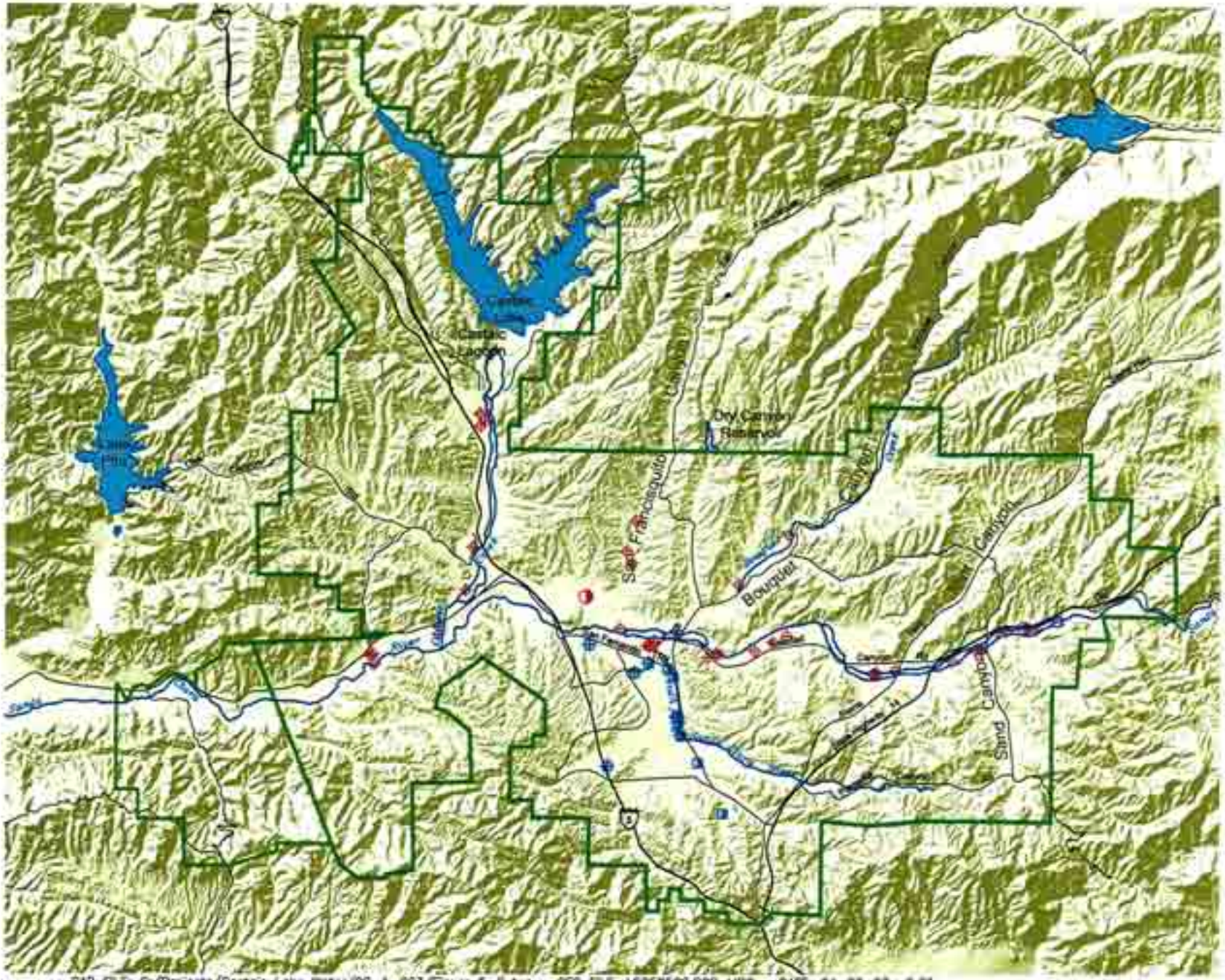
Scale in Miles

0' 1.5 3

CAD FILE: G:/Projects/Castaic Lake Water/02-1-023/Figure 5-1.dwg CFG FILE: LSCE2500.PCP_MRG DATE: 02-24-03 9:41am

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Figure 5-1
Water Level Monitoring Well Network
Santa Clara River Valley East Groundwater Subbasin



LEGEND

- ACTIVE ALLUVIAL WELL
- INACTIVE ALLUVIAL WELL
- ACTIVE SAUGUS WELL
- INACTIVE SAUGUS WELL
- CLWA BOUNDARY

Scale in Miles

0' 1.5 3

CAD FILE: G:/Projects/Castaic Lake Water/02-1-023/Figure 5-2.dwg CFG FILE: LSCE2500.PCP_MRG DATE: 04-03-03 9:36am

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Figure 5-2
Water Quality Monitoring Network
Santa Clara River Valley East Groundwater Subbasin

by periodic natural surface water flows in parts of the basin, generally to the east of Bouquet Canyon; and groundwater discharges to the river in other parts of the basin, generally to the west of Bouquet Canyon. As a result of the latter groundwater discharges to the river, in combination with treated waste water discharges from the two local regional treatment plants, there is a significant surface water outflow from the basin in the Santa Clara River. That surface water flow to the west across the County line has increased over the last 20 years (Figure 5-3).

When considered in concert with the other elements of this groundwater management plan, a number of challenges related to surface water flow and quality are evident. First, knowledge of surface flow rates and quality, and variations in both, will be essential to incorporating surface water considerations into management of the interconnected aquifer system. Thus, monitoring of surface water flows and quality will be part of this plan; and the resultant data will be incorporated in the database of groundwater data that results from implementation of this element and Primary Element 1.

Secondly, continuation of some surface flow and non-degradation of surface water quality would appear to be appropriate objectives, particularly as recycled water use is integrated into the overall water supply in the basin, and as dry-year dependence on groundwater increases. Those issues have begun to be addressed in the MOU process with neighboring United Water Conservation District, as described in Primary Element 9 of this Plan, but they will be addressed on a more comprehensive basis as monitored data is collected, as a numerical groundwater flow model is developed and utilized (Primary Element 3), and as recycled water becomes part of the integrated water supply (Primary Element 7). Basin management of surface water flows and quality will also relate to potential groundwater management actions intended to augment yield, e.g. artificial groundwater recharge (Primary Elements 3 and 5), and groundwater management actions intended to preserve groundwater quality (Primary Element 6). For initial implementation purposes, surface water monitoring protocols (locations and types of measurements, frequencies, etc.) are included in the Appendix to this Plan.

In light of the preceding, this plan element is included in the overall groundwater management plan to address surface water flows and quality in concert with analysis and management of groundwater levels and quality. The implementation of this plan element will be essential to accomplishment of the fourth management objective (goal) for the basin.

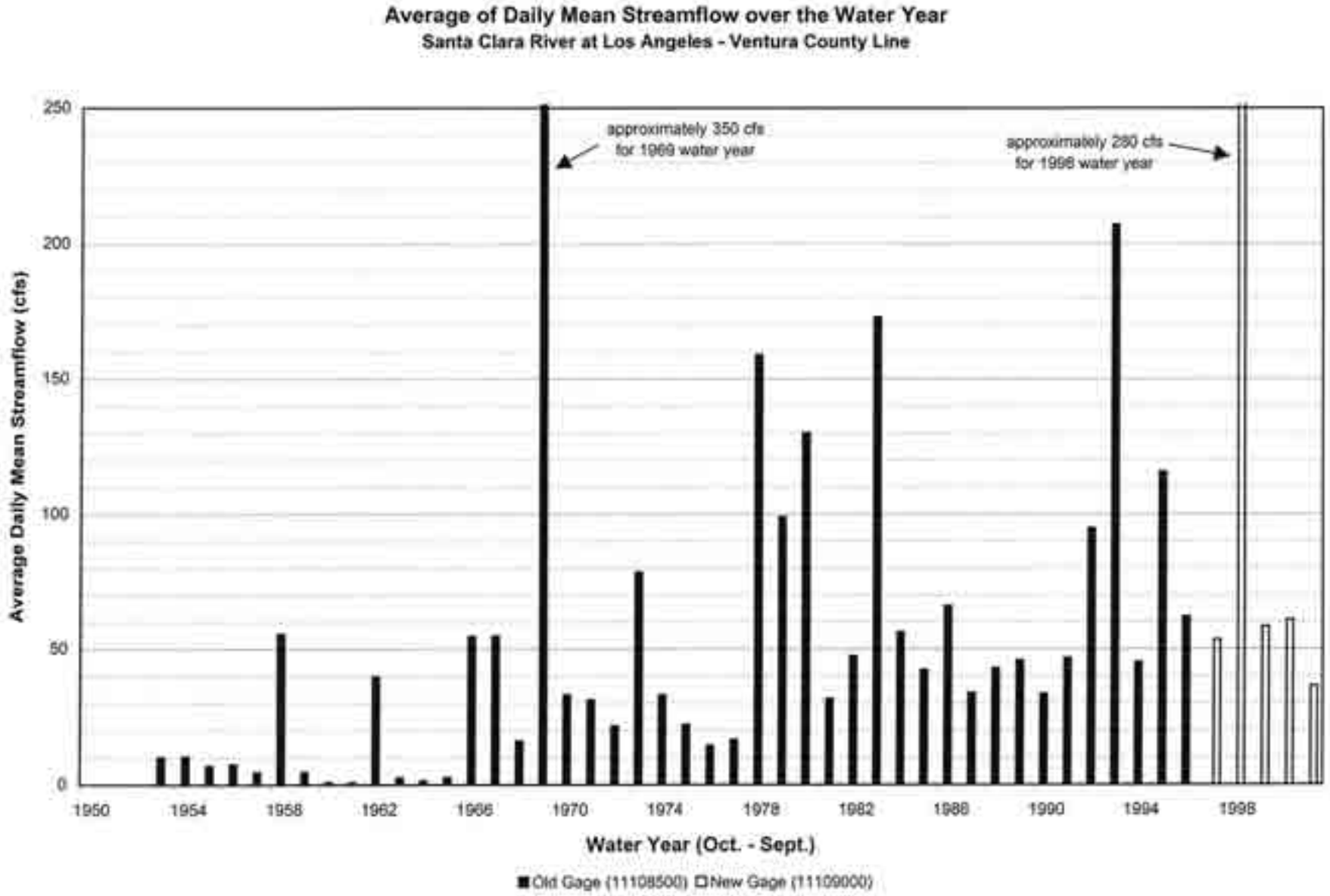
Average of Daily Mean Streamflow over the Water Year
Santa Clara River at Los Angeles - Ventura County Line
approximately 350 cfs
for 1969 water year
approximately 280 cfs
for 1998 water year
Average Daily Mean Streamflow (cfs)
250
200
150
100
50
0
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
Water Year (Oct. - Sept.)
Old Gage (11108500)
New Gage (11109000)

Figure 5-3

Primary Element 3 - Determination of Basin Yield and Avoidance of Overdraft

In order to accomplish all the goals for the basin, it will be essential to determine what yield can be developed on both a regular and an intermittent (dry period or emergency) basis. Such a determination of basin yield will be made to accomplish the main objective of operating within the yield of the groundwater basin, avoidance of overdraft.

On a long-term basis, there has not been any widespread, steady degradation of groundwater conditions that might be indicative of overdraft, i.e. decrease in groundwater levels or storage as a result of pumping in excess of the yield of the basin. There have been, and continue to be, short-term fluctuations in groundwater levels that are basically related to variations in local hydrological conditions, alternating increases and decreases in storage in response to wet and dry conditions (and associated fluctuations in recharge and pumping). Such fluctuations are typical of groundwater basin conditions in any conjunctive use setting, such as in this basin; groundwater is utilized from storage during dry years, or dry periods, and that storage is replenished during alternate wet years, or periods. The observation of these historical groundwater conditions, in combination with knowledge of pumpage from both the Alluvial and Saugus Aquifers, has led to current operational practices as well as general expectations regarding the approximate yield of the local groundwater system.

While historical operating experience, complemented by observed groundwater conditions, is an appropriate basis for generally planning for available groundwater supplies, it is possible and appropriate to more precisely analyze the basin to determine values or ranges of yield under varying hydrologic conditions, and to assess the impacts of various management actions that might be implemented in the basin. The MOU process described in Primary Element 9 of this Plan includes the development of a numerical groundwater flow model which is intended to be utilized for determination of the yield of the basin under existing land use and under existing groundwater and surface water development conditions. It is also expected to be used for implementation of this Plan Element to assess the yield of the basin under future land use conditions as well as future ranges of surface water importation, groundwater development, and recycled water use through varying hydrologic conditions, i.e. wet and dry periods that affect the availability of imported surface water.

The ultimate intent of this Plan Element is to develop an understanding and quantification of the yield of the basin, under varying hydrologic conditions and developing local cultural conditions,

so that groundwater development and use can be managed in such a way to meet an appropriate fraction of total water demand while avoiding levels of groundwater use that would result in overdraft conditions. Thus, implementation of this Plan Element is essential to accomplishing the first and second management objectives (goals) for the basin.

Primary Element 4 - Development of Regular and Dry Year/Emergency Water Supply

The most recent updated Urban Water Management Plan (UWMP, December 2000) prepared by CLWA and the retail water purveyors in the basin (Newhall County Water District, Santa Clarita Water Company and Valencia Water Company) includes plans to develop 30,000 to 40,000 acre-feet per year (afy) from the Alluvial aquifer and 7,500 to 15,000 afy from the Saugus Formation in average/normal years. Both ranges of numbers are consistent with recent historical pumping that has not resulted in any indication of overdraft or other undesirable conditions. The UWMP also includes plans to slightly reduce Alluvial pumping in dry years (in recognition of historical experience with decreased groundwater levels in the eastern part of the basin during dry periods) to 30,000 to 35,000 afy, while potentially increasing dry-period Saugus pumping to 21,000 to 35,000 afy depending on the duration of dry conditions.

A major consideration in this plan is the accomplishing ~~of~~ this element in concert with Primary Element 3, i.e. development of both regular and dry year/emergency groundwater supply within the yield of the basin in order to avoid overdraft. Toward that goal, the model described in Primary Element 3 will be used to analyze projected results, i.e. groundwater levels, storage and stream flow impacts, in order to design the optimal distribution of pumpage or to refine the ranges of regular or dry period/emergency pumping volumes. The result will facilitate a water transmission and distribution design, and will also facilitate planning for supplemental water supplies and planning for proactive recharge activities to augment basin yield as necessary to meet water supply requirements. Thus, implementation of this Plan Element, within the confines of Primary Element 3, will be essential to accomplishment of the first management objective (goal) for the basin.

Primary Element 5 - Continuation of Conjunctive Use Operations

Beginning with the initial delivery of imported surface water from the State Water Project (SWP) in 1980, CLWA and the retail water purveyors in the basin have been practicing the conjunctive

use of imported surface water and local groundwater. Conjunctive use in this setting has consisted of meeting water demands with a combination of imported surface water and local groundwater. Groundwater pumping has remained within a range that has not caused any evidence of overdraft, or associated undesirable impacts, and has fluctuated within that range to meet a larger fraction of water demand during periods of reduced surface water availability, such as at the end of the 1987-1992 drought and for several years immediately thereafter. Imported surface water use, on the other hand, progressively increased from 1980 through 1990, substantially decreased in the early 1990's due to extended drought conditions in Northern California, returned slowly to pre-drought levels over about a five year period, and has progressively increased again since 1996. The historical trend in water demand and the trends in groundwater and imported (SWP) surface water use to meet that demand are illustrated in Figure 5-4.

Conjunctive use of local groundwater and imported surface water will continue to be a key element in meeting all the goals for the basin, most notably utilizing groundwater for water supply without overdrafting the basin. Historical experience with groundwater pumping and aquifer response to varying hydrologic conditions has shown that the groundwater basin can support notable variations in pumping during wet and dry periods, but it cannot support continuous pumping at rates high enough to meet total local water demand. Thus, utilization of imported surface water in conjunction with local groundwater is essential to the management of groundwater for water supply without overdrafting that resource.

As part of conjunctively using surface water and groundwater, it is recognized that, particularly when the surface water supply is imported from the State Water Project, there will be variations in the amount of available surface water supply from year to year. Similarly, there are expected to be variations in local groundwater conditions as a function of local hydrologic conditions which affect, among other things, the natural recharge to the groundwater basin from year to year. In the case of this basin, local (Southern California) hydrology which affects local groundwater conditions may not necessarily be the same as the hydrology in a distant (i.e., northern California) location that directly affects the availability of supplemental, imported surface water in any given year. Thus, conjunctive use management is necessary to ensure that the groundwater basin is maintained to meet a regular component of water supply and to also provide a larger component of water supply during "dry periods" that affect supplemental surface water availability. Conjunctive use management is similarly important to ensure that local groundwater can be replenished, via reduced pumping and/or as a result of wetter local

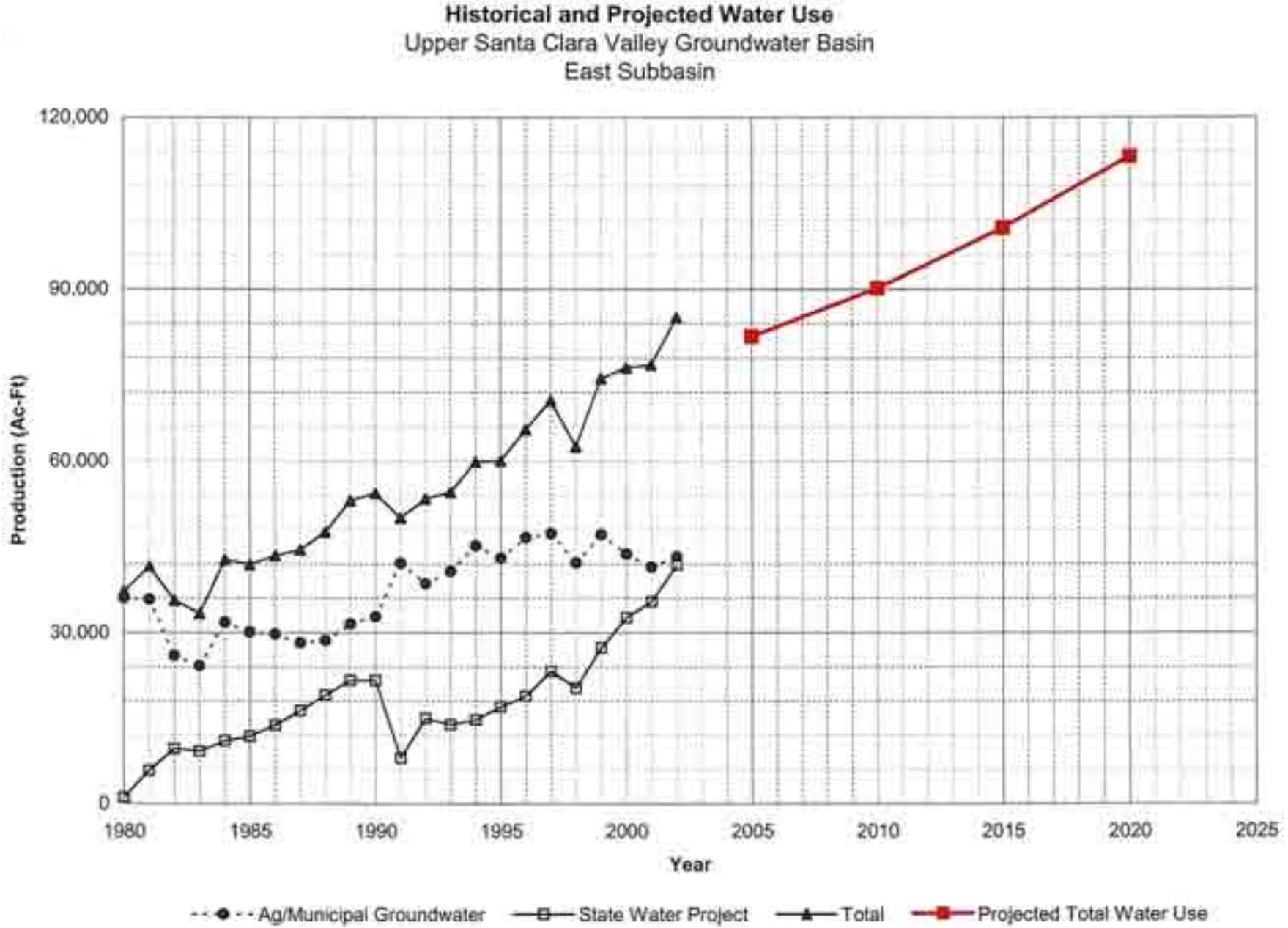
Historical and Projected Water Use
Upper Santa Clara Valley Groundwater Basin
East Subbasin
120,000
90,000
60,000
30,000
0
Production (Ac-Ft)
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
Ag/Municipal Groundwater
State Water Project
Total
Projected Total Water Use

Figure 5-4

hydrologic conditions, during periods of wet/normal surface water availability. In light of all the preceding, implementation of this Plan Element is essential to accomplishing all the management objectives (goals) for the basin.

Primary Element 6 - Long Term Salinity Management

In general, groundwater quality in the basin is such that groundwater supplies meet standards for beneficial use in the basin, most of which is for municipal (domestic) use but some of which remains for agricultural and some other irrigation (non-domestic) use. There also have been no notable historical trends of groundwater quality degradation in the basin over time. However, a number of geologic and hydrologic factors suggest that observations and interpretation of groundwater quality warrant attention to ensure long-term preservation of groundwater quality. Notable among those geologic and hydrologic factors are: 1) the largely "closed" geologic nature of the aquifer system at the western limit of the basin (other than a thin section of Alluvium beneath the Santa Clara River, there is no continuity of aquifer materials between the Santa Clara River Valley East groundwater subbasin and the next downstream groundwater basin on the Santa Clara River, the Piru Basin in Ventura County); 2) the predominant groundwater flow direction in the basin toward the west, where there is the lack of continuity of aquifer materials for groundwater outflow; 3) a certain amount of rising groundwater discharge into the Santa Clara River; and 4) an increasing discharge of treated waste water into the Santa Clara River toward the western end of the basin which, when accounting for the planned use of a substantial amount of recycled water in the Basin (Primary Element 7) will result in higher salt concentrations than other sources of water supply in the Basin. The combination of the preceding factors suggests that, on a long-term basis, there could be an accumulation of dissolved minerals in the aquifer system if salinity is not managed in a way to avoid undesirable groundwater quality degradation. Consequently, this primary element is included in the overall groundwater management plan to include the interpretation of groundwater quality data (Primary Element 1) and to incorporate groundwater quality as an important consideration in the implementation of the other elements of the plan, most notably Continuation of Conjunctive Use Operations (Primary Element 5), Integration of Recycled Water (Primary Element 7), and Identification and Cleanup of Contaminated Groundwater (Primary Element 8). The Long Term Salinity Management element of the plan is essential to accomplishing the third management objective (goal) of preserving groundwater quality in the basin.

Primary Element 7 - Integration of Recycled Water

In 1993, CLWA prepared a Reclaimed Water System Master Plan that outlined a multi-phase program to deliver highly treated, recycled water in the Valley. At that time, potential recycled water uses in excess of 10,000 afy, of which about 9,000 afy were located within the CLWA service area, were identified. The first phase of the Reclaimed Water System Master Plan to deliver 1,700 afy has been environmentally reviewed and is being implemented, with initial deliveries having commenced in August 2003.

The 1993 recycled water plan expected to reclaim up to 10,000 afy. CLWA has been updating that plan to ultimately provide up to about 17,000 afy for irrigation and other non-potable uses. It has also been recognized that, if the Newhall Ranch project is approved, total annual demands for recycled water in the area could ultimately approach 20,000 afy.

This plan element is included in the groundwater management plan primarily because recycled water use in the Valley will supplant a substantial fraction of fresh water demand that would otherwise be met with potable water from some combination of pumped groundwater and imported surface (SWP) water. With total municipal, agricultural and other water demands projected to increase from about 75,000 afy at present to slightly more than 100,000 afy by 2020, the progressive increase in recycled water use from 1,700 afy to as much as 17,000 to 20,000 afy, recycled water use would reduce demands on potable sources (groundwater and imported SWP water) by up to nearly 20 percent. Accomplishment of this Plan Element will benefit the accomplishment of Elements 3 and 4, and will also contribute to the accomplishment of all four of the Basin Goals.

Primary Element 8 - Identification and Mitigation of Soil and Groundwater Contamination

As in numerous other groundwater basins in California, there have been a number of leaking underground storage tanks or other similar situations which have released organic constituents into soil, and possibly into groundwater, in the basin. None of those has impacted municipal or other water supply wells and, consequently, there has been no adverse impact on groundwater supply in municipal or other water supply systems in the basin. However, the detection of perchlorate in the discharge from four Saugus wells (CLWA Santa Clarita Water Division Saugus Wells 1 and 2, Newhall County Water District Well 11, and Valencia Water Company Well 157) in 1997, followed by the detection of perchlorate in one Alluvial well (CLWA Santa Clarita Water Division Stadium Well) in 2002, has led to the inactivation of all those wells.

They remain out of municipal water supply service to date.

Experts retained by CLWA have opined that the cause of perchlorate contamination in the Saugus Formation is former operations associated with munitions manufacturing on property formerly owned by Whittaker-Bermite Corporation, which is immediately adjacent to all the impacted wells. Investigation and characterization of the perchlorate contamination, and initiation of control and cleanup are ongoing; however, remediation actions have not yet commenced. Consequently, the municipal water purveyors continue to be impacted by the loss of water supply capacity of the impacted wells. Associated with that loss is a concern about the migration of perchlorate contamination in a generally downgradient direction, toward other active wells completed in the Saugus Formation and the Alluvium and toward other potential well sites. In light of both the inactivation of wells and the potential downgradient impact on the aquifers, CLWA and the other retail water purveyors had initiated both legal action against responsible parties and technical investigation of the contamination. Recently the parties have entered into an interim settlement agreement which is intended to complete investigation and characterization of the contamination in a collaborative effort. This effort will facilitate and expedite remediation actions.

The primary purpose for technical investigation of the perchlorate contamination by CLWA and the other municipal purveyors is to ultimately recover the currently unavailable water supply capacity that has resulted from the inactivation of impacted wells. Conceptually, that may be accomplished by some combination of reactivation of impacted wells and new well construction. CLWA has joined with the U.S. Army Corps of Engineers in a study to develop information about the contamination. CLWA and the retail water purveyors have also independently commissioned an assessment to conclude what treatment technology is appropriate for removal of perchlorate from pumped groundwater; they have also independently commissioned the application of a numerical groundwater flow and quality model to determine an optimal pumping program for 1) perchlorate removal from the aquifer, 2) control of its migration in the aquifer, and 3) restoration of impacted pumping capacity for water supply. With data derived from that work, CLWA and the other purveyors are preparing to submit an application to the State Department of Health Services, by late 2004, for a permit to return to pumping from the locally impaired Saugus Formation. The proposed pumping would be combined with approved wellhead treatment to render the treated water suitable for municipal supply. In addition to the latter objective to recover currently inactivated water supply, the proposed pumping would be designed and operated to remove contaminated groundwater and to control any further migration

of contaminated groundwater toward other Saugus wells to the west. CLWA and the retail water purveyors then expect to be able to design and implement, alone or in concert with responsible parties, a contamination control and treatment program at or near their impacted wells that can, in part, make groundwater available for municipal or other beneficial use. They also expect that such a program will provide some hydraulic and associated water quality protection for other parts of the aquifer system to keep contamination from impacting other wells or other parts of the aquifers in which water supply wells might be completed.

Regarding the balance of the aquifer system, water supply planning to date (i.e. the current Urban Water Management Plan) includes expanded development of the Saugus Formation for dry-period and emergency water supply. Data development and control and treatment of groundwater contamination in the Saugus Formation will be critical to accomplishing that water supply plan. In terms of this groundwater management plan, accomplishment of this plan element will contribute to the accomplishment of all four management objectives (goals) for the basin.

Primary Element 9 - Development and Continuation of Local, State and Federal Agency Relationships

As the local SWP contractor, CLWA has long-established working relationships with local and state agencies that will continue on an ongoing basis. By nature of its primary function, CLWA will continue to interact with state agencies, most notably the Department of Water Resources, on the operation of the State Water Project. The latter, of course, has been the source of supplemental imported surface water that has made the initiation and continuation of conjunctive use operations possible since 1980. It will also be the primary component, with local groundwater, in continuation of conjunctive use operations in the future (Primary Element 5 of this Plan).

CLWA is the treated surface water provider to all the retail water purveyors, including Newhall County Water District, Los Angeles County Waterworks District No. 36, Valencia Water Company, and its own Santa Clarita Water Division. CLWA has a historical and ongoing working relationship with all those local agencies, as well as with other local groundwater pumpers, to manage water supplies to effectively meet water demands within the available yields of imported surface water and local groundwater. In fact, the Advisory Council convened to assist in the preparation of this Plan is comprised representatives of all the local water purveyors

and significant groundwater pumpers.

A local Memorandum of Understanding (MOU) process among CLWA, other purveyors within CLWA's service area, and United Water Conservation District (UWCD) in neighboring Ventura County is a classic illustration of a local agency relationship that has produced the beginnings of local groundwater management, now embodied in this comprehensive plan, most notably in Primary Elements 1 through 5. In 2001, out of a willingness to seek opportunities to work together and develop programs that mutually benefit the region as well as their individual communities, those agencies prepared and executed the MOU that initiated a collaborative and integrated approach to several of the aspects of water resource management that are now included in this Plan. UWCD manages surface water and groundwater resources in seven groundwater basins, all located in Ventura County, downstream of the East Subbasin of the Santa Clara River Valley that is the focus of this Plan. United is thus a logical partner in the cooperation of management efforts to accomplish the objectives (goals) for this basin, particularly as they relate to preservation of surface water resources that flow through the respective basins. As a result of that MOU, the cooperating agencies have integrated their database management efforts (part of Primary Elements 1 and 2 of this Plan), have initiated the development of a numerical groundwater flow model (for utilization in Primary Elements 3, 4 and 5 of this Plan), and are continuing to prepare reports on the status of basin conditions, as well as on geologic and hydrologic aspects of the overall stream-aquifer system.

A local extension of the interaction among CLWA, the retail water purveyors, and UWCD is an ongoing working relationship with the City of Santa Clarita. CLWA and the retail water purveyors meet regularly with City staff and also present water supply conditions via study sessions with the City Council on a routine basis. It is expected that the implementation of this Plan will result in the availability of a broader range of information transfer with the City relative to the existing and future water supply to its residents. An additional expectation of this Plan with respect to the relationship among CLWA, the retail water purveyors, and the City is the intent of CLWA and the purveyors to provide input to the City as a reviewer of proposed development relative to any potential contamination of groundwater associated with such proposed development. CLWA provides input to the City, as suggested in Water Code Section 10753.8, via review of land use plans and coordination with the City Planning Department to identify and assess any development-related activities which might pose a risk of groundwater contamination. By expressing this expectation of its groundwater management plan, CLWA is not intending to insert itself into the jurisdiction or authorization of any other land use permitting

agency; rather, CLWA is intending to provide review and input to the land use permitting process to protect the groundwater supply against any potential contamination that might occur as a result of any given development project.

This Primary Element is included in this Plan to formalize the historical local and state agency working relationships as part of comprehensively managing local groundwater, in concert with imported surface water and local recycled water, to accomplish all the management objectives (goals) for the basin.

Primary Element 10 - Groundwater Management Reports

As briefly described in the Introduction of this Plan, local groundwater management planning already includes, among several other activities, analysis of groundwater conditions and preparation of annual reports on groundwater and all other aspects of water resources and water supplies in the Santa Clara River Valley East groundwater basin. In addition, recently formalized cooperative work with neighboring UWCD includes both regular reporting on the status of groundwater conditions and specific reporting on geologic and hydrologic aspects of the overall stream-aquifer system. For example, documentation of the numerical groundwater modeling work currently in progress is expected to be the first of the latter reports in the next year.

Beginning in 1998, CLWA and the retail water purveyors in the basin have prepared a series of annual reports, known locally as the Santa Clarita Valley Water Report, to describe all aspects of water supply and water resource conditions in the basin. That report provides current information to local City and County land use agencies, and to other interested parties, about current water requirements, use of groundwater and treated imported surface water to meet those water requirements, groundwater conditions (pumping, groundwater levels and quality, etc.), local surface water conditions, the status of imported surface water supplies including details of delivered SWP water in the reported year as well as an up-to-date summary of available imported SWP water for the next year, a short-term projection of water requirements in the next year, and other appropriate details about water requirements and supplies such as, for example, the status of introducing recycled water as a component of non-potable water supply.

In light of the frequency and comprehensive nature of the annual Water Reports, and also in light of the planned preparation of more detailed technical reports on various aspects of the basin as appropriate, the continued preparation of those reports will serve as regular and

complete reporting on all aspects of this groundwater management plan.

Secondary Element 1 - Continuation of Public Education and Water Conservation Programs

CLWA has provided water conservation and public education programs that will continue and will be expanded as a complement to and an element of this groundwater management plan. The expansion of water conservation will largely stem from CLWA's having signed the "Memorandum of Understanding Regarding Water Conservation in California" (Urban MOU) in 2001, which made CLWA a wholesaler member of the California Urban Water Conservation Council. CLWA has thus committed to implementation of cost-effective water conservation measures known as Best Management Practices (BMPs) that are included in the Urban MOU and are intended to reduce California's long-term urban water demands. The BMPs have been incorporated into the water demand management measures section of the Urban Water Management Planning Act.

Water conservation and related public education measures have generally been developed in California to achieve the following goals:

- meet legal mandates
- reduce average annual potable water demands
- reduce sewer flows
- reduce water demands during peak seasons
- meet drought restrictions.

As a wholesaler of imported surface water CLWA has implemented the following BMPs for several years prior to signing the MOU:

- distribution system water audits, leak detection and repair
- public information
- school education
- wholesale agency assistance
- conservation pricing
- conservation coordinator.

As a signatory to the MOU, CLWA's water conservation and public education program will expand to include the following BMPs found to be locally cost-effective, as detailed in the 2000 Urban Water Management Plan for CLWA and the Santa Clarita Valley retail purveyors.

- water survey programs for single-family residential and multi-family residential programs
- residential plumbing retrofits
- metering with commodity rates for all new connections and retrofit of existing connections
- large landscape conservation programs and incentives
- high-efficiency washing machine rebate programs (when also provided by local energy providers or wastewater utilities)
- conservation programs for commercial, industrial, and institutional accounts
- wholesale agency programs to financially or otherwise support water conservation efforts by retailers (this measure will be expanded)
- residential ultra-low-flow toilet replacement program.

This Secondary Element, while identical to independent CLWA efforts in water conservation and public education, is incorporated in this Plan to complement other Plan elements, and to move toward accomplishment of all management objectives (goals) for the groundwater basin.

Secondary Element 2 - Identification and Management of Recharge Areas and Wellhead Protection Areas

The 1986 Amendments to the federal Safe Drinking Water Act (SDWA) established a new Wellhead Protection Program (WPP) to protect groundwater that supplies drinking water wells for public water systems. Each state was required to prepare a WPP and submit it to the USEPA by June 19, 1989. However, California did not develop an active state-wide Wellhead Protection Program at that time. Subsequently, in 1996, reauthorization of the SDWA established a related program called the Source Water Assessment Program. In 1999, the California Department of Health Services (DHS) Division of Drinking Water and Environmental Management developed its Drinking Water Source Assessment Program (DWSAP), and EPA approved it. The overall objective of the DWSAP is to ensure that the quality of drinking water sources is protected.

As discussed in Section 1 of this Plan, the potential groundwater management plan component

"identification and management of wellhead protection areas and recharge areas" is stated, even in the most recently amended version of Water Code Section 10753.8, as one that "may" be included. However, the wellhead protection aspect of this component, which was optional when AB 3030 was adopted, is now essentially required as a result of the 1996 SDWA reauthorization. In California, the DWSAP satisfies the mandates of both the 1986 and 1996 SDWA amendments. The California DWSAP includes delineation of the areas (i.e., protection areas or Groundwater Protection Zones) surrounding an existing or proposed drinking water source where contaminants have the potential to migrate and reach that source. The program includes preparation of an inventory of activities that may lead to the release of contaminants within these zones. The activities, referred to in the DWSAP as Potentially Contaminating Activities, include such land uses as gas stations and dry cleaners, as well as many other land uses. The activities also include known contaminant plumes regulated by local, state, and federal agencies. The zones, which are calculated based on local hydrogeological conditions and also well operation and construction parameters, represent the approximate area from which groundwater may be withdrawn during 2, 5, and 10 year time periods. These zones also represent the area in which contaminants released to groundwater could migrate and potentially affect the groundwater extracted by wells located within the designated zones. The DWSAP assessment also includes a risk or vulnerability ranking based on a combined numerical score that results from points assigned to various evaluations conducted as part of the DWSAP process. This ranking provides a relative indication of the potential susceptibility of drinking water sources to contamination.

Although DHS is responsible for conducting drinking water source assessments for systems existing prior to the adoption of the California program, DHS has encouraged purveyors to perform their own assessments. Assessments for existing systems were due at the end of 2002; however, DHS received an extension allowing its assessment work to be completed by May 2003. Permitting of a new water supply well requires that a DWSAP be completed as part of the permit process, and this is responsibility of the applicant. Within CLWA, DWSAP assessments have been completed for the three municipal water purveyors who utilize groundwater for some of their water supply, including 15 for the CLWA Santa Clarita Water Division, 20 for Valencia Water Company, and 13 for Newhall County Water District.

The results of the DWSAPs can be used as a planning tool to guide land use development in the vicinity of water sources. The DWSAPs prepared for water sources in the basin should, in some fashion, be reviewed every five years and updated more frequently as appropriate. The collective DWSAP information can also be integrated with other management activities (e.g., the

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geographical position of potential or existing contaminating activities can be incorporated in the monitoring program database; plume extents, as available, can be graphically displayed by aquifer and isoconcentrations) to aid siting of new wells, particularly when contaminant migration problems are also evaluated with respect to local hydrogeological conditions and the potential influence of nearby wells on plume migration.

In addition to the wellhead protection program that is focused on wells that are sources of drinking water, a broader aspect of this Plan Element is protection of the overall recharge areas of the aquifer system in the basin. As discussed in Section III, the most developed aquifer, the Alluvium, has experienced historical fluctuations in groundwater levels in the eastern portion of the basin, but has had essentially constant groundwater levels in the western portion of the basin. The characteristic difference between the two portions of the basin, generally divided at the confluence of the Santa Clara River and its Bouquet Canyon tributary, is the perennial flow in the Santa Clara River to the west of that location versus the intermittent flow in the river to the east. The intermittent fluctuations in groundwater levels east of Bouquet Canyon are indicative of rapid response, i.e. recharge, from streamflow when it is present. Similarly, the relatively constant groundwater levels west of Bouquet Canyon are indicative of ongoing response, i.e. recharge, from the perennial flow in the river. In light of those conditions, part of this Plan Element is intended to protect the overall channel system of the Santa Clara River and its tributary system, notably where they overlie Alluvial aquifer materials of significant extent. Protection in this case is intended to mean preservation of the infiltration capacity of the stream channel so that both intermittent and perennial flows can continue to recharge the aquifer as has historically occurred.

Finally, with regard to protection of recharge areas, it is expected that additional exploration and development of the Saugus Formation, for additional water supply as described in this Plan, will lead to further understanding of the locations and mechanisms for recharge of that aquifer, which is exposed at the surface throughout much of the area of this Plan. As that understanding evolves, part of this Plan Element will be to identify means of ensuring that significant portions of Saugus recharge are not compromised by land development activities.

This Plan Element is included to incorporate the DWSAP efforts and the overall protection of groundwater recharge into the local groundwater management plan. Completion of DWSAP efforts to comply with state DHS requirements and preservation of overall aquifer recharge are key parts of accomplishing the first and third management objectives (goals) for the basin.

Secondary Element 3 - Identification of Well Construction, Abandonment, and Destruction Policies

Well construction permitting in the basin is administered by the Los Angeles County Health Department, which effectively implements the State Well Standards for water wells, monitoring wells, and cathodic protection wells. Permitting of municipal supply wells is also within the purview of the State Department of Health Services. One goal of this management plan for the area, protection and preservation of groundwater quality requires that all wells be properly constructed and maintained during their operational lives, and properly destroyed after their useful lives, so that they not adversely affect groundwater quality by, for example, serving as conduits for movement of contaminants from the ground surface and/or from a poor quality aquifer to one of good quality. Toward that end, this element is included in the overall plan to support well construction and destruction policies, and to participate in their implementation in the Basin, particularly with regard to surface and inter-aquifer well sealing and proper well destruction, which are critical in the management of a multiple aquifer system that has some connection with the Santa Clara River and its tributaries.

Secondary Element 4 - Provisions to Update the Groundwater Management Plan

The primary and secondary elements of this local area groundwater management plan reflect the current understanding of the occurrence of groundwater in the Santa Clara River East Valley groundwater subbasin, and specific problems or areas of concern about that resource. Those management elements are designed to achieve specified goals to develop local groundwater for regular and dry year/emergency water supply while protecting and preserving groundwater quantity and quality for overlying beneficial use into the foreseeable future, and while also protecting and preserving valuable surface water resources that are directly related or connected to groundwater. While the groundwater management plan provides a framework for present and future actions, new data will be developed as a result of implementing the plan. That new data could define conditions which will require modifications to currently definable management actions. As a result, this plan is intended to be a flexible document which will be reviewed and updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future groundwater and surface water conditions. Although not intended to be a rigid schedule, review and updating of this plan will initially be conducted in five years, with subsequent future updates scheduled as appropriate at that time. In accordance with Primary Element 10, the retail purveyors and CLWA will continue to produce the Santa

Clarita Valley Water Report on an annual basis. Data and information from these reports will be compiled and utilized as part of the review and updating of this plan.

Appendix I

Groundwater and Surface Water Monitoring Protocols

The CLWA Groundwater Management Plan includes two Elements (Primary Elements 1 and 2) that relate directly to ongoing, and expanded as appropriate, monitoring of key hydrologic quantities associated with the implementation of the Plan. Notable among the data to be collected are groundwater levels, groundwater quality, pumpage from water supply wells, and surface water flows and quality. Other hydrologic data such as precipitation are intended to be measured and maintained in accordance with the standards in place for the respective precipitation gage stations in the Valley; consequently, this Appendix does not address the specific establishment of protocols for precipitation gaging. On another matter of hydrologic data, land subsidence, the Plan discusses the low probability for subsidence in the Valley, particularly as related to historical groundwater pumping from both the Alluvial and Saugus Formation aquifers. Consequently, the Appendix does not address the establishment of protocols for measuring land subsidence. As noted in the Plan, if future analysis of increased pumping from the Saugus Formation, as currently planned, suggests changes in groundwater levels that might be conducive to inelastic subsidence, the need for subsidence monitoring will be reconsidered at that time; and some combination of land surface elevation surveying, remote sensing of land surface deformation, and measurement of earth consolidation via extensometers would be considered as part of establishing protocols for monitoring subsidence.

Groundwater Monitoring

For purposes of Plan implementation, the most essential groundwater-related data are water levels, water quality, and pumpage. Consequently, the following discussion of monitoring protocols focuses on those hydrologic parameters.

Groundwater Levels - The distribution and frequency of current groundwater level measurements in Alluvial wells and in Saugus Formation wells are illustrated in Figures A1 and A2, respectively. Tables A1, A1a and A2 show the dates that groundwater level measurements were made in Alluvial and Saugus Formation wells. As discussed in the Plan, for the Alluvium, the distribution of monitoring is sufficient to interpret water level and groundwater storage trends. Thus, it is intended that the fundamental distribution and frequency of Alluvial groundwater level measurements remain generally as illustrated in Figure A1: general semi-annual measurements complemented by some quarterly measurements dispersed throughout the Alluvial aquifer. The only exception to the preceding intention is in the western-most portion of the Alluvium, where agricultural pumping remains the water supply objective and water level measurements are primarily annual. In part to conform to the balance of Alluvial groundwater

level measurements, and more importantly to monitor stream-aquifer connection near the western, or downgradient, end of the Alluvium in the basin, it is the intent of Plan implementation to increase that water level monitoring to semi-annual to quarterly frequency.

In the Saugus Formation, the distribution of groundwater level measurements is limited by the number and location of wells; the locations in Figure A2 reflect where the Saugus has been developed for water supply. Ultimately, as future exploration and development of the Saugus expand, it is expected that the distribution of groundwater level measurements will expand to those future well locations. For Plan implementation purposes, the existing monthly frequency of water level monitoring is intended to continue.

Water level measurement methodology, which is dominated by utilization of electric sounders, is expected to remain largely unchanged. Some calibrated airlines and possibly some dedicated electro-hydraulic transducers are expected to complement electric sounders in certain wells. All those water level measurement methods are sufficiently accurate to satisfy the needs to which the resultant data is to be put.

Groundwater Quality - The distribution and frequency of current groundwater quality monitoring in Alluvial wells and in Saugus Formation wells are illustrated in Figures A3 and A4, respectively. Tables A3 and A4 show the dates that groundwater quality (total dissolved solids) was monitored in Alluvial and Saugus wells. For the most part, the distribution and frequency of water quality sampling are sufficient to interpret general quality trends. One notable constraint in the Alluvium, however, is the discontinuation of water quality data collection in some wells since 1988, mostly toward the western, or downgradient, end of the basin. In order to restore an ongoing historical record, part of Plan implementation will be to attempt to re-establish regular, i.e. yearly to triennial, water quality sampling and analyses in those wells with some form of historical water quality record. In the same vein, part of Plan implementation will include selection of a number of wells in key locations, e.g. near the mouths of canyons, for semi-annual analysis of indicator parameters as a basis for assessing seasonal or other variations in groundwater quality.

Finally with regard to groundwater quality, the spatial limitations on Saugus water quality data are comparable to the limitations related to Saugus groundwater levels, but as a result of the limited, localized development of the Saugus for water supply. While the regular monitoring of quality will continue via Plan implementation, the expansion of Saugus water quality data is expected to follow the expanded exploration and development of that aquifer as described for

groundwater levels above.

Production (Pumpage) - The great majority of water supply wells in the basin are now dedicated to municipal supply; consequently, those wells are equipped with production meters which allow direct monitoring of pumpage on any desired frequency, e.g. instantaneous flow rate, or cumulative volumes on a daily, monthly, or other frequency. A few wells remain dedicated to agricultural water supply, and those wells are not equipped with flow meters. However, long-standing practice at all those wells has been to meter power consumption for each well and to combine that data with the results of annual pump performance testing in order to indirectly compute approximate pumpage from each agricultural well. That methodology is sufficiently accurate for ongoing documentation of pumpage and interpretation of basin response to pumping; it is also sufficiently accurate for groundwater flow model input as part of assessing basin yield, all as part of this Plan. Consequently, implementation of this Plan includes regular reading of flow meters on municipal supply wells and continued indirect computation of agricultural pumpage from the remaining agricultural water supply wells in the basin.

Surface Water Monitoring

Part of Plan implementation is the development of a surface water quality monitoring network. Of particular concern is establishing a surface water quality data set that, combined with groundwater data, will allow for a more detailed analysis of stream-aquifer interactions. The data of primary interest for this and other Plan purposes are surface water flow and surface water quality, discussed below.

Surface Water Flow - The existing surface water flow monitoring network within the basin consists of stream flow gaging stations along the Santa Clara River and its tributaries, and measurements of discharge to the River from the Saugus and Valencia Water Reclamation Plants. Monitoring of stream flow gages along the River and its tributaries has been mostly sporadic and limited to times prior to 1977, although measurements at some gages resumed in 2002. One exception is the gage at the Los Angeles-Ventura County line, where the daily mean stream flow was monitored from 1953 to 1996; the gage was replaced with one downstream near Piru in 1996. The Los Angeles County Sanitation Districts monitors the average discharge flow of treated wastewater from the Saugus and Valencia Water Reclamation Plants to the Santa Clara River.

Plan implementation will include evaluating the distribution, future accessibility and

configuration of the existing stream flow gaging stations to determine if they will be suitable for inclusion in the ongoing surface water flow monitoring network. Plan implementation will further include installation and operation of gage station modifications, as well as installation and operation of additional dedicated gaging stations as determined to be required.

Surface Water Quality - Surface water quality has been analyzed at many locations along the Santa Clara River and its tributaries but, with few exceptions, the data is limited to several measurements at each location. Water quality in the Santa Clara River at the Los Angeles-Ventura County line was analyzed on a semi-annual basis from 1951 to 1988, and is currently measured quarterly by United Water Conservation District. Since 2002, the Los Angeles County Department of Public Works has monitored water quality in the Santa Clara River near Interstate 5 during four wet weather events and at two other times each year to comply with the requirements of a National Pollution Discharge Elimination System (NPDES) permit that covers the County and 84 incorporated cities. The Saugus and Valencia Water Reclamation Plants also monitor the quality of the treated wastewater they discharge to the Santa Clara River as part of compliance with the requirements of their NPDES permits

Plan implementation will include identifying key locations for future surface water quality monitoring, identification of constituents of concern and monitoring frequency for each location, and implementation of appropriate sampling and analytical methodology at the selected key sites.

Table A1
Dates of Historic Water Level Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

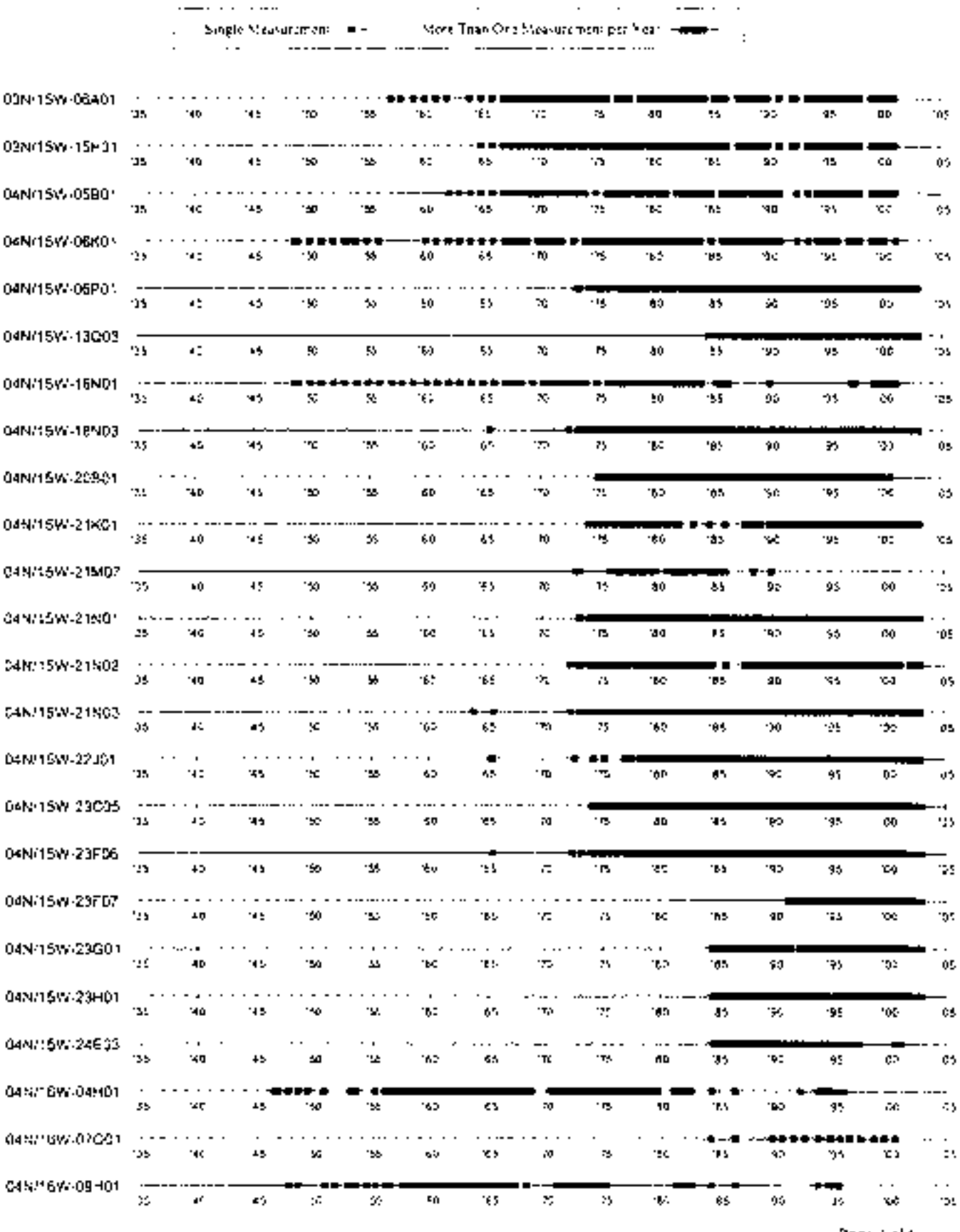


Table A1 - Continued
Dates of Historic Water Level Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

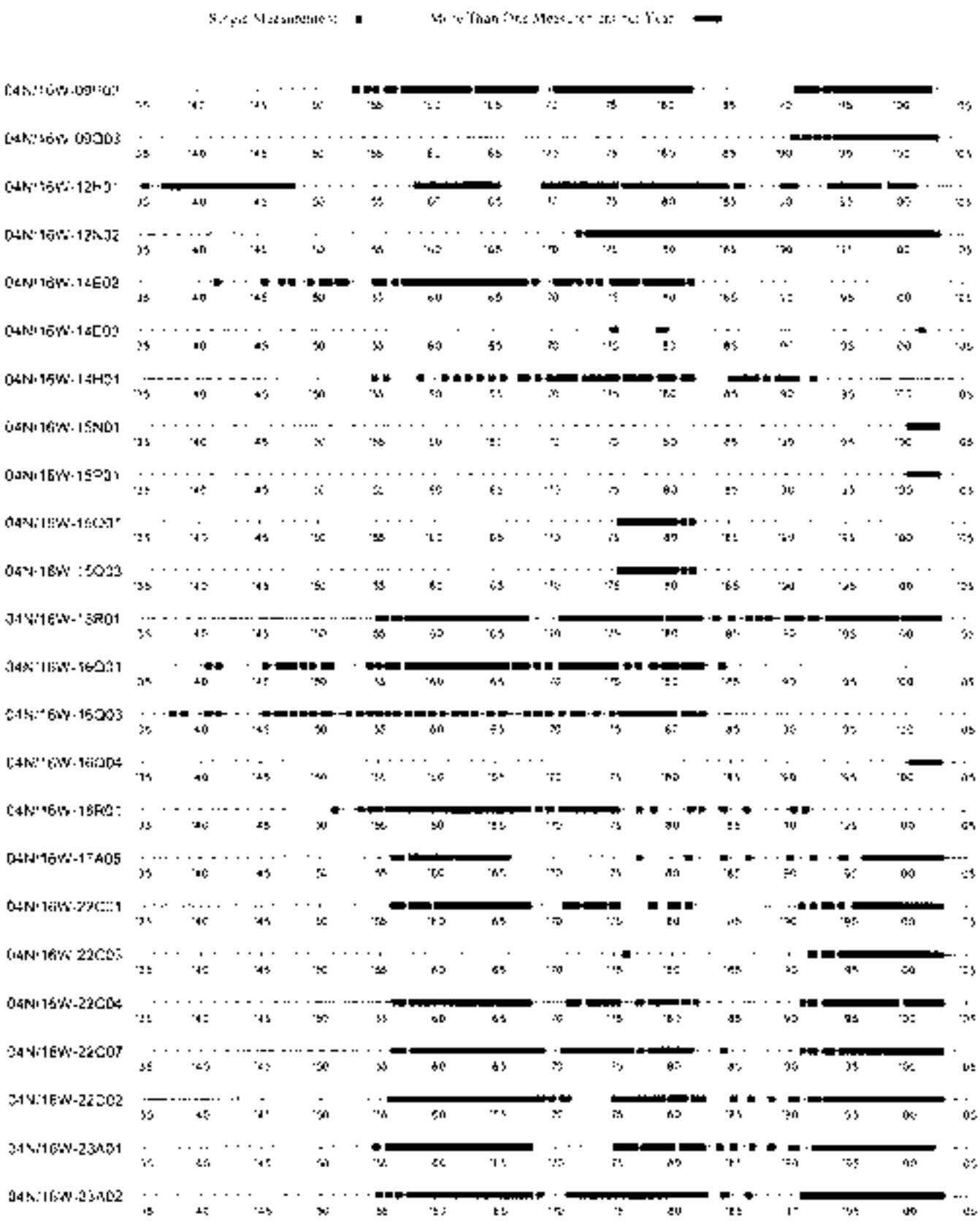


Table A1 - Continued
Dates of Historic Water Level Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

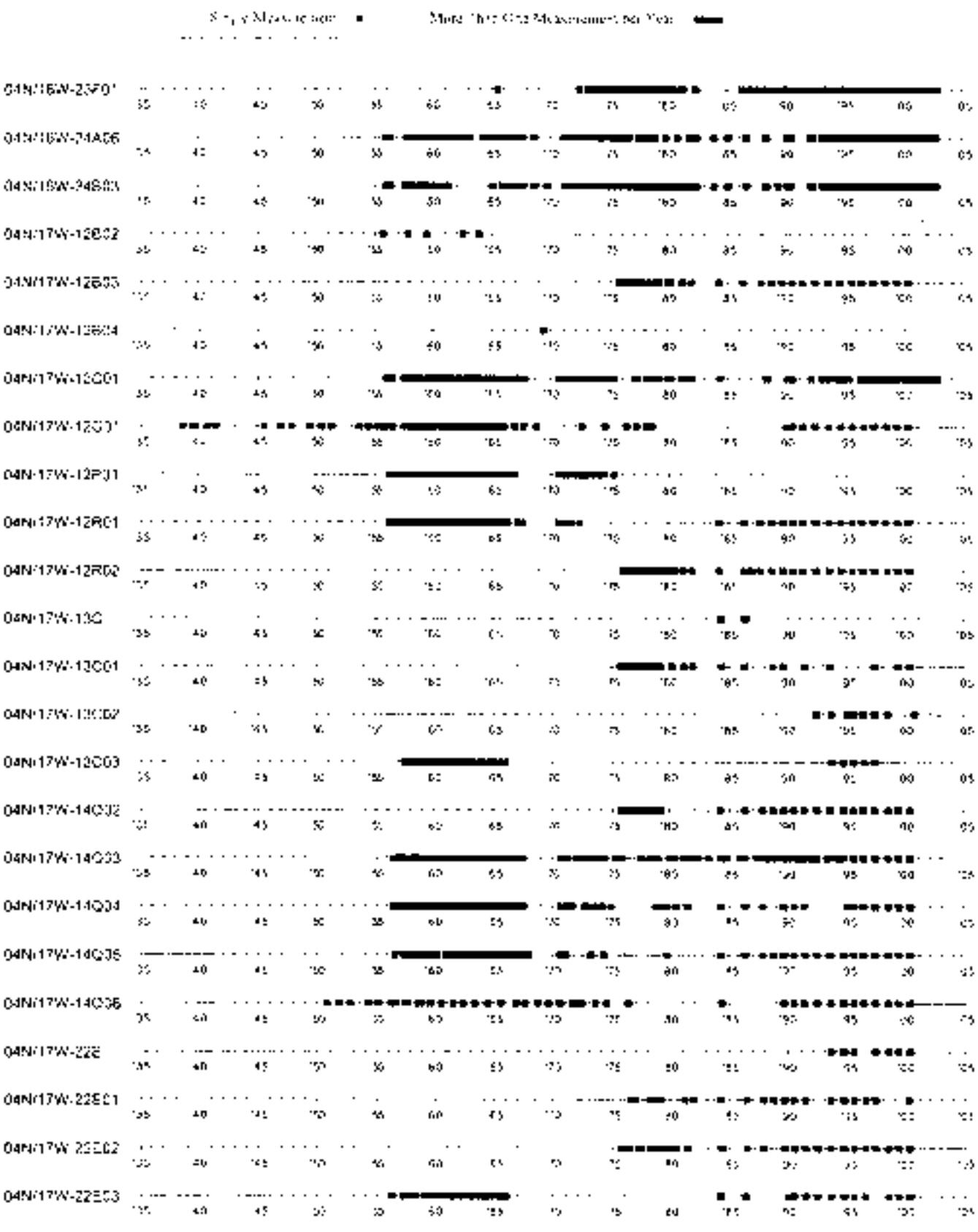


Table A1 - Continued
Dates of Historic Water Level Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

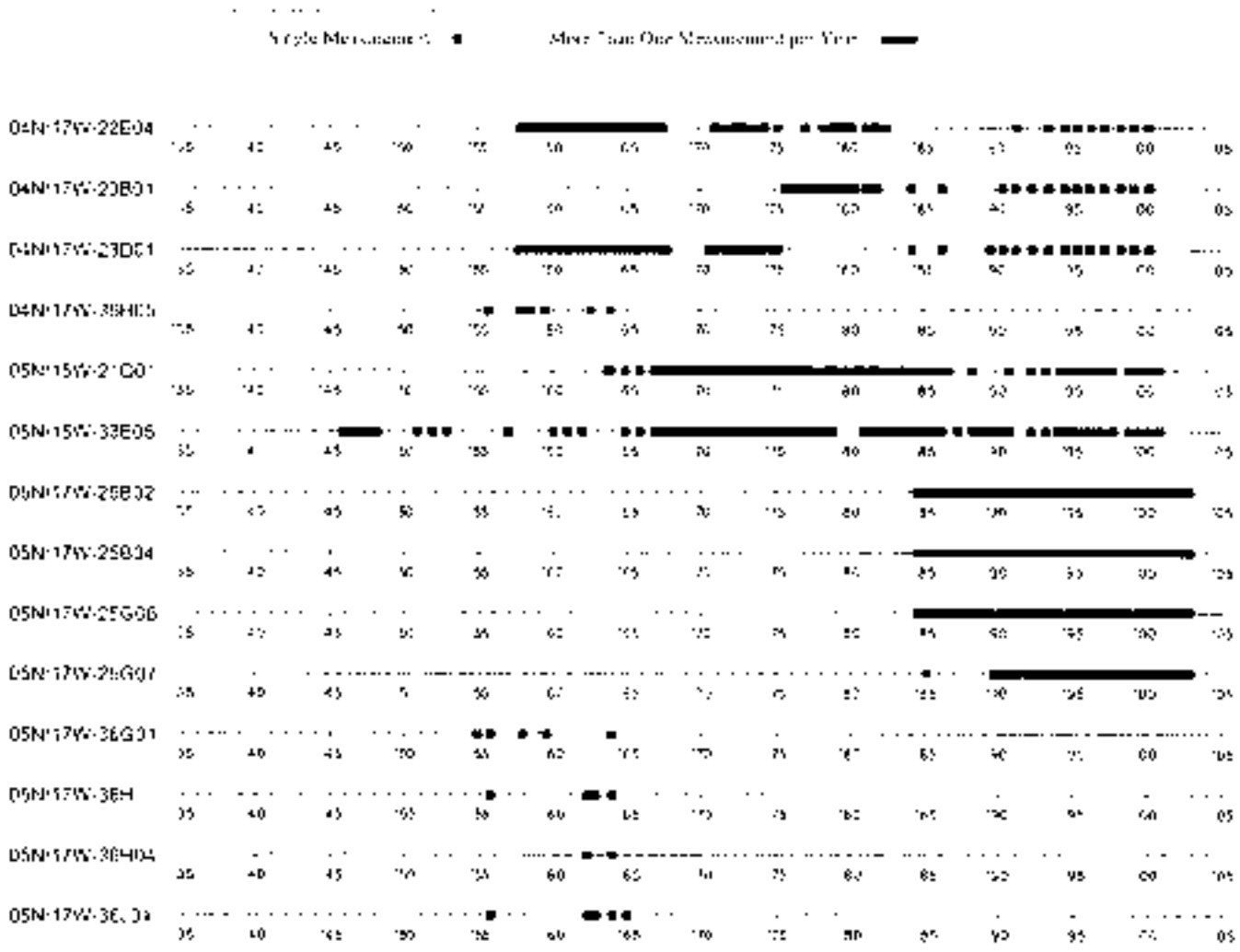


Table A1a
Dates of Historic Water Level Measurements in LACFCD Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbbasin

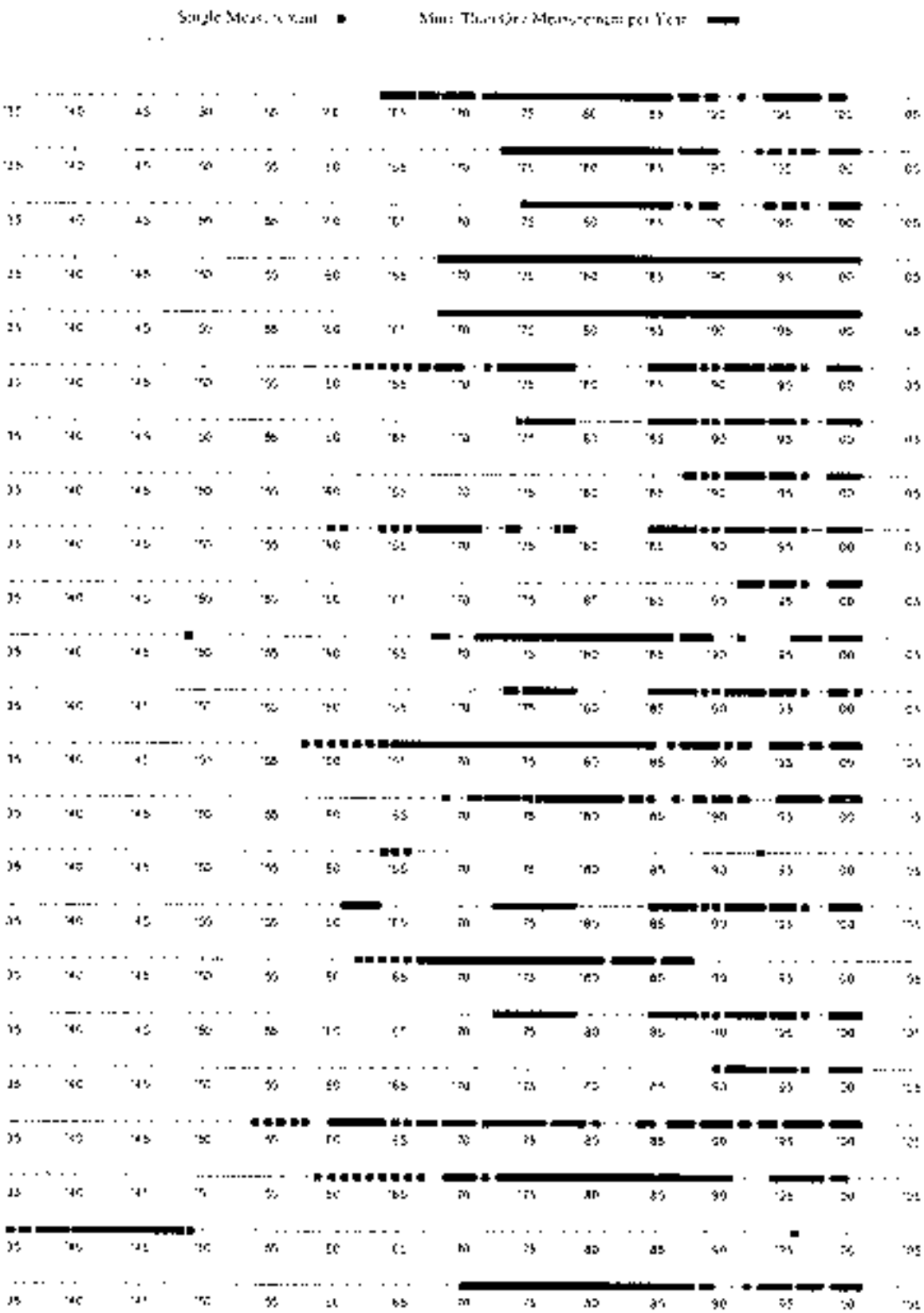


Table A1a - Continued
Dates of Historic Water Level Measurements in LACFCD Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

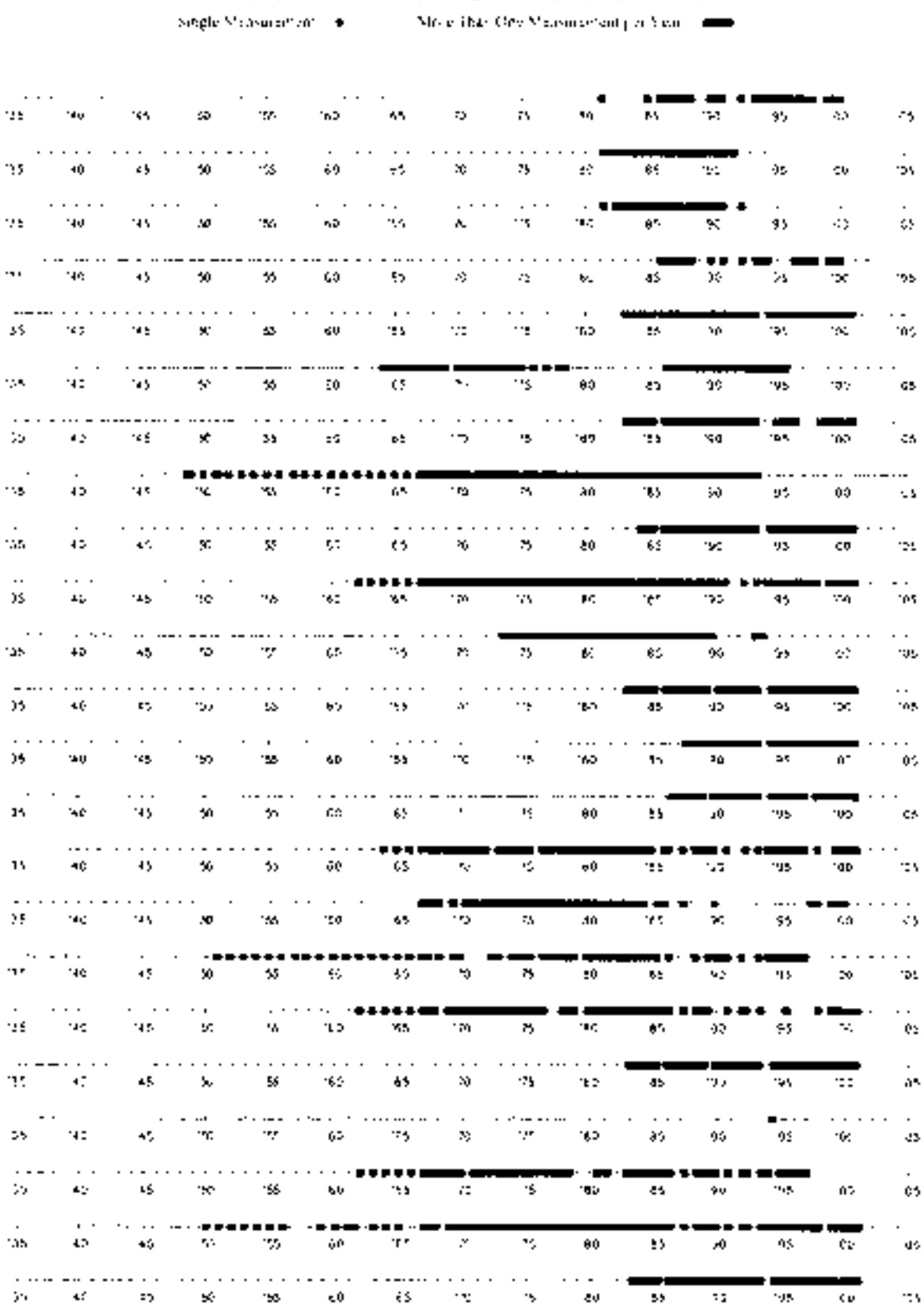


Table A1a - Continued
Dates of Historic Water Level Measurements in LACFCD Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

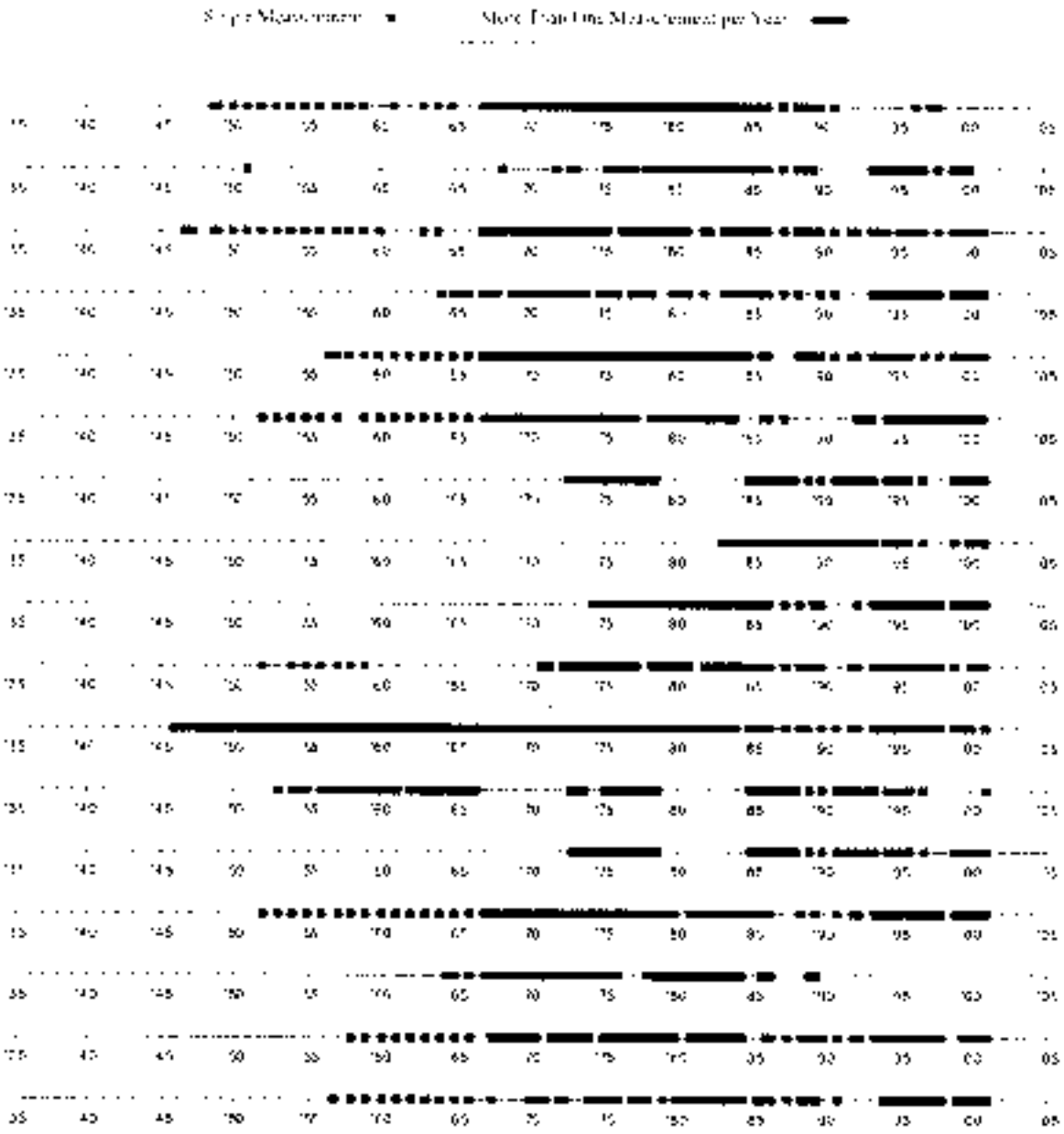


Table A2
Dates of Historic Water Level Measurements in Singles Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

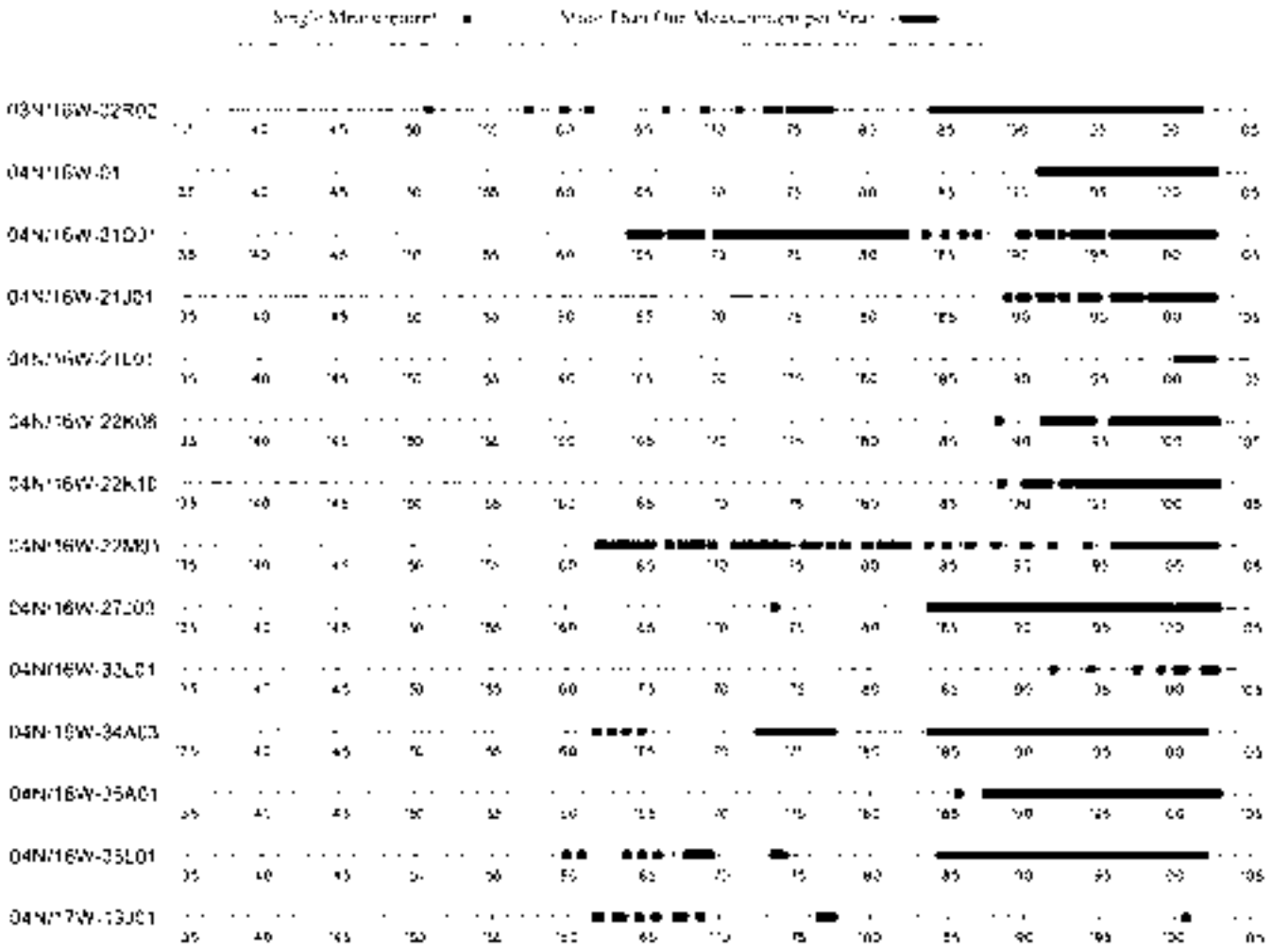


Table A3

Dates of Historic Water Quality Measurements (TDS) in Alluvial Wells

Santa Clara River Valley Groundwater Basin, East Subbasin

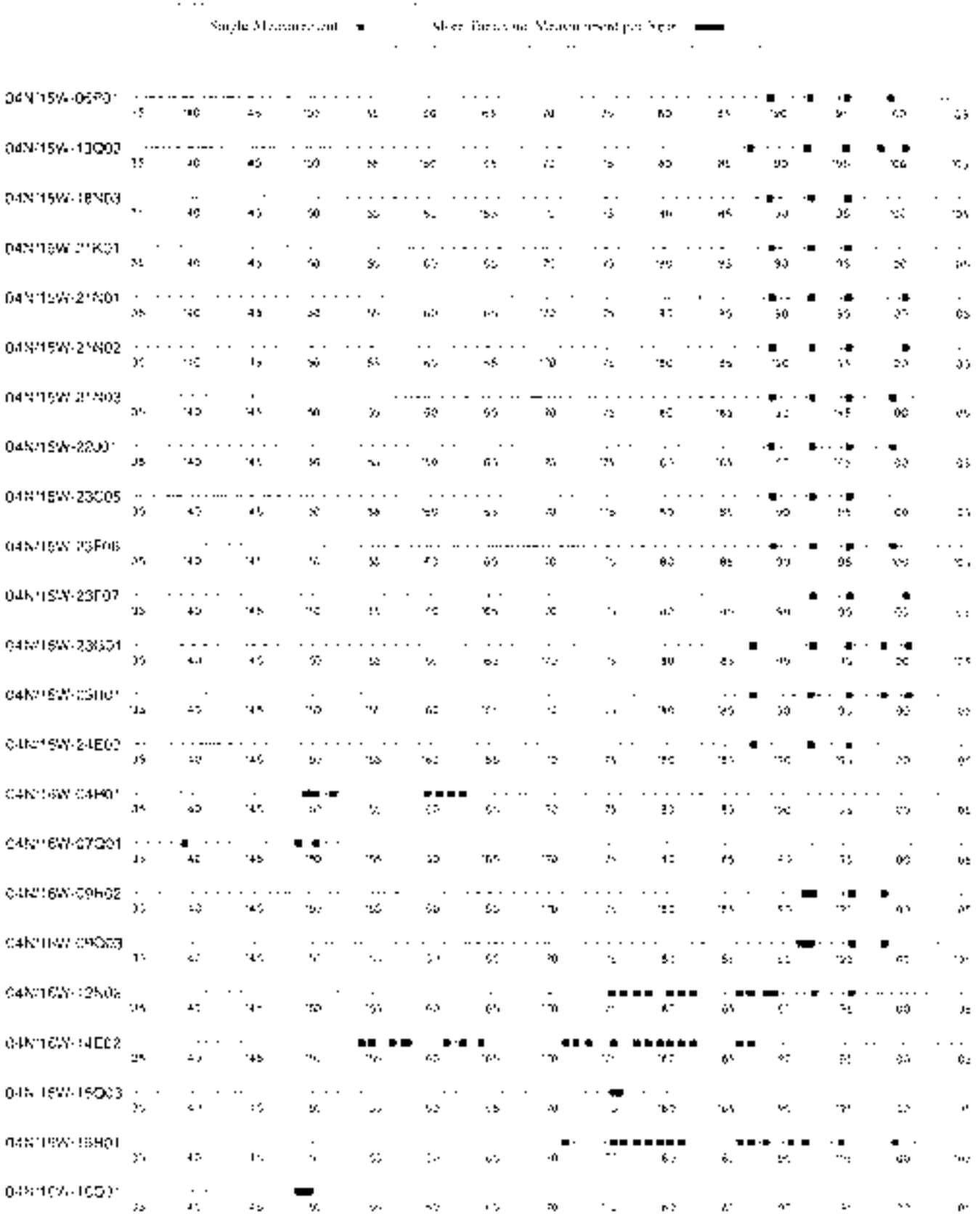


Table A3 Continued
Dates of Historic Water Quality Measurements (TDS) in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

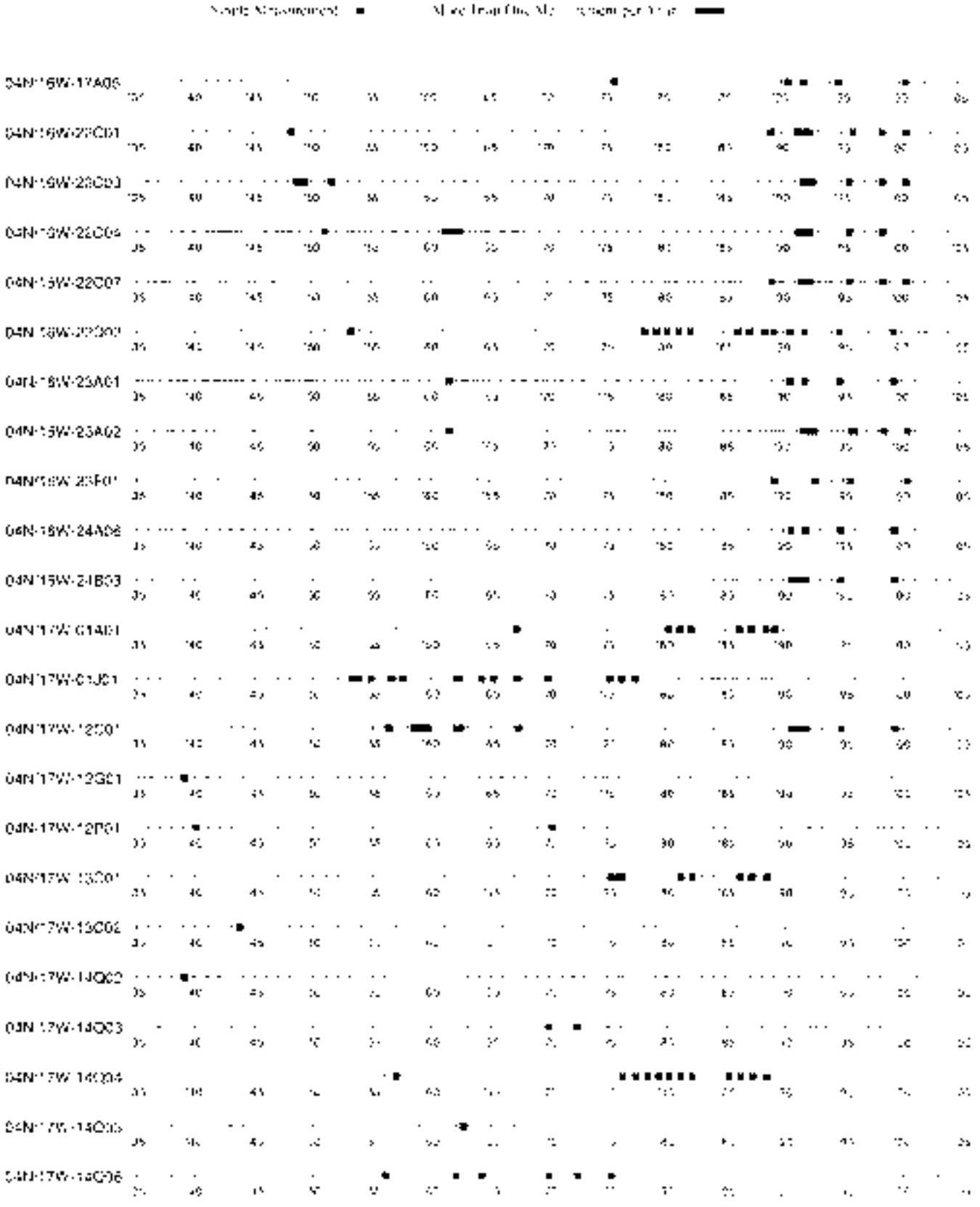


Table A3 - Continued
Dates of Historic Water Quality Measurements (TDS) in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

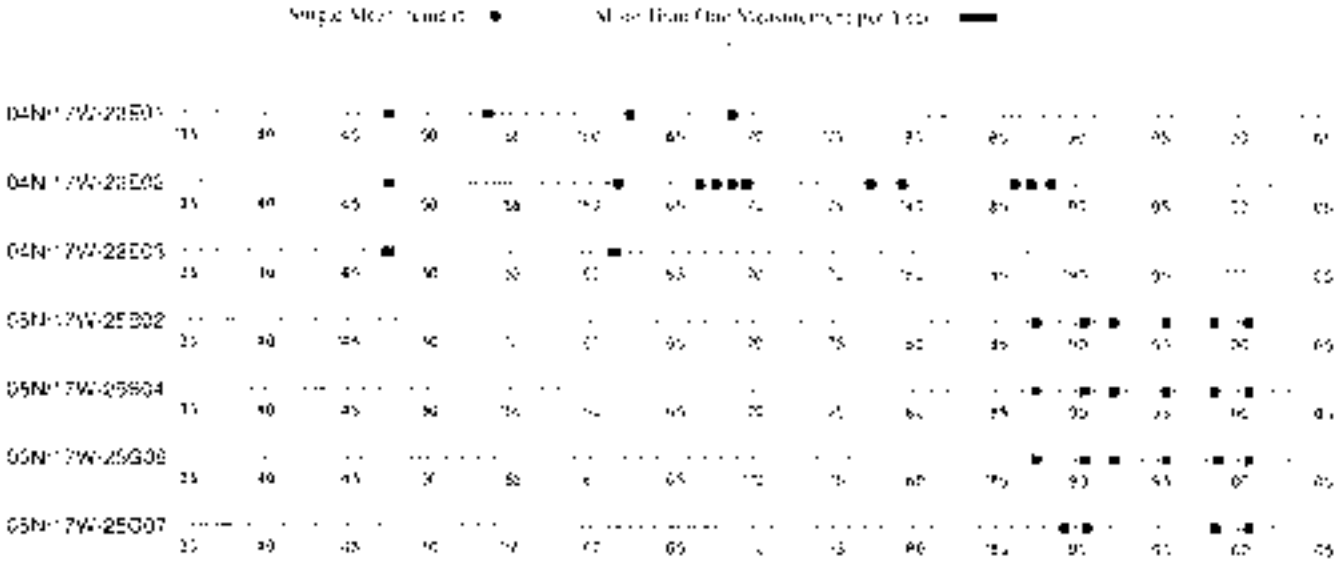
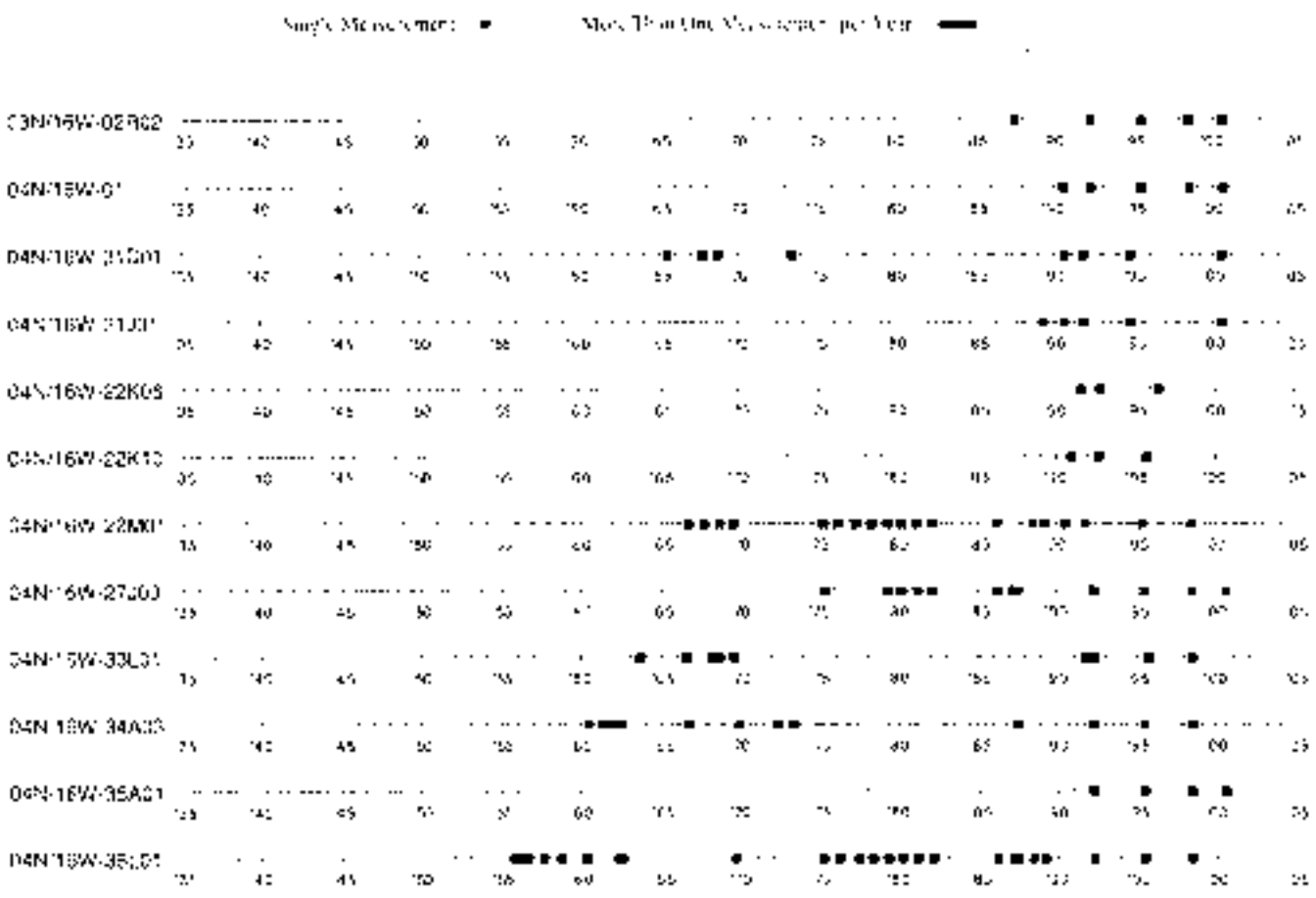


Table A4
Dates of Historic Water Quality Measurements (TDS) in Stagtes Wells
Santa Clara River Valley Groundwater Basin, East Subbasin



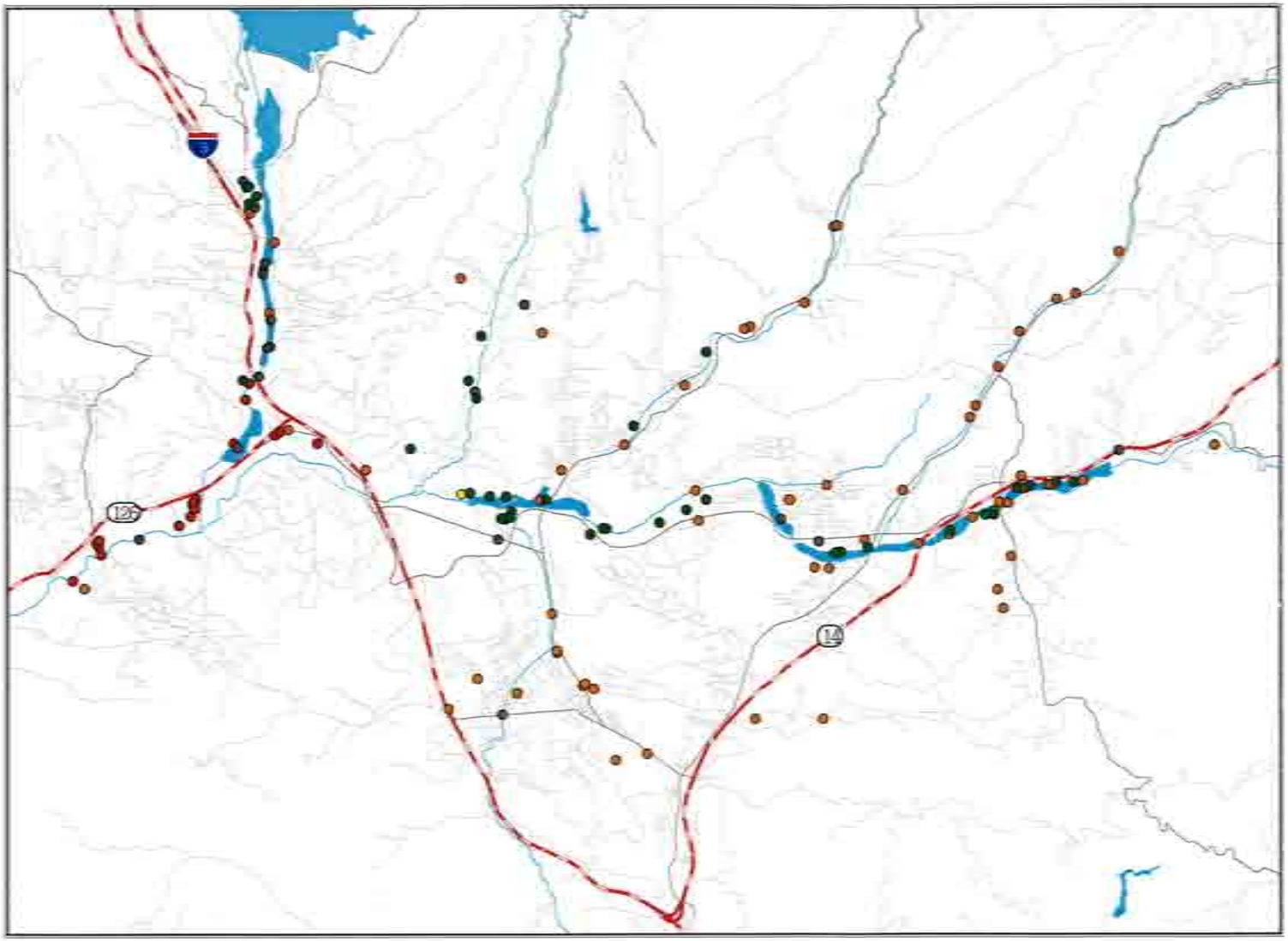


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Figure A1
Frequency of Water Level Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

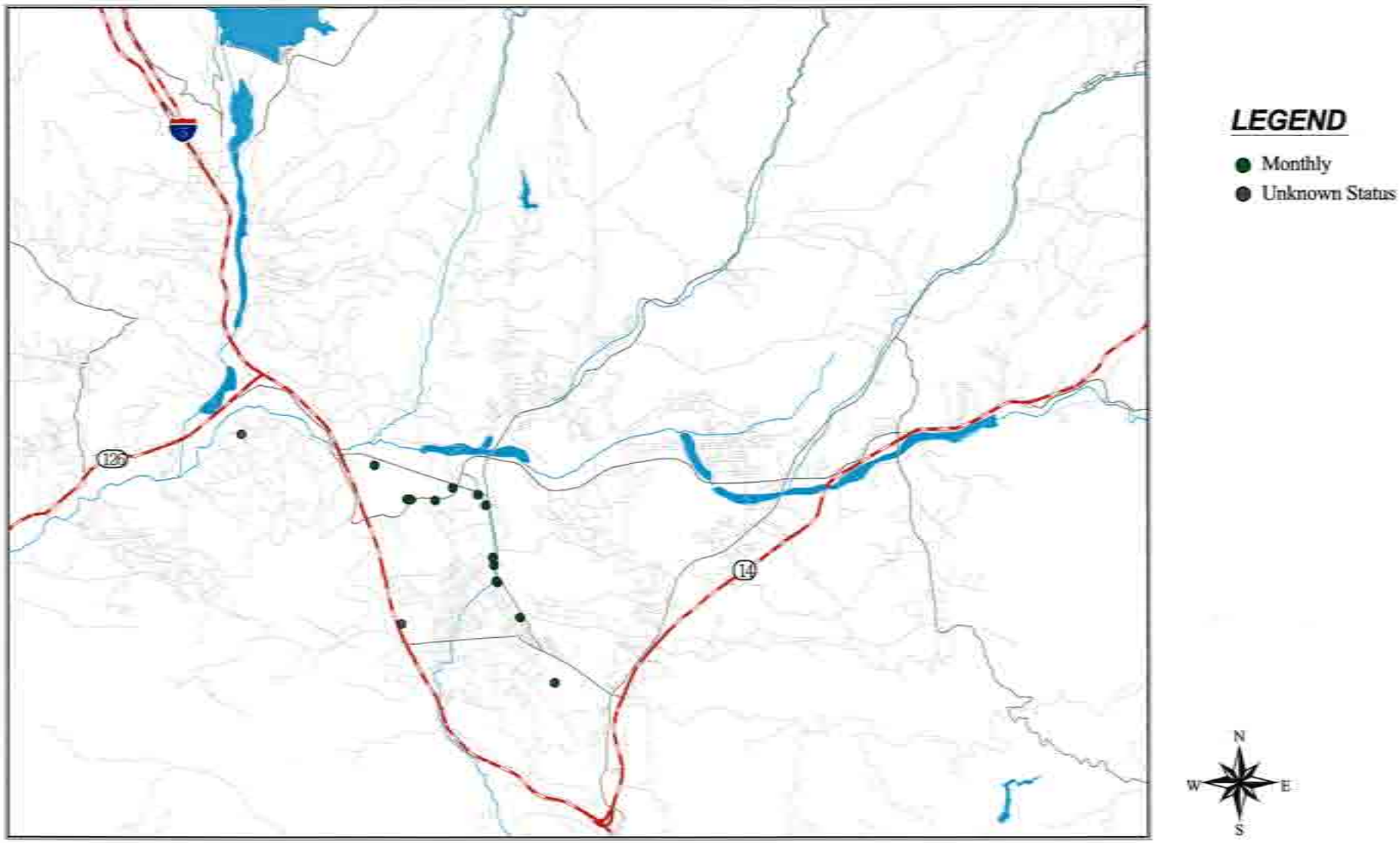

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Figure A2
Frequency of Water Level Measurements in Saugus Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

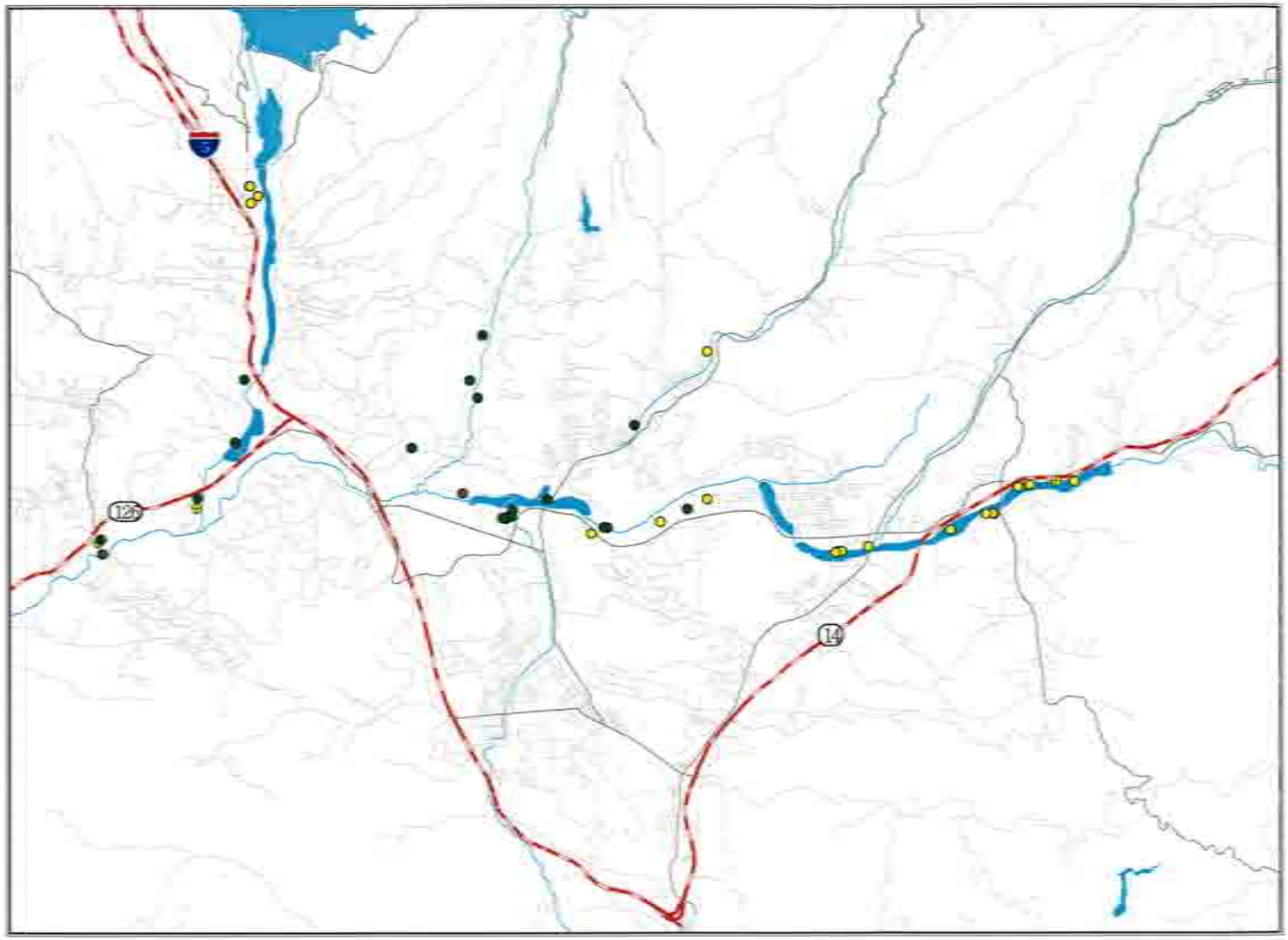

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Figure A3
Frequency of Water Quality Measurements in Alluvial Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

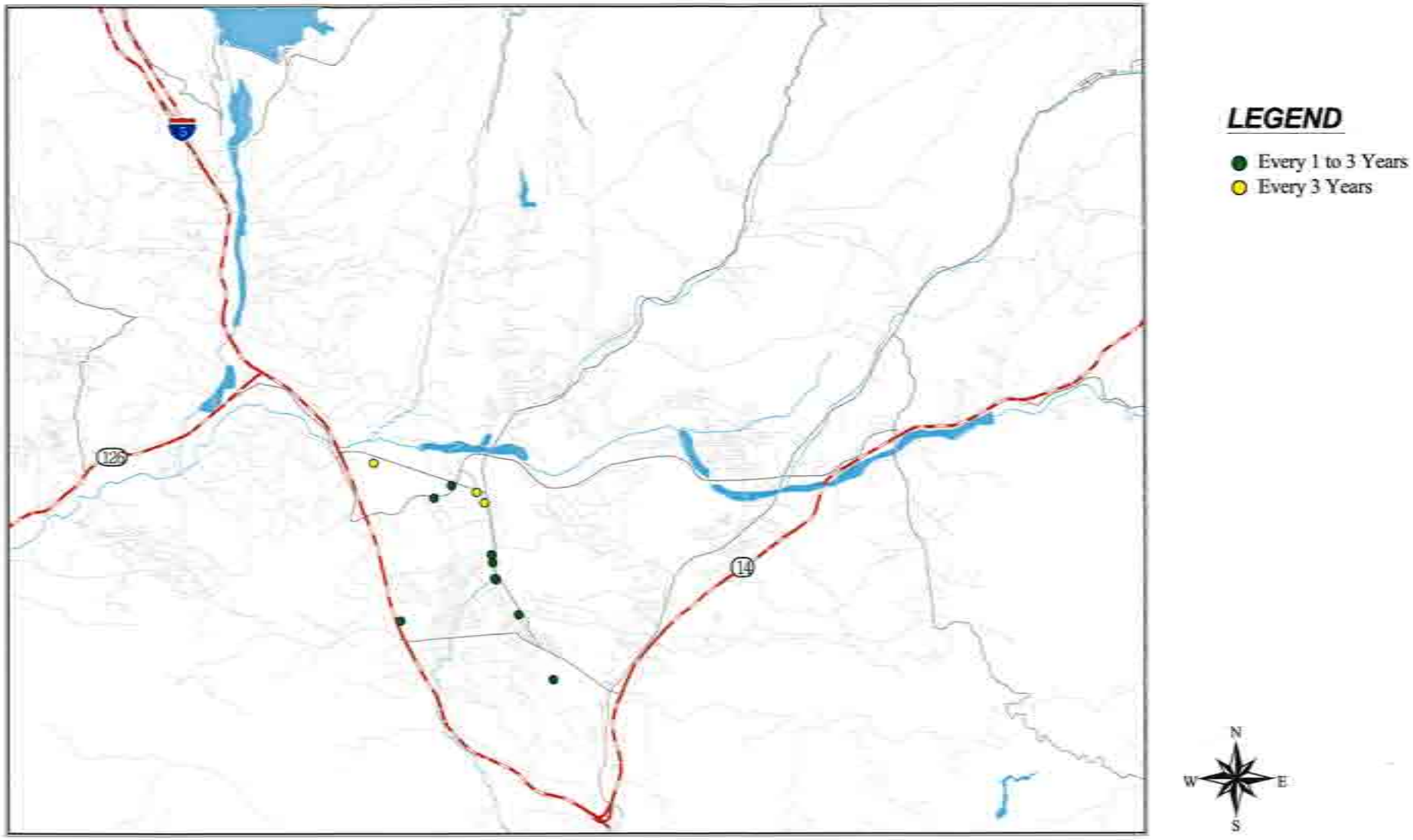

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Figure A4
Frequency of Water Quality Measurements in Saugus Wells
Santa Clara River Valley Groundwater Basin, East Subbasin

Appendix II

Groundwater Management Plan
Public Comments

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
UWCD #5	Under Primary Element 2 related to surface flows, in addition to SWP water contributing to the increased flow of the Santa Clara River, other considerations should be noted (hydrologic cycle, Alluvial pumping).	Primary Element 2	As noted above, discussion of groundwater related conditions is included in the Plan as a frame of reference for the Plan objectives and elements. Future interpretation and reporting will take such details as the impacts of the hydrologic cycle and Alluvial pumping into account.
Santa Clarita Organization for Planning and the Environment #1	Extensive pumping and lack of protection of recharge areas have resulted in almost complete elimination of surface flows and summer ponding necessary to wildlife as well as causing water level drops in wells that have resulted in water quality and availability problems for small users.	Section III (Groundwater Levels and Storage) and (Groundwater Quality) and Primary Elements 1, 2 and 3	See responses to SCOPE Comments 5, 6 and 9, Sand Canyon Comments 1 and 7, and Sierra Club Comment 3 regarding pumping within basin yield, avoidance of overdraft, preservation of recharge areas, and consideration of riparian conditions.
SCOPE #7	Concern that environmental organizations, small well owners, City of Santa Clarita, LA County, and others were not included on the Advisory Board.	Water Code Appendix § 103-15.1(e)(2)	CLWA legal counsel has confirmed that CLWA complied with the requirements of AB 134 regarding the composition of the Advisory Council. LA County was represented by LA Co. WWD #36 and LA County Sheriff's Department.
SCOPE #3	The GWMP should include a timeline for completion of the plan components.	AB 3030[2] and AB 134[3]	AB 3030 and AB 134 do not require the inclusion of a timeline.
SCOPE #4	The GWMP is lacking in the review of land use plans and coordination with land use agencies. Land use issues should be given higher priority. This may include a wellhead protection plan.	Water Code § 10753.8(f), Primary Element 9 and Secondary Element 2	Primary Element 9 and Secondary Element 2 have been expanded to further address general preservation of recharge areas and appropriate review of land use plans to protect against potential groundwater contamination.
SCOPE #5	GWMP should address maintaining tributaries in a natural state to enhance water recharge and quality.	This is not explicitly required by AB 3030 but does relate to Secondary Element 2	Secondary Element 2 has been expanded to address preservation of in-channel recharge areas in both the Santa Clara River and its tributaries.

[2] Stats. 1992, Ch. 947.
[3] Stats. 2001, Ch. 929.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[5]	RESPONSE
SCOPE #6	GWMP should find ways to increase water recharge. Water agencies should also coordinate to prevent paving of permeable recharge areas.	This is not explicitly required by AB 3030 but relates to Primary Elements 3, 4 and 5 and Secondary Element 2	Potentially increasing groundwater recharge will be part of Primary Elements 3, 4 and 5. Prevention of paving permeable recharge areas is included in the expanded Secondary Element 2.
SCOPE #7	Number One Goal should not be "Development of Local Groundwater for Water Supply" because groundwater has many other important uses (recreational, biological, etc…)	This is not required by AB 3030 or AB 1314. See Section II of GWMP	The text of Section II, Management Objectives (Goals) for the Basin does not indicate a preference of any one objective over the others. The listing is not intended to indicate that any objective will not be attempted, all objectives are intended to be achieved
SCOPE #8	Agricultural water usage in the GWMP is overestimated with the perennial yield (40,000 afy) estimate higher than that in a Richard Slade report, less agricultural runoff water is available for recharge today	Section IV (Existing and Projected Water Supplies)	Reported historical agricultural pumping is consistent with all available records. A perennial yield of 60,000 afy is not included or implied in the GWMP. Rather, estimated ranges of 30,000 to 40,000 afy, depending on hydrologic conditions, are included as expected yield from the Alluvium. That range is consistent with historical reports, and with observations of actual Alluvial aquifer response to pumping in that range for at least the last 50 years
SCOPE #9	Disappearance of year round Santa Clara River flow is indication of overdraft. "There are numerous records and observations by long-time residents indicating that surface flow usually occurred year round."	Section III (Areas of Concern and Identified Problems). Water Code § 10753.8(c).	Disappearance of year round stream flow does not necessarily indicate groundwater overdraft. In fact, stream flow west of Bouquet Canyon is now perennial. Part of implementing Primary Element 1 will be to obtain the "numerous records" of year round stream flow that are noted to have actually occurred.
SCOPE #10	GWMP should disclose the reduction in production capability because of perchlorate contamination.	Primary Element 8, § 10753.8(j).	The GWMP notes the inactivation of wells that have been impacted by perchlorate contamination
Sand Canyon Area Well Owners Assoc. #1	Groundwater is extensively pumped and recharge areas are not adequately protected. water level in four wells has dropped from 12 ft in 1997 to 93 ft currently.	This relates to Primary Elements 1 and 3, and Secondary Element 2	The noted groundwater level fluctuations are consistent with those described in Section III and illustrated in Figure 3-2 for the Sand Canyon area. Section III also describes and illustrates the historical recovery from such declines. Avoidance of overdraft, i.e. continuous lowering of water levels, and protection of recharge areas are included in Primary Element 3 and Secondary Element 2, respectively.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Sand Canyon #2	Advisory board lacks representation by rural well owners.	Water Code Appendix § 103-15.1(e)(2)	CLWA complied with the requirements of AB 134 regarding the composition of the Advisory Council.
Sand Canyon #3	GWMP should include timelines for completing its phases.	AB 3030 and AB 134.	Timelines are not required by AB 3030 or AB 134.
Sand Canyon #4	GWMP is lacking in its review of land use plans and coordination with land use agencies.	Water Code §10753.8(i)	See response to SCOPE Comment 3 above.
Sand Canyon #5	Perennial yield estimates for the Santa Clara River are higher than that provided in a Richard Slade report. Agricultural runoff is no longer a factor; agricultural usage was not metered historically, and former recharge areas have been paved.	Section IV (Existing and Projected Water Supplies)	See response to SCOPE Comment 8 above.
Sand Canyon #6	Santa Clara River should not be defined in terms of percolating groundwater. GWMP should clarify relationship between river and Saugus formation.	Section III	The GWMP is not an appropriate document in which to define the legal classification of groundwater, whether in the Alluvium or the Saugus Formation; consequently, there is no expression in the GWMP to describe the legal classification of groundwater in the basin. The entire focus of the GWMP is management of groundwater toward long-term preservation of both the quantity and quality of the resource.
Sand Canyon #7	GWMP's assertions against existence of overdraft or other undesirable conditions are incorrect since water levels in wells have reached historic lows. In addition, riparian conditions on the Santa Clara River and tributaries show signs of water deprivation.	Section III (Areas of Concern and Identified Problems)	See response to Sand Canyon Comment 1. Further, intermittent fluctuations reaching the equivalent of historic low levels is not overdraft. Primary Elements 1 and 3 are included to monitor groundwater levels throughout the basin, and to operate in an ongoing manner to avoid overdraft. Finally, the statement that riparian conditions show signs of water deprivation is non-specific as to location and is otherwise unsubstantiated. Primary Elements 1 and 2 are included in the Plan to quantify the existence and extent of such conditions, if they occur. Primary Element 3 is included to avoid overdraft-related conditions of the type noted.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Sand Canyon #8	GWMP should include reports regarding water contamination from Robinson Ranch. City of Santa Clarita had stipulated that water quality adjacent to the golf course be monitored with results published in a report.	Primary Element 1	See response to UWCD Comment 1 regarding extent of detail regarding occurrence of groundwater as framework for understanding the objectives and elements of the GWMP. As regards this comment, there is no documented groundwater contamination from Robinson Ranch, including that golf course. Required reports on Robinson Ranch have not shown any contamination as alleged in this comment. Monitoring in accordance with Primary Element 1 is intended to detect any groundwater contamination of the nature alleged in this comment.
Friends of the Santa Clara River #1	Disappointed that GWMP's primary goal is "Development of Local Groundwater for Water Supply" because other objectives should include protection of groundwater resources.	AB 3030 and AB 134. Section II of GWMP	See response to SCOPE Comment 7 above regarding lack of priority for all management objectives, and lack of "primary" status for "Development of Local Groundwater for Water Supply".
Friends #2	GWMP should emphasize that paving of streams reduces recharge and should be avoided. Buffer zones around streams should be discussed.	This is not explicitly required by AB 3030 but relates to Primary Elements 1, 4 and 5 and Secondary Element 2	See response to SCOPE Comments 4, 5 and 6. Further, given the importance of in-channel recharge to the yield of the Alluvium, a priority in implementation of the Plan can logically be expected to be avoidance of paving stream channels.
Friends #3	Advisory Board should include representatives from environmental groups and county agencies.	Water Code Appendix § 103-15.1(c)(2)	CLWA complied with the requirements of AB 134 regarding the composition of the Advisory Council.
Santa Clarita Sierra Club Group #1	GWMP should include timelines for completion of components.	AB 3030 and AB 134.	Timelines are not required by AB 3030 or AB 134.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Sierra Club #2	GWMP does not account for loss of groundwater from perchlorate contamination. "The numbers do not adequately represent the real water supply."	Primary Element 8; Water Code §10753.8(j)	See response to SCOPE Comment 10 regarding the inactivation of wells impacted by perchlorate contamination. The inactivation of certain wells impacts pumping capacity until the wells can be reactivated, with treatment if necessary, or replaced. However, perchlorate contamination does not reduce the available yield of the aquifer system, hence, the numbers included in the GWMP accurately reflect the current state of water supply.
Sierra Club #3	Loss of groundwater due to development and pavement is not considered. GWMP must address coordination of land use with water necessities.	This is not explicitly required by AB 3030 but relates to Primary Elements 3, 4 and 5 and Secondary Element 2.	See responses to SCOPE Comments 4 and 6. Further, there has been no "loss" of groundwater due to development or pavement; groundwater conditions remain as generally described in Section III, with nearly constant water levels to the west and repetitive fluctuations to the east (see response to Sand Canyon Comment 1).
Sierra Club #4	Drought planning is inadequate as it fails to take account of loss of primary water sources and reclaimed water.	Primary Element 1, 4, 5 and 7	Drought planning is embedded in the GWMP in that the Plan is intended to result in groundwater management that ensures adequacy of groundwater supplies through both wet and dry (drought) hydrologic cycles. While "drought planning", per se, relates more specifically to overall water supply planning, of which groundwater is only one component, this Plan is intended to manage groundwater in such a way that it will be a reliable component of overall water supply through dry periods without being overdrafted on a long-term basis, e.g. through wet/normal periods that follow dry periods. Primary Elements 3, 4, 5 and 7 in the Plan relate to drought planning as well as parts of groundwater management through long-term fluctuations in hydrologic conditions.
Sierra Club #5	GWMP does not adequately discuss maintaining river and tributary habitats. Sierra Club supports a citizen monitoring program for water quality.	This is not explicitly required by AB 3030 but does relate to Secondary Element 7	See response to SCOPE Comment 5 and Friends Comment 2.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Sierra Club #6	CLWA should involve the public and other government and private entities in its water supply planning.	Water Code Appendix § 103-15.2(e)(2)	CLWA complied with the requirements of AB 134 regarding the composition of the Advisory Council.
Ed & Joan Dunn #1	Concern because CLWA did not hold more public meetings before release of draft. Concern whether CLWA has regularly met with Advisory Board.	Water Code § 10753 et seq.	CLWA has complied with all requirements thus far regarding public meetings and gone beyond that legally required.
Dunn #2	Doubt regarding replenishment of water in the Alluvial Aquifer.	Primary Elements 3, 4 and 5	Fundamentally, as discussed in the Plan, the long-term objectives for the basin include utilizing groundwater for water supply while not overdrafting the basin. As also discussed in the Plan, historically, in the western part of the basin there has been sufficient water for recharge to maintain an essentially full basin throughout both wet and dry hydrologic periods. Part of the reference to "sustain recharge" relates to that historical condition. Whether or not additional artificial recharge will be implemented in other parts of the basin, and what water sources might be used for such recharge, are to be addressed via implementation of the Plan, particularly Primary Elements 3, 4 and 5.
Dunn #3	Doubt over Richard Slade's assertion as to Alluvial Aquifer capacity	This challenges evidence which the GWMP cites	The analysis and determination of the storage capacity of the Alluvium has been exhaustively described in Slade's reports. The comment conveys no specific aspect of its "question"; the commentors are referred to Slade's reports, which address the storage calculations in proper technical detail.
Dunn #4	GWMP should state that SWP water was interrupted for 6 months in 1991. Newspaper clipping is provided for this point.	Primary Elements 3, 4 and 5	Primary Elements 3, 4 and 5 are included in the GWMP to ensure the maximum reliability of local groundwater in order to endure any future drought-related impacts on SWP deliveries, such as occurred in 1991.

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PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Dunn #5	Statement in GWMP that no wells exceeded DHS action level for perchlorate is false. Newspaper clippings provided	Section III (Groundwater Quality)	The Plan has been revised to reflect that, while there remains no primary or secondary drinking water standard for perchlorate, and although only some of the detected concentrations of perchlorate in the Saugus wells exceeded the Action Level established by the State Department of Health Services at that time (18 ug/l), all these wells were inactivated by their respective owners after detection of perchlorate; those wells remain out of municipal water supply service since then
Dunn #6	Statement that perchlorate contamination has not reduced groundwater capacity is misleading	Primary Element 8	See response to SCOPE Comment 10 and Sierra Club Comment 2
Dunn #7	The Urban Water Management Plan should not be referred to because it is under legal attack.	While it has been challenged, the UWMP is still a valid document	While it has been challenged, the UWMP is still a valid document and represents the current plan for urban water supply through its 20 year planning horizon. The Kern County Superior Court in February 2003 ruled completely in favor of the water suppliers in their defense of the UWMP litigation. The remaining petitioners have appealed
Dunn #8	The Saugus Formation does NOT underlie the entire CLWA service area	Section I (Santa Clara River Valley Groundwater Basin)	The text of the Plan has been revised to reflect that the Saugus Formation underlies much of the CLWA service area
Dunn #9	GWMP should state CLWA's inability to transport additional SWP to Santa Clarita Valley	Section IV (Existing and Projected Water Supplies)	CLWA does not have an inability to transport additional SWP water to the Santa Clarita Valley. Fundamentally, the comment is erroneous since the State conveys SWP water to CLWA's diversion points from Castaic Lake; from there CLWA has sufficient treatment and conveyance capacity for its current water demands, and is in the process of designing additional treatment plant capacity to treat and distribute additional water to accommodate projected increased demand

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PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Dunn #10	CLWA's recycled water program is for private business only, not public agencies.	Primary Element 7	The recycled water program has no restrictions against use by public agencies. As described in Primary Element 7, the integration of recycled water to meet some non-potable demand is expected to decrease overall demand for potable water by up to 17,000 afy. As public agencies develop capabilities to utilize recycled water for non-potable uses, they are expected to reduce potable water demands by integrating recycled water into their overall water delivery systems. Initially, recycled water service to a specific user or area frees up potable water supplies for other users or areas, thus enhancing the reliability of the overall water supply of the Valley.
Dunn #11	Groundwater production from both the Alluvium and Saugus Formation is overstated	Section IV (Existing and Projected Water Supplies)	The comment is unsubstantiated and includes no support in the form of records or other data to validate it. The historical use of groundwater reported in the Plan is based on a combination of metered pumping and indirect estimation of pumping based on metered power consumption and pump performance testing. There is no basis for claiming that reported groundwater production is "overstated".
Dunn #12	CLWA should develop an emergency plan.	Primary Elements 3, 4 and 5	Development of an emergency plan, presumably an emergency water supply plan, is beyond the scope of a GWMP. However, Primary Elements 3, 4 and 5 are intended to further develop both a regular and a dry year/emergency component of water supply from local groundwater.
Dunn #13	Claim depicting SWP water received in 1991 is erroneous. Newspaper clipping provided	Figure 4-1	The final 1991 M&I allocation was 30% (October 1991). CLWA's M&I entitlement at that time was 41,500 af. The total amount made available to CLWA by DWR was 13,050 af. Since by October, CLWA and the retail purveyors had already instituted emergency operations, the entire amount was not used.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Dunn #14	Claim that CLWA meetings with retail water purveyors, the City, and UWCD have not occurred.	Primary Element 9	The Commentors' lack of knowledge of such meetings does not mean they have not occurred. Appropriate documentation of such meetings, including presentation materials, discussion topics, and resultant work assignments, are maintained by meeting participants.
Dunn #15	Secret meetings and secret reports related to Primary Element 10 should not be included as part of the GWMP.	Primary Element 10	The preparation of the annual Water Reports does not indicate that any secret meetings have taken place. Previous Water Reports have been prepared, and future Water Reports are envisioned to be prepared, with few, if any, meetings of any type; both public and private meetings have been convened to present and discuss the findings of the various Water Reports, and such meetings are intended to occur in the future for the same purpose.
Dunn #16	CLWA should provide an accounting of water conserved.	N/A	Providing an accounting of water conserved is beyond the scope of the GWMP. More water sales are occurring through time due to increasing demand in the Valley. Water conservation measures result in water savings even though demand is increasing.
Diane Trautman (City Planning Commissioner) #1	What percentage of water demand will be drawn from local groundwater?	Primary Element 5	In terms of groundwater management planning, projected urban water demand (the 106,000 afy projected urban demand in 2020) does not represent total valley-wide demand; total projected demand is 113,100 afy, including both urban and agricultural. In that light, on an average basis, local groundwater is expected to be utilized to meet about 40 percent of total water demand.

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PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Trautman #2	Will pumping of the Alluvial Aquifer reduce recharge of the Saugus Formation and reduce water that can be produced from the Saugus Formation during dry periods?	Primary Elements 5, 6 and 9	No. Since the Saugus Formation is recharged over a much larger area, beyond the spatial extent of the Alluvium, there is a limited relationship between Alluvial pumping and recharge to the Saugus Formation. The fundamental tenet of the GWMP is to utilize groundwater for water supply within its sustainable yield (see the Management Objectives, or Goals, for the Basin, GWMP Section II; see also the various GWMP Elements intended to achieve those objectives, GWMP Section V). In that light, it is expected and intended to operate in such a way that recharge to the Saugus Formation will not be "reduced" by pumping from the Alluvial Aquifer and that groundwater will be available in varying amounts, as needed depending on weather year-types, within the sustainable yields of the respective aquifers (or without overdrafting them).
Trautman #3	Does CLWA have sufficient data regarding the Alluvial Aquifer and Saugus Formation, if not, how will it obtain such data?	Section II and Primary Element 1.	The reference to "useful amount of groundwater quality data" in the GWMP includes both Alluvial and Saugus data. However, due to the historically greater development and use of groundwater from the Alluvium (number and distribution of wells, volume of pumping), and due to the historically smaller development and use of the Saugus Formation (fewer wells, smaller geographical distribution of wells, smaller pumpage), there is comparatively limited ability to examine relationships among pumping, recharge, and quality in the Saugus Formation. CLWA and the other purveyors intend to expand the overall knowledge of the Saugus Formation as that resource is further explored and developed (number of wells, additional sampling as new wells are added, etc.). All that data will be included in ongoing implementation of GWMP Primary Element 1, Monitoring of Groundwater Levels, Quality and Production.
Trautman #4	The 2002 Water Report indicates that "there are limited Saugus (Formation) water level data." Does CLWA plan to collect more comprehensive data on the Saugus Formation?	Section II and Primary Element 1	The "limited nature of Saugus water level data" as a result of the same smaller extent of historical Saugus development described in the preceding answer. Acquisition of additional data on the Saugus Formation is planned as also described in the preceding answer.

PARTY	COMMENT[1]	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Trautman #5	Is CLWA sharing detailed information with the City of Santa Clarita regarding contamination risks in relation to existing closed wells?	Primary Element 9	All publicly available information regarding the investigation of perchlorate contamination, its extent, its impact on water supply, and plans for cleanup, control of migration, etc. [illegible] available to the City. Representatives of CLWA and the purveyors meet routinely with City representatives to review the status of perchlorate cleanup and remediation activities. CLWA and the impacted water purveyors will continue to pursue control and cleanup of perchlorate contamination in order to restore impacted groundwater pumping capacity and to ensure the long term quantity and quality of groundwater in accordance with the GWMP. As a practical matter, there are no surface contamination risks relating to perchlorate that would affect land use development adjacent to the impacted wells.
Trautman #6	Where is the Stadium Well located?	Section IV (Groundwater Quality)	The Stadium Well is located on the south side of the Santa Clara River, approximately two miles upstream (east) of its confluence with the South Fork tributary, or about 4,000 feet east of the Bouquet Canyon Road crossing of the Santa Clara River.
Trautman #7	Why isn't conservation a primary element (instead of secondary) since it may reduce water demand by 10%?	Secondary Element 1	The assignment of "primary" or "secondary" status to any GWMP element is discretionary and certainly not absolute. Secondary status is not intended to indicate that any element of the GWMP will not be implemented; all elements are intended to be implemented. Final status of all GWMP elements will be reviewed by the Advisory Council and the CLWA Board.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Trautman #8	How is CLWA delivering recycled water?	Primary Element 7	Recycled water is being delivered to the TPC golf course, the first customer of the system, via the dedicated, recycled water distribution system, which is also capable of delivering water to other non-potable water users, and which will be expanded in accordance with the Draft Recycled Water Master Plan. The costs and time frame for expanding recycled water distribution and use are included in the Draft Recycled Water Master Plan which is complementary to, but beyond the scope of the Groundwater Management Plan. The intent is to develop 17,000 afy of recycled water use by 2020. The capital cost of the complete system is estimated to be $68 million, and will be funded through CLWA's connection fee program.
Trautman #9	How is recycled water reprocessed?	Primary Element 7	Recycled water is not "reprocessed" at points of use such as the TPC golf course. In general, recycled water is highly treated (tertiary treated) waste water. In the case of the Santa Clarita Valley, treatment already occurs at the Valencia Reclamation Plant operated by the Sanitation Districts of Los Angeles County. The treated water, ready for non-potable use, is distributed from the plant site in a dedicated transmission pipeline system to end users such as the TPC. Pesticide and fertilizer uses, as part of cultural practices at end-user locations such as golf courses, are discretionary actions of the respective end users of recycled water.
Trautman #10	What is the average per capita water usage?	N/A	Most water agencies no longer use "per capita" water use as a standard because it is not an accurate representation of actual per person water use, mainly due to the effects of landscape and commercial/industrial water use. (It is also expressed in "gallons per day," rather than "acre-feet per year," since it refers to individual water usage.) In general for the South Coast hydrologic region of California, water use is approximately 200 gallons per person per day (DWR Bulletin 160-98). Per capita use for the Santa Clarita Valley is slightly higher due to landscape irrigation demands caused by local climatic conditions.

PARTY	COMMENT	APPLICABLE GWMP SECTION/ COMPLIANCE[1]	RESPONSE
Trautman #21	The Semitropic Water Bank/Transfer is not mentioned in discussion of the Supplemental (SWP) Surface Water on page 21. Is that because it is a relatively short-term water supply? Are any of the other water transfers Kern Water Bank, Kern Delta Water, North Las Posas Water Bank -- as listed on GWMP p. 2-16, of limited duration? And if the Semitropic Water Bank Transfer is short term, how can it be included in the 305,000-306,000 afy need projected for the next 20 years? When will take its place?	Section IV (Existing and Projected Supplies)	The SWP is referred to as "supplemental" water because that is the original purpose of the SWP: to serve as a supply that would "supplement" local supplies (whether groundwater or local surface water or both). The specific amounts referred to in the GWMP are from the contractual terms between CLWA and the California Department of Water Resources. The water banked in the Semitropic Water Storage Program during 2002 is a short-term, dry period supply. The program has a term of ten years (i.e., the water must be returned to CLWA for use in its service area within that time period). Thus it is not included as a supply for long-term needs. However, the other programs listed in the GWMP (most of which, by the way, are not water "transfers," but are instead groundwater banking programs) are long-term sources of supply. CLWA is in the process of designing and implementing a Long-Term Reliability Plan to begin bringing such long-term programs on line as a means to store water available in wet years, for use in later dry years. CEQA analysis, with its accompanying public comment opportunities, will be part of the long term reliability program approval process.
Trautman #12	What specific efforts will be made to manage salinity?	Primary Element 6	Primary Element 6 – Long Term Salinity Management is included in the GWMP for the reasons presented in the text discussion of that element. The element recognizes the need to plan for salinity management but also recognizes that, to the present, there has been no extraordinary trend of salinity increase. Hence, there are no specific efforts currently in place to "manage" salinity. It is envisioned that specific efforts will be developed over time in response to implementation of the GWMP and, in particular, its Primary Element 6. CLWA is participating in efforts by the Sanitation Districts of Los Angeles County to address the Los Angeles Regional Water Quality Control Board's proposed TMDL standard for chloride in the Santa Clara River. This effort is separate from and beyond the scope of the Groundwater Management Plan.

UNITED WATER CONSERVATION DISTRICT

Conserving Water Since 1927

August 7, 2003

Dan Masnada
Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350

Re: Response on Draft Groundwater Management Plan, Santa Clara River Valley Groundwater Basin, East Sub-basin

Thank you for giving us the opportunity to review and comment on your *Draft Groundwater Management Plan, Santa Clara River Valley Groundwater Basin, East Sub-basin*. United Water considers this plan as one piece of a broader effort at groundwater management that is being accomplished as part of the Memorandum of Understanding between United Water and water purveyors in the Santa Clarita area. We offer some specific comments and suggestions for your consideration.

Comments include:

Figure 3-2. The vertical and horizontal scales associated with the hydrographs are very difficult to read. The T4N R17W, Section 22 well, in the western arm of the Alluvial Aquifer does not show data from approximately 1983 through 1991. In previous reports and analyses, the NLF #05 well was used for this area. This well depicted variable groundwater levels for the period from the mid-1980s to the early 1990s. Because this is the discharge area of the Alluvial Aquifer to the Santa Clara River, we need to understand the response of the system to the onset of agricultural pumping in this area in the mid-1980s. The T4N R17W, Section 22 well does not possess the data needed to show that response.

Page 13. The comment near the top of the page that "*over the last 25 years, groundwater quality in the Saugus has remained generally constant*" would be more supportable if it was accompanied by a groundwater quality map similar to Figure 3-5, with a few groundwater quality time-series specific to the Saugus Formation.

Figure 5-3. The average daily mean streamflow data appears to be shifted one year on the histogram graph. As an example to show the error, the histograms suggest that there were high flow years in 1968 and 1997. The high flow years were actually 1969 and 1998.

UNITED WATER CONSERVATION DISTRICT

Page 27. Local Groundwater – The planned production of 30,000 to 40,000 acre-feet per year from the Alluvial Aquifer and 7,500 to 15,000 acre-feet per year from the Saugus Formation, along with 11,000 to 15,000 acre-feet per year from the Saugus in dry years has yet to be implemented. The current development of a regional transient groundwater flow model for the East Sub-basin is for the expressed purpose of evaluating the potential impacts to the basin and surface water outflow into Ventura County, of this increased pumping. Irrespective of the modeling results, only real groundwater and surface water data can verify the influence of significantly increased pumping within the sub-basin; and

Page 29. Primary Element 2 – Monitoring and Management of Surface Water Flows and Quality – While imported SWP water no doubt contributes to the observed increased flow in the Santa Clara River at the Ventura County line, there exist additional explanations for a portion of the increased flow. Other considerations include:

1. Influence of the hydrologic cycle. The cumulative departure for precipitation was declining during the 1950s and first half of the 1960s. The cumulative departure improved significantly during the period of 1978 through 1983; and
2. The amount of Alluvial Aquifer pumping may influence flow at the Ventura County line. During the latter half of the 1960's and through the 1970s, groundwater pumping of the Alluvial Aquifer declined by 30%. Pumping during the 1980s was 30% lower than during the 1950s and early 1960s.

In this particular case, it would be very difficult to differentiate between the influence on streamflow from changes to groundwater pumping and the hydrologic changes.

If you have any questions about United Water's comments, please contact Steve Bachman at (805) 525-4431.

Sincerely,

Dana L. Wisehart

Dana L. Wisehart
General Manager

cc: BRRF
Lowell Preston, Ph.D., Ventura County Water Resources Division

SCOPE

Santa Clarita Organization for Planning and the Environment

TO PROMOTE, PROTECT AND PRESERVE THE ENVIRONMENT, ECOLOGY AND QUALITY OF LIFE IN THE SANTA CLARITA VALLEY

POST OFFICE BOX 1182, SANTA CLARITA, CA 91380

8-6-03

Castaic Lake Water Agency
27234 Bouquet Cyn Rd.
Santa Clarita, Ca. 91350
Faxed to 661 297 1611 Hard copy to follow via regular mail

Re: Comments on Ground Water Management Plan

Dear Sirs

Thank-you for the opportunity to comment on your plan. We are pleased that your agency has begun a ground water management plan in response to the community's concerns over the excessive use of ground water. This extensive pumping and lack of protection of re-charge areas has resulted in almost complete elimination of surface flows and summer ponding necessary to wildlife as well as causing water level drops in wells that have resulted in water quality and availability problems for small users.

General Areas of Concern

We regret that environmental organizations, small well owners, the City of Santa Clarita, the County of Los Angeles (watershed and flood control divisions), Regional Water Quality Control and other members of the community interested in water issues in our valley were not included on your advisory board. We believe that inclusion of these groups early on would have helped resolved some of the issues with your plan at an earlier stage. Including only the water companies, Newhall Land and Robinson Ranch effectively excluded many of the groups and individuals that have voiced strong concerns over your present actions. The water agencies have consistently excluded these groups from all water planning, including water supply reports and the Urban Water Management Plan process. We strongly suggest that a more inclusive committee be formed to include representatives of the environmental community and rural well owners who are now being affected by overdraft of the Santa Clara River.

We also note that there are no timelines for completion of any of the components of the plan. Without such timelines, it would seem that there is little real intention or commitment to follow through on the various parts of the plan.

The Land Use/Wellhead Protection Component of the Groundwater Management Plan

Perhaps the most significant outcome of a ground water management plan in the Santa Clarita Valley would be implementation of the portion of Section 10753 which requires review of land use plans and coordination with land use agencies. Your plan assigns this area to

"Secondary element 2", an indication that you do not intend to pay much attention to this important component.

The coordination of land use and water planning has been sadly lacking in the Santa Clarita Valley. A simple wellhead protection plan would help decision makers understand the potentially polluting impacts of certain land uses such as gas stations, auto repair shops, etc and how they could negatively affect our water supply. Instead, these uses are routinely permitted next to water supply wells.

Paving over of prime re-charge areas is allowed without a word of protest from the water agencies, even though such loss of recharge capacity will severely affect water availability. Recreational uses should be encouraged in recharge areas that will accommodate and perhaps even enhance water re-charge and thus increase water availability.

Newhall County Water District began a well head protection program and educational presentations with its ground water management plan in the mid 90's, but efforts to both educate the planners and protect recharge and water supply wells have been stalled by the strong developer involvement with water agency decisions. This involvement has precluded advocacy of long term decisions that would protect water availability and water quality in favor of short term profits for development companies.

The ground water management plan should stress the importance of avoiding the concreting of tributaries when approving new land uses and require adequate set back from natural water courses to allow these blue line streams to remain in a natural state. This will enhance water re-charge (and thus, ensure water availability). It will also aid water quality because riparian vegetation absorbs many pollutants before they can enter the ground water system.

It is an indication of the myopic view of the water agencies that this plan states its number one goal to be "Development of Local Groundwater for Water Supply". There are many other uses of ground water and surface water which are important to the community. These include recreational and aesthetic values, biological value and the quality of the water supply. More pumping will result in diminution of all these other aspects of our ground water resource and ignore the strong protests and demands for their protection which are already being heard from many voices in the community.

Monitoring of Ground Water and Surface to Establish Safe Yield

Agricultural Water Usage is Overestimated

In its presentation, Luhdorff and Scalmanini revise the previous perennial yield estimate of the Santa Clara River by Richard Slade (perennial yield 32,600 AF, Hydrology of the Alluvial Sediments of the Santa Clara River, 1988, page 109) to approximately 40,000 AF. This revision is based in part on an average agricultural usage from the 1940s to the 1960s. We believe that these calculations are incorrect for three reasons.

1. No inclusion of recharge from agricultural run-off was included in the usage calculations as was included in previous reports. Agricultural run-off was a substantial source of re-charge to the river that no longer exists, therefore not as much water is available for extraction.

2. Agricultural withdrawal was not metered, so water usage is merely an estimate based on crops and weather. It appears that estimates of withdrawals may have been over-stated.
3. Agricultural lands provided a source of recharge during wet years. Urbanization has paved over most of this area, so recharge is no longer occurring. This will reduce that amount of recharge to the river alluvium and thus reduce the amount available for extraction. (Slade, 1988, Hydrological Investigation of the Perennial Yield of the Alluvial Aquifer, page 88)

These evaluation errors have caused the water companies to believe that they can withdraw a higher amount of water than can actually occur without causing impacts to public trust matters and small well users.

Monitoring and Managing Surface Water Flows

Visual Historical Evidence has been ignored

There are numerous records and observations by long-time residents indicating that surface flow usually occurred year round. Ponding that harbored fish and amphibians (many of which are listed as threatened or endangered) in areas that did not support year round flow has also been attested to by local residents. The disappearance of year-round flows and ponding is an indication of overdraft of the alluvial system. The impacts to riparian life and water quality are substantial. A goal of returning or replacing these summer surface waters should be incorporated in your plan. Such replacement may help to avoid potential future litigation brought to enforce the Endangered Species Act.

Water Quality Monitoring

Water Pollution

We appreciate that the water agencies have finally admitted that 5 municipal wells are closed and that there is a concern that the pollution plume is moving in a westerly direction (Plan at page 32). It is very regrettable that these facts were not disclosed to decision makers over the past several years and, further, were even denied by representatives of the water agencies.

However, we believe it is imperative that this plan additionally include a disclosure of the current reduction in production capability due to pollution of the Saugus and alluvial aquifer by ammonium perchlorate. Continued pumping may extend the pollution plume and increase clean-up costs. It is important that the extent of the problem be honestly outlined for the public so that alternative remedies may be developed and discussed. Failure to disclose the extent of the pollution problem and its real impact may lead to serious water quality problems if the Saugus aquifer is relied upon for drought supply.

Conclusion

We submit the following recommendations:

1. We encourage CLWA to re-form its advisory committee to be inclusive of the community and other local agencies.

2. We suggest that the goals of the plan be re-ordered to place land use issues in a position of significance, and include recommendations from other agencies, organizations and individuals that might enhance water availability and water quality.
3. A time line must be established, financial commitment discussed, and responsibility assigned so that the water management goals will actually be attained.

Sincerely,

Pat Salcisbury

Cc: City of Santa Clarita
County of Los Angeles
Regional Water Quality Control Board
Local Newspapers

Sand Canyon Area Well Owners Association
c/o 27363 Sand Canyon Road
Santa Clarita, CA 91387-3632

August 8, 2003

Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350-2173

RE. Groundwater Management Plan ("AB 3030 Plan")

Gentlemen:

This letter is in response to your letter of June 16, 2003 which solicited comments about the above plan to ensure that the general public has had the opportunity to provide input on this local effort to manage our community's groundwater resources.

We are pleased to respond to your request for public participation. As well using residents of the Sand Canyon area who are affected by ground water use and plans for future use of it, we feel that our interests are very much at stake in determining how our river and ground water is to be used.

Our first and foremost concerns are that both river and ground water is being extensively pumped and that recharge areas are not being adequately protected. Surface flows and summer ponds have virtually vanished from our vicinity. In 1997, the water level in four wells adjacent to Sand Canyon Creek stood at twelve feet. As of last month, those same wells' water level now stands at ninety-three feet.

Other general concerns include the lack of representation on your advisory board by rural well owners. While water companies and the Robinson Ranch Golf Course have their own interests in how our community's water resources are used, many small well users have an equally valid interest in seeing that our area's water resources are managed in an equitable fashion that ensures no entity's use will result in the deprivation of others.

Also, none of we Sand Canyon area small well users have been consulted during the creation of water supply reports or the Urban Water Management Plan, despite the fact we are being affected by an increasingly serious overdraft of the Santa Clara River. Including members of our group in a groundwater management committee will bring important stakeholders to the planning process. We have important data to present.

It is disappointing to note that the ground water management plan specifies no timelines or dates for executing and completing its phases. We question whether there is sincere intent to carry out the plan given the lack of work plan.

On a broader scale, we are deeply concerned about the plan's land use and wellhead protection sections. Section 10753 calls for a review of land us plans and coordination with land use agencies, as stipulated in secondary element 2 of the plan. A critically important aspect of effective ground water management, such coordination has not taken place to any meaningful extent in the Santa Clarita Valley, and more specifically, in the Sand Canyon area. We have noted with dismay that vital recharge areas have been built upon and paved over with no comment from any water agencies, despite an obvious impact on water availability for all water users, particularly small well holders.

While intelligently planned development is meant to result in well designed, livable communities where all inhabitants are assured of fair access to resources, we note that ongoing strong developer involvement with water agency decisions has led to the potential compromise of water availability and quality in exchange for near term profits for developers and increased tax revenues for local governments.

In the draft plan's sections that deal with ground water monitoring to establish a safe yield, we believe that estimates of agricultural water consumption are not accurate. In Richard Slade's 1988 perennial yield estimate of the Santa Clara River, he stated on page 109 that it was approximately 32,000 acre-feet. Yet Lahdroff and Scalmanini raise this estimate to 40,000 acre feet. They base their calculations on data measured for agricultural operations between the 1940's and 1960's.

Since our membership includes individuals who have farmed a large parcel in the Sand Canyon area from 1951, we feel qualified to comment on the above figures.

First, agricultural usage during the reference years was never metered. Usage during this period is estimated based on available crop reports (when they were recorded) and available weather data. A reading of withdrawal estimates raises a suspicion that they are overstated.

Second, the upward revision of Slade does not include agricultural runoff. Since agriculture in our area has virtually disappeared, it is no longer a contributing factor to aquifer recharge. Yet earlier estimates included agricultural runoff, a significant source of recharge.

Third, land in our area that previously was planted in both irrigated and dry land crops has now been paved over. During rainy years, farm fields were an important component of recharge, since rain soaked into them. Slade specifically mentions this reduction of extractable water on page 88 of his 1988 report.

Flawed calculations like these have caused water companies and other institutional users to think that they can extract more water than they can and should without adversely affecting small well users.

Primary element number two gives the appearance of an attempt to establish a commingled inter relationship between the Saugus Formation and the Santa Clara River. With a clearly defined bed and banks, the Santa Clara River has historically behaved as a river, and despite severe depletion from over pumping, still exhibits the dynamics of a river during episodes of precipitation. With our members holding rights of diversion from the State Water Resources Board, we strongly feel that any attempt to define the river in terms of percolating groundwater defies logic and the laws of physics.

Also, in the "Existing and Projected Water Supplies" section, the draft report states that "...it is currently expected that ongoing utilization of local groundwater will continue to be in amounts that have historically been pumped, 30,000 to 40,000 afy from the Alluvium..."

As stated above, Slade's 1988 report clearly and unequivocally sets the upper pumping limit of the Santa Clara flow at 32,000 afy. By relying on generous overstatements and exaggerated potentials, a plan will go forward that will have serious negative impacts for small well users in the Sand Canyon area.

In primary element three, Determination of Basin Yield and Avoidance of Overdraft, we are concerned with the second paragraph's first sentence that states " ...there has not been any widespread, steady degradation of groundwater conditions that might be indicative of overdraft..."

Again in Primary Element 4, the second sentence asserts..."Both ranges of numbers are consistent with recent historical pumping that has not resulted in any indication of overdraft or other undesirable conditions." And in Primary Element 5, the third sentence further posits that ..."Groundwater pumping has remained within a range that has not caused any evidence of overdraft, or associated undesirable impacts..."

It is the direct and incontrovertible evidence of water levels in our own wells that presents us with a clear contradiction to this assertion. Based on members' records that cover a fifty-year span, the current water levels in our wells have reached an unprecedented low. We are left with inescapable evidence that large users pumping from the Santa Clara River have contributed to a cone of depression that is negatively affecting our small wells.

In addition, riparian conditions along the tributaries and main channel of the Santa Clara River reflect highly stressed, water deprived environments. In areas away from river feeder creeks, some heritage California Coastal Oaks (Quercus Agrifolia) have begun showing signs of water deprivation.

In a related matter, the proposed plan calls for identification of potential sources of contamination to assure water quality. When Robinson Ranch Golf Course was granted permission to open and operate, the city stipulated that water quality adjacent to and on the golf course be monitored and that regular reports about it be published. These reports have not been included in the draft plan, despite the fact that Robinson Ranch is a participant on the advisory committee for this draft plan. Pesticide, insecticide, fertilizer, and other volatile organic compounds are all possible runoff and plume contaminants that may be leaching from the golf course.

As members of your advisory committee, we would be glad to share with others the data from five decades of small well usage. We believe that recent developments, specifically in our area, have seriously lowered both the alluvial water levels to historic levels.

While modeling, projection, and prediction can yield abstract theories, we small well users must live with the consequences of miscalculation, however unintentional or inadvertent.

Small well holders are franchised, integral, entitled members of the water using community, and as such, must be included in the planning process associated with any groundwater management plan that is to be implemented in the Santa Clarita Valley.

Primary element nine specifies a MOU (Memorandum of Understanding) executed between the United Water Conservation District in Ventura County as an example of..."a local agency relationship that has produced the beginnings of local groundwater management, now embodied in this comprehensive (sic) plan..." While we laud all attempts to widen the base of data and participation in the planning process for water resources, we are disappointed that as stakeholders in the Eastern Sub basin of the Santa Clara River Valley, our interests are not being represented on the advisory committee that has been created to direct the groundwater management plan.

We ask to be included in the planning committee that is helping to shape the future of water use in our community.

Respectfully,

The Sand Canyon Area Well Owners Association
Robert and Jane Fleck
Eugene and Marylou Ruddell
Richard and Leslie Christensen
Shawn Clement
Joan Waldman

Friends of the Santa Clara River

[illegible] • (661) 296-4523

August 7, 2003

Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350

Board of Directors

[illegible]

Affiliated Organizations

[illegible]

Re: Groundwater Management Plan

Dear Sirs,

Friends of the Santa Clara River submits the following comments on the June 2003 Draft Groundwater Management Plan (Plan).

We are disappointed and dismayed that the Plan sets as its primary goal the "Development of Local Groundwater for Water Supply". While providing adequate water supplies is an important objective, it would seem to us that the primary goal should be the long-term protection of local groundwater resources, including groundwater quality. Groundwater resources provide many benefits to the community, including those related to the biological and environmental health of the river corridor. Long-term protection, if implemented, should curtail the over-pumping of local aquifers which is currently occurring.

We are also concerned that water agencies, in general, have failed to weigh-in on the paving over of recharge areas in the Santa Clarita Valley. Loss of recharge could have very substantial impacts on future water availability. The Plan should emphasize that concreting of ephemeral tributary streams reduces recharge, and thus should be avoided. Adequate setbacks, or buffer zones, around major streams should be stressed - an item that is rarely adequately addressed in development projects.

The Plan advisory board is too narrowly constituted. The Regional Water Quality Control Board should be represented, as should environmental groups and county agencies working on watershed protection.

Thank you for the opportunity to comment.

Sincerely,

Ron Bottorff

Ron Bottorff, Chair

Attention: CLWA Directors August 8, 2003
RE: Comments on Ground Water Management Plan

FAX: (661) 297-1611

From: Henry Schultz
Phone: (661) 284-5613 or (805) 447-2863 (work) or FAX at (805) 480-1333
Email: hschultz@amgen.com henry50@pacbell.net
Three pages total

There follow 2 pages of comments on the water plan. If there are any questions I can be contacted at the above locations.

Henry Schultz
Chair, Santa Clarita Sierra Club Group

S 7 03

Castaic Lake Water Agency
27234 Bouquet Canyon Rd
Santa Clarita, CA 91350
FAX 661-297-1611

RE Ground Water Management Plan Comments

Dear Directors,

We appreciate the chance to comment on the ground water management plan. This plan has been a long time in the making. We hope that your response to concerned public input will make it a viable document. A few comments follow.

1. Based on the (too) long history of this plan, it is essential to include deadlines (with penalties for failure) for completion of the various components of the plan. Otherwise our water will just slip away.

2. There is no accounting for loss of groundwater from pollution such as perchlorates. As soon as the magnitude of the problem has been adequately determined, a realistic plan can then be implemented. As it stands right now, the numbers do not adequately represent the real water supply.

3. Loss of groundwater due to loss of percolation due to extensive development, which paves over permeable soil, is not considered. It is a continuous and cumulative impact on the water supply. More generally, the water plan must address coordination of land use with water necessities such as the preservation of water percolation basins and similar amenities.

4. Drought planning is inadequate in the plan. For example, if a water treatment plant is built then a certain number of acre ft of water can be reclaimed. Current planning would say that this is real water, which can be counted on. In a drought, not only do you lose primary water sources, but also the correspondine amount of reclaimed water, a double hit which must be accounted for in any realistic water plan.

5. The Sierra Club strongly supports an active river-monitoring program so that potential and existing water quality issues can be addressed in a timely manner. This must be an integral part of the plan. In lieu of the water agency producing reliable data, a citizen-monitoring program will have to be undertaken to assure the quality of our water.

6. The plan does not adequately discuss maintaining river and tributary habitats such as the biological unhealthy zones created from the Rio Vista Plant's outflow into the Santa Clara River. While there are green plants growing in the area, UCLA researchers have shown that it is barren of many insects which would normally be present in such an environment. This engenders a ripple effect in the biota.

7. Just as the City of Santa Clarita involves the public and other government and private agencies in its long range planning, CLWA should do the same with its water planning. People in the Santa Clarita Valley are just beginning to realize the importance and the fragility of their water supply. The time to start RMA planning is now.

Thanks for your kind attention.

Henry Schultz
Chair, Santa Clarita Sierra Club Group
21827 Parvin Dr
Santa Clarita, CA 91350
Henry50@pacbell.net
661-284-5513

Ed & Joan Dunn
15414 Rhododendron Dr
Canyon Country, CA 91387
August 8, 2003

Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350-2173

RE: Groundwater Management Plan ; AB 3030

Dear Sirs:

We are pleased to have the opportunity to comment on your draft AB 3030 Plan. Enclosed please find copies of individual pages of this plan and associated comments for these pages.

We are disappointed that the writing of this plan appears to be following the same path of the UWMP. We are also displeased there has not been an attempt to hold more public meetings prior to this draft release. As required in AB 134, when has the agency met regularly with the advisory council to consult on this plan? What was the frequency of the meetings and how many were there?

We are quite interested in an AB 3030 Plan and would appreciated this draft be made into an honest and truthful document, allowing it to go ahead on a timely schedule without challenges and delays.

Respectfully submitted,

Ed and Joan Dunn

Enclosures: 3 Exhibits, 16 draft groundwater pages and 16 associated comment pages

Top of page:
Basin objective "manage groundwater levels and discharge to the Santa Clara River, at the west end of the basin"?
Wording should include "the entire basin".

Bottom paragraph, last sentence.
The plan is replenishing the aquifer with WITH sufficient water"

and effects, e.g. chronic water level decline, loss of groundwater storage, onset of land subsidence, groundwater quality degradation, a corresponding basin objective is to manage groundwater levels and associated groundwater discharge to the Santa Clara River at the west end of the basin, and thus not adversely impact surface and groundwater discharges to the downstream basin(s).

3. Preservation of groundwater quality for beneficial use in the basin, and for beneficial use of surface water and groundwater discharges from the basin. Included in this management goal will be the active characterization and solution of any groundwater contamination problems, through cooperation with responsible parties or through independent action if timely action by responsible parties is not forthcoming and the preceding management objectives are thereby impacted or constrained.

4. Preservation of interrelated surface water resources. Included in this management goal will be the maintenance of appropriate surface water flows and non-degradation of surface water quality as a result of managing groundwater conditions to meet the other management goals for the basin.

Quantitatively, the preceding goals translate into general preservation of groundwater levels and quality in the Alluvial aquifer system consistent with the last 30 years, including fluctuations through seasonal demands and local hydrologic variations (wet and dry periods). As discussed in more detail in the next chapter, the hydrogeologic setting in the area has resulted in smaller Alluvial groundwater level fluctuations toward the western half of the basin (generally west of Bouquet Canyon), and larger fluctuations to the east. However, largely due in part to the importation of supplemental surface water over the last 20 years, and the integrated or conjunctive use of that supplemental water with local groundwater, there has been no chronic decline in groundwater levels or storage. A continuation of such basin conditions, possibly complemented by management actions to decrease the historical water level fluctuations in the eastern part of the basin, will accomplish the second basin objective, continued avoidance of overdraft as has been the ongoing historical condition in the basin, while continuing to utilize local groundwater to meet part of projected water requirements, the latter being the first management objective for the basin. Corresponding management actions to sustain recharge and net overdraft groundwater storage will accomplish the third basin objective by replenishing the aquifer system with sufficient water to sustain what has been generally consistent quality of groundwater on a long-term basis.

We question Stokes 1986 and 2002 Report stating the Alluvium has the capacity of 240,000 acre feet.

III. Groundwater Basin Conditions

Occurrence of Groundwater

Groundwater in the Santa Clara River Valley East groundwater subbasin occurs in two aquifer systems, the Alluvium associated with the Santa Clara River and its tributaries, and the Saugus Formation. There are also some scattered outcrops of Terrace deposits in the basin that likely have the capacity to contain limited amounts of groundwater; however, since these deposits are located in limited areas that are situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and have consequently not been developed for water supply.

The Alluvial aquifer system, of Quaternary to Holocene (Recent) geologic age, consists primarily of stream channel and flood plain deposits of the Santa Clara River and its tributaries. The Alluvium is deepest along the center of the present river channel, with a maximum thickness of about 200 feet near the area known as Saugus. It thins toward the flanks of the adjoining hills and toward the eastern and western boundaries of the basin and, at the tributaries, becomes a mere veneer in their upper reaches. The spatial extent of the Alluvium throughout the basin is illustrated in Figure 3-1.

The Alluvium is the most permeable of the local aquifer units. Based on well yields and aquifer testing, transmissivity values in the range of 50,000 to 500,000 gallons per day per foot (gpd ft) have been reported for the Alluvium, with the higher values where the Alluvium is thickest in the center of the valley and generally west of Bouquet Canyon (Slade 1986 & 2002). The amount of groundwater in storage can vary considerably because of the effects of recharge, discharge, and pumping from the aquifer. The maximum storage capacity of the Alluvium has been estimated to be about 240,000 acre-feet (af) (Slade, 1986 & 2002).

The Saugus Formation, of Pliocene to Pleistocene geologic age, has traditionally been divided into two stratigraphic units, the lowermost, geologically older Sunshine Ranch member, which is of mixed marine to terrestrial (non-marine) origin; and the overlying, of upper, portion of the Formation which is entirely terrestrial in origin. The Sunshine Ranch Member of the Saugus Formation has a maximum thickness of about 3,000 to 3,500 feet in the central part of the valley,

Top, bottom of first paragraph
The plan states "the most significant period of Saugus pumpage was 1991 through 1994, when pumpage ranged from 10,600 afy to nearly 15,000 afy and averaged over 12,000 afy, during which time SWP water deliveries were reduced at the end of extended drought conditions".

It should be stated that the SWP water was INTERRUPTED for approximately 6 months. See Feb. 27,1991 Daily News newspaper article " Santa Clarita will turn to wells as state water supplies dry up" . As stated in the article, the SWP water processing plant was shut down. Exhibit A.

"Officials say state's water delivery system inadequate". See Exhibit B

Since 1980, total pumpage from the Saugus Formation has ranged between about 3,850 afy and nearly 15,000 afy, average pumpage over that period has been about 6,900 afy. The great majority of pumpage from the Saugus is for municipal supply (nearly 6,700 afy, or 92 percent, on average). For comparison, although historical Saugus pumping records prior to 1980 are limited, there appears to have been essentially no pumping from the Saugus prior to 1960 (on the order of about 100 af in most years, beginning in 1948), and some increased pumping for agricultural water supply beginning in about 1962 (about 900 af). The largest amount of agricultural pumping from the Saugus was during the mid-1960's, when annual Saugus pumpage was about 3,000 af. Agricultural pumping from the Saugus declined to near zero by the late 1970's, but has been generally in the 500 to 1,000 afy range since 1982. There was no Saugus pumpage for municipal supply in the early 1960's; limited data suggests that municipal pumping from the Saugus began in the 1970's, and reached nearly 5,000 afy by 1980-81. The most significant period of Saugus pumpage was 1991 through 1994, when pumpage ranged from 10,600 afy to nearly 15,000 afy and averaged over 12,000 afy, during which time SWP water deliveries were reduced at the end of extended drought conditions.

Groundwater Monitoring Network and Program

There is no formal groundwater monitoring network of wells for groundwater level measurements and/or groundwater quality sampling in the basin. Consequently, one component of this Plan is to formalize both a network of wells for groundwater monitoring and a program for water level measurements, water quality sampling, and other pertinent groundwater data collection (Primary Plan Element 2). Despite the lack of an existing formal groundwater monitoring network and program, however, there is a significant amount of historical groundwater data, some of which dates back into the 1940's, on which to base reasonable assessments of groundwater conditions in the basin. For example, groundwater level measurements have been made over varying periods of record in a total of 154 wells, mostly alluvial wells, throughout the basin. Similarly, groundwater quality data, consisting of varying numbers of constituents analyzed, are available from some wells, but a much smaller number than is the case for groundwater level data. These data, along with direct measurements or indirect estimates of pumpage, primarily from high capacity municipal and agricultural wells, allow for analysis of groundwater basin conditions, as discussed in this Plan, and also provide the bases on which a groundwater model can be developed (Primary Plan Element 3) and on which various management criteria such as operational yield, baseline groundwater quality, etc. can be determined (Primary Plan Elements 3 to etc.).

Middle paragraph.
"Exceedence of action level of perchlorate".
Newhall County Water District perchlorate level was 19 micro-grams per liter and Santa Clarita Water Co. was 24 or more micro-grams per liter.
The statement that more two wells; exceeded 18 micro-grams per liter is false. See Exhibit C

higher quality (low TDS) water and dry periods have resulted in the notable declines in water levels described above, with a corresponding increase in TDS (and individual component constituents) in the deeper parts of the Alluvium.

Due to a much more limited number of wells and the limited spatial extent of groundwater development in the Saugus Formation, long-term Saugus groundwater quality data are not sufficiently extensive to permit any sort of basin-wide analysis or assessment of pumping-related impacts on quality. Based on the most complete historical record, over the last 35 years, however, groundwater quality in the Saugus has remained generally constant, and the Saugus Formation is, on a groundwater quality basis, a viable agricultural and municipal water supply.

The most notable groundwater quality issue in the basin centers around the detection and impact of perchlorate on several Saugus wells and one Alluvial well in the central part of the basin near the location of the former Whittaker Bermite facility, which is immediately southeast of the confluence of the main Santa Clara River and its South Fork tributary. In 1997, routine water quality sampling detected the presence of perchlorate in four municipal wells completed in the Saugus Formation (CLWA Santa Clarita Water Division Saugus Wells 1 and 2, Newhall County Water District Well 21, and Valencia Water Company Well 157). While there remains no primary or secondary drinking water standard for perchlorate, and although the detected concentrations of perchlorate in the Saugus wells did not exceed the Action Level established by the State Department of Health Services at that time (18 ug/), all those wells were inactivated by their respective owners after detection of perchlorate; those wells remain out of municipal water supply service to date.

More recently, in late 2002, routine water quality sampling of Alluvial wells detected perchlorate in one of them (CLWA Santa Clarita Water Division Stadium Well) at a concentration which slightly exceeds the current Action Level (4 ug/). This well has also been voluntarily inactivated, and thus remains removed from municipal water supply service.

This Plan, notably through Primary Plan Elements 1, 6 and 8, is intended to incorporate both short-term and long-term groundwater quality considerations in the management of the groundwater basin in order to formalize groundwater quality monitoring and assessment, to investigate and correct groundwater contamination problems, and to preserve or improve groundwater quality for ongoing water supply as well as for avoiding adverse water quality impacts on interconnected surface waters.

Paragraph #2.
The statement of this paragraph is misleading. The correction should show "lack of service wells significantly reduced groundwater capacity for existing groundwater supplies, so much so, that a substantial increase of state water use, has been initiated".

Areas of Concern and Identified Problems

A number of concerns have been expressed about groundwater conditions in the basin. While not all of the expressed concerns have been substantiated, they are listed and briefly discussed here, and they are addressed in the management objectives for the basin, intended to be achieved via implementation of the various primary and secondary elements in this Plan.

The most notable concern in the basin, at least at present, is the impact of perchlorate contamination on a number of municipal water supply wells, thus affecting the available pumping capacity from some municipal wells. While perchlorate impacts on a few wells do not preclude the ability to pump groundwater in accordance with existing water supply plans, activities to characterize the contamination, and ultimately to control it and treat it, have been initiated in order to return the impacted wells' pumping capacity to water supply service. Primary Element 8 is included in this Plan to formalize the addressing of groundwater contamination issues in the basin.

Concern has also been expressed that groundwater development in the basin will adversely impact the quantity and/or quality of surface flows leaving the basin via the Santa Clara River. Such concern extends to the potential impact on groundwater in the next downstream basin, the Piru Basin in Ventura County. While there are no established provisions regarding surface flows out of the Santa Clara River Valley East subbasin, Primary Element 3 is included in this Plan to formally address the monitoring and management of surface water flows and quality within, and flowing out of, the basin. Some work is already ongoing related to this area of concern via a Memorandum of Understanding (MOU) among CLWA, other purveyors within CLWA's service area, and United Water Conservation District, which manages surface water and groundwater in the downstream basins on the Santa Clara River in Ventura County. That cooperative effort, which is incorporated into this Plan via Primary Element 9, includes integration of databases, development of a numerical groundwater flow model, and interpretation and reporting on surface water and groundwater conditions.

A third expressed concern in the basin, although never substantiated, is that groundwater is already overdrafted. Associated with that expressed concern is a related issue that reliance on overdrafted groundwater results in an overstated water supply in the basin. As discussed earlier in this Section, long-term groundwater levels, storage, and quality all indicate a lack of overdraft. As also discussed above, the importation of supplemental surface water over the last 22 years,

Plan, page #19 Dunn, page 7

References to the Urban Water Management Plan (UWMP).
The UWMP of 2000 contains incorrect information and is under legal attacks for corrections. The UWMP does not address the total interruption of the state water supply in the event of drought, earthquake, or Delta problems. It is suggested that the UWMP not be utilized or referred to until its contents have been corrected to reflect accurate and truthful information.

32,000 afy. The history and trend of municipal groundwater use in the basin are illustrated in Figure 4-1.

As noted above, until 1980, all water supply in the basin was from local groundwater. Imported surface water was first available from the State Water Project (SWP) in 1980, when a total of 1,125 af were imported into the basin. Since then, importations of SWP water have increased in two separate steady trends, interrupted by a notable decrease at the end of, and following, the 1987-1992 drought period: a steady increase beginning in 1980, to about 21,600 afy in each of 1989 and 1990, followed by a substantial decrease, to less than 8,000 af in 1991, and then a steady increase back to about 21,000 afy in 1997 and 1998, followed by further increases to about 35,000 af in 2001. The history and trends in importation of SWP water to the basin are illustrated in Figure 4-2, which also illustrates the historical trends in groundwater pumping and total water use in the basin since the importation of SWP water.

In the context of this groundwater management plan, the historical utilization of imported SWP water to augment local groundwater represents the initiation of conjunctive use of surface water and groundwater supplies, a groundwater management principle which is intended to be continued via adoption of Primary Element 5 of this plan.

Projected Water Requirements

Detailed projections of municipal water requirements were most recently completed as part of the Urban Water Management Plan prepared by CLWA and the municipal water purveyors (Newhall County Water District, Santa Clarita Water Company, and Valencia Water Company) in 2000. Those projections, which are forecast for a 20 year period, also recognize an ongoing but decreasing agricultural water demand over the same period, from about 15,000 afy in 2005 to about 7,000 afy by 2020. The municipal water demand projections in the Urban Water Management Plan were derived from utilization and interpretation of multiple projection methods, including Per-Capita Water-Use applied to population projections; extrapolation of number of service connections (using two different projection techniques, an average rate and an accelerated rate projection) applied to the rate of service connection additions since 1990; and land use projections combined with unit water use factors on multiple land use categories (urban, including residential, commercial, industrial and recreational; irrigated agricultural; and vacant and open space). The water demand projections in the Urban Water Management Plan also considered weather effects (variations due to hot-dry years vs. cool-wet years) and conservation

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In the context of this groundwater management plan, the historical utilization of imported SWP water to augment local groundwater represents the initiation of conjunctive use of surface water and groundwater supplies, a groundwater management principle which is intended to be continued via adoption of Primary Element 5 of this plan.

Projected Water Requirements

Detailed projections of municipal water requirements were most recently completed as part of the Urban Water Management Plan prepared by CLWA and the municipal water purveyors (Newhall County Water District, Santa Clarita Water Company, and Valencia Water Company) in 2000. These projections, which are forecast for a 20 year period, also recognize an ongoing but decreasing agricultural water demand over the same period, from about 15,000 afy in 2005 to about 7,000 afy by 2020. The municipal water demand projections in the Urban Water Management Plan were derived from utilization and interpretation of multiple projection methods, including Per-Capita Water-Use applied to population projections; extrapolation of number of service connections (using two different projection techniques, an average rate and an accelerated rate projection) applied to the rate of service connection additions since 1990; and land use projections combined with unit water use factors on multiple land use categories (urban, including residential, commercial, industrial and recreational; irrigated agricultural; and vacant and open space). The water demand projections in the Urban Water Management Plan also considered weather effects (variations due to hot-dry years vs. cool-wet years) and conservation

Top
"Local Groundwater" The statement is made: "That for all practical purposes the Saugus Aquifer underlies the entire CLWA service area". That statement is absolutely false! It does not!
Please correct.

Bottom paragraph:
Supplemental (SWP) Surface Water

CLWA's SWP Water Entitlement
The CLWA, indeed, has purchased water in addition to the original Table A entitlement, but cannot obtain contractual agreement to transport the additional water to the Santa Clarita Valley

water and possibly some water supply derived from water transfers and desalination outside the basin.

Local Groundwater - Local groundwater has historically been developed from the two aquifers that comprise the groundwater basin, the Alluvium that underlies the Santa Clara River and its tributaries, and the Saugus Formation that underlies, for all practical purposes, the entire CLWA service area. Those two aquifers, and the groundwater basin they comprise, are the focus of this groundwater management plan. Based on historical experience and observation of groundwater conditions, it is currently expected that ongoing utilization of local groundwater will continue to be in amounts that are generally comparable to what has historically been pumped, 30,000 to 40,000 afy from the Alluvium and 7,500 to 15,000 afy from the Saugus Formation. It is also expected that there is some additional development potential in the Saugus Formation, in the range of 10,000 to 20,000 af which might be intermittently extracted during one or more dry years when supplemental imported water might be reduced. Ultimately, it is expected that local groundwater will continue to be a component of water supply, at appropriate production levels in both aquifers, in the basin. The intent of this groundwater management plan is to ensure that ongoing utilization of local groundwater continues to result in acceptable aquifer conditions, i.e. avoidance of overdraft (Primary Plan Element 3), no degradation of quality (Primary Plan Element 6), no adverse impacts to surface waters (Primary Plan Element 2), all via continuation of conjunctive use operations that have been ongoing since the initial importation of supplemental surface water in 1980 (Primary Plan Element 5) and via monitoring and interpretation of surface water and groundwater conditions on an ongoing basis (Primary Plan Elements 1 and 2).

Supplemental (SWP) Surface Water - CLWA has a contractual Table A amount of 95,200 af of water from the SWP. CLWA's original contract, signed in 1963, was for 23,000 af, that Table A amount was later increased to 41,500 af. In 1988, CLWA purchased a Table A amount of 12,700 af from Devil's Den Water District, and it acquired another Table A amount of 41,000 af in 1995 from Kern County Water Agency and its member district, the Wheeler Ridge-Maricopa Water Storage District. There is ongoing CEQA-related litigation over the most recent acquisition of the additional SWP Table A amount, the 41,000 af acquired from Kern County Water Agency and Wheeler Ridge-Maricopa WSD. However, there has been no invalidation of the completed agreement to transfer the 41,000 af Table A amount to CLWA, and current water supply planning includes that Table A amount as CLWA corrects the CEQA technicality by preparing a new EIR to address the environmental consequences of the transfer.

Tap:
Recycled Water

It should be noted CLWA's planned recycle water program is and has been for one private business only. No public agency is receiving or is planned to receive recycled water from CLWA.

Recycled Water - In 1993, CLWA prepared a draft Recycled Water System Master Plan that outlined a multi-phase program to integrate recycled water into the overall water supply system in the basin. Construction has begun on Phase I of that project, which will deliver approximately 1,700 afy, and deliveries are expected to begin in 2003. Overall, recycled water is expected to ultimately reclaim up to 17,000 afy of treated waste water suitable for irrigation use on golf courses, landscaping, and other non-potable uses.

Plan, page #25 Dunn, page 70

Top
Number 7 should read: Valley wide integration of recycled water.

Middle
Secondary (Potential Elements) Item #2 Change to: Involvement in land use planning per Water Code 10753.7 (f)

4. Development of Regular and Dry Year/Emergency Water Supply
5. Continuation of Conjunctive Use Operations
    - active and passive groundwater recharge
6. Long Term Salinity Management
7. Integration of Recycled Water
8. Identification and Mitigation of Soil and Groundwater Contamination
    - involvement with other local agencies in investigation, cleanup, and closure
9. Development and Continuation of Local, State and Federal Agency Relationships
10. Groundwater Management Reports

Secondary (Potential) Elements

1. Continuation of Public Education and Water Conservation Programs
2. Identification and Management of Recharge Areas and Wellhead Protection Areas
    - involvement in land use planning process
3. Identification of Well Construction Abandonment, and Destruction Policies
    - water quality protection
    - manage vertical distribution of pumpage
4. Provisions to Update the Groundwater Management Plan

Primary Element 1 - Monitoring of Groundwater Levels, Quality, and Production

Prior to 1980, all water supply in the Upper Santa Clara River Area was developed from local groundwater; since 1980, imported surface water has become an increasing component of overall water supply in the area, but groundwater continues to meet all agricultural water demand and a significant part of municipal water demand. As a result of the long term development and use of groundwater in the area, there is a fairly substantial amount of historical groundwater level data, and a useful amount of groundwater quality data, and groundwater pumping data that has been collected in the basin. All the available historical groundwater level, quality, and pumping data have been organized into a computerized data base for the Upper Santa Clara River Area. That data base, while separate, has been coordinated with an equivalent data base maintained by United Water Conservation District for the downstream basins on the Santa Clara River. The intent of database coordination has been to facilitate interpretation and reporting on groundwater and other water resources related issues by the respective agencies overlying the various basins along the River.

Bottom:
As stated earlier the UWMP is inaccurate and under legal attack and not certified by the courts.
Primary Element 4 – Development of Regular and Dry Year Emergency Water Supply

40,000 acre feet from the alluvium and 15,000 a f from the Sangers is optimistic.
We strongly suggest developing an emergency plan for an extended interruption of the state water project. How many times must we ask for such an obvious safeguard!

conditions (and associated fluctuations in recharge and pumping). Such fluctuations are typical of groundwater basin conditions in any conjunctive use setting, such as in this basin: groundwater is utilized from storage during dry years, or dry periods, and that storage is replenished during alternate wet years, or periods. The observation of these historical groundwater conditions, in combination with knowledge of pumpage from both the Alluvial and Saugus Aquifers, has led to current operational practices as well as general expectations regarding the approximate yield of the local groundwater system as discussed in this plan.

While historical operating experience, complemented by observed groundwater conditions, is an appropriate basis for generally planning for available groundwater supplies, it is possible and appropriate to more precisely analyze the basin to determine values or ranges of yield under varying hydrologic conditions, and to assess the impacts of various management actions that might be implemented in the basin. The MOU process described in Primary Element 9 of this Plan includes the development of a numerical groundwater flow model which is intended to be utilized for determination of the yield of the basin under existing land use and under existing groundwater and surface water development conditions. It is also expected to be used for implementation of this Plan Element in order to assess the yield of the basin under future land use conditions as well as future ranges of surface water importation, groundwater development, and recycled water use through varying hydrologic conditions, i.e. wet and dry periods that affect the availability of imported surface water.

The ultimate intent of this Plan Element is to develop an understanding and quantification of the yield of the basin, under varying hydrologic conditions and developing local cultural conditions, in order that groundwater development and use be managed in such a way to meet an appropriate fraction of total water demand while avoiding levels of groundwater use that would result in overdraft conditions. Thus, implementation of this Plan Element is essential to accomplishing the first and second management objectives (goals) for the basin.

Primary Element 4 - Development of Regular and Dry Year/Emergency Water Supply

The most recent updated Urban Water Management Plan (UWMP, December 2010) prepared by CLWA and the other purveyors in the basin (Newhall County Water District, Santa Clarita Water Company, and Valencia Water Company) includes plans to develop 30,000 to 40,000 acre-feet per year (afy) from the Alluvial aquifer and 7,500 to 15,000 afy from the Saugus Formation in average normal years. Both ranges of numbers are consistent with recent historical pumping that

The SWP water received in 1991 is erroneous. The chart indicates 8,000 a.f. It is incorrect. CVWA only received 10% of its then allocation 54, 200 a.f. The 10% was received in January and the plant shut down in March. See Exhibit A. It should be noted that this is a state water project interruption for months, not a reduction.

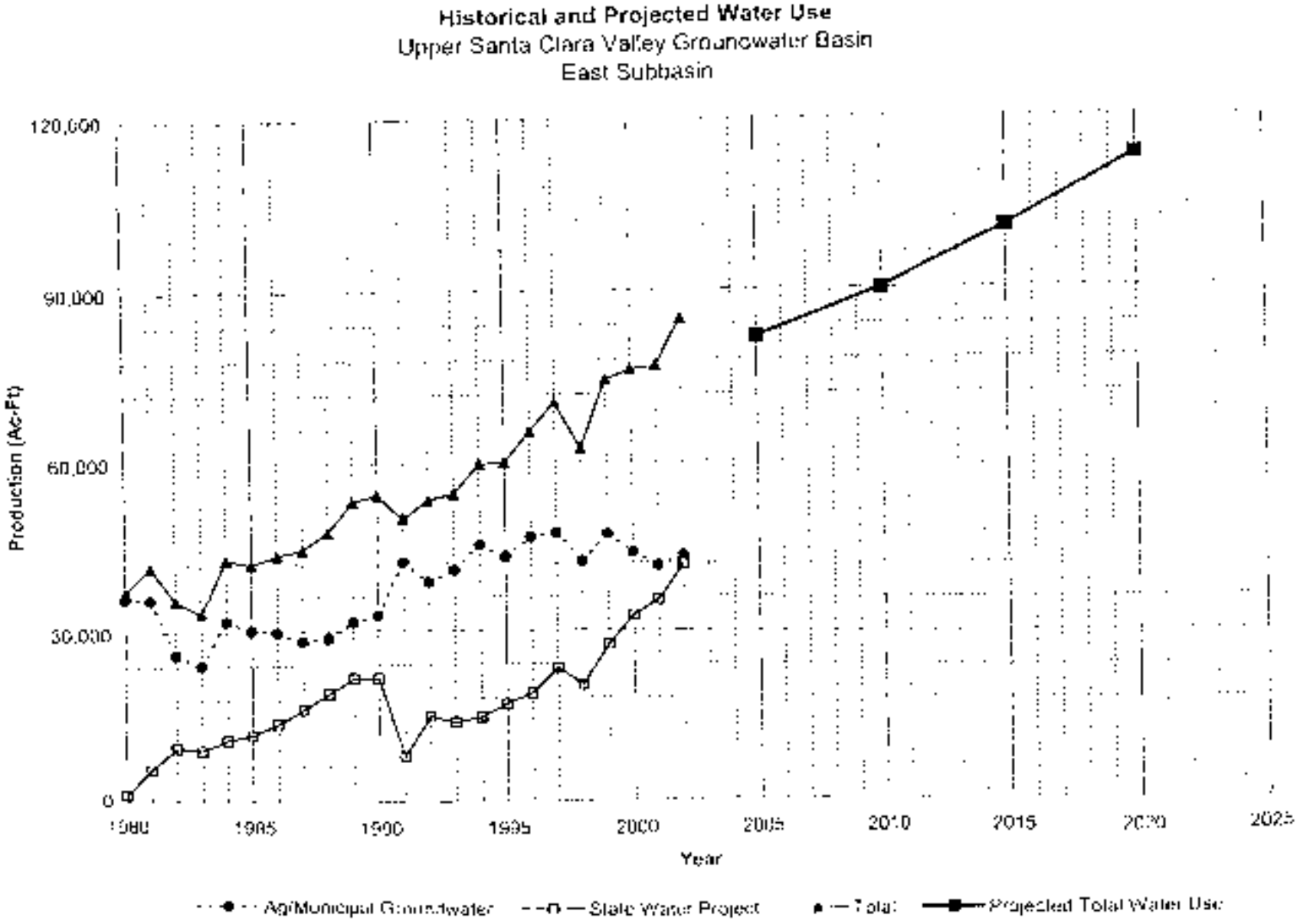

Historical and Projected Water Use
Upper Santa Clara Valley Groundwater Basin
East Subbasin
120,000
90,000
60,000
30,000
0
Production (Ac-Ft)
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year
Ag/Municipal Groundwater
State Water Project
Total
Projected Total Water Use

Figure 5-4

Plan. page #30 District page 13

Top paragraph:

There is no mention what the folks can do if groundwater cannot meet demand and the supplemental water is not there for an extended period of time. Please develop a plan to solve this most serious occurance.

Conjunctive use of local groundwater and imported surface water will continue to be a key element in meeting all the goals for the basin, most notably utilizing groundwater for water supply without overdrafting the basin. Historical experience with groundwater pumping and aquifer response to varying hydrologic conditions has shown that the groundwater basin can support notable variations in pumping during wet and dry periods, but it cannot support continuous pumping at rates high enough to meet total local water demands. Thus, utilization of imported surface water in conjunction with local groundwater will be essential to the management of groundwater for water supply without overdrafting that resource.

As part of conjunctively using surface water and groundwater, it is recognized that, particularly when the surface water supply is imported from the State Water Project, there will be variations in the amount of available surface water supply from year to year. Similarly, there are expected to be variations in local groundwater conditions as a function of local hydrologic conditions which affect, among other things, the natural recharge to the groundwater basin from year to year. In the case of this basin, local (Southern California) hydrology which affects local groundwater conditions may not necessarily be the same as the hydrology in a distant (Northern California) location that directly affects the availability of supplemental, imported surface water in any given year. Thus, conjunctive use management is challenging, but is notably important to ensure that the groundwater basin is maintained to meet a regular component of water supply and to also be able to meet a larger component of water supply during "dry periods" that affect supplemental surface water availability. Conjunctive use management is similarly important to ensure that local groundwater can be replenished, via reduced pumping and or as a result of wetter local hydrologic conditions, during periods of wet/normal surface water availability. In light of all the preceding, implementation of this Plan Element is essential to accomplishing all the management objectives (goals) for the basin.

Primary Element 6 - Long Term Salinity Management

In general, groundwater quality in the basin is such that groundwater supplies meet standards for beneficial use in the basin, most of which now is for municipal (domestic) use but some of which remains for agricultural and some other irrigation (non-domestic) use. There also have been no notable historical trends of groundwater quality degradation in the basin over time. However, a number of geologic and hydrologic factors suggest that observations and interpretation of groundwater quality warrant some focus to ensure long-term preservation of groundwater quality. Notable among those geologic and hydrologic factors are: 1) the largely "closed" geologic nature

Bottom of page:

It appears the entire paragraph is false. There is no knowledge of such meetings occurring.

Newhall County Water District, Los Angeles County Waterworks District No. 36, Valencia Water Company, and its own Santa Clarita Water Division. As such, CLWA has a historical and ongoing working relationship with all those local agencies, as well as with other local groundwater pumpers, to manage water supplies in order to effectively meet water demands within the available yields of imported surface water and local groundwater. In fact, the Advisory Council convened to assist in the preparation of this Plan is comprised representatives of all the local water purveyors and significant groundwater pumpers.

A local MOU process among CLWA, other purveyors within CLWA's service area, and United Water Conservation District in neighboring Ventura County is a classic illustration of a local agency relationship that has produced the beginnings of local groundwater management, now embodied in this comprehensive plan, most notably in Primary Elements 1 through 5. In 2001, out of a willingness to seek opportunities to work together and develop programs that mutually benefit the region as well as their individual communities, those agencies prepared and executed a Memorandum of Understanding (the MOU) that initiated a collaborative and integrated approach to several of the aspects of water resource management that are now included in this Plan. United WCD manages surface water and groundwater resources in seven groundwater basins, all located in Ventura County, downstream of the East Subbasin of the Santa Clara River Valley that is the focus of this Plan. United is thus a logical partner in the cooperation of management efforts to accomplish the objectives (goals) for this basin, particularly as they relate to preservation of surface water resources that flow through the respective basins. As a result of that MOU, the cooperating agencies have integrated their database management efforts (part of Primary Elements 1 and 2 of this Plan), have initiated the development of a numerical groundwater flow model (for utilization in Primary Elements 3, 4 and 5 of this Plan), and are continuing to prepare reports on the status of basin conditions, as well as on geologic and hydrologic aspects of the overall stream-aquifer system.

A local extension of the interaction among CLWA, the retail water purveyors, and United is an ongoing working relationship with the City of Santa Clarita. CLWA and the municipal purveyors meet regularly with City staff and also present water supply conditions via study sessions with the City Council on a regular basis. It is expected that the implementation of this Plan will result in the availability of a broader range of information transfer with the City relative to the existing and future water supply to its residents.

This Primary Element is included in this Plan to formalize the historical local and state agency

Middle:

Primary Element 10-Groundwater Management Reports
These secretly created reports contain erroneous numbers to overstate supply and understate demand. The creators meet secretly, allow no public participation or oversight and meet without authority or sanction from any public agency. The meetings are held secretly and without benefit of the Brown Act. Since these reports are created with no public oversight, do not appear to have credibility, and usually are not signed by anyone, they should not be included as part of an AB3030 groundwater management plan. It is time to form an official joint powers authority between the purveyors and other participating parties

working relationships as part of comprehensively managing local groundwater, in concert with imported surface water and local recycled water, to accomplish all the management objectives (goals) for the basin.

Primary Element 10 - Groundwater Management Reports

As briefly described in the Introduction of this Plan, local groundwater management planning already includes, among several other activities, analysis of groundwater conditions and preparation of annual reports on groundwater and all other aspects of water resources and water supplies in the Santa Clara River Valley East ground water basin. In addition, recently formalized cooperative work with neighboring United Water Conservation District includes both regular reporting on the status of groundwater conditions and specific reporting on geologic and hydrologic aspects of the overall stream-aquifer system. For example, documentation of the numerical groundwater modeling work currently in progress is expected to be the first of the latter reports in the next year.

Beginning in 1998, CLWA and the retail water purveyors in the basin have prepared a series of annual reports, known locally as the Water Report, to describe all aspects of water supply and water resource conditions in the basin. That report provides current information to local City and County land use agencies, and to other interested parties, about current water requirements, use of groundwater and treated imported surface water to meet those water requirements, groundwater conditions (pumping, groundwater levels and quality, etc.), local surface water conditions, the status of imported surface water supplies including details of delivered SWP water in the reported year as well as an up-to-date summary of available imported SWP water for the next year, a short-term projection of water requirements in the next year, and other appropriate details about water requirements and supplies such as, for example, the status of introducing recycled water as a component of non-potable water supply.

In light of the frequency and comprehensive nature of the annual Water Reports, and also in light of the planned preparation of more detailed technical reports on various aspects of the basin as appropriate, the continued preparation of those reports will serve as regular and complete reporting on all aspects of this groundwater management plan.

(Not much info on this page – CLWA constantly preaches conservation but continually sells more and more water. CLWA should provide the public with an accounting of the water CLWA is conserving.

Secondary Element 1 - Continuation of Public Education and Water Conservation Programs

CLWA has provided water conservation and public education programs that will continue and expand as a complement to and an element of this groundwater management plan. The expansion of water conservation will largely stem from CLWA's having signed the "Memorandum of Understanding Regarding Water Conservation in California" (Urban MOU) in 2002, which made CLWA a wholesaler member of the California Urban Water Conservation Council. CLWA has thus committed to implementation of cost-effective water conservation measures known as Best Management Practices (BMPs) that are included in the Urban MOU and are intended to reduce California's long-term urban water demands. The BMPs have been incorporated into the water demand management measures section of the Urban Water Management Planning Act.

Water conservation and related public education measures have generally been developed in California to achieve the following goals:

meet legal mandates
- reduce average annual potable water demands
- reduce sewer flows
- reduce water demands during peak seasons
meet drought restrictions.

As a wholesaler of imported surface water CLWA has implemented the following BMPs for several years prior to signing the MOU:

distribution system water audits, leak detection and repair
public information
school education
- wholesale agency assistance ?
- conservation pricing ?
conservation coordinator. ?

Top:

(Not much truth here either.) Mostly deception. The UWMP doesn't exist for the reasons mentioned earlier. The UWMP must not be considered here.

As a signatory to the MOU, CLWA's water conservation and public education program will expand to include the following BMPs found to be locally cost-effective, as detailed in the 2000 Urban Water Management Plan for CLWA and the Santa Clarita Valley retail purveyors.

- water survey programs for single-family residential and multi-family residential programs
- residential plumbing retrofits
  metering with commodity rates for all new connections and retrofit of existing connections
- large landscape conservation programs and incentives
- high-efficiency washing machine rebate programs (when also provided by local energy providers or wastewater utilities)
- conservation programs for commercial, industrial, and institutional accounts
- wholesale agency programs to financially or otherwise support water conservation efforts by retailers (this measure will be expanded)
  residential ultra-low-flow toilet replacement program.

This Primary Element, while identical to independent CLWA efforts in water conservation and public education, is incorporated in this Plan to complement other Plan elements, and to move toward accomplishment of all management objectives (goals) for the groundwater basin.

Secondary Element 2 - Identification and Management of Recharge Areas and Wellhead Protection Areas

The 1986 Amendments to the federal Safe Drinking Water Act (SDWA) established a new Wellhead Protection Program (WPP) to protect groundwater that supplies drinking water wells for public water systems. Each state was required to prepare a WPP and submit it to the USEPA by June 19, 1989. However, California did not develop an active state-wide Wellhead Protection Program at that time. Subsequently, in 1996, reauthorization of the SDWA established a related program called the Source Water Assessment Program. In 1999, the California Department of Health Services (DHS) Division of Drinking Water and Environmental Management developed its Drinking Water Source Assessment Program (DWSAP), and EPA approved it. The overall objective of the DWSAP is to ensure that the quality of drinking water sources is protected.

As discussed in Section 3 of this Plan, the potential groundwater management plan component

EXHIBIT A

Suppliers driven into the ground

Drought forces area to rely on well water

2-27-91

By Kimberly Heinrichs
Daily News Staff Writer

SANTA CLARITA — The state is expected to stop water deliveries March 15 in the Santa Clarita Valley, forcing the area to rely on ground water as California's worst drought on record continues, officials said Tuesday.

The Castaic Lake Water Agency, which treats, stores and distributes state water to local purveyors, will close its plant after the last of the imported water arrives, agency General Manager Robert Sagehorn said.

Related story:
■ Conservation law gets OK. Page 4

"For all substantial purposes we're shutting the plant down on March 15," he said, adding, "No one's going to go bone dry over this."

Local water suppliers still will pump water from the Santa Clarita Valley's extensive network of wells, he said.

The state Department of Water Resources told Sagehorn on Saturday that the expected cut of 50 percent of the agency's water supply has been increased to 90 percent as the drought continues its fifth year. The agency will have received 10 percent of this year's water allocation by the middle of March, Sagehorn said.

Of the four purveyors receiving state water from the Castaic Lake agency, only the Los Angeles County Waterworks District No. 36 -- which serves Val Verde

See WATER / Pg. 2

Santa Clarita will turn to wells as state water supplies dry up

2-27-91 DN.

WATER / From Page 1

and Hasley Canyon -- does not have a ground-water supply.

The county agency has drilled a well about 1,000 feet northwest of the intersection of Hasley Canyon and Del Valle roads that it had planned on using in about a year after building a 250,000-gallon storage tank, Assistant Deputy Director Gary Hartley said. However, with the new cutback, the county is hurriedly seeking permission from several property owners to run a temporary pipeline from that well to customers, Hartley said.

County officials hope to have the pipeline operating in about six weeks, he said. Meanwhile, the county is working on agreements with the three other purveyors in the valley — the public Newhall County Water District and the private Valencia Water Co. and Santa Clarita Water Co., Hartley said.

If the county cannot set aside enough well water from the other purveyors, there is a chance the state would send emergency supplies through the Castaic agency, he said.

While the city considers a law that would restrict wasteful practices in the hopes of achieving a 25 percent reduction in water use, Hartley said that county water officials are drafting a conservation proposal that would require different levels of participation in different areas. Because of the severity of the water cuts in the Val Verde and Hasley Canyon areas, he said he would expect a 20 percent to 30 percent mandatory cutback in water use.

Although the plant near Castaic Lake will be closed, the agency most likely will lay off just a temporary maintenance worker, Sagehorn said. The worker was hired when one of the two permanent maintenance workers was on medical leave and was kept on.

FOR FIG. 17 + FIG. 5-4

EXHIBIT 6

Officials say state's water delivery system inadequate

By Laura Myers
[illegible]

MONTEREY, Calif. — The top key [illegible] for many years in California because of an inadequate water delivery system, representatives of the three main groups vying for the precious commodity said Thursday.

The 5-year-old drought that has [illegible] when supplies were drastically cut only magnified the problem this year, said representatives of the urban, agriculture and wildlife interests.

"The biggest problem we have is that the reliability of the water supply is grossly inadequate," said Tim Quinn, conservation director for the urban Metropolitan Water District of Southern California. "The way the system works now, people can't count on a steady water supply because the water delivery system just doesn't work like it should."

Quinn's comments came at the annual spring conference of the California Association of Water Agencies, which attracted more than 2,000 of the state's top water officials.

Stephen Hall, representing agriculture, and Charles Hansen, representing wildlife and the environment, agreed with Quinn that the State Water Project and the federal Central Valley Water Project can't [illegible] competing water needs.

All three men portrayed dire pictures of what would happen if there weren't [illegible] if the drought continues — the quality of urban life will decline, farmers [illegible] will be jobless and wildlife will dwindle with some species becoming extinct.

But beyond the present drought [illegible] competition for scarce supplies, they said water officials must improve the delivery and storage system that essentially hasn't changed for decades.

"We shouldn't have to continue to fight one another for resources," said Hall, executive director of the California Farm Water Coalition.

The Sacramento-San Joaquin Delta, the cornerstone of the delivery system, is a bottleneck even in non-drought years, Quinn and Hall said.

Part of the problem, according to Hansen, who [illegible] environmental [illegible], is the growing importance on protecting endangered and threatened species while making water transfers in the delta.

The winter-run chinook salmon already is listed by state and federal wildlife officials as threatened and the delta smelt also is expected to [illegible] the U.S. Fish and Wildlife Service [illegible].

Certain water flow rates [illegible] when these fish spawn under wildlife protection rules, he said.

"We need to manage the delta [illegible] to provide adequate water throughout the year," Hansen said.

EXHIBIT C

A boost for toxic cleanup in state

Feds back state on perchlorate

By Heather MacDonald
Staff Writer 8-8-03 D.N.

SANTA CLARITA — The Department of Defense agreed Thursday to obey California's drinking water standards for perchlorate and not try to avoid paying for cleanup of the toxic rocket fuel byproduct.

The agreement, announced by U.S. Sen. Barbara Boxer and Pentagon officials during a visit to a contaminated site in Rialto, could help speed the cleanup of the defunct Bermite explosives factory in the center of Santa Clarita, and dozens of other polluted sites all over California, officials said.

"This is an important breakthrough," said Boxer, a California Democrat. "Defense Department activities have been a major source of perchlorate contamination in California. This kind of active cooperation will help us find and fix perchlorate problems throughout the state."

The agreement also appeared to put to rest concerns expressed by Santa Clarita leaders that legislation introduced by President George W. Bush would exempt some defense contractors from having to pay for environmental cleanups in the name of military readiness.

The Newhall County Water District Board of Directors was afraid the language of the bill could be used to let Whittaker Corp., which operated the site until 1987 and has recently begun studying the best ways to clean up the pollution, off the hook.

"The well-being of millions of Californians depends on this agreement," Boxer said.

More than 7 million Californians drink water with at least traces of perchlorate, which can damage the thyroid gland and be risky for pregnant women, whose fetuses can be affected, according to the U.S. Environmental Protection Agency.

A provisional standard set by the EPA recommends that drinking water have no more than 1 part per billion of perchlorate. The old standard considered water with 32 parts per billion of perchlorate safe.

Although the EPA is not expected to set a final standard

See WATER / Page 2

Help on the way for toxic cleanups

8-8-03 D.N.

WATER / From Page 1

until at least 2008, Boxer has called for the agency to act next year because of the threat perchlorate poses to California residents.

Five wells in Santa Clarita have been shut down because of high levels of perchlorate, with tests showing as much as 40 parts per billion of the toxin in the water, officials said. The wells draw on the Saugus Aquifer, which serves as a backup water supply for the Santa Clarita Valley in times of drought.

State officials believe the pollution is coming from the Bermite property near the Santa Clarita Metrolink Station on Soledad Canyon Road. From World War II to the end of the Cold War, several companies manufactured and tested munitions and explosives for the U.S. military on the 996-acre site.

While the California Department of Health Services requires that wells with more than 4 parts per billion of perchlorate be shut down, the state Office of Environmental Health Hazard Assessment has found that water with as much as 6 parts per billion is safe to drink.

Heather MacDonald, (661) 257-5257
heather.macdonald@scnewspapers.com

FOR PG. 15

-----Original Message-----
From: Diane Trautman [mailto:dianetrautman@comcast.net]
Sent: Friday, August 08, 2003 2:41 PM
To: Dan Masnada
Cc: Marsha McLean; Vince Bertani
Subject: Draft Groundwater Management Plan

TO: Dan Masnada

RE: Draft Groundwater Management Plan

Following are my questions and comments related to the Agency's Draft Groundwater Management Plan:

1. What percentage of the 106,000 afy (needed over the next 20 years) will be drawn from local groundwater sources? Does the Agency expect to maintain roughly the same 60% SWP/40% local groundwater mix in most years?

2. If the Saugus Formation absorbs recharge much more slowly than the Alluvial Aquifer, won't pumping of the Alluvial Aquifer at the high end of the scale over a sustained period of time reduce recharge of the Formation and reduce the amount of potable water that can be drawn from the Formation in dry periods?

3. Both this report (p. 15) and the 2002 Water Report (p. 19) state that the Agency does not have sufficient groundwater quality data on the Saugus Formation to perform an analysis of "pumping related inpacts on quality." On page 25 of this report under Primary Element 1, the Agency states that it has "a useful amount of groundwater quality data." Is the latter in reference only to the Alluvial and not the Saugus? And if the Agency does not have sufficient data on quality of water from the Saugus Formation, how does the agency propose to collect that data to ensure quality in order to maintain the current pumpage level and to increase the yield as proposed on page 21?

4. Looking back at the 2002 Water Report, the Agency indicates (on page 19) that "there are limited Saugus (Formation) water level data." Does the Agency plan to collect more comprehensive data on the Saugus Formation general groundwater stability to determine reliability of projected yields and "artificial groundwater recharge" (p. 27) capacity?

5. Regarding Secondary Element 2,the Agency states: "The results of the DWSAPs can be used as a planning tool to guide land use development in the vicinity of water sources." Is the Agency currently sharing more recent, detailed information with the City regarding contamination risks in relation to the existing closed wells?

6. Where is the SCWC Stadium Well located?

7. Why is "Continuation of Public Education and Water Conservation listed as a Secondary (Potential) Element" when increased conservation savings are projected to reduce water demand by 10%? Shouldn't conservation be one of the primary elements of water management?

8. How is the Agency delivering recycled water to the TPC? Is it being run through a parallel piping system? Is so, what is the estimated cost and time frame for constructing such a system to carry the estimated 17,000afy? And how does the Agency propose to pay for this system?

9. How is the recycled water in locations, such as the golf course, reprocessed to remove pesticides and fertilizers?

10. What is the current average per capita water usage in afy?

11. The Semitropic Water Bank/Transfer is not mentioned in discussion of the Supplemental (SWP) Surface Water on page 21. Is that because it is a relatively short-term water supply? Are any of the other water transfers – Kern Water Bank, Kern Delta Water, North Las Posas Water Bank – as listed on UWMP p. 2-16, of limited duration? And if the Semitropic Water Bank Transfer is short term, how can it be included in the 105,000-106,000 afy need projected for the next 20 years? What will take its place?

12. What specific efforts will be made to manage salinity?

Thank you for giving me an opportunity to respond.

Diane Trautman

Responses to Trautman

1. In terms of groundwater management planning, projected urban water demand (the 106,000 afy projected urban demand in 2020) does not represent total valley-wide demand; total projected demand is 113,100 afy, including both urban and agricultural. In that light, on an average basis, local ground water is expected to be utilized to meet about 40 percent of total water demand.

   In regards to maintaining "roughly the same 60% SWP 40% local groundwater mix in most years", please refer to page 20 of the draft GWMP for a more complete response to your question. For example, about 54 percent of water demand in 2001 was supplied by local groundwater, and about 46 percent was supplied by imported SWP water. Also please refer to Table II-5 in the 2002 Santa Clarita Valley Water Report, which displays the build up of SWP water use through time, and the relative percentages of groundwater and SWP water used in a given year. As noted above, it is expected that, over time, again on an average basis, the annual amount of local groundwater pumping will not appreciably change but its fraction of total water supply will decrease. Conversely, over time, and once again on an average basis, both the annual volume of imported SWP water and its fraction of total water supply will increase.

2. No. Since the Saugus Formation is recharged over a much larger area, beyond the spatial extent of the Alluvium. There is a limited relationship between Alluvial pumping and recharge to the Saugus Formation.

   The fundamental tenet of the GWMP is to utilize groundwater for water supply within its sustainable yield (see the Management Objectives, or Goals, for the Basin, GWMP Section II; see also the various GWMP Elements intended to achieve those objectives, GWMP Section V). In that light, it is expected and intended to operate in such a way that recharge to the Saugus Formation will not be "reduced" by pumping from the Alluvial Aquifer and that groundwater will be available in varying amounts, as needed depending on weather year-types, within the sustainable yields of the respective aquifers (i.e. without overdrafting them).

3. The reference to "useful amount of groundwater quality data" in the GWMP includes both Alluvial and Saugus data. However, due to the historically greater development and use of groundwater from the Alluvium (number and distribution of wells, volume of pumping), and due to the historically smaller development and use of the Saugus Formation (fewer wells, smaller geographical distribution of wells, smaller pumpage), there is a comparatively limited ability to examine relationships among pumping, recharge, and quality in the Saugus. CLWA and the other purveyors intend to expand the overall knowledge of the Saugus Formation as that resource is further explored and

developed (number of wells, additional sampling as new wells are added, etc.) All that data will be included in ongoing implementation of GWMP Primary Element 1, Monitoring of Groundwater Levels, Quality, and Production.

4. The "limited nature of Saugus water level data" is a result of the same smaller extent of historical Saugus development described in the preceding answer. Acquisition of additional data on the Saugus Formation is planned as also described in the preceding answer.

5. All publicly available information regarding the investigation of perchlorate contamination, its extent, its impact on water supply, and plans for cleanup, control of migration, etc. is available to the City. Representatives of CLWA and the purveyors meet routinely with City representatives to review the status of perchlorate cleanup and remediation activities. CLWA and the impacted water purveyors will continue to pursue control and cleanup of perchlorate contamination in order to restore impacted groundwater pumping capacity and to ensure the long-term quantity and quality of groundwater in accordance with the GWMP. As a practical matter, there are no surface contamination risks relating to perchlorate that would affect land use development adjacent to the wells.

6. The stadium well is located on the south side of the Santa Clara River, approximately two miles upstream (east) of its confluence with the South Fork tributary, or about 4,000 feet east of the Bouquet Canyon Road crossing of the Santa Clara River.

7. The assignment of "primary" or "secondary" status to any GWMP element is discretionary and certainly not absolute. Secondary status is not intended to indicate that any element of the GWMP will not be implemented; all elements are intended to be implemented. Final status of all GWMP elements will be reviewed by the Advisory Council and decided by the CLWA Board.

8. Recycled water is being delivered to the TPC via the dedicated, recycled water distribution system, which is also capable of delivering water to other non-potable water users, and which will be expanded in accordance with the Draft Recycled Water Master Plan. The costs and time frame for expanding recycled water distribution and use are included in the Draft Recycled Water Master Plan, which is complementary to, but beyond the scope of the Groundwater Management Plan. The intent is to develop the 17,000 AFY of use by 2020. The capital cost of the complete system is estimated to be $68 million, and will be funded through CLWA's connection fee program.

9. Recycled water is not "reprocessed" at points of use such as the TPC golf course. In general, recycled water is highly treated (tertiary treated) waste water. In the case of the Santa Clarita Valley, treatment already occurs at the Valencia Reclamation Plant operated by the Sanitation Districts of Los Angeles County. The treated water, ready for non-potable use, is distributed from the plant site in a dedicated transmission pipeline system to end users such as the TPC. Pesticide and fertilizer uses, as part of cultural practices at end-user locations such as golf courses, are discretionary actions of the respective end users of recycled water.

10. Most water agencies no longer use "per capita" water use as a standard because it is not an accurate representation of actual per person water use, mainly due to the effects of landscape and commercial/industrial water use. (It is also expressed in "gallons per day," rather than "acre-feet per year, since it refers to individual water usage.") In general for the South Coast hydrologic region of California, water use is approximately 200 gallons per person per day (DWR Bulletin 160-98). Per capita use for the Santa Clarita Valley is slightly higher than this due to landscape irrigation demands caused by local climate conditions.

11. The SWP is referred to as "supplemental" water because that is the original purpose of the SWP: to serve as a supply that would "supplement" local supplies (whether groundwater or local surface water or both). The specific amounts referred to in the GWMP are from the contractual terms between CLWA and the California Department of Water Resources.

    The water banked in the Semitropic Water Storage Program during 2002 is a short-term, dry period supply. The program has a term of ten years (i.e., the water must be returned to CLWA for use in its service area within that time period). Thus it is not included as a supply for long-term needs. However, the other programs listed in the UWMP (most of which, by the way, are not water "transfers," but are instead groundwater banking programs) are long-term sources of supply. As of this writing, the Agency is in the process of designing and implementing a Long-Term Reliability Plan to begin bringing such long-term programs on line as a means to store water available in wet years, for use in later dry years. CEQA analysis, with its accompanying public comment opportunities, will be part of the long-term reliability program approval process.

12. Primary Element 6 – Long Term Salinity Management is included in the GWMP for the reasons presented in the text discussion of that element. The element recognizes the need to plan for salinity management but also recognizes that, to the present, there has been no extraordinary trend of salinity increase. Hence, there are no specific efforts currently in place to "manage" salinity. It is envisioned that specific efforts will be developed over

time in response to implementation of the GWMP and, in particular, its Primary Element 6

CLWA is participating in efforts by the Sanitation Districts of Los Angeles County to address the Los Angeles Regional Water Quality Control Board's proposed TMDL standard for chloride in the Santa Clara River. This effort is separate from and beyond the scope of the Groundwater Management Plan.

Additional Comments

Ed and Joan Dunn
15414 Rhododendron Dr.
Canyon Country, CA 91387
November 25, 2003

Castaic Lake Water Agency
President Peter Kavoumas and Board of Directors
27234 Bouquet Canyon Road
Santa Clarita, CA 91350-2173

Re: Groundwater Management Plan (AB 3030) Nov. 2003 Draft

Dear President Kavoumas and Directors:

We would like to comment on some statements of your new draft plan. On page 38 there is a bullet - Conservation pricing. Since we have never seen any conservation pricing locally, this should be explained or removed. We seriously question this being presently implemented.

On page 41, we ask why you are stating that only the eastern portion of the alluvium has experienced historical fluctuations in groundwater levels. How can there be constant groundwater levels in the western portion of the basin, when the western basin is supposed to receive its re-charge primarily from the eastern portion of the river? You imply that tributaries in the Bouquet Canyon area are the source of water in that area. We believe you are avoiding the real source of water to the area. That source appears to be the large amount of effluent from Sanitation District #26, and is maintaining the water level. Why is this not explained?

As usual, there is no explanation for a total extended interrupt of the state wholesale water system or the CLWA facilities!

We are disappointed that of the numerous comments of August 8, 2003 that we supplied, only a few were considered. We spent our time and efforts to supply comments and suggestions to make the water plan a good plan. So much for that!

Sincerely,

Ed and Joan Dunn

November 25, 2003

Mary Lou Cotton
Water Resources Manager
CLWA
via fax only

Subject: November 25, 2003 Groundwater Management Plan Protest Hearing

I will not be attending the protest hearing this evening, but I do have three comments on the information you provided to me.

First, I commented previously on the proposed network of monitoring wells and the public availability of data. The monitoring wells in figures 5-1 and 5-2 appear to cover a wide range of the valley. However, the text on p. 27 states the network will be mostly as illustrated in figures 5-1 and 5-2, but possibly expanded. I hope the final network is extensive and covers all areas of the valley. Further expansion of the network would add valuable data points and should be encouraged.

I did not see any indication of whether the collected monitoring data would be publicly available. I have heard comments from others that some well data is not being released to the public even upon request. I think that concerned citizens and groups should be allowed access to the monitoring database.

Second, I have one new comment on the wording on page 34 regarding perchlorate cleanup. The last paragraph states "The proposed pumping would be combined with approved wellhead treatment to render the treated water suitable for municipal supply." This may be a wording issue, but my understanding is that wellhead treatment is not always approved or allowed by the permitting agencies. This wording implies that wellhead treatment is already an approved scenario. While it may be determined that treatment followed by re-injection of non-potable usage makes more sense, I think it would be more accurate to not specify the final treatment scenario until the plume characterization is complete and the pilot studies are finished and accepted.

Finally, the plan is clearly an overview that will have to be expanded upon with supporting policies and target dates. Some commenters requested more information on goals in the groundwater plan. While the agency does not add implementation strategies and target dates to the plan, they should be prepared, separately updated annually, and made available to the public upon request.

I understand the time for commenting may have past, but if you are able to address these comments on the final draft, I would be appreciated.

Sincerely,

Maria Gutzeit
24463 Shadeland Dr
Newhall, CA 91321

CH2MHill, "Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration" (April 2004)

Final Report

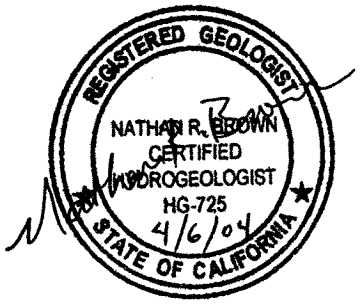
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Development and Calibration

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water District



April 2004

CH2MHILL

Executive Summary

The water purveyors in the Santa Clarita Valley of Southern California have constructed a regional-scale numerical groundwater flow model of the valley. The model, which is called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. Figure ES-1 shows the study area, including the Regional Model's boundaries. Figure ES-2 shows the extent of the watershed that the valley occupies, and shows the sub-watersheds that drain into the study area covered by the Regional Model.

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the Upper Basin Water Purveyors in the Santa Clarita Valley and the United Water Conservation District in Ventura County. This report documents the construction and calibration of the Regional Model, including presenting the conceptual hydrogeologic model on which the Regional Model is based.

ES.1 Model Development Objectives and Approach

The Regional Model is intended to become an evolving tool for managing the local groundwater resource. Specific objectives that are identified for the model are:

a. To be able to evaluate the long-term sustainability (yield) of the two aquifer systems that are present in the valley, the Alluvial Aquifer and the Saugus Formation, under a range of existing and potential future water resource management conditions

b. To be able to evaluate artificial recharge to increase the long-term sustainability of the aquifer system, particularly in conjunction with the availability of imported surface water supplies

c. To evaluate the influences of future water management plans and alternatives on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County

d. To facilitate general management of water quantity and water quality issues

The approach to developing the Regional Model included the following steps:

1. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system

2. Creating a variety of data sets to conduct steady-state and transient calibrations

3. Constructing the Regional Model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley

4. Calibrating the Regional Model
5. Performing sensitivity tests on the Regional Model

ES.2 Hydrogeology of the Santa Clarita Valley

Section 2 of the report describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the State Water Project (SWP) in the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report focuses particularly on information of specific relevance to development of the Regional Model. Figure ES-3 is a schematic representation of the regional-scale geology and hydrologic cycle in the Santa Clarita Valley. Figure ES-4 is a geologic map.

ES.2.1 Geology

The geology of the valley is defined in part by the non-water-bearing bedrock that underlies and surrounds the valley's aquifer systems. This bedrock forms a bowl-shaped aquifer system, which is thickest at the center of the valley and progressively thins outwards towards the margins of the valley. The deeper of the two aquifer systems is contained in the Saugus Formation, which consists of lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. The most productive portion of the Saugus Formation is thought to be the area southwest of the San Gabriel Fault. The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone that preclude development of municipal water supplies. Evidence from geophysical logs also indicates that the groundwater in much of the Sunshine Ranch Member may be somewhat brackish in quality.

Overlying the Saugus Formation is the Alluvial Aquifer, which consists of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

ES.2.2 Groundwater Recharge

Average annual rainfall in the Santa Clarita Valley is approximately 18 inches per year, and higher (up to 30 inches per year or more) in the surrounding mountains. Natural groundwater recharge occurs from direct precipitation and from stormwater flowing in the Santa Clara River and its tributaries. Each of these streams have their headwaters in areas lying upstream of the Alluvial Aquifer and Saugus Formation. Consequently, stormwater that is generated in these upstream watersheds flows into the valley and is an important source of groundwater recharge. Because the climate is semi-arid, rainfall and stormwater runoff occur primarily between November and March and can vary considerably in

magnitude from year to year. The direct precipitation in the valley and the recharge of stormwater generated in upstream watersheds together provide approximately 94 percent of the total groundwater recharge to the valley's groundwater resources. Irrigation on agricultural and urban lands represents another 4 percent, and underflow beneath Castaic Dam into the adjoining Alluvial Aquifer is estimated to represent approximately 2 percent of the total basinwide groundwater recharge.

ES.2.3 Groundwater Discharge

Groundwater discharge from the Alluvial Aquifer occurs primarily as discharge to the Santa Clara River and evapotranspiration (ET) by the riparian vegetation growing along the river corridor. The Alluvial Aquifer also discharges as subsurface outflow into the Piru Basin at Blue Cut, which is located just downstream of the Los Angeles-Ventura County line. Groundwater pumping occurs from both the Alluvial Aquifer and the Saugus Formation, and Saugus Formation groundwater also discharges to the Alluvial Aquifer.

ES.2.4 Aquifer Physical Properties

Specific capacity data from Alluvial Aquifer production wells indicates that the horizontal hydraulic conductivity is approximately 300 to 700 feet per day, and possibly higher, along the Santa Clara River. In the tributaries, the horizontal hydraulic conductivity is approximately 100 to 600 feet per day. The horizontal hydraulic conductivity in the Saugus Formation has been estimated to be approximately 6.5 feet per day, based on pumping and injection tests conducted on production wells with long screen intervals.

ES.2.5 Basin Hydrology

Long-term records of groundwater elevations and pumping exist for the Alluvial Aquifer throughout the valley. These records indicate that groundwater elevations can fluctuate significantly from year to year in the eastern part of the valley, in response to patterns of droughts and above-normal rainfall. In the western part of the valley, groundwater levels are stable, as this is the regional groundwater discharge area. Despite the variations in groundwater elevations in the eastern valley and the variations in pumping throughout the valley during the past five decades, groundwater elevations in the Alluvial Aquifer have shown no permanent long-term declines. In addition, the availability of SWP water has allowed the valley to become increasingly urbanized, and the resulting gradual increase in urbanization and SWP water imports have resulted in a gradual increase in flows in the Santa Clara River.

Similar conditions are seen in the Saugus Formation. From the late 1980s through the early to mid-1990s, groundwater elevations declined in response to drought conditions and increased pumping. However, starting in the mid-1990s, Saugus groundwater elevations increased notably as pumping decreased and rainfall increased. As with the Alluvial Aquifer, the Saugus Formation showed groundwater elevation recovery to levels seen prior to the drought.

ES.2.6 Water Supply

The Santa Clarita Valley obtains its water supply from local groundwater sources and from SWP water that is delivered to the Castaic Lake Water Agency by the California Department

of Water Resources (DWR) via the California Aqueduct. Water use includes municipal and agricultural uses.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 acre-feet per year (AF/yr). Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The Castaic Lake Water Agency (CLWA) has a contract amount of SWP Table A water of 95,200 AF/yr. Modeling by DWR has indicated that actual SWP water imports, based on the current CLWA Table A contract amount, will be 66,300 AF/yr in wet years, 56,800 AF/yr in average years, and 37,900 AF/yr in multiple dry years. The occurrences of drought years in the SWP system is based on the hydrology of Northern California, and hence only occasionally coincides with the occurrence of drought locally. In addition to the above entitlements, DWR occasionally releases flood flows into Castaic Creek from Castaic Dam. These flows averaged 15,700 AF/yr during the 24-year period of water years 1977 through 2000. However, no flood flows were stored or delivered in five of those years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow).

ES.3 Model Construction

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation wherever the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member.

The boundary conditions in the model consist of specified flux boundaries for precipitation; irrigation; recharge from ephemeral streams; pumping; and underflow from beneath Castaic Dam. Head-dependent flux boundaries are used in the perennial reach of the Santa Clara River, and to model any residual drainage of groundwater that might occur in the

ephemeral reach under high water table conditions. A head-dependent flux boundary is also used for ET. A constant-head boundary was used in the Alluvial Aquifer at the downgradient (western) end of the valley, at the County Line gage.

Groundwater recharge rates were estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates were calculated using a detailed Surface Water Routing Model that was written specifically for the construction and calibration of the Regional Model. Pumping rates and pumping depths were defined from groundwater pumping and well construction records.

ES.4 Model Calibration Process

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation. The steady-state calibration was performed for calendar years 1980 through 1985, and the transient calibration was performed for calendar years 1980 through 1999. The goals of the calibration process were generally to match groundwater flow directions, groundwater gradients, and groundwater elevations that were measured throughout the 20-year simulation period at wells across the valley. Figures ES-5 and ES-6 show the locations of wells that were used to evaluate calibration in the Alluvial Aquifer and the Saugus Formation, respectively. The figures also show how each aquifer was subdivided into zones to facilitate parameter selection and model calibration. An additional calibration goal was to match the patterns of total flow in the Santa Clara River and estimated groundwater discharge rates to the river. Model variables were adjusted in a manner that sought to honor independent estimates of parameter values while resulting in the best possible calibration.

ES.5 Model Calibration and Sensitivity

The Regional Model meets most of the qualitative and quantitative goals that were established for the calibration process. For the steady-state model, statistical goals for the head residuals, which are equal to the modeled minus measured groundwater elevations, were easily met for the Alluvial Aquifer and adequately met for the Saugus Formation. For the transient model, trends in groundwater elevations were generally well matched. However, during the mid- and late 1990s, the model tended to simulate too much decline in Alluvial Aquifer groundwater elevations in the eastern-most portion of the valley and water level fluctuations that were too variable in Castaic Creek. Groundwater discharges to the river were simulated well for both the steady-state and transient models.

The groundwater budget for the 20-year transient calibration period showed that recharge from precipitation and streamflows varied considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to as much as 270,000 AF/yr in the wettest years (see Figure ES-7). In contrast, total groundwater discharges were less variable, ranging from approximately 61,000 AF/yr at the end of the late 1980s/early 1990s drought to 116,000 AF/yr during 1998 (see Figure ES-8). This variability in groundwater discharge did not follow the year-to-year pumping patterns, but instead was caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlated well with groundwater recharge patterns. During the 20-year transient

calibration period, changes in the volume of groundwater stored in the combined Alluvial-Saugus aquifer system varied primarily according to year-to-year variations in regional rainfall. No long-term decline in groundwater storage was observed in the field or simulated by the model (see Figure ES-9) during this period. As Section 2.6.2 of this report will discuss, available data dating back to the 1950s also show that no long-term water level declines have occurred in the valley, despite past periods of significant pumping (particularly during the 1950s) and drought cycles.

Sensitivity analyses were performed to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the Regional Model. Variables that were tested were the hydraulic properties (horizontal and vertical hydraulic conductivities and storage coefficients) for the Alluvial Aquifer and the Saugus Formation; the riverbed leakage terms for the Santa Clara River and Castaic Creek; and the ET parameters. The sensitivity analysis indicated that the model is calibrated well and that it is sensitive to the choices of horizontal hydraulic conductivity in both aquifers and vertical hydraulic conductivity in the Saugus Formation. The Regional Model was also sensitive to the riverbed leakage terms in both groundwater recharge and groundwater discharge areas. However, the model was insensitive to the choice of ET parameters.

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property)

c. Its use of an integrated model of the watershed, the Surface Water Routing Model, to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

ES.6 Model Use and Recommendations

The Regional Model is generally well-calibrated and therefore can be applied to meet the objectives for which it was developed. Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. It is recommended that future applications of the model include sensitivity analyses on key variables and that the Regional Model and the Surface Water Routing Model be updated as water use conditions change in the future. Additionally, data gathering efforts should continue or resume, to facilitate updates of the Regional Model. In particular, controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at the locations of new Saugus Formation wells and streamflow monitoring should resume at the Lang gage, in order to better understand the magnitudes and timing of Santa Clara River flows into the valley.

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Figures

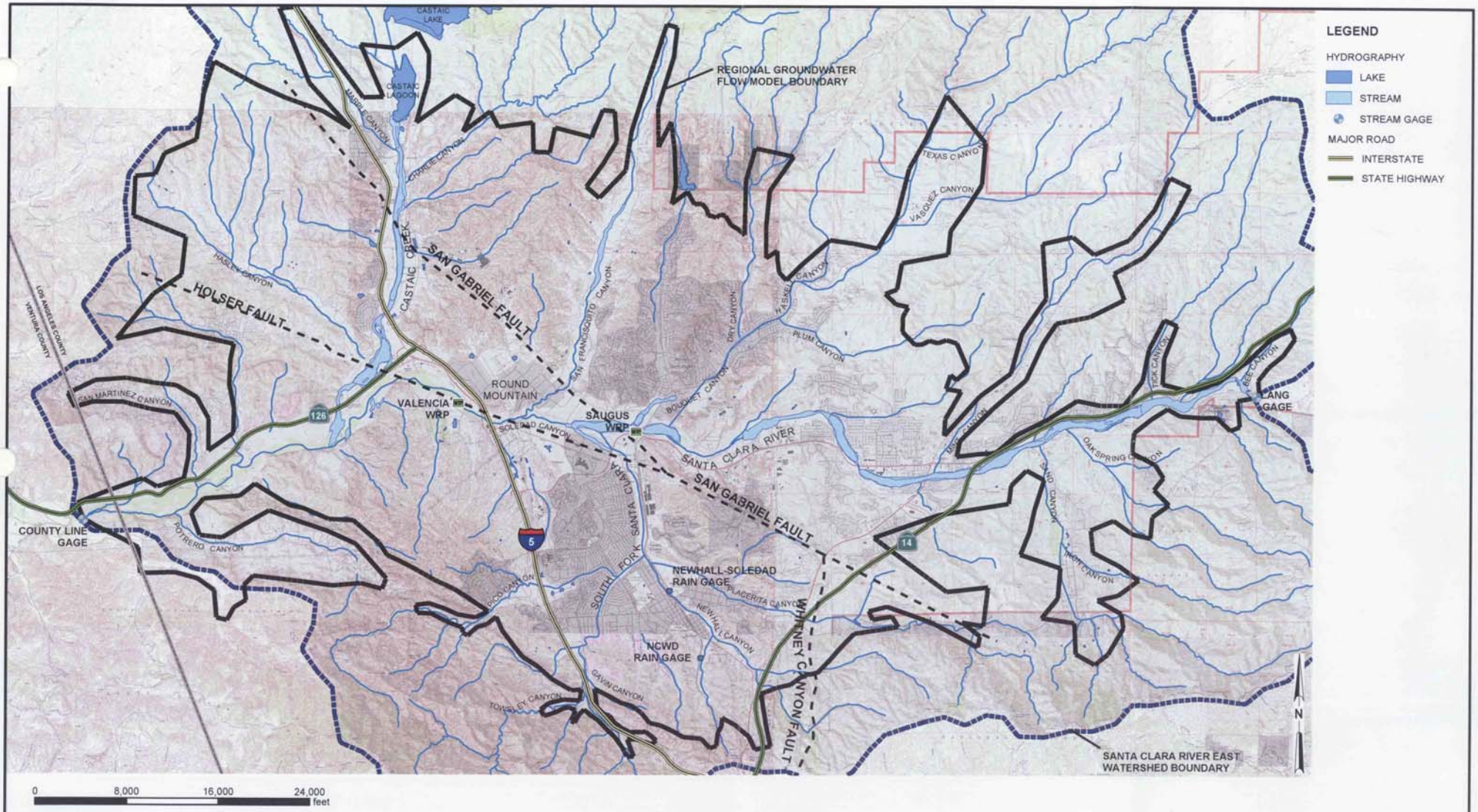

FIGURE ES-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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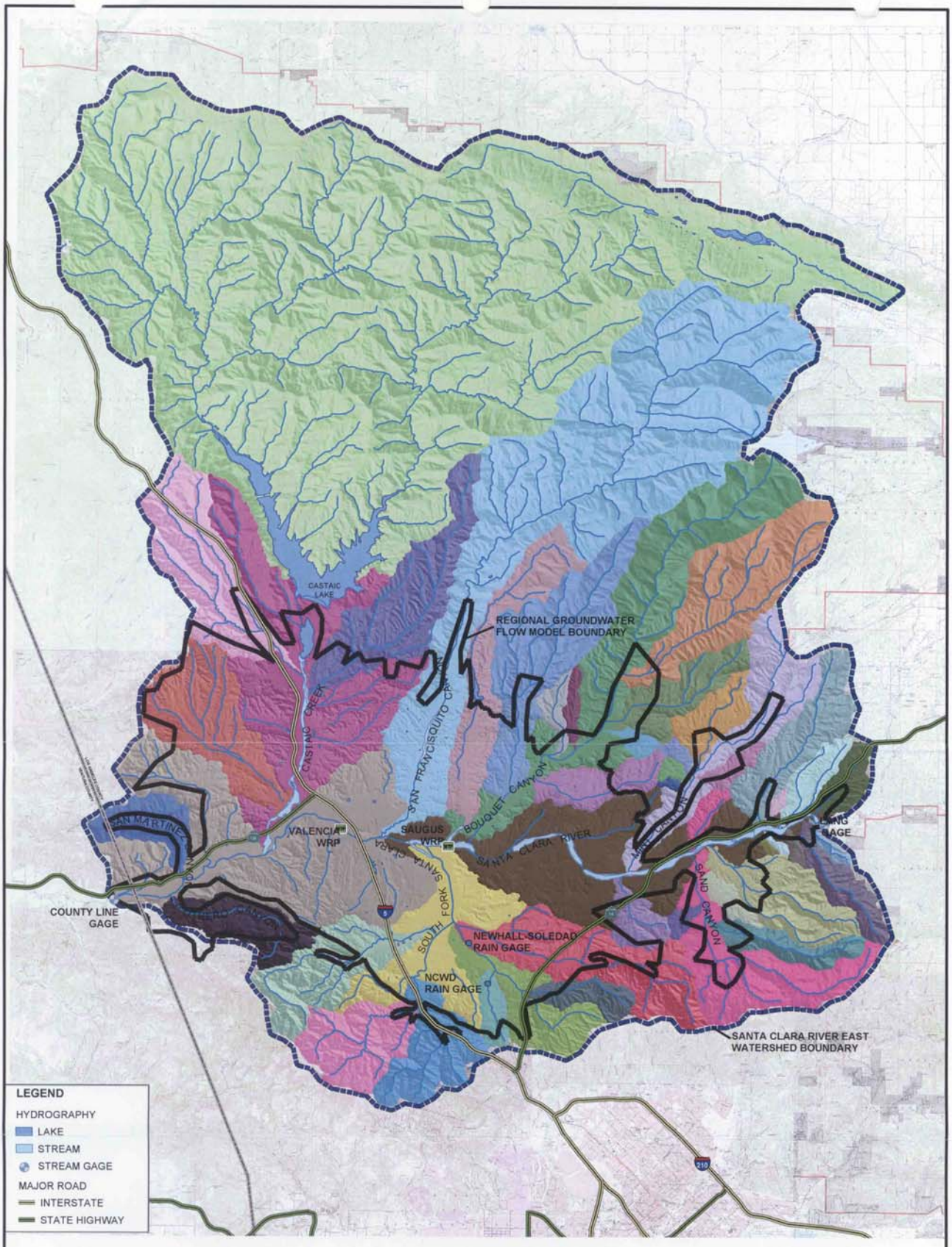

FIGURE ES-2
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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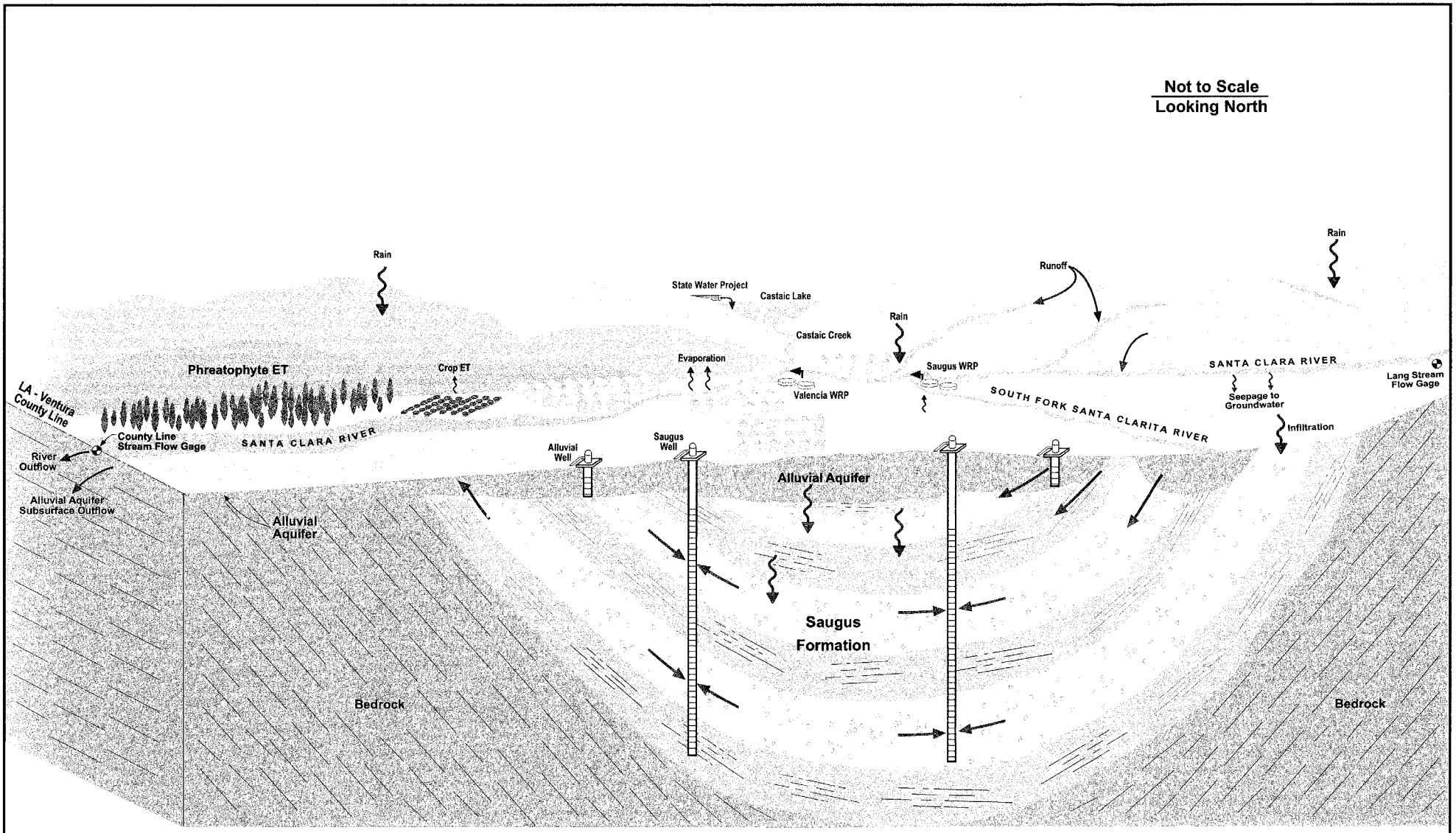

FIGURE ES-3
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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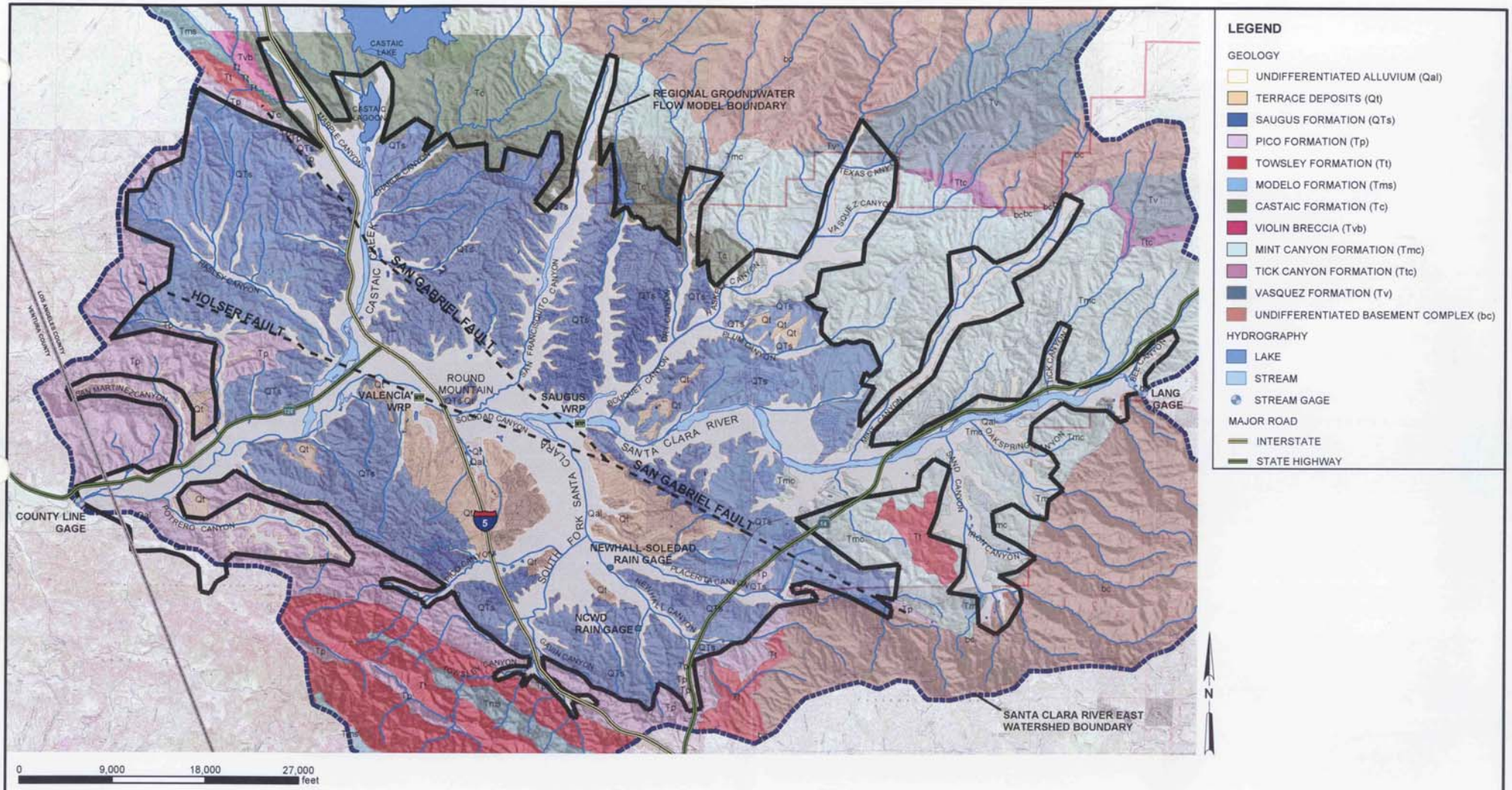

FIGURE ES-4
BASIN GEOLOGIC MAP
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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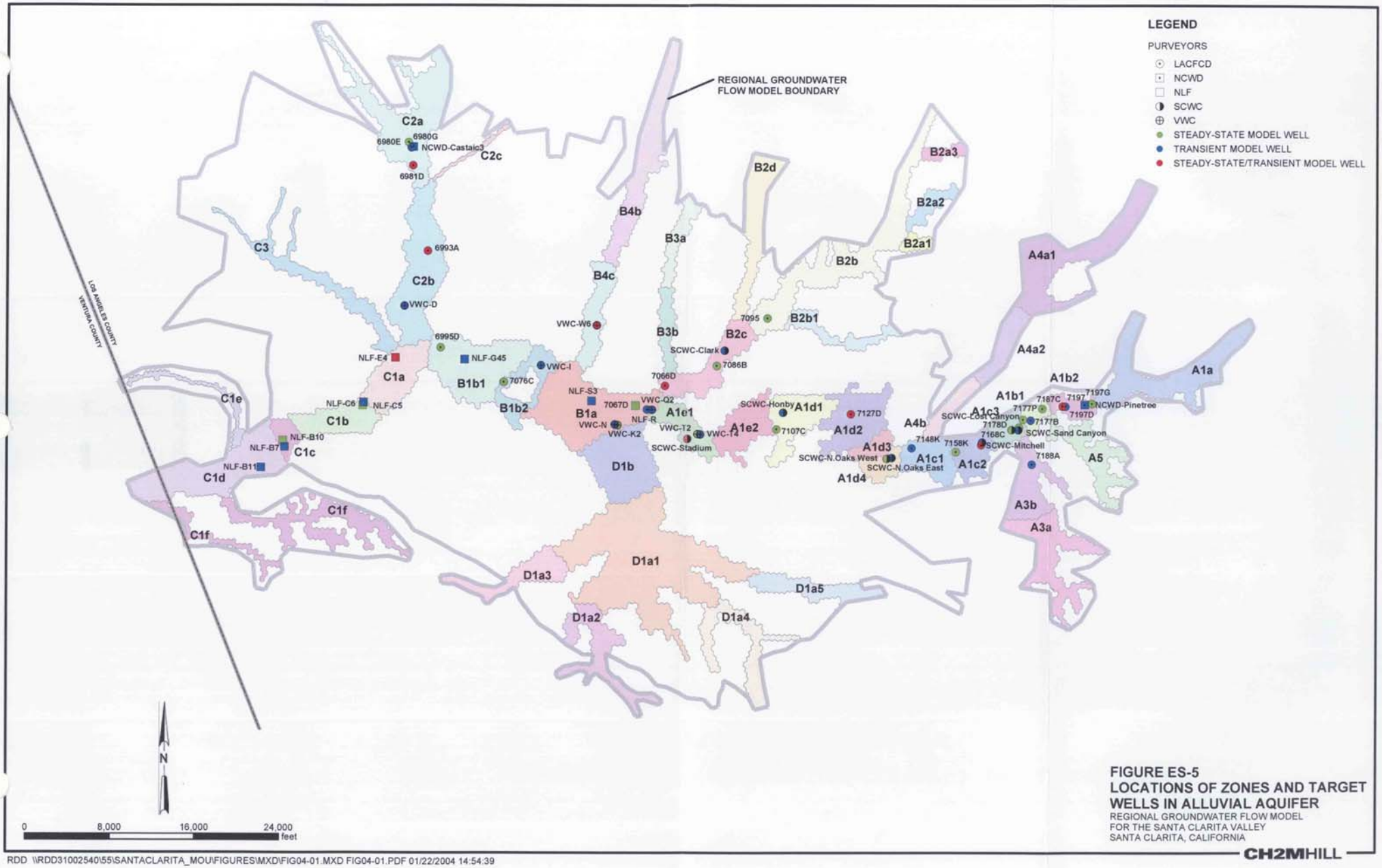

FIGURE ES-5
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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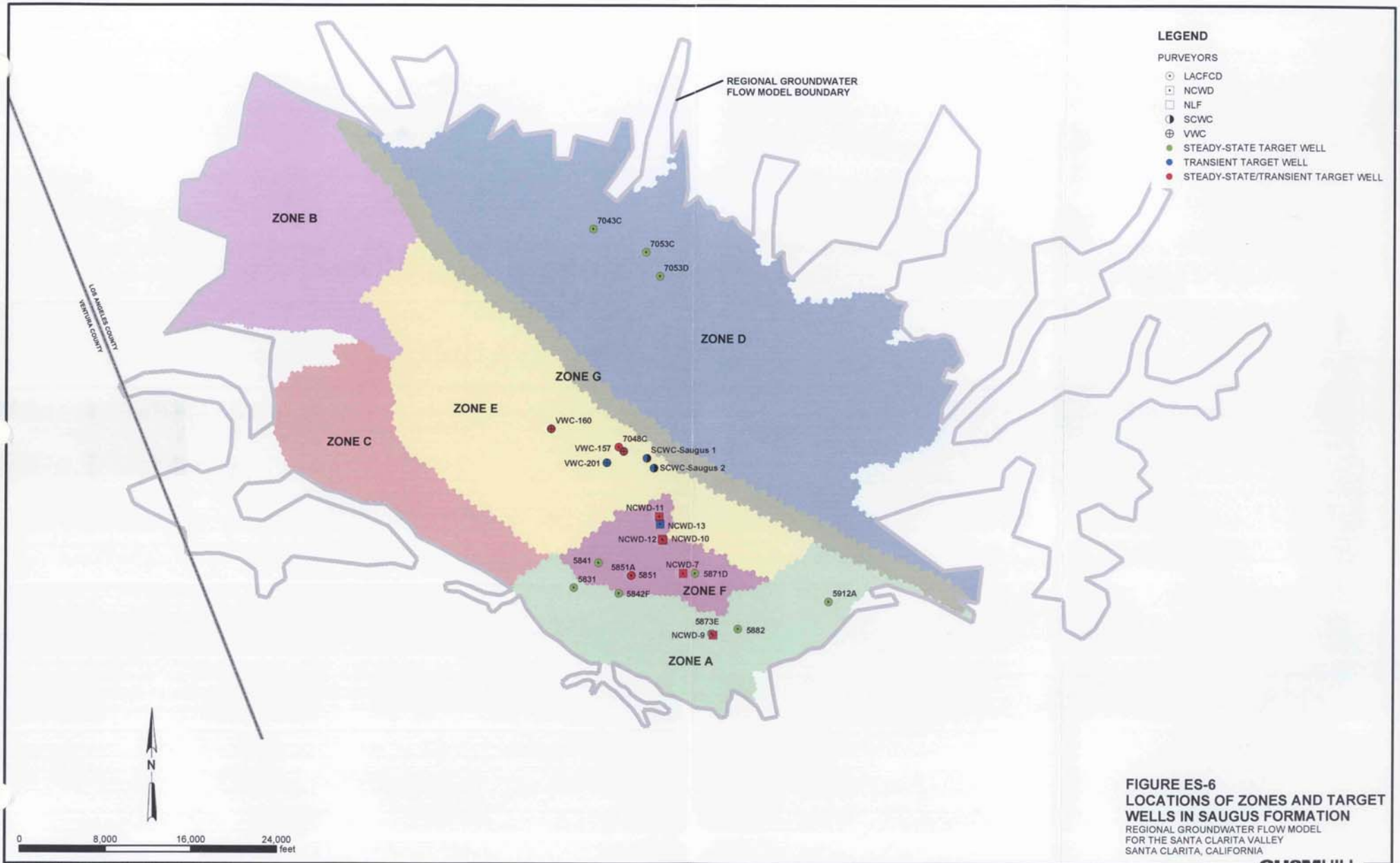

FIGURE ES-6
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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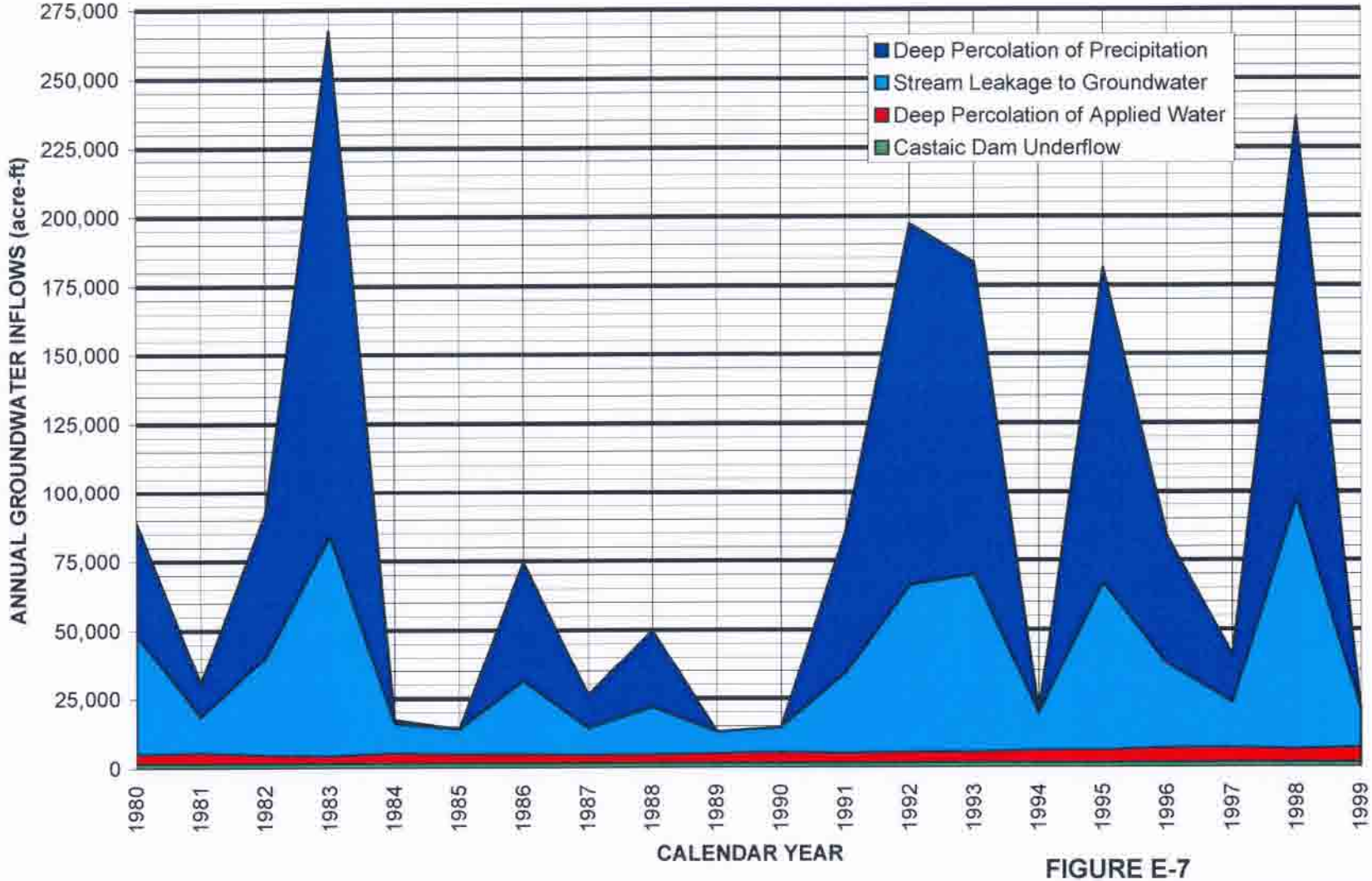

FIGURE E-7
ANNUAL GROUNDWATER INFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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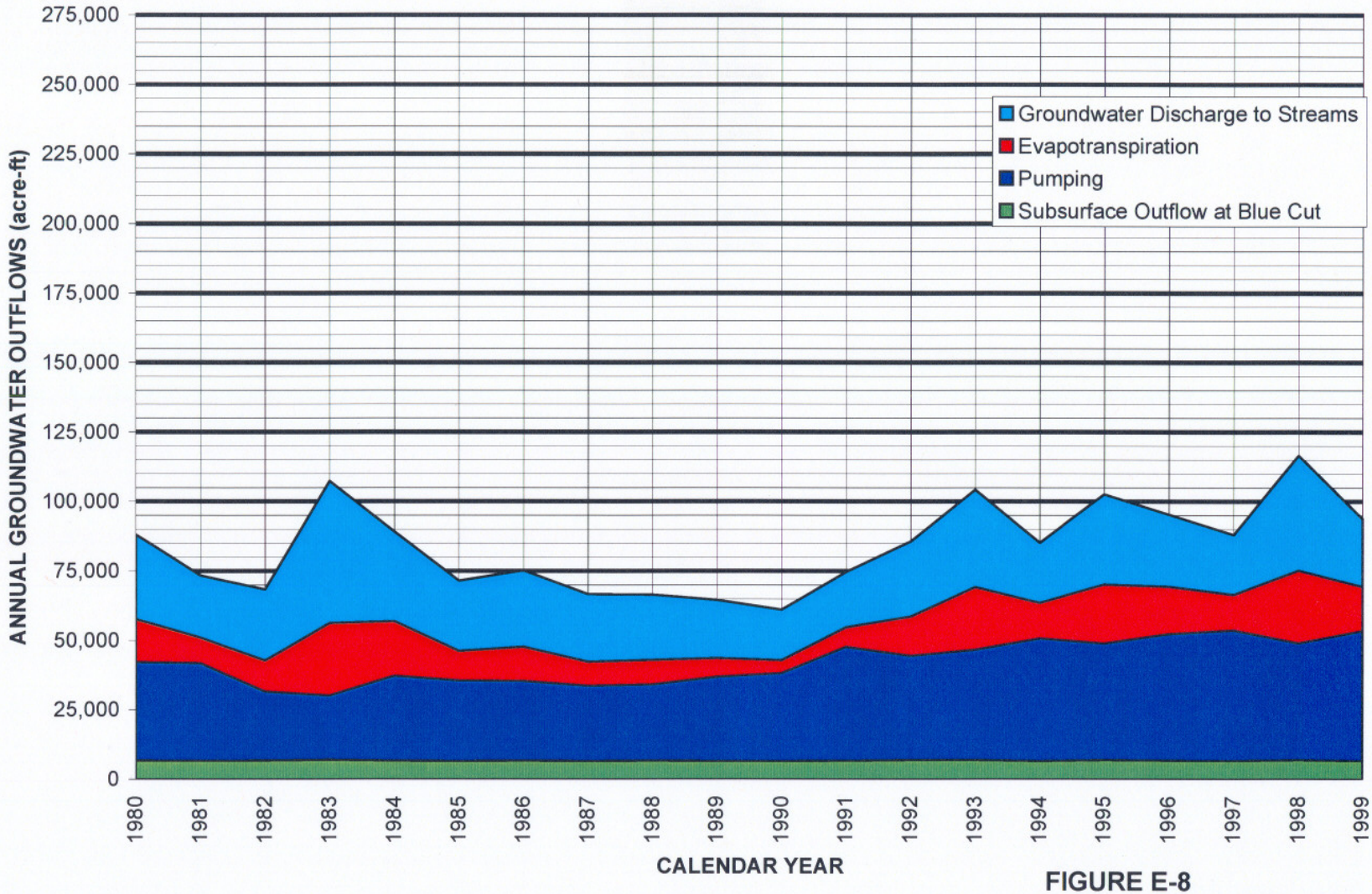

FIGURE E-8
ANNUAL GROUNDWATER OUTFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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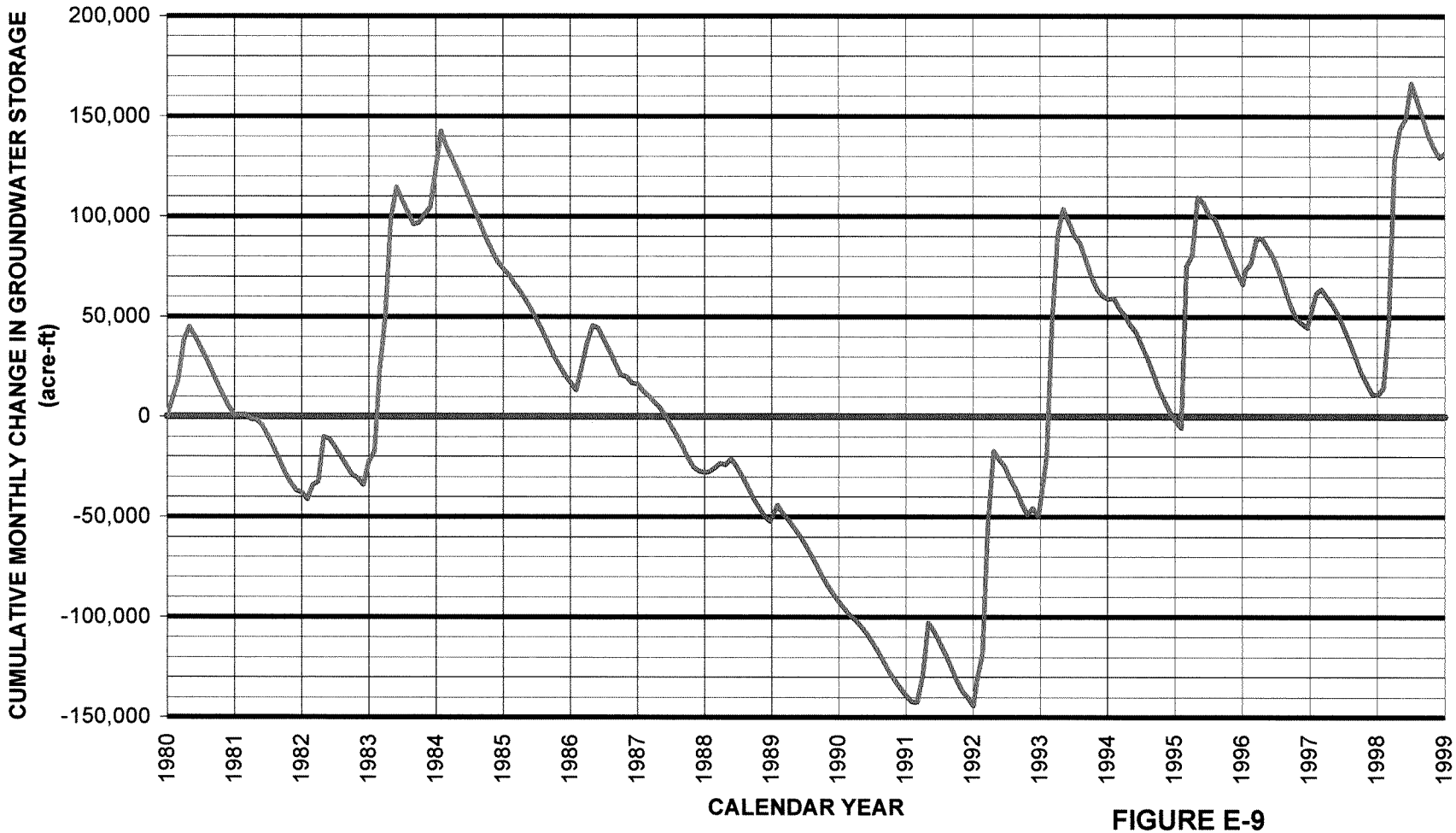

FIGURE E-9
CUMULATIVE CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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178973-410.xls/Fig E-9

Contents

Page

Executive Summary iii

Acronyms and Abbreviations xxxix

Section

1 Introduction 1-1
- 1.1 Model Use Objectives 1-1
- 1.2 Model Development 1-2
- 1.3 Previous Studies 1-2
- 1.4 Report Organization 1-3

2 Hydrogeology of the Santa Clarita Valley 2-1
- 2.1 Setting 2-1
- 2.2 Climate 2-2
- 2.3 Geology 2-3
  - 2.3.1 Non-Water-Bearing Bedrock 2-3
  - 2.3.2 Water-Bearing Sediments 2-3
  - 2.3.3 Geologic Structure 2-5
- 2.4 Groundwater Occurrence, Recharge, and Discharge 2-5
  - 2.4.1 Alluvium 2-5
  - 2.4.2 Saugus Formation 2-6
- 2.5 Aquifer Physical Properties 2-8
  - 2.5.1 Alluvium 2-8
  - 2.5.2 Saugus Formation 2-8
- 2.6 General Hydrology and Hydrologic Cycle 2-9
  - 2.6.1 Basin Hydrology 2-10
  - 2.6.2 Historical Hydrologic Trends 2-11
  - 2.6.3 State Water Project Operations and Hydrology 2-15
- 2.7 Previous Studies 2-18
  - 2.7.1 1986 Alluvial Aquifer Study 2-18
  - 2.7.2 1988 Saugus Aquifer Study 2-19
  - 2.7.3 2002 Aquifer Study Update 2-19
  - 2.7.4 Newhall Ranch ASR Impact Evaluation 2-20

3 Model Construction 3-1
- 3.1 Modeling Software 3-1
- 3.2 Extent of the Model Domain 3-1
- 3.3 Model Grid 3-1
- 3.4 Layering 3-2
  - 3.4.1 Alluvial Aquifer Layer 3-2
  - 3.4.2 Saugus Formation Layers 3-2
- 3.5 Boundary Conditions 3-3

Contents, Continued

Page

3.6 Estimation of Groundwater Recharge Rates 3-4
3.7 Assignment of Pumping Rates 3-5

4 Model Calibration Process 4-1
4.1 Calibration Conditions 4-1
4.1.1 Steady-State Calibration 4-1
4.1.2 Transient Calibration 4-2
4.2 Calibration Goals 4-2
4.2.1 Calibration Goals for the Steady-State Model 4-2
4.2.2 Calibration Goals for the Transient Model 4-4
4.3 Calibration Variables 4-4
4.3.1 Horizontal Hydraulic Conductivity and Vertical Anisotropy 4-4
4.3.2 Storage Coefficients 4-5
4.3.3 Stormwater Runoff in Upstream Watersheds 4-5
4.3.4 Riverbed Permeabilities 4-5
4.3.5 Evapotranspiration Parameters 4-6
4.4 Calibration Procedure and Target Calibration Data 4-6
4.4.1 Groundwater Elevation Target Data 4-7
4.4.2 Santa Clara River Baseflow and Total Flow 4-8
4.4.3 Adjustments to Model Parameters 4-8

5 Calibration Results and Sensitivity Analysis 5-1
5.1 Calibration Results for the Steady-State Model 5-1
5.1.1 Groundwater Flow Directions – Calibration Goal 1 5-1
5.1.2 Groundwater Elevation Residuals – Calibration Goal 2 5-1
5.1.3 Statistics of Groundwater Elevation Residuals – Calibration Goal 3 5-2
5.1.4 Groundwater Gradients – Calibration Goal 4 5-3
5.1.5 Groundwater Below Ground Surface – Calibration Goal 5 5-4
5.1.6 Groundwater Discharge to River – Calibration Goal 6 5-4
5.2 Calibration Results for the Transient Model 5-4
5.2.1 Groundwater Elevation Trends/Hydrographs – Calibration Goal 1 5-4
5.2.2 Groundwater Below Ground Surface – Calibration Goal 2 5-7
5.2.3 Total River Flow at County Line Gage – Calibration Goal 3 5-7
5.2.4 Groundwater Discharge to River – Calibration Goal 4 5-7
5.3 Groundwater Budget 5-8
5.4 Sensitivity Analysis 5-9
5.4.1 Method of Sensitivity Analysis 5-9
5.4.2 Sensitivity Analysis Results 5-9
5.5 Conclusion 5-11

Contents

Page

6 Model Applicability to Local Water Resource Management 6-1

7 References 7-1

Appendices

A Memorandum of Understanding, August 2001
B Analyses of Specific Capacity Tests Conducted in the Alluvial Aquifer
C Surface Water Routing Model

Contents, Continued

Tables—Tables appear at the end of each section.

2-1 Annual Groundwater Pumping from the Alluvial Aquifer

2-2 Annual Groundwater Pumping from the Saugus Formation

2-3 Summary of Selected Tests and Estimated Parameter Values for the Alluvial Aquifer

2-4 Summary of Selected Tests and Estimated Parameter Values for the Saugus Formation

2-5 Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin

2-6 Estimated Annual Groundwater Discharge to the Santa Clara River

2-7 Statistics on Annual Groundwater Discharge to the Santa Clara River, All Years

2-8 Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 vs. 1975 through 1999

2-9 Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974

2-10 Historical Hydrology in Northern California and the Santa Clarita Valley

2-11 Historical State Water Project Allocations and Local Hydrology, 1980 through 1999

2-12 Castaic Creek Flood Flows

3-1 Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

3-2 Allocation of Pumping by Month for Agricultural and Urban Production Wells

4-1 Target Wells for Calibration of the Regional Model

5-1 Alluvial Aquifer Parameters in Calibrated Regional Model

5-2 Aquifer Hydraulic Parameters Used in the Regional Model

5-3 Residual Errors for 1980 through 1985 Steady-State Calibration Model

5-4 Statistics of Residual Errors for 1980 through 1985 Steady-State Calibration Model

Contents, Continued

Tables (continued)

5-5 Comparison of Modeled and Measured Horizontal Hydraulic Gradients for Multi-Port Monitoring Wells

5-6 Groundwater Budget for 1980 through 1985 Steady-State Model

5-7 Annual Water Budgets Calculated by the Calibrated Regional Model for 1980 through 1999

Figures—Figures appear at the end of each section.

1-1 Map of Study Area

2-1 Santa Clarita Valley Hydrology

2-2 Groundwater Basins in the Santa Clara River Basins

2-3 Well Location and Features Map (Pocket)

2-4 Annual Precipitation at the Newhall-Soledad and NCWD Rain Gages since 1950

2-5 Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

2-6 Basin Geologic Map

2-7 Groundwater Elevation Contour Map for the Alluvium – Spring 2000

2-8 Groundwater Elevation Contour Map for the Saugus – Fall 2000

2-9 Groundwater Elevations in Multi-Port Saugus Formation Monitoring Wells January 2003 through December 2003

2-10 Sub-Watersheds within the Santa Clara Valley East Watershed

2-11 Annual Precipitation and Cumulative Departure from the 1950 to 2000 Average at the Newhall-Soledad Rain Gage since 1950

2-12 Alluvial Groundwater Elevations versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-13 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-14 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

Contents, Continued

Figures (continued)

2-15 Saugus Groundwater Elevations Along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-16 Saugus Groundwater Elevations Along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

2-17 Groundwater Elevations in Adjacent Alluvial and Saugus Wells versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-18 Net Castaic Creek Flood Flows Available to Downstream Users

3-1 Model Grid

3-2 Schematic Diagram of Model's Representation of Basin Stratigraphy

3-3 Thickness of Model Layer 1

3-4 Thickness of Model Layer 2

3-5 Thickness of Model Layer 3

3-6 Thickness of Model Layer 4

3-7 Thickness of Model Layer 5

3-8 Thickness of Model Layer 6

3-9 Thickness of Model Layer 7

3-10 Thickness of Saugus Formation (Model Layers 1 through 7)

3-11 Layer 1 Base Elevation

3-12 Layer 2 Base Elevation

3-13 Layer 3 Base Elevation

3-14 Layer 4 Base Elevation

3-15 Layer 5 Base Elevation

3-16 Layer 6 Base Elevation

3-17 Layer 7 Base Elevation

3-18 Schematic Cross Sections

4-1 Locations of Zones and Target Wells in Alluvial Aquifer

4-2 Locations of Zones and Target Wells in Saugus Formation

Contents, Continued

Figures (continued)

5-1 Hydraulic Conductivity Layer 1

5-2 Hydraulic Conductivity Layer 2

5-3 Hydraulic Conductivity Layer 3

5-4 Hydraulic Conductivity Layer 4

5-5 Hydraulic Conductivity Layer 5

5-6 Hydraulic Conductivity Layer 6

5-7 Hydraulic Conductivity Layer 7

5-8 Steady-State 1980 to 1985 Groundwater Elevation Contours for Alluvial Aquifer

5-9 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 2

5-10 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 3

5-11 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 4

5-12 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 5

5-13 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 6

5-14 Steady-State 1980 to 1985 Groundwater Elevation Contours for Saugus Formation in Model Layer 7

5-15 Simulated versus Measured Groundwater Elevations for the Steady-State Model

5-16 Steady-State Model Error for Alluvial Aquifer Target Wells Along the Santa Clara River

5-17 Steady-State Model Error for Alluvial Aquifer Target Wells Away from the Santa Clara River

5-18 Steady-State Model Error for Saugus Formation Production Wells

5-19 Steady-State Model Error for Saugus Formation Observation Wells

5-20 Simulated and Measured Groundwater Elevations in Alluvial Aquifer Wells West of Interstate 5

Contents, Continued

Figures (continued)

5-21 Simulated and Measured Groundwater Elevations in Alluvial Aquifer Wells Between Interstate 5 and Soledad Canyon

5-22 Simulated and Measured Groundwater Elevations in Alluvial Aquifer Wells in Soledad Canyon (2 pages)

5-23 Simulated and Measured Groundwater Elevations in Alluvial Aquifer Wells Along Castaic Creek

5-24 Simulated and Measured Groundwater Elevations in Alluvial Aquifer Wells in Other Tributary Canyons to the Santa Clara River

5-25 Simulated and Measured Groundwater Elevations in Saugus Formation Wells (3 pages)

5-26 Simulated versus Measured Hydrographs of Santa Clara River Flow at County Line

5-27 Simulated versus Measured Hydrograph of Groundwater Discharge to Santa Clara River

5-28 Annual Groundwater Inflows

5-29 Annual Groundwater Outflows

5-30 Annual Change in Groundwater Storage

5-31 Cumulative Change in Groundwater Storage

5-32 Sensitivity of Groundwater Elevations at NLF-B7

5-33 Sensitivity of Alluvial Groundwater Elevations at NLF-G45 to Aquifer Parameters

5-34 Sensitivity of Alluvial Groundwater Elevations at VWC-N to Aquifer Parameters

5-35 Sensitivity of Alluvial Groundwater Elevations at SCWC-Stadium to Aquifer Parameters

5-36 Sensitivity of Alluvial Groundwater Elevations at SCWC-North Oaks East to Aquifer Parameters

5-37 Sensitivity of Alluvial Groundwater Elevations at NCWD-Pinetree1 to Aquifer Parameters

5-38 Sensitivity of Alluvial Groundwater Elevations at VWC-D to Aquifer Parameters

5-39 Sensitivity of Saugus Groundwater Elevations at 7048C to Aquifer Parameters

5-40 Sensitivity of Saugus Groundwater Elevations at VWC-201 to Aquifer Parameters

Contents, Continued

Figures (continued)

5-41 Sensitivity of Saugus Groundwater Elevations at SCWC-Saugus2 to Aquifer Parameters

5-42 Sensitivity of Saugus Groundwater Elevations at NCWD-11 to Aquifer Parameter

5-43 Sensitivity of Saugus Groundwater Elevations at 5851 to Aquifer Parameters

5-44 Sensitivity of Alluvial Groundwater Elevations at NLF-B7 to River and Evapotranspiration Parameters

5-45 Sensitivity of Alluvial Groundwater Elevations at NLF-G45 to River and Evapotranspiration Parameters

5-46 Sensitivity of Alluvial Groundwater Elevations at VWC-N to River and Evapotranspiration Parameters

5-47 Sensitivity of Alluvial Groundwater Elevations at SCWC-Stadium to River and Evapotranspiration Parameters

5-48 Sensitivity of Alluvial Groundwater Elevations at SCWC-North Oaks East to River and Evapotranspiration Parameters

5-49 Sensitivity of Alluvial Groundwater Elevations at SCWC-Pinetree1 to River and Evapotranspiration Parameters

5-50 Sensitivity of Alluvial Groundwater Elevations at VWC-D to River and Evapotranspiration Parameters

5-51 Sensitivity of Saugus Groundwater Elevations at 7048C to River and Evapotranspiration Parameters

5-52 Sensitivity of Saugus Groundwater Elevations at VWC-201 to River and Evapotranspiration Parameters

5-53 Sensitivity of Saugus Groundwater Elevations at SCWC-Saugus2 to River and Evapotranspiration Parameters

5-54 Sensitivity of Saugus Groundwater Elevations at NCWD-11 to River and Evapotranspiration Parameters

5-55 Sensitivity of Saugus Groundwater Elevations at 5851 to River and Evapotranspiration Parameters

5-56 Sensitivity of Groundwater Discharges to the Santa Clara River to Aquifer, River, and Evapotranspiration Parameters

Acronyms and Abbreviations

°F	degrees Fahrenheit
AF	acre-feet
AF/yr	acre-feet per year
ASR	aquifer storage and recovery
bgs	below ground surface
cfs	cubic feet per second
CLWA	Castaic Lake Water Agency
cm/sec	centimeters per second
county line	Los Angeles-Ventura County line
Downstream Water Users	Los Angeles County Waterworks District, Newhall Land & Farming Company, Newhall County Water District, and United Water Conservation District
DWR	California Department of Water Resources
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
ft/yr	feet per year
GIS	geographic information system
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GPS	global positioning system
I-5	Interstate 5
in/yr	inches per year
K	hydraulic conductivity
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation District

LACWWD	Los Angeles County Waterworks District
LADPW	Los Angeles County Department of Public Works
MOU	Memorandum of Understanding
NCDC	National Climate Data Center
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
Purveyors	Upper Basin Water Purveyors
R	vertical anisotropy ratio (Kh:Kv)
RCS	Richard C. Slade and Associates, LLC
Regional Model	Santa Clarita Valley Groundwater Model
residual	residual error
RMS	root-mean-square
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
Sy	aquifer specific yield
T	transmissivity
UWCD	United Water Conservation District
USGS	U.S. Geological Survey
VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
WY	water year

SECTION 1

Introduction

This report describes the development of a regional groundwater flow model for the Santa Clarita Valley, located in northwestern Los Angeles County, California. The model, called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. It has been developed for the water purveyors in the valley as a tool for the analysis of groundwater management options in the context of future water demands and water supply conditions in the valley. Figure 1-1 is a map showing the study area.

1.1 Model Use Objectives

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the water purveyors in the Santa Clarita Valley (the Purveyors) and the United Water Conservation District (UWCD), located downstream in Ventura County. The MOU, which is contained in Appendix A, is a commitment by the Purveyors to expand the analysis of groundwater conditions such that the adequacy of the local water supply is well understood and questions about surface water and groundwater resources can be more readily addressed. The MOU contained a number of technical components, including the development and calibration of a regional-scale groundwater flow model and the preparation of technical reports on topics such as groundwater model development. This report and the model described herein reflect the accomplishment of two of the MOU technical components.

The Regional Model is intended to become a tool for managing the local groundwater resource, including the relationship of surface water to groundwater in the valley. The model has been designed to be an evolving tool that will analyze groundwater development, natural and artificial recharge (particularly in conjunction with the availability of imported surface water supplies), and the resultant impacts of these activities on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County. As discussed in the MOU, one use will be to evaluate the long-term sustainability, or operational yield, of the shallow Alluvial Aquifer and the deeper groundwater resources that are present in the underlying Saugus Formation. Specifically, this assessment will look at basin operations over a multi-year wet/dry cycle, with operational yield defined as a basin operating plan that allows continued pumping from these aquifers while assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. The parties to the MOU agreed to use the Regional Model for this assessment because (1) data show no long-term lowering of the water table or degradation of water quality has occurred during the 50 to 60 years of historical groundwater development in the valley, and (2) current planning places future pumping of the Alluvial Aquifer in the same range as historical pumping. At this time, the primary question of interest to the MOU parties is the effect of pumping the Saugus Formation during short-term dry periods at rates that are higher than have been historically pumped from that formation. An additional

planned application of the model will be to evaluate the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley.

Based on these objectives, the MOU specified that a model would be constructed that covers the entire area within the Santa Clarita Valley where Alluvial and Saugus groundwater resources are present, and that the model should be subjected to a transient calibration.

1.2 Model Development

The approach to developing the model included:

a. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system.

b. Creating a variety of data sets to conduct steady-state and transient calibrations.

c. Constructing the groundwater flow model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley.

d. Calibrating the flow model.

e. Performing sensitivity tests on the flow model.

This project was conducted for the parties to the MOU, who are the United Water Conservation District (UCWD) in Ventura County and the Upper Basin Water Purveyors, the water providers in the Santa Clarita Valley. The Upper Basin Water Purveyors consist of four retail purveyors of municipal water and the Castaic Lake Water Agency (CLWA), which has a contract with the State of California to obtain water from the State Water Project (SWP), and which furnishes SWP water to the four retail purveyors. The four retail purveyors are Los Angeles County Waterworks District (LACWWD) No. 36, the Newhall County Water District (NCWD), Santa Clarita Water Company (SCWC, a division of CLWA), and the Valencia Water Company (VWC).

1.3 Previous Studies

There are several previous studies of the groundwater system in the Santa Clarita Valley that were used to help develop the conceptual and numerical models of the hydrogeologic system. These studies include reports on the regional geology and hydrogeology, and a previous modeling analysis of the feasibility of constructing an aquifer storage and recovery (ASR) system. These studies are listed below and are described in more detail in Section 2.7 of this report.

a. *Hydrogeologic Investigation: Perennial Yield and Artificial Recharge Potential of the Alluvial Sediments in the Santa Clarita River Valley of Los Angeles County, California* (Richard C. Slade and Associates, LLC [RCS], 1986). This report was the first comprehensive study of the geology and hydrology of the Alluvial Aquifer.

b. *Hydrogeologic Assessment of the Saugus Formation in the Santa Clara Valley of Los Angeles County, California* (RCS, 1988). This report was the first comprehensive study of the geology and hydrology of the Saugus Formation.

c. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). This report documented the results of ASR field tests in the Saugus Formation that evaluated the feasibility of injecting water into, and recovering water from, deep Saugus Formation wells.

d. *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems* (RCS, 2002). This report was a summary and update of the 1986 and 1988 RCS reports.

e. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001). This document evaluated the longer-term basinwide influences that would occur for an ASR program that was proposed as part of the water supply for the planned Newhall Ranch community.

f. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002). This document updated the ASR impact evaluation, including analyzing the effects of all aspects of the Newhall Ranch community (not just ASR) on the valley's water resources.

1.4 Report Organization

The remainder of this report is organized as follows:

Section 2 describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the SWP on the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report (along with Appendix B) focuses on information of specific relevance to development of the regional flow model.

Section 3 discusses the construction of the model, including the modeling software; the grid design; the layer-by-layer representation of the aquifers; the boundary conditions; the estimation of groundwater recharge rates; and the assignment of pumping rates in the model. Appendix C describes the design, operation, and data for a surface water routing model that was developed to provide the Regional Model with recharge rates from urban irrigation, agricultural irrigation, direct precipitation, streamflows entering the model domain, and discharges from water reclamation plants (WRP).

Section 4 describes the calibration conditions; the calibration goals; the model variables that were adjusted during calibration; the calibration procedure; and the measured (target) data that were used to evaluate calibration quality.

Section 5 presents quantitative and semi-quantitative evaluations of the calibration results, with a focus on the assessment of the model's calibration quality compared with the calibration goals presented in Section 4. Section 5 then concludes with a sensitivity analysis that further evaluates calibration quality and demonstrates the sensitivity of simulated groundwater elevations and water budget terms to changes in model parameter values.

Section 6 summarizes the applicability of the model for use in managing local groundwater resources, including the key attributes of the model and recommendations for further data collection and future model updates.

Section 7 is the reference list.

Figures

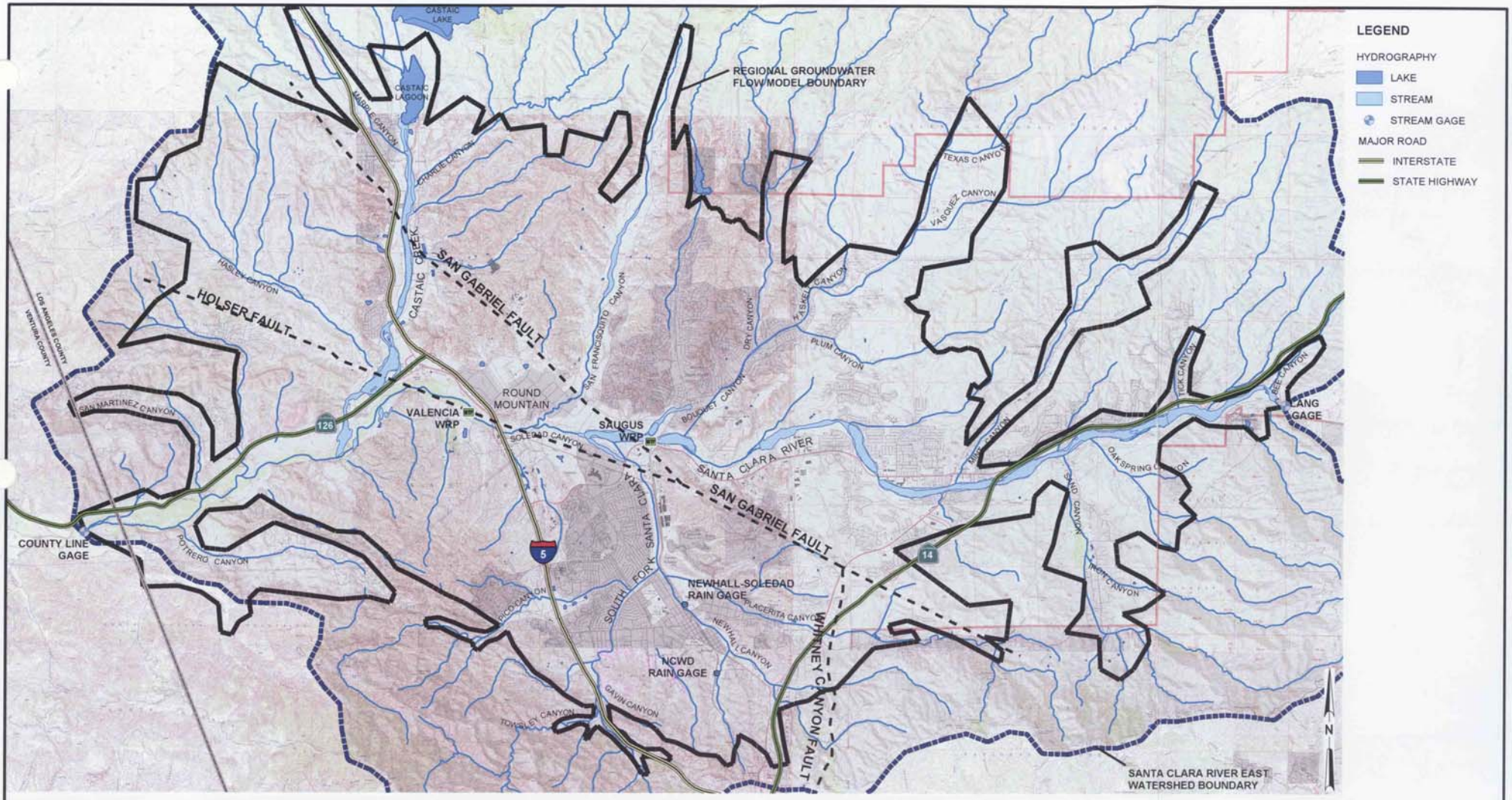

FIGURE 1-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 2

Hydrogeology of the Santa Clarita Valley

The geology and hydrogeology of the Santa Clarita Valley are described in this section, which is derived primarily from the reports described in Section 1.3 and Section 2.7. Figure 2-1 is a schematic representation of the regional scale geology and hydrologic cycle in the Santa Clarita Valley. As shown on Figure 2-1, the two aquifer systems in the Santa Clarita Valley are the Alluvial Aquifer and the Saugus Formation. Groundwater is exchanged between these two units. Additionally, the aquifer systems are affected by direct rainfall; streamflows in the Santa Clara River and its tributaries; evapotranspiration (ET) by riparian vegetation along portions of the river; and human influences which consist of pumping, agricultural and urban irrigation, discharge of treated water into the Santa Clara River from two water reclamation plants, and occasional releases of water into Castaic Creek from Castaic Lake and Castaic Lagoon.

Figure 2-2 shows the location of the Santa Clarita Valley groundwater basin. This groundwater basin is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley East Groundwater Subbasin and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Figure 2-3 is a map of the Santa Clarita Valley, showing the locations of production wells completed in the Alluvial Aquifer and Saugus Formation.

2.1 Setting

The study area comprises the relatively flat-lying Santa Clarita Valley and portions of the surrounding hills and mountains. The study area extends from approximately the Los Angeles-Ventura County line (county line) on the west to the community of Lang on the east, and from the southern end of Castaic Lake on the north to the intersection of the Golden State Freeway (Interstate 5 [I-5]) and the Antelope Valley Freeway (State Highway 14) on the south. The mountains that surround the Santa Clarita Valley include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from approximately 800 feet on the valley floor to approximately 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of approximately 3,200 feet at the topographic divide separating the Upper Santa Clara River Hydrologic Area from the Mojave Desert.

The largest community in the study area is the City of Santa Clarita, which was formed in 1987 through the amalgamation of the communities of Newhall, Valencia, Saugus, and Canyon Country. Other smaller unincorporated communities in the study area include Stevenson Ranch and Val Verde in the west, Castaic in the northwest, and Lang in the east. The population of the City of Santa Clarita was estimated to be approximately 151,260 in the 2000 U.S. Census. In 2001, the Southern California Association of Governments estimated the population of the surrounding unincorporated Santa Clarita Valley at 48,237. Hence, the total current population of the Santa Clarita Valley is approximately 200,000 (RCS, 2002).

Prior to the 1960s, the predominant land use in the Santa Clarita Valley was agricultural, with much of the valley undeveloped. Urbanization began gradually in the 1960s, with a rapid increase beginning in the late 1970s and early 1980s and continuing to the present. Accompanying the rapid population increase has been a gradual change in valley land use patterns, from largely agricultural to urban and suburban developments. Nevertheless, a considerable portion of the hills and low mountains bordering the main river valley remain in a natural, undeveloped condition (RCS, 2002).

2.2 Climate

The study area has a semi-arid Mediterranean-type climate, characterized by long, dry summers and relatively short, wet winters. Temperatures in the Santa Clarita Valley range from a minimum of 20 degrees Fahrenheit (°F) to 30°F in the winter to a maximum of approximately 100 to 110°F during the summer. Mean monthly temperatures range between approximately 48°F in the winter and 77°F in the summer.

Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. The average rainfall at this gage was 17.95 inches from 1883 through 2000 and 17.84 inches from 1950 through 2000.[1] A second rain gage is located approximately 1.3 miles to the south, at the NCWD office. Figure 2-4 shows the annual rainfall at the Newhall-Soledad and NCWD gages for calendar years 1950 through 2000. As shown in the figure, annual rainfall is highly variable from year to year. During this period, the highest calendar-year rainfall was 42.17 inches in 1978 at the Newhall-Soledad gage, and 48.33 inches in 1983 at the NCWD gage. The lowest amount of annual rainfall from 1950 through 2000 was 4.15 inches in 1972 at the Newhall-Soledad gage, and 8.47 inches in 1989 at the NCWD gage. Average annual rainfall from 1979 through 2000 was 18.67 inches at the Newhall-Soledad gage and 22.88 inches at the NCWD gage. Rainfall at the NCWD gage is usually greater than at the Newhall-Soledad gage, because the NCWD gage is located closer to the hills that form the southern boundary of the watershed and receive a greater amount of orographic precipitation.

Rainfall is not only variable on an annual basis, but is also highly seasonal. Approximately 80 percent of the annual precipitation in the Santa Clarita Valley falls between November and March. Most of the precipitation comes from winter storms that last only a few days and are separated by relatively long periods of clear weather.

As shown by the difference in rainfall values between the Newhall-Soledad and NCWD rain gages, rainfall varies across the basin according to elevation differences and the locations of surrounding mountain ranges. Figure 2-5 shows lines of equal precipitation (rainfall isohyets), based on long-term mean annual precipitation data compiled from the U.S. Geological Survey (USGS), DWR, and California Division of Mines maps and data. The source maps consist primarily of U.S. Weather Service data for approximately 800 precipitation stations, but in the Los Angeles and San Francisco Bay areas the

[1] Annual rainfall values for the Newhall-Soledad gage are based on monthly records reported by the National Climate Data Center (NCDC) and LADPW.

U.S. Weather Service data have been supplemented by county and local agency precipitation data. The precipitation isohyets shown on Figure 2-5 display the average annual rainfall during the period from 1900 through 1960. (See the internet site http://gis.ca.gov/meta.epl?oid=286 for more information.)

2.3 Geology

Figure 2-6 presents a geologic map of the Santa Clarita Valley, as reported by RCS (2002). The geologic units shown on the map include water-bearing sediments and non-water-bearing bedrock.

The Santa Clarita Valley is underlain and bounded by non-water-bearing bedrock units that are Miocene, Oligocene, and pre-Tertiary in geologic age. These units yield little water and are not considered viable for groundwater development.

Where the bedrock units are not exposed at the ground surface, they are overlain by younger geologic units. The Pliocene-age to Pleistocene-age Saugus Formation (map symbol, QTs) overlies the bedrock in much of the basin. At the far western and eastern ends of the basin, and in the upper reaches of some of the canyons, the Saugus Formation is absent and the bedrock units are overlain by a blanket of unconsolidated alluvium of Quaternary geologic age (map symbol, Qal). Where present, the alluvium overlies the Saugus Formation within much of the Santa Clarita Valley. In some areas where the alluvium is absent, the Saugus Formation is overlain by scattered outcrops of Quaternary-age Terrace deposits (map symbol, Qt). Groundwater is present in much of the alluvium and the Saugus Formation. However, the terrace deposits do not contain significant water resources because they are typically situated at elevations above the regional water table.

2.3.1 Non-Water-Bearing Bedrock

Underlying the water-bearing sediments in the Santa Clarita Valley are a series of consolidated, older, cemented sedimentary and crystalline rocks of Tertiary geologic age or older. For the most part, the sedimentary rocks are exposed along the flanks of the hills and mountains that border the Santa Clarita Valley, while the geologically older crystalline metamorphic and igneous rocks crop out in the upper watershed areas of the Sierra Pelona and San Gabriel Mountains.

Geologically older sedimentary rocks underlie the base of the Saugus Formation and are exposed in the hills beyond the exterior boundary line for the mapped surface limits of the Saugus Formation. The older rocks lying immediately below the Saugus Formation are: (1) the Pico Formation, composed of siltstone and shale, which underlies the Saugus Formation in the region southwest of the San Gabriel fault; and (2) the Castaic Formation and the Mint Canyon Formation, mainly siltstone and shale, which underlie the Saugus Formation in areas northeast of the San Gabriel fault. These sedimentary rock formations are generally fine grained, have low permeability, and do not yield substantial quantities of water to wells. In the project area, these rocks are considered barriers to groundwater flow.

2.3.2 Water-Bearing Sediments

Water-bearing sediments in the Santa Clarita Valley consist of:

a. Alluvial and valley fill deposits that underlie the Santa Clara River and its tributaries

b. Partially consolidated, older sediments of the Saugus Formation, including the Sunshine Ranch Member, that underlie the alluvium and are also exposed in the hillsides surrounding the main portion of the valley

2.3.2.1 Alluvium

The alluvial sediments are composed of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Drillers' logs indicate the presence of discrete sand zones and discrete gravel zones in many areas of the alluvium. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

The alluvial sediments lie within and along the course of the Santa Clara River and its main tributaries. The maximum thickness of the alluvium varies along the Santa Clara River, but generally is considered to be 200 feet. Typically, the alluvium tends to be thickest near the central portion of the river, and thins or pinches out near the flanks of the adjoining hills.

The alluvium overlies the Saugus Formation in much of the valley. However, in the eastern part of Soledad Canyon, the Saugus Formation is absent, and instead the alluvium overlies Miocene-age terrestrial sediments of the Tick Canyon and Mint Canyon Formations. In the upper reaches of some tributaries to the Santa Clara River, the alluvium overlies these or other Miocene-age sediments, such as the Pico and Castaic Formations. At the west end of the valley, the alluvium overlies the Pico Formation.

2.3.2.2 Saugus Formation

The Saugus Formation is present throughout the main portion of the Santa Clarita Valley and extends to the surrounding foothills. The Saugus Formation contains lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. These terrestrial sediments were deposited in stream channels, floodplains, and alluvial fans by the ancestral drainage system in the valley. The coarser-grained materials in the Saugus Formation were deposited in the main channels of the ancestral drainage system, and the locations of these channels changed throughout the approximately 3-million-year period of deposition of the Saugus Formation. Recent interpretations of geophysical electric log data indicate that the coarse-grained channel deposits (the primary water-bearing strata) are thicker and more numerous in some areas than in other locations in the valley. Although the Saugus Formation displays a considerable amount of lateral variability in lithology and grain size, some thicker stratigraphic packages can be traced through portions of the valley, primarily on the west (downthrown) side of the San Gabriel Fault (RCS, 2002).

The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone. The Sunshine Ranch Member has a maximum thickness of approximately 3,500 feet in the central part of the valley. It is present at or very close to ground surface at the margins of the valley. Geophysical (electric) logging indicates that the groundwater in

much of the Sunshine Ranch Member may be somewhat brackish in quality and is not useful for municipal water supply purposes.

2.3.3 Geologic Structure

Faulting and folding of the rocks in the region have caused the sedimentary rocks, including the Saugus Formation, to form a bowl-shaped structure. The Saugus Formation and the underlying bedrock dip generally toward the center of the "bowl" from all locations along the bottom (basal) contact of the Saugus Formation.

Dominating the geologic structure in the valley is the southeast-northwest-trending San Gabriel fault. The fault is a northeast-dipping reverse fault. The vertical displacement of the Saugus Formation on each side of the fault varies along the length of the fault and ranges from 100 feet to 2,600 feet within the valley (RCS, 1988). The Saugus Formation is thickest south of the fault, and this is the area where all significant Saugus production wells are located. North of the San Gabriel fault, the Saugus Formation is older, thinner, and finer grained than south of the fault. Little groundwater development has occurred north of the San Gabriel Fault.

A spur from this fault, referred to as the Holser fault, trends west through the valley. Cross sections prepared by RCS (1988, 2002) show that marker beds are offset by approximately 100 to 200 feet across the Holser Fault, which is substantially less than the offset across the San Gabriel Fault. Another spur fault called the Whitney Canyon fault extends south from the San Gabriel Fault in the southeastern corner of the valley.

2.4 Groundwater Occurrence, Recharge, and Discharge

Groundwater is present in the alluvium under generally unconfined conditions. Saugus Formation groundwater is thought to be present under unconfined conditions in the shallowest water-bearing zones where the Alluvial Aquifer is absent, and under semi-confined and confined conditions at greater depths. Figure 2-1 is a schematic cross-sectional representation of the groundwater flow patterns in the Santa Clarita Valley, including the predominant recharge and discharge mechanisms for the two aquifer systems. These are discussed in detail below.

2.4.1 Alluvium

Natural sources of recharge to the alluvium include deep percolation (infiltration) of direct precipitation within the valley; percolation of stream runoff flowing into the valley along the Santa Clara River and its tributaries; subsurface inflow from the adjoining (upgradient) portions of the Alluvial Aquifer to the north and east of the valley; and discharge of groundwater from the Saugus Formation to the Alluvial Aquifer, primarily on the west side of the Santa Clarita Valley.

Manmade sources of recharge to the Alluvial Aquifer include infiltration of irrigation water; infiltration of stormwater runoff from urban areas; infiltration of surface flow and underflow from Castaic Dam within the Castaic Creek area; infiltration of water released by the Los Angeles Department of Water and Power from its reservoir facilities in upper San Francisquito Canyon and upper Bouquet Canyon; and infiltration of water reclamation

plant (WRP) discharges to the Santa Clara River from two Los Angeles County Sanitation District (LACSD) WRPs in the valley (Plant No. 26 near Bouquet Canyon and Plant No. 32 near Valencia).

Groundwater discharge is significant in the western portion of the Alluvial Aquifer, where it occurs primarily as discharge to the Santa Clara River and ET by the riparian vegetation growing along the river corridor. Groundwater discharge from the west end of the basin also occurs as subsurface outflow through the Alluvial Aquifer to the downstream Piru Basin. Other groundwater discharge mechanisms in the Santa Clarita Valley are pumping for agricultural and municipal uses and seepage to underlying permeable portions of the Saugus Formation, particularly in the eastern portion of the basin.

According to RCS (1986), groundwater present within the Alluvial Aquifer flows from east to west roughly coincident with the direction of surface water flow. Figure 2-7 displays a groundwater elevation contour map for the Alluvial Aquifer, using water level data collected during the spring of 2000.

RCS (2002) estimated that the amount of groundwater in storage in the Alluvial Aquifer has historically fluctuated between approximately 100,000 and 200,000 acre-feet. Table 2-1 summarizes the well-by-well historical annual groundwater pumping from the Alluvial Aquifer from 1980 through 2000. Historical groundwater production rates during this period averaged 29,700 acre-feet per year (AF/yr) and ranged from approximately 20,300 to 43,500 AF/yr. As discussed later in Section 2.6.2, these pumping rates are at or below pumping rates during the 1950s and 1960s, when groundwater was used primarily for agricultural purposes.

2.4.2 Saugus Formation

The Saugus Formation is recharged by two principal sources: (1) infiltration of precipitation in the exposed portions of the Saugus in the highlands surrounding the valley, and (2) seepage from the Alluvial Aquifer along the Santa Clara River and its tributaries, particularly in the eastern and central portions of the Santa Clarita Valley. Minor recharge may also occur in limited areas through irrigation seepage, where the land overlying the Saugus is cultivated. In the eastern part of the Santa Clarita Valley, the Saugus Formation is underlain by older rocks of the Castaic Formation and Mint Canyon Formation, which surround the bowl-shaped Saugus structure. Little, if any, groundwater exchange occurs between these formations and the Saugus Formation.

Discharge from the Saugus Formation occurs in part as groundwater pumping from wells as deep as 2,000 feet. Discharge from the Saugus Formation also occurs at the west end of the valley, west of the I-5 bridge, where Saugus groundwater is thought to discharge to the Alluvial Aquifer. The older and relatively impermeable rocks of the Pico Formation, that underlie and form the western boundary of the Saugus Formation, form a barrier to groundwater flow and force Saugus groundwater to discharge upwards into the Alluvial Aquifer in the area extending between two miles and six miles upstream of the county line (refer to Figure 2-1). The Saugus is not present at Blue Cut, which is approximately three miles downstream of the Saugus/Pico Formation contact and approximately one mile downstream of the county line.

Because the Saugus Formation and underlying bedrock units tilt downward from the edges of the valley to the center of the valley, the permeable sand layers within the Saugus Formation near the margins of the valley are thought to be oriented so that they are in direct connection with the overlying Alluvial Aquifer. Consequently, recharge to the Saugus Formation from the Alluvial Aquifer is thought to be greatest in these areas, particularly on the east side of the valley. Also, discharge from the Saugus Formation to the Alluvial Aquifer is thought to be enhanced where permeable sand layers of the Saugus are contacting the Alluvial Aquifer on the western end of the valley where the Saugus Formation discharges.

The available water level data, which are concentrated in localized areas, indicate that the direction of groundwater flow in the Saugus is toward the center of the valley from the highlands. The data indicate that Saugus groundwater flows toward the western end of the Santa Clara Valley where it discharges naturally into the Alluvial Aquifer. Figure 2-8 displays a groundwater elevation contour map for the Saugus Formation, using water level data collected during the fall of 2000 (RCS, 2002).

Although few wells have been drilled into the Saugus Formation at or north/northeast of the San Gabriel fault, there is evidence of limited Saugus groundwater flow across the fault. Data that suggest this limited hydraulic connection between the two fault blocks are as follows:

a. Geologic and geophysical logging of former exploratory oil wells indicates that the Saugus Formation is much thinner north of the San Gabriel Fault than south of it (see geologic cross section E-E' in RCS, 1988). Preliminary interpretations of recent geologic and geophysical logging at multi-port monitoring wells on the Whittaker-Bermite property also suggest the Sunshine Ranch Member is present at much shallower depths on the upthrown fault block, north/northeast of the fault, than on the downthrown block, south/southwest of the fault. Together, these data indicate that the older and fine-grained Sunshine Ranch Member of the Saugus Formation predominates in the area north of the fault.

b. Water level monitoring on the Whittaker-Bermite property shows groundwater elevations in multi-port monitoring well MP-3, on the upthrown side of the fault, are approximately 100 to 150 feet higher than in the other multi-port wells, which are on the downthrown side of the fault. Additionally, the three monitoring wells on the downthrown side (MP-1, MP-2, and MP-4) that have been monitored since January 2003, show responses to seasonal pumping of nearby water supply wells, whereas the monitoring well on the upthrown side (MP-3) shows no such response. (See Figure 2-3 for the locations of these wells, and Figure 2-9 for plots of groundwater elevations over time at each of these wells.)

In contrast, recent drilling, well construction, and pump testing work has indicated that the Holser Fault does not act as a barrier to groundwater flow. In early 2003, well MP-5 was installed in the Saugus Formation, located just north of the fault. This is a multi-port monitoring well that measures water levels at four discrete depths as great as 965 feet in the Saugus Formation. During March 2004, a deep Saugus production well south of the Holser Fault (VWC-205, located 4,700 feet away) was pumped for 72 hours under controlled conditions that included allowing no pumping to occur from other Saugus wells in the area.

The test was performed in part to evaluate the Holser Fault's hydraulic influence in the Saugus Formation. During pumping at VWC-205, measurable drawdown was observed at the two deepest ports at MP-5, which are situated at depths (795 feet and 965 feet) that correspond with the depths of the upper portion of the screen of VWC-205. Water level recovery monitoring conducted when VWC-205 was shut down showed rising water levels in these same two ports at MP-5. These observations are consistent with previous indications that the Holser Fault is not a significant barrier to groundwater flow in the Saugus Formation.

RCS (2002) estimated that the amount of groundwater in storage in the freshwater-portion of the Saugus Formation is approximately 1.65 million acre-feet. Historical groundwater production rates since 1980 have ranged from approximately 3,000 to nearly 15,000 AF/yr. Table 2-2 summarizes the well-by-well historical annual groundwater pumping from the Saugus Formation from 1980 through 2000.

2.5 Aquifer Physical Properties

2.5.1 Alluvium

Available groundwater elevation data and aquifer test data from Alluvial wells indicate that the Alluvial Aquifer is unconfined (i.e., is under water table conditions). Transmissivity values range from 4,700 square feet per day (ft^2/day), or 35,000 gallons per day (gpd) per foot (gpd/ft) to over 100,000 ft^2/day, or 750,000 gpd/ft. Specific yield values range from approximately 0.09 to 0.16 (RCS, 1986, 2002).

The transmissivity values are estimated (indirectly calculated) from pumping plant efficiency (specific capacity) tests conducted on a number of alluvial water wells over the years by the Southern California Edison Company. The transmissivity estimates that are calculated from these tests vary widely over short distances, and in some cases they vary substantially over time at individual wells. This is because the drawdown data that are collected during these tests are solely from the pumping wells themselves. Consequently, the use of water level drawdown data from pumping wells may provide transmissivity estimates that are strongly influenced (potentially biased low) by the condition of the well's screen or perforations and the gravel pack, particularly in the case of older wells. Nonetheless, these estimates can be useful for identifying substantial spatial variations in aquifer permeability if one selects the highest transmissivity values that are calculated for each given well (those values least impacted by well structure or well-related issues). Table 2-3 summarizes the results of the interpretations of the specific capacity data. Appendix B contains detailed tables of the testing data and the calculations of transmissivity and hydraulic conductivity, along with a comparison of these values to parameter values used in the regional model.

2.5.2 Saugus Formation

Available aquifer test data from Saugus wells located near the center of the valley where the Saugus is thickest indicate that the Saugus is semi-confined to confined (under pressure). In areas where the Saugus crops out, the uppermost saturated zones are partially unconfined because the permeable beds are folded upwards. In the highlands, the Saugus beds are

exposed at the ground surface, and in the valley the Saugus beds are in contact with the Alluvial Aquifer.

Transmissivity values range from approximately 400 to 25,000 ft^2/day (3,000 to 180,000 gpd/ft), but are typically between 5,500 and 11,000 ft^2/day (40,000 and 80,000 gpd/ft). Storativity values are on the order of 10^{-3} to 10^{-4}. These aquifer parameter values have been estimated from well performance tests and from the Saugus Formation ASR study conducted in 2000 (RCS, 2001, 2002). Table 2-4 summarizes this parameter data.

The ASR study consisted of a three-phase field test:

a. Phase 1: Injection of approximately 24 million gallons of treated drinking water into well VWC-205 at three injection rates (500, 800, and 1,100 gallons per minute [gpm]). Injection at each rate was performed for 7 days, for a total injection period of 21 days.

b. Phase 2: Recovery of 33 million gallons of water by pumping well VWC-205 at an average rate of 2,300 gpm for a period of 10 days. This pumping began 13 days after injection had ended.

c. Phase 3: Pumping 35 million gallons of water from nearby well VWC-201 at an average rate of 2,400 gpm for a period of 10 days. This pumping began 24 days after pumping had stopped at well VWC-205.

Water levels were monitored in nearby non-pumping Saugus Formation wells, including a Saugus monitoring well located 35 feet from well VWC-205, and in a newly installed Alluvial Aquifer monitoring well located 40 feet from well VWC-201. Monitoring began 22 days prior to Phase 1 and continued 3 days beyond the completion of Phase 3. Testing and monitoring details are provided in the report titled *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). The ASR test indicated that it is hydrogeologically feasible to inject and recover significant volumes of water from a well completed in the Saugus Formation. The data also indicated that there was no measurable effect on water levels at the alluvial monitoring well during the monitoring period.

The ASR testing data also indicated that wells VWC-201 and VWC-205 have specific capacities between 10 and 20 gpm per foot (gpm/ft), which is intermediate in value between those of nearby wells. NCWD's wells to the south have specific capacities ranging from approximately 2 to 10 gpm/ft. To the north, wells that are owned by VWC and SCWC show specific capacities ranging from approximately 25 to 50 gpm/ft. Although these data suggest the possible existence of slightly more permeable zones in the center of the basin than along the southern edge, the apparent difference may also be caused by differences in well construction and well efficiency. Analyses of the ASR test data, including numerical model calibration runs, indicate that the bulk permeability of the Saugus Formation at wells VWC-201 and VWC-205 is approximately 6.5 feet per day (ft/day) (CH2M HILL, 2001).

2.6 General Hydrology and Hydrologic Cycle

The major sources of surface water in the Santa Clarita Valley include precipitation, return flows of urban and agricultural irrigation water, and treatment plant discharges to the Santa Clara River from two WRPs which were built in 1962 and 1967. Another significant source

of surface water is the increased importing of SWP water, which is stored in Castaic Lake and Castaic Lagoon, then treated and delivered by CLWA to the retail water purveyors in the Santa Clarita Valley. In some years, DWR releases flood flows from Castaic Dam/ Lagoon into Castaic Creek during the winter or spring months. Further details regarding the operation of the SWP system and its effect on the valley's hydrology and water supply are provided in Section 2.6.3 below.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 AF/yr. Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The remainder of this section describes the hydrology of the Santa Clarita Valley, historical hydrologic trends, and the operation of the SWP system and its influence on local hydrology and water supplies.

2.6.1 Basin Hydrology

The natural surface water features in the basin are the Santa Clara River and the tributaries that flow into it from canyons lying north and south of the river (Figure 2-10). Flows in the tributary canyons, and in the reach of the Santa Clara River that lies upstream of San Francisquito Canyon, are ephemeral, or intermittent. In these ephemeral streams, flow is limited to short-term runoff periods during storm events. The reach of the Santa Clara River west of San Francisquito Canyon is a perennially flowing river that obtains its flow from natural discharge of Alluvial Aquifer groundwater and from discharge of treated water from two WRPs. The other significant surface water feature is Castaic Lake, an SWP reservoir that lies at the north end of Castaic Creek in the northwestern portion of the valley. Like other tributaries to the Santa Clara River, the flows in Castaic Creek are ephemeral.

Figure 2-1 is a schematic diagram showing the hydrologic cycle for the Santa Clarita Valley. Table 2-5 lists the components of the hydrologic cycle for the basin. The components are classified in the table as one or more of the following:

a. Surface water recharge
b. Surface water discharge

c. Groundwater recharge
d. Groundwater discharge

These four elements of the hydrologic cycle have an important influence on the availability of surface water and groundwater resources in the basin. Time-series plots were constructed to show the relative magnitudes and trends of the various components of the hydrologic cycle in recent years. The time-series plots also illustrate the interrelationships of the hydrologic system components and their relationships to trends in groundwater levels in the Alluvial Aquifer and the Saugus Formation. The time-series analyses are discussed below.

2.6.2 Historical Hydrologic Trends

Long-term water level data have been collected over the years at purveyor-owned wells in the City of Santa Clarita and along the South Fork Santa Clara River. The data have been collected in pumping wells, and the hydrographs of these wells are steep at certain times, suggesting that some water levels are influenced by pumping at the well. Nonetheless, the data show some general trends over time and are useful for assessing general relationships between groundwater elevation trends and changes in groundwater recharge and pumping over time. Following are discussions of the observed hydrologic trends in the basin during the 50-year period from 1950 through 1999, as well as a comparison of hydrologic trends locally and in the SWP system.

2.6.2.1 Historical Trends in Rainfall

Figure 2-11 shows the annual precipitation along with the cumulative departure from the average annual precipitation since 1950. Cumulative departure refers to the cumulative amount of rainfall that is greater than or less than the long-term average rainfall. The slope of the cumulative departure plot shows the temporal trends in rainfall over successive years. The figure shows the following trends in precipitation within the Santa Clarita Valley:

a. 1950 through 1964: Dry conditions except for single wet years in 1952, 1957, 1958, and 1962 (a nearly continual decrease in cumulative departure values)

b. 1965 through 1970: Wet conditions (increase in cumulative departure values)

c. 1971 through 1977: Average to dry conditions (flat or declining cumulative departure values)

d. 1978 through 1983: Wet conditions (increase in cumulative departure values)

e. 1984 through 1991: Dry conditions (decrease in cumulative departure values)

f. 1992 through 1999: Highly variable conditions from year to year, but overall increase in cumulative departure values

2.6.2.2 Historical Trends in Alluvial Groundwater Elevations

Figure 2-12 shows trends in groundwater elevations in two Alluvial Aquifer wells located near the mouth of the South Fork Santa Clara River (VWC-N and NLF-S) and two Alluvial Aquifer wells near the western end of the basin (NLF-C5 and NLF-C7). The figure also shows trends in the following other components of the hydrologic cycle:

a. Precipitation at the Newhall-Soledad rain gage (plotted as the cumulative departure from the average precipitation)

b. Annual pumping volumes from the Alluvial Aquifer and the Saugus Formation

c. Total discharges from the WRPs to the Santa Clara River

d. Measured flow volume in the Santa Clara River during the lowest flow month of each year

Observations from Figure 2-12 are as follows:

a. Alluvial Aquifer groundwater elevations show greater variability over time within the basin interior (wells VWC-N and NLF-S) than near the basin outlet (wells NLF-C5 and NLF-C7). The range in water levels during the 50-year period of record is approximately 100 feet at the interior wells but only 20 to 30 feet in the two wells near the basin outlet.

b. The effect of reduced pumping from the Alluvial Aquifer from 1967 through 1989 was to minimize seasonal fluctuations in Alluvial Aquifer water levels near the aquifer's regional discharge zone at the western end of the valley. In this area, fluctuations in Alluvial pumping over time affected Alluvial groundwater elevations only seasonally; year-to-year variations in groundwater elevations were small. This indicates that water levels in this area are controlled less by pumping than by the discharge of Alluvial Aquifer groundwater to the Santa Clara River in the area downstream of I-5.

c. As with the western portion of the Alluvial Aquifer, the central portion of the Alluvial Aquifer has not shown long-term water level declines. During the 1950s and early 1960s, total pumping from the Alluvial Aquifer ranged between 35,000 AF/yr and 44,000 AF/yr during all but one year, and long-term (year-to-year) groundwater elevations were relatively stable (see the hydrographs for wells VWC-N, and NLF-S). When pumping from the Alluvial Aquifer decreased beginning in 1967, Alluvial groundwater elevations in this area quickly rose and have been relatively stable since about 1970, despite an increase in Alluvial Aquifer pumping during the 1990s. The hydrographs indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above normal rainfall patterns return.

d. The seasonal low flow in the Santa Clara River at the County Line gage has shown a long-term increase since the mid-1970s and, to some degree, during the late 1960s. The figure shows that this increase in flow coincides with increases in the annual discharges of treated water to the Santa Clara River from the two WRPs. Although Alluvial Aquifer pumping increased during the 1980s and 1990s, the seasonal low river flow did not show a long-term decrease during this period. The increases in WRP and Santa Clara River flows and the fluctuations in Alluvial Aquifer pumping have not caused long-term changes in Alluvial Aquifer groundwater elevations at the two wells near the basin outlet.

2.6.2.3 Historical Trends in Saugus Groundwater Elevations

Figures 2-13 and 2-14 compare groundwater elevation trends in the Saugus near the Santa Clara River, below the mouth of the South Fork Santa Clara River, with the same hydrologic

components displayed on Figure 2-12. Figure 2-13 shows this information for the period 1950 through 1999, and Figure 2-14 shows this information during the 1990s, when groundwater levels rose in the Saugus Formation. Figures 2-15 and 2-16 show the same information, but for groundwater elevations at Saugus Formation wells located farther away from the Santa Clara River, along the tributary valley containing the South Fork Santa Clara River.

In examining the four Saugus figures, it is difficult to distinguish between the influences of precipitation and pumping trends on changes in Saugus water levels. Although a slight rise in water levels may have occurred at VWC-157 and VWC-160 during the late 1960s and early 1970s, it appears to follow the trends in Saugus pumping volumes more closely than the precipitation trends. The data at VWC-157 also suggest that a succession of above-normal precipitation years (e.g., 1978 through 1983) or a year of precipitation that is substantially above normal (e.g., 1983) may have some influence on Saugus water levels. However, the data are limited, and the periods of increased precipitation tend to coincide with periods of decreased pumping, making it difficult to identify the effect of precipitation or pumping on Saugus water levels.

Another observation is that the rise in Saugus water levels in the late 1960s and early 1970s occurred despite an increase in annual pumping volumes from the Alluvial Aquifer. This indicates that Saugus water levels are controlled by precipitation and/or Saugus pumping trends, and not by Alluvial pumping trends.

2.6.2.4 Comparison of Historical Trends in Alluvial and Saugus Groundwater Elevations

Figure 2-17 compares groundwater elevations at Alluvial and Saugus wells located near each other along the Santa Clara River, just below the mouth of the South Fork Santa Clara River. At this location, the trends in Alluvial groundwater elevations show no clear relationship with the trends in Saugus groundwater elevations. A moderate overall increase in groundwater elevations is observed in both the Alluvial Aquifer and the Saugus Formation during the late 1960s. However, this similarity in the water level trends may be a coincidence arising from reduced pumping in both aquifers. During the early 1970s, water levels in Saugus well VWC-157 decreased while water levels in the nearby Alluvial Aquifer well (VWC-N) generally increased. During the 1990s, the Alluvial Aquifer groundwater elevations at well VWC-N were generally stable despite (1) increased basinwide alluvial pumping and (2) a sharp decrease, then increase, in Saugus groundwater elevations, which correlated with the trends in Saugus pumping. In summary, although there may be a relationship between Alluvial and Saugus groundwater elevations near the margins of the Santa Clara Valley, where folding of Saugus beds has brought permeable zones in contact with the alluvium, Figure 2-17 indicates that there is general independence between the Alluvial and Saugus water level trends at this location, which is near the center of the bowl-shaped Saugus Formation structure discussed in Section 2.3.3.

2.6.2.5 Historical Trends in Santa Clara River Baseflow

Hydrograph separation techniques were applied to the daily streamflow data for the County Line gage to estimate historical groundwater discharges (baseflow) to the Santa Clara River within the Santa Clarita Valley. The hydrograph separation was performed for calendar years 1953 through 1999 using the following five steps:

1. For each day, the average daily flow at the County Line gage in cubic feet per second (cfs) was converted to acre-feet of volumetric flow for the day.

2. The daily flows from Castaic Dam and at the Castaic Creek South gage (located near the mouth of Castaic Creek) were subtracted from the flow at the County Line gage. These data reflect surface water flow from tributaries. Data from the Castaic Creek South gage were used through June 1977. Beginning in July 1977, operational data for Castaic Lagoon, presented in annual reports by DWR, were used to estimate surface flow contributions from Castaic Creek.

3. The discharges of treated effluent from WRPs owned by LACSD were subtracted. This was performed for calendar years 1975 and later, as 1975 was the first year that such records were available.

4. The resulting day-to-day trends in streamflows were scrutinized for days when notably elevated flows occurred suddenly. These days were assumed to be dominated by storm flow. In some cases, the elevated flows lasted for only 2 to 5 days. In other cases, flows remained elevated for several days but showed steady declines, indicating that only the beginning of the elevated-flow period was dominated by surface runoff.

5. On all other days, storm flow was considered to be minimal or zero, and the flow values calculated for days not dominated by storm flow were assumed to represent river base-flow (that is, groundwater discharge to the river). For each month, an average flow was calculated for these non-storm days. The average flow was then converted to a total flow for the month, and the monthly flow volumes were summed to come up with the total flow for each year.

Table 2-6 presents the annual calculations from the hydrograph separation analysis. Table 2-7 presents summary statistics for the entire 47-year period that was analyzed, as well as for shorter time frames. Tables 2-8 and 2-9 show dry-year, normal-year, and wet-year statistics for the entire period of record and the shorter time frames. The shorter time frames are:

a. Calendar years 1953 through 1965, which were years of primarily agricultural water use prior to urbanization and construction of WRPs. This 13-year period was also characterized by 5 years of below-normal rainfall.

b. Calendar years 1975 through 1999, which represent 25 years of significant urbanization, including SWP water importation and WRP operations. This 25-year period was characterized by 6 years of below-normal rainfall, though rainfall volumes in general were somewhat higher (19.4 inches per year [in/yr] average, versus 15.5 in/yr average for 1953 through 1965).

c. Calendar years 1953 through 1999, but excluding 8 years (1966 through 1974) when WRP discharges occurred but were not recorded.

The daily streamflow data and the hydrograph separation technique indicate the following:

a. Summary statistics in Table 2-7 for all types of rainfall years (dry, normal, and wet) show that average groundwater discharges to the river from 1953 through 1965 were approximately 2,500 AF/yr (3.5 cfs). Groundwater discharges to the river were typically

14,000 to 22,000 AF/yr (19 to 31 cfs) from 1975 through 1999 because of more rainfall, increasing urbanization, and increasing importation of water from outside the valley.

b. For normal rainfall years only, median and average groundwater discharges to the river were approximately 12,500 and 14,300 AF/yr (17 and 20 cfs), respectively, during 1975 through 1999 (Table 2-8); approximately 8,600 and 10,000 AF/yr (12 and 14 cfs), respectively, for the entire historical record (Table 2-9); and approximately 4,000 and 3,600 AF/yr (5.5 and 5.0 cfs), respectively, from 1953 through 1965 (Table 2-8).

c. For drought years only, Table 2-8 shows that groundwater discharges to the river ranged from 400 to 4,900 AF/yr (0.5 to 7 cfs) between 1953 and 1965, and from 5,200 to 14,500 AF/yr (7 to 20 cfs) between 1975 and 1999. Table 2-8 also shows that median and average groundwater discharges to the river during drought years were 600 and 1,700 AF/yr (1 and 2 cfs), respectively, from 1953 through 1965, and typically 9,600 and 10,200 AF/yr (13 and 14 cfs), respectively, from 1975 through 1999.

2.6.3 State Water Project Operations and Hydrology

The import of SWP water is an important aspect of the local hydrologic system, particularly for water supplies. Following is a summary of the SWP system's operations and history in the Santa Clarita Valley, the amount of SWP water available to the valley, and a comparison of the timing of wet-dry rainfall cycles in the SWP system and in the Santa Clarita Valley.

2.6.3.1 State Water Project Operations and History

SWP water is transported to the Santa Clarita Valley by the California Aqueduct and is stored in Castaic Lake prior to use. Castaic Lake is one of several facilities that store SWP water that is transported to Southern California by the California Aqueduct and other aqueducts. The designated uses of Castaic Lake are recreation and storage of SWP water intended for eventual municipal use.

The stored SWP water is delivered by CLWA, which was formed in 1962 to provide a supplemental supply of imported water to the retail water purveyors in the valley. CLWA treats this water at two facilities, the Earl Schmidt Filtration Plant and the Rio Vista Water Treatment Plant, then wholesales this water to each of the retail water purveyors through an extensive transmission pipeline system. The CLWA service area covers approximately 195 square miles (124,800 acres), including the City of Santa Clarita and the surrounding unincorporated communities.

In 1966, CLWA signed a contract with DWR that established a contract amount of 41,500 acre-feet of SWP water. CLWA subsequently purchased 12,700 AF/yr from a Kern County water district during the 1980s, and recently purchased an additional 41,000 AF/yr from a member agency of the Kern County Water Agency, for a current total of 95,200 AF/yr of Table A SWP water. From 1980, when SWP water was first imported into the Santa Clarita Valley, through 1999, the total amount of SWP water delivered to the CLWA service area was approximately 298,972 acre-feet.

The SWP water is combined with local groundwater to meet both residential and non-residential interior and exterior water demands. Ultimately, a substantial portion of the municipal water supply reaches the local existing WRPs in the valley. Historically, the

treated water has been discharged from these WRPs to the Santa Clara River, where it contributes significantly to the natural surface water and groundwater flows reaching Ventura County. As discussed previously, stream gage data at the county line (USGS Gage No. 11108500)[2] demonstrate an increase in annual flow since the import of SWP water and the operation of the WRPs began, even during dry years. This is expected to continue in the future because increased urbanization will increase CLWA water deliveries, which in turn will increase inflows and outflows at LACSD's two WRPs (LACSD, 1998; CH2M HILL, 2002). However, over time, a portion (up to 17,000 AF/yr) of the future increases in flows into the WRPs will become reclaimed water that is used for outdoor irrigation, rather than being discharged into the river.

2.6.3.2 State Water Project Water Availability

The current CLWA Table A contract amount of 95,200 AF/yr of SWP water is affected by a number of factors, including hydrologic conditions; the status of SWP facilities construction; environmental requirements; and evolving policies for water resources management in the San Francisco Bay and Sacramento Delta system, which help route SWP water. While several programs may improve the reliability of SWP water imports to Southern California, such as Interim Delta Improvements and future improvements called the Full Delta Fix and South of Delta Storage, water planning efforts in the Santa Clarita Valley have conservatively assumed that future SWP water supplies will be equal to the SWP supply available under existing conditions. (See the Urban Water Management Plan 2000 [S.A. Associates et al., 2000] for details.)

The DWR has created a model of the SWP system and its allocations. The results from the model, called the DWRSIM model, are used by water agencies in the Santa Clarita Valley as planning numbers for SWP deliveries. The planning numbers for annual SWP water imports to the Santa Clarita Valley, based on CLWA's current Table A contract amount, are as follows:

a. Average years = 56,800 AF/yr (59.7 percent of the 95,200 AF/yr Table A contract amount)

b. Wet years = 66,300 AF/yr (69.6 percent of the 95,200 AF/yr Table A contract amount)

c. Multiple dry years = 37,900 AF/yr (39.8 percent of the 95,200 AF/yr Table A contract amount)

d. Multiple critical years = 19,000 AF/yr (20.0 percent of the 95,200 AF/yr Table A contract amount)

The DWRSIM model also indicates that a dry year allocation occurs, on average, once every 10 years, and that 3 consecutive years of drought occur, on average, once every 20 years. A separate DWR study (Roos, 1992) also concluded that droughts in excess of 3 years are rare in Northern California. Consequently, because of the availability of storage in the SWP

[2] Until October 1996, this gage was located just downstream of the county line at Blue Cut, an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure 1-1 for this location. This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

system, DWR and the water agencies in the Santa Clarita Valley use the dry year allocation of 37,900 AF/yr to plan for single dry years, and also for droughts lasting up to 3 years.

2.6.3.3 Local and State Water Project Historical Hydrology

Table 2-10 compares the historical hydrologic pattern for the SWP system with the local basin hydrology since 1944. The SWP hydrologic pattern is affected by the hydrology of Northern and Central California and is specifically mentioned in the Sacramento Four Rivers Unimpaired Runoff Index in Volume 1 of *Bulletin 160-98: The California Water Plan Update* (DWR, 1998). This index provides a general indication of SWP water delivery patterns, though it only describes runoff into the SWP system and does not account for system storage and other factors that affect actual SWP deliveries. The local hydrologic pattern shown in Table 2-10 is based on the long-term rainfall record at the Newhall-Soledad rain gage. Table 2-10 shows the following:

a. Critically low runoff years occurred in the SWP system during the 2-year period 1976 through 1977; during 1988; during the 3-year period 1990 through 1992; and again during 1994.

b. The period 1980 through 1999 shows primarily extreme hydrologic conditions (wet, dry, or critical), with moderate hydrologic conditions occurring only twice, above-normal years in 1980 and 1993.

c. Hydrologic conditions in the SWP system are often different from local hydrologic conditions. Below-normal years in the SWP system often do not coincide with local droughts, and only some critical SWP years, 1990 and 1994, coincide with local drought. Likewise, historical SWP hydrology has varied considerably during years of local droughts.

The Regional Model was calibrated to time-varying hydrologic conditions for the historical time period 1980 through 1999 (see Section 4 for more details on Regional Model calibration). Table 2-11 compares SWP hydrology, SWP allocations, and local hydrology for the period 1980 through 1999. Based on the historical cycle and the goals listed above, the hydrologic cycle relating to the availability of SWP water during that period was as follows:

a. Years 1 through 5 (water years [WY] 1980 through 1984): normal or above-normal availability

b. Year 6 (WY 1985): 1-year drought (below-normal availability)

c. Years 7 through 10 (WYs 1986 through 1989): normal or above-normal availability

d. Years 11 through 13 (WYs 1990 through 1992): 3-year drought (below-normal availability)

e. Year 14 (WY 1993): normal or above-normal availability

f. Year 15 (WY 1994): 1-year drought (below-normal availability)

g. Years 16 through 20 (WYs 1995 through 1999): normal or above-normal availability

Although SWP hydrology was dry or critical during water years 1987 through 1989, the DWRSIM model indicates that the storage volume in the SWP would have provided normal water deliveries to the Santa Clarita Valley (S.A. Associates et al., 2000).

2.6.3.4 Availability of Castaic Creek Flood Flows

As provided through agreement with DWR, CLWA has access to approximately 4,700 acre-feet of storage in Castaic Lake. This water is stormwater that flows into Castaic Lake from its upstream watersheds. Prior to completion of Castaic Dam in 1972, the LACWWD, Newhall Land & Farming Company (NLF), NCWD, and UWCD, which together constitute the Downstream Water Users, had certain rights to the stormwater flowing in Castaic Creek. On October 24, 1978, DWR entered into agreements with the Downstream Water Users regarding their rights to this water. Under the terms of the agreement, DWR would release the first 100 cfs of inflow. At the time of the agreement, flows in excess of 100 cfs were believed to be wasted to the ocean. When the local inflow to Castaic Reservoir exceeds 100 cfs, the excess of 100 cfs inflow is retained in the reservoir. Until May 1 of each year, the Downstream Water Users can receive 75 percent of this retained water by paying specified storage charges. If the Downstream Water Users request this water, it is delivered by releasing water into Castaic Lagoon, and then Castaic Creek. These releases are called Castaic Creek Flood Flows. If the Downstream Water Users do not request this water on or before May 1, any retained water becomes the property of DWR.

The allocation of stored water among the Downstream Water Users is specified in a separate agreement. Under that agreement, UWCD receives 48 percent of the delivered flood flows, while the three Santa Clarita Valley entities, NLF, NCWD, and LACWWD, together receive 52 percent.

The Castaic Creek flood flows available to the group of four Downstream Water Users averaged 15,700 AF/yr during water years 1977 through 2000. (See Table 2-12.) However, the magnitudes of these flows varied greatly from year to year, as shown on Figure 2-18. No flood flows were stored or delivered in 5 of these years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow). The highest flood flow was 67,400 AF/yr, in water year 1978, and the flood flow exceeded the average flow in only 7 of these 24 years. The Regional Model simulated these historical flows, as described in Appendix C.

2.7 Previous Studies

Several prior studies have been important in developing a general understanding of the valley's geology and hydrology and in developing and calibrating the Regional Model.

2.7.1 1986 Alluvial Aquifer Study

In 1986, RCS studied the alluvial sediments in the Santa Clarita Valley to estimate the amount of groundwater in storage and the amount of recharge that occurs over the long-term, and also to evaluate the feasibility of artificially recharging these sediments (RCS, 1986). This was the first published report detailing the hydrogeologic characteristics of the Alluvial Aquifer system, water well construction and testing information, and magnitudes and changes in groundwater elevation and groundwater quality. Prior studies in the Santa Clarita Valley focused on oil development, and therefore evaluated the regional geology

with an emphasis on the subsurface geologic conditions in the hills and mountains surrounding the valley.

The 1986 study identified 650 water wells that had been drilled in the valley up to that time, all but 22 of which were drilled in the alluvium to depths less than 250 feet. The study examined geologic logs, well testing (specific capacity) records, long-term water level data, and water quality records. The study concluded that the coarse-grained, permeable sediments comprising this aquifer system are subjected to seasonal and year-to-year variations in water levels and groundwater in storage due to highly variable rainfall and streamflow patterns. In addition to describing the hydrogeology of the Alluvial Aquifer, the study mapped and identified the watersheds contributing to streamflows in the Santa Clara River and its tributaries, and estimated the amount of runoff from these watersheds that is potentially available as recharge to the Alluvial Aquifer. The study also concluded that it would be feasible to artificially recharge portions of the Alluvial Aquifer using spreading basins, primarily along the Santa Clara River in the area east of the mouth of Bouquet Canyon.

2.7.2 1988 Saugus Aquifer Study

In 1988, RCS conducted a study of the Saugus Formation that was similar in scope to the 1986 study of the Alluvial Aquifer (RCS, 1988). The scope of work included conducting 24-hour, constant discharge aquifer tests in five different Saugus Formation wells, including monitoring water level recovery rates. Six regional geologic cross-sections were also constructed from geologic and geophysical logs that had been compiled prior to this study at water wells and numerous oil wells within and around the Santa Clarita Valley.

The study concluded that the Saugus Formation is discretely layered, with groundwater production occurring from discrete sand and gravel zones that exist throughout much of the total thickness of the formation. The study also concluded that it is hydrogeologically feasible to develop additional groundwater supplies from the Saugus Formation as long as wells are properly sited and constructed, and that the groundwater-yielding capability of the Saugus Formation is likely greater south of the San Gabriel fault than north of the fault.

2.7.3 2002 Aquifer Study Update

In 2002, RCS updated the 1986 and 1988 studies with more recent data and prepared a report for both the Alluvial and Saugus Formation aquifers (RCS, 2002). As part of this work, a GIS and digital database were constructed. Field activities conducted during the study included surveying water well locations and elevations using a global positioning system (GPS) survey and water level data collected at Alluvial and Saugus wells.

The report concluded that groundwater levels in the Alluvial Aquifer and Saugus Formation have fluctuated over time, but have shown no long-term progressive declines in the amount of groundwater storage that could be considered indicative of overdraft conditions. From the long-term pumping and water level data, the report concluded that the Alluvial Aquifer can be pumped at rates between 30,000 and 40,000 AF/yr over the long-term, and suggested that pumping be between 30,000 and 35,000 AF/yr during dry years. For the Saugus Formation, the study concluded that pumping can occur at rates between 7,500 and 15,000 AF/yr on a long-term basis, with short-term increases to as much as

35,000 AF/yr during the end of a multi-year drought period. These pumping rates for the Alluvial and Saugus aquifer systems were referred to in the 2002 study as the operational yields of both aquifers.[3]

2.7.4 Newhall Ranch ASR Impact Evaluation

The Newhall Ranch Company performed analyses of potential impacts resulting from development of the proposed Newhall Ranch Specific Plan, including implementation of an ASR program. Findings were documented in the following reports:

a. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001).

b. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001).

c. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002).

The study consisted of the following work:

a. An ASR field test was conducted by RCS in the Saugus Formation at VWC-205 in July 2000. The objective of the test was to determine the feasibility of injecting water into the Saugus Formation and later extracting the stored water. Approximately 24 million gallons of treated drinking water were injected into the well at a rate of up to 1,100 gpm for 21 days (RCS, 2001). The stored water was then recovered at a rate of 2,300 gpm for 10 days. Water levels were monitored in nearby Saugus Formation wells and in a newly installed Alluvial Aquifer monitoring well. This test demonstrated that ASR is indeed feasible in the Saugus Formation. Also, there was no measurable effect on water levels during the injection or pumping phase at the Alluvial monitoring well.

b. A pumping test was conducted by RCS in the Saugus Formation at VWC-201 to further demonstrate the limited hydraulic connection between the Saugus Formation and the Alluvial Aquifer. Well VWC-201 was pumped at 2,400 gpm for 10 days and water levels were monitored at an Alluvial Aquifer well located less than 50 feet away. Again, no response to Saugus Formation pumping was discernible at the Alluvial monitoring well.

While the ASR field test demonstrated that ASR is feasible in the Saugus Formation and that there is limited effect on the Alluvial Aquifer, it was necessary to conduct additional

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[3] The concept of operational yield was described in the RCS report as follows (RCS, 2002):

"One of the disadvantages of utilizing perennial yield as a basis for managing the pumpage from an aquifer system is that it represents a long-term average value for annual yield. There is a potential for the perennial yield value to be interpreted as a "not-to-exceed" volume, with a related potential for pumping above the perennial yield value in any give year to be incorrectly interpreted as "overdraft." A recently advanced concept intended to deal with such misinterpretations is that of operational yield. Operational yield can be defined as a fluctuating value of pumpage that may be above or below the perennial (or average) yield in any given year, and that varies as a function of the availability of other water supplies. The basic intent of the operational yield value is that it should not exceed the perennial yield of the groundwater basin over multi-year wet and dry cycles."

"The operational yield concept includes flexibility of groundwater use by allowing increased pumping during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is available in wet/normal rainfall periods. The operational yield protects the aquifer by helping to assure that groundwater supplies are adequately replenished on a long-term basis from one wet/dry cycle to the next. In the Valley, historical groundwater data demonstrate that the alluvium has been, and continues to be, developed within its long-term sustainability (i.e., no continuous lowering of water levels, no notable trend toward degradation of groundwater quality, etc.)"

analysis to extrapolate the results of RCS's well field testing to a full-scale, long-term ASR operation. This additional analysis was designed to address the following questions:

a. Can 4,500 AF/yr of water be stored in the Saugus Formation for withdrawal during drought years?

b. Will storage of water in the Saugus Formation increase the rate of natural groundwater discharge to the Alluvial Aquifer and to the Santa Clara River, and, if so, by how much?

c. Will pumping Saugus Formation ASR wells during a drought period reduce groundwater elevations in the Alluvial Aquifer and, subsequently, flows in the Santa Clara River?

d. Will the ASR program result in water quality changes within the Saugus Formation, the Alluvial Aquifer, and the Santa Clara River?

e. Will the ASR program cause spreading of perchlorate that is present in the Saugus Formation?

To answer these questions, CH2M HILL prepared a numerical groundwater flow model of the western and central portions of the Santa Clarita Valley. The model simulated the groundwater flow in the Saugus Formation and the Alluvial Aquifer, accounting for the inflows and outflows to and from the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River under historical conditions. The model was also used to simulate the changes in the groundwater flow system that would arise from operation of the ASR system. Of particular interest was the model's simulation of changes in subsurface groundwater flow out of the valley and changes in groundwater discharge into the Santa Clara River that would arise from ASR operations under a historical climatic cycle (wet and dry hydrologic conditions) observed during the 1980s and 1990s. These two groundwater discharge mechanisms were evaluated in detail with the model to estimate the potential changes in flow to Ventura County from the ASR system. The western limit of the model was placed at the county line, and the eastern limit of the Saugus Formation was established as the eastern limit of the model domain.

The primary findings from the analysis were:

a. On the basis of the historical timing of drought years, the proposed ASR system would provide long-term benefits to the river and the groundwater system. ASR pumping cycles would cause small (less than 1 foot) declines during drought years, and long-term operation of the ASR system would not cause long-term groundwater elevation declines in the Alluvial Aquifer, where riparian habitat is present along the river.

b. The combined influence of the proposed ASR program and the other water resource attributes[4] of Newhall Ranch would result in an overall increase in river flows over the long term.

c. The continued increase in water supplies to meet the water demands arising from a combination of growth outside Newhall Ranch and development of the Newhall Ranch

[4] Direct discharges of treated effluent into the river from the Newhall Ranch WRP, and the redistribution of irrigation demands (rates and locations) associated with conversion of water use from agricultural to municipal demands.

project would further enhance the long-term flows to the river, compared with present conditions. The occurrence of increased annual river flows during drought and nondrought years alike, compared with present conditions, is consistent with historical records, showing that continued urbanization and associated importation of water from areas outside the valley would increase river flows gradually over time.

Tables

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	Castaic1	244	257	253	189	251	274	295	450	520	478	444	561	515	458	496	401	385	535	166	426	118
	Castaic2	124	48	0	0	0	0	380	535	324	678	0	0	0	477	518	380	327	268	257	331	289
	Castaic3	0	108	136	172	240	301	0	0	324	0	660	532	488	0	0	0	0	0	0	0	0
	Castaic4	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	95	57	6	7
	Pinetree1	346	326	355	242	148	273	8	0	2	152	0	47	16	247	154	79	64	89	227	403	245
	Pinetree2	58	84	209	112	154	113	206	309	351	348	31	0	283	326	218	165	70	0	0	0	0
	Pinetree3	398	527	225	432	753	655	719	756	758	672	801	724	682	450	607	595	624	812	716	505	494
	Pinetree4	0	0	0	0	3	28	234	77	4	0	0	0	10	19	232	55	333	510	338	5	355
NLF	161	317	370	271	223	314	220	170	0	0	0	120	82	401	753	791	0	0	0	0	123	106
	B10	0	0	0	0	0	0	0	0	0	0	0	291	1,225	452	1,406	894	1,045	930	1,244	1,155	990
	B11	186	217	159	133	184	138	60	0	0	127	445	311	0	136	51	127	151	30	250	212	182
	B5	1,218	1,423	1,041	858	1,208	772	1,178	1,002	1,481	1,928	1,893	1,880	860	989	1,950	1,921	1,649	1,756	1,273	1,748	1,500
	B6	858	1,002	733	604	850	543	946	788	165	96	137	263	615	283	808	1,359	1,421	1,602	1,572	2,133	1,830
	B7	0	0	0	0	0	0	60	0	0	127	0	0	400	180	581	373	56	286	176	444	381
	C	723	845	618	510	717	575	660	387	418	557	338	226	756	1,024	417	1,324	715	1,126	598	716	614
	C3	196	229	168	138	195	140	254	63	130	71	134	48	197	259	582	333	397	355	378	619	531
	C4	260	304	222	183	258	196	137	25	30	7	213	225	166	12	108	150	293	483	609	819	703
	C5	459	536	392	323	455	359	328	191	198	154	147	250	428	414	394	472	676	894	628	685	588
	C6	203	237	174	143	201	166	161	103	117	77	59	123	0	0	0	360	229	226	128	154	132
	C7	575	671	491	405	570	354	195	192	318	337	339	220	427	279	625	778	582	779	779	1,167	1,001
	C8	0	0	0	0	0	0	0	0	0	0	0	0	126	254	166	199	458	432	179	236	202
	E	2,067	2,416	1,767	1,457	2,051	3,342	1,842	1,180	812	624	965	498	1,325	1,513	1,022	1,366	2,542	1,949	1,522	2,506	2,150
	E2	174	203	149	123	173	138	103	0	0	251	1,284	830	560	584	555	115	669	525	426	138	118
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	138	0	0	0	0	0	0
	E4	1,011	1,181	864	712	1,003	639	716	83	566	392	553	284	376	16	0	381	140	339	80	281	241
	E5	0	0	0	0	0	0	0	0	0	0	0	0	65	274	0	142	514	598	42	0	0
	E7	0	0	0	0	0	0	0	0	0	0	0	0	116	80	105	88	79	2	0	0	0
	E9	96	113	82	68	96	78	117	288	476	411	339	596	252	187	435	319	12	142	170	42	36
	G45	324	378	277	228	321	179	153	98	123	99	143	146	165	82	144	137	159	180	144	231	198
	Q	441	515	377	311	438	159	360	382	312	185	15	0	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	159	186	136	112	158	71	104	47	0	0	0	87	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	293	342	250	206	290	95	0	958	0	0	503	0	0	0	0	0	0	0	0	276	237
	S3	655	765	560	461	649	327	124	0	0	0	29	37	52	99	87	109	97	55	10	3	0
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0
	Topco 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W4	303	354	259	213	300	138	60	1	0	300	157	252	1	0	36	5	128	29	20	3	3
	W5	553	646	472	389	548	191	315	205	308	192	0	175	0	0	0	0	0	0	0	21	18
	X3	260	304	222	183	258	508	244	314	497	308	412	215	350	135	205	222	8	108	22	112	96
SCWC	Clark	303	228	131	137	194	200	208	342	248	301	407	542	662	635	572	662	1,027	873	697	878	747
	Guida	1,058	795	457	477	677	698	221	569	158	530	676	801	978	895	942	744	1,252	1,479	1,274	1,556	853
	Honby	594	447	257	268	381	392	193	391	462	216	930	893	731	1,393	476	553	352	814	532	1,162	815
	Lost Canyon 2	1,083	814	468	489	693	714	765	923	787	588	601	404	465	692	669	773	678	792	757	946	708
	Lost Canyon 2A	0	0	0	0	0	0	0	0	0	0	293	832	1,284	1,080	1,383	1,230	1,370	1,055	973	890	998
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell	1,189	893	515	537	761	785	444	582	485	435	264	3	474	663	564	610	598	633	482	913	439
	N.Oaks Central	488	367	211	220	313	322	304	361	153	329	525	704	701	1,403	1,313	965	851	870	1,490	1,682	1,145
	N.Oaks East	601	451	260	271	385	396	863	972	776	914	454	194	588	1,233	1,473	1,295	900	1,033	1,407	695	1,483
	N.Oaks West	643	483	278	290	412	424	874	465	842	413	275	78	634	866	972	795	663	952	934	1,894	1,663
	Sand Canyon	721	542	312	325	461	477	514	466	498	1,115	458	49	661	918	781	842	1,211	1,533	1,622	1,629	1,317
	Sierra	2,780	2,089	1,202	1,255	1,780	1,834	856	220	459	730	772	719	1,050	1,413	1,433	1,092	1,034	597	814	1,158	640
	Stadium	0	0	0	0	0	0	167	291	211	214	328	374	60	825	418	656	509	637	444	338	721

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
VWC	D	289	269	164	163	240	41	0	305	588	614	510	680	239	173	494	403	454	1,134	1,209	921	880
	I	214	200	122	121	177	181	95	0	91	132	73	108	1	0	1	0	0	0	0	0	0
	K2	0	0	0	0	0	0	0	0	0	0	0	982	1,134	1,708	2,089	1,155	1,305	1,076	1,489	1,420	861
	L2	9	8	5	5	7	91	0	0	0	0	0	838	526	996	1,236	818	961	308	190	532	494
	N	1,475	1,376	840	833	1,223	1,093	1,472	1,420	1,473	1,177	792	976	697	66	0	24	263	808	768	1,036	935
	N3	0	0	0	0	0	0	0	0	0	0	0	10	999	1,536	29	943	1,325	1,034	1,093	1,057	778
	N4	5	5	3	3	4	65	0	0	0	0	0	847	248	133	911	1,329	1,328	1,185	772	894	710
	Q2	440	411	251	248	367	461	838	893	512	1,483	1,398	1,783	335	548	1,348	1,126	1,385	1,462	1,655	1,288	1,387
	S6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	515
	S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111
	S8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79
	T2	621	580	354	351	515	704	894	913	1,007	1,030	643	662	379	0	3	280	733	837	941	726	984
	T4	160	150	91	91	133	54	167	0	0	0	0	163	687	3	1	975	1,258	804	523	892	625
	U3	1,476	1,378	841	834	1,225	1,278	1,033	638	323	823	1,254	1,199	369	1	2	765	987	851	560	702	1,126
	U4	1,306	1,220	744	738	1,084	665	668	606	696	567	551	584	42	3	2	7	742	789	529	828	1,073
	W6	0	0	0	0	0	0	0	146	145	0	0	217	260	204	224	365	615	493	355	416	445
	W9	0	0	0	0	0	0	0	0	0	0	11	902	699	444	507	508	1,077	915	627	1,111	1,176
WHR	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,229	1,376	772	1,104	1,204	1,352	760	614	1,229	1,131	1,010
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	137	137	137	137	137	137	137	137	137	137	91	102	57	82	89	100	56	46	91	84	75
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	680	762	427	612	666	748	421	340	680	627	559
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pumping (NCWD)		1,170	1,350	1,178	1,147	1,549	1,644	1,842	2,127	2,283	2,367	1,936	1,864	1,994	1,977	2,225	1,675	1,803	2,309	1,761	1,676	1,508
Total Pumping (NLF)		11,331	13,237	9,684	7,983	11,237	9,328	8,287	6,512	5,951	6,243	8,225	7,039	8,938	8,020	10,606	11,174	12,020	12,826	10,250	13,824	11,857
Total Pumping (SCWC)		9,460	7,109	4,091	4,269	6,057	6,242	5,409	5,582	5,079	5,785	5,983	5,593	8,288	12,016	10,996	10,217	10,445	11,268	11,426	13,741	11,529
Total Pumping (VWC)		5,995	5,597	3,415	3,387	4,975	4,633	5,167	4,921	4,835	5,826	5,232	9,951	6,615	5,815	6,847	8,698	12,433	11,696	10,711	11,823	12,179
Total Pumping (WHR)		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,240	1,256	1,798	1,959	2,200	1,237	1,000	2,000	1,842	1,644
Total Pumping (All Purveyors)		30,956	30,293	21,368	19,786	26,818	24,847	23,705	22,142	21,148	23,221	23,376	26,687	27,091	29,626	32,633	33,964	37,938	39,099	36,148	42,906	38,717
Total Pumping (Others)		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	932	953	890
Total Alluvial Aquifer Pumping		31,456	30,793	21,868	20,286	27,318	25,347	24,205	22,642	21,648	23,721	23,876	27,187	27,591	30,126	33,133	34,464	38,438	39,599	37,080	43,859	39,607

Notes:

N. = north

WHR = Wayside Honor Rancho, owned by LACWWD

All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, Consulting Engineers. April 2003. *Santa Clarita Valley Water Report 2002.* Prepared for the Castaic Lake Water Agency, Los Angeles County Waterworks District #36, Newhall County Water District, and Valencia Water Company.

TABLE 2-2

Annual Groundwater Pumping from the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	7	404	396	350	348	355	384	271	260	332	242	242	274	180	268	321	364	332	288	280	172	0
	4	440	449	319	385	315	369	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	119	227	115	138	1	0	5	1	1	0	4	1	1	0	1	0	0
	10	790	906	1,287	1,300	1,007	997	731	888	613	453	644	343	351	61	0	1	0	0	2	0	0
	11	729	870	716	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0
	12	0	0	0	0	0	0	0	0	1,830	2,713	2,603	3,342	2,807	1,956	1,918	2,264	2,140	1,798	1,909	1,155	1,767
	13	0	0	0	0	0	0	0	0	0	0	0	0	1,393	2,053	2,246	1,623	2,045	3,001	2,351	1,295	419
NLF	156	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
SCWC	Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0
	Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0
VWC	157	635	604	529	239	387	314	581	483	1,223	1,146	635	1,005	570	436	616	403	46	80	0	0	0
	159	0	0	0	0	0	0	0	0	0	0	3	63	65	74	147	68	3	0	0	0	0
	160	1,571	1,725	368	372	467	571	846	822	1,077	1,326	839	1,325	580	920	957	585	206	401	133	95	776
	201	0	0	0	0	0	0	0	0	0	57	2,039	2,249	1,170	752	845	530	71	35	16	11	172
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59
Total Pumping (NCWD)		2363	2621	2672	2787	2955	3255	3548	3657	4041	4688	4746	4994	5160	5068	5103	4775	4871	5168	4557	2622	2186
Total Pumping (NLF)		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
Total Pumping (SCWC)		0	0	0	0	0	0	0	0	63	0	40	4781	2913	2901	3863	1726	2176	1068	0	0	0
Total Pumping (VWC)		2206	2329	897	611	854	885	1427	1305	2300	2529	3516	4642	2385	2182	2565	1586	326	516	149	106	1007
Total Pumping (All Purveyors)		4,589	4,970	3,589	3,418	3,829	4,160	4,995	4,982	6,424	7,237	8,322	14,437	10,478	10,171	11,551	8,107	7,639	7,197	5,132	3,207	3,567
Total Pumping (Others)		0	0	501	434	620	555	490	579	504	522	539	480	446	439	474	453	547	548	423	509	513
Total Saugus Formation Pumping		4,589	4,970	4,090	3,852	4,449	4,715	5,485	5,561	6,928	7,759	8,861	14,917	10,924	10,610	12,025	8,560	8,186	7,745	5,555	3,716	4,080

Note:

All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, 2003.

TABLE 2-3

Summary of Selected Tests and Estimated Parameter Values for the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Area	Well Owner-Name	Estimated T (ft^2/day)	Model T (ft^2/day)	Estimated K (ft/day)	Model K (ft/day)	Model Zone
West of I-5	NLF-B5	80,000 to 150,000	60,500	750 to 1,400	550	C1c
	NLF-B6	40,000 to 70,000	60,500	100 to 600	550	C1c
	NLF-C4	20,000 to 35,000	60,500	100 to 300	550	C1b
	NLF-E5	40,000 to 55,000	71,500	100 to 400	550	C1a
Between I-5	VWC-I	30,000 to 45,000	22,500	250 to 350	375	B1b2
and Soledad	VWC-K2	60,000 to 90,000	54,375	400 to 600	375	B1a
Canyon	VWC-N3	55,000 to 80,000	79,750	375 to 550	550	B1a
	VWC-N4	75,000 to 100,000	54,375	500 to 750	375	B1a
	VWC-Q2	35,000 to 50,000	79,750	250 to 350	550	B1a
	NLF-R2	50,000 to 105,000	22,050	600 to 1,200	245	B1a
	NLF-S	35,000 to 85,000	54,375	250 to 600	375	B1a
	NLF-S3	35,000 to 55,000	79,750	250 to 350	550	B1a
Lower Soledad	SCWC-Stadium	85,000 to 150,000	63,250	950 to 1,650	550	A1e1
Canyon	VWC-U3	90,000 to 170,000	63,250	800 to 1,500	550	A1e2
	VWC-U4	65,000 to 135,000	63,250	550 to 1,200	550	A1e2
	SCWC-Honby	30,000 to 50,000	49,500	300 to 550	550	A1d1
Upper Soledad	SCWC-N.Oaks West	35,000 to 55,000	49,500	400 to 600	550	A1d4
Canyon	SCWC-N.Oaks Central	85,000 to 120,000	49,500	900 to 1,350	550	A1d4
	SCWC-N.Oaks East	50,000 to 70,000	49,500	500 to 800	550	A1d4
	SCWC-Sierra	80,000 to 145,000	49,500	900 to 1,600	550	A1c1
	SCWC-Mitchell	40,000 to 60,000	49,500	450 to 650	550	A1c2
	SCWC-Sand Canyon	35,000 to 125,000	36,000	400 to 1,400	400	A1c3
	NCWD-Pinetree 3 and 4	30,000 to 50,000	31,500	300 to 550	350	A1b1
Castaic Valley	VWC-D	30,000 to 50,000	35,000	300 to 500	350	C2b
	NLF-E	60,000 to 90,000	35,000	600 to 900	350	C2b
	NLF-E2	45,000 to 100,000	35,000	450 to 1,000	350	C2b
	WHR Wellfield	40,000 to 75,000	35,000	400 to 750	350	C2a and C2b
Northern Canyons	NLF-W4	25,000 to 35,000	10,500	250 to 350	105	B4c
	VWC-W6	25,000 to 40,000	10,500	250 to 400	105	B4c
	SCWC-Guida	45,000 to 65,000	12,600	500 to 700	140	B2b
	SCWC-Clark	55,000 to 80,000	22,050	650 to 900	245	B2c

Note:

See Section 4.3.1 for a discussion of the model zones.

TABLE 2-4

Summary of Selected Tests and Estimated Parameter Values for the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Name	Date	Type of Test	Pumping or Injection Rates (gpm)	Length of Test (minutes)	Well Monitored	Specific Capacity (gpm/ft)[a]	T (gpd/ft)	T (ft^2/day)	Storativity	Model Zone
NCWD-7	03/04/1987	Drawdown	341	1,440	NCWD-7	3.1	26,400	3,530		F
NCWD-7	03/05/1987	Recovery		1,500	NCWD-7		23,300	3,110		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-10	8.3	28,500	3,810		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-12 (160 feet away)		57,700	7,710	9.10E-04	F
NCWD-10	03/11/1987	Recovery		1,480	NCWD-10		38,400	5,130		F
NCWD-10	03/11/1987	Recovery		1,490	NCWD-12 (160 feet away)		61,500	8,220	7.60E-04	F
NCWD-9	03/17/1987	Drawdown	256	1,460	NCWD-9	1.9	3,700	490		A
NCWD-9	03/17/1987	Recovery		1,500	NCWD-9		3,000	400		A
VWC-160	03/24/1987	Drawdown	2,562	720	VWC-160	49.8	163,000	21,790		E
VWC-160	03/24/1987	Recovery		850	VWC-160		182,000	24,330		E
VWC-205	07/01/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-205M (40 feet)	12.2	41,370	5,530	8.88E-04	E
VWC-205	07/02/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-201 (2,400 feet)		50,450	6,740	7.56E-04	E
VWC-205	07/03/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-157 (4,100 feet)		54,880	7,340	6.45E-04	E
VWC-205	08/01/2000	Pumping	2,273	12,960 / 14,440	VWC-205	18.7				E
VWC-205	08/01/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-205M (40 feet)	18.7	78,910	10,550	9.48E-04	E
VWC-205	08/02/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-201 (2,400 feet)		76,410	10,220	1.37E-03	E
VWC-205	08/03/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-157 (4,100 feet)		65,880	8,810	1.36E-03	E
VWC-201	10/01/2000	Pumping	2,439	14,440 / 2,880	VWC-201	30	65,100	8,700	5.75E-04	E
VWC -201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-157 (1,900 feet)		44,230	5,910	1.17E-03	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205M (2,360 feet)		57,210	7,650	8.49E-04	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205 (2,400 feet)		47,890	6,400	6.75E-04	E
SCWC-Saugus1	07/01/1988	Pumping	2,941	1,440	SCWC-Saugus1	30.2	69,300	9,260		E
SCWC-Saugus1	07/01/1988	Recovery	2,941	480	SCWC-Saugus1		59,700	7,980		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus2	24.1	53,500	7,150		E
SCWC-Saugus2	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus2		55,700	7,450		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus1		71,500	9,560	3.60E-04	E
SCWC-Saugus3	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus1		60,200	8,050		E

[a]gpm/ft of drawdown

Note:

See Section 4.3.1 for a discussion of the model zones.

Data source: RCS, 2002 (except model zones)

TABLE 2-5
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges into the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered to be a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow occurs into the Santa Clarita Valley beneath Castaic Creek due to water seepage beneath Castaic Dam.

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1953	0	4,986	4,943	0	4,943	4.88	Dry
1954	977	7,316	5,554	0	5,554	15.82	Normal
1955	134	4,795	4,122	0	4,122	13.91	Normal
1956	311	5,429	3,803	0	3,803	14.21	Normal
1957	559	4,782	2,410	0	2,410	22.85	Wet
1958	21,204	38,756	5,344	0	5,344	23.14	Wet
1959	473	3,277	2,206	0	2,206	9.81	Dry
1960	1	777	586	0	586	11.64	Dry
1961	79	804	410	0	410	8.82	Dry
1962	5,101	28,460	2,433	0	2,433	21.22	Wet
1963	32	1,884	1,058	0	1,058	12.79	Normal
1964	1	1,030	646	0	646	10.09	Dry
1965	3,702	35,614	996	0	996	32.28	Wet
1966	5,780	10,101	2,332	No data	---	14.57	Normal
1967	27,819	40,480	8,640	No data	---	23.23	Wet
1968	4,381	7,216	3,895	No data	---	6.90	Dry
1969	46,461	258,660	29,395	No data	---	32.42	Wet
1970	6,597	31,066	14,924	No data	---	23.19	Wet
1971	2,310	15,883	10,843	No data	---	13.75	Normal
1972	2,205	16,027	12,975	No data	---	4.15	Dry
1973	12,671	52,631	26,115	No data	---	19.79	Wet
1974	7,288	25,265	11,918	No data	---	18.04	Wet
1975	2,027	14,770	10,806	5,534	5,272	10.92	Dry
1976	156	10,162	9,754	6,095	3,659	14.02	Normal
1977	1,380	13,454	9,359	6,004	3,355	20.87	Wet
1978	35,378	129,187	60,955	6,982	53,973	42.17	Wet
1979	13,626	57,594	42,448	7,397	35,051	21.47	Wet
1980	16,785	95,211	57,593	7,372	50,221	27.00	Wet
1981	6,519	24,232	21,172	7,949	13,223	13.42	Normal
1982	9,102	36,488	32,531	8,436	24,095	20.20	Wet
1983	67,058	131,236	55,878	9,420	46,458	39.07	Wet
1984	13,787	39,279	35,215	9,512	25,703	12.86	Normal
1985	2,619	24,466	24,089	9,614	14,475	8.37	Dry
1986	4,945	48,024	31,327	10,822	20,505	18.02	Wet

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1987	911	26,198	23,663	11,844	11,819	14.45	Normal
1988	2,415	36,611	24,934	12,363	12,571	16.92	Wet
1989	Unavailable	24,799	23,453	13,560	9,893	7.56	Dry
1990	0	23,472	21,772	14,006	7,766	6.98	Dry
1991	65	34,901	18,702	14,108	4,594	17.21	Wet
1992	4,450	68,577	23,601	15,703	7,898	32.03	Wet
1993	7,725	152,783	65,054	17,179	47,875	32.72	Wet
1994	Unavailable	32,039	31,239	16,946	14,293	10.27	Dry
1995	5,611	82,409	51,001	17,824	33,177	29.15	Wet
1996	5,632	47,930	36,366	16,831	19,535	15.88	Normal
1997	9,885	36,780	27,521	15,778	11,743	13.35	Normal
1998	47,803	205,139	81,744	17,695	64,049	30.73	Wet
1999	5,830	32,382	27,176	17,847	9,329	8.96	Dry

[a]Annual rainfall values are based on monthly records for this gage, as reported by NCDC and LADPW.

[b]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-7
Statistics on Annual Groundwater Discharge to the Santa Clara River, All Years
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	311	4,795	2,410	0	2,410	13.91
Average	2,506	10,608	2,655	0	2,655	15.50
Maximum	21,204	38,756	5,554	0	5,554	32.28
Statistics for 1975 through 1999						
Minimum	0	10,162	9,359	5,534	3,355	6.98
Median	5,632	36,611	27,521	11,844	14,293	16.92
Average	11,466	57,125	33,894	11,873	22,021	19.38
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	3,161	30,250	22,613	11,844	8,613	15.14
Average	8,230	41,211	23,207	11,873	15,396	18.05
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	4,450	28,460	18,702	11,844	8,613	15.82
Average	9,151	43,050	21,338	11,873	15,396	17.92
Maximum	67,058	258,660	81,744	17,847	64,049	42.17

TABLE 2-8
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 vs. 1975 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 5 Dry Years during 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	1	1,030	646	0	646	9.81
Average	111	2,175	1,758	0	1,758	9.05
Maximum	473	4,986	4,943	0	4,943	11.64
Statistics for 4 Normal Years during 1953 through 1965						
Minimum	32	1,884	1,058	0	1,058	12.79
Median	222	5,112	3,963	0	3,963	14.06
Average	363	4,856	3,634	0	3,634	14.18
Maximum	977	7,316	5,554	0	5,554	15.82
Statistics for 4 Wet Years during 1953 through 1965						
Minimum	559	4,782	996	0	996	21.22
Median	4,402	32,037	2,421	0	2,421	23.00
Average	7,641	26,903	2,796	0	2,796	24.87
Maximum	21,204	38,756	5,344	0	5,344	32.28
Statistics for 6 Dry Years during 1975 through 1999						
Minimum	0	14,770	10,806	5,534	5,272	6.98
Median	2,323	24,633	23,771	13,783	9,611	8.67
Average	2,619	25,322	23,089	12,918	10,171	8.84
Maximum	5,830	32,382	31,239	17,847	14,475	10.92
Statistics for 6 Normal Years during 1975 through 1999						
Minimum	156	10,162	9,754	6,095	3,659	12.86
Median	6,076	31,489	25,592	10,678	12,521	13.72
Average	6,148	30,763	25,615	11,335	14,280	14.00
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 13 Wet Years during 1975 through 1999						
Minimum	65	13,454	9,359	6,004	3,355	16.92
Median	7,725	68,577	42,448	10,822	33,177	27.00
Average	16,642	83,970	42,702	11,639	31,063	26.74
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-9
Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 13 Dry Years during 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	473	14,770	10,806	13,783	5,272	8.82
Average	1,601	14,311	12,630	12,918	6,347	8.41
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 12 Normal Years during 1953 through 1999						
Minimum	0	7,316	2,433	6,004	2,433	13.35
Median	5,101	26,198	21,172	11,844	11,743	16.92
Average	5,238	27,883	16,963	10,788	8,671	17.10
Maximum	12,671	52,631	27,521	15,778	13,223	21.22
Statistics for 22 Wet Years during 1953 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	7,507	44,252	25,525	10,822	20,505	23.17
Average	15,807	73,060	29,877	11,639	24,412	25.62
Maximum	67,058	258,660	81,744	17,824	64,049	42.17
Statistics for 11 Dry Years during 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	79	14,770	10,806	13,783	5,272	8.96
Average	1,226	14,800	13,393	12,918	6,347	8.94
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 10 Normal Years during 1953 through 1965 and 1975 through 1999						
Minimum	32	1,884	1,058	6,095	1,058	12.79
Median	944	17,197	15,463	10,678	8,649	13.97
Average	3,834	20,400	16,823	11,335	10,022	14.07
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 17 Wet Years during 1953 through 1965 and 1975 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	5,611	48,024	31,327	10,822	20,505	23.14
Average	14,524	70,543	33,312	11,639	24,412	26.30
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1944	Dry	Wet
1945	Below Normal	Normal
1946	Below Normal	Wet
1947	Dry	Dry
1948	Below Normal	Dry
1949	Dry	Dry
1950	Below Normal	Dry
1951	Above Normal	Normal
1952	Wet	Wet
1953	Wet	Dry
1954	Above Normal	Normal
1955	Dry	Normal
1956	Wet	Normal
1957	Above Normal	Wet
1958	Wet	Wet
1959	Below Normal	Dry
1960	Dry	Dry
1961	Dry	Dry
1962	Below Normal	Wet
1963	Wet	Normal
1964	Dry	Dry
1965	Wet	Wet
1966	Below Normal	Normal
1967	Wet	Wet
1968	Below Normal	Dry
1969	Wet	Wet
1970	Wet	Wet
1971	Wet	Normal
1972	Below Normal	Dry
1973	Above Normal	Wet
1974	Wet	Wet
1975	Wet	Dry
1976	Critical	Normal
1977	Critical	Wet
1978	Above Normal	Wet
1979	Below Normal	Wet

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1980	Above Normal	Wet
1981	Dry	Normal
1982	Wet	Wet
1983	Wet	Wet
1984	Wet	Normal
1985	Dry	Dry
1986	Wet	Wet
1987	Dry	Normal
1988	Critical	Wet
1989	Dry	Dry
1990	Critical	Dry
1991	Critical	Wet
1992	Critical	Wet
1993	Above Normal	Wet
1994	Critical	Dry
1995	Wet	Wet
1996	Wet	Normal
1997	Wet	Normal
1998	Wet	Wet
1999	Wet	Dry

[a]Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest.

[b]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-11
Historical State Water Project Allocations and Local Hydrology, 1980 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	SWP Hydrology[a]	SWP Allocations[b]	Local Hydrology[c]
1980	Above Normal	100%	Wet
1981	Dry	100%	Normal
1982	Wet	100%	Wet
1983	Wet	100%	Wet
1984	Wet	100%	Normal
1985	Dry	100%	Dry
1986	Wet	100%	Wet
1987	Dry	85%	Normal
1988	Critical	100%	Wet
1989	Dry	100%	Dry
1990	Critical	100%	Dry
1991	Critical	30%	Wet
1992	Critical	45%	Wet
1993	Above Normal	85%	Wet
1994	Critical	50%	Dry
1995	Wet	80%	Wet
1996	Wet	100%	Normal
1997	Wet	100%	Normal
1998	Wet	100%	Wet
1999	Wet	100%	Dry

[a]Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest. SWP = State Water Project.

[b]Contractor demands, and therefore requests for water, have been increasing through the time period shown. Water allocations in the earlier part of the time period reflect that 100% of contractor requests were met. Those requests were for amounts of water less than the full SWP contract (i.e., Table A) amounts totaling 4.1 million acre-feet. In recent years, SWP contractors have been requesting nearly all of the 4.1 million acre-foot Table A amount contained in the 29 SWP contracts.

[c]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-12

Castaic Creek Flood Flows

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Water Year[a]	Natural Inflows	Flood Flows 10/1 - 4/30	Late Flood Flows[b] 5/1 - 9/30	Total Flood Flows	Net Flood Flows[c]	Flood Flow Shares				Total NLF/LACWWD/ NCWD Flood Flows
						UWCD 48%	NLF 44.867%	LACWWD 4.471%	NCWD 2.662%	
1977	752	0	0	0	0	0	0	0	0	0
1978	92,780	89,592	325	89,917	67,438	32,370	30,257	3,015	1,795	35,068
1979	31,440	19,641	0	19,641	14,731	7,071	6,609	659	392	7,660
1980	54,158	47,625	101	47,726	35,794	17,181	16,060	1,600	953	18,613
1981	6,186	628	0	628	471	226	211	21	13	245
1982	8,930	3,544	0	3,544	2,658	1,276	1,193	119	71	1,382
1983	78,010	74,287	3,020	77,307	57,981	27,831	26,014	2,592	1,543	30,150
1984	10,582	2,106	0	2,106	1,580	758	709	71	42	822
1985	3,361	0	0	0	0	0	0	0	0	0
1986	20,005	13,867	0	13,867	10,400	4,992	4,666	465	277	5,408
1987	1,212	0	0	0	0	0	0	0	0	0
1988	4,401	807	0	807	605	290	272	27	16	315
1989	919	0	0	0	0	0	0	0	0	0
1990	540	0	0	0	0	0	0	0	0	0
1991	6,719	4,375	0	4,375	3,281	1,575	1,472	147	87	1,706
1992	29,409	22,631	0	22,631	16,973	8,147	7,615	759	452	8,826
1993	81,264	77,722	0	77,722	58,291	27,980	26,154	2,606	1,552	30,312
1994	6,424	502	0	502	377	181	169	17	10	196
1995	57,914	53,363	0	53,363	40,022	19,211	17,957	1,789	1,065	20,812
1996	7,105	1,654	0	1,654	1,241	596	557	55	33	645
1997	9,028	3,918	0	3,918	2,938	1,410	1,318	131	78	1,528
1998	68,846	66,597	11,639	78,236	58,677	28,165	26,327	2,623	1,562	30,512
1999	7,793	238	0	238	179	86	80	8	5	93
2000	7,212	4,118	0	4,118	3,088	1,482	1,386	138	82	1,606
Totals	**594,990**	**487,215**	**15,085**	**502,300**	**376,725**	**180,828**	**169,025**	**16,843**	**10,028**	**195,897**
Average	**24,791**	**20,301**	**629**	**20,929**	**15,697**	**7,535**	**7,043**	**702**	**418**	**8,162**
Median	**8,362**	**3,731**	**0**	**3,731**	**2,798**	**1,343**	**1,255**	**125**	**74**	**1,455**

[a]A water year is from October 1 to September 30, but the flood flow water is generally available only from October 1 through April 30.

[b]Late flood flows are from May 1 through September 30.

[c]Net flood flows are 75% of total flood flows.

Note:

All flows are listed in acre-feet.

Figures

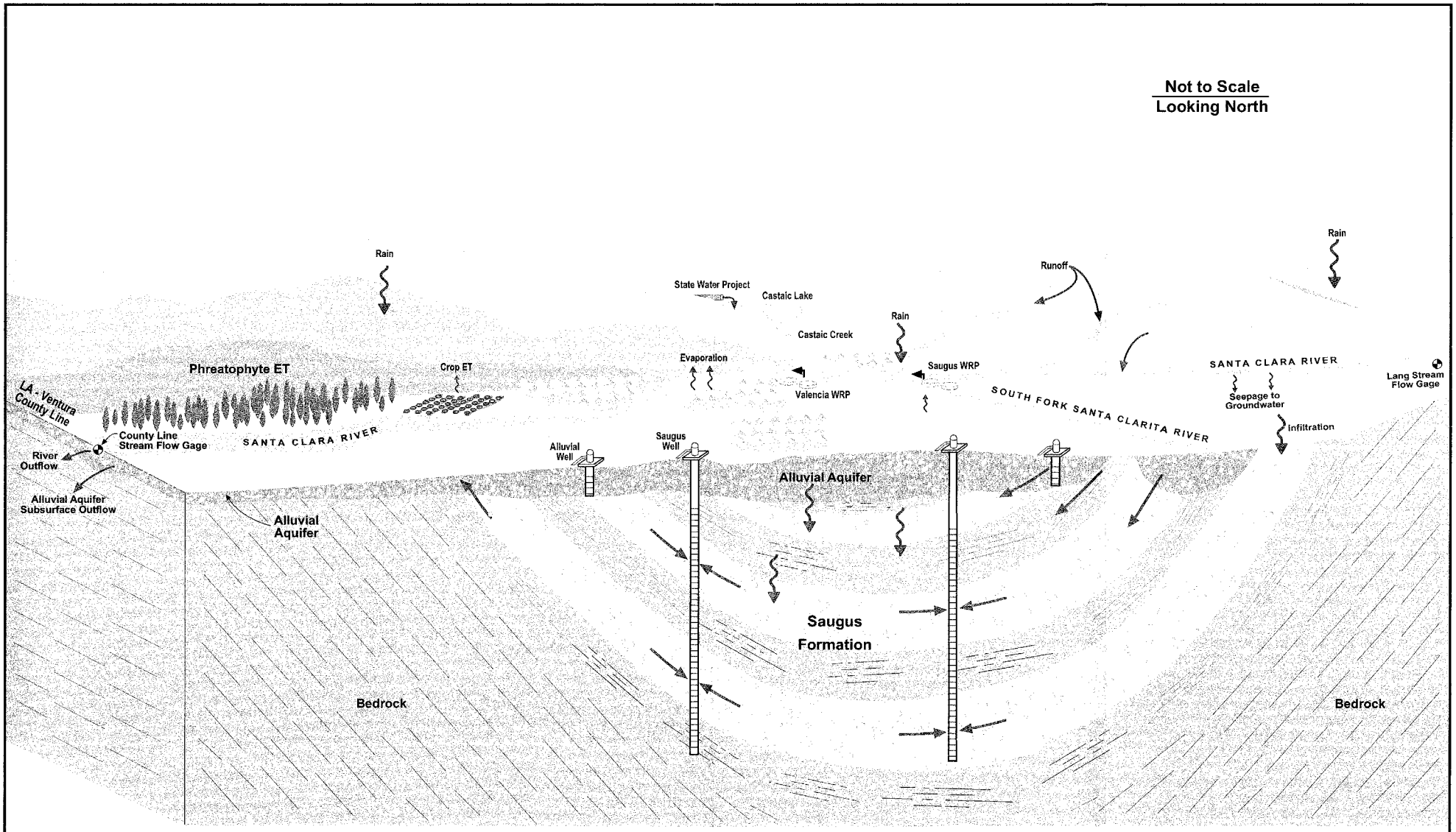

FIGURE 2-1
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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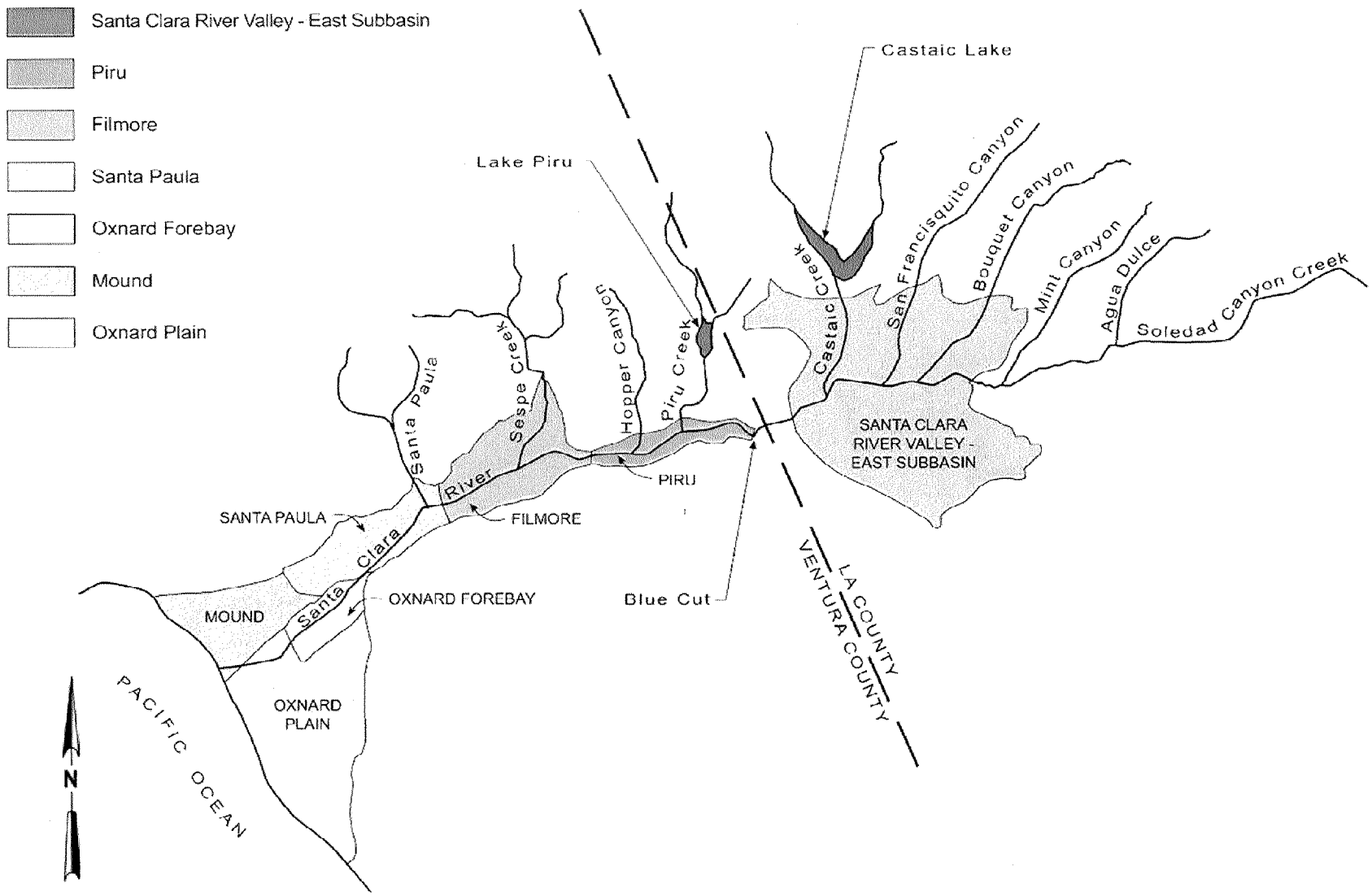

FIGURE 2-2
GROUNDWATER BASINS IN THE SANTA CLARA RIVER DRAINAGE
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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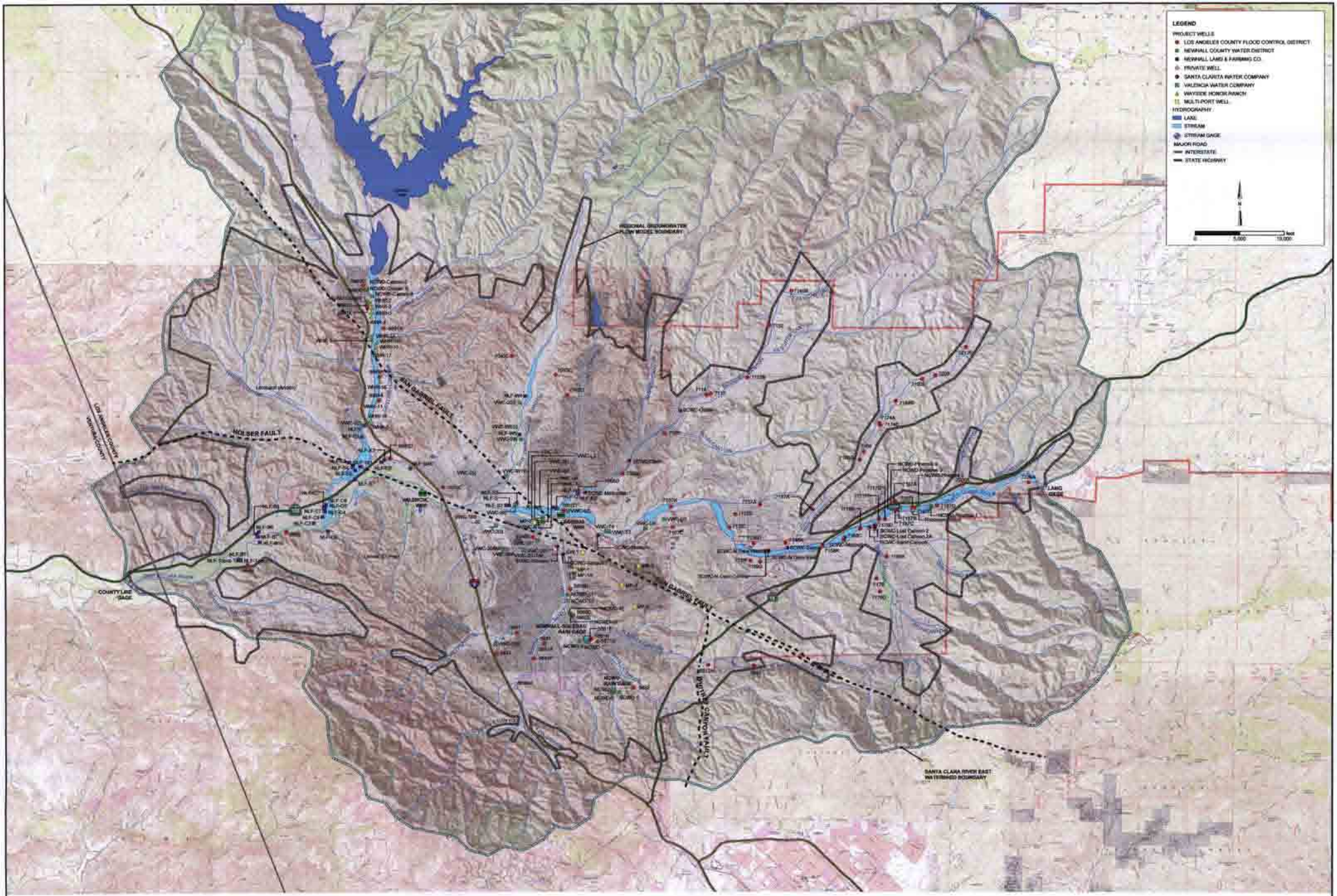

FIGURE 2-3
WELL LOCATIONS AND FEATURES MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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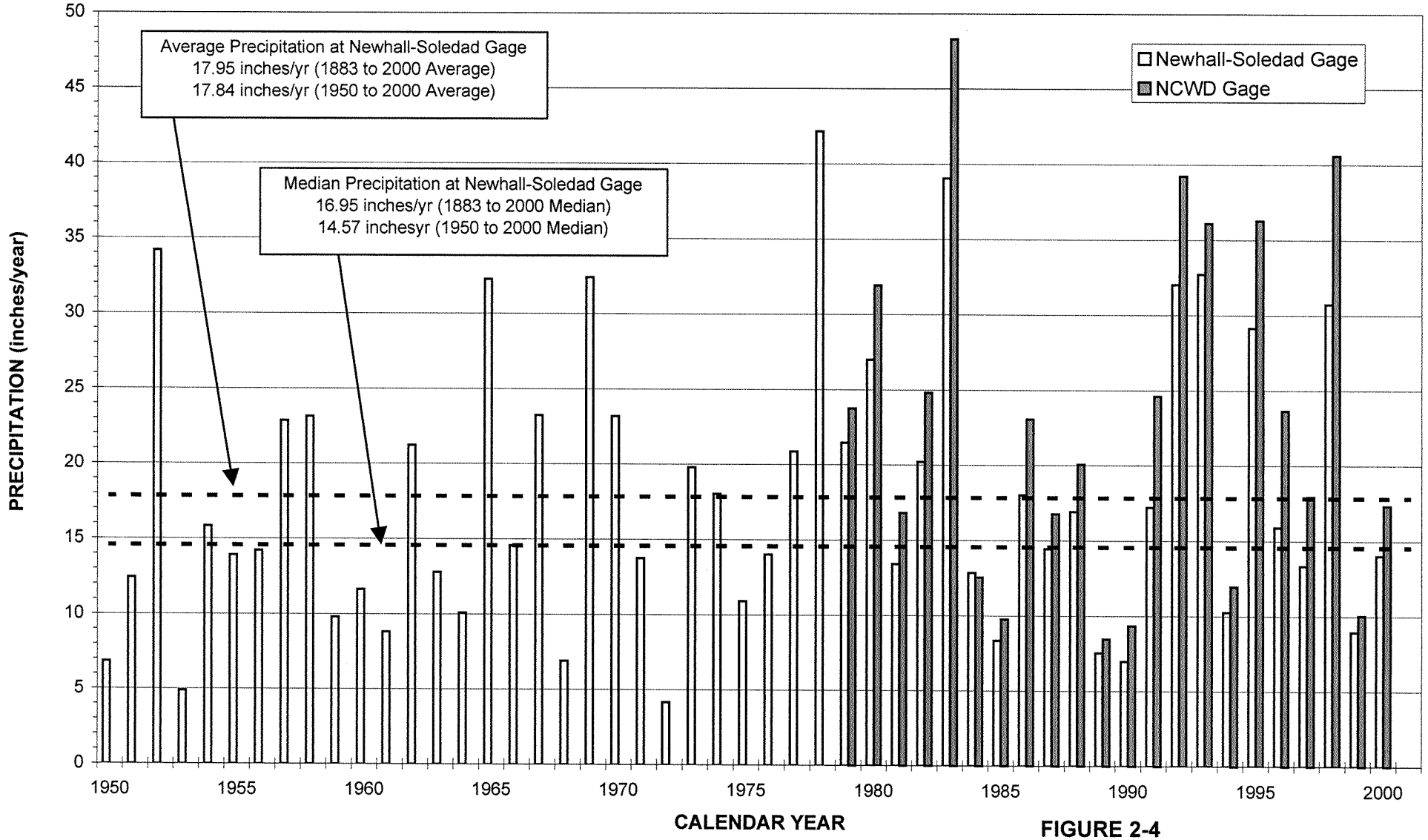

FIGURE 2-4
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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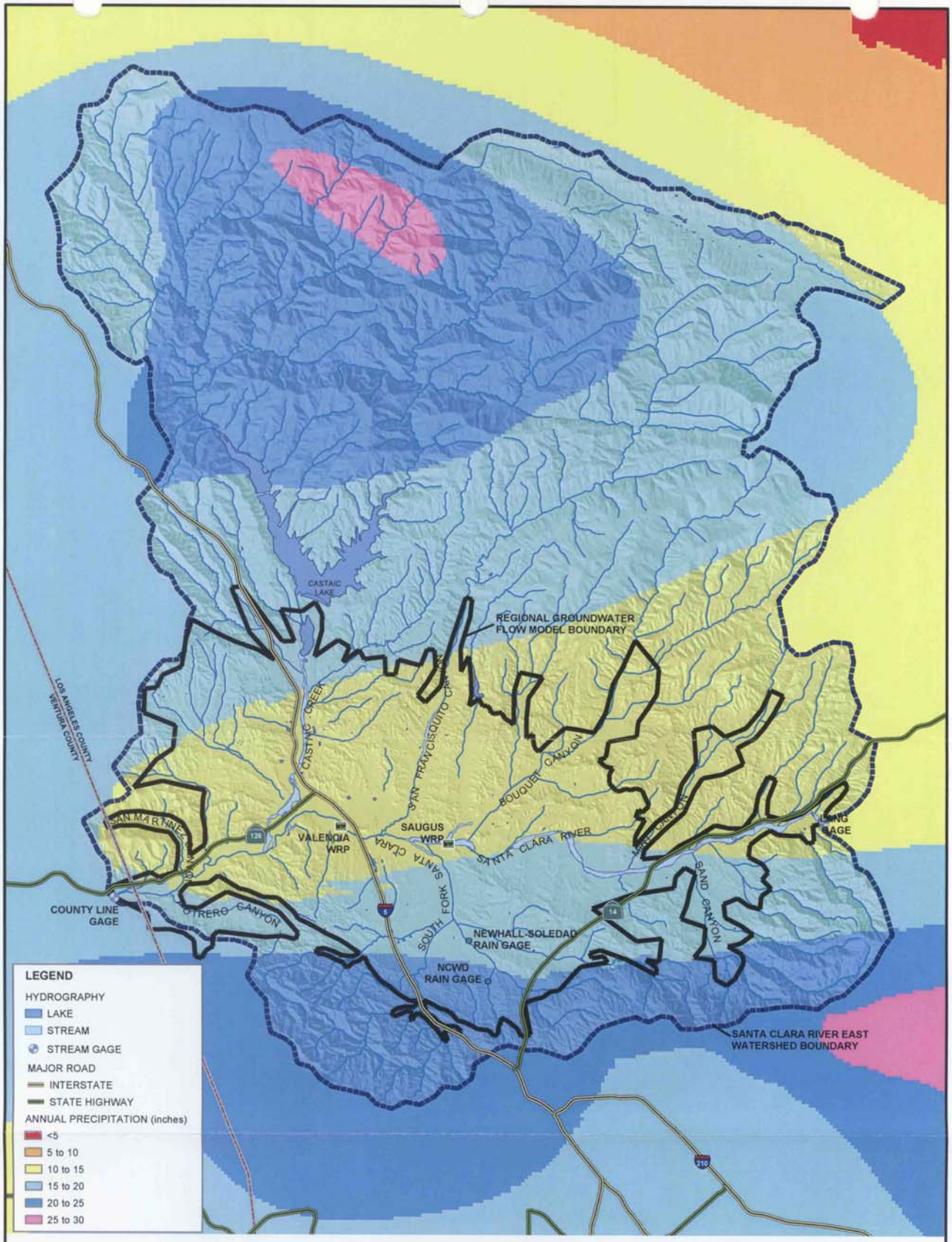

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

FIGURE 2-5
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0205.MXD FIG0205.PDF

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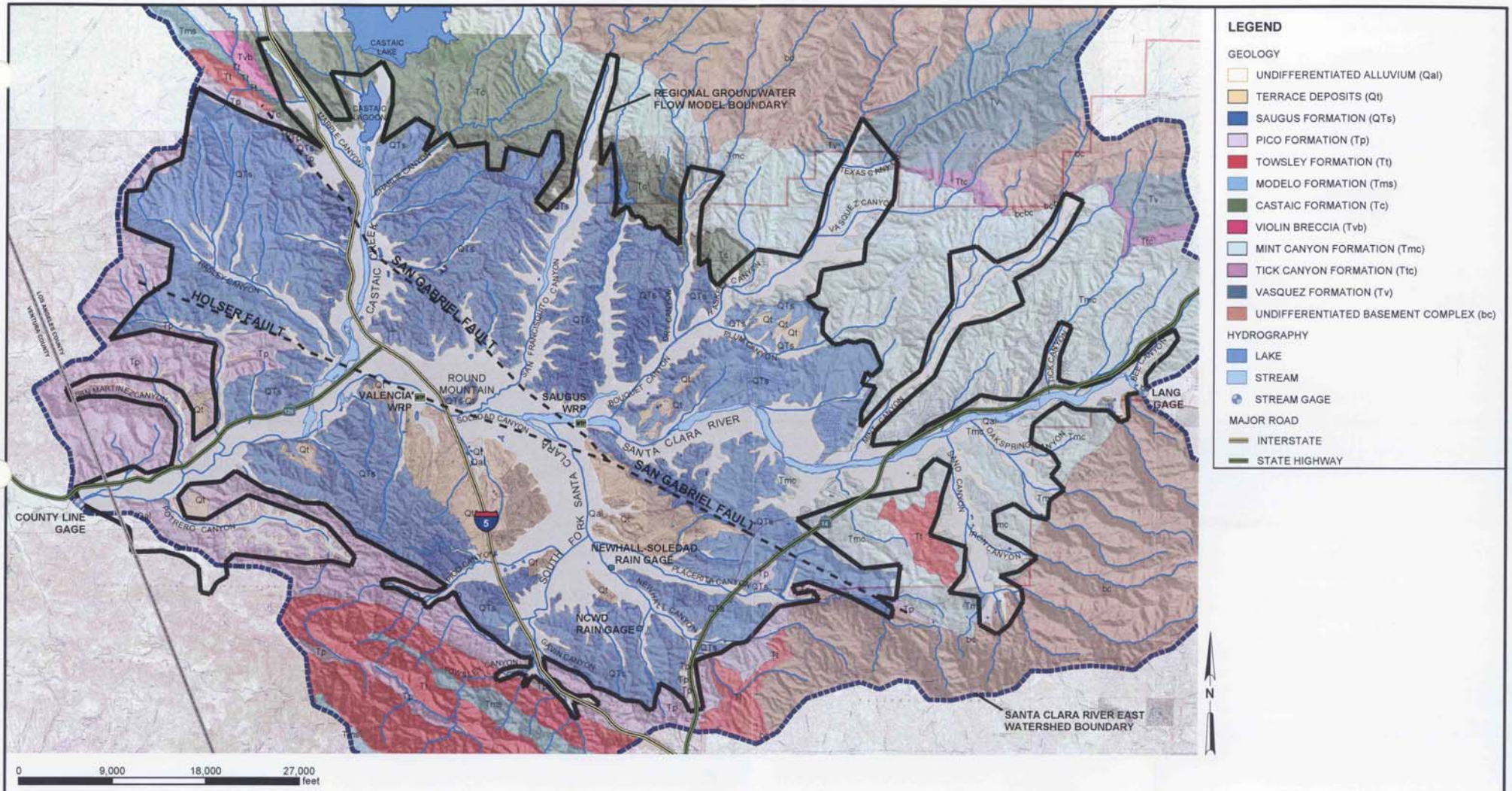
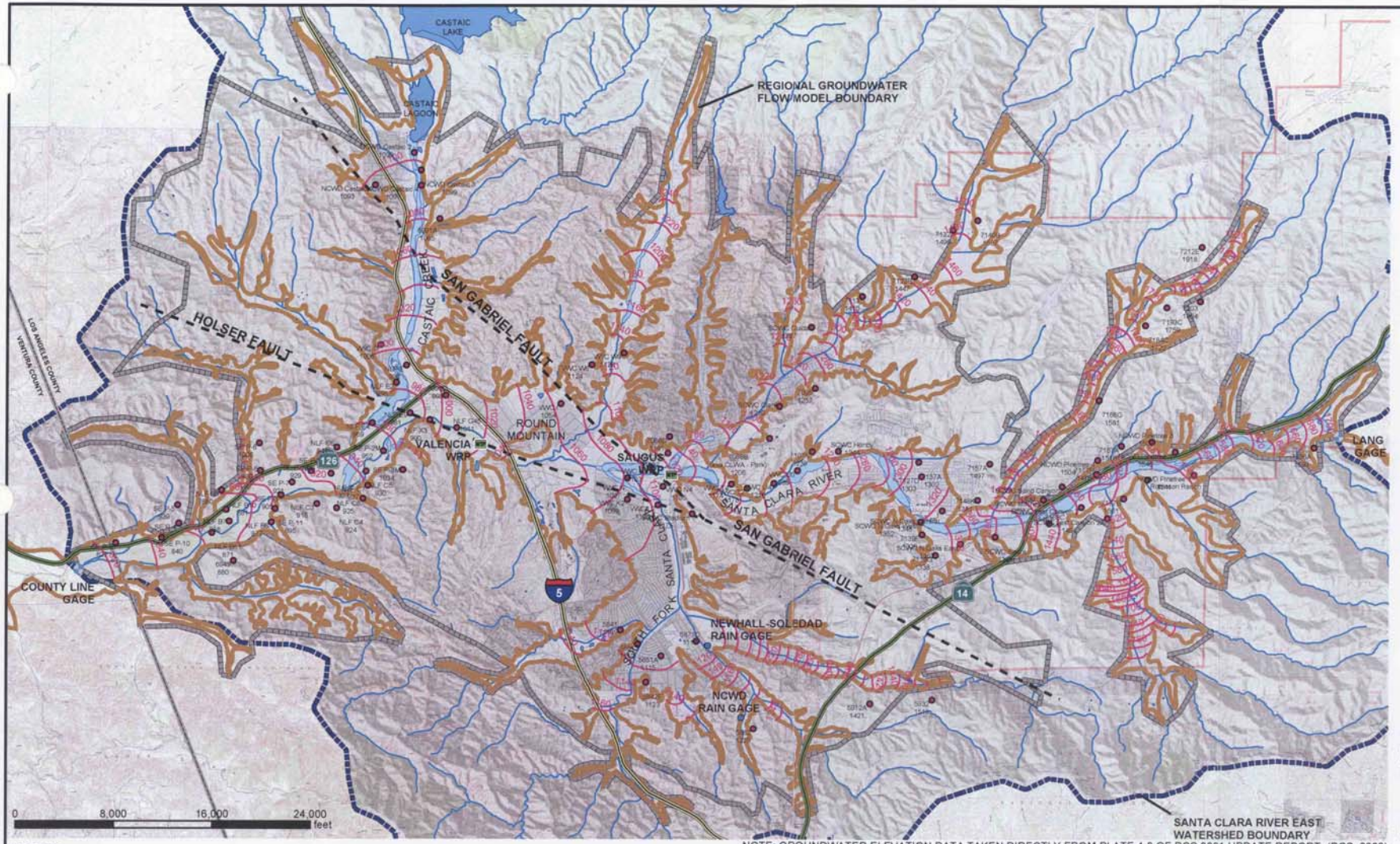


FIGURE 2-6
BASIN GEOLOGIC MAP
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\RDD31002540\SANTACLARITA\MXD\FIG0206.MXD FIG02-06.PDF 04/04/2004 17:54:36



NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 4-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

LEGEND

- CONTOUR OF SPRING 2000 GROUNDWATER ELEVATION (feet MSL)
- SPRING 2000 GROUNDWATER ELEVATION (feet MSL)
- EXTENT OF ALLUVIUM
- LAKE
- STREAM

FIGURE 2-7
GROUNDWATER ELEVATION CONTOUR MAP FOR THE ALLUVIUM – SPRING 2000
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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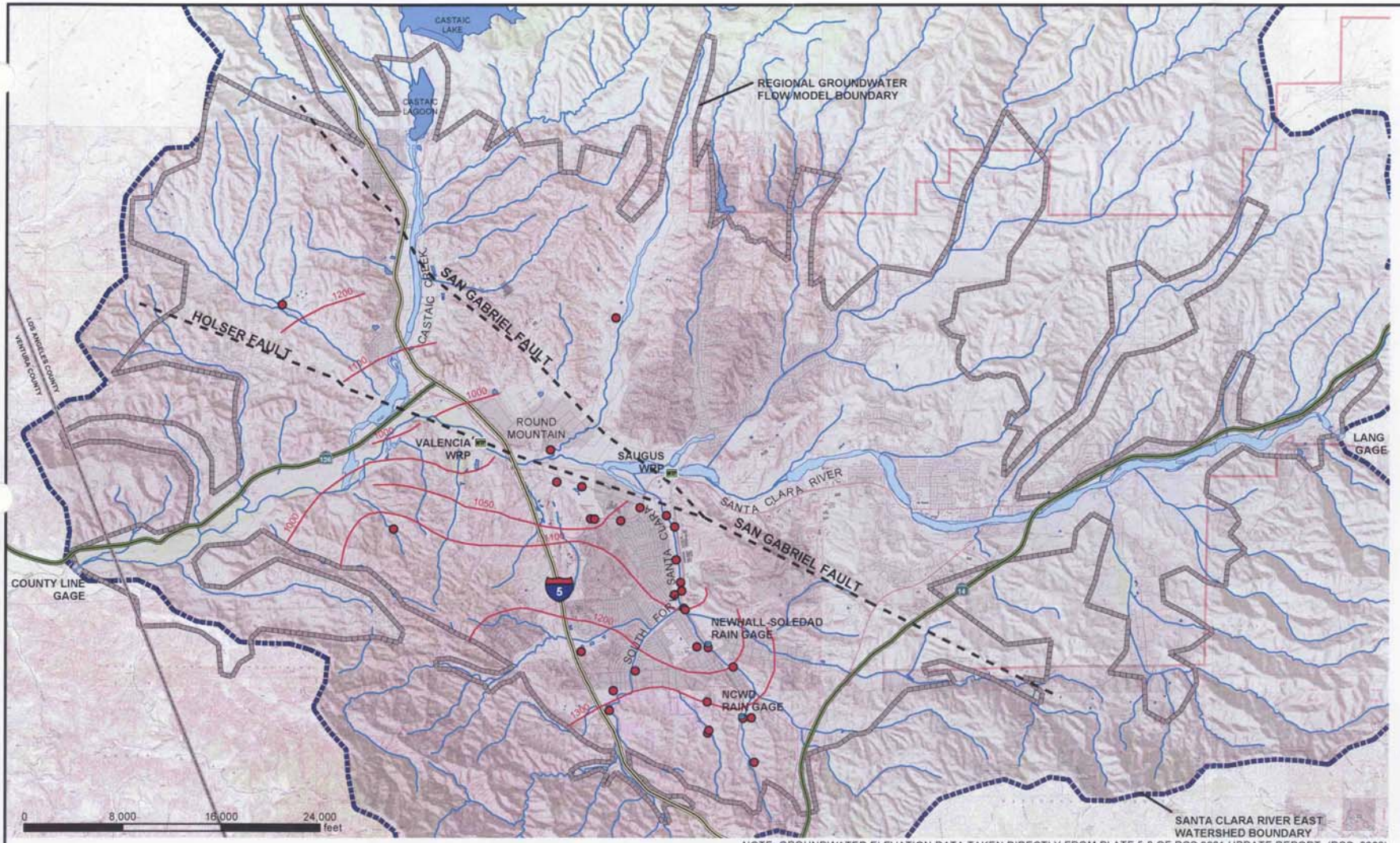
RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0207.MXD FIG02-07.PDF 02/02/2004 12:27:27



NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 5-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

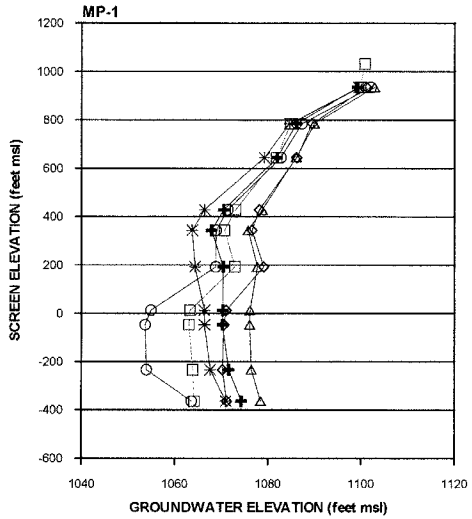
LEGEND

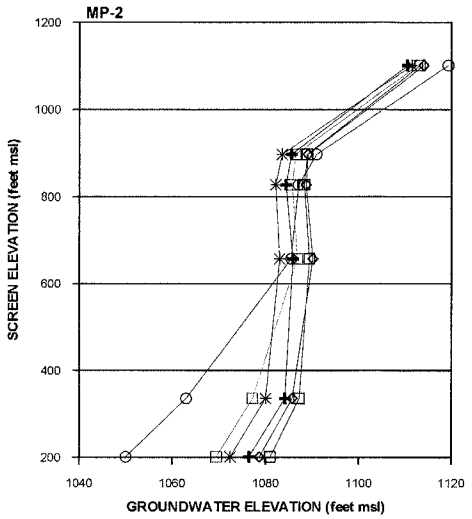
- SAUGUS WELLS
- CONTOUR OF FALL 2000 GR0UNDWATER ELEVATION (feet MSL)
- LAKE
- STREAM

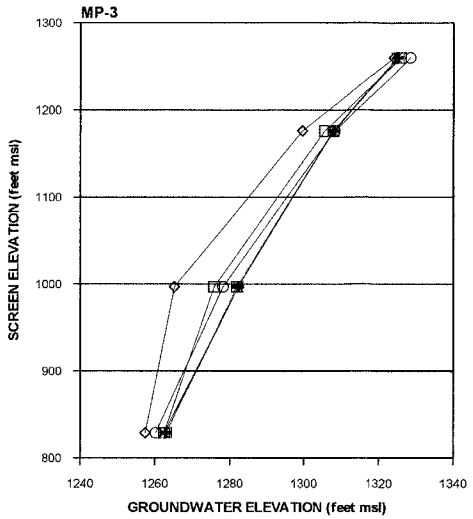
FIGURE 2-8
GROUNDWATER ELEVATION CONTOUR MAP FOR THE SAUGUS – FALL 2000
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0208.MXD FIG02-08.PDF 02/04/2004 10:57:48





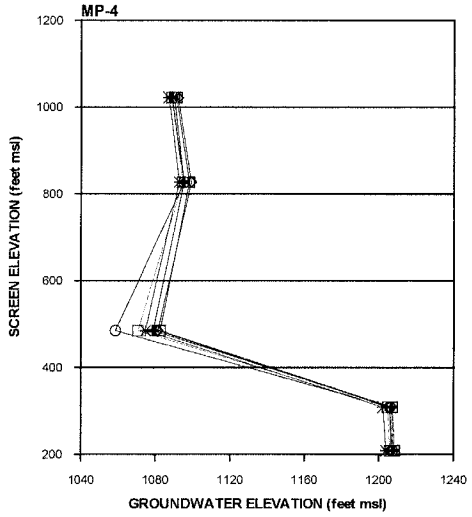


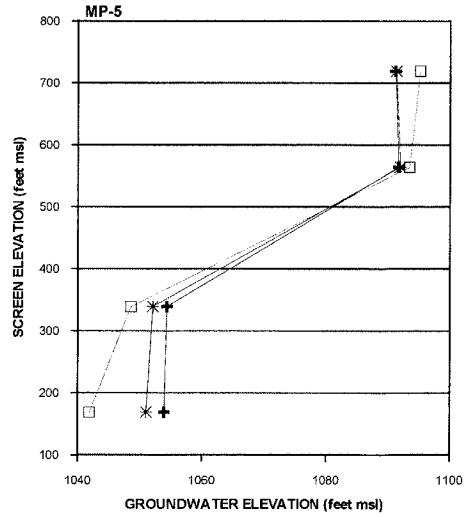
LEGEND

- JANUARY to FEBRUARY 2003
- APRIL 2003
- JULY 2003
- OCTOBER 2003
- NOVEMBER 2003
- DECEMBER 2003

NOTE:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.





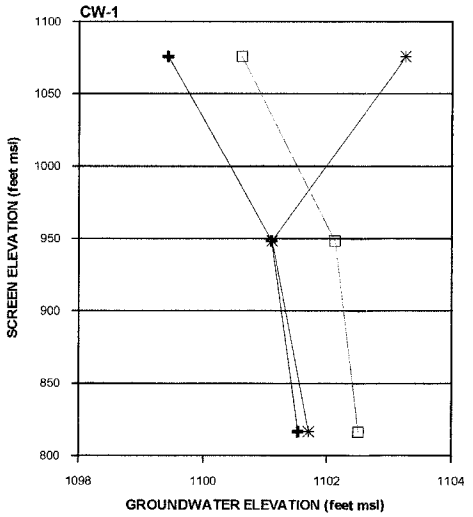


FIGURE 2-9
GROUNDWATER ELEVATIONS IN MULTI-PORT SAUGUS FORMATION MONITORING WELLS JANUARY 2003 THROUGH DECEMBER 2003
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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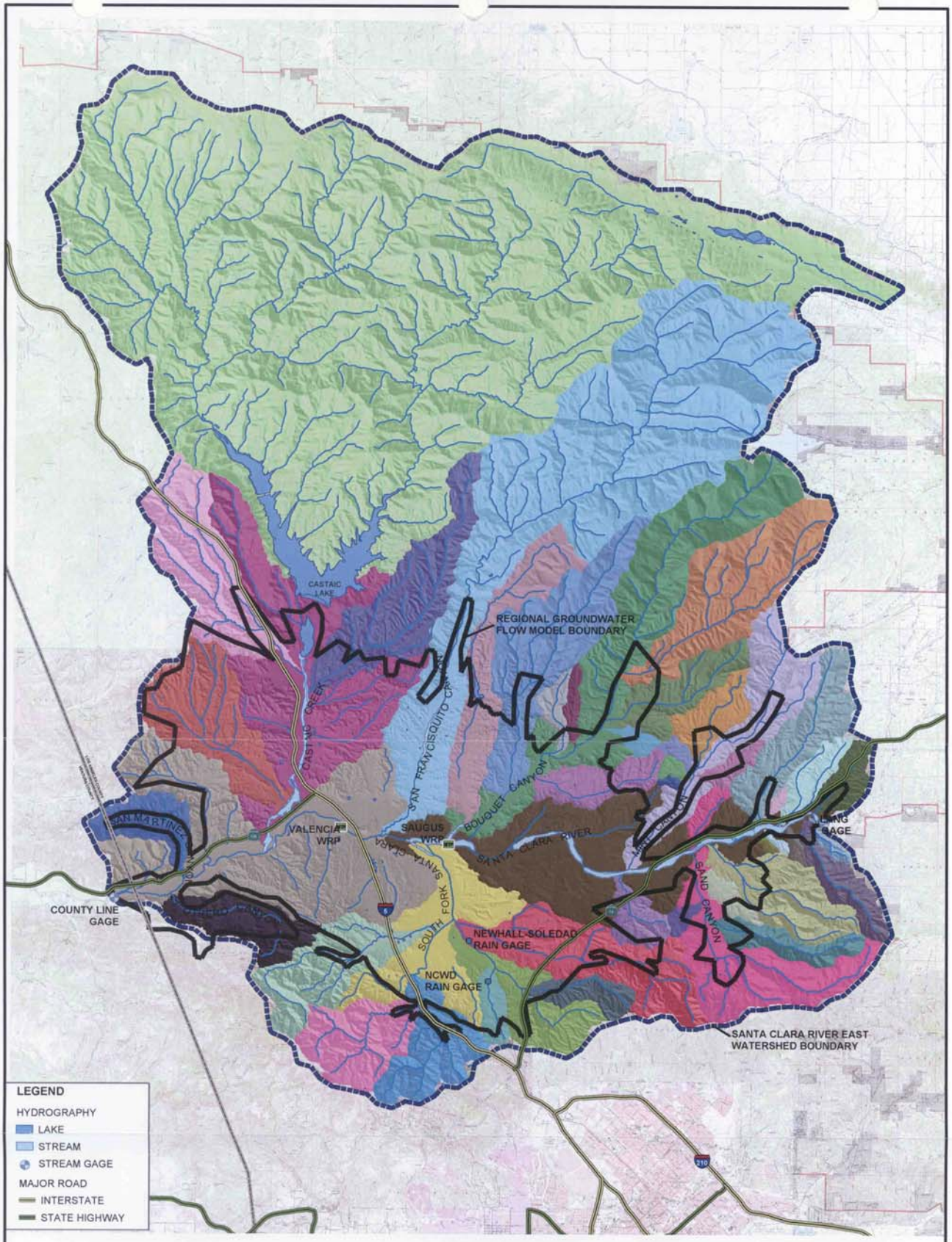


FIGURE 2-10
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

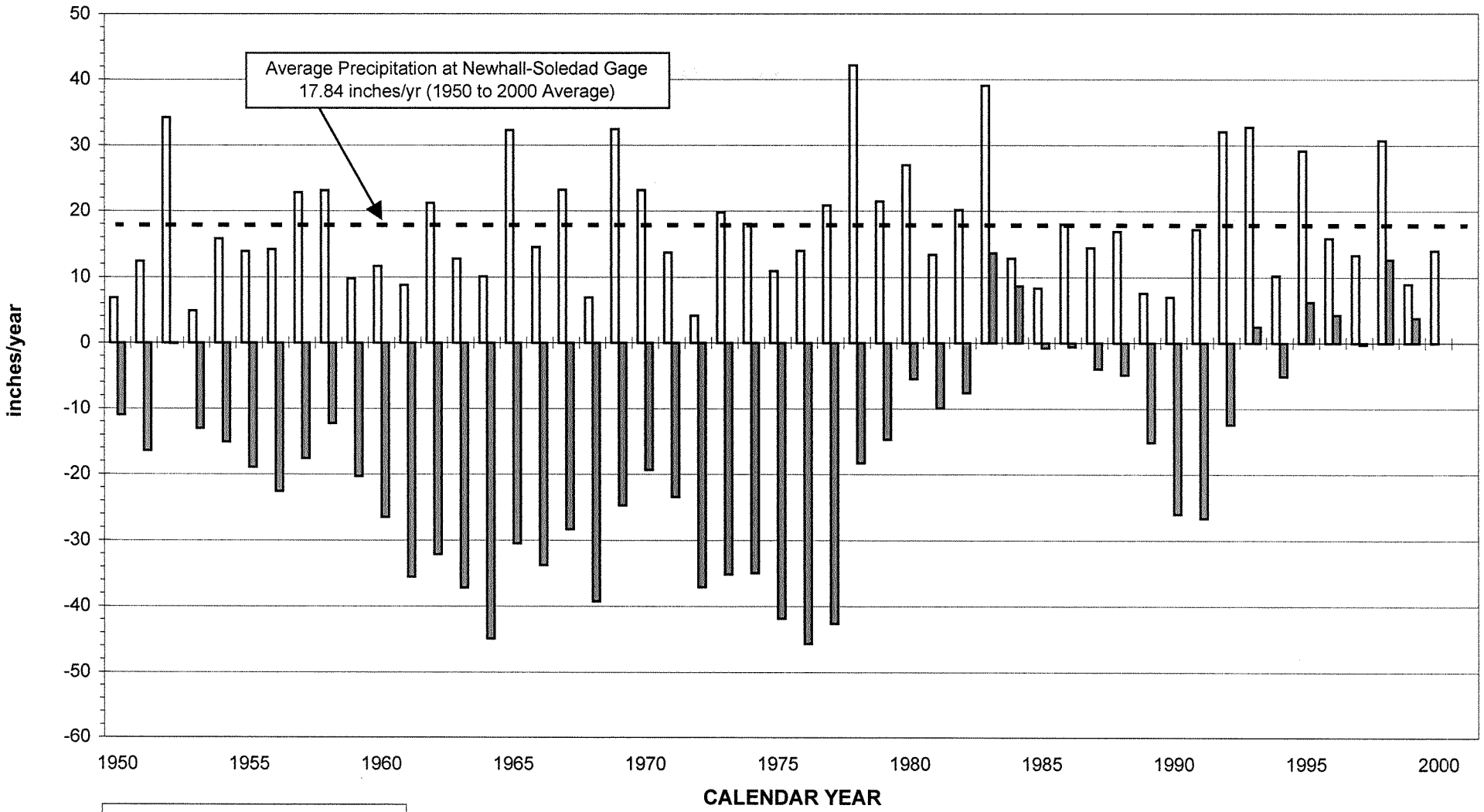
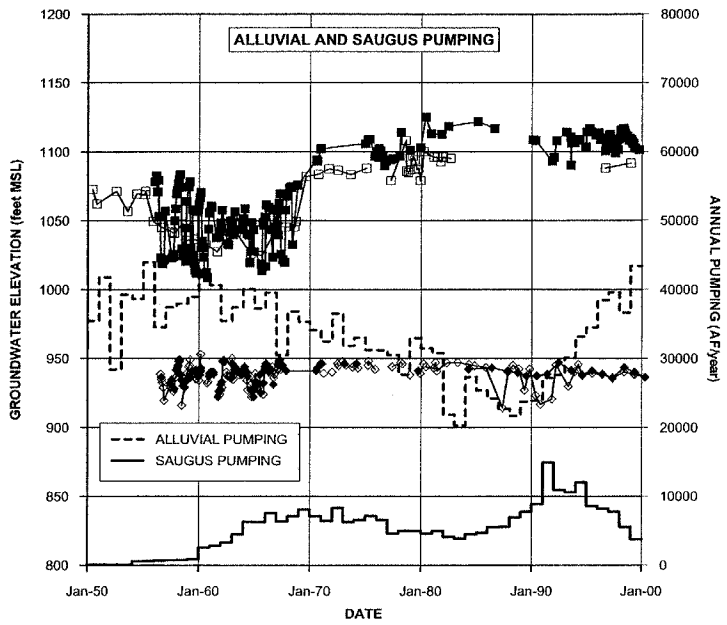
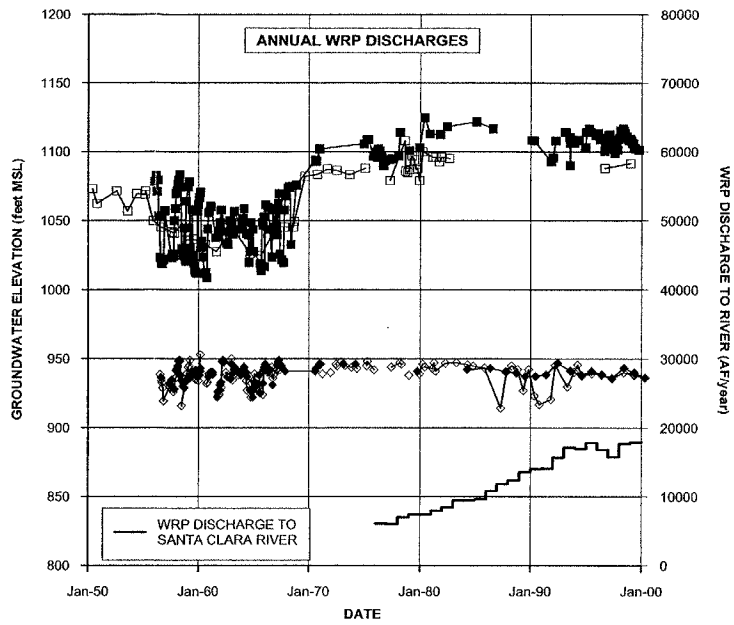


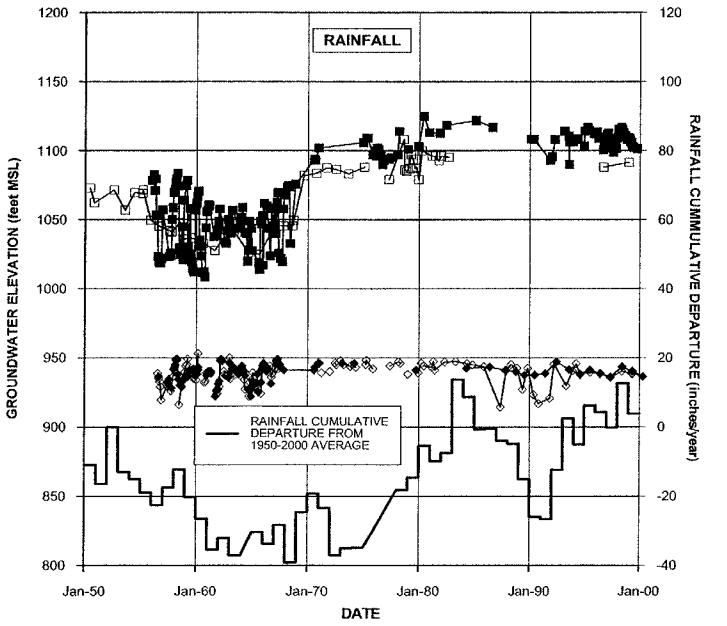
FIGURE 2-11
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 TO 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE SINCE 1950
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

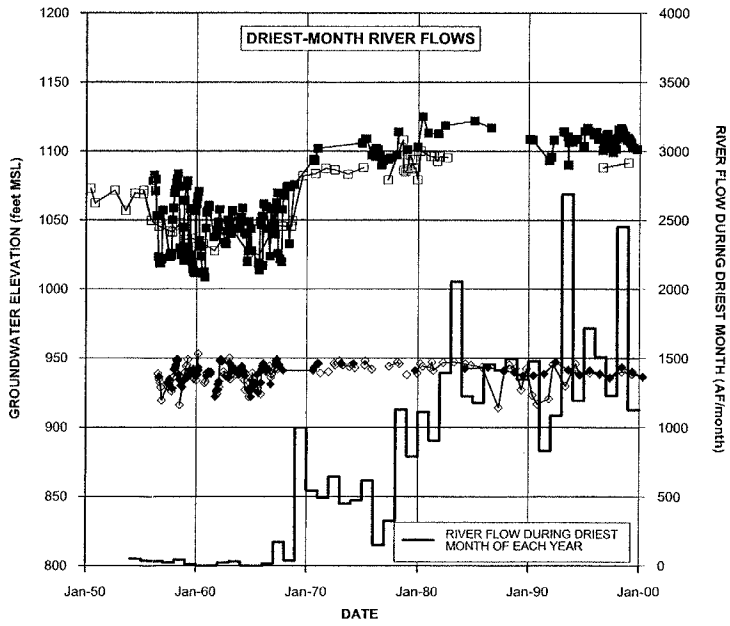
CH2MHILL

178973-401.xls\Fig 2-11









LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N
- ELEVATION OF GROUNDWATER IN NLF-S
- ELEVATION OF GROUNDWATER IN NLF-C5
- ELEVATION OF GROUNDWATER IN NLF-C7

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-12
ALLUVIAL GROUNDWATER ELEVATIONS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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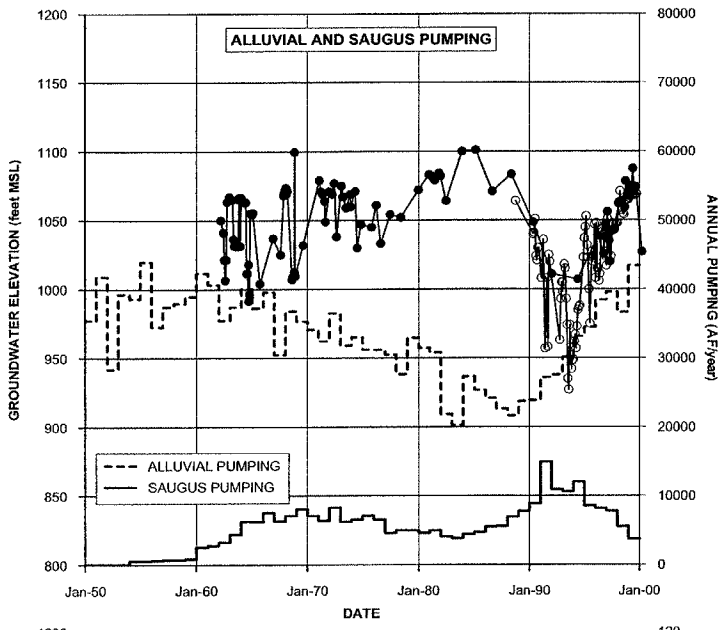
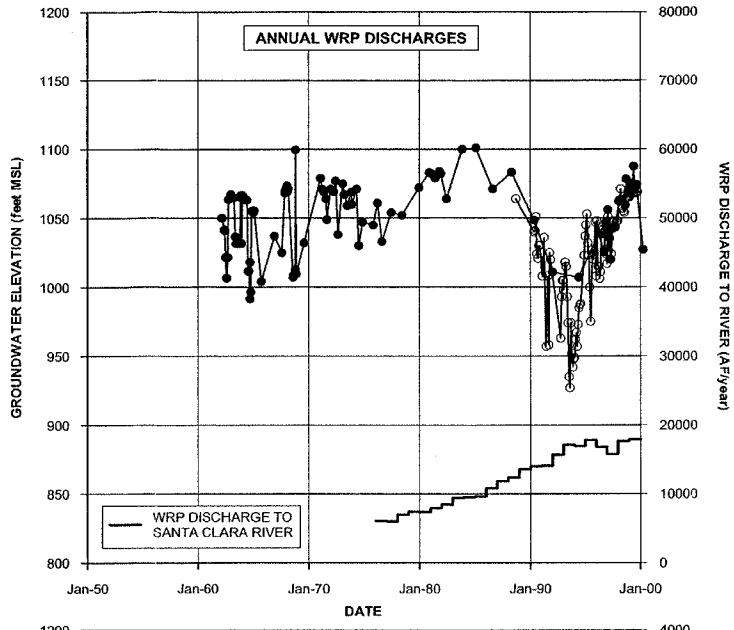
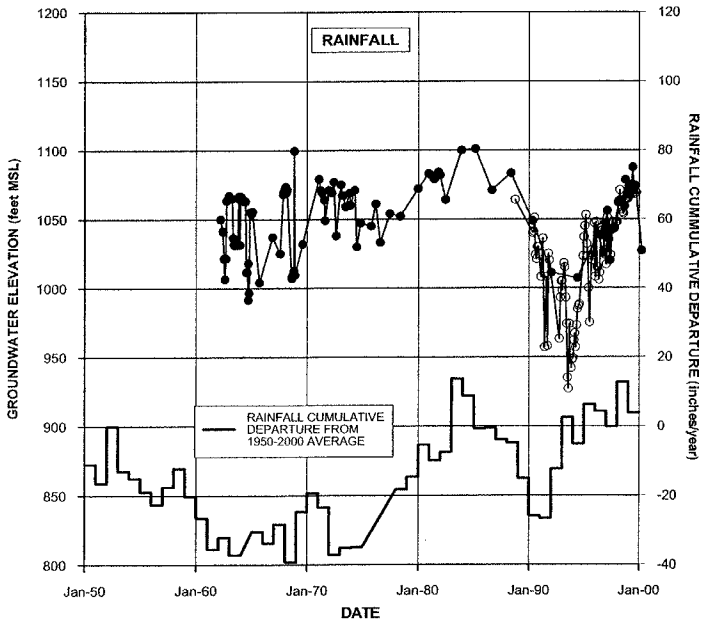
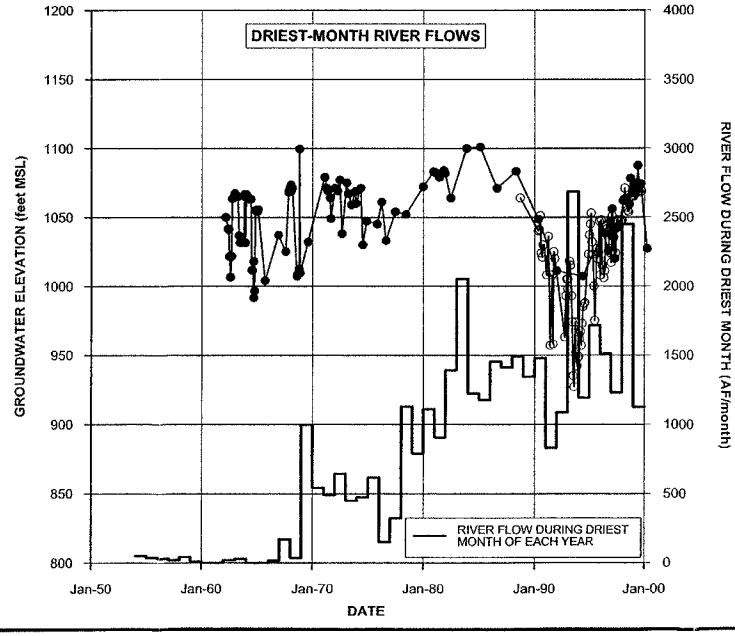








LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157
- ELEVATION OF GROUNDWATER IN SCWC SAUGUS 2

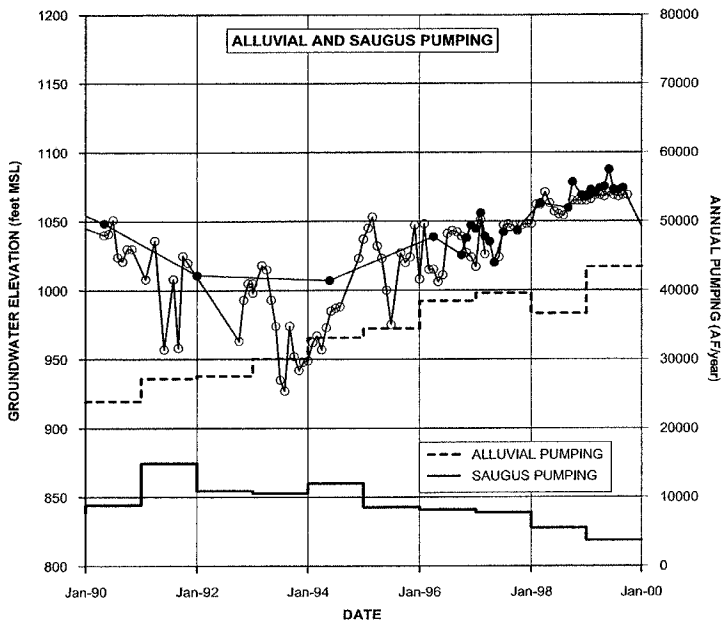
NOTES:

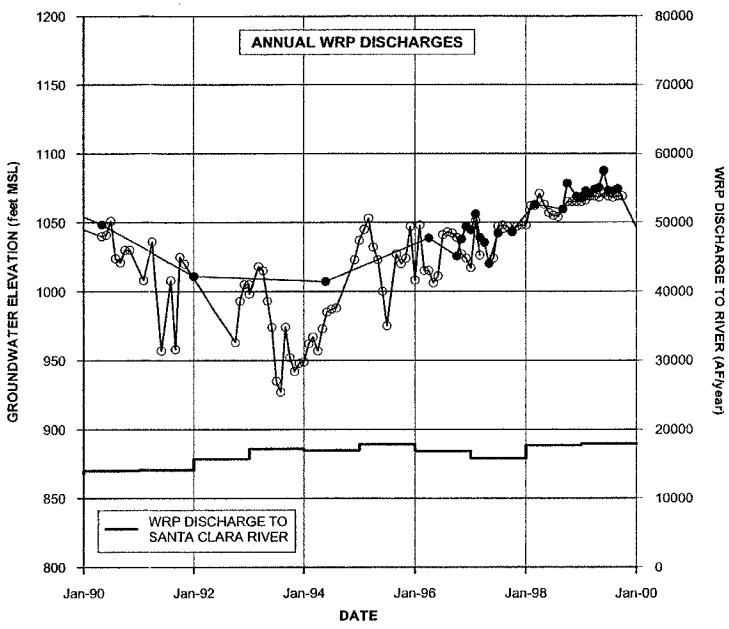
1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

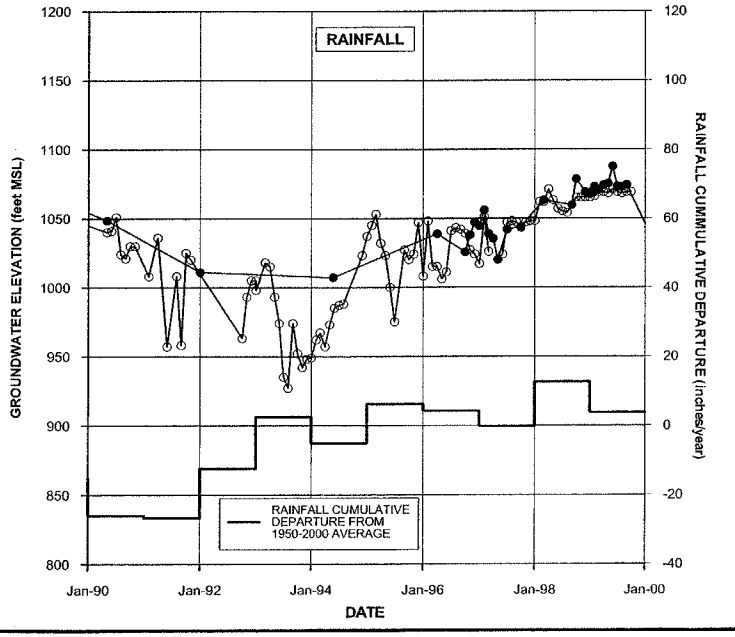
FIGURE 2-13
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

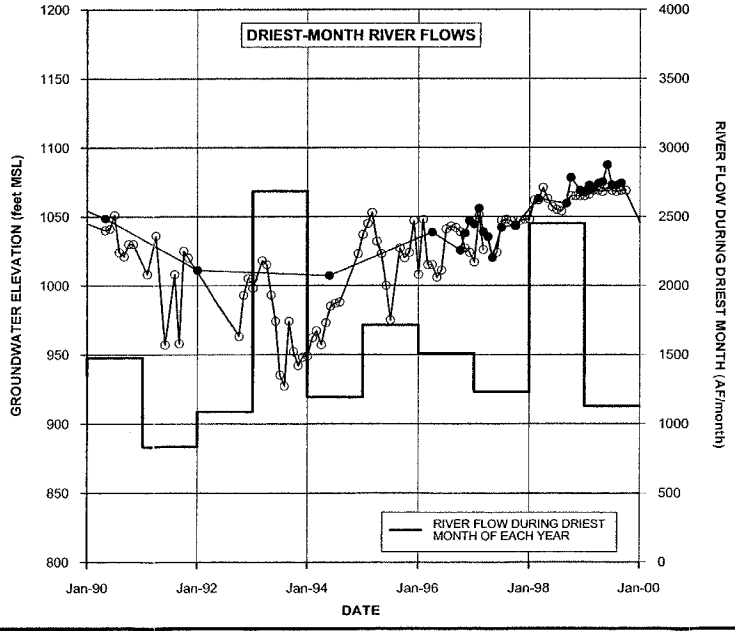
CH2MHILL

178973-302.GRF









LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157
- ELEVATION OF GROUNDWATER IN SCWC SAUGUS 2

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-14
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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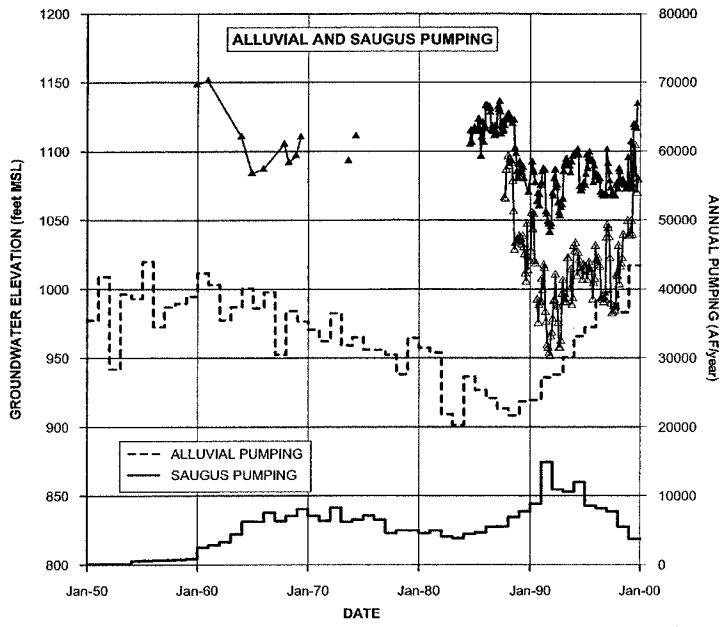

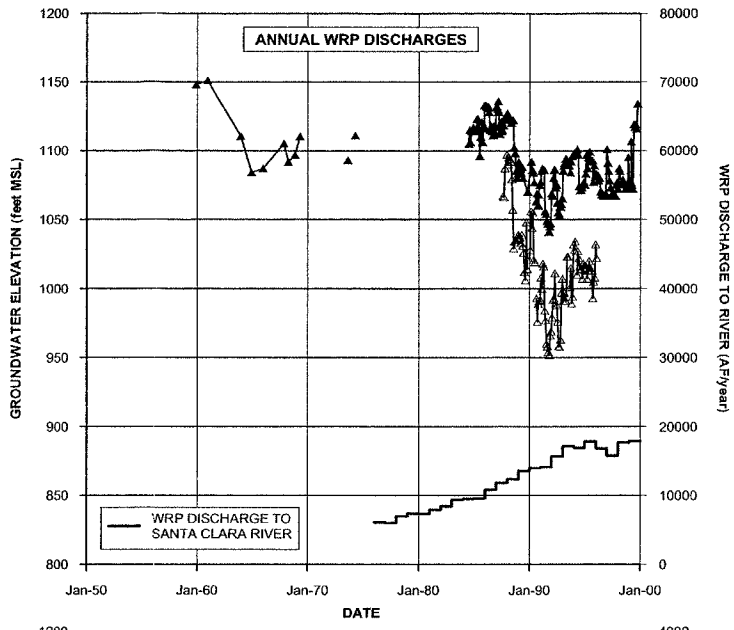

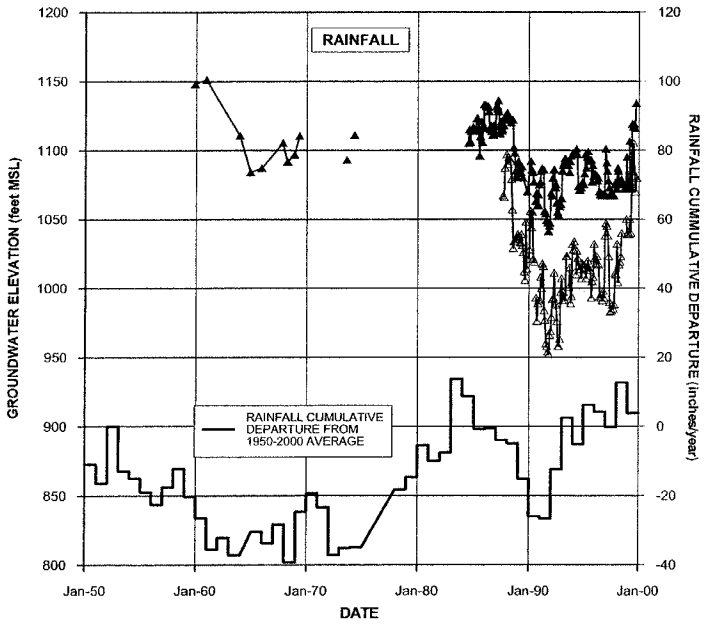

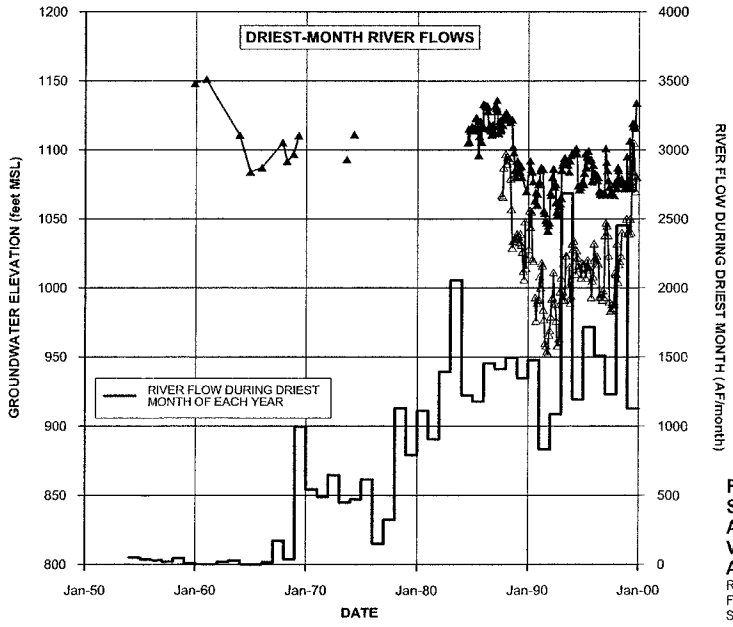

LEGEND

- ELEVATION OF GROUNDWATER IN NCWD-7
- ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-15
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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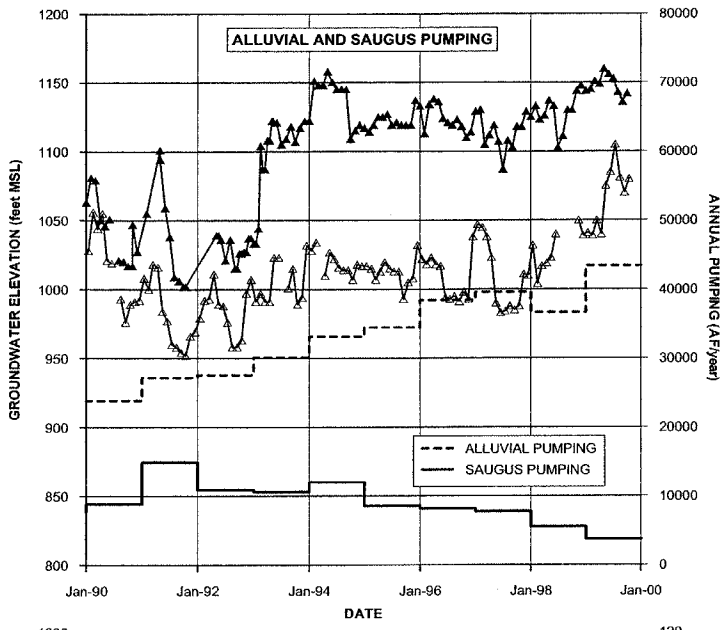
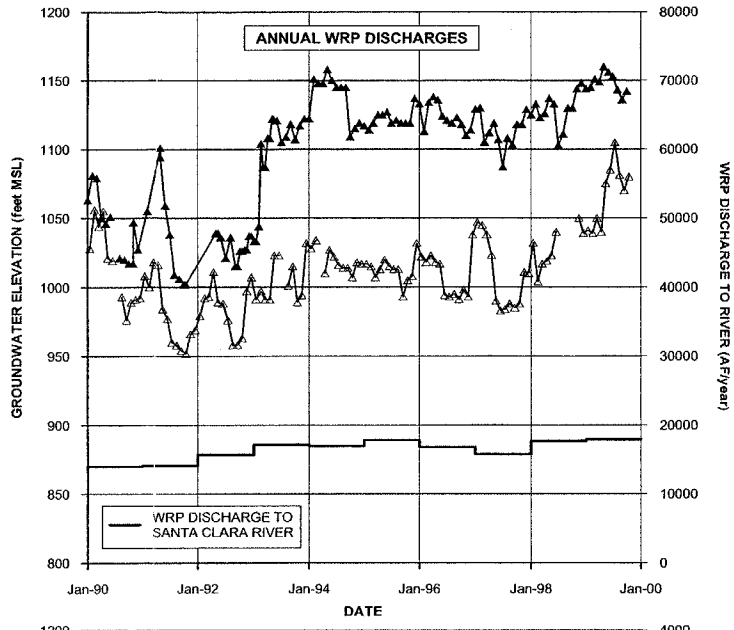
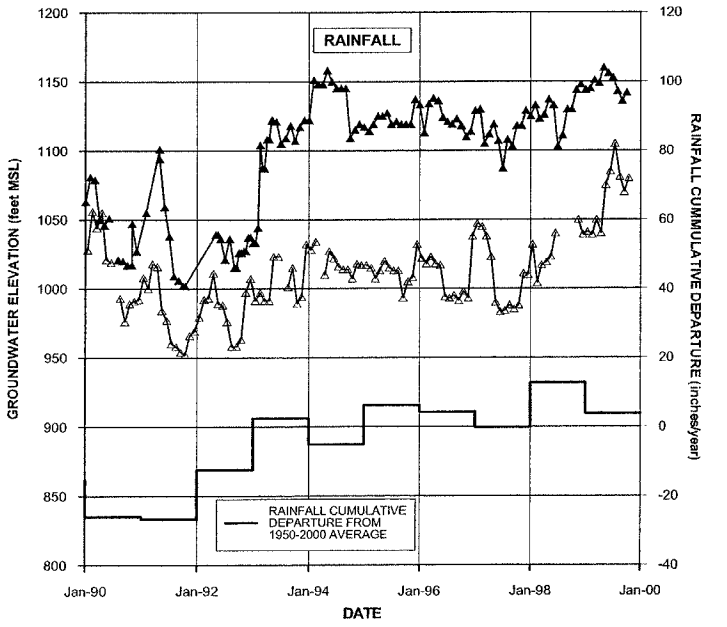
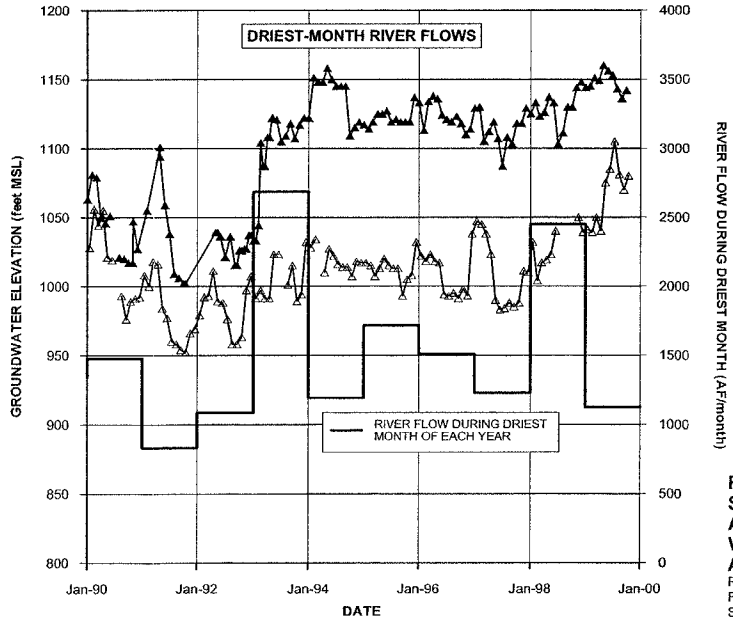








LEGEND

- ELEVATION OF GROUNDWATER IN NCW-10
- ELEVATION OF GROUNDWATER IN NCW-12

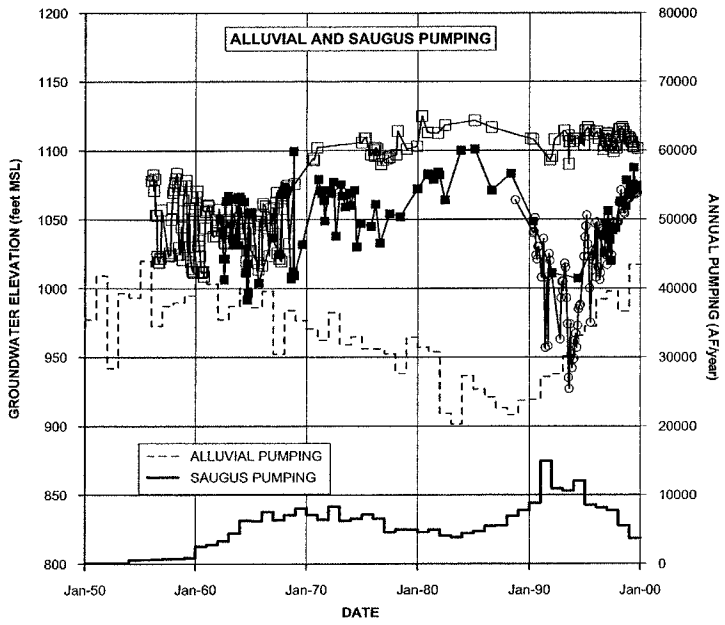
NOTES:

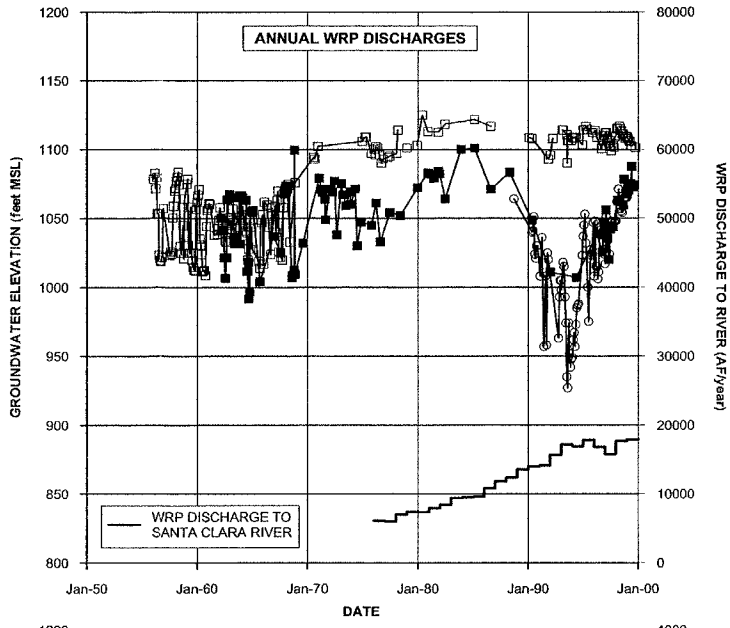
1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

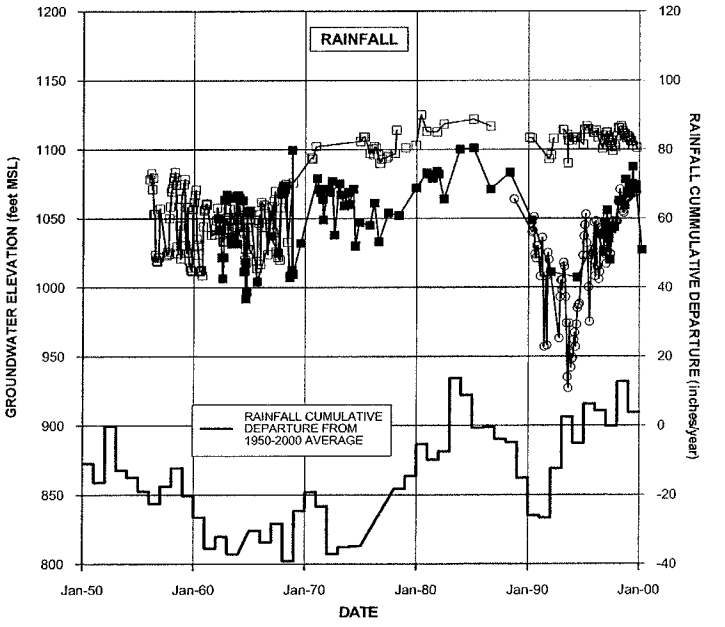
FIGURE 2-16
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

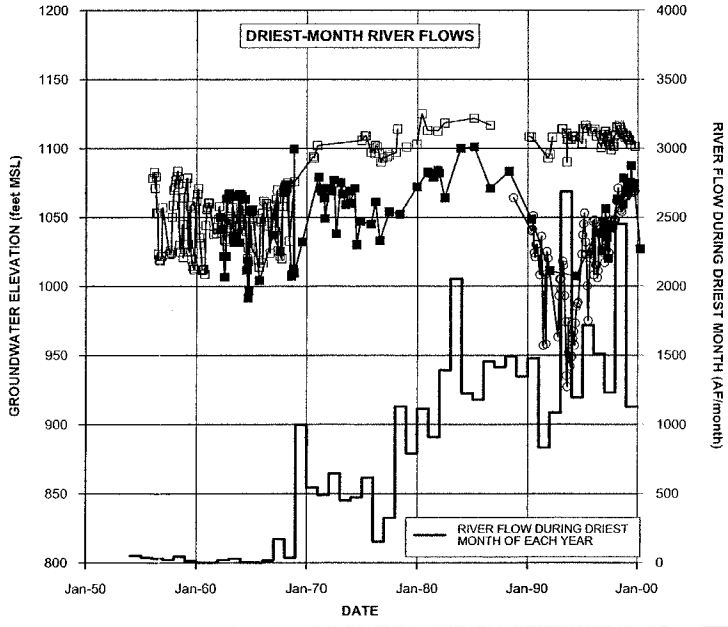
CH2MHILL

178973-305.GRF









LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N (ALLUVIUM)
- ELEVATION OF GROUNDWATER IN NVWC-157 (SAUGUS)
- ELEVATION OF GROUNDWATER IN SWC SAUGUS 2 (SAUGUS)

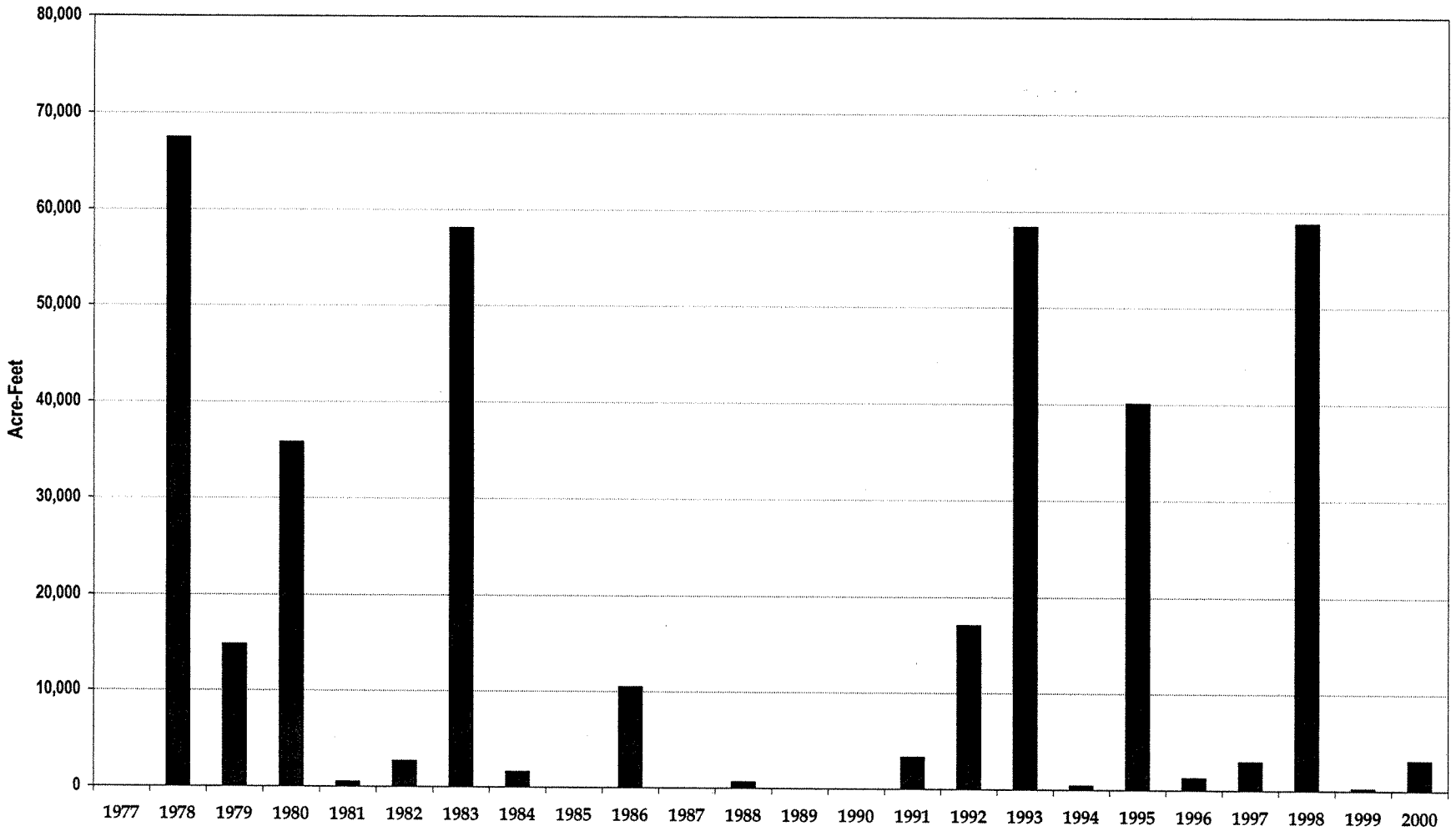
NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-17
GROUNDWATER ELEVATIONS IN ADJACENT ALLUVIAL AND SAUGUS WELLS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-306.GRF



This chart shows the potential Flood Flows available during water years 1977 through 2000. Water Year 1977 is defined as October 1, 1976 through September 30, but the water is generally available only from October 1 through April 30.

FIGURE 2-18
NET CASTAIC CREEK FLOOD FLOWS AVAILABLE TO DOWNSTREAM USERS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

SECTION 3

Model Construction

The Regional Model is a three-dimensional numerical model of groundwater flow in the Alluvial Aquifer and the Saugus Formation. The model simulates changes in groundwater flow and storage during the recent 20-year period from 1980 through 1999. This section of the report presents the overall approach to the construction of the Regional Model including the model software; model domain; grid design; layering scheme; boundary conditions; designation of subareas within the model domain; and the process for estimating the magnitudes of groundwater recharge and pumping terms required by the model.

3.1 Modeling Software

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). MicroFEM® operates in a Windows™ environment and can be used to solve groundwater flow problems for unconfined, semi-confined, or confined aquifer systems. This software simulates steady-state or transient flow conditions in up to a 20-layer aquifer system; the finite-element mesh may contain as many as 50,000 nodes in each model layer. The software contains several different methods for simulating groundwater/surface water interactions. MicroFEM® is based on software developed in the Netherlands during the 1980s for use in evaluating the effects of groundwater pumping in areas with complicated meandering rivers. Further details regarding this software's design, capabilities, and functionality can be found on the Internet at www.microfem.com and in two reviews of the software by Diodato (1997, 2000).

3.2 Extent of the Model Domain

A finite-element mesh was designed that covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The northern and southern edges of the model domain are defined by the geologic contacts mapped by RCS (2002) for the Alluvial Aquifer and the Saugus Formation. Figure 2-10 shows the model domain, along with its location relative to the upstream watersheds that contribute runoff into the model study area.

3.3 Model Grid

Figure 3-1 shows the spacing of the individual nodes that comprise the grid. The mesh contains 17,103 nodes in each model layer. The nodes are connected by segments, forming 32,496 triangular elements. Calculations of all flow components (recharge and discharge),

groundwater storage, and groundwater elevations are performed by the model for each node and segment.

The nodes are 500 feet apart in the majority of the modeled area. However, a finer node spacing (150 feet) was used along the Santa Clara River and its tributaries to allow a more exact simulation of surface water/groundwater exchanges. Additionally, specific nodes were placed within this regional grid at the locations of production and monitoring wells.

3.4 Layering

The groundwater system was represented in the Regional Model with seven layers. The layer representation is summarized schematically on Figure 3-2. The Alluvial Aquifer, where present, was modeled with a single layer, and the Saugus Formation was modeled with multiple layers to its total depth, which was defined as the base of the Sunshine Ranch Member of the Saugus Formation. Figures 3-3 through 3-9 show the assigned thicknesses in model layers 1 through 7. Figure 3-10 shows the total modeled saturated thickness of the Saugus Formation. Figures 3-11 through 3-17 show the elevations of the base of each model layer. Figure 3-18 shows the model layering in three cross-sectional views. Further details regarding model layering are presented below.

3.4.1 Alluvial Aquifer Layer

In 2002, RCS compiled and geographically grouped hydrogeologic data from Alluvial Aquifer wells to estimate the aquifer's saturated thickness during various historical periods. The saturated thickness was defined from the average base elevation of the aquifer and the water level elevations measured during the fall of 1985 and the spring of 2000, then typical saturated thicknesses for geographic subareas were defined. The spatial distribution of the Alluvial Aquifer's typical saturated thickness is shown on Figure 3-3. Along the Santa Clara River, the typical saturated thickness ranges between 110 and 130 feet west of I-5; is less than 100 feet near Round Mountain; ranges between 100 and 150 feet between Round Mountain and Soledad Canyon; and ranges between 80 and 90 feet in Soledad Canyon. The typical saturated thickness ranges between 80 and 100 feet in the Castaic Creek Valley and in the lower reach of Bouquet Canyon. Other tributary canyons to the Santa Clara River have typical saturated thicknesses of 60 feet or less, and the saturated thickness decreases significantly in the upstream direction within each canyon, particularly along the South Fork Santa Clara River, where all production wells are constructed in the Saugus Formation, rather than the alluvium (RCS, 2002).

3.4.2 Saugus Formation Layers

The Saugus Formation was simulated using 500-foot-thick model layers through the freshwater-bearing deposits, which are present in the basin at depths up to 2,500 feet (RCS, 1988, 2002). The model layers were specified at each node by importing digitized contours of the total thickness of the Saugus Formation's freshwater-bearing deposits (Plate 5 in RCS, 1988). Figure 3-4 is a contour fill map showing the total thickness of the Saugus Formation's freshwater-bearing deposits that was programmed into the model. As shown in the individual thickness maps for each model layer, the Saugus is present in the

model at progressively fewer nodes with depth, due to the bowl-shaped structure of the unit and the underlying bedrock.

3.5 Boundary Conditions

The boundary conditions used in the Regional Model were the following:

a. **Specified flux for precipitation within the model grid.** Deep percolation of precipitation was simulated using the precipitation top-system package contained in MicroFEM®.

b. **Specified flux for irrigation.** Deep percolation of agricultural irrigation and urban irrigation in developed areas was simulated using the precipitation top-system package contained in MicroFEM®.

c. **Specified flux and head-dependent flux along ephemeral streams.** With respect to groundwater discharges to streams, the Santa Clara River was modeled as an ephemeral, predominantly losing stream at and upstream of the mouth of San Francisquito Canyon, and as a perennial, predominantly gaining stream downstream of San Francisquito Canyon. Although flows in the river are currently perennial below the mouth of Bouquet Canyon, because of discharges from the Saugus WRP, the river was perennial only below the mouth of San Francisquito Canyon in the 1960s, prior to WRP operations. The tributaries to the Santa Clara River were modeled as ephemeral streams, using the precipitation top-system package to specify stream leakage to groundwater. Aerial photos and historical observations indicate that under high water table conditions, groundwater can locally discharge into Castaic Creek and the ephemeral reach of the Santa Clara River wherever Alluvial groundwater levels rise above the riverbed elevation. Consequently, the drain package in MicroFEM® was used in these streams to allow drainage of any groundwater that was calculated to be above the riverbed elevation at each river node.

d. **Specified flux and head-dependent flux along perennial Santa Clara River.** In the perennial reach of the Santa Clara River, the river was modeled using the wadi top-system package contained in MicroFEM®. The wadi package allows groundwater to discharge to the river whenever groundwater elevations are higher than the specified river stage. When groundwater levels are below the river stage, the river recharges the Alluvial Aquifer. The rate of recharge is proportional to the difference between the river stage elevation and the model-calculated groundwater elevation. However, once the groundwater elevation drops below the streambed sediments, the rate of leakage from the stream is constant (i.e., does not vary as the groundwater elevation fluctuates). For the Regional Model, each node along the perennial reach of the Santa Clara River was assigned a river stage 1 foot higher than the mapped bed elevation of the river. The riverbed permeability, or conductance, which helps control the model-calculated groundwater/surface water exchange rates, was adjusted during model calibration by calibrating to streamflow data collected at the county line. (See Section 4.3 for further details on the use of the streamflow data during model calibration.)

e. **Specified flux for pumping.** Pumping rates and locations for wells completed in the Alluvial Aquifer and the Saugus Formation were directly imported into the Regional

Model from the Upper Santa Clara River Groundwater Basin database. Further information on how pumping was specified in the model is contained in Section 3.7.

f. **Specified flux at upgradient Alluvial Aquifer boundaries.** Where there is Alluvial groundwater flow into the study area from beneath Castaic Dam, the magnitude of the specified flux was adjusted during the model calibration process, using groundwater elevations and gradients published by RCS (1986 and 2002).

g. **Specified groundwater elevation in the Alluvial Aquifer at the county line.** The groundwater elevation (805 feet) was obtained from water level contour maps for the Alluvial Aquifer prepared by RCS (1986, 2002). (See Figure 2-7 for groundwater elevation contours during Spring 2000, as mapped by RCS [2002].)

h. **Head-dependent flux for evapotranspiration.** ET from the water table by riparian vegetation was simulated using the evaporation top-system package contained in MicroFEM®. This package requires specification of the maximum rooting depth for the riparian vegetation, the maximum potential ET rate, and the ground surface elevation.

i. **No-flow.** In general, the outermost line of nodes that form the model boundary and the bottom of the model are no-flow boundaries. The exceptions are the western model boundary (specified head) and the specified-flux nodes representing underflow into the Alluvial Aquifer from beneath Castaic Dam. Also, all nodes on the model boundary are assigned specified fluxes due to precipitation and, in some cases, ephemeral streamflow.

3.6 Estimation of Groundwater Recharge Rates

The groundwater recharge rates required by the model were derived from the following information sources:

a. Precipitation records

b. Watershed maps and topographic maps

c. Aerial photography (to identify vegetation patterns and areas of agricultural and urban irrigation)

Groundwater recharge was defined on a month-to-month basis for the transient calibration process. Groundwater recharge rates were assigned at all model nodes using the GIS for the valley and a Surface Water Routing Model (SWRM), which was written specifically for the Regional Model using the Visual Basic Editor within Microsoft® Excel 97. For each month during the transient calibration period, the SWRM estimated the following:

a. The amount of water potentially available to recharge the aquifer, which consisted of:

   1. Infiltration of direct precipitation within the model grid area
   2. Infiltration of urban irrigation water
   3. Infiltration of agricultural irrigation water
   4. The amount of stormwater yielded by upstream watersheds in each tributary to the Santa Clara River
   5. The amount of water entering the valley in the Santa Clara River at the Lang gage

6. The amount of water released into Castaic Creek by DWR
7. The locations and volumes of flow discharged into the Santa Clara River from the two LACSD WRPs

b. The amount of water in each stream that actually infiltrates to the aquifer, based on an assigned streambed leakage rate at each model node

c. The amount of water in each stream that does not infiltrate and therefore remains as surface water in the Santa Clara River at the west end of the valley, at the County Line gage

During model calibration, the SWRM was used to adjust the streambed conductance terms for Castaic Creek and the ephemeral reach of the Santa Clara River. These adjustments were made by examining the differences between measured and modeled groundwater elevations at wells located in the valleys where these ephemeral streams are present. In addition, the streambed conductance terms were allowed to vary from month to month because the conductance implicitly incorporates the streambed area, which is large during high river flows and smaller during low-flow periods.

A detailed discussion of the SWRM's design, operations, and input data is contained in Appendix C.

3.7 Assignment of Pumping Rates

Pumping rates were assigned in the Regional Model using the following information:

a. Water use records maintained by the Purveyors and other agencies in the valley. These records were available in the form of AF/yr of water use at each well.

b. Estimates of monthly water demand for urban water use and agricultural water use.

c. Well construction records, which were needed to determine which model layers at each individual well should be assigned pumping.

Tables 2-1 and 2-2 summarize annual pumping rates at each well and for each year during the transient model calibration period. All production wells in the Alluvial Aquifer were assigned pumping rates in model layer 1. For each production well completed in the Saugus Formation, the pumping assignments in each model layer were based on the total pumping rate, the percentage of the model layer in which the well was open, and the thickness and hydraulic conductivity of each model layer. Table 3-1 summarizes this information and shows the percentage of the total well yield that was derived from each model layer.

Table 3-2 summarizes the monthly distribution of the annual pumping volumes. Separate distributions were used for agricultural demands, which are exclusively for outdoor uses, and for urban demands, which are for both indoor and outdoor uses. The monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining monthly flow records for the two LACSD WRPs and monthly demand distributions recorded by VWC during the past several years.

Tables

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-7	3	520	974	454	2	908	100.0
NCWD-8	2	342	970	158	10	1,580	62.7
NCWD-8	3	342	970	470	2	940	37.3
NCWD-9	2	311	674	189	0.03371	6.37	59.4
NCWD-9	3	311	674	174	0.025	4.35	40.6
NCWD-10	3	780	1,544	220	2	440	28.8
NCWD-10	4	780	1,544	500	2	1,000	65.4
NCWD-10	5	780	1,544	44	2	88	5.8
NCWD-11	2	200	1,075	300	10	3,000	72.3
NCWD-11	3	200	1,075	500	2	1,000	24.1
NCWD-11	4	200	1,075	75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
NCWD-12	3	485	1,280	500	2	1,000	58.5
NCWD-12	4	485	1,280	280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
NCWD-13	3	420	750	250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
NLF-156	3	320	1,800	500	6.5	3,250	39.4
NLF-156	4	320	1,800	500	4	2,000	24.2
NLF-156	5	320	1,800	300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
SCWC-Saugus1	3	490	1,620	500	6.5	3,250	59.9
SCWC-Saugus1	4	490	1,620	500	4	2,000	36.8
SCWC-Saugus1	5	490	1,620	20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.8
SCWC-Saugus2	3	490	1,591	500	6.5	3,250	56.9
SCWC-Saugus2	4	490	1,591	500	4	2,000	35.0
SCWC-Saugus2	5	490	1,591	91	4	364	6.4
VWC-157	3	586	2,008	414	6.5	2,691	40.2
VWC-157	4	586	2,008	500	4	2,000	29.9
VWC-157	5	586	2,008	500	4	2,000	29.9
VWC-159	3	662	1,900	338	0.025	8.45	27.3
VWC-159	4	662	1,900	500	0.025	12.5	40.4
VWC-159	5	662	1,900	400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.5
VWC-160	4	950	2,000	500	4	2,000	46.2
VWC-160	5	950	2,000	500	4	2,000	46.2

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
VWC-201	3	540	1,670	460	6.5	2,990	52.7
VWC-201	4	540	1,670	500	4	2,000	35.3
VWC-201	5	540	1,670	170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
VWC-205	4	820	1,930	500	4	2,000	40.9
VWC-205	5	820	1,930	430	4	1,720	35.2

TABLE 3-2

Allocation of Pumping by Month for Agricultural and Urban Production Wells

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Month	% of Annual Water Use, Agricultural	% of Annual Water Use, Urban	% of May through October Water Use, Urban
January	3.8	5.2	
February	5.1	3.7	
March	6.6	5.2	
April	9.1	6.6	
May	10.6	8.7	13.2
June	11.4	10.4	15.8
July	14.1	13.0	19.7
August	12.9	13.6	20.6
September	10.2	10.9	16.5
October	7.5	9.3	14.1
November	5.0	7.1	
December	3.8	6.3	
Total	**100.0**	**100.0**	**100.0**

Figures

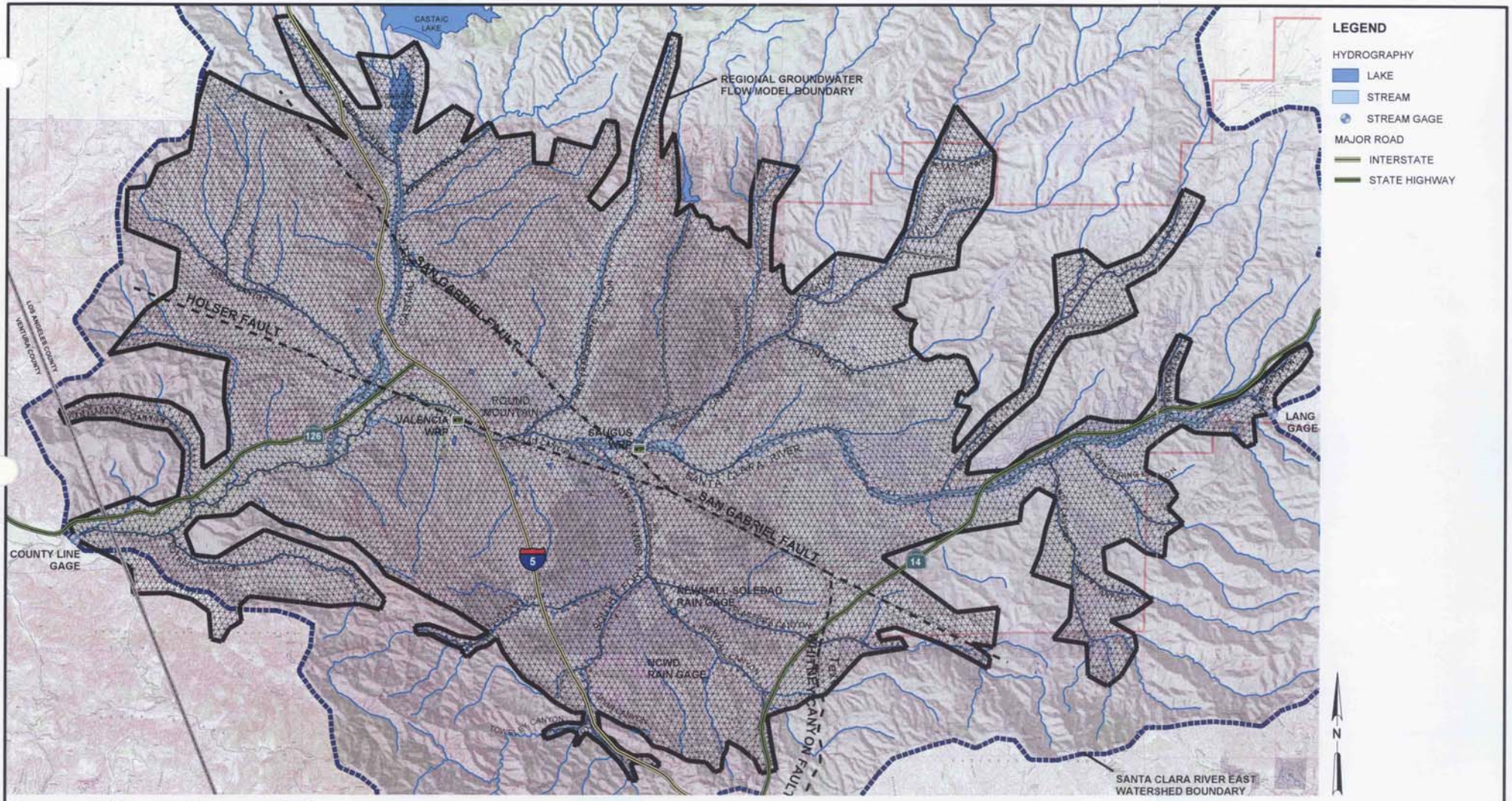


FIGURE 3-1
MODEL GRID
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0301.MXD FIG03-01.PDF 02/03/2004 09:40:41

	Stratigraphy		Model Layer	Thickness (feet)
Saugus	Alluvium	Saugus	1	500
Saugus	Saugus	Saugus	2	
Saugus	Saugus	Saugus	3	500
Saugus	Saugus	Saugus	4	500
Saugus	Saugus	Saugus	5	500
Saugus	Saugus	Saugus	6	500
Sunshine	Sunshine	Sunshine	7	Variable

FIGURE 3-2
SHEMATIC DIAGRAM OF THE MODEL'S REPRESENTATION OF STRATIGRAPHY IN THE MIDDLE OF THE BASIN
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

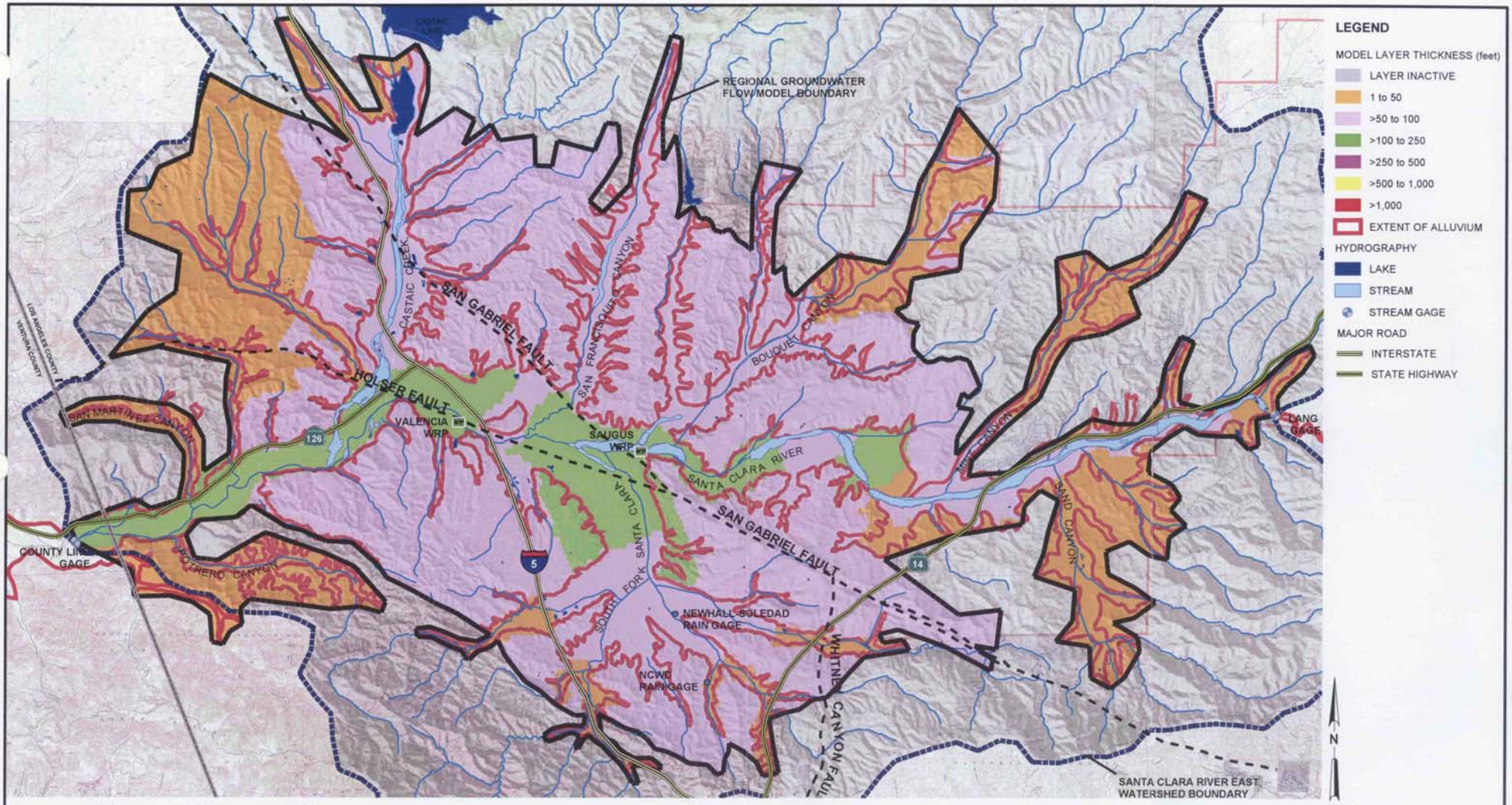

FIGURE 3-3
THICKNESS OF MODEL LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG020.MXD FIG03-03.PDF 02/02/2004 13:01:44

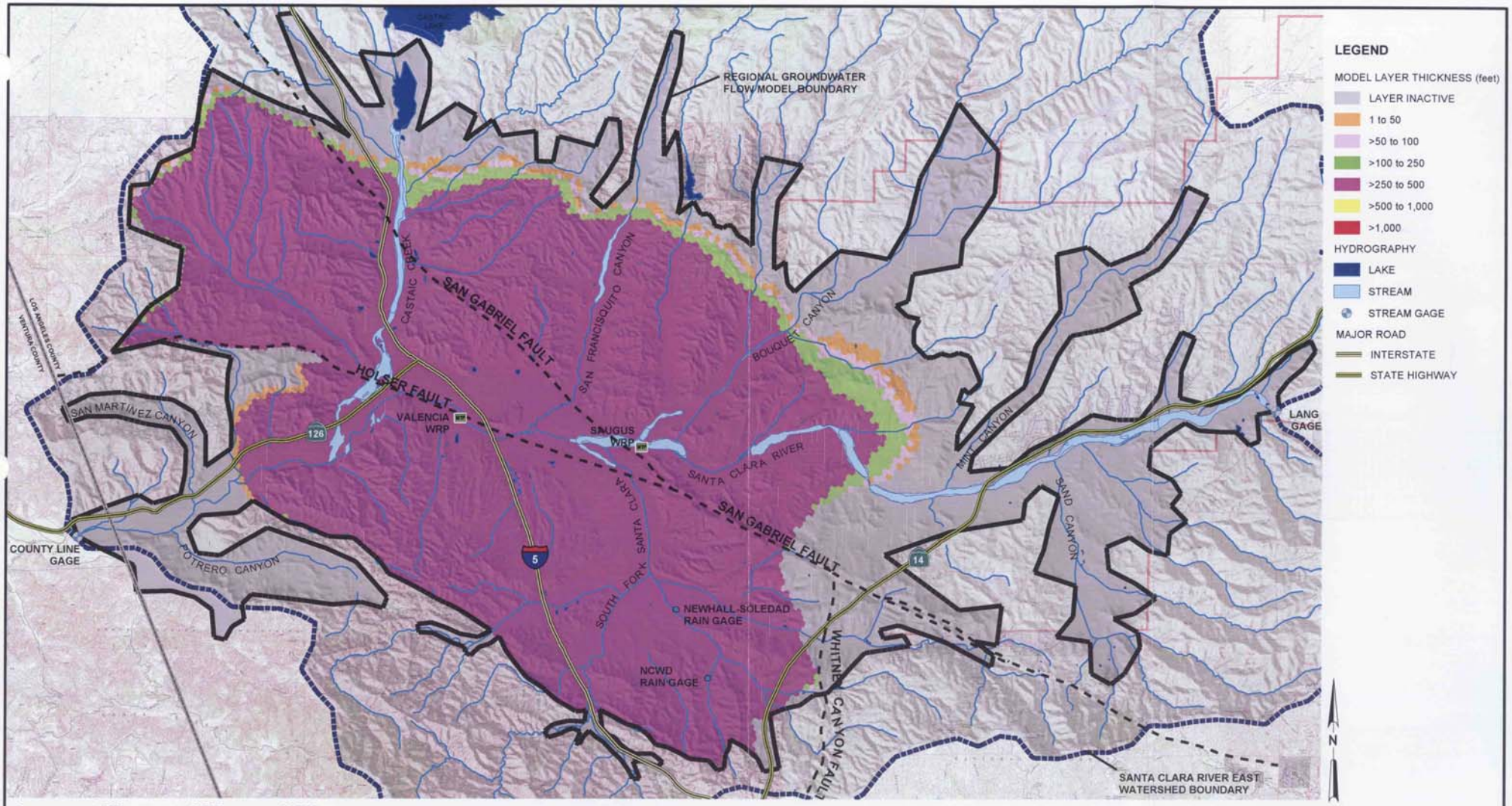

FIGURE 3-4
THICKNESS OF MODEL LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG021.MXD FIG03-04.PDF 02/02/2004 13:21:28

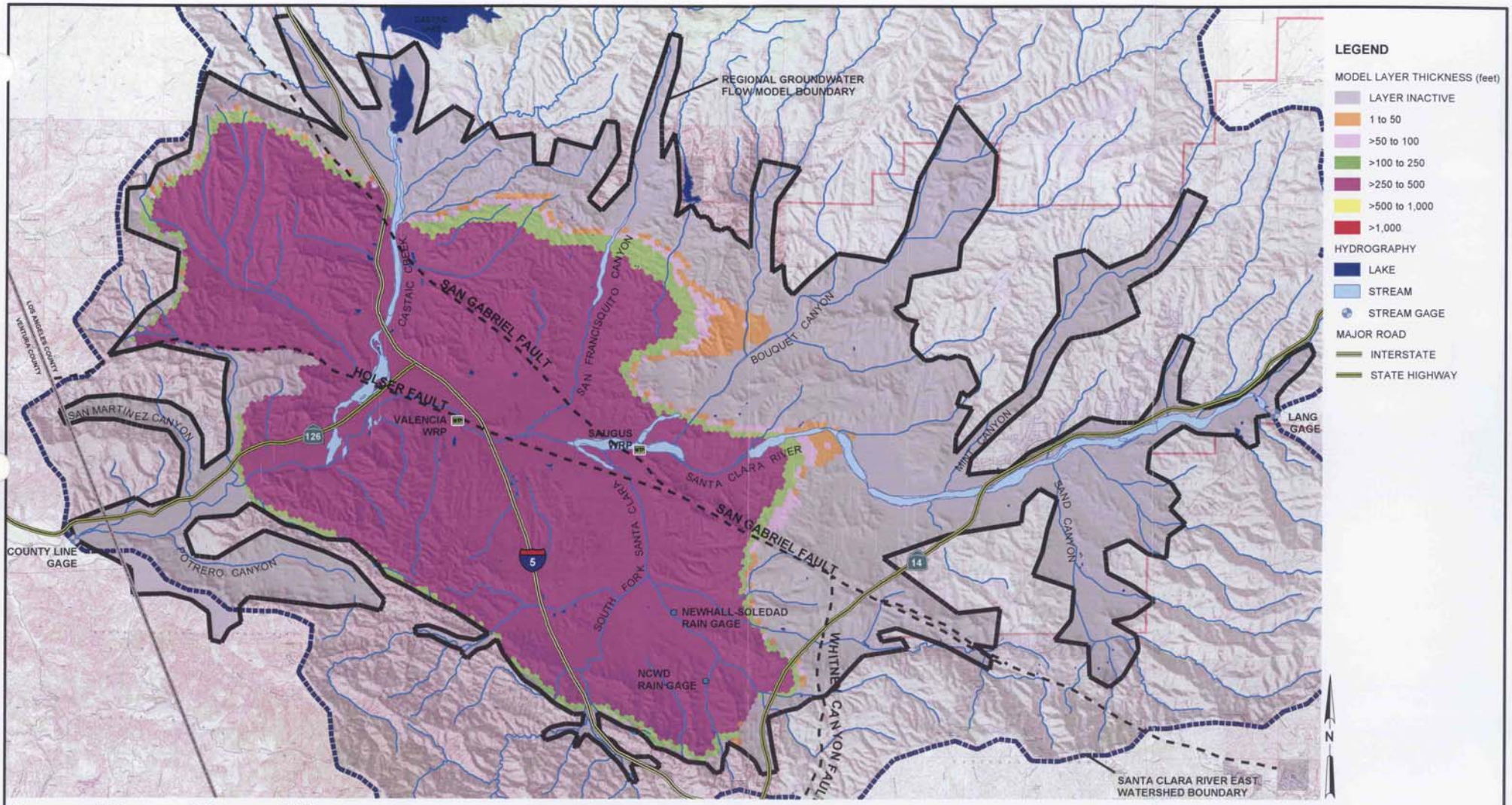

FIGURE 3-5
THICKNESS OF MODEL LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG022.MXD FIG03-05.PDF 02/04/2004 11:14:10

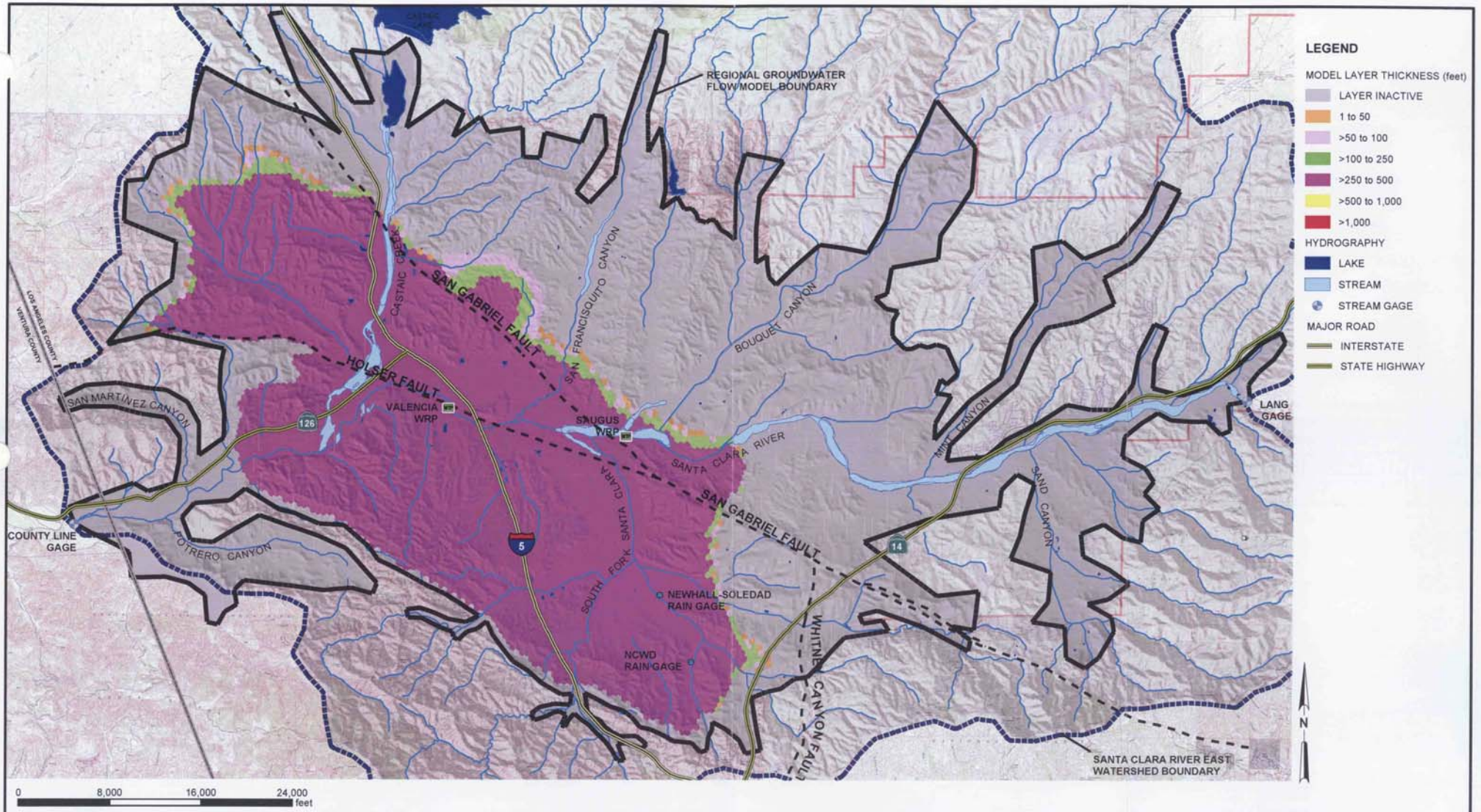

FIGURE 3-6
THICKNESS OF MODEL LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG023.MXD FIG03-06.PDF 02/04/2004 11:19:11

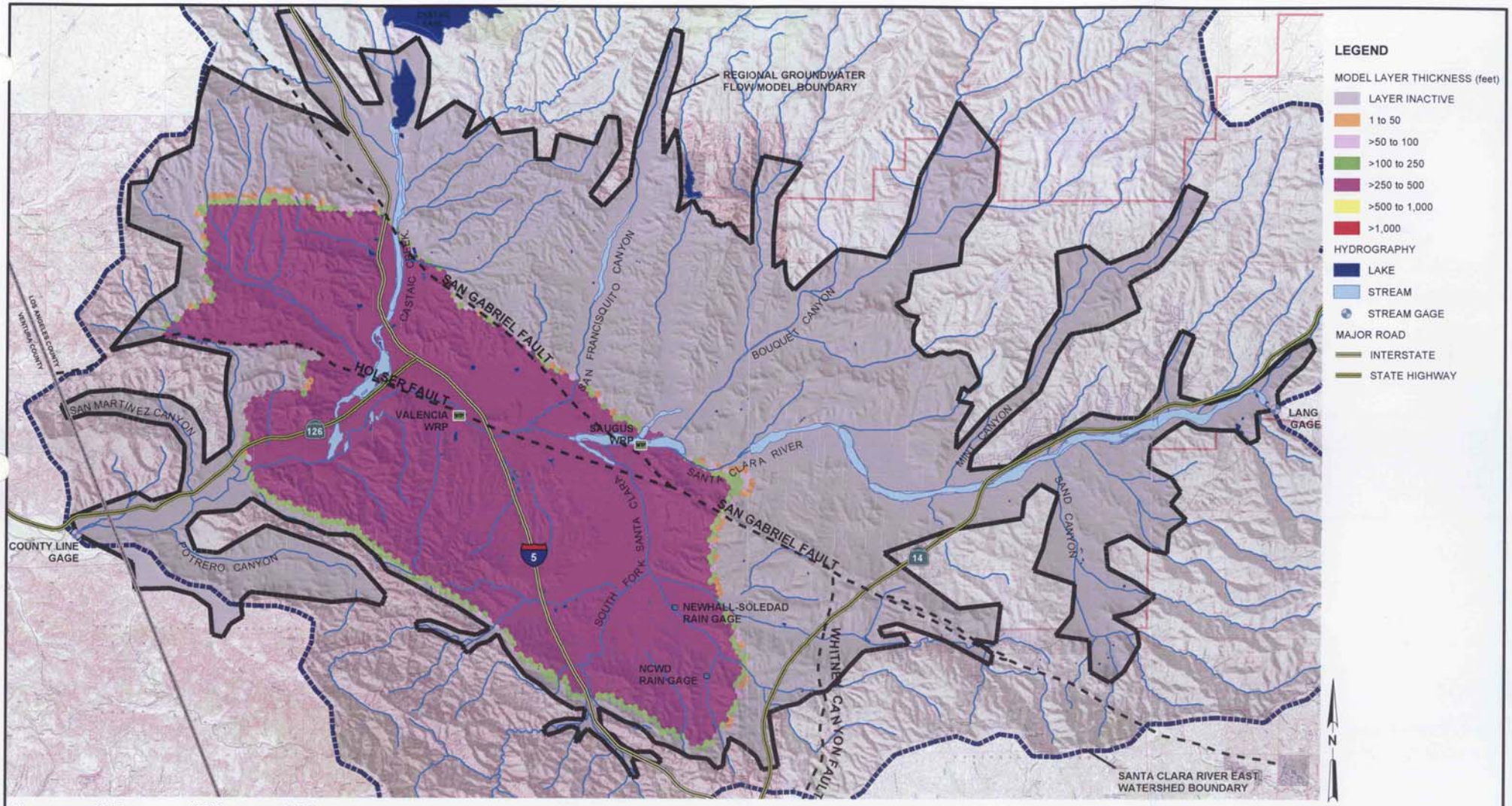

FIGURE 3-7
THICKNESS OF MODEL LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG024.MXD FIG03-07.PDF 02/04/2004 11:23:01

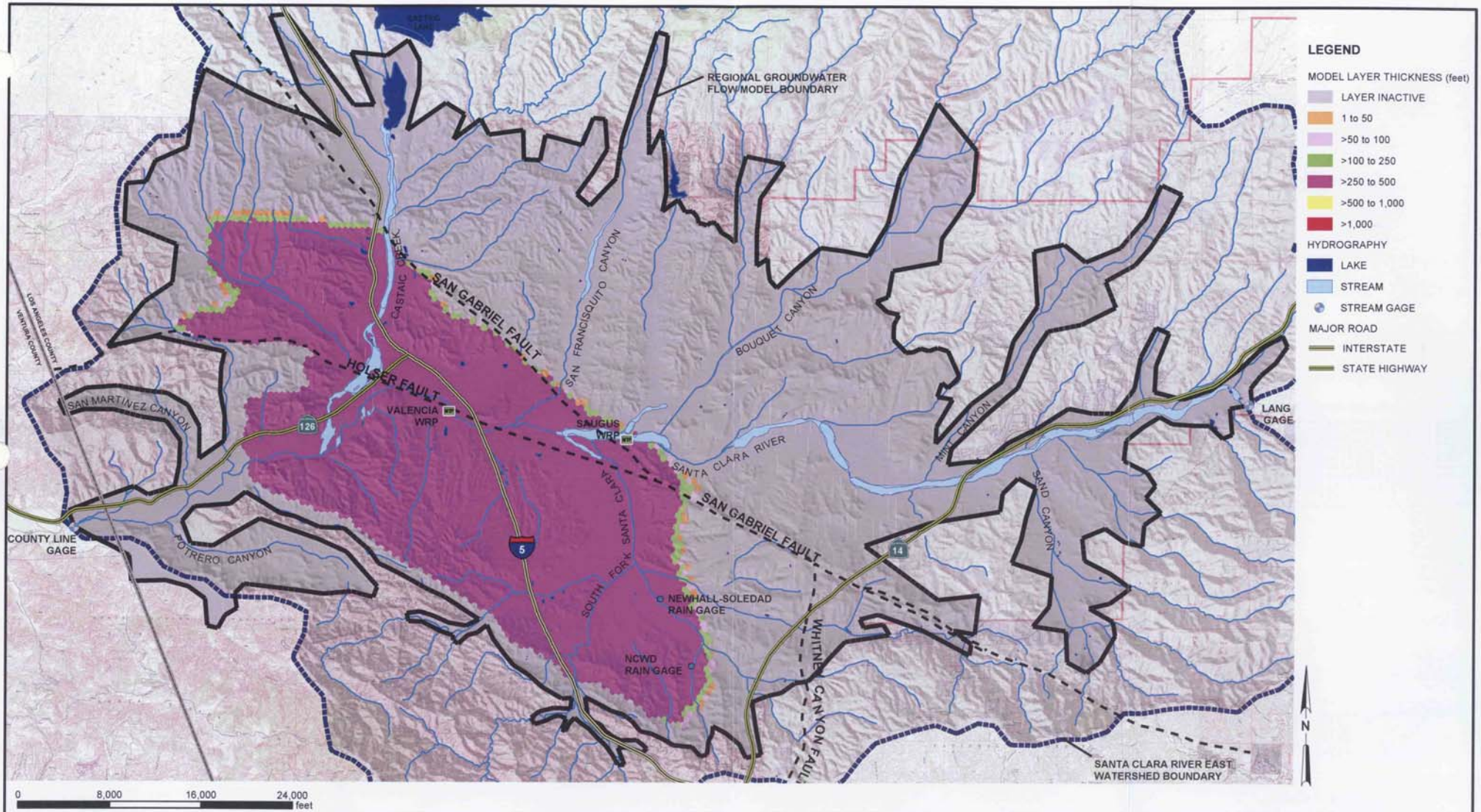

FIGURE 3-8
THICKNESS OF MODEL LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG025.MXD FIG03-08.PDF 02/04/2004 11:26:22

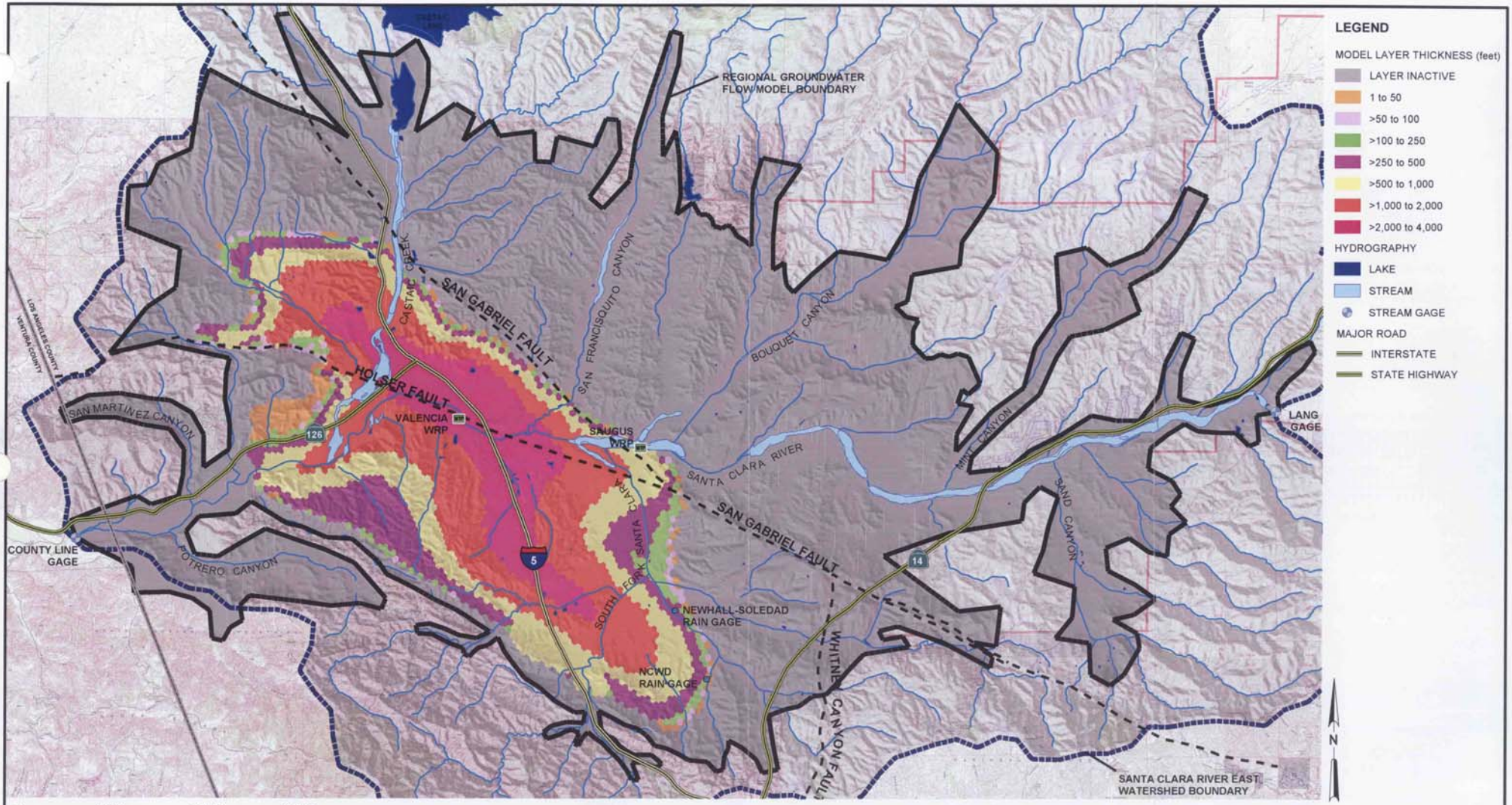

FIGURE 3-9
THICKNESS OF MODEL LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG026.MXD FIG03-09.PDF 02/02/2004 14:09:12

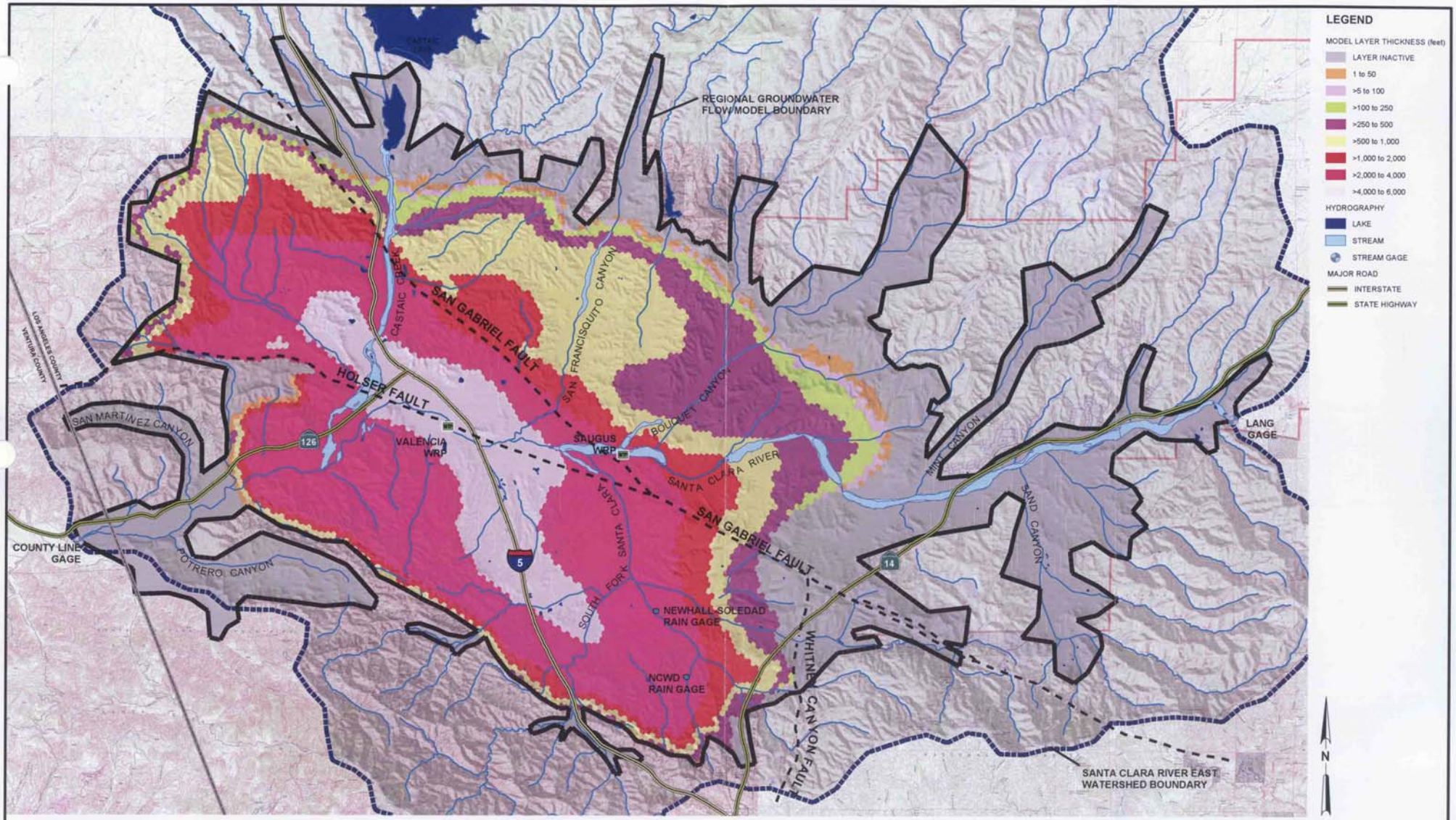

FIGURE 3-10
THICKNESS OF SAUGUS FORMATION (MODEL LAYERS 1 THROUGH 7)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG044.MXD FIG03-10.PDF 02/04/2004 14:19:00

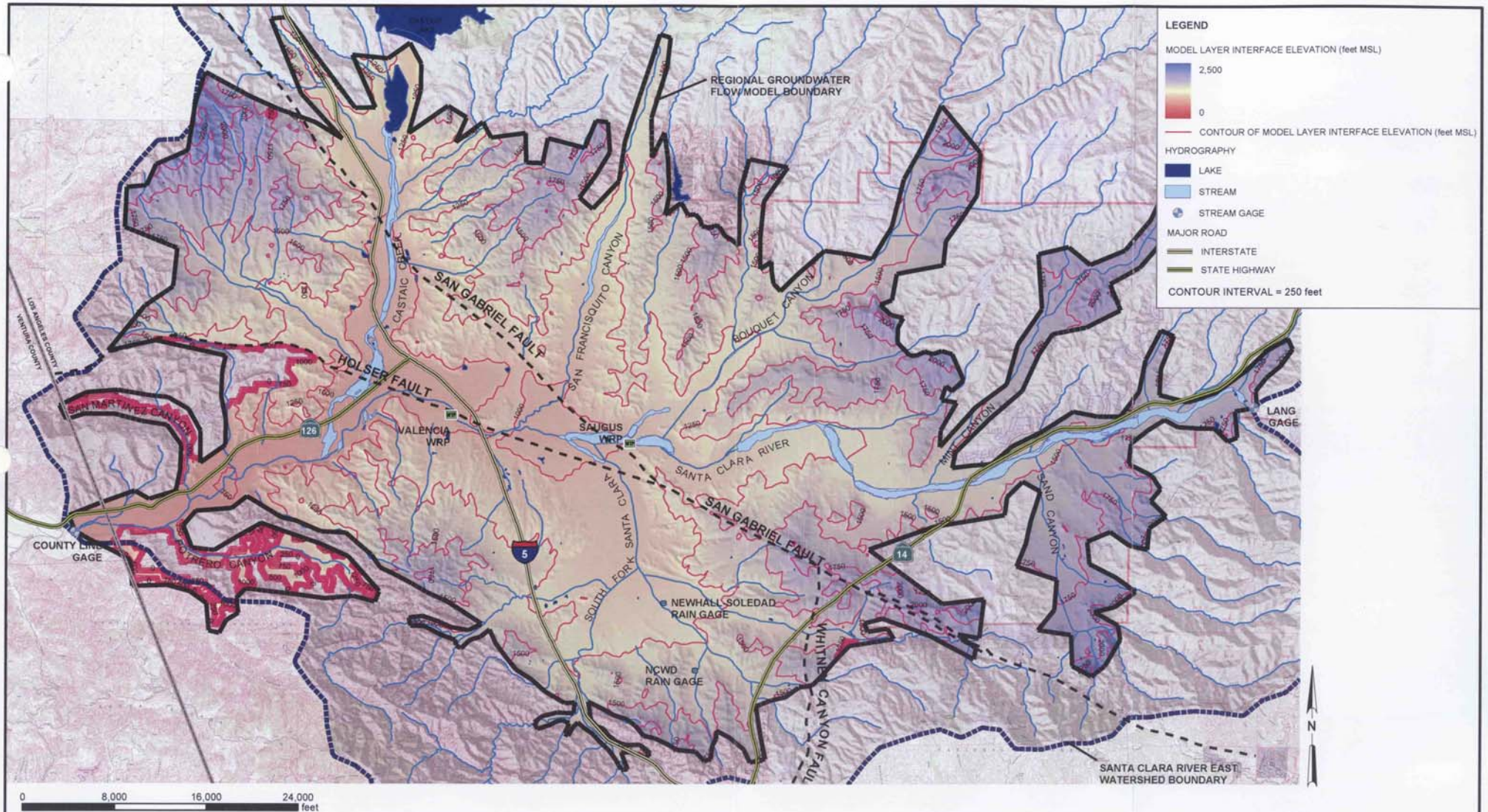

FIGURE 3-11
LAYER 1 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG027.MXD FIG03-11.PDF 02/04/2004 11:36:12

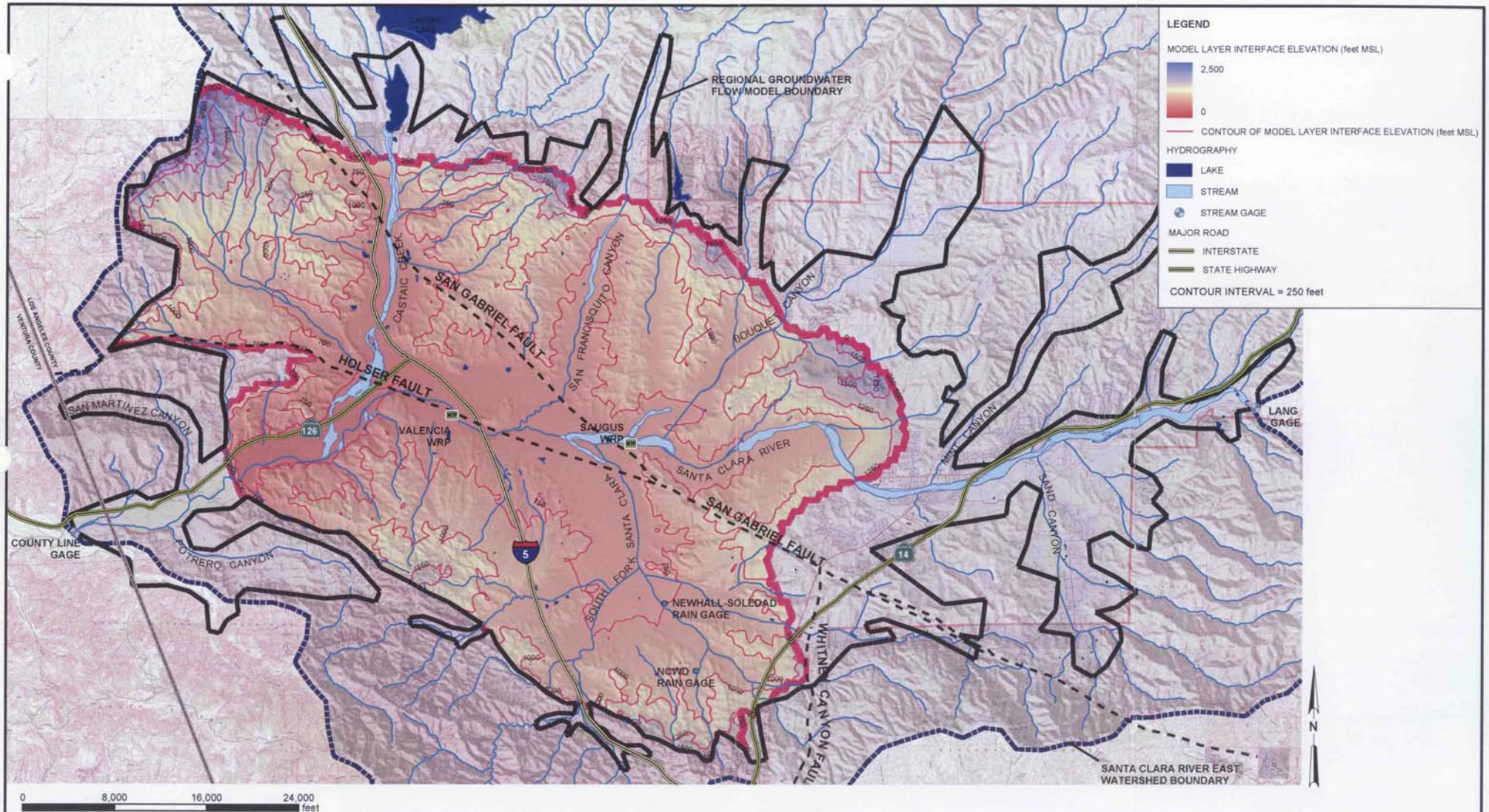

FIGURE 3-12
LAYER 2 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG028.MXD FIG03-12.PDF 02/04/2004 11:36:12

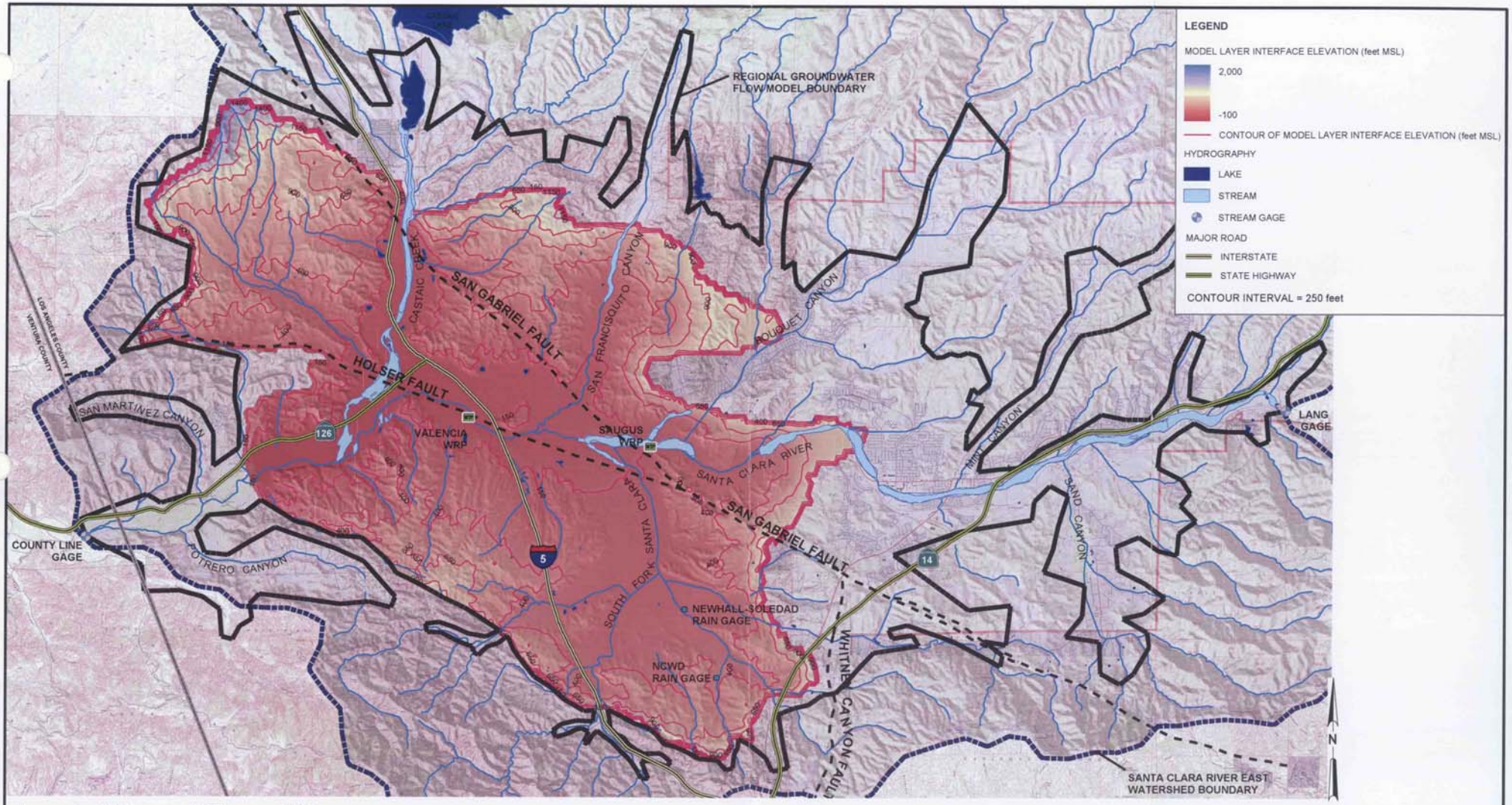

FIGURE 3-13
LAYER 3 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG029.MXD FIG03-13.PDF 02/04/2004 11:42:48

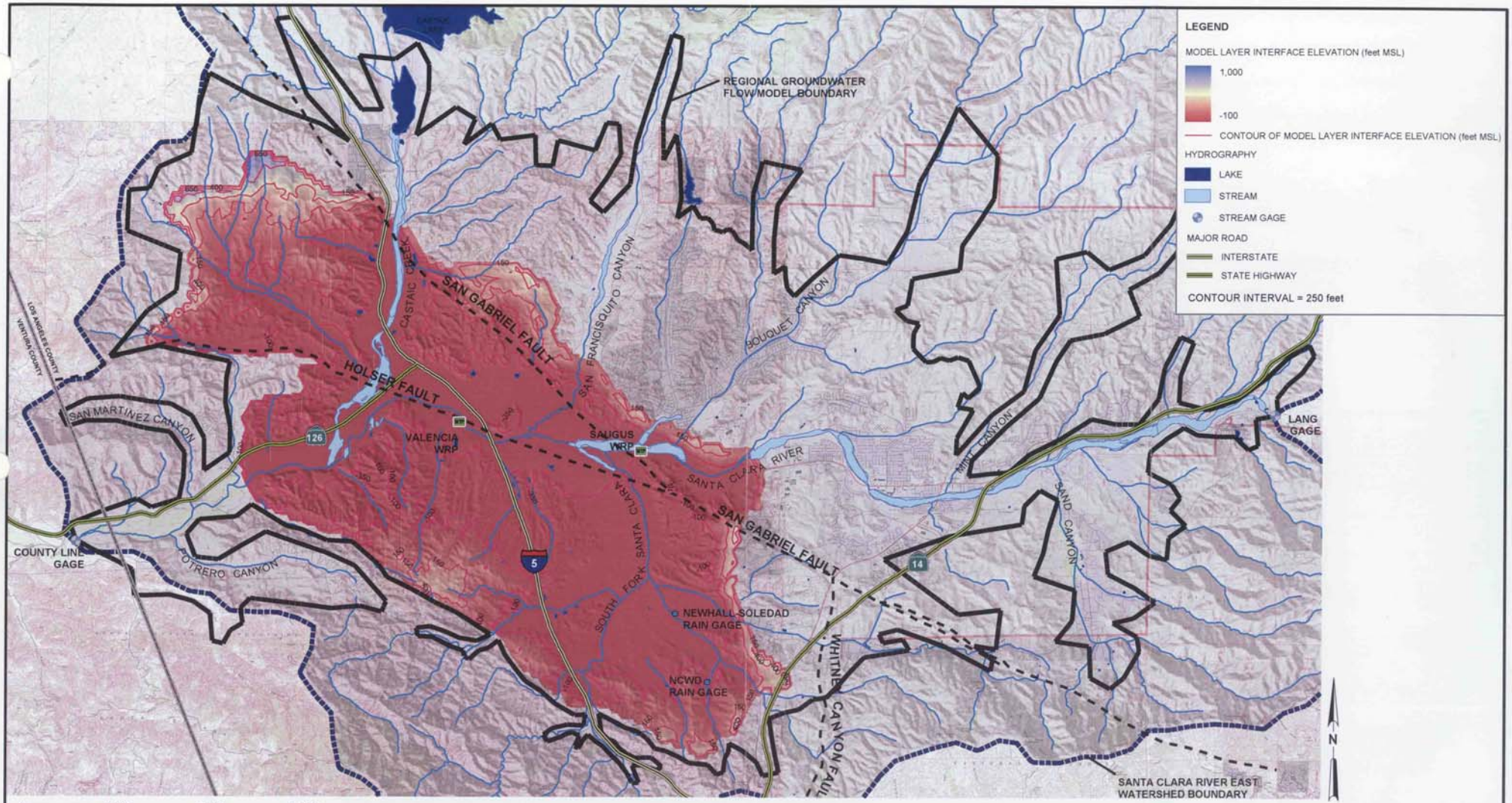

FIGURE 3-14
LAYER 4 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG030.MXD FIG03-14.PDF 02/04/2004 11:53:17

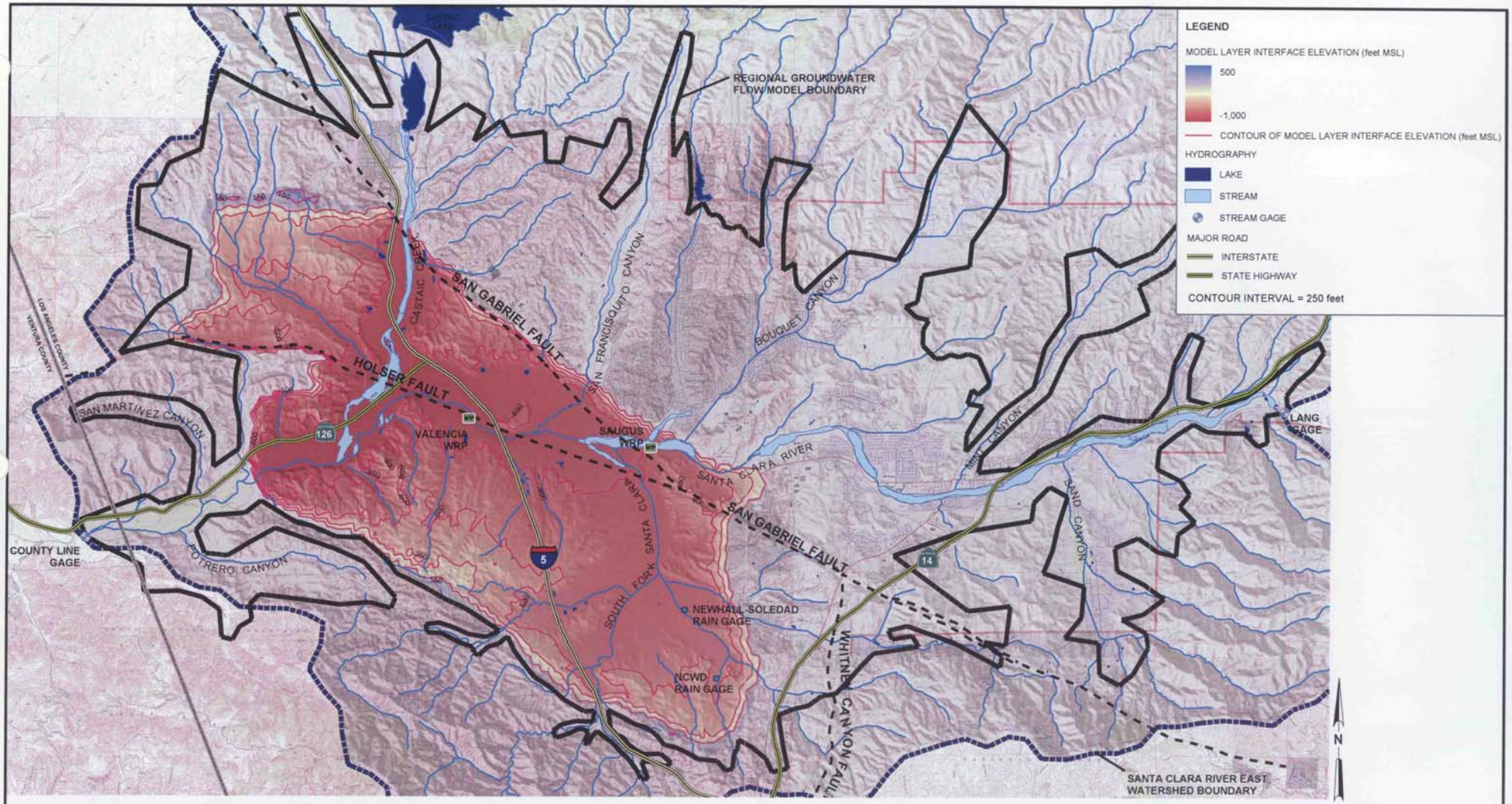

FIGURE 3-15
LAYER 5 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG031.MXD FIG03-15.PDF 02/04/2004 12:53:31

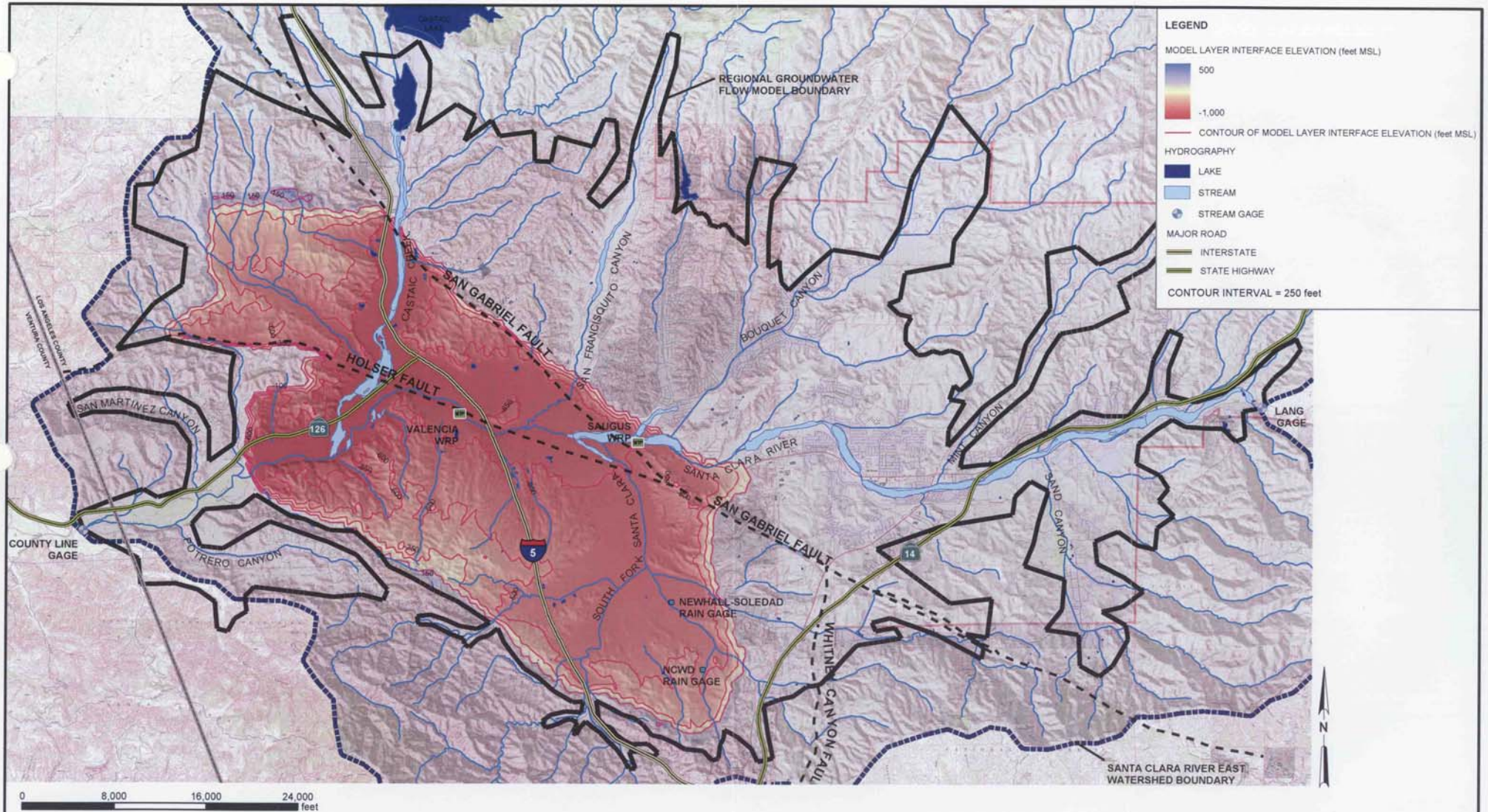

FIGURE 3-16
LAYER 6 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG032.MXD FIG03-16.PDF 02/04/2004 13:03:59

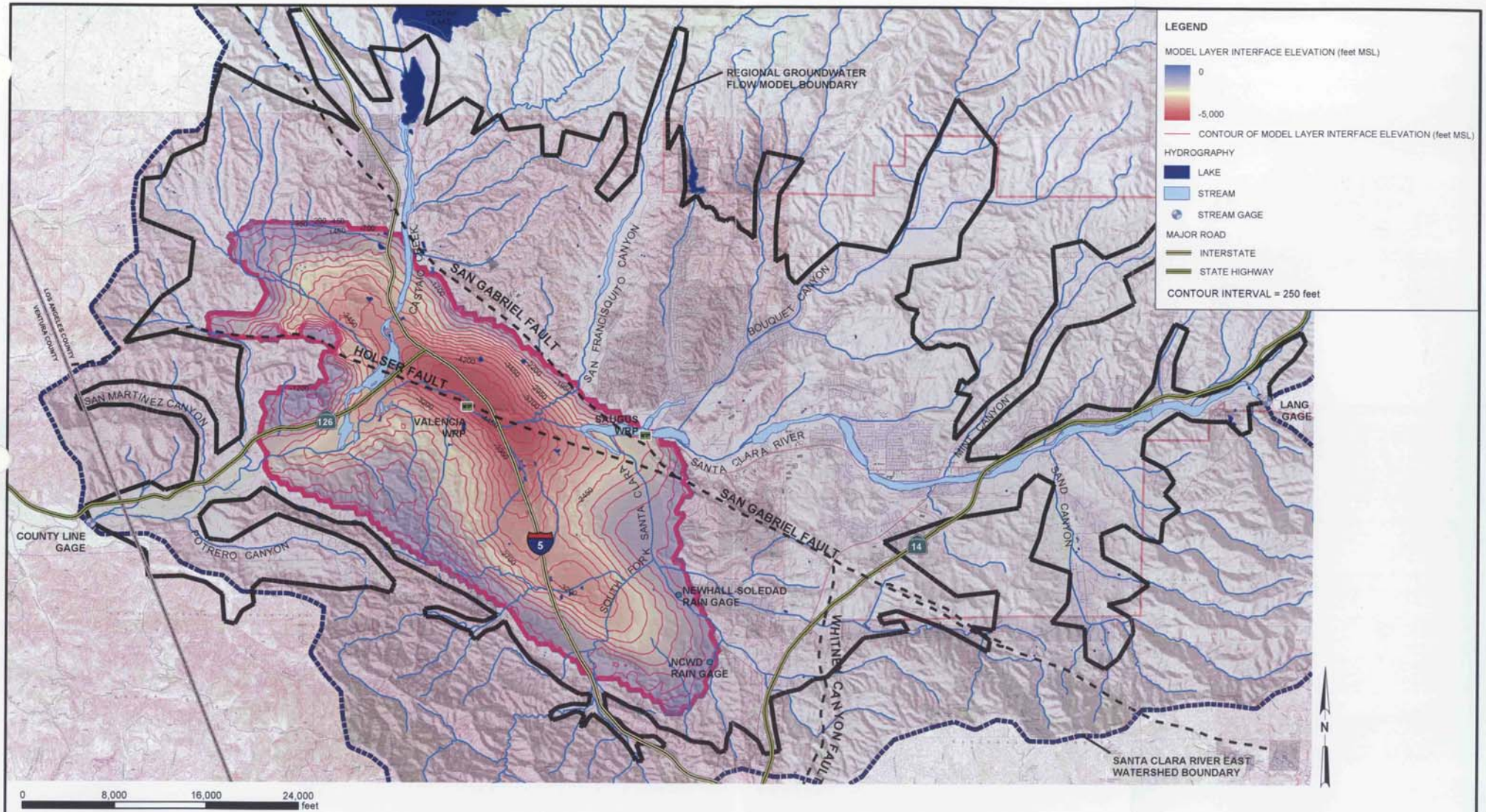

FIGURE 3-17
LAYER 7 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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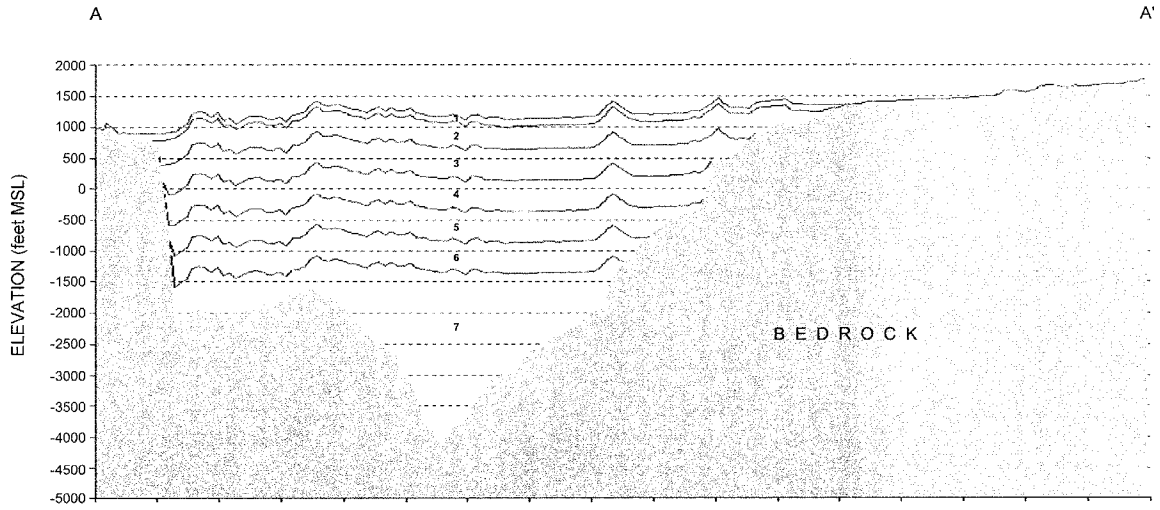
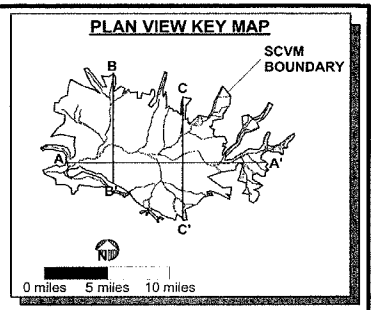




LEGEND

1 = MODEL LAYER 1

2 = MODEL LAYER 2

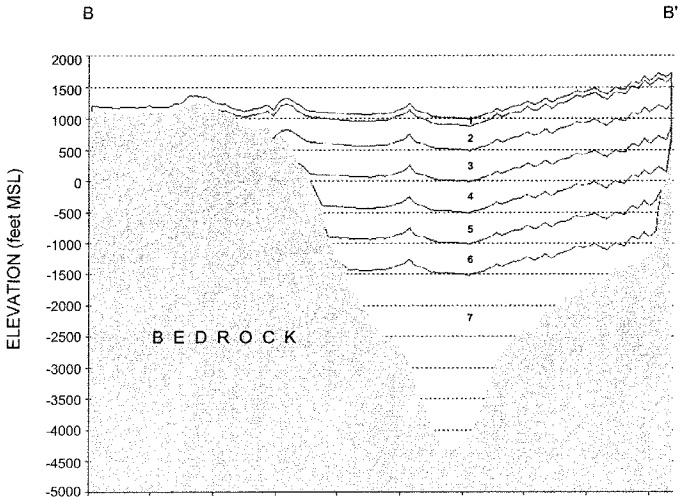
3 = MODEL LAYER 3

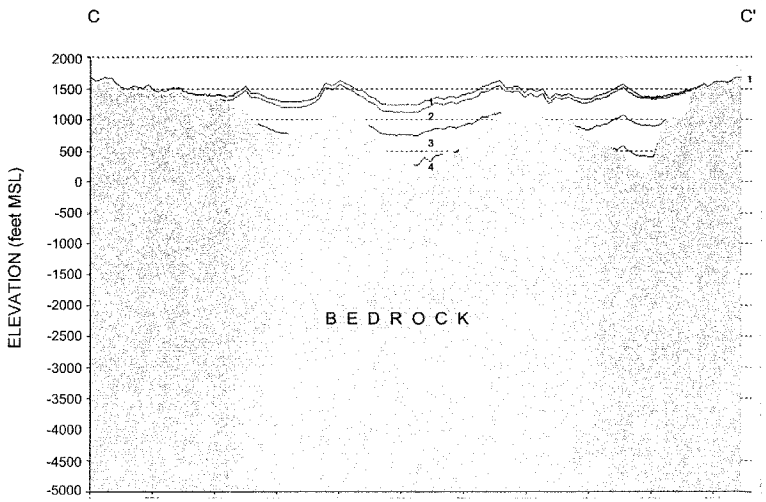
4 = MODEL LAYER 4

5 = MODEL LAYER 5

6 = MODEL LAYER 6

7 = MODEL LAYER 7





HORIZONTAL CROSS SECTION SCALE

0 feet 10,000 feet 20,000 feet

5x VERTICAL EXAGGERATION

FIGURE 3-18
SCHEMATIC CROSS SECTIONS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

SCHEMATICCROSSSECTIONS.SRF

SECTION 4

Model Calibration Process

This section describes the model calibration process. The Regional Model was calibrated according to the *Standard Guide for Calibrating a Ground-Water Flow Model Application,* published by the American Society for Testing and Materials (1996), which describes how to calibrate a model using historical data, including how to establish calibration target data, identify calibration parameters, and compare field data to model calibration results.

Following are discussions of the historical field conditions that were simulated during calibration; the goals of the calibration process; the model parameters (variables) that were adjusted during calibration; and the procedures and target data that were used to conduct the calibration process.

4.1 Calibration Conditions

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation.

4.1.1 Steady-State Calibration

The steady-state calibration was performed for calendar years 1980 through 1985. The purpose of the steady-state model was to simulate average regional flow patterns, regional hydraulic gradients, and groundwater budgets during the initial time period to be modeled as part of the transient calibration effort. The steady-state model also provided initial groundwater elevations for the beginning of the transient model.

During the 1980 through 1985 period:

a. The average precipitation (20.15 in/yr) was approximately 2.5 inches higher than the 1950 through 2000 mean (17.35 in/yr).

b. Alluvial Aquifer pumping decreased slightly (see Table 2-1).

c. Saugus pumping remained relatively constant, between 3,800 and 5,000 AF/yr (see Table 2-2).

d. Importation of SWP water increased steadily, from 1,125 acre-feet in 1980 to 11,823 acre-feet in 1985.

e. WRP discharges into the Santa Clara River increased from approximately 7,400 AF in 1980 to approximately 9,600 AF in 1985.

f. Groundwater elevations in the Alluvial Aquifer remained relatively stable, except for a slight decline in the eastern part of the valley during 1984 and 1985, due to below-normal rainfall during those years.

g. Groundwater elevations in the Saugus Formation remained relatively stable.

Hence, even though SWP imports and WRP discharges increased during this period, groundwater elevations did not rise, instead remaining fairly stable or decreasing slightly due to the relatively stable natural hydrologic conditions during this 6-year period and the below-normal rainfall in 1984 and 1985. Consequently, this time period was deemed suitable for the steady-state portion of the model calibration effort.

4.1.2 Transient Calibration

The transient calibration was performed for calendar years 1980 through 1999 to create a model capable of simulating seasonal and long-term variations in groundwater elevations, groundwater recharge, and groundwater discharge for a historical period characterized by variable rainfall and recharge and changing land use and water use patterns. This 20-year period was chosen for the following reasons:

a. The volume of data is greater during this period than in previous years. In particular, SCWC and VWC installed several production wells in the Saugus Formation during this time period. Also, regular monitoring of groundwater levels was performed at more wells during this period than before.

b. Annual pumping volumes are well known before and after the 1970s, but are not as well known during that decade. Hence, it would be more difficult to calibrate a model during the 1970s because of the uncertainties in pumping volumes during that time.

c. Significant urban growth occurred in the valley between 1980 and 1999. This growth resulted in changes in land use and increased importation of SWP water, from 1,125 acre-feet in 1980 to 27,302 acre-feet in 1999.

d. The local hydrology and the hydrology of the SWP system varied considerably during this period, and included single-year and multi-year droughts both locally and in the SWP system. (See Section 2.6.3.3.) Specifically, the groundwater elevations in the Alluvial Aquifer and the Saugus Formation showed multi-year periods of water level decline followed by multi-year periods of water level recovery. Consequently, calibrating to this period would allow a model to predict basin conditions during and between future drought periods.

4.2 Calibration Goals

The success of the model calibration was determined by its ability to satisfy specific calibration goals that were established by the CH2M HILL project team and the Purveyors. Separate calibration goals were defined for the steady-state model and the transient model. The specific goals are given below, along with a discussion of how calibration success was measured. Calibration goals are comprised of quantitative (statistical) and qualitative criteria.

4.2.1 Calibration Goals for the Steady-State Model

a. **Groundwater Flow Directions.** Correctly simulate groundwater flow directions in the Alluvial Aquifer and Saugus Formation, as defined by regional groundwater elevation contour maps prepared by RCS (1985, 1986, 2002) for various periods in both aquifer systems. (See Figures 2-7 and 2-8.)

b. **Groundwater Elevation Residuals.** At each target well, simulate groundwater elevations to within 10 feet in the Alluvial Aquifer and 25 feet in the Saugus Formation, compared with observed average groundwater elevations during this period. The value of the modeled groundwater elevation minus the observed average groundwater elevation is called the residual error (residual). A positive residual at a given target well indicates that the model simulates too high a groundwater elevation. Conversely, a negative residual indicates that the model simulates too low a groundwater elevation.

c. **Statistics of Groundwater Elevation Residuals.** Achieve the following statistics for the residuals on a modelwide scale (i.e., for the combined group of calibration target wells):

   1. A mean residual as close to zero as possible.

   2. A mean residual that is less than 5 percent of the range in groundwater elevations measured at the target wells.

   3. A root-mean-square (RMS) error of less than 10 feet for the residuals at Alluvial Aquifer target wells and less than 25 feet for the residuals at Saugus target wells.

   4. A normalized RMS error of 10 percent or less. The normalized RMS error equals the modelwide RMS error divided by the range in groundwater elevations across the entire model domain.

   5. A normalized residual standard deviation of less than 10 percent. The normalized residual standard deviation equals the standard deviation of the residuals divided by the range in groundwater elevations across the entire model domain.

   6. Minimize the degree of spatial bias in the distribution of the residuals. Specifically, avoid creating large areas where the residuals are predominantly positive or predominantly negative. A well-calibrated model shows a scattering of negative and positive residuals within any given localized area.

d. **Groundwater Gradients.** Simulate the direction and magnitude of groundwater gradients across the model domain, including a significant horizontal gradient in the Saugus Formation that exists across the San Gabriel Fault (as measured at four multi-port monitoring wells located on the Whittaker-Bermite property, east of wells SCWC-Saugus1 and SCWC-Saugus2).

e. **Groundwater Below Ground Surface.** At nodes where streams are not present, maintain groundwater elevations below ground surface. At stream nodes, groundwater elevations should also be below ground surface in most ephemeral reaches, though a limited number of nodes can have higher groundwater elevations in the downstream ephemeral reaches, where the exact location of the transition from ephemeral to perennial conditions is variable over time and is only approximately known.

f. **Groundwater Discharge to River.** Simulate a groundwater discharge to the Santa Clara River on the order of 29,000 AF/yr, which is the estimated average baseflow during the steady-state model period (see Section 2.6.2.5).

4.2.2 Calibration Goals for the Transient Model

a. **Water Level Trends/Hydrographs.** Match observed fluctuations in groundwater elevations.

b. **Groundwater Below Ground Surface.** Maintain groundwater elevations below ground surface in the same general areas as previously discussed for the steady-state model.

c. **Total River Flow at County Line Gage.** Match the observed Santa Clara River flows measured at the County Line gage.

d. **Groundwater Discharge to River.** Match the estimated groundwater discharge rates to the Santa Clara River.

Discussions of how these calibration goals are met by the Regional Model are contained in Section 4.4.

4.3 Calibration Variables

The following variables were the subject of model calibration and testing:

a. The horizontal hydraulic conductivity (Kh) and the vertical anisotropy (R), which is the ratio of horizontal to vertical hydraulic conductivity

b. The storage coefficients

c. The relationship between rainfall and stormwater runoff in the tributary watersheds lying upstream of the groundwater basin

d. The riverbed permeabilities in gaining and losing reaches of stream systems, particularly in the ephemeral reach of the Santa Clara River and in Castaic Creek

e. ET parameters (primarily rooting depth and the maximum potential ET rate)

4.3.1 Horizontal Hydraulic Conductivity and Vertical Anisotropy

Because the Regional Model consists of over 17,000 active nodes in each of the seven model layers, the calibration process relied on the definition of zones of uniform hydraulic conductivity (K), spanning multiple nodes in a given layer and, in some areas, spanning multiple layers. Specifically, in a given layer, a geographic area was defined as a zone, and the Kh and R values were assigned to all model cells in that zone.

The number of zones and their locations were assigned in the model by primarily considering the hydrostratigraphy and the locations of target wells in the various calibration models, then considering the spatial variations in saturated thickness as summarized by RCS (2002). During the course of the calibration process, adjustments were made to the locations of the zone boundaries and the number of zones. Figures 4-1 and 4-2 show the geographic area designations for the Alluvial Aquifer and Saugus Formation, respectively. In the final calibrated Regional Model, 48 zones were used in the Alluvial Aquifer and 8 zones were used in the Saugus Formation, including a zone along the San Gabriel fault.

The values of Kh for each zone in the Alluvial Aquifer were specified at the beginning of the calibration process from the analyses of specific capacity tests (Table 2-3). In the Saugus Formation, Kh and R values were initially defined from the ASR test analysis (CH2M HILL, 2001) and, in the case of Kh values, also from slug test results on the Whittaker-Bermite property (CH2M HILL, 2003). During calibration, attempts were made to keep these values as close to the initial assigned values as possible. However, adjustments were made if changes to other parameter values were unable to bring the model into calibration.

4.3.2 Storage Coefficients

Model layer 1 was assigned a specific yield of 0.10 to simulate this layer as unconfined. The specific yield was allowed to range between values as low as 0.075 and as high as 0.15. The final Regional Model used a value of 0.10 at each node in layer 1 for both the Alluvial Aquifer and the Saugus Formation (see Section 5).

In model layers 2 through 7, which simulate portions of the Saugus Formation lying below the uppermost model layer, the storage coefficients were allowed to range between 10^{-4} and 10^{-3}, based on analyses of the ASR test results (RCS, 2001) and pumping tests at other Saugus wells (RCS, 2002).

4.3.3 Stormwater Runoff in Upstream Watersheds

See Section 3.6 and Appendix C for discussions of the SWRM, which determined the amount of stormwater generated in upstream watersheds that is available to recharge the Alluvial Aquifer.

4.3.4 Riverbed Permeabilities

The establishment of streambed permeabilities for perennial (gaining) and ephemeral (losing) stream reaches are discussed separately below.

4.3.4.1 Perennial (Gaining) Streams

The streambed conductance terms in the MicroFEM® drain and wadi packages regulate the rate of water exchange between groundwater and surface water along selected stream reaches in the valley. As discussed in Section 3.5, the wadi package is used along the perennial reach of the Santa Clara River, and the drain package is used in the river's ephemeral reach and along Castaic Creek to drain groundwater during periods of high water table conditions. For the drain and wadi packages, the streambed conductance at each node where these packages are used is defined from the following relationship:

$$C = (a/LW) * ([0.5*b_{aq}/Kv_{aq}] + [b_{stream}/Kv_{stream}]) \quad (1)$$

where at each stream node:

a = wetted area of the streambed

L = one-half of the combined lengths of the two grid segments (lines) that connect the stream node to the adjoining upstream and downstream stream nodes

W = the width of the streambed

b_{aq} = the thickness of the Alluvial Aquifer beneath the stream node

Kv_{aq} = the vertical hydraulic conductivity of the Alluvial Aquifer beneath the stream node

b_{stream} = the thickness of the riverbed sediments

Kv_{stream} = the vertical hydraulic conductivity of the riverbed sediments

The calibrated Regional Model uses values of 2 feet for b_{aq} and 10 ft/day (3.5×10^{-3} centimeters per second [cm/sec]) for Kv_{aq}.

4.3.4.2 Ephemeral (Losing) Streams

During the transient calibration phase of model development, the SWRM adjusted the streambed conductance terms for Castaic Creek and for the ephemeral reach of the Santa Clara River. Adjustments in streambed conductance values were made for the following reasons:

a. To integrate this term into the transient model calibration process

b. To account for the variations in streambed conductance that arise from:

   1. Variations in riverbed permeability along the length of the streambed

   2. Variations in riverbed permeability that can occur at a given location due to sediment scouring and redeposition processes that occur during storm runoff periods

   3. Variations in streambed conductance that arise from variations in the width of the river (greatest during storm runoff periods, smallest during low-flow periods)

The adjustment of streambed conductance values during calibration of the transient model was performed for each month and was conducted in an iterative manner by running both the SWRM and the Regional Model repeatedly until the streambed conductance terms or groundwater elevations showed no significant changes (see Appendix C).

4.3.5 Evapotranspiration Parameters

The ET rooting depth was set at 10 feet to correspond to typical rooting depths for phreatophytes such as the willow and cottonwood trees that are present in the riparian corridor along the perennial reach of the Santa Clara River. The maximum potential ET rate was set at 6 feet per year (ft/yr) during model calibration. Ground surface elevation was specified by importing USGS Digital Elevation Model files.

4.4 Calibration Procedure and Target Calibration Data

The steady-state and transient models were calibrated by running the Regional Model and comparing results to the calibration goals described in Section 4.2. The comparison of model results with calibration goals relied on the use of target data that consisted of groundwater elevation data, groundwater discharge to the river, and total flow in the river. Following are discussions of the target calibration data.

4.4.1 Groundwater Elevation Target Data

Alluvial Aquifer target wells were selected for each of the Alluvial zones shown in Figure 4-1. In the Saugus Formation, most wells were used as targets (Figure 4-2). Generally, the selected target wells were those with the greatest number of groundwater elevation measurements during the periods 1980 through 1985 for the steady-state model and 1980 through 1999 for the transient model. Some wells were measured routinely through 1985 but not through 1999, and some wells were not measured until after 1985. Therefore, the list of wells used as targets is different for the steady-state and transient models.

Figure 4-1 shows the target wells for the Alluvial Aquifer, and Figure 4-2 shows the target wells for the Saugus Formation. Table 4-1 provides location and construction information for each target well. The target wells include (1) purveyor-owned production wells; (2) production wells located at the Wayside Honor Rancho (WHR) facility; and (3) a network of non-pumping or low-pumping monitoring wells where water levels have been measured routinely by the Los Angeles County Flood Control District (LACFCD) for many years.

For the production wells, the available water level measurements have been recorded as pumping elevations and static elevations. Static elevations are collected when the well is not pumping. Model-simulated groundwater elevations at a pumping well will be higher than those measured under pumping conditions for the following reasons:

a. In the model, pumping is assigned at these wells, but the pumping nodes have much larger areas than the diameter of the borehole in which each well is completed.

b. The field measurements of groundwater elevations under pumping conditions measure lower groundwater elevations than exist in the aquifer adjacent to the borehole, due to well losses across the borehole wall and the screen or slotted pipe.

Therefore, for model calibration purposes, the calibration goal at target wells that pump was to simulate groundwater elevations as close to the static elevations as possible, while also ensuring that simulated elevations were higher than the pumping elevations. More importantly, the transient calibration effort focused on the periods with the greatest groundwater elevation changes, and the analysis specifically focused on the slopes of the hydrographs, not just the absolute magnitudes of the groundwater elevations.

In the tributary canyons east of I-5, geologic logs were unavailable for many of the LACFCD wells. The total depths and open intervals for many of these wells suggested that they were completed in the geologic units underlying the alluvium, probably due to limited saturated thickness in the alluvium, particularly in the upper reaches of each canyon. For this reason, no targets were selected in Mint Canyon or upstream of the SCWC-Clark production well in Bouquet Canyon. In Sand Canyon, only the well farthest downstream, 7188A, was deemed suitable for use as an Alluvial Aquifer target well. Along the South Fork Santa Clara River, geologic logs and well construction data indicate that all target wells are constructed in the Saugus Formation, not the alluvium. The geologic data indicate that there is very limited saturated thickness in the alluvium in this area.

4.4.2 Santa Clara River Baseflow and Total Flow

Target river flow data to which the Regional Model results were compared were the total gaged flow at the County Line gage and estimates of how much of the gaged flow consisted of groundwater discharge to the river (baseflow).

The simulated total flow at the County Line gage equaled the sum of:

a. The simulated groundwater discharge to the river as calculated by the groundwater model from all wadi and drain nodes

b. The volume of water in the streams that the Visual Basic program (described in Section 3.6 and Appendix C) calculated as surplus stream flow that would not infiltrate to the underlying Alluvial Aquifer

This simulated total flow was compared directly with County Line gage results. The simulated groundwater discharge to the river was compared with the estimated values of river baseflow described previously in Section 2.6.2.5 of this report and listed in Table 2-6. For the steady-state model, the average baseflow during the period 1980 through 1985 was approximately 29,000 AF/yr.

4.4.3 Adjustments to Model Parameters

The steady-state and transient calibration process involved the adjustment of multiple parameters. Initially, the calibration effort focused on the steady-state model, where adjustments were made to Kh and Kv values and streambed coefficients, particularly in the gaining reaches of streams, to establish groundwater elevations, gradients, and flow directions. Attention was then devoted to the transient model, where the parameters receiving adjustment were the storativity, Sy, and the stormwater infiltration rates. Adjustments to Kh and Kv values that had been established during steady-state calibration were considered during transient calibration, but adjustments to these parameters were found to be unnecessary.

Initially, these efforts to calibrate the steady-state and transient models used a fixed, specified relationship between precipitation and stormwater to define the amount of water available for potential infiltration to groundwater. As Appendix C discusses, this relationship was in the form of an empirical power-function equation developed by Turner (1986). The empirical equation uses power-function coefficients that Turner (1986) developed from measurements of the yields from 68 different watersheds throughout California. Although the equation was used throughout the calibration process, including in the final model, the steady-state and transient calibration processes indicated that the empirical power-function coefficients reported by Turner (1986) generated too much stormwater and groundwater recharge to the Santa Clarita Valley during dry years and too little stormwater and groundwater recharge during wet years. This was determined by comparing hydrographs of measured and modeled groundwater elevations and river flows. After many attempts to achieve calibration by adjusting other model parameters, it was concluded that a different set of power coefficients would need to be developed for the Santa Clarita Valley. Consequently, during the final stages of calibration, adjustments to the model focused primarily on the values of these coefficients and on the values of the streambed vertical hydraulic conductivity. Calibration was considered complete once it was determined that the calibration goals were achieved or that no further improvements to the model were possible.

Tables

TABLE 4-1
Target Wells for Calibration of the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer West of I-5																		
NLF-B11	Santa Clara River	C1c	No	Yes	---	Active	Active	Agricultural supply	6362161	1971971	886							
NLF-B10	Santa Clara River	C1c	Yes	No	1956	Active	Active	Agricultural supply	6364235	1974541	901.4	142	30	130	Knife cut			
NLF-B7	Santa Clara River	C1c	No	Yes	1946	Active	Active	Agricultural supply	6364397	1973939	901.6	102	18	88	Knife cut			
NLF-C5	Santa Clara River	C1b	Yes	No	1939	Active	Active	Agricultural supply	6371746	1977874	960.1	139	31	133	Knife cut			
NLF-C6	Santa Clara River	C1b	No	Yes	1939	Active	Active	Agricultural supply	6371835	1978154	966	103	26	93	Knife cut			
NLF-E4	Santa Clara River	C1a	Yes	Yes	1940	Active	Active	Agricultural supply	6374844	1982371	992.5	142	50	136	Knife cut			
6995D	Santa Clara River	C1a	Yes	No	1970	Active	Active	Water levels	6379091	1983329	1018						0	
NLF-G45	Santa Clara River	B1b1	No	Yes	---	Active	Active	Agricultural supply	6381356	1982222	1030	140	40	140				
7076C	Santa Clara River	B1b1	Yes	No	---	Active	Destroyed?	Water levels	6385042	1980084	1059						0	
Alluvial Aquifer between I-5 and Soledad Canyon																		
VWC-I	Santa Clara River	B1b2	No	Yes	1945	Active	Inactive	Municipal supply	6388567	1981657	1090	171	30	165			55	120
NLF-S3	Santa Clara River	B1a	No	Yes	---	Active	Destroyed	Agricultural supply	6393334	1978292	1129	250	95	205				
VWC-N	Santa Clara River	B1a	No	Yes	1936	Active	Active	Municipal supply	6395527	1976081	1130	280	76	237	Knife cut		50	140
VWC-K2	Santa Clara River	B1a	Yes	No	1945	Active	Active	Municipal supply	6395788	1976021	1132	242	62	230	Knife cut		50	63
NLF-R	Santa Clara River	B1a	Yes	No	---	Active	Destroyed	Agricultural supply	6397463	1977860	1157	160	40	140				
7067D	Santa Clara River	B1a	No	Yes	1964	Active	Destroyed?	Water levels	6398546	1977483	1157.5						0	
VWC-Q2	Santa Clara River	B1a	No	Yes	1954	Active	Active	Municipal supply	6399032	1977459	1158	170	76	126				100
Alluvial Aquifer in Soledad Canyon																		
SCWC-Stadium	Santa Clara River	A1e1	Yes	Yes	1946	Active	Active	Municipal supply	6402385	1974713	1197	130	33	130	Knife cut	Unknown		130
VWC-T4	Santa Clara River	A1e1	Yes	No	1953	Active	Active	Municipal supply	6403350	1975164	1191	150	50	135	Knife cut		50	100
VWC-T2	Santa Clara River	A1e1	No	Yes	1952	Active	Active	Municipal supply	6403623	1975127	1201	150	50	138	Knife cut			100
LACFCD-7107C	Santa Clara River	A1d1	Yes	No	---	Active	Destroyed?	Water levels	6410792	1975622	1276						0	
SCWC-Honby	Santa Clara River	A1d1	No	Yes	1959	Active	Active	Municipal supply	6411408	1977202	1282	226	50	202	Factory	Rotary	30	130
7127D	Santa Clara River	A1d2	Yes	Yes	1974	Active	Active	Water levels	6417808	1977062	1333	157					0	
SCWC-N.Oaks West	Santa Clara River	A1d4	Yes	No	1940	Active	Active	Municipal supply	6421187	1972857	1392	136	80	118	Knife cut	Unknown		110
SCWC-N.Oaks East	Santa Clara River	A1d4	No	Yes	1940	Active	Active	Municipal supply	6421651	1972936	1398	132	81	150	Knife cut	Unknown		130
7148K	Santa Clara River	A1c1	No	Yes	---	Active	Active	Water levels	6423523	1973851	1435						0	
7158K	Santa Clara River	A1c2	Yes	No	1965 or earlier	Active	Active	Water levels	6427699	1973490	1460						0	
7168C	Santa Clara River	A1c2	Yes	Yes	---	Active	Active	Water levels	6430088	1974149	1488						0	
SCWC-Mitchell	Santa Clara River	A1c2	No	Yes	1976	Active	Active	Municipal supply	6430168	1974420	1489	262	76	246	125 Mesh	Rotary	76	162
SCWC-Sand Canyon	Santa Clara River	A1c3	Yes	No	1973	Active	Active	Municipal supply	6432953	1975589	1523	127	60	140	Factory	Rotary	60	112
7178D	Santa Clara River	A1c3	Yes	No	1950 or earlier	Active	Active	Water levels	6433648	1975837	1528						0	
SCWC-Lost Canyon 2	Santa Clara River	A1c3	No	Yes	1965	Active	Active	Municipal supply	6433582	1975573	1530	310	95	125	Factory	Rotary	30	295
7177B	Santa Clara River	A1b1	No	Yes	1949 or earlier	Active	Active	Water levels	6434745	1976476	1542						0	
7177P	Santa Clara River	A1b1	Yes	No	---	Active	Active	Water levels	6434036	1976556	1542						0	
7187C	Santa Clara River	A1b2	Yes	No	---	Active	Active	Water levels	6435847	1977582	1548						0	
7197	Santa Clara River	A1b2	Yes	Yes	1945 or earlier	Active	Destroyed?	Water levels	6437790	1977821	1579						0	
7197D	Santa Clara River	A1b2	No	Yes	---	Active	Active	Water levels	6438053	1977798	1582						0	
NCWD-Pinetree1	Santa Clara River	A1b2	No	Yes	1966	Active	Active	Municipal supply	6439881	1977964	1588	235	50	210			20	160
7197G	Santa Clara River	A1b2	Yes	No	1974 or earlier	Active	Active	Water levels	6440544	1978061	1600						0	
Alluvial Aquifer along Castaic Creek																		
VWC-D	Castaic Creek	C2b	No	Yes	1950	Active	Active	Municipal supply	6375668	1987267	1036	142	60	136	Knife cut		50	100
6993A	Castaic Creek	C2b	Yes	Yes	1958 or earlier	Active	Active	Water levels	6377865	1992457	1067						0	
6981D	Castaic Creek	C2a	Yes	Yes	1972 or earlier	Active	Active	Water levels	6376437	2000534	1127						0	
NCWD-Castaic3	Castaic Creek	C2a	No	Yes	1961	Active	Active	Municipal supply	6376475	2002309	1141	135	55	136				100
6980E	Castaic Creek	C2a	No	Yes	1962 or earlier	Active	Active	Water levels	6376282	2002242	1144						0	
6980G	Castaic Creek	C2a	Yes	No	1962 or earlier	Active	Destroyed?	Water levels	6376020	2002731	1151						0	

TABLE 4-1

Target Wells for Calibration of the Regional Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River																		
VWC-W6	San Francisquito Canyon	B4c	Yes	Yes	1952	Active	Active	Municipal supply	6393801	1985449	1159	158	90	153	Knife cut		50	100
7066D	Bouquet Canyon	B2c	Yes	Yes	---	Active	Active	Water levels	6400238	1979734	1182						0	
7086B	Bouquet Canyon	B2c	Yes	No	---	Active	Active	Water levels	6405151	1981611	1247						0	
SCWC-Clark	Bouquet Canyon	B2c	No	Yes	1946	Active	Active	Municipal supply	6405894	1983061	1257	160	20	120	Knife cut	Unknown		110
7095	Bouquet Canyon	B2b	Yes	No	1930 or earlier	Active	Active	Water levels	6409922	1986103	1323	146					0	
7188A	Sand Canyon	A3b	No	Yes	1952	Active	Active	Water levels	6434878	1972313	1588						0	
Saugus Formation																		
VWC-160	Santa Clara River	E	Yes	Yes	1964	Active	Active	Municipal supply	6388950	1976191	1101	2000	950	2000	Louvers	Rotary	65	260
7048C	Santa Clara River	E	Yes	Yes	1981	Active	Destroyed?	Water levels	6395222	1974491	1147						0	
VWC-157	S. Fork Santa Clara River	E	Yes	Yes	1962	Active	Active	Municipal supply	6395696	1974099	1151	2008	586	2008	Vertical slots	Rotary	15	340
VWC-201	S. Fork Santa Clara River	E	No	Yes	1989	Not Built	Active	Municipal supply	6394125	1973032	1152	1690	540	1670	Louvers	Mud rotary	460	360
SCWC-Saugus1	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6397847	1973452	1162	1640	490	1620	Wire wrap screen	Reverse	450	500
SCWC-Saugus2	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6398514	1972540	1158	1612	490	1591	Wire wrap screen	Reverse	460	500
NCWD-11	S. Fork Santa Clara River	F	Yes	Yes	1973	Active	Active	Municipal supply	6399004	1968019	1187	1136	200	1075	Louvers	Reverse rotary	150	340
NCWD-13	S. Fork Santa Clara River	F	No	Yes	1990	Not Built	Active	Municipal supply	6399098	1967327	1194	1300	420	750			50	445
NCWD-12	S. Fork Santa Clara River	F	Yes	Yes	1985	Inactive	Active	Municipal supply	6399282	1965920	1206	1340	485	1280	Louvers	Reverse rotary	420	400
NCWD-10	S. Fork Santa Clara River	F	Yes	Yes	1961	Active	Inactive	Municipal supply	6399388	1965803	1207	1555	780	1544	Louvers	Rotary	114	335
5851	S. Fork Santa Clara River	F	Yes	Yes	1968	Active	Active	Water levels	6396468	1962533	1233						0	
5851A	S. Fork Santa Clara River	F	Yes	No	1968	Active	Active	Water levels	6396432	1962504	1233						0	
5842F	S. Fork Santa Clara River	A	Yes	No	1974	Active	Active	Water levels	6395286	1960869	1248						0	
NCWD7	S. Fork Santa Clara River	F	Yes	Yes	1954	Active	Inactive	Municipal supply	6401264	1962732	1251	994	520	974	Knife cut	Cable tool		306
5841	S. Fork Santa Clara River	F	Yes	No	1973	Active	Active	Water levels	6393394	1963704	1256						0	
5871D	S. Fork Santa Clara River	F	Yes	No	1948 or earlier	Active	Active	Water levels	6402392	1962734	1262						0	
7053C	San Francisquito Canyon	D	Yes	No	---	Active	Destroyed?	Water levels	6397679	1992663	1291						0	
5882	S. Fork Santa Clara River	A	Yes	No	1931 or earlier	Active	Active	Water levels	6406409	1957586	1327						0	
5873E	S. Fork Santa Clara River	A	Yes	No	1957	Active	Active	Water levels	6403977	1957147	1353						0	
NCWD-9	S. Fork Santa Clara River	A	Yes	Yes	1958	Active	Inactive	Municipal supply	6404122	1956997	1354	675	311	674	Louvers	Rotary	75	230
5831	S. Fork Santa Clara River	A	Yes	No	1962	Active	Active	Water levels	6391103	1961398	1381						0	
7053D	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6398984	1990433	1402						0	
5912A	S. Fork Santa Clara River	A	Yes	No	1948 or earlier	Active	Active	Water levels	6414810	1960110	1445						0	
7043C	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6392762	1994816	1528						0	

[a]Coordinates are listed in California State Plane, NAD83 Datum, Zone V.

Notes:

Wells without owner designations belong to the Los Angeles County Flood Control District (LACFCD).

-- = No data available.

N. = nouth.

S. = south.

Figures

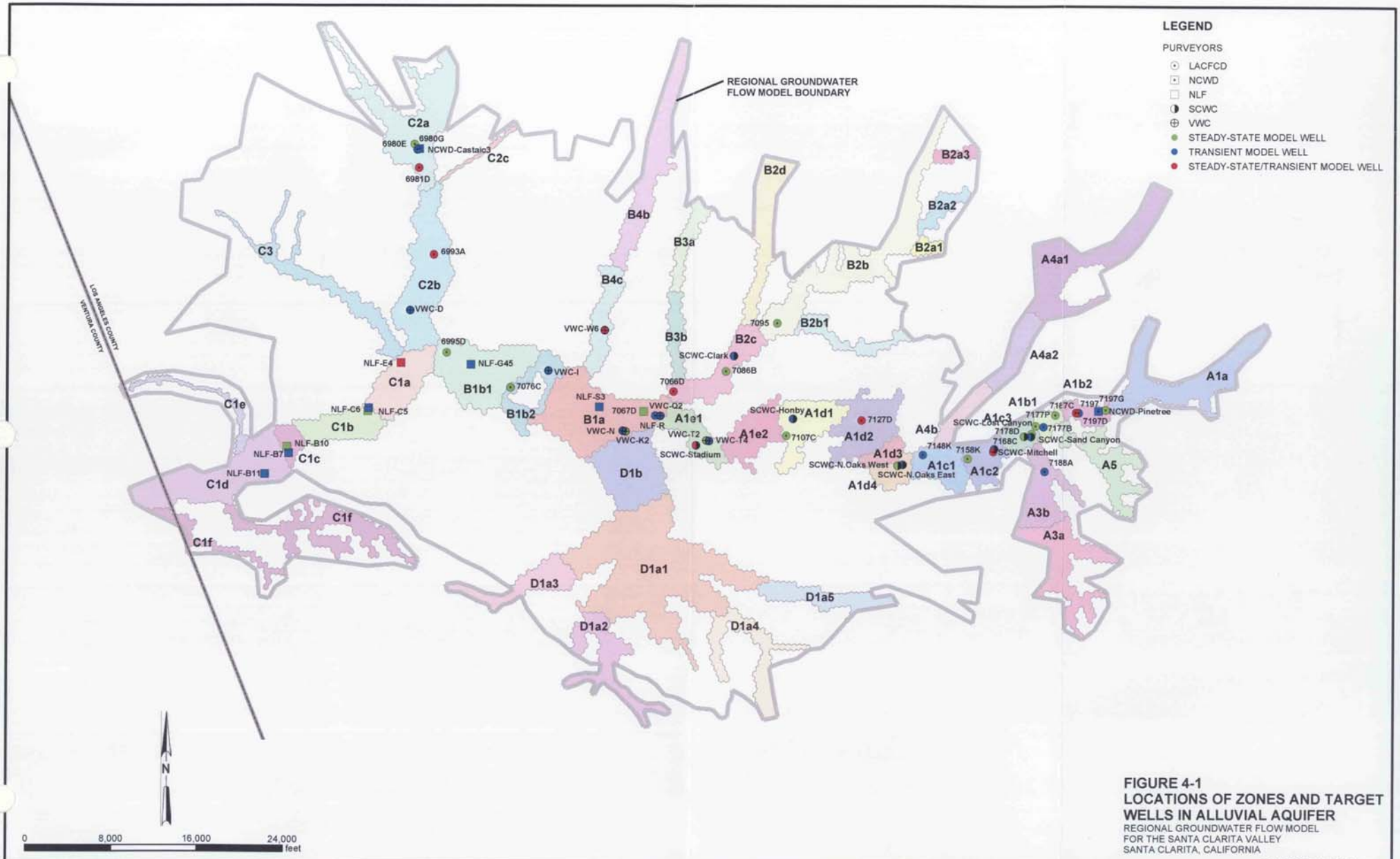


FIGURE 4-1
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG04-01.MXD FIG04-01.PDF 01/22/2004 14:54:39

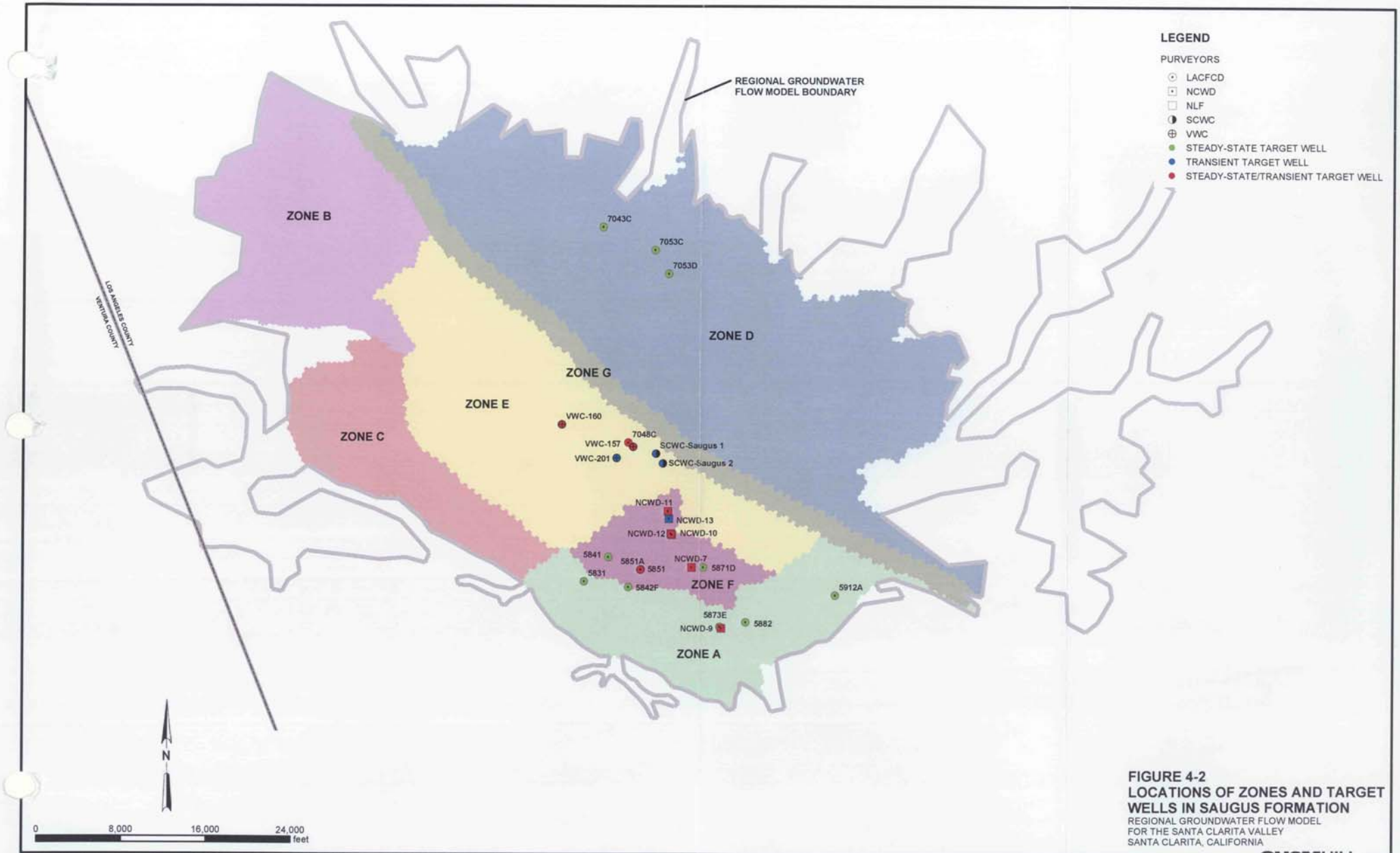

FIGURE 4-2
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 5

Calibration Results and Sensitivity Analysis

This section of the report presents the calibrated Regional Model and a sensitivity analysis of the Regional Model. Sections 5.1 and 5.2 discuss the calibration quality of the steady-state and transient models (respectively) with reference to the calibration goals discussed in Section 4.2. Section 5.3 discusses the groundwater budgets for both models. Section 5.4 describes a sensitivity analysis that further evaluated calibration quality by comparing the sensitivity of the model-predicted groundwater elevations and river flows to the values of key model parameters.

The distribution of Kh in the calibrated model is presented on Figures 5-1 through 5-7 for model layers 1 through 7, respectively. Table 5-1 summarizes the values of transmissivity, thickness, and hydraulic conductivity in the 48 alluvial zones. Table 5-2 summarizes values of the other calibrated hydraulic properties that are used in the model.

5.1 Calibration Results for the Steady-State Model

Following are discussions of how the calibrated model compares with the six calibration goals established for the 1980 through 1985 steady-state model.

5.1.1 Groundwater Flow Directions – Calibration Goal 1

Figure 5-8 shows simulated groundwater elevations and flow directions in the Alluvial Aquifer as computed by the steady-state model. The groundwater flow directions are from east to west along the Santa Clara River, which is in agreement with published contour maps for the Alluvial Aquifer (see Figure 2-7). The contours show a very flat hydraulic gradient in the lower reach of the valley containing the South Fork Santa Clara River, which also agrees with published interpretations.

Figures 5-9 through 5-14 show groundwater elevation contour maps for layers 2 through 7 of the Regional Model, which represent the Saugus Formation. Layer 3 (Figure 5-10) is situated from 500 feet bgs to 1,000 bgs and is partially or fully screened by several of the Saugus production wells that are situated in the valley containing the South Fork Santa Clara River. In this area, the model-simulated flow directions in layer 3 are in good general agreement with published interpretations (see Figure 2-8).

5.1.2 Groundwater Elevation Residuals – Calibration Goal 2

Figure 5-15 is a scatter plot comparing simulated and observed average groundwater elevations for target wells in both the Alluvial Aquifer and the Saugus Formation. For a perfect simulation, each point shown on the figure would lie on the diagonal line. The figure shows that the Alluvial Aquifer target wells lie very close to the diagonal line, indicating a very good calibration to the observed average groundwater elevations from 1980 through 1985. For the Saugus Formation, there is greater variability. Some Saugus wells plot very close to the diagonal line, while one well (5882) lies 80 feet above the line and another well

(5831) lies 80 feet below the line. These two particular wells are near the southern model boundary, where the available water level data indicate that the groundwater gradients in the Saugus are very steep compared to areas closer to the Saugus production wells. Nonetheless, the Saugus wells are generally close to the diagonal line and do not plot consistently above or consistently below the line, indicating that the Saugus Formation is closely calibrated in the steady-state model.

Table 5-3 lists the residuals for Alluvial and Saugus wells. The residuals are also plotted on Figures 5-16 through 5-19. Positive residuals indicate that the Regional Model over-predicts the groundwater elevation, and negative residuals indicate that it under-predicts the groundwater elevation. Observations regarding the residuals are as follows:

a. Figure 5-16 shows the magnitudes of the groundwater elevation residuals for the 21 target wells in the Alluvial Aquifer that lie along the Santa Clara River. The plot shows the target wells in order from the downstream end of the valley (left side) to the upstream limit of the valley (right side). The plot shows that 13 of the 21 wells have residuals in the range of –5 to +5 feet, and that only one well (7158K) does not meet the 10-foot residual criterion for Goal 2. The plot also shows little, if any, spatial bias in the direction of the residuals; specifically, long reaches of the river do not show consistently positive or consistently negative residuals. Consequently, the groundwater elevations are very well calibrated along the Santa Clara River.

b. Figure 5-17 shows an equivalent plot for Alluvial Aquifer wells located in three of the tributary canyons. In these areas, where gradients are steep, the modeled groundwater elevations are generally within 10 to 11 feet of the average measured elevations. The plot indicates a tendency to slightly under-predict groundwater elevations, particularly in the upper-most reach of Bouquet Canyon, but the residuals generally meet the criterion for Goal 2.

c. Figures 5-18 and 5-19 show similar residual plots for production wells and for LACFCD monitoring wells, respectively, in the Saugus Formation. Three of the seven production wells meet the 25-foot residual criterion for Goal 2, and three of the monitoring wells meet this criterion. Both plots indicate a tendency to under-predict static groundwater elevations, particularly in four wells that are near the outer limits of the Saugus Formation (wells NCWD-9, 5831, 7043C, and 7053D). However, the water levels in these four wells appear to be anomalously high, compared with the water levels in surrounding wells. Consequently, the water level data indicate that these wells (particularly the three LACFCD wells) are constructed in perched Saugus zones lying above the regional Saugus aquifer system, and the negative residuals at these wells correspond to the anomalously high groundwater elevations. Excluding these four wells, three of the six production wells and five of the ten LACFCD monitoring wells meet the Goal 2 criterion, indicating that the steady-state calibration of the Saugus Formation is adequate, particularly because the focus of the model calibration effort is transient calibration, which is discussed in Section 5.2.

5.1.3 Statistics of Groundwater Elevation Residuals – Calibration Goal 3

Table 5-4 lists the residual statistics for target wells in both aquifer systems. The table shows statistics for the same wells listed in Table 5-3 and shown on Figures 5-16 through 5-19,

except for Saugus wells 5831, 7043C, and 7053D. Table 5-4 shows that the residual statistics for the Alluvial Aquifer generally meet the criteria specified in Goal 3. For the Saugus Formation, the statistics meet the mean residual criterion, but the statistics for the square of the residuals are slightly above the criteria of (1) less than 25 feet for RMS error or (2) 10 percent or less for normalized RMS error. The Regional Model as a whole, however, with the Alluvial Aquifer and Saugus Formation combined, meets all Goal 3 criteria.

5.1.4 Groundwater Gradients – Calibration Goal 4

In the Alluvial Aquifer, the results for the first three calibration goals indicate that the steady-state model simulates groundwater gradients quite well, and therefore meets Goal 4.

For the Saugus Formation, the residuals for the NCWD wellfield in the South Fork Santa Clara River are consistently negative. However, the residual at the upgradient end of the wellfield at NCWD-7[5] is similar in magnitude to the average residual at the downgradient end of the wellfield at NCWD-10 and NCWD-11. Consequently, the gradients in this area are simulated reasonably well. Simulated gradients from the NCWD wellfield to the downgradient well VWC-160 are slightly low, as suggested by the more negative residuals in the NCWD wellfield and the less negative residual at VWC-160.

Additionally, recent water level data from the Whittaker-Bermite property indicate that the gradients are well simulated within the Saugus Formation in that area, which lies east and northeast of NCWD's wellfield. Table 5-5 shows the calculations of the model-simulated and measured groundwater gradients between wells MP-1 and MP-2, which are both on the downthrown side of the San Gabriel fault, and between MP-2 and MP-3, which are located on the downthrown side and upthrown side of the fault, respectively. These calculations are based on three rounds of manual water level measurements that were taken from January through October in 2003. Between wells MP-1 and MP-2, the gradients are almost perfectly matched. However, across the San Gabriel fault, the modeled gradient is approximately half as large as the measured gradient because the simulated groundwater elevation is low at MP-3.

Several attempts were made during model calibration to reduce the Saugus permeability to very low levels across the fault, but no further increases in MP-3 water levels could be obtained. The calibrated Regional Model uses a permeability along the fault that is between 100 and 1,000 times lower than the permeability of adjoining Saugus areas. Although the Regional Model was unable to simulate as high a groundwater elevation as has been measured recently at MP-3, it does simulate a substantial drop in groundwater elevations across the San Gabriel fault, which is consistent with the understanding of the limited hydraulic connection across the fault (see Section 2.4.2 and Figure 2-9). Therefore, the Regional Model is well calibrated across the fault because it simulates the permeability differences that exist on each side of the fault and also simulates the very limited movement of groundwater across the fault that is indicated by the significant difference in groundwater elevations that has been measured in the multi-port wells on each side of the fault.

[5] Well NCWD-9 is located farther upgradient, but has been used only sparingly since 1987.

5.1.5 Groundwater Below Ground Surface – Calibration Goal 5

Groundwater elevations simulated by the steady-state model are below ground surface at all non-stream nodes and in each tributary stream. Along the Santa Clara River, a small number of nodes showed groundwater elevations above the streambed in the western portion of Soledad Canyon, and also at and immediately upstream of Round Mountain, a Saugus outcrop that likely lies at shallow depths beneath the river itself. The reach of the river west of I-5 was calculated to be predominantly gaining (groundwater above ground surface). However, the Regional Model predicts that the river is losing over a reach extending between approximately 0.75 mile upstream to 0.5 mile downstream of the location where the river crosses over the western limit of the Saugus Formation. In this area, the riverbed has a gentler slope than in adjoining areas, and the riverbed does not lie beneath the water table in this particular reach.

5.1.6 Groundwater Discharge to River – Calibration Goal 6

The model-simulated groundwater discharge to the river was 28,600 AF/yr, which closely agrees with the 29,000 AF/yr value estimated from the hydrograph separation process described in Section 2.6.2.5.

5.2 Calibration Results for the Transient Model

Following are discussions of how the calibrated Regional Model compares with the four calibration goals established for the 1980 through 1999 transient model.

5.2.1 Groundwater Elevation Trends/Hydrographs – Calibration Goal 1

Trends in groundwater elevations are discussed for the following areas:

a. The Alluvial Aquifer along the Santa Clara River, west of I-5, as shown on Figure 5-20

b. The Alluvial Aquifer along the Santa Clara River, between I-5 and Soledad Canyon, as shown on Figure 5-21

c. The Alluvial Aquifer along the Santa Clara River in Soledad Canyon, as shown on Figure 5-22

d. The Alluvial Aquifer along Castaic Creek, as shown on Figure 5-23

e. The Alluvial Aquifer in other tributary canyons to the Santa Clara River, as shown on Figure 5-24

f. The Saugus Formation, where targets are located along the South Fork Santa Clara River, as shown on Figure 5-25

As discussed in Section 4.4.1, the calibration goal at target production wells was to simulate groundwater elevations that were higher than the pumping elevations and as close as possible to the static elevations. Therefore, the hydrographs show the model-simulated groundwater elevations, the measured static groundwater elevations, and, for production wells, the measured pumping groundwater elevations.

5.2.1.1 Alluvial Aquifer West of I-5

Modeled and measured groundwater elevations both show long-term stability, with no significant increases or decreases during the 1980 through 1999 transient calibration period. The Regional Model simulates somewhat greater seasonal variation in groundwater elevations than is suggested by the field measurements. However, the field measurements were collected infrequently. In general, the Regional Model is well calibrated in this area because of the close match between simulated and measured groundwater elevations and because it simulates the long-term stability of groundwater elevations in this area.

5.2.1.2 Alluvial Aquifer Between I-5 and Soledad Canyon

North of the Santa Clara River, near the mouth of San Francisquito Canyon, the Regional Model simulates the observed trends in static groundwater elevations at wells NLF-S3 and VWC-I during the period that data are available. The groundwater elevation trends are particularly well simulated at VWC-I starting in mid-1996, when the water level measurement frequency increased at this well.

Just upstream and along the south side of the river, the Regional Model simulates the trends in static water levels at well VWC-N very closely throughout the 20-year simulation period. The Regional Model also simulates the trends in static water levels quite well at well VWC-Q2, near the mouth of Soledad Canyon. In this same area, monitoring well 7067D simulates groundwater elevations that are somewhat lower than measured elevations, and the 40-foot fluctuation in simulated water levels at this well is of a generally similar magnitude as the observed fluctuation of 50 feet.

5.2.1.3 Alluvial Aquifer In Soledad Canyon

At wells throughout Soledad Canyon, the Regional Model closely simulates the regional decline in groundwater elevations during the late 1980s and early 1990s. The simulated and measured declines are especially close for wells in the eastern portion of this area, such as SCWC-North Oaks, SCWC-Mitchell, SCWC-Lost Canyon 2, and NCWD-Pinetree1.

Although the sharp increases in groundwater elevations in 1992 and 1993 are modeled well, these same wells (in the eastern half of Soledad Canyon) are unable to maintain high enough groundwater elevations during short dry periods that occur intermittently from 1993 through 1999. During this period, wells further to the west, such as SCWC-Stadium, VWC-T2, SCWC-Honby, and 7127D show better matches between modeled and measured groundwater elevations. Many model runs were performed to try to maintain higher water levels in eastern Soledad Canyon, but no substantial improvements could be made, suggesting that the lack of stream gage data at the Lang gage during this period may be responsible for the discrepancies.

A visual inspection of the former Lang gage station was conducted on July 17, 2003 during the model calibration process. The equipment that records the depth of water in the river was observed to be approximately 3 to 4 feet above the bed of the river at the time of the inspection. Although high river flows are known to have occurred since the time the gage was abandoned, it is unlikely that the bed elevation would have been lowered 3 or 4 feet by the net sediment scouring and redeposition processes that occur during high river flows. This observation means there likely was more flow occurring in the river prior to October

1989 than was recorded by this gage. This in turn means that measured and estimated flows during the period 1980 through 1999 are likely too low in the Regional Model, which would explain the model's simulation of too rapid a decline in water levels after high river flows recharge the aquifer. In summary, the design of the gage and the absence of data after October 1989 are the likely reasons that the Regional Model has difficulty maintaining sufficiently high groundwater elevations during dry periods in the eastern portion of the Alluvial Aquifer.

5.2.1.4 Alluvial Aquifer Along Castaic Creek

In the upper reaches of the Castaic Creek valley, the Regional Model simulates the measured groundwater elevation trends very well during the drought at wells NCWD-Castaic3, 6980E, and 6980G, though this evaluation is somewhat uncertain during the early 1980s due to infrequent data collection. However, these same wells show too much recovery during the initial post-drought recovery period in 1992, and they also show a small rise in groundwater elevations from 1993 through 1999 that is not indicated by the field measurements.

Farther downstream, the Regional Model closely matches the measured groundwater elevation trends at well 6993A well until the last few years of the drought, when groundwater elevations do not drop sufficiently. Well VWC-D (farther downstream) is modeled even better, but also shows a bit too much fluctuation during the mid- and late 1990s.

5.2.1.5 Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River

At production well VWC-W6 in the lower reaches of San Francisquito Canyon, the Regional Model appears to simulate the measured groundwater elevations well, except for a possibly insufficient decline in early 1992 at the conclusion of the regional drought.

In Bouquet Canyon, the Regional Model closely simulates the measured groundwater elevation changes at the SCWC-Clark production well, although the groundwater elevations are a bit high throughout the simulation. The groundwater elevation trends are also well simulated farther downstream at monitoring well 7066D, though the groundwater elevations are somewhat under-predicted throughout the simulation.

In Sand Canyon, the simulation at monitoring well 7188A is good, although there is some uncertainty at the end of the drought due to the lack of data collection during 1990 and 1991.

5.2.1.6 Saugus Formation

In general, the Regional Model simulates the trends in groundwater elevations quite well at each Saugus production and monitoring well. Simulated and measured static groundwater elevations agree particularly well in the NCWD wellfield at the observation well (5851) and each NCWD production well.

Farther downgradient, the model tends to slightly over-predict groundwater elevations in the VWC and SCWC production wells (VWC-157, VWC-201, SCWC-Saugus1, and SCWC-Saugus2) and slightly under-predict groundwater elevations in the lone monitoring well (7048-C). However, the Regional Model closely simulates the groundwater elevation trends

at each of these locations, which is the primary consideration for evaluating the quality of the transient calibration process in the Saugus Formation.

5.2.2 Groundwater Below Ground Surface – Calibration Goal 2

This goal was met at each target in the transient model. Of the 44 transient model target wells, 11 had simulated groundwater elevations within 5 feet of ground surface during the wettest periods of the model simulation. Three of these wells were located in the Castaic Valley (6980E, 6981D, and NCWD-Castaic3), one was in lower Sand Canyon (7188A), one was in Bouquet Canyon (SCWC-Clark), and six were in Soledad Canyon (VWC-T2, 7127D, SCWC-Mitchell, SCWC-Lost Canyon 2, 7177B, and NCWD-Pinetree1).

5.2.3 Total River Flow at County Line Gage – Calibration Goal 3

Figure 5-26 compares the modeled and measured total flows of the Santa Clara River at the County Line gage. The figure contains both a linear plot and a semi-logarithmic plot to better illustrate how the modeled and measured flows compare during low flow periods in the river.

Figure 5-26 also shows that the Regional Model adequately replicates seasonal cycles of low and high river flows. Prior to 1992, peak flows during the wettest months tend to be somewhat underestimated, probably because of under-predicted flow in the streams rather than insufficient groundwater discharge to the river. From 1992 through 1997, peak flows match well, but they are again underestimated in 1998 and 1999.

Seasonal low flows, during the summer months, are slightly over-predicted. In years such as 1990, the model over-estimates river flows by approximately 100 to 200 acre-feet per month. In other years, the Regional Model over-estimates the river flows by as much as 1,000 acre-feet per month. To evaluate this further, the estimated and model-simulated groundwater discharges to the river were compared, as discussed below.

5.2.4 Groundwater Discharge to River – Calibration Goal 4

Figure 5-27 compares the model-simulated groundwater discharges to the river with the discharges that have been estimated from hydrograph separation techniques (see Section 2.6.2.5). Because of uncertainty in the amount of treated water that infiltrates the streambed, Figure 5-27 displays a range for the estimated values, varying according to how much of the Saugus WRP treated water is estimated to infiltrate to groundwater as it travels down the Santa Clara River. For the purposes of this comparison, it was estimated that the infiltration could be negligible (blue line) and would be unlikely to exceed 75 percent of the Saugus WRP discharge (green line).

Figure 5-27 shows that the Regional Model simulates the patterns of groundwater discharges well. The Regional Model predicts lower groundwater discharge rates during high flow/high water table periods than were estimated from the hydrograph separation technique, but model uncertainty may not be the cause of this difference. It is equally, if not more, likely that the difference is due to the significant uncertainties associated with the hydrograph separation process during periods of high river flows. Specifically, as discussed in Section 2.6.2.5, it is difficult to determine how much of the receding flow after peak flow

events is due to groundwater discharges versus continued stormwater drainage from within the basin or from upstream watersheds.

Figure 5-27 also shows that the Regional Model tends to predict higher rates of groundwater discharge during dry periods than estimated from the County Line gage. This is consistent with the Regional Model's over-prediction of total river flows, but anecdotal observations at the former gaging station site during low flow periods indicate that the river sometimes carved small channels that diverted a portion of the flow away from the gage, where it could not be measured. Consequently, the differences between modeled and measured total river flows and measured versus estimated groundwater discharges result from uncertainties in both the Regional Model and the gage data.

5.3 Groundwater Budget

Table 5-6 summarizes the groundwater budget for the 1980 through 1985 steady-state model. The values in the table are the average groundwater recharge and discharge rates in AF/yr during this period. As shown in the table, the majority of the recharge occurs from direct rainfall and stormwater flows, with irrigation and Castaic Lake underflow each comprising a very small portion of the total basin recharge. Groundwater discharge during this time period was approximately one-third pumping and one-third discharge to the Santa Clara River, with the rest consisting of subsurface outflow and ET. The table shows that ET is an important part of the groundwater budget, 15 percent of the total groundwater discharge in the basin.

Table 5-7 summarizes the groundwater budget for each year of the 20-year transient model simulation period (1980 through 1999). Figures 5-28 and 5-29 show the annual groundwater recharge and groundwater discharge rates, respectively. Figure 5-30 shows the change in groundwater storage each year, and Figure 5-31 shows the cumulative change in groundwater storage during the simulation period.

As is evident from Figure 5-28, recharge from precipitation and streamflows varies considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to over 100,000 AF/yr in wetter years. In fact, for the five wettest years during this period, the model estimates that groundwater recharge ranged between 175,000 AF/yr and 270,000 AF/yr. In contrast, total groundwater discharges have been less variable (Figure 5-29), ranging from approximately 61,000 AF/yr at the end of the drought in the late 1980s through early 1990s to 116,000 acre-feet during 1998. Table 5-7 and Figure 5-29 together show that this variability in groundwater discharge does not follow the year-to-year pumping patterns, but instead is caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlate well with groundwater recharge patterns. For example, groundwater discharge rates increase during or immediately after significant rainfall years in 1983, 1992 through 1993, 1995, and 1998, and subsequently decrease in response to below-normal precipitation in the ensuing 1 to 2 years. This indicates that the predominant factors influencing changes in storage and groundwater discharge are the local rainfall recharge and stream recharge patterns from year to year, with anthropogenic influences (pumping and irrigation) having a smaller effect on the groundwater system. This is reinforced by Figures 5-30 and 5-31, which show that changes in groundwater storage volumes reflect year-to-year variations in regional rainfall.

5.4 Sensitivity Analysis

Sensitivity analyses were performed on the calibrated Regional Model to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the model. The sensitivity analyses focused on the transient model. Following is a description of the design of the analyses and the findings.

5.4.1 Method of Sensitivity Analysis

Analysis focused on identifying the sensitivity of the transient model to Kh and Kv for both aquifer systems, the permeability of the bed of the Santa Clara River, and, to a lesser degree, the ET parameters.

To perform the analysis, one model variable, or group of variables, was varied upward or downward, and the model was run again. The amount by which each model variable was adjusted upward or downward was based on the range of values that was considered to be plausible for the variable, according to the data analysis that was conducted in support of development of the hydrogeologic conceptual model for the valley, which is described in Section 2 of this report. The following pairs of sensitivity runs were performed:

a. Adjusting the Kh. This parameter was multiplied and divided by a factor of 1.5 in all model layers. The R (Kh:Kv) was left unchanged for these runs, but the change in Kh caused a change in Kv values.

b. Adjusting the R upward or downward by a factor of 4.0. This caused changes to Kv, but not to Kh.

c. Adjusting the storage parameters. In model layer 1, the Sy was adjusted from the calibrated model value of 0.10 to 0.075 and 0.15. In model layers 2 through 7, the storativity was adjusted from the calibrated model value of 5×10^{-4} to values of 1×10^{-4} and 1×10^{-3}. The reductions to Sy and storativity were run simultaneously in a single model run, and the increases in Sy and storativity were run simultaneously in a single model run.

d. Adjusting the riverbed leakage terms at drain and wadi nodes in the Santa Clara River and Castaic Creek. These terms were multiplied and divided by a factor of 10.

e. Adjusting the ET parameters in a way that produced less ET. In one run, the maximum evaporation depth was changed from 10 feet to 5 feet. In another run, the maximum evaporation rate was changed from 6 ft/yr to 3 ft/yr.

5.4.2 Sensitivity Analysis Results

The results of the focused sensitivity analysis are presented as time-series plots of water levels and groundwater discharges to the river. Results are first presented for the aquifer hydraulic parameters (Kh, R, Sy, and storativity), then for the riverbed permeability and ET terms.

5.4.2.1 Sensitivity of Groundwater Elevation Trends to Aquifer Parameters

Figures 5-32 through 5-38 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in Kh, R, and Sy. Figures 5-39 through 5-43 show the same information for three Saugus production wells and two Saugus monitoring wells. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western part of the basin (NLF-B7 and NLF-G45) show slight sensitivity to the choice of Kh, and little sensitivity to R and Sy. Lower Kh values would degrade the calibration quality of the Regional Model, whereas the tested ranges of the other parameters would have little effect on calibration quality.

b. Further east, VWC-N shows greater sensitivity to each parameter, though it is relatively insensitive to lower Kh values. Lower Kh values or changes to R values would not degrade calibration quality, whereas other parameter changes could potentially degrade the calibration.

c. Results are similar in Soledad Canyon at SCWC-Stadium, SCWC-North Oaks East, and NCWD-Pinetree1. Higher Kh values substantially degrade the calibration quality of the transient model at each of these wells.

d. The transient model was slightly to moderately sensitive to the choice of Alluvial Aquifer Kh in Castaic Creek at well VWC-D. In this area, it showed little sensitivity to R or Sy in the Alluvial Aquifer. The results suggest that higher K values could slightly improve the calibration.

e. Water levels at Saugus production wells along the lower reaches of the South Fork Santa Clara River (VWC-201 and SCWC-Saugus2) are sensitive to the choice of R, moderately sensitive to the choice of Kh, and comparatively insensitive to storativity. The transient model is more sensitive to Kh and storativity at nearby monitoring well 7048C than at the pumping wells. The plots generally indicate the model is well calibrated, although small decreases in Kh might slightly improve the calibration quality.

f. Similar results are seen for production well NCWD-11 and monitoring well 5851 farther upstream in the South Fork Santa Clara River valley. At NCWD-11, the R appears to be particularly well calibrated, as lower values cause groundwater elevations to fluctuate insufficiently, and higher values cause too much fluctuation, and in some cases, model-simulated water levels that are below pumping levels. Changes to Kh would not improve the model, and could in fact degrade it at the monitoring well.

5.4.2.2 Sensitivity of Groundwater Elevation Trends to River and Evapotranspiration Parameters

Figures 5-44 through 5-50 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in the riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figures 5-51 through 5-55 show the same information for the three Saugus production wells and two Saugus monitoring wells discussed in Section 5.4.2.1. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western and central parts of the basin (NLF-B7, NLF-G45, and VWC-N) and along Castaic Creek (VWC-D) are sensitive to the choice of the riverbed K for the drain and wadi nodes. Reduced conductivity values notably increase the groundwater elevations at some wells, while higher values somewhat decrease groundwater elevations. The plots suggest that changes to this term would not improve calibration quality and could substantially degrade the calibration at some of these wells. Further east, in Soledad Canyon, the Regional Model is relatively insensitive to riverbed K in the gaining reaches of the Santa Clara River.

b. Reductions in drain and wadi riverbed K increase groundwater elevations by raising groundwater elevations in the Alluvial Aquifer, to which the Saugus discharges. Decreased riverbed permeability backs up water in the Alluvial Aquifer, and hence in the Saugus Formation. Changes to riverbed permeability do not improve Saugus calibration.

c. Groundwater levels in both the Alluvial Aquifer and the Saugus Formation are insensitive to the choice of ET parameters.

5.4.2.3 Sensitivity of Groundwater Discharge to the River to Changes in Aquifer Parameters

Figures 5-56 shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in K, R, and Sy. The plots show that the model-calculated discharge to the river is sensitive to Kh, but not to R or Sy. A reduction in Alluvial Aquifer Kh would improve the calibration quality during seasonal or longer dry periods, but at the expense of degrading the calibration during the rainfall season for all but the wettest years. Increasing the Kh would slightly increase the predicted discharges during seasonal or longer dry periods.

5.4.2.4 Sensitivity of Groundwater Discharge to the River to Changes in River and Evapotranspiration Parameters

Figure 5-56 also shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figure 5-56 shows that a lower riverbed permeability would improve calibration during seasonal and longer dry periods, but notably degrade calibration during all rainfall periods. Figure 5-56 shows that reducing the ET extinction depth from 10 feet to 5 feet has little effect on model-calculated discharge to the river, while reducing the maximum ET rate slightly increases the model-calculated discharge.

5.5 Conclusion

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use.

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property).

c. Its use of an integrated model of the watershed (the SWRM) to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system.

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

Tables

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
A1a	Santa Clara River below Lang gage	9,000 to 25,500	300	30 to 85
A1b2	Santa Clara River below A1a	31,500	350	90
A1b1	Santa Clara River below A1b2	31,500	350	90
A1c3	Santa Clara River below A1b1	36,000	400	90
A1c2	Santa Clara River below A1c3	49,500	550	90
A1c1	Santa Clara River below A1c2	49,500	550	90
A1d4	Santa Clara River below A1c1	49,500	550	90
A1d3	Santa Clara River below A1d4	16,500	550	30
A1d2	Santa Clara River below A1d3	60,500	550	110
A1d1	Santa Clara River below A1d2	49,500	550	90
A1e2	Santa Clara River below A1d1	63,250	550	115
A1e1	Santa Clara River below A1e2	63,250	550	115
B1a	Santa Clara River at South Fork mouth	54,375 to 79,750	375 to 550	145
B1b2	Santa Clara River below B1a	22,500	375	60
B1b1	Santa Clara River below Bb2	63,250	550	115
C1a	Santa Clara River below B1b1	71,500	550	130
C1b	Santa Clara River below C1a	60,500	550	110
C1c	Santa Clara River below C1b	60,500	550	110
C1d	Santa Clara River below C1c	60,500	550	110
D1b	Lower South Fork Santa Clara River	12,600	105	120
D1a1	Upper South Fork Santa Clara River	5,775	105	55
D1a2	Gavin Canyon	15	0.75	20
D1a3	Pico Canyon	15	0.75	20
D1a4	Newhall Canyon	15	0.75	20
D1a5	Placerita Canyon	200	10	20
A3a	Upper Sand Canyon	1,750	175	10
A3b	Lower Sand Canyon	5,250	105	50
A4a1	Upper Mint Canyon	2,800	140	20
A4a2	Central Mint Canyon	2,100	105	20
A4b	Lower Mint Canyon	13,125	175	75
A5	Oak Spring Canyon	8,750	175	50
B2a1	Unnamed tributary canyon	10,500	105	100
B2a2	Vasquer Canyon	10,500	105	100
B2a3	Texas Canyon	10,500	105	100

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
B2b1	Plum Canyon	10,500	105	100
B2b	Upper Bouquet Canyon	2,625 to 12,600	25 to 90	105
B2c	Lower Bouquet Canyon	22,050	245	90
B2d	Haskell Canyon	6,825	105	65
B3a	Lower Dry Canyon	6,300	105	60
B3b	Upper Dry Canyon	6,300	105	60
B4b	Upper San Francisquito Canyon	6,300	105	60
B4c	Lower San Francisquito Canyon	10,500	105	100
C1e	San Martinez Canyon	5,250	105	50
C1f	Potrero and Salt Canyons	5,250	105	50
C2a	Upper Castaic Creek valley	25,200	315	80
C2b	Lower Castaic Creek valley	35,000	350	100
C2c	Charlie Canyon	10,500 to 17,500	175	60 to 100
C3	Hasley Canyon	3,150	30	105

Notes:

The zones are based on alluvial storage units defined by RCS (1986, 2002).
However, they have been further subdivided in certain areas to facilitate model calibration.

See Figure 4-1 for the locations of the alluvial storage units.

TABLE 5-2
Aquifer Hydraulic Parameters Used in the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Parameter	Aquifer	Value	Comment
Kh	Alluvium	Variable	See Figure 5-1 and Table 5-1.
	Saugus	Variable	See Figures 5-2 through 5-7.
R (Kh:Kv)	Alluvium	10:1	Derived during model calibration process.
	Saugus	50:1 to 100:1	
Sy	Alluvium and Saugus outcrops	0.10	Derived during model calibration process.
Storativity	Saugus below model layer 1	5×10^{-4}	Derived during model calibration process.
Santa Clara River and Castaic Creek streambed thicknesses	Alluvium	2 feet	Assumed thickness of streambed sediments in gaining river reaches.
Santa Clara River and Castaic Creek streambed Kv	Alluvium	10 ft/day (3.5×10^{-3} cm/sec)	Derived during model calibration process.
ET extinction depth	Alluvium and Saugus	10 feet	Corresponds to typical rooting depth for phreatophytes along Santa Clara River.
Potential ET rate	Alluvium and Saugus	6 ft/yr	Estimated maximum water use by phreatophytes along Santa Clara River.

Notes:
cm/sec = centimeters per second
ET = evapotranspiration

TABLE 5-3

Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Aquifer	Owner	Well Name	Number of Measurements	Measured Groundwater Elevation (feet msl)	Modeled Groundwater Elevation (feet msl)	Residual (Modeled - Measured) (feet)	Residual^2 (ft^2)
Alluvium	NLF	B10	5	890.70	889.51	-1.19	1.42E+00
	NLF	C5	14	940.61	945.04	4.44	1.97E+01
	NLF	E4	4	977.18	977.84	0.67	4.45E-01
	LACFCD	6995D	17	1003.04	998.75	-4.29	1.84E+01
	LACFCD	7076C	5	1037.16	1027.58	-9.58	9.18E+01
	VWC	K2	2	1113.00	1114.36	1.36	1.84E+00
	NLF	R	4	1137.50	1129.94	-7.56	5.72E+01
	VWC	T4	14	1180.20	1187.69	7.49	5.61E+01
	SCWC	Stadium	15	1186.27	1184.41	-1.86	3.44E+00
	LACFCD	7107C	51	1258.45	1256.45	-2.00	4.00E+00
	LACFCD	7127D	66	1315.83	1320.11	4.28	1.83E+01
	SCWC	N.Oaks West	45	1378.61	1373.49	-5.12	2.62E+01
	LACFCD	7158K	13	1427.48	1444.48	17.00	2.89E+02
	LACFCD	7168C	13	1464.85	1465.79	0.94	8.85E-01
	LACFCD	7178B	12	1495.78	1493.56	-2.21	4.90E+00
	SCWC	Sand Canyon	60	1504.32	1503.73	-0.59	3.47E-01
	LACFCD	7178D	12	1499.21	1509.63	10.42	1.09E+02
	LACFCD	7177P	11	1523.64	1514.99	-8.65	7.47E+01
	LACFCD	7187C	16	1526.06	1534.57	8.51	7.24E+01
	LACFCD	7197	13	1560.34	1556.41	-3.93	1.55E+01
	LACFCD	7197G	3	1577.00	1584.72	7.72	5.96E+01
	LACFCD	6993A	12	1042.95	1032.18	-10.77	1.16E+02
	LACFCD	6981D	3	1092.00	1092.24	0.24	5.66E-02
	LACFCD	6980G	10	1110.77	1107.87	-2.90	8.43E+00
	VWC	W6	5	1146.80	1139.03	-7.77	6.04E+01
	LACFCD	7066D	13	1154.92	1158.65	3.72	1.39E+01
	LACFCD	7086B	9	1227.33	1216.15	-11.19	1.25E+02
	LACFCD	7095	11	1297.96	1277.59	-20.38	4.15E+02
Saugus	LACFCD	5841	14	1114.98	1104.27	-10.71	1.15E+02
	LACFCD	5842F	13	1154.65	1111.16	-43.49	1.89E+03
	LACFCD	5851	45	1137.58	1109.08	-28.50	8.12E+02
	LACFCD	5851A	42	1140.77	1109.09	-31.68	1.00E+03
	LACFCD	5871D	13	1138.03	1117.18	-20.85	4.35E+02
	LACFCD	5873E	3	1286.67	1243.22	-43.44	1.89E+03
	LACFCD	5882	11	1251.99	1318.26	66.26	4.39E+03
	LACFCD	5912A	10	1424.13	1441.47	17.34	3.01E+02
	LACFCD	7048C	47	1110.32	1099.48	-10.84	1.17E+02
	LACFCD	7053C	9	1266.52	1267.60	1.08	1.16E+00

TABLE 5-4

Statistics of Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Statistic	Alluvial Aquifer	Saugus Formation	Combined System	Criterion for Goal 3
Target Groundwater Elevations				
Number of Target Wells	28	10	38	---
Maximum Groundwater Elevation	1,577	1,424	1,577	---
Minimum Groundwater Elevation	891	1,110	891	---
Range in Groundwater Elevations	686	314	686	---
Statistics for Residuals				
Mean Residual	-1.19	-10.48	-3.63	As close to zero as possible
Mean Residual / Range in Groundwater Elevations	-0.2%	-3.3%	-0.5%	5%
Standard Deviation of Residuals	7.62	31.39	17.86	---
Standard Deviation of Residuals / Range in Groundwater Elevations	1.1%	10.0%	2.6%	10%
Statistics for Residual^2 Values				
Sum of Residual^2 Values	1,664	10,954	12,617	---
Average of Residual^2 Values	59	1,095	332	---
Root-Mean-Square Error (RMS)	8	33	18	10 feet for Alluvial, 25 feet for Saugus
RMS / Range in GW Elevations	1.1%	10.5%	2.7%	10%

Note:

An entry of --- means no criterion was established.

TABLE 5-5

Comparison of Modeled and Measured Horizontal Hydraulic Gradients for Multi-Port Monitoring Wells Near the San Gabriel Fault

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	MP-3	MP-2	MP-1	MP-2
Modeled Groundwater Elevation (feet)	1,225.52	1,092.02	1,084.78	1,092.02
Measured Groundwater Elevation (feet)	1,304.46	1,074.28	1,066.99	1,074.28
Residual Error (feet)	-78.94	17.74	17.79	17.74
Easting (feet)	6,406,801	6,405,215	6,399,944	6,405,215
Northing (feet)	1,971,284	1,968,850	1,970,850	1,968,850
Distance Between Wells		2,905.13		5,637.68
Difference in Modeled Groundwater Elevations		133.50		-7.24
Difference in Measured Groundwater Elevations		230.18		-7.29
Modeled Horizontal Gradient		-4.60E-02		1.28E-03
Measured Horizontal Gradient		-7.92E-02		1.29E-03
Modeled Gradient / Measured Gradient		0.58		0.99

Notes:

Wells MP-1 and MP-2 are located on the west (downthrown) side of the fault.

Well MP-3 is located on the east (upthrown) side of the fault.

Measured groundwater elevations are the average of measurements from January through July of 2003.

Wells MP-1 and MP-2 are in model layer 4; well MP-3 is in model layer 2.

TABLE 5-6

Groundwater Budget for 1980 through 1985 Steady-State Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Total Recharge	**AF/yr**	**Percent**
Rainfall	35,000	44.8
Streams	38,200	48.8
Irrigation	3,300	4.2
Subsurface Inflow (Castaic)	1,700	2.2
Total	**78,200**	**100.0**

Total Discharge	**AF/yr**	**Percent**
Discharge to Santa Clara River	28,600	36.6
Evapotranspiration	12,000	15.3
Subsurface Outflow	6,600	8.4
Pumping	31,000	39.6
Total	**78,200**	**100.0**

TABLE 5-7

Annual Water Budgets Calculated by the Calibrated Regional Model for 1980 through 1999

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Castaic Dam Underflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
1980 to 1981	41,003	3,375	43,226	1,705	89,310	35,542	30,507	15,387	6,691	88,128	1,181	1,181
1981 to 1982	12,102	3,871	13,148	1,700	30,821	35,209	22,304	9,214	6,641	73,368	-42,547	-41,365
1982 to 1983	52,415	3,022	35,134	1,700	92,270	24,918	25,583	11,157	6,695	68,353	23,917	-17,448
1983 to 1984	183,342	2,657	79,681	1,700	267,380	23,169	51,128	26,020	7,017	107,333	160,047	142,598
1984 to 1985	1,316	3,606	10,714	1,705	17,341	30,645	32,258	19,609	6,647	89,158	-71,817	70,781
1985 to 1986	2	3,279	9,082	1,700	14,063	28,963	25,369	10,629	6,572	71,533	-57,470	13,311
1986 to 1987	43,258	3,211	26,471	1,700	74,641	28,658	27,557	12,354	6,668	75,236	-595	12,716
1987 to 1988	11,915	2,991	9,694	1,700	26,299	27,085	24,434	8,601	6,566	66,686	-40,386	-27,670
1988 to 1989	27,949	3,075	17,106	1,705	49,835	27,571	23,518	8,752	6,613	66,454	-16,619	-44,289
1989 to 1990	0	3,393	7,899	1,700	12,993	30,415	21,004	6,676	6,520	64,614	-51,621	-95,911
1990 to 1991	0	3,787	9,092	1,700	14,579	31,652	18,151	4,711	6,530	61,043	-46,464	-142,375
1991 to 1992	51,315	3,397	28,933	1,700	85,345	41,067	19,924	6,963	6,647	74,600	10,745	-131,630
1992 to 1993	131,293	3,850	60,449	1,705	197,296	37,567	27,043	14,114	6,906	85,629	111,666	-19,964
1993 to 1994	113,547	3,773	64,341	1,700	183,361	39,741	34,976	22,598	6,875	104,191	79,170	59,207
1994 to 1995	813	4,415	13,436	1,700	20,365	44,120	21,612	12,839	6,586	85,157	-64,793	-5,586
1995 to 1996	114,663	4,517	60,647	1,700	181,527	42,009	32,426	21,314	6,887	102,637	78,890	73,305
1996 to 1997	46,312	5,205	30,512	1,705	83,734	45,574	25,888	17,092	6,762	95,317	-11,583	61,721
1997 to 1998	17,485	5,267	16,277	1,700	40,729	47,051	21,488	12,791	6,667	87,997	-47,268	14,453
1998 to 1999	138,991	4,758	90,634	1,700	236,084	42,043	41,283	26,213	6,959	116,498	119,585	134,039
1999 to 2000	26	5,343	13,714	1,700	20,783	46,867	24,335	15,943	6,607	93,752	-72,969	61,070
Minimum	0	2,657	7,899	1,700	12,993	23,169	18,151	4,711	6,520	61,043	-72,969	-142,375
Maximum	183,342	5,343	90,634	1,705	267,380	47,051	51,128	26,213	7,017	116,498	160,047	142,598
Average	49,387	3,840	32,010	1,701	86,938	35,493	27,539	14,149	6,703	83,884	3,053	5,907
Median	34,476	3,689	21,789	1,700	62,238	35,376	25,476	12,815	6,657	85,393	-14,101	6,949

Note:

All flow volumes are listed in AF/yr.

Figures

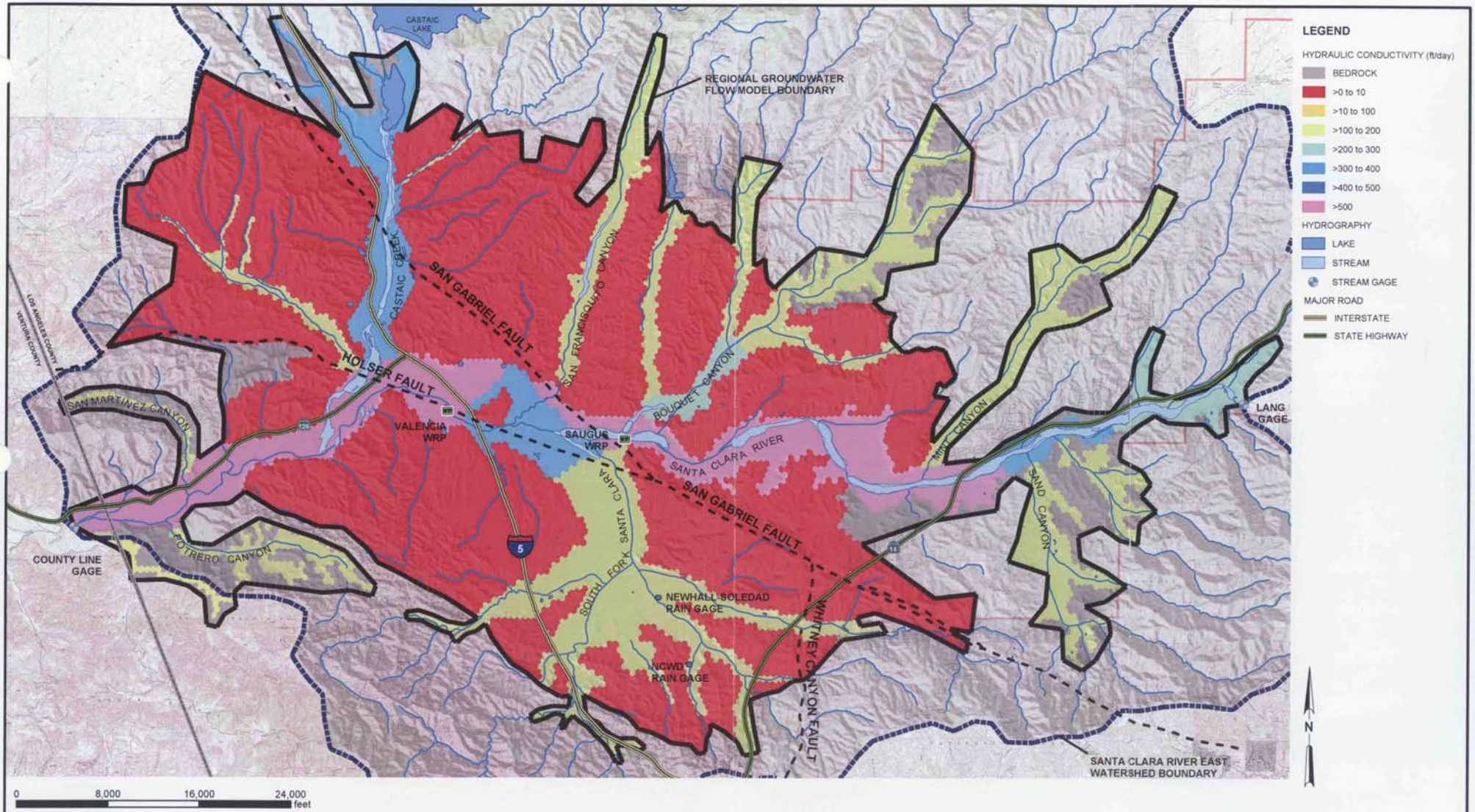

FIGURE 5-1
HYDRAULIC CONDUCTIVITY LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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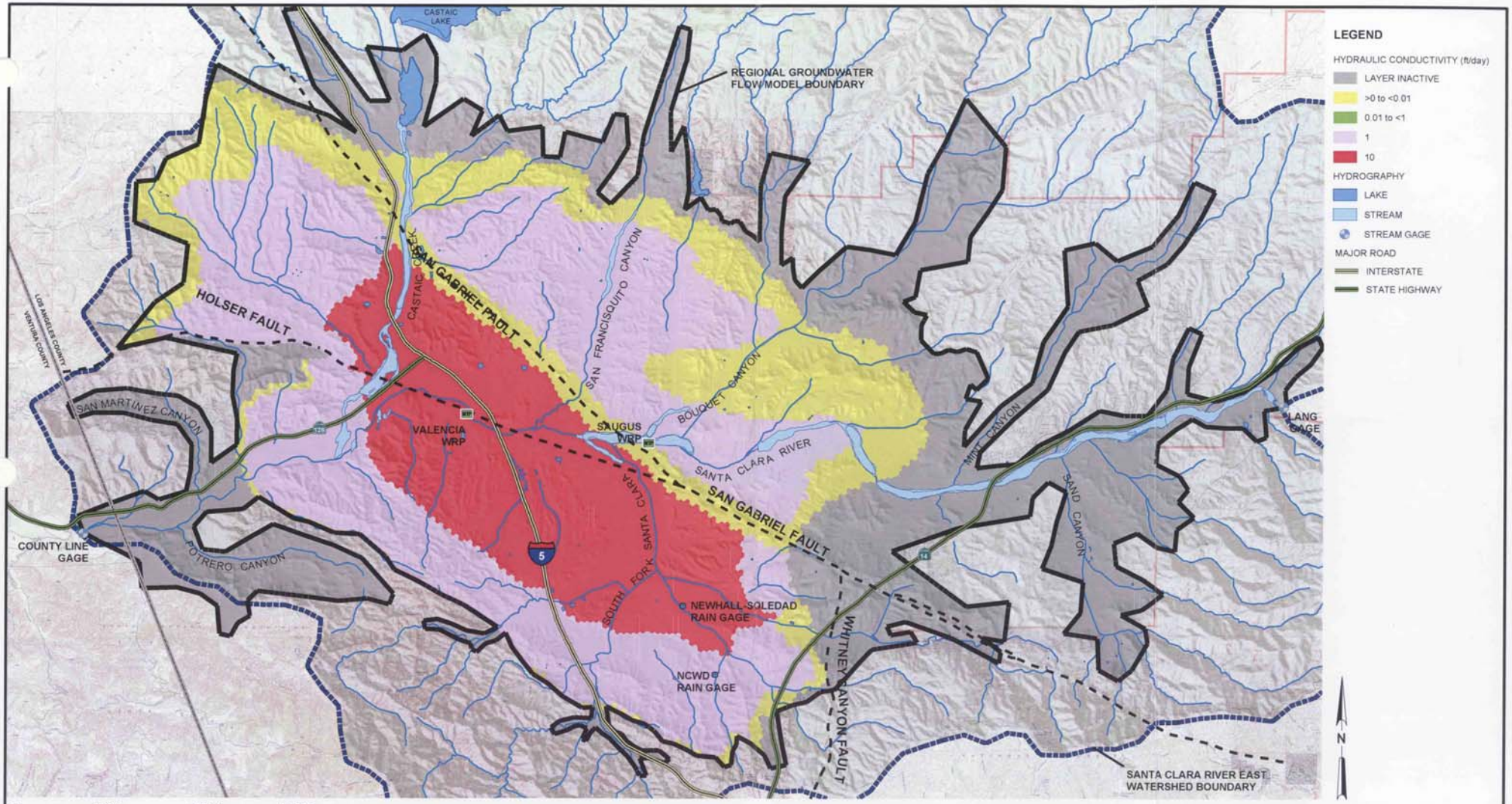

FIGURE 5-2
HYDRAULIC CONDUCTIVITY LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG037.MXD FIG05-02.PDF 01/22/2004 17:55:45

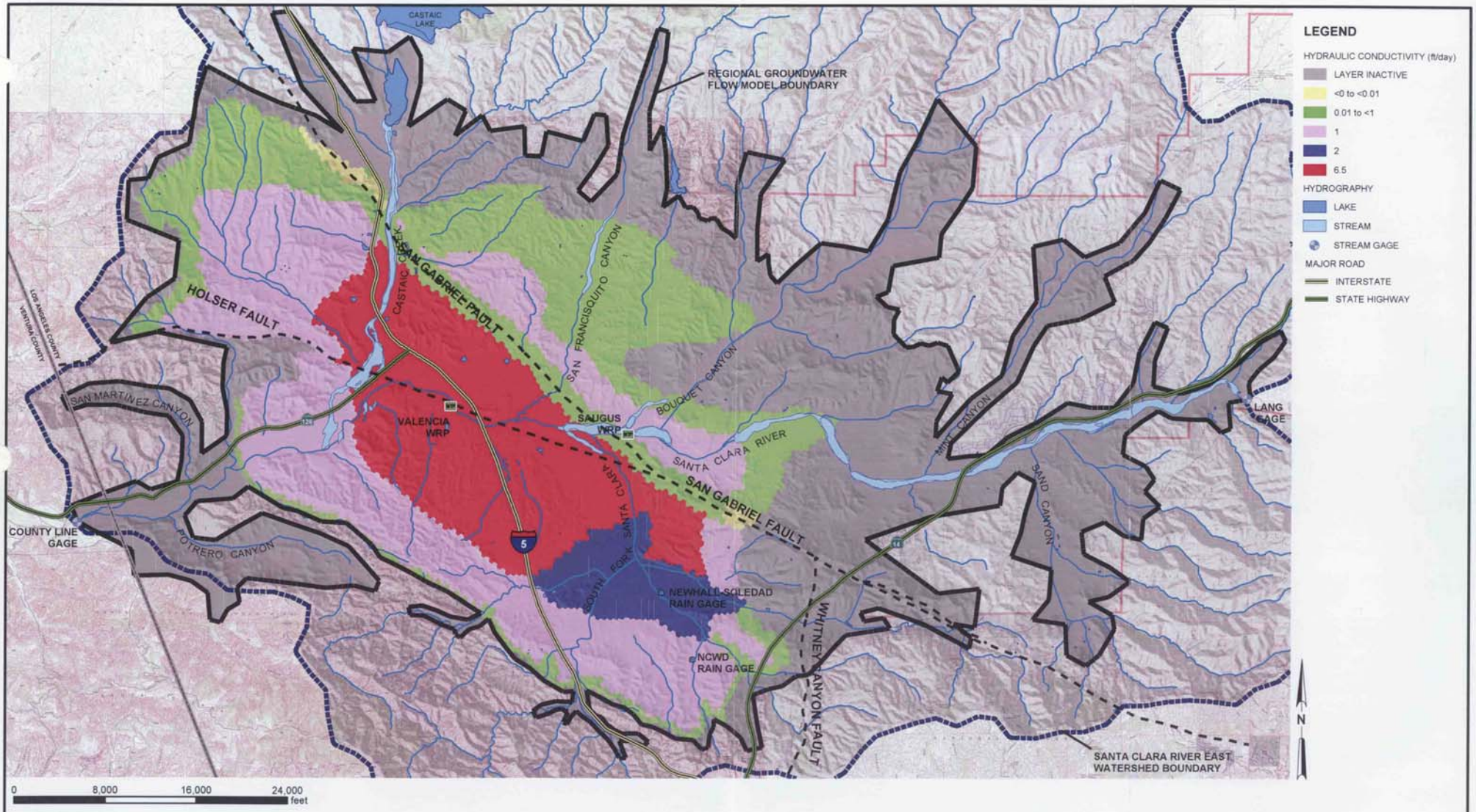

FIGURE 5-3
HYDRAULIC CONDUCTIVITY LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG039.MXD FIG05-03.PDF 01/22/2004 18:08:34

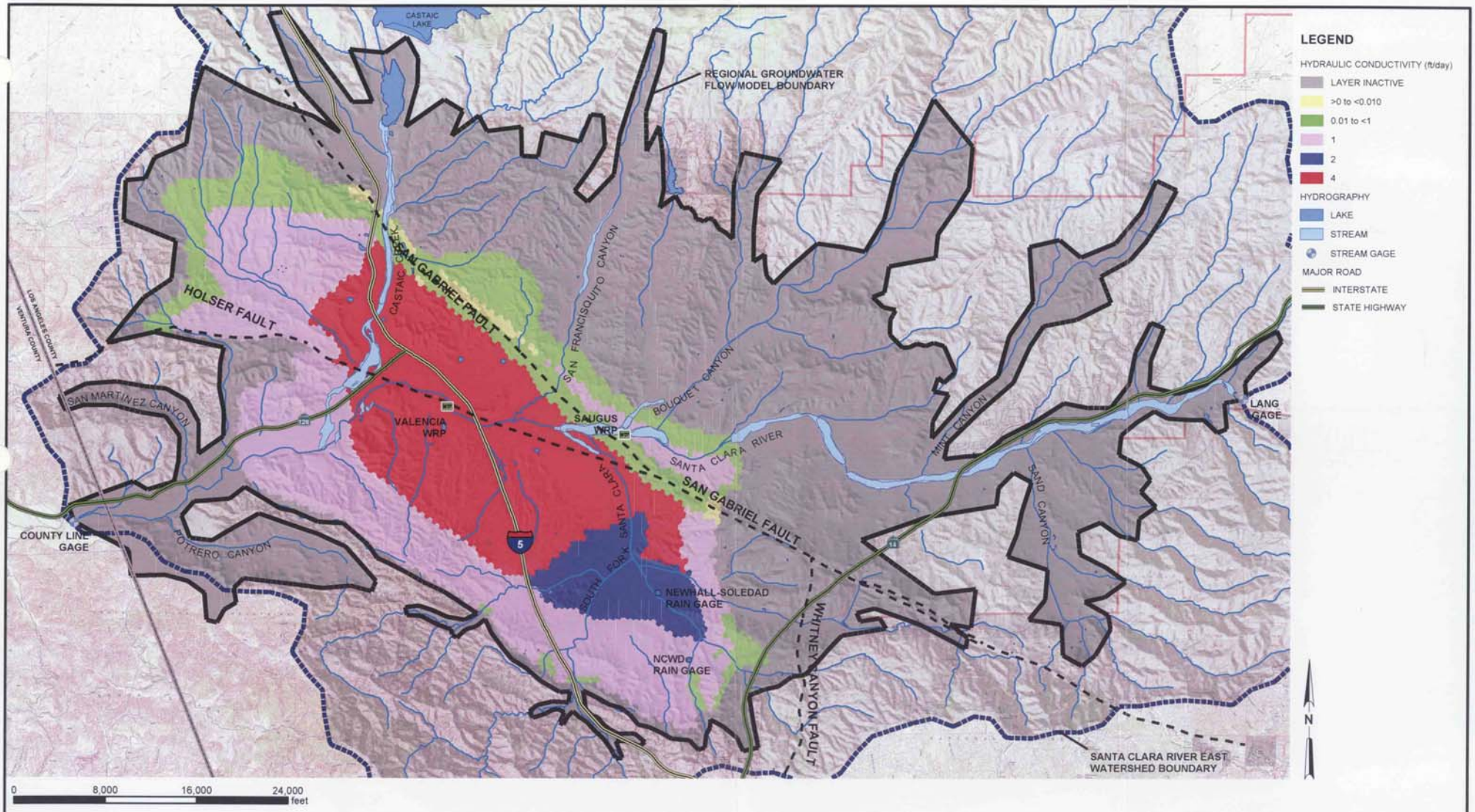

FIGURE 5-4
HYDRAULIC CONDUCTIVITY LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG040.MXD FIG05-04.PDF 01/22/2004 18:16:22

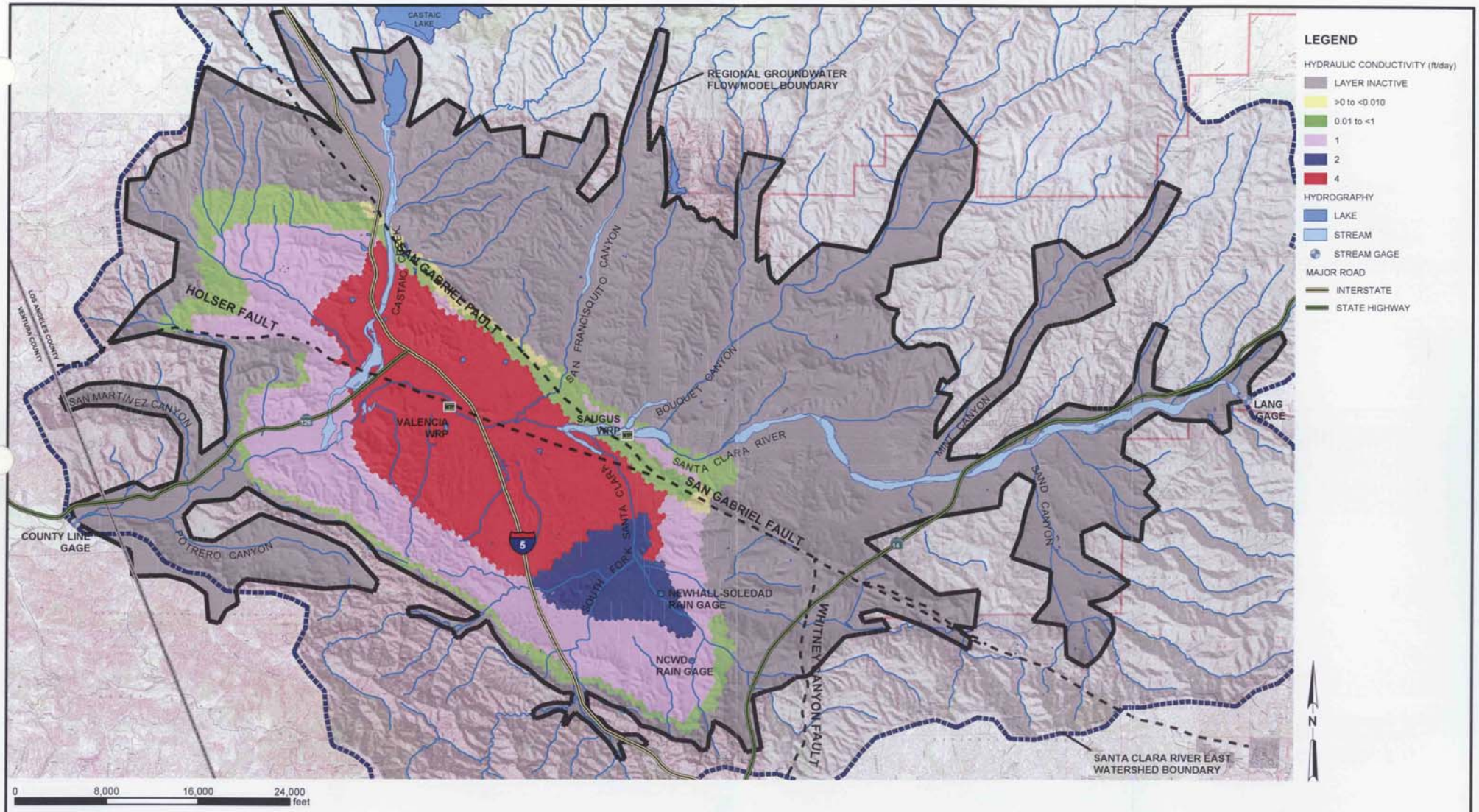

FIGURE 5-5
HYDRAULIC CONDUCTIVITY LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG041.MXD FIG05-05.PDF 01/22/2004 18:16:22

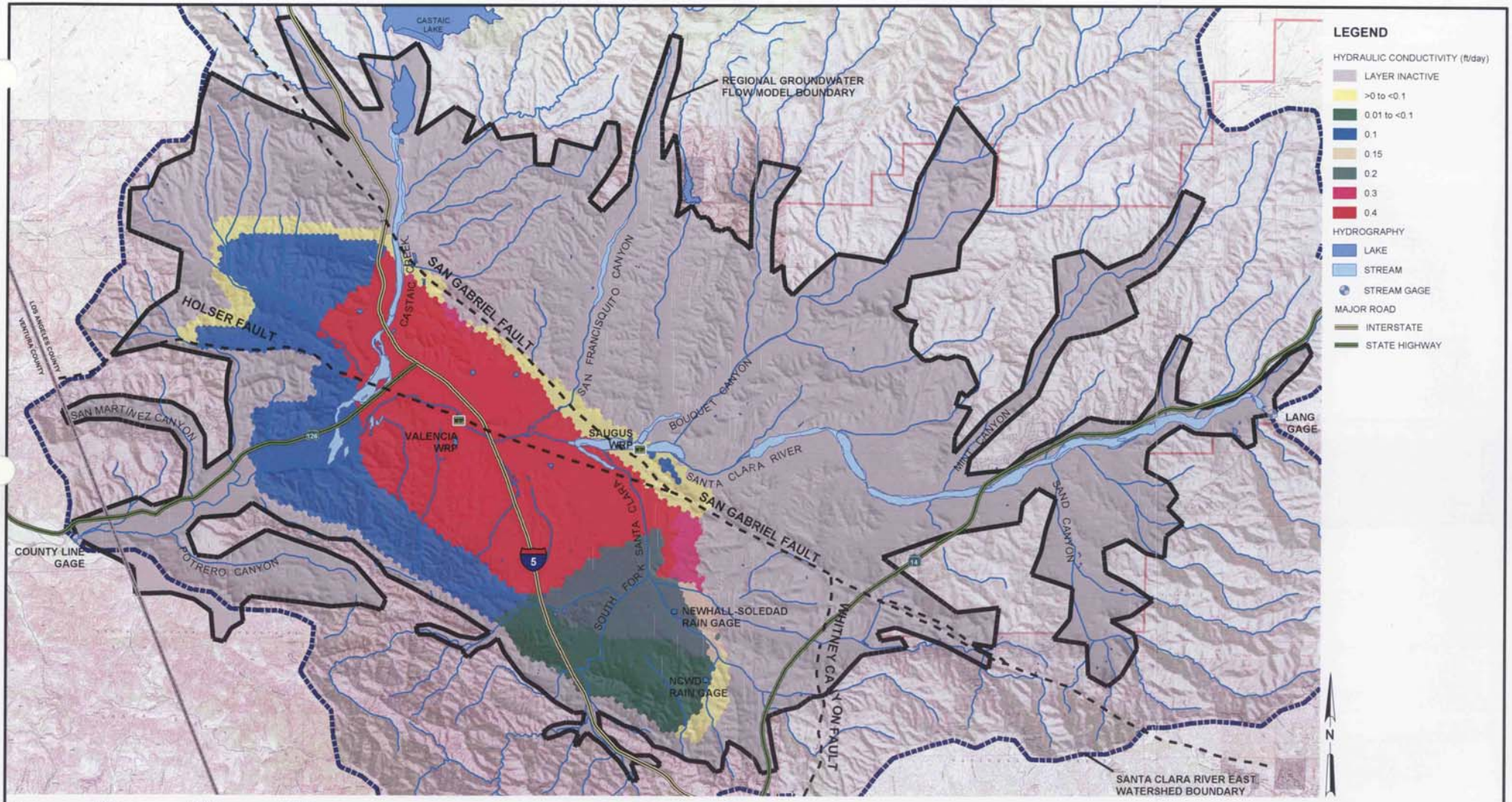

FIGURE 5-6
HYDRAULIC CONDUCTIVITY LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG038_.MXD FIG05-06.PDF 01/22/2004 18:47:29

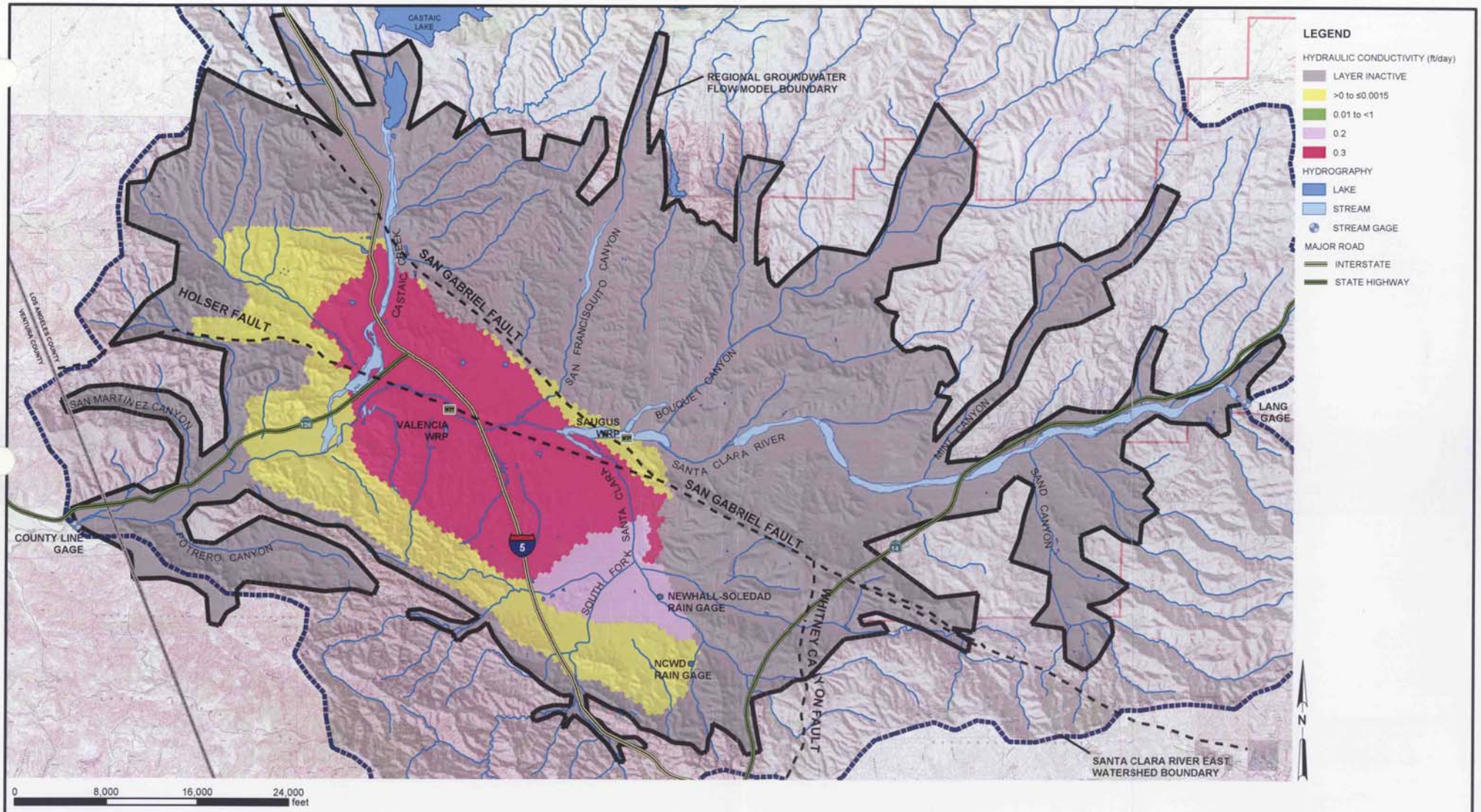

FIGURE 5-7
HYDRAULIC CONDUCTIVITY LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG042.MXD FIG05-07.PDF 01/22/2004 18:22:27

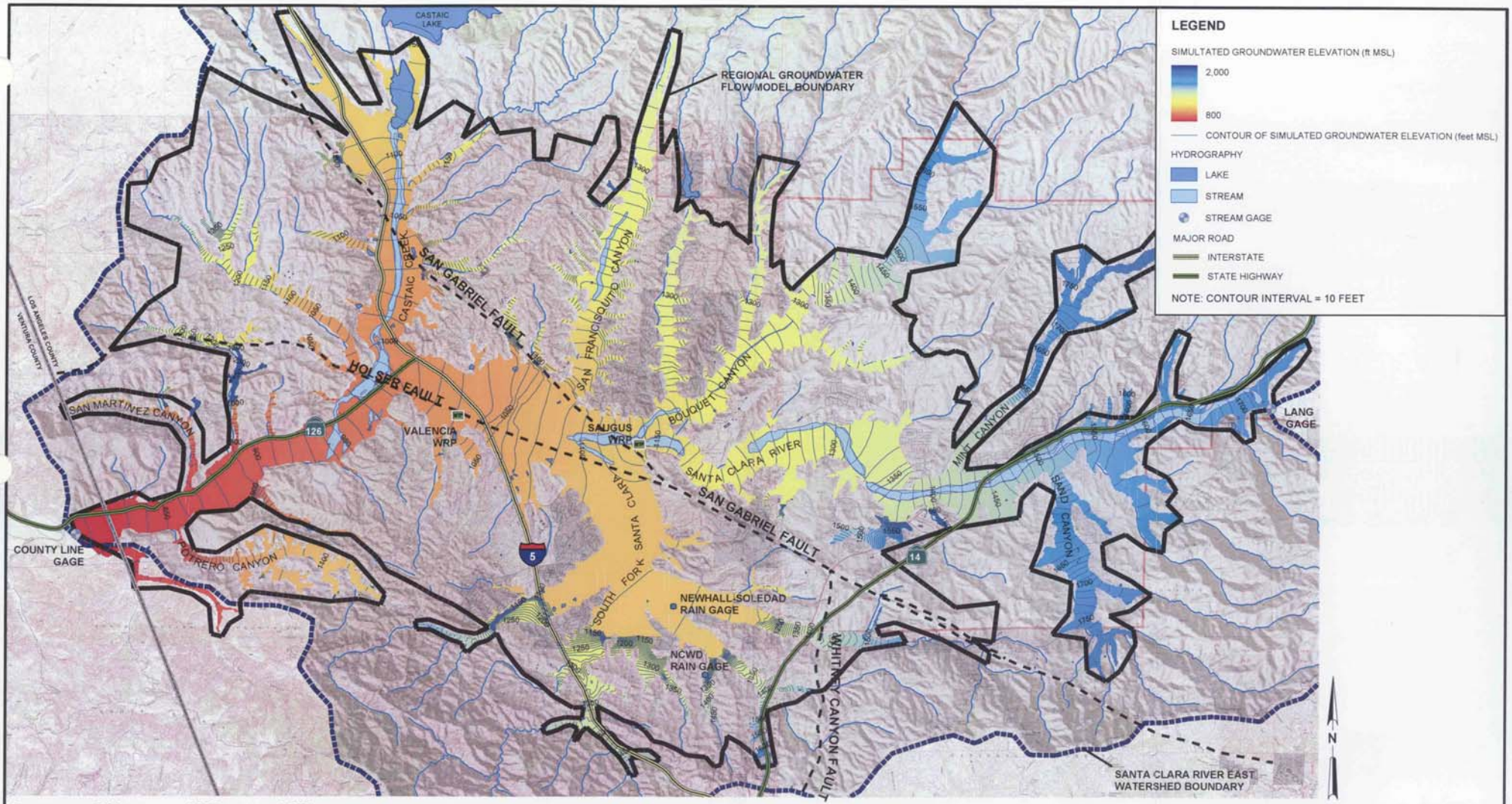

FIGURE 5-8
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG052.MXD FIG05-8.PDF 02/03/2004 08:46:47

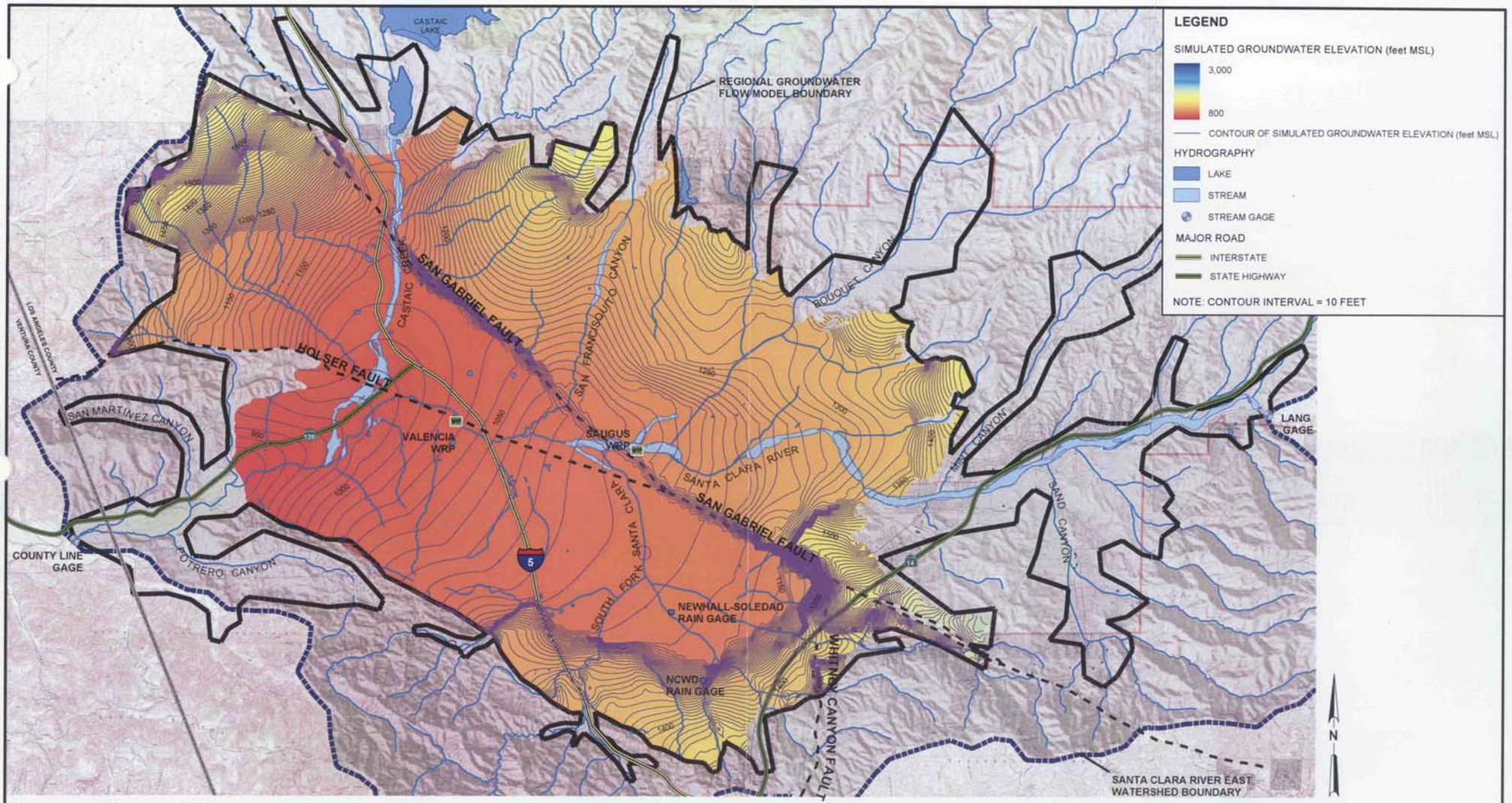

FIGURE 5-9
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG046.MXD FIG05-9.PDF 02/02/2004 10:58:01

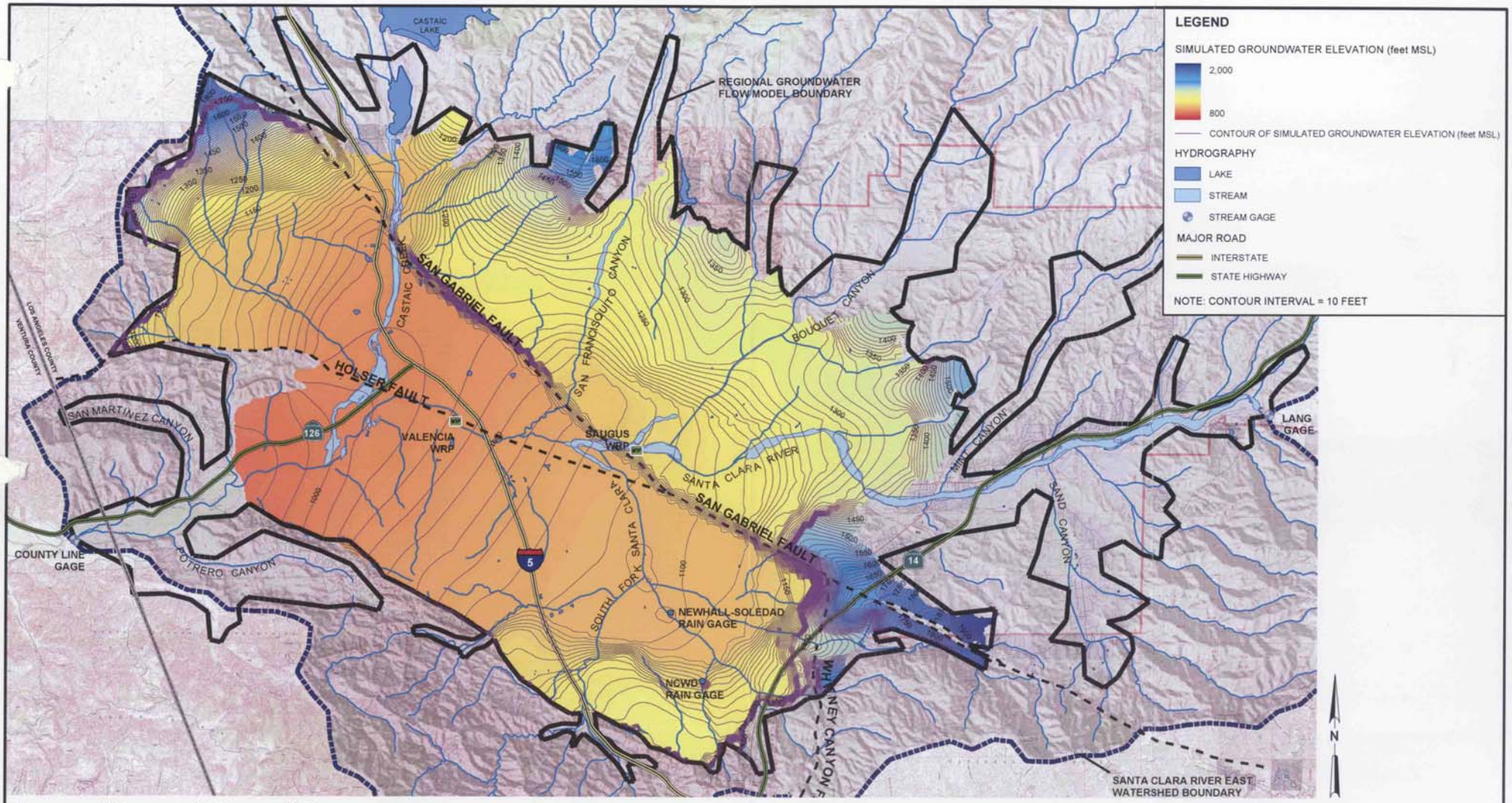

FIGURE 5-10
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG045.MXD FIG05-10.PDF 02/02/2004 10:42:32

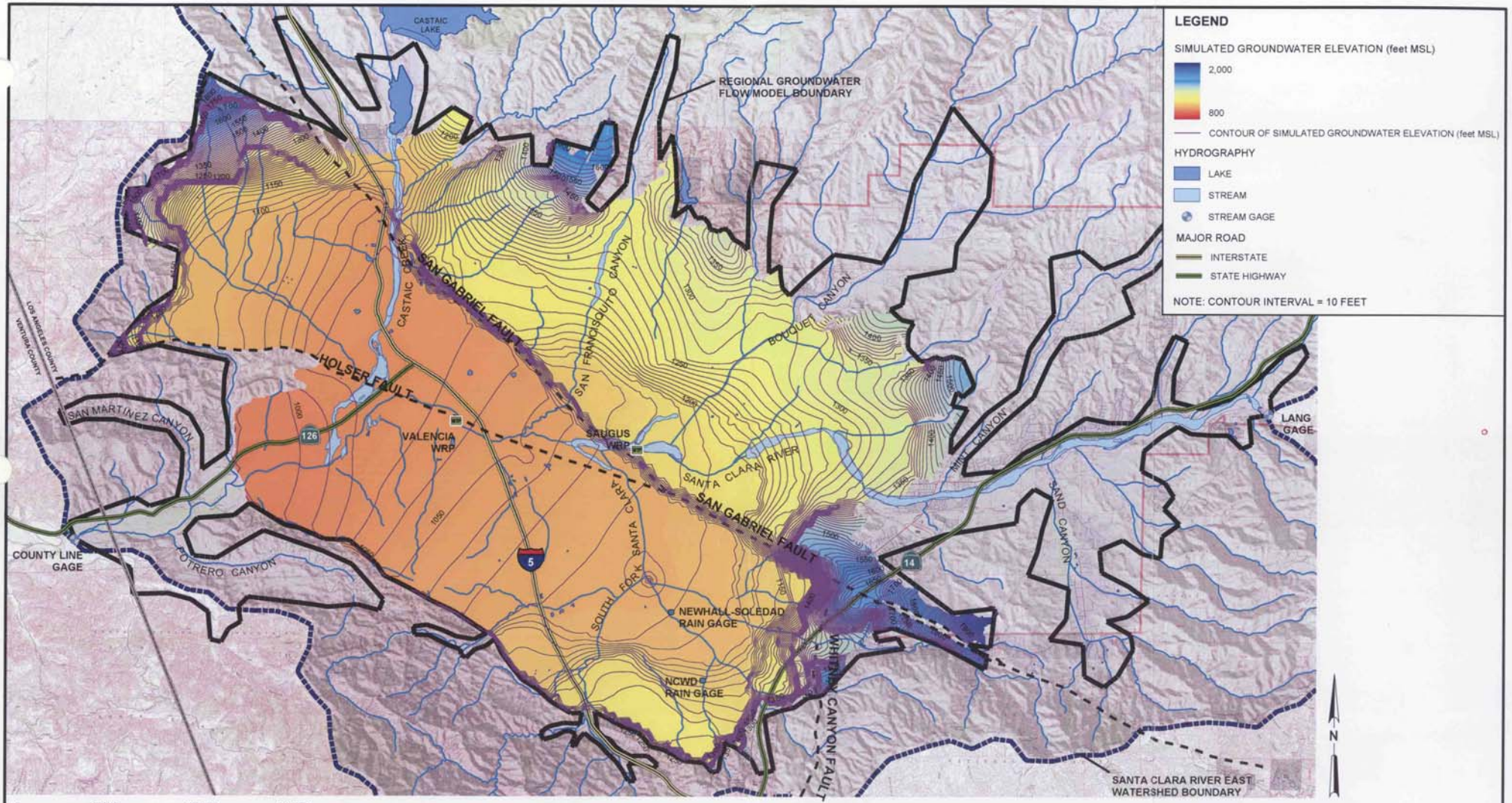

FIGURE 5-11
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG047.MXD FIG05-11.PDF 02/02/2004 10:07:23

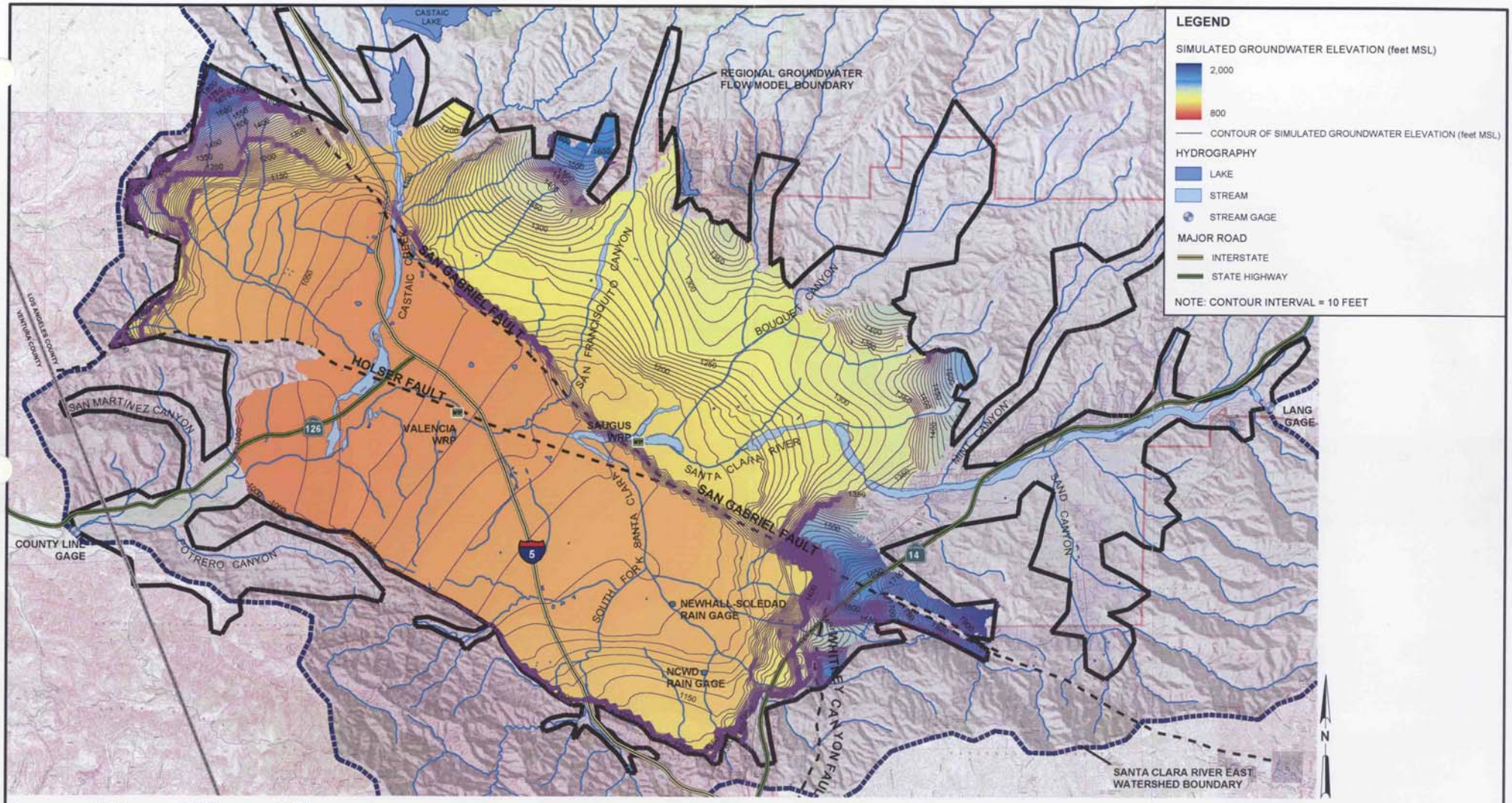

FIGURE 5-12
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG048.MXD FIG05-12.PDF 02/02/2004 11:04:46

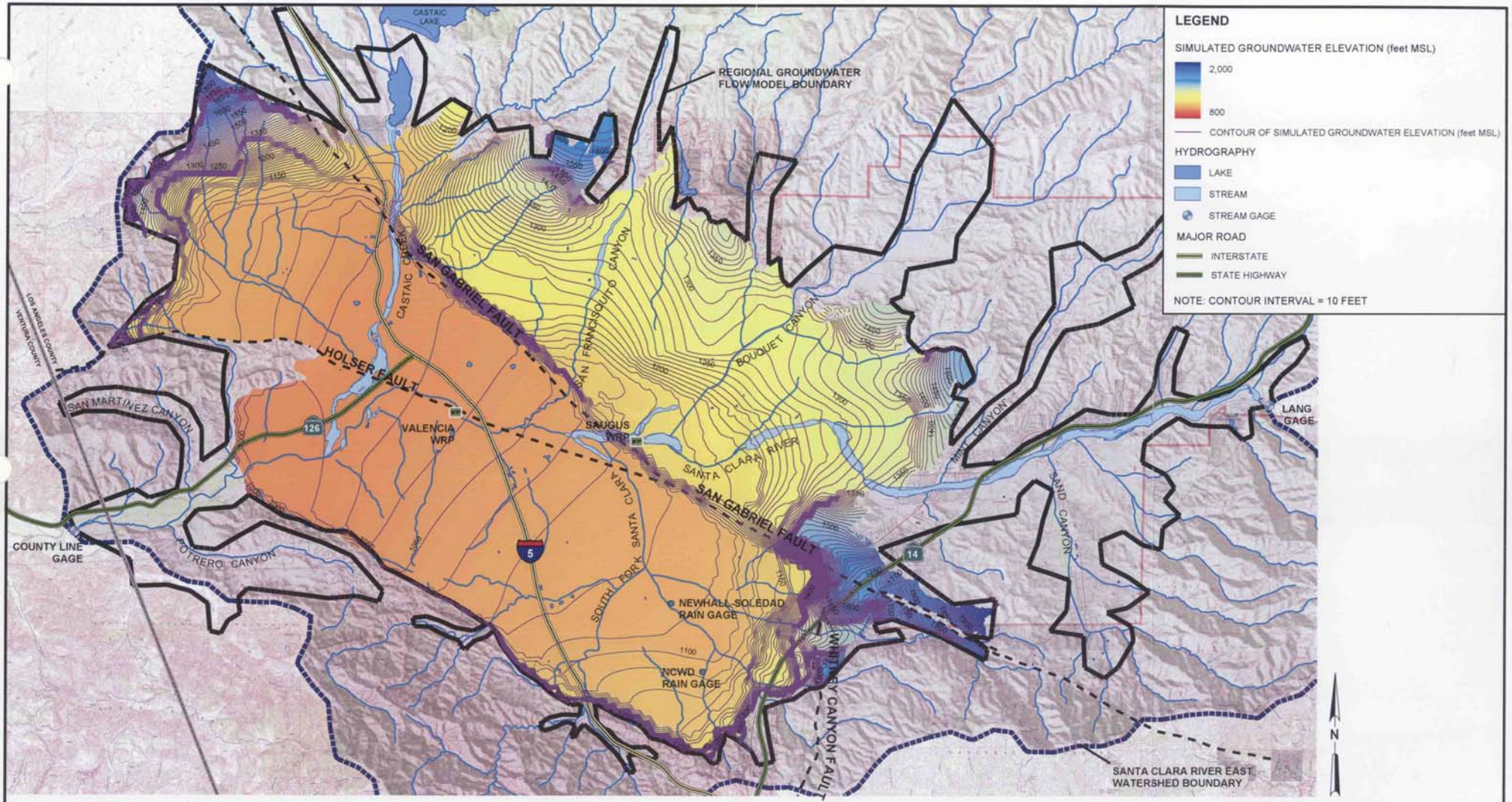

FIGURE 5-13
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG051.MXD FIG05-13.PDF 02/02/2004 11:11:08

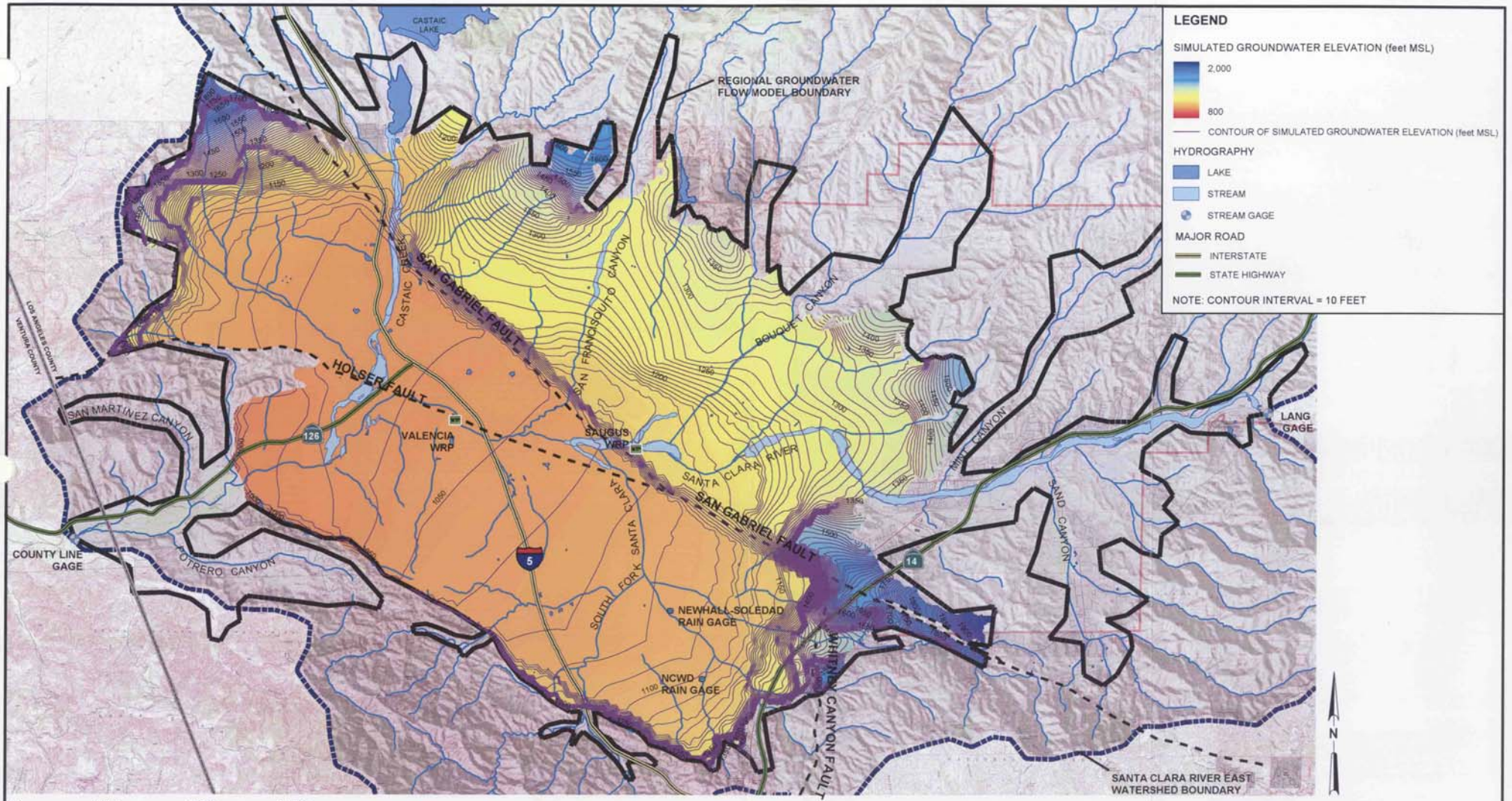

FIGURE 5-14
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG050.MXD FIG05-14.PDF 02/02/2004 11:18:17

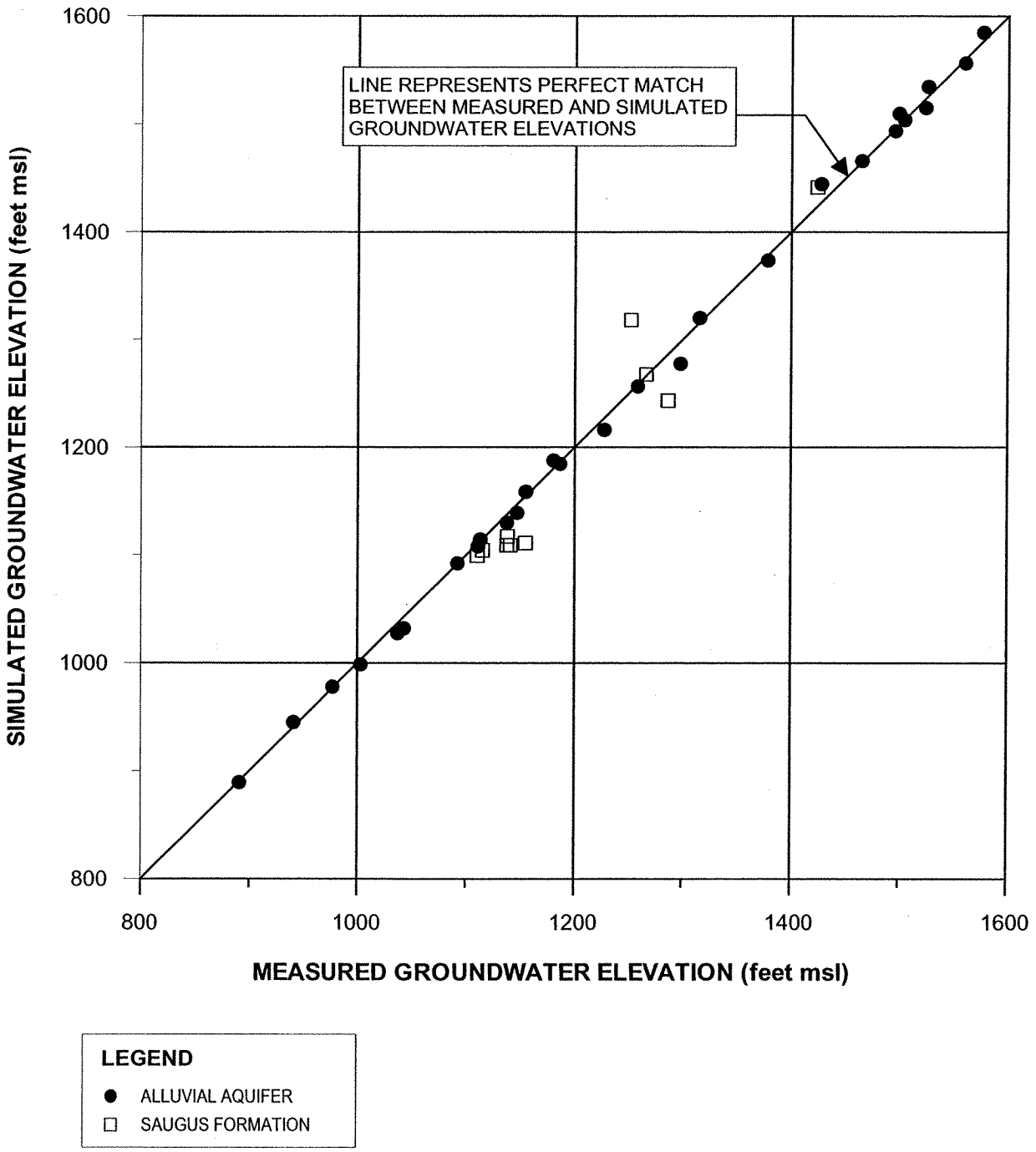

FIGURE 5-15
SIMULATED VERSUS MEASURED GROUNDWATER ELEVATIONS FOR THE STEADY-STATE MODEL
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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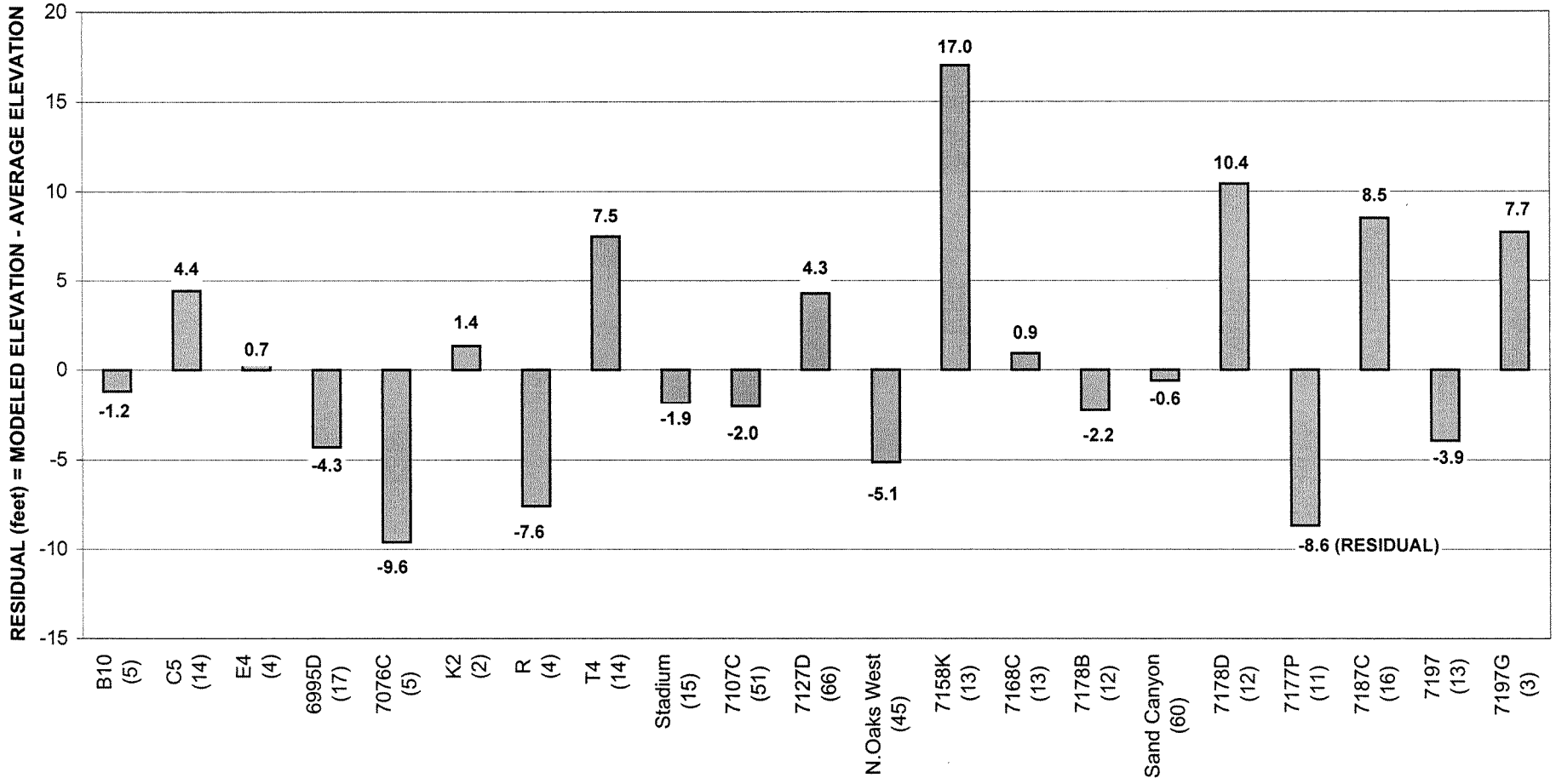

FIGURE 5-16
STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS ALONG THE SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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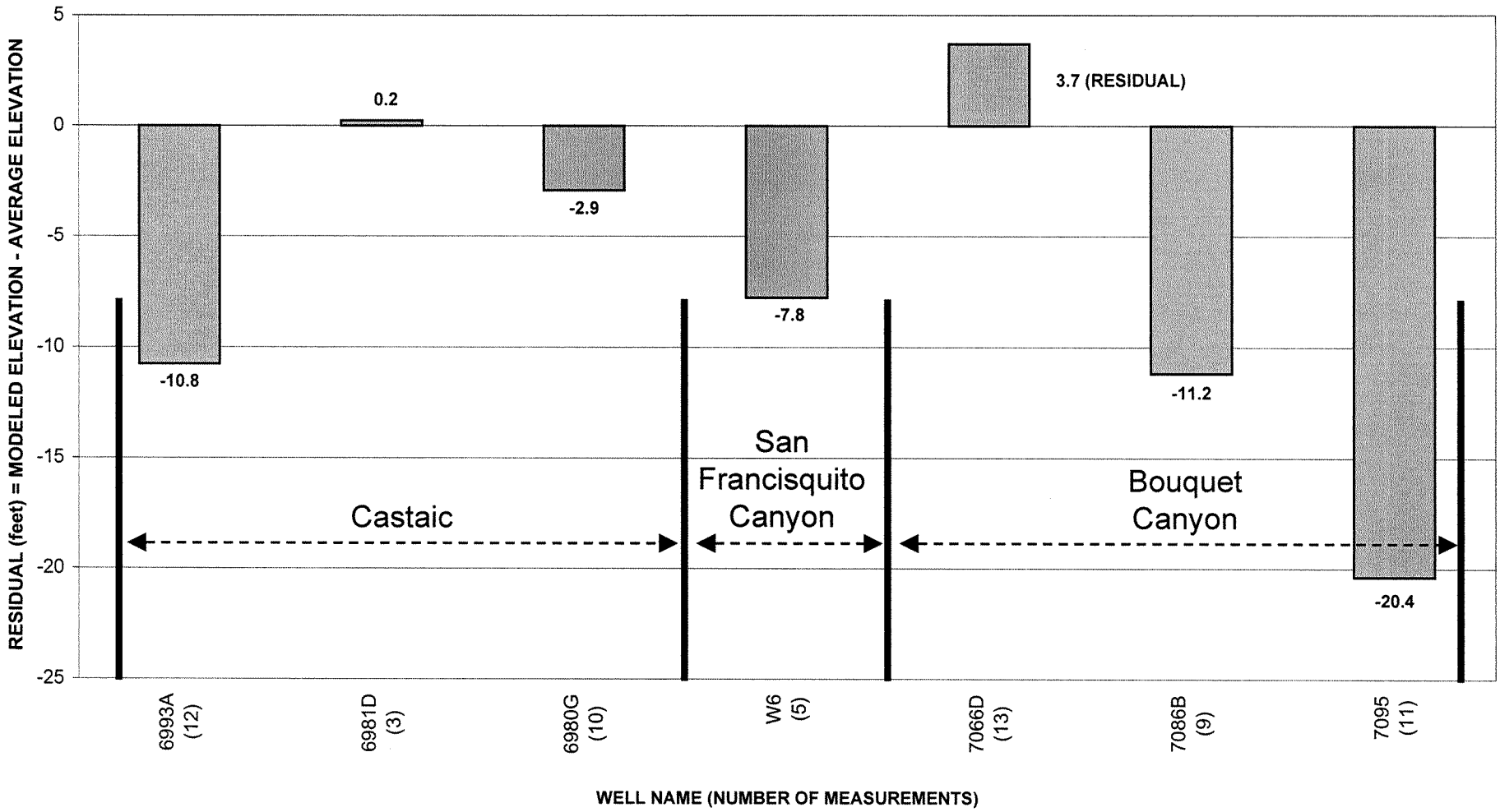

FIGURE 5-17
STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS AWAY FROM THE SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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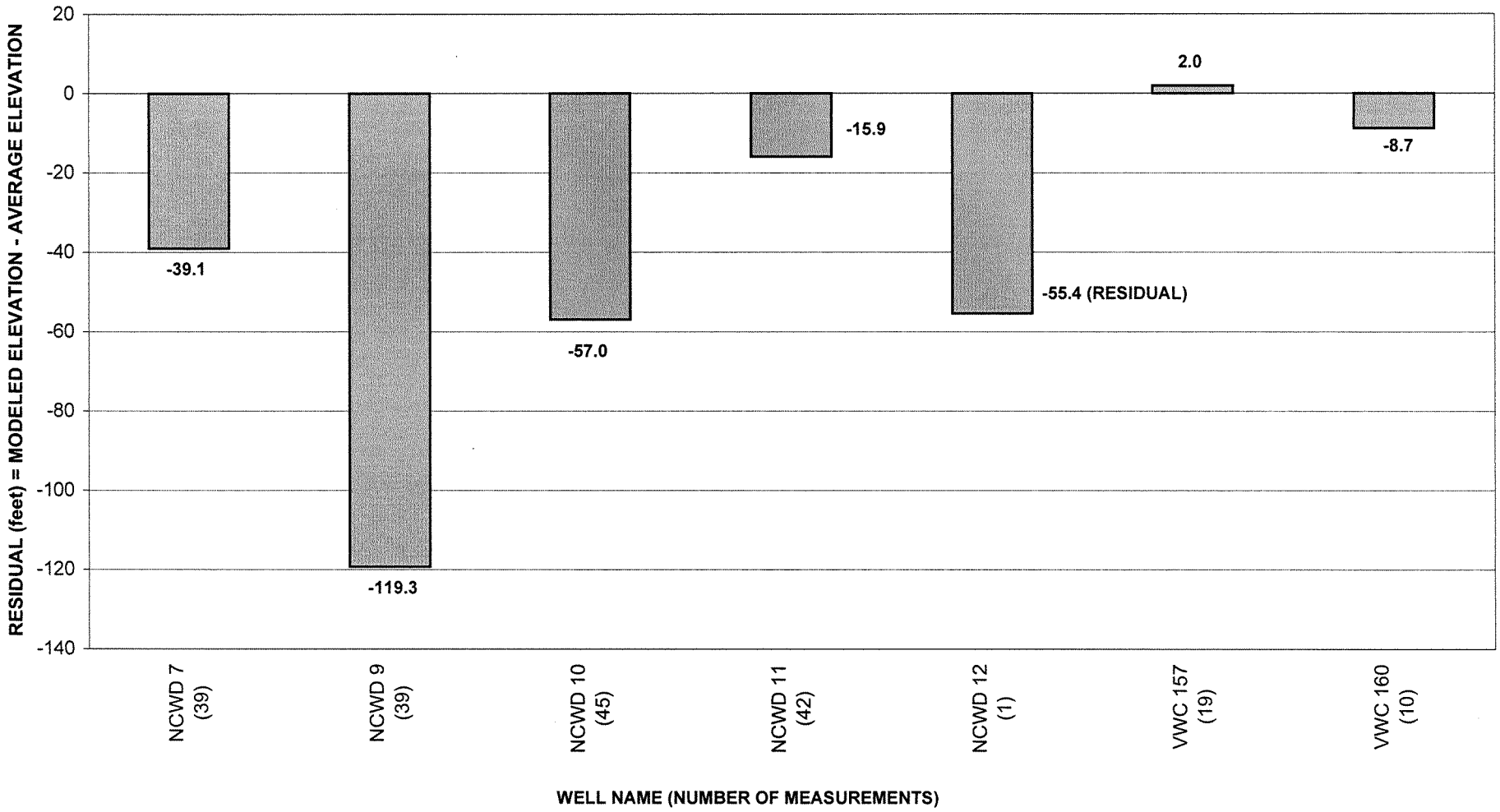
178973-403.xls/Fig 5-17



NOTE:
ALL WELLS SHOWN ON THIS PLOT ARE LOCATED IN THE SOUTH FORK SANTA CLARA RIVER VALLEY

FIGURE 5-18
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION PRODUCTION WELLS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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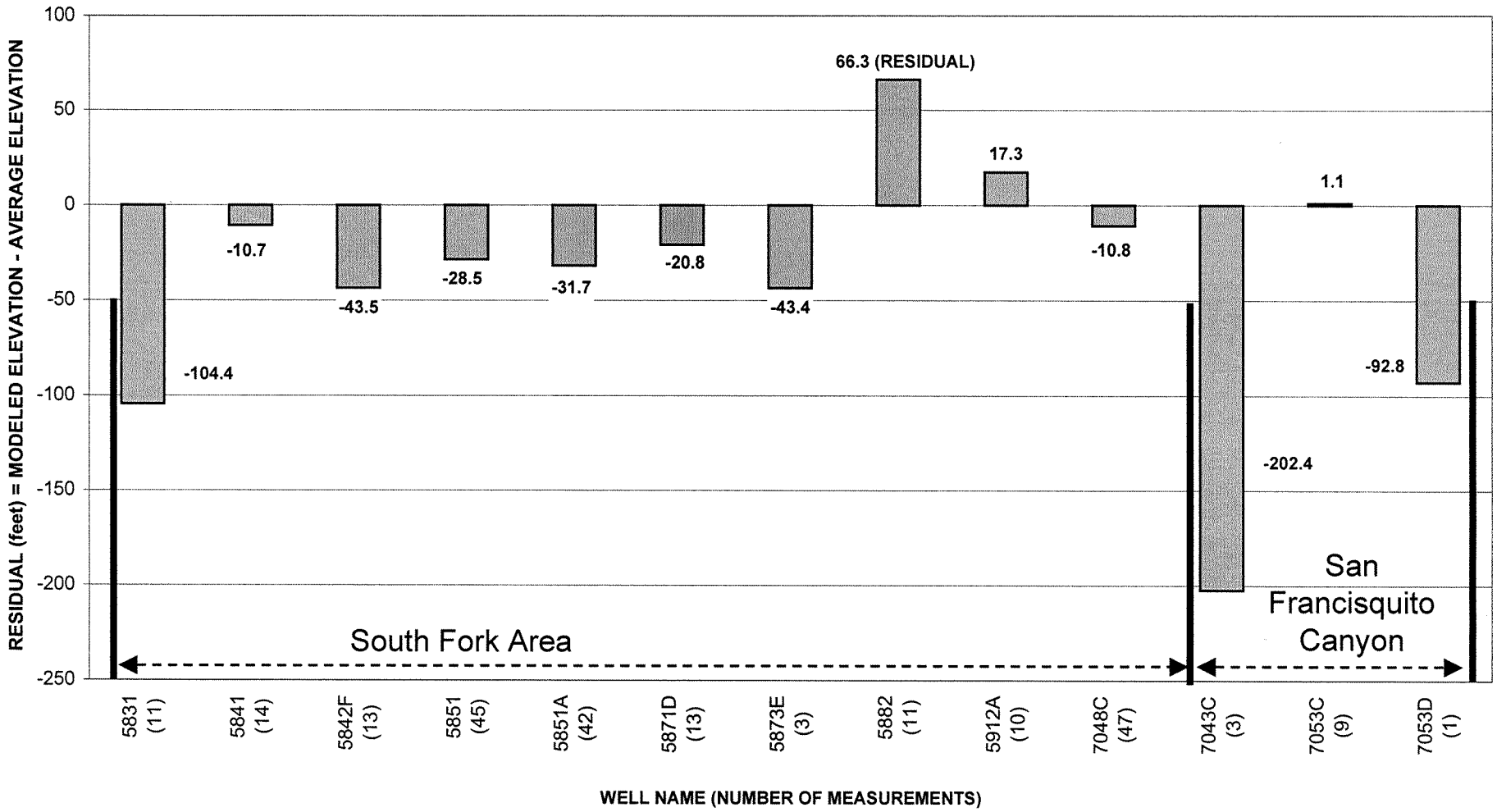

FIGURE 5-19
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION OBSERVATION WELLS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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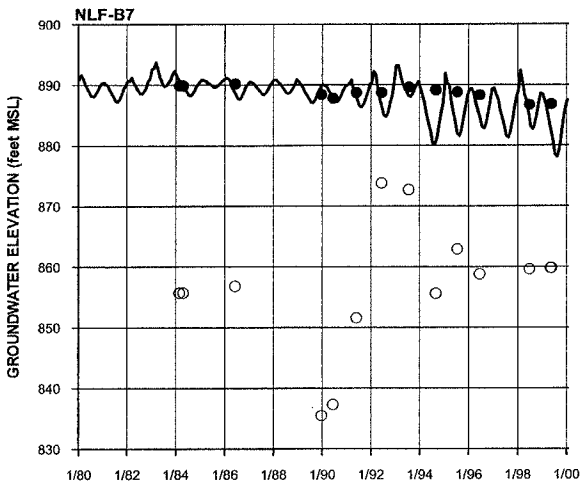

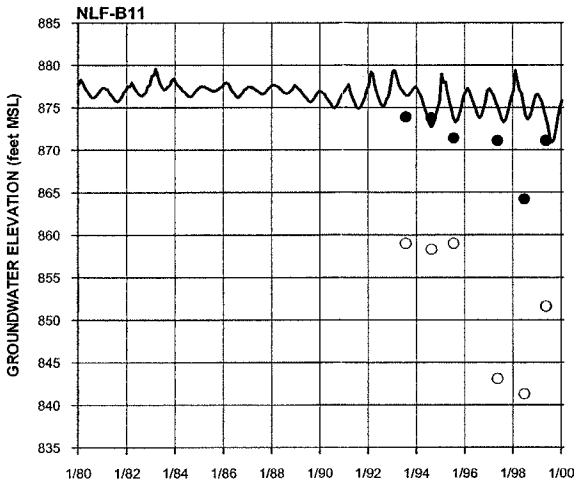

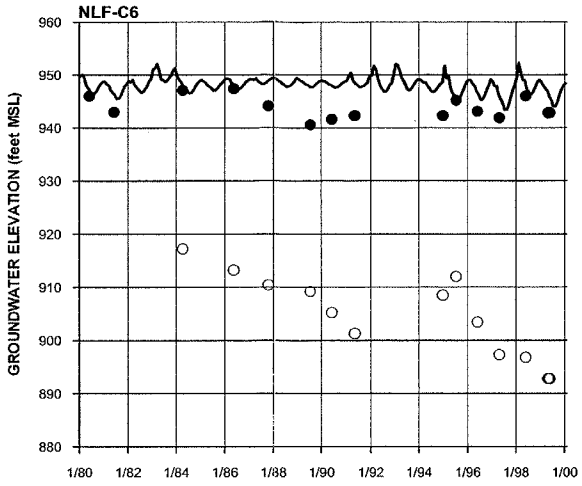

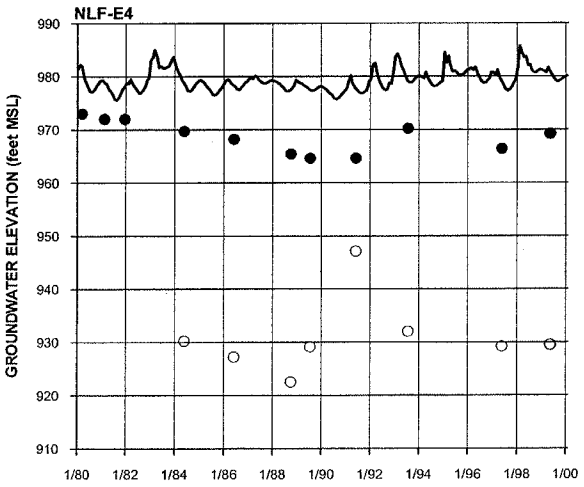

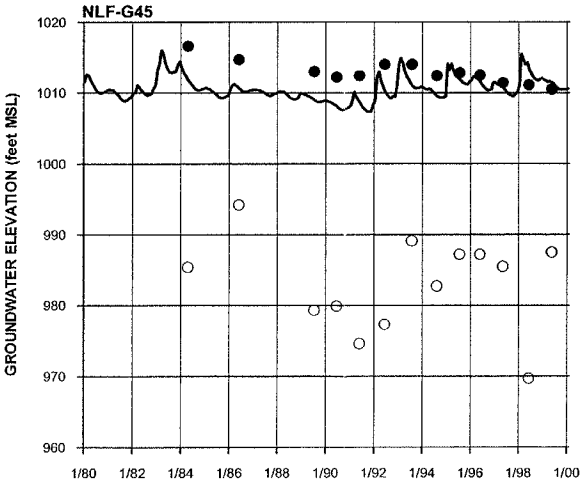

LEGEND

- SIMULATED ELEVATION
- MEASURED STATIC (NONPUMPING) ELEVATION
- MEASURED PUMPING ELEVATION

NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-20
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS WEST OF INTERSTATE 5
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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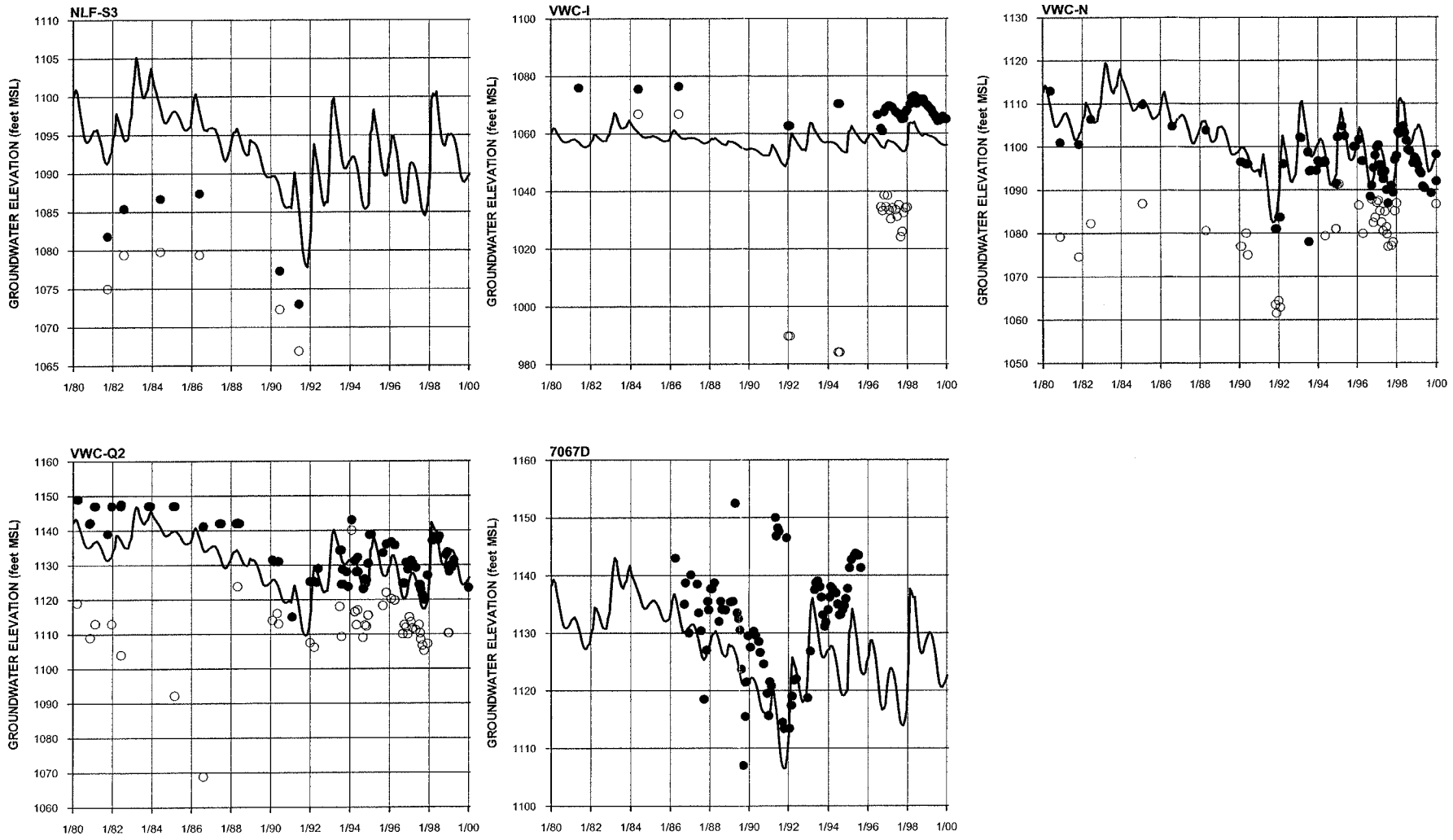


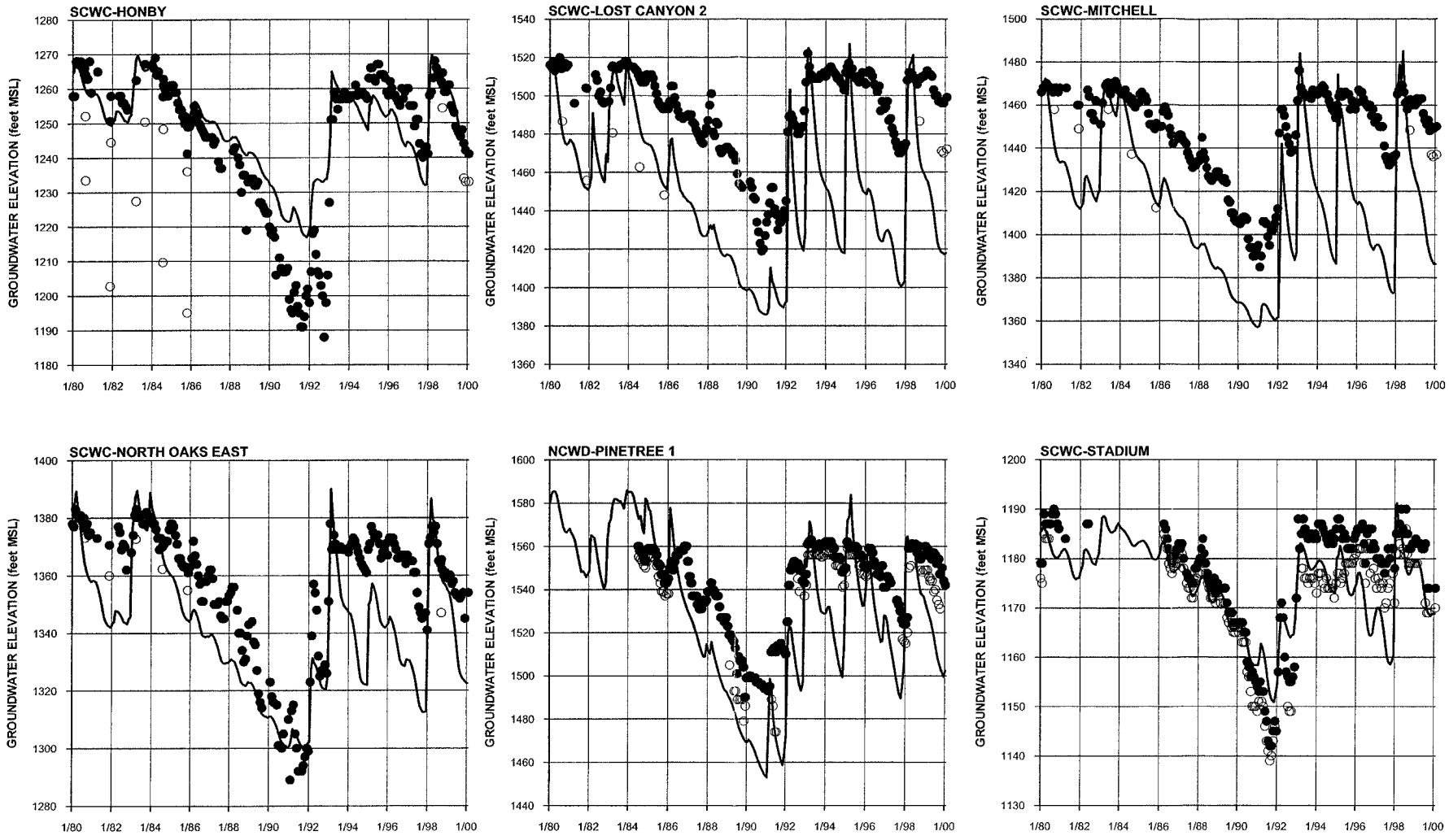
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-21
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS BETWEEN INTERSTATE 5 AND SOLEDAD CANYON

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

175570-312.GRF



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 1 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-313.GRF

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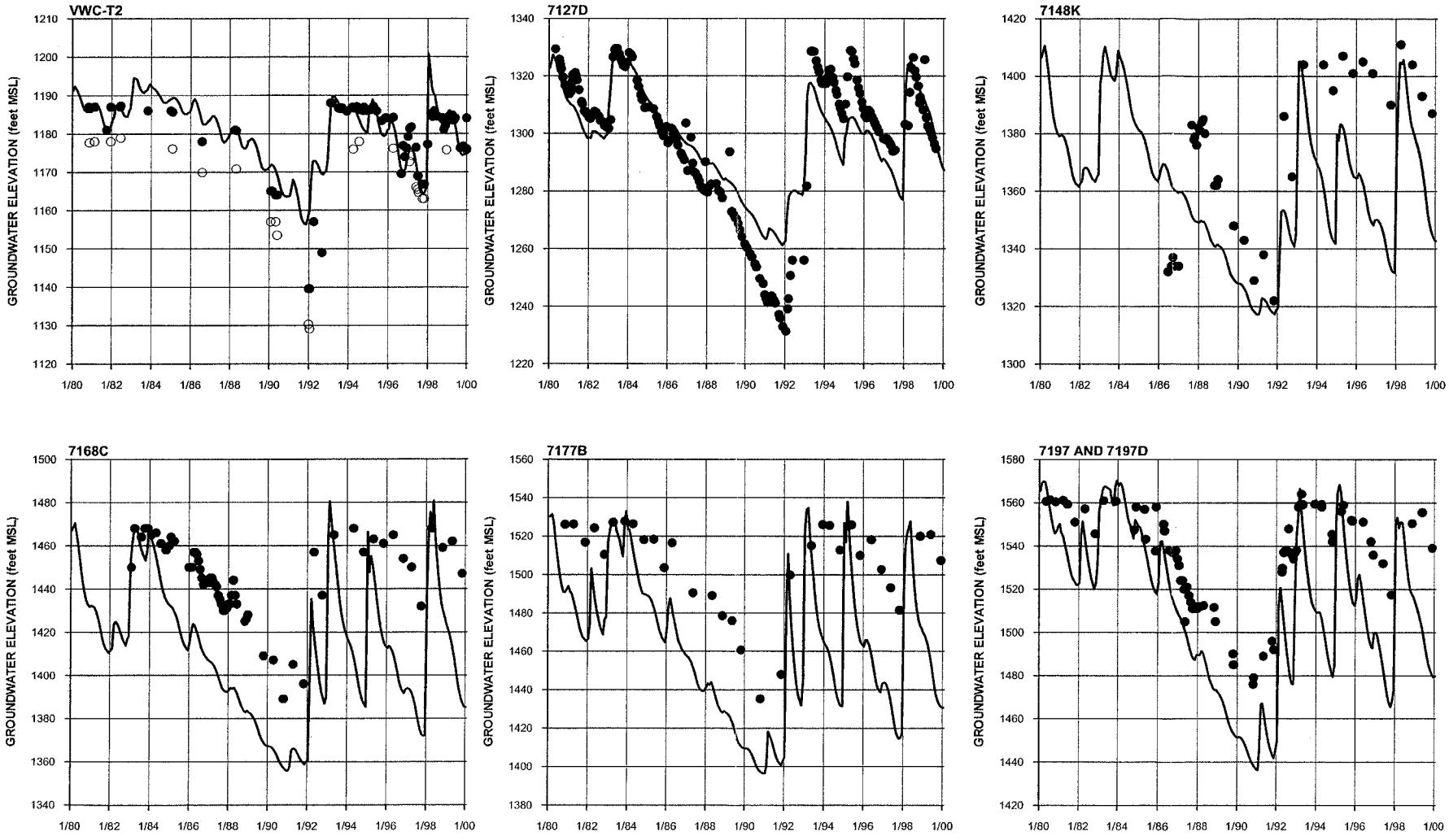


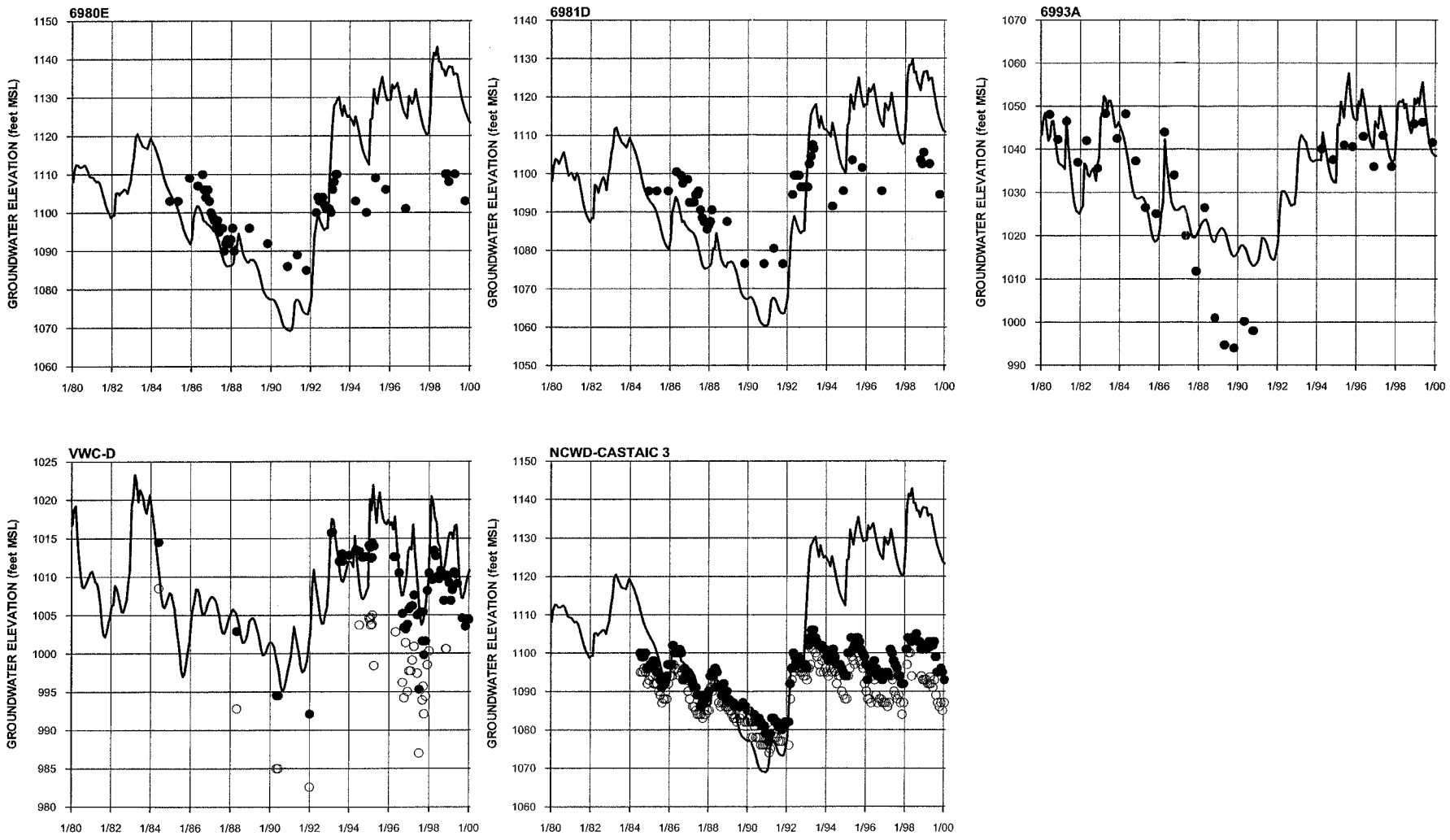
NOTE: SEE FIGURE 2-3 FOR LOCATION OF WELLS.

178973-314.GRF

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 2 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

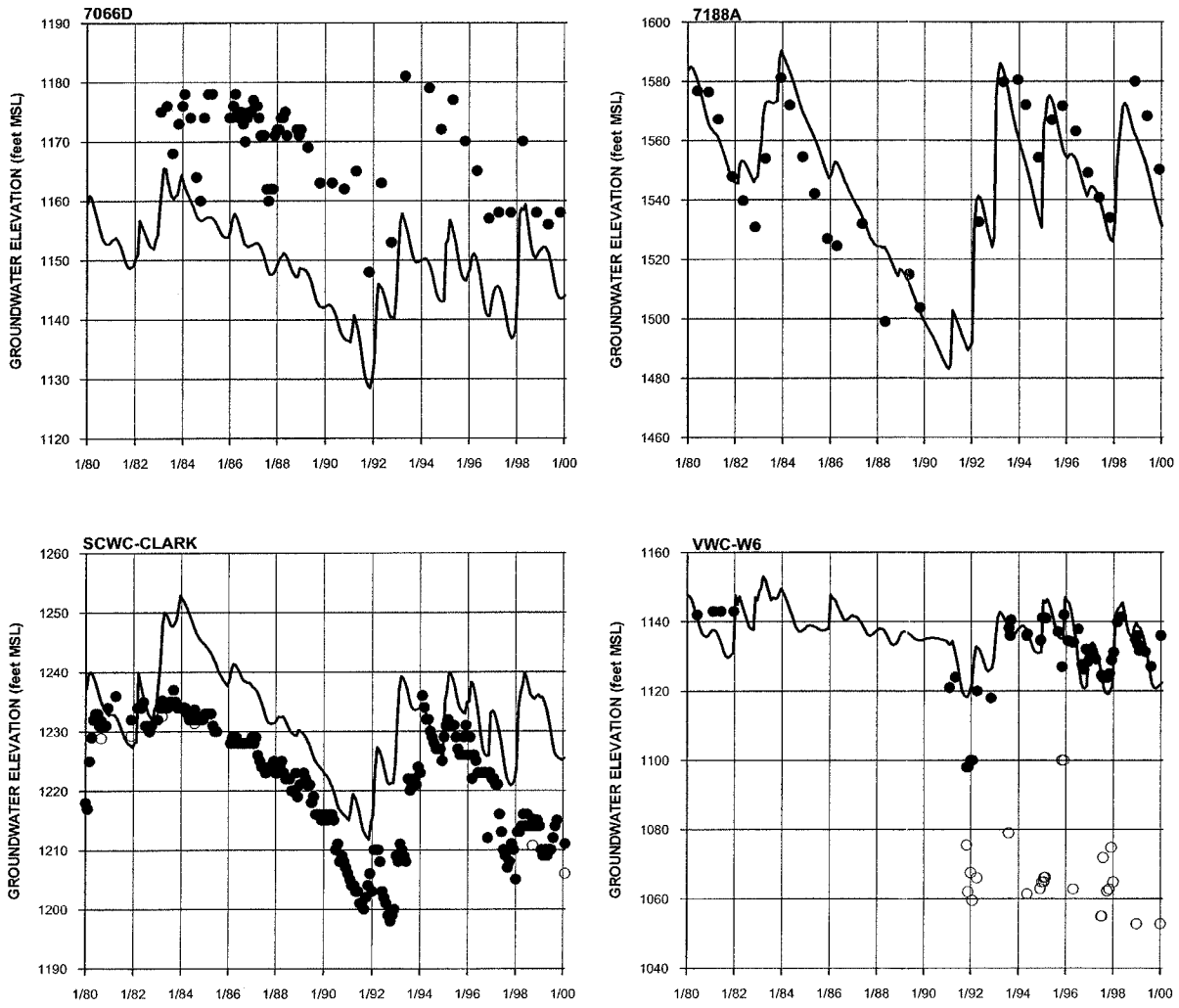


NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-23
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS ALONG CASTAIC CREEK
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

175570-315.GRF



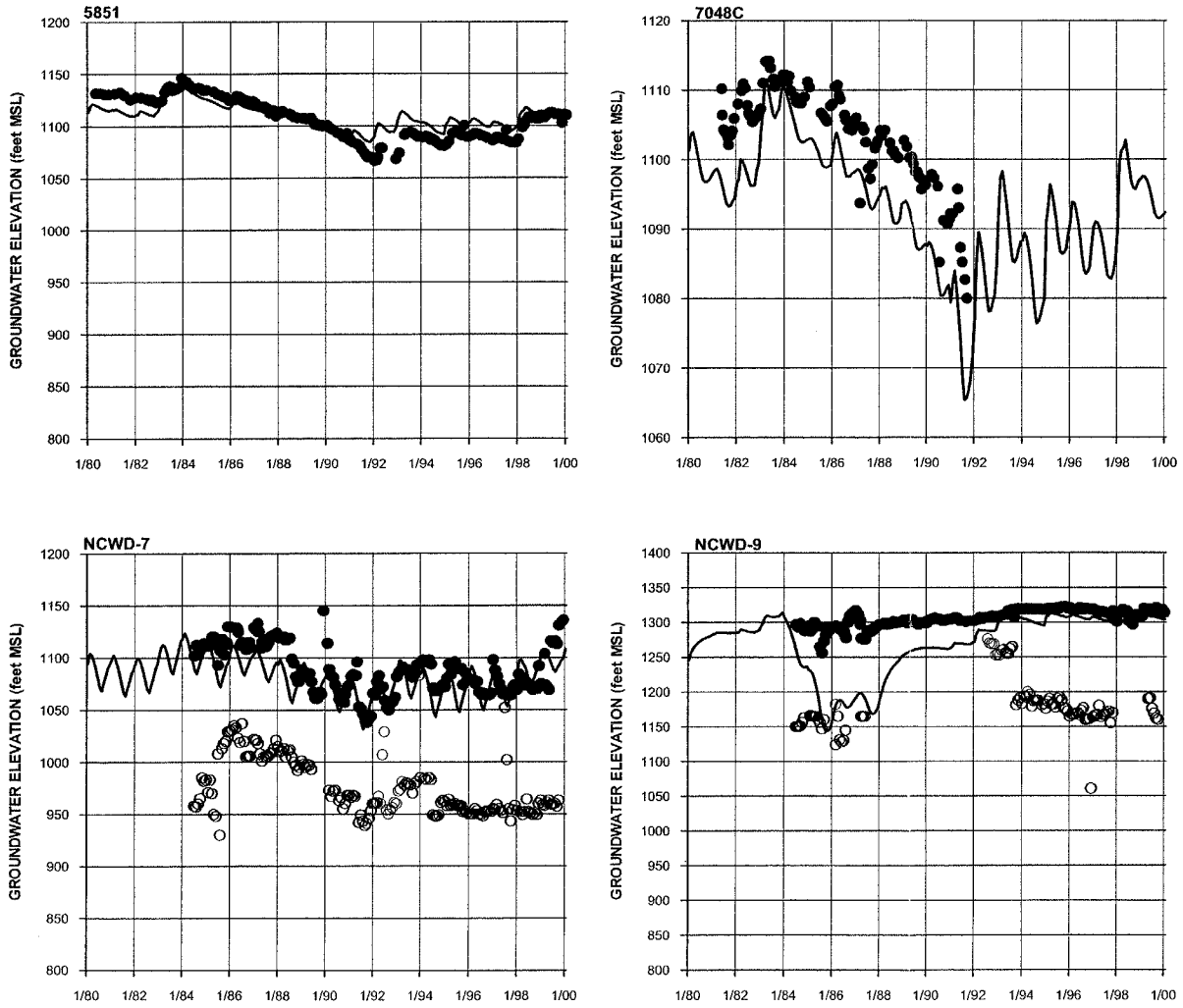
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-316.GRF

FIGURE 5-24
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN OTHER TRIBUTARY CANYONS TO THE SANTA CLARA RIVER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

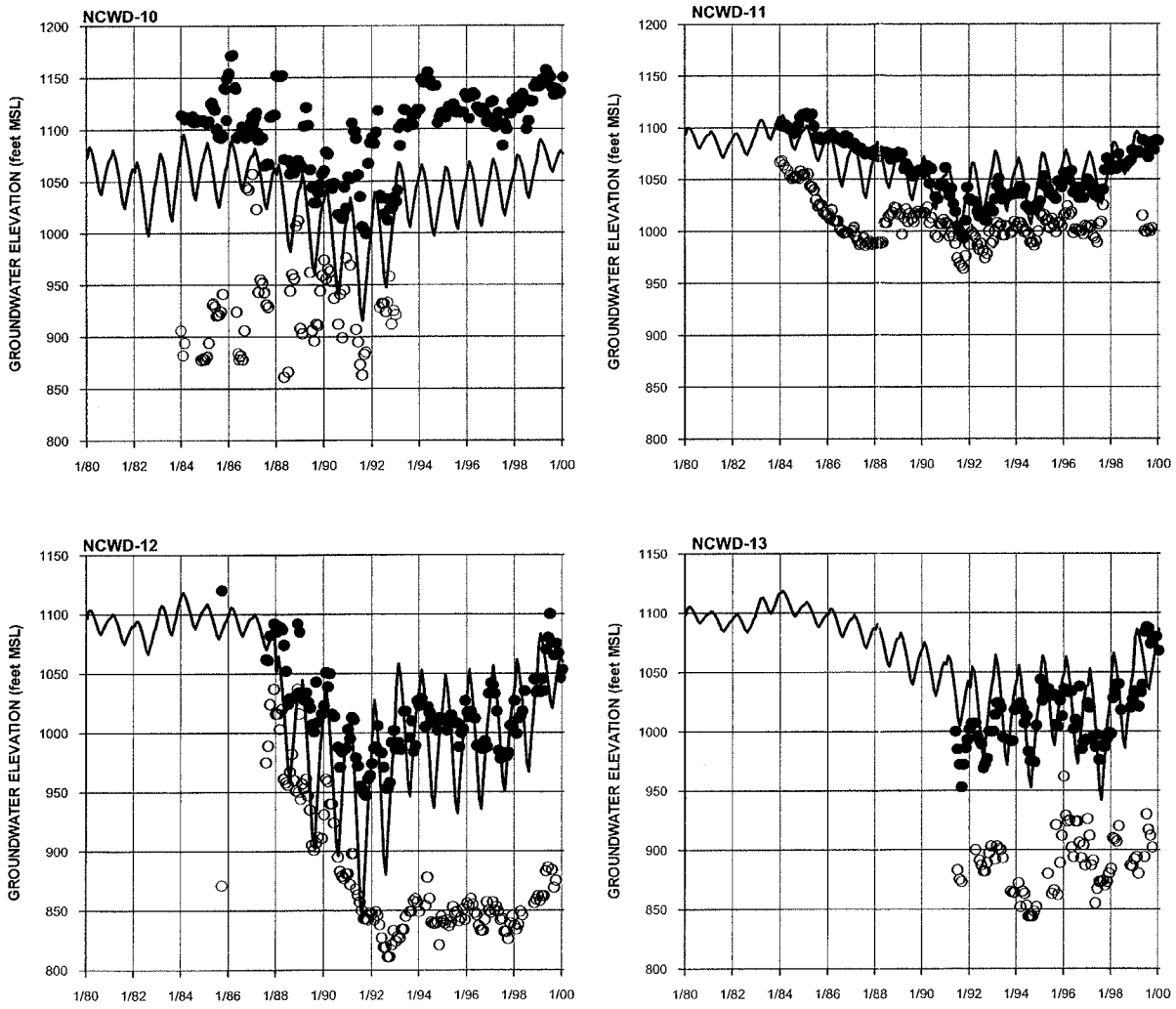


NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 1 0F 3)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

175570-319.GRF

CH2MHILL



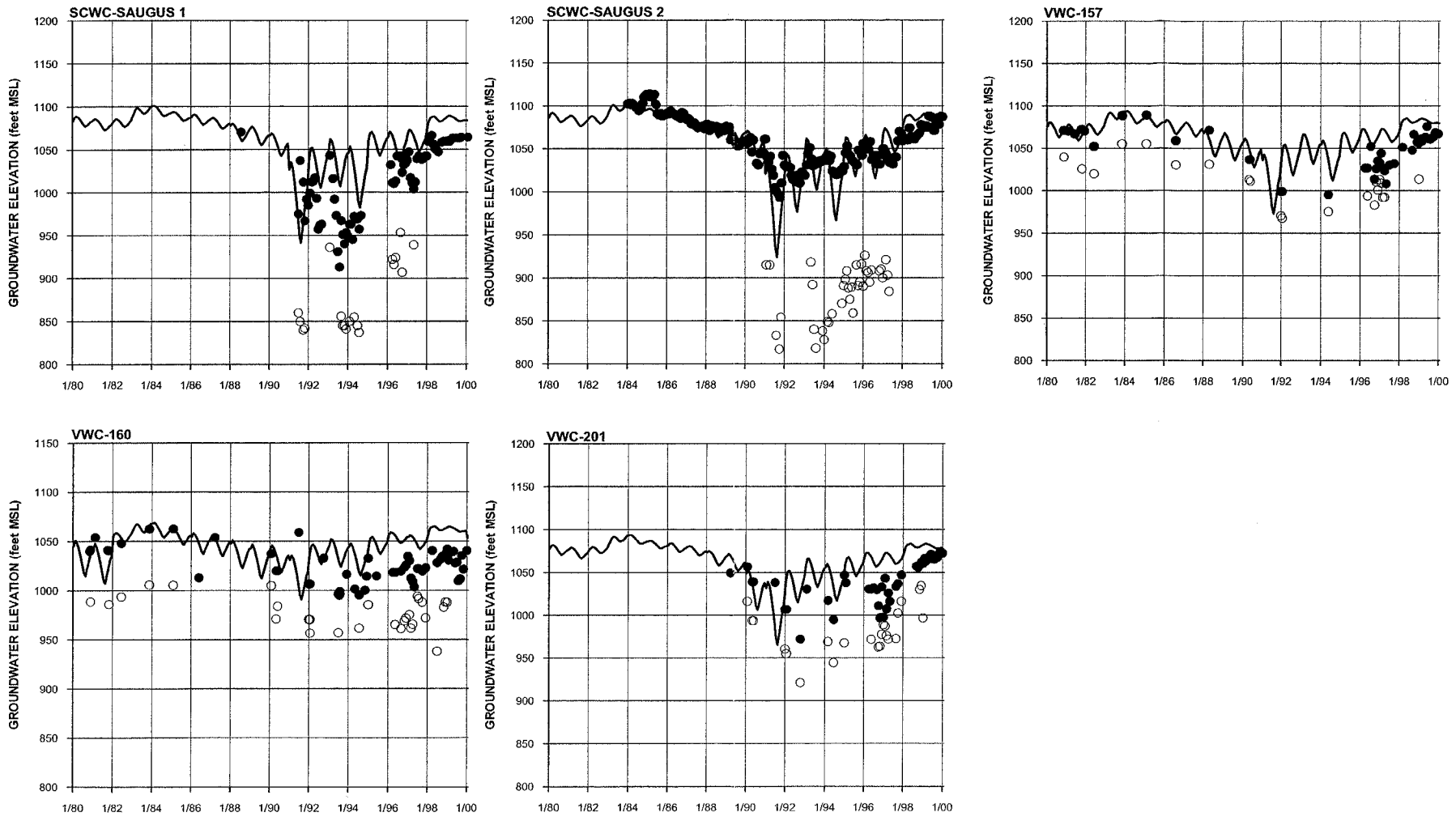
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-317.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 2 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-318.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 3 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

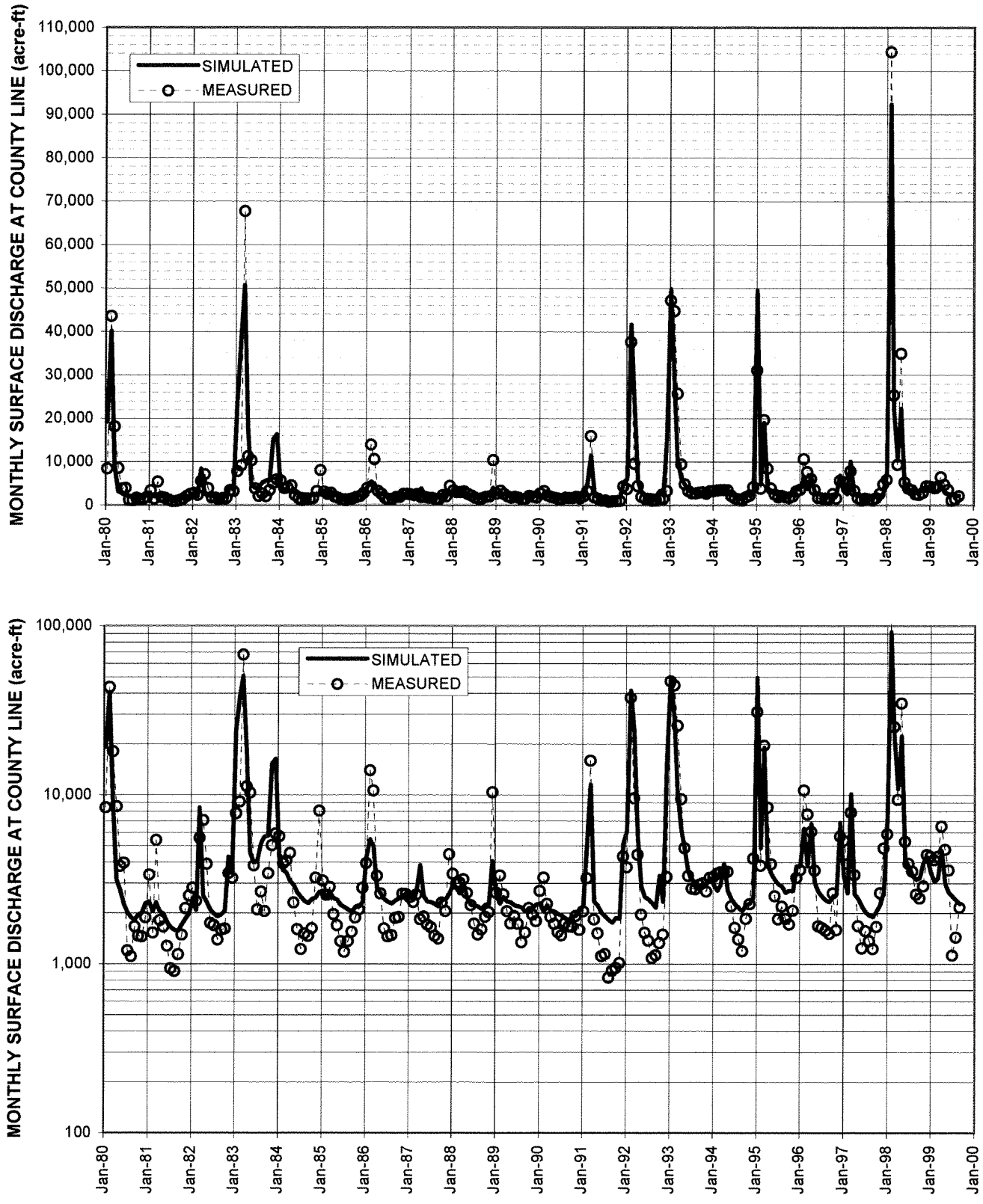


FIGURE 5-26
SIMULATED VERSUS MEASURED HYDROGRAPHS OF SANTA CLARA RIVER FLOW AT COUNTY LINE
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

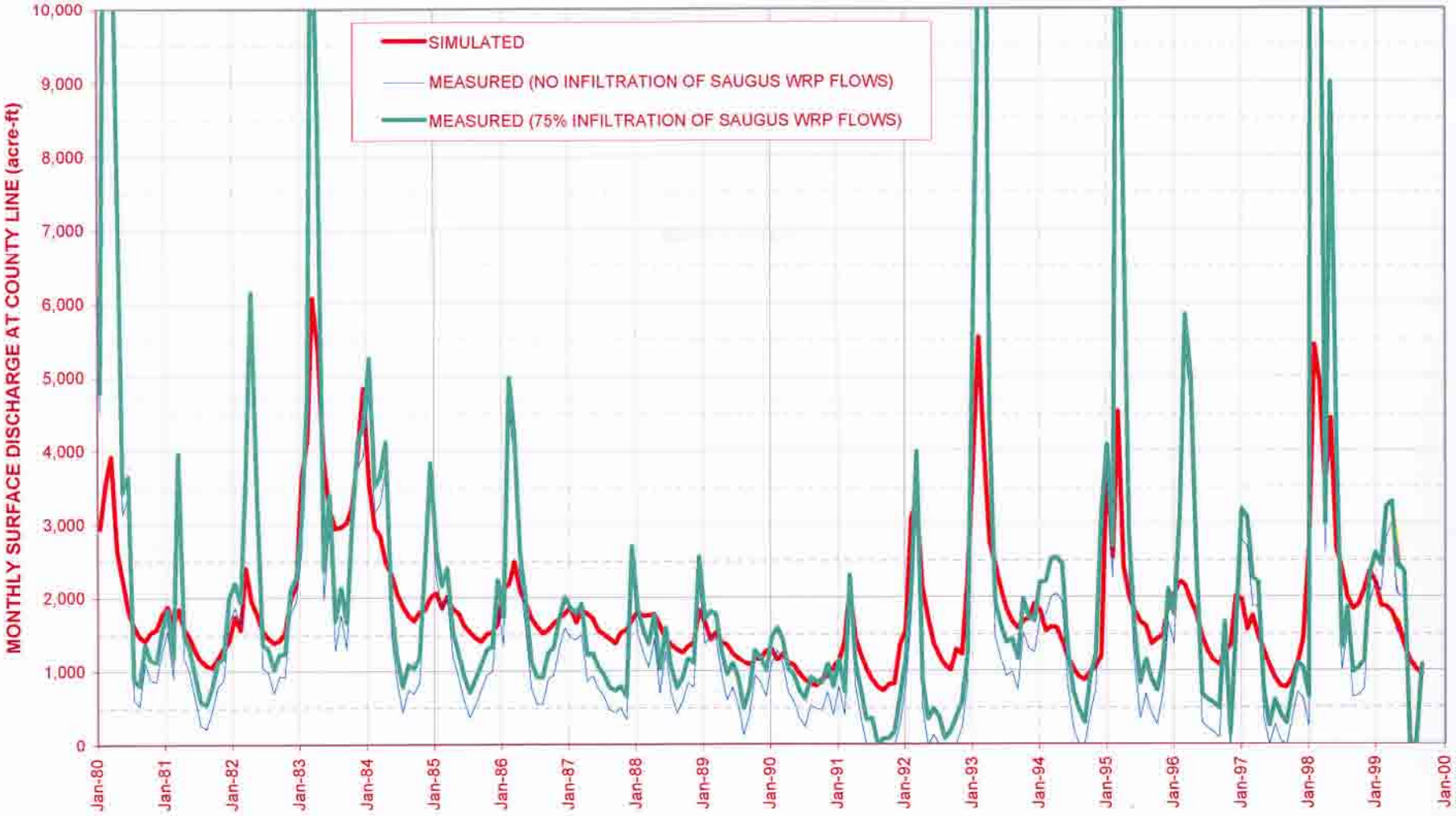


FIGURE 5-27
SIMULATED VERSUS MEASURED HYDROGRAPH OF GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

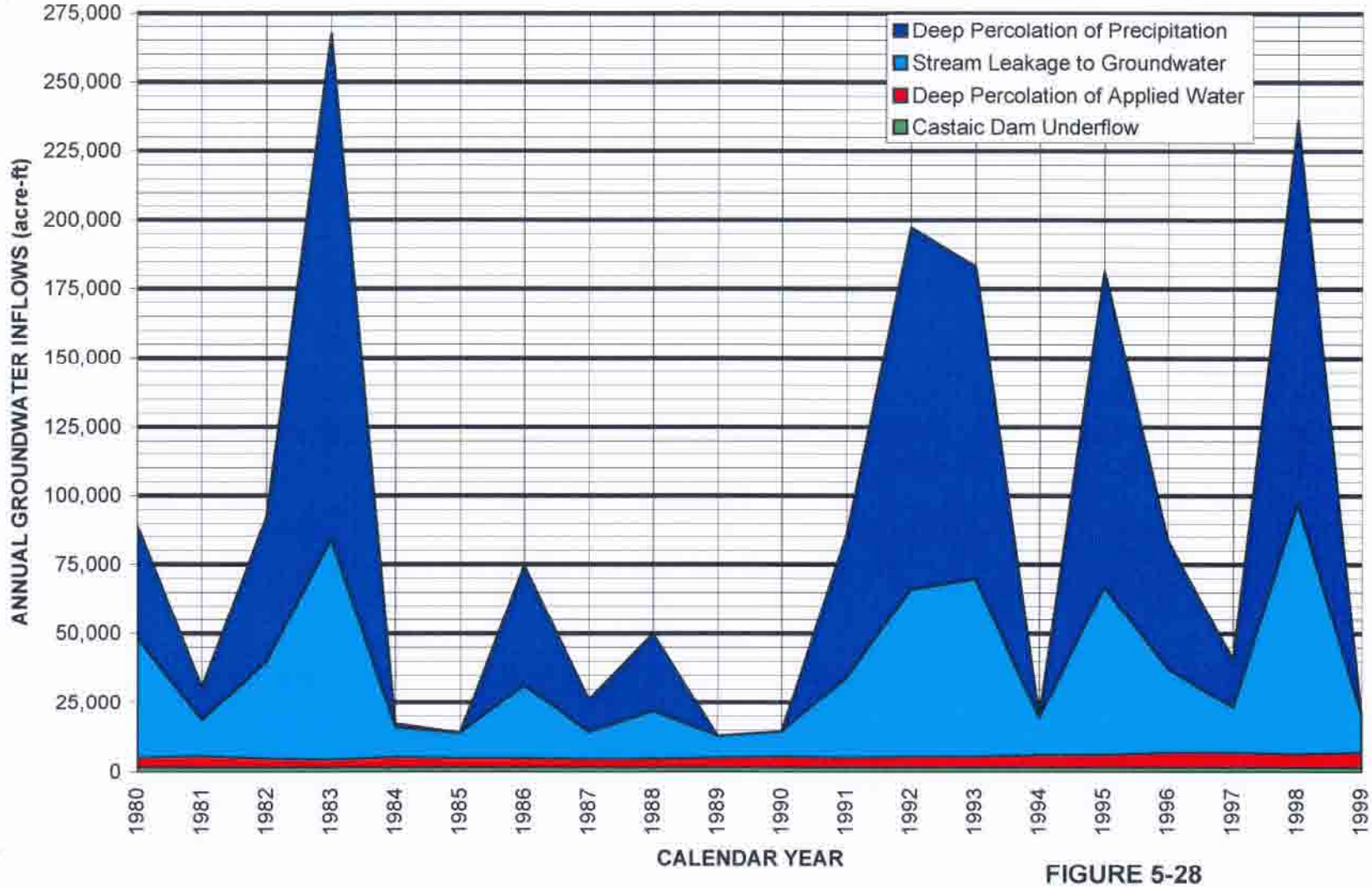


FIGURE 5-28
ANNUAL GROUNDWATER INFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-28

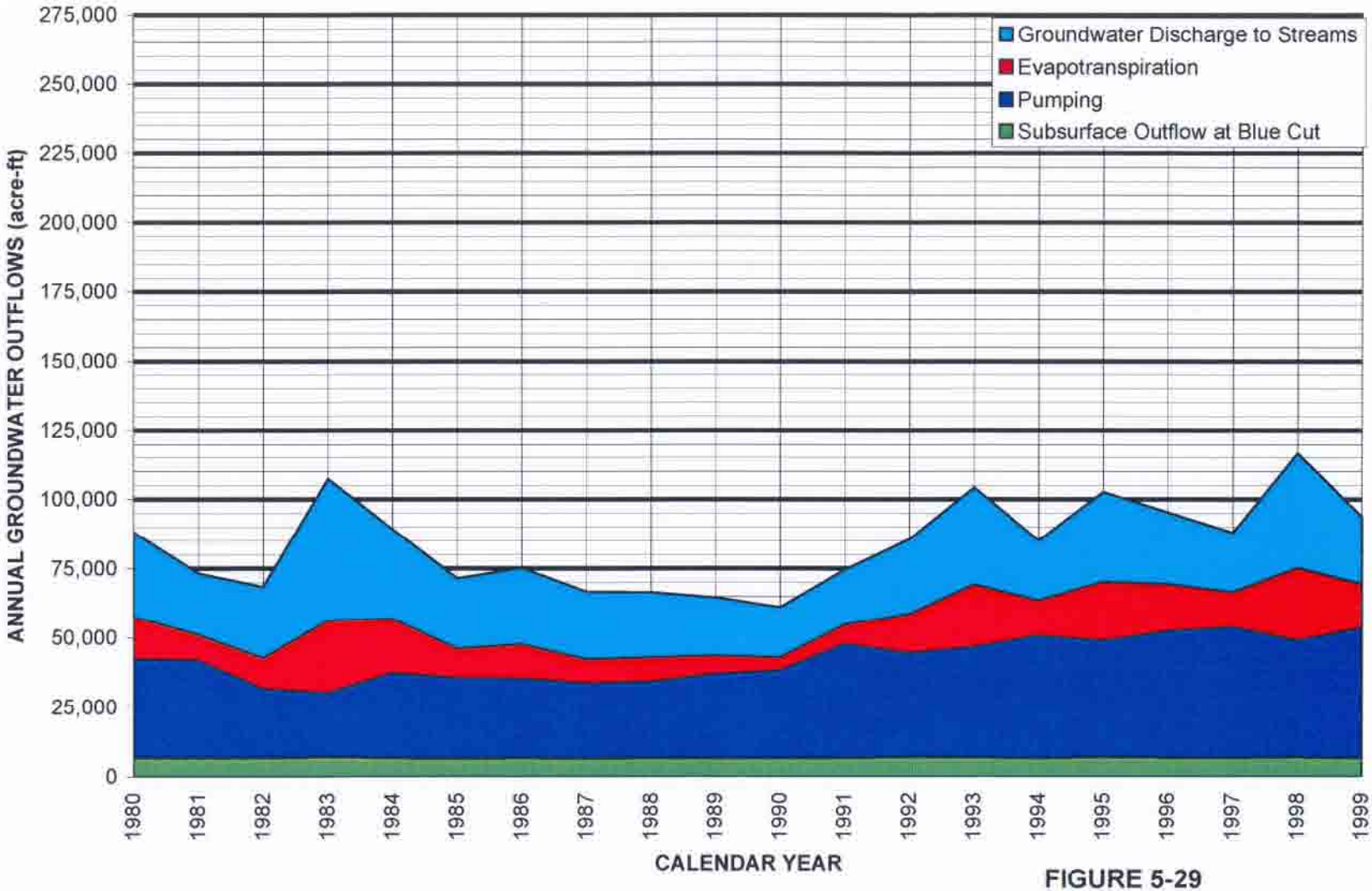


FIGURE 5-29
ANNUAL GROUNDWATER OUTFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-29

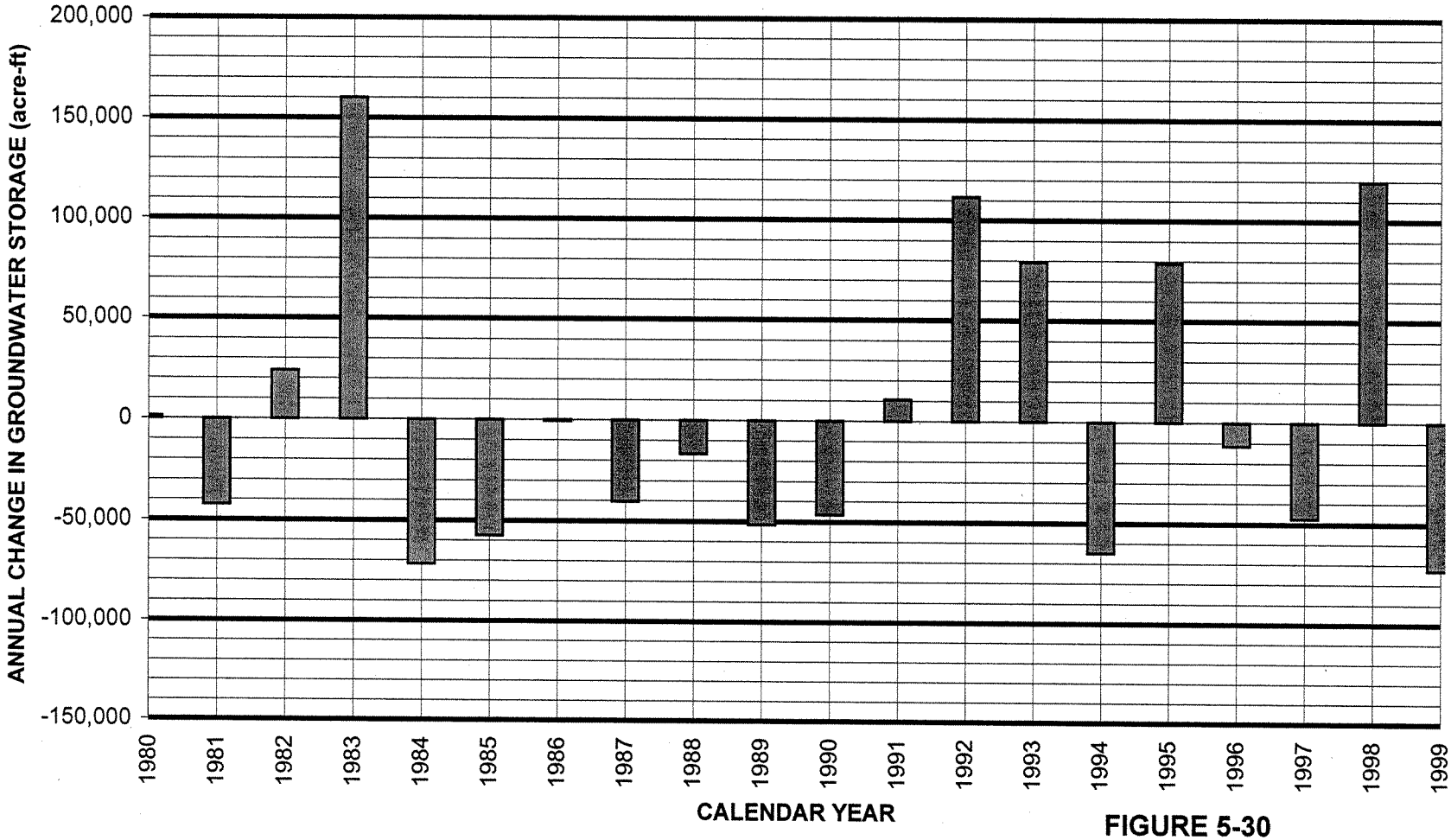


FIGURE 5-30
ANNUAL CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-30

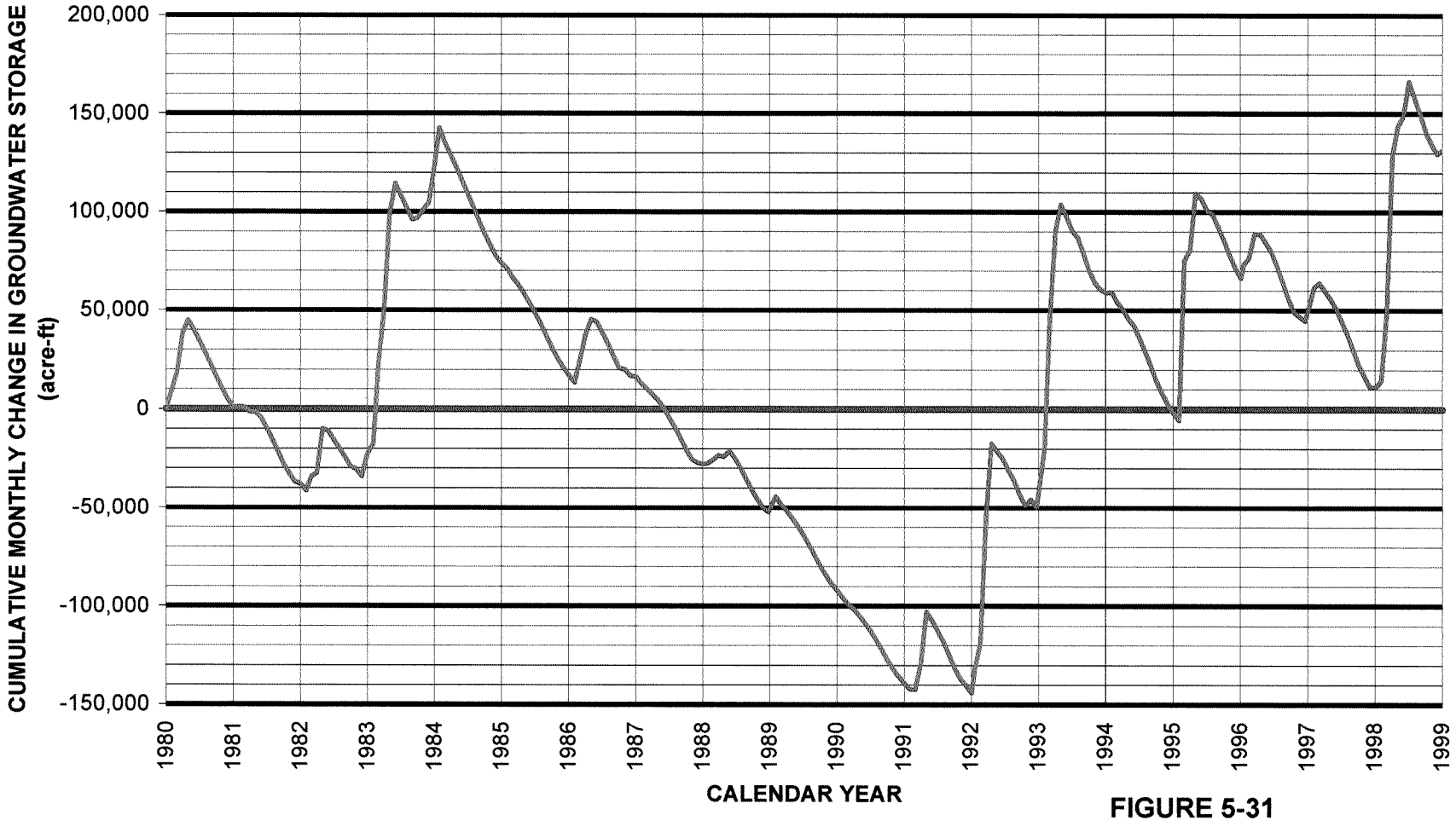


FIGURE 5-31
CUMULATIVE CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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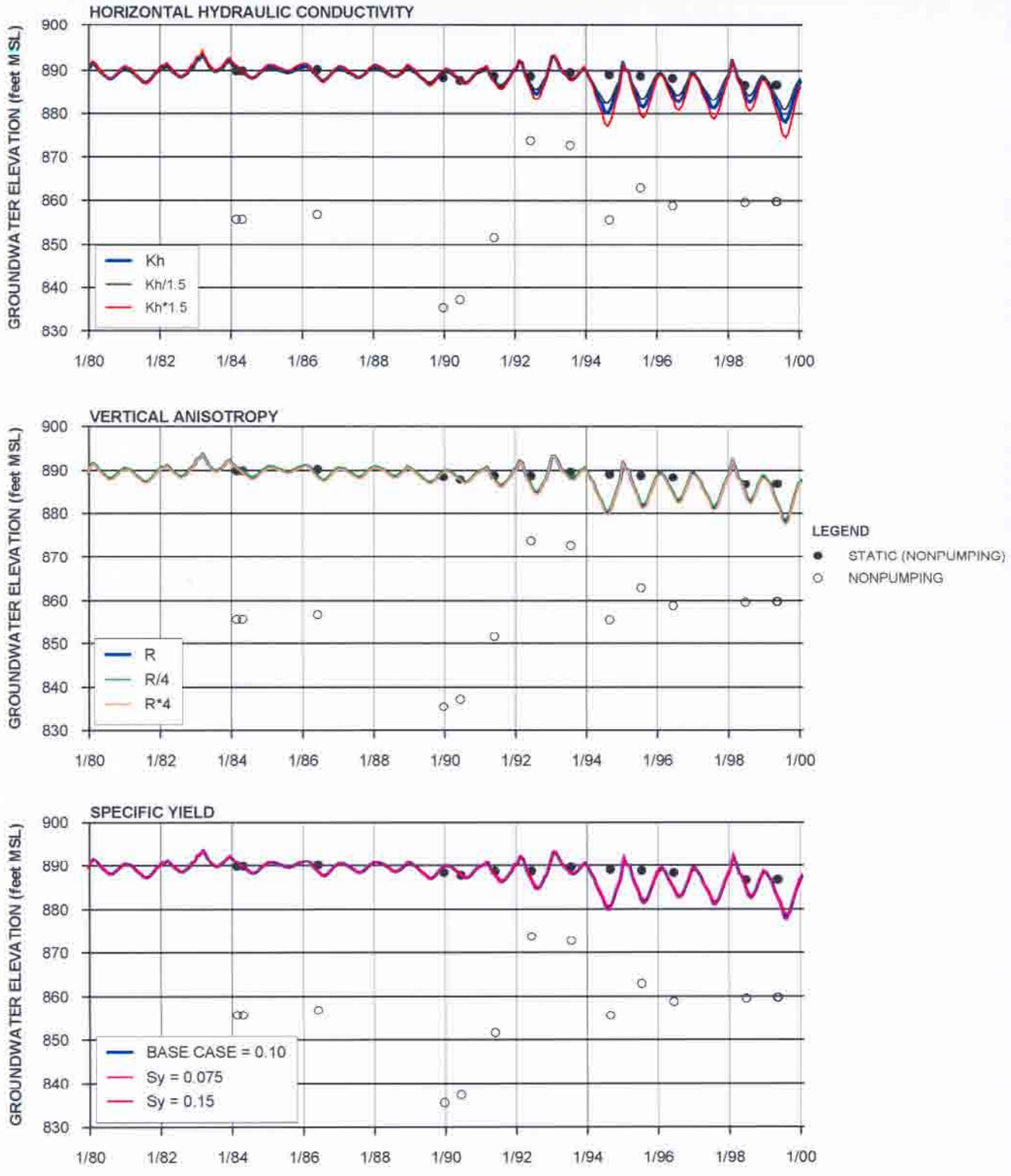
04/04/2004
178973-410.xls/Fig 5-31



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-32
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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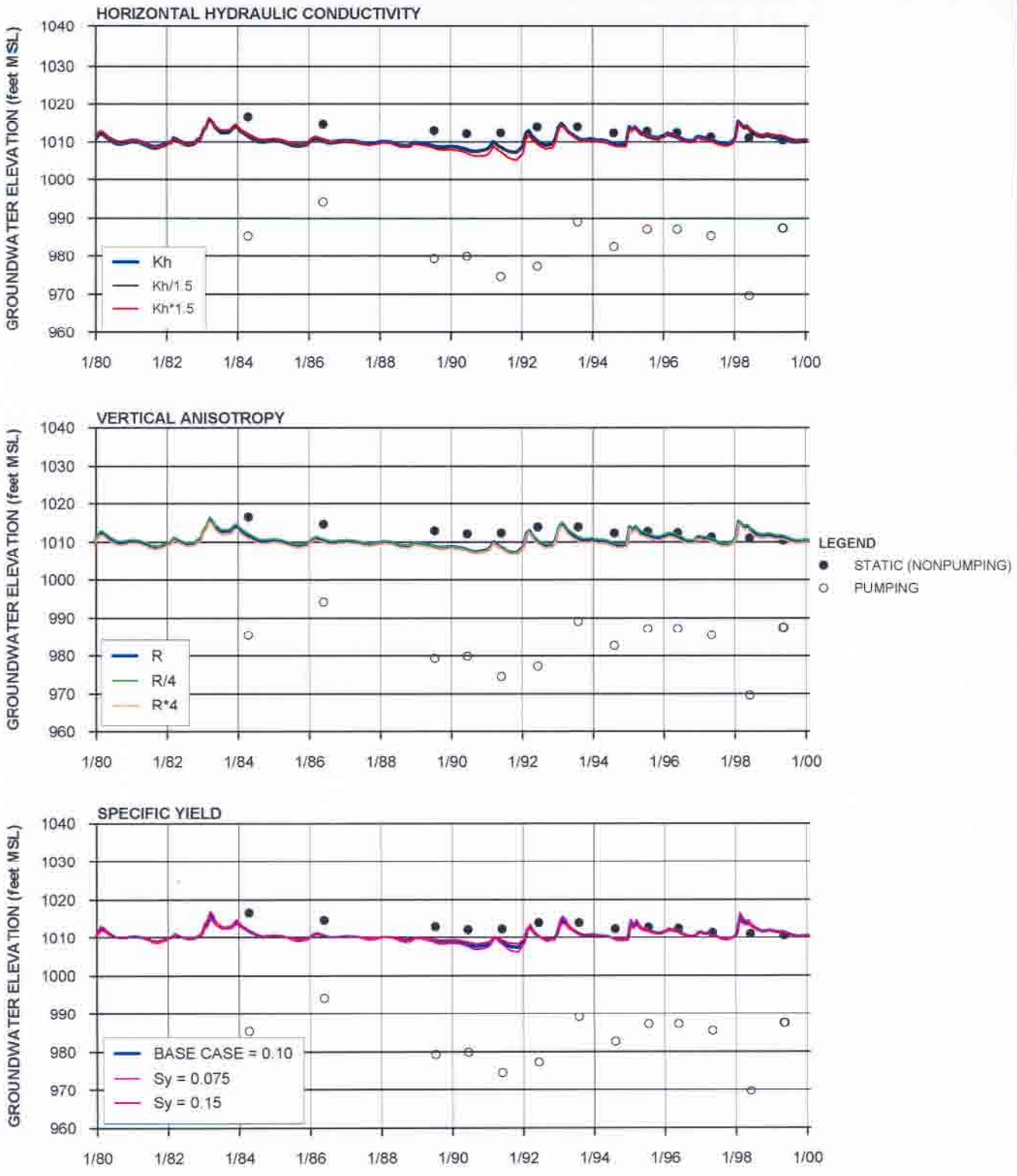

NOTES:
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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-33
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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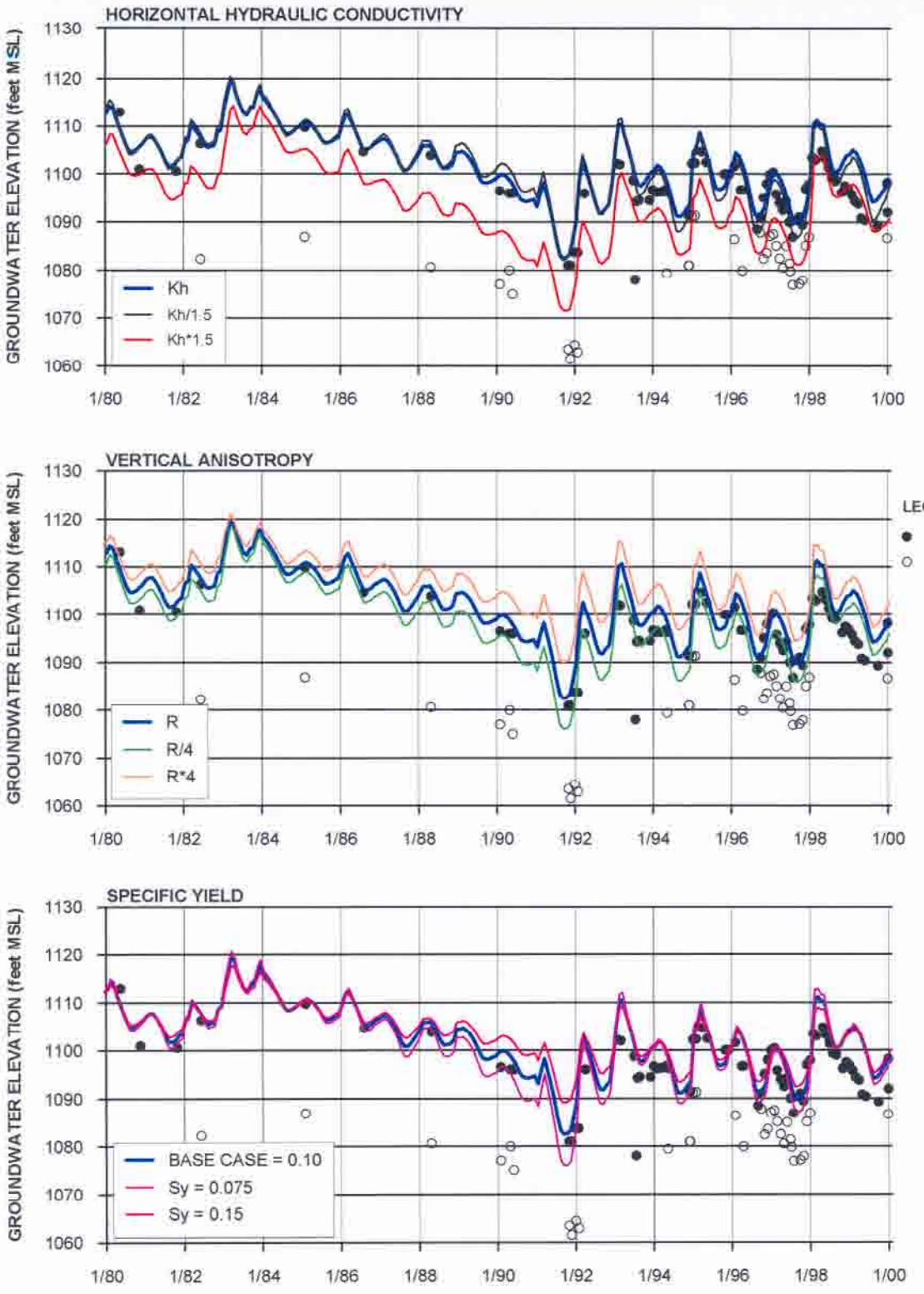

NOTES:
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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-34
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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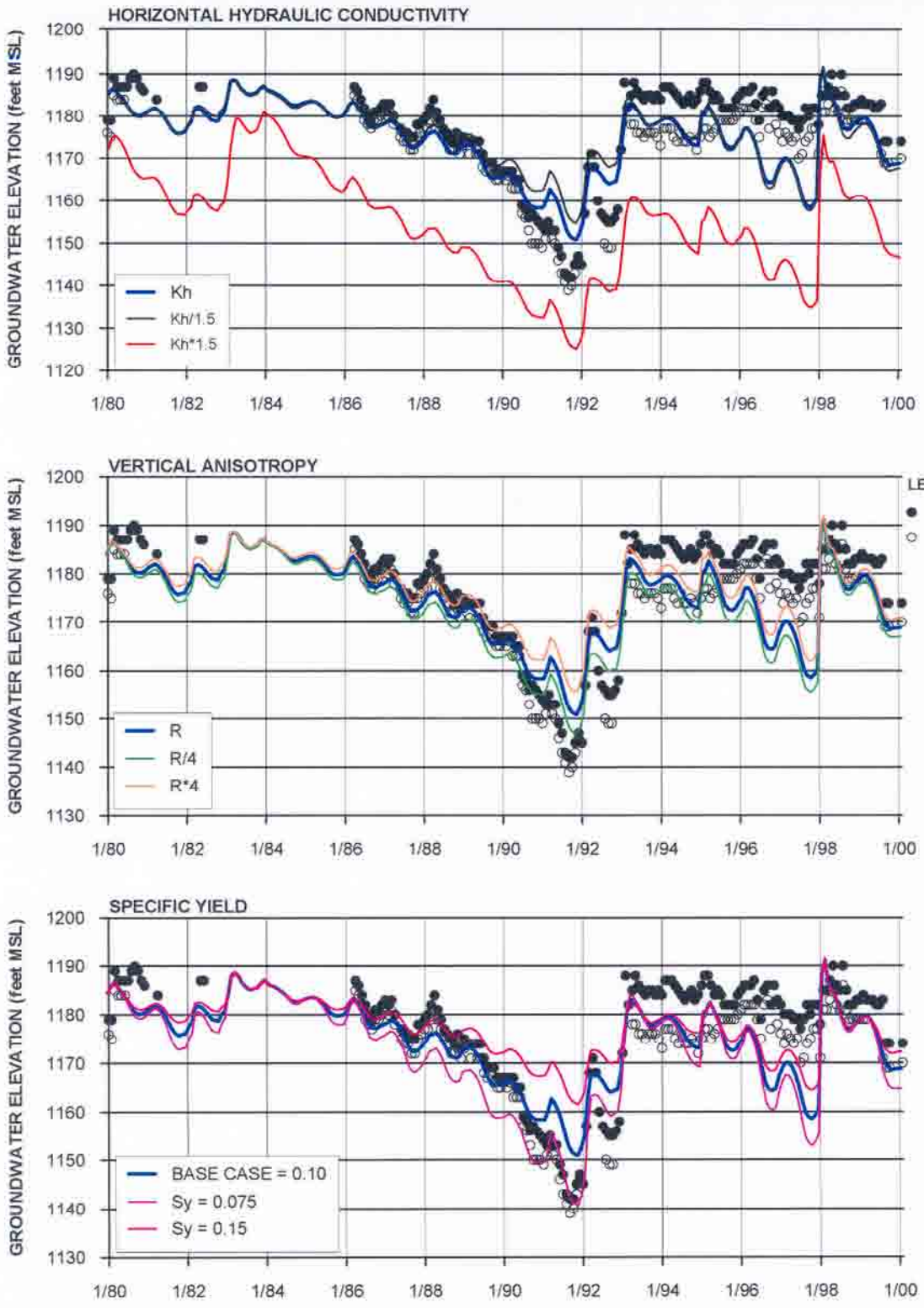

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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-35
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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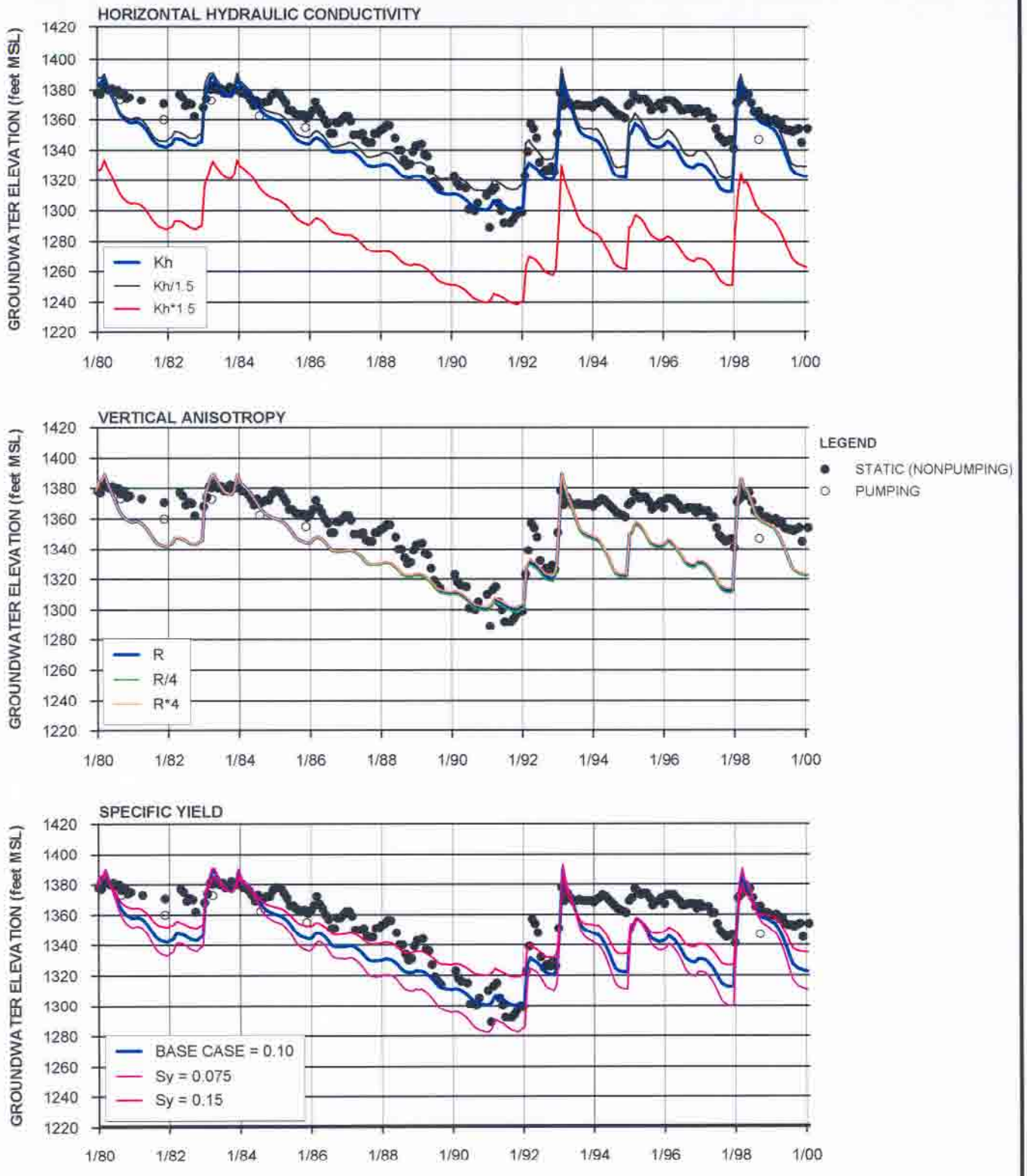

NOTES:
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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-36
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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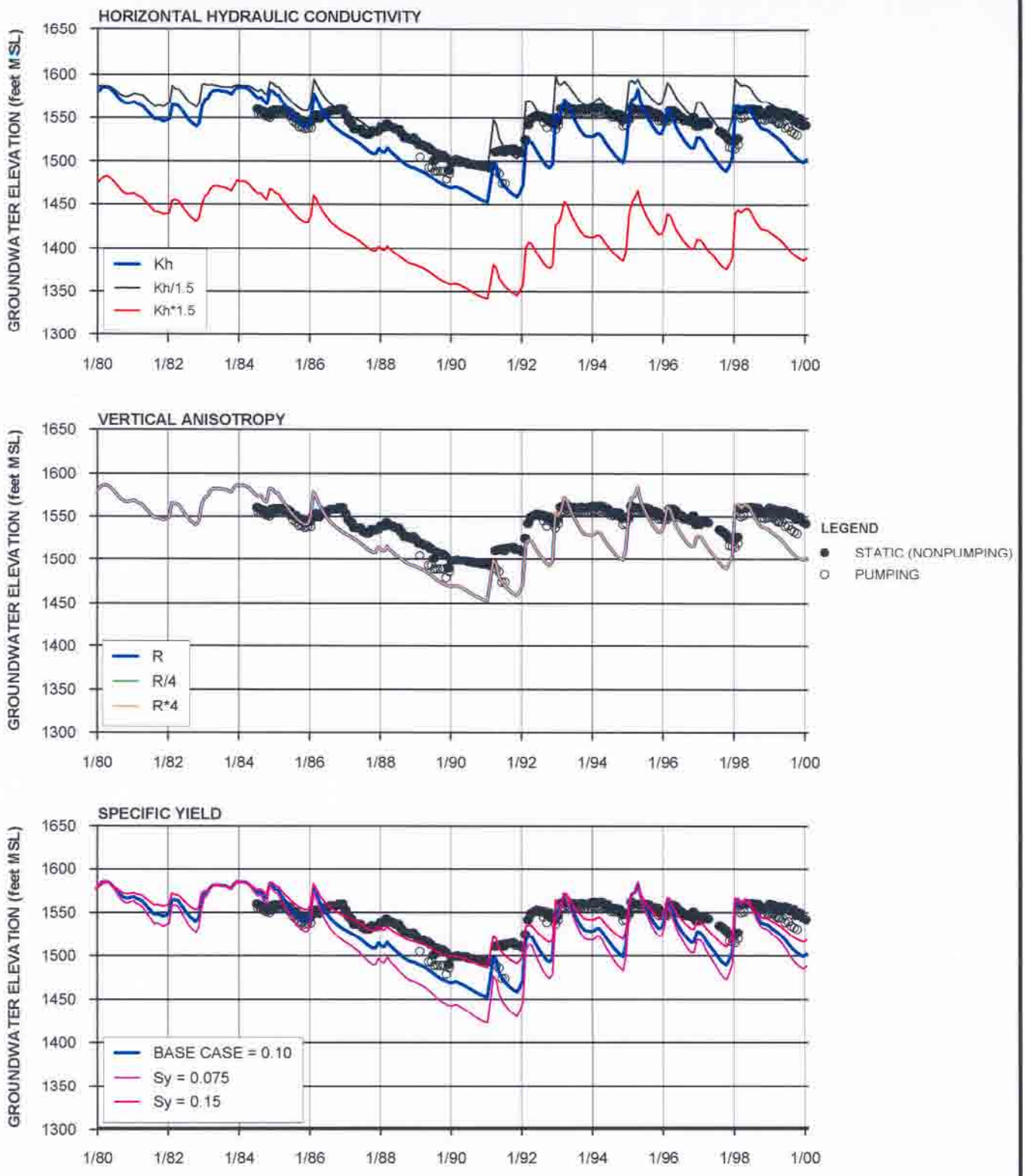

NOTES:
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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-37
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NCWD-PINETREE1 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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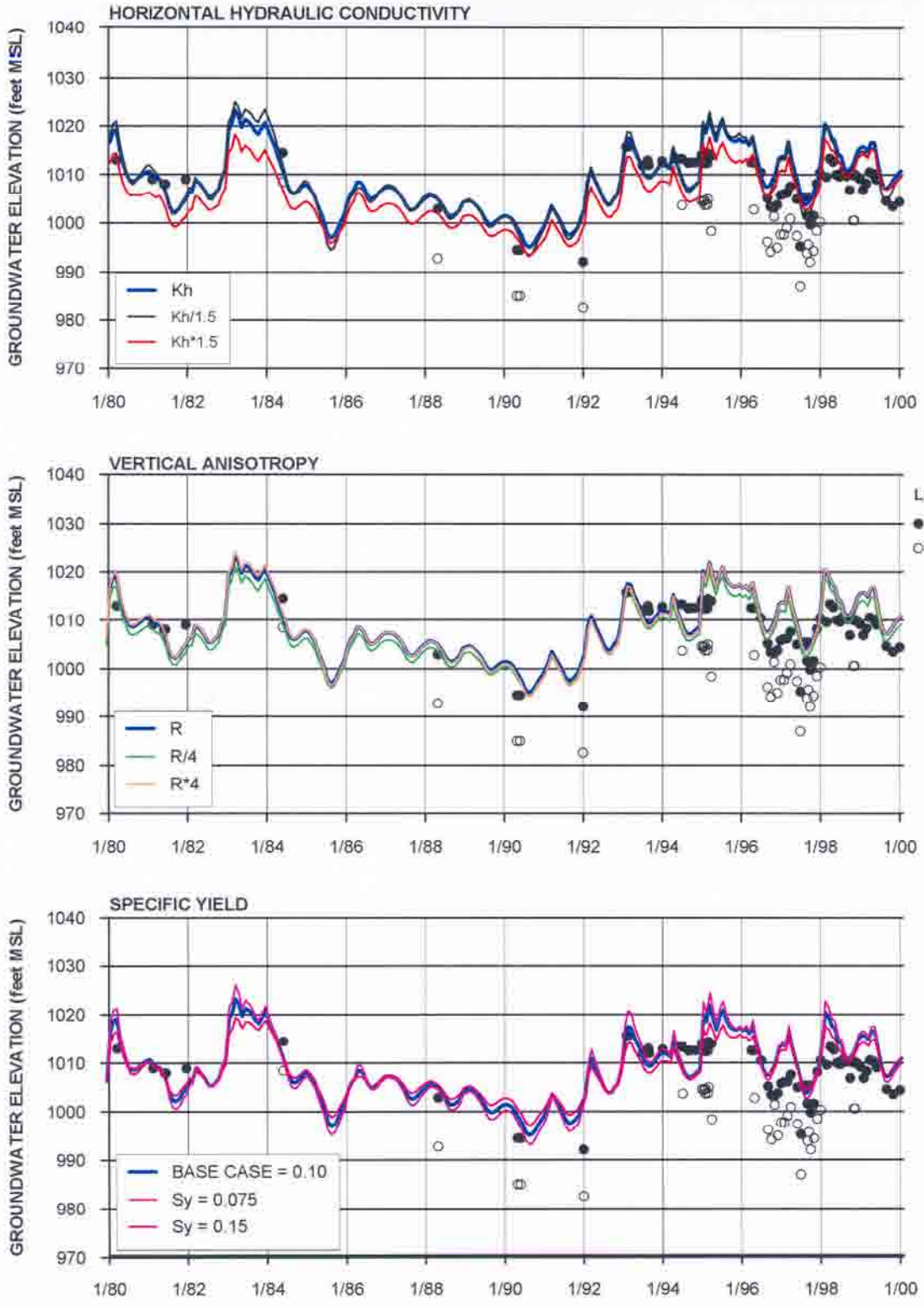

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3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-38
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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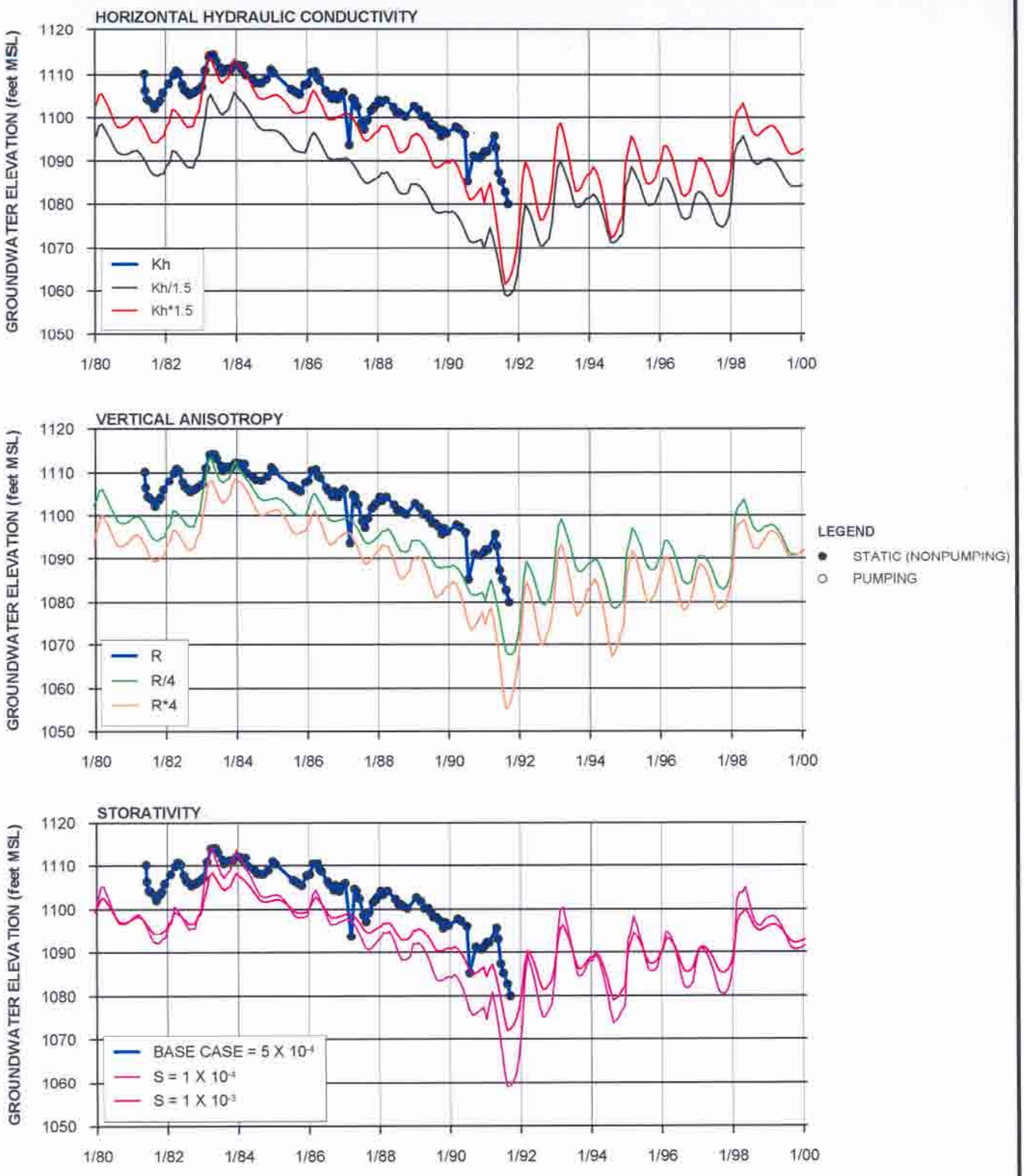

NOTES:
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2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-39
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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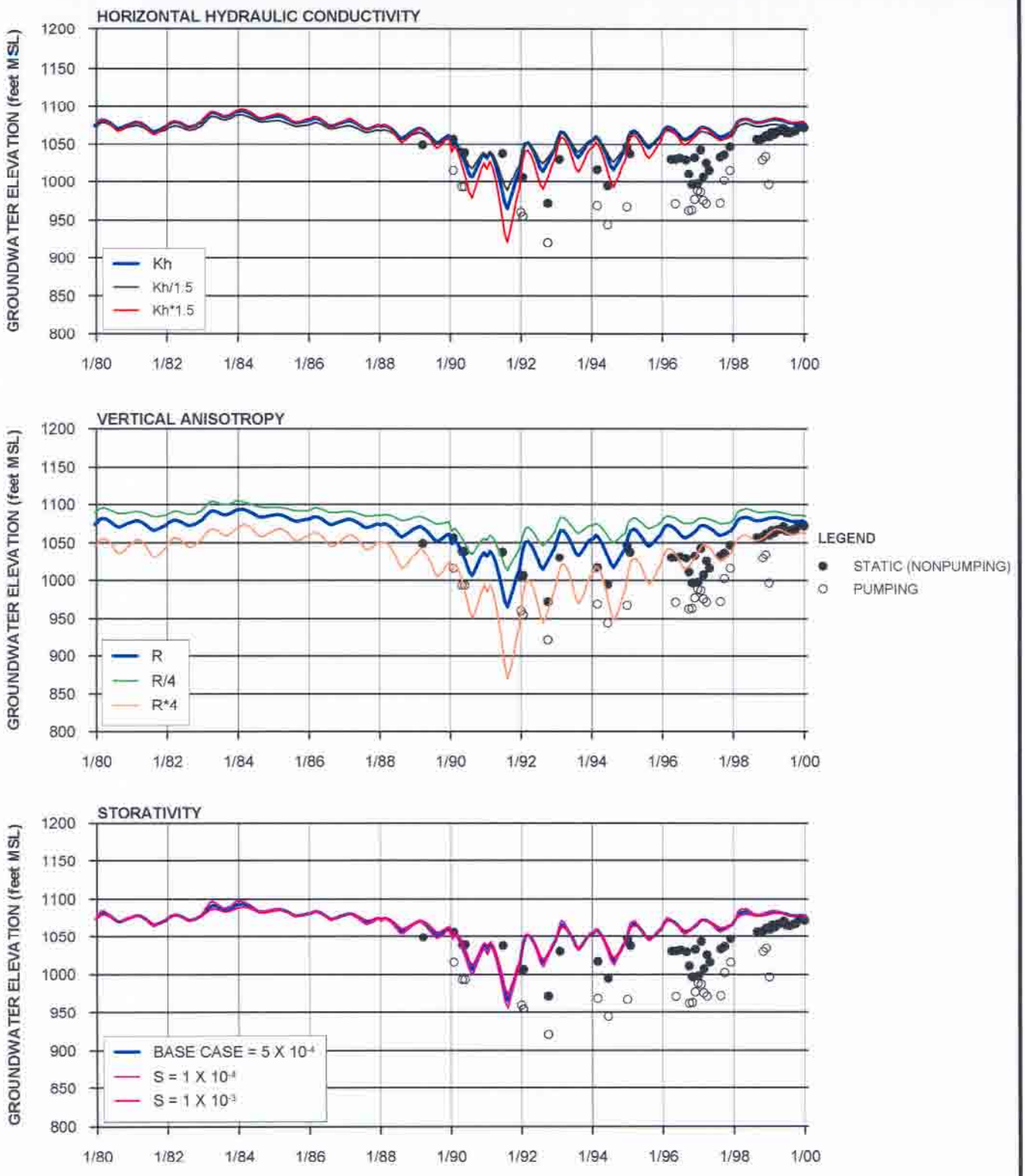

NOTES:
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3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-40
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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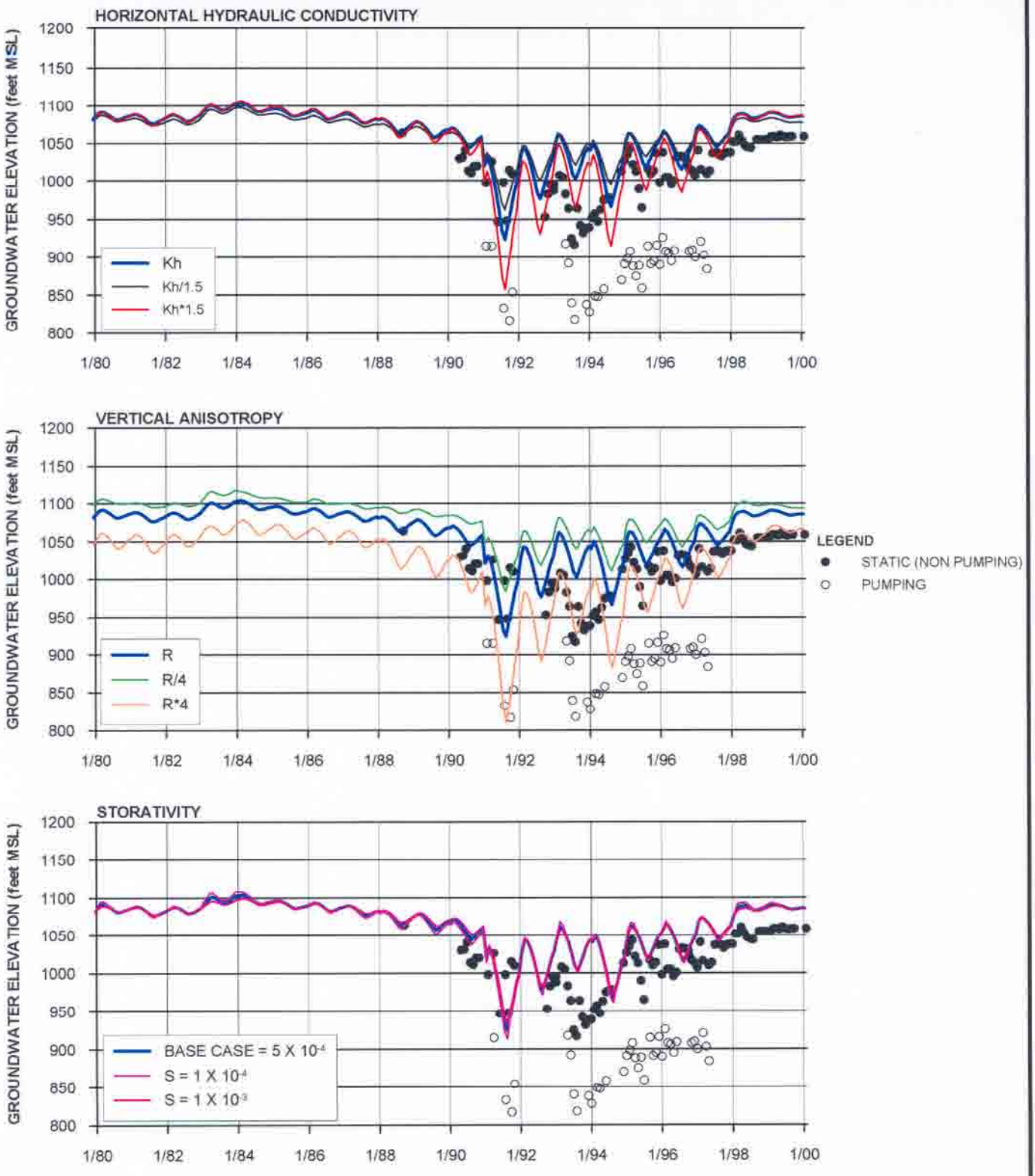

FIGURE 5-41
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

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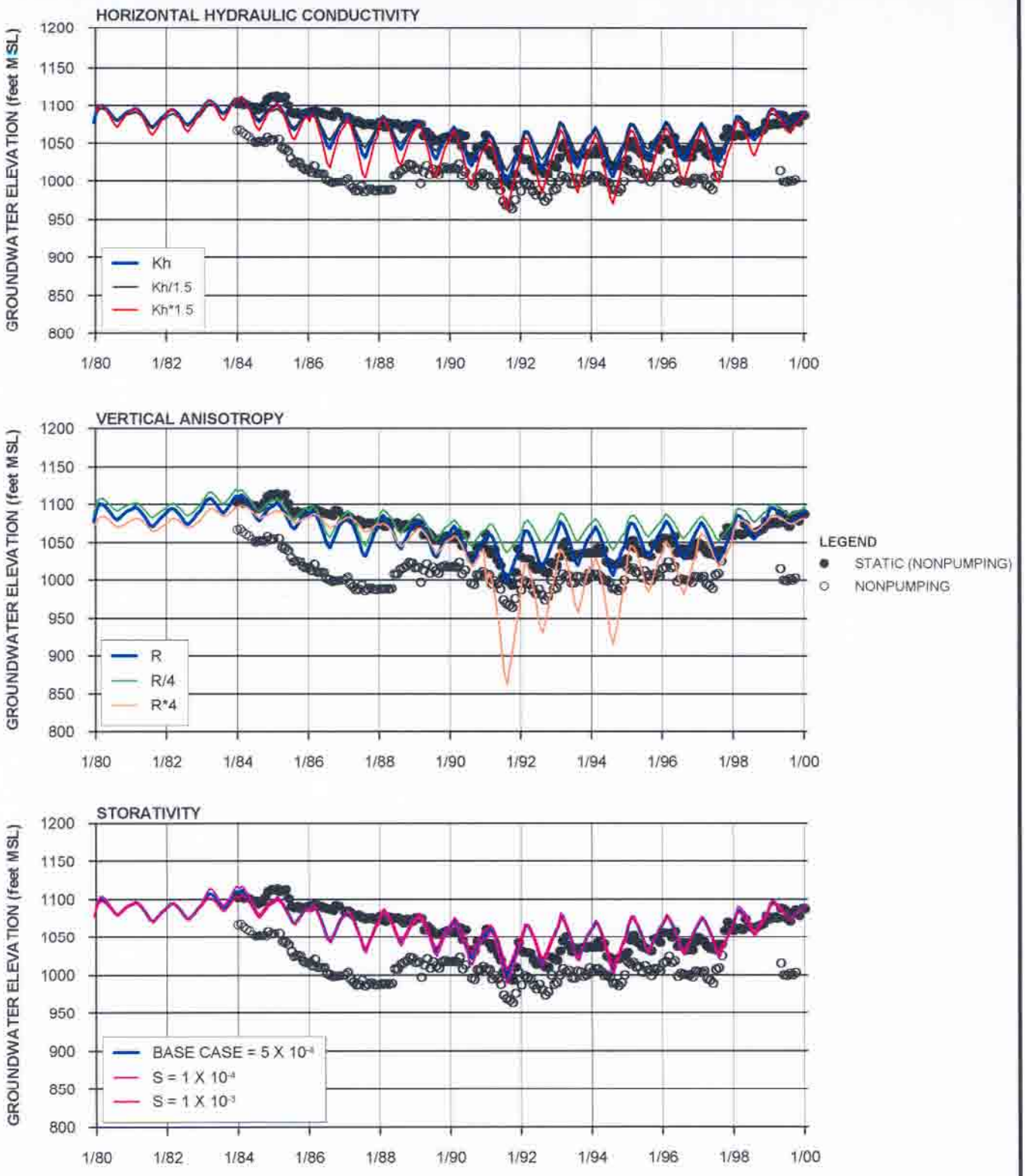

NOTES:
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2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-42
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO AQUIFER PARAMETER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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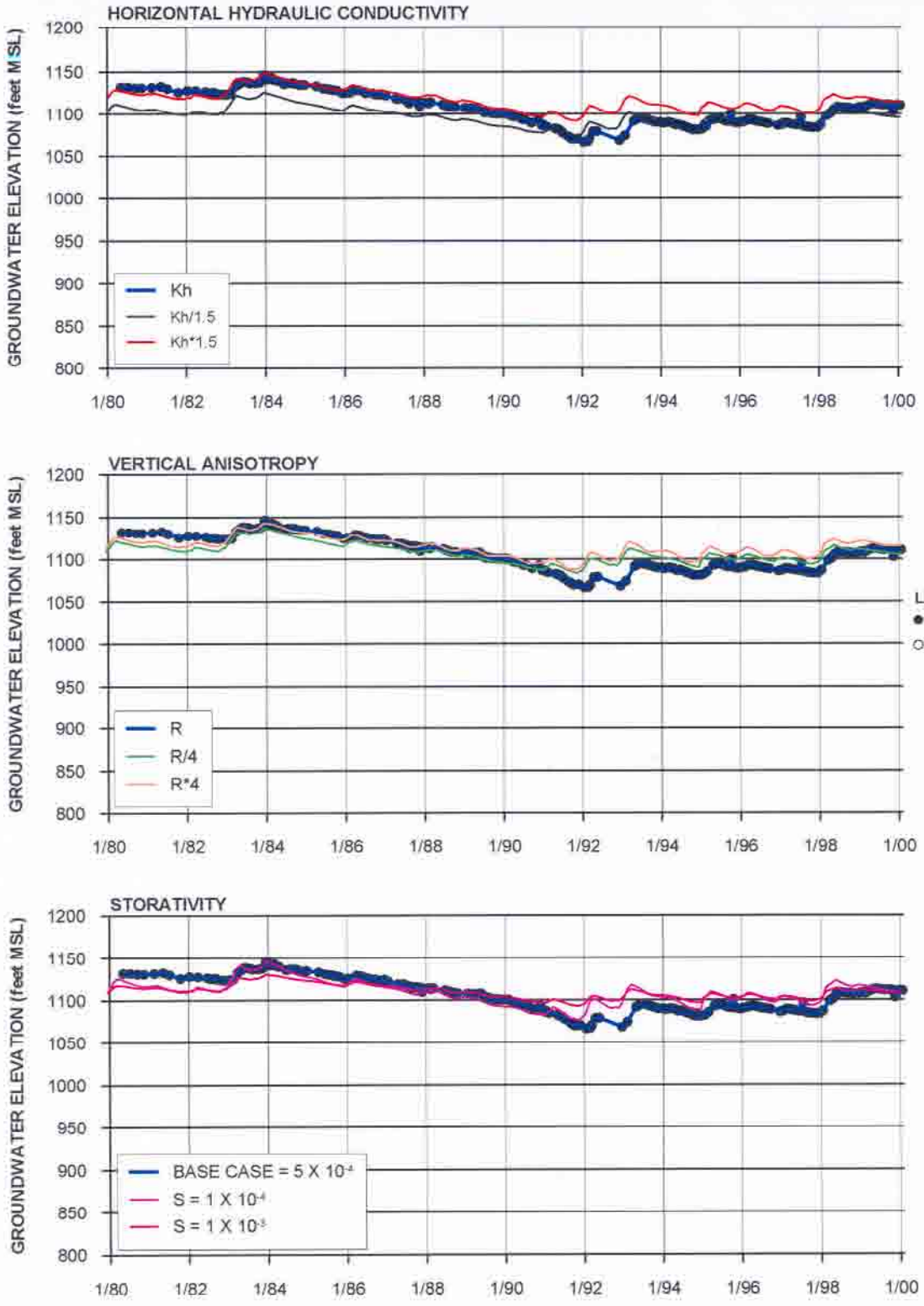

NOTES:
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2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-43
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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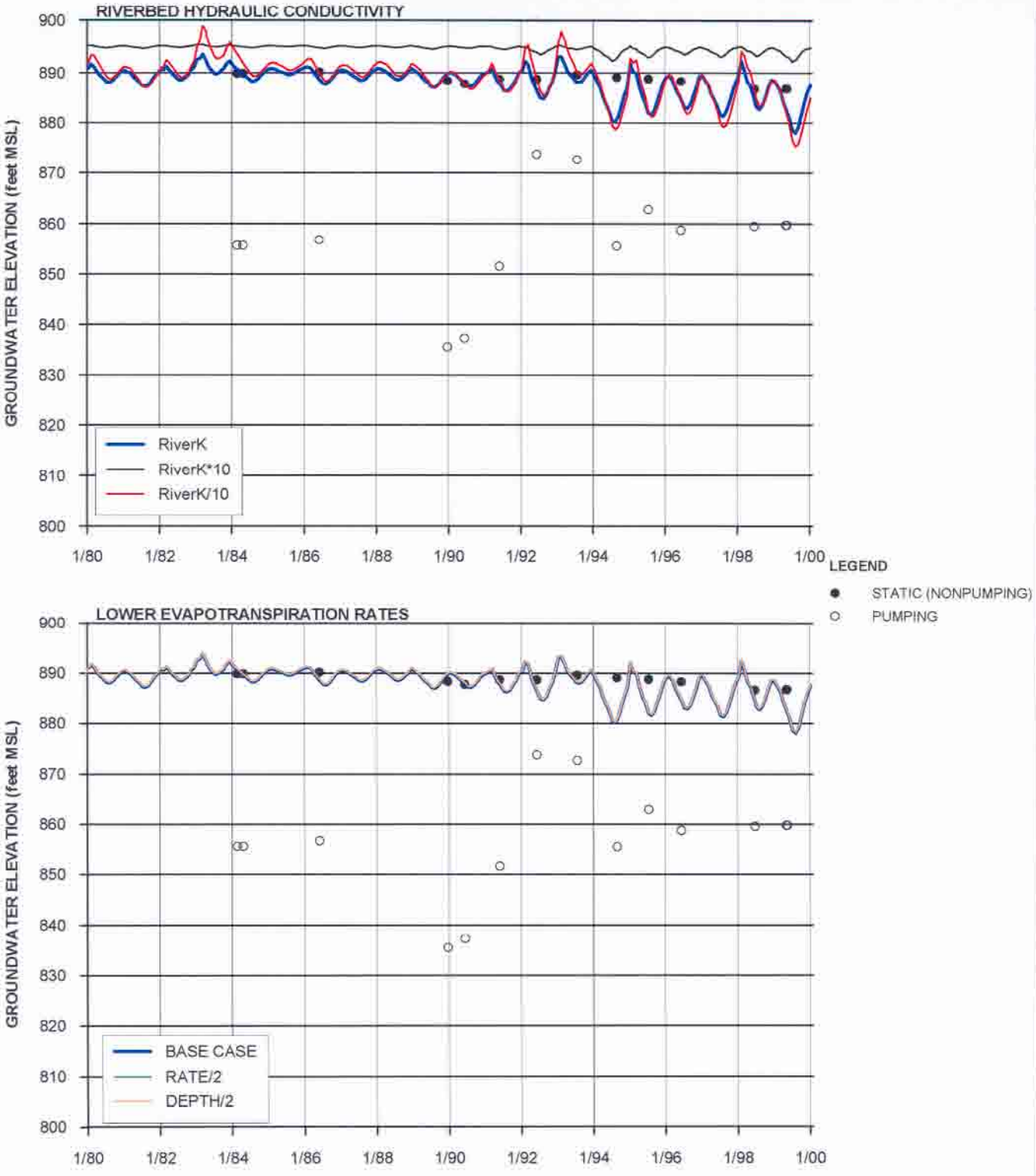

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-44
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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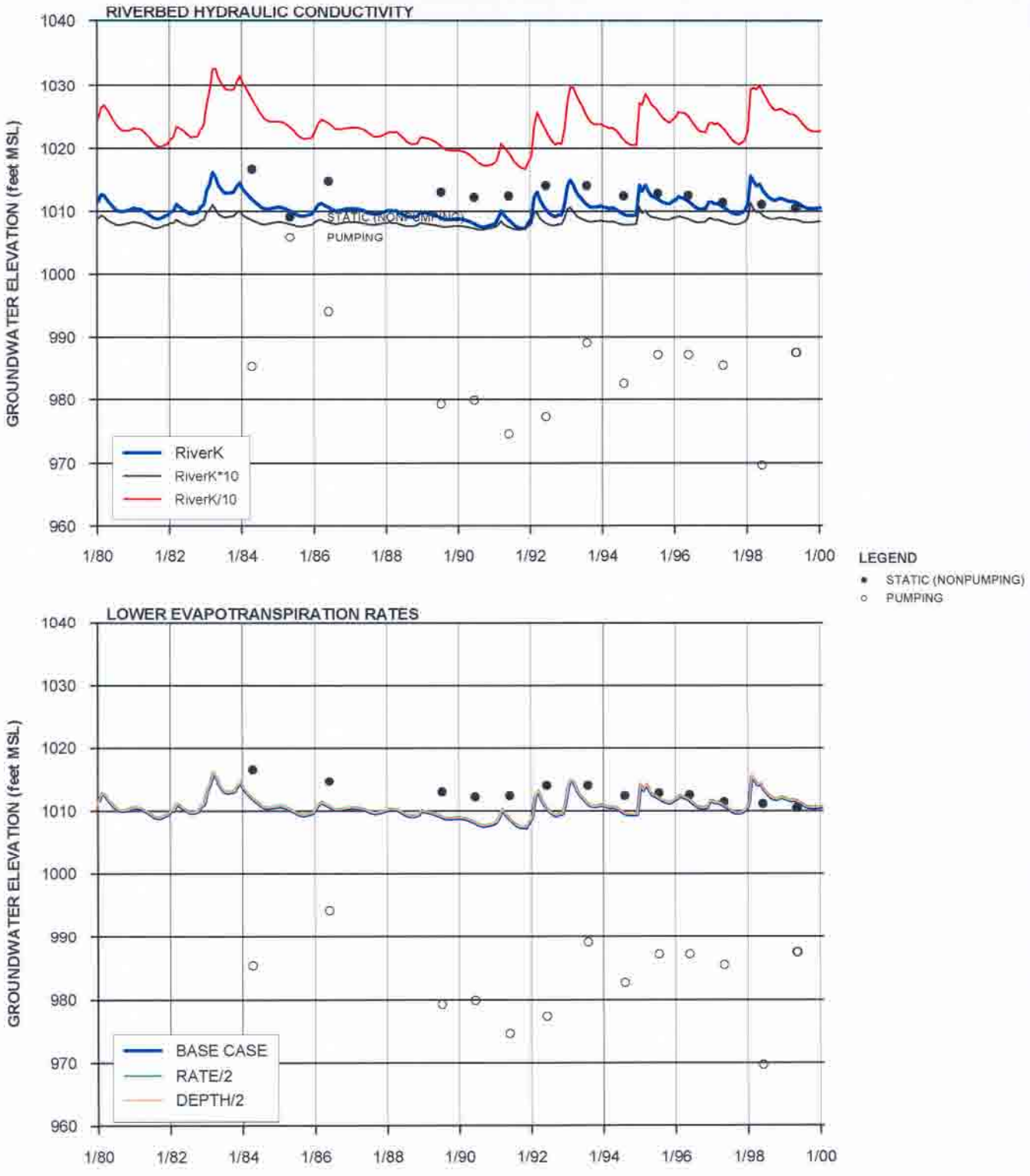

NOTES:
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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-45
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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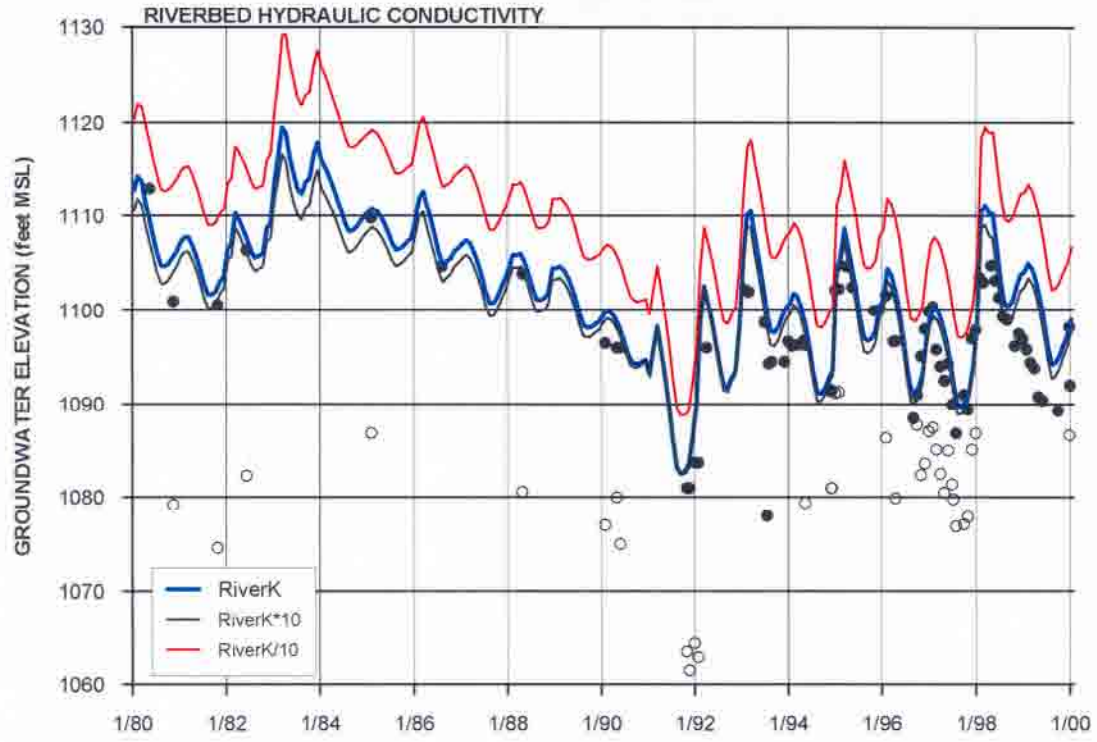

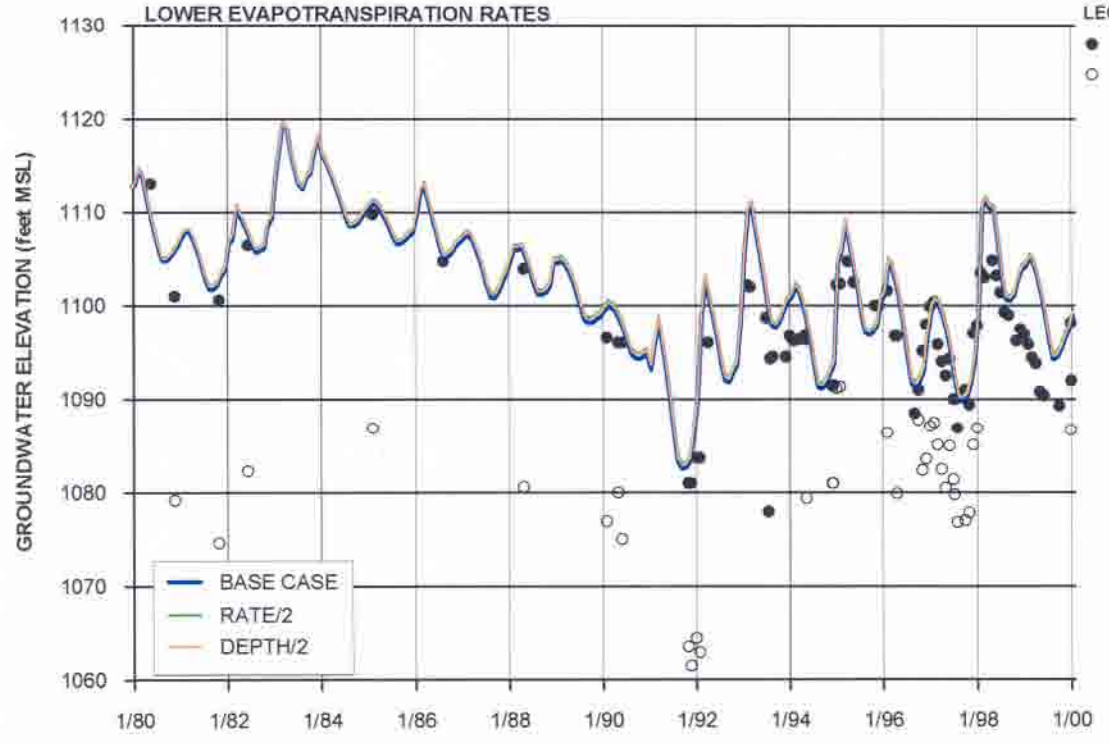

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-46
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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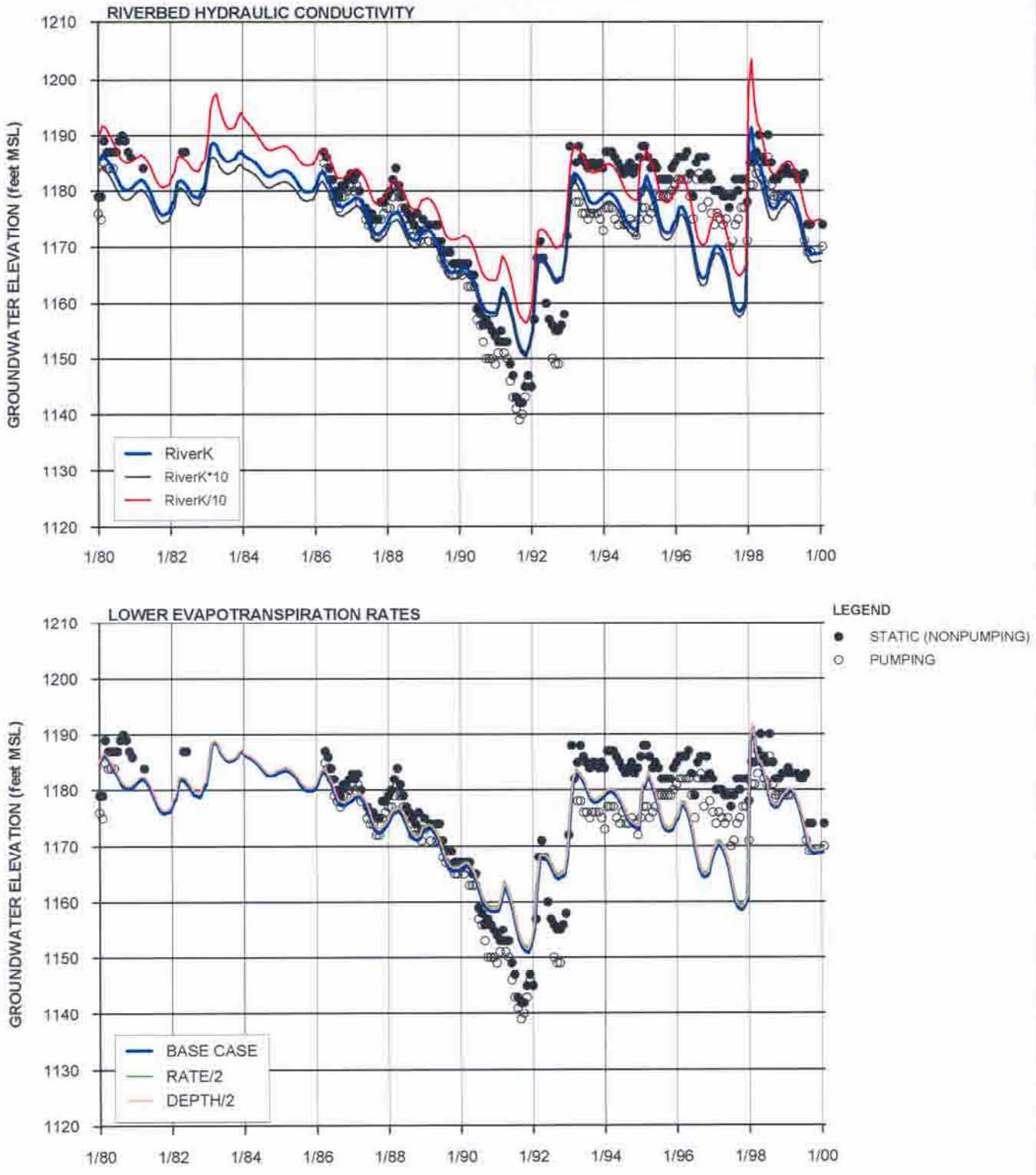

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-47
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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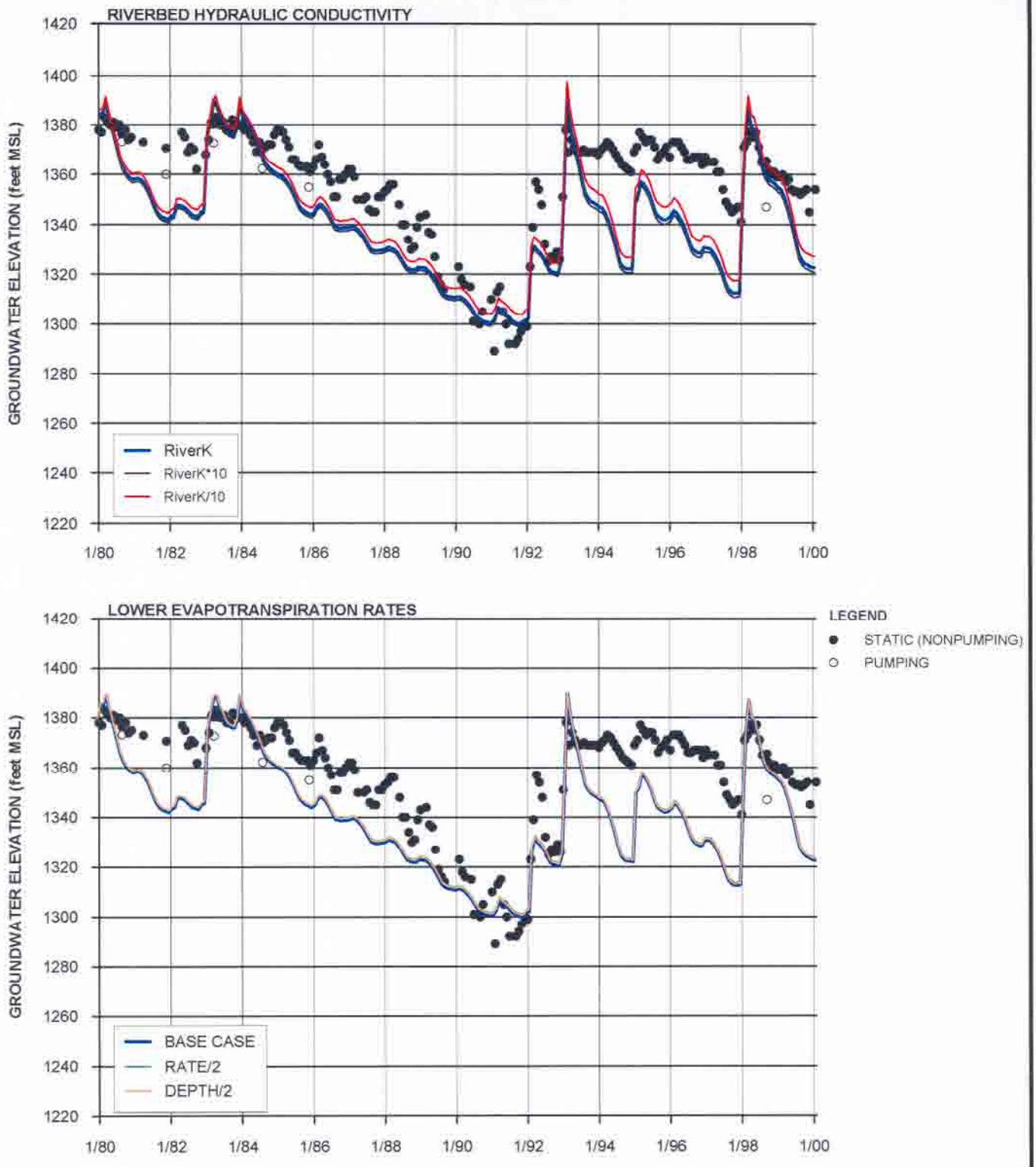

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-48
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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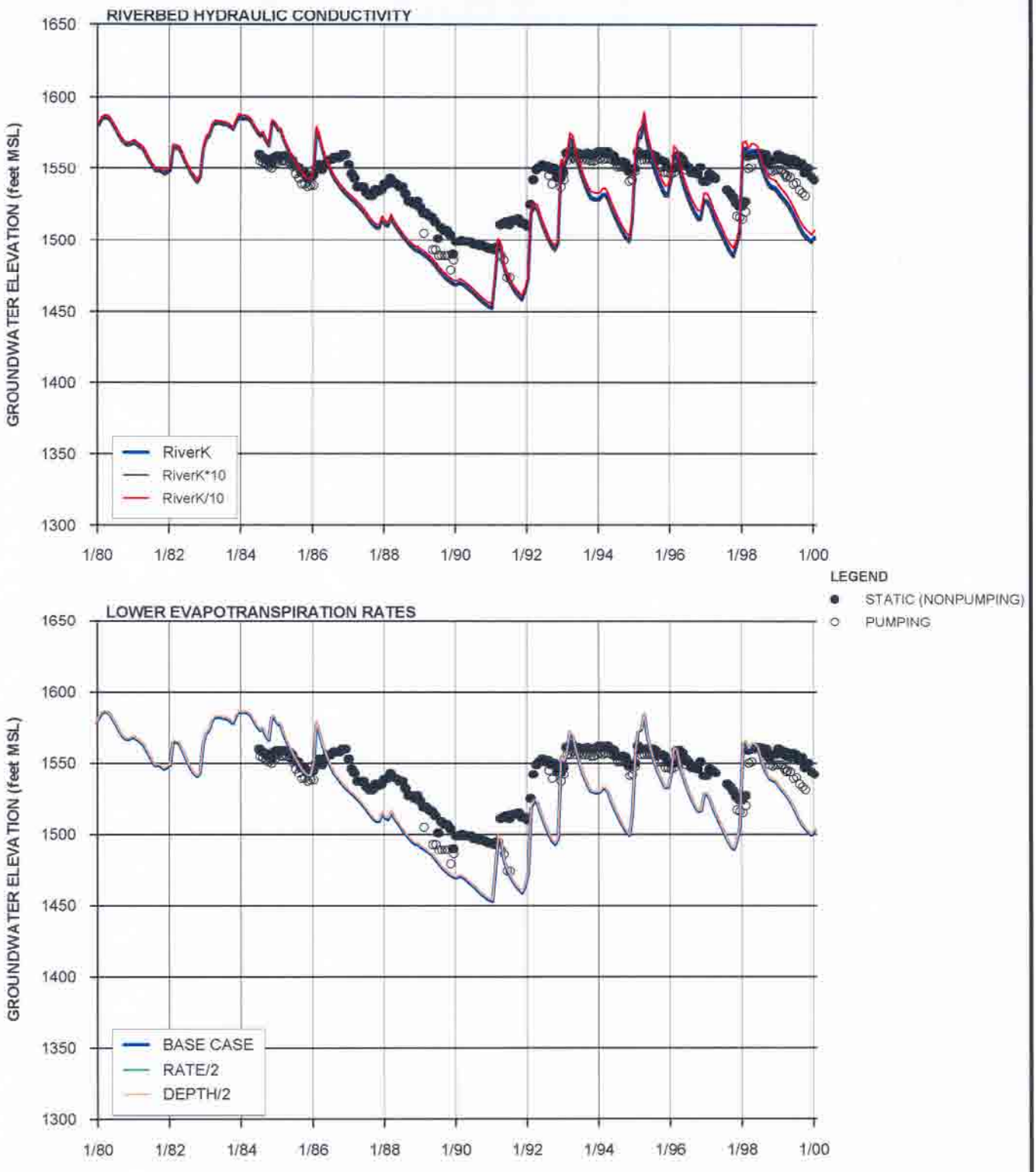

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-49
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-PINETREE1 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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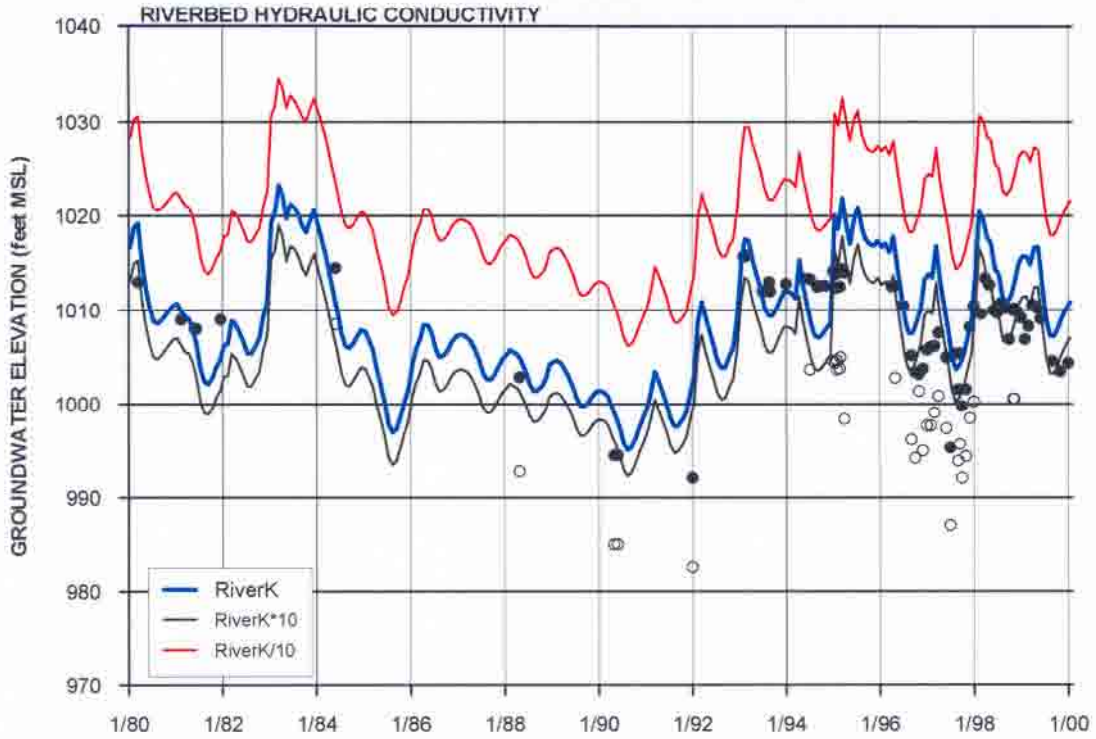

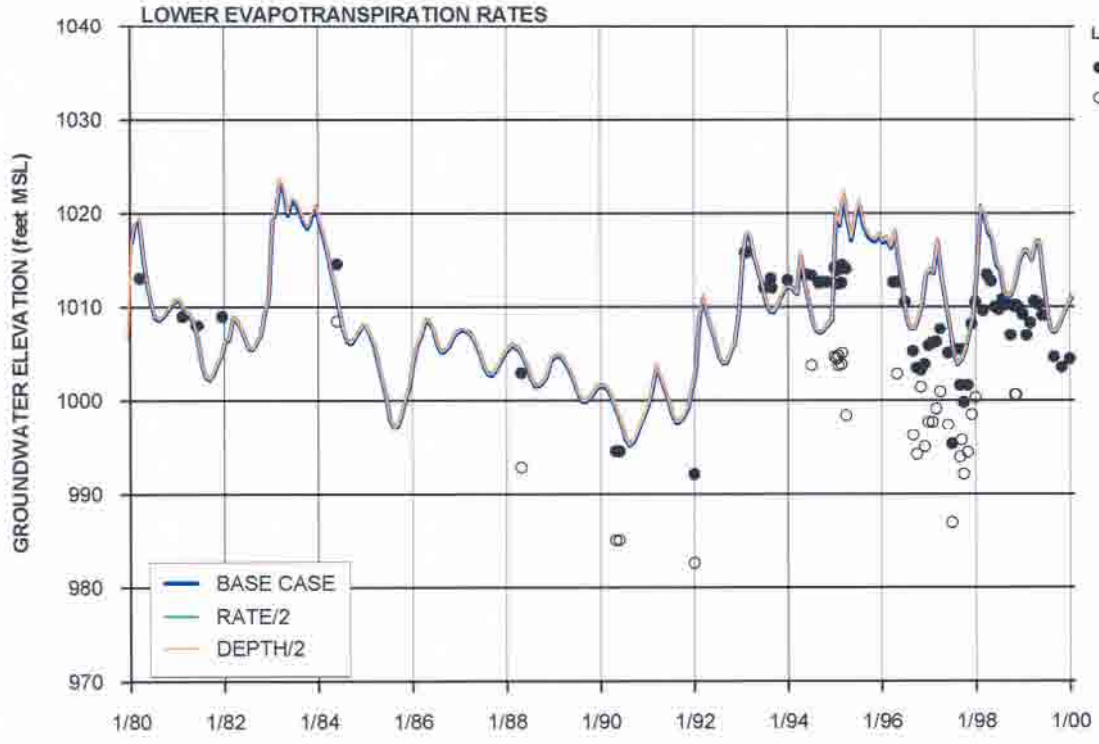

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3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-50
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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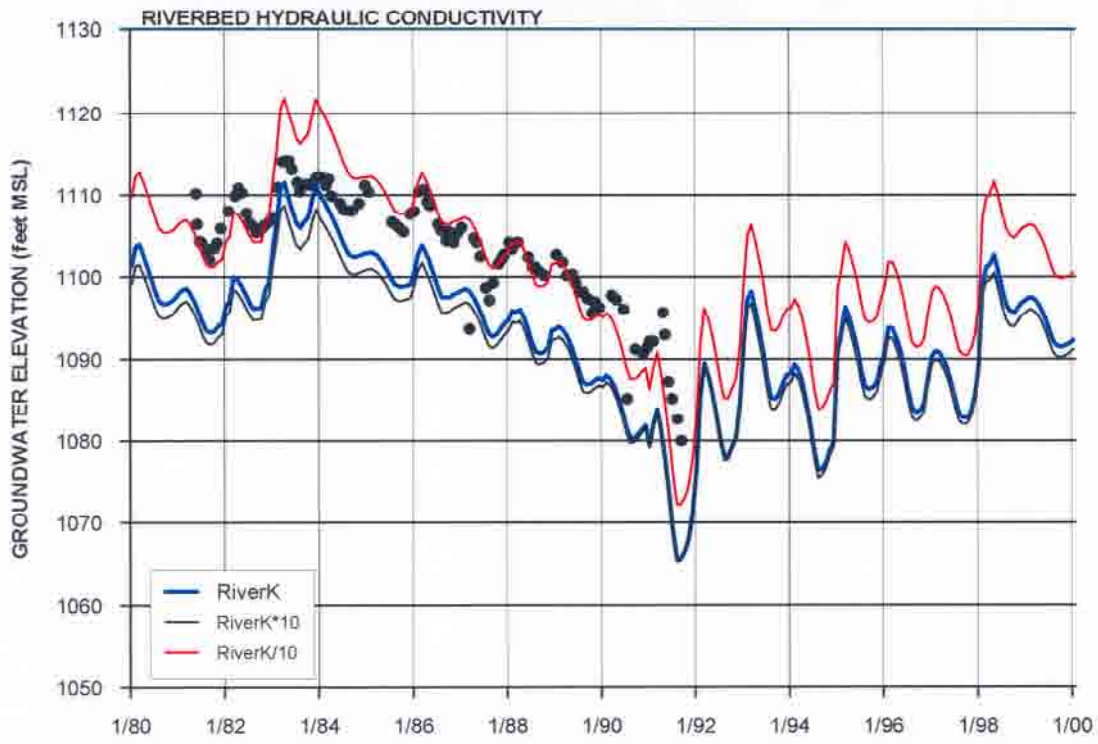

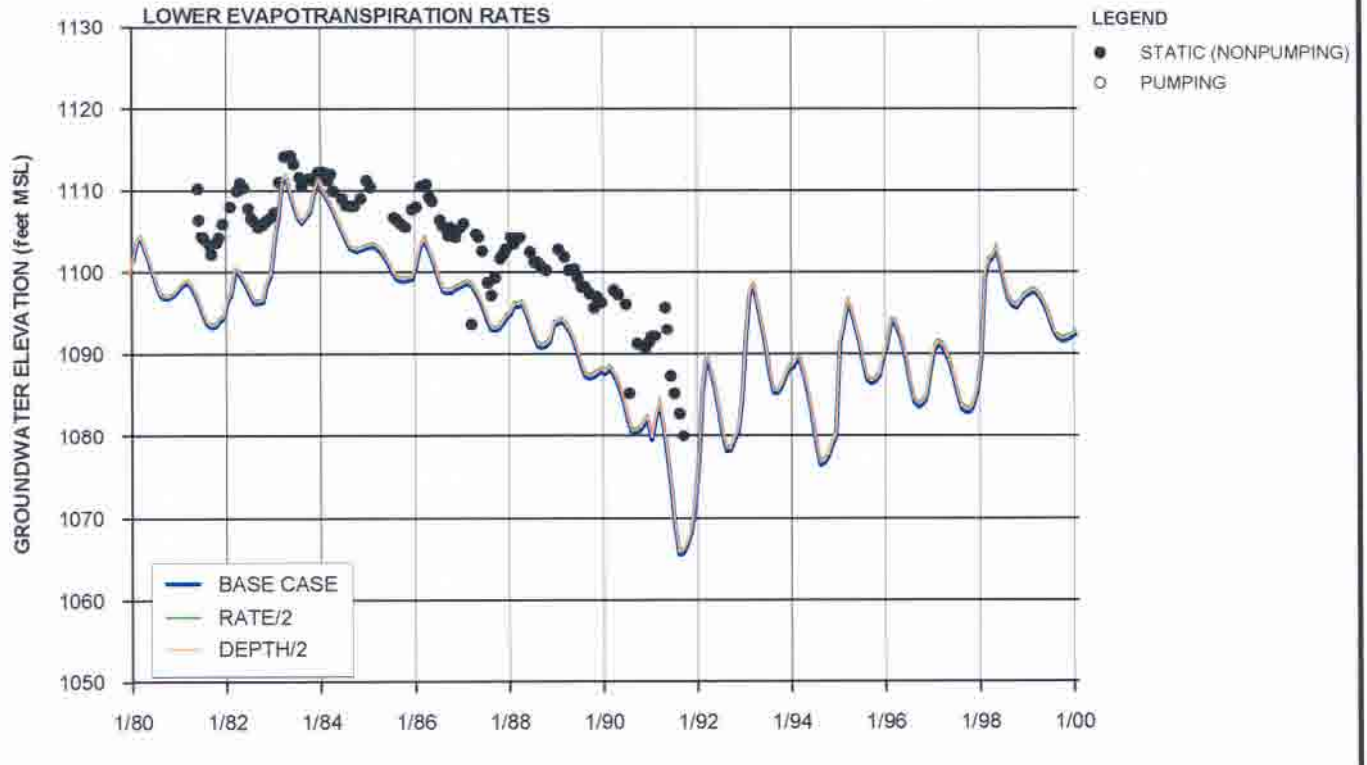

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-51
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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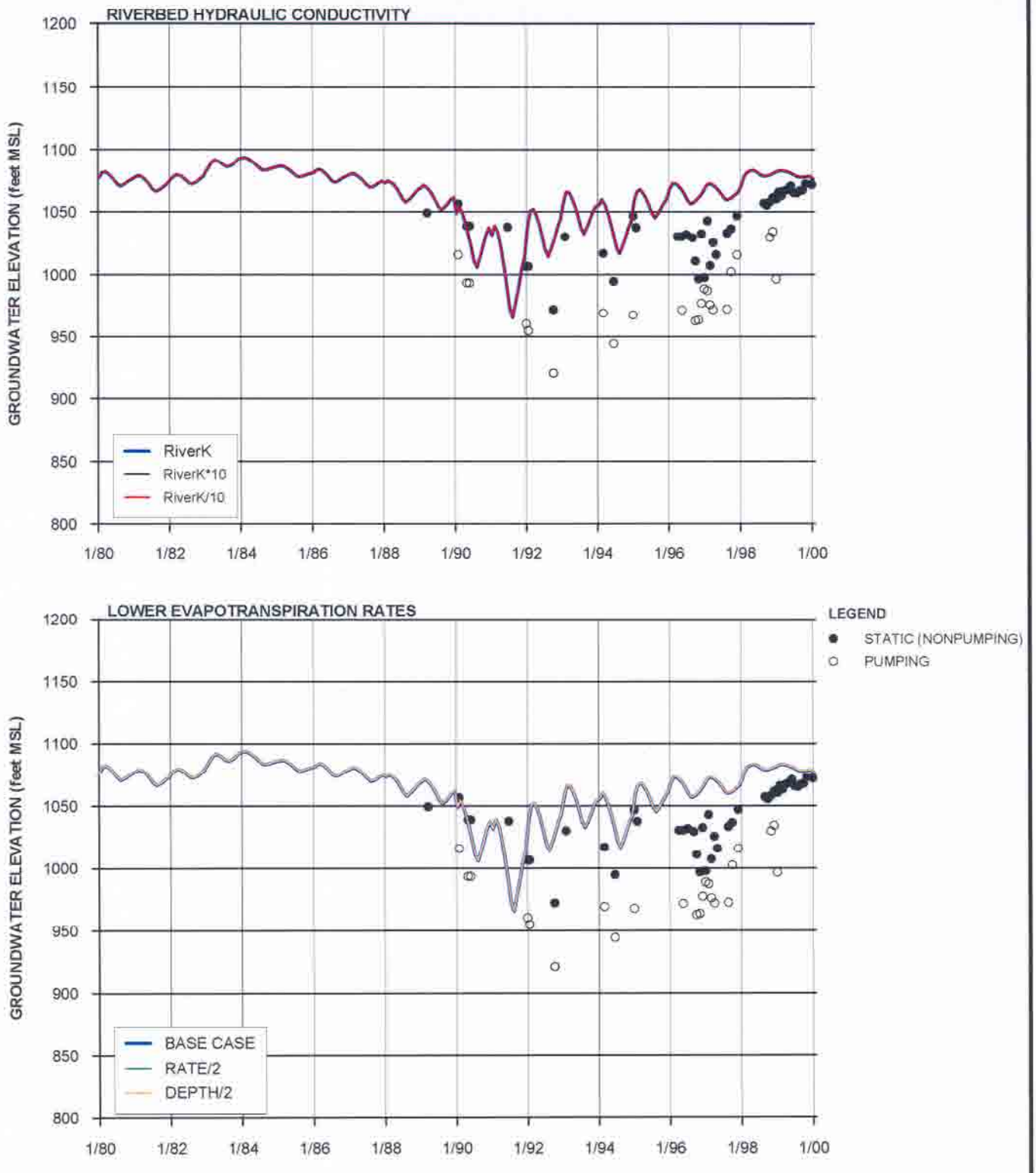

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-52
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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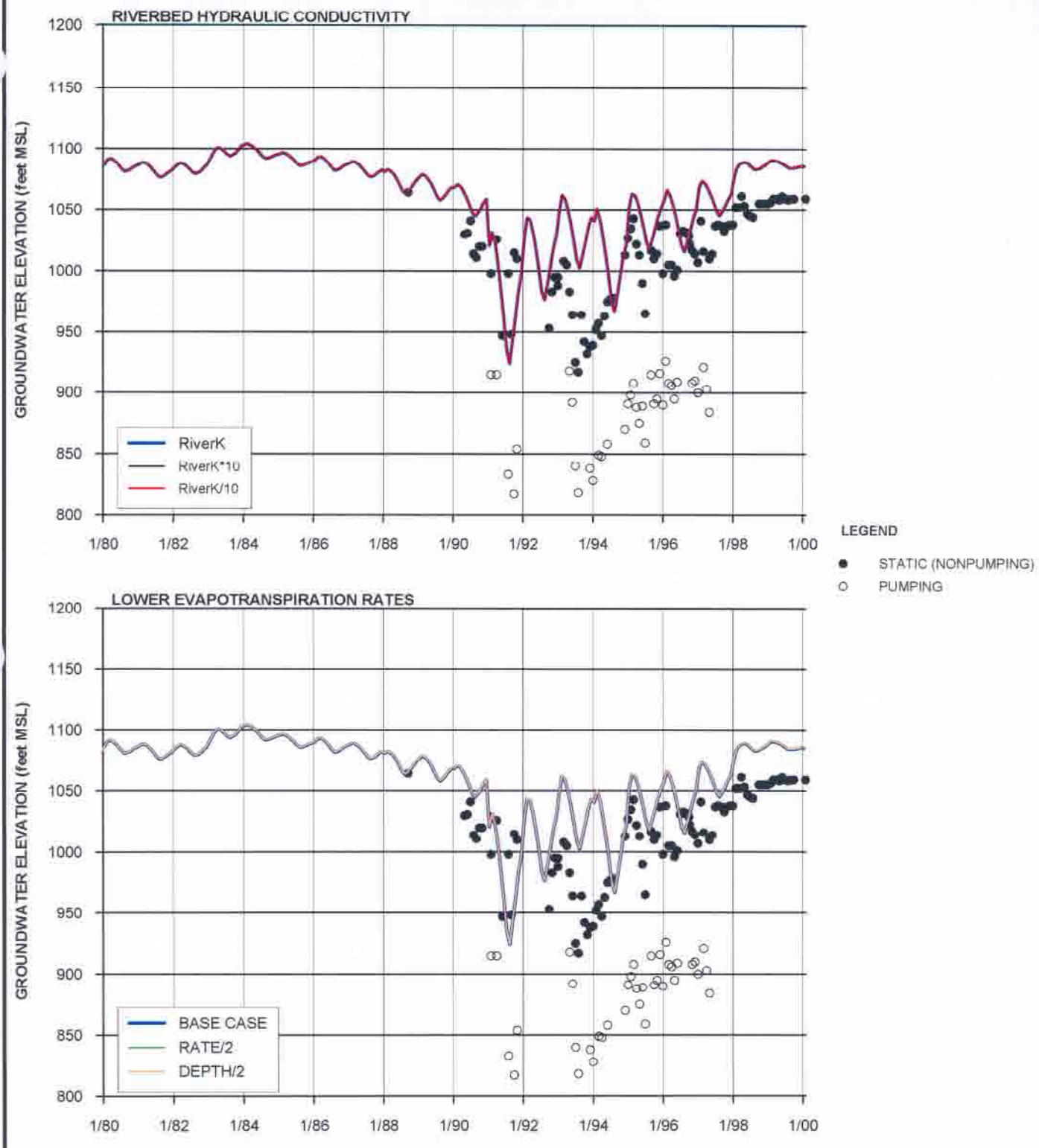

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3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-53
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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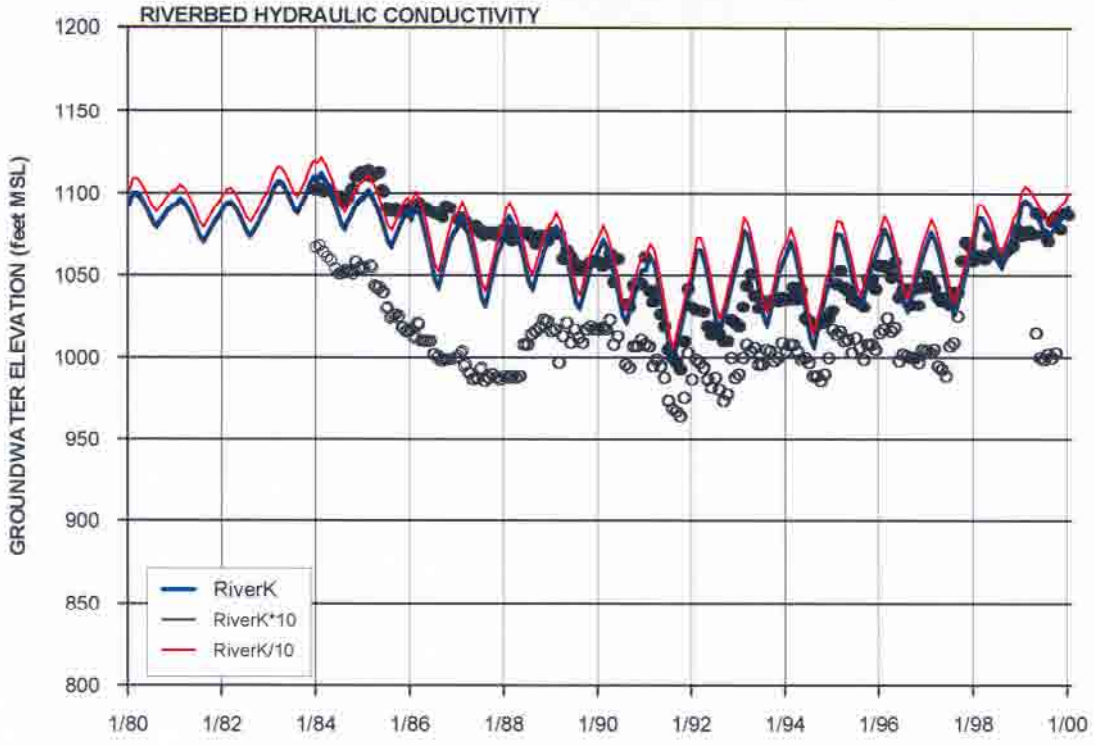

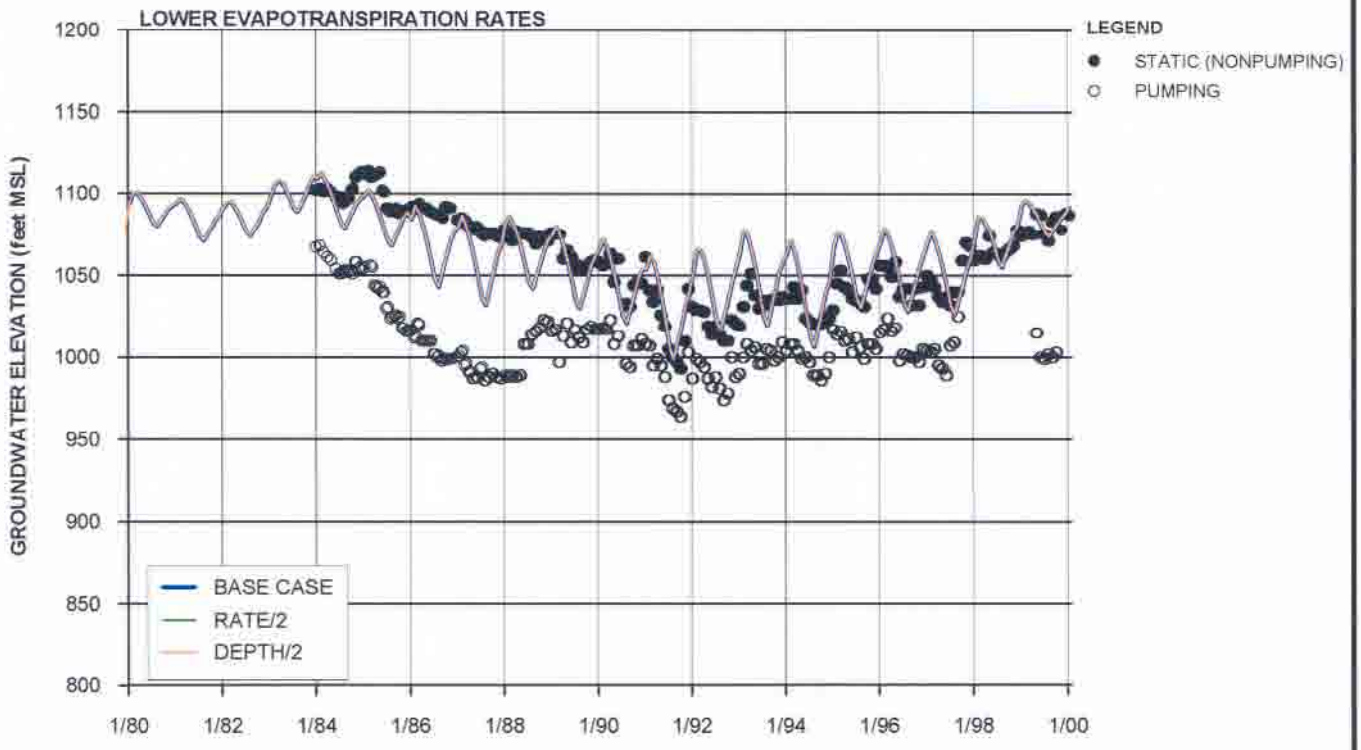

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3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-54
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO RIVER AND EVAPORTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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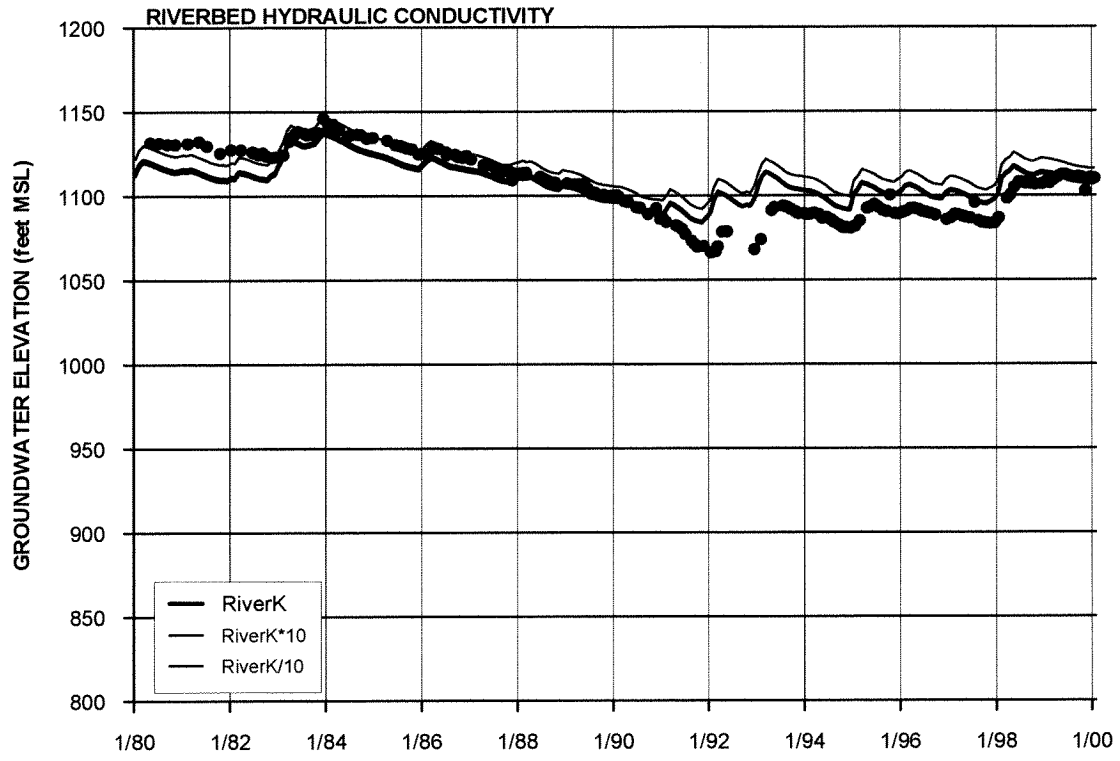

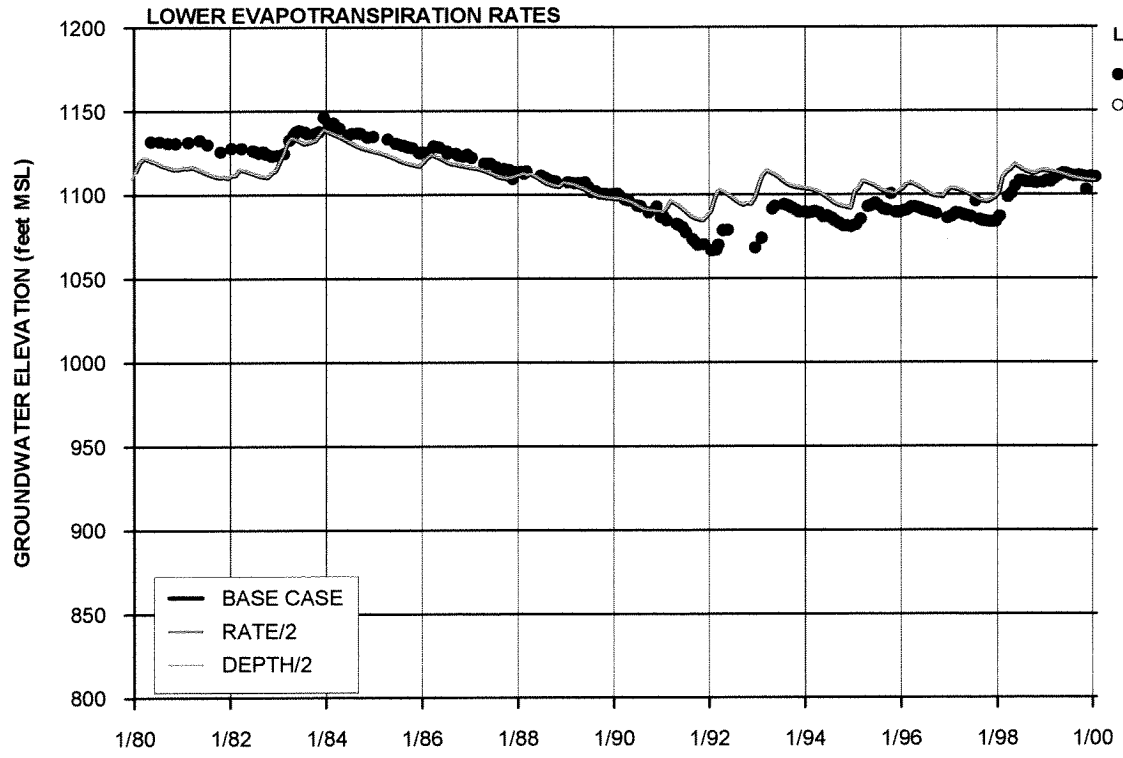

LEGEND

- ● STATIC (NONPUMPING)
- ○ PUMPING

NOTES:

1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-55
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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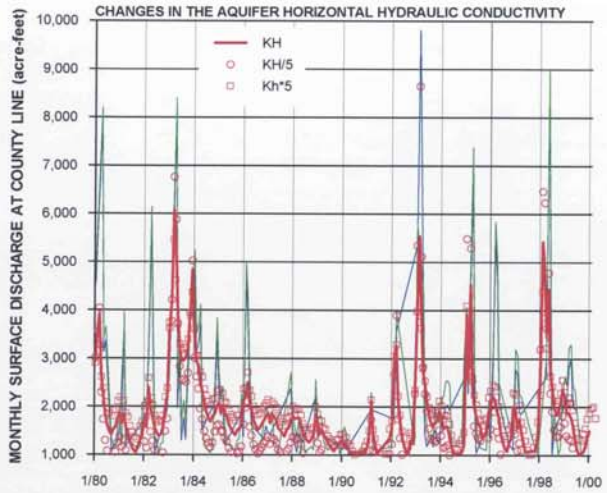

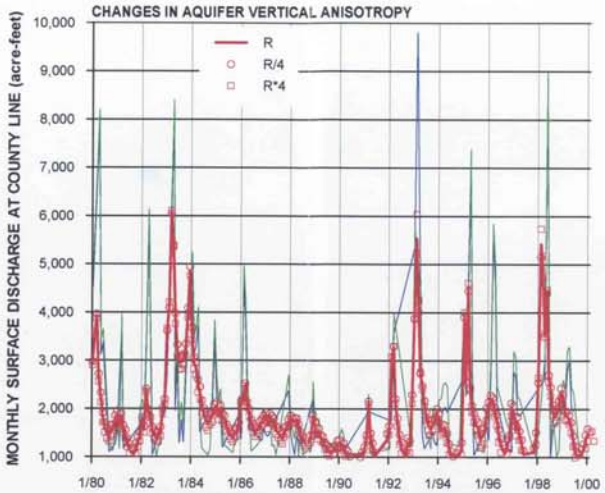

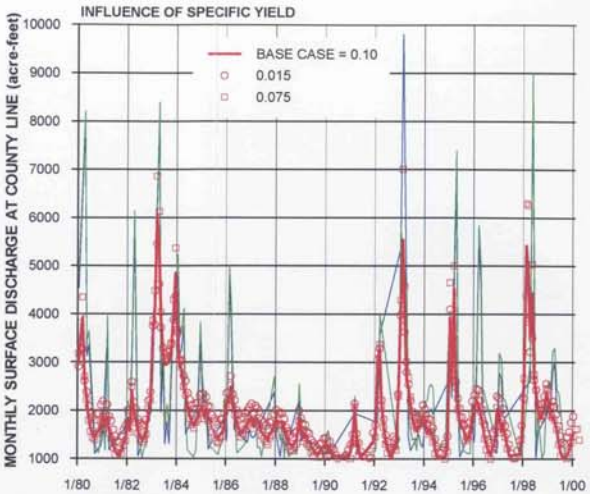

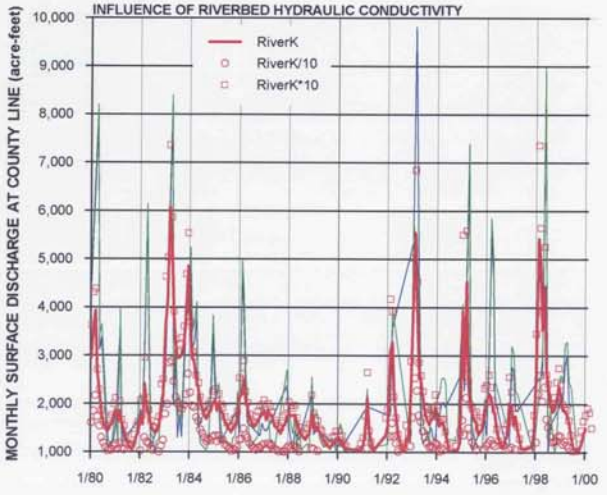

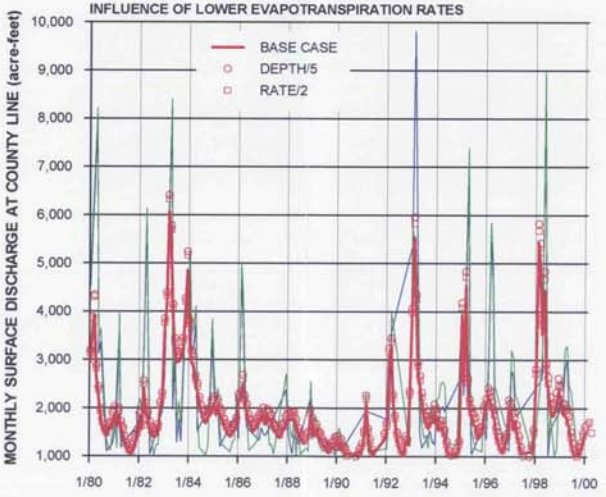

LEGEND

MEASURED (NO INFILTRATION OF SAUGUS WRP FLOWS)
MEASURED (75% INFILTRATION OF SAUGUS WRP FLOWS)

NOTES:

1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
4. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
5. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)

FIGURE 5-56
SENSITIVITY OF GROUNDWATER DISCHARGES TO THE SANTA CLARA RIVER TO AQUIFER, RIVER, AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 6

Model Applicability to Local Water Resource Management

The Purveyors have developed the Regional Model as the main computer tool for their use in ongoing management of the groundwater resources in the Santa Clarita Valley. Among the objectives in developing the model were (1) to be able to evaluate the long-term sustainability (yield) of the Alluvial and Saugus aquifer systems under a range of existing and potential future water resource management conditions, and (2) to facilitate general management of water quantity and water quality issues.

The Regional Model simulates groundwater flow in the two aquifers that are present in the Santa Clara River Valley East Groundwater Subbasin. It has been developed using the database and GIS that were developed by, and are being used by, the Purveyors to manage the valley's water resources. The modeling effort built upon previous and ongoing hydrogeologic studies in the valley (RCS, 1986, 1988, 2001, 2002; CH2M HILL, 2003), as well as previous modeling efforts (CH2M HILL, 1996, 2001, 2002). Key aspects of the Regional Model's construction and calibration include the following:

a. The Regional Model covers the entire Santa Clara River Valley East Groundwater Subbasin, from the Lang stream gage, at the eastern end of the valley, to Blue Cut, just west of the county line.

b. The Regional Model includes the SWRM, which determines the monthly volume of rainfall that is available to streams that are tributaries to the Santa Clara River. The SWRM also computes how much of the runoff can recharge the Alluvial Aquifer, the locations of the recharge, and the amount of flow that remains in each stream. Further, the SWRM calculates how much flow occurs in the Santa Clara River due to tributary inflows and to WRP discharges. Together, the SWRM and the Regional Model allow for estimation of the time-varying magnitudes of total river flow and groundwater discharges to the river. In summary, the Regional Model is actually a groundwater flow model coupled with an empirical tool that estimates stormwater generation from each watershed lying upstream of, and extending into, the Regional Model's boundaries.

c. The Regional Model has been calibrated on a monthly basis to time-varying hydrologic conditions that were observed from 1980 through 1999. Calibration data consisted of groundwater elevations in both aquifers at production and monitoring wells; estimated fluctuations in groundwater discharges to the Santa Clara River; and gaged flows in the Santa Clara River. Consequently, the Regional Model is calibrated not only to groundwater elevation trends, but also to the flows of water into and out of the valley.

The Regional Model has been specifically designed for use in managing groundwater resources on a local and regional scale. Its design and calibration make it a useful tool for:

a. Evaluating groundwater management strategies, including analyzing basin operations over multi-year wet/dry cycles

b. Evaluating ASR projects or other aquifer recharge projects

c. Evaluating options for locating new or proposed water supply wells, with consideration of the avoidance and management of any contamination in the aquifer system

d. Evaluating the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley

Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. Specific recommendations for the continued use and maintenance of this tool, including hydrogeologic data needs, are as follows:

a. Future predictive modeling activities should include sensitivity analyses on key model variables, particularly the Kh and Kv of both aquifer systems. This recommendation is based on the sensitivity analysis results, which show that groundwater elevations and groundwater discharge to the Santa Clara River are both sensitive to these parameters.

b. Streamflow monitoring should resume at the Lang gage, to better understand the magnitudes and timing of Santa Clara River flows into the valley. Stream gaging was discontinued at this location after October 1989. Because inflow in the Santa Clara River is one of the principal sources of water, the absence of data at this location is likely the primary reason that the Regional Model has difficulties simulating historical water level trends during certain periods at wells in the eastern-most portion of the valley. Without data from the Lang gage, simulations of future water level trends in this area will be uncertain, due to the Regional Model's tendency to under-predict groundwater elevations during drought periods.

c. The Regional Model and the SWRM should both be updated as water use conditions change in the future. Specific activities that merit updates to these tools include the planned implementation of recycled water use in the valley, continued urbanization in currently undeveloped and agricultural lands, and the increasing import of SWP water in response to increasing urban water demands.

d. Transient calibration runs should eventually be performed to test the transient model's ability to simulate conditions after 1999. The success of this activity will be more likely if streamflow data are collected at the Lang gage.

e. The Regional Model's calibration in the Saugus Formation should be tested whenever new wells are completed in this aquifer. Specifically, long-term water level monitoring should commence in these wells, and controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at new well locations, particularly in areas where wells have not been previously constructed.

f. Other activities described in the MOU between Ventura County and the Purveyors should continue, in order to provide data that can be used to improve the Regional Model and management of the local water resources. These data include pumping, rainfall, WRP discharge, streamflow, and groundwater elevation information. In particular, the groundwater elevation monitoring program that has been conducted for the past several years at production and monitoring wells should continue. Data from this program, collected by the Purveyors and LACFCD, provide valuable information for identifying and understanding the changes that occur in the hydrologic system, including the relationships between groundwater and surface water.

SECTION 7

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Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation.** The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights.** Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By _____
General Manager

Castaic Lake Water Agency

By _____
General Manager

Newhall County Water District

By _____
General Manager

Valencia Water Company

By _____
President

Santa Clarita Water Company

By _____
President

Los Angeles County Waterworks District No. 36

By _____
County of Los Angeles

United Water Conservation District Boundary

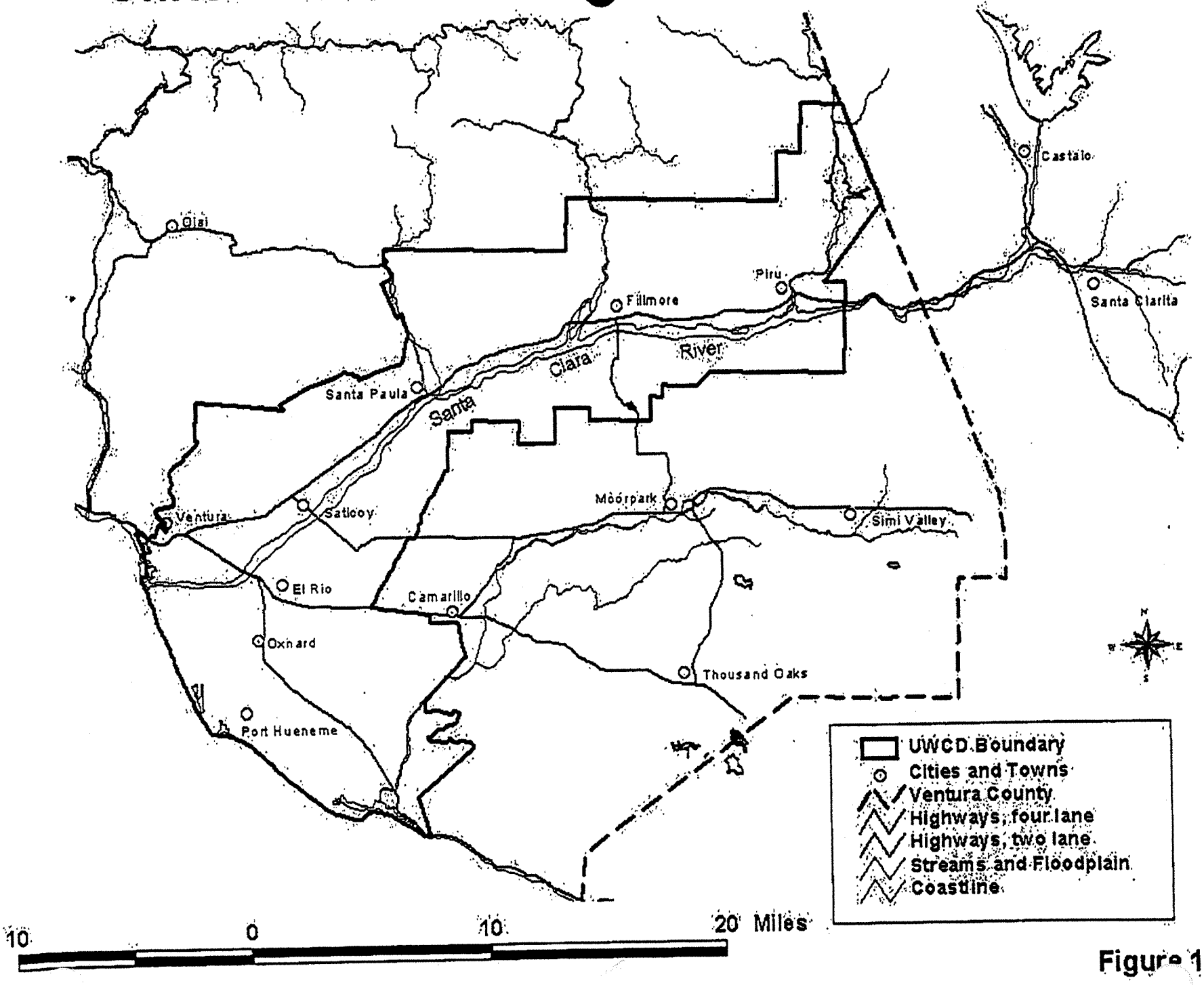


Figure 1-1

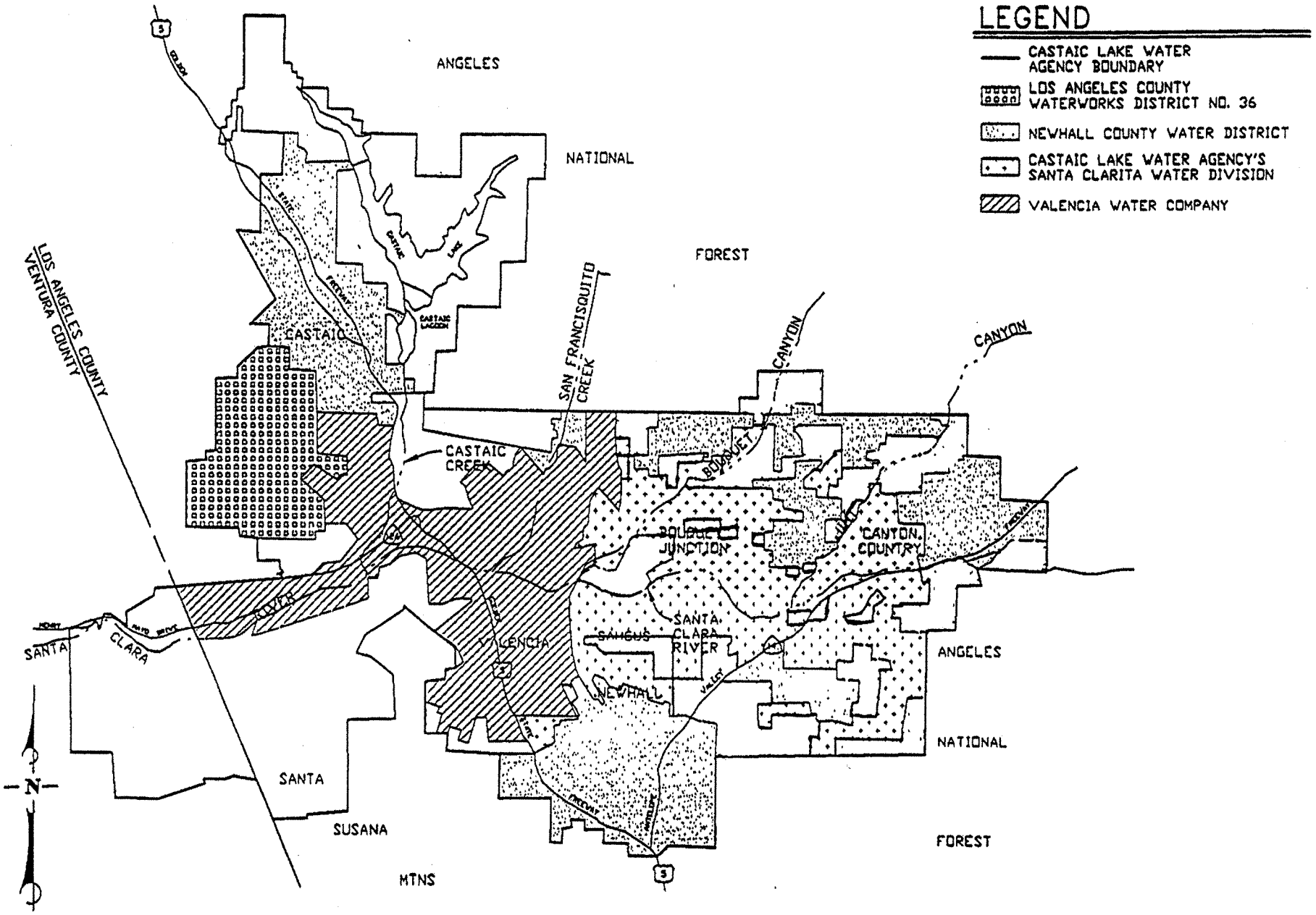


FIGURE 1-2

CLWA AND WATER PURVEYOR SERVICE AREAS

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the

area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the

gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is

available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

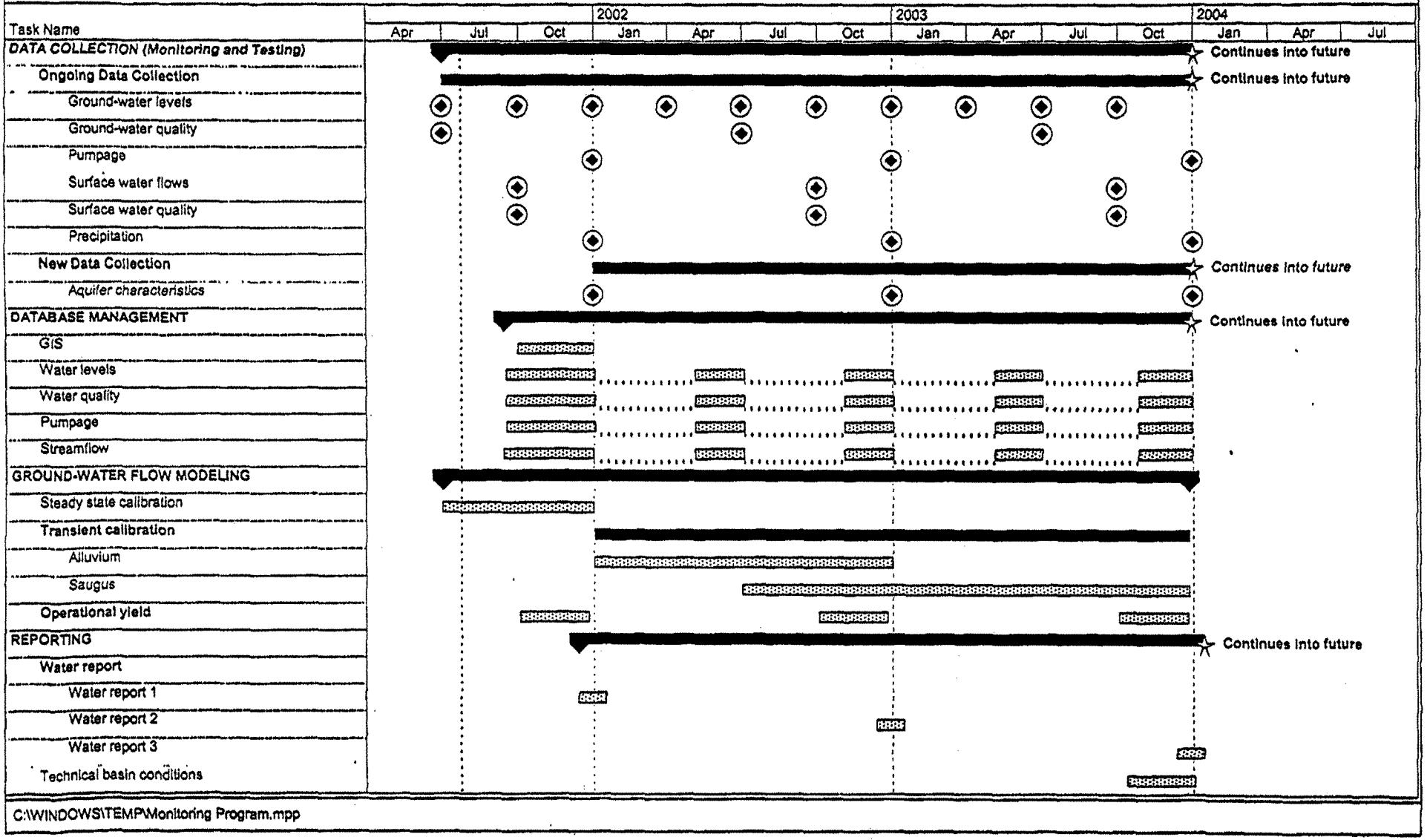
REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as

well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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APPENDIX B

Analyses of Specific Capacity Test Data for the Alluvial Aquifer

Specific capacity data are available for production wells in the Alluvial Aquifer through 2000. Tables B-1 through B-6 present these data and the calculations of estimated transmissivity (T) and horizontal hydraulic conductivity (Kh) values, along with how these values compare with the values used in the calibrated groundwater flow model at each well location. Rows in bold font identify specific capacity tests that were considered to provide the best indications of aquifer properties.

The tables show the testing data for different geographic areas in the Alluvial Aquifer[1], as well as the estimated drawdown in the aquifer formation for different values of well efficiency. Because of the unconfined nature of the Alluvial Aquifer system, the following equations were used to calculate T and Kh (Driscoll, 1986):

$$s = s_{well} * E$$

$$T = 1500 * Q / s \qquad (1)$$

$$Kh = T / (7.48 * b_{typical})$$

where:

s = the estimated drawdown in the aquifer formation

s_{well} = the measured drawdown in the well during the efficiency test

E = the well estimated efficiency

T = the transmissivity (gallons per day per foot [gpd/ft])

Q = the pumping rate (gallons per minute [gpm])

Q/s = specific capacity of the well

Kh = the horizontal hydraulic conductivity of the alluvial aquifer (feet per day [ft/day])

$b_{typical}$ = the typical long-term average saturated thickness (feet [ft]) of the alluvial aquifer at the location of the specific well

For each test, Tables B-1 through B-6 show the data and the calculations for drawdown, T, and Kh at different estimated well efficiencies (70 percent is the typical efficiency of a well that is in good condition; 50 percent reflects a well that is less efficient).[2] As shown in the table, the T and Kh values vary widely with location, as well as over time at individual wells. The table uses bold font to identify those tests that are believed to be the least affected

[1] See Figure 2-3 for well locations. See also Figure 4-1 for the locations of the target wells and zones that were used during calibration of the Alluvial Aquifer in the Santa Clarita Valley Groundwater Model (Regional Model).

[2] Well efficiency is a function of the design, construction, and condition of the well.

by well efficiency issues (i.e., show the highest specific capacity values) and therefore provide the best estimate of aquifer parameter values at each well location. Specific conclusions from this analysis are:

a. In the western alluvium along the main Santa Clara River valley (west of I-5), it appears that few wells have high enough efficiencies to provide estimates of Alluvial Aquifer Kh values. The highest specific capacities for the Alluvial Aquifer are indicated by only about 19 of the 335 tests performed in this area. For these 19 tests and a well efficiency of 70 percent, the Kh ranges from approximately 300 to 1,000 ft/day and is typically approximately 500 to 600 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

b. In the central valley, between I-5 and Soledad Canyon, 8 of the 11 tested wells appear to provide usable estimates of Alluvial Aquifer Kh values. These wells indicate a Kh range typically between 250 and 600 feet/day, though one well (NLF-R2) indicates Kh values potentially as high as 800 ft/day or greater. The Regional Model uses values between 245 and 375 ft/day in most of this area, and 550 ft/day at the very eastern edge of this area, at the mouth of Soledad Canyon.

c. In the lower reach of Soledad Canyon, most wells indicate Kh values ranging from 600 ft/day to more than 1,000 ft/day. Only the SCWC-Honby well suggests lower Kh values of approximately 300 to 550 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

d. In the upper reach of Soledad Canyon, the Kh values show more variability from well to well than lower Soledad Canyon. Kh values in upper Soledad Canyon range from approximately 300 to 700 ft/day at some wells, and 900 to 1,500 ft/day at the other wells. The Regional Model uses Kh values ranging from 350 ft/day at the eastern end of the canyon to 550 ft/day farther west.

e. In the tributary canyons north of the Santa Clara River, Alluvial Aquifer Kh values tend to be slightly lower than along the Santa Clara River main valley.

    1. Along Castaic Creek, Kh values are commonly between 350 and 600 ft/day, though a few tests suggest values as high as 800 to 1,000 ft/day. The Regional Model uses a value of 315 ft/day below Castaic Dam and at the NCWD Castaic wellfield, and 350 ft/day between this wellfield and the alluvial valley containing the Santa Clara River.

    2. In San Francisquito Canyon, the W series wells owned by VWC and NLF suggest Kh values of approximately 200 to 400 ft/day. The Regional Model uses a value of 105 ft/day.

    3. In Bouquet Canyon, the two SCWC wells suggest Kh values of approximately 500 to 900 ft/day. The Regional Model uses a value of 140 ft/day at SCWC-Guida in the central portion of the canyon, and 245 ft/day at SCWC-Clark well in the lower reaches of the canyon.

The estimation of K values from specific capacity test data is a method that provides only an approximation of aquifer properties. This method is valuable for constraining the Regional Model's calibration because specific capacity tests provide the only source of data that allow

estimation and comparison of Alluvial Aquifer properties across the valley. Nonetheless, the method is affected by the following factors and uncertainties:

a. The measured drawdown in a well is affected by the radius of the well and the borehole, and the efficiency of the well at the time it is tested.

b. Yield and drawdown are affected by the length of the well screen and the fraction of the aquifer's thickness that is screened.

c. Fluctuations in water levels that occur seasonally and over multi-year periods affect the yield and drawdown of the well, and also the estimates of saturated thickness that are necessary for performing the calculations.

Reference

Driscoll, Fletcher G. 1986. *Groundwater and Wells*. Second Edition.

Tables

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	B5	**04/24/1984**	**1988**	**6.9**	**288.1**	**6.9**	**4.83**	**3.45**	**82,534**	**115,548**	**60,500**	**110**	**750**	**1,050**	**550**
		06/09/1986	1816	5.6	324.3	5.6	3.92	2.8	92,905	130,067		110	845	1,182	
		10/15/1987	1878	6.6	284.5	6.6	4.62	3.3	81,503	114,104		110	741	1,037	
		10/04/1988	1342	6.7	200.3	6.7	4.69	3.35	57,382	80,334		110	522	730	
		07/20/1989	1659	8.6	192.9	8.6	6.02	4.3	55,262	77,366		110	502	703	
		06/13/1990	1699	8	212.4	8	5.6	4	60,848	85,187		110	553	774	
		05/28/1991	**2013**	**7.6**	**264.9**	**7.6**	**5.32**	**3.8**	**75,888**	**106,243**	**60,500**	**110**	**690**	**966**	**550**
		07/26/1993	1895	7.2	263.2	7.2	5.04	3.6	75,401	105,561		110	685	960	
		08/15/1994	1870	6.3	296.8	6.3	4.41	3.15	85,027	119,037		110	773	1,082	
		07/18/1995	2081	6.5	320.2	6.5	4.55	3.25	91,730	128,422		110	834	1,167	
		06/10/1996	**2045**	**6.5**	**314.6**	**6.5**	**4.55**	**3.25**	**90,126**	**126,176**	**60,500**	**110**	**819**	**1,147**	**550**
		05/08/1997	1898	6.6	287.6	6.6	4.62	3.3	82,391	115,348		110	749	1,049	
		03/28/2000	**2357**	**6**	**392.8**	**6**	**4.2**	**3**	**112,529**	**157,540**	**60,500**	**110**	**1,023**	**1,432**	**550**
NLF	B6	05/21/1984	1473	12.1	121.7	12.1	8.47	6.05	34,864	48,810		110	317	444	
		06/09/1986	1886	15	125.7	15	10.5	7.5	36,010	50,414		110	327	458	
		10/15/1987	1190	10.4	114.4	10.4	7.28	5.2	32,773	45,882		110	298	417	
		07/20/1989	1043	8.4	124.2	8.4	5.88	4.2	35,581	49,813		110	323	453	
		06/13/1990	1083	10.4	104.1	10.4	7.28	5.2	29,822	41,751		110	271	380	
		05/30/1991	1603	11.9	134.7	11.9	8.33	5.95	38,589	54,024		110	351	491	
		06/10/1992	**1746**	**11.6**	**150.5**	**11.6**	**8.12**	**5.8**	**43,115**	**60,361**	**60,500**	**110**	**392**	**549**	**550**
		07/26/1993	1473	6.7	219.9	6.7	4.69	3.35	62,997	88,195		110	573	802	
		08/15/1994	1460	15.5	94.2	15.5	10.85	7.75	26,986	37,781		110	245	343	
		07/19/1995	**1600**	**9.2**	**173.9**	**9.2**	**6.44**	**4.6**	**49,819**	**69,746**	**60,500**	**110**	**453**	**634**	**550**
		06/10/1996	1274	18.6	68.5	18.6	13.02	9.3	19,624	27,473		110	178	250	
		05/08/1997	1394	15.6	89.4	15.6	10.92	7.8	25,611	35,856		110	233	326	
		06/26/1998	1554	15	103.6	15	10.5	7.5	29,679	41,551		110	270	378	
		05/06/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		05/21/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		04/21/2000	1086	22.4	48.5	22.4	15.68	11.2	13,894	19,452		110	126	177	
NLF	B7	02/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746	60,500	110	63	89	550
		04/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746		110	63	89	
		06/03/1986	766	33.4	22.9	33.4	23.38	16.7	6,560	9,184		110	60	83	
		12/21/1989	700	52.9	13.2	52.9	37.03	26.45	3,782	5,294		110	34	48	
		06/12/1990	766	50.5	15.2	50.5	35.35	25.25	4,354	6,096		110	40	55	
		05/29/1991	878	37.1	23.7	37.1	25.97	18.55	6,790	9,505		110	62	86	
		06/10/1992	837	14.9	56.2	14.9	10.43	7.45	16,100	22,540		110	146	205	
		07/23/1993	911	16.9	53.9	16.9	11.83	8.45	15,441	21,618		110	140	197	
		08/30/1994	730	33.5	21.8	33.5	23.45	16.75	6,245	8,743		110	57	79	
		07/17/1995	720	25.9	27.8	25.9	18.13	12.95	7,964	11,150		110	72	101	
		06/11/1996	725	29.5	24.6	29.5	20.65	14.75	7,047	9,866		110	64	90	
		06/26/1998	689	27.1	25.4	27.1	18.97	13.55	7,277	10,187		110	66	93	
		05/10/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		05/21/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		04/21/2000	945	49.6	19.1	49.6	34.72	24.8	5,472	7,660		110	50	70	
NLF	B10	07/13/1982	1325	33.2	39.9	33.2	23.24	16.6	11,430	16,003	60,500	110	104	145	550
		05/29/1991	1556	38.7	40.2	38.7	27.09	19.35	11,516	16,123		110	105	147	
		07/26/1993	1637	41	39.9	41	28.7	20.5	11,430	16,003		110	104	145	
		08/10/1994	1328	31.9	41.6	31.9	22.33	15.95	11,917	16,684		110	108	152	
		07/18/1995	1409	37.2	37.9	37.2	26.04	18.6	10,858	15,201		110	99	138	
		06/10/1996	1339	40	33.5	40	28	20	9,597	13,436		110	87	122	
		05/08/1997	1316	45.7	28.8	45.7	31.99	22.85	8,251	11,551		110	75	105	
		06/04/1998	1263	36.5	34.6	36.5	25.55	18.25	9,912	13,877		110	90	126	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/06/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		05/21/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		04/21/2000	1259	39.4	32	39.4	27.58	19.7	9,167	12,834		110	83	117	
NLF	B11	07/27/1993	219	14.9	14.7	14.9	10.43	7.45	4,211	5,896	60,500	110	38	54	550
		08/17/1994	226	15.5	14.6	15.5	10.85	7.75	4,183	5,856		110	38	53	
		07/17/1995	429	12.4	34.6	12.4	8.68	6.2	9,912	13,877		110	90	126	
		05/14/1997	950	28	33.9	28	19.6	14	9,712	13,596		110	88	124	
		06/26/1998	817	22.9	35.7	22.9	16.03	11.45	10,227	14,318		110	93	130	
		05/10/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		05/21/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		04/21/2000	860	26.2	32.8	26.2	18.34	13.1	9,396	13,155		110	85	120	
NLF	C	04/09/1984	1351	49.4	27.3	49.4	34.58	24.7	7,821	10,949	60,500	110	71	100	550
		05/21/1986	1325	54.2	24.4	54.2	37.94	27.1	6,990	9,786		110	64	89	
		10/19/1987	1342	46	29.2	46	32.2	23	8,365	11,711		110	76	106	
		10/04/1988	1336	45	29.7	45	31.5	22.5	8,508	11,912		110	77	108	
		07/10/1989	1360	35.2	38.6	35.2	24.64	17.6	11,058	15,481		110	101	141	
		06/11/1990	1331	36.6	36.4	36.6	25.62	18.3	10,428	14,599		110	95	133	
		05/06/1991	1342	48.3	27.8	48.3	33.81	24.15	7,964	11,150		110	72	101	
		06/08/1992	1257	48	26.2	48	33.6	24	7,506	10,508		110	68	96	
		07/30/1993	1178	26.6	44.3	26.6	18.62	13.3	12,691	17,767		110	115	162	
		08/02/1994	1318	24.6	53.6	24.6	17.22	12.3	15,355	21,497		110	140	195	
		06/28/1995	1290	29	44.5	29	20.3	14.5	12,748	17,848		110	116	162	
		05/30/1996	1238	35.6	34.8	35.6	24.92	17.8	9,969	13,957		110	91	127	
		04/24/1997	1247	34	36.7	34	23.8	17	10,514	14,719		110	96	134	
		05/27/1998	1282	36.3	35.3	36.3	25.41	18.15	10,113	14,158		110	92	129	
		04/27/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		05/21/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		04/21/2000	1195	34	35.1	34	23.8	17	10,055	14,078		110	91	128	
NLF	C3	04/17/1984	935	42.4	22.1	42.4	29.68	21.2	6,331	8,864	60,500	110	58	81	550
		05/14/1986	870	54.7	15.9	54.7	38.29	27.35	4,555	6,377		110	41	58	
		07/12/1989	908	37.3	24.3	37.3	26.11	18.65	6,961	9,746		110	63	89	
		06/11/1990	549	25.1	21.9	25.1	17.57	12.55	6,274	8,783		110	57	80	
		05/07/1991	573	24.3	23.6	24.3	17.01	12.15	6,761	9,465		110	61	86	
		06/09/1992	814	45.5	17.9	45.5	31.85	22.75	5,128	7,179		110	47	65	
		07/31/1993	633	31.4	20.2	31.4	21.98	15.7	5,787	8,102		110	53	74	
		08/05/1994	739	19.2	38.5	19.2	13.44	9.6	11,029	15,441		110	100	140	
		07/11/1995	638	23.3	27.4	23.3	16.31	11.65	7,850	10,989		110	71	100	
		06/04/1996	553	30.9	17.9	30.9	21.63	15.45	5,128	7,179		110	47	65	
		05/07/1997	894	62.4	14.3	62.4	43.68	31.2	4,097	5,735		110	37	52	
		06/03/1998	754	64.1	11.8	64.1	44.87	32.05	3,380	4,733		110	31	43	
		05/03/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		05/21/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		04/21/2000	573	53.2	10.8	53.2	37.24	26.6	3,094	4,332		110	28	39	
NLF	C4	04/17/1984	1280	43.2	29.6	43.2	30.24	21.6	8,480	11,872		110	77	108	
		05/14/1986	1056	41	25.8	41	28.7	20.5	7,391	10,348		110	67	94	
		06/11/1990	1130	30	37.7	30	21	15	10,800	15,120		110	98	137	
		05/07/1991	1348	35.9	37.5	35.9	25.13	17.95	10,743	15,040		110	98	137	
		06/09/1992	1225	36.7	33.4	36.7	25.69	18.35	9,568	13,396		110	87	122	
		07/29/1993	834	21.3	39.2	21.3	14.91	10.65	11,230	15,722		110	102	143	
		08/05/1994	**1038**	**12.6**	**82.4**	**12.6**	**8.82**	**6.3**	**23,606**	**33,048**	**60,500**	**110**	**215**	**300**	**550**
		07/11/1995	1248	24.9	50.1	24.9	17.43	12.45	14,353	20,094		110	130	183	
		06/04/1996	1279	25.1	51	25.1	17.57	12.55	14,610	20,455		110	133	186	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/07/1997	1310	27.8	47.1	27.8	19.46	13.9	13,493	18,890		110	123	172	
		06/03/1998	1279	29.4	43.5	29.4	20.58	14.7	12,462	17,447		110	113	159	
		05/03/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		05/21/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		04/21/2000	1156	30	38.5	30	21	15	11,029	15,441		110	100	140	
NLF	C5	04/09/1984	674	56.9	11.8	56.9	39.83	28.45	3,380	4,733	60,500	110	31	43	550
		05/15/1986	592	88.2	6.7	88.2	61.74	44.1	1,919	2,687		110	17	24	
		10/19/1987	587	84.3	7	84.3	59.01	42.15	2,005	2,807		110	18	26	
		07/18/1989	697	49.9	14	49.9	34.93	24.95	4,011	5,615		110	36	51	
		06/12/1990	638	68.3	9.3	68.3	47.81	34.15	2,664	3,730		110	24	34	
		05/08/1991	715	63.5	11.3	63.5	44.45	31.75	3,237	4,532		110	29	41	
		06/09/1992	722	63.9	11.3	63.9	44.73	31.95	3,237	4,532		110	29	41	
		07/30/1993	715	41.9	17.1	41.9	29.33	20.95	4,899	6,858		110	45	62	
		08/08/1994	796	13.6	58.5	13.6	9.52	6.8	16,759	23,463		110	152	213	
		07/07/1995	802	14.9	53.8	14.9	10.43	7.45	15,413	21,578		110	140	196	
		05/30/1996	945	21.6	43.8	21.6	15.12	10.8	12,548	17,567		110	114	160	
		05/06/1997	880	18.2	48.4	18.2	12.74	9.1	13,866	19,412		110	126	176	
		06/01/1998	885	21.5	41.2	21.5	15.05	10.75	11,803	16,524		110	107	150	
		04/27/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		05/21/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		04/21/2000	804	17.2	46.7	17.2	12.04	8.6	13,379	18,730		110	122	170	
NLF	C6	04/09/1984	153	29.9	5.1	29.9	20.93	14.95	1,461	2,045	60,500	110	13	19	550
		05/15/1986	137	34.2	4	34.2	23.94	17.1	1,146	1,604		110	10	15	
		10/19/1987	147	33.7	4.4	33.7	23.59	16.85	1,261	1,765		110	11	16	
		07/12/1989	124	31.4	3.9	31.4	21.98	15.7	1,117	1,564		110	10	14	
		06/06/1990	141	36.4	3.9	36.4	25.48	18.2	1,117	1,564		110	10	14	
		05/08/1991	133	41	3.2	41	28.7	20.5	917	1,283		110	8	12	
		12/21/1994	445	33.8	13.2	33.8	23.66	16.9	3,782	5,294		110	34	48	
		07/07/1995	459	33.2	13.8	33.2	23.24	16.6	3,953	5,535		110	36	50	
		05/28/1996	405	39.7	10.2	39.7	27.79	19.85	2,922	4,091		110	27	37	
		04/24/1997	364	44.6	8.2	44.6	31.22	22.3	2,349	3,289		110	21	30	
		05/27/1998	349	49.2	7.1	49.2	34.44	24.6	2,034	2,848		110	18	26	
		04/27/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		05/21/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		04/21/2000	260	50.5	5.1	50.5	35.35	25.25	1,461	2,045		110	13	19	
NLF	C7	04/10/1984	1118	44.5	25.1	44.5	31.15	22.25	7,191	10,067	60,500	110	65	92	550
		05/15/1986	1050	42.4	24.8	42.4	29.68	21.2	7,105	9,947		110	65	90	
		10/14/1987	1104	38.5	28.7	38.5	26.95	19.25	8,222	11,511		110	75	105	
		07/10/1989	434	38.3	11.3	38.3	26.81	19.15	3,237	4,532		110	29	41	
		06/11/1990	1067	32.8	32.5	32.8	22.96	16.4	9,311	13,035		110	85	118	
		05/28/1991	1082	37.6	28.8	37.6	26.32	18.8	8,251	11,551		110	75	105	
		06/08/1992	1047	47.1	22.2	47.1	32.97	23.55	6,360	8,904		110	58	81	
		07/31/1993	1054	37.9	27.8	37.9	26.53	18.95	7,964	11,150		110	72	101	
		08/01/1994	1008	39.5	25.5	39.5	27.65	19.75	7,305	10,227		110	66	93	
		06/28/1995	1082	38.1	28.4	38.1	26.67	19.05	8,136	11,390		110	74	104	
		06/03/1996	1032	43.7	23.6	43.7	30.59	21.85	6,761	9,465		110	61	86	
		05/06/1997	995	44.4	22.4	44.4	31.08	22.2	6,417	8,984		110	58	82	
		06/03/1998	919	50.9	18.1	50.9	35.63	25.45	5,185	7,259		110	47	66	
		05/03/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		05/21/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		04/21/2000	914	42.5	21.5	42.5	29.75	21.25	6,159	8,623		110	56	78	

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Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	C8	10/19/1950	318	76.3	4.2	76.3	53.41	38.15	1,203	1,684	60,500	110	11	15	550
		09/26/1951	365	52.5	7	52.5	36.75	26.25	2,005	2,807		110	18	26	
		10/01/1952	434	39.4	11	39.4	27.58	19.7	3,151	4,412		110	29	40	
		02/08/1955	548	56.4	9.7	56.4	39.48	28.2	2,779	3,890		110	25	35	
		10/04/1956	351	76.4	4.6	76.4	53.48	38.2	1,318	1,845		110	12	17	
		07/05/1957	260	92	2.8	92	64.4	46	802	1,123		110	7	10	
		09/12/1957	522	77	6.8	77	53.9	38.5	1,948	2,727		110	18	25	
		07/30/1958	394	49	8	49	34.3	24.5	2,292	3,209		110	21	29	
		10/31/1958	493	69.3	7.1	69.3	48.51	34.65	2,034	2,848		110	18	26	
		08/05/1959	443	76	5.8	76	53.2	38	1,662	2,326		110	15	21	
		07/06/1960	443	78.4	5.7	78.4	54.88	39.2	1,633	2,286		110	15	21	
		07/20/1961	329	72.3	4.6	72.3	50.61	36.15	1,318	1,845		110	12	17	
		05/31/1962	318	97.2	3.3	97.2	68.04	48.6	945	1,324		110	9	12	
		05/09/1963	271	104.6	2.6	104.6	73.22	52.3	745	1,043		110	7	9	
		07/14/1964	365	87.2	4.2	87.2	61.04	43.6	1,203	1,684		110	11	15	
		08/04/1965	362	88.9	4.1	88.9	62.23	44.45	1,175	1,644		110	11	15	
		11/01/1966	410	85	4.8	85	59.5	42.5	1,375	1,925		110	13	18	
		08/09/1967	377	104	3.6	104	72.8	52	1,031	1,444		110	9	13	
		08/28/1968	332	96.6	3.4	96.6	67.62	48.3	974	1,364		110	9	12	
		08/19/1969	410	75.4	5.4	75.4	52.78	37.7	1,547	2,166		110	14	20	
		07/09/1970	351	71.5	4.9	71.5	50.05	35.75	1,404	1,965		110	13	18	
		08/04/1971	572	76.4	7.5	76.4	53.48	38.2	2,149	3,008		110	20	27	
		01/12/1972	373	122.8	3	122.8	85.96	61.4	859	1,203		110	8	11	
		05/18/1972	414	110.9	3.7	110.9	77.63	55.45	1,060	1,484		110	10	13	
		07/17/1973	439	90.8	4.8	90.8	63.56	45.4	1,375	1,925		110	13	18	
		07/01/1974	419	108.8	3.9	108.8	76.16	54.4	1,117	1,564		110	10	14	
		05/03/1976	363	99.8	3.6	99.8	69.86	49.9	1,031	1,444		110	9	13	
		05/21/1984	546	59	9.3	59	41.3	29.5	2,664	3,730		110	24	34	
		07/10/1989	477	52.7	9.1	52.7	36.89	26.35	2,607	3,650		110	24	33	
		06/12/1990	488	52.2	9.3	52.2	36.54	26.1	2,664	3,730		110	24	34	
		05/06/1991	525	49.4	10.6	49.4	34.58	24.7	3,037	4,251		110	28	39	
		06/08/1992	477	48.6	9.8	48.6	34.02	24.3	2,807	3,930		110	26	36	
		07/30/1993	488	51.6	9.5	51.6	36.12	25.8	2,722	3,810		110	25	35	
		08/02/1994	520	30.4	17.1	30.4	21.28	15.2	4,899	6,858		110	45	62	
		07/11/1995	503	24.6	20.4	24.6	17.22	12.3	5,844	8,182		110	53	74	
		06/03/1996	535	29.3	18.3	29.3	20.51	14.65	5,243	7,340		110	48	67	
		05/06/1997	476	36.9	12.9	36.9	25.83	18.45	3,696	5,174		110	34	47	
		06/01/1998	478	34.5	13.9	34.5	24.15	17.25	3,982	5,575		110	36	51	
		05/03/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		05/21/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		04/21/2000	455	30.8	14.8	30.8	21.56	15.4	4,240	5,936		110	39	54	
NLF	E4	05/24/1984	1473	39.5	37.3	39.5	27.65	19.75	10,686	14,960	71,500	130	82	115	550
		06/02/1986	1511	41	36.9	41	28.7	20.5	10,571	14,799		130	81	114	
		10/03/1988	1897	42.9	44.2	42.9	30.03	21.45	12,662	17,727		130	97	136	
		07/18/1989	1576	35.5	44.4	35.5	24.85	17.75	12,720	17,807		130	98	137	
		06/04/1991	1225	17.5	70	17.5	12.25	8.75	20,053	28,075		130	154	216	
		07/23/1993	1944	38.2	50.9	38.2	26.74	19.1	14,582	20,414		130	112	157	
		05/22/1997	1956	37.2	52.6	37.2	26.04	18.6	15,069	21,096		130	116	162	
		05/11/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		05/21/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		04/21/2000	1691	30.5	55.4	30.5	21.35	15.25	15,871	22,219		130	122	171	

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Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	E5	06/10/1992	1320	84	15.7	84	58.8	42	4,498	6,297		130	35	48	
		08/11/1993	1274	63.3	20.1	63.3	44.31	31.65	5,758	8,061		130	44	62	
		12/21/1994	1203	24.9	48.3	24.9	17.43	12.45	13,837	19,372		130	106	149	
		07/25/1995	1191	23.8	50	23.8	16.66	11.9	14,324	20,053		130	110	154	
		05/28/1996	824	13.6	60.6	13.6	9.52	6.8	17,361	24,305		130	134	187	
		05/12/1997	1179	15.1	78.1	15.1	10.57	7.55	22,374	31,324		130	172	241	
		06/04/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		06/05/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		08/18/2000	**705**	**5.1**	**138.2**	**5.1**	**3.57**	**2.55**	**39,591**	**55,428**	**71,500**	**130**	**305**	**426**	**550**
NLF	E7	08/11/1993	263	2.5	105.2	2.5	1.75	1.25	30,138	42,193	71,500	130	232	325	550
		08/08/1994	328	2.5	131.2	2.5	1.75	1.25	37,586	52,620		130	289	405	
		07/03/1995	325	2.4	135.4	2.4	1.68	1.2	38,789	54,305		130	298	418	
		06/05/1996	334	2.7	123.7	2.7	1.89	1.35	35,437	49,612		130	273	382	
		05/12/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
		05/16/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
NLF	E9	04/11/1984	601	75.6	7.9	75.6	52.92	37.8	2,263	3,168	63,250	130	17	24	550
		05/20/1986	578	76.2	7.6	76.2	53.34	38.1	2,177	3,048		130	17	23	
		12/11/1986	1190	57.1	20.8	57.1	39.97	28.55	5,959	8,342		130	46	64	
		10/13/1987	1069	59.9	17.8	59.9	41.93	29.95	5,099	7,139		130	39	55	
		09/28/1988	894	61.2	14.6	61.2	42.84	30.6	4,183	5,856		130	32	45	
		07/11/1989	897	60	15	60	42	30	4,297	6,016		130	33	46	
		05/29/1990	876	60.3	14.5	60.3	42.21	30.15	4,154	5,816		130	32	45	
		04/18/1991	970	60.3	16.1	60.3	42.21	30.15	4,612	6,457		130	35	50	
		06/04/1992	897	62.4	14.4	62.4	43.68	31.2	4,125	5,775		130	32	44	
		07/22/1993	1021	55.6	18.4	55.6	38.92	27.8	5,271	7,380		130	41	57	
		07/19/1994	1053	52.1	20.2	52.1	36.47	26.05	5,787	8,102		130	45	62	
		07/03/1995	1058	51.5	20.5	51.5	36.05	25.75	5,873	8,222		130	45	63	
		05/23/1996	1073	49.7	21.6	49.7	34.79	24.85	6,188	8,663		130	48	67	
		04/23/1997	1050	50.1	21	50.1	35.07	25.05	6,016	8,422		130	46	65	
		06/03/1998	1021	50.8	20.1	50.8	35.56	25.4	5,758	8,061		130	44	62	
		05/04/1999	1107	39.8	27.8	39.8	27.86	19.9	7,964	11,150		130	61	86	
		04/21/2000	1117	29.6	37.7	29.6	20.72	14.8	10,800	15,120		130	83	116	
NLF	G45	04/16/1984	1590	31.2	51	31.2	21.84	15.6	14,610	20,455	63,250	115	127	178	550
		05/27/1986	1008	20.5	49.2	20.5	14.35	10.25	14,095	19,733		115	123	172	
		07/13/1989	1379	33.7	40.9	33.7	23.59	16.85	11,717	16,404		115	102	143	
		06/14/1990	1399	32.3	43.3	32.3	22.61	16.15	12,405	17,366		115	108	151	
		05/30/1991	1456	37.8	38.5	37.8	26.46	18.9	11,029	15,441		115	96	134	
		06/10/1992	1434	36.7	39.1	36.7	25.69	18.35	11,201	15,682		115	97	136	
		07/29/1993	1172	24.9	47.1	24.9	17.43	12.45	13,493	18,890		115	117	164	
		08/08/1994	1325	29.7	44.6	29.7	20.79	14.85	12,777	17,888		115	111	156	
		07/19/1995	1140	25.6	44.5	25.6	17.92	12.8	12,748	17,848		115	111	155	
		05/23/1996	1130	25.3	44.7	25.3	17.71	12.65	12,806	17,928		115	111	156	
		05/07/1997	1162	25.9	44.9	25.9	18.13	12.95	12,863	18,008		115	112	157	
		06/04/1998	1396	41.4	33.7	41.4	28.98	20.7	9,654	13,516		115	84	118	
		05/10/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		05/21/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		04/21/2000	1257	26.9	46.7	26.9	18.83	13.45	13,379	18,730		115	116	163	
NLF	X3	04/11/1984	802	41	19.6	41	28.7	20.5	5,615	7,861	63,250	115	49	68	550
		05/20/1986	505	53.4	9.5	53.4	37.38	26.7	2,722	3,810		115	24	33	
		10/13/1987	740	40.6	18.2	40.6	28.42	20.3	5,214	7,299		115	45	63	
		09/28/1988	477	45.5	10.5	45.5	31.85	22.75	3,008	4,211		115	26	37	
		07/11/1989	572	61.4	9.3	61.4	42.98	30.7	2,664	3,730		115	23	32	

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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/29/1990	444	47.5	9.3	47.5	33.25	23.75	2,664	3,730		115	23	32	
		04/18/1991	475	48.6	9.8	48.6	34.02	24.3	2,807	3,930		115	24	34	
		06/04/1992	587	46.1	12.7	46.1	32.27	23.05	3,638	5,094		115	32	44	
		07/22/1993	496	54	9.2	54	37.8	27	2,636	3,690		115	23	32	
		07/18/1994	465	52.2	8.9	52.2	36.54	26.1	2,550	3,570		115	22	31	
		07/03/1995	490	49.4	9.9	49.4	34.58	24.7	2,836	3,971		115	25	35	
		05/14/1996	449	53.9	8.3	53.9	37.73	26.95	2,378	3,329		115	21	29	
		04/23/1997	485	53.8	9	53.8	37.66	26.9	2,578	3,610		115	22	31	
		05/06/1998	531	47.9	11.1	47.9	33.53	23.95	3,180	4,452		115	28	39	
		05/04/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		05/21/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		04/21/2000	513	43.2	11.9	43.2	30.24	21.6	3,409	4,773		115	30	42	

Notes:

E = well efficiency

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	I	**05/23/1984**	**993**	**8.7**	**114.1**	**8.7**	**6.09**	**4.35**	**32,687**	**45,762**	**22,500**	**130**	**251**	**352**	**375**
		06/09/1986	**1058**	**9.6**	**110.2**	**9.6**	**6.72**	**4.8**	**31,570**	**44,198**	**22,500**	**130**	**243**	**340**	**375**
		02/03/1992	140	73	1.9	73	51.1	36.5	544	762		130	4	6	
		07/06/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
		08/01/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
VWC	K2	**01/29/1992**	**1563**	**7.1**	**220.1**	**7.1**	**4.97**	**3.55**	**63,054**	**88,275**	**54,375**	**145**	**435**	**609**	**375**
		05/13/1994	1365	7.1	192.3	7.1	4.97	3.55	55,090	77,126		145	380	532	
		04/17/1996	1650	8.6	191.9	8.6	6.02	4.3	54,975	76,965		145	379	531	
		07/11/1997	**1333**	**6.3**	**211.6**	**6.3**	**4.41**	**3.15**	**60,619**	**84,866**	**54,375**	**145**	**418**	**585**	**375**
		12/30/1998	1409	6.7	210.3	6.7	4.69	3.35	60,246	84,345		145	415	582	
VWC	L2	04/26/1984	2197	28.3	77.6	28.3	19.81	14.15	22,231	31,123	54,375	145	153	215	375
		11/21/1991	1400	19	73.7	19	13.3	9.5	21,113	29,559		145	146	204	
		01/29/1992	1466	26.1	56.2	26.1	18.27	13.05	16,100	22,540		145	111	155	
		05/13/1994	1256	32.8	38.3	32.8	22.96	16.4	10,972	15,361		145	76	106	
		04/17/1996	1210	29.6	40.9	29.6	20.72	14.8	11,717	16,404		145	81	113	
		07/14/1997	851	17.6	48.4	17.6	12.32	8.8	13,866	19,412		145	96	134	
		12/11/1998	931	24.5	38	24.5	17.15	12.25	10,886	15,241		145	75	105	
VWC	N	08/05/1969	1891	31.6	59.8	31.6	22.12	15.8	17,131	23,984	54,375	145	118	165	375
		08/27/1970	1787	27	66.2	27	18.9	13.5	18,965	26,551		145	131	183	
		07/21/1977	1427	15.2	93.9	15.2	10.64	7.6	26,900	37,660		145	186	260	
		05/23/1978	1448	14.6	99.2	14.6	10.22	7.3	28,419	39,786		145	196	274	
		11/05/1979	1427	15.4	92.7	15.4	10.78	7.7	26,557	37,179		145	183	256	
		11/17/1980	1450	21.8	66.5	21.8	15.26	10.9	19,051	26,671		145	131	184	
		10/26/1981	1427	26	54.9	26	18.2	13	15,728	22,019		145	108	152	
		06/10/1982	1427	24.1	59.2	24.1	16.87	12.05	16,960	23,743		145	117	164	
		02/04/1985	1562	22.9	68.2	22.9	16.03	11.45	19,538	27,353		145	135	189	
		08/07/1986	1450	23	63	23	16.1	11.5	18,048	25,267		145	124	174	
		04/25/1988	1404	23.3	60.3	23.3	16.31	11.65	17,275	24,184		145	119	167	
		02/01/1990	1380	22.5	61.3	22.5	15.75	11.25	17,561	24,586		145	121	170	
		05/30/1990	1350	21	64.3	21	14.7	10.5	18,421	25,789		145	127	178	
		11/21/1991	1320	19.5	67.7	19.5	13.65	9.75	19,395	27,152		145	134	187	
		01/30/1992	1378	20.8	66.3	20.8	14.56	10.4	18,994	26,591		145	131	183	
		05/13/1994	1328	16.9	78.6	16.9	11.83	8.45	22,517	31,524		145	155	217	
		04/18/1996	1320	16.8	78.6	16.8	11.76	8.4	22,517	31,524		145	155	217	
		07/11/1997	927	10.2	90.9	10.2	7.14	5.1	26,041	36,457		145	180	251	
		12/01/1998	1086	11.5	94.4	11.5	8.05	5.75	27,044	37,861		145	187	261	
VWC	N3	**11/21/1991**	**1550**	**8**	**193.8**	**8**	**5.6**	**4**	**55,519**	**77,727**	**79,750**	**145**	**383**	**536**	**550**
		05/12/1994	1520	11.3	134.5	11.3	7.91	5.65	38,531	53,944		145	266	372	
		04/18/1996	1294	7	184.9	7	4.9	3.5	52,970	74,158		145	365	511	
		07/14/1997	1121	6.5	172.5	6.5	4.55	3.25	49,417	69,184		145	341	477	
		12/11/1998	1319	8.5	155.2	8.5	5.95	4.25	44,461	62,246		145	307	429	
VWC	N4	**11/21/1991**	**1510**	**5.5**	**274.5**	**5.5**	**3.85**	**2.75**	**78,638**	**110,094**	**54,375**	**145**	**542**	**759**	**375**
		01/28/1992	1474	6.5	226.8	6.5	4.55	3.25	64,973	90,963		145	448	627	
		05/12/1994	1303	6.3	206.8	6.3	4.41	3.15	59,244	82,941		145	409	572	
		04/17/1996	1384	5.3	261.1	5.3	3.71	2.65	74,799	104,719		145	516	722	
		07/14/1997	1171	5	234.2	5	3.5	2.5	67,093	93,930		145	463	648	
		12/11/1998	1249	4.6	271.5	4.6	3.22	2.3	77,779	108,890		145	536	751	

TABLE B-2

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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	Q2	02/17/1955	2343	24.2	96.8	24.2	16.94	12.1	27,731	38,824		145	191	268	
		03/09/1955	2310	23.5	98.3	23.5	16.45	11.75	28,161	39,425		145	194	272	
		10/21/1955	2103	21.5	97.8	21.5	15.05	10.75	28,018	39,225		145	193	271	
		08/01/1957	1589	28.9	55	28.9	20.23	14.45	15,756	22,059		145	109	152	
		11/18/1958	1696	26.3	64.5	26.3	18.41	13.15	18,478	25,869		145	127	178	
		07/26/1960	1073	17.9	59.9	17.9	12.53	8.95	17,160	24,024		145	118	166	
		06/27/1962	1349	34.6	39	34.6	24.22	17.3	11,173	15,642		145	77	108	
		06/19/1963	1920	25.5	75.3	25.5	17.85	12.75	21,572	30,201		145	149	208	
		09/21/1964	1611	24.3	66.3	24.3	17.01	12.15	18,994	26,591		145	131	183	
		09/17/1965	1414	17.7	79.9	17.7	12.39	8.85	22,890	32,045		145	158	221	
		07/26/1967	1806	16	112.9	16	11.2	8	32,343	45,281		145	223	312	
		10/05/1970	1711	15.6	109.7	15.6	10.92	7.8	31,427	43,997		145	217	303	
		08/16/1971	1880	17.2	109.3	17.2	12.04	8.6	31,312	43,837		145	216	302	
		07/03/1974	2022	25.9	78.1	25.9	18.13	12.95	22,374	31,324		145	154	216	
		10/21/1975	1552	37.9	40.9	37.9	26.53	18.95	11,717	16,404		145	81	113	
		08/03/1976	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		06/14/1977	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		05/24/1978	1626	20.5	79.3	20.5	14.35	10.25	22,718	31,805		145	157	219	
		12/03/1979	1542	29.4	52.4	29.4	20.58	14.7	15,011	21,016		145	104	145	
		11/13/1980	1752	33.2	52.8	33.2	23.24	16.6	15,126	21,176		145	104	146	
		06/09/1982	1898	43.5	43.6	43.5	30.45	21.75	12,490	17,487		145	86	121	
		02/25/1985	1960	54.8	35.8	54.8	38.36	27.4	10,256	14,358		145	71	99	
		08/07/1986	1804	72.4	24.9	72.4	50.68	36.2	7,133	9,987		145	49	69	
		04/28/1988	**2297**	**18.4**	**124.8**	**18.4**	**12.88**	**9.2**	**35,752**	**50,053**	**79,750**	**145**	**247**	**345**	**550**
		02/01/1990	1965	19.5	100.8	19.5	13.65	9.75	28,877	40,428		145	199	279	
		05/29/1990	1890	18	105	18	12.6	9	30,080	42,112		145	207	290	
		03/19/1992	1874	19	98.6	19	13.3	9.5	28,247	39,545		145	195	273	
		05/24/1994	1637	15.3	107	15.3	10.71	7.65	30,653	42,914		145	211	296	
		04/05/1996	1466	15.9	92.2	15.9	11.13	7.95	26,413	36,979		145	182	255	
		07/23/1997	1206	14	86.1	14	9.8	7	24,666	34,532		145	170	238	
		12/17/1998	1225	19.1	64.1	19.1	13.37	9.55	18,363	25,709		145	127	177	
NLF	R2	07/23/1941	1730	29.5	58.6	29.5	20.65	14.75	16,788	23,503		90	187	261	
		06/21/1945	1520	8	190	8	5.6	4	54,431	76,203		90	605	847	
		12/18/1946	1352	6	225.3	6	4.2	3	64,544	90,361		90	717	1,004	
		10/29/1947	**1680**	**6.4**	**262.5**	**6.4**	**4.48**	**3.2**	**75,201**	**105,281**	**22,050**	**90**	**836**	**1,170**	**245**
		06/20/1949	**1672**	**9**	**185.8**	**9**	**6.3**	**4.5**	**53,228**	**74,519**	**22,050**	**90**	**591**	**828**	**245**
		05/23/1950	1152	45.5	25.3	45.5	31.85	22.75	7,248	10,147		90	81	113	
		10/16/1950	672	8.1	83	8.1	5.67	4.05	23,778	33,289		90	264	370	
		01/19/1951	1310	6	218.3	6	4.2	3	62,538	87,553		90	695	973	
		09/28/1951	328	4	82	4	2.8	2	23,491	32,888		90	261	365	
		06/06/1952	1200	11	109.1	11	7.7	5.5	31,255	43,757		90	347	486	
		01/15/1955	1010	19.5	51.8	19.5	13.65	9.75	14,840	20,775		90	165	231	
		03/03/1955	1119	19.1	58.6	19.1	13.37	9.55	16,788	23,503		90	187	261	
		10/18/1955	620	38.7	16	38.7	27.09	19.35	4,584	6,417		90	51	71	
		09/19/1956	588	22.4	26.3	22.4	15.68	11.2	7,534	10,548		90	84	117	
		08/01/1957	429	8.3	51.7	8.3	5.81	4.15	14,811	20,735		90	165	230	
		09/24/1957	600	28	21.4	28	19.6	14	6,131	8,583		90	68	95	
		08/18/1959	660	34.7	19	34.7	24.29	17.35	5,443	7,620		90	60	85	
		08/18/1960	538	32.4	16.6	32.4	22.68	16.2	4,756	6,658		90	53	74	
		09/11/1961	362	7.6	47.6	7.6	5.32	3.8	13,636	19,091		90	152	212	

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		06/13/1962	660	11.6	56.9	11.6	8.12	5.8	16,301	22,821		90	181	254	
		05/06/1963	880	14.6	60.3	14.6	10.22	7.3	17,275	24,184		90	192	269	
		09/21/1964	725	16.4	44.2	16.4	11.48	8.2	12,662	17,727		90	141	197	
		08/05/1965	491	12.1	40.6	12.1	8.47	6.05	11,631	16,283		90	129	181	
		10/12/1967	523	10.2	51.3	10.2	7.14	5.1	14,696	20,575		90	163	229	
		08/07/1968	588	8.5	69.2	8.5	5.95	4.25	19,824	27,754		90	220	308	
		08/16/1971	545	2.1	259.5	2.1	1.47	1.05	74,341	104,078		90	826	1,156	
		06/21/1972	548	1.9	288.4	1.9	1.33	0.95	82,620	115,668		90	918	1,285	
		10/20/1975	460	1.8	255.6	1.8	1.26	0.9	73,224	102,513		90	814	1,139	
		04/07/1977	714	3.4	210	3.4	2.38	1.7	60,160	84,225		90	668	936	
		09/30/1980	708	2.7	262.2	2.7	1.89	1.35	75,115	105,160		90	835	1,168	
NLF	S	08/25/1937	1220	15	81.3	15	10.5	7.5	23,291	32,607		145	161	225	
		08/01/1938	1113	10.9	102.1	10.9	7.63	5.45	29,249	40,949		145	202	282	
		08/03/1938	1195	12	99.6	12	8.4	6	28,533	39,947		145	197	275	
		07/17/1940	1052	11.3	93.1	11.3	7.91	5.65	26,671	37,340		145	184	258	
		09/25/1940	1173	13	90.2	13	9.1	6.5	25,840	36,176		145	178	249	
		07/23/1941	1278	12	106.5	12	8.4	6	30,510	42,714		145	210	295	
		06/28/1945	1183	14.5	81.6	14.5	10.15	7.25	23,377	32,727		145	161	226	
		07/01/1946	1135	23.5	48.3	23.5	16.45	11.75	13,837	19,372		145	95	134	
		12/18/1946	**1028**	**5**	**205.6**	**5**	**3.5**	**2.5**	**58,900**	**82,460**	**54,375**	**145**	**406**	**569**	**375**
		10/17/1947	1400	22.5	62.2	22.5	15.75	11.25	17,819	24,947		145	123	172	
		09/15/1948	1350	26	51.9	26	18.2	13	14,868	20,816		145	103	144	
		06/17/1949	1415	24	59	24	16.8	12	16,902	23,663		145	117	163	
		05/24/1950	1385	25	55.4	25	17.5	12.5	15,871	22,219		145	109	153	
		10/03/1950	1120	29.5	38	29.5	20.65	14.75	10,886	15,241		145	75	105	
		07/17/1952	1146	24.5	46.8	24.5	17.15	12.25	13,407	18,770		145	92	129	
		07/07/1953	913	13.5	67.6	13.5	9.45	6.75	19,366	27,112		145	134	187	
		05/14/1954	1320	24	55	24	16.8	12	15,756	22,059		145	109	152	
		02/23/1955	1101	20.8	52.9	20.8	14.56	10.4	15,155	21,217		145	105	146	
		03/07/1955	1293	21	61.6	21	14.7	10.5	17,647	24,706		145	122	170	
		11/14/1955	457	7.6	60.1	7.6	5.32	3.8	17,217	24,104		145	119	166	
		07/03/1958	1330	12	110.8	12	8.4	6	31,742	44,439		145	219	306	
		10/15/1958	726	7.5	96.8	7.5	5.25	3.75	27,731	38,824		145	191	268	
		07/23/1959	731	8.1	90.2	8.1	5.67	4.05	25,840	36,176		145	178	249	
		07/26/1960	695	7.8	89.1	7.8	5.46	3.9	25,525	35,735		145	176	246	
		08/17/1961	669	6.8	98.4	6.8	4.76	3.4	28,189	39,465		145	194	272	
		05/29/1962	721	6.2	116.3	6.2	4.34	3.1	33,317	46,644		145	230	322	
		04/22/1963	726	6.4	113.4	6.4	4.48	3.2	32,487	45,481		145	224	314	
		08/19/1964	658	6.4	102.8	6.4	4.48	3.2	29,450	41,230		145	203	284	
		08/18/1965	674	6.2	108.7	6.2	4.34	3.1	31,140	43,596		145	215	301	
		10/12/1967	638	5.6	113.9	5.6	3.92	2.8	32,630	45,682		145	225	315	
		08/06/1968	716	6.2	115.5	6.2	4.34	3.1	33,088	46,324		145	228	319	
		09/10/1968	721	6.4	112.7	6.4	4.48	3.2	32,286	45,201		145	223	312	
		08/06/1969	783	6.8	115.1	6.8	4.76	3.4	32,974	46,163		145	227	318	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1021	8.6	118.7	8.6	6.02	4.3	34,005	47,607		145	235	328	
		06/21/1972	1139	10.8	105.5	10.8	7.56	5.4	30,223	42,313		145	208	292	
		08/14/1973	**1169**	**9**	**129.9**	**9**	**6.3**	**4.5**	**37,214**	**52,099**	**54,375**	**145**	**257**	**359**	**375**
		01/14/1975	1082	9	120.2	9	6.3	4.5	34,435	48,209		145	237	332	
		05/13/1976	1115	44.2	25.2	44.2	30.94	22.1	7,219	10,107		145	50	70	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/07/1977	1011	9.4	107.6	9.4	6.58	4.7	30,825	43,155		145	213	298	
		08/15/1978	1035	45.5	22.7	45.5	31.85	22.75	6,503	9,104		145	45	63	
		09/24/1981	937	11.4	82.2	11.4	7.98	5.7	23,549	32,968		145	162	227	
		08/19/1982	1078	9.5	113.5	9.5	6.65	4.75	32,515	45,521		145	224	314	
NLF	S2	09/20/1940	2630	26	101.2	26	18.2	13	28,992	40,588	54,375	145	200	280	375
		07/24/1941	3055	32.2	94.9	32.2	22.54	16.1	27,187	38,061		145	187	262	
		06/12/1945	2775	50.4	55.1	50.4	35.28	25.2	15,785	22,099		145	109	152	
		07/24/1946	2630	28	93.9	28	19.6	14	26,900	37,660		145	186	260	
		12/17/1946	2380	49.8	47.8	49.8	34.86	24.9	13,694	19,171		145	94	132	
		03/31/1947	2940	40	73.5	40	28	20	21,056	29,479		145	145	203	
		10/18/1947	2630	48	54.8	48	33.6	24	15,699	21,979		145	108	152	
		09/15/1948	2130	54	39.4	54	37.8	27	11,287	15,802		145	78	109	
		06/17/1949	2090	46	45.4	46	32.2	23	13,006	18,209		145	90	126	
		05/24/1950	1970	41	48	41	28.7	20.5	13,751	19,251		145	95	133	
		10/03/1950	1420	45.3	31.3	45.3	31.71	22.65	8,967	12,553		145	62	87	
		01/19/1951	2130	50	42.6	50	35	25	12,204	17,086		145	84	118	
		05/15/1954	2040	32.5	62.8	32.5	22.75	16.25	17,991	25,187		145	124	174	
		02/16/1955	1466	28.3	51.8	28.3	19.81	14.15	14,840	20,775		145	102	143	
		03/07/1955	1692	27.3	62	27.3	19.11	13.65	17,762	24,866		145	122	171	
		11/04/1955	1201	31	38.7	31	21.7	15.5	11,087	15,521		145	76	107	
		12/30/1955	1950	20	97.5	20	14	10	27,932	39,104		145	193	270	
		09/27/1956	1448	43.5	33.3	43.5	30.45	21.75	9,540	13,356		145	66	92	
		08/02/1957	1337	35.9	37.2	35.9	25.13	17.95	10,657	14,920		145	73	103	
		10/09/1957	1605	43	37.3	43	30.1	21.5	10,686	14,960		145	74	103	
		07/03/1958	1800	44	40.9	44	30.8	22	11,717	16,404		145	81	113	
		10/10/1958	1485	39.4	37.7	39.4	27.58	19.7	10,800	15,120		145	74	104	
		07/23/1959	1305	39.6	33	39.6	27.72	19.8	9,454	13,235		145	65	91	
		07/19/1960	1120	31	36.1	31	21.7	15.5	10,342	14,479		145	71	100	
		08/17/1961	1178	27	43.6	27	18.9	13.5	12,490	17,487		145	86	121	
		06/14/1962	1225	30.9	39.6	30.9	21.63	15.45	11,345	15,882		145	78	110	
		04/22/1963	1406	30	46.9	30	21	15	13,436	18,810		145	93	130	
		07/28/1964	1016	29	35	29	20.3	14.5	10,027	14,037		145	69	97	
		08/18/1965	1142	24.8	46	24.8	17.36	12.4	13,178	18,449		145	91	127	
		01/09/1967	1748	26	67.2	26	18.2	13	19,251	26,952		145	133	186	
		10/12/1967	1634	26	62.8	26	18.2	13	17,991	25,187		145	124	174	
		08/05/1968	1455	24.8	58.7	24.8	17.36	12.4	16,816	23,543		145	116	162	
		08/06/1969	1490	30.6	48.7	30.6	21.42	15.3	13,951	19,532		145	96	135	
		08/24/1970	2194	29.8	73.6	29.8	20.86	14.9	21,085	29,519		145	145	204	
		08/19/1971	2308	32.2	71.7	32.2	22.54	16.1	20,540	28,757		145	142	198	
		07/26/1972	2206	30.6	72.1	30.6	21.42	15.3	20,655	28,917		145	142	199	
		08/14/1973	1783	18	99.1	18	12.6	9	28,390	39,746		145	196	274	
		01/15/1975	2251	52.2	43.1	52.2	36.54	26.1	12,347	17,286		145	85	119	
		05/13/1976	1554	47.6	32.6	47.6	33.32	23.8	9,339	13,075		145	64	90	
		04/06/1977	2001	22	91	22	15.4	11	26,070	36,497		145	180	252	
		06/21/1978	2613	48	54.4	48	33.6	24	15,584	21,818		145	107	150	
		09/24/1981	1824	21.8	83.7	21.8	15.26	10.9	23,978	33,570		145	165	232	
		07/27/1982	1790	21.9	81.7	21.9	15.33	10.95	23,405	32,767		145	161	226	
		05/30/1984	1813	22.2	81.7	22.2	15.54	11.1	23,405	32,767		145	161	226	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	S3	04/11/1951	939	57	16.5	57	39.9	28.5	4,727	6,618		145	33	46	
		07/07/1953	766	72.3	10.6	72.3	50.61	36.15	3,037	4,251		145	21	29	
		07/23/1954	844	57	14.8	57	39.9	28.5	4,240	5,936		145	29	41	
		03/03/1955	928	45.5	20.4	45.5	31.85	22.75	5,844	8,182		145	40	56	
		03/07/1955	871	45	19.4	45	31.5	22.5	5,558	7,781		145	38	54	
		11/04/1955	736	53.5	13.8	53.5	37.45	26.75	3,953	5,535		145	27	38	
		08/03/1956	700	60.5	11.6	60.5	42.35	30.25	3,323	4,652		145	23	32	
		07/24/1957	674	57.5	11.7	57.5	40.25	28.75	3,352	4,693		145	23	32	
		10/02/1957	594	82	7.2	82	57.4	41	2,063	2,888		145	14	20	
		08/16/1961	576	58.1	9.9	58.1	40.67	29.05	2,836	3,971		145	20	27	
		06/14/1962	695	50.8	13.7	50.8	35.56	25.4	3,925	5,495		145	27	38	
		06/06/1963	786	31.2	25.2	31.2	21.84	15.6	7,219	10,107		145	50	70	
		08/19/1964	716	36.5	19.6	36.5	25.55	18.25	5,615	7,861		145	39	54	
		08/18/1965	720	35.2	20.5	35.2	24.64	17.6	5,873	8,222		145	41	57	
		09/11/1968	**945**	**7.3**	**129.5**	**7.3**	**5.11**	**3.65**	**37,099**	**51,939**	**79,750**	**145**	**256**	**358**	**550**
		08/06/1969	1033	8.4	123	8.4	5.88	4.2	35,237	49,332		145	243	340	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1040	8.4	123.8	8.4	5.88	4.2	35,466	49,652		145	245	342	
		06/12/1972	1042	8.8	118.4	8.8	6.16	4.4	33,919	47,487		145	234	327	
		08/14/1973	1045	8.8	118.8	8.8	6.16	4.4	34,034	47,647		145	235	329	
		01/14/1975	**1016**	**7.9**	**128.6**	**7.9**	**5.53**	**3.95**	**36,841**	**51,578**	**79,750**	**145**	**254**	**356**	**550**
		04/14/1977	1007	8.6	117.1	8.6	6.02	4.3	33,547	46,965		145	231	324	
		06/21/1978	587	6.1	96.2	6.1	4.27	3.05	27,559	38,583		145	190	266	
		09/24/1981	632	6.8	92.9	6.8	4.76	3.4	26,614	37,259		145	184	257	
		07/26/1982	649	6	108.2	6	4.2	3	30,997	43,396		145	214	299	
		05/29/1984	649	6.9	94.1	6.9	4.83	3.45	26,958	37,741		145	186	260	
		05/22/1986	639	8	79.9	8	5.6	4	22,890	32,045		145	158	221	
		06/14/1990	433	5	86.6	5	3.5	2.5	24,809	34,733		145	171	240	
		06/04/1991	520	6.1	85.2	6.1	4.27	3.05	24,408	34,171		145	168	236	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-3

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Lower Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Stadium	07/20/1965	812	8.3	97.8	8.3	5.81	4.15	28,018	39,225		90	311	436	
		06/06/1972	531	1.6	331.9	1.6	1.12	0.8	95,082	133,115		90	1,056	1,479	
		03/19/1974	**1046**	**2.8**	**373.6**	**2.8**	**1.96**	**1.4**	**107,028**	**149,840**	**63,250**	**90**	**1,189**	**1,665**	**550**
		04/10/1975	**965**	**2.8**	**344.6**	**2.8**	**1.96**	**1.4**	**98,720**	**138,209**	**63,250**	**90**	**1,097**	**1,536**	**550**
		04/12/1976	901	3.4	265	3.4	2.38	1.7	75,917	106,283		90	844	1,181	
		07/11/1977	836	4	209	4	2.8	2	59,874	83,824		90	665	931	
		05/10/1978	942	3.9	241.5	3.9	2.73	1.95	69,184	96,858		90	769	1,076	
		04/01/1979	930	3.1	300	3.1	2.17	1.55	85,943	120,321		90	955	1,337	
		09/01/1979	**937**	**3.1**	**302.3**	**3.1**	**2.17**	**1.55**	**86,602**	**121,243**	**63,250**	**90**	**962**	**1,347**	**550**
		09/22/1998	945	3.6	262.5	3.6	2.52	1.8	75,201	105,281		90	836	1,170	
VWC	U4	07/27/1967	1383	13.1	105.6	13.1	9.17	6.55	30,252	42,353		115	263	368	
		08/07/1968	1686	12.4	136	12.4	8.68	6.2	38,961	54,545		115	339	474	
		08/18/1969	**2621**	**10.2**	**257**	**10.2**	**7.14**	**5.1**	**73,625**	**103,075**	**63,250**	**115**	**640**	**896**	**550**
		08/13/1973	**2679**	**8**	**334.9**	**8**	**5.6**	**4**	**95,942**	**134,318**	**63,250**	**115**	**834**	**1,168**	**550**
		10/31/1979	1021	3.8	268.7	3.8	2.66	1.9	76,977	107,767		115	669	937	
		11/10/1980	1123	4.1	273.9	4.1	2.87	2.05	78,466	109,853		115	682	955	
		06/08/1982	1144	4.4	260	4.4	3.08	2.2	74,484	104,278		115	648	907	
		01/29/1985	962	3.8	253.2	3.8	2.66	1.9	72,536	101,551		115	631	883	
		08/18/1986	941	3.9	241.3	3.9	2.73	1.95	69,127	96,778		115	601	842	
		04/21/1988	1080	4.2	257.1	4.2	2.94	2.1	73,654	103,115		115	640	897	
		02/01/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		05/29/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		01/23/1992	978	4.5	217.3	4.5	3.15	2.25	62,252	87,152		115	541	758	
		06/14/1994	1057	4.2	251.7	4.2	2.94	2.1	72,107	100,949		115	627	878	
		04/04/1996	958	3.5	273.7	3.5	2.45	1.75	78,409	109,773		115	682	955	
		07/17/1997	919	3.3	278.5	3.3	2.31	1.65	79,784	111,698		115	694	971	
		12/29/1998	**1198**	**5.3**	**226**	**5.3**	**3.71**	**2.65**	**64,744**	**90,642**		**115**	**563**	**788**	
VWC	U3	07/27/1967	1389	9	154.3	9	6.3	4.5	44,204	61,885		115	384	538	
		08/07/1968	784	9	87.1	9	6.3	4.5	24,952	34,933		115	217	304	
		08/15/1973	**1997**	**4.7**	**424.9**	**4.7**	**3.29**	**2.35**	**121,725**	**170,414**	**63,250**	**115**	**1,058**	**1,482**	**550**
		10/21/1975	1087	3	362.3	3	2.1	1.5	103,791	145,307		115	903	1,264	
		08/02/1976	997	2.9	343.8	2.9	2.03	1.45	98,491	137,888		115	856	1,199	
		06/13/1977	907	4.1	221.2	4.1	2.87	2.05	63,369	88,717		115	551	771	
		05/31/1978	1074	4.3	249.8	4.3	3.01	2.15	71,562	100,187		115	622	871	
		10/31/1979	939	3.5	268.3	3.5	2.45	1.75	76,862	107,607		115	668	936	
		11/10/1980	898	3.4	264.1	3.4	2.38	1.7	75,659	105,922		115	658	921	
		06/08/1982	1181	4	295.3	4	2.8	2	84,597	118,436		115	736	1,030	
		01/28/1985	**1276**	**4**	**319**	**4**	**2.8**	**2**	**91,387**	**127,941**	**63,250**	**115**	**795**	**1,113**	**550**
		08/18/1986	961	3.2	300.3	3.2	2.24	1.6	86,029	120,441		115	748	1,047	
		04/21/1988	**1249**	**3.6**	**346.9**	**3.6**	**2.52**	**1.8**	**99,379**	**139,131**	**63,250**	**115**	**864**	**1,210**	**550**
		02/01/1990	**1253**	**3**	**417.7**	**3**	**2.1**	**1.5**	**119,662**	**167,527**	**63,250**	**115**	**1,041**	**1,457**	**550**
		05/29/1990	1162	3	387.3	3	2.1	1.5	110,953	155,334		115	965	1,351	
		01/24/1992	1078	5.2	207.3	5.2	3.64	2.6	59,387	83,142		115	516	723	
		07/18/1994	1217	3.9	312.1	3.9	2.73	1.95	89,410	125,174		115	777	1,088	
		04/04/1996	979	2.9	337.6	2.9	2.03	1.45	96,715	135,401		115	841	1,177	
		07/17/1997	861	2.6	331.2	2.6	1.82	1.3	94,882	132,834		115	825	1,155	
		01/18/1999	**1224**	**3.6**	**340**	**3.6**	**2.52**	**1.8**	**97,403**	**136,364**	**63,250**	**115**	**847**	**1,186**	**550**
SCWC	Honby	07/23/1965	613	26.4	23.2	26.4	18.48	13.2	6,646	9,305		90	74	103	
		06/02/1972	712	4	178	4	2.8	2	50,993	71,390		90	567	793	
		06/05/1972	781	14.4	54.2	14.4	10.08	7.2	15,527	21,738		90	173	242	
		04/02/1974	684	14.6	46.8	14.6	10.22	7.3	13,407	18,770		90	149	209	
		04/16/1975	654	14.2	46.1	14.2	9.94	7.1	13,207	18,489		90	147	205	

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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/13/1976	623	3.5	178	3.5	2.45	1.75	50,993	71,390		90	567	793	
		05/03/1976	674	13.8	48.8	13.8	9.66	6.9	13,980	19,572		90	155	217	
		07/28/1977	801	16.5	48.5	16.5	11.55	8.25	13,894	19,452		90	154	216	
		08/25/1977	702	7.2	97.5	7.2	5.04	3.6	27,932	39,104		90	310	434	
		05/11/1978	**970**	**8.2**	**118.3**	**8.2**	**5.74**	**4.1**	**33,890**	**47,447**	**49,500**	**90**	**377**	**527**	**550**
		05/25/1978	835	18.4	45.4	18.4	12.88	9.2	13,006	18,209		90	145	202	
		04/01/1979	1065	13.7	77.7	13.7	9.59	6.85	22,259	31,163		90	247	346	
		09/01/1979	**1080**	**8.9**	**121.3**	**8.9**	**6.23**	**4.45**	**34,750**	**48,650**	**49,500**	**90**	**386**	**541**	**550**
		08/19/1980	**1178**	**12**	**98.2**	**12**	**8.4**	**6**	**28,132**	**39,385**	**49,500**	**90**	**313**	**438**	**550**
		08/22/1980	914	29.6	30.9	29.6	20.72	14.8	8,852	12,393		90	98	138	
		11/18/1981	919	48	19.1	48	33.6	24	5,472	7,660		90	61	85	
		12/01/1981	1277	13.4	95.3	13.4	9.38	6.7	27,301	38,222		90	303	425	
		03/14/1983	868	35	24.8	35	24.5	17.5	7,105	9,947		90	79	111	
		08/24/1983	1287	16.7	77.1	16.7	11.69	8.35	22,087	30,922		90	245	344	
		07/24/1984	832	48.1	17.3	48.1	33.67	24.05	4,956	6,939		90	55	77	
		08/02/1984	1232	14.5	85	14.5	10.15	7.25	24,351	34,091		90	271	379	
		10/22/1985	756	46.2	16.4	46.2	32.34	23.1	4,698	6,578		90	52	73	
		10/24/1985	1217	15.1	80.6	15.1	10.57	7.55	23,090	32,326		90	257	359	
		09/22/1998	904	10.2	88.6	10.2	7.14	5.1	25,382	35,535		90	282	395	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	N. Oaks West	06/05/1972	1245	17.8	69.9	17.8	12.46	8.9	20,025	28,035		90	222	311	
		08/05/1972	1527	18.6	82.1	18.6	13.02	9.3	23,520	32,928		90	261	366	
		03/20/1974	1578	17.8	88.7	17.8	12.46	8.9	25,411	35,575		90	282	395	
		04/07/1975	1407	12.6	111.7	12.6	8.82	6.3	32,000	44,799		90	356	498	
		04/15/1976	1232	10.6	116.2	10.6	7.42	5.3	33,289	46,604		90	370	518	
		08/24/1977	578	7.2	80.3	7.2	5.04	3.6	23,004	32,206		90	256	358	
		06/07/1978	1392	12	116	12	8.4	6	33,231	46,524		90	369	517	
		04/01/1979	1298	10.8	120.2	10.8	7.56	5.4	34,435	48,209		90	383	536	
		09/01/1979	1185	9.7	122.2	9.7	6.79	4.85	35,008	49,011		90	389	545	
		08/02/1980	1317	11.4	115.5	11.4	7.98	5.7	33,088	46,324		90	368	515	
		12/01/1981	1598	13.4	119.3	13.4	9.38	6.7	34,177	47,848		90	380	532	
		03/07/1983	**1598**	**12.5**	**127.8**	**12.5**	**8.75**	**6.25**	**36,612**	**51,257**	**49,500**	**90**	**407**	**570**	**550**
		07/31/1984	**1558**	**12**	**129.8**	**12**	**8.4**	**6**	**37,185**	**52,059**	**49,500**	**90**	**413**	**578**	**550**
		10/23/1985	**1538**	**11.4**	**134.9**	**11.4**	**7.98**	**5.7**	**38,646**	**54,104**	**49,500**	**90**	**429**	**601**	**550**
		09/17/1998	1405	11.7	120.1	11.7	8.19	5.85	34,406	48,168		90	382	535	
SCWC	N. Oaks Central	03/26/1974	989	3.8	260.3	3.8	2.66	1.9	74,570	104,398		90	829	1,160	
		04/07/1975	823	3	274.3	3	2.1	1.5	78,581	110,013		90	873	1,222	
		04/13/1976	861	3.3	260.9	3.3	2.31	1.65	74,742	104,639		90	830	1,163	
		07/14/1977	759	4.5	168.7	4.5	3.15	2.25	48,329	67,660		90	537	752	
		05/18/1978	1023	3.6	284.2	3.6	2.52	1.8	81,417	113,984		90	905	1,266	
		04/01/1979	953	3.7	257.6	3.7	2.59	1.85	73,797	103,316		90	820	1,148	
		09/01/1979	930	1.3	715.4	1.3	0.91	0.65	204,947	286,925		90	2,277	3,188	
		08/27/1980	1021	3.5	291.7	3.5	2.45	1.75	83,566	116,992		90	929	1,300	
		11/19/1981	1078	3.8	283.7	3.8	2.66	1.9	81,274	113,783		90	903	1,264	
		03/07/1983	1139	3.4	335	3.4	2.38	1.7	95,970	134,358		90	1,066	1,493	
		07/26/1984	1164	3.5	332.6	3.5	2.45	1.75	95,283	133,396		90	1,059	1,482	
		10/23/1985	1087	3	362.3	3	2.1	1.5	103,791	145,307		90	1,153	1,615	
		09/17/1998	**1450**	**4.8**	**302.1**	**4.8**	**3.36**	**2.4**	**86,545**	**121,163**	**49,500**	**90**	**962**	**1,346**	**550**
SCWC	N. Oaks East	11/27/1963	1099	8.9	123.5	8.9	6.23	4.45	35,380	49,532		90	393	550	
		08/24/1965	707	42.1	16.8	42.1	29.47	21.05	4,813	6,738		90	53	75	
		06/02/1972	1169	8.5	137.5	8.5	5.95	4.25	39,391	55,147		90	438	613	
		03/20/1974	1016	6.5	156.3	6.5	4.55	3.25	44,777	62,687		90	498	697	
		04/15/1975	842	4.8	175.4	4.8	3.36	2.4	50,248	70,348		90	558	782	
		04/13/1976	873	5.3	164.7	5.3	3.71	2.65	47,183	66,056		90	524	734	
		07/14/1977	699	6.3	111	6.3	4.41	3.15	31,799	44,519		90	353	495	
		06/07/1978	750	4.4	170.5	4.4	3.08	2.2	48,845	68,382		90	543	760	
		04/01/1979	578	3.1	186.5	3.1	2.17	1.55	53,428	74,799		90	594	831	
		09/01/1979	510	2.2	231.8	2.2	1.54	1.1	66,406	92,968		90	738	1,033	
		08/25/1980	531	3.2	165.9	3.2	2.24	1.6	47,527	66,537		90	528	739	
		11/19/1981	1312	10.6	123.8	10.6	7.42	5.3	35,466	49,652		90	394	552	
		03/23/1983	**1312**	**7.6**	**172.6**	**7.6**	**5.32**	**3.8**	**49,446**	**69,225**	**49,500**	**90**	**549**	**769**	**550**
		07/30/1984	1261	8	157.6	8	5.6	4	45,149	63,209		90	502	702	
		11/18/1985	1143	7.3	156.6	7.3	5.11	3.65	44,862	62,807		90	498	698	
		09/17/1998	1091	18.4	59.3	18.4	12.88	9.2	16,988	23,783		90	189	264	

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Sierra	**03/20/1974**	**1679**	**5.7**	**294.6**	**5.7**	**3.99**	**2.85**	**84,396**	**118,155**	**49,500**	**90**	**938**	**1,313**	**550**
		04/08/1975	1425	5.3	268.9	5.3	3.71	2.65	77,034	107,848		90	856	1,198	
		04/14/1976	1418	5.8	244.5	5.8	4.06	2.9	70,044	98,061		90	778	1,090	
		07/12/1977	1291	8.9	145.1	8.9	6.23	4.45	41,568	58,195		90	462	647	
		05/16/1978	**1574**	**5.4**	**291.5**	**5.4**	**3.78**	**2.7**	**83,508**	**116,912**	**49,500**	**90**	**928**	**1,299**	**550**
		04/01/1979	1538	4.9	313.9	4.9	3.43	2.45	89,926	125,896		90	999	1,399	
		09/01/1979	1507	5.5	274	5.5	3.85	2.75	78,495	109,893		90	872	1,221	
		08/25/1980	1558	4.6	338.7	4.6	3.22	2.3	97,030	135,842		90	1,078	1,509	
		11/30/1981	1448	4.2	344.8	4.2	2.94	2.1	98,778	138,289		90	1,098	1,537	
		03/15/1983	**1950**	**5.5**	**354.5**	**5.5**	**3.85**	**2.75**	**101,557**	**142,179**	**49,500**	**90**	**1,128**	**1,580**	**550**
		07/26/1984	1860	16.8	110.7	16.8	11.76	8.4	31,713	44,398		90	352	493	
		10/29/1985	**1840**	**6.4**	**287.5**	**6.4**	**4.48**	**3.2**	**82,362**	**115,307**	**49,500**	**90**	**915**	**1,281**	**550**
		09/16/1998	851	3.3	257.9	3.3	2.31	1.65	73,883	103,436		90	821	1,149	
SCWC	Mitchell	07/19/1965	536	11.4	47	11.4	7.98	5.7	13,464	18,850		90	150	209	
		08/07/1972	1250	6.5	192.3	6.5	4.55	3.25	55,090	77,126		90	612	857	
		03/26/1974	627	2.8	223.9	2.8	1.96	1.4	64,142	89,799		90	713	998	
		04/08/1975	529	2.6	203.5	2.6	1.82	1.3	58,298	81,618		90	648	907	
		08/25/1977	**709**	**5**	**141.8**	**5**	**3.5**	**2.5**	**40,623**	**56,872**	**49,500**	**90**	**451**	**632**	**550**
		07/25/1978	613	7.7	79.6	7.7	5.39	3.85	22,804	31,925		90	253	355	
		04/01/1979	653	8.7	75.1	8.7	6.09	4.35	21,515	30,120		90	239	335	
		09/01/1979	660	9	73.3	9	6.3	4.5	20,999	29,398		90	233	327	
		08/25/1980	602	9.8	61.4	9.8	6.86	4.9	17,590	24,626		90	195	274	
		11/23/1981	664	11	60.4	11	7.7	5.5	17,303	24,225		90	192	269	
		05/23/1983	674	12.3	54.8	12.3	8.61	6.15	15,699	21,979		90	174	244	
		08/02/1984	689	25.8	26.7	25.8	18.06	12.9	7,649	10,709		90	85	119	
		10/24/1985	694	39	17.8	39	27.3	19.5	5,099	7,139		90	57	79	
		09/22/1998	593	14.3	41.5	14.3	10.01	7.15	11,889	16,644		90	132	185	
SCWC	Lost Canyon 2	04/01/1979	743	17.3	42.9	17.3	12.11	8.65	12,290	17,206	36,000	90	137	191	400
		09/01/1979	885	28	31.6	28	19.6	14	9,053	12,674		90	101	141	
		09/16/1998	799	22.1	36.2	22.1	15.47	11.05	10,371	14,519		90	115	161	
SCWC	Lost Canyon 2A	10/29/1997	834	12.4	67.3	12.4	8.68	6.2	19,280	26,992	36,000	90	214	300	400
SCWC	Sand Canyon	07/02/1975	648	2.7	240	2.7	1.89	1.35	68,755	96,257		90	764	1,070	
		04/01/1979	540	2.5	216	2.5	1.75	1.25	61,879	86,631		90	688	963	
		09/01/1979	**825**	**2.6**	**317.3**	**2.6**	**1.82**	**1.3**	**90,900**	**127,259**	**36,000**	**90**	**1,010**	**1,414**	**400**
		08/22/1980	709	3.2	221.6	3.2	2.24	1.6	63,484	88,877		90	705	988	
		11/18/1981	684	3.4	201.2	3.4	2.38	1.7	57,639	80,695		90	640	897	
		05/23/1983	714	3.2	223.1	3.2	2.24	1.6	63,913	89,479		90	710	994	
		07/24/1984	**774**	**4.2**	**184.3**	**4.2**	**2.94**	**2.1**	**52,798**	**73,917**	**36,000**	**90**	**587**	**821**	**400**
		10/22/1985	658	3.3	199.4	3.3	2.31	1.65	57,124	79,973		90	635	889	
		09/16/1998	**1147**	**9.3**	**123.3**	**9.3**	**6.51**	**4.65**	**35,323**	**49,452**	**36,000**	**90**	**392**	**549**	**400**
NCWD	Pinetree1	04/02/1999	297	13.7	21.7	13.7	9.59	6.85	6,217	8,703	31,500	90	69	97	350
NCWD	Pinetree3	**04/02/1999**	**554**	**4.7**	**117.9**	**4.7**	**3.29**	**2.35**	**33,776**	**47,286**	**31,500**	**90**	**375**	**525**	**350**
NCWD	Pinetree4	**04/02/1999**	**497**	**4.8**	**103.5**	**4.8**	**3.36**	**2.4**	**29,650**	**41,511**	**31,500**	**90**	**329**	**461**	**350**

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	D	05/29/1984	503	6	83.8	6	4.2	3	24,007	33,610		100	240	336	
		04/27/1988	**1171**	**10.1**	**115.9**	**10.1**	**7.07**	**5.05**	**33,203**	**46,484**	**35,000**	**100**	**332**	**465**	**350**
		05/29/1990	990	9.5	104.2	9.5	6.65	4.75	29,851	41,791		100	299	418	
		07/06/1994	**1119**	**9.6**	**116.6**	**9.6**	**6.72**	**4.8**	**33,403**	**46,765**	**35,000**	**100**	**334**	**468**	**350**
		04/29/1996	1105	9.8	112.8	9.8	6.86	4.9	32,315	45,241		100	323	452	
		09/15/1997	1135	9.7	117	9.7	6.79	4.85	33,518	46,925		100	335	469	
		11/03/1998	**1086**	**9.6**	**113.1**	**9.6**	**6.72**	**4.8**	**32,401**	**45,361**	**35,000**	**100**	**324**	**454**	**350**
		11/13/1998	1086	9.6	113.1	9.6	6.72	4.8	32,401	45,361		100	324	454	
NLF	E	**04/10/1984**	**1726**	**7.8**	**221.3**	**7.8**	**5.46**	**3.9**	**63,398**	**88,757**	**35,000**	**100**	**634**	**888**	**350**
		05/21/1986	1613	7.1	227.2	7.1	4.97	3.55	65,088	91,123		100	651	911	
		10/14/1987	1151	15.6	73.8	15.6	10.92	7.8	21,142	29,599		100	211	296	
		10/05/1988	766	11	69.6	11	7.7	5.5	19,939	27,914		100	199	279	
		07/11/1989	877	8.2	107	8.2	5.74	4.1	30,653	42,914		100	307	429	
		05/30/1990	1291	13.9	92.9	13.9	9.73	6.95	26,614	37,259		100	266	373	
		04/17/1991	1187	15.8	75.1	15.8	11.06	7.9	21,515	30,120		100	215	301	
		06/03/1992	**1732**	**7.9**	**219.2**	**7.9**	**5.53**	**3.95**	**62,796**	**87,914**	**35,000**	**100**	**628**	**879**	**350**
		07/20/1993	1613	7.4	218	7.4	5.18	3.7	62,452	87,433		100	625	874	
		07/20/1994	1603	7.6	210.9	7.6	5.32	3.8	60,418	84,586		100	604	846	
		07/12/1995	1644	7.4	222.2	7.4	5.18	3.7	63,655	89,118		100	637	891	
		05/14/1996	1613	7.9	204.2	7.9	5.53	3.95	58,499	81,898		100	585	819	
		04/23/1997	1583	9.9	159.9	9.9	6.93	4.95	45,808	64,131		100	458	641	
		05/06/1998	1501	6.8	220.7	6.8	4.76	3.4	63,226	88,516		100	632	885	
		05/04/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		05/21/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		04/21/2000	1378	11.4	120.9	11.4	7.98	5.7	34,635	48,489		100	346	485	
NLF	E2	07/29/1938	1921	20.7	92.8	20.7	14.49	10.35	26,585	37,219		100	266	372	
		08/05/1938	1625	18.5	87.8	18.5	12.95	9.25	25,153	35,214		100	252	352	
		08/11/1938	1630	18.2	89.6	18.2	12.74	9.1	25,668	35,936		100	257	359	
		07/25/1939	1530	15.7	97.5	15.7	10.99	7.85	27,932	39,104		100	279	391	
		08/01/1939	1846	19.1	96.6	19.1	13.37	9.55	27,674	38,743		100	277	387	
		06/13/1941	1905	13.2	144.3	13.2	9.24	6.6	41,339	57,874		100	413	579	
		07/16/1945	**1635**	**9.9**	**165.2**	**9.9**	**6.93**	**4.95**	**47,326**	**66,257**	**35,000**	**100**	**473**	**663**	**350**
		12/18/1946	**1819**	**10**	**181.9**	**10**	**7**	**5**	**52,110**	**72,955**	**35,000**	**100**	**521**	**730**	**350**
		10/28/1947	1760	16.2	108.6	16.2	11.34	8.1	31,112	43,556		100	311	436	
		06/23/1949	1225	12.5	98	12.5	8.75	6.25	28,075	39,305		100	281	393	
		06/07/1950	1070	11	97.3	11	7.7	5.5	27,874	39,024		100	279	390	
		04/11/1951	1095	37.7	29	37.7	26.39	18.85	8,308	11,631		100	83	116	
		08/07/1953	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		02/10/1955	1481	14.9	99.4	14.9	10.43	7.45	28,476	39,866		100	285	399	
		08/12/1955	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		09/20/1956	998	28.2	35.4	28.2	19.74	14.1	10,141	14,198		100	101	142	
		07/16/1957	938	29.2	32.1	29.2	20.44	14.6	9,196	12,874		100	92	129	
		10/09/1957	828	11	75.3	11	7.7	5.5	21,572	30,201		100	216	302	
		07/25/1958	1582	12.5	126.6	12.5	8.75	6.25	36,268	50,775		100	363	508	
		10/24/1958	1532	16.6	92.3	16.6	11.62	8.3	26,442	37,019		100	264	370	
		09/03/1959	1329	24.8	53.6	24.8	17.36	12.4	15,355	21,497		100	154	215	
		07/29/1960	1084	39.2	27.7	39.2	27.44	19.6	7,935	11,110		100	79	111	
		08/03/1961	888	20.2	44	20.2	14.14	10.1	12,605	17,647		100	126	176	
		07/17/1962	1503	18.5	81.2	18.5	12.95	9.25	23,262	32,567		100	233	326	
		05/07/1963	1487	16.2	91.8	16.2	11.34	8.1	26,299	36,818		100	263	368	

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		07/16/1964	759	47.8	15.9	47.8	33.46	23.9	4,555	6,377		100	46	64	
		08/05/1965	652	34.2	19.1	34.2	23.94	17.1	5,472	7,660		100	55	77	
		11/01/1966	536	60.1	8.9	60.1	42.07	30.05	2,550	3,570		100	25	36	
		08/10/1967	842	9.6	87.7	9.6	6.72	4.8	25,124	35,174		100	251	352	
		09/26/1968	1161	62.5	18.6	62.5	43.75	31.25	5,328	7,460		100	53	75	
		06/23/1972	1345	12.8	105.1	12.8	8.96	6.4	30,109	42,152		100	301	422	
		07/08/1974	1287	17.3	74.4	17.3	12.11	8.65	21,314	29,840		100	213	298	
		05/06/1976	1065	25.5	41.8	25.5	17.85	12.75	11,975	16,765		100	120	168	
		03/14/1977	1056	43.7	24.2	43.7	30.59	21.85	6,933	9,706		100	69	97	
		08/10/1978	725	4.8	151	4.8	3.36	2.4	43,258	60,561		100	433	606	
		12/21/1989	1086	34.6	31.4	34.6	24.22	17.3	8,995	12,594		100	90	126	
		05/30/1990	1205	36.1	33.4	36.1	25.27	18.05	9,568	13,396		100	96	134	
		04/17/1991	1056	48.5	21.8	48.5	33.95	24.25	6,245	8,743		100	62	87	
		06/03/1992	1235	22.9	53.9	22.9	16.03	11.45	15,441	21,618		100	154	216	
		07/20/1993	**1312**	**8.3**	**158.1**	**8.3**	**5.81**	**4.15**	**45,292**	**63,409**	**35,000**	**100**	**453**	**634**	**350**
		07/21/1994	**1305**	**6.3**	**207.1**	**6.3**	**4.41**	**3.15**	**59,330**	**83,061**	**35,000**	**100**	**593**	**831**	**350**
		07/12/1995	**1395**	**6.2**	**225**	**6.2**	**4.34**	**3.1**	**64,458**	**90,241**	**35,000**	**100**	**645**	**902**	**350**
		06/05/1996	**1473**	**5.8**	**254**	**5.8**	**4.06**	**2.9**	**72,765**	**101,872**	**35,000**	**100**	**728**	**1,019**	**350**
		04/23/1997	1087	6.4	169.8	6.4	4.48	3.2	48,644	68,102		100	486	681	
		06/26/1998	1055	8.3	127.1	8.3	5.81	4.15	36,411	50,976		100	364	510	
		05/04/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		05/21/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		04/21/2000	1052	6.7	157	6.7	4.69	3.35	44,977	62,968		100	450	630	
WHR	8	04/10/1969	849	5.8	146.4	5.8	4.06	2.9	41,940	58,717	35,000	100	419	587	350
WHR	16	10/06/1955	1205	8.3	145.2	8.3	5.81	4.15	41,597	58,235		100	416	582	
		11/13/1957	1052	7.6	138.4	7.6	5.32	3.8	39,649	55,508		100	396	555	
		05/28/1959	810	6.3	128.6	6.3	4.41	3.15	36,841	51,578		100	368	516	
		06/19/1959	**1436**	**9.9**	**145.1**	**9.9**	**6.93**	**4.95**	**41,568**	**58,195**	**35,000**	**100**	**416**	**582**	**350**
		06/26/1962	**1150**	**7**	**164.3**	**7**	**4.9**	**3.5**	**47,068**	**65,896**	**35,000**	**100**	**471**	**659**	**350**
		12/04/1963	1073	6.9	155.5	6.9	4.83	3.45	44,547	62,366		100	445	624	
WHR	11	11/10/1954	1401	10.9	128.5	10.9	7.63	5.45	36,812	51,537		100	368	515	
		10/06/1955	**1444**	**10.4**	**138.8**	**10.4**	**7.28**	**5.2**	**39,763**	**55,668**	**35,000**	**100**	**398**	**557**	**350**
		03/07/1962	1125	8.5	132.4	8.5	5.95	4.25	37,930	53,102		100	379	531	
		10/31/1962	1288	10.6	121.5	10.6	7.42	5.3	34,807	48,730		100	348	487	
		12/04/1963	1172	8.2	142.9	8.2	5.74	4.1	40,938	57,313		100	409	573	
WHR	18	01/27/1959	1244	9	138.2	9	6.3	4.5	39,591	55,428		100	396	554	
		05/28/1959	**1369**	**9.3**	**147.2**	**9.3**	**6.51**	**4.65**	**42,170**	**59,037**	**35,000**	**100**	**422**	**590**	**350**
		06/26/1962	1262	8	157.8	8	5.6	4	45,206	63,289		100	452	633	
		12/04/1963	940	6	156.7	6	4.2	3	44,891	62,848		100	449	628	
WHR	17	**10/06/1955**	**576**	**3.2**	**180**	**3.2**	**2.24**	**1.6**	**51,566**	**72,193**	**35,000**	**100**	**516**	**722**	**350**
		03/06/1962	539	3.3	163.3	3.3	2.31	1.65	46,782	65,495		100	468	655	
		10/31/1962	536	3.2	167.5	3.2	2.24	1.6	47,985	67,179		100	480	672	
		12/04/1963	**595**	**3.3**	**180.3**	**3.3**	**2.31**	**1.65**	**51,652**	**72,313**	**35,000**	**100**	**517**	**723**	**350**
WHR	10	10/06/1955	442	18.5	23.9	18.5	12.95	9.25	6,847	9,586	35,000	100	68	96	350
		03/06/1962	452	11.1	40.7	11.1	7.77	5.55	11,660	16,324		100	117	163	
		10/31/1962	480	15	32	15	10.5	7.5	9,167	12,834		100	92	128	
		12/03/1963	508	23.6	21.5	23.6	16.52	11.8	6,159	8,623		100	62	86	
		11/13/1964	467	27.1	17.2	27.1	18.97	13.55	4,927	6,898		100	49	69	

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
WHR	15	10/06/1955	815	3.6	226.4	3.6	2.52	1.8	64,859	90,802		100	649	908	
		11/13/1957	1231	6.6	186.5	6.6	4.62	3.3	53,428	74,799		100	534	748	
		06/18/1958	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		05/28/1959	**1655**	**9.6**	**172.4**	**9.6**	**6.72**	**4.8**	**49,389**	**69,144**	**35,000**	**100**	**494**	**691**	**350**
		06/18/1959	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		06/26/1962	1260	6	210	6	4.2	3	60,160	84,225		100	602	842	
		12/05/1963	1180	7.6	155.3	7.6	5.32	3.8	44,490	62,286		100	445	623	
WHR	5	03/06/1962	684	9.7	70.5	9.7	6.79	4.85	20,197	28,275	35,000	100	202	283	350
		12/03/1963	693	8.8	78.8	8.8	6.16	4.4	22,574	31,604		100	226	316	
NCWD	Castaic1	03/31/1986	580	51.6	11.2	51.6	36.12	25.8	3,209	4,492	25,200	100	32	45	315
		04/23/1999	644	55.2	11.7	55.2	38.64	27.6	3,352	4,693		100	34	47	
NCWD	Castaic4	04/23/1999	271	87.6	3.1	87.6	61.32	43.8	888	1,243	25,200	100	9	12	315
NCWD	Castaic3	04/23/1999	470	41.3	11.4	41.3	28.91	20.65	3,266	4,572	25,200	100	33	46	315
NCWD	Castaic2	04/01/1986	428	37.9	11.3	37.9	26.53	18.95	3,237	4,532	25,200	100	32	45	315

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-6

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer In Tributary Canyons, Santa Clarita Valley, CA

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	W4	02/05/1992	592	9.4	63	9.4	6.58	4.7	18,048	25,267		100	180	253	
		08/12/1994	**957**	**10.8**	**88.6**	**10.8**	**7.56**	**5.4**	**25,382**	**35,535**	**10,500**	**100**	**254**	**355**	**105**
VWC	W6	11/22/1991	720	36	20	36	25.2	18	5,730	8,021		100	57	80	
		01/27/1992	636	40.5	15.7	40.5	28.35	20.25	4,498	6,297		100	45	63	
		05/11/1994	504	75	6.7	75	52.5	37.5	1,919	2,687		100	19	27	
		04/23/1996	531	71.3	7.4	71.3	49.91	35.65	2,120	2,968		100	21	30	
		07/15/1997	539	69.5	7.8	69.5	48.65	34.75	2,235	3,128		100	22	31	
		12/28/1998	468	83.2	5.6	83.2	58.24	41.6	1,604	2,246		100	16	22	
VWC	W9	04/23/1996	946	10.1	93.7	10.1	7.07	5.05	26,843	37,580		100	268	376	
		07/15/1997	958	10.5	91.2	10.5	7.35	5.25	26,127	36,578		100	261	366	
		12/28/1998	**990**	**10.2**	**97.1**	**10.2**	**7.14**	**5.1**	**27,817**	**38,944**	**10,500**	**100**	**278**	**389**	**105**
SCWC	Guida	**03/18/1974**	**1016**	**6.4**	**158.8**	**6.4**	**4.48**	**3.2**	**45,493**	**63,690**	**12,600**	**90**	**505**	**708**	**140**
		04/17/1975	990	6.2	159.7	6.2	4.34	3.1	45,751	64,051		90	508	712	
		04/19/1976	940	5.6	167.9	5.6	3.92	2.8	48,100	67,340		90	534	748	
		07/06/1977	890.7	5.2	171.3	5.2	3.64	2.6	49,074	68,703		90	545	763	
		05/09/1978	915	5.5	166.4	5.5	3.85	2.75	47,670	66,738		90	530	742	
		04/01/1979	990	6.5	152.3	6.5	4.55	3.25	43,631	61,083		90	485	679	
		09/01/1979	990	3.6	275	3.6	2.52	1.8	78,782	110,294		90	875	1,225	
		08/20/1980	1000	7	142.9	7	4.9	3.5	40,938	57,313		90	455	637	
		11/24/1981	1009	7.2	140.1	7.2	5.04	3.6	40,136	56,190		90	446	624	
		03/15/1983	1024	6.9	148.4	6.9	4.83	3.45	42,513	59,519		90	472	661	
		07/25/1984	**1014**	**6.4**	**158.4**	**6.4**	**4.48**	**3.2**	**45,378**	**63,529**	**12,600**	**90**	**504**	**706**	**140**
		10/28/1985	1044	7.8	133.8	7.8	5.46	3.9	38,331	53,663		90	426	596	
		09/23/1998	1066	9.4	113.4	9.4	6.58	4.7	32,487	45,481		90	361	505	
SCWC	Clark	**06/06/1972**	**814**	**4**	**203.5**	**4**	**2.8**	**2**	**58,298**	**81,618**	**22,050**	**90**	**648**	**907**	**245**
		03/18/1974	587	3.8	154.5	3.8	2.66	1.9	44,261	61,965		90	492	689	
		05/27/1975	541	3.7	146.2	3.7	2.59	1.85	41,883	58,636		90	465	652	
		04/12/1976	490	3.3	148.5	3.3	2.31	1.65	42,542	59,559		90	473	662	
		07/06/1977	500.3	3	166.8	3	2.1	1.5	47,785	66,898		90	531	743	
		05/08/1978	488	3.1	157.4	3.1	2.17	1.55	45,092	63,128		90	501	701	
		04/01/1979	600	3	200	3	2.1	1.5	57,296	80,214		90	637	891	
		09/01/1979	600	2.6	230.8	2.6	1.82	1.3	66,119	92,567		90	735	1,029	
		08/20/1980	573	2.9	197.6	2.9	2.03	1.45	56,608	79,251		90	629	881	
		11/24/1981	602	2.7	223	2.7	1.89	1.35	63,885	89,439		90	710	994	
		03/08/1983	608	2.6	233.8	2.6	1.82	1.3	66,979	93,770		90	744	1,042	
		07/25/1984	608	2.3	264.3	2.3	1.61	1.15	75,716	106,003		90	841	1,178	
		09/23/1998	677	4.4	153.9	4.4	3.08	2.2	44,089	61,725		90	490	686	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

Contents

Page

Surface Water Routing Model **C-1**

C.1 Introduction C-1
C.2 Sources of Recharge C-2
C.3 SWRM Design C-2
C.4 Infiltration of Applied Water (Urban Use, Excluding Golf Courses) C-3
C.5 Infiltration of Applied Water (Golf Course Irrigation) C-4
C.6 Infiltration of Applied Water (Agricultural) C-4
C.7 Infiltration of Direct Precipitation C-5
C.7.1 Precipitation Data C-5
C.7.2 Infiltration Within the Regional Model Area C-6
C.8 Infiltration From Streams C-7
C.8.1 Surface Water Runoff Volume Outside the Regional Model Area C-7
C.8.2 Santa Clara River Streamflow at Eastern Regional Model Boundary C-8
C.8.3 Releases from Castaic Lake C-10
C.8.4 Treated Wastewater C-10
C.8.5 Assignment of Stream Leakage C-10
C.9 Rejected Stream Leakage C-13
C.10 References C-14

Tables—All tables appear at the end of the appendix.

C-1 Comparison of WRP Discharges with Urban Water Demands

C-2 Calculation of Outdoor Irrigation Infiltration Rates to Groundwater for Non-Agricultural Water Uses

C-3 Irrigation Infiltration Rates over 1999 Suburban Residential Area

C-4 Irrigation Infiltration Rates over 1999 Retail and Industrial Area

C-5 Irrigation Infiltration Rates over 1999 Golf Course Areas

C-6 Irrigation Infiltration Rates for Agricultural Lands

C-7 Monthly Precipitation Rates Measured at the Newhall County Water District Rain Gage

C-8 Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds

C-9 Monthly Streamflows Measured in the Santa Clara River at the Lang Gage

C-10 Monthly Releases of Water from Castaic Lagoon to Castaic Creek

Contents, Continued

C-11 Monthly Treated Wastewater Discharge Measured at the Valencia Water Reclamation Plant

C-12 Monthly Treated Wastewater Discharge Measured at the Saugus Water Reclamation Plant

C-13 Monthly Streamflows Measured in the Santa Clara River at the County Line Gage

Figures—All figures appear at the end of the appendix.

C-1 Map of Study Area

C-2 Land Use Map

C-3 Analysis of Agricultural Water Use and Associated Infiltration to Groundwater

C-4 Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

C-5 Infiltration and Runoff as a Function of Precipitation

C-6 Sub-Watersheds Within the Santa Clara Valley East Watershed

C-7 Santa Clara River Streamflow Regression

C-8 Map Showing Example of Stream Ranking

C-9 Flow Chart Showing Iterative Process Used to Vary Streambed Infiltration Capacities During Model Calibration

APPENDIX C

Surface Water Routing Model

A Surface Water Routing Model (SWRM) was developed to support groundwater flow modeling efforts in the Santa Clarita Valley of Southern California. The SWRM was developed as a pre- and post-processor for the Santa Clarita Valley Groundwater Model (hereafter called the Regional Model), which was constructed by the Upper Basin Water Purveyors. The Regional Model will be briefly described in this appendix; however, the reader should refer to the main body of this report for a more detailed description of the Regional Model.

C.1 Introduction

The Regional Model simulates monthly groundwater conditions from 1980 through 1999 over a 120 square mile (mi^2) area within a portion of the Santa Clara River Valley East Groundwater Subbasin. This subbasin lies within the Upper Santa Clara River Hydrologic Area, which is a watershed of approximately 460 mi^2 that lies in northwest Los Angeles County and a small portion of eastern Ventura County (Figure C-1).

The outer limits of the Regional Model correspond to the outer limits of the Santa Clarita Valley's groundwater systems, which consist of the Alluvial Aquifer and the Saugus Formation. These aquifers lie in the south-central portion of the hydrologic area, and the watershed extends upstream beyond the outer limits of the groundwater systems. Geologic formations located within the watershed, but outside of the Regional Model area, consist of bedrock and do not transmit significant quantities of groundwater flow due to their low permeability. However, an understanding of the availability of surface water runoff and infiltration within and upstream of the Regional Model area is critical to accurately simulate the water budget through time within the Regional Model area. Therefore, a surface water routing tool was developed to estimate, on a monthly basis, the location, magnitude, and timing of surface water infiltration to groundwater within the Regional Model boundary.

The SWRM was written in the Visual Basic Editor within Microsoft® Excel 97. The remainder of this appendix is organized as follows:

a. A list of the sources of recharge that are evaluated by the SWRM

b. The design of the SWRM

c. Detailed discussions of the calculations of magnitudes of each surface water source and its associated infiltration rate to groundwater

C.2 Sources of Recharge

The sources of recharge to the groundwater system in the Santa Clarita Valley are:

a. Infiltration of applied water for urban and industrial outdoor uses and for irrigating golf courses. Sources of urban and golf course irrigation water are groundwater pumping from the Alluvial Aquifer and the Saugus Formation, and import of water from the State Water Project (SWP).

b. Infiltration of water that is used for agricultural irrigation within the Regional Model area. This source of water consists exclusively of groundwater pumping from the Alluvial Aquifer.

c. Infiltration of direct precipitation within the Regional Model area, which is derived from precipitation data.

d. Infiltration of stormwater and anthropogenic streamflows. These sources include the following:

    1. Surface water runoff and infiltration from portions of the Upper Santa Clara River Hydrologic Area located outside of the Regional Model boundary

    2. Santa Clara River flows that enter the valley from the east

    3. Water released from Castaic Lagoon into Castaic Creek by the California Department of Water Resources

    4. Treated water discharged into the Santa Clara River from two Los Angeles County Sanitation District (LACSD) water reclamation plants (WRP)

C.3 SWRM Design

At every node in the grid that forms the Regional Model domain, the SWRM estimates groundwater recharge terms using the following three basic steps:

1. Calculate the monthly volume of surface water from each water source within and upstream of the Regional Model area.

2. Calculate the monthly volume of water in a stream that leaks through the streambed and collects on the water table, based on an assigned streambed leakage rate at each Regional Model stream node.

3. Calculate the monthly volume of water in a stream that does not infiltrate because of gaining stream conditions (i.e., rejected stream leakage). Rejected stream leakage remains as surface water as it passes the mouth of the stream and flows into the next stream system. For the Santa Clara River, rejected stream leakage eventually exits the Regional Model area at the west end of the valley, at the County Line stream gage.

Flow volumes in streams and rates of infiltration to groundwater from all water sources vary both geographically and over time based on sets of rules programmed into the SWRM. One of the most significant rules in the SWRM is that the infiltration rates to groundwater are not allowed to exceed the total amount of water generated by all surface water sources

in a given month. The magnitude of each potential source of groundwater recharge is based on local hydrologic measurements that have been recorded over time.

Following are discussions of the data and methods that were used to estimate the source water volumes and the amount of infiltration from each of these sources.

C.4 Infiltration of Applied Water (Urban Use, Excluding Golf Courses)

A significant portion of water that is used outdoors goes to plant uptake and direct evaporation, and a smaller portion infiltrates to the underlying aquifer system. The magnitude of infiltration was estimated using recent water use and land use data (Figure C-2) for developed areas within the Santa Clarita Valley.

The average annual water demand provided by the Upper Basin Water Purveyors was approximately 49,000 acre-feet per year (AF/yr) from 1994 through 1998. On a long-term basis, outdoor water use in urbanized areas is approximately 66 percent of the total annual water demand, as indicated by records of total water demands and WRP flows (see Table C-1). Within urbanized areas that are industrial and retail land uses, the outdoor water use is estimated to be approximately 30 percent of the total water use. For all urbanized areas excluding golf courses, it was assumed that 10 percent of the applied water in areas of urban development could potentially recharge groundwater. This assumption means that a total of 90 percent of the applied water goes to evapotranspiration (ET) demands, surface runoff, and return flow to surface water.

Aerial photographs of the valley taken in 1999 were used to identify land uses in developed areas, and a geographic information system (GIS) was used to determine the acreage of each land use type. Table C-2 summarizes the derivation of estimated values of infiltration for urban irrigation water from land use and water use data. The table shows the average annual water use volumes, the land use acreage, and the calculated depths of annual infiltration to groundwater. As shown in the table, infiltration of urban irrigation water is estimated to be approximately 1 inch per year (in/yr) for retail and industrial land uses, and 2.2 in/yr for suburban residential land use and recreational land use (parks). These values were used as direct specified input to the SWRM and were not varied during calibration of the Regional Model.

An attempt was made to vary over time, the locations at which urban applied water was specified in the Regional Model. However, electronic records of historical land use data were unavailable. Consequently, to ensure that the total infiltration volume in urbanized areas reflected the increase in development and water use that occurred throughout the 1980s and 1990s, this infiltration was applied to the 1999 urbanized area, but at rates that were adjusted upward or downward in a given year according to the difference between water uses in that year and in 1999. Tables C-3 and C-4 show the actual rates that were applied to the 1999 urbanized area to account for the gradual increase in water use from 1980 through 1999.

C.5 Infiltration of Applied Water (Golf Course Irrigation)

From 1994 through 1998, the average annual water use for golf course irrigation was approximately 500 AF/yr. The majority of this water use was for irrigation and was specified in the SWRM as 100 percent of the total water use for the golf course.

The amount of return flow to groundwater resulting from golf course irrigation was estimated to be 30 percent of applied water, which is three times higher than the assumed rate for other urbanized areas. This estimate was based on information suggesting that golf courses irrigate beyond the water demand requirements of grassy areas to maintain the quality of the greens. As shown in Table C-2, this resulted in an estimated annual average infiltration rate of 4.6 in/yr. As with urban irrigation, the golf course irrigation was increased gradually from 1980 through 1999 to account for the increased population growth and urban water use in the urbanized Santa Clarita Valley (see Table C-5).

C.6 Infiltration of Applied Water (Agricultural)

Aerial photographs of the valley taken in 1999 indicate that approximately 877 acres are currently irrigated for agricultural uses in the model study area. Approximately 90 percent of these irrigated lands are underlain by the Alluvial Aquifer, while the remaining 10 percent lie on the terrace deposits or in areas where the Saugus Formation is exposed at the ground surface. The total area of irrigated agriculture has diminished substantially since the 1960s as a result of development in the area.

Agricultural land in the Santa Clarita Valley is used primarily to grow row crops. A review was performed of detailed records of agricultural pumping, crop types, the acreage of each crop type, and the water use requirements for each crop type (as listed in the California Irrigation Management Information System). This review was performed for the period 1996 through 2000 to estimate the amount of applied irrigation water that infiltrates to groundwater beneath irrigated agricultural lands. Figure C-3 shows the analysis, which compares crop water use requirements with applied water volumes and identifies the difference as being equal to the infiltration volume to groundwater. For the period 1996 through 2000, Figure C-3 shows the following:

a. The average applied water volume was 7,038 AF/yr

b. The average amount of water that was not consumptively used (and which therefore infiltrated to groundwater) was 2,583 AF/yr, which is approximately 37 percent of the applied water volume

c. The equivalent average infiltration rate over the 877-acre area was 2.9 AF/acre/yr (which is equivalent to 2.9 ft/yr)

The infiltration rate of 2.9 ft/yr corresponds to the 7,038 AF/yr average water use during 1996 through 2000. A higher infiltration rate would be expected during years of higher water use and lower rate during years of reduced water use. Table C-6 shows the corresponding infiltration rates for each year, based on the water use each year. The 500-foot spacing of the Regional Model grid resulted in slight over-estimation of the acreage within

the model (1,205 acres) compared with the actual irrigated acreage (877 acres). This adjustment is also shown in Table C-6.

C.7 Infiltration of Direct Precipitation

As water falls onto the land surface or onto a body of water, it follows the three following natural pathways:

1. **Evapotranspiration.** This is the process by which water passes from a liquid to a vapor state via direct evaporation and through transpiration by plants (crops, urban landscaping, and native vegetation).
2. **Surface water runoff.** This represents water occurring as overland flow or water flowing in a stream.
3. **Infiltration.** This is the process by which water moves from the land surface downward through the upper soil layers. The process of infiltration increases the soil moisture content. If the soil moisture content reaches its field capacity, then any additional infiltration that takes place displaces water in the vadose zone and collects on the water table as groundwater recharge (deep percolation of precipitation). For the sake of clarity, references to infiltration in the rest of Appendix C will be synonymous with deep percolation of precipitation.

To estimate the infiltration rate, an understanding of the spatial pattern of precipitation must first be developed. To estimate the total volume of precipitation that falls onto the watershed, one would ideally like to have long-term precipitation data from several active rain gages located on a fairly consistent spacing throughout the watershed. However, due to the expense and maintenance required to operate a rain gage, such an extensive network of rain gages within a single watershed is typically not available for an extended period in most watersheds, as is the case for the Santa Clarita Valley.

C.7.1 Precipitation Data

The SWRM used precipitation data from the rain gage at the Newhall County Water District (NCWD) office, which is located south of Newhall Creek, approximately 1.3 miles south of the Newhall-Soledad rain gage (Figure C-4). Table C-7 lists the monthly precipitation at the NCWD gage from 1980 through 1999.

Because data from a single rain gage is not ideal for estimating the total volume of precipitation that falls within the entire watershed area, an isohyet map of California was also used. Figure C-4 shows contours of long-term average annual rainfall (isohyets) based on data compiled by the U.S. Geological Survey (USGS), the California Department of Water Resources, the California Geologic Survey (formerly the California Division of Mines and Geology), and where available, county and/or other local agencies. The source maps that were used to create the isohyet map are based primarily on U.S. Weather Service data from approximately 800 precipitation stations statewide. The U.S. Weather Service data were supplemented with county and local agency precipitation data in the Los Angeles area. The precipitation data were collected by these agencies over a sixty-year period from 1900 to

1960. Further information on the source of the isohyet data is available at the California Spatial Information Library.[1]

Because these isohyet data represent long-term hydrologic conditions from 1900 to 1960, a methodology was developed to estimate monthly precipitation throughout the Upper Santa Clara River Hydrologic Area using the NCWD gage data and the isohyets. For each month during the 1980 through 1999 Regional Model calibration period, this was done both within the Regional Model area and in the portions of the watershed lying outside the Regional Model area. The long-term average annual precipitation distribution shown in Figure C-4 was electronically draped over the nodes that comprise the Regional Model grid using the ESRI® ArcMap™/ArcInfo™ 8.3 GIS software. The annual precipitation rates at the NCWD rain gage from 1980 through 1999 were computed and compared with the value presented on the 1900 to 1960 isohyet map at that same location. The percent difference between the annual precipitation value and the isohyet value was computed for the NCWD rain gage location and applied to all isohyet values assigned to the Regional Model nodes, to estimate the average spatial distribution of precipitation for that particular calendar year. For example, the 1900-1960 isohyet value at the NCWD rain gage was 20.50 inches, but the 1980 annual precipitation data indicate 31.95 inches fell that year. Therefore, the adjustment factor for the isohyet values at all Regional Model nodes for 1980 was 31.95 divided by 20.50 or 1.559. This adjustment factor was then multiplied by the isohyet values at all Regional Model node locations to estimate the spatial distribution of annual precipitation during 1980.

The derivation of infiltration rates from direct precipitation within the Regional Model boundary is described in Section C.7.2. The derivation of streamflow rates from precipitation occurring outside the regional model boundary is discussed in Section C.8.1.

C.7.2 Infiltration Within the Regional Model Area

Because the Regional Model is a groundwater flow model, it does not directly input precipitation data. Instead, the monthly component of infiltration is estimated by the SWRM and used as input for the Regional Model. The infiltration rate is computed by the SWRM, within the Regional Model area, as described in the following paragraphs.

Annual precipitation infiltration volumes within the Regional Model domain were estimated from annual precipitation data using a variation of the Turner (1986) method. Turner empirically derived a power-function equation that described the relationship between annual rainfall and ET rates, based on the measured yields from 68 different watersheds located throughout California. Rainfall that does not go to ET is available for surface water runoff and infiltration to groundwater. During the largest storm events, some of this water leaves the basin before it has a chance to infiltrate to groundwater. However, during all but the largest storm events, precipitation that is not consumed by ET eventually infiltrates to groundwater, as defined by the following equation (Turner, 1986):

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 2.32(\text{Precipitation})^{0.66} \qquad \text{(C-1)}$$

[1] http://gis.ca.gov/meta.epl?oid=286

Equation C-1 is plotted on Figure C-5 for a range of annual precipitation values expressed in units of inches. Because this expression was empirically derived based on a best-fit to data from 68 watersheds throughout California, it is not necessarily representative of the conditions in an individual watershed. Therefore, the two power-function coefficients were adjusted during the process of calibrating the Regional Model. A final set of power-function coefficients for the Regional Model produced the following relationship for the Santa Clarita Valley:

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 6.20(\text{Precipitation})^{0.33} \qquad \text{(C-2)}$$

Equation C-2 (Figure C-5) was then applied to the annual precipitation-adjusted isohyet values to estimate the annual rate of infiltration from 1980 through 1999. Finally, based on the percentage of annual precipitation that fell each month during that calendar year at the NCWD rain gage, the annual infiltration rates were converted into monthly rates for every node in the Regional Model.

C.8 Infiltration From Streams

The natural sources of water to streams within the Santa Clarita Valley are surface water runoff from portions of the Upper Santa Clara River Hydrologic Area watershed that lie outside of the Regional Model boundary, and flow in the Santa Clara River where it enters the valley. Additionally, DWR releases water into Castaic Creek from Castaic Lagoon in some years, and treated water is discharged into the river from two WRPs on a continual basis. Following are discussions of the volumes of these water sources and the method used to determine infiltration rates in stream beds, based on the magnitude of flow in each stream.

C.8.1 Surface Water Runoff Volume Outside the Regional Model Area

For the Regional Model to honor the water budget for the entire watershed, a method was developed to estimate the monthly availability of surface water runoff and subsurface inflow from areas that are tributary to the Regional Model boundary. To do this, GIS software was used to provide specific input data to the SWRM as follows:

a. First, GIS software was used to delineate the extents of selected subwatersheds within the Upper Santa Clara River Hydrologic Area, using 30-meter digital elevation model data obtained from the USGS. Figure C-6 depicts the extents of these subwatersheds. The extents of the subwatersheds were important to delineate because precipitation rates vary spatially (see Figure C-4); therefore, at any given time, each sub-watershed receives different magnitudes of precipitation, and yields different quantities of surface water runoff and subsurface inflow into the Regional Model area.

b. Once the selected subwatersheds were delineated, the spatial areas were computed by GIS software for the entire subwatershed and for the portion of the subwatershed lying outside the Regional Model boundary. The GIS software also computed the mean of the 1900 to 1960 precipitation (isohyet) distribution within each subwatershed. The areas and the 1900 to 1960 mean precipitation values for each subwatershed are listed in Table C-8. The means of the 1900-1960 precipitation data were then multiplied by the precipitation adjustment factor (discussed in Section C.7.1) for each calendar year to

estimate the average magnitude of precipitation that fell within each sub-watershed during that calendar year.

c. Equation C-2 was then applied to the adjusted annual precipitation values for each sub-watershed to estimate the annual rate of surface water runoff from 1980 through 1999. This provided an estimate of the annual volume of water from subwatersheds that is then available as potential groundwater recharge within the stream reach that lies within the Regional Model domain. These annual estimates were then converted to monthly estimates by multiplying by the monthly percentage of precipitation that fell at the Newhall County Water District rain gage.

C.8.2 Santa Clara River Streamflow at Eastern Regional Model Boundary

The eastern point of the Regional Model, the location at which the Santa Clara River enters the model area, marks the approximate location of the Lang gage (Figure C-6). Streamflow was measured at this gage by the USGS and Los Angeles County for a discontinuous period of 36 years starting in 1949. The gaging station was removed from service in October 1989. Because the Santa Clara River flow into the model domain is a critical boundary condition for the Regional Model, it was necessary to estimate this streamflow beginning in October 1989.

The following paragraphs describe the method used to estimate the monthly streamflow at the Lang gage. This process used the Lang gage data through September 1989 and monthly precipitation data from a rain gage in the Acton groundwater basin, which is immediately east and upgradient of the Regional Model area. Using a multiple linear regression method described below, a good correlation between monthly precipitation data from the U.S Forest Service's Acton rain gage and the Lang stream gage was achieved. The resulting regression equation was used to generate estimates of streamflow during the period that streamflow data were unavailable (October 1989 through December 1999).

C.8.2.1 Data Sources

Monthly precipitation data for 1949 to 2001 were obtained for the Acton, California rain gage maintained by the U.S. Forest Service from the Western Regional Climate Data Center. This gage was determined to be the closest rain gage to the center of the Acton watershed with a long enough period of record to complete the regression analysis. Average rainfall at the Acton rain gage was 10.3 inches during the period of record, which is approximately 58 percent of the 17.83-inch average measured from 1883 through 2000 at the Newhall-Soledad gage.

C.8.2.2 Streamflow Estimation Method

The streamflow estimation procedure for the Lang gage site assumed that a predictable relationship exists between streamflows at the Lang gage and precipitation at the Acton rain gage. This assumption was used to develop a multiple linear regression relationship and to test the quality of that relationship using historical data. A simple mathematical model was established in which the streamflow at the Lang gage during a given month was estimated from the precipitation during the prior month. A Microsoft® Excel spreadsheet was used to perform the multiple linear regression calculations and to determine the regression coefficients for each monthly rainfall value.

The regression model was calibrated using monthly streamflow data for the Lang gage during water years 1949 to 1956. The calibration was verified using streamflow and precipitation data for water years 1957 to 1989. Numerous iterations using different rainfall periods and durations were attempted before achieving a good correlation. The final regression model bases the streamflow estimates on the previous six monthly rainfall values to predict each monthly streamflow value at the Lang gage.

The final regression equation was of the form:

$$\text{Streamflow at the Lang gage} = C1*Rain_{month1} + C2*Rain_{month2} + \ldots + C6*Rain_{month6} \quad \text{(C-3)}$$

where C1, C2, ...C6 are the regression constants.

C.8.2.3 Accuracy of Streamflow Estimates

Once a regression equation is developed and its predictions are verified, streamflows are commonly estimated by applying the equation to any set of precipitation data that are similar in magnitude to those which were used to develop the regression relationship (in this case, the historic values at the Acton rain gage). To verify that the regression equations produced accurate streamflow predictions, streamflow rates calculated from the regression equations were plotted and compared against measured streamflow rates for the period of record at the Lang gage. Figure C-7 shows a comparison plot using the results of this analysis, along with the final regression equation. The plotted data indicate that the regression equation produced streamflow estimates that closely matched measured streamflows. Where differences are apparent between computed and measured streamflows, this results from one or more of the following influences:

a. **System Operation.** The effects of streamflow diversions, pump stations, and wet weather bypasses are not consistent from storm to storm, and can result in irregular streamflows under similar precipitation events.

b. **Rainfall Distribution.** The regression equations were generated from the rain gage that was thought to best represent the precipitation distributed over the entire Acton basin. However, variability of rainfall volume and intensity is normal across basins, resulting in differences in streamflow volume and timing.

c. **Gage Data.** It is common to have intermittent problems with streamflow measurement devices, particularly because of changes in the depth-versus-streamflow relationship at the gaging station over time. The regression equation was produced from storm events during periods where the Acton precipitation data appeared to be the most reliable. These data are reasonable and appropriate for the uses of this study.

d. **Antecedent Conditions.** Streamflow predicted by the regression equation will be most accurate when applied to periods when storm intensity, duration, and antecedent conditions are similar to those used to generate the regression equations. If the antecedent conditions differ significantly from those present in the historical record, then the ability to forecast streamflow characteristics may be hindered.

As Figure C-7 shows, the relationship between monthly precipitation at the Acton rain gage and streamflow at the Lang gage is fairly predictable and has been consistent over time. This

mathematical relationship would be expected to remain consistent unless significant changes occur within the basin to affect streamflows, such as major land use changes.

The Acton rain gage was removed from service at the end of August 2000, therefore streamflow predictions cannot be made beyond this date using the calibrated regression model parameters described above. Table C-9 lists the combined set of measured and computed monthly streamflow values for the Lang gage from 1980 through 1999.

The monthly availability of streamflows at the Lang gage were input into the SWRM and allowed to infiltrate based on the specified maximum stream leakage rate, as Section C.8.5 of this appendix will discuss.

C.8.3 Releases from Castaic Lake

As described in Section 2.6.3.4 in the main body of this report, Castaic Creek occasionally receives surface water releases from Castaic Lagoon (i.e., Castaic Lake). The SWRM treats this surface water as it would any other available surface water in a stream. Based on the volume of available water during each monthly stress period, that water is allowed to infiltrate the Castaic Creek streambed and recharge the underlying groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5). Table C-10 lists the monthly releases of state surface water into Castaic Creek.

C.8.4 Treated Wastewater

Another anthropogenic source of recharge to the groundwater system is treated wastewater from the two LACSD WRPs in the valley, Plant No. 32 near Valencia, known as the Valencia WRP, and Plant No. 26 near Bouquet Canyon known, as the Saugus WRP. Tables C-11 and C-12 list the monthly volumes of treated wastewater that are discharged to the Santa Clara River from the Valencia WRP and the Saugus WRP, respectively.

The SWRM treats this surface water component as it would any other available surface water in a simulated stream. The volume of available treated wastewater during each monthly stress period is simulated to infiltrate the Santa Clara River streambed and recharge the groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5).

C.8.5 Assignment of Stream Leakage

Once the monthly streamflows were established for the Santa Clara River and each of its selected tributaries, a method had to be developed to determine the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system. The following paragraphs describe this method.

C.8.5.1 Stream Connectivity and Ranking System

For the SWRM to assign stream leakage rates accurately, a stream ranking convention was adopted (Figure C-8) as follows:

1. Santa Clara River
2. All modeled streams that merge with the Santa Clara River (2nd order streams)

3. All modeled streams that merge with the 2nd order streams (3rd order streams)
4. All modeled streams that merge with the 3rd order streams (4th order streams)
5. All modeled streams that merge with the 4th order streams (5th order streams)

For the entire model domain, the SWRM processes the assignment of stream leakage beginning with the highest ranking stream nodes and progressing sequentially downstream to the lowest ranking stream nodes for each subwatershed. This ensures a correct accounting of available stream leakage throughout the stream network in the Regional Model domain. Within a given stream, the connectivity relationships between each Regional Model grid node in that stream were established by ordering the Regional Model stream node number from upgradient nodes to downgradient nodes (Figure C-8). Additionally, the last stream node of a given stream was assigned a "next node number," which indicated the nearest node for the next downstream (lower ranking) stream that could receive any surface flows that remained in the higher ranking stream. This "next node number" attribute allowed the SWRM to simulate continued surface water infiltration in the lower ranking streams as long as the total volume of available recharge water was not consumed in upstream reaches of the simulated stream.

C.8.5.2 Stream Geometry at Each Node

Another necessary input for specifying infiltration rates from streams was the geometry of each individual stream node, specifically, the length, width, and area of each stream node (Figure C-8). This was required because the groundwater recharge module that was used within the Regional Model requires input in units of feet per day, then internally computes the volumetric groundwater recharge rate (in cubic feet per day) using the nodal area (in square feet). Thus, the SWRM requires input of simulated stream geometry assumptions to ensure that the correct volume of water is being recharged through the simulated streambeds.

C.8.5.3 Streambed Infiltration Capacity at Each Node

The streambed infiltration capacity was specified at each stream node in the SWRM. The streambed infiltration capacity is the maximum volume of water that can infiltrate through streambed sediments, assuming a sufficient volume of water in the stream. The streambed infiltration capacity is measured in cubic feet per second per stream mile and is a function of streambed sediment permeability and wetted width of the stream at any given time.

The wetted width of a stream at any given time will vary as a function of the amount of flow in the stream and will be less than the nodal width for all but the highest streamflows. Additionally, permeability of the streambed sediments will vary spatially and can even vary over time at any given location because of the scouring and deposition that occur during high flow events. Consequently, the streambed infiltration capacity of a stream at any given location can vary over time. For this reason, and because stream widths can vary in the field but not in the Regional Model, streambed infiltration capacity was allowed to vary over time in the SWRM.

A post-processor was written into the SWRM code to aid in the selection of time-varying streambed infiltration rates. The post-processor became a part of the calibration process of the Regional Model, in that differences between measured and simulated groundwater

elevations were used to help determine whether the streambed infiltration capacity of a given stream reach needed to be raised or lowered during any given month. Because this process required groundwater elevation data in the underlying groundwater system (in this case, the Alluvial Aquifer), the post-processor could only be applied along the Santa Clara River and Castaic Creek. Few, if any, records of groundwater elevations exist for the Alluvial Aquifer along the other streams, so streambed infiltration capacities were not varied over time along those streams. A complete description of the Regional Model calibration process and results can be found in Sections 4 and 5 in the main body of this report.

The monthly adjustment of the assumed streambed infiltration capacities during calibration of the Regional Model was performed in an iterative manner, using the following steps (which are also shown in Figure C-9):

1. Initial estimates of the maximum stream leakage rate were specified in the SWRM, which then generated monthly sets of groundwater recharge rates at each Regional Model node along the Santa Clara River and Castaic Creek during the 20-year simulation period.

2. The Regional Model was then run, and simulated groundwater elevations were recorded over time at selected calibration well locations along the Santa Clara River and Castaic Creek.

3. Simulated groundwater elevations were compared with measured elevations at each calibration well, and the differences (head residuals) were used to compute the surplus or deficit of water calculated by the Regional Model. For example, if a set of calibration wells in a particular area along the Santa Clara River indicated that simulated groundwater levels were 10 feet too high during a monthly stress period, then the computation would proceed as follows:

    a. Multiply the head residuals by the specific yield and the adjacent stream node area in the stream reach where the calibration well is located, to obtain the volume of surplus recharge water in the model.

    b. Reduce the assumed maximum stream leakage rate so that the calculated surplus recharge volume of water would not infiltrate in the stream reach associated with the calibration well during that particular monthly stress period. In other words, at a location where the model simulates too much stream leakage, the post-processor computes the volume of surplus recharge that, if eliminated, would allow the simulated groundwater elevations to better match the measured groundwater elevations. In this example, streamflow would be infiltrating the simulated streambed at a slower rate, thereby persisting as streamflow for a longer downstream reach of the stream channel.

4. Using the new values of streambed infiltration capacity, the SWRM was then run again to provide new groundwater recharge rates each month at the nodes where the post-processor was applied. The Regional Model was then run again with the new groundwater recharge rates, and this entire process was repeated until the assumed maximum stream leakage rate and/or the simulated groundwater elevations showed little to no change from one simulation to the next.

The streambed infiltration capacity that is assigned by the SWRM for each month is not necessarily the rate that surface water leaks into the Regional Model at any given location. The specified infiltration capacity simply allows stream leakage to occur as long as streamflows are available. For example, if the selected calibration wells are simulating groundwater elevations too low in comparison with measured groundwater elevations during a drought period, then the post-processor function within the SWRM would try to increase the assumed maximum stream leakage rate. However, during a drought, the availability of surface water is diminished. Therefore, even though the SWRM might increase the streambed infiltration capacity, there would be reaches where streamflows would be too low to allow water to infiltrate at a rate as high as the streambed infiltration capacity. The SWRM can only infiltrate the surface water if it is available, based on the complete water balance within the watershed. This rule allows the SWRM and the Regional Model to honor the watershed water budget.

C.9 Rejected Stream Leakage

As previously mentioned, the SWRM also tracks the volume of surface water in each simulated stream that does not infiltrate during each monthly stress period because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage remains as surface water in the Santa Clara River and eventually exits the Regional Model at the west end of the valley at the County Line stream gage. The monthly volumes of rejected stream leakage (calculated by the SWRM) and groundwater discharges to the river (calculated by the Regional Model) were used during the calibration process to compare these combined flow rates with streamflows measured at the County Line stream gage. This is discussed in detail in Sections 4.4.2 and 5.2.3 of the report.

Table C-13 lists the monthly streamflow measured from 1980 through 1999 at the County Line gage, which is located on the Santa Clara River at the western (downstream) end of the Santa Clarita Valley. Until October 1996, this gage was located just downstream of the Los Angeles-Ventura County line and just upstream of Blue Cut.[2] This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

[2] Blue Cut is an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure C-1 for this location.

C.10 References

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Tables

Table C-1

Comparison of WRP Discharges with Urban Water Demands

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	WRP Discharges to the Santa Clara River (AF/yr)	Urban Water Demands (AF/yr)	Percentage of Urban Demand Used Indoors (Routed to WRPs)	Percentage of Urban Demand Used Outdoors
1980	7,374	22,319	33.0	67.0
1981	7,950	24,822	32.0	68.0
1982	8,438	21,912	38.5	61.5
1983	9,422	21,386	44.1	55.9
1984	9,514	27,386	34.7	65.3
1985	9,616	28,482	33.8	66.2
1986	6,020	31,152	19.3	80.7
1987	11,843	33,877	35.0	65.0
1988	12,363	37,634	32.9	67.1
1989	13,560	42,813	31.7	68.3
1990	14,006	43,066	32.5	67.5
1991	14,108	39,793	35.5	64.5
1992	15,702	41,266	38.1	61.9
1993	17,178	43,352	39.6	60.4
1994	16,946	45,988	36.8	63.2
1995	17,823	45,673	39.0	61.0
1996	16,827	50,147	33.6	66.4
1997	15,775	54,173	29.1	70.9
1998	17,691	48,858	36.2	63.8
1999	17,847	57,250	31.2	68.8
1999	17,847	57,250	31.2	68.8
Statistics for 1980 through 1999				
Minimum	**6,020**	**21,386**	**19.3**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**80.7**
Average	**13,231**	**38,981**	**34.2**	**65.8**
Median	**14,006**	**41,266**	**33.8**	**66.2**
Statistics for 1980 through 1999, Excluding 1986				
Minimum	**7,374**	**21,386**	**29.1**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**70.9**
Average	**13,592**	**39,372**	**34.9**	**65.1**
Median	**14,057**	**42,040**	**34.3**	**65.7**

TABLE C-2
Calculation of Outdoor Irrigation Infiltration Rates to Groundwater for Non-Agricultural Water Uses
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Term	Value	Units	Reference or Calculation Method	Comment
NCWD Annual Water Use, 5-Year Average 1994 through 1998	8,150	AF/yr	Table III-6 in *1999 Annual Basin Report* (Luhdorff and Scalmanini Consulting Engineers, 2000)	16 percent of retailer-supplied water.
SCWD Annual Water Use, 5-Year Average 1994 through 1998	20,920	AF/yr		42 percent of retailer-supplied water.
VWC Total Annual Use, 5-Year Average 1994 through 1998	19,330	AF/yr		40 percent of retailer-supplied water.
LA County 36 Annual Water Use, 5-Year Average 1994 through 1998	570	AF/yr		1 percent of retailer-supplied water.
Valencia Country Club (VCC) Annual Water Use, 5-Year Average 1994 through 1998	490	AF/yr		1 percent of retailer-supplied water.
Annual Water Use, 5-Year Average 1994 through 1998	**49,460**	**AF/yr**		
Area of Water Use (excluding agriculture and undeveloped)	17,691	acres	Aerial photography (1999).	Area where retailer-supplied water is used.
Alluvial Aquifer Area of Water Use (excluding agriculture and undeveloped)	8,000	acres		Alluvial area where retailer-supplied water is used.
Saugus Area of Water Use (excluding agriculture and undeveloped)	9,691	acres		Saugus area where retailer-supplied water is used.
Alluvial Aquifer Lands – Suburban Residential Area	4,765	acres	Aerial photography (1999) and geologic mapping.	60 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Retail – Office – Industrial Area	2,900	acres		36 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Recreational Area	0	acres		No recreational areas were identified as overlying alluvium.
Alluvial Aquifer Lands – Golf Course Area	335	acres		4 percent of alluvium area receiving applied water.
Saugus Lands – Suburban Residential Area	8,192	acres		85 percent of Saugus area receiving applied water.
Saugus Lands – Retail - Office – Industrial Area	1,411	acres		15 percent of Saugus area receiving applied water.
Saugus Lands – Recreational Area	46	acres		Less than 1 percent of Saugus area receiving applied water.
Saugus Lands – Golf Course Area	42	acres		Less than 1 percent of Saugus area receiving applied water.
Percent Annual Water Consumption for Outdoor Use – Suburban Residential	65		Comparison of historical water use records and WRP flow records. See Table C-1.	
Percent Annual Water Consumption for Outdoor Use – Retail/Office/Industrial	30			
Percent Annual Water Consumption for Outdoor Use – Recreational	65			
Percent Annual Water Consumption for Outdoor Use – Golf Course	100			
Percent Applied Water Going to Deep Percolation – Suburban Residential	10		Assumed irrigation efficiency is 10 percent for all urban land uses where irrigation occurs.	
Percent Applied Water Going to Deep Percolation – Retail/Office/Industrial	10			
Percent Applied Water Going to Deep Percolation – Recreational	10			
Percent Applied Water Going to Deep Percolation – Golf Course	30			
Percent Total Water Use Going to Deep Percolation – Suburban Residential	6.5		Calculated.	Equals 65 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation – Retail/Office/Industrial	3.0			Equals 30 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation – Recreational	6.5			Equals 65 percent times 10 percent
Percent Total Water Use Going to Deep Percolation – Golf Course	30.0			Equals 100 percent times 30 percent.
Alluvial Aquifer Annual Deep Percolation – Suburban Residential	866	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the alluvium for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (4765 acres / 17691 acres) * 6.5 percent.
Alluvial Aquifer Annual Deep Percolation – Retail/Office/Industrial	243	AF/yr		Equals 49,460 AF/yr * (2900 acres / 17691 acres) * 3.0 percent.
Alluvial Aquifer Annual Deep Percolation – Recreational	0	AF/yr		No recreational areas overlie alluvium.
Alluvium Annual Deep Percolation – Golf Course	130	AF/yr		Equals 490 AF/yr * (335 acres / (335+42 acres)) * 30.0 percent.
Alluvial Aquifer Annual Deep Percolation	**1,239**	**AF/yr**		
Alluvial Aquifer 5-Year Deep Percolation (1994 through 1998)	**6,195**	**AF**		
Saugus Annual Deep Percolation – Suburban Residential	1,489	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the Saugus for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (8192 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Retail/Office/Industrial	118	AF/yr		Equals 49,460 AF/yr * (1411 acres / 17691 acres) * 3.0 percent.
Saugus Annual Deep Percolation – Recreational	8	AF/yr		Equals 49,460 AF/yr * (46 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Golf Course	16	AF/yr		Equals 490 AF/yr * (42 acres / (335+42 acres) * 30.0 percent.
Saugus Annual Deep Percolation	**1,631**	**AF/yr**		
Saugus 5-Year Deep Percolation (1994 through 1998)	**8,155**	**AF**		
Average Area-Wide Deep Percolation -- Suburban Residential	2.2	in/yr	Calculated from applied water volumes in Alluvial and Saugus samples, as well as combined area in alluvium and Saugus occupied by each land use category.	Equals (12 in/ft)* (866+1,489 AF/yr) / (4,765+8,192 acres).
Average Area-Wide Deep Percolation -- Retail/Office/Industrial	1.0	in/yr		Equals (12 in/ft)* (243+118 AF/yr) / (2,900+1411 acres).
Average Area-Wide Deep Percolation – Recreational	2.2	in/yr		Equals (12 in/ft)* (0+8 AF/yr) / (0+46 acres).
Average Area-Wide Deep Percolation – Golf Course	4.6	in/yr		Equals (12 in/ft)* (130+16 AF/yr) / (335+42 acres).

Notes:

Applied water recharge to Saugus includes areas where terrace deposits are present at the ground surface.
in/ft = inches per foot

Table C-3

Irrigation Infiltration Rates over 1999 Suburban Residential Area

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Suburban Residential Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.86	0.391
1981	24,822	0.95	0.432
1982	21,912	0.84	0.382
1983	21,386	0.82	0.373
1984	27,386	1.05	0.477
1985	28,482	1.09	0.495
1986	31,152	1.2	0.545
1987	33,877	1.3	0.591
1988	37,634	1.45	0.659
1989	42,813	1.65	0.75
1990	43,066	1.65	0.75
1991	39,793	1.53	0.695
1992	41,266	1.59	0.723
1993	43,352	1.67	0.759
1994	45,988	1.77	0.805
1995	45,673	1.76	0.8
1996	50,147	1.93	0.877
1997	54,173	2.08	0.945
1998	48,858	1.88	0.855
1999	57,250	2.2	1
2000	60,988	2.34	1.064

Note:

Eq. = equivalent

Table C-4

Irrigation Infiltration Rates over 1999 Retail and Industrial Area

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Retail/Industrial Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.39	0.39
1981	24,822	0.43	0.43
1982	21,912	0.38	0.38
1983	21,386	0.37	0.37
1984	27,386	0.48	0.48
1985	28,482	0.5	0.5
1986	31,152	0.54	0.54
1987	33,877	0.59	0.59
1988	37,634	0.66	0.66
1989	42,813	0.75	0.75
1990	43,066	0.75	0.75
1991	39,793	0.7	0.7
1992	41,266	0.72	0.72
1993	43,352	0.76	0.76
1994	45,988	0.8	0.8
1995	45,673	0.8	0.8
1996	50,147	0.88	0.88
1997	54,173	0.95	0.95
1998	48,858	0.85	0.85
1999	57,250	1	1

Table C-5
Irrigation Infiltration Rates over 1999 Golf Course Areas
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Golf Courses Area (in/yr)	Ratio Compared with 1999
1980	22,319	1.79	0.389
1981	24,822	1.99	0.433
1982	21,912	1.76	0.383
1983	21,386	1.72	0.374
1984	27,386	2.2	0.478
1985	28,482	2.29	0.498
1986	31,152	2.5	0.543
1987	33,877	2.72	0.591
1988	37,634	3.02	0.657
1989	42,813	3.44	0.748
1990	43,066	3.46	0.752
1991	39,793	3.2	0.696
1992	41,266	3.32	0.722
1993	43,352	3.48	0.757
1994	45,988	3.7	0.804
1995	45,673	3.67	0.798
1996	50,147	4.03	0.876
1997	54,173	4.35	0.946
1998	48,858	3.93	0.854
1999	57,250	4.6	1

Table C-6
Irrigation Infiltration Rates for Agricultural Lands
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Agricultural Applied Water Volume (AF/yr)	Infiltration Rate (ft/yr)	Infiltration Rate for Modeled Acreage (ft/yr)	Percentage of 1996 through 2000 Average
1980	6,364	2.7	1.9	90
1981	7,433	3.1	2.2	106
1982	5,441	2.3	1.6	77
1983	4,487	1.9	1.3	64
1984	6,311	2.6	1.9	90
1985	5,241	2.2	1.5	74
1986	4,657	1.9	1.4	66
1987	3,662	1.5	1.1	52
1988	3,348	1.4	1.0	48
1989	3,511	1.5	1.0	50
1990	4,623	1.9	1.4	66
1991	3,958	1.7	1.2	56
1992	5,022	2.1	1.5	71
1993	4,508	1.9	1.3	64
1994	5,958	2.5	1.8	85
1995	6,276	2.6	1.8	89
1996	6,728	3.2	2.2	108
1997	7,528	3.0	2.1	102
1998	5,980	2.7	1.9	93
1999	7,479	2.9	2.1	99
2000	7,476	2.9	2.0	98
Average (1996 through 2000)	**7,038**	**2.9**	**2.1**	100

Note:
Actual acreage is 877 acres; modeled acreage is 1,205 acres.

TABLE C-7
Monthly Precipitation Measured at the Newhall County Water District Rain Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05

Note:

All precipitation values are measured in inches.

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
Bee Canyon	1,163.38	970.06	11.41
Bouquet Canyon	11,995.90	9,100.66	14.09
Bouquet Canyon Tributary 1	409.84	291.36	12.81
Bouquet Canyon Tributary 2	683.75	577.67	13.25
Bouquet Canyon Tributary 3	459.20	393.53	13.18
Lower Castaic Creek	13,109.20	4,205.12	14.73
Upper Castaic Creek	98,417.60	98,417.60	19.62
Charlie Canyon	6,323.41	5,418.33	15.55
Dry Canyon	4,883.13	2,900.08	14.20
Gavin Canyon	3,608.62	2,913.39	21.32
Haskell Canyon	7,608.26	5,976.49	14.01
Hasley Canyon	5,609.59	385.96	14.25
Iron Canyon	1,734.63	1,401.94	18.92
Marple Canyon	6,031.13	4,980.94	17.09
Mint Canyon	5,711.30	4,155.07	12.45
Mint Canyon Tributary 1	615.56	367.82	12.14
Mint Canyon Tributary 2	1,697.89	1,438.90	12.22
Mint Canyon Tributary 3	304.45	296.87	12.61
Mint Canyon Tributary 4	234.88	231.90	12.93
Mint Canyon Tributary 5	118.01	114.80	13.01
Newhall Canyon	3,191.67	1,625.11	18.98
Oak Spring Canyon	3,628.60	2,721.91	16.21
Pico Canyon	4,404.42	2,853.93	19.47
Placerita Canyon	6,117.92	2,490.47	18.20
Plum Canyon	2,085.00	753.09	13.25
Pole Canyon	1,744.04	1,614.78	15.95
Potrero Canyon	2,865.18	1,074.76	15.88
Railroad Aqueduct Canyon	865.82	198.83	20.27

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
San Francisquito Canyon	31,388.60	26,878.10	16.51
San Martinez Canyon	2,117.60	1,384.49	13.67
Sand Canyon	5,489.51	4,191.58	19.39
Sand Canyon Road Tributary	554.03	508.56	13.12
Sand Canyon Tributary 1	644.26	251.41	15.97
Sand Canyon Tributary 2	338.66	221.79	16.99
Santa Clara River East	12,696.90	2,562.57	14.16
Santa Clara River West	17,105.90	3,169.86	13.76
Santa Clara River Tributary 1	1,278.18	927.13	16.97
Santa Clara River Tributary 2	277.82	264.96	13.64
Santa Clara River Tributary 3	219.50	189.19	13.65
Santa Clara River Tributary 4	101.25	91.84	13.54
Santa Clara River Tributary 5	114.80	106.31	13.44
South Fork Santa Clara River	5,491.11	655.74	17.62
Tapie Canyon	1,260.27	1,235.25	11.39
Texas Canyon	6,956.88	6,659.55	13.59
Tick Canyon	3,662.58	3,428.16	11.57
Tick Canyon Tributary	175.19	154.75	12.09
Towsley Canyon	3,681.64	3,606.56	21.43
Vasquer Canyon	2,743.26	2,151.81	12.66
Whitney Canyon	1,321.58	1,104.38	18.95
Area Totals	**293,241.89**	**217,615.36**	

TABLE C-9
Monthly Streamflows Measured in the Santa Clara River at the Lang Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
1981	594	98	339	240	107	18	18	12	338	321	258	394	2,739
1982	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
1983	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
1984	0	596	405	240	143	166	228	411	154	220	904	578	4,044
1985	483	461	274	215	77	0	0	0	12	179	221	301	2,224
1986	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
1987	117	117	65	31	12	0	0	0	0	0	258	516	1,116
1988	222	209	506	117	77	68	0	0	0	0	12	25	1,236
1989	50	111	60	25	6	0	0	0	102	94	34	18	499
1990	212	276	230	46	46	5	0	0	0	27	36	147	1,025
1991	162	775	879	736	145	142	14	0	45	69	62	263	3,291
1992	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
1993	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
1994	388	493	497	319	163	80	20	7	37	102	193	941	3,239
1995	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
1996	666	896	730	315	151	46	7	0	54	154	307	510	3,836
1997	517	346	140	85	33	5	4	50	66	240	566	809	2,859
1998	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
1999	92	85	204	224	197	107	80	46	52	54	31	80	1,252

Note:

All monthly streamflows are measured in acre-feet.

TABLE C-10
Monthly Releases of Water from Castaic Lagoon to Castaic Creek
Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
1981	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1982	0	0	0	0	0	667	842	735	0	0	0	0	2,244
1983	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1987	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
1988	0	0	809	341	900	0	0	0	0	0	0	0	2,050
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	66	66
1992	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
1993	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
1994	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
1995	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
1996	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
1997	0	0	8701	873	0	0	0	0	0	0	0	310	9,884
1998	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
1999	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830

Note:

All monthly releases are measured in acre-feet.

TABLE C-11
Monthly Treated Wastewater Discharge Measured at the Valencia Water Reclamation Plant
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	266	258	257	239	247	212	219	219	212	228	239	247	2,844
1981	248	220	249	235	244	237	253	255	248	263	285	270	3,006
1982	275	247	284	271	277	269	275	268	254	266	271	284	3,241
1983	286	261	301	288	296	277	287	296	282	286	276	295	3,432
1984	303	281	304	294	321	315	320	317	314	322	315	319	3,723
1985	309	283	316	316	333	331	354	359	348	361	357	341	4,006
1986	350	341	374	359	377	380	415	454	446	440	421	445	4,801
1987	455	415	472	489	550	567	603	594	579	633	600	624	6,582
1988	622	557	588	587	603	537	575	606	587	608	600	602	7,072
1989	622	593	695	666	671	708	714	731	668	678	673	676	8,095
1990	698	644	725	695	666	693	725	714	692	700	658	680	8,290
1991	715	662	702	627	668	646	647	691	709	743	717	748	8,276
1992	777	777	819	813	824	800	853	869	818	828	811	786	9,775
1993	778	733	863	858	869	925	910	846	816	834	818	858	10,107
1994	722	729	809	776	802	761	771	764	739	763	735	760	9,132
1995	889	777	935	887	884	848	853	814	826	834	823	855	10,225
1996	893	838	935	890	902	876	903	891	886	817	810	816	10,456
1997	815	713	866	829	852	879	860	851	824	826	778	775	9,867
1998	778	787	955	955	984	965	1,136	1,139	1,020	993	911	906	11,529
1999	930	868	962	953	985	968	1,003	1,018	961	1,020	1,040	987	11,695

Note:

All monthly releases are measured in acre-feet.

TABLE C-12
Monthly Treated Wastewater Discharge Measured at the Saugus Water Reclamation Plant
Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	362	365	419	414	419	387	362	362	350	362	359	371	4,529
1981	382	337	390	398	444	412	417	429	431	434	412	460	4,945
1982	445	399	456	444	446	434	434	421	415	434	431	438	5,196
1983	460	421	514	541	562	545	520	477	458	481	477	534	5,990
1984	558	505	499	485	476	443	458	456	451	467	474	519	5,791
1985	503	461	505	458	448	444	452	459	452	470	460	498	5,610
1986	498	475	528	501	499	483	481	476	500	511	518	552	6,023
1987	524	475	542	487	425	383	391	403	395	397	411	430	5,264
1988	443	411	439	434	440	430	445	457	435	464	436	460	5,294
1989	462	410	441	450	464	436	476	479	462	471	451	466	5,468
1990	463	403	432	426	483	492	513	504	489	493	508	512	5,718
1991	495	423	479	427	491	516	557	525	486	474	470	493	5,835
1992	488	507	530	472	489	476	493	521	492	498	452	514	5,931
1993	595	534	616	581	615	587	622	604	578	609	567	567	7,075
1994	601	606	694	677	687	644	642	645	619	663	655	685	7,817
1995	657	578	676	705	699	631	641	635	617	613	568	581	7,602
1996	532	504	525	501	517	506	511	525	532	579	558	583	6,375
1997	564	516	515	461	469	417	442	474	475	503	521	553	5,911
1998	529	541	544	511	617	587	426	399	457	501	521	533	6,166
1999	542	485	551	391	544	512	547	532	521	527	487	514	6,153

Note:

All monthly discharges are measured in acre-feet.

TABLE C-13
Monthly Streamflows Measured in the Santa Clara River at the County Line Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	8,428	43,565	18,125	8,551	3,792	3,963	1,202	1,111	1,668	1,470	1,452	1,884	95,211
1981	3,376	1,533	5,415	1,815	1,662	1,279	942	906	1,139	1,488	2,138	2,539	24,232
1982	2,826	2,358	5,572	7,091	3,909	1,749	1,694	1,392	1,597	1,621	3,449	3,229	36,488
1983	7,787	9,122	67,712	11,240	10,320	3,828	2,102	2,678	2,053	3,443	5,040	5,911	131,236
1984	5,691	3,931	4,084	4,530	2,309	1,607	1,224	1,511	1,464	1,624	3,237	8,067	39,279
1985	3,116	2,561	2,852	1,974	1,694	1,365	1,178	1,365	1,551	1,880	2,102	2,828	24,466
1986	3,955	13,991	10,616	3,328	2,612	1,622	1,454	1,482	1,870	1,896	2,606	2,590	48,024
1987	2,485	2,325	2,575	1,841	1,908	1,710	1,650	1,470	1,412	2,309	2,057	4,457	26,198
1988	3,421	2,981	3,025	3,172	2,636	2,231	1,734	1,494	1,605	1,904	2,027	10,381	36,611
1989	2,644	3,340	2,584	2,055	1,740	1,920	1,732	1,345	1,535	2,146	1,964	1,795	24,799
1990	2,709	3,247	2,269	1,898	1,730	1,545	1,478	1,751	1,668	1,660	1,924	1,593	23,472
1991	2,051	3,219	15,981	1,837	1,519	1,113	1,144	831	912	948	1,014	4,332	34,901
1992	3,737	37,636	9,576	4,439	1,964	1,533	1,377	1,085	1,129	1,329	1,496	3,277	68,577
1993	47,199	44,749	25,738	9,459	4,860	3,324	2,797	2,771	2,949	3,005	2,686	3,247	152,783
1994	3,281	3,437	3,501	3,533	3,519	2,200	1,640	1,400	1,192	1,855	2,263	4,219	32,039
1995	31,125	3,828	19,662	8,452	3,901	2,527	1,843	2,192	1,855	1,716	2,075	3,235	82,409
1996	3,604	10,669	7,678	6,073	3,584	1,678	1,640	1,579	1,509	2,625	1,590	5,701	47,930
1997	5,375	3,913	7,884	3,370	1,680	1,240	1,571	1,371	1,230	1,662	2,636	4,848	36,780
1998	5,875	104,388	25,377	9,378	34,992	5,312	3,935	3,537	2,579	2,450	2,890	4,427	205,139
1999	4,328	4,128	4,322	6,526	4,760	3,590	1,125	1,439	2,164	1,888	2,243	2,434	32,382

Note:

All monthly streamflows are measured in acre-feet.

Figures

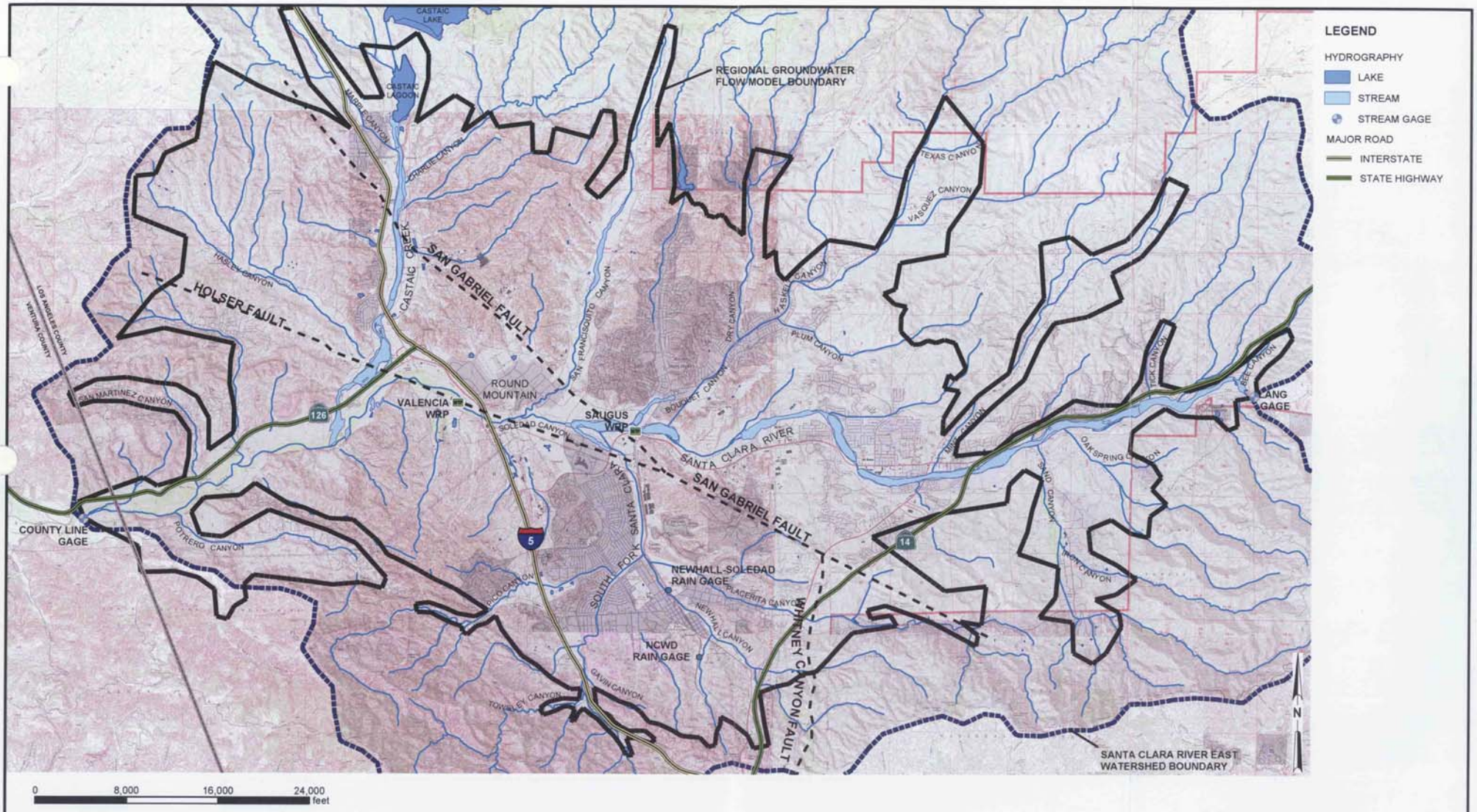

FIGURE C-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-01.MXD FIGC-01.PDF

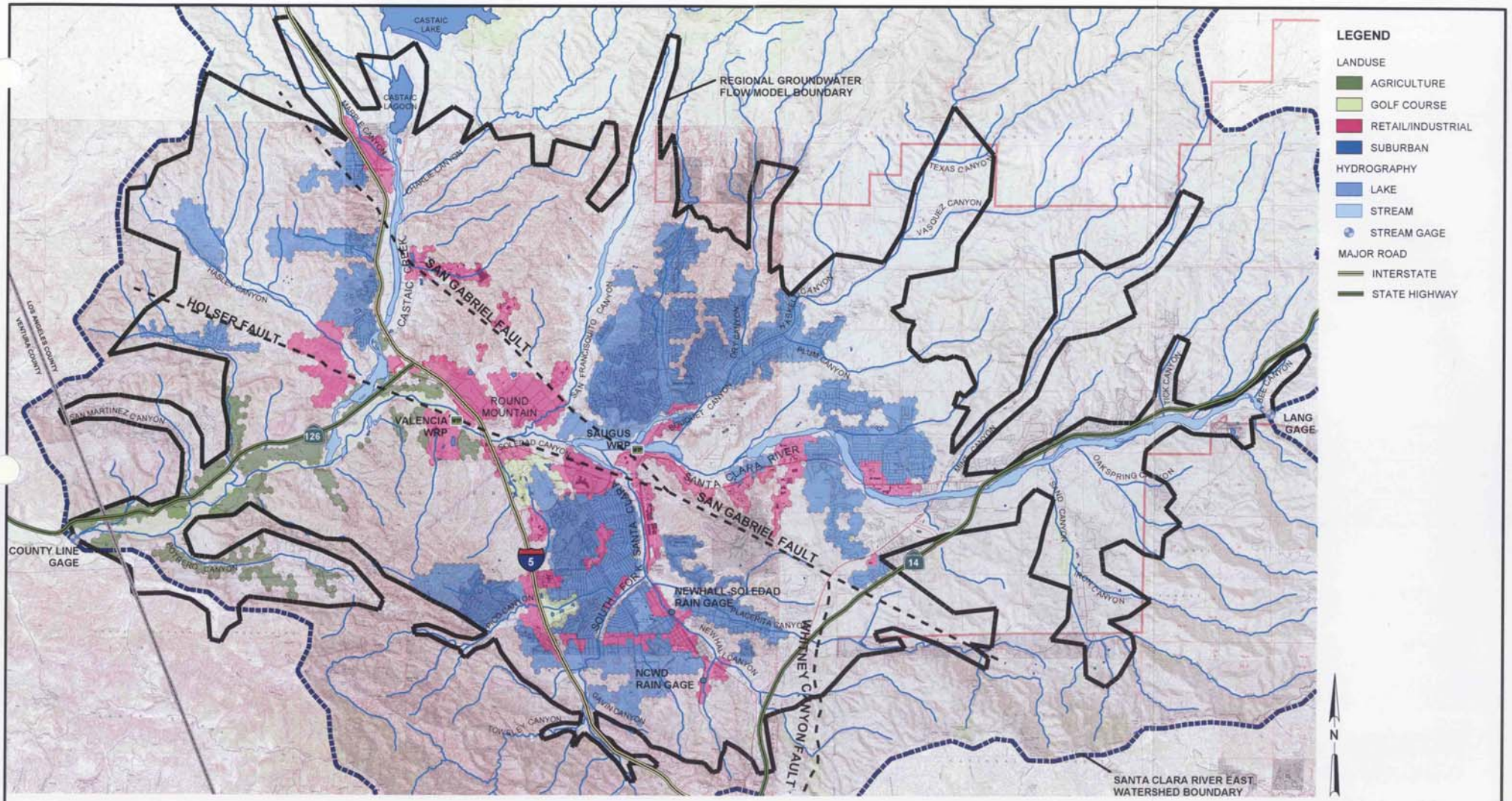

FIGURE C-2
LAND USE MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-06.MXD FIGC-02.PDF 02/03/2004 09:36:51

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Year	Acres				Acreage %		
	Alfalfa	Sudan	Vegetables	Total	Alfalfa	Sudan	Vegetables
1996	105	170	537	812	12.9%	20.9%	66.1%
1997	160	103	663	926	17.3%	11.1%	71.6%
1998	115	100	590	805	14.3%	12.4%	73.3%
1999	55	150	709	914	6.0%	16.4%	77.6%
2000	55	150	722	927	5.9%	16.2%	77.9%
Average	**98**	**134.6**	**644.2**	**876.8**	**11.3%**	**15.4%**	**73.3%**

Year	CIMIS AF/yr		
	Alfalfa	Sudan	Vegetables
1996	10.21	10.21	7.3
1997	10.22	10.22	7.3
1998	9.4	9.4	6.71
1999	10.51	10.51	7.51
2000	10.37	10.37	7.41
Average	**10.142**	**10.142**	**7.246**

Year	Water Use (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	1,072	1,736	3,920	6,728
1997	1,635	1,053	4,840	7,528
1998	1,081	940	3,959	5,980
1999	578	1,577	5,325	7,479
2000	570	1,556	5,350	7,476
Average	**987**	**1,372**	**4,679**	**7,038**

Data Source: Appendix 2.5(m) of
Draft Additional Analysis to the Newhall Ranch Specific Plan and Water Reclamation Plant, Final Environmental Impact Report
Impact Sciences, Inc., April 2001)

Crop Efficiency		
Alfalfa	Sudan	Vegetables
50%	50%	70%

Year	Estimated Infiltration (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	536	868	1,176	2,580
1997	818	526	1,452	2,796
1998	541	470	1,188	2,198
1999	289	788	1,597	2,675
2000	285	778	1,605	2,668
Average	**494**	**686**	**1,404**	**2,583**

Year	Estimated Infiltration (AF/acre/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	5.1	5.1	2.2	3.2
1997	5.1	5.1	2.2	3.0
1998	4.7	4.7	2.0	2.7
1999	5.3	5.3	2.3	2.9
2000	5.2	5.2	2.2	2.9
Average	**5.1**	**5.1**	**2.2**	**2.9**

This represents the average deep percolation on irrigated acreage during the past 5 years, consistent with the water application of an average 7,038 AF/yr during this period. Values are in AF/acre/year, which is equivalent to feet/year.

FIGURE C-3
ANALYSIS OF AGRICULTURAL WATER USE AND ASSOCIATED INFILTRATION TO GROUNDWATER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-409.xls\FigureC-3

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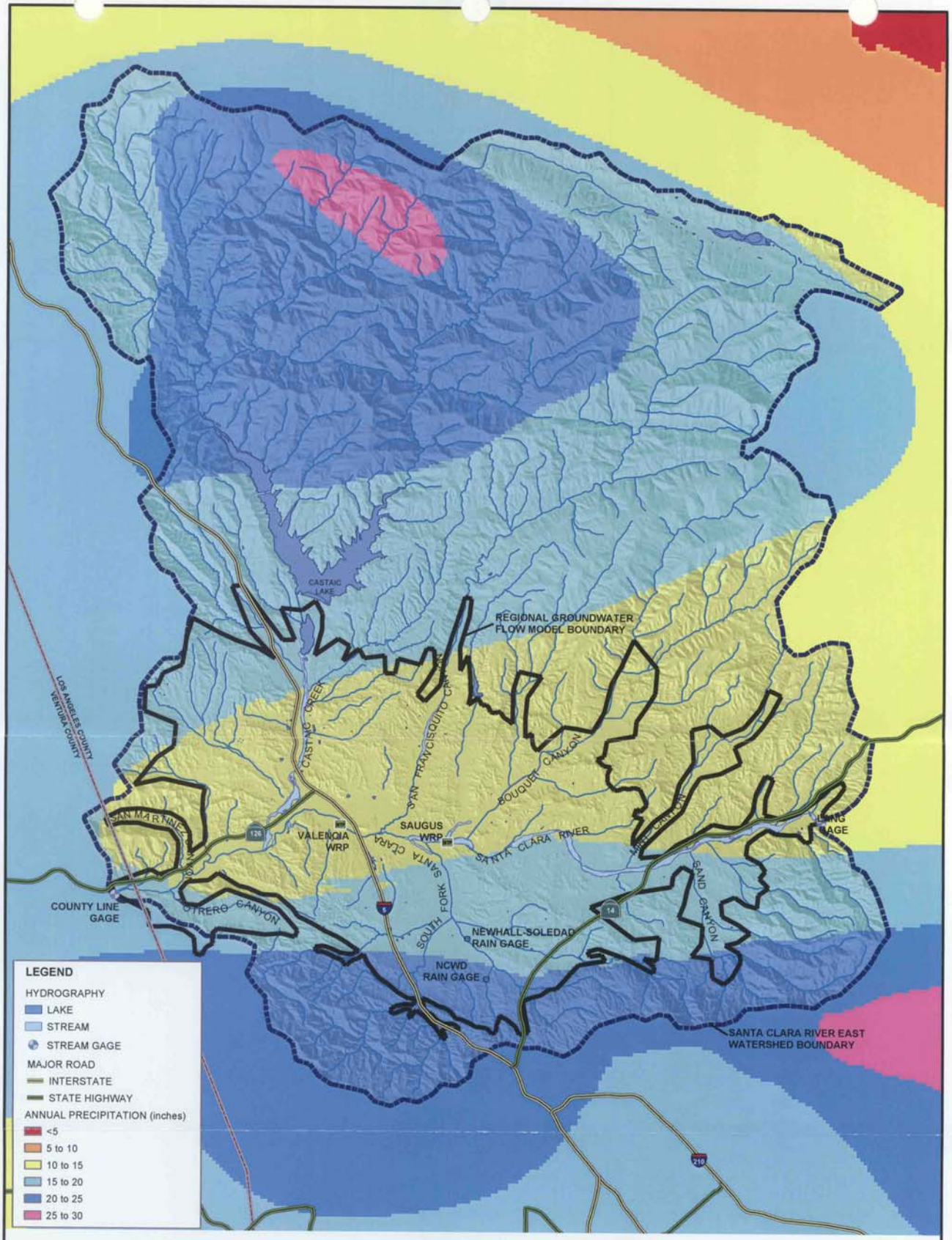

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

N

0 2.5 5 miles

FIGURE C-4
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ\255\SANTACLARITA_MOU\FIGURES\MXD\FIGC-07.MXD FIGC-07.PDF

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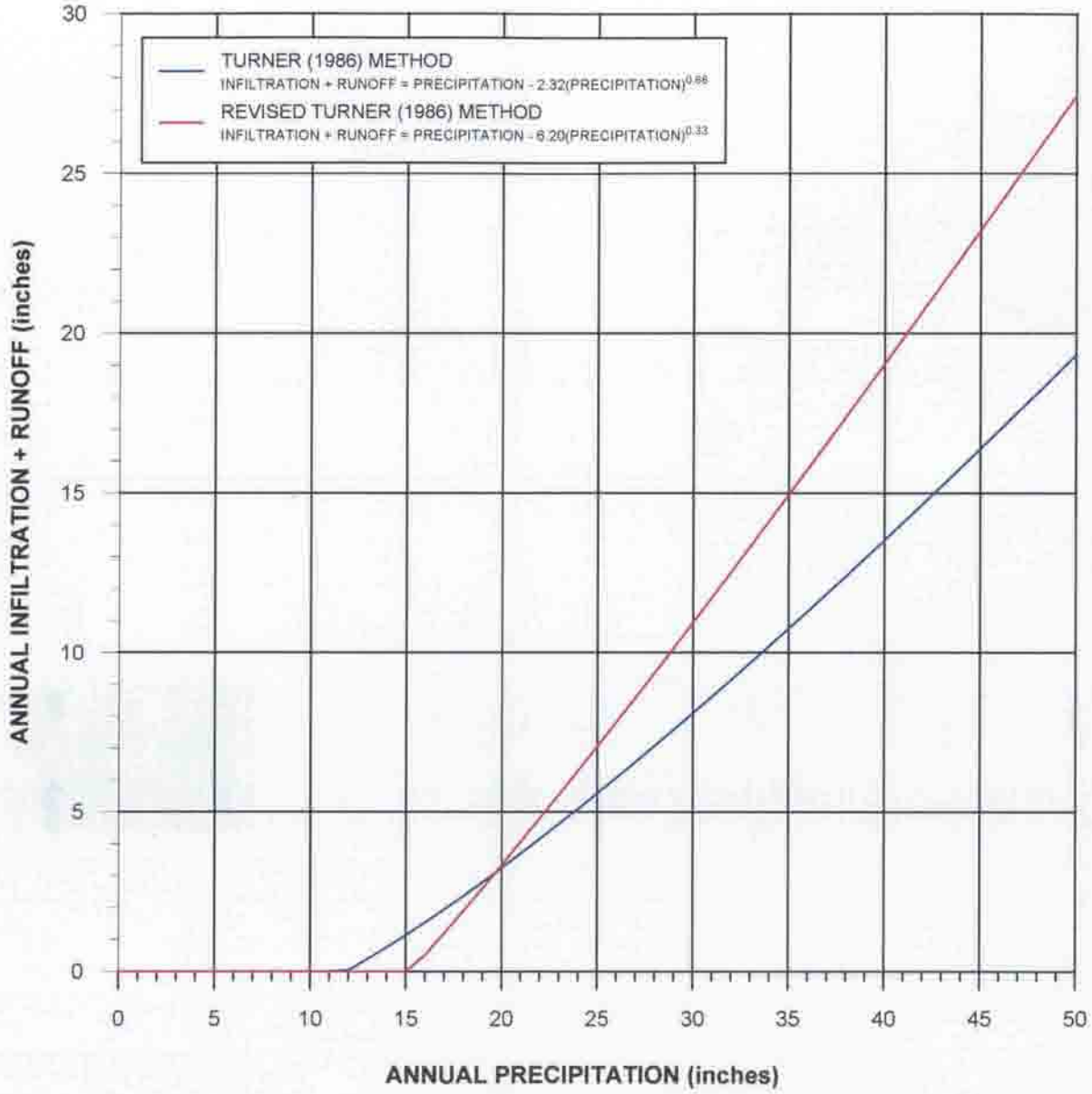

SOURCE:

TURNER, K.M. 1986. WATER LOSS FROM FOREST AND RANGE LANDS IN CALIFORNIA. *IN* PROCEEDINGS OF THE CHAPPARRAL ECOSYSTEMS CONFERENCE, SANTA BARBARA, CALIFORNIA, MAY 16-17, 1986, J. DEVRIES (EDITOR). WATER RESOURCES CENTER, REPORT 62, UNIVERSITY OF CALIFORNIA-DAVIS, CALIFORNIA, PP. 63-66.

FIGURE C-5
INFILTRATION AND RUNOFF AS A FUNCTION OF PRECIPITATION
REGIONAL GROUNDWATER MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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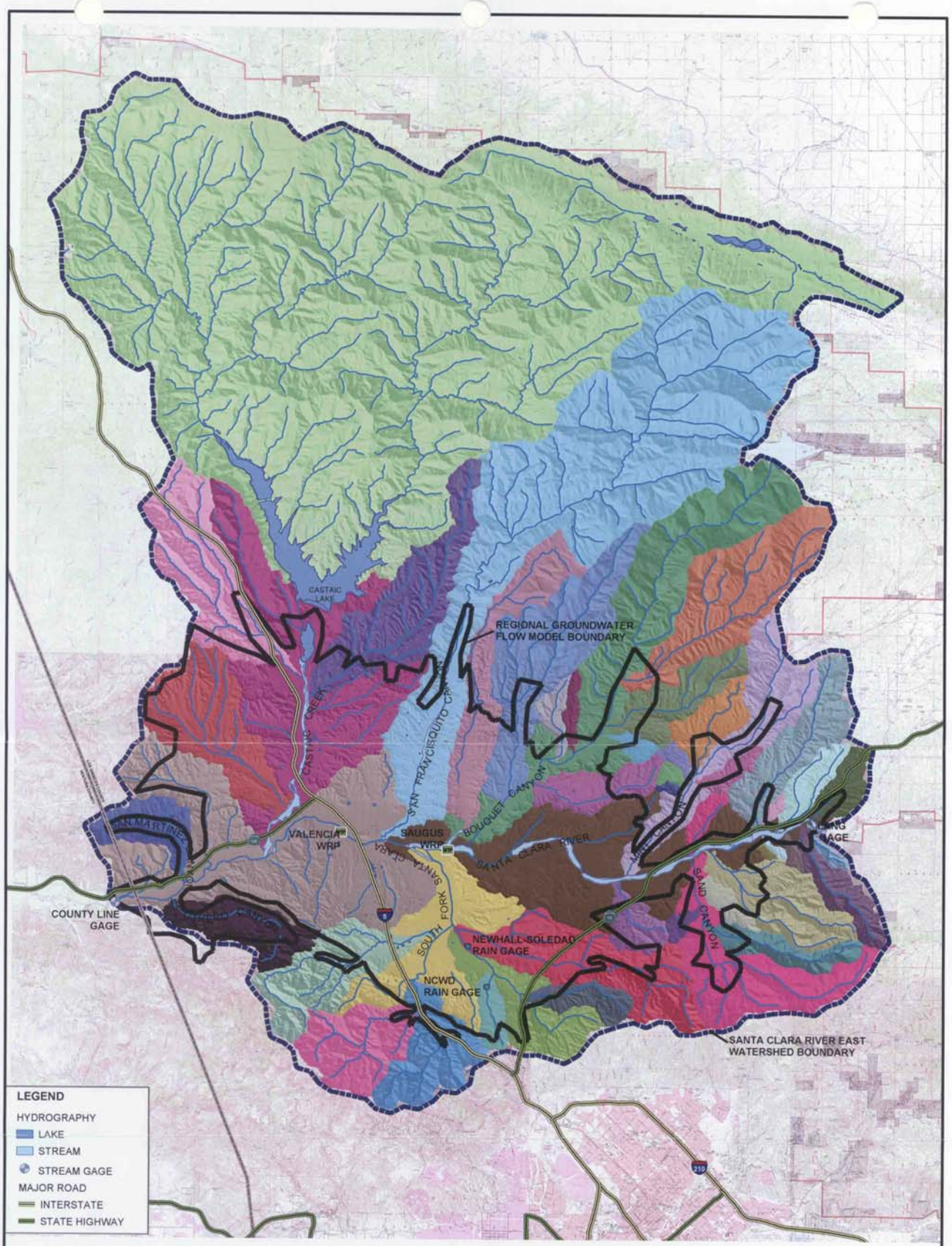

FIGURE C-6
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\RCD31\0025405\SANTACLARITA_MOU\FIGURES\MXD\FIGC-06.MXD FIGC-06.PDF 01/22/2004 08:19:58

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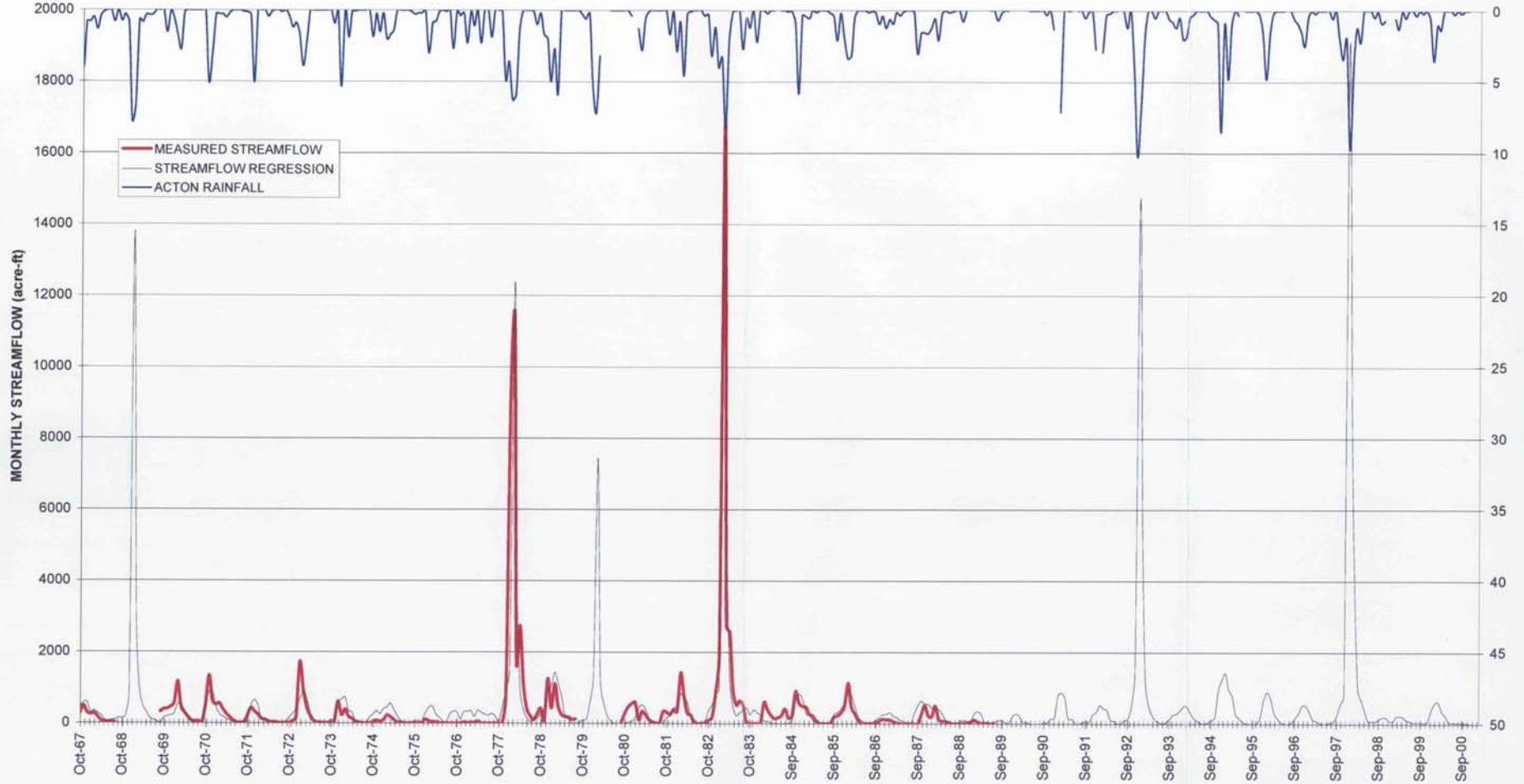

REGRESSION EQUATION:
MONTHLY STREAMFLOW AT LANG = 90.00*1 mo + 120.00*2 mo + 100.00*3 mo + 20.00*4 mo + 20.00*5 mo + 2.00*6 mo

FIGURE C-7
SANTA CLARA RIVER STREAMFLOW REGRESSION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-408.xls/FIG C-7

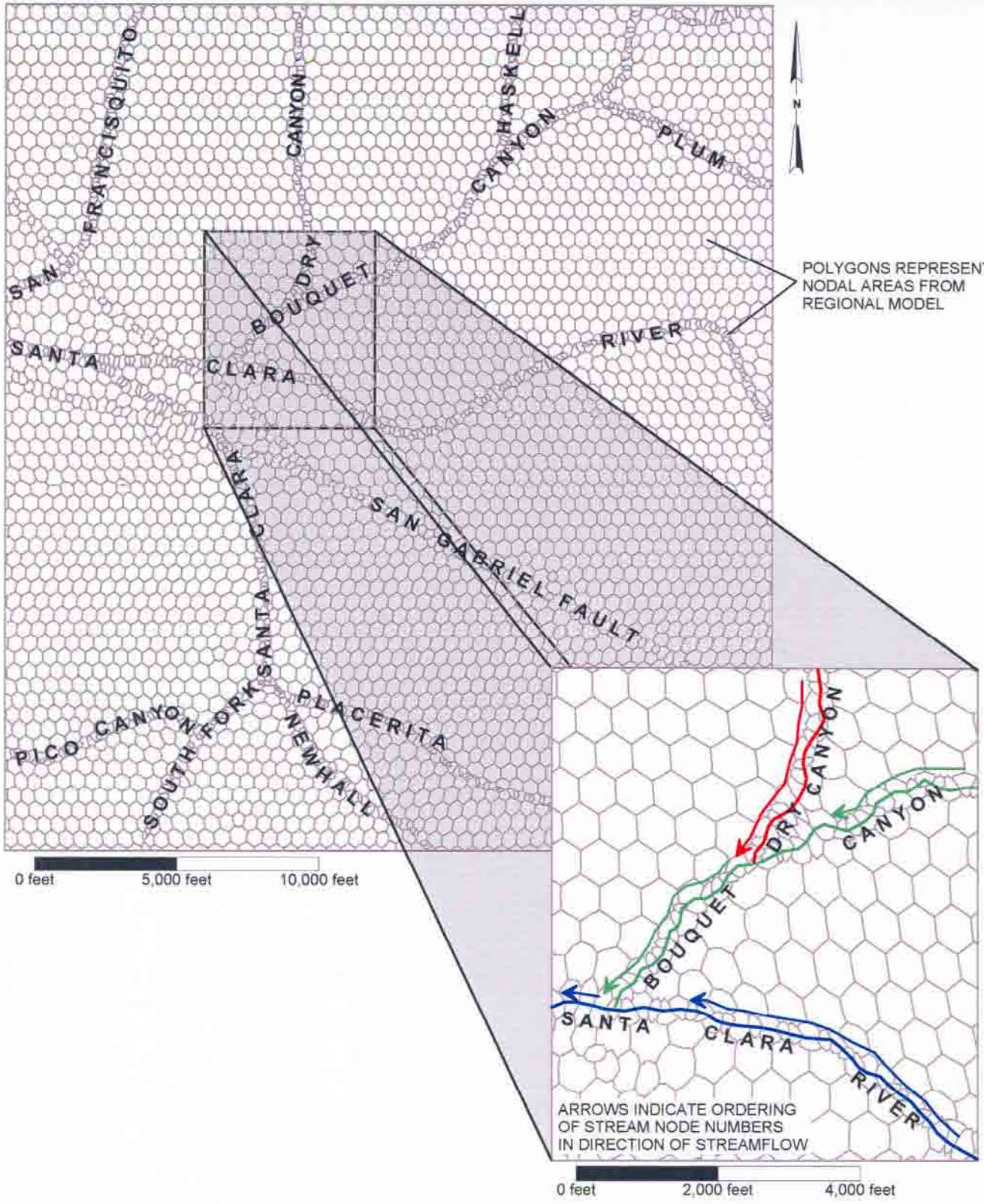

FIGURE C-8
MAP SHOWING EXAMPLE OF STREAM RANKING
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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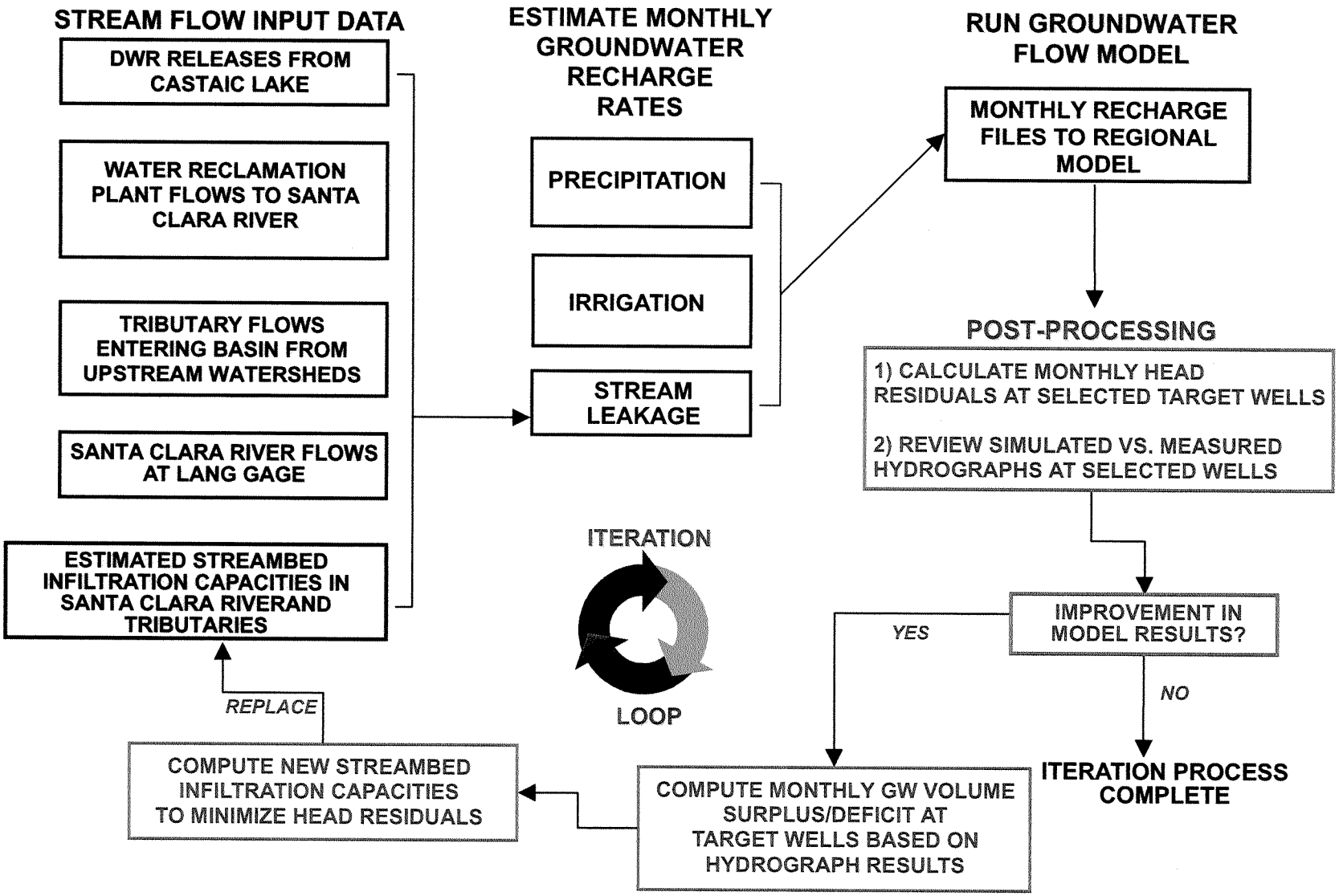

FIGURE C-9
FLOW CHART SHOWING ITERATIVE PROCESS USED TO VARY STREAMBED INFILTRATION CAPACITIES DURING MODEL CALIBRATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-002.FH9

CH2MHILL

CH2MHill, "Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California" (August 2005)

Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

PREPARED FOR: The Santa Clarita Valley Water Purveyors

PREPARED BY: John Porcello/CH2M HILL
Nate Brown, P.G./CH2M HILL

DATE: August 2005

PROJECT NUMBER: 178973.A4.02

Introduction

The Santa Clarita Valley Regional Groundwater Flow Model (hereafter referred to as the Regional Model) is a three-dimensional, numerical model of groundwater flow in the Santa Clara River Valley Groundwater Basin, East Subbasin, which is located in the northwestern portion of Los Angeles County, California. As shown on Figure 1, the Regional Model simulates groundwater flow for the area occupied by the local groundwater aquifers, which consist of the shallow Alluvial Aquifer and the deeper Saugus Formation (tables and figures are located at the end of this technical memorandum). The Regional Model was developed as part of the work scope contained in an August 2001 Memorandum of Understanding that was entered into by the Upper Basin Water Purveyors (hereafter referred to as the Purveyors[1]) and the United Water Conservation District, located downstream in Ventura County.

The construction and calibration of the Regional Model are described in detail in the *Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California* (CH2M HILL, 2004a). As discussed in that report, calibration of the Regional Model was performed for the period 1980 through 1999. This technical memorandum describes a recent extension of the model to simulate observed conditions in the basin during the period from January 2000 through February 2005. The purpose of the simulations was to update and test the model's calibration against an independent data set consisting of the recently observed hydrologic and pumping conditions in the basin. Following are discussions of the design of the simulation for this extended period and the findings.

[1]The Upper Basin Water Purveyors consist of the Castaic Lake Water Agency (CLWA), the Santa Clarita Water Division of CLWA (formerly called the Santa Clarita Water Company [SCWC]), the Newhall County Water District (NCWD), and the Valencia Water Company (VWC).

Simulation Design

The calibration update process consisted of transient modeling that simulated monthly variations in pumping from, and recharge to, the Alluvial Aquifer and the Saugus Formation during the period January 2000 through February 2005. As with the original calibration effort, simulation results were compared to measured fluctuations in groundwater elevations and streamflows in the Santa Clara River.

Hydrologic input data for the calibration update simulation were as follows:

1. Groundwater pumping data were provided by the Purveyors for each production well. Tables 1 and 2 show annual pumping for the Alluvial Aquifer and Saugus Formation, respectively, from 1980 through 2004. As with the initial model calibration effort, the monthly distribution of pumping was defined from information on the monthly distribution of urban and agricultural water demands, as listed in Table 3.

2. Groundwater recharge was defined using a Surface Water Routing Model (SWRM) that was written specifically for the Regional Model during the original model development effort (see Appendix C of CH2M HILL, 2004a). The SWRM defined recharge from applied water use (i.e., irrigation)[2]; direct precipitation within the model domain (see Table 4); Santa Clara River flows into the valley as measured at the Lang stream gage (see Table 5); SWRM-estimated stormwater inflows into the model domain along ephemeral streams that are tributaries to the Santa Clara River; measured volumes of treated water discharge into the Santa Clara River from two Los Angeles County Sanitation District water reclamation plants (WRP) (see Tables 6 and 7); and water released from Castaic Lagoon into Castaic Creek by the California Department of Water Resources (see Table 8).

As discussed in two recent reports (CH2M HILL, 2004b and 2005) that were prepared after the model development report (CH2M HILL, 2004a) was completed, the boundary condition in the Alluvial Aquifer at the Lang gage was converted to a constant-head boundary shortly after completion of the model development report. This change was made based on field reconnaissance that was performed in April and May 2004, when the Santa Clara River was dry at the Lang gage. At that time, groundwater was locally discharging from the bed of the Santa Clara River in isolated locations where the riverbed intersects the water table, then seeping back into the riverbed nearby. Significant phreatophyte growth was also present along the riverbed in this same area (just downstream of the Lang gage). Additionally, water was present and actively flowing in the river east (upstream) of the Santa Clarita Valley, in the area between the Santa Clarita Valley and the upstream Acton Basin. Based on these observations, a specified groundwater elevation of 1,746 feet was established in the Alluvial Aquifer at the eastern boundary of the Regional Model to simulate subsurface flow beneath the channel of the Santa Clara River at the Lang gage. This specified elevation was held constant throughout the simulation period. Because of this change to the Regional Model, the simulation was performed for the entire calibration period (January 1980 through February 2005).

[2]Infiltration of applied water was simulated in the same locations as in the original model calibration effort, and at the 1999 rates described in the model development report (CH2M HILL, 2004a). These rates were 24.7 inches per year (in/yr) for irrigated agricultural land, 2.2 in/yr for residential areas, and 1.0 in/yr for retail/industrial lands and golf courses.

The simulation results were compared with hydrographs of measured groundwater elevations at production wells and other wells with long-term groundwater elevation data; measured flows in the Santa Clara River at the west end of the basin (at the County Line gage; see Table 9); and estimated volumes of groundwater discharge to the Santa Clara River (see Table 10). These comparisons are discussed in the following section.

Simulated and Measured Groundwater Elevations Trends

Simulated groundwater elevation trends were compared with data collected at specific Alluvial Aquifer wells (see Figure 2) and Saugus Formation wells (see Figure 3) where long-term records of groundwater elevations were available. These wells are referred to herein as target wells. As discussed in the model development report (CH2M HILL, 2004a), the calibration goal at target wells was to simulate groundwater elevations that were higher than the pumping elevations and as close as possible to the static elevations. Therefore, the hydrographs show the model-simulated groundwater elevations, the measured static groundwater elevations, and, for production wells, the measured pumping groundwater elevations. Additionally, the comparison of time-varying simulated and measured groundwater elevations was equally focused on the slopes of the hydrographs, not just the absolute values of the groundwater elevations at any given time.

Figures 4 through 8 show simulated and measured groundwater elevation hydrographs at target wells in specific geographic areas where the Alluvial Aquifer is present. The hydrographs and principal observations about the calibration quality in each area are as follows:

1. Along the Santa Clara River, west of Interstate 5, Figure 4 shows that simulated groundwater elevations were generally stable in this area during both the original calibration period (1980 through 1999) and the calibration update period (January 2000 through February 2005). However, few groundwater elevation measurements are available in this area for evaluating calibration quality during the latter period.

2. Along the Santa Clara River between Interstate 5 and Soledad Canyon, Figure 5 shows that the Regional Model closely simulates the trends at the three wells where data were collected before and after January 2000 (wells VWC-I, VWC-N, and VWC-Q2). This includes the general decline in groundwater elevations from 1998 through 2003, the more stable elevations in late 2003 and much of 2004, and the steep rise in elevations that began at the end of 2004.

3. Along the Santa Clara River in Soledad Canyon, Figure 6 shows that in the western portion of the canyon, the Regional Model simulates somewhat less decline in water levels during 2003 and 2004 than was observed at three wells (SCWC-Stadium, SCWC-Honby, and VWC-T2). However, the Regional Model simulates the steep declines seen elsewhere in the canyon in most of the production wells (such as SCWC-Mitchell and SCWC-Lost Canyon 2), including at the production wells where pumping has historically been reduced when groundwater elevations decreased during local drought periods. At these wells, the hydrographs show that the Regional Model closely simulates the slopes in the groundwater elevation hydrographs during dry and wet periods, and does not overestimate groundwater elevations during droughts.

4. Along Castaic Creek, Figure 7 shows that the Regional Model simulates groundwater elevations that are too high in early 2001 at three wells located in the upper reaches of the valley (production well NWCD-Castaic3 and other wells 6980E and 6981D). However, the subsequent declines in simulated groundwater elevations at these wells are similar to observed declines. In the lower reach of the valley, the simulated groundwater elevations and elevation trends at well VWC-D closely match the measured data.

5. In other tributary canyons to the Santa Clara River, Figure 8 shows a good match between simulated and measured groundwater elevations at well VWC-W6 in San Francisquito Canyon through May 2002, when data collection ended at this well. In Bouquet Canyon, the simulated groundwater elevations are too high in production well SCWC-Clark beginning in 1997, but agree more closely with observations at well 7066D, located farther downstream in the canyon. Farther east, well 7188A in Sand Canyon shows agreement between simulated and measured groundwater elevations and elevation trends.

In the Saugus Formation, the target wells are located along the South Fork Santa Clara River, as shown on Figure 3. Figure 9 shows the simulated and measured hydrographs for the Saugus Formation target wells. In general, the Regional Model simulates the trends in groundwater elevations quite well at each Saugus production and monitoring well. The trends (hydrograph slopes) are particularly close in the NCWD wellfield at observation well 5851 and NCWD production wells 10 through 13. Farther downgradient, the Regional Model tends to slightly over-predict groundwater elevations in the VWC and SCWC production wells (VWC-157, VWC-201, SCWC-Saugus1, and SCWC-Saugus2). However, the Regional Model closely simulates the groundwater elevation trends at each of these locations, which is the primary consideration for evaluating the quality of the transient calibration process in the Saugus Formation.

Simulated and Measured Flows in the Santa Clara River

Figure 10 compares the simulated and measured total flows of the Santa Clara River at the County Line gage. The figure contains both a linear and a semi-logarithmic plot to better illustrate how the simulated and measured flows compare during low-flow periods in the river. The figure shows that the Regional Model adequately replicates seasonal cycles of low and high river flows during the calibration update period (January 2000 through February 2005), as it did for the original calibration period (1980 through 1999), although seasonal low flows during the summer months are slightly over-predicted.

Figure 11 compares the model-simulated groundwater discharges to the river with the discharges that have been estimated from hydrograph separation techniques (see Section 2.6.2.5 of the model development report [CH2M HILL, 2004a]). Because of uncertainty in the amount of treated water that infiltrates the streambed, Figure 11 displays a range for the estimated values, varying according to how much treated Saugus WRP water is estimated to infiltrate to groundwater as it travels down the Santa Clara River. As with the analysis in the model development report, it was estimated that the infiltration could be negligible (blue line) and would be unlikely to exceed 75 percent of the Saugus WRP discharge (green line). As shown on Figure 11, the Regional Model predicts higher rates of

groundwater discharge during the driest months of the year than those estimated from the County Line gage data. However, the Regional Model simulated the predominantly low total river flow (Figure 10) and groundwater discharge (Figure 11) that occurred from mid-1998 through most of 2004. As discussed in the model development report, it is likely that differences between modeled and measured total river flows and measured versus estimated groundwater discharges result from uncertainties in both the Regional Model and the gage data at the County Line during periods of low river flows.

Water Budget

Table 11 summarizes the groundwater budget for each year of the 25-year transient model simulation period (1980 through 2004). Figures 12 and 13 show the annual groundwater recharge and groundwater discharge rates, respectively. Figure 14 shows the change in groundwater storage each year, and Figure 15 shows the cumulative change in groundwater storage during the simulation period. The plots show that groundwater recharge from rainfall and stream leakage were generally less during the calibration update period than during the mid-1980s and several years during the 1990s. Year-to-year fluctuations in groundwater discharge continued to be less variable than year-to-year fluctuations in groundwater recharge. The volume of groundwater in storage generally declined from mid-1998 through 2004 because of the below-normal rainfall that occurred during this period.

Conclusions

The Regional Model calibration was extended an additional 62 months (from January 2000 through February 2005) to update and test the model's calibration against an independent data set consisting of recently observed hydrologic and pumping conditions in the basin. Additionally, the simulation was repeated for the initial calibration period (January 1980 through December 1999) because of a change in the boundary condition at the east end of the basin in the Alluvial Aquifer.

Examination of groundwater elevation hydrographs for the Alluvial Aquifer and the Saugus Formation indicates that the Regional Model has a similar overall ability to simulate conditions during the calibration update period as for the preceding 20-year period to which it was originally calibrated. Specifically, the transient model simulates trends in groundwater elevations and Santa Clara River flows that are generally well matched with observed trends. In Soledad Canyon, where local droughts have sometimes affected the Upper Basin Water Purveyors' ability to pump groundwater from the Alluvial Aquifer, the Regional Model simulates the trends in groundwater elevations particularly well and does not over-predict groundwater elevations. In the Saugus Formation, the groundwater elevations and elevation trends are closely matched at most wells where data are available. Consequently, the process of updating the Regional Model's calibration for the most recent 5-year period has confirmed that the model is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies.

References

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Tables

TABLE 1

Annual Groundwater Pumping from the Alluvial Aquifer

Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NCWD	Castaic1	244	257	253	189	251	274	295	450	520	478	444	561	515	458	496	401	385	535	166	426	118	345	385	561	456
	Castaic2	124	48	0	0	0	0	380	535	324	678	0	0	0	477	518	380	327	268	257	331	289	166	0	123	403
	Castaic3	0	108	136	172	240	301	0	0	324	0	660	532	488	0	0	0	0	0	0	0	0	0	0	0	0
	Castaic4	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	95	57	6	7	100	47	56	80
	Pinetree1	346	326	355	242	148	273	8	0	2	152	0	47	16	247	154	79	64	89	227	403	245	164	0	0	0
	Pinetree2	58	84	209	112	154	113	206	309	351	348	31	0	283	326	218	165	70	0	0	0	0	0	0	0	0
	Pinetree3	398	527	225	432	753	655	719	756	758	672	801	724	682	450	607	595	624	812	716	505	494	566	544	525	643
	Pinetree4	0	0	0	0	3	28	234	77	4	0	0	0	10	19	232	55	333	510	338	5	355	300	5	0	0
NLF	161	317	370	271	223	314	220	170	0	0	0	120	82	401	753	791	0	0	0	0	123	328	496	485	2,021	1,834
	B10	0	0	0	0	0	0	0	0	0	0	0	291	1,225	452	1,406	894	1,045	930	1,244	1,155	1,446	1,240	534	344	589
	B11	186	217	159	133	184	138	60	0	0	127	445	311	0	136	51	127	151	30	250	212	87	205	232	271	338
	B5	1,218	1,423	1,041	858	1,208	772	1,178	1,002	1,481	1,928	1,893	1,880	860	989	1,950	1,921	1,649	1,756	1,273	1,748	2,008	1,680	2,280	1,582	2,166
	B6	858	1,002	733	604	850	543	946	788	165	96	137	263	615	283	808	1,359	1,421	1,602	1,572	2,133	870	1,312	2,175	1,766	1,356
	B7	0	0	0	0	0	0	60	0	0	127	0	0	400	180	581	373	56	286	176	444	461	474	584	402	71
	C	723	845	618	510	717	575	660	387	418	557	338	226	756	1,024	417	1,324	715	1,126	598	716	1,034	1,319	1,720	1,373	1,202
	C3	196	229	168	138	195	140	254	63	130	71	134	48	197	259	582	333	397	355	378	619	441	93	192	186	59
	C4	260	304	222	183	258	196	137	25	30	7	213	225	166	12	108	150	293	483	609	819	1,078	1,028	809	764	274
	C5	459	536	392	323	455	359	328	191	198	154	147	250	428	414	394	472	676	894	628	685	605	680	850	622	649
	C6	203	237	174	143	201	166	161	103	117	77	59	123	0	0	0	360	229	226	128	154	164	231	241	108	119
	C7	575	671	491	405	570	354	195	192	318	337	339	220	427	279	625	778	582	779	779	1,167	503	741	866	443	369
	C8	0	0	0	0	0	0	0	0	0	0	0	0	126	254	166	199	458	432	179	236	241	286	593	408	390
	E	2,067	2,416	1,767	1,457	2,051	3,342	1,842	1,180	812	624	965	498	1,325	1,513	1,022	1,366	2,542	1,949	1,522	2,506	2,084	1,691	16	28	0
	E2	174	203	149	123	173	138	103	0	0	251	1,284	830	560	584	555	115	669	525	426	138	125	141	55	14	463
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	138	0	0	0	0	0	0	0	0	0	0
	E4	1,011	1,181	864	712	1,003	639	716	83	566	392	553	284	376	16	0	381	140	339	80	281	66	0	0	0	0
	E5	0	0	0	0	0	0	0	0	0	0	0	0	65	274	0	142	514	598	42	0	47	172	679	537	284
	E7	0	0	0	0	0	0	0	0	0	0	0	0	116	80	105	88	79	2	0	0	0	0	0	0	0
	E9	96	113	82	68	96	78	117	288	476	411	339	596	252	187	435	319	12	142	170	42	38	238	814	47	609
	G45	324	378	277	228	321	179	153	98	123	99	143	146	165	82	144	137	159	180	144	231	197	291	283	60	0
	Q	441	515	377	311	438	159	360	382	312	185	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	159	186	136	112	158	71	104	47	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	293	342	250	206	290	95	0	958	0	0	503	0	0	0	0	0	0	0	0	276	237	0	0	0	0
	S3	655	765	560	461	649	327	124	0	0	0	29	37	52	99	87	109	97	55	10	3	0	0	0	0	0
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0
	Topco 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W4	303	354	259	213	300	138	60	1	0	300	157	252	1	0	36	5	128	29	20	3	0	46	1	0	0
	W5	553	646	472	389	548	191	315	205	308	192	0	175	0	0	0	0	0	0	0	21	17	276	104	23	0
	X3	260	304	222	183	258	508	244	314	497	308	412	215	350	135	205	222	8	108	22	112	10	12	0	0	6
SCWC	Clark	303	228	131	137	194	200	208	342	248	301	407	542	662	635	572	662	1,027	873	697	878	747	696	782	712	728
	Guida	1,058	795	457	477	677	698	221	569	158	530	676	801	978	895	942	744	1,252	1,479	1,274	1,556	853	1,047	1,320	1,230	1,432
	Honby	594	447	257	268	381	392	193	391	462	216	930	893	731	1,393	476	553	352	814	532	1,162	815	721	696	874	707
	Lost Canyon 2	1,083	814	468	489	693	714	765	923	787	588	601	404	465	692	669	773	678	792	757	946	708	741	730	644	785
	Lost Canyon 2A	0	0	0	0	0	0	0	0	0	0	293	832	1,284	1,080	1,383	1,230	1,370	1,055	973	890	998	1,034	905	593	756
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell	1,189	893	515	537	761	785	444	582	485	435	264	3	474	663	564	610	598	633	482	913	439	407	293	19	54
	N.Oaks Central	488	367	211	220	313	322	304	361	153	329	525	704	701	1,403	1,313	965	851	870	1,490	1,682	1,145	822	1,646	1,641	669
	N.Oaks East	601	451	260	271	385	396	863	972	776	914	454	194	588	1,233	1,473	1,295	900	1,033	1,407	695	1,483	1,234	448	485	595
	N.Oaks West	643	483	278	290	412	424	874	465	842	413	275	78	634	866	972	795	663	952	934	1,894	1,663	898	1,123	31	858
	Sand Canyon	721	542	312	325	461	477	514	466	498	1,115	458	49	661	918	781	842	1,211	1,533	1,622	1,629	1,317	930	705	195	562
	Sierra	2,780	2,089	1,202	1,255	1,780	1,834	856	220	459	730	772	719	1,050	1,413	1,433	1,092	1,034	597	814	1,158	640	846	87	0	0
	Stadium	0	0	0	0	0	0	167	291	211	214	328	374	60	825	418	656	509	637	444	338	721	565	778	0	0

TABLE 1
Annual Groundwater Pumping from the Alluvial Aquifer
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
VWC	D	289	269	164	163	240	41	0	305	588	614	510	680	239	173	494	403	454	1,134	1,209	921	880	646	772	687	833
	I	214	200	122	121	177	181	95	0	91	132	73	108	1	0	1	0	0	0	0	0	0	0	0	0	0
	K2	0	0	0	0	0	0	0	0	0	0	0	982	1,134	1,708	2,089	1,155	1,305	1,076	1,489	1,420	861	669	954	364	0
	L2	9	8	5	5	7	91	0	0	0	0	0	838	526	996	1,236	818	961	308	190	532	494	349	490	71	0
	N	1,475	1,376	840	833	1,223	1,093	1,472	1,420	1,473	1,177	792	976	697	66	0	24	263	808	768	1,036	935	591	700	622	587
	N3	0	0	0	0	0	0	0	0	0	0	0	10	999	1,536	29	943	1,325	1,034	1,093	1,057	778	226	857	255	0
	N4	5	5	3	3	4	65	0	0	0	0	0	847	248	133	911	1,329	1,328	1,185	772	894	710	458	909	248	0
	N7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q2	440	411	251	248	367	461	838	893	512	1,483	1,398	1,783	335	548	1,348	1,126	1,385	1,462	1,655	1,288	1,387	923	1,167	1,451	1,096
	S6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	515	1,490	1,320	2,134	2,301
	S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111	564	419	1,095	471
	S8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79	327	190	409	153
	T2	621	580	354	351	515	704	894	913	1,007	1,030	643	662	379	0	3	280	733	837	941	726	984	700	696	1,014	822
	T4	160	150	91	91	133	54	167	0	0	0	0	163	687	3	1	975	1,258	804	523	892	625	690	831	799	747
	U3	1,476	1,378	841	834	1,225	1,278	1,033	638	323	823	1,254	1,199	369	1	2	765	987	851	560	702	1,126	956	572	823	0
	U4	1,306	1,220	744	738	1,084	665	668	606	696	567	551	584	42	3	2	7	742	789	529	828	1,073	942	796	934	625
	W6	0	0	0	0	0	0	0	146	145	0	0	217	260	204	224	365	615	493	355	416	445	182	0	0	0
	W9	0	0	0	0	0	0	0	0	0	0	11	902	699	444	507	508	1,077	915	627	1,111	1,176	806	939	764	566
	W10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	1,537
	W11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123
WHR	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,229	1,376	772	1,104	1,204	1,352	760	614	1,229	1,131	1,010	1,000	1,000	1,000	2,000
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	137	137	137	137	137	137	137	137	137	137	91	102	57	82	89	100	56	46	91	84	75	74	72	173	74
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	680	762	427	612	666	748	421	340	680	627	559	530	530	1,100	1,031
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pumping (NCWD)		1,170	1,350	1,178	1,147	1,549	1,644	1,842	2,127	2,283	2,367	1,936	1,864	1,994	1,977	2,225	1,675	1,803	2,309	1,761	1,676	1,508	1,641	981	1,265	1,582
Total Pumping (SCWC)		9,460	7,109	4,091	4,269	6,057	6,242	5,409	5,582	5,079	5,785	5,983	5,593	8,288	12,016	10,996	10,217	10,445	11,268	11,426	13,741	11,529	9,941	9,513	6,424	7,146
Total Pumping (VWC)		5,995	5,597	3,415	3,387	4,975	4,633	5,167	4,921	4,835	5,826	5,232	9,951	6,615	5,815	6,847	8,698	12,433	11,696	10,711	11,823	12,179	10,519	11,612	11,706	9,861
Total Pumping (All Purveyors)		16,625	14,056	8,684	8,803	12,581	12,519	12,418	12,630	12,197	13,978	13,151	17,408	16,897	19,808	20,068	20,590	24,681	25,273	23,898	27,240	25,216	22,101	22,106	19,395	18,589
Total Pumping (NLF)		11,331	13,237	9,684	7,983	11,237	9,328	8,287	6,512	5,951	6,243	8,225	7,039	8,938	8,020	10,606	11,174	12,020	12,826	10,250	13,824	12,087	12,652	13,513	10,999	10,778
Total Pumping (WHR)		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,240	1,256	1,798	1,959	2,200	1,237	1,000	2,000	1,842	1,644	1,604	1,602	2,273	3,105
Total Pumping (Others)		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	932	932	932	932	953	890	909	1,071
Total Alluvial Aquifer Pumping		31,456	30,793	21,868	20,286	27,318	25,347	24,205	22,642	21,648	23,721	23,876	27,187	27,591	30,126	33,133	34,464	38,438	40,031	37,080	43,838	39,879	37,310	38,111	33,576	33,543

Notes:

All pumping volumes are listed in acre-feet and are from records maintained by the Upper Basin Water Purveyors.

N. = north

WHR = Wayside Honor Rancho, owned by the Los Angeles County Waterworks District

TABLE 2

Annual Groundwater Pumping from the Saugus Formation

Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NCWD	7	404	396	350	348	355	384	271	260	332	242	242	274	180	268	321	364	332	288	280	172	0	0	0	0	0
	4	440	449	319	385	315	369	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	119	227	115	138	1	0	5	1	1	0	4	1	1	0	1	0	0	0	0	0	0
	10	790	906	1,287	1,300	1,007	997	731	888	613	453	644	343	351	61	0	1	0	0	2	0	0	0	0	0	0
	11	729	870	716	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	1,830	2,713	2,603	3,342	2,807	1,956	1,918	2,264	2,140	1,798	1,909	1,155	1,767	1,242	1,758	1,013	1,833
	13	0	0	0	0	0	0	0	0	0	0	0	0	1,393	2,053	2,246	1,623	2,045	3,001	2,351	1,295	419	1,190	1,637	1,500	1,906
NLF	156	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374	300	211	122	268
SCWC	Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0	0	0	0	0
	Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0	0	0	0	0
VWC	157	635	604	529	239	387	314	581	483	1,223	1,146	635	1,005	570	436	616	403	46	80	0	0	0	0	0	0	0
	159	0	0	0	0	0	0	0	0	0	0	3	63	65	74	147	68	3	0	0	0	0	91	0	30	9
	160	1,571	1,725	368	372	467	571	846	822	1,077	1,326	839	1,325	580	920	957	585	206	401	133	95	1,332	707	347	864	1,526
	201	0	0	0	0	0	0	0	0	0	57	2,039	2,249	1,170	752	845	530	71	35	16	11	295	128	495	168	148
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	0	123	511	813
	206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pumping (NCWD)		2,363	2,621	2,672	2,787	2,955	3,255	3,548	3,657	4,041	4,688	4,746	4,994	5,160	5,068	5,103	4,775	4,871	5,168	4,557	2,622	2,186	2,432	3,395	2,513	3,739
Total Pumping (SCWC)		0	0	0	0	0	0	0	0	63	0	40	4,781	2,913	2,901	3,863	1,726	2,176	1,068	0	0	0	0	0	0	0
Total Pumping (VWC)		2,206	2,329	897	611	854	885	1,427	1,305	2,300	2,529	3,516	4,642	2,385	2,182	2,565	1,586	326	516	149	106	1,728	926	965	1,573	2,496
Total Pumping (All Purveyors)		4,569	4,950	3,569	3,398	3,809	4,140	4,975	4,962	6,404	7,217	8,302	14,417	10,458	10,151	11,531	8,087	7,373	6,752	4,706	2,728	3,914	3,358	4,360	4,086	6,235
Total Pumping (NLF)		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374	300	211	122	268
Total Pumping (Others)		0	0	501	434	620	555	490	579	504	522	539	480	446	439	474	453	547	548	423	509	513	513	513	513	513
Total Saugus Formation Pumping		4,589	4,970	4,090	3,852	4,449	4,715	5,485	5,561	6,928	7,759	8,861	14,917	10,924	10,610	12,025	8,560	8,186	7,745	5,555	3,716	4,801	4,171	5,084	4,721	7,016

Note:

All pumping volumes are listed in acre-feet and are from records maintained by the Upper Basin Water Purveyors.

TABLE 3

Allocation of Pumping, by Month, for Agricultural and Urban Production Wells

Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Month	% of Annual Water Use, Agricultural	% of Annual Water Use, Urban	% of May through October Water Use, Urban
January	3.8	5.2	
February	5.1	3.7	
March	6.6	5.2	
April	9.1	6.6	
May	10.6	8.7	13.2
June	11.4	10.4	15.8
July	14.1	13.0	19.7
August	12.9	13.6	20.6
September	10.2	10.9	16.5
October	7.5	9.3	14.1
November	5.0	7.1	
December	3.8	6.3	
Total	**100.0**	**100.0**	**100.0**

TABLE 4
Monthly Precipitation Measured at the Newhall County Water District Rain Gage
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
2000	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
2001	5.84	10.76	3.38	2.56	0.00	0.00	0.00	0.00	0.00	0.22	3.18	1.30	27.24
2002	1.55	0.51	0.38	0.05	0.12	0.01	0.00	0.00	0.02	0.00	3.01	5.85	11.50
2003	0.00	9.03	2.38	2.35	1.70	0.00	0.02	0.00	0.00	1.10	0.63	2.57	19.78
2004	0.65	8.07	0.37	0.20	0.00	0.00	0.00	0.00	0.00	4.79	0.64	8.54	23.26
2005	17.06	16.69											

Note:

All precipitation values are measured in inches.

TABLE 5
Monthly Streamflows Measured in the Santa Clara River at the Lang Gage
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
1981	594	98	339	240	107	18	18	12	338	321	258	394	2,739
1982	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
1983	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
1984	0	596	405	240	143	166	228	411	154	220	904	578	4,044
1985	483	461	274	215	77	0	0	0	12	179	221	301	2,224
1986	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
1987	117	117	65	31	12	0	0	0	0	0	258	516	1,116
1988	222	209	506	117	77	68	0	0	0	0	12	25	1,236
1989	50	111	60	25	6	0	0	0	102	94	***34***	***18***	***499***
1990	***212***	***276***	***230***	***46***	***46***	***5***	***0***	***0***	***0***	***27***	***36***	***147***	***1,025***
1991	***162***	***775***	***879***	***736***	***145***	***142***	***14***	***0***	***45***	***69***	***62***	***263***	***3,291***
1992	***336***	***534***	***429***	***398***	***117***	***84***	***16***	***5***	***108***	***144***	***498***	***1,446***	***4,115***
1993	***14,709***	***5,336***	***1,194***	***530***	***239***	***110***	***54***	***10***	***64***	***145***	***264***	***281***	***22,937***
1994	***388***	***493***	***497***	***319***	***163***	***80***	***20***	***7***	***37***	***102***	***193***	***941***	***3,239***
1995	***1,211***	***1,421***	***954***	***802***	***268***	***156***	***62***	***8***	***6***	***1***	***27***	***189***	***5,104***
1996	***666***	***896***	***730***	***315***	***151***	***46***	***7***	***0***	***54***	***154***	***307***	***510***	***3,836***
1997	***517***	***346***	***140***	***85***	***33***	***5***	***4***	***50***	***66***	***240***	***566***	***809***	***2,859***
1998	***18,997***	***8,508***	***3,837***	***961***	***667***	***347***	***81***	***91***	***70***	***139***	***190***	***186***	***34,074***
1999	***92***	***85***	***204***	***224***	***197***	***107***	***80***	***46***	***52***	***54***	***31***	***80***	***1,252***
2000	***117***	***117***	***65***	***31***	***12***	***0***	***0***	***0***	***0***	***0***	***258***	***516***	***1,116***
2001	***333***	***1,420***	***785***	***283***	***238***	***0***	***0***	***0***	***0***	***95***	***178***	***855***	***4187***
2002	***50***	***111***	***60***	***25***	***6***	***0***	***0***	***0***	***102***	***94***	***34***	***18***	***500***
2003	***666***	***896***	***730***	***315***	109	0	0	0	0	0	0	0	2,716
2004	0	30	0	0	0	0	0	0	0	23	0	1,849	1,902
2005	***26,052***	***20,243***											

Note:

All monthly streamflows are measured in acre-feet. Values in bold italicized font are estimated from regression techniques, because (1) the Lang gage was out of service from November 1989 through April 2003 and (2) the gage was flooded during several days in January 2005 and February 2005.

TABLE 6
Monthly Treated Water Discharge Measured at the Valencia Water Reclamation Plant
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	266	258	257	239	247	212	219	219	212	228	239	247	2,844
1981	248	220	249	235	244	237	253	255	248	263	285	270	3,006
1982	275	247	284	271	277	269	275	268	254	266	271	284	3,241
1983	286	261	301	288	296	277	287	296	282	286	276	295	3,432
1984	303	281	304	294	321	315	320	317	314	322	315	319	3,723
1985	309	283	316	316	333	331	354	359	348	361	357	341	4,006
1986	350	341	374	359	377	380	415	454	446	440	421	445	4,801
1987	455	415	472	489	550	567	603	594	579	633	600	624	6,582
1988	622	557	588	587	603	537	575	606	587	608	600	602	7,072
1989	622	593	695	666	671	708	714	731	668	678	673	676	8,095
1990	698	644	725	695	666	693	725	714	692	700	658	680	8,290
1991	715	662	702	627	668	646	647	691	709	743	717	748	8,276
1992	777	777	819	813	824	800	853	869	818	828	811	786	9,775
1993	778	733	863	858	869	925	910	846	816	834	818	858	10,107
1994	722	729	809	776	802	761	771	764	739	763	735	760	9,132
1995	889	777	935	887	884	848	853	814	826	834	823	855	10,225
1996	893	838	935	890	902	876	903	891	886	817	810	816	10,456
1997	815	713	866	829	852	879	860	851	824	826	778	775	9,867
1998	778	787	955	955	984	965	1,136	1,139	1,020	993	911	906	11,529
1999	930	868	962	953	985	968	1,003	1,018	961	1,020	1,040	987	11,695
2000	1,010	956	1,027	1,015	1,066	1,076	1,149	1,140	1,009	1,076	1,033	1,011	12,568
2001	964	916	1,044	1,013	1,082	1,049	1,120	1,105	1,059	1,107	1,053	1,064	12,576
2002	1,107	1,001	1,120	1,100	1,186	1,164	1,211	1,246	1,213	1,200	1,141	1,154	13,843
2003	1,159	1,083	1,205	1,311	1,367	1,339	1,416	1,423	1,374	1,346	1,316	1,321	15,660
2004	1,315	1,263	1,345	1,296	1,343	1,331	1,371	1,414	1,284	1,416	1,371	1,397	16,146
2005	1,519	1,468											

Note:

All monthly releases are measured in acre-feet.

TABLE 7
Monthly Treated Water Discharge Measured at the Saugus Water Reclamation Plant
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	362	365	419	414	419	387	362	362	350	362	359	371	4,529
1981	382	337	390	398	444	412	417	429	431	434	412	460	4,945
1982	445	399	456	444	446	434	434	421	415	434	431	438	5,196
1983	460	421	514	541	562	545	520	477	458	481	477	534	5,990
1984	558	505	499	485	476	443	458	456	451	467	474	519	5,791
1985	503	461	505	458	448	444	452	459	452	470	460	498	5,610
1986	498	475	528	501	499	483	481	476	500	511	518	552	6,023
1987	524	475	542	487	425	383	391	403	395	397	411	430	5,264
1988	443	411	439	434	440	430	445	457	435	464	436	460	5,294
1989	462	410	441	450	464	436	476	479	462	471	451	466	5,468
1990	463	403	432	426	483	492	513	504	489	493	508	512	5,718
1991	495	423	479	427	491	516	557	525	486	474	470	493	5,835
1992	488	507	530	472	489	476	493	521	492	498	452	514	5,931
1993	595	534	616	581	615	587	622	604	578	609	567	567	7,075
1994	601	606	694	677	687	644	642	645	619	663	655	685	7,817
1995	657	578	676	705	699	631	641	635	617	613	568	581	7,602
1996	532	504	525	501	517	506	511	525	532	579	558	583	6,375
1997	564	516	515	461	469	417	442	474	475	503	521	553	5,911
1998	529	541	544	511	617	587	426	399	457	501	521	533	6,166
1999	542	485	551	391	544	512	547	532	521	527	487	514	6,153
2000	493	487	501	490	503	467	457	509	585	555	514	596	6,157
2001	592	531	572	510	500	490	485	519	510	527	553	560	6,349
2002	520	459	518	493	491	526	564	551	518	552	556	567	6,315
2003	551	500	528	343	352	332	328	335	325	326	325	352	4,597
2004	360	360	384	373	376	362	378	374	397	406	371	396	4,537
2005	409	359											

Note:

All monthly discharges are measured in acre-feet.

TABLE 8
Monthly Releases of Water from Castaic Lagoon to Castaic Creek
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
1981	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1982	0	0	0	0	0	667	842	735	0	0	0	0	2,244
1983	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1987	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
1988	0	0	809	341	900	0	0	0	0	0	0	0	2,050
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	66	66
1992	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
1993	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
1994	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
1995	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
1996	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
1997	0	0	8701	873	0	0	0	0	0	0	0	310	9,884
1998	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
1999	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
2000	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
2001	0	389	1,218	0	0	0	0	0	0	0	0	0	1,607
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	2,286	418	315	0	0	0	0	0	0	3,019
2004	0	59	1,004	0	0	0	0	0	0	0	0	60	1,123
2005	32,391	37,514											

Note:

All monthly releases are measured in acre-feet.

TABLE 9

Monthly Streamflows Measured in the Santa Clara River at the County Line Gage

Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	8,428	43,565	18,125	8,551	3,792	3,963	1,202	1,111	1,668	1,470	1,452	1,884	95,211
1981	3,376	1,533	5,415	1,815	1,662	1,279	942	906	1,139	1,488	2,138	2,539	24,232
1982	2,826	2,358	5,572	7,091	3,909	1,749	1,694	1,392	1,597	1,621	3,449	3,229	36,488
1983	7,787	9,122	67,712	11,240	10,320	3,828	2,102	2,678	2,053	3,443	5,040	5,911	131,236
1984	5,691	3,931	4,084	4,530	2,309	1,607	1,224	1,511	1,464	1,624	3,237	8,067	39,279
1985	3,116	2,561	2,852	1,974	1,694	1,365	1,178	1,365	1,551	1,880	2,102	2,828	24,466
1986	3,955	13,991	10,616	3,328	2,612	1,622	1,454	1,482	1,870	1,896	2,606	2,590	48,024
1987	2,485	2,325	2,575	1,841	1,908	1,710	1,650	1,470	1,412	2,309	2,057	4,457	26,198
1988	3,421	2,981	3,025	3,172	2,636	2,231	1,734	1,494	1,605	1,904	2,027	10,381	36,611
1989	2,644	3,340	2,584	2,055	1,740	1,920	1,732	1,345	1,535	2,146	1,964	1,795	24,799
1990	2,709	3,247	2,269	1,898	1,730	1,545	1,478	1,751	1,668	1,660	1,924	1,593	23,472
1991	2,051	3,219	15,981	1,837	1,519	1,113	1,144	831	912	948	1,014	4,332	34,901
1992	3,737	37,636	9,576	4,439	1,964	1,533	1,377	1,085	1,129	1,329	1,496	3,277	68,577
1993	47,199	44,749	25,738	9,459	4,860	3,324	2,797	2,771	2,949	3,005	2,686	3,247	152,783
1994	3,281	3,437	3,501	3,533	3,519	2,200	1,640	1,400	1,192	1,855	2,263	4,219	32,039
1995	31,125	3,828	19,662	8,452	3,901	2,527	1,843	2,192	1,855	1,716	2,075	3,235	82,409
1996	3,604	10,669	7,678	6,073	3,584	1,678	1,640	1,579	1,509	2,625	1,590	5,701	47,930
1997	5,375	3,913	7,884	3,370	1,680	1,240	1,571	1,371	1,230	1,662	2,636	4,848	36,780
1998	5,875	104,388	25,377	9,378	34,992	5,312	3,935	3,537	2,579	2,450	2,890	4,427	205,139
1999	4,328	4,128	4,322	6,526	4,760	3,590	1,125	1,439	2,164	1,888	2,243	2,434	32,382
2000	2,470	12,210	6,400	2,910	3,610	5,250	1,890	1,490	1,560	1,950	1,890	2,290	43,920
2001	3,680	5,430	7,370	2,970	2,650	1,890	1,520	1,100	970	1,510	2,310	3,220	34,620
2002	2,980	2,060	2,610	2,390	1,730	1,680	1,600	772	1,010	1,440	2,490	4,330	25,092
2003	2,690	5,540	3,910	5,470	2,810	2,150	1,670	1,280	1,600	2,491	2,688	3,816	36,115
2004	4,046	7,204	4,262	2,003	1,851	1,853	1,339	1,646	1,438				
2005													

Note:

All monthly streamflows are measured in acre-feet. Because reported flows appear highly uncertain beginning in October 2004, they are not listed in this table.

TABLE 10
Estimated Annual Groundwater Discharge to the Santa Clara River
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Flow in Castaic Creek (acre-feet)	Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)
1980	16,785	95,211	57,593	7,372	50,221
1981	6,519	24,232	21,172	7,949	13,223
1982	9,102	36,488	32,531	8,436	24,095
1983	67,058	131,236	55,878	9,420	46,458
1984	13,787	39,279	35,215	9,512	25,703
1985	2,619	24,466	24,089	9,614	14,475
1986	4,945	48,024	31,327	10,822	20,505
1987	911	26,198	23,663	11,844	11,819
1988	2,415	36,611	24,934	12,363	12,571
1989	Unavailable	24,799	23,453	13,560	9,893
1990	0	23,472	21,772	14,006	7,766
1991	65	34,901	18,702	14,108	4,594
1992	4,450	68,577	23,601	15,703	7,898
1993	7,725	152,783	65,054	17,179	47,875
1994	Unavailable	32,039	31,239	16,946	14,293
1995	5,611	82,409	51,001	17,824	33,177
1996	5,632	47,930	36,366	16,831	19,535
1997	9,885	36,780	27,521	15,778	11,743
1998	47,803	205,139	81,744	17,695	64,049
1999	5,830	32,382	27,176	17,847	9,329
2000	7,007	43,920	30,131	18,721	11,410
2001	1,607	34,620	27,900	18,925	8,975
2002	0	25,092	23,243	20,158	3,085
2003	3,019	36,115	28,835	20,257	8,578
2004[a]					

[a]Annual volumes of groundwater discharge could not be calculated because of uncertainties in streamflow data at the County Line stream gage in late 2004.

TABLE 11

Annual Water Budgets Calculated by the Calibrated Regional Model for 1980 through 2004

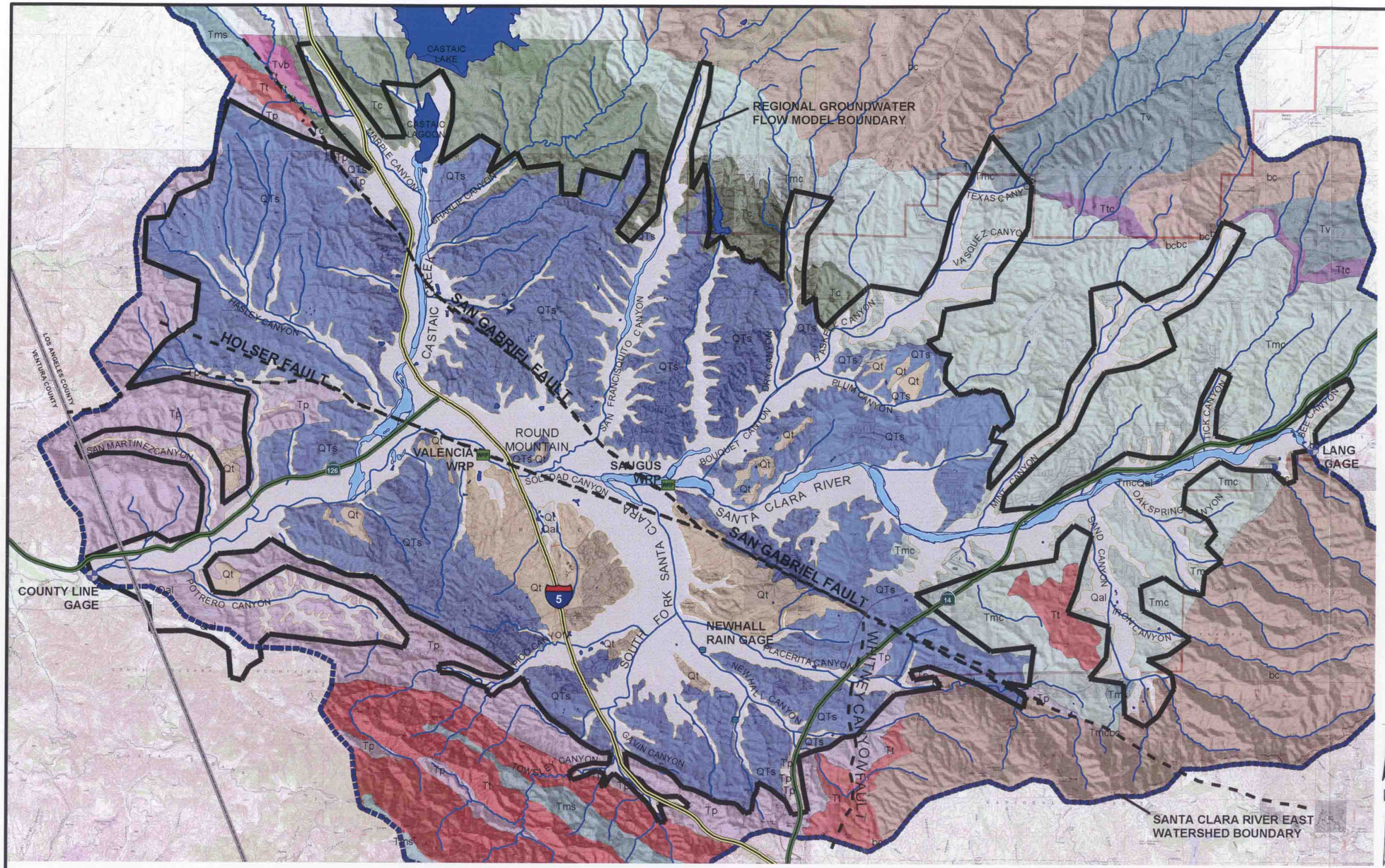
Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Castaic Dam Underflow	Subsurface Inflow from Acton Basin	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
1980 to 1981	35,608	3,375	46,386	1,705	16,122	103,197	35,542	32,667	16,722	18,362	103,293	-96	-96
1981 to 1982	9,454	3,871	15,958	1,700	16,513	47,497	35,209	22,673	10,589	18,115	86,586	-39,089	-39,185
1982 to 1983	46,064	3,022	46,009	1,700	16,279	113,073	24,918	26,469	13,072	18,367	82,827	30,247	-8,938
1983 to 1984	168,155	2,657	83,635	1,700	15,437	271,584	23,169	56,932	29,067	18,802	127,969	143,615	134,677
1984 to 1985	959	3,606	10,778	1,705	16,281	33,328	30,645	33,670	21,482	18,198	103,995	-70,667	64,010
1985 to 1986	0	3,279	9,123	1,700	16,607	30,709	28,963	25,845	11,466	18,059	84,333	-53,624	10,386
1986 to 1987	37,673	3,211	36,076	1,700	16,398	95,057	28,658	28,066	13,770	18,335	88,828	6,229	16,615
1987 to 1988	9,288	2,991	12,575	1,700	16,947	43,501	27,085	24,232	9,896	18,115	79,327	-35,826	-19,211
1988 to 1989	23,720	3,075	23,369	1,705	16,892	68,761	27,571	23,426	10,431	18,315	79,743	-10,982	-30,193
1989 to 1990	0	3,393	7,925	1,700	17,340	30,358	30,415	20,932	7,499	18,125	76,970	-46,612	-76,805
1990 to 1991	0	3,787	9,073	1,700	17,592	32,152	31,652	18,242	5,055	18,141	73,090	-40,937	-117,742
1991 to 1992	45,055	3,397	36,390	1,700	16,884	103,427	41,067	19,864	7,434	18,238	86,603	16,824	-100,918
1992 to 1993	119,272	3,850	67,935	1,705	16,009	208,772	37,567	30,452	15,003	18,558	101,580	107,192	6,274
1993 to 1994	102,692	3,773	61,563	1,700	15,751	185,479	39,741	45,991	24,538	18,564	128,834	56,645	62,919
1994 to 1995	554	4,415	12,629	1,700	16,466	35,763	44,120	22,265	13,478	18,072	97,935	-62,172	747
1995 to 1996	103,734	4,517	61,628	1,700	15,935	187,514	42,009	38,348	21,081	18,567	120,006	67,507	68,254
1996 to 1997	40,468	5,205	37,922	1,705	16,303	101,602	45,574	26,784	17,501	18,474	108,334	-6,732	61,523
1997 to 1998	14,265	5,267	20,537	1,700	16,547	58,316	47,051	21,205	13,598	18,237	100,091	-41,775	19,748
1998 to 1999	126,481	4,758	86,384	1,700	15,692	235,014	42,043	45,379	26,261	18,678	132,360	102,654	122,402
1999 to 2000	4	5,343	13,716	1,700	16,446	37,209	46,867	24,011	15,442	18,101	104,420	-67,211	55,191
2000 to 2001	692	5,343	17,472	1,705	17,158	42,369	43,664	19,733	10,284	18,247	91,927	-49,558	5,633
2001 to 2002	57,816	5,343	51,538	1,700	16,359	132,755	40,406	23,390	14,233	18,410	96,439	36,317	41,950
2002 to 2003	305	5,343	9,900	1,700	16,969	34,216	42,120	17,517	9,380	18,128	87,144	-52,928	-10,979
2003 to 2004	22,496	5,343	24,812	1,700	17,072	71,423	37,229	19,022	9,214	18,369	83,834	-12,411	-23,390
2004 to 2005	38,619	5,343	38,288	1,705	17,449	101,403	39,545	19,319	10,125	18,523	87,512	13,891	-9,499
Minimum	0	2,657	7,925	1,700	15,437	30,358	23,169	17,517	5,055	18,059	73,090	-70,667	-117,742
Maximum	168,155	5,343	86,384	1,705	17,592	271,584	47,051	56,932	29,067	18,802	132,360	143,615	134,677
Average	40,135	4,140	33,665	1,701	16,538	96,179	36,513	27,457	14,265	18,324	96,559	-380	9,335
Median	23,720	3,850	24,812	1,700	16,466	71,423	37,567	24,011	13,478	18,315	91,927	-10,982	5,633

Note:

All flow volumes are listed in AF/yr.

Figures



LEGEND

GEOLOGY

- UNDIFFERENTIATED ALLUVIUM (Qal)
- TERRACE DEPOSITS (Qt)
- SAUGUS FORMATION (QTs)
- PICO FORMATION (Tp)
- TOWSLEY FORMATION (Tt)
- MODELO FORMATION (Tms)
- CASTAIC FORMATION (Tc)
- VIOLIN BRECCIA (Tvb)
- MINT CANYON FORMATION (Tmc)
- TICK CANYON FORMATION (Ttc)
- VASQUEZ FORMATION (Tv)
- UNDIFFERENTIATED BASEMENT COMPLEX (bc)

HYDROGRAPHY

- LAKE
- STREAM
- STREAM GAGE

MAJOR ROAD

- INTERSTATE
- STATE HIGHWAY

FIGURE 1
BASIN GEOLOGIC MAP
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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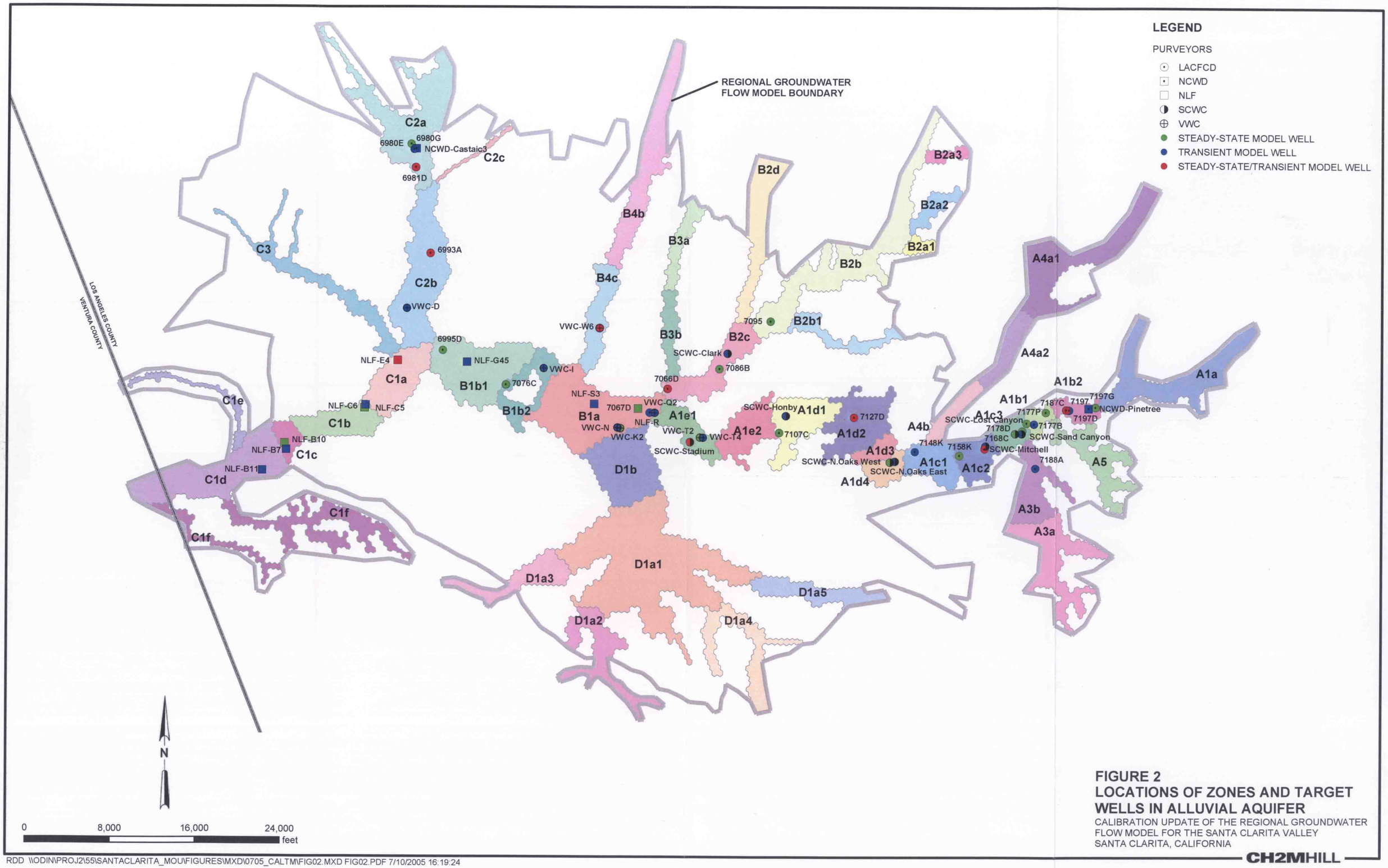

FIGURE 2
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\0705_CALTM\FIG02.MXD FIG02.PDF 7/10/2005 16:19:24

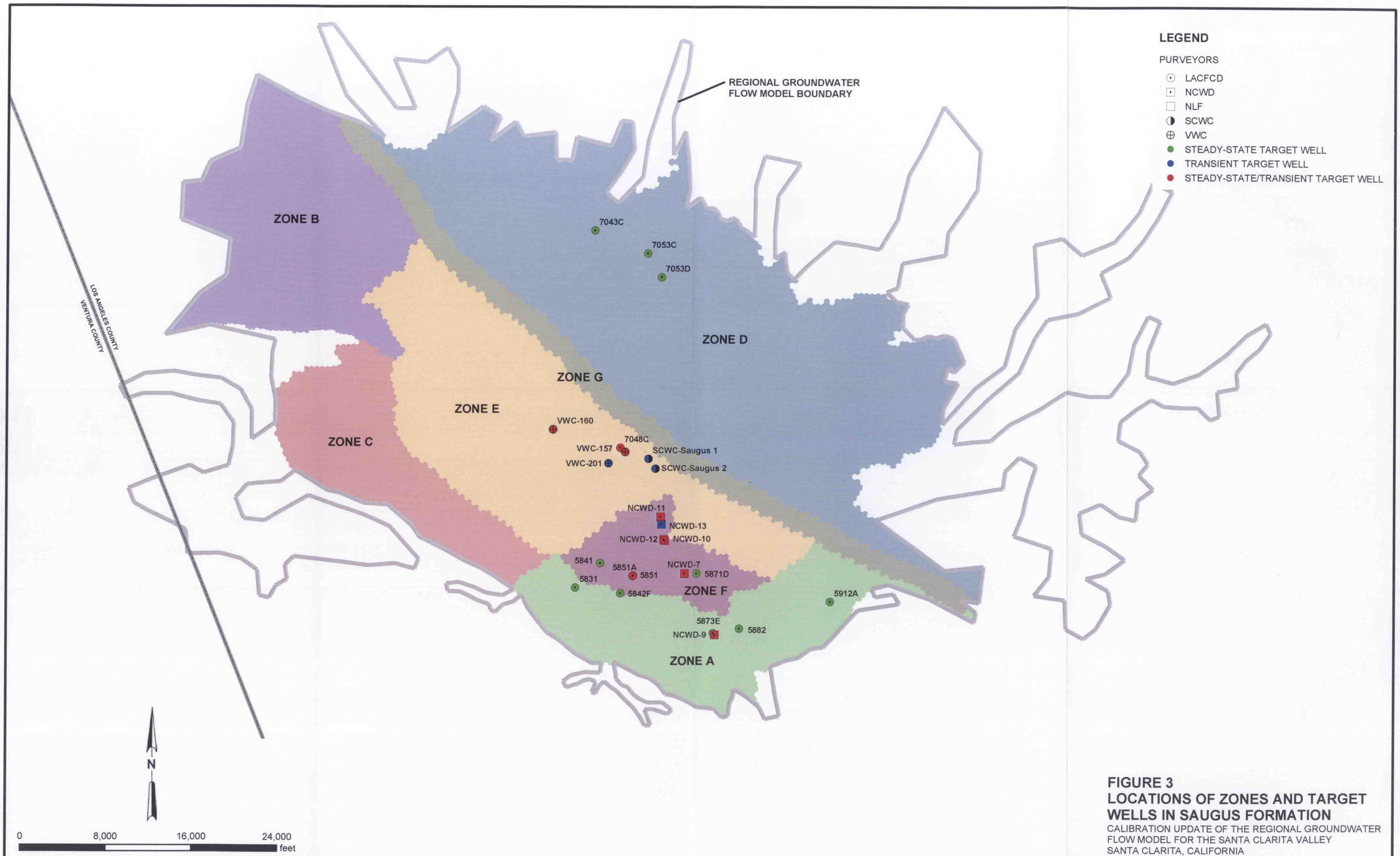

FIGURE 3
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\0705_CALTM\FIG03.MXD FIG03.PDF 7/10/2005 16:23:06

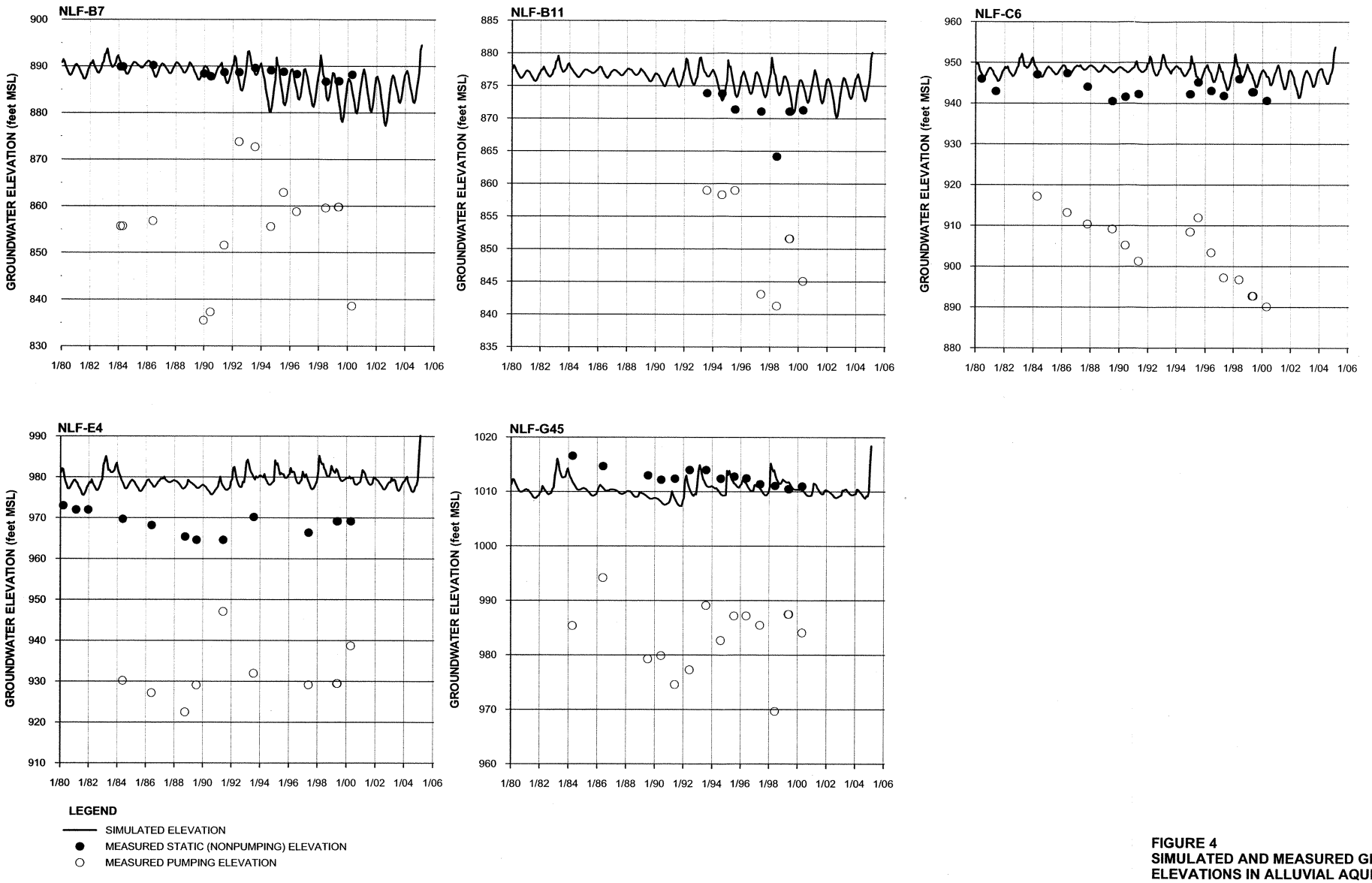

FIGURE 4
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS WEST OF INTERSTATE 5
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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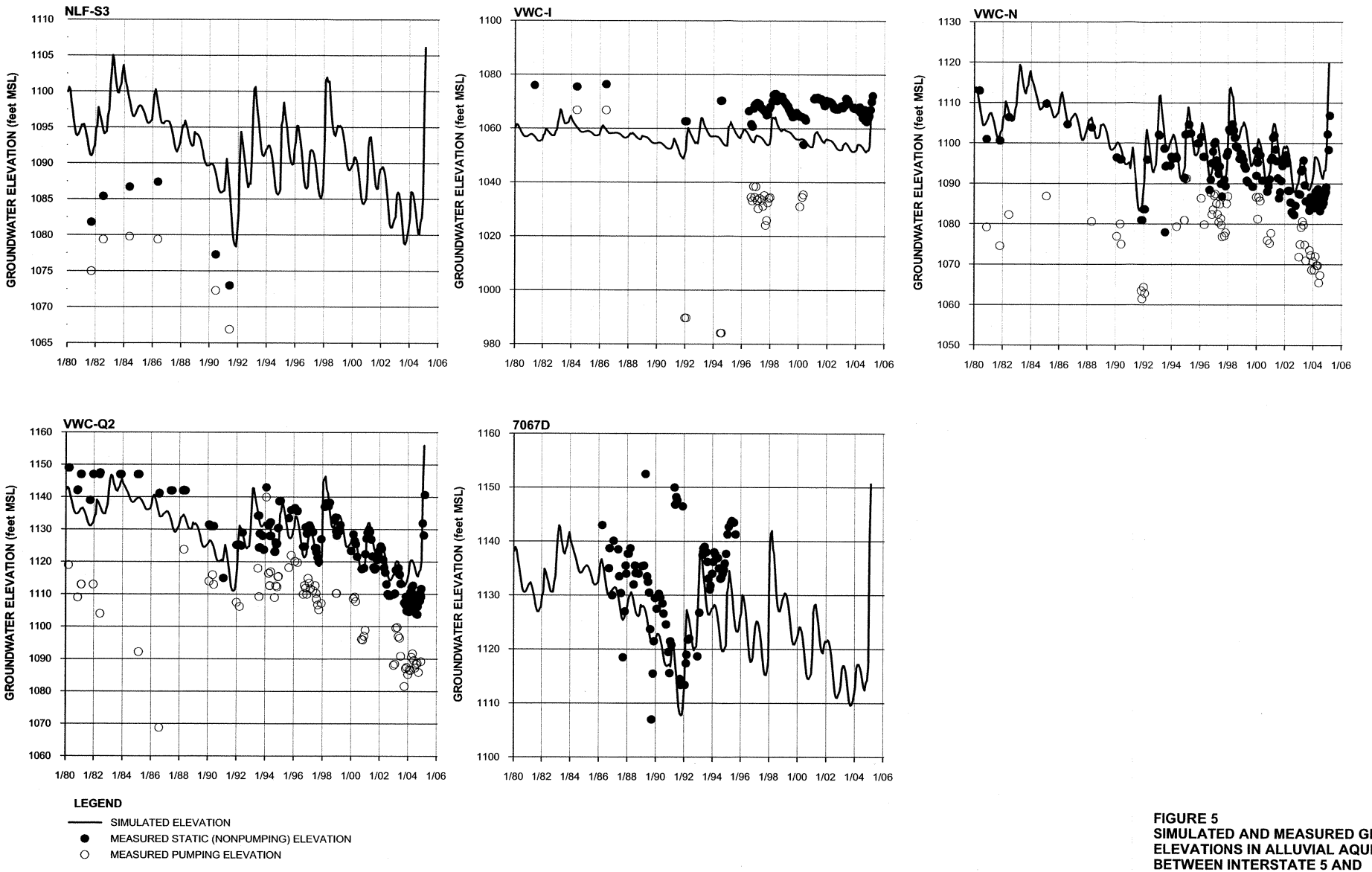

FIGURE 5
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS BETWEEN INTERSTATE 5 AND SOLEDAD CANYON
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

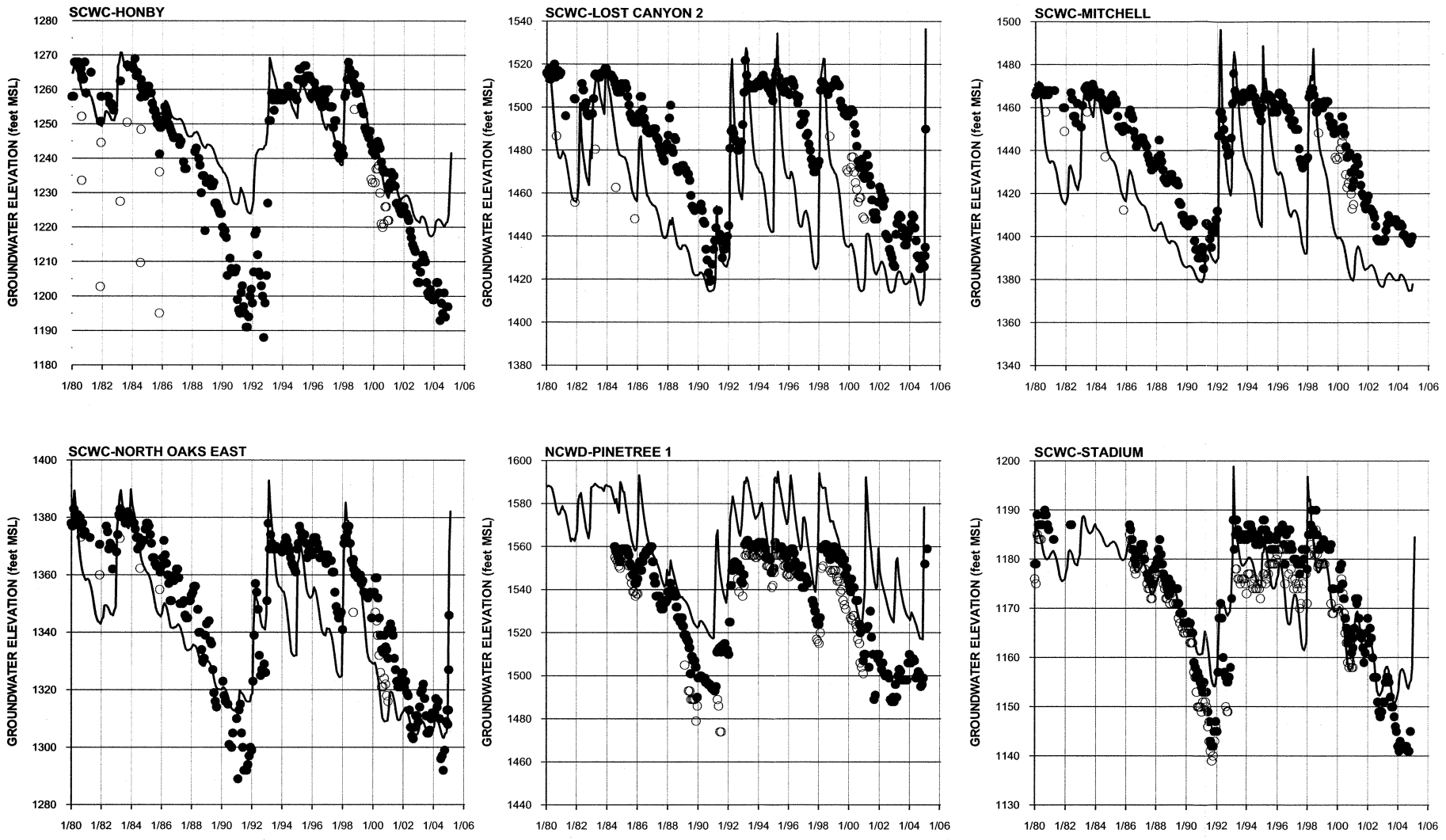

FIGURE 6
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 1 OF 2)
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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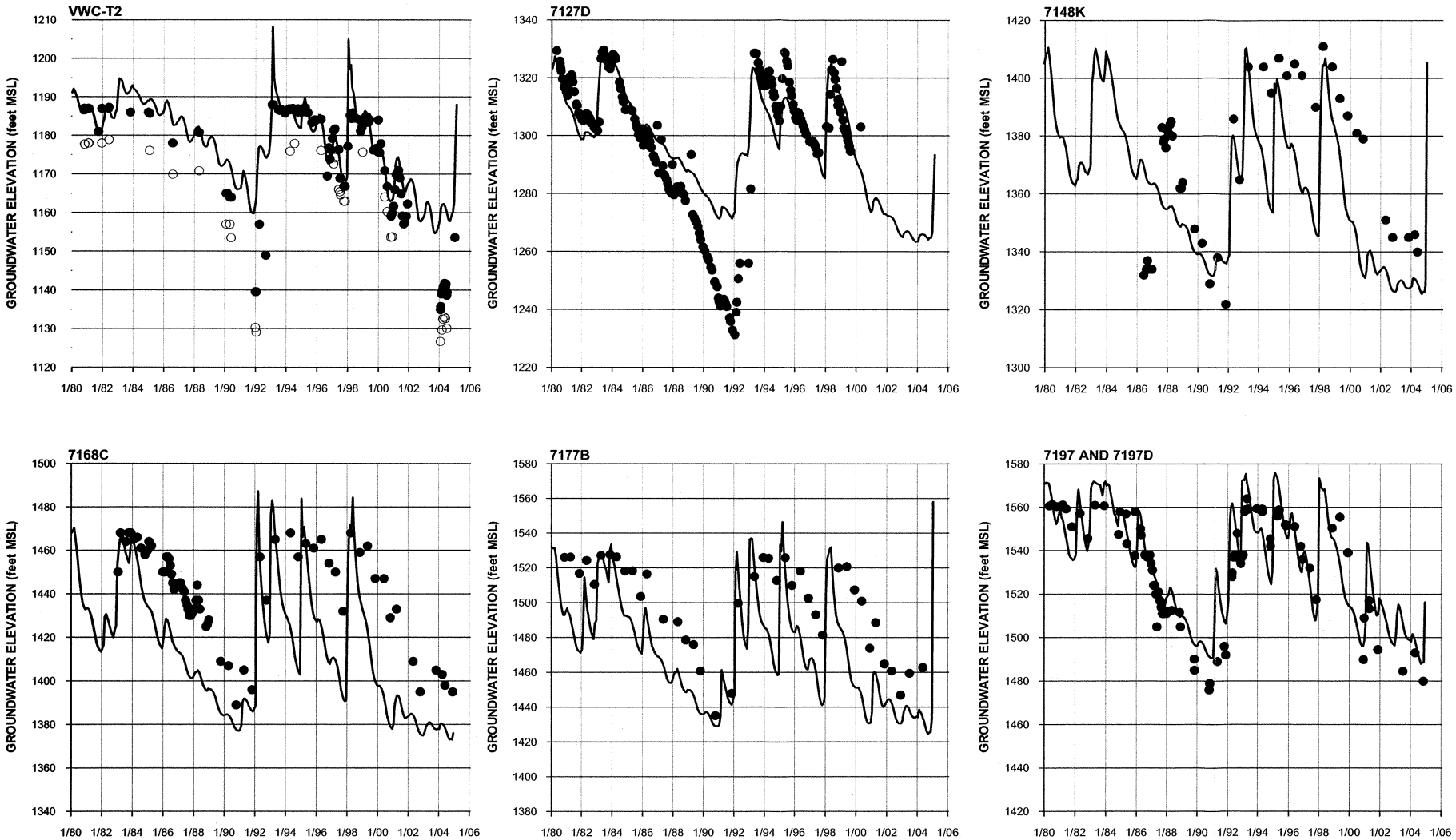

FIGURE 6
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 2 OF 2)
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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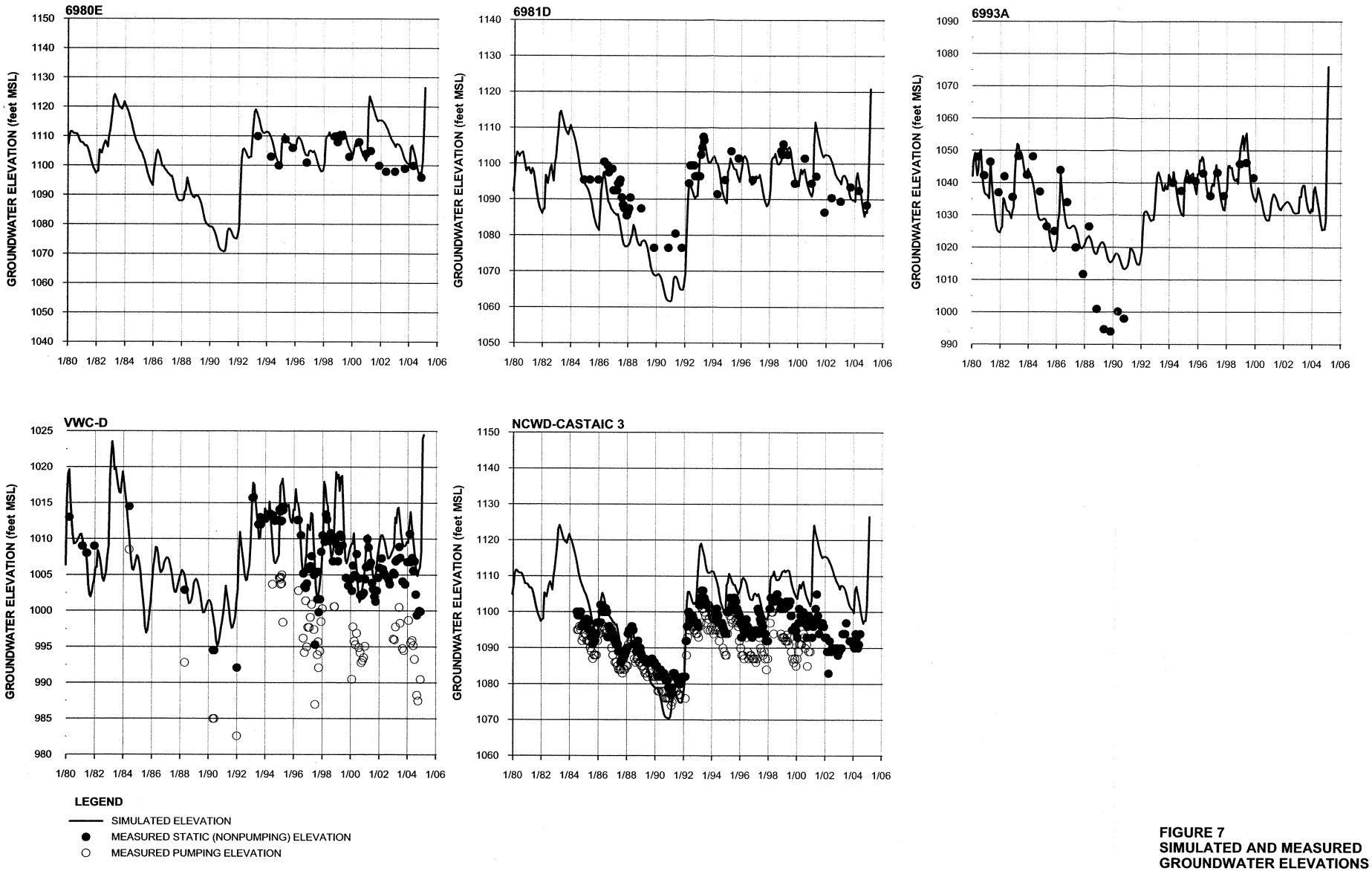

FIGURE 7
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS ALONG CASTAIC CREEK
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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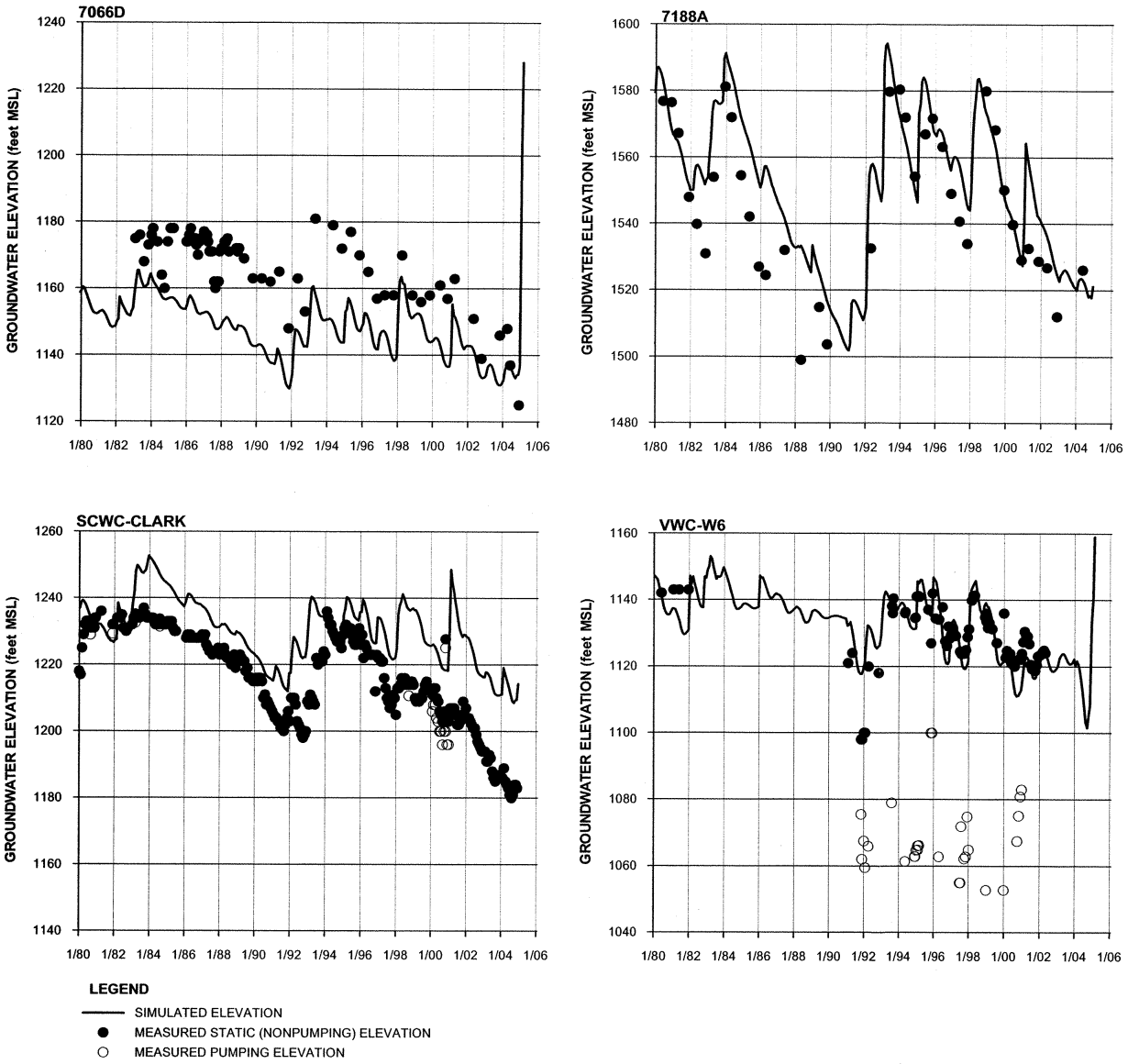

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FIGURE 8
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN OTHER TRIBUTARY CANYONS TO THE SANTA CLARA RIVER
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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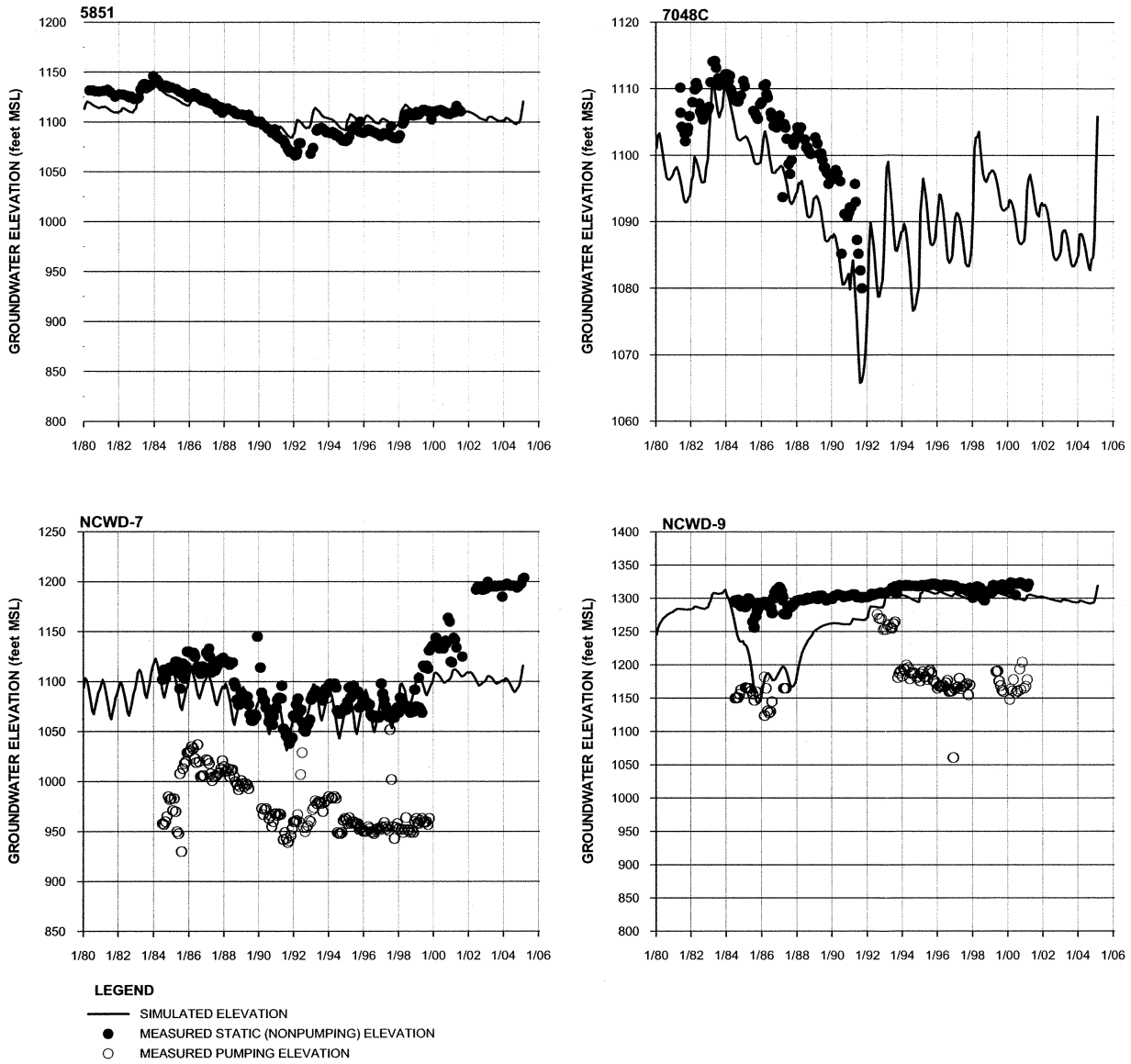

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FIGURE 9
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 1 OF 3)
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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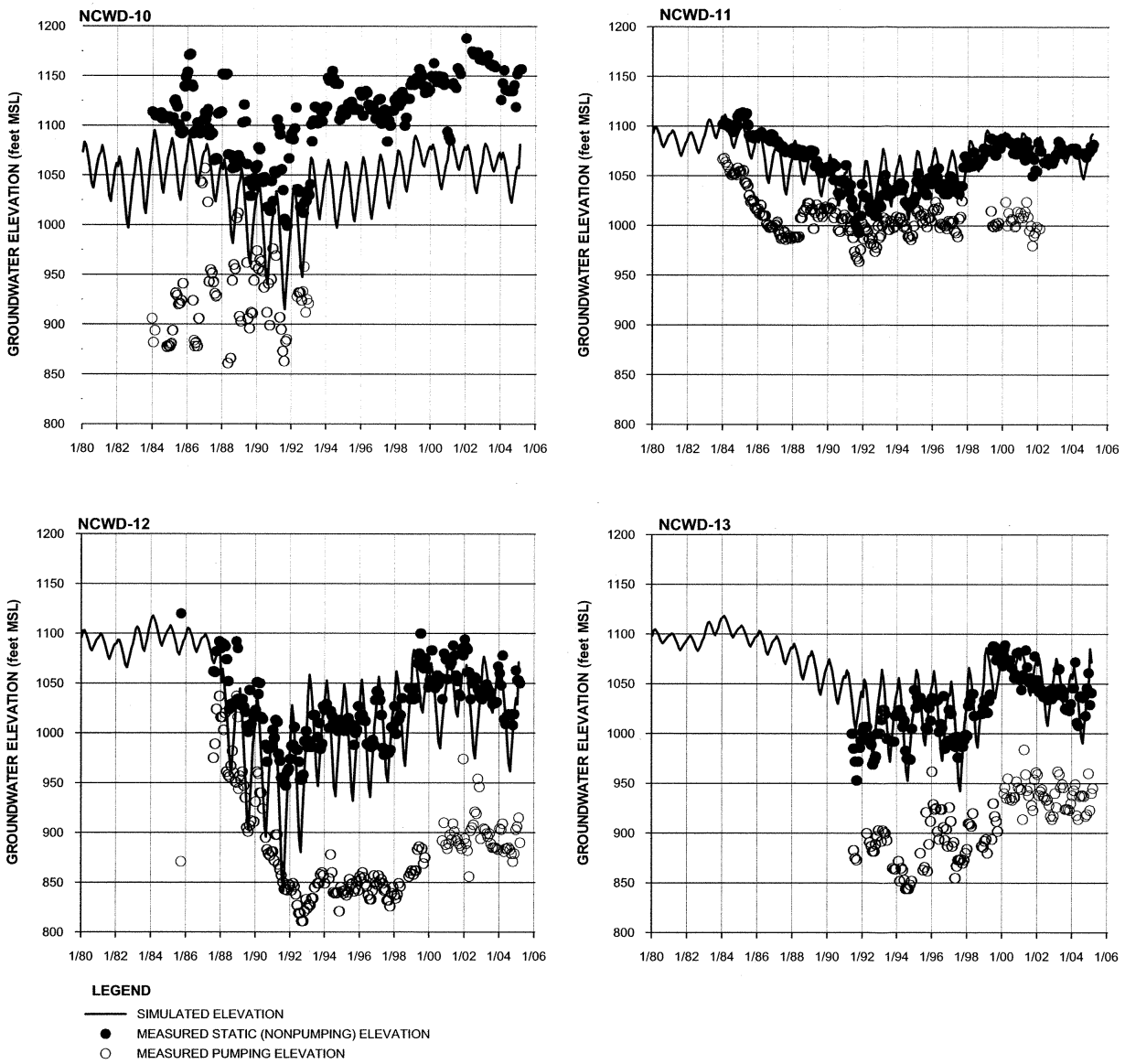

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FIGURE 9
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 2 OF 3)
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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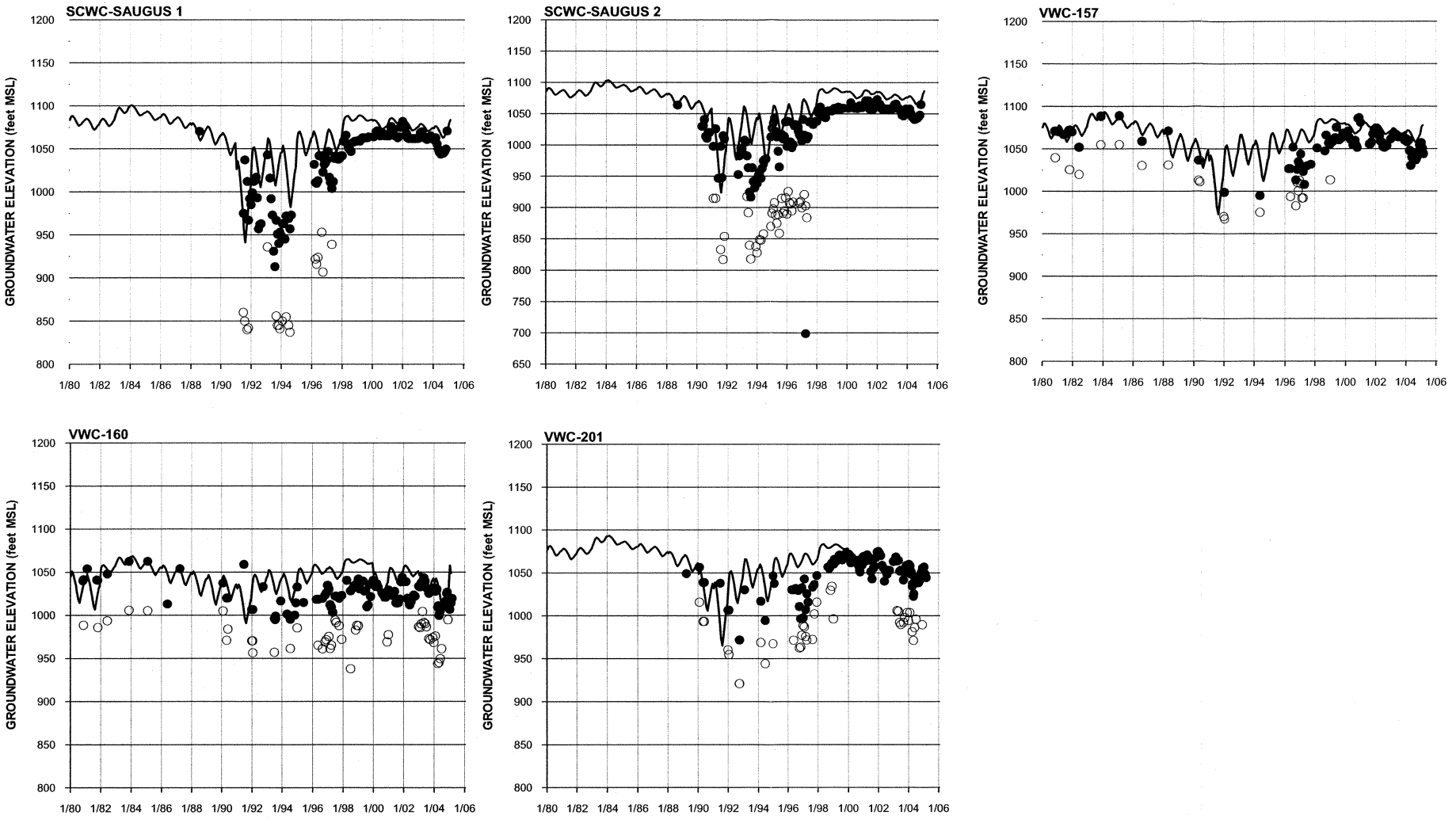

FIGURE 9
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 3 OF 3)
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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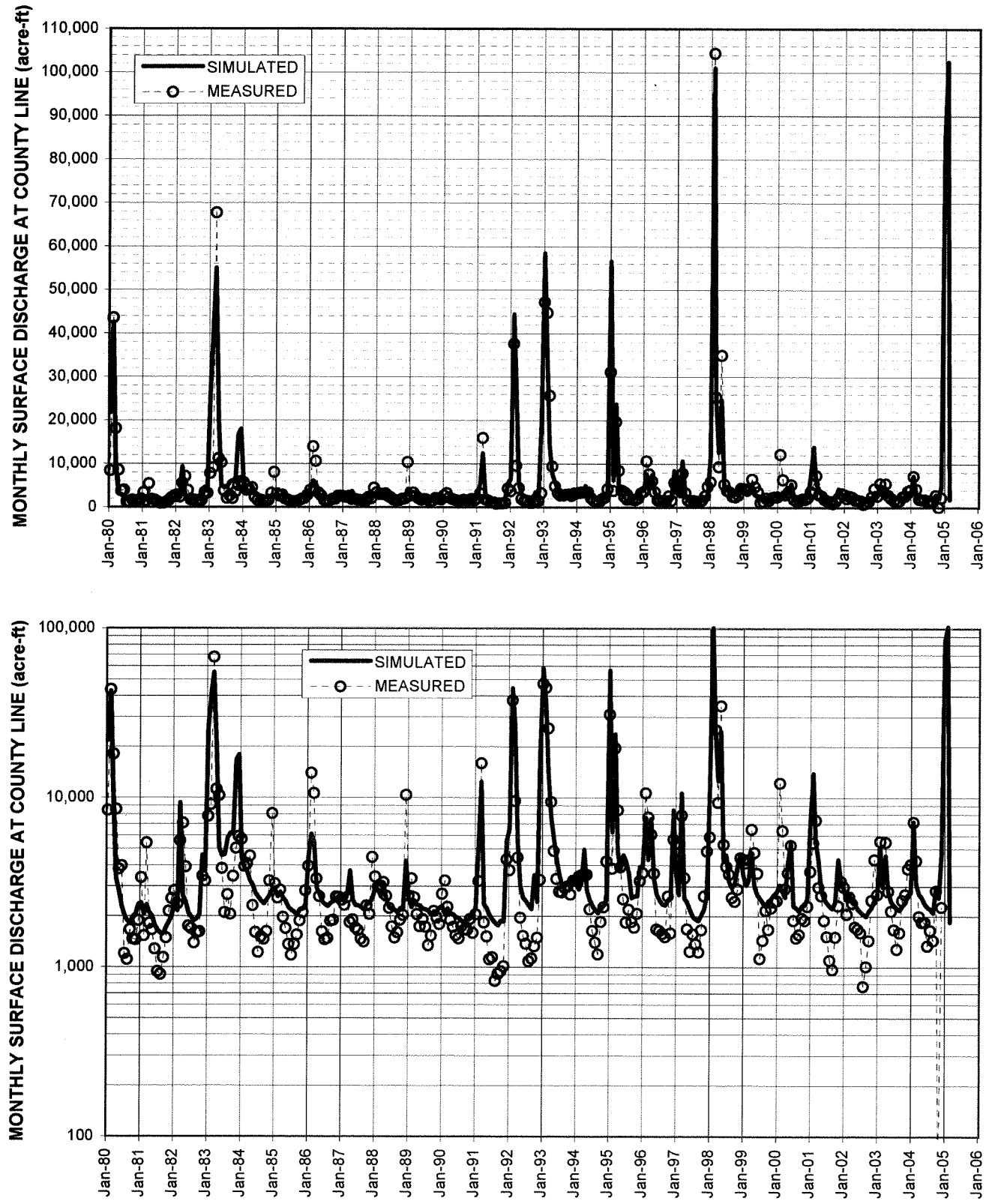

FIGURE 10
SIMULATED VERSUS MEASURED HYDROGRAPHS OF SANTA CLARA RIVER FLOW AT COUNTY LINE
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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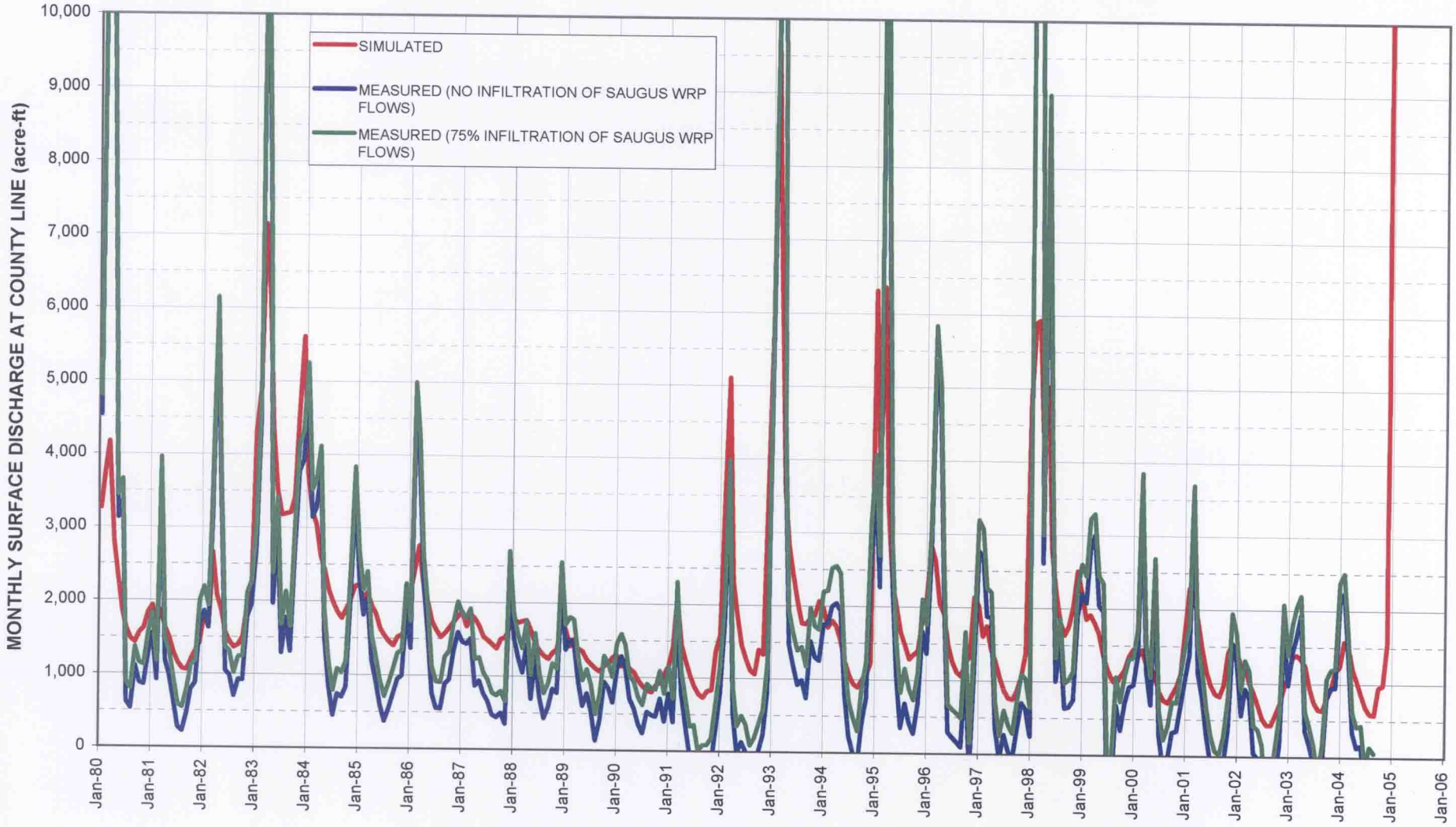

FIGURE 11
SIMULATED VERSUS MEASURED HYDROGRAPH OF GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
CALIBRATION UPDATE OF THE REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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178973-416.xls\FIG11

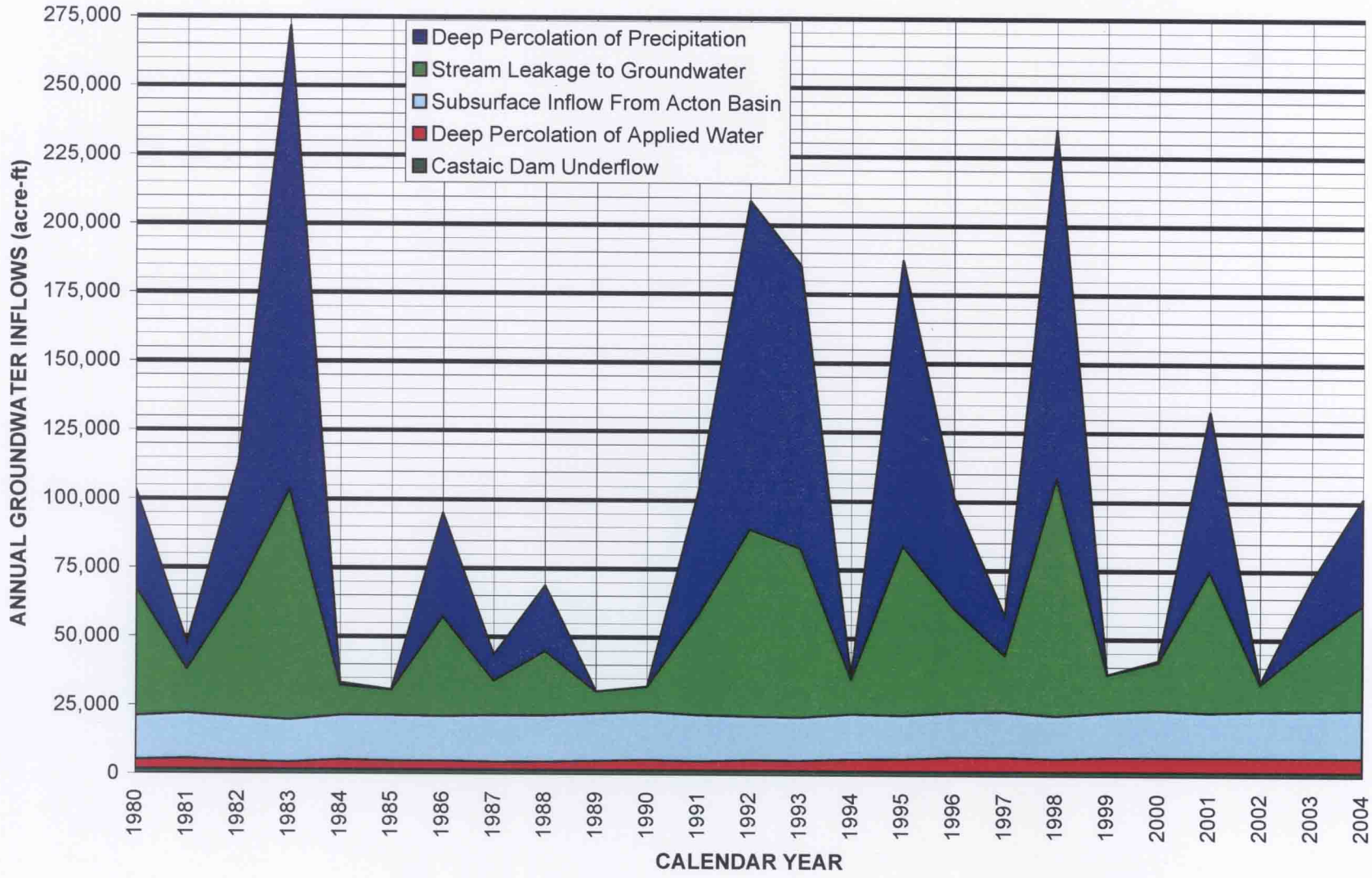

FIGURE 12
SIMULATED ANNUAL GROUNDWATER INFLOWS
CALIBRATION UPDATE OF REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY

178973-417.xls/Fig 12

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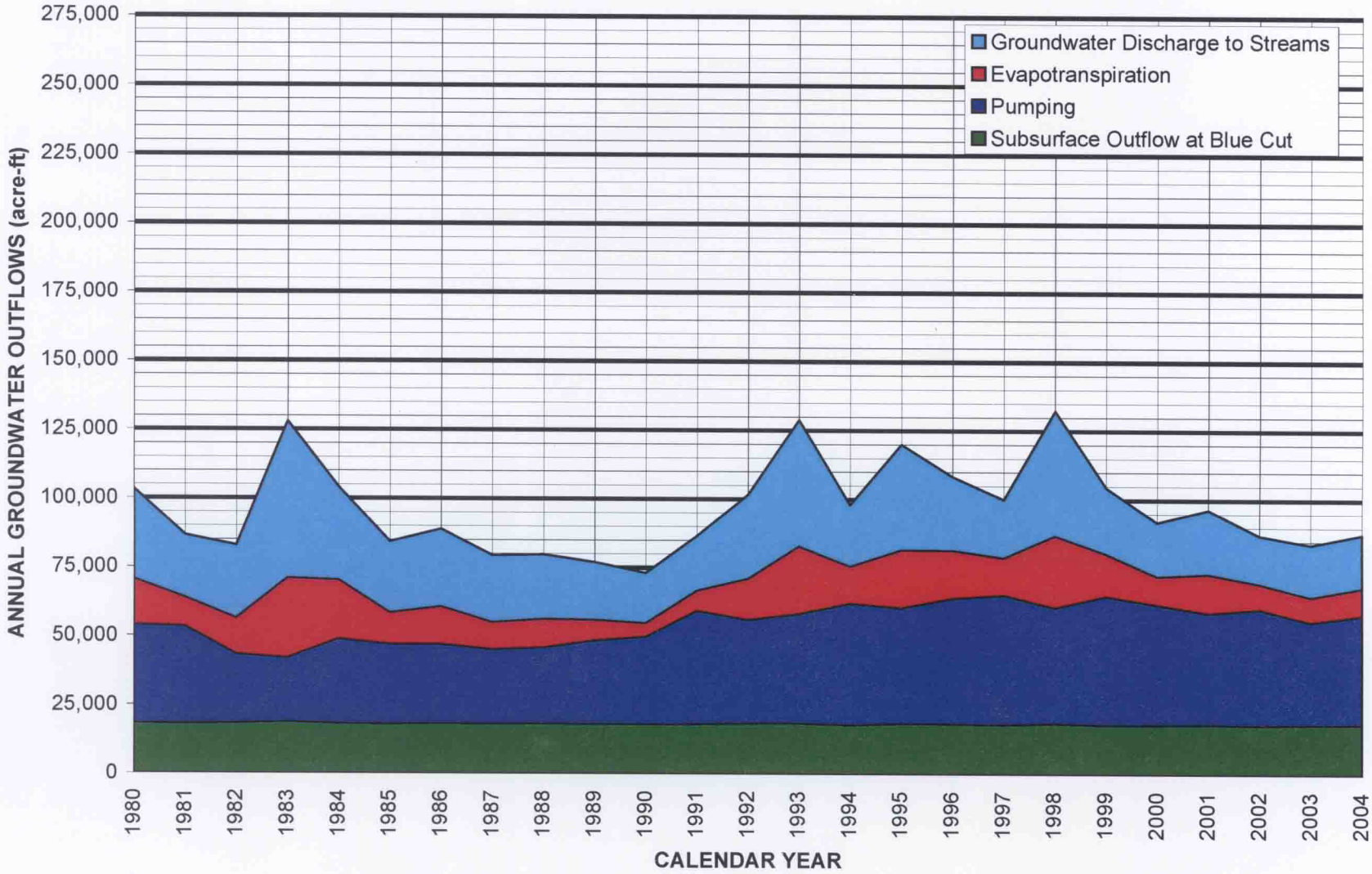

FIGURE 13
SIMULATED ANNUAL GROUNDWATER OUTFLOWS
CALIBRATION UPDATE OF REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-417.xls/Fig 13

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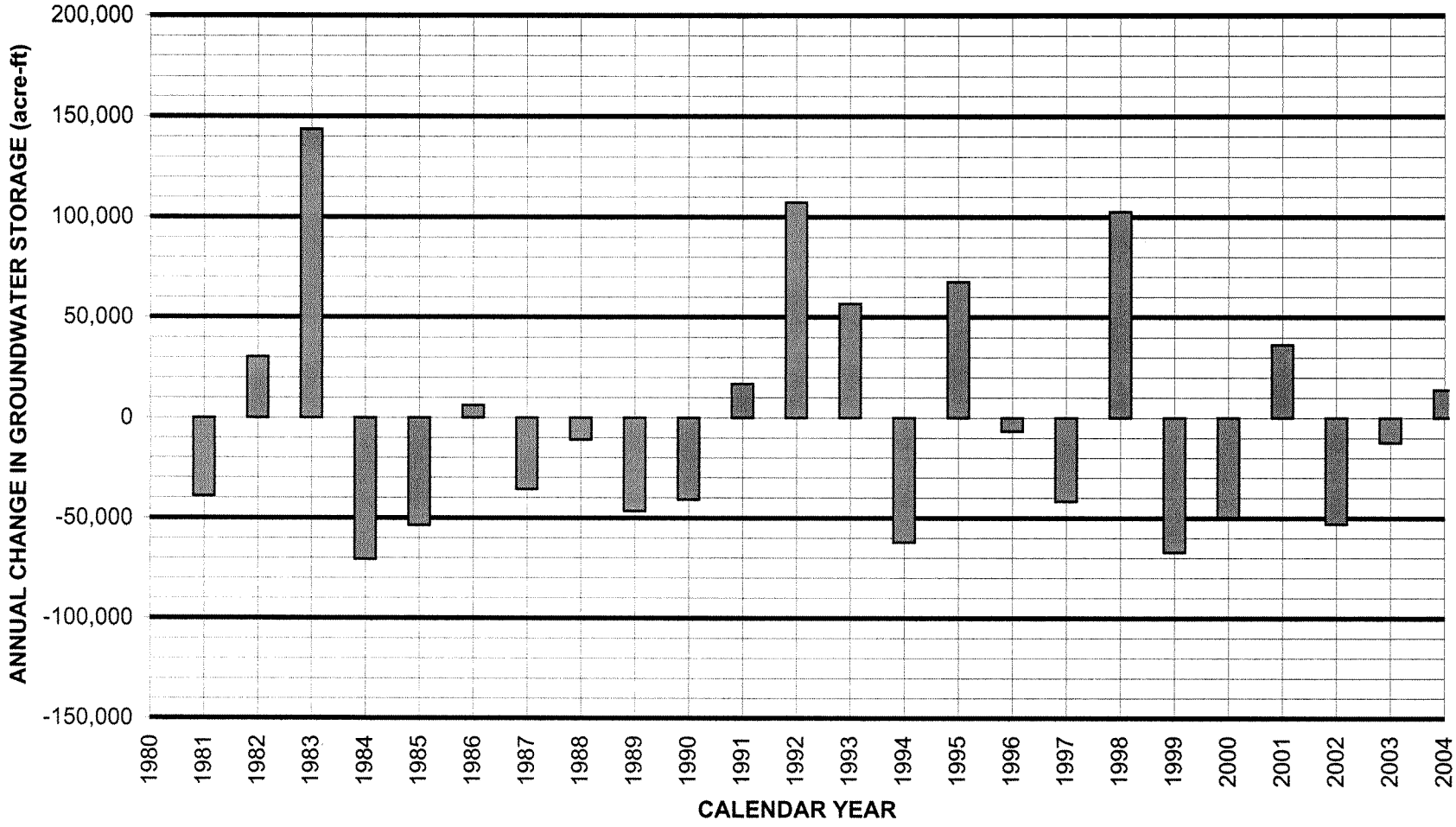

FIGURE 14
ANNUAL CHANGE IN SIMULATED GROUNDWATER STORAGE
CALIBRATION UPDATE OF REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-417.xls/Fig 14

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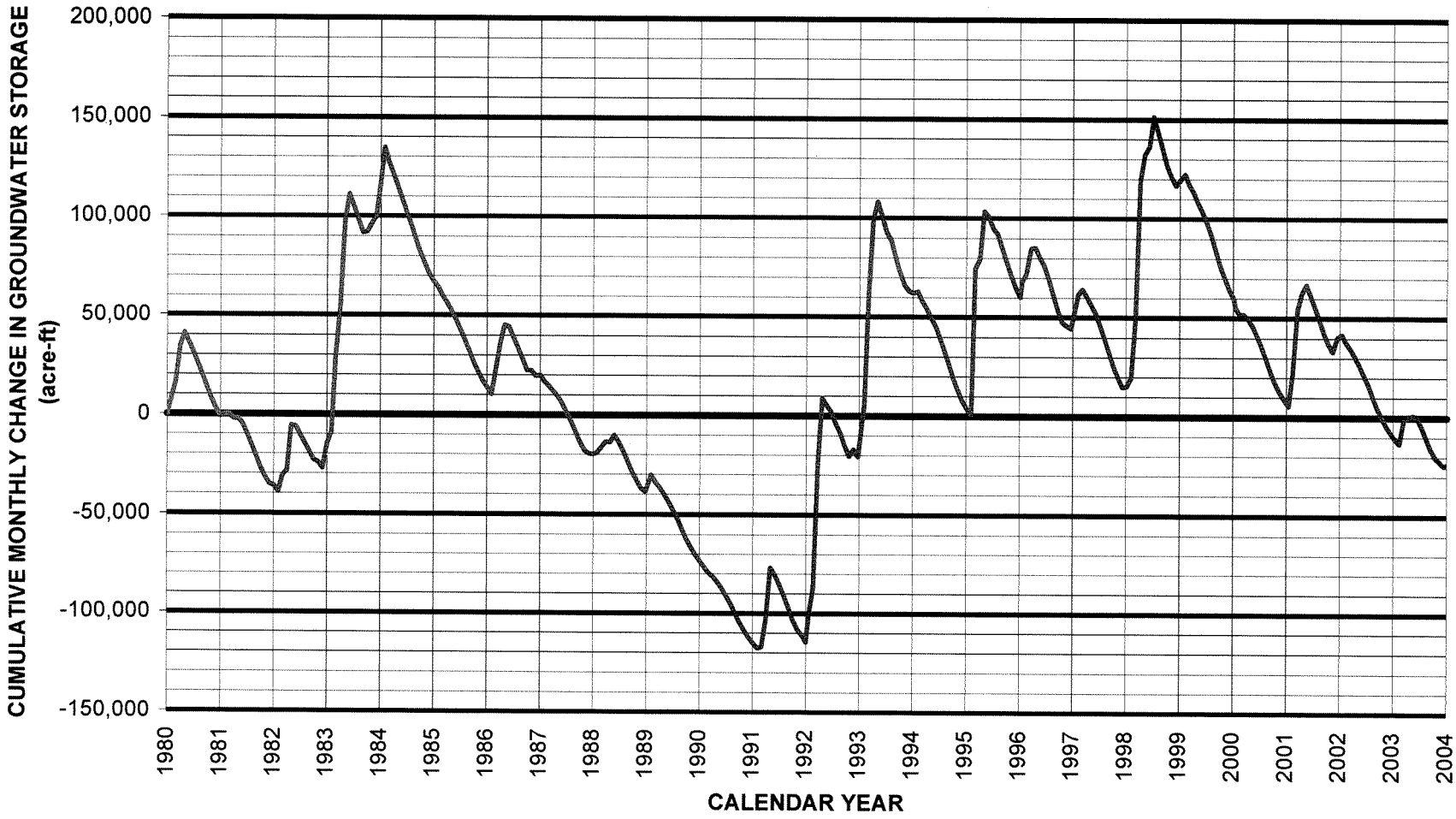

FIGURE 15
CUMULATIVE CHANGE IN SIMULATED GROUNDWATER STORAGE
CALIBRATION UPDATE OF REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-417.xls/Fig 15

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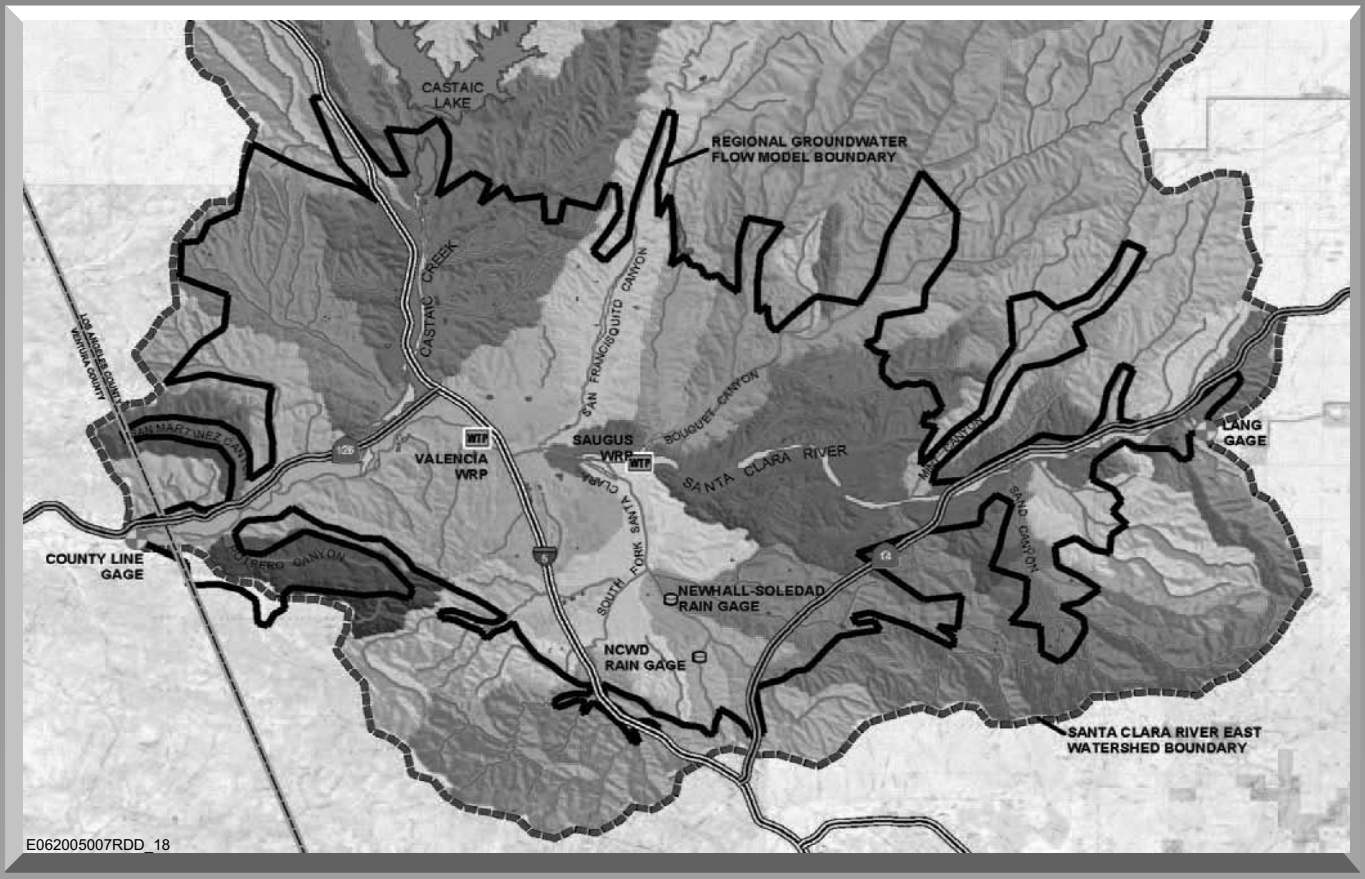
CH2MHill, "Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California"
(August 2005)

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Prepared in Support of the August 2001 Memorandum of Understanding between the Upper Basin Water Purveyors and the United Water Conservation District



Prepared by

CH2MHILL

In cooperation with
Luhdorff & Scalmanini Consulting Engineers

August 2005

Prepared for
Upper Basin Water Purveyors:
Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water Company

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CH2MHILL

September 23, 2005

178973.A4.02

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Valencia Water Company
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Valencia, California 91385-5904

Mr. Dan Masnada
Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, California 91350-2173

Mr. William Manetta
Santa Clarita Water Division, CLWA
22722 Soledad Canyon Road
Saugus, California 91350

Mr. Steve Cole
Newhall County Water District
P.O. Box 220970
23780 North Pine Street
Santa Clarita, California 91322-0970

Subject: Submittal of Report on Basin Yield Analysis

Dear Mr. DiPrimio, Mr. Masnada, Mr. Manetta, and Mr. Cole:

CH2M HILL is pleased to submit the enclosed report titled *Analysis of Groundwater Basin Yield, Upper Santa Clara River Basin, East Subbasin, Los Angeles County, California*. This report has been developed for the Upper Basin Water Purveyors and is the second of two reports that present and evaluate the groundwater operating plan for water supply wells completed in the Alluvial Aquifer and the Saugus Formation. This work has been performed as part of the August 2001 Memorandum of Understanding between the Santa Clara River Valley Upper Basin Water Purveyors and the United Water Conservation District. The first report, dated April 2004, documented the construction and calibration of a groundwater flow model for the Santa Clarita Valley. The enclosed report presents a modeling analysis of the groundwater operating plan and concludes that the groundwater operating plan is a reliable long-term component of water supply for the valley.

It has been our pleasure to serve the Upper Basin Water Purveyors on this important project. Please call me at 503/235-5022 if you have any questions.

Sincerely,

CH2M HILL

John J. Porcello
Project Manager

Nathan R. Brown, P.G.
Hydrogeologist

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Enclosures

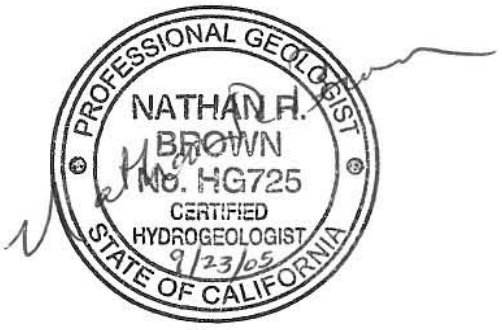
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Prepared in Support of the August 2001 Memorandum of Understanding between the Upper Basin Water Purveyors and the United Water Conservation District

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water Company



Prepared by

CH2MHILL

In cooperation with

Luhdorff & Scalmanini Consulting Engineers

August 2005

Contents

Page

Section

Acronyms and Abbreviations xi

1 Introduction 1-1
1.1 Background 1-1
1.2 Report Organization 1-4

2 Groundwater Hydrology and Operating Plan 2-1
2.1 Basin Hydrogeology 2-1
2.2 Groundwater Operating Plan 2-2
2.2.1 Historical Groundwater Conditions 2-2
2.2.2 Historical Estimates of Basin Yield 2-7
2.2.3 Development of Current Operating Plan 2-9

3 Modeling Approach for Analyzing Basin Yield 3-1
3.1 Model Description 3-1
3.2 Modeling Approach 3-2
3.3 Simulation Period 3-3
3.3.1 Selection of Simulation Period 3-3
3.3.2 Relationship of Simulation Period to Variations in Alluvial Aquifer Pumping 3-4
3.3.3 Relationship of Simulation Period to Variations in Saugus Pumping 3-5
3.4 Assignment of Pumping Rates 3-5
3.4.1 Variations in Alluvial Aquifer Pumping 3-6
3.4.2 Variations in Saugus Formation Pumping 3-7
3.4.3 Monthly Allocation of Pumping 3-7
3.4.4 Influence of Perchlorate Contamination on Groundwater Pumping 3-7
3.5 Simulation Methods for Other Local Hydrologic Processes 3-10
3.5.1 Recharge from Urban Irrigation 3-10
3.5.2 Recharge from Agricultural Irrigation 3-10
3.5.3 Precipitation Recharge 3-11
3.5.4 Stormwater Flows and Recharge from Streams 3-11
3.5.5 WRP Discharges to the Santa Clara River 3-11
3.5.6 Monthly Assignment and Tracking of Surface Water Budget 3-12
3.6 Running the Model and Evaluating Results 3-12

4 Model Results 4-1
4.1 Groundwater Elevations 4-1
4.2 Groundwater Recharge, Discharge, and Storage 4-1

Contents, Continued

Page

4.3 River Flows 4-2
4.4 Relationship of Simulation Results to Future Conditions 4-3

5 Conclusions 5-1
5.1 Principal Findings 5-1
5.2 Implications for Long-term Water Management 5-2

6 References 6-1

Appendices

A Memorandum of Understanding
B Description of the Santa Clarita Valley Regional Groundwater Flow Model

Tables—Located at the end of each section.

2-1 Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin

2-2 Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999

2-3 Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999

2-4 Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 versus 1975 through 1999

2-5 Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974

2-6 Annual Pumping Rates Specified by the Operating Plan for the Santa Clarita Valley's Groundwater Resources

2-7 CALSIM II Calculated State Water Project Municipal and Industrial Allocations

3-1 Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003

3-2 Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation

3-3 State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation

3-4 Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Contents, Continued

Tables, continued

3-5 Simulated Annual Groundwater Pumping from the Saugus Formation for the 78-year Simulation

3-6 Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

3-7 Allocation of Pumping, by Month, for Agricultural and Urban Production Wells

3-8 Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

3-9 Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

3-10 Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

3-11 Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)

3-12 Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

3-13 Simulated Monthly Treated Wastewater Discharge from Santa Clarita Valley WRPs under Full Build-out Conditions

4-1 Simulated Annual Groundwater Budget

Contents, Continued

Figures—Located at the end of each section.

1-1 Map of Study Area

2-1 Groundwater Basins in the Santa Clara River Drainage

2-2 Basin Geologic Map

2-3 Santa Clarita Valley Hydrology

2-4 Regional Well Location Map

2-5 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage

2-6 Annual Precipitation at the Newhall-Soledad and NCWD Rain Gages since 1950

2-7 Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

2-8 Alluvial Groundwater Elevations versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-9 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-10 Saugus Groundwater Elevations Closest to Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

2-11 Saugus Groundwater Elevations along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-12 Saugus Groundwater Elevations along the South Fork Santa Clara River versus Groundwater Recharge and Discharge Mechanisms (1990 to 2000)

2-13 Groundwater Elevations in Adjacent Alluvial and Saugus Wells versus Groundwater Recharge and Discharge Mechanisms (1950 to 2000)

2-14 Historical Castaic Creek Flood Flows Available to Downstream Users

3-1 Subwatersheds within the Santa Clara Valley East Watershed

3-2 Regional Model Grid

3-3 Schematic Diagram of Model's Representation of Stratigraphy in the Middle of the Basin

3-4 Schematic Cross Sections

Contents, Continued

Figures, continued

3-5 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage for the 78-year Simulation Period

3-6 Well Locations and Perchlorate Concentrations near the Whittaker-Bermite Property

3-7 Simulated Land Use within the Regional Model Boundary under Full Build-out Conditions

4-1 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer West of Interstate 5

4-2 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer East of Interstate 5

4-3 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer in Soledad Canyon

4-4 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer along Castaic Creek

4-5 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer along the South Fork Santa Clara River

4-6 Simulated Average Annual Groundwater Elevations in the Saugus Formation West of Interstate 5

4-7 Simulated Average Annual Groundwater Elevations in the Saugus Formation East of Interstate 5

4-8 Simulated Annual Groundwater Inflows

4-9 Simulated Annual Groundwater Outflows

4-10 Simulated Annual and Cumulative Change in Groundwater Storage

4-11 Simulated Santa Clara River Flow at County Line

4-12 Simulated Groundwater Discharge to Santa Clara River

Acronyms and Abbreviations

µg/L	micrograms per liter
AF/yr	acre-feet per year
AL	State of California's Action Level
Amended 2000 UWMP	2000 Urban Water Management Plan and 2005 amendments
CLWA	Castaic Lake Water Agency
DWR	California Department of Water Resources
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
in/yr	inches per year
Kh	horizontal hydraulic conductivity
LACSD	Los Angeles County Sanitation District
LADPW	Los Angeles County Department of Public Works
LSCE	Luhdorff & Scalmanini Consulting Engineers
MOU	Memorandum of Understanding
msl	mean sea level
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
OCAP	Operating Criteria and Plan
Purveyors	Upper Basin Water Purveyors
RCS	Richard C. Slade and Associates, LLC
Regional Model	Santa Clarita Valley Regional Groundwater Flow Model
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
T	transmissivity
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
UWMP	Urban Water Management Plan

VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
UWCD	United Water Conservation District

SECTION 1

Introduction

This report presents an evaluation of the long-term sustainability of existing groundwater management practices in the Santa Clarita Valley, located in northwestern Los Angeles County, California. The groundwater system in the Santa Clarita Valley is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07) and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Groundwater in the basin is pumped from a shallow Alluvial Aquifer and deeper groundwater resources that are present in an older, underlying unit called the Saugus Formation. Most groundwater pumping is by the local water purveyors (the Upper Basin Water Purveyors [herein referred to as the Purveyors[1]]) for municipal uses (in the range of approximately 23,000 to 28,000 acre-feet per year [AF/yr] in recent years), with some continuing pumping by private landowners, primarily for irrigation uses (approximately 15,000 to 16,000 AF/yr in recent years). The Purveyors also have access to other sources of water, including imported State Water Project (SWP) water, groundwater banking outside the basin, recycled water, short-term water exchanges, and dry-year water purchase programs (Luhdorff & Scalmanini Consulting Engineers [LSCE], 2005a). The water management practices of the Purveyors call for maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, and limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus Formation pumping during years when supplemental imported water supplies are significantly reduced because of drought conditions.

The evaluation of the Purveyors' current groundwater management practices has been performed using a detailed numerical groundwater flow model of the basin. The model, called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. The Regional Model has been developed for the Purveyors as a tool for the analysis of groundwater management options in the context of future water demands and water supply conditions in the valley. Among the objectives in developing the model were (1) to be able to evaluate the long-term sustainability (yield) of the Alluvial and Saugus aquifer systems under a range of existing and potential future water resource management conditions, and (2) to facilitate general management of water quantity and water quality issues. Figure 1-1 is a map showing the area simulated by the model (tables and figures are located at the end of each section).

1.1 Background

The Regional Model has been developed as part of the work scope contained in an August 2001 Memorandum of Understanding (MOU) that was entered into by the

[1]The Purveyors consist of the Castaic Lake Water Agency (CLWA), the Newhall County Water District, the Santa Clarita Water Division of CLWA, and the Valencia Water Company. The Santa Clarita Water Division of CLWA was acquired by CLWA in 1999. It was formerly called the Santa Clarita Water Company (SCWC).

Purveyors and the United Water Conservation District (UWCD), located downstream in Ventura County. The MOU, which is provided in Appendix A, is a commitment by the Purveyors to expand on previous analyses of groundwater conditions such that the adequacy of the local groundwater supply can be better understood and questions about surface water and groundwater resources can be more readily addressed. The MOU initiated a collaborative and integrated approach to data collection; database management; evaluating groundwater conditions and the sustainability of the Purveyors' operating plan; groundwater flow modeling; annual reporting on basin conditions; and technical reporting focused on geologic and hydrologic aspects of the overall stream-aquifer system.

In 2003, subsequent to the MOU, CLWA prepared and adopted a formal Groundwater Management Plan (CLWA, 2003), which includes 14 elements intended to achieve four management objectives, or goals, for the groundwater basin that were identified in the plan. Those four management objectives were development of local groundwater for water supply; avoidance of overdraft and associated undesirable effects; preservation of groundwater quality; and preservation of interrelated surface water resources. The intent of the Groundwater Management Plan is to ensure that ongoing utilization of local groundwater continues to result in acceptable aquifer conditions, specifically avoidance of overdraft (Element 3 of the plan), no degradation of quality (Element 6 of the plan), no adverse impacts to surface waters (Element 2 of the plan). The plan identified these objectives and elements as being accomplished via continued conjunctive use operations that have been ongoing since the initial importation of supplemental surface water in 1980 (Element 5 of the plan) and via monitoring and interpretation of surface water and groundwater conditions on an ongoing basis (Elements 1 and 2 of the plan).

Both the MOU and the Groundwater Management Plan contain several technical components, including the development and calibration of a regional-scale groundwater flow model and the application of the model to evaluate the sustainability of the Purveyors' current groundwater operating plan. The development and calibration of the model was documented in detail in April 2004 in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a). A summary of the Regional Model's construction and calibration is presented in Appendix B. The analysis of the sustainability of the Purveyor's current groundwater operating plan began in 2004 and is the subject of this report. Consequently, this report and the earlier report on the development and calibration of the model represent the accomplishment of two of the key technical work components that were described in the MOU and in several elements of the Groundwater Management Plan.

The Purveyors prepared the first Urban Water Management Plan (UWMP) for the Santa Clarita Valley in 1985. At about that same time, the Purveyors began studying the local water resources to assess the condition, hydrogeologic character, storage capacity, water budgets, and water quality of the local groundwater aquifers. Some of that work involved evaluating the potential for conjunctive use of groundwater and imported water resources, specifically artificial recharge of the Alluvial Aquifer using spreading basins, and aquifer storage and recovery in the Saugus Formation. An update of the UWMP in December 2000 projected water demands in the valley through 2020 and delineated a number of local and other water supplies, in conjunction with SWP water, to meet those projected water demands. The UWMP also identified a water supply plan that consisted of using alternate

supplies and/or development of future supplies from groundwater storage projects, short-term transfers, local groundwater, and other sources to offset potentially reduced deliveries of SWP water, while meeting demands in a manner that would not cause overdraft conditions in the local aquifer systems. In 2005, CLWA amended the 2000 UWMP to address the adequacy of groundwater supplies in light of perchlorate contamination that had caused the inactivation of five municipal water supply wells. Included in the amendments to the 2000 UWMP (CLWA et al., 2005; hereafter referred to, together with the 2000 UWMP [Black & Veatch, 2000], as the Amended 2000 UWMP) was discussion of the plan currently being implemented to install treatment and restore impacted wells for water supply by 2006. In accordance with the California Urban Water Management Planning Act, the UWMP is currently undergoing a 5-year update that will be completed in late 2005.

The Purveyors and UWCD initially agreed in the MOU, and the Purveyors subsequently committed in the Groundwater Management Plan, to develop and use the Regional Model for the sustainability evaluation of the local groundwater operating plan, in part because (1) the available data showed that no long-term lowering of the water table or degradation of water quality had occurred during the 50 to 60 years of historical groundwater development in the valley, and (2) the various studies and water planning efforts performed up to that time had resulted in a local groundwater operating plan that places future pumping of the Alluvial Aquifer in the same range as historical pumping. However, although the MOU recognized a need to formally analyze the Alluvial Aquifer, it identified that the primary question to evaluate with the Regional Model would be the operational yield of the Saugus Formation, given that the Purveyors' operating plan called for dry-year pumping at rates higher than historically had been pumped. For that reason, the MOU identified that the model would evaluate the effect of the current groundwater operating plan on groundwater conditions in both the Alluvial Aquifer and the Saugus Formation over a multi-year wet/dry cycle. The operational yield was defined in the MOU as an operating plan for the local groundwater basin that would allow continued pumping from the Alluvial Aquifer and Saugus Formation while assuring that groundwater supplies would be adequately replenished from one wet/dry cycle to the next.

Together, the historical development of these plans and the evaluation of their sustainability that is described in this report are grounded in the following objectives, which have been identified by the Purveyors for local groundwater resource management:

1. Prepare a groundwater operating plan for the basin (locations of wells, pumping capacities, and variations in annual pumping volumes) that is integrated with SWP and other imported supplies and recycled water to meet local water demands.

2. Analyze the groundwater operating plan to quantify possible basin responses to the plan, in terms of temporal variations that could occur in groundwater levels, groundwater storage, and Santa Clara River streamflows. This includes evaluating the rate of recovery of Saugus Formation groundwater levels after 1 or more years of increased pumping in the Saugus Formation.

3. Evaluate the range of basin responses to the groundwater operating plan to determine whether the plan will result in sustainable groundwater resources and supplies. This includes evaluating the following:

    a. Whether groundwater level declines during future drought periods will continue to arise primarily from local drought conditions, instead of from the groundwater operating plan for the basin; and, more importantly, whether groundwater levels and storage will recover (recharge) in wet periods following dry or drought conditions

    b. Whether groundwater discharges to the Santa Clara River will continue to be relatively stable over time, compared to the year-to-year variations in groundwater recharge that occur in the rest of the basin

To meet these objectives, the Purveyors developed the Regional Model to be an evolving tool for local groundwater resource management. As discussed in the model development report (CH2M HILL, 2004a), specific objectives identified for the Regional Model were as follows:

1. To evaluate the long-term sustainability (yield) of the two aquifer systems in the valley, the Alluvial Aquifer and the Saugus Formation, under a range of existing and potential future water resource management conditions

2. To evaluate artificial recharge for the purpose of increasing the long-term sustainability of the aquifer system, particularly in conjunction with the availability of imported surface water supplies

3. To evaluate the influences of future water management plans and alternatives on groundwater conditions in the valley and on the flows of water into the downstream basins in Ventura County

4. To facilitate general management of water quantity and water quality issues

This report focuses on the application of the Regional Model to meet the first objective.

1.2 Report Organization

The remainder of this report is organized as follows:

- **Section 2** discusses the hydrogeology of the basin and describes the groundwater operating plan.
- **Section 3** describes the process that was used to simulate the groundwater operating plan with the Regional Model and evaluate the modeling results.
- **Section 4** discusses the results of the simulated groundwater operating plan.
- **Section 5** discusses the principal findings from the analyses of historical data and numerical modeling results, and the implications of these findings for long-term water management in the Santa Clarita Valley.
- **Section 6** is the reference list.

Figure

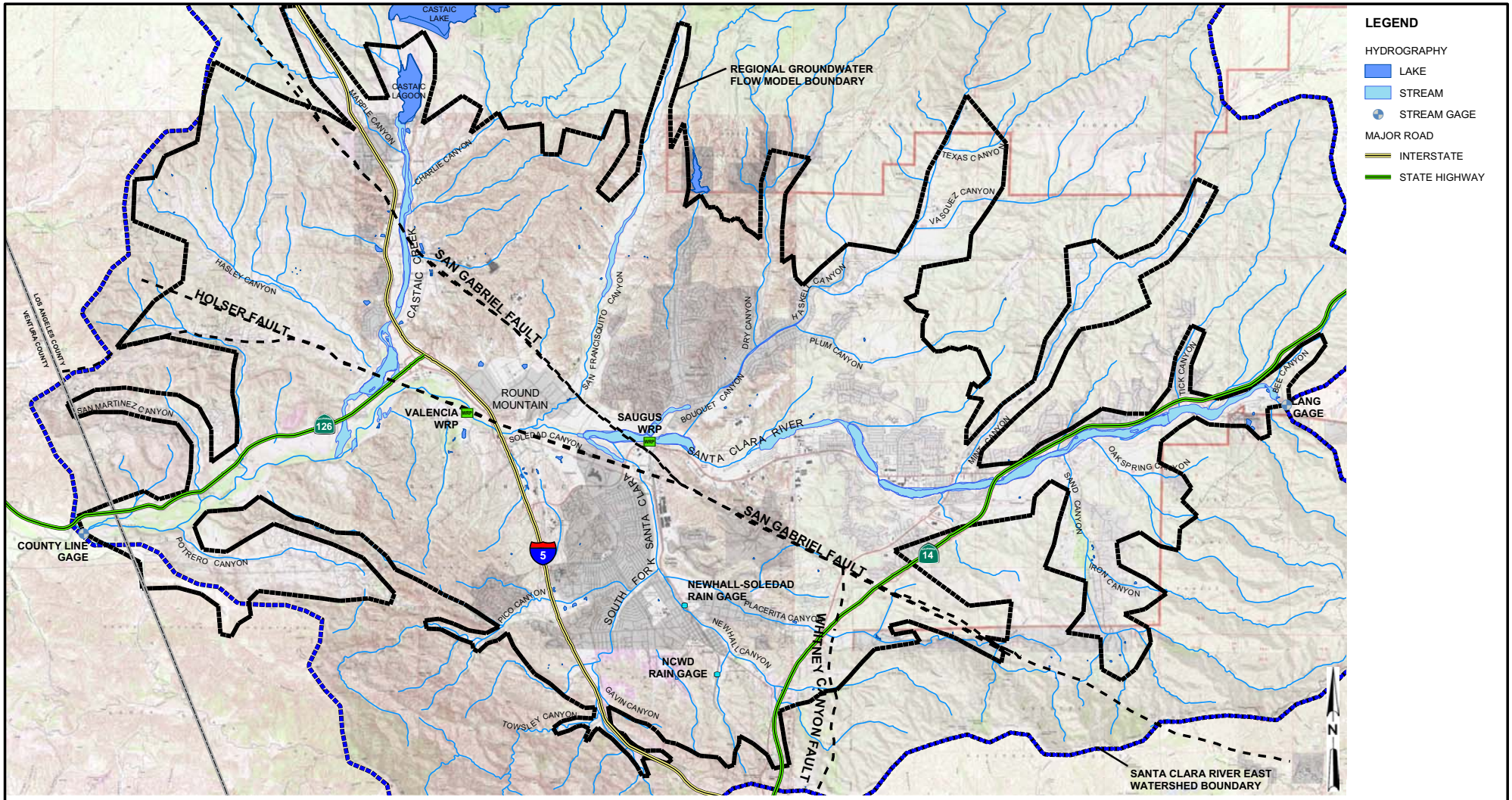


FIGURE 1-1
MAP OF STUDY AREA
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 2

Groundwater Hydrology and Operating Plan

2.1 Basin Hydrogeology

The groundwater system in the Santa Clarita Valley is identified by DWR as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Figure 2-1 shows the location of this groundwater basin. The basin contains two aquifer systems: the Alluvial Aquifer and the Saugus Formation. Figure 2-2 is a geologic map showing the geographical extent of these and other rock units in and around the basin.

In general, natural groundwater recharge occurs in the eastern portion and at the northern and southern limits of the basin, and natural groundwater discharge occurs in the west-central portion of the basin, in the alluvial valley occupied by the Santa Clara River. Groundwater pumping is an additional groundwater discharge mechanism that occurs in discrete portions of the basin. A schematic representation of the regional-scale geology and hydrologic cycle in the Santa Clarita Valley is shown on Figure 2-3, and the components of the hydrologic cycle for the basin's groundwater and surface water resources are listed in Table 2-1. As indicated by the diagram and the table, groundwater is exchanged between the Alluvial Aquifer and the Saugus Formation, with the Alluvial Aquifer recharging the Saugus Formation in certain portions of the regional recharge areas, and the Alluvial Aquifer receiving groundwater from the Saugus Formation in the regional groundwater discharge areas. Additionally, the aquifer systems are affected by direct rainfall; stream-flows in the Santa Clara River and its tributaries; evapotranspiration (ET) by riparian vegetation along portions of the river; and human influences, which consist of pumping, agricultural and urban irrigation, discharge of treated water into the Santa Clara River from two water reclamation plants (WRP), and occasional releases of water into Castaic Creek from Castaic Lake and Castaic Lagoon.

The Santa Clarita Valley obtains its water supply from local groundwater sources and from imported water supplies. Total water use in the valley is largely for municipal and industrial uses and, to a lesser extent, for agricultural uses. In 2004, approximately 61 percent of groundwater pumping was by the Purveyors (for municipal uses) and 39 percent was by private land owners, primarily for irrigation. Figure 2-4 is a map showing the locations of production wells that are currently present in the Alluvial Aquifer and the Saugus Formation. Prior to the 1960s, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during much of the 1950s and early 1960s ranged between approximately 35,000 and 44,000 AF/yr. Pumping from the Alluvial Aquifer dropped gradually from approximately 40,000 AF/yr in the mid-1960s to less than 30,000 AF/yr through the 1980s, and did not rise above 30,000 AF/yr until 1993. Since then, it has ranged between 30,000 and nearly 44,000 AF/yr. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. As a

result of statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available.

2.2 Groundwater Operating Plan

The water management practices of the Purveyors call for maximizing the use of Alluvial Aquifer groundwater and SWP water during years of normal or above-normal availability of SWP water supplies and local Alluvial Aquifer groundwater resources. These practices recognize ongoing Alluvial pumping for agricultural water supply as well as other smaller (private) domestic and related water supply, and are intended to maintain overall pumping within sustainable rates. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. These water management practices are based, in part, on observations about the historical hydrology of the basin (described in Section 2.2.1) and form the groundwater operating plan for the basin (described in Section 2.2.2).

2.2.1 Historical Groundwater Conditions

Long-term water level data have been collected over the years at agricultural wells and Purveyor-owned wells in the City of Santa Clarita and along the South Fork Santa Clara River. The data have been collected in pumping wells, and the hydrographs of these wells are steep at certain times, suggesting that the measured water levels are influenced, to a certain degree, by pumping at the well. Nonetheless, the data show general relationships between groundwater elevation trends and changes in groundwater recharge and pumping over time. These relationships have been identified by examining the 50-year period from 1950 through 1999. During this period, the average rainfall was close to the long-term average rainfall observed since 1883. Consequently, long-term changes in the basin's hydrology arising from other factors could be more easily identified because rainfall was near normal for the 50-year period as a whole.

Following are discussions of the observed hydrologic trends in the basin, including rainfall, groundwater elevations in the Alluvial Aquifer and the Saugus Formation, and flows in the Santa Clara River.

2.2.1.1 Historical Trends in Rainfall

Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. The average rainfall at this gage was 17.95 inches from 1883 through 2000 and 17.84 inches from 1950 through 2000[2]. Figure 2-5 shows the annual rainfall at the Newhall-Soledad gage for calendar years 1950 through 2000. Figure 2-5 also shows the cumulative departure from the average annual precipitation since 1950. Cumulative departure refers to the cumulative amount of rainfall that is greater than or less than the long-term average rainfall. The slope of the cumulative departure plot shows the temporal trends in rainfall

[2]Annual rainfall values for the Newhall-Soledad gage were derived from monthly values reported by the National Climate Data Center and LADPW.

over successive years. The figure shows the following trends in precipitation within the Santa Clarita Valley:

1. 1950 through 1964: Dry conditions except for single wet years in 1952, 1957, 1958, and 1962 (a nearly continuous decrease in cumulative departure values)
2. 1965 through 1970: Wet conditions (increase in cumulative departure values)
3. 1971 through 1977: Average to dry conditions (flat or declining cumulative departure values)
4. 1978 through 1983: Wet conditions (increase in cumulative departure values)
5. 1984 through 1991: Dry conditions (decrease in cumulative departure values)
6. 1992 through 1999: Highly variable conditions from year to year, but overall increase in cumulative departure values

A second rain gage is located approximately 1.3 miles to the south, at the Newhall County Water District (NCWD) office (see Figure 1-1). Figure 2-6 compares the annual rainfall at the Newhall-Soledad and NCWD gages for calendar years 1950 through 2000. Rainfall at the NCWD gage is usually greater than at the Newhall-Soledad gage, because the NCWD gage is located closer to the hills that form the southern boundary of the watershed and receive a greater amount of orographic precipitation, as shown on Figure 2-7.

2.2.1.2 Historical Trends in Alluvial Aquifer Groundwater Elevations

Figure 2-8 shows trends in groundwater elevations in two Alluvial Aquifer wells located in the basin interior (wells VWC-N and NLF-S, near the mouth of the South Fork Santa Clara River) and two Alluvial Aquifer wells located near the regional groundwater discharge zone at the western end of the basin (wells NLF-C5 and NLF-C7). The figure also shows trends in the following other components of the hydrologic cycle:

1. Precipitation at the Newhall-Soledad rain gage (plotted as the cumulative departure from the average precipitation)
2. Annual pumping volumes from the Alluvial Aquifer and the Saugus Formation
3. Total discharges to the Santa Clara River from two WRPs (which are discussed further in Section 2.2.1.5)
4. Measured flow volume in the Santa Clara River during the lowest flow month of each year

Observations from Figure 2-8 are as follows:

1. Alluvial Aquifer groundwater elevations show greater variability over time within the basin interior (wells VWC-N and NLF-S) than near the basin outlet (wells NLF-C5 and NLF-C7). The range in water levels during the 50-year period of record is approximately 100 feet at the interior wells, but only 20 to 30 feet in the two wells near the basin outlet.
2. The effect of reduced pumping from the Alluvial Aquifer from 1967 through 1989 was to minimize seasonal fluctuations in Alluvial Aquifer water levels near the aquifer's regional discharge zone at the western end of the valley. In this area, fluctuations in

Alluvial Aquifer pumping over time affected Alluvial groundwater elevations only seasonally; year-to-year variations in groundwater elevations were small. This indicates that water levels in this area are controlled less by pumping than by the discharge of Alluvial Aquifer groundwater to the Santa Clara River in the area downstream of Interstate 5.

3. As with the western portion of the Alluvial Aquifer, the central portion of the Alluvial Aquifer has not shown long-term water level declines. During the 1950s and early 1960s, total pumping from the Alluvial Aquifer ranged between approximately 35,000 and 44,000 AF/yr during all but 1 year, and long-term (year-to-year) groundwater elevations were relatively stable (see the hydrographs for wells VWC-N and NLF-S). When pumping from the Alluvial Aquifer decreased beginning in 1967, Alluvial groundwater elevations in this area quickly rose and have been relatively stable since about 1970, despite an increase in Alluvial Aquifer pumping during the 1990s. The hydrographs indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above-normal rainfall patterns return.

4. The seasonal low flow in the Santa Clara River at the County Line gage has shown a long-term increase since the mid-1970s and, to some degree, since the late 1960s. Figure 2-5 shows that this increase in flow coincides with increases in the annual discharges of treated water to the Santa Clara River from the two WRPs. Although Alluvial Aquifer pumping increased during the 1980s and 1990s, the seasonal low river flow did not show a long-term decrease during this period. The increases in WRP and Santa Clara River flows and the fluctuations in Alluvial Aquifer pumping have not caused long-term changes in Alluvial Aquifer groundwater elevations at the two wells near the basin outlet.

2.2.1.3 Historical Trends in Saugus Formation Groundwater Elevations

Figures 2-9 and 2-10 compare groundwater elevation trends in the Saugus Formation near the Santa Clara River, below the mouth of the South Fork Santa Clara River, with the same hydrologic components displayed on Figure 2-8. Figure 2-9 shows this information for the period 1950 through 1999, and Figure 2-10 shows this information during the 1990s, when groundwater levels rose in the Saugus Formation. Figures 2-11 and 2-12 show the same information, but for groundwater elevations at Saugus Formation wells located farther away from the Santa Clara River, along the tributary valley containing the South Fork Santa Clara River.

In examining the four Saugus Formation figures, it is difficult to distinguish between the influences of precipitation and pumping trends on changes in Saugus water levels. Although a slight rise in water levels might have occurred at wells VWC-157 and VWC-160 during the late 1960s and early 1970s, it appears to follow the trends in Saugus pumping volumes more closely than the precipitation trends. The data at VWC-157 also suggest that a succession of above-normal precipitation years (e.g., 1978 through 1983) or a year of precipitation that is substantially above normal (e.g., 1983) might have some influence on Saugus water levels. However, the data are limited, and the periods of increased precipitation tend to coincide with periods of decreased pumping, making it difficult to identify the effect of precipitation or pumping on Saugus water levels.

Another observation is that the rise in Saugus Formation water levels in the late 1960s and early 1970s occurred despite an increase in annual pumping volumes from the Alluvial Aquifer. During the late 1980s and 1990s, Saugus pumping increased from slightly less than 6,000 AF/yr (in 1986 and 1987) to approximately 15,000 AF/yr in 1991. When SWP deliveries were substantially reduced in 1991, pumping from the Saugus Formation made up for almost half of the reduction that year. This increased Saugus pumping resulted in short-term declines in groundwater elevations at the pumping wells, particularly from 1991 through 1994, reflecting the use of naturally-stored Saugus groundwater. However, as shown on Figures 2-9 and 2-10, the water levels subsequently rose when pumping declined. This indicates that Saugus water levels are controlled by precipitation and/or Saugus pumping trends, and not by pumping trends in the Alluvial Aquifer.

2.2.1.4 Comparison of Historical Trends in Alluvial and Saugus Groundwater Elevations

Figure 2-13 compares groundwater elevations at Alluvial Aquifer and Saugus Formation wells located near each other along the Santa Clara River, just below the mouth of the South Fork Santa Clara River. At this location, the trends in Alluvial groundwater elevations show no clear relationship with the trends in Saugus groundwater elevations. A moderate overall increase in groundwater elevations was observed in both the Alluvial Aquifer and the Saugus Formation during the late 1960s. However, this similarity in the water level trends might be a coincidence arising from reduced pumping in both aquifers. During the early 1970s, water levels in Saugus well VWC-157 decreased while water levels in the nearby Alluvial Aquifer well (VWC-N) generally increased. During the 1990s, the Alluvial Aquifer groundwater elevations at well VWC-N were generally stable despite (1) increased pumping from the Alluvial Aquifer and (2) a sharp decrease, then increase, in Saugus groundwater elevations, which correlated with the trends in Saugus pumping. In summary, although there might be a relationship between Alluvial and Saugus groundwater elevations near the margins of the groundwater basin, where folding of Saugus beds has brought permeable zones in contact with the alluvium, Figure 2-13 indicates that there is general independence between the Alluvial and Saugus water level trends at this location, which is near the center of the bowl-shaped Saugus Formation structure shown on Figure 2-3.

2.2.1.5 Historical Trends in Santa Clara River Baseflow

Long-term records of flows in the Santa Clara River are available for the eastern and western ends of the basin. The locations of the two gages are shown on Figure 1-1 and Figure 2-3. At the western end of the basin, the County Line gage has recorded Santa Clara River flows leaving the basin for most of the period since 1952, except for a 1-year period during water year 1969 (October 1968 through September 1969). At the eastern end of the basin, the Lang gage has recorded Santa Clara River flows entering the basin from October 1949 through September 1989 and from April 2003 to the present.

Baseflow in the Santa Clara River is perennial in the western portion of the Santa Clarita Valley. The following sources of water contribute to the river's baseflow:

1. **Groundwater discharge from the Alluvial Aquifer to the riverbed.** Groundwater in the Alluvial Aquifer seeps into the riverbed near, and downstream of, Round Mountain (which is located just below the mouth of San Francisquito Canyon).

2. **Discharges from two WRPs.** Treated water is discharged to the Santa Clara River from two Los Angeles County Sanitation District (LACSD) WRPs in the valley. The Saugus WRP (Plant No. 26) is located along the south side of the river near Bouquet Canyon, just above the mouth of the South Fork Santa Clara River. The Valencia WRP (Plant No. 32) is located along the north side of the river, just west of Interstate 5.

3. **Flood Flows in Castaic Creek.** DWR stores SWP water in Castaic Lake. In some years, DWR releases flood flows from Castaic Dam/Lagoon into Castaic Creek during the winter or spring months. Depending on the magnitude of the releases, some of these flows enter the Santa Clara River downstream of the Valencia WRP. As shown on Figure 2-14, these releases have occurred during many, though not all, years since the release program began in the late 1970s.

Hydrograph separation techniques were applied to the daily streamflow data for the County Line gage to estimate historical groundwater discharges (baseflow) to the Santa Clara River within the Santa Clarita Valley. The hydrograph separation was performed for calendar years 1953 through 1999 using the following five steps:

1. For each day, the average daily flow at the County Line gage, in cubic feet per second (cfs), was converted to acre-feet of volumetric flow for the day.

2. The daily flows from Castaic Dam and at the Castaic Creek South gage (located near the mouth of Castaic Creek) were subtracted from the flow at the County Line gage. These data reflect surface water flow from tributaries. Data from the Castaic Creek South gage were used through June 1977. Beginning in July 1977, operational data for Castaic Lagoon, presented in annual reports by DWR, were used to estimate surface flow contributions from Castaic Creek.

3. The discharges of treated water from the two WRPs were subtracted. This step was performed for calendar years 1975 and later, because 1975 was the first year that such records were available.

4. The resulting day-to-day trends in streamflows were scrutinized for days when notably elevated flows occurred suddenly. These days were assumed to be dominated by storm flow. In some cases, the elevated flows lasted for only 2 to 5 days. In other cases, flows remained elevated for several days, but showed steady declines, indicating that only the beginning of the elevated-flow period was dominated by surface runoff.

5. On all other days, storm flow was considered to be minimal or zero, and the flow values calculated for days not dominated by storm flow were assumed to represent river base-flow (that is, groundwater discharge to the river). For each month, an average flow was calculated for these non-storm days. The average flow was then converted to a total flow for the month, and the monthly flow volumes were summed to come up with the total flow for each year.

Table 2-2 presents the annual calculations from the hydrograph separation analysis. Table 2-3 presents summary statistics for the entire 47-year period that was analyzed, as well as for shorter time frames. Tables 2-4 and 2-5 show dry-year, normal-year, and

wet-year statistics for the entire period of record and the shorter time frames. The shorter time frames are as follows:

1. Calendar years 1953 through 1965, which were years of primarily agricultural water use prior to urbanization and construction of WRPs. This 13-year period was also characterized by 5 years of below-normal rainfall.

2. Calendar years 1975 through 1999, which represent 25 years of significant urbanization, including SWP water importation and WRP operations. This 25-year period was characterized by 6 years of below-normal rainfall, although rainfall volumes in general were somewhat higher (19.4 inches per year [in/yr] average, versus 15.5 in/yr average for 1953 through 1965).

3. Calendar years 1953 through 1999, but excluding 8 years (1966 through 1974) when WRP discharges occurred but were not recorded.

The daily streamflow data and the hydrograph separation technique indicate the following:

1. Summary statistics in Table 2-3 for all types of rainfall years (dry, normal, and wet) show that average groundwater discharges to the river from 1953 through 1965 were approximately 2,500 AF/yr (3.5 cfs). Groundwater discharges to the river were typically 14,000 to 22,000 AF/yr (19 to 31 cfs) from 1975 through 1999 because of more rainfall, increasing urbanization, and increasing importation of water from outside the valley.

2. For normal rainfall years only, median and average groundwater discharges to the river were approximately 4,000 and 3,600 AF/yr (5.5 and 5.0 cfs), respectively, from 1953 through 1965 (see Table 2-4); and approximately 12,500 and 14,300 AF/yr (17 and 20 cfs), respectively, during 1975 through 1999 (see Table 2-4).

3. For drought years only, Table 2-4 shows that groundwater discharges to the river ranged from 400 to 4,900 AF/yr (0.5 to 7 cfs) between 1953 and 1965, and from 5,200 to 14,500 AF/yr (7 to 20 cfs) between 1975 and 1999. Table 2-4 also shows that median and average groundwater discharges to the river during drought years were 600 and 1,700 AF/yr (1 and 2 cfs), respectively, from 1953 through 1965, and typically 9,600 and 10,200 AF/yr (13 and 14 cfs), respectively, from 1975 through 1999.

In summary, significant increases in the baseflow of the Santa Clara River have occurred since urbanization of the Santa Clarita Valley began during the late 1960s and early 1970s. Water imports began in 1980, and have increased in volume as urbanization has continued. The imported water has reached the river through releases from Castaic Dam/Lagoon and, more significantly, discharges of treated water into the river. As a result, water is now present in the Santa Clara River on a continuous basis in the western portion of the basin, even during dry years. This is a sharp contrast to conditions prior to the 1970s, when the river would become dry during drought periods.

2.2.2 Historical Estimates of Basin Yield

During the late 1980s, Richard C. Slade, Consulting Groundwater Geologist, now known as Richard C. Slade and Associates, LLC (both hereafter referred to as RCS), conducted hydrogeologic assessments of the two aquifer systems in the basin. RCS performed separate

evaluations for the Alluvial Aquifer in 1986 and the Saugus Formation in 1988, then updated this work in 2002.

The first study of the Alluvial Aquifer (RCS, 1986) identified a "practical or perennial yield" of 31,600 to 32,600 AF/yr. RCS derived these values using the so-called "Pumpage and Change-In-Storage" method, a commonly used method at the time that compares groundwater pumping volumes with changes in the volume of groundwater in storage during a multi-year period when cumulative rainfall is close to average. As RCS discussed in a more recent report (2002), this method works best in aquifers that are fully developed or in overdraft, and where recharge does not play an important role in determining the amount of groundwater in storage. Consequently, as discussed by RCS (2002), this method is not well suited to estimating sustainable pumping rates in this setting because natural recharge and water importation are major influences on the groundwater basin in the Santa Clarita Valley, and the local groundwater resources are not fully developed or in overdraft.

The first study of the Saugus Formation (RCS, 1988) did not identify a practical or perennial yield or a range of pumping rates that were estimated to be sustainable on a long-term basis. Instead, this study first estimated the "usable groundwater in storage," which was defined as the volume of Saugus Formation groundwater that is economically obtainable and of satisfactory quality for beneficial use. RCS estimated the usable groundwater in storage to be 1.41 million acre-feet. Then, using precipitation records and calculations of the exposed area of the Saugus Formation and overlying terrace deposits, and also considering the hydraulic potential for inter-aquifer flow from the overlying Alluvial Aquifer, RCS estimated that the Saugus Formation potentially receives between approximately 11,000 and 22,000 AF/yr of recharge from a combination of direct rainfall and inter-aquifer flow in any given year, depending on local hydrologic conditions. However, RCS did not discuss the relationship of these estimates to long-term pumping from the Saugus Formation. In fact, RCS noted that these assessments "…should not be construed as a rigorous determination of the perennial yield of the Saugus…."

In the *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems* (RCS, 2002), RCS concluded that groundwater levels in the Alluvial Aquifer and Saugus Formation have fluctuated over time, but have shown no long-term progressive declines in the amount of groundwater storage that could be considered indicative of overdraft conditions. From the long-term pumping and water level data, the report concluded that the Alluvial Aquifer can be pumped at rates between 30,000 and 40,000 AF/yr over the long term, and suggested that pumping be between 30,000 and 35,000 AF/yr during local droughts. For the Saugus Formation, the report concluded that pumping can occur at rates between 7,500 and 15,000 AF/yr on a long-term basis, with short-term increases to as much as 35,000 AF/yr toward the end of a multi-year period of reduced availability of imported water supplies.

RCS (2002) referred to these pumping rates for the Alluvial and Saugus aquifer systems as the "operational yield" of both aquifers, a term that was previously described in the August 2001 MOU. The term perennial yield is often interpreted as a "not-to-exceed" volume, with a related potential for pumping above the perennial yield value in any given year to be incorrectly interpreted as "overdraft." Consequently, the MOU advanced the concept of operational yield to deal with the misinterpretations commonly associated with the concept of perennial yield. In the Santa Clarita Valley, operational yield is used today to describe the

flexible use of groundwater that allows increased pumping during dry periods and subsequent recharge (direct or in-lieu) in wet/normal rainfall periods, performed in a manner that protects the aquifer by assuring that groundwater supplies are adequately replenished on a long-term basis from one wet/dry cycle to the next. This concept is the basis for the development of the current groundwater operating plan for the local groundwater basin, which is discussed in the following section.

2.2.3 Development of Current Operating Plan

The groundwater operating plan for the Santa Clarita Valley's groundwater resources has been defined in the Amended 2000 UWMP for the Santa Clarita Valley (Black & Veatch, 2000; CLWA et al., 2005) and in annual water reports that discuss the water demands, water supplies, and surface water and groundwater resources of the valley (including the *Santa Clarita Valley Water Report 2004* [LSCE, 2005a]). These reports provide ranges of values for groundwater extractions from the Alluvial Aquifer and the Saugus Formation during wet/normal years and dry years. The Purveyors have developed the operating plan by considering the water supply needs of the valley, the availability of imported water supplies, and knowledge of the historical recovery of both aquifers (following the peak pumping years that occurred prior to the mid-1960s in the Alluvial Aquifer and during the early 1990s in the Saugus Formation). The plan is summarized in Table 2-6 and is as follows:

1. Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the eastern part of the basin. Under the operating plan, pumping ranges between 30,000 and 40,000 AF/yr during normal and above-normal rainfall years, but, because of operational constraints in the eastern part of the basin, is reduced to between 30,000 and 35,000 AF/yr during locally dry years.

2. Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly imported water from the SWP system. For the Saugus Formation, the operating plan consists of pumping between 7,500 and 15,000 AF/yr during average-year conditions within the SWP system. Planned dry-year pumping from the Saugus Formation ranges between 15,000 and 25,000 AF/yr during a drought year, and increases to between 21,000 and 25,000 AF/yr if SWP deliveries are reduced for 2 consecutive years, and between 21,000 and 35,000 AF/yr if SWP deliveries are reduced for 3 consecutive years. Such high pumping would be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 AF/yr, to further enhance the effectiveness of natural recharge processes that would rapidly recover water levels and groundwater storage volumes in the Saugus Formation, as has been historically experienced.

The Purveyors have developed this plan as part of an overall water supply strategy designed to meet increasing water demands in the Santa Clarita Valley while assuring a reasonable degree of water supply reliability[3] and not exceeding the operational yield of the local aquifer systems on a long-term basis. In particular, this plan employs an integrated use

[3]As discussed in Section ES.5 of the *2004 Santa Clarita Valley Water Report* (LSCE, 2005a), the Purveyors are in the process of establishing a water reliability policy, for planning purposes, sufficient for meeting projected demands 95 percent of the time over each 20-year period. In the remaining 5 percent of the time, it is planned that the maximum supply shortage will be 10 percent of demand, a level that is based on past experience that a 10 percent water demand reduction is feasible during a drought. (During the last drought, in the early 1990s, voluntary conservation efforts by area residents resulted in a reduction in water demands of approximately 20 percent below demands in preceding years.)

of the Alluvial Aquifer and the Saugus Formation that recognizes the fundamental differences in the hydrogeologic characteristics of these two units[4]. Maintaining the substantial volume of water in the Saugus Formation is an important part of this strategy, to help maintain local groundwater supplies on a long-term basis. In implementing this operating plan, the Purveyors blend groundwater and imported water for area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and any given location in the valley is an operational decision, which varies over time according to source availability and the operational capacities of Purveyor-owned facilities. In years when SWP supplies are reduced because of regulatory factors and/or dry weather conditions in the watersheds that provide SWP water supplies, the water demands in the Santa Clarita Valley can be met through a combination of the following alternate supplies:

1. Local groundwater pumping (increased short-term Saugus pumping)
2. Deliveries from CLWA's groundwater banking programs, such as the Semitropic Groundwater Storage Program in Kern County, where CLWA has banked excess SWP water in recent years
3. Deliveries from CLWA's flexible storage account in Castaic Lake Reservoir
4. Participation in DWR dry-year water purchase programs
5. Short-term water exchanges

The Purveyors have emphasized developing water supplies that add diversity in water supply options, especially in years of dry conditions in the Santa Clarita Valley (which can reduce Alluvial Aquifer supplies) and/or reduced availability of SWP imports. Drought periods, local or in the SWP system, can affect water supplies in single and multiple years. Details concerning the nature of local hydrologic variations, which govern Alluvial Aquifer pumping, are presented in Section 2.2.3.1. Section 2.2.3.2 discusses variations in imported water availability, which governs pumping from the Saugus Formation.

2.2.3.1 Variations in Local Hydrology and Alluvial Aquifer Pumping

The rate of pumping from the Alluvial Aquifer in a given year is partly affected by groundwater elevations in the eastern portion of the basin, which is the primary groundwater recharge area for the local groundwater systems. Historically, during dry years, decreases in Alluvial Aquifer pumping occur in the eastern-most Alluvial Aquifer production wells, which are located adjacent to the Santa Clara River in Soledad Canyon, upstream of the mouth of Bouquet Canyon. Reduced groundwater pumping occurs in these areas because of declines in groundwater elevations resulting from reduced groundwater recharge by the Santa Clara River during dry years. Groundwater levels in this area have historically decreased between approximately 50 and 100 feet during multi-year periods of below-normal rainfall and Santa Clara River streamflows. Consequently, the approximate

[4]As discussed in this report and other documents (RCS, 2002; CH2M HILL, 2004a; LSCE, 2005a), the Alluvial Aquifer is more permeable and much thinner than the Saugus Formation. The eastern portion of the Alluvial Aquifer also shows considerably greater short-term (month-to-month) and long-term (year-to-year) fluctuations in groundwater levels than the rest of the Alluvial Aquifer and the Saugus Formation.

5,000 AF/yr reduction in Alluvial Aquifer pumping in dry years that is called for under the operating plan occurs primarily as reduced pumping from wells in eastern Soledad Canyon.

Elsewhere in the Alluvial Aquifer, where groundwater elevations have fluctuated much less during single-year or multi-year dry periods, reductions in pumping rates have been unnecessary. Throughout the Alluvial Aquifer, groundwater elevations have historically recovered fully in response to the normal and above-normal rainfall and stream flows that mark the end of each dry period.

The historical record of rainfall and pumping indicates that the 5,000 AF/yr of dry-year reduction in Alluvial Aquifer pumping typically occurs when rainfall is below 12 in/yr, as measured at the Newhall-Soledad rain gage. Annual rainfall at this gage was below 12 in/yr during 14 years of this 50-year period, as shown on Figure 2-5.

2.2.3.2 Variations in State Water Project Hydrology and Saugus Formation Pumping

The rate of pumping from the Saugus Formation in a given year is governed by the availability of imported water supplies, particularly imported water from the SWP system. CLWA has performed a statistical evaluation of SWP deliveries (Kennedy/Jenks Consultants, 2003) using the 2021B scenario from the CALSIM II model, which was developed by DWR for its SWP Delivery Reliability Report (DWR, 2003). The CALSIM II model and the SWP Delivery Reliability Report were developed to support (1) the preparation of urban water management plans by the water agencies that are SWP contractors, (2) analyses required to comply with Senate Bills 221 and 610, and (3) other water supply planning activities that include the SWP as a supply component. The 2021B scenario simulates the anticipated deliveries of water to the 29 SWP contractors using an historical hydrologic record and anticipated operating and regulatory conditions for the SWP system in 2021. The U.S. Bureau of Reclamation (USBR) has also used CALSIM II to perform biological assessment studies for the Operating Criteria and Plan (OCAP) for the SWP (USBR, 2004). Both the CLWA and the USBR studies, which were made public for review in February 2004, include evaluations of the role and function of an Environmental Water Account (EWA), which consists of water purchased to mitigate the water supply impacts of protection measures for endangered species. These CALSIM II simulations have been performed for the SWP system at a present-day level of development and for the anticipated level of development in 2020. Table 2-7 compares the municipal and industrial water use allocations calculated by CALSIM II for the SWP Reliability Report (DWR, 2003) and for the OCAP (USBR, 2004) for the hydrology that occurred from 1950 through 1993.

CLWA's evaluation reached the following conclusions regarding the deliveries it will receive under this scenario (Kennedy/Jenks Consultants, 2003):

1. A regression analysis indicates that there is a weak relationship between the SWP delivery in a given year and the previous year's delivery.

2. SWP deliveries will equal or exceed 70 percent of CLWA's 95,200 AF/yr Table A water amount during approximately 75 percent of the simulated years. During the remaining years, the deliveries will vary between 20 and 70 percent.

3. A Monte Carlo analysis of projected deliveries during 73 consecutive years indicated that at a 95 percent confidence level, 4 years of a 7-year drought period in the SWP

system (such as was observed from 1988 through 1994) will have sufficiently low deliveries to require short-term pumping of increased groundwater volumes to meet local water demands. This includes a period of 3 consecutive years of increased pumping.

Section 3.3.3 of this report discusses the relationship between SWP hydrology, SWP allocations to the 29 SWP contractors, and corresponding pumping from the Saugus Formation, and how this relationship was built into the modeling analysis of the groundwater operating plan.

Tables

TABLE 2-1
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges to the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam, Lang gage)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial Aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow into the Santa Clarita Valley occurs beneath Castaic Creek through water seepage beneath Castaic Dam.

TABLE 2-2
Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Calendar Year	Total Flow at Mouth of Castaic Creek (acre-feet)[a]	Total Gaged Flow at County Line (acre-feet)[b]	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[c]	Local Rainfall Condition[d]
1953	0	4,986	4,943	0	4,943	4.88	Dry
1954	977	7,316	5,554	0	5,554	15.82	Normal
1955	134	4,795	4,122	0	4,122	13.91	Normal
1956	311	5,429	3,803	0	3,803	14.21	Normal
1957	559	4,782	2,410	0	2,410	22.85	Wet
1958	21,204	38,756	5,344	0	5,344	23.14	Wet
1959	473	3,277	2,206	0	2,206	9.81	Dry
1960	1	777	586	0	586	11.64	Dry
1961	79	804	410	0	410	8.82	Dry
1962	5,101	28,460	2,433	0	2,433	21.22	Wet
1963	32	1,884	1,058	0	1,058	12.79	Normal
1964	1	1,030	646	0	646	10.09	Dry
1965	3,702	35,614	996	0	996	32.28	Wet
1966	5,780	10,101	2,332	No data	---	14.57	Normal
1967	27,819	40,480	8,640	No data	---	23.23	Wet
1968	4,381	7,216	3,895	No data	---	6.90	Dry
1969	46,461	258,660	29,395	No data	---	32.42	Wet
1970	6,597	31,066	14,924	No data	---	23.19	Wet
1971	2,310	15,883	10,843	No data	---	13.75	Normal
1972	2,205	16,027	12,975	No data	---	4.15	Dry
1973	12,671	52,631	26,115	No data	---	19.79	Wet
1974	7,288	25,265	11,918	No data	---	18.04	Wet
1975	2,027	14,770	10,806	5,534	5,272	10.92	Dry
1976	156	10,162	9,754	6,095	3,659	14.02	Normal
1977	1,380	13,454	9,359	6,004	3,355	20.87	Wet
1978	35,378	129,187	60,955	6,982	53,973	42.17	Wet
1979	13,626	57,594	42,448	7,397	35,051	21.47	Wet
1980	16,785	95,211	57,593	7,372	50,221	27.00	Wet
1981	6,519	24,232	21,172	7,949	13,223	13.42	Normal
1982	9,102	36,488	32,531	8,436	24,095	20.20	Wet
1983	67,058	131,236	55,878	9,420	46,458	39.07	Wet

TABLE 2-2
Estimated Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Calendar Year	Total Flow at Mouth of Castaic Creek (acre-feet)[a]	Total Gaged Flow at County Line (acre-feet)[b]	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[c]	Local Rainfall Condition[d]
1984	13,787	39,279	35,215	9,512	25,703	12.86	Normal
1985	2,619	24,466	24,089	9,614	14,475	8.37	Dry
1986	4,945	48,024	31,327	10,822	20,505	18.02	Wet
1987	911	26,198	23,663	11,844	11,819	14.45	Normal
1988	2,415	36,611	24,934	12,363	12,571	16.92	Wet
1989	Unavailable	24,799	23,453	13,560	9,893	7.56	Dry
1990	0	23,472	21,772	14,006	7,766	6.98	Dry
1991	65	34,901	18,702	14,108	4,594	17.21	Wet
1992	4,450	68,577	23,601	15,703	7,898	32.03	Wet
1993	7,725	152,783	65,054	17,179	47,875	32.72	Wet
1994	Unavailable	32,039	31,239	16,946	14,293	10.27	Dry
1995	5,611	82,409	51,001	17,824	33,177	29.15	Wet
1996	5,632	47,930	36,366	16,831	19,535	15.88	Normal
1997	9,885	36,780	27,521	15,778	11,743	13.35	Normal
1998	47,803	205,139	81,744	17,695	64,049	30.73	Wet
1999	5,830	32,382	27,176	17,847	9,329	8.96	Dry

[a]Values through June 1977 are from the former Castaic Creek South gage (U.S. Geologic Survey [USGS] Gage Station 11108145). Values after June 1977 are derived from records of releases from Castaic Dam/Lagoon into Castaic Creek, as provided by DWR.

[b]Values through September 30, 1996, are from USGS Gage Station 11108500. This gage was located immediately downstream of the Los Angeles-Ventura County Line and was taken permanently out of service after October 21, 1996. Data beginning on October 1, 1996, are from new USGS gage station 11109000, located approximately 2.5 miles farther downstream, near Piru Junction, at the Las Brisas Bridge.

[c]Annual rainfall values are based on monthly records for this gage, as reported by the National Climate Data Center and LADPW.

[d]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-3
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	311	4,795	2,410	0	2,410	13.91
Average	2,506	10,608	2,655	0	2,655	15.50
Maximum	21,204	38,756	5,554	0	5,554	32.28
Statistics for 1975 through 1999						
Minimum	0	10,162	9,359	5,534	3,355	6.98
Median	5,632	36,611	27,521	11,844	14,293	16.92
Average	11,466	57,125	33,894	11,873	22,021	19.38
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	3,161	30,250	22,613	11,844	8,613	15.14
Average	8,230	41,211	23,207	11,873	15,396	18.05
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	4,450	28,460	18,702	11,844	8,613	15.82
Average	9,151	43,050	21,338	11,873	15,396	17.92
Maximum	67,058	258,660	81,744	17,847	64,049	42.17

TABLE 2-4
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 versus 1975 through 1999
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 5 Dry Years during 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	1	1,030	646	0	646	9.81
Average	111	2,175	1,758	0	1,758	9.05
Maximum	473	4,986	4,943	0	4,943	11.64
Statistics for 4 Normal Years during 1953 through 1965						
Minimum	32	1,884	1,058	0	1,058	12.79
Median	222	5,112	3,963	0	3,963	14.06
Average	363	4,856	3,634	0	3,634	14.18
Maximum	977	7,316	5,554	0	5,554	15.82
Statistics for 4 Wet Years during 1953 through 1965						
Minimum	559	4,782	996	0	996	21.22
Median	4,402	32,037	2,421	0	2,421	23.00
Average	7,641	26,903	2,796	0	2,796	24.87
Maximum	21,204	38,756	5,344	0	5,344	32.28
Statistics for 6 Dry Years during 1975 through 1999						
Minimum	0	14,770	10,806	5,534	5,272	6.98
Median	2,323	24,633	23,771	13,783	9,611	8.67
Average	2,619	25,322	23,089	12,918	10,171	8.84
Maximum	5,830	32,382	31,239	17,847	14,475	10.92
Statistics for 6 Normal Years during 1975 through 1999						
Minimum	156	10,162	9,754	6,095	3,659	12.86
Median	6,076	31,489	25,592	10,678	12,521	13.72
Average	6,148	30,763	25,615	11,335	14,280	14.00
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 13 Wet Years during 1975 through 1999						
Minimum	65	13,454	9,359	6,004	3,355	16.92
Median	7,725	68,577	42,448	10,822	33,177	27.00
Average	16,642	83,970	42,702	11,639	31,063	26.74
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-5
Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 13 Dry Years during 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	473	14,770	10,806	13,783	5,272	8.82
Average	1,601	14,311	12,630	12,918	6,347	8.41
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 12 Normal Years during 1953 through 1999						
Minimum	0	7,316	2,433	6,004	2,433	13.35
Median	5,101	26,198	21,172	11,844	11,743	16.92
Average	5,238	27,883	16,963	10,788	8,671	17.10
Maximum	12,671	52,631	27,521	15,778	13,223	21.22
Statistics for 22 Wet Years during 1953 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	7,507	44,252	25,525	10,822	20,505	23.17
Average	15,807	73,060	29,877	11,639	24,412	25.62
Maximum	67,058	258,660	81,744	17,824	64,049	42.17
Statistics for 11 Dry Years during 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	79	14,770	10,806	13,783	5,272	8.96
Average	1,226	14,800	13,393	12,918	6,347	8.94
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 10 Normal Years during 1953 through 1965 and 1975 through 1999						
Minimum	32	1,884	1,058	6,095	1,058	12.79
Median	944	17,197	15,463	10,678	8,649	13.97
Average	3,834	20,400	16,823	11,335	10,022	14.07
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 17 Wet Years during 1953 through 1965 and 1975 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	5,611	48,024	31,327	10,822	20,505	23.14
Average	14,524	70,543	33,312	11,639	24,412	26.30
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-6
Annual Pumping Rates Specified by the Operating Plan for Santa Clarita Valley Groundwater Resources
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Aquifer	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
Operating Plan Pumping				
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	15,000 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**45,000 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**
Modeled Pumping				
Alluvium	38,429	33,767	33,767	33,767
Saugus	10,679	15,760	24,346	34,096
Total	**49,108**	**49,527**	**58,113**	**67,863**

Notes:

All pumping volumes are listed in acre-feet.

The operating plan is defined in the Amended 2000 UWMP (Black & Veatch, 2000; CLWA et al., 2005).

In the model simulations, total pumping is different than listed in this table when dry-year pumping conditions in one aquifer coincide with normal-year pumping conditions in the other aquifer (because of differences in the timing of dry conditions locally versus reduced deliveries of SWP water imports).

TABLE 2-7
CALSIM II Calculated State Water Project Municipal and Industrial Allocations
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	OCAP Current EWA[a]	OCAP Future EWA[a]	2020 SWP Reliability[b]
1950	0.88	0.91	0.79
1951	1.00	1.00	0.96
1952	1.00	1.00	1.00
1953	1.00	1.00	0.95
1954	1.00	1.00	0.96
1955	0.44	0.45	0.43
1956	1.00	1.00	1.00
1957	0.94	0.91	0.75
1958	1.00	1.00	1.00
1959	0.84	0.88	0.83
1960	0.51	0.55	0.56
1961	0.68	0.72	0.76
1962	0.93	0.98	0.87
1963	1.00	1.00	1.00
1964	0.84	0.74	0.73
1965	0.87	0.81	0.77
1966	1.00	1.00	0.92
1967	1.00	1.00	1.00
1968	0.89	0.90	0.85
1969	1.00	1.00	1.00
1970	1.00	1.00	0.95
1971	1.00	1.00	1.00
1972	0.76	0.75	0.65
1973	1.00	1.00	0.91
1974	1.00	1.00	1.00
1975	1.00	1.00	1.00
1976	0.78	0.75	0.65
1977	0.03	0.04	0.20
1978	1.00	1.00	1.00
1979	1.00	0.94	0.89
1980	1.00	0.91	0.85
1981	0.90	0.92	0.84
1982	1.00	1.00	1.00
1983	1.00	1.00	1.00
1984	0.66	1.00	0.99
1985	0.97	0.91	0.83
1986	0.74	0.70	0.78
1987	0.70	0.77	0.71
1988	0.12	0.17	0.23
1989	0.96	0.95	0.83
1990	0.24	0.27	0.28
1991	0.24	0.29	0.25
1992	0.39	0.43	0.29
1993	1.00	1.00	1.00

[a]Source: USBR, 2004

[b]Source: DWR, 2003

Figures

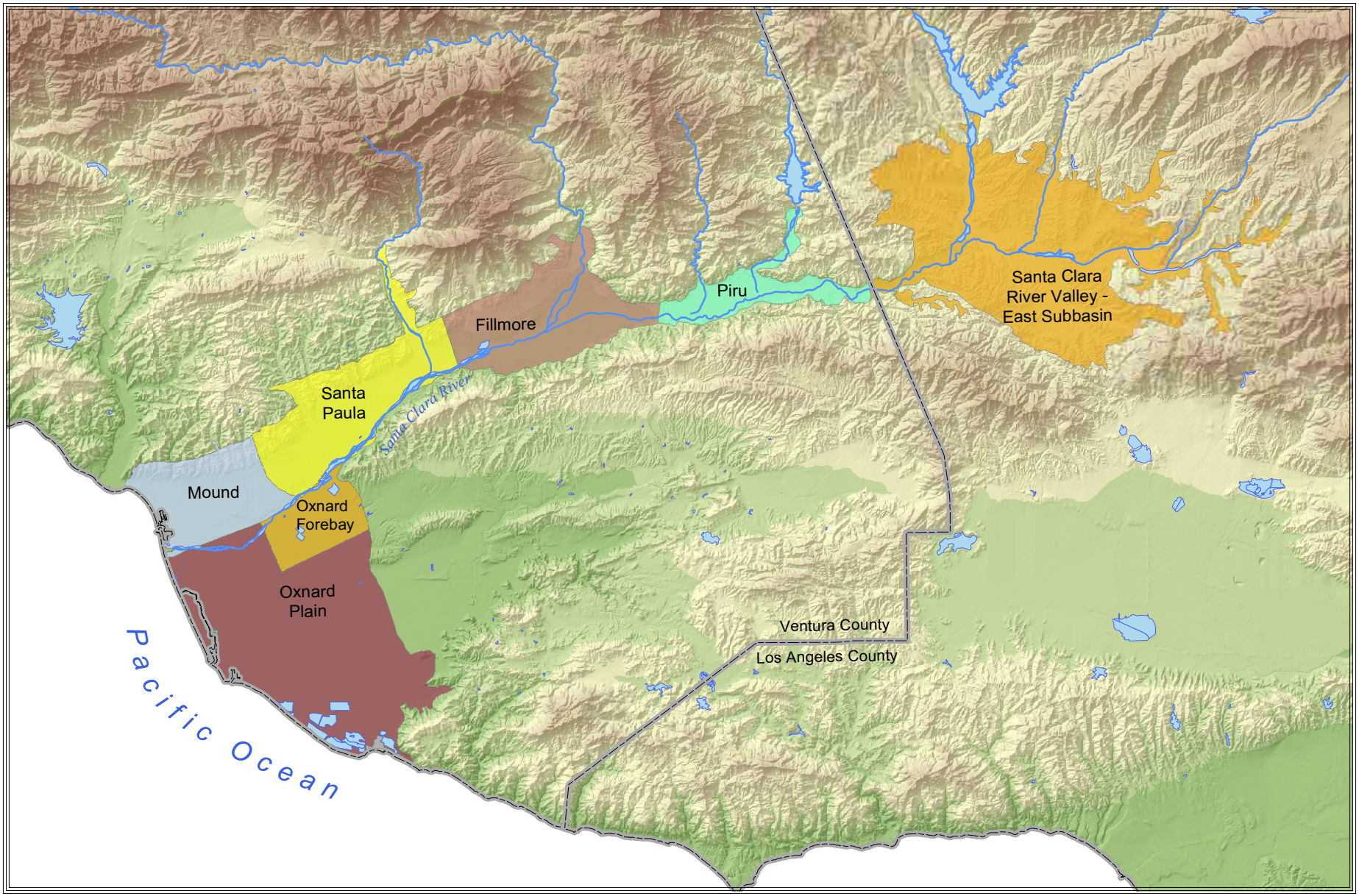

FIGURE 2-1
GROUNDWATER BASINS IN THE SANTA CLARA RIVER DRAINAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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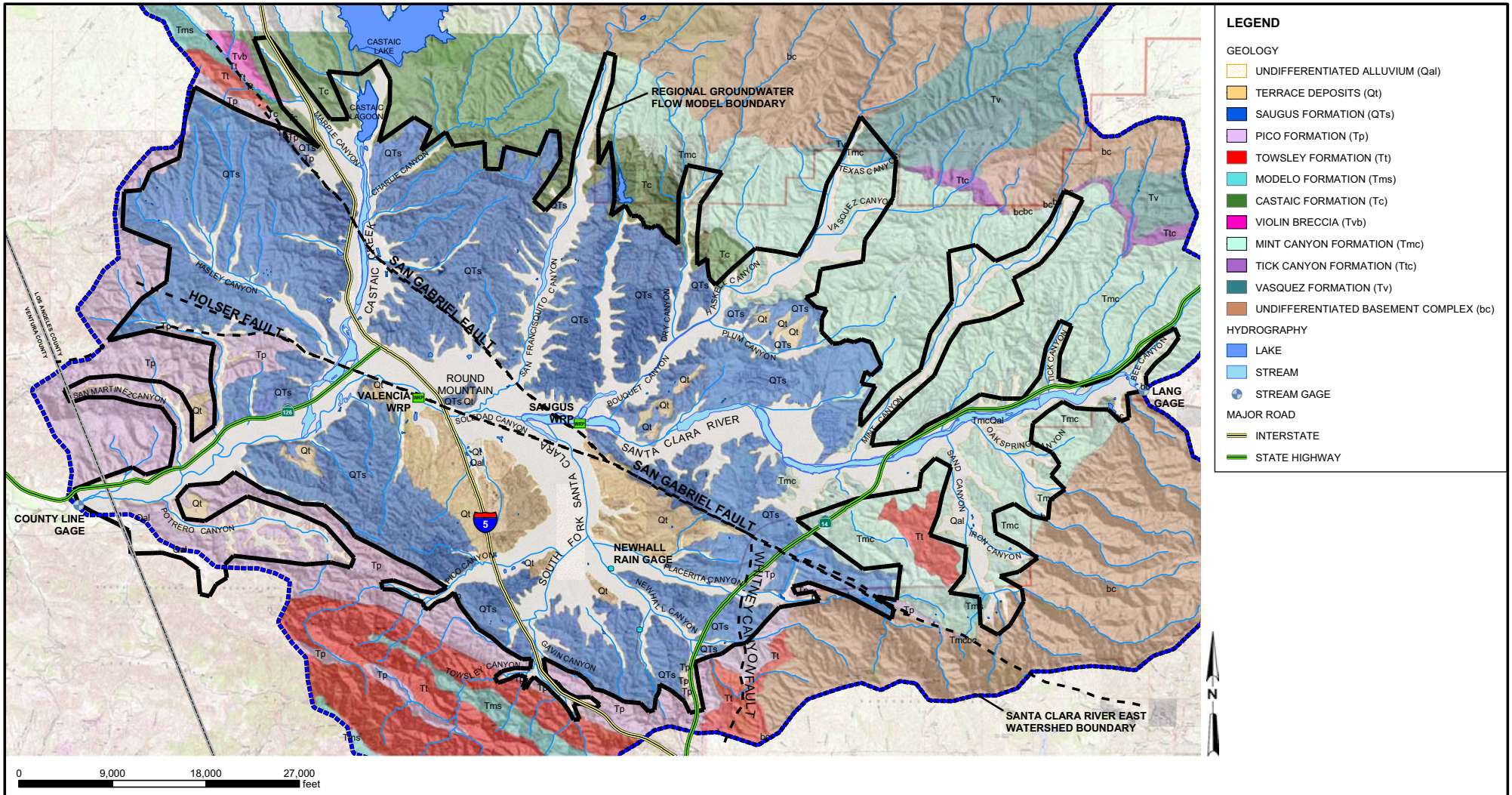

LEGEND

GEOLOGY
- UNDIFFERENTIATED ALLUVIUM (Qal)
- TERRACE DEPOSITS (Qt)
- SAUGUS FORMATION (QTs)
- PICO FORMATION (Tp)
- TOWSLEY FORMATION (Tt)
- MODELO FORMATION (Tms)
- CASTAIC FORMATION (Tc)
- VIOLIN BRECCIA (Tvb)
- MINT CANYON FORMATION (Tmc)
- TICK CANYON FORMATION (Ttc)
- VASQUEZ FORMATION (Tv)
- UNDIFFERENTIATED BASEMENT COMPLEX (bc)

HYDROGRAPHY
- LAKE
- STREAM
- STREAM GAGE

MAJOR ROAD
- INTERSTATE
- STATE HIGHWAY

FIGURE 2-2
BASIN GEOLOGIC MAP
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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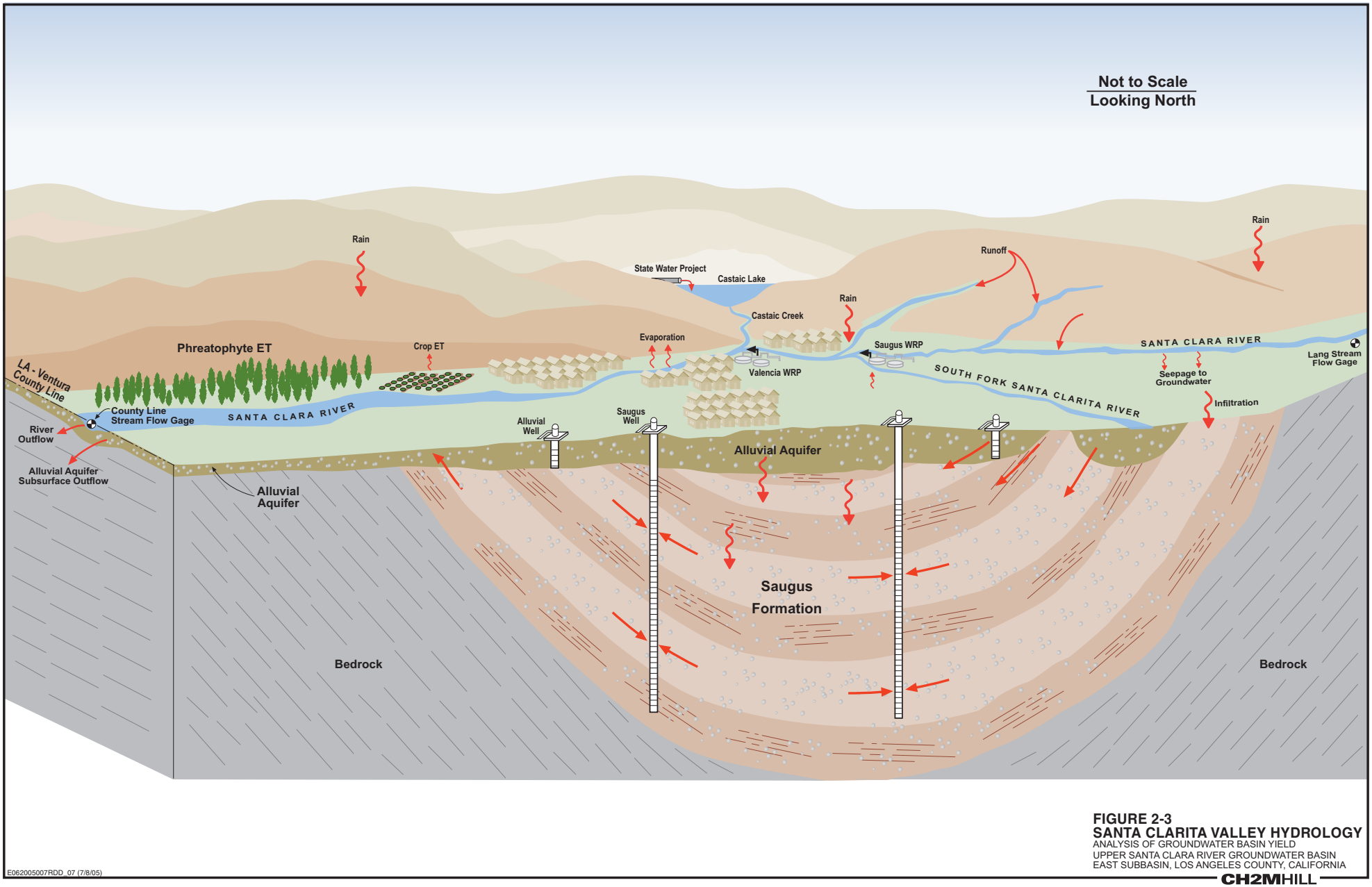

FIGURE 2-3
SANTA CLARITA VALLEY HYDROLOGY
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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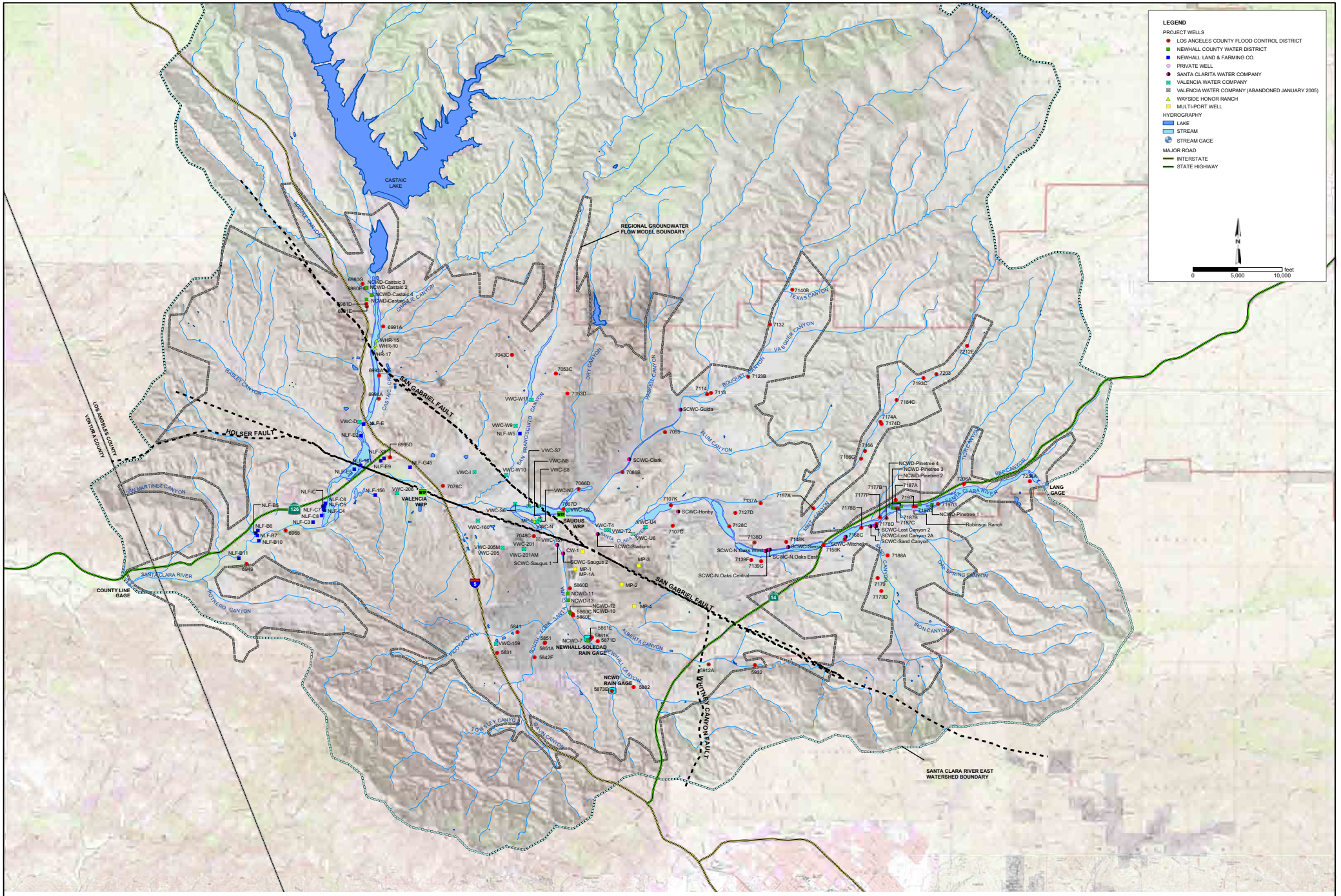

FIGURE 2-4
REGIONAL WELL LOCATION MAP
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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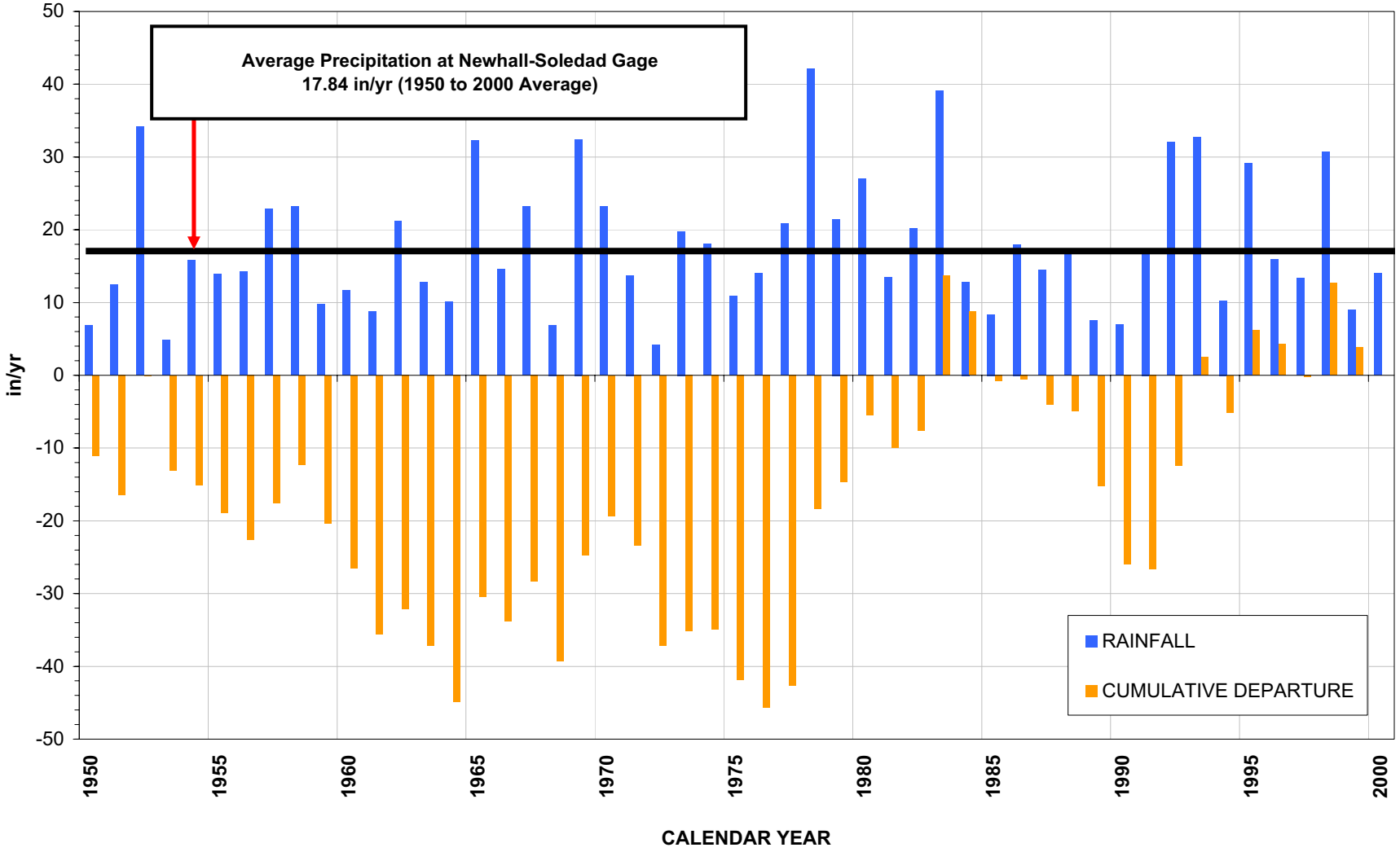

FIGURE 2-5
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE

ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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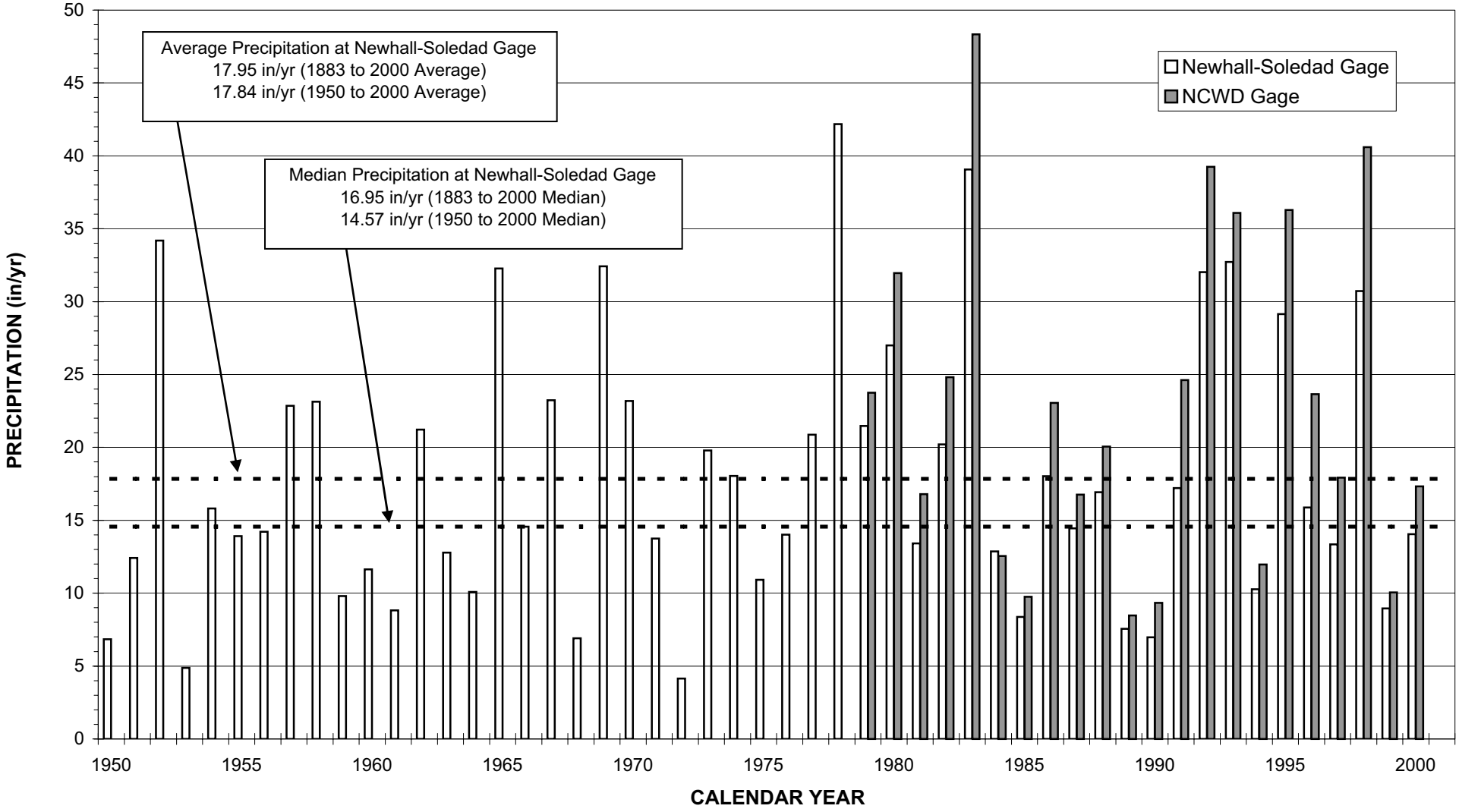

FIGURE 2-6
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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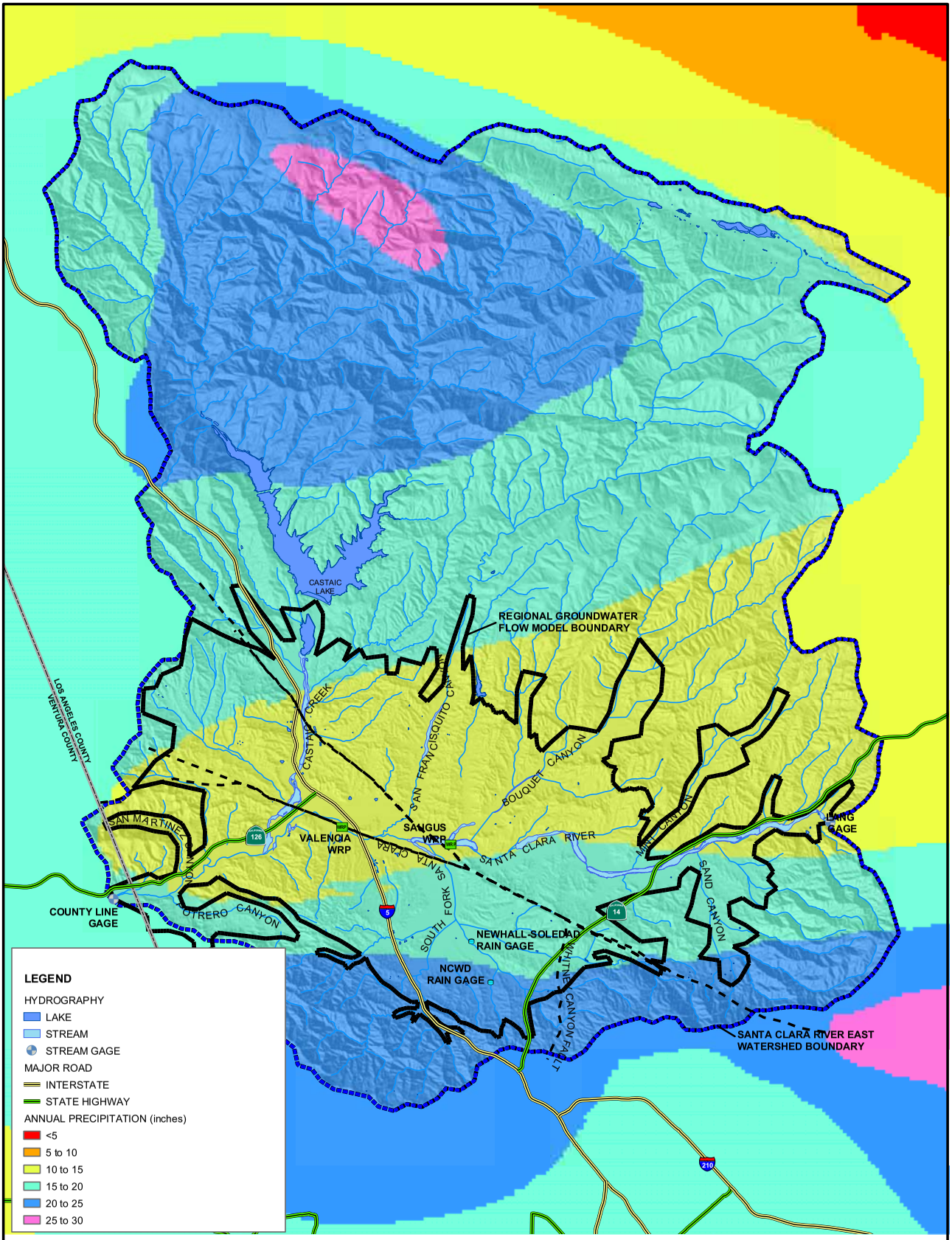

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

N

0 2.5 5 miles

FIGURE 2-7
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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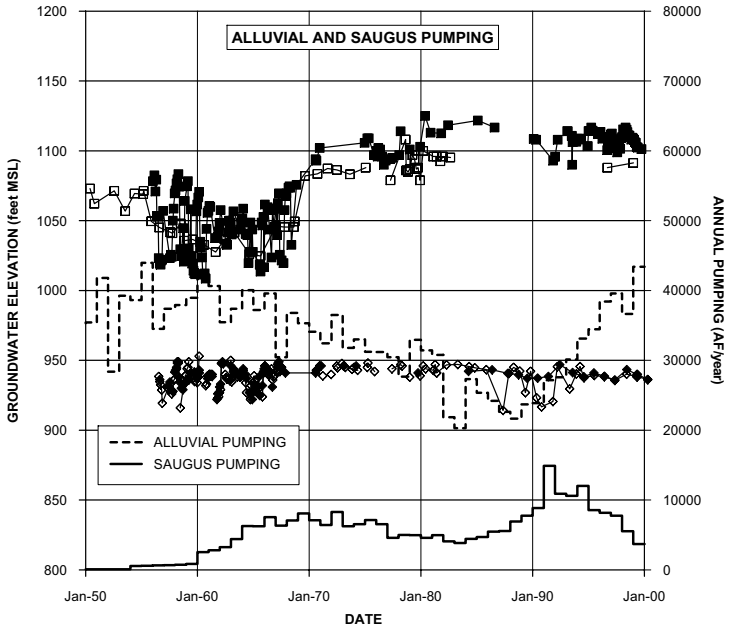

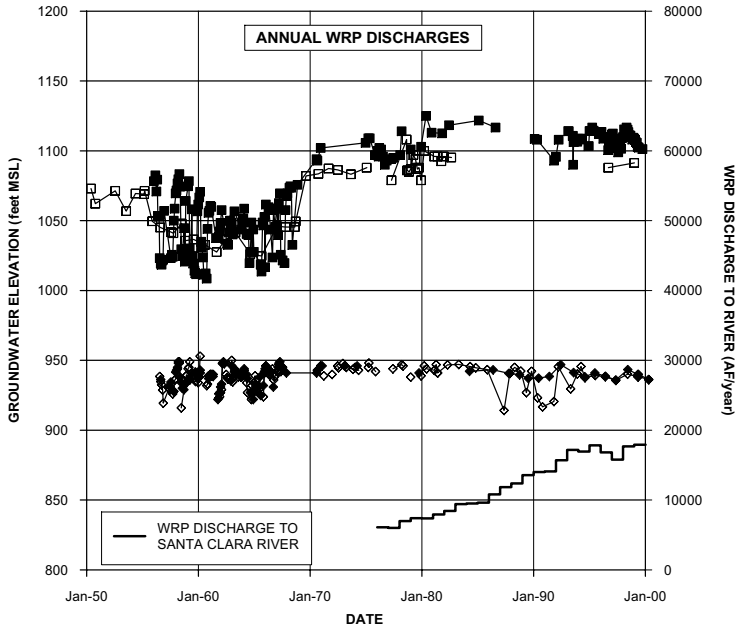

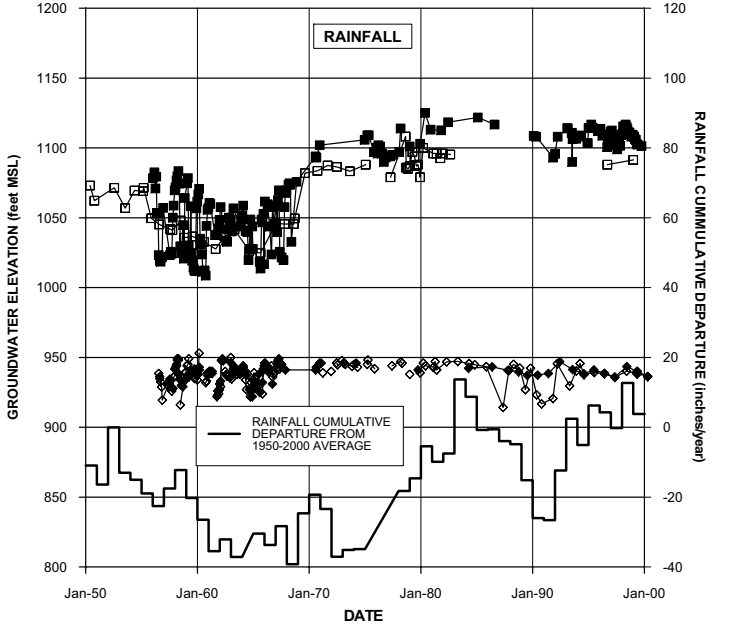

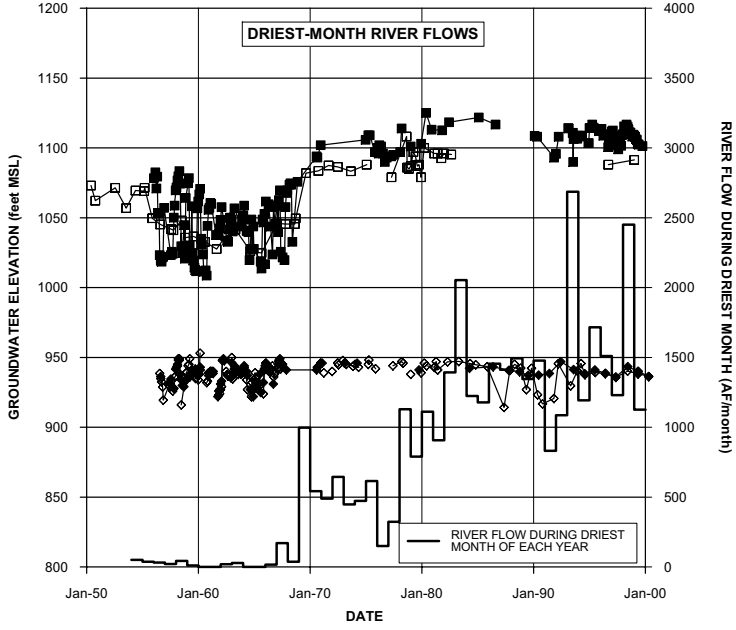

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N
- ELEVATION OF GROUNDWATER IN NLF-S
- ELEVATION OF GROUNDWATER IN NLF-C5
- ELEVATION OF GROUNDWATER IN NLF-C7

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS. FORMER WELL NLF-S WAS LOCATED 940 feet SOUTHWEST OF WELL VWC-S6.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-8
ALLUVIAL GROUNDWATER ELEVATIONS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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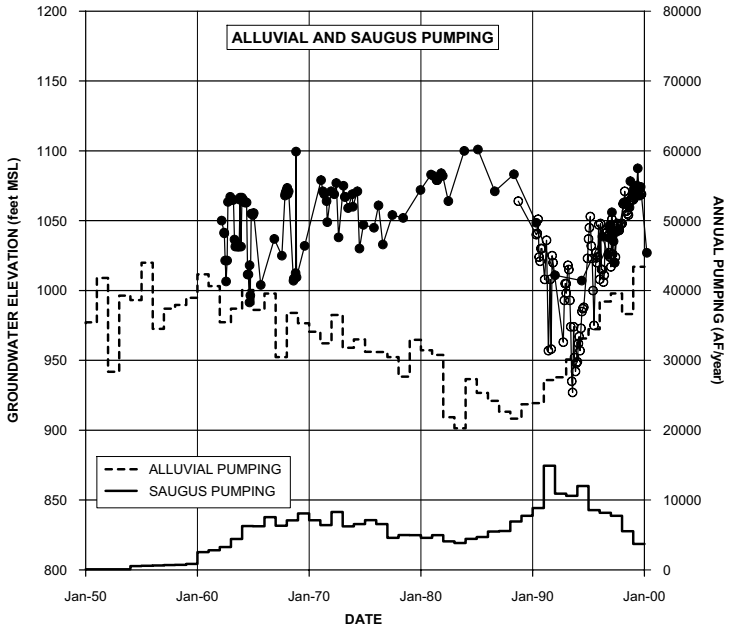

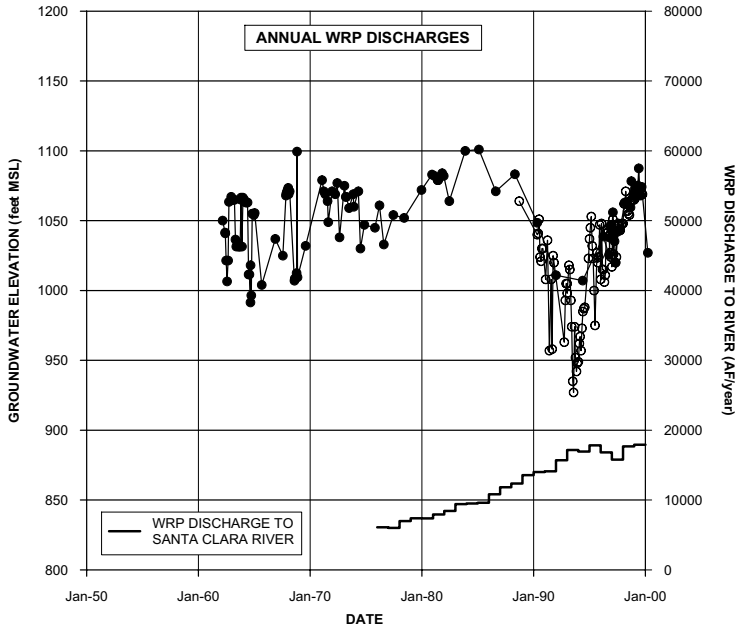

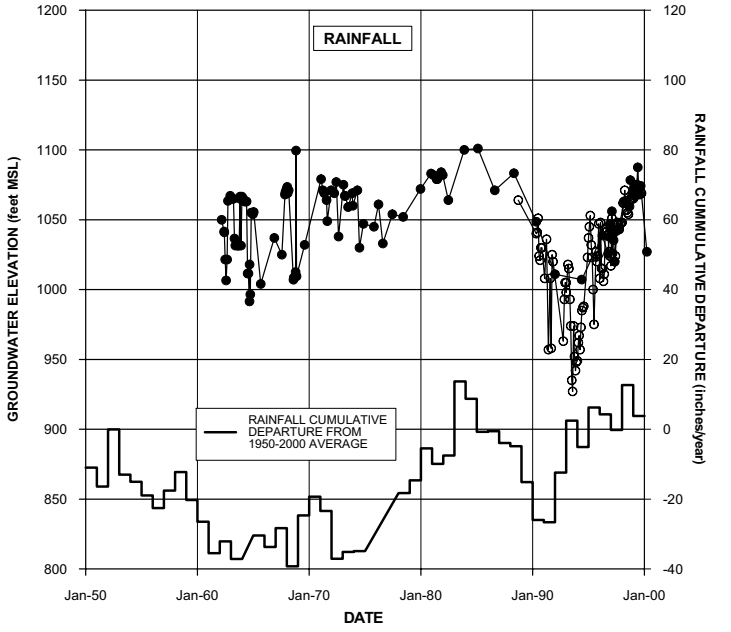

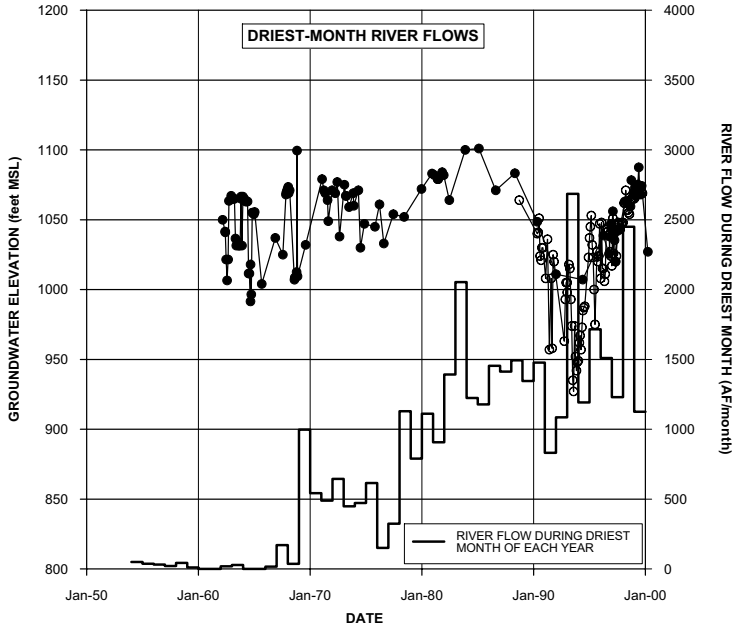

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157 (DESTROYED JANUARY 2005)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-9
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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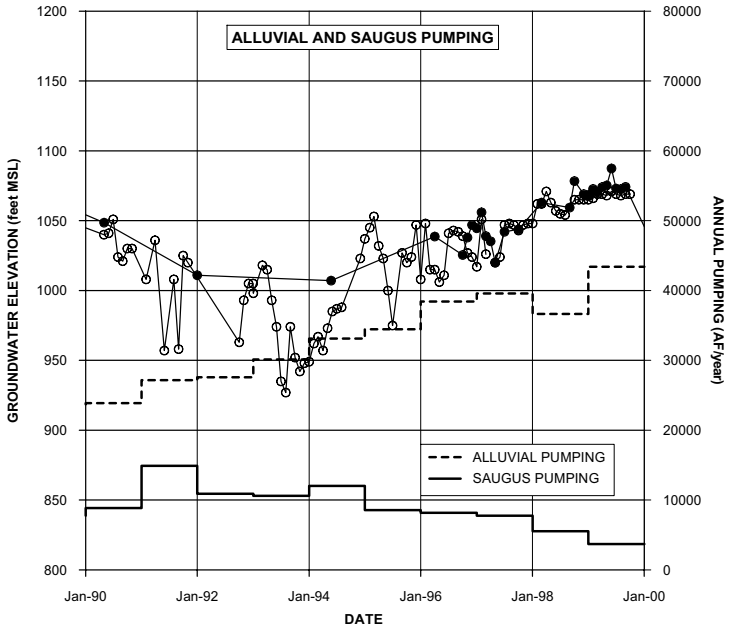

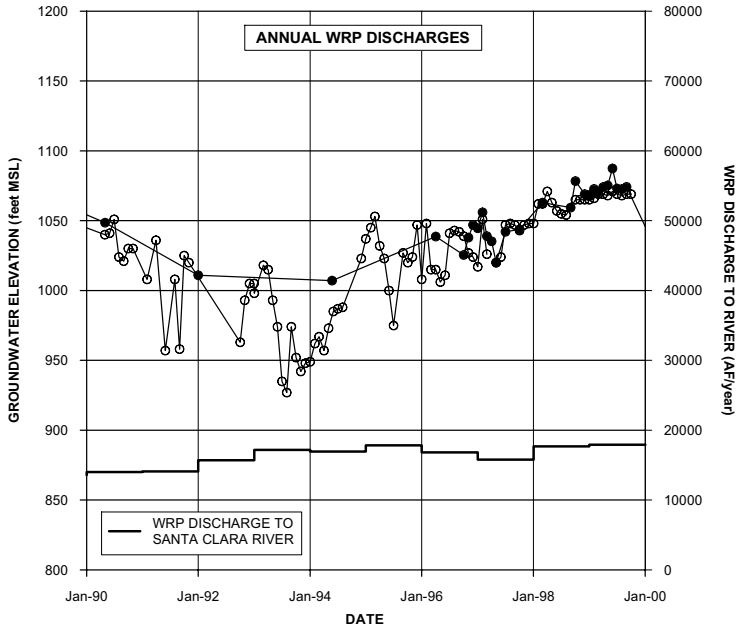

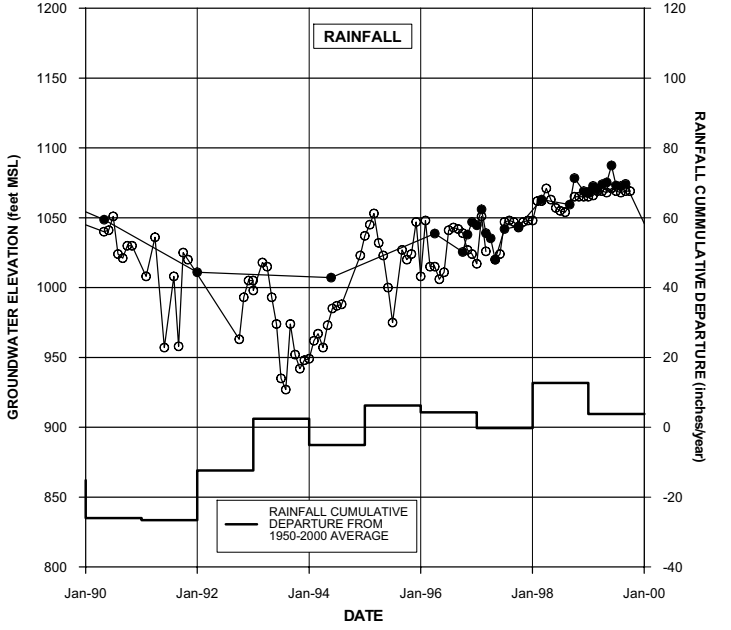

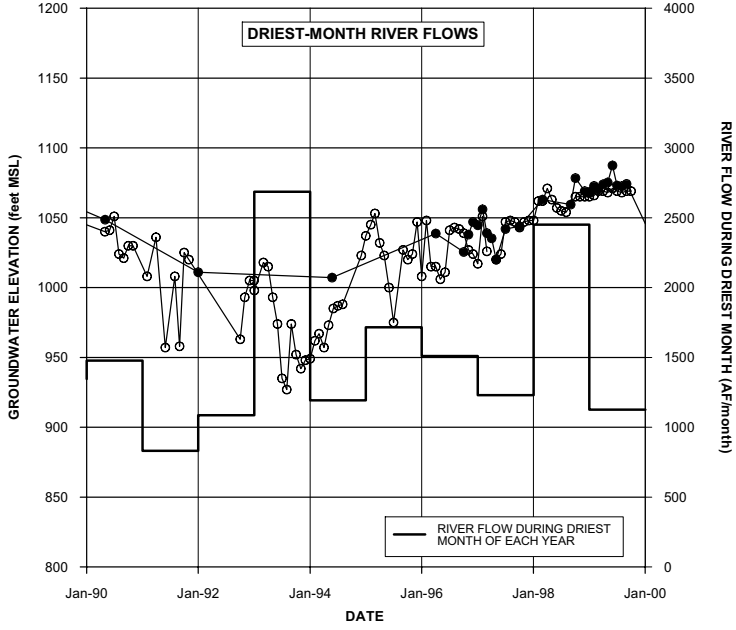

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157 (ABANDONED JANUARY 2005)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-10
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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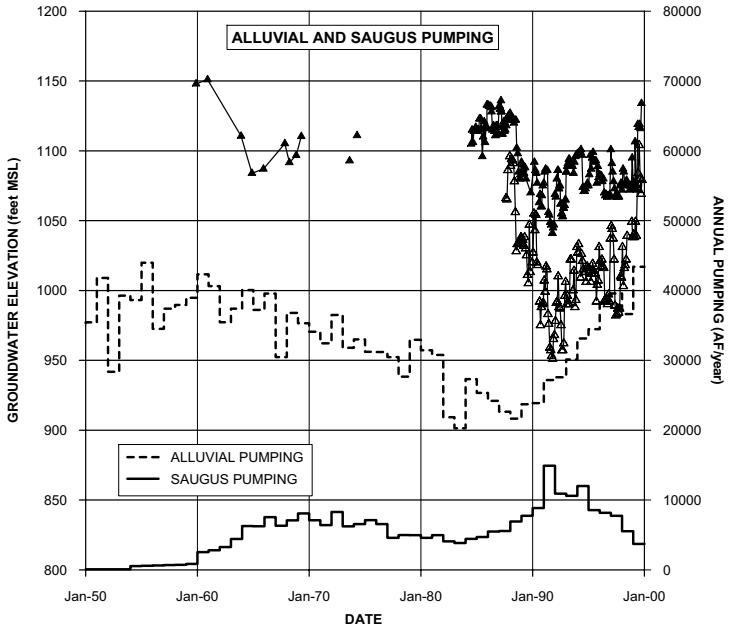

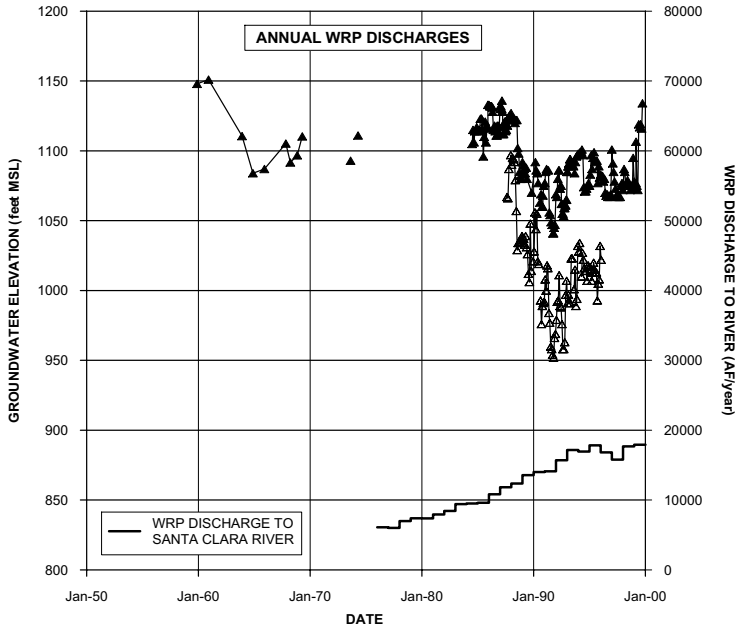

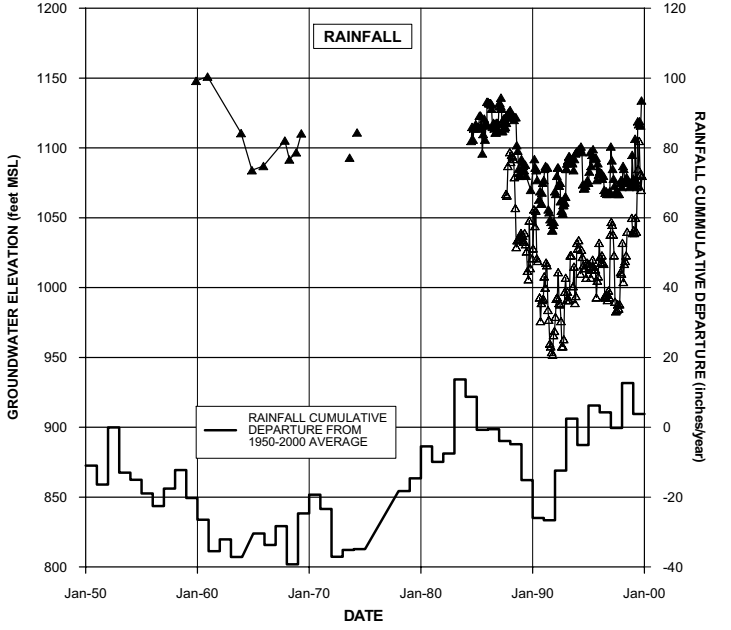

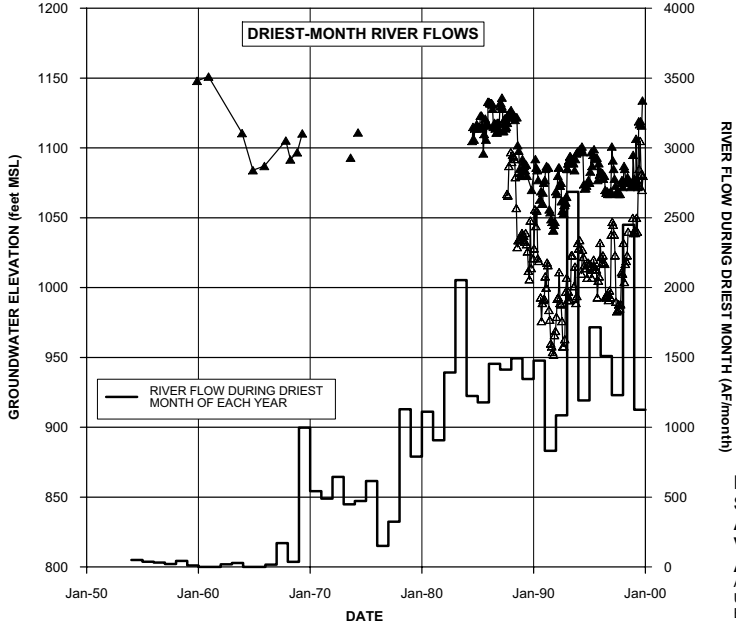

LEGEND

- ELEVATION OF GROUNDWATER IN NCWD-7
- ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-11
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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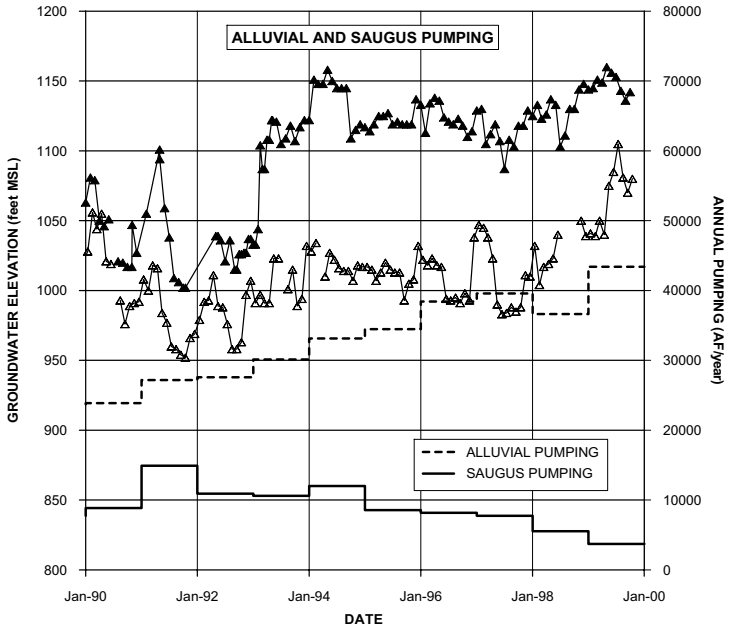

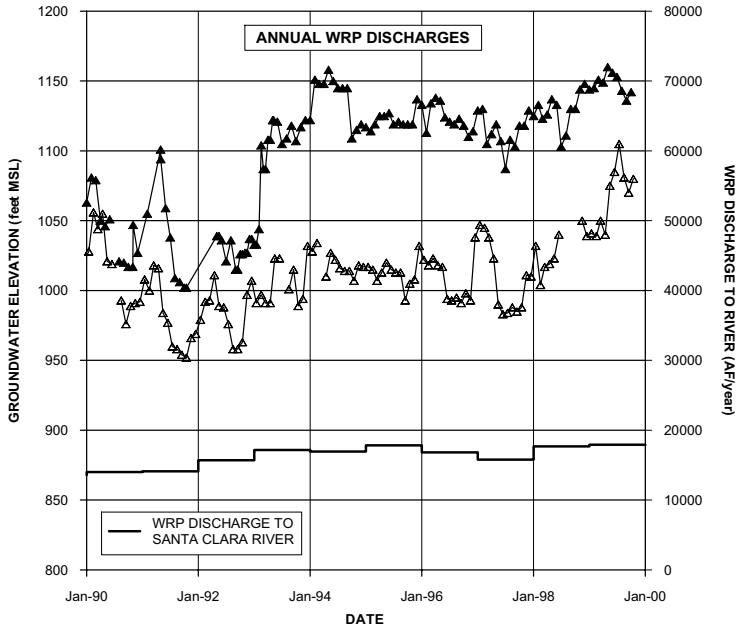

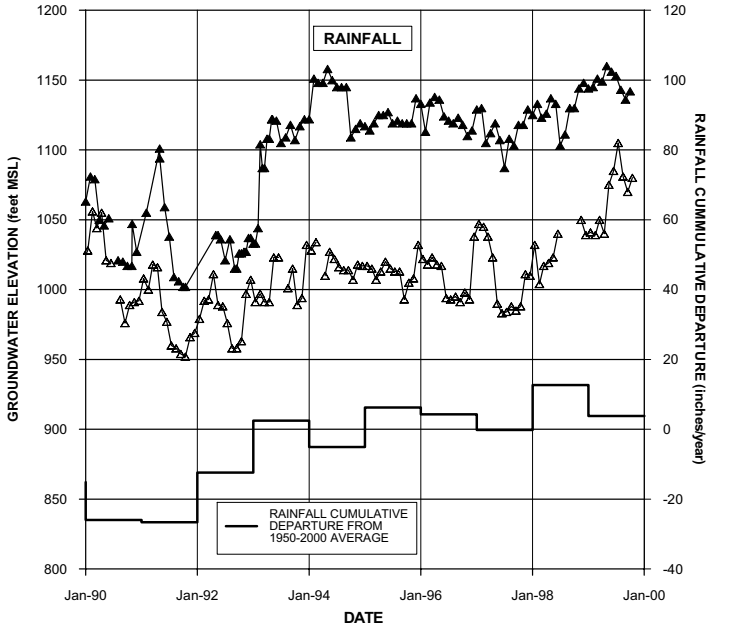

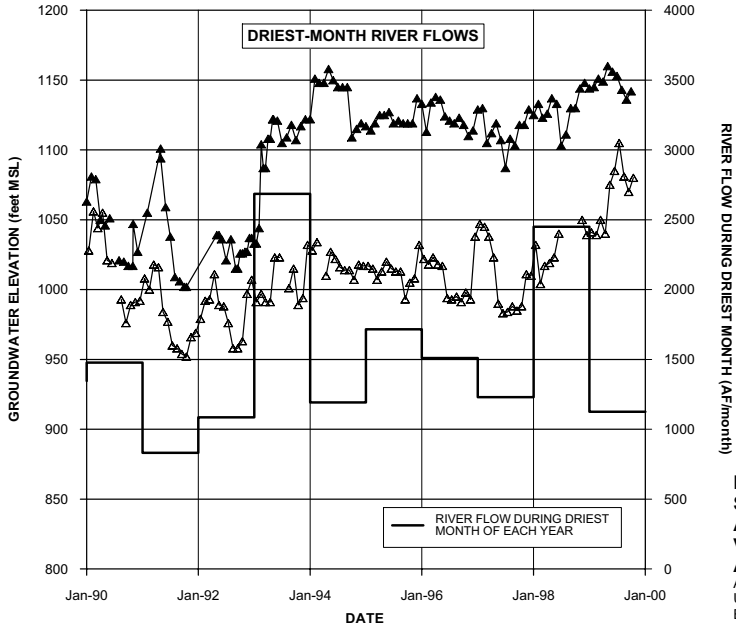

LEGEND

ELEVATION OF GROUNDWATER IN NCWD-10
ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-12
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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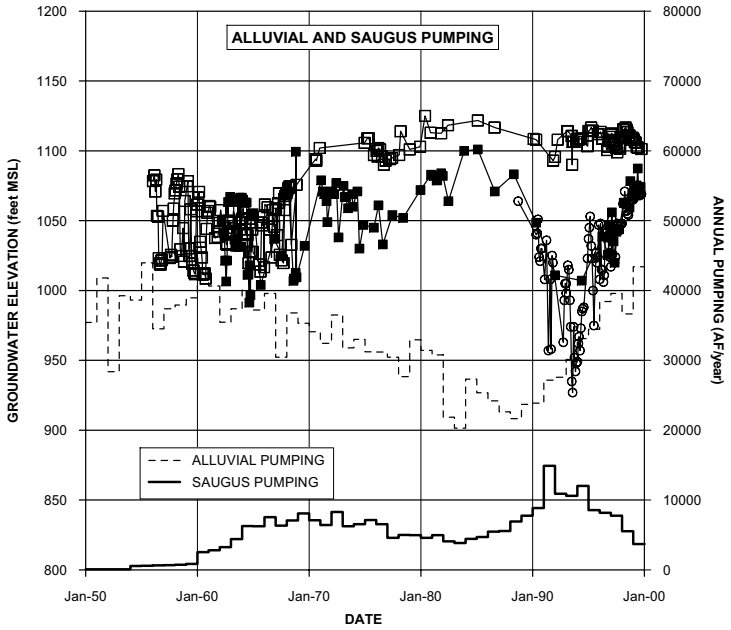

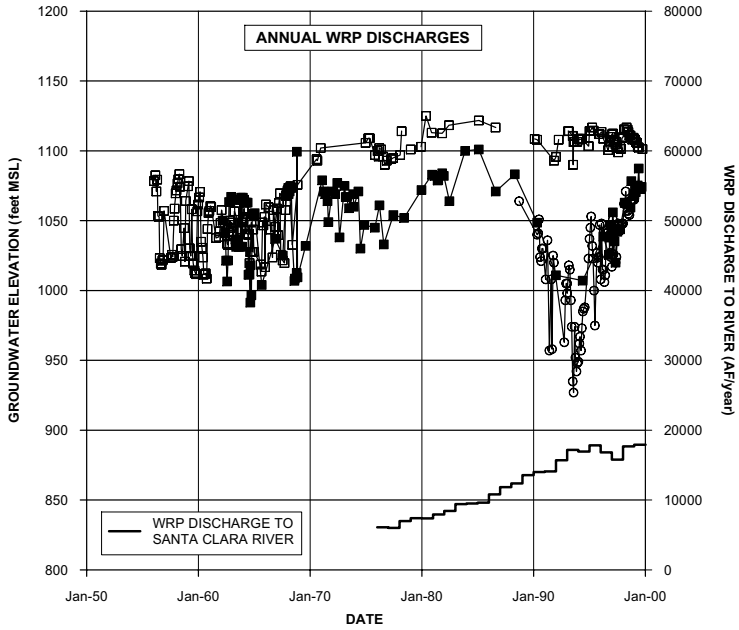

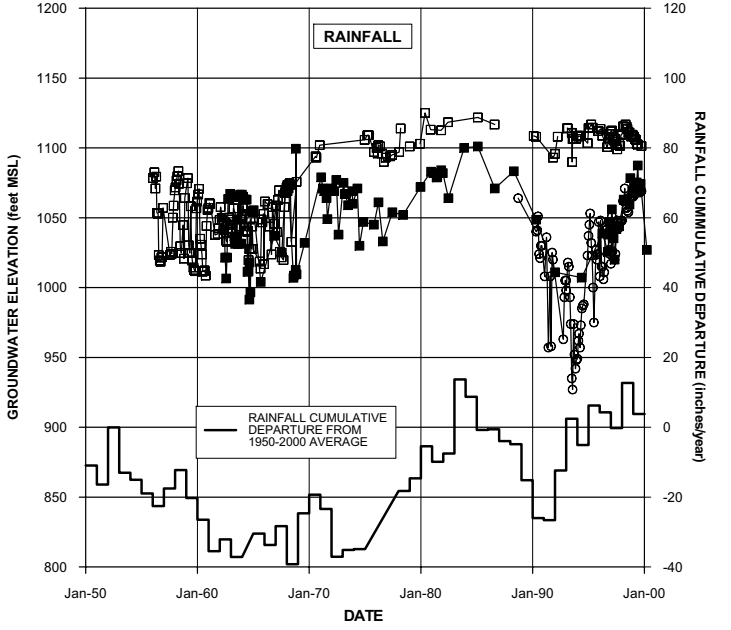

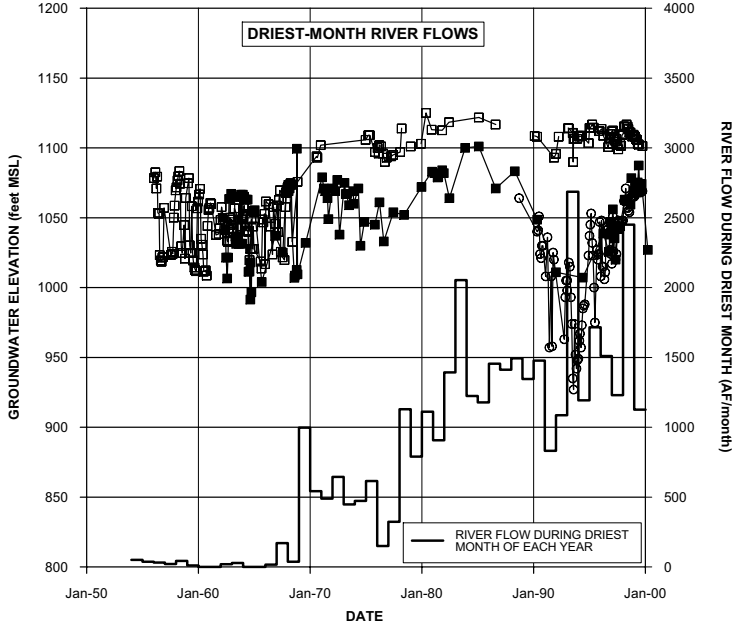

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N (ALLUVIUM)
- ELEVATION OF GROUNDWATER IN VWC-157 (SAUGUS)
- ELEVATION OF GROUNDWATER IN SCWC-SAUGUS 2 (SAUGUS)

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-13
GROUNDWATER ELEVATIONS IN ADJACENT ALLUVIAL AND SAUGUS WELLS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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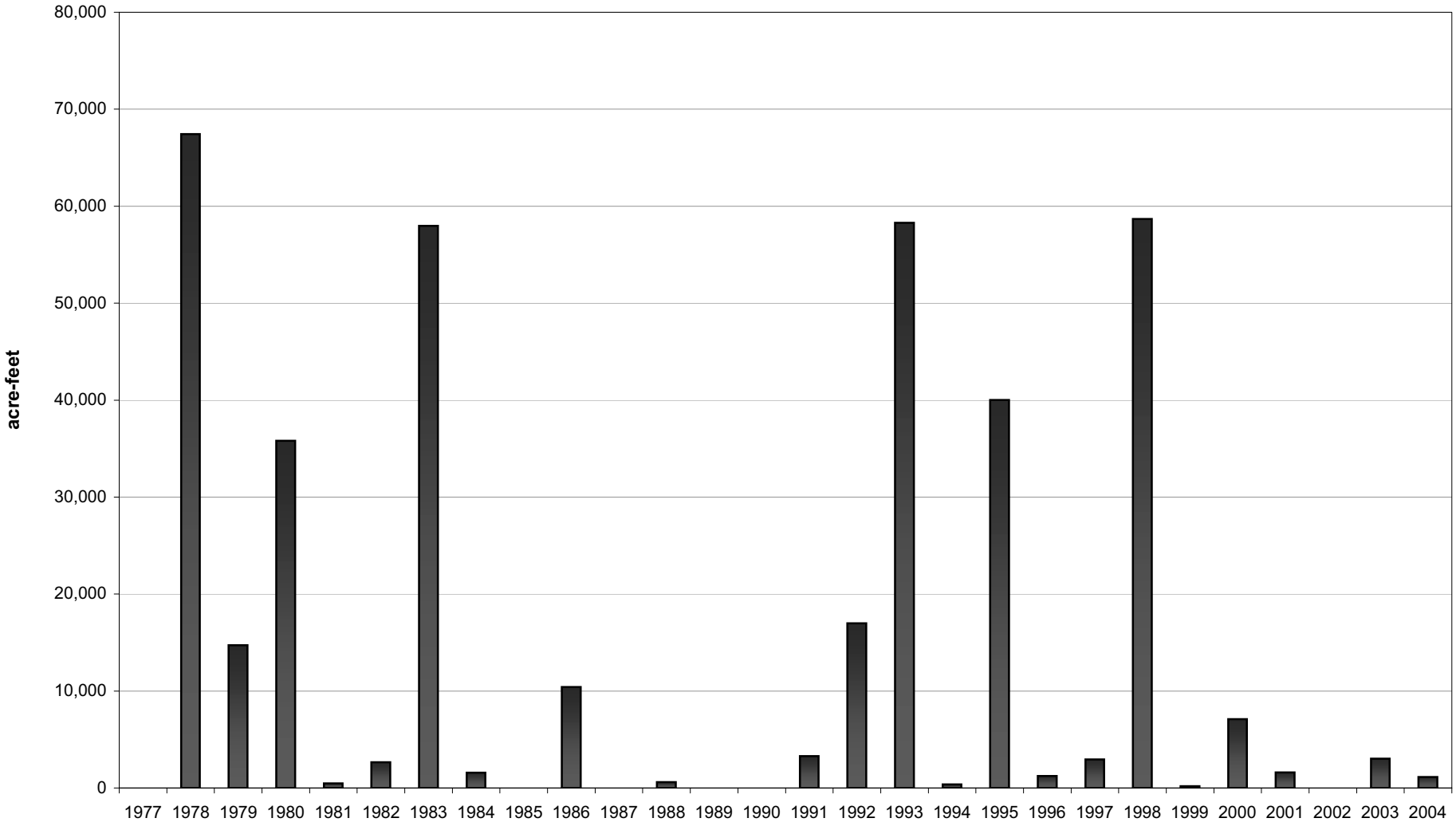

Note:
This chart shows the potential Flood Flows available during water years 1977 through 2004. Water Year 1977 is defined as October 1, 1976, through September 30, 1977, but the water is generally available only from October 1 through April 30.

FIGURE 2-14
HISTORICAL CASTAIC CREEK FLOOD FLOWS AVAILABLE TO DOWNSTREAM USERS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 3

Modeling Approach for Analyzing Basin Yield

The approach to using the Regional Model for the basin yield analysis began with identifying a simulation period spanning several decades to capture short-term (year-to-year) and longer-term (multi-year) variations in pumping from both aquifer systems. Pumping was then assigned in the Regional Model in accordance with historical and current uses of each production well, and in consideration of how the pumping rate assignments are currently impacted by the presence of perchlorate in groundwater in specific areas. Regional Model simulation results were then studied to evaluate short-term and long-term trends in groundwater elevations, groundwater budgets, and river flows. This section presents the design details of this modeling evaluation.

3.1 Model Description

The Regional Model is a three-dimensional, numerical model that uses MicroFEM® finite-element software (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. Figure 3-1 shows the model domain, along with its location relative to the upstream watersheds that contribute runoff into the model study area. The Regional Model's construction and calibration is summarized in Appendix B and discussed in detail in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a).

The Regional Model area largely coincides with the Santa Clara River Valley Groundwater Basin, East Subbasin, delineated by DWR, extending from the Lang stream gage at the eastern end of the valley to the County Line stream gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. Figure 3-2 shows the spacing of the individual nodes that make up the grid. The upper model layer simulates the Alluvial Aquifer and also the upper portion of the Saugus Formation where the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and its Sunshine Ranch Member. The layer representation is summarized schematically on Figure 3-3. Figure 3-4 shows the model layering in three cross-sectional views.

The boundary conditions in the model consist of the following:

1. Specified flux boundaries for the following:

    a. Precipitation
    b. Irrigation
    c. Recharge from ephemeral streams
    d. Pumping
    e. Underflow from beneath Castaic Dam

2. Head-dependent flux boundaries for the following:
    a. Groundwater discharges to the perennial reach of the Santa Clara River
    b. Residual drainage of groundwater to the Santa Clara River in the ephemeral reach under high water table conditions
    c. Evapotranspiration (ET) by phreatophyte plants, which extract groundwater from the shallow water table that lies along riparian river corridors
3. Constant-head boundaries for the following:
    a. Subsurface inflow in the Alluvial Aquifer at the eastern end of the valley, at the Lang gage[5]
    b. Subsurface outflow in the Alluvial Aquifer at the western end of the valley, at the County Line gage

Groundwater recharge rates are estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates are calculated using a detailed Surface Water Routing Model (SWRM), which was written specifically to provide time-dependent, spatially varying recharge rates as input to the Regional Model. The SWRM relies on streamflow records at the Lang and County Line gages; historical records of rainfall data from the NCWD rain gage (see Figure 1-1 for the location of this gage); spatial variations in rainfall across the basin (see Figure 2-7); and, for the basin yield analysis, the rates and locations of future WRP discharges to the Santa Clara River and irrigation from agricultural and urban water uses.

The depths from which production wells obtain water are defined in the Regional Model from well construction records. The rates and locations of pumping are based on the Purveyors' operating plan for the basin and on the surveyed location of each production well.

3.2 Modeling Approach

The process of designing the modeling analysis of the operating plan for the basin consisted of the following five activities:

1. Selecting a period over which to simulate groundwater conditions resulting from various pumping configurations
2. Defining pumping rates and schedules for each production well in the Santa Clarita Valley, considering the variability in pumping demands that occur due to cycles of drought and nondrought conditions and year-to-year variations in the availability of other water supplies
3. Defining the variation in local hydrology (rainfall, streamflows, and groundwater recharge) on a month-to-month basis throughout the simulation period

[5]A constant-head boundary was established in the Regional Model at this location using recent field conditions that were observed after the model calibration report (CH2M HILL, 2004a) was published. This change improved the Regional Model's calibration in the Alluvial Aquifer in the upper reaches of Soledad Canyon and did not appreciably change the calibration quality elsewhere. See CH2M HILL (2005) for further details.

4. Running the model to calculate time-varying (monthly) groundwater elevations and groundwater discharge terms throughout the multi-year simulation period
5. Evaluating the modeling results by examining forecasted time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the effects of the operating plan in the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River

These activities are described in further detail below.

3.3 Simulation Period

The locations and temporal variation in pumping from the Alluvial Aquifer were defined in the model from the operating plan and from historical records of the year-to-year variability in local hydrology. Simulated pumping from the Saugus Formation was defined from the operating plan, historical pumping records, and operational constraints and historical patterns of SWP water supply availability.

3.3.1 Selection of Simulation Period

Because the operating plan for the Saugus Formation is linked to the hydrology and operational constraints for the SWP system, the year-to-year variability in Saugus Formation pumping is, to a great extent, dependent on the hydrology outside the valley (i.e., in northern California). As shown in Table 3-1, local hydrology is often not a good indicator of local pumping conditions in the Saugus Formation, because local droughts and SWP droughts frequently do not coincide with each other. The following are examples:

1. In 1955, dry conditions in the SWP system coincided with approximately 14 inches of rainfall at the Newhall-Soledad rain gage, which is similar to the long-term median rainfall recorded at this gage.
2. In 1976 and 1977, the SWP system hydrology was critical, while the local hydrology during those years was near normal (1976) and wetter than normal (1977).
3. In 1987 and 1988, the SWP system hydrology was dry (1987) and critical (1988), while the local hydrology during those years was near normal (1987) and wetter than normal (1988).
4. In 1991 and 1992, the SWP system hydrology was in its fifth and sixth consecutive years of dry or critical hydrology, while the local hydrology was wetter than normal both years.
5. In 2001, dry conditions in the SWP system coincided with wetter-than-normal local conditions.

Consequently, it was decided that the model would need to be run over several decades to capture the year-to-year variability in the hydrology of each system, as well as the less frequent times when both systems experience similar hydrologic conditions (as occurred

periodically during the 1960s and in 1994). Historical records were then analyzed to identify a synthetic simulation period that would meet the following criteria:

1. The simulation time should be long enough to include an historical period that accounts for the year-to-year variations in local hydrology that have been observed in the past.
2. The period should be long enough to include longer-term (i.e., on the order of decades) periods of relatively dry conditions and relatively wet conditions.
3. The average rainfall during the simulation period should be similar to the average rainfall of 17.84 in/yr that was observed from 1950 through 2000 at the Newhall-Soledad gage.
4. The period should be sufficiently long to allow simulation of two occurrences of reduced SWP water supplies during the period 1990 through 1992, which corresponds to periods of increased pumping from the Saugus Formation under the operating plan.
5. The frequency of dry-year occurrences in the SWP system, corresponding to increased pumping from the Saugus Formation, should be similar to the historical frequency.
6. If necessary to meet other criteria, the simulation should repeat parts of this sequence before and/or after the historical sequence.

Examination of historical local hydrology and independent simulations of SWP deliveries resulted in the selection of a 78-year period over which the model was run, with monthly time steps. The 78-year period replicates the historical hydrology of the following years:

1. Years 1 through 24 = 1980 through 2003
2. Years 25 through 78 = 1950 through 2003

3.3.2 Relationship of Simulation Period to Variations in Alluvial Aquifer Pumping

Figure 3-5 shows the year-to-year rainfall in the valley and the cumulative departure from average rainfall for each year during the 78-year simulation period. The figure also shows each simulation year's corresponding historical year. The cumulative departure from average rainfall is plotted to show the occurrence of relatively wet versus relatively dry periods. A year-to-year decline in the slope of the cumulative departure curve indicates that conditions are dry, whereas a year-to-year increase indicates that rainfall is above normal. Also plotted are the occurrences of SWP droughts. The figure shows the following:

1. The first 19 years of the simulation period are generally wet, as a whole, though a multi-year drought occurs in years 5 through 12 (1984 through 1991).
2. A prolonged dry period begins in year 20, as indicated by the downward slope in the cumulative departure curve. This period lasts through year 39, as the curve starts to slope upward to the right beginning in year 40[6]. This 20-year period of generally dry conditions corresponds to the historical period 1999 through 2003, followed by 1950 through 1964.

[6]Year 40 is equivalent to historical year 1965, when rainfall was over 32 inches, or 2.2 times the long-term median rainfall and 1.8 times the long-term average rainfall.

3. Rainfall was generally at or above normal from years 40 through 45 (historical years 1965 through 1970), before a drought ensued from years 46 through 51 (historical years 1971 through 1976).

4. Rainfall was then generally above normal during years 52 through 58 (1977 through 1983), followed by the drought years 59 through 66 (1984 through 1991), the wetter-than-normal years 67 through 76 (1992 through 2001), and dry years 77 and 78 (2002 and 2003).

Table 3-2 shows the sequence of local hydrologic conditions and resulting valleywide pumping volumes for the Alluvial Aquifer that have been defined from the groundwater operating plan for the valley. The 78-year simulation period contains the following:

1. Twenty-four years of sporadic dry-year pumping, which is approximately 30 percent of the simulated 78-year period.

2. One drought consisting of 4 consecutive years of below-normal pumping (in years 34 through 37, based on historical hydrology from 1959 through 1962).

3. Two droughts consisting of 3 consecutive years of below-normal pumping (in years 10 through 12 and 64 through 66, both of which are based on historical hydrology from 1989 through 1991).

4. Three years (years 12, 37, and 66) when rainfall is near or above normal, but pumping is assigned at a dry-year rate because the year was preceded by a multi-year local drought.

3.3.3 Relationship of Simulation Period to Variations in Saugus Pumping

Table 3-3 shows the sequence of SWP droughts, SWP allocations, and resulting pumping volumes for the Saugus Formation that have been defined based on the CLWA and USBR analyses. With respect to Saugus Formation pumping, the 78-year period contains the following:

1. Two droughts lasting 2 years
2. Two droughts lasting 3 years
3. A dry year that occurs 2 years before the beginning of each 3-year drought
4. A dry year that begins 1 year after each 3-year drought has ended
5. A total of 18 dry years, or an average of 1 dry year approximately every 4 years
6. Sixty years of normal-year pumping from the Saugus Formation

3.4 Assignment of Pumping Rates

Pumping rates for Purveyor-owned wells and known private pumping wells (owned by the Newhall Land & Farming Company (NLF), the Wayside Honor Rancho, and Robinson Ranch) were assigned in accordance with the groundwater operating plan for the Santa Clarita Valley, which defines ranges of valleywide annual pumping, given the water supply needs of the Purveyors. Pumping rates at individual wells were also assigned using the recent and planned production schedules for each well, information on the depths and lengths of the intake sections (open intervals) of each well, and by incorporating current

plans addressing the presence of perchlorate in specific portions of the Saugus Formation and the Alluvial Aquifer.

As noted in the discussion of the groundwater operating plan in Section 2.2, the water management practices of the Purveyors recognize ongoing Alluvial Aquifer pumping for agricultural water supply, as well as other smaller private domestic and related pumping. For the last 7 years of formal annual water report preparation in the Santa Clarita Valley, those reports have included estimates of the latter private pumping. In recent years, that estimate has been 500 AF/yr. Initially in 2003, during the preparation of the Groundwater Management Plan (CLWA, 2003), and recently, during ongoing preparation of the 2005 UWMP, the Santa Clarita Valley Well Owners' Association submitted limited information about the nature and magnitude of private well pumping. The most notable input from the Well Owners' Association was its detailed estimate of private well pumping in the San Francisquito Canyon portion of the basin: a total of 85 AF/yr by 73 individual private pumpers, or an average of approximately 1.2 AF/yr per private well (equivalent to approximately 0.7 gallon per minute). As a result of that information, there is increased confidence that total private pumping in the basin by smaller users is within the 500 AF/yr estimate presented in recent annual water reports and is, therefore, approximately 1 percent of typical Alluvial Aquifer pumping by the Purveyors and other known private well owners (including agricultural pumpers) combined. However, the small private wells are not explicitly modeled in the basin yield analysis described herein because their locations and operations are not known, and their operation creates a pumping stress that is essentially negligible at the scale of the regional model. Ultimately, as discussed throughout this report, the intent to maintain overall pumping within the operating plan, including private pumping, will result in sustainable groundwater conditions to support the combination of municipal (Purveyor), agricultural, and private groundwater use on an ongoing basis. Thus, private well owners in the basin, like the large municipal and agricultural pumpers, can expect groundwater supplies to continue to be available as they have been in the past, with some fluctuations in water levels through wet and dry periods, but no long-term depletion of supply.

Details of pumping rate assignments for Purveyor-owned wells and known private pumping wells are discussed for the Alluvial Aquifer in Section 3.4.1 and for the Saugus Formation in Section 3.4.2. Section 3.4.3 discusses the monthly distribution of pumping for each well. Section 3.4.4 discusses how the pumping rate assignments relate to the presence of perchlorate in groundwater.

3.4.1 Variations in Alluvial Aquifer Pumping

Pumping rates at specific wells were assigned for normal and dry years using the operating plan and information on the capacity, recent and planned use, and location of each well. Figure 2-4 shows the locations of these wells and other wells in the valley. Table 3-4 compares recent annual pumping volumes at each Alluvial Aquifer well with the assumed future production rates at each well under normal and dry-year conditions. Most Alluvial Aquifer wells were specified to operate at similar rates regardless of year type. However, there were two exceptions, as follows:

1. Wells in the eastern portion of the basin (the NCWD-Pinetree wells, nine wells owned by SCWC, and the privately owned Robinson Ranch well) were assumed to have lower

pumping capacities during dry years than nondrought years because of lower groundwater elevations during dry periods. This assumption was based on historical observations indicating that the eastern portion of the Alluvial Aquifer, in contrast to other parts of the valley, experiences declines in water levels during dry periods.

2. Pumping was also reduced at NCWD's three operating wells in Castaic Valley, in accordance with recent pumping records from those wells.

3.4.2 Variations in Saugus Formation Pumping

Pumping rates at specific Saugus Formation production wells were assigned for each type of year (normal, dry year 1, dry year 2, and dry year 3) using the operating plan for the valley and information on the capacity, recent and planned use, and location of each well. Table 3-5 summarizes the annual pumping volumes at each Saugus Formation well[7]. Significant aspects of the pumping rate selection at each well are as follows:

1. Pumping from most existing Saugus Formation production wells was based on recent and planned use of these wells, as defined by the Purveyors. The simulation included increased dry-year pumping from the Saugus Formation in the western portion of the basin, where it is anticipated that future wells will be installed.

2. Each Saugus Formation production well has an intake section (open interval) that is significantly longer in vertical extent than the thicknesses of the individual layers that represent the Saugus Formation in the Regional Model. Consequently, the Saugus pumping rates were assigned to multiple layers in the model by considering the depths of the intake section of each well and the transmissivity of each model layer. Table 3-6 shows the allocation of pumping in each model layer for each Saugus Formation production well, along with the intake sections of each well and the model-simulated transmissivity in each layer at each well location.

3.4.3 Monthly Allocation of Pumping

Table 3-7 shows the allocation of pumping, by month, for agricultural and urban production wells in both the Saugus Formation and the Alluvial Aquifer. Separate distributions were used because agricultural demands are for exclusively outdoor uses, whereas urban demands are for both indoor and outdoor uses. As discussed in the model development report (CH2M HILL, 2004a), the monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining historical monthly flow records for the two LACSD WRPs and monthly demand distributions recorded by the Purveyors during the past several years.

3.4.4 Influence of Perchlorate Contamination on Groundwater Pumping

In 1997, two Saugus Formation production wells owned by CLWA's Santa Clarita Water Division (formerly SCWC) (wells SCWC-Saugus1 and SCWC-Saugus2), one Saugus Formation production well owned by the Newhall County Water District (NCWD)

[7]Table 3-5 only lists wells that are anticipated to be operating in the future. Existing wells that are not listed in this table (such as NCWD-7 and NCWD-10) are currently not in service or pump very limited quantities of groundwater, and, therefore, are not expected to provide significant quantities of water in the future.

(well NCWD-11), and one Saugus Formation production well owned by VWC (well VWC-157) were shut down because perchlorate was detected in groundwater at these wells[8]. In 2002, an Alluvial Aquifer production well owned by SCWC (well SCWC-Stadium) was shut down because of perchlorate detection. In March 2005, an Alluvial Aquifer production well owned by VWC (well VWC-Q2) was shut down because of perchlorate detection. The locations of the six impacted production wells and nearby nonimpacted production wells are shown on Figure 3-6, along with the locations of monitoring wells and exploratory borings that have been installed to investigate the extent of perchlorate contamination. Figure 3-6 also shows perchlorate concentrations at locations where perchlorate has been detected in groundwater. At each of the six production wells, the detected perchlorate concentrations exceeded the State of California's Action Level (AL) for perchlorate at the time of the detection[9].

In 2003, the Purveyors entered into a voluntary cleanup agreement with the California Department of Toxic Substances Control whereby the Department of Toxic Substances Control provides review and oversight of the activities of the Purveyors in response to the perchlorate detections. The Purveyors have also initiated a process for approval by the California Department of Health Services, in accordance with its Policy 97-005, for restoration of water supply from "severely impaired" water sources, such as the perchlorate-impacted wells. Also in 2003, the Purveyors and the responsible party (the Whittaker Corporation) entered into an Interim Settlement Agreement. Activities since execution of the Interim Settlement Agreement have consisted of developing the elements of a remedial strategy that will entail pumping of two impacted wells for containment of perchlorate migration; treatment and subsequent use of the pumped water for water supply; and installation of replacement wells in non-impacted portions of the basin to restore the remainder of groundwater supply impacted by perchlorate. A noteworthy detail of these activities is that the Regional Model was used to identify the design of a pumping scheme that would meet the Purveyors' objectives for perchlorate containment in the Saugus Formation (CH2M HILL, 2004b).

With respect to perchlorate presence in the Alluvial Aquifer, the selection of pumping rates for the basin yield analysis was as follows:

1. Well SCWC-Stadium was simulated as pumping during each year of the 78-year simulation period. The Whittaker Corporation is developing plans to mitigate the source of perchlorate to the portion of the Alluvial Aquifer immediately north and downgradient of the Whittaker-Bermite property. The modeled pumping scenario simulates the possibility that the well will be returned to service in the future and pump at a rate similar to historical volumes after source mitigation activities have reduced perchlorate concentrations to undetectable levels in the Alluvial Aquifer at and near this well.

[8]As part of the ongoing implementation of perchlorate containment and restoration of impacted capacity, well VWC-157 was abandoned in January 2005 and replaced by new well VWC-206. Thus, this analysis includes planned pumping from replacement well VWC-206.

[9]The AL has varied over time. The California Department of Health Services initially established an AL of 18 micrograms per liter (μg/L) in 1997, at the same time the four impacted Saugus Formation production wells were taken offline. In 2002, the Department of Health Services revised the AL to 4 μg/L based on studies by the U.S. Environmental Protection Agency. In March 2004, the AL was revised to 6 μg/L based on a public health goal published by the Office of Environmental Health Hazard Assessment. See http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/actionlevel.htm for further details.

2. Well VWC-Q2 was simulated as pumping during each year of the 78-year simulation period. VWC and the Whittaker Corporation are currently implementing plans to install perchlorate treatment (ion exchange) facilities at the wellhead to remove perchlorate so that the well can be returned to service (LSCE, 2005b). VWC is working with USFilter to install and maintain this treatment and is preparing an application to amend its water supply permit to allow treatment at this well, which is expected to be returned to service by fall 2005. The perchlorate detected in well VWC-Q2 does not significantly impact the water supplies used to meet demand in the Santa Clarita Valley during the time required to respond to the contamination at this well (LSCE, 2005b).

With respect to perchlorate presence in the Saugus Formation, the Purveyors have developed a hydraulic containment plan for the Saugus Formation that consists of pumping from the SCWC-Saugus1 and SCWC-Saugus2 production wells. The three Saugus wells impacted by perchlorate had produced a combined average of 4,186 AF/yr of water during the 5 years preceding the detection of perchlorate. Restoration of that volume of water is currently planned to be achieved by reactivating wells SCWC-Saugus1 and SCWC-Saugus2, with treatment for removal of perchlorate, and by constructing replacement wells in other parts of the Saugus Formation not impacted by perchlorate. Full restoration of impacted water supply, including implementation of the containment plan, is currently scheduled for 2006. The containment plan will consist of (1) pumping groundwater on a nearly continual basis from production wells SCWC-Saugus1 and SCWC-Saugus2 production wells; (2) treating the pumped water using ion exchange resins followed by chlorine and ammonia disinfection; and (3) pumping the treated water to CLWA's Rio Vista Intake Pump Station for subsequent distribution for municipal water supply. This containment plan was developed to meet the following objectives, which were identified by the Purveyors:

1. Hydraulically contain perchlorate that is migrating westward in the Saugus Formation from the Whittaker-Bermite property toward the impacted production wells
2. Hydraulically contain perchlorate that is present at monitoring well MP-5 and production well VWC-157, which are located downgradient of the impacted wells
3. Protect downgradient production wells that are currently not impacted
4. Restore the annual volumes of water that were pumped from the impacted wells before they were shut down
5. Operate the impacted wells in a manner that is consistent with the groundwater operating plan
6. If possible, pump one or more of the impacted Saugus Formation production wells in a manner that also contains perchlorate migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property

A detailed analysis of this perchlorate containment plan in the Saugus Formation is presented in *Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property* (CH2M HILL, 2004b). The pumping plan described in that report for the SCWC-Saugus1 and SCWC-Saugus2 production wells was also used in the basin yield modeling evaluation. These wells were assumed to operate on a continuous basis to contain perchlorate in this portion of the Saugus Formation. The analysis assumed each well

would be offline 1 month each year for routine maintenance, but would otherwise operate on a continuous basis.

Additionally, for the previous evaluations of the containment plan and for the basin yield analysis, the third impacted production well (NCWD-11) was assumed to operate at a yield of 1,200 gallons per minute for a period of 5 months during the peak-demand season, providing a volume of 811 acre-feet that would be treated prior to entering the distribution system. Consequently, total pumping from the three perchlorate-impacted Saugus Formation production wells that will be returned to service (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11) was simulated as 4,355 AF/yr. Total pumping from NCWD wells completed in the Saugus Formation was simulated as 3,441 AF/yr in normal years and 4,899 AF/yr in dry years, with pumping occurring from NCWD-11 and nearby production wells NCWD-12 and NCWD-13. Because they are closely spaced geographically, the three wells together form a pumping center in the Saugus Formation. Thus, although NCWD may choose to no longer use well NCWD-11, this analysis includes a pumping distribution that examines the sustainability of the Saugus Formation with a conservatively high pumping capacity at this pumping center.

3.5 Simulation Methods for Other Local Hydrologic Processes

In addition to groundwater pumping, infiltration from irrigation (from urban and agricultural lands), precipitation, and streamflows (stormwater and WRP discharges) were also modeled. These other local hydrologic processes were defined using the Surface Water Routing Model (SWRM), which is described in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Key aspects of the derivation of these terms are described in the following sections.

3.5.1 Recharge from Urban Irrigation

Under existing land use and water use conditions, the estimated long-term infiltration rates of applied irrigation water beneath urban areas, under full build-out conditions in the valley, were estimated to be 1.0 in/yr for industrial and retail lands, 2.2 in/yr for residential developments and parks, and 4.6 in/yr for golf courses. These rates were applied during each year (and each month) of the 78-year simulation period. The areas over which these rates were applied were larger than under current conditions. The areas were defined from existing land use data and from LACSD mapping of projected future land uses in the rest of the Santa Clarita Valley under full build-out conditions[10]. Figure 3-7 shows the land use that was simulated in the model for full build-out conditions.

3.5.2 Recharge from Agricultural Irrigation

As discussed in the *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002), irrigation of lands owned by NLF results in existing agricultural return flows. The source of most irrigation water is groundwater pumping from the Alluvial Aquifer, with some limited pumping occurring from one Saugus Formation well (NLF-156).

[10]LACSD land use mapping indicates that, including Newhall Ranch, approximately 14,000 acres of currently undeveloped land will be urbanized in the future within the Regional Model simulation area. Additional urbanization will also occur in areas that are within the watershed, but outside the Regional Model's boundaries.

Under full valley build-out conditions, the currently irrigated lands will no longer be irrigated because their water source will be used as part of the water supply for Newhall Ranch. Therefore, under full build-out conditions, no agricultural irrigation will occur within the area simulated by the Regional Model.

3.5.3 Precipitation Recharge

Infiltration from direct precipitation within the Regional Model domain was defined using data from the Newhall-Soledad and NCWD rain gages, an isohyet map of rainfall throughout the watershed, and a power-function equation developed by Turner (1986) that describes the relationship between annual rainfall and ET rates within the valley. Details concerning the derivation of precipitation infiltration rates from these data are contained in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Table 3-8 lists the simulated monthly precipitation at the NCWD rain gage for the 78-year model period[11].

3.5.4 Stormwater Flows and Recharge from Streams

For each month of the simulation, the SWRM calculated the amounts of stormwater flow and groundwater recharge in all streams, plus the amount of flow and groundwater recharge arising from projected future WRP discharges to the Santa Clara River. For the Santa Clara River, the volume of streamflow was defined from measured and estimated streamflow data at the Lang gage (Table 3-9). For Castaic Creek, the volume of streamflow was defined from historical DWR operations and consideration of the hydrologic year type (Table 3-10). For the remaining Santa Clara River tributaries, streamflow volumes were defined by the SWRM using monthly rainfall data and the Turner (1986) relationship between rainfall, ET, and the subsequent yield from each watershed.

3.5.5 WRP Discharges to the Santa Clara River

Treated water is discharged to the Santa Clara River from two LACSD WRPs. As shown on Figure 1-1, the Saugus WRP discharges to the river immediately above the mouth of the South Fork Santa Clara River, and the Valencia WRP discharges to the river just west of Interstate 5.

Under full valley build-out conditions, future flows into and from WRPs will be higher than historical flows because of increased development and the associated increase in indoor water use volumes. Additionally, a portion of the future treated water will be reclaimed, as described in CLWA's recycled water master plan (Kennedy/Jenks Consultants, 2002). Future inflows to the Saugus and Valencia WRPs were estimated from projected future water demands and from comparisons of historical water use and measured inflows to both WRPs. Table 3-11 shows the derivation of urban water demands outside the Newhall Ranch development (which will be served by a new, separate WRP). Table 3-12 shows the total amount of treated water generated by the Saugus and Valencia WRPs, and the amount of this water that is reclaimed and discharged to the river, by month. The analysis assumes that the reclaimed water volume will be no more than 16,000 AF/yr, to maintain existing flow volumes in the Santa Clara River. For the Newhall Ranch WRP, discharges to the river

[11]The simulated monthly precipitation was defined from measurements at the NCWD gage from 1979 through 2003, as well as by combining the isohyet map with measurements at the Newhall-Soledad gage from 1950 through 1978.

will be 286 AF/yr, occurring primarily in December and January, when demands for reclaimed water are at their seasonal low. The total combined volumes of treated water discharged to the Santa Clara River under full valley build-out conditions (including Newhall Ranch) are summarized, by month, in Table 3-13. These rates were used in each year of the 78-year simulation.

3.5.6 Monthly Assignment and Tracking of Surface Water Budget

The month-by-month assignment of the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system was performed by the SWRM using the procedures described in Section C.8.5 of Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Streambed infiltration capacities were the same as those used in the calibrated model. For each of the 78 years in the model simulation, the streambed infiltration capacity values were selected by matching the year to 1 of the 20 years (1980 through 1999) from the model calibration runs, using rainfall and streamflow data to select the corresponding streambed infiltration rates.

The SWRM also tracked the volume of surface water in each simulated stream that does not infiltrate during each month because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage was calculated to remain as surface water in the Santa Clara River and to eventually exit the Regional Model at the west end of the valley, at the County Line gage.

3.6 Running the Model and Evaluating Results

As discussed in the previous sections, the modeling evaluations were performed by simulating conditions on a monthly basis for the 78-year simulation period. The first step in this process consisted of running the SWRM to calculate the monthly distribution of recharge to the Alluvial Aquifer system (from rainfall, streamflow, irrigation, and WRP discharges) and recharge to the Saugus Formation (from rainfall and irrigation) in areas where the Alluvial Aquifer is not present. The output from the SWRM consisted of monthly files that assigned recharge to each node in the model grid.

The Regional Model was then run using monthly time steps, in which pumping and recharge terms were varied each month. The model was run by solving the groundwater flow equations for three time intervals during each month to improve the accuracy of the calculations. For each sub-interval of time, the model was run with a convergence criterion of 0.0001 foot for groundwater elevations and a water budget convergence criterion of 1 cubic foot per day. The model results were then evaluated by generating time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the potential effects of the groundwater operating plan across the basin. The hydrographs were used to evaluate whether the operating plan is consistent with the objective of operating the basin in a manner that maintains long-term stability in groundwater levels and river flows. This analysis and its findings are presented in Section 4.

Tables

TABLE 3-1
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1950	Below Normal	6.84
1951	Above Normal	12.42
1952	Wet	34.19
1953	Wet	4.88
1954	Above Normal	15.82
1955	Dry	13.91
1956	Wet	14.21
1957	Above Normal	22.85
1958	Wet	23.14
1959	Below Normal	9.81
1960	Dry	11.64
1961	Dry	8.82
1962	Below Normal	21.22
1963	Wet	12.79
1964	Dry	10.09
1965	Wet	32.28
1966	Below Normal	14.57
1967	Wet	23.23
1968	Below Normal	6.90
1969	Wet	32.42
1970	Wet	23.19
1971	Wet	13.75
1972	Below Normal	4.15
1973	Above Normal	19.79
1974	Wet	18.04
1975	Wet	10.92
1976	Critical	14.02
1977	Critical	20.87
1978	Above Normal	42.17
1979	Below Normal	21.47
1980	Above Normal	27.00
1981	Dry	13.42
1982	Wet	20.20
1983	Wet	39.07
1984	Wet	12.86

TABLE 3-1
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1985	Dry	8.37
1986	Wet	18.02
1987	Dry	14.45
1988	Critical	16.92
1989	Dry	7.56
1990	Critical	6.98
1991	Critical	17.21
1992	Critical	32.03
1993	Above Normal	32.72
1994	Critical	10.27
1995	Wet	29.15
1996	Wet	15.88
1997	Wet	13.35
1998	Wet	30.73
1999	Wet	8.96
2000	Above Normal	14.04
2001	Dry	22.24
2002	Dry	7.90
2003	Above Normal	15.70

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest.

[b]Records are for the Newhall-Soledad rain gage (Station No. FC32CE), in inches. As shown on Figure 2-6, the median and average rainfall at this gage from 1950 through 2002 were 14.57 in/yr and 17.84 in/yr, respectively.

TABLE 3-2
Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Model Year	Based on Historical Year	Local Rainfall (inches)[a]	Alluvial Aquifer Pumping under the Groundwater Operating Plan[b,c] (AF/yr)
1	1980	27.00	35,000-40,000
2	1981	13.42	35,000-40,000
3	1982	20.20	35,000-40,000
4	1983	39.07	35,000-40,000
5	1984	12.86	35,000-40,000
6	1985	8.37	30,000-35,000
7	1986	18.02	35,000-40,000
8	1987	14.45	35,000-40,000
9	1988	16.92	35,000-40,000
10	1989	7.56	30,000-35,000
11	1990	6.98	30,000-35,000
12	1991	17.21	30,000-35,000
13	1992	32.03	35,000-40,000
14	1993	32.72	35,000-40,000
15	1994	10.27	30,000-35,000
16	1995	29.15	35,000-40,000
17	1996	15.88	35,000-40,000
18	1997	13.35	35,000-40,000
19	1998	30.73	35,000-40,000
20	1999	8.96	30,000-35,000
21	2000	14.04	35,000-40,000
22	2001	22.24	35,000-40,000
23	2002	7.90	30,000-35,000
24	2003	15.70	35,000-40,000
25	1950	6.84	30,000-35,000
26	1951	12.42	35,000-40,000
27	1952	34.19	35,000-40,000
28	1953	4.88	30,000-35,000
29	1954	15.82	35,000-40,000
30	1955	13.91	35,000-40,000
31	1956	14.21	35,000-40,000
32	1957	22.85	35,000-40,000
33	1958	23.14	35,000-40,000
34	1959	9.81	30,000-35,000
35	1960	11.64	30,000-35,000
36	1961	8.82	30,000-35,000
37	1962	21.22	30,000-35,000
38	1963	12.79	35,000-40,000
39	1964	10.09	30,000-35,000
40	1965	32.28	35,000-40,000
41	1966	14.57	35,000-40,000

TABLE 3-2
Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Model Year	Based on Historical Year	Local Rainfall (inches)[a]	Alluvial Aquifer Pumping under the Groundwater Operating Plan[b,c] (AF/yr)
42	1967	23.23	35,000-40,000
43	1968	6.90	30,000-35,000
44	1969	32.42	35,000-40,000
45	1970	23.19	35,000-40,000
46	1971	13.75	35,000-40,000
47	1972	4.15	30,000-35,000
48	1973	19.79	35,000-40,000
49	1974	18.04	35,000-40,000
50	1975	10.92	30,000-35,000
51	1976	14.02	35,000-40,000
52	1977	20.87	35,000-40,000
53	1978	42.17	35,000-40,000
54	1979	21.47	35,000-40,000
55	1980	27.00	35,000-40,000
56	1981	13.42	35,000-40,000
57	1982	20.20	35,000-40,000
58	1983	39.07	35,000-40,000
59	1984	12.86	35,000-40,000
60	1985	8.37	30,000-35,000
61	1986	18.02	35,000-40,000
62	1987	14.45	35,000-40,000
63	1988	16.92	35,000-40,000
64	1989	7.56	30,000-35,000
65	1990	6.98	30,000-35,000
66	1991	17.21	30,000-35,000
67	1992	32.03	35,000-40,000
68	1993	32.72	35,000-40,000
69	1994	10.27	30,000-35,000
70	1995	29.15	35,000-40,000
71	1996	15.88	35,000-40,000
72	1997	13.35	35,000-40,000
73	1998	30.73	35,000-40,000
74	1999	8.96	30,000-35,000
75	2000	14.04	35,000-40,000
76	2001	22.24	35,000-40,000
77	2002	7.90	30,000-35,000
78	2003	15.70	35,000-40,000

[a]From records at Newhall-Soledad rain gage (Station No. FC32CE).

[b]Alluvial Aquifer pumping rates listed in this column will occur under the operating plan for the valley if the 1950 through 2003 local hydrology repeats itself in the future.

[c]Alluvial Aquifer pumping is set at the dry-year rate in years 12, 37, and 66 because each of these years is the first nondrought year that occurs after a multi-year drought ends.

TABLE 3-3
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
1	Above Normal	90	Normal (7,500-15,000)
2	Dry	90	Normal (7,500-15,000)
3	Wet	100	Normal (7,500-15,000)
4	Wet	100	Normal (7,500-15,000)
5	Wet	100	Normal (7,500-15,000)
6	Dry	95	Normal (7,500-15,000)
7	Wet	70	Normal (7,500-15,000)
8	Dry	75	Normal (7,500-15,000)
9	Critical	15	Dry Year 1 (15,000)
10	Dry	95	Normal (7,500-15,000)
11	Critical	25	Dry Year 1 (15,000)
12	Critical	30	Dry Year 2 (25,000)
13	Critical	45	Dry Year 3 (35,000)
14	Above Normal	100	Normal (7,500-15,000)
15	Critical	50	Dry Year 1 (15,000)
16	Wet	80	Normal (7,500-15,000)
17	Wet	100	Normal (7,500-15,000)
18	Wet	100	Normal (7,500-15,000)
19	Wet	100	Normal (7,500-15,000)
20	Wet	100	Normal (7,500-15,000)
21	Above Normal	90	Normal (7,500-15,000)
22	Dry	39	Dry Year 1 (15,000)
23	Dry	70	Normal (7,500-15,000)
24	Above Normal	90	Normal (7,500-15,000)
25	Below Normal	90	Normal (7,500-15,000)
26	Above Normal	100	Normal (7,500-15,000)
27	Wet	100	Normal (7,500-15,000)
28	Wet	100	Normal (7,500-15,000)
29	Above Normal	100	Normal (7,500-15,000)
30	Dry	45	Dry Year 1 (15,000)
31	Wet	100	Normal (7,500-15,000)
32	Above Normal	90	Normal (7,500-15,000)
33	Wet	100	Normal (7,500-15,000)
34	Below Normal	85	Normal (7,500-15,000)
35	Dry	55	Dry Year 1 (15,000)
36	Dry	70	Dry Year 2 (25,000)
37	Below Normal	95	Normal (7,500-15,000)
38	Wet	100	Normal (7,500-15,000)
39	Dry	75	Dry Year 1 (15,000)
40	Wet	80	Normal (7,500-15,000)
41	Below Normal	100	Normal (7,500-15,000)
42	Wet	100	Normal (7,500-15,000)

TABLE 3-3
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
43	Below Normal	90	Normal (7,500-15,000)
44	Wet	100	Normal (7,500-15,000)
45	Wet	100	Normal (7,500-15,000)
46	Wet	100	Normal (7,500-15,000)
47	Below Normal	75	Normal (7,500-15,000)
48	Above Normal	100	Normal (7,500-15,000)
49	Wet	100	Normal (7,500-15,000)
50	Wet	100	Normal (7,500-15,000)
51	Critical	75	Dry Year 1 (15,000)
52	Critical	4	Dry Year 2 (25,000)
53	Above Normal	100	Normal (7,500-15,000)
54	Below Normal	95	Normal (7,500-15,000)
55	Above Normal	90	Normal (7,500-15,000)
56	Dry	90	Normal (7,500-15,000)
57	Wet	100	Normal (7,500-15,000)
58	Wet	100	Normal (7,500-15,000)
59	Wet	100	Normal (7,500-15,000)
60	Dry	95	Normal (7,500-15,000)
61	Wet	70	Normal (7,500-15,000)
62	Dry	75	Normal (7,500-15,000)
63	Critical	15	Dry Year 1 (15,000)
64	Dry	95	Normal (7,500-15,000)
65	Critical	25	Dry Year 1 (15,000)
66	Critical	30	Dry Year 2 (25,000)
67	Critical	45	Dry Year 3 (35,000)
68	Above Normal	100	Normal (7,500-15,000)
69	Critical	50	Dry Year 1 (15,000)
70	Wet	80	Normal (7,500-15,000)
71	Wet	100	Normal (7,500-15,000)
72	Wet	100	Normal (7,500-15,000)
73	Wet	100	Normal (7,500-15,000)
74	Wet	100	Normal (7,500-15,000)
75	Above Normal	90	Normal (7,500-15,000)
76	Dry	39	Dry Year 1 (15,000)
77	Dry	70	Normal (7,500-15,000)
78	Above Normal	90	Normal (7,500-15,000)

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest.

[b]Defined from simulations performed by CLWA (Kennedy/Jenks Consultants, 2003) and USBR (2004) using the CALSIM II model. This condition is for the year 2020 level of development. In any given year, the allocation may be made up, in part, of carryover water from the prior year.

TABLE 3-4

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location**[a]	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
NCWD-Castaic 1	Castaic Valley	345	385	561	385	345
NCWD-Castaic 2	Castaic Valley	166	0	123	166	125
NCWD-Castaic 3	Castaic Valley	0	0	0	0	0
NCWD-Castaic 4	Castaic Valley	100	47	56	100	45
NCWD-Pinetree 1	Mint Canyon	164	0	0	164	0
NCWD-Pinetree 2	Mint Canyon	0	0	0	0	0
NCWD-Pinetree 3	Mint Canyon	566	544	525	545	525
NCWD-Pinetree 4	Mint Canyon	300	5	0	300	0
NCWD Total		**1,641**	**981**	**1,265**	**1,660**	**1,040**
NLF-161	Downstream of Valencia WRP	496	485	2,021	485	485
NLF-B10	Downstream of Valencia WRP	1,240	534	344	344	344
NLF-B11	Downstream of Valencia WRP	205	232	271	232	232
NLF-B5	Downstream of Valencia WRP	1,680	2,280	1,582	1,582	1,582
NLF-B6	Downstream of Valencia WRP	1,312	2,175	1,766	1,766	1,766
NLF-B7	Downstream of Valencia WRP	474	584	402	584	584
NLF-C	Downstream of Valencia WRP	1,319	1,720	1,373	1,373	1,373
NLF-C3	Downstream of Valencia WRP	93	192	186	192	192
NLF-C4	Downstream of Valencia WRP	1,028	809	764	809	809
NLF-C5	Downstream of Valencia WRP	680	850	622	850	850
NLF-C6	Downstream of Valencia WRP	231	241	108	241	241
NLF-C7	Downstream of Valencia WRP	741	866	443	866	866
NLF-C8	Downstream of Valencia WRP	293	594	408	594	594
NLF-E	Castaic Valley	1,691	16	28	16	16
NLF-E2	Castaic Valley	141	55	14	55	55
NLF-E4	Downstream of Valencia WRP	0	0	0	0	0
NLF-E5	Downstream of Valencia WRP	172	679	537	679	679
NLF-E9	Downstream of Valencia WRP	238	814	47	814	814
NLF-G45	Downstream of Valencia WRP	291	283	60	283	283
NLF-W4	San Francisquito Canyon[b]	46	1	0	0	0
NLF-W5	San Francisquito Canyon	276	104	23	107	107
NLF-X3	Downstream of Valencia WRP	12	0	0	0	0
NLF Total		**12,659**	**13,514**	**10,999**	**11,872**	**11,872**
SCWD-Clark	Bouquet Canyon	696	782	712	782	700
SCWD-Guida	Bouquet Canyon	1,047	1,320	1,230	1,320	1,230
SCWD-Honby	Above Saugus WRP	721	696	874	696	870
SCWD-Lost Canyon 2	Mint Canyon	741	730	644	741	640
SCWD-Lost Canyon 2A	Mint Canyon	1,034	905	593	1,034	590
SCWD-Mitchell #5A	Mint Canyon	407	143	19	0	0
SCWD-Mitchell #5B	Mint Canyon	0	150	0	557	0
SCWD-N. Oaks Central	Mint Canyon	822	1,646	1,641	822	1,640
SCWD-N. Oaks East	Mint Canyon	1,234	448	485	1,234	485
SCWD-N. Oaks West	Mint Canyon	898	1,123	31	898	0
SCWD-Sand Canyon	Mint Canyon	930	705	195	930	195
SCWD-Sierra	Mint Canyon	846	87	0	846	0
SCWD-Stadium	Above Saugus WRP	565	778	0	800	800
SCWD Total		**9,941**	**9,513**	**6,424**	**10,660**	**7,150**

TABLE 3-5
Simulated Annual Groundwater Pumping from the Saugus Formation for the 78-year Simulation
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Owner	Well Name	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
NCWD	11	811	811	811	811
	12	1,315	2,044	2,044	2,044
	13	1,315	2,044	2,044	2,044
Total Pumping (NCWD)		**3,441**	**4,899**	**4,899**	**4,899**
NLF	156	369	369	369	369
Total Pumping (NLF)		**369**	**369**	**369**	**369**
SCWC	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
Total Pumping (SCWC)		**3,544**	**3,544**	**3,544**	**3,544**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Valencia Country Club)	500	500	500	500
	201	100	100	3,577	3,577
	205	1,000	2,734	3,827	3,827
	206	1,175	2,734	3,500	3,500
Total Pumping (VWC)		**3,325**	**6,948**	**12,284**	**12,284**
To Be Determined	Future #1	0	0	3,250	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
	Future #4	0	0	0	3,250
Total Pumping (Future)		**0**	**0**	**3,250**	**13,000**
Total Saugus Formation Pumping		**10,679**	**15,760**	**24,346**	**34,096**

Notes:

All pumping volumes are listed in acre-feet.

Wells VWC-157 and NCWD-7, 8, 9, and 10 are assumed to no longer operate in the future.

TABLE 3-6

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-11	2	200	1,075	300	10	3,000	72.3
	3			500	2	1,000	24.1
	4			75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
	3			500	2	1,000	58.5
	4			280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
	3			250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
	3			500	6.5	3,250	39.4
	4			500	4	2,000	24.2
	5			300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
	3			500	6.5	3,250	59.9
	4			500	4	2,000	36.8
	5			20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.7
	3			500	6.5	3,250	56.9
	4			500	4	2,000	35.0
	5			91	4	364	6.4
VWC-159	3	662	1,900	338	0.025	8.45	27.3
	4			500	0.025	12.5	40.4
	5			400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.6
	4			500	4	2,000	46.2
	5			500	4	2,000	46.2
VWC-201	3	540	1,670	460	6.5	2,990	52.7
	4			500	4	2,000	35.3
	5			170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
	4			500	4	2,000	40.9
	5			430	4	1,720	35.2
VWC-206	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6

TABLE 3-6

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
Future Wells	3	820	1,930	180	6.5	1,170	23.9
Near VWC-206	4			500	4	2,000	40.9
(Assumed)	5			430	4	1,720	35.2

Notes:

Existing wells NCWD-7 and NCWD-10 are assumed to no longer operate in the future.

Kh = horizontal hydraulic conductivity
T = transmissivity
ft/day = feet per day
ft^2/day = square feet per day

TABLE 3-7
Allocation of Pumping, by Month, for Agricultural and Urban Production Wells
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Month	Percent of Annual Water Use, Agricultural	Percent of Annual Water Use, Urban	Percent of May through October Water Use, Urban
January	3.75	5.2	
February	5.10	3.7	
March	6.60	5.2	
April	9.10	6.6	
May	10.55	8.7	13.2
June	11.40	10.4	15.8
July	14.10	13.0	19.7
August	12.95	13.6	20.6
September	10.20	10.9	16.6
October	7.50	9.3	14.1
November	5.00	7.1	
December	3.75	6.3	
Total	**100.0**	**100.0**	**100.0**

TABLE 3-8

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
2	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
3	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
4	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
5	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
6	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
7	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
8	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
9	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
10	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
11	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
12	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
13	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
14	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
15	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
16	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
17	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
18	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
19	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
20	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
21	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
22	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
23	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
24	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47
25	2.58	1.69	1.27	0.86	0.01	0.00	0.00	0.00	0.32	0.36	0.73	0.21	8.03
26	2.96	0.93	1.16	1.69	0.09	0.00	0.00	0.05	0.00	0.49	1.33	5.88	14.57
27	17.68	0.61	10.30	1.80	0.00	0.00	0.00	0.00	0.12	0.00	4.52	5.09	40.12
28	0.80	0.02	0.21	1.64	0.69	0.00	0.00	0.00	0.00	0.00	2.32	0.04	5.73
29	6.38	3.36	4.86	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.38	1.47	18.56
30	5.69	1.69	0.21	3.38	1.91	0.00	0.00	0.00	0.00	0.00	1.43	2.01	16.32
31	7.55	1.00	0.00	5.90	1.82	0.00	0.11	0.00	0.00	0.15	0.00	0.15	16.68
32	7.22	2.71	3.05	1.16	1.06	0.25	0.00	0.00	0.00	2.68	0.40	8.30	26.81
33	2.11	10.42	5.82	7.18	0.00	0.00	0.00	0.00	0.04	1.35	0.23	0.00	27.15
34	3.70	5.47	0.00	0.59	0.00	0.00	0.00	0.00	0.08	0.00	0.00	1.68	11.51
35	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
36	1.88	0.00	0.76	0.33	0.09	0.00	0.07	0.00	0.11	0.00	4.12	2.99	10.35
37	3.86	19.44	1.53	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.00	24.90
38	0.99	3.63	4.10	2.23	0.06	0.43	0.00	0.00	0.77	0.50	2.29	0.01	15.01
39	2.95	0.00	1.88	2.41	0.04	0.12	0.00	0.00	0.00	0.52	1.47	2.48	11.84
40	0.25	0.07	1.65	9.14	0.00	0.02	0.26	0.16	0.95	0.00	17.49	7.89	37.88
41	1.42	1.55	0.33	0.00	0.09	0.00	0.00	0.00	0.09	0.11	7.56	5.95	17.10

TABLE 3-8

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	6.76	0.22	3.23	5.41	0.19	0.00	0.00	0.00	0.50	0.00	9.36	1.58	27.26
43	0.86	0.93	2.91	0.97	0.07	0.00	0.00	0.38	0.00	0.39	0.35	1.24	8.10
44	19.53	13.89	0.82	1.16	0.05	0.05	0.18	0.00	0.00	0.00	2.32	0.05	38.04
45	0.94	6.63	4.33	0.00	0.00	0.00	0.00	0.00	0.00	0.13	8.86	6.33	27.21
46	1.23	1.41	0.48	0.94	0.15	0.00	0.00	0.00	0.47	0.50	0.38	10.57	16.14
47	0.00	0.12	0.00	0.02	0.05	0.05	0.00	0.06	0.00	0.05	3.45	1.08	4.87
48	5.19	11.74	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.83	1.03	23.22
49	10.58	0.02	4.30	0.06	0.00	0.00	0.02	0.00	0.00	1.17	0.12	4.89	21.17
50	0.28	3.02	6.04	2.96	0.00	0.00	0.00	0.00	0.00	0.39	0.04	0.09	12.81
51	0.00	7.39	1.47	0.46	0.15	0.35	0.01	0.00	3.40	0.22	2.09	0.90	16.45
52	5.75	0.12	2.15	0.00	5.27	0.00	0.00	2.68	0.02	0.05	0.06	8.40	24.49
53	10.74	13.23	17.10	2.72	0.00	0.00	0.00	0.00	1.23	0.01	2.70	1.76	49.49
54	12.44	3.20	6.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.89	1.19	23.75
55	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
56	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
57	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
58	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
59	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
60	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
61	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
62	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
63	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
64	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
65	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
66	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
67	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
68	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
69	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
70	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
71	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
72	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
73	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
74	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
75	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
76	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
77	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
78	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47

TABLE 3-9

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
2	594	98	339	240	107	18	18	12	338	321	258	394	2,739
3	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
4	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
5	0	596	405	240	143	166	228	411	154	220	904	578	4,044
6	483	461	274	215	77	0	0	0	12	179	221	301	2,224
7	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
8	117	117	65	31	12	0	0	0	0	0	258	516	1,116
9	222	209	506	117	77	68	0	0	0	0	12	25	1,236
10	50	111	60	25	6	0	0	0	102	94	34	18	499
11	212	276	230	46	46	5	0	0	0	27	36	147	1,025
12	162	775	879	736	145	142	14	0	45	69	62	263	3,291
13	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
14	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
15	388	493	497	319	163	80	20	7	37	102	193	941	3,239
16	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
17	666	896	730	315	151	46	7	0	54	154	307	510	3,836
18	517	346	140	85	33	5	4	50	66	240	566	809	2,859
19	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
20	92	85	204	224	197	107	80	46	52	54	31	80	1,252
21	117	117	65	31	12	0	0	0	0	0	258	516	1,116
22	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
23	50	111	60	25	6	0	0	0	102	94	34	18	499
24	666	896	730	315	151	46	7	0	54	154	307	510	3,836
25	83	198	184	126	105	83	51	54	56	53	43	42	1,078
26	49	40	66	91	98	84	79	72	57	71	47	53	807
27	9,629	636	7,091	2,114	895	326	153	138	86	97	178	313	21,656
28	300	282	271	237	165	134	102	86	85	83	74	68	1,888
29	145	278	404	356	181	108	110	99	91	90	80	75	2,017
30	103	156	157	128	153	99	78	76	74	68	66	62	1,220
31	69	85	130	137	139	98	86	80	77	76	67	69	1,113
32	67	55	78	90	93	80	78	78	76	79	66	71	910
33	66	329	743	4,550	825	283	130	108	95	145	146	116	7,536
34	246	351	189	127	111	92	84	86	83	69	68	68	1,575
35	68	67	70	69	70	68	65	65	60	58	316	164	1,140
36	124	91	38	38	36	32	28	33	22	19	19	119	597
37	139	1,904	791	449	329	169	97	82	80	84	82	82	4,287
38	85	142	145	131	104	86	79	74	66	65	62	58	1,096
39	69	50	51	62	66	54	53	53	54	45	43	41	640
40	30	23	25	46	43	36	31	34	37	35	1,305	3,300	4,944
41	1,765	1,014	778	450	308	115	68	54	45	63	91	523	5,274

TABLE 3-9

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	757	489	1,028	2,295	1,880	729	212	104	89	73	255	487	8,397
43	300	247	276	180	72	32	32	30	25	133	208	851	2,384
44	13,797	2,856	1,005	489	320	147	98	98	46	318	392	399	19,966
45	461	550	1,168	465	290	169	74	60	58	27	501	1,338	5,161
46	614	524	556	397	262	167	70	25	5	30	200	420	3,270
47	332	250	131	90	50	22	32	6	0	0	11	58	983
48	153	1,717	950	471	226	71	18	12	8	3	8	44	3,679
49	608	229	392	190	129	49	17	6	0	3	19	87	1,728
50	53	90	228	181	104	31	15	3	0	0	0	0	704
51	0	110	63	39	33	12	0	0	1	0	0	0	258
52	28	7	28	19	60	5	0	0	0	0	0	0	147
53	744	9,486	11,412	1,696	2,736	1,154	418	209	101	264	422	86	28,730
54	1,254	433	1,113	506	246	190	178	111	125	90	120	558	4,925
55	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
56	594	98	339	240	107	18	18	12	338	321	258	394	2,739
57	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
58	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
59	0	596	405	240	143	166	228	411	154	220	904	578	4,044
60	483	461	274	215	77	0	0	0	12	179	221	301	2,224
61	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
62	117	117	65	31	12	0	0	0	0	0	258	516	1,116
63	222	209	506	117	77	68	0	0	0	0	12	25	1,236
64	50	111	60	25	6	0	0	0	102	94	34	18	499
65	212	276	230	46	46	5	0	0	0	27	36	147	1,025
66	162	775	879	736	145	142	14	0	45	69	62	263	3,291
67	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
68	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
69	388	493	497	319	163	80	20	7	37	102	193	941	3,239
70	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
71	666	896	730	315	151	46	7	0	54	154	307	510	3,836
72	517	346	140	85	33	5	4	50	66	240	566	809	2,859
73	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
74	92	85	204	224	197	107	80	46	52	54	31	80	1,252
75	117	117	65	31	12	0	0	0	0	0	258	516	1,116
76	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
77	50	111	60	25	6	0	0	0	102	94	34	18	499
78	666	896	730	315	151	46	7	0	54	154	307	510	3,836

TABLE 3-10

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
2	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
3	0	0	0	0	0	667	842	735	0	0	0	0	2,244
4	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
8	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
9	0	0	809	341	900	0	0	0	0	0	0	0	2,050
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	66	66
13	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
14	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
15	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
16	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
17	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
18	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
19	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
20	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
21	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
22	0	0	0	0	0	667	842	735	0	0	0	0	2,244
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
30	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
31	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
32	0	0	0	0	0	667	842	735	0	0	0	0	2,244
33	0	0	0	0	0	667	842	735	0	0	0	0	2,244
34	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
35	0	0	0	0	0	0	0	0	0	0	0	0	0
36	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
37	0	0	0	0	0	667	842	735	0	0	0	0	2,244
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
40	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
41	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853

TABLE 3-10

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 78-year Simulation

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	0	0	0	0	0	667	842	735	0	0	0	0	2,244
43	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
45	0	0	0	0	0	667	842	735	0	0	0	0	2,244
46	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
47	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	667	842	735	0	0	0	0	2,244
49	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
50	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
51	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
52	0	0	0	0	0	667	842	735	0	0	0	0	2,244
53	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
54	0	0	0	0	0	667	842	735	0	0	0	0	2,244
55	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
56	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
57	0	0	0	0	0	667	842	735	0	0	0	0	2,244
58	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
59	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0
61	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
62	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
63	0	0	809	341	900	0	0	0	0	0	0	0	2,050
64	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	66	66
67	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
68	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
69	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
70	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
71	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
72	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
73	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
74	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
75	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
76	0	0	0	0	0	667	842	735	0	0	0	0	2,244
77	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632

TABLE 3-11
Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year 2000 Actual (AF/yr)	Full Build-out Conditions (AF/yr)	Comments
Annual Urban Water Use Outside Newhall Ranch		
60,988	123,038	Year 2000 value is retail purveyor demand plus other demands in Table II-6 of the *2004 Santa Clarita Valley Water Report* (LSCE, 2005a). Year 2045 value is from Table 2.5-4 of the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2001). Consists of 89,805 AF/yr Development Monitoring System[a] demand, plus 55,995 AF/yr additional urban demand, minus 14,480 AF/yr conservation, minus 5,193 AF/yr agricultural uses and 3,089 AF/yr "other" uses. Does not include 4,500 AF/yr for aquifer storage and recovery or 17,680 AF/yr of demand for the Newhall Ranch Specific Plan.
Annual Indoor Water Use Outside Newhall Ranch (Equal to LACSD WRP Influent Volumes)		
18,723	40,313 (average year)	The year 2000 volume is from the Saugus and Valencia WRPs for the period January 2000 through December 2000. The long-term current generated effluent volume is based on the influent volume estimated from water balance calculations performed for the chloride mass balance analysis. The effluent volume is 32.8 percent of the total urban water production of 123,038 AF/yr, which includes other uses.

[a]Development Monitoring System water demands are demands associated with future build-out of developments identified in Los Angeles County's Development Monitoring System for the Santa Clarita Valley.

TABLE 3-12

Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Month	Treated Water Volume (2000)[a]	Treated Water Volume (Full Build-out Conditions)[b]	Percent of Annual Outdoor Demand	Reclaimed Volume under Full Build-out Conditions (Before Maintaining Existing Streamflows)	Reclaimed Volume under Full Build-out Conditions (After Maintaining Existing Streamflows)	WRP Discharges to River under Full Build-out Conditions[c]	Month
January	1,503	3,237	3.75	637	637	2,600	January
February	1,443	3,106	5.10	867	867	2,239	February
March	1,528	3,290	6.60	1,122	1,122	2,168	March
April	1,505	3,240	9.10	1,547	1,547	1,693	April
May	1,569	3,379	10.55	1,794	1,794	1,585	May
June	1,543	3,322	11.40	1,938	1,781	1,541	June
July	1,606	3,459	14.10	2,397	1,854	1,605	July
August	1,649	3,550	12.95	2,202	1,902	1,648	August
September	1,593	3,430	10.20	1,734	1,734	1,696	September
October	1,631	3,512	7.50	1,275	1,275	2,237	October
November	1,546	3,329	5.00	850	850	2,479	November
December	1,607	3,459	3.75	637	637	2,822	December
Total Annual	**18,723**	**40,313**	**100.0**	**17,000**	**16,000**	**24,313**	**Total Annual**

[a]Values shown are the actual volumes of treated water discharged to the Santa Clara River from the Saugus and Valencia WRPs during calendar year 2000. (See also Table 3-11.)

[b]Values shown are the combined treated water volumes estimated to be produced by the Saugus and Valencia WRPs for full build-out conditions in the Santa Clarita Valley. These values do not include the future Newhall Ranch WRP, which will be operated by LACSD.

[c]Values shown do not include discharges of treated water to the river from the future Newhall Ranch WRP. These volumes are 10 acre-feet in November, 138 acre-feet in December, and 138 acre-feet in January. During the other nine months of the year, this WRP will not discharge treated water to the river (see the *Newhall Ranch Draft Additional Analysis* [Impact Sciences, Inc., 2001] for further details). The combined total discharge from the Saugus, Valencia, and Newhall Ranch WRPs is summarized in Table 3-13.

Note:
All units are in acre-feet.

TABLE 3-13

Simulated Monthly Treated Wastewater Discharges from Santa Clarita Valley WRPs under Full Build-out Conditions

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

WRP	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Saugus	493	487	500	490	503	466	457	508	586	555	514	596	6,155
Valencia	2,107	1,752	1,668	1,203	1,082	1,075	1,148	1,140	1,110	1,682	1,965	2,226	18,158
Newhall	138	0	0	0	0	0	0	0	0	0	10	138	286
Total	**2,738**	**2,239**	**2,168**	**1,693**	**1,585**	**1,541**	**1,605**	**1,648**	**1,696**	**2,237**	**2,489**	**2,960**	**24,599**

Note:

Wastewater discharge volumes are listed in acre-feet.

Figures

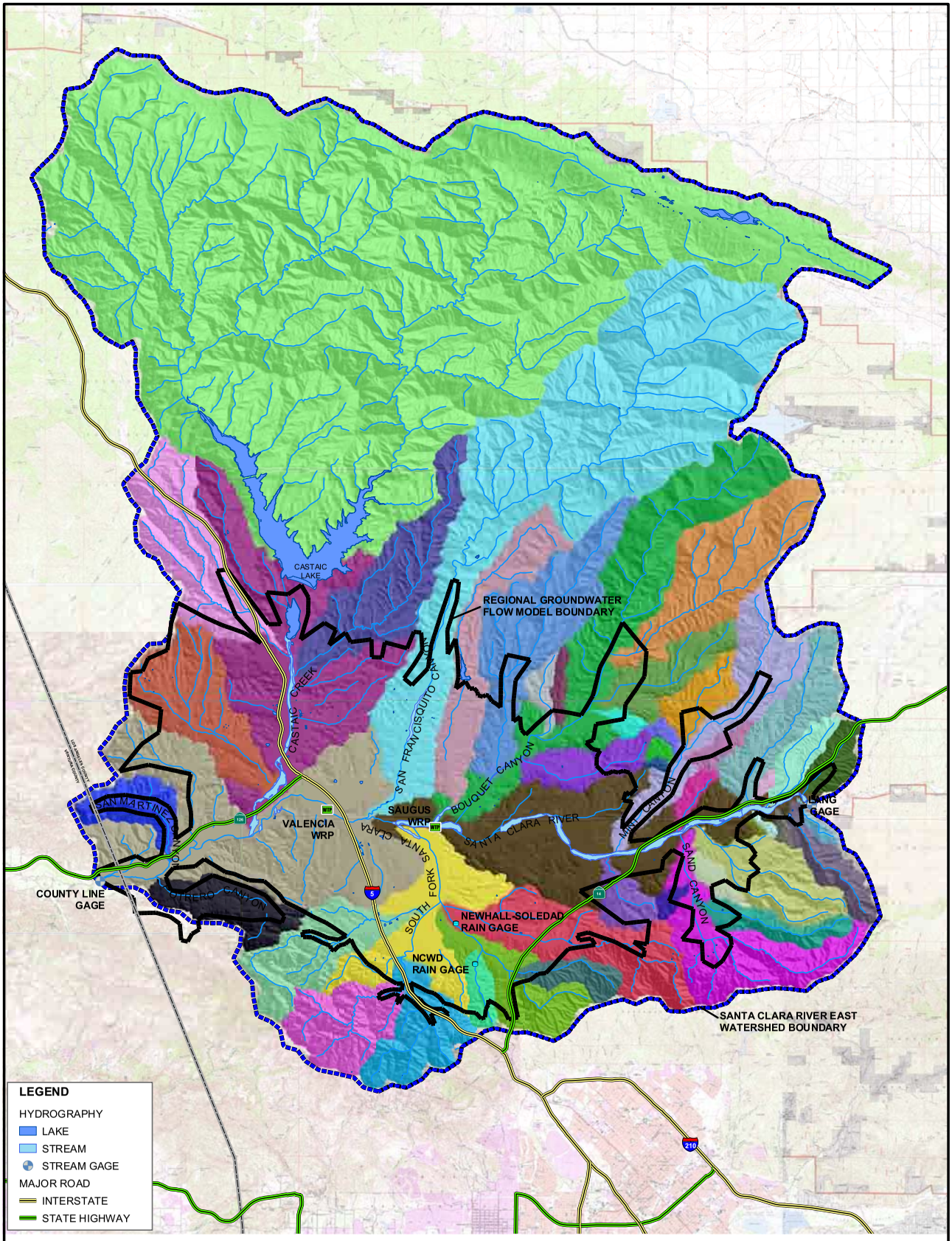

FIGURE 3-1
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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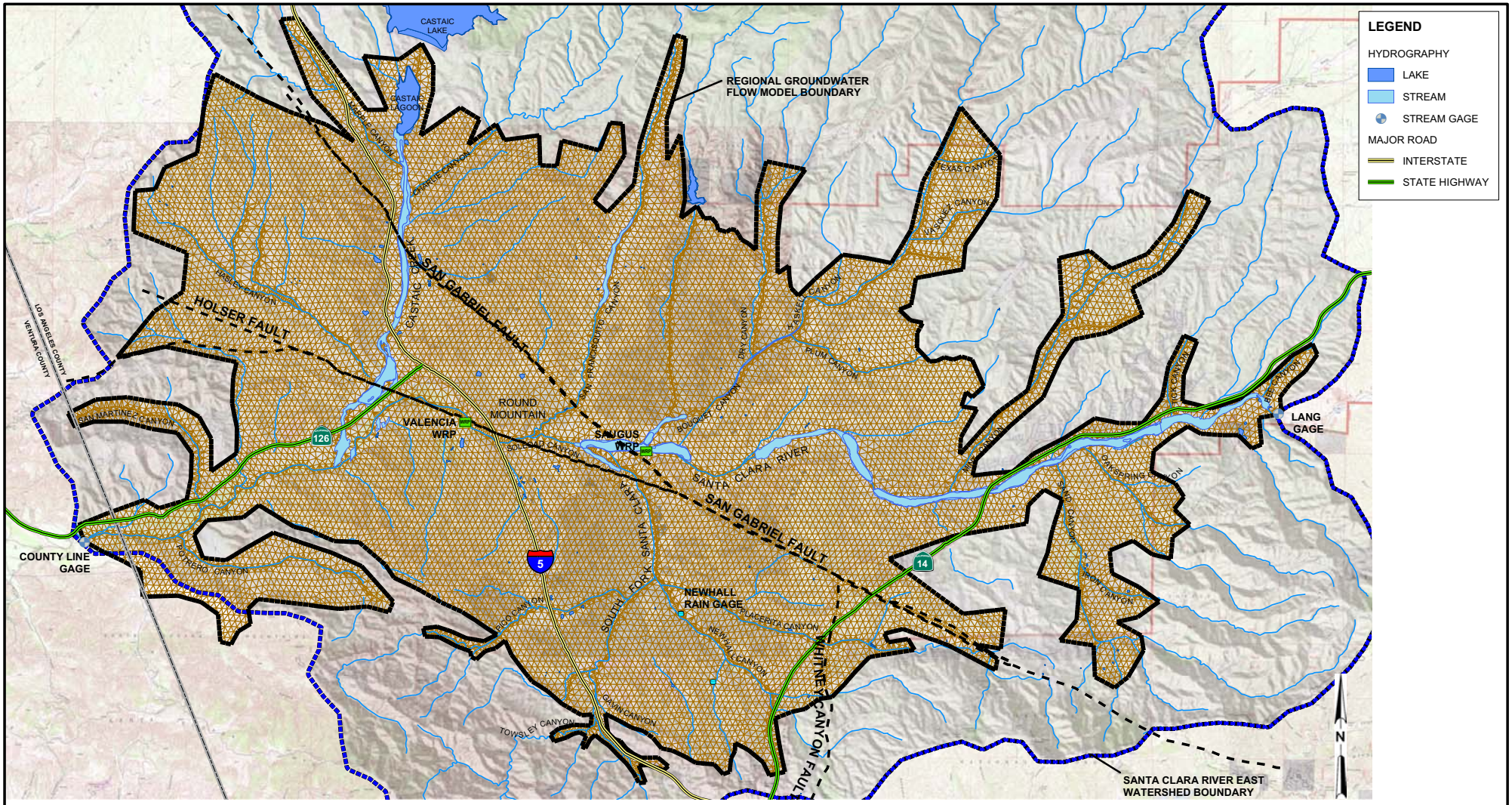

FIGURE 3-2
REGIONAL MODEL GRID
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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	Stratigraphy		Model Layer	Thickness (feet)
Saugus	Alluvium	Saugus	1	500
Saugus	Saugus	Saugus	2	
Saugus	Saugus	Saugus	3	500
Saugus	Saugus	Saugus	4	500
Saugus	Saugus	Saugus	5	500
Saugus	Saugus	Saugus	6	500
Sunshine	Sunshine	Sunshine	7	Variable

FIGURE 3-3
SCHEMATIC DIAGRAM OF THE MODEL'S REPRESENTATION OF STRATIGRAPHY IN THE MIDDLE OF THE BASIN
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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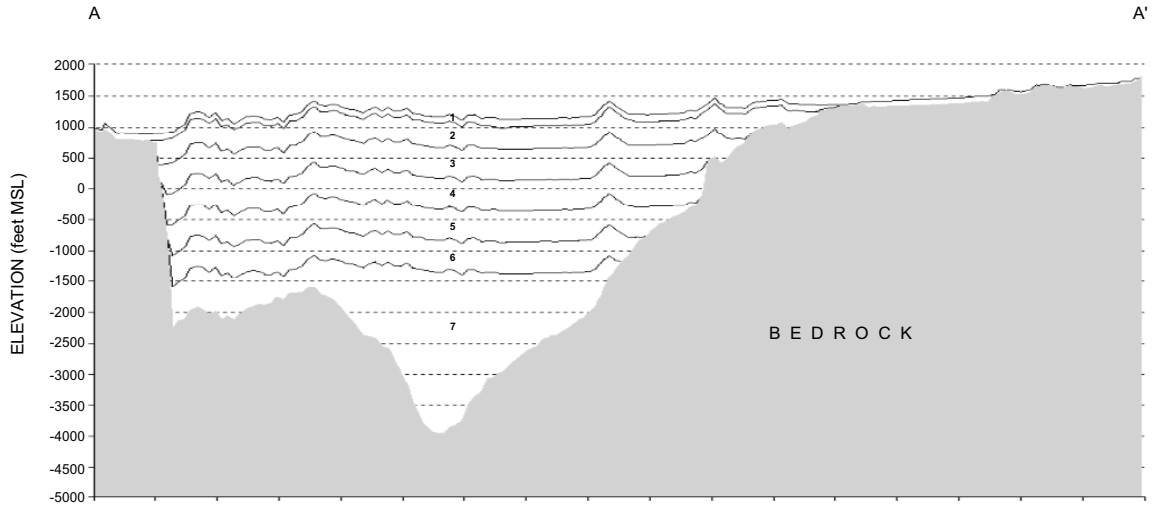
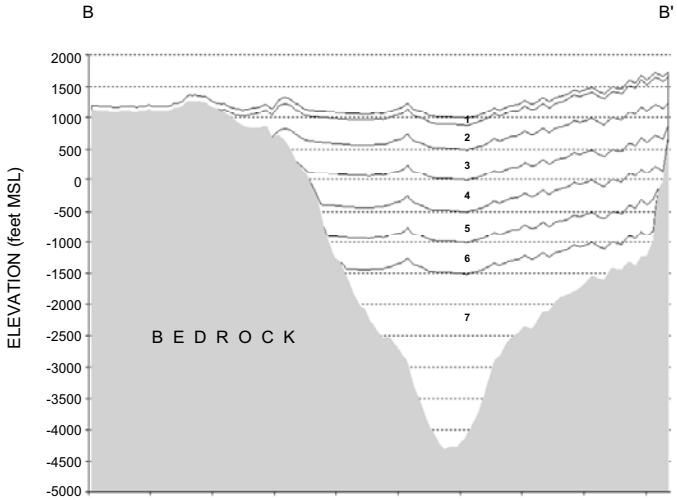
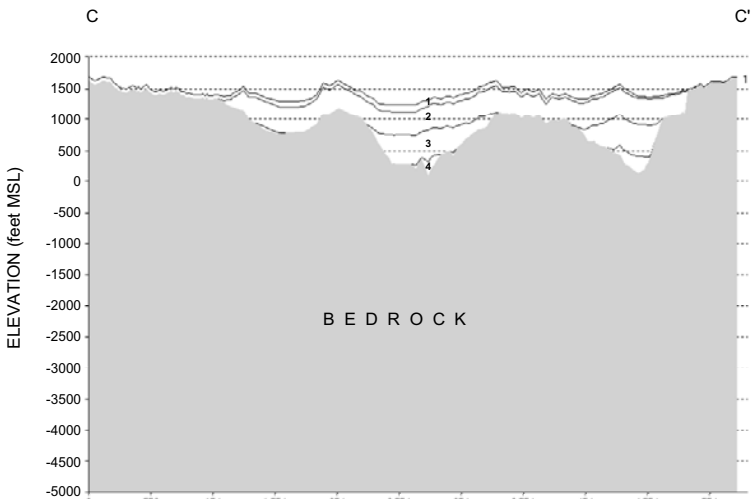
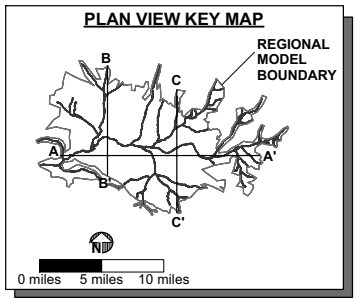
178973-414.xls\FIG3-3









LEGEND

1 = MODEL LAYER 1

2 = MODEL LAYER 2

3 = MODEL LAYER 3

4 = MODEL LAYER 4

5 = MODEL LAYER 5

6 = MODEL LAYER 6

7 = MODEL LAYER 7

HORIZONTAL CROSS SECTION SCALE

0 feet 10,000 feet 20,000 feet

5x VERTICAL EXAGGERATION

FIGURE 3-4
SCHEMATIC CROSS SECTIONS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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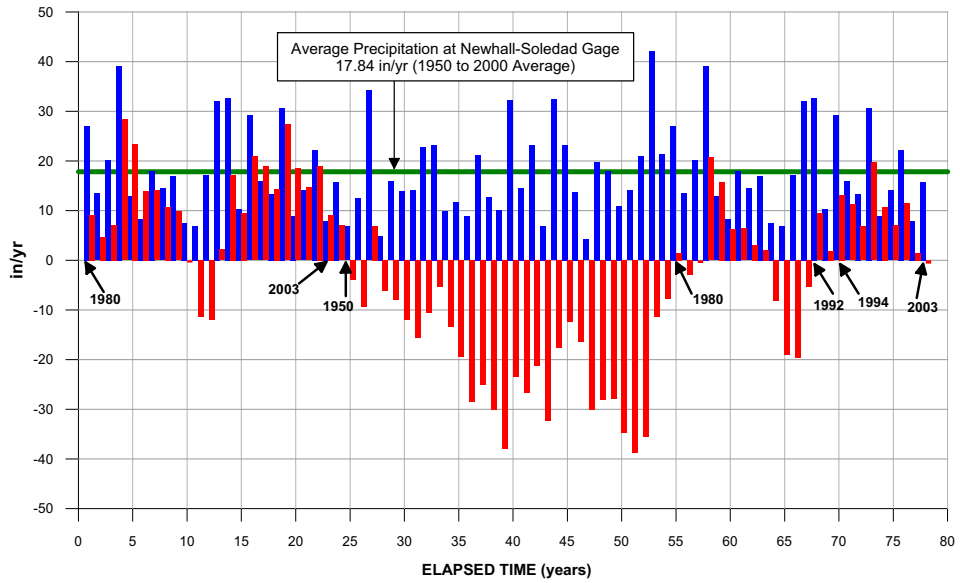

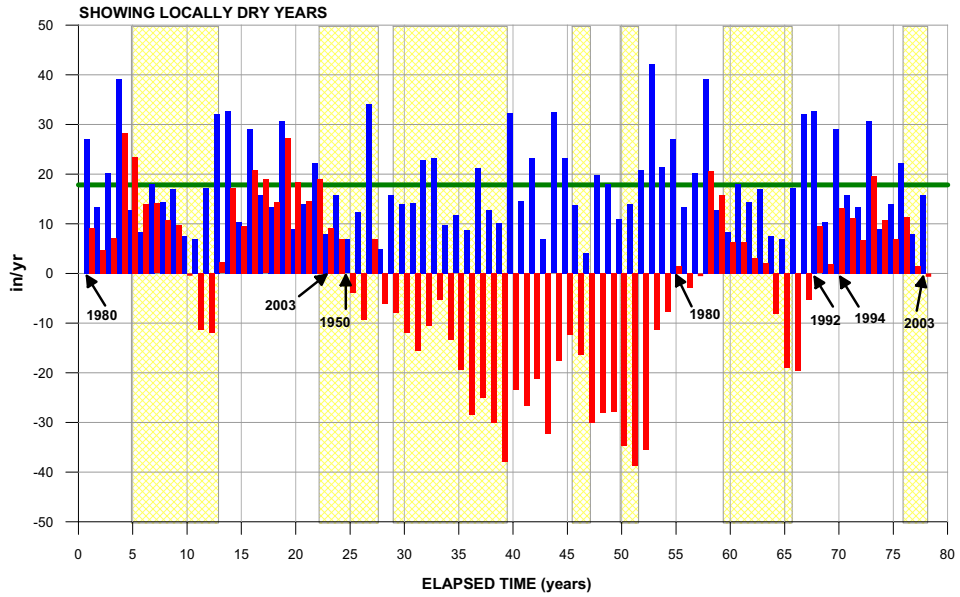

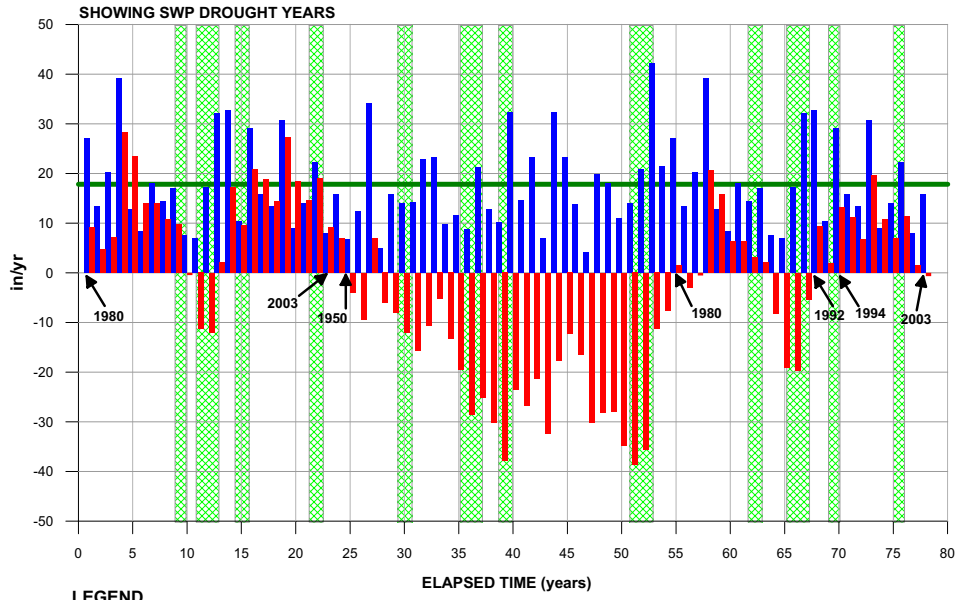

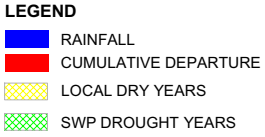

FIGURE 3-5
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE FOR THE 78-YEAR SIMULATION PERIOD
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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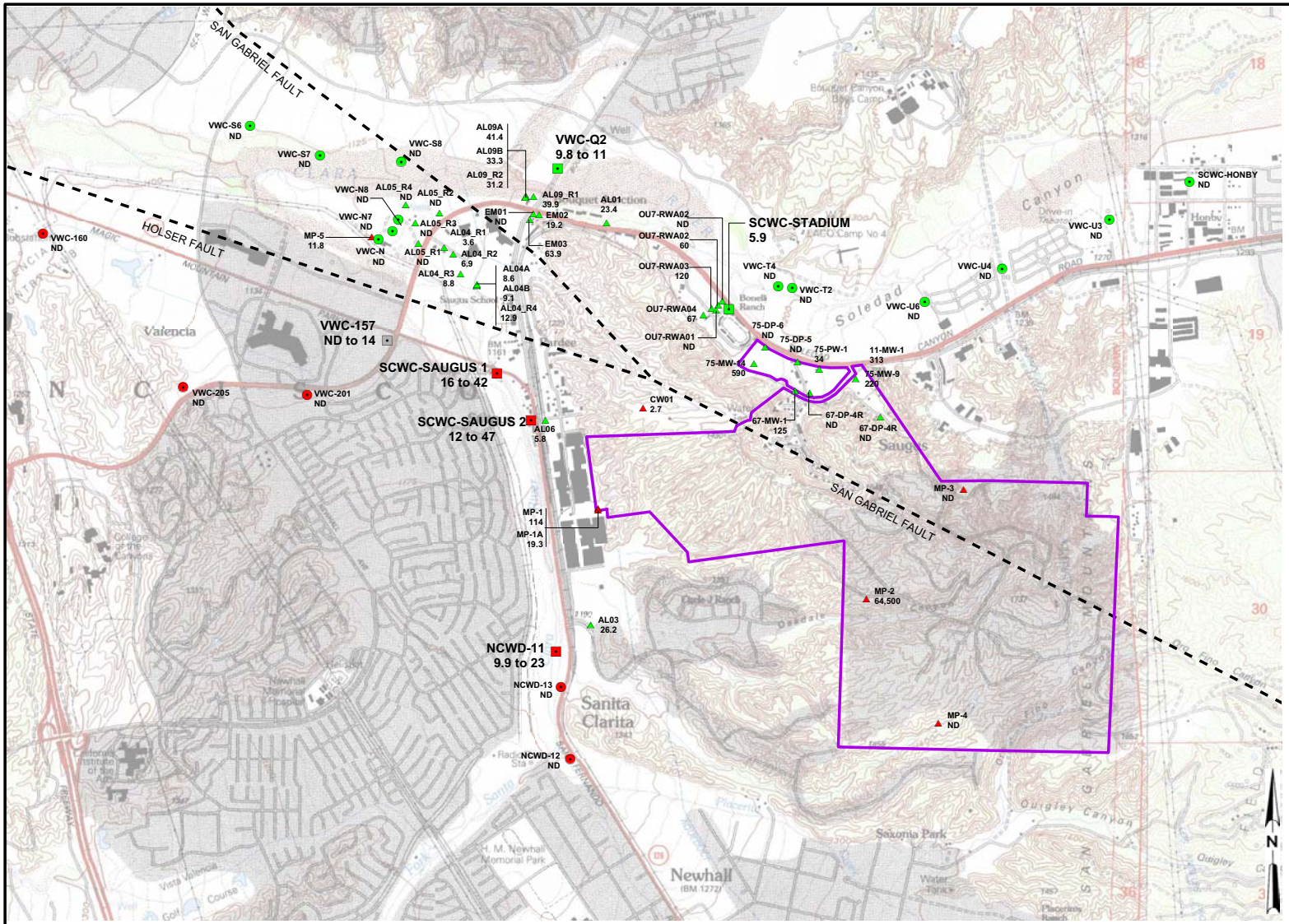

LEGEND

CONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS
- SAUGUS (DESTROYED JANUARY 2005)

UNCONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELL

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE 3-6
WELL LOCATIONS AND PERCHLORATE CONCENTRATIONS NEAR THE WHITTAKER-BERMITE PROPERTY
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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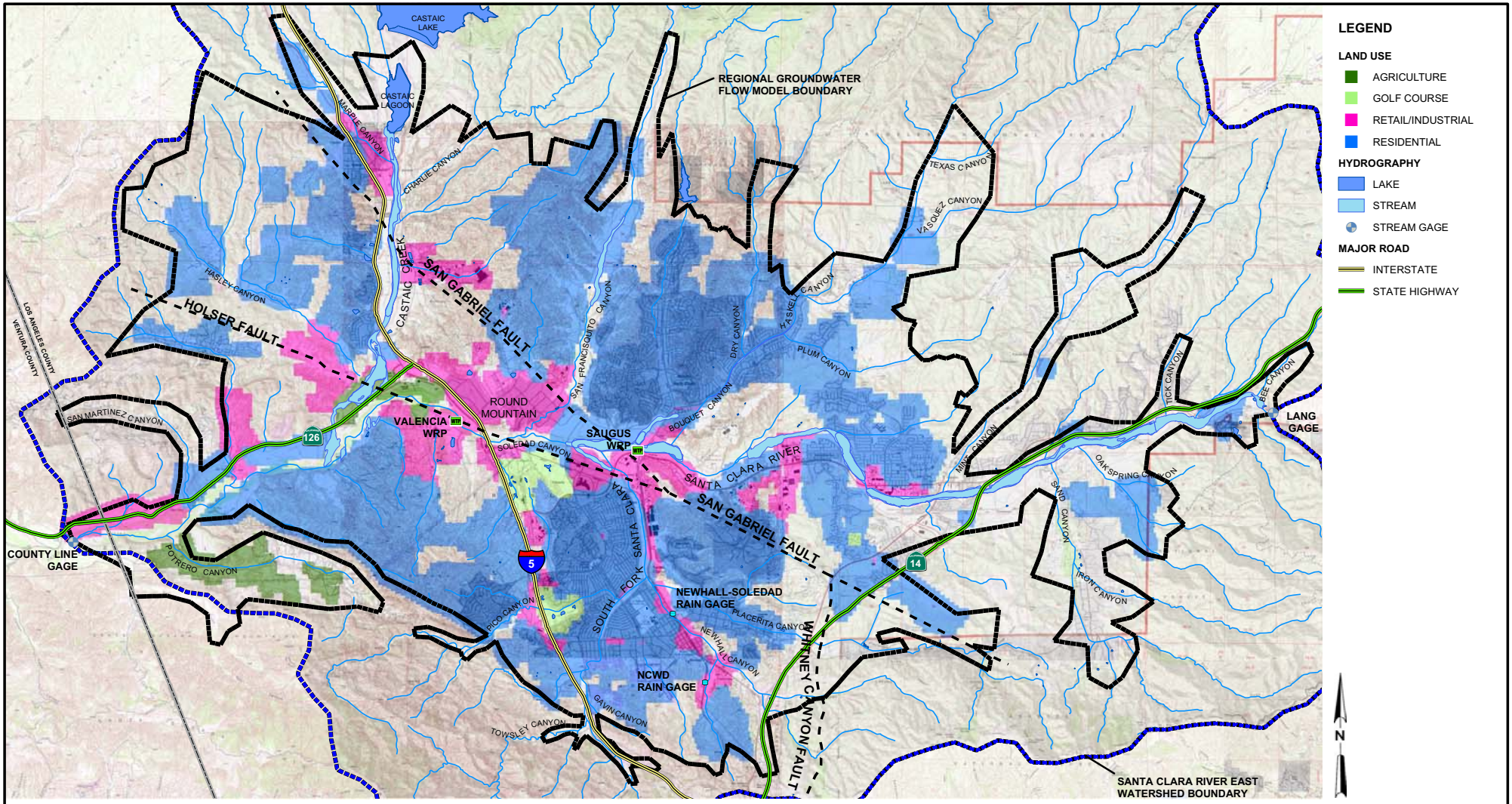


NOTE:
LAND USES UNDER FULL BUILD-OUT CONDITIONS ARE SHOWN ONLY INSIDE THE MODEL BOUNDARY, AND ARE NOT SHOWN OUTSIDE THE MODEL BOUNDARY.

FIGURE 3-7
SIMULATED LAND USE WITHIN THE REGIONAL MODEL BOUNDARY UNDER FULL BUILD-OUT CONDITIONS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

SECTION 4

Model Results

This section of the report presents and discusses hydrographs of simulated groundwater elevations, groundwater budget terms, and Santa Clara River flows for the 78-year modeling period.

4.1 Groundwater Elevations

Groundwater elevation hydrographs for different portions of the Alluvial Aquifer are presented on Figures 4-1 through 4-5. Hydrographs for different portions of the Saugus Formation are presented on Figures 4-6 and 4-7. Each figure shows the monthly groundwater elevations simulated for the 78-year modeling period.

These figures show that the spatial distribution and temporal variation of pumping are not expected to cause a long-term decline in groundwater levels in the Alluvial Aquifer or the Saugus Formation. The Regional Model simulates distinct multi-year periods of overall declining or overall increasing groundwater elevations resulting from cycles of below-normal and above-normal rainfall periods. This variation is consistent with historical observations of the relationship between rainfall and groundwater level fluctuations (CH2M HILL, 2004a). The Regional Model also simulates short-term declines in Saugus Formation groundwater elevations that arise from the increased Saugus pumping that occurs during the second and third years of reduced water imports. The model simulates water level recovery within a few years after Saugus pumping returns to normal-year pumping rates, a finding that is consistent with historical observations following a peak pumping period in the early 1990s (see Figures 2-9 and 2-10).

4.2 Groundwater Recharge, Discharge, and Storage

Figures 4-8 and 4-9 show the annual valleywide variations in groundwater recharge and discharge, respectively, throughout the 78-year simulation period. These groundwater recharge and discharge rates are also listed in Table 4-1. Figure 4-10 shows the annual and cumulative changes in groundwater storage volumes. Figures 4-8 through 4-10 and Table 4-1 together show the following:

1. Groundwater recharge rates (see Figure 4-8) vary greatly from year to year, because of variations in (a) precipitation within the groundwater basin and (b) precipitation and stormwater generation in the watersheds lying upstream of the groundwater basin. In contrast, total groundwater discharge (see Figure 4-9) is much less variable from year to year, with the more limited variations arising from increased pumping during drought years and increased ET and groundwater discharge to the Santa Clara River during wet years.
2. Year-to-year and cumulative changes in groundwater storage during the 78-year simulation period (see Figure 4-10) provide insights as to the manner in which the basin is

functioning hydrologically under the groundwater operating plan for the valley. The cumulative change in groundwater storage is a measure of the longer-term trends in the amount of groundwater in storage, and is plotted on a monthly basis. Table 4-1 tabulates the annual water budget for each year of the 78-year simulation, and shows the cumulative change on an annual basis (in contrast to the monthly basis shown on Figure 4-10). Figure 4-10 and Table 4-1 together show the following:

a. The cumulative change in total groundwater storage volume, which measures the continuous change in storage in the combined Alluvial-Saugus aquifer system since the beginning of the simulation, ranges between approximately a 150,000-acre-foot decline and a 260,000-acre-foot increase. The change in groundwater storage during a single year ranges from approximately an 80,000-AF/yr decline to a 170,000-AF/yr increase.

b. A nearly 20-year period of overall decline in the cumulative groundwater storage volume occurs between years 19 and 39, as shown on Figure 4-10. Beginning in year 40, the cumulative change in storage shows a generally upward trend, with occasional downward trends during specific drought periods.

3. Implementation of the groundwater operating plan will not cause permanent declines in groundwater storage volumes. This is shown by the forecasted recovery of groundwater storage volumes after periods of continued decline, such as after the 20-year period of groundwater declines that occurs during years 19 through 39.

4. Based on the previous observations, changes in groundwater storage volumes, particularly over a period of many years, are governed significantly by variations in local hydrologic conditions. Local precipitation and streamflows are the primary recharge mechanisms in the valley and therefore have a direct influence on year-to-year and longer-term changes in groundwater storage volumes.

4.3 River Flows

Figure 4-11 shows the total flows estimated by the model for the Santa Clara River at the County Line gage, which is located at the western end of the valley. The figure contains both a linear plot and a semi-logarithmic plot, to better illustrate the flows during low-flow periods. As shown by both plots, the total streamflows vary considerably over time at this location, due primarily to variations in rainfall.

The influences of the local hydrology and the groundwater operating plan on the Santa Clara River are also shown by Figure 4-12, which displays the model-calculated volumes of monthly groundwater discharge to the river. Groundwater discharges to the river occur along the river reach lying downstream of the mouth of San Francisquito Canyon. The figure shows that the groundwater discharge rates to the river also vary over time, both seasonally and over multi-year periods. Additionally, the figure shows that the Regional Model simulates a period of relatively low groundwater discharge to the river from years 23 through 39 (historical years 2002 through 2003, followed by 1950 through 1964), which corresponds to the prevailing below-normal rainfall conditions in those years. The figure also shows higher volumes of groundwater discharge to the river in years of above-normal

rainfall, particularly the very wet periods years 1 through 4, 13 through 19, 52 through 58, and 67 through 72.

The similarity between rainfall and groundwater discharges to the river indicates that local hydrology is the primary influence on these discharges. Additionally, the groundwater discharge hydrographs do not show any marked short-term declines in flows when Saugus Formation groundwater levels decrease during years of increased Saugus Formation pumping. The Regional Model, therefore, indicates that the operating plan for the groundwater system is not expected to adversely affect river flows.

4.4 Relationship of Simulation Results to Future Conditions

The curves presented on Figures 4-1 through 4-12 provide a general indication of the types of fluctuations in groundwater conditions that could be expected to occur in the future in the Santa Clarita Valley over a period of many years. However, these curves have been derived using an assumed sequence of local hydrologic conditions that is based on the sequence of rainfall and streamflow volumes that were measured during the past several decades. In the future, the year-to-year volumes and trends in rainfall and streamflow could vary from those observed in the past. Consequently, actual future trends in rainfall and streamflow might differ from those presented in this simulation on a short-term basis. However, over a period of several years or decades, the model-simulated recharge values and basin responses are more likely to reflect actual long-term average basin conditions under this operating plan.

The modeling simulation described in this report meets the intended objectives of quantifying possible basin responses to the operating plan, in terms of temporal variations that could occur in groundwater levels, groundwater storage, and Santa Clara River streamflows; and using the quantified responses to evaluate the sustainability of the operating plan with respect to potential trends in groundwater levels and Santa Clara River flows. The principal conclusions about the groundwater operating plan that have been drawn from the historical analyses and modeling simulations presented in this report are discussed in Section 5.

Table

TABLE 4-1

Simulated Annual Groundwater Budget

Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year			Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
0	to	1	41,053	13,970	39,953	17,871	112,847	49,119	21,649	17,524	18,464	106,756	6,091	6,091
1	to	2	11,601	13,970	3,373	18,632	47,576	49,035	10,147	10,469	18,136	87,788	-40,212	-34,120
2	to	3	51,672	13,970	28,415	18,444	112,501	49,035	10,925	12,319	18,585	90,863	21,638	-12,483
3	to	4	181,820	13,970	89,448	16,985	302,223	49,035	36,265	29,506	19,056	133,861	168,361	155,879
4	to	5	687	13,970	527	18,253	33,437	49,119	16,665	23,150	18,225	107,158	-73,721	82,158
5	to	6	2	13,970	535	18,927	33,434	44,372	9,497	13,286	18,171	85,326	-51,891	30,266
6	to	7	42,574	13,970	19,998	18,619	95,161	49,035	11,479	14,376	18,568	93,458	1,703	31,969
7	to	8	11,415	13,970	2,484	19,419	47,288	49,035	7,923	10,419	18,277	85,654	-38,366	-6,397
8	to	9	27,363	13,970	10,507	19,743	71,583	54,214	6,664	10,234	18,507	89,618	-18,036	-24,433
9	to	10	0	13,970	523	20,113	34,606	44,372	4,739	8,041	18,359	75,510	-40,904	-65,336
10	to	11	0	13,970	1,472	20,347	35,789	49,446	2,584	5,612	18,354	75,996	-40,208	-105,544
11	to	12	50,580	13,970	28,173	19,613	112,336	58,025	3,061	8,476	18,563	88,125	24,211	-81,334
12	to	13	130,074	13,970	80,760	17,850	242,654	72,600	14,234	18,462	18,728	124,024	118,630	37,296
13	to	14	112,433	13,970	51,561	17,509	195,472	49,035	24,221	29,084	18,797	121,137	74,335	111,632
14	to	15	414	13,970	1,979	18,575	34,939	49,446	7,788	16,616	18,157	92,007	-57,068	54,563
15	to	16	113,543	13,970	60,100	17,636	205,250	49,035	29,255	26,983	18,745	124,018	81,232	135,795
16	to	17	45,609	13,970	21,594	18,204	99,376	49,119	15,122	21,342	18,635	104,218	-4,842	130,954
17	to	18	16,967	13,970	5,320	18,758	55,015	49,035	11,851	16,757	18,242	95,885	-40,870	90,084
18	to	19	137,727	13,970	59,717	17,397	228,810	49,035	27,143	31,249	18,923	126,350	102,460	192,544
19	to	20	13	13,970	4,717	18,586	37,286	49,035	14,305	20,865	18,200	102,405	-65,119	127,425
20	to	21	14,095	13,970	4,962	19,294	52,321	49,119	11,194	14,485	18,342	93,139	-40,818	86,607
21	to	22	58,364	13,970	35,154	18,639	126,127	54,116	12,710	19,337	18,655	104,818	21,309	107,917
22	to	23	0	13,970	523	19,557	34,050	44,372	8,105	13,129	18,311	83,916	-49,866	58,051
23	to	24	19,602	13,970	5,065	19,867	58,504	49,035	8,138	10,710	18,375	86,258	-27,754	30,297
24	to	25	0	13,970	524	20,258	34,752	44,441	5,486	7,896	18,418	76,240	-41,489	-11,192
25	to	26	3,053	13,970	518	20,406	37,947	49,035	4,033	6,132	18,386	77,587	-39,639	-50,832
26	to	27	135,033	13,970	73,747	18,014	240,763	49,035	16,024	17,254	18,639	100,951	139,812	88,980
27	to	28	0	13,970	536	18,764	33,270	44,372	9,238	15,229	18,125	86,963	-53,693	35,287
28	to	29	20,048	13,970	4,960	19,518	58,496	49,119	7,646	10,808	18,326	85,898	-27,402	7,885
29	to	30	9,397	13,970	2,999	19,929	46,296	54,116	4,726	8,252	18,339	85,433	-39,138	-31,253
30	to	31	11,022	13,970	2,348	20,308	47,647	49,035	4,024	7,140	18,409	78,609	-30,962	-62,215
31	to	32	62,138	13,970	37,429	19,568	133,105	49,035	6,854	11,497	18,820	86,205	46,900	-15,315
32	to	33	63,939	13,970	36,375	18,890	133,174	49,119	11,471	19,025	18,678	98,293	34,881	19,566
33	to	34	244	13,970	2,395	20,199	36,808	44,372	6,943	11,585	18,375	81,275	-44,466	-24,900
34	to	35	1,555	13,970	524	20,530	36,579	49,446	3,767	7,507	18,404	79,124	-42,545	-67,445
35	to	36	32	13,970	4,852	20,690	39,543	58,025	303	5,882	18,401	82,610	-43,067	-110,512
36	to	37	52,098	13,970	24,510	19,931	110,509	44,441	4,564	10,236	18,620	77,860	32,648	-77,864
37	to	38	4,170	13,970	616	20,483	39,239	49,035	2,503	6,237	18,378	76,152	-36,913	-114,777
38	to	39	362	13,970	2,463	20,816	37,610	49,446	719	4,966	18,418	73,549	-35,938	-150,716
39	to	40	122,459	13,970	74,037	19,276	229,741	49,035	8,546	10,468	18,766	86,814	142,927	-7,789
40	to	41	12,997	13,970	4,096	19,066	50,129	49,119	8,998	13,953	18,220	90,290	-40,161	-47,950
41	to	42	64,499	13,970	40,945	18,797	138,210	49,035	10,243	16,890	18,577	94,745	43,465	-4,484
42	to	43	0	13,970	536	19,752	34,258	44,372	6,577	12,461	18,301	81,711	-47,454	-51,938
43	to	44	123,377	13,970	53,751	18,022	209,121	49,035	17,543	21,442	18,640	106,660	102,461	50,523
44	to	45	64,250	13,970	39,379	18,423	136,022	49,119	13,271	20,449	18,544	101,383	34,639	85,163
45	to	46	8,541	13,970	2,217	19,103	43,830	49,035	10,232	18,196	18,249	95,712	-51,882	33,281
46	to	47	0	13,970	533	19,897	34,399	44,372	6,746	10,372	18,334	79,823	-45,424	-12,143

TABLE 4-1

Simulated Annual Groundwater Budget

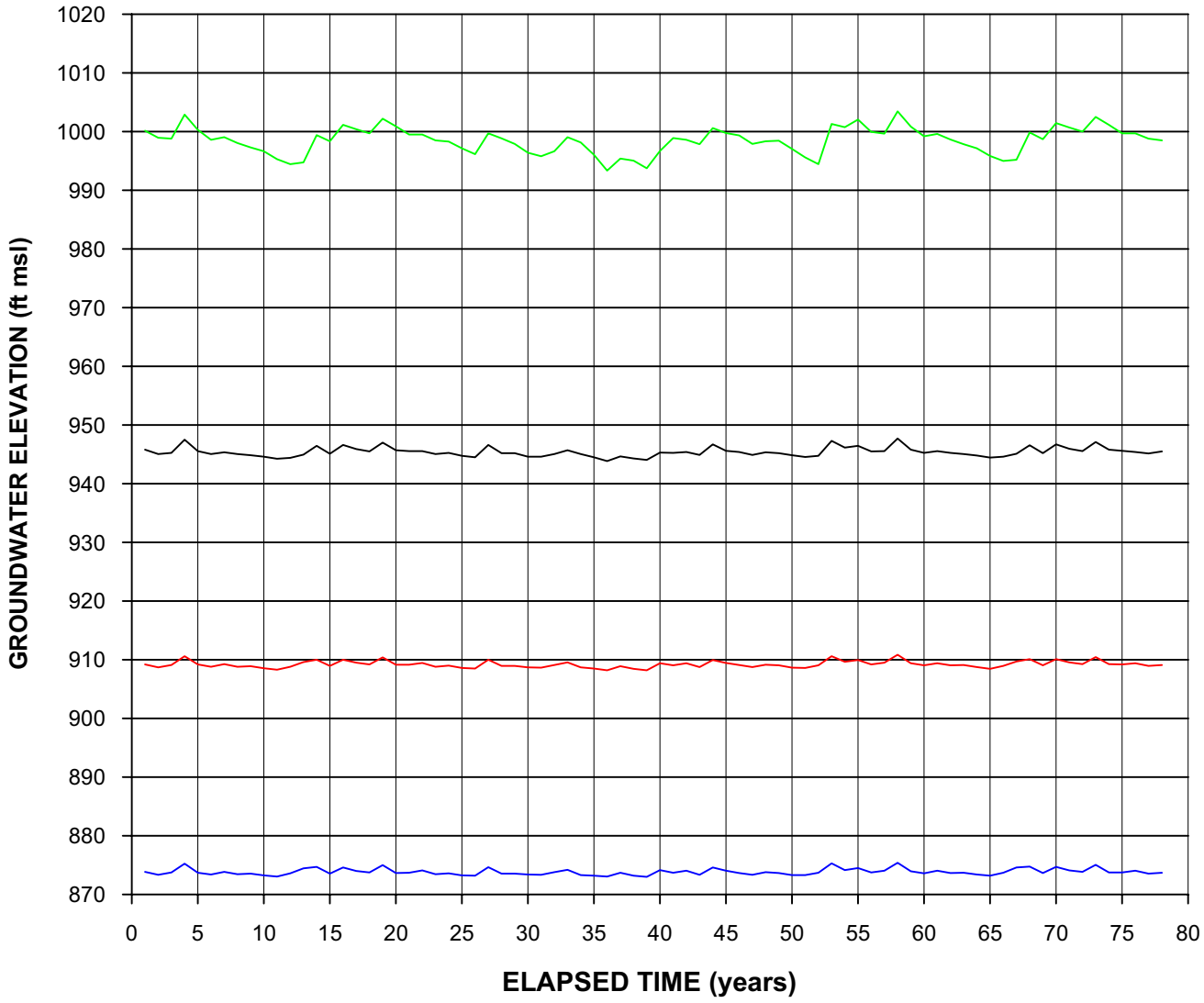
Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California

Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
47 to 48	43,414	13,970	18,560	19,505	95,448	49,035	8,927	12,755	18,638	89,355	6,094	-6,050
48 to 49	32,966	13,970	13,527	19,953	80,416	49,119	8,497	12,634	18,666	88,916	-8,499	-14,549
49 to 50	839	13,970	1,856	20,451	37,117	44,372	5,528	8,992	18,434	77,326	-40,209	-54,758
50 to 51	9,990	13,970	2,645	20,684	47,289	54,116	3,517	6,845	18,455	82,933	-35,643	-90,401
51 to 52	49,961	13,970	25,027	20,153	109,112	62,702	3,319	9,913	18,755	94,689	14,423	-75,978
52 to 53	188,493	13,970	69,633	17,584	289,679	49,119	22,292	27,398	18,933	117,742	171,937	95,959
53 to 54	46,125	13,970	20,155	18,290	98,539	49,035	15,148	24,661	18,522	107,366	-8,827	87,132
54 to 55	89,718	13,970	39,953	17,979	161,620	49,035	20,589	29,655	18,624	117,903	43,716	130,848
55 to 56	11,601	13,970	3,373	19,267	48,211	49,035	11,347	18,242	18,316	96,940	-48,729	82,119
56 to 57	51,672	13,970	28,415	19,203	113,260	49,119	11,982	18,862	18,806	98,769	14,491	96,610
57 to 58	181,820	13,970	89,448	17,106	302,343	49,035	32,399	38,747	19,048	139,229	163,114	259,725
58 to 59	687	13,970	527	18,350	33,534	49,035	16,623	29,046	18,213	112,917	-79,383	180,342
59 to 60	2	13,970	535	19,266	33,773	44,372	10,576	17,223	18,266	90,437	-56,664	123,678
60 to 61	42,574	13,970	19,998	18,987	95,529	49,119	12,553	18,152	18,704	98,527	-2,998	120,680
61 to 62	11,415	13,970	2,484	19,754	47,622	49,035	9,005	13,268	18,366	89,674	-42,052	78,628
62 to 63	27,363	13,970	10,507	20,014	71,853	54,116	7,752	12,812	18,539	93,219	-21,366	57,262
63 to 64	0	13,970	523	20,416	34,909	44,372	5,755	10,119	18,437	78,683	-43,774	13,488
64 to 65	0	13,970	1,472	20,680	36,121	49,522	3,569	7,254	18,475	78,820	-42,698	-29,210
65 to 66	50,580	13,970	28,173	19,854	112,576	58,025	4,004	10,335	18,623	90,989	21,588	-7,622
66 to 67	130,074	13,970	80,760	17,898	242,702	72,452	13,502	21,223	18,686	125,863	116,839	109,216
67 to 68	112,433	13,970	51,561	17,536	195,499	49,035	23,462	32,532	18,803	123,833	71,667	180,883
68 to 69	414	13,970	1,979	18,661	35,024	49,522	8,596	18,842	18,226	95,186	-60,162	120,721
69 to 70	113,543	13,970	60,100	17,647	205,261	49,035	29,552	30,176	18,761	127,523	77,737	198,459
70 to 71	45,609	13,970	21,594	18,166	99,339	49,035	15,740	23,534	18,602	106,911	-7,572	190,886
71 to 72	16,967	13,970	5,320	18,777	55,034	49,035	12,551	18,552	18,264	98,402	-43,368	147,518
72 to 73	137,727	13,970	59,717	17,442	228,856	49,119	28,296	34,847	19,001	131,263	97,592	245,111
73 to 74	13	13,970	4,717	18,592	37,292	49,035	14,986	23,059	18,220	105,299	-68,007	177,103
74 to 75	14,095	13,970	4,962	19,254	52,281	49,035	11,783	15,930	18,311	95,059	-42,779	134,324
75 to 76	58,364	13,970	35,154	18,654	126,142	54,116	13,385	20,958	18,673	107,132	19,010	153,334
76 to 77	0	13,970	523	19,646	34,139	44,441	8,624	14,082	18,380	85,527	-51,388	101,946
77 to 78	19,602	13,970	5,065	19,899	58,536	49,035	8,607	11,515	18,393	87,550	-29,014	72,932
Minimum	0	13,970	518	16,985	33,270	44,372	303	4,966	18,125	73,549	-79,383	-150,716
Maximum	188,493	13,970	89,448	20,816	302,343	72,600	36,265	38,747	19,056	139,229	171,937	259,725
Average	42,498	13,970	21,480	19,092	97,040	49,823	11,520	16,262	18,498	96,105	935	44,866
Median	19,602	13,970	5,193	19,153	58,500	49,035	9,822	14,430	18,446	92,573	-28,384	36,292

Note:

All flow volumes are listed in AF/yr.

Figures



NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS. WELL NLF-TOPCO1 IS LOCATED 210 feet SOUTHWEST OF WELL NLF-B11.

FIGURE 4-1
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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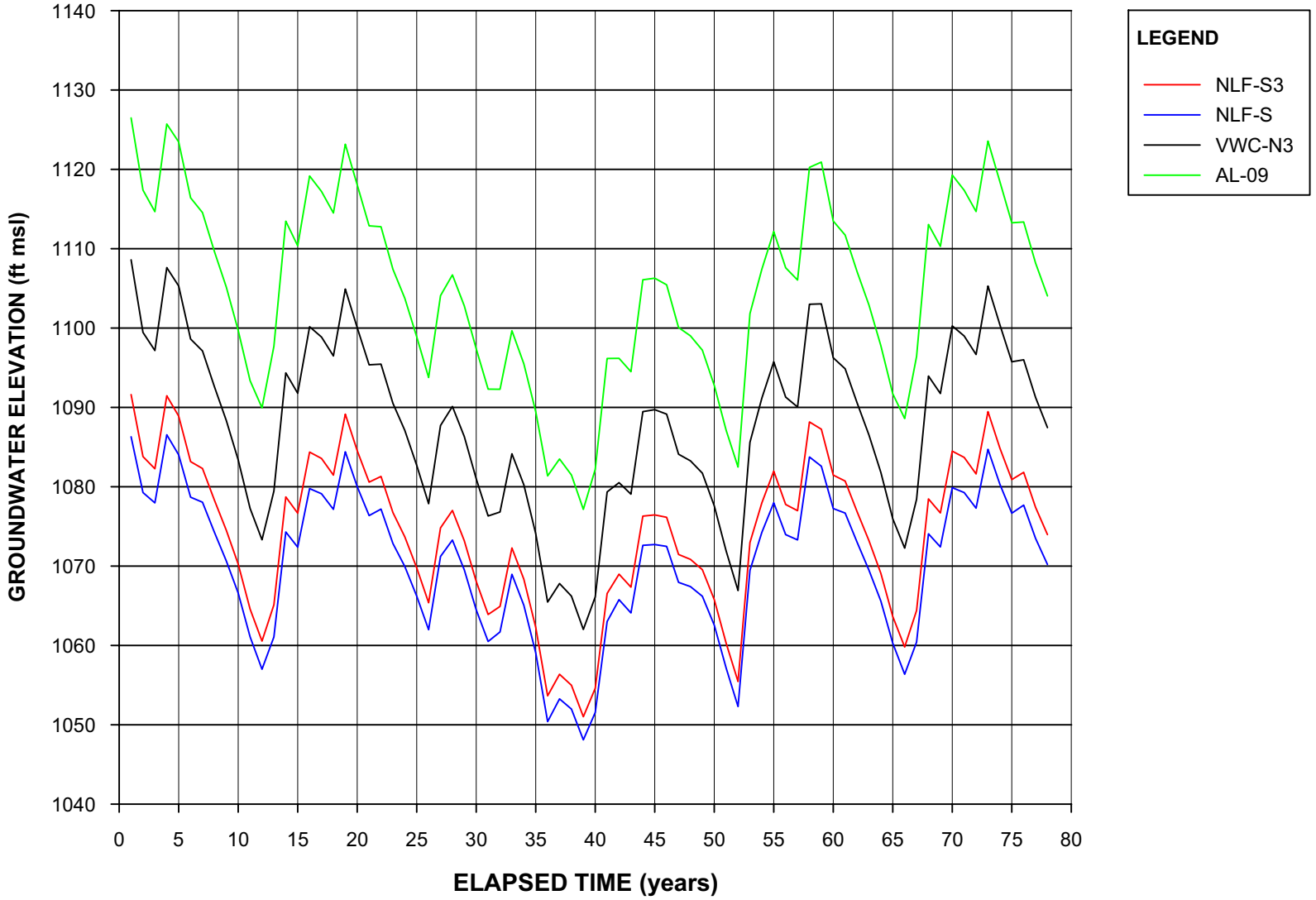

NOTES:

1. AL09 IS A CLUSTER OF OBSERVATION WELLS LOCATED 845 feet SOUTHWEST OF PRODUCTION WELL VWC-Q2.

2. THE REMAINING HYDROGRAPHS REPRESENT FORMER ALLUVIAL AQUIFER WELLS THAT HAVE BEEN ABANDONED AND THEREFORE ARE NOT PUMPED IN THE MODEL SIMULATIONS. RELATIVE TO EXISTING WELLS SHOWN ON FIGURE 2-4, THESE FORMER WELLS WERE LOCATED AS FOLLOWS:

   – WELL NLF-S3 WAS LOCATED 305 feet EAST OF WELL VWC-S6
   – WELL NLF-S WAS LOCATED 940 feet SOUTHWEST OF WELL VWC-S6
   – WELL VWC-N3 WAS LOCATED 435 feet NORTHEAST OF WELL VWC-N8

FIGURE 4-2
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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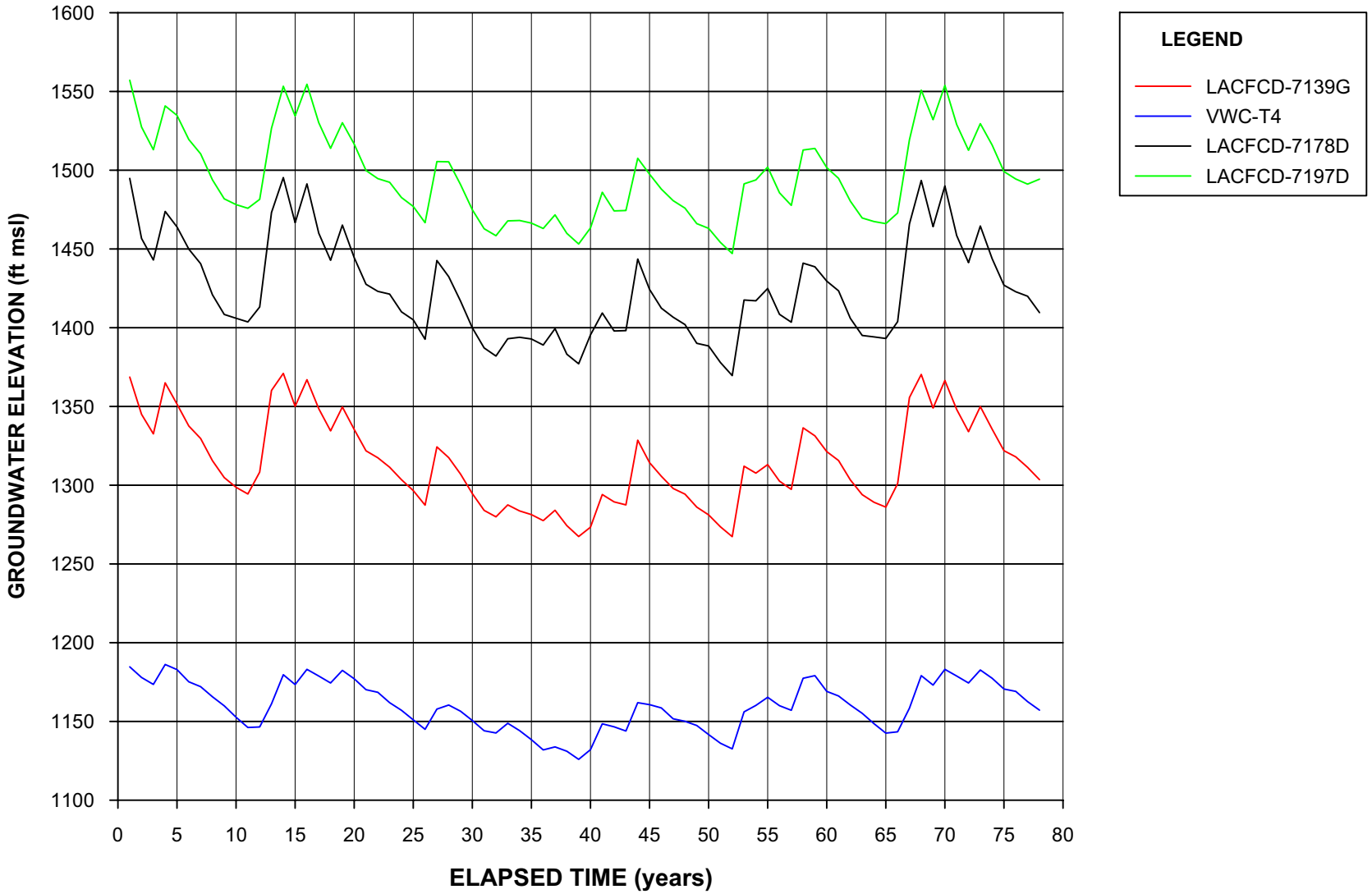

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR VWC- T4 = 1101 ft msl; ALLUVIUM BOTTOM ELEVATION ~1050 TO 1065 ft msl.
3. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7139G = 1289 ft msl; ALLUVIUM BOTTOM ELEVATION ~1256 ft msl OR LOWER.
4. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7178D = 1463 ft msl; ALLUVIUM BOTTOM ELEVATION ~1398 TO 1425 ft msl.
5. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7197D = 1474 ft msl; ALLUVIUM BOTTOM ELEVATION ~1423 TO 1447 ft msl.

FIGURE 4-3
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER IN SOLEDAD CANYON
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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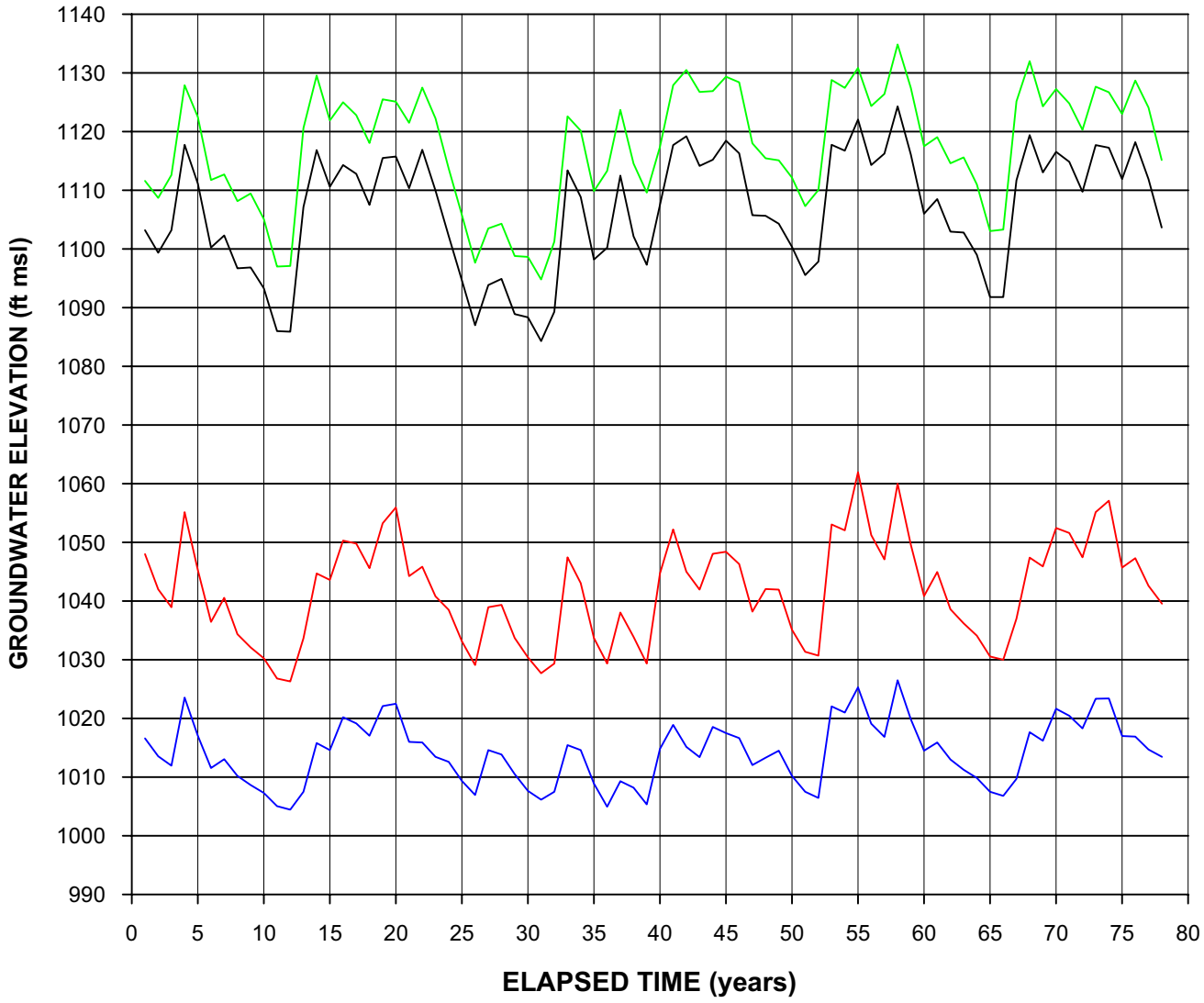

NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE 4-4
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG CASTAIC CREEK
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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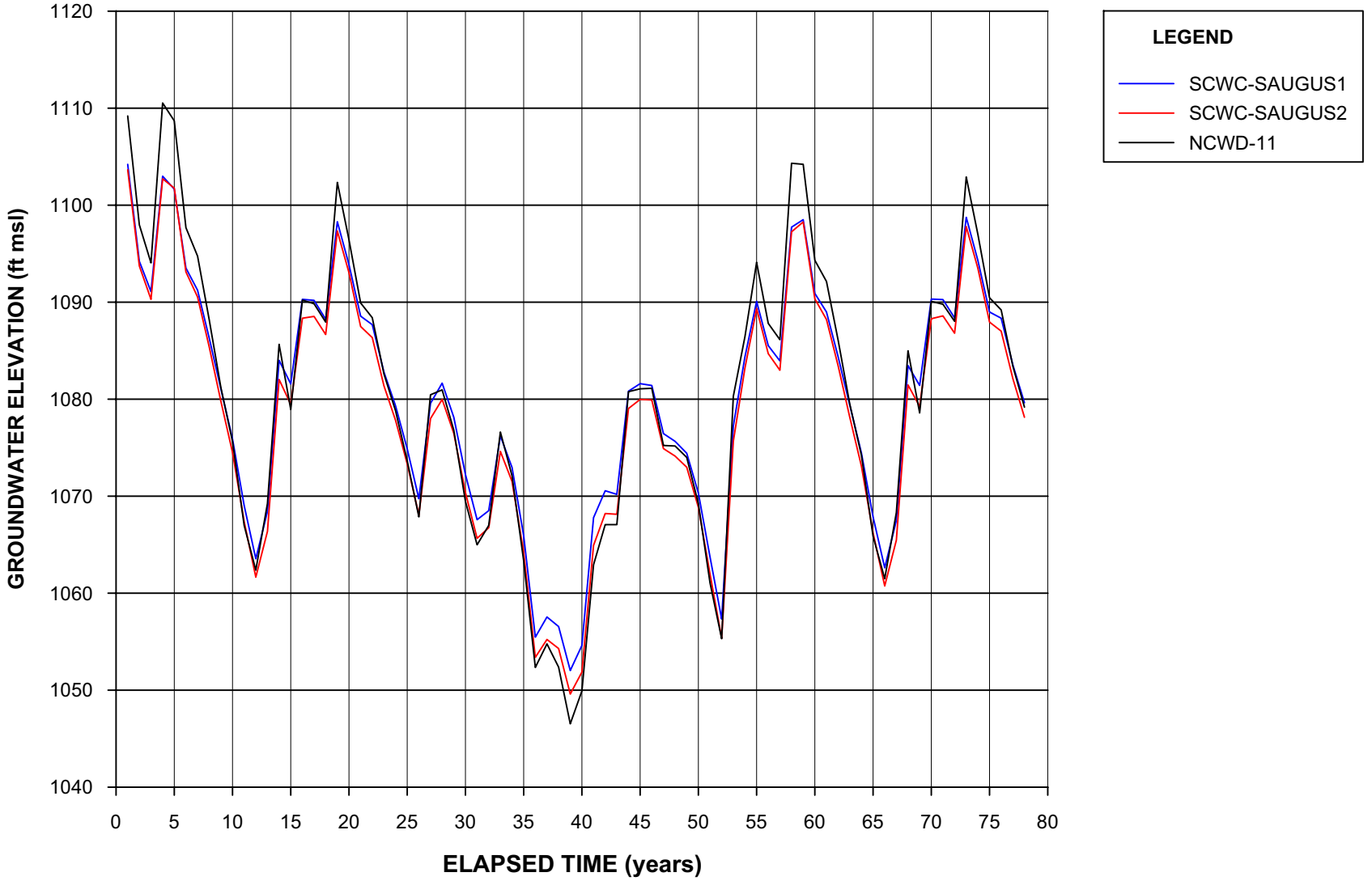

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

2. THESE WELLS ARE CONSTRUCTED IN THE SAUGUS FORMATION AND ARE NOT OPEN TO THE ALLUVIAL AQUIFER. THE SIMULATED HYDROGRAPHS AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE ALLUVIAL AQUIFER, ABOVE THE OPEN INTERVALS OF THESE WELLS.

FIGURE 4-5
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG THE SOUTH FORK SANTA CLARA RIVER
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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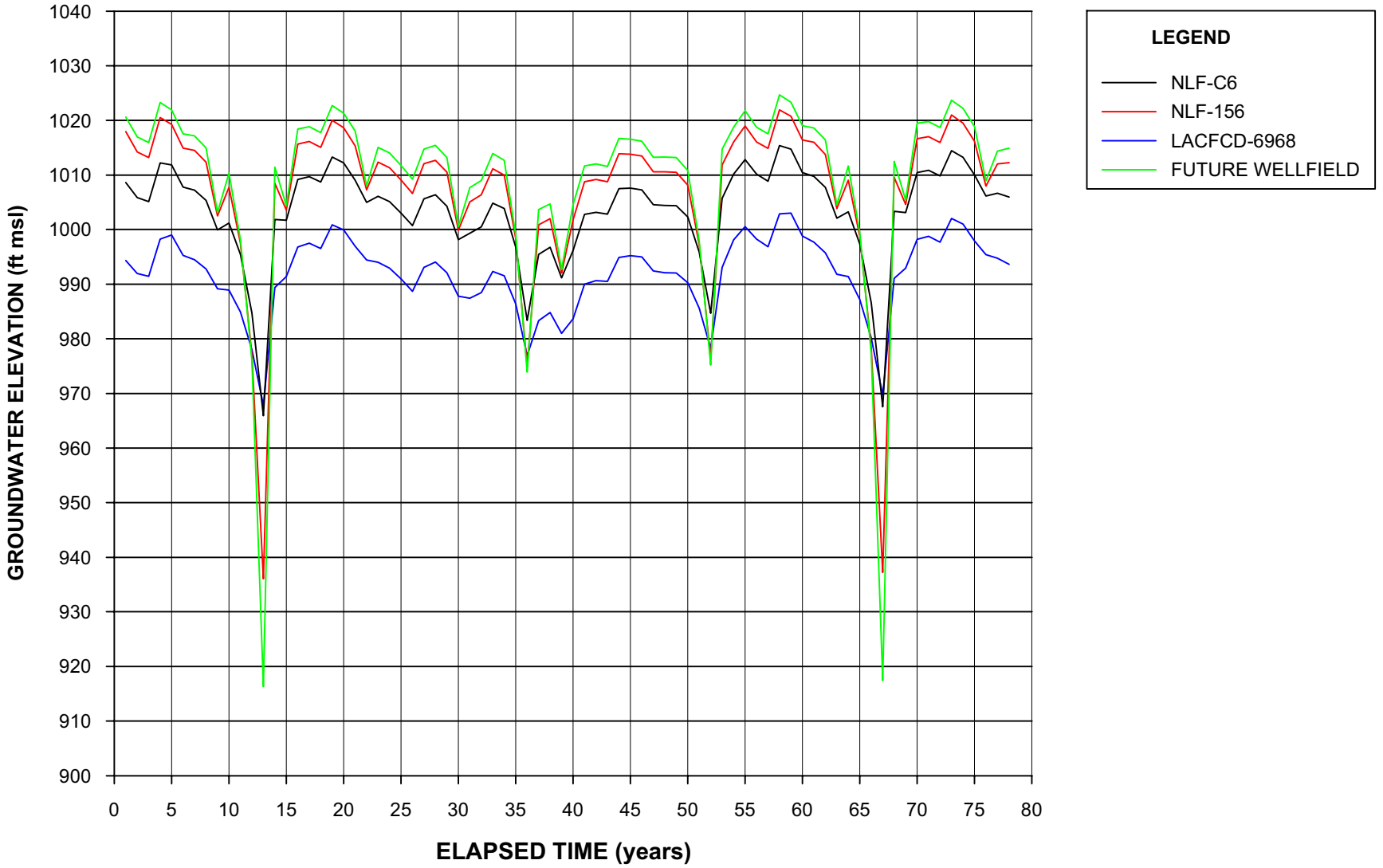

NOTES:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.
2. WELLS NLF-C6 AND LACFCD-6968 ARE CONSTRUCTED IN THE ALLUVIAL AQUIFER AND ARE NOT OPEN TO THE SAUGUS FORMATION. THE SIMULATED HYDROGRAPHS SHOWN AT THESE WELL LOCATIONS ARE FOR GROUNDWATER LEVELS IN THE SAUGUS FORMATION, BELOW THE OPEN INTERVALS OF THESE WELLS.
3. THE SIMULATED HYDROGRAPH FOR THE FUTURE WELLFIELD IS FOR A MODEL NODE WITH NO ASSIGNED PUMPING, LOCATED INSIDE THE WELLFIELD NEAR VWC-206.

FIGURE 4-6
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION WEST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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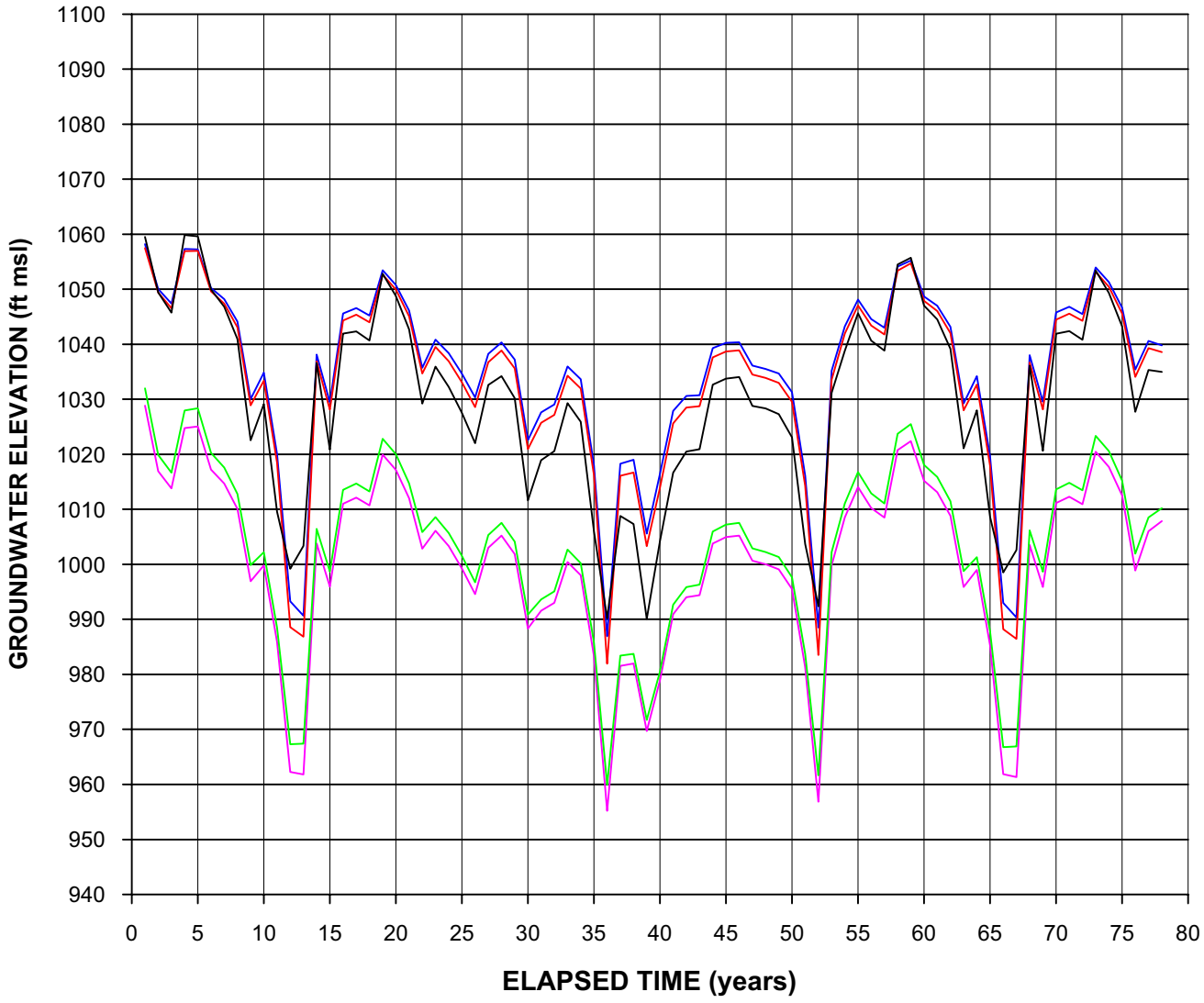

NOTE:

1. SEE FIGURE 2-4 FOR LOCATIONS OF WELLS.

FIGURE 4-7
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION EAST OF INTERSTATE 5
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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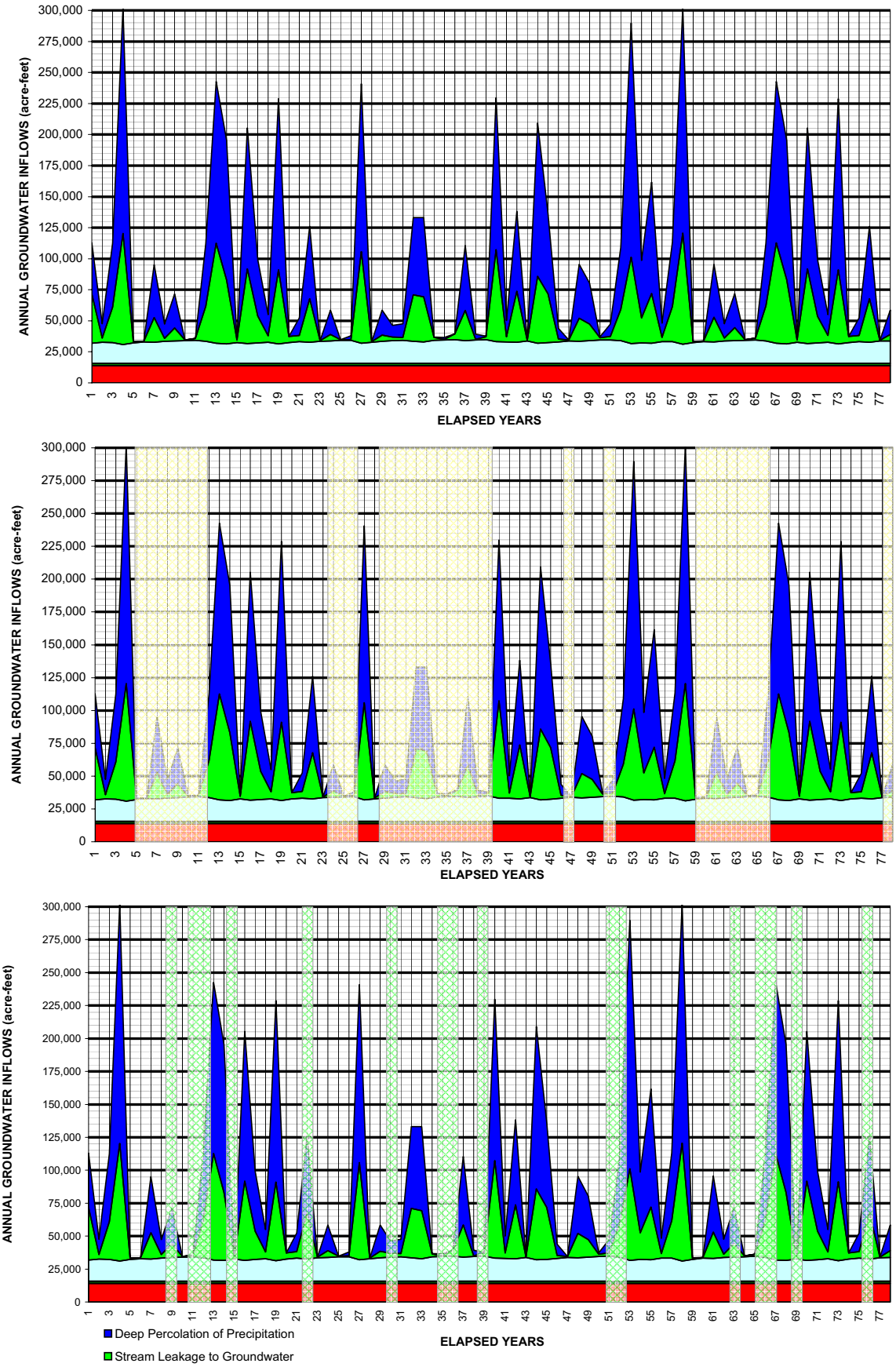

Note:

The deep percolation of applied water is calculatedfor full build-out conditions within the Regional Model boundary, as shown on Figure 3-7 and discussed in Section 3.5.

FIGURE 4-8
SIMULATED ANNUAL GROUNDWATER INFLOWS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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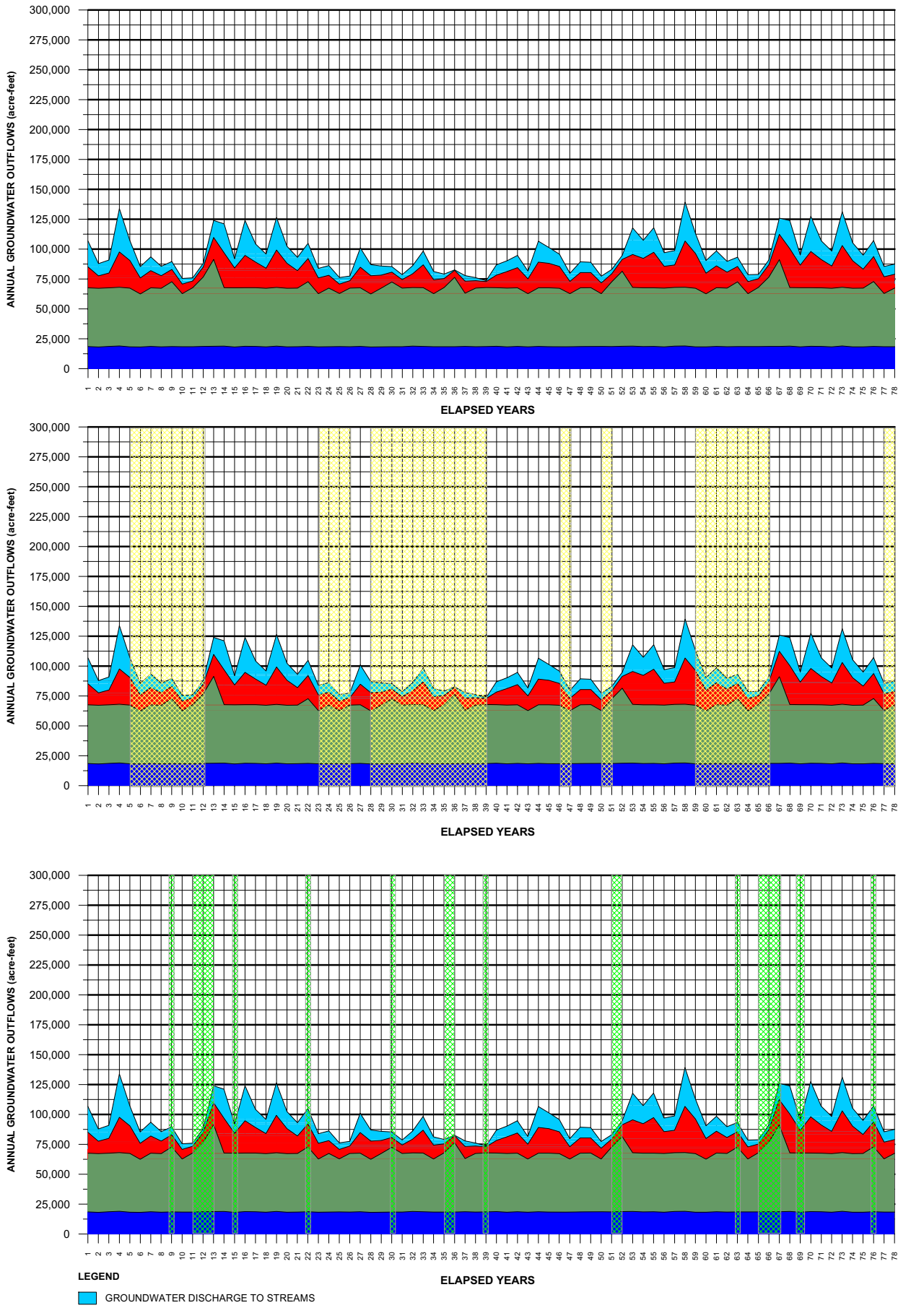

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FIGURE 4-9
SIMULATED ANNUAL GROUNDWATER OUTFLOWS
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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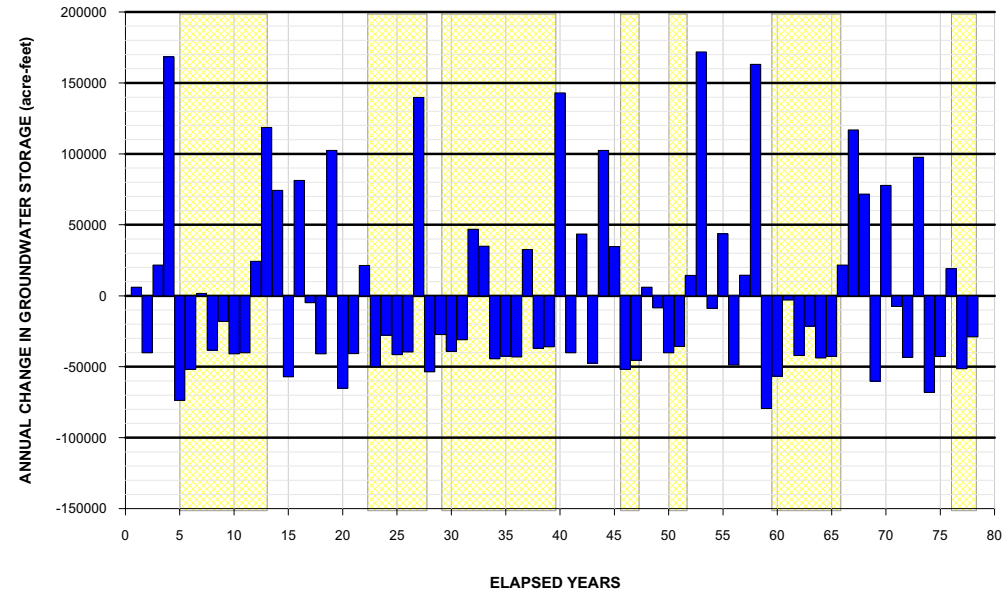

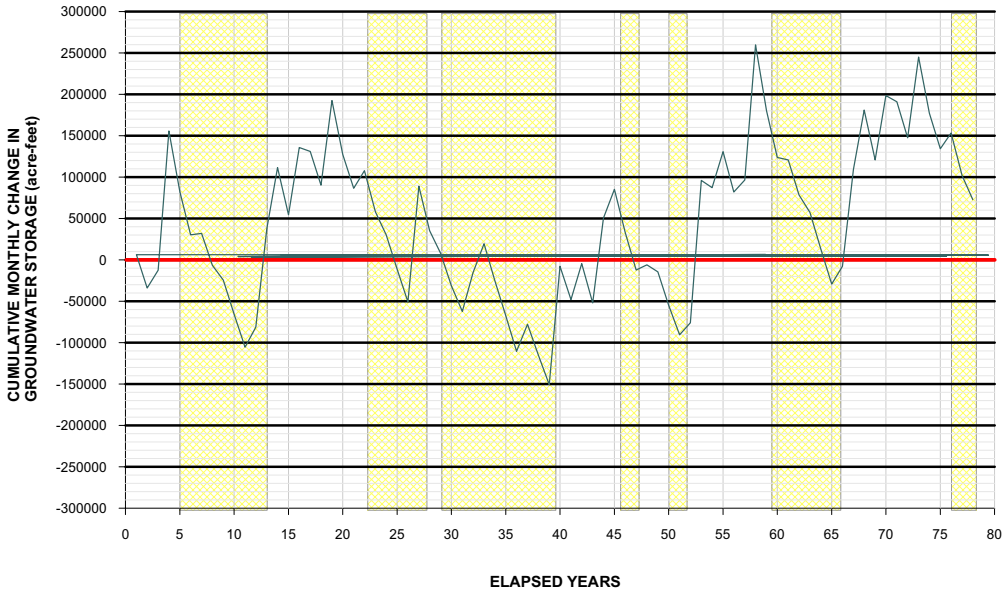

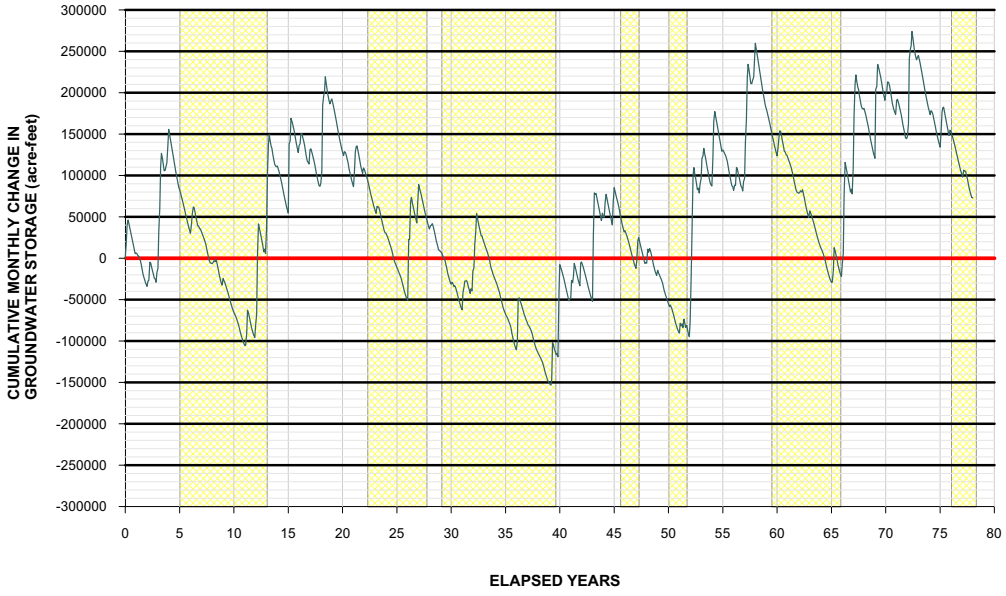

LOCAL DRY YEARS

FIGURE 4-10 (PAGE 1 OF 2)
ANNUAL AND CUMULATIVE CHANGE IN SIMULATED GROUNDWATER STORAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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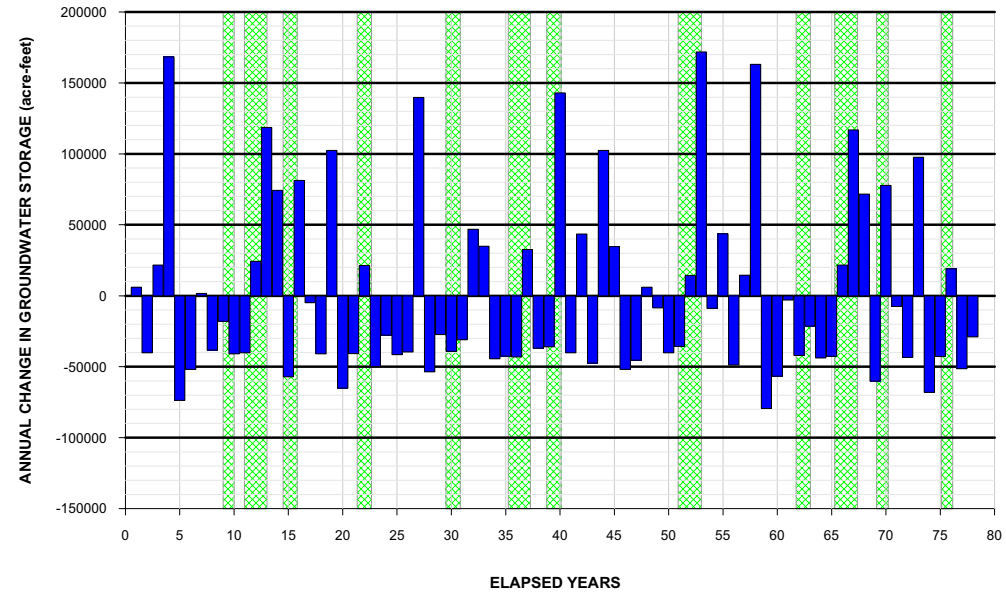

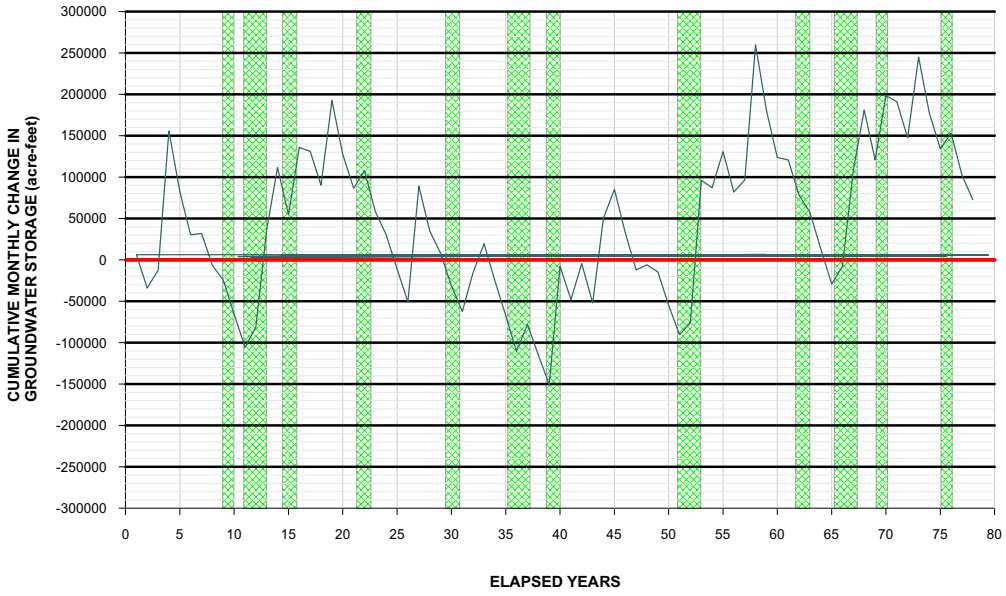

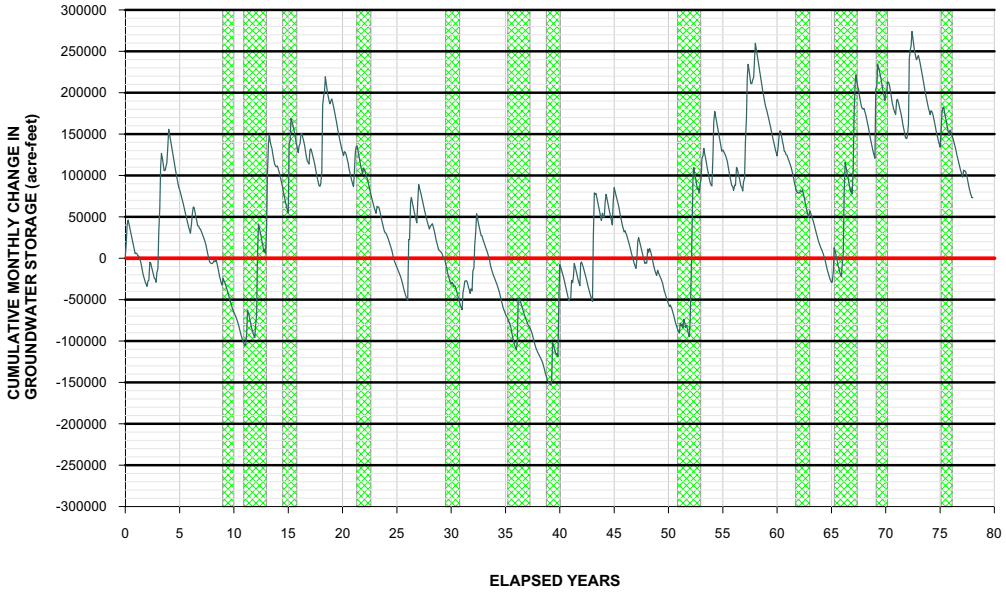

FIGURE 4-10 (PAGE 2 OF 2)
ANNUAL AND CUMULATIVE CHANGE IN SIMULATED GROUNDWATER STORAGE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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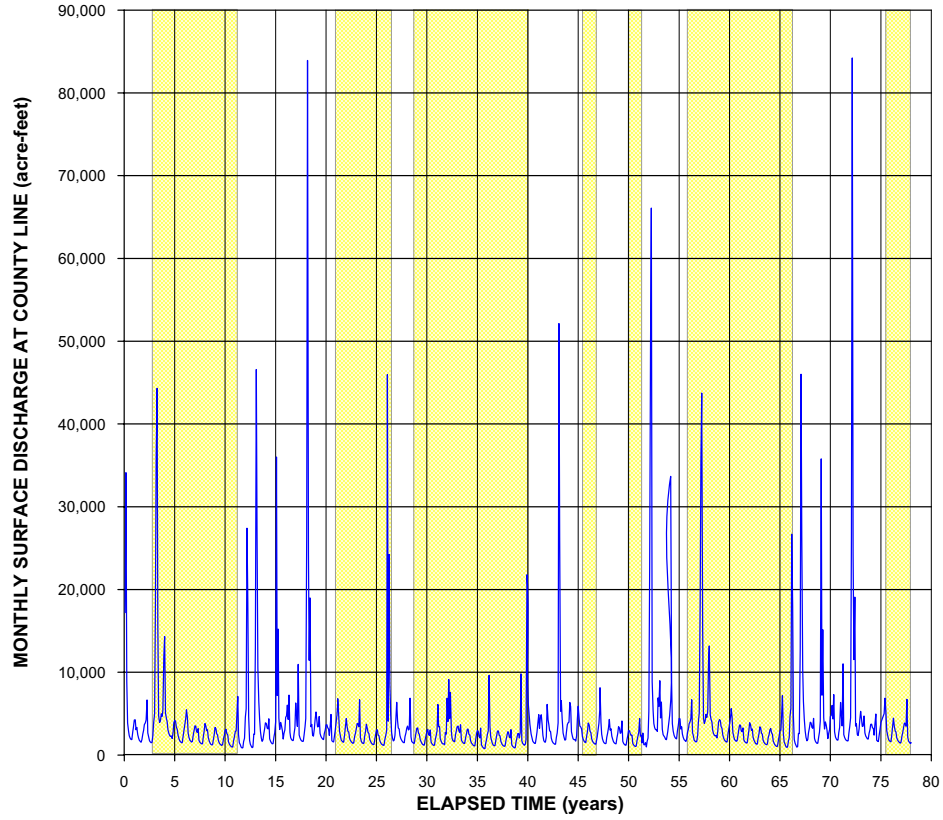

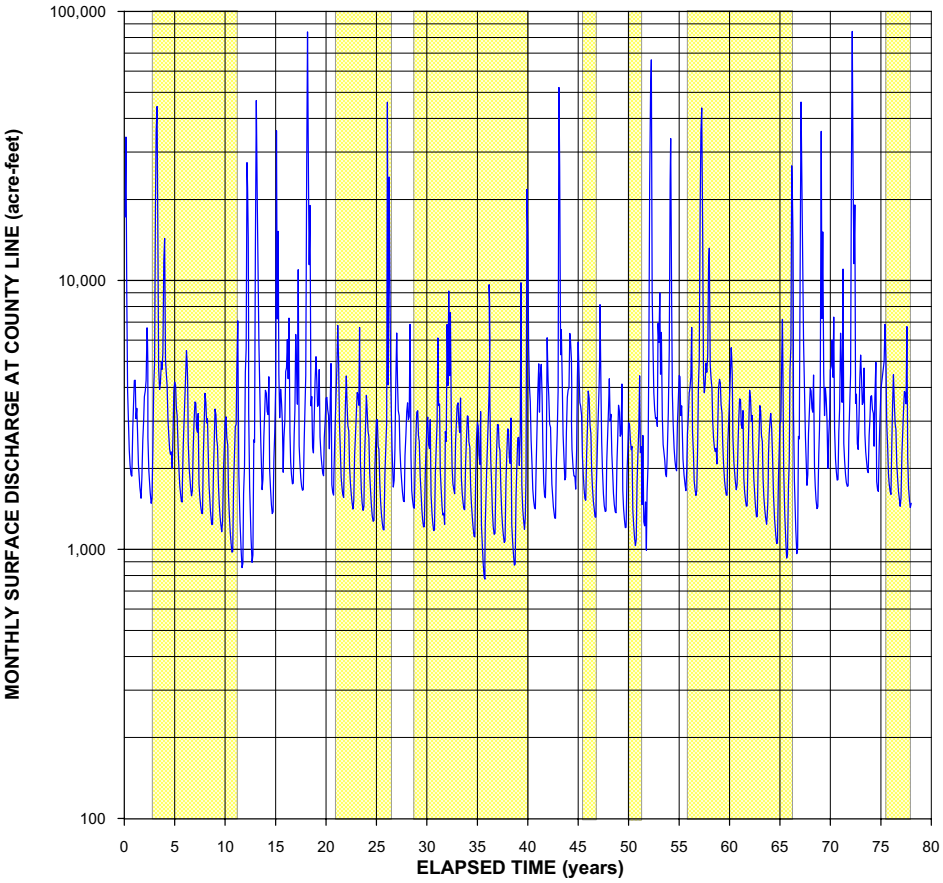

LEGEND

LOCAL DRY YEARS

FIGURE 4-11
SIMULATED SANTA CLARA RIVER FLOW AT COUNTY LINE
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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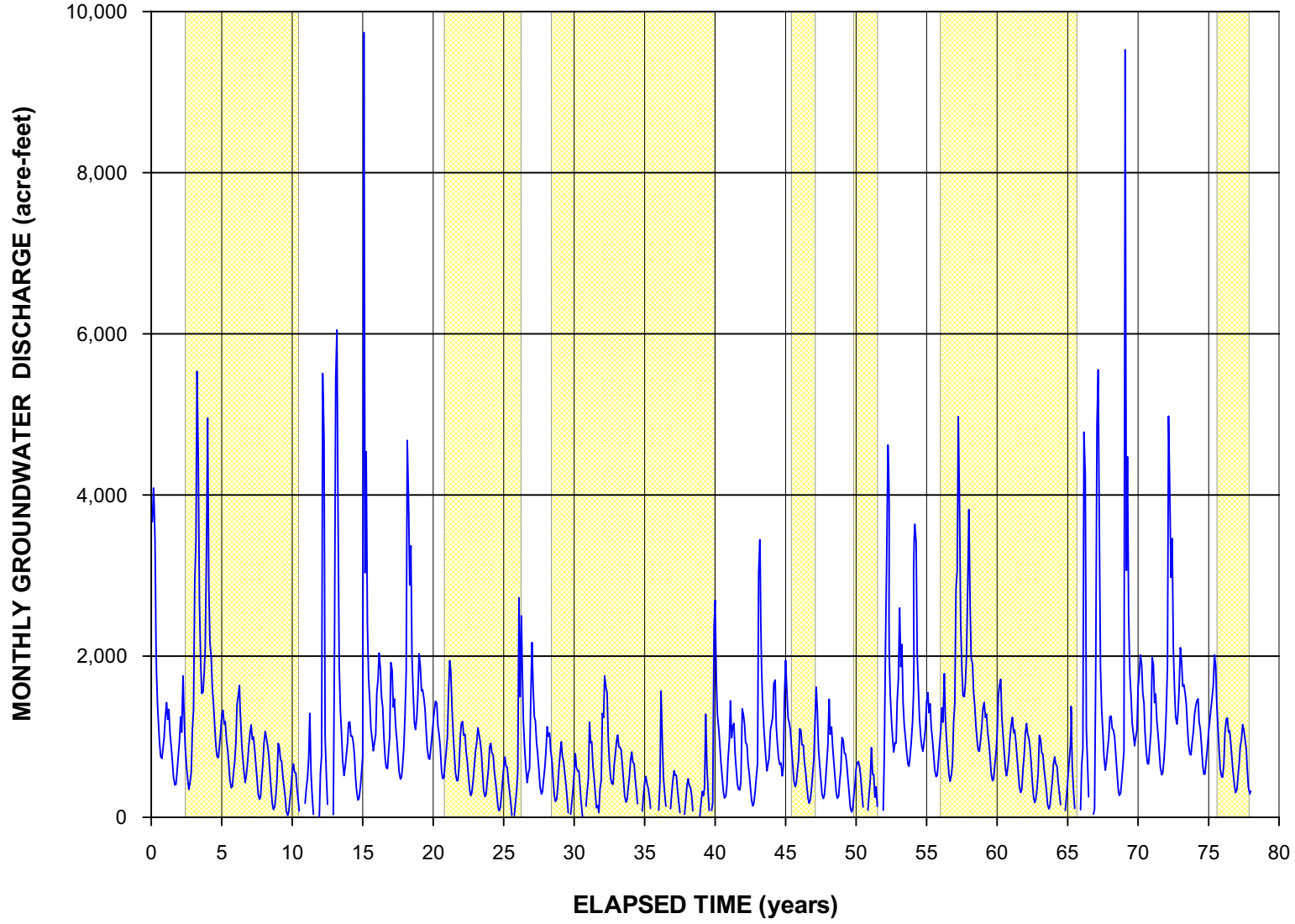

FIGURE 4-12
SIMULATED GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
ANALYSIS OF GROUNDWATER BASIN YIELD
UPPER SANTA CLARA RIVER GROUNDWATER BASIN
EAST SUBBASIN, LOS ANGELES COUNTY, CALIFORNIA

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SECTION 5

Conclusions

This section discusses the principal findings from the analyses of historical data and numerical modeling results and the implications of these findings for both groundwater management and water supply in the Santa Clarita Valley.

5.1 Principal Findings

The primary objective of the groundwater basin yield evaluation was to use the Regional Model to examine the groundwater operating plan under a range of potential hydrologic conditions to determine whether the groundwater resources in the valley could be expected to respond to such operations in a sustainable fashion. For the purposes of this evaluation, as in other settings, sustainability is defined in terms of renewability (recharge) of groundwater as reflected by the following indicators:

1. Lack of chronic, or sustained, depletion of groundwater storage, as indicated by projected groundwater levels, over a reasonable range of wet, normal, and dry hydrologic conditions

2. Maintenance of surface water flows in the western portion of the basin (which are partially maintained by groundwater discharge) and surface water outflow to downstream basins over the same range of hydrologic conditions

Regarding maintenance of surface water flows, although the development and use of groundwater in a sustainable manner necessitates the inducement of recharge from surface water, sustainability, in this case, does not rely on inducing groundwater recharge by eliminating surface water flows. Rather, it retains and, as supported by increased supplemental water importation, generally increases surface water outflow. Regarding both indicators of sustainability, the range of analyzed hydrologic conditions is a long-term period that includes anticipated occurrences of the types of years and groups of year types that have historically occurred in the basin.

The primary conclusion from the modeling analysis is that the current operating plan for the groundwater basin in the Santa Clarita Valley will not cause detrimental short- or long-term effects to the groundwater and surface water resources in the valley and is, therefore, sustainable. The modeling analysis, along with the historical data described in this report, result in the following specific conclusions regarding the sustainability of the operating plan:

1. The groundwater basin has historically been, and continues to be, in good operating condition and not in overdraft conditions, as indicated by historical data.

2. The operating plan is sustainable over varying hydrologic conditions, because it is feasible to intermittently exceed a long-term average yield for 1 or more years without

creating long-term adverse impacts to the groundwater system and the Santa Clara River.

3. Yields from the Alluvial Aquifer and the Saugus Formation during wet and dry years can be used for long-term water supply planning purposes. In particular, although increased pumping from the Saugus Formation during years of reduced SWP deliveries can be expected to cause short-term declines in groundwater levels during such pumping, it is not projected to cause permanent declines in groundwater discharges or streamflow. Additionally, Saugus groundwater levels will rapidly recover to pre-drought conditions.

4. The strategy around which the plan was designed (maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, while limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus pumping during years when SWP supplies are significantly reduced because of drought conditions) is viable on a long-term basis.

5. The historical observations of basin conditions and the model simulations together support the historical and ongoing confidence that groundwater can continue to be a sustainable source of water supply under the current groundwater operating plan described in the Amended 2000 UWMP (Black & Veatch, 2000; CLWA et al., 2005), the Groundwater Management Plan (CLWA, 2003), and the annual water reports (LSCE, 2005a).

In summary, the groundwater basin can be expected to respond to the operating plan in a manner similar to what has been experienced over approximately the last 50 years: use of water from groundwater storage during drier periods, mostly reflected by small to large fluctuations in Alluvial Aquifer groundwater levels from the middle to the eastern part of the basin, followed by full to near-full recovery in wet years or periods of years. A notable difference from historically experienced conditions is in the Saugus Formation. Greater Saugus pumping during periods of significantly reduced imported water supplies is projected to cause larger fluctuations in groundwater levels during such pumping, with full to near-full recovery of Saugus water levels in subsequent years, when the availability of imported water supplies returns to normal.

5.2 Groundwater Management and Water Supply Implications

The primary focus of the MOU and a key focus of the Groundwater Management Plan is basin yield; specifically, whether a groundwater operating yield could be developed whereby some defined amount of groundwater could be pumped on a sustainable basis. The evaluation described in this report addresses that question. The MOU did not envision impacts from groundwater contamination such as have recently impacted a number of municipal water supply wells. Fortunately, the Regional Model could be used, and has been used, to also examine the effectiveness of the operating plan in containing groundwater contaminants while concurrently pumping (with appropriate treatment at contaminated wells) for municipal water supply (CH2M HILL, 2004b). Thus, in addition to the water supply and groundwater management findings derived from the original intent of the MOU, as discussed below, an additional significant finding derived from the

development and application of the model is that groundwater supply and the control of groundwater contamination migration can be concurrently accomplished without having to modify or, more importantly, compromise the operating yield of the basin.

In addition to the preceding contamination-related findings, there are other findings that directly relate to the original intent of the MOU and can be classified as findings related to the yield of the basin and/or the long-term water supply in the valley. First, the long-term yield of the basin can be considered, for the present, to be equivalent to the operating plan for the basin, based on the simulated projections of groundwater levels, storage, and stream flows. In other words, with the existing and planned distribution of wells and pumping capacities in the operating plan, the basin can be expected to sustainably yield the annual volumes of groundwater in the operating plan for ongoing municipal and agricultural water supply. Additionally, other pumpers in the basin, such as small private well owners, can expect to experience Alluvial Aquifer groundwater conditions generally similar to what they have experienced in the past. This expression of basin yield, based on the existing and planned distribution of wells and pumping capacities, should not be considered or interpreted as a limit to the yield of the basin. It is possible that some alternate configurations of well locations and pumping capacities, potentially complemented by other management actions (e.g., artificial recharge activities), could increase the yield of the basin in the future. The Regional Model, developed for analysis of the current operating plan, can be used to examine potential changes in the operating plan and associated changes in basin yield if that is ever desirable. For the present, however, the main finding of the current groundwater operating plan is that basin conditions can be expected to generally repeat what has been experienced over the last several decades, with some increase in Saugus groundwater level fluctuations if dry-year increases in pumping are actually needed as planned, all resulting in no long-term depletion of groundwater.

From a water supply perspective, the main finding of the operational yield analysis is that it supports the groundwater component of overall water supply for the Santa Clarita Valley as described in the 2000 UWMP, and as expected to be carried forward in the 2005 UWMP.

As discussed in Section 5.1, the Saugus Formation has not been historically pumped at the dry-year rates described in the operating plan. Consistent with the ongoing water resource management, data collection, data management, data evaluation, and reporting activities that have been ongoing in the basin for the past several years, the Purveyors will closely monitor the effects of the greater-than-historical Saugus Formation pumping when it occurs. Depending on the findings from monitoring activities during the first period of increased Saugus pumping, the conjunctive use program that currently relies on SWP deliveries could potentially expand to include artificial recharge activities to enhance Saugus water level recovery after periods of increased Saugus pumping.

In conclusion, through the UWMP, the MOU, the Groundwater Management Plan, and other related water resource management activities, the Purveyors have developed an ongoing process for groundwater resource management in the Santa Clarita Valley that results in a sustainable operating plan for the local groundwater basin. As discussed in the annual water reports (including LSCE, 2005a), the ongoing process of groundwater management relies not only on the historical evaluations and numerical modeling analyses, but also on other program elements identified in the MOU—data gathering, database maintenance, and annual reporting—as well as other activities, such as implementing

conservation measures, increasing the use of recycled water, planning for water reliability, updating the UWMP on a regular schedule, and administering the Groundwater Management Plan. The development and implementation of the UWMP, the MOU, and the Groundwater Management Plan have resulted in a significantly improved understanding of the local water resources, and, in particular, have demonstrated that the current groundwater operating plan results in a reliable, long-term component of water supply for the valley. Ongoing monitoring and interpretation of actual groundwater conditions, as discussed in the MOU and the Groundwater Management Plan, will allow (1) continued assessment of basin responses to future pumping; (2) verification that, as public and private development increase with time, both within and adjacent to the basin, the groundwater basin responds in the same general manner as described herein; and (3) identification of whether adjustments to the operating plan might be warranted to achieve its primary objective of a sustainable groundwater resource.

SECTION 6

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Appendix A
Memorandum of Understanding

Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation**. The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights**. Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By _____
General Manager

Castaic Lake Water Agency

By _____
General Manager

Newhall County Water District

By _____
General Manager

Valencia Water Company

By _____
President

Santa Clarita Water Company

By _____
President

Los Angeles County Waterworks District No. 36

By _____
County of Los Angeles

United Water Conservation District Boundary

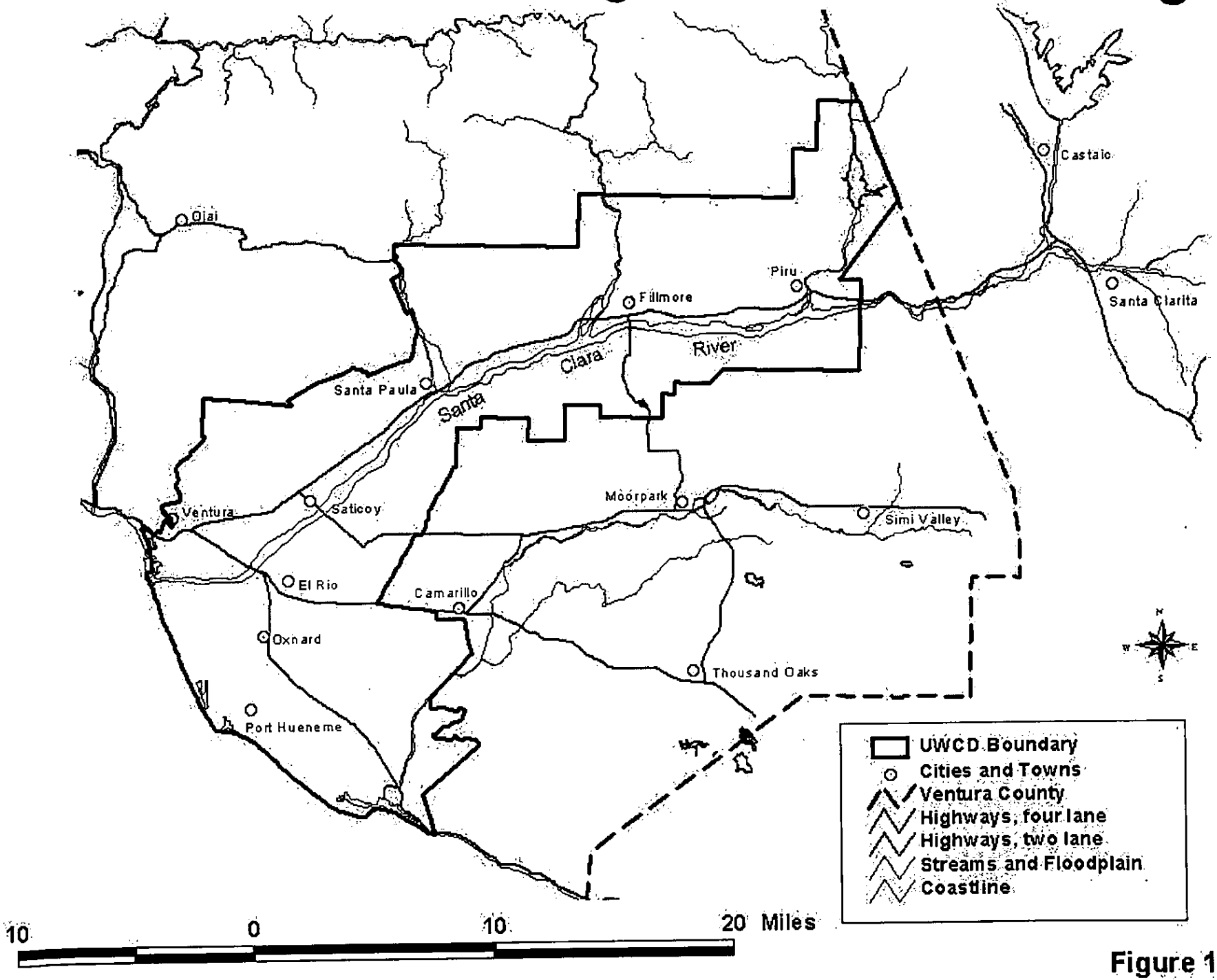


Figure 1-1

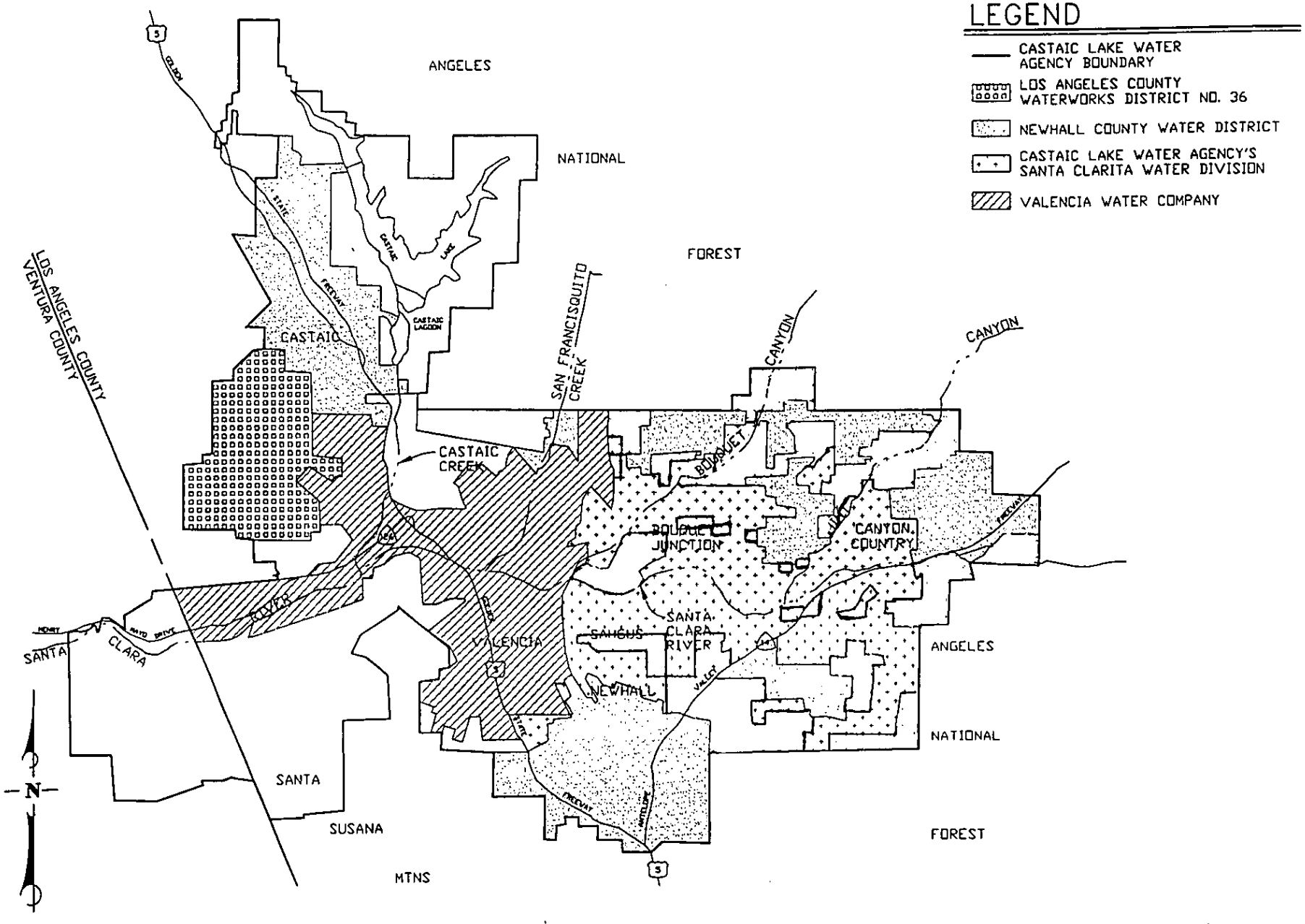


FIGURE 1-2

CLWA AND WATER PURVEYOR SERVICE AREAS

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the

area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the

gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is

available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

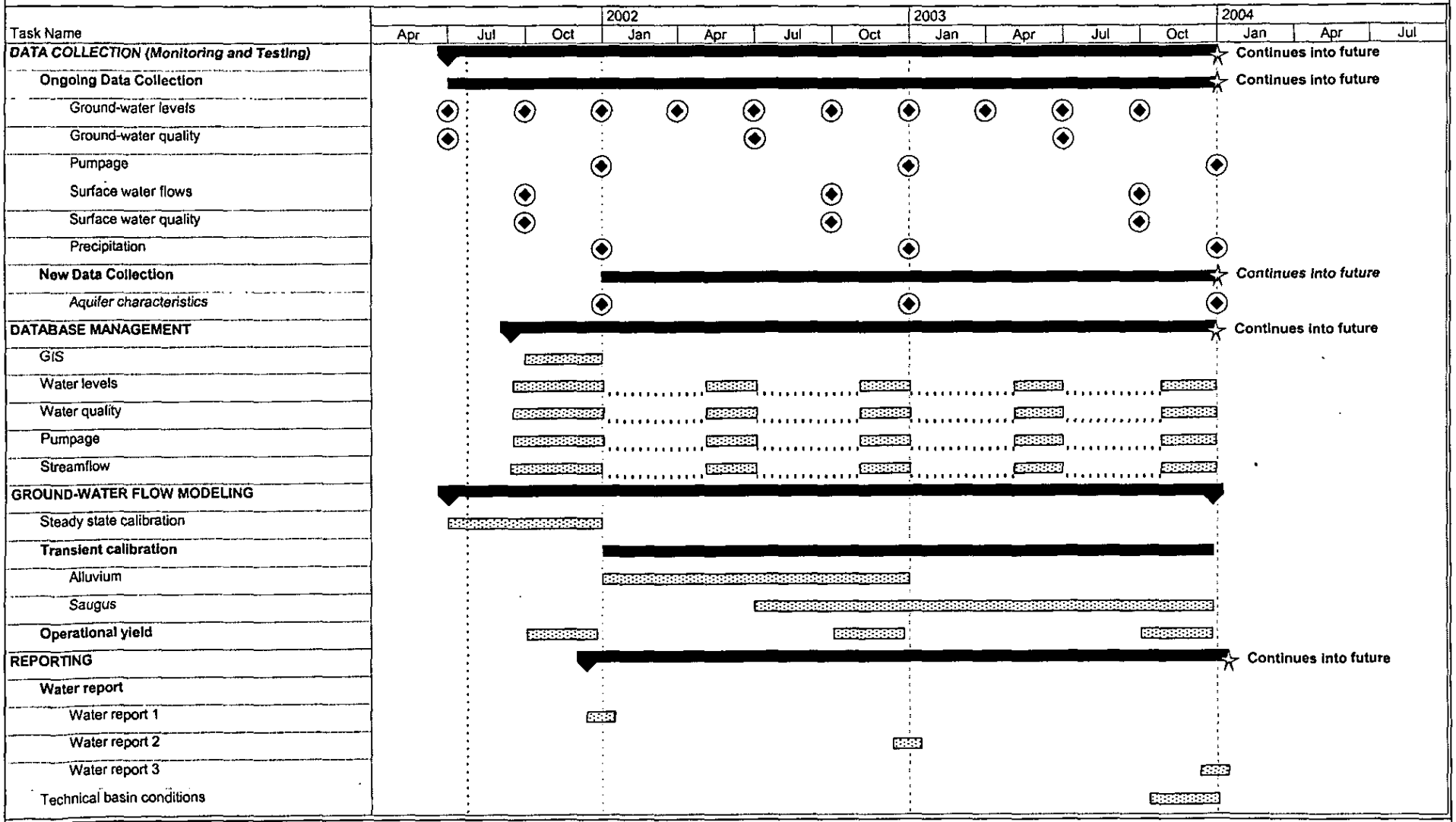
REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as

well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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Appendix B
Description of the Santa Clarita Valley Regional Groundwater Flow Model

APPENDIX B

Description of the Santa Clarita Valley Regional Groundwater Flow Model

B.1 Introduction

The Santa Clarita Valley Regional Groundwater Flow Model (hereafter referred to as the Regional Model) is a three-dimensional, numerical model of groundwater flow that covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. A Surface Water Routing Model (SWRM) was also developed specifically for this basin as a pre- and post-processor for the Regional Model.

The approach to developing the Regional Model included the following steps:

1. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system
2. Creating a variety of data sets to conduct steady-state and transient calibrations
3. Constructing the Regional Model using the MicroFEM® finite-element groundwater flow code (Hemker and de Boer, 2003), and also using the available database and geographic information system (GIS) information for the Santa Clarita Valley
4. Calibrating the Regional Model
5. Performing sensitivity tests on the Regional Model

This appendix provides an overview of the Regional Model's construction and calibration. The construction and calibration of the Regional Model and the SWRM are described in detail in the *Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California* (CH2M HILL, 2004a).

B.2 Model Construction

B.2.1 Software

The Regional Model was constructed using the three-dimensional, finite-element groundwater modeling software MicroFEM® (Hemker and de Boer, 2003). MicroFEM® operates in a Windows™ environment and can be used to solve groundwater flow problems for unconfined, semi-confined, or confined aquifer systems. This software simulates steady-state or transient flow conditions in up to a 20-layer aquifer system; the finite-element mesh may contain as many as 50,000 nodes in each model layer. The software contains several different methods for simulating groundwater/surface water interactions. MicroFEM® is based on software developed in the Netherlands during the 1980s for use in evaluating the effects of groundwater pumping in areas with complicated meandering rivers. Further

details regarding this software's design, capabilities, and functionality can be found on the Internet at www.microfem.com and in two reviews of the software by Diodato (1997, 2000).

B.2.2 Model Grid

The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The nodes are spaced 500 feet apart in the majority of the modeled area. However, a finer node spacing (150 feet) was used along the Santa Clara River and its tributaries to allow a more exact simulation of surface water/ groundwater exchanges. Additionally, specific nodes were placed within this regional grid at the locations of production and monitoring wells.

B.2.3 Layering

The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation wherever the Alluvial Aquifer is not present. The six underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member. The northern and southern edges of the model domain are defined by the geologic contacts mapped by Richard C. Slade and Associates, LLC (2002), formerly known as Richard C. Slade, Consulting Groundwater Geologist (both hereafter referred to as RCS), for the Alluvial Aquifer and the Saugus Formation.

The saturated thickness of the Alluvial Aquifer was defined from the average base elevation of the aquifer and the water level elevations measured during the fall of 1985 and the spring of 2000, as described by RCS (1986 and 2002). Along the Santa Clara River, the typical saturated thickness of the Alluvial Aquifer is as much as 130 feet in the western (down-gradient) portion of the basin and between 80 and 90 feet in the eastern (upgradient) portion of the basin, though it can be notably less in this area during droughts. Saturated thicknesses can be less than 60 feet in some tributary canyons, particularly along the South Fork Santa Clara River, where all production wells are constructed in the Saugus Formation, rather than the alluvium (RCS, 2002).

The Saugus Formation is generally a bowl-shaped structure that thins at its margins and has its greatest thickness (about 5,500 feet) in the center of the basin. The upper, freshwater-bearing portion of the Saugus Formation was simulated using 500-foot-thick model layers to depths as great as 2,500 feet in the center of the basin (RCS, 1988 and 2002). The deepest active model layer at any given location represented the Sunshine Ranch Member of the Saugus Formation, which is of marine origin and is, therefore, more saline and thought to have lower water-bearing potential than the overlying Saugus Formation deposits that are terrestrial in origin.

B.2.4 Boundary Conditions

The following boundary conditions were used in the Regional Model:

1. **Specified flux for precipitation within the model grid.** Deep percolation of precipitation was simulated using the precipitation top-system package contained in MicroFEM®.
2. **Specified flux for irrigation.** Deep percolation of agricultural irrigation and urban irrigation in developed areas was simulated using the precipitation top-system package contained in MicroFEM®.

3. **Specified flux and head-dependent flux along ephemeral streams**. With respect to groundwater discharges to streams, the Santa Clara River was modeled as an ephemeral, predominantly losing stream at and upstream of the mouth of San Francisquito Canyon, and as a perennial, predominantly gaining stream downstream of San Francisquito Canyon. The tributaries to the Santa Clara River were modeled as ephemeral streams, using the precipitation top-system package to specify stream leakage to groundwater. For these tributaries and the ephemeral reach of the Santa Clara River, groundwater recharge rates were estimated from precipitation records, stream-flow records, watershed maps, topographic maps, and aerial photography using the SWRM, which was developed specifically to calculate time-varying recharge at each stream node from these data. Aerial photos and historical observations indicated that under high water table conditions, groundwater can locally discharge into Castaic Creek and the ephemeral reach of the Santa Clara River wherever Alluvial groundwater levels rise above the riverbed elevation. Consequently, the drain package in MicroFEM® was used in these streams to allow for drainage of any groundwater that was calculated by MicroFEM® to be above the riverbed elevation in any given river node at any given time step.

4. **Specified flux and head-dependent flux along perennial Santa Clara River**. The perennial reach of the Santa Clara River was modeled using the wadi top-system package contained in MicroFEM®. The wadi package allows groundwater to discharge to the river whenever groundwater elevations are higher than the specified river stage. When groundwater levels are below the river stage, the river recharges the Alluvial Aquifer. The rate of recharge is proportional to the difference between the river stage elevation and the model-calculated groundwater elevation. However, after the groundwater elevation drops below the streambed sediments, the rate of leakage from the stream is constant (i.e., does not vary as the groundwater elevation fluctuates). For the Regional Model, each node along the perennial reach of the Santa Clara River was assigned a river stage 1 foot higher than the mapped bed elevation of the river. The riverbed permeability, or conductance, which helps control the model-calculated groundwater/surface water exchange rates, was adjusted during model calibration by calibrating to streamflow data collected at the County Line gage.

5. **Specified flux for pumping**. Pumping rates and locations for wells completed in the Alluvial Aquifer and the Saugus Formation were directly imported into the Regional Model from the Upper Santa Clara River Groundwater Basin database. For model calibration, pumping rates were assigned from water use records maintained by the Upper Basin Water Purveyors; estimates of monthly water demand for urban water use and agricultural water use; and well construction records, which were needed to determine which model layers at each individual well should be assigned pumping

6. **Specified flux at upgradient Alluvial Aquifer boundaries.** Where there is Alluvial groundwater flow into the study area from beneath Castaic Dam, the magnitude of the specified flux was adjusted during the model calibration process using groundwater elevations and gradients published by RCS (1986 and 2002).

7. **Specified groundwater elevation in the Alluvial Aquifer at the county line.** The groundwater elevation (805 feet) was obtained from water level contour maps for the

Alluvial Aquifer prepared by RCS (1986, 2002). (See Figure 2-7 in the main text for groundwater elevation contours during Spring 2000, as mapped by RCS [2002].)

8. **Specified groundwater elevation in the Alluvial Aquifer at the Lang gage.** The groundwater elevation (1,746 feet) was derived from topographic maps of the elevation of the Santa Clara River bed. As discussed in CH2M HILL in *Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property* (2004b), the boundary condition at this location was converted to a constant-head boundary shortly after completion of the model development report. This change was made based on results from field reconnaissance that was performed in April and May of 2004, when the Santa Clara River was dry at the Lang gage. At that time, groundwater was locally discharging from the bed of the Santa Clara River in isolated locations where the riverbed intersects the water table, then seeping back into the riverbed nearby. Significant phreatophyte growth was also present along the riverbed in this same area (just downstream of the Lang gage). Additionally, water was present and actively flowing in the river east (upstream) of the Santa Clarita Valley (in the area between the Santa Clarita Valley and the upstream Acton Basin). Based on these observations, a specified groundwater elevation of 1,746 feet was established in the Alluvial Aquifer at the eastern boundary of the Regional Model to simulate subsurface flow beneath the channel of the Santa Clara River at the Lang gage. This specified elevation was held constant throughout the simulation period.

9. **Head-dependent flux for evapotranspiration (ET).** ET from the water table by riparian vegetation was simulated using the evaporation top-system package contained in MicroFEM®. This package requires specification of the maximum rooting depth for the riparian vegetation, the maximum potential ET rate, and the ground surface elevation.

10. **No-flow boundaries**. In general, the outermost line of nodes that form the model boundary and the bottom of the model are no-flow boundaries. The exceptions are the western model boundary (specified head) and the specified-flux nodes representing underflow into the Alluvial Aquifer from beneath Castaic Dam. Also, all nodes on the model boundary are assigned specified fluxes due to precipitation and, in some cases, ephemeral streamflow.

B.2.5 Aquifer Parameters

The selection of the aquifer parameter values (horizontal and vertical hydraulic conductivity, storage coefficients, streambed conductance, and ET parameters) is described in detail in Sections 4 and 5 of the Regional Model development report (CH2M HILL, 2004a). Initial estimates of, and ranges of values for, these parameters were defined during initial model development and adjusted on an as-needed basis, and within certain limits, during model calibration. Additionally, the calibration process adjusted the coefficients for an empirical power-function equation (Turner, 1986) that was used in the SWRM to define the relationship between precipitation, stormwater flow, and the amount of stormwater flow available for potential infiltration to groundwater.

B.3 Model Calibration

B.3.1 Calibration Process

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation. The steady-state calibration was performed for calendar years 1980 through 1985, and the transient calibration was performed for calendar years 1980 through 1999. The goals of the initial calibration process were generally to match groundwater flow directions, groundwater gradients, and groundwater elevations that were measured throughout the 20-year simulation period at wells across the valley. An additional calibration goal was to match the patterns of total flow in the Santa Clara River and estimated groundwater discharge rates to the river. The Alluvial Aquifer and the Saugus Formation were each subdivided into zones to facilitate parameter selection and model calibration. Model variables were adjusted in a manner that sought to honor independent estimates of parameter values while resulting in the best possible calibration.

B.3.2 Calibration Quality

The Regional Model meets most of the qualitative and quantitative goals that were established for the calibration process. For the steady-state model, statistical goals for the head residuals, which are equal to the modeled minus measured groundwater elevations, were easily met for the Alluvial Aquifer and adequately met for the Saugus Formation. For the transient model, trends in groundwater elevations were generally well matched, and groundwater discharges to the river were simulated well for both the steady-state and transient models. However, during the middle and late 1990s, the model tended to simulate too much decline in Alluvial Aquifer groundwater elevations in the eastern-most portion of the valley. This is the area where local droughts have the greatest effect on the Upper Basin Water Purveyors' ability to pump groundwater, so this deviation is acceptable because predictive simulations of various groundwater pumping strategies will not overestimate the degree to which groundwater can be pumped from the Alluvial Aquifer in this area during periods of below-normal rainfall.

The groundwater budget for the 20-year transient calibration period showed that recharge from precipitation and streamflows varied considerably from year to year, ranging from less than 15,000 acre-feet per year (AF/yr) in the driest years to as much as 270,000 AF/yr in the wettest years. In contrast, total groundwater discharges were less variable, ranging from approximately 61,000 AF/yr at the end of the late 1980s/early 1990s drought to 116,000 AF/yr during 1998. This variability in groundwater discharge did not follow the year-to-year pumping patterns, but instead was caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlated well with groundwater recharge patterns. During the 20-year transient calibration period, changes in the volume of groundwater stored in the combined Alluvial-Saugus aquifer system varied primarily according to year-to-year variations in regional rainfall. No long-term decline in groundwater storage was observed in the field or simulated by the Regional Model during the calibration period.

B.3.3 Calibration Update

In a recent technical memorandum (CH2M HILL, 2005), the calibration of the Regional Model was extended an additional 62 months (from January 2000 through February 2005) to update and test the model's calibration against an independent data set consisting of recently observed hydrologic and pumping conditions in the basin. Examination of groundwater elevation hydrographs for the Alluvial Aquifer and the Saugus Formation indicated that the model showed a similar overall ability to simulate conditions during the recent 5-year period, as was the case for the preceding 20-year period to which the model was originally calibrated.

B.4 Model Sensitivity

Sensitivity analyses were performed to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the Regional Model. Variables that were tested were the hydraulic properties (horizontal and vertical hydraulic conductivities and storage coefficients) for the Alluvial Aquifer and the Saugus Formation, the riverbed leakage terms for the Santa Clara River and Castaic Creek, and the ET parameters. The sensitivity analysis indicated that the Regional Model is calibrated well and that it is sensitive to the choices of horizontal hydraulic conductivity in both aquifers and the vertical hydraulic conductivity values in the Saugus Formation. The model is also sensitive to the surface water parameters, specifically the choice of empirical coefficients used by the Turner (1986) equation to estimate stormwater flows from rainfall data and the riverbed leakage terms in both the eastern (groundwater recharge) and western (groundwater discharge) portions of the basin. The model is relatively insensitive to the choice of ET parameters.

B.5 Model Applicability

The process of developing the conceptual model of the local groundwater basin, developing a detailed numerical model, calibrating the model to a 20-year period of groundwater elevation and streamflow data, and independently testing the calibration against a recent set of basin conditions has resulted in a groundwater flow model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary design and calibration attributes that make the Regional Model appropriate for its intended uses are as follows:

1. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased State Water Project water imports (from outside the valley), and associated changes in land use and water use
2. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property)
3. Its use of an integrated model of the watershed to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system

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Impact and Response to Perchlorate Contamination

Valencia Water Company Well Q2

prepared for

Valencia Water Company

prepared by

Luhdorff & Scalmanini,
Consulting Engineers

April 2005

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CONSULTING ENGINEERS

Table of Contents

Page

I. Introduction and Background....1

II. Impact of Water Supply....3
Adequacy of Source Capacity....3
Sustainability of Groundwater....5
Protection of Other Sources (Wells)....8

III. Response Plan for Well Q2....10

IV. Protection Plan for Non-Impacted Wells....12

V. Status of Saugus Restoration and Containment....13

VI. References....16

List of Figures and Tables

Figure **After Page**

I-1 Well Location Map 1

Table **Page**

II-1 Active Groundwater Source Capacity 4
II-2 Turnout Connections to CLWA Treated Water Distribution 5

I. Introduction and Background

Perchlorate has been a water quality concern in the Santa Clarita Valley since 1997 when it was originally detected in four Saugus wells operated by the municipal water purveyors in the eastern part of the Saugus Formation, near the former Whittaker-Bermite facility. In late 2002, perchlorate was detected in a fifth municipal well, in this case an Alluvial well also located near the former Whittaker-Bermite site. The five perchlorate-impacted wells have been removed from active water supply service.

At present, perchlorate is not a regulated chemical in drinking water. However, the state Department of Health Services (DHS) requires that water utilities test their water sources for certain unregulated chemicals, and perchlorate is one of those chemicals. The DHS "notification level" for perchlorate is 6 micrograms per liter (ug/l).[1] DHS currently anticipates proposing a Maximum Contaminant Level (MCL) for perchlorate in 2005.

Since the detection of perchlorate and resultant inactivation of impacted wells, the Purveyors have been conducting regular monitoring of active wells near the Whittaker-Bermite site. In late March 2005, that monitoring detected the presence of perchlorate in Valencia Water Company's Well Q2, an alluvial well located immediately northwest of the confluence of Bouquet Creek and the Santa Clara River (Figure I-1). The initial detection of perchlorate was at a concentration of 11 ug/l; two confirmation samples in the first two weeks of April detected perchlorate at concentrations of 9.8 and 10 ug/l, respectively. As a result of the detection and confirmation of perchlorate in its Well Q2, Valencia has removed the well from active service and is pursuing rapid permitting and installation of wellhead treatment, as described herein, in order to return the well to water supply service.

For several years prior to the recent detection of perchlorate in Valencia's Well Q2, the water Purveyors have recognized that, among other aspects of an overall remediation program, such a program would most likely include an element of pumping from impacted wells, or from other wells in the immediate area, to establish hydraulic conditions that would control the migration of contamination from further impacting the aquifer in a downgradient (westerly) direction. The overall program would also include the installation of treatment to allow the restored pumping capacity to be used for municipal supply. In cooperation with state regulatory agencies and

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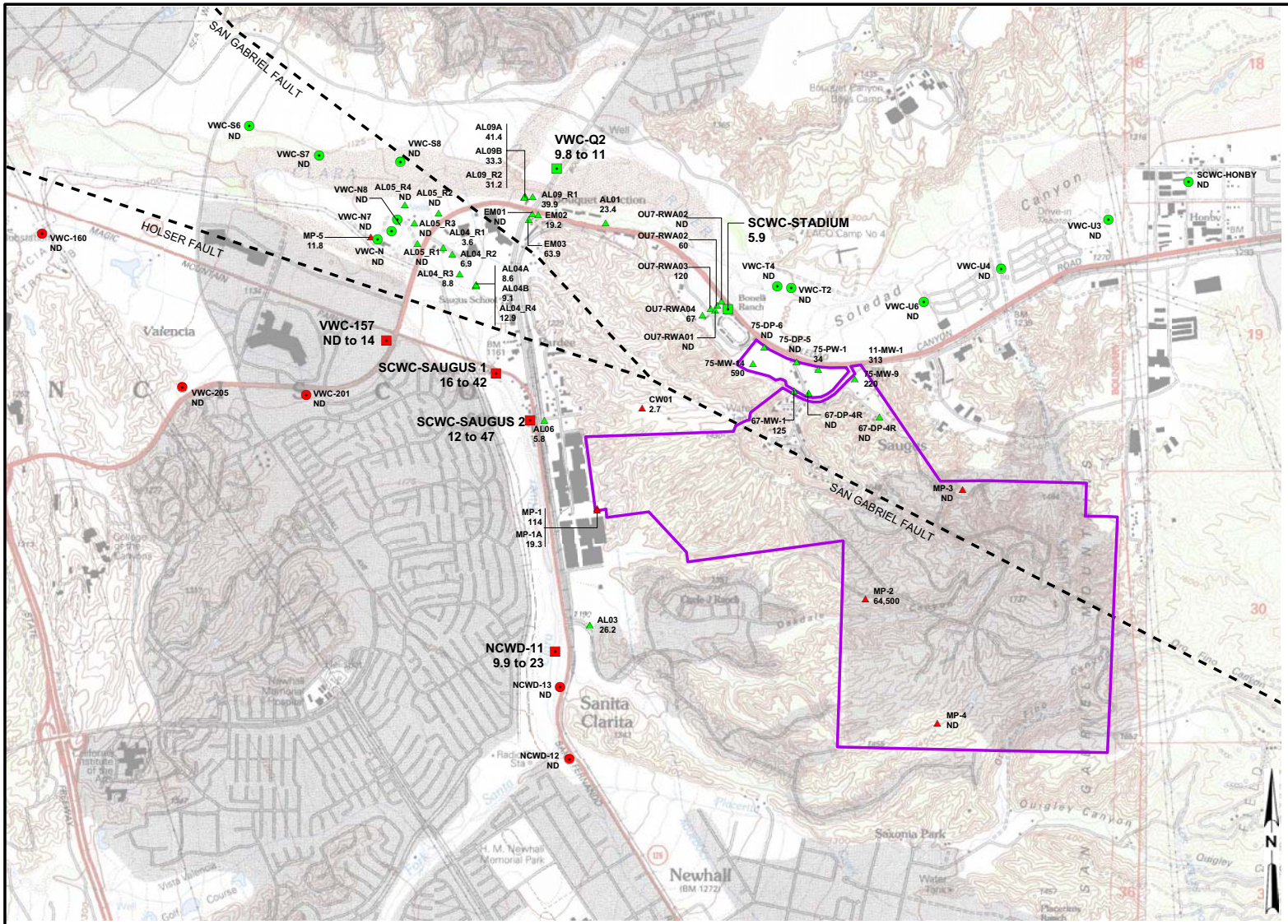
[1] "Notification level" means the concentration level of a contaminant in drinking water delivered for human consumption that DHS has determined, based on available specific information, does not pose a significant health risk but warrants notification pursuant to applicable law. Notification levels are nonregulatory, health-based advisory levels established by DHS for contaminants in drinking water for which maximum contaminant levels have not been established. Notification levels are established as precautionary measures for contaminants that may be considered candidates for establishment of maximum contaminant levels, but have not yet undergone or completed the regulatory standard setting process prescribed for the development of maximum contaminant levels. Notification levels are not drinking water standards.



LEGEND

CONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELL

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE 1-1
WELL LOCATION MAP
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\042205\FIG01.MXD FIG01.PDF 04/22/2005

investigators working for Whittaker-Bermite, Castaic Lake Water Agency (CLWA) and the Purveyors, including Valencia Water Company, have developed an off-site plan that will include installation of water treatment facilities to remove perchlorate and restore operation of two of the initially impacted Saugus wells through that treatment process. The operation of those two wells with treatment, scheduled to be in service in 2006, will hydraulically contain the perchlorate contamination moving from the former Whittaker-Bermite site and protect downgradient non-impacted wells. It will also restore the annual volumes of water that were pumped from the impacted wells before they were inactivated. In concert with the installation of treatment and the return of certain impacted wells to active water supply service, the balance of total pumping capacity from the impacted wells will be restored by constructing replacement wells in a non-impacted portion of the basin west of Interstate 5.

The development of the control and restoration plan for the initially impacted wells included consideration that it should fit within the larger scale of on-site and possibly other off-site remediation activities. While such activities did not specifically anticipate the treatment of VWC's Well Q2 as described herein, utilization of the same treatment methodology and operation of the well to contain perchlorate from contamination of downgradient wells, are consistent with currently planned and other potential on-site and off-site remediation activities.

II. Impact of Water Supply

As a result of the recent detection of perchlorate, Valencia Water Company has removed Well Q2 from active water supply service until it can install wellhead treatment for perchlorate removal, as described herein, such that the well can be returned to service. Although it is expected that the permitting and installation of wellhead treatment can be accomplished by mid-summer, in advance of the peak water demand season, it is appropriate to assess the impact of the removal of Well Q2 on the overall adequacy of Valencia's water supply until such treatment is in place and the well is returned as part of Valencia's total water supply.

The overall adequacy of water supply derives from three considerations: 1) sufficient source capacity (wells and pumps, plus other sources such as, in this case, connections to CLWA's treated surface water distribution system); 2) sustainability of the groundwater resource to meet the demand of Valencia and other pumpers in the basin on a renewable basis; and 3) protection of groundwater sources (wells) from known contamination, or provisions for treatment in the event of contamination. All three considerations are discussed in the following sections.

Adequacy of Source Capacity

The temporary removal of Well Q2 from active service represents a reduction of 1,200 gpm of source capacity. After that removal, Valencia still has a total of 19 active operational wells, 14 wells completed in the Alluvial aquifer and 5 wells completed in the Saugus Formation. The combined pumping capacities of the 14 Alluvial wells is slightly more than 20,000 gpm, and the combined pumping capacities of the 5 Saugus wells is slightly more than 10,000 gpm. The individual pumping capacity of each Valencia well is listed in Table II-1.

In addition to its water supply wells, Valencia has six connections to CLWA's system that distributes treated surface water from the State Water Project to the various municipal purveyors in the Valley. The combined capacity of those four connections (Turnouts V2, V4, V5, V6, V7 and V8) is 26,500 gpm. The individual capacity of each CLWA turnout connection to the Valencia distribution system is listed in Table II-2.

The combined source capacity of Valencia's active wells, after temporary inactivation of Well Q2, and its CLWA turnouts is thus a total of about 57,000 gpm.

As part of recent review of its overall water supply, Valencia examined its maximum day demand in the last year, 2004. The maximum day demand occurred in July, when the largest historical single day demand of 143.3 acre-feet was experienced. That volumetric demand equates to an average flow on that day of nearly 32,500 gpm.

Table II-1
Active Groundwater Source Capacity
Valencia Water Company

Well	Pump Capacity (gpm)	Maximum Annual Capacity (af)	Normal Year Production[1] (af)	Dry Year Production[1] (af)
Alluvium				
Well D	1,050	1,690	690	690
Well N	1,250	2,010	620	620
Well N7	2,500	4,030	1,160	1,160
Well N8	2,500	4,030	1,160	1,160
Well S6	2,000	3,220	865	865
Well S7	2,000	3,220	865	865
Well S8	2,000	3,220	865	865
Well T2	800	1,290	460	460
Well T4	700	1,120	460	460
Well U4	1,000	1,610	935	935
Well U6	1,250	2,010	825	825
Well W9	800	1,290	600	600
Well W10	1,600	2,410	865	865
Well W11	1,000	1,610	350	350
Alluvial Subtotal	**20,350**	**32,760**	**10,720**	**10,720**
Saugus Formation				
159	500	800	50	50
160	2,000	3,220	1,000	1,330
201	2,400	3,670	100	3,577
205	2,700	4,350	1,000	3,827
206	2,500	4,030	1,175	3,500
Saugus Subtotal	**10,100**	**16,270**	**3,325**	**12,284**
Total Active Capacity	**30,450**	**49,030**	**14,045**	**23,004**

1. based on recent actual annual pumping; also as simulated in perchlorate containment analysis (CH2M Hill, 2004).

Table II-2
Turnout Connections to CLWA Treated Water Distribution
Valencia Water Company

Station Number	Number of Pumps and Total Horsepower	Capacity (gpm)
V2	Pressure Regulating Station	3,000
V4	3 – 195	4,500
V5	3 – 155	4,500
V6	2 – 25	1,500
V7	Pressure Regulating Station	5,000
V8	3 – 300	8,000
	Total	**26,500**

In accordance with the provisions of the Waterworks Standards in the California Health and Safety Code, and also in accordance with the provisions of the State Public Water Commission, the source capacity of a municipal water purveyor should be adequate to meet maximum day demand. Generally accepted engineering practice adds a factor of safety to those minimum requirements to account for possible outages of one or more supply sources during a period of maximum day demand. With total source capacity of about 57,000 gpm, after temporary deactivation of Well Q2, Valencia has sufficient source capacity to meet its maximum day demand of 32,500 gpm with allowance for potential outage of one or more individual sources (wells) or treated surface water connections. As a result, the temporary deactivation of Well Q2 does not adversely impact Valencia's ability to meet existing demands; in fact, Valencia has sufficient surplus source capacity to meet future increases in maximum day demand with existing sources, to be increased by returning Q2 to service after installation of treatment as described herein.

Sustainability of Groundwater

In contrast to assessing the adequacy of Valencia's source capacity by examining the total capacity of its water sources and comparing it to Valencia's maximum day demand, the sustainability of groundwater resources in the Valley is more appropriately assessed by

examining the response of the groundwater basin to the collective pumping demands placed on it for municipal and ongoing agricultural water supply. Until recently, the long-term renewability of Alluvial groundwater was empirically determined from approximately 60 years of recorded experience: long-term stability in groundwater levels and storage, with some dry period fluctuations in the eastern part of the basin, over a historical range of Alluvial pumpage from as low as about 20,000 afy to as high as about 43,000 afy. The long-term sustainability of Saugus groundwater was empirically determined from a more historical record that shows fairly low annual pumping in most years, with one four-year period of increased pumping up to about 15,000 afy, that produced no long-term depletion of the substantial groundwater storage in the Saugus. Those empirical observations in both the Alluvium and the Saugus Formation have now been complemented by the development and application of a numerical groundwater flow model, which has been used to predict aquifer response to the planned operating ranges of pumping from both aquifers for both municipal and agricultural water supply. The numerical groundwater flow model has also been used to analyze the control of contaminant migration under selected pumping conditions that would restore, with treatment, pumping capacity that has been inactivated due to perchlorate contamination detected in some wells in the basin as described herein.

To examine the yield of the Alluvium or, in other words, the sustainability of Alluvium on a renewable basis, the groundwater flow model was used to examine long-term projected response of the aquifer to pumping for municipal and agricultural uses in the 30,000 to 40,000 afy range under average/normal and wet conditions, and in the 30,000 to 35,000 afy range under locally dry conditions. To examine the response of the entire aquifer system, the model also incorporated pumping from the Saugus Formation in accordance with the normal (7,500-15,000 afy) and dry year (15,000-35,000 afy) operating plan for that aquifer. The preceding ranges of pumping from the two aquifer systems, commonly known locally as the operating plan for groundwater supply, are described in detail in the Amended 2000 Urban Water Management Plan prepared by CLWA and the municipal Purveyors in the Valley. The model was run over a 78 year hydrologic period which was selected from actual historical hydrology (i.e., precipitation) to examine a number of hydrologic conditions that would be expected to affect both groundwater pumping and groundwater recharge. The selected 78 year simulation period was assembled from an assumed recurrence of 1980 to 2003 hydrologic conditions, followed by an assumed recurrence of 1950 to 2003 hydrologic conditions. The 78 year period was analyzed to define both local hydrologic conditions (normal vs. dry), which affect the rate of pumping from the Alluvium, and hydrologic conditions that affect State Water Project operations, which in turn affect the rate of pumping from the Saugus.

The resultant pumping cycles are summarized as follows:

- Twenty-four years of dry year Alluvial pumping at 30,000 to 35,000 afy,

- One drought of four consecutive dry years of Alluvial pumping at 30,000 to 35,000 afy,

- Two droughts of three consecutive dry years each, with Alluvial pumping at 30,000 to 35,000 afy,

- Three selected years with assigned dry-year Alluvial pumping despite near-normal or above-normal rainfall because each selected year was preceded by a multi-year drought,

- Eighteen years of dry-year pumping from the Saugus, or an average of one dry year approximately every four years,

- Two droughts lasting three years, plus (in both cases) a dry year that occurs two years before the beginning of each three-year drought and another dry year that begins one year after each three-year drought has ended; Saugus pumping increased into the 15,000 to 35,000 afy range in all those years,

- Two droughts lasting two years; Saugus pumping increased into the 15,000 to 25,000 afy range in those years,

- Sixty years of normal-year Saugus pumping, 7,500 to 15,000 afy.

The preceding ranges of Saugus pumping included the planned restoration of recent historic pumping from the perchlorate-impacted wells. That pumping was analyzed to assess, in addition to the overall recharge of the Saugus, the effectiveness of controlling the migration of perchlorate by extracting and treating contaminated water close to the source of contamination.

Simulated Alluvial aquifer response to the preceding range of hydrologic conditions and pumping stresses was essentially a long-term repeat of the historical conditions that have resulted from similar pumping over the last several decades. The resultant response consisted of: 1) generally constant groundwater levels in the middle to western portion of the Alluvium, and fluctuating groundwater levels in the eastern portion of the Alluvium as a function of wet and dry hydrologic conditions, 2) variations in recharge that directly correlate with wet and dry hydrologic conditions, and 3) no long-term decline in groundwater levels or storage. Based on the combination of actual experience with Alluvial aquifer pumping at capacities similar to those planned for the future and the resultant sustainability (recharge) of groundwater levels and storage, complemented by modeled projections of aquifer response to planned pumping rates that also show no depletion of groundwater, the Alluvial aquifer can be considered a sustainable water supply source to meet the Alluvial portion of the operating plan for the groundwater basin.

Simulated Saugus Formation response to the ranges of pumping under assumed recurrent historical hydrologic conditions was consistent with actual experience under smaller pumping rates. The response consisted of: 1) short-term declines in groundwater levels and storage near pumped wells during dry-period pumping, 2) rapid recovery of groundwater levels and storage after cessation of dry-period pumping, and 3) no long-term decreases or depletion of groundwater levels or storage. The combination of actual experience with Saugus pumping and recharge up to about 15,000 afy, now complemented by modeled projections of aquifer response that show long-term utility of the Saugus at 7,500 to 15,000 afy in normal years and rapid recovery from higher pumping rates during intermittent dry periods, shows that the Saugus Formation can be considered a sustainable water supply source to meet the Saugus portion of the operating plan for the groundwater basin.

Protection of Other Sources (Wells)

Some detail of the overall perchlorate contamination issue, which has had a larger impact on the Saugus Formation than on the Alluvium, is included in **Status of Saugus Restoration and Containment** below. As detailed in that section, there has been extensive investigation of the extent of perchlorate contamination which, in combination with the groundwater modeling described above, has led to the current plan for integrated control of contamination migration and restoration of impacted pumping (well) capacity by 2006. While most of the perchlorate control and restoration plan is focused on the Saugus Formation, part of that plan includes induced capture of potentially contaminated groundwater in the Alluvium by pumping of selected Saugus wells. Specific long-term resolution of perchlorate contamination in the Alluvium, which had previously impacted just one water supply well, is currently expected to focus on source control through on-site treatment in the northern Alluvium (at the north of the former Whittaker-Bermite site) and subsequent restoration of the contaminated Stadium Well. In the interim, the questions are how the recently impacted Well Q2 will be resolved, and whether other active Alluvial wells could be contaminated and, if so, what effect that might have on the adequacy of Alluvial groundwater supplies.

Until the recent detection of perchlorate in Valencia's Well Q2, ongoing monitoring of all active municipal wells near the Whittaker-Bermite site had shown no detections of perchlorate in any active Alluvial wells. However, based on a combination of proximity to the Whittaker-Bermite site and prevailing groundwater flow directions, there was logical concern that perchlorate could contaminate nearby, downgradient Alluvial wells, and, as a result, there have been provisions in place to respond to perchlorate contamination if it should occur. The groundwater model was used to examine capture zones around Alluvial wells under planned operating conditions (pumping capacities and volumes) for the time period through currently scheduled restoration of impacted contaminated wells by 2006. That capture zone analysis of Alluvial wells generally near the Whittaker-Bermite site suggested that inflow to those wells would either be upgradient

of the contamination site, or would be from the Alluvium beyond where perchlorate is most likely to be transported.

At the time of the preceding analysis, a noted possible exception to its conclusions involved Valencia Water Company's Pardee wellfield, which includes its Wells N, N7, and N8. Although the capture zone analysis did not show the Pardee wells to be impacted, they were considered to be at some potential risk due to the proximity of their capture zone to the Whittaker-Bermite site. Other nearby Alluvial wells, including Valencia's Well Q2, were considered to be at lesser risk due to their distances from the site, orientation to groundwater flow near the site, and other factors such as the presence of the Santa Clara River between the wells and the Whittaker-Bermite site.

With recognition that potentially at-risk wells such as Valencia's Pardee wellfield could be readily replaced on an interim basis by utilizing some of the surplus capacity among all the other Alluvial wells, Valencia has planned for some time that, if the Pardee wells were impacted by perchlorate contamination, it has made site provisions at those wells for installation of wellhead treatment. Such treatment would be the same methodology as planned for long-term treatment of the contaminated Saugus wells. With treatment installed, Valencia would retain the wells in service for the same objectives as planned for restoring impacted Saugus pumping capacity by extracting contaminated water, treating it for beneficial (drinking water) use, and controlling local groundwater flow to protect further downgradient wells. The response to perchlorate detection in Well Q2 is identical to what was envisioned in the event of contamination at the Pardee wells.

III. Response Plan for Well Q2

As described in the status discussion below, one of the completed tasks in the overall response to perchlorate contamination of four Saugus wells has been the evaluation of alternative treatment methodologies and the selection of ion exchange for removal of perchlorate from water to be pumped from the two impacted wells that will be used for a combination of containment and capture of perchlorate contamination. As a result of that completed work, Valencia was in a position to immediately respond to the confirmed detection of perchlorate in Well Q2 by opening contract discussions with a selected contractor who can furnish, install and operate the same ion exchange treatment methodology which has been selected for the impacted Saugus wells.

In light of the preceding, after detection of perchlorate in its Well Q2, Valencia contacted USFilter to prepare a complete turnkey service contract to install and maintain treatment facilities capable of removing perchlorate pumped from the well to a non-detectable level. USFilter would cover all major components and estimate of installation materials and labor for start-up. The specific Q2 treatment system will incorporate USFilter HP1220HF ion exchange pressure vessels operating in a lead/lag configuration. The vessels are 12 feet in diameter and each will contain a selective resin designed to remove perchlorate. There is no waste brine generated from this treatment system. If resign replacement is necessary, USFilter will remove the resin from the treatment system and destroy it by incineration at an approved waste site.

Well Q2 is located along Bouquet Canyon Road adjacent to the Rio Vista Pump Station owned by CLWA. The treatment system will be located on the existing well site property which is owned by Valencia or, if necessary, use a small portion of land owned by CLWA. Valencia is preparing a site plan that will require constructing a concrete foundation for the ion exchange pressure vessels and other ancillary equipment and controls required to integrate the treatment system into its water supply operations.

Installing wellhead treatment at Well Q2 will require review and approval by the California Department of Health Services (DHS). Valencia will prepare and submit an application to amend Valencia's water supply permit allowing wellhead treatment at Well Q2. DHS approval is expected since ion exchange technology is recognized by DHS as "best available technology" for perchlorate removal, and multiple ion exchange treatment systems have been approved and permitted by DHS for drinking water systems. Also, the Department of Toxic Substances Control (DTSC) will include this project as part of the interim actions required to address perchlorate contamination in the Northern Alluvium. Their review was contemplated under the existing Environmental Oversight Agreement between the water purveyors and DTSC.

Since Valencia is able to rapidly respond to the contamination of its Well Q2 by installation of site modifications and turnkey contracting for treatment equipment, it intends to cooperatively pursue the amended water supply permit so it can return the well to service as soon as possible.

IV. Protection Plan for Non-Impacted Wells

As noted above, based on a combination of proximity to the Whittaker-Bermite site and prevailing groundwater flow directions, there is a logical concern that perchlorate could impact nearby downgradient Alluvial wells, the closest of which are owned and operated by Valencia. As part of assessing their overall groundwater supply during the period before the impacted Saugus wells are restored in 2006, the Purveyors commissioned the use of the groundwater flow model to examine capture zones around nearby Alluvial wells under planned pumping operations through that time period. The results of that work, as reported in the CH2M Hill Technical Memorandum "*Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property*" (Santa Clarita, California), suggested that inflow to the nearby Alluvial wells would either be upgradient of the contamination site, or would be from the Alluvium beyond where perchlorate is most likely to be transported. However, again due primarily to proximity, in this case between the capture zones and the Whittaker-Bermite site, the nearest Valencia Pardee wellfield (Wells N, N7 and N8) was considered to be at some potential risk because perchlorate had been detected in nearby Alluvial monitoring wells that were installed as part of a federally funded investigation of the extent and nature of contamination by the Army Corps of Engineers. As previously described, the other nearby Alluvial wells, including Valencia's Well Q2, were considered to be at lesser risk. Ultimately, irrespective of model simulations or other considerations, Valencia has responsibilities to supply both adequate and safe municipal water and, as a result, is prepared to respond to impacts at any of its nearby Alluvial wells in a similar manner as described for Well Q2 herein.

Thus, the response by Valencia to any future well impacted by perchlorate contamination will be to install wellhead treatment as soon as practicable, thereby ensuring adequate supplies of high quality water to its customers. Toward that end, Valencia has already dedicated space at each of the nearest well sites for addition of wellhead treatment facilities, as will be installed at Well Q2, if necessary. This short-term response plan complements the longer term actions being taken by the property owner under supervision of DTSC. For example, studies conducted by consultants under contract with the property owner have completed successful testing of in-situ groundwater remediation of perchlorate. It is anticipated this program along with several other measures approved by DTSC will be implemented over time to contain and remove perchlorate from the Northern Alluvium. Once this is accomplished, the detection of perchlorate in the Northern Alluvium is expected to decline below detectable levels over time. Successful groundwater remediation will ultimately result in the removal of wellhead treatment at wells no longer impacted by perchlorate contamination.

V. Status of Saugus Restoration and Containment

From the outset of dealing with the detection of perchlorate in the four Saugus wells in 1997, the Purveyors have recognized that, among other aspects of an overall remediation programs, such a program would most likely include an element of pumping from impacted wells, or from other wells in the immediate area, to establish hydraulic conditions that would control the migration of contamination from further impacting the aquifer in a downgradient (westerly) direction. Thus, the Purveyors expected that, as the regulatory process moved forward, the overall perchlorate remediation program could include dedicated pumping from some or all of their impacted wells, with appropriate treatment, such that two desirable objectives could both be achieved: control of subsurface flow and protection of downgradient wells, and restoration of some or all impacted water supply. Not all impacted capacity is required, however, for control of groundwater flow. As a result, the remaining capacity would be replaced by construction of replacement wells at other non-impacted locations.

In cooperation with state regulatory agencies and investigators working for Whittaker-Bermite, CLWA and the water Purveyors in the Santa Clarita Valley have developed an off-site plan that focuses on the above concepts of groundwater flow control and restored pumping capacity, and also fits within the larger scale of on-site and possibly other off-site remediation activities. As specifically relates to water supply, the plan includes the following:

- constructing and operating a water treatment process that removes perchlorate from two contaminated wells such that the produced water can be used for municipal supply,

- hydraulically containing the perchlorate contamination moving from the Whittaker-Bermite site toward the impacted wells by pumping the wells at rates that will capture water from all directions around them,

- protecting the downgradient non-impacted wells via the same hydraulic containment that results from pumping two of the contaminated wells,

- restoring the annual volumes of water that were pumped from the impacted wells before they were inactivated, and also restoring the wells' total capacity to produce water in a manner consistent with the Purveyor's operational plan for groundwater supply.

The schedule for implementation of the plan to restore the initially impacted wells is that permitting, design and construction is to be complete by 2006.

Returning any of the contaminated wells to municipal water supply service by installing treatment requires issuance of a permit from DHS before the water can be considered potable and safe for delivery to consumers. The permit requirements, contained in DHS Policy Memo 97-005 for direct domestic use of impaired water sources, include formal studies and engineering work to demonstrate that pumping these wells and treating the water will be protective of public health for users of the water. The policy memo requires that DHS review the water purveyor's plan, establish appropriate permit conditions for the wells and treatment system, and provide overall approval of returning the contaminated wells to service for potable use. Ultimately, the Purveyor's plan and the DHS requirements are intended to ensure that the water introduced to the potable water distribution system has no detectable concentration of perchlorate.

As part of the formal permitting for use of impacted wells with treatment, DHS Policy 97-005 requires an analysis to demonstrate contaminant capture and protection of other nearby water supply wells. The development and calibration of a numerical groundwater flow model of the entire basin was initiated as a result of a 2001 Memorandum of Understanding among the Upper Basin Water Purveyors (CLWA, CLWA Santa Clarita Water Division, Los Angeles County Waterworks District 36, and Valencia Water Company) and the United Water Conservation District in Ventura County. Although the groundwater model was initially intended for use in analyzing the yield and sustainability of groundwater in the basin, it was adaptable to analyze both the sustainability of groundwater under an operational scenario that included the full restoration of perchlorate-impacted supply, and the containment of perchlorate near the Whittaker-Bermite property (i.e. by pumping some of the impacted wells), including preventing the movement of perchlorate contamination to other portions of the aquifer system. DTSC reviewed and approved the construction and calibration of the regional model as described in the final model report "*Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration*" (CH2M Hill, April, 2004).

After DTSC approval of the model, it was used to simulate the capture and control of perchlorate via restoration of contaminated wells, with treatment, as described above. The results of that work are summarized in a second report "*Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California*" (CH2M Hill, September 2004). The modeling analysis indicated that the pumping of contaminated wells SCWC-Saugus1 and SCWC-Saugus2 at rates of 1,200 gpm each on a nearly continual basis will effectively contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property. The analysis also indicated that 1) no new production wells are needed in the Saugus Formation to meet the perchlorate containment objective, 2) impacted well NCWD-11 is not a required component of the containment program, and 3) the use of other water supplies in lieu of pumping at SCWC-Saugus1 and SCWC-Saugus2 would likely be detrimental to the long-term quality of groundwater in the Saugus Formation because pumping at SCWC-Saugus1 and SCWC-Saugus2 is necessary to prevent migration of perchlorate to other portions of the Saugus Formation.

The perchlorate containment report also includes the general design of a sentinel groundwater monitoring network and program required by DHS as part of its 97-005 permitting. The perchlorate containment report was approved by DTSC in November 2004. With that approval, the model is now being used to support the source water assessment and the balance of the permitting process required by DHS under is 97-005 policy.

A detailed history of the perchlorate issue and its impact on municipal water supply in the Valley is included in the Amended 2000 Urban Water Management Plan for the Valley. Included in that history are discussions of the detection of perchlorate in municipal supply wells, investigation and oversight by regulatory agencies, federally funded investigation of the extent and nature of contamination, litigation by the affected Purveyors, and cooperative settlement work toward selection and implementation of solutions that will restore impacted municipal groundwater supply and control the migration of perchlorate, the latter to protect downgradient wells. As noted above, the overall schedule for installation of treatment and return of impacted wells to service has been that those facilities be operational by 2006. The most current status of overall work toward that schedule was prepared in early April 2005. As of that date, the treatment and well reoperation project description has been finalized, and final settlement discussions were proceeding between the Purveyors and the Whittaker-Bermite parties. A draft Remedial Action Plan (RAP) has been completed; finalization of the RAP is pending determination of requirements by DTSC. A final report on the federally funded conceptual hydrogeology investigation prepared by the Army Corps of Engineers was completed in January 2005; funding is in place for limited monitoring of existing test wells in the next fiscal year. Draft reports on Source Water Assessment, Water Quality Investigation, and Source Protection Plan, all part of the DHS 97-005 approval process, are complete and in review. Draft reports on Effective Monitoring and Treatment, Human Health Risk, and Alternatives Evaluation are scheduled for completion in early May and June, respectively. CEQA review is scheduled for completion by the first of July. In the general area of design and construction, pipeline alignment studies have been completed, and work is continuing on final treatment process selection. The start of construction is scheduled for October 2005, with startup of the restored wells and new treatment facilities scheduled for February 2006. Thus, the descriptions of planned perchlorate containment, restoration of impacted wells, and adequacy of water supply in the interim remain as detailed in the Amended 2000 Urban Water Management Plan. The response plan for Valencia's Well Q2, as detailed herein, is consistent with maintaining the planned volumes and distribution of Alluvial pumping that are part of the overall restoration of perchlorate-impacted groundwater supply in the Valley.

VI. References

California Department of Water Resources, **Final State Water Project Delivery Reliability Report, 2002**, May 2003.

Castaic Lake Water Agency (CLWA), CLWA Santa Clarita Water Division, Newhall County Water District, and Valencia Water Company, **Groundwater Perchlorate Contamination Amendment and Other Amendments, 2000 Urban Water Management Plan,** January 2005, including Black and Veatch, Reiter/Lowry/Consultants, and SA Associates **Urban Water Management Plan Update, 2000**, Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Company, and Valencia Water Company.

CH2M Hill, **Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration**, April, 2004.

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Richard C. Slade & Associates, LLC, **2001 Update Report, Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems**, prepared for Santa Clarita Valley Water Purveyors, July 2002.

CH2MHill, "Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property (Santa Clarita, California)" (December 21, 2004)

Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property (Santa Clarita, California)

PREPARED FOR: The Santa Clarita Valley Water Purveyors

PREPARED BY: John Porcello/CH2M HILL
Nate Brown, R.G., C.Hg./CH2M HILL

DATE: December 21, 2004

Introduction

In cooperation with state regulatory agencies and investigators working for Whittaker-Bermite, the Castaic Lake Water Agency (CLWA) and the retail water purveyors in the Santa Clarita Valley (hereafter referred to collectively as the Purveyors) have developed a plan to restore municipal groundwater supply that has been impacted by perchlorate. The plan will include the resumption of groundwater pumping at two of the contaminated production wells (SCWC-Saugus1 and SCWC-Saugus2) that were shut down in 1997 because perchlorate was detected in both wells. In addition to resuming the production of water for municipal water supply, the pumping plan is also a groundwater containment plan that is designed to hydraulically control local groundwater flow patterns in a manner that protects other Saugus production wells located downgradient, to the west and northwest, where perchlorate has not been detected in groundwater. The SCWC-Saugus1 and SCWC-Saugus2 production wells are completed in the Saugus Formation aquifer system that underlies the Santa Clarita Valley in Los Angeles County, California. Figure 1 is a map of the study area, showing the locations of these and other nearby wells (tables and figures are located at the end of this technical memorandum).

The Saugus wells contaminated by perchlorate had produced a combined average of 4,186 acre-feet per year over the five years preceding the detection of perchlorate. Restoration of that amount of water supply is currently planned to be achieved by reactivating the SCWC-Saugus1 and SCWC-Saugus2 wells, with treatment for removal of perchlorate, and by constructing replacement wells in other parts of the Saugus Formation not impacted by perchlorate. Full restoration of impacted water supply, including the containment plan, is currently scheduled for implementation by 2006. The containment plan will consist of (1) pumping groundwater on a nearly continual basis from the SCWC-Saugus1 and SCWC-Saugus2 production wells; (2) treating the pumped water using ion exchange resins followed by chlorine and ammonia disinfection; and (3) pumping the treated water to CLWA's Rio Vista Intake Pump Station for subsequent distribution for municipal water supply.

The Purveyors have requested that CH2M HILL conduct an analysis to evaluate the possibility that uncontaminated Saugus production wells will be impacted by perchlorate migration while they are used for regular water supply during this interim period (prior to

the 2006 implementation of the containment plan). This issue has been evaluated using the regional groundwater flow model for the Santa Clarita Valley (hereafter referred to as the Regional Model), and is described in this technical memorandum. The Regional Model was used to forecast the locations and extents of the hydraulic capture zones that would result from the interim operation of production wells that lie north and west of the Whittaker-Bermite property and withdraw water from the Saugus Formation and Alluvial Aquifer. The Regional Model's construction and calibration are described in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a). An analysis of the long-term containment plan for the contaminated Saugus Formation production wells is described in the final report, *Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California* (CH2M HILL, 2004b).

The remainder of this technical memorandum describes the methods used to forecast groundwater capture by production wells during the interim period, followed by the findings from the analysis.

Methodology

Figure 1 shows the location of each production well that lies in the vicinity of the Whittaker-Bermite property. The figure identifies the production wells that are completed in the surficial Alluvial Aquifer and production wells that are completed in the deeper Saugus Formation. The figure also identifies which wells have been contaminated by perchlorate. As shown on the figure, the contaminated Saugus production wells are SCWC-Saugus1, SCWC-Saugus2, NCWD-11, and VWC-157, and Alluvial Aquifer production well SCWC-Stadium. Figure 1 also shows measured perchlorate concentrations at each production well and the highest perchlorate concentrations that have been measured at monitoring wells and other exploratory borings that have been drilled on and near the Whittaker-Bermite property in recent years.

Table 1 shows the pumping rates for normal years at each active Saugus Formation production well not contaminated by perchlorate. Table 2 shows the same information for each active production well in the Alluvial Aquifer. Important notes regarding the pumping distribution during this interim period are as follows:

1. All pumping rates were derived from records of instantaneous and annual pumping in recent years.
2. In a few of the Alluvial wells, the pumping rates were increased for the purposes of this analysis to include Alluvial pumping that has ceased at the one contaminated Alluvial well (SCWC-Stadium).
3. There is no pumping at the four contaminated Saugus production wells, or at the one contaminated Alluvial well.
4. The combined pumping rate is 1,100 acre-feet per year (AF/yr) from wells VWC-201 and VWC-205, which are the closest wells to contaminated wells SCWC-Saugus1 and SCWC-Saugus2.

5. The combined pumping rate is 2,630 AF/yr from wells NCWD-12 and NCWD-13, which are the closest wells to contaminated well NWCD-11.

6. The Alluvial Aquifer production wells that are closest to the contaminated Saugus production wells are six wells owned by the Valencia Water Company (VWC). These six wells (VWC-N, -N7, -N8, -S6, -S7, and -S8) are located along the Santa Clara River at the mouth of the South Fork Santa Clara River. These wells pump 5,880 AF/yr under the operational plan that will be in effect during the interim period. Well VWC-Q2, which lies just to the east, pumps 1,046 AF/yr.

7. Two VWC-owned Alluvial Aquifer wells that are due north of the Whittaker-Bermite property (VWC-T2 and VWC-T4) pump a combined 978 AF/yr. These wells lie along the north side of Soledad Canyon, on the opposite side of the Santa Clara River from the Whittaker-Bermite facility.

8. Two VWC-owned Alluvial Aquifer wells (VWC-U4 and VWC-U6) that lie south of the river and east (upgradient) of the Whittaker-Bermite site pump a combined 1,869 AF/yr.

9. The normal-year pumping rates listed in Tables 1 and 2 were simulated with the model. Dry-year pumping was not simulated because (a) the remainder of 2004 has an average water supply, and (b) if 2005 were to be a dry year, water demands during such a year can be met from a combination of non-impacted local groundwater, water imported from the State Water Project, and alternate firming supplies available to CLWA, most notably some of the nearly 51,000 AF that CLWA can recover from its banked water in the Semitropic Groundwater Banking Program.

The pumping rates listed in Tables 1 and 2 were used to generate new groundwater elevations and groundwater flow fields in each of the seven model layers, using the steady-state version of the Regional Model. Groundwater capture zones[1] were then delineated for a 2-year period, which is conservative in light of the approximately 1.5-year period that is currently scheduled for returning the SCWC-Saugus1 and SCWC-Saugus2 production wells to service. For the groundwater capture zone delineation process, an effective porosity of 0.05 was assumed, which is at or slightly below the low end of the range of effective porosity values that are typical for the deposits that comprise the aquifer matrix in the Saugus Formation. The longer time and the lower effective porosity were used together for modeling purposes to minimize the possibility of underestimating the extents of the 2-year groundwater capture zone for each well.

Results for Saugus Production Wells

Figure 2 shows the forecasted 2-year groundwater capture zones for the four actively pumping Saugus Formation production wells that lie closest to the Whittaker-Bermite property. The figure shows the following:

1. Wells VWC-201 and VWC-205 would draw water from very localized areas around these wells, and would not draw water from locations where perchlorate has been detected in the Saugus Formation. Specifically:

[1] A groundwater capture zone is defined in this technical memorandum as the geographic area within which a well obtains a specified volume of groundwater during a specific time period.

a. During the next two years, well VWC-201 will potentially draw Saugus groundwater from areas located as far as 450 feet east of this well, but is unlikely to draw water from areas any farther to the east during this period.

b. During the next two years, well VWC-205 will potentially draw Saugus groundwater from areas lying as far as 650 feet to the east and northeast of this well.

2. Wells NCWD-12 and NCWD-13, which are owned by the Newhall County Water District (NCWD), would also draw water from relatively localized areas during the modeled 2-year period, although the areal extent of these groundwater capture zones is larger than for the two Valencia Water Company wells because the simulated pumping is higher at the two NCWD wells (2,630 AF/yr) than at the two Valencia Water Company wells (1,100 AF/yr). The areal extent of these 2-year groundwater capture zones is approximately 1,500 feet for Well 12 and 1,300 feet for Well 13. Additionally, the outer portion of the 2-year groundwater capture zone for NCWD-13 includes the location of contaminated well NCWD-11. A reduction in the pumping rate at NCWD-13 would decrease the areal extent of its groundwater capture zone so that it does not include the location of NCWD-11. A decrease in the NCWD-13 pumping rate could be accomplished by shifting some or all of its pumping to another NCWD well and/or by increasing NCWD's importation of State Water Project water.

The groundwater capture zones shown on Figure 2 for each uncontaminated well might be larger than the areas that actually contribute water to these wells during the interim period that precedes implementation of the long-term containment plan. This is because (1) the analysis period (two years) is longer than is likely to be required to implement the long-term containment plan, and (2) the assumed effective porosity (0.05) is relatively low for the types of sediment that comprise the Saugus Formation, which therefore makes the areal extent of each simulated groundwater capture zone larger for each Saugus production well than might arise in the field.

Results for Alluvial Production Wells

Figure 3 shows the forecasted 2-year groundwater capture zones for the Alluvial Aquifer production wells in the vicinity of the Whittaker-Bermite property. The figure uses separate colors to distinguish the groundwater capture zones for each well. The analysis suggests the following:

1. VWC's Pardee wellfield (wells VWC-N, -N7, and -N8) could be impacted by perchlorate during the interim period, because the groundwater capture zones for these wells lie close to the contaminated well SCWC-Stadium and are closer to the Whittaker-Bermite property than the groundwater capture zones of the other Alluvial Aquifer production wells.

2. The other Alluvial Aquifer production wells will likely obtain water from areas upgradient of the Whittaker-Bermite property or from areas that lie north of the groundwater capture zones for the Pardee wells. Consequently, these wells are less likely to be impacted by perchlorate during the interim period.

3. The VWC-owned Alluvial Aquifer production wells shown in Figure 3 obtain their water from the portion of the Alluvial Aquifer that lies along the Santa Clara River in and near Soledad Canyon. These wells do not obtain water from areas to the south that include the alluvial valley occupied by the South Fork Santa Clara River. The groundwater capture zones for these wells also do not include the area at, and immediately south of, Bouquet Junction where observation wells with historical perchlorate detections are located (observation wells EM01, EM02, EM03, AL04A, AL04B, AL04_R1, AL04_R2, AL04_R3, and AL04_R4).

References

CH2M HILL. 2004a. *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration.* Prepared for the Upper Basin Water Purveyors (Castaic Lake Water Agency, Santa Clarita Water Division of CLWA, Newhall County Water District, and Valencia Water Company). April.

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TABLE 1
Active Municipal Groundwater Source Capacity for Saugus Formation Wells
Technical Memorandum: Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property, Santa Clarita, California

Wells	Pump Capacity (gpm)	Maximum Annual Capacity (AF)	Normal-year Production[a] (AF)
Newhall County Water District			
7	300	480	N/A[b]
10	600	960	N/A[b]
12	2,300	3,700	1,315
13	2,500	4,030	1,315
NCWD Subtotal	5,700	9,170	2,630
Valencia Water Company			
159	500	800	50
160	2,000	3,220	1,000
201	2,400	3,870	100
205	2,700	4,350	1,000
206	2,500	4,030	1,175
VWC Subtotal	10,100	16,270	3,325
Total Active Capacity	**15,800**	**25,440[c]**	**5,955[c]**

[a]Based on recent actual annual pumping, as simulated in the perchlorate containment analysis report (CH2M HILL, 2004b), except contaminated production wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 do not currently operate

[b]Emergency supply only

[c]Currently active wells only; additional capacity to meet dry-year operating plan would be met by restoration of contaminated wells and new well construction

Notes:

gpm = gallons per minute
AF = acre-feet

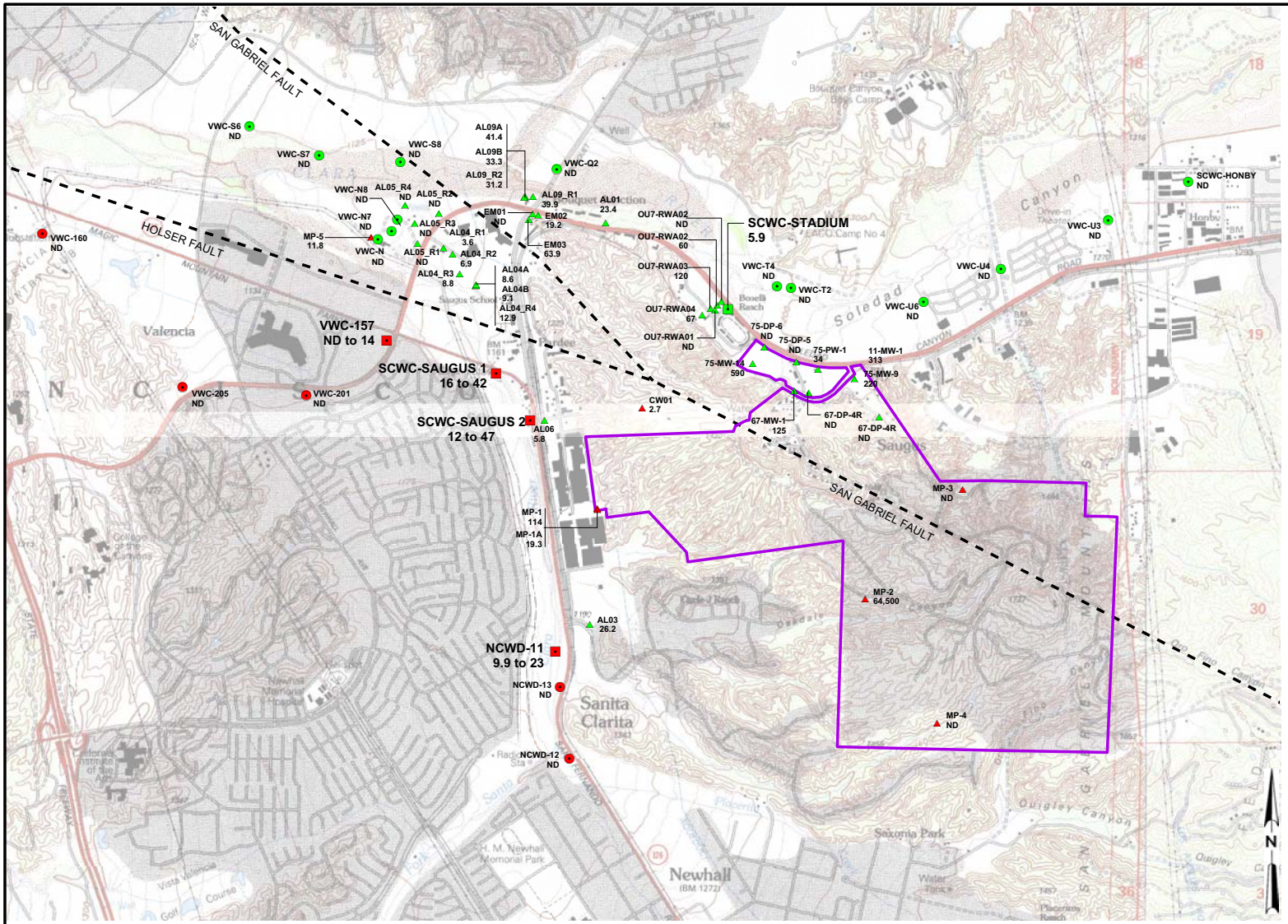
TABLE 2
Active Municipal Groundwater Source Capacity for Alluvial Aquifer Wells
Technical Memorandum: Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property, Santa Clarita, California

Wells	Pump Capacity (gpm)	Maximum Annual Capacity (AF)	Normal-year Production[a] (AF)
Newhall County Water District			
Castaic1	600	960	385
Castaic2	425	680	166
Castaic4	270	430	100
Pinetree1	300	480	164
Pinetree3	550	880	545
Pinetree4	500	800	300
NCWD Subtotal	2,645	4,230	1,660
Santa Clarita Water Division of CLWA			
Clark	600	960	782
Guida	1,000	1,610	1,320
Honby	950	1,530	740
Lost Canyon 2	850	1,370	741
Lost Canyon 2A	825	1,330	1,034
Mitchell 5B	700	1,120	557
N. Oaks Central	1,000	1,610	873
N. Oaks East	950	1,530	1,311
N. Oaks West	1,400	2,250	954
Sand Canyon	750	1,200	930
Sierra	1,500	2,410	846
SCWD Subtotal	10,525	16,920	10,088
Valencia Water Company			
Well D	1,050	1,690	690
Well N	1,250	2,010	659
Well N7	2,500	4,030	1,232
Well N8	2,500	4,030	1,232
Well Q2	1,200	1,930	1,046
Well S6	2,000	3,220	919
Well S7	2,000	3,220	919
Well S8	2,000	3,220	919
Well T2	800	1,290	489
Well T4	700	1,120	489
Well U4	1,000	1,610	876

TABLE 2
Active Municipal Groundwater Source Capacity for Alluvial Aquifer Wells
Technical Memorandum: Analysis of Near-Term Groundwater Capture Areas for Production Wells Located Near the Whittaker-Bermite Property, Santa Clarita, California

Wells	Pump Capacity (gpm)	Maximum Annual Capacity (AF)	Normal-year Production[a] (AF)
Well U6	1,250	2,010	993
Well W9	800	1,290	600
Well W10	1,500	2,410	865
Well W11	1,000	1,610	350
VWC Subtotal	21,550	34,690	12,278
Wayside Honor Rancho			
Well 10	500	800	300
Well 15	1,600	2,580	950
Well 17	600	960	350
WHR Subtotal	2,700	4,340	1,600
Total Purveyors	**34,720**	**55,840**	**24,026**
Total Purveyors and Wayside Honor Rancho	**37,420**	**60,180**	**25,626**

[a]Based on recent actual annual pumping, as simulated in the perchlorate containment analysis report (CH2M HILL, 2004b), but with SCWC-Stadium well pumping (800 AF/yr) assigned to selected wells owned by the Valencia Water Company and the Santa Clarita Water Division of CLWA.



LEGEND

CONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELL

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE 1
WELL LOCATION MAP
SANTA CLARITA, CALIFORNIA

CH2MHILL

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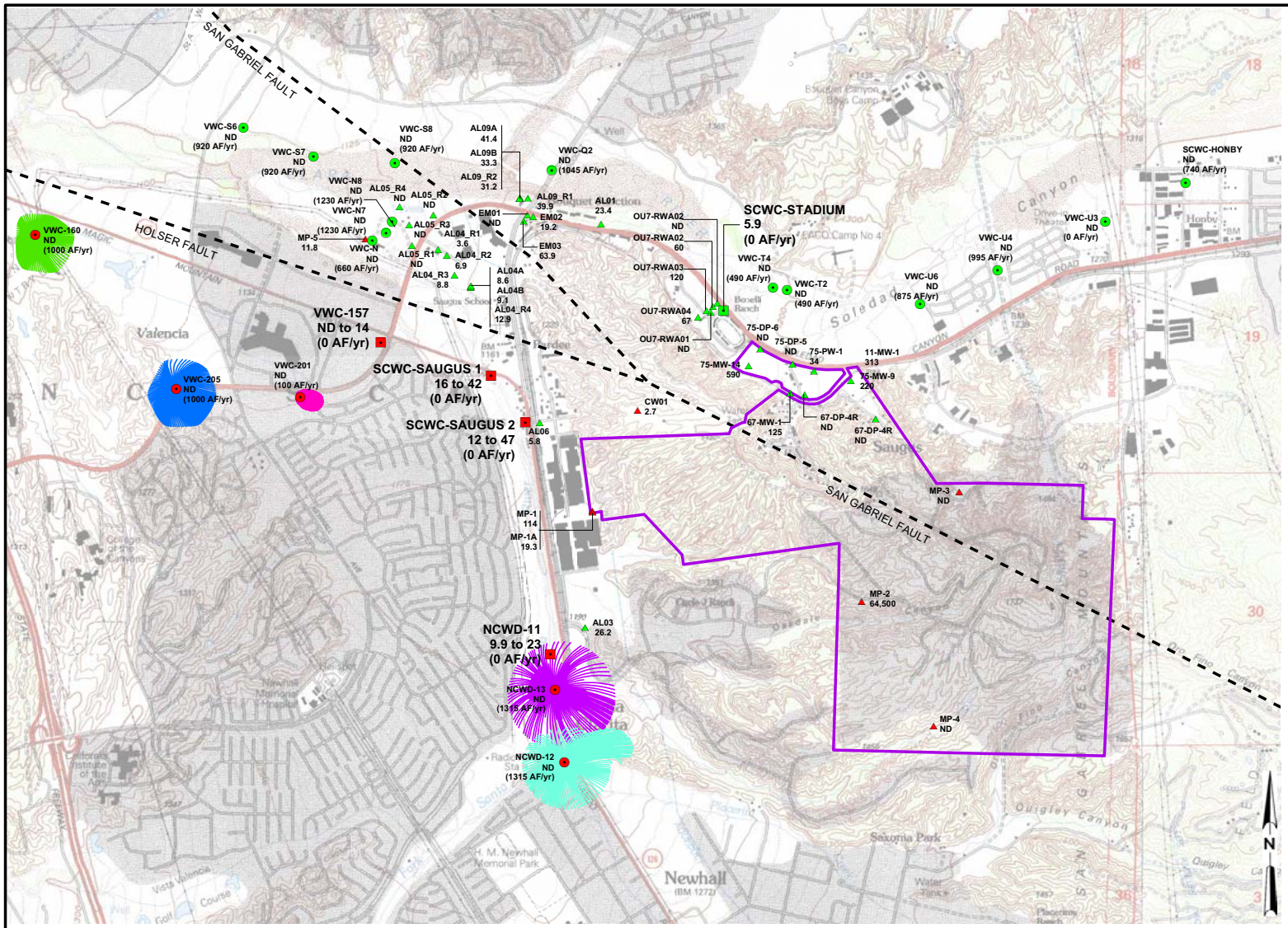

LEGEND

CONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELL

- ALLUVIUM
- SAUGUS

TWO-YEAR GROUNDWATER CAPTURE ZONE

- NC-12
- NC-13
- VWC-160
- VWC-201
- VWC-205
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. PUMPING VALUES IN PARENTHESES ARE ANNUAL PUMPING VOLUMES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; AF/yr = acre feet per year
5. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND 0.05 IN THE SAUGUS FORMATION.

FIGURE 2
FORECASTED TWO-YEAR GROUNDWATER CAPTURE ZONES FOR ACTIVE SAUGUS PRODUCTION WELLS LOCATED CLOSEST TO THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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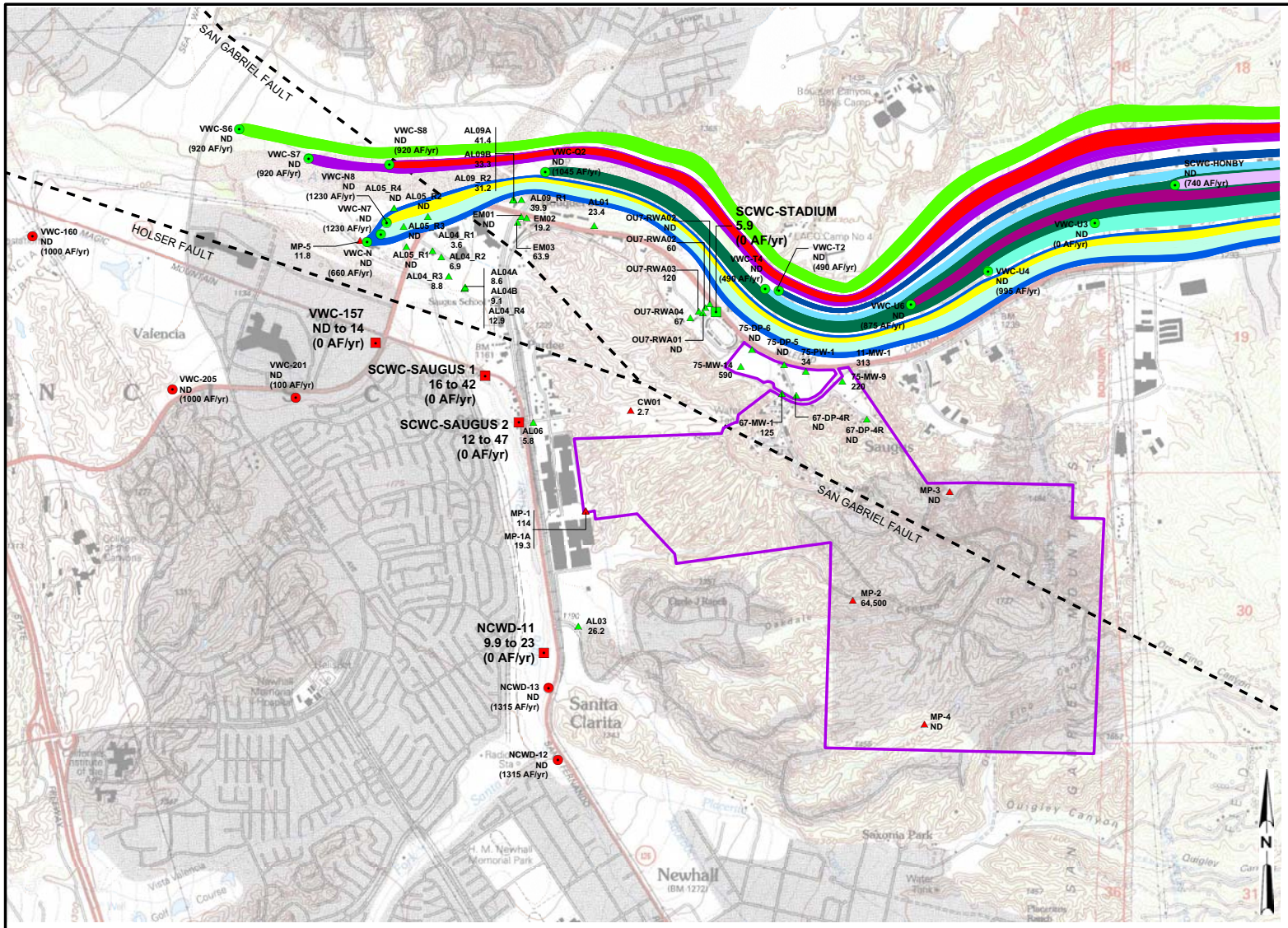

LEGEND

CONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

UNCONTAMINATED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELL
- ALLUVIUM
- SAUGUS

TWO-YEAR GROUNDWATER CAPTURE ZONE
- SCWC-HONBY
- VWC-N
- VWC-N7
- VWC-N8
- VWC-Q2
- VWC-S6
- VWC-S7
- VWC-S8
- VWC-T2
- VWC-T4
- VWC-U4
- VWC-U6
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. PUMPING VALUES IN PARENTHESES ARE ANNUAL PUMPING VOLUMES
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; AF/yr = acre feet per year
5. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND 0.05 IN THE SAUGUS FORMATION.

FIGURE 3
FORECASTED TWO-YEAR GROUNDWATER CAPTURE ZONES FOR ACTIVE ALLUVIAL PRODUCTION WELLS LOCATED CLOSEST TO THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

CH2MHILL

Geomatrix, "Letter to the Department of Toxic Substances Control Regarding the Former Whittaker-Bermite Facility, Santa Clarita, CA – Summary Report for Month of November 2007" (January 15, 2008)

Geomatrix

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January 15, 2008
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Sayareh Amir
Department of Toxic Substances Control
Site Mitigation Branch
1011 N. Grandview Avenue
Glendale, CA 91201

Subject: Former Whittaker-Bermite Facility, Santa Clarita, CA
Summary Report for Month of November 2007

Dear Ms. Amir:

This letter constitutes a progress report for the month of November 2007, prepared pursuant to Task 4 and Section 6.3 of the "Imminent and Substantial Endangerment Determination and Order and Remedial Action Order" (the Order) that the Department of Toxic Substances Control (DTSC) issued on November 22, 2002 for the former Whittaker-Bermite facility (site) in Santa Clarita, California.

SECTION I – SITE WIDE ISSUES

Specific actions taken on behalf of the respondent, actions expected to be undertaken, and planned activities for site-wide issues are summarized in the following:

PUBLIC PARTICIPATION

Activities for This Report Period

Cerrell Associates Inc. team provided the following services in support of the project and on behalf of the Whittaker Corporation during the month of December 2007.

Researched DTSC EnviroStor web site Community Outreach section for Bermite updates.

Regularly monitored the Community Information Line for messages and/or inquiries from area residents.

Regularly monitored and updated client and DTSC on Bermite site-related media coverage by the *Los Angeles Daily News, Santa Clarita Signal,* and other area media outlets.

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Anticipated Activities for This Month

Continue supporting DTSC's public outreach activities and assist with updating the DTSC's Web site (www.envirostor.dtsc.ca.gov) as necessary.

UXO/OE Clearance Activities

Activities for This Report Period

EOD Technology, Inc. (EODT) has developed a scope of work for ordnance survey and clearance of the areas referenced in the Historical Site Assessment (HSA) Report. The EODT work plan addresses the specific areas that require survey and clearance for potential scattered UXO. The scope of work of the geophysical sweeps includes the detection procedure and equipment to be utilized, and the quality control program to be followed. A draft of the document was submitted to the insurance company (AIG) for review to ensure coverage and budget allocation. AIG provided comments and requested clarifications of scope items which EODT provided responses. EODT has revised the work plan for the surface area sweeps that has incorporated AIG's comments. The revised document has been sent to AIG's technical team for final review.

Anticipated Activities for This Month

Following AIG's concurrence with the scope of work and fund allocation, the work plan for geophysical clearing of the specific target areas will be submitted to DTSC for review and approval prior to implementation.

Long-Term Actions

Following DTSC's review and approval of the scope of geophysical sweep activities, the specific areas addressed in the HSA Report will be swept and surveyed for UXO/ordnance and explosives.

SECTION II – SOIL ISSUES

Specific actions taken on behalf of the respondent, actions expected to be undertaken, and planned activities for soil issues are summarized in the following sections:

RI AND RCRA MONITORING

Activities for This Report Period (1)

All Remedial Investigation (RI) activities for characterization of soils have been completed. No additional soil RI work is anticipated.

Activities for This Report Period (2)

Geomatrix submitted a letter to DTSC on July 24th 2006 requesting DTSC's agreement to incorporate the current Resource Conservation and Recovery Act (RCRA) groundwater monitoring of the Area 317 to the OU-7 groundwater study and monitoring. DTSC provided a response letter on October 31, 2006 and requested that a closure report be prepared and submitted to provide the status of the closure activities identified in the closure plan for the Area 317 RCRA unit. Geomatrix participated in a conference call with the DTSC Site Mitigation and the Permitting Units to clarify specific items of the October 31, 2006, letter. Based on DTSC request and the discussions during the conference call, the closure report and a letter of response to DTSC comments were prepared and submitted to DTSC on April 30, 2007.

Environ has prepared the scope and the frequency of the monitoring activities to focus the RCRA groundwater monitoring to those areas that will provide meaningful results. The document has been provided to AIG for their review to ensure adequate funding.

Meanwhile, monitoring of the groundwater under the Area 317 continues on schedule.

Anticipated Activities for This Month

The current RCRA groundwater monitoring program will continue per the current plan until further agreements and arrangements are made.

Long-Term Actions

Provide recommendation for modification of the current RCRA monitoring program, and continue the closure activities.

REMEDIAL ACTION PLAN

Activities for This Report Period

The final site-wide feasibility study (FS) for soil was submitted to DTSC on October 15. DTSC requested that the draft site-wide Remedial Action Plan (RAP) for OU2 through OU6 be prepared and submitted. The submittal date for the draft site-wide RAP was set for January 15, 2008. During the December 14, 2007 joint meeting of representatives of the Department of Toxic Substances Control (DTSC), City of Santa Clarita (City), SunCal Santa Clarita LLC (SSC), American International Specialty Lines Insurance Company (AISLIC), and Whittaker; SSC representatives presented an outline of the approach to integrate the shallow soil treatment and treated soil disposition programs with the site grading and land use plans to avoid potential "piecemealing" issues under the California Environmental Quality Act (CEQA). In addition, representatives of the parties discussed strategies to accelerate planning for groundwater containment and remediation and other remedies (e.g., soil vapor extraction, depleted uranium removal, and sweeps for potential munitions and explosives of concern [MEC]) through series of accelerated pilot studies. It was realized that the deadline for submittal of the RAP needed to be extended to enable further discussions and work as necessary regarding integration of soil and groundwater and integration of site soils with grading activities for future development and compliance with all applicable CEQA requirements.

Anticipated Activities for This Month

As discussed during the December 14, 2007 meeting with DTSC and City of Santa Clarita, a request for deadline extension for sit-wide RAP will be submitted.

Long-Term Actions

Work with DTSC to set a new deadline for submittal of the site-wide RAP. Prepare and submit work plans for pilot studies.

REMOVAL ACTIONS AND INTERIM REMEDIAL MEASURES

Activities for this Report Period

A Work Plan for Supplemental Characterization and Bench Top Testing of Proposed Method for depleted uranium (DU) removal at Areas 57 and 14 of the Whittaker-Bermite site was prepared

by EnergySolutions and submitted to DTSC and the Radiological Health Branch of the California Department of Public Health (DPH) on December 10, 2007.

Submittal was made to the CA Department of Public Health (CDPH), Radiologic Health Branch requesting reciprocal recognition of the EnergySolutions mobile radioactive materials license issued by the U.S. Nuclear Regulatory Commission (NRC) to perform work in California for the 2008 calendar year. A request for additional information was received in December 2007.

Anticipated Activities for this Month

Address and incorporate any comments on the Draft Work Plan provided by DTSC and CDPH and submit the final version of or an addendum to the Work Plan, if necessary. All comments received from these agencies will be reviewed and addressed.

Long Term Actions

After the Work Plan has been accepted, field work will be scheduled. Results of the field work will support the dose modeling effort.

OU1 REMEDIATION

Activities for This Report Period (1)

Operated soil vapor extraction (SVE) systems at Area 43. The hi-vacuum system is currently at the Building 329 area, but is not being operated until a site-specific permit is obtained from the South Coast Air Quality Management District (SCAQMD). The hi-vacuum system was previously operated under a various locations permit that expired.

Anticipated Activities for This Month

Continue operation and optimization of SVE system in Area 43 and restart the Building 329 operations upon receipt of the site-specific permit.

Long-Term Actions

Two SVE systems will be operated at Area 43 and Building 329 concurrently until halogenated volatile organic compound levels are eliminated or reduced to appropriate levels or asymptotic levels are reached.

Activities for This Report Period (2)

Approximately 3,588 cubic yards of soil were excavated from Area 55 during this reporting period. Excavation operations were limited due to weather conditions, shutdown of the operation during the holidays, and limited space on the treatment pad resulting from the slowdown in the bioremediation process during the winter.

Full-scale enhanced biological treatment of impacted soils continued during this reporting period using a combination of glycerin, di-ammonium phosphate, and bioaugmentation culture (0.01% when available). During this reporting period, approximately 2,280 tons of soil was processed and placed into treatment cells (4). Sampling results have generally shown consistent and successful reduction of perchlorate to non-detectable levels, although the incubation time has increased from approximately 2 weeks or less to 4 to 6 weeks, due to colder ambient air temperatures and higher baseline perchlorate concentrations. A total of one Ag Bag and 9 treatment cells were approved as "clean" by DTSC during this reporting period and the treated soil was transported to clean soil stockpile areas for later use as backfill material.

Dust monitoring indicated that, in general, the net dust readings at the downwind monitoring stations were below 50 micrograms per cubic meter ($\mu g/m^3$) during the soil excavation and processing operations. In the few cases when the dust readings exceeded 50 $\mu g/m^3$, the dust was suppressed with water; therefore, the exceedances were insignificant.

Anticipated Activities for This Month

Continue full-scale operations.

Long-Term Actions

Continue soil remediation operations in accordance with the OU1 RAP/Remedial Design.

SECTION III – GROUNDWATER AND SURFACE WATER ISSUES

Specific actions taken on behalf of the respondent, action expected to be undertaken and planned activities for groundwater and surface water issues are summarized in the following sections:

REMEDIAL INVESTIGATIONS AND GROUNDWATER/SURFACE WATER MONITORING AND INTERIM ACTIONS

Activities for This Report Period (1)

The updated groundwater (OU-7) RI was submitted in February 2007 for DTSC review and comment. Section 7, Risk Evaluation of Groundwater and Surface Water, was revised to address comments received from DTSC, and the Response to Comments was completed. The responses and revised Section 7 were sent to the DTSC on November 16, 2007 for final review and approval. DTSC issued a letter dated December 10, 2007 approving the OU-7 RI Report, including Section 7.

Anticipated Activities for This Month

Complete the distribution of the final Section 7 and Response to Comments.

Long-Term Actions

Groundwater monitoring and sampling data will be used in developing the OU-7 FS.

Activities for This Report Period (2)

A Pilot Remediation Pumping Program was started in Northern Alluvium Areas 11, 67, and 75, in 2006. As a part of expanded pumping program, an alternate extraction well 75-MW-35 for higher groundwater extraction and observation well clusters were completed in January 2007. Well 75-MW-35 and the six hot spot wells were connected to the new higher capacity groundwater treatment system. The low flow wells were brought online during the week of June 11, 2007. System shake-down and performance startup testing began on June 18, 2007, and continued through early October. Sustained pumping of the extraction well 75-MW-35 began in mid-October and continued during December. In late December, the wells were shut down for treatment system maintenance.

Monitoring of the aquifer response to pumping from the alternate extraction well 75-MW-35 was conducted during December following the start up of sustained pumping of the extraction well and completion of the system shake-down and startup testing of the new treatment system.

Anticipated Activities for This Month

Monitoring of the aquifer response to pumping from the alternate extraction well 75-MW-35 and the downgradient site boundary low flow extraction wells will continue during January after the wells are restarted.

Long-Term Actions

Continue operating the extraction and treatment system and conduct additional performance monitoring.

Activities for This Report Period (3)

Potential remedial technologies to address Northern Alluvium groundwater hot spots, including evaluation of the Area 75 boundary containment established by sustained operation of the low flow pumping wells that started in early October, are being evaluated as part of the OU-7 FS.

Anticipated Activities for This Month

Work on the draft OU-7 FS will continue during this month.

Long-Term Actions

Additional source control measures in Northern Alluvium will be considered and recommended where determined to be necessary.

Activities for This Report Period (4)

The Quarterly Groundwater Monitoring Report, Second Quarter 2007 was submitted to DTSC on December 11, 2007.

Anticipated Activities for This Month

The Quarterly Groundwater Monitoring Report, Third Quarter 2007 was submitted to DTSC on January 10, 2008. Data review and reporting for the Fourth Quarter 2007 quarterly monitoring

conducted in November is in progress. In addition, a proposed plan to refine and focus the groundwater monitoring program is being developed based on the extensive body of groundwater monitoring data that has been collected at the Site since 2003. The draft plan is currently being reviewed by AIG and their consultants.

Long-Term Actions

Continue monitoring and reporting of the proposed network of monitoring wells on quarterly schedule.

NORTHERN ALLUVIUM GROUNDWATER TREATMENT SYSTEM CONSTRUCTION (OU5)

Activities for This Report Period

The December compliance samples were collected on December 3, 2007 and results indicated an exceedance of copper over the monthly average compliance limit and the daily maximum limit for nitrogen. The system was placed in recycle mode after the samples analyses were received. The media in the lag nitrate vessel was replaced on December 13, 2007 and the filter media of the lead vessel was replaced on December 18, 2007. Weekly samples for nitrate compliance were collected on December 17, 24, and 31, results of which indicated that the water treatment plant was operating within the permit limits. Additionally, a process sample collected on December 31, 2007 brought the monthly average for copper below the permit limit.

In addition to the downtime while waiting for the nitrate media to be replaced, the overnight freezing temperatures kept the system from operating in normal mode for most of December, with a few exceptions when weekly samples were collected and rainwater was processed. As of December 3, 2007 we have treated and discharged 2,509,803 gallons of impacted water from Northern Alluvium. During December we treated and discharged 20,027 gallons of storm water collected from various areas of the site.

CDM sent a written request to RWQCB on 12/11/07 for using the clean discharge water for dust control purposes.

Anticipated Activities for This Month

Bag filters are expected to be removed from the site in January.

Monthly sampling is anticipated to occur on January 8, 2008. The GAC vessel that was sent for processing in November is expected to be put into service in January; also, the media in the metals resin vessels is expected to be replaced.

CDM will follow up with RWQCB on the status of the 12/11/07 request for using the clean discharge water for dust control purposes.

FEASIBILITY STUDIES, INTERIM REMEDIAL MEASURES, STORM WATER POLLUTION PREVENTION (SWPP)

Activities for This Report Period (1)

Work on the draft OU-7 FS is in progress.

Anticipated Activities for This Month

The refined site conceptual model will be incorporated into the OU-7 FS. Work on the draft OU-7 FS will continue during this month.

Long-Term Actions

Submit the OU-7 FS to DTSC.

Activities for This Report Period (2)

Pursuant to the Site Storm Water Pollution Prevention Plan, Environ continued coordinating the implementation of short-term surface water run-off mitigation measures. Implementation of the short-term mitigation measures is being coordinated with CDM, particularly in the areas of the site where soil remediation activities are in progress.

Anticipated Activities for This Month

Upgrades to the short-term mitigation measures will continue as necessary.

Long-Term Actions

Long-term mitigation of the drainages and excavations will be conducted in conjunction with the soil remediation.

REMEDIAL ACTION PLAN

Activities for This Report Period

No activity at this time, other than those outlined above for OU1 remediation.

SECTION IV – REQUIREMENTS UNDER THE ORDER THAT WERE NOT COMPLETED

All requirements of the Order were completed. Whittaker has met or exceeded all the substantive requirements of the Order.

SECTION V – PROBLEMS OR ANTICIPATED PROBLEMS IN COMPLYING WITH THE ORDER

Following DTSC's agreement with Whittaker's proposed modifications to implementation plans in compliance with the Order reflected in the letter dated September 28, 2004, DTSC's letter dated July 11, 2005, included a schedule for submitting a number of documents. All deadlines have been met and documents have been submitted per requested schedule.

SECTION VI – RESULTS OF SAMPLE ANALYSIS, TESTS, AND OTHER DATA

Whittaker has instructed its contractors to continue to provide DTSC staff with raw data sets for ongoing quarterly groundwater monitoring events and RI/FS work upon receipt from the lab.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC.

Hassan Amini, PhD, CHG
Project Coordinator

cc: Eric Lardiere, Whittaker Corp; William Weaver, CDM; Jessica Donovan, ENVIRON; Paul Bergstrom, Knight Piésold; Jeremy Duncan, EODT; Tim Bricker, Santa Clarita L.L.C.; Myla Bobrow, RFI Corporate Offices; Megan Trend, Chubb Financial Solutions; Cindy Hunter and Stacy Parker, AIG Insurance; Vitthal Hosangadi, MACTEC; Jim Strandberg, Malcom Pirnie; John Carty, Zurich North America; Hal Dash, Cerrell Associates; Lisa Hardy and Jeff Hogan, City of Santa Clarita; Yueh Chuang, CH2M Hill; Kathy Stryker Anderson, US Army Corps of Engineers; Robert DiPrimio, Valencia Water Company; Lynn Takaichi, and Meredith Durant, Kennedy Jenks; David Bacharowski, RWQCB; James Leserman, Castaic Lake Water Agency; Steve Cole, Newhall County Water District; Neil Elsey, Avion Holdings LLC; Mauricio Guardado, Santa Clarita Water; Scott Andrews and Doug Mosteller, Cherokee Investment Services, Inc.; Jeff O'Keefe, Department of Public Health.

United States Environmental Protection Agency, "Perchlorate Update" (March 2002)

Perchlorate Update

United States Environmental Protection Agency

march 2002

The United States Environmental Protection Agency (EPA) has released its revised draft toxicity assessment, "Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization." When finalized, this assessment will be an important update of EPA's health assessment that reflects the state of the science regarding the health effects of the chemical perchlorate. The preliminary revised human health risk estimates found in the document are still undergoing review and deliberations both by the external scientific community and within EPA, and do not represent EPA policy at this stage.

How To Review and Comment on EPA's Draft Perchlorate Toxicity Assessment

The draft perchlorate toxicity assessment is available at EPA's National Center for Environmental Assessment (NCEA) Web site www.epa.gov/ncea under "what's new." Written public comments on the scientific literature and on EPA's characterization of the science in the draft perchlorate assessment will be accepted by EPA's contractor, Eastern Research Group, for consideration during the Agency's document revision process. These comments will be made available to the peer reviewers. Public comments must be received by April 5, 2002. Send your comments to: Eastern Research Group ERG, Attn: Meetings, 100 Hartwell Avenue, Lexington, MA 02421. If your comments are under 50 pages in length, you can send them via email attachment (in Word, WordPerfect or PDF) to *meetings@erg.com*.

What is Perchlorate?

Perchlorate is both a naturally occurring and man-made chemical. Most of the perchlorate manufactured in the United States is used as the primary ingredient of solid rocket propellant. Wastes from the manufacture and improper disposal of perchlorate-containing chemicals are increasingly being discovered in soil and water.

How Can Perchlorate Affect Human Health?

Perchlorate interferes with iodide uptake into the thyroid gland. Because iodide is an essential component of thyroid hormones, perchlorate disrupts how the thyroid functions. In adults, the thyroid helps to regulate metabolism. In children, the thyroid plays a major role in proper development in addition to metabolism. Impairment of thyroid function in expectant mothers may impact the fetus and newborn and result in effects including changes in behavior, delayed development and decreased learning capability. Changes in thyroid hormone levels may also result in thyroid gland tumors. EPA's draft analysis of perchlorate toxicity is that perchlorate's disruption of iodide uptake is the key event leading to changes in development or tumor formation.

What are the Preliminary Conclusions of the Draft Toxicity Assessment?

The EPA draft assessment concludes that the potential human health risks of perchlorate exposures include effects on the developing nervous system and thyroid tumors. The draft assessment includes a draft reference dose (RfD) that is intended to be protective for both types of effects. It is based on early events that could potentially result in these effects, and factors to account for sensitive populations, the nature of the effects, and data gaps were used. The draft RfD is 0.00003 milligrams per kilogram per day (mg/kg/day). The RfD is defined as an estimate, with uncertainty spanning perhaps an order of magnitude, of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of adverse effects over a lifetime. As with any EPA draft assessment document containing a quantitative risk value, that risk value is also draft and should not at that stage be construed to represent EPA policy. Thus, the draft RfD for perchlorate is still undergoing science review and deliberations both by the external scientific community and within the Agency.

The assessment provides a hypothetical conversion of the draft RfD to a drinking water equivalent level, assuming factors of 70 kilograms (kg) body weight and 2 liters (L) of water consumption per day. The converted draft estimate would be 1 microgram per liter (ug/L) or 1 part per billion (ppb). If the Agency were to make a determination to regulate perchlorate, the RfD, along with other considerations would factor into the final value.

Does Perchlorate Cause Cancer?

Perchlorate is associated with disruption of thyroid function which can potentially lead to thyroid tumor formation. This draft toxicity assessment accounts for both developmental and tumor formation effects.

Does My Water Contain Perchlorate?

Confirmed perchlorate releases have occurred in at least 20 states throughout the United States (see Figure 2). In EPA Region 9, perchlorate releases have occurred in California, Arizona, and Nevada. Perchlorate has also been released into the Colorado River, which is a drinking water source for some areas of the region. Additional information and maps detailing those sites are available in Chapter 1 of the draft of the "Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization." EPA, other federal agencies, states, water suppliers and industry are already actively addressing perchlorate contamination through monitoring for perchlorate in drinking water and surface water. The full extent of perchlorate contamination is not known at this time.

What is Being Done about Perchlorate?

A peer review of the draft perchlorate toxicity assessment will be held March 5 and 6, 2002 in Sacramento, CA. The purpose of the peer review is to provide an independent review of the scientific information and interpretation used in the document. Once the assessment is finalized, the reference dose will be used in EPA's ongoing efforts to address perchlorate problems. EPA's draft reference dose represents a preliminary estimate of a protective health level and is not a drinking water standard. In the future, EPA may issue a Health Advisory that will provide information on protective levels for drinking water. This is one step in the process of developing a broader response to perchlorate including, for example, technical guidance, possible regulations and additional health information. A federal drinking water regulation for perchlorate, if ultimately developed, could take several years.

In 1998, perchlorate was placed on EPA's Contaminant Candidate List for consideration for possible regulation. In 1999, EPA required drinking water monitoring for perchlorate under the Unregulated Contaminant Monitoring Rule (UCMR). Under the UCMR, all large public water systems and a representative sample of small public water systems are required to monitor for perchlorate over the next two years to determine whether the public is exposed to perchlorate in drinking water nationwide.

How is Perchlorate Removed from Water?

Several types of treatment systems designed to reduce perchlorate concentrations are operating around the United States, reducing perchlorate to below the 4 ppb reporting level. Biological treatment and ion (anion) exchange systems are among the technologies that are being used, with additional treatment technologies under development.

Many other perchlorate studies have been completed during the last several years. A May 2001 summary of 65 perchlorate treatment studies is available online at www.gwrtac.org/ (click on "Technical Documents" then look for "Technology Status Reports"). The summary report was prepared by the Ground-Water Remediation Technologies Analysis Center. Most of the projects described in the report are bench-scale and pilot-scale demonstrations of water treatment technologies, although several entries describe full-scale systems and soil treatment methods. Most of the projects employ biological treatment methods or ion (anion) exchange technology, although reverse osmosis, nanofiltration, granular activated carbon, and chemical reduction are also discussed. Results of federally-funded perchlorate treatment research, managed by the American Water Works Association Research Foundation (AWWARF), are also becoming available (see www. awwarf. com/ research/spperch.asp).

Is Perchlorate-contaminated Water Safe to Drink?

EPA's draft toxicity assessment is preliminary and thus, it is difficult to make definitive recommendations at this stage. Other factors that influence the answer to this question include how much water is consumed, the degree of perchlorate contamination and the health status of the consumer.

Sensitive populations, like pregnant women, children and people who have health problems or compromised thyroid conditions, should follow the advice of their health care provider regarding the amount and type of liquids, including water that should be consumed.

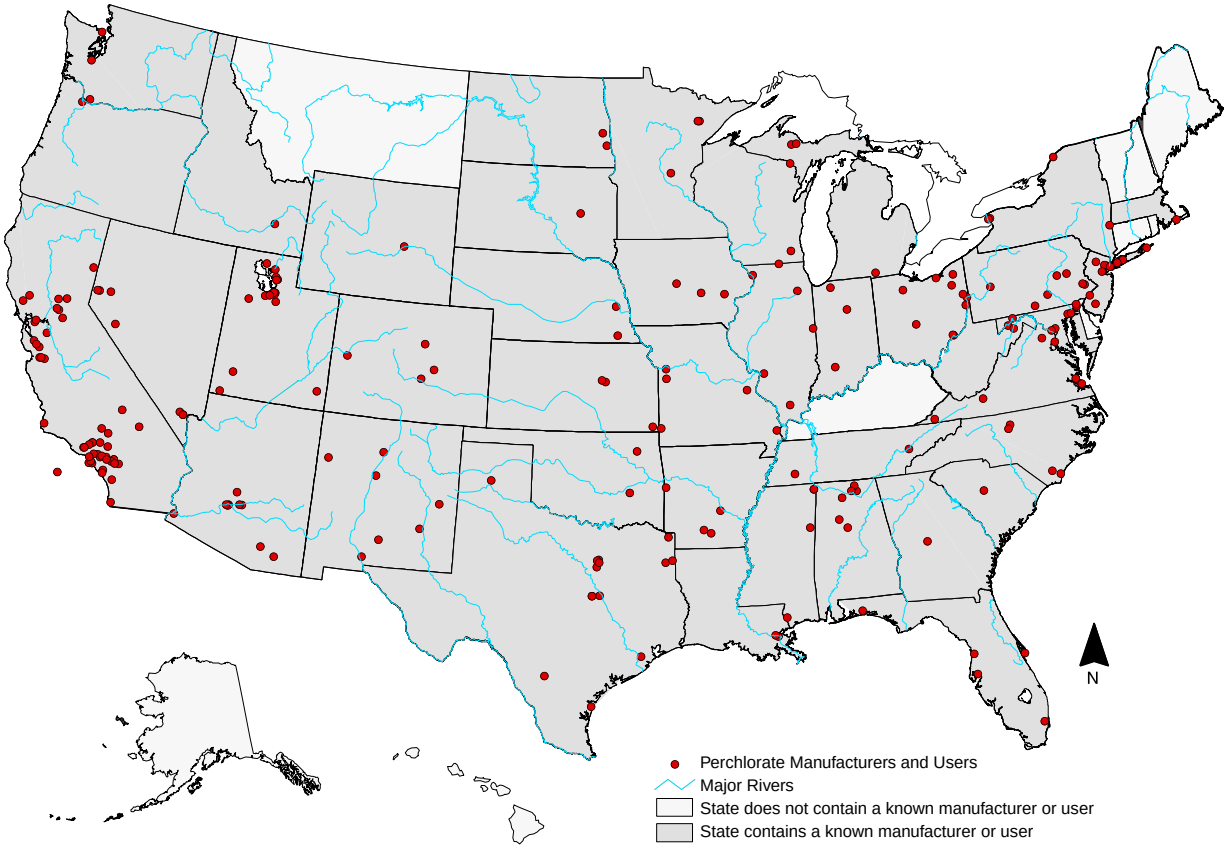

Figure 1: U.S. Perchlorate Manufacturers and Users, as of October 2001

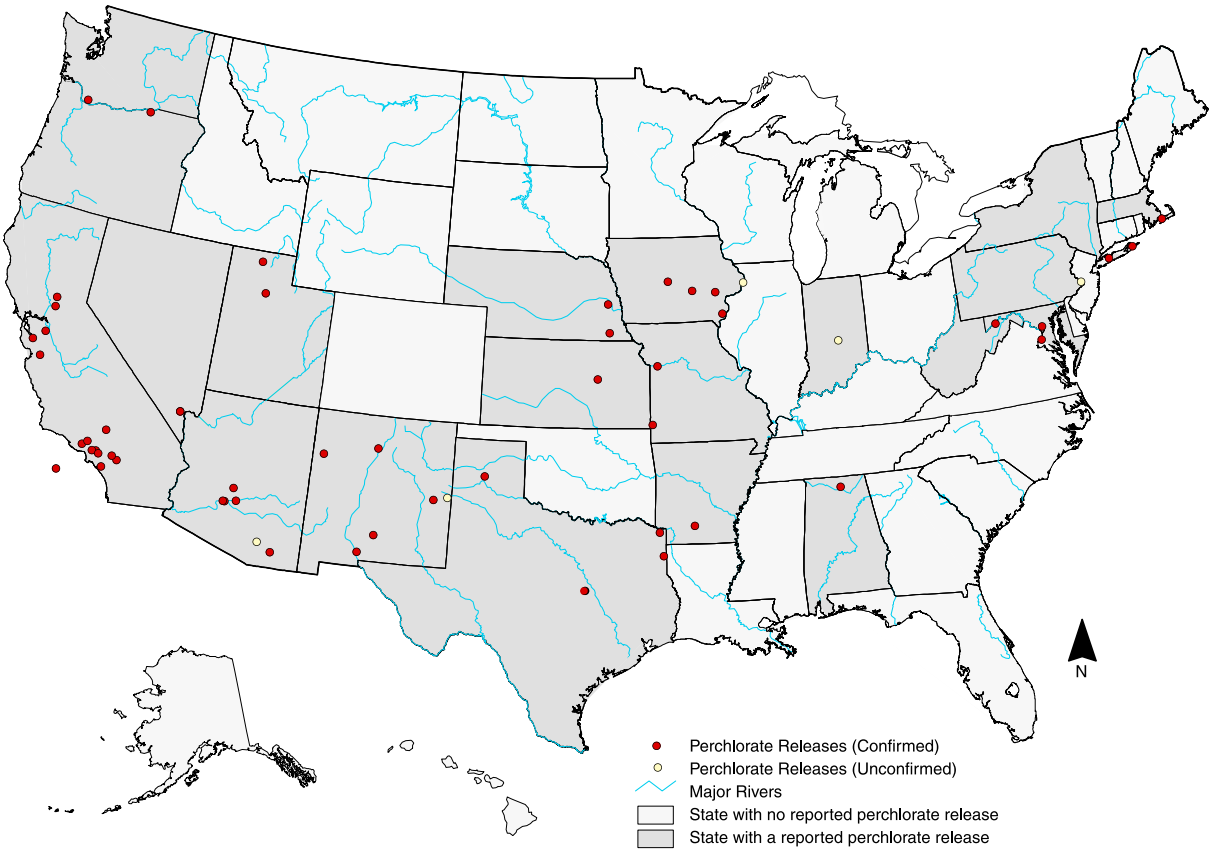

Figure 2: Reported Releases of Perchlorate into the Environment, as of November 2001

For more information

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Carollo Engineers, "Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer, Technical Memorandum No. 3 Bench and Pilot Test Results" (February 2004)

Castaic Lake Water Agency

Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer

TECHNICAL MEMORANDUM NO. 3
BENCH AND PILOT TEST RESULTS

February 2004

CASTAIC LAKE WATER AGENCY

TREATMENT OF PERCHLORATE CONTAMINATED GROUNDWATER FROM THE SAUGUS AQUIFER

TECHNICAL MEMORANDUM NO. 3

TABLE OF CONTENTS

		Page No.
1.0	EXECUTIVE SUMMARY	3-1
	1.1 Background	3-1
	1.2 Ion Exchange	3-1
	1.3 Biological Filtration	3-2
2.0	INTRODUCTION	3-3
	2.1 Overview	3-3
	2.2 Project Objectives	3-4
3.0	BACKGROUND AND TEST SITING	3-5
	3.1 Test Approach and Siting	3-5
	3.2 Feed Water	3-6
	3.3 Discharge Streams	3-9
4.0	EQUIPMENT DESCRIPTION AND CAPABILITIES	3-9
	4.1 Ion Exchange	3-9
	4.2 Biological Fixed-Bed Filter	3-15
	4.3 Biological Fluidized-Bed Reactor	3-19
	4.4 Submerged Membrane Bioreactor	3-21
	4.5 DBP Formation Potential Testing	3-25
	4.6 Simulated Distribution System Test	3-29
5.0	ANALYTICAL METHODS	3-29
	5.1 pH	3-29
	5.2 Temperature	3-29
	5.3 Turbidity	3-30
	5.4 Perchlorate	3-30
	5.5 Common Anions	3-30
	5.6 Dissolved Oxygen	3-30
	5.7 Metals	3-30
	5.8 Sulfide	3-30
	5.9 NDMA	3-30
	5.10 Uranium	3-30
	5.11 Total Suspended Solids	3-31
	5.12 Total Alkalinity	3-31
	5.13 Total Hardness	3-31
	5.14 Organic Carbon	3-31
	5.15 UV_{254} Absorbance	3-31

5.16 Total and Free Chlorine 3-31
5.17 Microbial Parameters 3-31
5.18 Particle Counts 3-31
5.19 Disinfection By-Products 3-32
5.20 Ozone Residual 3-32
5.21 COD 3-32

6.0 OPERATING PROTOCOL 3-32
6.1 Ion-Exchange Columns 3-32
6.2 Biological Fixed-Bed Filter 3-36
6.3 Biological Fluidized-Bed Reactor 3-40
6.4 Submerged Membrane Bioreactor 3-43

7.0 TEST RESULTS 3-44
7.1 Ion-Exchange Testing Results 3-44
7.2 NDMA Formation Potential Testing 3-53
7.3 Spent Resin Characterization 3-58
7.4 Summary of Ion-Exchange Testing Results 3-64
7.5 Fixed-Bed Filter 3-66
7.6 Fluidized Bed Reactor 3-90
7.7 Submerged Membrane Bioreactor (Post-Treatment of FXB Effluent) 3-106
7.8 In-Line Ion Chromatographic Analysis 3-110
7.9 DBP Formation Potential Testing 3-112
7.10 Summary of DBPFP Results 3-121

8.0 CONCLUSION 3-121

9.0 REFERENCES 3-122

LIST OF TABLES

Table 3.1 Water Quality Parameters in the Groundwater at Newhall 11 and 12 Wells 3-6
Table 3.2 Fixed-Bed Filter Design Criteria 3-15
Table 3.3 Fixed-Bed Filter Technical Specifications 3-15
Table 3.4 SMBR ZW-10 Module Specifications 3-24
Table 3.5 SMBR ZW-10 System Specifications 3-24
Table 3.6 SMBR ZW-10 System Operating Limits 3-25
Table 3.7 DBPFP Analytical Matrix 3-28
Table 3.8 Breakthrough of Anions 3-33
Table 3.9 Breakthrough of Anions for a Generic Perchlorate Selective Resin 3-33
Table 3.10 Testing Matrix for Bench-Scale Ion Exchange 3-35
Table 3.11 Sampling Schedule for Fixed-Bed Biological Pilot 3-39
Table 3.12 Fluidized-Bed Sampling Matrix 3-41
Table 3.13 SMBR ZW-10 System Operating Parameters 3-43
Table 3.14 SMBR Sampling Matrix 3-43
Table 3.15 Range of Constituent Concentration in Feedwater to the IX System 3-45
Table 3.16 Run Lengths Until Perchlorate Breakthrough (1 μg/L) 3-53
Table 3.17 Comparison of TTLC Metals in Spent Resins to Federal and State Toxicity Limits 3-59

Table 3.18 Comparison of Perchlorate, Nitrate and Uranium in Spent Resins Leachates 3-60
Table 3.19 Radionuclides Reportable Quantities (Table 2 of Appendix A under CERCLA) 3-60
Table 3.20 A1 and A2 Values for Radionuclides- Shipments 3-63
Table 3.21 Calculated Accumulated Amount of Uranium on the Spent Resins 3-64
Table 3.22 Backwash Water Quality 3-89
Table 3.23 FBR Mechanical and Operational Adjustments 3-90
Table 3.24 Testing Matrix for Bench-Scale Chlorination of SMBR Effluent 3-106
Table 3.25 Comparison of Perchlorate Results (μg/L) (<MRL indicates less than method reporting limit of 4 μg/L) 3-112
Table 3.26 Conditions Applied during DBPFP testing 3-113
Table 3.27 Conditions Applied During Ozonation Testing 3-114
Table 3.28 Conditions Applied During DBPFP Testing of Ozonated Waters 3-114
Table 3.29 DBPFP Testing Results 3-115
Table 3.30 DBPFP Yields 3-116
Table 3.31 DBPFP Testing Results-Ozone Test 3-117

LIST OF FIGURES

Figure 3.1 Process Flow Schematic for Bench- and Pilot-Scale Testing 3-8
Figure 3.2 Bench-Scale Flow-Through Ion-Exchange Equipment 3-10
Figure 3.2(a) Bench-Scale Column Setup and Autosamplers 3-11
Figure 3.3 Fixed-Bed Filtration Pilot Plant 3-16
Figure 3.4 Fixed Bed Biological Filtration Pilot Schematic 3-18
Figure 3.5 Fluidized-Bed Biological Filtration Process Schematic 3-20
Figure 3.6 Post-FXB Treatment MBR Schematic 3-23
Figure 3.7 Carollo's Continuous Bench-Scale Ozone Reactor 3-27
Figure 3.8 Anticipated Breakthrough Curves for Key Anions 3-34
Figure 3.9 Flow Rates Measured Through the Three Ion-Exchange Columns 3-46
Figure 3.10 Column Effluent Temperature Measured Over the Course of the Study. 3-48
Figure 3.11 pH Values Measured in the Feed and IX Column Effluents 3-49
Figure 3.12 Breakthrough of Major Anions from Cal 2100 Series Resin in the First 2000 BVs 3-50
Figure 3.13 Breakthrough of Major Anions from 9708 Resin in the First 2000 BVs ... 3-51
Figure 3.14 Breakthrough of Major Anions from 9710 Resin in the First 2000 Bvs 3-52
Figure 3.15 Comparison of Perchlorate Breakthrough Curves 3-54
Figure 3.16 Breakthrough of Critical Anions from USF 9710 3-55
Figure 3.17 Post-Chlorination Testing with Free Chlorine NDMA Results 3-56
Figure 3.18 Post-Chlorination Testing with Combined Chlorine NDMA Results 3-57
Figure 3.19 Post-Chlorination Testing NDMA Results 3-61
Figure 3.20 Resin Leach Test Results 3-62
Figure 3.21 Fixed-Bed Acclimation and Optimization 3-67
Figure 3.22 Fixed-Bed EBCT and Acetic Acid Set-Points 3-68
Figure 3.23 Fixed-Bed Dissolved Oxygen 3-70
Figure 3.24 Fixed-Bed Nitrate and Perchlorate 3-71
Figure 3.25 Fixed-Bed Total Organic Carbon 3-73
Figure 3.26 Fixed-Bed BDOC 3-74
Figure 3.27 Fixed-Bed Sulfate 3-75
Figure 3.28 Fixed-Bed pH 3-76

Figure 3.29 Fixed-Bed Heterotrophic Plate Counts 3-77
Figure 3.30 Fixed-Bed Total Coliforms 3-78
Figure 3.31 Fixed-Bed Effluent Turbidity and Particle Counts 3-79
Figure 3.32 Fixed-Bed Headloss 3-80
Figure 3.33 Fixed-Bed Backwash Challenge Test 3-81
Figure 3.34 Fixed-Bed Perchlorate Spike Challenge Test 3-82
Figure 3.35 Fixed-Bed Nitrate Spike Challenge Test 3-84
Figure 3.36 Fixed-Bed Intentional Shut-Down Challenge Test 3-86
Figure 3.37 Fixed-Bed Unintentional Shut-Down Performance 3-87
Figure 3.38 Fixed-Bed Acetic Acid Feed Failure Challenge Test 3-88
Figure 3.39 Fluidized-Bed Perchlorate 3-93
Figure 3.40 Fluidized-Bed Phosphorus 3-96
Figure 3.41 Fluidized-Bed Perchlorate, DO, and Nitrate 3-98
Figure 3.42 Fluidized-Bed Sulfate 3-99
Figure 3.43 Fluidized-Bed TOC 3-100
Figure 3.44 Fluidized-Bed BDOC 3-101
Figure 3.45 Fluidized-Bed pH 3-102
Figure 3.46 Fluidized-Bed Heterotrophic Plate Counts 3-103
Figure 3.47 Fluidized-Bed Total Coliforms 3-104
Figure 3.48 Fluidized-Bed Turbidity 3-105
Figure 3.49 SMBR Dissolved Oxygen 3-107
Figure 3.50 SMBR pH 3-108
Figure 3.51 SMBR Heterotrophic Plate Counts 3-109
Figure 3.52 SMBR Total Organic Carbon 3-111
Figure 3.53 Comparison of DBPFP THM4 Samples from Several Streams 3-119
Figure 3.54 Comparison of DBPFP HAA5 Samples from Several Streams 3-120

1.0 EXECUTIVE SUMMARY

1.1 Background

A 6-month study was performed to evaluate the effectiveness of ion exchange (IX) and biological processes for treating perchlorate-contaminated water from the Saugus aquifer. Three single-pass perchlorate-selective IX resins were evaluated at the bench-scale while fixed-bed biological reactors (FXBs) and fluidized-bed biological reactors (FBRs) were tested at the pilot-scale. These processes were chosen due to their ability to remove perchlorate from groundwater without generating a perchlorate-laden waste stream or brine that needs to be discharged.

1.2 Ion Exchange

Breakthrough of most anions from the IX resins occurred in the first 24 hours of run time. No chromatographic peaking was observed for any of the critical anions. Chloride breakthrough decreased from 325 mg/L to background concentrations (~35 mg/L) after 280 bed volumes. Perchlorate breakthrough (i.e., greater than 1 μg/L) occurred at 25,000 to 76,000 bed volumes (26 to 79 days). This translates to treated water volumes of 187,000 to 569,000 gal/cu-ft resin.

Contacting IX effluent with free and combined chlorine for 2- and 24-hour incubation periods produced no detectable (i.e., < 2 ng/L) N-nitrosdimethylamine (NDMA) concentrations for all three resins tested, indicating that NDMA precursors did not leach from the resins. When 2 mg/L of free chlorine was dosed to the IX feed water, effluent NDMA concentrations were below or just over the detection limit. To evaluate the NDMA precursor leaching potential of the resins, 100 mL batches of fresh resin were incubated for four hours in deionized water and groundwater. NDMA was detected in only one sample, which measured at less than half the 10 ng/L Action Level.

A California Total Threshold Limit Concentration (TTLC) analysis showed that metals were mostly non-detect in all three spent resins. Chromium, vanadium, and zinc were detected in two of the spent resins at levels significantly below the regulatory TTLC threshold concentrations. Uranium levels in the spent resin leachate were significantly below the Title 22 MCL of 20 pCi/L. To investigate whether the spent resins would be classified as hazardous for transportation to an incineration facility, a mass balance of the uranium adsorbed and desorbed from the resin up to 50 percent perchlorate breakthrough was performed. The amount of uranium accumulated on the spent resins is far below the lowest permissible reporting quantity and A-value of the California Department of Transportation.

1.3 Biological Filtration

Consistent perchlorate removal to below detection was achieved in the FXB filter using only organisms indigenous to the Saugus aquifer. With influent DO and nitrate concentrations of 7 and 15 mg/L, respectively, the lowest EBCT and acetic acid concentration that allowed consistent perchlorate removal to below detection was 15 minutes and 7.8 mg/L as carbon, respectively. Run times ranged from 24 hours to several days. Effluent from the FXB filter was biologically stable and contained no fecal coliforms. Challenge tests demonstrated that the FXB filter was robust with respect to backwashing episodes, changes in feed water quality, system shut-downs, and electron donor addition failures. Large step increases in feed nitrate concentration (e.g., 23 mg/L) required a period of bio-acclimation before perchlorate removal to below detection could be reestablished in the FXB filter.

Demonstration testing showed that a submerged membrane bioreactor (SMBR) can meet several post-FXB treatment objectives in a single step: 1) aeration, 2) biomass separation, 3) residual organic carbon removal, and 4) hydrogen sulfide removal.

The FBR did not achieve perchlorate removal to below detection over a period greater than 8 days, in spite of numerous mechanical and operational adjustments made to the system. However, testing did demonstrate that biological perchlorate removal can be achieved using indigenous microorganisms, a feature that had not yet been demonstrated for the FBR system. Because the FBR was not optimized, challenge testing was not performed.

Disinfection by-product formation potential (DBPFP) tests were performed using effluent from the FXB, FBR, and SMBR reactors. After 7 days of incubation with an excess chlorine residual, DBPs were formed in all three streams, though only the FBR stream produced DBPs exceeding the current MCLs of 80 μg/L total trihalomethanes (TTHMs) and 60 μg/L HAA5s. It should be noted that the FBR was not optimized prior to the DBPFP tests. Because the FBR feed acetic acid concentrations were higher than ultimately required, the FBR DBPFP tests are considered conservative. DBPs formed in all three streams consisted primarily of haloacetic acids (HAAs). Seven-day incubation of process effluents with combined chlorine produced only low levels of THMs and HAAs. A follow-up 72-hour simulated distribution system (SDS) DBP formation test was conducted on the FBR effluent. The SDS-THM4 and SDS-HAA5 concentrations were 40 μg/L and 23 μg/L, respectively.

To simulate DBP formation potential of FXB effluent that is post-treated at the Rio Vista Water Treatment Plant (WTP), a blend of 90 percent State Project Water (SPW) and 10 percent FXB effluent was ozonated and contacted with free or combined chlorine. Bromate was formed at concentrations ranging from 1.8 to 8.7 μg/L due to high bromide concentrations (200 μg/L) in the blended water. Aldehydes were formed at moderate levels, even in one sample that was spiked with 7.5 mg/L of acetic acid carbon prior to ozonation. High levels of THMs and HAAs were measured in the ozonated samples following a 7-day incubation with free chlorine. However, residual chlorine concentrations were excessive

during incubation and, more importantly, a large fraction of DBP precursors would likely be removed downstream of ozonation, prior to chlorination at the Rio Vista WTP. Seven-day incubation of ozonated water with combined chlorine generated only 23 μg/L TTHM4 and 12 μg/L HAA5.

2.0 INTRODUCTION

2.1 Overview

Castaic Lake Water Agency (CLWA) retained Carollo Engineers (Carollo) to screen available perchlorate treatment alternatives applicable to Saugus Aquifer water, test the most promising alternatives, and select a process train for predesign to treat perchlorate-impacted wells.

Carollo identified the following processes as potential treatment approaches for perchlorate:

- Conventional regenerable IX.
- "Throw-away" perchlorate selective IX.
- FBR biological filtration.
- FXB biological filtration.
- High-pressure membrane separation.

A desktop study was conducted to narrow the treatment alternatives. The benefits and issues related to each one of these approaches were presented at a workshop held at CLWA on February 3, 2003. During the workshop, participants from CLWA, member agencies (Newhall County Water District (NCWD), Valencia Water Company, and Santa Clarita Water Company), Carollo, and Kennedy/Jenks performed a process selection based on the following criteria:

- Effectiveness in treating other potential contaminants such as NDMA, HMX, RDX, TNT, etc.
- DHS approval (fast track implementation).
- O&M costs.
- Capital costs.
- Architectural, siting, and permitting issues.
- Robustness of the process.
- TDS and hardness removal ability.

Workshop participants performed a pair-wise comparison analysis to weight the relative importance of each criterion, and assigned criteria scores to each process. The following alternatives were recommended by the participants for bench and/or pilot testing.

- "Throw-away" perchlorate selective IX.
- FBR biological filtration.
- FXB biological filtration.

These alternatives were selected because they can treat perchlorate with minimal production of perchlorate-laden liquid waste or brine that needs to be discharged.

2.2 Project Objectives

The overall goal of bench and pilot testing at the CLWA was to develop design parameters for a treatment facility that is capable of removing perchlorate to below the action level (AL) at affected Santa Clarita Valley wells. The AL in the State of California is currently 4 µg/L. The method detection limit (MDL) used by the CLWA lab was 1 to 4 µg/L and the minimum reporting limit (MRL) for the standard analytical method (EPA 314.0) is currently 4 µg/L.

The specific objectives of this work were to:

1. Compare the perchlorate removal performance of three commercially available and NSF certified perchlorate-selective IX resins using water from the Saugus Aquifer under identical operational conditions by running a parallel bench-scale flow-through column test.
2. Determine the NDMA formation potential of the three IX resins when subject to pre- or post-chlorination at the bench-scale.
3. Determine characteristics of the spent IX resins.
4. Demonstrate the efficacy of FBR and FXB treatment for perchlorate removal from Saugus aquifer water (i.e., show consistent removal of perchlorate to below the MRL of 4 µg/L).
5. Verify that sufficient perchlorate-reducing biological activity can be developed in the pilot-scale reactors using microorganisms indigenous to the Saugus Aquifer.
6. Using pilot-scale FBRs and FXBs, develop full-scale design criteria for empty-bed contact time (EBCT), backwashing procedures, electron donor (acetic acid) addition, and nutrient addition.
7. Evaluate the robustness of the fluidized- and FXB biological process with respect to system upsets, such as electron donor feed failure, process shutdowns, and changes in the feedwater oxidant concentrations.

8. Compare overall process performance between a FXB and FBR configuration.

9. Demonstrate the efficacy and robustness of the FBR's on-line perchlorate analyzer in comparison to other laboratories.

10. Prepare planning-level capital and O&M cost analyses for biological- and IX-based treatment facilities to be incorporated in the pre-design report.

11. Determine post-treatment requirements for the IX, FBR, and FXB perchlorate removal processes (i.e., characterize process effluent quality and disinfection by-product formation potential).

3.0 BACKGROUND AND TEST SITING

3.1 Test Approach and Siting

The preliminary test program included two main testing protocols:

- Bench-scale IX testing using three perchlorate selective resins.
- Pilot-scale biological testing using two system configurations.

The perchlorate selective resins have a high capacity for perchlorate adsorption and depending on the influent perchlorate and sulfate concentrations, may experience extensive run-times to reach perchlorate breakthrough (i.e., perchlorate > 4 µg/L). To simplify testing logistics, IX testing was conducted at the bench-scale. The test was carried out in the chemical building at the Rio Vista WTP. This site also served as the pilot-scale testing site. Bench-sale IX data are readily scaleable. Factors considered in scaling-up the bench test are water quality, bed volumes until perchlorate breakthrough, EBCT, and separation factors specific to the selected resin. The controlling factor of the contaminants' diffusion into the resin matrix is the selectivity of the resin's positively charged quaternary amine functional group for a specific anion relative to the chloride anion. The order of elution of ions from the resin is determined solely by the selectivity sequence. The species exit the column in reverse preferential order, with the less preferred ions (smallest separation factors) emerging first. Other factors include charge of ion, valence of ion (mono- or divalent), and other resin-specific physical factors.

While the effectiveness of treating perchlorate using biological processes has been demonstrated extensively at the bench-scale, the scalability of these processes is not well established. This project evaluated the removal of perchlorate from Saugus Aquifer water using two pilot-scale biological system configurations (FXB and FBR).

3.2 Feed Water

Perchlorate-contaminated wells were not used for testing due to the complications and costs associated with the discharge requirements and the need for an extensive analysis of influent and effluent waters. Instead, a perchlorate-free operational well (NC-12) located near one of the perchlorate contaminated wells (NC-11) was used as feed water for both bench- and pilot-scale systems. Perchlorate was spiked to achieve a final target concentration of 50 µg/L for most of the study. NC-11 and NC-12 draw water from the Saugus Aquifer and have comparable raw water quality (chemistry). Sulfate was spiked to the feed of the ion-exchange unit to achieve a final target concentration of 300 mg/L. This mimics the highest average sulfate concentration measured in Saugus wells. Sulfate is a critical parameter in the ion-exchange process since it competes with the perchlorate ion. NC-11 and NC-12 were sampled and characterized in February and March 2003, respectively (Table 3.1). NC-12 well water was transferred to four 6,500-gallon storage tanks located outside the chemical building at the Rio Vista WTP via a 6,000-gallon stainless steel tanker truck which was filled at the well site and transferred to the pilot site. The tanker used for transferring the raw feed water was washed with hot water or a caustic solution and then rinsed prior to use, to ensure no impact on the raw water quality. The water stored in the baker tanks at the site was delivered to the test equipment via Schedule 80 PVC. To maintain a consistent water temperature, feed flows were routed through an ITT Standard heat exchanger, Model SX200. The water was used at a rate varying from 2,900 to 5,800 gallons per day (2 to 4 gpm).

Table 3.1 Water Quality Parameters in the Groundwater at Newhall 11 and 12 Wells Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

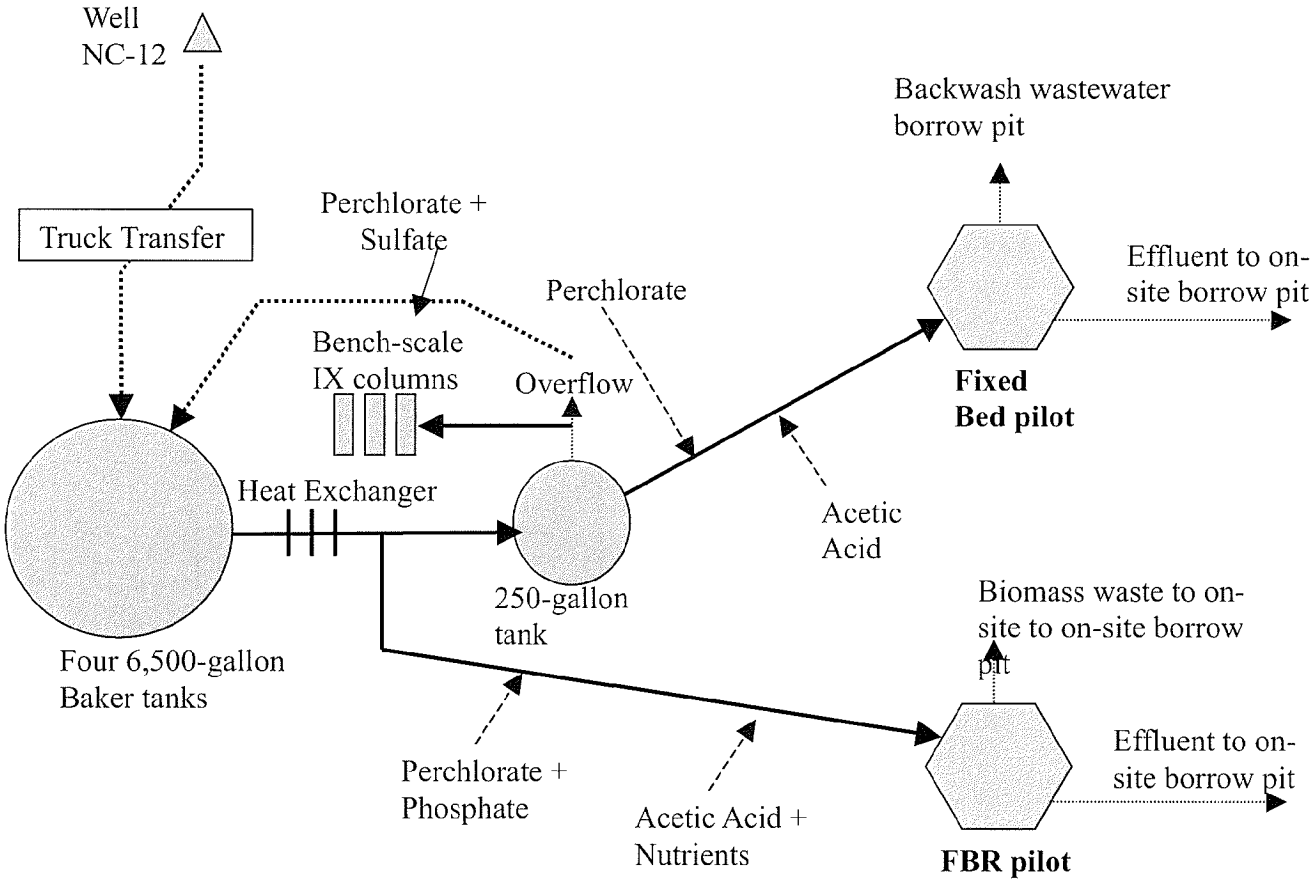
Parameter	Units	NC-12 (March 2003)	NC-11 (Feb 2003)	NC-11 (Historic)
Perchlorate	µg/L	ND[1]	17-20	13-23
Nitrate-NO_3^-	mg/L	14.6	18-20	14-30
Sulfate	mg/L	131	309-330	255-443
Bicarbonate	mg/L	199	220	232-235
Chloride	mg/L	38	28	29-38
Alkalinity	mg/L as $CaCO_3$	163	180	182-280
pH	–	7.5	7.4	7.5-7.7
Conductivity	µhom/cm	846	1,120-1,138	980-1,116
Temperature	degrees C	19	16	
Uranium	pCi/L	0.679	2.887-4.368	NA

Table 3.1	Water Quality Parameters in the Groundwater at Newhall 11 and 12 Wells Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency			
Parameter	**Units**	**NC-12 (March 2003)**	**NC-11 (Feb 2003)**	**NC-11 (Historic)**
Arsenic	µg/L	1.3	<1.0-1.0	<2.0-2.0
TOC[2]	mg/L	<0.7	2.0[3]	N/A[4]

Notes:
(1) Not detected.
(2) Total Organic Carbon.
(3) After approximately three hours of flushing.
(4) Not available.

A process flow schematic for bench- and pilot-testing is provided in Figure 3.1. The water was pumped from the four 6,500-gal tanks to a 250-gallon tank inside the building. The flow was then split two ways into the FXB and the FBR pilots. Schedule 80 PVC was used to hard pipe the baker tank to the feed pump of each biological pilot skid. Perchlorate stock solution was prepared as necessary by spiking reagent grade sodium perchlorate (Fischer Scientific, Hanover Park, Illinois) to 1 liter of deionized, distilled water from the CLWA laboratory. Peristaltic pumps (Ismatec, Northbrook, Illinois) dosed the perchlorate stock solution near the front end of each pilot feed line for adequate mixing. Perchlorate was dosed independently to each pilot skid to maintain flexibility in the pilot testing protocol. For example, using this configuration, perchlorate spiking tests were applied to one pilot without having to be applied to the other. Technical-grade acetic acid (Eastman Chemical Company, Kingsport, Tennessee) was used as the stock electron donor solution and dosed to the pilot feed lines just before entry to the biological reactors using a peristaltic pump. This acetic acid is undergoing ANSI/NSF 60 certification, which should be completed by the mid-2004. ANSI/NSF 60 - certified, food-grade phosphoric acid (Prayon, Inc., Augusta, Georgia) was also dosed to the pilot feed lines using peristaltic pumps. For the FBR system, a micronutrient mixture was added to the phosphoric acid solution for selected tests. The micronutrient mixture contained trace amounts of iron, copper, magnesium, manganese, zinc, boron, sulfur, molybdenum, and cobalt. The main PVC feed pipes were fitted with a static mixer downstream of the chemical injection points.

For the bench-scale IX tests, water was collected from the pilot feed tank in two 55-gallon tanks (approximately 1 week's supply). The tanks were filled from the overflow line of the 250-gallon tank. A 1,000-mg/L perchlorate stock solution was prepared by adding reagent-grade sodium perchlorate salt to distilled deionized water obtained from the CLWA laboratory. This solution was spiked directly into the containers to result in a final concentration of 50 µg/L. Additional sulfate was also added to the containers by dissolving reagent sodium sulfate (Na_2SO_4) in distilled-deionized water to reach a final sulfate concentration of 300 mg/L.



PROCESS FLOW SCHEMATIC FOR BENCH- AND PILOT-SCALE TESTING

FIGURE 3.1

3.3 Discharge Streams

All process effluents (i.e., bench-scale effluent, pilot-scale effluents, and backwash wastewater) were pumped to a borrow pit on the Rio Vista plant site. The discharge waters were first directed to off-site GAC drums to remove any residual perchlorate prior to ultimate disposal in the borrow pit. The backwash water from the pilot-scale systems was first directed to a 100-gallon drum to allow for settling, and the decant wastewater was then directed to the feed of the GAC drums. The effluent stream from the GAC drums was analyzed for perchlorate once per week. Additional tanks with approximately 300 pounds of Virgin GAC were installed before the discharge point to treat any perchlorate that may be present in the effluents. If perchlorate was detected in the GAC effluent, the spent GAC was removed and replaced with virgin GAC. The borrow pit has no surface discharge and allows negligible percolation due to the presence of a heavy clay soil lining. There was no discharge to the sewer system or Santa Clara River. Spent resins were sent to a certified laboratory for further characterization and disposal.

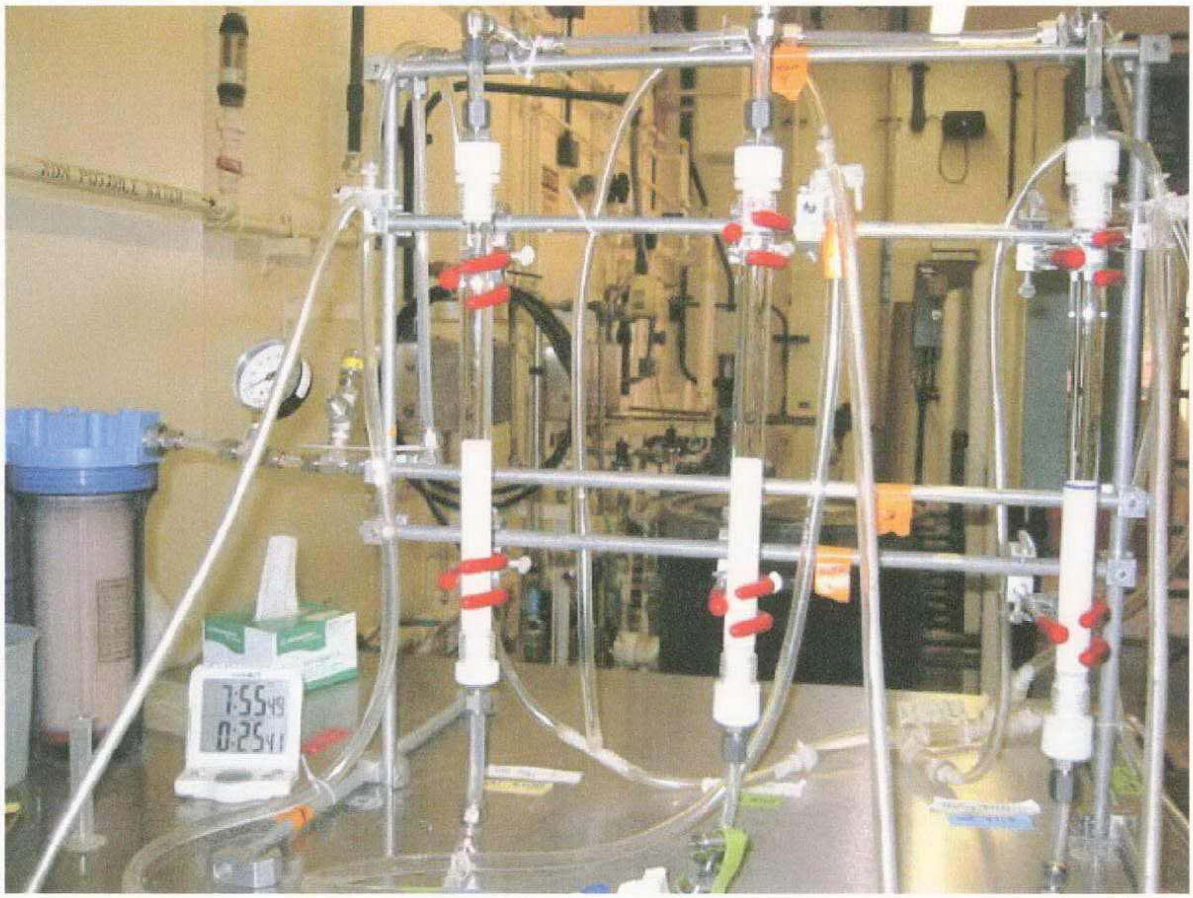
4.0 EQUIPMENT DESCRIPTION AND CAPABILITIES

4.1 Ion Exchange

4.1.1 Bench-Scale Flow-Through Column Testing Unit

A bench-scale flow-through column apparatus was used to evaluate the removal of perchlorate and other anions by IX (Figures 3.2 and 3.2(a)). This equipment was used to determine performance and cost data for three commercially-available perchlorate-selective, IX resins.

Three glass columns were set up to run in parallel, each with a different resin. The columns are 15 mm in diameter, 30 cm in length, and were filled to a depth of 12.7 cm with resin media (22.5 mL of resin). The media was supported with stainless steel screens. Each column was first half-filled with distilled water. Resin was then added from the top and allowed to settle to the bottom of the column. Resin was added until the settled resin level reached the 12.7-cm mark. Resin was added with excess water in the column to prevent the formation of air-gaps in the packed resin. Once the full amount of resin was added, the column was filled with distilled water. An in-line pre-filter (9.824-inch Osmonics Flotrex-GF pleated 3.0 μm absolute Model FGF031AAS) was installed after the feed pump to remove suspended material from the feed water. To monitor headloss, pressure gauges were installed upstream and downstream of the filter housing unit, and pressure relief valves were used to prevent pressure build-up. A three-way valve was also installed in the effluent line to provide a location for manual sampling.



BENCH-SCALE FLOW-THROUGH ION EXCHANGE EQUIPMENT

FIGURE 3.2

20-CLWA204F3.2-6625A10.CDR

carollo engineers

CASTAIC LAKE WATER AGENCY

BENCH-SCALE COLUMN SETUP AND AUTOSAMPLERS

FIGURE 3.2(a)

The columns were set up to run in parallel such that perchlorate spiked water was delivered from the two 55-gallon storage tanks to the head of the columns using an LMI model QG 400 piston lab pump. Flow-rates from each column were measured using a stopwatch and a 5-mL graduated cylinder. Volumetric measurements were taken on a daily basis. The flow was adjusted as necessary using a needle valve located at the effluent of each column. Timed effluent water samples were collected by autosamplers (leased from ISCO, Lincoln, Nebraska) during the first week of testing. The autosamplers were used to collect a one-hour composite batch from each column over a period of 24 hours. This process was repeated over the entire first week. The sampling intervals were determined from modeling results provided by the resin suppliers and/or generated by IX Pro Software using the Saugus water quality and separation factors associated with a perchlorate-selective resin as inputs.

4.1.2 Resins

There are several commercial resin manufacturers/suppliers. Based on the raw water quality in the Saugus Aquifer (i.e., perchlorate, sulfate, nitrate, TDS) and the lack of a dedicated line for disposing spent brine produced from conventional ion-exchange systems, perchlorate-selective, throw-away ion-exchange resins were selected for further evaluation using bench-scale testing. The following three resins were tested in parallel based on the availability for use in packaged systems, vendor recommendations and applicability to treating Saugus groundwater based on modeling results:

- US Filter K-9710 (US Filter Corporation, Rockford, Illinois): USF K-9710 is a strong base quarternary amine macroporous anion resin consisting of a styrene divinylbenzene matrix. The resin was tested at the Edwards Air Force Base. This resin, which received on NSF-61 certification in July 2003, can be supplied directly through a system manufacturer (e.g., US Filter, Calgon Carbon). A full-scale system using this resin is operational in the City of Rialto, California. The resin has a unique dual functionality exhibiting very high selectivity for oxy anions, such as perchlorate and pertechnate, that allows for efficient removal in a relatively high TDS background. US Filter recommends the use of this resin for single pass applications.

- Calgon Carbon Cal Resin 2 Resin 2100 Series (Calgon Carbon Corporation, Pittsburgh, Pennsylvania): This resin consists of a trimethylamine functionalized, chloromethylated copolymer of styrene and divinylbenzene in the chloride form. DHS approved packaged treatment systems are located at the City of Riverside and at California Domestic Water Company. Cal 2100 Series resins are NSF certified (NSF/ANSI Standard 61) through WQA.

- US Filter K-9708 resin (US Filter Corporation, Rockford, Illinois): USF K-9708 is a strong base quarternary amine macroporous anion resin consisting of a styrene divinylbenzene matrix. The resin has a special functionality which exhibits high

selectivity for perchlorates and nitrates over sulfates. This selectivity allows the resin to remove perchlorates and nitrates preferentially over sulfates with no potential for perchlorate or nitrate dumping. The resin is initially in the chloride form. USF K-9708 is an NSF-certified resin.

4.1.3 Autosamplers

During the first week of testing, sample collection from each column was automated using 3700 Portable Isco autosamplers (Isco, Inc., Lincoln, NE). Effluent samples were drawn every hour from 2-L glass Erlenmeyer flasks into the custom-fit polypropylene bottles located within the autosampler. Selected samples were stored at 4 degrees C in amber glass bottles until they were analyzed by CLWA or MWH laboratories. Samples were preserved by laboratory personnel with the exception of TOC/DOC samples for which 8 drops of 50 percent HCl were added on site to reduce the pH to less than 2.

During the remainder of the weeks, samples were manually collected by allowing the effluent to flow directly into the sampling bottles using three-way valves.

4.1.4 NDMA Formation Potential Testing

Bench-scale NDMA formation potential tests were conducted during the later phases of the ion-exchange testing. Post-chlorination testing with free and combined chlorine was conducted on each column effluent, as well as pre-chlorination testing with free chlorine. In addition, resin leaching testing in groundwater and DI water without the addition of chlorine was conducted for baseline comparison.

4.1.4.1 Post-Chlorination Testing with Free Chlorine

A 2,000 mg/L free chlorine stock solution was prepared from a 17,000 mg/L hypochlorite solution provided by CLWA. Two 1-L samples were collected from each column effluent. A 1-mL volume of chlorine stock solution was added to each of the bottles, resulting in a 2 mg/L free chlorine dose. The bottles were incubated for 24 hours in the dark under ambient room temperature. Free chlorine residuals were measured after 2 hours of incubation and after 24 hours of incubation. Samples were sent to MWH Laboratories for NDMA analysis. All chlorine stock solutions, doses, and residuals were measured on-site using a Hach DPD field test kit.

4.1.4.2 Post-Chlorination Testing with Chloramines

An ammonium chloride stock solution was prepared by dissolving 1.9 g of reagent-grade anhydrous NH_4Cl (also provided by CLWA laboratory) in 500 mL water. A chlorine:ammonia-N ratio of 4.0 on a weight basis was used (i.e., 2 mg/L chlorine and 0.5 mg/L ammonia-nitrogen) and 2-hour and 24-hour incubation periods were used as described above. Free and total chlorine residuals were measured in the bottles at the end of the incubation period. Bottles were sent to MWH Laboratories for NDMA analysis.

4.1.4.3 Pre-Chlorination Testing with Free Chlorine

Toward the end of the study, a 2 mg/L free chlorine dose was added to the 55-gallon drum, which fed the IX columns. Two samples were collected over a 4-day time period from each column effluent for NDMA analysis. Free chlorine residuals were measured in the bottles.

4.1.4.4 Fresh Resin Batch Testing

To evaluate the leaching potential of fresh resin, approximately 100 mL of fresh resin was added to 1 L of DI water and 1 L of feed groundwater. Bottles were allowed to incubate for a period of 4 hours. Samples were shipped to MWH Laboratories for NDMA analysis.

4.1.5 Spent Resin Characterization

TTLC and Soluble Threshold Limit Concentration (STLC) are used when determining the hazardous waste characterization of a substance under California State regulations as outlined in Title 26 of the California Code of Regulations (CCR). The three spent resins were shipped to MWH Laboratories (TTLC analyses were subcontracted to Columbia Labs in Canoga Park, California) for the following characterizations:

- TTLC Analysis for CAM 17 Metals (in California): This analysis determines the total concentration of each target analyte in a sample. Resin samples were homogenized and 5 grams of each sample were digested and analyzed for the TTLC metals according to standardized EPA methods (EPA Methods 6020 for most metals, 6010B for cooper, lead, and zinc, and 7471A for mercury). When any target analyte exceeds the TTLC limits (Table 3.19 in the Results Section), the waste is classified as hazardous and its waste code is determined by the compound(s) that failed TTLC. The results of this analysis can be used to determine if analysis for STLC level is necessary by comparing 10 times the STLC limit to the TTLC results. A factor of ten is necessary to compensate for a 1:10 dilution factor that is present in one analysis but not the other. If the TTLC results do not exceed 10 times the STLC limit, then normally no further STLC analysis is required.

- STLC Analysis for Perchlorate, Nitrate, and Uranium: This analysis determines the amount of each analyte that is soluble in the "Waste Extraction Test" (WET) leachate. This WET leachate procedure is used for solid samples or for samples containing more than 0.5 percent solids. The sample is tumbled in 10 times its weight of a 0.2 M sodium citrate buffer for 48 hours.

- Approximately 100 mL of STLC extract was obtained from each resin sample. These extracts were returned to MWH Labs for analysis of perchlorate, nitrate, and radioactive uranium.

4.2 Biological Fixed-Bed Filter

4.2.1 Pilot Skid

A photo of the FXB granular media filtration skid is provided in Figure 3.3. Important process components are identified.

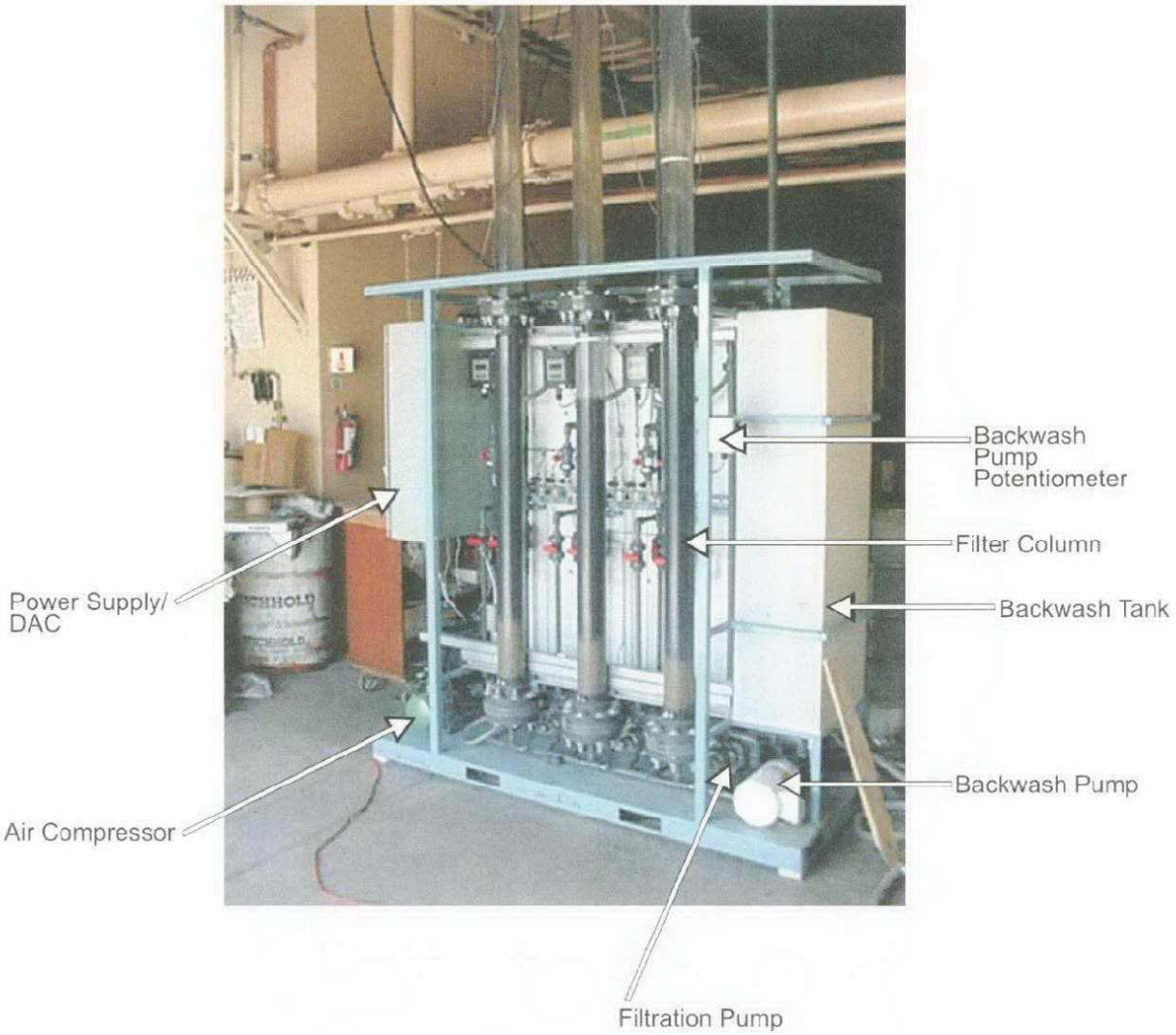
Design criteria and technical specifications for the FXB biological filtration skid are provided in Tables 3.2 and 3.3, respectively.

Table 3.2 Fixed-Bed Filter Design Criteria
Treatment of Perchlorate Contaminated Groundwater
from the Saugus Aquifer
Castaic Lake Water Agency

Parameter	Value/Description
Filter dimensions	4" diameter, 14' tall
Number of filters per skid	3
Number of independent feed pumps	3
Maximum flow per filter	1.5 gpm
Hydraulic loading rate	2-17 gpm/ft^2
Media support mechanism	Retention plate
Backwash type	Air and/or water
Air supply	On-board compressor (with 5 μm filter)
Backwash water tank volume	20 gallons
Parameters measured by in-line meters	Flow Effluent turbidity Effluent particle counts Headloss across the filters

Table 3.3 Fixed-Bed Filter Technical Specifications
Treatment of Perchlorate Contaminated Groundwater
from the Saugus Aquifer
Castaic Lake Water Agency

Parameter	Value/Description
Skid weight	750 lbs
Skid dimensions (LxWxH)	6'6"x2'6"x14'
Electrical requirements	3-phase, 30A, 208-Volt, AC power (Y connection)
Influent, effluent, overflow connections	1" Cam Lock



FIXED-BED BIOLOGICAL FILTRATION PILOT PLANT

FIGURE 3.3

A schematic of the FXB pilot is shown in Figure 3.4. The FXB skid is configured for down-flow operation. Initially, all three columns on the skid were utilized for pilot testing.

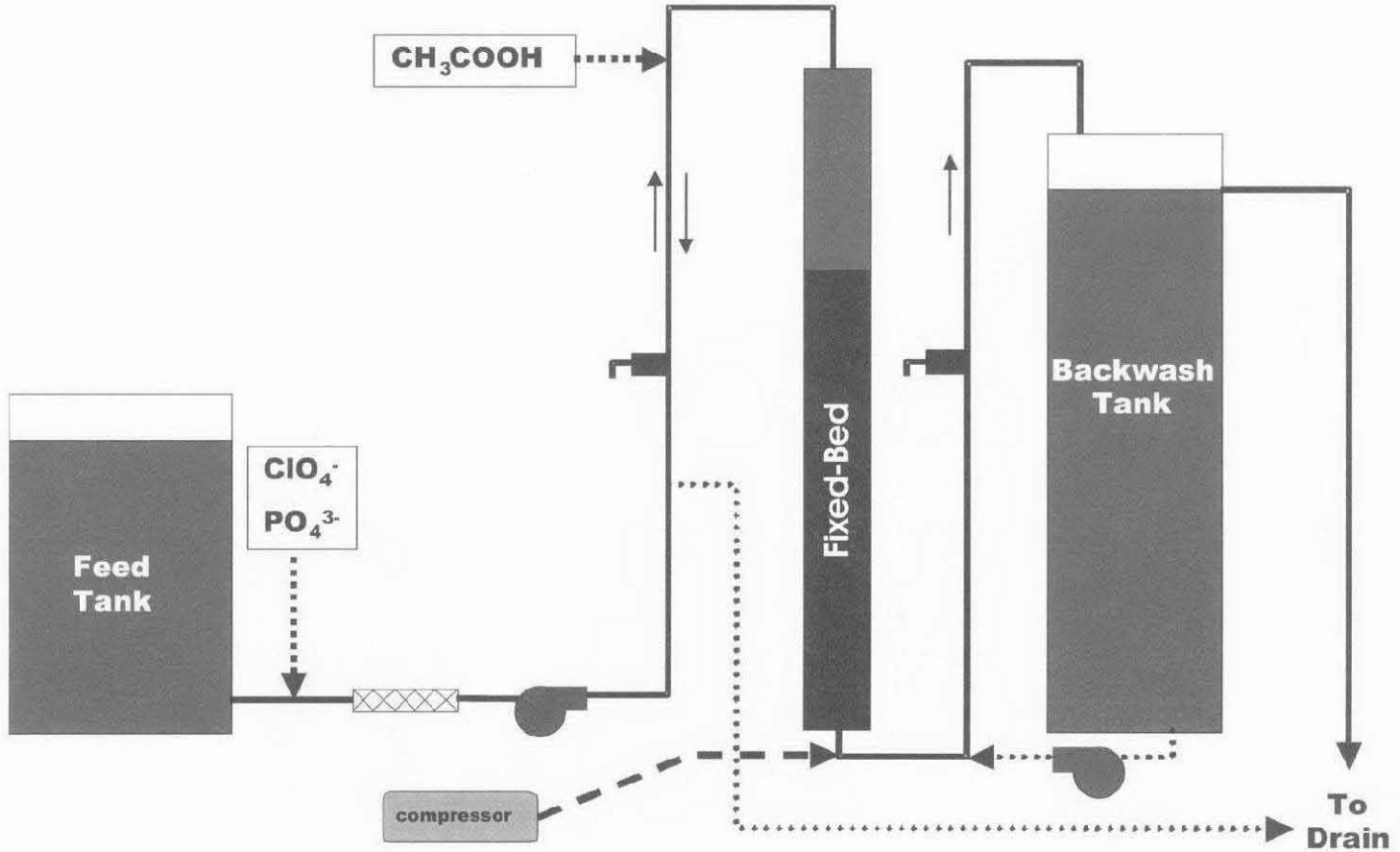
However, because sampling and other daily pilot tasks required for three columns were too onerous for a single operator, two of the columns were shut down one month into the piloting period. Stock perchlorate and (temporarily) phosphate solutions were added upstream of an in-line static mixer using an Ismatec ISM 832B two-channel eight-roller peristaltic pump together with Pharmed 0.020-inch ID peristaltic pump tubing. A second head was added to the peristaltic pump to add acetic acid to the system. Initially, acetic acid was also added at the same location as the perchlorate stock solution. However, excessive growth in the feed lines prompted a relocation of the acetic acid feed to the top of the column one month into the piloting period. Filter effluent turbidity and particle counts were monitored continuously by dedicated turbidimeters and particle counters. A pressure transducer mounted on the pilot skid monitored head loss development across the filter; backwashes, which could include air scour, were initiated manually. The pilot skid is equipped with a data acquisition and control (DAC) system, which stores and manages data. For each filter column, the DAC continuously logs date/time, flow, headloss, effluent turbidity, and effluent particle counts. The skid includes a touch screen interface to monitor and control pilot operations.

4.2.2 Media

The columns were filled to a depth of 7 feet (approximately 0.6 ft^3) with virgin Calgon F-400 granular activated carbon (GAC). This allowed for bed expansion up to 50 percent. F-400 is a bituminous-based carbon commonly used in the United States. The GAC was stored overnight in 5-gallon buckets to wet the surface and internal pores. The filter columns were filled with NC-12 well water and the GAC was dosed slowly into the columns until the 7-foot depth was reached. Once the columns were packed with GAC, they were backwashed for a period of 24 hours at a 45 percent bed expansion to remove carbon fines from the GAC bed.

4.2.3 Stock Solutions

For the biological pilot systems, an intermediate stock perchlorate solution of 136.17 g/L ClO_4^- was made using reagent grade sodium perchlorate salt and distilled deionized water. Individual stock solutions were made as necessary in 2-L glass bottles using the intermediate stock solution. During periods where phosphorus was added to the feed stream, 75 percent pure food-grade phosphoric acid was added directly to the perchlorate stock solution. For the acetic acid stock solutions, technical-grade acetic acid (Eastman Chemical Company, Kingsport, Tennessee) was used. Stock solutions were stored in 2-L glass bottles that were flame sterilized using ethanol.



FIXED-BED BIOLOGICAL FILTRATION PILOT SCHEMATIC (NOT TO SCALE)

FIGURE 3.4

4.3 Biological Fluidized-Bed Reactor

4.3.1 Pilot Skid

The basic components of the pilot FBR system included the bioreactor, bed height control component (when required), biomass separator, a fluid distribution system at the bottom of the reactor, a feed pump, and chemical feed systems (Figure 3.5). The bed of GAC media is hydraulically fluidized to reduce its resistance to flow and to improve substrate/biomass contact by directing liquid flow upward into the bed. The fluidization rate is controlled to maintain a 25 to 30 percent bed expansion over the resting bed height. Feed flow is supplemented with recycle flow to provide the appropriate up-flow velocity for fluidization. When biofilm growth occurs on the GAC media, the particle diameter increases and the effective density of the particle decreases, which causes further expansion of the bed. It is necessary to manage film thickness to control or prevent bed carryover. In full-scale FBR systems, bed height is managed in the top portion of the bed by mechanically shearing the biomass from the GAC through a valve. The "cleaned" GAC particles settle back into the bed, ready to support more biofilm growth, and the sloughed biomass is discharged. In the pilot test unit, mechanical mixing or pump shear was used to perform this task.

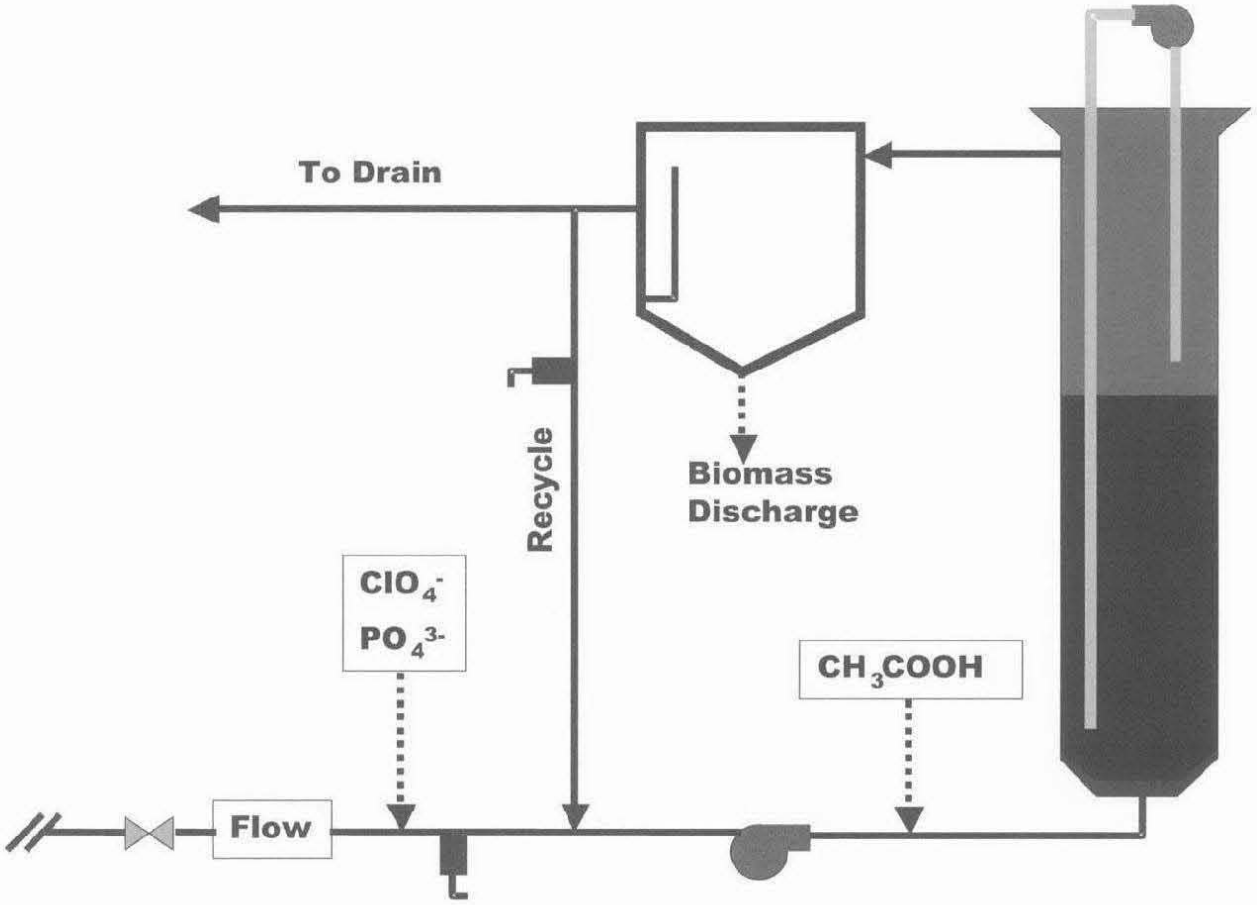
Perchlorate and phosphorous stock solutions were added directly to the feed line upstream of the recycle line connection using a diaphragm metering pump. A second diaphragm metering pump was used to add acetic acid stock solution to the feed line. Initially, the acetic acid was injected just prior to the feed pump, but was later moved closer to the bioreactor to minimize biofouling in the feed lines.

4.3.2 Media

The FBR bioreactor uses a proprietary coconut shell based carbon that meets Shaw Environmental-Envirogen specifications for hardness, apparent density, effective size, iodine number, and uniformity coefficient.

4.3.3 Stock Solutions

For the biological pilot systems, an intermediate stock perchlorate solution of 136.17 g/L ClO_4^- was made using reagent grade sodium perchlorate salt and distilled deionized water. Individual stock solutions were made as necessary in 2-L glass bottles using the intermediate stock solution. Food-grade phosphoric acid (Prayon, Inc., Augusta, Georgia) was added directly to the perchlorate stock solution. Acetic acid stock solutions were prepared using technical-grade acetic acid (Eastman Chemical Company, Kingsport, Tennessee) and were stored in a 10-L polypropylene carboy. Before stock solutions were prepared, these carboys were rinsed with rubbing alcohol for sterilization. For selected tests, a micronutrient mixture (GrowMore, Gardena, California) was added directly to the acetic acid stock solution. The micronutrient mixture contained trace amounts of iron, copper, magnesium, manganese, zinc, boron, sulfur, molybdenum, and cobalt.



FLUIDIZED-BED BIOLOGICAL FILTRATION PROCESS SCHEMATIC (NOT TO SCALE)

FIGURE 3.5

4.4 Submerged Membrane Bioreactor

4.4.1 Objectives

Zenon Zeeweed® membranes, operating in an SMBR configuration, were evaluated as an alternative combined treatment step for post-treatment of effluent from the biological filtration process. The post-treatment process must achieve four treatment goals:

1. Aeration: Since biological perchlorate reduction requires anaerobic conditions, DO must be supplied during the post-treatment process.

2. Residual Organic Carbon Removal: Organic substrate is added to the FXB to achieve perchlorate reduction. Therefore, to prevent regrowth problems and to minimize the formation of DBPs, the effluent water must be stabilized biologically.

3. Sulfide Removal: Under anaerobic conditions, sulfate can be reduced to sulfide, which generates a rotten-egg odor. Therefore, the post-treatment process must be able to remove sulfide, which can be accomplished via biological oxidation or air stripping.

4. Biomass Separation: The post-treatment process must provide a barrier for removal of biological matter (HPC bacteria) that sloughs from the biological filters.

4.4.2 System Description

The ZeeWeed® water treatment process is a proprietary ZENON process technology that involves the production of treated water by drawing water through ZeeWeed® "outside-in" hollow fiber membranes that are immersed in the feed water. The ZeeWeed® ultrafiltration membranes have nominal and absolute pore sizes of 0.04 and 0.10 mm, respectively. The membranes act as a physical barrier that prohibits particulate matter exceeding 0.1 μm in size, including *Giardia* cysts and *Cryptosporidium* oocysts, from entering the treated water supply. The small pore size ensures the removal of a high percentage of impurities, including some viruses (typically 2 to 4.5 log reduction), which are removed by a combination of adsorption onto the solids in the process tank and membrane filtration.

The ZeeWeed® membrane filtration system operates under a low-pressure vacuum that is induced within the hollow membrane fibers by a connection to the inlet (suction) side of a centrifugal permeate pump. The treated water is drawn through the membrane by vacuum, enters the hollow fibers and is pumped out to distribution by the permeate pumps. Airflow is introduced at the bottom of the membrane module to create turbulence that scrubs and cleans the outside of the membrane fibers. This reduces the solids accumulation on the membrane surface, thereby allowing the membrane to operate for extended periods at high permeate fluxes. The air also has the beneficial side effect of oxidizing iron and other organic compounds that may be present. It also provides mixing within the process tank to maintain solids in suspension. The membranes are periodically backwashed which consists

of passing permeate through the membranes in the reverse direction to dislodge solids from the membrane surface.

The ZeeWeed® Ultrafiltration system provides a single step process, effectively replacing both the clarification and granular media type (sand) filtration processes found in conventional water treatment plants. The membrane pore size is extremely small and effectively provides a physical barrier to solids present in the water. Therefore, there is no need to create flocculated particles that are large enough to settle in clarifiers or large enough to be captured by granular media filters. Also, as the membranes are immersed directly in the process tank and under only low vacuum, high levels of suspended solids do not foul the membrane.

The ZeeWeed® membranes, operating in an MBR configuration, were considered in this case as an alternative combined treatment step for post-treatment of the effluent from the biological filtration processes. Post-treatment has three main purposes:

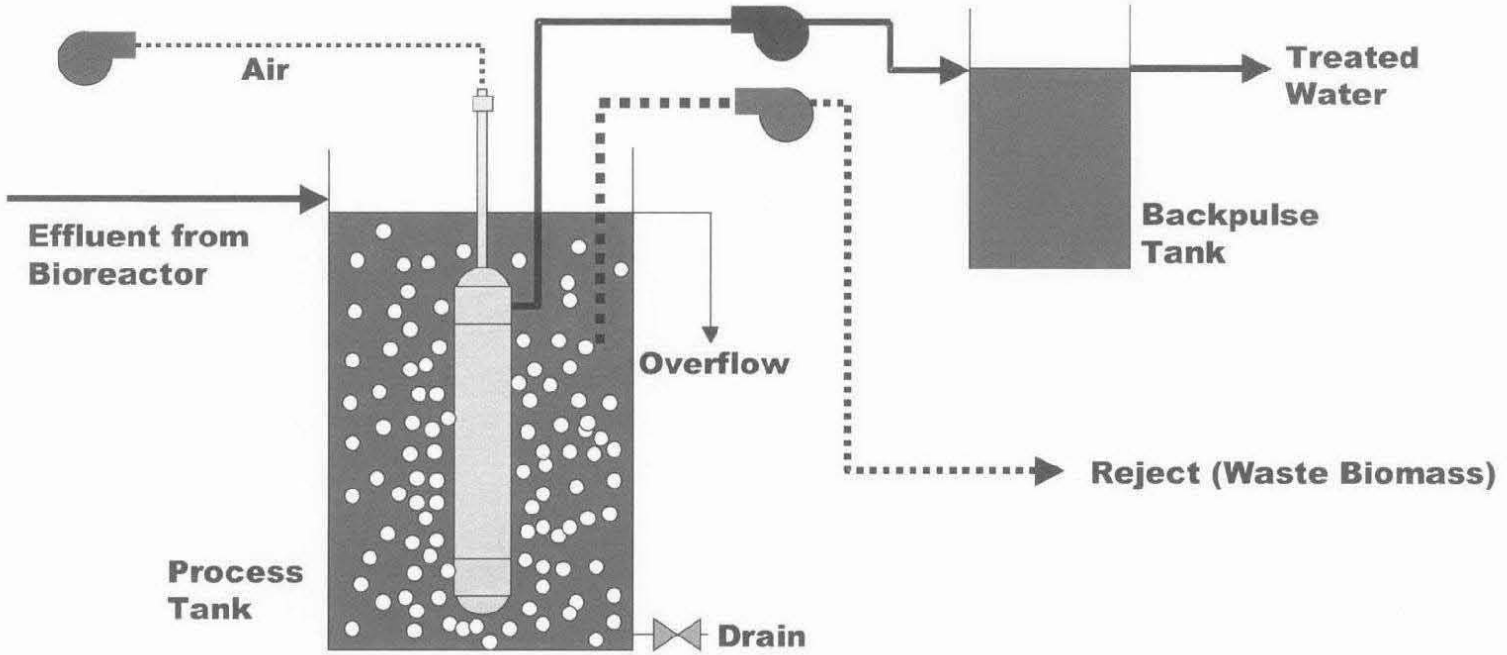
- To provide biological oxidation of excess substrate (acetic acid) fed to the filters;
- To re-oxygenate the water; and
- To provide a barrier for removal of biological matter (HPC bacteria) present in effluent from the biological filters.

A flow schematic for the ZeeWeed®-based post biological FXB filtration process is presented in Figure 3.6.

4.4.3 System Components and Specifications

The unit is equipped with:

- Coagulant Feed Pump and Chemical Tank.
- Cleaning Chemicals.
- Process Tank (hydraulic retention time is 3 to 5 hours).
- Membrane Air Scour Blower.
- Dual head, variable speed, reversible, metering pump for permeate and reject.
- One ZeeWeed®-10 Ultrafiltration Membrane.
- Backpulse Tank.
- Instrumentation and Control Panel.



POST-FXB TREATMENT MBR SCHEMATIC (NOT TO SCALE)

FIGURE 3.6

ZW-10 module and system specifications are listed in Tables 3.4 and 3.5, respectively. Table 3.6 lists system operating limits.

Table 3.4	**SMBR ZW-10 Module Specifications Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency**
Model	ZW-10, Submersible Module
Configuration	Outside/In Hollow Fiber
Dimensions (length x width x height)	6'x4'x5'
Nominal Membrane Surface Area	0.93 m^2 (10 ft^2)
Absolute Pore Size	0.1 micron
Weight of Module (Drained)	1.9 kg (4.2 lb)
Weight of Module (Wet)	2.1 kg (4.6 lb)
Permeate (Fiber Side) Hold-up Volume	0.13 liters (0.033 gal)

Table 3.5	**SMBR ZW-10 System Specifications Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency**
Designation	ZW-10 Bench Test Unit
Electrical service required	115 V, 60 Hz, 2A
Process tank total volume	220 L (58 usg)
Process tank working volume, nominal	190 L (50 usg)
Backpulse tank total volume	20 L (5 usg)
Backpulse tank working volume	15 L (4 usg)
Shipping weight	75 kg (160 lb)
Operating weight	300 kg (660 lb)
Process tank size (with backpulse tank)	75 cm Ø x 160 cm H (30"Ø x 60" H)
Process pump size	40 cm x 15 cm x 15 cm (16" x 6" x 6")
Blower size	40 cm x 25 cm x 25 cm (16" x 10" x 10")
Control panel size	38 cm x 38 cm x 20 cm (15" x 15" x 8")

Table 3.6 SMBR ZW-10 System Operating Limits Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency	
Maximum pump capacity	2 liters/minute (0.53 gpm)
Maximum Transmembrane Pressure	62 kPa (9.0 psig) @ 40°C (104°F)
Typical Operating TMP	10-50 kPa (1.0-7.0 psi) @ 40°C (104°F)
Maximum Operating Temperature	40°C (104°F)
Operating pH range	5-9
Maximum Cleaning Temperature	40°C (104°F)
Cleaning pH Range	2-10.5
Maximum OCl^- Exposure(1)	1,000 mg/L
Maximum TMP Back Wash Pressure	55 kPa (8.0 psi)
Maximum Aeration Flow per Module	3.6 m^3/h (2 scfm)

Notes:
(1) Higher OCl^- concentrations can occasionally be used.

4.5 DBP Formation Potential Testing

4.5.1 Source Waters

DBPFP is defined as the difference between the TTHM or HAA concentration after 7 days of incubation with excess free or combined chlorine residual and the initial TTHM or HAA concentration. Free chlorine and combined chlorine DBPFP tests were conducted using the following source waters:

- FXB and FBR Effluent: This test served as a worst-case scenario test (i.e., no post-treatment downstream to remove excess electron donor).
- SMBR Effluent: This test simulated on-site post-treatment with an aerated SMBR.
- Ozonated FXB and FBR Effluent: This test simulated post-treatment at the Rio Vista WTP.

4.5.2 Formation Potential Method

Test waters were subjected to formation potential evaluation of trihalomethanes and haloacetic acids. The trihalomethane formation potential method (THMFP) is described in the 20th Edition of Standard Methods (Method 5710B). All samples for DBP formation potentials were subjected to the standard methodology for THM formation potential:

"Under standard conditions, samples are buffered at pH 7.0 ±0.2, chlorinated with an excess of free chlorine, and stored at 25 ± 2 degrees C for 7 days to allow the reaction to approach completion. As a minimum, pH is buffered at a defined value and a free chlorine residual of 3 to 5 mg/L exists at the end of the reaction time and THMFP = TTHM at day 7-TTHM at day 0."

In the same manner, HAAFP = THAA at day 7 – THAA at day 0. The same conditions were be used for THMFP and HAAFP with combined chlorine (w:w, chlorine:ammonia = 4).

4.5.3 DBPFP Yield

The THMFP and HAAFP TOXFP yields are a measure of DBP formation potential per mg dissolved organic carbon and are defined as the following:

THMFP yield = THMFP/DOC, where DOC = dissolved organic carbon;

HAAFP yield = HAAFP/DOC and TOXFP yield = TOXFP/DOC.

The yield is a way to estimate the fraction of natural organic matter that is a precursor to formation of halogenated disinfection by-products. It was determined as part of this test.

4.5.4 Chlorine Demand

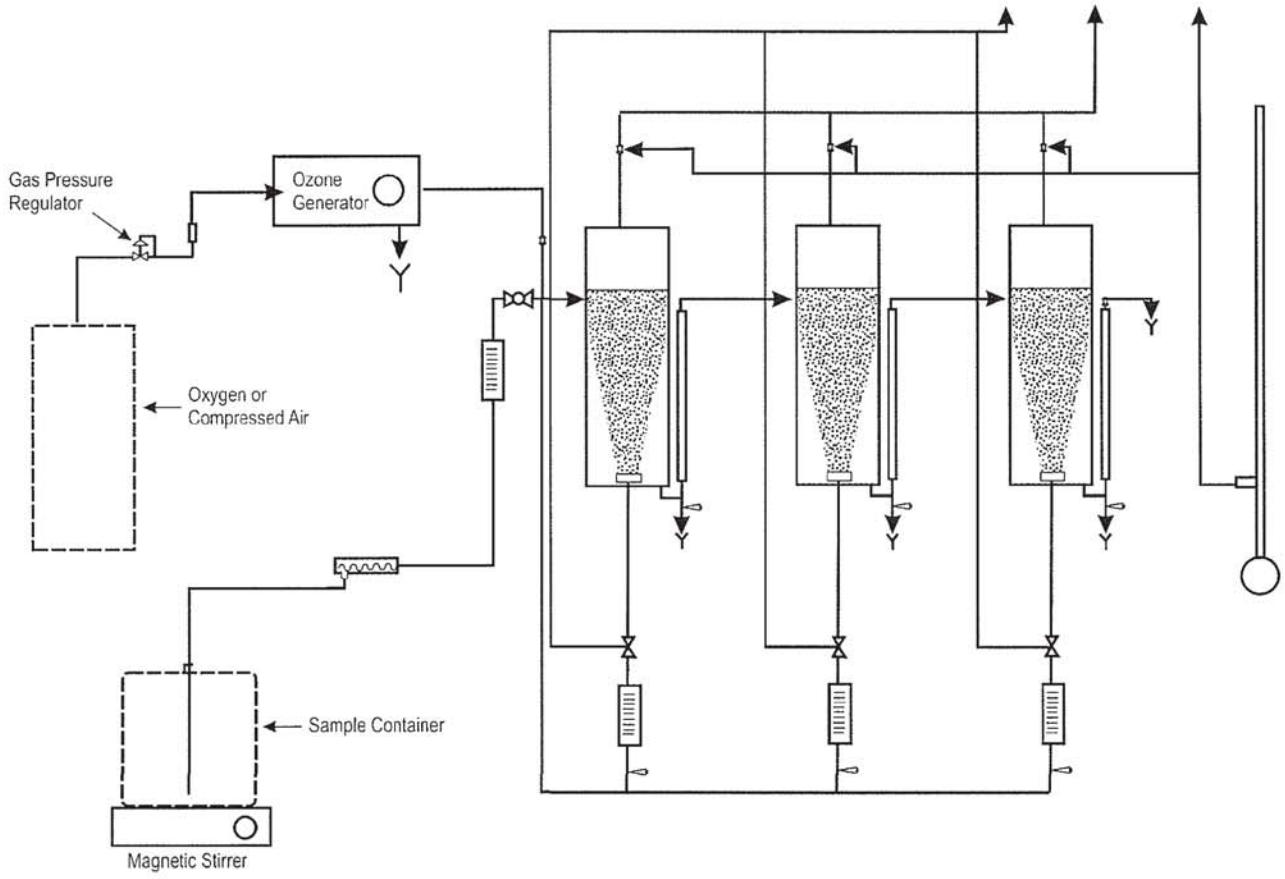
The 7-day chlorine demand was determined by the following procedure:

- Upon receipt of the samples, each sample was analyzed for ammonia, total and free chlorine, and TOC/DOC. The one-hour chlorine demand was measured at day 0. A chlorine:DOC ratio ranging from 2.5 to 5 was used. The results of this preliminary evaluation were used to estimate the required chlorine dose to achieve a 3 to 5 mg/L free chlorine residual at the end of the 7-day incubation period. It was assumed that once the instantaneous free chlorine demand is satisfied, the free chlorine decay would be much slower over the 7-day incubation period.

  A total chlorine residual of 3 to 5 mg/L after the 7-day incubation period was targeted. A chlorine:ammonia ratio of 4 was used.

4.5.5 Ozone Testing

An ozone demand test was conducted on two blended water samples that simulated the feed of the biological effluent to the Rio Vista Surface Water Treatment Plant: 90 percent SPW with 10 percent fixed bed reactor effluent and 90 percent SPW with 10 percent fixed bed effluent spiked with acetic acid. Carollo's bench-scale, continuous-flow, three-chamber ozone contactor was used (Figure 3.7). The hydraulic retention time in the bench-scale contactor was set at 6 minutes, and the test was conducted at ambient water temperature and ambient pH. The applied ozone dose (1.5 mg/L) was equally split between the three chambers. Ozone residuals were measured at the effluent of the third chamber. The



CAROLLO'S CONTINUOUS BENCH-SCALE OZONE REACTOR (NOT TO SCALE)

FIGURE 3.7

20-CLWA204F3.7-6625A10.CDR

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effluent of the third ozone chamber was sampled for parameters listed in Table 3.7. Effluent samples were taken after a minimum of three nominal hydraulic retention times (HRTs) were achieved. The ozonated waters were then subjected to chlorine and chloramines for formation potential testing.

Table 3.7 DBPFP Analytical Matrix Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Parameter	FXB and FBR BIO Effluent	MBR Effluent	Ozonated Effluent	Lab
TOC/DOC	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
BDOC	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	MWH
AOC	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	MWH
TTHM	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	
HAA5	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
	7-day Cl_2/NH_2Cl	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	
Free/Total Chlorine				On-site
	After Cl_2/NH_2Cl (time 0 and time 7 day)	After Cl_2/NH_2Cl (time 0 and time 7 day)	After Cl_2/NH_2Cl (time 0 and time 7 day)	
Ammonia	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	On-site
	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	
pH	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	On-site
	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	
UV_{254} Absorbance	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
Alkalinity	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
Bromide	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	Before Cl_2/NH_2Cl	CLWA
	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	After Cl_2/NH_2Cl	
Bromate			Before Cl_2/NH_2Cl	CLWA/MWH
Aldehydes			Before Cl_2/NH_2Cl	MWH

4.5.6 Water Quality Analysis

Each sample was analyzed according to the matrix presented in Table 3.7 for full characterization before the addition of disinfectant and 7 days after addition. Ozonated waters were analyzed for bromate and aldehydes. On day 7 of the test following application of chlorine or chloramines, samples were analyzed for free and total chlorine residual, THM4, HAA5, pH, and bromide.

4.6 Simulated Distribution System Test

A follow-up SDS test was conducted on the FBR effluent with free chlorine to confirm the high THM4 and HAA5 levels measured in the FBR effluent during the DBPFP test. Free chlorine was added to the FBR effluent to satisfy the initial demand (approximately 8 mg/L) and to result in a free chlorine residual of 0.3 to 0.5 mg/L after an incubation period of 72 hours. This free chlorine residual and incubation period mimic the free chlorine residuals and maximum hydraulic residence time in the distribution system served by Newhall County Water District wells. The SDS test was conducted at ambient room temperature.

5.0 ANALYTICAL METHODS

Water quality data were measured on-site using bench-top equipment, on-line instruments, and laboratory analyses. The CLWA lab performed the majority of the laboratory analyses. Initial samples for nitrate, sulfate, chloride and bicarbonate were sent to MWH Laboratories in Monrovia, California, in addition to routine analysis for BDOC, sulfide, AOC, VSS, COD, NDMA, uranium, HAAs, TTHMs, and split perchlorate samples. For laboratory analyses, samples were collected in amber glass or polypropylene bottles. Samples sent to MHW labs were placed in bottles supplied by the laboratory and stored at 4 degrees C until analyzed.

5.1 pH

pH was measured on-site using Standard Method 4500-H + B. The pH meter was an Oakton 300 series with a single junction pH electrode. A 2-point calibration of the pH meter was performed daily.

5.2 Temperature

Temperature was measured in accordance with Standard Method 2550 B. This was done daily to check in-line temperature transmitters on the pilot plants. Temperature measurements were made daily using an Oakton 300 series pH/Conductivity meter with a built-in automatic temperature compensation ATC element.

5.3 Turbidity

Feed and permeate water in-line turbidity measurements were logged continuously on the pilot plant using Hach 1720 D low range process turbidimeters. The feed and permeate turbidimeters were calibrated after each run using primary calibration standards purchased from the manufacturer. Turbidimeter sensor lenses were cleaned every two weeks according to the manufacturer's instructions. Turbidimeter flow rates were checked daily to insure that they were within the range required by the manufacturer. Daily bench-top turbidity analyses were performed using a Hach 2100 P field turbidimeter. The instrument was calibrated before measurements using primary turbidity standards (0, 20, 100, 800 NTU).

5.4 Perchlorate

Perchlorate was measured by the CLWA laboratory using EPA method 3.14.0 with a minimum reporting limit of 4 µg/L.

5.5 Common Anions

Analysis for nitrate, nitrite, sulfate, bicarbonate, chloride, and phosphate were provided by CLWA using EPA method 300.0A.

5.6 Dissolved Oxygen

On-site DO measurements were taken using a YSI 5500 portable dissolved oxygen (DO) meter that was calibrated daily.

5.7 Metals

Calcium, magnesium, iron, chromium, and manganese measurements were analyzed using EPA method 200.7 by the CLWA laboratory.

5.8 Sulfide

Total sulfide measurements were made by MWH laboratories using EPA method 376.2.

5.9 NDMA

Analysis for NDMA was made using EPA method 1625 at MWH laboratory.

5.10 Uranium

Uranium analysis was performed by MWH using EPA method 908.1.

5.11 Total Suspended Solids

Total suspended solids (TSS) were measured at CLWA laboratory according to Standard Method 2540 D.

5.12 Total Alkalinity

Total alkalinity was measured at CLWA laboratory according to Standard Method 2320 B.

5.13 Total Hardness

Total hardness was measured at CLWA laboratory according to EPA Method 200.7 and Standard Method 2340 B.

5.14 Organic Carbon

Total organic carbon (TOC) and dissolved organic carbon (DOC) were measured at CLWA laboratory according to EPA Method 415.1. CLWA uses a Shimadzu TOC-5050 Total Organic Carbon Analyzer. The minimum reporting level was 0.7 mg/L. Biodegradable DOC was measured by MWH using the Servais method.

5.15 UV_{254} Absorbance

UV_{254} absorbance was measured at CLWA laboratory according to Standard Method 5910 B. The instrument used for measurements was a Shumadzu UV-1201 UV-VIS Spectrophotometer.

5.16 Total and Free Chlorine

Total and free chlorine concentrations were measured using an on-site, HACH DR 890 field spectrophotometer. High range measurements (0 to 5 mg/L) for total and free chlorine were made in accordance with HACH methods 10070 and 10069, respectively (adapted from Standard Methods). Measurements for total and free chlorine concentrations from 0 to 2.00 mg/L were made using HACH methods 8167 and 8021, respectively (equivalent to Standard Method 4500-Cl G).

5.17 Microbial Parameters

Heterotrophic plates counts (HPCs) and total and fecal coliform counts were measured according to Standard Methods 9215B and 9221 D, respectively by CLWA and MWH laboratories.

5.18 Particle Counts

FXB in-line particle count measurements of the effluent water were logged continuously using a Hach 2200 PCX particle counter. Continuous maintenance of the particle counter (cleaning and flow adjustment) ensured accurate readings.

5.19 Disinfection By-Products

TTHMs and HAAs were measured by MWH laboratories according to EPA Methods 502.2 and 552.2, respectively.

5.20 Ozone Residual

Ozone residual was measured according to the Indigo Blue Method (Standard Method 4500-O3 B). Hach accuvacs were used that withdraw 10 mL of samples directly reacting with the Indigo Powder in the ampule.

5.21 COD

Chemical oxygen demand (COD) analysis was performed at MWH laboratories using EPA method 410.4.

6.0 OPERATING PROTOCOL

6.1 Ion-Exchange Columns

6.1.1 Experimental Design

The bench-scale IX study was conducted by Carollo. There were four objectives for this work:

1. Evaluate the efficiency of three ion-exchange resins for perchlorate removal under the identical feed water, flow rate, and EBCT.
2. Establish the perchlorate breakthrough curves for Saugus Aquifer water using three perchlorate-selective, throw-away resins.
3. Determine the NDMA formation potential of treating Saugus Aquifer water with these resins.
4. Determine characteristics of the spent resin.

- Phase 1 (Perchlorate Breakthrough: Approximately 2 to 4 Months): The columns were fed at a constant flow rate with perchlorate- and sulfate-spiked groundwater and sufficient influent and effluent samples were taken to establish a complete breakthrough curve for each anion. The columns were shut off once perchlorate breakthrough in all columns reached approximately 20 percent of the feed concentration. This translates into an effluent perchlorate concentration of 10 µg/L.

  The operating conditions for each ion-exchange column are listed in Table 3.8. The columns were operated at a service loading rate of 5 gpm/ft^3. With a resin volume of 22.5 mL in each column, the flow rate to each column was approximately 15 mL/min, which equates to an EBCT of 1.5 minutes.

Table 3.8	Breakthrough of Anions Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency
Parameter	**Value**
EBCT	1.5 min
Service Flow Rate	15 mL/min
Service Loading Rate	5 gpm/ft^3
Surface Loading Rate	2.1gpm/ft^2
Run Length- from Preliminary Modeling	> 20,000 BVs
Batch Feedwater Volume per Column	40 gal/week
Total Batch Feedwater Volume	119 gal/week

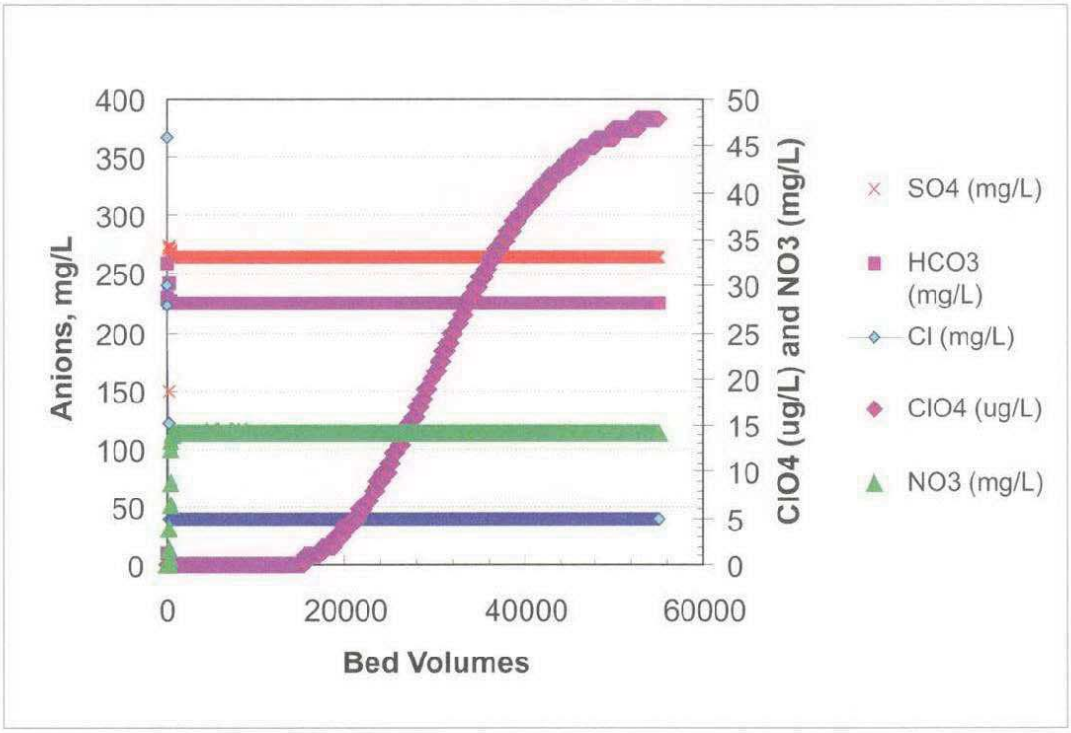
The breakthrough profiles of the various anions depend on the resins selected. Breakthrough modeling data (IX Pro Software) for a generic perchlorate selective resin are tabulated and plotted in Table 3.9 and Figure 3.8, respectively. The anticipated anionic breakthrough order was as follows: bicarbonate, sulfate, nitrate, perchlorate. The inputs to the modeling program were: component concentration, component separation factor (or selectivity coefficient); resin capacity; number of plates; and run length. The separation factors were based on the research conducted by Tripp et al. (2003).

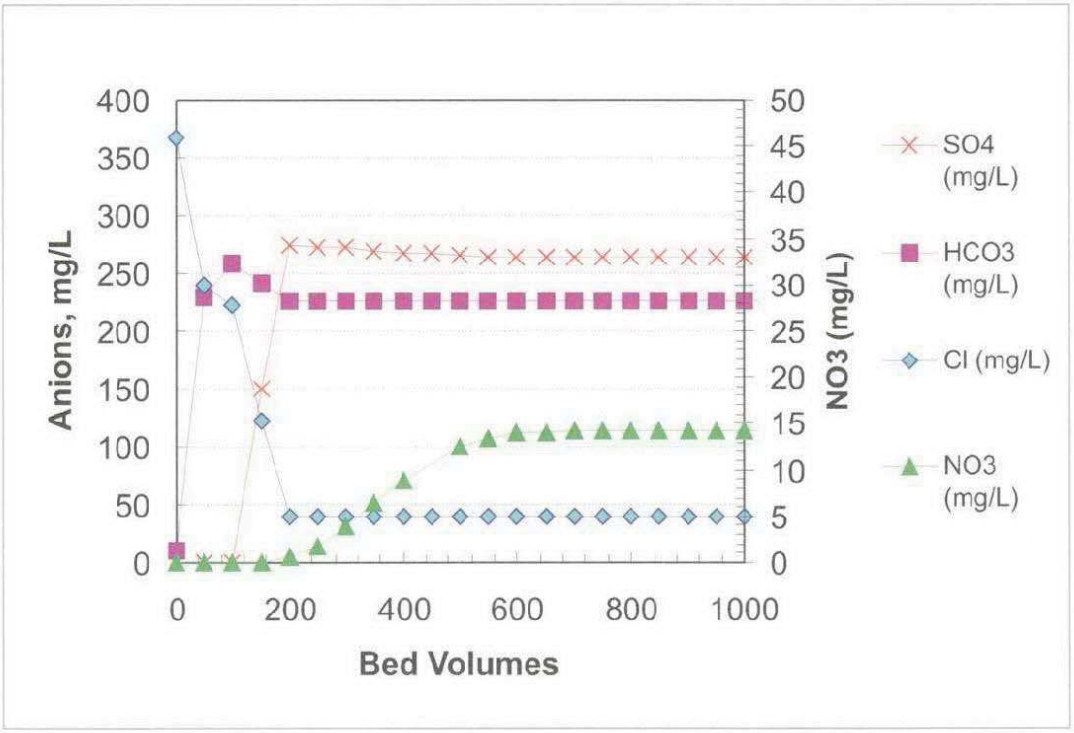
Table 3.9	Breakthrough of Anions for a Generic Perchlorate Selective Resin Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency	
Anions	**Bed Volumes (BVs)**	**Equivalent Time (EBCTxBVs)**
Bicarbonate	40 BVs for complete breakthrough	1 hr
Sulfate	200 BVs for complete breakthrough	5 hours
Nitrate	600 BVs for complete breakthrough	15 hours
Perchlorate	>20,000 BVs for breakthrough up to 4 μg/L	21 days

6.1.2 Sampling

Carollo staff was responsible for day-to-day operation and sampling of the bench-scale IX columns during regular weekdays (excluding holidays). CLWA staff checked on the columns during the weekend and holidays. To address emergencies during off-hours, CLWA staff contacted the lead Carollo operator. Operator log sheets were used daily to record flow rates and sample collection times.

Perchlorate-spiked raw water was analyzed once per week for perchlorate, nitrate, sulfate, bicarbonate, chloride, pH, and conductivity.





ANITICIPATED BREAKTHROUGH CURVES FOR KEY ANIONS

FIGURE 3.8

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Sampling frequencies for column effluents were established so that breakthrough profiles for sulfate, bicarbonate, chloride, nitrate, and perchlorate were captured. Sampling frequencies were as follows:

- First 48 hours: One sample per hour. Analyzed 12 (every 3 to 4 hours) samples for nitrate, sulfate, chloride, and bicarbonate. Perchlorate was analyzed three times per week.
- After the first two days of operation, sample frequencies were decreased to six samples per day, depending on whether the parameter has broken through. Perchlorate was analyzed three per week.

Table 3.10 lists the sampling frequencies and locations from Day 3 until 20 percent perchlorate breakthrough occurred. This sampling schedule was adequate to capture breakthrough of all anions for all three types of resins. During the first week of operation (i.e., the time-sensitive breakthrough period for bicarbonate, chloride, sulfate, and nitrate), samples were collected with a timed autosampler. Subsequently, all samples were collected manually at the frequencies describe in Table 3.10.

Table 3.10 Testing Matrix for Bench-Scale Ion Exchange Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Chemical Parameter	Lab	Sampling Frequency from Each Column Effluent		
		Day 3-Day 7	Weeks 2-5	Weeks 6-10
pH[1]	-	1/day	1/day	1/day
Temperature[1]	-	1/day	1/day	1/day
Conductivity[1]	-	1/day	1/day	1/day
Perchlorate	CLWA & MWH	2/week	3/week	1/day
Nitrate	CLWA	6/day	3/week	1/week
Sulfate	CLWA	6/day	3/week	1/week
Bicarbonate	CLWA	6/day	3/week	1/week
Chloride	CLWA	6/day	3/week	1/week
Alkalinity	CLWA	2/week	1/week	1/week
Hardness	CLWA	1/week	1/week	1/week
Iron	CLWA	1/week	1/week	1/week
Manganese	CLWA	1/week	1/week	1/week
Calcium	CLWA	1/week	1/week	1/week
Magnesium	CLWA	1/week	1/week	1/week

Table 3.10 Testing Matrix for Bench-Scale Ion Exchange Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency				
Chemical Parameter	Lab	Sampling Frequency from Each Column Effluent		
		Day 3-Day 7	Weeks 2-5	Weeks 6-10
Turbidity	CLWA	1/week	1/week	1/week
TOC	CLWA	1/week	1/week	1/week
Chromium	CLWA	As needed	As needed	As needed
NDMA	MWH	As needed	As needed	As needed
Bromide	CLWA	As needed	As needed	As needed
Arsenic	CLWA	As needed	As needed	As needed
Uranium	MWH	As needed	As needed	As needed

Note:
(1) Measured on-site.

Table 3.10 also identifies the laboratory that was responsible for analyzing each parameter. The majority of parameters were analyzed at CLWA, while perchlorate checks, NDMA, and uranium were measured at MWH laboratories. All samples not analyzed immediately were stored at 4 degrees C for no more than the recommended holding time before analysis.

6.2 Biological Fixed-Bed Filter

6.2.1 Experimental Design

A 6-month biological FXB filtration pilot study was conducted. The overall objective of this study was to demonstrate the efficacy of biological FXB filtration for perchlorate removal from Saugus aquifer water. A more specific objective was to determine whether biologically acclimating the GAC with indigenous microorganisms would be sufficient to achieve efficient perchlorate reduction in the filter. Once these objectives were achieved, a testing protocol was employed to determine requirements for EBCT, backwashing protocol, and acetic acid addition. A series of short-term experiments were also performed to evaluate the robustness of the process with respect to system upsets.

During the first 2 weeks of pilot-testing, acetic acid was fed to each filter at a concentration twice that required to stoichiometrically reduce all influent DO and nitrate ($(O_2 \Rightarrow H_2O$, $NO_3^- \Rightarrow N_2$; for calculation purposes, it was assumed that no electron donor is used for cell synthesis). This ensured that electron donor was not limiting. EBCT and acetic acid feed were optimized during Phase 2 of the FXB pilot study. Perchlorate was spiked to the influent at 50 μg/L except during the perchlorate spiking tests (see Phase 3 of this section). Phosphoric acid was added for a two-month portion of the pilot study. No other chemicals were added to the process system during the pilot study.

- Phase 1 (Biological Acclimation): The purpose of this phase was to determine whether or not efficient perchlorate-reducing biological activity could be developed in the GAC filters using microorganisms indigenous to the Saugus Aquifer. Once the filtration skid was mobilized, the filters began treating Saugus Aquifer water from Well NC-12 spiked with perchlorate. Technical-grade acetic acid (electron donor) was added to the feed water. An EBCT of 15 minutes was used during the first few weeks of the acclimation phase to allow for the rapid saturation of sorption sites on the surface of the GAC and to promote rapid growth of the microbial community in the biological FXB filter.

- Phase 2 (EBCT and Acetic Acid Optimization): The purpose of this phase was to determine the minimum EBCT required to achieve perchlorate removal to below the 4 μg/L reporting limit ($EBCT_{critical}$). Acetic acid was initially added at 100 percent excess relative to the emperical stoichiometric influent DO and nitrate demand (based on an influent DO concentration of 7.0 mg/L and an influent nitrate concentration of 15 mg/L). EBCT was incrementally lowered until perchlorate breakthrough was observed. Once $EBCT_{critical}$ was found, the feed acetic acid concentration was incrementally lowered until perchlorate breakthrough was observed ($AC_{critical}$).

- Phase 3 (Robustness Characterization): The purpose of this phase was to determine how the FXB system responds to various process up-sets. The $EBCT_{critical}$ and $AC_{critical}$ were set as operating parameters throughout this phase of testing. Five process upsets were tested: 1) backwashing, 2) perchlorate spiking, 3) nitrate spiking, 4) electron donor feed failure simulation, and 5) a total system shutdown.
  - Backwashing: These tests were designed to evaluate perchlorate removal performance immediately after backwash episodes. Because backwashes remove perchlorate-reducing biomass from the filter, it is possible that perchlorate breakthrough would occur after backwashes until the biological community in the filter had sufficient time to regrow. This test was performed twice, one-month apart. Samples were taken a 0, 15, 30, 45, and 60 minutes after the filter was put into production following a backwash.
  - Perchlorate Spiking: These tests were designed to evaluate perchlorate removal performance during periods of transient perchlorate loading episodes. Perchlorate was spiked to the feed at 100 μg/L for a 48-hour period and effluent perchlorate concentrations were monitored. Influent perchlorate concentration was then readjusted to 50 μg/L and the system was allowed to stabilize (i.e., reestablish pre-spiking, perchlorate removal performance), if necessary. A 48-hour spiking test was then performed using 300 μg/L perchlorate, followed by a 5 mg/L perchlorate spiking test. The 5 μg/L perchlorate spiking test was designed to: 1) demonstrate perchlorate removal performance at a low-end feed perchlorate concentration, 2) initiate the desorption of perchlorate from the carbon surface (if any) as the bed equilibrated with a lowered feed perchlorate concentration. Along

with the regular daily samples, samples were taken at 0, 15, 30, 45, and 60 minutes after the filter was put into production following a change in feed perchlorate concentration.

- Nitrate Spiking: This test was designed to evaluate perchlorate removal performance during periods of transient nitrate loading episodes. Over a 48-hour period, nitrate was spiked to the feed to reach a final influent concentration of 30 mg/L (the historical Saugus aquifer maximum concentration) and effluent perchlorate concentrations were monitored. During the first part of the test, EBCT and acetic acid concentration were not adjusted to account for the increased nitrate in the feed. A second nitrate spiking test was performed during which the EBCT and acetic acid were both adjusted to achieve perchlorate removal to below detection. Along with the regular daily samples, samples were taken at 0, 15, 30, 45, and 60 minutes after the filter was put into production following a change in feed nitrate concentration.
- Electron Donor Feed Failure Simulation: This test was designed to evaluate perchlorate removal performance during a period of simulated electron donor feed system failure. The acetic acid feed was shut off for 48 hours and effluent perchlorate concentrations were monitored. The acetic acid feed was then restarted and the time required to reestablish efficient perchlorate reduction was evaluated. Along with the regular daily samples, samples were taken at 0, 15, 30, 45, 60, 120, 180, 240, and 630 minutes after the filter was put into production following a change in feed perchlorate concentration.
- System Shutdown: This test was designed to evaluate perchlorate removal performance after the system has been shut down for 1-day, 2-day, and 2-week periods. The time required to reestablish efficient perchlorate reduction in the filters was evaluated.

- Backwashing Protocol: Backwashes were performed using effluent water stored in the pilot backwash tank (see Figure 2.4). Backwashes were performed approximately every 48 hours. If run times did not reach 48 hours due to rapid headloss build-up, operating parameters were adjusted (i.e., EBCT and acetic acid concentration). Backwashes consisted of a 10-minute air scour period using ~0.1-0.2 scfm, followed by a 20-minute backwash at 0.8 gpm (9 gpm/ft^2), which resulted in a 45 percent bed expansion.

6.2.2 Sampling

Table 3.11 lists the various water quality parameters that were measured, sampling location and frequency, and the associated laboratory responsible for the analysis. Increased perchlorate sampling frequencies during the challenge tests are described above.

Table 3.11 Sampling Schedule for Fixed-Bed Biological Pilot Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Parameter	Sampling Location	Sampling Frequency	Lab
ClO_4^-	Feed	Once per 2 days	CLWA and occasional checks with MWH
	Effluent	Daily	
	Backwash	As Needed	
NO_3^-	Feed	2/week	CLWA
	Effluent	3/week	
DO	Feed	Daily	On-site
	Effluent	Daily	
NO_2^-	Feed	1/week	CLWA
	Effluent	1/week	
PO_4^{3-}	Feed	1/week	CLWA
	Effluent	1/week	
SO_4^{2-}	Feed	1/week	CLWA
	Effluent	1/week	
NH_3	Feed	1/week	CLWA
	Effluent	2/week	
H_2S	Feed	1/week	MWH
	Effluent	1/week	
TOC/DOC	Feed	3/week	CLWA
	Effluent	3/week	
BDOC	Feed	2/week	MWH
	Effluent	2/week	
HPC	Feed	2/week	CLWA
	Effluent	2/week	
Total coliforms	Feed	1/week	CLWA & MWH
	Effluent	1/week	
	Backwash	1/backwash	
Fecal coliforms	Feed	1/week	CLWA & MWH
	Effluent	1/week	
	Backwash	1/backwash	
Turbidity	Feed	3/wk	Dedicated in-line HACH 1720D turbidimeters and Bench-top turbidimeter
	Effluent	Continuous	
Total particle counts	Effluent	Continuous	In-line particle counter

Table 3.11 Sampling Schedule for Fixed-Bed Biological Pilot Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency			
Parameter	**Sampling Location**	**Sampling Frequency**	**Lab**
pH	Feed	Daily	On-site
	Effluent	Daily	
Headloss	Across FXB	Continuous	In-line pressure transducer
Backwash volatile suspended solids (VSS)	Backwash water	Once per backwash	CLWA
Assimilable Organic Carbon	Backwash water	Once per backwash	MWH
Chemical Oxygen Demand	Backwash water	Once per backwash	MWH
Total Suspended Solids	Backwash water	Once per backwash	MWH

Given that adjustments to process operation were made based on perchlorate removal performance in the filters, it was important to maintain a short turn-around time for perchlorate samples throughout pilot testing. Therefore, perchlorate samples was taken for analysis at the CLWA laboratory to expedite the acquisition of perchlorate data. However, since the CLWA laboratory has partial certification for perchlorate analysis, duplicate samples were set weekly to MWH for analysis. Bacterial samples, TOC/DOC, and anions were transported to the laboratory every Tuesday. Additional anion samples were transported to the lab every 3 days (i.e., Monday, Wednesday, and Friday) due to the short holding time of nitrate (48 hours).

The on-line ion chromatography perchlorate analyzer (DX-800 Process Analyzer), which was generally used to continuously monitor FBR effluent perchlorate concentrations, was configured to accept manual injections of FXB samples. Thus, near real-time perchlorate removal performance was monitored during the majority of FXB pilot testing.

6.3 Biological Fluidized-Bed Reactor

6.3.1 Experimental Design

A 6-month biological FBR pilot study was conducted using Shaw Environmental-Envirogen/US Filter/Envirex Products' low-flow FBR. The overall objective of this study was to demonstrate the efficacy of an FBR biological process for perchlorate removal from Saugus aquifer water. A more specific objective was to determine whether biologically acclimating the GAC with indigenous microorganisms is sufficient to achieve efficient perchlorate reduction in the FBR. The testing protocol was also designed to optimize HRT and acetic acid addition, and to test the robustness of the process during system upsets.

However, establishing consistent perchlorate removal to below detection required the entire length of the pilot testing period.

The FBR system was monitored using a Dionex On-Line Ion Chromatography Perchlorate analyzer (DX-800 Process Analyzer). The use of the DX-800 analyzer provided a better understanding of the instrument's capabilities in a field setting. The testing of this system also allowed for immediate operational responses based on FBR performance.

- Phase 1 (Biological Acclimation): During start-up, the FBR system was filled with NC-12 groundwater. Carbon was added to provide a desired settled bed height of approximately 5 feet. The system was then started in recycle and the carbon hydraulically fluidized 1.25 to 1.30 times the settled bed height. The feed and recycle rates required to meet this bed expansion were documented and utilized as a baseline for future bed growth measurements. Following this procedure, nutrients and electron donor were added to the reactor in batch mode to allow the microbial consortium to develop over a period of two days. The system was then put into continuous operation mode at a feed flow of 1 gpm and a recycle flow of 8 to 9 gpm. The feed flow was set between 1 and 3 gpm throughout pilot testing and the recycle flow was typically set so that total flow was approximately 10 gpm.

- Phase 2 (Continuous Operation): This phase was initially intended to determine optimal feed and recycle flow rates as well as optimal feed phosphorous and acetic acid concentrations. During the bulk of this phase, Carollo worked with Shaw Environmental (formerly Envirogen) staff to make mechanical and operational changes designed to improve the perchlorate removal performance of the FBR.

- Phase 3 (Robustness Characterization): FBR robustness characterization testing did not occur for the FBR as stable performance was not achieved during the 6-month period.

6.3.2 Sampling

Table 3.12 lists the various water quality parameters that were measured once start-up was completed, the sampling location and frequency, and the associated laboratory responsible for the analysis.

Table 3.12 Fluidized-Bed Sampling Matrix
Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer
Castaic Lake Water Agency

Parameter	Sampling Location	Sampling Frequency	Lab
Perchlorate	Feed	Once per 2 days	CLWA and occasional checks with MWH + on-line ion chromatograph
	Effluent	Daily	

Table 3.12 Fluidized-Bed Sampling Matrix
Treatment of Perchlorate Contaminated Groundwater
from the Saugus Aquifer
Castaic Lake Water Agency

Parameter	Sampling Location	Sampling Frequency	Lab
Nitrate	Feed	3/week	CLWA
	Effluent	3/week	
Nitrite	Feed	1/week	CLWA
	Effluent	1/week	
Phosphate	Feed	1/week	CLWA
	Effluent	1/week	
Sulfate	Feed	-	CLWA
	Effluent	-	
DO	Influent	Daily	On-site analysis
	Effluent	Daily	
H_2S	Influent	1/week	MWH
	Effluent	1/week	
BDOC	Feed	2/week	MWH
	Effluent	2/week	
HPC	Feed	1/week	CLWA
	Effluent	1/week	
Total Coliforms	Feed	1/week	CLWA
	Effluent	1/week	
Fecal Coliforms	Feed	1/week	CLWA
	Effluent	1/week	
TOC	Feed	-	CLWA
	Effluent	2/week	
TSS	Feed	-	CLWA
	Effluent	-	
Ammonia	Feed	1/week	CLWA
	Effluent	1/week	
Total phosphorous	Feed	1/week	CLWA
	Effluent	2/week	

6.4 Submerged Membrane Bioreactor

6.4.1 Experimental Design

Due to the short SMBR testing period, the experimental design focused only on demonstration, not optimization, of the SMBR process. Operational settings for the SMBR are listed in Table 3.13.

Table 3.13 SMBR ZW-10 System Operating Parameters Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Parameter	Value
Q_{FEED} (mL/min)	300-680
$Q_{PERMEATE}$ (mL/min)	300-680
Recovery (%)	80-99
HRT (hours)	4.7-10.6
Aeration rate (scfm)	1-2

For the majority of SMBR testing, the biological FXB filter was operated using $EBCT_{critical}$ and $AC_{critical}$. SMBR backpulses were initiated every 15 minutes, for a duration of 15 seconds. The system was operated continuously and monitored regularly for two months to determine whether each of the four post-treatment objectives was being met. A three-week acetic acid spiking test was performed after it was observed that biological FXB filter effluent contained non-detect concentrations of TOC. During this test, 3.5 mg/L of acetic acid carbon was continuously spiked to the SMBR process tank using a peristaltic pump to validate residual organic removal efficiency.

6.4.2 Sampling

Table 3.14 lists the various water quality parameters that were measured, sampling location and frequency, and the associated laboratory responsible for the analysis.

Table 3.14 SMBR Sampling Matrix Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Parameter	Sampling Location	Sampling Frequency	Lab
DO	Feed	Daily	On-site
	Effluent	Daily	
H_2S	Feed	1/week	CLWA & qualitative (i.e., by nose)
	Effluent	1/week	

Table 3.14 SMBR Sampling Matrix Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency			
Parameter	**Sampling Location**	**Sampling Frequency**	**Lab**
TOC/DOC	Feed	3/week	CLWA
	Effluent	3/week	
BDOC	Feed	2/week	MWH
	Effluent	2/week	
HPCs	Feed	2/week	CLWA
	Effluent	2/week	
Total coliforms	Feed	1/week	CLWA
	Effluent	1/week	
Fecal coliforms	Feed	1/week	CLWA
	Effluent	1/week	
Turbidity	Feed	3/week	Bench-top turbidimeter
	Effluent	3/week	
pH	Feed	2/week	On-site probe
	Effluent	2/week	
Process tank volatile suspended solids	Process tank	2/week	CLWA

7.0 TEST RESULTS

7.1 Ion-Exchange Testing Results

7.1.1 Feed Water Quality

The range of constituent concentrations in the feed water to the ion-exchange columns is presented in Table 3.15. The feed water is characterized as low in organic matter, moderately hard and buffered, and moderate in iron and bromide. It should be noted that during the month of October 2003 the NC-12 groundwater quality was observed to slowly change over a 4-week period before returning to its steady-state quality at the end of the bench-scale study. The nitrate concentration decreased from 3.3 mg/L as N to 1.7 mg/L as N, sulfate increased from 290 mg/L to 373 mg/L (after sulfate spike), and the chloride concentration increased from 35 mg/L to 45 mg/L.

Table 3.15	Range of Constituent Concentration in Feedwater to the IX System Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency				
Chemical Parameter	**Unit**	**Count**	**Average**	**Min**	**Max**
Perchlorate	µg/L	18	45.5	42.6	52.9
Nitrate-N	mg/L	18	3.0	1.7	3.4
Sulfate	mg/L	18	301	276	373
Bicarbonate	mg/L	18	199	171	221
Chloride	mg/L	18	37	32	45
pH	—	18	8.1	7.9	8.4
Alkalinity	mg/L as $CaCO_3$	18	165	152	181
TOC	mg/L			<0.7	<0.7
DOC	mg/L			<0.7	<0.7
Arsenic	µg/L			ND	ND
Iron	µg/L	9	15.3	7	27
Manganese	µg/L	9		<1	<1
Hardness	mg/L as $CaCO_3$	2		282	315
Calcium	mg/L	3	84	77	94
Magnesium	mg/L	3	17.7	17	18
Uranium	pCi/L			ND	1.03
NDMA	ng/L			ND	ND
Vanadium	µg/L	3	10.7	2.0	15.0
Bromide	mg/L	2		0.22	0.24
Turbidity	NTU	12	0.337	0.180	0.580
Conductivity	µmhos/cm	15	1043	1003	1158

7.1.2 Operational Data

Two operational parameters were recorded on a daily basis for the ion-exchange setup: flowrate through the columns (Figure 3.9) and pressure buildup. The pump setting and/or the needle valves connected downstream of the columns were adjusted when the measured flow rate deviated by more than 10 percent from the target flow rate of 15 mL/min. The flow rate ranged from 13.5 to 16.5 mL/min during the course of the study, which resulted in an EBCT range of 1.4 to 1.6 minutes. The pressure drop remained constant at 5 psi throughout most of the project duration, and increased to 7 psi during the last two weeks of testing. The level of water in the 55-gal feed tanks was monitored daily. The experimental apparatus was monitored for the presence of air bubbles and leaks.

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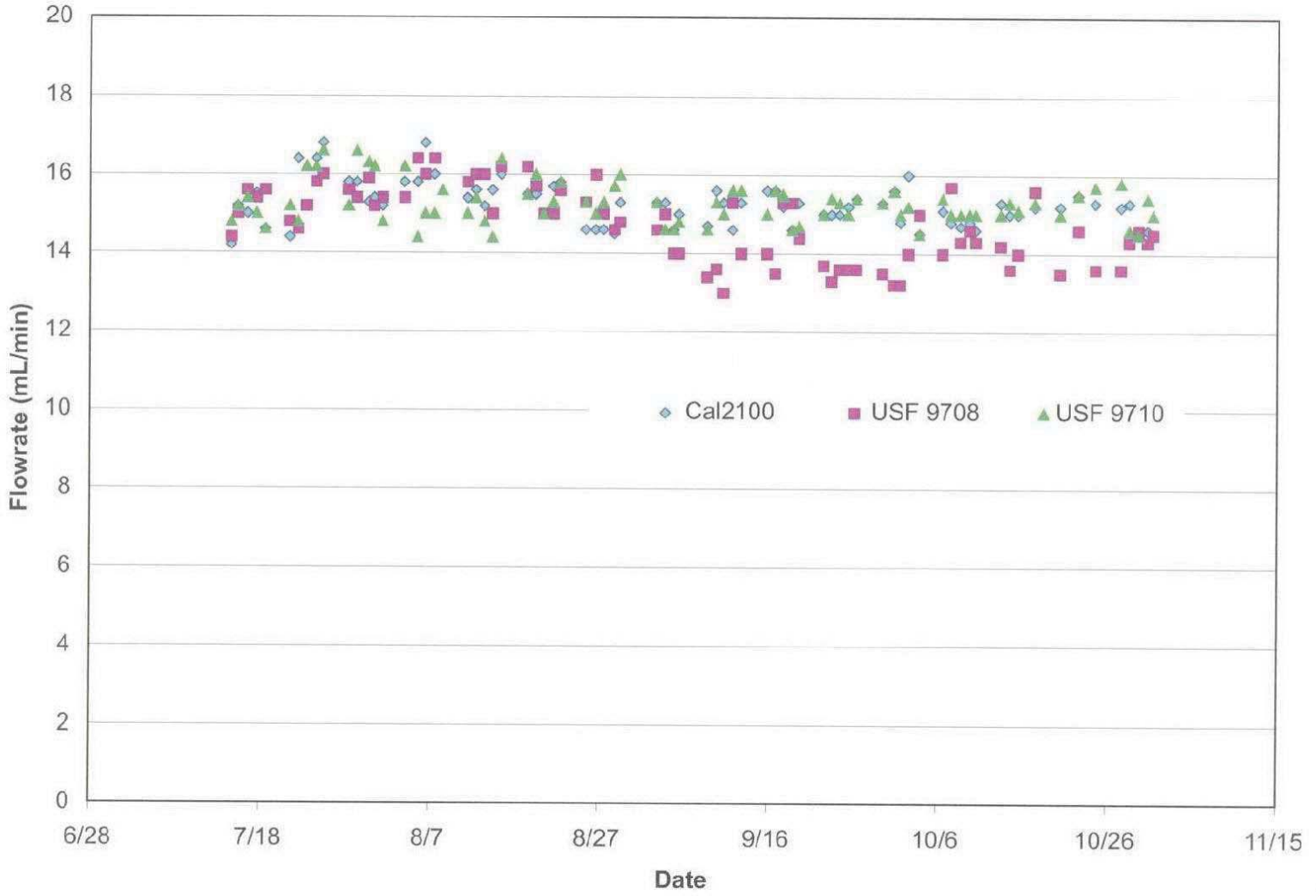

FLOW RATES MEASURED THROUGH THE THREE ION-EXCHANGE COLUMNS

FIGURE 3.9

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7.1.3 Temperature

The temperature, which was measured in the effluent of the three columns over the course of the study, ranged from 32 degrees C (89 degrees F) in the summer months to 16 degrees C (61 degrees F) in the fall (Figure 3.10).

7.1.4 pH Values

pH was measured in the feed and effluent of the three columns, and both ranged from 7.6 to 8.4 (Figure 3.11), indicating only minor impact on pH by the resins.

7.1.5 Breakthrough Curves

Breakthrough curves of key anions were developed for the ion-exchange resins under identical conditions of water quality, flowrate, and EBCT. The three columns were operated in parallel using one feed pump. The columns ran continuously with minimal shut-down periods. A 45-hour shut-down period was simulated at the end of the study to investigate its potential effect on breakthrough.

7.1.5.1 High-Resolution Breakthrough Curves of Key Anions

As predicted by the IXPro Model, the breakthrough of most anions (with the exception of perchlorate) was very fast and occurred in the first 24 hours of operation. This breakthrough sequence was similar for the three resins tested, as illustrated in Figures 3.12 through 3.14. The figures are plotted for the first 2,000 bed volumes of run time.Bicarbonate was the first anion to break through reaching its background value of 220 mg/L after 80 to120 bed volumes. Sulfate was next to breakthrough after 80 bed volumes and reached its steady-state concentration of 300 mg/L after 280 to 310 bed volumes. The nitrate breakthrough rate was somewhat different for the three columns. Nitrate broke through after 280 bed volumes, 440 bed volumes, and 600 bed volumes from USF 9708, USF 9710, and Cal 2100 resins, respectively. Steady-state concentrations were reached after 1,000 bed volumes for all three tested resins. No chromatographic peaking was observed for any of the critical anions within the test conditions.

Chloride concentration dropped from a high of approximately 325 mg/L to background levels of approximately 35 mg/L after 280 bed volumes. The highest measured chloride levels in the first 280 bed volumes did not exceed the Title 22 Secondary Maximum Contaminant Level of 500 mg/L. However, they did exceed the Los Angeles County Sanitation District (LACSD) maximum acceptable chloride level of 100 mg/L in the Santa Clara Valley Basin.

In a full-scale application, following a resin change-out, the new resin may need to be flushed over a few days to meet DHS requirements. This flushed water, which will contain higher concentrations of chloride during the first few hours of flushing (as illustrated in Figures 3.12 to 3.14), will need to be dealt with by discharge to a sewer, for example. The flushed water will be free of perchlorate.

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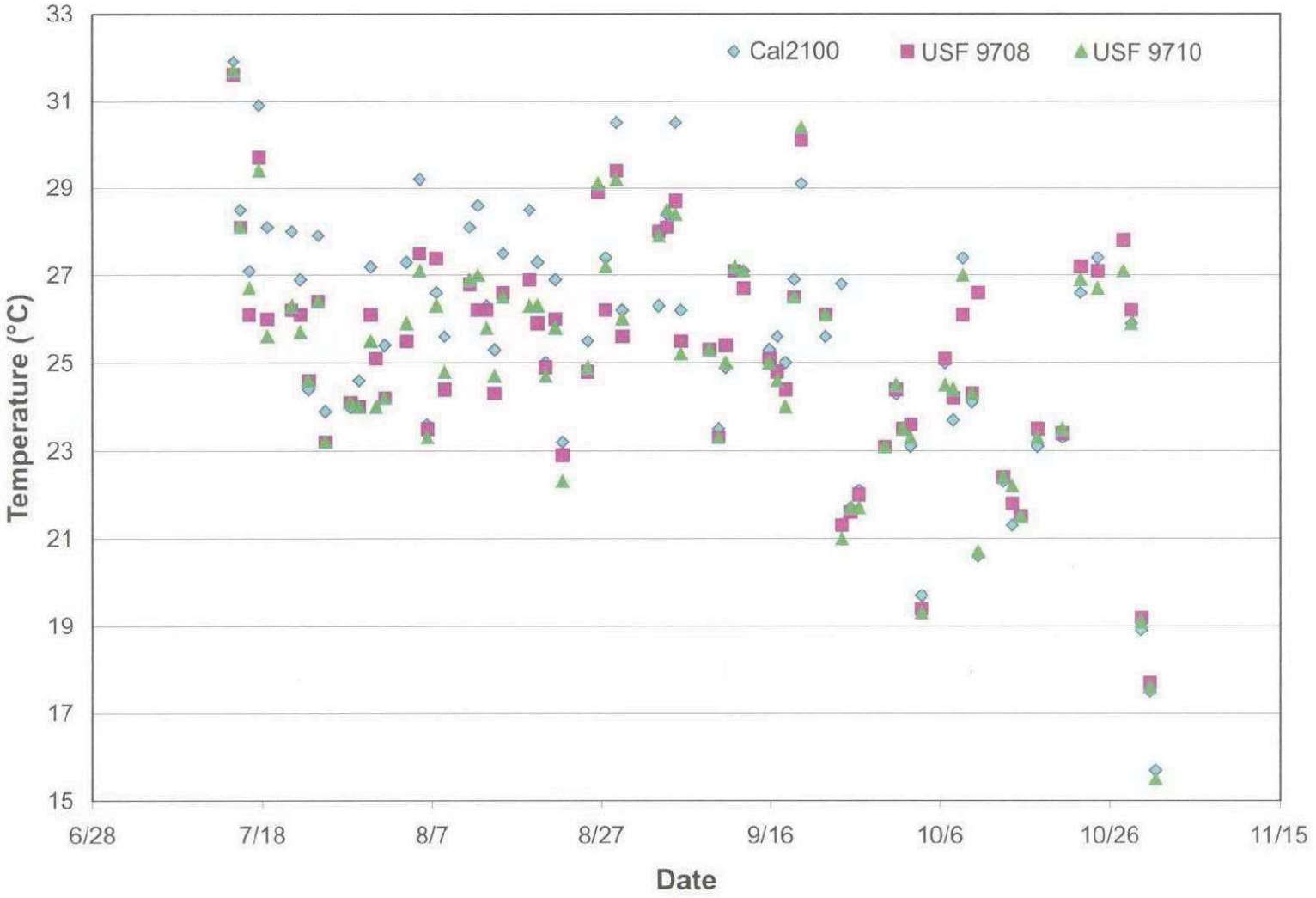

COLUMN EFFLUENT TEMPERATURE MEASURED OVER THE COURSE OF THE STUDY

FIGURE 3.10

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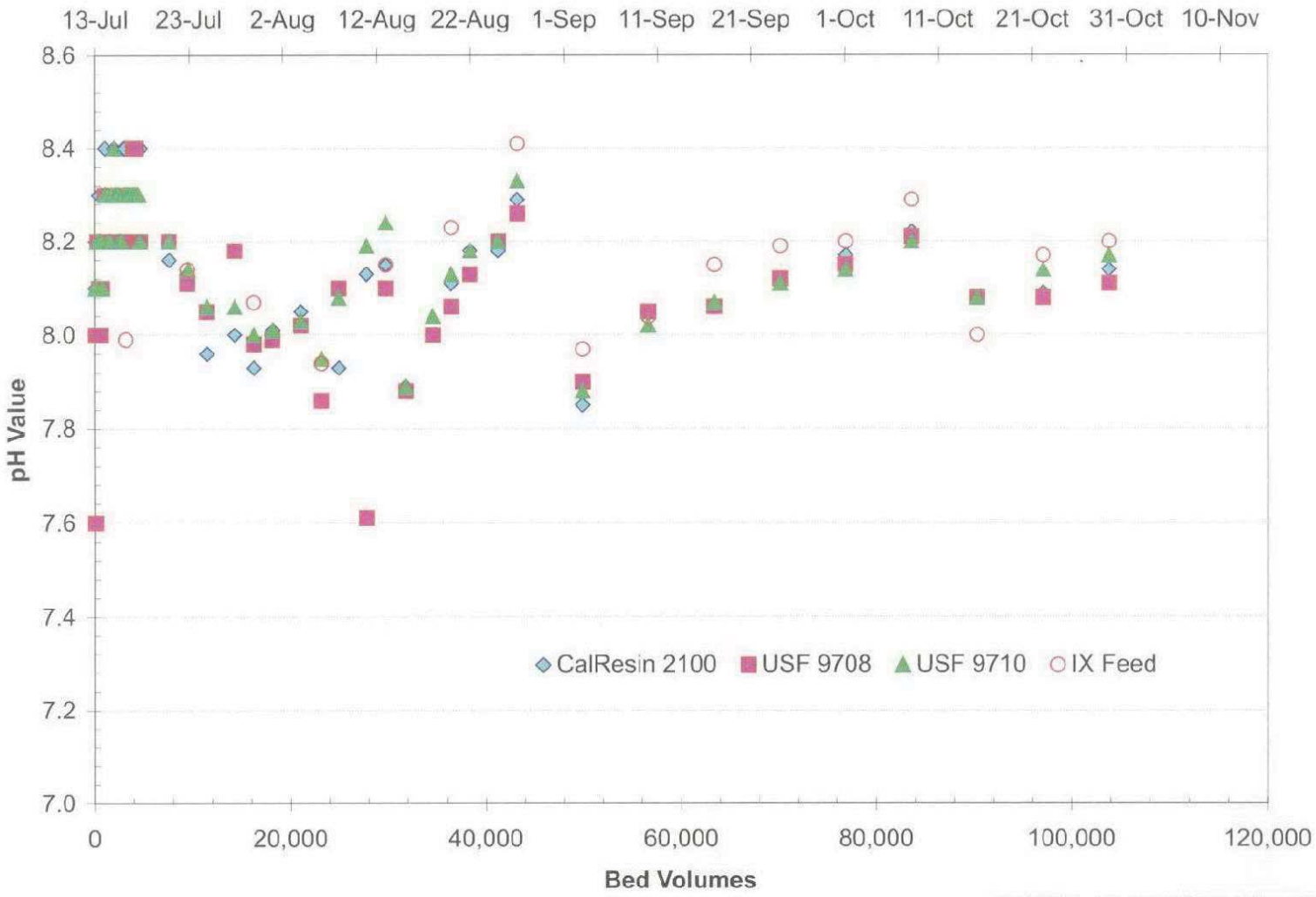
20-CLWA204F3.11-6625A10.CDR



pH VALUES MEASURED IN THE FEED AND IX COLUMN EFFLUENT

FIGURE 3.11

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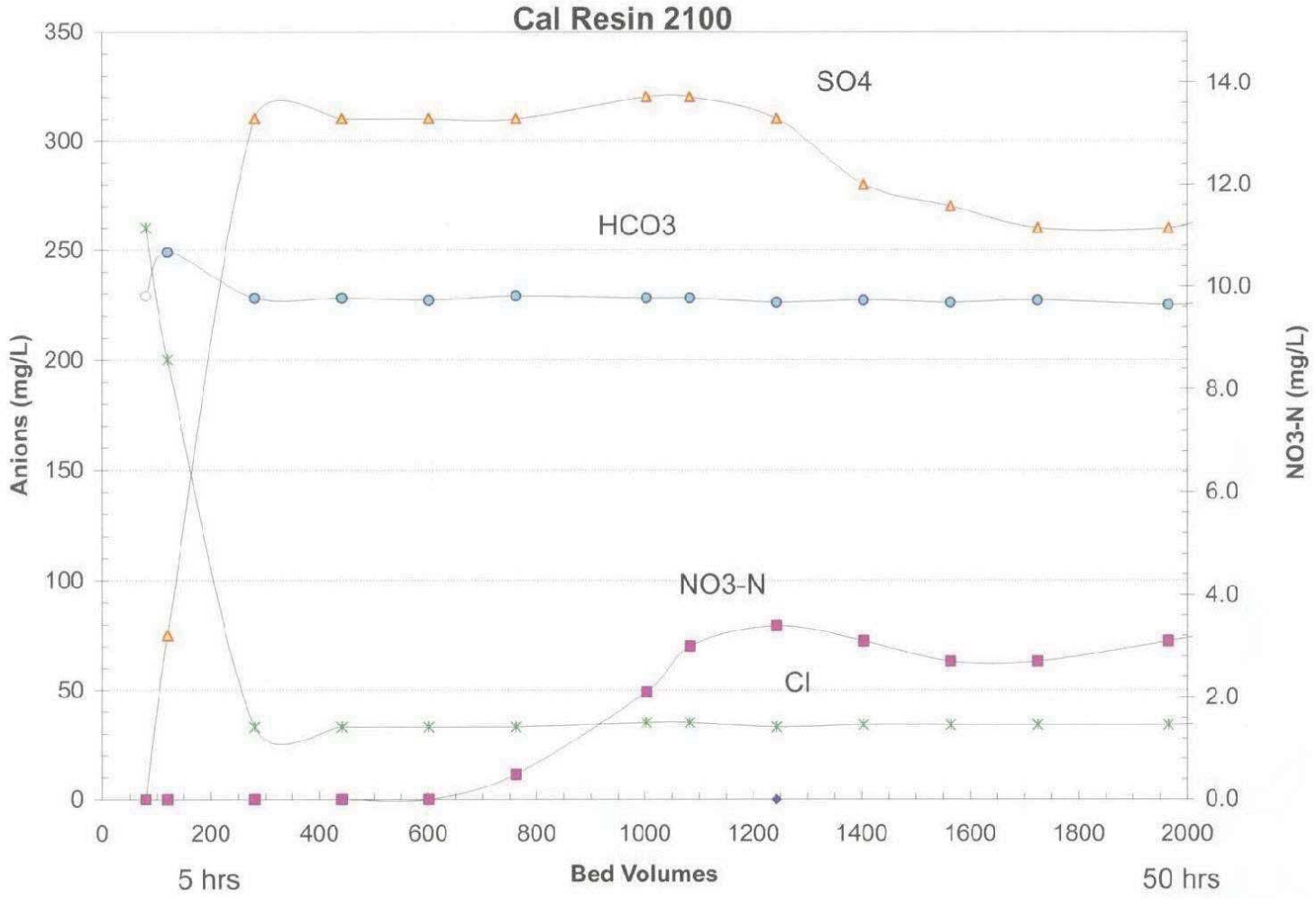

BREAKTHROUGH OF MAJOR ANIONS FROM CAL 2100 SERIES RESIN IN THE FIRST 2000 BVs

FIGURE 3.12

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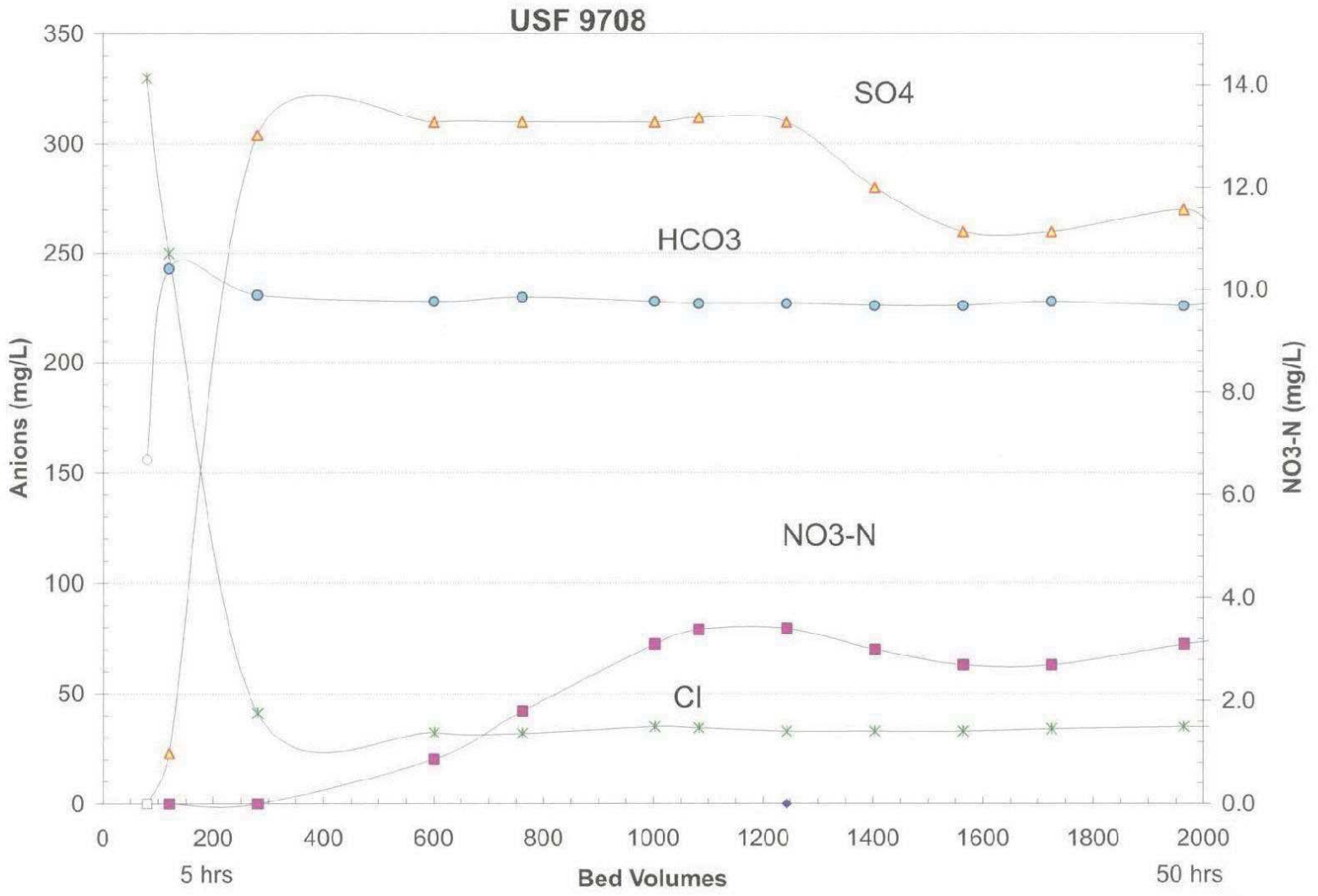

BREAKTHROUGH OF MAJOR ANIONS FROM 9708 RESIN IN THE FIRST 2000 BVs

FIGURE 3.13

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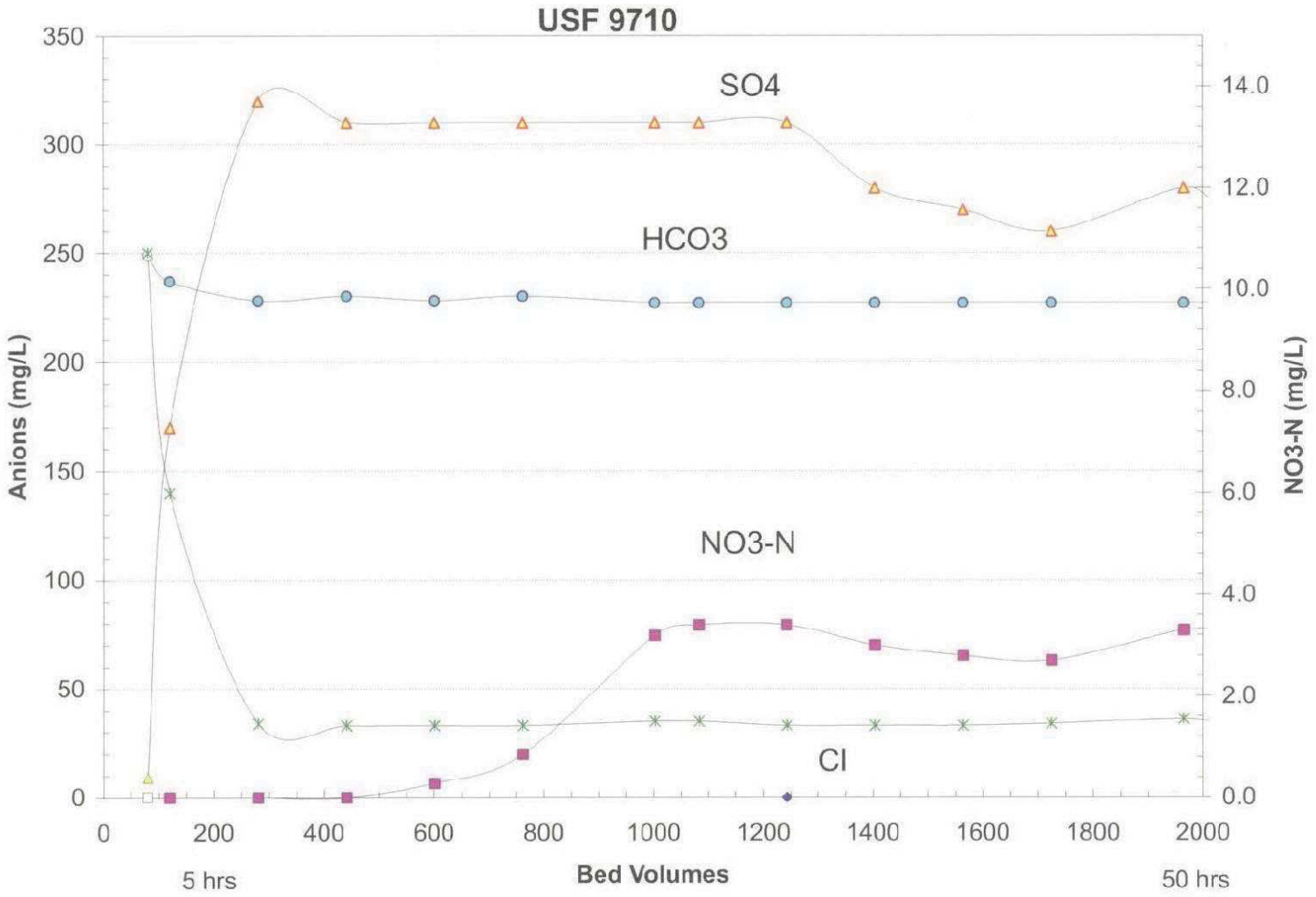
20-CLWA204F3.14-6625A10.CDR



BREAKTHROUGH OF MAJOR ANIONS FROM 9710 RESIN IN THE FIRST 2000 BVs

FIGURE 3.14

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7.1.5.2 Breakthrough Curves of Perchlorate and Other Anions

Perchlorate breakthrough curves for the three ion-exchange resins are illustrated in Figure 3.15. As expected, perchlorate breakthrough did not occur until several thousand bed volumes had been treated by the resin. Actual run lengths were longer than those predicted by the IX-Pro Model. Bed volumes to perchlorate breakthrough (greater than 1 μg/L) were 25,000 bed volumes (26 days), 72,000 bed volumes (75 days), and 76,000 bed volumes (79 days) for USF 9708 resin, USF 9710 resin, and CalResin 2100, respectively. The details of run lengths until perchlorate breakthrough are presented in Table 3.16.

Table 3.16 Run Lengths Until Perchlorate Breakthrough (1 μg/L) Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Resin	Bed Volumes	Treated Water Volumes (gal)	Treated Volume gal/cu-ft resin
USF 9708	25,000	145.3	187,045
USF 9710	72,000	418.5	538,735
CalResin 2100	76,000	441.7	568,600

A temporal change in raw well water quality occurred between 85,000 and 100,000 bed volumes. However, this did not seem to impact the breakthrough of anions, with the possible exception of the USF 9708 perchlorate breakthrough curve, for which a noticeable drop in perchlorate concentration was measured in the effluent during that period.

At the end of the study, a 45-hour shutdown period was simulated by shutting off the feed pump. During this period, the resins were allowed to sit in the columns containing the groundwater. Critical anions were measured immediately after the shut-down period and breakthrough curves were developed for all key anions after restarting the columns. Breakthrough curves of all major anions for USF 9710 are illustrated in Figure 3.16. An increase in chloride concentration (45 to 72 mg/L) was observed upon column restart. Similar trends were observed for USF 9708 and CalResin 2100, indicating leaching from the IX resins.

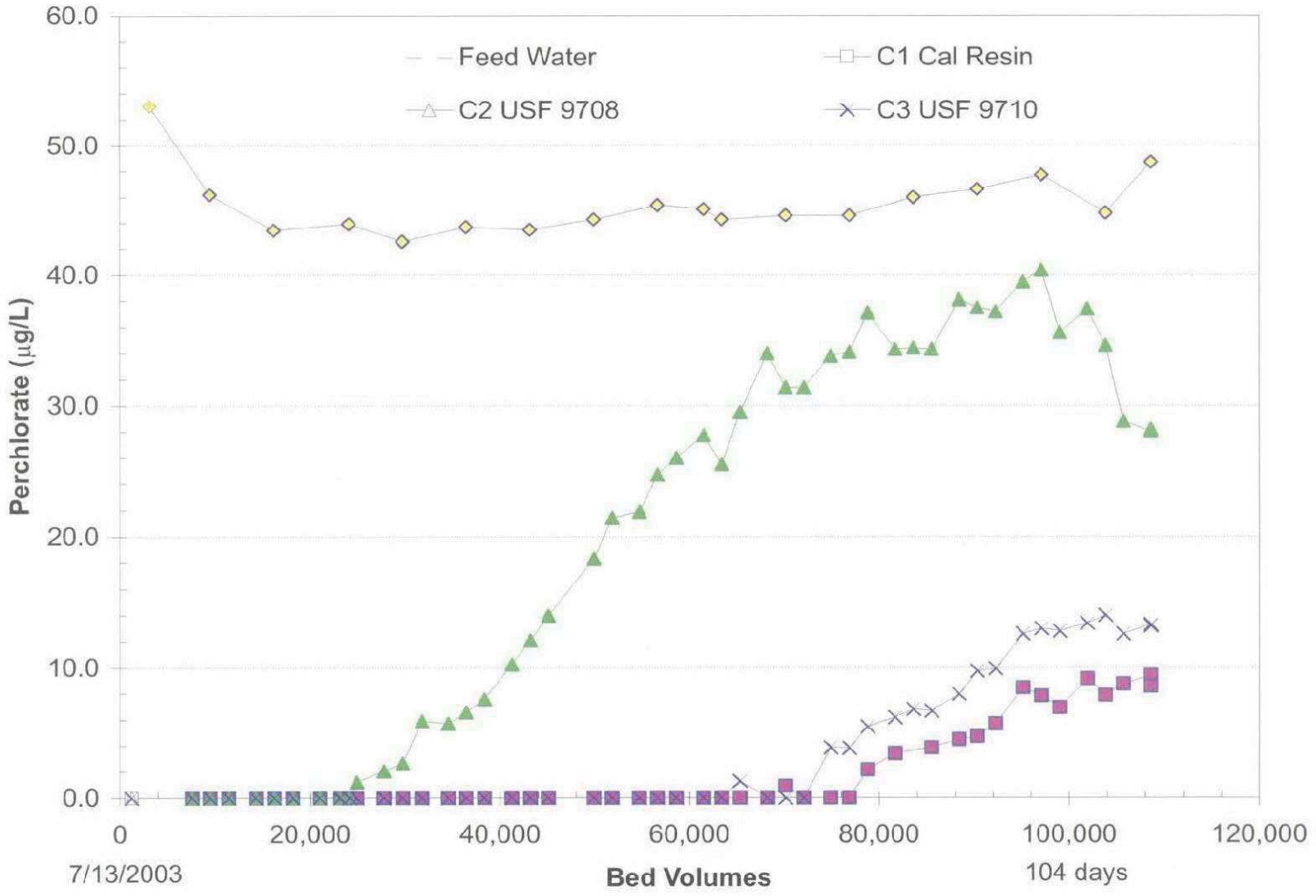
7.2 NDMA Formation Potential Testing

7.2.1 Post-Chlorination Testing

The results from the post-chlorination testing with free chlorine are plotted in Figure 3.17. Free chlorine residuals ranged from 1.8 to 1.9 mg/L after 24 hours of incubation. The 2- and 24-hour NDMA concentrations in all three ion-exchange column effluents were below the 2 ng/L detection limit. Therefore, precursors did not leach from the resin to form NDMA upon post-chlorination with free chlorine.

The results from the post-chlorination testing with combined chlorine are plotted in Figure 3.18. Total chlorine residuals ranged from 1.6 to 2.2 mg/L after 24 hours of

20-CLWA204F3.15-6625A10.CDR



COMPARISON OF PERCHLORATE BREAKTHROUGH CURVES

FIGURE 3.15

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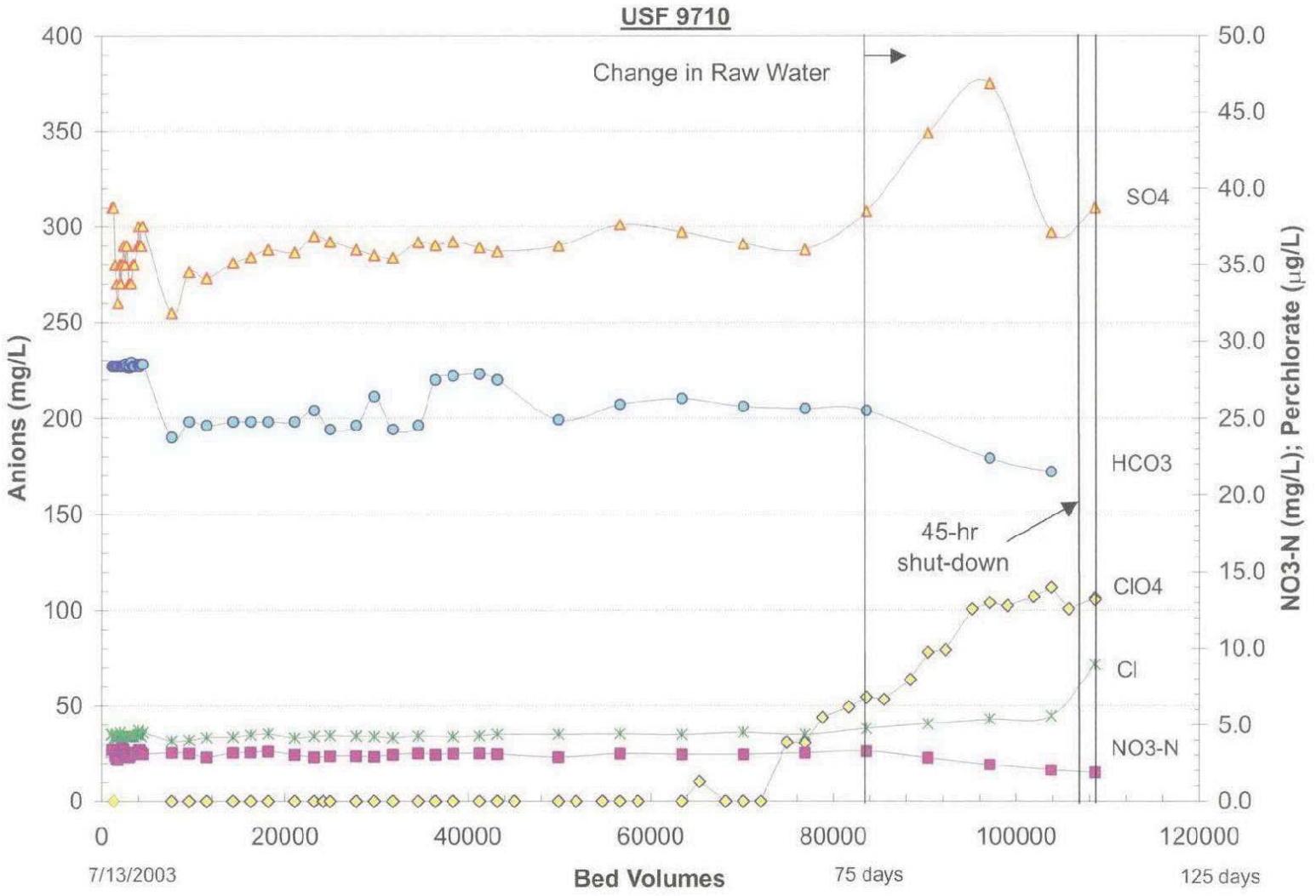

BREAKTHROUGH OF CRITICAL ANIONS FROM USF 9710

FIGURE 3.16

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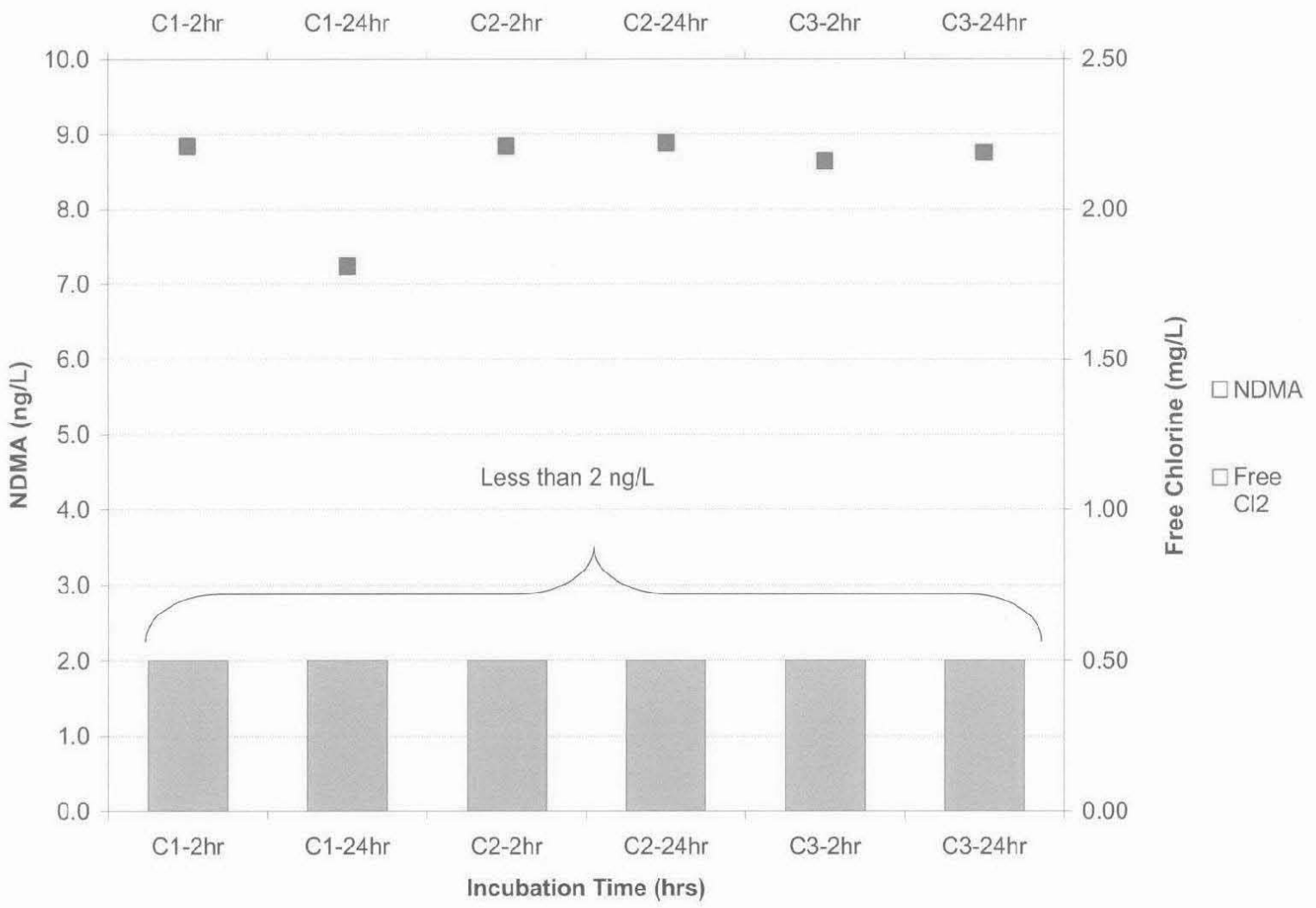

POST-CHLORINATION TESTING WITH FREE CHLORINE NDMA RESULTS

FIGURE 3.17

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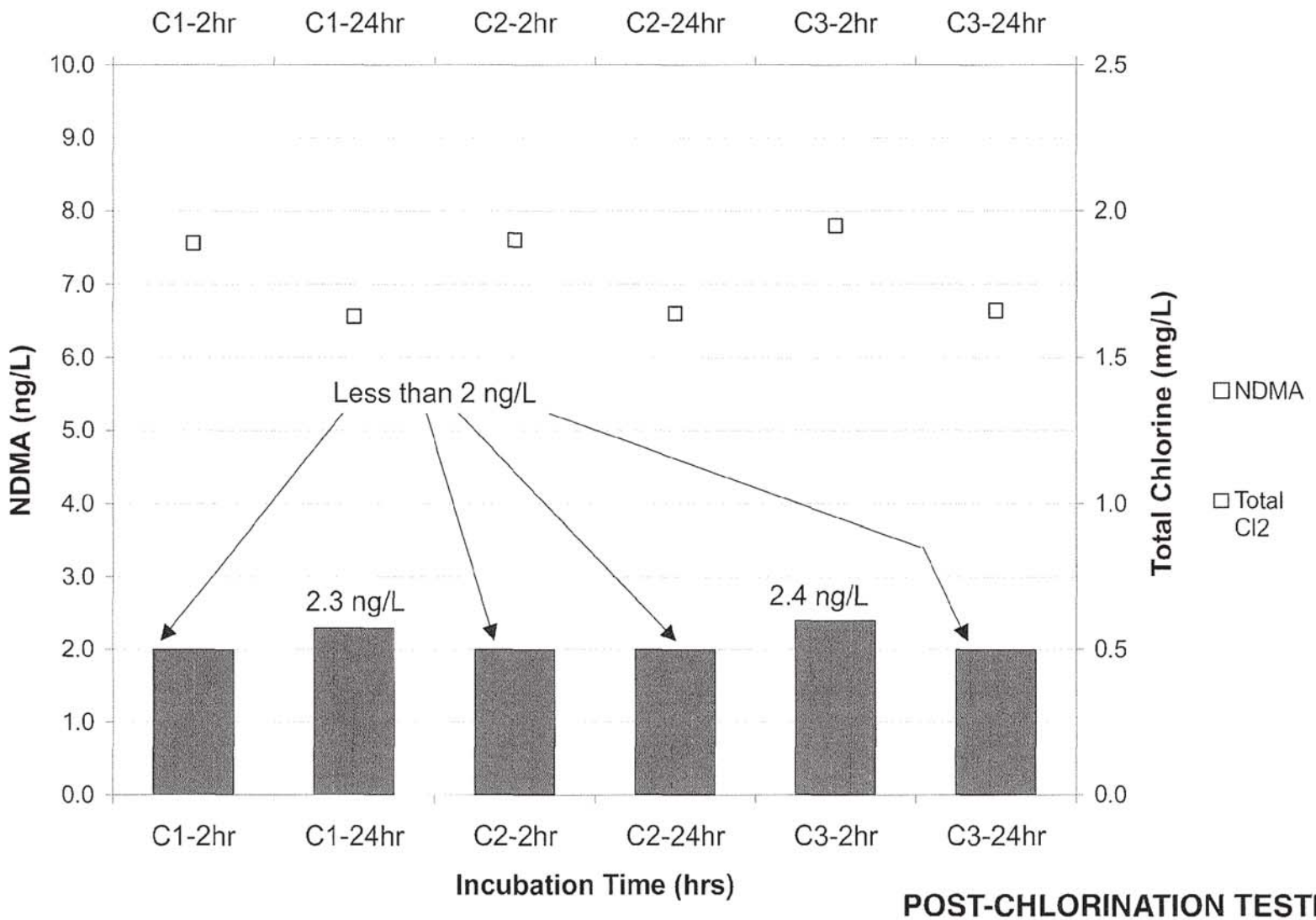

POST-CHLORINATION TESTING WITH COMBINED CHLORINE NDMA RESULTS

FIGURE 3.18

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incubation. The 2- and 24-hour NDMA concentrations in all three ion-exchange column effluents were below or just above the detection limit of 2 ng/L.

7.2.2 Pre-Chlorination Testing

To test the effect of prechlorinated water on the resins, chlorinated feedwater was allowed to run through the columns for a period of 2 hours. After that time, samples were collected and analyzed for NDMA. No detectable free chlorine residual was measured at the column effluents. This experiment was repeated four days later by adding a second 2 mg/L dose of free chlorine (duplicate samples). NDMA results are plotted in Figure 3.19. Measured levels were below or just over the detectable limit of 2 ng/L. The NDMA concentration in the feedwater (control sample) was non-detect.

7.2.3 Fresh Resin Batch Testing

Each resin was tested to determine if leaching of NDMA occurred from precursors in the resin functional sites. These results are plotted in Figure 3.20. Although NDMA was detected in one sample (CalResin), the result was less than half the current Action Level of 10 ng/L.

7.3 Spent Resin Characterization

7.3.1 Lab Results

Table 3.17 presents the Federal Toxicity Characteristic Leaching Procedure (TCLP) toxicity limits, TTLC, and STLC threshold values defined in the California Code of Regulations, Title 22, Chapter 11, Article 3, Section 66261.24, as well as the results from the actual TTLC metal concentrations measured in the three ion-exchange spent resins. TTLC results indicate the total bulk amount of each constituent per unit mass of solid waste. If the TTLC (or bulk) content is low, then the solid waste when subjected to leaching tests (STLC, TCLP) does not produce significant amounts of contaminants in the leachate. Since TTLC results are very low, there would not be any problem with the STLC or TCLP. These soluble limits, however, are listed in the table for comparison.

Most values for the TTLC analysis were non-detect. Chromium, vanadium, and zinc were detected in USF 9708 and USF 9710 spent resins at levels just above minimum reporting limits, but these values are several orders of magnitude below the regulatory TTLC threshold concentrations. Given that the TTLC metal concentrations were 10 times lower than the STLC limits, no further metals analysis for STLC was needed.

Due to the limited quantity of resin samples, TTLC for uranium, which required separate analysis, was not performed by the lab. However, projected total amount of uranium was calculated to be well below the regulatory limit (see Table 3.21). The leachate from spent resins was further analyzed for perchlorate, nitrate, and uranium (Table 3.18). Uranium

levels in the spent resin leachate were significantly below the drinking water Title 22 maximum contaminant limit of 20 pCi/L.

Table 3.17 Comparison of TTLC Metals in Spent Resins to Federal and State Toxicity Limits
Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer
Castaic Lake Water Agency

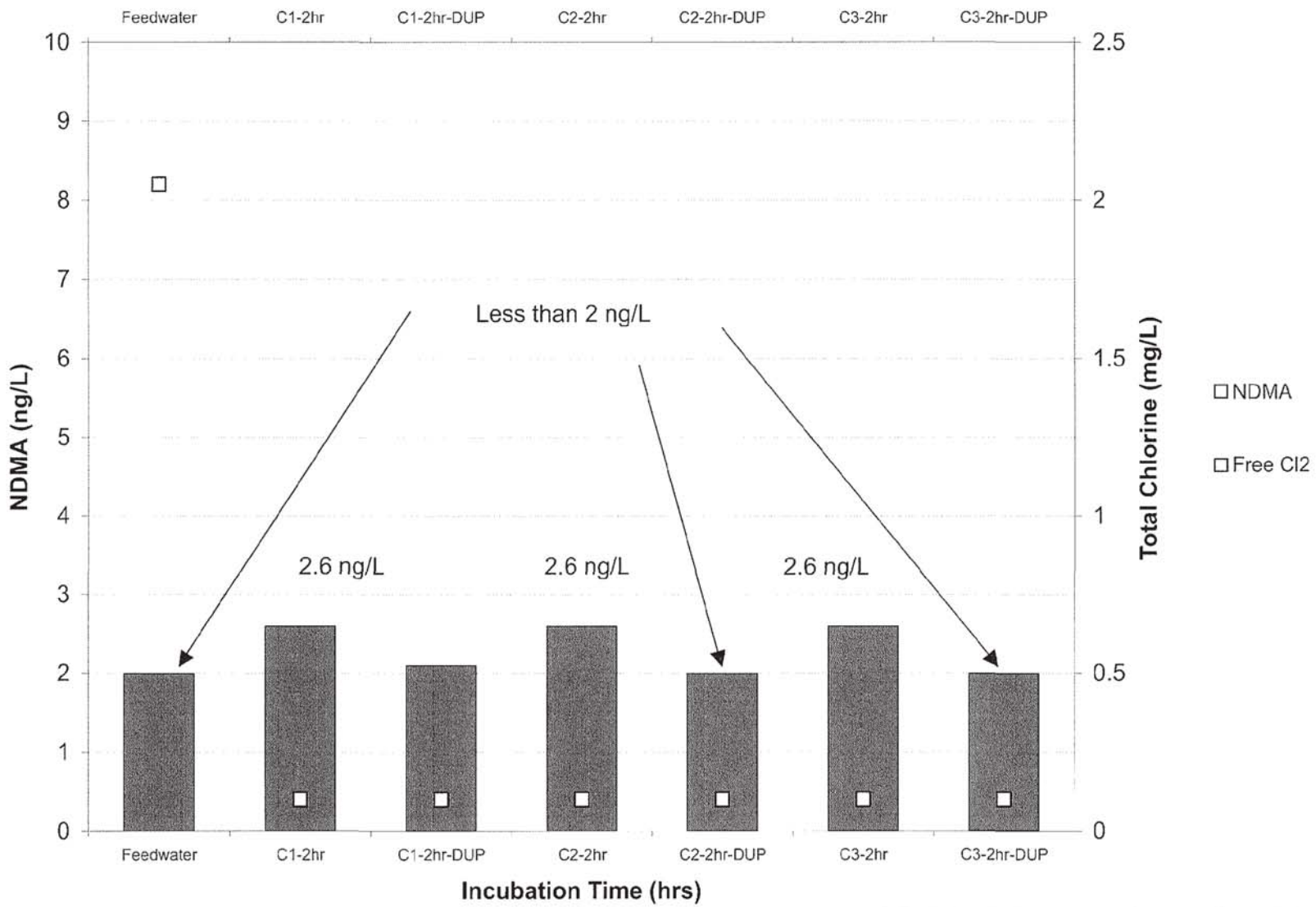
	Actual TTLC Metals Concentrations Measured in Spent Resins (mg/kg)			Federal and State Regulatory Limits		
Contaminant	Cal 2100 Series	USF 9708	USF 9710	TTLC Threshold Concentration (mg/kg)	STLC Threshold Concentration (mg/L)	TCLP Regulatory Level (mg/L)
Antimony	<4	<4	<4	500	15	
Arsenic	<0.5	<0.5	<0.5	500	5.0	5.0
Barium	<0.3	<0.3	<0.3	10,000	100	100.0
Beryllium	<0.2	<0.2	<0.2	75	0.75	
Cadmium	<0.2	<0.2	<0.2	100	1.0	1.0
Chromium	<0.3	**0.4**	<0.3	2,500	5	5.0
Chromium VI				500	5	
Cobalt	<1	<1	<1	8,000	80	
Copper	<4	<4	<4	2,500	25	
Lead	<10	<10	<10	1,000	5.0	5.0
Mercury	<0.05	<0.05	<0.05	20	0.2	0.2
Molybdenum	<2	<2	<2	3,500	350	
Nickel	<2	<2	<2	2,000	20	
Selenium	<3	<3	<3	100	1.0	1.0
Thallium	<0.2	<0.2	<0.2	700	7.0	
Vanadium	<0.5	**0.6**	<0.5	2,400	24	
Zinc	<4	<4	**7.8**	5,000	250	

Table 3.18 Comparison of Perchlorate, Nitrate and Uranium in Spent Resins Leachates Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency					
Contaminant	**Cal 2100 Series**	**USF 9708**	**USF 9710**	**CA-T22 MCL**	**DHS Action Level**
Perchlorate (μg/L)	< 4,000	< 4,000	< 4,000	—	4
Nitrate-N (mg/L)	21	19	22	10	—
Uranium (pCi/L)	3.0 ± 0.307	7.35 ± 0.752	4.06 ± 0.419	20	—

Table 3.19 Radionuclides Reportable Quantities (Table 2 of Appendix A under CERCLA) Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency		
Radionuclide	**Atomic Number**	**RQ (Ci)**
Uranium 230	92	1
Uranium 231	92	1,000
Uranium 232	92	0.01
Uranium 233	92	0.1
Uranium 234	92	0.1
Uranium 235	92	0.1
Uranium 236	92	0.1
Uranium 237	92	100
Uranium 238	92	0.1
Uranium 239	92	1000
Uranium 240	92	1000

7.3.2 Uranium Accumulation

To further assess any challenges of transporting spent resins from the treatment plant to an incineration facility, a mass balance was performed to calculate the amount of uranium accumulated on the resins for comparison to the Department of Transportation's (DOT's) reportable quantities (which define whether or not a substance is hazardous) and A-Values (values used during shipping of hazardous substances).



POST-CHLORINATION TESTING
NDMA RESULTS

FIGURE 3.19

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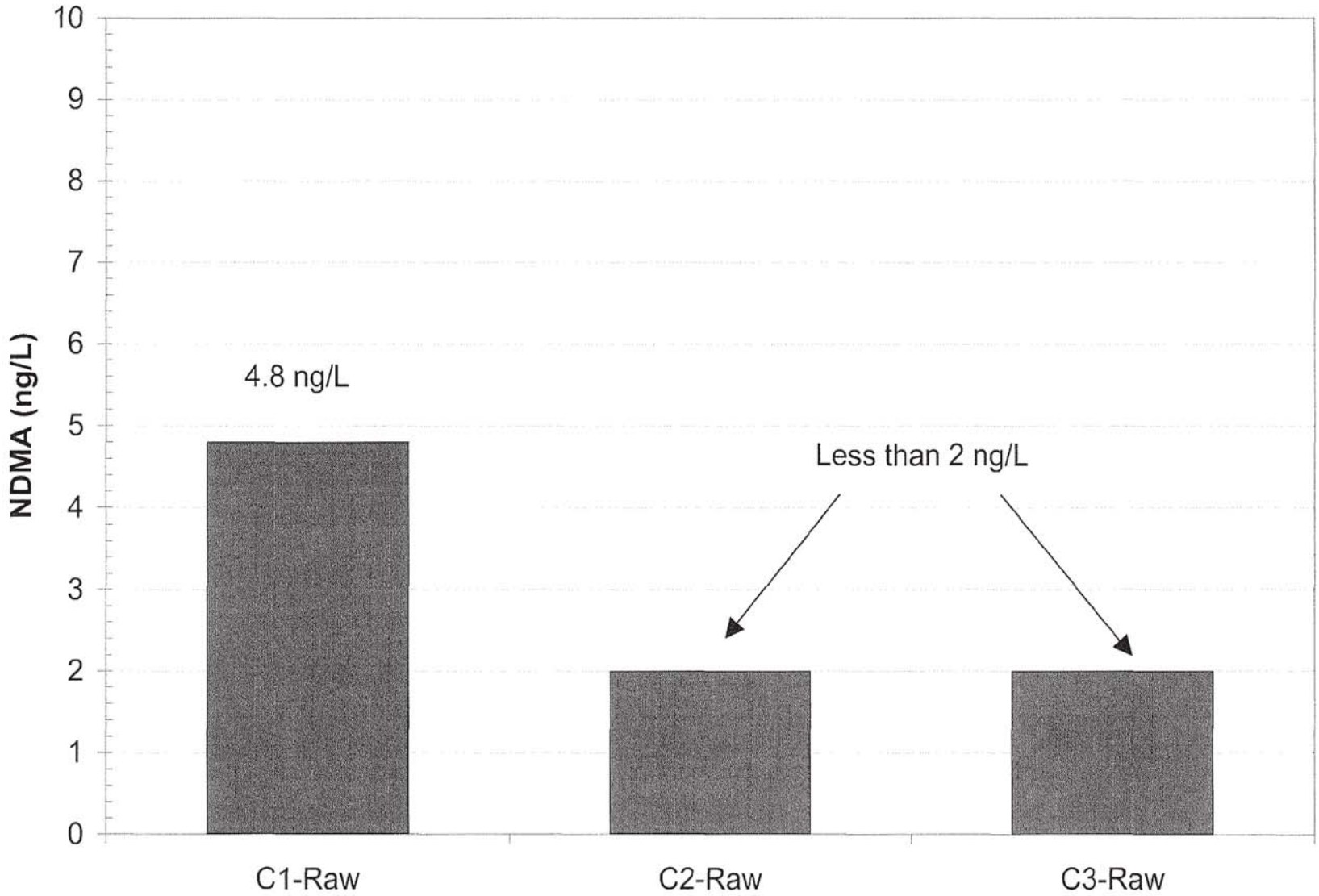

RESIN LEACH TEST RESULTS

FIGURE 3.20

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According to DOT's Hazardous Materials Regulations, 49 Code of Regulation SubChapter C (Hazardous Materials Regulations), subpart §171.8 (Definitions), a hazardous substance means a material, including its mixtures and solutions, that:

1. Is listed in the Appendix A to subpart §172.101 of the subchapter (Purpose and use of hazardous materials table).

2. Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in the Appendix A to §172.101 of the subchapter.

Appendix A lists materials and their corresponding RQs that are listed or designated as "hazardous substances" under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601(14) (CERCLA; 42 U.S.C. 9601 et seq). Table 2 of Appendix A lists radionuclides that are hazardous substances and their corresponding RQs. The RQs in Table 2 for radionuclides are expressed in units of curies, and are shown in Table 3.20.

Table 3.20 A1 and A2 Values for Radionuclides- Shipments Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Radionuclide	Atomic Number	A1 (Ci)	A2 (Ci)	Specific Activity (Ci/g)
Uranium 230	92	1,080	0.270	27,000
Uranium 232	92	81.1	0.00811	22
Uranium 233	92	270	0.027	9,700
Uranium 234	92	270	0.027	6,200
Uranium 235	92	Unlimited	Unlimited	0.0000022
Uranium 236	92	270	0.027	0.000065
Uranium 238	92	Unlimited	Unlimited	0.00000034
Uranium Natural	92	Unlimited	Unlimited	0.00000071

As far as transportation of hazardous substances, in Part 173 (Shippers- General Requirements for Shipments and Packaging), Subpart § 173.435, the values of A1 and A2 for radionuclides are defined. A1 means the maximum activity of special form Class 7 (radioactive) material permitted in a Type A package. A2 means the maximum activity of Class 7 (radioactive) material, other than special form, Low-Specific Activity (LSA) or Surface Contaminated Object (SCO), permitted in a Type A package, see Table 3.21.

Table 3.21 Calculated Accumulated Amount of Uranium on the Spent Resins Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency				
Resin	Days Until 50% ClO_4^- Breakthrough	Projected Uranium Accumulation (Ci)	Lowest RQ (Ci)	Lowest A Value (Ci)
Cal Resin	146(1)	1.6E-09	0.01	0.027
USF 9708	60	3.1E-09	0.01	0.027
USF 9710	138(1)	1.2E-09	0.01	0.027

Note:
(1) Extrapolated from perchlorate breakthrough plots

A mass balance of the uranium adsorbed and desorbed from each of the three resins up to 50 percent perchlorate breakthrough was performed based on an influent concentration range of 1.0 to 3.9 pCi/L and measured effluent uranium concentrations from each of the columns. The amount of uranium accumulated on the resins through 50 percent perchlorate breakthrough was calculated and is presented in Table 3.21. Accumulated uranium is far below the lowest permissible reporting quantity and A-value. The resins are thus not classified as hazardous and their transportation and disposal to an incineration facility should not pose a challenge to CLWA.

7.4 Summary of Ion-Exchange Testing Results

7.4.1 Feed Water Quality

The feed water is low in organic matter, has moderate hardness and alkalinity, and contains moderate levels of iron and bromide. The raw water quality was stable over the testing period with the exception of the month of October 2003, during which period pumping rates at the NC-12 well were temporarily reduced, causing a decrease in nitrate concentration, and increases in sulfate and chloride concentrations.

7.4.2 Operational Data

The flow rate ranged from 13.5 to16.5 mg/L during the course of the study, which resulted in EBCTs of 1.4 to 1.6 minutes (the target was 1.5 min).The pressure drop across the column remained constant at 5 psi during most of the project. The water temperature ranged from 32 degrees C (89 degrees F) in the summer months to 16 degrees C (61 degrees F) in the fall. pH ranged from 7.6 to 8.4.

7.4.3 Focused Breakthrough Curves of Nitrate, Sulfate, Chloride, and Bicarbonate

The breakthrough of most anions (with the exception of perchlorate) occurred in the first 24 hours of run time. Bicarbonate broke through immediately, followed by sulfate at 80 bed volumes. Nitrate broke through after 280 bed volumes, 440 bed volumes, and 600 bed

volumes from USF 9708, USF 9710, and Cal 2100 resins, respectively. No chromatographic peaking was observed for any of the critical anions. Chloride level dropped from a high of approximately 325 mg/L to background concentrations (~35 mg/L) after 280 bed volumes.

7.4.4 Long-Term Breakthrough Curves of Perchlorate and Other Anions

Bed volumes to reach perchlorate breakthrough (greater than 1 μg/L) were 25,000 (26 days), 72,000 (75 days), and 76,000 (79 days) for USF 9708 resin, USF 9710 resin, and CalResin 2100, respectively. This translates in treated water volumes of 187,000 gal/ft^3, 540, 000 gal/ft^3, and 569,000 gal/ft^3, respectively. A small increase in chloride concentration was observed after a simulated 45-hour shutdown period, likely due to leaching from the resin.

7.4.5 NDMA Results

The results from the post-chlorination testing with free chlorine (residual of 1.8 to 2.2 mg/L after 24 hours) and with combined chlorine (residual of 1.6 to 1.9 mg/L after 24 hrs) showed that NDMA concentrations in all three ion-exchange column effluents after 2- and 24-hour incubation times were below the detection limit of 2 ng/L. Therefore NDMA precursors did not leach from the resin .

To investigate the formation potential of NDMA upon the reaction of chlorine with DBP precursors in the water or leaching from the resin, a 2-mg/L free chlorine dose was added directly to the feed water. Measured NDMA levels were below or just over the detectable limit of 2 ng/L.

To evaluate the NDMA precursor leaching potential of the resins, 100 mL batches of fresh resin were incubated for four hours in deionized water and groundwater. NDMA was detected in only one sample, which measured at less than half the 10 ng/L Action Level.

7.4.6 Spent Resin Characterization

The California TTLC metal concentration values were mostly non-detect in all three spent resins. Chromium, vanadium, and zinc were detected in USF 9708 and USF 9710 spent resins at levels significantly below the regulatory TTLC threshold concentrations. Uranium levels in the spent resin leachate were significantly below the Title 22 MCL of 20 pCi/L. To investigate whether the spent resins would be classified as hazardous for transportation to an incineration facility, a mass balance of the uranium adsorbed and desorbed from the resin up to 50 percent perchlorate breakthrough was performed. The amount of uranium accumulated on the spent resins is far below the lowest permissible reporting quantity and A-value of the California DOT.

7.5 Fixed-Bed Filter

7.5.1 Biological Acclimation

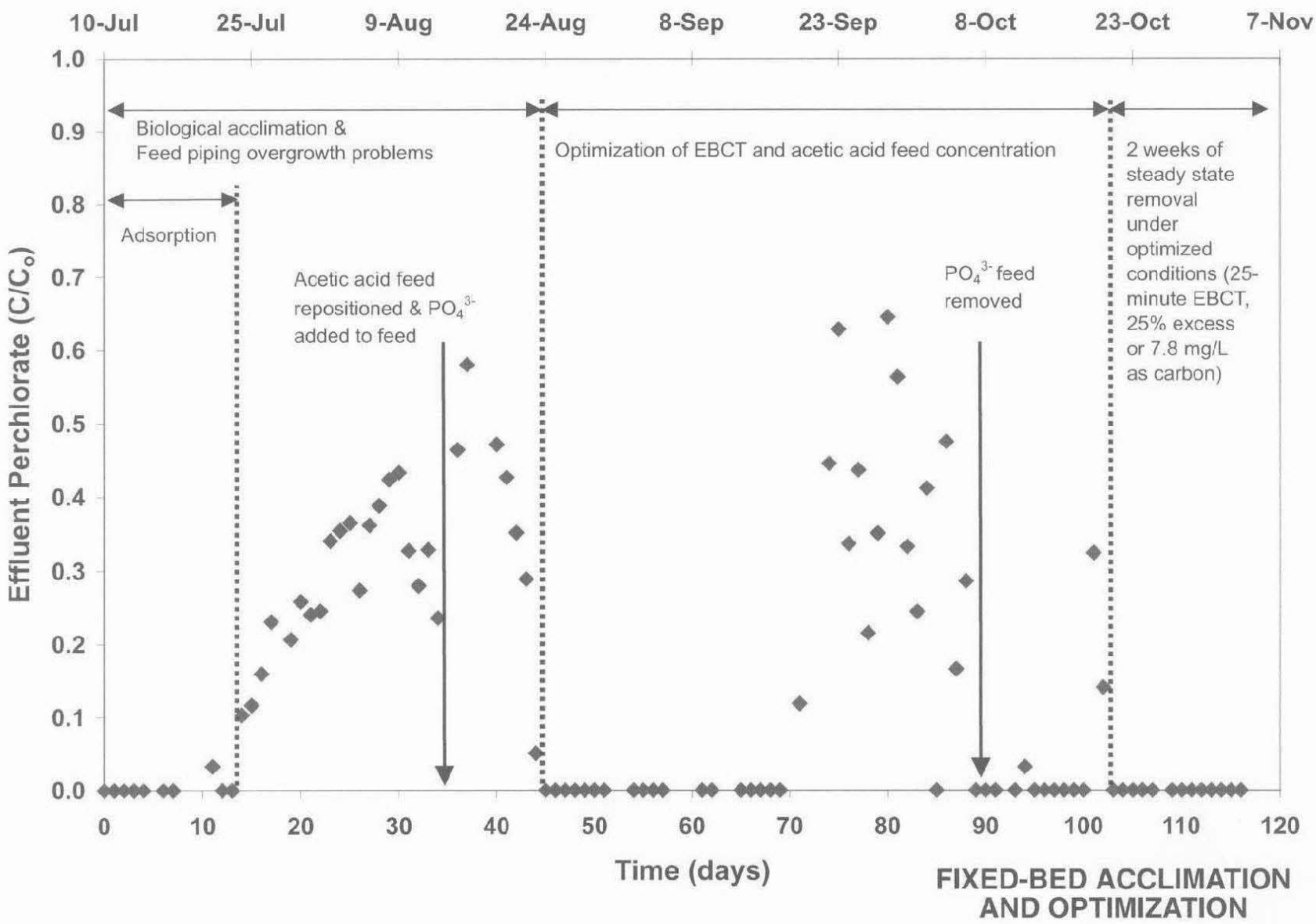
Figure 3.21 shows FXB perchlorate removal performance during the biological acclimation and optimization phases[1]. Perchlorate was initially removed by adsorption onto the virgin GAC, and began to break through after 12 days as the carbon's adsorption capacity diminished. These data are consistent with other perchlorate/GAC breakthrough curves reported in the literature (Na et al., 2002, Brown et.al, 2002). During the subsequent month of biological acclimation, run times were less than 24 hours due to rapid headloss development in the filter. The pilot feed lines were experiencing heavy biological growth, and the biofilm from the feedlines would occasionally detach and clog the bed. The acetic acid feed concentration was lowered during the acclimation phase (Figure 3.22) to minimize growth. However, excessive biogrowth in the feed lines continued to generate rapid headloss build-up. Phosphoric acid was added at 0.2 mg/L PO_4-P to select away from filamentous organisms suspected of causing the overgrowth and clogging problems. Simultaneously, the electron donor feed was repositioned so that acetic acid was fed directly to the top of the filter column instead of upstream of the static mixer, thus minimizing biofilm growth in the feed line. Consequently, biogrowth was isolated to the filter bed, headloss development rates decreased, and 48-hour run times were achieved. Within 10 days of adding phosphoric acid and repositioning the acetic acid feed, steady perchlorate removal to below detection was achieved in the filter. The phosphoric acid feed was removed during the optimization tests without affecting perchlorate removal performance, indicating that phosphorous in the natural water did not limit biological activity in the filter. Therefore, repositioning the acetic acid feed was likely the key to effectively acclimating the FXB filter for biological perchlorate removal. If this electron donor feed configuration had been used from time zero, it is estimated that steady-state biological perchlorate removal to below detection would have required 3 to 4 weeks of operation.

7.5.2 Optimization

During the two months of piloting after the acclimation period, EBCT and acetic acid feed concentrations were optimized (Figures 3.21 and 3.22). The minimal acetic acid concentration that still allowed removal of perchlorate to below detection was 7.8 mg/L as carbon (25% excess).[2] EBCTs as low as 15 minutes allowed for the consistent, complete removal of perchlorate to below detection, although only 24-hour run times were achieved. To lengthen run times, the EBCT was increased to 20 minutes. However, short-circuiting of the filter was observed throughout this period, resulting in perchlorate breakthroughs from 20 to 65 percent. While the 15-minute EBCT operation resulted in rapid headloss development (i.e., < 24-hour run times) but no perchlorate breakthrough, the 20-minute EBCT resulted in short-circuiting and variable perchlorate breakthrough. It appears that the

[1] All perchlorate detections (even those lower than the 4 μg/L MRL) are shown in the FXB and FBR figures.

[2] Assumes complete reduction of 7.0 mg/L of feed DO and 15 mg/L of feed nitrate.



FIXED-BED ACCLIMATION AND OPTIMIZATION

FIGURE 3.21

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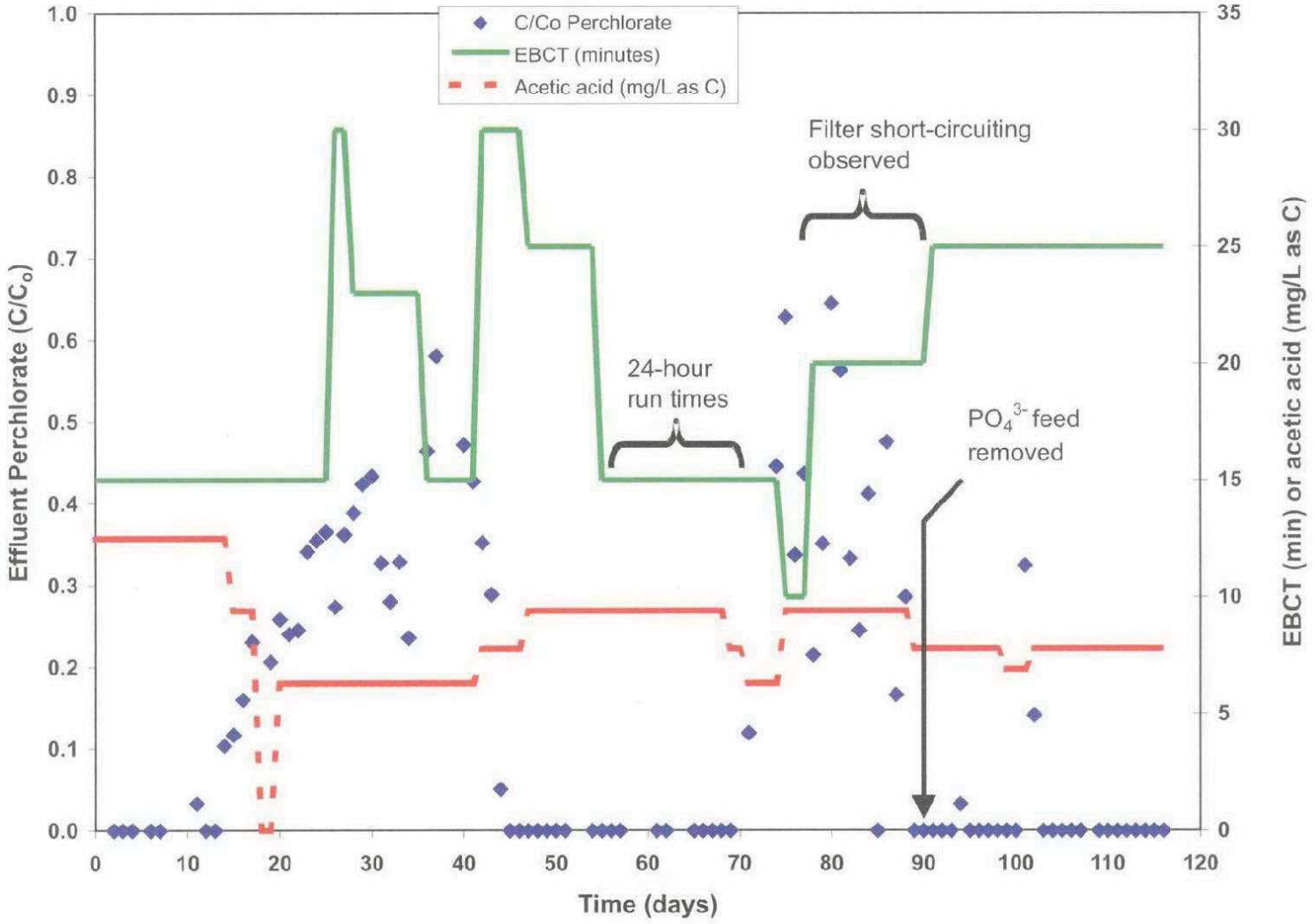

FIXED-BED EBCT AND ACETIC ACID SET-POINTS

FIGURE 3.22

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higher flow rate promoted more uniform hydraulic loading in the filter, which distributed growth evenly across the bed. Instead of passing through the filter evenly, feedwater pumped at lower flow rates followed preferential paths that produced the observed channeling. The shortest EBCT that allowed ≥ 48-hour run times while consistently removing perchlorate to below detection was 25 minutes. Though some channeling was observed under 25-minute EBCT conditions, it was less extensive than that observed during 20-minute EBCT operation. After the optimization period, the filter was run for two weeks using a 25-minute EBCT and 7.8 mg/L acetic acid carbon. Removal of perchlorate to below detection was observed throughout this period as well.

7.5.3 Dissolved Oxygen and Nitrate

All perchlorate-reducing bacteria described in the literature are facultative aerobes or microaerophiles. Thus, oxygen can inhibit biological perchlorate reduction by acting as a competing electron acceptor. Similar to oxygen, nitrate has a high redox potential that allows it to compete with perchlorate for use as an electron acceptor. Research has confirmed the occurrence of this competitive inhibition by demonstrating that DO and nitrate concentrations must be very low to achieve efficient perchlorate reduction in biological reactors (Brown et al., 2001, Herman and Frankenberger, 1999). Therefore, influent and effluent DO and nitrate concentrations were monitored closely during pilot testing.

Effluent DO concentrations were generally low during the acclimation phase (Figure 3.23). DO was likely reacting with the surface of the GAC initially, and was being reduced biologically as bacteria colonized the bed. Influent DO concentrations ranged from 4 to 8 mg/L and were reduced to 0.2 percent 0.3 mg/L throughout most of the pilot testing period. While effluent DO concentrations were steady, Figure 3.24 shows that effluent nitrate concentrations were variable. It was also observed that when effluent nitrate concentrations were detected, effluent perchlorate concentrations were also detected. These data: 1) indicate that DO was preferentially reduced over nitrate, and 2) confirm that DO and nitrate inhibit biological perchlorate reduction, as has been widely reported in the literature.

Figure 3.24 also reveals that feed nitrate concentrations gradually declined to approximately 7 mg/L as NO_3 after operating for 80 days at 15 mg/L as NO_3. The decline in feed nitrate concentrations coincided with a change in the NC-12 pumping schedule. After Day 80 of pilot operation, NC-12 was no longer pumped continuously for production, but rather was turned on periodically only to produce water for pilot plant operation. The resultant decrease in NC-12 production may have caused the variable background nitrate as well as sulfate (Figure 3.27).

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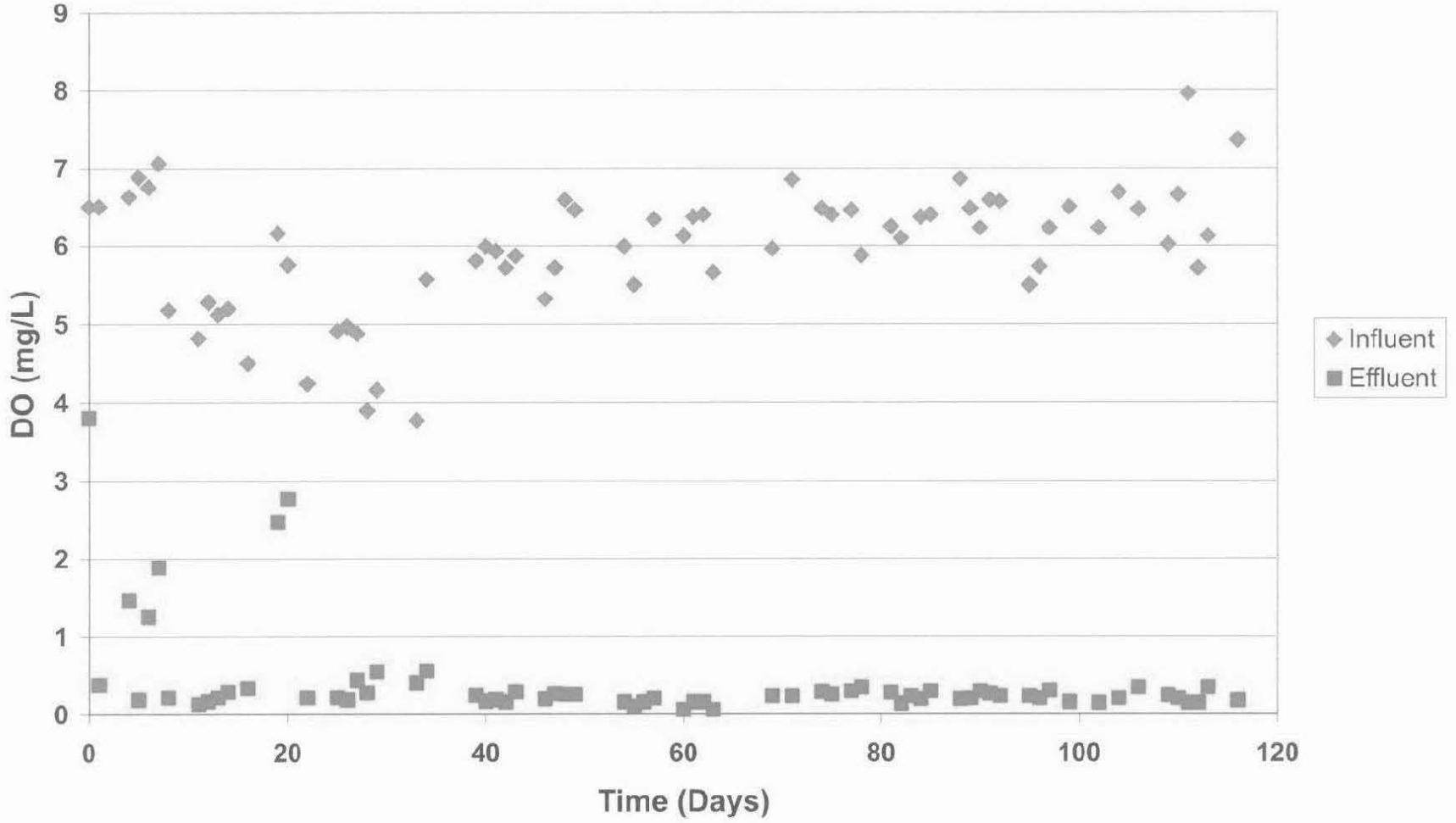

FIXED-BED DISSOLVED OXYGEN

FIGURE 3.23

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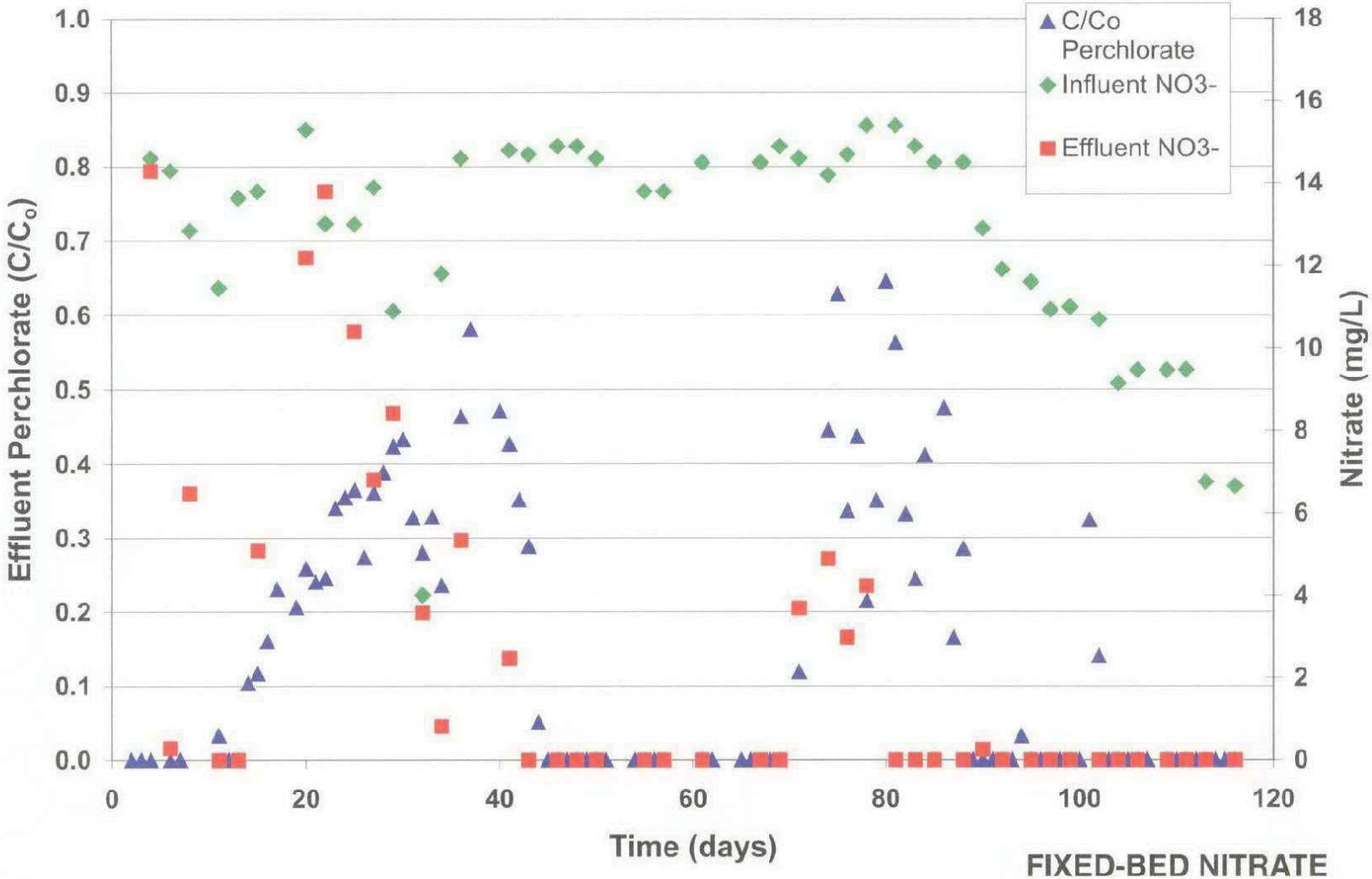

FIXED-BED NITRATE AND PERCHLORATE

FIGURE 3.24

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7.5.4 Other Parameters

The following water quality observations were made during acclimation and optimization phases of FXB piloting:

- Effluent TOC concentrations were very low (Figure 3.25); generally non-detect (i.e, ≤ 0.7 mg/L). Effluent BDOC concentrations were non-detect (Figure 3.26). These data indicate that effluent from the FXB filter is biologically stable, and suggest that the post-treatment steps may be somewhat simplified to aeration and disinfection.
- Sulfate concentrations and pH were not significantly impacted across the filter (Figures 3.27 and 3.28, respectively). However, sulfide was occasionally detectable by smell.
- HPCs increased across the filter, resulting in counts between 70,000 and 650,000/mL (Figure 3.29).
- With the exception of two data points, total coliforms were not detected in the feed or effluent of the filter (Figure 3.30). The two detections indicated that coliforms in the feed water were partially removed across the filter. No fecal coliforms were detected.
- Average feed water turbidities were approximately 0.5 NTU. Average effluent turbidities were approximately 0.6 NTU (Figure 3.31). Average effluent particle count (>2 µm) was 99 counts/mL (Figure 3.31). The particle counter malfunctioned after 80 days of operation.
- Headloss across the filter ranged from < 2 feet to 30 feet (Figure 3.32). Under optimal operating EBCT and acetic acid conditions, headloss peaked at 25 feet, but was typically between 5 and10 feet.

7.5.5 Robustness Characterization

7.5.5.1 Backwashing

The results of the backwash challenge tests are shown in Figure 3.33. After the filter was put back into production following a backwash event, samples were taken every 15 minutes for an hour. No perchlorate was detected. This experiment was repeated one month after the first backwash challenge test with the same result.

7.5.5.2 Perchlorate Spiking

Transient perchlorate loading episodes did not impact perchlorate removal performance in the FXB filter (Figure 3.34). The feed perchlorate concentration was varied from 50 µg/L to 100 µg/L to 50 µg/L to 300 µg/L to 5 µg/L while EBCT and feed acetic acid concentration were maintained at 25 minutes and 7.8 mg/L as carbon, respectively. No perchlorate was detected in the effluent, even for the high resolution samples (i.e., samples taken at 0, 15, 30, 45, and 60 minutes) taken immediately after the influent perchlorate concentration was changed.

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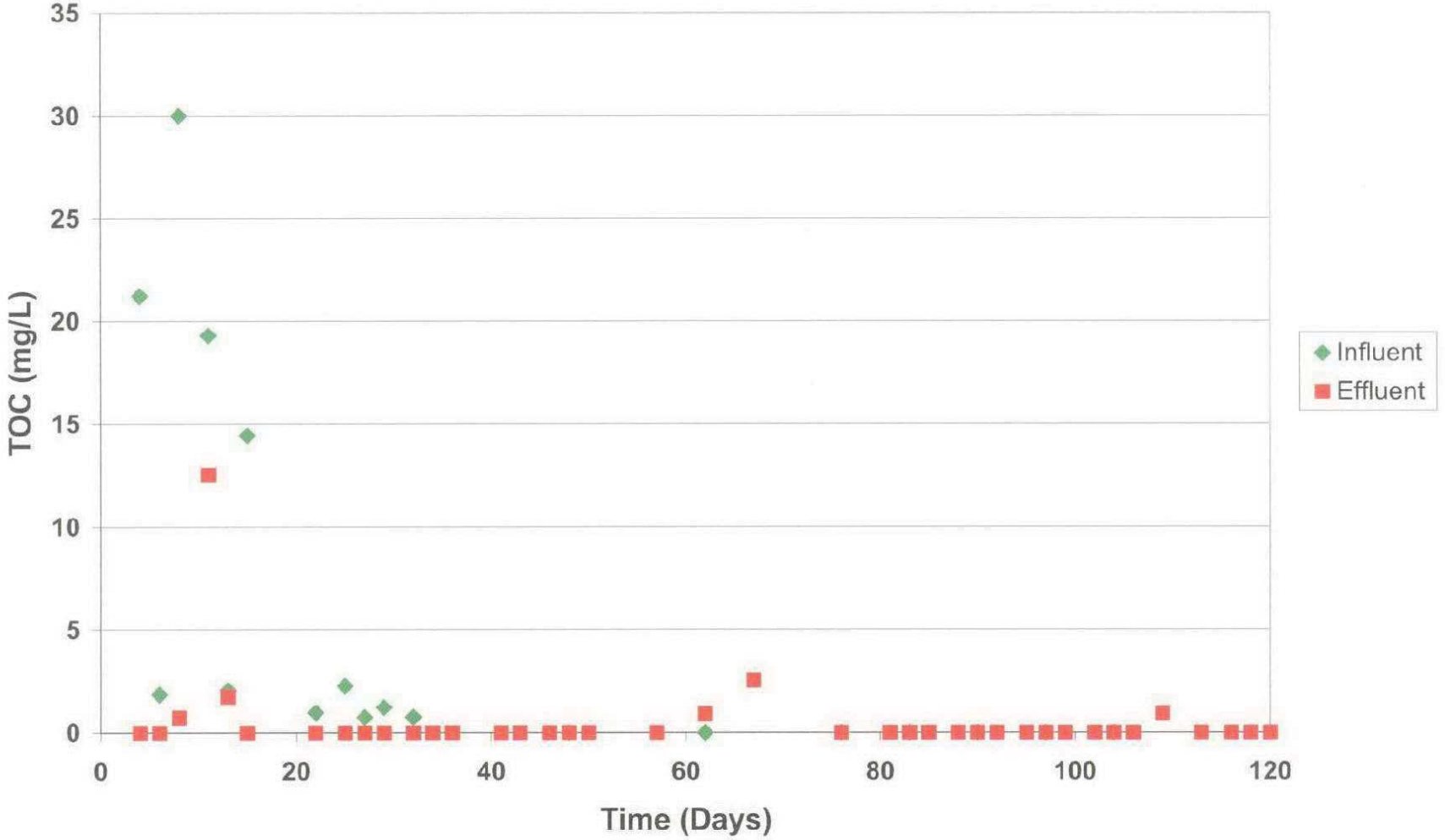

FIXED-BED TOTAL ORGANIC CARBON

FIGURE 3.25

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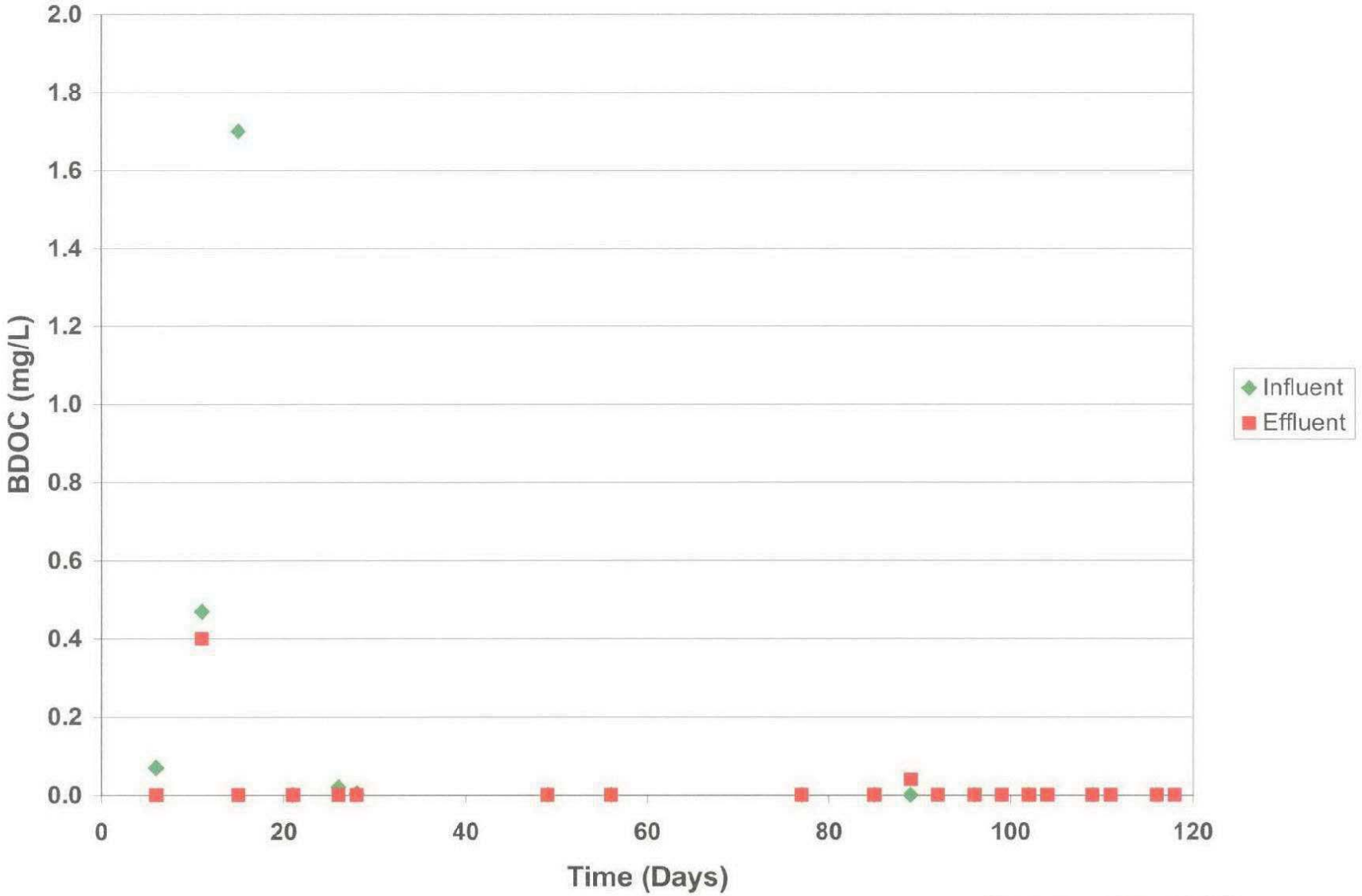

FIXED-BED BDOC

FIGURE 3.26

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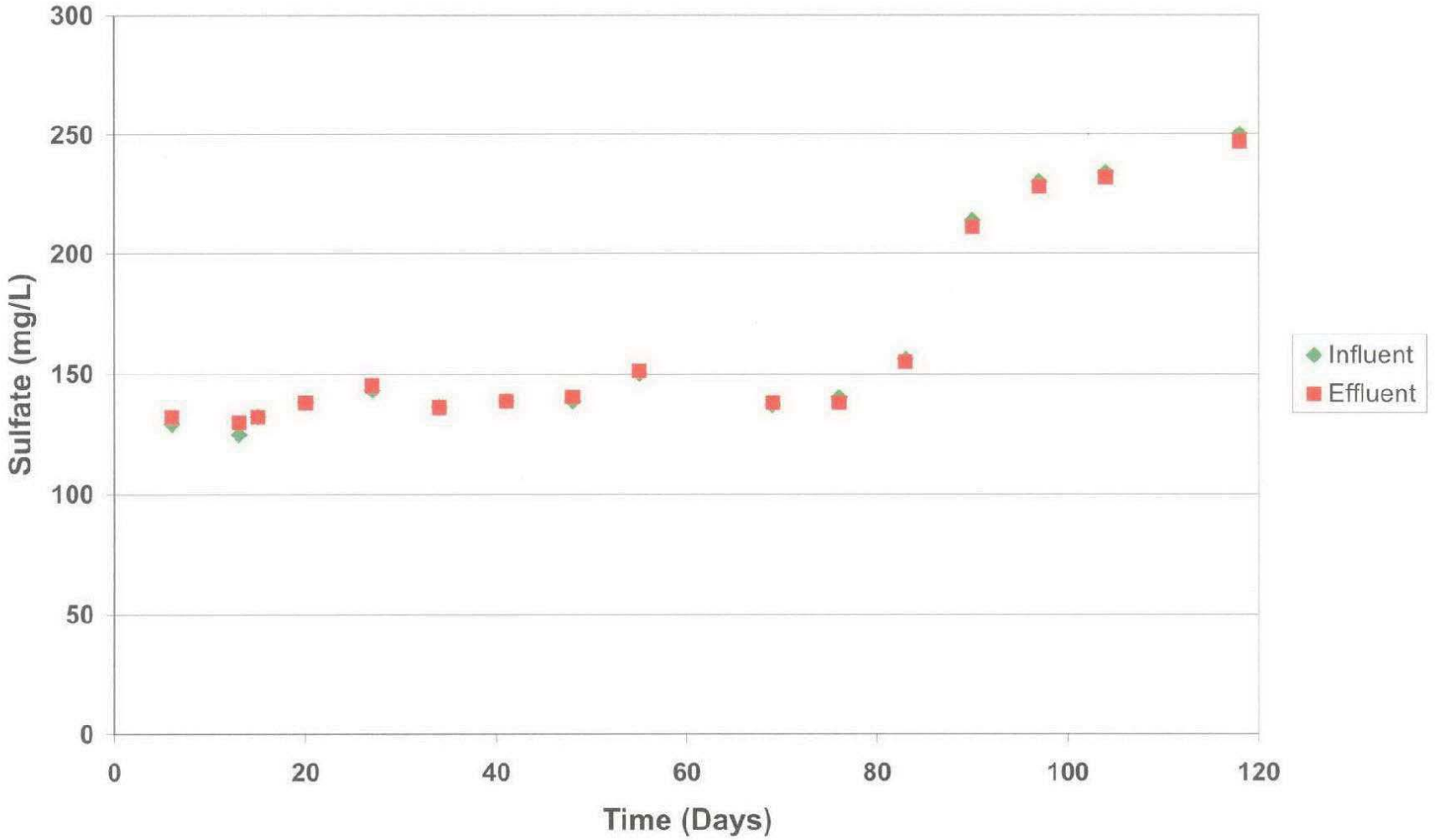

FIXED-BED SULFATE

FIGURE 3.27

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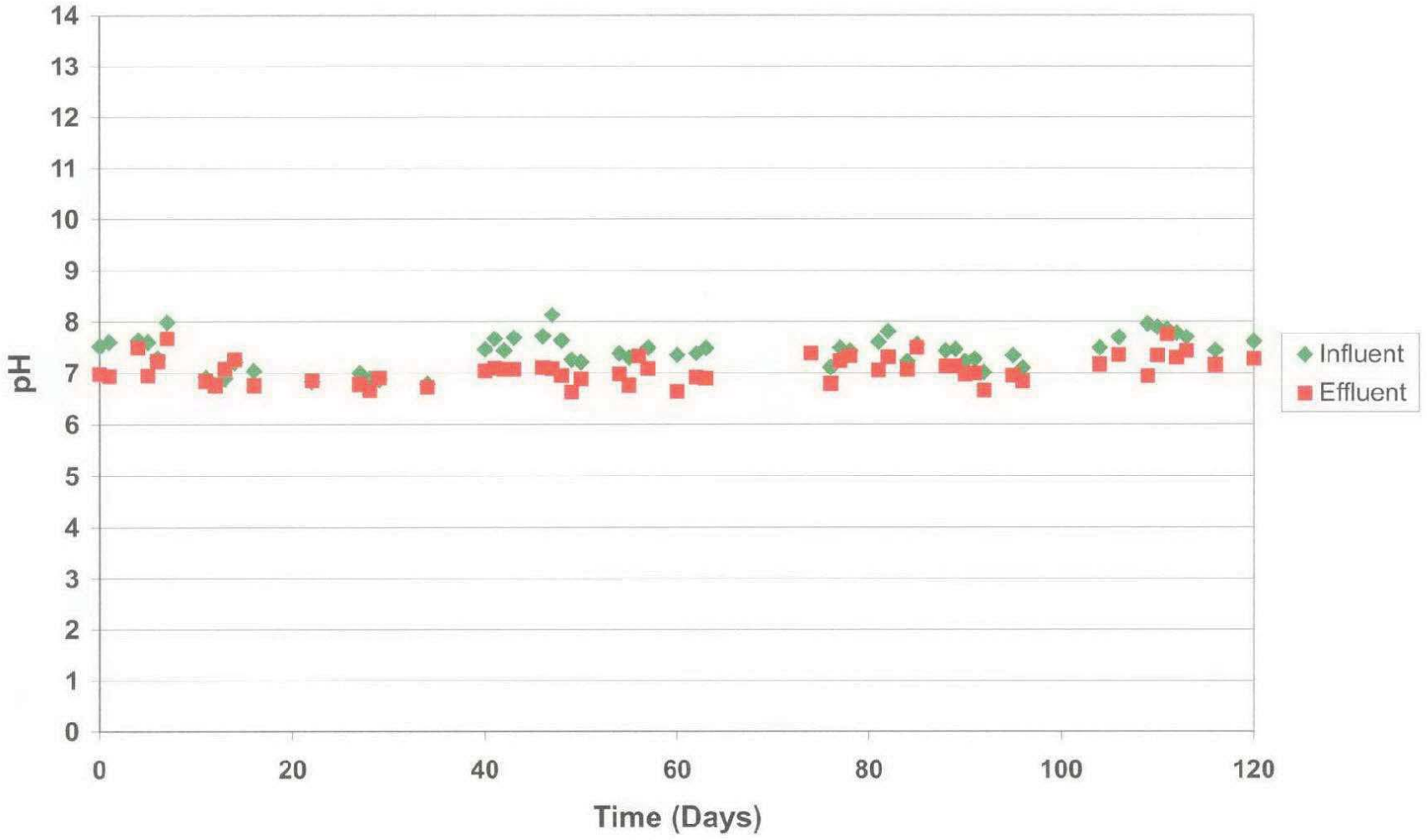

FIXED-BED pH

FIGURE 3.28

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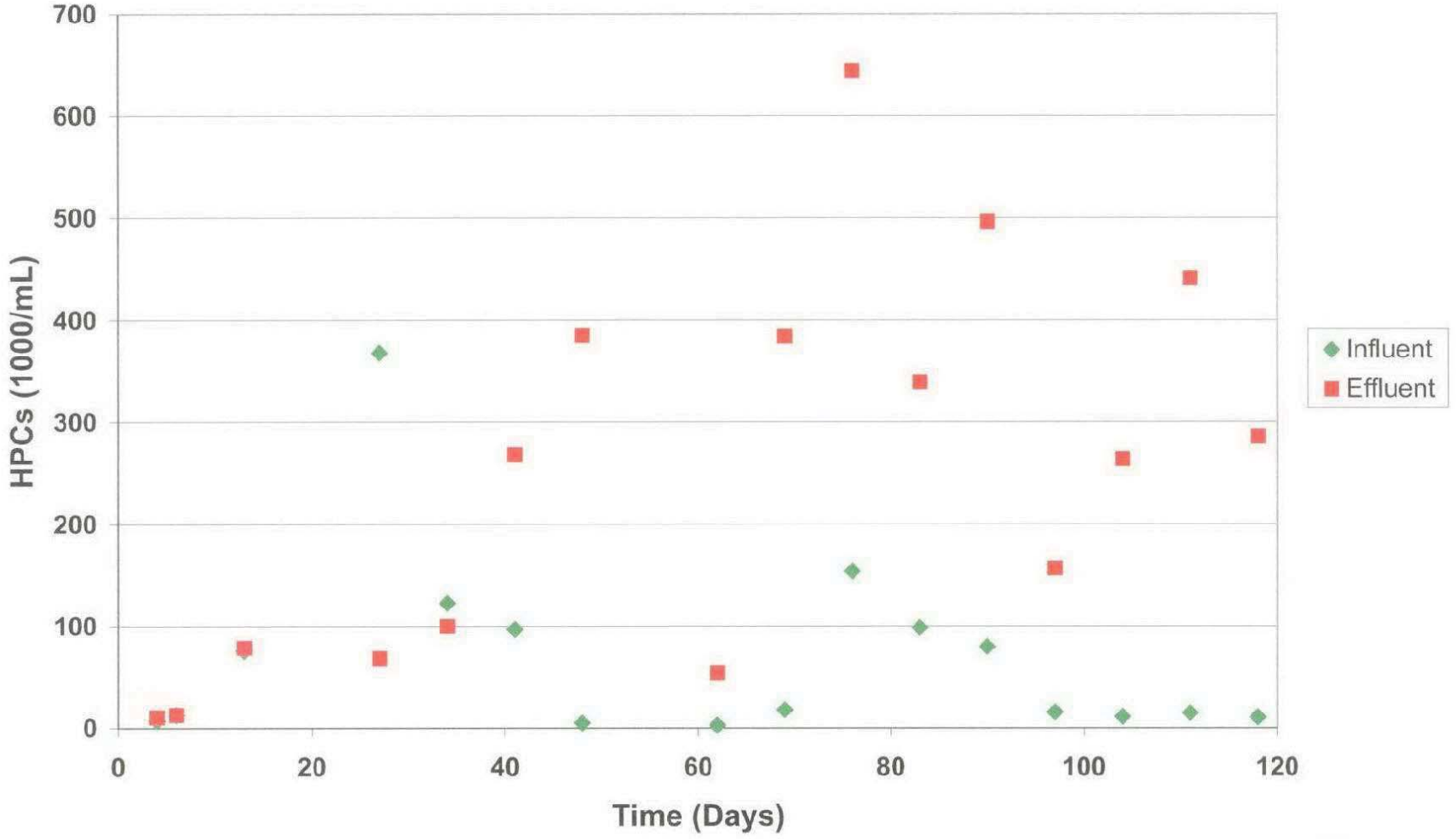

FIXED-BED HETEROTROPHIC PLATE COUNTS

FIGURE 3.29

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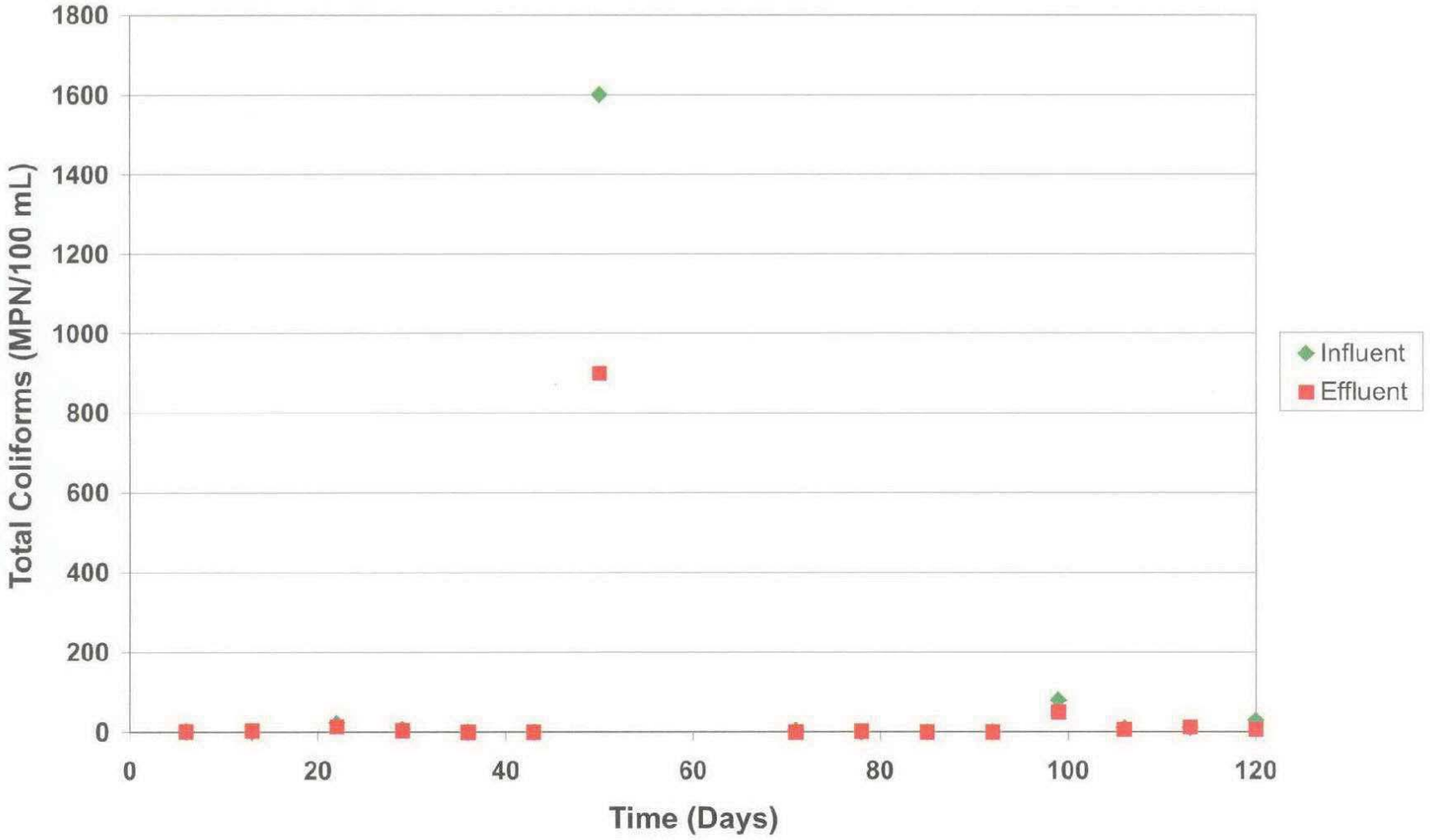

FIXED-BED TOTAL COLIFORMS

FIGURE 3.30

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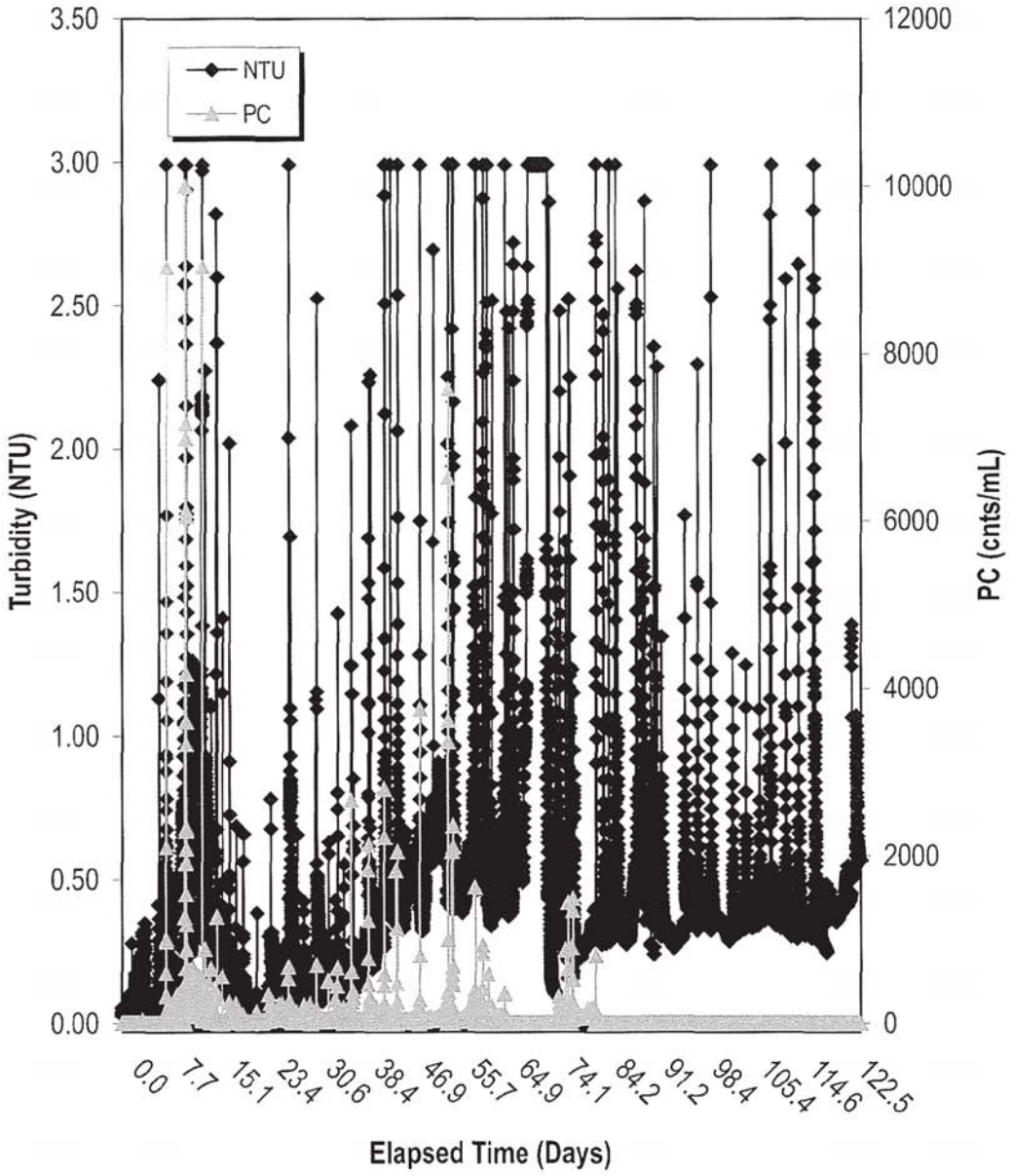

FIXED-BED EFFLUENT TURBIDITY AND PARTICLE COUNTS

FIGURE 3.31

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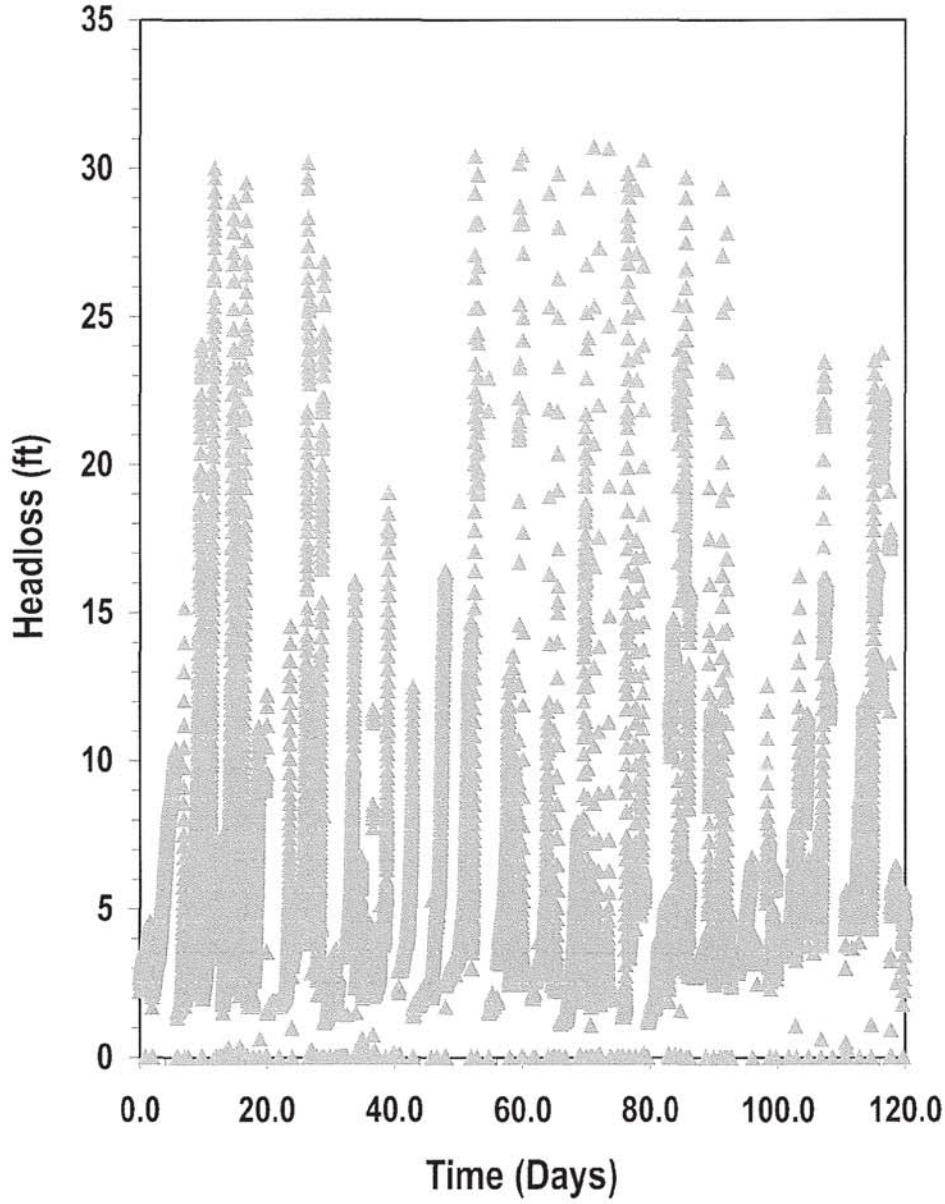

FIXED-BED HEADLOSS

FIGURE 3.32

20-CLWA204F3.32-6625A10.CDR

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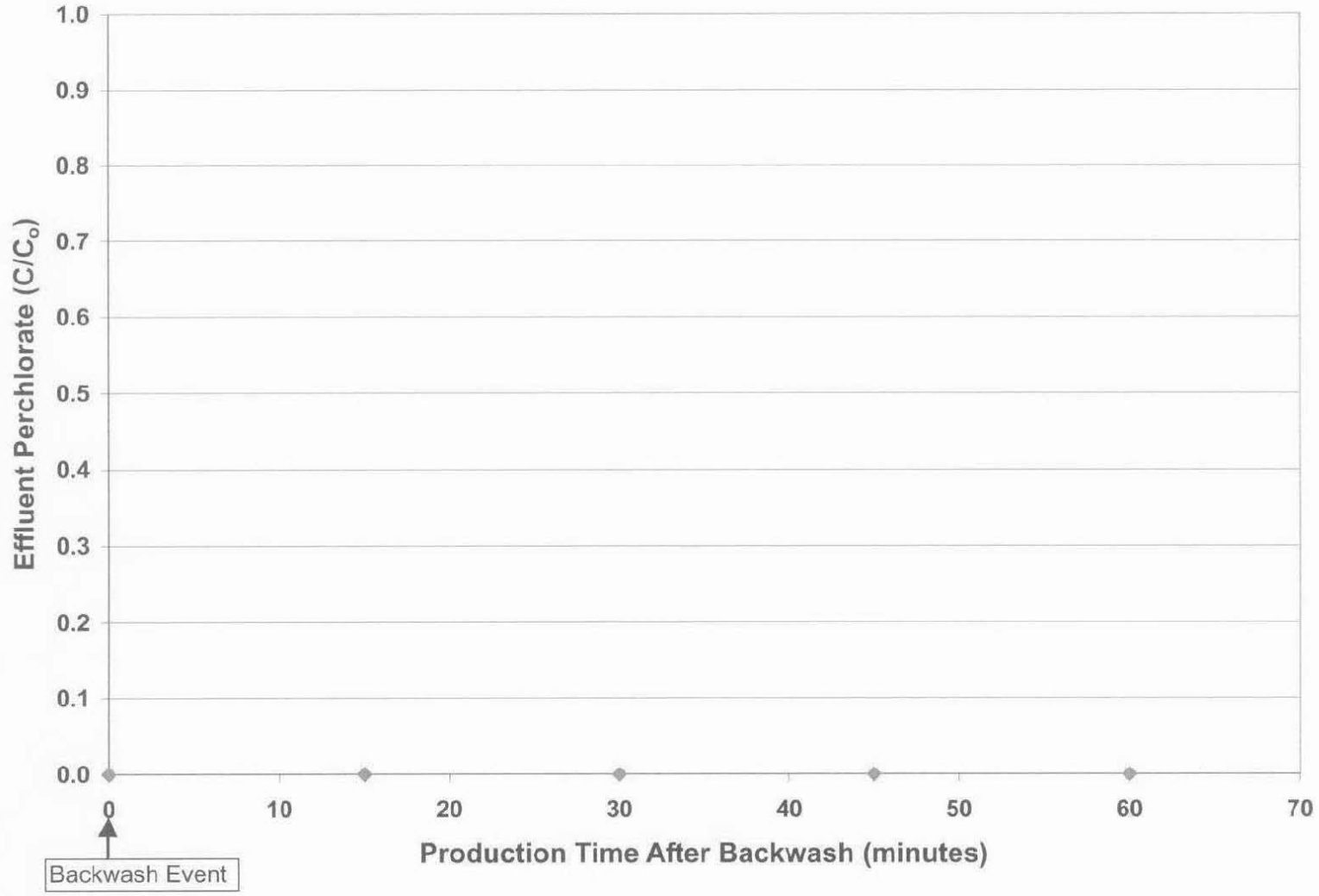
20-CLWA204F3.33-6625A10.CDR



FIXED-BED BACKWASH CHALLENGE TEST

FIGURE 3.33

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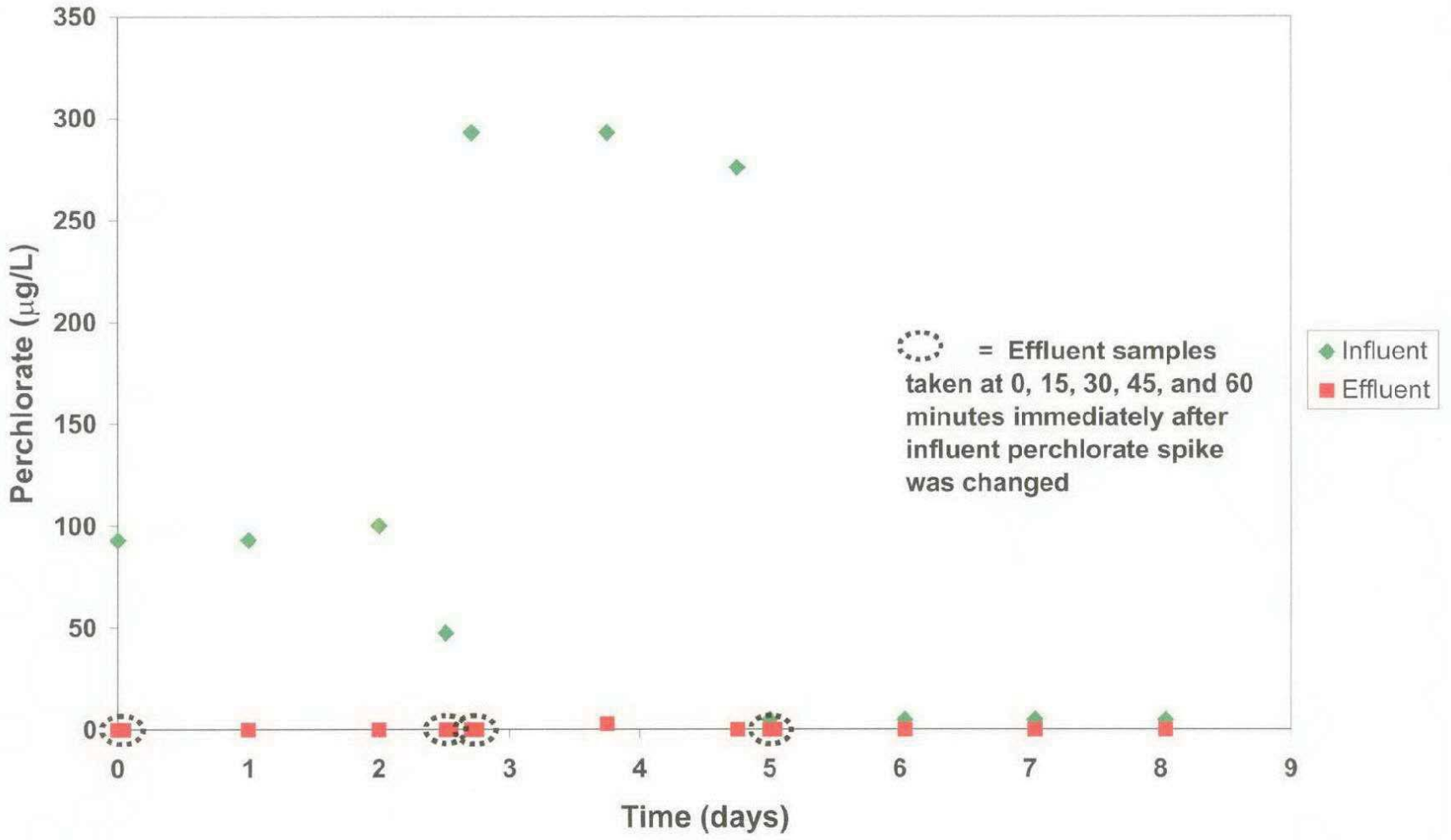
20-CLWA204F3.34-6625A10.CDR



FIXED-BED PERCHLORATE SPIKE CHALLENGE TEST

FIGURE 3.34

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7.5.5.3 Nitrate Spiking

When the feed nitrate concentration was increased stepwise from 6 mg/L as NO_3 to 29 mg/L as NO_3, perchlorate was not detected in the high resolution samples taken up to an hour after the event (Figure 3.35). However, samples taken ≥ 24 hours after the step increase showed perchlorate, nitrate, and nitrite breakthrough. Increasing the acetic acid feed concentration and EBCT did not immediately recover perchlorate removal performance to below detection. Eight days after the feed nitrate concentration was increased by 23 mg/L as NO_3^-, complete removal of nitrate, nitrite, and perchlorate was again observed in the FXB. These data suggest two important phenomena:

1. When large step increases in feed oxidant concentrations occur, the biological FXB requires a period of bioacclimation before perchlorate removal to below detection can be reestablished and maintained. In other words, the bacterial mass in the FXB, which was equilibrated to a feed nitrate concentration of 6 mg/L as NO_3^-, was insufficient to handle a sudden increase in feed nitrate concentration of 23 mg/L as NO_3^-. The bacterial community had to grow and equilibrate with a much higher nitrate concentration before it could produce the redox conditions necessary for complete perchlorate removal.

2. Via adsorption, GAC provides a safety factor with respect to perchlorate removal in the FXB. This is supported by the lack of perchlorate detections immediately following the step nitrate increase. The primary perchlorate removal mechanism in the biological FXB is biological reduction. However, if the microbial activity in the filter is insufficient to remove perchlorate, the GAC can adsorb perchlorate for a period of time to prevent breakthrough. If perchlorate diffusion through the biofilm is fast, adsorption could be occurring near the top of the GAC bed, where the biological activity is highest. If perchlorate diffusion through the biofilm is slow, adsorption could be occurring in the lower portions of the GAC bed, where there is little biological activity. Sorption sites may be biologically regenerated when perchlorate reducing conditions return to the FXB. This may be the case even for adsorption sites in the lower portions of the bed, as GAC tends to migrate toward the top of the column during a backwash event, positioning it at depths of increased biological activity. This hypothesis explains why there might be perchlorate adsorption capacity available on the GAC after five months of pilot testing.

Large step changes in nitrate concentration, like the one tested during this experiment, are not typical for a groundwater system. Unintentional, gradual nitrate fluctuations were observed throughout pilot testing and did not impact perchlorate removal performance in the FXB.

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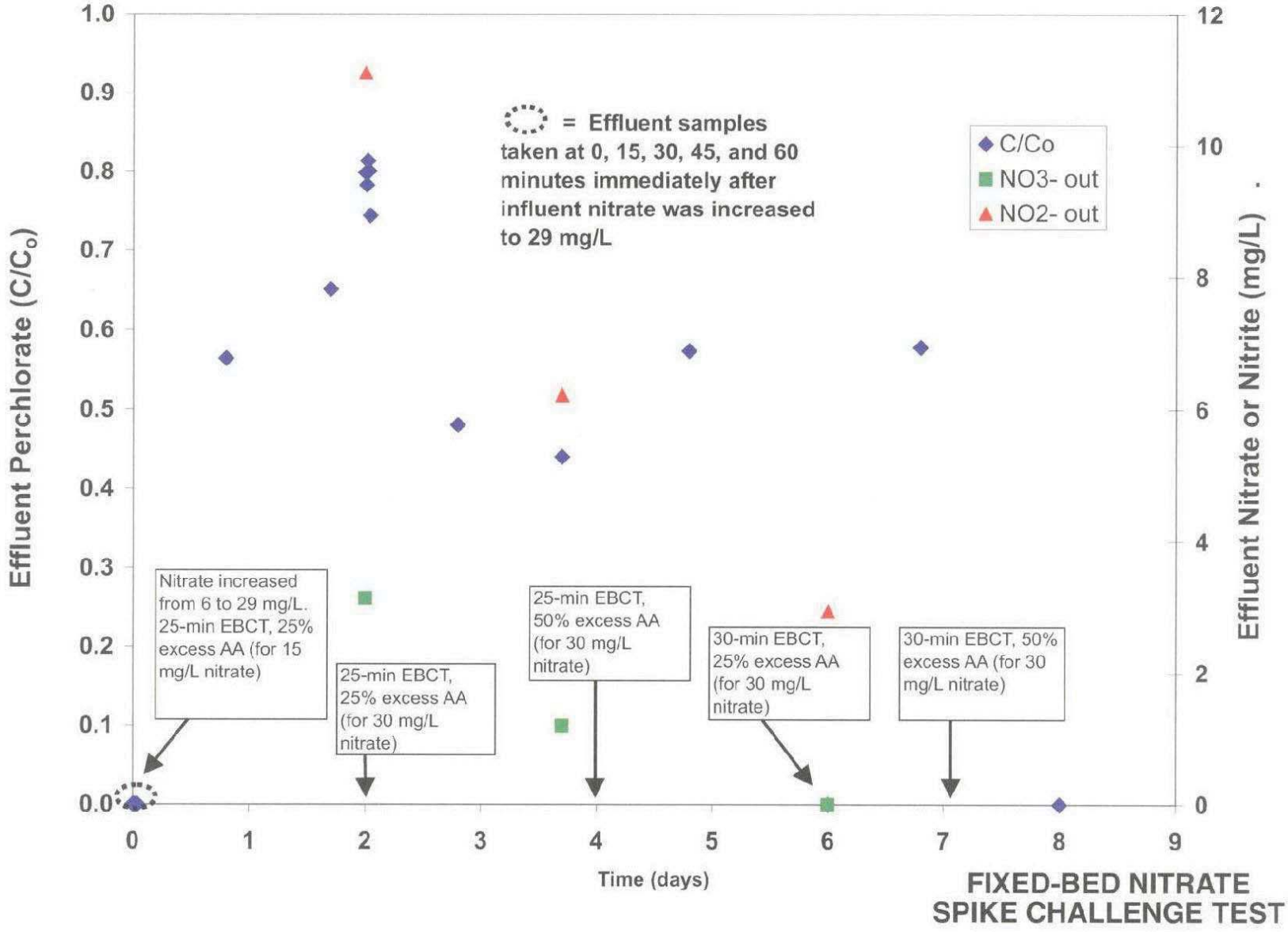

FIXED-BED NITRATE SPIKE CHALLENGE TEST

FIGURE 3.35

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7.5.5.4 System Shut-Down

Figure 3.36 shows the results of the 24- and 48-hour shut-down tests. The pilot plant was turned off for 24 hours and then restarted using a 25-minute EBCT and 7.8 mg/L acetic acid carbon. No backwash was performed prior to restarting the FXB. Samples taken at 0, 15, 30, 45, and 60 minutes and 24 hours after the pilot was restarted showed no perchlorate breakthrough. However, 26 percent and 40 percent breakthrough occurred 48 and 72 hours after the pilot was put back into production. After the 72-hour sample, the pilot was turned off for a period of 48-hours and then restarted without a backwash. Samples taken at 0, 15, 30, 45, and 60 minutes, 24 hours, and 48 hours after the pilot was restarted showed no perchlorate breakthrough. The 72-hour sample showed 24 percent breakthrough and the 96-hour sample again showed perchlorate removal to below detection.

The 24-hour shut-down experiment was repeated, but included a backwash prior to restarting the system. As Figure 3.36 indicates, no perchlorate was detected in the effluent in the high resolution samples or in subsequent samples taken daily for five days. A review of previous data also revealed four periods over which the biological FXB pilot system was shut down unintentionally. These periods ranged from 12 to 62 hours, the biological FXB was backwashed prior to restarting after each period, and production EBCTs were 15 or 25 minutes. No effluent perchlorate was detected following the shut down periods (Figure 3.37).

The biological FXB was also shut down for a two-week period in December 2003. It was backwashed and restarted at a 25-minute EBCT. Consistent perchlorate removal was immediately observed and sustained; no effluent perchlorate was detected.

7.5.5.5 Electron Donor Feed Failure Simulation

To investigate the impact of the future of the electron donor addition on perchlorate removal performance in the FXB, the acetic acid feed was shut off and effluent perchlorate concentrations were monitored. Samples taken at 0, 15, 30, 45, and 60 minutes and 2, 3, 5 and 24-hours after the acetic acid pump was turned off showed no perchlorate breakthrough (Figure 3.38). The acetic acid pump was then restarted and perchlorate continued to be removed to below detection. The following hypothesis may account for the exceptional perchlorate removal performance in the biological FXB while no exogenous electron donor was being added to the system:

1. The bacterial community in the biological FXB was respiring endogenously. That is, bacteria were metabolizing their own cells for use as an electron donor. This often occurs when food sources are scarce.

2. Via adsorption, GAC was providing a safety factor with respect to perchlorate removal in the FXB. When the acetic acid pump was turned off, biologically reductive activity likely slowed in the filter, allowing adsorption to become a more active mechanism for perchlorate removal.

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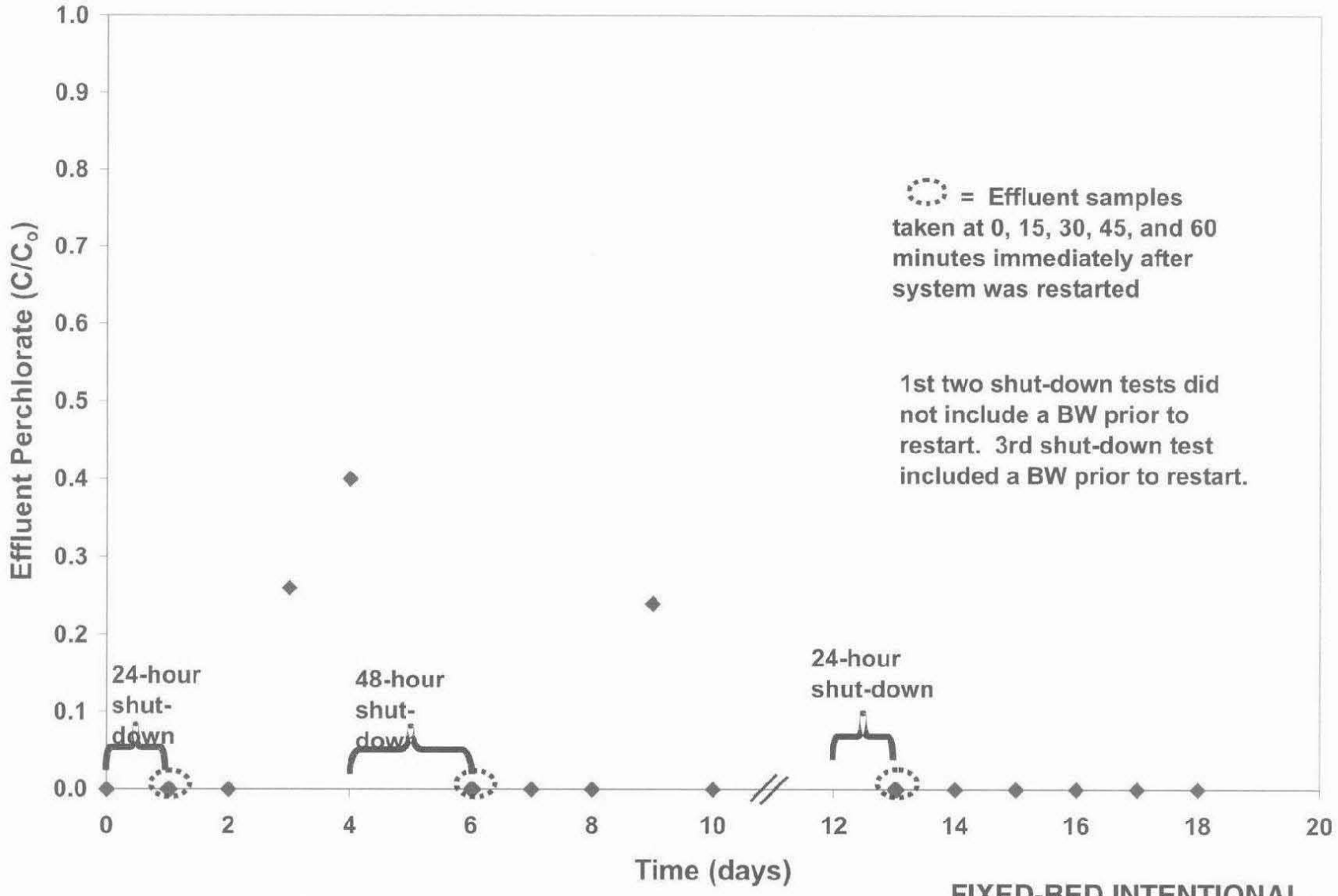

FIXED-BED INTENTIONAL SHUT-DOWN CHALLENGE TEST

FIGURE 3.36

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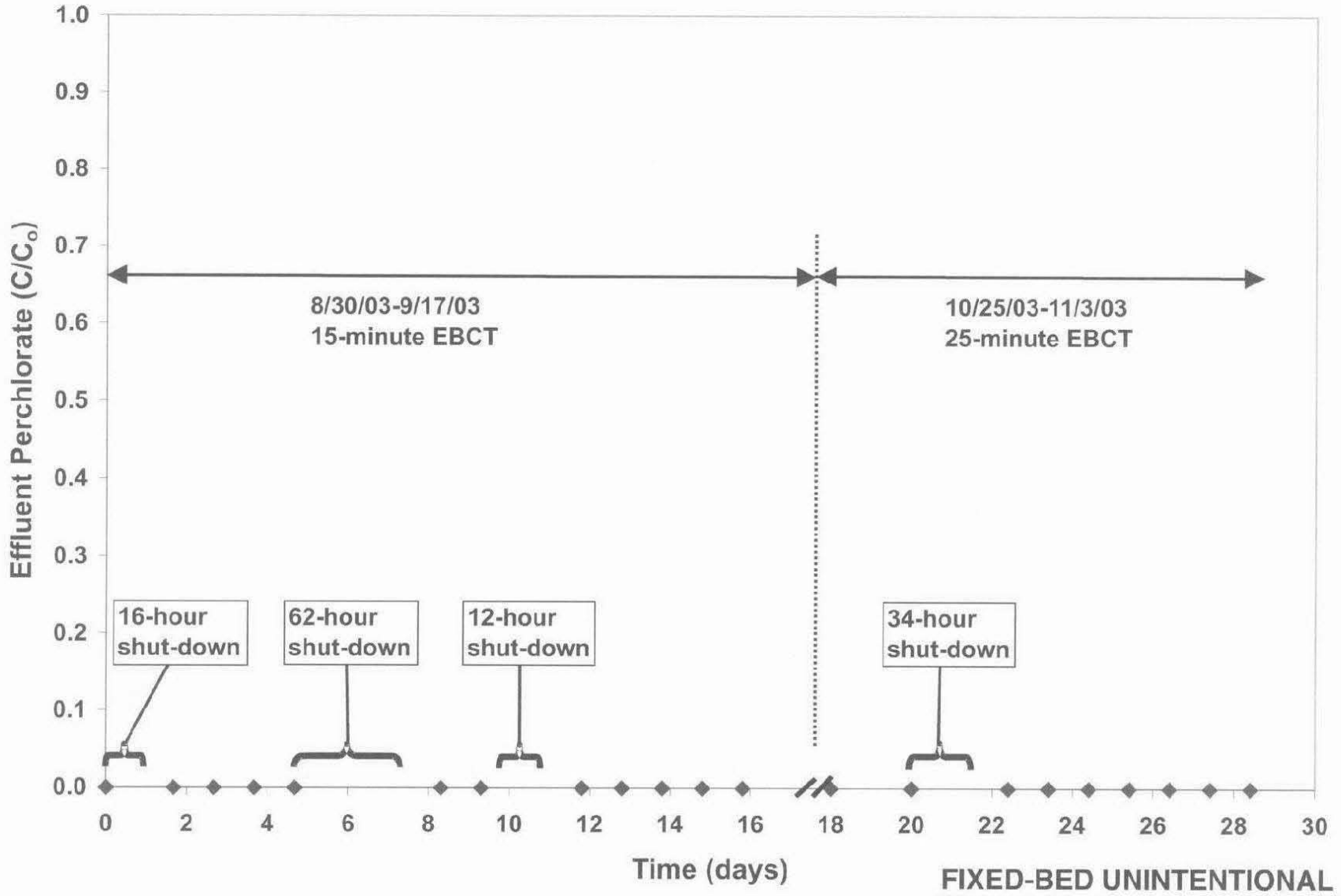
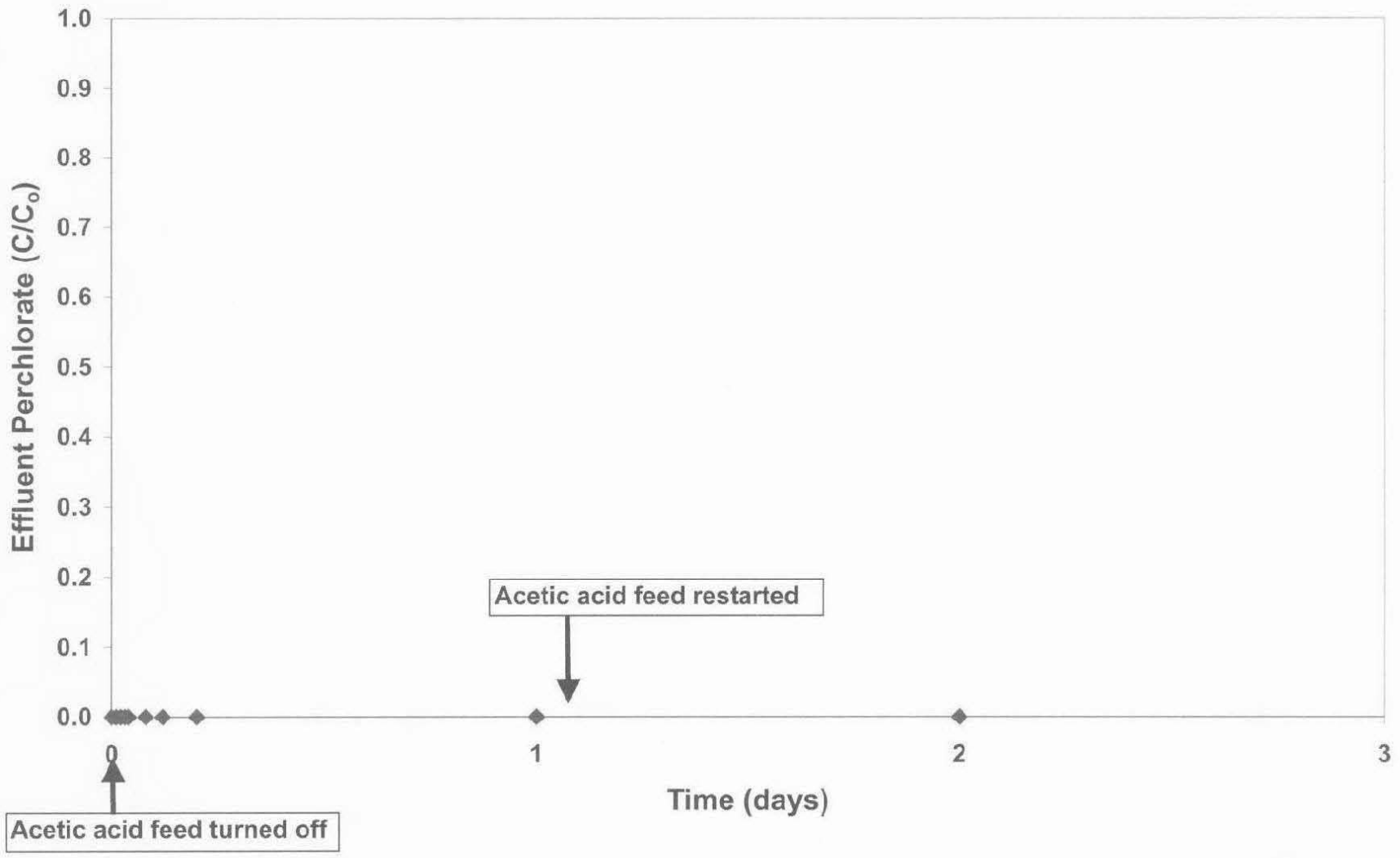


FIXED-BED UNINTENTIONAL SHUT-DOWN PERFORMANCE

FIGURE 3.37

20-CLWA204F3.38-6625A10.CDR



FIXED-BED ACETIC ACID FEED FAILURE CHALLENGE TEST

FIGURE 3.38

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It is possible that both of the above phenomena contributed to the 24-hour removal of perchlorate to below detection in the biological FXB while the acetic acid feed was shut off, though no experiments were performed to confirm this.

7.5.6 Backwash Water Quality

Table 3.22 lists backwash water quality data, as determined using composite samples of backwash water.

Table 3.22 Backwash Water Quality
Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer
Castaic Lake Water Agency

Parameter	Range
Perchlorate (µg/L)	ND (two points)
AOC (mg/L)	1.0-2.5
COD (mg/L)	63-250
VSS (mg/L)	41-140
TSS (mg/L)	39
Total coliforms (MPN/100 mL)	4-110
Fecal coliforms (MPN/100 mL)	ND - 4

The level of perchlorate in the backwash water (ND) is below the Los Angeles County Sanitation District (LACSD) Phase I limit of 4 ppb. The values for COD and TSS are used in obtaining discharge permits for the disposal of the backwash water if the water is being discharged into LACSD lines.

7.5.7 Summary

Consistent perchlorate removal to below detection was achieved in the FXB filter using only organisms indigenous to the Saugus aquifer. With influent DO and nitrate concentrations of 7 and 15 mg/L, respectively, the lowest EBCT and acetic acid concentration that allowed consistent perchlorate removal to below detection was 15 minutes and 7.8 mg/L as carbon, respectively. Run times ranged from 24 hours to several days. Effluent from the FXB filter was biologically stable and contained no fecal coliforms. Challenge tests demonstrated that the FXB filter was robust with respect to backwashing episodes, changes in feed water quality, system shutdowns, and electron donor addition failures. Large step increases in feed nitrate concentration (e.g., 15 mg/L) required a period of bio-acclimation before perchlorate removal to below detection could be reestablished in the FXB filter.

7.6 Fluidized Bed Reactor

7.6.1 Perchlorate Removal Performance

Over the course of pilot testing, the FBR achieved perchlorate removal to below detection for periods of up to 8 days. However, perchlorate removal performance generally fluctuated and sustained (i.e., ≥ 2 weeks) removal to below detection was not achieved (Figure 3.39).

7.6.1.1 Mechanical & Operational Adjustments

Numerous mechanical and operational adjustments were made throughout pilot testing to establish sustained perchlorate removal to below detection. A detailed list of these adjustments is provided in Table 3.23 followed by a description of the main mechanical and operational changes, reasons for their implementation, and their impact on perchlorate removal performance. Throughout the course of the study, changes made to the system were done under the direction of representatives from Shaw Environmental.

Table 3.23 FBR Mechanical and Operational Adjustments Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Date (Day of operation)	Event
7/21/03 (0)	System started. 3 gpm.
8/2/03 (11)	Power outage at pilot caused system shutdown
8/4/03 (13)	System restarted, causing carbon to blow out top of reactor.
8/6/03 (15)	Phosphorous added to feed at 0.2 PO_4–P
8/11/03 (20)	Carbon ball-like mass observed in reactor.
8/13/03 (22)	Mechanical mixer observed to be missing
8/14/03 (24)	System put in recycle to scour carbon.
8/19/03 (29)	Carbon manually cleaned with PVC pole and air scour. Carbon/biomass mats broken up and biomass removed.
8/26/03 (36)	Biomass separator installed with 3/8" SS. Top of reactor removed to insert tubing. Designed to operate continuously by drawing carbon from the bottom of the reactor and place carbon back to top of bed.
8/28/03 (38)	Biomass separator clogged, shut down.
8/29/03 (39)	Biomass separator system changed to 3/4" PVC. Configuration changed to draw from top and put carbon back to bottom.
9/1/03 (41)	Solids recovery tank overflowed. Lowered flow to 1 gpm. Large mat of biomass observed in tank, possibly due to aerobic growth. Large amounts of growth in pump.
9/2/03 (42)	Feed and recycle lines and pump cleaned of biomass.
9/9/03 (49)	Nitrogen blanket added to the top of the reactor to minimize re-entrainment

Table 3.23	FBR Mechanical and Operational Adjustments Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency
Date (Day of operation)	**Event**
	of oxygen.
9/16/03 (56)	Reconfigured system piping to bypass oxygenation vessel. Moved acetic acid injection point closer to bioreactor vessel. Biomass separator system to be operated for 1 hour per day.
9/17/03 (59)	Solids recovery tank overflowing, system shut down for 1 hour (recycle).
9/18/03 (58)	Acetic acid pump replaced. It had lost prime several times.
9/24/03 (64)	Phosphorous feed concentration increased to 3 mg/L PO_4-P
9/25/03 (65)	Excessive biogrowth in effluent line causing back-up of the solids recovery tank. Effluent line cleaned out.
9/26/03 (66)	Flow decreased to 2 gpm
9/29/03 (69)	Flow increased to 3 gpm. Large amounts of biomass floating on water surface in solids recovery tank. Mat removed from tank.
10/1/03 (71)	Water observed in nitrogen line. Water removed and nitrogen restarted. Flow decreased to 2.5 gpm.
10/3/03 (73)	Phosphorous feed concentration increased to 3.5 mg/L PO_4-P.
10/6/03 (76)	Small carbon ball mass observed in reactor. Ball broken up manually and with biomass separator.
10/8/03 (78)	Feed flow reduced to 1.5 gpm.
10/17/03 (87)	Feed flow reduced to 1.0 gpm.
10/21/03 (91)	Feed flow reduced to 0.8 gpm.
10/23/03 (93)	Samples sent to Shaw lab for analysis. Results corroborate results seen from CLWA lab.
10/24/03 (94)	Biomass separator to remain off to promote bed expansion.
10/30/03 (100)	Carbon removed from reactor and bottom of bioreactor removed to check for distribution header clogging. No clogging observed. Added 2 feet of carbon to the reactor for settled bed of 72" and expanded of 92". Flow changed to 2 gpm.
10/31/03 (101)	Flow increased to 3 gpm.
11/3/03 (104)	More carbon added to reactor for settled bed of 82" and expanded of 106".
11/5/03 (106)	Phosphorous feed concentration decreased to 2.5 mg/L PO_4-P
11/13/03 (114)	Micronutrients added to the feed water through electron donor feed.
11/26/03 (127)	Second dose of micronutrient added to system
11/28/03 (129)	Third dose of micronutrient added to system
12/3/03 (134)	Flow decreased to 1.5 gpm and mircronutrient eliminated from feed.

Table 3.23	FBR Mechanical and Operational Adjustments Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency
Date (Day of operation)	**Event**
12/5/03 (136)	Flow increased to 3 gpm and acetic acid feed concentration lowered to 13.9 mg/L as C (15% dilution)
12/10/03 (141)	Plant shutdown for 3 hours. Electron donor decreased (94 grams/day).
12/15/03 (146)	Acetic acid feed concentration increased to 20% dilution (125 grams/day)
12/19/03 (150)	Acetic acid feed concentration increased to 30% dilution (185 grams/day)
12/22/03 (153)	Rapid bed expansion noticed in reactor.
12/23/03 (154)	Biomass separator pump turned on for 1 hour due to rapid bed expansion
12/27/03 (158)	Biomass separator pump turned on for 2 hours
12/30/03 (161)	Biomass separator pump turned on for ½ hour
12/31/03 (162)	System placed in recycle due to rapid bed expansion
1/2/04 (164)	System restarted at 3 gpm.
1/7/04 (169)	Acetic acid feed solution decreased to 20% dilution (125 grams/day)
1/9/04 (171)	Suspended biomass removed from top of the reactor
	Phosphate addition reduced by 50% to 1.25 mg/L PO_4-P
1/12/04 (174)	Acetic acid feed solution increased to 25% dilution (155 grams/day)
1/16/04 (178)	Due to phosphoric acid supply limitations, phosphate addition was reduced to 25 mL in 1 L total volume.
1/19/04 (181)	Flow decreased to 2 gpm w/ current donor addition remaining the same (25% dilution at 1 mL/min).
1/20/04 (182)	System reconfigured to bypass solids recovery tank due to high DO in recycle. New perchlorate stock solution mixed incorrectly, causing influent concentrations to be 20-25 ug/L. Increase of phosphate concentrations back to previous levels (>2 mg/L).
1/21/04 (183)	Flow increased to 3 gpm (1 mL/min 25% dilution for donor) and increased ClO4 back to 50 ug/L. Increased flow of donor to 7 strokes/min from 6 (160 grams/day).
1/24/04 (186)	Increased electron donor to 33% dilution. (210 grams/day)
2/2/04 (195)	Increased flow of donor to 8 strokes/min from 7 (225 grams/day).
2/3/04 (196)	Added micronutrient (~50 mL to 8 L)
2/4/04 (197)	Reduced flow of donor to 5 strokes /min from 8 (180 grams/day).
2/5/04 (198)	Reduced flow to 2 gpm.
2/6/04 (199)	System shutdown (recycle).

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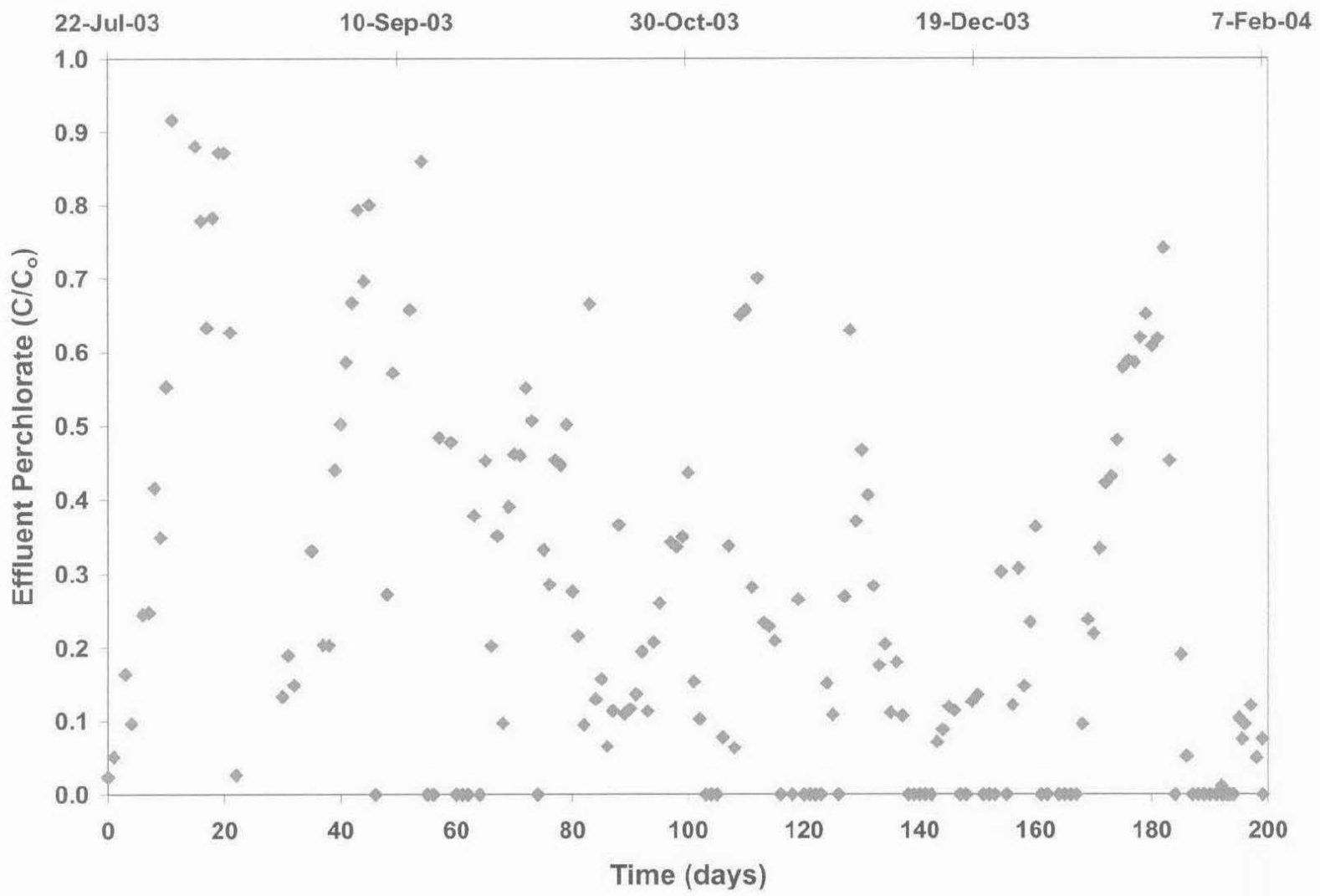

FLUIDIZED-BED PERCHLORATE

FIGURE 3.39

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Mechanical Adjustments:

- Concern: Excessive clumpy biogrowth was observed in the FBR, potentially causing clogging or short-circuiting. The mechanical mixer, which was designed to control overgrowth in the system, did not function properly.

  Adjustment: A biomass separator system was installed (Day 35) and used intermittently throughout pilot testing.

  Impact: The biomass separator was effective at controlling bed expansion and overgrowth. However, perchlorate removal performance did not appear to improve by the installation of the biomass separator system.

- Concern: Excessive biogrowth was observed across the entire FBR system, which was clogging pumps and piping and may have been causing short-circuiting in the reactor.

  Adjustments: On Day 29, the GAC was manually scoured using a PVC pipe and aeration. Piping and pumps were cleaned out on Days 42 and 65. Biomass clumps were removed from the solids recovery tank (Day 69) and from the reactor (Day 171). The acetic acid feed point was moved closer to the base of the reactor on Day 56.

  Impact: These adjustments were effective at controlling excessive biogrowth, though they did not appear to positively impact perchlorate removal performance.

- Concern: DO was being entrained between the top of the reactor and the recycle line. This could cause aerobic growth in the system and inhibit perchlorate reduction by increasing the redox potential.

  Adjustments: A nitrogen blanket was added to the top of the reactor on Day 49. The effluent/recycle piping was reconfigured to completely bypass the solids recovery tank on Day 182.

  Impact: Adding the nitrogen blanket and bypassing the oxygenation vessel lowered DO entrainment, and perchlorate removal performance improved slightly with each adjustment. Bypassing the solids recovery tank eliminated DO entrainment and appeared to improve perchlorate removal performance substantially. Four days after the system was reconfigured, perchlorate removal to below detection was achieved and sustained for eight days. However, electron donor was also being adjusted during this period and, after eight days of removal to below detection, perchlorate breakthrough was observed. Therefore, though controlling DO entrainment did appear to improve perchlorate removal performance in the FBR, it did not completely eliminate perchlorate breakthrough.

- Concern: The turbulent zone near the base of the FBR is essentially abiotic due to the high shear stresses generated by the feed jets. If this abiotic zone is a significant

fraction of the overall bed depth, then the depth of the anaerobic zone within the carbon bed might be insufficient to allow for the removal of perchlorate to below detection.

- Adjustment: Two feet of carbon were added to the top of the GAC bed on Day 100. An additional 10 inches of carbon were added to the top of the GAC bed on Day 104.

  Impact: Perchlorate removal performance appeared to improve for about a week after the carbon was added to the bed, though this may have been due to adsorption. Regardless, this improvement in perchlorate removal performance was not sustained beyond one week.

Operational Adjustments:

- Concern: Low phosphorous concentrations may be limiting biological activity in the FBR.

  Adjustment: Phosphorous was added to the feed at 0.2 mg/L PO_4-P beginning on Day 15. Phosphorous addition was increased to 3.0 mg/L PO_4-P on Day 64. Phosphorous addition was increased to 3.5 mg/L PO_4-P on Day 73 (Figure 3.40).

  Impact: Adjusting the concentration of phosphorous being added to the feed did not appear to impact perchlorate removal performance in the FBR. Feed PO_4-P was later reduced to 2.5 mg/L and then 1.25 mg/L for short periods of operation, without impacting perchlorate removal performance.

- Concern: The contact time may be insufficient to allow for sustained perchlorate removal to below detection.

  Adjustment: The feed flow was reduced gradually from 3.0 gpm to 0.8 gpm over a four-week period (Days 71 through 99).

  Impact: While increasing the HRT did appear to improve perchlorate removal performance initially, it did not effect perchlorate removal to below detection, and, eventually, perchlorate removal performance declined at the lower feed flow rates.

- Concern: Low concentrations of micronutrients may be limiting biological activity in the FBR.

  Adjustment: A micronutrient solution was added to the feed from Day 114 to Day 134. It was again added on Day 196 through the end of pilot testing. The micronutrient contained low concentrations of iron, copper, magnesium, manganese, zinc, boron, sulfur, molybdenum, and cobalt.

  Impact: The addition of the micronutrient feed might have caused improved perchlorate removal performance initially, though the impact was confounded due to the nearly simultaneous addition of fresh carbon to the bed. Regardless, perchlorate removal performance eventually declined in spite of the micronutrient feed.

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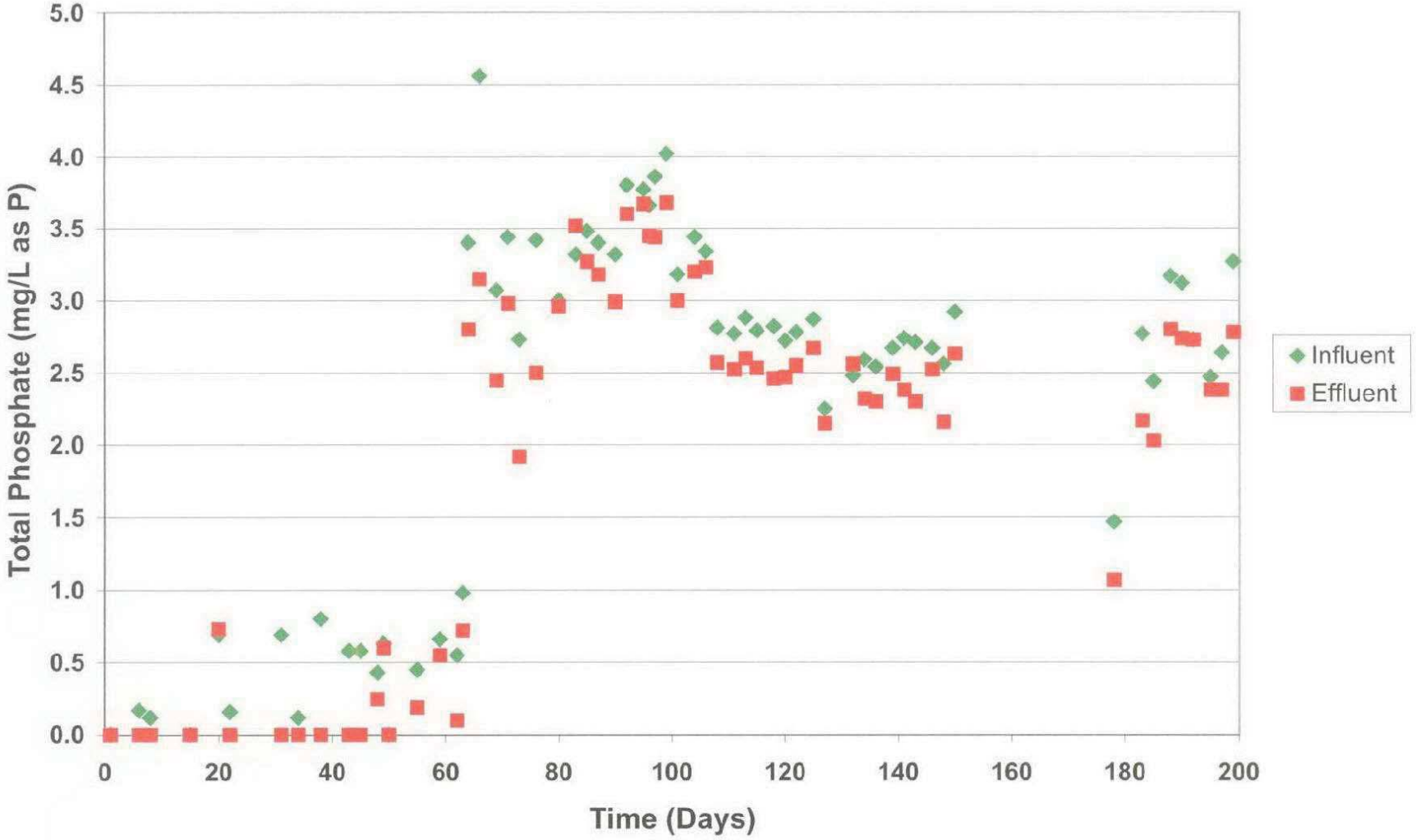

FLUIDIZED-BED PHOSPHOROUS

FIGURE 3.40

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- Concern: Over-excess acetic acid concentrations in the feed may have been selecting away from perchlorate-reducing bacteria and toward sulfate-reducing bacteria. As the feed nitrate concentration decreased during the pilot test period, the acetic acid concentration was not adjusted to account for the decreased oxidant demand in the system. It was theorized that this could help explain why only partial perchlorate removal was observed in spite of very low redox conditions (down to –200 mV). In other words, though complete DO and nitrate reduction and partial sulfate reduction was occurring in the reactor, only partial perchlorate reduction was observed (Figures 3.41 and 3.42), suggesting that the perchlorate-reducing community in the reactor was being depressed.

  Adjustment: Feed acetic acid concentration was lowered on Day 136.

  Impact: Perchlorate was removed to below detection for about a week after the acetic acid feed concentration was lowered. Subsequently, feed acetic acid concentrations were adjusted up and down as feed nitrate concentrations fluctuated. Though perchlorate removal was generally ≥ 90% during this period, sustained perchlorate removal to below detection was not achieved.

7.6.2 Other Parameters

The following non-anionic water quality observations were made during the course of FBR piloting:

- Effluent TOC concentrations were typically 1 to 9 mg/L (Figure 3.43).
- Effluent BDOC concentrations ranged from non-detect to 1.3 mg/L (Figure 3.44).
- On average, pH decreased by 0.5 units across the FBR bed (Figure 3.45). This was likely due to the addition of CO_2 to the water as acetic acid was oxidized.
- HPCs increased across the filter, resulting in counts between 50,000 and 870,000/mL (Figure 3.46).
- Total effluent coliforms ranged from non-detect to 900 MPN/100 mL, but were typically 300 MPN/100 mL or less (Figure 3.47). No fecal coliforms were detected.
- Average feed water turbidities were approximately 0.5 NTU. Effluent turbidities ranged from 2 to 70 NTU (Figure 3.48).

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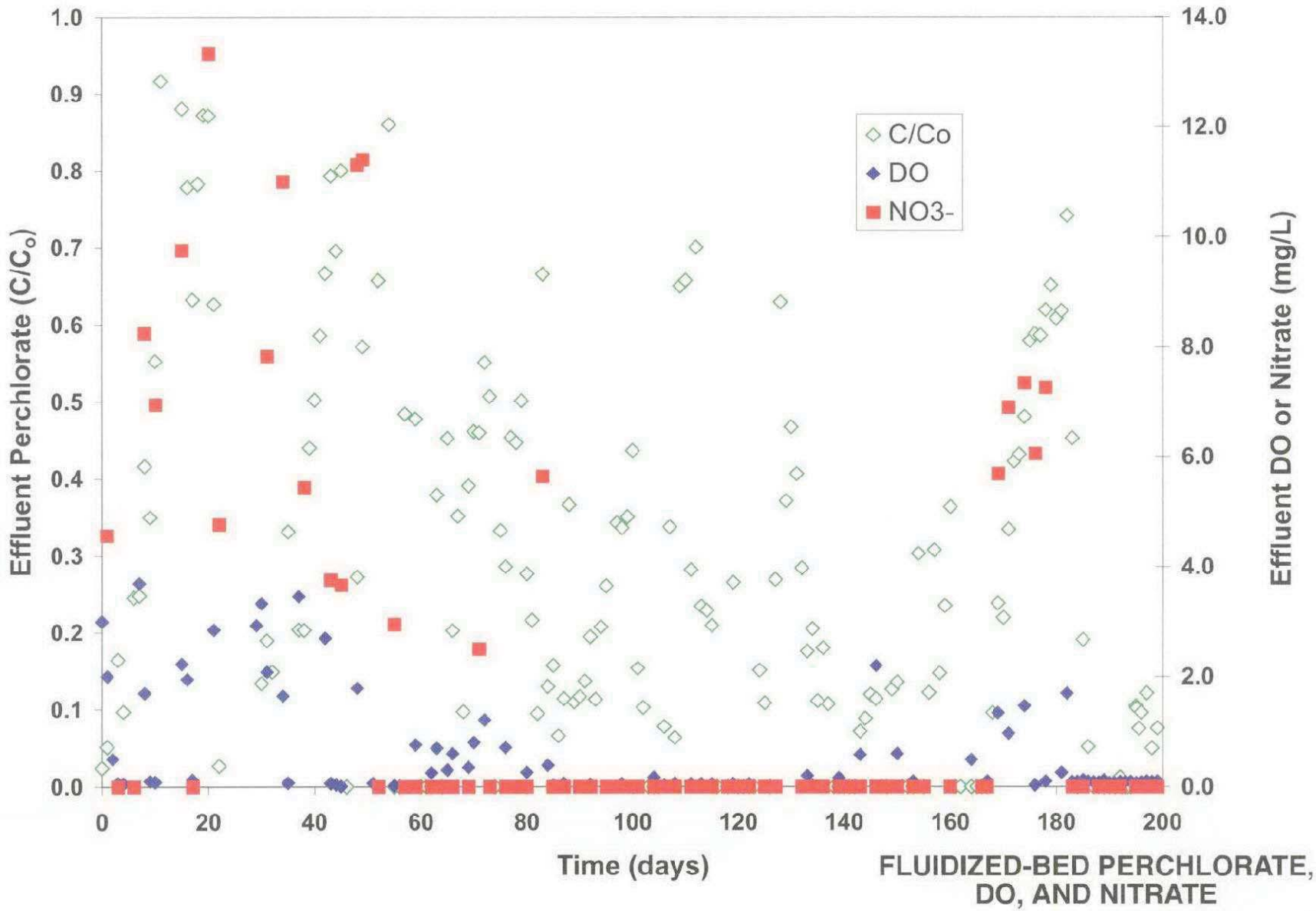

FLUIDIZED-BED PERCHLORATE, DO, AND NITRATE

FIGURE 3.41

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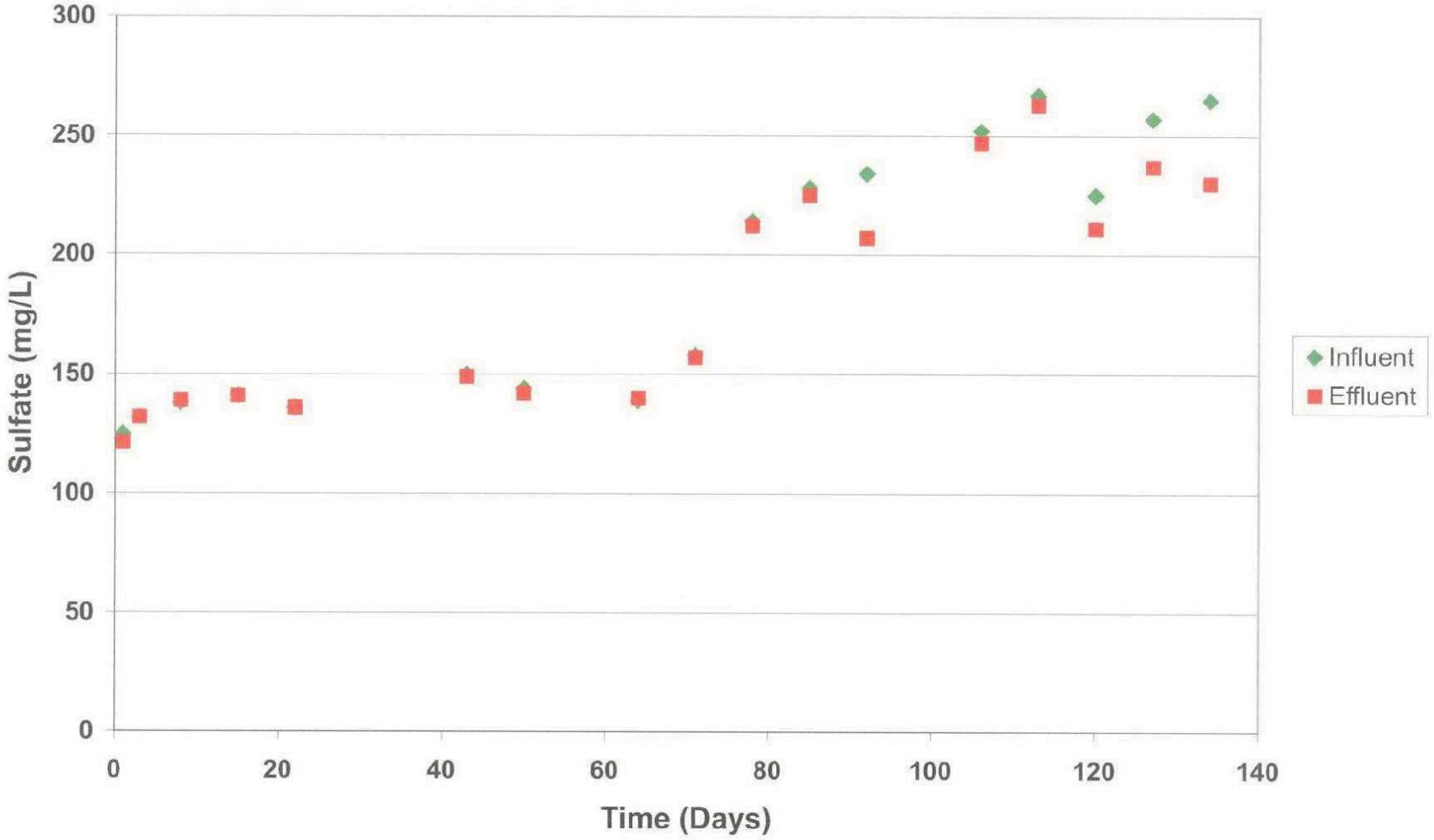

FLUIDIZED-BED SULFATE

FIGURE 3.42

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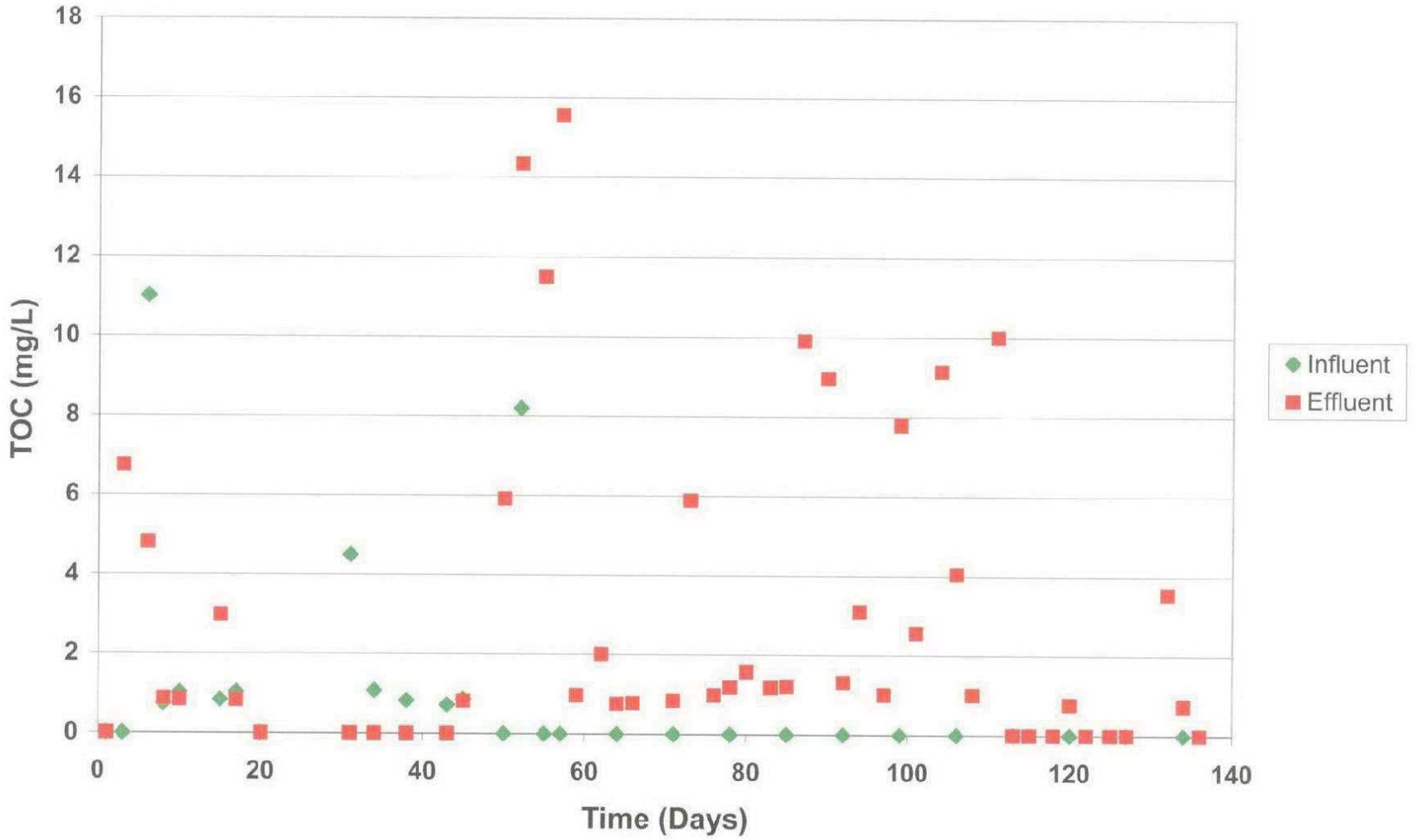

FLUIDIZED-BED TOC

FIGURE 3.43

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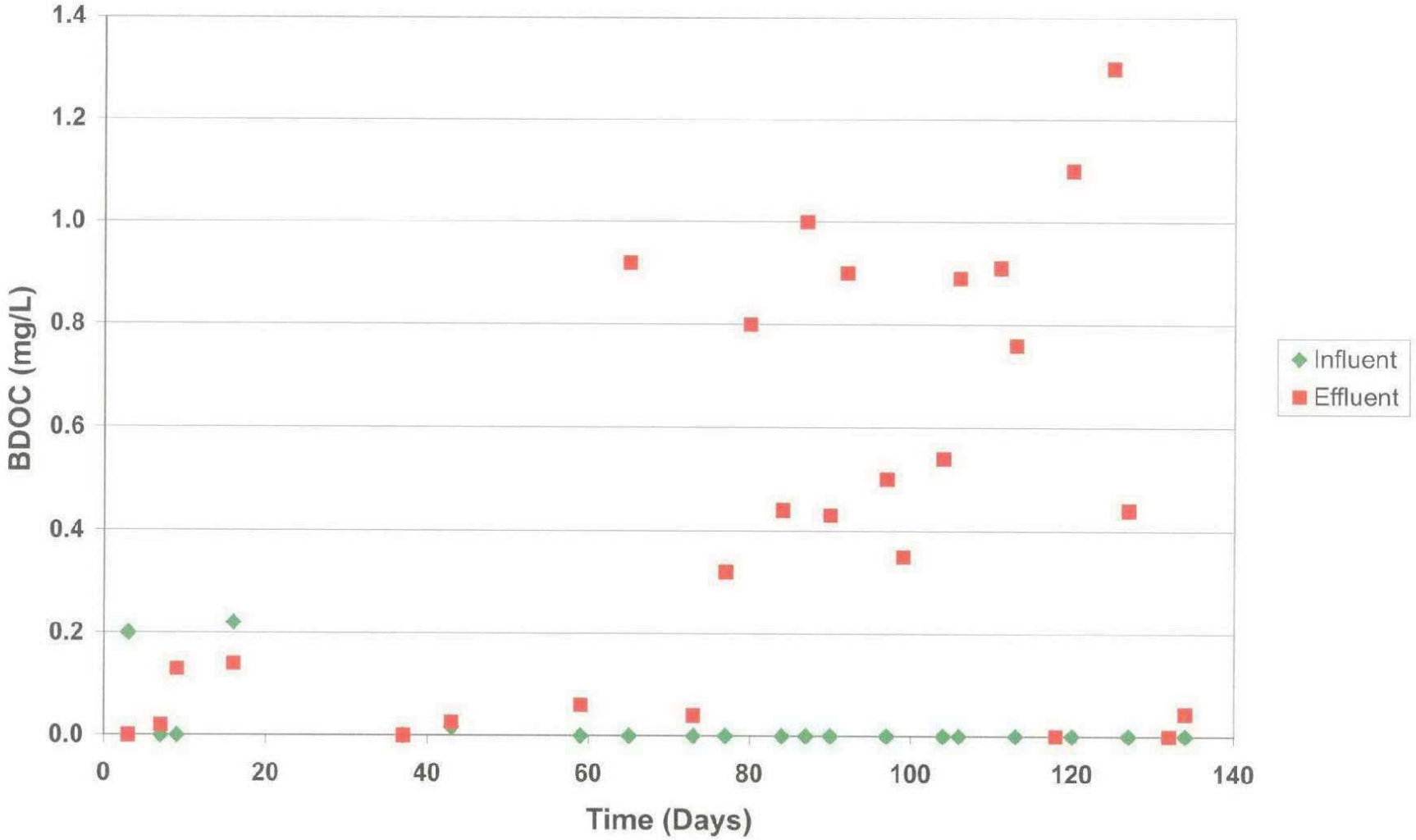

FLUIDIZED-BED BDOC

FIGURE 3.44

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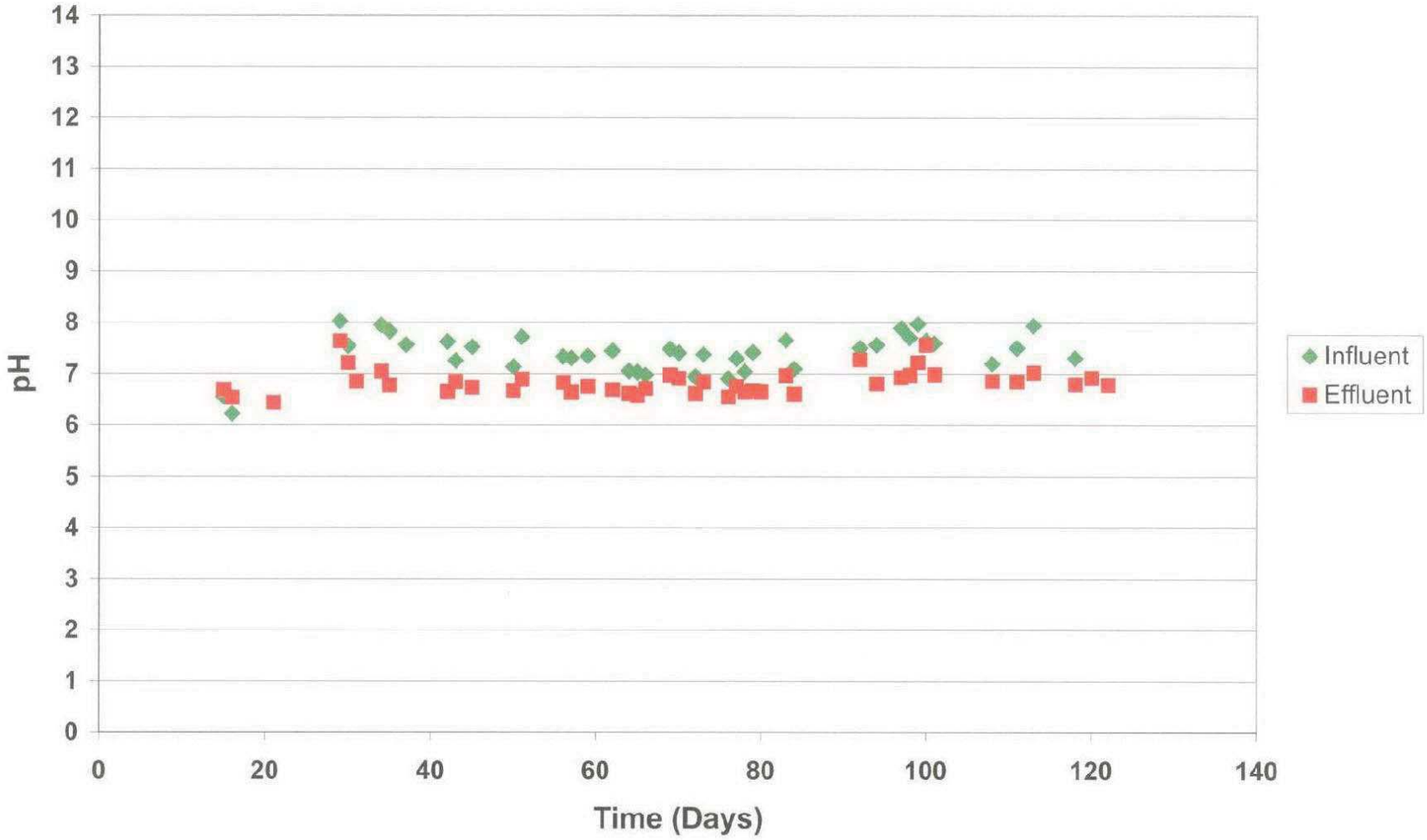

FLUIDIZED-BED pH

FIGURE 3.45

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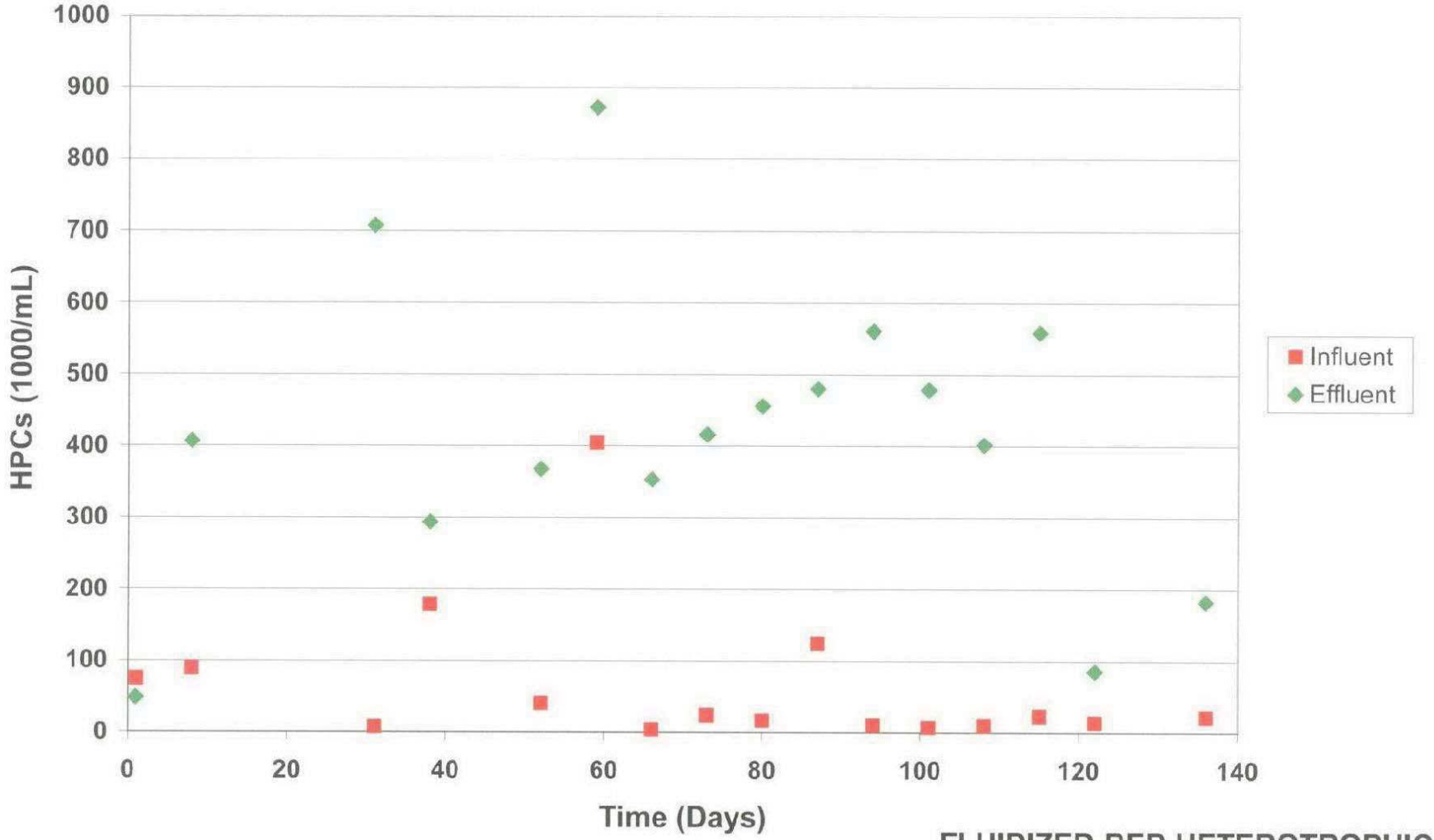

FLUIDIZED-BED HETEROTROPHIC PLATE COUNTS

FIGURE 3.46

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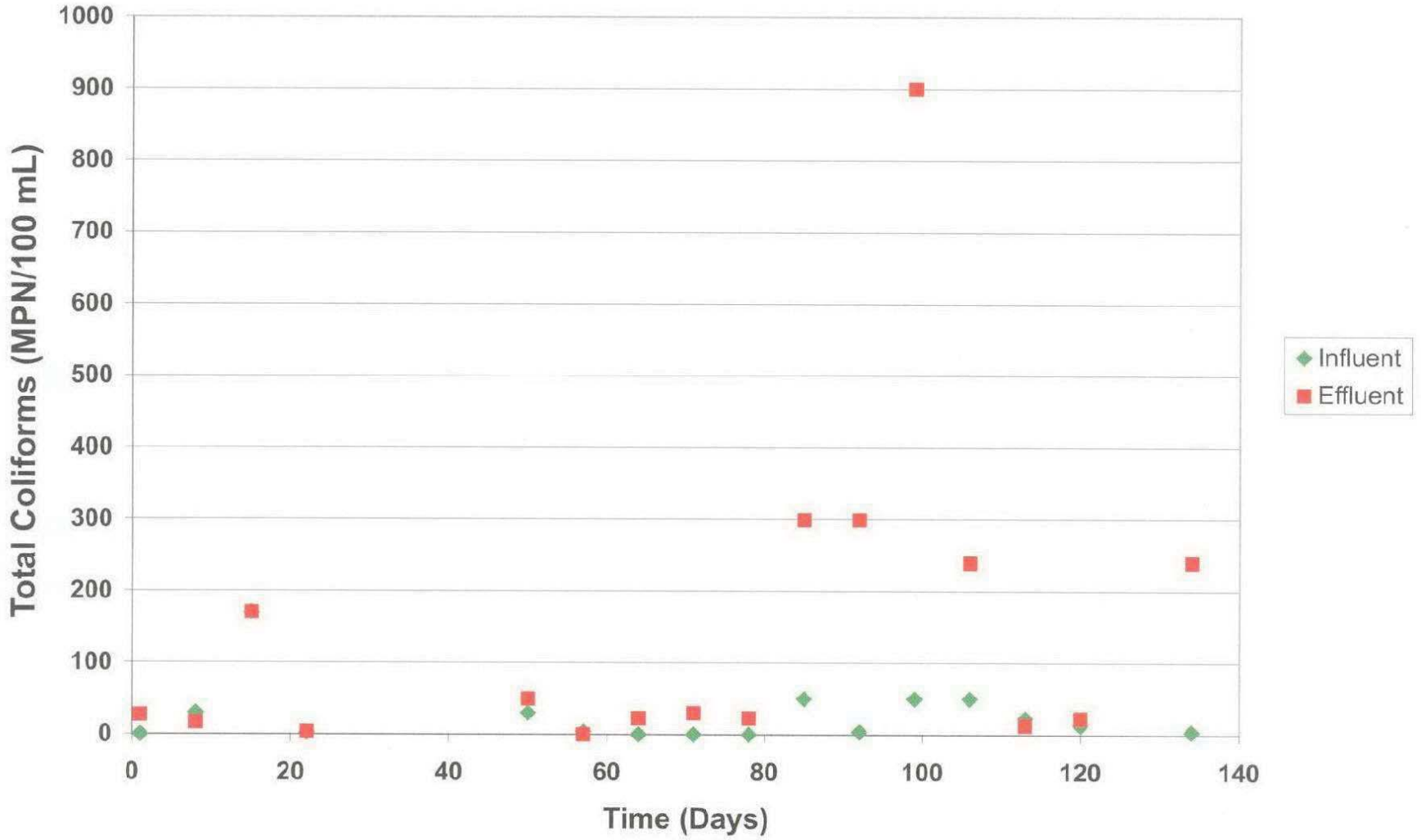

FLUIDIZED-BED TOTAL COLIFORMS

FIGURE 3.47

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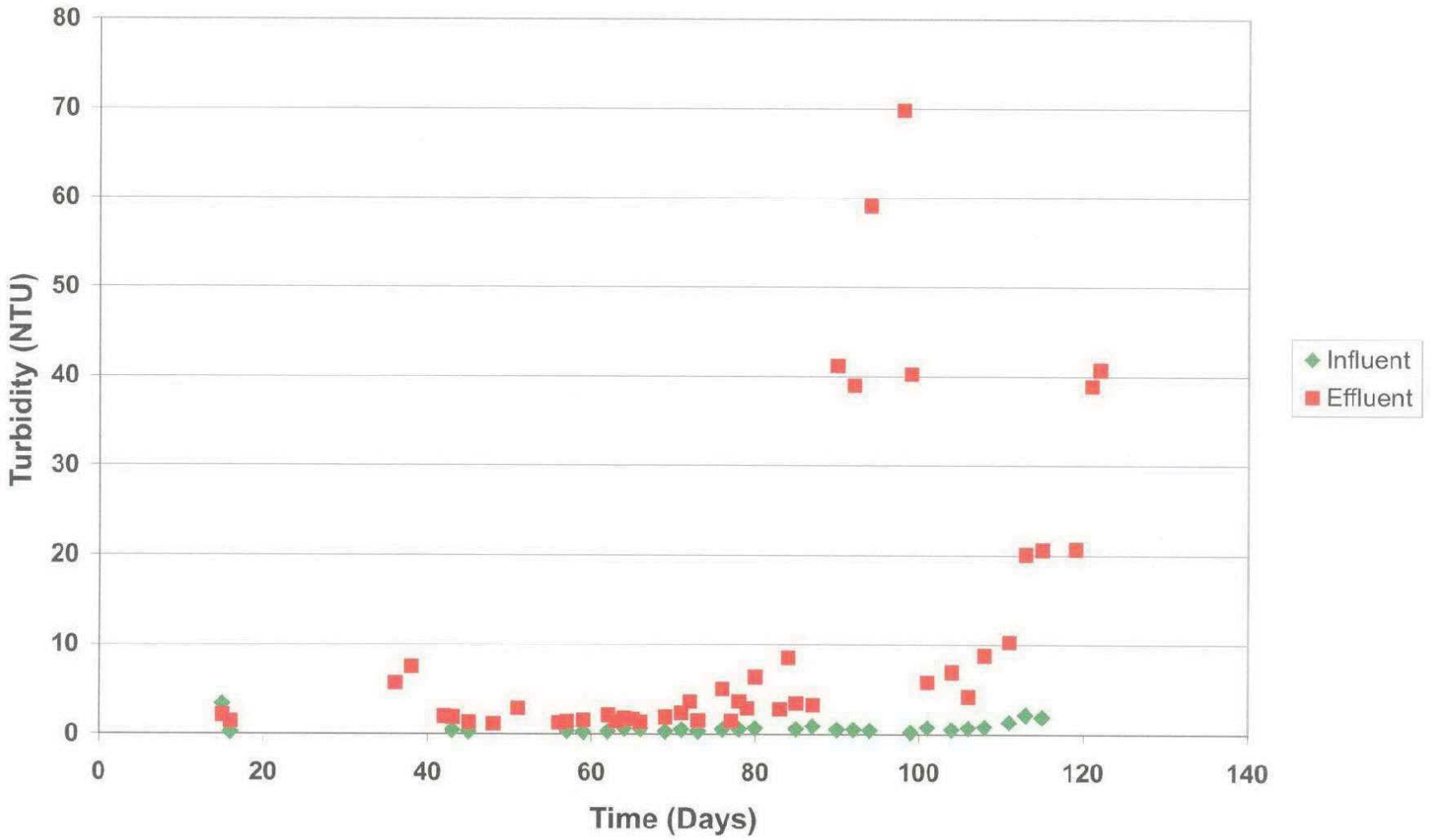

FLUIDIZED-BED TURBIDITY

FIGURE 3.48

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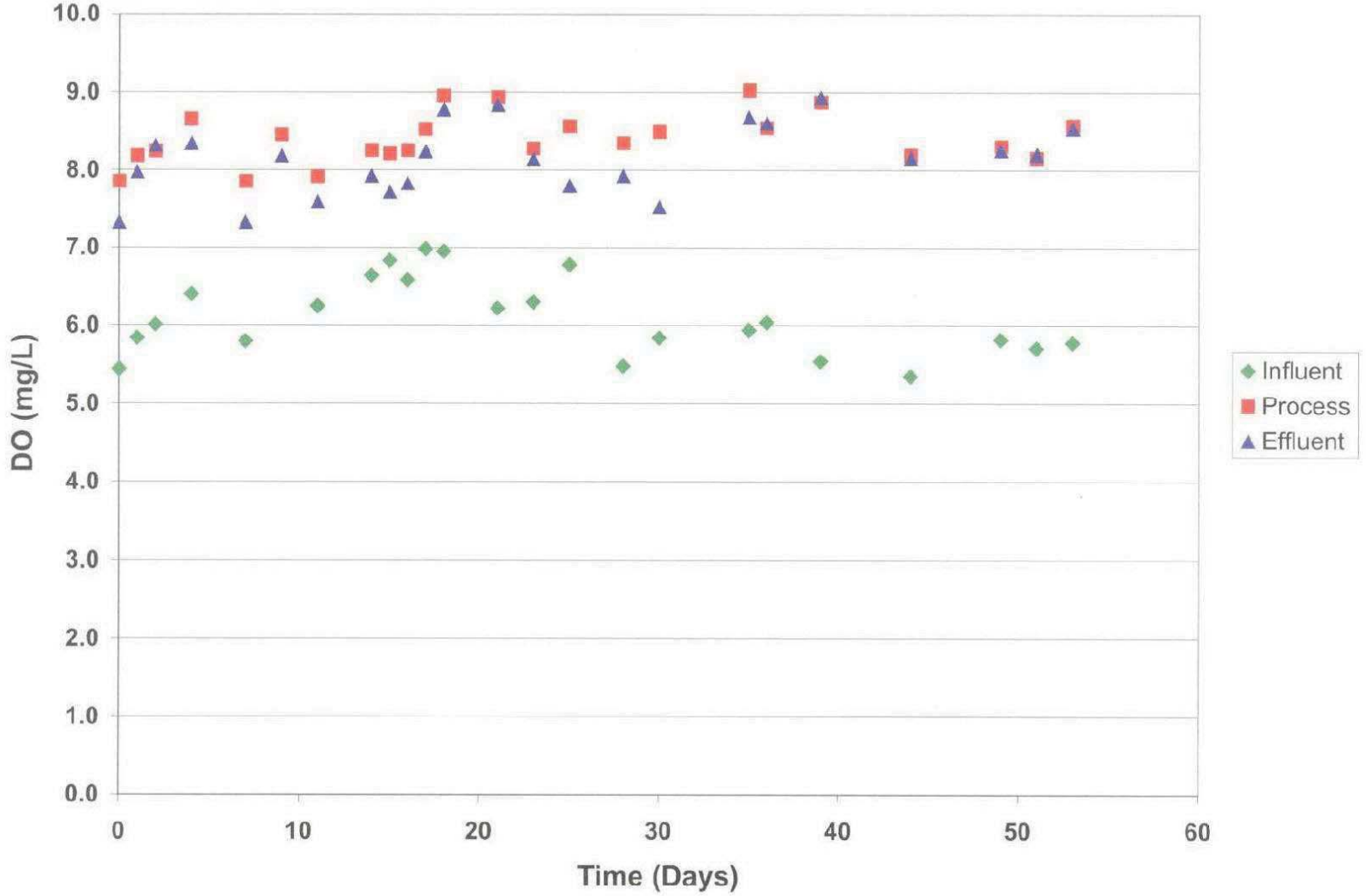

SMBR DISSOLVED OXYGEN

FIGURE 3.49

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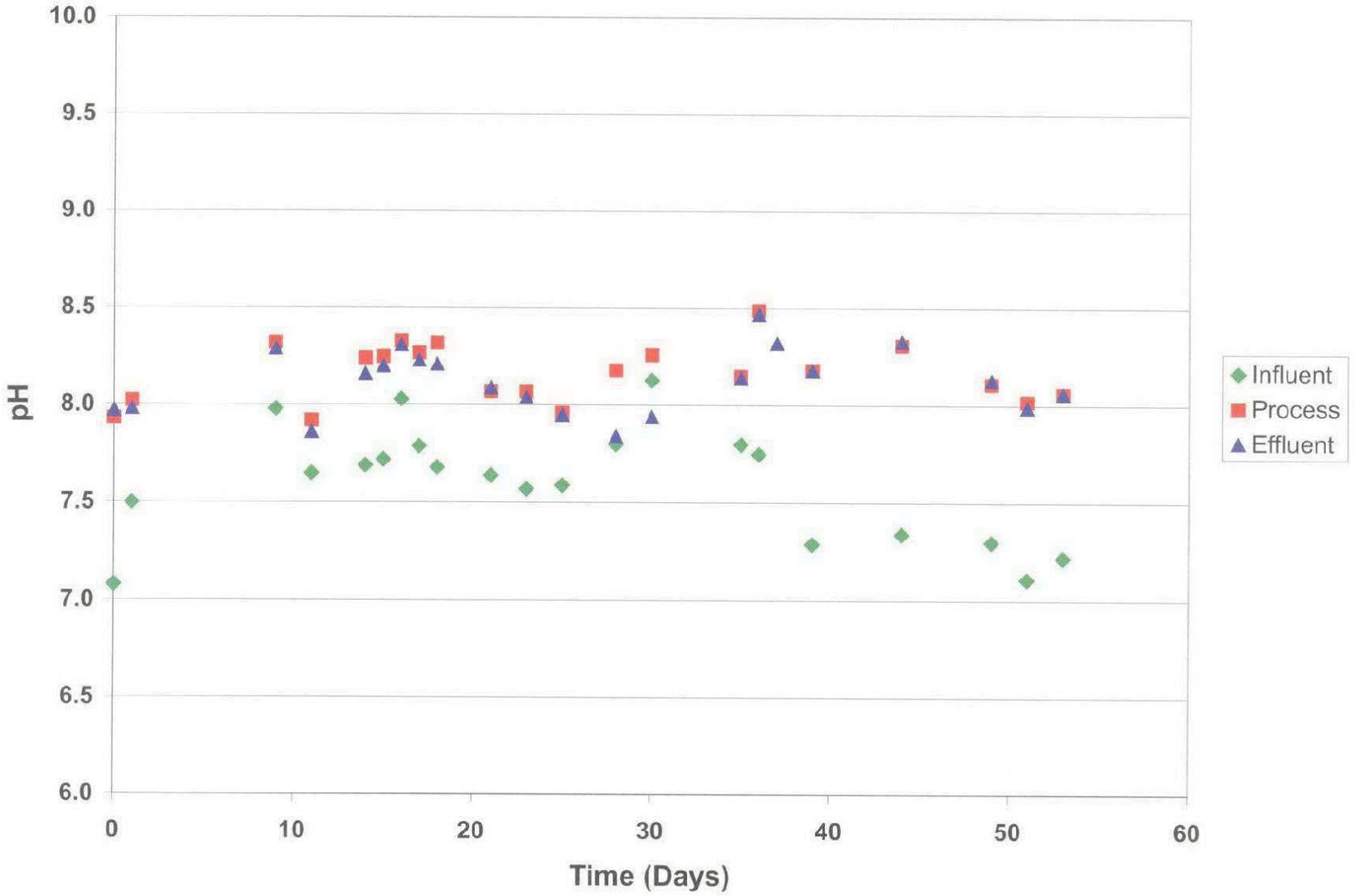

SMBR pH

FIGURE 3.50

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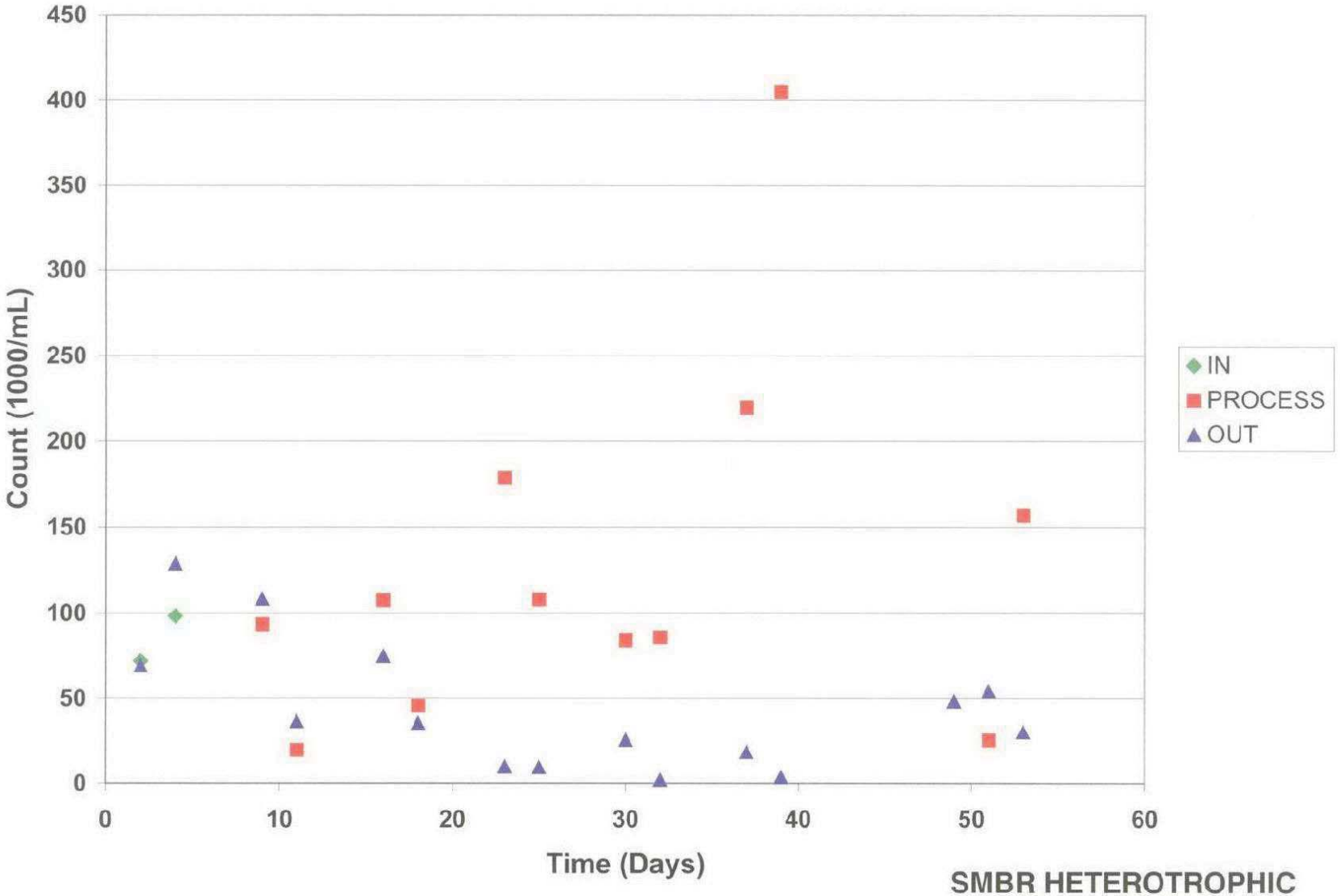

SMBR HETEROTROPHIC PLATE COUNTS

FIGURE 3.51

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7.6.3 Summary

The fluidized-bed reactor did not achieve perchlorate removal to below detection over a period greater than 8 days, in spite of numerous mechanical and operational adjustments made to the system. However, testing did demonstrate that biological perchlorate removal can be achieved using indigenous microorganisms, a feature that had not yet been demonstrated for the FBR system. Because the FBR was not optimized, challenge testing was not performed.

7.7 Submerged Membrane Bioreactor (Post-Treatment of FXB Effluent)

The SMBR was set up to provide post-treatment for the FXB effluent, as required by DHS, i.e., aeration, filtration, and biological degradation of excess BDOC. The SMBR was fed with effluent from the FXB biological filter, which was already partially reaerated due to exposure to atmospheric conditions in the backwash tank. As expected, DO concentrations further increased in the SMBR process tank (Figure 3.49). pH also increased during the post-treatment process (Figure 3.50). The water entering the process tank is likely supersaturated with CO_2, produced by the oxidation of acetic acid in the FXB. Aeration within the process tank volatilizes supersaturated CO_2, thus bringing the water into equilibrium with atmospheric conditions and increasing the pH. Figure 3.51 shows that HPCs were being reduced across the ultrafiltration membrane. The effluent HPC concentrations are typically lower than the values observed in the raw well water. (See Figure 3.29.) Additional removal of heterotrophic bacteria can be achieved through disinfection following the SMBR. Batch experiments were performed to assess chlorine demand and HPC reduction using SMBR effluent. The chlorine demand of SMBR effluent was < 1 mg/L in all but one case, and only low doses of chlorine were required to reduce HPCs below 500 counts/mL (Table 3.24).

Table 3.24 Testing Matrix for Bench-Scale Chlorination of SMBR Effluent Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Chlorine Dose (mg/L)	12/1/03		12/3/03		12/5/03	
	Residual (mg/L)	HPCs (counts/mL)	Residual (mg/L)	HPCs (counts/mL)	Residual (mg/L)	HPCs (counts/mL)
0	0	48,450	0	54,150	0	30,400
0.5	0	69,250	0.15	250	0.08	4
1.0	0.17	271	0.31	100	0.60	52
2.0	0.88	10	1.15	450	1.58	2

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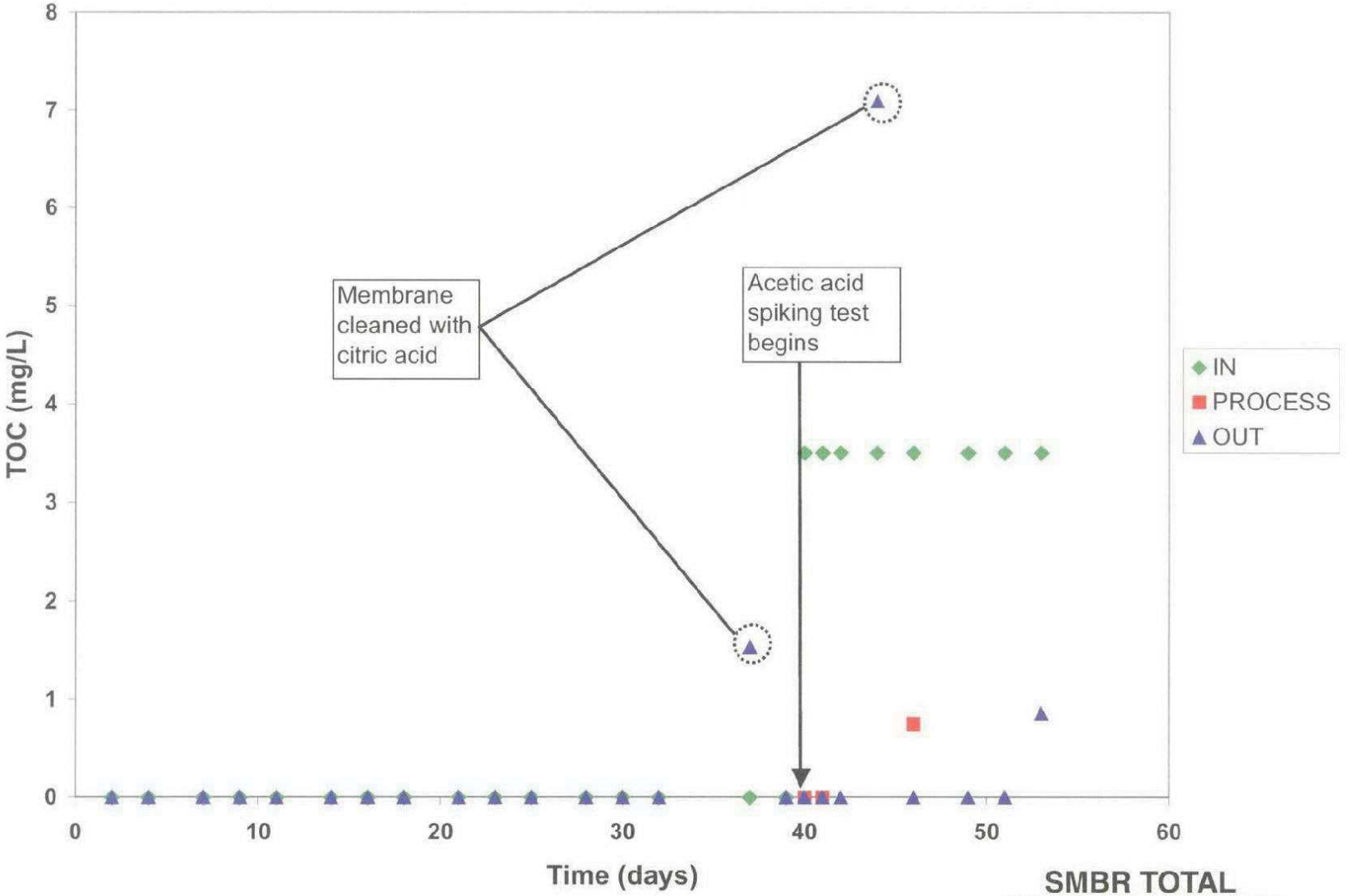

SMBR TOTAL ORGANIC CARBON

FIGURE 3.52

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Organic carbon concentrations in the effluent of the biological FXB were typically below detection throughout pilot testing. Therefore, 3.5 mg/L of acetic acid carbon was spiked to the SMBR process tank to evaluate the ability of the SMBR system to remove residual organic carbon. Figure 3.52 shows that in all but one instance, TOC concentrations were below detection in the SMBR effluent. Though some of the acetic acid may have volatilized, the lack of acetic acid smell in the vicinity of the process tank suggests that biological oxidation was the dominant mechanism of organic carbon removal in the SMBR.

Hydrogen sulfide odor was rarely detected in the feed to the SMBR and was never detected in the SMBR effluent. Analytical measurements resulted in no detectable sulfide (MRL = 0.1 mg/L). Any observed removal may have been due to volatilization. However, given a $pK_{a,1} = 7.1$ and an average process tank pH of 8.2, approximately 92 percent of the sulfide was in the HS^- form, thus minimizing the contribution of volatilization to sulfide removal. It is also possible that sulfide oxidation was occurring in the reactor, either spontaneously or via microbial catalysis. No effort was made to isolate the sulfide removal mechanism.

7.7.1 Summary

Demonstration testing showed that a submerged membrane bioreactor can meet several post-FXB treatment objectives in a single step: 1) aeration, 2) biomass separation, 3) residual organic carbon removal, and 4) hydrogen sulfide removal.

7.8 In-Line Ion Chromatographic Analysis

In addition to perchlorate analyses performed by CLWA and MWH labs, an in-line perchlorate analyzer was installed to provide real time perchlorate data. A Dionex DX-800 in-line ion chromatograph was used that can sample, analyze, and store data from up to 21 process streams. The system uses a 2 x 250 mm IonPac® AS16 analytical column (Dionex P/N 055378) with a 2 x 50 mm AG16 guard column. The sample volume was 1,000-mL with a flow rate of 0.4 mL/min. The effluent was an EG50-generated 50 mM potassium hydroxide (KOH) solution with a back pressure of approximately 2,500 psi. A 2-mm AMMS III suppressor operated in the chemical suppression mode and a CD20-PA Conductivity Detector was used for detection. The system was controlled by a CC81 controller. Run times for the samples were 30 minutes.

The instrument was initially connected directly to the FBR with samples being continuously drawn into the analyzer every 30 min for analysis. This created a problem due to the high amount of biomass being sloughed from the system. A rough prefilter was installed to complement the 20-µm pre-sample loop filter. This provided some removal of biomass but clogging continued to occur in the instrument, thus causing high excessive pressure build-up in the system. As a result, the system was configured to analyze only occasional grab samples for remainder of the project. This was beneficial in that the results were obtained in 30 minutes rather than 2 or 3 day for the CLWA lab or up to 1 month for MWH labs.

To test the accuracy of the instrument, split samples of raw water, spiked raw water, and effluents from each of the treatment alternatives were analyzed using the instrument. These samples were also sent to the CLWA lab and two different DHS labs. The results from the tests are provided in Table 3.25.

Table 3.25 Comparison of Perchlorate Results (μg/L) (<MRL indicates less than method reporting limit of 4 μg/L) Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency

Sample	CLWA	DHS-LA	DHS-Berkley	In-Line Instrument
Raw water	<MRL	<MRL	<MRL	<MRL
IX-Spike	45.1	54.4	47.5	48.5
IX-C1	<MRL	<MRL	<MRL	<MRL
IX-C2	27.7	32.8	29.1	27.3
IX-C3	<MRL	<MRL	<MRL	<MRL
FXB-Spike	42.1	48.6	44.5	38.9
FXB-Out	<MRL	<MRL	<MRL	<MRL
FBR-Spike	41.8	50.2	43.2	42.4
FBR-Out	<MRL	34.2	26.8	<MRL

The results for the Dionex DX-800 were acceptable in most cases and correlated well with results from the other 3 labs. One sample, FBR out, read 27 and 34 mg/L from the two DHS labs, where the CLWA lab and the in-line monitor read below the reporting limit. This may be due to the lack of sample preservation of samples from the FBR. These samples were not preserved, therefore perchlorate degradation could have been an issue. In general, the Dionex instrument showed good correlation with measurements from other laboratories.

7.9 DBP Formation Potential Testing

7.9.1 Experimental Matrix

7.9.1.1 DBPFP Testing on FXB, FBR, and MBR Effluents

Conditions applied during the DBPFP testing conducted on the FXB effluent, the FBR effluent, and the MBR effluent are presented in Table 3.26. For each experiment, three samples were dosed with a range of free and combined chlorine concentrations in order to reach the target free and combined chlorine residual of 3 to 5 mg/L after an incubation period of 7 days. At the end of the incubation period, the sample with the chlorine residual closest to the target was used for DBP analysis and the other two samples were discarded.

Table 3.26 Conditions Applied during DBPFP testing Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency					
Free Chlorine Testing					
Stream	**Free Cl_2 Dose (mg/L)**	**$[Cl_2]_{Free, 0}$ (mg/L)**	**Initial Demand (mg/L)**	**$[Cl_2]_{Free, 7}$ (mg/L)**	**7-day Demand (mg/L)**
FXB Effluent	10	7.4	2.6	8.6	0
FBR Effluent	24	15.5	8.5	8.0	7.5
MBR Effluent	12	7.4	4.6	7.6	0
Combined Chlorine Testing					
Stream	**Free Cl_2 Dose (mg/L)**	**NH_3-N Dose (mg/L)**	**$[Cl_2]_{Total, 0}$ (mg/L)**	**$[Cl_2]_{Total, 7}$ (mg/L)**	**7-day Demand (mg/L)**
FXB Effluent	8	2.0	6.3	3.0	3.3
FBR Effluent	12	3.0	5.1	3.1	2.0
MBR Effluent	6	1.5	6.4	3.2	3.2

Free chlorine demand was slightly overestimated, resulting in free chlorine residuals ranging from 7.6 to 8.6 mg/L after 7 days of incubation, which was considerably higher than expected. Instantaneous free chlorine demands ranged from 2.6 mg/L in the FXB effluent to 8.5 mg/L in the FBR effluent. This was expected, since the FBR effluent contained higher levels of organic matter relative to the FXB effluent. The free chlorine demand in the FXB effluent and the MBR effluent was satisfied immediately and no decay of free chlorine was measured thereafter. In the case where the initial free chlorine concentration for the fixed bed effluent was lower than after 7-days of incubation, this was most likely due to the error in the measurements. Sample above 5 mg/L free chlorine had to be diluted to fall within the linear range of the method. In contrast to the other systems, free chlorine continued to decay over the 7-day incubation period in the FBR effluent.

As expected, combined chlorine residuals were more stable, measuring at 3 mg/L after 7 days of incubation in all three streams. The initial combined chloramine demand was greater in the FBR effluent relative to the other two streams.

7.9.1.2 DBPFP Testing on Ozonated FXB Effluent

The ozone test was conducted on a blend of 90 percent SPW and 10 percent FXB effluent to simulate the feed of the biological reactor effluent into the Rio Vista WTP. Conditions applied during ozone testing are presented in Table 3.27. Ozone demand ranged from 1.2 to 1.4 mg/L.

Table 3.27 Conditions Applied During Ozonation Testing Perchlorate Treatment from Saugus Aquifer Castaic Lake Water Agency			
Stream	Transferred Ozone Dose (mg/L)	Ozone Residual (mg/L)	HRT (min)
FXB Effluent	1.76	0.37	5.4
FXB Effluent + Acetic Acid (AA)	1.72	0.54	5.3

Ozonated streams were further analyzed for critical parameters and subjected to DBPFP testing with free and combined chlorine. DBPFP conditions applied during ozone testing are presented in Table 3.28. Seven-day free chlorine residuals were higher than the target residual of 5 mg/L. Due to the limited availability of ozonated water, multiple bottles could not be incubated. Therefore, the DBP formation potential results are conservative. The free chlorine residual at time zero was not measured. Combined chlorine residuals ranged from 3.4 to 4.3 mg/L, falling within the target range of 3 to 5 mg/L.

Table 3.28 Conditions Applied During DBPFP Testing of Ozonated Waters Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency					
Free Chlorine Testing					
Stream	Free Cl_2 Dose (mg/L)	$[Cl_2]_{Free, 0}$ (mg/L)	Initial Demand (mg/L)	$[Cl_2]_{Free, 7}$ (mg/L)	7-day Demand (mg/L)
Ozonated FXB Effluent	16	NA	NA	11.4	NA
Ozonated FXB Effluent+ AA	16	NA	NA	10.4	NA
Combined Chlorine Testing					
Stream	Free Cl_2 Dose (mg/L)	NH_3-N Dose (mg/L)	$[Cl_2]_{Total, 0}$ (mg/L)	$[Cl_2]_{Total, 7}$ (mg/L)	7-day Demand (mg/L)
Ozonated FXB Effluent	8	2	NA	4.3	NA
Ozonated FXB Effluent+ AA	8	2	NA	3.4	NA

7.9.2 Analytical Results

7.9.2.1 DBPFP Testing on FXB, FBR, and MBR Effluents

Control samples of each stream were analyzed for critical parameters (Table 3.28). Prior to chlorination, the FBR effluent contained a DOC concentration of 6 mg/L, whereas the other two streams contained negligible quantities of organic matter. It should be mentioned that DBPFP samples were collected from the FBR at a time before feed acetic acid concentration had been optimized. Since the acetic acid feed concentration was later reduced, the NOM and DBP results are conservative. A BDOC of 1.1 mg/L was measured in the FBR effluent. This BDOC level is higher than the 0.15 to 0.3 mg/L range of acceptable BDOC level for microbial growth in the distribution system. The AOC level in the FBR effluent of 178 μg/L is higher than the suggested 50 μg/L level to control coliform growth in distribution systems. The AOC concentration in the MBR effluent was higher than the AOC concentration in the MBR feed (i.e., FXB effluent), reflecting the fact that the MBR system was still being optimized at the time of the DBPFP tests. As expected, background THM4 and HAA5 levels (prior to chlorination) were non-detect.

Following free chlorine addition with an excess 7-day residual of 7.6 to 8.6 mg/L, THM4 and HAA5 levels were detected in all three streams. TTHM and HAA5 concentrations in the chlorinated FBR stream exceeded Stage 1 and Stage 2 D/DBP maximum contaminant levels of 80 μg/L and 60 μg/L, respectively. HAAs were the dominant DBPs in the biological and MBR effluents. All four TTHM species and all five HAA5 species were detected during the DBPFP testing with FBR effluent.

The reported 7-day TTHM and HAA concentrations are equivalent to formation potential levels since the concentrations on day zero (controls) were non-detect. It should be noted that a detectable level of DOC was measured in the FXB effluent, resulting in a BDOC of 0.23 mg/L. This is unexpected because the DOC in the control FXB effluent sample (i.e., prior to chlorination) was non-detect. THMs and HAAs in the MBR were below the Stage 1 and Stage 2 MCLs.

As expected, chloramination resulted in low levels of TTHMs and lower levels of HAA5 relative to free chlorination.

Table 3.29 DBPFP Testing Results
Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer
Castaic Lake Water Agency

	Prior to Chlorination (Control)				
Stream	DOC (mg/L)	BDOC (mg/L)	AOC (μg/L)	THM4, $_0$ (μg/L)	HAA5, $_0$ (μg/L)
FXB Effluent	<0.5	ND	47	ND	ND
FBR Effluent	6.0	1.1	178	ND	ND
MBR Effluent	<0.5	ND	95	ND	ND

Table 3.29 DBPFP Testing Results Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency					
Following DBPFP with Free Chlorine- Day 7					
Stream	**DOC (mg/L)**	**BDOC (mg/L)**	**AOC (μg/L)***	**THM4, 7 (μg/L)**	**HAA5, 7 (μg/L)**
FXB Effluent	NA	NA	NA	20	26
FBR Effluent	NA	NA	NA	110	140
MBR Effluent	NA	NA	NA	24	39
Following DBPFP with Combined Chlorine- Day 7					
Stream	**DOC (mg/L)**	**BDOC (mg/L)**	**AOC (μg/L)***	**THM4, 7 (μg/L)**	**HAA5, 7 (μg/L)**
FXB Effluent	NA	NA	NA	ND	17
FBR Effluent	NA	NA	NA	2.2	24
MBR Effluent	NA	NA	NA	ND	13
Notes: NA: not analyzed					

The DBPFP yields are presented in Table 3.30. The highest DBP formation yields were observed for the tests using FBR effluent. HAA formation yields were higher than THM yields for the same samples. Even though the DOC was non-detect in the MBR effluent, an HAA concentration of 13 μg/L was measured after chloramination, resulting in a yield of > 26 μg/mg DOC.

Table 3.30 DBPFP Yields Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency				
	THM4FP Yield (μg/mg DOC)		**HAA5FP Yield (μg/mg DOC)**	
Stream	**Free Chlorine**	**Combined Chlorine**	**Free Chlorine**	**Combined Chlorine**
FXB Effluent	5.0	0	6.6	4.3
FBR Effluent	32.0	2.1	40.7	7.0
MBR Effluent	0.2	0	0.4	>26(1)
Notes: (1) DOC was ND				

A follow-up 72-hr SDS test was conducted on the FBR effluent. A free chlorine dose of 2.6 mg/L was used, which resulted in a 3-day residual of 0.4 mg/L. The SDS-TTHM4 and SDS-HAA5 concentrations were 40 and 23 μg/L, respectively.

7.9.2.2 DBPFP Testing on Ozonated FXB Effluent

Following ozonation of the FXB effluent and the acetic acid-spiked FXB effluent samples, DBPFP testing was conducted with both free and combined chlorine (Table 3.32).

Bromate was formed at concentrations ranging from 1.8 to 8.7 μg/L. The bromide levels of 200 μg/L for the blended water (i.e., 90 percent SPW and 10 percent FXB effluent) are on the higher side. For comparison, bromate concentrations measured following ozonation at the Rio Vista WTP are less than 5 μg/L.

Aldehydes were formed at moderate levels when the FXB effluent was ozonated. As expected, total aldehydes (acetaldehyde, formaldehyde, glyoxal, pyruvic aldehyde, and pentanal) were slightly higher in the ozonated FXB effluent spiked with acetic acid relative to the unspiked FXB effluent. It should be noted that the filtration process at the Rio Vista WTP downstream of ozonation may further reduce the aldehyde levels in the finished water.

Ozonation increased the concentration of BDOC and AOC, a phenomenon widely reported in the literature. In a full-scale treatment process, the biodegradable organic matter would be reduced through the filters prior to final chlorination by biological oxidation. Chlorination and chloramination of the samples resulted in a decrease in the BDOC concentration, probably as a direct result of NOM oxidation by the disinfectant.

High concentrations of TTHMs and HAAs were measured in the ozonated samples following DBP formation testing with free chlorine. It should be noted that since the measured free chlorine residuals after 7 days of incubation were higher than the target residual range of 3 to 5 mg/L, these DBP results are conservative. In addition, in a full-scale treatment process, the preozonated water would be filtered prior to final chlorination. This filtration process would be expected to remove some of the DBP precursors by biological oxidation, resulting in lower DBP levels than those shown in Table 3.31.

Table 3.31 DBPFP Testing Results-Ozone Test
Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer
Castaic Lake Water Agency

	Raw Samples				
Stream	**TOC (mg/L)**	**DOC (mg/L)**	**BDOC (mg/L)**	**AOC (μg/L)**	**Bromide, low (mg/L)**
FXB Effluent	2.4	2.5	0.53	200	200
FXB Effluent+AA	9.2	8.8	2.5	1266	200

Table 3.31 DBPFP Testing Results-Ozone Test Treatment of Perchlorate Contaminated Groundwater from the Saugus Aquifer Castaic Lake Water Agency									
Ozonated Samples Prior to Chlorination (Control)									
Stream	**DOC (mg/L)**	**TOC (mg/L)**	**BDOC (mg/L)**	**AOC (μg/L)**	**Br (μg/L)**	**BrO_3 (μg/L)**	**Aldehyde (μg/L)**	**THM4, 0 (μg/L)**	**HAA5, 0 (μg/L)**
FXB Effluent	2.6	2.4	3.7	240	190	8.7	40	ND	ND
FXB Effluent +AA	3.2	8.8	5.6	1,446	200	1.8	54	ND	ND
Following DBPFP with Free Chlorine- Day 7									
Stream		**TOC (mg/L)**		**DOC (mg/L)**		**BDOC (mg/L)**	**THM4, 7 (μg/L)**	**HAA5, 7 (μg/L)**	
FXB Effluent		2.0		1.9		0.22	200	56	
FXB Effluent+AA		8.6		8.5		1.5	180	65	
Following DBPFP with Combined Chlorine- Day 7									
Stream		**TOC (mg/L)**		**DOC (mg/L)**		**BDOC (mg/L)**	**THM4, 7 (μg/L)**	**HAA5, 7 (μg/L)**	
FXB Effluent		2.3		2.2		0.38	23	12	
FXB Effluent+AA		8.8		9.0		0.50	25	13	

While HAAs were the dominant DBPs in the chlorinated FXB, FBR, and MBR effluents, TTHMs were the dominant DBPs in the blended FXB effluent samples, which is confirmed by typical DBP concentrations measured in the full-scale Rio Vista WTP distribution System (i.e., approximately 65 μg/L for THMs and 15 μg/L for HAAs).

7.9.3 Comparison of DBP Formation Results

THMFP and HAAFP results for all streams are plotted in Figures 3.53 and 3.54. It must be emphasized that the chlorination and ozone results are conservative. The HAA concentrations in the ozonated samples are lower than the TTHM concentrations, suggesting that the SPW water favors the formation of THMs over HAAs. Non-blended water tended to form HAAs over THMs.

In summary THMs and HAAs tend to form in the effluent of the biological systems upon the addition of free chlorine. The THMs and HAAs in the FXB effluent (which was already at steady-state operation) were lower than the current Stage MCLs. Higher DBP concentrations measured in the chlorinated and ozonated FBR effluent are premature since the FBR was not optimized.

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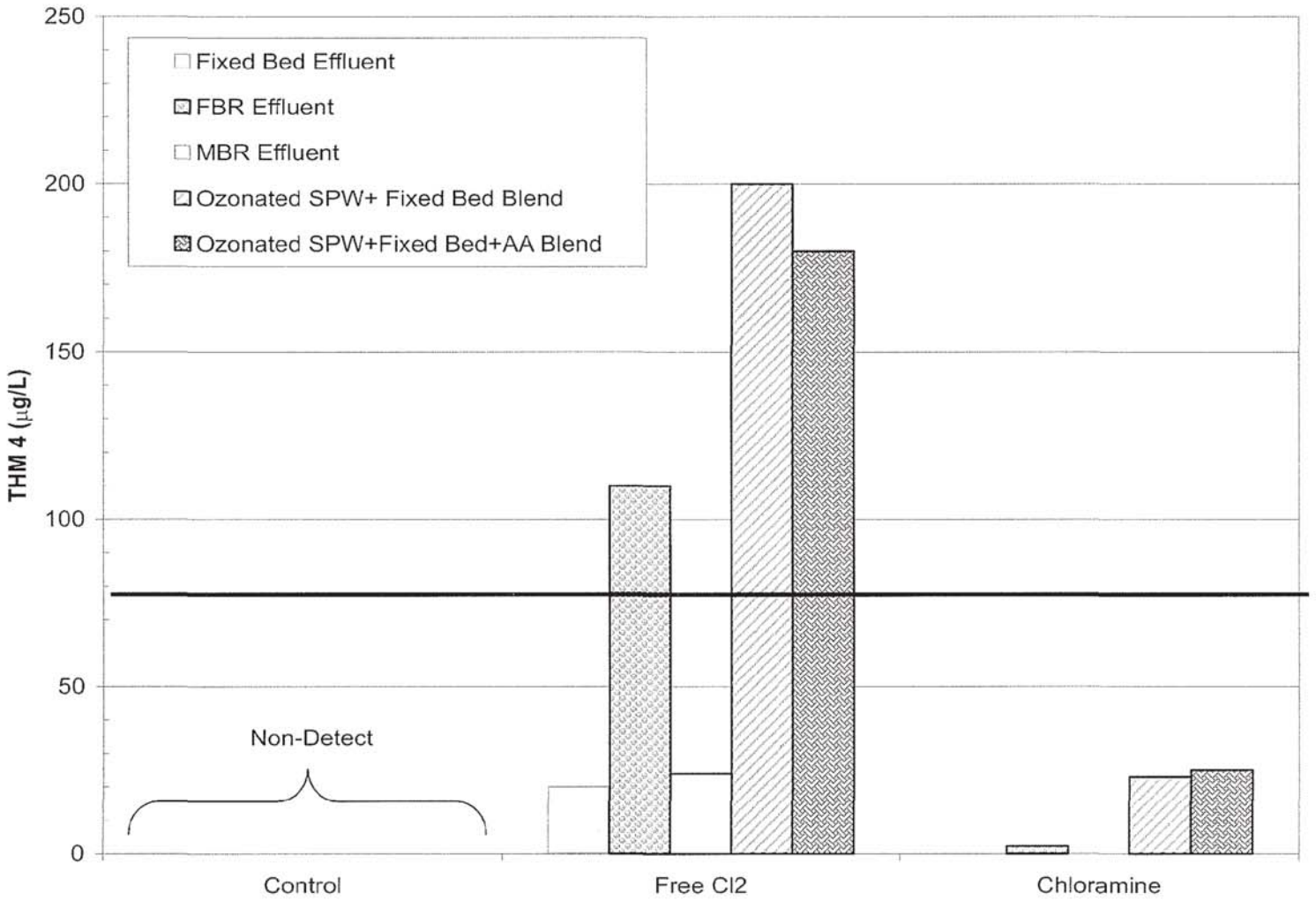

COMPARISON OF DBPFP THM4 SAMPLES FROM SEVERAL STREAMS

FIGURE 3.53

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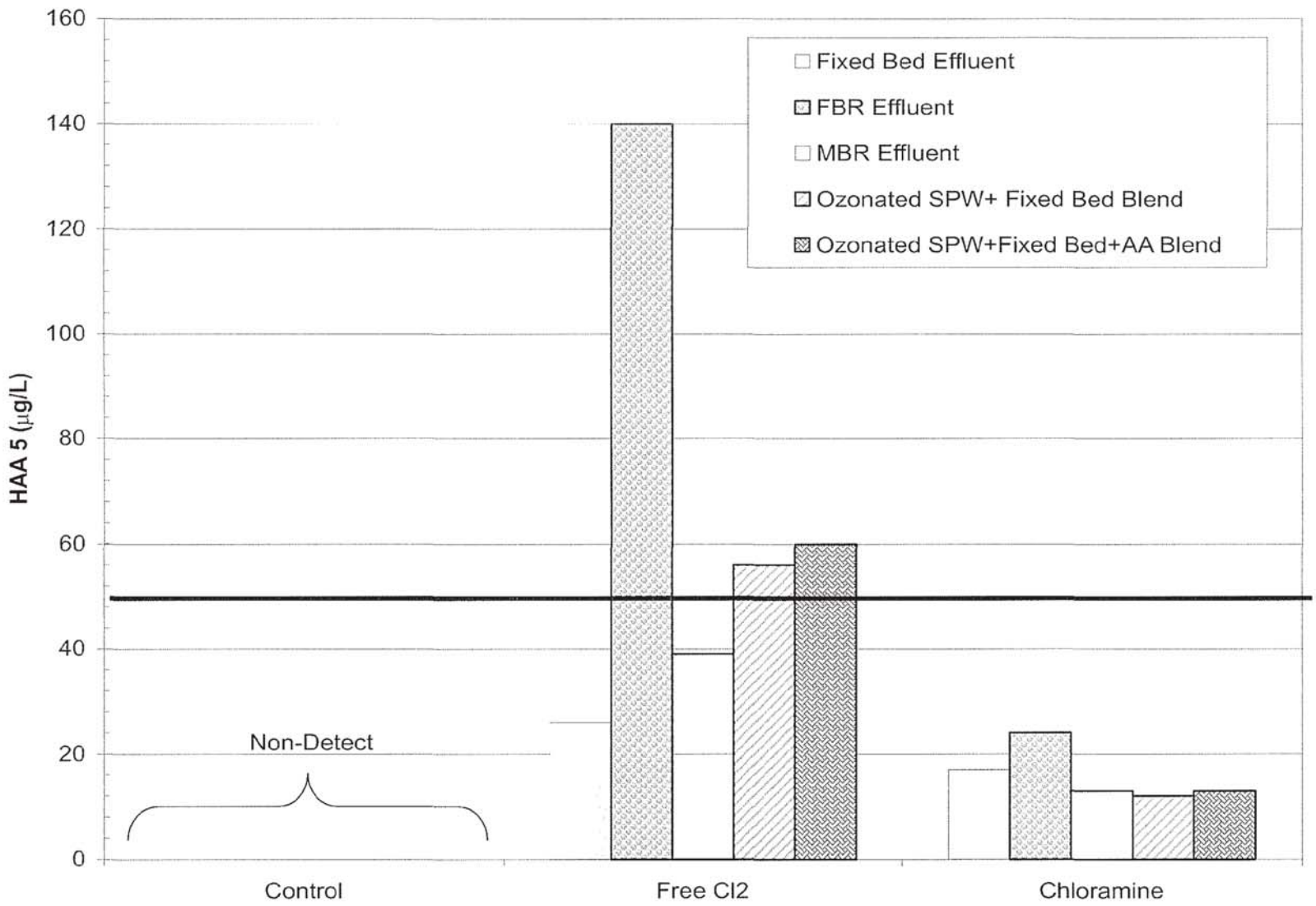

COMPARISON OF DBPFP HAA5 SAMPLES FROM SEVERAL STREAMS

FIGURE 3.54

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As expected, chloramination results in THM and HAA levels significantly lower than the Stage 2 MCLs.

7.10 Summary of DBPFP Results

7.10.1 DBPFP Testing on Fixed Bed, Fluidized Bed, and MBR Effluents

Following free chlorine addition with an excess residual after 7 days of incubation, DBP levels were formed in all streams, with levels in the FBR stream exceeding current MCLs of 80 μg/L and 60 μg/L for THMs and HAAs, respectively. It should be noted that the FBR was not optimized prior to the DBPFP tests. Because the FBR feed acetic acid concentrations were higher than ultimately required, the FBR DBPFP tests are considered conservative. HAAs were the dominant DBPs in the three samples. As expected, chloramination resulted in low levels of THMs and lower levels of HAAs as compared to free chlorination. Higher DBP formation yields were calculated in the FBR effluent relative to the FXB effluent. A follow-up 72-hour SDS test was conducted on the FBR effluent. The SDS-THM4 and SDS-HAA5 concentrations were lower than the D/DBPR Stage 2 MCLs, measured at 40- and 23-µg/L, respectively.

7.10.2 DBPFP Testing on Ozonated Fixed Bed Effluent

To simulate DBP formation potential of FXB effluent that is post-treated at the Rio Vista Water Treatment Plant (WTP), a blend of 90 percent State Project Water (SPW) and 10 percent FXB effluent was ozonated and contacted with free or combined chlorine. Following ozonation, bromate was formed at concentrations ranging from 1.8 to 8.7 μg/L due to high bromide levels of 200 μg/L for the blended water. Aldehydes were formed at moderate levels, even in the effluent spiked with acetic acid. The ozonation of the samples resulted in an increase in the BDOC and AOC concentrations. It should be noted that the filtration process at the Rio Vista WTP downstream of ozonation may further reduce the aldehydes and BDOC levels in the finished water. High levels of THMs and HAAs were measured in the ozonated samples following DBP formation testing with free chlorine. THM4 concentrations were two times the Stage 2 MCL. However, residual chlorine concentrations were excessive during incubation and, more importantly, a large fraction of DBP precursors would likely be removed downstream of ozonation, prior to chlorination at the Rio Vista WTP. The HAA concentrations in the ozonated samples, although relatively high, were lower or equal to the Stage 2 MCL. Seven-day incubation of ozonated water with combined chlorine generated only 23 μg/L TTHM4 and 12 μg/L HAA5.

8.0 CONCLUSION

All three ion-exchange resins removed perchlorate to below detection for run times exceeding model predictions. Preliminary NDMA formation potential tests with pre- and post-disinfection, as well as spent resin characterization tests suggest that the operation and disposal of these resins under the conditions tested should not raise any concern. It

should be noted however that in a full-scale process, the temporal discharge of groundwater following a resin change-out may pose a challenge due to potential restrictions in chloride level imposed by the relative agency (e.g., county sanitation district or regional water quality control board).

Consistent perchlorate removal to below detection was achieved in the FXB filter using only organisms indigenous to the Saugus aquifer. With influent DO and nitrate concentrations of 7 and 15 mg/L, respectively, the lowest EBCT and acetic acid concentration that allowed consistent perchlorate removal to below detection was 15 minutes and 7.8 mg/L as carbon, respectively. Run times ranged from 24 hours to several days. Effluent from the FXB filter was biologically stable and contained no fecal coliforms. Challenge tests demonstrated that the FXB filter was robust with respect to backwashing episodes, changes in feed water quality, system shut-downs, and electron donor addition failures. Large step increases in feed nitrate concentration (e.g., 15 mg/L) required a period of bio-acclimation before perchlorate removal to below detection could be reestablished in the FXB filter. A short-term post-treatment test performed on the FXB system with an SMBR demonstrated that the SMBR would be able to meet regulatory requirements in terms of aeration and filtration in a single step. DBP formation tests for the fixed bed reactor resulted in THM and HAA levels lower than the Stage 2 MCLs.

The fluidized-bed reactor did not achieve perchlorate removal to below detection over a period greater than 8 days, in spite of numerous mechanical and operational adjustments made to the system. However, testing did demonstrate that biological perchlorate removal can be achieved using indigenous microorganisms, a feature that had not yet been demonstrated for the FBR system. Because the FBR was not optimized, challenge testing was not performed.

A number of critical design parameters have been established based on the test results. These will be used during the pre-design of a selected system. Based on the performance of these systems, preliminary budget level costs have been developed, which will be presented in the pre-design report.

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BULLETIN
132-04
SEPTEMBER 2005

MANAGEMENT OF THE
CALIFORNIA STATE WATER PROJECT

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BULLETIN 132-04

SEPTEMBER 2005

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Chapter 9
Water Contracts and Deliveries

San Luis Reservoir

Significant Events in 2003

- On May 5, 2003, the Monterey Settlement Agreement was formally executed and was approved by the court on May 20, 2003. This settlement agreement offered an alternative to further litigation and, with certain conditions, allows the State Water Project to continue to operate pursuant to the Monterey Agreement while the new EIR is being prepared.
- The Department executed 39 long-term water supply contract amendments, 18 water conveyance/exchange agreements, 1 turn-in agreement, 10 turnout agreements, 34 Turnback Water Pool Program agreements, and 16 Article 21 Water Program agreements, with State Water Project contractors.
- The SWP approved delivery of 90 percent of SWP contractors' Table A requests, and conveyed 4,223,255 acre-feet to 27 long-term contractors and 26 other agencies.
- In 2003, 29,770 acre-feet of water were sold and purchased under the Turnback Water Pool Program.
- Implementation of the 2003 Colorado River Quantification Settlement Agreement resulted in a 2003 Exchange Agreement, pending execution, among Coachella Valley Water District, Metropolitan Water District of Southern California, and Desert Water District, which provides for the transfer of 88,100 acre-feet of Metropolitan's Table A amounts to Coachella, and 11,900 acre-feet of Metropolitan's Table A amounts to Desert.

The long-term water supply contracts for water service from the State Water Project between the Department and 29 local agencies are basic to the project's construction and operation. In return for State financing, constructing, operating, and maintaining facilities needed to provide water service, the agencies contractually agreed to repay all associated SWP capital and operating costs.

The Department delivers water to SWP contractors in accordance with their long-term water supply contracts.

These contracts set forth Table A amounts, which determine how much water a contractor may request each year from the Department.

Annual Table A represents the total amount of project water that an SWP contractor may request each year, according to that contractor's long-term water supply contract.

Approved Table A represents the amount of annual Table A requested by the contractors and approved for delivery by the Department, based on hydrologic conditions, current reservoir storage, and total requests by the SWP water contractors. The Department is not always able to deliver the quantity of water requested by the contractors; under certain

Long-Term SWP Water Supply Contracts

The first water supply contract was signed with the Metropolitan Water District of Southern California on November 4, 1960. The contract was negotiated by the Department and Metropolitan according to terms of the contracting principles for water service contracts announced by Governor Edmund G. Brown on January 20, 1960.

The Metropolitan contract became the prototype for all water contracts; by the end of 1967, 31 agencies had contracted for water. In addition, a water supply contract was executed with the City of West Covina in December 1963, but was terminated in August 1965; the city's Table A amount was transferred to Metropolitan through an amendment to the district's long-term contract with the Department. Long-term contracts with Hacienda Water District and Devil's Den Water District were also terminated when those districts transferred their Table A amounts, through contract amendments, to Tulare Lake Basin Water Storage District (1981) and Castaic Lake Water Agency (1992), respectively. Today the SWP has long-term water supply contracts with 29 agencies. Those contracts have been amended periodically to incorporate mutually desired modifications.

All water contracts signed in the 1960s included an estimate of the date water would first be delivered and a schedule of the amount of water the agency could expect to be delivered annually (annual Table A amounts). That amount was designed to increase gradually until the maximum amount of annual Table A was reached. The total combined maximum annual Table A amount for all water contracting agencies was initially 4,230,000 acre-feet, assuming full development of the SWP.

The contracts were initially designed to be valid for 75 years or until all bonds sold as part of the California Water Resources Development Bond Act were repaid, whichever period was longer. As a result of amendments to contracts in the 1990s, the current combined maximum annual Table A amount totals 4,172,786 acre-feet, and the contracts are in effect for the longest of the following periods: (1) the project repayment period, which extends to the year 2035; (2) 75 years from the date of the contract; or (3) the period ending with the latest maturity date of any bond used to finance the construction costs of project facilities.

conditions, a lesser amount, allocated according to the long-term water supply contracts and the process noted above, is made available for delivery.

Approved Table A amounts may also be referred to in this chapter as *approved amounts* or *approved water.*

The long-term water supply contracts are amended as needed. During 2003, 39 amendments were executed, 27 of which were related to the Monterey Settlement Agreement. A number of long-term consolidated contracts, with the amendments integrated into the contract, are available online at www.swpao.water.ca.gov/wsc/index.cfm.

The Department also enters into miscellaneous agreements with SWP contractors and other agencies—which may be amended periodically—to convey SWP and non-SWP water through the California Aqueduct and to approve the construction, operation, and maintenance of turnouts along SWP facilities. During 2003, the Department executed 18 water conveyance/exchange agreements, 1 turn-in agreement, 10 turnout agreements, 34 Turnback Water Pool Program agreements, and 16 Article 21 Water Program agreements with SWP contractors. The Department also delivered water pursuant to 11 miscellaneous agreements executed prior to 2003 with the SWP contractors. Pending execution are 3 water conveyance/exchange agreements (including one unscheduled water program agreement) and 8 storage agreements.

The State Water Project Analysis Office has developed a numbering system for contracts, amendments, and agreements executed by the Department. These numbers, designated as SWPAO #XXXXX, are located in parentheses after each contract, amendment, or agreement.

Detailed information about amendments and agreements follows.

Amendments to Long-Term SWP Water Supply Contracts

All the original contracts signed by the Department and local agencies have been previously amended to incorporate mutually desired changes. Most amendments fall under the following five general categories:

(1) revision of annual Table A amounts in the water supply contracts;
(2) allocation of costs and benefits for the enlargement or extension of the East Branch and extension of the Coastal Branch of the California Aqueduct;
(3) purchase of excess capacity in the California Aqueduct;
(4) provisions to allow contractors, under certain conditions, to carry over undelivered SWP approved Table A water from one year for delivery in the next year; and
(5) implementation of Monterey Agreement principles.

The following long-term SWP Water Supply Contracts were amended during 2003.

Alameda County Flood Control and Water Conservation District-Zone 7. The Department executed Amendment No. 23 to the Water Supply Contract between Alameda-Zone 7 and the Department on August 1, 2003. The Amendment provided for the permanent transfer of 400 acre-feet of SWP Table A amounts from Tulare Lake Basin Water Storage District to Alameda-Zone 7, and set forth conditions for the transfer. The transfer is effective January 1, 2003. (SWPAO #03001)

Alameda County Flood Control and Water Conservation District-Zone 7. The Department executed Amendment No. 24 to the Water Supply Contract between Alameda-Zone 7 and the Department on November 7, 2003. This Amendment set forth the terms and conditions for the financing and repayment of costs attributable to the South Bay Aqueduct Enlargement. (SWPAO #03013)

Alameda County Flood Control and Water Conservation District-Zone 7. The Department executed Amendment No. 25 to the Water Supply Contract between Alameda-Zone 7 and the Department on October 31, 2003. The Amendment provided for the permanent transfer of 2,219 acre-feet of SWP Table A amounts from Kern County Water Agency to Alameda-Zone 7, and set forth conditions for the transfer. The transfer becomes effective January 1, 2004. (SWPAO #04002)

Coachella Valley Water District. The Department executed Amendment No. 18 to the Water Supply Contract between Coachella and the Department on October 10, 2003. The amendment provided for the permanent transfer of 88,100 acre-feet of SWP Table A amounts from Metropolitan Water District of Southern California to Coachella, and set forth conditions for the transfer. This amendment is a result of the 2003 Exchange Agreement pending execution, among Coachella, Metropolitan, and Desert Water Agency, which will provide for the transfer of 88,100 acre-feet of Metropolitan's Table A amounts to Coachella, and 11,900 acre-feet of Metropolitan's Table A amounts to Desert. The transfer is consistent with the implementation of the 2003 Colorado River Quantification Settlement Agreement. The amendment will become effective the later of January 1, 2004, or January 1 of the subsequent year that the 2003 Exchange Agreement becomes effective. The 2003 Exchange Agreement was not executed at the end of 2003. (SWPAO #04009)

County of Kings. The Department executed Amendment No. 16 to the Water Supply Contract between County of Kings and the Department on December 5, 2003. The amendment provided for the permanent transfer of 5,000 acre-feet of SWP Table A amounts from Tulare to County of Kings, and set forth conditions for the transfer. The transfer is effective January 1, 2004. (SWPAO #04004)

Desert Water Agency. The Department executed Amendment No. 18 to the Water Supply Contract between Desert and the Department on November 3, 2003. The amendment provided for the permanent transfer of 11,900 acre-feet of SWP Table A amounts from Metropolitan to Desert, and set forth conditions for the transfer. This amendment is a result of the 2003 Exchange Agreement pending execution, among Coachella, Metropolitan, and Desert Water Agency, which will provide for the transfer of 88,100 acre-feet of Metropolitan's Table A amounts to Coachella, and 11,900 acre-feet of Metropolitan's Table A amounts to Desert. The transfer is consistent with the implementation of the 2003 Colorado River Quantification Settlement Agreement. The amendment will become effective the later of January 1, 2004, or January 1 of the subsequent year that the 2003 Exchange Agreement becomes effective. The 2003 Exchange Agreement was not executed at the end of 2003. (SWPAO #04011)

Kern County Water Agency. The Department executed Amendment No. 36 to the Water Supply Contract between Kern and the Department on October 31, 2003. The amendment provided for the permanent transfer of 2,219 acre-feet of SWP Table A amounts from Kern to Alameda-Zone 7, and set forth conditions for the transfer. The transfer becomes effective January 1, 2004. (SWPAO #04001)

Metropolitan Water District of Southern California. The Department executed Amendment No. 27 to the Water Supply Contract between Metropolitan and the Department on October 24, 2003. The amendment provided for the permanent transfer of 88,100 acre-feet of SWP Table A amounts from Metropolitan to Coachella, and set forth conditions for the transfer. This amendment is a result of the 2003 Exchange Agreement pending execution, among Coachella, Metropolitan, and Desert, which will provide for the transfer of 88,100 acre-feet of Metropolitan's Table A amounts to Coachella, and 11,900 acre-feet of Metropolitan's Table A amounts to Desert. The transfer is consistent with the implementation of the 2003 Colorado River Quantification Settlement Agreement. The amendment will become effective the later of January 1, 2004, or January 1 of the subsequent year that the 2003 Exchange Agreement becomes effective. The

2003 Exchange Agreement was not executed at the end of 2003. (SWPAO #04008)

Metropolitan Water District of Southern California. The Department executed Amendment No. 28 to the Water Supply Contract between Metropolitan and the Department on October 24, 2003. The amendment provided for the permanent transfer of 11,900 acre-feet of SWP Table A amounts from Metropolitan to Desert, and set forth conditions for the transfer. This amendment is a result of the 2003 Exchange Agreement pending execution, among Coachella, Metropolitan, and Desert, which will provide for the transfer of 88,100 acre-feet of Metropolitan's Table A amounts to Coachella, and 11,900 acre-feet of Metropolitan's Table A amounts to Desert. The transfer is consistent with the implementation of the 2003 Colorado River Quantification Settlement Agreement. The amendment will become effective the later of January 1, 2004, or January 1 of the subsequent year that the 2003 Exchange Agreement becomes effective. The 2003 Exchange Agreement was not executed at the end of 2003. (SWPAO #04010)

Solano County Water Agency. The Department executed Amendment No. 19 to the Water Supply Contract between Solano and the Department on November 12, 2003. The amendment provided for the approval for Solano to pay only the prospective charge for the North Bay Aqueduct costs attributable to the 5,756 acre-feet annual Table A increase made effective in Amendment No. 17 to Solano's long term Water Supply Contract. The amendment becomes effective January 1, 2004. (SWPAO #03005)

Tulare Lake Basin Water Storage District. The Department executed Amendment No. 29 to the Water Supply Contract between Tulare and the Department on June 2, 2003. The amendment provided for the permanent transfer of 400 acre-feet of SWP Table A amounts from Tulare to Alameda-Zone 7, and set forth conditions for the transfer. The transfer is effective January 1, 2003. (SWPAO #03002)

Tulare Lake Basin Water Storage District. The Department executed Amendment No. 30 to the Water Supply Contract between Tulare and the Department on December 5, 2003. The amendment provided for the permanent transfer of 5,000 acre-feet of SWP Table A amounts from Tulare to Kings County, and set forth conditions for the transfer. The transfer becomes effective January 1, 2004. (SWPAO #04003)

Monterey Amendments

The Monterey Amendments increase the reliability of existing water supplies; provide stronger financial management for the SWP; and increase water management flexibility, providing more tools for local water agencies to maximize use of existing facilities.

The Monterey Amendments incorporated changes in determination of approved Table A water, the transfer of Table A amounts and land, financial restructuring, and increased operational flexibility. The Monterey Amendments are discussed in detail in Chapter 1, *Summary of Significant Events*, of Bulletin 132-95.

Plumas County Flood Control and Water Conservation District and Empire West Side Irrigation District, the only long-term SWP contractors who have not signed the Monterey Amendment, await completion of the EIR to decide whether to sign.

The Planning and Conservation League filed a lawsuit on December 27, 1995, challenging the California Environmental Quality Act compliance for the Monterey Amendment. A Sacramento County Superior Court judge later dismissed the lawsuit. PCL appealed the decision and on September 15, 2000, the Third District Court of Appeal reversed the Superior Court ruling. On December 13, 2000, the California Supreme Court denied review. The parties commenced mediation on March 26, 2002, and proceedings in Superior Court were stayed pending completion of mediation. On July 18, 2002, the parties reached agreement on principles for settling the lawsuit.

Monterey Settlement Agreement

On May 5, 2003, the Monterey Settlement Agreement was formally executed and was approved by the court on May 20, 2003. This settlement agreement offered an alternative to further litigation and, with certain conditions, allows the State Water Project to continue to operate pursuant to the Monterey Agreement while the new EIR is being prepared. The Department and the contractors agree not to approve any new projects or activity in reliance on the 1995 EIR, which was not approved, initiated or implemented prior to March 26, 2001, and the approval, initiation, or implementation of which would require a separate environmental document under CEQA. Information on the litigation can be found in *Chapter 6, Legislation and Litigation.*

The settlement agreement is a complex agreement with multiple components that balance the interests of the Department, the SWP contractors, Central Coast Water Authority, and Kern Water Bank Authority, with the disparate interests of the three plaintiffs.

All litigation costs will be paid by all SWP contractors, apportioned according to each agency's portion of the total maximum Table A Amounts as of January 1, 2003. Most of the contractors executed an agreement with the Department providing that the litigation costs will be allocated as incurred.

In addition to procedural items including attorney fees, mediation, and disposition of the lawsuit, items concerning the operation and management of the SWP are described below.

New Amendments to the SWP Contracts

The Department and 28 SWP contractors executed new amendments to the SWP long-term water supply contracts to improve and clarify disclosure of information about the delivery capability of the SWP. The amendments deleted the term "entitlement" and replaced that term with "Table A Amount." This does not change the Department's water delivery obligations or any other rights under the SWP contracts.

Language is also added to the bottom of each contractor's Table A to clarify that Table A is not to be interpreted to mean that the Department is able to deliver those amounts in all years. Empire, which has never signed the Monterey Amendment, did not execute the Monterey Settlement Amendment.

The amendment also requires the Department to distribute a biennial report to SWP contractors and all city, county, and regional planning agencies within the SWP project area, providing information as to SWP delivery capabilities, historic deliveries, and estimated deliveries under a range of hydrologic conditions. This report is intended to assist the SWP contractors in the assessment of the adequacy of the SWP component of their overall water supplies. The first edition of this report was issued in 2003 for SWP deliveries through 2002. More information on this report can be found in *Chapter 7, Water Supply Development and Reliability.*

SWP Availability

In addition to the biennial report mentioned above, the settlement agreement requires the Department to develop guidelines to assist the SWP urban contractors in providing information to land use planning agencies regarding local and regional programs to manage or supplement SWP supplies. The Department is also required to assist these contractors in providing complete and accurate information to land use agencies to assure that local land use decisions reflect accurate information on the availability of water from State, local, and other sources. Preparation of this document is underway.

New EIR

Agreement was reached on the content, scope, and process for the new EIR. The project to be analyzed in the new EIR is the Monterey Amendment and certain components of the settlement agreement. The Department will act as lead agency in preparing the new EIR. A Notice of Preparation was issued in January 2003 and scoping meetings were held throughout the State.

Under the agreement, a committee of plaintiffs and SWP contractors advises the Department on developing the EIR. The Department's Director serves as chair of this committee. Preparation of the new EIR is underway. The committee met nine times during 2003.

Public Participation in SWP Contract Negotiations

Future negotiations for SWP-wide contract amendments and for contract amendments to transfer Table A Amounts between SWP contractors will be conducted in public. The Department agrees that public review of significant changes to the water supply contracts is beneficial and in the public interest. The Department notified the contractors of this new process through Notice to State Water Project Contractors No. 03-10, on July 3, 2003, which is available online at swpao.water.ca.gov/notices/index.cfm).

Guidelines for Review and Approval of Permanent Water Transfers

The Department is required to issue guidelines to describe the process for the Department's review of proposed permanent transfers of Table A Amounts. These guidelines are to assist contractors in developing their transfer proposals and obtaining Department review expeditiously, and to assist the public in participating in that review. The Department issued these guidelines on July 3, 2003, through Notice to State Water Project Contractors No. 03-09 and published them in Bulletin 132-02, Chapter 9 (available online at swpao.water.ca.gov/publications/bulletin/02/Bulletin132-02.pdf).

Kern Water Bank

The Kern Water Bank will remain in local ownership and will operate as it has, but will be subject to additional restrictions on use. The Department agrees to prepare an independent study of KWB regarding impacts related to the transfer, development, and operation of KWB in light of the Kern environmental permits, as part of the new EIR.

Permanent Table A Transfers

The following permanent Table A transfers from Kern already completed under the Monterey Amendment are final:

- Kern to Mojave, Table A Amount of 25,000 acre-feet, effective 1998;
- Kern to Palmdale, Table A Amount of 4,000 acre-feet, effective 2000;
- Kern to Alameda-Zone 7, Table A Amount of 7,000 acre-feet, effective 2000;
- Kern to Alameda-Zone 7, Table A Amount of 15,000 acre-feet, effective 2000;
- Kern to Alameda-Zone-7, Table A Amount of 10,000 acre-feet, effective 2001;
- Kern to Solano, Table A Amount of 5,756 acre-feet, effective 2001; and
- Kern to Napa, Table Amount of 4,025 acre-feet, effective 2001.

The parties recognize that the Kern-Castaic Lake Water Agency 41,000 acre-feet Table A transfer is subject to pending litigation and agree that jurisdiction with respect to that litigation remain in the Los Angeles County Superior Court and that nothing in the agreement is intended to predispose the remedies or other actions that may occur in the pending litigation.

The potential environmental effects of these transfers are required to be analyzed in the new EIR.

Plumas County Flood Control and Water Conservation District

Plumas will resume payments pursuant to its SWP water supply contract beginning in 2003. The Department will not collect any Plumas arrearages. Plumas agreed to support the Monterey Amendments and, along with the other contractors, executed the amendment discussed above which deleted the term "entitlement" and replaced that term with "Table A Amounts."

Up to $8 million will be paid over 8 years to Plumas beginning in 2003, primarily for watershed

improvements for the mutual benefit of Plumas and the SWP in the Feather River watershed, and for other district-related purposes, to be disbursed with input from a watershed forum composed of representatives of Plumas, the Department, and SWP contractors. A technical committee composed of the Department, Plumas, SWP contractors, and local resource management groups was formed to assist the forum. To help the forum set priorities for watershed management and restoration action, a consultant was hired during 2003 to help prepare the Feather River Watershed Management Strategy.

In addition, the Department will offer Plumas an amendment to its water supply contract which will include the Department's agreement that water supplied to Plumas be determined based on availability of Lake Davis' water supply and that water deliveries to Plumas will not be reduced during SWP shortages so long as sufficient water is available from Lake Davis.

Miscellaneous Agreements with Long-Term SWP Contractors

2003 Water Conveyance/Exchange Agreements

During 2003, water conveyance/exchange agreements were executed or pending execution with long-term SWP contractors as described below.

Dudley Ridge Water District. A long-term agreement executed June 30, 2003, among the Department, Dudley Ridge, and Tulare, approved a change in point of delivery of a portion of Dudley Ridge's annual approved SWP water and other water supplies to Tulare's turnout at Reach 8D of the California Aqueduct. Two long-term water supply contract amendments with Tulare (Amendment No. 26) and Dudley Ridge (Amendment No. 24), were executed in December 2001 for the permanent transfer of 3,973 acre-feet of Tulare's Table A amounts to Dudley Ridge to accommodate the needs of Sandridge Partners, a landowner who farms in both Tulare and Dudley Ridge service areas. This is a subsequent agreement to provide delivery of water to Sandridge Partners in Dudley Ridge's service area through Tulare's turnout at Reach 8D. No water was delivered in 2003. (SWPAO #02005)

Dudley Ridge Water District. A letter agreement dated October 8, 2003, and executed November 18, 2003, among the Department, Dudley Ridge, and Tulare, approved the delivery of up to 4,000 acre-feet of Dudley Ridge's 2003 Table A amounts to Tulare at Tulare's turnout B in Reach 8D of the California Aqueduct. The agreement facilitated the water transfer from Dudley Ridge to Tulare on behalf of Sandridge Partners, who farms in both Dudley Ridge and Tulare service areas. During 2003, a total of 1,100 acre-feet was delivered to Tulare. (SWPAO #03052)

Dudley Ridge Water District. A letter agreement dated November 19, 2003, and executed November 20, 2003, among the Department, Dudley Ridge, and San Gabriel Valley Municipal Water District, approved the delivery of up to 11,458 acre-feet of Dudley Ridge's 2003 Table A amounts to San Gabriel at Reach 26A of the California Aqueduct. In exchange, San Gabriel will return a like amount of its future Table A amounts to Dudley Ridge by December 31, 2013. During 2003, a total of 8,700 acre-feet of Dudley Ridge's 2003 Table A amounts was delivered to San Gabriel. (SWPAO #03055)

Empire West Side Irrigation District. An agreement, pending execution between the Department and Empire, will provide for the delivery of unscheduled water to Empire in 2003 at times when project water is not needed for fulfilling approved Table A deliveries or for meeting project operational commitments. A total of 175 acre-feet of unscheduled water was delivered to Empire in 2003. (SWPAO #03012)

Kern County Water Agency. A letter agreement dated June 6, 2003, and executed July 3, 2003, between the Department and Kern, approved the delivery of up to 20,000 acre-feet of 2002 CVP water from three CVP contractors

to Kern. In exchange, Kern would return a like amount of its 2003 approved Table A amounts to the CVP contractors by December 31, 2003. The Department petitioned the State Water Resources Control Board on July 25, 2003, and received approval on August 26, 2003, for a temporary change of place of use for delivery of the return water. A total of 18,428 acre-feet was delivered to Kern from O'Neill Forebay and 18,428 acre-feet of water was returned to the CVP contractors at O'Neill Forebay in 2003. (SWPAO #03009)

Kern County Water Agency. A letter agreement dated June 12, 2003, and executed July 3, 2003, between the Department and Kern, approved the delivery of up to 13,000 acre-feet of 2001 CVP water from two CVP contractors to Kern. In exchange, Kern would return a like amount of its 2002 approved Table A amounts to the CVP contractors by December 31, 2002. The Department petitioned SWRCB on June 21, 2002, and received approval on August 16, 2002, for a temporary change of place of use for delivery of the return water. A total of 7,400 acre-feet was delivered to Kern from O'Neill Forebay and a total of 7,400 acre-feet of water was returned to the CVP contractors at O'Neill Forebay in 2002. (SWPAO #02014)

Kern County Water Agency. A letter agreement dated October 2, 2003, and executed December 15, 2003, among the Department, Kern, and Dudley Ridge, approved the delivery of up to 8,000 acre-feet of Kern's 2003 approved Table A amounts to Dudley Ridge at Reach 8D of the California Aqueduct. The agreement facilitated the water transfer from Kern to Dudley Ridge on behalf of the landowner Sandridge Partners who farms in both Kern and Dudley Ridge service areas. During 2003, a total of 8,000 acre-feet was delivered to Dudley Ridge. (SWPAO #03054)

Santa Clara Valley Water District. A letter agreement, pending execution between the Department and Santa Clara, provides for the delivery of up to 3,100 acre-feet of Brown's Valley Irrigation District's water (nonproject) to Santa Clara. This water, which is under Brown's Valley pre-1914 water rights, will be made available at Banks Pumping Plant and conveyed to Santa Clara at Reach 9 of the South Bay Aqueduct. Santa Clara requested this water be delivered pursuant to Article 55 of its long-term Water Supply Contract. During 2003, a total of 2,480 acre-feet of Brown's Valley water (nonproject) was delivered to Santa Clara. (SWPAO #03058)

Solano County Water Agency. A settlement agreement executed May 19, 2003, among the Department, Solano, and the Cities of Fairfield, Vacaville, and Benicia, and a conveyance agreement, executed concurrently between the Department and Solano, approved the delivery of up to 31,260 acre-feet annually of settlement water to Solano for delivery to the Cities of Fairfield, Vacaville, and Benicia. The agreements resulted from negotiations following the cities' petitions to SWRCB to appropriate water from the Sacramento River. The purpose of the agreements was to avoid disputing issues of appropriation before SWRCB. The agreement provides a supplemental water supply to the cities to assist in meeting current and future water demands through the North Bay Aqueduct. Water will be made available during excess conditions in the Delta as defined in the Coordinated Operations Agreement, or during balanced conditions when Water Rights Standard Permit term 91, which relates to availability of water for appropriation, is not in effect. The cities pay a fee per acre-foot of settlement water delivered during balanced conditions at NBA. The agreement remains in effect until December 31, 2035. During 2003, a total of 860 acre-feet of the settlement water was delivered to the Cities of Fairfield, Vacaville, and Benicia through Reaches 1 and 3A of the North Bay Aqueduct. (SWPAO #03017)

Tulare Lake Basin Water Storage District. A letter agreement dated April 14, 2003, and executed April 22, 2003, between the Department and Tulare, approved the transfer of up to 5,000 acre-feet of Tulare's 2003 approved Table A amounts to Westlands Water District at Reaches 5, 6, and 7 of the California Aqueduct on behalf of two landowners, Hansen Ranches

and Newton Farms, who farm in both the Tulare and Westlands service areas. The Department petitioned SWRCB on April 1, 2003, and received approval on May 23, 2003, for a temporary change of place of use. During 2003, a total of 3,900 acre-feet was delivered to Westlands at Reach 5. (SWPAO #03006)

Tulare Lake Basin Water Storage District. A letter agreement dated August 6, 2003, and executed August 25, 2003, between the Department and Tulare, approved the delivery of up to 25,000 acre-feet of Lower Tule River Irrigation District's water (nonproject) to Tulare at Reaches 8C and 8D of the California Aqueduct. Tulare requested this water be delivered pursuant to Article 55 of its long-term water supply contract. No water was delivered in 2003. (SWPAO #03007)

Tulare Lake Basin Water Storage District. A letter agreement dated April 4, 2003, and executed April 10, 2003, between the Department and Tulare, approved the transfer of up to 1,000 acre-feet of Tulare's 2003 Table A amounts to Westlands at Reach 7 of the California Aqueduct on behalf of Westlake Farms Inc., who farms in both Tulare and Westlands service areas. The water was delivered to Westlands for use on lands within the Kings County portion of Westland's service area. During 2003, a total of 1,000 acre-feet was delivered to Westlands at Reach 7. (SWPAO #03011)

Tulare Lake Basin Water Storage District. A letter agreement dated June 5, 2003, and executed August 25, 2003, between the Department and Tulare, approved the delivery of up to 10,000 acre-feet of nonproject water to Tulare at Reaches 8C and 8D (SWPAO #02025). Lower Tule River Irrigation District requested this water be delivered to Tulare and, in exchange, will receive a like amount of Tulare's Tule River water. Tulare requested the water be delivered pursuant to Article 55 of its long-term water supply contract. The water was made available at Banks Pumping Plant and delivered to Tulare in 2002. A subsequent Amendment pending execution between the Department and Tulare, will amend the delivery amounts to 10,596 acre-feet. (SWPAO #04022)

Water Conveyance/Exchange Agreements Prior to 2003

During 2003, water delivered pursuant to agreements with SWP contractors that were executed prior to 2003, is described below.

Alameda County Flood Control and Water Conservation District-Zone 7. A conveyance agreement dated July 28, 1995, between Alameda-Zone 7 and the Department, provides for the transfer of up to 5,000 acre-feet of Byron-Bethany Irrigation District's local water annually to Alameda-Zone 7 through SWP facilities. An amendment to extend the agreement to December 31, 2001, was executed April 26, 2002. Byron-Bethany may only transfer water that has been made available by conservation and crop idling. In 2003, 1,000 acre-feet of Byron Bethany's local water was pumped at Banks Pumping Plant and delivered to Alameda-Zone 7's turnouts in the South Bay Aqueduct. (SWPAO #02325)

Castaic Lake Water Agency. An agreement executed on December 27, 2001, among the Department, Castaic Lake, United Water Conservation District, Newhall Land and Farming Company, Newhall County Water District, and Los Angeles County, provided for the temporary extension through December 31, 2001, to store and release up to 8,786 acre-feet of local flood flows in Castaic Reservoir to Castaic Lake. United, a member unit of Ventura, transferred 4,512 acre-feet of stored local water to Castaic Lake in 2001. In 2003, Castaic Lake released 6,768 acre-feet of its 2003 Table A allocation to the Department (1.5 times the amount transferred by United). The Department in turn released 6,768 acre-feet of local water from Piru Creek to United. (SWPAO #01036)

Kern County Water Agency. An agreement executed on June 8, 2000, among the Department, Kern, and Western Hills Water District, approved delivery of 8,000 acre-feet of pre-1914 Lower Kern River Rights water banked in

Kern's share of the Pioneer Groundwater Banking Project. A portion of Kern's annual Table A amounts will be delivered annually to Western Hills from Reach 2A of the California Aqueduct; in exchange, Kern will take a like amount of banked local water from the Pioneer Groundwater Bank. The Department petitioned SWRCB and by SWRCB Order dated April 21, 2000, Western Hills' service area was included within the authorized SWP place of use. During 2003, a total of 917 acre-feet of Kern's Table A amounts was delivered to Western Hills at Reach 2A. (SWPAO #01001)

Kern County Water Agency. A letter agreement executed October 11, 2002, between the Department and Kern, approved the delivery of up to 30,000 acre-feet of nonproject water from four CVP contractors, members of the San Luis and Delta Mendota Water Authority, to Kern in 2000. In exchange, Kern would return a like amount of its approved Table A amounts to CVP contractors by December 31, 2003. During 2000, a total of 23,941 acre-feet of CVP water was delivered to Kern. During 2003, a total of 1,787 acre-feet was returned to CVP contractors. A balance of 22,154 acre-feet remained to be returned to the CVP contractors at the end of the contract term. (SWPAO #00032)

In a letter dated August 1, 2003, Kern requested an extension on the return period of the CVP water since Kern was unable to return all the water by December 31, 2003. Extension of the return period and other possible alternatives for Kern to return the remaining water to CVP contractors are being discussed among the Department, Kern, and San Luis and Delta Mendota Water Authority.

Mojave Water Agency. An agreement executed November 13, 1997, among AVEK, Mojave, and the Department, approved a change in point of delivery through 2019 of up to 2,250 acre-feet annually of Mojave's approved Table A amount to AVEK's Fairmont Turnout in Reach 19 of the California Aqueduct. Mojave does not have conveyance facilities to provide service to a solar energy generating station located within its service area. AVEK has conveyance capability and has agreed to provide service. During 2003, the Department delivered 816 acre-feet of Mojave's 2003 approved Table A amounts through AVEK's turnout at Reach 19. (SWPAO #97003)

San Bernardino Valley Municipal Water District. San Bernardino and Metropolitan entered into an agreement, Attachment 2, Coordinated Use Agreement for Conveyance Facilities and State Water Project Water Supplies, on May 14, 2001. The Department responded on February 27, 2002, concurring with the agreement and acknowledging the coordinated use of local facilities currently existing within San Bernardino's jurisdictional boundaries. This coordinated use involves delivery of San Bernardino's SWP water to Metropolitan's facilities within San Bernardino's service area. This action is permitted under Article 10 of the long-term water supply contract. During 2003, a total of 5,000 acre-feet of San Bernardino's approved Table A amounts was delivered to Metropolitan at Reach 26A. (SWPAO #02035)

Tulare Lake Basin Water Storage District. A letter agreement, dated June 15, 2001, and executed July 26, 2001, between the Department and Tulare, approved the delivery of up to 50,000 acre-feet of nonproject water from Westlands to Tulare between December 2000 and April 15, 2001, in exchange for a like amount of Tulare's Table A amounts during 2001 through 2003. The delivery of SWP exchange water to Westlands will be from the Delta to Reach 7 of the California Aqueduct, for use within the Kings County portion of Westlands' service area. A combined total of 28,145 acre-feet was delivered to Tulare during 2000 and 2001. During 2001, 1,975 acre-feet were returned to Westlands. During 2002, a total of 12,067 acre-feet was delivered to Westlands, leaving a balance of 14,103 acre-feet to be returned to Westlands. During 2003, a total of 14,103 acre-feet was returned to Westlands, completing this agreement. (SWPAO #01009)

EWA 2:1 Exchange Agreements

During 2002, six SWP contractors had agreements with the Department for the in lieu exchange of a portion of their 2002 Table A amounts for stored Environmental Water Account water. A portion of the EWA water subject to "spilling" in San Luis Reservoir was made available for exchange as of midnight March 29, 2002. For every two units of EWA water delivered to each contractor noted below, the contractor returned one unit of its 2002 approved Table A amounts to EWA by August 31, 2002. The following agreements include provisions concerning the exchanges.

Alameda County Flood Control and Water Conservation District, Zone 7. A letter agreement, dated March 27, 2003, and executed April 4, 2003, between the Department and Alameda-Zone 7, approved an in lieu exchange of a portion of Alameda-Zone 7's 2002 approved Table A amounts for up to 2,000 acre-feet of stored EWA water. During 2002, a total of 803 acre-feet of EWA water was delivered to Semitropic in April in accordance with the *Alameda County Flood Control and Water Conservation District, Zone 7 and Semitropoic Water Storage District Banking Program Agreement*, pursuant to a change in point of delivery agreement among the Department, Alameda-Zone 7, and Kern (SWPAO #02010); a total of 402 acre-feet of Alameda-Zone 7's 2002 Table A amounts was returned to EWA in July and August. (SWPAO #02017)

Alameda County Water District. A letter agreement, dated March 28, 2003, and executed April 8, 2003, between the Department and Alameda County, approved an in lieu exchange of a portion of Alameda County's 2002 approved Table A amounts for up to 2,000 acre-feet of stored EWA water. During 2002, a total of 571 acre-feet of EWA water was delivered to Alameda County in March and April, and a total of 286 acre-feet of Alameda County's 2002 Table A amount was returned to EWA in July and August. (SWPAO #02018)

Dudley Ridge Water District. A letter agreement, dated March 27, 2003, and executed April 9, 2003, between the Department and Dudley Ridge, approved an in lieu exchange of a portion of Dudley Ridge's 2002 approved Table A amount for up to 4,000 acre-feet of stored EWA water. During 2002, the Department delivered a total of 2,140 acre-feet of EWA water to Dudley Ridge, of which 1,597 acre-feet were delivered to Dudley Ridge's turnout and 543 acre-feet were delivered to Tulare's turnout in March and April pursuant to a long-term change in point of delivery agreement among the Department, Dudley Ridge, and Tulare (SWPAO #02005). A total of 1,070 acre-feet of Dudley Ridge's 2002 Table A amounts was returned to EWA in July and August. (SWPAO #02020)

Kern County Water Agency. A letter agreement, dated March 28, 2003, and executed April 15, 2003, between the Department and Kern, approved an in lieu exchange of a portion of Kern's 2002 approved Table A amounts for stored EWA water. During 2002, a total of 6,744 acre-feet of EWA water was delivered to Kern in March and April, and a total of 3,372 acre-feet of Kern's 2002 Table A amounts was returned to EWA in July and August. (SWPAO #02021)

Santa Clara Valley Water District. A letter agreement, dated March 27, 2003, and executed April 15, 2003, between the Department and Santa Clara, approved an in lieu exchange of a portion of Santa Clara's 2002 approved Table A amounts for up to 2,176 acre-feet of stored EWA water. During 2002, a total of 1,448 acre-feet of EWA water was delivered to Santa Clara in March and April, and a total of 724 acre-feet of Santa Clara's 2002 Table A amounts was returned to EWA in July and August. (SWPAO #02019)

Tulare Lake Basin Water Storage District. A letter agreement, dated March 28, 2003, and executed August 25, 2003, between the Department and Tulare, approved an in lieu exchange of a portion of Tulare's 2002 approved Table A amounts for up to 800 acre-feet of stored EWA

water. During 2002, a total of 675 acre-feet of EWA water was delivered to Tulare in March and April, and a total of 337 acre-feet of Tulare's 2002 Table A amounts was returned to EWA in July and August. (SWPAO #02023)

Turn-in Agreements

Antelope Valley-East Kern Water Agency. A turn-in agreement executed April 1, 2003, between the Department and AVEK, approved the introduction of local water into the California Aqueduct during 2001. The local water was introduced from a temporary turn-in structure located at Reach 22B, and AVEK took delivery of local water by exchange with project water delivered upstream in Reach 22A. During 2001, a total of 152 acre-feet of local water was introduced at Reach 22B and 152 acre-feet of SWP water was delivered to AVEK at Reach 22A. (SWPAO #01029)

Kern County Water Agency. During 2003, a total of 20,486 acre-feet of local water was introduced into California Aqueduct through Kern's existing turnouts in Reaches 12E and 13B. Letter agreements to allow the introduction of local water are pending.

Turnout Agreements

Alameda County Flood Control and Water Conservation District, Zone 7. An agreement dated January 23, 2002, between the Department and Alameda-Zone 7, allowed the construction, operation, and maintenance of the Corbett-Ising Turnout at Milepost 14.2, Reach 4 of the South Bay Aqueduct. The turnout has a design capacity of 6.7 cfs. Construction was essentially completed in 2002, but not formally accepted in 2003.

Antelope Valley-East Kern Water Agency. An agreement dated March 28, 2000, between the Department and AVEK, allowed the construction, operation, and maintenance of the Rancho Vista Turnout at Milepost 339.68, Reach 20B of the California Aqueduct. The turnout has a design capacity of 5 cfs. Construction was completed in March 2000, but was not formally accepted in 2003.

Kern County Water Agency and Belridge Water Storage District. An agreement dated October 29, 2001, among the Department, Kern, and Belridge Water Storage District, allowed the modification, operation, and maintenance of the existing Belridge Turnout No. 1A at Milepost 209.71, Reach 10A of the California Aqueduct. The turnout has a design capacity of 100 cfs. Modification work was completed in 2002, and formally accepted on March 27, 2003.

Agreements and Activities Related to the Monterey Amendments

Turnback Water Pool Program. Pursuant to Article 56(d) of the Monterey Amendments, the eighth year of the Turnback Water Pool Program was initiated through Notice to State Water Project Contractors No. 03-02, dated February 3, 2003. All SWP contractors who signed Monterey Amendments were permitted to participate in the program. The program allowed SWP contractors to offer a portion of their approved 2003 Table A water for sale in a turnback pool for use by interested SWP contractors. Based on Table A supply and demand, the turnback water was allocated among the selling and purchasing contractors. In 2003, 29,770 acre-feet of water were purchased under the Turnback Water Pool Program.

Transactions for Pool A and Pool B of the Turnback Water Pool Program occurred in February and March 2003, respectively. Turnback water sold for $11.90 per acre-foot—50 percent of the Delta Water Rate—through Pool A, and for $5.95 per acre-foot—25 percent of the Delta Water Rate—through Pool B. All money collected through the Turnback Water Pool Program was paid to the selling contractors. The 2003 Turnback Water Pool Program closed April 1, 2003. Notices to State Water Project Contractors describing the Turnback Water Pool Program are available online at www.swpao.water.ca.gov/notices/index.cfm.

Table 9-1 lists contractors who participated in Pool A and Pool B of the Turnback Water Pool Program.

Storage of Water Outside Service Area. Pursuant to Article 56 of the Monterey Amendments, six SWP contractors have agreements with the Department to deliver and store SWP water outside their service area for later use within their service area. The following agreements include provisions concerning the points of delivery and method for transporting such water.

Table 9-1. 2003 Turnback Water Pool Program (Acre-feet)

Contractor	Sold	Purchased
	Pool A	
Butte	375	
Mojave	16,900	
Ventura County	6,750	
Yuba City	2,320	
Alameda County		314
Alameda-Zone 7		583
AVEK		250
Coachella		172
Desert		285
Dudley Ridge		428
Kern		7,476
Kings		30
Metropolitan		15,024
Napa		160
Oak Flat		43
Santa Clara		747
Tulare		833
Total	*26,345*	*26,345*
	Pool B	
Butte	175	
Mojave	2,500	
Ventura	750	
Alameda County		40
Alameda-Zone 7		73
Castaic Lake		90
Coachella		22
Desert		36
Dudley Ridge		54
Kern		943
Kings		4
Metropolitan		1,896
Napa		20
Oak Flat		5
Santa Barbara		43
Santa Clara		94
Tulare		105
Total	*3,425*	*3,425*

Alameda County Flood Control and Water Conservation District, Zone 7. A change in point of delivery agreement pending execution, among the Department, Alameda-Zone 7, and Kern, will provide for the delivery of Alameda-Zone 7's approved 2002 carryover water and a portion of Alameda-Zone 7's approved 2003 SWP water supplies for storage in and later recovery from Semitropic, in accordance with the Alameda County Flood Control and Water Conservation District, Zone 7 and Semitropic Water Storage District Banking Program Agreement. Alameda-Zone 7 signed similar delivery agreements annually since 1998. All return water is to be delivered to Alameda-Zone 7 by December 31, 2013. During 2003, the Department delivered a total of 6,500 acre-feet of Alameda-Zone 7's 2002 extended carryover to Reach 10A for storage in Semitropic. (SWPAO #03008)

Alameda County Water District. A change in point of delivery agreement pending execution, among the Department, Alameda County, and Kern, will provide for the delivery of a portion of Alameda County's approved 2003 SWP water supplies for storage and later recovery from Semitropic, in accordance with the Alameda County and Semitropic Banking Program Agreement. Alameda County has signed similar delivery agreements annually since 1996. All return water is to be delivered to Alameda County by December 31, 2013. During 2003, the Department delivered a total of 18,800 acre-feet of Alameda County's approved SWP water to Reach 10A for storage in Semitropic, of which 16,100 acre-feet were 2003 Table A amounts and 2,700 acre-feet were 2002 extended carryover water. (SWPAO #03014)

Castaic Lake Water Agency. A change in point of delivery agreement pending execution, among the Department, Castaic Lake, and Kern, will provide for the delivery of up to 35,000 acre-feet of Castaic Lake's 2003 approved SWP water supplies for storage in and later recovery from Semitropic, in accordance with the Castaic Lake and Semitropic Banking Program Agreement. All return water is to be delivered to Castaic

Lake by March 31, 2014. No water was delivered in 2003. (SWPAO #03060)

Dudley Ridge Water District. A change in point of delivery agreement pending execution, among the Department, Dudley Ridge, and Kern, will provide for the delivery of up to 1,000 acre-feet of Dudley Ridge's approved 2003 Table A amounts for storage in and later recovery from Kern Water Bank. Dudley Ridge has signed similar delivery agreements annually since 1996. All return water is to be delivered to Dudley Ridge by December 31, 2013. During 2003, the Department delivered 350 acre-feet of Dudley Ridge's approved 2003 Table A amounts for storage in KWB. (SWPAO #03018)

Dudley Ridge Water District. A long-term change in point of delivery agreement pending execution, among the Department, Dudley Ridge, and Kern, will approve the delivery of a portion of Dudley Ridge's approved annual SWP water supplies to Kern to be used within Cawelo Water District, a member unit of Kern, the return of a like amount of such water, and the delivery of local Cawelo water supplies to Dudley Ridge by in lieu exchange for a portion of Cawelo's future allocation of Kern's SWP water supplies. This agreement is effective July 1, 2003, and remains in force until December 31, 2035. No water was delivered in 2003. (SWPAO #03053)

Dudley Ridge Water District. A letter agreement, executed November 10, 1997, among the Department, Dudley Ridge, and Kern, approved the delivery of up to 5,000 acre-feet of Dudley Ridge's 1997 Article 21 water and up to 2,000 acre-feet of Dudley Ridge's Table A amounts to KWB for storage and later recovery. A like amount of water is to be returned to Dudley Ridge by December 31, 2007. During 1997, a total of 5,342 acre-feet was delivered to Kern. During 2002, a total of 721 acre-feet was recovered and delivered to Dudley Ridge at Reach 8D. During 2003, a total of 350 acre-feet was recovered and delivered to Dudley Ridge at Reach 8D. (SWPAO #97021)

Metropolitan Water District of Southern California. A long-term change in point of delivery agreement pending execution, among the Department, Metropolitan, and Kern, will provide the delivery of a portion of Metropolitan's approved SWP supplies for storage in and later recovery from the groundwater basin underlying Kern Delta Water District, a member unit of Kern, in accordance with the Metropolitan and Kern Delta Water Management Program Agreement. During 2003, a total of 20,134 acre-feet of Metropolitan's Table A amounts was delivered to Kern Delta at Reaches 12E and 13B. (SWPAO #03019)

Metropolitan Water District of Southern California. A change in point of delivery agreement pending execution, among the Department, Metropolitan, and Mojave Water Agency, will provide for the delivery of up to 75,000 acre-feet of Metropolitan's 2003 and 2004 approved SWP water supplies for storage in and later recovery from Mojave River Basin within Mojave, in accordance with the Metropolitan and Mojave Water Banking Demonstration Program Agreement. The water is to be returned to Metropolitan by January 15, 2010. During 2003, the Department delivered a total of 24,874 acre-feet of Metropolitan's approved SWP water to Mojave at Reaches 22B and 24. (SWPAO #03057)

Metropolitan Water District of Southern California. A long-term agreement (SWPAO #01013), pending execution among the Department, Metropolitan, and Kern, will approve the delivery of a portion of Metropolitan's annual Table A and other water supplies for storage and later recovery from groundwater basins within Arvin-Edison Water Storage District, in accordance with the Metropolitan and Arvin-Edison Water Management Program Agreement. The return water is to be delivered to Metropolitan from Arvin-Edison and /or by exchange of Metropolitan's water for a like amount of Kern's SWP approved Table A amounts or other water delivered from the California Aqueduct. The water is to be returned to Metropolitan by December 31, 2035.

Before this long-term agreement was prepared, three interim agreements dated December 29, 1997 (SWPAO #97025), September 17, 1998 (SWPAO #98018, first amendment to SWPAO #97025), and April 13, 1999 (SWPAO #99009, second amendment to SWPAO #97025), among the Department, Metropolitan, and Kern, provided temporary authorization for Metropolitan to store water in Arvin-Edison. Water was delivered to Arvin-Edison for storage each year from 1997 to 2000 under these agreements. During 2001, water previously stored under SWPAO #97025 was returned to Metropolitan, completing the agreement. During 2003, a total of 7,297 acre-feet previously stored under SWPAO #98018 was recovered and delivered to Metropolitan at Reach 26A, completing this agreement. During 2003, a total of 5,083 acre-feet previously stored under SWPAO #99009 was recovered and delivered to Metropolitan at Reach 26A. During 2003, a total of 40,631 acre-feet of Metropolitan's Table A amounts was delivered to Arvin-Edison for storage at Reaches 12C and 14E. (SWPAO #01013)

Metropolitan Water District of Southern California. A letter agreement executed April 21, 1993, among the Department, Metropolitan, and Kern, approved the delivery of Metropolitan's 1992 carryover water for storage in and later recovery from Semitropic. Water is to be returned by December 31, 2010. A subsequent long-term agreement, executed August 21, 1995, among the Department, Metropolitan, and Kern, approved the annual delivery of a portion of Metropolitan's annual Table A and other water supplies for storage in and later recovery from Semitropic, in accordance with the Metropolitan and Semitropic's Water Banking Program Agreement. This agreement remains in effect until November 4, 2035. Water was delivered to Semitropic for storage in 1993, and each year from 1995 to 1999. During 2001, a total of 31,500 acre-feet was recovered and delivered to Metropolitan at Reach 30. During 2003, a total of 10,000 acre-feet was recovered and delivered to Metropolitan at Reach 26A, and a total of 70,940 acre-feet of Metropolitan's Table A amounts was delivered to Reach 10A for storage in Semitropic. (SWPAO #95010)

Santa Clara Valley Water District. A change in point of delivery agreement pending execution, among the Department, Santa Clara, and Kern, will provide for the delivery of a portion of Santa Clara's approved 2003 SWP water supplies for storage in and later recovery from Semitropic, in accordance with the Santa Clara and Semitropic Banking Program Agreement. Santa Clara has signed similar delivery agreements annually since 1996. All return water is to be delivered to Santa Clara by December 31, 2013. During 2003, the Department delivered 33,000 acre-feet of Santa Clara's 2003 Table A amounts to Reach 10A for storage in Semitropic. (SWPAO #03051)

Article 21 Water Program

Pursuant to Article 21 of the Monterey Amendments, Article 21 water replaces surplus, wet weather, and Article 12(d) water. The Article 21 water program allows a contractor to take delivery of water over the approved and scheduled Table A amounts for the current year. Article 21 water is available for delivery on a short-term basis as determined by the Department when water is still available after operational requirements for project water deliveries, water quality, and other requirements are being met.

The conditions for the Article 21 Water Program for 2003 were described in the March 14, 2003, Notice to State Water Project Contractors No. 03-03, available online at www.swpao.water.ca.gov/notices/index.cfm. Sixteen participants signed the notice, which indicated acceptance of the criteria, procedures, and charges for the program, and collectively received a total of 59,653 acre-feet of Article 21 water (Table 9-2).

During the Article 21 water program period, unscheduled water was also made available to Empire pursuant to its long-term water supply contract. Empire received 175 acre-feet of unscheduled water in 2003 for agricultural purposes.

Table 9-2. 2003 Article 21 Water Deliveries (Acre-feet)

Contractor	Amount
Castaic Lake	991
Coachella	204
Kings	58
Desert	330
Dudley Ridge	1,928
Empire[a]	175
Kern	27,891
Metropolitan	17,622
Napa	376
Oak Flat	19
San Bernardino	200
San Gabriel	200
San Luis Obispo	36
Santa Barbara	339
Santa Clara	936
Solano	2,280
Tulare	6,243
Total	*59,828*

[a]Unscheduled agricultural water

Flexible Storage Program

Pursuant to Article 54 of the Monterey Amendments, the Flexible Storage Program provides SWP contractors participating in the repayment of the capital costs of Castaic Lake and Lake Perris the option to withdraw water in excess of approved deliveries. The objective of this program is to provide additional flexibility and water management benefits to local participating agencies.

Available "flexible storage" is approximately 50 percent of active storage, providing for 160,000 acre-feet at Castaic Lake and 65,000 acre-feet at Lake Perris. Participating contractors of the Castaic Lake program include Metropolitan, Ventura, and Castaic Lake. Each can withdraw a maximum amount of 153,940 acre-feet, 1,377 acre-feet, and 4,683 acre-feet, respectively. At Lake Perris, Metropolitan can withdraw a maximum amount of 65,000 acre-feet. Any participating contractor is given 5 years to replace the water with Table A amounts, purchased water, exchange water, or local water.

One SWP contractor participated in the Flexible Storage Program in 2003. At the end of 2002, Metropolitan had a zero balance in Castaic Lake and Lake Perris. Metropolitan withdrew 77,804 acre-feet from Castaic Lake in 2003, and replaced 77,804 acre-feet in 2003, resulting in a zero water balance at the end of 2003. Metropolitan withdrew 17,993 acre-feet from Lake Perris, and replaced 17,993 acre-feet of Article 21, carryover, and Table A water in 2003, resulting in a zero water balance at the end of 2003. At the end of 2002, Castaic Lake Water Agency had a negative balance of 395 acre-feet from Castaic Lake. There was no action in 2003. Therefore, at the end of 2003, a negative balance of 395 acre-feet remains in Castaic Lake.

Carryover Programs

Pursuant to Article 56 of the Monterey Amendments, contractors can elect to store project water outside of their service area for later use within their service area. Qualified contractors can request carryover Table A amounts for delivery in the following year to the extent that such deliveries do not adversely affect current or future project operations. Factors that influence how much extended carryover water can be delivered include operational constraints of project facilities, filling of SWP conservation storage facilities, flood control releases, and water quality restrictions. If storage requests exceed the available storage capacity, the amount available is allocated among the contractors requesting storage in proportion to their annual Table A amounts for that year. Six SWP contractors took direct delivery of 75,584 acre-feet of 2002 approved Table A amounts carried over into 2003 as extended carryover. One SWP contractor used 45,600 acre-feet of this extended carryover for flexible storage payback. Two SWP contractors had a combined total of 9,200 acre-feet of their extended carryover delivered to storage outside their service areas.

Pursuant to Article 12(e) of the Water Supply Contract, contractors can carry over approved Table A water previously scheduled during October, November, and December that was not delivered due to local outages of wet conditions. One SWP contractor took delivery of 140 acre-feet of 2002 approved Table A amounts carried over into 2003 as Article 12(e) carryover. Addi-

tionally, another SWP contractor took delivery of 187 acre-feet of 2002 approved Table A amounts carried over into 2003 as Article 45(f) carryover.

2002 Summer Allocation Carryover Program

To help contractors prepare for potentially limited water supplies in 2003, the Department provided a 2002 Summer Allocation Carryover Program on October 11, 2002. Under this program, long-term SWP contractors were allowed to carry over up to 5 percent of their 2003 Table A amounts for temporary storage in San Luis Reservoir during 2003. This program is separate from, and in addition to, other carryover programs afforded by Articles 12(e) and 56 of the long-term water supply contracts. Twelve SWP contractors took a total delivery of 89,204 acre-feet of 2002 approved Table A amounts carried over into 2003 (Table 9-3).

Dry Year Water Purchase Program

In 2003, the Department initiated a Dry Year Water Purchase Program to reduce the possibility of adverse economic impacts and hardship associated with water shortages. Two SWP contractors and two Delta farmers participated in the program by signing a Memorandum of Understanding with the Department. The program participants requested a total of 11,355 acre-feet of dry year water. To meet participant demands, the Department obtained water from Butte Water District who made it available through crop idling.

Table 9-3. 2002 Summer Allocation Carryover Program Deliveries (Acre-feet)

Contractor	Amount
AVEK	7,049
Castaic Lake	4,760
Dudley Ridge	1,452
Metropolitan	54,975
Mojave	3,528
Napa	1,055
Palmdale	1,065
San Bernardino	1,844
Santa Barbara	2,274
Santa Clara	5,000
Solano	1,918
Tulare	4,284
Total	*89,204*

The four participants and the amount of water purchased from the 2003 Dry Year Program is detailed below:

- Kern County Water Agency - 8,741 acre-feet
- Dudley Ridge Water District - 2,220 acre-feet
- Phelps Brothers - 300 acre-feet
- Ronald Conn - 94 acre-feet

The participants entered into separate conveyance agreements with the Department to convey the dry year water across the Delta and through SWP facilities. Actual dry year water received by these participants was less than the amount purchased due to the Delta being in excess conditions during all of May and most of June 2003 which prevented the transfer and conveyance of the dry year water. The cumulative amount of dry year water made available to all participants was 7,653 acre-feet.

Environmental Water Account

EWA is a cooperatively managed program intended to provide protection to the fish of the Bay-Delta Estuary through environmentally beneficial changes and increased flexibility in the operations of the SWP and CVP, at no uncompensated water cost to the projects' water users. Responsibility for implementing EWA rests with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the Department of Fish and Game (management agencies), as well as with the Bureau of Reclamation and the Department (project agencies).

Under EWA, fish protection is achieved by periodically curtailing project water delivery from the Bay-Delta to project water users south of the Delta and replacing it at a later date within the same calendar year. This necessitates the acquisition of alternative sources of project water, called EWA assets, which are used to replace the project water supply (i.e., the undelivered water). EWA assets consist of *purchase assets*,

which are acquired through purchases from willing water sellers; *variable assets*, which are acquired through changes in operations; and *source shifting*, which involves deferral of scheduled delivery of water allocations by willing participants. EWA is considered operational for any year when these assets are in place and Endangered Species Act commitments are provided by the management agencies.

In 2003, EWA's third operational year, a total of 316,216 acre-feet of curtailments for fish protection was requested by the management agencies between January and May. These exports occurred at Clifton Court Forebay (290,213 acre-feet) and Tracy Pumping Plants (25,799 acre-feet) in the Delta. All purchase asset acquisitions in 2003 were made by the Department as single-year transactions and environmental studies were carried out to ensure that the transactions complied with CEQA.

In fall 2002, the SWP backed approximately 20,000 acre-feet of EWA assets into Lake Oroville, transferring the debt from San Luis Reservoir to Lake Oroville. In spring 2003, heavy rains forced Oroville Reservoir into flood control status which led to the spill of 20,000 acre-feet of stored EWA water. In July, the SWP released 8,474 acre-feet of SWP water from Lake Oroville, using EWA's 500 cfs capacity at Clifton Court Forebay and creating a debt in Lake Oroville, as the likelihood of spilling EWA's debt to the SWP from Oroville Reservoir was deemed to be greater than that in San Luis Reservoir. The SWP also backed 18,922 acre-feet of EWA water (Yuba transfer) into Lake Oroville in July.

The Department and the Bureau acquired 90,591 acre-feet in variable assets and 214,914 acre-feet of purchase assets through contract agreements. A source shift was not implemented because there was no risk of low-point problems at San Luis Reservoir. The initial year of EWA operation ended with an 83,437 acre-foot credit of water for use during 2002 EWA actions. The second year of EWA operation ended with a 31,273 acre-foot credit for use during 2003 EWA actions. The third year of EWA ended with a 252 acre-foot credit for use during 2004 EWA actions.

The following section lists the SWP contractors and non-SWP contractors that participated in the EWA Program in 2003.

Purchase Assets

The purchase asset water amounts below represent the total amounts of water acquired for EWA from various sources. These amounts have not been adjusted to reflect conveyance losses.

Kern County Water Agency. An agreement executed on August 27, 2003, between the Department and Kern approved the purchase of up to 198,240 acre-feet of water stored in Kern Water Bank through the exchange of approved Table A water for support of EWA under the CALFED Program. A total of 125,000 acre-feet of Kern's water was purchased and used to repay SWP debt. (SWPAO #03704)

Yuba County Water Agency. An agreement executed on April 22, 2003, between the Department and Yuba approved the transfer of up to 185,000 acre-feet of water from storage in New Bullards Bar Reservoir and groundwater substitution for support of EWA under the CALFED Program. A total of 65,000 acre-feet of Yuba's water was purchased. Of the total, 6,000 acre-feet was used to repay CVP debt and 59,000 was used to repay SWP debt incurred through Delta fish actions (pumping curtailments at Tracy and Banks pumping plants) (SWPAO #03702).

Santa Clara Valley Water District and Kern County Water Agency. An agreement executed on December 1, 2003, between the Department, Santa Clara, and Kern approved the purchase of up to 30,000 acre-feet of water stored in Santa Clara's portion of Semitropic Groundwater Bank through the exchange of approved Table A water for support of EWA under the CALFED Program. A total of 20,000 acre-feet of Santa Clara's water was purchased and used to repay CVP debt. No water was delivered in 2003. (SWPAO #03703)

Metropolitan Water District of Southern California and Kern County Water Agency. An agreement executed on June 4, 2003, between the Department, Metropolitan, and Kern approved the exchange of up to 36,776 acre-feet of water for support of EWA under the CALFED program. The water was delivered by Kern to the Department, conveyed through the California Aqueduct, and delivered to Metropolitan in exchange for Metropolitan's approved Table A water. A total of 29,596 acre-feet of water was exchanged and Kern provided the remaining 7,180 acre-feet directly to the Department. (SWPAO #03700)

South Feather Water and Power Agency. An agreement executed on February 21, 2003, between the Department and South Feather Water and Power Agency, formerly Oroville-Wyandotte Irrigation District, approved the transfer of up to 10,000 acre-feet of water that would otherwise remain in storage from Little Grass Valley Reservoir and Sly Creek Reservoir for support of EWA under the CALFED Program. A total of 4,914 acre-feet of South Feather's water was transferred. (SWPAO #03701)

Operational Assets

Relaxation of the Export/Import Ratio. The Department has the opportunity to gain water credits if the EWA management agencies decide that the E/I ratio can be relaxed, thus allowing the SWP and CVP to pump any extra water that the fisheries do not need. In 2003, relaxation of the E/I ratio resulted in a total of 65,780 acre-feet of water being credited to EWA. (SWPAO #03730)

EWA Share of State Gain. The Department has the opportunity to pump half the CVPIA (b)(2) releases that reach the Delta on behalf of EWA. A total of 19,208 acre-feet of water was pumped at Banks Pumping Plant in 2003, and credited to EWA. (SWPAO #03740).

For additional information on EWA, see Chapter 7, *Water Supply Development and Reliability.*

Miscellaneous Agreements with Other Agencies

In addition to negotiating agreements with SWP contractors to provide for specified water deliveries, the Department also entered into several agreements with other agencies for water conveyance, or exchange, between January 1, 2003, and December 31, 2003.

Water Conveyance Agreements-CVP Water

The Department regularly enters into agreements to convey CVP water such as agreements with contractors receiving water from the Bureau through the Cross Valley Canal, a water conveyance facility that connects with the Aqueduct near Tupman in Kern County. Other agencies or corporations receive CVP water through agreements between the Department and the Bureau, including the U.S. Department of Veterans Affairs, USFWS, and Musco Family Olive Company. Occasionally, the Department also enters into agreements with the Bureau to convey CVP or SWP water from the Delta to O'Neill Forebay through CVP or SWP facilities. Some of these agreements allow the Bureau to make up for curtailed water exports from Tracy Pumping Plant associated with improving conditions for fish in the Delta. Other agreements allow replacing water exports foregone during maintenance and repair of Tracy and Banks Pumping Plants and CVP and SWP conveyance facilities between the Delta and O'Neill Forebay.

Byron-Bethany Irrigation District. An agreement executed May 28, 2003, between the Department and Byron-Bethany Irrigation District, approved the annual diversion of up to 50,000 acre-feet of Byron-Bethany's water from the Delta for agricultural, municipal and industrial uses. Historically, Byron-Bethany diverted water from the Delta under a pre-1914 water right and the diversions were primarily for agricultural purposes during the irrigation season. Land use within the District is changing from strictly agricultural uses to a mixture of agriculture, urban, and industrial which resulted in a change in the pattern of demand within the District from sea-

sonal to year-round use. This agreement describes the nature and extent of the District's diversion rights between the District and the Department, and is effective until December 31, 2035. No water was delivered in 2003. (SWPAO #02027)

Cross Valley Canal. Eight CVP water contractors use CVC to obtain water from the California Aqueduct either by exchange with other agencies or by direct delivery. The eight water contractors are: County of Fresno, County of Tulare, Hills Valley Irrigation District, Kern-Tulare Water District, Lower Tule River Irrigation District, Pixley Irrigation District, Rag Gulch Water District, and Tri-Valley Water District. These agencies have had water conveyance service by the Department since 1976 through

- long-term 3-party contracts with the Department and the Bureau, executed in 1976, and amendments extending the contracts through February 29, 1996; and
- interim renewal contracts: (1) March 1, 1996, through February 28, 1998; (2) March 1, 1998, through February 28, 2000; (3) March 1, 2000, through November 30, 2000; (4) December 1, 2000, through February 28, 2001; (5) March 1, 2001, through February 28, 2002; (6) March 1, 2002 through February 28, 2003; and (7) April 24, 2003 through February 29, 2004.

Between January 1, 2003, and December 31, 2003, the Department delivered CVP water to the CVC contractors as follows:

In May 2003, the following six CVC contractors received part of their 2003-04 approved CVP water: Kern-Tulare Water District (1,076 acre-feet), Rag Gulch Water District (357 acre-feet), Tri-Valley Water District (82 acre-feet), Hills Valley Irrigation District (242 acre-feet), Fresno County Public Works (216 acre-feet), and County of Tulare (383 acre-feet). The water delivered to the CVC contractors totaled 2,356 acre-feet. (SWPAO #s 03300, 03301, 03304, 03305, 03306, and 03307)

Department of Parks and Recreation. Water is provided for recreation facilities at several SWP lakes and reservoirs under an agreement between the Department and the Department of Parks and Recreation, dated October 28, 1971. The agreement implements the provisions of the Davis-Dolwig Act, and specifies maximum quantities of water that can be allocated to each lake per year. The lakes included in the agreement are Del Valle Reservoir, Lake Perris, Castaic Lake and Lagoon, Bethany Reservoir, and the San Luis Division facilities. Allocations to each lake are based on the percentages of Table A water allocated to SWP contractors in a given year.

Madera Irrigation District. On July 22, 2003, Madera Irrigation District requested that the Department convey 1,237 acre-feet of CVP water from the San Joaquin River Exchange Contractor Authority to Madera through SWP facilities. Under an agreement executed on March 22, 2004, the Department delivered 1,200 (1,237 minus 3 percent conveyance loss) acre-feet of water in October 2003. (SWPAO #03318)

Musco Family Olive Company. An agreement dated September 22, 2003, and executed November 21, 2003, among Musco Family Olive Company, Plain View Water District, the Department, and the Bureau, provides for the conveyance of up to 800 acre-feet of Plain View's CVP water to Reach 2A of the California Aqueduct for use by Musco Family Olive Company. A total of 719 acre-feet—95 acre-feet (SWPAO #02320) and 62 acre-feet (SWPAO #03311)—was delivered in 2003 under this agreement. Construction of a permanent turnout is currently being pursued.

U.S. Department of Veterans Affairs. A letter agreement dated November 6, 2002 and executed January 1, 2003, among the U.S. Department of Veterans Affairs, the Department, and the Bureau, provides for the conveyance of up to 450 acre-feet of CVP-approved water to Reach 2B of the California Aqueduct to the U.S. Department of Veterans Affairs' San

Joaquin Valley National Cemetery. A total of 5 acre-feet was delivered to the National Cemetery in Reach 2B of the California Aqueduct in 2003 under this 2002 agreement (SWPAO #02321), and a total of 80 acre-feet was delivered to the National Cemetery in Reach 2B of the California Aqueduct in 2003 under a pending letter agreement. (SWPAO #03312)

U.S. Fish and Wildlife Service Cooperative Agreement. The Bureau initiated a cooperative agreement with the Department to deliver CVP water to the Kern National Wildlife Refuge for USFWS. Under the terms of this cooperative agreement, dated September 9, 1994, up to 26,530 acre-feet of CVP water would be delivered from Check 21 to the Buena Vista Water Storage District Turnout BV-1B, on Reach 10A of the California Aqueduct, from October 1, 1993, through April 10, 1995. Since the cooperative agreement was signed, 13 modifications to the agreement have been executed. Under Modification No. 001, dated October 31, 1994, additional funding was provided. Similar funding adjustments through modifications were made each year to the agreement. Modification No. 013, executed February 3, 2002, extended the agreement through April 30, 2002, and defined the water delivery rates for 2001 and 2002. A new 5-year agreement with the Bureau for Kern National Wildlife Refuge is currently pending. The Department conveyed 14,936 acre-feet of CVP water to Kern National Wildlife Refuge in 2003.

Other Turnout Agreements. In 2003, there was one new turnout agreement with a non-SWP contractor agency.

Plain View Water District. An agreement executed October 1, 2003, between the Department and Plain View Water District, allowed the construction, operation, and maintenance of a permanent Musco Family Olive Turnout at Milepost 12.47, Reach 2A of the California Aqueduct. Construction is currently unscheduled. The agreement contains provisions for submitting plans and specifications within 1 year of executing the agreement.

Water Deliveries

Approved Table A Deliveries

Each year, by October 1, the SWP long-term water contractors submit initial requests for approved Table A deliveries allocated to contractors for use in the subsequent calendar year. Initial approved Table A amounts for the coming year are made by the Department in December and are based on operations studies that assume 90 percent exceedence of historic water supply (where exceedence refers to the possibility that water supply in the coming year will be exceeded by the historic water supply), current reservoir storage, and total requests by the SWP water contractors. Forecasts for the year are updated as hydrological conditions change. Approved Table A amounts are increased or decreased depending on both actual and projected hydrologic conditions.

On October 1, 2002, SWP long-term contractors submitted initial requests for 2003.

The Department approved deliveries of 825,375 acre-feet on December 3, 2002, resulting in initial approved Table A amounts of 20 percent of most SWP contractor requests. The Department increased the 2003 approved Table A amounts to 1.86 million acre-feet, or 45 percent on January 16, 2003. As water conditions improved, approved Table A amounts were increased to 2.06 million acre-feet (50 percent) on March 28; 2.89 million acre-feet (70 percent) on April 24; and finally to 3.71 million acre-feet (90 percent) on May 16.

Notices to State Water Project Contractors informing them of increases or decreases in approved Table A amounts are online at www.swpao.water.ca.gov/notices/index.cfm.

SWP Deliveries

The SWP delivers water for a variety of beneficial uses. In addition to delivering approved Table A water to long-term water supply contractors, the SWP

- conveys water to, and stores water for, other public agencies through special contracts and agreements;
- provides water for wildlife and recreational uses; and
- stores, releases, and delivers local runoff water from SWP facilities to agencies that hold local water rights.

In 2003, 4,223,255 acre-feet of water were conveyed to 27 long-term contractors and 26 other agencies. That amount includes

- 2,901,041 acre-feet of approved Table A water;
- 59,653 acre-feet of Article 21 water and 175 acre-feet of unscheduled water;
- 2,846 acre-feet of SWP water for recreation, fish and wildlife; and
- 1,037,324 acre-feet of water delivered to satisfy water rights settlement agreements and agreements with SWP contractors for local water supplies.

Figure 9-1, located before the tables at the end of the chapter, shows amounts of water delivered to various locations during 2003.

Specific information about water deliveries made to long-term contractors and other agencies during 2003 and historical deliveries from 1962 through 2003 are presented in the following three sections, each with a corresponding table, located at the end of the chapter:

- Water Delivered to Long-term Water Supply Contractors in 2003, by Service Area (Table 9-4);
- Water Delivered in 2003, by Month (Table 9-5); and
- Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-03 (Table 9-6).

Water Deliveries and Credits to Long-Term SWP Contractors

Table 9-4 shows amounts of water delivered in 2003. The following information is arranged by column number.

2003 Approved Table A Water Delivered. Columns 1 through 6 show a detailed breakdown of approved Table A water delivered to long-term water supply contractors in 2003.

Turnback Pool Water. Column 5 shows 29,770 acre-feet of turnback pool water was delivered to long-term water supply contractors in 2003.

2002 Carryover Approved Table A Water Delivered During 2003. For several years, the Department has offered contractors the opportunity to carry over a portion of their approved Table A water for delivery in the current year to be delivered during the next year.

The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The SWP contractors' long-term contracts and amendments state the criteria for carrying over approved Table A water from one year to the next. Column 7 shows 219,915 acre-feet of water was carried over from 2002 for delivery in 2003.

Total Table A Water Delivered. Column 8 shows all approved Table A water delivered in 2003—a total of 2,898,144 acre-feet.

2003 Water Bank Recoveries. Column 9 shows 72,812 acre-feet of water bank recoveries in 2003.

2003 Article 21 Water. Column 10 shows 59,828 acre-feet of 2003 Article 21 water delivered to long-term water supply contractors in 2003 (includes 59,653 acre-feet of Article 21 water and 175 acre-feet of unscheduled water). Long-term water supply contractors who have

not signed the Monterey Amendment receive unscheduled water.

Dry Year Water Purchase Program. Column 11 shows 7,388 acre-feet of Dry Year Water Purchase Program water delivered in 2003.

2003 Article 54 Flexible Storage Withdrawal Recoveries. Column 12 shows 95,797 acre-feet of Article 54, Flexible Storage Withdrawal in 2003.

Total SWP Water Delivered. Column 13 shows 3,134,769 acre-feet of total SWP water delivered in 2003. This includes total approved Table A water, water bank recoveries, Dry Year Water Purchase Program, Flexible Storage Withdrawal, and Article 21 and unscheduled water.

Non-SWP Water Deliveries. Column 14 includes deliveries of nonproject water to long-term water contractors. Nonproject water is generally local and permit water that a SWP contractor has a water right to, or water purchased from, exchanged with, or transferred from non-SWP agencies. In 2003, nonproject water deliveries totaled 51,769 acre-feet.

Total Deliveries. Column 15 shows total amounts of water delivered to long-term contractors. In 2003, the SWP delivered 3,186,528 acre-feet to 27 long-term contractors. This amount included 2,901,041 acre-feet of approved Table A water, 59,828 acre-feet of Article 21 and unscheduled water, and 51,139 acre-feet of nonproject water.

Water Delivered in 2003 by Month

During 2003, the SWP provided water service to 53 agencies, including 27 long-term water contractors. Those agencies and the amounts of water delivered to them by month are listed in Table 9-5, and are summarized below as SWP water and nonproject water.

SWP Water. SWP water as defined in the *long-term water supply contracts,* includes Article 21 water; carryover approved Table A water; current year approved Table A amounts; flexible storage water; transfer and exchange of approved Table A water; and turnback pools A and B.

Related water includes operational flood release and recreation and fish and wildlife. There was no operational flood water released in 2003.

Article 21 Water. The Article 21 water program allows a contractor to take delivery of water over the approved and scheduled Table A amounts for the current year. In 2003, 16 contractors participated in the program. A total of 59,828 acre-feet of Article 21 water was delivered to Napa, Solano, Santa Clara, County of Kings, Dudley Ridge, Castaic Lake, Metropolitan, Kern, Oak Flat, Tulare, San Luis Obispo, Santa Barbara, Coachella, Desert, San Bernardino, and San Gabriel. Empire took delivery of 175 acre-feet of unscheduled water.

2002 Carryover Approved Table A Water. In 2003, 174,315 acre-feet of 2002 approved Table A water were delivered that had been stored in SWP storage facilities in 2002.

Approved Table A Water. A total of 2,735,926 acre-feet of 2003 approved Table A water was delivered to 27 long-term contractors. Also, 174,315 acre-feet of carryover water, and 95,797 acre-feet of flexible storage withdrawal water were delivered in 2003.

Exchanges and Transfers of Approved Table A Water. During 2003, a total of 66,677 acre-feet of approved Table A water was exchanged or transferred to SWP long-term contractors and non-SWP water agencies as follows:

- Kern transferred 8,000 acre-feet to Dudley Ridge;
- Tulare transferred 4,900 acre-feet of water to Westlands and exchanged 14,103 acre-feet with Westlands;
- Metropolitan exchanged 24,874 acre-feet with Mojave;
- Dudley Ridge exchanged 8,700 acre-feet with San Gabriel and transferred 1,100 acre-feet to Tulare; and

- San Bernardino transferred 5,000 acre-feet to Metropolitan.

Turnback Pool Water. A total of 29,770 acre-feet of turnback pool water was delivered to long-term water supply contractors.

Water for Recreation and Fish and Wildlife. A total of 2,846 acre-feet of SWP water was conveyed for recreational use and enhancement of fish and wildlife.

Recreational Use. The SWP delivered 563 acre-feet of water for facilities at Lake Oroville, Lake del Valle, O'Neill Forebay, Silverwood Lake, and Lake Perris. In addition, 1,776 acre-feet were delivered to Castaic Lake and Castaic Lagoon, an impoundment downstream from Castaic Lake devoted entirely to recreation.

Wildlife Management. The SWP delivered 507 acre-feet of water to use in managing wildlife in the Pilibos Wildlife Area, located on about 770 acres of land near O'Neill Forebay, 40 miles south of Los Banos.

Water for North Bay Aqueduct Flow Test. A total of 27 acre-feet was conveyed through the North Bay Aqueduct to test the flow capacity downstream of Barker Slough Pumping Plant, following a clean out of a portion of the pipeline.

Non-SWP Water

In 2003, the Department used SWP facilities to convey non-SWP water for various agencies according to the terms of water rights and water transfer and exchange agreements. Detailed information concerning those conveyances is found under the *Miscellaneous Agreements with Other Agencies* section in this chapter.

Floodwater. Occasionally, during wet years, the Department accepts floodwater from the Kern River into the California Aqueduct through the Kern River-California Aqueduct Intertie under an agreement entitled *Agreement among the State of California, Kern County Water Agency, and the Kern River Interests for Diversions of Floodwaters through the Kern River-California Aqueduct Intertie*, dated November 18, 1975. In 2003, the Department did not accept any floodwater into the California Aqueduct.

Water Rights Water. Water in this category is transported through SWP facilities to long-term SWP contractors and other agencies according to terms of various local water rights agreements. Some water simply passes through SWP transportation facilities; a portion is stored in SWP reservoirs for release at a later time. In 2003, 1,037,324 acre-feet of water in this category were delivered to the Feather River, South Bay, North Bay, and Southern California.

Feather River Area. Ten nonproject agencies in the Feather River area received 1,008,093 acre-feet. Those agencies are

- Last Chance Creek Water District, 6,598 acre-feet
- Thermalito Irrigation District, 2,398 acre-feet
- South Feather Water and Power Agency, formerly Oroville-Wyandotte Irrigation District, 4,879 acre-feet
- Western Canal Water District, 282,251 acre-feet
- Joint Water Districts Board, 682,403 acre-feet
- Oswald Water District, 445 acre-feet
- Tudor Mutual Water Company, 3,220 acre-feet
- Garden Highway Mutual Water Company, 16,303 acre-feet
- Plumas Mutual Water Company, 8,498 acre-feet
- Dana Brothers, 1,098 acre-feet

North Bay Area. In the North Bay Area, 4,600 acre-feet of Solano permit and settlement water were delivered.

South Bay Area. In the South Bay area, a total of 17,290 acre-feet of local water was delivered to Alameda-Zone 7 (9,378 acre-feet) and Alameda County (7,912 acre-feet). These two South Bay Aqueduct contractors hold water rights to runoff from Lake Del Valle watershed.

Southern California. In Southern California, 573 acre-feet of local runoff from the Houston Creek watershed were stored and delivered to Crestline under water rights held by the Department on Houston Creek. The authorized place of use is limited to Crestline.

The Department also released 6,768 acre-feet of local water from Piru Creek to United Water Conservation District, a member unit of Ventura.

Annual Table A Water and Water Delivered Since 1962

Information about annual Table A water and water conveyed for the past 40 years is contained in Table 9-6. The following discussion of conveyed Table A water is arranged according to column numbers.

Annual Table A. Columns 1 through 7 of Table 9-6 show the amount of long-term contractor's annual Table A water by area for years 1962 through 2003 as specified in the Table A schedules of the long-term water supply contracts.

In some instances Table A schedules—projections of each contractor's need for water to 2035—have been amended to meet the needs of individual contractors. The amounts of annual Table A water each contractor may request for years 1962 through 2035 can be found in Table B-4 in Appendix B.

Water Delivered. Columns 8 through 16 show water delivered or conveyed, including initial fill water and operational losses and storage changes.

Approved Table A Water. Column 8 shows amounts of approved Table A water delivered each year from 1962 through 2003.

Article 21 and Unscheduled Water. Article 21 and unscheduled water is water in excess of that required to meet all demands for the year's approved Table A water and water to be stored in SWP reservoirs.

Column 9 shows amounts of Article 21 water, as defined under *SWP Deliveries*, and unscheduled water delivered from 1962 through 2003.

Other Water. Column 10 includes amounts of water classified as other water delivered in 2003, including nonproject water conveyed through SWP facilities and regulated delivery of local supply.

In 2003, a total of 251,447 acre-feet of other water was delivered.

Feather River Diversions. Column 11 includes amounts of water from the Feather River delivered according to agreements for water rights water. In 2003, a total of 1,008,093 acre-feet in this category was delivered to agencies in the Feather River area.

Recreation Water. Column 12 shows water conveyed for recreational use or to provide water to improve water quality for fish and wildlife. In 2003, a total of 2,846 acre-feet of SWP water was conveyed for this purpose.

Initial Fill Water. The quantities listed in Column 14 represent the amounts used to initially fill the aqueducts and reservoirs south of the Delta to maximum operating capacities. Initial filling began in 1962 with the filling of the South Bay Aqueduct and was completed in 1979 when Lake Perris reached its maximum operating capacity of 127,000 acre-feet. In 1996 and 1997, the Coastal Aqueduct was initially filled.

Operational Losses. Column 15 includes the total amounts of water lost through evaporation and seepage, net storage changes in reservoirs south of the Delta, and amounts of inflow from local drainage areas, including inflows into San Luis Canal and from the Kern River Intertie.

Negative values are indicated for years when withdrawals and evaporation from reservoirs south of the Delta exceed the amounts of water added to the reservoirs.

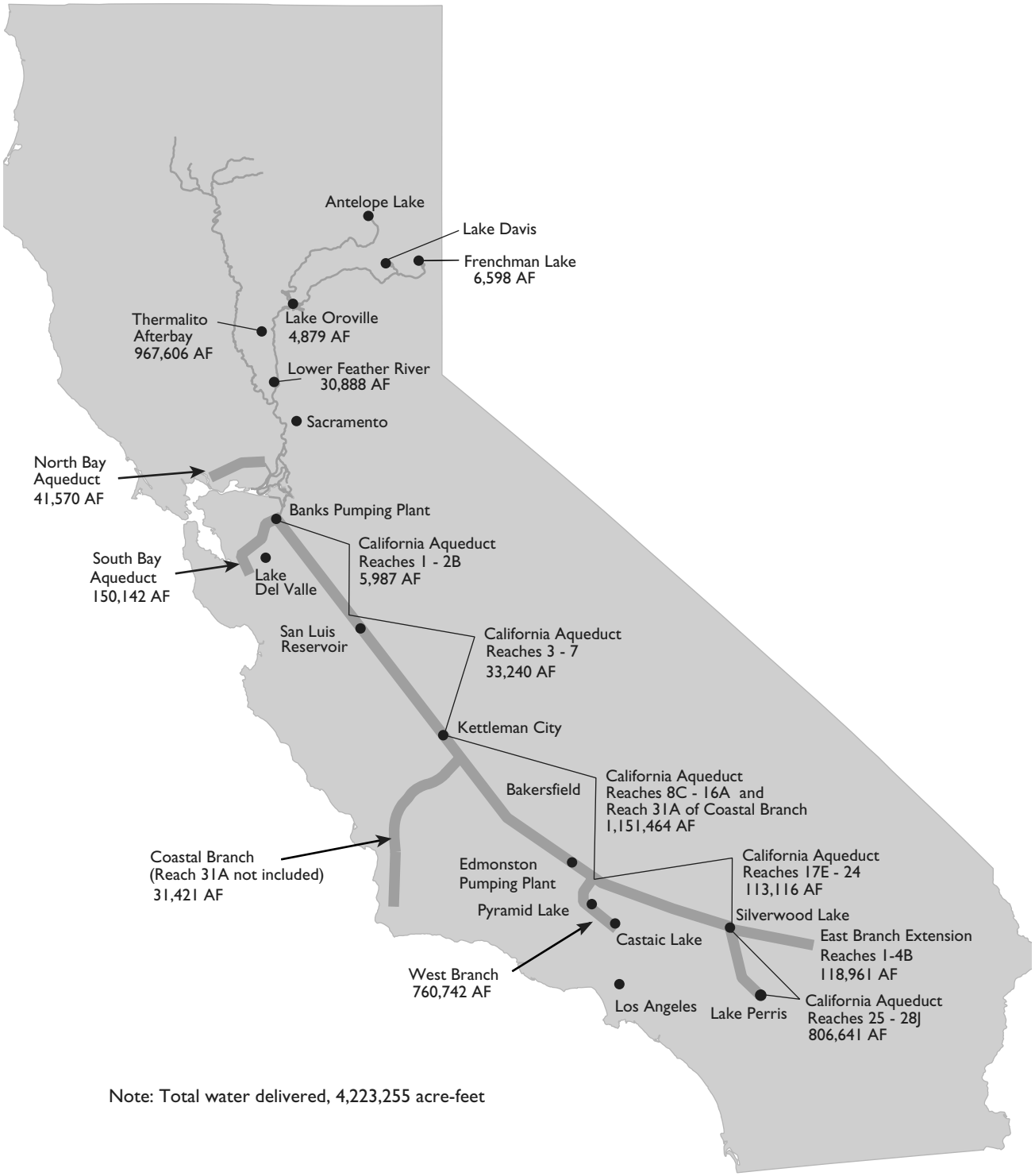

Figure 9-1. Water Delivered in 2003 and Delivery Locations of Long-Term Water Supply Contractors and Feather River Area Districts with Water Right Agreements with the Department

Table 9-4. Water Delivered to Long-Term Contractors through 2003, by Service Area (Acre-Feet)

Water Contractor or Agency	Approved Table A Water Deliveries								Water Bank Recoveries (9)	2003 Article 21 Water (10)	2003 Dry Year Water Purchase (11)	2003 Article 54 Flexible Withdrawal (12)	Total SWP Water Delivered (13)	Non-SWP Water Deliveries (14)	Total Deliveries
	2003 Table A without Transfers, Exchanges, and Storage (1)	2003 Table A Supplied (Not a Delivery) (2)	2003 Table A Delivered through Transfers and Exchanges (3)	2003 Table A Delivered to Storage (4)	Pool Water (5)	Total 2003 Table A Delivered (6)	2002 Carryover Table A Delivered during 2003 (7)	Total Table A Deliveries (8)							
Feather River Area															
County of Butte	551	0	0	0	0	551	0	551	0	0	0	0	551	0	551
Plumas County Flood Control and Water Conservation District	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Yuba City	1,324	0	0	0	0	1,324	0	1,324	0	0	0	0	1,324	0	1,324
North Bay Area															
Napa County Flood Control and Water Conservation District	6,026	0	0	0	180	6,206	1,055	7,261	0	376	0	0	7,637	0	7,637
Solano County Water Agency	25,135	0	0	0	0	25,135	1,918	27,053	0	2,280	0	0	29,333	4,600[p]	33,933
South Bay Area															
Alameda County Flood Control and Water Conservation District-Zone 7	30,695	0	0	6,500[h]	656	31,351	13,099[h]	44,450	0	0	0	0	44,450	10,378[q]	54,828
Alameda County Water District	14,986	0	0	18,800[i]	354	31,440	5,150[i]	36,590	0	0	0	0	36,590	7,912[r]	44,502
Santa Clara Valley Water District	57,000	0	0	33,000[i]	841	90,841	14,104	104,945	0	936	0	0	105,881	3,100[s]	108,981
San Joaquin Valley Area															
Castaic Lake Water Agency	3,506	0	0	0	0	3,506	0	3,506	0	495	0	0	4,001	0	4,001
County of Kings	3,600	0	0	0	34	3,634	0	3,634	0	58	0	0	3,692	0	3,692
Dudley Ridge Water District	39,274	0	9,800[c]	350[k]	482	49,906	1,452	51,358	350	1,928	1,496	0	55,132	0	55,132
Empire West Side Irrigation District	1,074	0	0	0	0	1,074	187	1,261	0	175[m]	0	0	1,436	0	1,436
Kern County Water Agency	697,169	155,565[a]	8,000[d]	0	8,419	713,588	22,380	735,968	0	27,891[n]	5,892	0	790,237	18,428[t]	808,665
Oak Flat Water District	4,059	0	0	0	48	4,107	140	4,247	0	19	0	0	4,266	0	4,266
Tulare Lake Basin Water Storage District	75,373	0	19,003[e]	0	938	95,314	4,284	99,598	0	6,243	0	0	105,841	0	105,841
Central Coastal Area															
San Luis Obispo County Flood Control and Water Conservation District	4,417	0	0	0	0	4,417	0	4,417	0	36	0	0	4,453	0	4,453
Santa Barbara County Flood Control and Water Conservation District	24,312	0	0	0	43	24,355	2,274	26,629	0	339	0	0	26,968	0	26,968
Southern California															
Antelope Valley-East Kern Water Agency	52,730	0	0	0	250	52,980	7,049	60,029	0	0	0	0	60,029	0	60,029
Castaic Lake Water Agency	46,389	0	0	0	90	46,479	4,760	51,239	0	496	0	0	51,735	0	51,735
Coachella Valley Water District	14,045	0	0	0	194	14,239	0	14,239	0	204	0	0	14,443	0	14,443
Crestline-Lake Arrowhead Water Agency	1,563	0	0	0	0	1,563	0	1,563	0	0	0	0	1,563	573[u]	2,136
Desert Water Agency	23,168	0	0	0	321	23,489	0	23,489	0	330	0	0	23,819	0	23,819
Littlerock Creek Irrigation District	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metropolitan Water District of Southern California	1,261,502	107,771[b]	24,874[f]	131,705[l]	16,920	1,435,001	134,845[w]	1,524,246	51,976	17,622[o]		95,797	1,689,641	0	1,689,641
Mojave Water Agency	10,907	0	0	0	0	10,907	3,528	14,435	0	0	0	0	14,435	0	14,435
Palmdale Water District	9,701	0	0	0	0	9,701	1,846	11,547	0	0	0	0	11,547	0	11,547
San Bernardino Valley Municipal Water District	20,371	0	5,000[g]	0	0	25,371	1,844	27,215	0	200	0	0	27,415	0	27,415
San Gabriel Valley Municipal Water District	13,034	0	0	0	0	13,034	0	13,034	0	200	0	0	13,234	0	13,234
San Gorgonio Pass Water Agency	116	0	0	0	0	116	0	116	0	0	0	0	116	0	116
Ventura County Watershed Protection District	5,000	0	0	0	0	5,000	0	5,000	0	0	0	0	5,000	6,768[v]	11,768
Total	2,447,027	263,336	66,677	190,355	29,770	2,724,629	219,915	2,898,944	72,812	59,828	7,388	95,797	3,134,769	51,769	3,186,528

[a]Kern supplied 125,000 af to EWA; exchanged 350 af of Dudley Ridge for Kern Water Bank water exchanged 10,000 af to Metropolitan for Semitropic Water Bank water; exchanged 6,436 af with Del Puerto Water District; exchanged 4,284 af with Panoche Water District; exchanged 9,495 af to San Luis Water District.

[b]Metropolitan supplied 29,596 af to EWA; used 45,600 af of carryover for flexible storage payback; used 32,575 af for flexible storage payback.

[c]Dudley Ridge exchanged 8,700 af with San Gorgonio; transferred 1,100 af to Tulare.

[d]Kern transferred 8,000 af to Dudley Ridge.

[e]Tulare exchanged 14,103 af with Westlands; transferred 4,900 af to Westlands.

[f]Metropolitan exchanged 24,874 af with Mojave.

[g]San Bernardino transferred 5,000 af to Metropolitan.

[h]6,500 af of 2002 carryover water delivered to Semitropic Water Bank (not shown in Column 6).

[i] 2,700 af of 2002 carryover water delivered to Semitropic Water Bank(not shown in Column 6).

[i]Delivered to Semitropic Water Bank.

[k]350 af delivered to Kern Water Bank.

[l]40,631 af to Arvin-Edison Water Bank, 20,134 af to Kern Delta Water Bank, and 70,940 af to Semitropic Water Bank..

[m]Empire's unscheduled water.

[n]Kern's Article 21 includes 7,180 af delivered to EWA.

[o]Metropolitan's Article 21 was used for flexible storage payback

[p]Santa Clara's permit and settlement water.

[q]Alameda Zone-7's 9,378 af of local water and 1,000 af of Byron-Bethany water.

[r]Alameda County's 7,912 af of local water.

[s]6,000 af of transferred water from Del Puerto WD, transferred 4,000 af from Panoche WD, and transferred 8,418 af from San Luis Water District.

[t]Transferred water from Browns Valley Irrigation District.

[u]Crestline's local water.

[v]Ventura's local water.

[w]Metropolitan used 45,600 af of carryover for flexible storage payback (not a delivery and not shown in Column 8).

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Feather River Area														
City of Yuba City														
Approved Table A water	0	0	0	0	0	0	741	583	0	0	0	0	1,324	9,600
Pool A water sale[a]	2,320	0	0	0	0	0	0	0	0	0	0	0	2,320	
Agency total	0	0	0	0	0	0	741	583	0	0	0	0	1,324	
County of Butte														
Approved Table A water	34	18	107	62	3	95	54	24	71	5	1	77	551	3,500
Pool A water sale[a]	375	0	0	0	0	0	0	0	0	0	0	0	375	
Pool B water sale[a]	175	0	0	0	0	0	0	0	0	0	0	0	175	
Agency total	34	18	107	62	3	95	54	24	71	5	1	77	551	
Plumas County Flood Control and Water Conservation District														
Approved Table A water	0	0	0	0	0	0	0	0	0	0	0	0	0	1,690
Recreation/Fish and Wildlife														
Recreation/fish and wildlife water	0	0	0	0	0	1	1	0	1	0	0	0	3	
Last Chance Creek Water District														
Regulated delivery of local supply	0	0	0	0	1,127	2,493	1,210	990	611	167	0	0	6,598	
Thermalito Irrigation District														
Regulated delivery of local supply	31	50	123	112	193	367	402	336	301	269	112	102	2,398	
South Feather Water and Power Agency														
Regulated delivery of local supply	0	0	0	0	200	893	922	922	893	678	199	172	4,879	
Western Canal Water District														
Regulated delivery of local supply	3,130	0	0	1,110	30,937	49,316	58,530	47,044	15,467	27,994	33,700	15,023	282,251	
Joint Water Districts Board														
Regulated delivery of local supply	31,850	0	0	2,027	62,250	110,610	123,760	106,821	66,885	46,240	71,130	60,830	682,403	
Oswald Water District														
Regulated delivery of local supply	0	0	0	0	13	130	156	93	53	0	0	0	445	
Tudor Mutual Water Company														
Regulated delivery of local supply	0	0	0	0	97	961	1,025	426	553	158	0	0	3,220	
Garden Highway Mutual Water Company														
Regulated delivery of local supply	0	0	0	696	2,205	3,050	3,906	2,801	1,567	2,017	61	0	16,303	
Plumas Mutual Water Company														
Regulated delivery of local supply	0	0	0	0	645	2,123	2,432	929	1,748	621	0	0	8,498	
Dana Brothers														
Regulated delivery of local supply	0	0	0	32	189	439	285	51	25	77	0	0	1,098	
SWP	34	18	107	62	3	96	796	607	72	5	1	77	1,878	
Non-SWP	35,011	50	123	3,977	97,856	170,382	192,628	160,413	88,103	78,221	105,202	76,127	1,008,093	
Feather River Area Total	35,045	68	230	4,039	97,859	170,478	193,424	161,020	88,175	78,226	105,203	76,204	1,009,971	14,790
North Bay Area														
Napa County Flood Control and Water Conservation District														
Approved Table A water	0	42	554	690	286	578	731	681	673	473	438	880	6,026	21,475
Article 21 water	0	0	376	0	0	0	0	0	0	0	0	0	376	
2002 summer allocation carryover	335	720	0	0	0	0	0	0	0	0	0	0	1,055	
Pool A water	0	0	0	0	0	160	0	0	0	0	0	0	160	
Pool B water	0	0	0	0	0	20	0	0	0	0	0	0	20	
Flow capacity test[a]	9	0	0	0	0	0	0	0	0	0	0	0	9	
Agency Total	335	762	930	690	286	758	731	681	673	473	438	880	7,637	
Solano County Water Agency														
Approved Table A water	0	0	100	925	2,365	3,464	5,320	4,126	3,531	1,660	1,546	2,098	25,135	46,756
Article 21 water	0	0	0	0	1,210	1,070	0	0	0	0	0	0	2,280	
2002 summer allocation carryover	279	782	857	0	0	0	0	0	0	0	0	0	1,918	
Solano settlement water	0	0	0	0	0	0	0	0	0	860	0	0	860	
Vallejo permit water	0	0	0	0	0	0	0	0	26	1,338	941	1,435	3,740	
Flow capacity test[a]	18	0	0	0	0	0	0	0	0	0	0	0	18	
Agency Total	279	782	957	925	3,575	4,534	5,320	4,126	3,557	3,858	2,487	3,533	33,933	
Delivery of Dry Year Purchase Water to Non-SWP Agencies														
Dry year purchase water to Ronald Conn	0	0	0	0	0	0	0	0	0	0	63	0	63	
Dry year purchase water to the Phelps Brothers	0	0	0	0	0	0	0	0	0	0	202	0	202	
SWP	614	1,544	1,887	1,615	3,861	5,292	6,051	4,807	4,204	2,133	1,984	2,978	36,970	
Non-SWP	0	0	0	0	0	0	0	0	26	2,198	941	1,435	4,600	
North Bay Area Total	614	1,544	1,887	1,615	3,861	5,292	6,051	4,807	4,230	4,331	2,925	4,413	41,570	68,231
South Bay Area														
Alameda County Flood Control and Water Conservation District, Zone 7														
Approved Table A water	0	0	286	1,136	231	3,778	6,369	5,820	4,629	5,041	1,945	1,460	30,695	78,400
Article 56 extended carryover stored in Semitropic[a]	3,800	2,700	0	0	0	0	0	0	0	0	0	0	6,500	
Article 56(c) extended carryover	1,513	2,304	2,782	0	0	0	0	0	0	0	0	0	6,599	
Local water	283	338	292	2,255	3,904	1,185	65	39	637	34	20	326	9,378	

[a]Excluded water from Agency Total

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Pool A water	0	0	0	0	0	583	0	0	0	0	0	0	583	
Pool B water	0	0	0	0	0	73	0	0	0	0	0	0	73	
Transfer water from Byron-Bethany	0	0	0	0	0	0	0	0	500	500	0	0	1,000	
Agency Total	1,796	2,642	3,360	3,391	4,135	5,619	6,434	5,859	5,766	5,575	1,965	1,786	48,328	
Alameda County Water District														
Approved Table A water	0	0	0	0	0	566	3,116	2,733	3,471	3,608	722	770	14,986	42,000
Approved Table A water stored in Semitropic[a]	0	0	0	0	10,000	6,100	0	0	0	0	0	0	16,100	
Article 56 extended carryover water stored in Semitropic[a]	2,000	700	0	0	0	0	0	0	0	0	0	0	2,700	
Article 56C extended carryover	918	1,169	363	0	0	0	0	0	0	0	0	0	2,450	
Local water	203	0	1,207	1,491	1,841	2,053	65	599	84	34	19	316	7,912	
Pool A water	0	0	0	0	0	314	0	0	0	0	0	0	314	
Pool B water	0	0	0	0	0	40	0	0	0	0	0	0	40	
Agency Total	1,121	1,169	1,570	1,491	1,841	2,973	3,181	3,332	3,555	3,642	741	1,086	25,702	
Santa Clara Valley Water District														
Advanced approved Table A water	0	0	0	0	0	0	0	0	0	0	0	620	620	100,000
Approved Table A water	0	0	3,675	4,842	6,131	6,923	7,295	6,250	9,656	4,187	3,407	4,014	56,380	
Approved Table A water stored in Semitropic[a]	0	0	0	0	0	20,000	0	0	9,500	3,500	0	0	33,000	
Article 21 water	0	0	714	222	0	0	0	0	0	0	0	0	936	
Article 56C extended carryover	24	6,871	2,209	0	0	0	0	0	0	0	0	0	9,104	
2002 Summer Allocation Carryover	5,000	0	0	0	0	0	0	0	0	0	0	0	5,000	
Pool A water	0	0	0	0	0	747	0	0	0	0	0	0	747	
Pool B water	0	0	0	0	0	94	0	0	0	0	0	0	94	
Transfer water from Browns Valley Irrigation District	0	0	0	0	0	0	0	0	0	3,100	0	0	3,100	
Agency Total	5,024	6,871	6,598	5,064	6,131	7,764	7,295	6,250	9,656	7,287	3,407	4,634	75,981	
Recreation/Fish and Wildlife														
Recreation/fish and wildlife water, Lake Del Valle	2	2	4	4	11	19	26	21	20	15	5	2	131	
SWP	7,457	10,346	10,033	6,204	6,373	13,137	16,806	14,824	17,776	12,851	6,079	6,866	128,752	
Non-SWP	486	338	1,499	3,746	5,745	3,238	130	638	1,221	3,668	39	642	21,390	
South Bay Area Total	7,943	10,684	11,532	9,950	12,118	16,375	16,936	15,462	18,997	16,519	6,118	7,508	150,142	220,400
San Joaquin Valley Area														
Castaic Lake Water Agency	0	105	2,197	538	0	0	0	0	0	0	0	666	3,506	12,700
Approved Table A water	0	0	396	99	0	0	0	0	0	0	0	0	495	
Article 21 water	0	105	2,593	637	0	0	0	0	0	0	0	666	4,001	
Agency total														
County of Kings														
Approved Table A water	0	0	0	0	0	500	500	500	500	500	550	550	3,600	4,000
Article 21 water	0	0	50	8	0	0	0	0	0	0	0	0	58	
Pool A water	0	0	0	0	0	0	0	30	0	0	0	0	30	
Pool B water	0	0	0	0	0	0	0	4	0	0	0	0	4	
Agency Total	0	0	50	8	0	500	500	534	500	500	550	550	3,692	
Dudley Ridge Water District														
Approved Table A water	0	2,312	2,540	2,288	5,189	8,296	9,745	8,267	61	399	0	177	39,274	57,343
Approved Table A water in Kern Water Bank[a]	0	0	0	0	0	0	0	0	0	0	0	350	350	
Article 21 water	0	0	1,801	127	0	0	0	0	0	0	0	0	1,928	
Bank water recovery, Kern Water Bank	0	0	350	0	0	0	0	0	0	0	0	0	350	
2002 Summer Allocation Carryover	1,359	93	0	0	0	0	0	0	0	0	0	0	1,452	
Dry Year Water Purchase Program	0	0	0	0	0	0	0	0	0	1,249	247	0	1,496	
Exchange approved Table A water to San Gabriel[a]	0	0	0	0	0	0	0	754	2,555	2,889	2,502	0	8,700	
Pool A water	0	0	0	428	0	0	0	0	0	0	0	0	428	
Pool B water	0	0	0	54	0	0	0	0	0	0	0	0	54	
Transfer of approved water to Tulare[a]	0	0	0	0	0	0	0	0	0	1,100	0	0	1,100	
Transfer of approved from Kern	0	0	0	0	0	0	0	0	5,300	2,700	0	0	8,000	
Agency Total	1,359	2,405	4,691	2,897	5,189	8,296	9,745	8,267	5,361	4,348	247	177	52,982	
Empire West Side Irrigation District														
Approved Table A water	11	395	90	0	200	105	0	0	0	0	0	273	1,074	3,000
Carryover wet	187	0	0	0	0	0	0	0	0	0	0	0	187	
Unscheduled water	0	0	171	4	0	0	0	0	0	0	0	0	175	
Agency Total	198	395	261	4	200	105	0	0	0	0	0	273	1,436	
Kern County Water Agency														
Approved Table A water	1,630	3,446	20,468	12,373	50,130	114,180	190,415	107,059	55,209	49,607	47,967	45,768	696,252	1,000,949
Approved Table A water to EWA[a]	0	0	0	0	0	36,000	36,000	36,000	17,000	0	0	0	125,000	
Approved Table A water to Western Hills	0	0	28	110	114	155	181	104	107	81	29	8	917	
Article 21 water	0	0	18,478	2,233	0	0	0	0	0	0	0	0	20,711	
Article 21 water to EWA	0	0	7,180	0	0	0	0	0	0	0	0	0	7,180	
Article 56C extended carryover	7,031	15,177	172	0	0	0	0	0	0	0	0	0	22,380	

[a]Excluded water from Agency Total

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Dry Year Water Purchase Program	0	0	0	0	0	0	0	0	0	0	5,892	0	5,892	
Exchange approved Table A water for water bank water[a]	0	0	350	0	0	0	0	0	0	0	0	0	350	
Exchange approved Table A water for water bank water[a]	0	0	0	8,867	1,133	0	0	0	0	0	0	0	10,000	
Exchange approved Table A water to Del Puerto[a]	0	0	0	0	0	0	0	0	436	0	0	0	436	
Exchange approved Table A water to Panoche[a]	0	0	0	0	0	0	0	0	284	0	0	0	284	
Exchange approved Table A water to San Luis[a]	0	0	0	0	0	0	0	0	1,067	0	0	0	1,067	
Exchange approved Table A water to Del Puerto[a]	0	0	0	0	0	0	0	0	6,000	0	0	0	6,000	
Exchange approved Table A water to Panoche[a]	0	0	0	0	0	0	0	0	1,129	750	1,168	953	4,000	
Exchange approved Table A water to San Luis[a]	0	0	0	0	0	0	0	0	2,922	4,533	973	0	8,428	
Exchange water from Del Puerto	0	4,942	979	79	0	0	0	0	0	0	0	0	6,000	
Exchange water from Panoche	0	3,070	858	72	0	0	0	0	0	0	0	0	4,000	
Exchange water from San Luis	0	5,000	3,428	0	0	0	0	0	0	0	0	0	8,428	
Pool A water	0	0	0	0	0	0	7,476	0	0	0	0	0	7,476	
Pool B water	0	0	0	0	0	0	943	0	0	0	0	0	943	
Turn-in water recovered by Kern	0	0	678	19,808	0	0	0	0	0	0	0	0	20,486	
Transfer of approved Table A water to Dudley Ridge[a]	0	0	0	0	0	0	0	0	5,300	2,700	0	0	8,000	
Deliveries to water banks in Kern														
Approved Table A water from Alameda County stored in Semitropic	3,800	2,700	0	0	0	0	0	0	0	0	0	0	6,500	
Article 56 extended carryover from Alameda-Zone 7 stored in Semitropic	0	0	0	0	10,000	6,100	0	0	0	0	0	0	16,100	
Article 56 extended carryover from Alameda County stored in Semitropic	2,000	700	0	0	0	0	0	0	0	0	0	0	2,700	
Approved Table A water from Santa Clara stored in Semitropic	0	0	0	0	0	20,000	0	0	9,500	3,500	0	0	33,000	
Approved Table A water from Dudley Ridge stored in Kern Water Bank	0	0	0	0	0	0	0	0	0	0	0	350	350	
Approved Table A water from Metropolitan stored in Semitropic	0	0	0	0	0	16,000	14,940	40,000	0	0	0	0	70,940	
Approved Table A water from Metropolitan stored in Arvin-Edison	0	0	0	0	5,477	13,990	11,799	1,900	1,400	1,520	675	3,870	40,631	
Approved Table A water from Metropolitan stored in Kern Delta	0	0	0	0	0	837	1,491	17,806	0	0	0	0	20,134	
Subtotal (Water Bank Deliveries)	5,800	3,400	0	0	15,477	56,927	28,230	59,706	10,900	5,020	675	4,220	190,355	
Agency Total[a]	14,461	35,035	45,089	34,675	65,721	171,262	227,245	166,869	66,216	54,708	52,563	49,996	983,840	
Oak Flat Water District														
Approved Table A water	0	0	0	194	635	704	926	776	416	400	7	1	4,059	5,700
Article 21 water	0	0	7	12	0	0	0	0	0	0	0	0	19	
Carryover 12(e)	0	18	122	0	0	0	0	0	0	0	0	0	140	
Pool A water	0	0	0	0	0	43	0	0	0	0	0	0	43	
Pool B water	0	0	0	0	0	5	0	0	0	0	0	0	5	
Agency Total	0	18	129	206	635	752	926	776	416	400	7	1	4,266	
Tulare Lake Basin Water Storage District														
Approved Table A water	0	1,288	1,241	2,883	1,077	14,373	12,363	20,616	1,428	3,441	12,275	4,388	75,373	111,127
Article 21 water	0	0	5,993	250	0	0	0	0	0	0	0	0	6,243	
2002 Summer Allocation Carryover	2,413	1,871	0	0	0	0	0	0	0	0	0	0	4,284	
Exchange approved Table A water to Westlands	0	0	0	0	11,103	3,000	0	0	0	0	0	0	14,103	
Pool A water	0	0	0	0	0	0	818	15	0	0	0	0	833	
Pool B water	0	0	0	0	0	0	102	3	0	0	0	0	105	
Transfer approved Table A water to Westlands	0	0	0	0	0	3,200	0	0	0	0	0	700	3,900	
Transfer approved Table A water to Westlands	0	0	0	0	250	250	250	0	0	0	250	0	1,000	
Transfer approved Table A water from Dudley	0	0	0	0	0	0	0	0	0	1,100	0	0	1,100	
Agency Total	2,413	3,159	7,234	3,133	1,077	14,373	13,283	20,634	1,428	4,541	12,275	4,388	87,938	
Westlands Water District														
Exchange approved Table A water from Tulare	0	0	0	0	11,103	3,000	0	0	0	0	0	0	14,103	
Transfer approved Table A water from Tulare	0	0	0	0	0	3,200	0	0	0	0	0	700	3,900	
Transfer approved Table A water from Tulare	0	0	0	0	250	250	250	0	0	0	250	0	1,000	
Agency Total	0	0	0	0	11,353	6,450	250	0	0	0	250	700	19,003	
Recreation/Fish and Wildlife														
Department of Fish and Game, O'Neill Forebay/Lateral 4	23	14	37	3	55	63	93	30	37	37	62	53	507	
Department of Parks and Recreation, O'Neill Forebay/San Luis/Cattle	3	0	2	5	9	10	17	11	9	6	1	1	74	
Total	26	14	39	8	64	73	110	41	46	43	63	54	581	
SWP	18,457	28,119	62,001	41,447	84,239	201,811	252,059	197,121	73,967	63,291	59,816	56,805	1,139,103	
Non-SWP	0	13,012	5,265	151	0	0	0	0	0	1,249	6,139	0	25,816	
San Joaquin Valley Area subtotal	18,457	41,131	67,266	41,568	84,239	201,811	252,059	197,121	73,967	64,540	65,955	56,805	1,164,919	
Other non-SWP Water Conveyed														
Tracy Golf and Country Club	0	0	0	0	0	0	0	0	0	0	0	0	0	
CVP Water Conveyed–Annual Contracts														
Plain View Water District/ Musco Family Olive Company	44	51	0	0	0	0	0	0	0	0	0	0	95	
Plain View Water District/ Musco Family Olive Company	0	0	62	64	63	71	72	72	74	87	56	3	624	
U.S. Department of Veteran Affairs, S.J.V. National Cemetery	1	4	0	0	0	0	0	0	0	0	0	0	5	
U.S. Department of Veteran Affairs, S.J.V. National Cemetery	0	0	3	4	7	9	14	16	15	7	3	2	80	
Subtotal	45	55	65	68	70	80	86	88	89	94	59	5	804	

[a]Excluded water from Agency Total

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Cross Valley Canal Contracts														
CVP water to Tulare	0	0	0	383	0	0	0	0	0	0	0	0	383	
CVP water to Fresno County Public Works	0	0	0	216	0	0	0	0	0	0	0	0	216	
CVP water to Hills Valley Irrigation District	0	0	242	0	0	0	0	0	0	0	0	0	242	
CVP water to Kern-Tulare	0	0	0	1,076	0	0	0	0	0	0	0	0	1,076	
CVP water to Rag Gulch	0	0	0	357	0	0	0	0	0	0	0	0	357	
CVP water to Tri-Valley Irrigation District	0	0	0	82	0	0	0	0	0	0	0	0	82	
Agency Total	0	0	242	2,114	0	0	0	0	0	0	0	0	2,356	
Bureau of Reclamation														
Conveyance of nonproject water to O'Neill Forebay	0	0	0	0	0	0	0	0	6,000	0	0	0	6,000	
Kern National Wildlife Refuge	1,136	2,139	1,291	220	236	145	0	1,008	3,497	0	1,255	4,009	14,936	
Recreation/fish and wildlife water	18	13	34	5	53	60	88	35	38	37	52	43	476	
Transfer of water to Madera Water District	0	0	0	0	0	0	0	0	0	1,200	0	0	1,200	
Agency Total	0	0	0	0	0	0	0	0	6,000	1,200	0	0	7,200	
SWP	0	0	0	0	0	0	0	0	0	0	0	0	0	
Non-SWP	45	55	307	2,182	70	80	86	88	6,089	1,294	59	5	25,772	
San Joaquin Valley Area subtotal	45	55	307	2,182	70	80	86	88	6,089	1,294	59	5	25,772	
SWP (Total)	18,457	28,119	62,001	41,417	84,239	201,811	252,059	197,121	73,967	63,291	59,816	56,805	1,139,103	
Non-SWP (Total)	45	13,067	5,572	2,333	70	80	86	88	6,089	2,543	6,198	5	51,588	
San Joaquin Valley Area Total	18,502	41,186	67,573	43,750	84,309	201,891	252,145	197,209	80,056	65,834	66,014	56,810	1,190,691	1,194,819
Central Coastal Area														
San Luis Obispo County Flood Control and Water Conservation District														
Approved Table A water	180	352	330	325	398	452	476	493	441	423	266	281	4,417	25,000
Article 21 water	0	0	24	12	0	0	0	0	0	0	0	0	36	
Agency Total	180	352	354	337	398	452	476	493	441	423	266	281	4,453	
Santa Barbara County Flood Control and Water Conservation District														
Approved Table A water	0	665	1,887	2,761	3,322	3,193	3,089	2,942	2,686	1,799	717	1,251	24,312	45,486
Article 21 water	0	0	236	103	0	0	0	0	0	0	0	0	339	
Carryover special (2002)	1,414	860	0	0	0	0	0	0	0	0	0	0	2,274	
Pool B water	0	0	0	43	0	0	0	0	0	0	0	0	43	
Agency Total	1,414	1,525	2,123	2,907	3,322	3,193	3,089	2,942	2,686	1,799	717	1,251	26,968	
SWP	1,594	1,877	2,477	3,244	3,720	3,645	3,565	3,435	3,127	2,222	983	1,532	31,421	
Non-SWP	0	0	0	0	0	0	0	0	0	0	0	0	0	
Central Coastal Area Total	1,594	1,877	2,477	3,244	3,720	3,645	3,565	3,435	3,127	2,222	983	1,532	31,421	70,486
Southern California Area														
Antelope Valley-East Kern Water Agency														
Approved Table A water	0	0	187	3,253	5,074	6,972	8,946	8,224	6,797	5,846	3,984	3,447	52,730	141,400
2002 Summer Allocation Carryover	2,274	2,143	2,632	0	0	0	0	0	0	0	0	0	7,049	
Pool A water	0	0	0	0	0	250	0	0	0	0	0	0	250	
Mojave's Approved Table A water delivered through AVEK	0	0	0	84	0	0	162	202	155	108	81	24	816	
Agency Total	2,274	2,143	2,819	3,337	5,074	7,222	9,108	8,426	6,952	5,954	4,065	3,471	60,845	
Castaic Lake Water Agency														
Approved Table A water	0	0	1,964	3,262	3,481	4,122	5,578	5,659	5,216	4,856	3,088	2,395	39,621	82,500
Approved Table A water to the Department	0	0	0	0	768	2,000	2,737	1,263	0	0	0	0	6,768	
Article 21 water	0	0	397	99	0	0	0	0	0	0	0	0	496	
2002 Summer Allocation Carryover	2,609	1,931	220	0	0	0	0	0	0	0	0	0	4,760	
Pool B water	0	0	0	0	0	90	0	0	0	0	0	0	90	
Agency Total	2,609	1,931	2,581	3,361	3,481	4,212	5,578	5,659	5,216	4,856	3,088	2,395	44,967	23,100
Coachella Valley Water District														
Approved Table A water	0	0	0	2,310	2,310	2,310	2,310	3,557	1,248	0	0	0	14,045	(1,748)
Article 21 water	0	0	152	52	0	0	0	0	0	0	0	0	204	
Pool A water	0	0	0	172	0	0	0	0	0	0	0	0	172	
Pool B water	0	0	0	0	0	22	0	0	0	0	0	0	22	
Agency Total	0	0	152	2,534	2,310	2,332	2,310	3,557	1,248	0	0	0	14,443	
Crestline-Lake Arrowhead Water Agency														
Approved Table A water	146	24	0	0	0	166	263	269	250	229	180	36	1,563	5,800
Local water	0	98	122	110	113	28	0	0	0	0	0	102	573	
Agency Total	146	122	122	110	113	194	263	269	250	229	180	36	2,136	
Desert Water Agency														
Approved Table A water	0	0	0	3,810	3,810	3,810	3,810	5,869	2,059	0	0	0	23,168	38,100
Article 21 water	0	0	246	84	0	0	0	0	0	0	0	0	330	
Pool A water	0	0	0	285	0	0	0	0	0	0	0	0	285	
Pool B water	0	0	0	0	0	36	0	0	0	0	0	0	36	
Agency Total	0	0	246	4,179	3,810	3,846	3,810	5,869	2,059	0	0	0	23,819	
Littlerock Creek Irrigation District														
Approved Table A water	0	0	0	0	0	0	0	0	0	0	0	0	0	2,300
Agency Total	0	0	0	0	0	0	0	0	0	0	0	0	0	
Metropolitan Water District of Southern California														
Approved Table A water	0	0	77,525	101,953	134,116	121,735	152,455	154,742	145,886	150,859	115,721	106,510	1,261,502	2,011,500

[a]Excluded water from Agency Total

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Approved Table A water to EWA[a]	0	0	0	0	29,596	0	0	0	0	0	0	0	29,596	
Approved Table A water stored in Semitropic[a]	0	0	0	0	0	16,000	14,940	40,000	0	0	0	0	70,940	
Approved Table A water stored in Arvin-Edison[a]	0	0	0	0	5,477	13,990	11,799	1,900	1,400	1,520	675	3,870	40,631	
Approved Table A water stored in Kern Delta[a]	0	0	0	0	0	837	1,491	17,806	0	0	0	0	20,134	
Article 56(c) extended carryover	0	0	34,270	0	0	0	0	0	0	0	0	0	34,270	
Bank water recovery, Arvin-Edison	5,795	1,502	0	0	0	0	0	0	0	0	0	0	7,297	
Bank water recovery, Arvin-Edison	0	4,186	897	0	0	0	0	0	0	0	0	0	5,083	
Bank water recovery, Semitropic	0	0	0	8,867	1,133	0	0	0	0	0	0	0	10,000	
2002 Summer Allocation Carryover	27,803	23,018	4,154	0	0	0	0	0	0	0	0	0	54,975	
Exchange approved water in behalf of EWA	12,287	15,309	2,000	0	0	0	0	0	0	0	0	0	29,596	
Exchange approved water to Mojave[a]	0	0	0	0	0	0	0	0	0	0	4,683	20,191	24,874	
Flexible storage replacement with Article 21 water (Lake Perris)	0	0	1,139	0	0	0	0	0	0	0	0	0	1,139	
Flexible storage replacement with Article 21 water (Castaic Lake)	0	0	12,000	4,483	0	0	0	0	0	0	0	0	16,483	
Flexible storage replacement with carryover special water (Lake Perris)[a]	0	1,100	0	0	0	0	0	0	0	0	0	0	1,100	
Flexible storage replacement with carryover special water (Castaic Lake)[a]	0	6,000	38,500	0	0	0	0	0	0	0	0	0	44,500	
Flexible storage replacement with Table A water (Lake Perris)[a]	0	0	0	15,754	0	0	0	0	0	0	0	0	15,754	
Flexible storage replacement with Table A water (Castaic Lake)[a]	0	0	0	16,821	0	0	0	0	0	0	0	0	16,821	
Flexible storage withdrawal (Lake Perris)	9,712	8,281	0	0	0	0	0	0	0	0	0	0	17,993	
Flexible storage withdrawal (Castaic Lake)	36,059	41,745	0	0	0	0	0	0	0	0	0	0	77,804	
Pool A water	0	0	0	15,024	0	0	0	0	0	0	0	0	15,024	
Pool B water	0	0	0	0	0	1,896	0	0	0	0	0	0	1,896	
Transfer approved Table A water from Santa Barbara	0	0	0	0	0	0	0	0	0	0	0	5,000	5,000	
Agency Total	91,656	94,041	131,985	130,327	135,249	123,631	152,455	154,742	145,886	150,859	115,721	111,510	1,538,062	
Mojave Water Agency														
Approved Table A water	0	0	395	2,211	1,025	678	1,024	908	1,288	1,871	433	258	10,091	75,800
Mojave's approved Table A water delivered through AVEK	0	0	0	84	0	0	162	202	155	108	81	24	816	
2002 Summer Allocation Carryover	502	671	2,355	0	0	0	0	0	0	0	0	0	3,528	
Exchange approved water from Metropolitan	0	0	0	0	0	0	0	0	0	0	4,683	20,191	24,874	
Pool A water sale[a]	16,900	0	0	0	0	0	0	0	0	0	0	0	16,900	
Pool B water sale[a]	2,500	0	0	0	0	0	0	0	0	0	0	0	2,500	
Agency Total[a]	502	671	2,750	2,211	1,025	678	1,024	908	1,288	1,871	5,116	20,449	38,493	
Palmdale Water District														
Approved Table A water	0	0	148	688	1,021	1,333	1,810	746	1,170	1,566	1,042	177	9,701	21,300
Article 56(c) extended carryover	0	0	781	0	0	0	0	0	0	0	0	0	781	
2002 Summer Allocation Carryover	421	565	79	0	0	0	0	0	0	0	0	0	1,065	
Agency Total	421	565	1,008	688	1,021	1,333	1,810	746	1,170	1,566	1,042	177	11,547	
San Bernardino Valley Municipal Water District														
Approved Table A water	0	0	0	959	865	1,096	1,986	2,384	3,266	3,579	2,541	3,695	20,371	102,600
Article 21 water	0	0	120	80	0	0	0	0	0	0	0	0	200	
2002 Summer Allocation Carryover	1,177	597	70	0	0	0	0	0	0	0	0	0	1,844	
Table A transfer to Metropolitan[a]	0	0	0	0	0	0	0	0	0	0	0	5,000	5,000	
Agency Total	1,177	597	190	1,039	865	1,096	1,986	2,384	3,266	3,579	2,541	3,695	22,415	
San Gabriel Valley Municipal Water District														
Approved Table A water	0	0	0	746	2,713	2,613	2,686	1,936	0	0	0	2,340	13,034	28,800
Article 21 water	0	0	136	64	0	0	0	0	0	0	0	0	200	
Exchange approved water from Dudley	0	0	0	0	0	0	0	754	2,555	2,889	2,502	0	8,700	
Agency Total	0	0	136	810	2,713	2,613	2,686	2,690	2,555	2,889	2,502	2,340	21,934	
San Gorgonio Pass Water Agency														
Approved Table A water	0	0	0	0	0	0	2	14	13	22	26	39	116	4,000
Agency Total	0	0	0	0	0	0	2	14	13	22	26	39	116	
Ventura County Watershed Protection District														
Approved Table A water	154	154	154	154	484	1,186	572	1,501	177	154	154	156	5,000	20,000
Local water from the Department to United Conservation District	0	0	0	0	768	2,000	2,737	1,263	0	0	0	0	6,768	
Pool A water sale[a]	6,750	0	0	0	0	0	0	0	0	0	0	0	6,750	
Pool B water sale[a]	750	0	0	0	0	0	0	0	0	0	0	0	750	
Agency Total	154	154	154	154	1,252	3,186	3,309	2,764	177	154	154	156	11,768	
Recreation/Fish and Wildlife														
Castaic Lake	13	0	16	17	30	34	50	46	50	45	23	32	356	
Castaic Lake to Lagoon	256	0	0	0	0	0	168	182	292	297	0	225	1,420	
Silverwood Lake	2	2	2	2	6	13	18	15	15	14	3	3	95	
Lake Perris	0	0	3	3	2	39	49	47	44	30	18	25	260	
Agency Total	271	2	21	22	38	86	285	290	401	386	44	285	2,131	
Recreation/Fish and Wildlife														
USFWS recreation/fish and wildlife water (Pyramid Lake)	1	1	1	1	1	3	2	2	2	2	0	0	16	
SWP	99,210	100,128	142,042	148,662	156,838	150,401	184,626	188,318	170,481	172,365	134,479	144,553	1,792,103	
Non-SWP	1	99	123	111	882	2,031	2,739	1,265	2	2	0	102	7,357	
Southern California Area Total	99,211	100,227	142,165	148,773	157,720	152,432	187,365	189,583	170,483	172,367	134,479	144,655	1,799,460	2,558,200
SWP Water														
SWP Approved Table A Water														
Agricultural and M&I approved water	2,155	8,801	113,876	148,557	241,225	362,310	453,892	407,954	261,304	245,734	195,795	186,579	2,628,182	

[a]Excluded water from Agency Total

[b]EWA water is not included in the Grand Total to prevent double counting.

Table 9-5. Water Delivered in 2003, by Month (Acre-feet)

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	2003 Total Deliveries	2003 Contract Table A
Agricultural and M&I approved water for EWA[a]	0	0	0	0	29,596	36,000	36,000	36,000	17,000	0	0	0	154,596	
Article 21 water	0	0	29,126	3,445	1,210	1,070	0	0	0	0	0	0	34,851	
Article 21 water for EWA	0	0	7,180	0	0	0	0	0	0	0	0	0	7,180	
Article 56(c) extended carryover	15,286	28,921	40,577	0	0	0	0	0	0	0	0	0	84,784	
2002 Summer Allocation Carryover	45,586	33,251	10,367	0	0	0	0	0	0	0	0	0	89,204	
Carryover 12(e) carryover	0	18	122	0	0	0	0	0	0	0	0	0	140	
Carryover (wet)	187	0	0	0	0	0	0	0	0	0	0	0	187	
Exchange approved water	0	0	0	0	11,103	3,000	0	754	2,555	2,889	7,185	20,191	47,677	
Exchange approved water for banked water[a]	0	0	350	8,867	1,133	0	0	0	0	0	0	0	10,350	
Exchange approved water for nonproject water supplied[a]	0	0	0	0	0	0	0	0	11,838	5,283	2,141	953	20,215	
Exchange banked water in behalf of EWA	12,287	15,309	2,000	0	0	0	0	0	0	0	0	0	29,596	
Flexible storage replacement with Article 21 water (Lake Perris)	0	0	1,139	0	0	0	0	0	0	0	0	0	1,139	
Flexible storage replacement with Article 21 water (Castaic Lake)	0	0	12,000	4,483	0	0	0	0	0	0	0	0	16,483	
Flexible storage replacement with carryover water (Lake Perris)[a]	0	1,100	0	0	0	0	0	0	0	0	0	0	1,100	
Flexible storage replacement with carryover water (Castaic Lake)[a]	0	6,000	38,500	0	0	0	0	0	0	0	0	0	44,500	
Flexible storage replacement (Lake Perris)[a]	0	0	0	15,754	0	0	0	0	0	0	0	0	15,754	
Flexible storage replacement (Castaic Lake)[a]	0	0	0	16,821	0	0	0	0	0	0	0	0	16,821	
Flexible storage withdrawal (Lake Perris)	9,712	8,281	0	0	0	0	0	0	0	0	0	0	17,993	
Flexible storage withdrawal (Castaic Lake)	36,059	41,745	0	0	0	0	0	0	0	0	0	0	77,804	
Flow capacity test[a]	27	0	0	0	0	0	0	0	0	0	0	0	27	
Pool A water	0	0	0	15,909	0	2,097	8,294	45	0	0	0	0	26,345	
Pool B water	0	0	0	97	0	2,276	1,045	7	0	0	0	0	3,425	
Pool A water sale[a]	26,345	0	0	0	0	0	0	0	0	0	0	0	26,345	
Pool B water sale[a]	3,425	0	0	0	0	0	0	0	0	0	0	0	3,425	
Pump-in recoveries	0	0	678	19,808	0	0	0	0	0	0	0	0	20,486	
Transfer approved water	0	0	0	0	250	3,450	250	0	5,300	3,800	250	5,700	19,000	
Unscheduled water	0	0	171	4	0	0	0	0	0	0	0	0	175	
Water Bank water recoveries	5,795	5,688	1,247	8,867	1,133	0	0	0	0	0	0	0	22,730	
Agency Total	127,067	142,014	218,483	201,170	254,921	374,203	463,481	408,760	269,159	252,423	203,230	212,470	3,127,381	
SWP Table A-related water														
Recreation/fish and wildlife water	299	18	64	34	113	179	422	352	468	444	112	341	2,846	
Subtotal (SWP water)	127,366	142,032	218,547	201,204	255,034	374,382	463,903	409,112	269,627	252,867	203,342	212,811	3,130,227	
Non-SWP Water														
Other water														
Dry Year Purchase Program	0	0	0	0	0	0	0	0	0	1,249	6,139	0	7,388	
Conveyance of nonproject water to O'Neill Forebay	0	0	0	0	0	0	0	0	6,000	0	0	0	6,000	
Local	35,497	486	1,744	7,833	104,482	175,648	195,495	162,314	88,824	78,289	105,241	76,871	1,032,724	
Solano settlement water	0	0	0	0	0	0	0	0	0	860	0	0	860	
Vallejo permit water	0	0	0	0	0	0	0	0	26	1,338	941	1,435	3,740	
Subtotal	35,497	486	1,744	7,833	104,482	175,648	195,495	162,314	94,850	81,437	112,321	78,306	1,049,235	
CVP Water														
Conveying water to CVP contractor	0	0	0	242	2,114	0	0	0	0	0	0	0	2,356	
Conveying CVP water annual contract	45	55	65	68	70	80	86	88	89	94	59	5	804	
Conveying CVP water (Kern National Wildlife Refuge–the Bureau)	1,136	2,139	1,291	220	236	145	0	1,008	3,497	0	1,255	4,009	14,936	
Conveying CVP water recreation/fish and wildlife water (San Luis/Pyramid)	19	14	35	6	54	63	90	37	40	39	52	43	492	
Delivery of CVP water from CVP/CVC to SWP contractor	0	13,012	5,265	151	0	0	0	0	0	0	0	0	18,428	
Transfer of CVP water to SWP contractor	0	0	0	0	0	0	0	0	500	3,600	0	0	4,100	
Transfer of CVP/CVC water to CVP contractor	0	0	0	0	0	0	0	0	0	1,200	0	0	1,200	
Subtotal (CVP water)	1,200	15,220	6,656	687	2,474	288	176	1,133	4,126	4,933	1,366	4,057	42,316	
Total (Non-SWP water)	36,697	15,706	8,400	8,520	106,956	175,936	195,671	163,447	98,976	86,669	113,687	82,363	1,093,028	
Grand Total	164,063	157,738	226,947	209,724	361,990	550,318	659,574	572,559	368,603	339,536	317,029	295,174	4,223,255	4,126,926

[a]Excluded water from Agency Total

Table 9-6. Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-03 (Acre-feet)

Year	Annual Table A Water According to Long-Term Water Supply Contract							Water Conveyed								
								Deliveries								
	Upper Feather River Area (1)	*North Bay Area (2)*	*South Bay Area (3)*	*San Joaquin Valley Area (4)*	*Central Coastal Area (5)*	*Southern California Area (6)*	*Total (7)*	*Annual Table A Water (8)*	*Article 21 Surplus and Unscheduled Water[a] (9)*	*Other Water[b] (10)*	*Feather River Diversions[c] (11)*	*Wildlife/ Recreation Water (12)*	*Subtotal (13)*	**Initial Fill Water (14)**	**Operational Losses and Storage Changes[d] (15)**	**Total (16)**
1962	0	0	0	0	0	0	0	0	0	18,289	0	0	18,289	9	272	18,570
1963	0	0	0	0	0	0	0	0	0	22,456	0	0	22,456	71	185	22,712
1964	0	0	0	0	0	0	0	0	0	32,507	0	0	32,507	171	152	32,830
1965	0	0	0	0	0	0	0	0	0	44,105	0	0	44,105	93	729	44,927
1966	0	0	0	0	0	0	0	0	0	67,928	0	0	67,928	0	1,746	69,674
1967	0	0	11,538	0	0	0	11,538	11,538	0	53,605	0	0	65,143	8,328	4,212	77,683
1968	550	0	109,900	77,350	0	3,700	191,500	171,709	121,534	14,777	866,926	0	1,174,946	498,926	117,906	1,791,778
1969	620	0	98,700	163,075	0	5,000	267,395	193,020	72,397	18,829	794,374	0	1,078,620	510,614	72,196	1,661,430
1970	700	0	114,200	202,000	0	5,700	322,600	233,993	133,024	38,080	759,759	0	1,164,856	23,947	2,435	1,191,238
1971	890	0	116,200	251,800	0	6,700	375,590	357,340	296,019	44,119	778,362	8	1,475,848	7,853	5,812	1,489,513
1972	970	0	118,300	413,066	0	209,423	741,759	611,801	423,964	66,638	817,398	6,489	1,926,290	100,274	53,062	2,079,626
1973	1,100	0	120,400	383,652	0	481,100	986,252	694,388	296,416	42,511	800,743	1,155	1,835,213	204,638	53,798	2,093,649
1974	1,230	0	122,400	460,650	0	597,920	1,182,200	874,077	417,676	46,224	911,613	2,118	2,251,708	237,554	10,657	2,499,919
1975	1,610	0	124,500	545,809	0	714,950	1,386,869	1,223,990	622,902	63,793	862,218	3,377	2,776,280	103,352	(94,606)	2,785,026
1976	1,990	0	126,500	543,417	0	836,480	1,508,387	1,373,002	580,110	115,217	946,440	1,745	3,016,514	61,122	(681,025)	2,396,611
1977	2,420	0	128,600	581,400	0	954,901	1,667,321	574,155	0	389,065	581,994	1,111	1,546,325	0	(131,151)	1,415,174
1978	1,850	0	130,700	635,900	0	1,049,584	1,818,034	1,452,699	16,914	121,225	786,517	1,691	2,379,046	64,443	717,370	3,160,859
1979	2,130	0	132,700	702,685	0	1,190,573	2,028,088	1,659,896	648,389	187,630	882,549	1,766	3,380,230	12,302	(83,430)	3,309,102
1980	1,810	500	134,800	758,100	1,946	1,317,614	2,214,770	1,529,749	404,557	46,459	875,045	2,131	2,857,941	0	(26,606)	2,831,335
1981	1,940	650	137,000	818,000	2,813	1,432,065	2,392,468	1,909,562	908,428	279,161	838,557	4,688	3,940,396	0	(802,263)	3,138,133
1982	1,970	800	139,200	876,500	5,626	1,550,449	2,574,545	1,750,024	215,873	154,882	776,330	4,646	2,901,755	0	480,752	3,382,507
1983	2,000	950	141,400	867,118	8,439	1,681,257	2,701,164	1,184,869	13,019	181,453	602,905	7,849	1,990,095	0	(90,997)	1,899,098
1984	3,630	1,100	143,600	979,211	12,698	1,744,098	2,884,337	1,588,619	262,917	381,024	832,332	7,040	3,071,932	0	(140,182)	2,931,750
1985	3,760	1,250	145,800	1,019,049	21,138	1,864,849	3,055,846	1,995,453	307,672	404,842	870,008	4,033	3,582,008	0	92,885	3,674,893
1986	4,190	1,400	148,100	1,091,946	28,210	1,983,890	3,257,736	1,995,636	36,620	193,606	791,737	3,865	3,021,464	0	284,380	3,305,844
1987	4,620	1,550	150,300	1,188,500	35,204	2,103,941	3,484,115	2,130,086	114,907	377,592	831,947	7,672	3,462,204	0	(390,413)	3,071,791
1988	5,060	15,471	152,500	1,246,100	43,722	2,225,482	3,688,335	2,385,122	0	507,076	794,834	4,889	3,691,921	0	(92,850)	3,599,071
1989	5,500	24,615	156,700	1,290,400	56,342	2,424,633	3,958,190	2,853,747	0	474,559	830,500	8,135	4,166,941	0	447,917	4,614,858
1990	6,040	28,190	160,900	1,313,450	70,486	2,500,600	4,079,666	2,582,151	90	424,697	875,099	9,262	3,891,299	0	(528,869)	3,362,430
1991	11,880	29,590	166,400	1,338,011	70,486	2,510,200	4,126,567	549,113	3,521	551,051	565,395	4,879	1,673,959	0	167,435	1,841,394
1992	11,920	32,010	171,900	1,342,300	70,486	2,510,200	4,138,816	1,471,454	1,156	144,789	613,978	2,605	2,233,982	0	(63,541)	2,170,441
1993	11,960	34,620	177,400	1,342,300	70,486	2,510,200	4,146,966	2,315,235	0	254,854	822,589	2,609	3,395,287	0	726,123	4,121,410
1994	12,000	37,215	182,000	1,342,300	70,486	2,510,200	4,154,201	1,749,351	112,625	236,739	874,018	8,200	2,980,933	0	(295,405)	2,685,528
1995	12,050	44,030	184,000	1,342,300	70,486	2,510,200	4,163,066	1,967,093	64,330	78,425	860,077	2,575	2,972,500	0	69,536	3,042,036
1996	12,100	48,225	186,000	1,301,630	70,486	2,492,900	4,111,341	2,514,825	28,647	251,391	934,997	3,907	3,733,767	86	491,550	4,225,403
1997	12,150	49,315	188,000	1,297,300	45,201	2,492,900	4,084,866	2,325,775	21,432	322,000	993,211	4,146	3,666,564	527	(11,806)	3,655,285
1998	12,200	50,420	188,000	1,272,300	45,201	2,517,900	4,086,021	1,725,519	20,288	134,682	872,738	2,108	2,755,335	0	(132,491)	2,622,844
1999	12,250	51,500	188,000	1,272,300	70,486	2,519,900	4,114,436	2,738,891	158,070	85,312	1,108,672	4,324	4,095,269	0	(189,525)	3,905,744
2000	14,000	55,945	210,000	1,205,300	70,486	2,565,900	4,121,631	3,200,677	308,785	322,655	1,085,886	4,030	4,932,032	0	(20,103)	4,911,929
2001	14,670	66,561	220,000	1,185,519	70,486	2,566,900	4,124,136	1,690,926	43,435	477,835	1,078,656	2,929	3,293,781	0	159,983	3,453,764
2002	14,730	67,396	220,000	1,195,219	70,486	2,557,200	4,125,031	2,573,030	37,165	307,162	1,132,938	3,694	4,053,989	0	80,709	4,134,698
2003	14,790	68,231	220,400	1,194,819	70,486	2,558,200	4,126,926	2,901,041	59,828	251,447	1,008,093	2,846	4,223,255	0	459,377	4,682,632
Total	**223,280**	**711,534**	**5,567,038**	**33,040,776**	**1,152,372**	**59,707,709**	**100,402,709**	**59,059,556**	**6,752,710**	**8,240,690**	**30,659,435**	**132,522**	**104,844,913**	**1,834,310**	**725,916**	**107,405,139**

[a] Values include amounts of deliveries to short-term contractors (Mustang Water District, 1970-72; Tracy Golf and Country Club, 1974, 1979, and 1980; Green Valley Water District, 1974, 1975, 1978, 1979, 1980, and 1985; Granite Construction Company, 1980).
[b] Includes amounts of SWP non-Table A water and non-SWP water conveyed for SWP and non-SWP water contractors.
[c] Includes amounts of water diverted under various water rights agreements.
[d] Amounts reflect net effect of (1) operational losses from SWP transportation facilities; (2) changes in reservoir storage south of Delta; (3) storable local inflows to SWP reservoirs; (4) side inflow to San Luis Canal; and (5) inflow into California Aqueduct from Kern River Intertie.

Information for this chapter was provided by the State Water Project Analysis Office.

United States District Court, Eastern District of California, "*Natural Resources Defense Council v. Kempthorne*, 506 F.Supp.2d 322 (E.D. Cal. 2007)" ("2007 Wanger decision")

H

Natural Resources Defense Council v. Kempthorne
E.D.Cal.,2007.
Only the Westlaw citation is currently available.
United States District Court,E.D. California.
NATURAL RESOURCES DEFENSE COUNCIL, et al.,
Plaintiffs,
v.
Dirk KEMPTHORNE, in his official capacity as Secretary of the Interior, et al., Defendants,
California Department of Water Resources, Defendant-Intervenor,
State Water Contractors, Defendant-Intervenor,
San Luis & Delta-Mendota Water Authority, et al.,
Defendant-Intervenors.
No. 1:05-CV-01207 OWW (TAG).

May 25, 2007.

Andrea Arnold Treece, Deborah S. Reames, Michael Ramsey Sherwood, Earthjustice Legal Defense Fund Incorporated, Oakland, CA, Hamilton Candee, Katherine Scott Poole, Natural Resources Defense Council, Trent William Orr, Law Office of Trent W. Orr, San Francisco, CA, for Plaintiffs.
James A. Maysonett, Keith W. Rizzardi, Department of Justice, Wildlife and Marine Resources Section, Washington, DC, for Defendants.
Daniel Joseph O' Hanlon, Clifford W. Schulz, Kronick, Moskovitz, Tiedemann & Girard, Jon David Rubin, Diepenbrock Harrison, Brenda Washington Davis, Christian Charles Scheuring, John Robert Hewitt, Ronda Azevedo Lucas, California Farm Bureau Federation, Deborah A. Wordham, California Attorney General's Office, Andrew Morrow Hitchings, Somach, Simmons & Dunn, Kevin M. O' Brien, Steven Paul Saxton, Downey Brand LLP, Sacramento, CA, Christopher H. Buckley, Jr., Gibson Dunn and Crutcher, Washington, DC, Gregory K. Wilkinson, Anthony Leon Beaumon, Best Best & Krieger, LLP, Riverside, CA, Mark Diaz Servino, Best Best and Krieger LLP, Irvine, CA, Clifford Thomas Lee, California Attorney General's Office, San Francisco, CA, J. Mark Atlas, Frost Krup and Atlas, Willows, CA, for Defendants-Intervenors.

OLIVER W. WANGER, United States District Judge.

***1** This case concerns the effect on a threatened species of fish, the Delta smelt (*Hypomesus transpacificus*) FN1, of the coordinated operation of the federally-managed Central Valley Project (" CVP") and the State of California's State Water Project (" SWP"), among the world's largest water diversion projects. Both projects divert large volumes of water from the California Bay (Sacramento-San Joaquin) Delta (" Delta") and use the Delta to store water.

For over thirty years, the projects have been operated pursuant to a series of cooperation agreements. In addition, the projects are subject to ever-evolving statutory, regulatory, contractual, and judicially-imposed requirements. The Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (" 2004 OCAP" or " OCAP") surveys how the projects are currently managed in light of these evolving circumstances. At issue in this case is a 2005 FN2 biological opinion (" BiOp"), issued by the United States Fish and Wildlife Service (" FWS" or " Service") pursuant to the Endangered Species Act (" ESA"), which concludes that current project operations described in the OCAP and certain planned future actions will not jeopardize the continued existence of the Delta smelt or adversely modify its critical habitat.

The Delta smelt is a small, slender-bodied fish endemic to the Delta. Historically, Delta smelt could be found throughout the Delta. Although abundance data on the smelt indicates that the population has fluctuated wildly in the past, it is undisputed that, overall, the population has declined significantly in recent years, to its lowest reported volume in fall 2004.

In this case, Plaintiffs, a coalition of environmental and sportfishing organizations, challenge the 2005 BiOp's no jeopardy and no adverse modification findings as arbitrary, capricious, and contrary to law under the Administrative Procedure Act, 5 U.S.C. §§ 702 et seq. Before the court for decision is Plaintiffs' motion for summary judgment. Among other things, Plaintiffs allege that the BiOp fails to consider the best available science, relies upon uncertain (and allegedly inadequate) adaptive management processes to monitor and mitigate the potential impacts of the OCAP, fails to meaningfully analyze whether the 2004 OCAP will jeopardize the continued existence of the Delta smelt, fails to consider the OCAP's impact upon previously designated critical habitat, and fails to address the impacts of the entire project.

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Separate opposition briefs were filed by the Federal Defendants (Doc. 242), the Department of Water Resources (" DWR") (Doc. 246), and the State Water Contractors (" SWC") (Doc. 241), along with a final brief filed collectively by San Luis & Delta-Mendota Water Authority, Westlands Water District, and the California Farm Bureau Federation (" the San Luis Parties") (Doc. 247).

A recent Ninth Circuit opinion in *National Wildlife Federation v. National Marine Fisheries Service*, 481 F.3d 1224 (9th Cir.2007) [hereinafter " *NWF v. NMFS*"], succinctly summarizes the relevant provisions of the ESA:

***2** The ESA requires federal agencies to " insure that any action authorized, funded, or carried out by such agency ... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [designated critical] habitat...." 15 U.S.C. § 1536(a)(2). The ESA imposes a procedural consultation duty whenever a federal action may affect an ESA-listed species.*Thomas v. Peterson*, 753 F.2d 754, 763 (9th Cir.1985). To that end, the agency planning the action, usually known as the " action agency," must consult with the consulting agency. This process is known as a " Section 7" consultation. The process is usually initiated by a formal written request by the action agency to the consulting agency. After consultation, investigation, and analysis, the consulting agency then prepares a biological opinion. *See generally Ariz. Cattle Growers' Ass'n v. U.S. Fish & Wildlife Serv.*, 273 F.3d 1229, 1239 (9th Cir.2001). In this case, the action agencies are the U.S. Army Corps of Engineers and the Bureau of Reclamation, while the consulting agency is NMFS.

The consulting agency evaluates the effects of the proposed action on the survival of species and any potential destruction or adverse modification of critical habitat in a biological opinion, 16 U.S.C. § 1536(b), based on " the best scientific and commercial data available," *id.* § 1536(a)(2). The biological opinion includes a summary of the information upon which the opinion is based, a discussion of the effects of the action on listed species or critical habitat, and the consulting agency's opinion on " whether the action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat...." 50 C.F.R. § 402.14(h)(3). In making its jeopardy determination, the consulting agency evaluates " the current status of the listed species or critical habitat," the " effects of the action," and " cumulative effects." *Id.* § 402.14(g)(2)-(3). " Effects of the action" include both direct and indirect effects of an action " that will be added to the environmental baseline." *Id.* § 402.02. The environmental baseline includes " the past and present impacts of all Federal, State or private actions and other human activities in the action area" and " the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation." *Id.* If the biological opinion concludes that jeopardy is not likely and that there will not be adverse modification of critical habitat, or that there is a " reasonable and prudent alternative[ ]" to the agency action that avoids jeopardy and adverse modification and that the incidental taking of endangered or threatened species will not violate section 7(a)(2), the consulting agency can issue an " Incidental Take Statement" which, if followed, exempts the action agency from the prohibition on takings found in Section 9 of the ESA. 16 U.S.C. § 1536(b)(4); *ALCOA v. BPA*, 175 F.3d 1156, 1159 (9th Cir.1999).

* * *

***3** The issuance of a biological opinion is considered a final agency action, and therefore subject to judicial review. *Bennett v. Spear*, 520 U.S. 154, 178, 117 S.Ct. 1154, 137 L.Ed.2d 281 (1997); *Ariz. Cattle Growers' Ass'n*, 273 F.3d at 1235.

Id. at *2-*3.

For over thirty years the state and federal agencies charged with management of the CVP and SWP have operated the projects in an increasingly coordinated manner pursuant to a Coordinated Operating Agreement (" COA"). The COA, which dates to 1986, has evolved over time to reflect, among other things, changing facilities, delivery requirements, and regulatory restrictions. The most recent document surveying how the COA is implemented in light of these evolving circumstances is the 2004 Operating Criteria and Plan (" 2004 OCAP" or " OCAP") issued June 30, 2004. (AR 489-728.) [FN3]

A. *Overview of the 2004 OCAP.*

The OCAP begins with a " Purpose of Document" section which states:

This document has been prepared to serve as a baseline description of the facilities and operating environment of the Central Valley Project (CVP) and State Water Project (SWP). The Central Valley Project-Operations and

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Criteria Plan (CVP-OCAP) identifies the many factors influencing the physical and institutional conditions and decision-making process under which the project currently operates. Regulatory and legal instruments are explained, alternative operating models and strategies described.
The immediate objective is to provide operations information for the Endangered Species Act, Section 7, consultation. The long range objective is to integrate CVP-OCAP into the proposed Central Valley document. It is envisioned that CVP-OCAP will be used as a reference by technical specialists and policymakers in and outside the Bureau of Reclamation (Reclamation) in understanding how the CVP is operated. The CVP-OCAP includes numeric and nonnumeric criteria and operating strategies. Emphasis is given to explaining the analyses used to develop typical operating plans for simulated hydrologic conditions.
All divisions of CVP are covered by this document, including the Trinity River Division, Shasta and Sacramento Divisions, American River Division and Friant Division.

(AR 506.) [FN4]

The introductory chapter provides an overview of all of the physical components of the CVP and SWP (AR 507-520), as well as all of the relevant legal authorities affecting CVP operations (508-512).

Chapter 2, explains, among other things, that water needs assessments have been performed for each CVP water contractor, to confirm each contractor's past beneficial use in order to anticipate future demands. (AR 521.) Chapter 2 also reviews the 1986 COA and how it is implemented on a daily basis by Reclamation and DWR. (AR 523-25.) Also provided is a detailed overview of the " changes in [the] operations coordination environment since 1986," which include:
***4** Changes due to temperature control operations on the Sacramento River;
Increases in the minimum release requirements on the Trinity River;
Implementation of CVPIA 3406(b)(2) and Refuge Water Supply contracts;
Commitments made by the CVP and SWP pursuant to the Bay-Delta Accord and the subsequent implementation of State Water Resources Control Board (" SWRCB") Decision-1641;
The Monterey Agreement;
The Operation of the North Bay Aqueduct (which was not included in the 1986 COA).
The SWP's commitment to make up for 195,000 acre-feet of pumping lost to the CVP due to SWRCB Decision 1485;
Implementation of the Environmental Water Account; and Constraints imposed by various endangered species act listings, including that of the Sacramento River Winter-Run Chinook Salmon, the Sacramento River Spring-Run Chinook Salmon, the Steelhead Trout, and the Delta Smelt (which resulted in the issuance of biological opinions in 1993, 1994, and 1995 concerning CVP/SWP operations and the South Delta Temporary Barriers Biological Opinion in 2001)

(AR 525-28.) The OCAP also reviews the regulatory standards imposed by SWRCB D-1641, which include water quality standards based on the geographic position of the 2-parts-per-thousand isohale (otherwise known as " X2"), a Delta export restriction standard known as the export/inflow (E/I) ratio, minimum Delta outflow requirements, and Sacramento River and San Joaquin River flow standards. (AR 530-537.) In addition to imposing requirements, D-1641 granted the Bureau and DWR permission to use each project's capabilities in a coordinated manner. (AR 537-38.)

This is not a complete overview of the projects' operations covered in the OCAP. Numerous regulatory and operational changes have taken place in recent years. As the OCAP's " Purpose of Document" section explains, the immediate objective of the OCAP is to lay out all such regulatory and other operational information so that ESA Section 7 consultation can proceed to evaluate how project operations will effect the Delta smelt under various projected future conditions.

B. ***Applying the ESA to Project Operations.***

Because endangered and/or threatened species, including the Delta smelt, reside in the area affected by the CVP and SWP, the 2004 OCAP, administered on behalf of the federal government by the Bureau of Reclamation (" Bureau"), must comply with various provisions of the ESA. Specifically, prior to authorizing, funding, or carrying out any action, the acting federal agency (in this case, the Bureau) must first consult with FWS and/or NMFS to " insure that [the] action ... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined ... to be critical...." 16 U.S.C. § 1536(a)(2) [ESA § 7(a)(2)]. This form of consultation is called " formal consultation," and concludes with the issuance of a biological opinion. 50 C.F.R. § 402.02.

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***5** Alternatively, under certain circumstances, a federal agency may pursue " early consultation," on behalf of an agency or private party (referred to as a " prospective applicant") who will require formal approval or authorization to undertake a project. *Id.* Early consultation may be requested when the prospective applicant " has reason to believe that an endangered species or a threatened species may be present in the area affected by this project and that implementation of such action will likely affect such species." 50 C.F.R. § 402.11(b). The result of early consultation is a " preliminary biological opinion," the contents of which are " the same as for a biological opinion issued after formal consultation except that the incidental take statement provided with a preliminary biological opinion does not constitute authority to take listed species." § 402.11(e). Subsequently, the preliminary biological opinion may be " confirmed" after the prospective applicant applies to the federal agency for a permit or licence. Once a request for confirmation is received, the FWS must either confirm that the preliminary biological opinion stands as the final biological opinion or must request that the federal agency initiate formal consultation. § 402.11(f).

In this case, the 2004 OCAP BiOp [FN5] contemplates increases in water diversions and the construction of new facilities in the Delta. (AR 256-271.) The maximum daily diversion rate in Clifton Court Forebay will increase from 6,680 cubic feet per second (CFS) to 8,500 CFS (27% increase in pumping) and eventually to 10,300 CFS (54% increase). Permanent barriers within the south Delta will be constructed and operated. An intertie between the California Aqueduct and the Delta-Mendota Canal will be constructed and operated. Water deliveries from the American River will be doubled. New deliveries of CVP water to the Freeport Regional Water Project will be made. Water transfers resulting in an annual 200,000 to 600,000 acre-feet increase in Delta exports will result. (AR 256, 339-40, 357-59, 371, 382-83, 465.)

The Bureau submitted some of these operational changes for formal consultation with FWS concerning their impact on the Delta smelt, while other changes were subject only to early consultation:

This biological opinion covers formal and early consultation for the operations of the CVP and SWP. The formal consultation effects described in this biological opinion cover the proposed 2020 operations of the CVP including the Trinity River Mainstem ROD (Trinity ROD) flows on the Trinity River, the increased water demands on the American River, the delivery of CVP water to the proposed Freeport Regional Water Project (FRWP), water transfers, the long term Environmental Water Account (EWA), the operation of the Tracy Fish Facility, and the operation of the SWP-CVP intertie. The effects of operations of the SWP are also included in this opinion and include the operations of the North Bay Aqueduct, the Suisun Marsh Salinity Control Gates, the Skinner Fish Facility and water transfers.

***6** Early consultation effects include the effects of operations of components of the South Delta Improvement Program (SDIP). These operations include pumping of 8500 cubic feet per second (cfs) at the SWP and Banks Pumping Plant (hereafter referred to as 8500 Banks), permanent barrier operations in the South Delta, the long term EWA, water transfers, and CVP and SWP operational integration. There are two separate effects sections in this biological opinion, one for Formal Consultation and one for Early Consultation. In addition, there is an incidental take for formal consultation and a preliminary incidental take for early consultation.

(AR 2, 248.) [FN6]

C. *History of This Lawsuit.*

On July 30, 2004, FWS issued a Biological Opinion (the " 2004 OCAP BiOp"), addressing both formal and early consultation for the above-described OCAP actions. (AR 1.) [FN7]

On August 4, 2004, the Ninth Circuit decided *Gifford Pinchot Task Force v. United States Fish & Wildlife Serv.*, 378 F.3d 1059, 1069 (9th Cir.2004), which held that the FWS's definition of " adverse modification" to critical habitat is an impermissible interpretation of the ESA because it focuses on whether critical habitat modifications would impact the *survival* of a species, effectively ignoring the statutorily-mandated goal of " *recovery.*" On November 4, 2004, in response to this ruling, the Bureau requested reinitiation of consultation to address critical habitat issues.

Plaintiffs in this case, a coalition of non-profit conservation organizations, filed suit on February 15, 2005, alleging that the 2004 OCAP BiOp was legally inadequate in light of *Gifford Pinchot* and should be invalidated. (Doc. 1.) Plaintiffs named as defendants the Department of the Interior and the FWS. (*Id.*)

On February 16, 2005, FWS issued an amended BiOp (the " 2005 OCAP BiOp," " OCAP BiOp," or " BiOp"), which superceded the 2004 OCAP BiOp. (AR 247.) The 2005 OCAP BiOp concludes that the coordinated operation of the SWP and CVP, including the proposed future actions, will not jeopardize the Delta smelt's

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continued existence. (AR at 469.) Although the BiOp recognizes that *existing* protective measures may be inadequate, the FWS concluded that certain *proposed* protective measures, including the EWA and a proposed " adaptive management" protocol would provide adequate protection. (*Id.*)

Since the filing of this complaint, Federal Defendants have reinitiated § 7 consultation and contend this case should be dismissed as moot, or stayed for a voluntary remand of the 2005 BiOp without vacatur.

Plaintiffs filed a supplemental complaint on May 20, 2005, challenging the amended BiOp on various grounds. (Doc. 128 pt. 8.)

D. *Delta Smelt Abundance.*

Smelt once were one of the most common pelagic [FN8] fish in the Delta, having previously occupied the waters from " Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River." (AR 365.) Smelt abundance has " declined irregularly" for at least the past 20 years. (AR 365-67.) FWS relies primarily upon two indices to monitor Delta smelt abundance, calculated from the Summer Tow Net Survey (" TNS") and the Fall Midwater Trawl (" FMWT"). (AR 366-67, 1022.) The TNS index, which measures the abundance and distribution of juvenile Delta smelt, constitutes " one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959)." (AR 370.) Since 1983, except for three years (1986, 1993, and 1994), the TNS has remained consistently lower than ever previously recorded. (*Id.*)

***7** The FMWT index, which measures the abundance and distribution of late juveniles and adult Delta smelt from San Pablo Bay to Rio Vista on the Sacramento River and Stockton on the San Joaquin River, is the second longest running survey (since 1967). The BiOp reviewed the FMWT trends as follows:
Although this index has fluctuated widely (AR 9201-02, 9222), it has " declined irregularly over the past 20 years." (AR 370-71.) Since 1983, the FMWT has registered more low indices for more consecutive years than previously recorded. Until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.7 is a continuation of this trend. This occurred despite the high 1994 summer townet index for reasons unknown. The 1995 summer townet was a low index value of 319 but resulted in a high FMWT index of 898.7 reflecting the benefits of large transport and habitat maintenance flows with the Bay-Delta Accord in place and a wet year. The abundance index of 128.3 for 1996 represented the fourth lowest on record. The abundance index of 305.6 for 1997 demonstrated that the relative abundance of delta smelt almost tripled over last years results, and delta smelt abundance continued to rise, peaking in 1999 to an abundance index of 863, only to fall back down to the low abundance indexes of 139 for 2002 and 213 for 2003.

(AR at 371.)

The 2004 FMWT index, which was not discussed in the BiOp, was calculated to be 74, the lowest ever recorded. (AR 9202.) (This omission forms the basis of one of Plaintiffs' challenges to the BiOp.) The survey was apparently released in December 2004, and was specifically cited to FWS in February 2005.

At the hearing on the summary judgment motions, Federal Defendants in substance argued that despite years of study, the abundance data for the annual Delta smelt population is fraught with uncertainties and " not enough is known about the species" to accurately and finitely measure with certainty the project's effects on Delta smelt. FWS maintains the one to two year life expectancy of the smelt also contribute to this lack of certainty.

E. *Relationship Between Abundance and Project Operations.*

The BiOp cites several reasons for the smelt's decline. First, since the mid 1800s, mining, agricultural use, and levee construction caused the loss of a large portion of smelt habitat. (AR at 365.) Second, recreational boating in the Delta has resulted in the presence and propagation of " predatory non-native fish" and an increase in the rate of smelt erosion resulting from boat wakes.(*Id.*) Third, reduced water quality " from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduce the availability of the planctonic food source." (*Id.* at 366.)Finally, the BiOp acknowledges that " delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta." (*Id.*) The BiOp acknowledges that these final adverse effects are " *primarily a result of the steadily*

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increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts." (*Id.* (emphasis added).) The BiOp in no way quantifies the contribution of each of these factors to the smelt's decline. The parties dispute the extent to which project operations jeopardize the smelt.

F. *Relationship Between Smelt and " X2."*

***8** Smelt are euryhaline (tolerant of a wide range of salinities), but generally occur in water with less than 10-12 parts per thousand (ppt) salinity. (AR at 362.) For a large part of its life span, Delta smelt are thought to be associated with the " freshwater edge of the mixing zone," where the salinity is approximately 2 parts per thousand (often referred to as " X2"). (AR at 366.) The summer TNS index increases dramatically whenever X2 is located between Chipps and Roe islands. (*Id.*) Whenever the location of X2 shifts upstream of the confluence of the Sacramento and San Joaquin, either as a result of water diversions or natural conditions, smelt abundance decreases.(*Id.* at 371.)

G. *The Concept of " Salvage."*

The BiOp's " no jeopardy" conclusion relies on the concept of " salvage," which refers generally to the process of using mechanical devices to screen fish that would otherwise be entrained in project facilities (e.g., pumps) into holding tanks for transport to other parts of the Delta. (*See e.g.,* AR 321.) Unlike many other fish species in the Delta, Delta smelt do not survive the salvage process, " either due to stress and injury from handling, trucking and release, or from predation in or near the salvage facilities, the release sites, or in Clifton Court Forebay." (AR at 413.) As a result, for Delta smelt, FWS uses the terms salvage and entrainment essentially interchangeably. (*See id.*(" To simplify predictions of the difference in salvage (and by extension entrainment) between model scenarios....") FN9

Previous BiOps regarding CVP and SWP operations used salvage to set take limits. For example, the 1995 BiOp's incidental take statement set take exceedence levels for Delta smelt based on " [m]onthly average delta smelt salvage at the Federal and State Fish Facilities from 1980 to 1992 by water year type." (AR at 11765.) Essentially, take limits were set according to how much salvage had occurred in the past.

More recently, project managers, fisheries officials, and other experts came to the consensus that the salvage approach was insufficient on its own. For example, one DWR biologist noted that the singular focus on historic salvage had problems:

Higher levels of take are allowed in below normal years merely because this is what the projects " took" historically. However, the population is more condensed in below normal years and possibly more vulnerable to entrainment.

(AR 5532.) Experts advocated (a) further research into the relationship between the position of the Delta smelt and environmental conditions (AR 4881); and (b) the adoption of a flexible management approach, which would allow new information to be " folded back into the operation and conservation strategies." (AR 4870.) The result was a " layered" approach to managing the smelt, made up of more protective take limits than previously imposed along with the implementation of an adaptive management protocol.

I. *Revised Take Exceedence Levels Used In the BiOp.*

***9** The BiOp includes " hard" take limits,[FN10] based on historic " salvage density estimates," adjusted to account for operational constraints under the 2004 OCAP and presumed increased environmental water flows. Separate take limits were established for formal and early consultation purposes.

The revision of the take limits began with historic catch data from periodic samples of salvaged fish. (*See* AR 413.) Data about the volume of water diverted during the collection period is then used to estimate the fish per volume of water diverted. This is referred to as the " salvage density." [FN11](*Id.*) Historically, salvage density varied greatly depending on whether the year was wet (above normal), dry (below normal, dry, or critical) year. Wet and dry year data were analyzed separately. (*Id.*) The estimates were then inputted into a computer modeling system, CALSIM II, to estimate take under varying assumptions about future project operations, including programs designed to improve environmental conditions, such as the Environmental Water Account. (AR 413-14.)

Several different scenarios or " Studies" were run through CALSIM II and included in the BiOp. For example, Study No. 1 reflects the 1995 regulatory base case, without any changes in project operations and without the addition of any environmental water programs. Study No. 4a estimates a take level for flow conditions planned under the operations subject to final consultation (changes to flows in the Trinity River, future development levels, and the operation of the Freeport Regional Water Project and the Intertie). Study 4a

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included flow adjustments required by D-1641 and VAMP, along with projected CVPIA (b)(2) flows, but *did not include* operation of the EWA. Study No. 5a was similar to 4a, except that it added projected EWA flows. Separately, in Study No. 5, CALSIM II simulated flow modifications projected to occur as a result of " those projects subject to early consultation," specifically the increased pumping and permanent barriers called for in the planned South Delta Improvement Project (" SDIP"). (AR 374, 414-19; Sommer Decl. ¶ 5.) Each modeling scenario was run separately for various water year types (Wet, Above Normal, Below Normal, Dry, and Critically Dry) and independently estimated take at CVP and SWP facilities.

The BiOp based its conclusions for formal consultation on the results of the Study No. 5a, and for early consultation on the results of Study No. 5. The results of the modeling scenarios for Study No. 5a are set forth in several tables at pages 414 through 419 of the AR. The following table summarizes the changes in estimated take for Study No. 5a, for each type of water year, relative to the 1995 base case. In other words, the positive figures represent the number of additional smelt that will be taken per month under formal consultation relative to the 1995 base case (Study No. 1) while negative numbers represent how many fewer smelt will be taken per month relative to the 1995 base case.[FN12]

Table 1:

Summary of Results for CVP Salvage Under Study No. 5a

Month	Wet Year	Above Normal Year	Below Normal Year	Dry Year	Critically Dry Year
Adults					
December	-1	-1	-3	-3	-41
January	-13	-13	-12	-10	-98
February	-33	-36	+63	-60	+9
March	+29	-40	-83	-19	+1
Largely Juveniles					
April	0	0	-16	+5	0
May	0	0	-9017	-14469	-11652
June	0	0	0	-2910	0
July	0	+11	+7	-74	0
Net: December-March	-17	-89	-35	+28	-130
Net: April-July	0	+11	-9025	-17448	-1165

Table 2:

Summary of Results for SWP Salvage Under Study No. 5a

Month	Wet Year	Above Normal Year	Below Normal Year	Dry Year	Critically Dry Year
Adults					
December	-6	-6	-16	-15	-11

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January	-76	-87	-82	-87	-104
February	+86	-94	0	0	+51
March	+98	+91	+63	0	+2
Largely Juveniles					
April	-60	-77	-365	-144	0
May	-27188	-25933	-31122	-32083	-7269
June	-1096	-129	-53	1267	0
July	0	+282	+318	+493	+175
Net: December-March	+102	-95	-35	-102	-62
Net: April-July	-28346	-25857	-31213	-33000	-7095

***10** For the CVP, CALSIM II predicts significant reductions in smelt salvage during the months of December through July in below normal and dry years, when compared to the regulatory base case.[FN13] However, under certain scenarios, CVP salvage increases during other months of the year relative to the regulatory base case, because pumping is predicted to increase during these months to make up for water released from storage for fish protection purposes. For the SWP, salvage stays relatively level for the months of December through March. However, salvage decreases for the months of April through July relative to the regulatory base case.

Based on CALSIM II Study 5a, FWS calculated the amount of " combined salvage" (i.e., for both projects) estimated under the formal consultation scenario, for each month, according to water year type. The BiOp rounded the numbers up to the nearest 100 and used those figures to set incidental take limits by water year type. (AR 471-472.)

Table 3: Incidental Take Limits by Water Year Type (For Both CVP and SWP)

	Water Year Type		
	Month	Wet or Above Normal	Below Normal, Dry, or Critical
	October	100	100
	November	100	100
	December	700	400
Monthly	January	3000	1900
Incidental	February	2300	1700
Take	March	1300	1300
	April	1000	1100
	May	37800	30500
	June	45300	31700

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July	3500	2500
August	100	100
September	100	100

Because these incidental take levels are based on predictions produced by CALSIM II Study 5a, they do *not* assume any smelt protection actions under the DSRAM, but do assume continued availability of the EWA water. (AR 374, 471.)

FWS determined that the level of anticipated take " is not likely to result in jeopardy to the smelt because this level of take is at or below historical levels of take." (AR 474.)

However, the BiOp also acknowledges that " the operations of the Projects under formal consultation as described in the Project Description *will result in adverse effects to delta smelt* through entrainment at the CVP and SWP and by drawing delta smelt into poorer quality habitat in the south delta." (AR 422 (emphasis added).) The BiOp concludes that " with the inclusion of [certain] conservation measures described [in the BiOp] *and* the implementation of the [Delta Smelt Risk Assessment Matrix], these adverse effects would be avoided or minimized." (*Id.* (emphasis added).) " [W]ith these conservation measures in place, the re-operation of the Trinity River, the increased level of development on the American River, the Freeport Diversion, the Suisun Marsh Salinity Control Gates, the Barker Slough Diversion, or due to changes to X2 ... are not expected to result in adverse effects to delta smelt." (AR 423.)

FWS' conclusions admit project operations will result in adverse effects to delta smelt, which are unquantified, and can only be avoided by conservation measures and implementation of the DSRAM.

H. *" Conservation Measures."*

***11** The " conservation measures" contemplated are listed in the Summary of Effects section of the BiOp and include: (1) the Environmental Water Account (" EWA"); (2) Central Valley Project Improvement Act (b)(2) water; (3) State Water Resource Control Board's Water Rights Decision 1641; (4) the Vernalis Adaptive Management Plan (" VAMP"); and (5) the DSRAM adaptive management plan. (AR 466-68.)

1. CVPIA (b)(2) Water.

According to the 1992 Central Valley Project Improvement Act, the CVP must " dedicate and manage annually 800,000 acre-feet of Central Valley Project yield for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures authorized by this title; to assist the State of California in its efforts to protect the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and to help to meet such obligations as may be legally imposed upon the Central Valley Project under State or Federal law following the date of enactment of this title, including but not limited to additional obligations under the Federal Endangered Species Act." Title XXXXIV of the Reclamation Projects Authorization and Adjustment Act of 1992, Pub.L. 102-575, 106 Stat. 4600, 4706 (1992). (*See* AR 372.)

FWS, in consultation with the Bureau and other agencies, may use this " (b)(2) water" to meet Water Quality Control Plan (WQCP) obligations and any other requirements imposed by law after 1992. " For example, (b)(2) water has been used to maintain flows on Clear Creek to provide adequate spawning and rearing habitat for Chinook salmon. Water exports at the CVP have also been reduced using (b)(2) water to reduce entrainment of salmon or delta smelt at the salvage facilities. This ongoing action provides a benefit to delta smelt in most years." (AR 372.)

The base CVP yield committed to fish restoration is fixed by statute and is mandatory. This fixed supply is subject to reduction up to 25% in critically dry years under CVPIA § 3406(b)(2)(C).

2. Environmental Water Account.

The Environmental Water Account (" EWA") is " an adaptive management tool that aims to protect both fish and water users as it modifies water project operations in the Bay-Delta." (AR 373.)
The EWA provides water for the protection and recovery of fish beyond that which would be available through the existing baseline of regulatory protection related to project operations. The EWA buys water from willing sellers or diverts surplus water when safe for fish, then banks, stores, transfers and releases it as needed to protect fish and compensate water users for deferred diversions.

(*Id.*)

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The EWA has been used to benefit smelt by allowing for the curtailment of project export pumping during critical time periods. (*Id.*) The EWA could also be used to increase in-stream flows or increase outflows in the Delta, both of which would benefit the smelt. (*Id.*) The EWA is not fixed by statute nor is annual funding assured, and the water supply it provides, though reasonably anticipated, is not immutable.

3. Water Rights Decision 1641.

***12** State Water Resource Control Board Decision 1641 (D-1641) imposes certain minimum flow and water quality objectives upon the projects:
D-1641 includes specific outflow requirements throughout the year, specific export restraints in the spring, and export limits based on a percentage of estuary inflow throughout the year. D-1641 obligates the SWP and CVP to comply with the objectives in the 1995 Bay-Delta Plan. The Service issued a biological opinion on the Bay-Delta plan to the Environmental Protection Agency on November 2, 1994. The water quality objectives in the 1995 Bay-Delta Plan and in D-1641 are designed to protect in-Delta agricultural, municipal and industrial, and fishery uses and vary throughout the year and by water year type.... D-1641 will also protect delta smelt by providing transport, habitat and attraction flows.

(AR 373 (citations omitted).)

The D-1641 requirements are mandatory under the projects' operating permits. The water to satisfy D-1641 comes from 3406(b) (2) yield and supplemental sources the Bureau utilizes.

4. Vernalis Adaptive Management Plan (VAMP).

The Vernalis Adaptive Management Plan (VAMP) is an experimental program that had its origin in D-1641. (AR 373.) It provides for flows on the lower San Joaquin River and export curtailments at the projects. (*Id.*) VAMP's purpose is to " provide pulse flows on the San Joaquin River and improve habitat conditions in the Delta by reducing exports at the CVP and SWP" over a 31 day period in April and May for the benefit of Chinook salmon and Delta smelt.(*Id.*) Currently, water used to reduce exports at the CVP under VAMP is accounted for as CVPIA (b)(2) water. (*Id.*) If export reductions are taken, the EWA is used to supply contractors to make up for the transfers. VAMP flows " allow larval and juvenile smelt to avoid becoming entrained at the export facilities and to move downstream to Suisun Bay." (*Id.*)

The VAMP water supply is not irrevocably fixed or assured.

I. *Delta Smelt Risk Assessment Matrix (DSRAM).*

The BiOp's other, primary protection for the smelt is the implementation of a new adaptive management protocol, known as the Delta Smelt Risk Assessment Matrix (" DSRAM"). The DSRAM utilizes a list of trigger criteria to precipitate responses. (AR at 344.) The criteria are:

(1) the previous year's FMWT index;

(2) the risk of smelt entrainment based upon the location of X2;

(3) the estimated duration of the smelt spawning period, based on water temperature;

(4) the presence of spawning female smelt;

(5) the proximity of the smelt to project pumping facilities; and

(6) a salvage trigger for adult and juvenile smelt. (AR 346.)

1. The DSRAM Process.

If any trigger criteria is met or exceeded, a Delta Smelt Working Group (" DSWG") is convened. The DSWG consists of representatives from FWS, the California Department of Fish and Game, DWR, the United States Environmental Protection Agency, the Bureau, and the California Bay-Delta Authority. (*See* AR 344-45.) The DSWG then recommends corrective actions to a Water Operations Management Team (" WOMT").(*Id.*) The OCAP BiOp identifies four specific actions that the DSWG and WOMT must consider taking if one or more trigger criteria occur: (1) export reductions at one or both of the projects; (2) changes in the south Delta barrier operations; (3) changes in San Joaquin River flows; and (4) changes in the operation of the Delta cross channel.[FN14]The DSRAM does not contain defined action criteria, but instead leaves any response wholly to the discretion of the two groups who administer the DSRAM (DSWG and WOMT).

2. DSRAM Implementation.

***13** The BiOp acknowledges although FWS is " confident that use of the DSRAM will reduce the frequency with

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which actual salvage exceeds the median predicted salvage, the exceedence frequency could be as high as 50%." (AR 471.) There is no analysis of the duration or consequences from such exceedence. The DSRAM provides no operating criteria or action schedule, specifying when mitigation actions must be taken. It is not possible to predict what, how and when DSRAM measures will be implemented.

J. *Recent Experience with DSRAM.*

DWR offered post-record evidence regarding the manner in which DSRAM has actually been implemented since its inception. This post-record activity could not have been considered by the agency. A motion to strike the proffered evidence was sustained. The offer of proof includes two " fish actions" that were taken in 2005 in response to " triggers" and a third that was planned but avoided when project water increased in early 2006, a wet year. DWR's offer of proof is to show positive experience in operation of the DSRAM.

K. *Recent Procedural History.*

The Federal Defendants acknowledge that " [s]hortly before the 2005 OCAP BiOP was completed, a fall midwater trawl survey of delta smelt revealed a substantial decline in the population index for the species" to the lowest ever. (Doc. 242-1, at 4.) The Federal Defendants do not concede that the existence of this data renders the BiOp arbitrary and capricious, because " limited analysis of this data existed, and the Service relied on the raw data, and its own professional judgments as the best available scientific and commercial data available." (*Id.*) Nevertheless, " the CALFED agencies have continued to assemble and analyze new data and information." (*Id.*) For example, scientists from CALFED agencies " recently" developed a document based upon the new data: the Interagency Ecological Program Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary (the " IEP POD Synthesis"). This document led the Federal Defendants to conclude that the OCAP for the CVP and SWP may affect Delta smelt in a manner or to an extent not previously considered. (IEP POD Synthesis, Doc. 240, Attachment 1.)

On July 6, 2006, the Bureau requested that the FWS re-initiate consultation concerning the impact of the OCAP on the Delta smelt. (Doc. 240.) In a July 6, 2006 letter to the FWS, the Bureau acknowledged that " emerging data indicates an apparent substantial decline in the Delta smelt population index." (Doc. 240-2.)

1. *No Dismissal or Stay.*

In light of the second re-initiation of consultation, federal defendants sought dismissal on prudential mootness grounds, a voluntarily remand without vacatur, or a stay pending the completion of reconsultation. (*See* Docs. 242-1, 273.) The motion for stay was joined by the DWR (Doc. 277), and various Defendant-Intervenors (Doc. 274). Plaintiffs opposed because Federal Defendants refused to withdraw the challenged BiOp and stated their intent to continue CVP and SWP operations under the disputed BiOp and its incidental take statements during the time period necessary to complete re-consultation, now projected to be July 2008, more than two and one-half water years following the effective date of the disputed BiOp. (*See* Doc. 279.)

***14** Defendants' motion to dismiss on prudential mootness grounds was denied:
Plaintiffs' concerns have not been fully addressed by the reinitation of consultation. Federal Defendants are relying in part on the challenged BiOps in operating the CVP and intend to continue to do so. The controversy over whether the BiOps and OCAP should have continued viability is real and substantial. and this court could provide relief, in the form of a decision invalidating the BiOps followed by hearings on interim remedies. Under these circumstances, it is not appropriate to deem this case prudentially moot.

(Doc. 301 at 18 (footnotes omitted).)

The motion for voluntary remand without vacatur was denied based on the general standard for vacatur set forth in *Natural Resources Defense Council v. U.S. Dept. of the Interior*, 275 F.Supp.2d 1136, 1143 (C.D.Cal.2002), which considers " the seriousness of the order's deficiencies" and " the disruptive consequences of an interim change that may itself be changed." No evidence or argument was presented regarding the nature of the prejudice that might result from invalidating the BiOp (*id.* at 20), and numerous factual and legal disputes exist regarding the seriousness of the order's deficiencies (*see id.* at 27). The court was left to speculate what consequences to the species would result if injunctive relief were ordered against continued implementation of the disputed BiOp.

The stay motion, based on the primary jurisdiction doctrine, was denied on the authority of *Lockyer v. Mirant Corp.*, 398 F.3d 1098, 1109 (9th Cir.2005) (a party seeking a stay " must make out a clear case of hardship or inequity in being required to go forward, if there is even a

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fair possibility that the stay for which he prays will work damage to someone else."). The order held: " Plaintiffs are entitled to have their complaint decided on the merits, particularly given the fact that Defendants continue to rely on the challenged BiOps as if they were lawfully enacted." (Doc. 301 at 33.) The apparent increasing jeopardy to the smelt by and after February of 2005 militates against further delay while FWS continue " to study" the issue of jeopardy, an exercise that has continued for almost a decade.

A. *Objections to Declaration of Ted Sommer.*

DWR offers the post-record declaration of Ted Sommer, Ph.D, to explain (1) the concept of salvage and its relationship to the take exceedence levels in the BiOp; (2) the operation of DSRAM; (3) and the manner in which DSRAM has been implemented since its inception.

Generally, " the focal point for judicial review should be the administrative record already in existence, not some new record made initially in the reviewing court." *Camp v. Pitts*, 411 U.S. 138, 142, 93 S.Ct. 1241, 36 L.Ed.2d 106 (1973). However, the Ninth Circuit recognizes three main exceptions to this rule, allowing courts to consider extra-record evidence:
(1) if necessary to determine " whether the agency has considered all relevant factors and has explained its decision," (2) " when the agency has relied on documents not in the record," or (3) " when supplementing the record is necessary to explain technical terms or complex subject matter."

***15** *Southwest Ctr. for Biological Diversity v. U.S. Forest Service*, 100 F.3d 1443, 1450 (9th Cir.1996). A court may also consider extra-record evidence " when plaintiffs make a showing of agency bad faith." *Nat'l Audubon Soc. v. U.S. Forest Serv.*, 46 F.3d 1437, 1447 n. 9 (9th Cir.1993).

DWR maintains that the Sommer declaration explains " technical or complex subject matters" admissible under the exception for evidence " necessary to explain technical or complex subject matters." (Doc. 246-1 at 5-6 n. 5.) Plaintiffs move to strike the declaration on the ground that subject matters covered by Mr. Sommer are " neither technical nor complex." (Doc. 305 at 4 n. 1.) Rather, Plaintiffs contend that the declaration is offered to explain the agency's post-BiOp experience with DSRAM in an effort to counter the Plaintiffs' argument that the DSRAM is wholly discretionary and contains no defined standards or enforceable requirements.

Generally, " post hoc rationalizations of the agency ... cannot serve as a sufficient predicate for agency action." *Am. Textile Manuf. Inst. v. Donovan*, 452 U.S. 490, 539, 101 S.Ct. 2478, 69 L.Ed.2d 185 (1981); ***see also*** *Sierra Club v. Bosworth*, 199 F.Supp.2d 971, 986 (N.D.Cal.2002) (refusing to consider post hoc explanations that were " neither addressed nor supported by the record"). DWR does not disagree with this general principle, but instead insists that the declaration is offered only to explain complex and technical aspects of the incidental take exceedence levels and the DSRAM.

Paragraphs 11 through 15 of the Sommer Declaration concern the implementation measures taken under the DSRAM after the BiOp issued. There is no basis in the law for the admission of this post-record evidence. DWR does not assert otherwise. Plaintiffs' motion to strike is **GRANTED** as to paragraphs 11 through 15.

The information contained in the remainder of the Sommers declaration is drawn directly from the BiOp itself, explaining in plain language how the incidental take limits were set and how DSRAM operates. Although, much of the same information can be found in the BiOp, the subject matters covered are technical and complex and Dr. Sommer's declaration clarifies or explains them. This exception saves the remaining paragraphs of the Sommers declaration to explain the incidental take limits.

The motion to strike is **DENIED IN PART** as to the past record evidence paragraphs only.[FN15]

B. *Federal Defendants' Renewed Objections to Previously Admitted Extra-Record Documents.*

The May 13, 2006 memorandum decision admitted certain extra-record documents, for limited purposes (Doc. 219), including Document 10 (a Powerpoint presentation by Michael Dettinger given to the Bay-Delta Authority on December 8, 2004 entitled " Uncertainties & CALFED Planning What Are Current Observations and Models Saying?") for two purposes. First, " for the limited purpose[ ] of determining whether [ ]FWS failed to adequately consider the climate change issue and the scientific significance of any such failure....;" but not legal opinions. (Doc. 219 at 25.) Second, to the extent appropriate, all twenty two extra record documents presented by Plaintiffs, including Document 10, may be referenced to aid the court's understanding of various technical concepts under the " technical terms and complex subject matter exception." (*Id.* at 32.)

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***16** In the footnote to their opposition brief, Federal Defendants renew their objection to consideration of any of the documents under the technical terms and complex subject matter exception. (Doc. 242-1 at 22 n. 12.) The May 13, 2006 memorandum decision notes: " Defendants and Defendant Intervenors suggest that Plaintiff has failed to establish that the existing record is inadequate to explain the technical terms, but point to no authority requiring such a showing." (Doc. 219 at 30.) Federal Defendants now assert: " numerous courts, including the Supreme Court and district courts in this Ninth Circuit, have held that a record may not be supplemented for explanatory purposes unless the existing record has been demonstrated inadequate." (Doc. 242-1 at 22 n. 12.), citing an unpublished district court decision, City of *Santa Clarita v. United Stats Dept. Of Interior*, 2005 WL 2972987 at *2 n. 3 (C.D.Cal.2005):
... Plaintiffs bear the burden of making an initial showing that the administrative record is inadequate for effective judicial review and that one of the exceptions to record review applies. Animal Defense Council v. Hodel, 840 F.2d at 1436-38 (affirming district court order limiting review to administrative record and prohibiting discovery because plaintiffs did not show record presented was insufficient for review or that any of the exceptions to record review were applicable)....

(emphasis added).

A district court decision not cited by Defendants, *Karuk Tribe of Cal. v. U.S. Forest Serv.*, 379 F.Supp.2d 1071, 1087 (N.D.Cal.2005), reiterated this holding:
The Ninth Circuit allows a reviewing court to consider extra-record materials in an APA case only under four narrow exceptions: (1) when it needs to determine whether the agency has considered all relevant factors and has explained its decision; (2) when the agency has relied upon documents or materials not included in the record; (3) when it is necessary to explain technical terms or complex matters; and (4) when a plaintiff makes a showing of agency bad faith. *Southwest Center for Biological Diversity v. United States Forest Service*, 100 F.3d 1443, 1450 (9th Cir.1996).*For extra-record material to be considered, a plaintiff must first make a showing that the record is inadequate. Animal Defense Council v. Hodel*, 840 F.2d 1432, 1437 (9th Cir.1988) (" The [plaintiff] makes no showing that the district court needed to go outside the administrative record to determine whether the [agency] ignored information"). At the *1088 same time, " [a] satisfactory explanation of agency action is essential for adequate judicial review, because the focus of judicial review is not on the wisdom of the agency's decision, but on whether the process employed by the agency to reach its decision took into consideration all the relevant facts." *Asarco, Inc. v. U.S. Environmental Protection Agency*, 616 F.2d 1153, 1160 (9th Cir.1980).

(emphasis added).[FN16] *Karuk Tribe*, and *Animal Defense Council v. Hodel*, 840 F.2d 1432, 1437 (9th Cir.1988), on which it relies, do stand for the proposition that, before admitting documents under any exception to the general rule against extra-record evidence, a court should require that a plaintiff make an initial showing that the existing record is insufficient. Here, defendants maintain that those documents plaintiffs have referenced to explain complex or technical matters, are " the cart before the horse," because Plaintiffs have not shown the existing record is inadequate.

***17** First, Federal Defendants objection is arguably untimely. They did not cite cases requiring a preliminary showing of insufficiency when the motion to augment was briefed and heard. Nor did Federal Defendants timely move for reconsideration of the May 13, 2006 ruling on the motion to augment. Striking the challenged documents now, would cause prejudice to Plaintiffs, who relied upon these rulings to prepare their dispositive motions.

Even assuming a timely and specific objection, on the merits, Plaintiffs' extra-record documents were properly admitted. Of these twenty-two documents, Plaintiffs' papers only referenced eight: Docs. 9, 10, 11, 12, 13, 20, 21 & 22. With the exception of Documents 12 and 22, all were admitted on multiple grounds. (Documents 12 and 22 were admitted for the limited purpose of explaining technical materials.) The documents and the bases for their admission are as follows:

Document 9:	Summary of Annual Joint Meeting of California Bay-Delta Authority and Bay-

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	Delta Public Advisory Committee (December 8-9, 2004).	
		Admitted " for the limited purpose of determining whether USFWS failed to adequately consider the EWA/CVPIA(b)(2) issue," " for the limited purposes of determining whether USFWS failed to adequately consider the climate change issue and the scientific significance of any such failure ...," and, as appropriate, to explain complex and technical matters.
Document 10:	Climate Change Uncertainties & CALFED Planning: What Are Current	

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	Observations and Models Saying? Powerpoint presentation by Michael Dettinger, U.S. Geological Survey at the Scripps Institute for Oceanography, et al. to Bay-Delta Authority (December 8, 2004).	
	Admitted " for the limited purposes of determining whether USFWS failed to adequately consider the climate change issue and the scientific significance of any such failure," and as appropriate, to explain complex and technical matters.	
Document 11:	Summary of Annual Joint Meeting of California Bay-Delta Authority	

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	and Bay-Delta Public Advisory Committee (February 9-10, 2005).	
		Admitted for the limited purpose of showing that USFWS failed to consider relevant Delta smelt population data and its scientific significance," and, as appropriate, to explain complex and technical matters.
Document 12:	Letter from H. Candee and K. Poole, NRDC, to S. Thompson re Consultation on OCAP: Significant New Delta Smelt Information, Service (Feb. 14, 2005).	
		Admitted only to explain, as

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	appropriate, complex and technical matters.
Document 13:	Delta smelt abundance trends, Powerpoint presentation by Chuck Armor, DFG, to Bay-Delta Authority Admitted for the limited purpose of showing that USFWS failed to consider relevant Delta smelt population data and its scientific significance," and, as appropriate, to explain complex and technical matters.
Document 20:	Supplemental Biological Opinion on CVP and SWP Operations, April 1, 2004 through March 31, 2006 (Feb. 27, 2004). Admitted "

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	for the limited purpose of determining whether USFWS failed to adequately consider the EWA/CVPIA(b)(2) issue," and, as appropriate, to explain complex and technical matters.
Document 21:	Future Water Availability in the West: Will there be enough? Powerpoint presentation by M. Dettinger to 24th Annual Conference on Water, Climate and Uncertainty: Implications for Western Water Law, Policy, and Management (June 11-13, 2003).
	Admitted " for the limited purposes of determining whether USFWS

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	failed to adequately consider the climate change issue and the scientific significance of any such failure ...," and, as appropriate, to explain complex and technical matters.
Document 22:	Letter from John W. Keys, Bureau, to Hon. George Miller, House of Representatives re Bureau's renewal of CVP water contracts (Dec. 23, 2004).
	Admitted only to explain, as appropriate, complex and technical matters.

***18** With the exception of Documents 12 and 22, Plaintiffs were permitted to reference these documents to show whether FWS adequately considered included subject matter to support the BiOp. Although Plaintiffs did not expressly demonstrate that the record was insufficient, a finding of insufficiency can be implied from the rulings admitting the documents. For example, Document 10, the powerpoint presentation regarding " Climate Change Uncertainties & CALFED Planning" presented to the Bay-Delta Authority on December 8, 2004, references climatological information and issues not otherwise discussed in the administrative record, bearing on whether FWS failed to adequately consider the climate change issue. The same reasoning applies to Documents 9, 10, 11, 13, 20 & 21. As for Documents 12 and 22, were which were only admitted under the complex and technical matters exception, no prior

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showing of insufficiency was made. However, Documents 12 and 22 were only referenced as secondary citations or for context. Even if, any document was admitted in error, no prejudice has resulted.

Summary judgment is appropriate where there are no genuine issues of material fact and the moving party is entitled to judgment as a matter of law. Fed. R. Civ. Pro. 56(c). This is a challenge to the lawfulness of a biological opinion brought under the ESA and the Administrative Procedure Act (" APA"). Agency decisions made under the ESA are governed by the APA, which requires that the agency action be upheld unless it is found to be " arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law," or " without observance of procedure required by law." 5 U.S.C. § 706(2)(A), (D). The inquiry is designed to " ensure that the agency considered all of the relevant factors and that its decision contained no clear error of judgment." *Pacific Coast Fed'n of Fishermen's Ass'ns v. NMFS*, 265 F.3d 1028, 1034 (9th Cir.2001). Agency action should only be overturned if the agency has " relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Id.* In sum, a court must ask " whether the agency considered the relevant factors and articulated a rational connection between the facts found and the choice made." *Id.*" A biological opinion is arbitrary and capricious and will be set aside when it has failed to articulate a satisfactory explanation for its conclusions or when it has entirely failed to consider an important aspect of the problem." *Greenpeace v. NMFS*, 80 F.Supp.2d 1137, 1147 (W.D.Wash.2000). Alternatively, a biological opinion may also be invalid if it fails to use the best available scientific information as required by 16 U.S.C. § 1536(a)(2).*Id.* at 1150.

***19** As a general rule, a court must defer to the agency on matters within its expertise. *See National Wildlife Federation v. National Marine Fisheries Service*, 422 F.3d 782, 798 (9th Cir.2005). However, " [t]he deference accorded an agency's scientific or technical expertise is not unlimited." *Id.*" Deference is not owed when the agency has completely failed to address some factor consideration of which was essential to [making an] informed decision." *Id.* (internal citations and quotations omitted).

A final BiOp is final agency action for judicial review purposes. *American Rivers, infra*, 126 F.3d at 1124-25.

Plaintiffs move for summary judgment on the following grounds:

(1) First, the BiOp did not utilize the Best Available Science by: (a) failing to reference the " most recent Delta Smelt abundance data," namely the 2004 Fall Midwater Trawl Data; and (b) failing to consider the possible effects that climate change might have on the smelt's habitat.

(2) Second, the BiOp unlawfully relies upon the DSRAM as a mitigation measure because the DSRAM process is " entirely discretionary, uncertain, and unenforceable." In addition, Plaintiffs allege that Federal Defendants acted arbitrarily and capriciously by relying upon the EWA, CVPIA(b)(2), and/or VAMP programs as water sources necessary to implement the DSRAM. Plaintiffs allege that Federal Defendants have (a) failed to demonstrate that EWA, CVPIA and/or VAMP will continue to be available over the 20-year term of the BiOp and (b) failed to demonstrate that DSRAM can reliably operate without water assets from those programs.

(3) Third, there is no rational connection between the evidence in the record and the BiOp's " no jeopardy" conclusion. Specifically, Plaintiffs allege (a) that the BiOp's focus on salvage as the measure of harm to the species underestimates project impacts and results in a meaningless take limit; and (b) that the BiOp fails to explain how its no jeopardy conclusion can be justified in light of the identified adverse effects of the project, along with indirect and cumulative effects.

(4) Fourth, the BiOp failed to adequately analyze whether the OCAP's impacts on the Delta smelt's critical habitat are consistent with the smelt's recovery. In addition, the Federal Defendants failed to adequately take into account smelt habitat areas other than defined by X2.

(5) Finally, the BiOp is unlawfully narrow in its scope because it (a) fails to provide a comprehensive analysis of the effects of constructing facilities required to carry out long term CVP and SWP operations and (b) fails to analyze the impacts of the projects delivering the full amount of water authorized under CVP and SWP water service contracts.

A. *Threshold Issues.*

1. ESA 60-day notice requirement.

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The San Luis Parties argue that Plaintiffs have not complied with the ESA's citizen suit notice requirement, 16 U.S.C. § 1540(g)(2) (A)(I), that written notice be given to " the Secretary, and to any alleged violator" at least sixty days in advance of filing suit. Failure to give this notice is a bar to bringing suit under the ESA. *Southwest Ctr. for Biological Diversity v. U.S. Bureau of Reclamation*, 143 F.3d 515, 520 (9th Cir.1998).

***20** In *American Rivers v. National Marine Fisheries Serv.*, 126 F.3d 1118, 1124-25 (9th Cir.1997), the Ninth Circuit held that issuance of a biological opinion is a final agency action that is properly pled as a challenge under the APA, rather than as a citizen suit claim under the ESA. Failure to comply with the 60-day notice requirement does not deprive the court of jurisdiction. *Id.*

The San Luis Parties advocate an approach that ignores *American Rivers,*[FN17] taken in an unpublished district court opinion, *Pacific Coast Fed' of Fishermen's Ass'ns v. U.S. Bureau of Reclamation*, 2006 WL 1469390 at 27 n. 8 (N.D.Cal.2006).*Pacific Coast Federation* declined to apply *American Rivers'* general rule because the injunctive relief the Plaintiffs sought went beyond simply having the biological opinion invalidated. The *Pacific Coast Federation* Plaintiffs sought to have any new biological opinion first reviewed by the court. This requested *relief,* fell outside the scope of the APA but was " within the scope of the ESA and thus trigger[ed] the notice period requirement." *Id.* Here, the requested relief is invalidation of the BiOp, a remedy undeniably available under the APA. *American Rivers* controls. There was no need to comply with the ESA 60-day notice requirement. The district court has jurisdiction over APA review of the BiOp.

2. Jurisdiction to Review Challenges to Early Consultation and Preliminary Biological Opinion.

Defendants contend the case is not ripe for decision. The BiOp covers not only current operations, but also a variety of future actions, some subject to formal consultation, others to early consultation:

This biological opinion covers formal and early consultation for the operations of the CVP and SWP. The formal consultation effects described in this biological opinion cover the proposed 2020 operations of the CVP including the Trinity River Mainstem ROD (Trinity ROD) flows on the Trinity River, the increased water demands on the American River, the delivery of CVP water to the proposed Freeport Regional Water Project (FRWP), water transfers, the long term Environmental Water Account (EWA), the operation of the Tracy Fish Facility, and the operation of the SWP-CVP intertie. The effects of operations of the SWP are also included in this opinion and include the operations of the North Bay Aqueduct, the Suisun Marsh Salinity Control Gates, the Skinner Fish Facility and water transfers.

Early consultation [issues address] the effects of operations of components of the South Delta Improvement Program (SDIP). These operations include pumping of 8500 cubic feet per second (cfs) at the SWP and Banks Pumping Plant (hereafter referred to as 8500 Banks), permanent barrier operations in the South Delta, the long term EWA, water transfers, and CVP and SWP operational integration. There are two separate effects sections in this biological opinion, one for Formal Consultation and one for Early Consultation. In addition, there is an incidental take for formal consultation and a preliminary incidental take for early consultation.

***21** (AR 2, 248.)

The San Luis Parties object that the early consultation portions of the BiOp are not final agency action and any challenges to the early consultation process are not subject to judicial review. Early consultation, by definition, results in only a " preliminary opinion" and in a preliminary incidental take statement that " does not constitute authority to take listed species." 50 C.F.R. § 402.11(e). Upon request for " confirmation" of a preliminary biological opinion, FWS will review the proposed action to determine if there have been " significant changes in the action as planned or in the information used during early consultation." § 402.11(f). Within 45 days of such request, FWS must either confirm the preliminary biological opinion or request formal consultation. *Id.*

Plaintiffs concede that they " are not challenging the validity of FWS's early consultation or its preliminary biological opinion regarding certain segregated components of the 2004 OCAP." (Doc. 306 at 37.) Rather, Plaintiffs argue that the portion of the BiOp covering formal consultation is flawed because it fails to examine the full impacts of all aspects of the 2004 OCAP. (Doc. 306 at 37.) Plaintiffs maintain the formal consultation should have covered certain planned actions included in the early consultation that are interdependent with other planned actions not included in either consultation. This claim is cognizable, as it challenges the scope of the formal consultation and the completeness of evaluation of overall OCAP operations on jeopardy to the smelt, not the lawfulness of the early consultation on

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future actions.

B. *The Biological Opinion Unlawfully Relies Upon Uncertain, Unenforceable Mitigation Measures.*

The BiOp concludes that the " operations of the Projects under formal consultation ... will result in adverse effects to the delta smelt through entrainment at the CVP and SWP facilities and by drawing delta smelt into poorer quality habitat in the south delta. However with the inclusion of the *conservation measures* described above *and the implementation of the DSRAM,* these adverse effects would be avoided or minimized." (AR 467 (emphasis added).) The " conservation measures" mentioned in the BiOp's conclusion are various regulatory mechanisms already in place to " provide protection to delta smelt and/or their habitats," including D-1641, the EWA, CVPIA (b)(2) water, and VAMP. (AR 421-22, 466-67.)

1. Law Governing Mitigation Measures.

Mitigation measures must be " reasonably specific, certain to occur, and capable of implementation; they must be subject to deadlines or otherwise-enforceable obligations; and most important, they must address the threats to the species in a way that satisfies the jeopardy and adverse modification standards." *Ctr. for Biological Diversity v. Rumsfeld,* 198 F.Supp.2d 1139, 1152 (D.Ariz.2002) (citing *Sierra Club v. Marsh,* 816 F.2d 1376 (9th Cir.1987)); *see also NWF v. NMFS,* 481 F.3d 1224 at *12 & n. 16 (" Although the record does reflect a general desire to install structural improvements [to benefit fish] where feasible, it does not show a clear, definite commitment of resources for future improvements.").

***22** Plaintiffs allege that, in depending on the DSRAM and the other " conservation measures" to support its no jeopardy conclusion, the BiOp unlawfully relies upon uncertain, unenforceable mitigation measures which do not constitute a clear, definite commitment of resources. Specifically, Plaintiffs argue: (a) the DSRAM process is " entirely discretionary, uncertain, and unenforceable and (b) the biological opinion unjustifiably assumes that the other, currently operational " conservation measures" (e.g., the EWA and CVPIA(b) (2) water) will continue to be available for use by DSRAM in the future.

2. The DSRAM is Unlawfully Uncertain and Unenforceable.

All Defendants argue that the DSRAM is an effective adaptive management program that provides the agency the necessary remedial flexibility that makes the BiOp lawful. The BiOp describes the DSRAM as follows:

The delta smelt risk assessment matrix (DSRAM) consists of month by month criteria which, when exceeded will trigger a meeting of the Delta Smelt Working Group (Working Group). The purpose of the DSRAM is to take actions to protect delta smelt in a proactive manner prior to salvage events....The DSRAM is an adaptive management tool which may be further modified by the Working Group/WOMT as new information becomes available, without undergoing formal reconsultation....Data will be updated at least weekly to determine the need for a meeting.

Should a triggering criterion be met or exceeded, Reclamation and/or DWR will inform the members of the Working Group and the Working Group will determine the need to meet. Any member of the Working Group may set up a meeting of the Working Group at any time. A meeting of the Working Group may consist of an in-person meeting, a conference call, or a discussion by email. If needed, the Working Group will meet prior to the weekly meetings of the DAT and the WOMT and information will be shared with these groups.

Should a meeting of the Working Group prove necessary, the group will decide whether to recommend a change in exports, change in south delta barrier operations, San Joaquin River flows, or a change in delta cross channel operations, and the extent and duration of the potential action. These *potential actions* are listed in the DSRAM by the months wherein each of these tools generally become available. *The group will recommend actions which will be shared with the DAT and forwarded to the WOMT for discussion and potential implementation.*This recommendation will include a discussion of the level of concern for delta smelt and will include who participated in the working group discussions. All dissenting opinions and/or discussion points will also be forwarded to the WOMT. The Working Group will meet at least weekly throughout the period in which the triggering criteria are met or exceeded, to determine the need to provide further recommendations to the WOMT.

Notes and findings of Working Group meeting will be submitted to the Service and members of the WOMT for their records. *The WOMT will respond to the Working Group's recommendations and the actions taken by the WOMT will be summarized by Reclamation and/or DWR annually and submitted to all WOMT agencies.*

***23** *If an action is taken, the Working Group will follow up on the action to attempt to ascertain its effectiveness.*An assessment of effectiveness will be attached to the notes from the Working Group's discussion concerning the action.

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(AR 344-45 (emphasis added).)

The trigger criteria, which vary slightly from month to month, are set forth in a table (or matrix) at page 100 of the BiOp. (AR 346.) The criteria include: (1) the previous year's fall midwater trawl recovery index; (2) the risk of smelt entrainment based upon the location of X2; (3) the estimated duration of the smelt spawning period based upon water temperature; (4) the presence of spawning female smelt; (5) the proximity of the smelt to the Project pumping facilities; and, (6) a salvage trigger for adult smelt (calculated as the ratio of adult smelt salvage to the FMWT index) and juvenile smelt (set at zero for May and June, the months of the year during which salvage of smelt is highest). (AR 346-49.)

Plaintiffs argue that the DSRAM is not " reasonably specific, certain to occur, and capable of implementation" because: (1) the DSWG has complete discretion over whether to meet and whether to recommend mitigation measures; (2) even if the DSWG meets and recommends mitigation measures, the WOMT group is free to reject any recommendations; (3) there are no standards to measure the effectiveness of actions taken; (4) reconsultation is not required should mitigation measures prove ineffective; and (5) ultimately, no action is ever required.

DWR responds that implementation of the DSRAM *process* is " mandatory." For example, the incidental take statement requires that the projects shall be implemented " as described" in the BiOp. (AR 475.) Because the BiOp " describes" operation of the DSRAM, DWR asserts that its implementation is made mandatory by the incidental take statement's command that the project shall be implemented " as described;" if a DSRAM triggering criteria is met, the DSWG " *will* determine the need to meet." (AR 344 (emphasis added).) If circumstances warrant action, the DSWG will recommend fish protection actions and forward those recommendations to the WOMT. (*Id.*) The BiOp provides that the DSWG " *will* meet at least weekly throughout the period in which the triggering criteria are met or exceeded, to determine the need to provide further recommendations to the WOMT." (*Id.* at 345 (emphasis added).) The WOMT must then " respond" to DSWG's recommendations. (*Id.*) If actions are taken, the DSWG will monitor the action to determine its effectiveness. (*Id.*)

DWR correctly asserts that the DSRAM *process* must be followed; this does not address Plaintiffs' argument: that the DSRAM process itself does not *require* any mitigation *actions* be taken. Nothing in DSRAM requires the DSWG to make action recommendations, whatever the circumstances, and no criteria prescribe when the WOMT must act to effect DSWG's recommendations.

***24** DWR responds that as adaptive management, " DSRAM is intentionally flexible, taking into consideration the uncertainties surrounding delta smelt population abundance and dynamics ... [D]elta smelt abundance has fluctuated widely, without a clear explanation why. While experts can monitor trends in delta smelt populations, estimating overall population abundance presently is ' not possible,' nor are the sources of year-to-year variability in abundance well understood." (Doc. 246-1 at 12.) DWR suggests that " hard-wiring" the DSRAM to require specific actions be taken when triggering criteria occur would impair the DSRAM's flexibility. For example, the trigger for salvage of juvenile smelt is set at zero. This trigger was designed not to precipitate a meeting every time that standard is exceeded, but to cause heightened awareness of conditions that might require protective action. (Doc. 246-1, at 12, citing AR at 8217-18.)

The conflict between Defendants' choice of a flexible management approach and Plaintiffs' concern to ensure enforceable protective actions are taken when necessary, highlights the extent to which overly flexible adaptive management may be incompatible with the requirements of the ESA. Commentators recognize that adaptive management schemes do not fit neatly within the ESA's existing regulatory structure. *See J.B. Ruhl,*Taking Adaptive Management Seriously: A Case Study of the Endangered Species Act, 52 U. Kan. L.Rev. 1249, 1284 (2004) (" The [ESA] as a whole lacks a cohesive adaptive management architecture...."). H. Doremus, *Adaptive Management, The Endangered Species Act, and the Institutional Challenges of " New Age" Environmental Protection,* 41 Washburn. L.J. 50, 52 (2000) (" Adaptive Management ... runs counter to human nature and the current structure of our management institutions."); (" One key institutional challenge is to combine the flexibility required by adaptive management with the long-term certainty we often seek through our legal and political institutions.") 41 Washburn L.J. at 55.

The case law sheds little light on how to harmonize these competing objectives. The parties cite no cases applying the " reasonably specific, certain to occur, and capable of implementation" concept (or any closely related doctrine) to mitigation measures employed under an adaptive management protocol. Most cases the parties cite are either wholly inapplicable or factually distinguishable.

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For example, mitigation measures have been found unlawfully uncertain because their implementation was not within the control of the relevant federal agencies. *National Wildlife Federation v. NMFS*, 254 F.Supp.2d 1196, 1213 (D.Or.2003), invalidated a 2000 biological opinion addressing the effects of the operation of the Federal Columbia River Power System (" FCRPS") on several listed fish species. A 2000 biological opinion concluded that continued operation of the FCRPS would jeopardize several of the species and adversely modify their critical habitat and adapted mitigation measures to avoid jeopardy. The mitigation measures included a variety of short- and long-term state, regional, tribal, and private off-site mitigation actions. The plaintiffs argued that reliance on such " uncertain and vaguely defined actions of third parties to protect and restore salmon habitat," violated the " reasonably certain to occur" standard. *Id.* at 1209.The district court agreed, concluding that the no jeopardy determination unlawfully relied on " non-federal off-site mitigation actions that are not reasonably certain to occur." *Id.* at 1214.*See also Sierra Club v. Marsh*, 816 F.2d 1376, 1385 (9th Cir.1987) (invalidating biological opinion that relied on mitigation measure involving the transfer of 188 acres of marshland from private ownership to a publicly owned wildlife refuge; land remained under private control and subject to easements that rendered the land valueless for mitigation purposes, and private owners and local government indicated intent to increase use of one of the easements); *Oregon Natural Desert Ass'n v. Lohn*, 485 F.Supp.2d 1190, 2007 WL 1170629 (D.Or.2007) (setting aside biological opinion in part because it overly relied on the actions of private individuals who had a poor past record of compliance with standards); *Florida Key Deer v. Brown*, 364 F.Supp.2d 1345, 1355-56 (S.D.Fla.2005) (setting aside biological opinion that relied on mitigation measures to be implemented by private landowners; nothing compelled the landowners to act and " the record indicate[d] that some landowners entirely disregarded [prior mitigation measures]").

***25** Here, the BiOp's mitigation measures *are* largely under the control of the action agency (the Bureau), which, operating in concert with the DWR, directly regulates water pumping and releases from upstream reservoirs.*Natural Resources Defense Council v. Rodgers*, 381 F.Supp.2d 1212, 1241 (E.D.Cal.2004), does not provide guidance. In that case, plaintiffs contended a BiOp's mitigation measures were not reasonably certain to occur because the action agency had a poor track record of following through on prior commitments. The acknowledging that the agency's track record was " discouraging" district court recognized that the agency had made some progress toward implementing its prior commitments, *id.*, and declined to find that the new commitments were not certain to occur. *Id.* However, the *Rogers* plaintiffs did not attack the efficacy of the mitigation measures themselves, only the likelihood that the agency would not satisfy its commitment to implement them. Here, Plaintiffs challenge the inherent uncertainty and unenforceability of the DSRAM and the other conservation measures.

Plaintiffs cite *American Rivers v. U.S. Army Corps of Engineers*, 271 F.Supp.2d 230, 252 (D.D.C.2003), where, despite the fact that a prior biological opinion required the Corps to implement flow restrictions to mitigate impacts to listed species, the Corps " made it perfectly clear" to the district court " that it ha[d] no intention of ensuring that its future operations will be consistent" with the mitigation requirements. *Id.* at 253.A motion for preliminary injunction was granted: " Plaintiffs will be likely to prove that the 2003 Supplemental BiOp violated the ESA and APA by improperly and unreasonably relying on future actions by the Corps that are *virtually certain not to occur." Id.* at 254 (emphasis added). Here, in contrast, there is no such " smoking gun" evidence of the agency's intent to disregard its mitigation responsibilities, just no definite, certain, or enforceable measures.

Center for Biological Diversity v. Rumsfeld, 198 F.Supp.2d 1139, 1151-53 (D.Ariz.2002) addressed a biological opinion that concluded the Army's continued operations at Fort Huachuca, Arizona would not cause jeopardy to listed species that relied on flows from the Upper San Pedro River, even though rapid development in the area and uncontrolled groundwater pumping at the Fort posed threats to the species. The " no jeopardy" finding was premised on several required mitigation measures.

First, the Army had to develop and implement an on-base plan to protect and maintain populations of listed species and habitats; *id.* at 1148, even though the on-base plan was not designed to address the underlying problem of diminishing flows in the San Pedro River, *see id.* at 1153.Second, the Army had to develop a regional water resources plan, sufficient to maintain flows in the San Pedro River to sustain the protected species and their habitats. *Id.* at 1148.The biological opinion acknowledged, that the Army had no authority over the implementation of the regional plan and was only required to participate along with other stakeholders. *Id.* at 1153.Third, the Army had to monitor progress and

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report on the implementation of the various projects.*Id.* at 1149.Fourth, the biological opinion assumed the operation of a water recharge facility designed to temporarily delay the impact of groundwater overdraft, which the *Rumsfeld* court acknowledged was " subject to substantial uncertainty." *Id.* at 1145.

***26** Leaving it to the Army and other interested parties to develop a regional water management plan " enables the Army to sidestep any direct responsibility for addressing deficit groundwater pumping," and was " an admission that what is currently on the table as far as mitigation measures is inadequate to support the [ ] ' no jeopardy' decision." 198 F.Supp.2d at 1153-54.[FN18]

DWR distinguishes *Rumsfeld,* claiming it is like *NWF v. NMFS,* 254 F.Supp.2d 1196, where mitigation measures were unlawful because they depended upon third parties without any guarantee that those parties would implement the measures. Here, the DSRAM does not depend on actions by outsiders. *Rumsfeld* further found that the Army's on-base mitigation measures were insufficient because they did not require any measurable goals or an implementation schedule:
*There are no requirements in the Final BO to reduce reliance on groundwater pumping by any particular amount or to achieve any measurable goals with respect to water recharge. There is no date certain implementation requirement.*The MOA includes a laundry list of possible mitigation measures related to water conservation and recharge that the Army may implement, but it does not establish which projects have to be undertaken, when, nor what the conservation objectives are for the respective projects. Without such specificity, the mitigation measures in the Final BO are merely suggestions.

Id. at 1153 (emphasis added).*Rumsfeld* stands for the proposition that, at a minimum, a mitigation strategy must have some form of measurable goals, action measures, and a certain implementation schedule; i.e., that mitigation measures must incorporate *some* definite and certain requirements that ensure needed mitigation measures will be implemented.

Here, the agency's BiOp admits that mitigation measures are essential. The no jeopardy finding is conditioned on conservation measures *and the DSRAM.*(*See* AR 422.)

DWR's protestations that hard-wiring the DSRAM would cripple its effectiveness ignore the ESA's requirements of reasonable certainty, timetables, and enforceability standards for mitigation measures. The existing DSRAM process provides *absolutely no* certainty that any needed smelt protection *actions* will be taken at any time by DSWG or WOMT. The DSRAM is in substance an organizational flow chart that prescribes that certain administrative processes (meetings) will be held whenever a trigger criteria is met or exceeded. Although mitigation measures are identified, no defined mitigation goals are required, nor is any time for implementation prescribed. Incorporating *some* ascertainable mitigation standards and enforceable mitigation measures is not inconsistent with avoiding unduly restrictive " hard-wiring" of the DSRAM.

National Wildlife Federation v. Babbit, 128 F.Supp.2d 1274 (E.D.Cal.2000)(*" NWF v. Babbit"*), addresses an adaptive management approach that accommodated uncertainty by allowing regulators to apply new information gathered through monitoring to *adjust and employ well-defined* mitigation measures. There, a Habitat Conservation Plan (" HCP") called for a development fee to be collected on all acreage developed in the Natomas Basin, north of Sacramento, home to a number of endangered species. The HCP also incorporated adaptive management provisions designed to allow the mitigation fee to be modified if new information justified an adjustment:
***27** The [HCP] recognizes that the current state of knowledge as to the conservation needs of protected species is imperfect, and that its assumptions as to the amount, location, and pace of development in the Basin and as to the adequacy of the mitigation fee to accommodate increased expenses may prove inaccurate. The Plan addresses these uncertainties through its " adaptive management" provisions, which permit the Plan's conservation strategy to be adjusted based on new information. The HCP's conservation program can be modified under the adaptive management provisions if: (1) new information results from ongoing research on the GGS or other covered species; (2) recovery strategies under Fish and Wildlife Service recovery plans for the GGS or the Swainson's hawk differ from the measures contemplated by the HCP; (3) certain of the HCP's mitigation measures are shown through monitoring to require modification; or (4) the HCP's required minimum block sizes for reserve lands are shown to require revision. The Plan anticipates that the NBC will make discretionary decisions in future years based upon new information. The NBC will decide, for example, which lands to purchase, depending on a variety of future considerations difficult now to predict, and whether to change the mix of in and out of Basin reserve lands and agricultural as opposed to marsh reserve lands.

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Id. at 1281-82.[FN19]

Here, the adaptive management process has no quantified objectives or required mitigation measures. Although the *process* must be implemented by holding meetings and making recommendations, nothing requires that any *actions* ever be taken.[FN20]The BiOp asks the court to trust the agency to protect the species and its habitat. Notwithstanding any required deference to expertise, the ESA requires more.

All parties agree that adaptive management can be beneficial and that flexibility is a necessary incident of adaptive management. The law requires that a balance be struck between the dual needs of flexibility and certainty. The DSRAM, as currently structured, does not provide the required reasonable certainty to assure appropriate and necessary mitigation measures will be implemented. The DSRAM does not provide reasonable assurance admitted adverse impacts of the 2004 OCAP will be mitigated. This aspect of the BiOp is arbitrary and capricious and contrary to law. Plaintiffs' motion for summary adjudication as to this claim is **GRANTED.**The agency has not provided a reasonable explanation showing the DSRAM will satisfy ESA requirements to assure survival and recovery of the Delta smelt.

The Ninth Circuit's *recent NWF v. NMFS* decision suggests that mitigation measures that are not reasonably certain to occur should be excluded from the agency's no jeopardy analysis. *See*481 F.3d 1224 at *12 n. 16.[FN21]Because mitigation is insufficiently certain to occur under the DSRAM, the DSRAM cannot cure other shortcomings of the BiOp.

3. Plaintiffs' Alternative Argument that the BiOp is Arbitrary and Capricious Because DSRAM Depends Upon EWA, VAMP, CVPIA(b)(2) Water, Programs that are Uncertain in Terms of Funding and Effectiveness.

***28** Plaintiffs maintain that the DSRAM cannot feasibly be implemented without adequate water assets from the EWA, CVPIA(b)(2), and VAMP programs. Plaintiffs allege that Defendants have not demonstrated that adequate assets from these programs will be available during the 20 year term of the BiOp. (*See* Doc. 306 at 17.)

Plaintiffs correctly observe that the BiOp does not assure that adequate water assets from these programs will be available for future use under DSRAM. The BiOp itself acknowledges that " [a]lthough VAMP and [EWA] have helped to ameliorate these threats, it is unclear how effective these will continue to be over time based on available funding and future demands for water." (AR 367-68.) The BiOp recognizes that the " EWA Agencies envision implementation of a long-term EWA as part of the operation of the Project." (AR 335.) However, the BiOp cannot and does not commit to implement the EWA in the long run. (*Id.*)

The record reveals that the loss of EWA assets will " reduce the ability of the EWA agencies to provide [ ] fish protections...." (SAR 20.) Plaintiffs refer to statements made by FWS's D. Harlow during an annual joint meeting of CALFED and the Bay-Delta Public Advisory Committee, that a proposal to change CVPIA(b)(2) policy would " change fish protection envisioned in the Record of Decision (ROD)." (Doc. 9 at 4.) At the same time, Mr. Harlow also noted that this would " not necessarily diminish fish protection." (*Id.*) However, he opined that such a change would " necessitate an increase in the size of the EWA." (*Id.*) National Oceanic and Atmospheric Administration (" NOAA") staff questioned FWS's reliance on the EWA in the BiOp, noting that EWA assets would likely be used up for protective actions during the winter, before the peak months for Delta smelt salvage (May and June). (AR 8574.)

Plaintiffs' claim rests in part on the assumption that the EWA, CVPIA(b)(2), and VAMP programs are the *only* mechanisms by which DSRAM may be implemented. The record does not support this assumption. Under the BiOp, the DSWG is tasked to make recommendations regarding fish protection actions by selecting from a list of " tools for change," which include: (1) " export reduction[s] at one or both facilities" ; (2) " change[s] in barrier operations" ; (3) " change[s] in San Joaquin River flows" ; and (4) " change[s] [in the] position of cross channel gates." (AR 346 and 348 n. 7.) No mention is made of the EWA, CVPIA(b)(2), or VAMP in the DSRAM or its description of the " tools for change." DWR rejoins that, regardless of whether these programs are fully funded and/or remain functional mechanisms to provide water to the Delta, " the burden....falls on the Projects, not the smelt." (Doc. 246 at 10.)

The EWA is simply a means by which the SWP and CVP can obtain water by purchasing it from willing sellers. (AR 373.) EWA water may be used either to protect fish or to compensate project water users for reduced exports at the project pumps. (*Id.*) If money is unavailable to fund the EWA, Defendants are nonetheless required to prevent smelt take from exceeding permissible take limits.

***29** The BiOp sets forth a three-tier process to supply

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water to protect the smelt:
Tier 1 (Regulatory Baseline). Tier 1 is baseline water and consists of currently existing BOs, water right decisions and orders, CVPIA Section 3406(b)(2) water, and other regulatory actions affecting operations of the CVP and SWP. Also included in Tier 1 are other environmental statutory requirements such as Level 2 refuge water supplies.
Tier 2(EWA). Tier 2 is the EWA and provides fish protection actions supplemental to the baseline level of protection (Tier 1). Tier 2 consists of EWA assets, which combined with the benefits of CALFED's ERP, will allow water to be provided for fish actions when needed without reducing deliveries to water users. EWA assets will include purchased (fixed) assets, operational (variable) assets, and other water management tools and agreements to provide for specified level of fish protection. Fixed assets are those water supplies that are purchased by the EWA Agencies. These purchased quantities are approximations and subject to some variability. Operational assets are those water supplies made available through CVP and SWP operational flexibility. Some examples include the flexing of the export-to-inflow ratio standard required [ ] for meeting Delta water quality and flows, and ERP water resulting from upstream releases pumped at the SWP Banks Pumping Plant. Water management tools provide the ability to convey, store, and manage water that has been secured through other means. Examples include dedicated pumping capacity, borrowing, banking, and entering into exchange agreements with water contractors. Chapter 8 of this BA contains a more detailed description of EWA operations, as characterized in the CALSIM II modeling for the CVP OCAP.
Tier 3 (Additional Assets). In the event the EWA Agencies deem Tiers 1 and 2 levels of protection insufficient to protect at-risk fish species in accordance with the Act, Tier 3 would be initiated. Tier 3 sets in motion a process based upon the commitment and ability of the EWA Agencies to make additional water available, should it be needed. *This Tier may consist of additional purchased or operational assets, funding to secure additional assets if needed, or project water if funding or assets are unavailable.*It is unlikely that protection beyond those described in Tiers 1 and 2 will be needed to meet requirements of the Act.

(*Id.* at 336-37.)DWR emphasizes that, if all else fails, Tier 3 assets may be brought to bear, which include " additional purchased or operational assets, funding to secure additional assets if needed, or *project water* if funding or assets are unavailable." (*Id.* (emphasis added).)

There is a difference between the DSRAM's failure to require mitigation actions in response to trigger events, designed to assure the commitment of necessary resources to smelt protection, and the duty to have available or acquire those necessary resources. A court must leave to the agency the application of its expertise and authority to manage the complex hydrologic, legal, financial, physical, and logistical aspects of protecting the delta smelt. Plaintiffs motion for summary adjudication is **DENIED** as to the issue of the insufficiency of the EWA, VAMP, and CVPIA (b)(2) programs.

C. *Best Available Science.*

***30** The § 7 formal consultation process is designed to " insure" that any agency action " is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined ... to be critical...." 16 U.S.C. § 1536(a)(2)." In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available." *Id.*

An agency has wide discretion to determine what is " the best scientific and commercial data available." *San Luis v. Badgley*, 136 F.Supp.2d 1136, 1151 (E.D.Cal.2000). Yet, an agency must make its decision about jeopardy based on the best science available at the time of the decision, and may not defer that jeopardy analysis by promising future studies to assess whether jeopardy is occurring. *Rumsfeld*, 198 F.Supp.2d at 1156. While uncertainty is not necessarily fatal to an agency decision, *e.g.*, *Greenpeace Action v. Franklin*, 14 F.3d 1324, 1337 (9th Cir.1992) (" *Greenpeace I*") (upholding agency decision even though there was uncertainty about the effectiveness of management measures because agency premised its decision on a reasonable evaluation of all available data), an agency may not entirely fail to develop appropriate projections where data " was available but [was] simply not analyzed," *Greenpeace v. NMFS*, 80 F.Supp.2d 1137, 1149-50 (W.D.Wash.2000) (" *Greenpeace II*") (where agency totally failed to develop any projections regarding population viability, it could not use as an excuse the fact that relevant data had not been analyzed). Here, EWS maintains the necessary data cannot be obtained.

1. Does a " Benefit of the Doubt to the Species" Presumption Apply?

The parties debate at length whether the best available scientific information principle includes a requirement that the agency " give the benefit of the doubt to the

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species." This language has its origins in the legislative history of the ESA, H.R. Conf. Rep. No. 96-697, 96th Cong., 1st Sess. 12, reprinted in 1979 U.S.C.C.A.N. 2572, 2576:

Section 7(b) of the act requires the fish and wildlife service and the national marine fisheries service to render biological opinions which advise whether or not proposed agency actions would violate section 7(a)(2). Courts have given substantial weight to these biological opinions as evidence of an agency's compliance with section 7(a). The amendment would not alter this state of the law or lessen in any way an agency's obligation under section 7(a)(2).

As currently written, however, the law could be interpreted to force the fish and wildlife service and the national marine fisheries service to issue negative biological opinions whenever the action agency cannot guarantee with certainty that the agency action will not jeopardize the continued existence of the listed species or adversely modify its critical habitat. The amendment will permit the wildlife agencies to frame their section 7(b) opinions on the best evidence that is available or can be developed during consultation. If the biological opinion is rendered on the basis of inadequate information then the federal agency has a continuing obligation to make a reasonable effort to develop that information.

***31** *This language continues to give the benefit of the doubt to the species,* and it would continue to place the burden on the action agency to demonstrate to the consulting agency that its action will not violate section 7(a)(2). Furthermore, the language will not absolve federal agencies from the responsibility of cooperating with the wildlife agencies in developing adequate information upon which to base a biological opinion. If a federal agency proceeds with the action in the face of inadequate knowledge or information, the agency does so with the risk that it has not satisfied the standard of section 7(a)(2) and that new information might reveal that the agency has not satisfied the standard of section 7(a)(2).

(emphasis added).

In *Conner v. Burford,* 848 F.2d 1441, 1454 (9th Cir.1988), the Ninth Circuit applied this " benefit of the doubt" language to hold that FWS violated the ESA by " failing to use the best information available to prepare comprehensive biological opinions considering all stages of the agency action...." At dispute in *Conner* was a biological opinion reviewing the proposed sale of oil and gas leases on National Forest land. The biological opinion analyzed the impact of the " initial lease phase," but failed to address the potential impact of post leasing activities, such as oil and gas development. FWS reasoned that there was " insufficient information available to render a comprehensive biological opinion beyond the initial lease phase," relying instead on " incremental-step consultation." *Id.* at 1452.The Ninth Circuit recognized that " the precise location and extent of future oil and gas activities were unknown at the time," but, " extensive information about the behavior and habitat of the species in the areas covered by the leases was available." *Id.* at 1453.With this information, " FWS could have determined whether post-leasing activities in particular areas were fundamentally incompatible with the continued existence of the species." *Id.* at 1454.

In light of the ESA requirement that the agencies use the best scientific and commercial data available to insure that protected species are not jeopardized, 16 U.S.C. § 1536(a)(2), the FWS cannot ignore available biological information or fail to develop projections of oil and gas activities which may indicate potential conflicts between development and the preservation of protected species. We hold that the FWS violated the ESA by failing to use the best information available to prepare comprehensive biological opinions considering all stages of the agency action, and thus failing to adequately assess whether the agency action was likely to jeopardize the continued existence of any threatened or endangered species, as required by section 7(a)(2).*To hold otherwise would eviscerate Congress' intent to " give the benefit of the doubt to the species."*

Id. (emphasis added).*Conner* does not directly support the broader interpretation urged by Plaintiffs, that the agency should err on the side of the species when evaluating uncertain evidence. *Conner* stands for the proposition that an agency cannot abdicate its responsibility to evaluate the impacts of an action on a species by labeling available information " uncertain," because doing so violates Congress' intent that the agencies " give the benefit of the doubt to the species."

***32** *Center for Biological Diversity v. Lohn,* 296 F.Supp.2d 1223, 1239 (W.D.Wash.2003) (rev'd on other grounds, 483 F.3d 984, 2007 WL 1217738 (9th Cir.)), applied the Conner holding in conformity with Plaintiffs' interpretation. *Lohn* addressed the listing under the ESA of a population of orca whales. Despite considerable record evidence suggesting the Orca whales should be considered a separate species, the Orca population had not yet been identified as a separate *taxon.*NMFS decided not to list the species based on the scientific uncertainty that existed in the field of taxonomy, relying on the fact that the new taxon had not yet been designated. The district court ruled this decision was arbitrary and capricious:

Given the considerable morphological, behavioral, and

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genetic evidence that the global Orcinus orca taxon is inaccurate and that residents and transients do not belong to the same taxon, the decision not to list the Southern Residents cannot be based upon a lack of consensus in the field of taxonomy regarding the precise, formal taxonomic redefinition of killer whales, particularly when that lack of agreement is compounded by the extreme difficulty in gathering evidence to achieve consensus. *The best available science standard gives " the benefit of the doubt to the species."* *Conner v. Burford*, 848 F.2d 1441, 1454 (9th Cir.1988) (observing one of the purposes of the best available science standard in review of whether agency action may result in destruction or adverse modification of listed species' habitat pursuant to 16 U.S.C. § 1536(a)(2)).*To deny listing of a species simply because one scientific field has not caught up with the knowledge in other fields does not give the benefit of the doubt to the species and fails to meet the best available science requirement.*

Id. at 1239 (emphasis added).[FN22]

In response, Defendant Intervenors cite *Oceana, Inc. v. Evans*, 384 F.Supp.2d 203 (D.D.C.2003), a challenge to NMFS's choice between two estimates of how much take a particular type of fishing gear would cause. The agency chose the lower estimate, reasoning that it was the " best estimate possible." The plaintiff argued that this estimate failed to give the " benefit of the doubt" to the species. *Id.* at 228.Although the lower estimate was uncertain, the district court reasoned that " the ESA does not require the agency to reject the ' best estimate possible' in favor of a more ' conservative' estimate that, according to the scientists, would be lacking in support." *Id.*

Lohn and *Oceana* appear irreconcilable, but, they can be harmonized.*Lohn* rejected an agency's decision to follow the taxonomy in the face of significant and compelling scientific evidence favoring a different conclusion. To side with the agency under such circumstances would " not give the benefit of the doubt to the species...." *Id.* at 1239.In contrast, *Oceana*, concerned an agency's choice of the " best estimate possible" over a more " conservative" estimate that lacked scientific support. The *Oceana* court refused to ignore the general rule that an agency must choose the best available science, simply because the ESA commands that the agency give the " benefit of the doubt" to the species. *Both* cases stand for the proposition that the agency must carefully examine the available scientific data and models and rationally choose the most reliable.

2. The BiOp's Failure to Address the 2004 Fall Midwater Trawl Data.

***33** Plaintiffs assert that " one of the most egregious errors in the [BiOp] is its failure to consider available fall 2004 Delta smelt abundance data, which evoked grave concern among agencies involved in smelt management." [FN23](Doc. 232 at 5.) On February 9, 2005, FWS and other CALFED members met to discuss Delta smelt abundance. Among other things, participants discussed data from the 2004 fall midwater trawl (" FMWT") survey, which revealed that " estimates of Delta smelt appear to be their lowest since 1964." (Doc. 11 at 5; AR 9199-9200, 9202; Doc. 12.) The February 16, 2005, BiOp, contained no mention of the 2004 FMWT data.

Plaintiffs assert that FWS acted arbitrarily, capriciously and unlawfully by " ignoring" the 2004 FMWT data and relying instead on the more favorable abundance data from earlier abundance surveys. (AR 366-67 (noting that the 2003 FMWT results were more favorable than those from 2002, while simultaneously acknowledging that the 2003 summer townet index (1.6) was " well below the pre-decline average of 20.4 in (1959).").) Despite the receipt of the new, even less favorable 2004 FMWT data, FWS made no substantive changes to its jeopardy analysis in the biological opinion and did not use or address the new data in any way, not even to explain why the data was not discussed. At oral argument, the agency maintained that ESA analysis cannot go on forever, that there must be a cutoff.

Plaintiffs note that the low population numbers revealed by the FMWT data were " not unexpected," as smelt abundance had been on a downward trend for at least two years prior. (AR 370-71; 9199-9200, 9202.) One prominent smelt biologist warned at a June 2003 OCAP symposium that managers should expect very low smelt abundance data in the near future and that water exports were a key factor in the population decline, noting that the " cumulative proportion of the population lost to exports relative to abundance" could be as high as 30 percent. (AR 5069.)

Federal Defendants suggest that Plaintiffs' entire argument should be rejected as internally inconsistent. (Doc. 242 at 26-27.) Plaintiffs contend that FWS should have revised the BiOp in light of the 2004 FMWT data and that additional evidence of a downward trend was " not unexpected." These contentions are consistent with the central premise of Plaintiffs' position-that the 2004 FMWT data reflected a *record* low abundance (the data showed " estimates of Delta smelt appear to be at their lowest since 1964" (Doc. 11 at 5)); so low that the data

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should have been addressed in the BiOp, even if the agency already knew that smelt abundance was trending downward.

The State Water Contractors suggest that Plaintiffs' acknowledgment that the downward trend was " not unexpected," establishes that the BiOp fully recognizes the dire situation of the smelt. (Doc. 241 at 4.) The BiOp reflects that FWS had knowledge that smelt population levels were at extremely low levels, " [s]ince 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded." (AR 367.)

***34** The results of seven surveys conducted by the Interagency Ecological Program (IEP) corroborate the dramatic decline in delta smelt....According to seven abundance indices designed to record trends in the status of the delta smelt, this species was consistently at low population levels during the last ten years (Stevens et al.1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens et al.1990).

(AR at 370.) The State Water Contractors' argument ignores that the 2004 FMWT data evidences *record* low (the lowest) smelt abundance. Plaintiffs maintain that FWS' acknowledgment of a downward trend is inadequate as it does not address or analyze in survival and recovery terms, that smelt abundance levels had reached the lowest ever recorded.

The State Water Contractors argue that, although the BiOp admits the *fact* of the smelt's declining population, it does not and cannot explain the *cause* of the decline, because there is no scientific consensus as to causation. (Doc. 241 at 5.) " Contributing to [this] uncertainty," " is the fact that SWP and CVP operations have been ongoing for decades-a period during which Delta smelt abundance has increased as well as declined." (*Id.* at 6.) The State Water Contractors assert that the DSRAM was adopted in part to protect the smelt while further monitoring and research is carried out to resolve these uncertainties. They conclude that even if the 2004 FMWT data had been addressed in the BiOp, the ultimate opinion reached would not have differed; i.e., that operation of the projects under the 2004 OCAP BiOp would not jeopardize the smelt because, among other things, take will remain at or below historic levels and the DSRAM will protect smelt from salvage at project facilities.[FN24]But, this is post hoc argument; neither the agency or the biological opinion addressed the 2004 FMWT data and available scientific information opined that Project operations contributed to the decline of the smelt.

The cases the parties cite do not answer whether FWS did not have to analyze most recent data because it would not have altered the ultimate conclusion. Some cases suggest that FWS must use all available information to ensure that a biological opinion analyzes the threats to a species in a comprehensive manner. Plaintiffs refer to *Greenpeace II*, 80 F.Supp.2d at 1149-50, for the proposition that failure to analyze and incorporate available data is fatal to a biological opinion. In that case, NMFS concluded in a biological opinion that the total groundfish catch authorized in the Bering Sea and Gulf of Alaska in a single fishing season (1999) would not jeopardize the endangered Stellar sea lion. NMFS limited the scope of the biological opinion to that single year of fisheries management activities. The district court ruled that the agency should have broadened the scope of the biological opinion to consider the overall fishery management regime, including relevant regulations and specifications. *Id.* at 1146-47.This failure to produce a comprehensive biological opinion permeated all other aspects of the agency's decision. The district court found fault with the BiOp's superficial analysis, emphasizing the agency's failure to address the overall effects of the fisheries upon the sea lion:

***35** As far as the Court can ascertain, the focus of BiOp2 is limited to analyzing whether the fisheries compete with the sea lion for prey. In particular, BiOp2 focuses on the potential for localized depletions of prey caused by the fisheries. BiOp2 at 90, 112. *Even with respect to this limited topic of discussion, meaningful analysis is virtually non-existent. NMFS itself repeatedly concludes in BiOp2 that it simply lacks the information to make any determination one way or the other.*See BiOp2 at 111-118. Thus, NMFS's analysis is admittedly incomplete and its conclusions inconclusive. Although inconclusive data does not necessarily render a particular scientific conclusion invalid, the limited scope and quality of analysis that is contained in BiOp2 serves to highlight its overall inadequacy. For example, NMFS relies substantially on its conclusion that many of the target groundfish species are not important sea lion prey, despite uncertain evidence. BiOp2 at 114. That many of the target species may not individually constitute a major prey source, however, does not mean the cumulative impact of these fisheries is insignificant. *In other words, limited analysis which suggests the fisheries do not jeopardize the sea lion does not obviate the requirement that NMFS address the full scope of the FMPs in order to ascertain their overall effects.*

In sum, BiOp2 is limited in scope, heavy on general background information, and deficient in focused and meaningful discussion and analysis of how these large

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fisheries, and the complex management measures which regulate them, affect endangered Steller sea lions. That NMFS now finds it necessary to undertake yet another " comprehensive consultation" is a final indication to this Court that BiOp2 is not the broad and in-depth consultation it was purported to be by NMFS, much less coextensive in scope with the FMPs as required under the ESA.

A biological opinion which is not coextensive in scope with the identified agency action necessarily fails to consider important aspects of the problem and is, therefore, arbitrary and capricious. Here, BiOp2 not only fails to consider important aspects of the problem, the analysis it does contain is simply not adequate. Although an agency need not rely on conclusive scientific proof in a biological opinion, its conclusions must be based on " the best scientific and commercial data available." 16 U.S.C. § 1536(a)(2). Thus, an agency *" cannot ignore available biological information or fail to develop projections" which may indicate potential conflicts between the proposed action and the preservation of endangered species.*Conner, 848 F.2d at 1454.

Id. at 1149-50 (emphasis added).

In *Greenpeace II,* NMFS admitted that the information it needed to perform a more comprehensive review was available, but argued that it " could not have been analyzed in the time allowed." *Id.* at 1150.The district court rejected this argument:

***36** A federal agency ... is not " excused from [fulfilling the dictates of the ESA] if, in its judgment, there is insufficient information available to complete a comprehensive opinion and it takes upon itself [a more limited analysis]." Conner, 848 F.2d at 1455. This is not a situation where NMFS fully addressed the problem based on uncertain scientific data. *See Greenpeace Action v. Franklin,* 14 F.3d 1324, 1337 (9th Cir.1992).*Rather, NMFS entirely ignored relevant factors and admittedly failed to analyze and develop projections based on information that was available.*

Id. at 1150 (emphasis added); *see also Conner,* 848 F.2d at 1454 (biological opinion invalidated because agency failed to " use best information available to prepare comprehensive biological opinions considering all stages of agency action").

Plaintiffs analogize this case to *Greenpeace II,* because the agency has ignored available biological information. Here, Plaintiffs complain that FWS failed to incorporate into *existing* models and analyses that already reflected concern over an overall declining trend in smelt, the *most recent* survey information, evidencing a more pronounced decline in smelt populations than ever before recorded. In *Greenpeace II,* the agency entirely failed to perform a comprehensive review of threats to the sea lion. The difference in degree is not significant.

Federal Defendants cite *Oceana,* 384 F.Supp.2d 203, where NMFS concluded that an amendment to the Atlantic Sea Scallop Fishery Management Plan would not jeopardize the protected loggerhead sea turtle, based on a population model that involved a degree of uncertainty, but that the agency determined was the " most reliable method." *Id.* at 215.The *Oceana* plaintiffs did not dispute that the model represented the " best available science," instead arguing that the model was " so ill-suited to the purpose for which it was used, and so fraught with uncertainties," that the agency could not rationally reach its no jeopardy conclusion. *Id.* at 218.The district court upheld the agency's use of the model, reasoning " [t]ime and again courts have upheld agency action based on the ' best available' science, recognizing that some degree of speculation and uncertainty is inherent in agency decisionmaking, even in the precautionary context of the ESA." *Id.* at 219.Though the ESA should not be implemented " haphazardly, on the basis of speculation, *id.* at 219, the model " bears a rational relationship to the reality it purports to represent" and no other alternative model was available, *id.* at 221.

The circumstances here are not analogous to those in *Oceana,* where the plaintiffs *admitted* that the challenged model was the best, albeit uncertain, available science. Here, Plaintiffs maintain the agency's failure to analyze the most recent smelt population information prevented consideration of the best available, consequential scientific information.

***37** Federal Defendants also rely on *Greenpeace I,* 14 F.3d at 1337, an earlier challenge to a Stellar sea lion biological opinion. The *Greenpeace I* plaintiffs argued that the agency acted arbitrarily and capriciously by approving certain fishery management measures despite uncertainty about the effects of the measures on the sea lion. The Ninth Circuit concluded that the presence of some uncertainty did not violate the best available science requirement in part because that BiOp analyzed *all* the available data:

We hold that the Service has fulfilled its substantive duties as well. Despite Greenpeace's assertions to the contrary, the Service supported its conclusions with ample data and analysis. The June biological opinion indicates that the Service, the Alaska Fisheries Science Center, and the National Marine Mammal Laboratory " *analyzed all*

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the available data on the pollock fishery and Steller sea lions" in the Gulf of Alaska. The Service also sought the recommendations of the Steller Sea Lion Recovery Team. The opinion demonstrates that the Service evaluated the spatial and temporal distribution of commercial fishing across the Gulf of Alaska. It then addressed not only the total biomass of pollock in the Gulf and the effects of fishery removals on that biomass, but also the spatial and temporal distribution of pollock across the Gulf. And despite Greenpeace's claims to the contrary, the Service did not ignore hydroacoustic surveys of pollock biomass, but considered and compared them to bottom trawl surveys. *Finally, while the Service has repeatedly conceded that it was uncertain about the effectiveness of its management measures, it premised these measures on a reasonable evaluation of available data, not on pure speculation.*
The biological opinions indicate that the Service, an expert agency, consulted with other teams of experts to consider all relevant factors pertaining to the effects of the Gulf fishery on the Steller sea lion. And they indicate that the Service did not ignore data, as Greenpeace suggests. The Service's decision to go ahead with the 1991 fishery under the proposed restrictions, despite some uncertainty about the effects of commercial pollock fishing on the Steller sea lion, was not a clear error of judgment.

(Emphasis added.) *Id.* at 1337.Here, unlike *Greenpeace I*, FWS failed to analyze all of the available data on the Delta smelt, as the 2004 FMWT data is not mentioned in the BiOp. Nor has FWS resolved uncertainties about the identified causes of the serious decline in Delta smelt abundance by adopting unenforceable management measures.

" Although a decision of less than ideal clarity may be upheld if the agency's path may reasonably be discerned, [a court] cannot infer an agency's reasoning from mere silence. Rather, an agency's action must be upheld, if at all, on the basis articulated by the agency itself." *Pacific Coast Fed'n of Fishermen's Ass'ns v. United States Bureau of Reclamation*, 426 F.3d 1082, 1091 (9th Cir.2005) (internal citations and quotations omitted)." [W]hen reviewing a biological opinion, [a court may] rely only ' on what the agency actually said' ...." *Id.*(quoting *Gifford Pinchot Task Force*, 378 F.3d at 1072 & n. 9). Had FWS examined the FMWT 2004 data in the BiOp, the weight it gave to that data would have been entitled to deference. The agency's silence cannot be afforded deference.

a. *The timing of the 2004 FMWT Data relative to the issuance of the BiOp.*

***38** Federal Defendants complain the timing of the release of the 2004 FMWT data did not leave enough time to address the data before issuance of the biological opinion. The record shows at the very latest, the 2004 FMWT data was presented to FWS and other CALFED members on February 9, 2005, less than a week before the February 16, 2005, issuance of the biological opinion. Federal Defendants assert they were not required to rewrite the BiOp at the " eleventh hour." (Doc. 242 at 27).

Although the record shows the 2004 FMWT data was presented at the February 9, 2005 CALFED meeting, it is unclear when FWS *first* saw this data. Plaintiffs' claim that the data was available in December 2004, is not supported.[FN25]However, even assuming FWS was not aware of the 2004 FMWT data until February 9, 2005, the agency was not operating under a deadline. As in *Greenpeace II*, where the agency's statutory duty was not excused because the data could not be " analyzed in the time allowed," 80 F.Supp.2d at 1150, here, FWS could have delayed releasing the biological opinion until it had reviewed and analyzed the new abundance data, which was especially significant as it showed Delta smelt abundance at its nadir.

Defendants and Defendant-Intervenors rejoin that the failure of the BiOp to *directly* address the 2004 FMWT is harmless, because one of the DSRAM's trigger criteria is an index based upon the previous years' FMWT results, calling for any new abundance data to be incorporated into the adaptive management process. However, even if the data were considered later in the DSRAM process, no designated protective actions are required to be taken in response to any of the triggering criteria.[FN26]

Federal Defendants raise a legitimate concern about having to prolong completion of the BiOp on the eve of its release. In theory, new scientific information could arrive on FWS's doorstep on a daily basis. If FWS was required to consider and address every new piece of information it received prior to publication of its decision, it would be effectively impossible for the agency to complete a biological opinion. But, this is not such a case. The FMWT is a credible and reliable Delta smelt population abundance survey, regularly compiled on an annual basis, and relied upon by the agency in the past. There is no rational reason to ignore such important data. The BiOp places great weight on the FMWT as " the second longest running survey." (AR 366, 370). The agency does not suggest the time of receipt of the 2004 FMWT data was unexpected. The agency's failure to

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acknowledge and analyze the record low abundance levels revealed by the 2004 FMWT is unreasonable and violated its duty to use the best available scientific information. 16 U.S.C. § 1536(a)(2).

Plaintiffs' motion for summary adjudication is **GRANTED** as to this claim.

3. Global Climate Change Evidence.

Plaintiffs next argue that the BiOp ignored data about Global Climate Change that will adversely affect the Delta smelt and its habitat. (Doc. 232 at 7.) This is potentially significant because the BiOp's conclusions are based in part on the assumption that the hydrology of the water bodies affected by the OCAP will follow historical patterns for the next 20 years. (AR 375 (explaining that CALSIM II modeling involved making " adjustments to historic water supplies ... by imposing future level land use on historical meteorological and hydrologic conditions").)

***39** In a July 28, 2004 comment letter, Plaintiff NRDC directed FWS's attention to several studies on the potential effects of climate change on water supply reliability, urging that the issue be considered in the BiOp. (AR 8552-56.) The comment letter stated:

The best scientific data available today establishes that global climate change is occurring and will affect western hydrology. At least half a dozen models predict warming in the western United States of several degrees Celsius over the next 100 years (Redmond, 2003). Such sophisticated regional climate models must be considered as part of the FWS' consideration of the best available scientific data.8:43 AM 6/5/2007

Unfortunately, the Biological Assessment provided by the Bureau to FWS entirely ignores global climate change and existing climate change models. Instead, the BA projects future project impacts in explicit reliance on seventy-two years of historical records. In effect, the Biological Assessment assumes that neither climate nor hydrology will change. This assumption is not supportable.

In California, a significant percentage of annual precipitation falls as snow in the high Sierra Nevada mountains. Snowpack acts as a form of water storage by melting to release water later in the spring and early summer months (Minton, 2001). The effects of global climate change are expected to have a profound effect on this dynamic. *Among other things, more precipitation will occur as rain rather than snow, less water will be released slowly from snowpack " storage" during spring and summer months, and flooding is expected to increase* (Wilkinson, 2002; Dettinger, 2003).*These developments will make it more difficult to fill the large reservoirs in most years, reducing reservoir yields and will magnify the effect of CVP operations on downstream fishes* (Roos, 2001). These developments will also dramatically increase the cost of surface storage relative to other water supply options, such as conservation.

While the precise magnitude of these changes remains uncertain, judgments about the likely range of impacts can and have been made. *See e.g.,*U.S. Global Climate Action Report-2002; Third National Communication of the United States Under the United Nations Framework Convention on Climate Change at 82, 101 (2002). [FN3]. The Service can and must evaluate how that range of likely impacts would affect CVP operations and impacts, including the Bureau's ability to provide water to contractors while complying with environmental standards. We therefore request that the Service review and consider the work cited above, as well as the background and Dettinger presentation at a recent climate change conference held in Sacramento, June 9-11, 2004 [citation omitted] and climate change reports [citation omitted].

(AR at 8554-55 (emphasis added).)

A second presentation by Michael Dettinger at a December 8-9, 2004 CALFED meeting, attended by FWS staff, concluded that " warming is already underway ..." ; that this would result in earlier flows, more floods, and drier summers; and that " California water supplies/ecosystems are likely to experience [ ] changes earliest and most intensely." (Doc. 10 at 18.) Following Dettinger's presentation, members of CALFED noted " the need to reevaluate water storage policies and ERP [Ecosystem Recovery Program] recovery strategies, all of which would be affected by projected climate changes." (Doc. 9 at 3.) The record reflects that extreme water temperatures can have dramatic impacts upon smelt abundance. (AR 8979-80.)

***40** In addition to the specific studies and data cited by NRDC, FWS scientists recognized the issue of climate change warranted further consideration. At a June 2003 symposium entitled " Framing the issues for Environmental and Ecological Effects of Proposed Changes in Water Operations: Science Symposium on the State of Knowledge," a number of questions regarding climate change were raised, including: " How does the proposed operations plan account for the potential effects of climate change (e.g., El Nino or La Nina, long term changes in precipitation and runoff patters, or increases in

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water temperature)?" (AR at 4839.)

Plaintiffs argue that, despite this evidence that climate change could seriously impact the smelt by changing Delta hydrology and temperature, the BiOp " did not so much as mention the probable effects of climate change on the delta smelt, its habitat, or the magnitude of impacts that could be expected from the 2004 OCAP operations, much less analyze those effects." (Doc. 232 at 8.) Defendants and Defendant-Intervenors respond by arguing (1) that the evidence before FWS at the time the BiOp was issued was inconclusive about the impacts of climate change; and (2) that, far from ignoring climate change, the issue is built into the BiOp's analysis through the use of X2 as a proxy for the location and distribution of Delta smelt.

a. *Inconclusive Nature of Available Information Regarding the Impacts of Global Climate Change on Precipitation.*

Federal Defendants and the State Water Contractors characterize Mr. Dettinger's presentation, as reflecting " a great deal of uncertainty that climate change will impact future precipitation." The presentation is entitled " Climate Change Uncertainties and CALFED Planning." (Doc. 10 at 1.) Dettinger acknowledges that, although current climate models " yield consistent warming scenarios for California" (*id.* at 6), there is no similar consensus regarding the impact of warming on future precipitation (*id.* at 7). Federal Defendants suggest that FWS " responsibly refused to engage in sheer guesswork, and properly declined to speculate as to how global warming might affect delta smelt." (Doc. 242 at 23.) But, the NRDC letter cited a number of studies in addition to Mr. Dettinger's presentations, all of which predict that anticipated climate change will adversely impact future water availability in the Western United States.

At the very least, these studies suggest that climate change will be an " important aspect of the problem" meriting analysis in the BiOp. *Pacific Coast Fed'n*, 265 F.3d at 1034. However, as with the 2004 FMWT data, the climate change issue was not meaningfully discussed in the biological opinion, making it impossible to determine whether the information was rationally discounted because of its inconclusive nature, or arbitrarily ignored.[FN27]

b. *X2 as a Proxy for Climate Change.*

The State Water Contractors argue that the approaches taken in the DSRAM are " more than adequate to deal with the projected impacts of climate change-assuming they occur." (Doc. 241 at 8.) For example, Plaintiffs' suggestion that climate change will produce earlier flows, more floods, and drier summers is addressed by the DSRAM's X2 trigger. Flow level changes will be reflected in the position of X2. If climate change alters water temperatures, DSRAM also includes a temperature trigger, that monitors the temperature range within which successful Delta smelt spawning occurs.

***41** The DSRAM offers no assurance that any mitigating fish protection actions will be implemented if the X2 criteria is triggered. That X2 indirectly monitors climate change does not assuage Plaintiffs' concerns that the BiOp has not adequately analyzed the potential impact of climate change on the smelt.

The BiOp does not gauge the potential effect of various climate change scenarios on Delta hydrology. Assuming, *arguendo*, a lawful adaptive management approach, there is no discussion when and how climate change impacts will be addressed, whether existing take limits will remain, and the probable impacts on CVP-SWP operations.

FWS acted arbitrarily and capriciously by failing to address the issue of climate change in the BiOp. This absence of *any* discussion in the BiOp of how to deal with any climate change is a failure to analyze a potentially " important aspect of the problem." [FN28]

Plaintiffs' motion for summary adjudication is **GRANTED** as to this claim.

D. *There is No Rational Connection Between the No Jeopardy Finding and the Status of the Species.*

Plaintiffs next allege that there is no rational connection between the record evidence and the BiOp's " no jeopardy" conclusion. Plaintiffs first argue that the BiOp's approach to setting take limits is arbitrary and capricious because FWS failed to consider defined take limits in the context of current smelt abundance. Plaintiffs complain that the BiOp does not explain how its no jeopardy conclusion can be justified in light of the admitted adverse effects of the project, along with indirect and cumulative effects on the species.

In a formal consultation, the ESA requires FWS to " [f]ormulate its biological opinion as to whether the action, taken together with cumulative effects, is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical

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habitat." 50 C.F.R. § 402.14; *see also*16 U.S.C. § 1536(a)(2). The phrase " jeopardize the continued existence of" means " to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. § 402.02.

Agency action may be overturned if the agency has " relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Pacific Coast Fed'n*, 265 F.3d at 1034. A court must ask " whether the agency considered the relevant factors and articulated a rational connection between the facts found and the choice made." *Id.* The agency must " examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made." *Motor Vehicle Mfrs. Ass'n v. State Farm Mutual Ins.*, 463 U.S. 29, 43, 103 S.Ct. 2856, 77 L.Ed.2d 443 (1983).

1. Plaintiffs' Argument that Salvage Underestimates Project Impacts on the Smelt.

***42** Plaintiffs assert that the BiOp's reliance on salvage is arbitrary and capricious because salvage is not a reliable basis for setting Project take limits. Plaintiffs cite record evidence, including statements made by smelt biologists and FWS employees, that salvage does not accurately estimate incidental take of young Delta smelt. (*See* AR 8403, 7578.) The BiOp admits that salvages does not fully account for all smelt losses. (AR 419 (" It should be noted that although salvage is used to index delta smelt take, it does not reliably index delta smelt entrainment. Furthermore, delta smelt salvage is highly variable at all time scales....).") Plaintiffs have not shown that a better measure of smelt take could have been generated from available data. The agency is entitled to rely on this approach as it appears to be the " best estimate possible," no party has suggested an alternative. *See Oceana*, 384 F.Supp.2d at 228.

This objection standing alone is insufficient to justify summary adjudication.

2. The BiOp's Approach to Estimating Future Take Without Considering the Smelt's Current Abundance Is Arbitrary and Capricious.

The take limits are based on historic sampling from " salvage density" (number of fish taken per unit of water), which data is adjusted using CALSIM II modeling to reflect water flows anticipated under the circumstances of the final consultation. FWS's no jeopardy determination is based in part on flow modeling for the final consultation scenario that predicted *lower* than historic salvage levels during critical times. (AR 474 (finding that the level of anticipated take " is not likely to result in jeopardy to the smelt because this level of take is at or below historical levels of take.")

A close examination of the administrative record reveals that this conclusion relies upon an unsupported irrational assumption not justified by the record, i.e., that maintaining salvage at or below historic salvage levels will ensure that the 2004 OCAP is not likely to jeopardize the continued existence of the Delta smelt. First, by focusing only on how proposed operations will either increase or decrease smelt take, FWS effectively limited its analysis to determining whether the magnitude of the OCAP's impact upon the smelt would be different from the Projects' impact under the regulatory historical baseline. FWS did not analyze how the absolute number of smelt taken during any given period of Project operations will impact overall smelt abundance at the time of the 2005 BiOp or in the future. Nor does the finding the smelt " still persists," even at the lowest recorded abundance levels, have any meaning if the smelt's " persistence" is at a level at or near extinction. Evaluating " persistence" instead of smelt population abundance is irrational, arbitrary, and runs counter to the evidence before the agency.

The Ninth Circuit, in *NWF v. NMFS*, 481 F.3d 1224 at *8, invalidated a biological opinion in part because it failed to view the agency action " in the present and future human and natural contexts." Here, the BiOp similarly fails to provide a scientific explanation for why it is appropriate to set incidental take without considering the most current smelt population data. This methodology fails to take most recent available natural conditions (i.e., the smelt's current and/or future population abundance) into consideration. For example, if the smelt's population is currently 600,000, it might be justifiable to permit a monthly take of over 30,000. However, if the smelt's current population is only 60,000, allowing 30,000 to be entrained in the pumps in a single month would represent a 50% reduction in smelt population. Even if the 30,000 figure was significantly lower than historic take, Defendant-Intervenors agree " that salvage impacts cannot be accurately identified without a population

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estimate." (Doc. 247 at 9 n. 13.)

***43** DWR asserts that, in setting the take limits, the BiOp took into consideration concerns expressed by experts that using historic information alone would not create an appropriate take limit. (*See* AR 4880, 5532, 5543). The first of the citations offered by DWR, an email sent by FWS's Wim Kimmerer to several individuals at DWR, EPA and elsewhere, states that there was some discussion at FWS about " getting away from take as the principle criterion governing management and recovery of delta smelt." (AR 4880.) The next page of this email goes on to admit that " determining what level of mortality is acceptable or ' safe' is going to be difficult ...*Ultimately ... this should be done through some sort of population model or viability analysis.*" (AR 4881 (emphasis added).) The other cited communications express similar concerns. (*See* AR 5532, 5543.) It is time to do it, yet FWS continues to profess the smelt population cannot be reliably measured.

DWR argues that, together, the take limits *and* the DSRAM address these concerns by moving the focus of management away from salvage. However, there is no way to know when or what measures will be taken under the DSRAM, which leaves the existing take limits as the only enforceable measures in the BiOp, [FN29] while the species heads toward extinction. Using flawed take limits and refusing to quantify smelt population and recent viability trends create substantial doubt about the reliability of the BiOp.

Defendants and Defendant-Intervenors suggest that sufficient information was simply not available to accurately determine smelt abundance.[FN30] Plaintiffs rejoin by referring to an email sent by Zachary Hymanson to Ryan Olah at FWS, with copies to others at concerned federal and state agencies. Mr. Hymanson opined: " I think we are at the point where we should report and use quantified estimates of the total number of individuals at the various life stages monitories. Quantified population and life stage estimates of fishes around the world are routinely made with A LOT less data than we have for delta smelt." (AR 7542 (emphasis in original).)

The viability of Delta smelt has been under scrutiny for over ten years. No party has shown that producing a reliable population estimate is scientifically unfeasible. Information does not have to be perfect or infallible for the agency to be required to use it to create a population estimate. *See Greenpeace II*, 80 F.Supp.2d at 1149-50 (finding it unlawful for agency to entirely ignore relevant factor and fail to analyze and develop projections regarding that factor based on information that was available); *see also Conner*, 848 F.2d at 1454 (biological opinion invalidated because agency failed to " use best information available to prepare comprehensive biological opinions considering all stages of agency action."). Without population estimates, it is arbitrary for the agency to conclude that project operations will not result in jeopardy simply because the projects will take relatively fewer smelt than they did in the past, in the face of the undisputed fact that the smelt population has been declining steadily in recent years. Failing to incorporate any information about smelt population abundance into the setting of the take limits is a fundamental failure rendering the BiOp arbitrary and capricious.

***44** The San Luis Parties' rationalization of FWS's approach, setting the incidental take limits using a model that does not take current abundance data into consideration, is that historic records reveal " either no, or perhaps a very weak relationship, between juvenile abundance measured by the TNS and adult abundance measured by the FMWT." (Doc. 247 at 5.) This " lack of [a] linear relationship between the two indices, shows that events after the TNS, in late summer and early fall, are probably affecting the number of juveniles that mature into spawners." (Doc. 247 at 6.) From the lack of a linear relationship, San Luis infers that something other than salvage (i.e. entrainment in the pumps) is causing the smelt's decline.[FN31]

The BiOp interprets the data differently:
In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for delta smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993).*This relationship does indicate, however, that factors affecting numbers of spawning adults* (e.g., *entrainment*, toxics, and predation) *can have an effect on delta smelt numbers the following year.*

(AR at 364 (emphasis added).) [FN32] Plaintiffs refer to other record evidence creating doubt that salvage is not a statistically reliable indicator of smelt abundance, including high entrainment events in the early 1980s and other " extreme events," including the El Niño of 1982-83, which caused significant declines in smelt abundance. (AR 8979.)

The BiOp acknowledges that salvage can have an impact on smelt abundance (although the statistical relationship is non-linear). It is arbitrary and capricious for FWS to

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base take limits on a projection of future salvage calculated without considering the most current or future smelt abundance and without reliable smelt population estimate.

Plaintiffs' motion for summary adjudication is **GRANTED** as to this issue. The BiOp's approach to setting incidental take limits is arbitrary and capricious because it fails to incorporate reliable smelt population data and the most recent information regarding smelt abundance.

3. Plaintiffs' Argument That the Biop Fails to Explain How its No Jeopardy Conclusion Can Be Justified in Light of the Identified Adverse Effects of the Project, along with Indirect and Cumulative Effects.

In formulating a biological opinion, the ESA requires FWS to determine " whether the action, *taken together with cumulative effects,* is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat." 50 C.F.R. § 402.14 (emphasis added). " Jeopardize the continued existence of" means " to engage in an action that reasonably would be expected, *directly or indirectly,* to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. § 402.02 (emphasis added).

***45** The BiOp concludes that the 2004 OCAP will have numerous direct and indirect impacts apart from salvage, including habitat loss, increased vulnerability of Delta smelt to predation, and increased vulnerability to adverse temperature effects. (*See* AR 399, 443-44.) Plaintiffs allege that, although the BiOp lists indirect impacts, it fails to explain how they relate to the potential for jeopardy.

Federal Defendants respond to this allegation with a single paragraph, asserting generally that " the biological opinion considers the effects of dozens of project components, each with a multi-layered analysis," and indicating how many times the topics of predation (18), temperature changes (180 references), life cycle impacts (75 references to the term " juveniles") are discussed in the BiOp. (Doc. 242 at 30.) What Federal Defendants do not do is point to those portions of the BiOp which analyze these issues in *a way that demonstrates why these indirect impacts will not cause jeopardy or how they relate to survival and recovery of the smelt.*A review of the BiOp does not reveal such an analysis.

The State Water Contractors suggest that the DSRAM trigger criteria were designed to address all of the potential impacts identified in the BiOp. (Doc. 241 at 8.) This leaves for future consideration and speculation the impacts events activating DSRAM triggers will have.

a. *Cumulative Impacts.*

Plaintiffs also argue that the BiOp fails to meaningfully address cumulative impacts, " those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." 50 C.F.R. § 402.02. The BiOp highlights a number of predicted cumulative effects:

Any continuing or future non-Federal diversions of water that may entrain adult or larval fish would have cumulative effects to the smelt. Water diversions through intakes serving numerous small, private agricultural lands contribute to these cumulative effects. These diversions also include municipal and industrial uses. State or local levee maintenance may also destroy or adversely modify spawning or rearing habitat and interfere with natural long term habitat-maintaining processes.

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include but are not limited to selenium and numerous pesticides and herbicides as well as oil and gasoline products associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for smelt, these contaminants may adversely affect fish reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants, used a[s] substrates for adhesive egg attachment, are lost due to toxic substances.

Other cumulative effects could include: the dumping of domestic and industrial garbage may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses reduce habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove habitat and may introduce pollutants into the water; agricultural uses on levees reduce riparian and wetland habitats; and grazing activities may degrade or reduce suitable habitat, which could reduce vegetation in or near waterways.

***46** (AR 468.) There is no quantitative and qualitative analysis of the potential impact of these cumulative effects on the smelt and its habitat, except to identify the causes, the BiOp concludes without explanation, " [t]he cumulative effects of the proposed action [are] not

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expected to alter the magnitude of cumulative effects on the above described actions upon the critical habitat's conservation function for the smelt." (*Id.*)

The San Luis Parties argue that FWS's no jeopardy conclusion and impacts analysis is " rationally based on its determination that the proposed future changes will not significantly increase the magnitude of the ongoing Project's potential impacts." (Doc. 247 at 9.) This conclusion is the kind of analysis recently rejected by the Ninth Circuit in *NWF v. NMFS:*

To " jeopardize the continued existence of" means " to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 CFR § 402.02; 16 U.S.C. § 1536(a)(2). NMFS argues that, under this definition, it may satisfy the ESA by comparing the effects of proposed FCRPS operations on listed species to the risk posed by baseline conditions. Only if those effects are " appreciably" worse than baseline conditions must a full jeopardy analysis be made. Under this approach, a listed species could be gradually destroyed, so long as each step on the path to destruction is sufficiently modest. This type of slow slide into oblivion is one of the very ills the ESA seeks to prevent.

Requiring NMFS to consider the proposed FCRPS operations in their actual context does not, as NMFS argues, effectively expand the " agency action" at issue to include all independent or baseline harms to listed species. Nor does it have the effect of preventing any federal action once background conditions place a species in jeopardy. To " jeopardize" -the action ESA prohibits- means to " expose to loss or injury" or to " imperil." Either of these implies causation, and thus some new risk of harm. Likewise, the suffix " -ize" in " jeopardize" indicates some active change of status: an agency may not " cause [a species] to be or to become" in a state of jeopardy or " subject [a species] to" jeopardy. American Heritage Dictionary of the English Language (4th ed.). Agency action can only " jeopardize" a species' existence if that agency action causes some deterioration in the species' pre-action condition.

Even under the so-called aggregation approach NMFS challenges, then, an agency only " jeopardize[s]" a species if it causes some new jeopardy. An agency may still take action that removes a species from jeopardy entirely, or that lessens the degree of jeopardy. *However, an agency may not take action that will tip a species from a state of precarious survival into a state of likely extinction. Likewise, even where baseline conditions already jeopardize a species, an agency may not take action that deepens the jeopardy by causing additional harm.*

***47** Our approach does not require NMFS to include the entire environmental baseline in the " agency action" subject to review. It simply requires that NMFS appropriately consider the effects of its actions " within the context of other existing human activities that impact the listed species." *ALCOA,* 175 F.3d at 1162 n. 6 (citing 50 C.F.R. § 402.02's definition of the environmental baseline).*This approach is consistent with our instruction (which NMFS does not challenge) that " [t]he proper baseline analysis is not the proportional share of responsibility the federal agency bears for the decline in the species, but what jeopardy might result from the agency's proposed actions in the present and future human and natural contexts."* *Pac. Coast Fed'n,* 426 F.3d at 1093 (emphasis added).

481 F.3d 1224 at *7-8 (emphasis added) (footnote omitted).

Here, the BiOp does not consider the cumulative effects of any future DSRAM actions, which it relies on to avoid jeopardy, nor does it meaningfully relate the most current abundance of the species to future OCAP operations to assess jeopardy. The BiOp unlawfully fails to adequately analyze indirect and cumulative impacts of the 2004 OCAP. Summary adjudication on this issue is appropriate.

E. *Did the BiOp Fail to Adequately Consider Impacts to Critical Habitat?*

Plaintiffs allege that the BiOp fails to adequately consider critical habitat in two respects. First, by failing to analyze the impacts of the 2004 OCAP on the value of critical habitat for *the recovery* as opposed to just the survival of the smelt. Second, failure to consider impacts to all of the Delta smelt's critical habitat because it focuses only on X2.

1. Did the BiOp Fail to Consider Whether 2004 OCAP Would Diminish Value of Critical Habitat for Recovery?

The ESA requires FWS to determine whether the 2004 OCAP will destroy or adversely affect Delta smelt critical habitat. 16 U.S.C. § 1536(a)(2)." Destruction or adverse modification of critical habitat" means " a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical

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or biological features that were the basis for determining the habitat to be critical." 50 C.F.R. § 402.02

Initially, the critical habitat analysis was conducted pursuant to agency regulations that defined adverse modification as:
[A] direct or indirect alteration that appreciably diminishes the value of critical habitat for **both survival *and* recovery** of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical.

50 C.F.R. § 402.02 (emphasis added).

Following the issuance of the 2004 BiOp, the Ninth Circuit invalidated the adverse modification regulation, based on its own interpretation of the regulation's language, " alteration that appreciably diminish the value of critical habitat for both the survival *and* recovery of a listed species," " reads the ' recovery' goal out of the adverse modification inquiry." *Gifford Pinchot,* 378 F.3d at 1069-70.

***48** The Bureau requested that FWS reinitiate consultation on the 2004 OCAP to ensure compliance with *Gifford Pinchot.*The result was the disputed 2005 BiOp, which expressly states that it does not rely on the invalidated regulation. (AR 248.) Rather, the BiOp " relied on the statutory provisions of the ESA to complete the analysis with respect to critical habitat." (*Id.*) The ESA defines critical habitat as including " the specific areas ... occupied by the species ... which are ... essential to the *conservation* of the species" and the " specific areas outside the geographical area occupied by the species ... that ... are essential for the *conservation* of the species...." 16 U.S.C. § 1532(5)(A). This statutory reference to " conservation" was the premise for the Ninth Circuit's *Gifford Pinchot* reasoning:
" Conservation" is a much broader concept than mere survival. The ESA's definition of " conservation" speaks to the recovery of a threatened or endangered species. Indeed, in a different section of the ESA, the statute distinguishes between " conservation" and " survival." Requiring consultation only where an action affects the value of critical habitat to both the recovery and survival of a species imposes a higher threshold than the statutory language permits

378 F.3d at 1070 (internal citation omitted).

The 2005 BiOp uses the term " conservation," rather than " survival" and/or " recovery," several times in connection with its critical habitat analysis. In the " Critical Habitat Effects" section, the BiOp states that the " primary constituent elements essential to conservation of the species will not be affected by the proposed project." (AR 423.) In addition, after discussing critical habitat, including those areas essential to spawning, transport, rearing and migration, the BiOp acknowledges impacts, but explains that after the proposed diversions in the OCAP are implemented " the primary constituent elements [of critical habitat] essential to the conservation of the species still function." (*Id.* at 371.)[FN33]What specific effects any DSRAM measures will have on the smelt are not described, nor is there discussion of how the survival and recovery of the smelt will be accomplished.

The Ninth circuit explained in *NWF v. NFMS,* that the agency must conduct a " full analysis" of risks to recovery.
*The question before us is not whether, on the merits, recovery risks in fact require a jeopardy finding here, but whether, as part of the consultation process, NMFS must conduct a**full analysis**of those risks and their impacts on the listed species' continued existence.*Although recovery impacts alone may not often prompt a jeopardy finding, NMFS's analytical omission here may not be dismissed as harmless: the highly precarious status of the listed fishes at issue raises a substantial possibility that considering recovery impacts could change the jeopardy analysis. The only reasonable interpretation of the jeopardy regulation requires NMFS to consider recovery impacts as well as survival.

***49** 481 F.3d 1224 at *9-*10 (emphasis added).[FN34]

Plaintiffs claim that although the BiOp includes generic promises to consider recovery of the smelt, it does not competently analyze nor provide for recovery. Federal Defendants and Defendant Intervenors respond that the BiOp's discussion of critical habitat effects, in conjunction with the BiOp's conclusion that " the smelt's primary constituent elements essential to the conservation of the species [will] still function" (AR 371) under the 2004 OCAP, is a sufficient analysis of the impacts on recovery.

The BiOp's overarching conclusion is that " the smelt's primary constituent elements essential to the conservation of the species [will] still function." In designating critical habitat for a listed species, FWS must " consider those physical and biological features that are essential to the conservation of [the] species and that may require special management considerations or protection." 50 C.F.R. § 424.12. The features that must be considered include, but are not limited to, the following:

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1. Space for individual and population growth, and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and
5. Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

Id. The BiOp explained that, in designating critical habitat for the Delta smelt, FWS identified the following primary constituent elements " essential to the conservation of the species" :Physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration.

* * *
Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.
Larval and juvenile transport. Adequate river flow is necessary to allow larvae from upstream spawning areas to move to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the " entrapment zone" or zone where particles, nutrients, and plankton are " trapped," leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.
***50** Rearing habitat. An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.
Adult migration. Adequate flow and suitable water quality is needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

(AR 368-69.)

The BiOp acknowledges that this Delta smelt critical habitat has been adversely affected by numerous activities, but indicates that the 1994 and 1995 OCAP BiOps " provide a substantial part of the necessary riverine flows and estuarine outflows that allow smelt larvae to move downstream to suitable rearing habitat ... outside the influence of marinas, agricultural diversions, and Federal and State pumping plant." (AR 371.) The BiOp also explains that increasing demands for surface water " would likely result in lower delta outflows and increased entrainment," but that the impacts of these demands " have not altered critical habitat's conservation function for the delta smelt, and *the smelt's primary constituent elements essential to the conservation of the species still function."* (*Id.*) Finally, the BiOp concludes:
In evaluating the Status of the Species for critical habitat and the Environmental Baseline, while there are current actions that result in adverse effects to delta smelt critical habitat, the primary constituent elements continue to remain functional for the smelt. In the effects section, the Service determined that the primary constituent elements of delta smelt critical habitat would not be affected by the proposed project since there will not be a loss of physical habitat in the delta, river flows will continue to provide habitat, salinity will not be affected by the proposed project, and no breeding habitat will be affected and the sustainability of the food base will not be affected. In the cumulative effects section, we determined that the cumulative effects of the proposed action are not expected to alter the magnitude of future actions' effects on critical habitat's conservation function for the smelt. Based on the analysis in these four areas, it is our conclusion that Critical habitat is not likely to be adversely modified or destroyed as a result of implementing the proposed project.

(AR 469 (emphasis added).)

These conclusions are not supported by most recent smelt data to corroborate that the primary constituent elements of Delta smelt habitat will still function in a manner consistent with conservation (i.e.recovery). The functions and their locations are identified, but impacts upon

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breeding habitat are not analyzed. Second, although " there will still be water in the Delta....whether the water will be of adequate quality and quantity to allow the delta smelt to recover is an entirely different question." (Doc. 306 at 25.) The BiOp does not *analyze* the water supply, temperature, and quality under variable conditions with results that demonstrate the impact on smelt, nor is such an analysis found elsewhere in the administrative record.[FN35]

***51** The analysis of the predicted movement of X2 is more specific. When X2 is located upstream of Chipps Island, smelt are vulnerable to entrainment and are located in an area that is not ideal for feeding or protection. (*See* AR 424.) FWS opines that smelt reproduce better when X2 remains in a specific area, west of the confluence of the Sacramento and San Joaquin Rivers. That smelt reproduction is increased and the fish may be located where there are better sources of food does not assure that the smelt are on a path to *recovery*.The DSRAM is to provide the means by which FWS will maintain X2 in the most beneficial location. As the DSRAM is uncertain, speculative, and lacking enforceable action measures, there is no reasonable assurance that X2 will be maintained in the necessary protective location.

DSRAM utilizes other trigger criteria, arguably aimed at the recovery of the smelt. (Doc. 241 at 13-14.) One criteria is the " recovery index trigger," derived from the September and October FMWT sampling. (AR 347; Sommer Decl. at ¶ 9a.) The number used to trigger the DSWG is 74, the median value of the recovery index for the 1980-2002 period. Whenever the recovery index falls below this median, the DSWG convenes to decide whether to recommend actions. (AR 346-47.) Use of the term " recovery" in the title of the trigger index, suggests that this index will serve to monitor the potential for the smelt population to recover. This title is inaccurate. All that this trigger criteria monitors is whether the abundance of smelt drops below the 1980-2002 median abundance. As smelt have been in decline throughout the period to February 2005, the opinion that maintaining abundance slightly above this median leads to recovery of the smelt is unjustified.

The temperature trigger criterion of 12-18°C, the range within which the *most* smelt spawning occurs, is more arguably focused on recovery. (AR 347.) If the number of days falling within the temperature range is 39 days or less by April 15, or 50 days or less by May 1, DSWG is triggered. This trigger is arguably related to the recovery of smelt, because it focuses on spawning. However, no action except a group meeting is required in response to the trigger. Moreover, maximizing the potential for smelt to spawn is only one aspect of recovery. If Project operations and/or other impacts kill more smelt than are produced during spawning, recovery does not occur. The existence of this trigger, alone, does not establish that recovery of smelt was adequately considered or addressed.[FN36]

2. *The Biop Does Not Adequately Assess Impacts to All Areas of Critical Habitat.*

Plaintiffs also allege that the BiOp arbitrarily ignores impacts to certain areas of critical habitat because it focuses on X2 as a proxy for Delta smelt habitat. Plaintiffs argue that the focus on X2 ignores other areas of designated critical habitat.

The BiOp focuses on the impact project operations have had and will have on the position of X2. Defendants and Defendant-Intervenors argue that critical habitat will be protected, because any impacts to the position of X2 will be addressed by the DSRAM. The State Water Contractors contend that protecting critical habitat outside X2 " makes no sense if they are not the areas in which the fish resides." (Doc. 241 at 17.)

***52** Plaintiffs do not dispute the notion that X2 directly relates to where most smelt are located. Rather, Plaintiffs maintain that critical habitat is not coextensive with X2. The BiOp identifies numerous areas in which smelt occur (AR 362) and acknowledges that X2 " does not necessarily regulate smelt distribution in all years." (*Id.*) Delta smelt critical habitat is defined by physical boundaries:

California-Areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Montezuma Slough; and the existing contiguous waters contained within the Delta, as defined by section 12220, of the State of California's Water Code of 1969 (a complex of bays, dead-end sloughs, channels typically less than 4 meters deep, marshlands, etc.) as follows:

Bounded by a line beginning at the Carquinez Bridge which crosses the Carquinez Strait; thence, northeasterly along the western and northern shoreline of Suisun Bay, including Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; thence, upstream to the intersection of Montezuma Slough with the western boundary of the Delta as delineated in section 12220 of the State of California's Water Code of 1969; thence, following the boundary and including all contiguous

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water bodies contained within the statutory definition of the Delta, to its intersection with the San Joaquin River at its confluence with Suisun Bay; thence, westerly along the south shore of Suisun Bay to the Carquinez Bridge.

59 Fed.Reg. 65,256, 65,277 (Dec. 19, 1994).

Federal Defendants respond that " the agencies have developed an operating and adaptive management system that adequately protects the existing critical habitat, that reasonably uses X2 as an evaluation tool, and that also ensures that ' additional measures' will be taken in accordance with the DSRAM to affirmatively and proactively manage habitat, as needed." (Doc. 242 at 26.) But, apart from the X2 analyses, Federal Defendants identify no other record evidence that reflects the agency *analyzed* impacts to critical habitat or that any " additional measures" will be required under DSRAM, as the DSRAM does not require any measure be implemented.

Defendant Intervenors assert that it is unnecessarily costly to accommodate impacts to all of the geographically designated critical habitats because the smelt are not located in the entirety of their critical habitat range all of the time. They argue the focus must be on protecting the habitat occupied by the smelt. Even if more sensible, the law requires that the agency analyze whether project operations will directly or indirectly alter critical habitat in a way that " appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species." 50 C.F.R. § 402.02. " Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical." *Id.* The statute defines critical habitat to include both " the specific areas within the geographical area occupied by the species ... on which are found those physical or biological features ... essential to the conservation of the species" *and*" specific areas outside the geographical area occupied by the species ... upon a determination by the Secretary that such areas are essential for the conservation of the species." 16 U.S.C. § 1532(5)(A). The definition of critical habitat is broader than the specific areas of occupation.

***53** Here, the agency defined critical habitat to have a geographic scope. Absent any alterations to the critical habitat designation, the agency must address in the BiOp the full extent of impacts to the currently designated critical habitat,[FN37] which excluded " already degraded areas." Alternatively, the Delta smelt's critical habitat should be redefined to reflect the actual location of the smelt, if such redesignation would be consistent with law.

This has not been done. Plaintiffs motion for summary adjudication is **GRANTED** as to this issue.

F. *Did the BiOp Fail to Address the Impacts of the Whole Project?*

1. Plaintiffs' Argument That the Biop Should Have Analyzed the Effects of Constructing the SDIP, Intertie, and FRWP.

Plaintiffs complain that the BiOp's scope is unlawfully narrow because it fails to consider all planned actions. The BiOp includes within its formal consultation, " delivery of CVP water to the proposed Freeport Regional Water Project (FRWP)" as well as the " operation of the SWP-CVP intertie." The BiOp designates as an early consultation issue " operations of components of the South Delta Improvement Program (SDIP)," which include " permanent barrier operations in the South Delta." (AR 248.) The effects of constructing the FRWP, the Intertie, and the permanent barriers are to be covered in separate formal consultations. (AR 256, 339, 341, 421.)

The ESA requires FWS to address impacts associated with the entire agency action. *See* *Conner*, 848 F.2d at 1453-54 (holding that agency violated ESA by choosing not to analyze the effects of all stages of oil and gas activity on federal lands). According to ESA regulations, the effects of an agency action include " direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline." 50 C.F.R. § 402.02. " The meaning of ' agency action' is determined as a matter of law by the Court, not by the agency." *Greenpeace II*, 80 F.Supp.2d at 1146 (citing *Pacific Rivers Council v. Thomas*, 30 F.3d 1050, 1054 (9th Cir.1994).)

The BiOp explains its approach to scope as follows:
The proposed action is to continue to operate the CVP and SWP in a coordinated manner. In addition to current day operations, several future actions are to be included in this consultation. These actions are: (1) increased flows in the Trinity River, (2) 8500 Banks, (3) permanent barriers operated in the South Delta, (4) an intertie between the California Aqueduct (CA) and the Delta-Mendota Canal (DMC), (5) a long-term EWA, (6) delivery of CVP water to the FRWP, and (7) various operational changes that are identified in this project description. Some of these items will be part of early consultation including 8500 Banks,

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permanent barriers and the long-term EWA. These proposed actions will come online at various times in the future. Thus, the proposed action is continued operation of the Project without these actions, and operations as they come online.
***54** The actions listed in the preceding paragraph are not being implemented at present; however, they are part of the future proposed action on which Reclamation is consulting. Only the operations associated with the proposed activities are addressed in this consultation; i.e., the activities do not include construction of any facilities *to implement* the actions. All site specific/localized activities of the actions such as construction/screening and any other site specific effects will be addressed in separate action specific section 7 consultations.

(AR at 256 (emphasis added).) In sum, only those aspects of the 2004 OCAP that will be implemented without further approval were the subject of formal consultation. However, certain other changes that will be effectuated in the future were the subject of early consultation. With respect to future operational changes, including some subject to formal consultation, full implementation will require the construction of specified facilities. The impact of the construction activities themselves will be the subject of separate § 7 consultation.

Plaintiffs argue that the BiOp should have addressed the full impacts of construction of the Intertie, Freport diversion, and the SDIP because those projects are within the scope of the agency action as a whole and are " interrelated and interdependent" with the 2004 OCAP.FN38

In response, Federal Defendants cite the Endangered Species Consultation Handbook, which explains, in a hypothetical example, that operation of an existing dam project need not be considered an interrelated or interdependent activity, where the agency action being evaluated in a biological opinion was the addition of a new turbine to an existing dam.FN39(Handbook at 4-25 to 4-29.) Although not cited by the Federal Defendants for this purpose, the Handbook also describes a general approach FWS should use when determining whether certain actions are " interrelated or interdependent," so as to be considered part of the action:
Interrelated and interdependent actions: Effects of the action under consultation are analyzed together with the effects of other activities that are interrelated to, or interdependent with, that action. An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. (Note: the regulations refer to the action under consultation as the " larger action" [50 CFR § 402.02]) ....
As a practical matter, the analysis of whether other activities are interrelated to, or interdependent with, the proposed action under consultation should be conducted by applying a " but for" test. *The biologist should ask whether another activity in question would occur " but for" the proposed action under consultation.*If the answer is " no," that the activity in question would not occur but for the proposed action, then the activity is interrelated or interdependent and should be analyzed with the effects of the action. If the answer is " yes," that the activity in question would occur regardless of the proposed action under consultation, then the activity is not interdependent or interrelated and would not be analyzed with the effects of the action under consultation. There will be times when the answer to this question will not be apparent on its face. The biologist should ask follow-up questions to the relevant parties to determine the relationship of the activity to the proposed action under consultation. It is important to remember that interrelated or interdependent activities are measured against the proposed action. That is, the relevant inquiry is whether the activity in question should be analyzed with the effects of the action under consultation because it is interrelated to, or interdependent with, the proposed action. Be careful not to reverse the analysis by analyzing the relationship of the proposed action against the other activity. For example, as cited below, if the proposed action is the addition of a second turbine to an existing dam, the question is whether the dam (the other activity) is interrelated to or interdependent with the proposed action (the addition of the turbine), not the reverse.

***55** Section 7 Handbook at 4-26.

Here, applying the Handbook test, the question is whether the other activities (construction and operation of SDIP, Freeport, and the Intertie) are interrelated to or interdependent with the proposed actions subject to formal consultation? The formal consultation, as described in the BiOp, covers
... the proposed 2020 operations of the CVP including the Trinity River Mainstem ROD (Trinity ROD) flows on the Trinity River, the increased water demands on the American River, the *delivery of CVP water to the proposed Freeport Regional Water Project (FRWP),* water transfers, the long term Environmental Water Account (EWA), the operation of the Tracy Fish Facility, and *the operation of the SWP-CVP intertie.*The effects of operations of the SWP are also included in this opinion

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and include the operations of the North Bay Aqueduct, the Suisun Marsh Salinity Control Gates, the Skinner Fish Facility and water transfers.

(AR 248 (emphasis added).) The formal consultation admittedly covers *delivery* of CVP water to the proposed FRWP and operation of the Intertie. But, the BiOp expressly excludes the impacts of construction associated with FRWP or the Intertie:The actions listed in the preceding paragraph [including permanent barriers in the South Delta, an intertie, and the FRWP] are not being implemented at present; however, they are part of the future proposed action on which Reclamation is consulting. *Only the operations associated with the proposed activities are addressed in this consultation; i.e., the activities do not include construction of any facilities to implement the actions.*All site specific/localized activities of the actions such as construction/screening and any other site specific effects will be addressed in separate action specific section 7 consultations.

(AR 256 (emphasis added).)

Is there a " but-for" relationship between the 2004 OCAP and the new projects? The FRWP and the Intertie are designed to more effectively distribute CVP and SWP waters. There is no evidence in the record indicating that construction of either project is tied in any way to the pre-approval of delivery of water to the projects. Flow operations could be approved *after* or simultaneously with the approval of new construction. Under the Handbook test, the construction projects are not considered interdependent and interrelated. These projects may be consulted upon separately. By approving a flow regime before the construction, the Bureau may plann for the *possibility* that the FRWP will be constructed in the future. The entire OCAP BiOp would not need to be revised should the projects be constructed. This is a reasonable approach.

With respect to the SDIP, the BiOp currently excludes *both* its operation and related construction coverage under the formal consultation. Plaintiffs allege that *both* should have been covered by the BiOp because they are interrelated with or interdependent on the agency action. Applying the Handbook analysis, the operation and construction of the SDIP (which includes increased pumping at Banks and operation of permanent barriers) will not occur " but for" the approval of the 2004 OCAP for CVP-SWP operations? Each action is independent of the 2004 OCAP. The SDIP is a separate addition that may or may not be constructed. Project operations under the 2004 OCAP in no way depend upon the SDIP. There is no prohibition to addressing the future operation, if and when the construction of the SDIP will occur, in a separate consultation.

***56** Plaintiffs' motion for summary adjudication is **DENIED** as to the future projects issue.

2. Plaintiffs' Argument that the BiOp Failed to Analyze the Impact of Full Contract Deliveries.

A biological opinion must consider the effects of the entire agency action, meaning " all activities or programs of any kind authorized, funded, or carried out," including " the granting of ... contracts." 50 C.F.R. § 402.02. One of the primary purposes of the 2004 OCAP is to " deliver water supplies to affected water rights holders as well as project contractors." (AR 259.) The Bureau delivers water to numerous parties pursuant to long-term contracts (" CVP Contracts"), some of which were renewed shortly after the BiOp was issued. (AR 4732, 4796, 4855.)

The CALSIM II model incorporated water deliveries into its various flow scenarios, but only performed its analysis based on the effects of delivering between 11 and 89 percent of the full CVP Contract allocations. (*See* AR 1067; see also Doc. 242 at 31 (acknowledging that the agency " did not evaluate the impacts of 100% percent delivery of all contracted waters").) This range of delivery scenarios is based on historic average water deliveries.

Plaintiffs allege that, by failing to evaluate the impact of delivering full amount (100%) of contracted water, the BiOp violates the requirement that the it evaluate the entire agency action. Plaintiffs cite *Rodgers*, 381 F.Supp.2d at 1237-40, which examined a biological opinion approving long term water contracts in the Friant, Buchanan, and Hidden water units of the CVP. The BiOp only examined the impacts of the amount of historical water deliveries, which amounted to less than half of the water deliveries authorized under the long term water service contracts. *Id.* at 1237-28.
The Friant long-term contracts cumulatively authorized the Bureau to deliver more than 2.1 million acre-feet of water per year, for twenty-five years. Rather than analyzing the effects of 2.1 million acre-feet of water delivery, FWS explained that its " effects analysis is conducted under the expectation that water will be delivered to CVP service contractors in quantities that approximate historic deliveries (1988 through 1997), as given in Appendix D of the November 21, 2000 programmatic long-term CVP contracts consultation."

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This assumption was made, the BiOp explained, because " delivery of full contract quantities is unrealistic."

Id. at 1238. *Rodgers* rejected FWS's approach, reasoning that the " ESA requires that all impacts of agency action-both present and future effects-be addressed in the consultation's jeopardy analysis." The fact that it was thought by FWS that " delivery of full contract quantities is unrealistic" and that " deliveries continue to be impacted by existing climate, hydrology, actions and statutes, ... socio-economic factors" does not excuse consulting on the " entire agency action," which was the authorized delivery of over 2.1 million acre-feet of water, and nothing less than that.

***57** *Id.* at 1239.

Federal defendants assert that the *Rodgers* decision was wrong, arguing that " [a]bsent alternative information that the agency failed to consider, and given the fact that the agency did use the best available information, the *Rodgers* court should have deferred to the agency." (Doc. 242 at 32.) It is not the province of another district court to decide whether *Rodgers* is " wrong." *Rodgers* is distinguishable as it specifically addressed the government authorization of CVP water users' long-term water service contracts. Those contracts authorized 2.1 MAF of water deliveries in total. *Rodgers* found unlawful the biological opinion's limitation in its scope to approximate historic deliveries, instead of the full contract allocations. Here, however, the agency action subject to consultation is not the authorization or merits of the water service contracts, rather, it is the *operation* of the CVP and SWP under the OCAP and whether those projected operations will cause jeopardy to the survival and recovery of smelt or smelt habitat. The government is entitled to make *reasonable* assumptions about the operational volume of water flows, water levels, temperature, and quality based on the historical and projected data in the administrative record. The BiOp explains that the delivery of full water service contract entitlements is expected only when excess water conditions exist, i.e., in a wet water year when sufficient water is available to meet all beneficial needs. (AR 259.) Plaintiffs do not suggest that this assumption is factually impossible. (Nor would it be unreasonable for FWS to model a full (100%) water contract delivery scenario, even if it has not happened in the past fifteen years.) The agency model for the worst case scenario is indispensable. Analysis of a " best of the best" case in a wet water year is not indispensable, as such " wet" water year conditions do not present any reasonable likelihood of jeopardy, absent an additional showing. However, because such a scenario could eventuate, it is not unlawful for the agency to analyze the effects on the smelt of 100% water contract deliveries. However, the 100% delivery analysis is not required. This is a matter committed to the agency's expertise and discretion.

Plaintiffs motion for summary adjudication is **DENIED** as to this issue.

As the history of the many CVP water cases decided in this court evidences, the duty to defer to the agency's expertise is well recognized and honored, when the agency has acted reasonably and lawfully to discharge its statutory responsibilities. The disputed BiOp depends in material measure for its no jeopardy finding on the DSRAM, which is legally insufficient. The agency's recognition the Delta smelt is increasingly in jeopardy; that its operative BiOp is inadequate, as evidenced by its second initiation of reconsultation for the 2004 OCAP, now pending, and its insistence that it will nonetheless operate the Projects under the challenged BiOp is unreasonable. The agency could have, but did not, offer a viable protective alternative. Adaptive management is within the agency's discretion to choose and employ, however, the absence of any definite, certain, or enforceable criteria or standards make its use arbitrary and capricious under the totality of the circumstances.

***58** The agency's failure to reasonably estimate the Delta smelt population and to analyze most recent smelt abundance data make the take limits based on historical data unreliable and unreasonable. The Delta smelt is undisputedly in jeopardy as to its survival and recovery. The 2005 BiOp's no jeopardy finding is arbitrary, capricious, and contrary to law.

For all the reasons set forth above, the 2005 OCAP BiOp is unlawful and inadequate on the following grounds:
(1) The DSRAM, as currently structured, does not provide a reasonable degree of certainty that mitigation actions will take place, even if the agency retains the discretion to draw upon numerous sources of water, not just the EWA, CVPIA(b)(2), and VAMP programs, to support fish protection.
(2) The agency failed to utilize the best available scientific information by not addressing the 2004 FMWT data and the issue of climate change.
(3) The BiOp's historical approach to setting take limits fails to consider take in the context of most recent overall species abundance and jeopardy.
(4) The BiOp did not adequately consider impacts to critical habitat by (a) failing to analyze how project

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operations will impact the value of critical habitat for the recovery of the smelt and (b) failing to consider impacts upon the entire extent of known smelt critical habitat.

The Plaintiffs' motions for summary judgment are GRANTED IN PART AND DENIED IN PART, as delineated above.

Based on the legally flawed BiOp, an appropriate interim remedy must be implemented. All parties agree that it is not prudent to impose a remedy without further input from the parties. A separate remedies hearing will be scheduled within thirty days at the parties' mutual convenience.[FN40] During oral argument, Federal Defendants and Defendant-Intervenors jointly requested a stay of any order finding the BiOp unlawful to avoid the draconian consequences of operating the CVP-SWP without a lawful take limit. Affording all parties the opportunity to participate in a remedies hearing will not jeopardize the species or the public interest during interim operation of the projects. Plaintiffs did not object to such an approach.

A Scheduling Conference is set for May 30, 2007, at 8:45 a.m. in Courtroom 3 to afford the parties time for discussions to set a remedies hearing, and to consider the entry of a stay, if necessary.

Plaintiffs shall submit a form of order on the motions for summary judgment consistent with this decision within five (5) days following service of this decision.

IT IS SO ORDERED.

FN1. The Delta smelt was listed as a threatened species under the ESA, March 5, 1992, 58 Fed.Reg. 12863.

FN2. The biological opinion was first issued in July 2004. Then, after reconsultation, was reissued in February 2005.

FN3. All " AR" references are to the administrative record provided by the U.S. Fish and Wildlife Service..

FN4. Whether the 2004 OCAP is a " final agency action" for the purposes of the National Environmental Policy Act is at issue in a related lawsuit, *Pacific Coast Federation of Fishermen's Associations v. Gutierrez*, 1:06-cv-00245 OWW (TAG) (" *PCFFA*"). This overview of the OCAP does not prejudge the merits of the pending motion to dismiss in *PCFFA.*

FN5. The OCAP itself does not plan for increased pumping or the construction or operation of any new facilities, nor does it describe or model flow regimes under any of these future plans. These planned operational changes are set forth in the BA and the BiOp. (*See* AR 381-423 (describing the effects of those actions included in formal consultation, including re-operation of the Trinity River, increased demands on the American River, operation of the Freeport Regional Water Project (" FRWP"), and operation of an intertie between the Delta-Mendota Canal and the California Aqueduct); AR 357-61 (describing the " items for early consultation," including operation of components of the South Delta Improvement Project, which calls for pumping at Banks to increase to 8500 cfs, operation of permanent barriers in various places within the Delta, the operation of a long term EWA, the use of CVP/SWP capacity to facilitate expanded water transfers, and further integration of CVP/SWP operations.)

FN6. The first step in the consultation process is usually the preparation of a Biological Assessment (" BA") by the action agency (in this case, the Bureau), the purpose of which is to " evaluate the potential effects of the action on listed [ ] species and designated [ ] critical habitat and determine whether any such species or habitat are likely to be adversely affected by the action...." 50 C.F.R. § 402.12(a). In this case, the Bureau issued its BA regarding the " Long-Term Central Valley Project and State Water Project Operations and Criteria Plan" on June 30, 2004. (AR 729.) The BA describes the project on which consultation is being held, both early and formal, in much the same terms as are used in the BiOp.

FN7. Prior to 2004, the OCAP operated under Biological Opinions issued in 1993 and 1995.

FN8. Pelagic fish live in open water, generally away from vegetation or the bottom. (AR 365.) A significant amount of the smelt's habitat are the Delta waters and waters of surrounding areas.

FN9. The BiOp contradictorily acknowledges that " although salvage is used to index delta

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smelt take, it does not reliably index delta smelt entrainment." (AR 419.)

FN10. These " hard" take limits, as the Defendants and Defendant Intervenors referred to them during oral argument are different from a separate take trigger that is part of the DSRAM process described below.

FN11. DWR insisted during oral argument that the data used to run the CALSIM II models was not " salvage" data but was rather " density data." The BiOp is explicit that the models were run using a " salvage density" estimate generated from periodic samplings of salvaged fish.

FN12. The information contained in these tables was derived by the court from the BiOp but was not presented in this form in the BiOp.

FN13. The tables at pages 414 and 419 of the AR do not list the absolute number of smelt estimated to be taken in any given month under the 1995 regulatory base case (Study No. 1). However, the incidental take limits (set forth in the Table 3 below) were based on the absolute numbers of smelt that are projected to be taken under Study No. 5a. For example, the take limit for the month of May in a Critically Dry year, set at 30,500, under the CALSIM II results in a reduction of the 30,500 to 18,921 (representing 11,652 reduction in CVP salvage plus 7,269 reduction in SWP salvage) *lower* than the 1995 regulatory base case.

FN14. The DSRAM also includes a chart illustrating when during the year each of these actions will be available. (AR 346.)

FN15. In a footnote at the end of Plaintiffs' motion to strike the Sommer Declaration, Plaintiffs also challenge Federal Defendants' reliance on the declaration of Ann Lubas-Williams, which Federal Defendants filed with their response to Plaintiffs' motion for summary judgment/cross motion to dismiss. (*See* Doc. 242-4.) The Lubas-Williams declaration concerns the implementation of DSRAM and the sources from which DWR plans to obtain water to protect Delta smelt in the near future. Federal defendants relied on her declaration primarily to support their motion to dismiss or for voluntary remand. No party has relied upon this declaration in the context of the pending motions; it was not considered by the court. It is unnecessary to rule on this motion to strike.

FN16. Federal Defendants also cite *Pension Benefit Guar. Corp. v. LTV Corp.*, 496 U.S. 633, 654-655, 110 S.Ct. 2668, 110 L.Ed.2d 579 (1990), in which the Supreme Court reasoned: " Here, unlike in *Overton Park*, the Court of Appeals did not suggest that the administrative record was inadequate to enable the court to fulfill its duties under § 706."
Federal Defendants quote *Pension Benefit* entirely out of context. The quoted language is drawn from a part of the opinion addressing the Second Circuit's ruling about the adequacy of *procedures* used by the defendant agency. Specifically, that court ruled that the agency acted arbitrarily and capriciously because it failed to apprise the plaintiff of the material on which it was to base its decision, never gave plaintiff an adequate opportunity to offer contrary evidence, failed to proceed according to ascertainable standards, and failed to provide plaintiff a statement showing its reasoning. *Id.* at 653.One party claimed that *Overton Park* validated a court's order that an agency undertakes additional procedures.*Id.* The Supreme Court rejected this argument, reasoning that, at most, *Overton Park*" imposes a general ' procedural' requirement of sorts by mandating that an agency take whatever steps it needs to provide an explanation that will enable the court to evaluate the agency's rationale at the time of decision." *Id.* at 654.The Supreme Court then distinguished *Overton Park*, reasoning that " [h]ere, unlike in *Overton Park*, the Court of Appeals did not suggest that the administrative record was inadequate to enable the court to fulfill its duties under § 706." *Id.* at 655.This was a specific reference to language in *Overton Park* which criticized the lower courts for relying only on the litigation affidavits, rather than the whole administrative record. *Pension Benefit* sheds absolutely no light on the admissibility of extra-record evidence.

FN17. At least one district court has followed the holding in *American Rivers.See NRDC v. Rodgers*, 381 F.Supp.2d 1212, 1230 (E.D.Cal.2005).

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FN18.*Rumsfeld* also found fault with the biological opinion's monitoring plan, characterizing it as a means of delaying the implementation of necessary mitigation measures:
The Army may not delay identifying the measures necessary to mitigate the effects of its ten-year plan based on the monitoring provisions in the Final BO....
The Final BO's monitoring requirements do not measure the success or failure of the on-base and/or regional mitigation measures to reduce the groundwater deficit. It only requires the Army to develop " a monitoring program designed to assess progress," and requires an annual review of the AWRMP, as to which projects have been implemented the past year and which are to be implemented in the coming year. Especially since the Final BO and the AWRMP fail to quantify the remedial value of the proposed projects, simply reporting project implementation is not a meaningful assessment of the success or failure of the mitigation measures in protecting the water umbel, willow flycatcher, and critical habitat from adverse impact. Such an assessment would require systematic monitoring of either San Pedro baseflows or the groundwater aquifer.
198 F.Supp.2d at 1154 (internal record citations omitted). No such failure is alleged here. Plaintiffs do not suggest that the monitoring called for by the DSRAM is flawed.

FN19. In *NWF v. Babbit,* the district court expressly approved the design of the HCP as a whole, but invalidated the permit issued in connection with the plan on grounds wholly independent from the design of the HCP and/or the adaptive management plan. *See 128 F.Supp.2d* at 1298-99.

FN20. The only clearly enforceable standard or benchmark in the BiOp is compliance with the BiOp's " hard" take exceedence limits. But, the existence of enforceable take limits does not shield the DSRAM from scrutiny. There is no provision to allow the " hard" take exceedence limits to be adjusted to reflect new information about the species. Moreover, the BiOp expressly recognizes that the take limits alone are not enough to prevent jeopardy, requiring, among other things, implementation of the DSRAM as a reasonable and prudent measure. (*See* AR 475 (" The Project shall be implemented as described.") This is exactly the reason why the DSRAM must be made more certain and enforceable.

FN21. As of the date of oral argument, the mandate has not yet issued in *NWF v. NMFS.*

FN22. Plaintiffs cite another district court decision that applied the benefit of the doubt language: " To the extent that there is any uncertainty as to what constitutes the best scientific information, Congress intended for the agency to ' give the benefit of the doubt to the species.' " *Ctr. for Biological Diversity v. Bureau of Land Mgmt.,* 422 F.Supp.2d 1115, 1127 (N.D.Cal.2006) (citing *Conner,* 848 F.2d at 1454). However, that district court did not apply the " benefit of the doubt" concept in its analysis in any way, let alone as a presumption governing the agency's analysis of scientific information.
Another case Plaintiffs cite, *Rock Creek Alliance v. U.S. Fish & Wildlife Service,* 390 F.Supp.2d 993, 1003 (D.Mont.2005), does not support imposing a " benefit of the doubt" presumption to uncertain scientific evidence:
Though the agency has discretion to make decisions based in its expertise, the ESA expresses a legislative mandate " to require agencies to afford first priority to the declared national policy of saving endangered species.... Congress has spoken in the plainest of words, making it abundantly clear that the balance has been struck in favor of affording endangered species the highest of priorities, thereby adopting a policy which it described as ' institutionalized caution.' "
Id. (quoting *Tennessee Valley Authority v. Hill,* 437 U.S. 153, 185, 98 S.Ct. 2279, 57 L.Ed.2d 117 (1978)). However, as in *Center for Biological Diversity,* this language was part of a general discussion of the legal framework; the *Rock Creek* court never applied a benefit of the doubt presumption in the manner Plaintiffs suggest it should be applied here.

FN23. Defendants and Defendant-Intervenors dispute whether the data " evoked grave concern." The degree of concern is irrelevant to the inquiry, as it is undisputed that the 2004 FMWT data showed the lowest smelt abundance on record.

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FN24. The State Water Contractors maintain that CVP/SWP operations have been on-going for decades, during which time Delta smelt abundance has fluctuated greatly.

FN25. Plaintiffs' record citations, AR 9199-9202, are print-outs of the FMWT data which post date the issuance of the BiOp.

FN26. Abundance data is relevant to aspects of the BiOp that are independent of the DSRAM process. For example, the agency's conclusion that the level of anticipated take " is not likely to result in jeopardy to the smelt because this level of take is at or below historical levels of take" (AR 474), is irrational because no consideration is given to the current decline in smelt abundance nor any explanation provided how the further decline of the smelt does not exacerbate jeopardy to the species' survival and recovery.

FN27. Plaintiffs argue that " [r]egardless of the uncertainty involved in predicting the consequences of climate change, FWS had an obligation under the ESA to address the probable effects on Delta smelt." (Doc. 232 at 7.) In response, the State Water Contractors quote the following passage from *Bennett v. Spear*, 520 U.S. 154, 176-177, 117 S.Ct. 1154, 137 L.Ed.2d 281 (1997), in support of the proposition that the ESA intended to preclude exactly this kind of argument:

The obvious purpose of the requirement that each agency " use the best scientific and commercial data available" is to ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise. While this no doubt serves to advance the ESA's overall goal of species preservation, we think it readily apparent that another objective (if not indeed the primary one) is to avoid needless economic dislocation produced by agency officials zealously but unintelligently pursuing their environmental objectives.

But, this passage from *Bennet* was part of a broader discussion holding that persons who are economically burdened by a decision made under the ESA fall within the zone of interests the statute protects for the purposes of standing. *Bennet* sheds little light on the current inquiry-whether and to what extent the data that was before the FWS regarding climate change should have been considered and addressed in the BiOp.

FN28. There is no basis to determine what weight FWS should ultimately give the climate change issue in its analysis.

FN29. There is no recognized mechanism for introducing any population viability data, collected through the adaptive management process, into the setting of the take limits.

FN30. The San Luis Parties mischaracterize Plaintiffs argument as a request for FWS to undertake additional research projects. (Doc. 247.) Defendant Intervenors are correct that FWS is not required to undertake new research, *Greenpeace Action v. Franklin*, 14 F.3d 1324, 1335 (9th Cir.1992) (agency may proceed despite uncertainty about accuracy of modeling effort); Southwest Ctr for Biological Diversity, 215 F.3d 58, 60 (D.C.Cir.2000) (agency could rely on inconclusive data to make decision; not obligated to conduct new independent studies). Plaintiffs do point out that FWS acknowledges in the AR that an accurate determination of non-jeopardy would require knowledge of how many smelt existed, what proportion would be lost due to the projects, and what level of loss would be sustainable. (Doc. 232 at 23 (citing AR 8221).) However, the crux of Plaintiffs' concern is that FWS has not developed such population data and ignored important existing data on abundance in setting the take limits.

FN31. The Administrative Record reflects various explanations for the lack of a linear relationship between the TNS and the FMWT. (AR 1025-26.) One possible explanation for why the number of spawning age smelt (indexed by the FMWT) seems to be a poor predictor of subsequent offspring (indexed by the TNS) is that there is some environmental factor (not directly related to entrainment at the projects) limiting survivability, inferring that there is a carrying capacity for the population. (*Id.*) Alternatively, some scientists question whether it is proper to try to draw statistical conclusions from the entire 1969-2002 data pool, given that the smelt experienced a precipitous decline in 1981. These scientists have postulated that the data " may reflect two different relationships from two time periods with different delta smelt carrying capacities." (*Id.* at 1026.)One study cited in the AR indicates that food supply may

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be the limiting factor during this time period. (AR 8976.)

FN32. The San Luis Parties raise numerous questions regarding FWS's conclusion that there is a statistical relationship between the numbers of spawning adults and Delta smelt abundance the following year, criticizing the statistical analyses referenced in the BiOp. (Doc. 247 at 5.) It is unnecessary to adjudicate these issues, as the San Luis Parties have not separately challenged the conclusions reached in the BiOp on this ground nor have they moved for summary judgment on any issue in this case.

FN33. Defendant-Intervenors argue that, because of these mentions of " conservation," FWS is entitled to a " presumption of regularity," and the court must *assume* that agency considered recovery. (Doc. 247 at 12.) In *Gifford Pinchot,* after invalidating the destruction and adverse modification regulation, the Ninth Circuit considered whether it should presume that the agency followed its own regulation that was valid at the time the biological opinion was issued. The Ninth Circuit concluded that, because the agencies must be afforded a " presumption of regularity," a court must assume that the agency followed the then applicable regulation.*Id.* at 1072.Applying this presumption here, given that the agency specifically applied the statute, not the invalid regulation, there is no evidence the agency applied an invalid regulation. However, Defendant-Intervenors' suggestion that the presumption should be applied to validate the BiOp's *analysis* of recovery is misplaced. The agency still has an obligation to thoroughly consider the issue of recovery and to reach a reasoned conclusion based on the evidence in the administrative record.

FN34. Although this portion of *NWF v. NMFS* concerned analysis of recovery in the context of the " no jeopardy" determination, as opposed to the " destruction or adverse modification of critical habitat" analysis, the holding is equally applicable to habitat jeopardy.

FN35. There is also merit to Plaintiffs' argument that " [g]iven that the very same sorts of impacts to critical habitat have contributed to the species decline, one might expect FWS to examine carefully how the continuance and magnification of these kinds of impacts could allow for the survival of the species, much less its recovery." (Doc. 306 at 5.)

FN36. The San Luis Parties correctly note that the CALSIM II models indicate that increased pumping capacity and operational flexibility may actually *increase* the smelt's prospects vis-a-vis the regulatory baseline. However, that the species will fare better than in the past does not assure that the totality of OCAP operations are consistent with the smelt's recovery.

FN37. Plaintiffs raise an additional contention why the critical habitat analysis is insufficient; i.e., that the BiOp unlawfully " writes off" areas of critical habitat because they have already been degraded. For example, the BiOp concludes that " [a]n upstream movement of X2 of 0.5 km would not be significant when [X2] is located upstream of the [Sacramento-San Joaquin River] confluence because *smelt habitat is already poor* and the upstream movement does not result in any substantial additional loss of habitat or increase in adverse effects." (AR 443.) This issue need not be reached, as the critical habitat analysis is insufficient on other grounds. Federal Defendants are already revising the BiOp to reflect new information and new law.

FN38. The San Luis Parties cite *Gifford Pinchot* in support of the proposition that this is a properly " tiered" biological opinion. *In Gifford Pinchot,* the Ninth Circuit approved for the the tiering of a biological opinion for timber harvests in specified forest areas. The no jeopardy conclusion contained in that biological opinion relied on compliance with a very thorough, overarching forest management plan that was previously approved by the court. 378 F.3d at 1067-68. *Gifford Pinchot* allowed the agency to tier its BiOp of a timber harvest with a programmatic forest management plan that provided guidelines regarding the harvesting of timber. *Rodgers,* 381 F.Supp.2d at 1228 n. 27, interpreted the holding narrowly to apply tiering only to cases in which the programmatic opinion was particularly thorough. Tiering of future construction projects is not appropriate here, because the BiOp provides no programmatic guidelines regarding construction activities. However, just because the later projects cannot

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be " tiered" off the current BiOp does not mean they must be included in the current BiOp. The relevant inquiry is whether the construction projects are interrelated to and/or interdependent upon the BiOp and the 2004 OCAP.

FN39. Federal Defendants correctly point out that the FWS uses as a guidance document the ESA Section 7 Consultation Handbook (March 1998), available at " http:/ / www.fws.gov/endangered/consultations/s7hndbk /s7hndbk.htm" (last visited Apr. 27, 2006).*See e.g.*, *Oregon Natural Res. Council v. Allen,* 476 F.3d 1031, 1039 n. 7 (9th Cir.2007); *Ariz. Cattle Growers' Ass'n v. U.S. Fish & Wildlife Serv.*, 273 F.3d 1229 (9th Cir.2001).

FN40. The parties stated that they may be able to reach an agreement as to interim remedies, avoiding the need for a remedies hearing.

E.D.Cal.,2007.
Natural Resources Defense Council v. Kempthorne
--- F.Supp.2d ----, 2007 WL 1577896 (E.D.Cal.)

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California Court of Appeal, Second District, Division Six, "*Santa Clarita Organization for Planning the Environment v. County of Los Angeles* (2007) 157 Cal.App.4th 149" (2007)

Santa Clarita Organization for **Planning** the **Environment** v. **County** of **Los Angeles**
Cal.App. 2 Dist.,2007.

Court of Appeal, Second District, Division 6, California.
SANTA CLARITA ORGANIZATION FOR **PLANNING** THE **ENVIRONMENT** et al., Plaintiffs and Appellants,
v.
COUNTY OF **LOS ANGELES**, Defendant and Respondent;
Newhall Land and Farming Company et al., Real Parties in Interest and Respondents.
No. B189116.

Nov. 26, 2007.

Background: **Environmental organizations** petitioned for writ of mandate, requesting that court order **county** to vacate resolution certifying final **environmental** impact report (EIR) which approved development project. The trial court denied the petition, **organizations** appealed, and the Court of Appeal, 106 Cal.App.4th 715, 131 Cal.Rptr.2d 186, reversed. On remand after **county** revised and recertified EIR, the Superior Court, **Santa** Barbara **County**, No. 1043805,James W. Brown, J., again denied petition. **Organizations** appealed. The Court of Appeal, 66 Cal.Rptr.3d 559, affirmed, but granted rehearing, vacating its opinion.

Holdings: The Court of Appeal, Gilbert, P.J., held that:
(1) law of the case did not bar **organizations**' challenge to water transfer in revised EIR;
(2) EIR was not inadequate as it related to water transfer involved in pending litigation; and
(3) EIR was not required to discuss funding to remediate perchlorate contamination of local water wells.

Affirmed.

West Headnotes

[1] Environmental Law 149E 695

149E Environmental Law
149EXIII Judicial Review or Intervention
149Ek694 Determination, Judgment, and Relief
149Ek695 k. In General. Most Cited Cases
Court of Appeal's finding that water service portion of environmental impact report (EIR) for residential subdivision did not comply with California Environmental Quality Act (CEQA) did not bar, under doctrine of law of the case, environmental organizations' subsequent challenge to specific water transfer in revised EIR; Court of Appeal had stated no principle or rule of law bearing on the adequacy of the EIR's discussion of this water transfer, and silence on issue did not transform issue into law of the case. West's Ann.Cal.Pub.Res.Code § 21005(c).

[2] Appeal and Error 30 1097(1)

30 Appeal and Error
30XVI Review
30XVI(M) Subsequent Appeals
30k1097 Former Decision as Law of the Case in General
30k1097(1) k. In General. Most Cited Cases

Appeal and Error 30 1195(1)

30 Appeal and Error
30XVII Determination and Disposition of Cause
30XVII(F) Mandate and Proceedings in Lower Court
30k1193 Effect in Lower Court of Decision of Appellate Court
30k1195 As Law of the Case
30k1195(1) k. In General. Most Cited Cases
Where an appellate court states in its opinion a principle or rule of law necessary to its decision, that principle or rule becomes the "law of the case," which must be adhered to both in the lower court and upon subsequent appeal, even if the court that issued the opinion becomes convinced in a subsequent consideration that the former opinion is erroneous.

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[3] Environmental Law 149E 614

149E Environmental Law
149EXII Assessments and Impact Statements
149Ek612 Evidence
149Ek614 k. Presumptions, Inferences, and Burden of Proof. Most Cited Cases
Under California Environmental Quality Act (CEQA), an environmental impact report (EIR) approved by the appropriate governmental agency is presumed adequate, and the party challenging the EIR has the burden of showing otherwise. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[4] Environmental Law 149E 689

149E Environmental Law
149EXIII Judicial Review or Intervention
149Ek677 Scope of Inquiry on Review of Administrative Decision
149Ek689 k. Assessments and Impact Statements. Most Cited Cases
A party may challenge an environmental impact report (EIR) by showing the agency has abused its discretion either by reaching factual conclusions unsupported by substantial evidence or by failing to proceed in the manner California Environmental Quality Act (CEQA) provides. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[5] Environmental Law 149E 689

149E Environmental Law
149EXIII Judicial Review or Intervention
149Ek677 Scope of Inquiry on Review of Administrative Decision
149Ek689 k. Assessments and Impact Statements. Most Cited Cases
Where the alleged defect in an environmental impact report (EIR) under California Environmental Quality Act (CEQA) is that the agency's conclusions are not supported by substantial evidence, courts must accord deference to the agency's factual conclusions and may not weigh conflicting evidence to determine who has the better argument. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[6] Environmental Law 149E 689

149E Environmental Law
149EXIII Judicial Review or Intervention
149Ek677 Scope of Inquiry on Review of Administrative Decision
149Ek689 k. Assessments and Impact Statements. Most Cited Cases
Courts may not set aside an agency's approval of an environmental impact report (EIR) under California Environmental Quality Act (CEQA) on the ground that an opposite conclusion would have been equally or more reasonable. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[7] Environmental Law 149E 689

149E Environmental Law
149EXIII Judicial Review or Intervention
149Ek677 Scope of Inquiry on Review of Administrative Decision
149Ek689 k. Assessments and Impact Statements. Most Cited Cases
Where the alleged defect in an environmental impact report (EIR) is that the agency has failed to proceed in a manner provided by California Environmental Quality Act (CEQA), judicial review is de novo. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[8] Environmental Law 149E 599

149E Environmental Law
149EXII Assessments and Impact Statements
149Ek598 Adequacy of Statement, Consideration, or Compliance
149Ek599 k. In General. Most Cited Cases
An agency that fails to require an applicant to disclose information mandated by California Environmental Quality Act (CEQA) and to include that information in the environmental impact report (EIR), fails to proceed in a manner prescribed by CEQA. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[9] Environmental Law 149E 599

149E Environmental Law
149EXII Assessments and Impact Statements
149Ek598 Adequacy of Statement, Consideration, or Compliance
149Ek599 k. In General. Most Cited Cases
Where a party challenges an environmental impact report (EIR) under California Environmental Quality

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Act (CEQA) because it fails to disclose evidence that conflicts with its conclusions, the party must show that the failure to disclose the conflicting evidence precludes informed decision making or informed public participation. West's Ann.Cal.Pub.Res.Code § 21000 et seq.

[10] Environmental Law 149E 604(3)

149E Environmental Law
149EXII Assessments and Impact Statements
149Ek598 Adequacy of Statement, Consideration, or Compliance
149Ek604 Particular Projects
149Ek604(3) k. Waters and Water Courses; Dams and Flood Control. Most Cited Cases
Under California Environmental Quality Act (CEQA), water service portion of environmental impact report (EIR) for residential subdivision was not inadequate as it related to availability of water from water transfer agreement involved in pending litigation; EIR acknowledged that litigation made transfer legally uncertain, but substantial evidence supported finding that degree of uncertainty was small as transfer was intended to be permanent and any adverse outcome in litigation was unlikely to "unwind" transfer agreement in light of existing law and contracts. West's Ann.Cal.Pub.Res. Code § 21000 et seq.
See 12 Witkin, Summary of Cal. Law (10th ed. 2005) Real Property, § 840 et seq.; 9 Miller & Starr, Cal. Real Estate (3d ed. 2001) § 25:182 et seq.; Cal. Jur. 3d, Pollution and Conservation Laws, § 543 et seq.; Cal. Civil Practice (Thomson/West 2003) Environmental Litigation, § 8:17 et seq.

[11] Environmental Law 149E 604(3)

149E Environmental Law
149EXII Assessments and Impact Statements
149Ek598 Adequacy of Statement, Consideration, or Compliance
149Ek604 Particular Projects
149Ek604(3) k. Waters and Water Courses; Dams and Flood Control. Most Cited Cases
Under California Environmental Quality Act (CEQA), environmental impact report (EIR) for residential subdivision was not required to discuss funding to remediate perchlorate contamination of local water wells, since nothing suggested that described mitigation measures would not be implemented. West's Ann.Cal.Pub.Res. Code § 21000 et seq.

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****452** OPINION ON REHEARING

GILBERT, P.J.
152** In ***Santa Clarita Organization** for **Planning** the **Environment** v. **County** of **Los Angeles (2003) 106 Cal.App.4th 715, 131 Cal.Rptr.2d 186 (*Scope I*), we held that the water service portion of an **environmental** impact report (EIR) must analyze the actual amount of water that will be available for a project. In *Scope I*, the EIR for the West Creek residential subdivision did not comply with the California **Environmental** Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.).[FN1] It relied on contractual entitlements to water. Because this water is not of the "wet" variety, it has been called "paper water."

FN1. All statutory references are to the Public Resources Code unless otherwise stated.

After remand, the **County** of **Los Angeles** (**County**) revised and recertified the West Creek EIR. **Santa Clarita Organization** for **Planning** the **Environment** (SCOPE) again challenges the water services portion of the EIR. This time, SCOPE focuses on the EIR's analysis of a water transfer agreement and remediation costs for perchlorate contamination of water wells. The trial court denied SCOPE's petition for writ of administrative mandate.

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After the trial court denied SCOPE's petition, our Supreme Court decided *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 53 Cal.Rptr.3d 821, 150 P.3d 709*(Vineyard).* *Vineyard* states four principles governing the analysis of the water services portion of an EIR. We conclude the West Creek EIR satisfies all four principles.

FACTS

Background

In the 1950s, the Legislature and the voters approved the State Water Project (SWP). It was designed to deliver 4.23 million acre-feet of water annually. It is managed by the Department of Water Resources (DWR).

The DWR contracted to deliver water to water agencies throughout the state. The contracts entitle the agencies to specified amounts of water calculated on the designed capacity of the SWP. Only half of the SWP was constructed. The completion of the SWP was an expectation that has not grown beyond a hope. There is no reasonable expectation that the original plan will ever be completed. This leaves a vast difference between the amount of water to which the local agencies are entitled, and the amount of water the SWP can actually deliver.

***153** A drought in the 1990s highlighted the disparity between water entitlements and actual water. Agricultural and urban agencies disputed how shortfalls in water delivery would be allocated. The interested parties met in Monterey, and produced the Monterey Agreement.

Under the Monterey Agreement, the DWR and the contracting water agencies agreed to a statement of 14 principles. One principle provided for the permanent sale of water among agencies. The Castaic Lake Water Agency (Castaic) purchased 41,000 acre-feet per year (afy) from the Kern County Water Agency. Castaic serves the Santa Clarita Valley area, and the 41,000 afy constitutes over 40 percent of the 95,200 afy available to Castaic.

The Monterey Agreement scuttled the term "entitlement" to describe the amount of water the SWP has contracted to deliver to local water agencies. Instead, the agreement uses the term "Table A Amount." Table A of the agreement lists ****453** the contracting agencies and the amount of water the SWP has contracted to deliver. The change is not substantive.

In *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 100 Cal.Rptr.2d 173 (*PCL*), the court ordered the EIR for the Monterey Agreement decertified. The court determined that the EIR was prepared by the wrong lead agency, a water agency instead of the DWR, and failed to consider the "no project" alternative. Because the EIR for the Kern-Castaic 41,000 afy transfer was "tiered" on the Monterey Agreement EIR, the EIR for the Kern-Castaic transfer was also ordered decertified. (*Friends of Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1387, 116 Cal.Rptr.2d 54(*Friends*).) Although the EIRs for the Monterey Agreement and the Kern-Castaic transfer were decertified, the projects were not enjoined. The agreements remain in effect to this day.

On July 22, 2002, the parties to the *PCL* litigation that decertified the Monterey Agreement EIR entered into a settlement agreement approved by the Sacramento County Superior Court. The settlement agreement requires the DWR as the lead agency to prepare a new EIR for the Monterey Agreement. The settlement agreement acknowledges that certain water transfers listed in Attachment E to the settlement agreement are final, and the parties agree not to challenge those transfers. The Kern-Castaic transfer is not listed in Attachment E. Instead, the settlement agreement provides:

"*Acknowledgement and Agreement Regarding Kern-Castaic Transfer*.With respect to ... the Kern-Castaic Transfer, the Parties recognize that such water transfer is subject to pending litigation in the Los Angeles County Superior Court following remand from the Second District Court of Appeal (See ***154** *Friends of the Santa Clara River v. Castaic Lake Water Agency*, 95 Cal.App.4th 1373, 116 Cal.Rptr.2d 54 (2002); *review denied* April 17, 2002). The Parties agree that jurisdiction with respect to that litigation should remain in that court and that nothing in this Settlement Agreement is intended to predispose the

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remedies or other actions that may occur in that pending litigation."

In 2004, Castaic certified a revised EIR for the Kern-Castaic transfer. This EIR is not tiered on the Monterey Agreement EIR. SCOPE's opening brief states that Castaic's EIR is being challenged in **Los Angeles County** Superior Court by **environmental** groups.

West Creek

West Creek is a proposed mixed residential and commercial development in the **Santa Clarita** Valley area of northern **Los Angeles County**. The project includes 2,545 housing units, 180,000 square feet of commercial retail space and 46 acres of community facilities. The **County** served as the lead agency in preparing the EIR for the project. The project developers are The Newhall Land and Farming Company and Valencia Corporation (hereafter collectively Newhall).

SCOPE challenges the **County's** certification of the West Creek EIR. The trial court denied SCOPE's petition for a writ of administrative mandate. We reversed on the ground that the EIR's evaluation of the availability of the water supply was inadequate. (*Scope I, supra*, 106 Cal.App.4th 715, 131 Cal.Rptr.2d 186.) The EIR relied on water entitlements instead of actual water in analyzing water availability. (*Ibid.*)

The County revised the water supply analysis, and recertified the EIR. SCOPE challenges the water supply analysis in the ****454** recertified EIR. This time it opposes the 41,000 afy Kern-Castaic water transfer.

The recertified EIR states that Castaic's total maximum SWP water allocation is 95,200 afy. The Kern-Castaic transfer accounts for 41,000 afy of that. The EIR acknowledges that the EIR for the Monterey Agreement and the original EIR for the Kern-Castaic transfer were decertified.

With regard to the status of the Kern-Castaic transfer, the EIR states:

"The [Kern-Castaic] transfer of SWP Table A Amount was the type of water transfer that fell within the provisions of the Monterey Agreement. As stated above, under the Monterey Agreement, certain SWP agricultural contractors agreed that 130,000 AF of their Table A Amount could be ***155** transferred to urban contractors. The [Castaic] 41,000-AF acquisition was a part of the 130,000 AF of SWP Table A Amount, which has been transferred under the Monterey Agreement.

"... The Monterey Agreement provides ... for those transfers by the participating SWP contractors, thus facilitating transfers of Table A Amounts from agricultural to urban SWP contractors. As stated above, the environmental documentation for the Monterey Agreement has been decertified. However, the ... legal proceedings (*Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 100 Cal.Rptr.2d 173 [*PCL litigation*]) did not invalidate ... the Monterey Agreement or enjoin[ ] either the Monterey Agreement or further implementation of the Monterey Agreement.

"In addition, the subsequent Settlement Agreement in the *PCL litigation* did not invalidate or otherwise enjoin the Monterey Agreement.

"Even in the absence of the Monterey Agreement, [Castaic's] permanent acquisition of an additional 41,000 AF of SWP Table A Amount could occur under existing SWP water supply contract provisions, subject to appropriate environmental review.

"Nothing in the existing SWP water supply contracts, or applicable law, prohibit such water transfers with or without the Monterey Agreement. The Monterey Agreement simply provides a specific vehicle for accomplishing transfers of SWP Table A Amounts from agricultural to urban SWP contractors; the amendments under the Monterey Agreement are not the exclusive means by which that Amount may be transferred. In support of that fact, in 1981 (almost 15 years before the Monterey Agreement), the entire SWP Table A Amount of the Hacienda Water District was permanently transferred to the Tulare Lake Basin Water Storage District, pursuant to an agreement approved by DWR.

"The acquisition could proceed as a water transfer under existing law. See, e.g., Water Code §§ 382, 383

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(authority for transferring surplus water) and Water Code §§ 1745, et seq. (authority for transferring non-surplus water). The Kern County Water Agency has reaffirmed its willingness to allow transfers of up to 130,000 AF of SWP table A Amounts under pre-Monterey Agreement conditions and/or under the terms of the Settlement Agreement....

"Finally, [Castaic] is not a party to the pending Monterey Agreement litigation (*Planning Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 100 Cal.Rptr.2d 173). Although not a party, an adverse final judgment invalidating the Monterey Agreement could affect [Castaic's] completed ***156** acquisition of the 41,000 AF, which ****455** could in turn impair [Castaic's] supply of SWP water through its contracts with DWR and other SWP contractors. Nevertheless, [Castaic] believes that an adverse outcome in the Monterey Agreement litigation is not likely to adversely affect [Castaic's] water supplies over the long-term because (a) [Castaic] believes that such a result is unlikely to 'unwind' executed and completed agreements with respect to the permanent transfer of SWP water amounts; (b) existing SWP water supply contract provisions allow such transfers (without the need for the Monterey Agreement); and (c) existing law enables [Castaic] to enter into contracts outside the context of the Monterey Agreement."

The EIR also discloses that there is perchlorate contamination in six water wells that will comprise part of the water service for West Creek. The EIR identifies remediation measures, but does not identify any source of funding for those measures.

DISCUSSION

I

[1] Newhall contends the doctrine of law of the case bars SCOPE's Kern-Castaic transfer arguments.

[2] Where an appellate court states in its opinion a principle or rule of law necessary to its decision, that principle or rule becomes the law of the case. (*Clemente v. State of California* (1985) 40 Cal.3d 202, 211, 219 Cal.Rptr. 445, 707 P.2d 818.) The law of the case must be adhered to both in the lower court and upon subsequent appeal. (*Ibid.*) This is true even if the court that issued the opinion becomes convinced in a subsequent consideration that the former opinion is erroneous. (*Ibid.*)

But our former opinion in this case (*Scope I*) stated no principle or rule of law bearing on the adequacy of the West Creek EIR's discussion of the Kern-Castaic transfer. Newhall attempts to turn silence into positive effect by citing section 21005, subdivision (c). The subdivision requires that our opinion discuss all the alleged grounds for noncompliance with CEQA. Newhall concludes that because we did not discuss the Kern-Castaic transfer in *Scope I*, we approved the transfer.

Newhall cites no authority, however, for the proposition that not discussing an issue as required by section 21005, subdivision (c), transforms that issue into law of the case. In *Friends, supra*, 95 Cal.App.4th at page 1387, 116 Cal.Rptr.2d 54, on which Newhall relies, after finding one of appellant's contentions meritorious, the court expressly stated it considered all of appellant's other contentions ***157** and found them without merit. *(iBid.)FRiends* does not discuss the effect of a failure to consider an issue, and does not even mention the doctrine of law of the case. If Newhall believed we failed to discuss an issue raised in *Scope I*, its remedy was a timely petition for rehearing. (Cal. Rules of Court, rule 8.268 (formerly cited as rule 25).) The time for such a petition has long since passed.

Moreover, we discussed all issues raised in *Scope I*. SCOPE mentioned the Kern-Castaic transfer in its opening brief, but SCOPE did not raise the transfer as an issue. In fact, Newhall argued that we could not consider *Friends*, the decision that decertified the Kern-Castaic transfer EIR, because it occurred after the County approved the West Creek project. Newhall pointed out that once a project is approved, new information does not require reopening the approval. (*Scope I, supra*, 106 Cal.App.4th at p. 723, 131 Cal.Rptr.2d 186.) SCOPE replied that it cited *Friends* only to show that SWP entitlements cannot be taken at face value. ****456** (*Ibid.*) Thus, at Newhall's urging, we did not consider in *Scope I* the issues SCOPE now raises. They arose after the County's initial approval of the project. Newhall cites no authority that prevents us from considering issues that arose prior to the recertification of the EIR.[FN2]

FN2. SCOPE contends the EIR's failure to

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properly analyze the Kern-Castaic transfer violated the terms of the remittitur in *Scope I*. It follows from what we have said that the contention has no merit. We did not consider the Kern-Castaic transfer in *Scope I*, and it was not within the terms of our remittitur in that case.

II

Newhall contends SCOPE waived its perchlorate contamination arguments by failing to appeal them. Newhall argues SCOPE's claim is waived because it is essentially identical to that denied by the trial court in the first challenge to the project's EIR.

But SCOPE's first challenge to the project's EIR concerned disclosure of the extent of perchlorate contamination of local water wells. SCOPE did not appeal the trial court's denial of that challenge. Here SCOPE is not challenging the EIR's disclosure of the extent of perchlorate contamination. Instead, it is challenging the mitigation measures suggested by the EIR. That issue is not substantially identical to the issue raised in the first challenge. There has been no waiver.

III

[3][4] We now consider SCOPE's challenge to the West Creek EIR. An EIR approved by the appropriate governmental agency is presumed adequate, and ***158** the party challenging the EIR has the burden of showing otherwise. (*Barthelemy v. Chino Basin Mun. Water Dist.* (1995) 38 Cal.App.4th 1609, 1617, 45 Cal.Rptr.2d 688(*Barthelemy*).) A party may challenge an EIR by showing the agency has abused its discretion either by reaching factual conclusions unsupported by substantial evidence or by failing to proceed in the manner CEQA provides. (*Vineyard, supra*, 40 Cal.4th at p. 435, 53 Cal.Rptr.3d 821, 150 P.3d 709.)

[5][6] In evaluating an EIR for CEQA compliance, we must adjust our scrutiny to the nature of the alleged defect. (*Vineyard, supra*, 40 Cal.4th at p. 435, 53 Cal.Rptr.3d 821, 150 P.3d 709.) Where the alleged defect is that the agency's conclusions are not supported by substantial evidence, we must accord deference to the agency's factual conclusions. (*Ibid.*) We may not weigh conflicting evidence to determine who has the better argument. (*Ibid.*) Thus we may not set aside an agency's approval of an EIR on the ground that an opposite conclusion would have been equally or more reasonable. (*Ibid.*)

[7][8][9] Where the alleged defect is that the agency has failed to proceed in a manner provided by CEQA, our review is de novo. (*Vineyard, supra*, 40 Cal.4th at p. 435, 53 Cal.Rptr.3d 821, 150 P.3d 709.) An agency that fails to require an applicant to disclose information mandated by CEQA and to include that information in the EIR, fails to proceed in a manner prescribed by CEQA. (*Ibid.*) Where a party challenges an EIR because it fails to disclose evidence that conflicts with its conclusions, the party must show that the failure to disclose the conflicting evidence precludes informed decision making or informed public participation. (*Barthelemy, supra*, 38 Cal.App.4th at p. 1617, 45 Cal.Rptr.2d 688.)

IV

[10] SCOPE challenges the adequacy of the EIR's water supply analysis as it relates to the Kern-Castaic transfer.

****457** Recently, our Supreme Court in *Vineyard* articulated four principles for analysis of future water supplies under CEQA:

"First, CEQA's informational purposes are not satisfied by an EIR that simply ignores or assumes a solution to the problem of supplying water to a proposed land use project. Decision makers must, under the law, be presented with sufficient facts to 'evaluate the pros and cons of supplying the amount of water that the [project] will need.' [Citation.]" (*Vineyard,supra*, 40 Cal.4th at pp. 430-431, 53 Cal.Rptr.3d 821, 150 P.3d 709.)

"Second, an adequate environmental impact analysis for a large project, to be built and occupied over a number of years, cannot be limited to the water supply for the first stage or the first few years. While proper tiering ***159** of environmental review allows an agency to defer analysis of certain details of later phases of long-term linked or complex projects until those phases are up for approval, CEQA's demand for meaningful information 'is not satisfied by simply stating information will be provided in the future.' [Citation.]" (*Vineyard, supra*, 40 Cal.4th at p. 431,

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53 Cal.Rptr.3d 821, 150 P.3d 709.)

"Third, the future water supplies identified and analyzed must bear a likelihood of actually proving available; speculative sources and unrealistic allocations ('paper water') are insufficient bases for decisionmaking under CEQA. [Citation.] An EIR for a land use project must address the impacts of *likely* future water sources, and the EIR's discussion must include a reasoned analysis of the circumstances affecting the likelihood of the water's availability. [Citation.]" (*Vineyard, supra*, 40 Cal.4th at p. 432, 53 Cal.Rptr.3d 821, 150 P.3d 709.)

"Finally, where, despite a full discussion, it is impossible to confidently determine that anticipated future water sources will be available, CEQA requires some discussion of possible replacement sources or alternatives to use of the anticipated water, and of the environmental consequences of those contingencies. [Citation.] The law's informational demands may not be met, in this context, simply by providing that future development will not proceed if the anticipated water supply fails to materialize. But when an EIR makes a sincere and reasoned attempt to analyze the water sources the project is likely to use, but acknowledges the remaining uncertainty, a measure for curtailing development if the intended sources fail to materialize may play a role in the impact analysis. [Citation.]" (*Vineyard, supra*, 40 Cal.4th at p. 432, 53 Cal.Rptr.3d 821, 150 P.3d 709.)

The West Creek EIR does not simply ignore or assume a solution to the problem of supplying water to the project. It identifies specific water sources, including the Kern-Castaic transfer. Nor is the EIR's water supply analysis limited to the first stage or the first few years of the project. The EIR analyzes the Kern-Castaic transfer as part of the permanent supply for the entire project.

SCOPE's concerns center on the third principle articulated in *Vineyard*, that "the future water supplies identified and analyzed must bear a likelihood of actually proving available...."(*Vineyard, supra*, 40 Cal.4th at p. 432, 53 Cal.Rptr.3d 821, 150 P.3d 709.)

SCOPE challenges the EIR's conclusion that an adverse outcome in the Monterey Agreement litigation is unlikely to affect Castaic's water supplies over the long term. The EIR supports this conclusion by stating that an adverse outcome in the Monterey Agreement litigation is unlikely to "unwind" existing agreements for permanent transfer of SWP water amounts, ****458** and that existing law and contracts allow transfers without the need for the Monterey Agreement.

***160** SCOPE argues the EIR fails to disclose that the Kern-Castaic transfer is not final and permanent. SCOPE points out that the Kern-Castaic transfer is not included among the water transfers listed as final and permanent in the Monterey Settlement Agreement.

But the Monterey Settlement Agreement makes it clear that the Kern-Castaic transfer is not listed among the final transfer agreements because its EIR is subject to pending litigation in the Los Angeles Superior Court. (Citing *Friends, supra*, 95 Cal.App.4th 1373, 116 Cal.Rptr.2d 54.) SCOPE points to no evidence that the parties to the Monterey Settlement Agreement consider the transfer as anything other than permanent now that the revised EIR for the transfer has been certified. The Monterey Settlement Agreement did not make the Kern-Castaic transfer temporary. A disclosure that the Monterey Settlement Agreement does not include the Kern-Castaic transfer on its list of final transfer agreements adds nothing substantial to an understanding of water availability.

In *California Oak Foundation v. City of Santa Clarita* (2005) 133 Cal.App.4th 1219, 1237-1238, 35 Cal.Rptr.3d 434, the court reviewed the adequacy of the discussion of the Kern-Castaic transfer contained in an EIR for an unrelated project. The court determined the EIR was inadequate because it failed to discuss the legal uncertainty of the Kern-Castaic transfer; specifically, the uncertainty created by the decertification of the transfer's original EIR.

In contrast, here the EIR discloses that the Monterey Agreement litigation makes the Kern-Castaic transfer legally uncertain. The EIR states that a judgment invalidating the Monterey Agreement could affect Castaic's acquisition of the 41,000 acre feet of water. The EIR concludes, however, that as a practical matter an adverse outcome in the Monterey Agreement litigation is unlikely to "unwind" the transfer agreement. Contrary to SCOPE's argument,

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this conclusion is supported by reasoned analysis. The EIR points out that the Kern-Castaic transfer is intended to be permanent, and that the transfer can be valid even without the Monterey Agreement.

SCOPE argues the Monterey Agreement is necessary to validate the Kern-Castaic transfer because all transfers of SWP water require the DWR's consent. SCOPE cites no authority that expressly requires the DWR's consent for water transfers. Instead, SCOPE reasons the DWR's consent is required because it controls the SWP facilities necessary for delivery of the water. Assuming DWR's consent is necessary, SCOPE cites no authority that the consent must come through the Monterey Agreement. In fact, the EIR discloses that the transfer of surplus and nonsurplus water is authorized by statute. (Water Code, §§ 382, 383, 1745 et seq.) The EIR also notes that at ***161** least one Table A Amount of water was permanently transferred with the DWR's consent almost 15 years prior to the Monterey Agreement.

Quite aside from the Monterey Agreement, the legislative policy of this state is to facilitate water transfers. (See Water Code, §§ 475, 480 et seq.) SCOPE points to no evidence whatsoever that the DWR has any inclination to disapprove the Kern-Castaic transfer even if the Monterey Agreement is ultimately invalidated.

SCOPE points to a letter from the DWR to Castaic dated July 30, 2004. The letter is in an appendix to the West Creek EIR. ****459** The letter states that the DWR staff has reviewed the draft EIR for the Kern-Castaic transfer and found that the document "adequately and thoroughly discusses the proposed project and its impacts," and provides a good discussion of the relationship between the Kern-Castaic transfer and the current Monterey Agreement process. The letter also states that the DWR is using a new model to assess the potential impacts of Table A transfers in preparing the revised Monterey Agreement EIR. It acknowledges that Castaic used an earlier model to analyze the effect of the Kern-Castaic transfer. It states that the use of the new model "may cause slight changes in results, which may lead DWR to different conclusions than the conclusions made by [Castaic] in the current EIR."Nevertheless, the letter states Castaic's draft EIR adequately discusses SWP reliability and pre- and post-Monterey Agreement conditions.

SCOPE argues the West Creek EIR is deficient in that it fails to include or discuss information that a new water model may lead the DWR to different conclusions than those made by Castaic and its draft EIR. But the letter describes any possible change in result as "slight." The letter does not state that the slight change in results will probably lead to different conclusions; it says only that it "may" lead to unspecified different conclusions. It is highly improbable that a slight change in results will lead to radically different conclusions. In fact, the letter praises the draft EIR's discussion of the proposed project and its impacts. The information contained in the letter adds nothing substantial to West Creek's EIR.

SCOPE argues the EIR is devoid of any factual discussion of the impacts of the *PCL* decision on the West Creek project. But the EIR discloses that a final judgment invalidating the Monterey Agreement could impair Castaic's supply of SWP water. The EIR goes on to state that such a result is unlikely because the Kern-Castaic transfer can be validated outside the Monterey Agreement. SCOPE cites no authority for the proposition that the West Creek EIR must discuss the factors the DWR will be required to consider in preparing a revised Monterey Agreement EIR. The Kern-Castaic transfer is not dependent on the Monterey Agreement. Such a discussion is not necessary for informed decision making or public participation.

***162** SCOPE cites *Vineyard, supra*, 40 Cal.4th at p. 440, 53 Cal.Rptr.3d 821, 150 P.3d 709, for the proposition that it is improper for an EIR to tier from an environmental document that will be completed in the future. SCOPE points out that West Creek's EIR was certified without waiting for the DWR to complete its revised EIR for the Monterey Agreement. But West Creek's EIR was not tiered on future Monterey Agreement environmental documents. In fact, West Creek's water supply analysis is based on the premise that the Monterey Agreement litigation is unlikely to affect the Kern-Castaic transfer.

West Creek's EIR satisfies the third principle of analysis stated in *Vineyard*. The record contains substantial evidence demonstrating a reasonable likelihood that water from the Kern-Castaic transfer

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will be available for the project's near- and long-term needs. (See *Vineyard, supra*, 40 Cal.4th at p. 437, 53 Cal.Rptr.3d 821, 150 P.3d 709.) The record also shows the County proceeded in a manner required by CEQA. The EIR neither improperly used tiering to defer all analysis of supplies to future stages of the project, nor relied upon demonstrably illusory supplies. (*Ibid.*)

****460** SCOPE argues that West Creek's EIR is deficient because it fails to analyze the project's water supply in the absence of the 41,000 afy Kern-Castaic transfer. When first published, *Vineyard's* fourth principle was slightly different than the one stated in the subsequent modified opinion. Principle four then stated that an EIR requires analysis of replacement or alternative water sources where "a full discussion leaves some uncertainty regarding actual availability of the anticipated future water sources...." Principle four in the modified version of *Vineyard* allows slightly more flexibility in determining the issue of available future water sources. It requires analysis of replacement or alternative sources only if it is "impossible to confidently determine" that anticipated future water sources will be available.

Here West Creek's EIR acknowledges there is at least some legal uncertainty about the Kern-Castaic transfer. The EIR states in part: "An adverse final judgment invalidating the Monterey Agreement could affect [Castaic's] completed acquisition of the 41,000 AF, which could in turn impair [Castaic's] supply of SWP water through its contracts with DWR and other SWP contractors."

Some would argue it is certain that the outcome of litigation is seldom certain. But whatever the outcome of the *PCL litigation*, it is highly unlikely it will affect the Kern-Castaic water transfer. The water is now available, and for years has been available for the project under executed agreements. The recertified EIR notes that the Kern-Castaic transfer can legally occur without the Monterey Agreement. Suffice it to say, however the Monterey Agreement ***163** litigation is eventually decided, the Kern-Castaic transfer will likely not be affected. Per principle four, we can confidently determine that the water will be available.

V

[11] SCOPE contends West Creek's EIR is deficient in that it fails to discuss the impact of the lack of funding to remediate perchlorate contamination of local water wells. SCOPE has no quarrel with the EIR's discussion of perchlorate contamination of local wells. Its contention is limited to the lack of funding for remediation measures.

In addition to SWP water, two local aquifers will serve as part of the project's water supply, the Alluvial Aquifer and the Saugus Aquifer. SCOPE argues there are 67 wells owned by water companies in these aquifers and an undisclosed number of private wells. SCOPE points to evidence that the estimated cost of remediation is $500,000 per well. No source of funding is identified in the EIR to pay for the equipment necessary for remediation.

SCOPE relies on *Federation of Hillside & Canyon Associations v. City of Los Angeles* (2000) 83 Cal.App.4th 1252, 1261-1262, 100 Cal.Rptr.2d 301(*Federation*). There the city adopted a general plan framework (GPF) as part of its general plan. The GPF identified mitigation measures, including a transportation plan designed to mitigate the transportation impacts of the GPF's growth policies. The transportation plan acknowledged that to implement the mitigation measures would require the cooperation of various public agencies, that the city's portion of the costs would exceed its revenues, and that there is "great uncertainty" whether the mitigation measures would ever be funded or implemented. Although the city adopted the mitigation measures, it made no effort to ensure they will actually be implemented or enforceable. The court determined that the city's approval of the GPF must be vacated for failing to ensure that feasible mitigation measures will actually****461** be implemented. (*Id.* at p. 1261, 100 Cal.Rptr.2d 301, citing §§ 21002.1, subd. (b); 21081.)

Here, although water agencies may have 67 wells, only six of them have been identified as being contaminated with perchlorate. Unlike the city in *Federation*, here the County did not acknowledge there is great uncertainty that mitigation measures would ever be funded or implemented. To the contrary, the EIR states in part: "Due to the high value of this local water resource, the purveyors have placed a high priority on replacing the impacted groundwater capacity by installing wellhead

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treatment and the construction of new wells." Here, unlike *Federation*, there is nothing to suggest the mitigation measures will not be implemented. Finally, SCOPE points to nothing in *Federation* or any other case that requires the EIR to discuss funding for mitigation measures.

***164** DISPOSITION

The judgment is affirmed. Costs on appeal are awarded to respondents and real parties in interest.

COFFEE and PERREN, JJ., concur.
Cal.App. 2 Dist.,2007.
Santa Clarita Organization for Planning the Environment v. County of Los Angeles
157 Cal.App.4th 149, 68 Cal.Rptr.3d 449, 07 Cal. Daily Op. Serv. 13,422, 2007 Daily Journal D.A.R. 17,387

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California Court of Appeal, Second District, Division Three,
"*Sierra Club, et al. v. City of Santa Clarita, et al.*, Case No. B194771"
(January 2008)

Filed 1/29/08 Sierra Club v. City of Santa Clarita CA2/3

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

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IN THE COURT OF APPEAL OF THE STATE OF CALIFORNIA

SECOND APPELLATE DISTRICT

DIVISION THREE

SIERRA CLUB et al., Plaintiffs and Appellants, v. CITY OF SANTA CLARITA et al., Defendants and Respondents; THE NEWHALL LAND AND FARMING COMPANY, Real Party in Interest and Respondent.	B194771 (Los Angeles County Super. Ct. No. BS098722)

APPEAL from a judgment of the Superior Court of Los Angeles County, Dzintra Janavs, Judge. Affirmed.

Law Office of Babak Naficy and Babak Naficy for Plaintiffs and Appellants.

Burke, Williams & Sorenson, Carl K. Newton and Geralyn L. Skapik for Defendants and Respondents.

Paul, Hastings, Janofsky & Walker, Robert I. McCurry and A. Catherine Norian for Real Party in Interest and Respondent.

Sierra Club, Center for Biological Diversity, Friends of the Santa Clara River, and California Water Impact Network (collectively Petitioners) challenge the certification by City of Santa Clarita (city) of an environmental impact report (EIR) and the city's approval of a mixed-use development project known as Riverpark. Petitioners appeal a judgment denying their petition for a writ of mandate and denying relief on their complaint. They challenge the adequacy of the EIR and the city's findings under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.) with respect to impacts on water supply and biological resources, and the city's finding under the Planning and Zoning Law (Gov. Code, § 65000 et seq.) that the project is consistent with the city's general plan.

We conclude that the water supply analysis in the EIR, the analysis of impacts on the holly-leaf cherry and San Diego black-tailed jackrabbit, and the discussion of measures to mitigate the impacts on the western spadefoot toad were adequate, and that the city reasonably concluded that the project is consistent with the city's general plan. We therefore affirm the judgment.

FACTUAL AND PROCEDURAL BACKGROUND

1. *Proposed Project*

The Newhall Land and Farming Company (Newhall) proposed the development of 1,183 residential units, consisting of 439 single-family homes and 744 apartment units, and 40,000 square feet of commercial space, together with trails, a 29-acre park, and open space. The proposed project site is in the central part of the city, north of Soledad Canyon Road and east of Bouquet Canyon Road, and includes a section of the

Santa Clara River running east-west through the site. The total site acreage is 695.4 acres including the river, and 357 acres excluding the river.

The Santa Clara River is the last major unchannelized river in Los Angeles County. The city has designated the Santa Clara River a Significant Ecological Area (SEA). The SEA supports a variety of natural habitats including freshwater marsh, coastal sage scrub, oak woodlands, and riparian woodlands. The 100-year storm limit line determined by the Federal Emergency Management Agency defines the boundaries of the SEA. The proposed project includes 16.9 acres of development within the 100-year storm limit line and therefore within the SEA.

The proposed project site is predominantly undeveloped, but with some disturbed areas including several buildings used for construction purposes and electrical transmission lines. Plant communities on the site include coastal sage scrub, southern riparian scrub, native and non-native grasses and ruderal vegetation, small patches of oak trees, and other native and non-native trees. To the north of the site are undeveloped property, a water treatment facility and administrative offices owned by the Castaic Lake Water Agency, and single-family residential uses. To the south of the site, across the river from the proposed development, are retail commercial uses, the Saugus Speedway, a Metrolink commuter railway station, a mobile home park, and a business park. To the east of the site are undeveloped property and a business park, and to the west are retail commercial uses and open space.

2. *Environmental Review and Project Approval*

The city circulated a draft EIR for the proposed project on March 2, 2004. Focused surveys performed on March 5 and 6, 2004, at the request of the Department of Fish and Game disclosed the presence of western spadefoot toads on the proposed project site. The city circulated a revised biological resources section of the draft EIR discussing the western spadefoot toad on March 24, 2004.

The city's planning commission conducted several public hearings on the proposed project and recommended approval of the project with certain modifications. Newhall modified the proposed project accordingly. Those modifications reduced the number of residential units to 1,123, consisting of 419 single-family homes, 380 condominium units, and 324 apartment units, and reduced the area of commercial space to 16,000 square feet, among other changes.

A final EIR was prepared in December 2004. The city council conducted a public hearing on the proposed project in January 2005, and suggested further modifications. The city council conducted additional public hearings in March and May 2005. The final EIR was revised in May 2005. On May 25, 2005, the city council certified the final EIR, made findings under CEQA and other findings, adopted a statement of overriding considerations, and approved the project. The project approvals included a vesting tentative tract map, general plan amendment, conditional use permit, oak tree permit, and setback and wall height adjustments. The city council approved a zone change on second reading, on June 14, 2005.

The project as approved includes 1,098 residential units, consisting of 439 single-family homes and 657 condominium units, and 16,000 square feet of commercial space, in addition to trails, a 29-acre park, and open space.

3. *Trial Court Proceedings*

Petitioners filed a combined petition for writ of mandate and complaint against the city and its city council in the Ventura County Superior Court in June 2005, challenging the city's certification of the EIR and project approval. The city moved for a change of venue to Los Angeles County Superior Court. The court granted the motion.

The trial court conducted a hearing on the merits in May 2006. The court rejected the Petitioners' contentions in a Decision on Submitted Matter filed on August 14, 2006, and entered a judgment denying the petition for writ of mandate. Petitioners timely appealed the judgment.

CONTENTIONS

Petitioners contend (1) the EIR failed to adequately discuss the uncertainty of the proposed water supplies; (2) due to the uncertainty of the proposed water supplies, the EIR was required to discuss alternative sources and the environmental impact of supplying water from those alternative sources, but failed to do so; (3) the Department of Water Resources rather than the Castaic Lake Water Agency should be the lead agency for environmental review of a water transfer from Kern County; (4) the EIR applied an incorrect legal standard to determine the significance of impacts on the holly leaf cherry; (5) the EIR applied an incorrect legal standard to determine the significance

of impacts on the San Diego black-tailed jackrabbit, and the evidence does not support the city's finding that the impacts on the species will be less than significant; (6) the city failed to consider project revisions or feasible alternatives to reduce the significant impacts on the western spadefoot toad to an insignificant level, and the evidence does not support the city's finding that significant impacts on the species are unavoidable; and (7) the evidence does not support the city's finding that the project is consistent with particular general plan goals and policies.

DISCUSSION

1. *CEQA Requirements*

"CEQA is a comprehensive scheme designed to provide long-term protection to the environment. [Citation.] In enacting CEQA, the Legislature declared its intention that all public agencies responsible for regulating activities affecting the environment give prime consideration to preventing environmental damage when carrying out their duties. [Citations.] CEQA is to be interpreted 'to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.' [Citation.]" (*Mountain Lion Foundation v. Fish & Game Com.* (1997) 16 Cal.4th 105, 112 (*Mountain Lion*).)

An EIR is required for any project that a public agency proposes to carry out or approve that may have a significant effect on the environment. (Pub. Resources Code,

§§ 21100, subd. (a), 21151, subd. (a); Guidelines, § 15064,[1] subd. (a)(1).) An EIR must describe the proposed project and its environmental setting, state the objectives sought to be achieved, identify and analyze the significant effects on the environment, state how those impacts can be mitigated or avoided, and identify and analyze alternatives to the project, among other requirements. (Pub. Resources Code, §§ 21100, subd. (b), 21151; Guidelines, §§ 15124, 15125, 15126.6.) "The purpose of an environmental impact report is to provide public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment; to list ways in which the significant effects of such a project might be minimized; and to indicate alternatives to such a project." (Pub. Resources Code, § 21061.)

The lead agency must notify the public of the draft EIR, make the draft EIR and all documents referenced in it available for public review, and respond to comments that raise significant environmental issues. (Pub. Resources Code, §§ 21092, 21091, subds. (a), (d); Guidelines, §§ 15087, 15088.) The agency also must consult with and obtain comments from other agencies affected by the project and respond to their comments. (Pub. Resources Code, §§ 21092.5, 21104, 21153; Guidelines, § 15086.)

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[1] All references to Guidelines are to the CEQA Guidelines (Cal. Code Regs., Tit. 14, § 15000 et seq.) developed by the Office of Planning and Research and adopted by the Resources Agency. (Pub. Resources Code, §§ 21083, 21087.) "[C]ourts should afford great weight to the Guidelines except when a provision is clearly unauthorized or erroneous under CEQA." (*Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 391, fn. 2 (*Laurel Heights I*).)

The agency must prepare a final EIR including any revisions to the draft EIR, comments received from the public and from other agencies, and responses to comments. (Guidelines, §§ 15089, subd. (a), 15132.)

An agency may not approve a project that will have significant environmental effects if there are feasible alternatives or feasible mitigation measures that would substantially lessen those effects.[2] (Pub. Resources Code, §§ 21002, 21002.1, subd. (b); Guidelines, § 15021, subd. (a)(2); *Mountain Lion*, *supra*, 16 Cal.4th at p. 134.) An agency may find, however, that particular economic, social, or other considerations make the alternatives and mitigation measures infeasible and that particular project benefits outweigh the adverse environmental effects. (Pub. Resources Code, § 21081, subds. (a)(3), (b); Guidelines, § 15091, subd. (a)(3).) Specifically, an agency cannot approve a project that will have significant environmental effects unless it finds as to each significant effect, based on substantial evidence in the administrative record, that (1) mitigation measures required in or incorporated into the project will avoid or substantially lessen the significant effect; (2) those measures are within the jurisdiction of another public agency and have been adopted, or can and should be adopted, by that agency; or (3) specific economic, legal, social, technological, or other considerations make the mitigation measures or alternatives identified in the EIR infeasible, and

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[2] " 'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." (Pub. Resources Code, § 21061.1; see also Guidelines, § 15364.)

specific overriding economic, legal, social, technological, or other benefits outweigh the significant environmental effects. (Pub. Resources Code, §§ 21081, 21081.5; Guidelines, § 15091, subds. (a), (b).) A finding that specific overriding project benefits outweigh the significant environmental effects (Pub. Resources Code, § 21081, subd. (b)) is known as a statement of overriding considerations. (Guidelines, § 15093.)

Thus, a public agency is not required to favor environmental protection over other considerations, but it must disclose and carefully consider the environmental consequences of its actions, mitigate or avoid adverse environmental effects if feasible, explain the reasons for its actions, and afford the public and other affected agencies an opportunity to participate meaningfully in the environmental review process. The purpose of these requirements is to ensure that public officials and the public are aware of the environmental consequences of decisions before they are made. (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564 (*Goleta Valley*).) The EIR process also informs the public of the basis for environmentally significant decisions by public officials and thereby promotes accountability and informed self-government. (*Laurel Heights I, supra*, 47 Cal.3d at p. 392; *Concerned Citizens of Costa Mesa, Inc. v. 32nd Dist. Agricultural Assn.* (1986) 42 Cal.3d 929, 935-936.) Before approving the project, the agency must certify that its decisionmaking body reviewed and considered the information contained in the EIR, that the EIR reflects the agency's independent judgment and analysis, and that the EIR was completed in compliance with CEQA. (Pub. Resources Code, § 21082.1, subd. (c); Guidelines, § 15090.)

"We have repeatedly recognized that the EIR is the 'heart of CEQA.' [Citations.] 'Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions *before* they are made. Thus, the EIR "protects not only the environment but also informed self-government." [Citations.]' To this end, public participation is an 'essential part of the CEQA process.' [Citations.]" (*Laurel Heights Improvement Assn. v. Regents of University of California* (1993) 6 Cal.4th 1112, 1123 (*Laurel Heights II*).) "The preparation and circulation of an EIR is more than a set of technical hurdles for agencies and developers to overcome. The EIR's function is to ensure that government officials who decide to build or approve a project do so with a full understanding of the environmental consequences and, equally important, that the public is assured those consequences have been taken into account. (*Laurel Heights I*, *supra*, 47 Cal.3d at pp. 391-392.) For the EIR to serve these goals it must present information in such a manner that the foreseeable impacts of pursuing the project can actually be understood and weighed, and the public must be given an adequate opportunity to comment on that presentation before the decision to go forward is made." (*Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 449-450 (*Vineyard Area Citizens*).)

" 'Significant effect on the environment' means a substantial, or potentially substantial, adverse change in the environment." (Pub. Resources Code, § 21068.) The Guidelines define "significant effect on the environment" in relevant part as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals,

flora, fauna, ambient noise, and objects of historic or aesthetic significance."[3] (Guidelines, § 15382.)

"Substantial evidence" under CEQA "includes fact, a reasonable assumption predicated upon fact, or expert opinion supported by fact." (Pub. Resources Code, § 21080, subd. (e)(1); see Guidelines, §§ 15384, subd. (b), 15064, subd. (f)(5).) The Guidelines define "substantial evidence" as "enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached," and state that this determination must be made "by examining the whole record before the lead agency." (Guidelines, § 15384, subd. (a).) "Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence of social or economic impacts that do not contribute to, or are not caused by, physical impacts on the environment." (Pub. Resources Code, § 21080, subd. (e)(2); accord, *id.* § 21082.2, subd. (c); see also Guidelines, § 15384, subd. (a).)

2. *Standard of Review*

The standard of review of an agency's decision under CEQA is abuse of discretion. Abuse of discretion means the agency failed to proceed in a manner required

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[3] " 'Environment' means the physical conditions which exist within the area which will be affected by a proposed project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. The area involved shall be the area in which significant effects would occur either directly or indirectly as a result of the project. The 'environment' includes both natural and man-made conditions." (Guidelines, § 15360; see also Pub. Resources Code, § 21060.5.)

by law or there was no substantial evidence to support its decision. (Pub. Resources Code, §§ 21168, 21168.5; *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 945.) Whether the agency failed to proceed in a manner required by law is a question of law. A court determines de novo whether the agency complied with CEQA's procedural requirements, " 'scrupulously enforc[ing] all legislatively mandated CEQA requirements' (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564 [276 Cal.Rptr. 410, 801 P.2d 1161])." (*Vineyard Area Citizens, supra*, 40 Cal.4th at p. 435.) The failure to provide information required by CEQA in an EIR is a failure to proceed in a manner required by law. (*Save Our Peninsula Committee v. Monterey County Bd. of Supervisors* (2001) 87 Cal.App.4th 99, 118.) The failure to comply with CEQA's procedural or information disclosure requirements is a prejudicial abuse of discretion if the decision makers or the public is deprived of information necessary to make a meaningful assessment of the environmental impacts. (*Sierra Club v. State Bd. of Forestry* (1994) 7 Cal.4th 1215, 1236-1237; *County of Amador, supra,* at p. 946; see Pub. Resources Code, § 21005.)

Findings of fact made by the agency and factual conclusions stated in an EIR are reviewed under the substantial evidence standard. (*Vineyard Area Citizens, supra*, 40 Cal.4th at p. 435; *Laurel Heights I, supra*, 47 Cal.3d at pp. 392-393, 407.) Under the substantial evidence standard, the court does not determine whether the agency's factual determinations were correct, but only determines whether they were supported by substantial evidence. (*Laurel Heights I, supra*, at pp. 392-393.) On appeal, we

independently review the agency's decision under the same standard of review that governs the trial court. (*Vineyard Area Citizens, supra*, at p. 427.)

3. *Water Supply*

a. *CEQA Requirements for Water Supply Analysis*

An EIR must identify and analyze the significant environmental impacts that may result from the project. (Pub. Resources Code, § 21100, subds. (a), (b); Guidelines, §§ 15126.2, subd. (a), 15143.) It must include facts and analysis sufficient to allow the decision makers and the public to understand the environmental consequences of the project. (Guidelines, § 15151; *Laurel Heights I, supra*, 47 Cal.3d at pp. 404-405; *Napa Citizens for Honest Government v. Napa County Bd. of Supervisors* (2001) 91 Cal.App.4th 342, 356 (*Napa Citizens*).) An EIR for a large, mixed-use development project such as the present project must include an analysis of the reasonably foreseeable environmental impacts of supplying water to the project. (*Vineyard Area Citizens, supra*, 40 Cal.4th at pp. 428, 434.) The analysis must include a discussion of the planned and likely sources of water and the impacts of supplying water from those sources. (*Id.* at pp. 428, 432, 434.)

Vineyard Area Citizens involved an EIR prepared for a community plan and a specific plan for a large, mixed-use development project. The EIR stated that the project would rely on both groundwater and surface water for its water supplies. (*Vineyard Area Citizens, supra*, 40 Cal.4th at p. 423.) The projected long-term water supplies consisted of an unspecified combination of groundwater and surface water in "conjunctive use." (*Id.* at p. 440.) The EIR stated that a full analysis of the

"conjunctive use" program must await the pending environmental review of a master plan update by the county water agency. (*Id.* at p. 440.) Because the project did not have legal rights to the projected water supplies, a mitigation measure provided that subdivision maps, building permits, and other entitlements would not be granted unless agreements and financing for the water supplies were in place. (*Id.* at p. 424.)

Vineyard Area Citizens discussed several opinions by the Courts of Appeal concerning the sufficiency of an EIR's analysis of water supply (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at pp. 428-430) and derived four principles from those opinions:

"First, CEQA's informational purposes are not satisfied by an EIR that simply ignores or assumes a solution to the problem of supplying water to a proposed land use project. Decision makers must, under the law, be presented with sufficient facts to 'evaluate the pros and cons of supplying the amount of water that the [project] will need.' (*Santiago County Water Dist. v. County of Orange* [(1981)] 118 Cal.App.3d [818,] 829.)

"Second, an adequate environmental impact analysis for a large project, to be built and occupied over a number of years, cannot be limited to the water supply for the first stage or the first few years. While proper tiering of environmental review allows an agency to defer analysis of certain details of later phases of long-term linked or complex projects until those phases are up for approval, CEQA's demand for meaningful information 'is not satisfied by simply stating information will be provided

in the future.' (*Santa Clarita* [*Organization for Planning the Environment v. County of Los Angeles* (2003)] 106 Cal.App.4th [715,] 723.) . . . .

"Third, the future water supplies identified and analyzed must bear a likelihood of actually proving available; speculative sources and unrealistic allocations ('paper water') are insufficient bases for decisionmaking under CEQA. (*Santa Clarita, supra*, 106 Cal.App.4th at pp. 720-723.) An EIR for a land use project must address the impacts of *likely* future water sources, and the EIR's discussion must include a reasoned analysis of the circumstances affecting the likelihood of the water's availability. (*California Oak* [*Foundation v. City of Santa Clarita* (2005)] 133 Cal.App.4th [1219,] 1244.)

"Finally, where, despite a full discussion, it is impossible to confidently determine that anticipated future water sources will be available, CEQA requires some discussion of possible replacement sources or alternatives to use of the anticipated water, and of the environmental consequences of those contingencies. (*Napa Citizens, supra*, 91 Cal.App.4th at p. 373.)" (*Vineyard Area Citizens, supra*, 40 Cal.4th at pp. 430-432.)

Vineyard Area Citizens stated further: "[W]e emphasize that the burden of identifying likely water sources for a project varies with the stage of project approval involved; the necessary degree of confidence involved for approval of a conceptual plan is much lower than for issuance of building permits. The ultimate question under CEQA, moreover, is not whether an EIR establishes a likely source of water, but

whether it adequately addresses the reasonably foreseeable *impacts* of supplying water to the project." (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 434.)

Vineyard Area Citizens concluded that the analysis of near-term groundwater supplies in the EIR was adequate. It stated that the county's conclusion that certain groundwater supplies would be available to the project in the near term was supported by substantial evidence, and rejected the petitioners' argument that competing uses were likely to exhaust those water supplies. (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at pp. 436-437.)[4] It stated further that the county did not fail to proceed in the manner required by law in that the EIR neither improperly deferred analysis of water supplies to future stages of the project nor relied on illusory water supplies. (*Id.* at p. 437.)

Vineyard Area Citizens concluded that the analysis of long-term water supplies in the EIR was inadequate. It stated that the county's conclusion that surface water supplies would satisfy the project's long-term demands was not supported by substantial evidence because the EIR failed to explain inconsistencies in the figures provided on total demand and supply, failed to identify the intended and likely long-term water sources, relied on "vague and unquantified" water supplies (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 440), and failed to identify competing uses. (*Id.* at pp. 439-442.)[5]

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[4] "While much uncertainty remains, then, the record contains substantial evidence demonstrating a reasonable likelihood that a water source the provider plans to use . . . will indeed be available at least in substantial part to supply the Sunrise Douglas project's near-term needs." (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 437.)

[5] "Factual inconsistencies and lack of clarity in the FEIR leave the reader—and the decision makers—without substantial evidence for concluding that sufficient water is, in

It stated further that the county failed to proceed in the manner required by law by deferring environmental review of the conjunctive use program to a future EIR (*id.* at pp. 440-441), failing to properly incorporate information or tier from a prior EIR regarding surface water supplies on which the project relied (*id.* at pp. 442-443), failing to include enforceable mitigation measures for those surface water diversions (*id.* at p. 444), and by relying on a provision precluding further development in lieu of identifying and analyzing the project's intended and likely water sources (*ibid.*) *Vineyard Area Citizens* stated that there was "no plainly stated, coherent analysis of how the supply is to meet the demand." (*Id.* at p. 445.)

b. *Background of the State Water Project*

The State Water Project is a water storage and delivery system operated by the Department of Water Resources. It includes reservoirs, dams, power plants, pumping plants, canals, aqueducts, and other facilities. (See *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 898-899 (*PCL*).) California voters approved a bond measure in 1960 to fund its construction. (Stats. 1961, p. cxliii; Wat. Code, § 12930 et seq.) Although the system was designed to deliver 4.23 million acre-feet of water annually, for many years it delivered significantly less than that amount. (See *California Oak Foundation v. City of Santa Clarita* (2005) 133 Cal.App.4th 1219, 1227-1228 (*California Oak*); *PCL*, *supra*, at pp. 898-899.)

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fact, likely to be available for the Sunrise Douglas project at full build-out." (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 439.)

The Department of Water Resources is a party to 29 long-term contracts with local water agencies. Under the original contracts, each agency had the right to receive a proportionate share of the 4.23 million acre-feet of water per year that was projected to be supplied by the State Water Project. (See *PCL, supra*, 83 Cal.App.4th at p. 899; Wat. Code, § 12937, subd. (b).) The agencies were required to pay for their contractual entitlements of water regardless of whether they actually received the water. (See *PCL, supra*, 83 Cal.App.4th at p. 899.) Article 18(a) of the water supply contracts provided that in times of temporary shortage, the agricultural water agencies would receive a reduced allocation. Article 18(b) provided that in times of permanent water shortage, the allocations of all contracting agencies would be reduced proportionately. (See *id.* at pp. 899-900.)

After several years of drought in the late 1980's and early 1990's resulting in disputes between agricultural and urban water agencies, several contracting agencies and the Department of Water Resources entered into an agreement known as the Monterey Agreement. (See *PCL, supra*, 83 Cal.App.4th at pp. 897, 901.) The Monterey Agreement is a statement of 14 principles designed to govern revisions to the water supply contracts. It calls for the elimination of the provision requiring agricultural agencies to absorb the first deficiency and provides that in times of shortage, deliveries to all contracting agencies will be reduced in proportion to their entitlements. (See *Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1376 (*Friends*).) The Monterey Agreement also provides for the agricultural agencies to permanently transfer to the urban agencies 130,000

acre-feet of annual water entitlements. (See *id.* at pp. 1376-1377; *PCL, supra*, 83 Cal.App.4th at pp. 901-902.) The Monterey Agreement provides for its implementation through amendments to the long-term water supply contracts. (See *PCL, supra*, at p. 902.) Table A of those contracts states the amount of each agency's annual water allocation from the State Water Project. The amendments pursuant to the Monterey Agreement are known as the Monterey Amendments.

Pursuant to the Monterey Agreement, the Castaic Lake Water Agency entered into an agreement with the Kern County Water Agency in 1999 for the permanent transfer of 41,000 acre-feet of annual State Water Project water entitlement from the Kern County Water Agency to the Castaic Lake Water Agency (Kern-Castaic transfer). The Department of Water Resources approved the transfer in March 1999, and the long-terms water supply contracts between the two water agencies and the Department of Water Resources were amended accordingly.

The Central Coast Water Agency as lead agency prepared a program EIR for the Monterey Agreement and certified the EIR in October 1995.[6] The Department of Water Resources as a responsible agency also made findings and adopted the EIR. (*PCL, supra*, 83 Cal.App.4th at p. 902.) The Sacramento County Superior Court denied a petition for writ of mandate challenging the EIR. In September 2000, the Court of

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[6] A program EIR may be prepared for a series of related actions that can be characterized as one large project. (Guidelines, § 15168, subd. (a).) Subsequent program activities that would cause environmental impacts not analyzed in the program EIR require additional environmental review. (*Id.*, subd. (c).)

Appeal in *PCL* reversed the judgment by the trial court with directions to grant the petition. (*Id.* at pp. 903, 926.) *PCL* held that the Department of Water Resources rather than the Central Coast Water Agency was the proper lead agency, and that the EIR failed to provide a sufficient analysis of the no project alternative. (*Id.* at pp. 907, 916.) *PCL* directed the trial court to vacate the certification of the EIR and make any other order appropriate under Public Resources Code section 21168.9, subdivision (a), but did not direct the court to vacate the project approval, and declined to stay the implementation of the Monterey Agreement. (*PCL*, *supra*, at p. 926 & fn. 16.)

The Castaic Lake Water Agency as lead agency prepared an EIR for the Kern-Castaic transfer in March 1999. It was a project EIR that tiered from three other EIR's, including the Monterey Agreement program EIR.[7] (*Friends*, *supra*, 95 Cal.App.4th at pp. 1379-1380.) The Los Angeles County Superior Court denied a petition for writ of mandate challenging the Castaic Lake Water Agency's EIR. (*Id.* at p. 1381.) The appellate opinion invalidating the Monterey Agreement EIR (*PCL*, *supra*, 83 Cal.App.4th 892) was filed while the appeal in *Friends* was pending. (*Friends*, *supra*, at p. 1382.) In January 2002, the Court of Appeal in *Friends* reversed the

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[7] A project EIR "examines the environmental impacts of a specific development project." (Guidelines, § 15161.) " 'Tiering' or 'tier' means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report." (Pub. Resources Code, § 21068.5.)

judgment by the trial court with directions to grant the petition. (*Id.* at p. 1388.) *Friends* concluded that the Castaic Lake Water Agency's EIR relied on the analysis of environmental impacts in the Monterey Agreement EIR and that the decertification of the Monterey Agreement EIR precluded reliance on that analysis. (*Id.* at pp. 1384-1387.) *Friends* directed the trial court to vacate the certification of the EIR and make any other order appropriate under Public Resources Code section 21168.9, but did not direct the court to vacate the project approval, and stated that the trial court should determine whether to enjoin the project. (*Friends*, *supra*, at p. 1388.) The trial court entered a judgment on remand in October 2002 vacating the certification of the EIR but not the project approval. The trial court declined the petitioners' request to enjoin the use of water received pursuant to the transfer. The Court of Appeal in an unpublished opinion affirmed the judgment, rejecting the petitioners' challenge to the denial of an injunction (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (Dec. 1, 2003, B164027)).

The parties to the proceeding involving a challenge to the Monterey Agreement EIR (*PCL*, *supra*, 83 Cal.App.4th 892) entered into a settlement agreement in May 2003 specifying certain subjects to be discussed in a new Monterey Agreement EIR to be prepared by the Department of Water Resources. Those subjects included the environmental impacts relating to the transfers of water rights effected pursuant to the Monterey Agreement. The settlement agreement included an Attachment E listing certain transfers other than the Kern-Castaic transfer. The settlement agreement separately identified the Kern-Castaic transfer, and stated that the new Monterey

Agreement EIR would include an analysis of the impacts of both the Attachment E transfers and the Kern-Castaic transfer.

The settlement agreement stated with respect to the Attachment E transfers: "[N]otwithstanding the analysis of the potential impacts of the Attachment E Transfers in the New EIR and without specifically endorsing or opposing those transfers or any prior environmental assessments of them, the Parties recognize that such water transfers are final. Each of the Parties agrees not to, and it shall be a condition to the initial and continuing effectiveness of this Settlement Agreement that Plaintiffs do not, hereafter challenge the effectiveness or validity of such water transfers." It stated with respect to the Kern-Castaic transfer: "[R]egarding the Kern-Castaic Transfer, the Parties recognize that such water transfer is subject to pending litigation in the Los Angeles County Superior Court following remand from the Second District Court of Appeal (*See* Friends of the Santa Clara River v. Castaic Lake Water Agency, 95 Cal.App.4th 1373, 116 Cal.Rptr.2d 54 (2002); *review denied* April 17, 2002). The Parties agree that jurisdiction with respect to that litigation should remain in that court and that nothing in this Settlement Agreement is intended to predispose the remedies or other actions that may occur in that pending litigation."

The settlement agreement included certain proposed amendments to the long-term water service contracts, known as the Attachment A amendments. The settlement agreement stated that the parties would request an order authorizing the operation of the State Water Project on an interim basis in accordance with the Monterey Agreement, the

Attachment A amendments, and other terms of the settlement. The trial court approved the settlement and issued the requested order.

The Castaic Lake Water Agency prepared a second EIR for the Kern-Castaic transfer and certified the EIR in December 2004. The Los Angeles County Superior Court granted a petition for writ of mandate challenging the second EIR for the Kern-Castaic transfer in May 2007 (*Planning and Conservation League v. Castaic Lake Water Agency* (Super. Ct. L.A. County No. BS098724)).[8] The court concluded that although the EIR analyzed the environmental impacts of the project assuming three different State Water Project water allocation scenarios, it failed to adequately explain how those scenarios could result from the pending environmental review of the Monterey Amendments and any challenge to the new Monterey Agreement EIR. The court rejected all other challenges to the EIR. The petitioners, the Castaic Lake Water Agency, and the Kern County Water Agency appealed the judgment. That appeal is currently pending in the Second District Court of Appeal (No. B200673).

c. *Petitioners' Specific Contention*

Petitioners contend the ongoing environmental review of the Monterey Agreement and the possibility that the Department of Water Resources ultimately will exercise its discretion to disapprove or modify the Kern-Castaic transfer render the

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[8] We granted a joint request by the city and Newhall to judicially notice the judgment filed on May 22, 2007, and the statement of decision filed on April 2, 2007, in *Planning and Conservation League v. Castaic Lake Water Agency*, *supra*, No. BS098724.

transfer uncertain. They argue that the EIR fails to acknowledge that uncertainty. Petitioners cite a statement by the department in *Planning and Conservation League v. Castaic Lake Water Agency, supra*, No. BS098724, that, "[T]he contract amendments that effectuated the transfers under the Monterey Amendment do not preclude DWR in its choice of alternatives in the Monterey Amendment EIR or mitigation measures that may need to be imposed to reduce significant impacts to less than significant. Any contractual agreement to transfer SWP water from one contractor to another is always subject to possible changes or curtailments."[9]

d. *Draft EIR, Response to Comments, and the City's Findings*

The draft EIR here stated that the Castaic Lake Water Agency serves the proposed project area and relies on imported water from the State Water Project. It described the State Water Project and the Monterey Agreement. It stated that the agency's total annual water allocation from the State Water Project is 95,200 acre-feet and that the Kern-Castaic transfer represents 41,000 acre-feet of that amount. It explained that the amounts requested by the contracting agencies from the State Water Project and the amounts actually delivered to the agencies by the State Water Project vary from year to year and can be less than the maximum amounts allocated. It projected that 59.7 percent of the State Water Project water allocation would be available to the city in average years, and that 20 to 39.8 percent would be available in

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[9] We granted Petitioners' request for judicial notice of the Department of Water Resource's opposition brief filed on December 6, 2006, in *Planning and Conservation League v. Castaic Lake Water Agency, supra*, No. BS098724.

dry years. It stated that water transfer agreements made pursuant to the Monterey Agreement "are effective upon execution . . . and, therefore, are considered permanent water reallocations of SWP Table A water."

The draft EIR stated that the agency had completed an EIR for the Kern-Castaic transfer, that the trial court had rejected the petitioners' challenges to the EIR, and that the Court of Appeal had reversed the judgment on the sole ground that the EIR tiered from another EIR (the Monterey Agreement EIR) that had been decertified. It stated that neither the Court of Appeal nor the trial court had ordered the agency to vacate its approval of the transfer agreement pending completion of a new EIR, and that the trial court on remand had allowed the agency to continue to operate under the agreement. It stated that the agency was in the process of preparing a new EIR for the transfer.

The draft EIR stated further that the Court of Appeal had ordered the decertification of the Monterey Agreement EIR on the grounds that the Department of Water Resources should have been the lead agency and that the analysis of the no project alternative was inadequate. It stated that the Court of Appeal had directed the trial court to order the preparation of a new EIR and that neither the Court of Appeal nor the trial court had stayed the implementation of the Monterey Agreement.

The draft EIR stated that the Kern-Castaic transfer could have taken place even without the Monterey Agreement, "under existing SWP water supply contract provisions, subject to appropriate environmental review." It stated that the Kern-Castaic transfer "has been completed, CLWA has paid approximately $47 million for the additional Table A Amount, the monies have been delivered, . . . and DWR has

increased CLWA's SWP maximum Table A Amount to 95,200 AFY because it was a permanent transfer/reallocation of SWP Table A entitlement between SWP contractors." It stated further, "an adverse outcome in the Monterey Agreement litigation is not likely to adversely affect CLWA's water supplies over the long term because CLWA believes that such a result is unlikely to 'unwind' executed and completed agreements with respect to the permanent transfer of SWP Water Amounts."

Thus, the draft EIR characterized the Kern-Castaic transfer as "permanent" and downplayed the likelihood that the "permanent transfer" could be affected by the Monterey Agreement litigation. The draft EIR did not acknowledge the possibility that the environmental review of the Monterey Agreement by the Department of Water Resources could result in the modification of the Kern-Castaic transfer and a reduced allocation to the Castaic Lake Water Agency.

The draft EIR estimated the amounts of groundwater and imported water supplies that would be available in the project area. The estimate of imported water supplies was based on different percentages of the total Table A amount for average years and dry years. The draft EIR also estimated the demand for water and concluded that the supplies would be sufficient to meet the demand.

Several comments to the draft EIR objected to its reliance on the Kern-Castaic transfer and stated that the transfer was uncertain due to pending litigation and the absence of a certified EIR for either the transfer or the Monterey Agreement. The city in a "topical response" to the comments reiterated the discussion in the EIR of the reasons that it considered the transfer reliable "despite potential uncertainty arising from

litigation." The topical response stated, "Because the 41,000 AFY was a permanent water transfer, because DWR includes the 41,000 AFY in calculating CLWA's share of SWP Table A Amount, and because the courts have not prohibited CLWA from using or relying on those additional SWP supplies, the City has determined that it remains appropriate for the Riverpark project to include those water supplies in its water supply and demand analysis, while acknowledging and disclosing the potential uncertainty created by litigation." It stated further that the ongoing environmental review by the Department of Water Resources of the Monterey Agreement, including the Kern-Castaic transfer, did not preclude the city's reliance upon the transfer in these circumstances.

The city's findings under CEQA stated that the project would have no significant impacts on water supply and that no mitigation was required.

e. *The EIR Adequately Analyzed the Uncertainty of the Kern-Castaic Transfer*

We repeat with emphasis, "An EIR for a land use project must address the impacts of likely future water sources, and the EIR's discussion must include a reasoned analysis of the circumstances affecting the likelihood of the water's availability. (*California Oak, supra*, 133 Cal.App.4th at p. 1244.)" (*Vineyard Area Citizens, supra*, 40 Cal.4th at p. 432.) The sufficiency of an analysis in an EIR is measured by reference to a practical standard that demands neither technical perfection nor full disclosure of all information available on a subject. (*Berkeley Keep Jets Over the Bay Com. v. Board of Port Cmrs.* (2001) 91 Cal.App.4th 1344, 1355; *Al Larson Boat Shop, Inc. v. Board of*

Harbor Commissioners (1993) 18 Cal.App.4th 729, 748.) "The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure." (Guidelines, § 15151.) " 'To facilitate CEQA's informational role, the EIR must contain facts and analysis, not just the agency's bare conclusions or opinions.' [Citations.] An EIR must include detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project." (*Laurel Heights I*, *supra*, 47 Cal.3d at pp. 404-405.) The role of a reviewing court is not to determine whether the EIR's conclusions are correct, but only whether they are supported by substantial evidence and sufficient analysis to serve the EIR's informational purposes. (*Id.* at p. 407.)

The absence of relevant information from an EIR does not necessarily constitute a prejudicial abuse of discretion. Rather, a prejudicial abuse of discretion occurs only if the absence of relevant information precludes informed decisionmaking and informed public participation and thereby thwarts the statutory goals of the EIR process. (*Berkeley Keep Jets Over the Bay Com. v. Board of Port Cmrs.*, *supra*, 91 Cal.App.4th at p. 1355.)

The draft EIR and the final EIR, including the responses to comments, explained at length and in detail the reasons for the city's conclusion that water provided by the State Water Project pursuant to the Kern-Castaic transfer would continue to be available to serve the area of the proposed project. The analysis provided was incomplete because it failed to acknowledge the possibility that the environmental review of the Monterey Agreement by the Department of Water Resources could result in the

modification of the transfer and a reduced allocation to the Castaic Lake Water Agency. In our view, the analysis nonetheless was "a reasoned analysis" (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 432) that was adequate in these circumstances. This is true particularly in light of the indications that the Department of Water Resources, Castaic Lake Water Agency, and Kern County Water Agency did not wish to disturb the transfer and the fact that the trial courts and Courts of Appeal in the litigation directly involving the Monterey Agreement and the Kern-Castaic transfer never vacated the approval of either of those projects or enjoined the flow of water. These circumstances do not compel the conclusion that the transfer will be "permanent," but they support our conclusion that the failure to acknowledge the uncertainty of the transfer arising from the department's ongoing environmental review of the Monterey Agreement was not so momentous as to render the analysis provided in the EIR inadequate for its informational purposes.

The water supply analysis here did not rely on inconsistent figures or "vague and unquantified" water supplies (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 440), or fail to provide a complete and coherent analysis of water supply and demand as did the analysis of long-term water supply in *Vineyard Area Citizens*. Moreover, the city did not fail to comply with procedures required by law by, for example, deferring environmental review to a future EIR (*id.* at pp. 440-441), relying on a prior EIR without proper incorporation or tiering (*id.* at pp. 442-443), or relying on a provision precluding further development in lieu of identifying and analyzing the project's intended and likely water sources (*id.* at p. 444).

California Oak, *supra*, 133 Cal.App.4th 1219 is distinguishable. *California Oak* involved a proposed industrial/business park in Santa Clarita. (*Id.* at p. 1224.) The city certified an EIR and approved the project in June 2003. (*Id.* at p. 1225.) The primary dispute on appeal concerned the same 41,000 acre-feet of State Water Project water allocation at issue here. The text of the EIR failed to mention the January 2002 invalidation of the Castaic Lake Water Agency's EIR for the Kern-Castaic transfer and offered no explanation for the city's continued reliance on the transfer (*id.* at p. 1236), and apparently also failed to mention the invalidation of the Monterey Agreement EIR. The city's response to comments was "completely devoid of any direct discussion of the 41,000 AFY" (*id.* at p. 1237) and only referred obliquely to litigation "challenge[s]" (*id.* at pp. 1232-1233). The only mention of the invalidation of the Castaic Lake Water Agency's EIR was in an appendix to the final EIR. (*Id.* at p. 1239.) *California Oak* stated that the issue should be discussed, or at least referenced, in the text of the EIR and that the brief mention of the invalidation in the appendix with no meaningful and forthright discussion was insufficient in any event.[10] (*Ibid.*) Absent a reasoned analysis in the EIR of the uncertainty created by the invalidation of the EIR for the Kern-Castaic transfer, *California Oak* concluded that there was no substantial evidence to support the

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[10] *Vineyard Area Citizens* later endorsed this view, stating, " '[I]nformation "scattered here and there in EIR appendices," or a report "buried in an appendix," is not a substitute for "a good faith reasoned analysis . . . ." ' (*California Oak*, *supra*, 133 Cal.App.4th at p. 1239, quoting *Santa Clarita*, *supra*, 106 Cal.App.4th at pp. 722-723." (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 442.)

conclusion that the water supplies for the project were sufficient. (*Id.* at pp. 1226, 1240.)

Here, in contrast to *California Oak*, *supra*, 133 Cal.App.4th 1219, the EIR contains a reasoned analysis of the circumstances affecting the availability of the 41,000 acre-feet of water allocation. The analysis is supported by facts and discloses pertinent facts, including the invalidation of both the Castaic Lake Water Agency's EIR for the Kern-Castaic transfer and the Department of Water Resource's EIR for the Monterey Agreement. The city's EIR neither relegates that discussion to an appendix to the final EIR nor assumes without analysis that the 41,000 acre-feet of water allocation will be available. In light of that discussion, the EIR's failure to acknowledge the particular uncertainty arising from the Department's ongoing environmental review of the Monterey Agreement stands in stark contrast to the complete failure to offer any reasoned analysis of the circumstances affecting the availability of the transferred water in *California Oak*.

Petitioners also argue that the EIR for the Kern-Castaic transfer should tier from the Monterey Agreement EIR and that absent a proper EIR for the transfer, the present EIR cannot rely on the transfer. The question whether the EIR for the Kern-Castaic transfer complies with CEQA is beyond the scope of this appeal. The EIR for the Kern-Castaic transfer is the subject of a separate mandamus proceeding and a separate appeal (No. B200673). Absent a judgment determining that the EIR for the Kern-Castaic transfer fails to comply with CEQA in the manner asserted, we will not determine in this appeal the merits of a separate proceeding.

Petitioners argue further that due to the uncertainty of the Kern-Castaic transfer, the EIR here was required to discuss alternative sources of water and the environmental impact of supplying water from those alternative sources. *Vineyard Area Citizens* stated, "[W]here, despite a full discussion, it is impossible to confidently determine that anticipated future water sources will be available, CEQA requires some discussion of possible replacement sources or alternatives to use of the anticipated water, and of the environmental consequences of those contingencies. (*Napa Citizens*, *supra*, 91 Cal.App.4th at p. 373.)" (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 432.) "If the uncertainties inherent in long-term land use and water planning make it impossible to confidently identify the future water sources, an EIR may satisfy CEQA if it acknowledges the degree of uncertainty involved, discusses the reasonably foreseeable alternatives—including alternative water sources and the option of curtailing the development if sufficient water is not available for later phases—and discloses the significant foreseeable environmental effects of each alternative, as well as mitigation measures to minimize each adverse impact. ([Pub. Resources Code,] § 21100, subd. (b).)" (*Id.* at p. 434.)

Napa Citizens, *supra*, 91 Cal.App.4th 342, involved a subsequent EIR for an updated specific plan providing for the industrial development of a formerly agricultural area. (*Id.* at pp. 352-353.) The EIR stated that the City of American Canyon supplied water to the project area and would continue to do so in the future. The EIR acknowledged that American Canyon's current water supply would be inadequate in the longer term, but stated that American Canyon was in the process of reaching an

agreement with another municipality that would provide additional water. The EIR assumed that an agreement would be reached and therefore concluded that the project would have no significant impact on long-term water supply. (*Id.* at p. 372.) *Napa Citizens* concluded that the EIR could not rely on the uncertain water supplies without identifying alternative water sources and analyzing the environmental impacts of supplying water from those sources. *Napa Citizens* stated: "Because of the uncertainty surrounding the anticipated sources for water . . . , the FSEIR also cannot simply label the possibility that they will not materialize as 'speculative,' and decline to address it. The County should be informed if other sources exist, and be informed, in at least general terms, of the environmental consequences of tapping such resources. Without either such information or a guarantee that the resources now identified in the FSEIR will be available, the County simply cannot make a meaningful assessment of the potentially significant environmental impacts of the Project. [Citation.]" (*Id.* at pp. 373-374.)

We conclude that whether an EIR can "confidently determine that anticipated future water sources will be available" (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 432; see also *id.* at p. 434) is a question of fact. If the EIR confidently concludes that future water supplies will be sufficient to serve the project, and if that conclusion is supported by reasoned analysis and facts stated in the EIR, the EIR satisfies its informational purposes and a reviewing court must defer to the EIR's conclusion. (See *Laurel Heights*, *supra*, 47 Cal.3d at pp. 404-405, 407.) In those circumstances, the EIR need not evaluate alternative water sources and the environmental impacts of supplying

water from those sources. On the other hand, if the EIR reveals a substantial degree of uncertainty as to the availability of future water supplies, as in *Napa Citizens*, *supra*, 91 Cal.App.4th 342, the EIR must discuss alternative sources of water or alternatives to use of the water and the environmental impacts of those contingencies. (*Vineyard Area Citizens*, *supra*, 40 Cal.4th at p. 432 ["[W]here, despite a full discussion, it is impossible to confidently determine that anticipated future water sources will be available, CEQA requires some discussion of possible replacement sources or alternatives to use of the anticipated water, and of the environmental consequences of those contingencies"].)

After explaining in detail the circumstances affecting the availability of the imported water, the EIR here confidently concluded that water provided by the State Water Project pursuant to the Kern-Castaic transfer would continue to be available to serve the proposed project area despite the pending Monterey Agreement environmental review and litigation challenges. The EIR did not reveal a substantial degree of uncertainty as to the continued availability of the transferred water, unlike the situation in *Napa Citizens*, *supra*, 91 Cal.App.4th 342, where no agreement had been reached to secure the water transfer and no deliveries had occurred. We conclude that the facts stated in the EIR, including the executed agreements effecting the transfer, the implementation of those agreements and delivery of water for several years, and the absence of any court order vacating the approval of the transfer or the Monterey Agreement or staying the implementation of those agreements, constitute substantial evidence supporting the EIR's conclusion. Accordingly, we conclude that the EIR need

not identify alternative water sources or other alternatives to use of the anticipated water.

4. *Holly-Leaf Cherry*

Petitioners contend the EIR applied an incorrect legal standard in determining that the impacts on the holly-leaf cherry would be insignificant. They argue that in evaluating the impact of the proposed elimination of 3.6 acres of the species on the project site, the EIR failed to apply the Guidelines definition of "rare" (Guidelines, § 15380, subd. (b)(2)). We conclude that they have not shown a prejudicial abuse of discretion.

a. *CEQA Requirements*

A project will have a significant effect on the environment if it will cause "a substantial, or potentially substantial, adverse change in the environment." (Pub. Resources Code, § 21068; see also Guidelines, § 15382.) The "environment" means the existing physical conditions in the area of the proposed project, including flora, fauna, and other conditions. (Pub. Resources Code, § 21060.5; Guidelines, § 15360.) "The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting." (Guidelines, § 15064, subd. (b).)

An EIR must identify and analyze the significant environmental effects of a project. (Pub. Resources Code, § 21100, subd. (b)(1); Guidelines, § 15126.2.) An

EIR must identify mitigation measures for each significant effect and discuss alternatives to the project that would avoid or substantially lessen the significant effects, and the lead agency must make detailed findings on the infeasibility of any mitigation measures and alternatives rejected as infeasible. (Pub. Resources Code, §§ 21100, subd. (b)(3), (4), 21081, subd. (a)(3); Guidelines, §§ 15126.4, subd. (a)(1)(A), 15126.6, subd. (a), 15091, subd. (a)(3).) If an EIR determines that particular environmental impacts are insignificant, it must "contain a statement briefly indicating the reasons for determining that various effects on the environment of a project are not significant and consequently have not been discussed in detail in the environmental impact report." (Pub. Resources Code, § 21100, subd. (c); see also Guidelines, § 15128.)

Guidelines section 15065 describes certain impacts that necessarily are significant and therefore require the preparation of an EIR and must be analyzed in an EIR. (*Id.* subds. (a), (c).) These are known as mandatory findings of significance. A project necessarily will have a significant effect on the environment if it will "substantially degrade the quality of the environment; substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or *restrict the range of an endangered, rare or threatened species*; or eliminate important examples of the major periods of California history or prehistory." (Guidelines, § 15065, subd. (a)(1), italics added; see *Mountain Lion, supra*, 16 Cal.4th at p. 124 [equating "range" with "habitat"]; *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777, 792 (*Endangered Habitats*).)

Guidelines section 15065 describes impacts that must be considered significant, but "an impact need not satisfy the requirements of a mandatory finding of significance to be considered a significant impact." (*Mejia v. City of Los Angeles* (2005) 130 Cal.App.4th 322, 338, fn. 9.)

A species is "rare" under the Guidelines if "[a]lthough not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens; or [¶] [t]he species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered 'threatened' as that term is used in the Federal Endangered Species Act."[11] (*Id.*, § 15380, subd. (b)(2).) A species also is "presumed to be endangered, rare or threatened, as it is listed in" federal regulations under the Federal Endangered Species Act and California regulations under the Fish and Game Code. (Guidelines, § 15380, subd. (c).) "A species not included in any listing identified in subdivision (c) shall nevertheless be considered to be endangered, rare or threatened, if the species can be shown to meet the criteria in subdivision (b)." (*Id.*, subd. (d).)

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[11] A species is "endangered" under the Guidelines if "its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, disease, or other factors." (Guidelines, § 15380, subd. (b)(1).)

b. *Draft EIR, Response to Comments, and the City's Findings*

A rare plant survey conducted in the spring of 2003 and attached as an appendix to the draft EIR described "a unique stand of holly-leaf cherry scrub" on the project site. The survey stated, "The stand is dominated by relatively large, mature shrubs of holly-leaf cherry (*Prunus ilicifolia* ssp. *ilicifolia*), 3 to 5 m in height." It stated that although "mainland cherry forest" is ranked "very threatened" by the California Natural Diversity Database, "[t]he canopy cover of the holly-leaf cherry shrubs at this site did not amount to a forest canopy. Holly-leaf cherry scrub, as identified in this survey, is not defined in Holland (1986), and therefore, it has no assigned ranking. However, it should be recognized as a unique and sensitive community at the site."

The draft EIR described the holly-leaf cherry on the project site and stated that the project would result in the direct and permanent loss of 3.6 acres of holly-leaf cherry, which it quantified as approximately 67.9 percent of the holly-leaf cherry on the site. It stated further, "Because holly-leaf cherry scrub on the project site is not known to support special-status plant or wildlife species, and because this plant community is not considered to be sensitive by resource agencies, the loss of 3.6 acres of this habitat type is not considered a significant impact." The draft EIR defined "special-status plant or wildlife species" as "those species considered Rare, Threatened, Endangered, or otherwise sensitive by various state and federal resource agencies," and identified several published listings used as references.

The Department of Fish and Game stated in a comment letter: "The Department considers holly-leafed cherry woodland a declining vegetative community the loss of

which would be considered a significant adverse impact to wildlife habitat. This vegetative community is being systematically eliminated and/or degraded within the Santa Clara River watershed by development. . . . All holly-leafed cherry habitat should be avoided by project alternatives." The comment stated further that even temporary impacts to the plant community involving removal and replanting "will still result in an unacceptable impact to this resource."

The city responded: "The holly-leaf cherry habitat on-site is considered scrub habitat because the canopy cover of this habitat did not amount to a woodland canopy. According to the CDFG's [California Department of Fish and Game] List of California Terrestrial Natural Communities Recognized by the California Natural Diversity Data Base (September 2003 Edition), holly-leaf cherry scrub is not considered a special-status plant community. As stated in Revised Riverpark Draft EIR Section 4.6, Biological Resources, p. 4.6-65, because of the relatively small amount of habitat (3.6 acres) to be lost and because this stand of trees was not considered a sensitive plant community as identified by CDFG, the loss of the 3.6 acres was not considered a significant impact under CEQA."

The city's findings under CEQA stated that the impacts of the proposed project on the holly-leaf cherry would be less than significant.

c. *The EIR Adequately Analyzed the Impacts on the Holly-Leaf Cherry*

The draft EIR described the holly-leaf cherry on the project site and explained the impact of the project on the species. It stated that holly-leaf cherry scrub was not

a designated special status species and was not considered to be sensitive by the resource agencies, and that the loss of 3.6 acres of the species was not a significant impact. The response to the comment explained that the holly-leaf cherry on the project site was in scrub habitat rather than woodland, and therefore was different from the holly-leaf cherry woodland noted by the Department of Fish and Game to be in decline. We conclude that the information provided in the EIR supports the conclusion that the holly-leaf cherry on the project site is not "rare" as defined in Guidelines section 15380(b)(2) because it is not existing in such small numbers that it may become endangered, and that it does not otherwise satisfy the Guidelines definition. The EIR provided information and analysis sufficient to serve the EIR's informational purposes, and Petitioners have shown no abuse of discretion.

5. *San Diego Black-tailed Jackrabbit*

Petitioners contend the EIR failed to apply the correct legal standard to determine the significance of impacts on the San Diego black-tailed jackrabbit, and the evidence does not support the city's finding that the impact on the species will be less than significant. We conclude that they have not shown a prejudicial abuse of discretion.

a. *Draft EIR, Response to Comments, and the City's Findings*

The draft EIR stated that the San Diego black-tailed jackrabbit is designated by California as a species of special concern and is designated by the federal government as a species of concern. It stated that several San Diego black-tailed jackrabbits had been observed on the project site in areas that are subject to natural or manmade disturbances and that the species' habitat on site is considered to be of moderate quality.

It stated: "Where this species occurs within the region, it is common and found in relatively high numbers in some locations (e.g., coastal Orange County and the high desert of northern Los Angeles County). The habitat on the project site for this species is considered of moderate quality. Most individual jackrabbits are expected to disperse to remaining open space areas and the actual number of individual animals that would be lost due to grading and/or construction activities is expected to be low. Because this species is not state or federally listed as Endangered or Threatened, because it is considered relatively abundant in suitable habitat areas within its range, and because the direct loss of individual jackrabbits is expected to be low, it is expected that the regional population would not drop below a self-sustaining level with the implementation of this project. Therefore, the loss of any individual jackrabbits associated with the implementation of this project would not be considered a significant impact."
A biology report in the appendix stated that the species was "relatively common in the project area."

The draft EIR also described the Natural River Management Plan (NRMP), a long-term management plan for projects and activities potentially affecting the Santa Clara River and San Francisquito Creek. It stated that a certified combined EIR and federal environmental impact statement (EIS) for the NRMP had analyzed impacts associated with various proposed infrastructure improvements along the Santa Clara River, including bank stabilization, bridges, utility crossings, and storm drain outlets, and that the United States Army Corps of Engineers, Department of Fish and Game, and California Regional Water Quality Control Board had approved the NRMP. It also

stated that certain proposed infrastructure improvements on the project site (including two bridges, bank stabilization, and outlets) were governed by the NRMP and were subject to mitigation requirements imposed by the NRMP, including the capture of San Diego black-tailed jackrabbits and their relocation "to nearby undisturbed areas with suitable habitat," and the creation or enhancement of habitat for jackrabbits and other species. The draft EIR stated that those mitigation measures had been incorporated into the proposed project.

The draft EIR concluded that although the project impacts to the San Diego black-tailed jackrabbit would be insignificant, cumulative impacts to biological resources, apparently including the San Diego black-tailed jackrabbit, from the proposed project and related projects would be significant due to loss of habitat and increased human activities.

The Department of Fish and Game stated in a written comment: "The DEIR states that the San Diego black-tailed jackrabbit is common where it occurs in the region and abundant in coastal Orange County and the high deserts of Los Angeles County; that displaced individuals of this jackrabbit species will disperse to remaining open space; and that individuals lost i.e. killed by the project is expected to be low. This conclusion is difficult to draw since population estimates were not submitted with the DEIR.

"It is the Department's opinion that the project will result in a cumulative adverse impact to San Diego black-tailed jackrabbit, a California Species of Special Concern. This subspecies is localized within the coastal plains of southern California

including the Santa Clara River Valley. These areas have been and are continuing to be heavily developed and degraded. Jackrabbits do not adapt well to habitat losses and associated disturbances from human proximity. . . . The assumption that displaced jackrabbits will somehow survive by dispersing into remaining degraded open areas of uncertain protected status does not meet the mitigation requirements set forth and described under Section 15021 of CEQA. Insufficient mitigation measure for this subspecies will further assist its decline and may in the future cause more restrictive regulatory measures to protect this resource. The Department recommends a more detailed discussion in the EIR of the project related impacts to San Diego black-tailed jackrabbit with a tangible habitat avoidance and/or preservation element."

The city responded that because the habitat on site is "moderate in quality," "the Riverpark site is not considered to be occupied by a significant population of San Diego black-tailed jackrabbits." The response stated that NRMP mitigation measures had been incorporated into the proposed project with respect to infrastructure improvements governed by the NRMP. It stated that the EIR/EIS for the NRMP had analyzed in detail the impacts on the San Diego black-tailed jackrabbit and had concluded that certain NRMP mitigation measures "requiring capture and relocation of sensitive species including the San Diego black-tailed jackrabbit, and . . . replacement of habitat . . . reduced the impacts to less than significant." The response stated further that some of the infrastructure improvements in the proposed project were less extensive than those contemplated in the NRMP. The response also noted that the draft EIR had

concluded that cumulative impacts due to the loss of habitat were significant and unavoidable.

The city's findings under CEQA stated that the cumulative impacts on biological resources were unavoidable, and the city adopted a statement overriding considerations with respect to that cumulative impact.

b. *The EIR Adequately Analyzed the Impacts on the San Diego Black-tailed Jackrabbit*

The draft EIR explained its conclusion that the project's impacts on the San Diego black-tailed jackrabbit would be insignificant. It stated that the jackrabbit habitat on site was only moderate in quality, that the species is relatively common in other areas within the region, that most individuals of the species are expected disperse to other areas, and that the species is not designated endangered or threatened. The draft EIR also stated that mitigation measures from the NRMP had been incorporated into the project, including the capture and relocation of individual jackrabbits to suitable habitat nearby and the creation or enhancement of habitat for the species. The response to the comment explained further that the jackrabbit population on the site was low.

The statement that the species is relatively common in the region is supported by the statement in the biology report to that effect. The characterization of the habitat on site as only moderate in quality and the statement that individual jackrabbits are likely to disperse to other areas also are supported by substantial evidence, which "includes fact, a reasonable assumption predicated upon fact, or expert opinion supported by fact" (Pub. Resources Code, § 21080, subd. (e)(1)).

We conclude further that the information provided in the EIR supports the conclusion that the San Diego black-tailed jackrabbit is not "rare" as defined in Guidelines section 15380(b)(2) because it is not existing in such small numbers that it may become endangered, and that it does not otherwise satisfy the Guidelines definition. The EIR provided information and analysis sufficient to serve the EIR's informational purposes, and Petitioners have shown no abuse of discretion.

Endangered Habitats, supra, 131 Cal.App.4th 777, is distinguishable. The EIR in *Endangered Habitats* stated that an environmental impact was considered significant only if it caused the population of a species to drop below a self-perpetuating level or caused the species to become threatened or endangered. (*Id.* at pp. 792-793.) *Endangered Habitats* concluded that that was an impermissibly lenient standard and that the county failed to proceed in the manner required by law. (*Id.* at p. 793.) Here, in contrast, the statement in the EIR, "it is expected that the regional population would not drop below a self-sustaining level with the implementation of this project" was not the sole reason provided for the conclusion that the project's impacts on the San Diego black-tailed jackrabbit would be insignificant. Rather, the EIR also explained that the impacts would be insignificant because the jackrabbit population on the site was low, the habitat on site was only moderate in quality, and because individual jackrabbits were likely to disperse to other areas.

6. *Western Spadefoot Toad*

Petitioners challenge the EIR's failure to discuss project revisions or alternatives that would reduce the significant impacts on the western spadefoot toad to an

insignificant level. They argue that the proposed mitigation of constructing ponds and relocating the toads is inadequate and the city was required to consider more effective feasible mitigation. We conclude that Petitioners have not shown an abuse of discretion.

a. *Draft EIR, Response to Comments, and the City's Findings*

The city circulated a revised biological resources section of the draft EIR in March 2004 after the discovery of western spadefoot toads on the project site. The western spadefoot toad is designated by California as a species of special concern and by the federal government as a species of concern. The draft EIR estimated that 16 to 20 pairs of breeding western spadefoot toads were present in three seasonal rainpools on the site, all of which were located in areas of proposed development. A biology report in the appendix described the three seasonal rainpools. The draft EIR stated that the potential loss of that population of toads and their eggs would be a significant impact.

The draft EIR recommended several mitigation measures described in the biology report, including the construction of ponds, of a design and location to be approved by the Department of Fish and Game, and the capture and relocation of western spadefoot toads and their eggs to the new ponds. The biology report stated that although very few attempts had been made to relocate western spadefoot toads, there was "a very good possibility of success." The draft EIR concluded nonetheless that the impacts would remain significant despite mitigation: "While mitigation measures can be implemented to create habitat and relocate individuals observed on the project site, these measures are not considered highly effective. It is expected that not all individual

toads would be captured and relocated and that the created habitat might not meet the specific requirements for this species, thus, not supporting the relocated individuals. The loss of those individuals that are not captured and relocated, and those that are not adaptable to the created habitat, would be considered a significant and unavoidable impact."

The Department of Fish and Game stated in a written comment: "The continual loss of western spadefoot habitat within the Santa Clarita Valley, and Southern California as a whole, concerns the Department. The seasonal pools and associated uplands and floodplains habitats associated with the species are often lost with project development. Mitigation measures for this species are often experimental, and not always successful. The recent discovery of western spadefoot on the project site, despite past negative survey results for this species suggests the potential undocumented loss of occupied habitat for this species in the Santa Clarita area. These potential undocumented losses increase the importance of the known populations on the project site. The preservation, avoidance and protection of all existing seasonal pools which support or could support western spadefoot should be accomplished on the project site." The department stated further that if habitat avoidance is not feasible, breeding pools should be created away from areas of human activity and at least 150 feet away from any road or recreational trail.

The city responded that the existing seasonal pools were in disturbed areas and cited a discussion in another EIR stating that the western spadefoot toad " 'is apparently capable of adapting to a variety of artificial habitats in which to breed.' " The response

stated that this "illustrates that the species adapts well to disturbed environments." It also stated: "[W]estern spadefoot toads have no federal or State protected status, but are classified only as California Species of Special Concern and as a federal Species of Concern, which indicates that the species warrants monitoring due to population decline. Therefore, the species is not entitled to legal protection and a project redesign to preserve existing habitat is not required." The Department of Fish and Game later approved a habitat enhancement and relocation plan for the western spadefoot toad on the site.

The city's findings under CEQA stated that the proposed project's impacts on the western spadefoot toad cannot feasibly be mitigated to a level of insignificance and therefore are considered unavoidable, and the city adopted a statement of overriding considerations with respect to those impacts.

b. *The Discussion of Measures to Mitigate the Impacts on the Western Spadefoot Was Adequate*

CEQA does not require the avoidance of all significant environmental impacts or ensure that an approved project will minimize environmental harm. Rather, an adequate EIR that complies with CEQA's procedural requirements and serves its purpose as an informational document, together with appropriate findings by the lead agency, can support an agency's decision to approve the project despite adverse environmental consequences.

An EIR must discuss mitigation measures designed to avoid or reduce each significant impact, but need not discuss project alternatives that would avoid each

significant impact. (*Big Rock Mesas Property Owners Assn. v. Board of Supervisors* (1977) 73 Cal.App.3d 218, 227; see 1 Kostka & Zischke, Practice Under the California Environmental Quality Act (Cont.Ed.Bar 2006) § 15.15, p. 745.) Rather, an EIR must discuss a reasonable range of alternatives to the proposed project as a whole. (*Big Rock Mesas*, *supra*, at p. 227.) The draft EIR discussed several project alternatives, including a no project alternative that would not disturb the existing seasonal rainpools. Petitioners do not challenge the reasonableness of the range of alternatives. We conclude that the discussion of measures to mitigate the significant impacts on the western spadefoot toad was sufficient to serve CEQA's informational purposes and therefore was adequate, that the EIR need not discuss either a project revision or alternative (other than the no project alternative) that would reduce the impacts to the species to an insignificant level, and that Petitioners have shown no abuse of discretion in this regard.

Petitioners challenge the statement in the city's response to comments that "the species is not entitled to legal protection and a project redesign to preserve existing habitat is not required." They argue that the city declined to consider any project revision or alternative to avoid significant impacts to the western spadefoot toad and therefore could not reasonably conclude that the significant impacts to the species are unavoidable. We construe the statement to mean not that the city believed that it had no obligation to avoid or reduce the significant impacts to the western spadefoot toad, if feasible, but that the city understood that it had the discretion to determine that the

benefits of the project outweighed the significant impacts to the species. Petitioners have not shown an abuse of discretion.

7. *Consistency with the General Plan*

Every county and city must adopt a "comprehensive, long-term general plan" for its physical development. (Gov. Code, § 65300.) A general plan must include "a statement of development policies and . . . objectives, principles, standards, and plan proposals." (*Id.*, § 65302.) A general plan embodies fundamental policy decisions (*Goleta Valley*, *supra*, 52 Cal.3d at p. 571) and serves as a "charter for future development" (*Lesher Communications, Inc. v. City of Walnut Creek* (1990) 52 Cal.3d 531, 540). "The policies in a general plan typically reflect a range of competing interests. [Citation.]" (*Federation of Hillside & Canyon Assns. v. City of Los Angeles* (2004) 126 Cal.App.4th 1180, 1194.)

A subdivision must be consistent with applicable general and specific plans. (Gov. Code, §§ 66473.5, 66474.) A subdivision is consistent with an adopted plan only if "the proposed subdivision or land use is compatible with the objectives, policies, general land uses, and programs specified in such a plan." (*Id.*, § 66473.5.)

Consistency does not require full compliance with all general and specific plan policies. Rather, "[o]nce a general plan is in place, it is the province of elected city officials to examine the specifics of a proposed project to determine whether it would be 'in harmony' with the policies stated in the plan. [Citation.]" (*Sequoyah Hills Homeowners Assn. v. City of Oakland* (1993) 23 Cal.App.4th 704, 719 (*Sequoyah Hills*).) A local agency has unique competence to interpret the policies of its own

general plan and weigh competing interests in determining how to apply those policies. (*Save Our Peninsula Committee v. Monterey County Bd. of Supervisors*, *supra*, 87 Cal.App.4th at p. 142; *Sequoyah Hills*, *supra*, at p. 719.) "It is, emphatically, *not* the role of the courts to micromanage these development decisions." (*Sequoyah Hills*, *supra*, at p. 719.)

We review the city's finding that the subdivision is consistent with its general plan under the abuse of discretion standard. (Code Civ. Proc., § 1094.5, subd. (b); *Youngblood v. Board of Supervisors* (1978) 22 Cal.3d 644, 651, fn. 2; *Sequoyah Hills*, *supra*, 23 Cal.App.4th at p. 717.) To prevail on their contention that the project is inconsistent with the general plan, Petitioners must show that there is no substantial evidence to support the city's finding. (Code Civ. Proc., § 1094.5, subd. (b); *Sequoyah Hills*, *supra*, at p. 717.) In other words, Petitioners must show that no reasonable decision maker could conclude that the project is in harmony with the stated policies. (*No Oil, Inc. v. City of Los Angeles* (1987) 196 Cal.App.3d 223, 243.)

The Open Space and Conservation Element of the city's general plan states several goals and policies promoting the protection of natural features, significant ecological resources, and SEA's. The general plan goals cited by Petitioners include: "To preserve the special natural features which define the Santa Clarita planning area and give it its distinct form and identity," and, "To protect significant ecological resources and ecosystems, including, but not limited to, sensitive flora and fauna habitat areas." The general plan policies cited by Petitioners include: "Utilize major environmental features (significant landforms, significant ridgelines, significant

vegetation, ecologically significant areas, other natural resources) as open space within the planning area," "Identify and protect areas of significant ecological value, including, but not limited to, significant ecological habitats . . . and preserve and enhance existing Significant Ecological Areas (SEAs)," and "Preserve to the extent feasible natural riparian habitat and ensure that adequate setback is provided between riparian habitat and surrounding urbanization." Petitioners also cite a Land Use Element policy that "New development must be sensitive to the Significant Ecological Areas (SEAs) through utilization of creative site planning techniques to avoid and minimize disturbance of these and other sensitive areas."

The draft EIR discussed these general plan goals and policies. It stated that the proposed project would preserve the Santa Clara River and much of the significant vegetation on the site, restrict development on the steepest slopes on the site, and mitigate impacts on the portions of the SEA located on the project site, and concluded that the project was consistent with these goals and policies. The draft EIR also discussed numerous other general plan goals and policies and the project's consistency with them. The city in approving the project found that the project would preserve large areas of open space, including the river, and that the project was consistent with the general plan.

Petitioners' argument that the project is inconsistent with the cited general plan goals and policies is based on the presumption that any development incursion within the SEA necessarily would be inconsistent with those goals and policies. The argument largely disregards the city's considerable discretion to determine that the project, on

balance, is in harmony with those goals and policies, and merely expresses Petitioners' contrary point of view. Moreover, Petitioners focus only on particular goals and policies and do not attempt to show, and have not shown, that the project necessarily is inconsistent with the general plan as a whole. We conclude that they have not shown an abuse of discretion.

DISPOSITION

The judgment is affirmed. The city and Newhall are entitled to recover their costs on appeal.

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

CROSKEY, J.

WE CONCUR:

KLEIN, P. J.

KITCHING, J.

CM2MHill, "Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley" (February 22, 2004)

Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley

TO: Tom Worthington/Impact Sciences, Inc.

FROM: John Porcello/CH2M HILL

DATE: February 22, 2004

Introduction

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. This memorandum discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Summary of Findings

In the Santa Clarita Valley, stormwater runoff finds its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater.

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the

urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long-term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Effect of Pavement on Recharge Beneath Specific Land Parcels

The amount of paved cover on the ground affects the degree to which rainfall and outdoor-applied urban water will be able to infiltrate to groundwater. In heavily industrialized areas with high percentages of paved cover, such as exist in portions of the Los Angeles Basin, less rainfall recharge will occur than if the land is in an undeveloped condition. Furthermore, if the bottoms of rivers and other drainages are paved, then the majority of stormwater generated during a rainfall event will be unable to infiltrate to groundwater. In contrast, the amount of recharge to groundwater will be greater in urbanized areas, such as the Santa Clarita Valley, that have natural soils in the bottoms of rivers and local drainages or that have lower percentages of paved cover on the developed areas lying outside the principal drainages. In these areas, the outdoor use of water for irrigation landscape vegetation or agricultural lands can notably increase the amount of groundwater recharge, particularly if the outdoor water is imported from outside the local groundwater basin. This is discussed further below.

Effect of Vegetative Cover and Water Use

From the 1930s through the 1960s, H.F. Blaney and other researchers at the U.S. Department of Agriculture performed numerous studies to measure the amount of infiltration to groundwater that occurs beneath undeveloped lands and irrigated farmlands, and the differences in recharge rates for different types of native vegetation and crops. In California, these studies included a 1933 study by Blaney in Ventura County, a 1963 study by Blaney and others in the Lompoc Uplands, studies by the U.S. Geological Survey and various consultants in the Montecito and Carpenteria groundwater basins, and a groundwater basin study by Santa Barbara County[1] that incorporated the results of these earlier studies.

Together, these studies concluded that deep percolation to groundwater from undeveloped lands occurs only during years of average or above-average precipitation. This occurs because:

1. Southern California's rainfall is highly seasonal in nature, whereupon most rainfall occurs during the relatively cool period November through March, when plant water

[1] See Santa Barbara County Water Agency, December 15, 1977. *Report on Adequacy of the Groundwater Basins of Santa Barbara County.*

requirements are low, and little, if any, rainfall occurs during the remaining (and warmer months) when plant water requirements increase.

2. During the summer, when little or no rainfall occurs, the native vegetation extracts the residual moisture that is present in the soil, which substantially decreases the soil moisture within the root zone of the vegetation. At the end of the dry season, soil moisture levels on undeveloped lands are below the soil's field capacity, which is the amount of moisture that must be present in the soil before free drainage of water can occur below the rooting zone of the native vegetation.

3. When the seasonal rains arrive, the incident rainfall that is not consumed by plants and does not become stormwater runoff must first raise the soil moisture level to the soil's field capacity before any groundwater recharge will occur. The various studies indicate that about 17 inches/year of rainfall is necessary to raise the soil moisture to the field capacity on an undeveloped parcel of land. This is similar to the average annual rainfall in the Santa Clarita Valley and in other lowland coastal and near-coastal valleys in southern California.

On irrigated lands, irrigation occurs during several months of the year, with the exact duration depending on the amount and timing of rainfall and also the crops or type of urban landscaping being irrigated. The principal effect of converting undeveloped land to land that receives agricultural or urban irrigation is to increase the amount of water that is applied to the land during the low-rainfall months. This application of water to the vegetative cover on the surface of the developed land parcel results in the maintenance of higher soil moisture levels during the warm, dry months than would occur without development. This has three effects:

1. Because irrigation will generally be performed in a manner that maintains the health of the vegetative cover, enough water will be applied to maintain the soil moisture at, or close to, the field capacity of the soil. This in turn will allow some deep percolation to occur from the irrigation water itself.

2. When the rainy season begins, because irrigation has maintained soil moisture at or near field capacity, less of the initial rainfall entering the root zone needs to be stored in the soil (to meet soil moisture deficits) beneath an irrigated parcel than in the case of an undeveloped parcel. Therefore, a greater percentage of the initial rainfall and annual rainfall will be able to infiltrate to groundwater. The southern California studies estimated that irrigated land parcels would allow rainfall infiltration to occur in years when annual rainfall is at least 10.5 inches/year. This threshold rainfall value is 6.5 inches less than the threshold rainfall value that the studies estimated to be necessary for generating groundwater recharge beneath undeveloped land parcels.

3. Because the majority of irrigation occurs during the dry (low-rainfall) months, the total annual recharge to groundwater from irrigated developed lands is the sum of: (a) the deep percolation arising from irrigation (during the low-rainfall months); and (b) rainfall (during the months when less irrigation is occurring). Therefore, groundwater recharge beneath developed lands is greater and occurs for a longer period of time each year than in the case of undeveloped lands where no irrigation is occurring.

Historical Observations of Groundwater Conditions in the Santa Clarita Valley

The findings of the studies described above for other groundwater basins in southern California are consistent with observations that have been made in the Santa Clarita Valley, which are based on long-term water level records, water budget analyses, and groundwater modeling. Based on a month-by-month calibration to a 20-year record of historical water level records (throughout the Valley) and stream gaging records (at the Los Angeles – Ventura County line), the model simulates 10 percent of the applied outdoor water as being available for recharge to groundwater in retail and residential areas, with greater percentages infiltrating beneath golf courses and agricultural lands. This is consistent with a 1980 study by DWR of the groundwater resources of the Santee and El Monte hydrologic subareas of San Diego County. In that study, which was performed to evaluate reclaimed water use plans, DWR concluded that approximately 20 percent of the applied outdoor water in municipal areas infiltrates to the water table, with the remaining 80 percent going to evapotranspiration and direct evaporation. DWR also concluded that there would likely be no significant change in these percentages as urbanization continues.[2]

In the Santa Clarita Valley, as in any urbanized area, urbanization increases the paved area and can increase the magnitude and intensity of stormwater runoff from paved land areas. In the Santa Clarita Valley, this stormwater runoff will find its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater. Consequently, for a developed land parcel, the water that runs off of the paved portion of the land parcel will infiltrate to groundwater from a detention basin or a riverbed, rather than infiltrating onsite.

Riverbed infiltration is a significant percentage of total recharge in the Santa Clarita Valley in any given year. Streamflow records and the model calibration process together demonstrate that year-to-year fluctuations in total recharge in the Valley arise not just from year-to-year variations in incident rainfall within the Valley, but also from year-to-year variations in streamflows in the Santa Clara River and its tributaries. Because the areas contributing flow to the rivers are located both within and outside of the Valley, the recharge that occurs from riverbeds is a significant source of groundwater recharge within the Valley.

Evidence that stormwater infiltration to groundwater is not significantly decreased by urbanization comes from long-term water level records at wells completed in the Alluvial aquifer. These records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. Also, groundwater pumping volumes have not increased

[2] See State of California, Department of Water Resources, Southern District. August 1984, *San Diego County Cooperative Ground Water Studies: Reclaimed Water Use, Phase II*. Pages 40-41.

due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Additionally, beginning in 1980, water was imported into the Santa Clarita Valley from the State Water Project (SWP) for urban use, with SWP water use reaching nearly 30,000 acre-feet per year (AF/yr) by the end of the 1990s, and progressively increasing from about 32,500 AF in 2000 to nearly 44,500 AF in 2003. Because two-thirds of the total urban water demand is used outdoors, a substantial portion of the imported SWP water has been and continues to be applied to urban landscaping, thereby increasing the amount of recharge to groundwater. The remaining urban water is used indoors, and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Luhdorff & Scalmanini Consulting Engineers, "Evaluation of Groundwater Recharge Methods for the Saugus Formation in the Newhall Ranch Specific Plan Area" (March 2006)

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TECHNICAL MEMORANDUM

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Evaluation of Groundwater Recharge Methods for the Saugus Formation in the Newhall Ranch Specific Plan Area

Prepared for: Tom Worthington, Impact Sciences

Prepared by: Joseph C. Scalmanini

Date: March 8, 2006

Project Number: 06-1-017

Introduction

Included with the approval of the Newhall Ranch Specific Plan was a condition that "prior to approval of the first subdivision map which permits construction, a report will be provided by the applicant which evaluates methods to recharge the Saugus Aquifer within the Specific Plan, including the identification of appropriate candidate land areas for recharge". In response to that condition, this technical memorandum has been prepared to address recharge of the Saugus Formation in general, as well as within the Specific Plan area. It also addresses groundwater recharge methods as might be applicable to the Saugus Formation, and it provides a summary of artificial recharge feasibility that was previously assessed for the Saugus Formation. Finally, this technical memorandum includes a summary of the recently completed analysis of groundwater basin yield, where that yield is comprised of both the Alluvial and Saugus aquifers, as a basis for concluding about the need for identifying land areas for recharge of the Saugus Formation within the Specific Plan area.

The Saugus Formation

The Saugus Formation is one of two significant aquifers in the Santa Clara River Valley Groundwater Basin, East Subbasin, the other being the less extensive Alluvium that overlies part of the Saugus Formation, generally near the main Santa Clara River and several of its tributaries. The Alluvium extends to a maximum depth of about 200 feet and has been estimated to have a maximum storage capacity of about 240,000 acre-feet. The geologically older Saugus Formation extends several thousand feet in total depth but, for groundwater supply purposes, contains sand and gravel units that represent aquifer materials generally between depths of about 300 and 2,500 feet. The fresh water storage capacity of the Saugus in that depth interval has been estimated to be about 1.65 million acre-feet.

In general, natural groundwater recharge in the Santa Clarita Valley occurs in the eastern portion of the basin, and at the northern and southern limits of the basin. Natural groundwater discharge occurs from the Saugus Formation and the Alluvium in the west-central portion of the basin, in the alluvial valley occupied by the Santa Clara River. Of course, groundwater pumping is also a groundwater discharge mechanism that occurs at distinct locations throughout the basin. Ultimately, however, in the general context of the Specific Plan condition regarding recharge of the Saugus Formation, the occurrence of natural groundwater discharge in the west-central portion of the basin is suggestive of prevailing groundwater conditions that support such a discharge; in other words, the basin has sufficient natural recharge and groundwater flow toward the west that additional efforts to identify and potentially utilize new recharge areas in the Newhall Ranch Specific Plan area, which is where groundwater is already discharging from the basin, would be counter-productive. To place that in some context, however, artificial recharge methods and their potential applicability in the basin are discussed in some detail below, as is the operating plan for groundwater use in the basin and its associated effects on the prevailing groundwater flow direction and associated groundwater storage and discharge.

Groundwater Recharge Methods

The implied intent of the Specific Plan condition addressed in this technical memorandum is an evaluation of purposeful supplemental groundwater recharge, commonly called artificial recharge, to augment natural recharge processes, presumably to benefit the yield of the basin. By specifically noting that the evaluation of recharge methods should also identify appropriate land areas for recharge, the condition further implies that potential artificial recharge would most likely involve the spreading of surface water for infiltration and deep percolation to the water table. Despite the latter implication, however, rather than limit this overall discussion to potential surface spreading of water for artificial recharge, and recognizing the nature of the aquifer systems in the basin, and particularly in the Specific Plan area, the following discussion of artificial recharge methods is included to provide a context for considering the applicability of artificial recharge in that local setting, and also to provide a context for the recent investigation of the feasibility of injection as a potential recharge mechanism, the results of which are summarized in the next section of this technical memorandum.

In most general terms, artificial recharge can be defined as augmenting the natural movement of surface water into underground formations by some method of construction, by spreading of water, or by artificially changing natural conditions. While a variety of artificial recharge methods have been developed and applied in various areas, they can generally be grouped into three categories: water spreading on the ground surface to increase infiltration, recharging through wells to directly introduce water into the aquifer system, and pumping in proximity to surface water bodies to induce recharge from them.

Of the three general categories of artificial recharge methods, the most widely practiced are water spreading operations, where surface waters are purposely introduced to a spreading basin,

or onto selected lands, or into a stream channel such that the water can infiltrate from the surface and then deep percolate to the water table, thus adding to other waters that "naturally" recharge the aquifer, e.g. precipitation, water applied for irrigation, etc. In contrast to surface spreading, artificial recharge of groundwater through wells is much less widely practiced and is typically much smaller in rate of recharge. Individual wells might be capable of recharge rates of a few acre-feet per day, where surface spreading, depending on the nature and physical extent of the spreading ponds or in-channel watercourse, can infiltrate tens to hundreds of acre-feet per day. Despite such limitations, two key factors that lead toward the potential applicability of recharge wells, rather than spreading basins, in some settings are the physical presence of confining layers in the aquifer system that could impede the deep percolation of infiltration from the surface, and the lack of available surface area for surface spreading. In this setting, the nature and depth of the Saugus Formation, which contains alternating layers of fine (confining) and coarse aquifer materials, would likely warrant consideration of recharge wells for those reasons, if artificial recharge of the Saugus were being considered. However, as discussed below, neither recharge method (surface spreading or recharge wells) is warranted in the basin, and particularly in the westerly portion of the Saugus Formation in the vicinity of the Newhall Ranch Specific Plan.

Feasibility of Injection for Saugus Formation Recharge

Early considerations of potential water supply for the Newhall Ranch Specific Plan included so-called Aquifer Storage and Recovery, or "ASR", whereby water from outside the local basin would be imported and injected into the Saugus Formation, where it would be stored for subsequent recovery by pumping for the municipal water requirements of the project. While ASR is not part of the integrated groundwater/imported surface water/reclaimed water supply that is the current and planned future water supply in the valley, the consideration of ASR as a water supply concept for Newhall Ranch resulted in field testing and analysis to assess the hydrogeologic feasibility of injecting and recovering water in the Saugus Formation. That work, briefly summarized as follows, provides some useful insight to potential artificial recharge of the Saugus Formation since it specifically tested both injection (recharge) into, and recovery of water from that aquifer.

A detailed description of the assessment of the hydrogeologic feasibility of injection and recovery in the Saugus Formation, which was conducted in the summer-fall of 2000, is documented in **Assessment of the Hydrogeologic Feasibility of Injection and Recovery of Water in the Saugus Formation, Santa Clarita Valley** (Richard C. Slade & Associates, 2001). That feasibility assessment included the injection of water from Valencia Water Company's municipal distribution system into Valencia's Saugus Well No. 205 for seven day periods at each of 500, 800, and 1,100 gallons per minute (gpm). That injection was followed by a brief (9 days) observation of groundwater storage, followed in turn by pumping (recovery) of water from the same well at its normal operating capacity of about 2,300 gpm over a period of 10 days. During injection, groundwater quality sampling at a nearby production well was conducted to assess any discernable impacts of injection on groundwater quality during injection. During subsequent

pumping of the tested injection well, daily water quality sampling was conducted to assess the "recovery" of injected water, followed by extraction of typical formation water quality after recovery of the injected water. Other related work at the time of injection feasibility testing included the separate pumping of another Saugus Formation well, and concurrent observation of groundwater response in a number of wells completed in either the Saugus Formation or the overlying Alluvium. The purpose of the latter testing was to examine the extent of direct effects, if any, of Saugus pumping on the Alluvium.

The results of the testing described above were interpreted by Slade to conclude that it is hydrogeologically feasible to inject (recharge) and recover water in the Saugus Formation. The aquifer readily accepted water from the injection well, and it subsequently yielded a comparable volume to the same well when it was pumped. The measured effects of injection and pumping were indistinguishable from normal seasonal fluctuations in groundwater levels in the Saugus Formation. The yield of the injection/production well, as measured by its specific capacity (injection or pumping rate divided by water level increase during injection, or drawdown during pumping) was determined to be as generally expected; specific capacity during injection was about 60 to 80 percent of specific capacity during pumping, a phenomenon typically attributed to clogging during injection by some combination of sediment and air. Finally, the injection into, and pumping from the Saugus wells were observed to have no measurable effect on water levels in the overlying Alluvial aquifer system.

In the context of this technical memorandum, the conclusions derived from the assessment of hydrogeologic feasibility of injection and extraction in the Saugus Formation can be extrapolated to project that the Saugus can be recharged via injection at capacities that correlate with fractions of the yields of equivalent Saugus production wells. Some amount of clogging of the injection wells can be expected, resulting in a probable need to regularly interrupt injection (recharge) for routine "purging" of the wells by pumping and, probably less frequently, for well rehabilitation of a more complex nature, e.g. using chemical and/or mechanical means to restore and maintain well injectivity. In the more focused context of the Specific Plan condition regarding land areas for potential recharge, the feasibility assessment and conclusions to date suggest that typical well sites, plumbed with provisions to deliver water from the municipal distribution system for injection and also to discharge water from routine and other well rehabilitation efforts, can be adequate to provide for the installation of injection (recharge) wells if artificial recharge of the Saugus were to be desired for some reason. In that light, however, the next section discusses the yield of the local groundwater basin, and the integration of supplemental water supplies with that yield to meet existing and projected water requirements in the basin, including those of the Specific Plan area.

Groundwater Basin Yield

Total water requirements in the Santa Clarita Valley were nearly 88,000 acre-feet in 2004. That total demand represents an average annual increase of about 3.5 percent per year since 1980,

when surface water from the State Water Project (SWP) was initially imported to supplement local groundwater for municipal and agricultural water supply. Current groundwater use is lower than peak historic, pre-SWP use, and it has remained within a generally constant range of about 38,000 to 44,000 acre-feet per year over the last 15 years. That historical groundwater use and resultant conditions, i.e. no long-term changes in groundwater levels and storage, have been such that there has been no need to initiate and operate artificial groundwater recharge projects. In effect, natural recharge processes have resulted in recharge that sustains, i.e. refills, the aquifer system sufficiently that there has been no long-term depletion of groundwater. Groundwater levels have remained basically unchanged for several decades throughout the western half of the basin; to varying degrees, groundwater levels in the eastern part of the basin have fluctuated through wet and dry hydrologic cycles, but fully recover through natural recharge processes in wet and normal periods of rainfall and stream flow. Thus, with particular focus on the western portion of the basin where the Specific Plan is located, the aquifer system has remained basically full, discharging to some degree to the Santa Clara River to sustain surface water flows out of the basin and downstream to Ventura County.

Based on empirical observation of groundwater basin conditions in response to historical pumping, and also in recognition of the increases in Santa Clara River flows and related groundwater recharge that indirectly derive in part from increased imported SWP water, the concept of a groundwater operating plan was developed to define the groundwater component of overall water supply in the basin. The groundwater operating plan is also a product of the formal Groundwater Management Plan adopted for the basin in 2003, which incorporates a number of elements aimed at developing groundwater in conjunction with other water supplies to meet existing and projected water requirements, and to do so without overdrafting the groundwater basin. The groundwater operating plan is based on the concept that pumping can vary from year to year to allow increased groundwater use in dry periods and increased recharge during wet periods, and to collectively assure that the groundwater basin is adequately replenished through various wet/dry cycles, thus maintaining the basin in a sustainable condition, i.e. no long-term depletion of groundwater or interrelated surface water. In summary, the operating yield concept has been quantified as ranges of annual pumping volumes as follows:

Alluvium – Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the eastern Santa Clara River watershed. Pumping ranges between 30,000 and 40,000 afy during normal and above-normal rainfall years. However, due to hydrogeologic constraints in the eastern part of the Basin, pumping is reduced to between 30,000 and 35,000 afy during locally dry years.

Saugus Formation – Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly from the SWP. During average-year conditions within the SWP system, Saugus pumping ranges between 7,500 and 15,000 afy. Planned dry-year pumping from the Saugus Formation ranges between 15,000 and 25,000 afy during a drought year and can increase to between 21,000 and

25,000 afy if SWP deliveries are reduced for two consecutive years and between 21,000 and 35,000 afy if SWP deliveries are reduced for three consecutive years. Such high pumping would be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 afy, to further enhance the effectiveness of natural recharge processes that would recover water levels and groundwater storage volumes after the higher pumping during dry years.

To examine the sustainability of the groundwater basin under the operating plan, which already derived from observation of actual basin response to generally comparable historical operations, the municipal purveyors in the Santa Clarita Valley commissioned the development and calibration of a numerical groundwater flow model which could be used to project groundwater level and storage response to the variations in pumping planned through wet and dry hydrologic cycles as described in the operating plan. That model was developed and calibrated in 2004 (CH2M Hill, 2004) to simulate the basin's response to the various natural recharge processes (e.g. infiltration of precipitation, infiltration of applied water, infiltration of stream flow) and discharge processes (e.g. pumping, groundwater discharge to streams). The calibrated model was then used to analyze the yield of the basin, i.e. the groundwater operating plan, in 2005 (CH2M Hill and LSCE, 2005). Basin yield was examined by running the model over a 78-year hydrologic period, which was selected from actual historical precipitation to examine a number of hydrologic conditions which could be expected to affect both groundwater pumping and groundwater recharge. The selected 78-year simulation period was assembled from an assumed recurrence of 1980 to 2003 conditions, followed by an assumed recurrence of 1950 to 2003 conditions. The 78-year period was analyzed to define both local hydrologic conditions (normal and dry), which affect the rate of pumping from the Alluvium, and hydrologic conditions that affect SWP operations, which in turn affect the rate of pumping from the Saugus. The resultant simulated pumping cycles included the distribution of pumping among existing and planned Alluvial and Saugus Aquifer wells, for normal and dry years respectively, including the planned restoration of wells that have been impacted by perchlorate in the central part of the basin.

Simulated Alluvial Aquifer and Saugus Formation response to the ranges of pumping under assumed recurrent hydrologic conditions is essentially a long-term repeat of the historical conditions that have resulted from similar pumping over the last several decades in the Alluvium, and consistent with actual experience under smaller pumping rates in the Saugus Formation. The resultant response consists of: (1) generally constant groundwater levels in the middle to western portion of the Alluvium and fluctuating groundwater levels in the eastern portion as a function of wet and dry hydrologic conditions, (2) variations in natural recharge that directly correlate with wet and dry hydrologic conditions, and (3) no long-term decline in groundwater levels or storage. The combination of actual experience with Alluvial Aquifer pumping at capacities similar to those in the operating plan, and the resultant natural recharge of groundwater levels and storage, complemented by modeled projections of similar recharge to future pumping, result in a conclusion that the operating plan represents a sustainable yield of the Alluvium.

In the Saugus Formation, the simulated response consists of (1) short-term declines in groundwater levels and storage near pumped wells during dry-period pumping, (2) rapid recovery of groundwater levels and storage after cessation of dry-period pumping, and (3) no long-term decreases or depletion of groundwater levels or storage. The combination of actual experience with Saugus pumping and recharge up to about 15,000 afy, complemented by modeled projections of aquifer response that show long-term utility of the Saugus at 7,500 to 15,000 afy in normal years and rapid recovery from higher pumping rates during intermittent dry periods, all without any purposeful artificial recharge, shows that the Saugus Formation can be considered a sustainable water supply source to meet the Saugus portion of the operating plan for the groundwater Basin.

As a result of the analysis described in the preceding, i.e. the combination of actual historical basin conditions and simulated future basin conditions, the groundwater operating plan and the natural recharge associated with it have become the existing and projected groundwater supply component of water supply to meet ongoing water requirements in the valley.

For purposes of this technical memorandum, the existence of historical and existing groundwater conditions, combined with the balance of the hydrogeologic setting in the Specific Plan area, indicates that there has been no need for artificial recharge of the aquifer system in that portion of the basin. Since natural recharge processes have maintained long-term stable groundwater conditions, including sufficiently high groundwater storage that there is groundwater discharge from the aquifer to the Santa Clara River, efforts to artificially augment natural recharge in that area could be expected to result in "rejected" recharge, i.e. recharged water would simply add to groundwater discharging from the aquifer system, resulting in no net benefit to the basin's yield or storage. Recent analysis of the groundwater basin's yield and the projected impact of the operating plan for groundwater pumping in the basin shows that future conditions are expected to generally repeat historical observations, resulting in no need for artificial recharge in the western (Specific Plan) portion of the basin.

Need for Saugus Formation Recharge Locations in Newhall Ranch Area

All the preceding description and discussion of the occurrence of groundwater, its recharge and discharge areas, and its sustainable yield maintained by natural recharge processes can be summarized to conclude that there is no definable need to identify land areas for artificial recharge of the Saugus Formation. More specifically, there is no need to identify land areas for artificial recharge of the Saugus Formation in the small part of that aquifer system that underlies the Newhall Ranch Specific Plan area. In summary form, that conclusion derives from the following points.

- The Upper Santa Clara River Groundwater Basin, East Subbasin is comprised of two aquifers, the Alluvium and the Saugus Formation, which are generally recharged in the east to central portion of the basin, well east of the Newhall Ranch Specific Plan

area. Groundwater flow in the basin is generally east to west, with resultant groundwater discharge at the western end of the basin.

- The Newhall Ranch Specific Plan area overlies a very small portion of the Saugus Formation at the far western end of the basin, as illustrated in Figure 1, where the basin is discharging water that flows downstream toward Ventura County.

- Historical observations for several decades have shown no long-term changes in groundwater storage or levels. Natural recharge processes have sustained groundwater levels, including long-term essentially constant, high groundwater levels. There has thus been no need for addition of artificial recharge operations to augment natural recharge to the basin.

- The presence of high, relatively constant groundwater levels in the Specific Plan area is indicative of no vacant aquifer storage space into which artificial recharge might be introduced. Thus, attempts to artificially recharge the basin in that area can be expected to result in rejected recharge, or the rapid discharge of any recharged water to the overall outflow from the basin.

- The future operating plan for the basin includes future pumping that is generally similar to historic pumping, with one notable change whereby short-term intermittent increases in Saugus pumping would occur during dry periods when supplemental imported State Water Project deliveries might be reduced. Simulation of basin response to such pumping projects conditions generally comparable to historic experience: future Alluvial aquifer levels and storage comparable to historical conditions; and future Saugus Formation levels and storage lowered during dry periods (in response to increased pumping) but fully replenished by natural recharge processes in subsequent wet/normal conditions.

- While there is no defined need for artificial recharge in the western part of the basin, the nature of the Saugus Formation is such that, physically, recharge to that formation would likely be more effective through injection wells. Thus, if artificial recharge of the Saugus Formation were to become desirable for some reason, feasibility testing of injection has been undertaken, with results showing such a mechanism to be hydrogeologically feasible.

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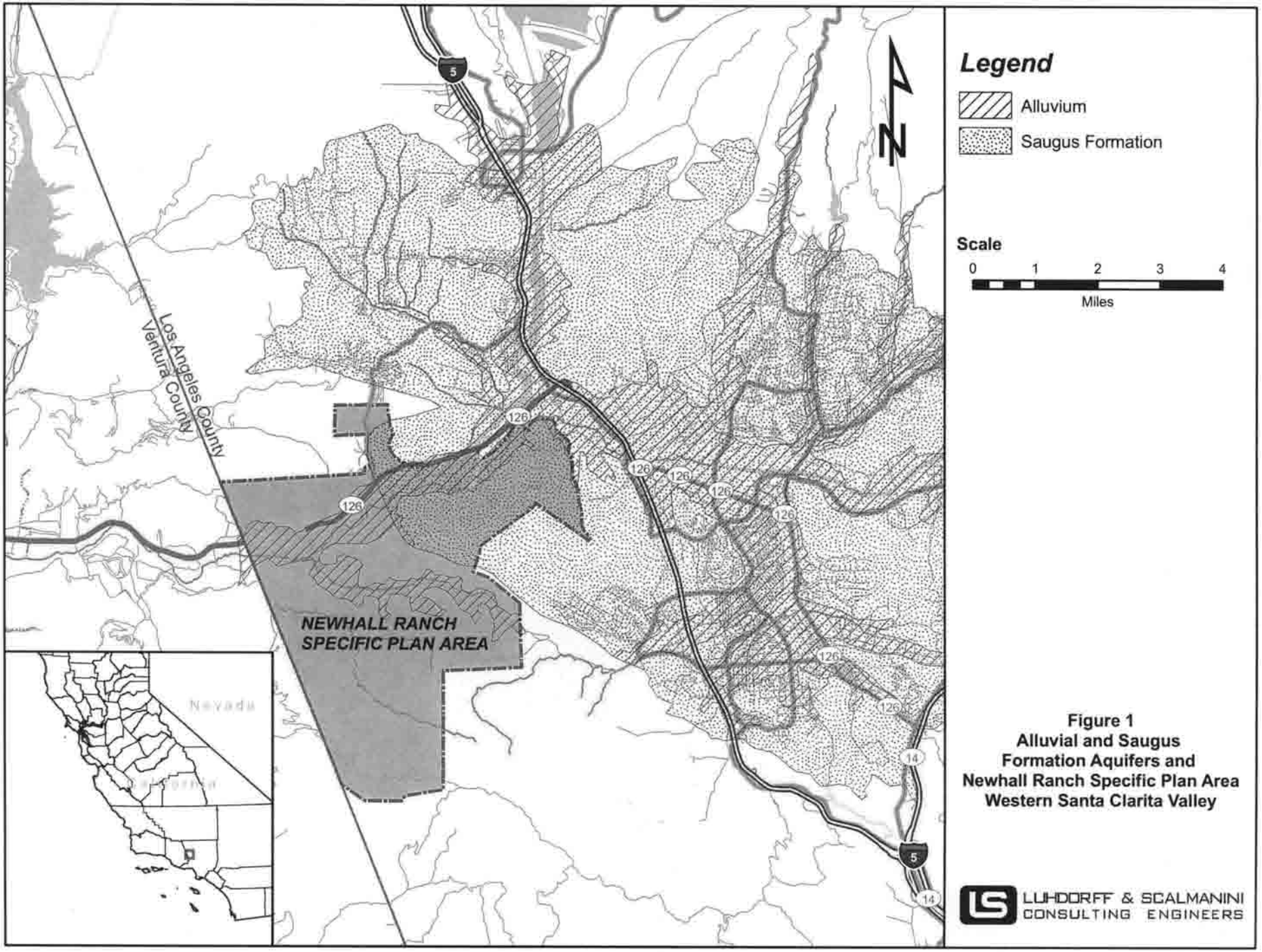

Figure 1
Alluvial and Saugus Formation Aquifers and Newhall Ranch Specific Plan Area Western Santa Clarita Valley

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TRANSMITTAL

Date March 17, 2006

TO: Tom Worthington
Steve Zimmer
Mark Dillon
Glenn Adamick

Phone

FROM: Bob DiPrimio
Valencia Water Company
24631 Avenue Rockefeller
Valencia, CA 91355

Phone 661-295-6501
Fax Phone 661-294-3806

CC:

REMARKS: ☐ Urgent ☒ For your review ☐ Reply ASAP ☐ Please Comment

Note: Here is Joe's signed Tech memo.

Bob

Filed 5/13/09 Cal. Water Impact Network v. Newhall County Water Dist. CA2/8

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

California Rules of Court, rule 8.1115(a), prohibits courts and parties from citing or relying on opinions not certified for publication or ordered published, except as specified by rule 8.1115(b). This opinion has not been certified for publication or ordered published for purposes of rule 8.1115.

IN THE COURT OF APPEAL OF THE STATE OF CALIFORNIA

SECOND APPELLATE DISTRICT

DIVISION EIGHT

CALIFORNIA WATER IMPACT NETWORK, Plaintiff and Appellant, v. NEWHALL COUNTY WATER DISTRICT et al., Defendants and Respondents; GATE KING PROPERTIES et al., Real Parties in Interest.	B203781 (Los Angeles County Super. Ct. No. BS098727)
CALIFORNIA OAK FOUNDATION et al., Plaintiffs and Appellants, v. CITY OF SANTA CLARITA, Defendant and Respondent; GATE KING PROPERTIES et al., Real Parties in Interest.	B203782 (Los Angeles County Super. Ct. No. BS084677)

APPEAL from judgments of the Superior Court of Los Angeles County, Dzintra Janavs, Judge. Affirmed.

Law Offices of Babak Naficy and Babak Naficy for Plaintiffs and Appellants.

Lagerlof, Senecal, Gosney & Kruse LLP, Thomas S. Bunn III; Carl K. Newton, City Attorney; Burke Williams & Sorensen LLP, Brian A. Pierik and Gregory M. Murphy for Defendants and Respondents.

Cox, Castle & Nicholson, Anne E. Mudge and Sarah E. Owsowitz for Real Parties in Interest.

This is the second time we address issues associated with a proposal to develop an industrial park in the City of Santa Clarita, the City's environmental impact report (EIR) for the proposed project, and water. Four years ago, we ruled that the City's EIR did not include an adequate discussion on the subject of water supplies for the proposed project. (See *California Oak Foundation v. City of Santa Clarita* (2005) 133 Cal.App.4th 1219 (*California Oak*).) At that time, we directed the trial court to issue a writ of mandate commanding the City to decertify its EIR, and to prepare and recertify an EIR complying with the requirements of the California Environmental Quality Act (CEQA).[1] We further directed the trial court to retain jurisdiction over the cause until the City recertified its EIR.

The consolidated appeals before our court today arise from two judgments which, together, have the effect of approving the City's recertification of its EIR — with a final additional analysis (FAA) — for the proposed project. We agree with the trial court that the City's EIR/FAA now complies with CEQA, and affirm both judgments.

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[1] See Public Resources Code section 21000 et seq. All section references are to the Public Resources Code, except where noted otherwise. All references to the CEQA Guidelines are to the California Code of Regulations, title 14, section 15000 et seq.

FACTS

I. Water

We begin our examination of the current appeal by revisiting some foundational background facts summarized in our prior opinion on the first appeal. The State Water Project (SWP) was authorized in the 1950s, and was envisioned to become a system of reservoirs, dams and other facilities for the storage and delivery of 4.23 million acre-feet of water per year (AFY). The Department of Water Resources (DWR) manages the SWP and operates its facilities. (*California Oak, supra*, 133 Cal.App.4th at p. 1227.)

When the SWP began, DWR entered into a number of long-term contracts with water suppliers (DWR contractors) throughout the state. The central provisions of these long-term contracts were the same: a DWR contractor was allotted an entitlement to a certain amount of water from the SWP each year, in exchange for which the contractor agreed to pay, on a proportionate basis, the costs of financing and maintaining the SWP's facilities. (*California Oak, supra*, 133 Cal.App.4th at p. 1227.) The long-term contracts also included a provision — "Article 18" — outlining the procedures for the reallocation of water among contractors in the event of water shortages within the SWP system. (See generally, *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 898-900 (*PCL*).)

The entitlements to SWP water which were allotted to the contractors under their long-term contracts with DWR were based on the predicate that the state would actually build out the SWP as planned, so that it actually had the capacity and capability to store and deliver 4.23 million AFY of water. The state, however, never completed the SWP as envisioned, and, today, the SWP simply does not have the physical capability to deliver 4.23 million AFY of water to its contractors. On the contrary, the actual, reliable water supply in the SWP is more in the vicinity of 2 to 2.5 million AFY of water. (*California Oak, supra,* 133 Cal.App.4th at pp. 1227-1228.)

With this general background of the state's water resources and some relevant statutory schemes in mind, we move on to other events.

II. The Monterey Agreement and Monterey Amendments

During the late 1980s and early 1990s, ongoing drought conditions in California diminished the supply of water in the SWP, and generated "Article 18 disputes" among state's agricultural water contractors, urban water contractors, and DWR regarding the distribution of water from the SWP. In the fall of 1994, DWR and its contractors met in Monterey to discuss the allocation of SWP water in times of shortage. These so-called "Article 18 negotiations" morphed into an attempt to implement an "omnibus revision of the SWP long-term contracts and their administration" (see *PCL, supra*, 83 Cal.App.4th at p. 901), and, in early 1995, DWR and a number of contractors took the first step toward that end by agreeing to a statement of principles known as the Monterey Agreement.

For purposes of the appeal before us today, the Monterey Agreement embodied two key principles: first, it contemplated that the then-existing long-term contracts with DWR would be amended to allow for the reallocation of the entitlements to SWP water which the state's agricultural contractors and urban contractors had previously enjoyed, and, second, it envisioned that these amendments would authorize contractors to transfer SWP water amongst themselves on a "willing buyer/willing seller" basis. (*California Oak, supra*, 133 Cal.App.4th at p. 1228; *PCL, supra*, 83 Cal.App.4th at pp. 900-902.)

In the years following the Monterey Agreement, various DWR contractors began implementing the agreement's principles by negotiating and purchasing transfers of SWP water. These consummated transfers of entitlements to SWP water became known as the Monterey Amendments. In 1999, the Castaic Lake Water Agency (CLWA) purchased a transfer of an entitlement to 41,000 AFY of SWP water from the Kern County Water Agency (KCWA). (*California Oak, supra*, 133 Cal.App.4th at p. 1228.)[2]

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[2] "CLWA is a public agency created and governed by the uncodified Castaic Lake Water Agency Law. (Stats. 1962, 1st Ex. Sess., ch. 28, §1, p, 208 . . . .) CLWA was formed to provide a . . . supply of imported water to . . . water purveyors of the Santa Clarita Valley. . . . CLWA contracts with [DWR] for water from the [SWP] . . . , treats those supplies at its treatment plants, and delivers the treated water to [local] water

As we will see below, the 1999 transfer of SWP water from KCWA to CLWA is the proverbial seed from which the appeal before us today is grown. With this second part of our story tucked away in mind, we turn to still more events.

III. Related Litigation

A. The CEQA Case Involving the Monterey Agreement/Monterey Amendments

The DWR contractors who negotiated the Monterey Agreement, along with DWR, recognized that implementation of the agreement's principles for the reallocation of water from the SWP might have potential adverse environmental effects, and, thus required the preparation of an EIR, including an opportunity for public input during the environmental review process. To that end, the Monterey Agreement adherents appointed one of their own contractors to serve as the "lead agency" in charge of preparing an EIR. In 1995, the contractor certified an EIR for the Monterey Agreement, and, later that same year, DWR, acting in the role of a "responsible agency," issued findings and adopted the EIR. (*PCL, supra,* 83 Cal.App.4th at p. 902.)

Shortly thereafter, two citizens groups (and others) filed a petition for writ of mandate in the Sacramento County Superior Court, challenging the sufficiency of the EIR for the Monterey Agreement. In 1996, the trial court entered judgment rejecting the

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retailers within [the Santa Clarita Valley] area." (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2004) 123 Cal.App.4th 1, 4.) CLWA is a statutorily-defined "urban water supplier" under the Urban Water Management Planning Act or UWMPA. (Stats. 1983, ch. 1009, § 1, p. 3555; Wat. Code, § 10610 et. seq.) The UWMPA requires all such water suppliers to prepare an Urban Water Management Plan (UWMP) every five years. Among other elements, a UWMP must provide information on a supplier's water usage, resources, reliability planning, demand management measures, and shortage contingency planning. A UWMP is intended to function as a planning tool to guide broad-perspective decision-making by the management of the water supplier; an UWMP is not a substitute for project-specific planning documents, such as those which are required under CEQA. In *Friends of the Santa Clara River v. Castaic Lake Water Agency*, *supra*, 123 Cal.App.4th 1, the Fifth District Court of Appeal in Fresno addressed challenges to CLWA's 2000 UWMP. In 2005, CLWA prepared its most recent UWMP. CLWA's UWMP envisions use of the transfer of the 41,000 AFY of SWP water purchased from KCWA.

CEQA challenges, ruling that, although the appointed contractor should not have been the lead agency for the preparation of the EIR, the EIR was nonetheless adequate, which meant that the CEQA violation was not prejudicial.

In 2000, the Third District Court of Appeal agreed with the trial court that DWR, not the appointed contractor, should have acted as the lead agency for the preparation of the EIR for the Monterey Agreement, but disagreed with the trial court that the EIR itself was adequate. The Third District reversed the judgment, concluding that the omissions in the EIR mandated preparation of a new EIR for the Monterey Agreement, under DWR's direction. (*PCL*, *supra*, 83 Cal.App.4th at p. 898.)

In June 2003, the Sacramento County Superior Court entered an order approving a settlement agreement in the CEQA case involving the Monterey Agreement. The order provided that the trial court would issue a writ of mandate compelling DWR to prepare a new EIR for the Monterey Agreement, and that the court would retain jurisdiction over the cause until DWR filed a return to the writ of mandate showing that it had complied with CEQA, and the court issued an order discharging the writ of mandate. (*Planning & Conservation League v. Department of Water Resources* (Super. Ct. Sacramento County, 2003, No. 95CS03216.)

The record before us today shows that the parties who are involved in the current appeal are of the understanding that, notwithstanding the passage of more than five years, DWR still has not yet completed its EIR for the Monterey Agreement.

With this summary of the CEQA litigation involving the Monterey Agreement, we turn to still more events.

B. The First CEQA Case Involving the Transfer of 41,000 AFY of SWP Water from KCWA to CLWA

In 1999, while the CEQA case involving the Monterey Agreement as a whole was pending in the Third District, the Castaic Lake Water Agency (CLWA) — in accord with the Monterey Agreement — agreed to purchase an entitlement to 41,000 AFY of SWP water from the Kern County Water Agency (KCWA) for approximately $47 million. The transfer of 41,000 AFY of water was memorialized in an amendment to the water supply

contract between DWR and CLWA, which now reflects that CLWA is entitled to receive its original entitlement of SWP water, and is entitled to receive an additional entitlement of 41,000 AFY of SWP water, i.e. the water KCWA transferred to CLWA. Also in 1999, CLWA certified an EIR for the transfer of the 41,000 AFY of SWP water. (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1379 (*Friends I*).)

Shortly after CLWA certified its EIR for the transfer of the 41,000 AFY of SWP water from KCWA, a nonprofit corporation filed a petition for writ of mandate in the Los Angeles County Superior Court, challenging the sufficiency of CLWA's EIR. In 2000, the trial court entered a final judgment denying the petition.

In 2002, Division Four of our court ruled that the decision by the Third District Court of Appeal in *PCL, supra,* 83 Cal.App.4th 892 — decertifying the original EIR for the Monterey Agreement/Monterey Amendments as a whole program — required the decertification of CLWA's "tiered" EIR for the ensuing transfer of the 41,000 AFY of SWP water from KCWA to CLWA. As Division Four explained, "tiering" — meaning the practice of incorporating prior environmental studies — is permitted under CEQA, but had resulted in a "defect" in CLWA's EIR when the original, underlying EIR for the Monterey Agreement as a whole, upon which CLWA's ensuing EIR had been expressly tiered, was decertified. (*Friends I, supra,* 95 Cal.App.4th at pp. 1375-1376, 1384-1387.) In short, Division Four ruled that an EIR may not be "tiered" on a decertified EIR. CLWA's options, suggested Division Four, were to wait until the EIR review process in the CEQA case involving the Monterey Agreement/Monterey Amendments had been completed (see *III., A., ante*), or to prepare its own independent EIR for the transfer of the 41,000 of SWP water from KCWA.

After *Friends I* was remanded to the trial court, the case litigants agreed the trial court should issue a writ of mandate directing CLWA to decertify its EIR, but a "bone of contention" remained whether the trial court should also enjoin CLWA from proceeding with the transfer of the entitlement to the 41,000 AFY of SWP water from KCWA before CLWA completed an adequate EIR for the transfer. (*Friends of the Santa Clara River v.*

Castaic Lake Water Agency (Dec. 1, 2003, B164027) [nonpub. opn. at p. 3] (*Friends II*).) In October 2002, the trial court denied the request to enjoin the transfer, and another appeal ensued. In December 2003, Division Four of our court affirmed the denial of injunctive relief. (*Ibid*.)

In February 2005, the California Water Impact Network (CWIN) dismissed its petition with prejudice.

C. The Second CEQA Case Involving the Transfer of 41,000 AFY of SWP Water from KCWA to CLWA

In 2004 (after Division Four decided *Friends II*), the CLWA certified an EIR for the permanent transfer of 41,000 AFY of SWP water from the Kern County Water District (KCWD). In January 2005, CWIN filed a petition for writ of mandate in the Ventura County Superior Court, challenging the EIR.[3] According to CWIN's petition, the EIR did not adequately discuss the threat posed by the permanent transfer of the water, i.e., the promotion of large-scale urban sprawl in Ventura and Los Angeles Counties, while diverting water forever from Kern County. On the same day that CWIN filed its petition, the Planning and Conservation League filed its own petition in Ventura County Superior Court challenging the transfer of water from KCWD to CLWA. The two petitions in Ventura County were consolidated, and, in June 2005, the consolidated Ventura County petitions were transferred to the Los Angeles County Superior Court and assigned case number BS098724.

On April 2, 2007, the trial court (Hon. James Chalfant) ruled that CLWA properly acted as the lead agency for the preparation of the 2004 EIR for the water transfer from KCWD to CLWA, and that CLWA's 2004 EIR "was properly prepared," except for one element — the EIR did not explain that the availability of water from the SWP "may be

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[3] CWIN filed its petition in the Ventura County Superior Court about one month before it filed its request for dismissal of its action in the Los Angeles County Superior Court (case No. BS056954) in which its request for a preliminary injunction had been denied. (See *III., B.*, *ante*; and see also *Friends II*, *supra*, B164027.)

impacted" by the outcome of DWR's pending preparation of an EIR for the Monterey Agreement/Monterey Amendments as a whole. For this reason, the trial court issued a writ commanding CLWA to set aside its approval of its 2004 EIR for the transfer of the 41,000 AFY of SWP water from KCWD, and to comply with CEQA, either through the preparation of a new EIR or an addendum "addressing the analytic route of the three water allocations." Judge Chalfant expressly ruled that that the transfer itself would not be set aside.

With this part of the related litigation in mind, we can now take a look at the proposed project at the heart of the appeal which is before us today.

IV. The Proposed Industrial Park Project, and the EIR Process for the Project

A. The Proposed Project

In 1999, Gate King Properties submitted a series of project requests to the City of Santa Clarita related to a proposal to develop an industrial/commercial park on a 584-acre site in the southern portion of the City. As described in our prior opinion, Gate King's original proposal envisioned the development of approximately 4.45 million square feet of industrial/commercial structures on 170.1 acres, with another 64.3 acres dedicated to rights-of-way (including public streets) and water wells. The remaining acreage was to include a combination of slopes, trails and open space. (See *California Oak, supra*, 133 Cal.App.4th at p. 1224.)

Gate King's proposed project envisions that the water which will be consumed on site by the industrial park's eventual occupants will be delivered at the retail level by the Newhall County Water District (NCWD). Moving up along the supply channel, NCWD obtains water at the wholesale level from the CLWA, and, as noted above, CLWA obtains water from the SWP, including an entitlement/transfer of an additional 41,000 AFY of SWP water from the KCWA.

B. The EIR Process for Gate King's Proposed Project

In January 2002, the City circulated a draft EIR for Gate King's proposed project. Section 4.10 of the City's draft EIR addressed the subject of "Utilities," including "Water Supplies." The discussion of water supplies explained that the NCWD would supply

water for the Gate King site at the retail level, and that NCWD obtained its water from local groundwater wells and the CLWA. The City's draft EIR also explained that CLWA obtained water from the SWP, and that CLWA's current total water entitlement from the SWP included 41,000 AFY of SWP water which CLWA had purchased from the KCWD. The draft EIR's discussion of water supplies included this broad proviso: "It should be noted . . . that CLWA's . . . entitlement [to SWP water] can fluctuate from year to year based on a number of factors, including hydrologic conditions, the status of [SWP] facilities, construction, environmental requirements, and evolving policies for the Bay-Delta."

During the comment period on the City's draft EIR, the Santa Clarita Organization for Planning the Environment (SCOPE) objected that the discussion of water supplies in the draft EIR for Gate King's proposed project was inadequate because it did not disclose that there was ongoing litigation which might affect the availability of the 41,000 AFY of SWP water transferred from KCWA to CLWA. The City, in turn, prepared a response to SCOPE's comments in which the City explained that the Newhall County Water District (NCWD) had completed a water supply assessment (WSA) for Gate King's proposed project, and that NCWD had concluded that it would have sufficient water to supply the needs of the project.

In October 2002, the City circulated a final EIR for Gate King's proposed project. In June 2003, the City passed a resolution adopting the findings set forth in the EIR, and certifying the EIR as final. The City's final EIR did not make any material alterations in the discussion of water supplies set forth in the draft EIR. SCOPE's comments regarding ongoing litigation involving the transfer of the 41,000 AFY of SWP water from KCWD to CLWA, along with the City's response, were included — along with other comments and responses — in the final EIR as "Appendix H." The final EIR also included a document prepared by NCWD entitled "Additional Water Supply Information" as "Appendix K."

Now, with the basic framework of Gate King's proposed project in mind, and the City's EIR for the project in mind, we may finally turn to the litigation from which the current appeal arises.

V. The Two Cases Giving Rise to the Current Appeal

A. Santa Clarita Oak Conservancy v. City of Santa Clarita (the California Oak case)

In July 2003, shortly after the City certified its final EIR for Gate King's proposed project, the Santa Clarita Organization for Planning the Environment (SCOPE) and other groups filed a petition for writ of mandate seeking to compel the City to decertify its EIR on the ground that it did not include adequate information on the "uncertainties" which were then still attendant to the transfer of the 41,000 AFY of SWP water from KCWA to CLWA. (L.A. Super. Ct. No. BS084677.) In March 2004, the trial court entered judgment denying SCOPE's writ petition, and, shortly thereafter, SCOPE filed an appeal.

In November 2005, we ruled that the information on the subject of water supplies set forth in the City's EIR for Gate King's proposed project was inadequate. There, we determined "the EIR's failure to present . . . an analysis of how demand for water would be met without the 41, 000 AFY entitlement, or of why it is appropriate to rely on the 41,000 transfer . . . render[ed] the EIR defective . . . ." (*California Oak, supra,* 133 Cal.App.4th at p. 1242.) We reversed the judgment, and remanded the cause with directions to the trial court to issue a writ of mandate compelling the City to decertify its EIR for Gate King's project, and to retain jurisdiction over the cause until such time as the City certified an EIR which complied with CEQA. (*Id*. at p. 1245.)

In March 2006, NCWD completed preparation of a new WSA for Gate King's proposed industrial park project. That same month, the City circulated a draft additional analysis for the EIR for Gate King's proposed project. The City's draft additional analysis stated that, "[b]ased on th[e] . . . [new WSA] prepared by NCWD, an adequate supply of water is available to serve the Gate-King project, [and] existing and planned future uses in the Santa Clarita [area]. No significant water supply . . . impacts are expected from supplying available water to meet the demands of both the project and

cumulative development in the [area]." The report went into detail in explaining its conclusions.

In July 2006, the City certified a final additional analysis (FAA) for the EIR for Gate King's proposed project. In August 2006, the City filed a return in the trial court, including requests to discharge the peremptory writ of mandate which had been issued in accord with *California Oak*, and to dismiss SCOPE's petition. In October 2006, SCOPE filed an objection to the City's return to the peremptory writ of mandate.

In June 2007, the adequacy of the City's EIR/FAA was argued to the trial court. On August 15, 2007, the trial court entered a statement of decision setting forth its ruling that the City's EIR/FAA was adequate. On September 5, 2007, the trial court entered judgment accepting the City's return to the court's peremptory writ of mandate, and discharging its preemptory writ of mandate.

In November 2007, SCOPE filed a timely notice of appeal. (case No. B203782.)

B. California Water Impact Network v. Newhall County Water District

In July 2005, about three months before we issued our opinion in *California Oak*, NCWD approved a water supply assessment (WSA) in connection with an application by Gate King to have the site of its proposed industrial park project annexed into NCWD's service territory. In August 2005, the California Water Impact Network (CWIN) filed a petition for writ of mandate, coupled with a complaint for declaratory and injunctive relief, challenging NCWD's WSA for purposes of annexation, and seeking to enjoin NCWD from proceeding with the annexation of the site of Gate King's proposed industrial park. (L.A. Super. Ct. No. BS098727.)

In November 2005, we issued our decision in *California Oak*. As noted above, we directed the trial court to issue a writ of mandate compelling the City to decertify its EIR for Gate King's proposed project on the ground that the EIR's discussion of the subject of water supplies was inadequate, and compelling the City to recertify an EIR after it had complied with CEQA.

In spring 2006, before the adequacy of the City's EIR for Gate King's proposed project had been resolved, CWIN and NCWD agreed on a stipulation for judgment in their parallel annexation case. On June 1, 2006, the trial court entered a judgment on the parties' stipulation. The judgment provided that the trial court would issue a peremptory writ of mandate commanding NCWD to set aside its WSA for the annexation of the Gate King site, and to stay all proceedings to annex the Gate King site, until such time as the City recertified its EIR for Gate King's proposed project in compliance with *California Oak*, and NCWD then "considered the project based on the City['s] certified EIR."

As noted above, the City certified its EIR/FAA for Gate King's proposed project in July 11, 2006. On July 13, 2006, NCWD adopted a resolution approving the City's EIR/FAA, and reaffirming NCWD's annexation of the Gate King site.

In October 2006, NCWD filed a return to the trial court's peremptory writ of mandate in which it requested an order discharging the trial court's writ, and dismissing CWIN's case. Broadly summarized, NCWD's return argued that the trial court's writ should be discharged because CWIN had complied with the writ's command to consider Gate King's project based on the City's recertified EIR/FAA. In November 2006, CWIN filed an objection to the return.

In June 2007, CWIN's objections to NCWD's return were argued to the trial court (on the same day that SCOPE's contentions were argued regarding the adequacy of the City's recertified EIR/FAA). On August 15, 2007, the trial court issued a statement of decision in which it ruled that NCWD had not violated CEQA by incorporating the City's environmental findings regarding Gate King's project. It followed, concluded the court, that its writ should be discharged, and that CWIN's petition should be dismissed.

On September 5, 2007, the trial court entered a formal order discharging its peremptory writ of mandate, and dismissing CWIN's petition.

In November 2007, CWIN filed a timely notice of appeal. (case No. B203781.)

VI. The Consolidation of the Appeals

In January 2008, the Newhall County Water District (NCWD) filed a motion in our court, asking us to consolidate SCOPE's appeal in the *California Oak* case involving the City's EIR/FAA (case No. B203782), and CWIN's appeal in its parallel annexation-related case (case No. B203781). In February 2008, we granted the motion to consolidate the appeals.

DISCUSSION

I. The City's EIR/FAA Includes Adequate Information on the Subject of Water Supplies for the Proposed Project

Picking up where our prior opinion in *California Oak* left off, CWIN contends the City's recertified EIR/FAA for Gate King's proposed project violates CEQA because the City still has not discussed the subject of water supplies adequately.[4] More specifically, CWIN contends the City's EIR/FAA does not adequately inform the public, and/or the appropriate decision-making government officials, that DWR's still-not-yet-completed "programmatic" review of the Monterey Agreement and Monterey Amendments may "undermine" the continuing viability of the transfer of 41,000 AFY of SWP water from the Kern County Water Agency (KCWA) to the Castaic Lake Water Agency (CLWA). This omission, argues CWIN, means that the relevant decision-makers do not have an adequate understanding of the potential problems that might affect the amount of water which CLWA will receive, meaning they do not have an adequate understanding of the potential problems which CLWA may have in delivering water to the Newhall County Water District (NCWD), meaning they do have an adequate understanding of the potential problems which NCWD may have in delivering water to the Gate King project. We disagree with CWIN's contention that the City's EIR/FAA is inadequate.

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[4] Our references to CWIN include both CWIN and SCOPE, which have filed joint briefs on appeal.

A. CEQA and EIRs

As noted above, the "heart" of CEQA lies in its mandate that a government agency shall prepare an EIR before approving a proposed project which may have a significant effect on the environment. (*Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 392; and see also § 21100, subd. (a).) An EIR is intended to be an *informational* document; its purpose is to provide public officials, and the public, with information regarding the potential environmental consequences that a proposed project may have on the environment, and to identify ways in which those consequences may be minimized, and to indicate alternatives to the project, including a "no project" alternative. (*California Oak, supra*, 133 Cal.App.4th at p. 1225; and see also § 21061.) Once an EIR is adequately presented, the governing agency may find that the project's environmental effects have been reasonably mitigated, and approve the project; or the agency may find that the unmitigated environmental effects of the project are outweighed by the project's benefits, and approve the project, or the agency may find the adverse environmental effects are so profound that the project should not go forward, in which case something else (or nothing else) must be done in place of the proposed project. (*California Oak, supra*, 133 Cal.App.4th at p. 1225.)

In short, "[t]he purpose of CEQA is not to generate paper, but to compel government at all levels to make decisions with environmental consequences in mind." (*Bozung v. Local Agency Formation Com.* (1975) 13 Cal.3d 263, 283.)

B. Analysis

We simply disagree with CWIN's perspective that the City's EIR/FAA for Gate King's proposed project — when viewed as an *informational* document — "never fully admits or explains" the uncertainties which may be attendant with the transfer the 41,000 AFY of water from KCWA to CLWA. In our view, CWIN is just plain wrong that the City's EIR/FAA for Gate King's proposed project fails to *disclose* — and that is the operative word — that DWR may, in preparing its new EIR for the Monterey Agreement, adopt mitigation measures which may undermine the continued availability of the transfer of the 41,000 AFY of water from KCWA to CLWA.

The City's EIR/FAA for Gate King's proposed project expressly discusses the Third District's decision in *PCL, supra*, 83 Cal.App.4th 892 — decertifying the original EIR for the Monterey Agreement — and its aftermath — DWR's pending preparation of a new EIR for the Monterey Agreement. The EIR/FAA also discusses Division Four's decision in *Friends I, supra*, 95 Cal.App.4th 1373 — decertifying the original EIR for the transfer of the 41,000 AFY of SWP water from KCWA to CLWA. The EIR/FAA also discusses our opinion in *California Oak*. And, the EIR/FAA expressly acknowledges that DWR's still-pending preparation of a new EIR for the Monterey Agreement "introduces an element of potential uncertainty" regarding the 41,000 AFY transfer of SWP water from KCWA to CLWA.

The City's EIR/FAA for Gate King's proposed project further sets forth reasons in support of the City's conclusion that DWR's still-pending preparation of an EIR for the Monterey Agreement is not expected to impact the amount of water available to CLWA vis-à-vis the transfer of the 41,000 AFY of SWP water from KCWA to CLWA.

No more is needed in an *informational* document. According to CWIN, the City's EIR/FAA for Gate King's proposed project is deficient because it does not include an "objective analysis" of the potential impacts that may follow when DWR completes its EIR for the Monterey Agreement and Monterey Amendments. We understand CWIN's arguments to embody the proposition that the City's EIR/FAA for Gate King's proposed project will not be adequate until it (1) sets forth, essentially in list form, all of the possible mitigation measures which DWR may adopt in the course of the ongoing EIR review process for the Monterey Agreement and Monterey Amendments, and then (2) sets forth the corresponding amounts of water which will be subtracted from the transfer of the 41,000 AFY of SWP water from KCWA to CLWA.

The cases cited by CWIN in support of its arguments — our decision in *California Oak, supra*, 133 Cal.App.4th 1219, and the Supreme Court's decision in *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412 (*Vineyard*) — do not, in our reading, support the proposition that the City's EIR/FAA for Gate King's proposed project must include the intricate specificity demanded by CWIN.

As we explained in *California Oak,* an EIR is adequate when it includes sufficient detail to enable those who did not participate in its preparation to understand and meaningfully consider the environmental issues raised by the proposed project. (See *California Oak, supra,* 133 Cal.App.4th at p. 1237, citing *Santa Clarita Organization for Planning the Environment v. County of Los Angeles* (2003) 106 Cal.App.4th 715, 721.) This standard necessarily contemplates a dose of common sense, and a rejection of the proposition that CEQA demands the inclusion of ever more information in an EIR, until the EIR itself becomes so overwhelmingly complex that it becomes essentially meaningless. We are satisfied that the City's decision-making officials were informed by the City's EIR/FAA for Gate King's proposed project that approval of Gate King's proposed project carried with it a number of potential water supply problems.

CWIN's arguments on appeal offer a well-written treatise explaining the rules governing EIRs. But CWIN's arguments then fail, in our view, to connect those rules to its claims of "inadequacy" in the present case. In other words, CWIN correctly states that CEQA jurisprudence requires an EIR to set forth adequate information upon which an agency may make an educated decision, but we see no discussion in CWIN's arguments in which it specifically offers an example of the type of information which it wants to see in the City's EIR/FAA. We see little explanation by CWIN of any possible mitigation scenario which may result from DWR's ongoing EIR review of the Monterey Agreement.

If we may take another tack, we understand CWIN to be arguing that the City's EIR/FAA for Gate King's proposed project is required to state something to this effect: "If DWR adopts _____ (with the City filling in the blank with a possible mitigation measure), then the 41,000 AFY of water from KCWD to CLWA will be diminished by _____ (with the City filling in the blank with the corresponding AFY figure)." CWIN's argument would be more convincing had CWIN explained to us even one possible mitigation measure which DWR may possibly take. We decline to accept CWIN's contention that the City is required to include something more in its EIR/FAA for Gate King's proposed project when CWIN has not offered us a

suggestion about what sort of "something more" might, in the real world, be a realistic possibility.

The City's EIR/FAA for Gate King's proposed project is now adequate.

II. The City's Conclusions Are Supported by Substantial Evidence

CWIN argues the City's recertification of its EIR/FAA for Gate King's proposed project must be vacated because the City's conclusion that the 41,000 AFY of water is reliable for planning purposes is not supported by substantial evidence. We disagree.

A. The Standard of Review

Noticeably absent from CWIN's argument is any acknowledgment of just what the concept of "substantial evidence" means in the context of judicial review of an agency's conclusions in the course of certifying an EIR. We begin our discussion of CWIN's substantial evidence claim by filling in that void.

Substantial evidence challenges in CEQA cases are resolved in the same manner as substantial evidence claims in other settings: a reviewing court, whether at trial court or on appeal, will resolve reasonable doubts in favor of the governing agency's administrative decision, and will not set aside an agency's determination on the ground that the opposite conclusion would have been equally or more reasonable. (*County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 945-946, citing *Laurel Heights Improvement Assn. v. Regents of University of California, supra,* 47 Cal.3d at pp. 392-393.) In other words, an appellate court's review of the administrative record for substantial evidence in a CEQA case "is the same" as the trial court's review of the administrative record. (*Vineyard, supra,* 40 Cal.4th at p. 427.) The appellate court reviews the agency's action, not the trial court's decision, and, "in that sense appellate judicial review under CEQA is de novo" insofar as the trial court's findings are concerned, but deferential to the agency's findings where they are supported by substantial evidence. (*Ibid*.) With this standard as our guide, we turn to an examination of CWIN's claim.

B. The Evidence

The City's EIR/FAA for Gate King's proposed project includes a broad overview of the SWP, a review of the historical deliveries of SWP water to CLWA and other local contractors, and DWR's projections of SWP water supplies which will be available for delivery to CLWA (which were projected for "average/normal" conditions, and "a single dry year . . . based on a repeat of the worst-case historic hydrologic conditions of 1977," and "a multiple dry-year period . . . based on a repeat of the worst-case historic four-year drought of 1931-1934").

The City's EIR/FAA for Gate King's proposed project also includes an extensive review of the myriad of litigation arising from the Monterey Agreement and Monterey Amendments, and the transfer of 41,000 AFY from KCWD to CLWA, and includes the accurate observation that "[n]o court has ordered any stay or suspension of the Monterey Agreement pending certification of a new EIR," and that no court has ordered any stay or suspension of the 41,000 AFY from KCWD to CLWA. The City's EIR/FAA further notes (correctly) that DWR and its contracting water agencies "continue to abide by the Monterey Agreement[,] as implemented by the Amendments, as the operating framework for the SWP."

We are satisfied that the evidence summarized above supports the City's finding that the 41,000 AFY of water from KCWD to CLWA is reliable for planning purposes, and we consider CWIN's real objection not to be that there is an absence of substantial evidence in support of the City's conclusions, but that City's conclusions are, themselves, wrong. Where, as here, substantial evidence supports an agency's findings, we will not substitute our conclusions for those of the agency.

Finally, even assuming we were inclined to discard the City's conclusions, and to take it upon ourselves to make our own independent conclusions based on the evidence, our decision would be the same. Although CWIN is abstractly correct that DWR's new EIR for the Monterey Agreement/Monterey Amendments *may* (if and when feasible mitigation measures are adopted) affect the amount of SWP water which will be delivered to CLWA pursuant to the transfer of 41,000 AFY of water from KCWD, that

potentiality must be juxtaposed against what we do know for a *certainty*, and that is that DWR is not now considering whether the transfer itself is valid.[5]

We find the City reasonably concluded — based on substantial evidence — that the 41,000 AFY of SWP water from KCWD to CLWA is reliable for planning purposes.

III. Alternative Water Sources for the Project

CWIN contends the City's EIR/FAA for Gate King's proposed project violates CEQA because it fails to discuss alternative sources of water for Gate King's proposed project in the event that the transfer of 41,000 AFY of water from KCWD to CLWA becomes unavailable. CWIN's argument is based on *Vineyard, supra*, 40 Cal.4th 412. We find CWIN's reliance on *Vineyard* to be unhelpful within the framework of the case before us today.

In *Vineyard*, the Supreme Court addressed the adequacy of an EIR for a proposed mixed-use project in Sacramento County which was to be built out in phases. A group of "objectors" filed a petition for writ of mandate challenging the EIR. The essential issue presented by the objectors' contentions was that, while the EIR may have adequately evaluated an initial phase of development, it was nonetheless inadequate under CEQA because its promise of future environmental analysis as each phase was to be built side-stepped the County's obligation to disclose and consider at the outset the environmental impacts of supplying water to the entire planned development. (*Vineyard, supra*, at p. 427.)

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[5] In this respect, we note Judge Chalfant's conclusions in the CEQA case involving the transfer itself (L.A. Super. Ct. No. BS098724): "Under contract and validation law, the Kern water transfer contract, entered into in 1999, is valid, has been approved by DWR, and Castaic has paid . . . for it. . . . DWR [cannot] terminate the Kern transfer contract. Nothing in CEQA permits a public agency to void a contract. . . . [¶] Thus, in evaluating the environmental effects of the Monterey Agreement, DWR may impose mitigations that are legal. But it cannot invalidate the Kern transfer."

The trial court denied the objectors' petition, and the Court of Appeal affirmed the trial court, but the Supreme Court reversed the Court of Appeal. Broadly summarizing its decision, the Supreme Court ruled that, while the EIR adequately discussed "near-term" water supplies for the project, it did not adequately discuss "long-term" water supplies.

Vineyard has attained a place of importance in CEQA jurisprudence insofar as the Supreme Court identified four elements which must be included in an EIR's discussion of water supplies for a proposed project that envisions development in stages: (1) the EIR must evaluate the pros and cons of supplying the amount of water that the project — in its entirety — will need; (2) the EIR cannot be limited to a discussion of the water supply which is needed for the first stages of the project's development, and cannot state that "information will be provided in the future" as new stages of development commence, (3) the future water supplies which are identified must bear an actual likelihood of being available; and (4) where it is impossible to determine confidently that future water sources will be available, CEQA requires a discussion of possible replacement water sources or alternatives. (*Vineyard, supra,* at pp. 430-432.)

The case before us today does not present a *Vineyard* problem because the full extent of Gate King's proposed industrial park project is described at the outset in the City's EIR/FAA, including the project's ultimate anticipated water consumption, and the anticipated water supplies for the project. In other words, the City's EIR/FAA for Gate King's proposed project does not limit its assessment of water supplies to a "first stage" of the project, with a mere promise of "further analysis" for later stages of the project. We see no *Vineyard* omission in the City's EIR/FAA for Gate King's proposed project.

IV. The CalSim-II Model

As noted above, the City's EIR/FAA for Gate King's proposed project relies on water supply projections from DWR. Those projection are based on data derived from a computer model used by DWR for predicting future availability of water supplies from the SWP — the so-called "CalSim-II model." CWIN contends the City's EIR/FAA for

Gate King's proposed project violates CEQA because the City's discussion and analysis of the CalSim-II model is inadequate. Again, we disagree.[6]

A. The Discussion of the CalSim-II Model

As noted above, the CalSim-II model is a computer program developed and used by DWR to predict future availability of SWP water. This is the information that the City disclosed about the CalSim-II model in the EIR/FAA for Gate King's proposed project:

> "Comments submitted on the [draft additional analysis for the EIR for Gate King's proposed project] state that the CalSim-II computer model is flawed, and provide articles and other attachments that are critical of DWR's use of the CalSim-II model, pointing out that '[a]ll of [the] documents [provided] clearly lay out the problems for anyone who wants to rely on CalSim-II as the predictor of reliability for the SWP.' . . . [O]ther comments . . . have criticized DWR's reliance upon the CalSim-II model, claiming that the model overstates the amount of water the SWP can deliver during average and dry years. Those comments rely on the . . . decision [to grant a preliminary injunction in *Planning and Conservation League v. United States Bureau of Reclamation* (N.D.Cal. Feb. 15, 2006, No. C 05 – 3527 CW)] as authority for limiting future SWP water deliveries because of flaws in DWR's CalSim-II model. The City . . . is aware of the criticisms leveled against DWR's CalSim-II model, including criticisms noted in the following documents:
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> "• *A Strategic Review of CALSIM[-]II And Its Use For Water Planning, Management And Operations in Central California*, submitted to the California Bay-Delta Authority Science Program Association of Bay Governments, by A. Close, *et al*., dated December 4, 2003;
>
> "• *Musings On A Model: CalSim[-]II In California's Water Community*, San Francisco Estuary and Watershed Science, Vol. 3, Issue 1 (March 2005), Article 1, by Ines C. Ferriera, *et al*;

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[6] We reject respondents' contention that CWIN's arguments regarding the CalSim-II model are barred by the "law of the case doctrine" (see, e.g., *Searle v. Allstate Life Ins. Co*. (1985) 38 Cal.3d 425, 434), and the law of this case as set forth in our prior opinion in *California Oak*. We did not address the validity of the CalSim-II model in *California Oak*. To the extent respondents seem to contend that CWIN should have raised the issue earlier, we are satisfied that CWIN had no meaningful opportunity to address the CalSim-II model until the City filed its return to the trial court's peremptory writ of mandate in 2006.

"• *An Environmental Review Of CalSim[-]II: Defining 'Full Environmental Compliance' And 'Environmentally Preffered' Formulations Of The CalSim[-]II Model*, by Jeffrey T. Payne, *et al.*, dated November 2005;

"• *Gerald Johns' Memo*, prepared by Jan de Leeuw, dated October 23, 2005; and

"• *On The Adequacy Of CALSIM[-]II For Environmental Impact Analysis And SWP Reliability Analysis*, prepared by Arve R. Sjovold, dated August 12, 2004; and *Some Insights On Water Deliveries To Settlement Contractors*, prepared by Arve R. Sjovold, dated October 24, 2004."

"Like any computer model, CalSim-II is subject to criticism, but the City has nonetheless considered DWR's view that CalSim-II is a generally well-rated and accurate model for California's two largest water projects, [the federal Central Valley Project (CVP)] and SWP. DWR has explained that:

'*CALSIM[-]II is a general water resources planning software developed by DWR. CALSIM[-]II, developed through a collaborative effort by DWR and [the United States Bureau of] Reclamation, represents a comprehensive simulation of the SWP and CVP. . . . CALSIM[-]II provides a reasonable planning level simulation of existing project operations, recognizing that the operating environment and regulatory requirements for the projects are in a constant state of transition and change. Since CALSIM[-]II is not a detailed operations model, it does not capture many of the complexities of forecasted and actual operations of project facilities. In determining suitability of these studies to a particular analysis, the user should consult all documentation that accompanies this release and the [Technical Coordination Team] and [Benchmark Study Team] as appropriate*.' [fn. omitted.]

"One of the above articles [fn. omitted.] states that:

'*The CalSim[-]II model is the most prominent water management model in California, and has become central to a variety of water management and policy issues and controversies. . . . CalSim[-]II is a complex model of a complex part of California's changing multi-purpose water system. As such, analytic controversies and misunderstandings are inevitable. . . . While CalSim[-]II is generally seen as a significant improvement over previous models, a wide variety of ideas suggested for improvements*.'

"The City further acknowledges that the CalSim-II model, like other computer models, contains several perceived strengths as well as weaknesses, several of which were noted in the article, *A Strategic Review of CALSIM[-]II And Its Use For Water Planning, Management And Operations in Central California*, [submitted to California Bay-Delta Authority Science Program Association of Bay Governments,] by A. Close,

et al., dated December 4, 2003, pp. 6-9. The City further acknowledges that CalSim[-]II is not a perfect model; no computer model is perfect. However, on balance, and after considering the various articles criticizing the CalSim-II model, the City agrees with DWR's determination that CalSim-II is a 'useful and appropriate tool for assessing the delivery capability of the SWP.' The City further believes that, despite criticisms of CalSim-II, it is still appropriate to rely on DWR for information based on the CalSim-II model, unless and until a new or updated model is known to exist and available for use.

"As stated above, other comments rely on the [federal district court's decision in *Planning and Conservation League v. United States Bureau of Reclamation, supra*] to support the claim that SWP delivery reliability is suspect, because DWR's CalSim-II model is flawed. The City does not believe that the comments properly characterize the *PCL/Bureau* decision.

"In the *PCL/Bureau* decision, the federal court issued an order granting [a] motion for a preliminary injunction . . . which enjoined construction of the 'Intertie' project until the case is decided on the merits. (The Intertie project is a proposed pipeline project that would connect the main delivery canals of two water diversion projects, the federal CVP and the state SWP, in California's Central Valley. The proposed pipeline is known as the 'Delta-Mendota Canal/California Aqueduct Intertie.' At issue is the [*PCL/Bureau* case] is the Bureau's decision to rely on [a negative declaration] for environmental review of the Intertie project under both [federal National Environmental Policy Act (NEPA)] and CEQA *in lieu* of an [Environmental Impact Study] EIS/EIR.)

"In granting the preliminary injunction, the federal court [incorporated its] . . . earlier . . . order granting [an] application for a temporary restraining order . . . In that [prior] order, the court addressed [a] claim that an EIS/EIR was required for the Intertie project because the existing environmental documents that found no significant impacts were based on CalSim-II modeling which [the plaintiff had claimed] was 'too unreliable to rule out the potential for significant impacts.' Order, p. 9. [fn. omitted.] In [addressing] that claim, the federal court did not appear concerned with the perceived shortcomings of the model, but rather the Bureau's failure to *disclose* the shortcomings. In fact, the court specifically stated that the use of CalSim-II 'alone does not show that [the Bureau] was arbitrary and capricious in reaching its finding of no significant impact.' *Id*. at p. 11.

"In short, the federal court did not prohibit the Bureau or any other agency from using or relying on the CalSim-II model, but rather, stated that the Bureau could rely on the model, provided it disclosed relevant shortcomings in the data or model . . . . Here, based on a review of the above reports, the City . . . is apprised of all known, perceived

shortcomings with DWR's CalSim-II model; nonetheless, the City believes that substantial evidence supports is conclusion that the model remains the best available data for assessing SWP operations and constraints."

B. The Discussion of the CalSim-II Model is Sufficient

We are satisfied that the City's EIR/FAA for Gate King's proposed project sets forth a sufficient discussion of the CalSim-II model, including its recognized shortcomings. In our view, the City's EIR/FAA for Gage King's proposed project is adequate because it summarizes points of disagreement regarding the CalSim-II model, and then explains the City's reasons for accepting one set of judgments instead of another. (*Association of Irritated Residents v. County of Madera* (2003) 107 Cal.App.4th 1383, 1390-1391.) A fair review and assessment of the City's EIR/FAA for Gate King's proposed project belies CWIN's contention that the City did not "describe objectively" the expert critiques of the model, and did not explain why, despite those critiques, it elected to consider the model an appropriate predictive tool. The City gave numerous examples of criticisms of the CalSim-II model, and explained that it decided to accept DWR's data based on the CalSim-II model because, for present purpose, the model provides the best available data.

We see nothing in CWIN's arguments which suggests that a better model exists, and, even assuming such a model did exist, the insurmountable problem for CWIN would remain that objections reflecting a conflict amongst conclusions do not show that an EIR is *inadequate.* (See CEQA Guidelines, section 15151 [disagreement among experts does not make an EIR inadequate].) Inadequate means an absence or omission of information needed to make an informed decision, and the City's EIR/FAA for Gate King's proposed project does not suffer from such a deficiency.

V. The State Water Resources Control Board

CWIN contends the City's EIR/FAA for Gate King's proposed project violates CEQA because its does not discuss adequately the potential impact on water supplies

which may result from DWR's compliance with an order issued by the State Water Resources Control Board (SWRCB).[7] Once more we find that CWIN is mistaken.

A. The SWRCB Order

SWRCB is authorized to issue a cease and desist order (CDO) when it determines that a government agency is violating or threatening to violate any condition of a permit or license issued by SWRCB. A CDO may only be issued after notice and an opportunity for hearing. In May 2005, SWRCB issued draft CDOs to DWR and the United States Bureau of Reclamation (USBR) regarding alleged threatened violations of their licenses and permits to divert water from the San Joaquin River and Bay Delta. The water rights granted to DWR and USBR include prescribed salinity standards for water at various specified geographic locations. As we can understand it, salinity levels of the water can be affected by diverting less water, i.e., allowing more water to remain in place, or, alternatively, by building "permanent operable barriers or other equivalent measures along with an operation plan," all designed to prevent salinity-increasing elements from accumulating in the water.

On February 15, 2006, SWRCB issued "Order WR 2006-0006" in the matter of the draft CDOs against DWR and USBR. Relevant provisions of the Order are set forth in the following paragraphs.

B. The EIR/FAA's Discussion of the Order

At about the same time that SWRCB was issuing Order WR 2006-0006, the City was circulating its draft additional analysis for the EIR for Gate King's proposed project. During the comment period on the draft additional analysis, CWIN claimed that Order WR 2006-0006 will require DWR to "shut down its pumps" in the event that prescribed

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[7] As we understand the state's organization structure, DWR and SWRCB appear to function as distinct but co-equal state agencies with possibly overlapping responsibilities. According to its official website, the SWRCB has authority (along with regional boards) over water allocation and water quality protection. According to the official website of its acting director, DWR protects, conserves and manages the state's water supply, which includes, of course, the operation of the SWP.

salinity standards for the San Joaquin River and Bay Delta are not met, and that the result will be "less water pumped to Southern California."

The City's EIR/FAA for Gate King's proposed project provides the following information on Order WR 2006-0006:

> "In . . . Order WR 2006-0006, [SWRCB] issued a cease and desist order requiring . . . DWR and [USBR] to take corrective action under a time schedule to correct threatened violations of their permits and license. *SWRCB Order*, p. 1. Their permits and license require DWR and [USBR] to meet salinity objectives at three locations in the southern Delta between April 1 and August 31 of each year. . . . Starting April 2006, [SWRCB] is now requiring DWR and [USBR] to meet the adopted salinity standards . . . , but not immediately. Instead, it allows the two agencies until July 1, 2009, to meet the adopted salinity objectives. *Id*. at p. 28-29. This is the date by which the agencies now predict completion of a 'permanent barriers project or equivalent measures' that will enable the agencies to meet the salinity objectives. In the interim, the two agencies are required to provide [SWRCB] Board with a detailed plan and schedule for compliance with the conditions set forth in the Order. *Id*. at p. 29-30.
>
> "In the event that DWR or [USBR] project a potential exceedance in the salinity objectives prior to July 1, 2009, the two agencies are required to immediately inform [SWRCB] of the potential exceedance, and describe the corrective actions they are initiating to avoid the exceedance. *Id.*, p. 30. The 'corrective actions' may include, but are not limited to 'additional releases from upstream [CVP] facilities or south of the Delta [SWP] or CVP facilities, modification in the timing of releases from Project facilities, reduction in exports, recirculation of water through the San Joaquin River, purchases or exchanges of water under transfers from other entities, modified operations of temporary barriers, reductions in highly saline drainage from upstream sources, or alternative supplies to Delta farmers (including overland supplies).' *Id.*
>
> "In response to comments, [SWRCB] determined that DWR and [USBR] were partially responsible for the salinity problems at certain locations because of export pumping. Decision 1641, which allocated the responsibility for implementing the salinity objectives of the 1995 Bay-Delta Plan, noted that the implementation of a 'barrier program' could help improve salinity concentrations and that DWR and [USBR] were working together on such a program. (*State Water Resources Control Board Cases* (2006) 136 Cal.App.4th 674, 711.) To the extent that the comment letters on the Gate-King Industrial Park Additional Analysis infer that meeting the salinity objectives will necessarily result in less water to pump to southern California, such an assumption is not accurate because it assumes that the

only way to control salinity is to reduce export pumping. While the reduction of exports is listed as one means of improving salinity concentrations, it is only one of many such methods. As noted above, implementation of a barrier program is another means for improving salinity concentrations and, in fact, DWR and the [USBR] are working on such a program. In addition, the Order itself emphasizes that constructing permanent barriers is not the exclusive method for compliance with the salinity objectives, and that additional potential corrective actions to avoid potential exceedance of the salinity objectives include actions such as additional releases from upstream CVP facilities or south of the Delta SWP or CVP facilities, modifications in the timing of releases from Project facilities, reduction in exports, purchases or exchanges of water under transfers from other entities, modified operations of temporary barriers, and several other options. *Id*. pp. 23, 30.

"Thus, the assertion in comments submitted on the Gate-King Industrial Park Additional Analysis that DWR and [USBR] must 'shut down their pumps if the salinity standards are not met' is not accurate. [SWRCB]'s amended approval of the 'Water Quality Response Plan' (WQRP) requires that DWR and [USBR] be in compliance with the conditions contained in their permits and license, including salinity objectives, in order to enable 'joint points of diversion' (JPOD) operations, and orders that JPOD operations must cease if such conditions are not met. Hence, if the salinity objectives are not met, DWR and [USBR] may not conduct JPOD operations. However, this means that they are only restricted from use of *one another's* facilities – they are not restricted from using their *own* facilities. As such, DWR and [USBR] are not being ordered to 'shut down their pumps.' *Id.*, pp. 25, 32-33.

"As to the Board's Order that DWR and [USBR] take corrective actions under a time schedule to correct threatened violations of their permits and license in order to meet the salinity objectives, it is true that a complete failure to meet the salinity requirements by the time schedule (July 1, 2009) could result in further action by the Board. However, the Order encourages communication by requiring DWR and [USBR] to submit plans and schedules detailing how DWR and [USBR] intend to meet the objectives, periodic updates and progress reports, and notification of the Board if DWR and the [USBR] anticipate a potential exceedance of the salinity objectives, or if an exceedance has occurred. *Id.*, p. 29-31. The Order states that in the event of an exceedance, the Executive Director will *make a recommendation* to [SWRCB] *regarding whether to take enforcement action. Id.*, p. 30. In deciding *whether* to initiate enforcement action, the Executive Director must consider the extent to which the non-compliance was beyond DWR's or [USBR]'s control and the actions taken to correct the exceedance. *Id.*

> "Lastly, the Order provides that upon the failure . . . to comply with the requirements contained in the Order (by July 1, 2009), [SWRCB] Board may request the Attorney General to petition the Superior Court for injunctive relief, as appropriate. *Id.*, pp. 28-32. [SWRCB] also may issue monetary fines. *Id.*, p. 32. However, nowhere does the Order mandate that DWR and [USBR] shut down their pumps."

C. Analysis

In the light of the discussion reproduced above, we reject CWIN's argument that the City's EIR/FAA for Gate King's proposed project "does not provide any discussion or analysis from which the reader could decide the likelihood that meeting the salinity standards will in fact result in a reduction in [SWP] deliveries." Far from not providing "any discussion," the City's EIR/FAA for Gate King's proposed project contains an extensive discussion, and states the City's reasons for its conclusion that there is limited likelihood that measures taken by DWR and USBR to meet salinity standard will reduce SWP deliveries to CLWA.

As with its previous arguments, CWIN's assertions begin with abstractly correct assertions that information must be provided in an EIR, but then just seem to ignore that the City's EIR/FAA does contain information from which the decision-makers could make a reasoned decision on Gate King's proposed project.

VI. The Trial Court' Analysis of NCWD's Annexation Resolution

A. The Resolution

On July 11, 2006, the City recertified its EIR/FAA for Gate King's proposed project. Two days later, on July 13, 2006, the Newhall County Water District (NCWD) adopted a resolution approving the annexation of the Gate King site into NCWD's service territory. Section 2 of NCWD's resolution recites a finding by NCWD to the effect that City had then-recently recertified an EIR which complied with our decision in *California Oak* (i.e., the EIR/FAA), and that, for this reason, NCWD then considered it "appropriate" to annex the Gate King site "based on the [re]certified EIR."

B. The Trial Court's Decision on the Annexation

On August 15, 2007, the trial court entered its statement of decision in which it rejected CWIN's challenges to NCWD's annexation of the Gate King site. The trial court's order expresses the court's conclusion that NCWD — in making its annexation decision — had been required to presume that the City's EIR/FAA complied with CEQA. In other words, the trial court ruled that, for purpose of annexing the site of Gate King's proposed project, NCWD could not independently determine for itself whether the City's EIR/FAA was adequate or inadequate. That determination, the trial court explained, had to be made in a "single forum," i.e., in the context of SCOPE's parallel case directly challenging the City's EIR/FAA for Gate King's proposed project.

C. CWIN's Claim on Appeal

On appeal, CWIN contends the trial court "got it wrong," and that it should have required NCWD to "reach its own conclusions" on the adequacy of the City's EIR/FAA. Although we tend to agree with respondents that "[t]he purpose of [CWIN's] argument is not clear," we construe CWIN to argue that NCWD's reliance on the City's EIR/FAA in July 2006 (when NCWD approved its annexation resolution) must be "undone," and that this means that NCWD should also undo anything and everything which it has already has done in the annexation process, and that NCWD should then start all over again after making its owns determination on whether or not the City's EIR/FAA is adequate. In other words, we understand CWIN to be arguing either (1) NCWD "jumped the gun" by relying on the City's EIR/FAA before it had been approved by the trial court upon the City's return, or (2) NCWD had its own duty to review and pass the City's EIR/FAA for adequacy, and that NCWD did not fulfill that duty. It appears to be CWIN's position (in either event) that NCWD must go back to square one, and that approval of Gate King's proposed project must be delayed accordingly.

D. Analysis

Assuming that CWIN contends NCWD 'jumped the gun" by relying on the City's EIR/FAA prior to judicial review, we find the issue is moot. The trial court approved the City's EIR/FAA, and, for the reasons explained above, we have affirmed the trial court's decision.

Assuming that CWIN contends NCWD had a duty, independent of the trial court's jurisdiction, to review and determine the adequacy of the City's EIR/FAA, we disagree. Section 21167.3, subdivision (b), provides: "In the event that an action or proceeding is commenced [alleging an EIR does not comply with CEQA], but no injunction or similar relief is sought and granted, responsible agencies *shall* assume that the [EIR] . . . for the project does comply with [CEQA] and shall approve or disapprove the project according to the timetable for agency action [prescribed in the Government Code]. Such approval shall constitute permission to proceed with the project at the applicant's risk pending final determination of such action or proceeding [challenging the EIR for the project]."

We agree with NCWD that section 21167.3, subdivision (b), says what it says. A responsible agency must use the EIR prepared by the lead agency, even if the responsible agency believes that the EIR is inadequate. (See *Central Delta Water Agency v. State Water Resources Control Bd*. (2004) 124 Cal.App.4th 245, 274.) A responsible agency with permit authority, however, must still reach its own conclusions on whether and how to approve of the project, regardless of the lead agency's approval the project. (*Ibid*.) We see no error in the trial court's analysis insofar as the determination of the adequacy of the City's EIR/FAA is concerned. We can now turn to CWIN's attacks on NCWD's findings and conclusions.

VII. NCWD's Findings

CWIN contends NCWD violated CEQA and the CEQA Guidelines when it passed its resolution approving the annexation of the Gate King site into NCWD's service territory. More specifically, CWIN contends that NCWD violated CEQA and the CEQA Guidelines in two respects: first, NCWD should not have "incorporated" the City's findings regarding the significant environment effects identified in the City's EIR, and

should not have "incorporated" the City's statement of overriding considerations in favor of Gate King's proposed project, and second, NCWD should have made its own findings, and adopted its statement of overriding considerations. For the most part, the two challenges are corollaries of each other. We find no error in either respect.

A. NCWD's Resolution

Section 3 of NCWD's resolution is entitled "Environmental Impact Findings Required by CEQA." Section 3 sets forth NCWD's finding that the City's EIR/FAA for Gate King's proposed project "identifies and discloses project-specific impacts . . . ." Section 3 also sets forth NCWD's finding that Gate King's proposed project will result in potentially significant environmental impacts, but that the City has imposed mitigation measures and/or changes to the project which the City has determined will eliminate the impacts or reduce them to a level of less significance. Section 3 of NCWD's resolution also includes the following provision which gives rise to CWIN's claim that a responsible agency such as NCWD violates CEQA when it "incorporates" a lead agency's findings:

> "Although . . . NCWD lacks jurisdiction over most of the issues covered in the City's CEQA findings contained in the City's [resolution certifying the EIR for Gate King's proposed project, NCWD now] incorporate[s] by reference, as though fully set forth herein, the City's findings with respect to all significant environmental effects identified in the EIR, including those related to Land Use and Planning, Geology, Hydrology and Water Quality, Air Quality, Transportation and Circulation, Biological Resources, Noise, Human Health and Safety, Public Services, Public Utilities, Aesthetics, Cultural Resources, and Recreation."

B. The CEQA Guidelines

Article 7 of the CEQA Guidelines (§§ 15080–15097) governs the "EIR Process." Broadly summarized, sections 15080 through 15090 prescribe the rules with which the "Lead Agency" for a proposed project must comply during the process of preparing and certifying an EIR for the project.

Section 15091 prescribes the "Findings" which are required in the EIR process. Section 15091(a) provides: "No public agency shall approve or carry out a project for which an EIR has been certified which identifies one or more significant environmental effects of the project unless the public agency makes one or more written findings for each of those significant effects, accompanied by a brief explanation of the rationale for each finding. The possible findings are: [¶] (1) Changes or alterations have been required in, or incorporated into, the project which avoid or substantially lessen the significant environmental effects identified in the final EIR. [¶] 2. Such changes or alterations are within the responsibility and jurisdiction of another public agency and not the agency making the finding. Such changes have been adopted by such other agency or can and should be adopted by such other agency. [¶] 3. Specific economic, legal, social, technological, or other considerations, including provision of employment opportunities for highly trained workers, make infeasible the mitigation measures or project alternatives identified in the final EIR."

CEQA Guidelines section 15092 prescribes the rules governing the Lead Agency's approval of the project; section 15093 governs the Lead Agency's approval of the project with a statement of overriding considerations; section 15094 prescribes the rules under which the Lead Agency files its notice of determination with the appropriate authority; and section 15095 governs the Lead Agency's disposition of a final EIR.

CEQA Guidelines section 15096 specifically addresses the responsibilities of a "Responsible Agency" in the EIR Process. Unfortunately, the section is not a model of internal consistency.

Section 15096(a) provides: "A Responsible Agency complies with CEQA by considering the EIR . . . prepared by the Lead Agency *and by reaching its own conclusions on whether on how to approve the project involved. . . .*" At the same time, however, section 15096(g)(1) states that, "[w]hen considering alternative and mitigation measures, a Responsible Agency is more limited than a Lead Agency. A Responsible Agency has responsibility for mitigating or avoiding only the direct or indirect environmental effects *of those parts of the project which [the Responsible Agency]*

decides to carry out, finance, or approve," and section 15096(g)(2) provides that "the Responsible Agency shall not approve the project as proposed if [it] finds any feasible alternative or feasible mitigation measures *within its powers* that would substantially lessen or avoid any significant effect the project would have on the environment." (Emphasis added.) And then there is section 15096(h), which provides that "[t]he Responsible Agency *shall make the findings required by Section 15091 for each significant effect of the project . . . .*" (Emphasis added.)

C. The CEQA Guidelines Interpreted

We agree with the trial court that the most reasonable interpretation to be given to section 15096's provisions is as follows: section 15096(h)'s mandate that a Responsible Agency must make findings for each significant effect of a proposed project must itself be read in conjunction with section 15096(g), limiting the authority and responsibility of a Responsible Agency to avoid or mitigate only the environmental effects of those parts of the project which the Responsible Agency decides to carry out, finance, or approve. In short, CEQA Guidelines section 15096 requires a Responsible Agency to make findings about alternatives and mitigation measures only in connection with those environmental effects over which it has the jurisdiction to impose alternatives or mitigation measures. Otherwise, the CEQA Guidelines would require a Responsible Agency to make findings regarding matters over which it could no nothing. We decline to interpret the CEQA Guidelines to require such a pointless exercise.

D. NCWD Did Not Violate CEQA by Incorporating the City's Findings

CWIN contends NCWD violated CEQA and CEQA Guidelines section 15091 by "incorporating" the City's findings, instead of independently "adopting" its own findings. We disagree.

CWIN's argument rests (incorrectly) on the predicate that NCWD was required in the first instance to adopt findings regarding the potential adverse environmental impacts identified in the EIR for Gate King's proposed project. We agree with the trial court that NCWD did not have such an obligation, and adopt its reasoning. NCWD acted as a responsible agency for the Gate King project, and, as such, its discretionary authority was

limited to the annexation of the Gate King project into NCWD's service territory, so that NCWD could provide water service to the project. CEQA provides that a responsible agency is responsible for considering only the effect of those activities involved in a project which the agency is required by law to carry out or approve.

NCWD's resolution correctly stated that the City's EIR/FAA for Gate King's proposed project indentified significant effects in the area of air quality, biology, solid waste, and aesthetics. And NCWD's resolution further correctly stated that mitigation measures and alternatives in those areas were the authority and responsibility of the City as lead agency, and not NCWD, whose jurisdictional authority extended only insofar as the annexation of the project site was concerned. Under these circumstances, NCWD did not have a duty to make findings on those issues which were within and under the City's area of control, and thus, cannot be found to have acted inappropriately when it "incorporated" the City's findings. In other words, NCWD's incorporation of the City's findings was, for the most part, a superfluous act, not an act in violation of CEQA.

The bottom line is that the part of the "project" with which NCWD was concerned was the annexation of the Gate King site into NCWD's service territory. It makes no sense in our view to require NCWD to make findings with regard to alternatives and/or mitigation measures which may reasonably be imposed upon Gate King's proposed project when NCWD did not have control over such matters.

E. NCWD Did Not Have a Duty to Make Its Own Independent Findings

In a variation on its "incorporation" theme, CWIN contends NCWD violated CEQA Guidelines section 15091 because it did not make its own independent findings related to the potential adverse environmental impacts posed by Gate King's proposed project. For the reasons explained above, we disagree.

Although NCWD perhaps could have included in its resolution a specific finding that the City's EIR did not identify any project-related environmental impacts associated with NCWD's annexation of the Gate King site into NCWD's service area, we decline to undo the annexation process for no other purpose than to accommodate that technicality. The omitted finding, if any, plainly did not result in any harm under CEQA. By noting

the environmental effects that are attendant with Gate King's proposed project, NCWD's resolution implicitly notes that no other effects pose a significant environmental threat. In short, we find NCWD's findings to be sufficient.

F. NCWD Was Not Required to Adopt an Independent Statement of Overriding Considerations

Section 5 of NCWD's resolution states: "Changes or alternatives to address the significant and unavoidable impacts of the project related to air quality, biology, solid waste, and aesthetics are within the responsibility and jurisdiction of the City . . . , the lead agency under CEQA. NCWD finds that with respect to these impacts, the City has adopted a statement of overriding considerations, which NCWD incorporates herein by reference. Because the [EIR/FAA] identified no significant and unavoidable impacts of the project within the jurisdiction and responsibility of . . . NCWD, no additional statement of overriding considerations is required."

CWIN's objection to NCWD's incorporation of the City's statement of overriding considerations does not include a challenge to the City's decision itself. In other words, CWIN does not dispute that the City obeyed the procedural requirements of CEQA when it decided that the benefits of the project outweigh its environmental impacts. Given this context, we see no showing of harm in NCWD's "incorporation" of the City's statement of overriding considerations. Assuming, NCWD should have included a finding in its resolution to the effect that NCWD itself found that the benefits of the annexation were outweighed by environmental impacts, we find this omission, if any, did not cause any harm under CEQA.

To the extent that CWIN seems to contend that NCWD did not evaluate the City's findings or its statement of overriding considerations, we reject CWIN's claim. NCWD's resolution expressly represents that the City presented its EIR/FAA to NCWD, and that NCWD reviewed and considered the information contained in the City's EIR/FAA. The resolution further states that NCWD's decision to approve the annexation of the Gate King site reflected the independent judgment and analysis of NCWD. In short, NCWD did consider the City's findings and statement of overriding considerations before

incorporating/adopting them. In the absence of evidence to the contrary, we will not presume that NCWD simply rubber-stamped the City's findings and statement of overriding considerations. (Evid. Code, § 664.)

In the final analysis, we see no purpose to be served in requiring NCWD to expend scrivener's ink and paper to restate in rote findings with which it agrees and has adopted after due consideration. (*Fund For Environmental Defense v. County of Orange* (1988) 204 Cal.App.3d 1538, 1552-1553.)

DISPOSITION

The judgment dated September 5, 2007, in case number BS084677, *Santa Clarita Oak Conversancy v. City of Santa Clarita*, is affirmed.

The order dated September 5, 2007, in case number BS098727, *California Water Impact Network v. Newhall County Water District*, is affirmed.

Respondents shall recover their costs on appeal.

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

BIGELOW, J.

We concur:

RUBIN, Acting P. J.

O'NEILL, J.*

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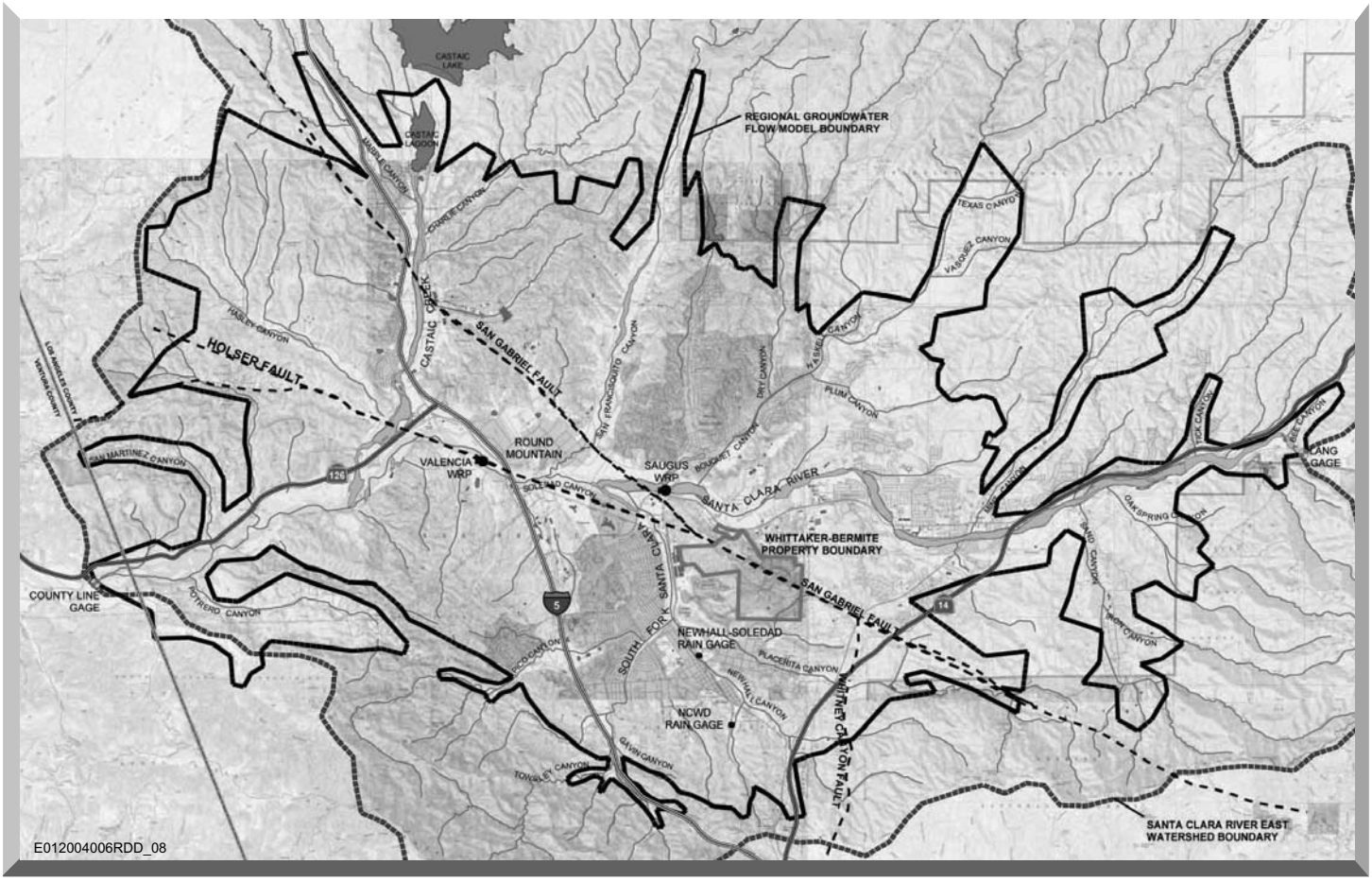
* Judge of the Ventura Superior Court, assigned by the Chief Justice pursuant to article VI, section 6 of the California Constitution.

CH2MHill Final Report, Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, December 2004

FINAL REPORT

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property

Prepared in Support of the 97-005 Permit Application



Prepared for
Upper Basin Water Purveyors:
Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water Company

CH2MHILL

Santa Clarita, California
December 2004

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178973.B1.01

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Mr. Steve Cole
Newhall County Water District
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23780 North Pine Street
Santa Clarita, California 91322-0970

Subject: Submittal of Final Report on Perchlorate Containment Analysis

Dear Mr. DiPrimio, Mr. Masnada, Mr. Manetta, and Mr. Cole:

CH2M HILL is pleased to submit the enclosed final report titled *Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California*. This report has been developed for the Upper Basin Water Purveyors and is the second of two reports that present and evaluate the strategy for containing perchlorate that is emanating from the Whittaker-Bermite site. This work has been performed as part of the Environmental Oversight Agreement with DTSC, which has approved both reports. The first report, dated April 2004, documented the construction and calibration of a ground-water flow model for the Santa Clarita Valley. The enclosed report presents a modeling analysis of the perchlorate containment plan and also discusses the general design of a sentinel monitoring plan that will be implemented in conjunction with the perchlorate containment plan (per the requirements of the Department of Health Services' 97-005 Policy).

It has been our pleasure to serve the Upper Basin Water Purveyors on this important project. Please feel free to call me at 503/235-5022, if you have any questions.

Sincerely,

CH2M HILL

John J. Porcello
Project Manager

Nathan R. Brown
Hydrogeologist

RDD/041620011(clr2739.doc)
Enclosures

Final

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Prepared in Support of the 97-005 Permit Application

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water Company

December 2004

CH2MHILL

Executive Summary

ES.1 Introduction

This report presents an analysis of a plan to contain perchlorate that is present in the Saugus Formation aquifer, which lies beneath a portion of the Santa Clarita Valley (located in northwestern Los Angeles County, California). The containment plan consists of pumping from two deep production wells (SCWC-Saugus1 and SCWC-Saugus2) that have not operated in several years because of elevated concentrations of perchlorate in groundwater. The SCWC-Saugus1 and SCWC-Saugus2 wells will be pumped on a nearly continual basis at a rate of 1,200 gallons per minute (gpm) at each well. A third impacted well, NCWD-11, might be pumped seasonally (during the summer) at 1,200 gpm if it is put back into service. However, this well is not needed to meet the containment objectives and might be destroyed. The groundwater that is pumped from these wells will then be treated at a central location to remove perchlorate prior to entering the potable water conveyance system. The treated water will be pumped to the Rio Vista Intake Pump Station (owned and operated by the Castaic Lake Water Agency [CLWA]) for subsequent distribution, to help meet water demands. In addition to these containment operations, one perchlorate-impacted production well (VWC-157) that lies downgradient of SCWC-Saugus1 and SCWC-Saugus2 will be destroyed, rather than being used for containment. Also, a network of sentinel monitoring wells will be used for performance monitoring of the containment plan and for providing early warning of any changes that might occur in groundwater quality upgradient of the containment wells.

The selected pumping plan has been designed to cause perchlorate, which is migrating in groundwater from the nearby Whittaker-Bermite property, to be captured by these wells, thereby controlling its movement toward other portions of the aquifer, where additional water supplies could otherwise be impacted. The operation of these wells is also designed to capture perchlorate-containing groundwater that is present just downgradient of these two wells. The pumping rates have been selected by considering the water supply needs of the valley and analyses of groundwater flow patterns that are expected under the pumping plan for these wells. The analyses of groundwater flow patterns have been performed using a numerical regional-scale groundwater flow model of the valley, which was developed by the local water purveyors (herein referred to as the Purveyors[1]) for use in managing the local groundwater resource. Figure ES-1 shows the study area, including the model boundaries (tables and figures are located at the end of this summary).

Returning perchlorate-impacted production wells to service with treatment requires the issuance of a permit by the California Department of Health Services (DHS) before the water can serve as a potable water supply. Before issuing a permit, DHS requires that formal studies and engineering work be performed to demonstrate that pumping these wells and

[1]The Purveyors, also referred to as the Upper Basin Water Purveyors, consist of the Castaic Lake Water Agency (CLWA), the Newhall County Water District, the Santa Clarita Water Division of CLWA, and the Valencia Water Company.

treating the water will be protective of human health for the users of the water[2]. To obtain a permit, the owner of the well must perform a detailed evaluation of the effects of returning the well to service. The process for conducting the evaluation is called the 97-005 process, named after the policy memo that describes the process (DHS, 1997). The policy memo also discusses the basic tenets under which the DHS Drinking Water Program evaluates proposals, establishes appropriate permit conditions, and approves returning an impacted well to service for direct potable use.

This report presents the modeling analysis of the Purveyors' preferred pumping plan for the Saugus Formation in the vicinity of the impacted Saugus production wells. This report also presents the objectives and general design of a groundwater quality monitoring program that will be implemented conjunctively with the pumping and treatment program, to identify any changes in groundwater quality that might adversely affect the treatment process. This monitoring program will include water level monitoring and groundwater modeling activities during startup of the long-term containment system, to verify that containment is being achieved and evaluate whether adjustments to the pumping program are warranted. This report has been prepared to support the source assessment and permitting process that the Purveyors are performing under the 97-005 Policy.

ES.2 Background

In 1997, two Saugus Formation production wells owned by the Santa Clarita Water Company (SCWC)[3] (wells SCWC-Saugus1 and SCWC-Saugus2), one Saugus Formation production well owned by the Newhall County Water District (NCWD) (well NCWD-11), and one Saugus Formation production well owned by Valencia Water Company (VWC) (well VWC-157) were shut down because perchlorate was detected in groundwater at these wells. In 2002, an Alluvial Aquifer production well owned by SCWC (well SCWC-Stadium) was shut down because of a perchlorate detection. The locations of the five impacted production wells and nearby nonimpacted production wells are shown on Figure ES-2, along with the locations of monitoring wells and exploratory borings that have been installed to investigate the extent of perchlorate contamination. Figure ES-2 also shows perchlorate concentrations at locations where perchlorate has been detected in groundwater. At each of the five production wells, the detected perchlorate concentrations exceeded the State of California's Action Level (AL) for perchlorate at the time of the detection[4].

Together, the four impacted production wells in the Saugus Formation pumped between 1,900 and 6,800 acre-feet per year (AF/yr) during the early and mid-1990s, prior to being shut down. The average pumping from these four wells was 4,186 AF/yr from 1991 through 1996, the 6 years preceding the perchlorate detections (see Table ES-1). The four wells have a combined instantaneous pumping capacity of 7,900 gpm. The Purveyors plan to return three of the four impacted Saugus Formation production wells to service (SCWC-Saugus1,

[2]The Purveyors and DHS require that water provided to customers contain no detectable perchlorate.

[3]The SCWC was acquired by CLWA in 1999. It was formerly called the Santa Clarita Water Company and is now called the Santa Clarita Water Division of CLWA.

[4]The AL has varied over time. DHS initially established an AL of 18 micrograms per liter (μg/L) in 1997, at the same time the four impacted Saugus Formation production wells were taken offline. In 2002, DHS revised the AL to 4 μg/L based on studies by the U.S. Environmental Protection Agency (EPA). In March 2004, the AL was revised to 6 μg/L based on a public health goal published by the Office of Environmental Health Hazard Assessment. See the internet site http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/actionlevel.htm for further details.

SCWC-Saugus2, and NCWD-11) and to replace one well (VWC-157) with a newer well located in the western portion of the valley (west of the area shown on Figure ES-2).

ES-3 Objectives

In addition to meeting the requirements of the 97-005 Policy Memo (DHS, 1997), the Purveyors have identified the following objectives that must be met by the pumping plan for the impacted Saugus Formation production wells:

1. Hydraulically contain perchlorate that is migrating westward in the Saugus Formation from the Whittaker-Bermite property toward the impacted production wells.
2. Hydraulically contain perchlorate that is present at wells MP-5 and VWC-157, which are located downgradient of the impacted wells.
3. Protect downgradient production wells that are currently not impacted.
4. Restore the annual volumes of water that were pumped from the impacted wells before they were shut down.
5. Operate the impacted wells in a manner consistent with the Purveyors' operational plan for the groundwater resources in the Santa Clarita Valley[5].
6. If possible, pump one or more of the impacted Saugus Formation production wells in a manner that also contains perchlorate migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property. Unlike the previous objectives, this is a secondary objective for operating the impacted Saugus Formation production wells, because other long-term remedies are being developed for the Alluvial Aquifer. Consequently, this objective is not the basis for selecting or rejecting any given pumping plan for the impacted Saugus Formation production wells.

The pumping plan that is developed and evaluated in this report for the impacted Saugus Formation production wells is an interim program that will operate throughout the period of evaluating, designing, and permitting long-term remedial actions for the Whittaker-Bermite property and nearby groundwater. It is anticipated that the pumping plan for the impacted Saugus Formation production wells will continue to be implemented after the long-term remedies are in place on the Whittaker-Bermite property, in part because the pumping plan is intended to meet the water supply needs of the Purveyors.

ES.4 Methodology

The containment evaluation for the impacted Saugus Formation production wells was performed using the regional groundwater flow model for the Santa Clarita Valley (Regional Model). The Regional Model's construction and calibration are discussed in detail in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a). The Regional Model simulates the temporal and spatial variations in groundwater flow patterns in three dimensions, including the recharge and

[5]This operational plan is described in the documents titled *Urban Water Management Plan 2000* (Black & Veatch, 2000) and *Santa Clarita Valley Water Report 2003* (Luhdorff & Scalmanini Consulting Engineers, 2004).

discharge rates of groundwater in the valley. The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The Regional Model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line stream gage area in the west.

The process of designing a modeling analysis to evaluate perchlorate containment consisted of the following activities:

1. Refining the model grid in and around the areas where impacted wells are located
2. Selecting a period over which to simulate groundwater conditions resulting from various pumping configurations
3. Defining the pumping plan at the impacted wells and all other wells in the Santa Clarita Valley, considering the objectives above and the variability in pumping demands that occur due to cycles of drought and nondrought conditions and year-to-year variations in the availability of other water supplies
4. Defining the variation in local hydrology (rainfall, streamflows, and groundwater recharge) on a month-to-month basis throughout the simulation period
5. Running the model to calculate time-varying (monthly) groundwater elevations and groundwater discharge terms throughout the multi-year simulation period
6. Evaluating the modeling results, as follows:
    a. Examining forecasted time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the effects of the pumping plan at the impacted Saugus Formation production wells and across the basin
    b. Analyzing forecasted groundwater flowpaths (using particle-tracking techniques) to identify the degree of containment provided by the pumping plan for the impacted Saugus Formation production wells
7. Performing two sets of sensitivity analyses to address the following questions concerning the selected pumping plan for the impacted Saugus Formation production wells:
    a. Can the containment objectives be met by using lower pumping rates at SCWC-Saugus1 and SCWC-Saugus2, rather than the rate of 1,200 gpm that has been selected for each well, based, in part, on the water supply needs of the valley?
    b. How would the model predictions change if the degree of connection between the Alluvial Aquifer and the Saugus Formation is less than the degree of connection that is simulated by the calibrated model?

Of importance to the analysis was not only the operation of the impacted wells, but also the operational pumping plan for other production wells in the Santa Clarita Valley. The operational plan for the Santa Clarita Valley's groundwater resources has been defined in the *Urban Water Management Plan 2000* (UWMP) for the Santa Clarita Valley (Black & Veatch, 2000) and in annual water reports that discuss the water demands, water supplies, and surface water and groundwater resources of the valley (including the *Santa Clarita*

Valley Water Report 2003 [Luhdorff & Scalmanini Consulting Engineers, 2004]). These reports provide ranges of values for groundwater extractions from the Alluvial Aquifer and the Saugus Formation during average/normal years and dry years. For the modeling analysis, the locations and temporal variation in pumping from the Alluvial Aquifer were defined from the operational plan and from historical records of the year-to-year variability in local hydrology. Simulated pumping from the Saugus Formation was defined from the operational plan, historical pumping records, and operational constraints and historical patterns of water supply availability for water supplies that are imported from the State Water Project (SWP). Pumping rates at individual wells were assigned using the recent and planned production schedules for each well and by evaluating the type of pumping plan that will meet the perchlorate containment objectives for the impacted wells.

The Regional Model was run using a synthetic 78-year period that was derived from historical records of year-to-year variations in both the local hydrology and the hydrology of the SWP system. The 78-year period simulates the following conditions:

1. Average rainfall during this period is similar to the long-term mean of approximately 18 inches per year, as measured at the Newhall-Soledad rain gage. The period includes long periods (i.e., on the order of decades) of relatively dry conditions and relatively wet conditions.
2. For the Saugus Formation, the simulation period includes 18 years of SWP drought and corresponding dry-year pumping during the 78-year period, including two droughts that last for 3 years and two droughts that last for 2 years. Dry-year pumping from the Saugus Formation ranges between 15,000 and 35,000 AF/yr, compared with 15,000 AF/yr or less in nondrought years (see Table ES-2).
3. For the Alluvial Aquifer, the 78-year period includes 24 years of dry-year pumping, which is approximately 5,000 AF/yr lower than the pumping that occurs during years of normal or above-normal rainfall and streamflows. This period includes one drought lasting for 4 years and two droughts that last 3 years.

Model results were evaluated as follows:

1. Time-series plots (hydrographs) of water budget terms and groundwater elevations were used to forecast the effects of the pumping plan at the impacted wells and across the basin.
2. Groundwater flowpaths were forecast using three-dimensional particle-tracking techniques to identify the degree to which pumping from the impacted Saugus Formation production wells contains perchlorate migrating westward toward these wells from the Whittaker-Bermite property.

ES.5 Conclusions from the Modeling Analysis

The major conclusions from the modeling analysis are as follows:

1. Operating production wells SCWC-Saugus1 and SCWC-Saugus2 at rates of 1,200 gpm each on a nearly continual basis will effectively contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property, and will also contain perchlorate that is present at Saugus wells MP-5 and VWC-157. This is shown by Figure

ES-3, which displays groundwater flowpaths from MP-5, VWC-157, and the Whittaker-Bermite property; and by Figure ES-4, which displays the areas within the Saugus Formation where water is obtained by each of the impacted production wells and each of the nonimpacted production wells that are located downgradient of SCWC-Saugus1 and SCWC-Saugus2.

2. Operating production wells SCWC-Saugus1 and SCWC-Saugus2 at rates as low as 700 to 800 gpm each will not fully contain groundwater that is migrating westward from the Whittaker-Bermite property. Additionally, if these wells are operated at 1,000 gpm each, perchlorate that is present in the Saugus Formation at wells MP-5 and VWC-157 will not be captured, and will instead migrate to existing nonimpacted wells VWC-160 and VWC-205.

3. No new production wells are needed in the Saugus Formation to meet the perchlorate containment objectives.

4. Impacted well NCWD-11 is not a required component of the containment program.

5. Use of other water supplies in lieu of pumping at SCWC-Saugus1 and SCWC-Saugus2 will likely be detrimental to the long-term quality of groundwater in the Saugus Formation. Pumping at these two wells is necessary to prevent migration of perchlorate to other portions of the Saugus Formation.

6. The pumping plan for SCWC-Saugus1 and SCWC-Saugus2 may contain perchlorate that is migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property, including perchlorate that has been detected in the Alluvial Aquifer at and south of Bouquet Junction.

7. The operational plan for the impacted production wells will not cause detrimental short-term or long-term effects to the groundwater and surface water resources of the Santa Clarita Valley. In particular, the modeling analysis indicates that short- and long-term variability in local rainfall and streamflows is the predominant cause of fluctuating groundwater elevations, river flows, and groundwater storage volumes. This is indicated by Figures ES-5 through ES-7, which together show that year-to-year changes in groundwater recharge volumes and groundwater storage volumes are much greater than year-to-year fluctuations in pumping. Compared to local hydrology, implementation of the operational pumping plan for the valley, including the planned use of wells SCWC-Saugus1 and SCWC-Saugus2, has much less influence on the water resources of the valley.

It is important to note that the model simulations described in this report distribute pumping in a manner that is based on current and projected uses of both the Alluvial Aquifer and the Saugus Formation. The conclusions presented in this report regarding containment of perchlorate-containing groundwater will potentially be different if the pumping plan for other Saugus Formation wells is significantly different than what was simulated. In particular, a significant change in the Saugus Formation pumping regime in the South Fork Santa Clara River area or near its mouth could potentially cause groundwater flow patterns and capture zones to be notably different from those described in this report. Changes that could appreciably alter groundwater flow patterns and capture zones could include the operation of new wells in that area, or notably greater instantaneous

pumping rates or annual pumping volumes than those simulated by the Regional Model. Consequently, before a new well is sited in that area or a significant increase in pumping occurs from an existing wellfield in that area, it is recommended that an analysis first be conducted of the potential effects of the contemplated change on the perchlorate containment program.

ES.6 Sentinel Monitoring Program

DHS Policy Memo 97-005 requires the implementation of sentinel monitoring in groundwater upgradient of impacted wells to provide early warning of any unanticipated changes in groundwater quality. Based on this policy, the sentinel monitoring plan for the impacted Saugus Formation production wells is intended to provide advanced warning of concentration changes or the presence of additional contaminants in groundwater that might affect the perchlorate treatment processes. Additionally, groundwater elevation and pumping data will be collected under the sentinel monitoring plan to evaluate the effectiveness of the perchlorate containment plan that is described in this report.

As shown on Figure ES-8 and in Table ES-3, the monitoring well network for the sentinel monitoring program will monitor both the Alluvial Aquifer and the Saugus Formation upgradient of each production well. Monitoring will occur at eleven wells, seven of which do not yet exist. Well locations were selected according to the following considerations:

1. Locating sentinel wells sufficient distances from the production well to allow adequate time to respond to significant concentration changes
2. Using existing monitoring wells, to the degree possible
3. Locating new monitoring wells in areas where site access will not cause undue restrictions on drilling, installing, and monitoring new sentinel monitoring wells

Table ES-4 lists the chemical constituents to be monitored, and the frequency at which monitoring will occur as the operational plan for the impacted wells is implemented. The program will focus primarily on monitoring for perchlorate, volatile organic compounds, nitrate, and sulfate, which are the constituents most likely to affect the treatment system if present at concentrations greater than those observed to date. General minerals (anions and cations) will be sampled on a biannual basis to provide geochemical information that may be helpful for evaluating groundwater migration in the vicinity of each impacted production well. However, nitrate and sulfate will be analyzed annually because of their potential influence on the ion-exchange treatment system, which is the system likely to be selected for perchlorate treatment at SCWC-Saugus1, SCWC-Saugus2, and NCWD-11.

Performance monitoring of the pumping plan's ability to meet the containment objectives will be accomplished by monitoring groundwater levels and pumping rates during system startup and analyzing these data with the Regional Model. Water level monitoring will be conducted at each sentinel well that is completed in the Saugus Formation and at multi-port monitoring well MP-5, which is also completed in the Saugus Formation and is located downgradient of SCWC-Saugus1 and SCWC-Saugus2. Water levels will be measured at these wells during the start-up period for the containment system, as well as immediately prior to startup. The water level trends will then be compared with water level trends that

are calculated from Regional Model simulations of the pumping at impacted and non-impacted wells during the initial startup period for the containment pumping plan. Together, the system monitoring data and the subsequent modeling analysis will used to draw conclusions concerning the effectiveness of the containment plan and whether adjustments to the pumping operations at SCWC-Saugus1 and SCWC-Saugus2 are warranted.

Tables

TABLE ES-1

Historical Pumping at Impacted Saugus Formation Production Wells

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Well Owner - Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
VWC-157	635	604	529	239	387	314	581	484	1,222	1,146	635	1,005	570	436	616	403	46	81	0	0	0
SCWC-Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0
SCWC-Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0
NCWD-11	729	870	715	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0
Total	**1,364**	**1,474**	**1,244**	**993**	**1,546**	**1,592**	**2,790**	**2,855**	**2,550**	**2,426**	**1,927**	**6,820**	**3,911**	**4,067**	**5,093**	**2,651**	**2,575**	**1,230**	**14**	**0**	**0**

1991 through 1996 average = 4,186

Note:

All pumping volumes are listed in AF/yr.

TABLE ES-2
Annual Pumping Rates Specified by the Operational Plan for the Santa Clarita Valley's Groundwater Resources
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Aquifer	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
Operational Plan Pumping				
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	7,500 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**37,500 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**
Modeled Pumping				
Alluvium	38,429	33,767	33,767	33,767
Saugus	10,679	15,760	24,346	34,096
Total	**49,108**	**49,527**	**58,113**	**67,863**

Notes:

All pumping volumes are listed in acre-feet.

The operational plan is defined in the documents titled *Urban Water Management Plan 2000* (Black & Veatch, 2000) and *Santa Clarita Valley Water Report 2003* (Luhdorff & Scalmanini Consulting Engineers, 2004).

In the model simulations, total pumping is different than listed in this table when dry-year pumping conditions in one aquifer coincide with normal-year pumping conditions in the other aquifer (due to differences in the timing of dry conditions locally versus reduced deliveries of water imports from the State Water Project).

TABLE ES-3

Well Network for Sentinel Groundwater Quality Monitoring

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Production Well	Sentinel Monitoring Locations	New Monitoring Well Needed?	Actual or Target Depth Interval for Well Screen (ft bgs)	Well Name	TOT Distance from Production Well	Rationale, Comments
SCWC-Saugus1	Alluvium: New well in Magic Mountain	Yes	40-60	AL-12A	1 year or less	Alluvial and Saugus HSU S-I monitoring is for a possible pathway to SCWC-Saugus1. Access constraints might require installation of these wells in the City of Santa Clarita right of way along Magic Mountain Parkway. There are currently no Saugus Formation monitoring wells within the delineated capture zone of SCWC-Saugus1. The Saugus wells for HSU S-III will be installed near the corner of San Fernando Road and Magic Mountain Parkway on land owned by the Newhall Land & Farming Company.
	Parkway north of Saugus1	Yes	170-180	AL-12B		
	Saugus (S-I unit): Adjacent to new alluvium well	Yes	230-250 (HSU S-I)	SG1-HSU1		
	Saugus (S-III unit): NLF land north of SCWC-Saugus1	Yes	490-520 (HSU S-III)	SG1-HSU3a		
		Yes	580-640 (HSU S-III)	SG1-HSU3b		
		Yes	750-770 (HSU S-III)	SG1-HSU3c		
SCWC-Saugus2	Alluvium: Existing well AL06	No	65-85	AL06	10 years	Alluvial monitoring is recommended to assess perchlorate near the SCWC-Saugus2 well. At MP-1, the port 2 screen correlates with the top of the screened intervals at SCWC-Saugus1 and SCWC-Saugus2. Port 4 is the uppermost port below a depth of 1,000 feet and below the zones containing perchlorate.
	Saugus: MP-1, ports 2 and 4	No	391.4-401.4 (HSU S-III)	MP-1 (port 2)		
		No	747.5-757.5 (HSU S-V)	MP-1 (port 4)		
NCWD-11	Alluvium: Existing well AL03	No	91-111	AL03	2 years	Alluvial monitoring is recommended because of the potential for the Alluvial Aquifer to be a pathway for perchlorate migration from the site to well NCWD-11. Additionally, movement within the Saugus Formation could be occurring from the site, which is the reason to install a Saugus sentinel well near the Alluvial sentinel well.
	Saugus: New well at AL03 location	Yes	280-320 (HSU S-III)	NC11-HSU3		

Notes:

TOT = time-of-travel

HSU = hydrostratigraphic unit (See *Draft Final Conceptual Hydrogeology Technical Memorandum for the Eastern Santa Clara Sub-basin Groundwater Stud*) [CH2M HILL, 2004b] for discussions of the locations and characteristics of the HSUs.)

TABLE ES-4
Chemical Constituents and Sampling Frequency for the 97-005 Sentinel Monitoring Program
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

		Frequency			
Analytical Parameters	**EPA Method**	**Initial**	**Semiannual**	**Annual**	**Biannual**
Organic Constituents					
Perchlorate	314.0	X	X		
Volatile Organic Compounds	524.2[a]	X	X		
1,2,4-Trimethyl Benzene		X	X		
Methyl Tertiary Butyl Ether		X	X		
General Minerals (Cations and Anions)					
Aluminum	6010	X			X
Bicarbonate/Alkalinity	310.1	X			X
Calcium	6010	X			X
Chloride	300	X			X
Total Phosphorus	365.3	X			X
Potassium	7610	X			X
Iron	6010	X			X
Magnesium	6010	X			X
Manganese	6010	X			X
Sodium	7770	X			X
Sulfate	300	X		X	
Nitrate	352.1	X		X	
Ammonia	350.3	X			X

[a]Tentatively identified compounds will also be reported.

Figures

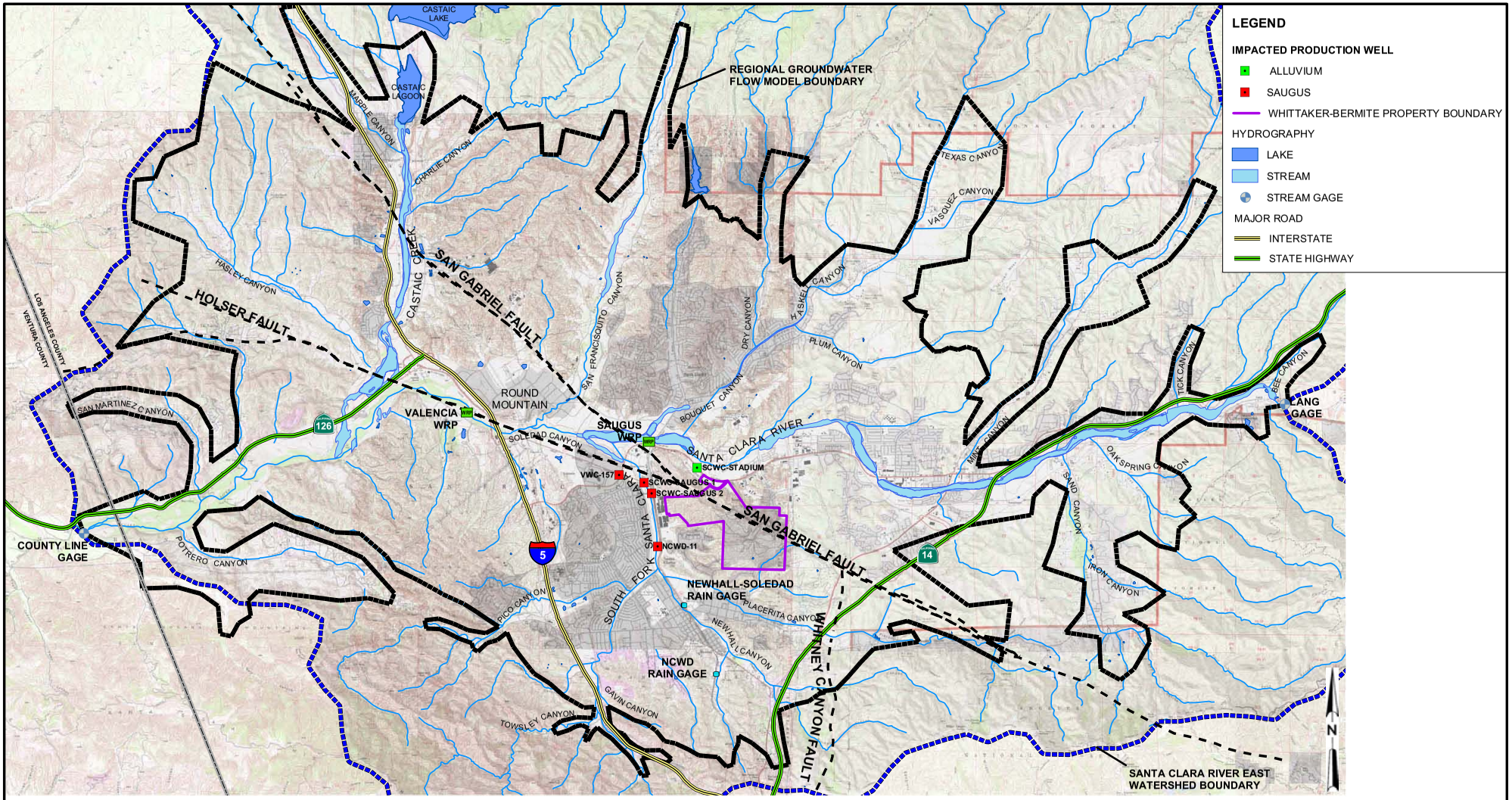

FIGURE ES-1
MAP OF STUDY AREA
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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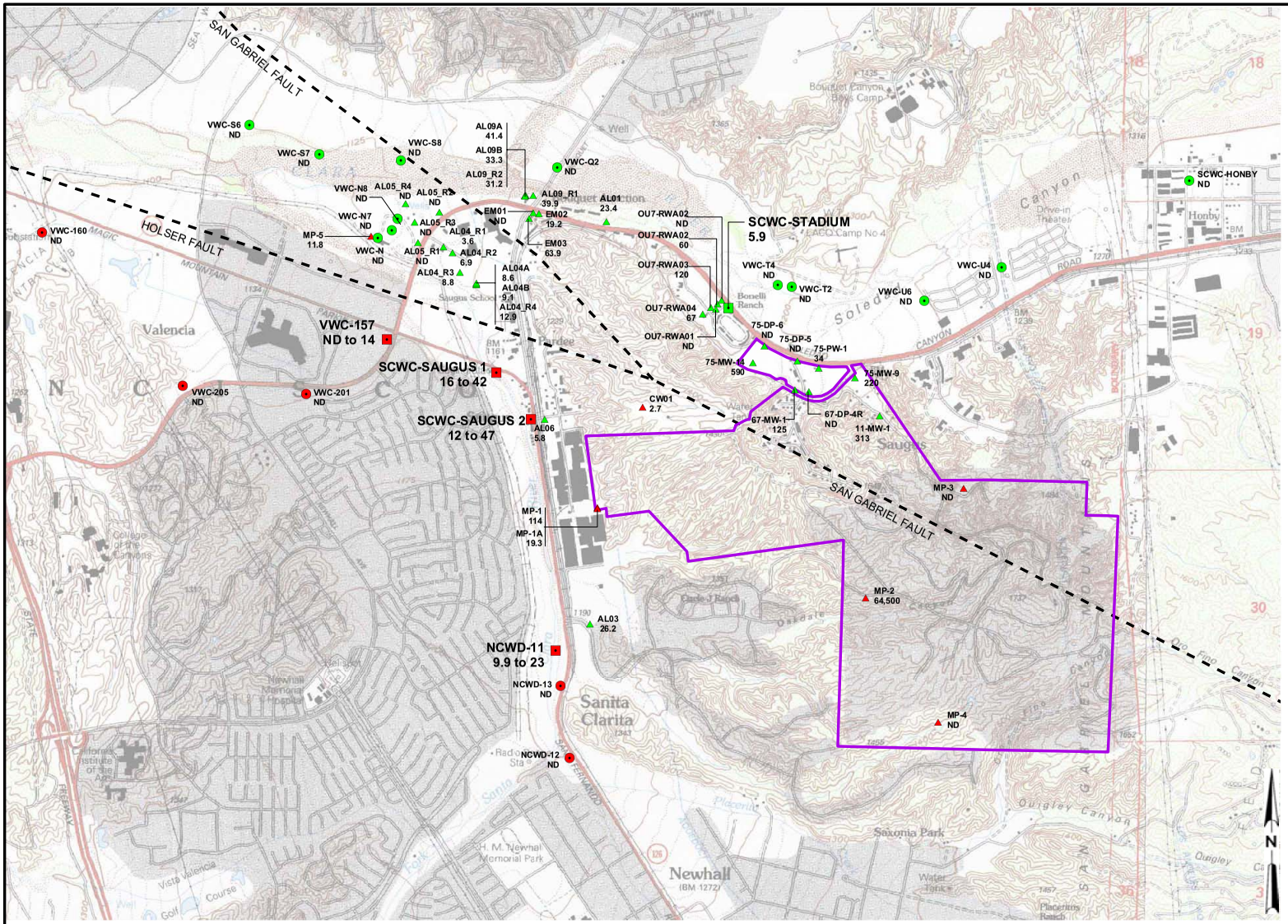

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NONIMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE ES-2
WELL LOCATION MAP
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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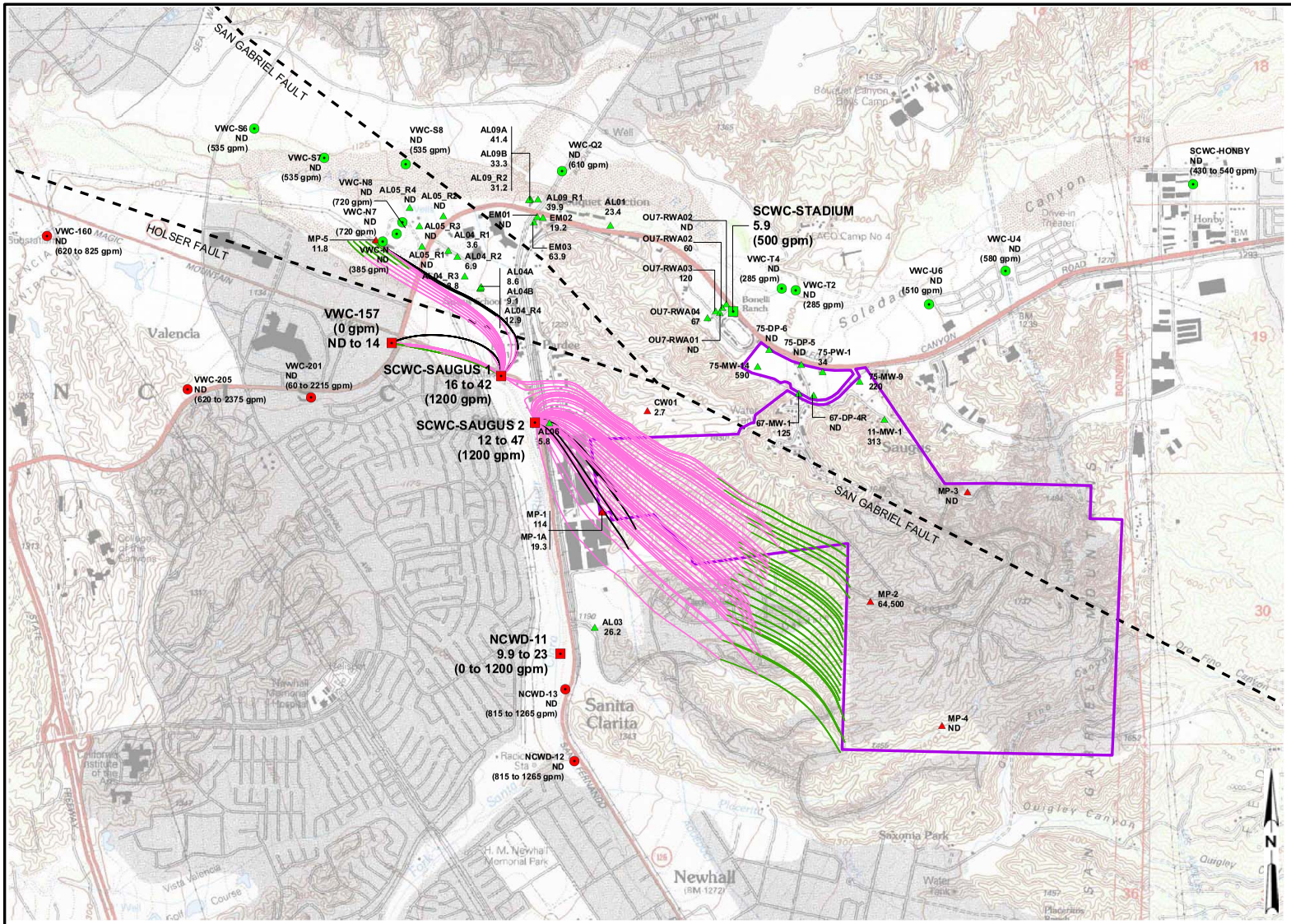

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATH

- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. FLOWPATHS AT VWC-157 AND MP-5 ARE INITIATED IN MODEL LAYERS 2, 3, 4, AND 5. FLOWPATHS AT THE WHITTAKER-BERMITE PROPERTY BOUNDARY ARE INITIATED IN MODEL LAYER 3.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE ES-3
GROUNDWATER FLOWPATHS IN THE SAUGUS FORMATION FROM VWC-157, MP-5, AND THE WESTERN BOUNDARY OF THE WHITTAKER-BERMITE PROPERTY

ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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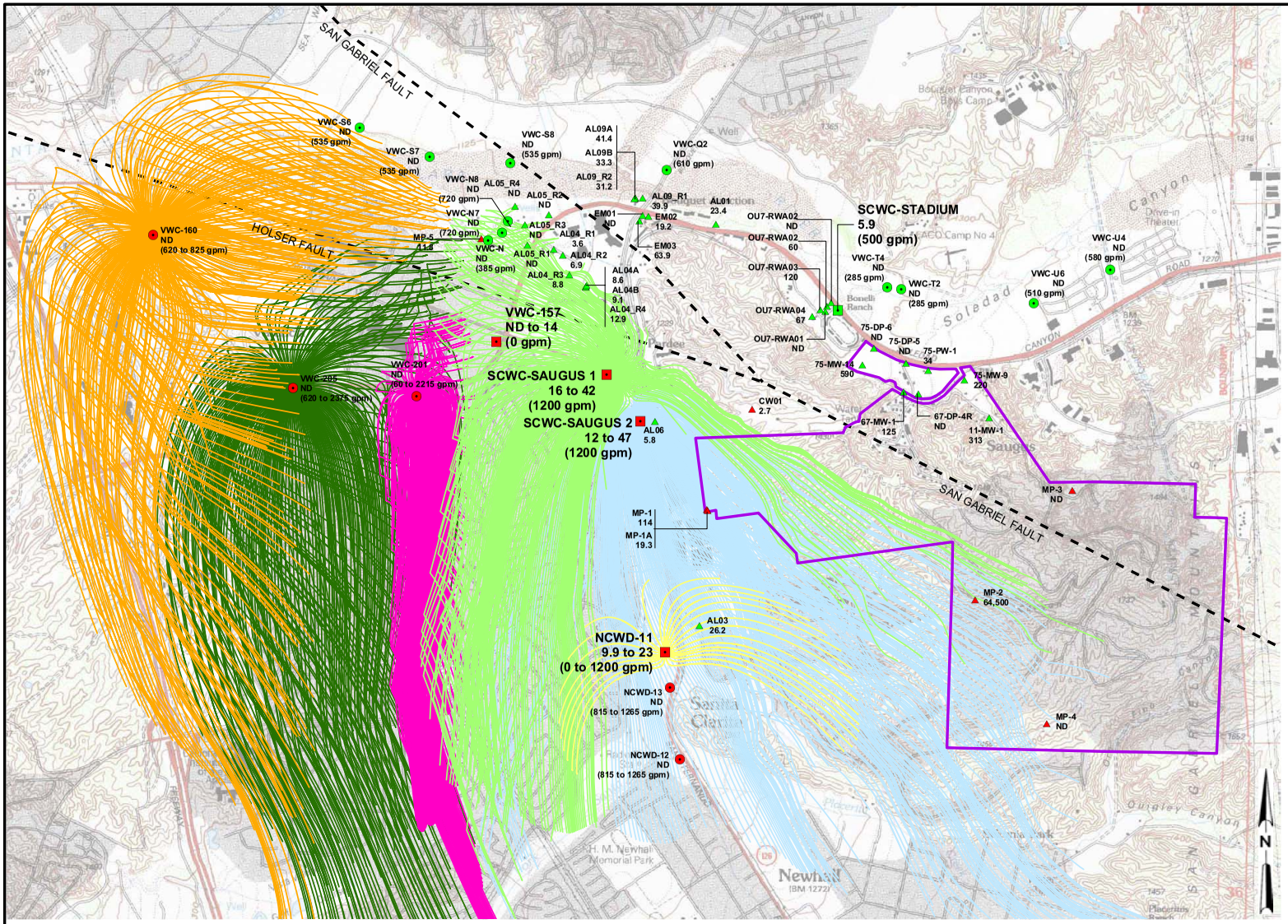

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS
- SCWC-SAUGUS 1
- SCWC-SAUGUS 2
- VWC-160
- VWC-201
- VWC-205
- NCWD-11
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES WERE INITIATED IN LAYERS 3, 4, AND 5. ALTHOUGH EACH WELL MAY DERIVE A PORTION OF ITS WATER FROM THE ALLUVIAL AQUIFER, PARTICLES THAT ARE TRACED INTO THE ALLUVIAL AQUIFER ARE NOT SHOWN ON THIS FIGURE BECAUSE THE INTENT OF THE FIGURE IS TO SHOW AREAS IN THE SAUGUS FORMATION THAT ARE CAPTURED BY EACH WELL.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE ES-4
SAUGUS FORMATION CAPTURE ZONES FOR IMPACTED AND NONIMPACTED PRODUCTION WELLS
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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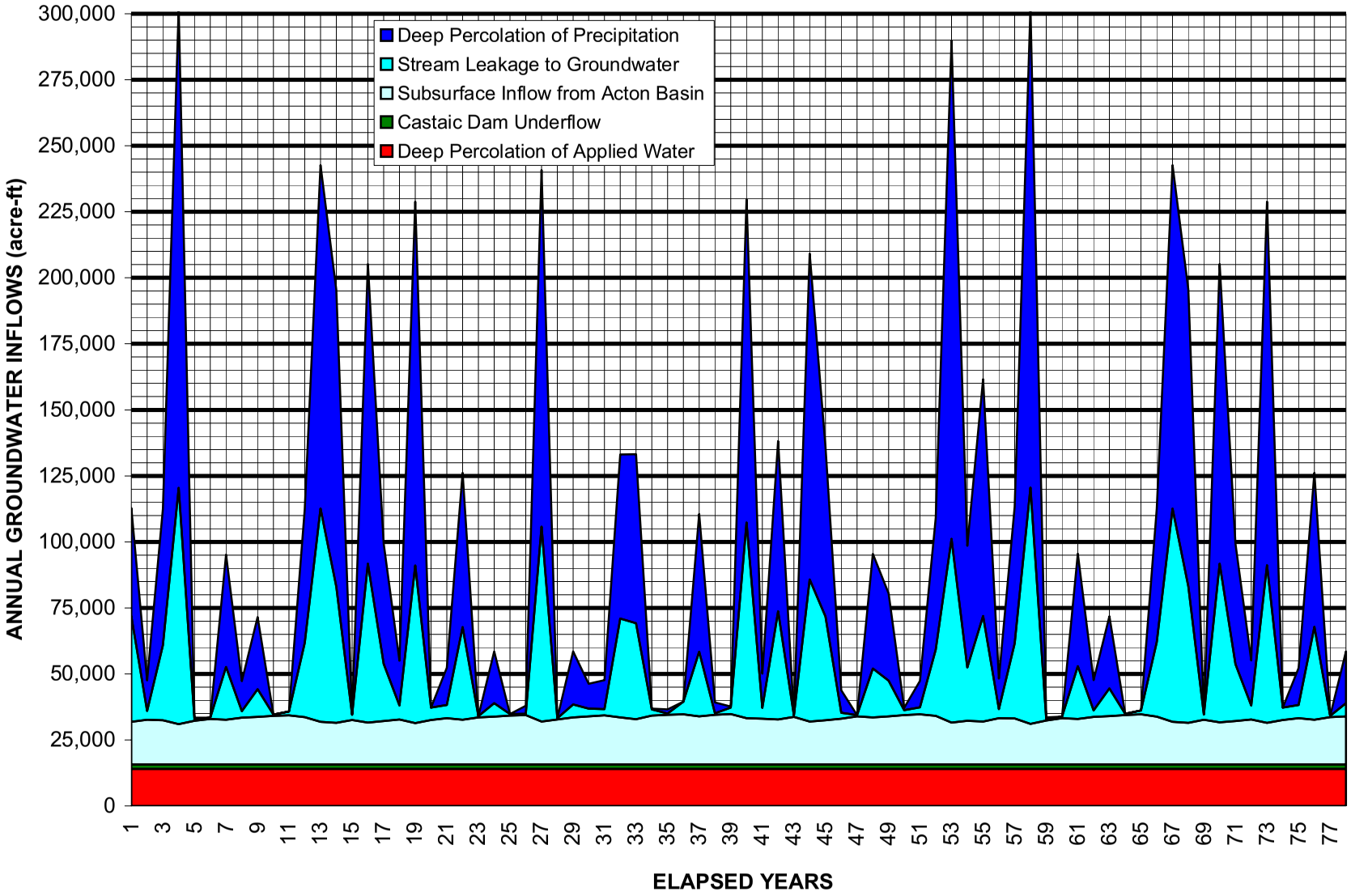

FIGURE ES-5
ANNUAL GROUNDWATER INFLOWS
ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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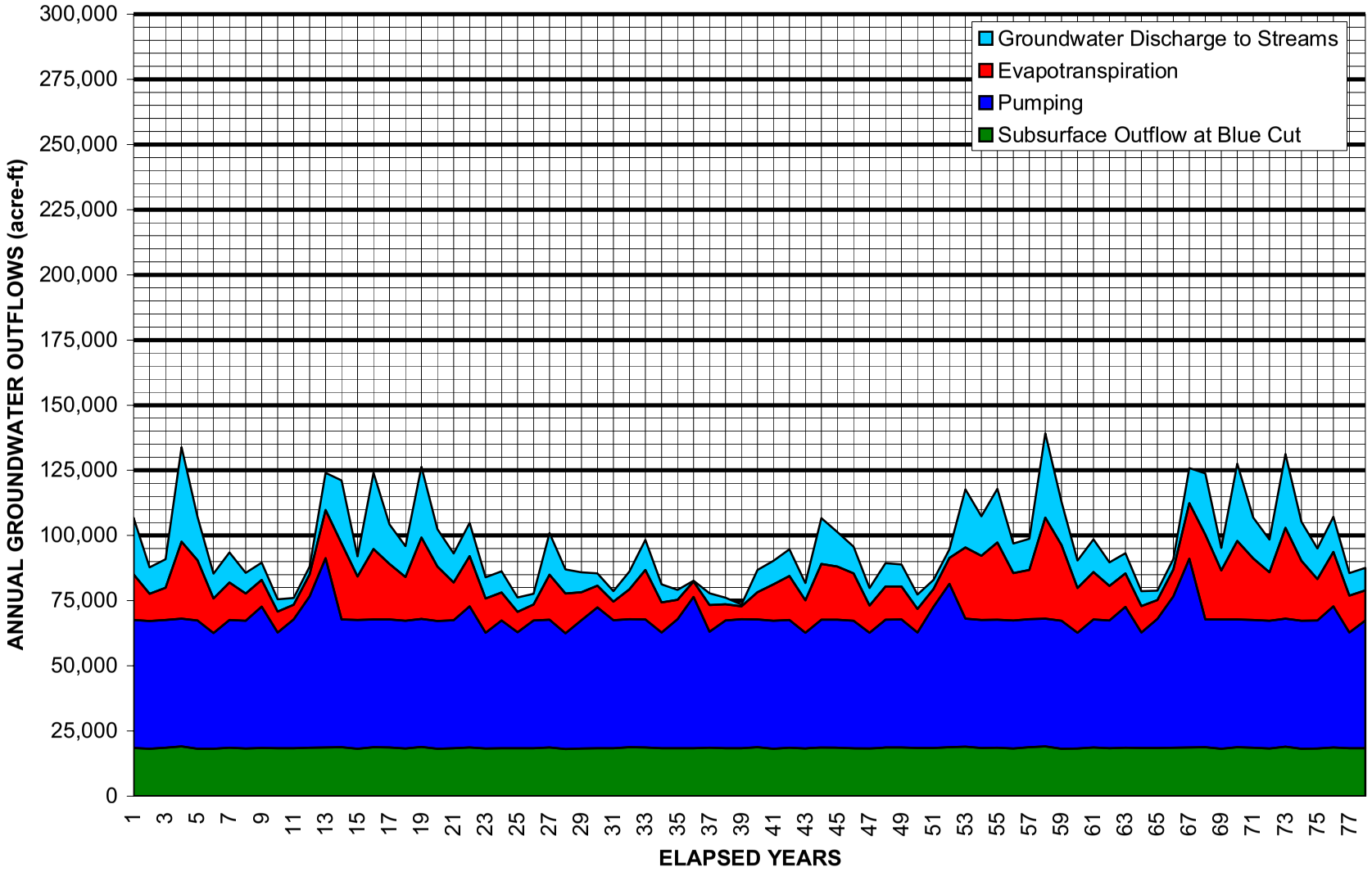

FIGURE ES-6
ANNUAL GROUNDWATER OUTFLOWS
ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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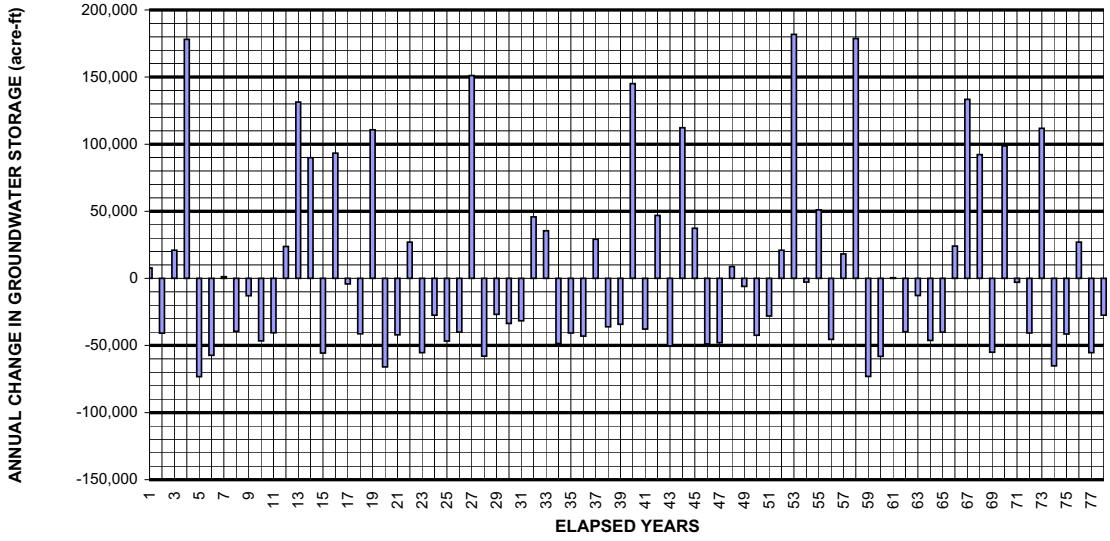
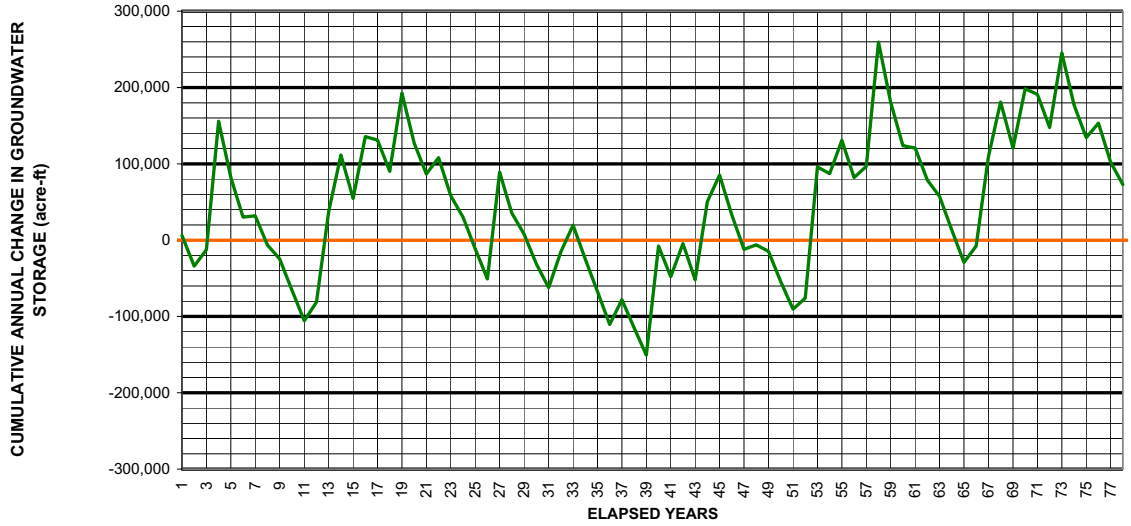




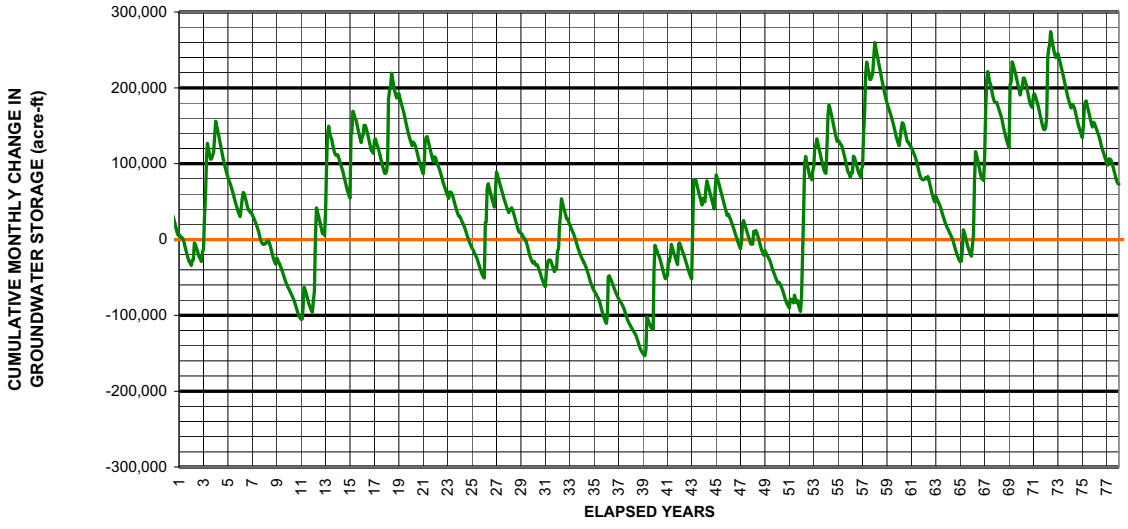
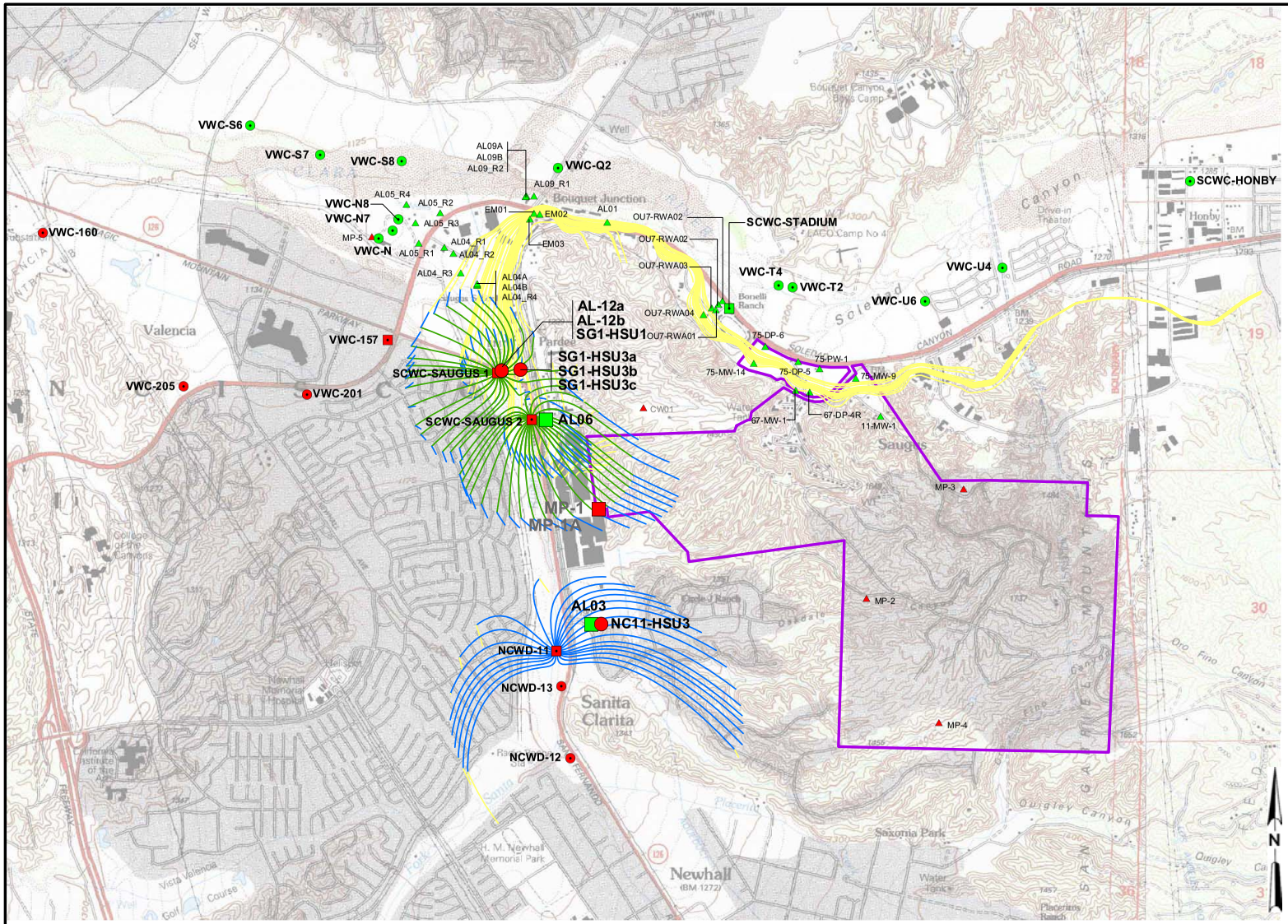


FIGURE ES-7
ANNUAL CHANGE AND CUMULATIVE CHANGE IN GROUNDWATER STORAGE
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA



LEGEND

SENTINEL WELLS

EXISTING SENTINEL WELL

- ALLUVIUM
- SAUGUS

NEW SENTINEL WELL

- ALLUVIUM
- SAUGUS

PRODUCTION WELL

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

OTHER MONITORING WELL

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS

- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. FLOWLINES STARTED THROUGHOUT MODEL LAYERS 2 AND 3 AND TRACED BACKWARDS FOR 20 YEARS.
2. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION. .

FIGURE ES-8
WELL LOCATIONS FOR SENTINEL MONITORING OF GROUNDWATER QUALITY
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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Contents

Page

Executive Summary **ES-1**

Acronyms and Abbreviations ..... **vii**

1 Introduction **1-1**
- 1.1 Background 1-1
- 1.2 State Regulatory Program 1-3
- 1.3 Report Purpose and Content 1-3

2 Analysis of Perchlorate Containment **2-1**
- 2.1 Objectives 2-1
- 2.2 Methodology 2-1
  - 2.2.1 Regional Model Design 2-2
  - 2.2.2 Design of Modeling Analysis 2-3
  - 2.2.3 Grid Refinements 2-4
  - 2.2.4 Simulation Period 2-4
  - 2.2.5 Assignment of Pumping Rates 2-6
  - 2.2.6 Simulation Method for Other Local Hydrologic Processes 2-11
  - 2.2.7 Running the Model 2-12
  - 2.2.8 Evaluation Methods (Particle Tracking) 2-13
  - 2.2.9 Sensitivity Analyses 2-13
- 2.3 Results 2-14
  - 2.3.1 Hydrographs 2-14
  - 2.3.2 Hydraulic Containment 2-16
  - 2.3.3 Time-related Capture Zones 2-18
  - 2.3.4 Sensitivity Analysis 2-19
- 2.4 Conclusions 2-20

3 Sentinel and Performance Monitoring Programs **3-1**
- 3.1 Objectives 3-1
- 3.2 Monitoring Network 3-1
- 3.3 Chemical Constituents and Monitoring Frequency 3-2
- 3.4 Evaluating Capture Zone Effectiveness 3-3

4 References **4-1**

Contents, Continued

Tables—Tables are located at the end of each section.

1-1 Historical Pumping at Impacted Saugus Formation Production Wells

2-1 Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin

2-2 Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003

2-3 Annual Pumping Rates Specified by the Operational Plan for the Santa Clarita Valley's Groundwater Resources

2-4 CALSIM II Calculated State Water Project Municipal and Industrial Allocations

2-5 State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation

2-6 Simulated Annual Groundwater Pumping from the Saugus Formation

2-7 Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

2-8 Allocation of Pumping by Month for Agricultural and Urban Production Wells

2-9 Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation

2-10 Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

2-11 Simulated Monthly Precipitation at the Newhall County Water District Rain Gage

2-12 Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage

2-13 Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek

2-14 Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)

2-15 Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

2-16 Simulated Monthly Treated Wastewater Discharge from Santa Clarita Valley WRPs under Full Build-out Conditions

2-17 Simulated Annual Groundwater Budget

3-1 Well Network for Sentinel Groundwater Quality Monitoring

3-2 Chemical Constituents and Sampling Frequency for 97-005 Sentinel Monitoring Program

Contents, Continued

Figures—Figures are located at the end of each section.

1-1 Map of Study Area

1-2 Well Location Map

2-1 Santa Clarita Valley Hydrology

2-2 Basin Geologic Map

2-3 Annual Precipitation at the Newhall-Soledad and NCWD Rain Gages since 1950

2-4 Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

2-5 Regional Model Grid

2-6 Local Model Grid

2-7 Regional Well Location Map

2-8 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage

2-9 Annual Precipitation and Cumulative Departure from the 1950 through 2000 Average at the Newhall-Soledad Rain Gage for the 78-year Simulation Period

2-10 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer West of Interstate 5

2-11 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer East of Interstate 5

2-12 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer in Soledad Canyon

2-13 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer along Castaic Creek

2-14 Simulated Average Annual Groundwater Elevations in the Alluvial Aquifer at Impacted Saugus Wells

2-15 Simulated Average Annual Groundwater Elevations in the Saugus Formation West of Interstate 5

2-16 Simulated Hydrographs of Average Annual Groundwater Elevations in the Saugus Formation East of Interstate 5

2-17 Simulated Santa Clara River Flow at County Line

Contents, Continued

2-18 Simulated Groundwater Discharge to Santa Clara River

2-19 Annual Groundwater Inflows

2-20 Annual Groundwater Outflows

2-21 Annual Change and Cumulative Change in Groundwater Storage

2-22 Simulated Average Groundwater Elevation Contours for Alluvial Aquifer

2-23 Simulated Average Groundwater Elevation Contours for Saugus Formation

2-24 Groundwater Flowpaths in the Saugus Formation from VWC-157, MP-5, and the Western Boundary of the Whittaker-Bermite Property

2-25 Saugus Formation Capture Zones for Impacted and Nonimpacted Production Wells

2-26 Two-year Capture Zones for Wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11

2-27 Five-year Capture Zones for Wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11

2-28 Ten-year Capture Zones for Wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11

2-29 Twenty-year Capture Zones for Wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11

2-30 Locations of Saugus Formation Recharge from the Alluvial Aquifer in the Vicinity of the Whittaker-Bermite Property

2-31 Measured Alluvial Aquifer Groundwater Elevations in the Vicinity of the Whittaker-Bermite Property

2-32 Sensitivity of Flowpaths in the Saugus Formation to Lower Pumping Rates at SCWC-Saugus1 and SCWC-Saugus2

2-33 Sensitivity of 20-year Capture Zones for Wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 to Lower Simulated Hydraulic Connection between the Alluvial Aquifer and the Saugus Formation

3-1 Well Locations for Sentinel Monitoring of Groundwater Quality

Acronyms and Abbreviations

°F	degrees Fahrenheit
µg/L	micrograms per liter
AF	acre-feet
AF/yr	acre-feet per year
AL	State of California Action Level
ASR	aquifer storage and recovery
bgs	below ground surface
CIMIS	California Irrigation Management Information Service
CLWA	Castaic Lake Water Agency
DHS	California Department of Health Services
DMS	Development Monitoring System
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
gpm	gallons per minute
HSU	hydrostratigraphic unit
I-5	Interstate 5
in/yr	inches per year
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation District
LACWWD	Los Angeles County Waterworks District
LADPW	Los Angeles County Department of Public Works
MCL	Maximum Contaminant Level
MP	multi-port monitoring well
NCWD	Newhall County Water District

NLF	Newhall Land & Farming Company
Purveyors	Upper Basin Water Purveyors
R	vertical anisotropy ratio (Kh:Kv)
Regional Model	Santa Clarita Valley Regional Groundwater Flow Model
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
T	transmissivity
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
UWMP	*Urban Water Management Plan 2000*
VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
WY	water year

SECTION 1

Introduction

This report presents an analysis of a plan to contain perchlorate that is present in the Saugus Formation aquifer, which lies beneath a portion of the Santa Clarita Valley (located in northwestern Los Angeles County, California). The containment plan consists of pumping from two deep production wells that have not operated in several years because of elevated concentrations of perchlorate in groundwater. The selected pumping plan has been designed to cause perchlorate, which is migrating in groundwater from the nearby Whittaker-Bermite property, to be captured by these wells, thereby controlling its movement toward other portions of the aquifer, where additional water supplies could otherwise be impacted. The operation of these wells is also designed to capture perchlorate-containing groundwater that is present just downgradient of these two wells. The pumping rates have been selected by considering the water supply needs of the valley and analyses of groundwater flow patterns that are expected under the pumping plan for these wells. The analyses of groundwater flow patterns have been performed using a numerical regional-scale groundwater flow model of the valley, which was developed by the local water purveyors (herein referred to as the Purveyors[1]) for use in managing the local groundwater resource. Figure 1-1 shows the study area, including the model boundaries.

Following is background information on the impacted production wells and the presence of perchlorate, followed by a summary of the state regulatory program under which the evaluation work was conducted, and a summary of the purpose and content of this report.

1.1 Background

In 1997, two Saugus Formation production wells owned by the Santa Clarita Water Company (SCWC)[2] (wells SCWC-Saugus1 and SCWC-Saugus2), one Saugus Formation production well owned by the Newhall County Water District (NCWD) (well NCWD-11), and one Saugus Formation production well owned by Valencia Water Company (VWC) (well VWC-157) were shut down because perchlorate was detected in groundwater at these wells. In 2002, an Alluvial Aquifer production well owned by SCWC (well SCWC-Stadium) was shut down because of a perchlorate detection. The locations of the five impacted production wells and nearby nonimpacted production wells are shown on Figure 1-2, along with the locations of monitoring wells and exploratory borings that have been installed to investigate the extent of perchlorate contamination. Figure 1-2 also shows perchlorate concentrations at locations where perchlorate has been detected in groundwater. At each of

[1]The Purveyors, also referred to as the Upper Basin Water Purveyors, consist of the Castaic Lake Water Agency (CLWA), the Newhall County Water District, the Santa Clarita Water Division of CLWA, and the Valencia Water Company.

[2]The SCWC was acquired by CLWA in 1999. It was formerly called the Santa Clarita Water Company and is now called the Santa Clarita Water Division of CLWA.

the five production wells, the detected perchlorate concentrations exceeded the State of California's Action Level (AL) for perchlorate at the time of the detection[3].

The four production wells that were shut down in 1997 are constructed in the Saugus Formation, a deep aquifer system that underlies much of the Santa Clarita Valley. Wells SCWC-Saugus1 and SCWC-Saugus2 are screened from depths ranging between 490 and 1,620 feet below ground surface (ft bgs), and NCWD-11 well is screened from 200 to 1,075 ft bgs. Well VWC-157 is screened from 586 to 2,008 ft bgs. The production well that was shut down in 2002 (SCWC-Stadium) pumps groundwater from the Alluvial Aquifer, and is screened from 33 to 130 ft bgs.

Together, the four impacted production wells in the Saugus Formation pumped between 1,900 and 6,800 acre-feet per year (AF/yr) during the early and mid-1990s, prior to being shut down. The average pumping from these four wells was 4,186 AF/yr from 1991 through 1996, the 6 years preceding the perchlorate detections (see Table 1-1). The four wells have a combined instantaneous pumping capacity of 7,900 gallons per minute (gpm). The Purveyors plan to return three of the four impacted Saugus Formation production wells to service (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11) and to replace one well (VWC-157) with a newer well located in the western portion of the valley (west of the area shown on Figure 1-2). The Purveyors have concluded that it is important to return these wells to service for the following reasons:

1. They are important sources of water supply to the valley, particularly in years of reduced availability of other water supplies.
2. Two of these wells (SCWC-Saugus1 and SCWC-Saugus2) are located in an area where they must be pumped to prevent perchlorate from migrating to currently nonimpacted areas in the Saugus Formation.

In addition, the Purveyors have established that the design of the operational plan for SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 should be protective of human health as follows:

1. Implementation of the selected pumping plan for the impacted Saugus Formation production wells should minimize the risks to other water supply wells in the valley.
2. A sentinel monitoring program should be implemented to provide early warning of any changes in groundwater quality that could adversely affect the perchlorate treatment system or other water supplies.

Accordingly, the Purveyors have developed the following primary elements for the perchlorate containment plan:

1. Pumping and treating groundwater from wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11. The pumped groundwater will be treated at a central location to remove perchlorate prior to entering the potable water conveyance system. The treatment

[3]The AL has varied over time. The California Department of Health Services (DHS) initially established an AL of 18 micrograms per liter (μg/L) in 1997, at the same time that the four impacted Saugus Formation production wells were taken offline. In 2002, DHS revised the Action Level to 4 μg/L based on studies by the U.S. Environmental Protection Agency (EPA). In March 2004, the Action Level was revised to 6 μg/L based on a public health goal (PHG) published by the Office of Environmental Health Hazard Assessment. See http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/actionlevel.htm for further details.

process will include the use of ion-exchange resins, followed by disinfection. The treatment system will be designed for a capacity of at least 2,400 gpm.

2. Pumping the treated groundwater to CLWA's Rio Vista Intake Pump Station for subsequent distribution, to help meet water demands.
3. Destroying one perchlorate-impacted production well (VWC-157) that lies downgradient of SCWC-Saugus1 and SCWC-Saugus2 and will not be used for containment.
4. Installing a network of sentinel monitoring wells for performance monitoring of the containment plan and sentinel water quality monitoring.

The pumping, treatment, and subsequent conveyance of water will be performed by CLWA for wells SCWC-Saugus1 and SCWC-Saugus2 and by NCWD for well NCWD-11.

1.2 State Regulatory Program

Returning perchlorate-impacted production to service with treatment requires the issuance of a DHS permit before the water can serve as a potable water supply. Before issuing a permit, DHS requires that formal studies and engineering work be performed to demonstrate that pumping these wells and treating the water will be protective of human health for the users of the water[4]. To obtain a permit, the owner of the well must perform a detailed evaluation of the effects of returning the well to service. The process for conducting the evaluation is called the 97-005 process, named after the policy memo that describes the process (DHS, 1997). The policy memo also discusses the basic tenets under which the DHS Drinking Water Program evaluates proposals, establishes appropriate permit conditions, and approves returning an impacted well to service for direct potable use.

1.3 Report Purpose and Content

Numerical modeling has been performed to forecast the degree of perchlorate containment in groundwater that is likely to be achieved by the pumping plan, and to assist in the selection of a monitoring well network for a sentinel monitoring program. This report presents a modeling analysis of the Purveyors' preferred pumping plan for the Saugus Formation in the vicinity of the impacted Saugus production wells. The modeling analysis was designed to evaluate the following aspects of the pumping plan:

1. Whether the existing impacted Saugus Formation production wells (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11) could be used to contain perchlorate while meeting the water supply needs of the valley
2. Whether additional Saugus Formation production wells are needed in addition to, or instead of, these three impacted wells to meet the containment objectives
3. How the wells should be operated (i.e., the frequency and magnitude of pumping)
4. How operation of other wells in the valley might affect perchlorate containment

[4]The Purveyors and DHS require that water provided to customers contain no detectable perchlorate.

In addition to the modeling analysis, this report discusses the general design of a groundwater quality monitoring program that will be implemented conjunctively with the pumping and treatment program, to identify changes in groundwater quality that might adversely affect the treatment process. This monitoring program will include water level monitoring and groundwater modeling activities during the startup of the long-term containment system, to verify that containment is being achieved and evaluate whether adjustments to the pumping program are warranted.

Although the impacted Alluvial Aquifer production well (SCWC-Stadium) has remained shut down, it is not part of the focus of this analysis because pumping activities, and any necessary perchlorate treatment for this well, will resume only after containment pumping has begun in the Saugus Formation. The longer period for returning the SCWC-Stadium well to service arises from the dependence of this activity on the effectiveness of ongoing groundwater remediation activities being conducted by the Whittaker-Bermite Corporation. Consequently, the plan for the SCWC-Stadium well will be developed in the future, separately from the plan that is described in this report.

This report has been prepared to support the source assessment and permitting process that the Purveyors are performing under the 97-005 Policy. Section 2 of this report presents the analysis of perchlorate containment, including its relationship to the operational plan for Santa Clarita Valley groundwater resources. Section 3 presents the objectives and general design of the sentinel groundwater quality monitoring program, which includes identifying the network of existing and new wells that will be sampled under this program. Section 4 is the reference list.

Table

TABLE 1-1

Historical Pumping at Impacted Saugus Formation Production Wells

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Well Owner - Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
VWC-157	635	604	529	239	387	314	581	484	1,222	1,146	635	1,005	570	436	616	403	46	81	0	0	0
SCWC-Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0
SCWC-Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0
NCWD-11	729	870	715	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0
Total	**1,364**	**1,474**	**1,244**	**993**	**1,546**	**1,592**	**2,790**	**2,855**	**2,550**	**2,426**	**1,927**	**6,820**	**3,911**	**4,067**	**5,093**	**2,651**	**2,575**	**1,230**	**14**	**0**	**0**

1991 through 1996 average = 4,186

Note:

All pumping volumes are listed in AF/yr.

Figures

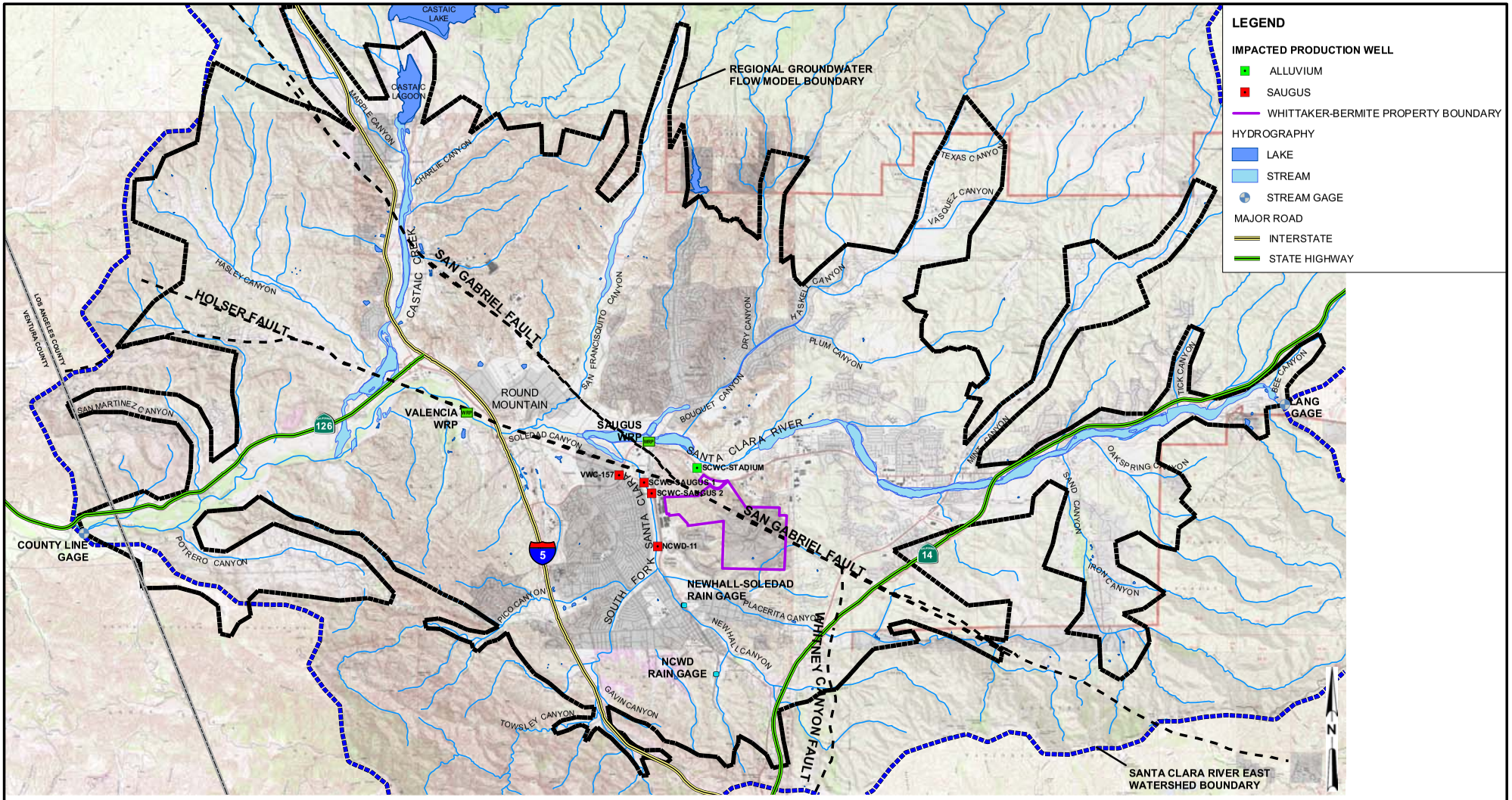

FIGURE 1-1
MAP OF STUDY AREA
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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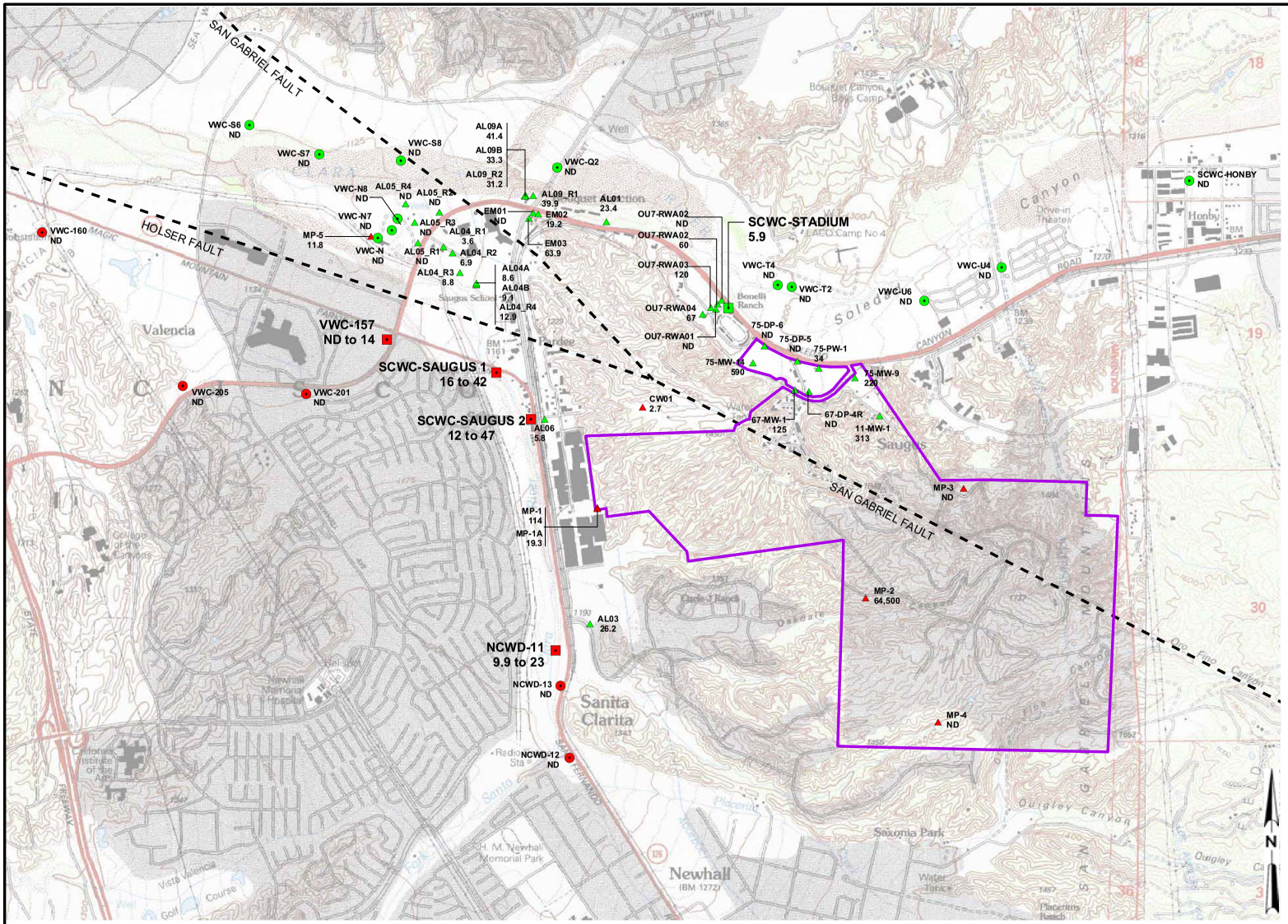

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NONIMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
3. µg/L = MICROGRAMS PER LITER.

FIGURE 1-2
WELL LOCATION MAP
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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SECTION 2

Analysis of Perchlorate Containment

2.1 Objectives

In addition to meeting the requirements of the 97-005 policy memo (DHS, 1997), the Purveyors have identified the following objectives that must be met by the pumping plan for the impacted Saugus Formation production wells:

1. Hydraulically contain perchlorate that is migrating westward in the Saugus Formation from the Whittaker-Bermite property toward the impacted production wells.
2. Hydraulically contain perchlorate that is present at wells MP-5 and VWC-157, which are located downgradient of the impacted wells.
3. Protect downgradient production wells that are currently not impacted.
4. Restore the annual volumes of water that were pumped from the impacted wells before they were shut down.
5. Operate the impacted wells in a manner that is consistent with the Purveyors' operational plan for the groundwater resources in the Santa Clarita Valley[5].
6. If possible, pump one or more of the impacted Saugus Formation production wells in a manner that also contains perchlorate migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property. Unlike the previous objectives, this is a secondary objective for operating the impacted Saugus Formation production wells, because other long-term remedies are being developed for the Alluvial Aquifer. Consequently, this objective is not the basis for selecting or rejecting any given pumping plan for the impacted Saugus Formation production wells.

The pumping plan that is developed and evaluated in this report for the impacted Saugus Formation production wells is an interim program that will operate throughout the period of evaluating, designing, and permitting long-term remedial actions for the Whittaker-Bermite property and nearby groundwater. It is anticipated that the pumping plan for the impacted Saugus Formation production wells will continue to be implemented after the long-term remedies are in place on the Whittaker-Bermite property, in part because the pumping plan is intended to meet the water supply needs of the Purveyors.

2.2 Methodology

The containment evaluation for the impacted Saugus Formation production wells was performed using the Regional Groundwater Flow Model for the Santa Clarita Valley (Regional Model). The Regional Model's construction and calibration are discussed in detail

[5]This operational plan is described in the documents titled *Urban Water Management Plan 2000* (Black & Veatch, 2000) and *Santa Clarita Valley Water Report 2003* (Luhdorff & Scalmanini Consulting Engineers, 2004).

in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a). The Regional Model simulates the temporal and spatial variations in groundwater flow patterns in three dimensions, including the recharge and discharge rates of groundwater in the valley. Table 2-1 summarizes the components of the valley's hydrology that are simulated by the model. Figure 2-1 shows these processes schematically. Following are discussions of the Regional Model's design and the methods by which the model was used to evaluate the containment approach for the impacted Saugus Formation wells.

2.2.1 Regional Model Design

The Regional Model is a three-dimensional numerical model that uses the MicroFEM® finite-element software (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The Regional Model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line stream gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation where the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member. Figure 2-2 is a geologic map of the valley, including the boundaries of the Regional Model.

The boundary conditions in the model consist of the following:

1. Specified flux boundaries for:
    a. Precipitation
    b. Irrigation
    c. Recharge from ephemeral streams
    d. Pumping
    e. Underflow from beneath Castaic Dam
2. Head-dependent flux boundaries for:
    a. Groundwater discharges to the perennial reach of the Santa Clara River
    b. Residual drainage of groundwater to the Santa Clara River in the ephemeral reach under high water table conditions
    c. Evapotranspiration (ET) by phreatophyte plants, which extract groundwater from the shallow water table that lies along riparian river corridors

3. Constant-head boundaries for:

    a. Subsurface inflow to the valley in the Alluvial Aquifer at the eastern end of the valley, at the Lang gage[6]

    b. Subsurface outflow in the Alluvial Aquifer at the western end of the valley, at the County Line gage

Groundwater recharge rates are estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates are calculated using a detailed Surface Water Routing Model (SWRM) that was written specifically to provide time-dependent, spatially varying recharge rates as input to the Regional Model. The SWRM relies on historical records of rainfall and streamflow data from several sources. Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. A second rain gage is located approximately 1.3 miles to the south, at the NCWD office. Figure 2-3 shows the annual rainfall at the Newhall-Soledad rain gage for calendar years 1950 through 2000 and at the NCWD gage from 1979 through 2000. Rainfall varies across the basin according to elevation differences and the locations of surrounding mountain ranges. Figure 2-4 shows lines of equal precipitation (rainfall isohyets) throughout the Santa Clara River East watershed, based on long-term mean annual precipitation data compiled from the U.S. Geological Survey (USGS), the California Department of Water Resources (DWR), and California Division of Mines and Geology maps and data.

The depths from which production wells obtain water are defined in the Regional Model from well construction records. The locations and rates of pumping are based on the Purveyors' pumping plan for the basin and on the surveyed location of each production well.

2.2.2 Design of Modeling Analysis

The process of designing a modeling analysis to forecast perchlorate containment consisted of the following activities:

1. Refining the model grid in and around the areas where impacted wells are located
2. Selecting a period over which to simulate groundwater conditions resulting from various pumping configurations
3. Defining the pumping plan at the impacted wells and all other wells in the Santa Clarita Valley, considering the objectives above and the variability in pumping demands that occur due to cycles of drought and nondrought conditions and year-to-year variations in the availability of other water supplies
4. Defining the variation in local hydrology (rainfall, streamflows, and groundwater recharge) on a month-to-month basis throughout the simulation period

[6]A constant-head boundary was established in the model at this location based on recent field conditions that were observed after the model calibration report (CH2M HILL, 2004) was published. This change to the model improved the model's calibration in the Alluvial Aquifer in the upper reaches of Soledad Canyon and did not appreciably change the calibration quality elsewhere.

5. Running the model to calculate time-varying (monthly) groundwater elevations and groundwater discharge terms throughout the multi-year simulation period
6. Evaluating the modeling results, as follows:
    a. Examining forecasted time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the effects of the pumping plan at the impacted Saugus Formation production wells and across the basin
    b. Analyzing forecasted groundwater flowpaths (using particle-tracking techniques) to identify the degree of containment provided by the pumping plan for the impacted Saugus Formation production wells
7. Performing two sets of sensitivity analyses to address the following questions concerning the selected pumping plan for the impacted Saugus Formation production wells:
    a. How large a factor of safety does the Purveyors' pumping plan for the impacted Saugus Formation wells provide for containment of Saugus groundwater migrating westward from the Whittaker-Bermite property, given that the plan is based, in part, on restoring groundwater pumping at the impacted production wells?
    b. How would the model predictions change if the degree of connection between the Alluvial Aquifer and the Saugus Formation is less than the degree of connection that is simulated by the calibrated model?

These activities are described in further detail below.

2.2.3 Grid Refinements

The Regional Model grid is shown on Figure 2-5. The Regional Model grid contains 17,103 nodes that are spaced 500 feet apart in the majority of the modeled area. However, the Regional Model contains finer node spacing (150 feet) along the Santa Clara River and its tributaries, to allow for improved resolution and precision in calculations of surface water/groundwater exchange rates. Nonetheless, it was deemed necessary to reduce the node spacing in the area around the impacted wells to increase the spatial resolution of the model, including its ability to calculate groundwater flowlines (groundwater particle traces) and hydraulic capture zones.

A node spacing of 75 feet was applied to an area of approximately 2,500 acres (approximately 4 square miles [mi^2]), which is approximately 3 percent of the 119-mi^2 area contained within the Regional Model's boundaries. This smaller node spacing was used within the northwestern portion of the Whittaker-Bermite property and adjacent areas to the north and west where perchlorate has been detected in groundwater. The 75-foot node spacing was used for all nodes in this area, including stream nodes. Figure 2-6 shows the refined finite-element grid in this localized area. The refinement of the grid caused the total number of nodes in the Regional Model to increase by 20,180 nodes per layer, for a total of 37,283 nodes per layer.

2.2.4 Simulation Period

The operational pumping plan for the Santa Clarita Valley's groundwater resources has been defined in the *Urban Water Management Plan 2000* (UWMP) for the Santa Clarita Valley (Black & Veatch, 2000) and in annual water reports that discuss the water demands, water

supplies, and surface water and groundwater resources of the valley (including the *Santa Clarita Valley Water Report 2003* [Luhdorff & Scalmanini Consulting Engineers, 2004]). These reports provide ranges of values for groundwater extractions from the Alluvial Aquifer and the Saugus Formation during average/normal years and dry years. For the modeling analysis, the locations and temporal variation in pumping from the Alluvial Aquifer were defined from the operational plan and from historical records of the year-to-year variability in local hydrology. Simulated pumping from the Saugus Formation was defined from the operational plan, historical pumping records, and operational constraints and historical patterns of water supply availability for water supplies that are imported from the State Water Project (SWP).

Because the local pumping plan for the Saugus Formation is linked to the hydrology and operational constraints for the SWP system, the year-to-year variability in Saugus Formation pumping is, to a certain extent, dependent on the hydrology outside the valley (i.e., in northern California). As shown in Table 2-2, local hydrology is often not a good indicator of local pumping conditions in the Saugus Formation, because local droughts and SWP droughts frequently do not coincide with each other. The following are examples:

1. In 1955, dry conditions in the SWP system coincided with approximately 14 inches of rainfall at the Newhall-Soledad rain gage, which is similar to the long-term median rainfall recorded at this gage.

2. In 1976 and 1977, the SWP system hydrology was critical, while the local hydrology during those years was near normal (1976) and wetter than normal (1977).

3. In 1987 and 1988, the SWP system hydrology was dry (1987) and critical (1988), while the local hydrology during those years was near normal (1987) and wetter than normal (1988).

4. In 1991 and 1992, the SWP system hydrology was in its fifth and sixth consecutive years of dry or critical hydrology, while the local hydrology was wetter than normal both years.

5. In 2001, dry conditions in the SWP system coincided with wetter-than-normal local conditions.

Consequently, it was decided that the model would need to be run over several decades to capture the year-to-year variability in the hydrology of each system, as well as the less frequent times when both systems are experiencing similar hydrologic conditions (as occurred periodically during the 1960s and in 1994). Analyses of historical records were then conducted to identify a synthetic simulation period that would meet the following criteria:

1. The simulation time should be long enough to include an historical period that accounts for the year-to-year variations in local hydrology that have been observed in the past.

2. The period should be long enough to include longer-term (i.e., on the order of decades) periods of relatively dry conditions and relatively wet conditions.

3. The average rainfall during the simulation period should be similar to the average rainfall of 17.84 inches per year (in/yr) that was observed from 1950 through 2000 at the Newhall-Soledad gage.
4. The period should be sufficiently long to allow simulation of two occurrences of reduced SWP water supplies during the period 1990 through 1992, which corresponds to periods of increased pumping from the Saugus Formation under the valley's operational plan.
5. The frequency of dry-year occurrences in the SWP system, corresponding to increased pumping from the Saugus Formation, should be similar to the historical frequency.
6. If necessary to meet other criteria, the simulation should repeat parts of this sequence before and/or after the historical sequence.

Examination of historical local hydrology and independent simulations of SWP deliveries resulted in the selection of a 78-year period over which the model was run, with monthly time steps. Details regarding how the pumping conditions and local hydrology were defined during this period are described below in Section 2.2.5.

2.2.5 Assignment of Pumping Rates

Pumping rates were assigned in accordance with the operational plan for the Santa Clarita Valley, which defines ranges of valleywide annual pumping, given the water supply needs of the Purveyors. Pumping rates at individual wells were assigned using the recent and planned production schedules for each well and by evaluating the type of pumping plan that will meet the perchlorate containment objectives for the impacted wells. Details of pumping rate assignments are discussed below.

2.2.5.1 Description of Operational Plan for Groundwater Pumping

The operational plan for the Santa Clarita Valley's groundwater resources defines the ranges of annual groundwater pumping rates that are planned for the Alluvial Aquifer and the Saugus Formation under variable hydrologic conditions as follows (Black & Veatch, 2000; Luhdorff & Scalmanini Consulting Engineers, 2004):

1. Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the eastern Santa Clara River watershed. Under the operational plan, pumping ranges between 30,000 and 40,000 AF/yr during normal and above-normal rainfall years, but is reduced to between 30,000 and 35,000 AF/yr during locally dry years.
2. Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly imported water from the SWP system. For the Saugus Formation, the operational plan consists of pumping between 7,500 and 15,000 AF/yr during average-year conditions within the SWP system. Planned dry-year pumping from the Saugus Formation ranges between 7,500 and 25,000 AF/yr during a drought year, and increases to between 21,000 and 25,000 AF/yr if SWP deliveries are reduced for longer than 1 year.

Table 2-3 summarizes the operational pumping plan for the Alluvial Aquifer and the Saugus Formation and compares this plan with the model-simulated valleywide pumping

rates for each type of year (normal and above-normal years, dry year 1, dry year 2, and dry year 3). The selections of the simulated valleywide pumping rates are described below.

2.2.5.2 Variations in State Water Project Hydrology and Saugus Formation Pumping

CLWA has performed a statistical evaluation of SWP deliveries using the 2021B scenario from the CALSIM II model, which was developed by DWR for its SWP Delivery Reliability Report (DWR, 2002). The CALSIM II model and the SWP Delivery Reliability Report were developed to support (1) the preparation of urban water management plans by the water agencies that are SWP contractors, (2) analyses required to comply with Senate Bills 221 and 610, and (3) other water supply planning activities that include the SWP as a component of supply. The 2021B scenario simulates the anticipated deliveries of water to the 29 SWP contractors using an historical hydrologic record and anticipated operating and regulatory conditions for the SWP system in 2021. In addition to the CLWA evaluation (Kennedy/Jenks Consultants, 2003), the U.S. Bureau of Reclamation (USBR) has used CALSIM II to perform biological assessment studies for the Operating Criteria and Plan (OCAP) for the SWP (USBR, 2004). These studies, which were made public for review in February 2004, include evaluations of the role and function of an Environmental Water Account (EWA) that consists of water purchased to mitigate the water supply impacts of protection measures for endangered species. These CALSIM II simulations have been performed for the SWP system at a present-day level of development and for the anticipated level of development in 2020. Table 2-4 compares the municipal and industrial water use allocations calculated by CALSIM II for the SWP Reliability Report (DWR, 2002) and for the OCAP (USBR, 2004) for the hydrology that occurred from 1950 through 1993.

CLWA's evaluation reached the following conclusions regarding the deliveries it will receive under this scenario (Kennedy/Jenks Consultants, 2003):

1. A regression analysis indicates that there is a weak relationship between the SWP delivery in a given year and the previous year's delivery.
2. SWP deliveries will equal or exceed 70 percent of CLWA's 95,200 AF/yr Table A Amount during approximately 75 percent of the simulated years. During the remaining years, the deliveries will vary between 20 and 70 percent.
3. A Monte Carlo analysis of projected deliveries during 73 consecutive years indicated that at a 95 percent confidence level, 4 years of a 7-year drought period in the SWP system (such as was observed from 1988 through 1994) will have sufficiently low deliveries to require short-term pumping of increased groundwater volumes to meet local water demands. This includes a period of 3 consecutive years of increased pumping.

As discussed in Sections 2.2.4 and 2.2.5.3, a 78-year period was simulated with the groundwater model. Table 2-5 shows the sequence of SWP droughts, SWP allocations, and resulting pumping volumes for the Saugus Formation that have been defined based on the CLWA and USBR analyses. The 78-year period contains the following:

1. Eighteen years of dry-year pumping from the Saugus Formation, or an average of 1 dry year approximately every 4 years

2. Two droughts lasting 3 years, plus (in both cases) a dry year that occurs 2 years before the beginning of each 3-year drought and another dry year that begins 1 year after each 3-year drought has ended

3. Two droughts lasting 2 years

4. Sixty years of normal-year pumping from the Saugus Formation

Pumping rates at specific wells were assigned for each type of year (normal, dry year 1, dry year 2, and dry year 3) using the operational plan for the valley and information on the capacity, recent and planned use, and location of each well. Figure 2-7 shows the locations of these wells and other wells in the valley. Table 2-6 summarizes the annual pumping volumes at each Saugus Formation well[7]. Significant aspects of the pumping rate selection at each well are as follows:

1. Two of the three impacted wells (SCWC-Saugus1 and SCWC-Saugus2) were assumed to operate on a continuous basis to contain perchlorate in this portion of the Saugus Formation. The modeling analysis simulated a continual pumping rate of 1,200 gpm at each well, consistent with the Purveyors' water supply needs from these wells. The analysis assumed each well will be offline 1 month each year for routine maintenance, but would otherwise operate on a continuous basis. The resulting simulated annual pumping volume was 1,772 AF at each of these two wells, for a combined annual pumping volume of 3,544 AF from both wells.

2. In contrast to the near-continuous operation of SCWC-Saugus1 and SCWC-Saugus2, modeling simulations showed that well NCWD-11 can operate on a seasonal basis without any adverse effects on the objective of containing perchlorate in the Saugus Formation east of this well. Consequently, well NCWD-11 was assumed to operate at a yield of 1,200 gpm for a period of 5 months during the peak-demand season, providing a volume of 811 acre-feet (AF) during this period. Consequently, total pumping from the three impacted Saugus Formation wells that will be returned to service (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11) was simulated as 4,355 AF/yr.

3. Pumping from other existing Saugus Formation production wells was based on recent and planned use of these wells, as defined by the Purveyors. The simulation included increased dry-year pumping from the Saugus Formation in the western portion of the basin, where it is anticipated that future wells will be installed.

The pumping rates at each Saugus Formation well were also allocated in specific manners with respect to the pumping depth and the time of year. These allocations were as follows:

1. Except for one well (NCWD-13), each Saugus Formation production well has open intervals that are significantly longer in vertical extent than the thicknesses of the individual layers that represent the Saugus Formation in the Regional Model. Consequently, the pumping rates were assigned to multiple layers in the model by considering the depths of the open interval and the transmissivity of each model layer. Table 2-7 shows the allocation of pumping in each model layer for each Saugus

[7]Table 2-5 only lists wells that are anticipated to be operating in the future. Existing wells that are not listed in this table (including VWC-157) are currently not in service or pump very limited quantities of groundwater, and therefore are not expected to provide significant quantities of water in the future. Well VWC-157 has been replaced by new well VWC-206.

Formation production well, as well as the open intervals of each well and the model-simulated transmissivity in each layer at each well location.

2. Table 2-8 shows the allocation of pumping, by month, for agricultural and urban production wells in both the Saugus Formation and the Alluvial Aquifer. Separate distributions were used because agricultural demands are for exclusively outdoor uses, whereas urban demands are for both indoor and outdoor uses. As discussed in the model development report (CH2M HILL, 2004a), the monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service (CIMIS). The monthly distribution of urban demand was determined by examining historical monthly flow records for the two LACSD water reclamation plants (WRP) and monthly demand distributions recorded by VWC during the past several years.

2.2.5.3 Variations in Local Hydrology and Alluvial Aquifer Pumping

Annual rainfall records from 1950 through 2003 at the Newhall-Soledad rain gage (Station No. FC32CE) were inspected to identify dry years, wet years, and years of near-normal rainfall in the Santa Clarita Valley. For near-normal and wet years, the operational plan for the Valley's groundwater resources calls for Alluvial Aquifer pumping to range between 35,000 and 40,000 AF/yr. During locally dry years, groundwater elevations in eastern Soledad Canyon can decline several feet per year, and the historical record shows that multiple dry years can occur before sufficient rainfalls return to increase streamflows and groundwater recharge (see Section 2.6 of the Regional Model development and calibration report [CH2M HILL, 2004a]). Consequently, the operational plan calls for reducing pumping to between 30,000 and 35,000 AF/yr during dry years. As shown on Figure 2-8, the average rainfall from 1950 through 2000 at the Newhall-Soledad rain gage was 17.84 in/yr. To define pumping trends in the Alluvial Aquifer, the dry-year pumping rate was assigned to years when rainfall at the Newhall-Soledad rain gage is below 12 in/yr.

Figure 2-9 shows the year-to-year rainfall in the valley and the cumulative departure from average rainfall for each year during the 78-year simulation period. The figure also shows each simulation year's corresponding historical year. The cumulative departure from average rainfall is plotted to show the occurrence of relatively wet versus relatively dry periods. A year-to-year decline in the slope of the cumulative departure curve indicates conditions are dry, whereas a year-to-year increase indicates rainfall is above normal. Also plotted are the occurrences of SWP droughts. The figure shows the following:

1. The first 19 years of the simulation period are generally wet, as a whole, though a multi-year drought occurs in years 5 through 12 (1984 through 1991).

2. A prolonged dry period begins in year 20, as indicated by the downward slope in the cumulative departure curve. This period lasts through year 39, as the curve starts to slope upward to the right beginning in year 40[8]. This 20-year period of generally dry conditions corresponds to the historical period 1999 through 2003, followed by 1950 through 1964.

[8]Year 40 is equivalent to historical year 1965, when rainfall was over 32 inches, or 2.2 times the long-term median rainfall and 1.8 times the long-term average rainfall.

3. Rainfall was generally at or above normal from years 40 through 45 (historical years 1965 through 1970), before a drought ensued from years 46 through 51 (historical years 1971 through 1976).

4. Rainfall was then generally above normal during years 52 through 58 (1977 through 1983), followed by the drought years 59 through 66 (1984 through 1991), the wetter-than-normal years 67 through 76 (1992 through 2001), and dry years 77 and 78 (2002 and 2003).

Table 2-9 shows the sequence of local hydrologic conditions and resulting valleywide pumping volumes for the Alluvial Aquifer that have been defined from the operational pumping plan for the valley. The 78-year simulation period contains the following:

1. Twenty-four years of dry-year pumping, which is approximately 30 percent of the simulated 78-year period.

2. One drought consisting of 4 consecutive years of below-normal pumping (in years 34 through 37, based on historical hydrology from 1959 through 1962).

3. Two droughts consisting of 3 consecutive years of below-normal pumping (in years 10 through 12 and 64 through 66, both of which are based on historical hydrology from 1989 through 1991).

4. Three years (years 12, 37, and 66) when rainfall is near or above normal, but pumping is assigned at a dry-year rate because the year was preceded by a multi-year local drought.

Pumping rates at specific wells were assigned for normal and dry years using the operational plan and information on the capacity, recent and planned use, and location of each well. Figure 2-7 shows the locations of these wells and other wells in the valley. Table 2-10 compares recent annual pumping volumes at each Alluvial Aquifer well with the assumed future production rates at each well under normal and dry-year conditions. Significant aspects of the pumping rate selection at each well are as follows:

1. The SCWC-Stadium well was simulated as pumping 800 AF/yr. The Whittaker Corporation is developing plans to mitigate the source of perchlorate to the portion of the Alluvial Aquifer situated immediately north and downgradient of the Whittaker-Bermite property. The modeled pumping scenario simulates the possibility that the well will be returned to service in the future, and will pump at a rate similar to historical volumes, after source mitigation activities have reduced perchlorate concentrations to undetectable levels in the Alluvial Aquifer at and near this well.

2. As shown in Table 2-10, most Alluvial Aquifer wells were specified to operate at similar rates regardless of year type. However, there were two exceptions, as follows:

    a. Wells in the eastern portion of the basin (the NCWD-Pinetree wells, nine wells owned by SCWC, and the privately owned Robinson Ranch well) were assumed to have lower pumping capacities during dry years than nondrought years because of lower groundwater elevations during dry periods. This assumption was based on historical observations indicating that the eastern portion of the Alluvial Aquifer

experiences declines in water levels, in contrast to other parts of the valley, during dry periods.

b. Pumping was also reduced at NCWD's three operating wells in Castaic Valley, in accordance with recent pumping records from those wells.

2.2.6 Simulation Method for Other Local Hydrologic Processes

In addition to groundwater pumping, infiltration from irrigation (from urban and agricultural lands), precipitation, and streamflows (stormwater and WRP discharges) were also modeled. These other local hydrologic processes were defined using the SWRM, which is described in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Key aspects of the derivation of these terms are as follows:

1. **Urban Irrigation.** Under existing land use and water use conditions, the estimated long-term infiltration rates of applied irrigation water beneath urban areas, under full build-out conditions in the valley, were estimated to be 1.0 in/yr for industrial and retail lands, 2.2 in/yr for residential developments and parks, and 4.6 in/yr for golf courses. These rates were applied during each year (and each month) of the 78-year simulation period. The areas over which these rates were applied were larger than under current conditions. The areas were defined from existing land use data and from LACSD mapping of projected future land uses in the rest of the Santa Clarita Valley[9].

2. **Agricultural Irrigation.** As discussed in the *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002), irrigation of lands owned by the Newhall Land & Farming Company results in existing agricultural return flows. The source of most irrigation water is groundwater pumping from the Alluvial Aquifer, with some limited pumping occurring from one Saugus Formation well (NLF-156). Under full valley build-out conditions, the currently irrigated lands will no longer be irrigated because their water source will be used as part of the water supply for Newhall Ranch. Therefore, under full build-out conditions, no agricultural irrigation will occur within the area simulated by the Regional Model.

3. **Precipitation.** Infiltration from direct precipitation within the Regional Model domain was defined using data from the two rain gages in the valley (the Newhall-Soledad and NCWD gages), an isohyet map of rainfall throughout the watershed, and a power-function equation developed by Turner (1986) that describes the relationship between annual rainfall and ET rates within the valley. Details concerning the derivation of precipitation infiltration rates from these data are contained in Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Table 2-11 lists the simulated monthly precipitation at the NCWD rain gage for the 78-year model period[10].

4. **Stormwater Flows in Streams.** For each month of the simulation, the SWRM calculated the amounts of stormwater flow and groundwater recharge in all streams, plus the

[9]LACSD land use mapping indicates that, including Newhall Ranch, approximately 14,000 acres of currently undeveloped land will be urbanized in the future within the Regional Model simulation area. Additional urbanization will also occur in areas that are within the watershed, but outside the Regional Model's boundaries.

[10]The simulated monthly precipitation was defined from measurements at the NCWD gage from 1979 through 2003, as well as by combining the isohyet map with measurements at the Newhall-Soledad gage from 1950 through 1978.

amount of flow and groundwater recharge arising from projected future WRP discharges to the Santa Clara River. For the Santa Clara River, the volume of streamflow was defined from measured and estimated streamflow data at the Lang gage (Table 2-12). For Castaic Creek, the volume of streamflow was defined from historical DWR operations and consideration of the hydrologic year type (Table 2-13). For the remaining Santa Clara River tributaries, streamflow volumes were defined by the SWRM using monthly rainfall data and the Turner (1986) relationship between rainfall, ET, and the subsequent yield from each watershed.

5. **WRP Discharges to the Santa Clara River.** Under full valley build-out conditions, future flows into and from WRPs will be higher than historical flows because of increased development and the associated increase in indoor water use volumes. Additionally, a portion of the future treated water will be reclaimed. Future inflows to the Saugus and Valencia WRPs were estimated from projected future water demands and from comparisons of historical water use and measured inflows to both WRPs. Table 2-14 shows the derivation of urban water demands outside the Newhall Ranch development (which will be served by a new, separate WRP). Table 2-15 shows the total amount of treated water generated by the Saugus and Valencia WRPs, and the amount of this water that is reclaimed and discharged to the river. Table 2-15 shows this information by month, and the analysis assumes that the reclaimed water volume will be no more than 16,000 AF/yr, to maintain existing flow volumes in the Santa Clara River. For the Newhall Ranch WRP, discharges to the river will be 286 AF/yr, occurring primarily in December and January, when demands for reclaimed water are at their seasonal low. The total combined volumes of treated water discharged to the Santa Clara River under full valley build-out conditions (including Newhall Ranch) are summarized, by month, in Table 2-16. These rates were used in each year of the 78-year model run.

The month-by-month assignment of rates and locations of surface water infiltration to the underlying Alluvial Aquifer system was performed by the SWRM using the procedures described in Section C.8.5 of Appendix C to the Regional Model development and calibration report (CH2M HILL, 2004a). Streambed infiltration capacities were the same as those used in the calibrated model. For each of the 78 years in the model simulation, the streambed infiltration capacity values were selected by matching the year to one of the 20 years (1980 through 1999) from the model calibration runs, using rainfall and streamflow data to select the corresponding streambed infiltration rates.

The SWRM also tracked the volume of surface water in each simulated stream that does not infiltrate during each month because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage was calculated to remain as surface water in the Santa Clara River and to eventually exit the Regional Model at the west end of the valley at the County Line gage.

2.2.7 Running the Model

As discussed in the previous sections, the Regional Model was run with monthly time steps, in which pumping and recharge terms were varied each month. The model was run using a convergence criterion of 0.0001 foot for groundwater elevations, and a water budget convergence criterion of 1 cubic foot per day.

2.2.8 Evaluation Methods (Particle Tracking)

Model results were evaluated as follows:

1. Time-series plots (hydrographs) of water budget terms and groundwater elevations were used to evaluate the potential effects of the pumping plan at the impacted wells and across the basin; and

2. Groundwater flowpaths were calculated using three-dimensional particle-tracking techniques to identify the degree to which pumping from the impacted Saugus Formation production wells contains perchlorate migrating westward toward these wells from the Whittaker-Bermite property. Particle tracking was performed by first calculating the time-weighted average groundwater elevations at each node in each model layer, using the monthly elevations calculated by the model. The particle tracking was then performed in two manners:

    a. Forward in time. Particles traces were delineated forward in time, starting along the western boundary of the Whittaker-Bermite property. These traces were delineated to evaluate the degree to which perchlorate-containing groundwater moving westward from the Whittaker-Bermite property will be captured by the impacted wells. This evaluation also provided an indication of whether this groundwater could migrate to currently nonimpacted production wells.

    b. Backward in time. Particle traces were tracked backward in time from SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 to delineate the groundwater capture zones of each well. The 2-year, 5-year, 10-year, and 20-year capture zones were defined for each of these wells, to support other 97-005 work activities (identifying contaminant sources and locating sentinel groundwater monitoring wells). The time-related capture zone delineations were based on an effective porosity of 0.10. Long-term particle tracking was also performed to define the size of the combined capture zone within the Saugus Formation that is created by pumping SCWC-Saugus1, SCWC-Saugus2, and NCWD-11. This included evaluating whether two wells with perchlorate detections to the northwest (former production well VWC-157 and Saugus monitoring well MP-5) would lie within the combined capture zone created by SCWC-Saugus1, SCWC-Saugus2, and NCWD-11.

2.2.9 Sensitivity Analyses

Two sets of sensitivity analyses were performed to address the following questions:

1. Can the containment objectives be met by using lower pumping rates at SCWC-Saugus1 and SCWC-Saugus2, rather than the rate of 1,200 gpm that has been selected for each well based, in part, on the water supply needs of the valley? This was evaluated by running the model several times to identify the pumping rates at the two wells (SCWC-Saugus1 and SCWC-Saugus2) that would potentially cause Saugus Formation groundwater to migrate to Saugus Formation wells that are not impacted by perchlorate. Particle-tracking analyses were performed for the entire 78-year simulation and for shorter periods within the 78-year period.

2. How would the model predictions change if the degree of connection between the Alluvial Aquifer and the Saugus Formation is less than the degree of connection that is

simulated by the calibrated model? This was evaluated by reducing the connection by a factor of 4, which corresponds to decreasing the vertical hydraulic conductivity of the Alluvial Aquifer and/or the uppermost beds of the Saugus Formation.

2.3 Results

This section presents and discusses the following analyses from the 78-year model runs:

1. Hydrographs of groundwater elevations and Santa Clara River flows. The purpose of the hydrographs is to show that the pumping plan at the impacted wells is consistent with the objective of operating the basin in a manner that maintains long-term stability in groundwater levels and river flows.
2. Maps of particle traces showing forecasted Saugus Formation groundwater flowpaths that leave the Whittaker-Bermite property.
3. A map of particle traces showing the area of forecasted hydraulic containment (capture) within the Saugus Formation that is achieved by pumping wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 at the planned pumping rates described in Section 2.2.5.2 of this report.
4. Maps showing the forecasted 2-year, 5-year, 10-year, and 20-year capture zones for SCWC-Saugus1, SCWC-Saugus2, and NCWD-11.

2.3.1 Hydrographs

Hydrographs are displayed for different portions of the Alluvial Aquifer on Figures 2-10 through 2-14 and for different portions of the Saugus Formation on Figures 2-15 and 2-16. Each figure shows results for the 78-year model run to illustrate the potential effect of the operational plan for the Santa Clarita Valley, including the planned pumping at the impacted Saugus Formation production wells. These figures show that the spatial distribution and temporal variation of pumping are not expected to cause a long-term decline in groundwater levels in the Alluvial Aquifer or the Saugus Formation. The model simulates distinct multi-year periods of overall declining or overall increasing groundwater elevations, due to cycles of below-normal and above-normal rainfall periods. This variation is consistent with historical observations of the relationship between rainfall and groundwater level fluctuations (CH2M HILL, 2004). The model also simulates short-term declines in Saugus Formation groundwater elevations that arise from the increased Saugus pumping that occurs during the second and third years of a drought in the SWP system.

Figure 2-17 shows the total flows estimated by the model for the Santa Clara River at the County Line gage, which is located at the western end of the valley. The figure contains both a linear plot and a semi-logarithmic plot, to better illustrate the flows during low-flow periods. As shown by both plots, the total streamflows vary considerably over time at this location, due primarily to variations in rainfall.

The relative influences of local hydrology and the operational plan on the Santa Clara River are illustrated by Figure 2-18, which shows the model-calculated volumes of monthly groundwater discharge to the river. Groundwater discharges to the river occur along the river reach lying downstream of the mouth of San Francisquito Canyon. The figure shows

that the groundwater discharges to the river also vary over time, both seasonally and over multi-year periods. Additionally, the figure shows a period of relatively low groundwater discharge to the river occurs from years 23 through 39 (historical years 2002 through 2003, followed by 1950 through 1964), which corresponds to the prevailing below-normal rainfall conditions in those years. The figure also shows higher volumes of groundwater discharge to the river in years of above-normal rainfall, particularly the very wet periods years 1 through 4, years 13 through 19, years 52 through 58, and years 67 through 72. The similarity between rainfall and groundwater discharges to the river indicates that local hydrology is the primary influence on these discharges. Additionally, the groundwater discharge hydrographs do not show any marked short-term declines in flows that coincide with the marked short-term declines in Saugus Formation groundwater levels when Saugus wells pump at drought-year rates. The model therefore indicates that the operational plan for the groundwater system is not expected to notably affect river flows.

Figures 2-19 and 2-20 show the variations in groundwater recharge and groundwater discharge, respectively, throughout the 78-year simulation period. These annual valleywide groundwater recharge and discharge rates are also listed in Table 2-17. Figure 2-21 shows the annual and cumulative changes in groundwater storage volumes. Figures 2-19 through 2-21 and Table 2-17 together show the following:

1. Groundwater recharge rates (Figure 2-19) are highly variable from year to year, due to variations in precipitation within the Regional Model domain, and precipitation and stormwater generation in the watersheds lying upstream of the aquifer system. In contrast, total groundwater discharge (Figure 2-20) is much less variable from year to year, with the more limited variations arising from increased pumping during drought years and increased ET and groundwater discharge to the Santa Clara River during wet years.

2. Year-to-year and cumulative changes in groundwater storage during the 78-year simulation period (Figure 2-21) provide insights as to the manner in which the basin is functioning hydrologically under the operational pumping plan for the Valley. The cumulative change in groundwater storage is a measure of the longer-term trends in the amount of groundwater in storage, and is plotted on a monthly basis. Table 2-17 tabulates the annual water budget for each year of the 78-year simulation, and shows the cumulative change on an annual basis (in contrast to the monthly basis shown on Figure 2-21). Figure 2-21 and Table 2-17 together show the following:

    a. The cumulative change in total groundwater storage volume, which measures the continuous change in storage since the beginning of the simulation, ranges between approximately a 150,000 AF decline and a 260,000 AF increase. The change in groundwater storage during a single year ranges from approximately an 80,000 AF/yr decline to a 170,000 AF/yr increase.

    b. A nearly 20-year period of overall decline in the cumulative groundwater storage volume occurs between years 19 and 39, as shown on Figure 2-21. Beginning in year 40, the cumulative change in storage shows a generally upward trend, with occasional downward trends during specific drought periods.

c. The Regional Model estimates that the total volume of groundwater in storage above a depth of 2,500 feet is approximately 5 million AF[11]. Consequently, the cumulative declines and increases in groundwater storage represent 5 percent or less of the volume of groundwater in storage.

3. Implementation of the operational pumping plan, including operation of the impacted Saugus Formation production wells, will have no significant effect on long-term groundwater conditions. This is shown by the forecasted recovery of groundwater storage volumes after periods of continued decline, such as the 20-year period of groundwater declines that occurs during years 19 through 39.

4. Based on the previous observations, changes in groundwater storage volumes, particularly over a period of many years, are governed primarily by local hydrologic conditions, not by the operational pumping plan. Local precipitation and streamflows are the most important influences on the year-to-year and longer-term changes in groundwater storage volumes.

The curves presented on Figures 2-10 through 2-21 provide a general indication of the types of fluctuations in groundwater conditions that could be expected to occur in the future in the Santa Clarita Valley over a period of many years. However, these curves have been derived using an assumed sequence of local hydrologic conditions that is based on the sequence of rainfall and streamflow volumes that were measured during the past several decades. In the future, the volumes and year-to-year trends in rainfall and streamflow could vary from those observed in the past. Consequently, the most significant conclusion from the 78-year simulations is that local hydrologic conditions, rather than the operational pumping plan and the use of the impacted Saugus Formation production wells, will be the predominant influence on the water resources (groundwater and river flows) of the Santa Clarita Valley.

2.3.2 Hydraulic Containment

As discussed previously in Section 2.2.5.2, the combined pumping volume from the three impacted wells was modeled as 4,355 AF/year. Figures 2-22 and 2-23 show the long-term average groundwater elevations in the Alluvial Aquifer and the Saugus Formation, respectively, in the vicinity of the Whittaker-Bermite property and the impacted production wells[12]. These groundwater elevations were used to delineate three-dimensional groundwater flowpaths using the MicroFEM® model's particle-tracking routines. The flowpaths were used to forecast the degree of hydraulic containment in the Saugus Formation that will arise from the pumping plan at wells SCWC-Saugus1, SCWC-Saugus2, and NCWD-11.

Figure 2-24 shows the traces of groundwater particles (1) migrating westward in the Saugus Formation from the Whittaker-Bermite property and (2) migrating away from Saugus wells

[11]This calculation excludes groundwater deeper than 2,500 feet and shallower groundwater residing in the Sunshine Ranch Member of the Saugus Formation. The calculation also assumes a specific yield of 0.15 for the Alluvial Aquifer and 0.065 for the Saugus Formation, which are similar to values used by Richard C. Slade and Associates, LLC (2002), for similar calculations of the volume of groundwater in storage. The model-based calculations estimate that the groundwater storage volumes are 1 million AF of groundwater in the Alluvial Aquifer and 4 million AF in the Saugus Formation. Richard C. Slade and Associates, LLC, estimated these volumes to be 0.16 million AF and 1.65 million AF, respectively. Robson (1972) estimated this volume to be 6 million AF based on a specific yield of 0.10 and a Saugus Formation thickness of 3,500 feet.

[12]Figure 2-23 shows the average groundwater elevations in the fourth layer of the model, which represents the depth interval from 1,000 to 1,500 ft bgs.

MP-5 and VWC-157. The figure uses different colors for the flowpaths to illustrate the depths in the Saugus Formation from which the wells derive their water. The flowpaths extending westward from the Whittaker-Bermite property were initiated at depths between 500 and 1,000 ft bgs, and the flowpaths migrating from MP-5 and VWC-157 were initiated at depths between 150 and 1,500 ft bgs. Three principal observations about the flowpaths are as follows:

1. Each flowpath initiated at these depths along the Whittaker-Bermite property's western boundary on Figure 2-24 ends at wells SCWC-Saugus1 and SCWC-Saugus2. This includes flowpaths originating near multi-port monitoring well MP-2, which end at well SCWC-Saugus2. Groundwater sampling results at MP-2 indicate that perchlorate is present as deep as approximately 800 ft bgs (CH2M HILL, 2003).

2. None of the groundwater particles migrate to nonimpacted production wells lying downgradient (west and northwest) of the three impacted wells that are closest to the Whittaker-Bermite property (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11). Consequently, no new production wells are needed in the area around SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 to control groundwater migrating from the Whittaker-Bermite property.

3. None of the flowpaths end at NCWD-11, which indicates that the pumping plan for SCWC-Saugus1 and SCWC-Saugus2 alone will contain groundwater migrating from areas on the Whittaker-Bermite property where perchlorate has been detected in groundwater, south and west of the San Gabriel Fault.

4. Saugus Formation groundwater at wells MP-5 and VWC-157 is captured by containment pumping at SCWC-Saugus1.

Figure 2-25 shows the area of hydraulic containment within the Saugus Formation that will be achieved by the planned pumping for SCWC-Saugus1, SCWC-Saugus2, and NCWD-11. The figure shows groundwater flowpaths that have been traced backward from these three wells to delineate the horizontal extent of the capture zone in the Saugus Formation created by pumping from these wells. Capture zones are also shown for three nearby nonimpacted Saugus Formation production wells (VWC-160, VWC-201, and VWC-205) that lie downgradient of SCWC-Saugus1, SCWC-Saugus2, and NCWD-11. The flowpaths were drawn by placing imaginary groundwater particles through the entire open interval of each well and tracing the flowpaths in a backward direction to delineate the full extent of the capture zones created in the Saugus Formation for each well[13] (see Table 2-7 for the depths of the open intervals at each Saugus Formation production well). Figure 2-25 shows the following:

1. The capture zones for SCWC-Saugus1 and SCWC-Saugus2 occupy a large volume of the Saugus Formation, extending as far east as the Whittaker-Bermite property and as far northwest as wells VWC-157 and MP-5, which have historical detections of perchlorate.

2. The capture zones for VWC-160, VWC-201, and VWC-205 lie west of, and generally do not overlap, the capture zones for SCWC-Saugus1 and SCWC-Saugus2.

[13]For clarity, flowlines that were delineated to the base of the Alluvial Aquifer were stopped at that location so Figure 2-25 would show capture zones only in the Saugus Formation, which is the focus of the containment evaluation.

3. The capture zones for VWC-160, VWC-201, and VWC-205 do not extend to the locations of other Saugus Formation wells that have historical perchlorate detections (VWC-157 and MP-5).

In summary, Figures 2-24 and 2-25 together indicate that the pumping plan for production wells SCWC-Saugus1 and SCWC-Saugus2 will likely meet the objectives of (1) containing perchlorate that is migrating westward in the Saugus Formation from the Whittaker-Bermite property, (2) containing perchlorate that is present in the Saugus Formation at wells MP-5 and VWC-157, and (3) preventing perchlorate migration to nonimpacted Saugus Formation wells located farther west in the Santa Clarita Valley. Additionally, pumping at NCWD-11 is not necessary for meeting these objectives. These conclusions are further reinforced by the results of sensitivity analyses that are described in Section 2.3.4.

2.3.3 Time-related Capture Zones

Delineations of the 2-year, 5-year, 10-year, and 20-year capture zones of the impacted wells have been developed at DHS' request, for use in conducting the contaminant source inventory that is required by DHS Policy Memo 97-005. These capture zones are shown on Figures 2-26 through 2-29 respectively. As shown by the color scheme for the flowlines in each figure, the hydraulic capture zones lie not only in the Saugus Formation, but also in portions of the Alluvial Aquifer. The particle traces indicate that a portion of the yield to the impacted Saugus Formation production wells comes from downward leakage of groundwater from the Alluvial Aquifer to the Saugus Formation. This finding is consistent with the understanding of the basinwide and localized hydrogeology, which is discussed in the Regional Model development and calibration report (CH2M HILL, 2004a) and is based on drilling records, well-yield data, aquifer tests, streamflow data, and long-term monitoring of pumping rates and groundwater elevations across the basin. These data together indicate SCWC-Saugus1, SCWC-Saugus2, and NCWD-11 lie in a regional groundwater recharge area where the Saugus Formation is recharged by the Alluvial Aquifer, which in turn receives recharge from rainfall and streamflows. Figure 2-30 shows where the Saugus Formation is recharged by the Alluvial Aquifer.

Figures 2-26 through 2-29 also show that the portion of the Alluvial Aquifer that would contain groundwater migrating toward production well SCWC-Saugus1 lies within an area where perchlorate has been detected in the Alluvial Aquifer, north of this well and south of the Santa Clara River. In this area, perchlorate detections in Alluvial Aquifer monitoring wells have ranged from as little as 3.6 μg/L (well AL04_R1) to as high as 40 μg/L (well AL09_R1) and 64 μg/L (well EM03). The flowpaths suggest that the Alluvial Aquifer monitoring wells with perchlorate detections contain groundwater that will eventually migrate to SCWC-Saugus1, and thereby be contained by the near-continuous pumping activity that is planned for SCWC-Saugus1. This conclusion is supported by recent groundwater elevation data from the Alluvial Aquifer that show higher groundwater elevations exist at the AL09 series wells than at the AL04 series wells (see Figure 2-31). These data indicate that under the nonpumping conditions that have existed in the Saugus Formation in this area since 1997, the groundwater flow direction in the Alluvial Aquifer in this area is from north and northeast to south and southwest. This observation is consistent with water budget analyses that indicate significantly greater flow rates of surface water and Alluvial Aquifer groundwater occur along the Santa Clara River than along the South

Fork Santa Clara River. Because the Saugus Formation is recharged by the Alluvial Aquifer in this area, this hydraulic connection between the two aquifers means that implementation of Saugus Formation pumping could gradually increase the rate of downward leakage from the Alluvial Aquifer over a long period of time. This, in turn, could potentially help reduce the migration of Alluvial Aquifer groundwater farther west from the area around monitoring wells AL04 and AL06. This is evaluated in further detail in the sensitivity analysis, which is discussed below.

2.3.4 Sensitivity Analysis

As discussed in Section 2.2.9, sensitivity analyses were performed to further evaluate the likelihood that implementation of the Purveyors' pumping plan for the impacted Saugus Formation production wells will meet the containment objectives, particularly the objective of preventing movement of perchlorate to nonimpacted Saugus Formation wells located farther downgradient (to the west of the impacted wells). A model run was performed to evaluate each of the following questions:

1. **Can the containment objectives be met by using lower pumping rates at SCWC-Saugus1 and SCWC-Saugus2, rather than the rate of 1,200 gpm that has been selected for each well based, in part, on the water supply needs of the valley?** The purpose of this simulation was to evaluate whether the pumping plan for SCWC-Saugus1 and SCWC-Saugus2 does either of the following:

    a. Involves more pumping than is necessary for containment reasons alone

    b. Provides a high degree of certainty that groundwater migrating westward from the western boundary of the Whittaker-Bermite property will be prevented from moving farther west to wells that are not currently impacted by perchlorate

2. **How would the model predictions change if the degree of connection between the Alluvial Aquifer and the Saugus Formation is less than the degree of connection that is simulated by the calibrated model?** The purpose of this simulation was to evaluate whether uncertainty in the degree of hydraulic connection would notably affect the Regional Model's prediction that Alluvial Aquifer groundwater north of this well will migrate to this well, rather than migrating westward in the Alluvial Aquifer. This was evaluated by reducing the hydraulic connection by a factor of 4, which corresponds to decreasing the vertical hydraulic conductivity (Kv) of the Alluvial Aquifer and/or the uppermost beds of the Saugus Formation.

The sensitivity analyses showed the following:

1. Containment of Saugus groundwater migrating westward from the Whittaker-Bermite property will not be completely achieved if the two wells are operated at 800 gpm each or lower. Figure 2-32 compares groundwater flowpaths initiated at the western boundary of the Whittaker-Bermite property for the base model run and the sensitivity run that models a pumping rate of 700 gpm at each of these two wells. The figure shows that for the lower pumping rate, the southern end of the western property boundary will not lie within the capture zone of SCWC-Saugus1 and SCWC-Saugus2. At monitoring wells MP-2 and MP-4, which are both located on the Whittaker-Bermite property, Saugus groundwater migrates northwest and lies within the capture zones of

SCWC-Saugus1 and SCWC-Saugus2 for both sets of pumping rates (1,200 gpm per well and 700 gpm per well).

2. Although Figure 2-32 shows that pumping rates of 800 gpm per well or higher will capture most of the Saugus groundwater moving west from the Whittaker-Bermite property, pumping rates below 1,200 gpm will not completely capture perchlorate and groundwater that are present in the Saugus Formation at wells MP-5 and VWC-157. This is illustrated on Figure 2-32 by the blue flowpaths, which were generated using a pumping rate of 1,000 gpm per well at SCWC-Saugus1 and SCWC-Saugus2. At MP-5, groundwater above a depth of 1,000 feet migrates to SCWC-Saugus1 and to nonimpacted well VWC-205, while groundwater at and below 1,000 feet migrates to nonimpacted well VWC-160. At VWC-157, groundwater within the well's open interval migrates to SWC-Saugus1 and nonimpacted well VWC-205. Consequently, because these lower pumping rates are unable to fully contain perchlorate that is present at MP-5 and VWC-157, the containment plan will consist of pumping SCWC-Saugus1 and SCWC-Saugus2 at 1,200 gpm each.

3. The continuous pumping of wells SCWC-Saugus1 and SCWC-Saugus2 will likely capture much of the Alluvial Aquifer groundwater north of these wells that has historically contained perchlorate detections (see Figure 2-33, which compares the 20-year capture zones for the base model run and the sensitivity run). Modeling analyses indicate that if the vertical anisotropy[14] is as high as 200:1 in the upper beds of the Saugus Formation, it is still possible to contain Alluvial Aquifer groundwater from this area.

2.4 Conclusions

Analyses using a locally scaled version of the Regional Model of Santa Clarita Valley's groundwater resources indicate that the Purveyors' pumping plan for the impacted Saugus Formation production wells will meet the following objectives that have been defined by the Purveyors:

1. Hydraulically contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property toward the impacted wells.

2. Hydraulically contain perchlorate that is present at wells MP-5 and VWC-157, which are located downgradient of the impacted wells.

3. Protect downgradient production wells that are currently not impacted.

4. Restore the annual volumes of water that were pumped from the impacted wells before they were shut down because of perchlorate detections.

5. Operate the impacted wells in a manner that is consistent with the Purveyors' operational plan for the Santa Clarita Valley's groundwater resources.

[14]The vertical anisotropy of a geologic unit is the ratio of its horizontal hydraulic conductivity (Kh) to its vertical hydraulic conductivity (Kv). In the Saugus Formation, the vertical anisotropy of 50:1 in the Regional Model was revised upward to 200:1 for this sensitivity analysis.

6. If possible, pump one or more of the impacted Saugus Formation production wells in a manner that also contains perchlorate migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property.

The major conclusions from the modeling analysis are as follows:

1. Operating production wells SCWC-Saugus1 and SCWC-Saugus2 at rates of 1,200 gpm each on a nearly continual basis will effectively contain perchlorate migrating westward in the Saugus Formation from the Whittaker-Bermite property and will also contain perchlorate that is present at Saugus wells MP-5 and VWC-157. This is shown by Figure 2-24, which displays groundwater flowpaths from MP-5, VWC-157, and the Whittaker-Bermite property; and by Figure 2-25, which displays the areas within the Saugus Formation where water is obtained by each of the impacted production wells and each of the nonimpacted production wells that are located downgradient of SCWC-Saugus1 and SCWC-Saugus2.

2. Operating production wells SCWC-Saugus1 and SCWC-Saugus2 at rates as low as 700 to 800 gpm each will not fully contain groundwater that is migrating westward from the Whittaker-Bermite property. Additionally, if these wells are operated at 1,000 gpm each, perchlorate that is present in the Saugus Formation at wells MP-5 and VWC-157 will not be captured and will instead migrate to existing nonimpacted wells VWC-160 and VWC-205. (See Figure 2-32.)

3. No new production wells are needed in the Saugus Formation to meet the perchlorate containment objective.

4. Impacted well NCWD-11 is not a required component of the containment program.

5. Use of other water supplies in lieu of pumping at SCWC-Saugus1 and SCWC-Saugus2 will likely be detrimental to the long-term quality of groundwater in the Saugus Formation. Pumping at these two wells is necessary to prevent migration of perchlorate to other portions of the Saugus Formation.

6. The pumping plan for SCWC-Saugus1 and SCWC-Saugus2 might contain perchlorate that is migrating in the Alluvial Aquifer from the northern portion of the Whittaker-Bermite property, including perchlorate that has been detected in the Alluvial Aquifer at and south of Bouquet Junction.

7. Planned operation of the impacted production wells will not cause detrimental short-term or long-term effects to the groundwater and surface water resources of the Santa Clarita Valley. In particular, the modeling analysis indicates that short- and long-term variability in local rainfall and streamflows is the predominant cause of fluctuating groundwater elevations, river flows, and groundwater storage volumes. Compared to local hydrology, implementation of the operational pumping plan for the valley, including the planned use of wells SCWC-Saugus1 and SCWC-Saugus2, has much less influence on the water resources of the valley.

It is important to note that the model simulations described in this report distribute pumping in a manner that is based on current and projected uses of both the Alluvial Aquifer and the Saugus Formation. The conclusions presented in this report regarding containment of perchlorate-containing groundwater will potentially be different if the

pumping plan for other Saugus Formation wells is significantly different than what was simulated. In particular, a significant change in the Saugus Formation pumping regime in the South Fork Santa Clara River area or near its mouth could potentially cause groundwater flow patterns and capture zones to be notably different from those described in this report. Changes that could appreciably alter groundwater flow patterns and capture zones could include the operation of new wells in that area, or notably greater instantaneous pumping rates or annual pumping volumes than those simulated by the Regional Model. Consequently, before a new well is sited in that area or a significant increase in pumping occurs from an existing wellfield in that area, it is recommended that an analysis first be conducted of the potential effects of the contemplated change on the perchlorate containment program.

Tables

TABLE 2-1
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges into the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam, Lang gage)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow occurs into the Santa Clarita Valley beneath Castaic Creek through water seepage beneath Castaic Dam.

TABLE 2-2
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1950	Below Normal	6.84
1951	Above Normal	12.42
1952	Wet	34.19
1953	Wet	4.88
1954	Above Normal	15.82
1955	Dry	13.91
1956	Wet	14.21
1957	Above Normal	22.85
1958	Wet	23.14
1959	Below Normal	9.81
1960	Dry	11.64
1961	Dry	8.82
1962	Below Normal	21.22
1963	Wet	12.79
1964	Dry	10.09
1965	Wet	32.28
1966	Below Normal	14.57
1967	Wet	23.23
1968	Below Normal	6.90
1969	Wet	32.42
1970	Wet	23.19
1971	Wet	13.75
1972	Below Normal	4.15
1973	Above Normal	19.79
1974	Wet	18.04
1975	Wet	10.92
1976	Critical	14.02
1977	Critical	20.87
1978	Above Normal	42.17
1979	Below Normal	21.47
1980	Above Normal	27.00
1981	Dry	13.42
1982	Wet	20.20
1983	Wet	39.07
1984	Wet	12.86

TABLE 2-2
Historical Hydrology in Northern California and the Santa Clarita Valley, 1950 through 2003
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Rainfall[b]
1985	Dry	8.37
1986	Wet	18.02
1987	Dry	14.45
1988	Critical	16.92
1989	Dry	7.56
1990	Critical	6.98
1991	Critical	17.21
1992	Critical	32.03
1993	Above Normal	32.72
1994	Critical	10.27
1995	Wet	29.15
1996	Wet	15.88
1997	Wet	13.35
1998	Wet	30.73
1999	Wet	8.96
2000	Above Normal	14.04
2001	Dry	22.24
2002	Dry	7.90
2003	Above Normal	15.70

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest.

[b]Records are for the Newhall-Soledad rain gage (Station No. FC32CE), in inches. As shown on Figure 2-3, the median and average rainfall at this gage from 1950 through 2002 were 14.57 in/yr and 17.84 in/yr, respectively.

TABLE 2-3
Annual Pumping Rates Specified by the Operational Plan for the Santa Clarita Valley's Groundwater Resources
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Aquifer	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
Operational Plan Pumping				
Alluvium	30,000 to 40,000	30,000 to 35,000	30,000 to 35,000	30,000 to 35,000
Saugus	7,500 to 15,000	7,500 to 25,000	21,000 to 25,000	21,000 to 35,000
Total	**37,500 to 55,000**	**37,500 to 60,000**	**51,000 to 60,000**	**51,000 to 70,000**
Modeled Pumping				
Alluvium	38,429	33,767	33,767	33,767
Saugus	10,679	15,760	24,346	34,096
Total	**49,108**	**49,527**	**58,113**	**67,863**

Notes:

All pumping volumes are listed in acre-feet.

The operational plan is defined in the documents titled *Urban Water Management Plan 2000* (Black & Veatch, 2000) and *Santa Clarita Valley Water Report 2003* (Luhdorff & Scalmanini Consulting Engineers, 2004).

In the model simulations, total pumping is different than listed in this table when dry-year pumping conditions in one aquifer coincide with normal-year pumping conditions in the other aquifer (due to differences in the timing of dry conditions locally versus reduced deliveries of water imports from the State Water Project).

TABLE 2-4

CALSIM II Calculated State Water Project Municipal and Industrial Allocations

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	OCAP Current EWA[a]	OCAP Future EWA[a]	2020 SWP Reliability[b]
1950	0.88	0.91	0.79
1951	1.00	1.00	0.96
1952	1.00	1.00	1.00
1953	1.00	1.00	0.95
1954	1.00	1.00	0.96
1955	0.44	0.45	0.43
1956	1.00	1.00	1.00
1957	0.94	0.91	0.75
1958	1.00	1.00	1.00
1959	0.84	0.88	0.83
1960	0.51	0.55	0.56
1961	0.68	0.72	0.76
1962	0.93	0.98	0.87
1963	1.00	1.00	1.00
1964	0.84	0.74	0.73
1965	0.87	0.81	0.77
1966	1.00	1.00	0.92
1967	1.00	1.00	1.00
1968	0.89	0.90	0.85
1969	1.00	1.00	1.00
1970	1.00	1.00	0.95
1971	1.00	1.00	1.00
1972	0.76	0.75	0.65
1973	1.00	1.00	0.91
1974	1.00	1.00	1.00
1975	1.00	1.00	1.00
1976	0.78	0.75	0.65
1977	0.03	0.04	0.20
1978	1.00	1.00	1.00
1979	1.00	0.94	0.89
1980	1.00	0.91	0.85
1981	0.90	0.92	0.84
1982	1.00	1.00	1.00
1983	1.00	1.00	1.00
1984	0.66	1.00	0.99
1985	0.97	0.91	0.83
1986	0.74	0.70	0.78
1987	0.70	0.77	0.71
1988	0.12	0.17	0.23
1989	0.96	0.95	0.83
1990	0.24	0.27	0.28
1991	0.24	0.29	0.25
1992	0.39	0.43	0.29
1993	1.00	1.00	1.00

[a]Source: USBR, 2004

[b]Source: DWR, 2002

Notes:

EWA = Environmental Water Account
OCAP = Operating Criteria and Plan

TABLE 2-5
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
1	Above Normal	90	Normal (7,500-15,000)
2	Dry	90	Normal (7,500-15,000)
3	Wet	100	Normal (7,500-15,000)
4	Wet	100	Normal (7,500-15,000)
5	Wet	100	Normal (7,500-15,000)
6	Dry	95	Normal (7,500-15,000)
7	Wet	70	Normal (7,500-15,000)
8	Dry	75	Normal (7,500-15,000)
9	Critical	15	Dry Year 1 (15,000)
10	Dry	95	Normal (7,500-15,000)
11	Critical	25	Dry Year 1 (15,000)
12	Critical	30	Dry Year 2 (25,000)
13	Critical	45	Dry Year 3 (35,000)
14	Above Normal	100	Normal (7,500-15,000)
15	Critical	50	Dry Year 1 (15,000)
16	Wet	80	Normal (7,500-15,000)
17	Wet	100	Normal (7,500-15,000)
18	Wet	100	Normal (7,500-15,000)
19	Wet	100	Normal (7,500-15,000)
20	Wet	100	Normal (7,500-15,000)
21	Above Normal	90	Normal (7,500-15,000)
22	Dry	39	Dry Year 1 (15,000)
23	Dry	70	Normal (7,500-15,000)
24	Above Normal	90	Normal (7,500-15,000)
25	Below Normal	90	Normal (7,500-15,000)
26	Above Normal	100	Normal (7,500-15,000)
27	Wet	100	Normal (7,500-15,000)
28	Wet	100	Normal (7,500-15,000)
29	Above Normal	100	Normal (7,500-15,000)
30	Dry	45	Dry Year 1 (15,000)
31	Wet	100	Normal (7,500-15,000)
32	Above Normal	90	Normal (7,500-15,000)
33	Wet	100	Normal (7,500-15,000)
34	Below Normal	85	Normal (7,500-15,000)
35	Dry	55	Dry Year 1 (15,000)
36	Dry	70	Dry Year 2 (25,000)
37	Below Normal	95	Normal (7,500-15,000)
38	Wet	100	Normal (7,500-15,000)
39	Dry	75	Dry Year 1 (15,000)
40	Wet	80	Normal (7,500-15,000)
41	Below Normal	100	Normal (7,500-15,000)
42	Wet	100	Normal (7,500-15,000)
43	Below Normal	90	Normal (7,500-15,000)

TABLE 2-5
State Water Project Allocations and Corresponding Saugus Formation Pumping for the 78-year Simulation
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	SWP Hydrology[a]	SWP Allocations[b] (%)	Simulated Saugus Pumping Conditions (AF/yr)
44	Wet	100	Normal (7,500-15,000)
45	Wet	100	Normal (7,500-15,000)
46	Wet	100	Normal (7,500-15,000)
47	Below Normal	75	Normal (7,500-15,000)
48	Above Normal	100	Normal (7,500-15,000)
49	Wet	100	Normal (7,500-15,000)
50	Wet	100	Normal (7,500-15,000)
51	Critical	75	Dry Year 1 (15,000)
52	Critical	4	Dry Year 2 (25,000)
53	Above Normal	100	Normal (7,500-15,000)
54	Below Normal	95	Normal (7,500-15,000)
55	Above Normal	90	Normal (7,500-15,000)
56	Dry	90	Normal (7,500-15,000)
57	Wet	100	Normal (7,500-15,000)
58	Wet	100	Normal (7,500-15,000)
59	Wet	100	Normal (7,500-15,000)
60	Dry	95	Normal (7,500-15,000)
61	Wet	70	Normal (7,500-15,000)
62	Dry	75	Normal (7,500-15,000)
63	Critical	15	Dry Year 1 (15,000)
64	Dry	95	Normal (7,500-15,000)
65	Critical	25	Dry Year 1 (15,000)
66	Critical	30	Dry Year 2 (25,000)
67	Critical	45	Dry Year 3 (35,000)
68	Above Normal	100	Normal (7,500-15,000)
69	Critical	50	Dry Year 1 (15,000)
70	Wet	80	Normal (7,500-15,000)
71	Wet	100	Normal (7,500-15,000)
72	Wet	100	Normal (7,500-15,000)
73	Wet	100	Normal (7,500-15,000)
74	Wet	100	Normal (7,500-15,000)
75	Above Normal	90	Normal (7,500-15,000)
76	Dry	39	Dry Year 1 (15,000)
77	Dry	70	Normal (7,500-15,000)
78	Above Normal	90	Normal (7,500-15,000)

[a]Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest. SWP = State Water Project.

[b]Defined from simulations performed by CLWA (Kennedy/Jenks Consultants, 2003) and USBR (2004) using the CALSIM II model. This condition is for the year 2020 level of development. In any given year, the allocation may be made up, in part, of carryover water from the prior year.

TABLE 2-6
Simulated Annual Groundwater Pumping from the Saugus Formation
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Owner	Well Name	Normal Years	Dry Year 1	Dry Year 2	Dry Year 3
NCWD	11	811	811	811	811
	12	1,315	2,044	2,044	2,044
	13	1,315	2,044	2,044	2,044
Total Pumping (NCWD)		**3,441**	**4,899**	**4,899**	**4,899**
NLF	156	369	369	369	369
Total Pumping (NLF)		**369**	**369**	**369**	**369**
SCWC	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
Total Pumping (SCWC)		**3,544**	**3,544**	**3,544**	**3,544**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Val. Ctry Club)	500	500	500	500
	201	100	100	3,577	3,577
	205	1,000	2,734	3,827	3,827
	206	1,175	2,734	3,500	3,500
Total Pumping (VWC)		**3,325**	**6,948**	**12,284**	**12,284**
To Be Determined	Future #1	0	0	3,250	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
	Future #4	0	0	0	3,250
Total Pumping (Future)		**0**	**0**	**3,250**	**13,000**
Total Saugus Formation Pumping		**10,679**	**15,760**	**24,346**	**34,096**

Notes:

All pumping volumes are listed in acre-feet.

Wells VWC-157 and NCWD-7, 8, 9, and 10 are assumed to no longer operate in the future.

NCWD = Newhall County Water District
NLF = Newhall Land and Farming Company
SCWC = Santa Clarita Water Company
VWC = Valencia Water Company
Val. Ctry Club = Valencia Country Club

TABLE 2-7

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-11	2	200	1,075	300	10	3,000	72.3
	3			500	2	1,000	24.1
	4			75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
	3			500	2	1,000	58.5
	4			280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
	3			250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
	3			500	6.5	3,250	39.4
	4			500	4	2,000	24.2
	5			300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
	3			500	6.5	3,250	59.9
	4			500	4	2,000	36.8
	5			20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.7
	3			500	6.5	3,250	56.9
	4			500	4	2,000	35.0
	5			91	4	364	6.4
VWC-159	3	662	1,900	338	0.025	8.45	27.3
	4			500	0.025	12.5	40.4
	5			400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.6
	4			500	4	2,000	46.2
	5			500	4	2,000	46.2
VWC-201	3	540	1,670	460	6.5	2,990	52.7
	4			500	4	2,000	35.3
	5			170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
	4			500	4	2,000	40.9
	5			430	4	1,720	35.2
VWC-206	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6

TABLE 2-7

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
Future Wells	3	820	1,930	180	6.5	1,170	23.9
Near VWC-206	4			500	4	2,000	40.9
(Assumed)	5			430	4	1,720	35.2

Notes:

Wells VWC-157 and NCWD-7, 8, 9, and 10 are assumed to no longer operate in the future.

Kh = horizontal hydraulic conductivity
T = transmissivity
ft/day = feet per day
ft^2/day = square feet per day

TABLE 2-8
Allocation of Pumping by Month for Agricultural and Urban Production Wells
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Month	Percent of Annual Water Use, Agricultural	Percent of Annual Water Use, Urban	Percent of May through October Water Use, Urban
January	3.75	5.2	
February	5.10	3.7	
March	6.60	5.2	
April	9.10	6.6	
May	10.55	8.7	13.2
June	11.40	10.4	15.8
July	14.10	13.0	19.7
August	12.95	13.6	20.6
September	10.20	10.9	16.6
October	7.50	9.3	14.1
November	5.00	7.1	
December	3.75	6.3	
Total	**100.0**	**100.0**	**100.0**

TABLE 2-9

Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Model Year	Based on Historical Year	Local Rainfall[a]	Alluvial Aquifer Pumping under the Operational Pumping Plan (AF/yr)[b,c]
1	1980	27.00	35,000-40,000
2	1981	13.42	35,000-40,000
3	1982	20.20	35,000-40,000
4	1983	39.07	35,000-40,000
5	1984	12.86	35,000-40,000
6	1985	8.37	30,000-35,000
7	1986	18.02	35,000-40,000
8	1987	14.45	35,000-40,000
9	1988	16.92	35,000-40,000
10	1989	7.56	30,000-35,000
11	1990	6.98	30,000-35,000
12	1991	17.21	30,000-35,000
13	1992	32.03	35,000-40,000
14	1993	32.72	35,000-40,000
15	1994	10.27	30,000-35,000
16	1995	29.15	35,000-40,000
17	1996	15.88	35,000-40,000
18	1997	13.35	35,000-40,000
19	1998	30.73	35,000-40,000
20	1999	8.96	30,000-35,000
21	2000	14.04	35,000-40,000
22	2001	22.24	35,000-40,000
23	2002	7.90	30,000-35,000
24	2003	15.70	35,000-40,000
25	1950	6.84	30,000-35,000
26	1951	12.42	35,000-40,000
27	1952	34.19	35,000-40,000
28	1953	4.88	30,000-35,000
29	1954	15.82	35,000-40,000
30	1955	13.91	35,000-40,000
31	1956	14.21	35,000-40,000
32	1957	22.85	35,000-40,000
33	1958	23.14	35,000-40,000
34	1959	9.81	30,000-35,000
35	1960	11.64	30,000-35,000
36	1961	8.82	30,000-35,000
37	1962	21.22	30,000-35,000
38	1963	12.79	35,000-40,000
39	1964	10.09	30,000-35,000
40	1965	32.28	35,000-40,000
41	1966	14.57	35,000-40,000
42	1967	23.23	35,000-40,000
43	1968	6.90	30,000-35,000

TABLE 2-9
Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 78-year Simulation
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Model Year	Based on Historical Year	Local Rainfall[a]	Alluvial Aquifer Pumping under the Operational Pumping Plan (AF/yr)[b,c]
44	1969	32.42	35,000-40,000
45	1970	23.19	35,000-40,000
46	1971	13.75	35,000-40,000
47	1972	4.15	30,000-35,000
48	1973	19.79	35,000-40,000
49	1974	18.04	35,000-40,000
50	1975	10.92	30,000-35,000
51	1976	14.02	35,000-40,000
52	1977	20.87	35,000-40,000
53	1978	42.17	35,000-40,000
54	1979	21.47	35,000-40,000
55	1980	27.00	35,000-40,000
56	1981	13.42	35,000-40,000
57	1982	20.20	35,000-40,000
58	1983	39.07	35,000-40,000
59	1984	12.86	35,000-40,000
60	1985	8.37	30,000-35,000
61	1986	18.02	35,000-40,000
62	1987	14.45	35,000-40,000
63	1988	16.92	35,000-40,000
64	1989	7.56	30,000-35,000
65	1990	6.98	30,000-35,000
66	1991	17.21	30,000-35,000
67	1992	32.03	35,000-40,000
68	1993	32.72	35,000-40,000
69	1994	10.27	30,000-35,000
70	1995	29.15	35,000-40,000
71	1996	15.88	35,000-40,000
72	1997	13.35	35,000-40,000
73	1998	30.73	35,000-40,000
74	1999	8.96	30,000-35,000
75	2000	14.04	35,000-40,000
76	2001	22.24	35,000-40,000
77	2002	7.90	30,000-35,000
78	2003	15.70	35,000-40,000

[a]From records at Newhall-Soledad rain gage (Station No. FC32CE).

[b]Alluvial pumping rates listed in this column are the rates that will occur under the operational plan for the Valley if the 1950 through 2003 local hydrology repeats itself in the future.

[c]Alluvial pumping is set at the dry-year rate in years 12, 37, and 66 because each of these years is the first nondrought year that occurs after a multi-year drought ends.

TABLE 2-10

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location**	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
NCWD-Castaic 1	Castaic Valley	345	385	561	385	345
NCWD-Castaic 2	Castaic Valley	166	0	123	166	125
NCWD-Castaic 3	Castaic Valley	0	0	0	0	0
NCWD-Castaic 4	Castaic Valley	100	47	56	100	45
NCWD-Pinetree 1	Mint Canyon	164	0	0	164	0
NCWD-Pinetree 2	Mint Canyon	0	0	0	0	0
NCWD-Pinetree 3	Mint Canyon	566	544	525	545	525
NCWD-Pinetree 4	Mint Canyon	300	5	0	300	0
NCWD Total		**1,641**	**981**	**1,265**	**1,660**	**1,040**
NLF-161	Downstream of Valencia WRP	496	485	2,021	485	485
NLF-B10	Downstream of Valencia WRP	1,240	534	344	344	344
NLF-B11	Downstream of Valencia WRP	205	232	271	232	232
NLF-B5	Downstream of Valencia WRP	1,680	2,280	1,582	1,582	1,582
NLF-B6	Downstream of Valencia WRP	1,312	2,175	1,766	1,766	1,766
NLF-B7	Downstream of Valencia WRP	474	584	402	584	584
NLF-C	Downstream of Valencia WRP	1,319	1,720	1,373	1,373	1,373
NLF-C3	Downstream of Valencia WRP	93	192	186	192	192
NLF-C4	Downstream of Valencia WRP	1,028	809	764	809	809
NLF-C5	Downstream of Valencia WRP	680	850	622	850	850
NLF-C6	Downstream of Valencia WRP	231	241	108	241	241
NLF-C7	Downstream of Valencia WRP	741	866	443	866	866
NLF-C8	Downstream of Valencia WRP	286	593	408	594	594
NLF-C9	Downstream of Valencia WRP	7	1	0	0	0
NLF-E	Castaic Valley	1,691	16	28	16	16
NLF-E2	Castaic Valley	141	55	14	55	55
NLF-E4	Downstream of Valencia WRP	0	0	0	0	0
NLF-E5	Downstream of Valencia WRP	172	679	537	679	679
NLF-E9	Downstream of Valencia WRP	238	814	47	814	814
NLF-G45	Downstream of Valencia WRP	291	283	60	283	283
NLF-S3	Downstream of Valencia WRP	0			0	0
NLF-W4	San Francisquito Canyon	46	1	0	0	0
NLF-W5	San Francisquito Canyon	276	104	23	107	107
NLF-X3	Downstream of Valencia WRP	12	0	0	0	0
NLF Total		**12,659**	**13,514**	**10,999**	**11,872**	**11,872**
SCWD-Clark	Bouquet Canyon	696	782	712	782	700
SCWD-Guida	Bouquet Canyon	1,047	1,320	1,230	1,320	1,230
SCWD-Honby	Above Saugus WRP	721	696	874	696	870
SCWD-Lost Canyon 2	Mint Canyon	741	730	644	741	640
SCWD-Lost Canyon 2A	Mint Canyon	1,034	905	593	1,034	590
SCWD-Mitchell #5A	Mint Canyon	407	143	19	0	0
SCWD-Mitchell #5B	Mint Canyon	0	150	0	557	0
SCWD-N. Oaks Central	Mint Canyon	822	1,646	1,641	822	1,640
SCWD-N. Oaks East	Mint Canyon	1,234	448	485	1,234	485
SCWD-N. Oaks West	Mint Canyon	898	1,123	31	898	0
SCWD-Sand Canyon	Mint Canyon	930	705	195	930	195
SCWD-Sierra	Mint Canyon	846	87	0	846	0
SCWD-Stadium	Above Saugus WRP	565	778	0	800	800
SCWD Total		**9,941**	**9,513**	**6,424**	**10,660**	**7,150**

TABLE 2-10

Recent and Simulated Future Annual Groundwater Pumping Volumes from the Alluvial Aquifer

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

		Historical Pumping			UWMP Pumping	
Well Name	**Location**	**2001**	**2002**	**2003**	**Normal Years**	**Dry Years**
VWC-D	Castaic Valley	645	772	687	690	690
VWC-I	San Francisquito Canyon	0	0	0	0	0
VWC-K2	Downstream of Saugus WRP	669	955	364	0	0
VWC-L2	Downstream of Saugus WRP	349	490	71	0	0
VWC-N	Downstream of Saugus WRP	591	700	622	620	620
VWC-N3	Downstream of Saugus WRP	226	857	255	0	0
VWC-N4	Downstream of Saugus WRP	458	909	248	0	0
VWC-N7	Downstream of Saugus WRP				1,160	1,160
VWC-N8	Downstream of Saugus WRP				1,160	1,160
VWC-Q2	Downstream of Saugus WRP	923	1,167	1,451	985	985
VWC-S6	Downstream of Saugus WRP	1,490	1,320	2,134	865	865
VWC-S7	Downstream of Saugus WRP	564	419	1,095	865	865
VWC-S8	Downstream of Saugus WRP	327	190	409	865	865
VWC-T2	Above Saugus WRP	900	696	1,014	460	460
VWC-T4	Above Saugus WRP	690	831	799	460	460
VWC-U3	Above Saugus WRP	956	572	823	0	0
VWC-U4	Above Saugus WRP	942	796	934	935	935
VWC-U6	Above Saugus WRP	0	0	0	825	825
VWC-W10	San Francisquito Canyon	182	0		0	0
VWC-W11	San Francisquito Canyon	806	939	764	600	600
VWC-W6	San Francisquito Canyon	0	0	36	865	865
VWC-W9	San Francisquito Canyon				350	350
VWC Total		**10,718**	**11,613**	**11,706**	**11,705**	**11,705**
Robinson Ranch	Mint Canyon				932	400
WHR (All Wells)	Castaic Valley	1,604	1,602	2,273	1,600	1,600
Total Alluvial Aquifer Pumping		**36,563**	**37,223**	**32,667**	**38,429**	**33,767**

Notes:

All pumping volumes are listed in AF/yr.

Wells that are not listed are assumed to not be pumping in the future.

NCWD = Newhall County Water District
NLF = Newhall Land and Farming Company
SCWC = Santa Clarita Water Company
VWC = Valencia Water Company
WHR = Wayside Honor Rancho, owned by LACWWD

TABLE 2-11

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
2	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
3	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
4	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
5	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
6	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
7	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
8	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
9	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
10	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
11	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
12	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
13	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
14	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
15	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
16	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
17	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
18	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
19	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
20	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
21	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
22	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
23	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
24	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47
25	2.58	1.69	1.27	0.86	0.01	0.00	0.00	0.00	0.32	0.36	0.73	0.21	8.03
26	2.96	0.93	1.16	1.69	0.09	0.00	0.00	0.05	0.00	0.49	1.33	5.88	14.57
27	17.68	0.61	10.30	1.80	0.00	0.00	0.00	0.00	0.12	0.00	4.52	5.09	40.12
28	0.80	0.02	0.21	1.64	0.69	0.00	0.00	0.00	0.00	0.00	2.32	0.04	5.73
29	6.38	3.36	4.86	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.38	1.47	18.56
30	5.69	1.69	0.21	3.38	1.91	0.00	0.00	0.00	0.00	0.00	1.43	2.01	16.32
31	7.55	1.00	0.00	5.90	1.82	0.00	0.11	0.00	0.00	0.15	0.00	0.15	16.68
32	7.22	2.71	3.05	1.16	1.06	0.25	0.00	0.00	0.00	2.68	0.40	8.30	26.81
33	2.11	10.42	5.82	7.18	0.00	0.00	0.00	0.00	0.04	1.35	0.23	0.00	27.15
34	3.70	5.47	0.00	0.59	0.00	0.00	0.00	0.00	0.08	0.00	0.00	1.68	11.51
35	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
36	1.88	0.00	0.76	0.33	0.09	0.00	0.07	0.00	0.11	0.00	4.12	2.99	10.35
37	3.86	19.44	1.53	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.00	24.90
38	0.99	3.63	4.10	2.23	0.06	0.43	0.00	0.00	0.77	0.50	2.29	0.01	15.01
39	2.95	0.00	1.88	2.41	0.04	0.12	0.00	0.00	0.00	0.52	1.47	2.48	11.84
40	0.25	0.07	1.65	9.14	0.00	0.02	0.26	0.16	0.95	0.00	17.49	7.89	37.88
41	1.42	1.55	0.33	0.00	0.09	0.00	0.00	0.00	0.09	0.11	7.56	5.95	17.10

TABLE 2-11

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	6.76	0.22	3.23	5.41	0.19	0.00	0.00	0.00	0.50	0.00	9.36	1.58	27.26
43	0.86	0.93	2.91	0.97	0.07	0.00	0.00	0.38	0.00	0.39	0.35	1.24	8.10
44	19.53	13.89	0.82	1.16	0.05	0.05	0.18	0.00	0.00	0.00	2.32	0.05	38.04
45	0.94	6.63	4.33	0.00	0.00	0.00	0.00	0.00	0.00	0.13	8.86	6.33	27.21
46	1.23	1.41	0.48	0.94	0.15	0.00	0.00	0.00	0.47	0.50	0.38	10.57	16.14
47	0.00	0.12	0.00	0.02	0.05	0.05	0.00	0.06	0.00	0.05	3.45	1.08	4.87
48	5.19	11.74	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.83	1.03	23.22
49	10.58	0.02	4.30	0.06	0.00	0.00	0.02	0.00	0.00	1.17	0.12	4.89	21.17
50	0.28	3.02	6.04	2.96	0.00	0.00	0.00	0.00	0.00	0.39	0.04	0.09	12.81
51	0.00	7.39	1.47	0.46	0.15	0.35	0.01	0.00	3.40	0.22	2.09	0.90	16.45
52	5.75	0.12	2.15	0.00	5.27	0.00	0.00	2.68	0.02	0.05	0.06	8.40	24.49
53	10.74	13.23	17.10	2.72	0.00	0.00	0.00	0.00	1.23	0.01	2.70	1.76	49.49
54	12.44	3.20	6.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.89	1.19	23.75
55	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
56	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
57	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
58	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
59	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
60	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
61	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
62	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
63	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
64	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
65	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
66	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
67	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
68	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
69	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
70	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
71	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
72	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
73	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
74	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
75	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
76	5.96	9.79	3.70	1.88	0.00	0.00	0.00	0.00	0.00	0.36	3.33	1.08	26.10
77	1.08	1.10	0.26	0.05	0.05	0.00	0.00	0.00	0.01	0.00	2.48	4.25	9.27
78	0.00	9.88	2.73	2.42	0.05	0.00	0.00	0.00	0.09	0.10	0.63	2.57	18.47

TABLE 2-12

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
2	594	98	339	240	107	18	18	12	338	321	258	394	2,739
3	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
4	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
5	0	596	405	240	143	166	228	411	154	220	904	578	4,044
6	483	461	274	215	77	0	0	0	12	179	221	301	2,224
7	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
8	117	117	65	31	12	0	0	0	0	0	258	516	1,116
9	222	209	506	117	77	68	0	0	0	0	12	25	1,236
10	50	111	60	25	6	0	0	0	102	94	34	18	499
11	212	276	230	46	46	5	0	0	0	27	36	147	1,025
12	162	775	879	736	145	142	14	0	45	69	62	263	3,291
13	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
14	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
15	388	493	497	319	163	80	20	7	37	102	193	941	3,239
16	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
17	666	896	730	315	151	46	7	0	54	154	307	510	3,836
18	517	346	140	85	33	5	4	50	66	240	566	809	2,859
19	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
20	92	85	204	224	197	107	80	46	52	54	31	80	1,252
21	117	117	65	31	12	0	0	0	0	0	258	516	1,116
22	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
23	50	111	60	25	6	0	0	0	102	94	34	18	499
24	666	896	730	315	151	46	7	0	54	154	307	510	3,836
25	83	198	184	126	105	83	51	54	56	53	43	42	1,078
26	49	40	66	91	98	84	79	72	57	71	47	53	807
27	9,629	636	7,091	2,114	895	326	153	138	86	97	178	313	21,656
28	300	282	271	237	165	134	102	86	85	83	74	68	1,888
29	145	278	404	356	181	108	110	99	91	90	80	75	2,017
30	103	156	157	128	153	99	78	76	74	68	66	62	1,220
31	69	85	130	137	139	98	86	80	77	76	67	69	1,113
32	67	55	78	90	93	80	78	78	76	79	66	71	910
33	66	329	743	4,550	825	283	130	108	95	145	146	116	7,536
34	246	351	189	127	111	92	84	86	83	69	68	68	1,575
35	68	67	70	69	70	68	65	65	60	58	316	164	1,140
36	124	91	38	38	36	32	28	33	22	19	19	119	597
37	139	1,904	791	449	329	169	97	82	80	84	82	82	4,287
38	85	142	145	131	104	86	79	74	66	65	62	58	1,096
39	69	50	51	62	66	54	53	53	54	45	43	41	640
40	30	23	25	46	43	36	31	34	37	35	1,305	3,300	4,944
41	1,765	1,014	778	450	308	115	68	54	45	63	91	523	5,274

TABLE 2-12

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	757	489	1,028	2,295	1,880	729	212	104	89	73	255	487	8,397
43	300	247	276	180	72	32	32	30	25	133	208	851	2,384
44	13,797	2,856	1,005	489	320	147	98	98	46	318	392	399	19,966
45	461	550	1,168	465	290	169	74	60	58	27	501	1,338	5,161
46	614	524	556	397	262	167	70	25	5	30	200	420	3,270
47	332	250	131	90	50	22	32	6	0	0	11	58	983
48	153	1,717	950	471	226	71	18	12	8	3	8	44	3,679
49	608	229	392	190	129	49	17	6	0	3	19	87	1,728
50	53	90	228	181	104	31	15	3	0	0	0	0	704
51	0	110	63	39	33	12	0	0	1	0	0	0	258
52	28	7	28	19	60	5	0	0	0	0	0	0	147
53	744	9,486	11,412	1,696	2,736	1,154	418	209	101	264	422	86	28,730
54	1,254	433	1,113	506	246	190	178	111	125	90	120	558	4,925
55	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
56	594	98	339	240	107	18	18	12	338	321	258	394	2,739
57	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
58	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
59	0	596	405	240	143	166	228	411	154	220	904	578	4,044
60	483	461	274	215	77	0	0	0	12	179	221	301	2,224
61	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
62	117	117	65	31	12	0	0	0	0	0	258	516	1,116
63	222	209	506	117	77	68	0	0	0	0	12	25	1,236
64	50	111	60	25	6	0	0	0	102	94	34	18	499
65	212	276	230	46	46	5	0	0	0	27	36	147	1,025
66	162	775	879	736	145	142	14	0	45	69	62	263	3,291
67	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
68	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
69	388	493	497	319	163	80	20	7	37	102	193	941	3,239
70	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
71	666	896	730	315	151	46	7	0	54	154	307	510	3,836
72	517	346	140	85	33	5	4	50	66	240	566	809	2,859
73	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
74	92	85	204	224	197	107	80	46	52	54	31	80	1,252
75	117	117	65	31	12	0	0	0	0	0	258	516	1,116
76	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
77	50	111	60	25	6	0	0	0	102	94	34	18	499
78	666	896	730	315	151	46	7	0	54	154	307	510	3,836

TABLE 2-13

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
2	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
3	0	0	0	0	0	667	842	735	0	0	0	0	2,244
4	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
8	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
9	0	0	809	341	900	0	0	0	0	0	0	0	2,050
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	66	66
13	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
14	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
15	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
16	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
17	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
18	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
19	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
20	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
21	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
22	0	0	0	0	0	667	842	735	0	0	0	0	2,244
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
30	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
31	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
32	0	0	0	0	0	667	842	735	0	0	0	0	2,244
33	0	0	0	0	0	667	842	735	0	0	0	0	2,244
34	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
35	0	0	0	0	0	0	0	0	0	0	0	0	0
36	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
37	0	0	0	0	0	667	842	735	0	0	0	0	2,244
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
40	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
41	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853

TABLE 2-13

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
42	0	0	0	0	0	667	842	735	0	0	0	0	2,244
43	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
45	0	0	0	0	0	667	842	735	0	0	0	0	2,244
46	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
47	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	667	842	735	0	0	0	0	2,244
49	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
50	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
51	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
52	0	0	0	0	0	667	842	735	0	0	0	0	2,244
53	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
54	0	0	0	0	0	667	842	735	0	0	0	0	2,244
55	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
56	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
57	0	0	0	0	0	667	842	735	0	0	0	0	2,244
58	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
59	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0
61	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
62	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
63	0	0	809	341	900	0	0	0	0	0	0	0	2,050
64	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	66	66
67	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
68	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
69	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
70	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
71	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
72	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884
73	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
74	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830
75	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086
76	0	0	0	0	0	667	842	735	0	0	0	0	2,244
77	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632

TABLE 2-14
Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year 2000 Actual (AF/yr)	Full Build-out Conditions (AF/yr)	Comments
Annual Urban Water Use Outside Newhall Ranch		
60,988	123,038	Year 2000 value is retail purveyor demand plus other demands in Tables III-6 and IV-1 of the *Santa Clarita Valley Water Report 2000* (Luhdorff & Scalmanini Consulting Engineers, 2001). Year 2045 value is from Table 2.5-4 of the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2001). Consists of 89,805 AF/yr Development Monitoring System (DMS)[a] demand, plus 55,995 AF/yr additional urban demand, minus 14,480 AF/yr conservation, minus 5,193 AF/yr agricultural uses and 3,089 AF/yr "other" uses. Does not include 4,500 AF/yr for aquifer storage and recovery (ASR) or the 17,680 AF/yr demand for the Newhall Ranch Specific Plan.
Annual Indoor Water Use Outside Newhall Ranch (Equal to LACSD WRP Influent Volumes)		
18,723	40,313 (average year)	The year 2000 volume is from the Saugus and Valencia WRPs for the period January 2000 through December 2000. The long-term current generated effluent volume is based on the influent volume estimated from water balance calculations performed for the chloride mass balance analysis. The effluent volume is 32.8 percent of the total urban water production of 123,038 AF/yr, which includes other uses.

[a]DMS water demands are demands associated with future build-out of developments identified in Los Angeles County's DMS for the Santa Clarita Valley.

TABLE 2-15
Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Month	Treated Water Volume (2000)[a]	Treated Water Volume (Full Build-out Conditions)[b]	Percent of Annual Outdoor Demand	Reclaimed Volume under Full Build-out Conditions (Before Maintaining Existing Streamflows)	Reclaimed Volume under Full Build-out Conditions (After Maintaining Existing Streamflows)	WRP Discharges to River under Full Build-out Conditions[c]	Month
January	1,503	3,237	3.75	637	637	2,600	January
February	1,443	3,106	5.10	867	867	2,239	February
March	1,528	3,290	6.60	1,122	1,122	2,168	March
April	1,505	3,240	9.10	1,547	1,547	1,693	April
May	1,569	3,379	10.55	1,794	1,794	1,585	May
June	1,543	3,322	11.40	1,938	1,781	1,541	June
July	1,606	3,459	14.10	2,397	1,854	1,605	July
August	1,649	3,550	12.95	2,202	1,902	1,648	August
September	1,593	3,430	10.20	1,734	1,734	1,696	September
October	1,631	3,512	7.50	1,275	1,275	2,237	October
November	1,546	3,329	5.00	850	850	2,479	November
December	1,607	3,459	3.75	637	637	2,822	December
Total Annual	**18,723**	**40,313**	**100.0**	**17,000**	**16,000**	**24,313**	**Total Annual**

[a]Values shown are the actual volume of treated water discharged to the Santa Clara River from the Saugus and Valencia WRPs during calendar year 2000. (See also Table 2-14.)

[b]Values shown are the combined treated water volumes estimated to be produced by the Saugus and Valencia WRPs for full build-out conditions in the Santa Clarita Valley. These values do not include the future Newhall Ranch WRP, which will be operated by LACSD.

[c]Values shown do not include discharges of treated water to the river from the future Newhall Ranch WRP. These volumes are 10 AF in November, 138 AF in December, and 138 AF in January. During the other nine months of the year, this WRP will not discharge treated water to the river (see the *Newhall Ranch Draft Additional Analysis* [Impact Sciences, Inc., 2001] for further details). The combined total discharge from the Saugus, Valencia, and Newhall Ranch WRPs is summarized in Table 2-16 of this report.

Note:
All units are in acre-feet, unless otherwise indicated.

TABLE 2-16
Simulated Monthly Treated Wastewater Discharges from Santa Clarita Valley WRPs under Full Build-out Conditions
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

WRP	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Saugus	493	487	500	490	503	466	457	508	586	555	514	596	6,155
Valencia	2,107	1,752	1,668	1,203	1,082	1,075	1,148	1,140	1,110	1,682	1,965	2,226	18,158
Newhall	138	0	0	0	0	0	0	0	0	0	10	138	286
Total	**2,738**	**2,239**	**2,168**	**1,693**	**1,585**	**1,541**	**1,605**	**1,648**	**1,696**	**2,237**	**2,489**	**2,960**	**24,599**

Note:

Wastewater discharge volumes are listed in acre-feet.

TABLE 2-17

Simulated Annual Groundwater Budget

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year			Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
0	to	1	41,053	13,970	39,953	17,871	112,847	49,119	21,649	17,524	18,464	106,756	6,091	6,091
1	to	2	11,601	13,970	3,373	18,632	47,576	49,035	10,147	10,469	18,136	87,788	-40,212	-34,120
2	to	3	51,672	13,970	28,415	18,444	112,501	49,035	10,925	12,319	18,585	90,863	21,638	-12,483
3	to	4	181,820	13,970	89,448	16,985	302,223	49,035	36,265	29,506	19,056	133,861	168,361	155,879
4	to	5	687	13,970	527	18,253	33,437	49,119	16,665	23,150	18,225	107,158	-73,721	82,158
5	to	6	2	13,970	535	18,927	33,434	44,372	9,497	13,286	18,171	85,326	-51,891	30,266
6	to	7	42,574	13,970	19,998	18,619	95,161	49,035	11,479	14,376	18,568	93,458	1,703	31,969
7	to	8	11,415	13,970	2,484	19,419	47,288	49,035	7,923	10,419	18,277	85,654	-38,366	-6,397
8	to	9	27,363	13,970	10,507	19,743	71,583	54,214	6,664	10,234	18,507	89,618	-18,036	-24,433
9	to	10	0	13,970	523	20,113	34,606	44,372	4,739	8,041	18,359	75,510	-40,904	-65,336
10	to	11	0	13,970	1,472	20,347	35,789	49,446	2,584	5,612	18,354	75,996	-40,208	-105,544
11	to	12	50,580	13,970	28,173	19,613	112,336	58,025	3,061	8,476	18,563	88,125	24,211	-81,334
12	to	13	130,074	13,970	80,760	17,850	242,654	72,600	14,234	18,462	18,728	124,024	118,630	37,296
13	to	14	112,433	13,970	51,561	17,509	195,472	49,035	24,221	29,084	18,797	121,137	74,335	111,632
14	to	15	414	13,970	1,979	18,575	34,939	49,446	7,788	16,616	18,157	92,007	-57,068	54,563
15	to	16	113,543	13,970	60,100	17,636	205,250	49,035	29,255	26,983	18,745	124,018	81,232	135,795
16	to	17	45,609	13,970	21,594	18,204	99,376	49,119	15,122	21,342	18,635	104,218	-4,842	130,954
17	to	18	16,967	13,970	5,320	18,758	55,015	49,035	11,851	16,757	18,242	95,885	-40,870	90,084
18	to	19	137,727	13,970	59,717	17,397	228,810	49,035	27,143	31,249	18,923	126,350	102,460	192,544
19	to	20	13	13,970	4,717	18,586	37,286	49,035	14,305	20,865	18,200	102,405	-65,119	127,425
20	to	21	14,095	13,970	4,962	19,294	52,321	49,119	11,194	14,485	18,342	93,139	-40,818	86,607
21	to	22	58,364	13,970	35,154	18,639	126,127	54,116	12,710	19,337	18,655	104,818	21,309	107,917
22	to	23	0	13,970	523	19,557	34,050	44,372	8,105	13,129	18,311	83,916	-49,866	58,051
23	to	24	19,602	13,970	5,065	19,867	58,504	49,035	8,138	10,710	18,375	86,258	-27,754	30,297
24	to	25	0	13,970	524	20,258	34,752	44,441	5,486	7,896	18,418	76,240	-41,489	-11,192
25	to	26	3,053	13,970	518	20,406	37,947	49,035	4,033	6,132	18,386	77,587	-39,639	-50,832
26	to	27	135,033	13,970	73,747	18,014	240,763	49,035	16,024	17,254	18,639	100,951	139,812	88,980
27	to	28	0	13,970	536	18,764	33,270	44,372	9,238	15,229	18,125	86,963	-53,693	35,287
28	to	29	20,048	13,970	4,960	19,518	58,496	49,119	7,646	10,808	18,326	85,898	-27,402	7,885
29	to	30	9,397	13,970	2,999	19,929	46,296	54,116	4,726	8,252	18,339	85,433	-39,138	-31,253
30	to	31	11,022	13,970	2,348	20,308	47,647	49,035	4,024	7,140	18,409	78,609	-30,962	-62,215
31	to	32	62,138	13,970	37,429	19,568	133,105	49,035	6,854	11,497	18,820	86,205	46,900	-15,315
32	to	33	63,939	13,970	36,375	18,890	133,174	49,119	11,471	19,025	18,678	98,293	34,881	19,566
33	to	34	244	13,970	2,395	20,199	36,808	44,372	6,943	11,585	18,375	81,275	-44,466	-24,900
34	to	35	1,555	13,970	524	20,530	36,579	49,446	3,767	7,507	18,404	79,124	-42,545	-67,445
35	to	36	32	13,970	4,852	20,690	39,543	58,025	303	5,882	18,401	82,610	-43,067	-110,512
36	to	37	52,098	13,970	24,510	19,931	110,509	44,441	4,564	10,236	18,620	77,860	32,648	-77,864
37	to	38	4,170	13,970	616	20,483	39,239	49,035	2,503	6,237	18,378	76,152	-36,913	-114,777
38	to	39	362	13,970	2,463	20,816	37,610	49,446	719	4,966	18,418	73,549	-35,938	-150,716
39	to	40	122,459	13,970	74,037	19,276	229,741	49,035	8,546	10,468	18,766	86,814	142,927	-7,789
40	to	41	12,997	13,970	4,096	19,066	50,129	49,119	8,998	13,953	18,220	90,290	-40,161	-47,950
41	to	42	64,499	13,970	40,945	18,797	138,210	49,035	10,243	16,890	18,577	94,745	43,465	-4,484
42	to	43	0	13,970	536	19,752	34,258	44,372	6,577	12,461	18,301	81,711	-47,454	-51,938
43	to	44	123,377	13,970	53,751	18,022	209,121	49,035	17,543	21,442	18,640	106,660	102,461	50,523
44	to	45	64,250	13,970	39,379	18,423	136,022	49,119	13,271	20,449	18,544	101,383	34,639	85,163
45	to	46	8,541	13,970	2,217	19,103	43,830	49,035	10,232	18,196	18,249	95,712	-51,882	33,281
46	to	47	0	13,970	533	19,897	34,399	44,372	6,746	10,372	18,334	79,823	-45,424	-12,143

TABLE 2-17

Simulated Annual Groundwater Budget

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Subsurface Inflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
47 to 48	43,414	13,970	18,560	19,505	95,448	49,035	8,927	12,755	18,638	89,355	6,094	-6,050
48 to 49	32,966	13,970	13,527	19,953	80,416	49,119	8,497	12,634	18,666	88,916	-8,499	-14,549
49 to 50	839	13,970	1,856	20,451	37,117	44,372	5,528	8,992	18,434	77,326	-40,209	-54,758
50 to 51	9,990	13,970	2,645	20,684	47,289	54,116	3,517	6,845	18,455	82,933	-35,643	-90,401
51 to 52	49,961	13,970	25,027	20,153	109,112	62,702	3,319	9,913	18,755	94,689	14,423	-75,978
52 to 53	188,493	13,970	69,633	17,584	289,679	49,119	22,292	27,398	18,933	117,742	171,937	95,959
53 to 54	46,125	13,970	20,155	18,290	98,539	49,035	15,148	24,661	18,522	107,366	-8,827	87,132
54 to 55	89,718	13,970	39,953	17,979	161,620	49,035	20,589	29,655	18,624	117,903	43,716	130,848
55 to 56	11,601	13,970	3,373	19,267	48,211	49,035	11,347	18,242	18,316	96,940	-48,729	82,119
56 to 57	51,672	13,970	28,415	19,203	113,260	49,119	11,982	18,862	18,806	98,769	14,491	96,610
57 to 58	181,820	13,970	89,448	17,106	302,343	49,035	32,399	38,747	19,048	139,229	163,114	259,725
58 to 59	687	13,970	527	18,350	33,534	49,035	16,623	29,046	18,213	112,917	-79,383	180,342
59 to 60	2	13,970	535	19,266	33,773	44,372	10,576	17,223	18,266	90,437	-56,664	123,678
60 to 61	42,574	13,970	19,998	18,987	95,529	49,119	12,553	18,152	18,704	98,527	-2,998	120,680
61 to 62	11,415	13,970	2,484	19,754	47,622	49,035	9,005	13,268	18,366	89,674	-42,052	78,628
62 to 63	27,363	13,970	10,507	20,014	71,853	54,116	7,752	12,812	18,539	93,219	-21,366	57,262
63 to 64	0	13,970	523	20,416	34,909	44,372	5,755	10,119	18,437	78,683	-43,774	13,488
64 to 65	0	13,970	1,472	20,680	36,121	49,522	3,569	7,254	18,475	78,820	-42,698	-29,210
65 to 66	50,580	13,970	28,173	19,854	112,576	58,025	4,004	10,335	18,623	90,989	21,588	-7,622
66 to 67	130,074	13,970	80,760	17,898	242,702	72,452	13,502	21,223	18,686	125,863	116,839	109,216
67 to 68	112,433	13,970	51,561	17,536	195,499	49,035	23,462	32,532	18,803	123,833	71,667	180,883
68 to 69	414	13,970	1,979	18,661	35,024	49,522	8,596	18,842	18,226	95,186	-60,162	120,721
69 to 70	113,543	13,970	60,100	17,647	205,261	49,035	29,552	30,176	18,761	127,523	77,737	198,459
70 to 71	45,609	13,970	21,594	18,166	99,339	49,035	15,740	23,534	18,602	106,911	-7,572	190,886
71 to 72	16,967	13,970	5,320	18,777	55,034	49,035	12,551	18,552	18,264	98,402	-43,368	147,518
72 to 73	137,727	13,970	59,717	17,442	228,856	49,119	28,296	34,847	19,001	131,263	97,592	245,111
73 to 74	13	13,970	4,717	18,592	37,292	49,035	14,986	23,059	18,220	105,299	-68,007	177,103
74 to 75	14,095	13,970	4,962	19,254	52,281	49,035	11,783	15,930	18,311	95,059	-42,779	134,324
75 to 76	58,364	13,970	35,154	18,654	126,142	54,116	13,385	20,958	18,673	107,132	19,010	153,334
76 to 77	0	13,970	523	19,646	34,139	44,441	8,624	14,082	18,380	85,527	-51,388	101,946
77 to 78	19,602	13,970	5,065	19,899	58,536	49,035	8,607	11,515	18,393	87,550	-29,014	72,932
Minimum	0	13,970	518	16,985	33,270	44,372	303	4,966	18,125	73,549	-79,383	-150,716
Maximum	188,493	13,970	89,448	20,816	302,343	72,600	36,265	38,747	19,056	139,229	171,937	259,725
Average	42,498	13,970	21,480	19,092	97,040	49,823	11,520	16,262	18,498	96,105	935	44,866
Median	19,602	13,970	5,193	19,153	58,500	49,035	9,822	14,430	18,446	92,573	-28,384	36,292

Note:

All flow volumes are listed in AF/yr.

Figures

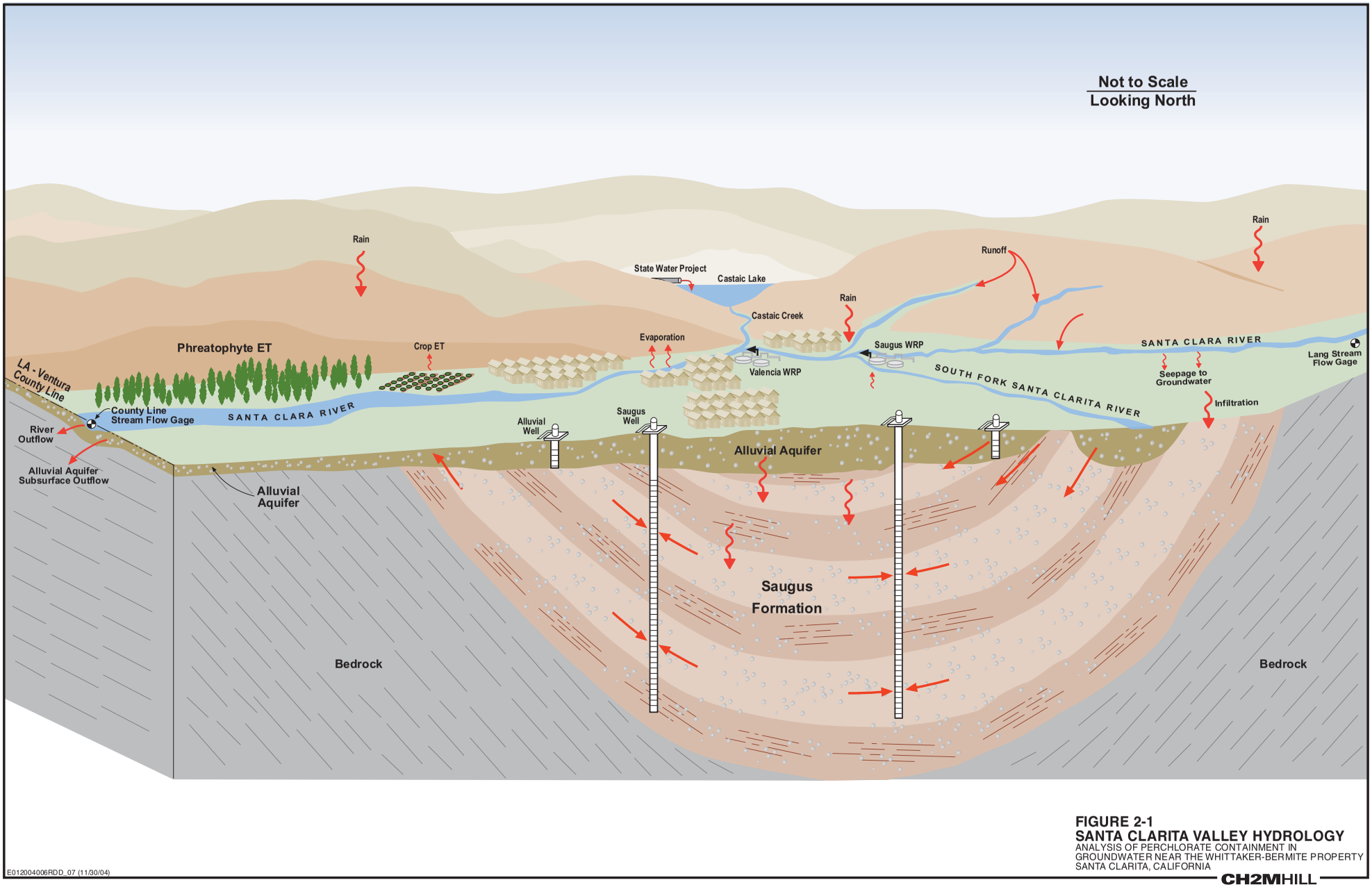

FIGURE 2-1
SANTA CLARITA VALLEY HYDROLOGY
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

E012004006RDD_07 (11/30/04)

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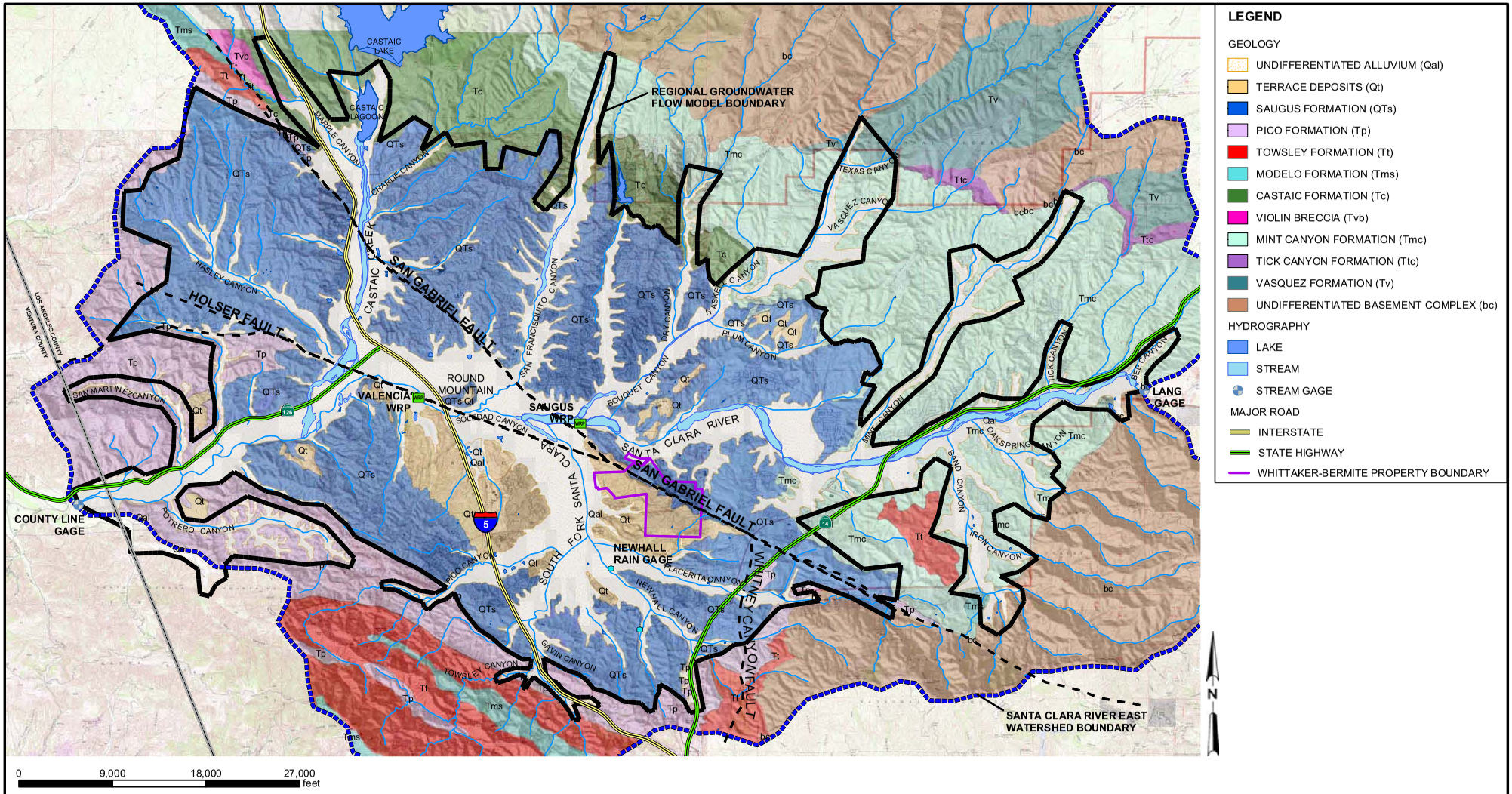

FIGURE 2-2
BASIN GEOLOGIC MAP
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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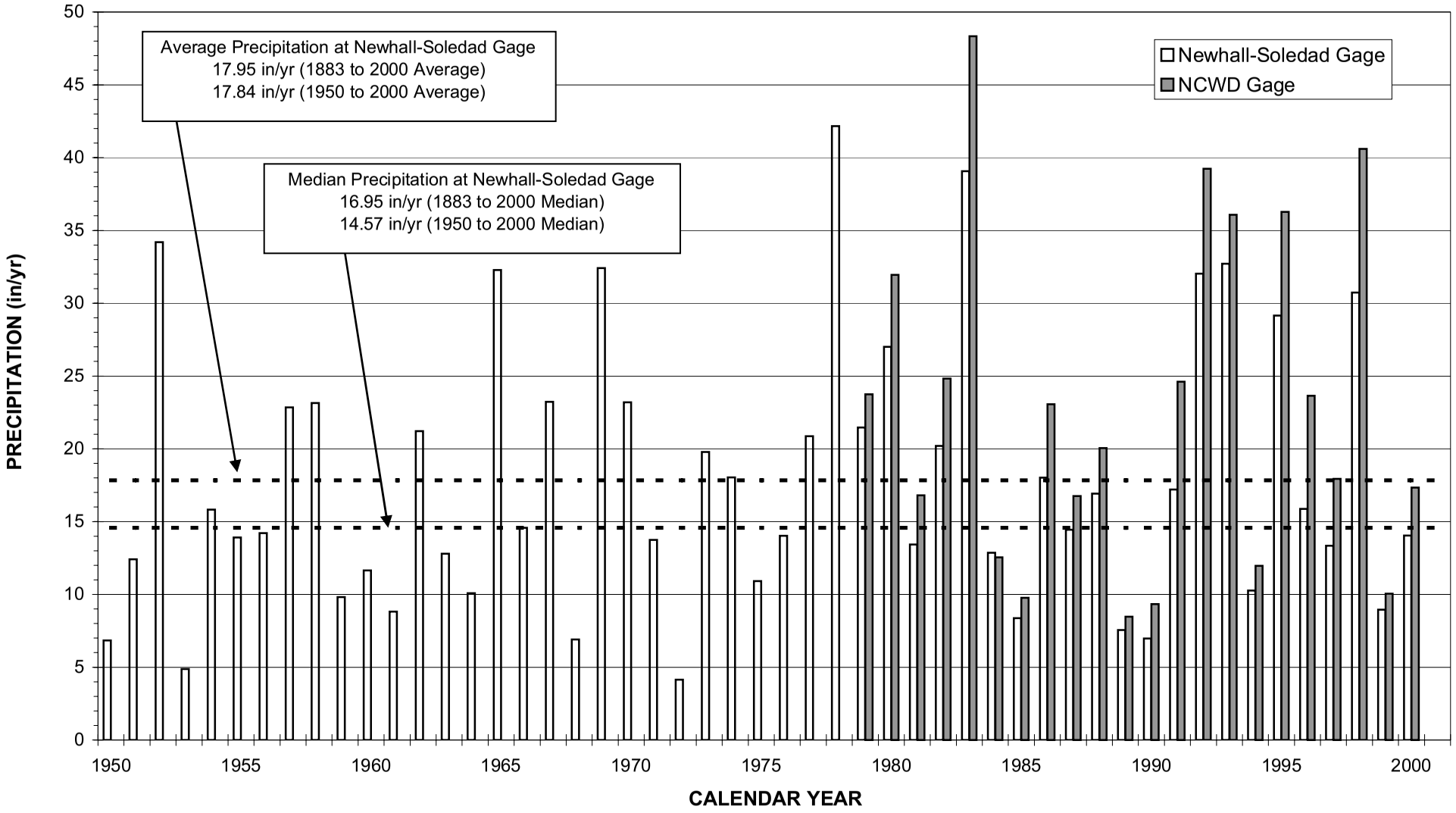

FIGURE 2-3
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950
ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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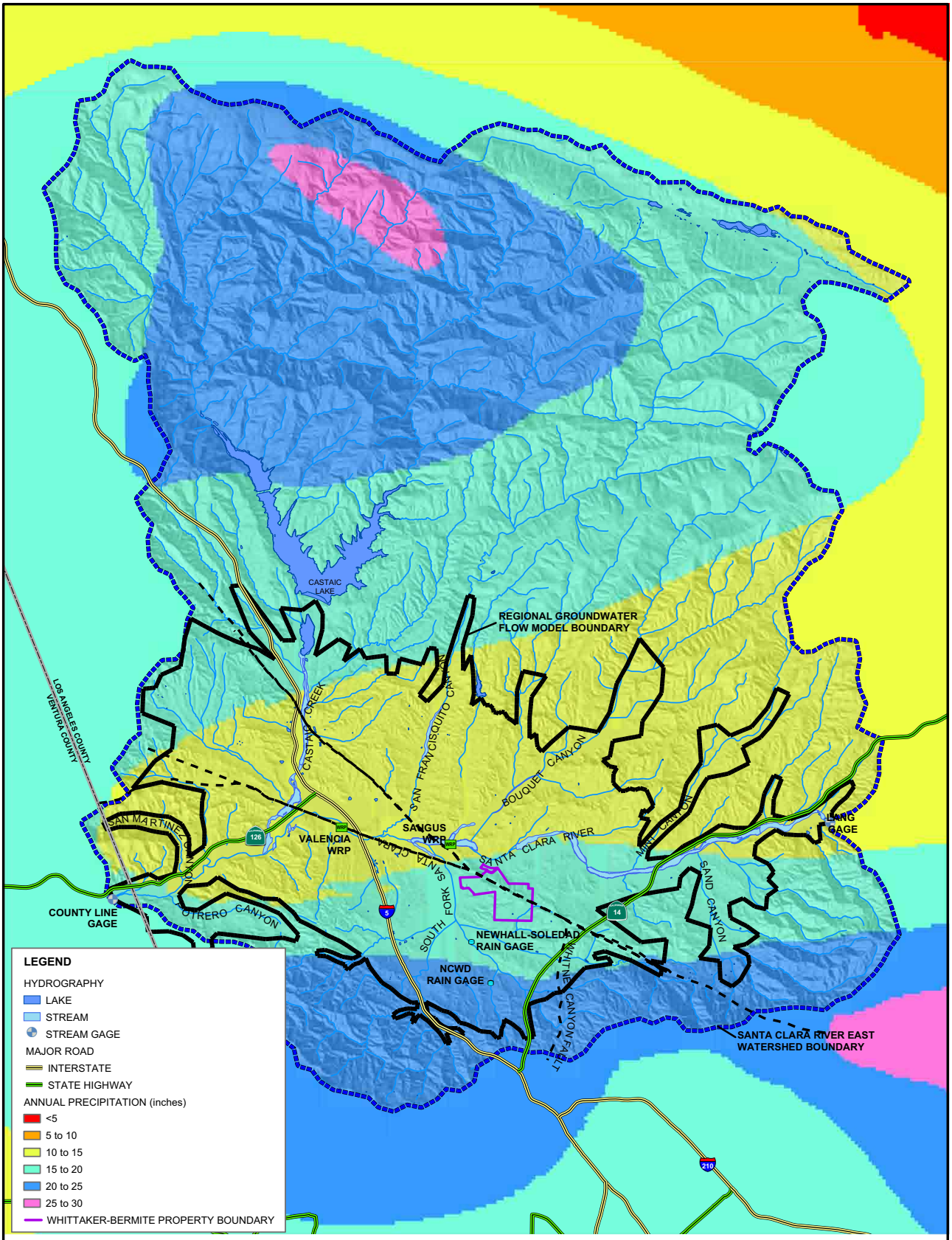
178973-P2-3.xls\Fig 2-3



SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

FIGURE 2-4
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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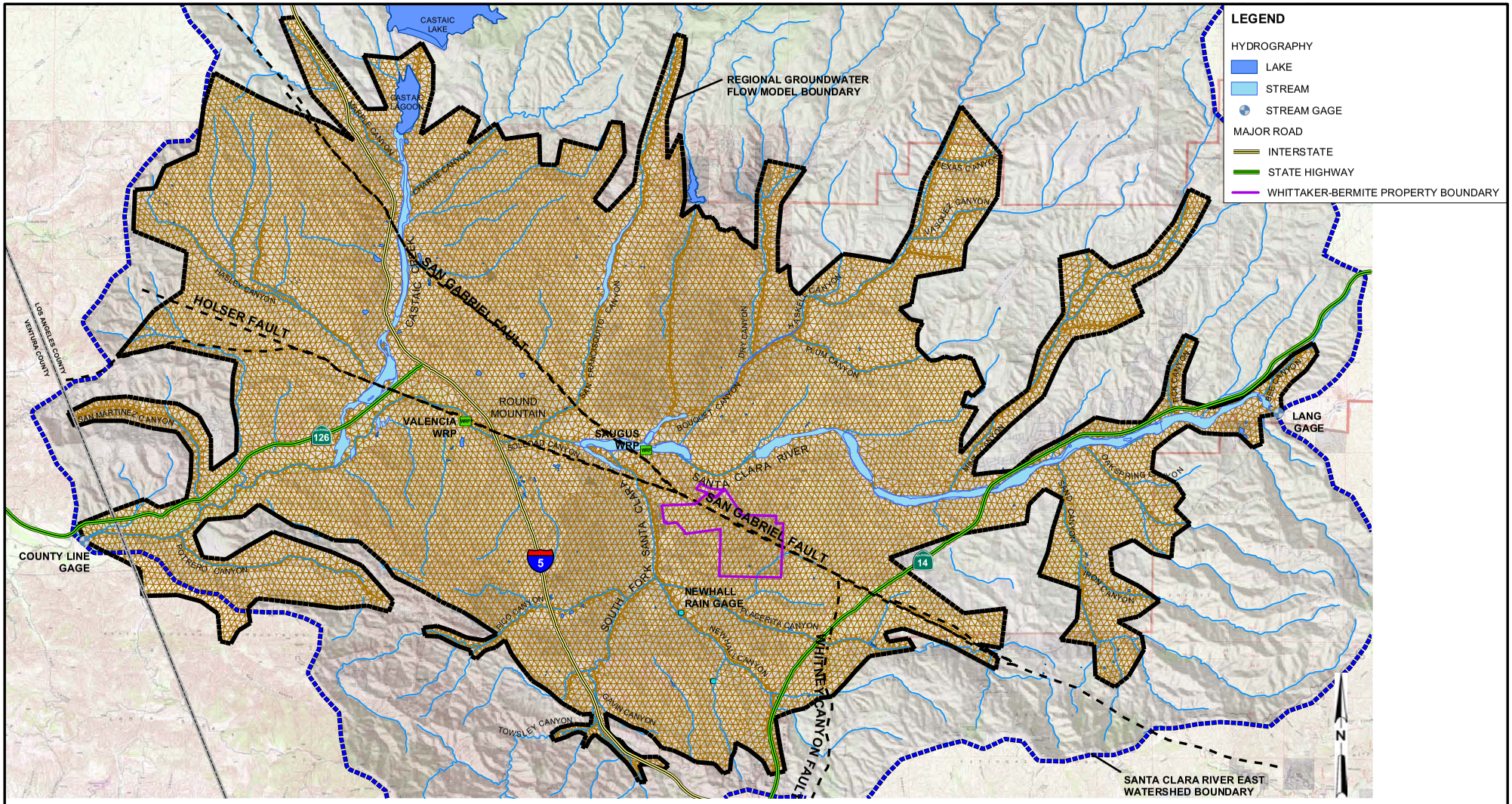

FIGURE 2-5
REGIONAL MODEL GRID
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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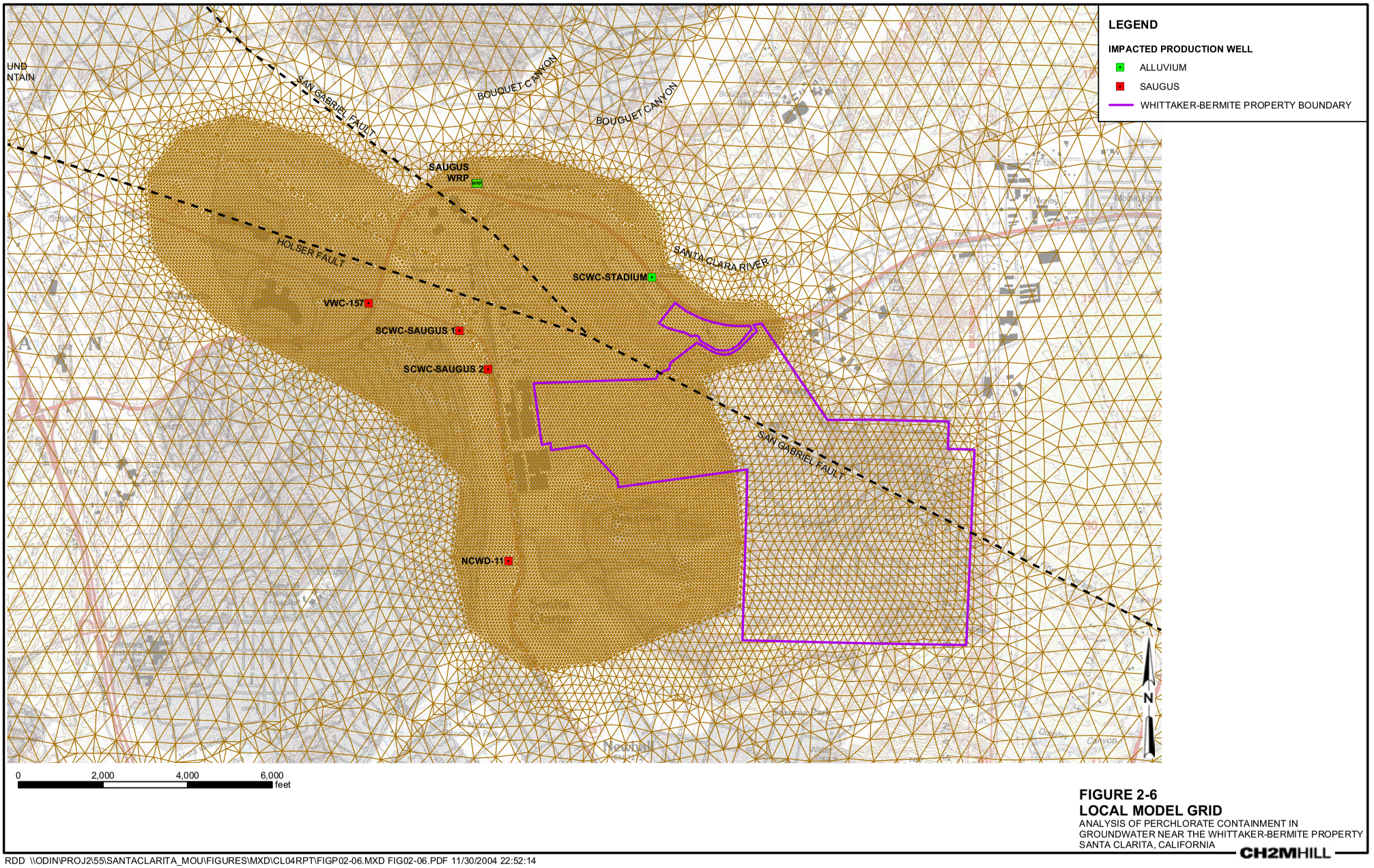

FIGURE 2-6
LOCAL MODEL GRID
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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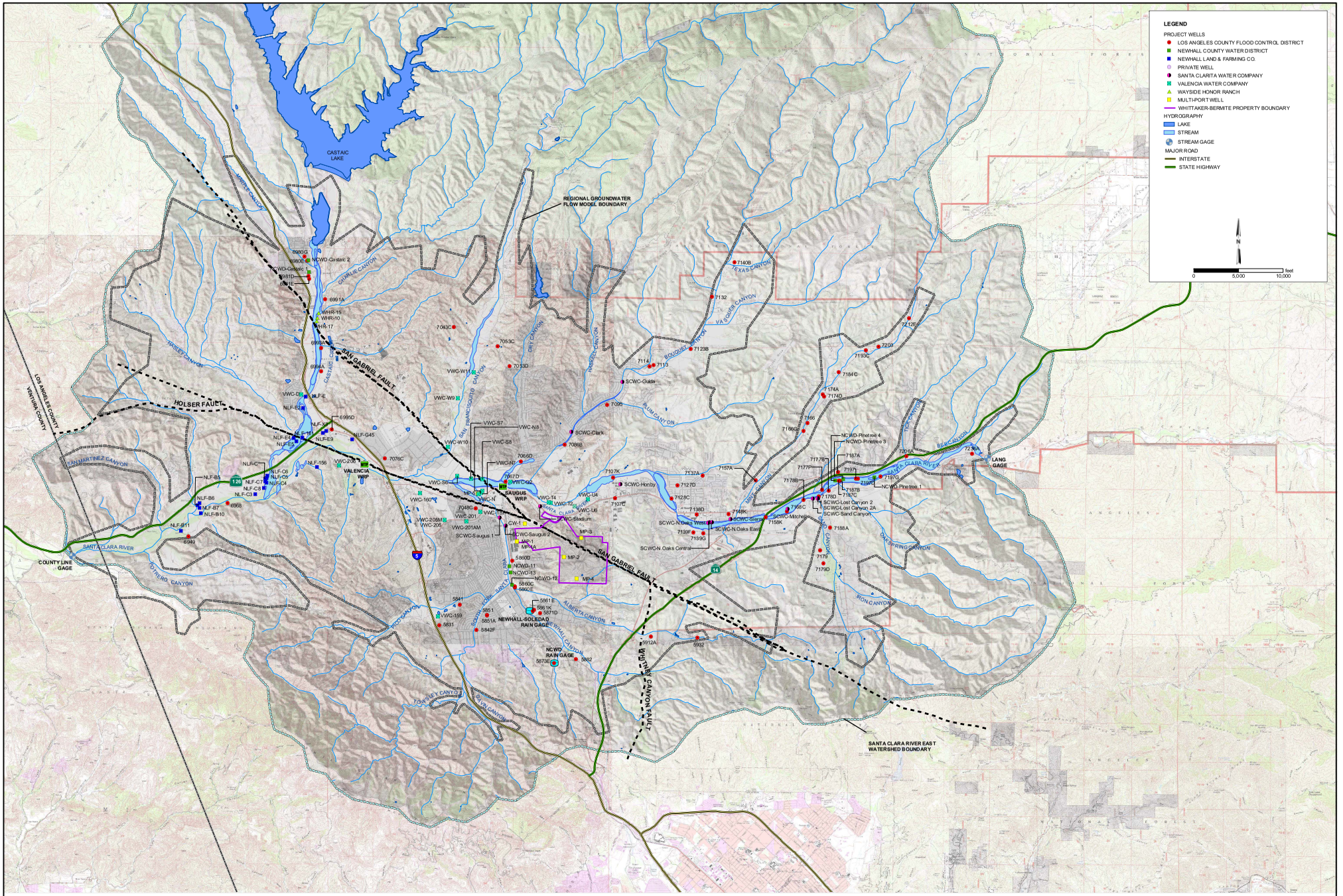

FIGURE 2-7
REGIONAL WELL LOCATION MAP
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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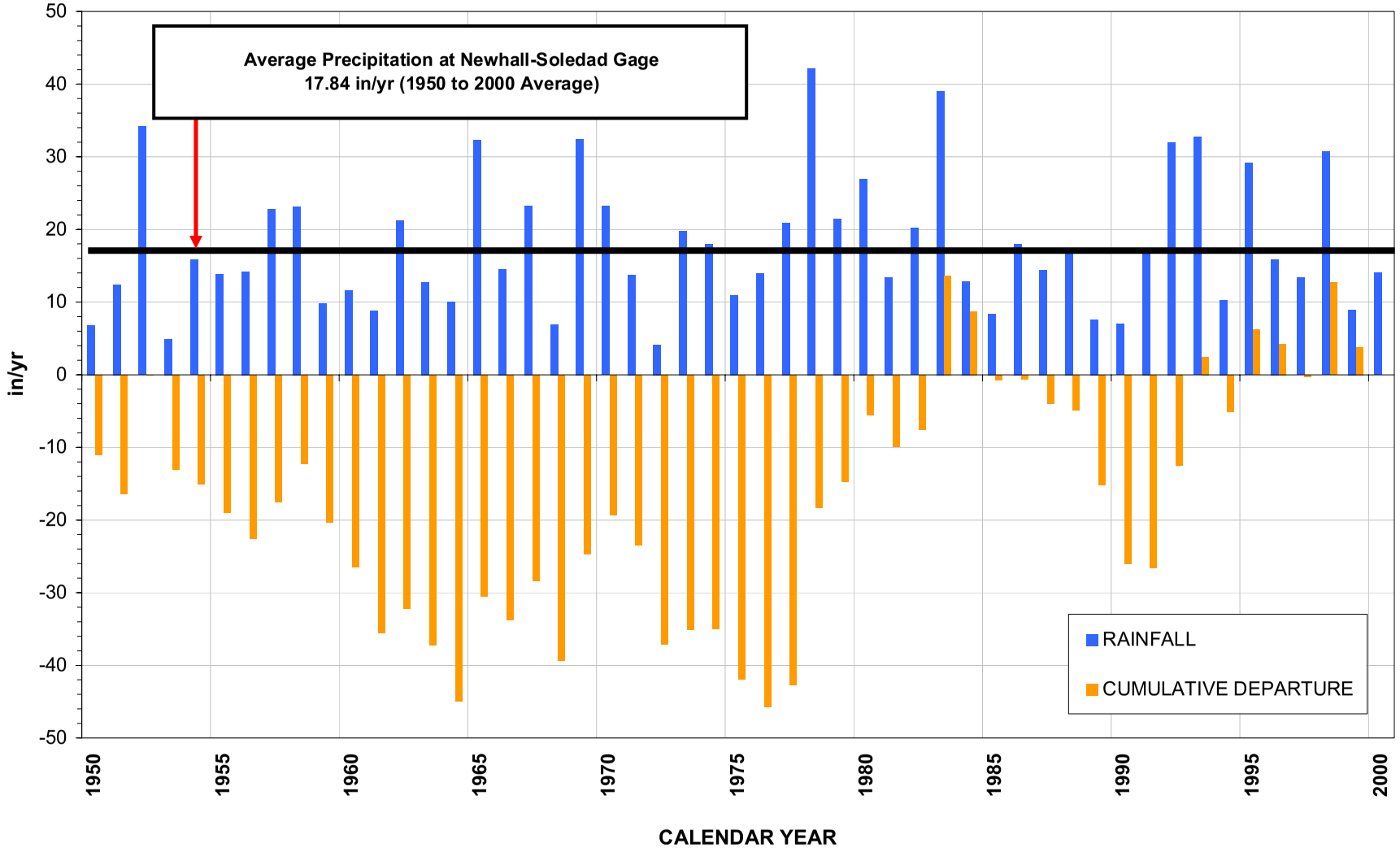

FIGURE 2-8
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE

ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

178973-P2-8_9.xls/FIG2-8

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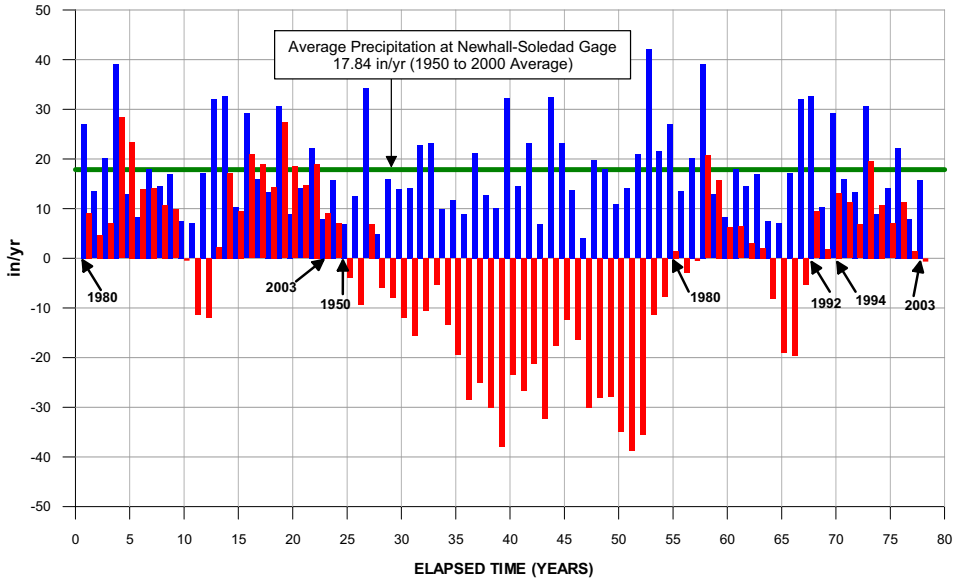

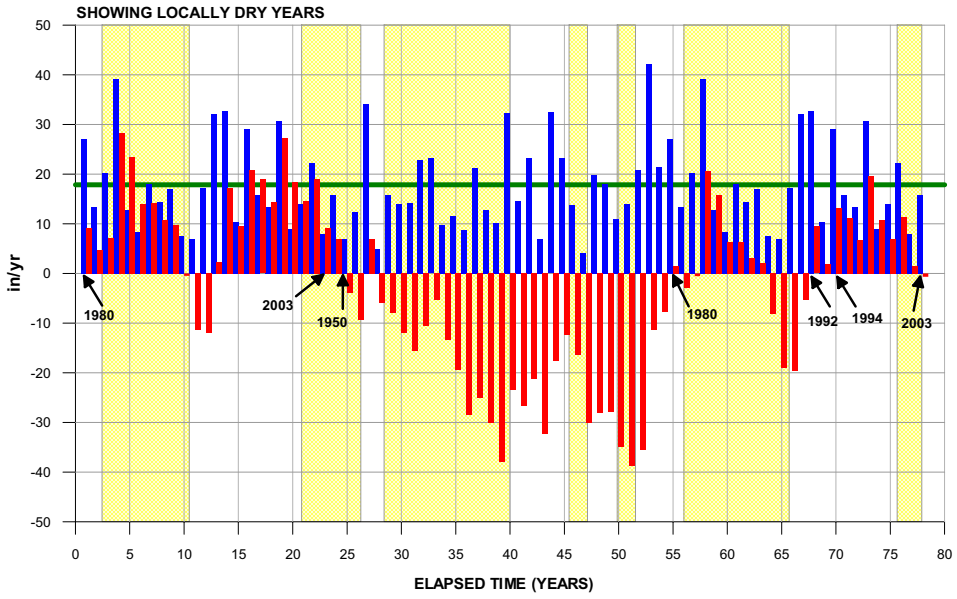

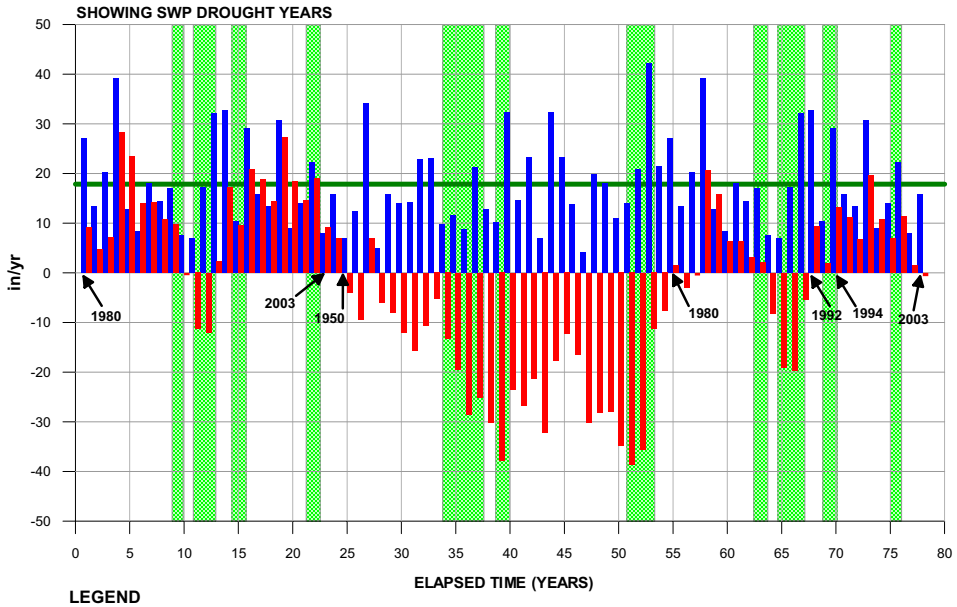

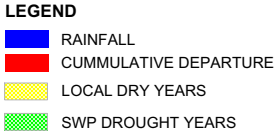

FIGURE 2-9
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 THROUGH 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE FOR THE 78-YEAR SIMULATION PERIOD
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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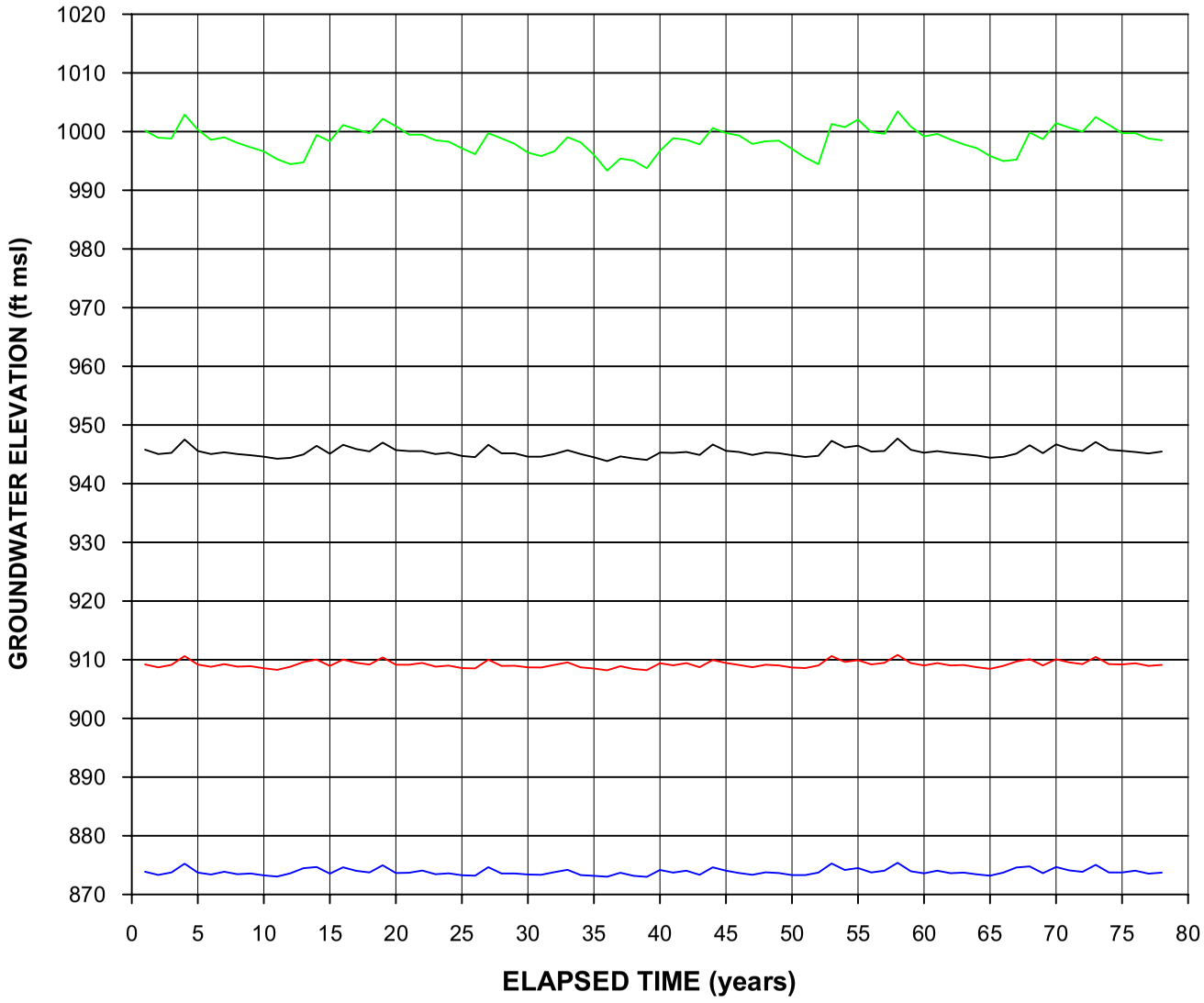

NOTES:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-10
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER WEST OF INTERSTATE 5
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

178973-346.GRF

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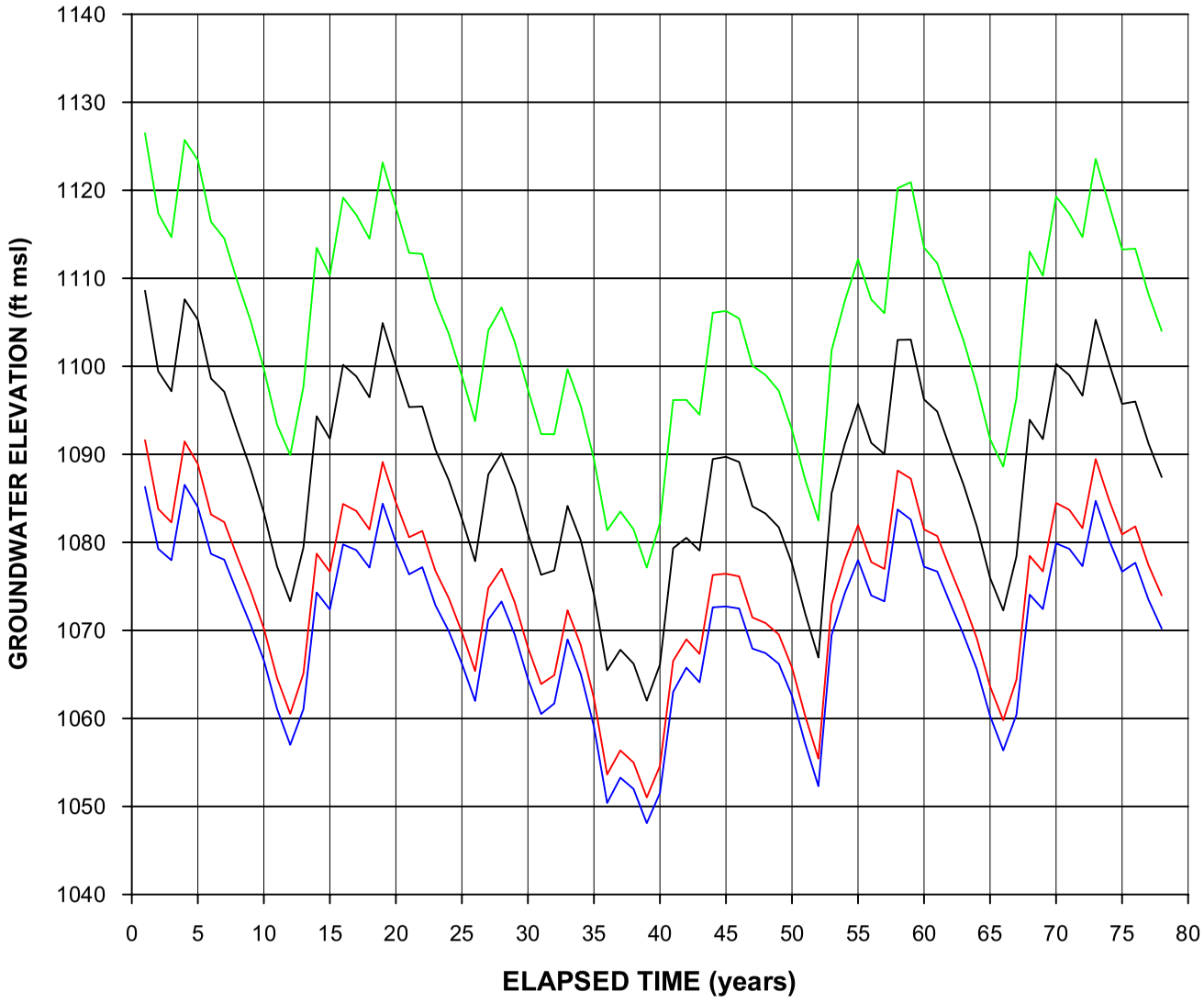

NOTES:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-11
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER EAST OF INTERSTATE 5
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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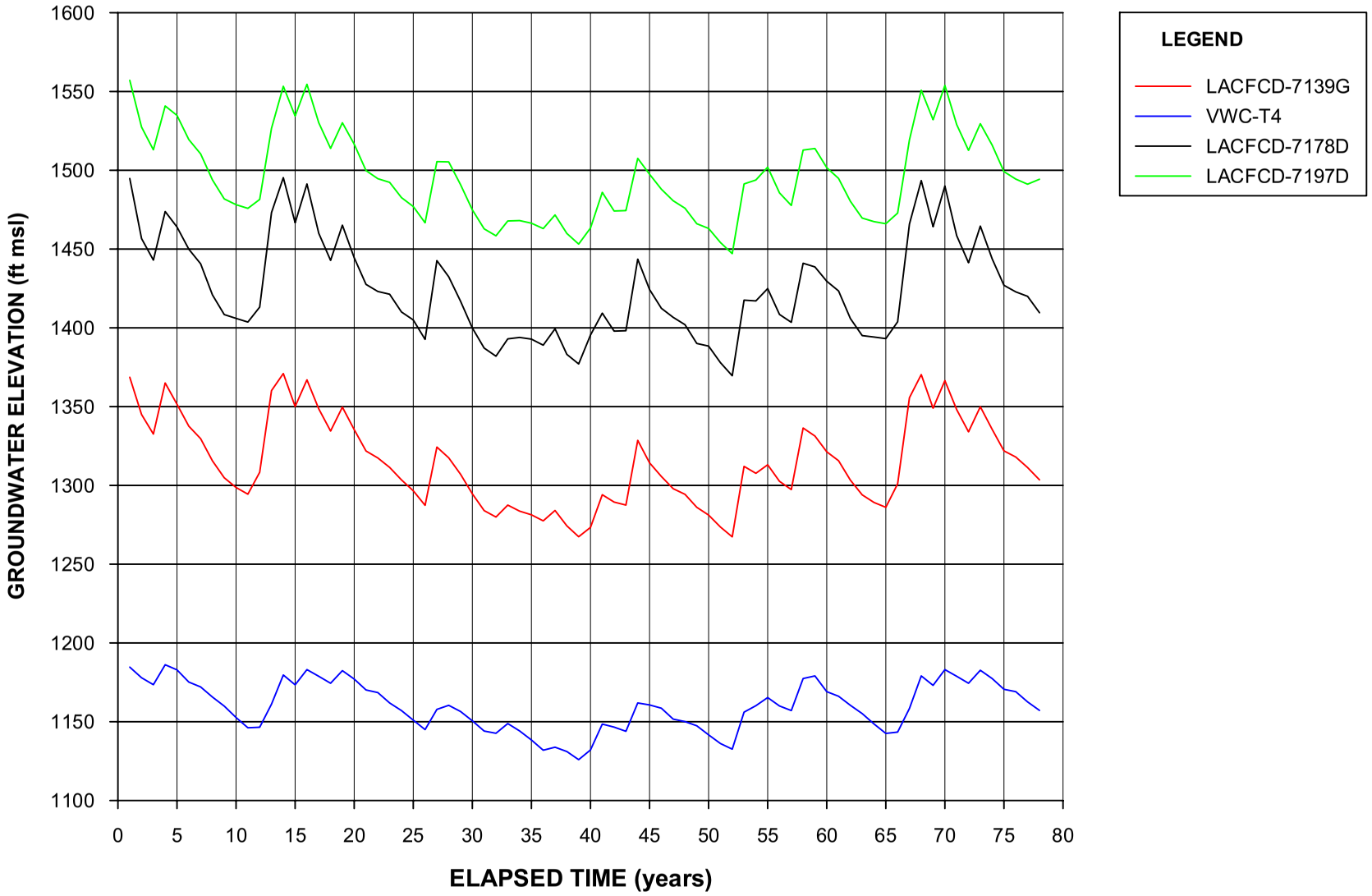

NOTES:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.
2. LOWEST HISTORICAL GROUNDWATER ELEVATIONFOR VWC- T4 = 1101 ft msl
   ALLUVIUM BOTTOM ELEVATION ~1050 TO 1065 ft msl.
3. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7139G = 1289 ft msl
   ALLUVIUM BOTTOM ELEVATION ~1256 ft msl OR LOWER.
4. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7178D = 1463 ft msl
   ALLUVIUM BOTTOM ELEVATION ~1398 TO 1425 ft msl.
5. LOWEST HISTORICAL GROUNDWATER ELEVATION FOR LACFCD-7197D = 1474 ft msl
   ALLUVIUM BOTTOM ELEVATION ~1423 TO 1447 ft msl.

FIGURE 2-12
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER IN SOLEDAD CANYON
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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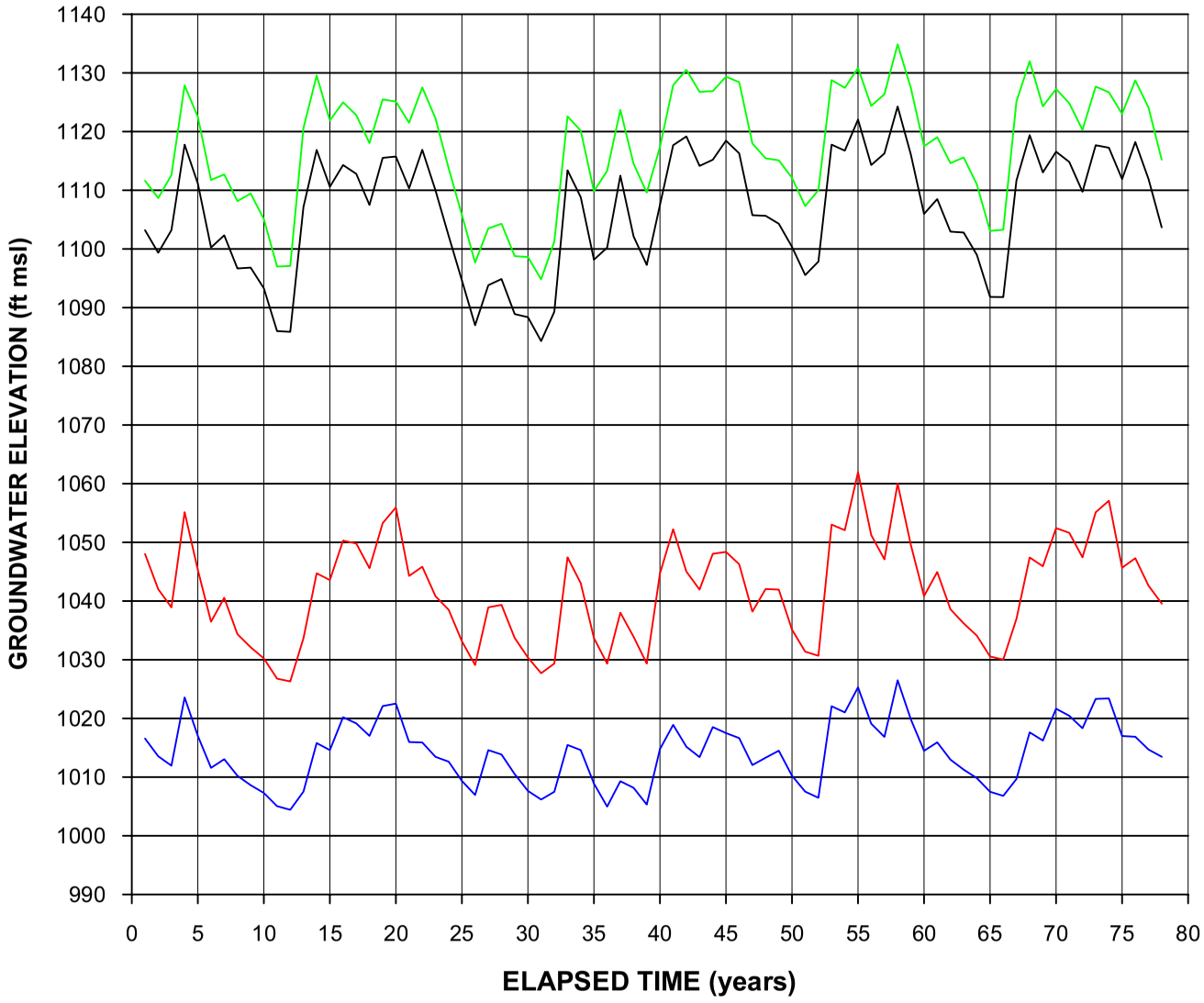

NOTE:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-13
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER ALONG CASTAIC CREEK
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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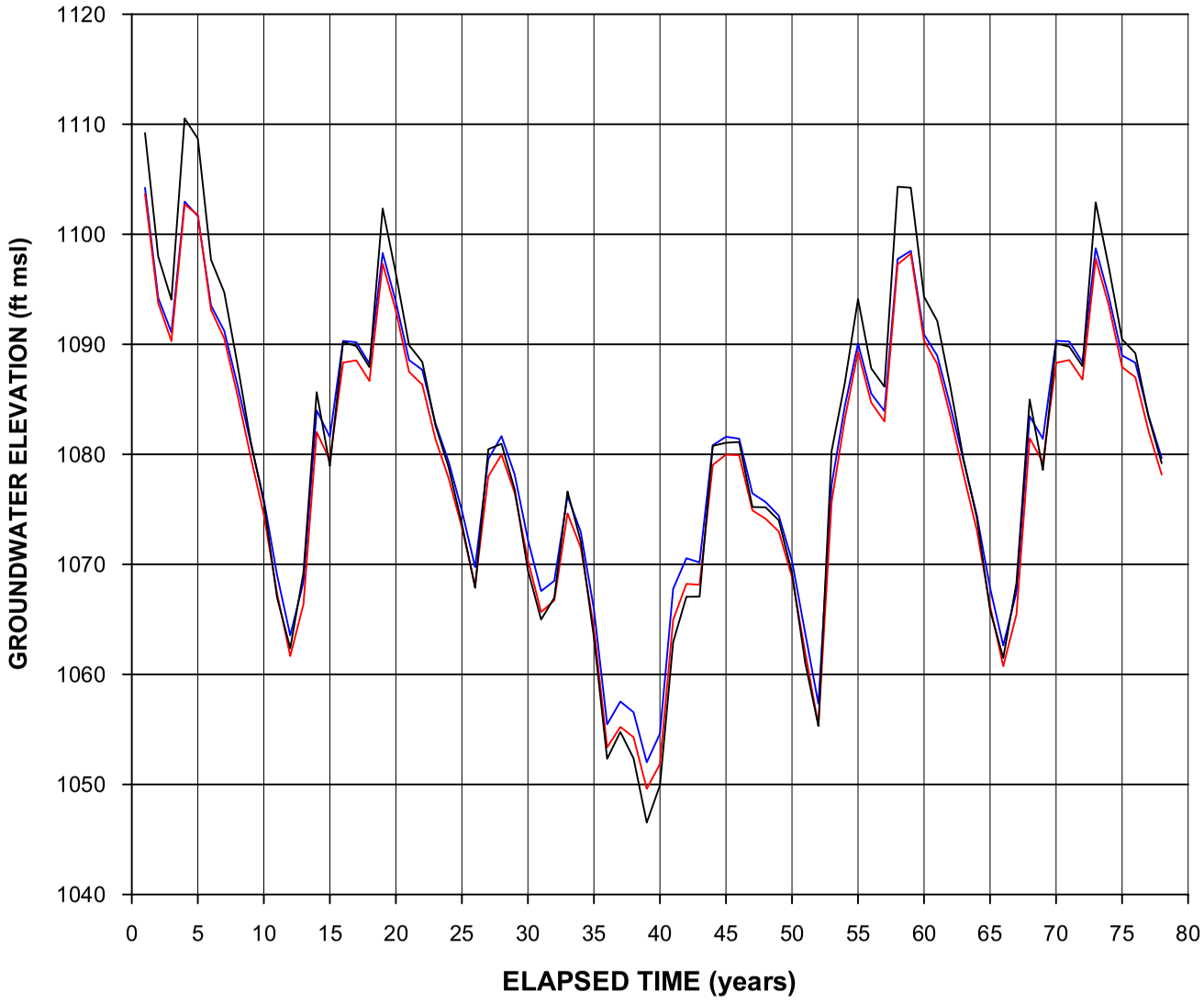

NOTE:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-14
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE ALLUVIAL AQUIFER AT IMPACTED SAUGUS WELLS
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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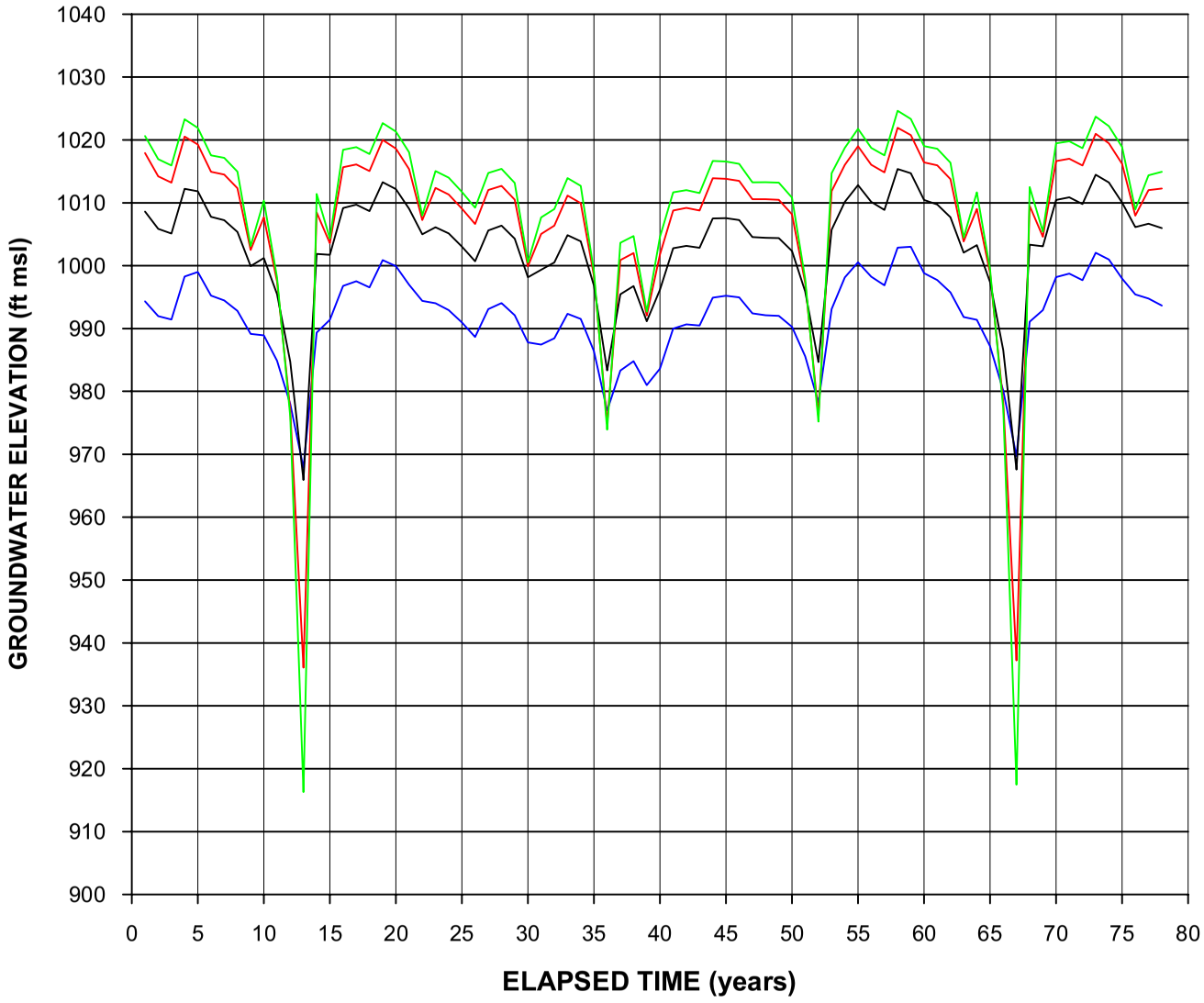

NOTE:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-15
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION WEST OF INTERSTATE 5
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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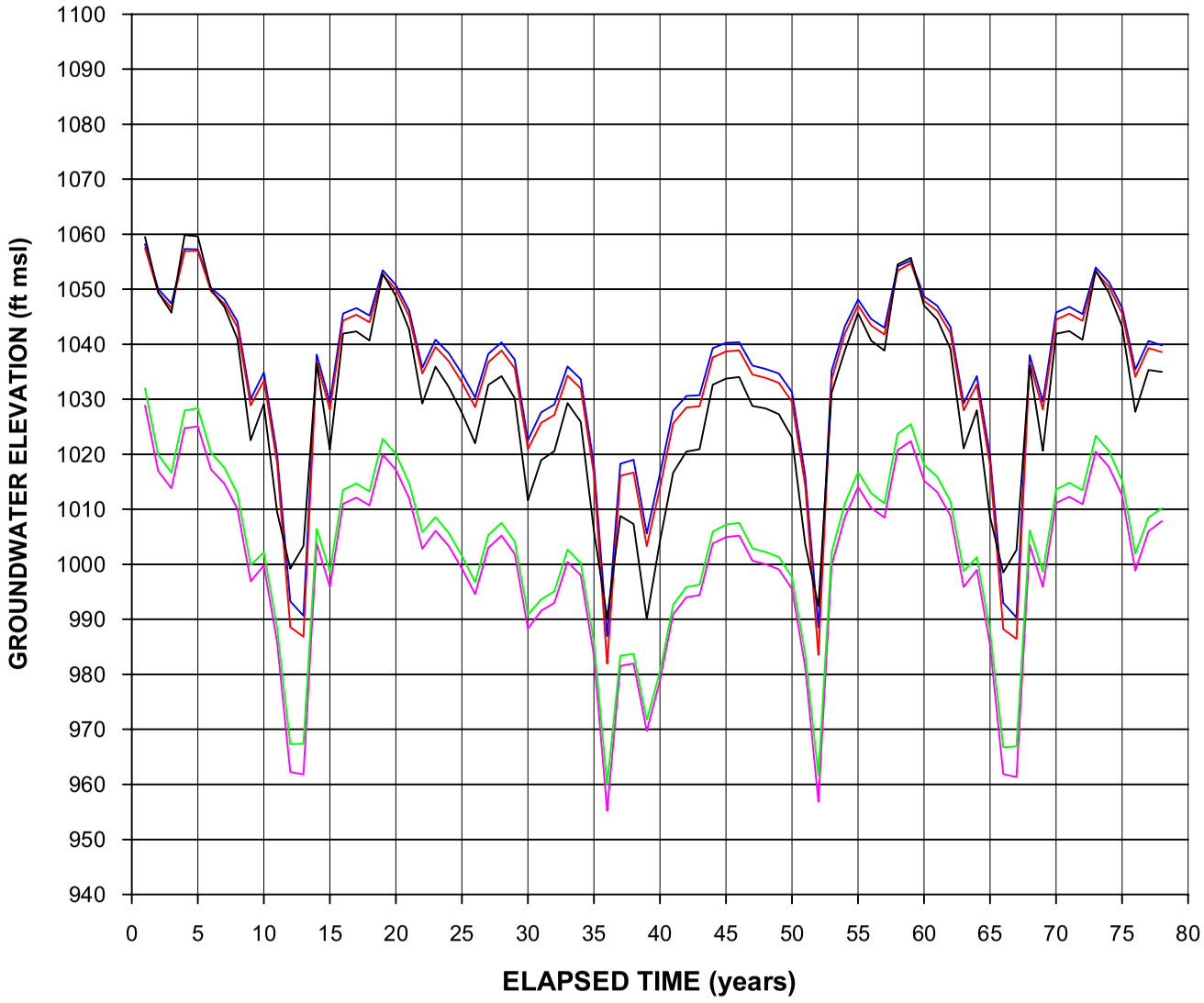

NOTE:

1. SEE FIGURE 2-7 FOR LOCATIONS OF WELLS.

FIGURE 2-16
SIMULATED AVERAGE ANNUAL GROUNDWATER ELEVATIONS IN THE SAUGUS FORMATION EAST OF INTERSTATE 5
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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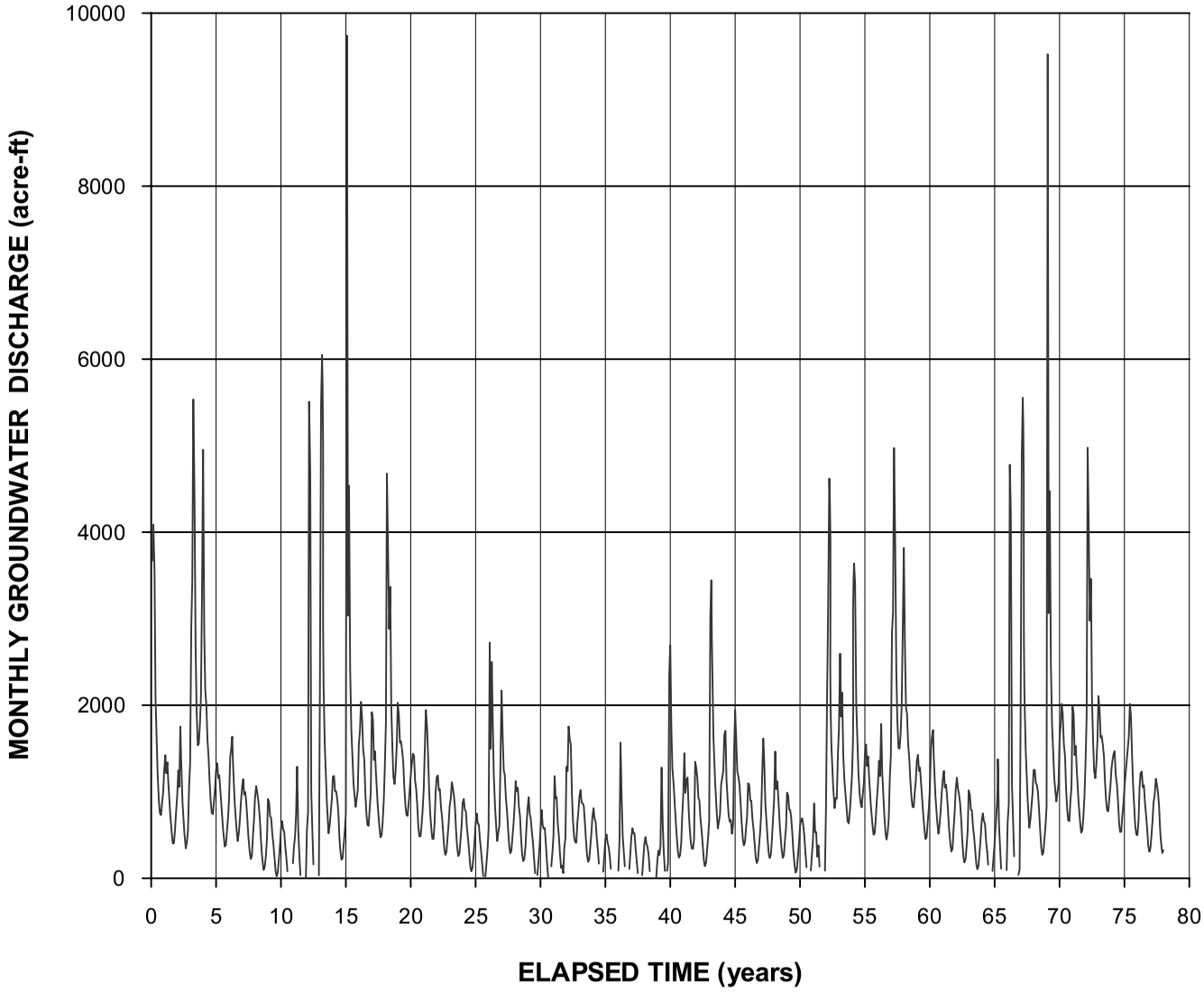

FIGURE 2-18
SIMULATED GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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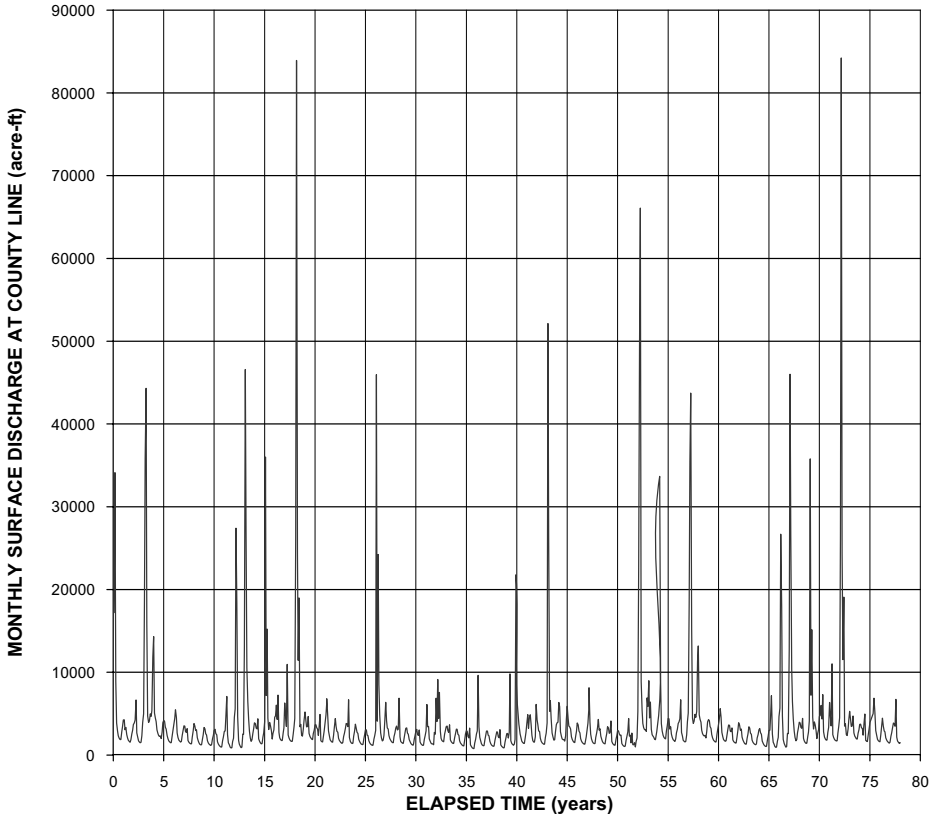

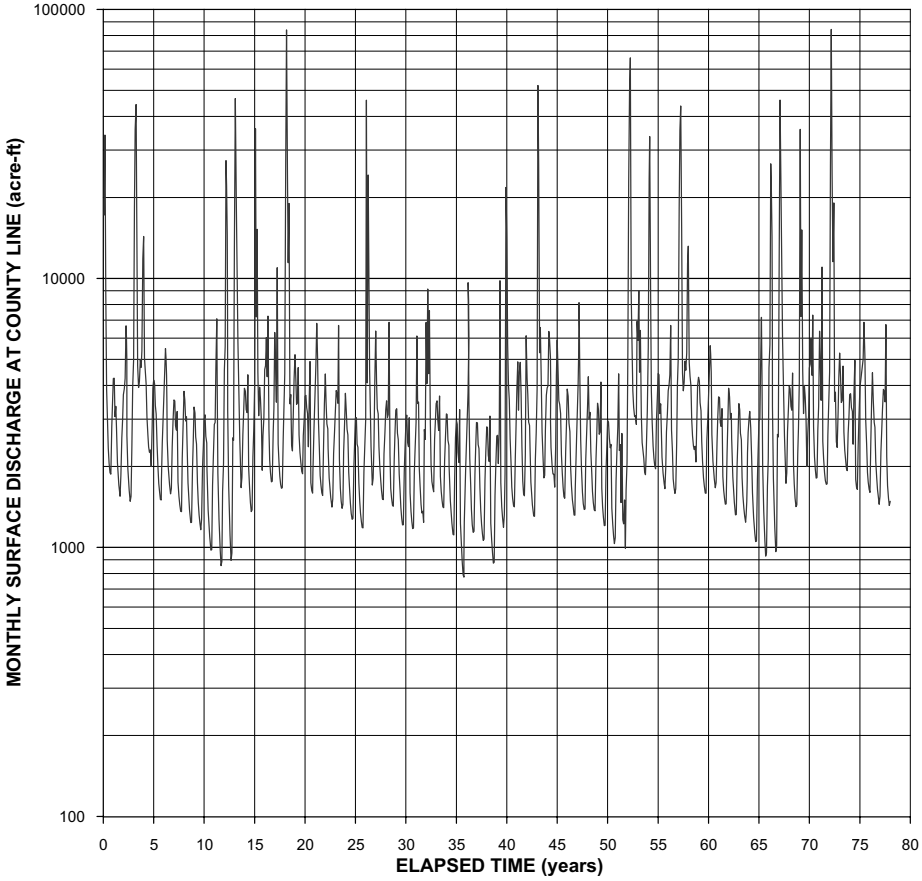

FIGURE 2-17
SIMULATED SANTA CLARA RIVER FLOW AT COUNTY LINE
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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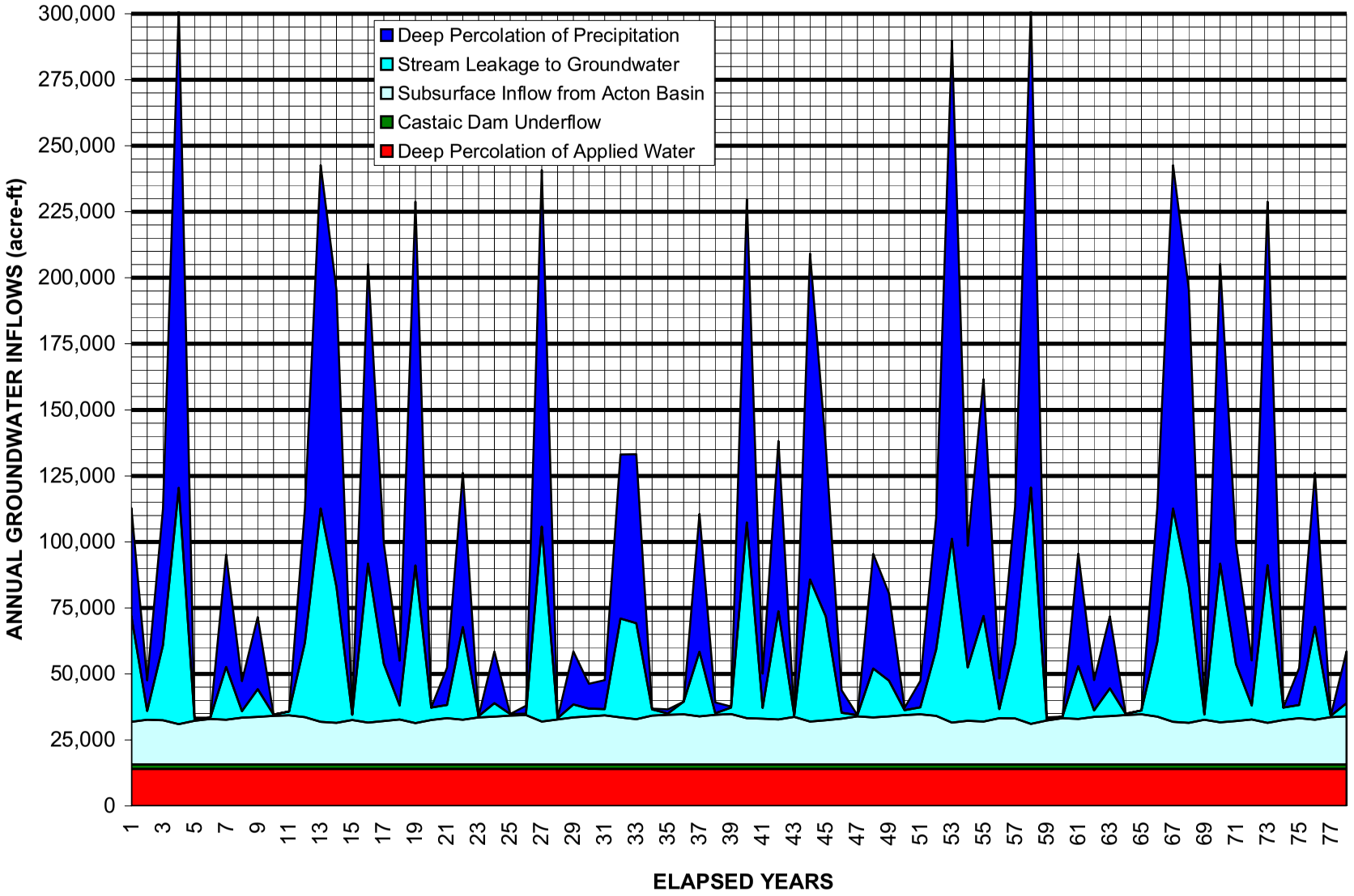

FIGURE 2-19
ANNUAL GROUNDWATER INFLOWS
ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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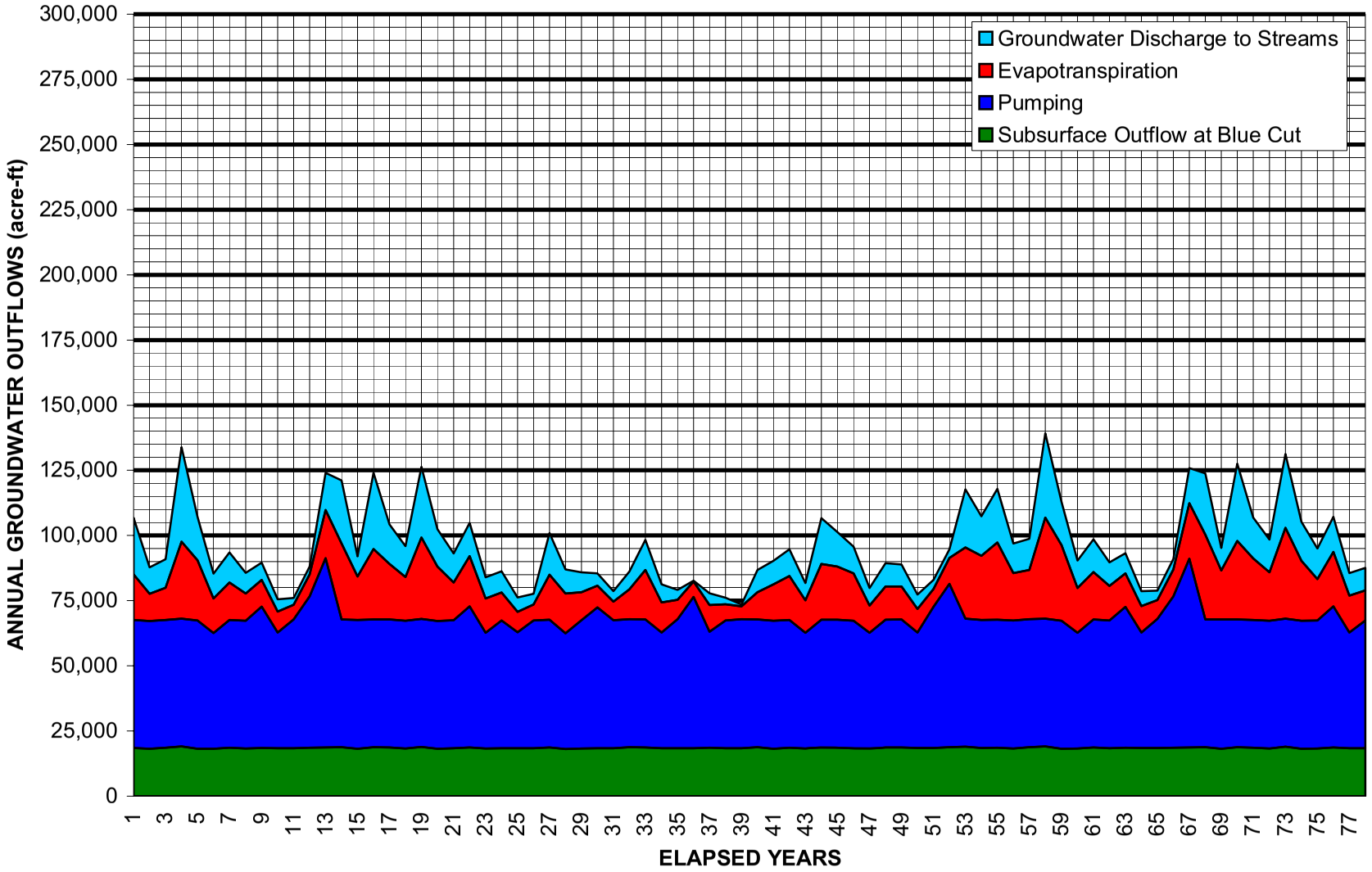

FIGURE 2-20
ANNUAL GROUNDWATER OUTFLOWS
ANALYSIS OF PERCHLORATE CONTAINMENT IN
GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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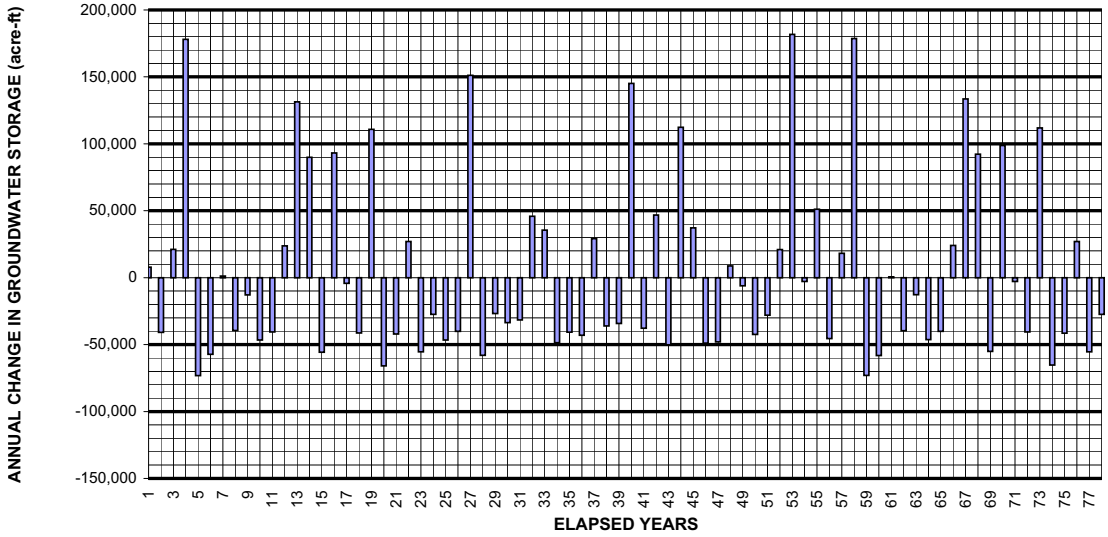
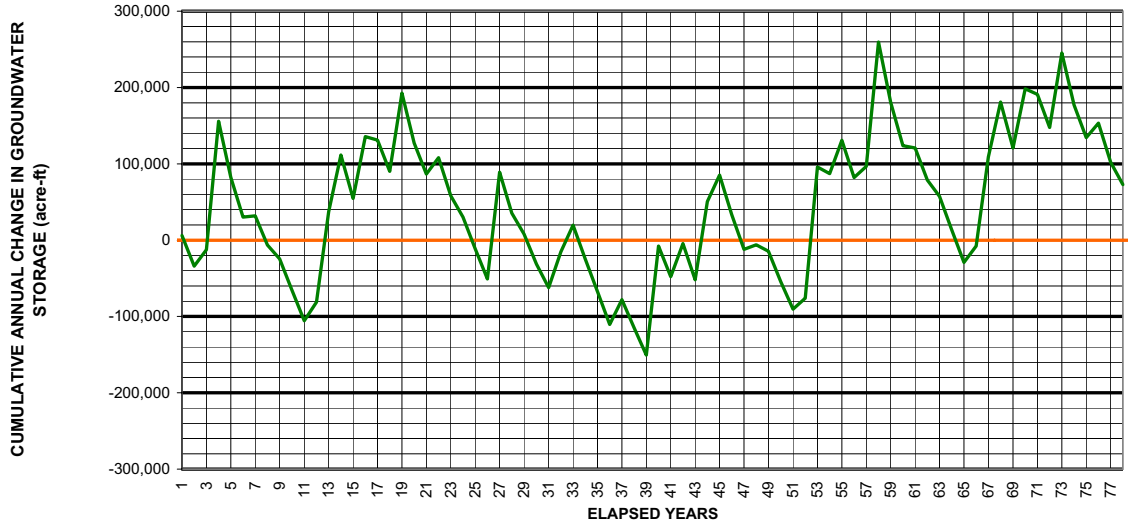




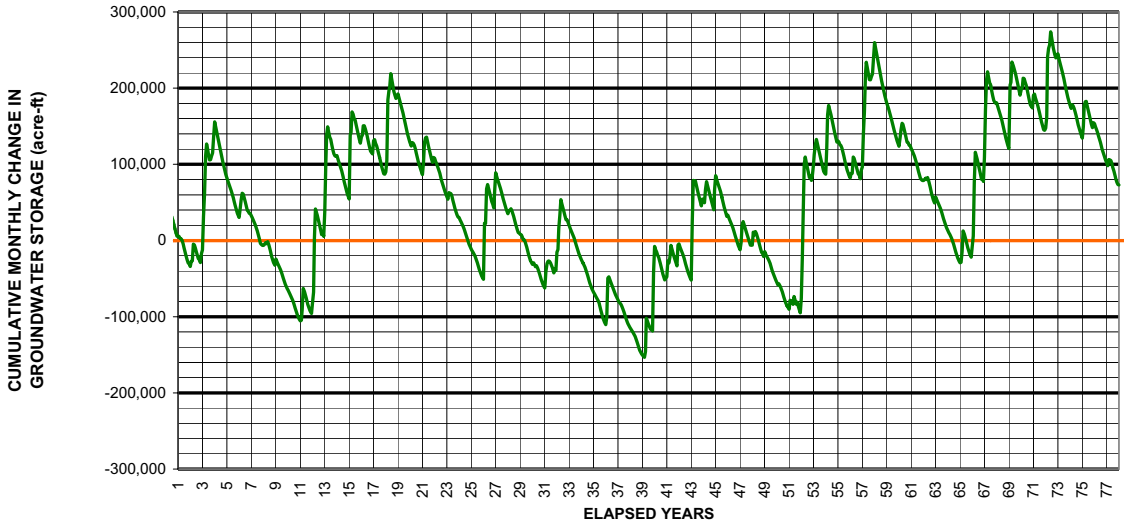
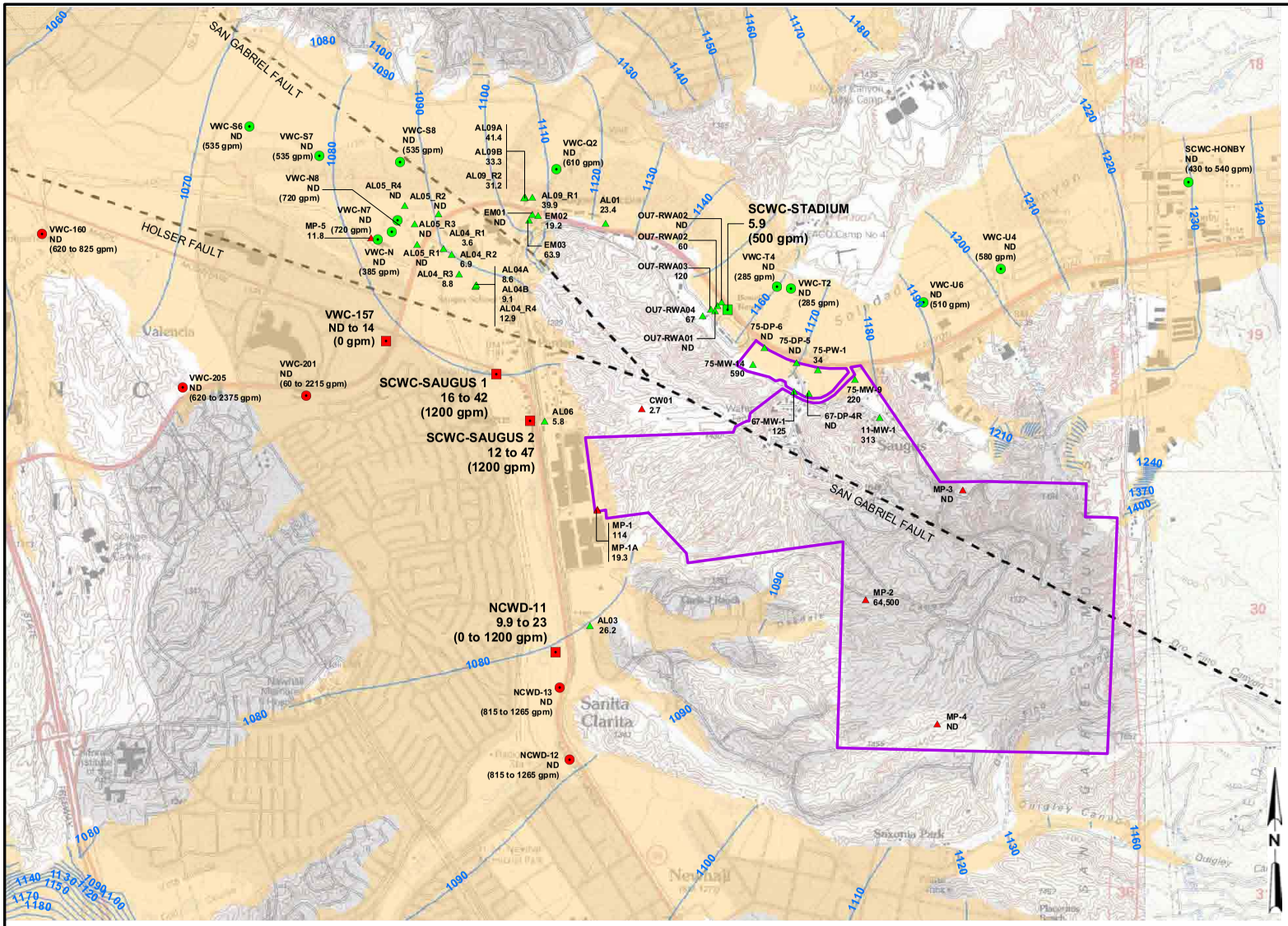


FIGURE 2-21
ANNUAL CHANGE AND CUMULATIVE CHANGE IN GROUNDWATER STORAGE
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA



LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NONIMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS
- SIMULATED GROUNDWATER ELEVATION (ft MSL)
- ALLUVIUM
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE

FIGURE 2-22
SIMULATED AVERAGE GROUNDWATER ELEVATION CONTOURS FOR ALLUVIAL AQUIFER
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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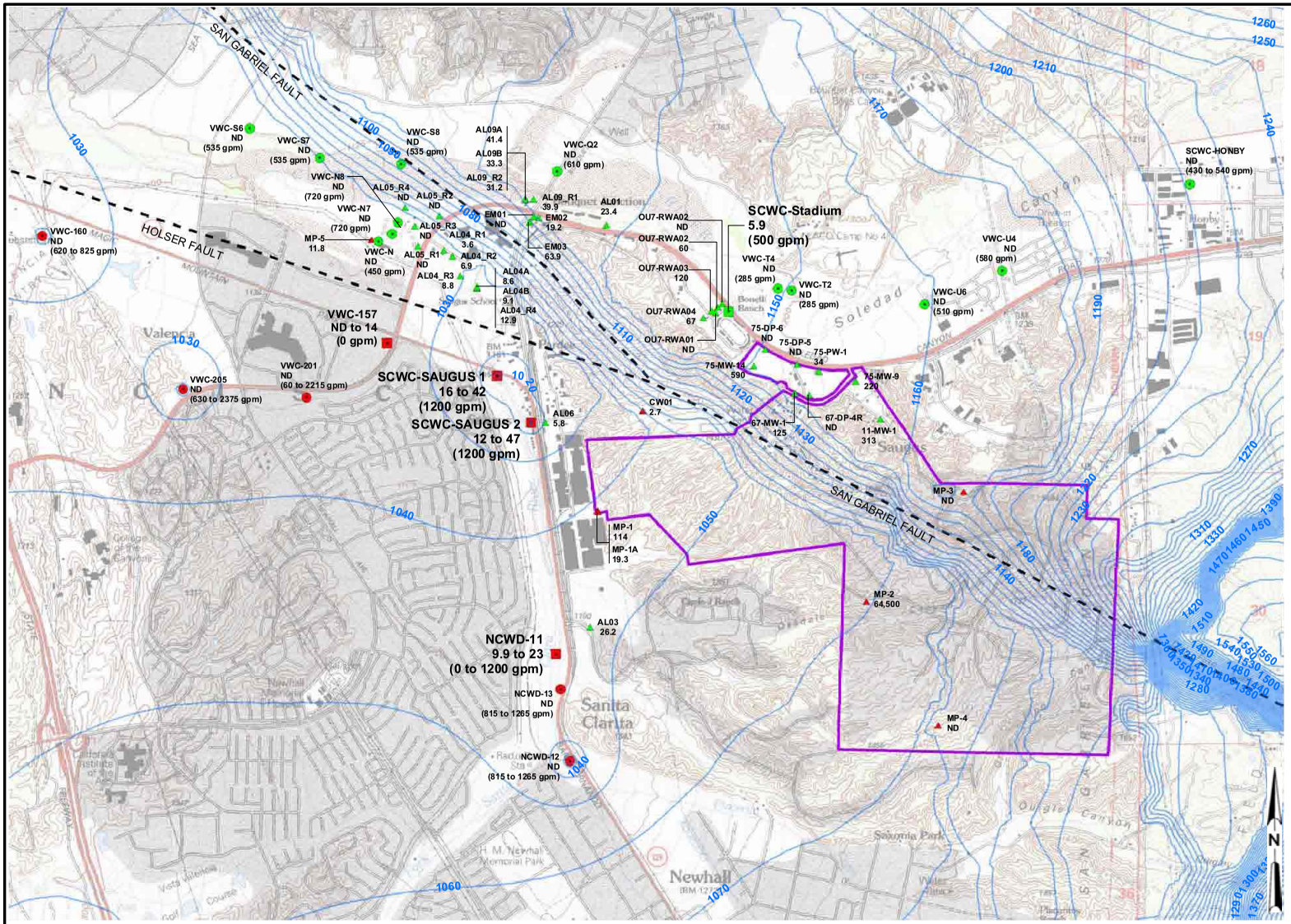

LEGEND

- SIMULATED GROUNDWATER ELEVATION (ft MSL)

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NONIMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE

FIGURE 2-23
SIMULATED AVERAGE GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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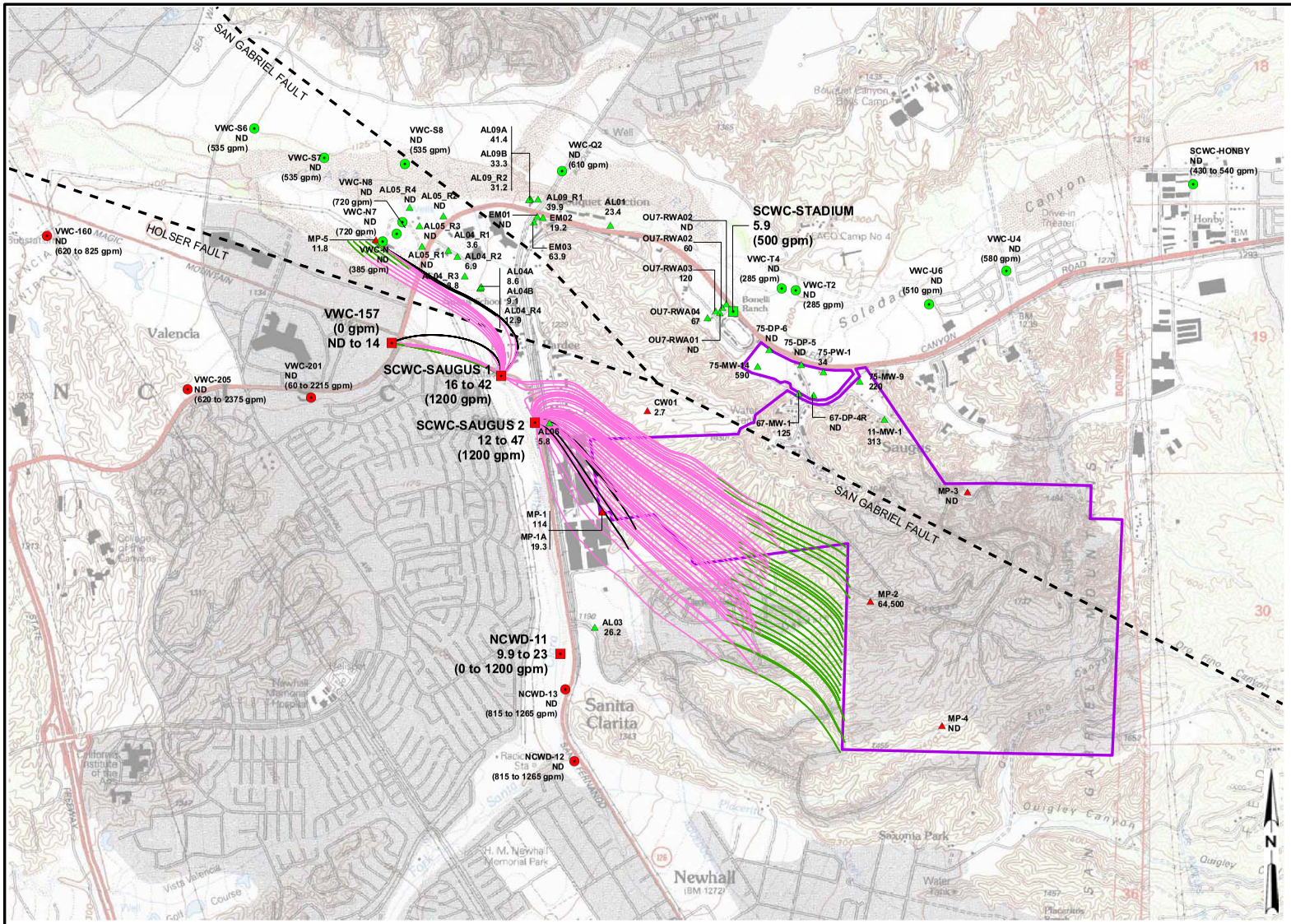

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATH

- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. FLOWPATHS AT VWC-157 AND MP-5 ARE INITIATED IN MODEL LAYERS 2, 3, 4, AND 5. FLOWPATHS AT THE WHITTAKER-BERMITE PROPERTY BOUNDARY ARE INITIATED IN MODEL LAYER 3.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-24
GROUNDWATER FLOWPATHS IN THE SAUGUS FORMATION FROM VWC-157, MP-5, AND THE WESTERN BOUNDARY OF THE WHITTAKER-BERMITE PROPERTY

ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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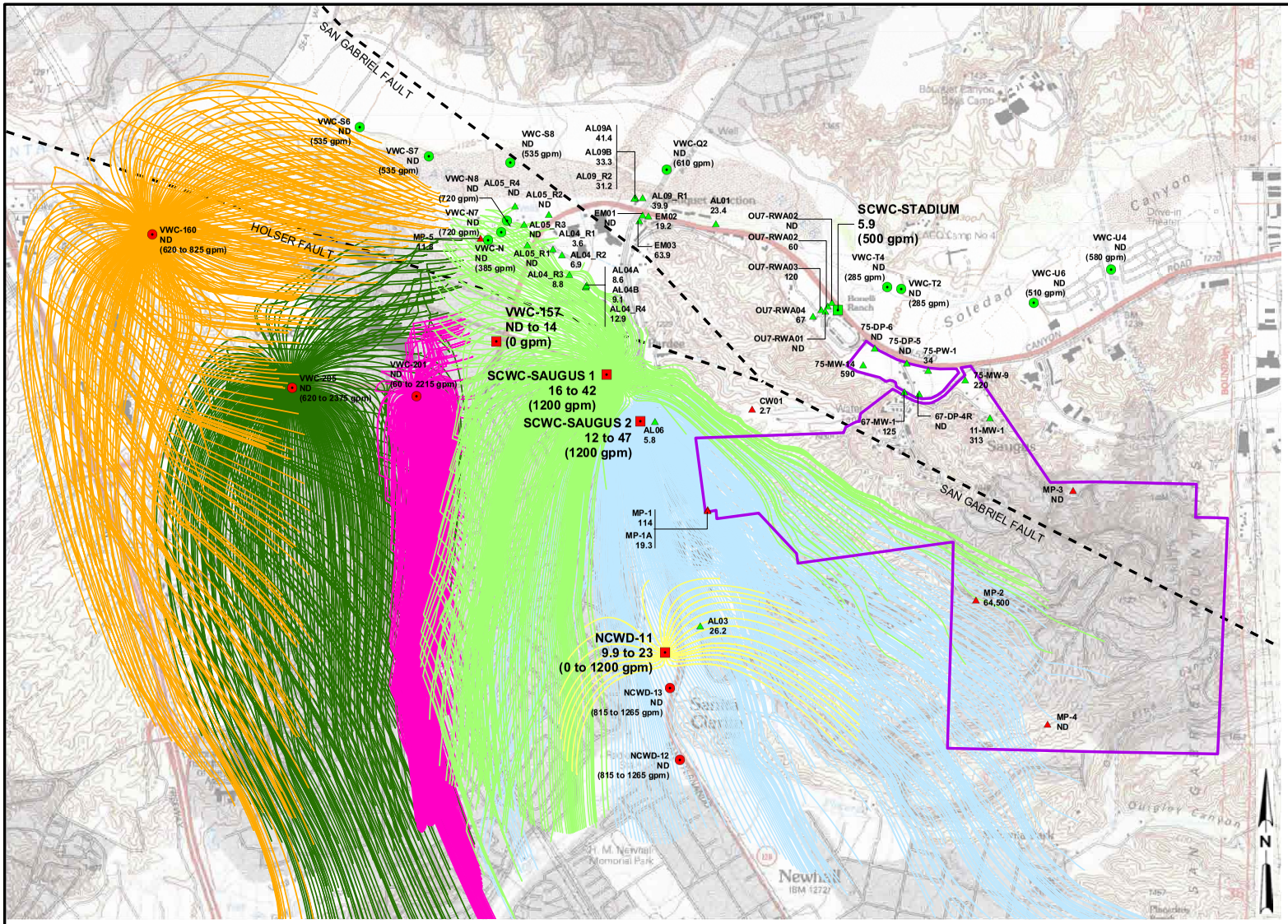

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELLS
- ALLUVIUM
- SAUGUS
- SCWC-SAUGUS 1
- SCWC-SAUGUS 2
- VWC-160
- VWC-201
- VWC-205
- NCWD-11
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES WERE INITIATED IN LAYERS 3, 4, AND 5. ALTHOUGH EACH WELL MAY DERIVE A PORTION OF ITS WATER FROM THE ALLUVIAL AQUIFER, PARTICLES THAT ARE TRACED INTO THE ALLUVIAL AQUIFER ARE NOT SHOWN ON THIS FIGURE BECAUSE THE INTENT OF THE FIGURE IS TO SHOW AREAS IN THE SAUGUS FORMATION THAT ARE CAPTURED BY EACH WELL.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-25
SAUGUS FORMATION CAPTURE ZONES FOR IMPACTED AND NONIMPACTED PRODUCTION WELLS
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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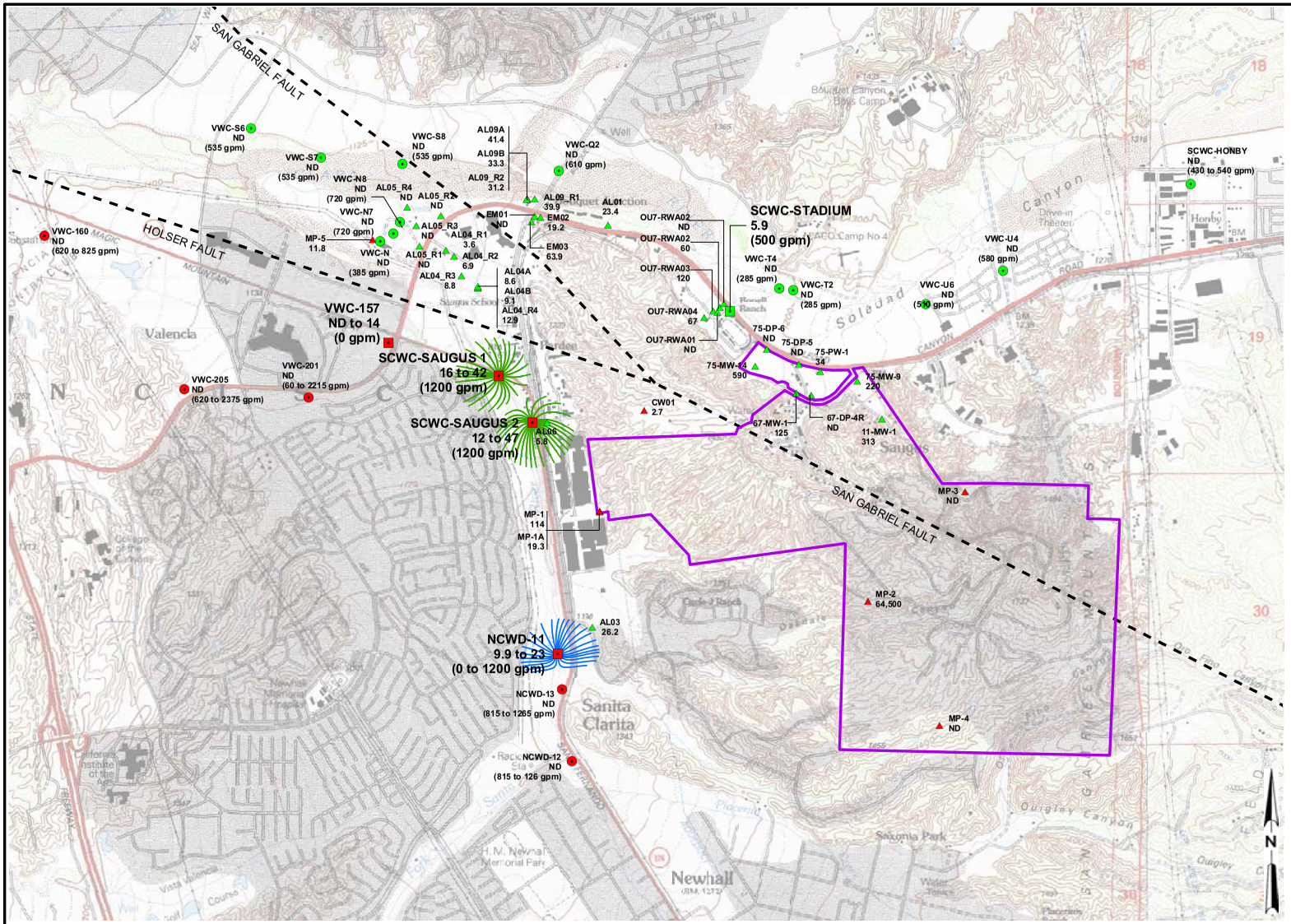

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELLS
- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATH
- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES WERE INITIATED IN LAYER 2 AT NCWD-11, AND LAYER 3 AT SCWC-SAUGUS 1 AND SCWC-SAUGUS 2.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-26
TWO-YEAR CAPTURE ZONES FOR WELLS SCWC-SAUGUS 1, SCWC-SAUGUS 2, AND NCWD-11
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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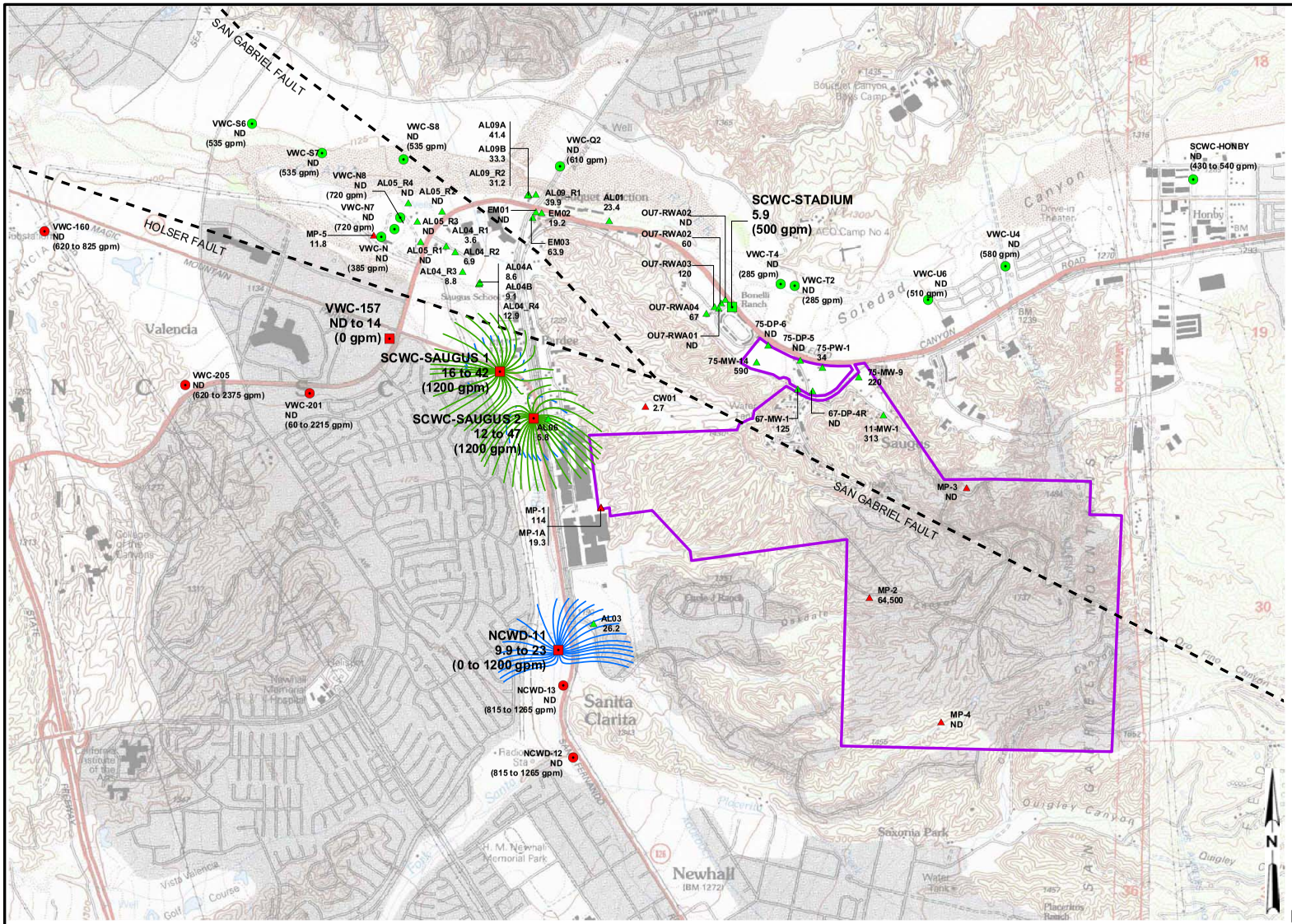

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELLS
- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS
- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES ARE INITIATED IN LAYER 2 AT NCWD-11, AND LAYER 3 AT SCWC-SAUGUS 1 AND SCWC-SAUGUS 2.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-27
FIVE-YEAR CAPTURE ZONES FOR WELLS SCWC-SAUGUS 1, SCWC-SAUGUS 2, AND NCWD-11
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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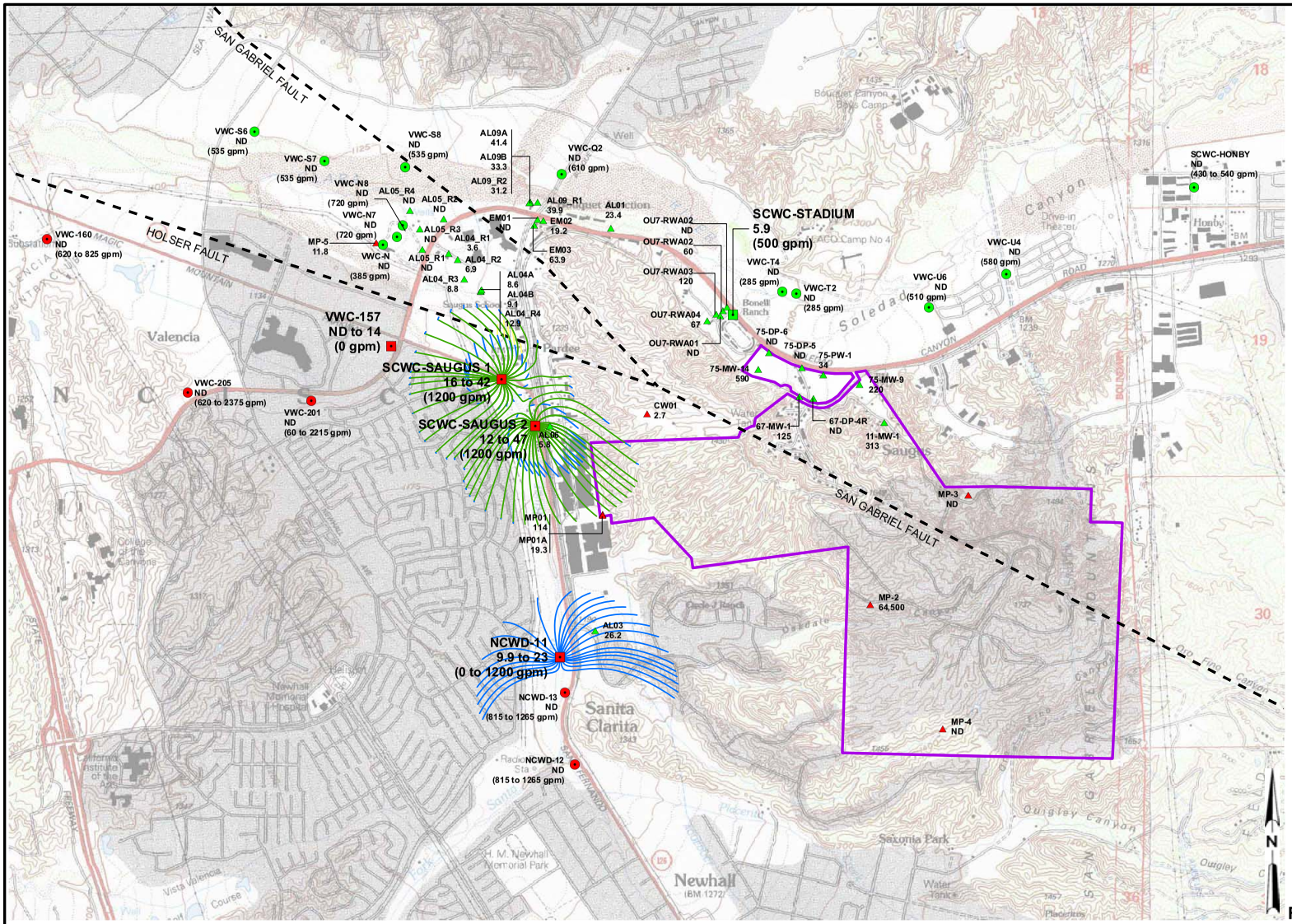

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS

- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES ARE INITIATED IN LAYER 2 AT NCWD-11, AND LAYER 3 AT SCWC-SAUGUS 1 AND SCWC-SAUGUS 2.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-28
TEN-YEAR CAPTURE ZONES FOR WELLS SCWC-SAUGUS 1, SCWC-SAUGUS 2, AND NCWD-11
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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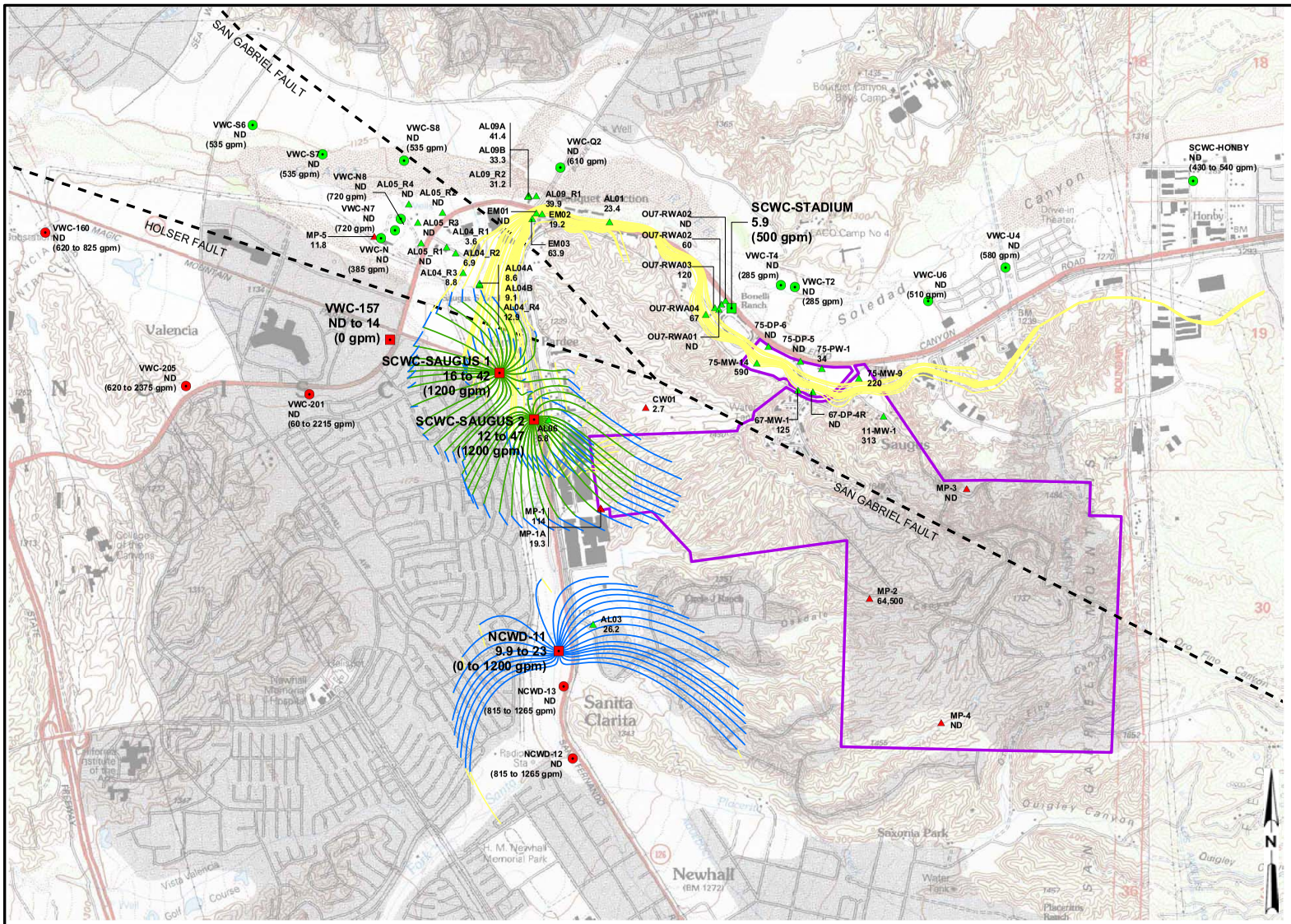

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELLS
- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS
- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES ARE INITIATED IN LAYER 2 AT NCWD-11, AND LAYER 3 AT SCWC-SAUGUS 1 AND SCWC-SAUGUS 2.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-29
TWENTY-YEAR CAPTURE ZONES FOR WELLS SCWC-SAUGUS 1, SCWC-SAUGUS 2, AND NCWD-11
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY SANTA CLARITA, CALIFORNIA

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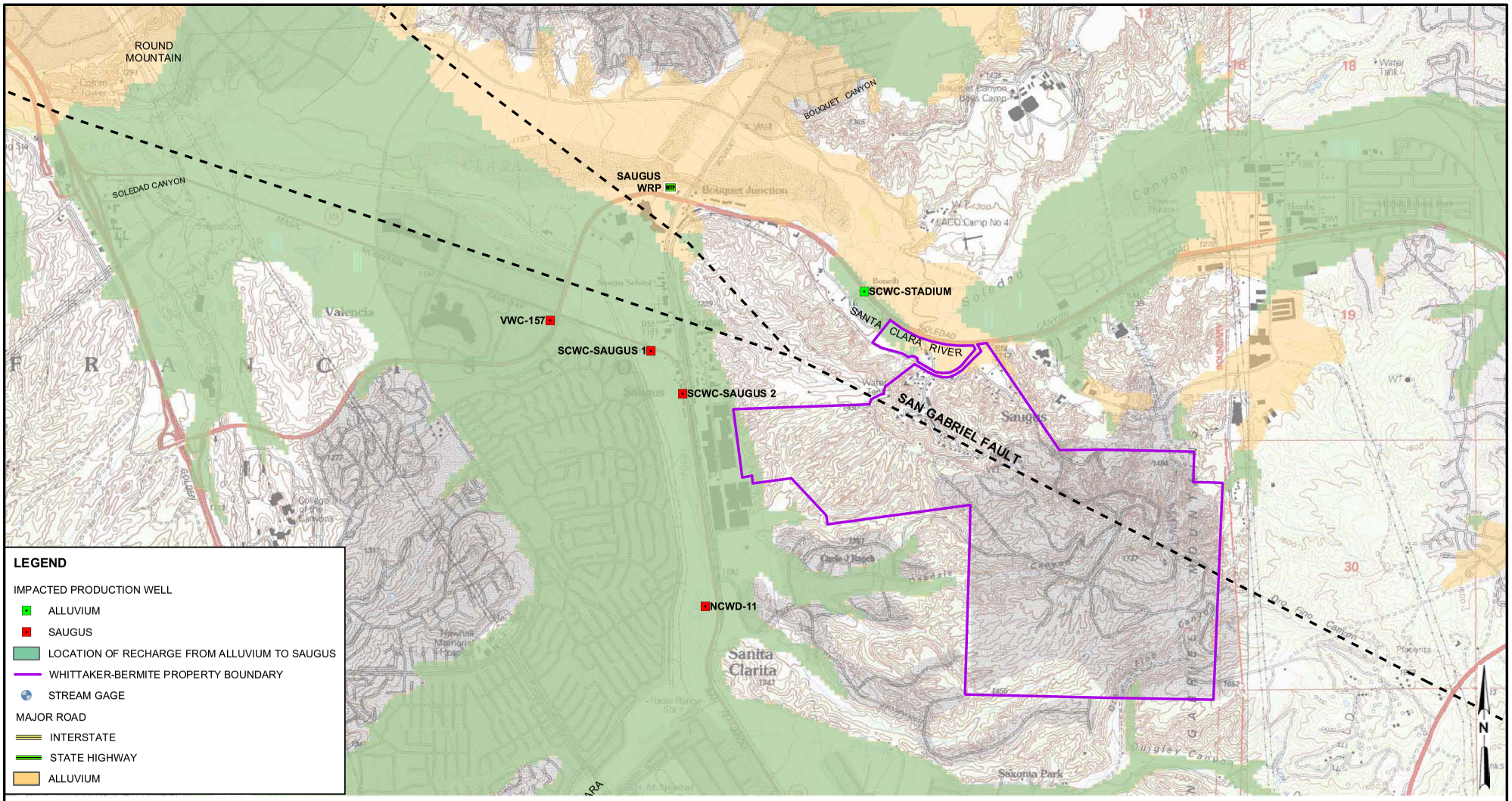

FIGURE 2-30
LOCATIONS OF SAUGUS FORMATION RECHARGE FROM THE ALLUVIAL AQUIFER IN THE VICINITY OF THE WHITTAKER-BERMITE PROPERTY
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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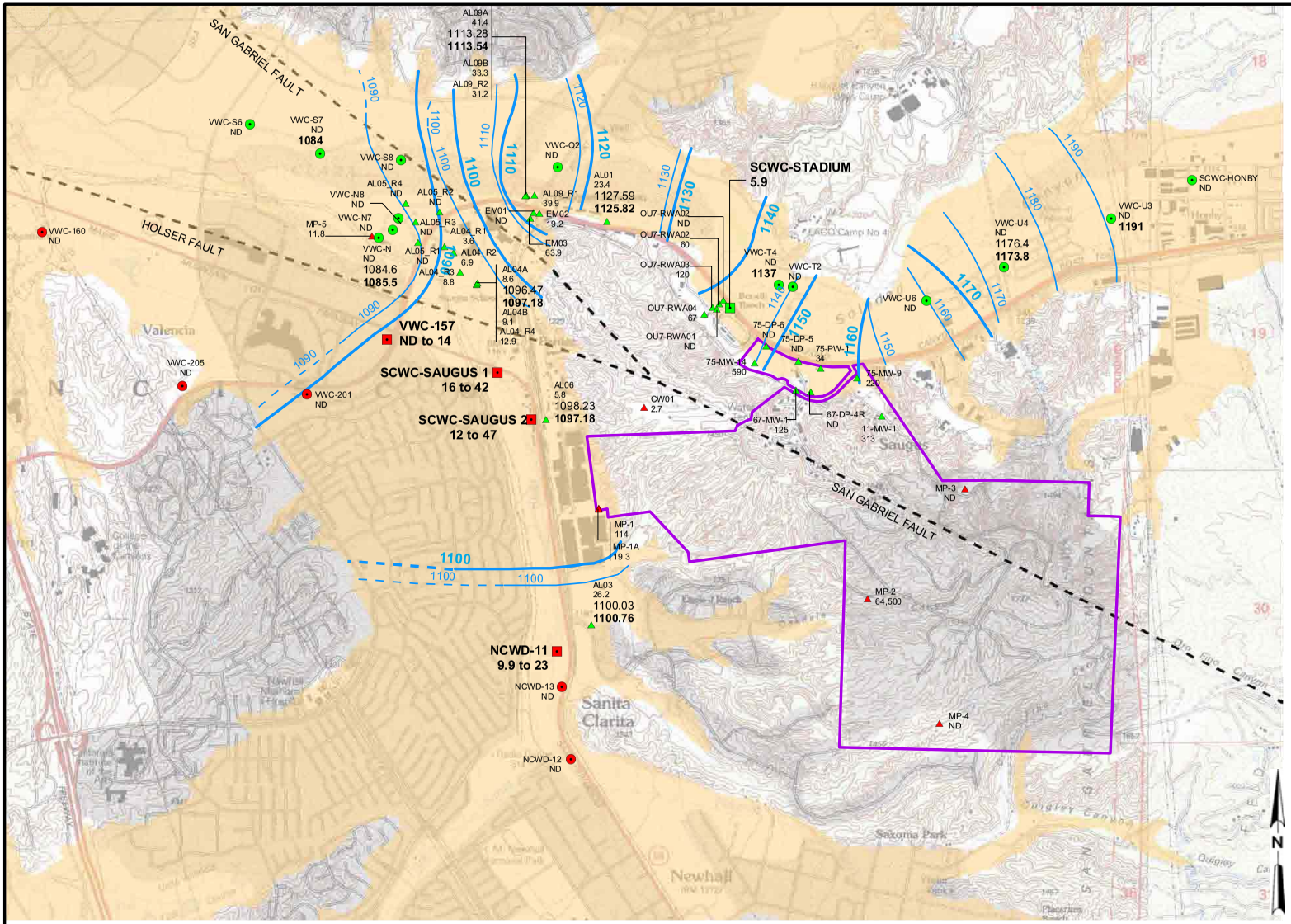

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NONIMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

GROUNDWATER ELEVATION CONTOURS (ft MSL)
- OCTOBER 2003 (DASHED WHERE INFERRED)
- DECEMBER 2003 (DASHED WHERE INFERRED)
- ALLUVIUM
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER
5. 1100.03 = OCTOBER 2003 GROUNDWATER ELEVATION (ft MSL)
6. **1097.18 = DECEMBER 2003 GROUNDWATER ELEVATION (ft MSL)**

FIGURE 2-31
MEASURED ALLUVIAL AQUIFER GROUNDWATER ELEVATIONS IN THE VICINITY OF THE WHITTAKER-BERMITE PROPERTY
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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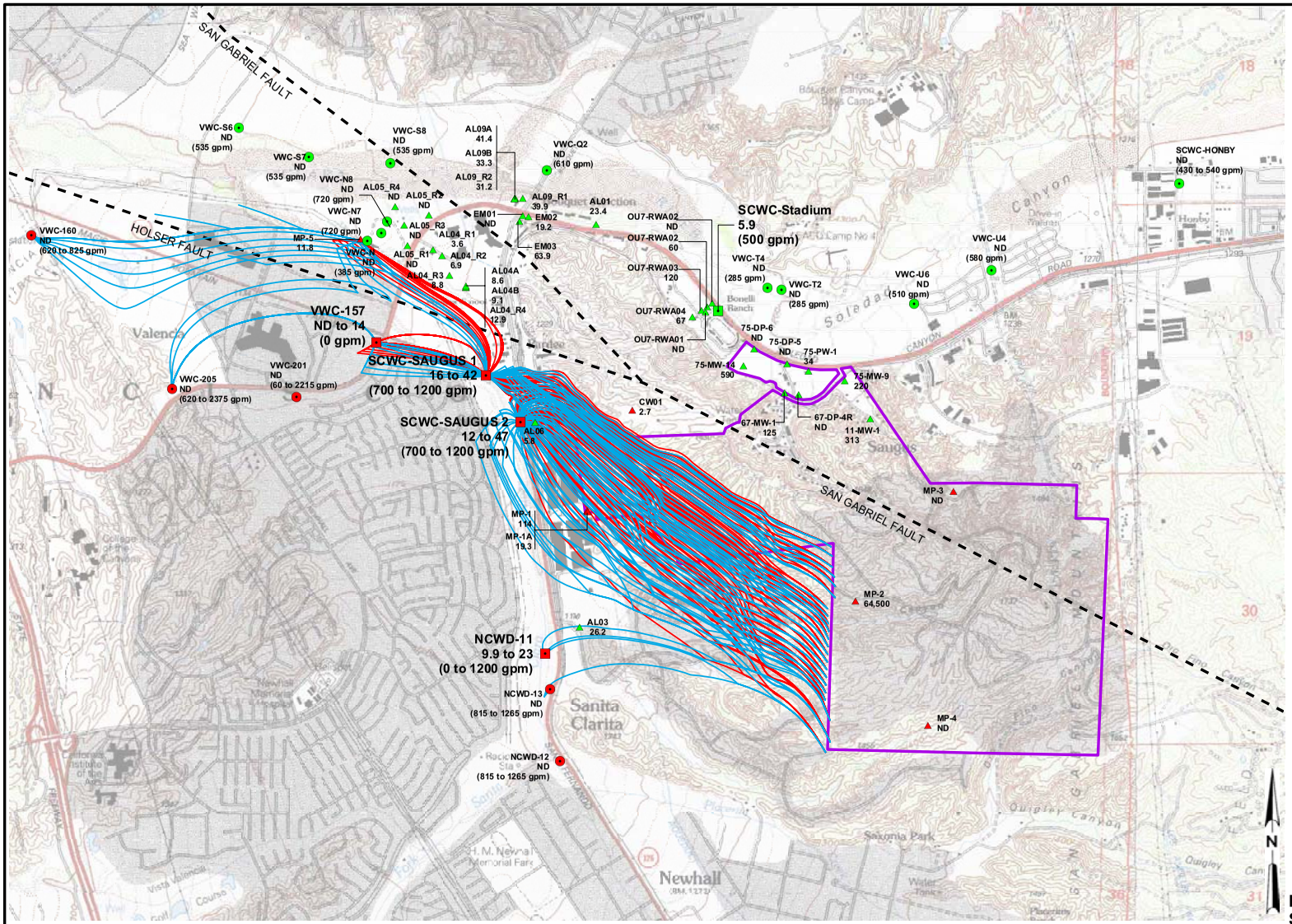

LEGEND

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

MONITORING WELLS

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS

- PUMPING RATE 1200 gpm
- PUMPING RATE 700 and 1000 gpm
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. FLOWPATHS AT VWC-157 AND MP-5 ARE INITIATED IN MODEL LAYERS 2, 3, 4, AND 5. FLOWPATHS AT THE WHITTAKER-BERMITE PROPERTY BOUNDARY ARE INITIATED IN MODEL LAYER 3.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.

FIGURE 2-32
SENSITIVITY OF FLOWPATHS IN THE SAUGUS FORMATION TO LOWER PUMPING RATES AT SCWC-SAUGUS1 AND SCWC-SAUGUS2
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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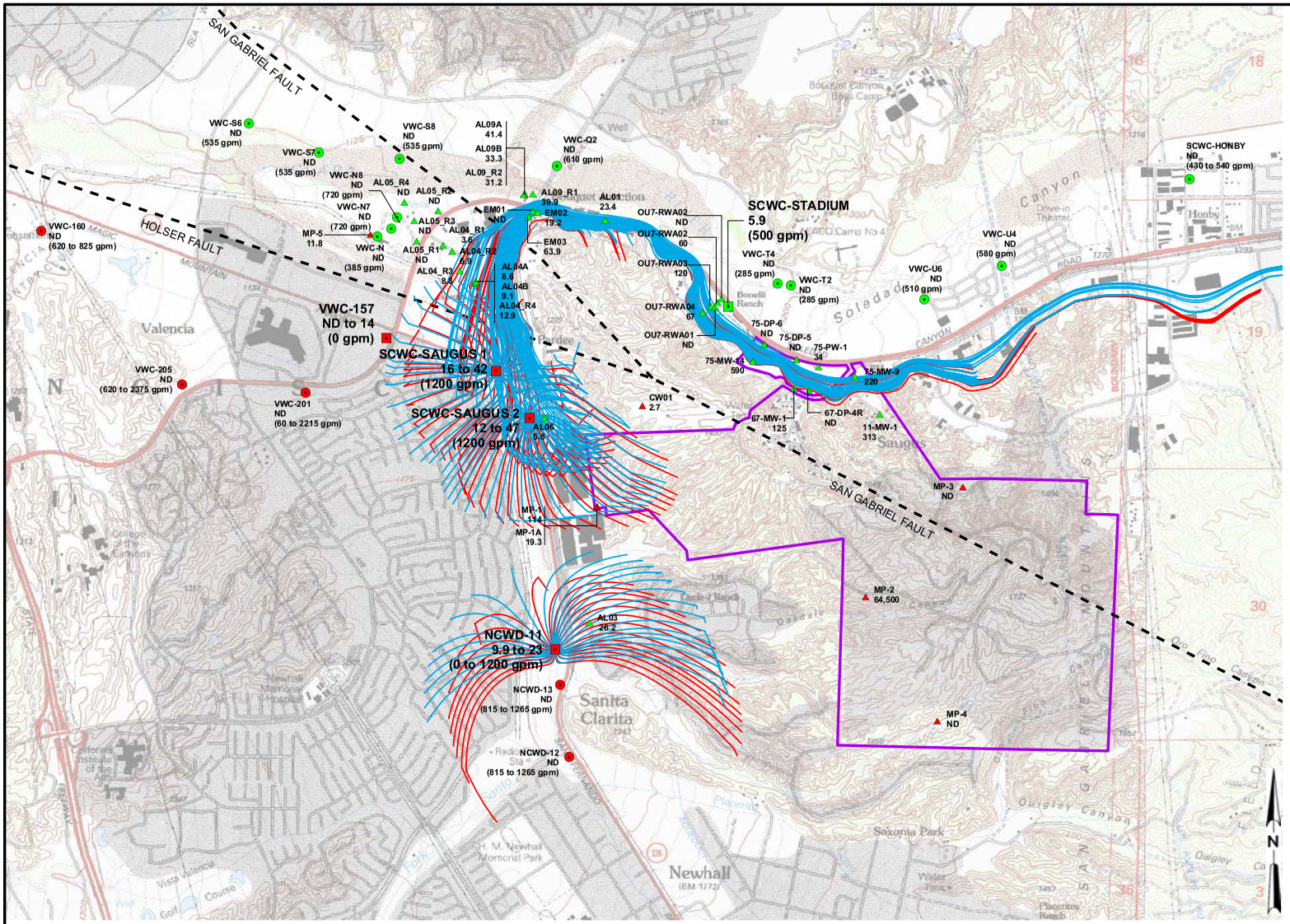

LEGEND

IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL
- ALLUVIUM
- SAUGUS

MONITORING WELLS
- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS
- BASE CASE RUN (Kh:Kv = 50:1)
- SENSITIVITY RUN (Kh:Kv = 200:1)

NOTES:
1. VALUES PRESENTED UNDER WELL SYMBOLS REPRESENT PERCHLORATE CONCENTRATION IN GROUNDWATER (µg/L).
2. INDICATED PUMPING RATES REPRESENT INSTANTANEOUS RATES WHEN THE WELL OPERATES.
3. ND = PERCHLORATE NOT DETECTED IN GROUNDWATER SAMPLE.
4. µg/L = MICROGRAMS PER LITER; gpm = GALLONS PER MINUTE
5. PARTICLES ARE INITIATED IN LAYER 2 AT NC-11, AND LAYER 3 AT SCWC-SAUGUS1 AND SCWC-SAUGUS2.
6. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION.
7. Kh:Kv = RATIO OF HORIZONTAL HYDRAULIC CONDUCTIVITY TO VERTICAL HYDRAULIC CONDUCTIVITY.

FIGURE 2-33
SENSITIVITY OF 20-YEAR CAPTURE ZONES FOR WELLS SCWC-SAUGUS1, SCWC-SAUGUS2, AND NCWD-11 TO LOWER SIMULATED HYDRAULIC CONNECTION BETWEEN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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SECTION 3

Sentinel and Performance Monitoring Programs

This section of the report discusses the objectives and design of the sentinel and performance monitoring programs that will be implemented for the impacted Saugus Formation production wells as part of the permitting process for returning them to service. The sentinel monitoring program is designed to provide early warning of any changes that might occur in groundwater quality. The scope of this discussion is limited to the ambient groundwater quality monitoring that will be performed upgradient of each impacted well (SCWC-Saugus1, SCWC-Saugus2, and NCWD-11). Monitoring of raw and/or treated water produced by the wells will be addressed in separate documents describing the selection and implementation of the planned perchlorate treatment process at each well. The performance monitoring program evaluates whether containment is being achieved by the containment pumping plan.

3.1 Objectives

DHS Policy Memo 97-005 requires the implementation of sentinel monitoring in groundwater upgradient of impacted wells to provide early warning of unanticipated changes in groundwater quality. This monitoring program is described under the source protection element of the evaluation process for returning an impacted well to service. Based on this policy, the sentinel monitoring plan for the impacted Saugus Formation production wells is intended to provide advanced warning of concentration changes or the presence of additional contaminants in groundwater that might affect the perchlorate treatment processes.

Additionally, groundwater elevation and pumping data will be collected under the sentinel monitoring plan to evaluate the effectiveness of the perchlorate containment plan that is described in this report. Specifically, these data will be evaluated to verify that the containment objectives of the containment pumping plan are being achieved and identify any changes to the operations of the containment wells that might be warranted.

3.2 Monitoring Network

As shown on Figure 3-1 and in Table 3-1, the monitoring well network for the sentinel monitoring program will provide access to both the Alluvial Aquifer and the Saugus Formation upgradient of each production well. Monitoring will occur at the following locations:

1. Two new Alluvial Aquifer monitoring wells and four new Saugus Formation monitoring wells (for monitoring upgradient of production well SCWC-Saugus1)
2. One existing Alluvial Aquifer monitoring well and two screens in existing Saugus Formation multi-port monitoring well MP-2 (for monitoring upgradient of production well SCWC-Saugus2)

3. One existing Alluvial Aquifer monitoring well and one new Saugus Formation monitoring well (for monitoring upgradient of production well NCWD-11)

This program will require the installation of seven new monitoring wells (six near SCWC-Saugus1, and one near NCWD-11).

The rationale for the well locations is provided in Table 3-1. Well locations were selected according to the following considerations:

1. Locating sentinel wells sufficient distances from the production well to allow adequate time to respond to significant concentration changes
2. Using existing monitoring wells, to the degree possible
3. Locating new monitoring wells in areas where site access will not cause undue restrictions on drilling, installing, and monitoring new sentinel monitoring wells

The shape of the SCWC-Saugus1 capture zone requires that sentinel wells be located north of SCWC-Saugus1. However, site access restrictions in this area are significant. Consequently, sentinel monitoring wells can only be located just north of SCWC-Saugus1, at locations that might provide only 1 year of warning and response time. At SCWC-Saugus2, the sentinel wells are anticipated to provide as much as 10 years of warning and response time. At NCWD-11, the sentinel wells are anticipated to provide approximately 2 years of warning and response time.

Alluvial Aquifer monitoring is planned near each production well because of the potential for groundwater containing perchlorate to migrate downward into the Saugus Formation and move toward each impacted production well. The *Draft Final Conceptual Hydrogeology Technical Memorandum for the Eastern Santa Clara Sub-basin Groundwater Study* (CH2M HILL, 2004b) has identified a potential pathway for perchlorate migration to production well NCWD-11, consisting of stormwater runoff from Oakdale Canyon that infiltrates into shallow groundwater and migrates vertically into the Saugus Formation due to ambient or induced (by pumping) hydraulic gradients. This pathway has been identified from the hydrogeologic data in this area and the detection of perchlorate in monitoring well AL03, which is located downstream of Oakdale Canyon near production well NCWD-11. In addition, perchlorate detections in Alluvial Aquifer monitoring well AL06, located near SCWC-Saugus2, are consistent with the conceptual pathway involving stormwater runoff influence on the Alluvial Aquifer. This impacted Alluvial Aquifer groundwater is likely to be in direct contact with the upper Saugus Formation, thereby warranting monitoring of the Alluvial Aquifer, and not just the Saugus Formation.

3.3 Chemical Constituents and Monitoring Frequency

Table 3-2 lists the chemical constituents to be monitored, and the frequency at which monitoring will occur as the operational plan for the impacted Saugus Formation production wells is implemented. The following are key aspects of the program's design:

1. The program will focus primarily on monitoring for perchlorate, VOCs, nitrate, and sulfate, which are the constituents most likely to affect the treatment system if present at concentrations greater than those observed to date at the impacted Saugus Formation

production wells. Perchlorate concentrations would need to increase by a factor of approximately 10 or higher above concentrations measured to date before the treatment systems (which will use ion-exchange resins) would be unable to function as necessary.

2. General minerals (anions and cations) will be sampled on a biannual basis to provide geochemical information that may be helpful for evaluating groundwater migration in the vicinity of each impacted production well. However, nitrate and sulfate will be analyzed annually because of their potential influence on the ion-exchange treatment system.

3. The monitoring frequency will be the same for Alluvial Aquifer sentinel wells as for Saugus Formation sentinel wells.

4. Laboratory-quality-assured analytical data will be submitted to DHS after each monitoring event. Additionally, an annual report will be prepared that summarizes the sentinel monitoring results and identifies any recommended changes to the scope of the monitoring program. Proposed changes will also consider treatment operations and analytical data for the production wells being monitored. Changes to the sentinel well monitoring program that are recommended in the annual reports will be implemented after DHS has reviewed and approved the proposed changes.

The sentinel monitoring program will coincide with a long-term groundwater monitoring program occurring at various locations to the east on the Whittaker-Bermite property. That program will consist of monitoring for the constituents above, plus other constituents that can be associated with perchlorate presence, but which have not been detected in groundwater beneath the site to date.

3.4 Evaluating Capture Zone Effectiveness

As discussed in Sections 1.1 and 2.2.5.2 of this report, CLWA will operate SCWC-Saugus1 and SCWC-Saugus2 on a nearly continual basis at a combined rate of 2,400 gpm to provide hydraulic containment of perchlorate that is moving westward in the Saugus Formation from the Whittaker-Bermite property. Groundwater level monitoring and additional groundwater modeling will be conducted to evaluate whether the containment plan is meeting its intended objectives.

Water level monitoring will be conducted at each sentinel well that is completed in the Saugus Formation and at multi-port monitoring well MP-5, which is also completed in the Saugus Formation and is located downgradient of SCWC-Saugus1 and SCWC-Saugus2. Water levels will be measured at these wells during the startup period for the containment system, as well as immediately prior to startup. Additionally, detailed records of groundwater extraction rates, and the timing of those extractions, will be maintained for SCWC-Saugus1 and SCWC-Saugus2 and the other nearby Saugus Formation production wells (VWC-160, VWC-201, VWC-205, NCWD-11, NCWD-12, and NCWD-13).

The water level trends will then be compared with water level trends that are calculated from Regional Model simulations of the pumping at impacted and nonimpacted wells during the initial startup period for the containment pumping plan. If the comparison of simulated and measured water level trends indicates that adjustments are warranted to the

assignment of Saugus Formation aquifer properties in the model, those adjustments will be made and the capture zone evaluations presented on Figure 2-24 of this report will be re-evaluated. Regardless of the need for changes to the model, the information that is obtained from this field data collection program and the subsequent modeling analysis will be used to draw conclusions concerning the effectiveness of the containment plan and whether adjustments to the pumping operations at SCWC-Saugus1 and SCWC-Saugus2 are warranted. These conclusions will be presented in a separate report to DHS.

Tables

TABLE 3-1

Well Network for Sentinel Groundwater Quality Monitoring

Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

Production Well	Sentinel Monitoring Locations	New Monitoring Well Needed?	Actual or Target Depth Interval for Well Screen (ft bgs)	Well Name	TOT Distance from Production Well	Rationale, Comments
SCWC-Saugus1	Alluvium: New well in Magic Mountain	Yes	40-60	AL-12A	1 year or less	Alluvial and Saugus HSU S-I monitoring is for a possible pathway to SCWC-Saugus1. Access constraints might require installation of these wells in the City of Santa Clarita right of way along Magic Mountain Parkway. There are currently no Saugus Formation monitoring wells within the delineated capture zone of SCWC-Saugus1. The Saugus wells for HSU S-III will be installed near the corner of San Fernando Road and Magic Mountain Parkway on land owned by the Newhall Land & Farming Company.
	Parkway north of Saugus1	Yes	170-180	AL-12B		
	Saugus (S-I unit): Adjacent to new alluvium well	Yes	230-250 (HSU S-I)	SG1-HSU1		
	Saugus (S-III unit): NLF land north of SCWC-Saugus1	Yes	490-520 (HSU S-III)	SG1-HSU3a		
		Yes	580-640 (HSU S-III)	SG1-HSU3b		
		Yes	750-770 (HSU S-III)	SG1-HSU3c		
SCWC-Saugus2	Alluvium: Existing well AL06	No	65-85	AL06	10 years	Alluvial monitoring is recommended to assess perchlorate near the SCWC-Saugus2 well. At MP-1, the port 2 screen correlates with the top of the screened intervals at SCWC-Saugus1 and SCWC-Saugus2. Port 4 is the uppermost port below a depth of 1,000 feet and below the zones containing perchlorate.
	Saugus: MP-1, ports 2 and 4	No	391.4-401.4 (HSU S-III)	MP-1 (port 2)		
		No	747.5-757.5 (HSU S-V)	MP-1 (port 4)		
NCWD-11	Alluvium: Existing well AL03	No	91-111	AL03	2 years	Alluvial monitoring is recommended because of the potential for the Alluvial Aquifer to be a pathway for perchlorate migration from the site to well NCWD-11. Additionally, movement within the Saugus Formation could be occurring from the site, which is the reason to install a Saugus sentinel well near the Alluvial sentinel well.
	Saugus: New well at AL03 location	Yes	280-320 (HSU S-III)	NC11-HSU3		

Notes:

TOT = time-of-travel

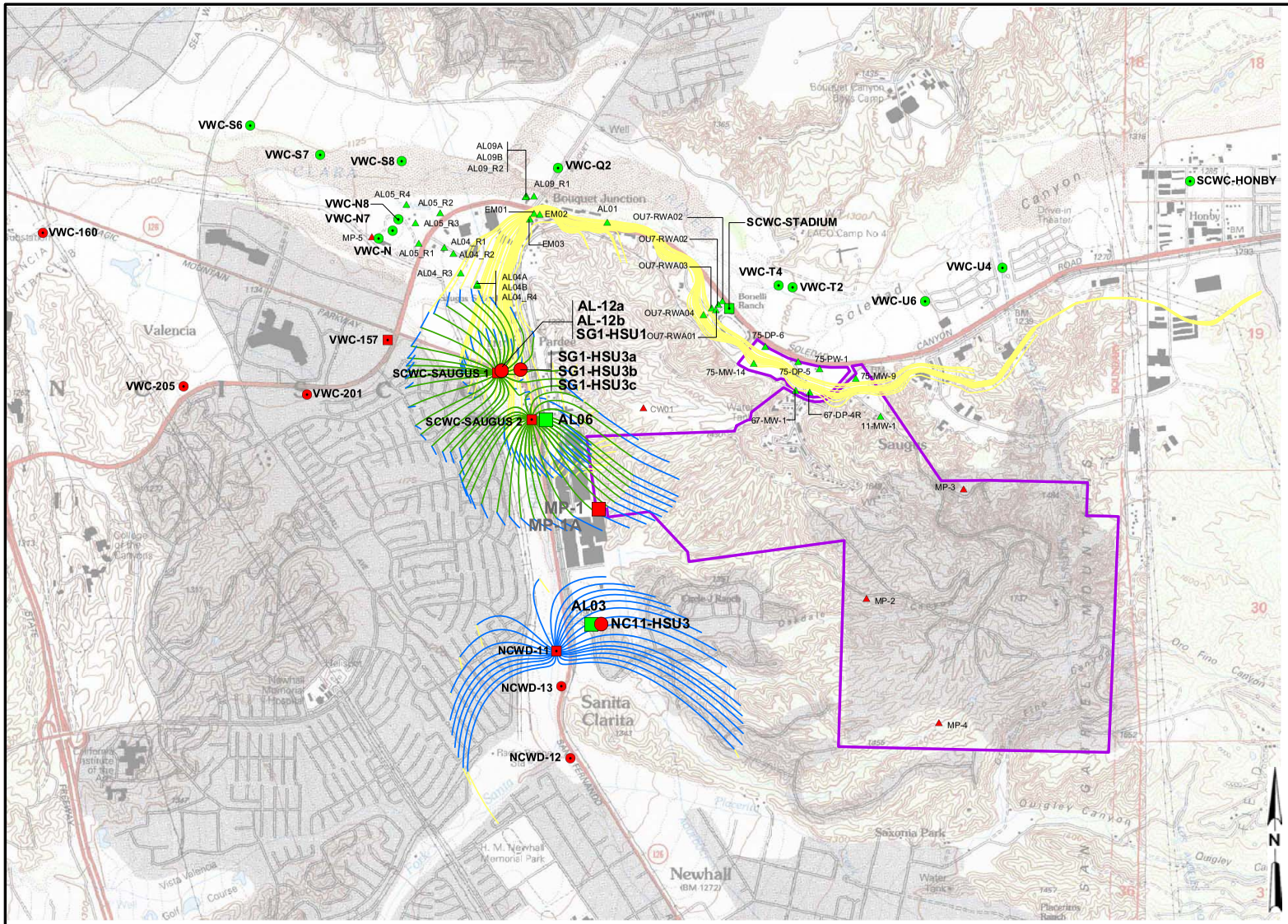
HSU = hydrostratigraphic unit (See *Draft Final Conceptual Hydrogeology Technical Memorandum for the Eastern Santa Clara Sub-basin Groundwater Study* [CH2M HILL, 2004b] for discussions of the locations and characteristics of the HSUs.)

TABLE 3-2
Chemical Constituents and Sampling Frequency for the 97-005 Sentinel Monitoring Program
Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property, Santa Clarita, California

		Frequency			
Analytical Parameters	**EPA Method**	**Initial**	**Semiannual**	**Annual**	**Biannual**
Organic Constituents					
Perchlorate	314.0	X	X		
Volatile Organic Compounds	524.2[a]	X	X		
1,2,4-Trimethyl Benzene		X	X		
Methyl Tertiary Butyl Ether		X	X		
General Minerals (Cations and Anions)					
Aluminum	6010	X			X
Bicarbonate/Alkalinity	310.1	X			X
Calcium	6010	X			X
Chloride	300	X			X
Total Phosphorus	365.3	X			X
Potassium	7610	X			X
Iron	6010	X			X
Magnesium	6010	X			X
Manganese	6010	X			X
Sodium	7770	X			X
Sulfate	300	X		X	
Nitrate	352.1	X		X	
Ammonia	350.3	X			X

[a]Tentatively identified compounds will also be reported.

Figure



LEGEND

SENTINEL WELLS

EXISTING SENTINEL WELL

- ALLUVIUM
- SAUGUS

NEW SENTINEL WELL

- ALLUVIUM
- SAUGUS

PRODUCTION WELL

IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

NON-IMPACTED PRODUCTION WELL

- ALLUVIUM
- SAUGUS

OTHER MONITORING WELL

- ALLUVIUM
- SAUGUS

GROUNDWATER FLOWPATHS

- MODEL LAYER 1
- MODEL LAYER 2
- MODEL LAYER 3
- MODEL LAYER 4
- MODEL LAYER 5
- WHITTAKER-BERMITE PROPERTY BOUNDARY

NOTES:

1. FLOWLINES STARTED THROUGHOUT MODEL LAYERS 2 AND 3 AND TRACED BACKWARDS FOR 20 YEARS.
2. FLOWPATHS ARE DELINEATED USING AN EFFECTIVE POROSITY OF 0.10 IN THE ALLUVIAL AQUIFER AND THE SAUGUS FORMATION. .

FIGURE 3-1
WELL LOCATIONS FOR SENTINEL MONITORING OF GROUNDWATER QUALITY
ANALYSIS OF PERCHLORATE CONTAINMENT IN GROUNDWATER NEAR THE WHITTAKER-BERMITE PROPERTY
SANTA CLARITA, CALIFORNIA

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SECTION 4

References

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ITEM NO. 4.1

Castaic Lake Water Agency
Memorandum

October 1, 2008

To: CLWA Board of Directors

From: Brian J. Folsom BJF
Engineering and Operations Manager

Subject: Engineering and Operations Department Report

TREATMENT PLANT OPERATIONS AND MAINTENANCE

Completed Work:

Deliveries to the purveyors in September totaled 4,290 acre-feet (AF), for an average daily flow rate of 47 million gallons per day (MGD). September 2008 deliveries were 11% below September 2007 deliveries. The fiscal-year-to-date (FYTD) deliveries for FY 2008/09 are 14,708 AF, which is 10% below FYTD 2007/08. Monthly flows for 2006, 2007, 2008 and 2009 are presented in the attached table. *(FY 2008/09 Action A2.4: Meet all purveyor water demands and Action B3.3: Meet all applicable water quality regulations.)*

Fiscal-year-to-date electrical use for FY 2008/09 at the Agency's major facilities is shown in the attached "Energy Usage at Major Facilities" table and equals 2,743,683 kWh at a total cost of $320,776.46.

At RVWTP, control strategies for chemical feed pumps were modified to improve control of chemical dosing, preventive maintenance was performed on airwash blower #1, new air compressors were installed, chemical feed meters on the caustic soda and ferric chloride feed systems were installed, and modification and upgrades to the rainwater collection system for the clearwell floating covers was completed.

Preventive maintenance was performed on Pump #1 at the Rio Vista Intake Pump Station.

At ESFP, polymer chemical feed pumps were replaced with automated flow pacing chemical feed pump.

Repairs were completed to Pump #2 at the Earl Schmidt Intake Pump Station.

Inspector Activities

Pitchess Pipeline modification work at Hasley Canyon: Coordinated with Security Paving.

Recycled Water Pipeline Phase I modification work at Magic Mountain/The Old Road: Attended bi-weekly utility coordination meetings with staff from CLWA, City of Santa Clarita and Security Paving; photographed activity at V-9 and coordinated paving work around the AVAR on The Old Road.

Recycled Water Pipeline irrigation service connection: Inspected service connection work and coordinated with Valencia Water Company and Pinnacle Surveying.

Groundwater Production Restoration & Transmission Mains Project: Located Newhall Lateral along South Fork Trail and coordinated with City of Santa Clarita regarding possible tree removal along South Fork Trail.

ESFP Chemical Storage and Delivery Project: Performed inspections, coordinated with Harris & Associates and attended progress meetings.

Sand Canyon Reservoir access road: Attended site visit with potential bidders and participated in bid opening.

Completed 54 Underground Service Alerts.

Work in Progress:

At ESFP, airwash blower #1 is off line for repairs and preventive maintenance. The chemical feed meters for the ferric chloride, caustic soda and cationic polymer feed systems will be replaced and a sludge collection system in the washwater recovery basins will be installed.

Maintenance of air vacs and pump-outs throughout the distribution system continues.

Planned Actions:

At ESFP, pumps at the central pump station will be overhauled.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT

(FY 2008/09 Action A4.2: Complete construction of the Groundwater Production Restoration Project; Action A4.3: Complete construction and startup of the Perchlorate Treatment Project; Action A4.5: Develop replacement wells for capacity lost due to perchlorate contamination.)

SUMMARY

Work continues on multiple tasks to address the groundwater contamination stemming from past manufacturing activities on the Whittaker-Bermite site. The Agency and purveyors are proceeding to restore the production capacity of the groundwater supply wells contaminated by perchlorate, while working on the objectives of containing the downgradient migration of perchlorate and recovering costs incurred in responding to the perchlorate contamination.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT

The following table provides a status report on the activities and tasks:

Task Group	Tasks	Consultant	Status
Settlement Activities	Project Description	K/J	Complete.
	Final Settlement	K/J, Nossaman	Settlement agreement took effect on 7/13/07 with U.S. District Court approval.
DTSC Approval Activities	Remedial Investigation (RI)	K/J	DTSC approved 8/16/05.
	Feasibility Study (FS)	K/J	DTSC approved 8/16/05.
	Final RAP	K/J	Public hearing held 9/7/05. DTSC approved 1/20/06.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT *(Continued from previous page...)*

Task Group	Tasks	Consultant	Status
U.S. Army Corps of Engineers Feasibility Phase Study	Conceptual Hydrogeology Technical Memorandum	CH2MHill	Final distributed 1/19/05. Progress report with model construction calibration distributed 10/11/05.
DPH Approval Activities (97-005)	Source Water Assessment	B&V, CE	Received comments on revised document from DPH 4/27/06.
	Water Quality Investigation	B&V, CE	Received comments on revised document from DPH 4/27/06.
	Human Health Risk	B&V	Received comments on revised document from DPH 4/27/06.
	Source Protection Plan	B&V	Received comments on revised document from DPH 4/27/06.
	Effective Monitoring and Treatment	B&V, CE, CH2MHill	Received comments on revised document from DPH 4/27/06.
	Alternatives Evaluation	B&V, CE	Received comments on revised document from DPH 5/10/06. Revised document will be returned to DPH with Engineer's Report.
	Engineers Report	B&V	Received final draft from B&V 5/23/08.
	CEQA	B&V	Mitigated Negative Declaration certified 9/14/05.
	Permit Application	B&V	Awaiting response from DPH.
	Public Hearing	B&V	Awaiting response from DPH.
	DPH Evaluation and Permit	B&V	Awaiting response from DPH.
Implementation Activities	Easements and Right of Way	K/J	Easement and right-of-way acquisition completed 1/08.
	Treatment Project	K/J	Notice to Proceed issued 11/14/07. Project is 75% complete.
	Pipeline Project	K/J	Notice to Proceed issued 12/14/07. Project is 35% complete.
	Start-up and Monitoring	K/J	Scheduled early 2009.
	Permit Application	B&V	Awaiting response from DPH.
	Public Hearing	B&V	Awaiting response from DPH.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT *(Continued from previous page...)*

The monthly Technical Committee Meeting was held on September 9, 2008. The next Technical Committee Meeting is scheduled for October 14, 2008. The next quarterly DTSC meeting will be held on October 14, 2008. The next Whittaker-Bermite Multi-Jurisdictional Task Force meeting will be held on December 10, 2008.

FINANCIAL STATUS

The Settlement Agreement among CLWA, the purveyors, Whittaker-Bermite and insurance carriers is in effect. Payments have been made for most expenses through 4/30/08. Approval of payments will be considered (retroactively) at future Technical Committee meetings.

CAPITAL IMPROVEMENT PROJECTS

Sand Canyon Pipeline and Reservoir

(FY 2008/09 Action B1.5: Complete construction for the Sand Canyon Reservoir Access Road project.)

Completed Work:

Final design of the Sand Canyon Reservoir Access Road Project is complete. The project was advertised for construction bids, the pre-bid conference was held on August 20, 2008 and bids were opened on September 10, 2008.

Prepared Certificate of Acceptance and recorded Notice of Completion for the Storm Drain Modification Project in the County of Los Angeles Recorder's Office.

Work In Progress:

Preparing conformed specifications and drawings.

Planned Actions:

Obtain Board approval to award the construction contract for the Sand Canyon Reservoir Access Road.

Rio Vista Water Treatment Plant Expansion

(FY 2008/09 Action B1.2: Complete design of the RVWTP Expansion Project; Action B1.7: Complete bidding process and start construction of the RVWTP Expansion Project.)

The project scope includes expansion from 30 to 60 mgd at RVWTP and Intake Pump Station, ozone system improvements and washwater system modifications.

Completed Work:

K/J has completed the 90% design.

Work In Progress:

Staff is reviewing the 90% design.

Planned Actions:

Complete design and prepare the final construction contract documents.

Modification to MWDSC Foothill Feeder Connection

(FY 2008/09 Action B1.3: Complete design of the new raw water connection to MWDSC's Foothill Feeder pipeline.)

Completed Work:

Staff has completed review of the connection agreement and has submitted comments to MWDSC. The 30% design plans have also been submitted to MWDSC for review.

Work in Progress:

Staff met with MWDSC on September 15, 2008 to discuss the revised connection agreement.

Planned Actions:

After the agreement is executed, MWDSC will review the submitted 30% design plans.

Honby Parallel Phase II

(FY 2008/09 Action B1.16: Complete construction of the Honby Parallel Phase 2.)

Completed Work:

The final design has been submitted to LADWP for approval.

Work in Progress:

LADWP is reviewing the design. The traffic control plans are being prepared. The permits, license agreements and easements are in the process of being acquired. The Honby Agreement with Newhall Land is being revised.

Planned Actions:

Complete and submit the traffic control plans to the City for approval. Mail notification letters to businesses along the project route to inform them of the project. Acquire permits, license agreement and easements.

RVWTP Relocate Entrance Gate and Security Kiosk

(FY 2008/09 Action B6.2: Complete design of RVWTP entrance gate and security kiosk relocation.)

Completed Work:

Staff has issued Requests for Proposals and has received proposals from several consultants.

Work In Progress:

Staff is evaluating proposals for the planning and preliminary design.

Planned Actions:

Select a consultant to perform the planning and preliminary design.

RVWTP Warehouse and Storage Facilities

(FY 2008/09 Action B1.11: Complete design of the RVWTP Maintenance Facility Expansion Project.)

Completed Work:

The latest floorplan was presented at the March 2008 Planning and Engineering Committee meeting.

On August 28, 2008, staff presented its analysis to the Planning and Engineering Committee of projected water demands for the summer of 2010 and the option of combining the Warehouse and Storage Facilities project with the RVWTP Expansion project, concluding that the two projects should remain segregated for bidding and construction.

Work in Progress:

Staff is preparing a Request for Proposal (RFP) for design services.

Planned Actions:

Select a consultant to perform design services.

ESFP Chemical Storage and Delivery

(FY 2008/09 Action B1.8: Complete construction of the ESFP chemical storage and delivery project.)

Completed Work:

Construction submittals have been completed. The two containment tanks have been installed.

Work in Progress:

Construction of the project is in progress.

Planned Actions:

Complete construction.

ESFP Drainage and Paving Improvements

(FY 2008/09 Action B2.8: Complete construction of the ESFP Drainage and Paving Improvements Project.)

Completed Work:

RFP for professional services for planning and preliminary design was issued and proposals received on August 27, 2008.

Work in Progress:

Staff is reviewing and evaluating submitted proposals.

Planned Actions:

Prepare recommendations to award contract for project planning and preliminary design.

ESFP Railing and Platform Enhancements

(FY 2008/09 Action B2.4: Complete modifications of the ESFP railings and platforms.)

Completed Work:

The topographic survey has been completed. Preliminary drawings for the platform extension have been completed.

Work in Progress:

The design is being finalized for bidding.

Planned Actions:

Advertise the project for construction bids.

Recycled Water Program Phase II

(FY 2008/09 Action B1.14: Complete CEQA compliance and design of the Recycled Water Program Phase II.)

Completed Work:

General area alternatives have been identified and coordinated with the purveyors and the Santa Clarita Valley Sanitation District of the Los Angeles County.

Work in Progress:

Kennedy/Jenks is evaluating and refining the alternatives with the support of IDModeling's hydraulic modeling and mapping services.

Planned Actions:

Complete the evaluation and meet with purveyors and the Sanitation District to coordinate the recycled water plans.

FACILITY CAPACITY FEES

(Goal C1.: Fairness Doctrine - Apply all costs using the Fairness Doctrine by applying costs to those who benefit from an expenditure and ensuring that existing and future users will pay their fair share.)

Completed Work:

During September, 26 new certificates were issued and $117,253 was collected in facility capacity fees, representing approximately 13 acre-feet of water demand. For the fiscal year, 77 new certificates have been issued and $772,108 has been collected in developer impact fees representing 78.5 acre-feet of water demand.

Attachments

Summary Report Letter from AMEC Geomatrix Regarding the Former Whittaker-Bermite Facility, October 2008

RECEIVED
NOV 21 2008
By

November 17, 2008

Project 9967.000.0

Sayareh Amir
Department of Toxic Substances Control
Site Mitigation Branch
9211 Oakdale Avenue
Chatsworth, CA 91311

Re: Former Whittaker-Bermite Facility, Santa Clarita, CA
Summary Report for Month of October 2008

Dear Ms. Amir:

This letter constitutes a progress report for the month of October 2008, prepared pursuant to Task 4 and Section 6.3 of the "Imminent and Substantial Endangerment Determination and Order and Remedial Action Order" (the Order) that the Department of Toxic Substances Control (DTSC) issued on November 22, 2002, for the former Whittaker-Bermite facility (site) in Santa Clarita, California.

SECTION I – SITE WIDE ISSUES

Specific actions taken on behalf of the respondent, actions expected to be undertaken, and planned activities for site-wide issues are summarized in the following:

PUBLIC PARTICIPATION

Activities for This Report Period

Cerrell Associates Inc. team provided community information assistance when needed.

Anticipated Activities for This Month

Continue supporting DTSC's public outreach activities and assist with updating the DTSC's Web site (www.envirostor.dtsc.ca.gov) as necessary.

SECTION II – SOIL ISSUES

Specific actions taken on behalf of the respondent, actions expected to be undertaken, and planned activities for soil issues are summarized in the following sections:

RI AND RCRA MONITORING

Activities for This Report Period (1)

All Remedial Investigation (RI) activities for characterization of soils have been completed. No additional soil RI work is anticipated.

AMEC Geomatrix, Inc.
510 Superior Avenue, Suite 200
Newport Beach, CA
USA 92663-3627
Tel (949) 642-0245
Fax (949) 642-4474
www.amecgeomatrixinc.com

AMEC Geomatrix

Activities for This Report Period (2)

Geomatrix submitted a letter to DTSC on July 24, 2006, requesting DTSC's agreement to incorporate the current Resource Conservation and Recovery Act (RCRA) groundwater monitoring of the Area 317 into the OU-7 groundwater study and monitoring.

Environ has prepared the scope and the frequency of the monitoring activities to focus the RCRA groundwater monitoring to those areas that will provide meaningful results. The document was submitted for DTSC review and approval on January 30, 2008. DTSC issued a letter on April 10, 2008, approving the revised RCRA groundwater monitoring program. In addition, DTSC requested that the revised RCRA groundwater monitoring plan be included in the Closure Report for Area 317.

Monitoring of the groundwater under the Area 317 continues on schedule. The Third Quarter 2008 groundwater monitoring was performed in September and the report is being prepared.

Anticipated Activities for This Month

Monitoring of the groundwater under the Area 317 continues on schedule. The Fourth Quarter 2008 groundwater monitoring was performed in November 2008.

Long-Term Actions

The current RCRA groundwater monitoring program will be modified to include the proposed wells and frequency and DTSC input to the monitoring plan and the revised plan will be included in the closure report for Area 317. Perform groundwater monitoring per the revised monitoring plan beginning in first quarter 2009 and continue the closure activities.

REMEDIAL ACTION PLAN

Activities for This Report Period

CDM completed the Remedial Action Plan (RAP) for OU2 through OU6 soils (Site-Wide Soils RAP), which was submitted to DTSC on May 15, 2008. DTSC provided comments on the Site-Wide Soils RAP on September 4, 2008. DTSC requested that a revised Site-Wide Soils RAP be prepared and submitted by October 31, 2008. Whittaker submitted a letter to DTSC on October 31, 2008 requesting an extension of the submittal deadline to January 31, 2009 in order to allow the various stakeholders to re-assess the remedial approach in light of SSC's departure.

CDM also prepared pilot study work plans for soil vapor extraction (SVE) and in-situ bioremediation of perchlorate-impact to deep soils via Gaseous Electron Donor Injection Technology (GEDIT). The SVE pilot study work plan and the GEDIT bench-scale and field pilot work plan were submitted to DTSC on August 27 and September 5, 2008, respectively. DTSC provided comments to the SVE pilot study work plan on September 22, 2008. CDM

subsequently prepared a response to comments letter that was submitted to DTSC on October 2, 2008 and a revised work plan on October 15, 2008. DTSC approved the revised work plan in a letter dated October 22, 2008.

Anticipated Activities for This Month

Address DTSC comments to the Site-Wide Soils RAP and prepare revised draft RAP. Continue to work on revisions to pilot study work plans for submittal to DTSC. Secure funding for SVE pilot studies program and schedule field activities.

Long-Term Actions

Work with DTSC to finalize the Site-Wide Soils RAP. Submit revisions to work plans for pilot studies for DTSC review and approval, if warranted.

REMOVAL ACTIONS AND INTERIM REMEDIAL MEASURES

Depleted Uranium (DU) Investigation and Clearance Activities

Activities for this Report Period

A meeting was held with the DTSC, and the Department of Public Health – Radiological Health Branch (DPH-RHB), and LA County to discuss the results of the Supplemental Characterization and Bench Scale Testing activities. In addition, a proposed path forward was introduced for discussion. The proposal is based on the direct removal and off-site disposal of approximately 4,200 yards of the most impacted materials in Areas 57 and 14. The removal would be followed by a comprehensive Final Status Survey. The proposal received a tentative OK from the regulatory agencies. Formal approval will come with their approval of the Removal Action Plan.

Anticipated Activities for this Month

A comprehensive report detailing the Supplemental Characterization and Bench Scale Testing activities and a review of the dose assessment is anticipated to be completed this month.

Long Term Actions

EnergySolutions will prepare a Removal Action Plan for implementation of the proposed DU removal activity. This will be submitted to the regulatory agencies for review and approval. After that approval is received, the DU removal and Final Status Survey will be implemented.

UXO/OE Investigation and Clearance Activities

Activities for This Report Period

EOD Technology, Inc. (EODT) completed the following activities during this reporting period:

Work Plan Addendum (WPA) Further Investigation and No Further Action Areas

EODT updated the WPA and associated Conceptual Site Model (CSM). The WPA will characterize the Further Investigations Areas and confirm the No Further Action status of the potential/Munitions and Explosives of Concerns (MEC) areas referenced in the 2006 Historical Site Assessment (HSA) Report.

Munitions and Explosives of Concern Clearance Activities at Hula Bowl II and III associated Drainage Area, and the Depleted Uranium Impacted Area.

The Work Plan Addendum was approved with comments by DTSC in June 2008. EODT is planning for project execution of Hula Bowl II and III Drainage Clearance in coordination with the DU Impacted Area clearance in Areas 57 and 14. The implementation of the clearances is pending the upcoming Energy Solutions report designating the DU removal areas based on the recent DU impact area characterization. It is anticipated the DU removal design may impact the strategy in the Work Plan Addendum – if so; the plan will be modified in coordination with DTSC.

Anticipated Activities for This Month

Work Plan Addendum Further Investigation and No Further Action Sites

Anticipate 90% of the Work Plan Addendum complete.

Munitions and Explosives of Concern Clearance Activities at Hula Bowl II and III associated Drainage Area, and the Depleted Uranium Impacted Area

Based on the findings of the recent Energy Solutions characterization effort, EODT anticipates scheduling and making any necessary adjustments to the planned clearance activities in the DU Impacted areas.

Long-Term Actions

Complete On-Call UXO Construction Report as required.

Submit and finalize the Work Plan Addendum for Further Investigation and No Further Action Sites. Execute the Work Plan Addendum and provide Remedial Alternative Analysis for the Further Investigation Areas and Confirm the No Further Action area status or assign the areas for further investigation/remedial alternative where warranted.

Implement the Munitions and Explosives of Concern Clearance Activities at Hula Bowl II and III associated Drainage Area, and the Depleted Uranium Impacted Area.

OU1 REMEDIATION

Activities for This Report Period (1)

Operated the secondary SVE system (hi-vacuum system) at the Building 329 area, then moved the system to Area 43 for continued operations in that Area. The primary SVE unit remained at Treatment Pad No. 3 in the event that VOC-impacted soils may be encountered during the Building 329 excavation. However, no VOC-impacted soils needing ex situ treatment were encountered.

Anticipated Activities for This Month

Continue operation and optimization of SVE system at Area 43. Schedule re-installation of deep SVE well at Area 7 and prepare area for re-initiation of SVE operations.

Long-Term Actions

Continue in situ SVE operations until halogenated volatile organic compound levels are eliminated or reduced to appropriate levels or asymptotic levels are reached.

Activities for This Report Period (2)

Backfilling was continued in Area 55/OU1B/OU1C and approximately 71,588 cubic yards of soil was placed into the former excavation and compacted in accordance with the Remedial Design specifications.

Approximately 15,036 cubic yards of soil were excavated from the Building 329 area during this reporting period and the excavation operations were completed.

Full-scale enhanced biological treatment of perchlorate-impacted soils continued during this reporting period using a combination of glycerin, di-ammonium phosphate, and bioaugmentation culture (0.01% when available). During this reporting period, approximately 17,588 tons of soil was processed and placed into treatment cells (24). Sampling results have generally shown consistent and successful reduction of perchlorate to non-detectable levels. The incubation time is generally on the order of 20 to 30 days. A total of 11 treatment cells were approved as "clean" by DTSC during this reporting period and the treated soil was transported to clean soil stockpile areas.

Dust monitoring indicated that, in general, the net dust readings at the downwind monitoring stations were below 50 micrograms per cubic meter ($\mu g/m^3$) during the soil excavation and processing operations. In the few cases when the dust readings exceeded 50 $\mu g/m^3$, the dust was suppressed with water; therefore, the exceedances were insignificant.

Anticipated Activities for This Month

Complete backfilling operations in Area 55 and Building 329 and begin vegetation restoration. Demobilize soil treatment equipment.

Long-Term Actions

Preparation of closure report documenting the soil remediation operations for OU1.

SECTION III – GROUNDWATER AND SURFACE WATER ISSUES

Specific actions taken on behalf of the respondent, action expected to be undertaken and planned activities for groundwater and surface water issues are summarized in the following sections:

REMEDIAL INVESTIGATIONS AND GROUNDWATER/SURFACE WATER MONITORING AND INTERIM ACTIONS

Activities for This Report Period (1)

The Numerical Groundwater Flow Model Development Report, Operable Unit 7 Groundwater Investigations has been submitted to DTSC and comments were provided by DTSC staff on June 4, 2008. The numerical groundwater flow model has since been refined to incorporate the results of the OU-7 RI. The comments received from DTSC, from CH2M Hill on behalf of the USACE, and the model refinements were discussed in a conference call with representatives of DTSC, USACE, CH2M Hill, and Whittaker held on September 26, 2008.

Anticipated Activities for This Month

The numerical groundwater flow model will be further refined for use in the OU-7 FS evaluations. DTSC and CH2M Hill comments on behalf of USACE are being addressed and will be incorporated into the model refinement process.

Long-Term Actions

Groundwater monitoring and sampling data will be used in refining the model which will be utilized in the OU-7 FS.

Activities for This Report Period (2)

A Pilot Remediation Pumping Program was started in Northern Alluvium Areas 11, 67, and 75, in 2006. An alternate extraction well 75-MW-35 for higher groundwater extraction and six hot spot wells were connected to the new higher capacity groundwater treatment system in 2007. Sustained pumping of the extraction well 75-MW-35 that began in mid-October 2007 continues to date, with the exception of a brief period of shut down for treatment system maintenance. As

of November 3, 2008 approximately 13,481,143 gallons of groundwater have been treated and discharged.

Monitoring of the aquifer response to pumping from the alternate extraction well 75-MW-35 was conducted during October. An evaluation of the aquifer response and capture zone development was presented in the Capture Zone Evaluation Report, Northern Alluvium Pilot Remediation Pumping Program dated October 8, 2008.

Anticipated Activities for This Month

Monitoring of the aquifer response to pumping from the alternate extraction well 75-MW-35 and the downgradient site boundary low flow extraction wells will continue.

Long-Term Actions

Continue operating the extraction and treatment system and conduct additional performance monitoring.

Activities for This Report Period (3)

Potential remedial technologies to address Northern Alluvium groundwater hot spots, including evaluation of the Area 75 boundary containment established by sustained operation of the low flow pumping wells that started in early October 2006, were evaluated as part of the OU-7 Technology Screening FS, which was submitted to DTSC on February 19, 2008.

Anticipated Activities for This Month

Evaluation of potential pilot studies for the Northern Alluvium area of the Site will continue.

Long-Term Actions

Additional source control measures in Northern Alluvium will be considered and recommended where determined to be necessary.

Activities for This Report Period (4)

Data review and reporting for the Third Quarter 2008 quarterly monitoring conducted in August 2008 is in progress. Sampling for the Third Quarter 2008 was conducted in August in accordance with the groundwater monitoring plan presented in Technical Memorandum No. 8. A plan to refine and focus the groundwater monitoring program was developed based on the extensive body of groundwater monitoring data that has been collected at the Site since 2003. The plan was presented in the Technical Memorandum No. 8, Groundwater Monitoring Plan, Operable Unit 7, which was submitted to DTSC on January 30, 2008. DTSC issued a letter approving the revised groundwater monitoring program on April 10, 2008.

Anticipated Activities for This Month

Data review and reporting for the Third Quarter 2008 quarterly monitoring conducted in August 2008 is in progress.

Long-Term Actions

Continue monitoring and reporting of the proposed network of monitoring wells on the updated schedule presented in Technical Memorandum No. 8.

NORTHERN ALLUVIUM GROUNDWATER TREATMENT SYSTEM OPERATION

Activities for This Report Period

The October monthly compliance sample was collected on October 6, 2008. All sampling results indicated that the system was in compliance during October. This was the first compliance sample collected under the new NPDES permit. The media in the nitrate vessels were replaced on October 2, 2008, October 10, 2008, and October 28, 2008. In all cases, the vessel containing the new media was brought on-line in the lag position after replacement. .

The system was operated routinely throughout the month. As of November 3, 2008 approximately 13,481,143 gallons of groundwater have been treated and discharged. Approximately 97.5% of the treated volume came from the extraction wells of the Northern Alluvium pumping system; the remaining 2.5 percent is from IDW water collected during the quarterly sampling events, and storm water collected from various areas of the site.

Anticipated Activities for This Month

Continue routine weekly and monthly NPDES sampling and media changeouts as needed.

Develop scope of work to address growth of biofilm occurring at several extraction wells. Notify RWQCB of changes to system operation to mitigate growth of biofilm in extraction wells.

FEASIBILITY STUDIES, INTERIM REMEDIAL MEASURES, STORM WATER POLLUTION PREVENTION PLAN

Activities for This Report Period (1)

The OU-7 Technology Screening FS was submitted to DTSC on February 19, 2008. The Technology Screening FS presented the results of evaluation and screening of feasible technologies to address groundwater and deep soils associated with potential transport of site-related chemicals of potential concern to underlying groundwater. In addition, the report identified preliminary remedial alternatives and specific field-scale pilot testing for the Northern Alluvium area of the Site, the Saugus Aquifer, and perched groundwater zones that will be

needed to refine the remedial alternatives and conduct the detailed FS evaluations for Site groundwater.

The Work Plan, Saugus Aquifer Pilot Remediation Well Network, Operable Unit 7 was submitted to DTSC on September 22, 2008.

Anticipated Activities for This Month

Continue the OU-7 FS evaluations. The pilot groundwater remediation work plan will be revised to incorporate DTSC comments when received.

Long-Term Actions

Implement the Saugus Groundwater Containment Pilot Plan. Prepare Remedial Action Plan for OU7.

Activities for This Report Period (2)

Pursuant to the Site Storm Water Pollution Prevention Plan, Environ continued coordinating the implementation of short-term surface water run-off mitigation measures. Implementation of the short-term mitigation measures is being coordinated with CDM, particularly in the areas of the site where soil remediation activities are in progress.

Anticipated Activities for This Month

Upgrades to the short-term mitigation measures will continue as necessary. CDM is working on a plan for upgrading the short-term mitigation measures.

Long-Term Actions

Long-term mitigation of the drainages and excavations will be conducted in conjunction with the soil remediation.

REMEDIAL ACTION PLAN

Activities for This Report Period

Implementation of the OU1 remediation is approaching its final stages. The revised Remedial Action Plan for OU2 – OU6 will be submitted by January 31, 2009.

SECTION IV – REQUIREMENTS UNDER THE ORDER THAT WERE NOT COMPLETED

All requirements of the Order were completed. Whittaker has met or exceeded all the substantive requirements of the Order.

SECTION V – PROBLEMS OR ANTICIPATED PROBLEMS IN COMPLYING WITH THE ORDER

Following DTSC's agreement with Whittaker's proposed modifications to implementation plans in compliance with the Order reflected in the letter dated September 28, 2004, DTSC's letter dated July 11, 2005, included a schedule for submitting a number of documents. All deadlines have been met and documents have been submitted per requested schedule.

SECTION VI – RESULTS OF SAMPLE ANALYSIS, TESTS, AND OTHER DATA

Whittaker has instructed its contractors to continue to provide DTSC staff with raw data sets for ongoing quarterly groundwater monitoring events and RI/FS work upon receipt from the lab.

Sincerely yours,
AMEC Geomatrix, Inc.

Hassan Amini, PhD, CHG
Project Coordinator

cc: Eric Lardiere, Whittaker Corp; William Weaver, CDM; Jessica Donovan, ENVIRON; Paul Bergstrom, Knight Piésold; Larry Sievers, EODT; Tim Bricker, Santa Clarita L.L.C.; Megan Trend, Chubb Financial Solutions; Cindy Hunter, Stacy Parker, Julie Diebenow, AIG Insurance; Vitthal Hosangadi, MACTEC; John Carty, Zurich North America; Hal Dash, Cerrell Associates; Jeff Hogan, City of Santa Clarita; Yueh Chuang, CH2M Hill; Kathy Stryker Anderson, US Army Corps of Engineers; Robert DiPrimio, Valencia Water Company; Lynn Takaichi, and Meredith Durant, Kennedy Jenks; David Bacharowski, RWQCB; James Leserman, Castaic Lake Water Agency; Steve Cole, Newhall County Water District; Mauricio Guardado, Santa Clarita Water; Neil Elsey, Avion Holdings LLC; Alisa Lacey, Stinson Morrison Hecker LLP; Jeff O'Keefe, Department of Public Health.

SETTLEMENT AGREEMENT

by and among

Planning and Conservation League, Plumas County Flood Control and Water Conservation District, Citizens Planning Association of Santa Barbara County, Inc.

and

The State of California Department of Water Resources, Central Coast Water Authority, Kern Water Bank Authority and those State Water Project Contractors identified herein.

MAY 0 5 2003
_____, 2003

DEFINITIONS 4
A. "Attachment A Amendments" 4
B. "Attachment B Principles" 4
C. "Attachment C Guidelines" 4
D. "Attachment D Principles" 4
E. "Attachment E Transfers" 4
F. "CEQA" 4
G. "Citizens Planning Association" 4
H. "CCWA" 4
I. "Consent to Entry of Order Discharging Writ" 5
J. "DWR" 5
K. "EIR Committee" 5
L. "HCP" 5
M. "Interim Implementation Order" 5
N. "JAMS Trust Account" 5
O. "Kern-Castaic Transfer" 5
P. "Kern Environmental Permits" 5
Q. "Kern Fan Element Transaction" 5
R. "KWB Lands" 6
S. "KWBA" 6
T. "Mediator" 6
U. "Mediation Issue" 6
V. "Monterey Agreement" 6
W. "Monterey Amendment" 7
X. "New EIR" 7
Y. "Party" 7
Z. "PCL" 7
AA. "PCL Complaint" 7
BB. "Plaintiffs" 7
CC. "Plaintiffs' Expenses Trust Account" 7

TABLE OF CONTENTS
(continued)

Page

DD. "Plumas" 7
EE. "Plumas Amendment" 7
FF. "Plumas Arrearages" 7
GG. "Return to Writ" 7
HH. "Rossmann" 7
II. "Section VI Trust Account Agreement" 8
JJ. "Superior Court" 8
KK. "SWP" 8
LL. "SWP Contracts" 8
MM. "SWP Contractors" 8
NN. "Validation Cause of Action" 8
OO. "Watershed Forum" 8
PP. "Watershed Programs" 9
QQ. "1995 EIR" 9

II. ADMINISTRATION OF THE STATE WATER PROJECT PENDING NEW ENVIRONMENTAL IMPACT REPORT AND DISCHARGE OF WRIT OF MANDATE 9

III. NEW ENVIRONMENTAL IMPACT REPORT 9

A. Preparation 9
B. EIR Committee 10
C. New EIR Content 10
D. Acknowledgement and Agreement Regarding Attachment E Transfers 12
E. Acknowledgement and Agreement Regarding Kern-Castaic Transfer 12
F. Acknowledgement and Agreement Regarding Kern Water Bank 12
G. Reimbursement of Plaintiffs' Expenses for Participation in the Preparation of New EIR 13
1. DWR Obligation to Reimburse Plaintiffs. 13
2. Deposit into Trust Account. 13
3. Disbursement of Funds to Plaintiffs. 13
H. Disputes Regarding Mediation Issues 14
1. Referral to Director of DWR. 14

TABLE OF CONTENTS
(continued)

Page

2. Referral to Mediator. 14
3. Notices to Other Parties. 14
4. Advisory Opinion by Mediator. 14
5. Final Decision by DWR. 14
6. Mediator's Costs and Expenses. 15
a. Referrals by Plaintiffs' Representatives. 15
b. Referrals by SWP Contractors' Representatives. 15
c. Frivolous or Harassing Referrals. 15
I. Filing of New EIR upon Completion 15
IV. PLUMAS MATTERS 16
A. Monetary Settlement 16
1. Agreement to Pay. 16
2. Schedule of Payments. 16
a. Annual Payments. 16
b. Post Notice-of-Determination Payments. 16
c. Effects of Litigation on Payment Obligation. 17
(1) Suspension of Payment Obligation. 17
(2) Termination of Payment Obligation. 17
3. Use of Funds. 18
a. Funding of Watershed Programs. 18
b. Balance of Funds to General Purposes. 18
c. Annual Carry-Over. 18
B. Watershed Forum and Programs 18
1. Formation of Watershed Forum. 18
2. Purpose and Goals 18
a. Generally. 18
b. Specific Goals. 19
c. Emphasis on Feather River Watershed. 19
d. Technical Advisors. 19
3. General Watershed Forum Issues 20

TABLE OF CONTENTS
(continued)

Page

a. Cooperation. 20
b. Dispute Resolution. 20
c. Interruption in Funding. 20
d. No Limitation on DWR Obligations. 20
C. Plumas Amendment 20
D. Dialogue between Plumas and DWR 21
E. Future Relations 22
F. Contract Payments 22
V. KERN WATER BANK. 22
A. Title 22
B. Restrictions on Use of KWB Lands 22
1. Continued Use as Water Bank. 22
2. Use of KWB Lands for other SWP Purposes. 23
3. Use of KWB Lands for other than SWP Purposes. 23
4. The 490 Acres. 23
5. Application of HCP Restrictions. 23
6. Land Use Changes Subject to CEQA. 24
C. Transfer/Development Proceeds 24
D. Consultation with Plaintiffs 24
E. Scope of Restrictions 25
F. Effective Date of Restrictions 25
VI. FUNDING TO PLAINTIFFS 26
A. Agreement to Pay 26
B. Schedule of Payments 26
C. Effects of Litigation on Payment Obligations 27
1. Suspension of Payment Obligation. 27
2. Termination of Payment Obligation. 27
D. Use of Funds 27
E. Unrelated to Attorney Fees 27

TABLE OF CONTENTS
(continued)

Page

VII. SEQUENCE AND PROCESS FOR IMPLEMENTATION OF SETTLEMENT 28

A. Non-Reliance on 1995 EIR 28

B. Attachment A Amendments 28

C. Motion for Order Approving Settlement Agreement and Interim Implementation Order 29

D. Implementation of New Policies, Procedures and Guidelines 30

E. Dismissal of Validation Cause of Action 30

F. Tolling of Statute of Limitations 30

G. Notice of Determination, Return to Writ and Motion for Order Discharging Writ 31

H. Consent to Entry of Order Discharging Writ 31

1. Obligation to File. 31

2. Conditions Precedent to Filing 31

3. Earliest Effective Date of Discharge of Writ. 31

I. Subsequent CEQA Challenge 31

1. Limited Basis for Challenge. 31

2. Stipulation to Continued Operations 32

3. Order for New EIR 32

J. No Future Challenges 33

K. Mutual Interdependency 33

L. Implementation Dispute Resolution 33

VIII. ATTORNEY FEES 33

IX. DISPUTE RESOLUTION 35

X. MISCELLANEOUS 35

A. No Admission 35

B. Compliance with Laws 36

C. Authority 36

D. Not a General Appearance or Concession to Jurisdiction 37

E. Successors and Assigns 37

F. Governance 37

G. Entirety of Agreement; No Amendment 37

TABLE OF CONTENTS
(continued)

Page

H. Mutual Preparation 38
I. Further Acts 38
J. No Waiver 38
K. No Representations or Warranties 38
L. Independent Investigations 39
M. Survival 39
N. Headings 39
O. Not Binding on Others 39
P. Counterparts 39
Q. Voluntary and Knowing Execution 39
R. Obligations Dependent on Validity of Monterey Amendments 40

LIST OF ATTACHMENTS AND EXHIBITS

Attachments

Attachment A	Amendment to SWP Contract
Attachment B	Principles Regarding State Water Project Reliability
Attachment C	Transfer Guidelines for Annual Table A Amounts
Attachment D	Principles Regarding Public Participation in SWP Contract Negotiations
Attachment E	Final Permanent Table A Amount Transfers from KCWA Subsequent to the Monterey Amendments

Exhibits

Exhibit 1	Plaintiffs' Expenses Trust Account Agreement
Exhibit 2	Kern Environmental Permits
Exhibit 3-A	Proposed 21168.9 Order
Exhibit 3-B	Proposed Writ of Mandate
Exhibit 4	Section VI Trust Account Agreement

SETTLEMENT AGREEMENT

This SETTLEMENT AGREEMENT is entered into as of MAY 0 5 2003, 2003, by and among Planning and Conservation League, Plumas County Flood Control and Water Conservation District, Citizens Planning Association of Santa Barbara County, Inc., The State of California Department of Water Resources, Central Coast Water Authority, Kern Water Bank Authority and those SWP Contractors who have executed this Settlement Agreement. Certain terms used herein are defined in Section I.

RECITALS

WHEREAS, in 1951, the State of California Legislature authorized the construction of the State Water Project ("**SWP**");

WHEREAS, eight years later, the Legislature authorized the submission for voter approval of a general obligation bond issue to build the SWP, which voters subsequently approved (California Water Code, Section 12930 et seq.);

WHEREAS, commencing in the early 1960's, DWR, as operator of the SWP, entered into certain SWP Contracts with various water districts throughout California;

WHEREAS, in 1994, as a result of disputes arising from water shortages experienced during an extended drought period, DWR and certain of the SWP Contractors entered into an agreement known as the Monterey Agreement and thereafter implemented the terms of the Monterey Agreement by execution of the so-called Monterey Amendments;

WHEREAS, pursuant to CEQA, the environmental impact report for the Monterey Amendments was prepared in 1995 by CCWA as "lead agency," and adopted by DWR as "responsible agency" (as those terms are defined in CEQA) (the "**1995 EIR**");

WHEREAS, on December 27, 1995, PCL filed the PCL Complaint against DWR and CCWA challenging the sufficiency of the 1995 EIR;

WHEREAS, on February 12, 1996, Plaintiffs filed a First Amended Complaint adding the Validation Cause of Action;

WHEREAS, the trial court ultimately determined that although CCWA was not the appropriate lead agency for the 1995 EIR, such designation of CCWA was not fatal to the EIR, and ruled against Plaintiffs with respect to their challenge to the sufficiency of the 1995 EIR. The trial court also granted summary adjudication in favor of DWR and CCWA on the Validation Cause of Action. Plaintiffs appealed the trial court's rulings;

WHEREAS, in Planning and Conservation League v. Department of Water Resources, 83 Cal. App. 4th 892 (2000), the Court of Appeal held that (i) DWR, not CCWA, had the statutory duty to serve as lead agency, (ii) the trial court erred by finding CCWA's EIR sufficient despite its failure to discuss implementation of Article 18, subdivision (b) of the SWP Contracts, as a no-project alternative, (iii) said errors mandate preparation of a new EIR under the direction of DWR, and (iv) the trial court erroneously dismissed the challenge to DWR's transfer of title to the KWB Lands (the Validation Cause of Action) and execution of amended SWP Contracts for failure to name and serve indispensable parties. The Court of Appeal remanded the case to the trial court, ordering it to take the following five actions: (1) vacate the trial court's grant of the motion for summary adjudication of the Validation Cause

of Action; (2) issue a writ of mandate vacating the certification of the 1995 EIR; (3) determine the amount of attorney fees to be awarded Plaintiffs; (4) consider such orders it deems appropriate under Public Resources Code Section 21168.9(a) consistent with the views expressed in the Appellate Court's opinion; and (5) retain jurisdiction over the action until DWR, as lead agency, certifies an environmental impact report in accordance with CEQA standards and procedures, and the Superior Court determines that such environmental impact report meets the substantive requirements of CEQA;

WHEREAS, since the Court of Appeal ruling, representatives of the Parties to this Settlement Agreement have engaged in extensive settlement negotiations, mediated by retired Judge Daniel Weinstein, with the intent of avoiding further litigation and associated fees and providing for an effective way to cooperate in the preparation of a new environmental impact report and make such other improvements in the operation and responsiveness of the SWP as set forth in this Settlement Agreement;

WHEREAS, on July 22, 2002, an agreement was reached regarding the principles for a settlement; and

WHEREAS, the Parties now desire to formally enter into this Settlement Agreement.

AGREEMENT

NOW, THEREFORE, in exchange for the following covenants and agreements and other valuable and sufficient consideration, the receipt of which is acknowledged, the Parties agree as follows:

I. **Definitions**. Certain terms, as used in this Settlement Agreement, are defined as follows.

A. **"Attachment A Amendments"** means those amendments in the substantive form of Attachment A hereto (conformed to the format of each individual SWP Contract and the parties thereto), to be executed by DWR and the SWP Contractors who are signatories to this Settlement Agreement pursuant to and in accordance with the terms and conditions of this Settlement Agreement.

B. **"Attachment B Principles"** means those principles set forth in Attachment B hereto regarding SWP reliability.

C. **"Attachment C Guidelines"** means the guidelines set forth in Attachment C hereto regarding review of proposed permanent transfers of Annual Table A Amounts (as such latter term is used in the SWP Contracts).

D. **"Attachment D Principles"** means those principles set forth in Attachment D hereto regarding public participation in SWP Contract negotiations.

E. **"Attachment E Transfers"** means those water transfers identified on Attachment E hereto.

F. **"CEQA"** means the California Environmental Quality Act, California Public Resources Code Section 21000 et seq.

G. **"Citizens Planning Association"** means Citizens Planning Association of Santa Barbara County, Inc.

H. **"CCWA"** means Central Coast Water Authority.

I. **"Consent to Entry of Order Discharging Writ"** has the meaning given in Section VII(H)(1).

J. **"DWR"** means The State of California Department of Water Resources.

K. **"EIR Committee"** means a committee of no more than four (4) SWP Contractor representatives, and no more than four (4) Plaintiff representatives, chaired by a DWR representative, which has been formed for the purposes set forth in Section III(B).

L. **"HCP"** means the Habitat Conservation Plan/Natural Community Conservation Plan prepared for the Kern Water Bank Authority and approved through an Implementation Agreement dated October 2, 1997, with the United States Fish and Wildlife Service and California Department of Fish and Game.

M. **"Interim Implementation Order"** has the meaning given in Section VII(C).

N. **"JAMS Trust Account"** means the account established by DWR with, and maintained by, the Mediator for the purpose set forth in Section VI.

O. **"Kern-Castaic Transfer"** means the transfer of 41,000 acre-feet of water from Kern County Water Agency to the Castaic Lake Water Agency approved by DWR on March 31, 1999.

P. **"Kern Environmental Permits"** means the HCP and certain other permits, approvals and agreements relating to the Kern Water Bank, as set forth in and contemplated by the Addendum to the 1995 EIR, including those specified in Exhibit 2 hereto and similar, related permits, approvals and agreements.

Q. **"Kern Fan Element Transaction"** means DWR's transfer of the KWB Lands to Kern County Water Agency, as described in Article 52 of the Monterey

Amendments. Kern County Water Agency subsequently conveyed the KWB Lands to KWBA. Each of the stated conveyances occurred on August 9, 1996, based upon separate agreements dated December 13, 1995.

R. **"KWB Lands"** means the property known as the Kern Fan Element, as more specifically described in that certain Deed, executed by the Kern County Water Agency in favor of KWBA, dated August 9, 1996, and recorded in the Official Records of Kern County as Instrument No. 0196101606.

S. **"KWBA"** means Kern Water Bank Authority.

T. **"Mediator"** means retired Judge Daniel Weinstein, unless Judge Weinstein is unavailable, in which case the Mediator shall be another retired jurist mutually agreed to by DWR and the other members of the EIR Committee with respect to matters referred to the Mediator under Section III(H), and for all other matters another retired jurist approved by agreement of the Parties.

U. **"Mediation Issue"** means any issue relating exclusively to the compliance of the New EIR with any of the following requirements: (a) the requirements of CEQA; (b) the direction of the courts in the underlying litigation; or (c) the terms and conditions of this Settlement Agreement.

V. **"Monterey Agreement"** means the formal agreement, dated as of December 1, 1994, by and among DWR and certain SWP Contractors that memorializes fourteen principles to address the distribution of water during shortages and various other issues under the SWP Contracts.

W. **"Monterey Amendment"** means the amendment to the SWP Contracts entered into by DWR and certain SWP Contractors for purposes of implementing the Monterey Agreement.

X. **"New EIR"** has the meaning given in Section III.

Y. **"Party"** and "**Parties**" mean the signatories, individually and collectively, to this Settlement Agreement.

Z. **"PCL"** means Planning and Conservation League.

AA. **"PCL Complaint"** means the Complaint for Declaratory and Injunctive Relief and Petition for Writ of Mandate filed December 27, 1995, by PCL in the Superior Court, as amended and supplemented by the First Amended Complaint filed February 12, 1996.

BB. **"Plaintiffs"** means PCL, Citizens Planning Association and Plumas.

CC. **"Plaintiffs' Expenses Trust Account"** means the account maintained by JAMS for the purposes set forth in Section III(G).

DD. **"Plumas"** means Plumas County Flood Control and Water Conservation District.

EE. **"Plumas Amendment"** means an amendment to the Plumas SWP Contract to be entered into by DWR and Plumas pursuant to Section IV(C).

FF. **"Plumas Arrearages"** means any amount owed by Plumas to DWR under its SWP Contract that accrued prior to the resumption of payments by Plumas under Section IV(F).

GG. **"Return to Writ"** has the meaning given in Section VII(G).

HH. **"Rossmann"** means the Law Offices of Antonio Rossmann.

II. "**Section VI Trust Account Agreement**" means a trust account agreement regarding the disbursement by JAMS to Plaintiffs of those funds delivered by DWR pursuant to Section VI of this Settlement Agreement, the form of which agreement is attached hereto as Exhibit 4.

JJ. **"Superior Court"** means the Superior Court of the State of California, County of Sacramento.

KK. **"SWP"** means the State Water Project, officially called the State Water Resources Development System, as defined in Water Code Section 12931.

LL. **"SWP Contracts"** means those long-term contracts entered into by and between DWR, as the operator of the SWP, and individual SWP Contractors for the delivery of water from the SWP.

MM. **"SWP Contractors"** for purposes of this Settlement Agreement, means those contracting agencies identified in Table 1-6 of the DWR Bulletin 132-00, dated December 2001. All references to "SWP Contractors who are parties to this Settlement Agreement" are meant to exclude Plumas. Specific issues relating to Plumas are addressed in Section IV.

NN. **"Validation Cause of Action"** means the fifth cause of action of the PCL Complaint.

OO. **"Watershed Forum"** means a newly formed stakeholder group consisting of one or more representatives from each of Plumas, local community-based groups, DWR and the SWP Contractors who are parties to this Settlement Agreement, established for the purposes set forth in Section IV(B).

PP. **"Watershed Programs"** means programs, studies or projects approved by the Watershed Forum and implemented in pursuit of the goals set forth in Section IV, and other such activities approved by the Watershed Forum that are consistent with such purposes and goals.

QQ. **"1995 EIR"** means the Final Programmatic Environmental Impact Report for the Implementation of the Monterey Agreement Statement of Principles by State Water Project Contractors and the State of California Department of Water Resources for Potential Amendments to State Water Supply Contracts, prepared in October, 1995 by CCWA, as lead agency, and reviewed and considered in December 1995, by DWR, as a responsible agency, as each of those terms is defined in CEQA.

II. **Administration of the State Water Project Pending New Environmental Impact Report and Discharge of Writ of Mandate**.

Pending the Superior Court's issuance of an order discharging the writ of mandate in the underlying litigation, the Parties will jointly request that the Superior Court enter an order approving this Settlement Agreement, and an order, pursuant to California Public Resources Code Section 21168.9, authorizing on an interim basis the administration and operation of the SWP and the Kern Water Bank in accordance with the Monterey Amendments, the terms of this Settlement Agreement and the Attachment A Amendments, as more specifically set forth in Section VII of this Settlement Agreement.

III. **New Environmental Impact Report**

A. Preparation. As lead agency (as defined in CEQA), DWR shall cause a new environmental impact report to be prepared with respect to the proposed "project" (as that term is defined in Public Resources Code Section 21065 and Section

15378 of the CEQA Guidelines), in accordance with and as further described in Section III(C) below (the "**New EIR**").

B. EIR Committee. To effectuate the desire of the Parties that the New EIR be the product of a cooperative effort and comply with the requirements of CEQA and the direction of the courts in the underlying litigation, the EIR Committee has been formed to provide advice and recommendations to DWR in connection with the preparation of the draft and final versions of the New EIR.

C. New EIR Content. The proposed project to be analyzed in the New EIR will be specifically defined during the scoping process. Under all circumstances, in order to provide DWR, the responsible agencies, and the public with adequate disclosure to consider the potential environmental impacts of the Monterey Amendments, and the additional actions set forth in this Settlement Agreement, the environmental analysis in the New EIR shall evaluate, as components of the proposed project, the Monterey Amendments (including the provisions relating to the transfer of the KWB Lands) and the Attachment A Amendments. DWR shall ensure that the New EIR evaluates all proposed actions that are necessary to implement this Settlement Agreement. The New EIR shall include the following:

1. Information on water deliveries of the SWP over the relevant historical period (at least 1991 -2002), as well as data regarding the deliveries in the last extended drought (1987-1992), to be included in the description of the setting and the background for the proposed project;

2. As part of the CEQA-mandated "no-project" alternative analysis, and in light of the Court of Appeal's opinion, an analysis of the effect of pre-

Monterey Amendment SWP Contracts, including implementation of Article 18 therein. This analysis shall address, at a minimum, (a) the impacts that might result from application of the provisions of Article 18(b) of the SWP Contracts, as such provision existed prior to the Monterey Amendments, and (b) the related water delivery effects that might follow from any other provisions of the SWP Contracts;

3. Analysis of the potential environmental impacts of changes in SWP operations and deliveries resulting from implementation of the proposed project. If the proposed project results in modifications to the water sources relied upon for the SWP, those sources will be identified and the resulting environmental effects will be assessed;

4. Analysis of the potential environmental effects relating to (a) the Attachment E Transfers and (b) the Kern-Castaic Transfer, in each case as actions that relate to the potential environmental impacts of approving the Monterey Amendments; and

5. Analysis of the potential environmental effects relating to the implementation of this Settlement Agreement, including:

    a. Evaluation of the potential environmental impacts arising from the payments to Plumas as described in Section IV; and

    b. Analysis of the potential environmental effects relating to implementation of the provisions of this Settlement Agreement relating to the Kern Water Bank as discussed in Section V.

D. Acknowledgement and Agreement Regarding Attachment E Transfers. With respect to Section III(C)(4)(a), notwithstanding the analysis of the potential impacts of the Attachment E Transfers in the New EIR and without specifically endorsing or opposing those transfers or any prior environmental assessments of them, the Parties recognize that such water transfers are final. Each of the Parties agrees not to, and it shall be a condition to the initial and continuing effectiveness of this Settlement Agreement that Plaintiffs do not, hereafter challenge the effectiveness or validity of such water transfers.

E. Acknowledgement and Agreement Regarding Kern-Castaic Transfer. With respect to Section III(C)(4)(b) regarding the Kern-Castaic Transfer, the Parties recognize that such water transfer is subject to pending litigation in the Los Angeles County Superior Court following remand from the Second District Court of Appeal (*See* Friends of the Santa Clara River v. Castaic Lake Water Agency, 95 Cal. App. 4th 1373, 116 Cal. Rptr. 2d 54 (2002); *review denied* April 17, 2002). The Parties agree that jurisdiction with respect to that litigation should remain in that court and that nothing in this Settlement Agreement is intended to predispose the remedies or other actions that may occur in that pending litigation.

F. Acknowledgement and Agreement Regarding Kern Water Bank. With respect to Section III(C)(5)(b) relating to the Kern Water Bank, the Parties acknowledge that the Kern Water Bank is currently operating under the Kern Environmental Permits, which were entered into based on an Addendum to the 1995 EIR. The Parties recognize that the Addendum has been completed and agree not to challenge it in any manner. KWBA agrees that it will not rely on the Addendum

to the 1995 EIR for any new KWBA project to the extent that such reliance is based on data or analysis incorporated into the Addendum from the 1995 EIR. In addition, the New EIR shall include an independent study by DWR, as the lead agency, and the exercise of its judgment regarding the impacts related to the transfer, development, and operation of the Kern Water Bank in light of the Kern Environmental Permits. Such study shall identify SWP and any non-SWP sources of water deliveries to the Kern Water Bank. The views of the trustee agencies, as evidenced by the requirements of the HCP, will be used to provide guidance to DWR. Finally, the Parties agree that this Settlement Agreement is not intended to and shall not affect the continuing effectiveness of the Kern Environmental Permits.

G. Reimbursement of Plaintiffs' Expenses for Participation in the Preparation of New EIR .

1. *DWR Obligation to Reimburse Plaintiffs*. Subject to and in accordance with clauses (2) and (3), DWR will provide up to $300,000 to Plaintiffs for expenses actually incurred as needed to support Plaintiffs' participation in DWR's preparation of the New EIR, including service on the EIR Committee.

2. *Deposit into Trust Account*. The Parties acknowledge that in accordance with the principles of settlement, DWR caused to be deposited $300,000 into the Plaintiffs' Expenses Trust Account at JAMS on August 22, 2002.

3. *Disbursement of Funds to Plaintiffs*. Funds provided by DWR under this Section III(G) are available for disbursement and will be disbursed to

Plaintiffs by JAMS from the Plaintiffs' Expenses Trust Account in accordance with that certain Plaintiff's Expenses Trust Account Agreement dated August 15, 2002, attached hereto as Exhibit 1 and incorporated herein by this reference.

H. Disputes Regarding Mediation Issues.

1. *Referral to Director of DWR*. If the Plaintiffs' or SWP Contractors' representatives on the EIR Committee, or both, disagree with DWR's proposed approach with respect to a Mediation Issue, such representatives may refer the issue in writing to the Director of DWR.

2. *Referral to Mediator*. If (a) two-thirds of Plaintiffs' representatives or (b) three-fourths of the SWP Contractors' representatives, or both, disagree with the DWR Director's written decision with respect to a Mediation Issue (which issue shall have first been referred to the Director pursuant to Section III(H)(1)), such representative(s) may refer the issue in writing for consideration to the Mediator.

3. *Notices to Other Parties*. DWR shall inform the Parties to this Settlement Agreement of any referrals made pursuant to this Section III(H).

4. *Advisory Opinion by Mediator*. In the event of a referral as described above, the Mediator will consider the views of the representatives of the EIR Committee and the DWR Director, and will provide a written advisory opinion on the issue to the EIR Committee and DWR Director.

5. *Final Decision by DWR*. After receipt of an advisory opinion from the Mediator, the DWR Director shall make a final decision on the issue.

6. *Mediator's Costs and Expenses*.

a. *Referrals by Plaintiffs' Representatives*. On any matter referred to the Mediator by Plaintiffs' representatives on the EIR Committee, the costs of the Mediator's services will be borne one-third (1/3) by the Plaintiffs and two-thirds (2/3) by DWR.

b. *Referrals by SWP Contractors' Representatives*. For any referral by the SWP Contractors who are representatives on the EIR Committee, the SWP Contractors who are signatory to this Settlement Agreement will compensate the Mediator for his services.

c. *Frivolous or Harassing Referrals*. In the event of frivolous or harassing matters referred to him/her, the Mediator shall have the authority to award costs to the prevailing party, as well as reasonable attorney fees in accordance with Section IX of this Settlement Agreement.

I. Filing of New EIR upon Completion. Upon completion of the New EIR, in accordance with the procedure set forth in CEQA, and after final consideration by and good faith consultation with the EIR Committee, DWR shall cause the New EIR to be filed with the Superior Court as a return to the writ of mandate issued by such court in connection with this case.

IV. **Plumas Matters.**

A. Monetary Settlement.

1. *Agreement to Pay*. In accordance with the procedures and subject to the conditions described herein, DWR shall pay to Plumas the sum of $8,000,000.

2. *Schedule of Payments*.

a. *Annual Payments*. A total sum of Four Million Dollars ($4,000,000) shall be paid in accordance with this Section IV(A)(2)(a). DWR shall pay to Plumas One Million Dollars ($1,000,000) within 30 days after approval of this Settlement Agreement by the Superior Court (or the first business day after said 30th day if the 30th day is not a business day).

On each anniversary date of the first $1,000,000 payment until (and inclusive of) the third (3rd) anniversary, DWR shall pay to Plumas One Million Dollars ($1,000,000).

b. *Post Notice-of-Determination Payments*. Subject to Section IV(A)(2)(c), the remaining Four Million Dollars ($4,000,000) shall be paid in four annual installments of $1,000,000 each, beginning on the later to occur of: (1) the date that is seventy days after the Notice of Determination (as defined in CEQA) has been filed for the New EIR (or the first business day after said 70th day if the 70th day is not a business day); or (2) the date that is one year after the last payment made under Section IV(A)(2)(a).

c. *Effects of Litigation on Payment Obligation*.

(1) Suspension of Payment Obligation. If litigation is commenced by anyone challenging CEQA compliance for, or the validity of, any Monterey Amendment (or any portion thereof), including matters pertaining to the Kern Fan Element Transaction, the monetary obligations of DWR under Section IV(A)(2)(b) shall be suspended until the date that is forty-five (45) days after final conclusion of that litigation (without further right of appeal) in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. Within thirty (30) days after final conclusion of any such litigation in said manner, DWR shall pay to Plumas any amounts then owed by DWR under this Section IV.

(2) Termination of Payment Obligation. If any such litigation results in a final judgment (without further right of appeal) that invalidates any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, the obligation for payments under Section IV(A)(2)(b) shall automatically terminate.

3. *Use of Funds*.

a. *Funding of Watershed Programs*. Plumas shall apply a majority of all funds received each year pursuant to Section IV(A) to Watershed Programs.

b. *Balance of Funds to General Purposes*. Plumas may apply the balance of funds received each year to other district-related purposes, as determined by Plumas with due consideration for the needs of the Watershed Forum.

c. *Annual Carry-Over*. Funds received but not spent in any given year may be carried over to the succeeding year(s), provided, however, that any such funds shall continue to be subject to the restrictions under Sections IV(A)(3)(a) and (b).

B. Watershed Forum and Programs.

1. *Formation of Watershed Forum*. Prior to the date hereof, the Watershed Forum was formed. The Watershed Forum is locally driven but includes the active and committed participation of the SWP Contractor and DWR members of the Forum.

2. *Purpose and Goals*

a. *Generally*. The Watershed Forum's purpose is to implement watershed management and restoration activities for the mutual benefit of Plumas and the SWP. Forum activities include design of, participation in, implementation of, and review of studies and demonstration projects related to watershed restoration.

b. *Specific Goals*. The specific focus of the Watershed Forum's activities is to implement programs designed to achieve the following benefits:

(1) Improved retention (storage) of water for augmented base-flow in streams;

(2) Improved water quality (specifically, reduced sedimentation), and stream bank protection;

(3) Improved upland vegetative management; and

(4) Improved groundwater retention/storage in major aquifers.

c. *Emphasis on Feather River Watershed*. The Watershed Forum specifically promotes and encourages restoration of the Feather River watershed, with particular focus on the drainages of the three SWP Upper Feather River reservoirs. The Watershed Forum seeks to obtain funding and investments in the Feather River watershed in order to facilitate programs that will generate significant local environmental and water supply benefits.

d. *Technical Advisors*. The Watershed Forum will retain a committee of technical advisors to assist the Watershed Forum in identifying activities that can provide timely and practical benefits based on the best scientific and technical information.

3. *General Watershed Forum Issues*

a. *Cooperation*. The Watershed Forum shall seek to foster mutual cooperation and support among Plumas, DWR and other SWP Contractors in achieving local and state-wide goals.

b. *Dispute Resolution*. Any disputes between members of the Watershed Forum, or between Plumas and the Watershed Forum, with respect to Watershed Forum activities and funding will be resolved by retention of a third party neutral expert reasonably acceptable to all members of the Watershed Forum.

c. *Interruption in Funding*. If payments by DWR are interrupted due to litigation challenging any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, as set forth in Section IV(A)(2)(c), the Parties shall, depending on the success of the watershed work and the litigation situation, give due consideration to the importance of funding watershed work in consecutive years without interruption.

d. *No Limitation on DWR Obligations*. DWR's participation in the Watershed Forum shall not compromise DWR's obligation to be impartial in the distribution of matching funds from public funding sources under its jurisdiction.

C. Plumas Amendment. Upon completion of any necessary environmental review(s), DWR shall offer to Plumas the Plumas Amendment which shall include (1) DWR's agreement that water supplied to Plumas shall be determined

based on availability of water supply from Lake Davis, and (2) DWR's agreement that water deliveries to Plumas will not be reduced during SWP shortages so long as sufficient water is available from Lake Davis. The Plumas Amendment shall apply only to the maximum Table A amount in Plumas' SWP Contract on the date that this Settlement Agreement is executed. The Plumas Amendment shall also contain assurances that Plumas' claim to area-of-origin rights will not be affected by the Amendment. The Plumas Amendment may also contain the Monterey Amendment, as modified to reflect current conditions relating to Plumas, and the Attachment A Amendments.

D. Dialogue between Plumas and DWR. Subject to Plumas' execution of this Settlement Agreement and compliance with the terms herein, DWR agrees to confer with Plumas to develop strategies and actions for the management, operation, and control of SWP facilities in Plumas County in order to increase water supply, recreational, and environmental benefits to Plumas from such facilities. In furtherance thereof, DWR and Plumas agree to evaluate and give due consideration to:

1. the potential re-operation of SWP facilities in Plumas County to increase the water supply available to Plumas;
2. the potential release of water from reservoirs, as part of planned operations, for Plumas' benefit; and
3. the appropriateness of certain charges in Plumas' SWP Contract in light of current circumstances and whether amendments thereto are warranted.

E. Future Relations. Upon the Superior Court's approval of this Settlement Agreement, Plumas agrees to maintain a positive relationship with the SWP Contractors and DWR, and to support the Monterey Amendments and the Attachment A Amendments. Plumas reserves the right to review critically the New EIR.

F. Contract Payments. Plumas shall resume and maintain timely payments under its SWP Contract. Such payments shall begin upon the earlier of (1) the first payment under Section IV(A)(2)(a) or (2) the date that Plumas or its member unit resumes taking water from Lake Davis, and shall cover the period beginning January 1 of that same year. DWR will not seek to collect the amount of any Plumas Arrearages.

V. **Kern Water Bank.**

A. Title. KWBA shall retain title to the KWB Lands. KWBA may continue to operate and administer the KWB Lands including the water bank, subject to the restrictions herein.

B. Restrictions on Use of KWB Lands.

1. *Continued Use as Water Bank.* As noted in Section III(F), the KWB Lands are subject to the HCP, which documents a plan to accomplish, among other things, certain water conservation and environmental objectives. Except as provided in Sections V(B)(2) and (3), the KWB Lands shall continue to be used for the operation of a water bank and other uses authorized by the HCP, so long as such use remains legally and economically feasible.

2. *Use of KWB Lands for other SWP Purposes*. If (a) the use of the KWB Lands as a water bank is determined by KWBA to no longer be economically and/or legally feasible, (b) DWR concurs with such determination, (c) the KWB Lands can be feasibly used for any of the SWP purposes provided in California Water Code §12930 et seq., and (d) DWR and KWBA agree on terms and conditions for such use, then the KWB Lands may be so used.

3. *Use of KWB Lands for other than SWP Purposes*. If (a) the KWB Lands can not feasibly be used for any of the SWP purposes provided in California Water Code §12930 et seq., or (b) KWBA and DWR are unable to agree on terms and conditions for such use, or (c) DWR determines not to use the KWB Lands for such purposes, then KWBA may transfer or develop all or a portion of the KWB Lands for alternative use(s), provided that any alternate use will not result in unmitigated environmental impacts. A finding by KWBA that such impacts will not occur will be subject to DWR's concurrence.

4. *The 490 Acres*. The approximately 490 acres currently subject to restrictions in the HCP, permitting use thereof as Conservation Bank Lands (as defined in the HCP), but which may be developed under the HCP, will continue to be subject to the restrictions in the HCP but may not be developed.

5. *Application of HCP Restrictions*. All of the KWB Lands, including the 490 acres, will remain subject to the restrictions contained in the HCP.

The restrictions will remain in effect regardless of amendment to, or termination of, the HCP, unless, in the event of such amendment or termination, DWR, after consultation with Plaintiffs, finds that such amendment or termination will not result in unmitigated environmental impacts. The provisions of this clause shall not apply to "Minor Amendments" to the HCP as that term is utilized in the HCP.

6. *Land Use Changes Subject to CEQA*. Changes to the allowable uses of the KWB Lands shall be subject to appropriate environmental review under CEQA.

C. Transfer/Development Proceeds. If all of the KWB Lands are transferred or developed by KWBA, the proceeds of such transfer or development (net of transaction or development costs) will be used for water management purposes identified by KWBA, subject to concurrence by DWR that such use is for bona fide water management purposes; provided, however, so long as the KWB Lands continue to be used for operation of a water bank, the proceeds (net of transaction or development costs) resulting from the transfer or development of a portion of the KWB Lands (which must be consistent with Section V(B)(5)) will be used for water management purposes identified by KWBA, subject to concurrence by DWR that the expenditure is consistent with such purposes.

D. Consultation with Plaintiffs.

1. Except as provided in Section V(D)(2), with respect to any matter that requires DWR's concurrence pursuant to Section V(B) and (C), DWR

shall consult with Plaintiffs prior to making any decision with respect thereto.

2. In lieu of consulting with Plaintiffs, following the conclusion of all litigation challenging CEQA compliance for, or the validity of, the Monterey Amendments, DWR may first provide notice and opportunity to comment to Plaintiffs and the public, and then, at Plaintiffs' request, shall consult with Plaintiffs.

E. Scope of Restrictions. The foregoing restrictions shall only apply to the KWB Lands and shall not affect the use or disposition of water stored under or withdrawn from the KWB Lands.

F. Effective Date of Restrictions. The foregoing restrictions in this Section V shall not be effective unless and until the court in the above-referenced litigation issues an order approving this Settlement Agreement and the Interim Implementation Order (as defined in Section VII(c)). The restrictions in this Section V shall become final only upon (1) filing of the Notice of Determination following the completion of New EIR, (2) discharge of the writ of mandate in the underlying litigation as provided below, and (3) conclusion of all litigation in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. The continuing effectiveness of the restrictions in this Section V, and the obligations under this Settlement Agreement to comply with these restrictions, are subject to the terms of Section VII(K) below.

VI. **Funding To Plaintiffs**

A. Agreement to Pay. In accordance with the procedures and subject to the conditions described herein, DWR shall pay to Plaintiffs, collectively, the sum of $5,500,000 (in addition to the $300,000 paid pursuant to Section III(G)).

B. Schedule of Payments.

1. On or before the date that is thirty (30) days after approval of this Settlement Agreement by the Superior Court and issuance of the Interim Implementation Order under Section VII, DWR shall pay to Plaintiffs One Million Eight Hundred Seventy-Five Thousand Dollars ($1,875,000).

2. On or before the first anniversary after the date upon which delivery of funds are made by DWR pursuant to Section VI(B)(1), DWR shall pay to Plaintiffs One Million Eight Hundred Seventy-Five Thousand Dollars ($1,875,000).

3. Subject to Section VI(C), on or before the seventieth (70th) day after the Notice of Determination has been filed for the New EIR (or the first business day after said 70th day if the 70th day is not a business day), DWR shall pay to Plaintiffs One Million Seven Hundred Fifty Thousand Dollars ($1,750,000).

4. All amounts to be paid by DWR under this Section VI(B) shall be paid by wire transfer, in immediately available funds, to a JAMS Trust Account from which funds are to be disbursed therefrom to Plaintiffs in accordance with the Section VI Trust Account Agreement.

C. Effects of Litigation on Payment Obligations.

1. *Suspension of Payment Obligation*. If litigation is commenced by anyone challenging CEQA compliance for, or the validity of, any Monterey Amendment (or any portion thereof), including matters pertaining to the Kern Fan Element Transaction, the monetary obligations of DWR under Section VI(B)(3) shall be suspended until the date that is forty-five (45) days after conclusion of such litigation (without further right of appeal) in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. Within thirty (30) days after final conclusion of any such litigation in said manner, DWR shall pay to Plaintiffs any amounts then owing under this Section VI.

2. *Termination of Payment Obligation*. If any such litigation results in a final judgment that invalidates any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, the obligation for payments under Section VI(B)(3) shall automatically terminate.

D. Use of Funds. The funds paid to Plaintiffs under this Section VI shall be used to implement this settlement, as determined by Plaintiffs in their reasonable judgment, including watershed restoration projects, follow-up actions arising from this settlement, and technical studies.

E. Unrelated to Attorney Fees. The payments under this Section VI are exclusive of, and in addition to, any amounts owing by DWR with respect to Plaintiffs' attorney fees, the latter of which are addressed by Section VIII.

VII. Sequence and Process for Implementation of Settlement

This Section VII addresses the process of implementing the terms of this Settlement Agreement to the extent not already addressed in this Settlement Agreement. All issues relating to the implementation of this Settlement Agreement not addressed by this Section VII or elsewhere herein shall be resolved through good faith discussions and mutual agreement among the Parties. If the Parties are unable to agree, the disputed matter shall be referred to and resolved by the Mediator.

A. Non-Reliance on 1995 EIR. DWR and the SWP Contractors who are signatories to this Settlement Agreement agree that they will not approve any new project or activity in reliance on the 1995 EIR, that was not approved, initiated or implemented prior to March 26, 2001, and the approval, initiation or implementation of which would require a separate environmental impact report or negative declaration under CEQA (other than, or in addition to, the 1995 EIR).

B. Attachment A Amendments. Within sixty (60) days after this Settlement Agreement is executed by all of the Parties, each of the SWP Contractors who are parties to this Settlement Agreement shall cause a duly authorized representative to execute an Attachment A Amendment, and deliver the executed Amendment to DWR. Upon approval of this Settlement Agreement by the Superior Court and issuance of the Interim Implementation Order, as discussed in Section VII(C), DWR shall execute the Attachment A Amendments. Thereupon, the Attachment A Amendments shall be deemed effective on an interim basis, and will not thereafter be modified without the written consent of the Plaintiffs, prior to the discharge of the writ of mandate. The Attachment A Amendments shall become

final upon (1) the filing of the Notice of Determination following the completion of the New EIR, (2) discharge of the writ of mandate in the underlying litigation as provided below, and (3) conclusion of all litigation in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

C. Motion for Order Approving Settlement Agreement and Interim Implementation Order. As soon as practical after the execution of this Settlement Agreement, the Parties shall jointly file with the Superior Court a motion for (1) an order approving this Settlement Agreement, and (2) an order (the "**Interim Implementation Order**") specifically authorizing on an interim basis, pursuant to Public Resources Code Section 21168.9, the administration and operation of the SWP and the KWB Lands, pending discharge of the writ of mandate in the underlying litigation, in accordance with the Monterey Amendments (as limited by Section VII(A) above), as supplemented by the Attachment A Amendments and the other terms and conditions of this Settlement Agreement, including the provisions in Section V(B) regarding the KWB Lands. Said motion shall include the proposed Section 21168.9 order attached hereto as Exhibit 3-A, and the proposed writ of mandate referenced therein and attached hereto as Exhibit 3-B. The parties shall jointly move the Superior Court for approval of said order and writ. Subject to Section VII(J), and except as provided in Section VII(I), Plaintiffs shall not seek any further order or writ concerning the Monterey Amendments or the New EIR.

D. Implementation of New Policies, Procedures and Guidelines. DWR has issued a [draft] Report of State Water Project Supply Reliability in response to paragraph 1 of the Attachment B Principles. Upon the Superior Court's approval of this Settlement Agreement, DWR shall issue Contractors' Memos on (1) the Attachment C Guidelines and (2) the Attachment D Principles. After the Superior Court's approval of this Settlement Agreement, and in no event later than January 1, 2004, DWR shall issue Contractors' Memos on the remainder of the Attachment B Principles (i.e., paragraphs 2 and 3). DWR may rely on DWR publications previously issued to comply with paragraph 2 of the Attachment B Principles, if appropriate.

E. Dismissal of Validation Cause of Action. Upon the execution of this Settlement Agreement by all the Parties and execution of the Attachment A Amendments as set forth in Section VII(B) and issuance by DWR of the Contractor Memos referenced in the second sentence of Section VII(D), Plaintiffs shall file a request for dismissal without prejudice of the Validation Cause of Action. So long as such conditions are timely met, Plaintiffs covenant and agree not to refile the Validation Cause of Action, nor any new cause of action relating thereto, nor a new claim challenging the validity of any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

F. Tolling of Statute of Limitations. As between Plaintiffs, DWR and the SWP Contractors who are signatories to this Settlement Agreement, it is agreed that the statute of limitations relating to the Validation Cause of Action shall be tolled as

to Plaintiffs until the date that is forty-five (45) days after the filing of the Notice of Determination for the New EIR.

G. Notice of Determination, Return to Writ and Motion for Order Discharging Writ. Upon completion of the New EIR, DWR will file with the Superior Court (1) a Notice of Determination including a copy of the New EIR, (2) a return to writ of mandate (the "**Return to Writ**"), (3) a request for an order discharging the writ of mandate previously issued by the Superior Court in the underlying case and (4) any other information required by the Superior Court for a discharge of writ.

H. Consent to Entry of Order Discharging Writ.

1. *Obligation to File*. Concurrent with DWR's filings referenced in Section VII(G), subject only to Sections VII(H)(2) and (3), and provided Plaintiffs have not challenged the Return to Writ (under the procedures set forth in Section VII(I)), Plaintiffs shall file with the Superior Court a pleading consenting to entry of an order discharging the writ of mandate (the "**Consent to Entry of Order Discharging Writ**").

2. *Conditions Precedent to Filing*. Plaintiffs' obligation to file the Consent to Entry of Order Discharging Writ shall be subject to, and conditioned upon, satisfaction of the requirement set forth in Section VII(B).

3. *Earliest Effective Date of Discharge of Writ*. The discharge of the writ of mandate shall not be effective until at least forty-five (45) days after the filing of the Notice of Determination for the New EIR.

I. Subsequent CEQA Challenge.

1. *Limited Basis for Challenge*. Plaintiffs may only challenge the Return to Writ if, during the preparation and review of the New EIR, (a) Plaintiffs

objected to the Mediator based on one or more Mediation Issues**,** (b) the Mediator upheld that objection in a written advisory opinion as described in Section III(H), (c) DWR rejected such written advisory opinion in its final decision, either expressly or as evidenced by the contents of the final New EIR, and (d) the challenge that Plaintiffs file to the Return to Writ is on the same ground(s) as the objection upheld by Mediator in the advisory opinion. Where such an objection was made to the Mediator and Plaintiffs file such a challenge to the Return to Writ, DWR shall maintain the advisory opinion as a public record. With respect to clause (c) of this subsection (I)(1), if the Parties dispute whether DWR has rejected the Mediator's advisory opinion, such matter shall be referred to the Mediator and (s)he shall make a final determination with respect thereto in accordance with Article IX.

2. *Stipulation to Continued Operations*. In the event of such a challenge, the challenging party will stipulate that, pending compliance with such writ as the court may issue, administration and operation of the SWP may continue in accordance with the Interim Implementation Order.

3. *Order for New EIR*. If such a challenge results in an order that DWR must prepare a new or supplemental environmental impact report, the provisions set out in Section III (regarding preparation of New EIR) shall be followed, and at the conclusion of the process, the provisions of Section VII(H) (filing of a Consent to Entry of Order Discharging Writ) and this Section VII(I) shall apply.

J. No Future Challenges. Except as specifically authorized herein, and as a condition to the initial and continuing effectiveness of this Settlement Agreement, Plaintiffs agree not to initiate any future litigation challenging the validity of any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

K. Mutual Interdependency. On an interim and final basis, the Attachment A Amendments, the Plumas Amendment, the provisions regarding the KWB Lands described in Section V(B), and the continued operations of the SWP based on the Monterey Amendments are mutually interdependent.

L. Implementation Dispute Resolution. Disputes arising in the implementation of this Settlement Agreement shall be addressed in accordance with Section IX.

VIII. Attorney Fees

Within forty-five (45) days after the execution of this Settlement Agreement by all Parties, the Parties shall engage in arbitration to determine the amount of attorney fees and costs to be paid to Rossmann as Plaintiffs' counsel. Such arbitration shall be conducted pursuant to the following terms and conditions:

A. The arbitrator will be selected by mutual agreement of the Parties. If the Parties cannot agree on the arbitrator, the Mediator will designate the arbitrator. JAMS arbitration rules will apply, providing for limited and focused discovery, but the arbitrator may be anyone the Parties select regardless of his/her professional affiliation.

B. Within five (5) business days after commencement of the arbitration, Rossmann shall file with the arbitrator a petition for fees. The petition for fees shall identify, in sufficient detail acceptable to the arbitrator, all fees for: (1) past service in the underlying litigation; (2) fees for participation in the settlement mediation to the

date thereof; and (3) projected fees for services to be rendered in implementing the Settlement Agreement, including fees incurred in advising Plaintiffs in connection with their participation in, and service on, the EIR Committee.

C. Rossmann may apply for a multiplier on fees earned in the underlying litigation. The award for fees relating to mediation and settlement implementation shall be subject to the lodestar amount and shall not include a multiplier.

D. The costs of the arbitration will be borne one-third (1/3) by Plaintiffs and two-thirds (2/3) by DWR.

E. DWR and CCWA reserve all rights and defenses, except the right to challenge Rossmann's entitlement to fees relating to the mediation and settlement implementation stages.

F. The arbitrator shall determine the amount of the award within thirty (30) days after submission of the fee petition to the arbitrator. The arbitrator's determination shall be binding upon the Parties.

G. DWR shall pay the fee award to Rossmann in accordance with the following schedule:

1. Sixty percent (60%) within thirty (30) days after the award;

2. Thirty percent (30%) within thirty (30) days after the filing of the Return to Writ with the Superior Court; and

3. Ten percent (10%) within thirty (30) days after the Plaintiffs' filing of the Consent to Entry of Order Discharging Writ with the Superior Court.

H. The amount of $100,000 previously paid as attorney fees to Rossmann by DWR will be credited toward the amount owed by DWR hereunder as determined by the arbitrator.

IX. **Dispute Resolution**

The Parties agree to cooperate in implementing this Settlement Agreement and to try in good faith to resolve any disputes. In addition, until the conclusion of the underlying litigation, as evidenced by the issuance of an order discharging the writ of mandate, the Mediator will decide all unresolved issues involving the interpretation and implementation of this Settlement Agreement and, to the extent permitted by law, will be authorized to enforce its terms, except for those matters properly reserved to the jurisdiction of the Superior Court. Any party may request a conference before the Mediator on seventy-two (72) hours' advance written notice to the Mediator and the other Parties. The Mediator will have the power to award reasonable attorney fees to the prevailing party in the event of frivolous, harassing or untimely motions. The party who initiates a dispute resolution proceeding with the Mediator pursuant to this Section IX shall be solely responsible for the payment of the Mediator's costs and expenses, except as otherwise provided herein.

X. **Miscellaneous**

A. No Admission. By entering into this Settlement Agreement, the Plaintiffs do not endorse or admit the validity of the Monterey Amendments, and neither DWR, KWBA, nor any of the SWP Contractors who are signatories hereto admit any of the Plaintiffs' allegations in the pending litigation including those concerning the Monterey Amendments and/or the Kern Fan Element Transaction**.**

B. Compliance with Laws. The Parties agree that nothing in this Settlement Agreement is intended to limit the discretion granted by law, including CEQA, to DWR, as lead agency and as the State agency responsible for administration and operation of the SWP, or the duty of DWR to comply with applicable requirements of law, including those of CEQA and the California Water Code.

C. Authority. Each of the Parties represents that: (1) it has the authority to execute and enter into this Settlement Agreement; (2) the individual executing this Settlement Agreement on behalf of the Party has the authority and has been specifically authorized to execute and deliver this Settlement Agreement on behalf of such Party; (3) upon execution by such person on behalf of the Party, this Settlement Agreement shall be valid and enforceable against such Party in accordance with the terms hereof; (4) the Party is authorized to implement this Settlement Agreement, without further action by the Party or its governing body, board of directors, or any other person or entity, as the case may be; and (5) the execution and entry into this Settlement Agreement and the implementation of its terms by the Party is not in violation of any applicable law or any other contract or agreement by which it is bound or to which it is a party. The Parties acknowledge that although DWR plans to make payments required under this Agreement pursuant to its authority under the State Water Resources Development System (Water Code Sections 12930 et seq.), and that under such authority accruals are continuously appropriated without regard to fiscal years (Water Code Section 12938), any such payments may nevertheless be contingent on the annual Budget Act and, under certain circumstances, payments may be

delayed or halted by non-party government authorities. If any payment under this Settlement Agreement is delayed beyond the date it is due, the amount due shall accrue interest at the rate of the State Pooled Money Investment Fund for the first forty-five (45) days after it is due and at eight percent (8%) per annum thereafter. The foregoing does not limit Plaintiff's rights to seek legal or equitable relief in the event of a breach of this Settlement Agreement.

D. Not a General Appearance or Concession to Jurisdiction. The execution of this Settlement Agreement by the SWP Contractors and KWBA does not constitute a general appearance in the underlying litigation, nor does it constitute a concession to jurisdiction of the Superior Court over the SWP Contractors or KWBA other than for the purpose of enforcing the terms of this settlement.

E. Successors and Assigns. This Settlement Agreement shall be binding upon and inure to the benefit of the Parties and their respective heirs, legal representatives, successors and assigns. No Party may assign their rights under this Settlement Agreement without the prior written consent of the other Parties.

F. Governance. This Agreement shall be construed under and enforced in accordance with the substantive laws of the State of California.

G. Entirety of Agreement; No Amendment. This Settlement Agreement sets forth the entire agreement among the Parties and supersedes all prior oral or written agreements, negotiations, discussions, or understandings concerning the subject matter hereof. The terms of this Settlement Agreement may not be altered, amended, waived or modified, except by a further written agreement signed by all Parties.

H. Mutual Preparation. The Parties each cooperated in the drafting and preparation of this Settlement Agreement. Thus, the language of all parts of this Settlement Agreement shall in all cases be construed as a whole, according to its fair meaning, and not strictly for or against any Party as the drafter thereof.

I. Further Acts. Each Party agrees to make, execute and deliver such other instruments or documents, and to do or cause to be done such further or additional acts, as reasonably may be necessary in order to effectuate the purposes or to implement the terms of this Settlement Agreement.

J. No Waiver. No waiver of any breach of any term or provision of this Settlement Agreement shall be construed to be, nor shall be, a waiver of any other breach of this Settlement Agreement. No waiver shall be binding unless in writing and signed by the Party waiving the breach. With respect to any breach of this Settlement Agreement by Plaintiffs, such breach may only be waived in writing by DWR, KCWA and The Metropolitan Water District of Southern California. With respect to any breach of this Settlement Agreement by the non-Plaintiffs, such breach may only be waived in writing by the Plaintiffs.

K. No Representations or Warranties. Each of Parties represents and declares that in executing this Settlement Agreement, it has relied solely upon its own judgment, belief and knowledge, and on the advice and recommendations of its independently selected counsel, concerning the nature, extent and duration of its rights and claims and that it has not been influenced to any extent whatsoever in executing the same by any representations or statements covering any matters made by any of the Parties or by any person representing them or any of them.

Each Party acknowledges that no other Party nor any of their representatives has made any promise, representation or warranty whatsoever, written or oral, as any inducement to enter into this Settlement Agreement, except as expressly set forth in this Settlement Agreement.

L. Independent Investigations. Each Party has made such investigation of the facts pertaining to this settlement and this Settlement Agreement and of all matters pertaining thereto as it deems necessary.

M. Survival. The representations, warranties and covenants contained in this Settlement Agreement are deemed to and shall survive the execution and delivery of this Settlement Agreement by all of the Parties.

N. Headings. All headings in this Settlement Agreement are included for convenience and reference only and shall not constitute a part of this Settlement Agreement for any purpose.

O. Not Binding on Others. This Settlement Agreement is not intended to, nor shall it (1) bind any non-Party persons or entities as to any claims or defenses they may otherwise now or in the future hold, or (2) waive any claims or defenses any Party hereto may have now or in the future against such non-Party persons or entities.

P. Counterparts. This Settlement Agreement may be executed in counterparts, each of which shall constitute an original, but all of which shall constitute one and the same agreement, provided each signing Party shall have received a copy of the signature page signed by every other Party.

Q. Voluntary and Knowing Execution. EACH PARTY REPRESENTS AND WARRANTS THAT IT HAS THOROUGHLY READ AND CONSIDERED

ALL ASPECTS OF THIS SETTLEMENT AGREEMENT, THAT IT UNDERSTANDS ALL PROVISIONS OF THIS SETTLEMENT AGREEMENT, THAT IT HAS HAD THE OPPORTUNITY TO CONSULT WITH COUNSEL THROUGHOUT THIS PROCESS AND THAT IT IS VOLUNTARILY ENTERING INTO THIS SETTLEMENT AGREEMENT OF ITS OWN FREE WILL, WITHOUT DURESS OR COERCION OF ANY KIND.

R. Obligations Dependent on Validity of Monterey Amendments. With respect to any obligation in this Settlement Agreement that terminates or is suspended upon a challenge to or final judgment that invalidates any portion of any Monterey Amendment, such termination or suspension of such obligation may be avoided if such invalidity is explicitly and irrevocably waived in accordance with the procedures set forth in Paragraph 29 of the Monterey Amendments.

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{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

IN WITNESS WHEREOF, the Parties have executed this Settlement Agreement as of the date first set forth above.

PLANNING AND CONSERVATION LEAGUE

By: _____
Name: Sage Sweetwood
Title: President

PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By: _____
Name: B. J. Pearson
Title: Chair, Board of Supervisors
Ex-officio Chair, District Board of Directors

CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC.

By: _____
Name: Louise Boucher
Title: President,
Citizens Planning association of Santa Barbara, Inc.

[Remainder of Page Intentionally Blank – Additional Signatures Follow]

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

By: _____

Name: Thomas M. Hannigan
Title: Director

Approved as to legal form and sufficiency:

By: _____

Name: Peggy Bernardy
Title: Chief Counsel

ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT, ZONE 7

By: _____

Name: William R. Stevens

Title: President, Board of Directors

Approved as to Form
RICHARD E. WINNIE, County Counsel

By _____

ALAMEDA COUNTY WATER DISTRICT

By: _____

Name: John H. Weed

Title: President

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

ANTELOPE VALLEY-EAST KERN WATER AGENCY

By: Andy D. Rutledge

Name: Andy D. Rutledge

Title: Board President

CASTAIC LAKE WATER AGENCY

By: [signature]

Name: DAN MASNADA

Title: ~~GENERAL~~ MANAGER

CITY OF YUBA

By: William P. Lewis

Name: WILLIAM P. LEWIS

Title: UTILITIES DIRECTOR

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

COACHELLA VALLEY WATER DISTRICT

By: John W. McFadden

Name: John W. McFadden

Title: President of the Board of Directors

COUNTY OF BUTTE

By: R. J. Beeler

Name: R. J. BEELER

Title: Chairman, Board of Supervisors

COUNTY OF KINGS 3-25-03

By: Joe Neves

Name: JOE NEVES

Title: CHAIRMAN

CRESTLINE-LAKE ARROWHEAD WATER AGENCY

By: James J. McCrory

Name: James J. McCrory

Title: President, Board of Directors

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

DESERT WATER AGENCY

By: _____

Name: Dan M. Ainsworth

Title: General Manager

DUDLEY RIDGE WATER DISTRICT

By: _____

Name: Joe MacIlvaine

Title: President

KERN COUNTY WATER AGENCY

By: _____

Name: Terry Rogers

Title: President

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

LITTLEROCK CREEK IRRIGATION DISTRICT

By: Frances Young

Name: _____

Title: President

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

By: Ronald R Gastelum

Name: Ronald R Gastelum

Title: CEO

MOJAVE WATER AGENCY

By: K Brill

Name: Kirby Brill

Title: General Manager

NAPA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

By: Mike Ripley

Name: Mike Ripley

Title: Vice-Chair

APPROVED 3/18/03
FLOOD CONTROL & WATER
CONSERVATION DISTRICT

~~MARY JEAN MCLAUGHLIN~~
SECRETARY OF THE DISTRICT
BY S. Vattuone Deputy

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

OAK FLAT WATER DISTRICT

By: William D. Harrison

Name: WILLIAM D. HARRISON

Title: MANAGER / SECRETARY

PALMDALE WATER DISTRICT

By: Leslie O. Carter

Name: Leslie O. Carter

Title: President, Board of Directors

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

By:

Name: C. Patrick Milligan

Title: President

SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT

By:

Name: J. C. Reichenberger

Title: President

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

SAN GORGONIO PASS WATER AGENCY

By: _____

Name: Stephen P. Stockton

Title: General Manager/Chief Engineer

SAN LUIS OBISPO COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

By: _____

Name: MICHAEL P. RYAN

Title: Chairman of the Board of Supervisors

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By: _____

Name: _____

Title: _____

APPROVE AS TO ACCOUNTING:
ROBERT W. GEIS, CPA
AUDITOR-CONTROLLER

BY: _____
Deputy

ATTEST:
MICHAEL F. BROWN
CLERK OF THE BOARD

BY: _____
Deputy

APPROVED AS TO FORM:
STEPHEN SHANE STARK
COUNTY COUNSEL

BY: _____
Deputy

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

SANTA CLARA VALLEY WATER DISTRICT

By: Stanley M Williams

Name: Stanley M. Williams

Title: Chief Executive Officer

SOLANO COUNTY WATER AGENCY

By: Don Holdener

Name: Don Holdener

Title: Chairman, Board of Directors

TULARE LAKE BASIN WATER STORAGE DISTRICT

By: Thomas R Hurlbutt

Name: THOMAS R. HURLBUTT

Title: PRESIDENT

VENTURA COUNTY FLOOD CONTROL DISTRICT

By: Jeff Pratt

Name: Jeff Pratt

Title: Director - Watershed Protection

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

CENTRAL COAST WATER AUTHORITY

By: _____

Name: William J. Brennan

Title: Executive Director

KERN WATER BANK AUTHORITY

By: _____

Name: **William D. Phillimore,** Chairman

Title: **Chairman**

ATTACHMENT A

AMENDMENT TO STATE WATER PROJECT CONTRACT

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. ____ TO THE WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND _____

This amendment is made this ____ day of _____, 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, hereinafter referred to as the "State", and _____, hereinafter referred to as the "District" [or "Agency"].

RECITALS

WHEREAS, the State and the District entered into and subsequently amended a water supply contract (the "contract") providing that the State shall supply certain quantities of water to the District and providing that the District shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payments; and

WHEREAS, on December 1, 1994, the State and representatives of certain State Water Project contractors executed a document entitled "Monterey Agreement – Statement of Principles – By The State Water Contractors And The State Of California Department Of Water Resources For Potential Amendments To The State Water Supply Contracts" (the "Monterey Agreement"); and

WHEREAS, the State, the Central Coast Water Authority ("CCWA") and those contractors intending to be subject to the Monterey Agreement subsequently negotiated an amendment to their contracts to implement provisions of the Monterey Agreement, and such amendment was named the "Monterey Amendment"; and

WHEREAS, in October 1995, an environmental impact report ("EIR") for the Monterey Amendment was completed and certified by CCWA as the lead agency, and thereafter the District and the State executed the Monterey Amendment; and

WHEREAS, the EIR certified by the CCWA was challenged by several parties (the "Plaintiffs") in the Sacramento County Superior Court and thereafter in the Third District Court of Appeal, resulting in a decision in *Planning and Conservation League, et al. v. Department of*

Water Resources, 83 Cal.App.4th 892 (2000), which case is hereinafter referred to as "PCL v. DWR"; and

WHEREAS, in its decision, the Court of Appeal held that (i) the Department of Water Resources ("DWR"), not CCWA, had the statutory duty to serve as lead agency, (ii) the trial court erred by finding CCWA's EIR sufficient despite its failure to discuss implementation of Article 18, subdivision (b) of the State Water Project contracts, as a no-project alternative, (iii) said errors mandate preparation of a new EIR under the direction of DWR, and (iv) the trial court erroneously dismissed the challenge to DWR's transfer of title to certain lands to Kern County Water Agency (the "Validation Cause of Action") and execution of amended State Water Project contracts for failure to name and serve indispensable parties. The Court of Appeal remanded the case to the trial court, ordering it to take the following five actions: (1) vacate the trial court's grant of the motion for summary adjudication of the Validation Cause of Action; (2) issue a writ of mandate vacating the certification of the EIR; (3) determine the amount of attorney fees to be awarded Plaintiffs; (4) consider such orders it deems appropriate under Public Resources Code Section 21168.9(a) consistent with the views expressed in the Appellate Court's opinion; and (5) retain jurisdiction over the action until DWR, as lead agency, certifies an environmental impact report in accordance with CEQA standards and procedures, and the Superior Court determines that such environmental impact report meets the substantive requirements of CEQA; and

WHEREAS, the State, the contractors, and the Plaintiffs in *PCL v. DWR* reached an agreement to settle *PCL v. DWR*, as documented by that certain Settlement Agreement dated _____, 2003 (the "Settlement Agreement"), and in such Settlement Agreement have agreed that the contracts should be amended, for clarification purposes, to delete terms such as "annual entitlement" and "maximum annual entitlement" so that the public, and particularly land use planning agencies, will better understand the contracts; and

WHEREAS, pursuant to the Settlement Agreement, the State and the District desire to so amend the District's contract, with the understanding and intent that the amendments herein with respect to subsections (m), (n), and (o) of Article 1, subsection (b) of Article 6, and subsection (a) of Article 16, and to Table A of the District's contract are solely for clarification purposes and that such amendments are not intended to and do not in any way change the rights, obligations or limitations on liability of the State or the District established by or set forth in the contract; and

WHEREAS, pursuant to the Settlement Agreement, the State, the contractors and the Plaintiffs in *PCL v. DWR* also agreed that the contracts should be amended to include a new Article 58 addressing the determination of dependable annual supply of State Water Project water to be made available by existing Project facilities, and the State and District desire to so amend the District's contract.

NOW THEREFORE, IT IS MUTUALLY AGREED, as follows:

1. Article 1(n) is amended to read:[1]

(n) **Annual Table A Amount**

"Annual Table A Amount" shall mean the amount of project water set forth in Table A of this contract that the State, pursuant to the obligations of this contract and applicable law, makes available for delivery to the District at the delivery structures provided for the District. The term Annual Table A Amount shall not be interpreted to mean that in each year the State will be able to make that quantity of project water available to the District. The Annual Table A Amounts and the terms of this contract reflect an expectation that under certain conditions the District will receive its full Annual Table A Amount; but that under other conditions only a lesser amount, allocated in accordance with this contract, may be made available to the District. This recognition that full Annual Table A Amounts will not be deliverable under all conditions does not change the obligations of the State under this contract, including but not limited to, the obligations to make all reasonable efforts to complete the project facilities, to perfect and protect water rights, and to allocate among contractors the supply available in any year, as set forth in Articles 6(b), 6(c), 16(b) and 18, in the manner and subject to the terms and conditions of those articles and this contract. Where the term "annual entitlement" appears elsewhere in this contract, it shall mean "Annual Table A Amount." The State agrees that in future amendments to this and other contractor's contracts, in lieu of the term "annual entitlement," the term "Annual Table A Amount" will be used and will have the same meaning as "annual entitlement" wherever that term is used.

2. Article 1(o) is amended to read:

(o) Maximum Annual Table A Amount

"Maximum annual entitlement" shall mean the maximum annual amounts set forth in Table A of this contract, and where the term "maximum annual entitlement" appears elsewhere in this contract it shall mean "Maximum Annual Table A Amounts."

3. Article 1(m) is amended to read:

(m) Minimum Project Yield

"Minimum project yield" shall mean the dependable annual supply of project water to be made available assuming completion of the initial project conservation facilities and additional project conservation facilities. The project's capability of providing the minimum project yield shall be determined by the State on the basis of coordinated operations studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon factors including but not limited to: (1) the estimated relative proportion of deliveries for agricultural use to deliveries for municipal use assuming Maximum Annual Table A Amounts

[1] The number of the articles is not the same for all the Water Supply Contractors. Article 1(n) is intended to be the article presently entitled "Annual Entitlement", whatever its number may be in each District's contract. The article numbers may have to be changed for each contractor to reflect the numbers in its contract.

for all contractors and the characteristic distributions of demands for these two uses throughout the year; and (2) agreements now in effect or as hereafter amended or supplemented between the State and the United States and others regarding the division of utilization of waters of the Delta or streams tributary thereto.

4. Article 6(b) is amended to read:

(b) District's Annual Table A Amounts

Commencing with the year of initial water delivery to the District, the State each year shall make available for delivery to the District the amounts of project water designated in Table A of this contract, which amounts shall be subject to change as provided for in Article 7(a) and are referred to in this contract as the District's Annual Table A Amounts.

5. Article 16(a) is amended to read:

(a) Limit on Total of all Maximum Annual Table A Amounts

The District's Maximum Annual Table A Amount hereunder, together with the maximum Table A amounts of all other contractors, shall aggregate no more than 4,185,000 acre-feet of project water.

6 Article 58 is added to read:

58. **Determination of Dependable Annual Supply of Project Water to be Made Available by Existing Project Facilities.**

In order to provide current information regarding the delivery capability of existing project conservation facilities, commencing in 2003 and every two years thereafter the State shall prepare and mail a report to all contractors, and all California city, county, and regional planning departments and agencies within the contractors' project service areas. This report will set forth, under a range of hydrologic conditions, estimates of overall delivery capability of the existing project facilities and of supply availability to each contractor in accordance with other provisions of the contractors' contracts. The range of hydrologic conditions shall include the delivery capability in the driest year of record, the average over the historic extended dry cycle and the average over the long-term. The biennial report will also include, for each of the ten years immediately preceding the report, the total amount of project water delivered to all contractors and the amount of project water delivered to each contractor.

7. Add the following language at the bottom of Table A:

In any year, the amounts designated in this Table A shall not be interpreted to mean that the State is able to deliver those amounts in all years. Article 58 describes the State's process for providing current information for project delivery capability.

8. Except for Article 58, the changes made by this amendment are solely for clarification purposes, and are not intended to nor do they in any way change the rights, obligations or

limitations on liability of the State or the District established by or set forth in the contract, and this amendment shall be interpreted in accordance with this intent.

9. At the time of execution of this Agreement and thereafter, the effectiveness of this Amendment is dependent upon the effectiveness of the District's Monterey Amendment (all provisions therein) and the Kern Fan Element Transaction.

IN WITNESS WHEREOF, the parties hereto have executed this amendment on the date first above written.

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES

By: _____
Name: _____
Title: Director

Approved as to legal form and sufficiency:

By: _____
Name: _____
Title: Chief Counsel

Attest:

_____ DISTRICT

By: _____
Name: _____
Title: _____

ATTACHMENT B

PRINCIPLES REGARDING STATE WATER PROJECT AVAILABILITY

Note: These principles are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. Commencing in 2003, and every two years thereafter, the Department of Water Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public.

2. DWR shall develop and, by January 1, 2004, publish guidelines to assist Municipal and Industrial Contractors in providing accurate information to land-use planning agencies with jurisdiction within the Contractors' respective service areas regarding local and regional programs to manage or supplement SWP supplies. DWR shall consult with the plaintiffs and contractors in developing the guidelines.

3. DWR shall provide assistance to enable all Municipal and Industrial Contractors to provide complete and accurate information to relevant land-use planning agencies to assure that local land-use decisions reflect accurate information on the availability of water from state, local, and other sources.

ATTACHMENT C

DWR GUIDELINES FOR REVIEW OF PROPOSED PERMANENT TRANSFERS OF STATE WATER PROJECT ANNUAL TABLE A AMOUNTS

Note: These guidelines are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. Purpose: The purpose of these guidelines is to describe the process for DWR's review of proposed permanent transfers of SWP Annual Table A Amounts and by so doing, provide disclosure to SWP Contractors and to the public of DWR's process and policy on approving permanent transfer of SWP Annual Table A Amounts. Such disclosure should assist contractors in developing their transfer proposals and obtaining DWR review expeditiously, and assist the public in participating in that review.

2. Coverage: These guidelines will apply to DWR's approval of permanent transfers of water among existing SWP Contractors and, if and when appropriate, to permanent transfers of water from an existing SWP Contractor to a new SWP Contractor.

3. Interpretation: These guidelines are in furtherance of the state policy in favor of voluntary water transfers and shall be interpreted consistent with the law, including but not limited to Water Code Section 109, the Burns-Porter Act, the Central Valley Project Act, the California Environmental Quality Act, area of origin laws, the public trust doctrine, and with existing contracts and bond covenants. These guidelines are not intended to change or augment existing law.

4. Format: The guidelines shall be issued by DWR as a "Notice to State Water Contractors."

5. Revisions: Revisions may be made to these guidelines as necessary to meet changed circumstances, changes in the law or long-term water supply contracts, or to address conditions unanticipated when the guidelines are adopted. Revisions shall be in accordance with the settlement agreement reached in *Planning and Conservation League vs. Department of Water Resources*.

6. Distribution: The transfer guidelines shall be published by DWR in the next available edition of Bulletin 132, and also as part of the biennial disclosure of SWP reliability as described in the PCL v. DWR Settlement Agreement.

7. Contract Amendment: Permanent transfers of SWP water are accomplished by amendment of each participating contractor's long-term water supply contract. The amendment consists of amending the Table A upwards for a buying contractor and downwards for a selling contractor. The amendment shall be in conformity with all provisions of the long-term water supply contracts, applicable laws, and bond covenants. Other issues to be addressed in the contract amendment will be subject to negotiation among DWR and the two participating contractors. The negotiations will be conducted in public, pursuant to the settlement agreement in PCL vs. DWR.

8. Financial issues: The purchasing contractor must demonstrate to the DWR's satisfaction that it has the financial ability to assume payments associated with the transferred water. If the purchasing entity was not a SWP Contractor as of 2001, special financial requirements pertain as described below, as well as additional qualifications.

9. Compliance with CEQA: Consistent with CEQA, the State's policy to preserve and enhance environmental quality will guide DWR's consideration of transfer proposals (Public Resources Code Section 21000). Identification of the appropriate lead agency will be based on CEQA, the CEQA Guidelines, and applicable caselaw, including *Planning and Conservation League vs. Department of Water Resources, 83 Cal. App. 4th 892 (2000).* CEQA requires the lead agency at a minimum to address the feasible alternatives to the proposed transfer and its potentially significant environmental impacts (1) in the selling contractor's service area; (2) in the buying contractor's service area; (3) on SWP facilities and operations; and (4) on the Delta and areas of origin and other regions as appropriate. Impacts that may occur outside of the transferring SWP Contractors' service areas and on fish and wildlife shall be included in the environmental analysis. DWR will not approve a transfer proposal until CEQA compliance is completed. The lead agency shall consult with responsible and trustee agencies and affected cities and counties; and when DWR is not the lead agency, shall provide an administrative draft of the draft EIR or Initial Study/Negative Declaration to DWR prior to the public review period. A descriptive narrative must accompany a checklist, if a checklist is used. The lead agency shall conduct a public hearing on the EIR during the public comment period and notify DWR's State Water Project Analysis Office of the time and place of such hearing in addition to other notice required by law.

10. Place of Use: The purchasing contractor must identify the place and purpose of use of the purchased water, including the reasonable and beneficial use of the water. Typically this information would be included in the environmental documentation. If a specific transfer proposal does not fit precisely into any of the alternatives listed below, DWR will use the principles described in these Guidelines to define the process to be followed. The information to be provided under this paragraph is in addition to the CEQA information described in paragraph 9 of these guidelines.

a) If the place of use is within the contractor's service area, the contractor should disclose the purpose of the transferred water, such as whether the water is being acquired for a specific development project, to enhance overall water supply reliability in the contractor's service area, or some other purpose. If the transferred water is for a municipal purpose, the contractor should state whether the transfer is consistent with its own Urban Water Management Plan or that of its member unit(s) receiving the water.

b) If the place of use is outside the contractor's service area, but within the SWP authorized place of use, and service is to be provided by an existing SWP Contractor: In addition to Paragraph 10(a) above, the contractor should provide DWR with copies of LAFCO approval and consent of the water agency with authority to serve that area, if any. In some instances, DWR's separate consent is required for annexations in addition to the approval for the transfer.

c) If the place of use is outside the SWP authorized place of use and service is to be provided by an existing SWP Contractor, the contractor should provide information in Paragraph 10(a) and 10(b). Prior to approving the transfer, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

d) If the place of use is outside the SWP authorized place of use and service is not to be provided by an existing SWP contractor, DWR will consider the transfer proposal as a proposal to become a new state water contractor. Prior to adding a new SWP Contractor, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. DWR will consult with existing SWP Contractors regarding their water supply needs and the proposed transfer. In addition to the information in Paragraph 10(a), 10(b), and 10(c), the new contractor should provide information similar to that provided by the original SWP contractors in the 1960's Bulletin 119 feasibility report addressing hydrology, demand for water supply, population growth, financial feasibility, etc. DWR will evaluate these issues independently and ordinarily will act as lead agency for CEQA purposes. In addition, issues such as area of origin claims, priorities, environmental impacts and use of water will be addressed. The selling contractor may not be released from financial obligations. The contract will be subject to a CCP 860 validation action initiated by the new contractor. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

11, DWR Discretion. Consistent with the long-term water supply contract provisions, CEQA, and other provisions of law, DWR has discretion to approve or deny transfers. DWR's exercise of discretion will incorporate the following principles:

(a) As required by CEQA, DWR as an agency with statewide authority will implement feasible mitigation measures for any significant environmental impacts resulting from a transfer, if such impacts and their mitigation are not addressed by other public agencies and are within DWR's jurisdiction.

(b) DWR will invoke "overriding considerations" in approving a transfer only as authorized by law, including but not limited to CEQA, and, to the extent applicable, the public trust doctrine and area of origin laws.

ATTACHMENT D

PRINCIPLES REGARDING PUBLIC PARTICIPATION PROCESS IN SWP CONTRACT NEGOTIATIONS

Note: These principles are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. Policy: Given the importance of the State Water Project to the State of California, and the key role that the long-term water supply contracts play in the administration of the State Water Project, DWR agrees that public review of significant changes to these contracts is beneficial and in the public interest.

2. Types of activities to be covered: Project-wide contract amendments (i.e., contracts with substantially similar terms intended to be offered to all long-term SWP Contractors) and contract amendments to transfer entitlements between existing SWP Contractors will not be offered to the contractors for execution unless DWR has first complied with the public participation process as described in paragraphs (3), (4), (5) and (6).

3. The Public Participation Process.

1) Negotiations will be conducted in public;

2) The public will be provided with advance notice of the time and place of the negotiations; and

3) The public will be provided the opportunity to observe negotiations and comment in each negotiating session

4. Timing of Public Participation: Public participation ordinarily will precede the formulation of the project description in the CEQA process in order to assure that the public participation is meaningful. When DWR is a responsible agency, (e.g., when existing SWP Contractors agree to transfer entitlement between themselves), the public participation will be scheduled to facilitate coordination with the lead agency's CEQA process.

5. Activities that will not be subject to public participation: Informal discussions prior to exchange of formal drafts and discussion of topics that are authorized to be kept confidential by law will not be subject to the public participation process.

6. Contract amendments resulting from litigation: If litigation has been formally initiated, and settlement negotiations result in a proposal to adopt project-wide amendments to settle the litigation, all proposed contract amendments shall be subject to the public participation process before they are approved by DWR.

ATTACHMENT E

FINAL PERMANENT TABLE A AMOUNT TRANSFERS FROM KERN COUNTY WATER AGENCY SUBSEQUENT TO MONTEREY AMENDMENTS (January 1, 2003)

Note: This Exhibit is prepared in connection with the settlement agreement between PCL and DWR.

From (Kern County Water Agency Member Unit)	To	Amount (afy)	Year Effective
Berrenda Mesa Water District	Mojave Water Agency	25,000	1998
Belridge Water Storage District	Palmdale Water Agency	4,000	2000
Berrenda Mesa Water District	Alameda County Flood Control and Water Conservation District Zone 7	7,000	2000
Lost Hills Water District	Alameda County Flood Control and Water Conservation District Zone 7	15,000	2000
Belridge Water Storage District	Alameda County Flood Control and Water Conservation District Zone 7	10,000	2001
Belridge Water Storage District and Berrenda Mesa Water District	Solano County Water Agency	5,756	2001
Belridge Water Storage District and Berrenda Mesa Water District	Napa County Flood Control and Water Conservation District	4,025	2001

EXHIBIT 1

PLAINTIFFS' EXPENSES TRUST ACCOUNT AGREEMENT

This Agreement is entered into this fifteenth day of August 2002, by JAMS and DWR, for the purpose of transferring $300,000 in trust to JAMS for use in accordance with Principles of Settlement in PCL vs. DWR.

WHEREAS, JAMS has acted as mediator between the Department and other parties to the litigation in PCL v. DWR (Superior Court No. 95CS03216).

WHEREAS, the Principles of Settlement as agreed to by the parties on July 22, 2002, provides for the placement of $300,000 in trust with JAMS.

WHEREAS, the money placed in the trust is to be provided to plaintiffs for expenses actually incurred as needed to support plaintiffs' participation in developing the new EIR to be filed as a return to the writ.

WHEREAS, the Principles of Settlement also provides that the funds will be provided based on a budget and participation plan to be submitted by plaintiffs to the mediator specifying the purposes for which the funds will be expended.

The parties agree as follows:

1. JAMS agrees to accept $300,000 in trust in accordance with the Principles of Settlement.

2. JAMS agrees to maintain the monies in trust, and following receipt of a budget and participation plan from plaintiffs, to disburse funds to plaintiffs for actual expenditures incurred for such purpose and pursuant to such schedule, budget, and participation plan, all in conformance with the Principles of Settlement. The funds will be disbursed to the plaintiffs' attorney, Antonio Rossmann, Law Offices of Antonio Rossmann.

3. Costs incurred by JAMS in providing this service will be paid as part of the mediator services as part of the existing contract between JAMS and the California Department of Justice, Office of the Attorney General.

4. This agreement may be amended in writing by agreement of both parties.

5. Funds not disbursed upon termination of the trust shall be returned to DWR.

6. The trust shall terminate upon notice to JAMS by DWR of termination based on the earlier of (a) failure of the parties to the mediation to execute a settlement agreement by January 1, 2003; (b) notice of termination given by the Director of DWR to JAMS and plaintiffs that this trust is terminated, which notice shall not be given without

defendants' consultation with plaintiffs and the mediator; or c) filing of the Notice of Determination on the new EIR.

7. JAMS will incur no liability to DWR arising from any disbursement made pursuant to this agreement.

8. This agreement is not intended to and shall not create any rights in any third party.

APPROVED:

/s/ Steve Macaulay for	8/10/02	/s/ Julie Sager	8/15/02
Thomas M. Hannigan Director	Date	Vice President & CFO JAMS	Date

EXHIBIT 1

AMENDMENT NO. 1

PLAINTIFFS' EXPENSES TRUST ACCOUNT AGREEMENT

Paragraph 6 of this Agreement is amended to read as follows:

6. The trust shall terminate upon notice to JAMS by DWR of termination based on the earlier of (a) failure of the parties to the mediation to execute a settlement agreement by May 1, 2003, (b) notice of termination given by the Director of DWR to JAMS and plaintiffs that this trust is terminated, which notice shall not be given without defendants' consultation with plaintiffs and the mediator; or (c) filing of the Notice of Determination on the new EIR.

APPROVED:

Thomas M. Hannigan Director	Date		Date JAMS

EXHIBIT 2

KERN WATER BANK AUTHORITY
AGREEMENTS AND PERMITS
WHICH MAY HAVE RELIED ON THE KWBA ADDENDUM

AGREEMENT/PERMIT	DATE	OTHER PARTIES
Incidental Take Permit - PRT-828086	2-Oct-97	Department of Interior, U.S. Fish & Wildlife Service
Approval/Management Authorization pursuant to California Endangered Species Act for Implementation of Kern Water Bank Habitat Conservation Plan/Natural Community Conservation Plan	2-Oct-97	Calif. Department of Fish & Game
Natural Community Conservation Plan/Habitat Conservation Plan Implementation Agreement	2-Oct-97	U.S. Fish & Wildlife Service; Calif Dept of Fish & Game; Kern Water Bank Authority
Approval, Cultural Resources Assessment and Plan for the KWBA Project	January, 1997	N/A
Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program	26-Oct-95	Numerous
Approval of Kern Water Bank Authority Mosquito Abatement Program	26-Oct-95	Mosquito Abatement Districts
Service Contracts for Operations and Maintenance	1996 - current	Numerous Vendors
Grazing Leases (Sheep and Cattle)	1997- current	Various Stockmen
Minor Amendment No. 1: Hunting/Research to the KWBA HCP/NCCP and Implementation Agreement	6/30/1998	California Department of Fish and Game and U.S. Fish and Wildlife Service
State of California Standard Agreement for "Improving Wildlife Habitat for Doves" (annual contract)	1998 - current	Calif. Department of Fish and Game
Conservation Credit Certificates	1998 - current	Conservation Credit Buyers
Construction and Service Contracts for Master Plan Construction Project - KWB Canal, Head-works, Aqueduct Turnout, New Wells, Well Rehabilitation, Pipelines	7/1999 - 8/2002	Numerous Contractors and Vendors
KWB Canal and Buena Vista Main Canal Joint Use Agreement	7/20/1999	Buena Vista Water Storage District

AGREEMENT/PERMIT	DATE	OTHER PARTIES
Business Loan Agreement ($21,000,000)	7/23/1999	Bank of America, N.A.
Agreement for Grant of Easement	September 1999	State of California Acting Through the Department of Parks and Recreation
Agreement for Construction, Operation, and Maintenance of the Kern Water Bank Turnout, a Permanent Turnout Within the California Aqueduct Right of Way	11/9/1999	Department of Water Resources
License Agreement for Kern River Canal Crossing	11/17/1999	City of Bakersfield
Loan Contract No. E75002 Under the "Safe, Clean, Reliable Water Supply Act Water Conservation and Ground Water Recharge Sub account ($5,000,000)	March 2000	State of California, Department of Water Resources, Division of Planning and Local Assistance
Reclamation Board Permit No. 17147-A GM Authorizing Construction of Pedestrian Bridge Across the Outlet Canal within the Kern River Designated Floodway	10/16/2000	State of California - The Resources Agency, Department of Water Resources
Reclamation Board Permit No. 16821 GM (Revised) Authorizing Construction of a 20-foot Wide Unlined Canal and Reinforced Concrete Gated Turnout Structure on the Right (North) Bank of the Designated Floodway and Install a 108-Inch Diameter, 700-foot long, Reinforced Concrete Pipe Across (Under the Kern River	2/26/2001	State of California - The Resources Agency, Department of Water Resources
Grant Awarded Under the "Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13) - Groundwater Storage Program ($3,375,000)	Jun-02	State of California, Department of Water Resources, Division of Planning and Local Assistance
Service Contracts for Well Testing and Rehabilitation Under the SB5X Program	2002	Various Vendors

EXHIBIT 3-A

PROPOSED 21168.9 ORDER

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF SACRAMENTO

PLANNING AND CONSERVATION LEAGUE, a California not for profit corporation, PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, a California public agency; CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC., a California not for profit corporation, Plaintiffs and Petitioners, v. DEPARTMENT OF WATER RESOURCES, a California State Agency, et al., Defendants and Respondents,	Case No: 95CS03216 [PROPOSED] ORDER PURSUANT TO PUBLIC RESOURCES CODE SECTION 21168.9

On remand from the Third District Court of Appeal on January ___, 2003, in Department 53 of the Sacramento Superior Court, the Honorable Loren E. McMaster, presiding, this proceeding came on for a status report and joint motion. Petitioners and Plaintiffs, Planning and Conservation League, Plumas County Flood Control and Water Conservation District, and Citizens Planning Association of Santa Barbara County ("Petitioners"), appeared through Antonio Rossmann and Roger B. Moore. Respondent and Defendant, Central Coast Water Authority (CCWA), appeared through Susan F. Petrovich of the Law Firm of Hatch & Parent. Respondent and Defendant, Department of Water Resources (DWR), appeared through Deputy Attorney General Marian E. Moe. Robert S. Draper of O'Melveny and Myers, LLP and Clifford W. Schulz appeared, respectively, on behalf of the Metropolitan Water District of Southern California and Dudley Ridge Water District, entities that submitted answers to the First

Amended Complaint subsequent to the Court of Appeal's final determination in this action and prior to any further order of this Court on remand.

In light of the direction from the Third District Court of Appeal on remand in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892, this Court hereby makes the following findings:

1. The parties to this lawsuit and other public agencies have engaged in extensive settlement negotiations, mediated by retired Judge Daniel Weinstein of JAMS Dispute Resolution, with the intent to avoid further litigation and associated expenses, to provide for an effective way to cooperate in the preparation of a new environmental impact report (EIR), and to make other specified improvements in the administration and operation of the State Water Project.

2. The mediation has resulted in an executed Settlement Agreement for approval by this Court, attached to this Order as Exhibit A.

3. DWR as lead agency has commenced the preparation of the new EIR.

4. As part of the Settlement Agreement, DWR and the State Water Project (SWP) contractors who are signatories to the Settlement Agreement have agreed that, pending DWR's filing of a return in satisfaction of the Writ of Mandate and this Court's dismissal of the Writ of Mandate, they will not approve any new project or activity (as defined in section VII.A of the Settlement Agreement) in reliance on the 1995 Environmental Impact Report for the Implementation of the Monterey Agreement.

5. This Order is made pursuant to the provisions of Public Resources Code section 21168.9 and pursuant to this Court's equitable powers. This Court finds that the actions described in this Order, including actions taken in compliance with the Writ of Mandate, comprise the actions necessary to assure DWR's compliance with Division 13 of the Public Resources Code. This Court further finds that this Order includes only those mandates necessary to achieve compliance with Division 13.

THEREFORE, IT IS HEREBY ORDERED as follows:

1. This Court's Final Judgment denying the petition for writ of mandate, entered August 15, 1996, is reversed in accordance with the directive of the Third District Court of Appeal's decision in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892.

2. This Court's order granting the summary adjudication on the fifth cause of action, entered June 10, 1996, is vacated.

3. The Settlement Agreement attached as Exhibit A is hereby approved.

4. A Peremptory Writ of Mandate directed to Respondents Central Coast Water Authority and DWR shall issue under seal of this Court in the form attached hereto as Exhibit B.

5. In accordance with the Settlement Agreement and this Order, pending DWR's filing of the return in compliance with the Peremptory Writ of Mandate and this Court's Order discharging the Writ of Mandate, DWR and CCWA shall not approve any new project or activity (as defined section VII.A of the Settlement Agreement) in reliance on the 1995 EIR for the Implementation of the Monterey Agreement.

6. In the interim, until DWR files its return in compliance with the Peremptory Writ of Mandate and this Court orders discharge of the Writ of Mandate, the administration and operation of the State Water Project and Kern Water Bank Lands shall be conducted pursuant to the Monterey Amendments to the State Water Contracts, as supplemented by the Attachment A Amendments to the State Water Contracts (as defined in the Settlement Agreement) and the other terms and conditions of the Settlement Agreement.

7. Plaintiffs and petitioners shall recover such costs and attorney's fees as provided in prior court orders and in an amount as determined in the arbitration procedures agreed to in the Settlement Agreement, or as otherwise agreed to by the parties.

8. Except as provided, the Peremptory Writ of Mandate shall not limit or constrain the lawful jurisdiction and discretion of DWR. This Court retains jurisdiction until DWR files a

return that complies with the terms of the Writ of Mandate, and this Court issues an order discharging the Writ of Mandate.

IT IS SO ORDERED.

Dated: _____, 2003 _____ _____

Judge of the Superior Court

EXHIBIT 3-B

PROPOSED WRIT OF MANDATE

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF SACRAMENTO

PLANNING AND CONSERVATION LEAGUE, a California not for profit corporation, PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, a California public agency; CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC., a California not for profit corporation, Petitioners, v. DEPARTMENT OF WATER RESOURCES, a California State Agency, and CENTRAL COAST WATER AUTHORITY, A Joint Powers Agency Respondents.	Case No: 95CS03216 PROPOSED PEREMPTORY WRIT OF MANDATE (Public Resources Code § 21168.9)

TO: Respondents California Department of Water Resources and Central Coast Water Authority:

The Third District Court of Appeal, in its decision in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892, having directed this Court to issue a Peremptory Writ of Mandate,

YOU ARE HEREBY COMMANDED to comply with the following:

1. Respondent Central Coast Water Authority shall set aside its October 26, 1995 certification that the Final Programmatic Environmental Impact Report for Implementation of

the Monterey Agreement (the 1995 Monterey Agreement EIR) was completed in compliance with the California Environmental Quality Act [AR 2183].

2. Respondent Department of Water Resources (DWR) shall:

(a) set aside its December 13, 1995 certification, as responsible agency, that the 1995 Monterey Amendment EIR is adequate under the California Environmental Quality Act [AR 1875]; and

(b) as lead agency, prepare and certify a new EIR. in compliance with the Court of Appeal's decision, the California Environmental Quality Act, and the Settlement Agreement.

3. Upon completion and certification of the new EIR, Respondent DWR shall make written findings and decisions and file a notice of determination identifying the components of the project analyzed in the new EIR**,** all in the manner prescribed by sections 15091 – 15094 of the CEQA Guidelines.

4. Respondent DWR shall, upon the filing of a Notice of Determination, submit the new EIR, the written findings, the Notice of Determination, and such additional documents as this Court may order by way of return to this writ of mandate.

5. This Court shall retain jurisdiction over this proceeding until DWR files a return that complies with this Writ of Mandate, and this Court issues an order discharging this Writ of Mandate. Except as provided, this Writ of Mandate shall not limit or constrain the lawful jurisdiction and discretion of the Department of Water Resources.

Dated: _____, 2003

_____

_____

Clerk of the Superior Court

Let the foregoing writ issue:

_____

Judge of the Superior Court

EXHIBIT 4

SECTION VI TRUST ACCOUNT AGREEMENT

This Section VI Trust Account Agreement (this "Trust Agreement") is entered into this _____ day of _____ 2003, by JAMS and the State of California Department of Water Resources (the "Department"), for the purposes of establishing and describing the trust account in accordance with that certain Settlement Agreement entered into in *Planning & Conservation League v. Department of Water Resources* ("PCL v. DWR").

WHEREAS, Judge Daniel Weinstein (ret.) of JAMS has acted as mediator between the Department and other parties to the litigation in *PCL v. DWR* (Sacramento Superior Court No. 95CS03216).

WHEREAS, the Settlement Agreement provides for the placement over time of $5,500,000 in trust with JAMS at the specific times and under the conditions in the Settlement Agreement.

The parties agree as follows:

1. JAMS will establish a trust account for receipt and disbursal of funds received from the Department for payment pursuant to the Settlement Agreement.

2. All funds deposited with JAMS pursuant to this agreement shall be placed into a trust account and shall be disbursed only in accordance with this Trust Agreement and the Settlement Agreement. Section VI of the Settlement Agreement provides that the funds shall be used to implement the Settlement Agreement, as determined by Plaintiffs in their reasonable judgment, including watershed restoration projects, follow-up actions arising from the Settlement Agreement, and technical studies.

3. JAMS agrees to maintain the monies in trust, and after receipt of a written statement executed by all Plaintiffs (as defined in the Settlement Agreement), to disburse funds to Plaintiffs in conformance with such statement. JAMS will provide a copy of the written statement to: Chief Counsel, The Office of the Chief Counsel, Department of Water Resources, P.O. Box 942836, Sacramento, CA 95814.

4. Costs incurred by JAMS in providing this service will be paid as part of the mediator services as part of the existing contract between JAMS and the California Department of Justice, Office of the Attorney General, or any successor contract.

5. This agreement may be amended only in writing by agreement of both parties.

6. Funds not disbursed before termination of this Trust Agreement shall be returned to DWR immediately upon termination of this Trust Agreement.

7. This Trust Agreement shall terminate if and when DWR notifies JAMS that the agreement is terminated, which notice shall not be given without DWR's consultation with Plaintiffs and the mediator.

8. JAMS will incur no liability to DWR arising from any disbursement made pursuant to this agreement.

9. This Trust Agreement is intended solely for the purposes of establishing and describing the trust account at JAMS and is not intended to and shall not create any rights in any third party.

APPROVED:

Thomas M. Hannigan Director	Date	JAMS	Date

Governor's Press Release, "Gov. Schwarzenegger Directs Immediate Actions to Improve the Deteriorating Delta, California's Water Supply," July 17, 2007

Office of the Governor
ARNOLD SCHWARZENEGGER
THE PEOPLE'S GOVERNOR

PRESS RELEASE

07/17/2007 GAAS:564:07 FOR IMMEDIATE RELEASE

Gov. Schwarzenegger Directs Immediate Actions to Improve the Deteriorating Delta, California's Water Supply

Governor Arnold Schwarzenegger today directed the Department of Water Resources to take immediate action steps to improve conditions in the Sacramento-San Joaquin Delta, to help restore its natural habitat and protect the Delta smelt and other species. The Governor also identified more than $120 million in specific Delta restoration projects to be part of his comprehensive water plan, which he is calling on the Legislature to pass by the end of this year. He made the announcements on Twitchell Island in the Delta.

"Today, I am calling for actions to help restore the Delta, the largest estuary on the West Coast and home to hundreds of native plant and animal species. The Delta is also one of the most vulnerable areas of our state. It faces dangers of contamination from a natural disaster or rising sea levels. And, we saw an example of its vulnerability when we had to shut off the pumps for nine days to protect the threatened Delta smelt," said Governor Schwarzenegger.

"The Delta is one of California's most important resources -- 25 million Californians rely on it for clean water. It also irrigates hundreds of thousands of acres of Central Valley farmland and is the heart of our $32 billion agricultural industry."

Without immediate changes, the Delta will fail as a reliable water source, according to state water experts. Climate models and current weather patterns require that we prepare for more severe floods, droughts and rising sea levels, which the Delta must be able to withstand to protect California's water supply.

Building on his Strategic Growth Plan from last year, the Governor introduced a $5.9 billion comprehensive water plan in January. The Governor's plan invests $4.5 billion to develop additional surface and groundwater storage. The plan also includes $1 billion toward restoration of the Delta, including development of a new conveyance system, $250 million to support restoration projects on the Klamath, San Joaquin and Sacramento rivers and the Salton Sea project and $200 million for grants to California communities to help conserve water for about 400,000 families.

Today, the Governor issued immediate directives to protect the Delta. Using existing resources, the Department of Water Resources will implement these actions:

- Prevent the spread of invasive species. Invasive species like the quagga mussel compete with native species like the smelt.
- Improve research on the Delta Smelt. State and federal agencies will upgrade and continue operation of a smelt culture laboratory.
- Screen Delta agricultural intakes to protect smelt. The state will install fish screens to protect the smelt when water is diverted from the Delta to irrigate state-owned lands on Sherman and Twitchell Islands.
- Restore the North Delta's natural habitat. The state will restore tidal wetlands and aquatic habitats at Cache Slough to provide spawning areas and promote the production of organisms that the smelt and other native fish eat. Dutch Slough is also a candidate for longer-term restoration.
- Improve Central Delta water flow patterns. The state will study and, if feasible, modify water circulation in the Central Delta near Frank's Tract to protect fish and improve water quality.
- Improve our ability to respond to Delta emergencies. The state will enhance Delta emergency response and levee failure plans and stockpile materials to repair damaged levees.

The Governor also called for additional actions to be included as part of a comprehensive water package, negotiated after the budget is passed. Totaling at more than $120 million, these actions could be funded out of the $1 billion proposed in the Governor's comprehensive plan, or by other funding sources:

- Restoring additional Delta habitats such as Dutch Slough. ($48 million)
- Helping local water agencies take actions to conserve and manage limited water supplies.
- Improving emergency planning in the event of an earthquake or flood. ($74 million)
- Assessing the feasibility of additional screening at state facilities to protect Delta smelt and expediting projects to modify water circulation and improve water quality. ($2.25 million)
- Funding subsidence and carbon sequestration projects on Sherman and Twichell Islands and other Delta locations. ($3.5 million)

The actions are not intended to replace recommendations from ongoing Delta planning efforts. Instead, they are to make incremental improvements until long-term plans are in place. They will be compatible with any long-term Delta plan and will not preclude future restoration options.

The Governor has directed the Delta Vision Blue Ribbon Task Force to develop a Delta management plan. The task force will present its findings and recommendations by January 1, 2008 and its Strategic Plan by October 31, 2008. The Bay Delta Conservation Plan is also underway, being developed with broad participation from water agencies, environmental organizations and local representatives. The $1 billion proposed in the Governor's comprehensive plan will be used to fund their recommendations.

United States District Court, Eastern District of California, "*Pacific Coast Federation of Fishermen's Associations, et al. v. Gutierrez, et al.*, No. 06-CV-00245-OWW-GSA (E.D. Cal. 2008)" ("2008 Wanger decision")

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF CALIFORNIA

PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS/INSTITUTE FOR FISHERIES RESOURCES, *et al.*, Plaintiffs, v. CARLOS M. GUTIERREZ, in his official capacity as Secretary of Commerce *et al.*, Defendants. SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, *et al.*, Defendant-Intervenors.	Case No. 1:06-CV-0245 OWW GSA ORDER GRANTING IN PART AND DENYING IN PART PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT AND GRANTING IN PART AND DENYING IN PART FEDERAL DEFENDANTS' CROSS-MOTION FOR SUMMARY JUDGMENT

The Court has read and considered the memoranda of points and authorities and other documents in support of and in opposition to Plaintiffs' motion for summary judgment and Federal Defendants' cross-motion for summary judgment, and has heard and considered the arguments of counsel at the hearing on these matters held on October 3, 2007. NOW THEREFORE, good cause appearing, the Court GRANTS IN PART AND DENIES IN PART Plaintiffs' motion for summary judgment, as follows.

1. As to the lawfulness of the National Marine Fisheries Service's ("NMFS") 2004 Biological Opinion on the impacts of the long-term operations of the Central Valley Project and State Water Project on Sacramento River winter-run Chinook, Central Valley spring-run Chinook, Central Valley steelhead ("CV steelhead"), Southern Oregon/Northern California Coast coho, and Central California Coast steelhead ("Biological Opinion") under the Administrative Procedure Act ("APA") and the Endangered Species Act ("ESA"), Plaintiffs' motion for summary judgment is:

(a) GRANTED as to NMFS's record findings and analyses, which fail to explain contradictory evidence as to the survival and recovery of winter-run Chinook, spring-run Chinook, and CV steelhead ("the three species"). Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(b) GRANTED as to the failure to analyze adverse effects on and modification to the critical habitat of the three species. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(c) GRANTED as to whether NMFS failed to conduct an ESA analysis on the three species' life cycles and population dynamics. NMFS is ordered to complete the required ESA analysis on the three species' life cycles and population dynamics in its forthcoming biological opinion. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(d) GRANTED as to whether NMFS's focus on incremental Project impacts was arbitrary and capricious. NMFS is ordered to complete the required ESA analysis on incremental Project impacts in relation to baseline conditions in its forthcoming biological opinion. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(e) DENIED as to the failure to address "Entire Agency Action." Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

(f) GRANTED as to the issue of global climate change and effects of the hydrology of northern California rivers. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(g) DENIED on the issue of the sufficiency of the Biological Opinion's adaptive management plan and mitigation measures. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

2. Plaintiffs' motion for summary judgment against the Bureau of Reclamation ("Bureau") under ESA § 7(a)(2) is:

(a) DENIED as to the issue of the Bureau's political bad faith. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

(b) DENIED as to the issue of mitigation standards. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

(c) GRANTED as to unexplained internal contradictions about jeopardy and recovery of the species. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(d) GRANTED as to the issue of the Bureau's reliance upon a biological opinion that failed to consider all relevant factors, including recovery and critical habitat impacts. Federal Defendants' cross-motion for summary judgment on this issue is DENIED.

(e) DENIED on the issue of global climate change. Federal Defendants' cross-motion on this issue is GRANTED, upon the condition that the Bureau complete a legally sufficient biological assessment that considers global climate change.

(f) DENIED as to the issue of the Temperature Control Point location. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

(g) DENIED as to alleged failure to consider 100% of water deliveries. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

(h) DENIED as to the issue of the Bureau's continued reliance on the Biological Opinion in the face of post-issuance information. Federal Defendants' cross-motion for summary judgment on this issue is GRANTED.

3. As to the Bureau's obligations under ESA § 7(d), Plaintiffs' Motion is DENIED. The Federal Defendants' cross-motion for summary judgment on this issue is GRANTED, upon the condition that Federal Defendants continue to take no actions during reconsultation that make any irreversible or irretrievable commitment of resources which forecloses the formulation or implementation of any reasonable and prudent alternative measures.

The parties shall comply with the schedule for the June 6, 2008, hearing on interim remedies and on whether the Biological Opinion should be remanded without vacatur.

SO ORDERED.

DATED: June 10, 2008

/s/ OLIVER W. WANGER
Oliver W. Wanger
United States District Judge

Los Angeles County Superior Court, "*Sierra Club, et al. v. City of Santa Clarita*, Case No. BS 098722" (August 14, 2006)

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LOS ANGELES
SUPERIOR COURT

SUPERIOR COURT OF CALIFORNIA

COUNTY OF LOS ANGELES

SIERRA CLUB, et al., Petitioner, vs. CITY OF SANTA CLARITA, et al., Respondent.	CASE NO. BS 098 722 DECISION ON SUBMITTED MATTER
NEWHALL LAND AND FARMING, Real Party in Interest.	

Having taken the matter under submission on May 31, 2005, having considered all the evidence admitted and the parties' oral and written arguments, the Court rules as follows:

Petitioners Sierra Club, Center for Biological Diversity, Friends of the Santa Clarita River, and California Water Impact Network ("Petitioners") seek a Writ of Mandate commanding Respondents City of Santa Clarita and Santa Clarita City Council ("City" or "Respondents") to set aside its decision certifying the Final Environmental Impact Report ("FEIR") and approving the Project known as Riverpark in favor of Real Party in Interest Newhall Land and Farming ("Newhall").

The Riverpark project is located on a 695.4-acre site. Originally, Riverpark proposed 1,183 residential units, consisting of 439 single-family homes and 744 apartments, and 40,000 square feet of commercial development, a trail system, a 29-acre active/passive park along the Santa Clara River, and approximately 442 acres of open space area, including most of the Santa Clara River. (2;1 AR, Tab 4, 340-42 [Draft EIR, § 1.0, Project Description].) Through the public hearing process, the project was revised by converting the apartments to condominiums or townhouses, reducing to 1,123 the residential units and to 16,000 square feet commercial development, and preserving additional areas of the Santa Clara River and its south fork. (10 AR, Tab 12, 11742-44 [FEIR, Project Revisions and Additional Information].) Further hearings in 2005 reduced the residential units to 1,089, consisting of 432 single family homes and 657 condominium/townhouses, and provided for the preservation of more land and river areas, totaling 788 acres (470-acres on-site) for recreation and open space. (10 AR 11742-44; 9 AR, Tab 11, 11418-22.) Included among the 318 off-site acres are the remaining portions of the south fork of the Santa Clara River owned by RPI, and 37 acres of the Santa Clara River significant ecological area ("SEA").

Project approvals included a General Plan Amendment, a Zone Change, a vesting tentative tract map, a conditional use permit to build in excess of two stories and a maximum of 50-feet, Hillside Innovative Application, a permit for vehicular gating, a variance to reduce setback requirements and to build sound walls in excess of 7 feet, Hillside Development Application, and an Oak Tree Permit. (1 AR, Tab 2, 9-114; 2 AR 259.)

The Planning Commission held 9 hearings and on 12/21/04 recommended that the City Council certify the EIR and adopt a Statement of

Overriding Considerations for impacts that could not be mitigated to a less than significant level. (1 AR, Tab 2, 9-22 [App. Reso.]; 7:2 AR, Tab 9, 8079-81 [12/21/04 Hearing Transcript]; 73 AR, Tab 652, 51639-43 [12/21/04 Staff Report].)

The City Council held 3 hearings and certified the EIR on 5/24/05, unanimously approving the project on 6/14/05. (1 AR, Tab 2, 22-26; 1 AR, Tab 3, 115-229.)

Petitioner filed within Petition for Writ of Mandate alleging non-compliance with CEQA.

To establish violation of the California Environmental Quality Act ("CEQA"), Petitioner must show an abuse of discretion in that the County either failed to proceed in the manner required by law or the determination or decision is not supported by substantial evidence. (Code Civ. Proc., § 1094.5(b); Pub. Resources Code, §§ 21168, 21168.5.) When CEQA non-compliance is alleged, the Court reviews the entire record to see if substantial evidence supports the challenged determinations.

"Substantial evidence" is defined as "enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached." (14 Cal. Code Regs., § 15384(a); Laurel Heights Improvement Assn. v. Regents of University of California (1988) 47 Cal.3d 376, 393.) Substantial evidence may include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts, but not argument, speculation, unsubstantiated opinion, or clearly erroneous evidence. (Pub. Resources Code, §§ 21080(e)(1)(2), 21082.2(c).)

"[I]n applying the substantial evidence standard, the reviewing court must resolve reasonable doubt in favor of the administrative

finding and decision. As such, if there are conflicts in the evidence, their resolution is for the agency." (River Valley Preservation Project v. Metropolitan Transit Development Board (1995) 37 Cal. App. 4th 154, 168.) Determinations in an EIR must be upheld if supported by substantial evidence, and the mere presence of conflicting evidence in the administrative record does not invalidate them. (Chaparral Greens v. City of Chula Vista (1996) 50 Cal.App.4th 1134, 1143.) An agency's approval of an EIR may not be set aside on the ground that an opposite conclusion would have been equally or more reasonable. (Laurel Heights Improvement Assn. v. Regents of University of California (1988) 47 Cal.3d 376, 393.) The Court's role is not to substitute its judgment for that of the local agency representatives, but to enforce legislatively mandated CEQA requirements. (Citizens of Goleta Valley v. Board of Supervisors (1990) 52 Cal.3d 553, 564.) The Court passes only upon the EIR's sufficiency as an informative document, not upon the correctness of its environmental conclusions. (Laurel Heights at 392.)

I. City Properly Relied on the 41,000 AFY Water Transfer for Planning Purposes

Petitioners contend that the City is legally precluded from relying on water from the transfer of 41,000 AFY acre feet per year ("AFY") of State Water Project ("SWP") water to the local SWP wholesaler, Castaic Lake Water Agency ("CLWA") ("41,000 AFY transfer") for planning purposes, and the EIR's reliance on water supplies is not supported by substantial evidence.

The water for the Riverpark project is to be supplied by CLWA.

In 1999, CLWA entered into a contract with the Kern Delta Water District for transfer of 41,000 acre feet per year (AFY) as part of the

"Monterey Agreement."[1] The CLWA certified an EIR for the 41,000 AFY transfer tiered on the earlier program EIR that had been prepared for the Monterey Agreement.

In Planning and Conservation League v. Dept. of Water Resources (2000) 83 Cal.App.4th 892 ("PCL"), the PCL challenged the Monterey Agreement program EIR. The Court of Appeal held that the EIR should have been prepared by DWR as the lead agency, rather than by one of the contractors, and that a new EIR must be prepared and certified by DWR. The Court did not invalidate the Monterey Agreement or enjoin the water transfers effected thereunder, but directed the trial court to consider under CEQA section 21168.9 whether the Monterey Agreement should remain in place pending preparation of DWR's new EIR, and to retain jurisdiction pending certification of DWR's EIR.

In Friends of Santa Clara River v. CLWA (2002) 95 Cal.App.4th 1373 ("Friends I"), the Court of Appeal ordered CLWA's EIR decertified because it had been tiered from the Monterey Agreement EIR, adjudged inadequate: "We have examined all of appellant's other contentions and find them to be without merit. If the PCL/tiering problem had not arisen, we would have affirmed the judgment." (Friends, supra, at 1387.) The Court did not issue any ruling affecting CLWA's ability to continue to use and rely on water supplies from the 41,000 AFY Transfer, leaving it to the trial court's discretion whether to enjoin CLWA's use of the water pending its completion of a new EIR. (Friends, supra, at 1388.)

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[1]An excellent history of the SWP and the role of Department of Water Resources ("DWR") in the management of the SWP, the Monterey Agreement and amendments, and relevant litigation is set forth in Calif. Oak Foundation v. Santa Clarita, 133 Cal.App.4th 1219 (2005).

In September 2002, on remand to the Los Angeles County Superior Court, the Friends petitioners applied under CEQA section 21168.9 to enjoin CLWA from continuing to use and rely on water from the 41,000 AFY Transfer. The trial court rejected that request, and in December 2003, the Court of Appeal affirmed the trial court's ruling allowing CLWA to continue to use and rely on water from the 41,000 AFY Transfer pending completion of its new EIR. (Id.; see also, Friends of the Santa Clara River v. Castaic Lake Water Agency, 2003 WL 22839353 ("Friends II"] at Tab 7, 5 AR 4180-97.)

Meanwhile, on 5/5/03, before the trial court acted on remand, the parties to the PCL litigation entered into the Monterey Settlement Agreement.[2] Section II of that agreement provides that SWP would continue to be administered and operated in accord with both the Monterey Amendments and the terms of the Monterey Settlement Agreement. (5:1 AR, Tab 7, 4367.) The Monterey Settlement Agreement did not invalidate or vacate the Monterey Amendments, or any water transfer effected under them.

A. PCL, Friends of the Santa Clara River and California Oak do not preclude reliance on the 41,000 AFY Water Transfer

Petitioners contend that legal uncertainties surrounding the 41,000 AFY transfer due to the PCL and Friends lawsuits preclude the City from relying on water from that transfer for planning purposes. Specifically, Petitioners contend that because PCL requires the Department of Water Resources ("DWR") to prepare an EIR analyzing the

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[2]On 6/6/03, the Sacramento County Superior Court issued its Order under CEQA section 21168.9, approving both the Monterey Settlement Agreement, and the continued operation of the SWP pursuant to the Monterey Amendment and the approved Monterey Settlement Agreement. (See 6 AR, Tab 8, 6557; 8 AR, Tab 10, 9775-78 [Order].)

effects of the eight SWP water transfers completed under the Monterey Agreement, none of those transfers, including the 41,000 AFY transfer, can be relied on for planning purposes until DWR has completed and certified that EIR. Moreover, Petitioners contend that the Court of Appeal so held in California Oak Foundation v. City of Santa Clarita (2005) 133 Cal.App.4th 1219.

PCL, Friends and California Oak (discussed infra) do not preclude reliance on the 41,000 AFY transfer for planning purposes.

While the Courts of Appeal could have simply said that all EIRs requiring reliance on the 41,000 AFY transfer, must await the certification of a new FEIR by DWR (and resolution of any litigation challenging such FEIR), they have not done that.

Although the Court in Friends and California Oak observed that CLWA "may be able to cure the PCL problem by awaiting action by the [DWR] complying with the PCL decision, then issuing a subsequent EIR, supplement to EIR, or addendum . . . tiering upon a newly certified Monterey Agreement EIR" (California Oak, supra, 133 Cal.App.4th at 1230, n.6), neither court said that the CLWA and City of Santa Clarita must await the DWR FEIR.

CLWA certified a new EIR on the 41,000 AFY Transfer on 12/22/04. (Tab 10, 8:2 AR 10441-480 [CLWA Resolution certifying the EIR]; see also Tab 637, 63 AR 43468-44683 [CLWA FEIR]; Tab 12, 10 AR 11750 [Final Riverpark EIR Project Revisions and Additional Information.) This new EIR analyzes the effects of the 41,000 AFY Transfer without tiering from the Monterey Agreement EIR.[3] Although CLWA's EIR is currently being

[3]The CLWA EIR concludes that the Monterey Settlement Agreement neither requires that DWR's new EIR be certified before CLWA can certify its new EIR for the 41,000 AFY Transfer, nor requires that DWR's new EIR

challenged, CEQA requires that the EIR be conclusively presumed to comply with CEQA, until a court has judged it deficient. (See. e.g., CEQA, § 21167.3(b), CEQA Guidelines, § 15231; see also, Barthelemy v. Chino Basin Water Dist., supra, 38 Cal.App.4th 1609, 1617.)

Since the prior CLWA EIR for the 41,000 AFY Transfer was overturned solely because it tiered from a later-decertified Monterey Agreement EIR, and CLWA has now certified an EIR approving the 41,000 AFY Transfer without tiering from the Monterey Agreement EIR,[4] the City reasonably included water from the 41,000 AFY Transfer in CLWA's supplies, after considering at length the current status of all litigation.[5]

B. The 41,000 AFY transfer is sufficiently certain and the Monterey Settlement Agreement does not preclude Respondents from relying on said transfer in its EIR pending DWR's preparation of its EIR.

As argued by Respondents, three provisions in the Monterey Settlement Agreement, read together, refute Petitioners' argument that the 41,000 AFY Transfer was excluded from Attachment E because it was a non-permanent transfer, which may not be used for planning purposes.

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serve as the EIR for that Transfer. (Tab 637.63 AR 43987-92 [CLWA Master Response to Comments].) These conclusions are consistent with Friends II, that the 41,000 AFY Transfer is *not* legally bound to the PCL litigation or to DWR's new EIR. (Tab 7, 5:1 AR 4195-4196.)

[4]Although DWR is in the process of certifying its own EIR pursuant to PCL and the Monterey Settlement Agreement, DWR approved CLWA's preparation of its EIR in a comment letter on the Draft EIR, and noted that CLWA's Draft EIR "adequately and thoroughly discusses the proposed project and its impacts," and "adequately discusses the reliability of the SWP, pre- and post-Monterey Amendment conditions, future conditions and SWP operations." (Tab 637, 63 AR 43482-83.)

[5]Respondents' Riverpark EIR discusses the prior litigation and devotes 8 pages to discussion of the litigation surrounding CLWA's EIR on the 41,000 AFY Transfer in its response to comments alone. (Tab 8, 6 AR 6551-6559.)

Section III(C)(4) requires DWR to conduct an "[a]nalysis of the potential environmental impacts relating to" all eight of the completed water transfers, not just of the 41,000 AFY Transfer (Tab 7. 5:1 AR 4368-69) and to analyze all of the transfers in the same manner, even though seven of them, defined in the Agreement as the "Attachment E Transfers," were beyond challenge. (Id. [Section III(C)(4)j; Tab 7, 5:1 AR 4370 [Sections III(D), III(E)].) Section III(D) precludes challenges to the Attachment E Transfers, which had been litigated in other forums or had become final without challenge by the expiration of limitation periods. (Tab 7. 5:1 AR 4370.) Section III(E) acknowledges the jurisdiction of Los Angeles Superior Court over the then-ongoing Friends litigation challenging CLWA's EIR on the 41,000 AFY Transfer (Tab 7, 6 5:1 AR 4370) pending completion of CLWA's new EIR, but does not distinguish the 41,000 AFY Transfer from the Attachment E transfers otherwise.

The Monterey Settlement Agreement does not prohibit reliance on the 41,000 AFY Transfer. All of the water transfers were effected as permanent transfers under the Agreement and are to be analyzed in the same way in DWR's new EIR, as required by Section III(C)(4).

Petitioner contends that the continued availability of the 41,000 AFY transfer is uncertain until DWR has concluded its EIR and that under California Oak, the City may not presume that the outcome of DWR's environmental review will be the continued availability of the 41,000 AFY.

DWR, however, has recognized the 41,000 AFY Transfer as a permanent transfer under the Monterey Agreement by entering into Amendment No. 18 to CLWA's agreement, which increases its Table A Amount by 41,000 AFY (Tab 10, 8:1 AR 9212-14), and has since consistently allocated water

supplies to CLWA based on that entitlement (Tab 4, 2:2 AR 1015-17 [DEIR]). Furthermore, as noted supra, DWR also submitted positive comments on CLWA's Draft EIR. (Tab 637, 63 AR 43482-83).

DWR's analysis of the 41,000 AFY Transfer in its new EIR will be part of a broader analysis of past and future permanent transfers of Table A Amounts, and will not constitute the EIR for the 41,000 AFY transfer. (5:1 AR, Tab 7, 4369.) As noted supra, PCL, Friends and the Monterey Settlement Agreement do not prohibit CLWA's preparation of its new EIR addressing the impacts of the 41,000 AFY transfer. (Tab 637, 63 AR 43987-92 [CLWA Master Response to Comments].)

California Oak, being most recent, deserves further discussion. In California Oak, the Court struck down the City's certification of an earlier EIR for an industrial project because it did not address the legal uncertainties surrounding the 41,000 AFY Transfer. California Oak did not bar the use of water from the 41,000 AFY transfer for all planning purposes. It criticized the City's failure to explain its reasoning for relying on the 41,000 AFY transfer, but held that it was up to the City to determine whether or not to rely on the 41,000 AFY transfer in its planning. The Court stated: "*[T]he question is whether the entitlement should be used for purposes of planning future development*, since its prospective availability is legally uncertain. *Although this decision must be made by the City*, the EIR is intended to serve as an informative document to make government action transparent. Transparency is impossible without a clear and complete explanation of the circumstances surrounding the reliability of the water supply." (Id. at 1237-38; emphasis supplied.) Before relying on water from the 41,000 AFY transfer for planning purposes, the City must "present a reasoned analysis of the significance . . . [or insignificance] of the

decertification of the EIR for the Castaic purchase; how demand for water would be met without the 41,000 AFY entitlement; or why it is appropriate to rely on the 41,000 AFY transfer in any event." (Id. at 1244.)

The Court in California Oak ruled that the EIR contained an inadequate discussion, in fact no discussion at all, of the uncertainty regarding the 41,000 AFY transfer in the EIR itself, but only references to it in the appendices, and responses to comments. The text of the EIR did not mention the decertification of the CLWA EIR, or that "entitlements are not really entitlements, but only 'paper' water." (California Oak, supra, 133 Cal.App.4th at 1236.) From the EIR, the Court could only assume that City concluded the 41,000 AFY would continue to be available, but found that the lack of a forthright discussion of a significant factor that could affect water supplies was antithetical to the purpose of an EIR to reveal to the public the basis on which officials approve or reject environmental action. (Id. at 1237-38). Thus, the Court held that the EIR failed to inform the public of the litigation uncertainties surrounding the 41,000 AFY transfer, and substantial evidence did not support the City's decision to rely on water from that transfer for planning purposes.

Here, by contrast, the City discussed the 41,000 AFY transfer and its uncertainties at considerable length, both in the EIR and throughout the review process. (See infra, pp. 12-16.) The PCL, Friends, Friends II, and California Oak decisions were all discussed. The City concluded that it was likely that the 41,000 AFY would be available for the project. By the time the City Council held it first Riverpark hearing on 1/25/05, the City also had before it CLWA's certified new EIR for the 41,000 AFY transfer, which was not the case in California Oak.

The Riverpark EIR adequately discloses the uncertainties regarding the 41,000 AFY transfer and discusses them forthrightly.

C. Substantial evidence supports reliance on 41,000 AFY water transfer and the EIR's analysis of the transfer is not flawed

Petitioners contend that substantial evidence does not support the City's decision to rely on water from the 41,000 AFY Transfer.

As noted, California Oak held that, as long as the city has analyzed the uncertainties surrounding this water supply, it is within the City's province to decide whether to rely on the 41,000 AFY Transfer for planning purposes.

The EIR and the Administrative Record contain substantial evidence supporting the City's decision that water from the 41,000 AFY Transfer can be relied on as part of CLWA's supplies.

CLWA, the SWP and the reliability of its water supplies, the Monterey Agreement, the PCL litigation, the Monterey Settlement Agreement, CLWA's Table A Amounts, and the Friends litigation are all extensively discussed in the EIR. The City specifically discloses that a future adverse judgment invalidating the Monterey Agreement could affect CLWA's ability to use water from the 41,000 AFY transfer and adversely affect CLWA's water supplies over the long term, but that, based on the information discussed, CLWA (the experts concerning water supply) believed that such a result "is unlikely to >unwind' executed and completed agreements with respect to the permanent transfer of SWP Water Amounts." (Tab 4,2:2 AR 1014-15; see also, Tab 8,6:2 AR 6551-59 [TR-3].) Further, the EIR notes the 41,000 AFY Transfer was completed in 1999, CLWA has paid approximately $47 million for the additional Table A Amount, the monies have been delivered, the sales price has been financed through CLWA by tax-exempt bonds, and DWR has increased CLWA's

SWP maximum Table A Amount and delivered or made available to CLWA the 95,200 AFY because it was a permanent transfer/reallocation of SWP Table A entitlement between SWP contractors." (Tab 4, 2:2 AR 1013.) Included in the EIR's Appendices and referenced in the EIR, are the 19 documents supporting the EIR's analyses, including the PCL decision, the Monterey Settlement Agreement, the Sacramento County Superior Court's "Order Pursuant to Public Resources Code Section 21168.9," the Friends decision, the Los Angeles County Superior Court's Judgment on remand in the Friends litigation, CLWA's final EIR for the 41,000 AFY Transfer, and CLWA's Resolution certifying that EIR.

The City responded to numerous comments challenging the EIR's conclusion that CLWA could rely on the 41,000 AFY Transfer for planning purposes. Due to the number of comments, and the amount of information required to respond, the City prepared a "master" response on this subject, TR-3 (Tab 8, 6:2 AR 6551-59). TR-3 reviews the information disclosed in the EIR's Water Services section regarding the 41,000 AFY Transfer and the Friends litigation, then responds to comments asserting that: (i) the PCL litigation and Monterey Settlement Agreement preclude CLWA from using or relying on that water transfer, and (ii) because the Monterey Settlement Agreement requires DWR to prepare a new EIR on the Monterey Agreement, CLWA cannot rely on the water transfer until that new EIR is completed. The City also prepared responses to individual comment letters on the 41,000 AFY Transfer[6] All of these comments and

[6]See, for example, responses to comments from the Santa Clarita Organization for Planning and the Environment (Tab 8, 6 AR 5962-66, 6689-6717), Petitioners Sierra Club (Tab 8, 6 AR 6194-6201, 6370, 6737-66, 6829-30), California Water Impact Network (Tab 8, 6 AR 6273-74, 6767-75), Friends (Tab 8, 6 AR 6387, 6835-36), and from a law firm involved in the PCL litigation (Tab 8, 6 AR 6275-78, 6776-83).

responses are included in the Riverpark Final EIR.

The City's Planning Commission also held a study session on the subject of the reliability of available water supplies. (Tab 9, 7 AR 7480-92.)

Ultimately, the City reviewed all of this information, and the views expressed in the EIR, by CLWA, and by commentators opposed to the City considering the 41,000 AFY Transfer, and determined it was appropriate for the City to rely on those SWP supplies. (Tab 2, 1 AR 9-114 [App. Reso]; Tab 3. 1 AR 174-220 [CEQA Findings].) The City explained that its determination to allow Riverpark to rely on the 41,000 AFY Transfer was supported by the information in the EIR for four main reasons: (i) nothing in the Monterey Settlement Agreement or in any court decision precludes that reliance; (ii) nothing in the Monterey Settlement Agreement precludes CLWA from preparing and certifying its revised EIR for that transfer as instructed by the Court of Appeal in the Friends decision and, in fact, the Settlement Agreement was carefully crafted to leave that EIR and any required remedies to the Los Angeles County Superior Court; (iii) the fact that DWR is preparing an EIR that will analyze all of the water transfers under the Monterey Agreement does not preclude CLWA from preparing and certifying its revised EIR, as instructed by Friends; and (iv) CLWA's Final EIR re-approving the transfer had been certified without tiering from the Monterey Agreement EIR. (Tab 8, 6:2 AR 6558-59 [TR-3]; Tab 10, 8:2 AR 10441-10480; Tab 12, 10 AR 11750.)

As directed by California Oak, the City here has analyzed in considerable detail the uncertainties surrounding the AFY water transfer and explained the basis for its reliance on that transfer. The City's

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determinations are not an abuse of discretion, but supported by substantial evidence.

Petitioners' contention that the City makes false statements about the transfer (OB 7-9) is not borne out by the record.

The City's statement reads: "Because the 41,000 AF was a permanent water transfer, because DWR includes the 41,000 AF in calculating CLWA's share of SWP Table A Amount, and because the courts have not prohibited CLWA from using or relying on those additional SWP supplies, the City has determined that it remains appropriate for the Riverpark project to include those water supplies in its water supply and demand analysis, while acknowledging and disclosing uncertainty created by litigation." (Tab 8, 6:2 AR 6768-69.)

This statement is qualified and explained by the City's extensive discussion of the legal uncertainties arising from litigation, supra, and is not misleading. The statement cannot be taken out of context and must be read in light of other statements and evidence in the record. As regards "reliance on the fact that DWR counts the 41,000 AFY in Table A amounts, DWR has acknowledged the 41,000 AFY Transfer by continuously delivering SWP water, including water from the Transfer, to CLWA for many years. The Monterey Settlement Agreement treats the 41,000 AFY Transfer identically to the Appendix E Transfers. The City's discussion of the reliability of SWP water supplies, including the 41,000 AFY Transfer water, is a discussion relating to the ability of the SWP to deliver only such supplies as are available on a year-to-year basis. (See, e.g., Tab 4, 2:2 AR 1022-30.) The City discussed the reliability of available SWP supplies under average, dry and critical dry years, and that there would be sufficient supplies to meet Riverpark's demand and cumulative demand. (Id. at 1051-70.)

Unlike California Oak, the record shows that the City considered the 41,000 AFY transfer in the EIR, including the legal uncertainties, the reliability of available supplies of SWP water in general, and concluded, based on substantial evidence, that it was appropriate to rely on those supplies for planning purposes. The City also considered and responded to numerous comments. After 12 hearings before the Planning Commission and City Council, the City certified the EIR and approved Riverpark, knowing that water supplies from the 41,000 AFY Transfer were to some degree uncertain, but explaining the reasoning for its determinations and the evidence that supported it. That is all that CEQA and California Oak require.

II. Impacts on Biological Resources were Appropriately Evaluated

Petitioner contends that the project's impact on three special-status species, the western spadefoot toad ("Toad"), the San Diego back-tailed jackrabbit ("Jackrabbit") and the holly-leaf cherry woodlands ("Holly-Leaf") must be considered significant because they are "rare" within the meaning of CEQA, the EIR's responses to comments by Department of Fish and Game ("DFG") were inadequate, as were mitigation measures for the Toad and Jackrabbit.

CEQA Guidelines section 15065(a) provides: "A lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where there is substantial evidence, in light of the whole record, that . . . : (1) The project has the potential to . . . substantially reduce the number or restrict the range of an endangered, rare or threatened species . . . ." (Guidelines, § 15065(a); 51 AR 33996.)

Here, an EIR was prepared and the impacts on the Toad, Jackrabbit, and Holly-Leaf considered. Petitioner contends that, to assess the

significance of the project impacts on the Toad, Holly-Leaf, and Jackrabbit, the EIR was required to determine whether the species are "rare" under Guidelines section 15380(b)(2)(A), which defines "rare" as "[a]lthough not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens."

The EIR's conclusions with regard to these species are supported by substantial evidence.

Toad

The EIR concluded that impacts on the Toad would be significant and unavoidable (Tab 7, 5:2 AR 5774, 5827).

The EIR describes the Toad as a special-status species (Tab 7, 5:2 AR 5720-5730, 5737, 5831-36; see also Tab 9, 7:2 AR 8572 [Revised Draft EIR ("RDEIR")]), and defines "special-status wildlife" to include rare species, that is, State Species of Special Concern and Federal Species of Concern. (Tab 7, 5:2 AR 5728.) The EIR notes that Toads were found in three seasonal rainpools created by human disturbances in the middle of areas planned for development: in the right-of-way for the extension of Newhall Ranch Road, in the middle of Planning Area A-1, and in the middle of Planning Area B (Tab 7, 5:2 AR 5832-34). The potential impacts on the Toad were analyzed in accordance with CEQA and City thresholds and found to be significant (id. at 5750-53, 5774). Mitigation was recommended in the form of pre-construction surveys, preparation of a Resource Management and Monitoring Plan ("RMMP"), design and construction of new enhanced Toad habitat and implementation of a capture and relocation and monitoring program. Ultimately the EIR concluded that the impacts would remain significant and unavoidable, because such measures have not yet been proven to he highly effective,

and because of the possibility that not all of the individual Toads could be successfully captured and relocated (id. at 5811).

The City's responses to comments and its actions addressed DFG's concerns (Tab 8, 6:1 AR 5880-86 [DFG letter], Tab 8, 6:2 AR 6621-30 [response]), and those of other commentators (see, e.g., Tab 8, 6:1 AR 5876-77 [Santa Monica Mountains Conservancy letter], Tab 8, 6:2 AR 6610-14 [response]). The City followed DFG's recommendations, the City's "Western Spadefoot Toad Habitat Enhancement and Mitigation Plan" ("Toad Plan") was created by the City's expert biologist in consultation with DFG and was ultimately approved by DFG.

Substantial evidence in the record supports the City's decision to mitigate the impacts on the Toad rather than reconfigure the Project. Such evidence included opinion of City's expert biologist that the Toad Plan was likely to succeed, and DFG's approval of that Plan. It properly exercised its discretion to consider the remaining impacts on the Toad to be significant and unavoidable, and adopted a Statement of Overriding Considerations for the Toad. (Tab 3, 1 AR 145-150, 155-163, esp. 159 [SOC].) Arguments similar to Petitioners' arguments here were rejected in Defend the Bay v. City of Irvine (2004) 119 Cal.App.4th 1261, 1276-77.

Jackrabbit

For the Jackrabbit, the Revised DEIR determined that "[b]ecause this species is not state or federally listed as Endangered or Threatened, because it is considered relatively abundant in suitable habitat areas within its range, and because the direct loss of individual jackrabbits is expected to be low, it is expected that the regional population would not drop below a self-sustaining level with the implementation of this project," the loss of any individual

jackrabbits would not be considered a significant impact. (Tab 7, 5:2 AR 5775.)

The EIR identifies the Jackrabbit as a State and federal special-status species, and determined the significance of impacts on that species based on CEQA and City thresholds that recognize substantial adverse effects on special-status species and substantial reduction of habitat as being significant impacts (Tab 7. 5:2 AR 5750-53). Based on field surveys (see, e.g., Tab 7, 5:2 AR 5707-08 [RDEIR, § 4.6; Tab 6, 4 AR 4153-54), the EIR reported that Jackrabbits. which occur in a variety of habitats, had been sighted on-site in the riverbed, open terraces and disked fields, but that because those areas are disturbed, the overall quality of the habitat on site suitable for Jackrabbits was only moderate. (Tab 7, 5:2 AR 5735, 5739, 5775; Tab 9, 7:2 AR 8572 [RDEIR].) The EIR noted that the Project had been designed to include all NRMP applicable mitigation measures for the areas in and adjacent to the Santa Clara River (Tab 7. 5:2 AR 5754-61, and 5789-5800 [RDEIR, § 4.61; Tab 9, 7:2 AR 8576 [RDEIR]), including preconstruction surveys, capture and relocation, and riparian habitat creation enhancement. (Id. at 5757-5759, and 5793-95 [RDEIR, § 4.6]; see also, Tab 9, 7:2 AR 8541-42 [RDEIR]).

The EIR concluded that project-level impacts would be less than significant, not just because Jackrabbit is not a listed species and does not require heightened protection, but also because the species is abundant where it occurs, and, since it is mobile and would likely disperse to nearby better habitat rather than be killed as the site is developed, few individuals would be lost due to development of the site. (Tab 7, 5:2 AR 5775.) Nevertheless mitigation including preparation of an RMMP and preconstruction surveys of areas outside the NRMP areas for

the potential capture and relocation of special-status species was recommended. (Tab 7, 5:2 AR 5800-01, 5809-10; Tab 9,7:2 AR 8543-45, 8584-85 [RDEIR pages].) The EIR also concluded that the project-level and cumulative impacts on an aggregate of 280 acres of habitat, in general, necessarily including that for Jackrabbits, would be significant and unavoidable even after mitigation (Tab 7, 5:2 AR 5761-62, 5811, 5825-26, 5827). A Statement of Overriding Considerations was adopted for these impacts. (Tab 3, 1 AR 145-163.)

The City did not ignore DFG's comments, but in response to DFG, stated that it had considered the NRMP and its EIS/EIR, which had earlier analyzed impacts on the Jackrabbit within the NRMP area (in and adjacent to the Santa Clara River), and found those impacts to be significant and imposed mitigation to reduce them to a less than significant level. (Tab 8, 6:2 AR 6622-23.) Those mitigation measures, the City explained, had been incorporated into the Project as design features, and that Riverpark scaled back the activities permitted by the NRMP, so that the activities within the NRMP area would have even less of an impact on the Jackrabbit than the NRMP EIS/EIR had determined. (Tab 8, 6:2 AR 6622-24.)

Development was moved further back from the Santa Clara River to protect riparian resources, including Jackrabbit habitat (including bank stabilization in a portion of the site). A public trail that had been proposed in the riverbed was moved out to join the pedestrian/bike bridge over the Aqueduct. (Tab 8, AR 6623-24; see also Tab 2, Tab 4, Tab 12 [FEIR, Final Project Revisions]; Tab 11) The City also explained that the mitigation requiring preconstruction surveys and capture and relocation was more definitive than DFG described B more than simply forcing individuals to disperse. As to cumulative impacts, the City

noted that because the NRMP's mitigation measures had been imposed on all of the land between the eastern border of Riverpark vest to Castaic Creek, and because Riverpark had been revised to preserve even more upland, the EIR had concluded that cumulative impacts on the species would be less than significant. (Tab 8, AR 6624.)

DFG disputed the EIR's conclusions without challenging the City's survey methodology. (Tab 8, AR 5882.) As the City's response to DFG's comment letter shows, the City considered DFG's comments, but disagreed with them. The City's response did not assert that the EIR relied solely upon the NRMP EIS/EIR's analysis of impacts on the Jackrabbit. (Tab 8, AR 6622-24.) Rather, the EIR conducted its own independent analysis. (Tab 7 [RDEIR, § 4.6]; Tab 6 [survey report]; Tab 9 [RDEIR].) The City's responses to DFG contained a reasoned explanation based on scientific information. (See CEQA Guideline ' 15088.) The City was not required to accept DFG's opinions over those of its own expert. (Assn. of Irritated Residents, supra, at 1394-97; Laurel Heights I, supra, 47 Cal.3d at 393-93.)

Substantial evidence supports the EIR's conclusions on the Jackrabbit. The evidence shows the EIR conducted its own analysis of the impacts on the Jackrabbit, and did not rely solely upon the NRMP EIS/EIR for that analysis.

Holly-Leaf Cherry Scrub

The surveys conducted by the Project's expert botanist concluded that the plant community identified was not "holly-leaf cherry woodlands," but "holly-leaf cherry scrub" ("HLCS"), which is different and one not specified in DFG's List of California Terrestrial Natural Communities recognized by the California Natural Diversity Data Base (i.e. without any State or federal protection). (Tab 7, AR 5716-17; Tab

416, 53 AR 37223, 37247 and Tab 6, 4 AR 3363, 3387 [DEIR appendices, 2003 and 2002 rare plant surveys Tab 8, 6:2 AR 6627 [response to DFG comments].)

Based on the evidence, including the rare plant surveys conducted in 2002 and 2003, and supporting evidence (Tab 6, AR 3359-82, 3383-95), the EIR reported the expert botanist's identification of the plant community on-site as HLCS (Tab 7, 5:2 AR 57 16-17). The EIR properly defined the class of plants that were considered to be "special status plants" (Tab 7, 5.2 AR 5722), and did not include HLCS within that class based on the botanist's expert opinion. Based on CEQA and City thresholds, the EIR concluded that the permanent disturbance of 3.6 acres of HLCS, which did not support special-status plant or wildlife species and is not considered to be sensitive by the resource agencies, was not significant (Tab 7. 5.2 AR 5767). As noted before, the EIR concluded that the project-level and cumulative impacts from disturbing an aggregate of 280 acres of habitat, in general, necessarily including HLCS, would be a significant impact, and unavoidable even after mitigation, and, a Statement of Overriding Considerations was adopted as to this impact (Tab 3, AR 145-163).

The City's response to DFG's comments on the HLCS was not "dismissive." The City responded that based on scientific and other information the identified plant community was not "holly-leafed cherry woodland," but HLCS, because the canopy did not amount to a woodland canopy, and that DFG does not include HLCS within its list of special status plant communities. Also because only 3.6 acres of habitat would be permanently impacted by the Project, and HLCS "stand of trees" was not considered a sensitive plant community as identified by the DFG, the

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loss of the 3.6 acres would be less than significant under CEQA. (Tab 8, AR 6627.)

Substantial evidence supports the conclusions that the HLCS on site was not a special status species, and that impacts to it alone would not be significant.

III. Description of the Project and Mitigation Measures

Petitioners contend that the EIR fails as an informational document to adequately describe the project or the mitigation measures, misstates the public and agency concerns raised in comment letters, and fails to meaningfully respond to them.

The EIR adequately describes impact on the Santa Clara River and is not misleading

Petitioners contend the project will damage the river and the EIR and the City's staff reports mislead by "perpetuat[ing] the myth that the project will improve the condition of the river," (OB 16-17) and by the statement in Final EIR that the project "has been designed to preserve the Santa Clara River corridor." (AR 28.)

A review of the record discloses extensive discussion in the EIR and staff reports concerning the encroachment into the Santa Clara River and the impacts to it. Among other things, the EIR discloses that the Project would install buried bank stabilization in the western portion of the site, but not the eastern portion where the river corridor would remain substantially undisturbed up to the eastern boundary where the Newhall Ranch Road Golden Valley Road Bridge would be built. (See Tabs 4, 5, 7, 11, 12.) There is evidence that buried bank stabilization is less harmful to the river and its resources than traditional cement stabilization, yet protects adjacent development adequately (Tab 11, 9 AR 10739-47 [FEIR, App. C. Functional AssessmentC Summary], 10877-90

[id., Hybrid Functional Assessment/Riverpark], 11180-97 [FEIR, App. G, Additional Hydrology and Water Quality Analyses], 11202-19 [id., Addendum No. 1], 11405-17 [id., App. J, Additional Flood and Floodplain Modifications data]). Furthermore, revisions to the Project would lessen intrusion into the SEA and protect mature riparian resources that serve as habitat (id., esp. Tab 11, 9 AR 11419-22, 11516 [FEIR App. K. Project Revisions and Additional Information]; Tab 12, 10 AR 11741-61 [FEIR Final Project Revisions]; Tab 11, 9 AR 11224-35 [FEIR App. 1. 7/20/04 Staff Report]). Other evidence shows that the overall (temporary and permanent) intrusion into the SEA was reduced from the original 37 acres to 32.1 acres, and the permanent intrusion from 24 to 16.9 acres. (Tabs 11, 12.) The Project was also revised to dedicate approximately 318 off-site acres, including the approximately 141-acre "Round Mountain" site containing 37 acres of Santa Clara River SEA, which will in part further offset the Project's impacts on biological resources and the floodplain (Tab 12). The City nevertheless still considered the Project's intrusion into the Santa Clara River SEA to be a significant and unavoidable impact, and included it in the Statement of Overriding Considerations (Tab 7.)

Thus, the City did not "ignore Riverpark's encroachment into the river." It considered at great length the Project's impacts on the river and adjacent areas and required changes in the Project to reduce those impacts.

The EIR adequately describes the project setting and is not misleading

The City found that "the proposed project is appropriate for the subject property," "proposes considerably lower densities than existing nearby developments," and that "[b]y proposing a maximum of 1,089

residential units and approximately 16,000 square feet of commercial space, the project proposes development that would be substantially less dense and less intense than those that both the current and the proposed land use classifications would allow." (1 AR 30.)

Petitioners contend the finding is incorrect, because the City "never actually calculated the number of residential units that can actually be built on the site," and the site's physical characteristics, such as topography, constrain the number of units that can be built on any given parcel.

The findings relating to the project setting are adequate under CEQA and not misleading. Prior to the approval of the General Plan Amendment and Zone Change proposed by the Project, the City's General Plan designations for the site permitted development more dense and intense than the now-approved designations. (See, e.g., Tab 4, 2:1 AR 346-48 [DEIR, § 1.0, Project Description], 830-837 [Id., § 4.7, Land Use]; Tab 4, 18 2:2 AR 947-52.)

There is no requirement the City must calculate exact number of units which actually can be built.

The EIR adequately describes on-site and off-site dedications to the City

Petitioners contend the EIR does not "adequately describe both the on-and off-site [land] dedications, which the City considers a significant benefit, and has identified as one main bases [sic] for over-riding the project's significant adverse impacts," and City staff and the EIR do not discuss in an Agenda Report to the City Council a Planning Commissioner's comments during a debate on whether the Commission would consider the Project's proposed dedication of portions of the South Fork of the Santa Clara River to be a benefit under the

City's Ridgeline Preservation and Hillside Development Ordinance (OB 24-28.)

Preliminarily, these issues were not raised during the administrative process and, consequently, are now barred. (CEQA, § 21177(a); see Park Area Neighbors v. Town of Fairfax (1994) 29 Cal.App.4th 1442, 1447-48.) Moreover, the dedications were not offered as mitigation measures, but as benefits in connection with the City's issuance of a Statement of Overriding Considerations and the Hillside Development Application. (Tab 3. 1 AR 147-1 50.)

In any case, CEQA requires that an EIR analyze a project's adverse environmental impacts, not its benefits. (See, e.g., CEQA, § 21002.1(a).) Dedication of on-site and off-site open space to the City to be preserved in perpetuity does not create adverse environmental impacts. Even so, the EIR does discuss the attributes of these land dedications. The on-site land to be dedicated was discussed extensively in the Draft EIR (see. e.g., Tab 4, AR 367 [DEIR, § 1.0, Project Description]; Tab 4, 2:2 AR 1214-44 [id., § 4.12, Parks and Recreation]; Tab 7, 5:2 AR 5689-5827 [RDEIR, § 4.6, Biological Resources]), as well as in City staff reports (Tab 604,61 AR 42947-42953; Tab 652, 73 AR 51639-51650; Tab 652, 73 AR 51651-51811; Tab 666, 74 AR 51913-51925; Tab 674, 74 AR 52073-52085; Tab 2-3, 1 AR 9-227) and in Planning Commission hearings (Tab 3, 1 AR 147-150). The attributes and benefits of the off-site land dedications are discussed in the Final EIR (see, e.g., Tab 12. 10 AR 11742-61 [FEIR. Final Project Revisions]; Tab 11, 9 AR 11419-22, 11516 [FEIR. App. K, map, land use table, new SEA chart]).

Failure to discuss comments in the agenda report is not fatal here. The Planning Commission debated which Project attributes should be considered as benefits in connection with their decision whether to

recommend approval of the Hillside Development Application, for which Newhall had submitted its Innovative Application Compliance Report. The EIR analyzed the land being dedicated to the extent necessary to inform the City and the public, and based on that information, the Planning Commission ultimately voted on which Project benefits it viewed as supporting the Hillside Development Application, including, without limitation, the on- and off-site land dedications (Tab 9,7:2 AR 8079-81 [12/21/04 HT]; Tab 652, 73 AR 51639-45, esp. 51643 [12/21/04 Staff Report]; Tab 2, 1 AR 15-18 [App. Reso.]). All of this information was before the City Council.

The EIR adequately describes on and off-site dedications and does not fail as an informational document in other respects.

IV. Alternatives Were Considered as Required by CEQA

An EIR's alternatives analysis must include a reasonable range of alternatives to the project that would feasibly obtain the basic objectives of the project and evaluate the comparative merits of the alternatives. (Guidelines, § 15126.6(a).)

Petitioners contend that the City's rejection of Alternative 2, the Santa Clara River Reduced Bank Stabilization Alternative, in the EIR and in its Findings was "disingenuous and pretextual, and therefore contrary to the mandates of CEQA" and not supported by substantial evidence.

Substantial evidence supports the determinations made by the City in rejecting Alternative 2 and finding that, due to the revisions to the Project, that alternative was no longer environmentally superior.

The City rejected Alternative 2 for multiple reasons.

After analyzing Alternative 2's impacts as compared to those of the Project as originally proposed, the EIR concluded that, while this alternative would reduce impacts in certain environmental areas

(including biological resources) and create similar impacts in other areas, it would create greater impacts on population/housing/employment and parks and recreation, and would not meet five of the project objectives. (Tab 4, 2:2 AR 1490-1500.) The EIR noted that the project objectives of (1) providing a substantial number of new housing units adjacent to existing and planned infrastructure, service, transit and transportation corridors and employment areas to accommodate projected growth, and (2) developing a range of housing types accommodating a range of incomes and commercial opportunities, would not be met due to the reduction in residential units (all of which were single-family units). (Tab 4, AR 1499.) The objective of providing adequate flood protection, including bank stabilization where necessary, would not he met because the alternative does not provide for bank stabilization. The objectives of providing sufficient parks to satisfy park dedication requirements and meet regional needs, and of providing a range of active/passive recreational opportunities, would not be met due to the reduction in the size of the flatter, active portion of the proposed 29-acre park. (Id.; see also 1497.)

As noted above, the original Project was substantially revised over the course of the 24 public hearings. The Project as revised and approved: (1) Moved all development back to the resource line established by the Planning Commission, which reduced the Project's intrusion into the SEA and protected mature riparian resources that serve as habitat (Id.. esp. Tab 11, 9 AR 11419-22, 11516 [FEIR App. K, Project Revisions and Additional Information]; Tab 12, 10 AR 11741-61 [FEIR, Final Project Revisions]; Tab 11,9 AR 11224-35 IFEIR App. 1,7/20/04 Staff Report]), (2) Moved the equestrian trail out of the river (Id. esp. Tab 12, 10 AR 11741-61 [FEIR, Final Project Revisions]),

(3) Reduced the Project's overall (temporary and permanent) intrusion into the SEA from the original 37 acres to 32.1 acres, and its permanent intrusion from 24 to 16.9 acres, 7.5 of which are attributable to the construction of Newhall Ranch Road and one of which is attributable to the Santa Clara River Trail (Id. esp. Tab 11, 9 AR 11516 [FEIR App. K, new SEA chart]; Tab 12, 10 AR 11741-61 [FEIR. Final Project Revisions]), (4) Was conditioned on an absolute prohibition of construction of any lots within the new FEMA floodplain boundaries (Tab 11, 9 AR 11406-09 [CLOMR]: Tab 12, 10 AR 11756, 11757-58 [FEIR, Final Project Revisions].) (5) Relocated the Newhall Ranch Road/Golden Valley Road Bridge abutments farther out of the active channel of the river, resulting in reduced impacts to biological resources in those riparian areas (Tab 11, 9 AR 11410-17 [FEIR App. J, Technical Memorandum Hydraulic Design and Analysis]; Tab 12, 10 AR 11758 [FEIR, Final Project Revisions]) and (6) Dedicated approximately 318 off-site acres, including, inter alia, the ARound Mountain" site containing 37 acres of Santa Clara River SEA, which further offset the Project's impacts on biota and the floodplain (Tab 12, 10 AR 11741-58 [FEIR, Final Project Revisions]).

Based on the evidence as regards the revised project, the City Council found that, as compared with the Project as approved, Alternative 2 was no longer environmentally superior because the new Project design reduced development, and thus impacts, in areas not affected by the revisions contemplated by Alternative 2, that although the approved Project would afford the City 94 fewer residential units, it still preserved a greater mix of housing opportunities than did Alternative 2, which reduced the number of single-family lots, and that

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the approved Project would donate substantial off-site acreage. (Tab 3, AR 139-140 [Alternatives Findings]; see also 156 & 3,156-159.)

The findings as to Alternative 2 are supported by substantial evidence and the record shows that the City Council considered and balanced all of the competing factors, and chose to approve the Project with those factors in mind.

V. City Properly Found that the Project is Consistent with General Plan Goals and Policies of Protecting Significant Natural Resources

Government Code section 66473.5 provides that "[n]o local agency shall approve a tentative tract map . . . unless . . . [it] is consistent with the general plan."

It is within the City's province, to balance the competing interests reflected in its General Plan policies, and the City has broad discretion to construe those policies in light of the plan's purposes. (San Franciscans Upholding the Downtown Plan, supra, at 678.) A reviewing court, therefore, may only ascertain whether the lead agency "considered the applicable policies and the extent to which the proposed project conforms with those policies" (id.) by considering whether, as a whole, the "'project is compatible with, and does not frustrate, the general plan's goals and policies" (Napa Citizens for Honest Government v. Napa County Board of Supervisors (2001) 91 Cal.App.4th 342, 355.) A project must be in agreement or in harmony with the applicable General Plan, "not in rigid conformity with every detail thereof." (San Franciscans Upholding the Downtown Plan, supra.)

A lead agency's determination that a project is consistent with its general plan "can be reversed only if based on evidence from which no reasonable person could have reached the same conclusion." (A Local and Regional Monitor v. City of Los Angeles (1993)16 Cal.App.4th 630, 648;

see also San Franciscans Upholding the Downtown Plan v. City and County of San Francisco (2002) 102 Cal.App.4th 656, 6771.) In approving the Project, the City considered its General Plan policies and the Project conformance to them.

Petitioners contend that the Project is inconsistent with the City's General Plan goals and policies to protect significant natural resources because its intrusions into the SEA and the floodplain are inconsistent with the General Plan requiring the developer to "enhance and preserve the SEA," and the EIR's conclusion that the project is consistent with Land Use Policy Element 5.3 by "not proposing development within the river" (2 AR 891) is not supported by the evidence in the record.

The EIR analyzes the original Project's consistency with the City's General Plan and concludes that the Project as originally proposed was consistent with Policy 1.1 of Goal I of the City's Open Space and Conservation Element because the Project preserves the Santa Clara River and much of its significant vegetation as open space (Tab 4, 2:2 AR 859-60) as shown by evidence noted above as to other issues. Furthermore, as discussed supra, the Project was later revised, further reducing the Project's overall intrusion into the SEA from 37 to 32.1 acres, and dedicating 37 undeveloped acres of SEA in the Round Mountain property.

The EIR also concludes that the Project as originally proposed was consistent with Policies 3.3 and 3.7 of Goal 3 of the City's Open Space and Conservation Element, because the EIR identifies areas of significant ecological value and natural riparian habitat and mitigates impacts to the extent possible (Tab 4, 2:2 AR 861-62: see also Tab 7. 5:2 AR 5689-5827 [RDEIR, § 4.6, Biological Resources]). Also, as

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discussed supra, the Project as approved further reduces impacts to the SEA and other sensitive resources.

The original Project was also found to be consistent with Policy 5.3 of Goal 5 to require new development to be sensitive to SEAs through creative planning techniques that avoid and minimize disturbance in these areas for these same reasons (Tab 4, 2:2 AR 890-91), a conclusion supported by the same substantial evidence that supports consistency with Goal 1, Policy 1.1 of the Open Space and Conservation Element.

Petitioners' arguments that the Project impermissibly intrudes into the SEA restate their CEQA arguments. The same evidence in the record supports the consistency findings. The Project was revised to limit intrusion into the SEA. The City's decision after circulation of the Draft EIR to protect the riparian resources and habitat by setting the resource line in the western portion of the site and moving the equestrian trail out of the river bed further ensured that the Project as approved was consistent with the General Plan policies. The Project always proposed placing 15 lots within the already disturbed SEA area next to Planning Area A-2. (See, e.g., Tab 7, 5:2 AR 5785.) Also, as revised Section 4.6 explains, even the permanent loss of 24 acres of habitat, now reduced to 16.9, is not expected to detract from the overall integrity and value of the SEA, and the Project will preserve and enhance various amounts of upland habitat in Planning Area B to serve as a buffer between the riparian habitat and development and to mitigate adverse impacts to riparian plant communities within the SEA. (Id.) The benefits of the Project's enhancements to the banks of the Santa Clara River and to its main drainage in the 29-acre park are confirmed by the Final EIR's Hybrid Functional Assessment for Riverpark (Tab 11, 9 AR 10877-90).

Substantial evidence supports the finding of consistency with the City's General Plan.

The Petition for Writ of Mandate is denied.

Counsel for Respondent is ordered to prepare, serve and lodge in Department 85 a proposed Judgment Denying the Petition for Writ of Mandate on or before August 21, 2006.

DATED: August 14, 2006

DZINTRA I. JANAVS

Dzintra I. Janavs
Judge of the Superior Court

CLWA Letter to the Los Angeles County Department of Regional Planning Regarding Availability of Future Water Supplies in the Santa Clarita Valley, February 5, 2008

CASTAIC LAKE WATER AGENCY

February 5, 2008

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SECRETARY
APRIL JACOBS

Subject: Availability of Future Water Supply in the Santa Clarita Valley

Dear Mr. ~~McClendon~~ BRUCE:

In your September 21, 2007 letter (copy attached), you noted that reductions in local water supplies "...may invalidate portions..." of environmental impact reports for pending and future developments. This is the result of the reliability of water supply from the State Water Project (SWP) having been impacted by an injunction issued by a federal court. As a result, deliveries of SWP water were reduced starting last year.

On May 25, 2007, the court had ruled that a biological opinion (BO) supporting the "incidental take" of Delta smelt by SWP pumping operations was not in compliance with the federal Endangered Species Act. Accordingly, the court ordered the preparation of a new BO so that a permit could be granted to the SWP for the incidental take of the fish by the pumps. The injunction will be in effect until the new BO is completed. The same federal court issued a written court order on December 14, 2007 setting forth the "interim remedies" to protect the Delta smelt. It is the implementation of these interim remedies that reduces the availability and reliability of the SWP water supply.

In the meantime, CLWA and the four local water retailer staffs have been meeting with County and City of Santa Clarita planning staff over the last three months to coordinate water supply and land use planning activities for the Santa Clarita Valley. On January 28, 2008, the California Department of Water Resources (DWR) issued its "Draft State Water Project Delivery Reliability Report 2007" (Reliability Report), an assessment of the SWP supply availability and reliability. *Based on this new information, CLWA has determined that, while the injunction is in effect, there are sufficient water supplies available for pending and future residential and commercial developments within the CLWA service area for the foreseeable future through 2030 as set forth in the Santa Clarita Valley (SCV) Urban Water Management Plan (2005 UWMP).*

The Reliability Report addresses the effect that the injunction will have on SWP water availability. The purpose of the Reliability Report, which is updated and issued biennially, is to indicate how much SWP water is available for various hydrologic scenarios (i.e., normal, dry and critically dry years). This report is used by water agencies that have contracted for SWP water to determine SWP water supply availability and reliability as part of their determinations of *overall* water supply availability and reliability.

The Reliability Report includes additional and updated information that was not available in earlier Reliability Reports, along with an assessment of the impact of climate change on the SWP supply. This additional data, in conjunction with a more exact analysis of the operational impacts of the federal court injunction, will reduce the available water to CLWA from the SWP, but not as much as had been previously estimated.

The 2005 UWMP uses a 77% reliability factor for the SWP supply, which is taken from DWR's 2005 Reliability Report. In other words, CLWA's available SWP supply in the 2005 UWMP is equal to 77% of CLWA's SWP contract amount.

The Reliability Report, factoring in the effects of the injunction and using the most conservative of four climate change scenarios modeled by DWR, reduces that reliability to 66%. Using this lower figure (and certain changes and updated information regarding other sources of supply) to update the water supply figures in the 2005 UWMP, CLWA and the local purveyors believe there will be adequate supplies to meet demand as forecast in the 2005 UWMP through the year 2030. Therefore, while the injunction is in place, proposed projects can once again cite the 2005 UWMP, with the additional information provided by the Reliability Report, in their environmental documents as evidence of adequate water supplies to serve the projects under consideration.

The discussion of water supply in environmental documents should be tempered, though, by noting that the Reliability Report represents a reasonable scenario as required by the California Environmental Quality Act (CEQA), and would close the gap between the available supply and the demand in the future, thereby making the CLWA service area more subject to shortages in certain dry years. Accordingly, the reduction in SWP supply reinforces the need to continue diligent efforts to conserve potable water and increase the use of recycled water, both to meet the goals in the 2005 UWMP and to maximize utilization of our potable water supplies. CLWA and the purveyors will continue to work diligently with the County and City in preparing a Water Conservation Ordinance and the enforcement mechanisms to aggressively implement water conservation in the CLWA service area.

The injunction will be in force until the BO is issued, which is currently anticipated at the end of 2008. At that time, long-term reductions in SWP water availability will probably result from the mitigation requirements for the take permit that DWR is required to obtain to comply with the Endangered Species Act. These long-term reductions will likely require another update of the Reliability Report and water supply planning documents that affect land use planning decisions in the Santa Clarita Valley. It is expected that the mitigation requirements in the BO will be no greater than the operational restrictions of the injunction (i.e., the interim remedies); as such,

the reductions in SWP water supply as a result of the granting of the Endangered Species Act permit should also be no greater than those required by the injunction.

After the long-term water supply reliability has been reassessed based on the mitigation requirements of the BO, CLWA will confirm that DWR's current estimate of SWP reliability is still applicable or if it needs to be updated, presumably by another Reliability Report. CLWA would then use this information to amend its 2005 UWMP, which would include identification of potential additional supplies to replace any necessary portion of CLWA's SWP supply that would have been lost as a result of the BO mitigation requirements.

In the meantime (i.e., during 2008 and part of 2009), based on the revised Reliability Report, local water retailers should be able to provide affirmative responses to requests for SB 610 Water Supply Assessments (WSAs) and SB 221 Water Verifications (WVs) for proposed projects. CEQA Lead Agencies may also rely on the 2005 UWMP, with the additional information provided by the Reliability Report, for the analysis of water supply impacts in CEQA documents, and in making a determination as to the adequacy of water supply for land use projects.

CLWA and the local water retailers – CLWA Santa Clarita Water Division, Los Angeles County Water Works District #36, Newhall County Water District and Valencia Water Company – look forward to working with the County in allocating water to proposed development in a consistent and equitable manner while at the same time ensuring that no water supply disruptions occur to our existing customers.

Sincerely,

Dan Masnada
General Manager

Attachment

cc: Mr. Paul Brotzman, Planning and Economic Development Director
City of Santa Clarita, Department of Regional Planning
Mr. Steve Cole, General Manager, Newhall County Water District
Mr. Robert DiPrimio, President, Valencia Water Company
Mr. Dean Efstathiou, Chief Deputy Director, Los Angeles County Department of Public Works
Mr. Mauricio Guardado, Retail Manager, Santa Clarita Water Division
Mr. Paul Novak, Planning Deputy, Los Angeles County Board of Supervisors

Los Angeles County
Department of Regional Planning

Planning for the Challenges Ahead

Bruce W. McClendon FAICP
Director of Planning

September 13, 2007

Castaic Lake Water Agency
Dan Masnada, General Manager
27234 Bouquet Canyon Road
Santa Clarita, CA 91350-2173

REC'D SEP 21 2007

Subject: Availability of Future Water Supply

Dear Mr. Masnada:

The recent decision handed down by U.S. District Judge Oliver Wanger appears to have significantly reduced the amount of water that Southern California will receive from the State Water Project. The Department of Regional Planning is requesting that your agency inform this Department of impacts that may affect pending and future residential and commercial developments within your agency's service area.

Possible reductions in local water supplies may invalidate portions of environmental impact reports related to development proposals currently awaiting public hearing. Therefore, it is urgent that your agency respond as soon as a reasonably accurate determination can be made.

Should you have any questions, please feel free to contact Mr. Paul McCarthy of my staff at (213) 974-6461 between 7:30 a.m. to 5:30 p.m., Monday through Thursday. Our offices are closed on Friday.

Sincerely,

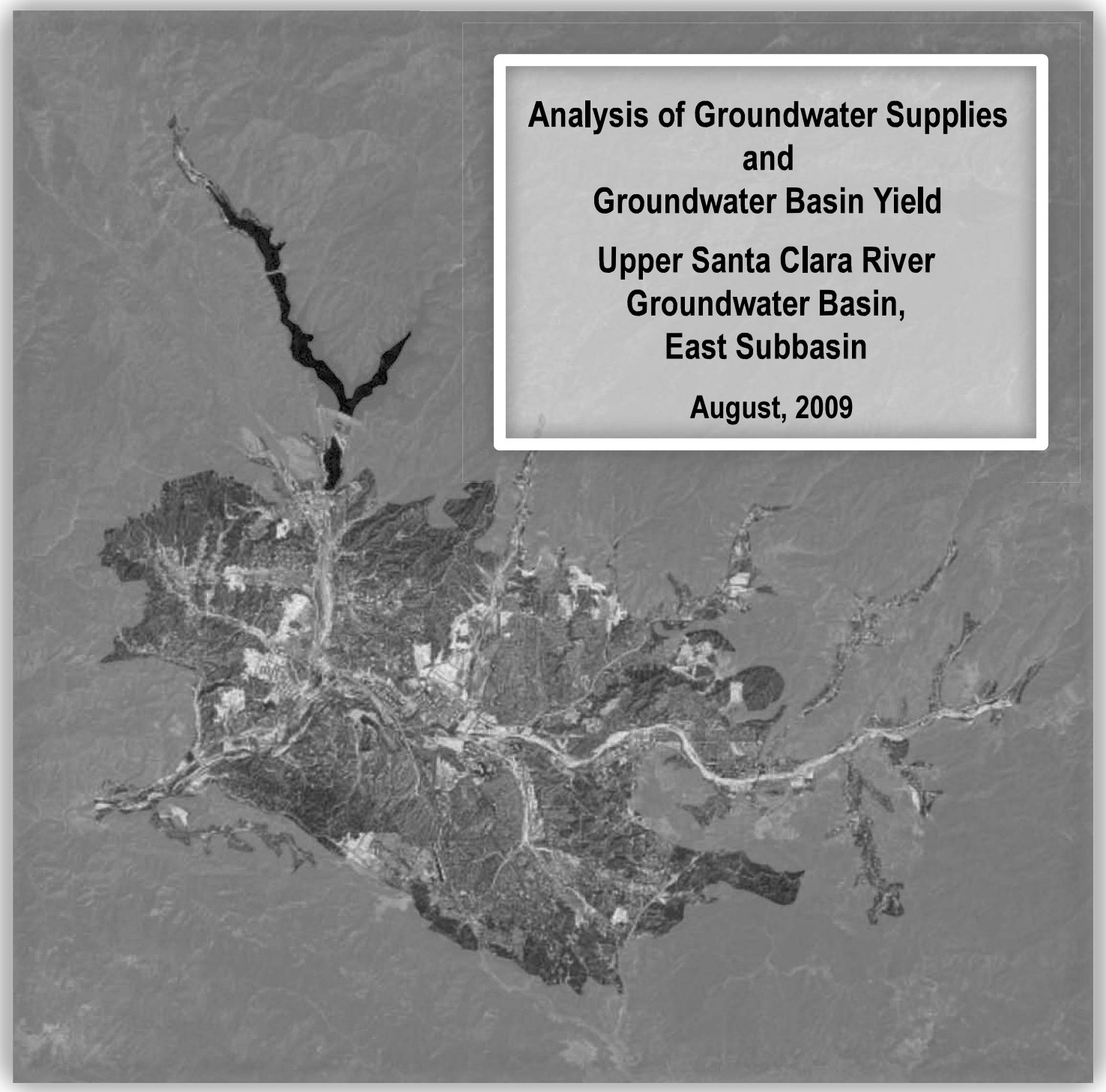
DEPARTMENT OF REGIONAL PLANNING

Bruce W. McClendon, FAICP
Director of Planning

BWM:JS:FM:PM:rs

Attachment

C: County Counsel
Department of Public Works



Analysis of Groundwater Supplies and Groundwater Basin Yield

Upper Santa Clara River Groundwater Basin, East Subbasin

August, 2009

prepared for

Santa Clarita Valley Municipal Water Purveyors

prepared by

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

GSI Water Solutions, Inc.

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August, 2009

Table of Contents

Page

Acronyms and Abbreviations vii

I. Introduction I-1
- 1.1 Background I-2
- 1.2 Scope of Updated Analysis I-4
- 1.3 Report Organization I-5

II. Updated Model Calibration II-1
- 2.1 Model Description II-1
- 2.2 Calibration Update Approach II-2
- 2.3 Results from the Calibration Update Process II-3

III. Modeling Approach for Analyzing Basin Yield III-1
- 3.1 Modeling Approach III-1
- 3.2 Simulation Period III-1
  - 3.2.1 Original Simulation Period III-1
  - 3.2.2 Current Simulation Period and Associated Hydrology III-2
- 3.3 2008 Operating Plan III-4
  - 3.3.1 General Description of 2008 Operating Plan III-4
  - 3.3.2 Alluvial Aquifer Pumping III-5
  - 3.3.3 Saugus Aquifer Pumping III-6
  - 3.3.4 Monthly Allocation of Pumping III-8
  - 3.3.5 Total Available Potable Water Supply Under the 2008 Operating Plan III-8
- 3.4 2008 Operating Plan with Pumping Redistribution III-9
- 3.5 Potential Future Operating Plan III-9
- 3.6 Simulation of Other Local Hydrologic Processes III-10
  - 3.6.1 Recharge from Urban Irrigation III-10
  - 3.6.2 Recharge from Agricultural Irrigation III-10
  - 3.6.3 Precipitation Recharge III-11
  - 3.6.4 Stormwater Flows and Recharge from Streams III-11
  - 3.6.5 WRP Discharges to the Santa Clara River III-11
  - 3.6.6 Monthly Assignment and Tracking of Surface Water Budget III-12
- 3.7 Running the Model and Evaluating Results III-12

IV. Sustainability of Operating Plans IV-1
- 4.1 Groundwater Elevations IV-1
  - 4.1.1 2008 Operating Plan IV-1
  - 4.1.2 2008 Operating Plan with Pumping Redistribution IV-3
  - 4.1.3 Potential Operating Plan IV-4
- 4.2 Groundwater Recharge, Discharge, and Storage IV-5
- 4.3 River Flows IV-6
- 4.4 Relationship of Simulation Results to Future Conditions IV-6

Table of Contents, continued

Page

V. Climate Change Considerations V-1
5.1 Objectives V-1
5.2 Approach V-2
5.2.1 Evaluation and Selection of Climate Change Scenarios V-2
5.2.2 Simulation Period V-3
5.2.3 Hydrologic Processes for Climate Change Scenarios V-3
5.3 2008 Operating Plan under Climate Change Scenarios V-4
5.3.1 Drying Climate Trend (Climate Scenario 1) V-4
5.3.2 Wetter Climate Trend (Climate Scenario 9) V-4
5.3.3 Average Climate Trend (Climate Scenario 6) V-5
5.4 Climate Change Summary V-5

VI. Local Artificial Recharge Projects VI-1
6.1 Los Angeles County Flood Control District Study VI-1
6.2 Project Locations Relative to Aquifer System VI-1
6.3 Conceptual Project Operation and Impacts VI-2

VII. Conclusions VII-1

References

Appendices

Appendix A Description of the Santa Clarita Valley Groundwater Flow Model
Appendix B Updated Santa Clarita Valley Groundwater Flow Model Calibration Tables and Hydrographs
Appendix C Modeled Groundwater Elevation Hydrographs 2008 and Potential Operating Plans
Appendix D Climate Change Literature Review and Model Simulations
Appendix E Simulated Climate Change Groundwater Elevation Hydrographs

List of Figures and Tables

Figures

Figure 1-1 Basin Location Map

Figure 2-1 Model Grid
Figure 2-2 Schematic Cross-Sections
Figure 2-3 Rainfall-Recharge Relationship for the Groundwater Flow Model
Figure 2-4 Alluvial Subareas and Well Locations

Figure 3-1 Annual Rainfall (Newhall-Soledad Rain Gage)
Figure 3-2 Annual Rainfall and Cumulative Departure from Average Rainfall (Newhall-Soledad Rain Gage)
Figure 3-3 Simulated Groundwater Pumping for 2008 Groundwater Operating Plan
Figure 3-4 Simulated Water Supplies For 2008 Groundwater Operating Plan (Excluding Recycled Water)
Figure 3-5 Simulated Groundwater Pumping for Potential Groundwater Operating Plan
Figure 3-6 Simulated Groundwater Pumping for 2008 and Potential Operating Plans
Figure 3-7 Simulated Water Supplies for Potential Groundwater Operating Plan (Excluding Recycled Water)

Figure 4-1 VWC-E15 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Below Valencia WRP)
Figure 4-2 VWC-S8 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Below Saugus WRP)
Figure 4-3 VWC-T7 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Above Saugus WRP)
Figure 4-4 SCWD-Sierra Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 4-5 NCWD-Pinetree 1 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 4-6 NCWD-Castaic 7 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in Castaic Valley)
Figure 4-7 VWC-W11 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in San Francisquito Canyon)
Figure 4-8 SCWD-Clark Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in Bouquet Canyon)
Figure 4-9 SCWD-Saugus 1 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)
Figure 4-10 VWC-206 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)
Figure 4-11 NCWD-13 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)

Figure 4-12 VWC-T7 Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer Above Saugus WRP)
Figure 4-13 SCWD-Clark Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer in Bouquet Canyon)
Figure 4-14 SCWD-Sierra Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 4-15 NCWD – Pinetree3 Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 4-16 Comparison of Simulated Trends in Groundwater Recharge and Discharge Terms for the 2008 Operating Plan Under Historical Hydrology
Figure 4-17 Comparison of Simulated Trends in Groundwater Discharge Terms for the 2008 and Potential Operating Plans Under Historical Hydrology
Figure 4-18 Cumulative Change in Groundwater Storage Volume
Figure 4-19 Simulated Monthly Flow in the Santa Clara River at the County Line For the 2008 and Potential Operating Plans Under Historical Hydrology
Figure 4-20 Modeled and Estimated Monthly Groundwater Discharges to the Perennial Reach of the Santa Clara River (from Round Mountain to Blue Cut)
Figure 4-21 Streamflow During Driest Month of Each Year

Figure 5-1 2010-2098 Cumulative Departure from Average Annual Rainfall at Newhall-Soledad Rain Gage
Figure 5-2 VWC-E15 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer Below Valencia WRP)
Figure 5-3 VWC-S8 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer Below Saugus WRP)
Figure 5-4 VWC-T7 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer Below Saugus WRP)
Figure 5-5 SCWD-Sierra Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 5-6 NCWD-Pinetree 1 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)
Figure 5-7 NCWD-Castaic 7 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer in Castaic Valley)
Figure 5-8 VWC-W11 Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer in San Francisquito Canyon)
Figure 5-9 SCWD-Clark Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer in Bouquet Canyon)
Figure 5-10 Groundwater Elevation Trends at SCWD-Saugus1 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9
Figure 5-11 Groundwater Elevation Trends at VWC-206 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9

Figure 5-12 Groundwater Elevation Trends at NCWD-13 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9

Figure 6-1 Locations of LACFCD Planned Recharge Projects

Tables

Table 3-1 Alluvial and Saugus Formation Pumping Patterns for the Simulation of 1922-2007 Historical Hydrology
Table 3-2 Local Hydrology and 2008 Operating Plan for the Alluvial Aquifer
Table 3-3 SWP Deliveries and 2008 Operating Plan for the Saugus Formation
Table 3-4 Pumping Rates Simulated for Individual Alluvial Aquifer Wells under the 2008 Groundwater Operating Plan
Table 3-5 Pumping Rates Simulated for Individual Saugus Formation Wells under the 2008 Groundwater Operating Plan
Table 3-6 Allocation of Pumping by Layer for Wells Completed in the Saugus Formation
Table 3-7 Allocation of Pumping, by Month, for Agricultural and Urban Production Wells
Table 3-8 Total Groundwater and SWP Supplies for 2008 Groundwater Operating Plan (Not Including Recycled Water and Other Water Supplies, e.g. Purchased or Banked Water)
Table 3-9 Pumping Rates Simulated for Individual Alluvial Aquifer Wells under the Redistributed 2008 Groundwater Operating Plan (Listed by Alluvial Subarea)
Table 3-10 Pumping Rates Simulated for Individual Alluvial Aquifer Wells under the Potential Groundwater Operating Plan
Table 3-11 Pumping Rates Simulated for Individual Saugus Formation Wells under the Potential Groundwater Operating Plan
Table 3-12 Total Groundwater and SWP Supplies for Potential Groundwater Operating Plan (Not Including Recycled Water and Other Water Supplies, e.g. Purchased or Banked Water)
Table 3-13 Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 86-year Simulation
Table 3-14 Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 86-year Simulation
Table 3-15 Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 86-year Simulation
Table 3-16 Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)
Table 3-17 Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions
Table 3-18 Simulated Monthly Treated Wastewater Discharges from Santa Clarita Valley WRPs under Full Build-out Conditions

Table 4-1 Pumping Rates Simulated for Individual Alluvial Aquifer Wells Under the Re-Distributed 2008 Groundwater Operating Plan (Listed By Alluvial Subarea)

Table 5-1 Climate Projection #1 (Global Climate Model GFDL_cm2_0.1sresB1) Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation
Table 5-2 Climate Projection #6 (Global Climate Model NCAR_PCM1.3_sresA2) Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation
Table 5-3 Climate Projection #9 (Global Climate Model NCAR_PCM1.3_sresB1) Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation
Table 5-4 Climate Projection #1 (Global Climate Model GFDL_cm2_0.1sresB1) Alluvial and Saugus Formation Pumping for the Simulation of 1922-2007 Historical Hydrology
Table 5-5 Climate Projection #6 (Global Climate Model NCAR_PCM1.3_sresA2) Alluvial and Saugus Formation Pumping for the Simulation of 1922-2007 Historical Hydrology
Table 5-6 Climate Projection #9 (Global Climate Model NCAR_PCM1.3_sresB1) Alluvial and Saugus Formation Pumping for the Simulation of 1922-2007 Historical Hydrology

Table 6-1 Los Angeles County Flood Control District Stormwater Runoff Recharge Projects

Acronyms and Abbreviations

afy	acre-feet per year
AWRM	Alternative Water Resources Management program
CCCC	California Climate Change Center
CLWA	Castaic Lake Water Agency
CMIP3	Climate Model Intercomparison Project 3
DPH	California Department of Health Services
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
ET	evapotranspiration
GCM	global climate model
GFDL	Geophysical Fluid Dynamics Laboratory
gpm	gallons per minute
in/yr	inches per year
IPCC	Intergovernmental Panel on Climate Change
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation District
LARWQCB	Los Angeles Regional Water Quality Control Board
LLNL	Lawrence Livermore National Laboratory
LSCE	Luhdorff & Scalmanini Consulting Engineers
mg/L	milligrams per liter
mgd	million gallons per day
MOU	Memorandum of Understanding
NCAR	National Center for Atmospheric Research
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
PCM1	Parallel Climate Model
Purveyors	Upper Basin Water Purveyors
RCS	Richard C. Slade and Associates, LLC
SCVSD	Santa Clarita Valley Sanitation District of Los Angeles County

SCWD	Santa Clarita Water Division of CLWA
SRES	Special Report on Emissions Scenarios
SWP	State Water Project
SWRM	Surface Water Routing Model
TMDL	Total Maximum Daily Loads
UWMP	Urban Water Management Plan
VWC	Valencia Water Company
WCRP	World Climate Research Programme
WHR	Wayside Honor Rancho
WRP	water reclamation plant
UCAR	University Corporation for Atmospheric Research
WRP	water reclamation plant

I. Introduction

In 2003, the retail water Purveyors in the Santa Clarita Valley (herein the Purveyors[1]) commissioned efforts to develop, calibrate and utilize a numerical groundwater model for purposes of analyzing the sustainability of local groundwater as a component of overall water supply in the Valley. At that time, the question of groundwater sustainability was complemented by a question about whether part of overall groundwater pumping could be employed to achieve containment and removal of perchlorate contamination in the deeper aquifer, the Saugus Formation, beneath the Valley. The results of those modeling efforts concluded that a certain groundwater operating plan (rates and distributions of groundwater pumping under varying local hydrologic conditions) would be expected to produce long-term sustainable groundwater conditions, and that a certain focused part of overall pumping would be expected to both extract perchlorate-contaminated groundwater (for use after treatment) and contain the migration of perchlorate-impacted groundwater. The development and calibration of the numerical groundwater flow model is described in *Regional Groundwater Flow Model for the Santa Clarita Valley, Model Development and Calibration* (CH2M Hill, April 2004). Application of the model for extraction and containment of perchlorate-impacted groundwater is described in *Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property* (CH2M Hill, December 2004). And application of the model for analysis of basin yield, including sustainability of groundwater pumping consistent with that employed in the perchlorate containment analysis, is documented in *Analysis of Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin, Los Angeles County, California* (CH2M Hill and LSCE, August 2005).

The groundwater system in the Santa Clarita Valley, located in northwestern Los Angeles County, is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07) and lies within the DWR-designated Upper Santa Clara River Hydrologic Area [Figure 1-1]. Groundwater in the basin is pumped from a shallow Alluvial Aquifer and from deeper groundwater resources that are present in an older, underlying unit called the Saugus Formation. Most groundwater pumping is by the Purveyors for municipal uses (in the range of approximately 23,000 to 33,000 acre-feet per year (afy) in recent years), with some continuing pumping by private landowners, primarily for irrigation uses (approximately 13,000 to 17,000 afy in recent years). The Purveyors also have access to other sources of water to supplement groundwater for municipal supply, including imported State Water Project (SWP) water, groundwater banking outside the basin, recycled water, short-term water exchanges, and dry-year water purchase programs. Those sources are described in the Purveyors' current *2005 Urban Water Management Plan* (Black & Veatch, et al., November 2005) and in a series of annual *Santa Clarita Valley Water Reports*, most recently for 2007 (LSCE, April 2008).

The water supply and water resource management practices of the Purveyors call for maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal

[1] The Santa Clarita Valley Purveyors are comprised of Los Angeles County Waterworks District 36, Newhall County Water District, Santa Clarita Water Division of the Castaic Lake Water Agency (formerly Santa Clarita Water Company, acquired by CLWA in 1999), and Valencia Water Company.

availability of these supplies, and limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus Formation pumping during years when supplemental imported water supplies are significantly reduced because of drought conditions. These local management practices have been called the local groundwater operating plan; that term has been adopted in this report to identify the previously analyzed operating plan (the 2004 Operating Plan) and subsequent iterations analyzed herein (the 2008 Operating Plan, the 2008 Operating Plan with Pumping Redistribution, and a Potential Operating Plan).

1.1 Background

The numerical groundwater model was originally developed as part of the work scope contained in an August 2001 Memorandum of Understanding (MOU) that was adopted by the Purveyors and the United Water Conservation District, located downstream in Ventura County. That MOU was a commitment by the Purveyors to expand on previous analyses of groundwater conditions such that the adequacy of the local groundwater supply could be better understood and questions about surface water and groundwater resources could be more readily addressed. The MOU initiated a collaborative and integrated approach to data collection; database management; evaluating groundwater conditions and the sustainability of the Purveyors' operating plan; groundwater flow modeling; annual reporting on basin conditions; and technical reporting focused on geologic and hydrologic aspects of the overall stream-aquifer system.

In 2003, subsequent to the MOU, Castaic Lake Water Agency (CLWA) prepared and adopted a formal Groundwater Management Plan (CLWA, 2003), which includes 14 elements intended to achieve four management objectives, or goals, for the groundwater basin. Those four management objectives include development of local groundwater for water supply; avoidance of overdraft and associated undesirable effects; preservation of groundwater quality; and preservation of interrelated surface water resources. The intent of the Groundwater Management Plan is to ensure that ongoing utilization of local groundwater continues to result in acceptable aquifer conditions, specifically avoidance of overdraft (Element 3 of the Plan), no degradation of quality (Element 6 of the Plan), and no adverse impacts to surface waters (Element 2 of the Plan). The Plan identified these objectives and elements as being accomplished via continued conjunctive use operations that have been ongoing since the initial importation of supplemental surface water in 1980 (Element 5 of the Plan) and via monitoring and interpretation of surface water and groundwater conditions on an ongoing basis (Elements 1 and 2 of the Plan).

The Purveyors initially agreed in the MOU, and the Purveyors subsequently committed in the Groundwater Management Plan, to develop and use a numerical groundwater flow model for the sustainability evaluation of the local groundwater operating plan. Prior to that, the available data showed that no long-term lowering of the water table or degradation of water quality had occurred during the 50 to 60 years of recorded historical groundwater development in the valley, and the various studies and water planning efforts performed up to that time had resulted in a local groundwater operating plan that placed future pumping of the Alluvial Aquifer in the same range as historical pumping. However, although the MOU recognized a need to formally analyze the Alluvial Aquifer, it identified that the primary question to be evaluated with the model would be the operational yield of the Saugus Formation, given that the Purveyors' operating plan called for dry-year pumping from that aquifer at rates higher than had historically

been pumped. For that reason, the MOU identified that the model would evaluate the effect of the current groundwater operating plan on groundwater conditions in both the Alluvial Aquifer and the Saugus Formation over a multi-year wet/dry cycle. The operational yield was defined in the MOU as an operating plan for the local groundwater basin that would allow continued pumping from the Alluvial Aquifer and Saugus Formation while assuring that groundwater supplies would be adequately replenished from one wet/dry cycle to the next.

As introduced above, a groundwater operating plan was formally analyzed with the groundwater model as part of the perchlorate containment analysis in 2004, and then specifically as the focus of basin yield analysis in 2005. In summary, that plan was as follows:

- Pumping from the Alluvial Aquifer in a given year is governed by local hydrologic conditions in the basin. Under the operating plan, pumping ranges between 30,000 and 40,000 afy during normal and above-normal rainfall years but, because of operational constraints in the eastern part of the basin, is reduced to between 30,000 and 35,000 afy during locally dry years.

- Pumping from the Saugus Formation in a given year is tied directly to the availability of other water supplies, particularly imported water from the SWP system. For the Saugus Formation, the operating plan consists of pumping between 7,500 and 15,000 afy during average-year to wet-year conditions within the SWP system. Planned dry-year pumping from the Saugus Formation ranges between 15,000 and 25,000 afy during a dry year, and increases to between 21,000 and 25,000 afy if SWP deliveries are reduced for two consecutive years, and between 21,000 and 35,000 afy if SWP deliveries are reduced for three consecutive years. Such high pumping would be followed by periods of reduced (average-year) pumping, at rates between 7,500 and 15,000 afy, to further enhance the effectiveness of natural recharge processes that would recover water levels and groundwater storage volumes in the Saugus Formation, as has been historically experienced.

Simulated groundwater basin response to groundwater pumping in accordance with the 2004 Operating Plan, over a long-term period of varying hydrologic conditions, was concluded to be sustainable based on a two-part definition of sustainability, which is continued in the updated analysis reported herein, as follows:

- lack of chronic, or sustained, depletion of groundwater storage, as indicated by projected groundwater levels, over a reasonable range of wet, normal, and dry hydrologic conditions

- maintenance of surface water flows in the western portion of the basin (which are partially maintained by groundwater discharge) and surface water outflow to downstream basins over the same range of hydrologic conditions

The primary conclusion from the modeling analysis of the 2004 Operating Plan was that it would not cause detrimental short-or long-term effects to the groundwater and surface water resources in the Valley and was, therefore, sustainable. In summary, the groundwater basin could be

expected to respond to the 2004 Operating Plan in a manner similar to what had been experienced over approximately the preceding 50 years: Use of water from the Alluvium, slightly decreased during locally drier periods, was projected to result in small to large fluctuations in Alluvial Aquifer groundwater levels from the middle to the eastern part of the basin, followed by full to near-full recovery in wet years or periods of years. Different from historically experienced conditions is in the Saugus Formation, where greater Saugus pumping during periods of significantly reduced imported water supplies was projected to cause larger fluctuations in groundwater levels during such pumping, with full to near-full recovery of Saugus water levels in subsequent years when the availability of imported water supplies was expected to return to normal.

After completion of the sustainability analysis, the 2004 Operating Plan was incorporated in the Purveyors' collective 2005 Urban Water Management Plan (UWMP) to reflect the groundwater component of overall water supplies available to meet current and projected water requirements over the planning horizon of the UWMP.

1.2 Scope of Updated Analysis

In 2008, partly in preparation for the next UWMP in 2010, and in part because of recent events that are expected to impact the future reliability of the principal supplemental water supply for Santa Clarita Valley, i.e., from the State Water Project, the Purveyors concluded that an updated analysis was needed to further assess groundwater development potential and possible augmentation of the groundwater operating plan. Near-term reductions in SWP water deliveries to CLWA are possible because of an August 2007 court ruling that is expected to reduce exports from the Bay-Delta by approximately 30 percent in the immediate future. Additionally, the National Marine Fisheries Service (NMFS) released its Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project on June 4, 2009. The proposed regulatory actions will further restrict Delta export operations of the State Water Project, however, studies have not been completed quantifying impacts on SWP reliability. The duration of reductions are unknown and depend on a number of factors, including whether DWR can construct alternative facilities in the future to make up for reductions. Additionally, DWR is evaluating the potential magnitude of longer-term future reductions in SWP deliveries because of potential effects of global climate change.

A second consideration in conducting an updated analysis of the basin is that global climate change could alter local rainfall and associated recharge patterns, thus affecting local groundwater supplies, i.e. the yield of the basin. Finally, the Los Angeles County Flood Control District (LACFCD) is planning a number of small flood control projects in the Santa Clarita Valley; estimated amounts of conservation/groundwater recharge potential are being included for each of the individual projects in the overall LACFCD planning, and the Purveyors have interest in whether that potential could appreciably augment the yield of the basin.

In light of the above, the scope of the updated basin yield analysis, reported herein, includes the following:

- consider potential increased utilization of groundwater for regular (wet/normal) and/or dry-year water supply, including distribution of the yield by reach of the Santa Clara River alluvium and its various tributaries;

- consider potential augmentation of basin yield via initiation of artificial groundwater recharge using stormwater runoff in selected areas of the basin as being planned by LACFCD; and

- quantitatively or qualitatively, depending on the availability of technical reference material, describe general impacts of climate change on the groundwater basin and its yield.

1.3 Report Organization

To address the scope of the updated basin yield analysis outlined above, the remainder of this report is organized as follows:

Chapter 2 discusses the extension of the numerical groundwater flow model from its previous calibration period of 1980 through 2004 to add three years and thus extend calibration through 2007; this section also describes some limited model recalibration after extension of the model through 2007.

Chapter 3 describes the operating plans that were developed for updated analysis of basin yield, and the process that was used to simulate basin response to those plans and to evaluate the results.

Chapter 4 discusses the results of the simulated basin response to the 2008 and Potential groundwater operating plans, including the sustainability and achievability of the plans.

Chapter 5 describes climate change considerations, the selection of a range of potential climate change impacts on local hydrologic conditions, and the simulated effects of those resultant hydrologic conditions on the sustainability and achievability of the 2008 groundwater operating plan.

Chapter 6 describes the potential groundwater recharge projects being planned by LACFCD and discusses the potential benefit to the yield of the basin.

Chapter 7 summarizes the conclusions derived from the overall updated basin yield analysis, and the implications of those conclusions for long-term groundwater supply and groundwater management in the Santa Clarita Valley.

References and Appendices follow Section 7. The Appendices include a description of the Santa Clarita Valley numerical groundwater flow model, description of the updated model calibration, hydrographs to illustrate simulated basin response to the operating plans, and discussion of climate projections and their incorporation in the analyses reported herein.

18W 17W 16W 15W 14W

05N 04N 03N

SAUGUS FORMATION

ALLUVIUM

Lang Gage

County Line Gage

Upper Santa Clara River Watershed Boundary

Legend

Purveyor Well Location

- CLWA-Santa Clarita Water Division
- Valencia Water Company
- Newhall County Water District
- Newhall Land & Farming
- Los Angeles County Flood Control District
- Wayside Honor Rancho
- Private Well
- Destroyed Well
- Rain Gage
- Stream Gage
- Water Reclamation Plant (WRP)

0 4,000 8,000 12,000 Feet

MAP LOCATION

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Figure 1-1
Basin Location Map
Upper Santa Clara River Valley Groundwater Basin, East Subbasin

II. Updated Model Calibration

2.1 Model Description

The Santa Clarita Valley groundwater flow model is a three-dimensional, numerical model that uses the MicroFEM® finite-element software (Hemker and de Boer, 2003). The model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation (Figure 3-1). The model's construction and calibration are summarized in Appendix A and discussed in detail in *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration* (CH2M HILL, 2004a).

The model simulates groundwater conditions within an area that largely coincides with the Santa Clara River Valley Groundwater Basin, East Subbasin, delineated by DWR. This area extends from the Lang stream gage at the eastern end of the valley to the County Line stream gage area in the west. The model is based on a finite-element mesh consisting of seven layers, with 17,103 nodes and 32,496 elements in each layer (Figure 2-1). The upper model layer simulates the Alluvial Aquifer and also the upper portion of the Saugus Formation where the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and its Sunshine Ranch Member. Figure 2-2 shows the model layering in three cross-sectional views.

The boundary conditions in the model consist of the following:

- Specified flux boundaries for the following:
  - precipitation
  - irrigation
  - recharge from ephemeral streams
  - pumping
  - underflow from beneath Castaic Dam

- Head-dependent flux boundaries for the following:
  - groundwater discharges to the perennial reach of the Santa Clara River
  - residual drainage of groundwater to the Santa Clara River in the ephemeral reach under high water table conditions
  - evapotranspiration (ET) by phreatophyte plants, which extract groundwater from the shallow water table that lies along riparian river corridors

- Constant-head boundaries for the following:
  - subsurface inflow in the Alluvial Aquifer at the eastern end of the valley, at the Lang gage[1]

[1] A constant-head boundary was established in the groundwater model at this location using recent field conditions that were observed after the model calibration report (CH2M HILL, 2004a) was published. This change improved the groundwater model's calibration in the Alluvial Aquifer in the upper reaches of Soledad Canyon and did not appreciably change the calibration quality elsewhere. See CH2M HILL (2005) for further details.

- subsurface outflow in the Alluvial Aquifer at the western end of the valley, at the County Line gage

Groundwater recharge rates are estimated using precipitation records, streamflow records, watershed maps, topographic maps, and aerial photography. These recharge rates are calculated using a detailed Surface Water Routing Model (SWRM), which was written specifically to provide time-dependent, spatially varying recharge rates as input to the groundwater model. The SWRM relies on streamflow records at the Lang and County Line gages; historical records of rainfall data from the NCWD rain gage (see Figure 1-1), spatial variations in rainfall across the basin, the rates and locations of future WRP discharges to the Santa Clara River, and irrigation from agricultural and urban water uses.

The depths from which production wells obtain water are defined in the groundwater model from well construction records. The rates and locations of pumping are based on the Purveyors' operating plan for the basin and on the surveyed location of each production well.

2.2 Calibration Update Approach

The calibration update process consisted of transient modeling that simulated monthly variations in pumping from, and recharge to, the Alluvial Aquifer and the Saugus Formation during the period January 2005 through December 2007. As with the original calibration effort, simulation results were compared to measured fluctuations in groundwater elevations and streamflows in the Santa Clara River.

Hydrologic input data for the calibration update simulation are tabulated in Appendix B and were as follows:

- Groundwater pumping data were provided by the Purveyors for each production well. Appendix Tables B-1 and B-2 show annual pumping for the Alluvial Aquifer and Saugus Formation, respectively, from 1980 through 2007. As with the initial model calibration effort, the monthly distribution of pumping was defined from information on the monthly distribution of urban and agricultural water demands, as listed in Appendix Table B-3.
- Groundwater recharge was defined using the SWRM, which was written specifically for the groundwater model during the original model development effort (see Appendix C of CH2M HILL, 2004a). The SWRM defined recharge from applied water use (i.e., irrigation)[2]; direct precipitation within the model domain (see Appendix Table B-4); Santa Clara River flows into the valley as measured at the Lang stream gage (see Appendix Table B-5); SWRM-estimated stormwater inflows into the model domain along ephemeral streams that are tributaries to the Santa Clara River; measured volumes of treated water discharge into the Santa Clara River from two Los Angeles County Sanitation District (LACSD) water reclamation plants (WRPs) (see Appendix Tables B-6

[2] Infiltration of applied water was simulated in the same locations as in the original model calibration effort, and at the 1999 rates described in the model development report (CH2M HILL, 2004a). These rates were 24.7 inches per year (in/yr) for irrigated agricultural land, 2.2 in/yr for residential areas, and 1.0 in/yr for retail/industrial lands and golf courses.

and B-7); and water released from Castaic Lagoon into Castaic Creek by DWR (see Appendix Table B-8).

- Coefficients for the riverbed leakage term at each river node vary over time in the model. For the years 2005 through 2007, the calibration update process initially used the same values as used for 1992, 1996, and 1989, respectively. These values were then adjusted as necessary during the calibration update process.

The quality of the model's calibration was evaluated as follows:

- Simulated groundwater elevation trends were compared with data collected at production wells where long-term records of groundwater elevations are available. These wells are referred to herein as target wells. As discussed in the model development report (CH2M HILL, 2004a), the calibration goal at target wells was to simulate groundwater elevations that were higher than the pumping elevations and as close as possible to the static elevations. Therefore, the hydrographs show the model-simulated groundwater elevations, the measured static groundwater elevations, and, for production wells, the measured pumping groundwater elevations. Additionally, the comparison of time-varying simulated and measured groundwater elevations was equally focused on the slopes of the hydrographs, not just the absolute values of the groundwater elevations at any given time.
- The groundwater budget was evaluated to compare simulation results with measured flows in the Santa Clara River at the west end of the basin (at the County Line gage; see Appendix Table B-9); and estimated volumes of groundwater discharge to the Santa Clara River (see Appendix Table B-10).

2.3 Results from the Calibration Update Process

The initial simulation of conditions during 2005 through 2007 produced findings that were deemed to require adjustments to the model's calibration of portions of the Alluvial Aquifer prior to conducting the predictive modeling necessary for the basin yield update analysis. Specifically, the results from the initial calibration update indicated that, from 2005 through 2007, the model simulated:

- too much groundwater level recovery in Castaic Valley at NCWD's Castaic wellfield during the high streamflow event of early 2005
- too much decline in groundwater levels in lower San Francisquito Canyon (at VWC's W9 and W11 wells)
- groundwater levels that were too high in lower Bouquet Canyon (at SCWD's Clark well) and below the mouth of Bouquet Canyon (at VWC's S6, S7, and S8 wells)

It was also noted that, the model simulated too little groundwater level decline immediately prior to 2005 in the eastern-most portions of the Alluvial Aquifer along the Santa Clara River (at and east of the mouth of Mint Canyon). Additionally, it was determined that, for NCWD's Pinetree wellfield, the groundwater level database contained incorrect reference elevations, which are

used to convert groundwater depths to groundwater elevations. As a result, it was concluded that the original calibration effort (during 2004) had compared simulation results with database-derived groundwater elevation values that were lower than the actual elevations of the water table throughout the entire simulation period (January 1980 to the present).

As a result of these findings, efforts were undertaken to improve the model's calibration quality in the eastern-most portion of the Alluvial Aquifer and in the tributary canyons noted above. This focused re-calibration process resulted in changes to the hydraulic conductivity in certain areas and riverbed leakage coefficients along certain reaches of Castaic Creek and the eastern reaches of the Santa Clara River. These changes were:

- increasing the hydraulic conductivity from 105 feet/day to between 250 and 500 feet/day in San Francisquito Canyon

- increasing the hydraulic conductivity from 245 feet/day to 300 feet/day in lower Bouquet Canyon

- introducing a zone of reduced hydraulic conductivity (250 feet/day) along the Santa Clara River at the mouth of Mint Canyon, to better simulate the hydraulic gradient between SCWD's Sierra and Mitchell wells

- reducing the hydraulic conductivity by 50 percent along the Santa Clara River from just east of NCWD's Pinetree wellfield upstream to the Lang gage at the eastern end of the valley (from 300 to 150 feet/day) and also in two nearby tributaries (Tick Canyon and Bee Canyon, from 150 to 75 feet/day)

- raising the Castaic Creek riverbed leakage coefficients during the high-flow events of 2001 and late 2004/early 2005

- raising the riverbed leakage coefficients in San Francisquito and Bouquet Canyons during and after the high-flow event of late 2004/early 2005

- raising the riverbed leakage coefficients for the reach of the Santa Clara River near SCWD's North Oaks and Sierra wells during the high-flow event of late 2004/early 2005

- revising the rainfall-runoff-recharge relationship for the basin. This relationship is based on a power-function equation developed by Turner (1986). As shown in Figure 2-3, the coefficients were revised slightly in a manner that, when compared with the original calibration (CH2M HILL, 2004a), generates slightly more recharge when annual precipitation is above normal. This increase in recharge ranges from about 0.25 inches to 1 inch for annual rainfall between 21 and 40 inches at the NCWD gage. For the wettest year on record at the NCWD gage (48.33 inches in calendar year 1983), annual recharge is 22.5 and 23.8 inches in the 2004 and 2008 calibrations, respectively, which is a difference of about 1.3 inches.

Appendix B contains groundwater elevation hydrographs comparing the model-simulated groundwater elevations with static and pumping groundwater elevations at the many production wells in the valley. Model simulation results are shown both for the original calibration (CH2M HILL, 2004a) and the updated calibration. The hydrographs are organized according to the primary subareas for the Alluvial Aquifer (see Figure 2-4 for the locations of these subareas) and by Purveyor for the Saugus Formation. The hydrographs show notable improvements in calibration quality in Castaic Valley, San Francisquito Canyon, and Bouquet Canyon. However, little improvement could be achieved at VWC's S-series wells without degrading the calibration quality in nearby wells (such as VWC's N-series wells). Along the Santa Clara River, substantial improvements to the model's simulation of drought periods in the Alluvial Aquifer were achieved at NCWD's Pinetree wellfield, and to a lesser extent at other wells further west (for example, SCWD's North Oaks, Sierra, and Honby wells).

In the Saugus Formation, the model simulates the trends in groundwater elevations quite well at each Saugus production well. The trends (hydrograph slopes) are particularly close in the NCWD wellfield (NCWD production wells 11, 12, and 13). Farther downgradient, the model tends to slightly over-predict groundwater elevations in SCWD's two production wells. However, the model closely simulates the groundwater elevation trends at these two wells, which is the primary consideration for evaluating the quality of the transient calibration process in the Saugus Formation. Groundwater elevations and trends are well-simulated at VWC's Saugus production wells (including the recently constructed VWC-206).

Appendix B also contains hydrographs comparing the simulated and measured values of 1) total river flow and 2) groundwater discharge to the river for the Santa Clara River at the County Line gage, where the river exits the valley and flows into Ventura County.[3] The hydrographs show that the model adequately replicates seasonal and year-to-year cycles of low and high river flows. Additionally, the model simulates temporal cycles in groundwater discharge to the river in a manner that is generally consistent with the cycles reflected in the estimates made from available stream gage data. As discussed in prior model development reports (CH2M HILL, 2004a and 2005), it is likely that differences between modeled and measured hydrographs for total river flow and groundwater discharges result from uncertainties in both the model and the County Line gage data, particularly during periods of low river flows.

[3] The "measured" groundwater discharges to the river are estimates that were derived from a hydrograph separation process, described by CH2M HILL (2004). This process estimated the monthly groundwater discharge to the river by examining the daily streamflow data at the County Line gage, the daily and monthly precipitation at local rain gages, monthly flows into Castaic Creek from Castaic Lagoon, and monthly flows into the Santa Clara River from the Saugus and Valencia WRPs.

III. Modeling Approach for Analyzing Basin Yield

3.1 Modeling Approach

The process of designing the modeling analysis to evaluate the sustainability and achievability of a given operating plan consisted of the following five activities:

- Selecting a period over which to simulate groundwater conditions under each operating plan, including:
    - defining a sequence of varying local hydrology (rainfall, streamflows, and groundwater recharge) on a month-to-month basis throughout the simulation period
    - defining a sequence of varying availability of imported water supplies, as defined from availability studies of the State Water Project (SWP), on a month-to-month basis throughout the simulation period
- Defining pumping rates and schedules for each production well in the valley, including consideration of the varying local hydrology and SWP water availability
- Running the model to calculate time-varying (monthly) groundwater elevations and groundwater discharge terms throughout the multi-year simulation period
- Evaluating the modeling results by examining forecasted time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the effects of the operating plan in the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River

These activities are described in further detail below.

3.2 Simulation Period

The locations and temporal variation in pumping from the Alluvial Aquifer were defined in the model from the operating plan and from historical records of the year-to-year variability in local hydrology. Simulated pumping from the Saugus Formation was defined from the operating plan, historical pumping records, and operational constraints and historical patterns of SWP water supply availability.

3.2.1 Original Simulation Period

Because the operating plan for the Saugus Formation is linked to the hydrology and operational constraints for the SWP system, the year-to-year variability in Saugus Formation pumping is, to a great extent, dependent on the hydrology outside the valley (i.e., in northern California). As discussed in the original basin yield analysis report (CH2M HILL and LSCE, 2005), local hydrology affects the availability of Alluvial Aquifer groundwater, but is not always a good

indicator of local pumping conditions in the Saugus Formation, because local droughts and SWP droughts do not necessarily coincide with each other. Consequently, it was decided that the model would need to be run over several decades to capture the year-to-year differences between local hydrology and SWP hydrology and water availability, as well as the less frequent times when both systems experience similar hydrologic conditions (as occurred periodically during the 1960s and in 1994). Historical records were then analyzed to identify a simulation period that would be long enough to capture the variety of year-to-year and longer-term trends in local hydrology and imported water availability.

The original basin yield analysis was conducted using a synthetic 78-year period that replicated the historical hydrology from 1980 through 2003, followed by a replication of historical hydrology from 1950 through 2003. This synthetic time period simulated 24 years of reduced pumping from the Alluvial Aquifer, including two 3-year periods and one 4-year period of reduced pumping. For the Saugus Formation, this synthetic time period contained 18 "drought years" in which imported water volumes were sufficiently low to result in increased pumping from the Saugus Formation. These 18 years included two droughts lasting 2 years and two droughts lasting 3 years.

3.2.2 Current Simulation Period and Associated Hydrology

As introduced in Section 1.2, the update of the basin yield analysis was conducted in part because of the possibility of near-term reductions in SWP water deliveries to CLWA. The most recent analysis of the SWP's delivery reliability (DWR, 2008) includes year-to-year projections of delivery volumes under various development conditions, assuming both a repeat of historical climate and the potential effects of climate change. The analyses that are based on historical climate are reported for the climate that occurred from 1922 through 2003. These year-to-year projections had not been completed and published at the time of the original basin yield analysis in 2004 and 2005. Because these new analyses are now available, the basin yield update analysis simulated the historical record of climate and corresponding SWP delivery volumes for an 86-year period beginning in 1922 and ending in 2007, rather than using a synthetic time period. This 86-year period is characterized by:

- 14 years when deliveries are 35 percent or less of maximum Table A amounts, including 3 years when the deliveries do not exceed 10 percent of the Table A amounts

- Two droughts lasting 6 years (1929 through 1934, and 1987 through 1992)

Under the groundwater operating plan for the Santa Clarita Valley, the SWP delivery volume in any given year affects the amount of groundwater pumping that occurs from the Saugus Formation during that year. The amount of groundwater pumping from the Alluvial Aquifer is controlled by local hydrology, as determined by the amount of rainfall that occurs within the watershed during a given year. Figure 3-1 shows the historical pattern of annual rainfall on a calendar year basis from 1922 through 2007 at the Newhall-Soledad rain gage, which has the longest rainfall record of any location within the watershed. Values for 1922 through 1930 are estimated from RCS (2002). RCS personnel have since indicated that the source of data to 1931 is an unofficial record obtained in 2001 from a former California State Climatologist. The figure

also shows the average and median values of rainfall for the period 1931 through 2007 (18.16 and 15.82 inches per year, respectively). The estimated rainfall values from 1922 through 1930 were not included in the calculations of the average and median values. The figure shows that annual rainfall at the Newhall-Soledad rain gage since 1922 has ranged from about 4.1 inches in the driest years (in 1947 and 1972) to as much as 42.1 inches in the wettest years (1941 and 1978). 52 of the 86 years of record were characterized by below-average rainfall, and 36 years were particularly dry years characterized by rainfall values below 13.5 inches/year, which is 85 percent of the long-term median rainfall.

For annual rainfall at the Newhall-Soledad rain gage, Figure 3-2 shows the cumulative departure since 1922 from the 1931-2007 average rainfall. The cumulative departure refers to the cumulative (accumulated) amount of rainfall deficit or rainfall surplus over time, compared with long-term average rainfall. The slope of the cumulative departure plot is indicative of whether a given time period is characterized by generally dry conditions (downward slope), near-normal conditions (flat), or wetter-than-normal conditions (upward slope). The figure shows the following patterns in the local rainfall cycle:

- Generally dry conditions (downward-trending slope) after 1922 and continuing through 1935

- Generally wet conditions (upward-trending slope) from 1938 through 1944

- Thirty years of generally dry conditions (downward-trending slope) from 1947 through 1976, except for modestly wet conditions from 1965 through 1970

- Generally wet conditions (upward-trending slope) from 1977 through 2005, interrupted by drought conditions from 1984 through 1991 and from 1999 through 2004

An additional noteworthy feature of the cumulative departure plot is the 48-inch rainfall deficit that occurred from 1947 through 1951, which was not fully captured in the original basin yield analysis, but is modeled in its entirety in this updated analysis. The total rainfall deficit from 1947 through 1976 was approximately 86 inches (from a cumulative 31 inches above average in 1946 to a cumulative 55 inches below average in 1976). After 1976, the cumulative departure returned to a slightly positive value because of significant rainfall events in 1978, 1980, and 1983.

Table 3-1 shows the sequence of normal-year versus dry-year pumping conditions for the Alluvial Aquifer, as derived from the local rainfall records, and for the Saugus Formation as derived from the availability of SWP water. For the Alluvial Aquifer, the pumping year type is assumed to lag the local hydrology by one year. An examination of historical rainfall data and Alluvial Aquifer pumping patterns shows such a lag occurred in several years during the past two decades. The table shows dry-year pumping occurring in 55 years from the Alluvial Aquifer and 15 years from the Saugus Formation. During the 86-year simulation period, there are nine periods when dry-year pumping from the Alluvial Aquifer lasts more than two consecutive years, and two periods have dry-year Saugus pumping lasting more than one year. The longest dry-year pumping periods last for 7 years in the Alluvial Aquifer and 4 years in the Saugus Formation.

During the predominantly dry period from 1922 through 1978, only 16 of these 57 years (28 percent) were years in which normal pumping would have occurred from the Alluvial Aquifer.

3.3 2008 Operating Plan

Following are a general description of the 2008 Operating Plan and discussions of how pumping is distributed spatially and over time in the Alluvial Aquifer and the Saugus Formation under this plan. This plan was analyzed for its long-term sustainability by using the groundwater flow model to simulate the plan under the historical hydrology dating back to 1922. Actual historical pumping at the operating plan rates and for the current basin-wide network of production wells dates back only to the mid-1990s. Prior to that time, less pumping occurred in some years, while in other years pumping was limited to the western portion of the valley. Consequently, the modeling analysis was conducted in a manner to allow evaluation of how the basin might respond to the current operating plan and the current network of production wells, as might occur if past multi-decadal cycles of local and SWP hydrology (such as those measured as far back as 1922) were to repeat themselves in the future.

3.3.1 General Description of 2008 Operating Plan

As discussed in Section 1.1, the 2008 Operating Plan for the local groundwater basin is as follows:

- Pumping from the Alluvial Aquifer ranges between 30,000 and 40,000 afy during normal and above-normal rainfall years but, because of operational constraints in the eastern part of the basin, is reduced to between 30,000 and 35,000 afy during locally dry years. Table 3-2 shows the sequence of historical rainfall cycles and associated pumping from the Alluvial Aquifer, based on this operating plan and the 86-year simulation period that reflects historical rainfall in the valley from 1922 through 2007.

- Pumping from the Saugus Formation ranges between 7,500 and 15,000 afy during average-year to wet-year conditions within the SWP system. Planned dry-year pumping from the Saugus Formation ranges between 15,000 and 25,000 afy during a dry year, and increases to between 21,000 and 25,000 afy if SWP allocation is reduced to about 35 percent or less of the maximum Table A amount for two consecutive years, and between 21,000 and 35,000 afy if SWP allocation is reduced to about 35 percent or less of the maximum Table A amount for three consecutive years. Table 3-3 shows the sequence of SWP water availability and associated pumping from the Saugus Formation, based on this operating plan and the 86-year simulation period that reflects historical hydrology in the SWP system from 1922 through 2007.

Pumping rates for Purveyor-owned wells were assigned in accordance with the groundwater operating plan for the Santa Clarita Valley, which defines ranges of valley-wide annual pumping, given the water supply needs of the Purveyors. Pumping rates at individual wells were also assigned using the recent and planned production schedules for each well, information on the depths and lengths of the intake sections (open intervals) of each well, and by incorporating current plans addressing two other specific issues affecting Purveyor pumping:

- The presence of ammonium perchlorate in parts of the Saugus Formation and the Alluvial Aquifer

- Intermittent planned pumping from the Saugus Formation for the purpose of meeting regulatory objectives for chloride concentrations in the Santa Clara River.

These two issues and the details of how pumping was specified in the modeling analysis of the current operating plan are discussed further in Sections 3.3.2 and 3.3.3 below.

3.3.2 Alluvial Aquifer Pumping

Simulated pumping rates under the 2008 Operating Plan for production wells completed in the Alluvial Aquifer are listed in Table 3-4. The table provides this information for 8 wells owned by NCWD, 13 wells owned by SCWD, 15 wells owned by VWC, 16 wells owned by NLF, and private wells owned by Robinson Ranch and Wayside Honor Rancho. Most Alluvial Aquifer wells were specified to operate at similar rates regardless of year type, except in the eastern portion of the basin. Wells in this area (the Robinson Ranch well, the four Pinetree wells owned by NCWD, and 11 wells owned by SCWD) were assumed to have lower pumping capacities during dry years than non-drought years because of historically experienced lower groundwater elevations during dry periods.

The 2008 Operating Plan for the Alluvial Aquifer accounts for historical perchlorate detections in two alluvial wells, as the result of contamination emanating from the former Whittaker-Bermite property.

- In 2002, an Alluvial production well owned by SCWD (SCWD-Stadium) was shut down because of the detection of perchlorate. SCWD has recently drilled a replacement well (Valley Center) further to the east, north-northeast of the Whittaker-Bermite property.

- In March 2005, an Alluvial production well owned by VWC (VWC-Q2) was shut down because of perchlorate detection. After returning the well to service with wellhead treatment in October 2005, followed by nearly two years of operation with wellhead treatment, during which there was no detection of perchlorate, Valencia was authorized by the California Department of Public Health (DPH) to discontinue treatment. Well Q2 has since been operated without treatment and there has been no detection of perchlorate since discontinuation of wellhead treatment. Consequently, Well Q2 is included in the 2008 Operating Plan.

The 2008 Operating Plan for the Alluvial Aquifer also accounts for known private pumping at wells owned by the Newhall Land & Farming Company (NLF) for agricultural water supply; wells owned by Los Angeles County Water District No. 36 that provide potable water to the Wayside Honor Rancho; and a well in eastern Soledad Canyon owned by Robinson Ranch that is used for golf course irrigation. In the future, portions of the current pumping by NLF are planned to be converted to pumping by Valencia Water Company to supply potable water to the future Newhall Ranch development. However, for the purposes of the groundwater modeling analysis,

this pumping volume is indicated in Table 3-4 as continuing to be conducted by NLF, to reflect current ownership and current operating conditions. The planned change from agricultural to municipal supply is expected to result in only locally small changes in pumping locations (new municipal wells in close proximity to existing agricultural wells that will then be abandoned), resulting in practically similar spatial distribution of pumping and thus similar conditions as simulated in the 2008 Operating Plan.

The water management practices of the Purveyors also recognize ongoing Alluvial Aquifer pumping for other smaller private domestic and related pumping. For the last ten years of formal annual water report preparation in the Santa Clarita Valley, those reports have included estimates of the latter private pumping. Based on limited data provided by private well owners as part of the overall Groundwater Management Plan effort, it is estimated that small private pumping is within 500 afy, or approximately one percent of typical Alluvial Aquifer pumping by the Purveyors and other known private well owners (including agricultural pumpers) combined. However, the small private wells are not explicitly modeled in the basin yield analysis described herein because their locations and operations are not known, and their operation creates a pumping stress that is essentially negligible at the scale of the overall groundwater model. Ultimately, as discussed throughout this report, the intent is to maintain overall pumping, including private pumping, within the operating plan to result in sustainable groundwater conditions to support the combination of municipal (Purveyor), agricultural, and private groundwater use on an ongoing basis. Thus, private well owners in the basin, like the large municipal and agricultural pumpers, can expect groundwater supplies to continue to be available as they have been in the past, with some fluctuations in water levels through wet and dry periods, but no long-term depletion of supply.

3.3.3 Saugus Aquifer Pumping

Simulated pumping rates under the 2008 Operating Plan for production wells completed in the Saugus Formation are listed in Table 3-5. The table provides this information for two wells owned by NCWD, two wells owned by SCWD, six wells owned by VWC, and a private well at the Palmer golf course, located just north of Hasley Canyon. Pumping rates at specific Saugus Formation production wells were assigned for each type of year (normal, dry year 1, dry year 2, and dry year 3) using information on the capacity, recent and planned use, and location of each well[1]. Significant aspects of the pumping rate selection at each well are as follows:

- Pumping from most existing Saugus Formation production wells was based on recent and planned use of these wells, as defined by the Purveyors. The simulation included increased dry-year pumping from the Saugus Formation in the western portion of the basin, where it is anticipated that future wells will be installed.

- Each Saugus Formation production well has an intake section (open interval) that is significantly longer in vertical extent than the thicknesses of the individual layers that represent the Saugus Formation in the groundwater flow model. Consequently, the

[1] Table 3-5 only lists wells that are anticipated to be operating in the future. Existing wells that are not listed in this table (such as NCWD-7, NCWD-10, and NCWD-11) are currently not in service and, therefore, are not expected to provide significant quantities of water in the future.

Saugus pumping rates were assigned to multiple layers in the model by considering the depths of the intake section of each well and the transmissivity of each model layer. Table 3-6 shows the allocation of pumping in each model layer for each Saugus Formation production well, along with the intake sections of each well and the model-simulated transmissivity in each layer at each well location.

The 2008 Operating Plan for the Saugus Formation accounts for historical perchlorate detections and the resulting containment and remedial response activities that are being constructed at this time. In 1997, two Saugus Formation production wells owned by SCWD (wells SCWD-Saugus1 and SCWD-Saugus2), one Saugus Formation production well owned by NCWD (well NCWD-11), and one former Saugus Formation production well owned by VWC (well VWC-157) were removed from service because perchlorate was detected in groundwater at these wells[2]. Under oversight by the California Department of Toxic Substances Control (DTSC), and with ultimate approval by DPH, in accordance with its Policy 97-005 (for restoration of water supply from "severely impaired" water sources), the Purveyors developed a remedial strategy that will entail pumping of two impacted wells for containment of perchlorate migration; treatment and subsequent use of the pumped water for water supply; and installation of replacement wells in non-impacted portions of the basin to restore the remainder of groundwater supply impacted by perchlorate. A noteworthy detail of these activities is that the groundwater flow model was used to identify the design of a pumping scheme that would meet the Purveyors' objectives for perchlorate containment in the Saugus Formation (CH2M HILL, 2004b). The final containment plan specifies that wells SCWD-Saugus1 and SCWD-Saugus 2 operate at an instantaneous pumping rate of 1,200 gallons per minute (gpm) at each well (for a combined total of 2,400 gpm from the two wells). The annual pumping volume of 1,772 afy per well shown in Table 3-5 is based on this rate and also on the assumption that pumping will occur continuously, except for up to four weeks per year for maintenance purposes. Construction of facilities and pipelines necessary to implement the containment program and to restore inactivated well capacity, to be followed by operational start-up, are currently scheduled to occur in 2009.

The 2008 Operating Plan for the Saugus Formation also accounts for intermittent pumping from the Saugus Formation that is expected to occur for the purpose of meeting regulatory objectives for chloride in the Santa Clara River. This pumping program is one component of an Alternative Water Resources Management (AWRM) program to be implemented by the Santa Clarita Valley Sanitation District of Los Angeles County (SCVSD, a division of the Los Angeles County Sanitation District [LACSD]), the Purveyors, and other parties for the purpose of meeting Total Maximum Daily Loads (TMDLs) for chloride in the Santa Clara River in western Los Angeles County and eastern Ventura County. The AWRM program was finalized in the form of a Memorandum of Understanding (MOU) dated October 2008. Under the AWRM program, CLWA will develop a plan to provide imported water to replace Saugus Formation groundwater that will be pumped to provide supplemental water for the AWRM program. The supplemental pumped groundwater from the Saugus Formation will be released to the Santa Clara River near the Los Angeles County / Ventura County line to improve water quality conditions in the river

[2]As part of the ongoing implementation of perchlorate containment and restoration of impacted capacity, well VWC-157 was abandoned in January 2005 and replaced by new well VWC-206. Thus, this analysis includes planned pumping from replacement well VWC-206.

and to allow for attainment of the AWRM's stated water quality objectives for the river. Under the AWRM, the supplemental water will be directed to the river during years of extreme drought conditions in the SWP, defined as time periods when chloride concentrations equal or exceed 80 milligrams per liter (mg/L) in SWP water (Geomatrix, 2008; LARWQCB, 2008). Pumping under this program is planned to occur from well VWC-206 and from two future wells that will be drilled near VWC-206. This supplemental pumping is factored into the annual pumping volumes listed in Table 3-5. The pumping rates listed in Table 3-5 for the individual Saugus Formation wells will occur regardless of whether a portion of a given year's pumping is being directed to the AWRM program. Any volume of pumping directed to the AWRM program in a given year will be made up with imported water supplies, rather than from increased pumping of Alluvial or other Saugus groundwater. Technical analyses indicate that this pumping could occur in about 24 percent of all years, with total pumping occurring at rates ranging from less than 1 million gallons per day (mgd) to as much as 8 mgd (Geomatrix, 2008).

3.3.4 Monthly Allocation of Pumping

The model simulations that evaluated the operating plan were conducted by modeling groundwater recharge and pumping on a monthly basis. Consequently, the annual pumping volumes specified in the groundwater operating plan were converted to monthly values at each well for modeling purposes. The allocation of pumping, by month, for agricultural and urban production wells in both the Alluvial Aquifer and the Saugus Formation is listed in Table 3-7. Separate monthly distributions were used because agricultural demands are for exclusively outdoor uses, whereas urban demands are for both indoor and outdoor uses. As discussed in the model development report (CH2M HILL, 2004a), the monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining historical monthly flow records for the two water reclamation plants (WRPs) that are present in the valley, and also by examining the distributions of monthly water consumption recorded by the Purveyors within their service areas during the past several years.

3.3.5 Total Available Potable Water Supply Under the 2008 Operating Plan

For the 2008 Operating Plan and the 1922-2007 simulation period, Table 3-8 lists the annual volumes of water available from each potable water source (Alluvial Aquifer, Saugus groundwater, and SWP imports), along with their combined total. The combined pumping from the Alluvial Aquifer and the Saugus Formation averages 51,400 afy and ranges between 47,335 and 73,577 under the 2008 Operating Plan. Year-by-year pumping from each aquifer is shown in Figure 3-3, along with total groundwater pumping.

Figure 3-4 compares total groundwater pumping with SWP water supply availability and the resulting total volume of water from a combination of local groundwater and imported SWP water (not including other water supplies, for example, purchased water, water banked in other groundwater basins, etc.). The total water supply from those two sources is as low as 64,858 afy during the driest years in the SWP system, when SWP deliveries are below 10,000 afy. For the 86-year simulation period, the total available supply from local groundwater and imported SWP water averages about 110,000 afy and can exceed 140,000 afy in the wettest years.

3.4 2008 Operating Plan with Pumping Redistribution

The 2008 Operating Plan with Pumping Redistribution was developed in response to model simulation results (discussed in Section 4 of this report) that identified a potential lack of achievability in maintaining alluvial pumping in the eastern portion of the basin, due to decline in groundwater levels below the intake sections of wells. The model simulations of the 2008 operating plan indicated that such declines, and the associated potential lack of achievability, could occur during periods which experience prolonged dry conditions, such as occurred from the mid-1940s through the mid-1970s, when there were few years of significantly greater-than-average rainfall. For this three-decade period, the model simulation found the 2008 Operating Plan to not be achievable in the most eastern part of the basin, the "Above Mint Canyon" subarea. However, it was also recognized that achievability might be accomplished by redistributing some pumping to other areas, specifically to reduce pumping stress in the far east and replace it with increased pumping farther west in the basin. This redistribution may not be necessary during other historical periods that were characterized by intermittent years of significant rainfall, streamflow, and associated groundwater recharge (such as occurred periodically from the late 1970s through 2005).

This variation of the 2008 Operating Plan was examined as follows. Recognizing that SCWD is in the midst of constructing new or replacement wells (e.g. to replace its perchlorate-impacted Stadium well) to the west of the "Above Mint Canyon" subarea, a redistribution of some SCWD pumping, as analyzed in the 2008 Operating Plan, was crafted whereby 1,600 afy of pumping was moved from three SCWD wells in the "Above Mint Canyon" subarea (near the mouth of Sand Canyon) to the replacement SCWD Santa Clara and Bouquet wells, located in the "Above Saugus WRP" and "Bouquet Canyon" subareas, respectively. Table 3-9 shows the resulting pumping plan for each Alluvial well under this redistribution scheme.

Besides the pumping redistribution in these Alluvial wells, all other aspects of Alluvial and Saugus pumping remains unchanged from the 2008 Operating Plan.

3.5 Potential Future Operating Plan

A third operating plan was analyzed at the request of the Purveyors. This plan is referred to herein as the Potential Operating Plan and contemplates increased utilization of groundwater during both regular (wet/normal) years and dry years. Target pumping volumes and locations under this plan were provided by the Purveyors and are summarized in Table 3-10 for the Alluvial Aquifer and Table 3-11 for the Saugus Formation. Under this plan, Alluvial Aquifer pumping would be on the order of 47,500 afy in normal/wet years and would be reduced to about 41,500 afy following two or more years of below-normal rainfall locally. Saugus Formation pumping would be on the order of 16,350 afy during years of normal SWP water availability and would increase to over 39,500 afy in the third year of reduced SWP water availability.

Consequently, total groundwater pumping under this plan would be almost 64,000 afy during normal years (compared with about 51,000 afy in the 2008 Operating Plan) and could be as high as about 87,000 afy during the highest pumping years (compared with about 73,500 afy in the 2008 Operating Plan). Figure 3-5 shows the fluctuation during the 86-year simulation period in

total groundwater pumping under this Potential Operating Plan, as well as the fluctuations in total Alluvial pumping and total Saugus pumping. Figure 3-6 compares the year-to-year pumping volumes, as well as the 86-year total pumping, for the potential plan and the 2008 plan. Total groundwater pumping during the 86-year simulation period would be about 1 million acre-feet, or about 80 percent, higher under the Potential Operating Plan.

The Potential Operating Plan differs from the 2008 Operating Plan only in the amount of groundwater being extracted. Both plans assume the same amount of SWP water availability. As shown in Table 3-12 and Figure 3-7, under the Potential Operating Plan, the total contemplated volume of available potable water supply from a combination of local groundwater and imported SWP water (not including other water supplies, for example, purchased water, water banked in other groundwater basins, etc.) ranges between about 77,000 afy and 156,000 afy, and averages nearly 122,000 afy for the 86-year simulation period. This represents an approximate 10 percent increase in water supply from those two sources during average and wet years, compared with the 2008 Operating Plan. During years of reduced SWP imports, the Potential Operating Plan contemplates almost 20 percent more potable water availability from local groundwater and imported SWP water during the driest years, compared with the 2008 Operating Plan.

3.6 Simulation of Other Local Hydrologic Processes

In addition to groundwater pumping, infiltration from irrigation (from urban and agricultural lands), precipitation, and streamflows (stormwater and WRP discharges) were also modeled. These other local hydrologic processes were defined using the Surface Water Routing Model (SWRM), which is described in Appendix C to the model development and calibration report (CH2M HILL, 2004a). The procedures used to derive these terms were the same as in the original basin yield analysis (CH2M HILL and LSCE, 2005) and are described in the following sections.

3.6.1 Recharge from Urban Irrigation

Under existing land use and water use conditions, the estimated long-term infiltration rates of applied irrigation water beneath urban areas, under full build-out conditions in the valley, were estimated to be 1.0 in/yr for industrial and retail lands, 2.2 in/yr for residential developments and parks, and 4.6 in/yr for golf courses (CH2M HILL, 2004a; CH2M HILL and LSCE, 2005). These rates were applied during each year (and each month) of the 86-year simulation period. The areas over which these rates were applied were larger than under current conditions. The areas were defined from recent land use data and LACSD mapping of projected future land uses in the rest of the Santa Clarita Valley under full build-out conditions[3] (CH2M HILL and LSCE, 2005).

[3]LACSD land use mapping indicates that, including Newhall Ranch, approximately 14,000 acres of currently undeveloped land will be urbanized in the future within the model simulation area. Additional urbanization will also occur in areas that are within the watershed, but outside the model's boundaries.

3.6.2 Recharge from Agricultural Irrigation

As discussed in the *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002), irrigation of lands owned by NLF results in existing agricultural return flows. The source of most irrigation water is groundwater pumping from the Alluvial Aquifer, with some limited pumping occurring from one Saugus Formation well (NLF-156) prior to 2008, when this well was taken out of service. Under full Valley build-out conditions, the currently irrigated lands will no longer be irrigated because their water source will be used as part of the water supply for Newhall Ranch. Therefore, under full build-out conditions, no agricultural irrigation will occur within the area simulated by the model.

3.6.3 Precipitation Recharge

Infiltration from direct precipitation within the model domain was defined using data from the Newhall-Soledad and NCWD rain gages, an isohyet map of rainfall throughout the watershed, and the Turner (1986) power-function equation that describes the relationship between annual rainfall and annual groundwater recharge within the valley. Details concerning the derivation of precipitation infiltration rates from these data are contained in Appendix C to the model development and calibration report (CH2M HILL, 2004a). Table 3-13 lists the simulated monthly precipitation at the NCWD rain gage for the 86-year model period[4].

3.6.4 Stormwater Flows and Recharge from Streams

For each month of the simulation, the SWRM calculated the amounts of stormwater flow and groundwater recharge in all streams, plus the amount of flow and groundwater recharge arising from projected future WRP discharges to the Santa Clara River (including from the future Newhall WRP, which will service the planned Newhall Ranch development). For the Santa Clara River, the volume of streamflow was defined from measured and estimated streamflow data at the Lang gage (Table 3-14). For Castaic Creek, the volume of streamflow was defined from historical DWR operations and consideration of the hydrologic year type (Table 3-15). For the remaining Santa Clara River tributaries, streamflow volumes were defined by the SWRM using monthly rainfall data and the Turner (1986) relationship between rainfall, ET, and the subsequent yield from each watershed.

3.6.5 WRP Discharges to the Santa Clara River

Treated water is discharged to the Santa Clara River from the two WRPs that are present in the Valley. The Saugus WRP discharges to the river immediately above the mouth of the South Fork Santa Clara River, and the Valencia WRP discharges to the river just west of Interstate 5. The planned Newhall WRP will discharge to the river just east of the Los Angeles / Ventura County line for limited durations in the winter months.

[4]The simulated monthly precipitation was defined from measurements at the NCWD rain gage from 1979 through 2003, as well as by combining the isohyet map with measurements at the Newhall-Soledad rain gage from prior to 1979.

Under full Valley build-out conditions, future flows into and from WRPs will be higher than historical flows because of increased development and the associated increase in indoor water use volumes. Additionally, a portion of the future treated water will be reclaimed, as described in CLWA's recycled water master plan (Kennedy/Jenks Consultants, 2002). In the original basin yield analysis work (CH2M HILL and LSCE, 2005), future inflows to the Saugus and Valencia WRPs were estimated from projected future water demands and from comparisons of historical water use and measured inflows to both WRPs. Table 3-16 shows the derivation of urban water demands outside the Newhall Ranch development (which will be served by a new, separate WRP). Table 3-17 shows the total amount of treated water generated by the Saugus and Valencia WRPs, and the amount of this water that is reclaimed and discharged to the river, by month. These values are the same as were used in the original basin yield analysis work. The values in Table 3-17 assume that the reclaimed water volume will be no more than 16,000 afy, to maintain existing flow volumes in the Santa Clara River. For the Newhall Ranch WRP, discharges to the river will be 286 afy, occurring primarily in December and January, when demands for reclaimed water are at their seasonal low. The total combined volumes of treated water discharged to the Santa Clara River under full Valley build-out conditions (including Newhall Ranch) are summarized, by month, in Table 3-18. These rates, which were used in the original basin yield analysis, were carried forward and used in each year of the 86-year simulation for the basin yield update analysis.

3.6.6 Monthly Assignment and Tracking of Surface Water Budget

The month-by-month assignment of the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system was performed by the SWRM using the procedures described in Section C.8.5 of Appendix C to the model development and calibration report (CH2M HILL, 2004a). Streambed infiltration capacities for the last 28 years of the 86-year simulation period (calendar years 1980 through 2007) were the same as those used in the calibrated model. For the prior 58 years (1922 through 1979), the monthly streambed infiltration capacity values for a given year were selected by using one of the calibration years as a prototype year. Rainfall and streamflow records were used to identify the best prototype year and to subsequently specify the corresponding streambed infiltration rates.

For each month of the 86-year simulation period, the SWRM also tracked the volume of surface water that does not infiltrate to groundwater from a given stream because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage was calculated to remain as surface water in the Santa Clara River and to eventually exit the model domain at the west end of the Valley, at the County Line gage.

3.7 Running the Model and Evaluating Results

As discussed in the previous sections, the modeling evaluations were performed by simulating conditions on a monthly basis for the 86-year simulation period. The first step in this process consisted of running the SWRM to calculate the monthly distribution of recharge to the Alluvial Aquifer system (from rainfall, streamflow, irrigation, and WRP discharges) and recharge to the Saugus Formation (from rainfall and irrigation) in areas where the Alluvial Aquifer is not

present. The output from the SWRM consisted of monthly files that assigned recharge to each node in the model grid.

The model was then run using monthly time steps, in which pumping and recharge terms were varied each month. For each sub-interval of time, the model was run by solving the groundwater flow equations for a given month, using a convergence criterion of 0.005 foot for groundwater elevations and a water budget convergence criterion of 2 cubic feet per day. The model results were then evaluated by generating time-series plots (hydrographs) of water budget terms and groundwater elevations to evaluate the potential effects of the groundwater operating plan across the basin. The hydrographs were used to evaluate whether the operating plan is consistent with the objective of operating the basin in a manner that maintains long-term stability in groundwater levels and river flows. This analysis and its findings are presented in the following Chapter 4.

Table 3-1

Alluvial and Saugus Formation Pumping Patterns for the Simulation of 1922-2007 Historical Hydrology

Calendar Year	Local Rainfall (inches)[a]	SWP Water Availability[b]	Simulated Pumping Conditions	
			Alluvium	Saugus
1922	~ 32	89%	Normal	Normal
1923	~ 14	76%	Normal	Normal
1924	~ 8	10%	Dry Year 1	Dry Year 1
1925	~ 7	40%	Dry Year 2	Normal
1926	~ 26	53%	Dry Year 3	Normal
1927	~ 24	89%	Normal	Normal
1928	~ 10	50%	Normal	Normal
1929	~ 12	18%	Dry Year 1	Dry Year 1
1930	~ 12	49%	Dry Year 2	Normal
1931	24.41	27%	Dry Year 3	Dry Year 2
1932	13.73	32%	Normal	Dry Year 3
1933	20.52	48%	Dry Year 1	Dry Year 4
1934	18.05	32%	Dry Year 2	Dry Year 5
1935	12.21	81%	Dry Year 3	Normal
1936	20.47	76%	Dry Year 4	Normal
1937	17.92	78%	Dry Year 5	Normal
1938	32.75	82%	Dry Year 6	Normal
1939	11.27	79%	Normal	Normal
1940	21.37	77%	Dry Year 1	Normal
1941	42.14	61%	Dry Year 2	Normal
1942	7.10	77%	Normal	Normal
1943	37.03	76%	Dry Year 1	Normal
1944	24.63	71%	Normal	Normal
1945	14.56	75%	Normal	Normal
1946	21.71	77%	Normal	Normal
1947	4.16	56%	Normal	Normal
1948	9.13	63%	Dry Year 1	Normal
1949	9.93	31%	Dry Year 2	Dry Year 1
1950	6.84	60%	Dry Year 3	Normal
1951	12.42	85%	Dry Year 4	Normal
1952	34.19	63%	Dry Year 5	Normal
1953	4.88	80%	Normal	Normal
1954	15.82	77%	Dry Year 1	Normal
1955	13.91	28%	Dry Year 2	Dry Year 1
1956	14.21	87%	Dry Year 3	Normal
1957	22.85	62%	Dry Year 4	Normal
1958	23.14	73%	Dry Year 5	Normal
1959	9.81	84%	Normal	Normal
1960	11.64	35%	Dry Year 1	Dry Year 1
1961	8.82	57%	Dry Year 2	Normal
1962	21.22	72%	Dry Year 3	Normal
1963	12.79	82%	Dry Year 4	Normal
1964	10.09	53%	Dry Year 5	Normal
1965	32.28	69%	Dry Year 6	Normal
1966	14.57	79%	Normal	Normal
1967	23.23	72%	Dry Year 1	Normal
1968	6.90	80%	Dry Year 2	Normal
1969	32.42	64%	Dry Year 3	Normal
1970	23.19	79%	Normal	Normal
1971	13.75	80%	Normal	Normal
1972	4.15	41%	Dry Year 1	Normal
1973	19.79	75%	Dry Year 2	Normal
1974	18.04	77%	Dry Year 3	Normal
1975	10.92	78%	Dry Year 4	Normal
1976	14.02	63%	Dry Year 5	Normal
1977	20.87	6%	Dry Year 6	Dry Year 3
1978	42.17	87%	Dry Year 7	Normal
1979	21.47	76%	Normal	Normal
1980	27.00	66%	Normal	Normal
1981	13.42	76%	Normal	Normal
1982	20.20	71%	Dry Year 1	Normal
1983	39.07	60%	Normal	Normal
1984	12.86	78%	Normal	Normal
1985	8.37	77%	Dry Year 1	Normal
1986	18.02	56%	Dry Year 2	Normal
1987	14.45	68%	Normal	Normal
1988	16.92	12%	Dry Year 1	Dry Year 1
1989	7.56	76%	Dry Year 2	Normal
1990	6.98	9%	Dry Year 3	Dry Year 2
1991	17.21	18%	Dry Year 4	Dry Year 3
1992	32.03	26%	Dry Year 5	Dry Year 4
1993	32.72	90%	Normal	Normal
1994	10.27	51%	Normal	Normal
1995	29.15	72%	Dry Year 1	Normal
1996	15.88	83%	Normal	Normal
1997	13.35	75%	Normal	Normal
1998	30.73	73%	Normal	Normal
1999	8.96	83%	Normal	Normal
2000	14.04	84%	Normal	Normal
2001	22.24	28%	Dry Year 1	Dry Year 1
2002	7.90	52%	Dry Year 2	Normal
2003	15.70	71%	Dry Year 3	Normal
2004	22.79	65%	Dry Year 4	Normal
2005	37.15	90%	Normal	Normal
2006	13.89	100%	Normal	Normal
2007	5.78	60%	Dry Year 1	Normal

aFrom records at Newhall-Soledad rain gage (Station No. FC32CE). Pumping year type lags local rainfall by one year. Dry year pumping occurs when rainfall in prior year is 12.5 inches or less, and may continue until after a year with high rainfall (well above normal) has occurred.

[b]Values for 1922-2003 are from Table B.3 in DWR (2008) and are for SWP Table A Deliveries under current (2007) conditions. Values in 2004 through 2007 are actual historical deliveries during those years.

TABLE 3-2

Local Hydrology and 2008 Operating Plan for the Alluvial Aquifer

Calendar Year	Local Rainfall (inches)[a]	Year Type	Alluvial Aquifer Pumping under the Groundwater Operating Plan (afy)
1922	~ 32	Normal	35,000-40,000
1923	~ 14	Normal	35,000-40,000
1924	~ 8	Dry Year 1	30,000-35,000
1925	~ 7	Dry Year 2	30,000-35,000
1926	~ 26	Dry Year 3	30,000-35,000
1927	~ 24	Normal	35,000-40,000
1928	~ 10	Normal	35,000-40,000
1929	~ 12	Dry Year 1	30,000-35,000
1930	~ 12	Dry Year 2	30,000-35,000
1931	24.41	Dry Year 3	30,000-35,000
1932	13.73	Normal	35,000-40,000
1933	20.52	Dry Year 1	30,000-35,000
1934	18.05	Dry Year 2	30,000-35,000
1935	12.21	Dry Year 3	30,000-35,000
1936	20.47	Dry Year 4	30,000-35,000
1937	17.92	Dry Year 5	30,000-35,000
1938	32.75	Dry Year 6	30,000-35,000
1939	11.27	Normal	35,000-40,000
1940	21.37	Dry Year 1	30,000-35,000
1941	42.14	Dry Year 2	30,000-35,000
1942	7.10	Normal	35,000-40,000
1943	37.03	Dry Year 1	30,000-35,000
1944	24.63	Normal	35,000-40,000
1945	14.56	Normal	35,000-40,000
1946	21.71	Normal	35,000-40,000
1947	4.16	Normal	35,000-40,000
1948	9.13	Dry Year 1	30,000-35,000
1949	9.93	Dry Year 2	30,000-35,000
1950	6.84	Dry Year 3	30,000-35,000
1951	12.42	Dry Year 4	30,000-35,000
1952	34.19	Dry Year 5	30,000-35,000
1953	4.88	Normal	35,000-40,000
1954	15.82	Dry Year 1	30,000-35,000
1955	13.91	Dry Year 2	30,000-35,000
1956	14.21	Dry Year 3	30,000-35,000
1957	22.85	Dry Year 4	30,000-35,000
1958	23.14	Dry Year 5	30,000-35,000
1959	9.81	Normal	35,000-40,000
1960	11.64	Dry Year 1	30,000-35,000
1961	8.82	Dry Year 2	30,000-35,000
1962	21.22	Dry Year 3	30,000-35,000
1963	12.79	Dry Year 4	30,000-35,000
1964	10.09	Dry Year 5	30,000-35,000
1965	32.28	Dry Year 6	30,000-35,000
1966	14.57	Normal	35,000-40,000
1967	23.23	Dry Year 1	30,000-35,000
1968	6.90	Dry Year 2	30,000-35,000
1969	32.42	Dry Year 3	30,000-35,000
1970	23.19	Normal	35,000-40,000
1971	13.75	Normal	35,000-40,000
1972	4.15	Dry Year 1	30,000-35,000
1973	19.79	Dry Year 2	30,000-35,000
1974	18.04	Dry Year 3	30,000-35,000
1975	10.92	Dry Year 4	30,000-35,000
1976	14.02	Dry Year 5	30,000-35,000
1977	20.87	Dry Year 6	30,000-35,000
1978	42.17	Dry Year 7	30,000-35,000
1979	21.47	Normal	35,000-40,000
1980	27.00	Normal	35,000-40,000
1981	13.42	Normal	35,000-40,000
1982	20.20	Dry Year 1	30,000-35,000
1983	39.07	Normal	35,000-40,000
1984	12.86	Normal	35,000-40,000
1985	8.37	Dry Year 1	30,000-35,000
1986	18.02	Dry Year 2	30,000-35,000
1987	14.45	Normal	35,000-40,000
1988	16.92	Dry Year 1	30,000-35,000
1989	7.56	Dry Year 2	30,000-35,000
1990	6.98	Dry Year 3	30,000-35,000
1991	17.21	Dry Year 4	30,000-35,000
1992	32.03	Dry Year 5	30,000-35,000
1993	32.72	Normal	35,000-40,000
1994	10.27	Normal	35,000-40,000
1995	29.15	Dry Year 1	30,000-35,000
1996	15.88	Normal	35,000-40,000
1997	13.35	Normal	35,000-40,000
1998	30.73	Normal	35,000-40,000
1999	8.96	Normal	35,000-40,000
2000	14.04	Normal	35,000-40,000
2001	22.24	Dry Year 1	30,000-35,000
2002	7.90	Dry Year 2	30,000-35,000
2003	15.70	Dry Year 3	30,000-35,000
2004	22.79	Dry Year 4	30,000-35,000
2005	37.15	Normal	35,000-40,000
2006	13.89	Normal	35,000-40,000
2007	5.78	Dry Year 1	30,000-35,000

aFrom records at Newhall-Soledad rain gage (Station No. FC32CE). Pumping year type lags local rainfall by one year. Dry year pumping occurs when rainfall in prior year is 12.5 inches or less, and may continue until after a year with high rainfall (well above normal) has occurred.

afy = acre-feet per year

TABLE 3-3
SWP Deliveries and 2008 Operating Plan for the Saugus Formation

Calendar Year	Historical SWP Hydrology	SWP Water Delivery from the California Bay-Delta: Percent of Maximum Table A Deliveries (Current Conditions)	Design of Updated Basin Analysis: Saugus Pumping: Year Type	Saugus Operating Plan Pumping Volume (afy)	
1922	Above Normal	89%	Normal	11,000	
1923	Below Normal	76%	Normal	11,000	
1924	Critical	10%	Dry Year 1	15,000	Mild Single Dry Year
1925	Dry	40%	Normal	11,000	
1926	Dry	53%	Normal	11,000	
1927	Wet	89%	Normal	11,000	
1928	Above Normal	50%	Normal	11,000	
1929	Critical	18%	Dry Year 1	15,000	6-Year Drought (1929-1934) and 4-Year Drought (1931-1934)
1930	Dry	49%	Normal	11,000	
1931	Critical	27%	Dry Year 2	25,000	
1932	Dry	32%	Dry Year 3	35,000	
1933	Critical	48%	Dry Year 4	35,000	
1934	Critical	32%	Dry Year 5	35,000	
1935	Below Normal	81%	Normal	11,000	
1936	Below Normal	76%	Normal	11,000	
1937	Below Normal	78%	Normal	11,000	
1938	Wet	82%	Normal	11,000	
1939	Dry	79%	Normal	11,000	
1940	Above Normal	77%	Normal	11,000	
1941	Wet	61%	Normal	11,000	
1942	Wet	77%	Normal	11,000	
1943	Wet	76%	Normal	11,000	
1944	Dry	71%	Normal	11,000	
1945	Below Normal	75%	Normal	11,000	
1946	Below Normal	77%	Normal	11,000	
1947	Dry	56%	Normal	11,000	
1948	Below Normal	63%	Normal	11,000	
1949	Dry	31%	Dry Year 1	15,000	Mild Single Dry Year
1950	Below Normal	60%	Normal	11,000	
1951	Above Normal	85%	Normal	11,000	
1952	Wet	63%	Normal	11,000	
1953	Wet	80%	Normal	11,000	
1954	Above Normal	77%	Normal	11,000	
1955	Dry	28%	Dry Year 1	15,000	Mild Single Dry Year
1956	Wet	87%	Normal	11,000	
1957	Above Normal	62%	Normal	11,000	
1958	Wet	73%	Normal	11,000	
1959	Below Normal	84%	Normal	11,000	
1960	Dry	35%	Dry Year 1	15,000	Mild Single Dry Year
1961	Dry	57%	Normal	11,000	
1962	Below Normal	72%	Normal	11,000	
1963	Wet	82%	Normal	11,000	
1964	Dry	53%	Normal	11,000	
1965	Wet	69%	Normal	11,000	
1966	Below Normal	79%	Normal	11,000	
1967	Wet	72%	Normal	11,000	
1968	Below Normal	80%	Normal	11,000	
1969	Wet	64%	Normal	11,000	
1970	Wet	79%	Normal	11,000	
1971	Wet	80%	Normal	11,000	
1972	Below Normal	41%	Normal	11,000	
1973	Above Normal	75%	Normal	11,000	
1974	Wet	77%	Normal	11,000	
1975	Wet	78%	Normal	11,000	
1976	Critical	63%	Normal	11,000	2-year Drought (1976-1977); Single Critical Dry Year (1977)
1977	Critical	6%	Dry Year 3	35,000	
1978	Above Normal	87%	Normal	11,000	
1979	Below Normal	76%	Normal	11,000	
1980	Above Normal	66%	Normal	11,000	
1981	Dry	76%	Normal	11,000	
1982	Wet	71%	Normal	11,000	
1983	Wet	60%	Normal	11,000	
1984	Wet	78%	Normal	11,000	
1985	Dry	77%	Normal	11,000	
1986	Wet	56%	Normal	11,000	
1987	Dry	68%	Normal	11,000	6-Year Drought (1987-1992)
1988	Critical	12%	Dry Year 1	15,000	
1989	Dry	76%	Normal	11,000	
1990	Critical	9%	Dry Year 2	25,000	
1991	Critical	18%	Dry Year 3	35,000	
1992	Critical	26%	Dry Year 4	35,000	
1993	Above Normal	90%	Normal	11,000	
1994	Critical	51%	Normal	11,000	
1995	Wet	72%	Normal	11,000	
1996	Wet	83%	Normal	11,000	
1997	Wet	75%	Normal	11,000	
1998	Wet	73%	Normal	11,000	
1999	Wet	83%	Normal	11,000	
2000	Above Normal	84%	Normal	11,000	
2001	Dry	28%	Dry Year 1	15,000	Mild Single Dry Year
2002	Dry	52%	Normal	11,000	
2003	Above Normal	71%	Normal	11,000	
2004	Below Normal / Dry	65%	Normal	11,000	
2005	Wet / Above Normal	90%	Normal	11,000	
2006	Wet / Wet	100%	Normal	11,000	
2007	Dry / Critical	60%	Normal	11,000	

[a]Values for 1922-2003 are from Table B.3 in DWR (2008) and are for SWP Table A Deliveries under current (2007) conditions.
Values in 2004 through 2007 are actual historical deliveries during those years. afy = acre-feet per year

TABLE 3-4
Pumping Rates Simulated for Individual Alluvial Aquifer Wells under the 2008 Groundwater Operating Plan

Well Name	Alluvial Subarea	2005 Operating Plan		2008 Operating Plan			Comments
		Normal	Dry	Normal	Dry Yr 1	Dry Yr 2+	
NCWD-Castaic 1	Castaic Valley	385	345	350	300	250	
NCWD-Castaic 2	Castaic Valley	166	125	100	100	100	
NCWD-Castaic 4	Castaic Valley	100	45	100	0	0	
NCWD-Castaic 7	Castaic Valley			300	200	200	Assume similar pumping as at NCWD-Castaic3 during early 1980s
NCWD-Pinetree 1	Above Mint Canyon	164	0	150	0	0	
NCWD-Pinetree 3	Above Mint Canyon	545	525	350	300	300	
NCWD-Pinetree 4	Above Mint Canyon	300	0	300	200	200	
NCWD-Pinetree 5	Above Mint Canyon			300	200	200	
NCWD Total		**1,660**	**1,040**	**1,950**	**1,300**	**1,250**	
NLF-161	Below Valencia WRP	485	485	1,000	1,000	1,000	
NLF-B10	Below Valencia WRP	344	344	500	350	350	
NLF-B11	Below Valencia WRP	232	232	100	200	200	
NLF-B14	Below Valencia WRP			300	1,000	1,000	
NLF-B20	Below Valencia WRP	584	584	350	500	500	Pumping was assigned to former B7 well in 2005 analysis.
NLF-B5	Below Valencia WRP	1,582	1,582	2,400	1,900	1,900	
NLF-B6	Below Valencia WRP	1,766	1,766	1,100	1,100	1,100	
NLF-C	Below Valencia WRP	1,373	1,373	1,100	1,000	1,000	
NLF-C3	Below Valencia WRP	192	192	100	200	200	
NLF-C4	Below Valencia WRP	809	809	200	450	450	
NLF-C5	Below Valencia WRP	850	850	900	850	850	
NLF-C7	Below Valencia WRP	1,107	1,107	350	300	300	
NLF-C8	Below Valencia WRP	594	594	400	400	400	
NLF-E5	Below Valencia WRP	750	750	100	150	150	
NLF-E9	Below Valencia WRP	814	814	900	350	350	
NLF-G45	Below Valencia WRP	390	390	350	400	400	
NLF Total		**11,872**	**11,872**	**10,150**	**10,150**	**10,150**	
SCWD-Clark	Bouquet Canyon	782	700	700	700	700	
SCWD-Guida	Bouquet Canyon	1,320	1,230	1,300	1,250	1,200	
SCWD-Honby	Above Saugus WRP	696	870	1,000	850	700	
SCWD-Lost Canyon 2	Above Mint Canyon	741	640	700	700	650	
SCWD-Lost Canyon 2A	Above Mint Canyon	1,034	590	700	650	600	
SCWD-Mitchell #5A	Above Mint Canyon	0	0	500	350	200	
SCWD-Mitchell #5B	Above Mint Canyon	557	0	800	550	300	
SCWD-N. Oaks Central	Above Mint Canyon	822	1,640	850	800	700	
SCWD-N. Oaks East	Above Mint Canyon	1,234	485	800	750	700	
SCWD-N. Oaks West	Above Mint Canyon	898	0	800	750	700	
SCWD-Sand Canyon	Above Mint Canyon	930	195	1,000	600	200	
SCWD-Sierra	Above Mint Canyon	846	0	1,100	900	700	
SCWD-Valley Center	Above Saugus WRP	800	800	800	800	800	Pumping transferred from former well SCWD-Stadium
SCWD Total		**10,660**	**7,150**	**11,050**	**9,650**	**8,150**	
VWC-D	Castaic Valley	690	690	880	880	880	
VWC-E15	Below Valencia WRP			800	800	800	
VWC-N	Below Saugus WRP	620	620	650	650	650	
VWC-N7	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	
VWC-N8	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	
VWC-Q2	Below Saugus WRP	985	985	1,100	1,100	1,100	
VWC-S6	Below Saugus WRP	865	865	1,000	1,000	1,000	
VWC-S7	Below Saugus WRP	865	865	500	500	500	
VWC-S8	Below Saugus WRP	865	865	500	500	500	
VWC-T7	Above Saugus WRP	920	920	750	750	750	Pumping transferred from former wells VWC-T2 and VWC-T4
VWC-U4	Above Saugus WRP	935	935	800	800	800	
VWC-U6	Above Saugus WRP	825	825	800	800	800	Pumping transferred from former well VWC-U3
VWC-W10	San Francisquito Canyon	865	865	1,000	1,000	1,000	Pumping was assigned to former W6 well in 2005 analysis.
VWC-W11	San Francisquito Canyon	600	600	800	800	800	
VWC-W9	San Francisquito Canyon	350	350	950	950	950	
VWC Total		**11,705**	**11,705**	**12,850**	**12,850**	**12,850**	
Robinson Ranch	Above Mint Canyon	932	400	600	550	450	
WHR	Castaic Valley	1,600	1,600	2,000	2,000	2,000	
Purveyor Alluvial Usage		**24,025**	**19,895**	**25,850**	**23,800**	**22,250**	**2008 Operating Plan:**
Other Alluvial Usage		**14,404**	**13,872**	**12,750**	**12,700**	**12,600**	**35,000 to 40,000 AF/yr in normal and wet years**
Total Alluvial Pumping		**38,429**	**33,767**	**38,600**	**36,500**	**34,850**	**30,000 to 35,000 AF/yr in dry years**

Notes:
All pumping volumes are listed in units of acre-feet per year (afy).
Wells that are not listed are assumed to not be pumping in the future.
NLF = Newhall Land & Farming Company
NCWD = Newhall County Water District
SCWD = Santa Clarita Division of Castaic Lake Water Agency
VWC = Valencia Water Company
WHR = Wayside Honor Rancho, whose wells are owned by the Los Angeles County Waterworks District No. 36
"Other Alluvial Usage" consists of pumping by NLF, WHR, and Robinson Ranch. An additional 500 afy of pumping by other private well owners is not included in this table.

TABLE 3-5

Pumping Rates Simulated for Individual Saugus Formation Wells under the 2008 Groundwater Operating Plan

Owner	Well Name	Non-Drought Years	Drought Year 1	Drought Year 2	Drought Year 3
NCWD	12	1,765	2,494	2,494	2,494
	13	1,765	2,494	2,494	2,494
Total Pumping (NCWD Wells)		**3,530**	**4,988**	**4,988**	**4,988**
SCWD	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
Total Pumping (SCWD Wells)		**3,544**	**3,544**	**3,544**	**3,544**
Private	Palmer Golf Course	500	500	500	500
Total Pumping (Future Golf)		**500**	**500**	**500**	**500**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Val. Ctry Club)	500	500	500	500
	201	300	300	3,777	3,777
	205	1,211	2,945	4,038	4,038
	206	1,175	2,734	3,500	3,500
	207	1,175	2,734	3,500	3,500
Total Pumping (VWC Wells)		**4,911**	**10,093**	**16,195**	**16,195**
	Future #1	0	0	0	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
Total Pumping (Future Wells)		**0**	**0**	**0**	**9,750**
Total Pumping (All Saugus Wells)		**12,485**	**19,125**	**25,227**	**34,977**

Notes:

All pumping volumes are listed in units of acre-feet per year (afy).

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

NCWD = Newhall County Water District

SCWD = Santa Clarita Division of Castaic Lake Water Agency

VWC = Valencia Water Company

TABLE 3-6

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-12	2	485	1,280	15	10	150	8.8
	3			500	2	1,000	58.5
	4			280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
	3			250	2	500	38.5
SCWD-Saugus1	2	490	1,620	10	10	100	1.8
	3			500	6.5	3,250	59.9
	4			500	4	2,000	36.8
	5			20	4	80	1.5
SCWD-Saugus2	2	490	1,591	10	10	100	1.7
	3			500	6.5	3,250	56.9
	4			500	4	2,000	35.0
	5			91	4	364	6.4
Palmer Golf Course	2			250	1	250	20.0
	3			500	1	500	40.0
	4			500	1	500	40.0
VWC-159	3	662	1,900	338	0.025	8.45	27.3
	4			500	0.025	12.5	40.4
	5			400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.6
	4			500	4	2,000	46.2
	5			500	4	2,000	46.2
VWC-201	3	540	1,670	460	6.5	2,990	52.7
	4			500	4	2,000	35.3
	5			170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
	4			500	4	2,000	40.9
	5			430	4	1,720	35.2
VWC-206	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6
VWC-207*	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6
Future Wells Near VWC-206 (Assumed)	3	500	2,000	500	6.5	3,250	44.8
	4			500	4	2,000	27.6
	5			500	4	2,000	27.6

Notes:

* VWC-207 well construction information was not available at the time of this investigation and therefore the allocation of pumping was assumed to be similar to VWC-206.

Existing wells NCWD-7, NCWD-10, and NCWD-11 are assumed to no longer operate in the future.

Kh = horizontal hydraulic conductivity
ft/day = feet per day

T = transmissivity
ft^2/day = square feet per day

Table 3-7

Allocation of Pumping, by Month, for Agricultural and Urban Production Wells

Month	Percent of Annual Water Use, Agricultural	Percent of Annual Water Use, Urban	Percent of May through October Water Use, Urban
January	3.75	5.2	
February	5.1	3.7	
March	6.6	5.2	
April	9.1	6.6	
May	10.55	8.7	13.2
June	11.4	10.4	15.8
July	14.1	13	19.7
August	12.95	13.6	20.6
September	10.2	10.9	16.6
October	7.5	9.3	14.1
November	5	7.1	
December	3.75	6.3	
Total	**100**	**100**	**100**

TABLE 3-8

Total Groundwater and SWP Supplies for 2008 Groundwater Operating Plan (Not Including Recycled Water and Other Water Supplies, e.g. Purchased or Banked Water)

Model Year	Based on Historical Year	SWP Hydrology [a]	SWP Allocations [b] (%)	SWP Deliveries (afy)	Simulated Pumping From Alluvial Aquifer (afy)	Simulated Pumping From Saugus Formation (afy)	Total Groundwater Pumping (afy)	SWP + Groundwater (afy)
1	1922	Above Normal	89%	82,227	38,600	12,485	51,085	133,312
2	1923	Below Normal	76%	70,699	38,600	12,485	51,085	121,784
3	1924	Critical	10%	8,960	36,500	19,125	55,625	64,585
4	1925	Dry	40%	36,784	34,850	12,485	47,335	84,119
5	1926	Dry	53%	48,929	34,850	12,485	47,335	96,264
6	1927	Wet	89%	82,786	38,600	12,485	51,085	133,871
7	1928	Above Normal	50%	46,079	38,600	12,485	51,085	97,164
8	1929	Critical	18%	16,858	36,500	19,125	55,625	72,483
9	1930	Dry	49%	45,379	34,850	12,485	47,335	92,714
10	1931	Critical	27%	24,732	34,850	25,227	60,077	84,809
11	1932	Dry	32%	29,204	38,600	34,977	73,577	102,781
12	1933	Critical	48%	44,339	36,500	34,977	71,477	115,816
13	1934	Critical	32%	29,424	34,850	34,977	69,827	99,251
14	1935	Below Normal	81%	74,625	34,850	12,485	47,335	121,960
15	1936	Below Normal	76%	69,911	34,850	12,485	47,335	117,246
16	1937	Below Normal	78%	72,037	34,850	12,485	47,335	119,372
17	1938	Wet	82%	75,970	34,850	12,485	47,335	123,305
18	1939	Dry	79%	72,883	38,600	12,485	51,085	123,968
19	1940	Above Normal	77%	70,837	36,500	12,485	48,985	119,822
20	1941	Wet	61%	56,535	34,850	12,485	47,335	103,870
21	1942	Wet	77%	70,890	38,600	12,485	51,085	121,975
22	1943	Wet	76%	70,599	36,500	12,485	48,985	119,584
23	1944	Dry	71%	65,569	38,600	12,485	51,085	116,654
24	1945	Below Normal	75%	69,041	38,600	12,485	51,085	120,126
25	1946	Below Normal	77%	71,596	38,600	12,485	51,085	122,681
26	1947	Dry	56%	51,794	38,600	12,485	51,085	102,879
27	1948	Below Normal	63%	58,403	36,500	12,485	48,985	107,388
28	1949	Dry	31%	28,443	34,850	19,125	53,975	82,418
29	1950	Below Normal	60%	55,099	34,850	12,485	47,335	102,434
30	1951	Above Normal	85%	78,272	34,850	12,485	47,335	125,607
31	1952	Wet	63%	57,855	34,850	12,485	47,335	105,190
32	1953	Wet	80%	74,381	38,600	12,485	51,085	125,466
33	1954	Above Normal	77%	71,652	36,500	12,485	48,985	120,637
34	1955	Dry	28%	25,439	34,850	19,125	53,975	79,414
35	1956	Wet	87%	80,155	34,850	12,485	47,335	127,490
36	1957	Above Normal	62%	56,957	34,850	12,485	47,335	104,292
37	1958	Wet	73%	67,806	34,850	12,485	47,335	115,141
38	1959	Below Normal	84%	77,554	38,600	12,485	51,085	128,639
39	1960	Dry	35%	32,679	36,500	19,125	55,625	88,304
40	1961	Dry	57%	52,756	34,850	12,485	47,335	100,091
41	1962	Below Normal	72%	66,287	34,850	12,485	47,335	113,622
42	1963	Wet	82%	76,230	34,850	12,485	47,335	123,565
43	1964	Dry	53%	49,474	34,850	12,485	47,335	96,809
44	1965	Wet	69%	64,021	34,850	12,485	47,335	111,356
45	1966	Below Normal	79%	73,083	38,600	12,485	51,085	124,168
46	1967	Wet	72%	66,920	36,500	12,485	48,985	115,905
47	1968	Below Normal	80%	73,794	34,850	12,485	47,335	121,129
48	1969	Wet	64%	58,766	34,850	12,485	47,335	106,101
49	1970	Wet	79%	72,904	38,600	12,485	51,085	123,989
50	1971	Wet	80%	74,236	38,600	12,485	51,085	125,321
51	1972	Below Normal	41%	38,213	36,500	12,485	48,985	87,198
52	1973	Above Normal	75%	69,052	34,850	12,485	47,335	116,387
53	1974	Wet	77%	71,257	34,850	12,485	47,335	118,592
54	1975	Wet	78%	72,018	34,850	12,485	47,335	119,353
55	1976	Critical	63%	58,273	34,850	12,485	47,335	105,608
56	1977	Critical	6%	5,428	34,850	34,977	69,827	75,255
57	1978	Above Normal	87%	80,556	34,850	12,485	47,335	127,891
58	1979	Below Normal	76%	70,013	38,600	12,485	51,085	121,098
59	1980	Above Normal	66%	60,652	38,600	12,485	51,085	111,737
60	1981	Dry	76%	69,997	38,600	12,485	51,085	121,082
61	1982	Wet	71%	65,809	36,500	12,485	48,985	114,794
62	1983	Wet	60%	55,886	38,600	12,485	51,085	106,971
63	1984	Wet	78%	72,233	38,600	12,485	51,085	123,318
64	1985	Dry	77%	71,579	36,500	12,485	48,985	120,564
65	1986	Wet	56%	51,344	34,850	12,485	47,335	98,679
66	1987	Dry	68%	63,232	38,600	12,485	51,085	114,317
67	1988	Critical	12%	10,665	36,500	19,125	55,625	66,290
68	1989	Dry	76%	70,061	34,850	12,485	47,335	117,396
69	1990	Critical	9%	8,056	34,850	25,227	60,077	68,133
70	1991	Critical	18%	16,313	34,850	34,977	69,827	86,140
71	1992	Critical	26%	24,330	34,850	34,977	69,827	94,157
72	1993	Above Normal	90%	83,055	38,600	12,485	51,085	134,140
73	1994	Critical	51%	47,101	38,600	12,485	51,085	98,186
74	1995	Wet	72%	66,992	36,500	12,485	48,985	115,977
75	1996	Wet	83%	76,979	38,600	12,485	51,085	128,064
76	1997	Wet	75%	69,401	38,600	12,485	51,085	120,486
77	1998	Wet	73%	67,316	38,600	12,485	51,085	118,401
78	1999	Wet	83%	76,976	38,600	12,485	51,085	128,061
79	2000	Above Normal	84%	77,238	38,600	12,485	51,085	128,323
80	2001	Dry	28%	26,050	36,500	19,125	55,625	81,675
81	2002	Dry	52%	48,382	34,850	12,485	47,335	95,717
82	2003	Above Normal	71%	65,873	34,850	12,485	47,335	113,208
83	2004	Below Normal / Dry	Actual was 65%	60,125	34,850	12,485	47,335	107,460
84	2005	Wet / Above Normal	Actual was 90%	83,250	38,600	12,485	51,085	134,335
85	2006	Wet / Wet	Actual was 100%	92,500	38,600	12,485	51,085	143,585
86	2007	Dry / Critical	Actual was 60%	55,500	36,500	12,485	48,985	104,485

[a] Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest

[b] From Table B.3 in *The State Water Project Delivery Reliability Report 2007* (DWR, August 2008). This is for current (2007) conditions as defined in the DWR report. In any given year, the allocation may be made up, in part, of carryover water from the prior year.

afy = acre-feet per year SWP = State Water Project

Table 3-9

Pumping Rates Simulated for Individual Alluvial Aquifer Wells Under the Redistributed 2008 Groundwater Operating Plan (Listed By Alluvial Subarea)

Well Name	Alluvial Subarea	Original 2008 Operating Plan			Redistributed 2008 Operating Plan			Comments
		Normal	Dry Yr 1	Dry Yr 2+	Normal	Dry Yr 1	Dry Yr 2+	
NCWD-Pinetree 1	Above Mint Canyon	150	0	0	150	0	0	
NCWD-Pinetree 3	Above Mint Canyon	350	300	300	350	300	300	
NCWD-Pinetree 4	Above Mint Canyon	300	200	200	300	200	200	
NCWD-Pinetree 5	Above Mint Canyon	300	200	200	300	200	200	
Robinson Ranch	Above Mint Canyon	600	550	450	600	550	450	
SCWD-Sand Canyon	**Above Mint Canyon**	**1,000**	**600**	**200**	**200**	**150**	**0**	**Reduce these three wells by 1,600 afy in order to**
SCWD-Lost Canyon 2	**Above Mint Canyon**	**700**	**700**	**650**	**300**	**150**	**0**	**offset increased pumping at the SCWD-Santa Clara and**
SCWD-Lost Canyon 2A	**Above Mint Canyon**	**700**	**650**	**600**	**300**	**150**	**0**	**SCWD-Bouquet wells in the "Above Saugus WRP" area.**
SCWD-Mitchell #5A	Above Mint Canyon	500	350	200	500	350	200	
SCWD-Mitchell #5B	Above Mint Canyon	800	550	300	800	550	300	
SCWD-N. Oaks Central	Above Mint Canyon	850	800	700	850	800	700	
SCWD-N. Oaks East	Above Mint Canyon	800	750	700	800	750	700	
SCWD-N. Oaks West	Above Mint Canyon	800	750	700	800	750	700	
SCWD-Sierra	Above Mint Canyon	1,100	900	700	1,100	900	700	
Mint Canyon Total		**8,950**	**7,300**	**5,900**	**7,350**	**5,800**	**4,450**	
SCWD-Honby	Above Saugus WRP	1,000	850	700	1,000	850	700	
SCWD-Santa Clara	Above Saugus WRP	800	800	800	800	800	800	
SCWD-Valley Center	**Above Saugus WRP**	**0**	**0**	**0**	**800**	**800**	**800**	**Pumps 800 afy moved from the "Above Mint Canyon" area.**
SCWD-Bouquet	**Above Saugus WRP**	**0**	**0**	**0**	**800**	**800**	**800**	**Pumps 800 afy moved from the "Above Mint Canyon" area.**
VWC-T7	Above Saugus WRP	750	750	750	750	750	750	
VWC-U4	Above Saugus WRP	800	800	800	800	800	800	
VWC-U6	Above Saugus WRP	800	800	800	800	800	800	
Above Saugus WRP Total		**4,150**	**4,000**	**3,850**	**5,750**	**5,600**	**5,450**	
VWC-N	Below Saugus WRP	650	650	650	650	650	650	
VWC-N7	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	1,160	
VWC-N8	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	1,160	
VWC-Q2	Below Saugus WRP	1,100	1,100	1,100	1,100	1,100	1,100	
VWC-S6	Below Saugus WRP	1,000	1,000	1,000	1,000	1,000	1,000	
VWC-S7	Below Saugus WRP	500	500	500	500	500	500	
VWC-S8	Below Saugus WRP	500	500	500	500	500	500	
Below Saugus WRP Total		**6,070**	**6,070**	**6,070**	**6,070**	**6,070**	**6,070**	
NLF-161	Below Valencia WRP	1,000	1,000	1,000	1,000	1,000	1,000	
NLF-B10	Below Valencia WRP	500	350	350	500	350	350	
NLF-B11	Below Valencia WRP	100	200	200	100	200	200	
NLF-B14	Below Valencia WRP	300	1,000	1,000	300	1,000	1,000	
NLF-B20	Below Valencia WRP	350	500	500	350	500	500	
NLF-B5	Below Valencia WRP	2,400	1,900	1,900	2,400	1,900	1,900	
NLF-B6	Below Valencia WRP	1,100	1,100	1,100	1,100	1,100	1,100	
NLF-C	Below Valencia WRP	1,100	1,000	1,000	1,100	1,000	1,000	
NLF-C3	Below Valencia WRP	100	200	200	100	200	200	
NLF-C4	Below Valencia WRP	200	450	450	200	450	450	
NLF-C5	Below Valencia WRP	900	850	850	900	850	850	
NLF-C7	Below Valencia WRP	350	300	300	350	300	300	
NLF-C8	Below Valencia WRP	400	400	400	400	400	400	
NLF-E5	Below Valencia WRP	100	150	150	100	150	150	
NLF-E9	Below Valencia WRP	900	350	350	900	350	350	
NLF-G45	Below Valencia WRP	350	400	400	350	400	400	
VWC-E15	Below Valencia WRP	800	800	800	800	800	800	
Below Valencia WRP Total		**10,950**	**10,950**	**10,950**	**10,950**	**10,950**	**10,950**	
SCWD-Clark	Bouquet Canyon	700	700	700	700	700	700	
SCWD-Guida	Bouquet Canyon	1,300	1,250	1,200	1,300	1,250	1,200	
Bouquet Canyon Total		**2,000**	**1,950**	**1,900**	**2,000**	**1,950**	**1,900**	
VWC-W10	San Francisquito Canyon	1,000	1,000	1,000	1,000	1,000	1,000	
VWC-W11	San Francisquito Canyon	800	800	800	800	800	800	
VWC-W9	San Francisquito Canyon	950	950	950	950	950	950	
San Francisquito Canyon Total		**2,750**	**2,750**	**2,750**	**2,750**	**2,750**	**2,750**	
NCWD-Castaic 1	Castaic Valley	350	300	250	350	300	250	
NCWD-Castaic 2	Castaic Valley	100	100	100	100	100	100	
NCWD-Castaic 4	Castaic Valley	100	0	0	100	0	0	
NCWD-Castaic 7	Castaic Valley	300	200	200	300	200	200	
VWC-D	Castaic Valley	880	880	880	880	880	880	
WHR	Castaic Valley	2,000	2,000	2,000	2,000	2,000	2,000	
Castaic Valley Total:		**3,730**	**3,480**	**3,430**	**3,730**	**3,480**	**3,430**	
Total Alluvial Pumping		**38,600**	**36,500**	**34,850**	**38,600**	**36,600**	**35,000**	**Current Operating Plan:**
								35,000 to 40,000 AF/yr in normal and wet years
								30,000 to 35,000 AF/yr in dry years

Notes:

All pumping volumes are listed in acre-feet per year (afy).

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

NCWD = Newhall County Water District

SCWD = Santa Clarita Division of Castaic Lake Water Agency

VWC = Valencia Water Company

WHR = Wayside Honor Rancho, whose wells are owned by the Los Angeles County Waterworks District No. 36

TABLE 3- 0

Pumping Rates Simulated for Individual Alluvial Aquifer Wells under the Potential Groundwater Operating Plan

Well Name	Alluvial Subarea	Potential Operating Plan			Comments
		Normal	Dry Yr 1	Dry Yr 2+	
NCWD-Castaic 1	Castaic Valley	450	400	400	100 to 150 afy more than 2008 operating plan.
NCWD-Castaic 2	Castaic Valley	300	200	100	0 to 200 afy more than 2008 operating plan.
NCWD-Castaic 4	Castaic Valley	150	100	50	50 to 100 afy more than 2008 operating plan.
NCWD-Castaic 7	Castaic Valley	1,800	1,800	1,800	1500 to 1600 afy more than 2008 operating plan.
NCWD-Pinetree 1	Above Mint Canyon	200	200	200	50 to 200 afy more than 2008 operating plan.
NCWD-Pinetree 3	Above Mint Canyon	450	450	450	100 to 150 afy more than 2008 operating plan.
NCWD-Pinetree 4	Above Mint Canyon	300	300	200	0 to 100 afy more than 2008 operating plan.
NCWD-Pinetree 5	Above Mint Canyon	300	300	200	0 to 100 afy more than 2008 operating plan.
NCWD Total		**3,950**	**3,750**	**3,400**	**Total is 2,000 to 2,450 afy more than in the 2008 operating plan.**
NLF-B14	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-B15	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-B16	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-C10	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-C11	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-C12	Below Valencia WRP	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF-E21	Castaic Valley	650	650	650	Future agricultural supply for Newhall Land & Farming Co.
NLF Total		**4,550**	**4,550**	**4,550**	**Total is 5,600 afy less than in the 2008 operating plan.**
SCWD-Clark	Bouquet Canyon	800	750	700	0 to 100 afy more than 2008 operating plan.
SCWD-Guida	Bouquet Canyon	1,500	1,400	1,300	100 to 200 afy more than 2008 operating plan.
SCWD-Honby	Above Saugus WRP	1,200	1,000	700	0 to 200 afy more than 2008 operating plan.
SCWD-Lost Canyon 2	Above Mint Canyon	850	800	700	50 to 150 afy more than 2008 operating plan.
SCWD-Lost Canyon 2A	Above Mint Canyon	800	700	600	0 to 100 afy more than 2008 operating plan.
SCWD-Mitchell #5A	Above Mint Canyon	900	550	200	0 to 400 afy more than 2008 operating plan.
SCWD-Mitchell #5B	Above Mint Canyon	1,000	900	800	200 to 500 afy more than 2008 operating plan.
SCWD-N. Oaks Central	Above Mint Canyon	1,400	800	800	0 to 550 afy more than 2008 operating plan.
SCWD-N. Oaks East	Above Mint Canyon	1,000	800	600	50 to 200 afy more than 2008 operating plan.
SCWD-N. Oaks West	Above Mint Canyon	1,000	800	600	50 to 200 afy more than 2008 operating plan.
SCWD-Sand Canyon	Above Mint Canyon	1,300	1,000	600	300 to 400 afy more than 2008 operating plan.
SCWD-Sierra	Above Mint Canyon	1,400	1,100	800	100 to 300 afy more than 2008 operating plan.
SCWD-Santa Clara	Above Saugus WRP	950	950	950	Future well.
SCWD-Valley Center	Above Saugus WRP	1,200	1,000	800	800 gpm (2008 plan) + 0 to 400 afy additional pumping.
SCWD-Bouquet	Above Saugus WRP	1,200	1,100	1,100	Future well.
SCWD Total		**16,500**	**13,650**	**11,250**	**Total is 3,100 to 5,450 afy more than in the 2008 operating plan.**
VWC-D	Castaic Valley	880	880	880	Same as 2008 operating plan.
VWC-E14	Castaic Valley	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-E15	Castaic Valley	800	800	800	Same as 2008 operating plan.
VWC-E16	Castaic Valley	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-E17	Castaic Valley	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-G1	Below Valencia WRP	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-G3	Below Valencia WRP	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-G4	Below Valencia WRP	1,175	1,175	1,175	Future operations for Newhall Ranch.
VWC-N	Below Saugus WRP	650	650	650	Same as 2008 operating plan.
VWC-N7	Below Saugus WRP	1,160	1,160	1,160	Same as 2008 operating plan.
VWC-N8	Below Saugus WRP	1,160	1,160	1,160	Same as 2008 operating plan.
VWC-Q2	Below Saugus WRP	1,100	1,100	1,100	Same as 2008 operating plan.
VWC-S6	Below Saugus WRP	1,000	1,000	1,000	Same as 2008 operating plan.
VWC-S7	Below Saugus WRP	500	500	500	Same as 2008 operating plan.
VWC-S8	Below Saugus WRP	500	500	500	Same as 2008 operating plan.
VWC-T7	Above Saugus WRP	750	750	750	Same as 2008 operating plan.
VWC-U4	Above Saugus WRP	800	800	800	Same as 2008 operating plan.
VWC-U6	Above Saugus WRP	800	800	800	Same as 2008 operating plan.
VWC-W10	San Francisquito Canyon	1,000	1,000	1,000	Same as 2008 operating plan.
VWC-W11	San Francisquito Canyon	800	800	800	Same as 2008 operating plan.
VWC-W9	San Francisquito Canyon	950	950	950	Same as 2008 operating plan.
VWC Total		**19,900**	**19,900**	**19,900**	**VWC and NLF total is 1,450 afy more than in the 2008 operating plan.**
Robinson Ranch	Above Mint Canyon	600	550	450	Same as 2008 operating plan.
WHR	Castaic Valley	2,000	2,000	2,000	Same as 2008 operating plan.
Purveyor Alluvial Usage		**40,350**	**37,300**	**34,550**	**2008 Operating Plan:**
Other Alluvial Usage		**7,150**	**7,100**	**7,000**	**35,000 to 40,000 afy in normal and wet years**
Total Alluvial Pumping		**47,500**	**44,400**	**41,550**	**30,000 to 35,000 afy in dry years**

Notes:

All pumping volumes are listed in units of acre-feet per year (afy).

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

NCWD = Newhall County Water District

SCWD = Santa Clarita Division of Castaic Lake Water Agency

VWC = Valencia Water Company

WHR = Wayside Honor Rancho, whose wells are owned by the Los Angeles County Waterworks District No. 36

"Other Alluvial Usage" consists of pumping by NLF, WHR, and Robinson Ranch. An additional 500 afy of pumping by other private well owners is not included in this table.

TABLE 3-11

Pumping Rates Simulated for Individual Saugus Formation Wells under the Potential Groundwater Operating Plan

Owner	Well Name	Non-Drought Years	Drought Year 1	Drought Year 2	Drought Year 3
NCWD	12	1,765	2,494	2,494	2,494
	13	1,765	2,494	2,494	2,494
	Future well	1,765	2,494	2,494	2,494
Total Pumping (NCWD Wells)		**5,295**	**7,482**	**7,482**	**7,482**
SCWD	Saugus1	1,772	1,772	1,772	1,772
	Saugus2	1,772	1,772	1,772	1,772
	Future well	1,800	1,800	1,800	1,800
Total Pumping (SCWD Wells)		**5,344**	**5,344**	**5,344**	**5,344**
LA County Water District #36	Future well	300	300	300	300
Total Pumping (LACWD #36)		**300**	**300**	**300**	**300**
Private (Palmer)	Future Golf Course	500	500	500	500
Total Pumping (Future Golf)		**500**	**500**	**500**	**500**
VWC	159	50	50	50	50
	160 (Municipal)	500	830	830	830
	160 (Val. Ctry Club)	500	500	500	500
	201	300	300	3,777	3,777
	205	1,211	2,945	4,038	4,038
	206	1,175	2,734	3,500	3,500
	207	1,175	2,734	3,500	3,500
Total Pumping (VWC Wells)		**4,911**	**10,093**	**16,195**	**16,195**
	Future #1	0	0	0	3,250
	Future #2	0	0	0	3,250
	Future #3	0	0	0	3,250
Total Pumping (Future Wells)		**0**	**0**	**0**	**9,750**
Total Pumping (All Saugus Wells)		**16,350**	**23,719**	**29,821**	**39,571**

Notes:

All pumping volumes are listed in units of acre-feet per year (afy).

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

NCWD = Newhall County Water District

SCWD = Santa Clarita Division of Castaic Lake Water Agency

VWC = Valencia Water Company

TABLE 3-12

Total Groundwater and SWP Supplies for Potential Groundwater Operating Plan (Not Including Recycled Water and Other Water Supplies, e.g. Purchased or Banked Water)

Model Year	Based on Historical Year	SWP Hydrology [a]	SWP Allocations [b] (%)	SWP Deliveries (afy)	Simulated Pumping From Alluvial Aquifer (afy)	Simulated Pumping From Saugus Formation (afy)	Total Groundwater Pumping (afy)	SWP + Groundwater (afy)
1	1922	Above Normal	89%	82,227	47,500	16,350	63,850	146,077
2	1923	Below Normal	76%	70,699	47,500	16,350	63,850	134,549
3	1924	Critical	10%	8,960	44,400	23,719	68,119	77,079
4	1925	Dry	40%	36,784	41,550	16,350	57,900	94,684
5	1926	Dry	53%	48,929	41,550	16,350	57,900	106,829
6	1927	Wet	89%	82,786	47,500	16,350	63,850	146,636
7	1928	Above Normal	50%	46,079	47,500	16,350	63,850	109,929
8	1929	Critical	18%	16,858	44,400	23,719	68,119	84,977
9	1930	Dry	49%	45,379	41,550	16,350	57,900	103,279
10	1931	Critical	27%	24,732	41,550	29,821	71,371	96,103
11	1932	Dry	32%	29,204	47,500	39,571	87,071	116,275
12	1933	Critical	48%	44,339	44,400	39,571	83,971	128,310
13	1934	Critical	32%	29,424	41,550	39,571	81,121	110,545
14	1935	Below Normal	81%	74,625	41,550	16,350	57,900	132,525
15	1936	Below Normal	76%	69,911	41,550	16,350	57,900	127,811
16	1937	Below Normal	78%	72,037	41,550	16,350	57,900	129,937
17	1938	Wet	82%	75,970	41,550	16,350	57,900	133,870
18	1939	Dry	79%	72,883	47,500	16,350	63,850	136,733
19	1940	Above Normal	77%	70,837	44,400	16,350	60,750	131,587
20	1941	Wet	61%	56,535	41,550	16,350	57,900	114,435
21	1942	Wet	77%	70,890	47,500	16,350	63,850	134,740
22	1943	Wet	76%	70,599	44,400	16,350	60,750	131,349
23	1944	Dry	71%	65,569	47,500	16,350	63,850	129,419
24	1945	Below Normal	75%	69,041	47,500	16,350	63,850	132,891
25	1946	Below Normal	77%	71,596	47,500	16,350	63,850	135,446
26	1947	Dry	56%	51,794	47,500	16,350	63,850	115,644
27	1948	Below Normal	63%	58,403	44,400	16,350	60,750	119,153
28	1949	Dry	31%	28,443	41,550	23,719	65,269	93,712
29	1950	Below Normal	60%	55,099	41,550	16,350	57,900	112,999
30	1951	Above Normal	85%	78,272	41,550	16,350	57,900	136,172
31	1952	Wet	63%	57,855	41,550	16,350	57,900	115,755
32	1953	Wet	80%	74,381	47,500	16,350	63,850	138,231
33	1954	Above Normal	77%	71,652	44,400	16,350	60,750	132,402
34	1955	Dry	28%	25,439	41,550	23,719	65,269	90,708
35	1956	Wet	87%	80,155	41,550	16,350	57,900	138,055
36	1957	Above Normal	62%	56,957	41,550	16,350	57,900	114,857
37	1958	Wet	73%	67,806	41,550	16,350	57,900	125,706
38	1959	Below Normal	84%	77,554	47,500	16,350	63,850	141,404
39	1960	Dry	35%	32,679	44,400	23,719	68,119	100,798
40	1961	Dry	57%	52,756	41,550	16,350	57,900	110,656
41	1962	Below Normal	72%	66,287	41,550	16,350	57,900	124,187
42	1963	Wet	82%	76,230	41,550	16,350	57,900	134,130
43	1964	Dry	53%	49,474	41,550	16,350	57,900	107,374
44	1965	Wet	69%	64,021	41,550	16,350	57,900	121,921
45	1966	Below Normal	79%	73,083	47,500	16,350	63,850	136,933
46	1967	Wet	72%	66,920	44,400	16,350	60,750	127,670
47	1968	Below Normal	80%	73,794	41,550	16,350	57,900	131,694
48	1969	Wet	64%	58,766	41,550	16,350	57,900	116,666
49	1970	Wet	79%	72,904	47,500	16,350	63,850	136,754
50	1971	Wet	80%	74,236	47,500	16,350	63,850	138,086
51	1972	Below Normal	41%	38,213	44,400	16,350	60,750	98,963
52	1973	Above Normal	75%	69,052	41,550	16,350	57,900	126,952
53	1974	Wet	77%	71,257	41,550	16,350	57,900	129,157
54	1975	Wet	78%	72,018	41,550	16,350	57,900	129,918
55	1976	Critical	63%	58,273	41,550	16,350	57,900	116,173
56	1977	Critical	6%	5,428	41,550	39,571	81,121	86,549
57	1978	Above Normal	87%	80,556	41,550	16,350	57,900	138,456
58	1979	Below Normal	76%	70,013	47,500	16,350	63,850	133,863
59	1980	Above Normal	66%	60,652	47,500	16,350	63,850	124,502
60	1981	Dry	76%	69,997	47,500	16,350	63,850	133,847
61	1982	Wet	71%	65,809	44,400	16,350	60,750	126,559
62	1983	Wet	60%	55,886	47,500	16,350	63,850	119,736
63	1984	Wet	78%	72,233	47,500	16,350	63,850	136,083
64	1985	Dry	77%	71,579	44,400	16,350	60,750	132,329
65	1986	Wet	56%	51,344	41,550	16,350	57,900	109,244
66	1987	Dry	68%	63,232	47,500	16,350	63,850	127,082
67	1988	Critical	12%	10,665	44,400	23,719	68,119	78,784
68	1989	Dry	76%	70,061	41,550	16,350	57,900	127,961
69	1990	Critical	9%	8,056	41,550	29,821	71,371	79,427
70	1991	Critical	18%	16,313	41,550	39,571	81,121	97,434
71	1992	Critical	26%	24,330	41,550	39,571	81,121	105,451
72	1993	Above Normal	90%	83,055	47,500	16,350	63,850	146,905
73	1994	Critical	51%	47,101	47,500	16,350	63,850	110,951
74	1995	Wet	72%	66,992	44,400	16,350	60,750	127,742
75	1996	Wet	83%	76,979	47,500	16,350	63,850	140,829
76	1997	Wet	75%	69,401	47,500	16,350	63,850	133,251
77	1998	Wet	73%	67,316	47,500	16,350	63,850	131,166
78	1999	Wet	83%	76,976	47,500	16,350	63,850	140,826
79	2000	Above Normal	84%	77,238	47,500	16,350	63,850	141,088
80	2001	Dry	28%	26,050	44,400	23,719	68,119	94,169
81	2002	Dry	52%	48,382	41,550	16,350	57,900	106,282
82	2003	Above Normal	71%	65,873	41,550	16,350	57,900	123,773
83	2004	Below Normal / Dry	Actual was 65%	60,125	41,550	16,350	57,900	118,025
84	2005	Wet / Above Normal	Actual was 90%	83,250	47,500	16,350	63,850	147,100
85	2006	Wet / Wet	Actual was 100%	92,500	47,500	16,350	63,850	156,350
86	2007	Dry / Critical	Actual was 60%	55,500	44,400	16,350	60,750	116,250

[a] Defined by water year, using DWR's Sacramento Valley Unimpaired Runoff Index: wet = wettest; critical = driest

[b] From Table B.3 in *The State Water Project Delivery Reliability Report 2007* (DWR, August 2008). This is for current (2007) conditions as defined in the DWR report. In any given year, the allocation may be made up, in part, of carryover water from the prior year.

afy = acre-feet per year SWP = State Water Project

TABLE 3-13

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	1922	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
2	1923	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
3	1924	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
4	1925	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
5	1926	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
6	1927	5.84	10.76	3.38	2.56	0.00	0.00	0.00	0.00	0.00	0.22	3.18	1.30	27.24
7	1928	1.55	0.51	0.38	0.05	0.12	0.01	0.00	0.00	0.02	0.00	3.01	5.85	11.50
8	1929	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
9	1930	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
10	1931	4.10	6.45	0.00	2.29	0.97	0.02	0.00	3.78	0.06	0.14	3.30	7.53	28.65
11	1932	4.81	9.42	0.18	0.46	0.21	0.00	0.00	0.00	0.08	0.06	0.00	0.89	16.11
12	1933	16.04	0.00	0.05	0.34	1.04	0.31	0.00	0.08	0.00	0.22	0.05	5.95	24.08
13	1934	6.54	2.93	0.11	0.00	0.02	0.59	0.00	0.00	0.01	2.17	2.25	6.56	21.18
14	1935	4.45	2.50	3.41	1.95	0.00	0.00	0.00	0.06	0.08	0.12	0.95	0.81	14.33
15	1936	0.06	8.40	1.84	0.36	0.00	0.00	0.06	0.00	0.01	2.45	0.01	10.82	24.02
16	1937	3.34	6.79	6.16	0.21	0.33	0.00	0.00	0.00	0.00	0.00	0.00	4.19	21.03
17	1938	0.62	12.79	11.37	0.84	0.05	0.12	0.00	0.00	0.15	0.07	0.01	12.40	38.43
18	1939	3.80	1.91	2.05	0.27	0.12	0.00	0.00	0.00	3.60	0.22	0.34	0.90	13.23
19	1940	3.29	6.25	1.43	2.12	0.00	0.00	0.00	0.00	0.00	1.29	0.07	10.62	25.08
20	1941	3.92	19.84	10.82	5.82	0.00	0.00	0.00	0.01	0.00	2.45	0.35	6.23	49.45
21	1942	0.14	0.88	1.64	2.73	0.00	0.00	0.00	0.68	0.00	0.93	0.23	1.09	8.33
22	1943	19.90	4.59	7.80	1.04	0.00	0.00	0.00	0.00	0.00	0.15	0.33	9.63	43.45
23	1944	1.20	16.38	3.76	0.54	0.01	0.00	0.00	0.00	0.00	0.00	5.82	1.20	28.90
24	1945	0.14	4.11	3.13	0.19	0.00	0.00	0.00	0.00	0.00	1.33	0.45	7.75	17.09
25	1946	0.19	2.42	5.95	0.61	0.00	0.00	0.00	0.00	0.00	0.75	10.87	4.69	25.48
26	1947	0.47	0.42	1.28	0.56	0.14	0.00	0.00	0.08	0.05	0.04	0.00	1.84	4.88
27	1948	0.00	1.87	3.49	1.56	0.00	0.09	0.00	0.00	0.00	0.14	0.00	3.57	10.71
28	1949	2.83	1.06	2.18	0.02	1.35	0.00	0.00	0.00	0.00	0.00	1.36	2.85	11.65
29	1950	2.58	1.69	1.27	0.86	0.01	0.00	0.00	0.00	0.32	0.36	0.73	0.21	8.03
30	1951	2.96	0.93	1.16	1.69	0.09	0.00	0.00	0.05	0.00	0.49	1.33	5.88	14.57
31	1952	17.68	0.61	10.30	1.80	0.00	0.00	0.00	0.00	0.12	0.00	4.52	5.09	40.12
32	1953	0.80	0.02	0.21	1.64	0.69	0.00	0.00	0.00	0.00	0.00	2.32	0.04	5.73
33	1954	6.38	3.36	4.86	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.38	1.47	18.56
34	1955	5.69	1.69	0.21	3.38	1.91	0.00	0.00	0.00	0.00	0.00	1.43	2.01	16.32
35	1956	7.55	1.00	0.00	5.90	1.82	0.00	0.11	0.00	0.00	0.15	0.00	0.15	16.68
36	1957	7.22	2.71	3.05	1.16	1.06	0.25	0.00	0.00	0.00	2.68	0.40	8.30	26.81
37	1958	2.11	10.42	5.82	7.18	0.00	0.00	0.00	0.00	0.04	1.35	0.23	0.00	27.15
38	1959	3.70	5.47	0.00	0.59	0.00	0.00	0.00	0.00	0.08	0.00	0.00	1.68	11.51
39	1960	4.17	2.21	0.20	2.05	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.07	13.66
40	1961	1.88	0.00	0.76	0.33	0.09	0.00	0.07	0.00	0.11	0.00	4.12	2.99	10.35
41	1962	3.86	19.44	1.53	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.00	24.90
42	1963	0.99	3.63	4.10	2.23	0.06	0.43	0.00	0.00	0.77	0.50	2.29	0.01	15.01
43	1964	2.95	0.00	1.88	2.41	0.04	0.12	0.00	0.00	0.00	0.52	1.47	2.48	11.84
44	1965	0.25	0.07	1.65	9.14	0.00	0.02	0.26	0.16	0.95	0.00	17.49	7.89	37.88
45	1966	1.42	1.55	0.33	0.00	0.09	0.00	0.00	0.00	0.09	0.11	7.56	5.95	17.10

TABLE 3-13

Simulated Monthly Precipitation at the Newhall County Water District Rain Gage for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
46	1967	6.76	0.22	3.23	5.41	0.19	0.00	0.00	0.00	0.50	0.00	9.36	1.58	27.26
47	1968	0.86	0.93	2.91	0.97	0.07	0.00	0.00	0.38	0.00	0.39	0.35	1.24	8.10
48	1969	19.53	13.89	0.82	1.16	0.05	0.05	0.18	0.00	0.00	0.00	2.32	0.05	38.04
49	1970	0.94	6.63	4.33	0.00	0.00	0.00	0.00	0.00	0.00	0.13	8.86	6.33	27.21
50	1971	1.23	1.41	0.48	0.94	0.15	0.00	0.00	0.00	0.47	0.50	0.38	10.57	16.14
51	1972	0.00	0.12	0.00	0.02	0.05	0.05	0.00	0.06	0.00	0.05	3.45	1.08	4.87
52	1973	5.19	11.74	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.83	1.03	23.22
53	1974	10.58	0.02	4.30	0.06	0.00	0.00	0.02	0.00	0.00	1.17	0.12	4.89	21.17
54	1975	0.28	3.02	6.04	2.96	0.00	0.00	0.00	0.00	0.00	0.39	0.04	0.09	12.81
55	1976	0.00	7.39	1.47	0.46	0.15	0.35	0.01	0.00	3.40	0.22	2.09	0.90	16.45
56	1977	5.75	0.12	2.15	0.00	5.27	0.00	0.00	2.68	0.02	0.05	0.06	8.40	24.49
57	1978	10.74	13.23	17.10	2.72	0.00	0.00	0.00	0.00	1.23	0.01	2.70	1.76	49.49
58	1979	12.44	3.20	6.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.89	1.19	23.75
59	1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
60	1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
61	1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
62	1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
63	1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
64	1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
65	1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
66	1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
67	1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
68	1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
69	1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
70	1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
71	1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
72	1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
73	1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
74	1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
75	1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
76	1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
77	1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
78	1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05
79	2000	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	17.33
80	2001	5.84	10.76	3.38	2.56	0.00	0.00	0.00	0.00	0.00	0.22	3.18	1.30	27.24
81	2002	1.55	0.51	0.38	0.05	0.12	0.01	0.00	0.00	0.02	0.00	3.01	5.85	11.50
82	2003	0.00	9.03	2.38	2.35	1.70	0.00	0.02	0.00	0.00	1.10	0.63	2.57	19.78
83	2004	0.65	8.07	0.37	0.20	0.00	0.00	0.00	0.00	0.00	4.79	0.64	8.54	23.26
84	2005	17.06	16.69	2.70	1.42	0.45	0.00	0.00	0.00	0.17	1.91	0.59	0.14	41.13
85	2006	3.27	3.78	5.68	4.22	0.99	0.00	0.00	0.00	0.00	0.42	0.05	0.83	19.24
86	2007	1.66	1.38	0.17	0.71	0.00	0.00	0.00	0.00	1.32	0.25	0.50	2.67	8.66

All precipitation values are listed in units of inches.

TABLE 3-14

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Prototype Year
1	1922	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115	1992
2	1923	117	117	65	31	12	0	0	0	0	0	258	516	1,116	2000
3	1924	212	276	230	46	46	5	0	0	0	27	36	147	1,025	1990
4	1925	50	111	60	25	6	0	0	0	102	94	34	18	499	1989
5	1926	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175	1980
6	1927	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188	2001
7	1928	50	111	60	25	6	0	0	0	102	94	34	18	499	2002
8	1929	68	67	70	69	70	68	65	65	60	58	316	164	1,140	1960
9	1930	68	67	70	69	70	68	65	65	60	58	316	164	1,140	1960
10	1931	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188	2001
11	1932	117	117	65	31	12	0	0	0	0	0	258	516	1,116	1987
12	1933	0	30	0	0	0	0	0	0	0	25	0	1,652	1,707	2004
13	1934	222	209	506	117	77	68	0	0	0	0	12	25	1,236	1988
14	1935	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104	1995
15	1936	0	30	0	0	0	0	0	0	0	25	0	1,652	1,707	2004
16	1937	222	209	506	117	77	68	0	0	0	0	12	25	1,236	1988
17	1938	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104	1995
18	1939	7,355	2,668	597	265	120	55	27	5	32	73	132	141	11,468	Half of 1993
19	1940	0	30	0	0	0	0	0	0	0	25	0	1,652	1,707	2004
20	1941	13,686	11,359	11,699	2,378	1,458	721	322	120	77	128	179	206	42,333	2005
21	1942	50	111	60	25	6	0	0	0	102	94	34	18	499	1989
22	1943	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074	1998
23	1944	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104	1995
24	1945	517	346	140	85	33	5	4	50	66	240	566	809	2,859	1997
25	1946	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104	1995
26	1947	332	250	131	90	50	22	32	6	0	0	11	58	983	1972
27	1948	50	111	60	25	6	0	0	0	102	94	34	18	499	2002
28	1949	50	111	60	25	6	0	0	0	102	94	34	18	499	2002
29	1950	83	198	184	126	105	83	51	54	56	53	43	42	1,078	1950
30	1951	49	40	66	91	98	84	79	72	57	71	47	53	807	1951
31	1952	9,629	636	7,091	2,114	895	326	153	138	86	97	178	313	21,656	1952
32	1953	300	282	271	237	165	134	102	86	85	83	74	68	1,888	1953
33	1954	145	278	404	356	181	108	110	99	91	90	80	75	2,017	1954
34	1955	103	156	157	128	153	99	78	76	74	68	66	62	1,220	1955
35	1956	69	85	130	137	139	98	86	80	77	76	67	69	1,113	1956
36	1957	67	55	78	90	93	80	78	78	76	79	66	71	910	1957
37	1958	66	329	743	4,550	825	283	130	108	95	145	146	116	7,536	1958
38	1959	246	351	189	127	111	92	84	86	83	69	68	68	1,575	1959
39	1960	68	67	70	69	70	68	65	65	60	58	316	164	1,140	1960
40	1961	124	91	38	38	36	32	28	33	22	19	19	119	597	1961
41	1962	139	1,904	791	449	329	169	97	82	80	84	82	82	4,287	1962
42	1963	85	142	145	131	104	86	79	74	66	65	62	58	1,096	1963
43	1964	69	50	51	62	66	54	53	53	54	45	43	41	640	1964
44	1965	30	23	25	46	43	36	31	34	37	35	1,305	3,300	4,944	1965
45	1966	1,765	1,014	778	450	308	115	68	54	45	63	91	523	5,274	1966

TABLE 3-14

Simulated Monthly Streamflows in the Santa Clara River at the Lang Gage for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Prototype Year
46	1967	757	489	1,028	2,295	1,880	729	212	104	89	73	255	487	8,397	1967
47	1968	300	247	276	180	72	32	32	30	25	133	208	851	2,384	1968
48	1969	13,797	2,856	1,005	489	320	147	98	98	46	318	392	399	19,966	1969
49	1970	461	550	1,168	465	290	169	74	60	58	27	501	1,338	5,161	1970
50	1971	614	524	556	397	262	167	70	25	5	30	200	420	3,270	1971
51	1972	332	250	131	90	50	22	32	6	0	0	11	58	983	1972
52	1973	153	1,717	950	471	226	71	18	12	8	3	8	44	3,679	1973
53	1974	608	229	392	190	129	49	17	6	0	3	19	87	1,728	1974
54	1975	53	90	228	181	104	31	15	3	0	0	0	0	704	1975
55	1976	0	110	63	39	33	12	0	0	1	0	0	0	258	1976
56	1977	28	7	28	19	60	5	0	0	0	0	0	0	147	1977
57	1978	744	9,486	11,412	1,696	2,736	1,154	418	209	101	264	422	86	28,730	1978
58	1979	1,254	433	1,113	506	246	190	178	111	125	90	120	558	4,925	1979
59	1980	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175	1980
60	1981	594	98	339	240	107	18	18	12	338	321	258	394	2,739	1981
61	1982	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188	1982
62	1983	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855	1983
63	1984	0	596	405	240	143	166	228	411	154	220	904	578	4,044	1984
64	1985	483	461	274	215	77	0	0	0	12	179	221	301	2,224	1985
65	1986	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744	1986
66	1987	117	117	65	31	12	0	0	0	0	0	258	516	1,116	1987
67	1988	222	209	506	117	77	68	0	0	0	0	12	25	1,236	1988
68	1989	50	111	60	25	6	0	0	0	102	94	34	18	499	1989
69	1990	212	276	230	46	46	5	0	0	0	27	36	147	1,025	1990
70	1991	162	775	879	736	145	142	14	0	45	69	62	263	3,291	1991
71	1992	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115	1992
72	1993	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937	1993
73	1994	388	493	497	319	163	80	20	7	37	102	193	941	3,239	1994
74	1995	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104	1995
75	1996	666	896	730	315	151	46	7	0	54	154	307	510	3,836	1996
76	1997	517	346	140	85	33	5	4	50	66	240	566	809	2,859	1997
77	1998	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074	1998
78	1999	92	85	204	224	197	107	80	46	52	54	31	80	1,252	1999
79	2000	117	117	65	31	12	0	0	0	0	0	258	516	1,116	1987
80	2001	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188	1982
81	2002	50	111	60	25	6	0	0	0	102	94	34	18	499	1989
82	2003	666	896	730	315	109	0	0	0	0	0	0	0	2,715	1996 and 2003
83	2004	0	30	0	0	0	0	0	0	0	25	0	1,652	1,707	2004
84	2005	13,686	11,359	11,699	2,378	1,458	721	322	120	77	128	179	206	42,333	2005
85	2006	418	352	510	920	381	69	0	0	0	0	0	0	2,650	2006
86	2007	1	57	30	20	0	0	0	0	0	3	8	6	125	2007

All simulated streamflow volumes are listed in units of acre-feet (af).

TABLE 3-15

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Prototype Year
1	1922	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450	1992
2	1923	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086	2000
3	1924	0	0	0	0	0	0	0	0	0	0	0	0	0	1990
4	1925	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
5	1926	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805	1980
6	1927	0	389	1,218	0	0	0	0	0	0	0	0	0	1,607	2001
7	1928	0	0	0	0	0	0	0	0	0	0	0	0	0	2002
8	1929	0	0	0	0	0	0	0	0	0	0	0	0	0	2002
9	1930	0	0	0	0	0	0	0	0	0	0	0	0	0	1984
10	1931	0	389	1,218	0	0	0	0	0	0	0	0	0	1,607	2001
11	1932	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
12	1933	0	59	1,004	0	0	0	0	0	0	0	0	60	1,123	2004
13	1934	0	0	809	341	900	0	0	0	0	0	0	0	2,050	1988
14	1935	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611	1995
15	1936	0	59	1,004	0	0	0	0	0	0	0	0	60	1,123	2004
16	1937	0	0	809	341	900	0	0	0	0	0	0	0	2,050	1988
17	1938	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611	1995
18	1939	0	70	93	1,516	951	318	171	169	407	0	0	171	3,863	Half of 1993
19	1940	0	59	1,004	0	0	0	0	0	0	0	0	60	1,123	2004
20	1941	32,391	37,514	12,993	3,613	2,891	90	1,657	32	0	0	0	0	91,181	2005
21	1942	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
22	1943	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802	1998
23	1944	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611	1995
24	1945	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884	1997
25	1946	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611	1995
26	1947	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
27	1948	0	0	0	0	0	0	0	0	0	0	0	0	0	2002
28	1949	0	0	0	0	0	0	0	0	0	0	0	0	0	2002
29	1950	0	0	0	0	0	0	0	0	0	0	0	0	0	2007
30	1951	0	0	0	0	0	0	0	0	0	0	0	0	0	1984
31	1952	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725	1993
32	1953	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
33	1954	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632	1996
34	1955	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
35	1956	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853	1987
36	1957	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
37	1958	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
38	1959	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282	1994
39	1960	0	0	0	0	0	0	0	0	0	0	0	0	0	1984
40	1961	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830	1999
41	1962	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
42	1963	0	0	0	0	0	0	0	0	0	0	0	0	0	1984
43	1964	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282	1994
44	1965	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450	1992
45	1966	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853	1987

TABLE 3-15

Simulated Monthly Water Releases from Castaic Lagoon to Castaic Creek for the 86-year Simulation

Model Year	Historical Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Prototype Year
46	1967	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
47	1968	0	0	0	0	0	0	0	0	0	0	0	0	0	2007
48	1969	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725	1993
49	1970	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
50	1971	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
51	1972	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
52	1973	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
53	1974	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
54	1975	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282	1994
55	1976	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853	1987
56	1977	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
57	1978	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928	1983
58	1979	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
59	1980	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805	1980
60	1981	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
61	1982	0	0	0	0	0	667	842	735	0	0	0	0	2,244	1982
62	1983	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928	1983
63	1984	0	0	0	0	0	0	0	0	0	0	0	0	0	1984
64	1985	0	0	0	0	0	0	0	0	0	0	0	0	0	1985
65	1986	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641	1986
66	1987	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853	1987
67	1988	0	0	809	341	900	0	0	0	0	0	0	0	2,050	1988
68	1989	0	0	0	0	0	0	0	0	0	0	0	0	0	1989
69	1990	0	0	0	0	0	0	0	0	0	0	0	0	0	1990
70	1991	0	0	0	0	0	0	0	0	0	0	0	66	66	1991
71	1992	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450	1992
72	1993	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725	1993
73	1994	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282	1994
74	1995	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611	1995
75	1996	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632	1996
76	1997	0	0	8,701	873	0	0	0	0	0	0	0	310	9,884	1997
77	1998	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802	1998
78	1999	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830	1999
79	2000	0	660	855	0	2,087	3,484	0	0	0	0	0	0	7,086	2000
80	2001	0	389	1,218	0	0	0	0	0	0	0	0	0	1,607	2001
81	2002	0	0	0	0	0	0	0	0	0	0	0	0	0	2002
82	2003	0	0	0	2,286	418	315	0	0	0	0	0	0	3,019	2003
83	2004	0	59	1,004	0	0	0	0	0	0	0	0	60	1,123	2004
84	2005	32,391	37,514	12,993	3,613	2,891	90	1,657	32	0	0	0	0	91,181	2005
85	2006	1,403	2,185	2,648	5,906	3,395	2,307	0	0	0	0	0	0	17,844	2006
86	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	2007

All simulated water releases are listed in units of acre-feet (af).

Table 3-16

Water Demands and Indoor Water Use under Full Build-out Conditions (Excluding Newhall Ranch)

Year 2000 Actual (afy)	Full Build-out Conditions (afy)	Comments
Annual Urban Water Use Outside Newhall Ranch		
60,988	123,038	Year 2000 value is retail purveyor demand plus other demands in Table II-6 of the *2004 Santa Clarita Valley Water Report* (LSCE, 2005a). Year 2045 value is from Table 2.5-4 of the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2001). Consists of 89,805 AF/yr Development Monitoring System[a] demand, plus 55,995 AF/yr additional urban demand, minus 14,480 AF/yr conservation, minus 5,193 AF/yr agricultural uses and 3,089 AF/yr "other" uses. Does not include 4,500 AF/yr for aquifer storage and recovery or 17,680 AF/yr of demand for the Newhall Ranch Specific Plan.
Annual Indoor Water Use Outside Newhall Ranch (Equal to LACSD WRP Influent Volumes)		
18,723	40,313 (average year)	The year 2000 volume is from the Saugus and Valencia WRPs for the period January 2000 through December 2000. The long-term current generated effluent volume is based on the influent volume estimated from water balance calculations performed for the chloride mass balance analysis. The effluent volume is 32.8 percent of the total urban water production of 123,038 AF/yr, which includes other uses.

[a]Development Monitoring System water demands are demands associated with future build-out of developments identified in Los Angeles County's Development Monitoring System for the Santa Clarita Valley.

Table 3-17

Treated Water Discharges from the Saugus and Valencia WRPs to the Santa Clara River under Full Build-out Conditions

Month	Treated Water Volume (2000)[a]	Treated Water Volume (Full Build-out Conditions)[b]	Percent of Annual Outdoor Demand	Reclaimed Volume under Full Build-out Conditions (Before Maintaining Existing Streamflows)	Reclaimed Volume under Full Build-out Conditions (After Maintaining Existing Streamflows)	WRP Discharges to River under Full Build-out Conditions[c]	Month
January	1,503	3,237	3.75	637	637	2,600	January
February	1,443	3,106	5.1	867	867	2,239	February
March	1,528	3,290	6.6	1,122	1,122	2,168	March
April	1,505	3,240	9.1	1,547	1,547	1,693	April
May	1,569	3,379	10.55	1,794	1,794	1,585	May
June	1,543	3,322	11.4	1,938	1,781	1,541	June
July	1,606	3,459	14.1	2,397	1,854	1,605	July
August	1,649	3,550	12.95	2,202	1,902	1,648	August
September	1,593	3,430	10.2	1,734	1,734	1,696	September
October	1,631	3,512	7.5	1,275	1,275	2,237	October
November	1,546	3,329	5	850	850	2,479	November
December	1,607	3,459	3.75	637	637	2,822	December
Total Annual	**18,723**	**40,313**	**100**	**17,000**	**16,000**	**24,313**	**Total Annual**

[a]Values shown are the actual volumes of treated water discharged to the Santa Clara River from the Saugus and Valencia WRPs during calendar year 2000. (See also Table 3-16.)

[b]Values shown are the combined treated water volumes estimated to be produced by the Saugus and Valencia WRPs for full build-out conditions in the Santa Clarita Valley. These values do not include the future Newhall Ranch WRP, which will be operated by LACSD.

[c]Values shown do not include discharges of treated water to the river from the future Newhall Ranch WRP. These volumes are 10 acre-feet in November, 138 acre-feet in December, and 138 acre-feet in January. During the other nine months of the year, this WRP will not discharge treated water to the river (see the *Newhall Ranch Draft Additional Analysis* [Impact Sciences, Inc., 2001] for further details). The combined total discharge from the Saugus, Valencia, and Newhall Ranch WRPs is summarized in Table 3-18.

Note: All volumes are in acre-feet.

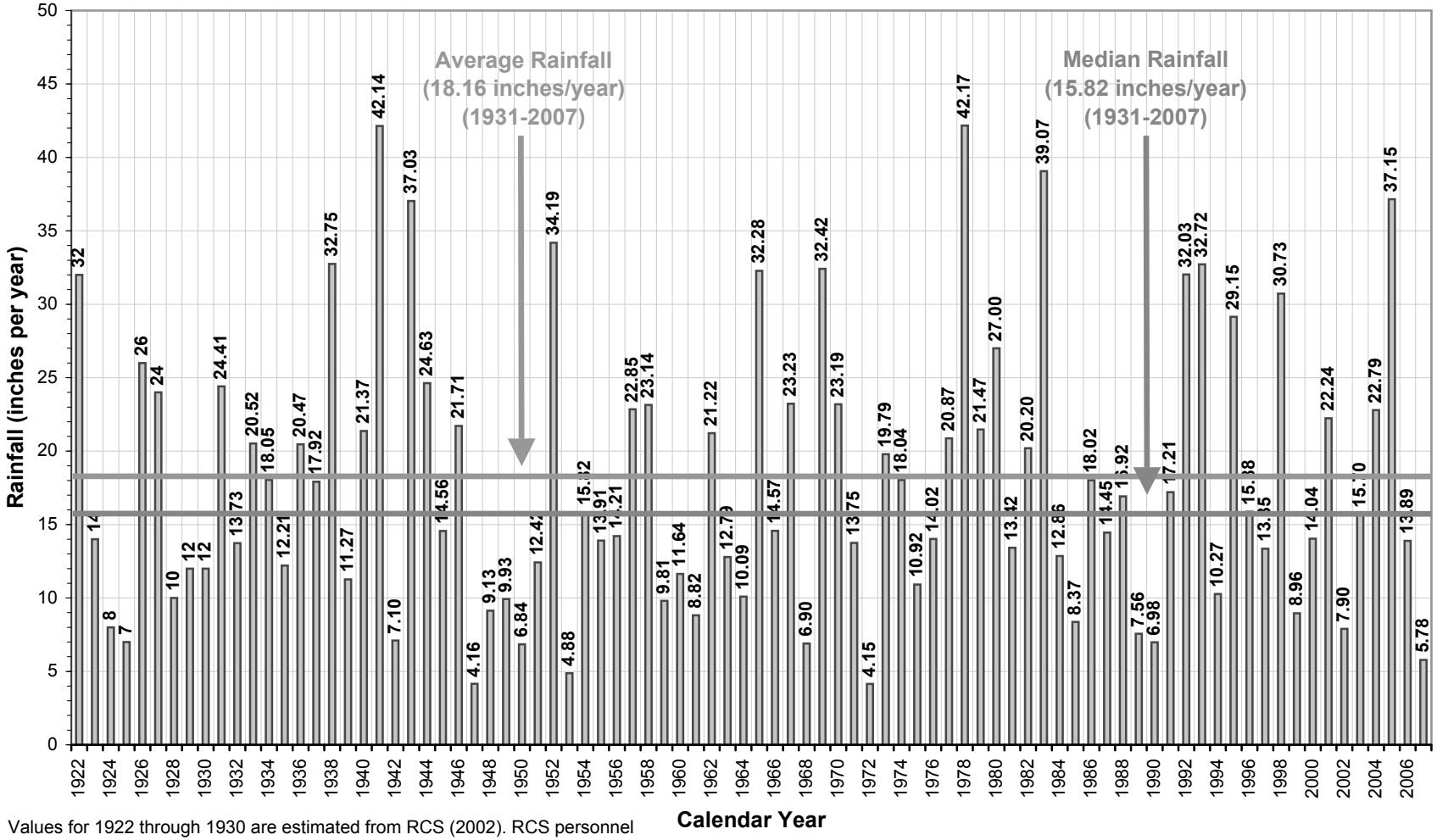
Table 3-18

Simulated Monthly Treated Wastewater Discharges from Santa Clarita Valley WRPs under Full Build-out Conditions

WRP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Saugus	493	487	500	490	503	466	457	508	586	555	514	596	**6,155**
Valencia	2,107	1,752	1,668	1,203	1,082	1,075	1,148	1,140	1,110	1,682	1,965	2,226	**18,158**
Newhall	138	0	0	0	0	0	0	0	0	0	10	138	**286**
Total	**2,738**	**2,239**	**2,168**	**1,693**	**1,585**	**1,541**	**1,605**	**1,648**	**1,696**	**2,237**	**2,489**	**2,960**	**24,599**

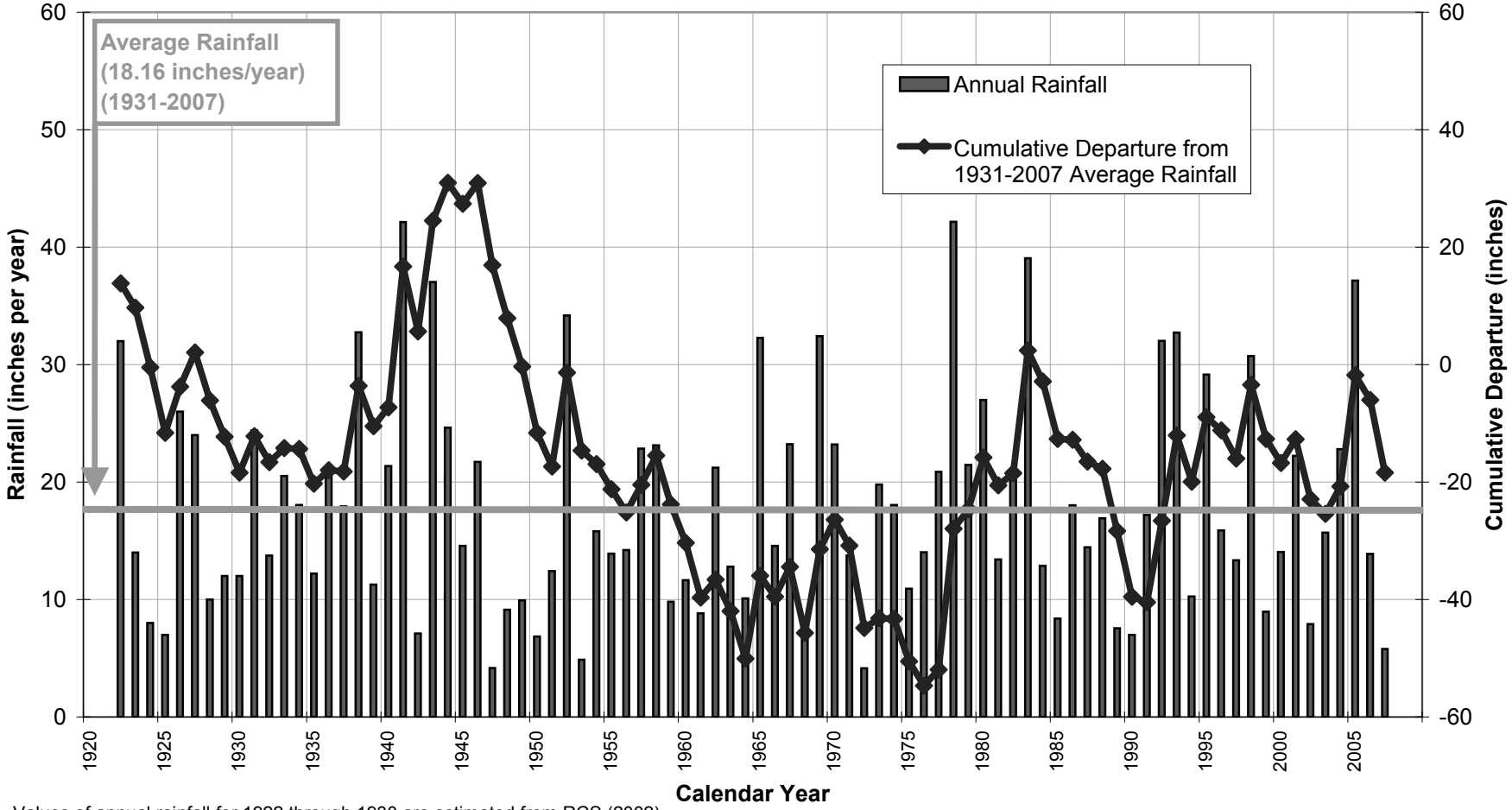
Note: All volumes are in acre-feet.

Figure 3-1
Annual Rainfall
(Newhall-Soledad Rain Gage)



Values for 1922 through 1930 are estimated from RCS (2002). RCS personnel have since indicated that the source of data to 1931 is an unofficial record obtained in 2001 from a former California State Climatologist.

Figure 3-2
Annual Rainfall and Cumulative Departure from Average Rainfall
(Newhall-Soledad Rain Gage)



Values of annual rainfall for 1922 through 1930 are estimated from RCS (2002). RCS personnel have since indicated that the source of data to 1931 is an unofficial record obtained in 2001 from a former California State Climatologist.

Figure 3-3
Simulated Groundwater Pumping for 2008 Groundwater Operating Plan

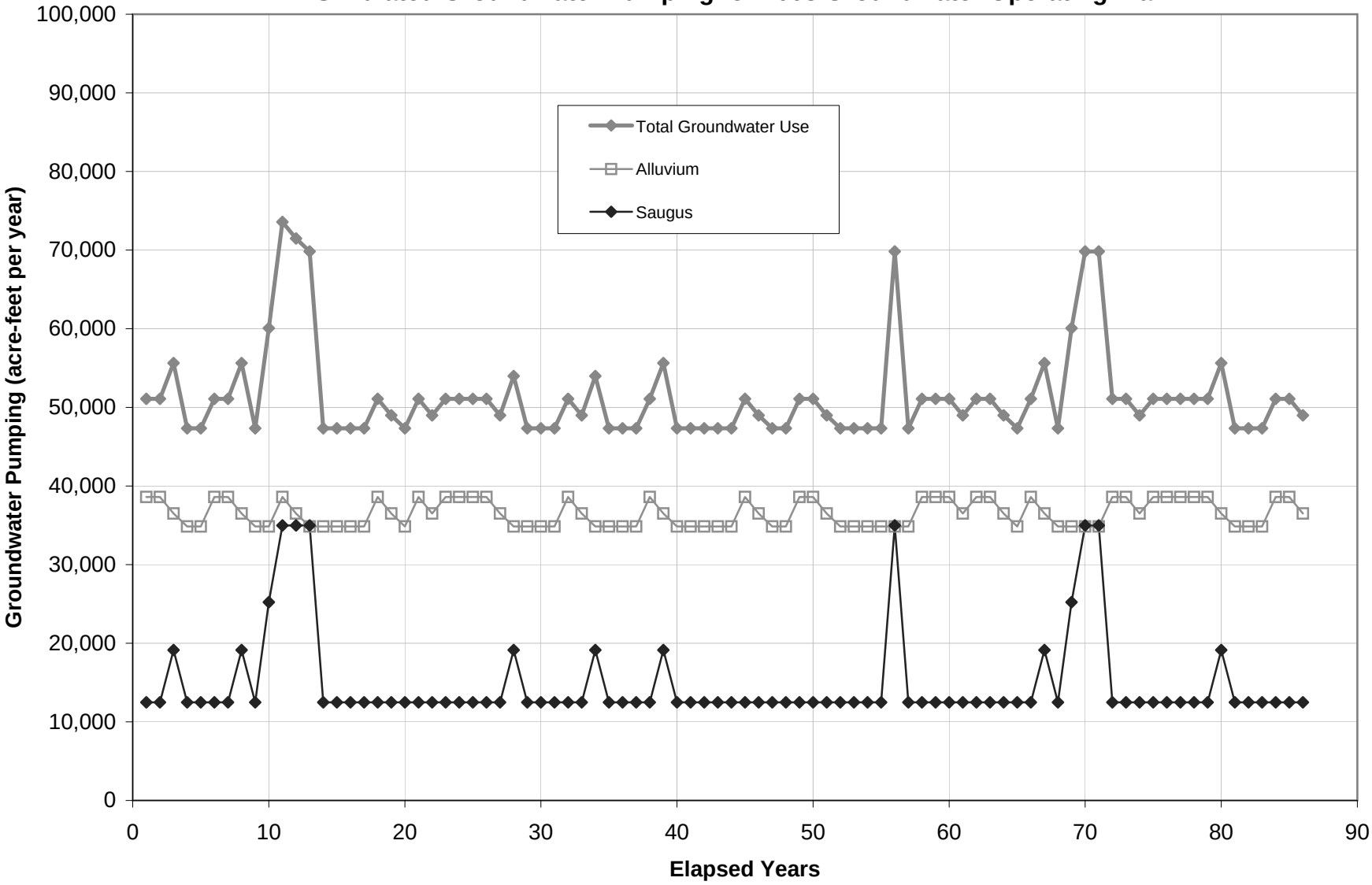


Figure 3-4
Simulated Water Supplies For 2008 Groundwater Operating Plan (Excluding Recycled Water)

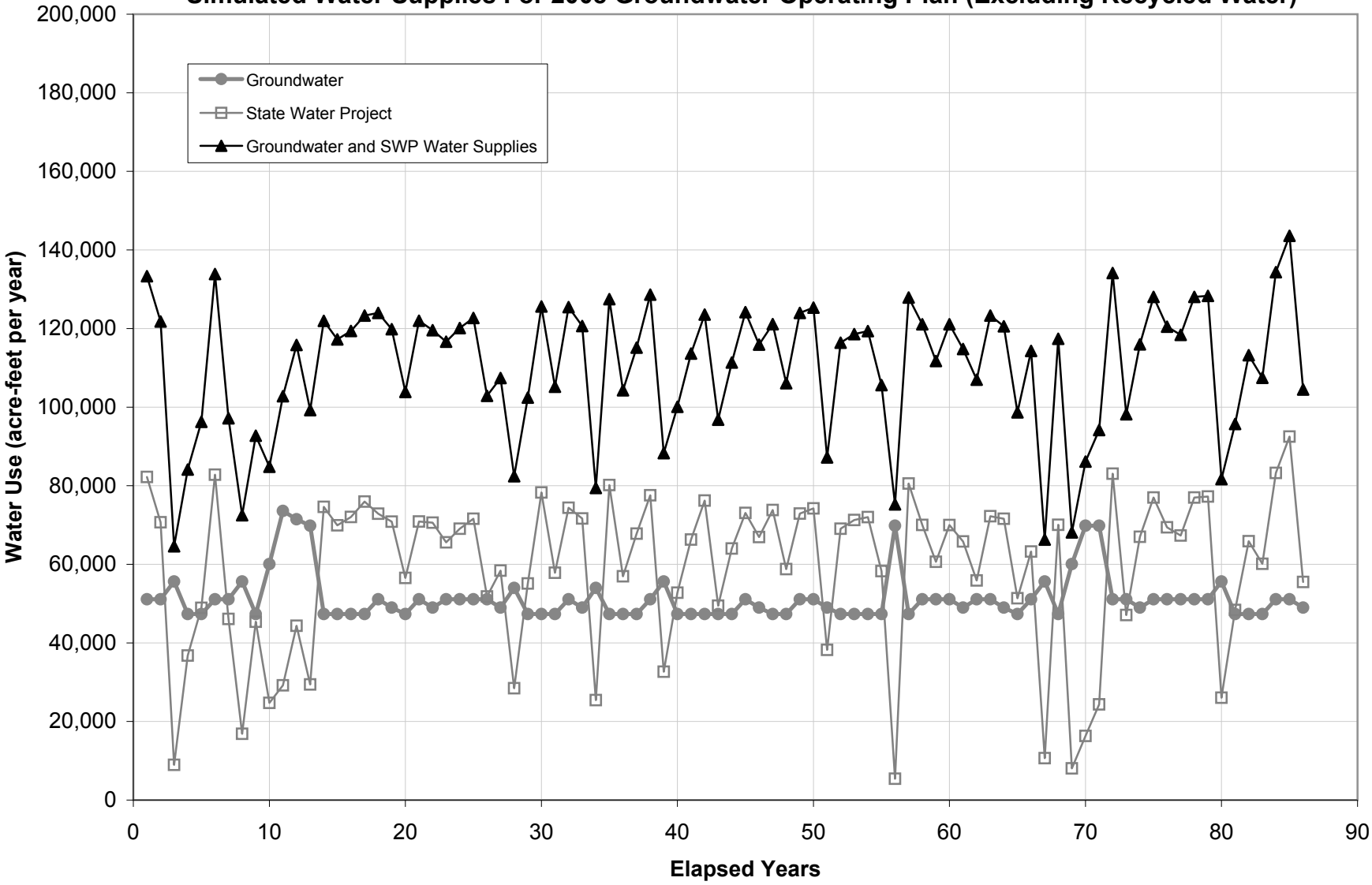


Figure 3-5
Simulated Groundwater Pumping For Potential Groundwater Operating Plan

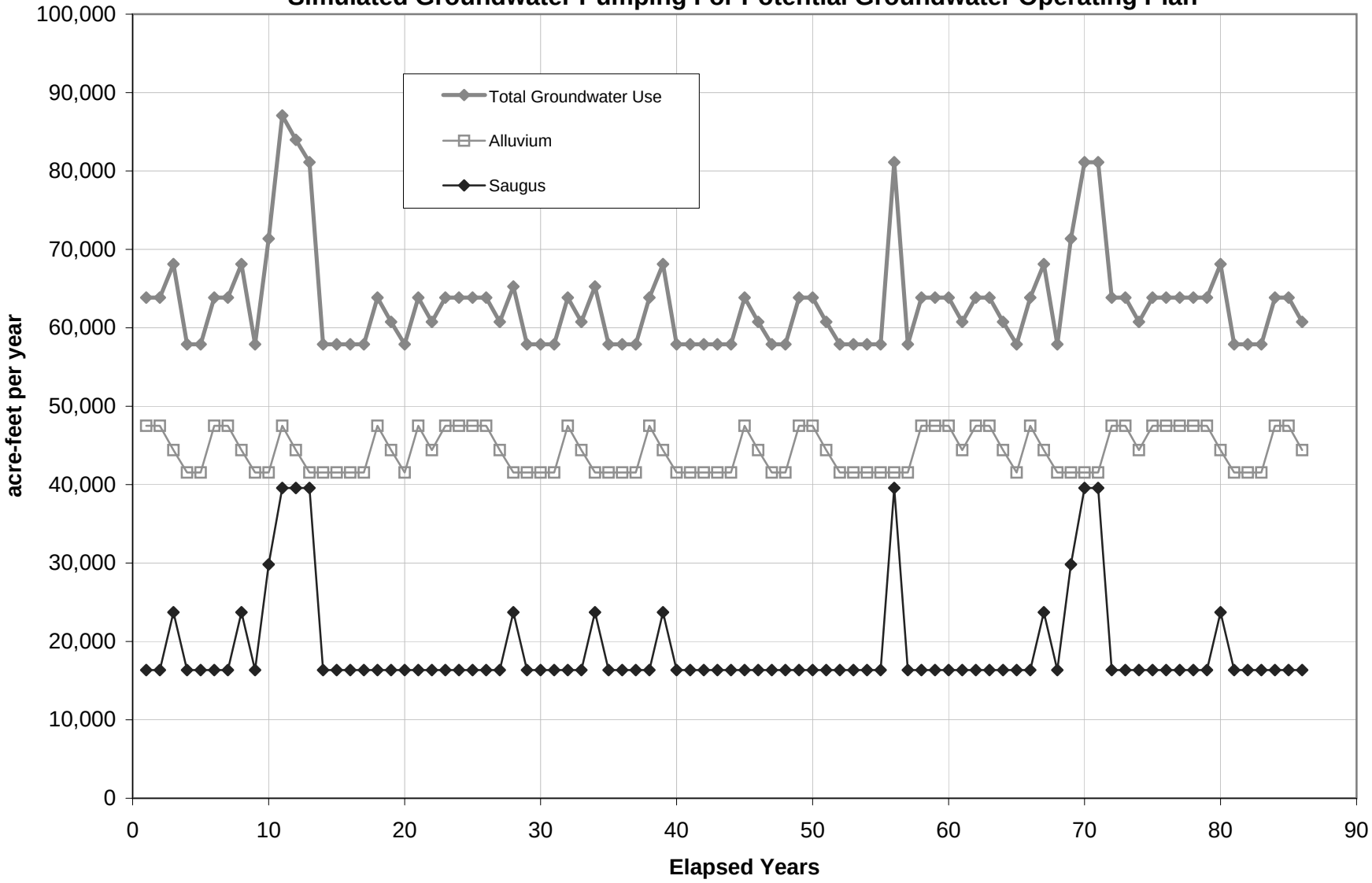


Figure 3-6
Simulated Groundwater Pumping For 2008 and Potential Groundwater Operating Plans

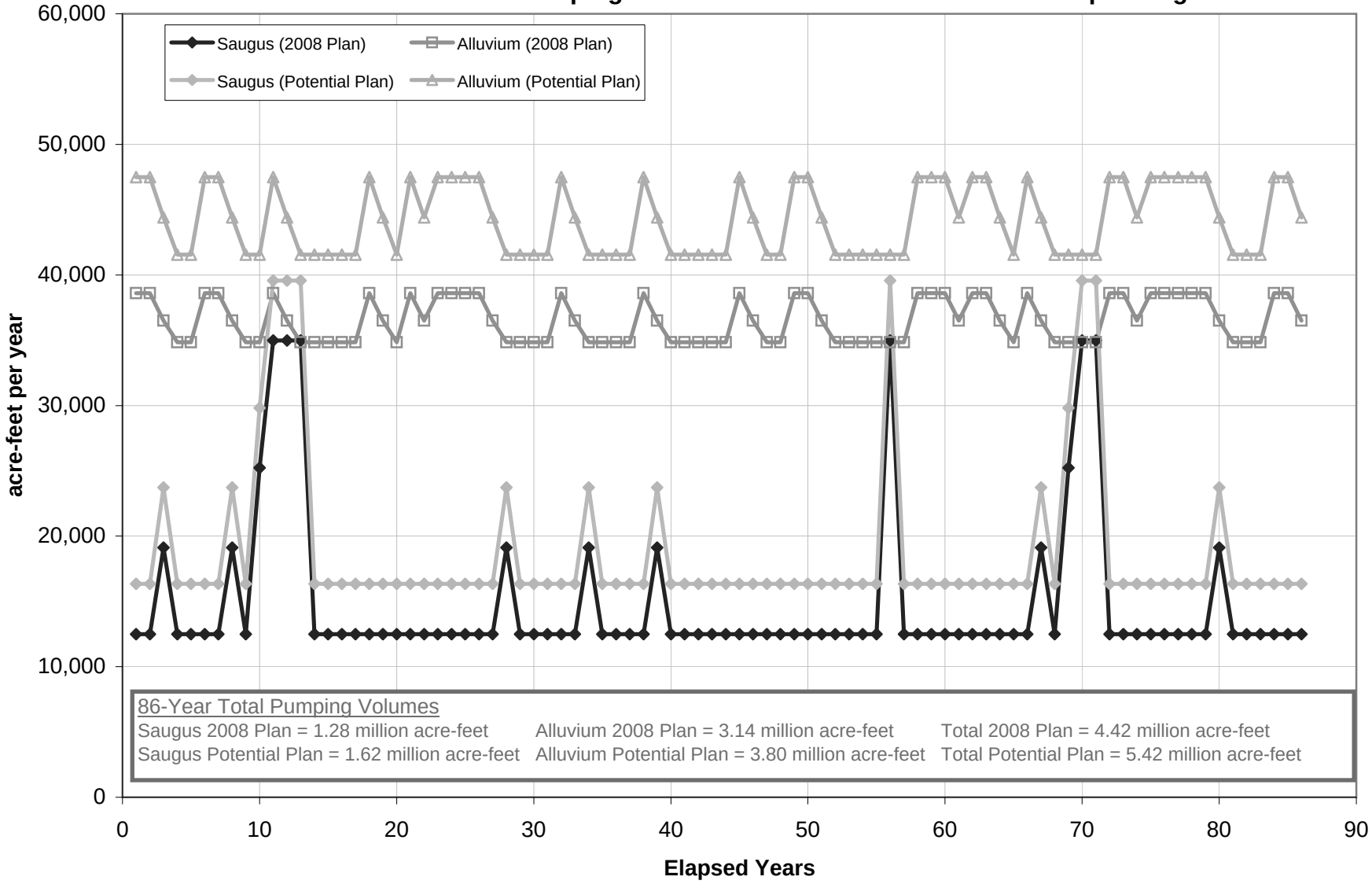
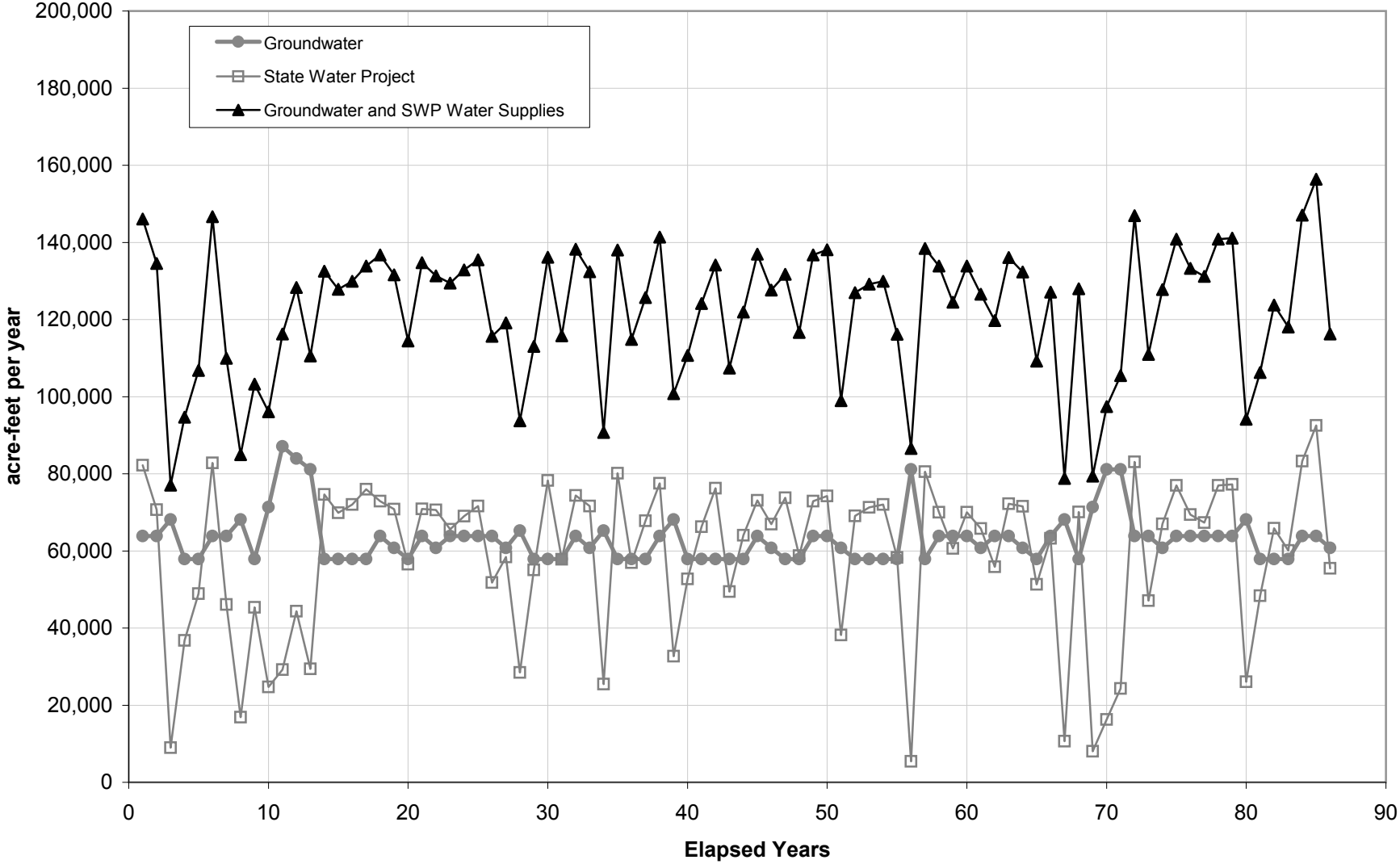


Figure 3-7
Simulated Water Supplies For Potential Groundwater Operating Plan
(Excluding Recycled Water)



IV. Sustainability of Operating Plans

This section of the report presents and discusses time-series plots (hydrographs) of simulated groundwater elevations, groundwater budget terms, and Santa Clara River flows for the 86-year modeling period. The results for the 2008 Operating Plan, the 2008 Operating Plan with Pumping Redistribution, and the future Potential Operating Plan are presented and discussed together.

4.1 Groundwater Elevations

As introduced above, groundwater elevation trends are considered to be the key indicator of long-term sustainability of an operating plan. A sustainable plan is characterized by the absence of long-term declines in groundwater levels or, if declines occur initially, subsequent long-term stabilization of groundwater levels. Concurrent with sustainability considerations, i.e. groundwater resource response to a certain level of pumping, is whether an operating plan is physically achievable. An achievable plan is one in which target pumping capacities and long-term (monthly and/or annual) target pumping volumes can be expected to be pumped without exceeding practical well and pump performance. Achievability of the plan at a given well can be evaluated by comparing groundwater elevations and trends against historical levels and against the depths in the aquifer to which the well is open (i.e., the depth interval for the well screen or the perforated steel casing).

Sections 4.1.1 through 4.1.3 discuss sustainability and achievability of the 2008 Operating Plan, the 2008 Operating Plan with Pumping Redistribution, and the Potential Operating Plan, respectively. Hydrographs illustrating basin response to each operating plan at each production well location in the Valley are contained in Appendix C.

4.1.1 2008 Operating Plan

Selected groundwater elevation hydrographs for different portions of the Alluvial Aquifer are presented on Figures 4-1 through 4-8. Each figure presents hydrographs for wells that are considered representative of conditions in the following alluvial subareas:

- Along the Santa Clara River, below the Valencia WRP (well VWC-E15)
- Along the Santa Clara River, below the Saugus WRP (well VWC-S8)
- Along the Santa Clara River, above the Saugus WRP (well VWC-T7)
- Along the Santa Clara River, at and above Mint Canyon (wells SCWD-Sierra and NCWD-Pinetree1)
- Castaic Valley (well NCWD-Castaic7)
- San Francisquito Canyon (well VWC-W11)
- Bouquet Canyon (well SCWD-Clark)

Each set of hydrographs in Figures 4-1 through 4-8 shows the simulated monthly groundwater elevations for both operating plans, as well as three sets of historical groundwater elevations

from 1980-2007 (static [non-pumping] groundwater elevations, groundwater elevations measured during pumping, and the model's simulation of historical conditions from 1980-2007).

Key findings from the simulated hydrographs for the 2008 Operating Plan are as follows:

The model simulates distinct multi-year periods of overall declining or overall increasing groundwater elevations resulting from cycles of below-normal and above-normal rainfall periods. This variation is consistent with historical observations of the relationship between rainfall and groundwater level fluctuations (CH2M HILL, 2004a; CH2M HILL and LSCE, 2005) and is particularly pronounced in much of the Alluvial Aquifer.

The 2008 Operating Plan is sustainable, but not fully achievable, in the Alluvial Aquifer as configured. Specifically:

- Alluvial Aquifer wells in each subarea do not show sustained long-term declines in groundwater elevations. Groundwater elevations decline notably in some areas during drought periods, but eventually recover in response to significant rainfall/recharge events that occur periodically, marking the end of a given drought cycle.

- The 2008 plan is achievable in most Alluvial Aquifer subareas in that the groundwater elevations remain similar to historical groundwater elevations, do not drop appreciably into the open intervals of the wells or, at wells such as SCWD-Clark, where groundwater levels are already within the open interval, are only modestly below levels observed in recent years. This means that groundwater levels in most areas are not expected to pose operational difficulties that would significantly reduce the pumping capacities of individual wells.

- However, a notable exception is in the "Above Mint Canyon" subarea, where groundwater elevations are simulated to be within the open intervals of wells during most of the simulation period. In some instances, the simulated groundwater elevations are predicted to drop below the bottom of the well, meaning that the pumping rates programmed into the model at, and prior to, that time are not expected to be physically achievable. As shown by the hydrographs, the 2008 Operating Plan is predicted to not be fully achievable in the "Above Mint Canyon" subarea under the types of drought cycles such as were observed from the mid-1920s through the late 1930s and from the mid-1940s through the mid-1970s.

- It is important to note that, because the model simulates more pumping than can physically be achieved in the "Above Mint Canyon" alluvial subarea during drought periods, actual groundwater elevations will be higher at the ends of the drought cycles than predicted by the model (because actual pumping will have to be less than what is simulated by the model). This in turn means that the relatively low groundwater elevations depicted on the hydrographs between 1976 and the early 1990s are lower than will actually occur. It also means that, while pumping at the rates contemplated in the 2008 Operating Plan may not be achievable, some lower extraction rates can likely be achieved in the "Above Mint Canyon" area, with the possibility that reductions in this

area could be offset by increased pumping in other parts of the basin. This idea is supported by a group of focused test simulations that were conducted during the course of evaluating the 2008 Operating Plan. Results are discussed in the following Section 4.1.2.

Figures 4-9 through 4-11 contain groundwater elevation hydrographs for three representative wells in the Saugus Formation (SCWD-Saugus1 just south of Bouquet Junction; NCWD-13 further to the south, along the South Fork Santa Clara River; and VWC-206 near the Valencia WRP). The principal observations from these hydrographs are:

- Groundwater elevations show long-term stability under the 2008 Operating Plan, with no sustained declines being evident. At each well, the groundwater elevations under this operating plan are slightly below the historical static elevations that were observed from 1980 through 2007, reflecting greater use of Saugus wells under the 2008 Operating Plan than has occurred historically (in particular, greater use of SCWD-Saugus1 and SCWD-Saugus2, which will begin pumping under the perchlorate containment plan described in Section 3.3.3). Nonetheless, the groundwater elevations are at or above historically recorded pumping elevations, and notably above the top of the open interval of each well, indicating that the 2008 Operating Plan should be achievable at each well and sustainable in the long-run.

4.1.2 2008 Operating Plan with Pumping Redistribution

During the prolonged dry period from the mid-1940s through the mid-1970s, when there were few years of significantly greater-than-average rainfall, the 2008 Operating Plan might have been achievable if pumping in the "Above Mint Canyon" alluvial subarea had been lower than the pumping volume contemplated in the 2008 Operating Plan. This reduction would not have been necessary during other historical periods that were characterized by intermittent years of significant rainfall, streamflow, and associated groundwater recharge (such as occurred periodically from the late 1970s through 2005).

This possibility was examined as follows. Recognizing that SCWD is in the midst of constructing new or replacement wells (e.g. to replace its perchlorate-impacted Stadium well) to the west of the "Above Mint Canyon" subarea, a potential redistribution of some SCWD pumping, as analyzed in the 2008 Operating Plan, was crafted whereby 1,600 afy of pumping was moved from three SCWD wells in the "Above Mint Canyon" subarea (near the mouth of Sand Canyon) to the replacement SCWD Santa Clara and Bouquet wells, located in the "Above Saugus WRP" and "Bouquet Canyon" subareas, respectively (Table 3-9). The resultant impact on groundwater levels to the west was nearly insignificant, indicating no adverse effect on either sustainability or achievability of groundwater at a higher pumping rate in those subareas (Figures 4-12 through 4-15). However, in the "Above Mint Canyon" area to the east, while there was appreciable improvement, in places up to 20 feet of higher groundwater levels through prolonged dry periods, the redistribution of 1,600 afy from this alluvial subarea is not predicted to significantly improve operating conditions at most of the production wells in this area, as groundwater levels are still predicted to decline close to, or below, the open intervals of many of the existing production wells under the historical hydrologic conditions observed from the mid-1940s through the mid-1970s (see Figures 4-12 through 4-15).

The preceding "redistribution" analysis suggests that the Purveyors can expect that the "Above Mint Canyon" subarea will suffer from significantly depressed groundwater levels through extended dry periods that will, in turn, physically limit the amount of groundwater pumping in that area, most notably from the SCWD wells in that subarea. The "redistribution" analysis indicates that increased pumping to the west, to offset reduced pumping in the "Above Mint Canyon" area, is both sustainable and achievable. The residual "Above Mint Canyon" pumping (a total of 4,450 afy in multiple dry years; 3,300 afy by SCWD, 700 afy by NCWD, and 450 afy by Robinson Ranch) in the 2008 Operating Plan does not appear to be fully achievable through those dry periods. Implications are likely to be in the following range of possibilities. One possibility is that additional redistribution can be achieved by further increasing pumping to the west; that would tend to keep the total groundwater supply near the upper end (35,000 afy) of the dry-year range in the Operating Plan (Section 3.3.1). Model results of limited redistribution above indicate the probability that such can be accomplished with small decreases in groundwater levels that will not have an adverse effect on overall sustainability and achievability. A second possibility is that pumping is not increased to the west, even if pumping is reduced in the "Above Mint Canyon" area; in that case, the total achievable pumping in dry periods would be near the lower end (30,000 afy) of the dry-year range in the Operating Plan. Additionally, in this second case, because of the absence of episodic recharge events during such a prolonged period, pumping during or after years of near-normal rainfall may also require reduction to this same low end of the range in the Operating Plan (30,000 afy).

In summary, the 2008 Operating Plan, as originally crafted, would utilize groundwater in a sustainable manner, but is not expected to be fully achievable due to depressed groundwater levels at the eastern end of the basin, i.e. in the "Above Mint Canyon" area, through extended dry periods. As pumping in that area declines due to depressed groundwater levels, total Alluvial pumping can be expected to remain within the overall dry-period range in the 2008 Operating Plan (30,000 to 35,000 afy). With redistribution of pumping to the west, Alluvial pumping can be achieved toward the upper end of that range. However, without pumping redistribution to the west, Alluvial pumping can be expected to decrease toward the lower end of that range during most years until an episodic rainfall and recharge event occurs that substantially recharges the aquifer in the "Above Mint Canyon" area.

4.1.3 Potential Operating Plan

The Potential Operating Plan is not sustainable or achievable in the Alluvial Aquifer as configured. Although there are local areas where groundwater conditions would appear sustainable, overall the Potential Operating Plan is not sustainable or achievable because several of the Alluvial Aquifer subareas show groundwater elevations that are distinctly lower during most of the 86-year simulation period than under the 2008 Operating Plan, and show a continued decline over time (Figures 4-1 through 4-8).

The Potential Operating Plan shows modest long-term declines in Saugus Formation groundwater elevations at each Saugus production well, as indicated by comparing the relatively high groundwater elevations in the mid-1940s (following the drought of the mid-1920s through late 1930s) with the relatively high, but slightly lower, groundwater elevations of the mid-1980s

(following the drought of the mid-1940s through mid-1970s). The hydrographs in Figures 4-9 through 4-11 indicate that pumping during the next several decades from the Saugus Formation under the Potential Operating Plan would likely be achievable, but the long-term decline indicates that the Potential Operating Plan may not be sustainable beyond the next several decades.

4.2 Groundwater Recharge, Discharge, and Storage

The sustainability of each operating plan can also be evaluated by examining trends in groundwater recharge and groundwater discharge during the 86-year simulation period. The magnitudes of individual groundwater recharge mechanisms at any given time are the same for the 2008 Operating Plan and the Potential Operating Plan, because recharge is an input to the model and is not affected by groundwater pumping. However, the groundwater discharge terms are different for the two plans because of the different groundwater pumping rates and the corresponding differences between the two plans in how they affect groundwater levels and, therefore, the magnitudes of the various components of groundwater discharge.

Figure 4-16 compares the magnitudes and trends in groundwater recharge and groundwater discharge for the 2008 Operating Plan. The figure shows that groundwater recharge rates vary greatly from year to year because of year-to-year variations in precipitation and stormwater generation within the groundwater basin and in the contiguous upstream watersheds. In contrast, total groundwater discharge is much less variable from year to year, with variations arising from increased pumping during drought years and increased evapotranspiration and groundwater discharge to the Santa Clara River during wet years. The groundwater discharge plot shows no obvious downward trend over time in groundwater discharges to streams or other discharge terms, and total discharges are do not show a continued downward trend over time. This indicates that the 2008 Operating Plan is sustainable in the long-term, a conclusion that is consistent with the examination of the groundwater elevation hydrographs discussed previously in Section 4.1.1.

Figure 4-17 compares the groundwater discharge terms for the 2008 and Potential Operating Plans. The figure shows that total groundwater discharges and discharges to streams are lower under the Potential Operating Plan than under the 2008 Operating Plan. The discharges to streams appear to decline gradually over time under the Potential Operating Plan, whereas these discharges appear more stable under the 2008 plan after the 1940s and early 1950s. This difference in groundwater discharge trends between the two operating plans is also evident in a plot showing the cumulative change in groundwater storage over time during the 86-year simulation period (Figure 4-18). The cumulative change in groundwater storage is a measure of the longer-term trends in the amount of groundwater in storage, and is plotted on a monthly basis. The 2008 Operating Plan shows a recovery of groundwater storage volumes beginning in the late 1970s, after the droughts of prior years. While the Potential Operating Plan also shows some recovery in the late 1970s, the curve as a whole remains lower in value after the 1940s than during the first two decades of the simulation.

In summary, the differences between the two operating plans' groundwater discharge trends and groundwater storage trends during the 86-year simulation period is consistent with the observed

trends in groundwater elevations and the associated conclusions about sustainability discussed above.

4.3 River Flows

Figure 4-19 shows the total flows estimated by the model for the Santa Clara River at the County Line gage, which is located at the western end of the Valley. The figure contains both a linear plot and a semi-logarithmic plot, to better illustrate the flows during low-flow periods. As shown by both plots, total flow in the river at the County Line varies considerably over time. This variation occurs because of temporal variations in rainfall, streamflow, and groundwater discharges to the river.

The influences of the local hydrology and the groundwater operating plans on the Santa Clara River are also shown by Figure 4-20, which displays the model-calculated volumes of monthly groundwater discharge to the river. Groundwater discharges to the river occur along the river reach lying downstream of the mouth of San Francisquito Canyon. The figure shows that the groundwater discharge rates to the river also vary over time, both seasonally and over multi-year periods. For the 2008 Operating Plan, the model simulates no groundwater discharge to the river at certain times during the droughts of the mid-1930s and the mid-1940s to mid-1970s. In contrast, the Potential Operating Plan not only results in smaller discharges to the river at most times, but also results in many more months of no groundwater discharge to the river compared with the 2008 Operating Plan.

As discussed by CH2M HILL (2004a), the river baseflow (flow other than from stormwater runoff) gage has increased at the County Line since water imports into the Valley began in 1980. Figure 4-21 shows the historically recorded monthly flow during the driest month of each year since 1950 and compares this flow with the driest-month flow predicted to occur each year under the 2008 and Potential Operating Plans. The plot shows that under the local, ambient hydrologic conditions observed from 1922 through 1979, the 2008 Operating Plan would have maintained river flows at levels higher than were actually recorded during those years (prior to the importation of water). The Potential Operating Plan also would have maintained higher river flow in most years, with a few years (1969, 1972, and 1975) showing similar driest-month river flows as were historically recorded. This indicates that both operating plans, and in particular the 2008 Operating Plan, will maintain river flows at higher levels than occurred prior to urbanization of the Valley.

4.4 Relationship of Simulation Results to Future Conditions

The curves presented on Figures 4-1 through 4-21 provide a general indication of the types of fluctuations in groundwater conditions that could be expected to occur in the future in the Santa Clarita Valley over a period of many years under the two operating plans. However, these curves have been derived using an assumed sequence of local hydrologic conditions that is based on the sequence of rainfall and streamflow volumes that were measured during the past several decades. In the future, the year-to-year volumes and trends in rainfall and streamflow could vary from those observed in the past because of 1) changes in the timing and magnitude of multi-decadal cycles of drought and wetter-than-normal conditions such as those that have been observed in the

past; and/or 2) because of global-scale changes in climate. The latter topic and its potential effect on the sustainability of the 2008 Operating Plan are discussed in the following Chapter 5 of this report.

Ta le 4-

Pumping Rates Simulated for Individual Alluvial Aquifer Wells nder the Re- istri uted 2008 Groundwater Operating Plan Listed B Alluvial Su area
er Santa lara i er roun ater asin, ast Subbasin, os ngeles ount , alifornia

		Original 2008 Operating Plan			Re-Distributed 2008 Operating Plan			
Well Name	**Alluvial Subarea**	**Normal**	**Dry Yr 1**	**Dry Yr 2+**	**Normal**	**Dry Yr 1**	**Dry Yr 2+**	**Comments**
NCWD-Pinetree 1	Above Mint Canyon	150	0	0	150	0	0	
NCWD-Pinetree 3	Above Mint Canyon	350	300	300	350	300	300	
NCWD-Pinetree 4	Above Mint Canyon	300	200	200	300	200	200	
NCWD-Pinetree 5	Above Mint Canyon	300	200	200	300	200	200	
Robinson Ranch	Above Mint Canyon	600	550	450	600	550	450	
SCWD-Sand Canyon	**Above Mint Canyon**	**1,000**	**600**	**200**	**200**	**150**	**0**	**Reduce these three wells by 1,600 afy in order to**
SCWD-Lost Canyon 2	**Above Mint Canyon**	**700**	**700**	**650**	**300**	**150**	**0**	**offset increased pumping at the SCWD-Santa Clara and**
SCWD-Lost Canyon 2A	**Above Mint Canyon**	**700**	**650**	**600**	**300**	**150**	**0**	**SCWD-Bouquet wells in the "Above Saugus WRP" area.**
SCWD-Mitchell #5A	Above Mint Canyon	500	350	200	500	350	200	
SCWD-Mitchell #5B	Above Mint Canyon	800	550	300	800	550	300	
SCWD-N. Oaks Central	Above Mint Canyon	850	800	700	850	800	700	
SCWD-N. Oaks East	Above Mint Canyon	800	750	700	800	750	700	
SCWD-N. Oaks West	Above Mint Canyon	800	750	700	800	750	700	
SCWD-Sierra	Above Mint Canyon	1,100	900	700	1,100	900	700	
Mint Canyon Total		**8,950**	**7,300**	**5,900**	**7,350**	**5,800**	**4,450**	
SCWD-Honby	Above Saugus WRP	1,000	850	700	1,000	850	700	
SCWD-Santa Clara	Above Saugus WRP	800	800	800	800	800	800	
SCWD-Valley Center	**Above Saugus WRP**	**0**	**0**	**0**	**800**	**800**	**800**	**Pumps 800 afy moved from the "Above Mint Canyon" area.**
SCWD-Bouquet	**Above Saugus WRP**	**0**	**0**	**0**	**800**	**800**	**800**	**Pumps 800 afy moved from the "Above Mint Canyon" area.**
VWC-T7	Above Saugus WRP	750	750	750	750	750	750	
VWC-U4	Above Saugus WRP	800	800	800	800	800	800	
VWC-U6	Above Saugus WRP	800	800	800	800	800	800	
Above Saugus WRP Total		**4,150**	**4,000**	**3,850**	**5,750**	**5,600**	**5,450**	
VWC-N	Below Saugus WRP	650	650	650	650	650	650	
VWC-N7	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	1,160	
VWC-N8	Below Saugus WRP	1,160	1,160	1,160	1,160	1,160	1,160	
VWC-Q2	Below Saugus WRP	1,100	1,100	1,100	1,100	1,100	1,100	
VWC-S6	Below Saugus WRP	1,000	1,000	1,000	1,000	1,000	1,000	
VWC-S7	Below Saugus WRP	500	500	500	500	500	500	
VWC-S8	Below Saugus WRP	500	500	500	500	500	500	
Below Saugus WRP Total		**6,070**	**6,070**	**6,070**	**6,070**	**6,070**	**6,070**	
NLF-161	Below Valencia WRP	1,000	1,000	1,000	1,000	1,000	1,000	
NLF-B10	Below Valencia WRP	500	350	350	500	350	350	
NLF-B11	Below Valencia WRP	100	200	200	100	200	200	
NLF-B14	Below Valencia WRP	300	1,000	1,000	300	1,000	1,000	
NLF-B20	Below Valencia WRP	350	500	500	350	500	500	
NLF-B5	Below Valencia WRP	2,400	1,900	1,900	2,400	1,900	1,900	
NLF-B6	Below Valencia WRP	1,100	1,100	1,100	1,100	1,100	1,100	
NLF-C	Below Valencia WRP	1,100	1,000	1,000	1,100	1,000	1,000	
NLF-C3	Below Valencia WRP	100	200	200	100	200	200	
NLF-C4	Below Valencia WRP	200	450	450	200	450	450	
NLF-C5	Below Valencia WRP	900	850	850	900	850	850	
NLF-C7	Below Valencia WRP	350	300	300	350	300	300	
NLF-C8	Below Valencia WRP	400	400	400	400	400	400	
NLF-E5	Below Valencia WRP	100	150	150	100	150	150	
NLF-E9	Below Valencia WRP	900	350	350	900	350	350	
NLF-G45	Below Valencia WRP	350	400	400	350	400	400	
VWC-E15	Below Valencia WRP	800	800	800	800	800	800	
Below Valencia WRP Total		**10,950**	**10,950**	**10,950**	**10,950**	**10,950**	**10,950**	
SCWD-Clark	Bouquet Canyon	700	700	700	700	700	700	
SCWD-Guida	Bouquet Canyon	1,300	1,250	1,200	1,300	1,250	1,200	
Bouquet Canyon Total		**2,000**	**1,950**	**1,900**	**2,000**	**1,950**	**1,900**	
VWC-W10	San Francisquito Canyon	1,000	1,000	1,000	1,000	1,000	1,000	
VWC-W11	San Francisquito Canyon	800	800	800	800	800	800	
VWC-W9	San Francisquito Canyon	950	950	950	950	950	950	
San Francisquito Canyon Total		**2,750**	**2,750**	**2,750**	**2,750**	**2,750**	**2,750**	
NCWD-Castaic 1	Castaic Valley	350	300	250	350	300	250	
NCWD-Castaic 2	Castaic Valley	100	100	100	100	100	100	
NCWD-Castaic 4	Castaic Valley	100	0	0	100	0	0	
NCWD-Castaic 7	Castaic Valley	300	200	200	300	200	200	
VWC-D	Castaic Valley	880	880	880	880	880	880	
WHR	Castaic Valley	2,000	2,000	2,000	2,000	2,000	2,000	
Castaic Valley Total:		**3,730**	**3,480**	**3,430**	**3,730**	**3,480**	**3,430**	
Total Alluvial Pumping		**38,600**	**36,500**	**34,850**	**38,600**	**36,600**	**35,000**	**Current Operating Plan:**
								35,000 to 40,000 AF/yr in normal and wet years
								30,000 to 35,000 AF/yr in dry years

Notes:

All pumping volumes are listed in acre-feet per year (afy).

Wells that are not listed are assumed to not be pumping in the future.

NLF = Newhall Land & Farming Company

NCWD = Newhall County Water District

SCWD = Santa Clarita Division of Castaic Lake Water Agency

VWC = Valencia Water Company

WHR = Wayside Honor Rancho, whose wells are owned by the Los Angeles County Waterworks District No. 36

Figure 4-1: VWC-E15 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Below Valencia WRP)

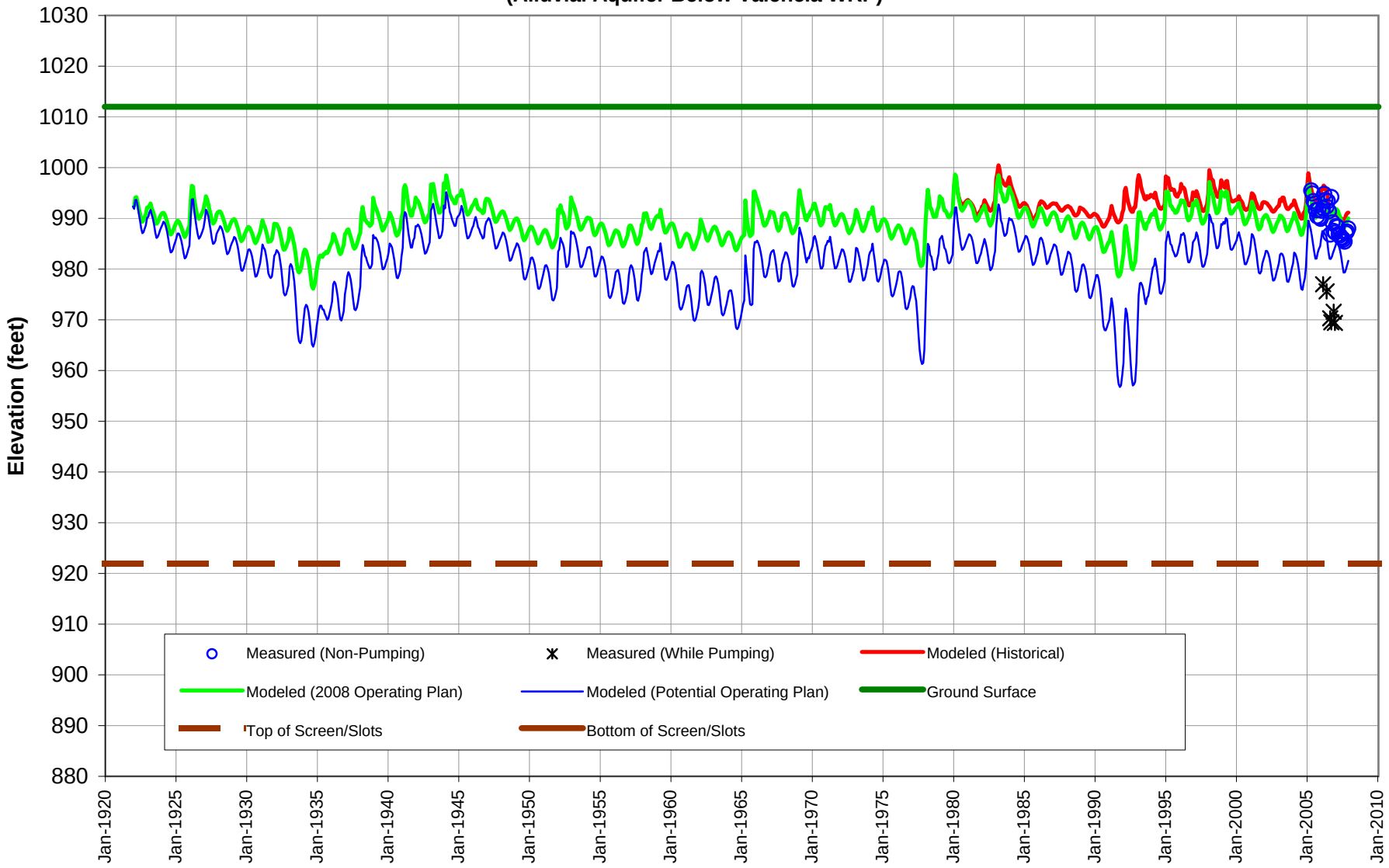


Figure 4-2: VWC-S8 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Below Saugus WRP)

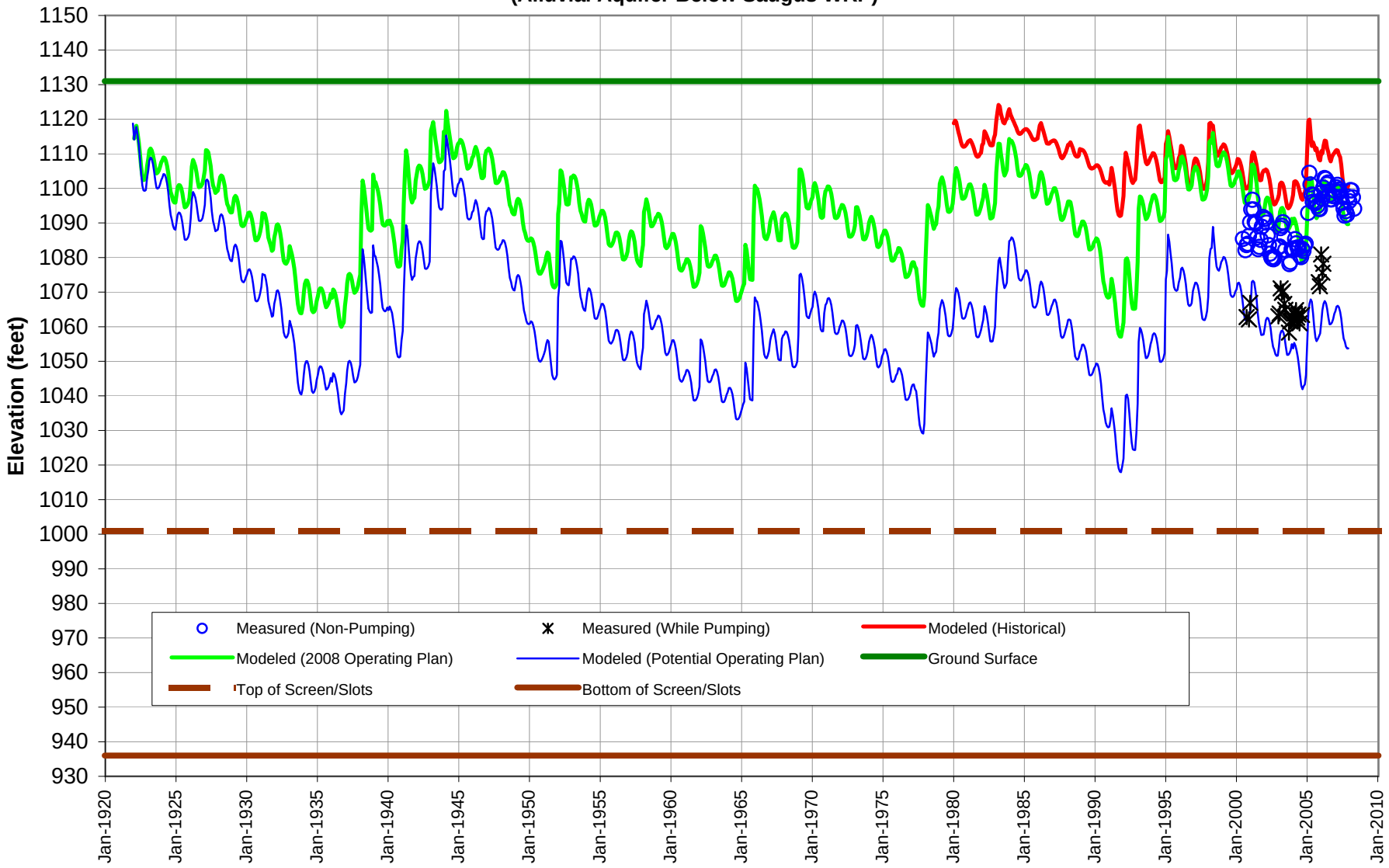


Figure 4-3: VWC-T7 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Above Saugus WRP)

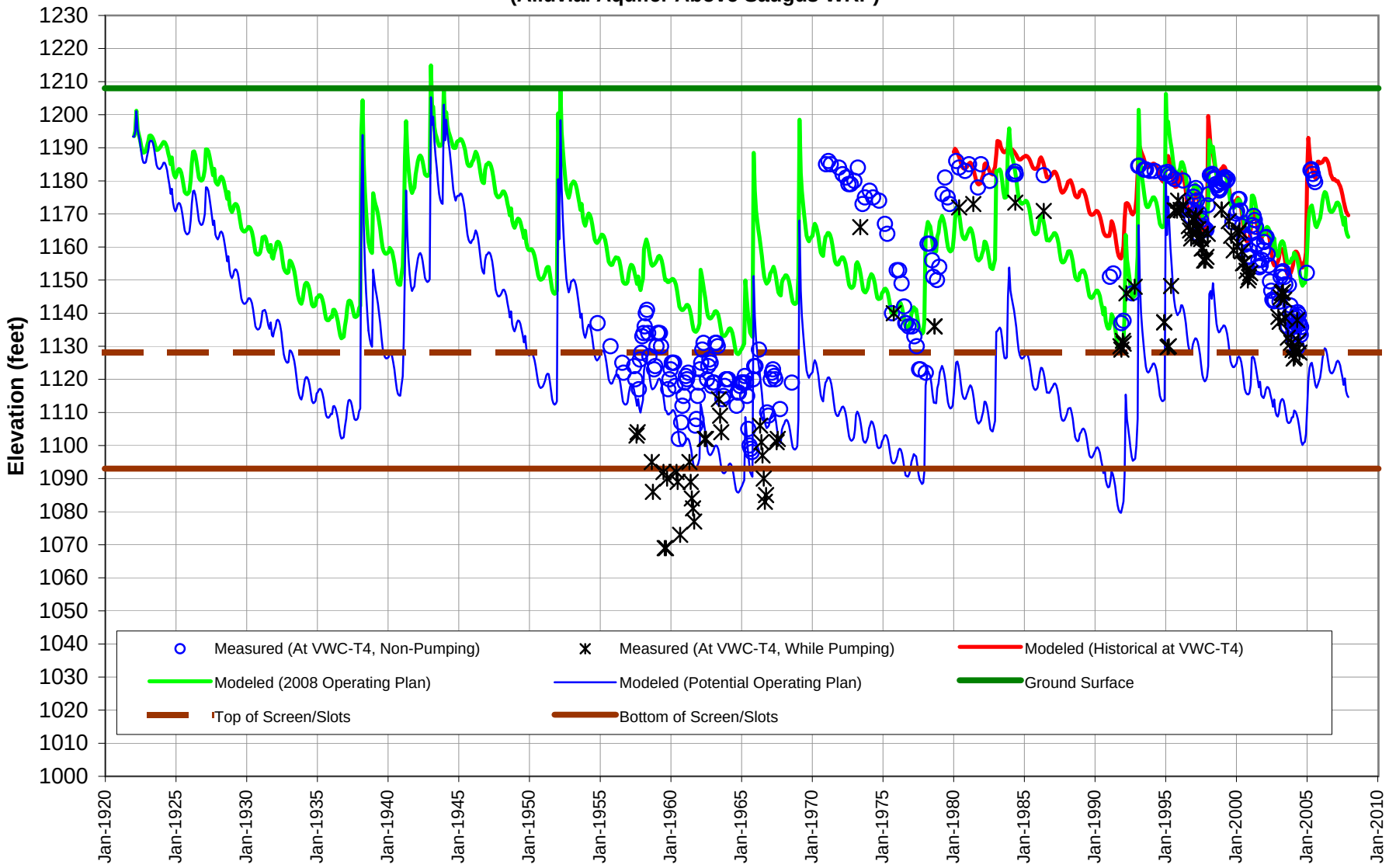


Figure 4-4: SCWD - Sierra Modeled Groundwater Elevations for 2008 and Potential Operating Plans
(Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)

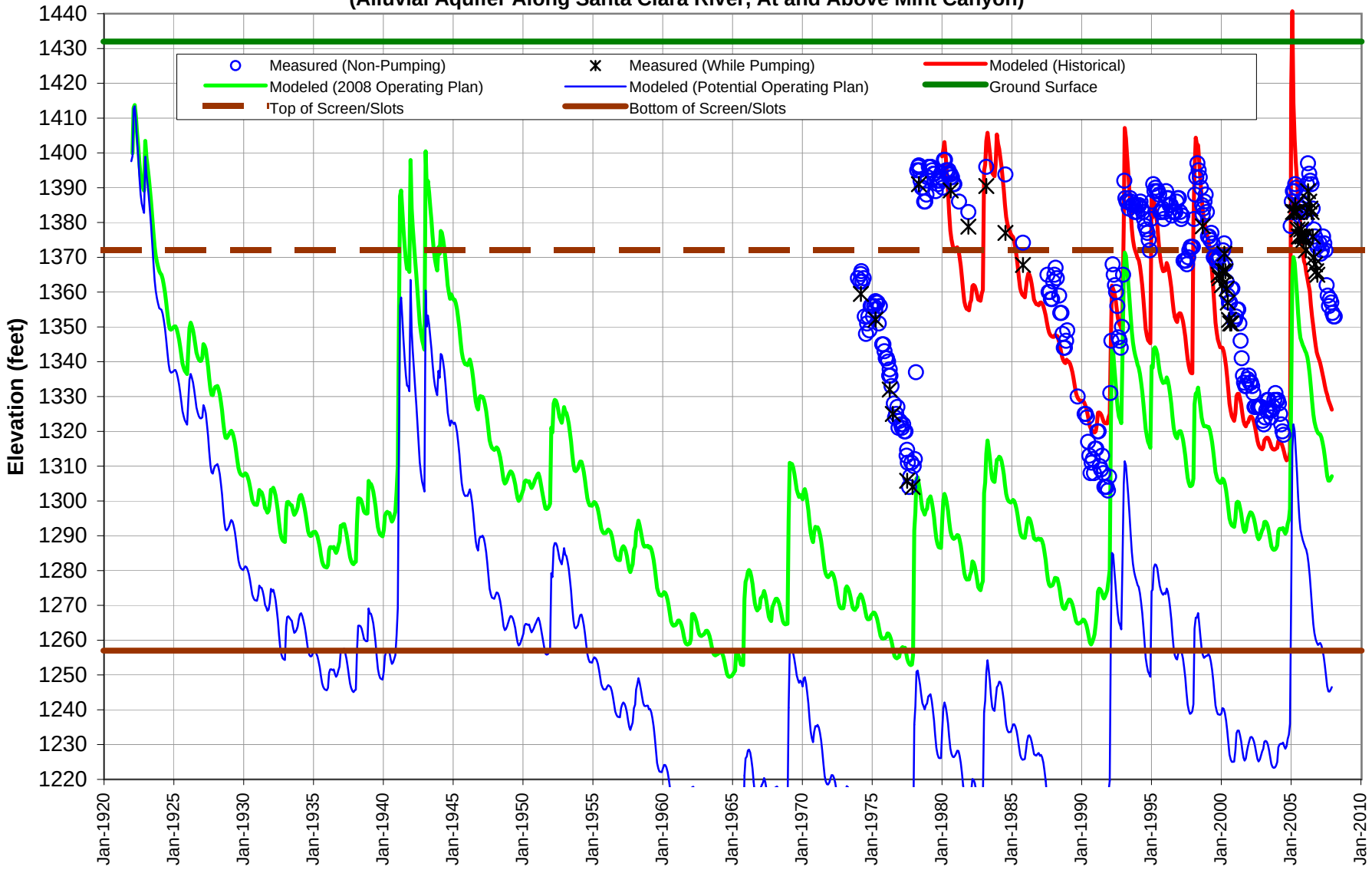


Figure 4-5: NCWD - Pinetree 1 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)

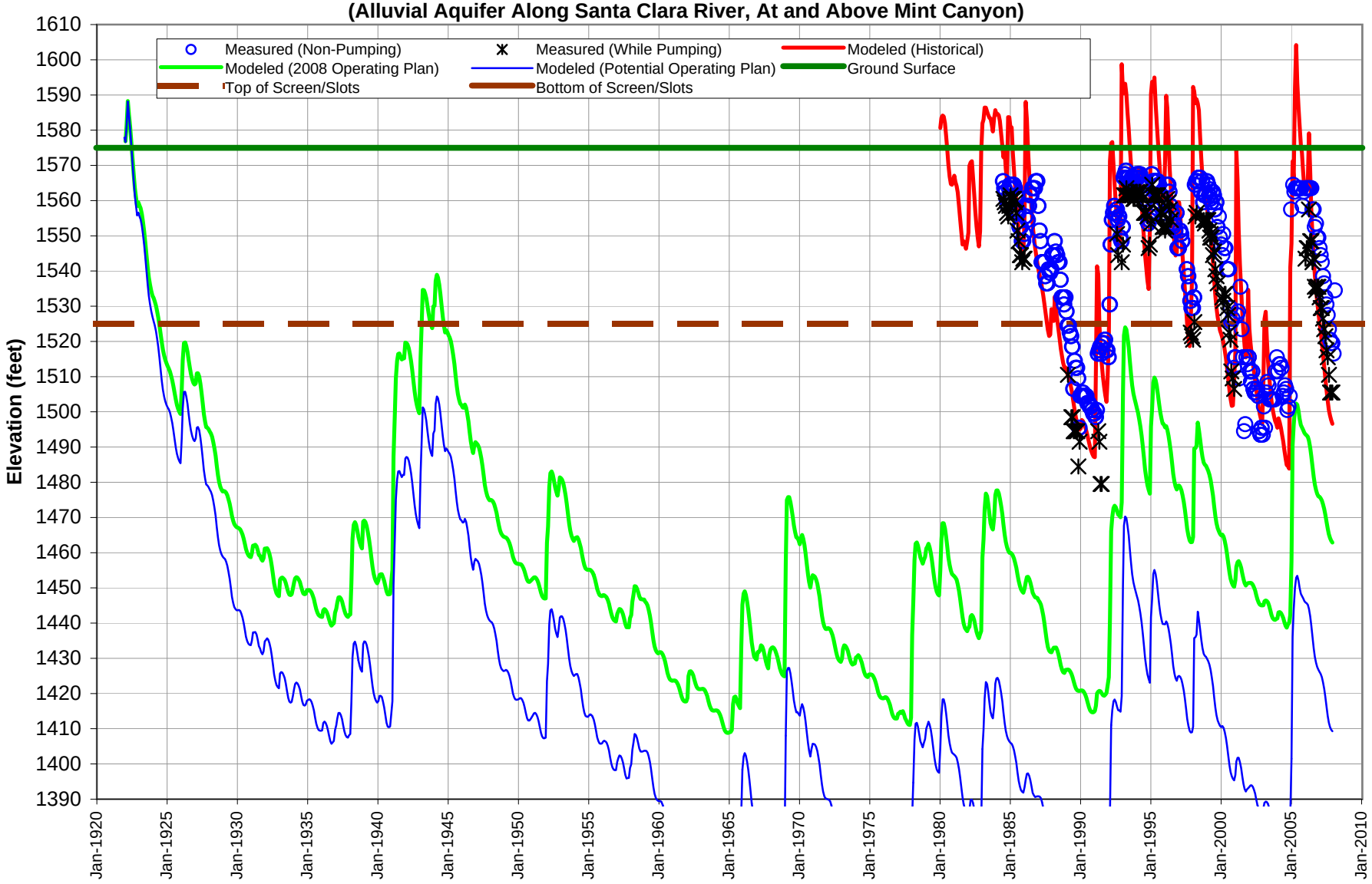


Figure 4-6: NCWD - Castaic 7 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in Castaic Valley)

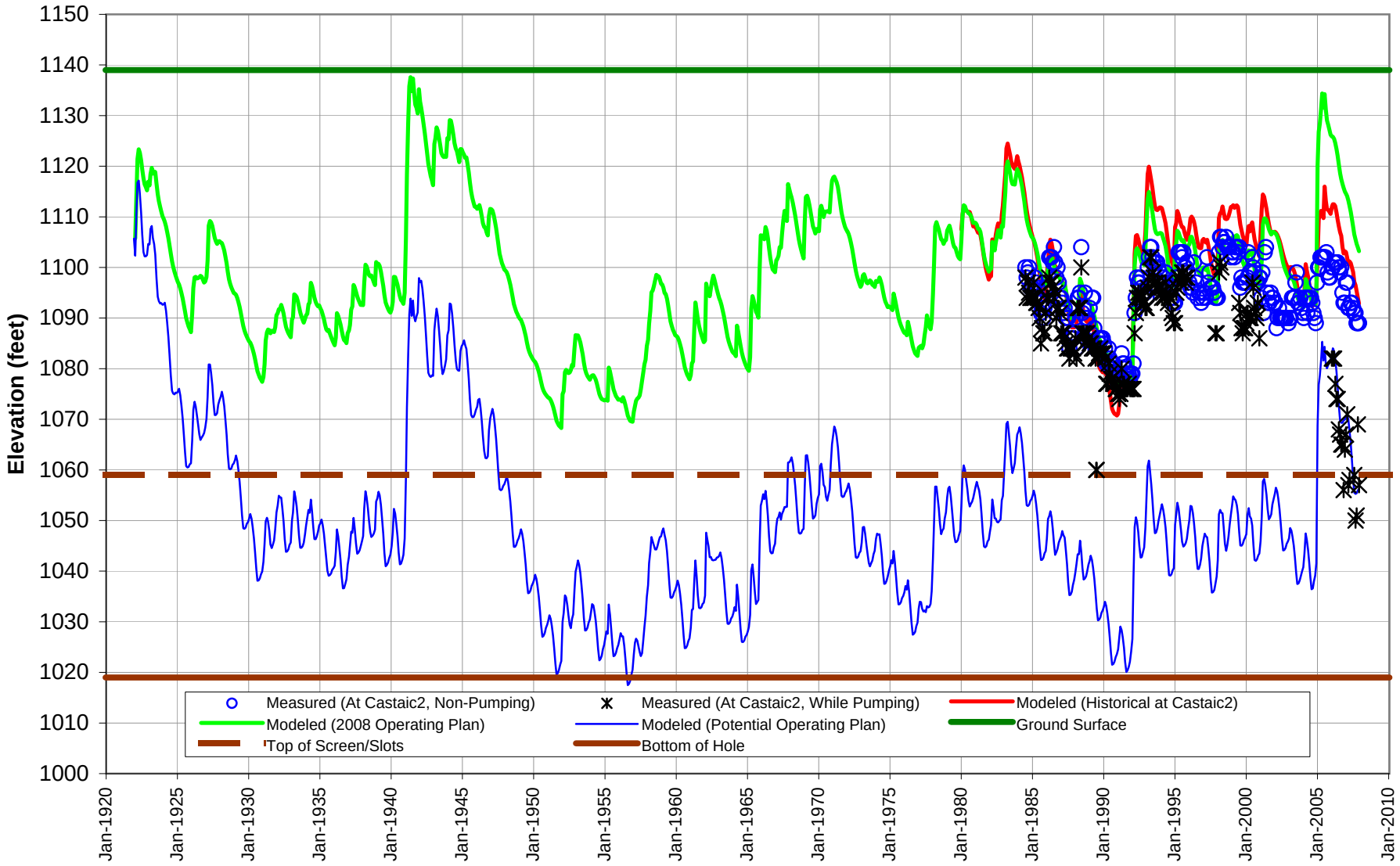


Figure 4-7: VWC-W11 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in San Francisquito Canyon)

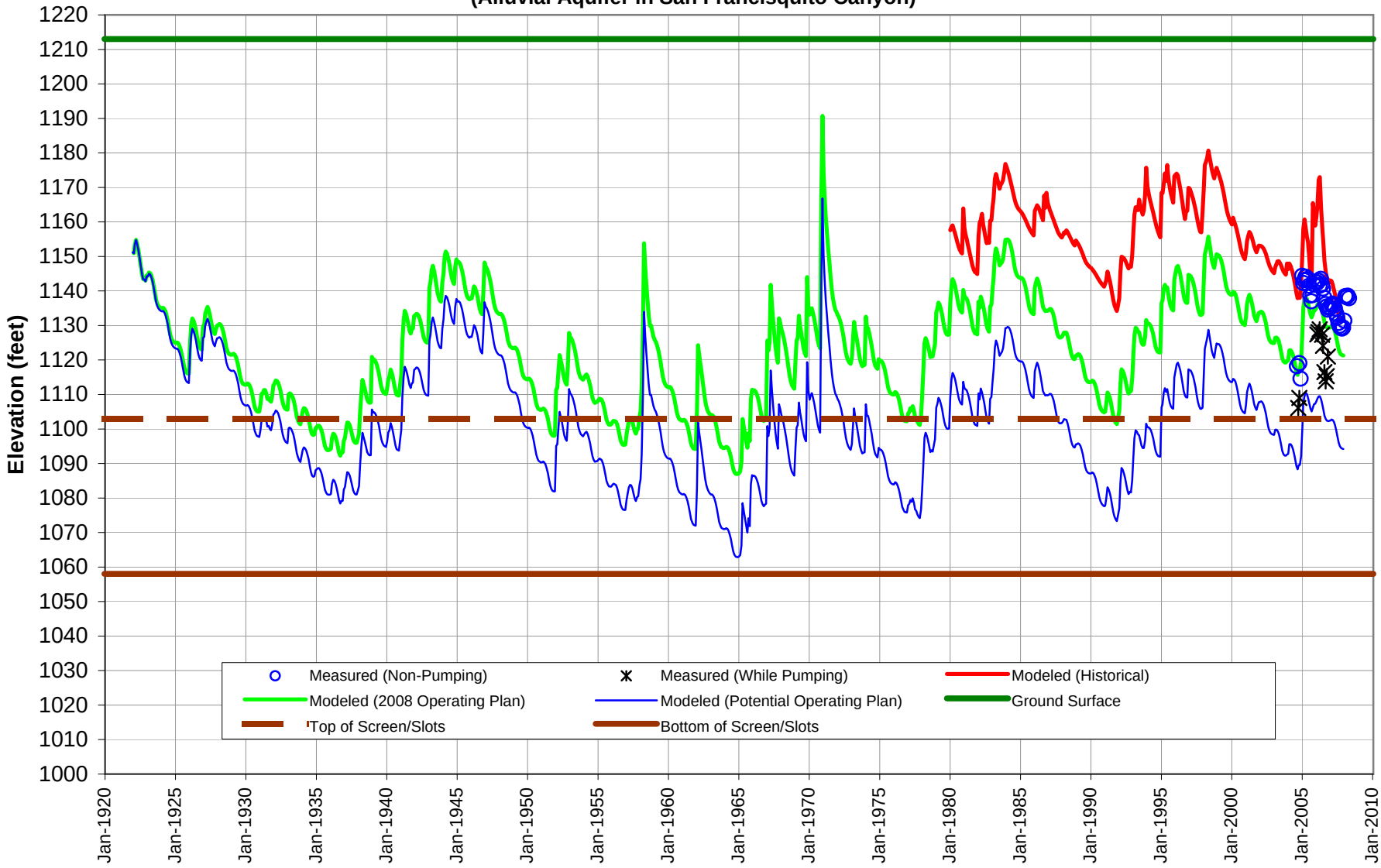


Figure 4-8: SCWD - Clark Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Alluvial Aquifer in Bouquet Canyon)

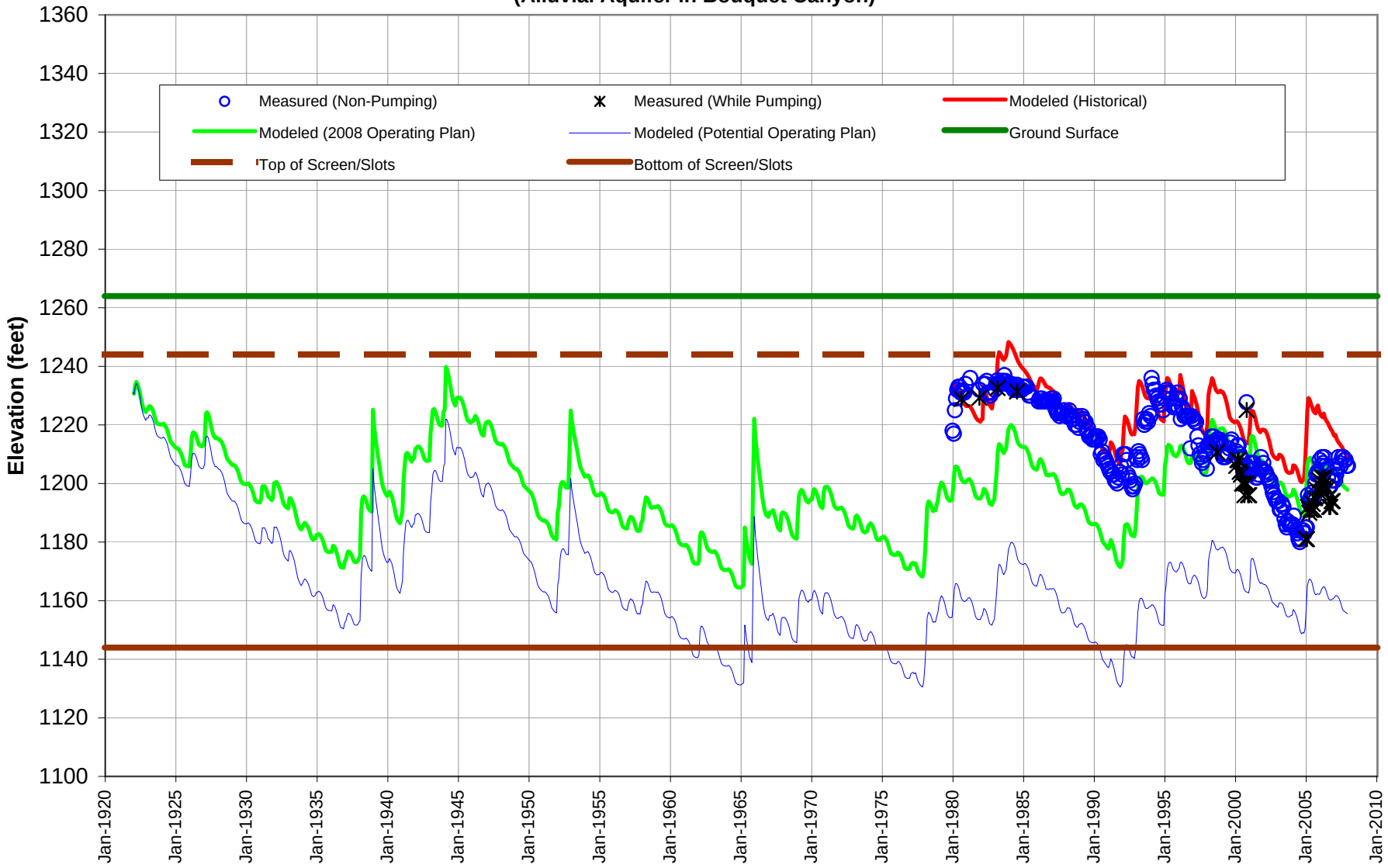


Figure 4-9: SCWD-Saugus1 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)

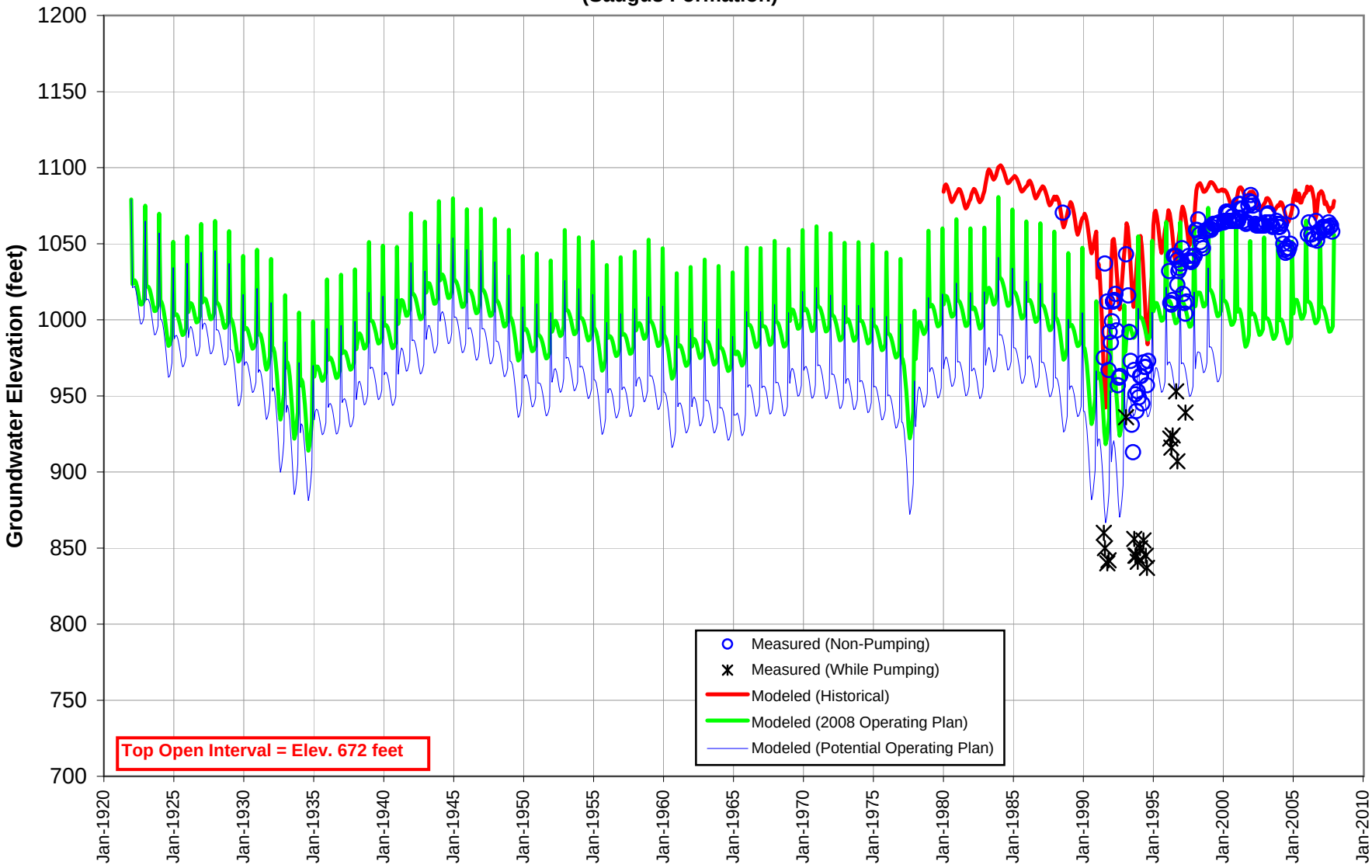


Figure 4-10: VWC-206 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)

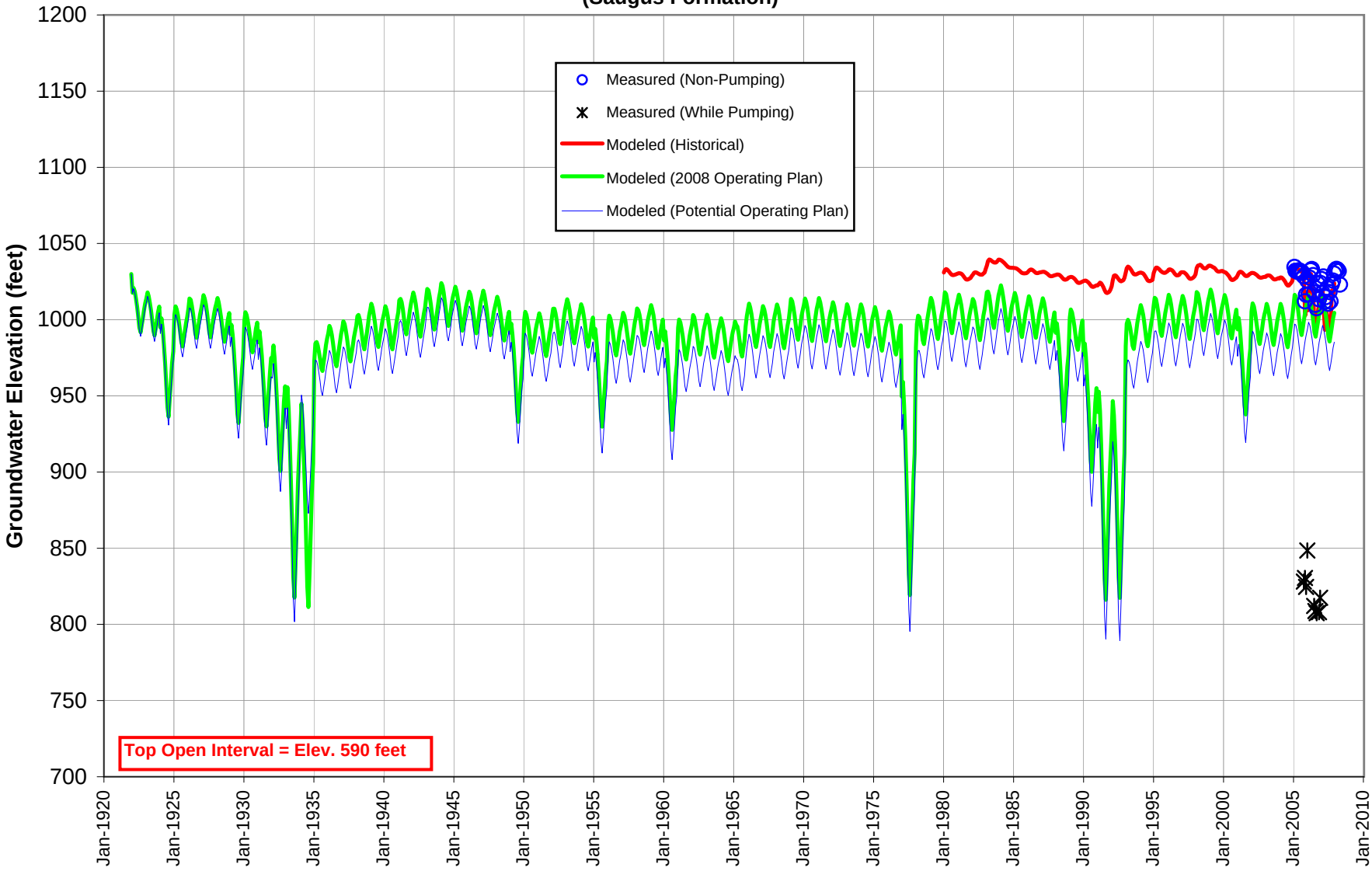


Figure 4-11: NCWD-13 Modeled Groundwater Elevations for 2008 and Potential Operating Plans (Saugus Formation)

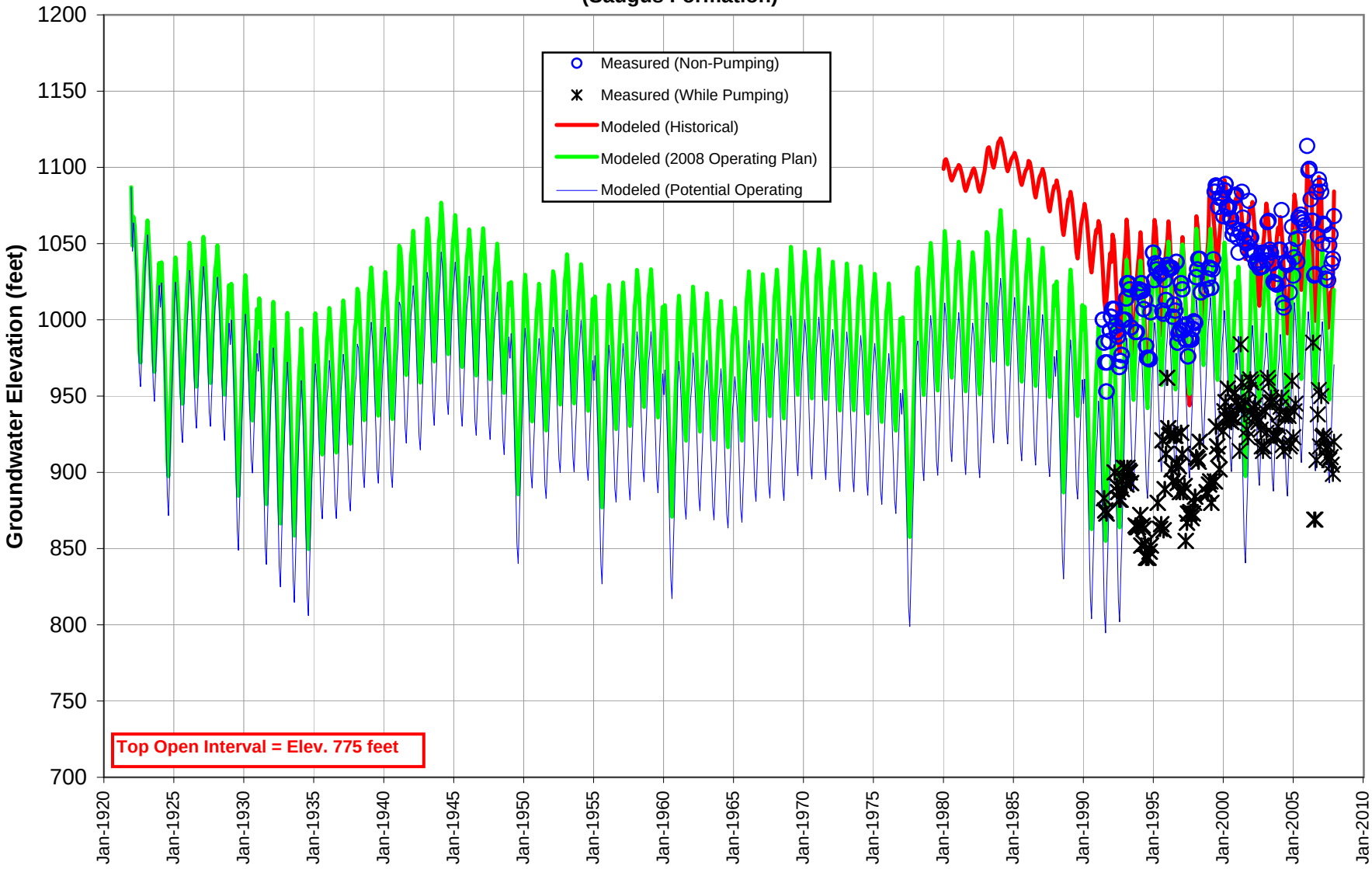


Figure 4-12: VWC-T7 Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer Above Saugus WRP)

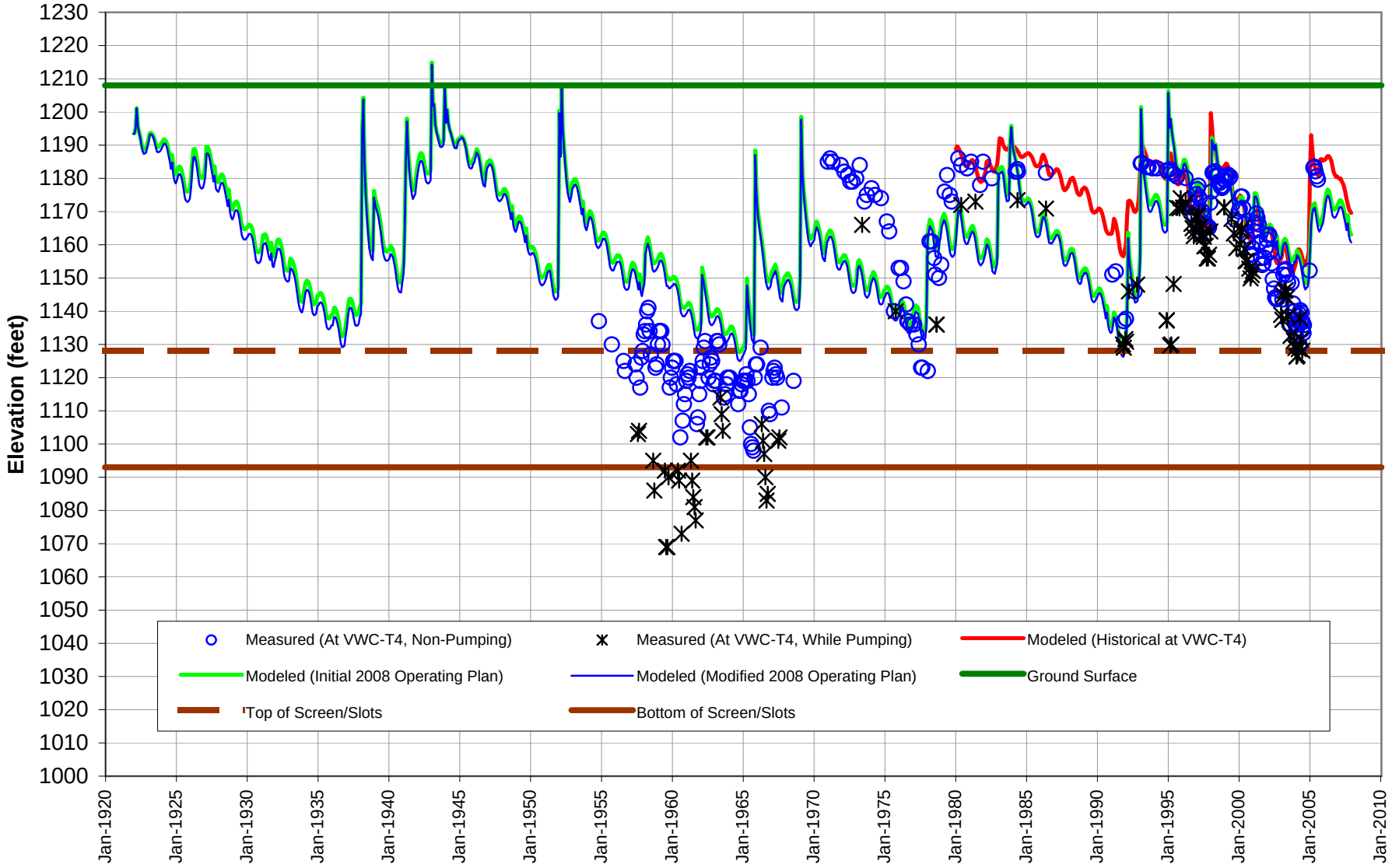


Figure 4-13: SCWD-Clark Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer in Bouquet Canyon)

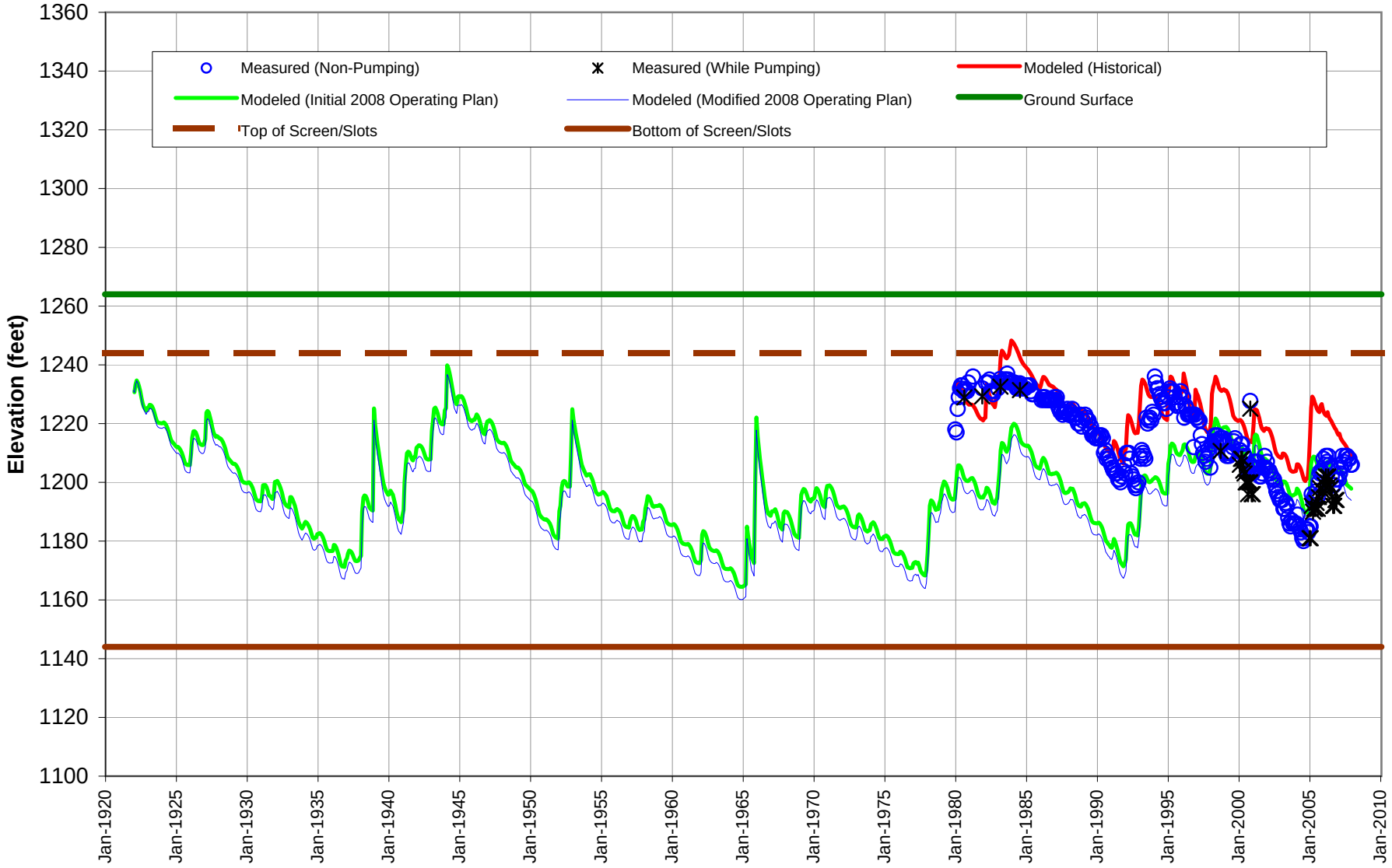


Figure 4-14: SCWD-Sierra Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans
(Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)

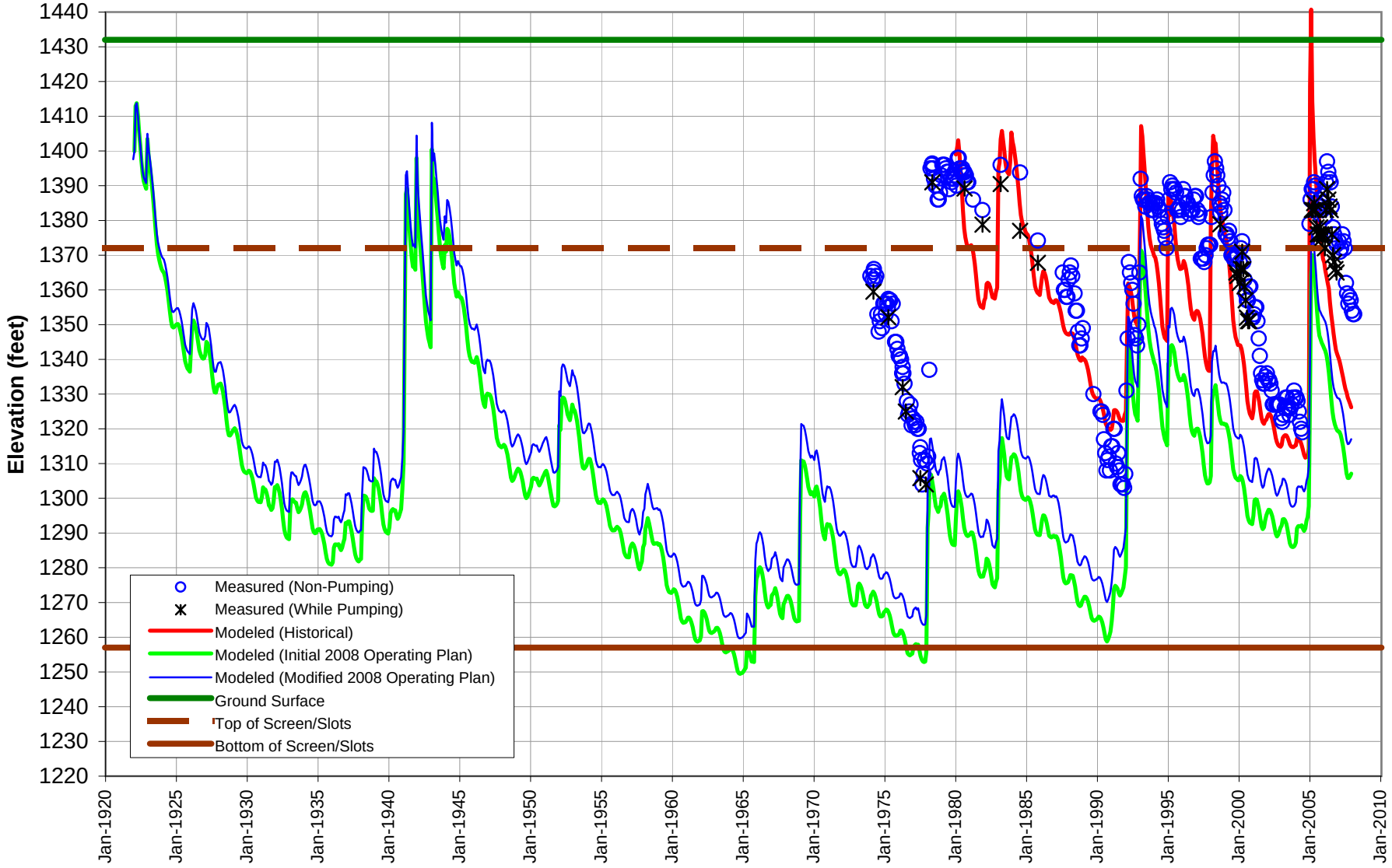


Figure 4-15: NCWD-Pinetree3 Modeled Groundwater Elevations for Initial and Modified 2008 Operating Plans (Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)

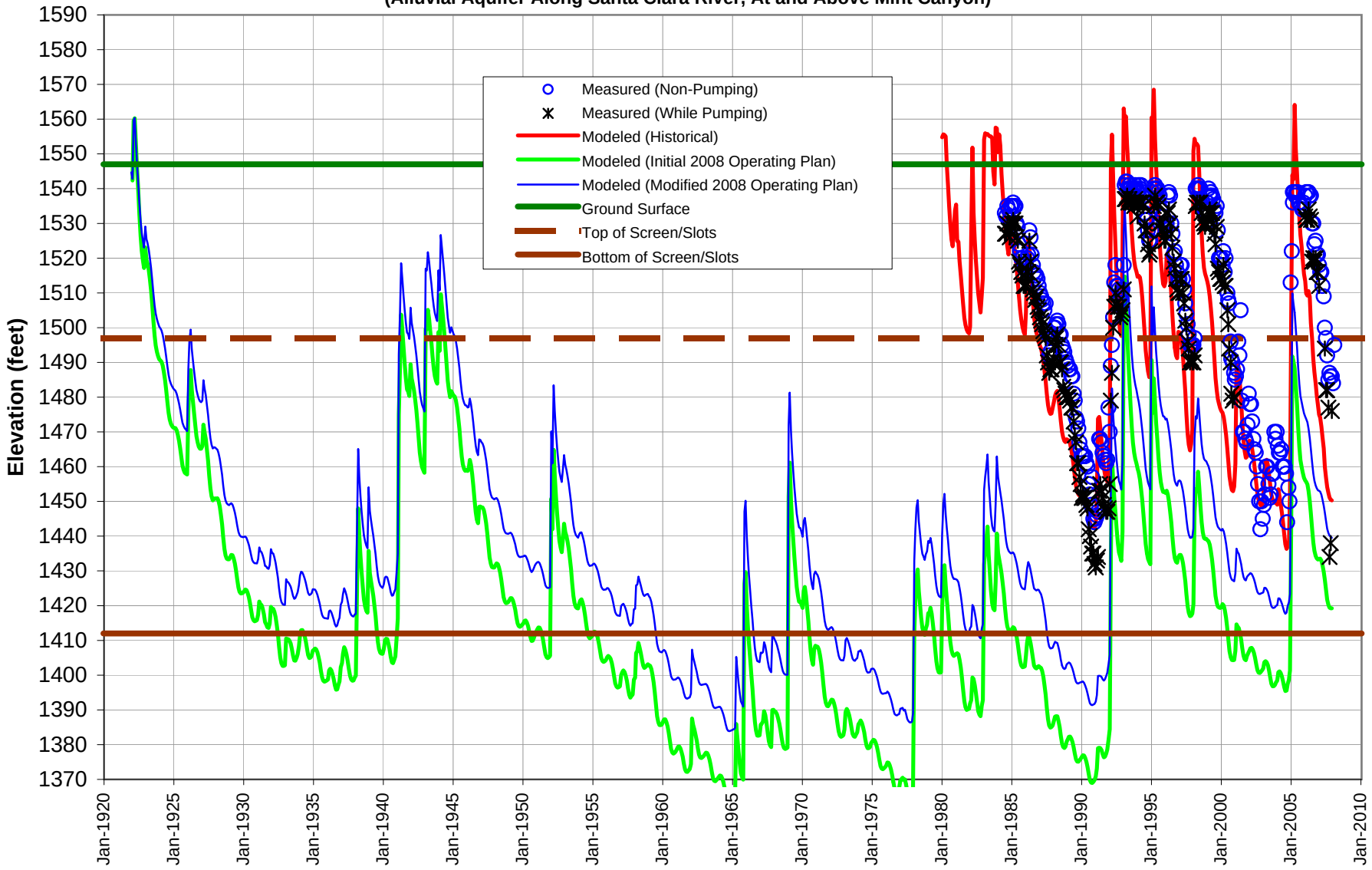
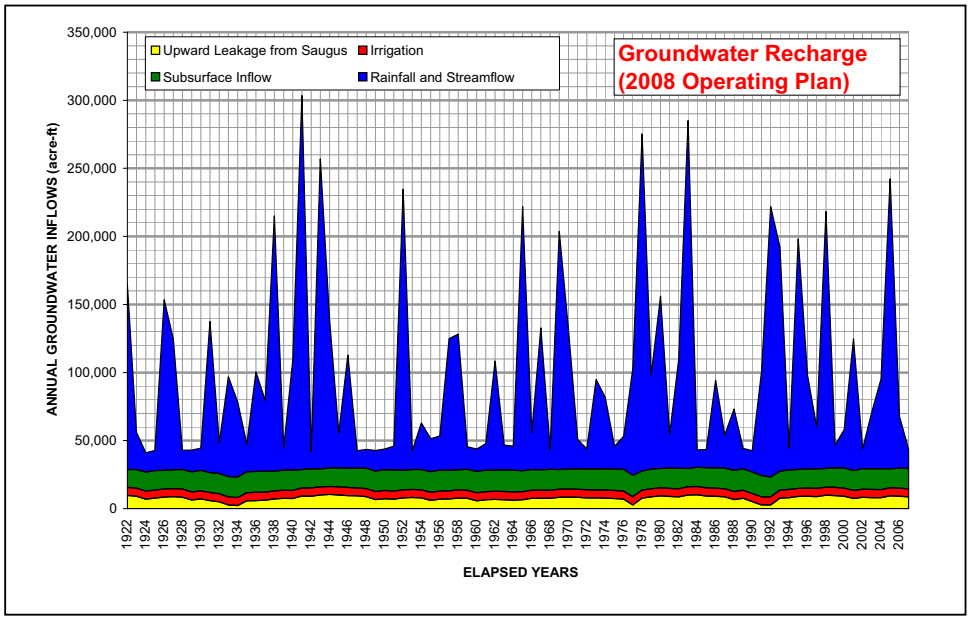
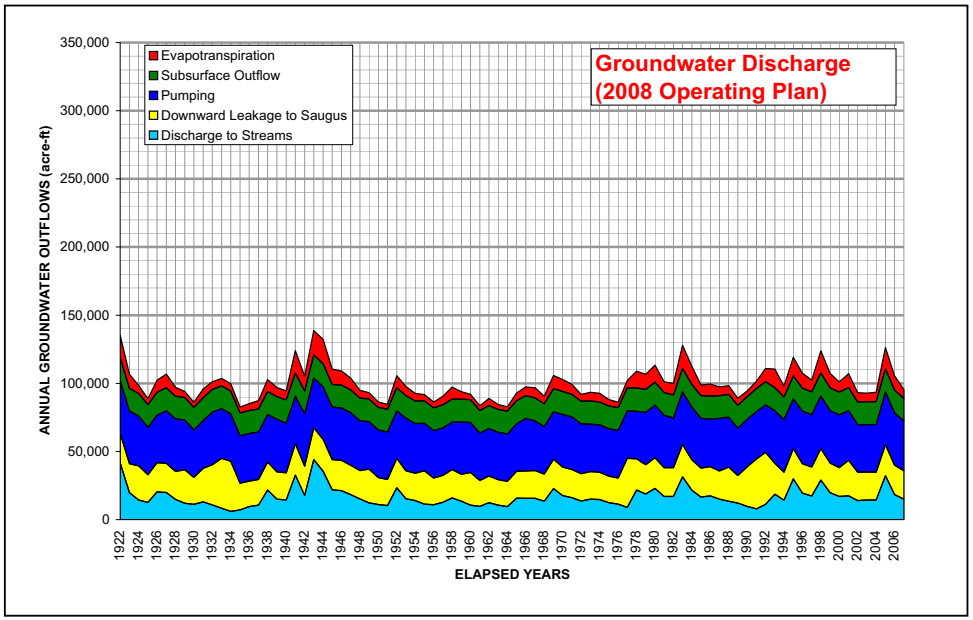


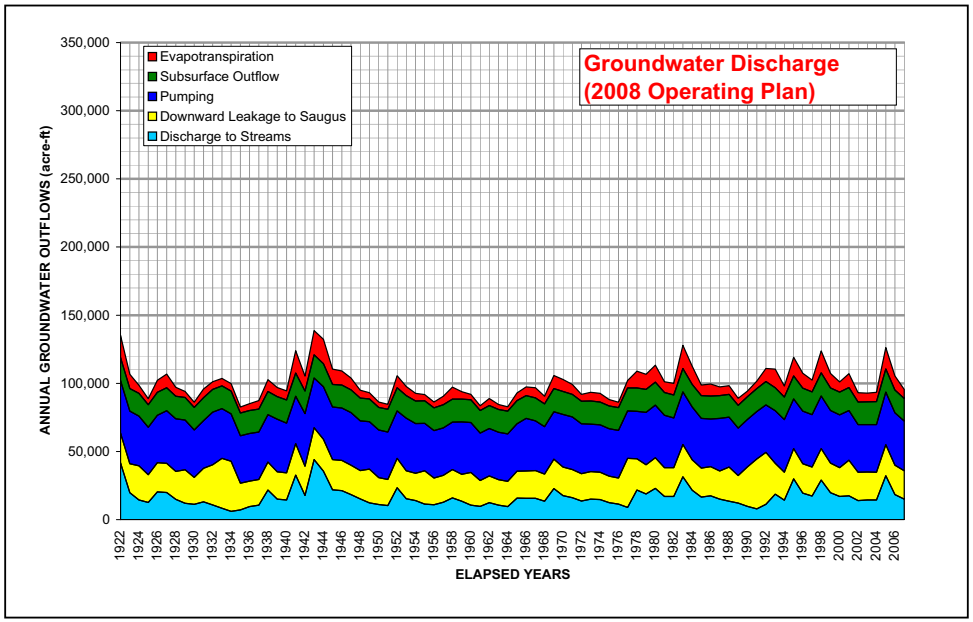
Figure 4-16: Comparison of Simulated Trends in Groundwater Recharge and Discharge Terms for the 2008 Operating Plan Under Historical Hydrology





Figures_Section4_Part3_WaterBudget.xls/Figure4-16

Figure 4-17: Comparison of Simulated Trends in Groundwater Discharge Terms for the 2008 and Potential Operating Plans Under Historical Hydrology



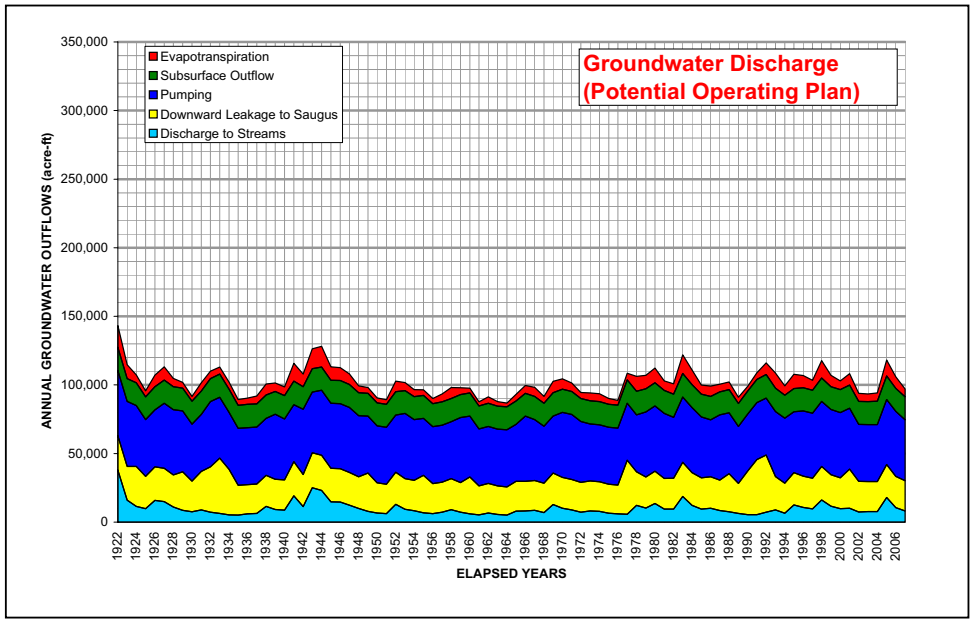


Figure 4-18: Cumulative Change in Groundwater Storage Volume

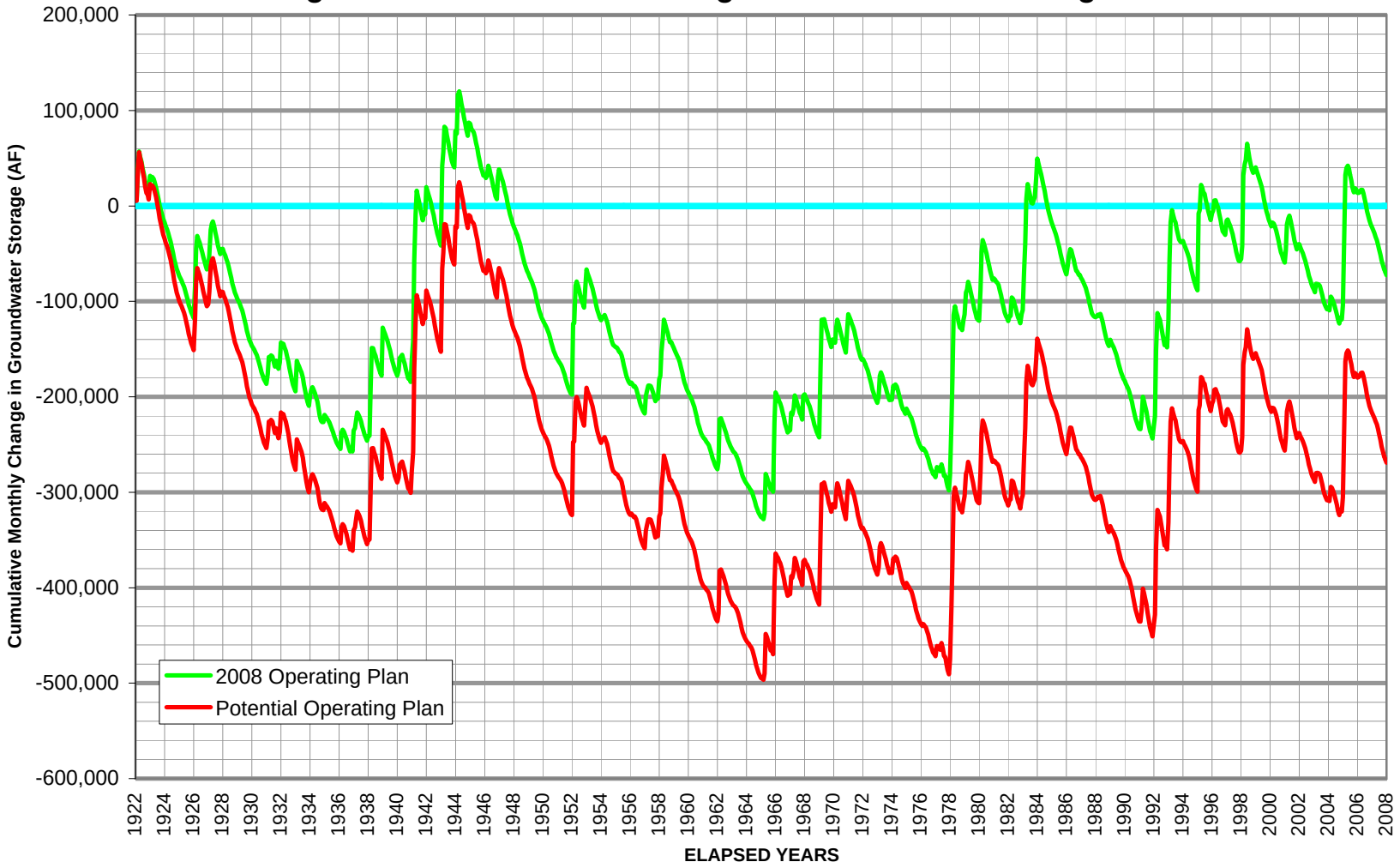
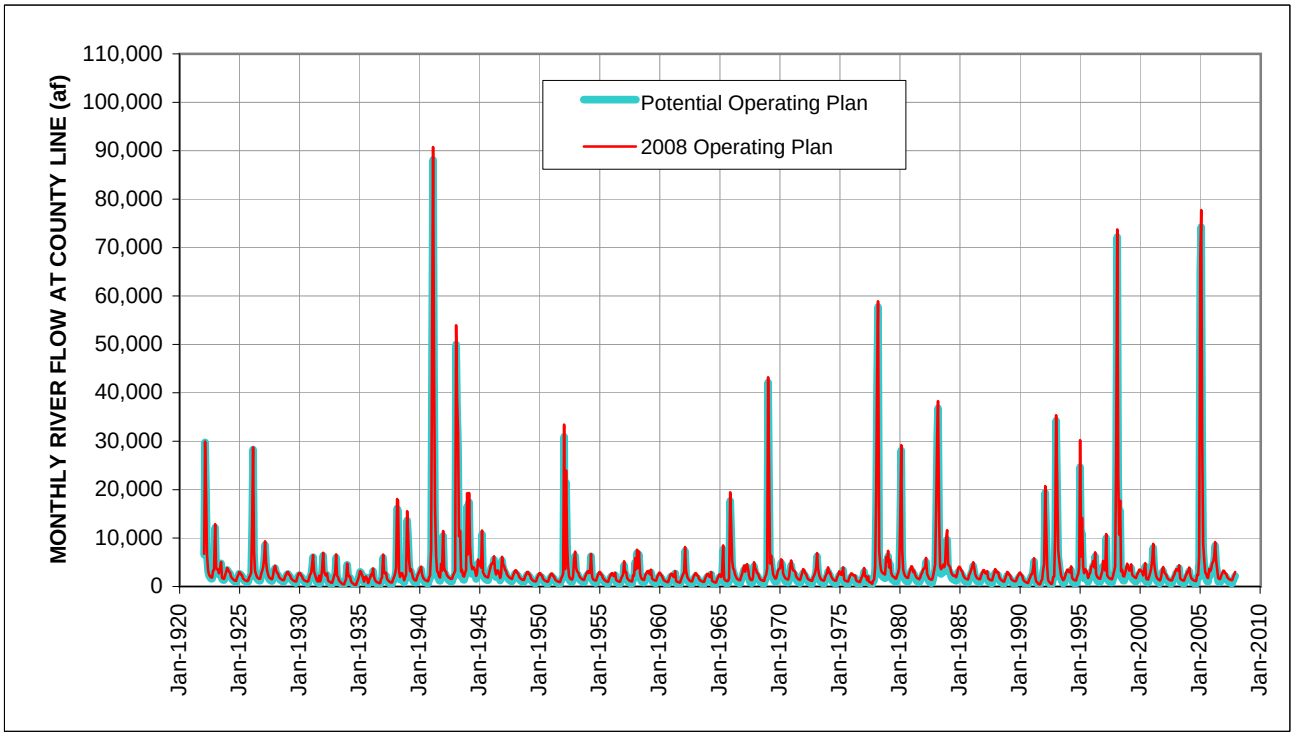


Figure 4-19
Simulated Monthly Flow in the Santa Clara River at the County Line
For the 2008 and Potential Operating Plans Under Historical Hydrology



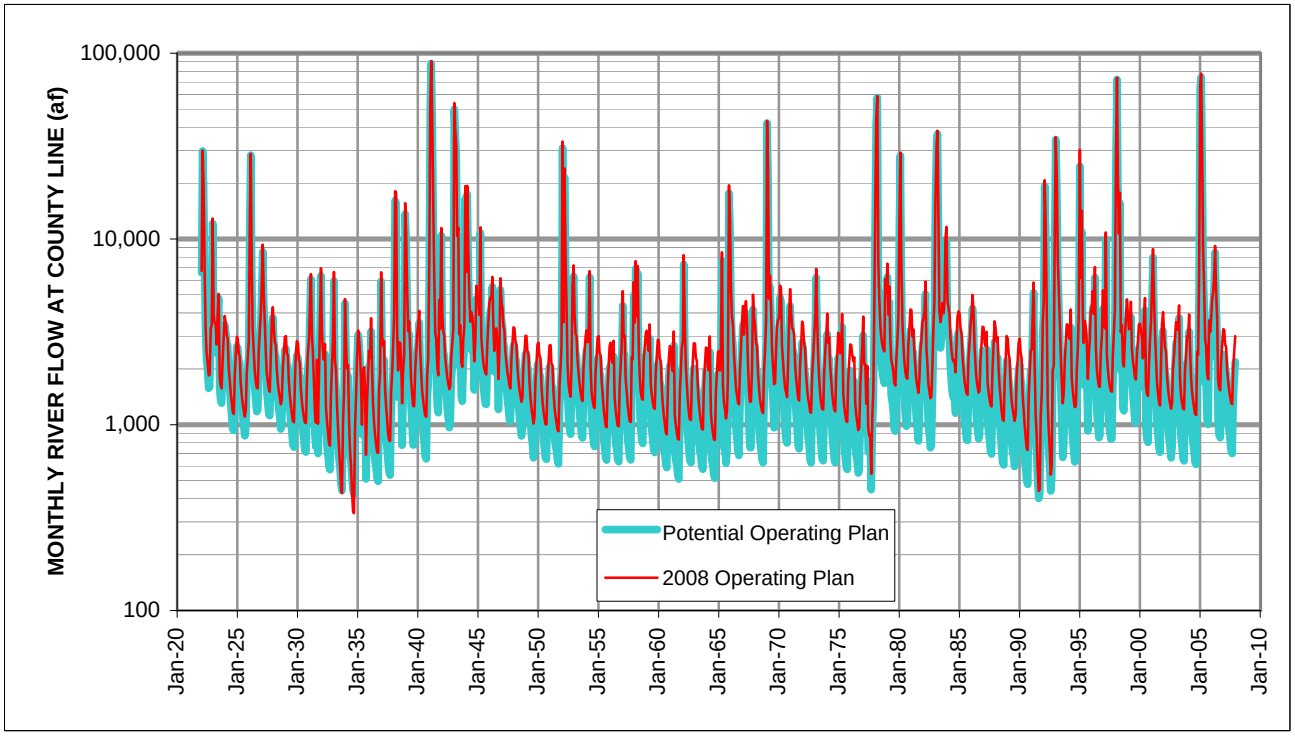


Figure 4-20
Modeled and Estimated Monthly Groundwater Discharges to the Perennial Reach of the Santa Clara River (from Round Mountain to Blue Cut)

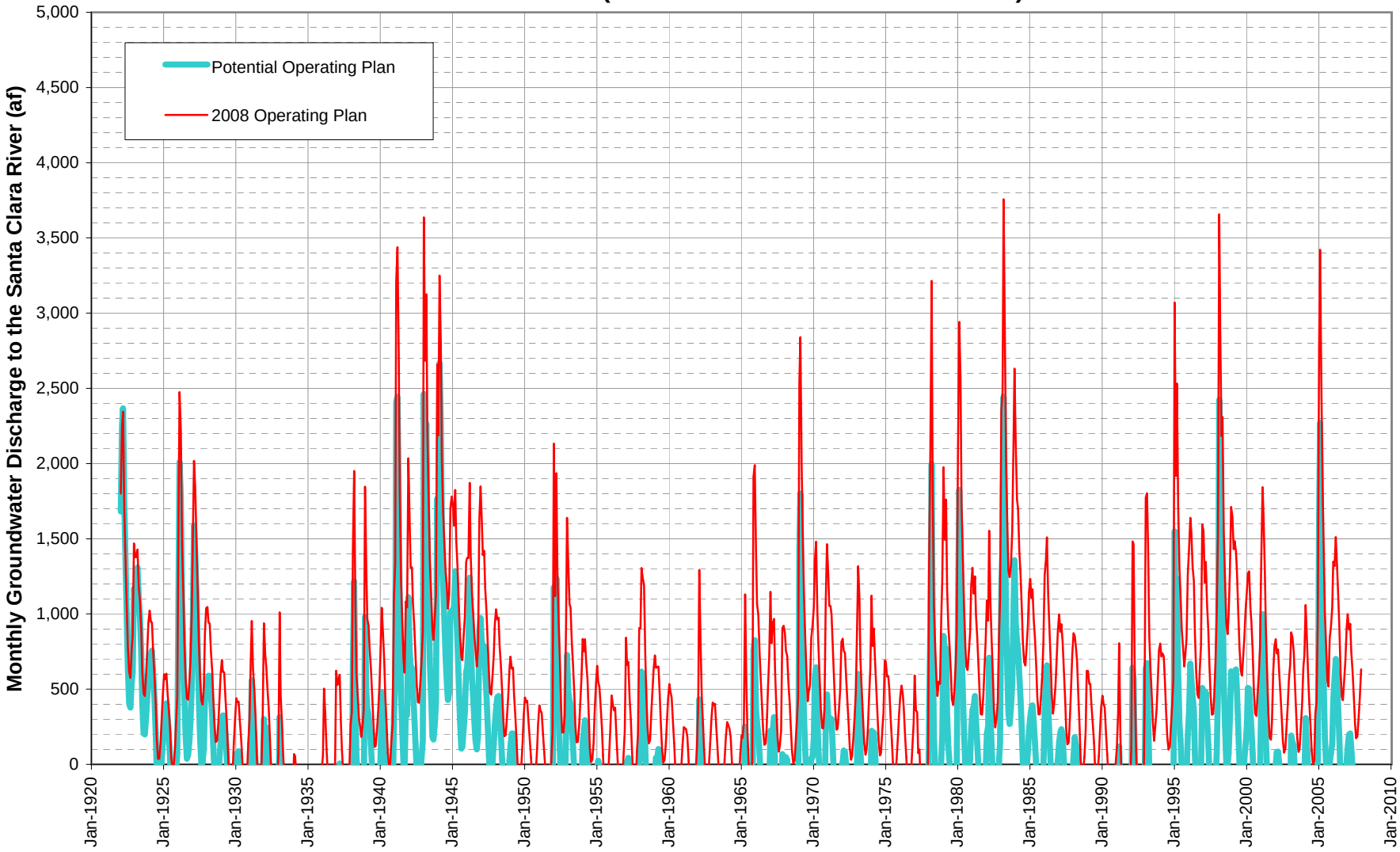
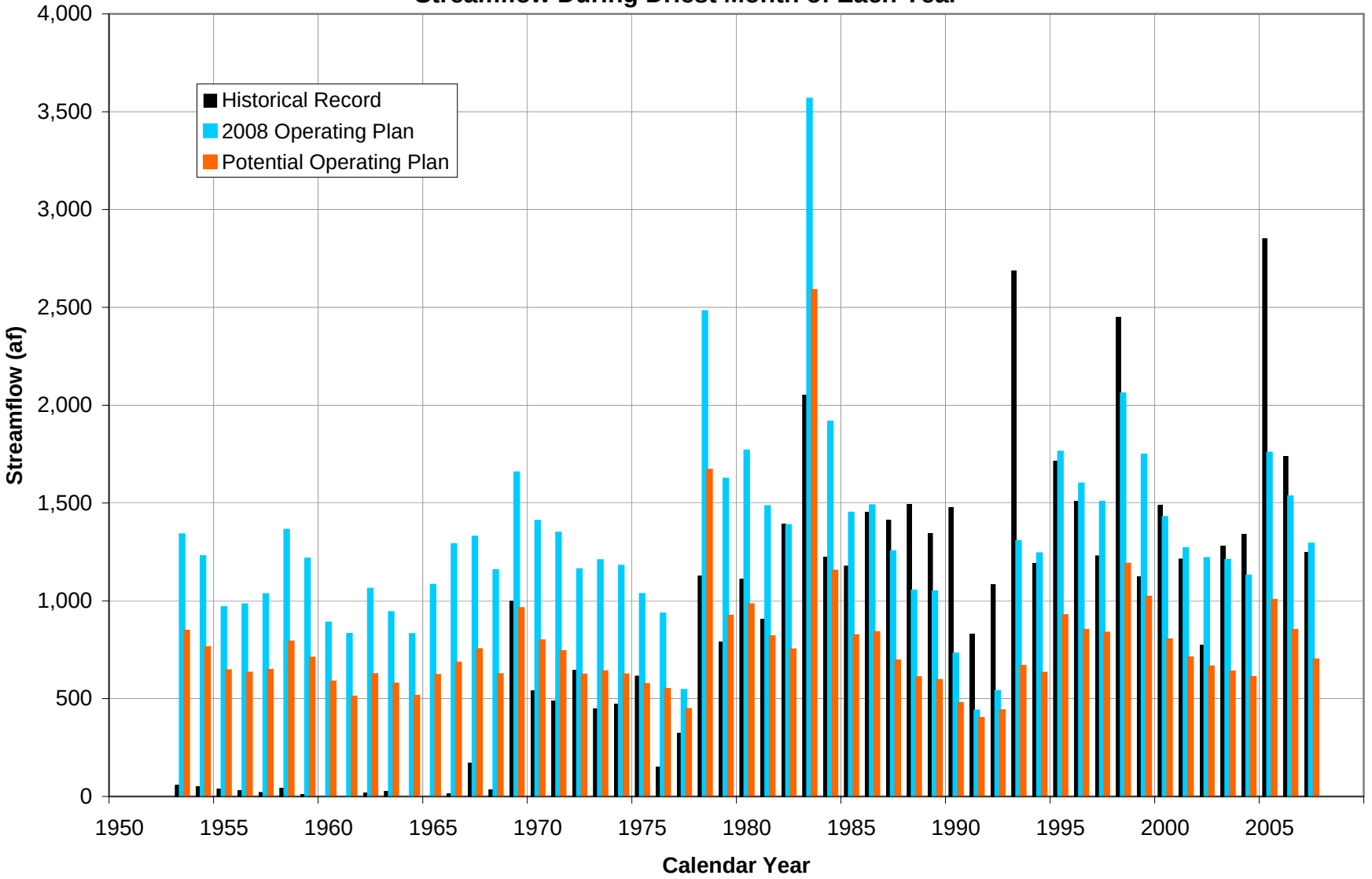


Figure 4-21
Streamflow During Driest Month of Each Year



V. Climate Change Considerations

This section of the report describes an analysis of the potential impacts of climate change on the 2008 Operating Plan for the Santa Clarita Valley. The analysis simulates a group of different potential future groundwater recharge events arising from a suite of published spatial-temporal distributions of future rainfall, as derived from global climate models that in turn have been scaled to watershed scales throughout California, including at the scale of the Santa Clarita Valley. The rainfall distributions, which are also known as rainfall projections, account for a variety of possible changes in global climate and have been published by climatologists conducting research and modeling of possible changes in climate arising from historic and potential future greenhouse gas emissions.

Following are discussions of the objectives of the analysis, a description of the technical approach that was used to simulate potential climate change effects on the local groundwater system in the Santa Clarita Valley, and the results of the modeling evaluation as they pertain to the 2008 Operating Plan. An overview of the current understanding regarding potential climate change in southern California is contained in Appendix D, along with details regarding the projections of future rainfall that were used in the groundwater model to evaluate potential climate change effects on local groundwater.

5.1 Objectives

As recently noted by California's state climatologist (Anderson, 2009), the scientific community's research on global climate processes "includes the expectation that climate will be changing over the course of the next century to an extent that these changes must be accounted for in the water resources planning process". The need to understand and plan for climate change was recognized in 2007 by the Purveyors who, in commissioning the updated basin yield analysis specified that this study should include an evaluation of the potential significance of climate change on local groundwater supplies.

As discussed below in Section 5.2, there are many different climate models, each with its own strengths and limitations. Additionally, the international scientific community has formally identified multiple scenarios for future greenhouse gas emissions. Each scenario has different assumptions about the magnitude and timing of these emissions. Consequently, absolute predictions regarding future climatic conditions and subsequent effect on local groundwater are not possible. Instead, the primary objective of the analysis reported herein is to quantitatively, or qualitatively, describe general impacts of climate change on the groundwater basin and its yield. As the work has progressed, this general objective has focused on understanding whether the yield of the basin, operated in accordance with the 2008 Operating Plan, might be different for future climate change scenarios than for the historical rainfall patterns under which the 2008 Operating Plan was evaluated in Chapter 4. The general objective and the more specific objective together seek to understand the sensitivity of the aquifer and the 2008 Operating Plan to climate change, rather than to make predictions about future climate and groundwater conditions.

5.2 Approach

The analysis was conducted by selecting a small number of published projections regarding possible future patterns of monthly rainfall over time between now and the year 2099. An 86-year time period from 2010 through 2095 was then simulated with the groundwater model, using monthly variations in groundwater recharge that were derived from the monthly projections of future rainfall patterns under a given climate change scenario. Details regarding this process are summarized below and described in greater detail in Appendix D.

5.2.1 Evaluation and Selection of Climate Change Scenarios

Nine of 112 published climate projections were studied for potential use in the Santa Clarita groundwater model. The nine projections that were studied are the same group of projections (models) that were evaluated by DWR in its most recent report on the reliability of State Water Project water deliveries (DWR, 2008).

The nine rainfall projections were studied for their ability to reasonably replicate recent historical rainfall at the Newhall-Soledad rain gage. More importantly, the projections were studied to ascertain the degree to which they show different or similar trends and magnitudes of rainfall at various times (during the Purveyor's UWMP planning time frame [20 to 25 years], and beyond that time frame); and the degree to which they project generally dry, wet, or average conditions over the long-term (through the next 86-year period). This trend evaluation was conducted by examining the cumulative departure of rainfall on a monthly basis for each projection, compared with the 1931-2007 long-term average rainfall. Figure 5-1 displays the cumulative departure from mean precipitation, beginning in 2010, for the nine projections that were studied and for the three projections that were selected for evaluating potential climate-change impacts on groundwater in the Santa Clarita Valley. The figure shows that the nine projections exhibit a broad range in the cumulative departure over time, with an increase in the range of predicted values as time goes on. This increase with time arises in part from differences between the emissions scenarios beginning in about the year 2030, as well as from the general increase in predictive uncertainty that exists in each climate model as it projects into the future the many physical processes that affect climate.

The three projections that were evaluated using the groundwater model were selected because they display a variety of rainfall cycles during the UWMP planning horizon and beyond. In particular:

- Over the course of the UWMP planning horizon, projection #1 shows considerable fluctuation and is generally wetter than normal, while projections #6 and #9 show less fluctuation and are generally drier than normal.

- Afterwards, the three projections show a variety of trends. Projection #1 shows a sustained long-term progressive drying of the climate, with rainfall generally below the historical average. Projection #9 shows the opposite trend: sustained long-term progressive wetting of the climate with more rainfall than the historical average.

Projection #6 shows wet conditions immediately after the UWMP planning horizon, then fluctuating cycles of below-normal and above-normal rainfall, with no net departure from historical average rainfall by the end of the projection time frame.

5.2.2 Simulation Period

An 86-year period beginning in 2010 and continuing through the year 2095 was evaluated with the model, using the local monthly rainfall projections specific to each of these years to define groundwater recharge terms and Alluvial Aquifer pumping patterns. The same pattern of Saugus Formation pumping that was used for the 2008 Operating Plan (representing SWP water availability from 1922 through 2007) was utilized in conjunction with the 2010-2095 simulation of conditions in the Alluvial Aquifer to assess the basin's response to a combination of pumping dictated by local and SWP hydrologic conditions plus runoff/recharge in the Valley resulting from local rainfall conditions.

5.2.3 Hydrologic Processes for Climate Change Scenarios

Four separate hydrologic processes were varied in the groundwater flow model for each climate change scenario. The four processes and the methods by which they were varied were as follows.

- **Groundwater pumping pattern -** Different approaches were taken for the Alluvium versus the Saugus.

  The sequence of normal-year versus dry-year pumping from the alluvium was defined from the prior year's rainfall, as contained in the particular climate projection being evaluated. Tables 5-1 through 5-3 list the alluvial year types for each of the three climate runs that were evaluated.

  The Saugus pumping pattern and pumping rates were specified to be the same as for the 1922-2007 period that was evaluated for the 2008 Operating Plan. Tables 5-4 through 5-6 compare the Saugus pumping pattern with the pumping pattern for the Alluvial Aquifer.

- **Infiltration of direct precipitation -** The month-by-month rainfall from a given climate projection was used by the SWRM to calculate this term for the uppermost layer in the model grid. This is calculated at each node in the grid.

- **Infiltration from stormwater generated within the watershed and from Santa Clara River flows entering the eastern end of the Valley (at the Lang gage) -** For a given future year, these terms were estimated by first identifying one or more similar rainfall years in the historic record, which were treated as prototypical years for the purpose of defining annual and monthly streamflow at each stream node. If more than one year was identified as a possible prototype for a given future year, then the prototypical year was selected by further considering whether hydrologic conditions were generally dry or generally wet. Infiltration from streamflow during a given year was then calculated by the SWRM model from the prototypical year's monthly flow rates and monthly riverbed infiltration rates.

- **Infiltration from water released by DWR from Castaic Lagoon to Castaic Creek -** The prototype-year method was used to identify this term, using the same general procedure as described above for Santa Clara River flows at the Lang gage.

5.3 2008 Operating Plan under Climate Change Scenarios

Hydrographs of simulated groundwater levels, at the locations of each production well, are included in Appendix E to show the simulated response of the groundwater system to the three modeled rainfall projections. Extracted from the complete set in Appendix E, Figures 5-2 through 5-9 are illustrative groundwater elevation hydrographs for each Alluvial Aquifer subarea, using the same set of representative wells as shown for the sustainability discussions in Chapter 4. Figures 5-10 through 5-12 are groundwater elevation hydrographs for the three representative Saugus Formation production wells discussed in Chapter 4.

Based on simulated aquifer response to a combination of pumping in accordance with the 2008 Operating Plan and the range of climate change hydrology, the potential effects of climate change on the yield of the local groundwater basin and the associated availability of groundwater as part of the Valley's overall water supply can be summarized as follows. In all cases, it should be noted that specific short-term patterns of precipitation, as projected by the climate models, significantly influence the potential sustainability of overall groundwater yield and/or the achievability, i.e. the physical ability to extract groundwater at the operating plan rates, of the operating plan in certain subareas of the overall basin.

5.3.1 Drying Climate Trend (Climate Scenario 1)

In the short term, i.e. through the horizon of current UWMP planning, a long-term drying trend in the local climate would not be expected to result in unsustainable groundwater conditions, but could result in unachievable pumping in the "Above Mint Canyon" area at the rates specified in the 2008 Operating Plan. Beyond that planning horizon, the prevailing trend of drier climate would be expected to result in a general long-term lowering of groundwater levels in most of the basin, indicative that pumping in accordance with the 2008 Operating Plan would not be considered sustainable. Directly related to the latter long-term lowering of groundwater levels, the prevailing trend of drier climate would be expected to result in groundwater levels sufficiently lowered in several parts of the basin (e.g. at and above Mint Canyon, below the Saugus WRP, and in Bouquet and San Francisquito Canyon) that the wells in those areas would no longer support the pumping rates in the 2008 Operating Plan. On a long-term basis, then, the drying climate trend analyzed herein would be expected to result in a smaller local groundwater supply over time.

5.3.2 Wetter Climate Trend (Climate Scenario 9)

A tendency toward wetter local hydrologic conditions would logically suggest that the 2008 Operating Plan, considered sustainable through historical hydrologic conditions, would continue to be sustainable. Simulated basin response supports that expectation. Ironically, however, primarily as a result of the specific patterns of precipitation as projected by this climate model,

near-term conditions through the UWMP planning horizon, could appear to be unsustainable, i.e. general declining trend in groundwater levels. Subsequent wetter conditions ultimately lead to the long-term appearance of groundwater sustainability at the pumping rates in the 2008 Operating Plan.

Over both the short term (UWMP planning horizon) and the long term simulated herein, the wetter climate trend appears to result in local issues with regard to achievability of 2008 Operating Plan pumping, commonly in the eastern part of the basin at and above Mint Canyon, and also in San Francisquito Canyon in the near term.

For the most part, the wetter climate trend analyzed herein would be expected to result in a sustainable local groundwater supply at the rates in the 2008 Operating Plan, albeit with some short-term challenges to physically extracting full pumping rates in the eastern part of the basin.

5.3.3 Average Climate Trend (Climate Scenario 6)

A climate tendency toward general continuation of a climate similar, on average, to historically experienced conditions would logically suggest that the 2008 Operating Plan, considered sustainable through historical hydrologic conditions, would continue to be sustainable. Simulated basin response supports that expectation. Similar also to expected response under historical hydrologic conditions, there would be expected challenges to the achievability of the 2008 Operating Plan, notably in the near-term UWMP planning horizon, under a climate "change" that continues long-term average historical precipitation. In summary, a "climate change" that results in essential continuation of long-term average precipitation would be expected to result in a sustainable local groundwater supply at the rates in the 2008 Operating Plan, with basically the same local issues relative to actual pumping capability as derived from the analysis of that operating plan through historical hydrologic conditions.

5.4 Climate Change Summary

Examination of the three simulated climate change scenarios was undertaken to provide a level of quantification to the possible impact of climate change on local groundwater basin yield and availability of groundwater as part of overall water supply to the Valley. In light of the range of global climate model output that was considered for development of the local scenarios analyzed herein, it is obvious that there is neither a unique result that can be expected to become a representative hydrologic condition in the Valley, nor is there a unique result that can be expected in terms of basin yield and associated sustainable groundwater supply as an outcome of climate change. Obviously, the Valley does not get to "choose" a future climate scenario, but rather will have to manage within whatever future patterns of rainfall actually occur over time, whether the future rainfall exhibit wet-dry cycles that are similar to or different from historically recorded conditions. Perhaps most useful in the consideration of climate change effects analyzed herein is with respect to results over the UWMP planning horizon of 20 to 25 years. For the range of relatively wet to relatively dry conditions analyzed herein, all three scenarios suggest that the 2008 Operating Plan can be considered sustainable and, with the same local exceptions as simulated through a repetition of historical hydrology (e.g. mainly at and above Mint Canyon), achievable over the UWMP planning horizon. Beyond that horizon, greater uncertainty

exists because the global climate models use different emissions scenarios and also become increasingly uncertain over time because of predictive uncertainty pertaining to the forward-looking representation of the many physical processes that affect climate into the future. As a result, for time periods beyond the UWMP planning horizon, some models predict long-term drying and subsequent sustained declines in groundwater levels, which would result in a smaller local groundwater supply over time, while other models predict hydrologic conditions similar to or wetter than those that have been historically observed, in which case the 2008 Operating Plan can be considered sustainable, albeit with some local issues relative to actual pumping capability at certain times (mainly in the Alluvium at the eastern end of the Valley).

Table 5-1

Climate Projection #1 (Global Climate Model GFDL_cm2_0.1_sresB1)

Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation

Model Year	Calendar Year	Local Rainfall (inches)[a]	Year Type	Alluvial Aquifer Pumping under the Groundwater Operating Plan (AF/yr)
1	2010	18.27	Normal	35,000-40,000
2	2011	19.17	Normal	35,000-40,000
3	2012	43.26	Normal	35,000-40,000
4	2013	20.63	Normal	35,000-40,000
5	2014	13.96	Normal	35,000-40,000
6	2015	11.24	Normal	35,000-40,000
7	2016	13.80	Dry Year 1	30,000-35,000
8	2017	22.80	Dry Year 2	30,000-35,000
9	2018	15.37	Normal	35,000-40,000
10	2019	23.75	Normal	35,000-40,000
11	2020	45.78	Normal	35,000-40,000
12	2021	38.53	Normal	35,000-40,000
13	2022	43.23	Normal	35,000-40,000
14	2023	25.37	Normal	35,000-40,000
15	2024	24.15	Normal	35,000-40,000
16	2025	9.65	Normal	35,000-40,000
17	2026	20.35	Dry Year 1	30,000-35,000
18	2027	15.10	Normal	35,000-40,000
19	2028	17.37	Normal	35,000-40,000
20	2029	22.37	Normal	35,000-40,000
21	2030	14.77	Normal	35,000-40,000
22	2031	14.56	Normal	35,000-40,000
23	2032	9.17	Dry Year 1	30,000-35,000
24	2033	31.25	Dry Year 2	30,000-35,000
25	2034	31.80	Normal	35,000-40,000
26	2035	10.36	Normal	35,000-40,000
27	2036	12.98	Dry Year 1	30,000-35,000
28	2037	13.51	Dry Year 2	30,000-35,000
29	2038	28.59	Dry Year 3	30,000-35,000
30	2039	16.63	Normal	35,000-40,000
31	2040	12.83	Normal	35,000-40,000
32	2041	20.67	Dry Year 1	30,000-35,000
33	2042	16.41	Normal	35,000-40,000
34	2043	9.38	Normal	35,000-40,000
35	2044	24.67	Dry Year 1	30,000-35,000
36	2045	29.24	Normal	35,000-40,000
37	2046	17.91	Normal	35,000-40,000
38	2047	10.47	Normal	35,000-40,000
39	2048	15.97	Dry Year 1	30,000-35,000
40	2049	19.69	Dry Year 2	30,000-35,000
41	2050	27.84	Dry Year 3	30,000-35,000
42	2051	12.19	Normal	35,000-40,000
43	2052	20.08	Dry Year 1	30,000-35,000
44	2053	14.02	Normal	35,000-40,000
45	2054	33.91	Dry Year 1	30,000-35,000
46	2055	19.94	Normal	35,000-40,000
47	2056	14.32	Normal	35,000-40,000
48	2057	14.01	Normal	35,000-40,000
49	2058	28.83	Dry Year 1	30,000-35,000
50	2059	35.10	Normal	35,000-40,000
51	2060	11.01	Normal	35,000-40,000
52	2061	9.40	Dry Year 1	30,000-35,000
53	2062	20.34	Dry Year 2	30,000-35,000
54	2063	10.66	Dry Year 3	30,000-35,000
55	2064	9.63	Dry Year 4	30,000-35,000
56	2065	17.94	Dry Year 5	30,000-35,000
57	2066	18.07	Dry Year 6	30,000-35,000
58	2067	13.68	Dry Year 7	30,000-35,000
59	2068	7.10	Dry Year 8	30,000-35,000
60	2069	20.97	Dry Year 9	30,000-35,000
61	2070	14.49	Dry Year 10	30,000-35,000
62	2071	17.87	Dry Year 11	30,000-35,000
63	2072	20.27	Dry Year 12	30,000-35,000
64	2073	11.02	Dry Year 13	30,000-35,000
65	2074	23.74	Dry Year 14	30,000-35,000
66	2075	20.98	Normal	35,000-40,000
67	2076	8.79	Normal	35,000-40,000
68	2077	12.56	Dry Year 1	30,000-35,000
69	2078	21.59	Dry Year 2	30,000-35,000
70	2079	30.22	Dry Year 3	30,000-35,000
71	2080	12.53	Normal	35,000-40,000
72	2081	21.67	Dry Year 1	30,000-35,000
73	2082	17.97	Normal	35,000-40,000
74	2083	36.13	Normal	35,000-40,000
75	2084	32.25	Normal	35,000-40,000
76	2085	18.51	Normal	35,000-40,000
77	2086	20.78	Normal	35,000-40,000
78	2087	30.97	Normal	35,000-40,000
79	2088	8.45	Normal	35,000-40,000
80	2089	32.79	Dry Year 1	30,000-35,000
81	2090	34.48	Normal	35,000-40,000
82	2091	18.49	Normal	35,000-40,000
83	2092	7.60	Normal	35,000-40,000
84	2093	21.56	Dry Year 1	30,000-35,000
85	2094	16.99	Normal	35,000-40,000
86	2095	21.56	Normal	35,000-40,000

aThe values from the global climate model were extrapolated to the location of the Newhall County Water District Rain Gage.

Table 5-2

Climate Projection #6 (Global Climate Model NCAR_PCM1.3_sresA2)

Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation

Model Year	Calendar Year	Local Rainfall (inches)[a]	Year Type	Alluvial Aquifer Pumping under the Groundwater Operating Plan (AF/yr)
1	2010	17.22	Normal	35,000-40,000
2	2011	13.37	Normal	35,000-40,000
3	2012	16.14	Dry Year 1	30,000-35,000
4	2013	16.53	Dry Year 2	30,000-35,000
5	2014	15.33	Dry Year 3	30,000-35,000
6	2015	40.92	Dry Year 4	30,000-35,000
7	2016	20.24	Normal	35,000-40,000
8	2017	19.50	Normal	35,000-40,000
9	2018	10.68	Normal	35,000-40,000
10	2019	15.15	Dry Year 1	30,000-35,000
11	2020	24.58	Dry Year 2	30,000-35,000
12	2021	16.38	Normal	35,000-40,000
13	2022	22.64	Normal	35,000-40,000
14	2023	21.29	Normal	35,000-40,000
15	2024	13.37	Normal	35,000-40,000
16	2025	19.50	Dry Year 1	30,000-35,000
17	2026	12.05	Dry Year 2	30,000-35,000
18	2027	18.89	Dry Year 3	30,000-35,000
19	2028	11.56	Dry Year 4	30,000-35,000
20	2029	8.46	Dry Year 5	30,000-35,000
21	2030	16.41	Dry Year 6	30,000-35,000
22	2031	19.44	Dry Year 7	30,000-35,000
23	2032	18.66	Dry Year 8	30,000-35,000
24	2033	30.29	Dry Year 9	30,000-35,000
25	2034	42.86	Normal	35,000-40,000
26	2035	16.39	Normal	35,000-40,000
27	2036	17.74	Dry Year 1	30,000-35,000
28	2037	50.04	Dry Year 2	30,000-35,000
29	2038	35.50	Normal	35,000-40,000
30	2039	39.98	Normal	35,000-40,000
31	2040	28.83	Normal	35,000-40,000
32	2041	23.15	Normal	35,000-40,000
33	2042	22.57	Normal	35,000-40,000
34	2043	22.20	Normal	35,000-40,000
35	2044	16.25	Normal	35,000-40,000
36	2045	34.88	Normal	35,000-40,000
37	2046	20.82	Normal	35,000-40,000
38	2047	14.35	Normal	35,000-40,000
39	2048	12.06	Dry Year 1	30,000-35,000
40	2049	12.16	Dry Year 2	30,000-35,000
41	2050	11.37	Dry Year 3	30,000-35,000
42	2051	28.47	Dry Year 4	30,000-35,000
43	2052	26.84	Normal	35,000-40,000
44	2053	25.59	Normal	35,000-40,000
45	2054	15.97	Normal	35,000-40,000
46	2055	21.26	Normal	35,000-40,000
47	2056	23.32	Normal	35,000-40,000
48	2057	13.55	Normal	35,000-40,000
49	2058	23.32	Dry Year 1	30,000-35,000
50	2059	13.04	Normal	35,000-40,000
51	2060	22.71	Dry Year 1	30,000-35,000
52	2061	10.15	Normal	35,000-40,000
53	2062	20.52	Dry Year 1	30,000-35,000
54	2063	71.95	Dry Year 2	30,000-35,000
55	2064	33.61	Normal	35,000-40,000
56	2065	13.39	Normal	35,000-40,000
57	2066	25.96	Dry Year 1	30,000-35,000
58	2067	28.69	Normal	35,000-40,000
59	2068	18.22	Normal	35,000-40,000
60	2069	11.17	Normal	35,000-40,000
61	2070	18.25	Dry Year 1	30,000-35,000
62	2071	17.85	Dry Year 2	30,000-35,000
63	2072	19.30	Dry Year 3	30,000-35,000
64	2073	14.70	Normal	35,000-40,000
65	2074	9.82	Dry Year 1	30,000-35,000
66	2075	14.96	Dry Year 2	30,000-35,000
67	2076	29.84	Dry Year 3	30,000-35,000
68	2077	19.05	Normal	35,000-40,000
69	2078	45.70	Normal	35,000-40,000
70	2079	25.20	Normal	35,000-40,000
71	2080	31.12	Normal	35,000-40,000
72	2081	29.50	Normal	35,000-40,000
73	2082	27.59	Normal	35,000-40,000
74	2083	15.50	Normal	35,000-40,000
75	2084	8.74	Normal	35,000-40,000
76	2085	18.76	Dry Year 1	30,000-35,000
77	2086	13.07	Dry Year 2	30,000-35,000
78	2087	22.89	Dry Year 3	30,000-35,000
79	2088	50.06	Normal	35,000-40,000
80	2089	27.24	Normal	35,000-40,000
81	2090	12.53	Normal	35,000-40,000
82	2091	9.14	Dry Year 1	30,000-35,000
83	2092	10.81	Dry Year 2	30,000-35,000
84	2093	23.07	Dry Year 3	30,000-35,000
85	2094	12.91	Dry Year 4	30,000-35,000
86	2095	26.47	Dry Year 5	30,000-35,000

[a]The values from the global climate model were extrapolated to the location of the Newhall County Water District Rain Gage.

Table 5-3

Climate Projection #9 (Global Climate Model NCAR_PCM1.3_sresB1)

Local Hydrology and Corresponding Pumping from the Alluvial Aquifer for the 86-year Simulation

Model Year	Calendar Year	Local Rainfall (inches)[a]	Year Type	Alluvial Aquifer Pumping under the Groundwater Operating Plan (AF/yr)
1	2010	22.14	Normal	35,000-40,000
2	2011	28.62	Normal	35,000-40,000
3	2012	18.21	Normal	35,000-40,000
4	2013	18.42	Normal	35,000-40,000
5	2014	17.85	Normal	35,000-40,000
6	2015	22.34	Normal	35,000-40,000
7	2016	17.51	Normal	35,000-40,000
8	2017	16.21	Normal	35,000-40,000
9	2018	11.56	Dry Year 1	30,000-35,000
10	2019	11.83	Dry Year 2	30,000-35,000
11	2020	37.62	Dry Year 3	30,000-35,000
12	2021	16.56	Normal	35,000-40,000
13	2022	15.17	Normal	35,000-40,000
14	2023	22.88	Normal	35,000-40,000
15	2024	13.18	Normal	35,000-40,000
16	2025	20.34	Dry Year 1	30,000-35,000
17	2026	26.96	Dry Year 2	30,000-35,000
18	2027	26.47	Normal	35,000-40,000
19	2028	18.04	Normal	35,000-40,000
20	2029	18.04	Normal	35,000-40,000
21	2030	16.49	Normal	35,000-40,000
22	2031	22.51	Dry Year 1	30,000-35,000
23	2032	22.84	Normal	35,000-40,000
24	2033	15.01	Normal	35,000-40,000
25	2034	13.40	Dry Year 1	30,000-35,000
26	2035	18.72	Dry Year 2	30,000-35,000
27	2036	26.43	Dry Year 3	30,000-35,000
28	2037	11.11	Normal	35,000-40,000
29	2038	12.97	Dry Year 1	30,000-35,000
30	2039	41.47	Dry Year 2	30,000-35,000
31	2040	18.62	Normal	35,000-40,000
32	2041	39.65	Normal	35,000-40,000
33	2042	33.75	Normal	35,000-40,000
34	2043	57.56	Normal	35,000-40,000
35	2044	14.63	Normal	35,000-40,000
36	2045	15.63	Dry Year 1	30,000-35,000
37	2046	15.41	Dry Year 2	30,000-35,000
38	2047	24.66	Dry Year 3	30,000-35,000
39	2048	53.80	Normal	35,000-40,000
40	2049	14.70	Normal	35,000-40,000
41	2050	9.79	Dry Year 1	30,000-35,000
42	2051	38.49	Dry Year 2	30,000-35,000
43	2052	19.57	Normal	35,000-40,000
44	2053	20.65	Normal	35,000-40,000
45	2054	10.40	Normal	35,000-40,000
46	2055	12.58	Dry Year 1	30,000-35,000
47	2056	17.80	Dry Year 2	30,000-35,000
48	2057	15.56	Dry Year 3	30,000-35,000
49	2058	45.18	Dry Year 4	30,000-35,000
50	2059	26.78	Normal	35,000-40,000
51	2060	23.78	Normal	35,000-40,000
52	2061	47.61	Normal	35,000-40,000
53	2062	28.90	Normal	35,000-40,000
54	2063	30.43	Normal	35,000-40,000
55	2064	18.15	Normal	35,000-40,000
56	2065	30.15	Normal	35,000-40,000
57	2066	13.65	Normal	35,000-40,000
58	2067	16.34	Dry Year 1	30,000-35,000
59	2068	10.60	Dry Year 2	30,000-35,000
60	2069	60.56	Dry Year 3	30,000-35,000
61	2070	20.56	Normal	35,000-40,000
62	2071	15.31	Normal	35,000-40,000
63	2072	33.67	Normal	35,000-40,000
64	2073	46.34	Normal	35,000-40,000
65	2074	33.69	Normal	35,000-40,000
66	2075	15.71	Normal	35,000-40,000
67	2076	14.36	Normal	35,000-40,000
68	2077	21.25	Dry Year 1	30,000-35,000
69	2078	37.14	Normal	35,000-40,000
70	2079	31.87	Normal	35,000-40,000
71	2080	8.14	Normal	35,000-40,000
72	2081	25.22	Dry Year 1	30,000-35,000
73	2082	32.82	Normal	35,000-40,000
74	2083	28.25	Normal	35,000-40,000
75	2084	7.23	Normal	35,000-40,000
76	2085	11.37	Dry Year 1	30,000-35,000
77	2086	27.47	Dry Year 2	30,000-35,000
78	2087	20.97	Normal	35,000-40,000
79	2088	16.12	Normal	35,000-40,000
80	2089	64.70	Normal	35,000-40,000
81	2090	21.30	Normal	35,000-40,000
82	2091	12.38	Normal	35,000-40,000
83	2092	22.06	Dry Year 1	30,000-35,000
84	2093	19.32	Normal	35,000-40,000
85	2094	20.91	Normal	35,000-40,000
86	2095	21.05	Normal	35,000-40,000

[a]The values from the global climate model were extrapolated to the location of the Newhall County Water District Rain Gage.

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Climate Projection #1 (Global Climate Model GFDL_cm2_0.1_sresB1)

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Model Year	Alluvium Year	Saugus Year	Year Name for Model Run	Simulated Pumping Conditions	
				Alluvium	Saugus
1	2010	1922	1922	Normal	Normal
2	2011	1923	1923	Normal	Normal
3	2012	1924	1924	Normal	Dry Year 1
4	2013	1925	1925	Normal	Normal
5	2014	1926	1926	Normal	Normal
6	2015	1927	1927	Normal	Normal
7	2016	1928	1928	Dry Year 1	Normal
8	2017	1929	1929	Dry Year 2	Dry Year 1
9	2018	1930	1930	Normal	Normal
10	2019	1931	1931	Normal	Dry Year 1
11	2020	1932	1932	Normal	Dry Year 2
12	2021	1933	1933	Normal	Dry Year 3
13	2022	1934	1934	Normal	Dry Year 4
14	2023	1935	1935	Normal	Normal
15	2024	1936	1936	Normal	Normal
16	2025	1937	1937	Normal	Normal
17	2026	1938	1938	Dry Year 1	Normal
18	2027	1939	1939	Normal	Normal
19	2028	1940	1940	Normal	Normal
20	2029	1941	1941	Normal	Normal
21	2030	1942	1942	Normal	Normal
22	2031	1943	1943	Normal	Normal
23	2032	1944	1944	Dry Year 1	Normal
24	2033	1945	1945	Dry Year 2	Normal
25	2034	1946	1946	Normal	Normal
26	2035	1947	1947	Normal	Normal
27	2036	1948	1948	Dry Year 1	Normal
28	2037	1949	1949	Dry Year 2	Dry Year 1
29	2038	1950	1950	Dry Year 3	Normal
30	2039	1951	1951	Normal	Normal
31	2040	1952	1952	Normal	Normal
32	2041	1953	1953	Dry Year 1	Normal
33	2042	1954	1954	Normal	Normal
34	2043	1955	1955	Normal	Dry Year 1
35	2044	1956	1956	Dry Year 1	Normal
36	2045	1957	1957	Normal	Normal
37	2046	1958	1958	Normal	Normal
38	2047	1959	1959	Normal	Normal
39	2048	1960	1960	Dry Year 1	Dry Year 1
40	2049	1961	1961	Dry Year 2	Normal
41	2050	1962	1962	Dry Year 3	Normal
42	2051	1963	1963	Normal	Normal
43	2052	1964	1964	Dry Year 1	Normal
44	2053	1965	1965	Normal	Normal
45	2054	1966	1966	Dry Year 1	Normal
46	2055	1967	1967	Normal	Normal
47	2056	1968	1968	Normal	Normal
48	2057	1969	1969	Normal	Normal
49	2058	1970	1970	Dry Year 1	Normal
50	2059	1971	1971	Normal	Normal
51	2060	1972	1972	Normal	Normal
52	2061	1973	1973	Dry Year 1	Normal
53	2062	1974	1974	Dry Year 2	Normal
54	2063	1975	1975	Dry Year 3	Normal
55	2064	1976	1976	Dry Year 4	Normal
56	2065	1977	1977	Dry Year 5	Dry Year 1
57	2066	1978	1978	Dry Year 6	Normal
58	2067	1979	1979	Dry Year 7	Normal
59	2068	1980	1980	Dry Year 8	Normal
60	2069	1981	1981	Dry Year 9	Normal
61	2070	1982	1982	Dry Year 10	Normal
62	2071	1983	1983	Dry Year 11	Normal
63	2072	1984	1984	Dry Year 12	Normal
64	2073	1985	1985	Dry Year 13	Normal
65	2074	1986	1986	Dry Year 14	Normal
66	2075	1987	1987	Normal	Normal
67	2076	1988	1988	Normal	Dry Year 1
68	2077	1989	1989	Dry Year 1	Normal
69	2078	1990	1990	Dry Year 2	Dry Year 2
70	2079	1991	1991	Dry Year 3	Dry Year 3
71	2080	1992	1992	Normal	Dry Year 4
72	2081	1993	1993	Dry Year 1	Normal
73	2082	1994	1994	Normal	Normal
74	2083	1995	1995	Normal	Normal
75	2084	1996	1996	Normal	Normal
76	2085	1997	1997	Normal	Normal
77	2086	1998	1998	Normal	Normal
78	2087	1999	1999	Normal	Normal
79	2088	2000	2000	Normal	Normal
80	2089	2001	2001	Dry Year 1	Dry Year 1
81	2090	2002	2002	Normal	Normal
82	2091	2003	2003	Normal	Normal
83	2092	2004	2004	Normal	Normal
84	2093	2005	2005	Dry Year 1	Normal
85	2094	2006	2006	Normal	Normal
86	2095	2007	2007	Normal	Normal

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Climate Projection #6 (Global Climate Model NCAR_PCM1.3_sresA2)

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Model Year	Alluvium Year	Saugus Year	Year Name for Model Run	Simulated Pumping Conditions	
				Alluvium	Saugus
1	2010	1922	1922	Normal	Normal
2	2011	1923	1923	Normal	Normal
3	2012	1924	1924	Dry Year 1	Dry Year 1
4	2013	1925	1925	Dry Year 2	Normal
5	2014	1926	1926	Dry Year 3	Normal
6	2015	1927	1927	Dry Year 4	Normal
7	2016	1928	1928	Normal	Normal
8	2017	1929	1929	Normal	Dry Year 1
9	2018	1930	1930	Normal	Normal
10	2019	1931	1931	Dry Year 1	Dry Year 1
11	2020	1932	1932	Dry Year 2	Dry Year 2
12	2021	1933	1933	Normal	Dry Year 3
13	2022	1934	1934	Normal	Dry Year 4
14	2023	1935	1935	Normal	Normal
15	2024	1936	1936	Normal	Normal
16	2025	1937	1937	Dry Year 1	Normal
17	2026	1938	1938	Dry Year 2	Normal
18	2027	1939	1939	Dry Year 3	Normal
19	2028	1940	1940	Dry Year 4	Normal
20	2029	1941	1941	Dry Year 5	Normal
21	2030	1942	1942	Dry Year 6	Normal
22	2031	1943	1943	Dry Year 7	Normal
23	2032	1944	1944	Dry Year 8	Normal
24	2033	1945	1945	Dry Year 9	Normal
25	2034	1946	1946	Normal	Normal
26	2035	1947	1947	Normal	Normal
27	2036	1948	1948	Dry Year 1	Normal
28	2037	1949	1949	Dry Year 2	Dry Year 1
29	2038	1950	1950	Normal	Normal
30	2039	1951	1951	Normal	Normal
31	2040	1952	1952	Normal	Normal
32	2041	1953	1953	Normal	Normal
33	2042	1954	1954	Normal	Normal
34	2043	1955	1955	Normal	Dry Year 1
35	2044	1956	1956	Normal	Normal
36	2045	1957	1957	Normal	Normal
37	2046	1958	1958	Normal	Normal
38	2047	1959	1959	Normal	Normal
39	2048	1960	1960	Dry Year 1	Dry Year 1
40	2049	1961	1961	Dry Year 2	Normal
41	2050	1962	1962	Dry Year 3	Normal
42	2051	1963	1963	Dry Year 4	Normal
43	2052	1964	1964	Normal	Normal
44	2053	1965	1965	Normal	Normal
45	2054	1966	1966	Normal	Normal
46	2055	1967	1967	Normal	Normal
47	2056	1968	1968	Normal	Normal
48	2057	1969	1969	Normal	Normal
49	2058	1970	1970	Dry Year 1	Normal
50	2059	1971	1971	Normal	Normal
51	2060	1972	1972	Dry Year 1	Normal
52	2061	1973	1973	Normal	Normal
53	2062	1974	1974	Dry Year 1	Normal
54	2063	1975	1975	Dry Year 2	Normal
55	2064	1976	1976	Normal	Normal
56	2065	1977	1977	Normal	Dry Year 1
57	2066	1978	1978	Dry Year 1	Normal
58	2067	1979	1979	Normal	Normal
59	2068	1980	1980	Normal	Normal
60	2069	1981	1981	Normal	Normal
61	2070	1982	1982	Dry Year 1	Normal
62	2071	1983	1983	Dry Year 2	Normal
63	2072	1984	1984	Dry Year 3	Normal
64	2073	1985	1985	Normal	Normal
65	2074	1986	1986	Dry Year 1	Normal
66	2075	1987	1987	Dry Year 2	Normal
67	2076	1988	1988	Dry Year 3	Dry Year 1
68	2077	1989	1989	Normal	Normal
69	2078	1990	1990	Normal	Dry Year 2
70	2079	1991	1991	Normal	Dry Year 3
71	2080	1992	1992	Normal	Dry Year 4
72	2081	1993	1993	Normal	Normal
73	2082	1994	1994	Normal	Normal
74	2083	1995	1995	Normal	Normal
75	2084	1996	1996	Normal	Normal
76	2085	1997	1997	Dry Year 1	Normal
77	2086	1998	1998	Dry Year 2	Normal
78	2087	1999	1999	Dry Year 3	Normal
79	2088	2000	2000	Normal	Normal
80	2089	2001	2001	Normal	Dry Year 1
81	2090	2002	2002	Normal	Normal
82	2091	2003	2003	Dry Year 1	Normal
83	2092	2004	2004	Dry Year 2	Normal
84	2093	2005	2005	Dry Year 3	Normal
85	2094	2006	2006	Dry Year 4	Normal
86	2095	2007	2007	Dry Year 5	Normal

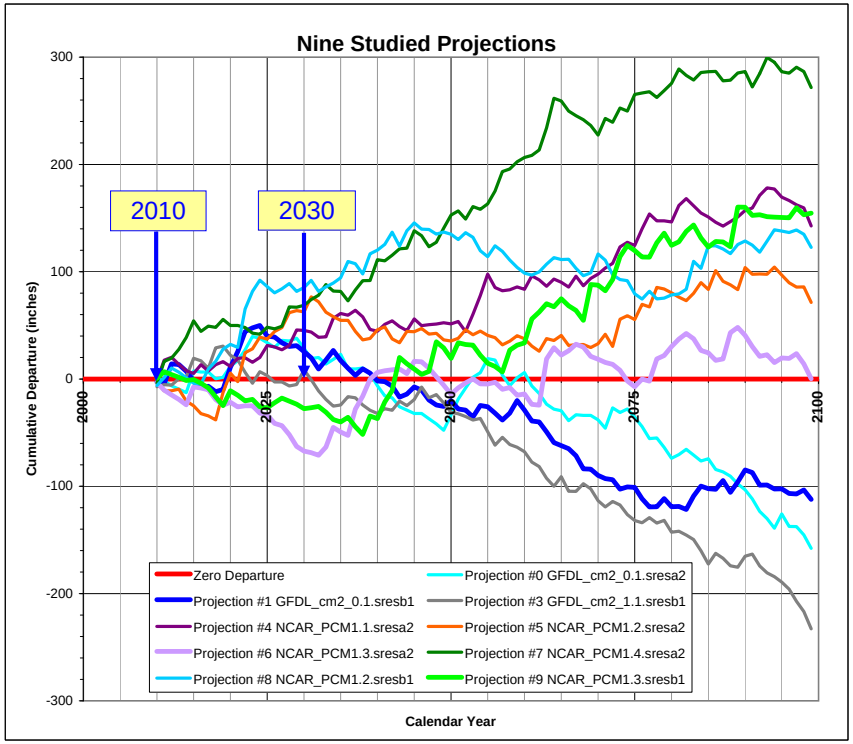
Ta le -

Climate Projection #9 (Global Climate Model NCAR_PCM1.3_sresB1)

llu ial an Saugus For ation Pu ing for t e Si ulation of 1 22-2 istorical rolog

Model Year	Alluvium Year	Saugus Year	Year Name for Model Run	Simulated Pumping Conditions	
				Alluvium	Saugus
1	2010	1922	1922	Normal	Normal
2	2011	1923	1923	Normal	Normal
3	2012	1924	1924	Normal	Dry Year 1
4	2013	1925	1925	Normal	Normal
5	2014	1926	1926	Normal	Normal
6	2015	1927	1927	Normal	Normal
7	2016	1928	1928	Normal	Normal
8	2017	1929	1929	Normal	Dry Year 1
9	2018	1930	1930	Dry Year 1	Normal
10	2019	1931	1931	Dry Year 2	Dry Year 1
11	2020	1932	1932	Dry Year 3	Dry Year 2
12	2021	1933	1933	Normal	Dry Year 3
13	2022	1934	1934	Normal	Dry Year 4
14	2023	1935	1935	Normal	Normal
15	2024	1936	1936	Normal	Normal
16	2025	1937	1937	Dry Year 1	Normal
17	2026	1938	1938	Dry Year 2	Normal
18	2027	1939	1939	Normal	Normal
19	2028	1940	1940	Normal	Normal
20	2029	1941	1941	Normal	Normal
21	2030	1942	1942	Normal	Normal
22	2031	1943	1943	Dry Year 1	Normal
23	2032	1944	1944	Normal	Normal
24	2033	1945	1945	Normal	Normal
25	2034	1946	1946	Dry Year 1	Normal
26	2035	1947	1947	Dry Year 2	Normal
27	2036	1948	1948	Dry Year 3	Normal
28	2037	1949	1949	Normal	Dry Year 1
29	2038	1950	1950	Dry Year 1	Normal
30	2039	1951	1951	Dry Year 2	Normal
31	2040	1952	1952	Normal	Normal
32	2041	1953	1953	Normal	Normal
33	2042	1954	1954	Normal	Normal
34	2043	1955	1955	Normal	Dry Year 1
35	2044	1956	1956	Normal	Normal
36	2045	1957	1957	Dry Year 1	Normal
37	2046	1958	1958	Dry Year 2	Normal
38	2047	1959	1959	Dry Year 3	Normal
39	2048	1960	1960	Normal	Dry Year 1
40	2049	1961	1961	Normal	Normal
41	2050	1962	1962	Dry Year 1	Normal
42	2051	1963	1963	Dry Year 2	Normal
43	2052	1964	1964	Normal	Normal
44	2053	1965	1965	Normal	Normal
45	2054	1966	1966	Normal	Normal
46	2055	1967	1967	Dry Year 1	Normal
47	2056	1968	1968	Dry Year 2	Normal
48	2057	1969	1969	Dry Year 3	Normal
49	2058	1970	1970	Dry Year 4	Normal
50	2059	1971	1971	Normal	Normal
51	2060	1972	1972	Normal	Normal
52	2061	1973	1973	Normal	Normal
53	2062	1974	1974	Normal	Normal
54	2063	1975	1975	Normal	Normal
55	2064	1976	1976	Normal	Normal
56	2065	1977	1977	Normal	Dry Year 1
57	2066	1978	1978	Normal	Normal
58	2067	1979	1979	Dry Year 1	Normal
59	2068	1980	1980	Dry Year 2	Normal
60	2069	1981	1981	Dry Year 3	Normal
61	2070	1982	1982	Normal	Normal
62	2071	1983	1983	Normal	Normal
63	2072	1984	1984	Normal	Normal
64	2073	1985	1985	Normal	Normal
65	2074	1986	1986	Normal	Normal
66	2075	1987	1987	Normal	Normal
67	2076	1988	1988	Normal	Dry Year 1
68	2077	1989	1989	Dry Year 1	Normal
69	2078	1990	1990	Normal	Dry Year 2
70	2079	1991	1991	Normal	Dry Year 3
71	2080	1992	1992	Normal	Dry Year 4
72	2081	1993	1993	Dry Year 1	Normal
73	2082	1994	1994	Normal	Normal
74	2083	1995	1995	Normal	Normal
75	2084	1996	1996	Normal	Normal
76	2085	1997	1997	Dry Year 1	Normal
77	2086	1998	1998	Dry Year 2	Normal
78	2087	1999	1999	Normal	Normal
79	2088	2000	2000	Normal	Normal
80	2089	2001	2001	Normal	Dry Year 1
81	2090	2002	2002	Normal	Normal
82	2091	2003	2003	Normal	Normal
83	2092	2004	2004	Dry Year 1	Normal
84	2093	2005	2005	Normal	Normal
85	2094	2006	2006	Normal	Normal
86	2095	2007	2007	Normal	Normal

Figure 5-1: 2010-2098 Cumulative Departure from Average Annual Rainfall at Newhall-Soledad Rain Gage



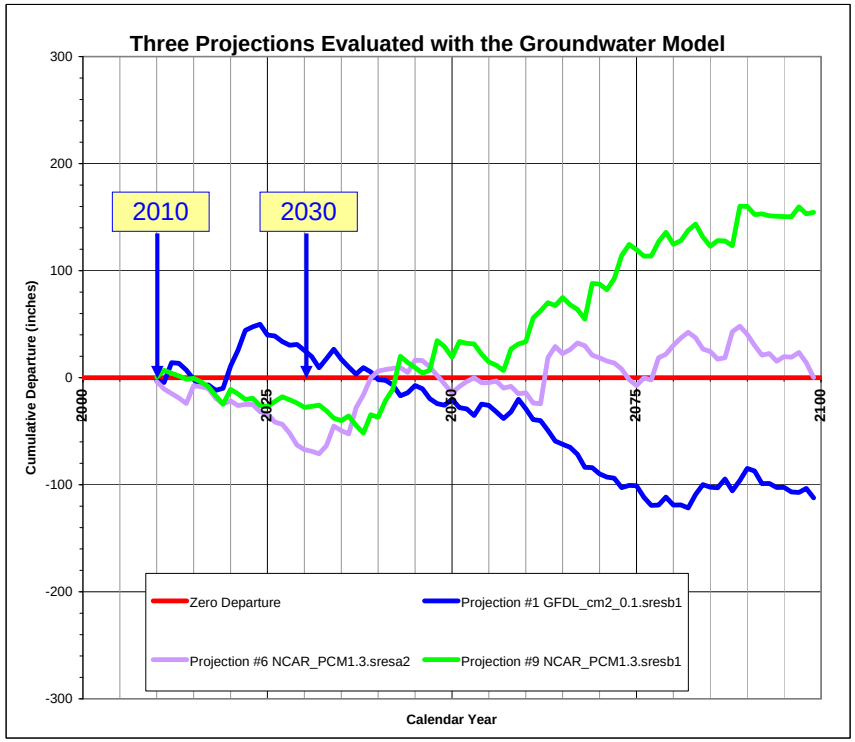


Figure 5-2: VWC-E15 Modeled Groundwater Elevations For Various Climate Projections (Alluvial Aquifer Below Valencia WRP)

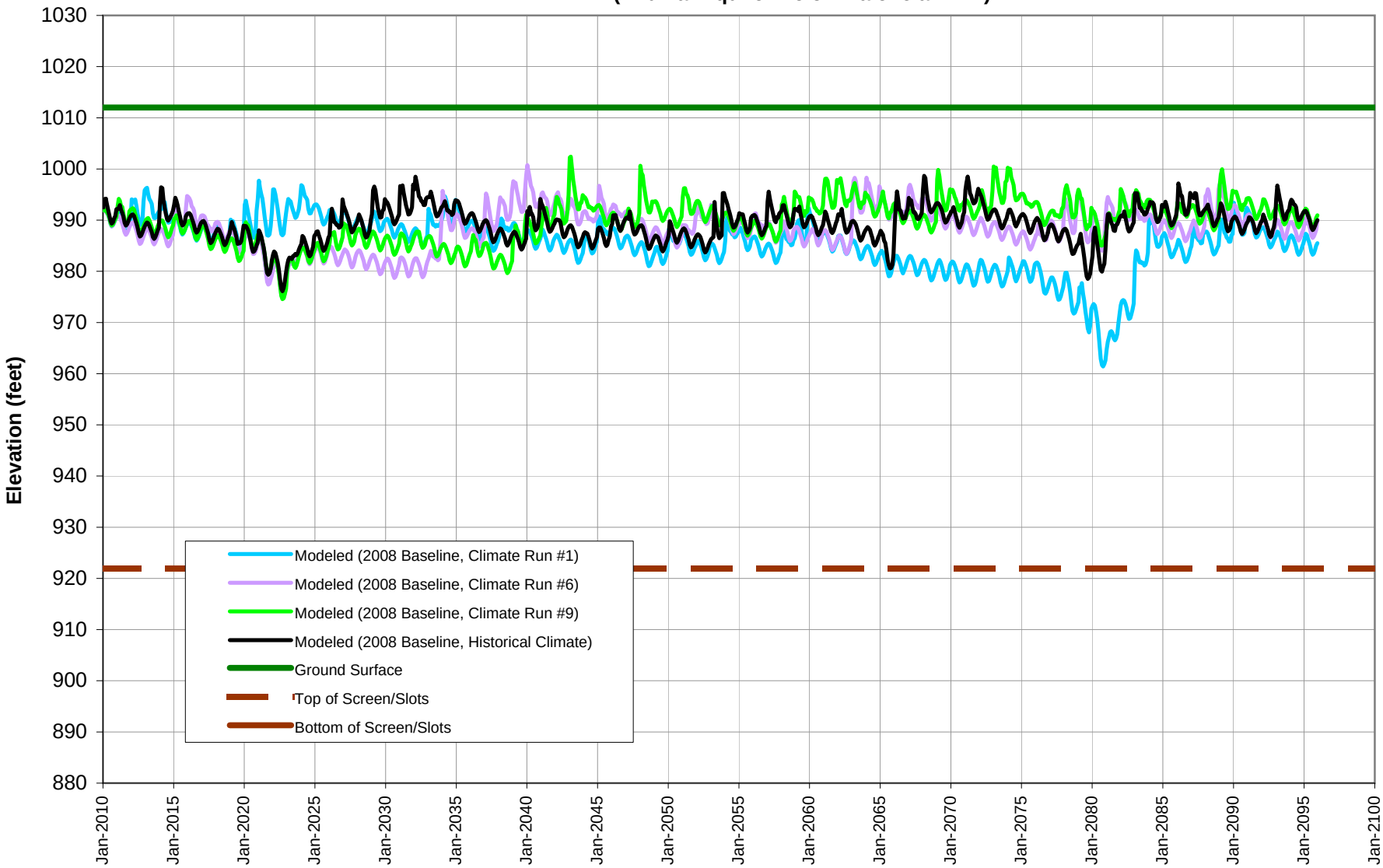


Figure 5-3: VWC-S8 Modeled Groundwater Elevations For Various Climate Projections (Alluvial Aquifer Below Saugus WRP)

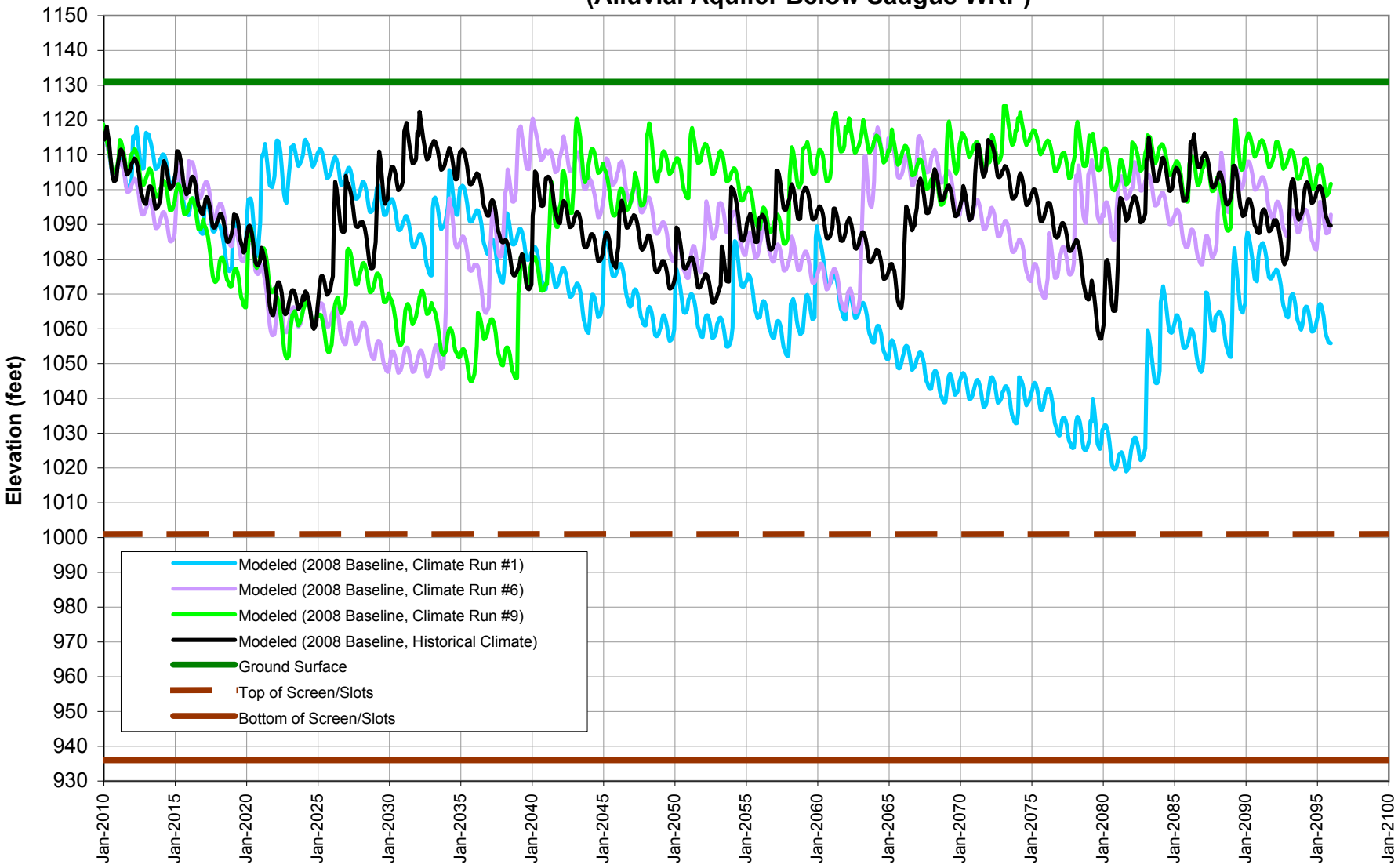


Figure 5-4: VWC-T7 Modeled Groundwater Elevations For Various Climate Projections (Alluvial Aquifer Below Saugus WRP)

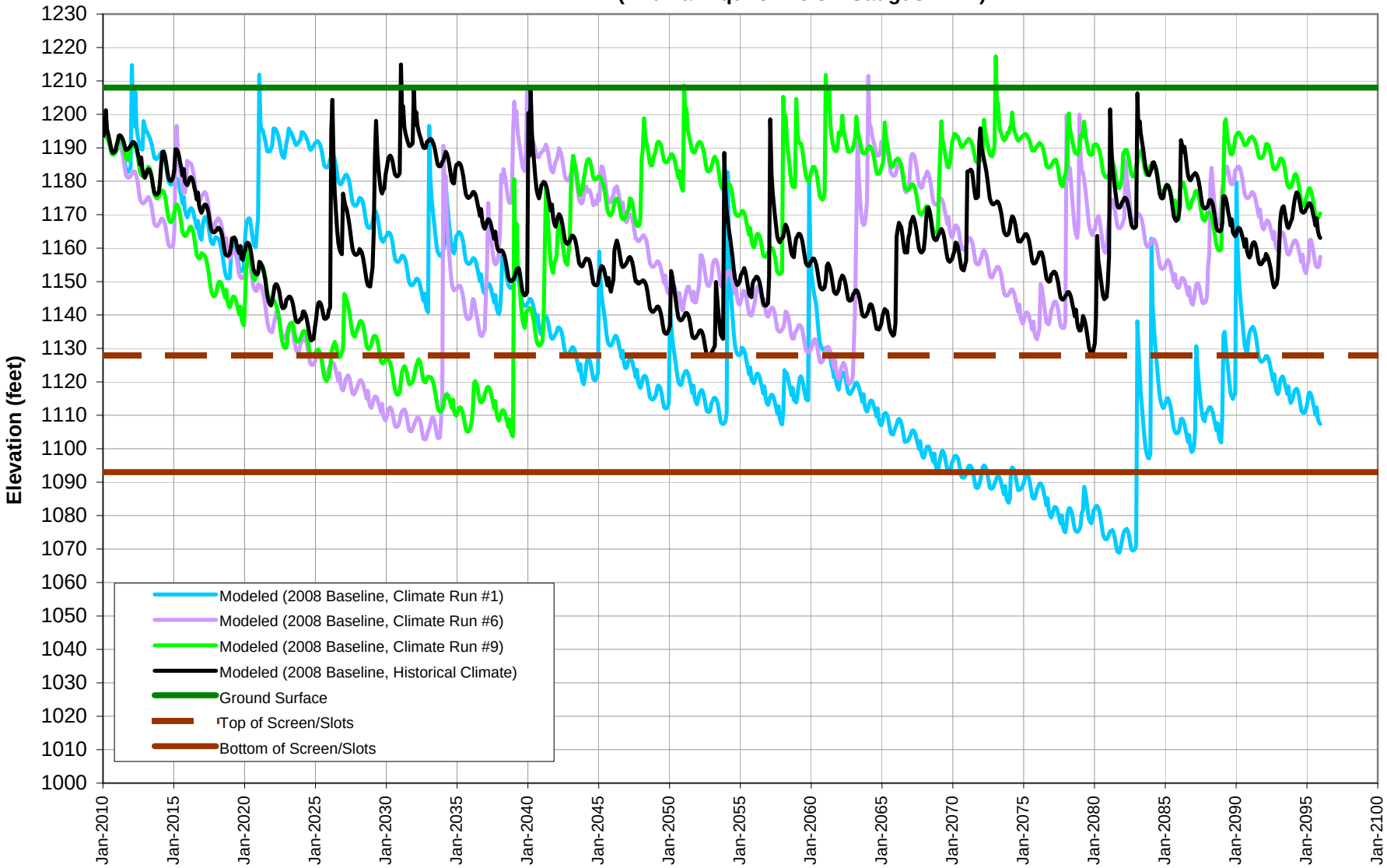


Figure 5-5: SCWD-Sierra Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer along Santa Clara River, At and Above Mint Canyon)

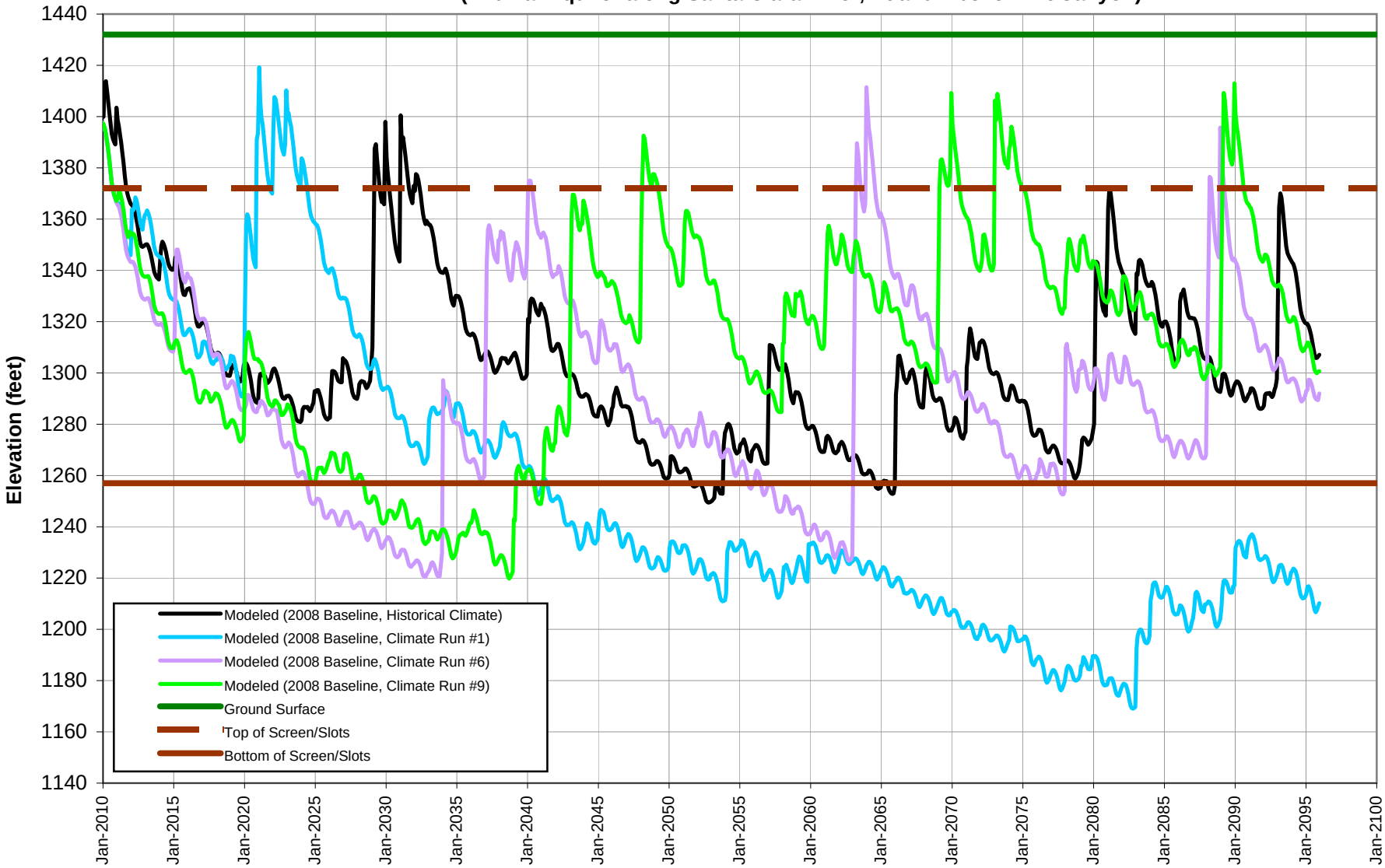


Figure 5-6: NCWD-Pinetree1 Modeled Groundwater Elevations For Various Climate Projections
(Alluvial Aquifer Along Santa Clara River, At and Above Mint Canyon)

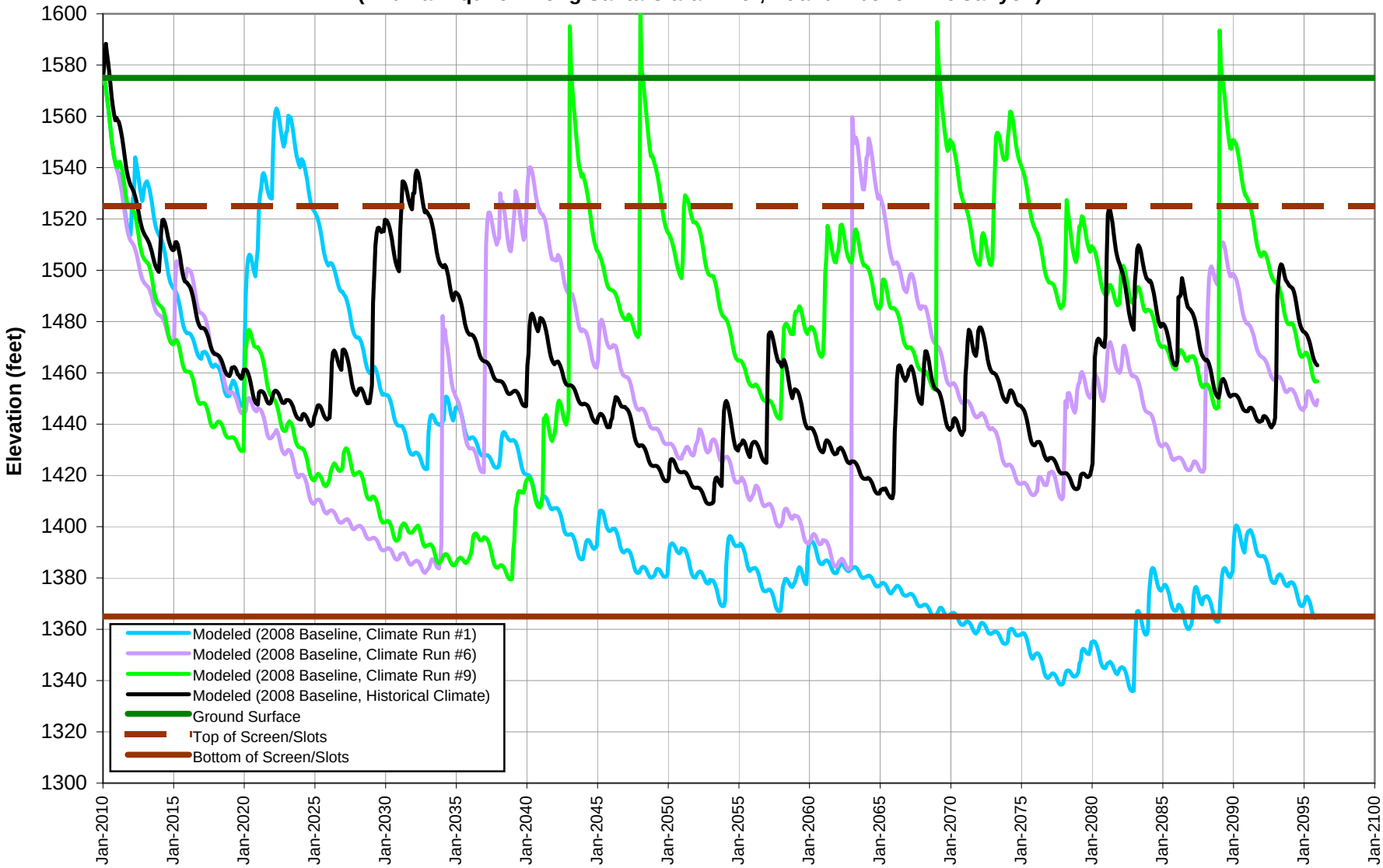


Figure 5-7: NCWD-Castaic7 Modeled Groundwater Elevations For Various Climate Projections (Alluvial Aquifer in Castaic Valley)

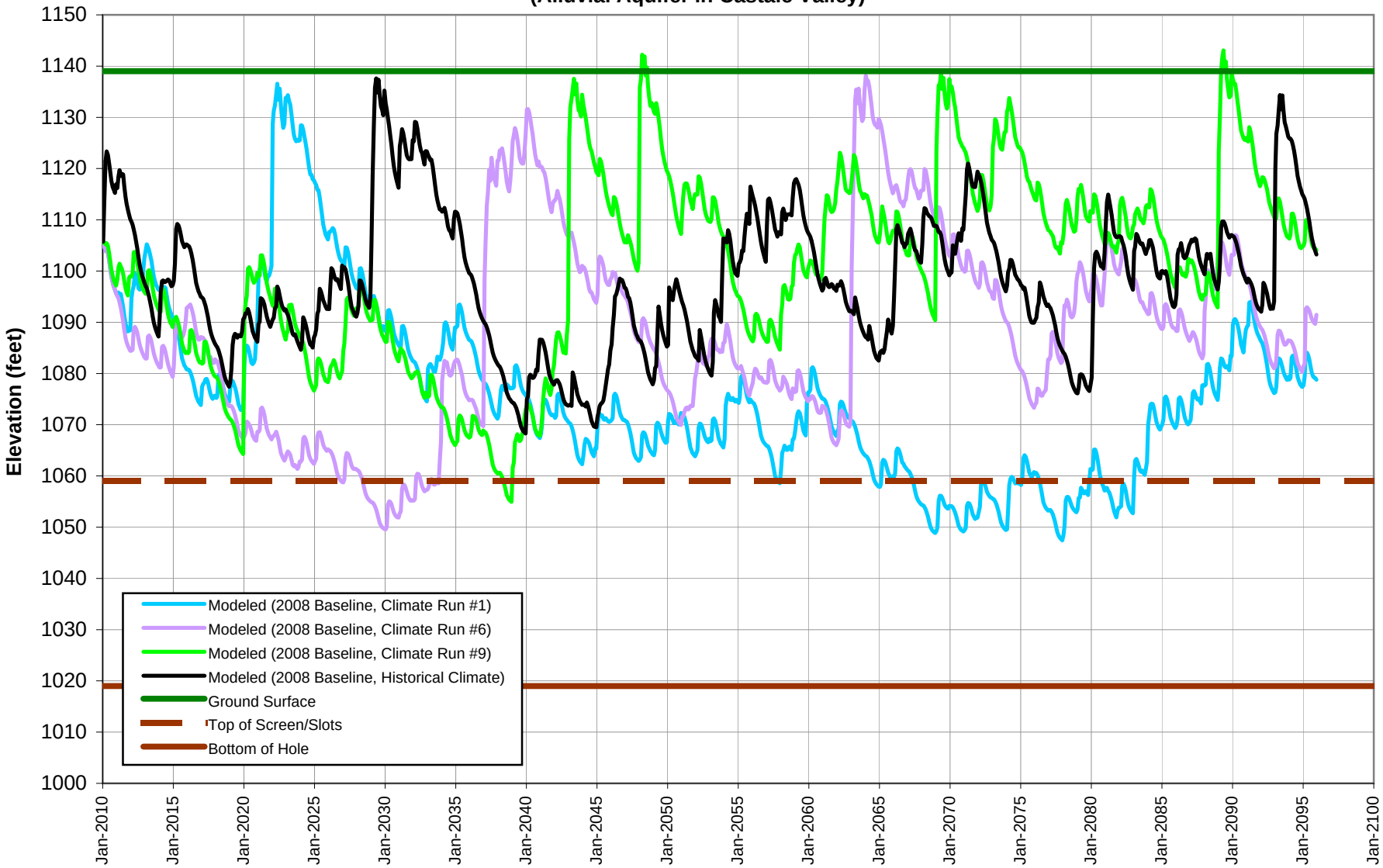


Figure 5-8: VWC-W11 Modeled Groundwater Elevations For Various Climate Projections (Alluvial Aquifer in San Francisquito Canyon)

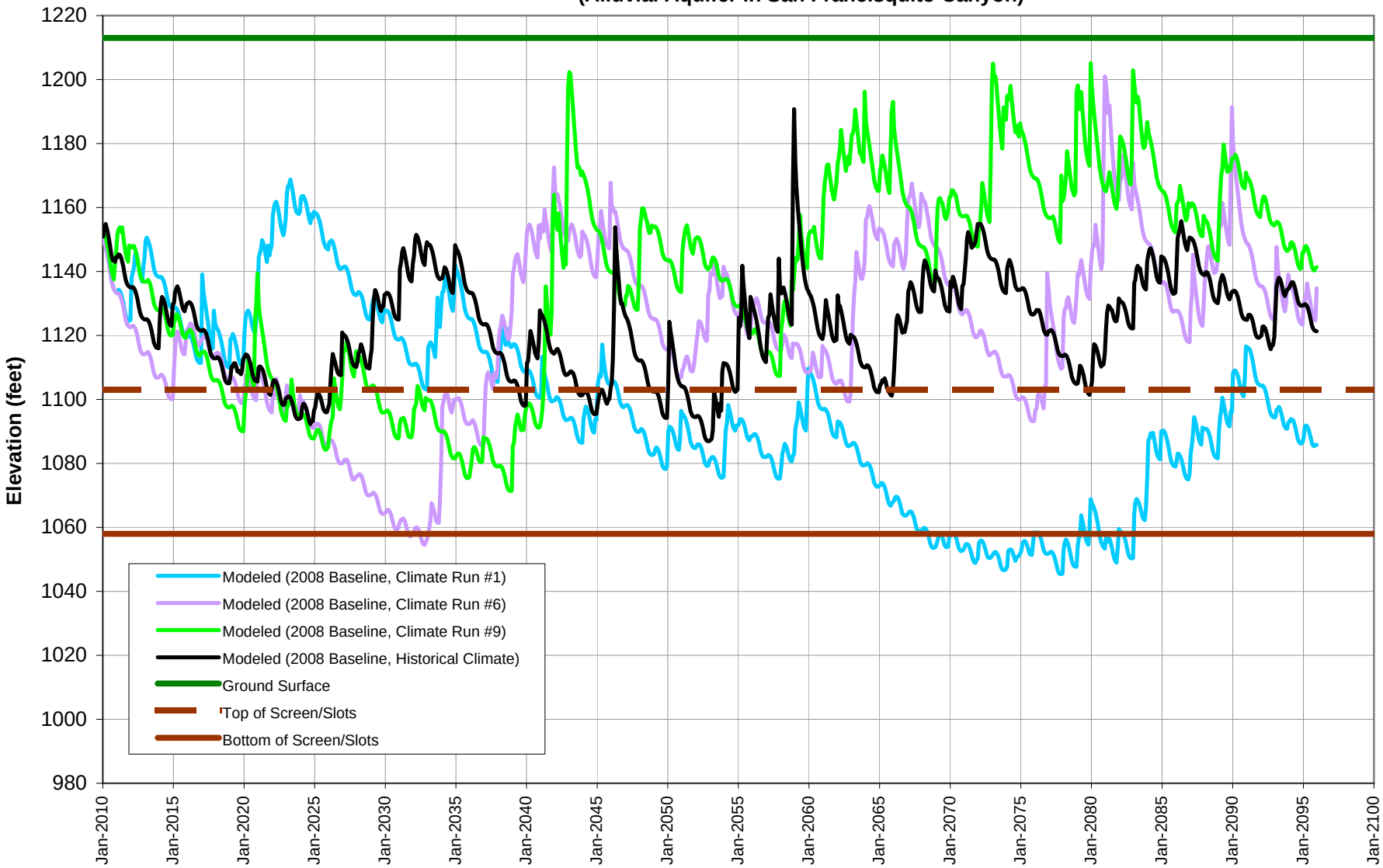


Figure 5-9: SCWD-Clark Modeled Groundwater Elevations for Various Climate Projections (Alluvial Aquifer in Bouquet Canyon)

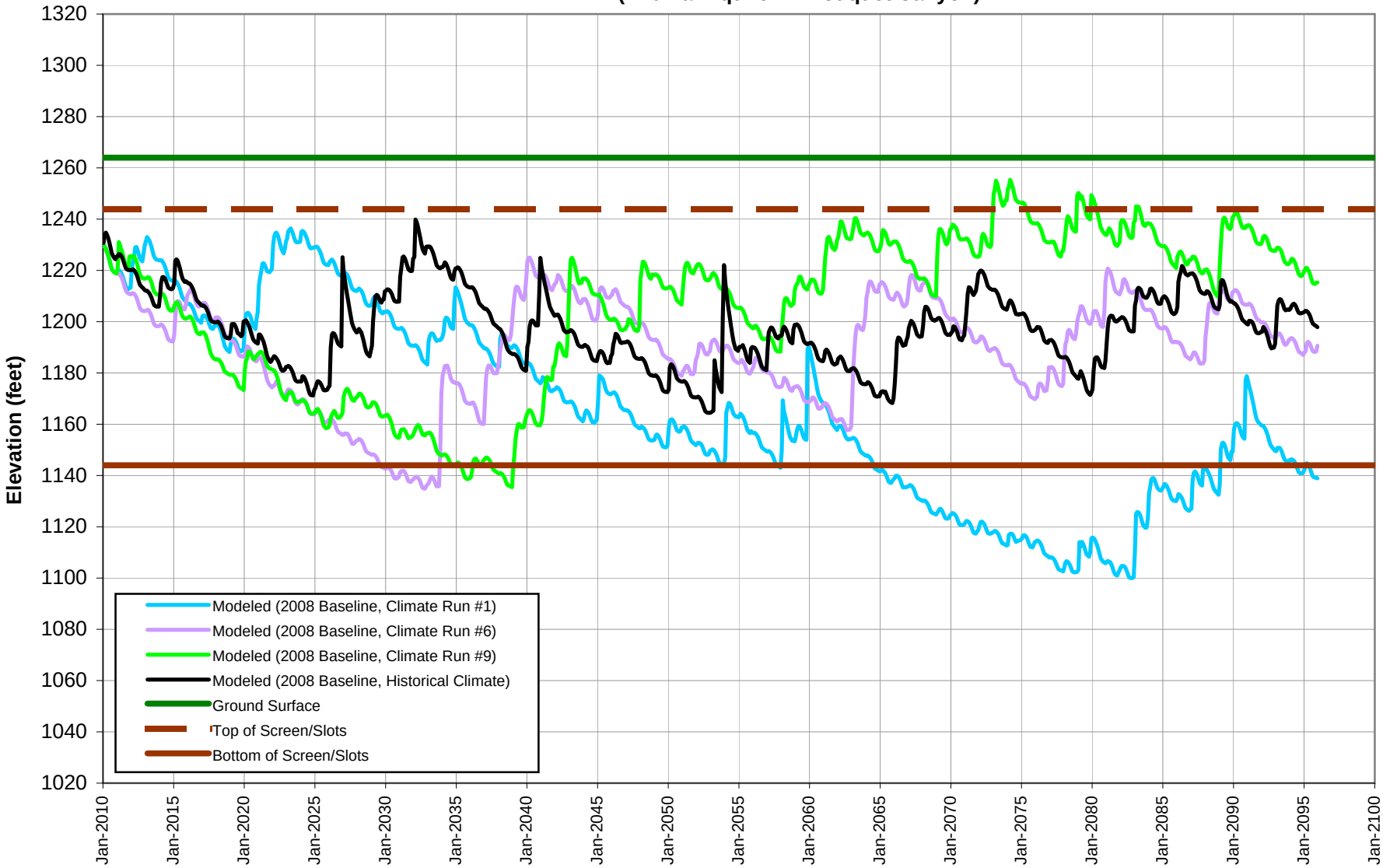


Figure 5-10: Groundwater Elevation Trends at SCWD-Saugus1 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9

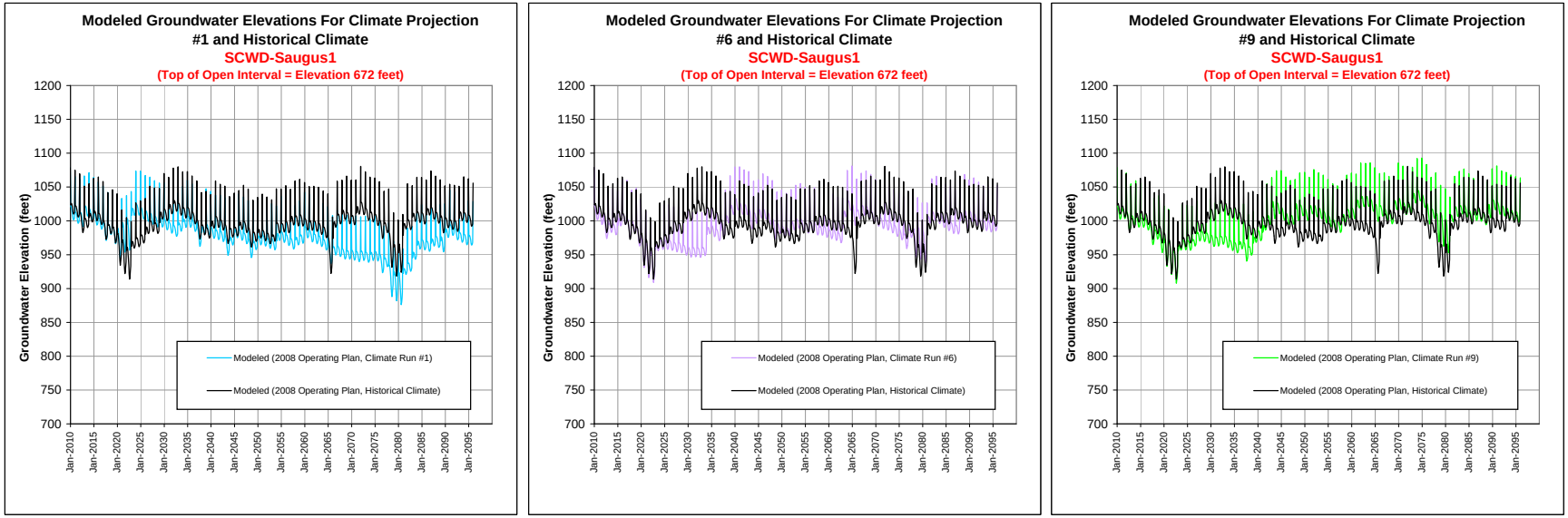
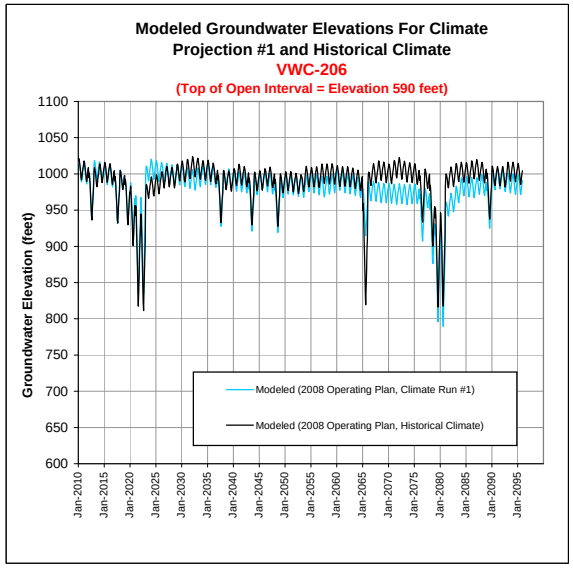
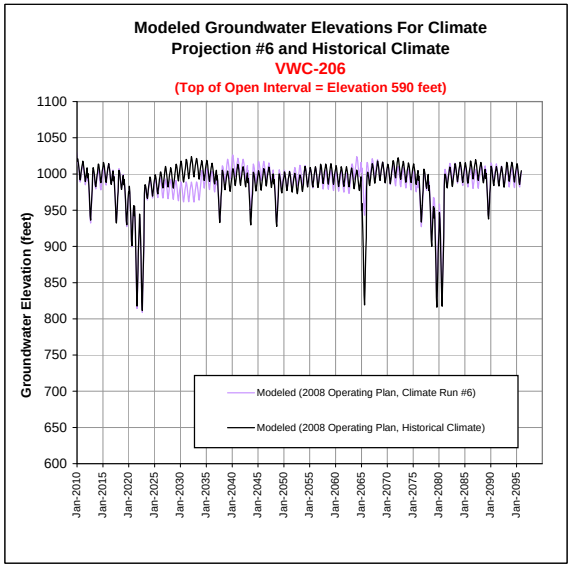


Figure 5-11: Groundwater Elevation Trends at VWC-206 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9





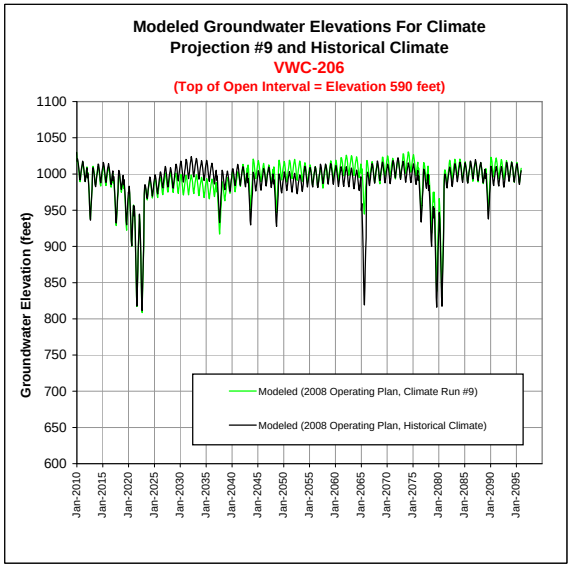
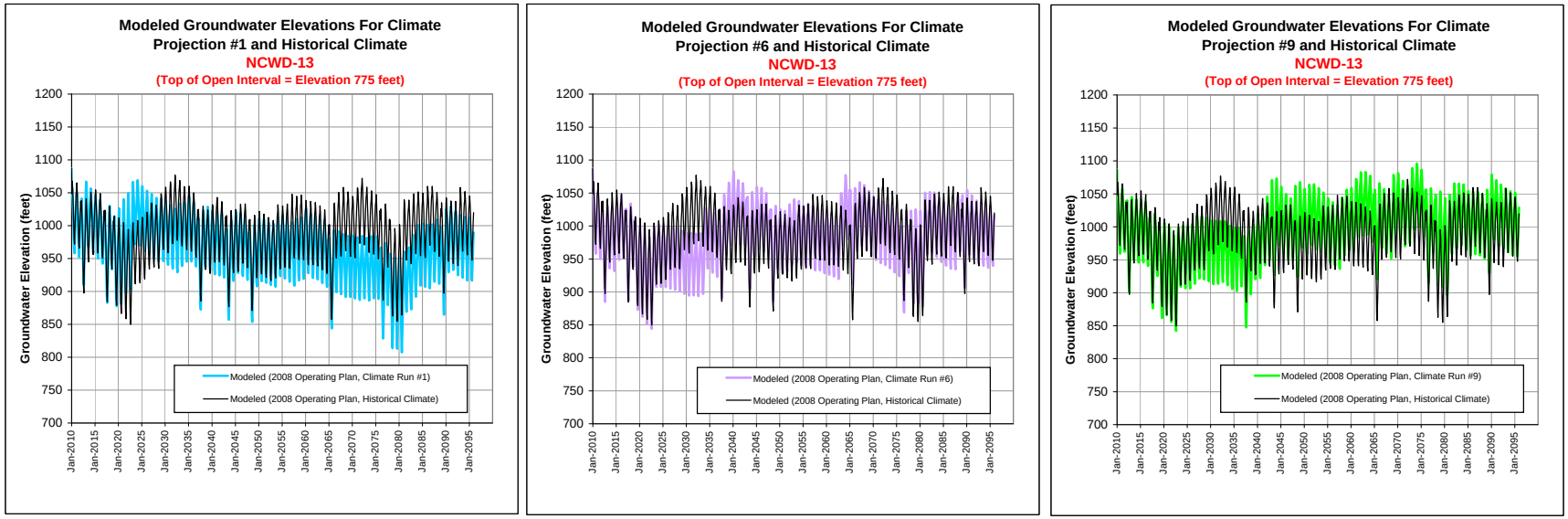


Figure 5-12: Groundwater Elevation Trends at NCWD-13 for the 2008 Operating Plan Under Historical Climate and Climate Projections #1, #6, and #9



VI. Local Artificial Recharge Projects

6.1 Los Angeles County Flood Control District Study

The Los Angeles County Flood Control District (LACFCD) prepared an unpublished water conservation plan that proposes constructing thirteen separate artificial recharge projects in the upper Santa Clara River Watershed. The focus of the plan is to capture or impede stormwater runoff to promote percolation to groundwater, specifically to the Alluvium located along the Santa Clara River. Although the plan acknowledged that there is a lack of runoff data to accurately predict the water conservation benefits of the projects, LACFCD estimated that, on average, a given year could be expected to have three storms that would be capable of producing enough stormwater runoff to fill the estimated storage capacities of each of the thirteen proposed projects. Therefore, to estimate the total water conservation benefit, LACFCD multiplied the total storage capacity of the thirteen projects by three. The total storage capacity and water conservation benefit of the thirteen projects combined were thus estimated to be 1,816 acre feet and 5,455 acre feet per year, respectively.

The plan subdivided the thirteen projects into three separate areas of the basin (Figure 6-1):

- six projects on the south fork of the Santa Clara River
- two projects in San Francisquito Canyon
- five projects on the main Santa Clara River System

Table 6-1 lists each project by subarea along with the LACFCD estimate of project capacity and water conservation benefit. The project locations relative to the Alluvial aquifer system by subarea are described below.

6.2 Project Locations Relative to Aquifer System

The six projects that would be located along the south fork of the Santa Clara River, as illustrated in Figure 6-1, consist of three rubber dam projects; two projects that divert water into spreading grounds; and a project that backs up flows behind a rubber dam for diversion into adjoining spreading grounds. The total capacity and estimated water conservation benefit of these six facilities are 496 acre feet and 1,475 acre feet per year, respectively. The riverbed of the south fork of the Santa Clara River lies along the eastern margin of the alluvial valley that the river occupies. In this area, the alluvium is thin and the Saugus Formation outcrops in the hills adjoining the river valley. Projects 1 through 5 are located in areas where groundwater pumping occurs from the Saugus Formation, but no Alluvial production wells are present because of the limited saturated thickness of the alluvium throughout this area. Project no. 6 is the furthest north (or downgradient) of the south fork projects and is located south of VWC's N7 and N8 Alluvial production wells in an area where the saturated thickness of the alluvium is much greater than further upstream where the other projects are located.

The two projects (no. 7 and 8 on Figure 6-1) proposed by LACFCD in San Francisquito Canyon would consist of spreading grounds along the unnamed ephemeral stream, tributary to the Santa

Clara River. The total capacity of the spreading grounds would be about 420 acre feet with a combined estimated water conservation benefit of 1,270 acre feet per year. The locations of the two spreading grounds are along the margins of the Alluvium north of Decoro Drive and Cooper Hill Drive where the alluvium is thin.

The five projects (no. 9 through 13 on Figure 6-1) proposed by LACFCD along the Santa Clara River extend from near the Saugus wastewater treatment plant eastward to areas just east of Newhall County Water District's Pinetree wells. These projects would include one rubber dam and four spreading grounds that are located along the margins of the Alluvium near outcrops of Saugus and bedrock formations in the hills adjoining the alluvial river valley. The five projects would have combined capacity of about 900 acre feet and an estimated total annual water conservation benefit of about 2,710 acre feet per year.

6.3 Conceptual Project Operation and Impacts

The purpose of the planned projects would be to capture stormwater runoff using inflatable rubber dams and to divert excess runoff into spreading grounds in order to recharge groundwater in the Alluvium in the immediate vicinity of each project site. The ability and related impact of the projects to effectively increase groundwater recharge in the Alluvium rather than to simply redistribute groundwater recharge is discussed in further detail below.

- **South Fork of the Santa Clara River.** Recharge projects in the South Fork of the Santa Clara River would be located primarily along the margins of the river valley where the Alluvium where this unit is thin. These project locations (nos. 1 through 5 on Figure 6-1) may not have sufficient alluvial thickness and available storage capacity during storm events to allow excess runoff captured by these projects to recharge groundwater at each project location. As a result, the excess stormwater runoff may not readily recharge groundwater and may be rejected due to the lack of available storage capacity in the vicinity of each project. Excess runoff captured by these projects would likely recharge groundwater elsewhere in the south fork of the Santa Clara River or near its mouth. Project locations 1 through 5 are proposed to be located in areas where groundwater production wells pump groundwater from the underlying Saugus Formation, rather than from the Alluvium. Consequently, even if some additional water were introduced to storage, little if any of the benefit would be able to be pumped at those project locations (again, there are no existing Alluvial production wells in the area and there is no likelihood of new production wells being constructed, all due to the lack of sufficient thickness of the Alluvium). Project location no. 6, the northernmost project in this area may have the potential to provide additional recharge to groundwater. However, due to the low storage capacity and estimated water conservation benefit, it would be difficult to differentiate between recharge from this project as compared to recharge under existing conditions, which already maintains sustainable groundwater conditions.

- **San Francisquito Canyon.** Project locations in San Francisquito Canyon would intercept stormwater runoff that would likely continue to recharge the Alluvium further downstream of the project locations; in essence, the projects would potentially

only redistribute stormwater recharge that currently has recharged the Alluvial aquifer in areas upstream of the Valencia waste water treatment plant (again, existing recharge already supports sustainable groundwater conditions in San Francisquito Canyon and immediately downstream in the main River area).

- **Santa Clara River** The project locations in the Santa Clara River area are very spread out with the easternmost project (no. 12) having the largest estimated capacity. However, Project no. 12 is located more than a mile east of Newhall County Water Districts Pinetree wells, and any stormwater runoff captured by this project would likely result in two different outcomes. One outcome is that the project would likely recharge groundwater in an area which currently has no production wells, and the water that is recharged would likely have recharged groundwater further downstream in the absence of the project. The second outcome is that the available storage in the alluvium in the area of the project would fill rapidly during a large stormwater runoff event, thereby limiting the amount of infiltration that can occur afterwards from the stormwater runoff captured by the project's spreading grounds. Three of the other four remaining projects (no. 10, 11, and 13) will likely encounter similar obstacles to Project no. 12 because of the similar surface and groundwater conditions that are present along the Santa Clara River between the Bouquet Canyon Bridge and the Lang gage (the eastern margin of the watershed). Project no. 9 (at the Bouquet Canyon Bridge) is similar in nature to Project no. 6 described above in that any benefit derived from the project might not be discernible from the conditions that would otherwise occur naturally in the absence of this and the other projects that are proposed along the Santa Clara River.

The overarching consideration with regard to the planned artificial recharge projects is that they might capture and "artificially recharge" water that already recharges the Alluvial aquifer system where it is of sufficient thickness to be developed as a groundwater supply. As evident from empirical observations and the simulations reported herein, the system "naturally" recharges to the point of sustaining groundwater pumping and, in the westerly end of the basin, to the point that stream recharge is rejected (and groundwater discharges to the stream). The small volumes of the various planned artificial recharge projects, and the arbitrarily estimated filling of those three times per year, do not represent "new" recharge; they likely represent some potential minor relocation of existing recharge.

Even if it were desirable to purposely relocate some existing recharge to one or more of the planned (LACFCD) locations, it would be difficult (possible but challenging) to redistribute the small amount of stream recharge and to then track the corresponding small effect of intercepting that water and removing it as a source of recharge as now occurs downstream. The results of the rest of the work reported herein, most notably that dealing with achievability of the 2008 Operating Plan, clearly suggest that artificial recharge could locally benefit certain areas, notably at and above Mint Canyon. However, such benefits would more logically develop from other water sources that would supplement natural recharge rather than simply redistribute it. The model used to simulate the basin response to the operating plans, under historic and potential climate change conditions, can readily simulate the effects and benefits of artificial recharge at selected locations using supplemental water.

Table 6-1

Los Angeles County Flood Control District
Stormwater Runoff Recharge Projects

Recharge Project	Storage Capacity (acre-feet)	Annual Water Conservation Benefit (acre-feet/year)
Santa Clara River South Fork		
1	109	330
2	75	220
3	5	75
4	112	330
5	60	180
6	115	340
Subtotal	496	1,475
San Francisquito Canyon		
7	230	700
8	190	570
Subtotal	420	1,270
Santa Clara River		
9	80	230
10	180	550
11	220	670
12	70	220
13	350	1040
Subtotal	900	2,710
Grand Total	1,816	5,455

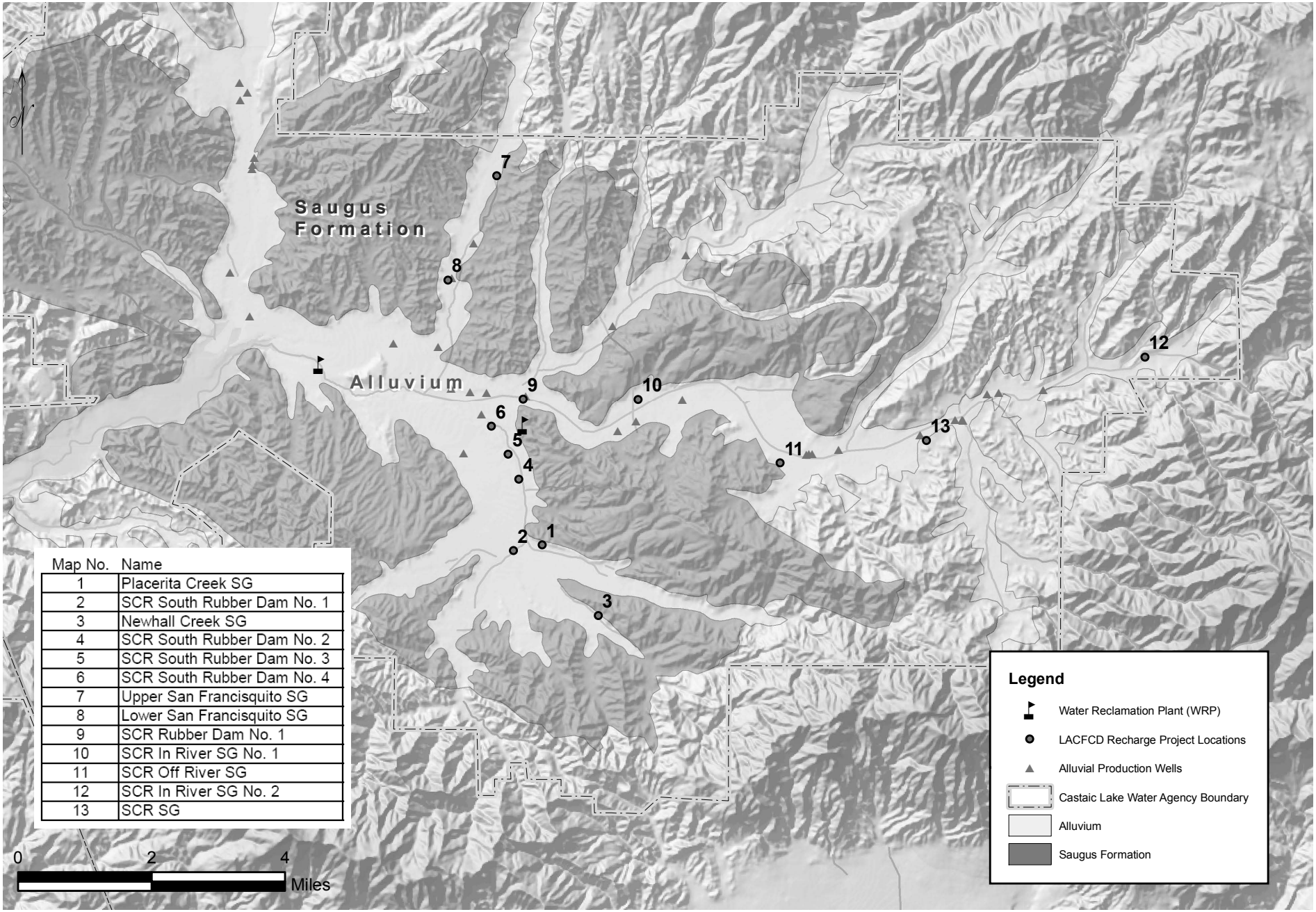


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Figure 6-1
Locations of LACFCD Planned Recharge Projects
Upper Santa Clara River Valley Groundwater Basin, East Subbasin

VII. Conclusions

The primary objective of the updated analysis of groundwater basin yield in the Santa Clarita Valley was to evaluate the planned utilization of groundwater by the Purveyors, after their consideration of potential impacts on traditional supplemental water supplies from the State Water Project (SWP), and with recognition of ongoing pumping by others for agricultural and other private water supply, for sustainability of the groundwater resource and for physical ability to extract groundwater at desired rates. As has previously been utilized in this basin, consistent with groundwater management in other settings, sustainability is defined in terms of renewability (recharge) of groundwater as reflected by the following indicators:

- lack of chronic, or sustained, depletion of groundwater storage, as indicated by projected groundwater levels, over a reasonable range of wet, normal, and dry hydrologic conditions

- maintenance of surface water flows in the western portion of the basin (which are partially maintained by groundwater discharge) and surface water outflow to downstream basins over the same range of hydrologic conditions

Regarding maintenance of surface water flows, although the development and use of groundwater in a sustainable manner necessitates the inducement of recharge from surface water, sustainability in this case does not rely on inducing groundwater recharge by eliminating surface water flows. Rather, sustainability retains surface water outflows and may even increase them with the importation of supplemental water when contrasted to pre-SWP conditions. Regarding both indicators of sustainability, the range of analyzed hydrologic conditions is a long-term period that includes anticipated occurrences of the types of years and groups of year types that have historically occurred in the basin.

A second objective of the updated groundwater basin yield analysis was to investigate and describe potential impacts of expected climate change on the groundwater basin and its yield. A third objective was to consider potential augmentation of basin yield via potential artificial groundwater recharge using storm water runoff in selected areas of the basin as being planned by the Los Angeles County Flood Control District.

The primary objective was investigated by analyzing, with the numerical groundwater flow model of the basin, two groundwater operating plans: a 2008 Operating Plan to reflect currently envisioned pumping rates and distribution throughout the Valley, including fluctuations through wet/normal and dry years, to achieve a desired amount of water supply that, in combination with anticipated supplemental water supplies, can meet existing and projected water requirements in the Valley; and a Potential Operating Plan that envisions potentially increased utilization of groundwater during both wet/normal and dry years.

With regard to the respective operating plans, a first conclusion is that the 2008 Operating Plan will not cause detrimental short- or long-term effects to the groundwater and surface water resources in the Valley and is, therefore, sustainable. Consistent with actual operating experience and empirical observations of historical basin response to groundwater pumping, the

2008 Operating Plan can be expected to have local difficulty, in the Alluvium at the eastern end of the basin during locally dry periods, with achievement of all the Alluvial pumping in the 2008 Operating Plan. This condition is particularly evident if several decades of predominantly below-normal rainfall years were to occur in the future such as occurred during much of the five decades from the mid-1920s through the mid-1970s. In other words, while the basin as a whole can sustain the pumping embedded in the 2008 Operating Plan, local conditions in the Alluvium in the eastern end of the basin can be expected to repeat historical groundwater level declines during dry periods, necessitating a reduction in desired Alluvial aquifer pumping due to decreased well yield and associated actual pumping capacity. The modeling analysis conducted to date suggests that those reductions in pumping from the Alluvial aquifer can be made up by an equivalent amount of increased pumping in other parts of the basin without disrupting basin-wide sustainability or local pumping capacity in those other areas. For the Saugus Formation, the modeling analysis indicates that this aquifer can sustain the pumping from this unit that is imbedded the 2008 Operating Plan.

Simulation of the 2008 Operating Plan with Pumping Redistribution indicates that westerly redistribution of 1,600 afy of alluvial pumping from the eastern end of the basin would help, but not eliminate, the lack of achievability. The residual unachievable pumping in the east end of the basin, about 4,500 afy, could be redistributed to other areas of the basin with minimal impact on groundwater levels. In this case, total Alluvial pumping in the basin could remain near the upper end of the 2008 Operating Plan range of 30,000 to 35,000 afy. Conversely, absent any additional efforts to redistribute pumping, the total Alluvial pumping capacity during extended dry periods would likely shrink toward the lower end of the 2008 Operating Plan range, toward 30,000 afy.

Another conclusion with regard to the respective operating plans is that the Potential Operating Plan would result in lower groundwater levels, failure of the basin to fully recover (during wet hydrologic cycles) from depressed storage that occurs during dry periods, and generally declining trends in groundwater levels and storage. This conclusion is strongly suggested for the Alluvial aquifer by the modeling results, but the model also indicates that long-term lowering of groundwater levels could also occur in the Saugus Formation, with only partial water level recovery occurring in the Saugus. Thus, the Potential Operating Plan would not be sustainable over a long-term period. The simulated combination of lower and declining groundwater levels under the Potential Operating Plan also leads to a conclusion that such an operating plan could not be physically achieved in several areas within the basin.

Conclusions with regard to another of the objectives of the updated groundwater basin yield analysis include a recognition that the runoff conservation/groundwater recharge projects being planned by the Los Angeles County Flood Control District are a combination of individually small projects that are not yet fully analyzed in terms of potential new yield, are but unlikely to provide any substantial recharge that does not already occur. Additionally, these proposed projects are mostly located in areas of the basin where the alluvial aquifer is of insufficient thickness and storage (and is thus not developed for water supply) or where the alluvial aquifer already fully recharges when stream flows are naturally present.

Final conclusions related to the overall objectives of the updated groundwater basin yield analysis all relate to the potential impacts of climate change on the yield of the basin and the

related groundwater supply from the basin. While "conclusions" would probably be an inappropriate term to describe future conditions that cannot be projected with any degree of certainty, the results of simulating basin response to the 2008 Operating Plan, under a range of potential climate change result in two important observations.

- for the broad range of climate change possibilities that was analyzed, the 2008 Operating Plan would appear to be both sustainable and, with the same physical constraints to full pumping in the eastern part of the basin as have otherwise been experienced, achievable through the shorter term horizon associated with UWMP planning.

- the range of potential climate change impacts extends from a possible wet trend to a possible dry trend over the long term. The trends that range from an approximate continuation of historical average precipitation, to something wetter than that, would appear to result in continued sustainability of the 2008 Operating Plan, again with intermittent constraints on full pumping in the eastern part of the basin. The potential long-term dry trend arising out of climate change would be expected to decrease local recharge to the point that lower and declining groundwater levels would render the 2008 Operating Plan unsustainable.

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Filed 4/20/09 California Water Impact Networkv. Castaic Lake Water Agency CA2/5

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

California Rules of Court, rule 8.1115(a), prohibits courts and parties from citing or relying on opinions not certified for publication or ordered published, except as specified by rule 8.1115(b). This opinion has not been certified for publication or ordered published for purposes of rule 8.1115.

IN THE COURT OF APPEAL OF THE STATE OF CALIFORNIA

SECOND APPELLATE DISTRICT

DIVISION FIVE

CALIFORNIA WATER IMPACT NETWORK, INC. et al., Plaintiffs and Appellants, v. CASTAIC LAKE WATER AGENCY, Defendant and Respondent.	B205622 (Los Angeles County Super. Ct. No. BS106546)

APPEAL from an order of the Superior Court of Los Angeles County, Dzintra I. Janavs, Judge. Affirmed.

Law Offices of Babak Naficy and Babak Naficy for Plaintiffs and Appellants.

Hortvitz & Levy, Barry R. Levy and Felix Shafir; McCormick, Kidman & Behrens, Russell G. Behrens and David Boyer for Defendant and Respondent.

I. INTRODUCTION

Plaintiffs, California Water Impact Network and the Friends of the Santa Clara River, appeal from a judgment denying their amended mandate petition which sought to set aside the certification of an environmental impact report and approval for a 2006 Water Acquisition Project ("the project") by defendant, Castaic Lake Water Agency. The 2006 project consists of a plan by defendant to purchase a minimum of 11,000 acre feet per year of water from the Buena Vista Water Storage District ("Buena Vista district") and the Rosedale-Rio Bravo Water Storage District ("Rosedale-Rio Bravo district"). The two districts operate the Buena Vista Water Storage District/Rosedale-Rio Bravo Water Storage District Water Banking and Recovery Program ("Buena Vista/Rosedale-Rio Bravo water banking program"). The Buena Vista/Rosedale-Rio Bravo water banking program, which was subject to full environmental review in 2002, sells water to third parties such as defendant. Defendant's 2006 project also allows for the additional purchase of 9,000 acre feet per year of water that may be available from time to time depending upon hydrologic and operational conditions affecting the Buena Vista/Rosedale-Rio Bravo water banking program.

Plaintiffs argue defendant's 2006 environmental impact report does not comply with the environmental review requirements of the California Environmental Quality Act. (Pub. Resources Code,[1] § 21000 et seq.) Plaintiffs argue the 2006 environmental impact report: does not properly describe the project; does not adequately analyze the growth inducing impacts of the 2006 project; was not prepared by the proper lead agency; and calls for the acquisition of water supplies for developments that are inconsistent with and unaccounted for in the Los Angeles County General Plan. We disagree the asserted grounds provide a basis for setting aside defendant's certification of the 2006

[1] All further statutory references are to the Public Resources Code unless otherwise indicated.

environmental impact report and affirm the judgment denying the amended mandate petition.

II. FACTUAL AND PROCEDURAL MATTERS

A. The 2002 Environmental Impact Report And Buena Vista/Rosedale-Rio Bravo Water Banking Program

The Buena Vista and Rosedale-Rio Bravo districts are adjacent water districts that jointly serve approximately 92,000 acres of primarily agricultural land in southern San Joaquin Valley, west of the City of Bakersfield. The Buena Vista district, which was organized in 1924, has a gross area of approximately 49,000 acres. The Rosedale-Rio Bravo district, which was formed in 1959, has a gross area of approximately 44,000 acres of land developed primarily for irrigated agriculture and urban users. Both water districts are engaged in groundwater recharge, banking, and recovery programs. Both are member units of the Kern County Water Agency ("Kern County agency") which is a water wholesaler. The Kern County agency was created in 1961 by the Legislature to secure and supply adequate water to its local member units in Kern County. Both the districts have rights to Kern River waters. Both the Buena Vista and Rosedale-Rio Bravo districts also have rights to a water supply from the State Water Project through the Kern County agency.

Water Code section 43001 allows a water district to "sell, distribute, or otherwise dispose" of water and water rights.[2] In September 2002, the Buena Vista and Rosedale-Rio Bravo districts certified an environmental impact report which evaluated the impacts of operating their water banking and recovery program including the sale of water to third-party users such as defendant. The 2002 environmental impact report expressly

[2] Water Code section 43001 states in its entirety, "The board may sell, distribute, or otherwise dispose of water and water rights not necessary for the uses and purposes of the district."

states that third party customers such as defendant will be required to conduct appropriate environmental review as a condition of any sales. The Buena Vista/Rosedale-Rio Bravo water banking and recovery program environmental impact report was certified on October 11, 2002.

The 2002 Buena Vista/Rosedale-Rio Bravo water banking environmental impact report states that approximately 25 percent of groundwater banking would be accomplished using existing accounts in the Buena Vista district. An additional 75 percent of water banking will be accomplished by using accounts to be developed primarily through recharge of Buena Vista Kern River high flow water within the Rosedale-Rio Bravo district. Defendant's 2006 environmental impact report defines "groundwater recharge" as follows, "Refers to the addition to the water within the earth that occurs naturally from infiltration of rainfall and from water flowing over the earth materials that allow water to infiltrate below the land surface." According to the 2002 Buena Vista/Rosedale-Rio Bravo water banking program environmental impact report, recovery from the groundwater banking accounts will be accomplished by: using direct and in-lieu methods; via groundwater pumping; and exchanges of State Water Project supplies. The Buena Vista and Rosedale-Rio Bravo districts were to jointly recover the groundwater. The groundwater was to be recovered by means of accounts to be developed through recharge within the Rosedale-Rio Bravo district. More than 80,000 acre feet of Buena Vista Kern River wet year water were to be captured and recharged within the Rosedale-Rio Bravo district service area in a given year. The recharged waters were to be included in the groundwater bank account. Also, the account would include groundwater which had been previously recharged within the Kern River area by the Buena Vista district. The Buena Vista district committed to the program 150,000 acre feet of previously recharged exportable groundwater which it currently stored. It was estimated that more than 20,000 acre feet of banked water could be recovered or withdrawn from the groundwater bank account in order to supply water demands created by the Buena Vista/Rosedale-Rio Bravo water banking program. The water recovered under the Buena Vista/Rosedale-Rio Bravo water banking program could be delivered to

third-party buyers such as defendant. The primary method of recovery or delivery would be through an "in-lieu" exchange of State Water Project Table A supplies. (Table A, an attachment to long-term water contracts, will be fully discussed later in this opinion.) When the Table A supplies were insufficient for an "in-lieu" exchange, the banked groundwater will be pumped into the California Aqueduct of the State Water Project for delivery to a buyer such as defendant. The 2002 Buena Vista/Rosedale-Rio Bravo water banking program "in-lieu" exchange process was approved by the Department of Water Resources prior to its implementation. The Department of Water Resources monitors all exchanges and deliveries.

B. The 2006 Project

The California Department of Water Resources is responsible for overall water planning for the State of California. Defendant is located in Los Angeles and Ventura Counties and was created by the Legislature in 1962. (Stats.1962, 1st Ex. Sess., ch. 28, p. 208, § 1. Amended by Stats.1970, ch. 443, p. 873, § 1; Wat. Code App. § 103-1.) Defendant is 1 of 29 State Water Project Contractors who enter into agreements with the Department of Water Resources. The 29 contractors have long-term water supply contracts for water service from the State Water Project. The 29 contractors obtain deliveries from the Department of Water Resources in accordance with the long-term contracts. The acre feet of water that may be delivered under an individual contractor's agreement with the Department of Water Resources is set forth in an attachment to the long-term contract. The attachment which sets forth the acre feet of water is referred to as Table A. The Table A attachment establishes the total amount of State Water Project that a contractor may request and potentially receive each year under the terms of the long-term water supply contract. In exchange, the contractors pay the Department of Water Resources any fees and costs related to the operation and maintenance of the State Water Project. The yearly fees are calculated by reference to the Table A amount. The Department of Water Resources is not always able to deliver the quantity of requested

water because of certain factors such as hydrologic conditions, current reservoir storage, and total water contractor requests.

Defendant's service area is approximately 195 square miles (124,800 acres) in incorporated and unincorporated areas in, or adjacent to, the Santa Clarita Valley. Defendant's purpose, at its formation, was to contract through the Department of Water Resources to acquire and distribute State Water Project water to four local purveyors. Defendant's purpose was subsequently expanded by legislation to: acquisition of water from the Department of Water Resources; distribution of water wholesale; water reclamation; retail water sale; and exercise of other related powers. Defendant has a fundamental duty to plan for and procure a reliable water supply. (Cal. Wat. Code-App. § 103-15.) Defendant principally obtains its water supply from the State Water Project.

In February 1984, the Los Angeles County Board of Supervisors adopted the Santa Clarita Valley Areawide General Plan. The 1984 general plan projected that 165,000 residents would inhabit defendant's area by the year 2000. In August 1987, the Los Angeles County Department of Regional Planning prepared a draft amendment to the 1984 general plan forecasting that the population would be 210,000 rather than 165,000 by the year 2000. The 1987 document forecast a population of 270,000 by 2010 in defendant's area. To address water supply and demand forecasts, defendant completed the Capital Program and Water Plan in 1988. The 1988 Capital Program involves a long-term plan for financing purchases, construction, and improvements to meet future needs. The 1988 plan is currently being implemented. In 2003, defendant issued a Water Supply Reliability Plan for the Santa Clarita Valley. The purpose of the 2003 plan is to develop a protocol to evaluate the technical, environmental, and economic issues surrounding a water supply reliability project. The goal is to have in the future only the most effective and cost-efficient projects.

The California Urban Water Planning Act (Wat. Code, § 10631 et seq.) requires contractors, such as defendant, to assess water supply reliability that compares total projected usage with the expected supply over a 20-year period in 5-year increments. (Wat. Code, § 10621, subd. (a), 10631, subd. (a); see *Friends of Santa Clara River v.*

Castaic Lake Water Agency (2004) 123 Cal.App.4th 1, 8.) In accordance with statutory requirements, defendant adopted the 2005 Urban Water Management Plan. However, defendant's 2005 Urban Water Management Plan exceeds the minimum 20-year period and covers a 25-year period. Defendant's 2005 Urban Water Management Plan built upon its 2000 Urban Water Management Plan, as amended. Defendant evaluated the long-term water needs within its service area and compared these requirements against existing potential water supplies. The United States Census indicates defendant's service area had a population of approximately 190,000 with 63,000 households. Defendant projects a population growth from 249,343 in 2005 to 428,209 in 2030. The 2005 Urban Water Management Plant was identified as a potential source to meet future demands for water.

On January 31, 2006, pursuant to section 21092, subdivision (a) defendant issued a notice of preparation of the draft environmental impact report for the 2006 project. The 2006 project consists of the contractual right to annually purchase water from the Buena Vista/Rosedale-Rio Bravo water banking program in the amount of 11,000 acre feet through the year 2035. Defendant further has the right to extend the contract with the Buena Vista and Rosedale-Rio Bravo districts subject to compliance with applicable law. The 2006 project environmental impact report states the 11,000 acre feet of water per year purchase from the Buena Vista/Rosedale-Rio Bravo water banking program "is to be used primarily for annexations" to defendant's service area. But until "any such annexations are likely approved," the supply would be available to meet existing demands. Defendant also has the right to purchase an additional 9,000 acre feet in any given year from the Buena Vista/Rosedale-Rio Bravo water banking program. The Buena Vista/Rosedale-Rio Bravo water banking program delivers water to customers such as defendant in two ways. The first way is the so-called "in lieu" exchange. Under the in lieu exchange method, the Buena Vista and Rosedale-Rio Bravo districts, rather than use their banked groundwater, transfers water to which they have rights under their contracts with the State Water Project. The groundwater could be sold to local customers or it can remain in the ground. In other words, in lieu of pumping groundwater, the

Buena Vista and Rosedale-Rio Bravo districts could ship other water to which they have rights to customers such as defendant. Hence, the terminology in lieu exchange describes this first method of delivering water to defendant under the 2006 project. The second way to deliver the contracted for water is to pump it out of the ground in the Buena Vista and Rosedale-Rio Bravo districts and deliver it via the California Aqueduct to defendant. The principal method of recovery and delivery would be from State Water Project water delivered to the Buena Vista and Rosedale-Rio Bravo districts for recharging or irrigation purposes. Resort to groundwater pumping would occur only in years when the State Water Project undergoes shortages—1 to 5 years in every 35-year period. Under either delivery system, all deliveries were required to comply with State Water Project standards.

Defendant determined its projected demands required supplemental water sources beyond the amounts specified in Table A attached to its long-term water contract with the Department of Water Resources. In addition, banking was needed to improve water supply especially in drought years. In some years, the full amount of contracted water due from the State Water Project may not be available for delivery to its long-term contractors due to: hydrology; the amount of water in storage; the operational constraints and environmental regulations; the amounts of water requested by other contractors; climatic conditions; and other factors. The 2006 environmental impact report states the project consists of an action by defendant to augment its supply to meet the demands of its service area. Further, the 2006 environmental impact report states defendant desired to augment its water supply to meet future demands in the event its service area is enlarged by reason of annexation; or transfer of water from the Buena Vista/Rosedale-Rio Bravo water banking program. Defendant's purchase of water from the Buena Vista/Rosedale-Rio Bravo water banking program guaranteed a firm water supply which is not subject to the variations in the State Water Project supply. The 2006 project is also identified in defendant's 2005 Urban Water Management Program as a source to meet projected demand in the Santa Clarita Valley.

The 2006 environmental impact report indicates that there were no significant direct impacts from the project. The 2006 environmental impact report states that less significant impacts included increased electrical power demand and air emissions from moving water to defendant's service area. This impact removed obstacles to growth in defendant's service area. As a result, defendant identified population growth or development as potential indirect impacts. However, defendant notes that its responsibility is to provide water in the service area and not to approve locations of any new development. To the extent that there were visual or aesthetic effects caused by water purchase programs, the 2006 environmental impact report states that such impact could be mitigated by the county and city agencies approving such developments in the project-specific environmental review process. The 2006 environmental impact report identifies three alternatives to the project: reduced water supply; purchase of desalinated water; and no project. The 2006 environmental impact report concludes the project was the environmentally superior alternative. This is because, under the reduced water supply and no project alternatives, defendant would be required to obtain additional water supplies to meet the projected needs of the service area. The 2006 environmental impact report notes that the desalination project could actually cause more direct impacts to the environment than the project. This is because the construction and operation of new desalination facilities would be required. These activities would have significant impacts on: air quality; aesthetic and visual resources; agricultural resources; biological resources; marine resources; geology and soils; hydrology and water quality; land use and planning; noise levels; and recreation.

The 2006 environmental impact report identifies five possible annexation sites within the service area. The 2006 environmental impact report states that whether the sites were actually annexed was not within the defendant's authority but that water availability was a factor in the annexation process. The potential annexations would result in a 4,375 acre feet of water per year increase in demand for water. The 2006 environmental impact report states that 11,000 acre feet of water per year of water would

be able to serve between approximately 11,340 and 11,830 households, which translates into approximately 36,290 and 37,850 persons.

Pursuant to section 21092, subdivisions (a) and (b)(i) and California Code of Regulations, title 14, section 15087, subdivision (c)(2),[3] the public was provided with the opportunity to comment on the draft 2006 environmental report. Among the issues raised during the comment period was whether the 2006 environmental impact report adequately disclosed whether the project was being pursued under the so-called Monterey Amendment to State Water Project long-term contracts. In the 1990's, disagreements arose between contractors and others with the Department of Water Resources concerning the distribution of State Water Project supplies. State Water Project contractors and the Department of Water Resources negotiated a settlement which provided for an overhaul of long term water contracts and a new approach to managing State Water Project supplies. The dispute arose under article 18 of the long-term contracts. The principles developed as part of the 1994 settlement are known as the "Monterey Agreement." The 1994 "Monterey Agreement" amended water contracts and those changes are known as the "Monterey Amendment." The Monterey Amendment was approved in 1995 and went into effect in August 1996. (See *Friends of Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1375; *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, 897-902.) One principle of the Monterey Amendment called for the transfer of about 130,000 acre feet of water per year from agriculture to urban users. (*Friends of the Santa Clara River v. Castaic Lake Water Agency*, *supra*, 95 Cal.App.4th at pp. 1376-1377; *Planning & Conservation League v. Department of Water Resources*, *supra*, 83 Cal.App.4th at pp. 901-902.)

The comments to the 2006 draft environmental impact report state: it did not fully disclose whether the transfers were permanent; a permanent transfer implicated the

[3] All future reference to the Guidelines are to the provisions of California Code of Regulations, title 14.

Monterey Amendment; and the project was the "functional equivalent" of a permanent transfer of water requiring the Department of Water Resources prepare an environmental impact report as the lead agency under the standards set forth in *Planning & Conservation League v. Department of Water Resources*, *supra*, 83 Cal.App.4 at page 920. Defendant responded to the comments by noting the water purchased from the Buena Vista Rosedale-Rio Bravo districts under the 2006 project did not involve the State Water Project Table A supplies. According to defendant, the Monterey Agreement applied to two types of water transfers—permanent transfers of Table A amounts and annual transfers of allocated Table A supplies. Defendant further stated that the Monterey Agreement did not address transfers of non-State Water Project supplies. Citing section 2.4 of the draft environmental impact report, defendant explained no purchase of water subject to Table A had occurred. Instead, defendant pointed out: the Table A supplies for it, as well as Buena Vista and Rosedale-Rio Bravo districts, would remain the same under the 2006 project; the purchased water originated from local and other supplies that will be recharged and banked in groundwater basins; and the supplies included Kern River wet year water and other acquired waters. Defendant also noted that all of the information about the program water supplies was set forth in the 2002 Buena Vista/Rosedale-Rio Bravo water banking environmental impact report.

Defendant denied that there was a functional equivalent of a permanent transfer of Table A waters subject to the Monterey Agreement. Defendant stated the State Water Project Table A supplies attributed to the long-term contract with the Department of Water Recovery constitute but one mechanism for the purchased water to be delivered to defendant through an in-lieu exchange. Thus, defendant argued the Department of Water Resources did not have to be the lead agency. The only role of the Department of Water Resources in the project is to approve the change in place of use and point of delivery of exchange water delivered from to another State Water Project long-term contractor and for the direct delivery of groundwater into the California Aqueduct.

Defendant's Board of Directors adopted Resolution No. 2492 on October 25, 2006, certifying the final 2006 environmental impact report for the project and adopting:

findings; a mitigation monitoring and reporting program; and a statement of overriding considerations. Resolution No. 2492 approved the project. The board determined: the 2006 project's benefits outweighed any significant and unavoidable environmental impacts; substantially all of the 2006 project's indirect impacts consist of growth inducement which is outside of its jurisdiction and control; the 2006 project will bring substantial benefits to the defendant's service area by improving the its ability to meet the present and projected water demands; and the 2006 project will bring substantial benefit to defendant's service area by preparing for projected growth.

C. The Amended Mandate Petition And Its Denial

On November 26, 2006, plaintiffs filed their mandate petition. The first amended petition alleged that plaintiffs are non-profit organizations. Plaintiffs sought to set aside the certification of the 2006 environmental impact report for the project and a declaration defendant's actions were unlawful. The amended petition further alleged: the 2006 environmental impact report fails to clearly identify and describe the likely source of water that will be acquired by defendant because it does not accurately describe the "in-lieu" method; the method employed by the 2006 project is really a transfer of State Water Project Table A water; the 2006 environmental impact report fails to forecast the project's potential impacts on marine life including some sensitive species which would be caused by additional winter pumping; defendant was not the proper lead agency to conduct environmental review of the 2006 project; and the 2006 environmental impact report fails to properly evaluate the use of State Water Project facilities to deliver the exchange of water to the service area which must be done by the Department of Water Resources. Plaintiffs requested issuance of alternative and peremptory writs of mandate commanding defendant to set aside, invalidate, and void the certification of the 2006 environmental impact report. Plaintiffs also requested declaratory and injunctive relief. The trial court denied the first amended petition after briefing and a hearing. Judgment

was entered on all of plaintiffs' causes of action in favor of defendant. This timely appeal followed.

III. DISCUSSION

A. Standard of Review

Our Supreme Court in *Citizens of Goleta Valley* v. *Board of Supervisors* (1990) 52 Cal.3d 553, 563-564, summarized the purposes of the California Environmental Quality Act: "As we recently observed in *Laurel Heights Improvement Assn.* v. *Regents of University of California* (1988) 47 Cal.3d 376, (*Laurel Heights*): 'The foremost principle under [the California Environmental Quality Act] is that the Legislature intended the act "to be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language."' [Citation.] [¶] The EIR has been aptly described as the 'heart of CEQA.' (Guidelines, § 15003, subd. (a); *Laurel Heights, supra,* 47 Cal.3d at p. 392; *County of Inyo* v. *Yorty* (1973) 32 Cal.App.3d 795, 810.) Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions *before* they are made. Thus, the EIR 'protects not only the environment but also informed self-government.' (*Laurel Heights, supra,* 47 Cal.3d at p. 392.) [Fn. omitted.]"

Whether defendant's certification of the 2006 environmental impact report complies with the relevant provisions of law is reviewed for a prejudicial abuse of discretion. (§ 21168.5; *In re Bay-Delta Programmatic Environmental Impact Report Coordinated Proceedings* (2008) 43 Cal.4th 1143, 1161; *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 435; *Citizens of Goleta Valley* v. *Board of Supervisors, supra,* 52 Cal.3d at pp. 563-564.) Section 21168.5 states, ". . . Abuse of discretion is established if the agency has not proceeded in a manner required by law or if the determination or decision is not supported by substantial evidence." In deciding whether a prejudicial abuse of discretion has occurred

our Supreme Court has stated: "As a result of this standard, 'The court does not pass upon the correctness of the EIR's environmental conclusions, but only upon its sufficiency as an informative document.' [Citation.] [¶] . . . [¶] A court may not set aside an agency's approval of an EIR on the ground that an opposite conclusion would have been equally or more reasonable. [Citation.] A court's task is not to weigh conflicting evidence and determine who has the better argument when the dispute is whether adverse effects have been mitigated or could be better mitigated. We have neither the resources nor scientific expertise to engage in such analysis, even if the statutorily prescribed standard of review permitted us to do so. Our limited function is consistent with the principle that 'The purpose of CEQA is not to generate paper, but to compel government at all levels to make decisions with environmental consequences in mind. . . . ' [Citation.]" (*Laurel Heights Improvement Assn. v. Regents of University of California, supra,* 47 Cal.3d at pp. 392-393; see also *Western States Petroleum Assn. v. Superior Court* (1995) 9 Cal.4th 559, 573-574; *Citizens of Goleta Valley v. Board of Supervisors, supra,* 52 Cal.3d at p. 564.) We review defendant's actions de novo determining whether the administrative record demonstrates any legal error and it contains substantial evidence to support the factual determinations. (*Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova, supra,* 40 Cal.4th at p. 427; *Citizens of Goleta Valley* v. *Board of Supervisors, supra,* 52 Cal.3d at pp. 563-564.)

B. Compliance With The California Environmental Quality Act

1. The environmental impact report adequately describes the project.

There is no merit to plaintiff's argument the 2006 project environmental impact report fails to include an adequate and consistent description of the water source. The absence of information from an environmental impact report does not establish a

violation of Guidelines, section 15124,[4] the controlling provision, as a matter of law. (*Berkeley Keep Jets Over the Bay Committee v. Board of Port Comrs.* (2001) 91 Cal.App.4th 1344, 1355; *Al Larson Boat Shop, Inc. v. Board of Harbor Commissioners* (1993) 18 Cal.App.4th 729, 749.) Rather, judicial review under the prejudicial abuse of discretion standard set forth in section 21168.5 focuses on the sufficiency of the environmental impact report as an informative document. (*Laurel Heights Improvement Assn. v. Regents of University of California, supra,* 47 Cal.3d at p. 392; accord *Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova, supra,* 40 Cal.4th at p. 445; *Western States Petroleum Assn. v. Superior Court, supra,* 9 Cal.4th at pp. 573-574.) A prejudicial abuse of discretion occurs when the failure to include information in the environmental impact report prevents informed decisions and public participation, which thwarts the goals of the evaluative process. (*Anderson First Coalition v. City of*

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[4] Guidelines, section 15124 states: "The description of the project shall contain the following information but should not supply extensive detail beyond that needed for evaluation and review of the environmental impact. [¶] (a) The precise location and boundaries of the proposed project shall be shown on a detailed map, preferably topographic. The location of the project shall also appear on a regional map. [¶] (b) A statement of the objectives sought by the proposed project. A clearly written statement of objectives will help the lead agency develop a reasonable range of alternatives to evaluate in the EIR and will aid the decision makers in preparing findings or a statement of overriding considerations, if necessary. The statement of objectives should include the underlying purpose of the project. [¶] (c) A general description of the project's technical, economic, and environmental characteristics, considering the principal engineering proposals if any and supporting public service facilities. [¶] (d) A statement briefly describing the intended uses of the EIR. [¶] (1) This statement shall include, to the extent that the information is known to the lead agency, [¶] (A) A list of the agencies that are expected to use the EIR in their decision-making, and [¶] (B) A list of permits and other approvals required to implement the project. [¶] (C) A list of related environmental review and consultation requirements required by federal, state, or local laws, regulations, or policies. To the fullest extent possible, the lead agency should integrate CEQA review with these related environmental review and consultation requirements. [¶] (2) If a public agency must make more than one decision on a project, all its decisions subject to CEQA should be listed, preferably in the order in which they will occur. On request, the Office of Planning and Research will provide assistance in identifying state permits for a project."

Anderson (2005) 130 Cal.App.4th 1173, 1178; *Galante Vineyards v. Monterey Peninsula Water Management Dist.* (1997) 60 Cal.App.4th 1109, 1117.) Guidelines section 15151 provides: "An EIR should be prepared with a sufficient degree of analysis to provide decisionmakers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. . . . The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure." (See *Anderson First Coalition v. City of Anderson, supra,* 130 Cal.App.4th at p. 1178; *Berkeley Keep Jets Over the Bay Committee v. Board of Port Comrs., supra,* 91 Cal.App.4th at p. 1355; *Rio Vista Farm Bureau Center v. County of Solana* (1992) 5 Cal.App.4th 351, 368.)

Plaintiffs argue the 2006 environmental impact report omits or mischaracterizes information about the sources for the water supply. To the extent plaintiffs are criticizing the ambiguity of the Buena Vista/Rosedale-Rio Bravo water banking program, they cannot raise that contention. The 2002 environmental impact report is conclusively presumed valid and it is not subject to challenge in this action. (§ 21167.2; *Laurel Heights Improvement Assn. v. Regents of University of California* (1993) 6 Cal.4th 1112, 1130.) Thus, plaintiffs cannot challenge the Buena Vista/Rosedale-Rio Bravo water banking and recovery program under the guise of litigating the 2006 environmental impact report. This action must be limited to whether the 2006 environmental impact report sufficiently informs the decisionmakers and the public about impacts from the project. Plaintiffs may not litigate the impact of the Buena Vista/Rosedale Rio Bravo water banking program. The aforementioned conclusive 2002 environmental impact report repeatedly states that the primary method of delivery will be through "in-lieu" exchange of State Water Project supplies. The 2002 environmental impact report sets forth: the environmental effects of operating the program which included the sale of water to third-parties; discussions of delivery through banked underground water; and analysis of delivery through "in-lieu" exchange of Table A supplies. The 2002 program

environmental impact report fully disclosed that the primary method of delivery would be "in-lieu" exchange but that in some years the delivery might vary depending upon State Water Project supplies.

In any event, the 2006 environmental impact report adequately describes the project. The 2006 environmental report: identifies the sources of the water that will be delivered; describes the growth related effects of the purchase in defendants' service area; and identifies the effects of additional water pumping. The 2006 environmental impact report explains that the primary source of water provided by the Buena Vista/Rosedale-Rio water banking program will be water provided to them by the State Water Project. There is no merit to plaintiffs' contention the discussion in that regard is incomplete or misleading.

Furthermore, we disagree with plaintiffs the "in-lieu" exchange delivery amounts to a permanent transfer of Table A water or the functional equivalent thereof. Before proceeding to a discussion of the merits of plaintiffs' environmental analysis, it bears emphasis that the Buena Vista and Rosedale-Rio Bravo Districts have the statutory authority to sell their water and water rights pursuant to Water Code section 43001. (See fn. 2, *infra*.) At oral argument, plaintiffs' counsel admitted there is no statutory bar to the sale of water rights by the Buena Vista and Rosedale-Rio Bravo Districts. Rather, as fleshed out at oral argument, plaintiffs argue that the proposed transfer of waters violate attachment C to the Monterey Agreement which are Department of Water Resources guidelines for review of proposed permanent transfers of Table A waters. The attachment C guidelines are in furtherance of the state policy favoring voluntary water transfers which includes a preference for use of water for non-irrigation purposes; i.e., for the sustenance of human beings, household conveniences, and the care of livestock. (Wat. Code, § 106; *Prather v. Hoberg* (1944) 24 Cal.2d 549, 562.) Further, paragraph 3 of attachment C states, "These guidelines are not intended to change or augment existing law."

In any event, as discussed above, all information concerning the environmental impacts from the two delivery methods was discussed and analyzed in the *conclusive*

2002 environmental impact report. Nevertheless, there is no merit to the contention that there is a permanent transfer of Table A amounts. Both the Buena Vista and Rosedale-Rio Bravo districts have contractual rights with the State Water Project which allow them to receive a maximum amount of water supply in a given year. The water supply from the State Water Project varies depending on the conditions such as: hydrologic conditions; current reservoir storage; and total water contractor requests. However, the actual amount of water delivered under the 2006 project is not contingent upon Table A supplies distributed by the State Water Project to the Buena Vista and Rosedale-Rio Bravo districts. It is undisputed that the Table A supplies can vary yearly. Rather, under the program, defendant has a contractual right to receive 11,000 acre feet of water per year regardless of whether the Buena Vista and Rosedale-Rio Bravo districts receive Table A supplies. Thus, use of Table A water is neither the actual nor the functional equivalent of a permanent transfer because it may not occur. The "in-lieu" exchange is simply one method to meet the contractual obligation to deliver 11,000 acre feet of water to defendant. It is not a permanent transfer of Table A supplies. And even if the project were such a transfer, it is sufficiently described along with its effects in the 2006 environmental impact report. The 2006 environmental impact report expressly states that the water purchased would come from two sources. The first source is the Buena Vista and Rosedale-Rio Bravo Districts State Water Project waters. The second source is the banked groundwater whose rights are owned by Buena Vista and Rosedale-Rio Bravo Districts. In an unusually dry year, groundwater supplies may be the sole source of waters sold to third parties such as defendant. And the 2006 environmental impact report states that 2006 project does not involve the purchase of Table A amounts. Contrary to plaintiffs' counsel's assertion at oral argument, the 2006 environmental impact report does not mask the source of the waters.

2. The 2006 environmental impact report adequately reviewed growth inducing impacts.

Plaintiffs contend that the 2006 environmental impact report fails to adequately review the growth inducing impacts generated by the purchase of the water. We disagree. In *Muzzy Ranch Co. v. Solano County Airport Land Use Com.* (2007) 41 Cal.4th 372, 388-389, our Supreme Court articulated an agency's responsibility to analyze growth inducing impacts as follows: "Under CEQA, a public agency is not always 'required to make a *detailed* analysis of the impacts of a project on [future] housing and growth.' [Citation.] 'Nothing in the [CEQA] Guidelines, or in the cases, requires more than a general analysis of projected growth. The detail required in any particular case necessarily depends on a multitude of factors, including, but not limited to, the nature of the project, the directness or indirectness of the contemplated impact and the ability to forecast the actual effects the project will have on the physical environment.' [Citation.] [¶] 'In addition, it is relevant, although by no means determinative, that future effects will themselves require analysis under CEQA.' [Citation.] And '[t]hat the effects will be felt outside of the project area . . . is one of the factors that determines the amount of detail required in any discussion. Less detail, for example, would be required where those effects are more indirect than effects felt within the project area, or where it [would] be difficult to predict them with any accuracy.' [Citations].) Most significantly, the CEQA Guidelines provide for streamlined review of projects that are consistent with existing general plans and zoning. [Citation.] When approving a project that is consistent with a community plan, general plan, or zoning ordinance for which an environmental impact report already has been certified, a public agency need examine only those environmental effects that are peculiar to the project and were not analyzed or were insufficiently analyzed in the prior environmental impact report. [Citation.]" (See also *Napa Citizens for Honest Government v. Napa County Bd. of Supervisors* (2001) 91 Cal.App.4th 342, 369.)

The 2006 environmental impact report complies with the statutorily imposed informational requirements. Chapter 4.0 of the 2006 environmental impact report discusses growth inducing impacts and potential indirect impacts on resources from growth. Furthermore, there is no evidence the additional water will induce any growth that is unaccounted for in the general plan of the area. Rather, chapter 5.0 of the 2006 environmental impact report contains a discussion of the project's consistency with general and regional plans. The 2006 environmental impact report assumes that the entire 11,000 acre feet of water per year would be for new growth. The project also assumes that approximately 37,850 people would be served by the water supply from the project. The growth potential was within the general plan forecasts of 270,000 by 2010 and 428,209 by 2030 for the Santa Clarita Valley. Moreover, the 2006 project is a part of a process to meet defendant's obligation to provide water to its service area in accordance with projected population increases. Thus, the 2006 environmental impact report contains a detailed analysis of growth inducing impacts. The 2006 project is also consistent with existent general and community plans projecting growth increases in the service area. The 2006 environmental impact report adequately discusses growth related issues. (*Muzzy Ranch Co. v. Solano County Airport Land Use Com., supra*, 41 Cal.4th at pp. 388-389; *Napa Citizens for Honest Government v. Napa County Bd. of Supervisors, supra*, 91 Cal.App.4th at p. 369; see also Guidelines, § 15126.2, subd. (d); *Sierra Club v. West Side Irrigation Dist.* (2005) 128 Cal.App.4th 690, 702-703.)

Finally, we disagree with plaintiffs that there was something amiss in the 2006 environmental impact report because defendant included five proposed annexation sites in the discussion. Plaintiffs interpret defendant's inclusion of the five potential sites identified in chapter 3.0 as evidence of a plan to grow the area. Because of the pending applications, defendant was required to include the sites in the environmental impact report. (Guidelines, § 15125; *Muzzy Ranch Co. v. Solano County Airport Land Use Com., supra*, 41 Cal.4th at pp. 387-388 [§ 21060.5 obligates an defendant to consider environmental impact of project outside the project area when it will have effect on geographically distant area].)

3. Defendant is the correct lead agency.

Plaintiffs assert that defendant's imprecise discussion is an attempt to mask what is the "functional equivalent" of a permanent transfer of surplus Table A supplies belonging to the Buena Vista and Rosedale-Rio Bravo districts. Relying on *Planning & Conservation League v. Department of Water Resources*, *supra*, 83 Cal.App.4th at pages 903-907, plaintiffs argue the proper lead agency should have been the Department of Water Resources. The *Planning & Conservation League* decision held the Department of Water Resources was the proper lead agency for conducting environmental review of the Monterey Agreement. (*Ibid*.; see *Santa Clarita Organization for Planning the Environment v. County of Los Angeles* (2007) 157 Cal.App.4th 149, 153.) The *Planning & Conservation League* decision had statewide implications and involved a number of urban and agricultural contractors. The issues also involved rights under the long-term water supply contracts which governed the entire State of California.

In this case, defendant is the correct lead agency. Section 21067 defines a lead agency, '"Lead agency' means the public agency which has the principal responsibility for carrying out or approving a project which may have a significant effect upon the environment." Defendant argues it is the proper lead agency because: it is the lead proponent of the water acquisition plan; a substantial portion of the 2006 project occurs within its geographic area; and it alone decides whether to accept any water. We agree. Defendant has the principal responsibility for approving and carrying out a project to acquire a water supply for its service area. (§§ 21005, 21080, subd. (c), 21165; Guidelines, §§ 15051-15053.) The 2006 project also affects defendant's duties and obligations to provide water to its service area. In addition, the 2006 project occurs within defendant's jurisdiction. The transfer of water applies to only three agencies, albeit that the transfer will take place within State Water Project facilities. The three agencies are the primary ones affected by the 2006 project. Thus, defendant was the proper lead agency. In any event, plaintiffs conceded in the trial court in their reply brief, and at hearing on the petition that its lead agency analysis rests on the conclusion the

2006 project is in effect a Table A transfer. We have concluded no disguised permanent nor functional equivalent transfer of Table A water has occurred. As a result, the Department of Water Resources was not required to be the lead agency such that it should have prepared the environmental impact report. (*Eller Media Co. v. Community Redevelopment Agency* (2003) 108 Cal.App.4th 25, 46; *Friends of Cuyamaca Valley v. Lake Cuyamaca Recreation & Park Dist*. (1994) 28 Cal.App.4th 419, 426-428; *City of Sacramento v. State Water Resources Control Bd*. (1992) 2 Cal.App.4th 960, 970-973; *City of Redding v. Shasta County Local Agency Formation Com.* (1989) 209 Cal.App.3d 1169, 1173-1177.)

4. The project does not impermissively rely on a draft of general plan.

Relying on *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 941-951, plaintiffs argue the 2006 project improperly appropriated water supplies for development that had not already been included in the Los Angeles County General Plan. In *County of Amador*, the environmental impact report was based on population projections contained in a draft general plan prepared by El Dorado County. (*Id*. at pp. 941, 947.) The *County of Amador* opinion concluded, "We hold only that, in this case, an [environmental impact report] predicated on a draft general plan is fundamentally flawed and cannot pass CEQA muster." (*Id.* at p. 951.)

The *County of Amador* decision is not controlling. Here, there is no draft general plan at issue. In other words, defendant did not predicate the project on a draft general plan which has been judicially determined to be inadequate. Rather, the water planning in this case for the project was based on projections from a number of sources including: the United States Census; defendant's 2005 Urban Water Management Plan; and the existing Santa Clarita Valley Area Plan of the County of Los Angeles General Plan. The existing Los Angeles County General Plan had projections of a population growth of 270,000 by the year 2010. The 2005 Urban Water Management Plan predicted the future need for water to meet the demand for population growth that had been projected by Los

Angeles County and the City of Santa Clarita. Defendant has a duty to plan for long term needs in the service area. The California Urban Water Planning Act (Wat. Code, § 10631 et seq.) requires water contractors, such as defendant, to assess water supply reliability that compares total projected water use with the expected water supply over a 20-year period in 5-year increments. (See *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova*, *supra*, 40 Cal.4th at pp. 434-435; *Friends of Santa Clara River v. Castaic Lake Water Agency, supra,* 123 Cal.App.4th at p. 8.) The proposed water purchase from the Buena Vista and Rosedale-Rio Bravo districts is one of several measures taken by defendant in order to meet the forecasts of population growth contained in county, city, and federal documents. The *County of Amador* opinion does not require reversal.

IV. DISPOSITION

The judgment is affirmed. Defendant, Castaic Lake Water Agency, is to recover its costs on appeal from plaintiffs, California Water Impact Network and Friends of the Santa Clara River.

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

TURNER, P. J.

We concur:

MOSK, J. KRIEGLER, J.

CASTAIC LAKE WATER AGENCY LITIGATION

SETTLEMENT AGREEMENT

TABLE OF CONTENTS

ARTICLE 1. DEFINITIONS 7

ARTICLE 2. COURT APPROVALS AND RELATED SETTLEMENTS 22

2.1 Final Bankruptcy Court Approval Order and Good Faith Certifications Required 22

2.2 Plaintiffs' Reservation of Rights Against Buyer 24

2.3 Plan Filed by Debtors 24

2.4 Final Approval Order Provisions 24

2.5 Plaintiffs' Recourse Against Debtors 25

ARTICLE 3. PAYMENTS DIRECTLY TO PLAINTIFFS 26

3.1 Payment for Plaintiffs' Past Environmental Claims 26

3.2 Payment for Plaintiffs' Past Design Costs 26

3.3 Payment to VWC 26

ARTICLE 4. FUNDING OF Q2 COSTS, REPLACEMENT WELL/DISTRIBUTION PIPELINE CAPITAL COSTS AND PROJECT CAPITAL COSTS 27

4.1 Funding of Q2 Capital Costs and Q2 O&M Costs 27

4.2 Termination of the Q2 Treatment System Operations 30

4.3 Replacement Wells/Distribution Pipeline Capital Costs Escrow Account 31

4.4 Project Capital Costs Escrow Account 33

ARTICLE 5. PAYMENT OF PROJECT O&M COSTS 34

5.1 Project O&M Escrow Account 34

5.2 Project O&M Costs 35

ARTICLE 6. PAYMENTS FROM THE ESCROW ACCOUNTS 40

6.1 General 40

6.2 Payment of Capital Costs 41

6.3 Payment of Q2 O&M Costs 43

6.4 Payment of Project O&M Costs 44

ARTICLE 7. COST CONSULTANT ARBITRATION 46

7.1 Cost Consultant *46*
7.2 Cost Consultant Dispute Resolution *47*

ARTICLE 8. OWNERSHIP, CONSTRUCTION, OPERATION AND MANAGEMENT OF FACILITIES **48**

8.1 Ownership of Facilities *48*
8.2 Plaintiffs' Responsibilities *48*
8.3 Operation, Maintenance and Management of Project *50*
8.4 Monthly Technical Meetings *52*
8.5 Audits *55*

ARTICLE 9. PROJECT MODIFICATION **55**

9.1 Project Modification *55*

ARTICLE 10. DISPUTES REGARDING POSSIBLE FUTURE PERCHLORATE CONTAMINATION **61**

10.1 Process for Addressing Possible Future Perchlorate Contamination *61*

ARTICLE 11. PROJECT INSURANCE; RAPID RESPONSE FUND **63**

11.1 Project Insurance *63*
11.2 Rapid Response Fund *65*

ARTICLE 12. RELEASES AND DISMISSAL OF UNDERLYING ACTION **70**

12.1 Plaintiffs' Releases *70*
12.2 Bankruptcy Releases. *74*
12.3 Civil Code Section 1542 ..... *74*
12.4 Dismissal of Underlying Action *75*
12.5 Notification Regarding Use of Well Disinfectant *76*

ARTICLE 13. DISPUTE RESOLUTION **77**

13.1 Disputes Governed by Article 13 ..... *77*
13.2 Expedited Arbitration Procedures *78*
13.3 Procedures Applicable To Arbitration of Future Perchlorate Contamination Disputes And Arbitration of Lump Sum *81*
13.4 Entry of Judgment. *85*
13.5 Location. *85*

13.6 Governing Law *85*

ARTICLE 14. INSURANCE ISSUES RELATED TO THE AISLIC POLICY 85

14.1 Condition M of AISLIC Policy *85*
14.2 Effect of This Agreement Under Condition M *86*
14.3 Written Agreement *87*
14.4 Full Compliance *87*
14.5 Covered Claims *87*
14.6 Proceedings Under Article 10 ..... *88*
14.7 AISLIC Preservation of Rights *88*
14.8 No Amendment or Waiver *88*
14.9 Coverages K and L *89*
14.10 Additional Clarifications Regarding AISLIC Policy and Other Agreements *89*

ARTICLE 15. PUBLIC AND OTHER FUNDING SOURCES 90

15.1 Background of Intent of the Parties *90*
15.2 Obtaining Funds from Public Funding Sources *90*
15.3 Administration of Funds from Public Funding Sources *91*
15.4 Conformity with Public Funding Sources Requirements *91*

ARTICLE 16. MISCELLANEOUS 92

16.1 Governing Law *92*
16.2 Waiver *92*
16.3 Amendment of the Agreement *92*
16.4 Notices *93*
16.5 Computation of Time *98*
16.6 Counterparts *98*
16.7 Assignment *98*
16.8 Cooperation *99*
16.9 Joint Drafting and Negotiation/Legal Counsel *99*
16.10 Article and Section Headings and Captions *99*
16.11 No Third Party Beneficiaries *99*
16.12 Severability *99*
16.13 Successors and Assigns *100*

16.14 Organization/Authorization 100
16.15 No Assignment of Claims 100
16.16 No Admission /Not Insurance 100
16.17 No Prejudice to Buyer 101
16.18 Entire Agreement 101
16.19 Survival 101

CASTAIC LAKE WATER AGENCY LITIGATION

SETTLEMENT AGREEMENT

This Castaic Lake Water Agency Litigation Settlement Agreement (the **"Agreement")** is dated as of April 6, 2007 **("Agreement Date"),** by and between the Castaic Lake Water Agency (**"CLWA"**), Santa Clarita Water Company (**"SCWC"**), Newhall County Water District (**"NCWD"**) and Valencia Water Company (**"VWC"**) (collectively, **"Plaintiffs"**), on the one hand, and Whittaker Corporation (**"Whittaker"**)**,** Santa Clarita L.L.C. (**"SCLLC"**), Remediation Financial, Inc. (**"RFI"**), and American International Specialty Lines Insurance Company (**"AISLIC"**), on the other hand. Hereinafter, Whittaker, SCLLC and RFI are collectively referred to as **"Defendants,"** the Plaintiffs and Defendants and AISLIC are collectively referred to as the **"Parties,"** each Plaintiff, each Defendant, and AISLIC is individually referred to as a **"Party,"** and SCLLC and RFI are collectively referred to as the **"RFI Parties"** or **"Debtors."**

RECITALS

A. SCLLC is the owner of approximately 964.79 acres of real property located in the City of Santa Clarita, County of Los Angeles, State of California, described more fully in Exhibit A hereto (the "**SCLLC Property**"). Bermite Recovery, LLC ("**BRLLC**") is the owner of approximately 23.6 acres of real property located in the City of Santa Clarita, County of Los Angeles, State of California, described more fully in Exhibit B hereto (the "**BRLLC Property**"). The SCLLC Property and the BRLLC Property are hereinafter referred to collectively as the "**Site**."

B. SCWC is the operator of water wells commonly designated as Saugus 1, Saugus 2 and the Stadium Well. NCWD is the owner and operator of water wells commonly designated as NC11 and NC13. VWC is the owner and operator of water wells commonly designated as V157 and Q2. Saugus 1, Saugus 2, the Stadium Well, NC11, V157 and Q2 are collectively referred to at all times as the "**Subject Wells**". As set forth in Section 9.1.7 hereof, NC13 shall be deemed a "Subject Well" in the event and only in the event it is treated as a Project Modification pursuant to Section 9.1.7 and only prospectively from that date it is so treated.

C. Plaintiffs and Defendants are parties to a civil action pending in the United States District Court for the Central District of California, Case No. CV 00-12613 AHM (RZx) (the "**Underlying Action**"). In the Underlying Action, Plaintiffs allege, among other things, that (1) groundwater in the vicinity of the Site has been contaminated by perchlorate and other hazardous materials and that such contamination is continuing with releases to the groundwater; (2) perchlorate has been found in the Subject Wells, and Plaintiffs have incurred and will continue to incur costs in responding to the contamination; and (3) Defendants caused and/or permitted (and are continuing to cause and/or permit) the contamination found on, above, under, or released to the environment at and near the Site and in the Subject Wells. Plaintiffs further allege that they have incurred "response costs" in addressing this contamination, including the costs of engaging consultants to undertake environmental assessment, water treatment studies, groundwater analysis and characterization work in connection with the alleged perchlorate contamination. Plaintiffs are seeking recovery of their alleged response costs and other damages, as well as injunctive and declaratory relief. Defendants deny Plaintiffs' allegations and, further, contend in their Counter-Claims that Plaintiffs are liable, in whole or in part, for Plaintiffs' alleged costs and damages **("the Counter-Claims").**

D. Plaintiffs have entered into that certain Environmental Oversight Agreement ("**EOA**") with the California Environmental Protection Agency, Department of Toxic Substances Control ("**DTSC**"). Plaintiffs are designated as "Proponents" under the EOA.

E. Whittaker and DTSC are parties to that certain 1994 Consent Order, Docket HAS 94/95-012 (the "**Consent Order**"), and the DTSC issued to Whittaker that certain Imminent and Substantial Endangerment Determination and Order and Remedial Action Order (the "**Order**") in 2002. SCLLC and DTSC are parties to that certain 2001 Enforceable Agreement (the "**Enforceable Agreement**").

F. Plaintiffs and Defendants entered into that certain Interim Settlement and Funding Agreement dated as of July 28, 2003 (the "**Interim Agreement**") and that certain First Amendment to Interim Settlement and Funding Agreement dated as of October 11, 2004 (the "**First Amendment**") which, among other things, extended the term of the Interim Agreement through January 2005.

G. Plaintiffs and Defendants mutually agree on the "Project and Associated Facilities" (as hereinafter defined) that shall be implemented by the Plaintiffs. The Project and Associated Facilities are intended to provide containment of perchlorate in off-site groundwater in portions of the Saugus Formation and to restore Plaintiffs' groundwater production capacity diminished by perchlorate contamination in the Subject Wells.

H. The Project fulfills some of Defendants' obligations under and resolves some of Defendants' alleged liabilities to DTSC under the Consent Order, the Order, and the Enforceable Agreement with respect to the remediation of groundwater, and Defendants' remaining responsibility for addressing groundwater remediation will be determined in compliance with the lawful requirements of the regulatory agencies.

I. This Agreement provides for certain funds to be available rapidly to address any future perchlorate contamination of Plaintiffs' presently existing **"Threatened Wells"** (as defined herein) during the period defined herein without prejudice to other rights and remedies of the Plaintiffs or the defenses of the Defendants. This Agreement also provides for arbitration to be available to Plaintiffs to resolve certain future disputes, if any, between or among the Parties involving possible future perchlorate contamination of Plaintiffs' **"Presently Existing Saugus Production Wells and Alluvial Production Wells"**, other than the Subject Wells, as hereinafter defined.

J. This Agreement contemplates that the Defendants (or any **"Buyer"** (as defined below) of the Site that assumes certain liabilities of Defendants) will be in compliance with their remediation responsibilities under law with respect to the Site and the associated groundwater, as reflected in the applicable requirements of the Consent Order, Order and the Enforceable Agreement, and that Defendants will conduct their remediation activities in a reasonably expedient, efficient and cost-effective manner as reasonably determined by Defendants and the regulatory authorities. In particular, the Defendants' (and/or any Buyer of the Site that assumes certain liabilities of Defendants) remedial activities within the Site are important to addressing the contamination within the Saugus and **"Alluvial Aquifers"** (as defined below). The Parties acknowledge that payments and expenditures under this Agreement are deemed reasonable and necessary for addressing offsite groundwater contamination emanating from the Site and are consistent with the National Contingency Plan, and are deemed **"Response Costs"** (as defined below) as that term is used and contemplated in CERCLA.

K. VWC reported detecting perchlorate in its alluvial well Q2 in connection with its regular monitoring of active municipal supply wells operating near the site in April 2005

(although a more recent sampling did not detect perchlorate above the current California Department of Health Services ("DHS") limit for reporting perchlorate). VWC temporarily removed the well from active service and installed wellhead treatment to remove perchlorate. The Q2 treatment system started operating in October 2005. The Defendants have funded five hundred thousand dollars ($500,000) for reasonable and necessary and approved capital costs and two hundred twenty three thousand and two hundred ten dollars ($223,210) for reasonable and necessary and approved operations and maintenance costs of the Q2 Treatment System in a Q2 Escrow Account. The Defendants have agreed to pay certain additional reasonable and necessary operating and maintenance costs of that system in accordance with the terms of this Agreement.

L. On July 7, 2004, SCLLC, and RFI filed voluntary Chapter 11 bankruptcy petitions, and the cases thereby commenced are pending in the United States Bankruptcy Court for the District of Arizona ("**Bankruptcy Court**"), denominated Cases Nos. 2-04-BK-11910 CGC, and 2-04-BK-11911 CGC. BRLLC filed a voluntary Chapter 11 bankruptcy petition on September 30, 2004, denominated Case No. 2-04-BK-17294 CGC, also pending in the Bankruptcy Court. Case Nos. 2-04-BK-11910 CGC, 2-04-BK 11911 CGC and 2-04-BK-17294 CGC are hereinafter referred to collectively as the "**Bankruptcy Cases.**" RFI Realty, Inc. filed a voluntary Chapter 11 bankruptcy petition on June 15, 2004 denominated as Case No. 2-04-BK-10486 CGC; the Bankruptcy Cases are jointly administered with RFI Realty, Inc.'s bankruptcy case under Case No. 2-04-BK-10486 CGC. SCLLC and BRLLC have filed a motion seeking Bankruptcy Court Approvals to sell the Site. The term "**Buyer**," as used herein, means the entity to which title to the Site is conveyed after Bankruptcy Court approval; provided, however, that if either the Bankruptcy Court does not approve a sale or a sale approved by the Bankruptcy Court

in the Bankruptcy Cases does not close pursuant to Bankruptcy Court approval, and consequently there is no Buyer, then this Agreement shall not be impacted in any way whatsoever.

M. Plaintiffs have prepared and submitted to DTSC for approval and DTSC has approved a Remedial Investigation ("RI") consisting of a technical memorandum prepared on behalf of the United States Army Corps of Engineers, a Feasibility Study ("FS") and an Interim Remedial Action Plan ("IRAP") for a containment and treatment system for perchlorate contamination in portions of the Saugus Formation. Such containment and treatment system is consistent with the discussions and understandings between the Plaintiffs and Defendants.

N. The Parties are entering into this Agreement in order to effectuate a settlement of the Underlying Action and to resolve certain disputes between Plaintiffs and Defendants that have arisen between them, as well as to provide the Parties with expedited alternative dispute resolution mechanisms for resolving certain disputes which may arise between Plaintiffs and Defendants in the future, to the extent provided and in accordance with the terms and conditions set forth in this Agreement. The Plaintiffs and Defendants have reached a separate settlement concerning the Defendants' Counter-Claims which will be the subject of a separate settlement agreement to be executed by certain of the Parties simultaneously with the execution of this Agreement, (the "Related Settlement") and which is part of the consideration for and a condition precedent to this Agreement.

O. Certain funds from the **"Steadfast PLC Policy"** (defined below), in accordance with and subject to the Coverage and Claims Settlement Agreement and the Bankruptcy Court's December 22, 2005 Order approving same, and the Joint Escrow 1 Agreement and Instructions, are being made available to settle the matters described and released herein. AISLIC shall

request the SF Escrow 1 Account Escrow Agent (Wells Fargo Bank or any successor) to release funds from the SF Escrow 1 Account to satisfy certain of Defendants' payment obligations and obligations to fund escrow accounts hereunder.

P. The Defendants and AISLIC represent that this Agreement is a settlement in the CLWA Case that meets all "Approved CLWA Settlement Parameters" set forth in Exhibit 16 to the Coverage and Claims Settlement Agreement.

Q. The Defendants and AISLIC represent that the payment obligations pursuant to this Agreement will be funded on behalf of Defendants as provided by Section VIII ("Funding Settlement of CLWA Case") of the Coverage and Claims Settlement Agreement and as provided herein.

R. Nothing in this Agreement is intended to alter any rights or obligations existing under the Coverage and Claims Settlement Agreement.

NOW, THEREFORE, in consideration of the execution of this Agreement and for other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties hereby agree as follows:

AGREEMENT

ARTICLE 1. DEFINITIONS

In addition to terms defined elsewhere in this Agreement, the following terms shall have the following meanings:

1.1 "**Administrator**" means AISLIC or such successor entity designated as the Administrator of the "SF Escrow 1" in the "Coverage and Claims Settlement Agreement."

1.2 **"Agreement"** means this "Castaic Lake Water Agency Litigation Settlement Agreement."

1.3 **"Agreement Date"** means April 6, 2007.

1.4 "**AISLIC**" means American International Specialty Lines Insurance Company, which issued Pollution Legal Liability Select/Cleanup Cost Cap, policy no. PLS 267-9186 (the "AISLIC Policy") to Defendant Whittaker Corporation and is the entity presently designated as the Administrator of the "SF Escrow 1" in the "Coverage and Claims Settlement Agreement."

1.5 "**AISLIC Future Perchlorate Determination of Coverage**" means a coverage determination by AISLIC satisfactory to Whittaker, at its discretion exercised in good faith, agreeing to provide coverage with respect to a "**Non-Subject Well Future Perchlorate Circumstance"** in response to the demand for coverage delivered by Whittaker as set forth in Section 10.1.1 below.

1.6 **"Allowed Claim"** has the meaning set forth in Section 12.1.5, below.

1.7 **"Alluvial Aquifer**" means the shallow (typically, 50 to 200 feet of saturated thickness), generally unconfined aquifer consisting of unconsolidated fluvial sand and gravel within the valleys and canyons of the Santa Clarita Valley. The Alluvial Aquifer unconformably overlies the Saugus Formation.

1.8 **"Annual Project O&M Deposit"** has the meaning set forth in Section 5.2.1.

1.9 **"Approved Capital Costs"** has the meaning set forth in Section 6.2.1, below.

1.10 **"Approved O&M Costs"** has the meaning set forth in Section 6.4.1, below.

1.11 **"Approved Q2 O&M Costs"** has the meaning set forth in Section 6.3.1, below.

1.12 **"Associated Facilities"** means the "Distribution Pipelines" and the "Replacement Wells & Associated Pipelines" (as defined below).

1.13 **"Bankruptcy Court"** has the meaning described in Recital L.

1.14 **"Bankruptcy Court Determinations"** has the meaning set forth in Section 2.4, below.

1.15 **"Bankruptcy Cases"** has the meaning described in Recital L.

1.16 **"BRLLC"** means Bermite Recovery, LLC the owner of approximately 23.6 acres of real property located in the City of Santa Clarita, County of Los Angeles, State of California and as more fully described in Exhibit B.

1.17 **"BRLLC Property"** has the meaning fully described in Exhibit B.

1.18 **"Buyer"** has the meaning fully described in Recital L.

1.19 **"CGL Policy"** has the meaning set forth in Section 11.1.1.

1.20 **"CLWA"** means Castaic Lake Water Agency.

1.21 **"Commencement of Operations"** means commencement of the operation to purvey water to the public from the Project or **"Q2 Treatment System" (as defined below)**, as the case may be. The Parties agree that Commencement of Operations for the Q2 Treatment System was October 12, 2005 ("Q2 Commencement Date").

1.22 **"Consent Order"** has the meaning fully described in Recital E.

1.23 **"Counter-Claims"** has the meaning fully described in Recital C

1.24 **"Coverage and Claims Settlement Agreement"** means the Settlement Agreement by and between the "RFI Parties", the "Zurich Companies", the "AISLIC Parties", and "Whittaker" (as those terms are defined in the Coverage and Claims Settlement Agreement) that provides for certain funding for this Agreement, and that was filed in the Bankruptcy Cases on November 15, 2005 and approved as modified by the Bankruptcy Court's Order Approving Coverage and Claims Settlement Agreement dated December 22, 2005 (the "Coverage Order").

1.25 **"Day"** or **"day"** means a calendar day unless expressly stated to be a Working Day.

1.26 **"Debtors"** means SCLLC and RFI.

1.27 **"Defendants"** means Whittaker, SCLLC and RFI, collectively.

1.28 **"Distribution Pipelines"** means construction of certain new distribution pipelines as described in Exhibit C.

1.29 **"DTSC"** means the California Environmental Protection Agency, Department of Toxic Substances Control as referred to in Recital D.

1.30 **"Earthquake Policy"** has the meaning set forth in Section 11.1.1.

1.31 **"EIL Policy"** has the meaning set forth in Section 11.1.1.

1.32 **"Effective Date"** has the meaning set forth in Section 2.1

1.33 **"Enforceable Agreement"** refers to that certain 2001 Enforceable Agreement made by SCLLC and DTSC, as described in Recital E, above.

1.34 **"EOA"** means the Environmental Oversight Agreement as referred to in Recital D.

1.35 "**Escrow Accounts**" means the "Project Capital Costs Escrow Account", the "Project O&M Escrow Account", the "Replacement Wells/Distribution Pipelines Escrow Account", and the "Q2 Escrow Account," (all as hereinafter defined.)

1.36 **"Final Approval Order"** has the meaning set forth in Section 2.1.

1.37 **"First Amendment"** has the meaning described in Recital F.

1.38 **"Good Faith Certifications"** has the meaning set forth in Section 2.1.1.

1.39 **"Initial Project Capital Costs Deposit"** has the meaning set forth in Section 4.4.

1.40 **"Interim Agreement"** has the meaning described in Recital F.

1.41 **"JAMS"** means Judicial Arbitration and Mediation Service.

1.42 **"Lump Sum Determination"** has the meaning set forth in Section 5.2.6.

1.43 **"MCL"** means Maximum Contaminant Level as set forth in Section 9.1.1.

1.44 **"NCWD"** means Newhall County Water District.

1.45 **"Order"** refers to that certain Imminent and Substantial Endangerment Determination and Order and Remedial Action Order described in Recital E.

1.46 **"Parties"** means Plaintiffs and Defendants and AISLIC, collectively.

1.47 **"Plaintiffs"** means Castaic Lake Water Agency ("CLWA"), Santa Clarita Water Company ("SCWC"), Newhall County Water District ("NCWD") and Valencia Water Company ("VWC"), collectively.

1.48 **"Plaintiffs' Past Environmental Claims"** means any claim for costs, including response costs, damages, attorneys and consultant fees, replacement water costs, and costs for remedial investigations, monitoring and litigation incurred by Plaintiffs prior to the Effective Date of this Agreement due to contamination of the Subject Wells or contamination of or threatened releases to groundwater at and in the vicinity of the Site; provided, however, that certain costs associated with Saugus 1 & 2 Treatment System, Replacement Wells and Associated Pipelines, and Distribution Pipelines, incurred prior to February 1, 2007, as set forth in Exhibit E to this Agreement (**"Plaintiffs' Past Design Costs"**) or incurred after January 31, 2007 and included within Project Capital Costs pursuant to Section 1.54, are excluded from Plaintiffs' Past Environmental Claims.

1.49 **"Plaintiffs' Past Design Costs"** means certain costs associated with Saugus 1 & 2 Treatment System, Replacement Wells and Associated Pipelines, and Distribution Pipelines, incurred by Plaintiffs prior to February 1, 2007, as set forth in Exhibit E to this Agreement.

1.50 **"Presently Existing Saugus Production and Alluvial Production Wells"** means the wells identified in Exhibit U, including wells replaced in the normal course of system operations in the immediate vicinity of the respective Presently Existing Saugus Production and Alluvial Wells.

1.51 **"Pro Forma Estimate of Project O&M"** has the meaning as set forth in Section 5.1.1 and is attached hereto as Exhibit D. **"Joint Estimate of Project O & M"** has the meaning as set forth in Section 5.2.1.

1.52 **"Project"** means:

1.52.1 The planning, development, design, permitting, construction, operation and maintenance of a system to be installed at the existing Rio Vista Intake Pump Station site for treatment of (i.e., removal of perchlorate from) water pumped from Saugus 1 and 2, so that the water will be available for potable purposes; any necessary operational modifications at the Saugus 1 and 2 Wells; any necessary "Sentry Wells" (as defined below) and/or monitoring wells, to the extent not paid for by other sources and to the extent consistent with applicable regulatory requirements; associated piping at the pump station; and the pipeline from Saugus 1 to Saugus 2 to the treatment plant, described more fully in Exhibit F hereto (the "Saugus 1 & 2 Treatment System"). The Parties through the monthly technical meetings will determine what Sentry Wells and/or monitoring wells may be required, provided that if the technical committee is unable to reach agreement on the number of or need for such wells, and if additional wells are required by DHS or other regulators, the number of and/or need for such wells will be determined by the Cost Consultant in accordance with Article 7.

1.52.2 The **"Q2 Treatment System"** (as defined below), when it has been relocated and incorporated into the Project pursuant to a Q2 Treatment System Relocation as provided in Section 4.2.1 herein.

1.53 **"Project Modification Notice"** has the meaning set forth in Section 9.1.2.

1.54 "**Project Capital Costs**" means the reasonable and necessary costs associated with the planning, development, design, permitting, construction, installation and/or closure of the Project, including such costs incurred after January 31, 2007, but prior to the Effective Date.

1.55 **"Estimate of Project Capital Costs"** means the estimate of the capital costs for the Project as set forth in Exhibit G.

1.56 **"Project Capital Costs Escrow Account"** means the escrow account into which Defendants shall deposit or cause to be deposited the initial amount of five million dollars ($5,000,000), to be used for the purposes described in Section 1.52 of this Agreement. Additional deposits by Defendants into the Project Capital Costs Escrow, up to a maximum additional amount of five million dollars ($5,000,000), may be required as described in Section 4.4 of this Agreement for the purposes set forth in Section 1.52 of this Agreement. Within thirty (30) days after Bankruptcy Court approval of this Agreement, Whittaker, on behalf of all Defendants shall open the "Project Capital Costs Escrow Account" by signing and delivering to City National Bank or other agreed bank escrow instructions substantially in the form of Exhibit H-1 hereto, and depositing the amount of five million dollars ($5,000,000) into said account as described above.

1.57 "**Project Costs**" means Project Capital Costs and Project O&M Costs, including costs arising from a Project Modification, to the extent provided in this Agreement.

1.58 **"Project Modification"** has the meaning set forth in Article 9.

1.59 "**Project O&M Costs**" means the identifiable reasonable and necessary costs actually incurred in operating and maintaining the Project to perform its intended function of providing containment of perchlorate as defined in Section 9.1 of this Agreement and restoring impacted groundwater production capacity, which shall be estimated in an annual estimate to be prepared

by CLWA and agreed to by Whittaker and AISLIC or confirmed by the Cost Consultant, unless and until all Lump Sum determinations are made pursuant to Sections 5.2.6 and 9.1.7 or the applicable regulatory authorities determine that treatment is no longer necessary. Costs of operations and maintenance of the Project incurred by Plaintiffs, limited to such reasonable and necessary additional costs directly related to the perchlorate contamination, shall include (based upon the Project as currently contemplated):

Saugus 1 and 2 Treatment Plant Operations and Maintenance

- Vendor Resin Service Contract(s) – (Replacement Resin, Labor, Transportation, Disposal, Disposal Certification, Insurance)-to be negotiated with Vendor jointly by Plaintiffs, Defendants, and AISLIC

- Power – Treatment Plant Operations, including the costs to pump water from Saugus 1 and 2 and, if applicable, Q2 (after relocation) through the treatment system, but excluding the power costs to pump water to the ground surface and the power costs to pump treated water into the CLWA's or VWC's water system. These power costs shall be based on an allocation calculated by CLWA and approved by Whittaker and AISLIC, and subject to Cost Consultant determination in the event that agreement cannot be reached.

- Materials/Supplies
  - Disinfection (Ammonia) and acid
  - Filters
  - Miscellaneous

- Spare Parts
  - Treatment Equipment
  - Pumping and Piping Systems at Treatment Plant
  - Miscellaneous

- Plaintiffs' Labor, if not performed by outside contractor – salary plus actual benefit load (but not-to-exceed 42%) imposition above his/her normal salary:
  - District Employee, Operations Monitoring/Sampling
  - District Employee, Treatment Equipment Maintenance
- Expenses
  - Water Testing (Directly Related to 97-005 Compliance or process monitoring at Purveyor's Rate Schedule)
  - DHS and POTW Fees
  - Miscellaneous Directly Related to Treatment System Maintenance
- Outside Consultants
  - Permits/Renewals
  - Services in addition to those of the Plaintiffs' employee(s) required to meet obligations under Section 8.3.1.1, 8.3.2.3, 8.3.2.4, and 8.4.1, to the extent such employee(s) are not able to meet such obligations
  - Reports/Compliance
  - Engineering
  - Modeling (Directly Related to 97-005 Compliance)
  - Legal (Directly Related to 97-005 Compliance and Plant Operations), limited to the services provided by law firm(s) employed by Plaintiffs for such DHS compliance and plant operations matters, and at the rates such firm(s) normally charge for such work.
  - Insurance – (Insurance as provided in Article 11)

- Arbitrator (per Section 13.2) and Cost Consultant Costs and Fees (per Article 7)
- Project O&M Escrow Costs and Fees

Project O&M costs shall also include an annual flat payment of twenty thousand dollars ($20,000) (to be adjusted after five years as necessary to account for inflation) in lieu of the following activities and costs: Plaintiffs' Employee(s) to provide services under Sections 8.3.1.1, 8.3.2.3, 8.3.2.4, and 8.4.1; any wages or salaries related to the perchlorate contamination plus all benefit load imposition above his/her normal salary; any additional costs for such employee(s) associated with the monitoring, reporting and record-keeping activities described in Section 8.3.1.1, 8.3.2.3, and 8.3.2.4 of this Agreement that are related to the perchlorate contamination; and any Plaintiffs' Employee(s) costs incurred by Plaintiffs in connection with the Monthly Technical Meetings described in Section 8.4.1 of this Agreement.

Project O&M Costs shall also include the identifiable reasonable and necessary costs of operating and maintaining the Q2 Treatment System when it is relocated from Well Q2 and incorporated into the Project as provided for in Section 4.2.1, monitoring and laboratory services for necessary Sentry Wells and monitoring wells encompassed within the Project to the extent not paid for by other sources and to the extent consistent with applicable regulatory requirements**,** and Project Modification O&M costs, including any costs of evaluating containment for purposes of determining whether a Project Modification is appropriate. The costs and approach of evaluating containment shall be discussed and agreed upon by representatives of Plaintiffs, Whittaker and AISLIC at the monthly Technical Meetings, or determined by Cost Consultant. Prior to determination of the Lump Sum pursuant to Section 5.2.6, Project O&M Costs will also include the reasonable and necessary outside fees and costs

incurred by Plaintiffs and Whittaker that are directly related to the perchlorate contamination and to obtaining funding from Public Funding Sources, subject to an annual cap of two hundred thousand dollars ($200,000) on Plaintiffs' outside fees and costs and one hundred thousand dollars ($100,000) on Whittaker's outside fees and costs, subject to such other restrictions as are found in Section 14.2, below. Fees and costs incurred by Plaintiffs or to be incurred by Plaintiffs in the future that are associated with obtaining funding from **"Public Funding Sources"** (as defined below) will not be considered in the determination of the Lump Sum pursuant to Section 5.2.6 and 9.1.7.

1.60 **"Project O&M Escrow Account"** means the escrow account established and funded by Defendants for payment of Project O&M Costs as described in Section 6.4 of this Agreement.

1.61 **"Property Policy"** has the meaning set forth in Section 11.1.1.

1.62 **"Proofs of Claim"** has the meaning set forth in Section 12.1.5.

1.63 **"Public Funding Sources"** has the meaning set forth in Article 15.

1.64 **"Q2 Capital Costs"** means the costs set forth in Exhibit I which were incurred by VWC for the design and installation of the Q2 Treatment System, all of which have been approved and reimbursed by Defendants.

1.65 **"Q2 Escrow Account"** has the meaning set forth in Section 4.1.

1.66 **"Q2 Escrow Account Instructions**" means the Escrow Instructions for the Q2 Capital Costs Escrow Account attached as Exhibit J hereto, as amended as reflected in Exhibits K-1 and K-2.

1.67 **"Q2 O&M Costs"** means the reasonable and necessary costs actually incurred in operating and maintaining the Q2 Treatment System prior to relocation and incorporation into the Project as provided in Section 4.2.1, as set forth in the Estimate of Q2 O&M Costs, and not

to exceed nine thousand and three hundred dollars ($9,300) on average per month for the first 2 years following Commencement of Operations, except in the event of a **"Q2 Resin Exchange,"** (as defined below). Costs of operation and maintenance of the Q2 Treatment System shall include, but not be limited to, equipment rental, service fees, chemicals, monitoring, laboratory services, and resin replacement related to the treatment of perchlorate and flow rates currently permitted by DHS for the Q2 Treatment System.

1.68 "**Estimate of Q2 O&M Costs**" means the approved monthly operations and maintenance estimate for Q2 O&M Costs for the first two years after Commencement of Operations prior to relocation and incorporation into the Project, set forth in Exhibit L.

1.69 **"Q2 Resin Exchange"** means the removal of ion exchange resin which VWC determines is no longer capable of performing its intended function from the ion exchange vessels and replacement with new resin, and includes but is not limited to, transportation of the spent and new resin, and proper destruction of the spent resin in accordance with applicable regulations.

1.70 **"Q2 Semi-Annual O&M Statement"** has the meaning set forth in Section 6.3.2.

1.71 **"Q2 Treatment System**" means the construction, operation and maintenance of a system installed in October 2005 for treatment of (i.e., removal of perchlorate from) water pumped from Valencia's well Q2.

1.72 **"Q2 Treatment System Relocation"** means the relocation of the Q2 Treatment System as described in Section 4.2.1.

1.73 **"Rapid Response Funds"** means the funds, limited to ten million dollars ($10,000,000), available to Plaintiffs for the period of time set forth in Section 11.2.1 of this Agreement, which the Defendants shall cause to be paid to Plaintiffs on a demand basis in accordance with Section

11.2 of this Agreement, as a result of specified perchlorate impacts to "Threatened Wells" (as defined herein).

1.74 **"Related Settlement"** has the meaning set forth in Recital N.

1.75 **"Remedial Action Plan"** means a technical report prepared in accordance with Section 25356.1 of the California Health and Safety Code and which, at a minimum, addresses the remedial investigation, risk assessment, and evaluation of remedial alternatives and proposes a remedial alternative.

1.76 **"Remedy Stoppage"** means a cessation of Project operations under circumstances requiring a Project Modification.

1.77 **"Replacement Wells & Associated Pipelines"** means:

1.77.1 Two new wells capable of producing water at the combined rate of 4200 gpm (**"Replacement Wells**") and associated pipeline to convey the water pumped from the Replacement Wells to a nearby reservoir and associated disinfection facility (**"Associated Pipelines"**). As currently contemplated, the Replacement Wells will be constructed in the vicinity of Magic Mountain Amusement Park and the Associated Pipelines will consist of approximately 1000 feet of a 12 inch pipeline and 2500 feet of 18 inch pipeline, as described more fully in Exhibit M hereto (the **"Magic Mountain Wells")**;

1.77.2 Potential closure and abandonment of the Stadium Well, in SCWC's reasonable discretion, and NC11, in NCWD's reasonable discretion, described more fully in Exhibit N hereto (the "Well Closures");

1.77.3 Construction of a new alluvial well (the **"Stadium Replacement Well"**), to be located northeast of the Site in an alluvial area where perchlorate is not present in groundwater, and associated pipeline(s), described more fully in Exhibit O hereto.

1.78 **"Replacement Wells/Distribution Pipelines Capital Costs Escrow Account**" means the escrow account into which Defendants shall make an initial deposit of four million seven hundred and fifty thousand dollars ($4,750,000), to be used for the purposes described in Section 4.3 of this Agreement. Additional deposits by Defendants into the Replacement Wells/Distribution Pipelines Capital Costs Escrow Account may be required for Replacement Wells/Distribution Pipelines Capital Cost additional costs as described in Section 4.3 of this Agreement and for the purposes set forth therein. These additional deposit(s) shall be paid as described in Section 4.3.3. Within thirty (30) business days after Bankruptcy Court approval of this Agreement, Whittaker, on behalf of all Defendants, shall open the "Replacement Wells/Distribution Pipelines Capital Costs Escrow Account" by signing and delivering to City National Bank or other agreed bank escrow instructions substantially in the form of Exhibit P hereto, and depositing the amount of $4,750,000 into said account as described above.

1.79 **"Response Costs"** means "response costs" as defined under CERCLA.

1.80 **"RFI"** means Remediation Financial, Inc.

1.81 **"RFI Parties"** means Santa Clarita L.L.C. ("SCLLC") and Remediation Financial, Inc. ("RFI"), collectively.

1.82 **"Saugus Formation"** means the generally deeper (up to 8,500 feet thick) formation of aquifers consisting of semi-consolidated sandstone, siltstone and conglomerate of Pleistocene age and occurs under confined, semi-confined and unconfined conditions.

1.83 **"SCLLC"** means Santa Clarita L.L.C.

1.84 **"SCLLC Property"** has the meaning described in Exhibit A.

1.85 **"SCWC"** means Santa Clarita Water Company.

1.86 **"Sentry Wells"** means groundwater monitoring wells located upgradient of the Subject Wells.

1.87 **"Site"** means the SCLLC Property and the BRLLC Property collectively

1.88 **"Steadfast PLC Policy"** means the Property Transfer Liability Policy Number PLC 3598792-00 issued by Steadfast Insurance Company ("Steadfast") to the Defendants.

1.89 **"Subject Wells"** has the meaning referred to in Recital B of this Agreement.

1.90 The "**SF Escrow 1 Account**" and the "SF Escrow 1" means the "SF Escrow 1" or "SF Escrow 1 Account" as defined in, established, and governed by the Coverage and Claims Settlement Agreement and the "Joint Escrow 1 Agreement and Instructions (Steadfast Escrow 1 Account)" filed in the Bankruptcy Cases on March 31, 2006.

1.91 The "**SF Escrow 2 Account**" means the "SF Escrow 2" or "SF Escrow 2 Account" as defined in, established, and governed by the Coverage and Claims Settlement Agreement and the "Joint Escrow 2 Agreement and Instructions (Steadfast Escrow 2 Account)" filed in the Bankruptcy Cases on March 31, 2006.

1.92 **"Steadfast"** means Steadfast Insurance Company.

1.93 **"SSCH"** means Steadfast Santa Clarita Holdings, LLC.

1.94 **"Estimate of Supplemental Project O&M"** has the meaning set forth in Section 5.2.3.

1.95 **"Third Party Claims"** has the meaning set forth in Section 12.1.1.

1.96 **"Threatened Wells"** has the meaning set forth in Section 11.2.1.

1.97 **"Underlying Action"** has the meaning referred to in Recital C of this Agreement.

1.98 "**V-206 Replacement Well"** means construction and installation of VWC's well V206 and associated pipelines, and permanent closure and abandonment of VWC's well V157 as described in Exhibit Q.

1.99 **"VWC"** means Valencia Water Company.

1.100 **"Whittaker"** means Whittaker Corporation.

1.101 "**Working Day**" means a day other than a Saturday, Sunday, or federal or California state holiday.

ARTICLE 2. COURT APPROVALS AND RELATED SETTLEMENTS

2.1 Final Bankruptcy Court Approval Order and Good Faith Certifications Required

Except for this Section which is effective upon execution of this Agreement by all Parties, this Agreement, including the Parties' promises, obligations, releases, representations and warranties under this Agreement, shall take effect on the later of the date of the Final Approval Order (as defined below) or the date of the "Good Faith Certifications" (as defined below) ("the **Effective Date**") and is absolutely contingent upon the entry of an order of the Bankruptcy Court that approves this Agreement in its entirety without any modifications and contains the Bankruptcy Court Determinations referenced below, and that has become effective and as to which no stay pending appeal has been issued ("**Final Approval Order**") and such order not being subject to any stay.

2.1.1 This Agreement, and the settlement of claims reflected herein, is absolutely contingent upon (i) court certification that such settlement is made in good faith, and (ii) a settlement of, or the dismissal with prejudice of, all of the claims asserted in the Counter-Claims (the "**Related Settlement**") and court certification of the Related Settlement as being made in good faith (collectively, the "**Good Faith Certifications**"). The court's order(s) setting forth the Good Faith Certifications shall at a minimum provide that "any and all claims against the settling Defendants and the settling counter-defendants, arising out of the matters addressed in the Underlying Action or addressed in the Related Settlement, regardless of when asserted or by whom, are barred; such claims are barred regardless of whether they are brought pursuant to

CERCLA, or pursuant to common law or other federal or state laws," or language substantially to the same effect.

2.1.2 This Agreement shall be null and void *ab initio,* and the Parties shall be returned to their respective positions in all aspects, if either (a) the Related Settlement, Good Faith Certifications and Final Approval Order have not all been obtained before October 31, 2007 for any reason; or (b) the Bankruptcy Court denies a motion to approve this Agreement as written or (c) a court denies a motion for good faith certification of either this Agreement, the Related Settlement or both, as written. RFI Parties, at their sole cost and expense, shall prepare and file a motion with the Bankruptcy Court in a form satisfactory to all Parties seeking the Final Approval Order promptly after the Agreement's execution by all Parties. RFI Parties' motion for a Final Approval Order shall include a request that the Bankruptcy Court in its Final Approval Order make the Bankruptcy Court Determinations in accordance with the requirements set forth in Section 2.4 of this Agreement.

2.1.3 All other Parties shall support the entry of the Final Approval Order and shall cooperate with RFI Parties in presenting the motion seeking approval. The Parties shall cooperate in preparing and filing motions with the District Court seeking the Good Faith Certifications. To the extent required under CERCLA or applicable federal law, the Parties agree to cooperate in obtaining approval of a United States District Court having appropriate jurisdiction (the "**District Court**") as necessary to ensure enforceability of the terms and intent of this Agreement (including but not limited to asking the Bankruptcy Court to certify its findings and/or conclusions regarding certain issues to such District Court).

2.2 Plaintiffs' Reservation of Rights Against Buyer

Plaintiffs specifically reserve all rights against Buyer with regard to Buyer's compliance with all environmental laws and performance of any applicable remediation obligations, subject only to the terms of Section 12.1 hereof.

2.3 Plan Filed by Debtors

If a Final Approval Order is entered by the Bankruptcy Court in the Bankruptcy Cases, then any plan filed by the Debtors in the Bankruptcy Cases ("**Plan**") shall not be materially inconsistent with the terms of this Agreement and the Final Approval Order.

2.4 Final Approval Order Provisions

Debtors and all other Parties hereto acknowledge and agree, and the Final Approval Order shall provide that (a) funds in SF Escrow 1 Account were, pursuant to the Coverage Order, already earmarked for the purposes of satisfying Defendants' obligations pursuant to this Agreement; (b) the requirement that the funds in SF Escrow 1 Account be used exclusively for the purposes for which they are agreed to be used pursuant to the Coverage and Claims Settlement Agreement as modified by the Coverage Order (which are consistent with the purposes for which those funds are to be used pursuant to this Agreement) is res judicata in the Debtors' Bankruptcy Cases; (c) payment of obligations under this Agreement, upon entry of the Final Approval Order, constitutes the permitted use of SF Escrow 1 funds to "fund settlement or a stipulated judgment pursuant to a settlement in the CLWA Case" that meets all of the "Approved CLWA Settlement Parameters" as provided in paragraph IV.F.5.a.(i) of the Coverage and Claims Settlement Agreement as modified by the Coverage Order and as described in Exhibit 16 thereto and such payments pursuant to this Agreement shall constitute, and shall be deemed to be consistent with the requirements for the administration of the SF Escrow 1 funds

by AISLIC pursuant to Section IV.F.5.d. of the Coverage and Claims Settlement Agreement as modified by the Coverage Order; (d) any payment or transfers of funds to or for the benefit of Plaintiffs from SF Escrow 1 Account that are consistent with this Agreement are free and clear of all other adverse claims, rights, title, interest, liens or encumbrances of any kind whatsoever that could be asserted against any property or interest of the Debtors; and (e) the Agreement is a complex agreement resolving numerous disputes and pending legal proceedings among numerous parties and that following the Effective Date, it will be practically and legally impossible to unwind this Agreement or restore the parties to their status quo based upon any reversal or modification on appeal or rehearing or other review; (f) upon entry of the Final Approval Order, the Defendants' payment obligations under this Agreement including any sum awarded pursuant to arbitration hereunder, may be made from the SF Escrow 1 Account; and (g) either i) the terms of the Agreement and Related Settlement are fully consistent with the terms of the SunCal Purchase and Sale Agreement and Joint Escrow Instructions dated July 6, 2006, or ii) that the Buyer consents to the Agreement and the Related Settlement to the extent there is any inconsistency. (Subparagraphs (a) through (g) above required to be included in the Final Approval Order are referred to herein as the "Bankruptcy Court Determinations.") The Final Approval Order shall also provide that the Order applies to any successor Administrator of the "SF Escrow 1" in the "Coverage and Claims Settlement Agreement."

2.5 Plaintiffs' Recourse Against Debtors

Plaintiffs' recourse to (i) enforce all of Debtors' obligations under this Agreement and (ii) for any and all actions, causes of action, claims, demands, liabilities, damages, penalties, debts, losses, costs, expenses and fees (including, without limitation, litigation costs and attorney and consultant fees) of every kind and nature whatsoever, past or future, in law and in equity against

the Debtors and BRLLC arising from or in any way related to releases or threatened releases, or other environmental conditions, past or future, at or around the Site is expressly and completely limited to Debtors' rights to use, and title and interest in, the SF Escrow 1 Account established pursuant to the Coverage and Claims Settlement Agreement and the "Joint Escrow 1 Agreement and Instructions (Steadfast Escrow 1 Account)". Plaintiffs' rights against Debtors are not waived in the Bankruptcy Cases to the extent of Debtors' rights, title and interest in the SF Escrow 1 Account.

ARTICLE 3. PAYMENTS DIRECTLY TO PLAINTIFFS

3.1 Payment for Plaintiffs' Past Environmental Claims

Within thirty (30) Days after the Effective Date, Defendants shall pay the amount of ten million dollars ($10,000,000) by payment of the amount of two million five hundred thousand dollars ($2,500,000) to each of the four Plaintiffs. The obligation to make such payments shall be joint and several, subject to Section 2.5. This payment is in full and complete satisfaction and resolution of Plaintiffs' Past Environmental Claims.

3.2 Payment for Plaintiffs' Past Design Costs

Within thirty (30) Days after the Effective Date, Defendants shall pay the amount of one million seven hundred fifty three thousand one hundred fourteen dollars and fifty-eight cents ($1,753,114.58) to CLWA. The obligation to make such payment shall be joint and several, subject to Section 2.5. This payment is in full and complete satisfaction and resolution of Plaintiffs' Past Design Costs, as set forth in Exhibit E to this Agreement.

3.3 Payment to VWC

Within thirty (30) Days after the Effective Date, Defendants shall pay to VWC one million dollars ($1,000,000). The obligation to make such payment shall be joint and several, subject to Section 2.5. This payment is in full and complete satisfaction and resolution of

Plaintiffs' claims in the Underlying Action for V-206 Replacement Well, including, but not limited to, construction and installation of VWC's well V206 and associated pipelines, and permanent closure and abandonment of VWC's well V157, as described in Exhibit Q.

ARTICLE 4. FUNDING OF Q2 COSTS, REPLACEMENT WELL/DISTRIBUTION PIPELINE CAPITAL COSTS AND PROJECT CAPITAL COSTS

4.1 Funding of Q2 Capital Costs and Q2 O&M Costs

Plaintiffs acknowledge that Defendants previously have caused to be deposited into the "**Q2 Escrow Account**" five hundred thousand dollars ($500,000) for reasonable and necessary and approved Q2 Capital Costs. This payment is in full and complete satisfaction and resolution of Plaintiffs' claims for the capital costs associated with the Q2 Treatment System. Plaintiffs acknowledge that Defendants previously have caused to be deposited into the "Q2 Escrow Account" two hundred twenty three thousand and two hundred ten dollars ($223,210) for certain reasonable and necessary and approved Q2 O&M Costs. This payment is in partial satisfaction and resolution of Plaintiffs' claims for the operations and maintenance costs associated with the Q2 Treatment System. Construction of the Q2 Treatment System has been completed and all Q2 Capital Costs associated with the Q2 Treatment System have been approved and paid by or on behalf of Defendants as of the Effective Date.

A copy of the Q2 Escrow Account Instructions is attached hereto as Exhibit J and incorporated herein by this reference. Copies of Amendments No. 1 and No. 2 to the Q2 Escrow Account Instructions are attached hereto as Exhibit K-1 and Exhibit K-2, respectively and incorporated herein by this reference. Any amounts, including interest, remaining in the Q2 Escrow Account as of the Effective Date shall be used by Plaintiffs for Q2 O&M Costs, and credited against Defendants' obligations for funding Q2 O&M Costs as set forth in Section 4.1.1 below.

4.1.1 The Q2 Treatment System commenced operations on October 12, 2005 ("Q2 Commencement Date"), and VWC has been incurring Q2 O&M Costs for the Q2 Treatment System since that date.

4.1.1.1 During the period prior to October 12, 2007, VWC's withdrawal of funds for Q2 O&M Costs shall not exceed nine thousand and three hundred dollars ($9300) on average per month except in the event of a Q2 Resin Exchange and except for reimbursement of any Q2 O&M Costs that have been incurred prior to the Effective Date and not previously paid out of the Q2 Escrow Account.

4.1.1.2 In the event Commencement of Operation of the Project has not occurred as of October 12, 2007, and the Q2 Treatment System must still be operated pursuant to applicable regulatory requirements, Defendants shall pay or cause to be paid an additional deposit of one hundred eleven thousand and six hundred dollars ($111,600) on or before October 12, 2007, to be used for Q2 O&M Costs. In the event Commencement of Operation of the Project has not occurred as of October 12, 2007, and the Q2 Treatment System must still be operated pursuant to applicable regulatory requirements, Defendants shall pay or cause to be paid additional reasonable and necessary Q2 O&M Costs until the Q2 Treatment System is relocated as provided in Section 4.2.1. After October 12, 2007, VWC may withdraw funds on a monthly basis as is reasonably necessary.

4.1.1.3 Defendants shall pay or cause to be paid into the existing Q2 Escrow Account an additional amount of one hundred sixty seven thousand and five hundred dollars ($167,500), or such other amount as may be agreed by the Defendants or determined by the Cost Consultant in accordance with Article 7, in the event a determination is made by VWC in accordance with its operating permit and upon agreement by Whittaker and AISLIC, that

replacement of the treatment resins used in the Q2 Treatment System is necessary. Such deposit shall be made within 10 days after VWC's written notice of determination and request for funding has been delivered to Defendants. Any dispute regarding such determination by VWC shall be resolved by the Cost Consultant in accordance with Article 7.

4.1.2 Defendants' obligations hereunder for deposits required to be made into the Q2 Escrow Account shall be on a joint and several basis subject to Section 2.5.

4.1.3 Any amounts, including interest, remaining in the Q2 Escrow Account upon Q2 Treatment System Relocation to the location of the Project shall be refunded into the SF Escrow 1 Account (as defined in the Coverage and Claims Settlement Agreement.).

4.1.4 Payments from the Q2 Escrow Account shall be made on a monthly basis in accordance with the procedures set forth in Article 6 and the applicable Q2 Escrow Account instructions.

4.1.5 Defendants and AISLIC shall not be entitled to withdraw any funds from the Q2 Escrow Account or to direct or control the payment of such funds, and shall have no rights with respect to such funds, except as provided in this Agreement.

4.1.6 Payments for Q2 O&M Costs shall continue until the date that VWC and CLWA are required to relocate and integrate the Q2 Treatment System into the Project pursuant to Section 4.2.1 or until treatment of Well Q2 is no longer required by DHS, whichever occurs first. The Q2 Escrow Account shall terminate following written notification from Plaintiffs that the Q2 Treatment System has been integrated into the Project or written notification from Plaintiffs or Cost Consultant or arbitrator determination that treatment of Well Q2 is no longer required by DHS, provided that payment has been made for all Q2 Capital Costs and Q2 O&M

Costs permitted to paid from the Q2 Escrow Account in accordance with the procedures set forth in this Agreement.

4.2 Termination of the Q2 Treatment System Operations

4.2.1 VWC shall undertake to terminate operation of the Q2 Treatment System as soon as reasonably feasible, in accordance with requirements of the California Department of Health Services (DHS). In connection with the construction of the Project, Plaintiffs shall incorporate the Q2 Well and the Q2 Treatment System into the Project, notwithstanding any prior determination that the treatment at Q2 Well is no longer required, so as to enable the Saugus 1&2 Treatment System to treat Q2 water in case the Q2 Well subsequently becomes recontaminated. In connection with the construction of the Project, VWC and CLWA shall incorporate the Q2 Well and the Q2 Treatment System into the operation of the Project not later than (i) two (2) years after the Q2 Commencement Date or (ii) the Commencement of Operations of the Project, whichever is later. Upon relocating operation of the Q2 Treatment System, VWC and CLWA shall transfer the treatment vessels used as part of the Q2 Treatment System to the location of the Project and incorporate the use of those vessels into that system. Upon terminating or relocating operation of the Q2 Treatment System, VWC and CLWA shall transfer the remaining resin used as part of the Q2 Treatment System to the location of the Project and incorporate the unused resin into that system.

4.2.2 The obligation to pay Q2 O&M Costs for the Q2 Treatment System pursuant to Section 4.1.1 of this Agreement shall cease either (i) upon written notification from Plaintiffs or Cost Consultant or arbitrator determination that treatment of Well Q2 is no longer required by DHS; or (ii) upon written notification from Plaintiffs that the Q2 Treatment System has been integrated with the Project and that the Q2 O&M Costs will be included in the Project

O&M Costs and handled in accordance with Article 5, which notice shall not occur later than (i) two (2) years after the Q2 Commencement Date or (ii) the Commencement of Operations of the Project, whichever occurs later. If, after a determination that treatment at well Q2 is no longer required, well Q2 becomes re-contaminated so as to require treatment, said treatment will be handled by means of the Project, and the costs thereof shall be Project O&M Costs.

4.2.3 Any dispute as to whether treatment of water pumped from Q2 can be discontinued or should be recommenced shall be resolved through binding Cost Consultant arbitration, as provided in Article 7 of this Agreement, provided that the arbitration decision must be consistent with the requirements of all regulatory agencies with jurisdiction regarding perchlorate.

4.3 Replacement Wells/Distribution Pipeline Capital Costs Escrow Account

Defendants shall be jointly and severally obligated subject to Section 2.5 to pay for their proportional share of the capital costs associated with the installation of new Distribution Pipelines and Replacement Wells & Associated Pipelines pursuant to this Section 4.3. CLWA, on behalf of all Plaintiffs, and Whittaker, on behalf of all Defendants, concurrently with execution of this Agreement, shall execute and, thereafter, promptly deliver to City National Bank or other agreed bank instructions for an escrow (the "**Replacement Wells/Distribution Pipeline Capital Costs Escrow Account**") substantially in the form of Exhibit P hereto. Within thirty (30) Days after the Effective Date, Defendants shall make an initial deposit into the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account of four million seven hundred and fifty thousand dollars ($4,750,000) to be used for Distribution Pipelines, and Replacement Wells & Associated Pipelines. The Replacement Wells & Associated Pipelines will provide new Saugus Formation production capacity to replace lost well capacity not

provided by the Project or V-206. The Distribution Pipelines will be connected to various turnouts within the Plaintiffs' system.

4.3.1 The Defendants' initial proportional share of the capital costs associated with the Distribution Pipelines and the Replacement Wells & Associated Pipelines will be based on the Percentage Cost Allocation for Distribution Pipelines and Replacement Wells & Associated Pipelines set forth in Exhibit R and the bid items submitted by the bidder selected through a competitive bidding process in accordance with CLWA bid procedures and applicable law. Whittaker's and AISLIC's technical representatives shall be provided reasonable opportunity to advise and consult on design, engineering, location of well replacement and other technical aspects of the contractor selection and construction process. For bid items that do not have specific cost allocations, the weighted cost allocation of the other bid items shall be applied. During construction, the Plaintiffs and Defendants shall provide the funds necessary to pay the selected contractors in the proportion provided for by the determination of the initial proportional share. Upon completion and Plaintiffs' acceptance of the construction, a true-up of the cost allocation shall be performed. To the extent feasible, the true-up shall apply the cost allocation of Distribution Pipelines and Replacement Wells presented in Exhibit R to the actual costs of the Distribution Pipelines and Replacement Wells, including approved change orders.

4.3.2 The Parties acknowledge that construction of the Replacement Wells and Associated Pipelines, except the drilling of the Replacement Wells, will be deferred until the construction of the extension of Magic Mountain Parkway is initiated.

4.3.3 In the event Defendants' proportional share of capital costs associated with Distribution Pipelines and Replacement Wells & Associated Pipelines exceeds four million and seven hundred fifty thousand dollars ($4,750,000), including all costs of redrilling

Replacement Wells that are not capable of producing water at the required rate, Defendants shall be obligated, on a joint and several basis subject to Section 2.5, to deposit in the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account additional funds sufficient to cover such excess, as reasonably determined by Plaintiffs, subject to approval by Whittaker and AISLIC or determination by the Cost Consultant. Such deposits shall be made by Defendants in a timely manner. The Estimate of Replacement Wells/Distribution Pipeline Capital Costs attached hereto as Exhibit S reflects that Defendants' proportional share of the Replacement Wells/Distribution Pipeline Capital Costs exceeds $4,750,000. However, in the event that cost savings are achieved such that Defendants' proportional share of capital costs associated with Distribution Pipelines and Replacement Wells & Associated Pipelines is less than the amounts deposited by Defendants into the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account, any amounts remaining in the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account shall be refunded into the SF Escrow 1 Account (as defined in the Coverage and Claims Settlement Agreement).

4.3.4 Any dispute regarding the reasonableness, timing or necessity of Replacement Wells/Distribution Pipeline Capital Costs, the selection of the lowest responsive and responsible bid in the competitive bidding process, or the Defendants' appropriate proportional share shall be resolved through Cost Consultant arbitration in accordance with Article 7.

4.4 Project Capital Costs Escrow Account

CLWA, on behalf of all Plaintiffs, and Whittaker, on behalf of all Defendants, concurrently with execution of this Agreement, shall execute and, thereafter, promptly deliver to City National Bank or other agreed bank instructions for an escrow (the **"Project Capital Costs**

Escrow Account") substantially in the form of Exhibit H-1 hereto. Within thirty (30) Days after the Effective Date, Defendants shall, jointly and severally, be obligated to make a deposit into the Project Capital Costs Escrow Account of five million dollars ($5,000,000) (**"Initial Project Capital Costs Deposit"**) to pay Project Capital Costs.

4.4.1 In the event Project Capital Costs exceed the amount of the Initial Project Capital Costs Deposit, Defendants shall deposit in the Project Capital Costs Escrow Account additional funds sufficient to cover such excess, as determined by Plaintiffs, subject to AISLIC and Whittaker approval or determination by the Cost Consultant; but such total additional funds shall not exceed five million dollars ($5,000,000). Defendants shall deposit the additional funds in a timely manner after approval by AISLIC and Whittaker or by the Cost Consultant. The Estimate of Project Capital Costs attached hereto as Exhibit G reflects that Project Capital Costs are projected to exceed five million ($5,000,000). However, in the event that cost savings are achieved such that Project Capital Costs are less than the amounts deposited by Defendants into the Project Capital Costs Escrow Account, any amounts remaining in the Project Capital Costs Escrow Account shall be refunded into the SF Escrow 1 Account (as defined in the Coverage and Claims Settlement Agreement.).

4.4.2 Any dispute regarding the reasonableness, timing or necessity of Project Capital Costs shall be resolved through arbitration in accordance with Article 7.

ARTICLE 5. PAYMENT OF PROJECT O&M COSTS

5.1 Project O&M Escrow Account

5.1.1 Defendants shall be jointly and severally obligated subject to Section 2.5 to pay Project O&M Costs in accordance with the terms of this Agreement. The "*pro forma*" Estimate of Project O&M ("**Pro Forma Estimate of Project O&M**") as of the date of execution of this Agreement is attached hereto as Exhibit D.

5.1.2 CLWA, on behalf of all Plaintiffs, and Whittaker, on behalf of all Defendants, and AISLIC shall, within thirty (30) days after Whittaker and AISLIC's receipt of Plaintiffs' written notice of anticipated commencement of Project operations execute and thereafter, promptly deliver to City National Bank or other agreed bank instructions for an escrow for funds to be used for payment of Project O&M Costs substantially in the form of Exhibit H-2 hereto.

5.1.3 Payments from the Project O&M Escrow Account shall be made on a monthly basis in accordance with the procedures set forth in this Article 5, Article 6, and the applicable escrow instructions, which instructions are subject to approval by Plaintiffs, Whittaker, and AISLIC and shall be consistent with the terms of this Agreement.

5.1.4 Upon termination of the Project O&M Escrow Account in accordance with this Agreement, any balance in that account shall be refunded into the SF Escrow 1 Account. The Project O&M Escrow Account shall terminate upon termination of this Agreement or earlier payment of all Lump Sum awards, provided that payment has been made for all Project O&M Costs in accordance with the procedures set forth in this Agreement.

5.2 Project O&M Costs

5.2.1 Defendants shall fund Project O&M Costs by depositing annually in the Project O&M Escrow Account the annual O&M amounts reasonably estimated by CLWA and modified as reasonably estimated by Defendants and AISLIC, or modified as determined by the Cost Consultant, and reflected in the Joint Estimate of Project O&M jointly prepared by the Parties (which may include determinations of the Cost Consultant). The first annual deposit ("**Initial Project O&M Deposit**") shall be due thirty (30) days after Whittaker's, and AISLIC's receipt of Plaintiffs' written notice of anticipated commencement of Project operations and a

Joint Estimate of Project O&M has been agreed between the Parties or determined by the Cost Consultant for the first year of operations. The initial "Joint Estimate of Project O&M" shall be based upon the Pro Forma Estimate of Project O&M attached as Exhibit D hereto, as modified by CLWA and approved by Defendants and AISLIC or determined by the Cost Consultant. ("**Joint Estimate of Project O&M**") Defendants will reasonably consider and respond to CLWA's proposed modifications to the attached Pro Forma Estimate of Project O&M as provided in this Article 5. The Parties will meet and confer concerning any disputes in preparing the initial Joint Estimate of Project O&M . Subsequent annual O&M deposits (each an **"Annual Project O&M Deposit"**) in the amount of the Joint Estimate of Project O&M for the upcoming year (each a "Joint Estimate of Project O&M") as agreed between the Parties or determined by the Cost Consultant, shall be due on or before the anniversary of the Initial Project O&M Deposit. CLWA will provide Whittaker, AISLIC, and Steadfast with a copy of each of Plaintiffs' proposed Joint Estimate of Annual Project O&M at least seventy-five (75) days prior to the anniversary date of the prior year's Annual Project O&M Deposit.

5.2.2 In the event of Defendants' or AISLIC's objection to any item included or excluded on any of the Plaintiffs' proposed Joint Estimates of Project O&M, Defendants or AISLIC shall notify Plaintiffs of their objection in writing within thirty (30) days after receipt of the proposed estimate, stating the reasons for its objection, and the Parties shall exercise their best efforts to resolve the disputed item(s). In the event that the disputed item is not resolved within fifteen (15) days after Defendants' or AISLIC's notice of objection, the disputed item(s) shall be submitted to the Cost Consultant, for expedited resolution in accordance with Article 7, below. Following meet and confer and any determinations of the Cost Consultant, the Parties

shall jointly prepare the Joint Estimate of Project O&M as agreed among the Parties or determined by the Cost Consultant.

5.2.3 In the event that CLWA determines it will be necessary to supplement the Project O&M Escrow Account in any given year to pay for Project O&M Costs, CLWA shall notify Defendants, AISLIC and Steadfast of its determination and provide an itemized statement, using the same format as the then-current Joint Estimate of Project O&M, of the amount of the supplemental funding **("Estimate of Supplemental Project O&M"**) required to cover the additional Project O&M Costs. In the event of Defendants' or AISLIC's objection to any item included in the Plaintiffs' proposed Estimate of Supplemental Project O&M, Defendants or AISLIC shall notify Plaintiffs of their objection in writing within fifteen (15) days after receipt of the proposed Estimate of Supplemental Project O&M, stating the reasons for its objection, and the Parties shall exercise their best efforts to resolve the disputed item(s). In the event that the disputed item is not resolved within fifteen (15) days after Defendants' or AISLIC's notice of objection, the disputed item(s) shall be submitted to the Cost Consultant for expedited resolution in accordance with Article 7. Defendants shall deposit into the Project O&M Escrow Account the amount of the Estimate of Supplemental Project O&M within ten (10) days after determination of the amount of the Estimate of Supplemental Project O&M by agreement of the Parties or determination of the Cost Consultant.

5.2.4 Subject to the provisions of Section 9.1.7 below, the obligation to pay Project O&M Costs pursuant to this Article 5 shall cease the earlier of (i) the California Department of Health Services (DHS), and any other agency that has asserted jurisdiction and whose agreement is required, agrees that treatment of water pumped from Saugus 1 & 2 can be discontinued; or (ii) thirty (30) years after Commencement of Operations of the Project.

5.2.5 Any dispute regarding the reasonableness, applicability or necessity of Project O&M Costs, except for the issue of whether treatment of water pumped from Saugus 1 & 2 can be discontinued, shall be resolved through binding arbitration, as provided in Article 7 of this Agreement, provided that the arbitration decision must be consistent with the requirements of all regulatory agencies with jurisdiction, and prior to determination of the Lump Sum as described in Section 5.2.6. Any dispute regarding whether treatment of water pumped from Saugus 1 & 2 can be discontinued, shall be resolved through binding arbitration, as provided in Sections 13.1 and 13.2 of this Agreement (unless all Parties agree that the issue may be resolved as provided in Article 7 of this Agreement), provided that the arbitration decision must be consistent with the requirements of all regulatory agencies with jurisdiction, and prior to determination of the Lump Sum as described in Section 5.2.6.

5.2.6 Subject to the provisions of Section 9.1.7 below, beginning five years after Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage), CLWA, Whittaker, or AISLIC may demand binding arbitration, as provided in Article 13 of this Agreement, for purposes of obtaining a determination of a lump sum for payment in lieu of the Project O&M Costs that would otherwise be due and payable during the remainder of the up-to thirty-year period (the "Lump Sum") based on the following criteria:

5.2.6.1 The Lump Sum will be calculated on a net present value basis using appropriate assumptions and techniques, including consideration of risk, activities and costs anticipated to occur after payment of the Lump Sum, and any other factors introduced by the Parties at arbitration and determined to be relevant by the arbitrator, but the Lump Sum shall be calculated on the assumption that the Defendants' obligation to pay for the Project O&M shall

cease not later than thirty years after Commencement of Operations of the Project, except as provided in Section 9.1.7. The Lump Sum determination shall also be based, in part, on consideration of the actual Project O&M Costs experienced prior to arbitration, but excluding any such Project O&M Costs as may have been associated with start-up of the system or otherwise not indicative of future Project O&M Costs. The Lump Sum amount will not include any capital costs, including but not limited to, capital costs of Project Modifications implemented pursuant to Article 9 of this Agreement or any projected or potential capital costs for Project Modifications which become or may become necessary after the first three years following Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage). The Lump Sum amount will not include any lobbying costs or legal fees or costs associated with obtaining funding from Public Funding Sources. With respect to the activities and costs subject to the annual flat fee payment of twenty thousand dollars ($20,000), described in Section 1.59, the Lump Sum will be calculated based on an assumption that the $20,000 annual flat fee will be escalated based on CPI. For purposes of this Agreement, CPI means the Consumer Price Index for All Urban Consumers (CPI-U) in the Los Angeles-Riverside-Orange County Consolidated Metropolitan Statistical Area, All Items, as published by the United States Department of Labor, Bureau of Labor Statistics, for which the base year is 1982-84 = 100, or if such publication ceases to be in existence, a comparable index agreed by the Parties.

5.2.7 In the event a Lump Sum determination is made in accordance with Section 5.2.6, the amount of the Lump Sum shall be paid by Defendants, jointly and severally, and subject to Section 2.5, to Plaintiffs within thirty (30) Working Days after the arbitrator's decision is issued and any petition filed prior to that time to vacate or correct the arbitrator’s

decision, pursuant to Cal. Code of Civil Procedure Section 1286.2 (Grounds for Vacation of Award) or Section 1286.6 (Grounds for Correction of Award), is finally adjudicated. Plaintiffs agree to use the Lump Sum amount solely for Project O&M Costs until such Lump Sum amount is exhausted, or until Plaintiffs' obligation to operate the Project, as set forth in Section 8.3.1, ceases.

ARTICLE 6. PAYMENTS FROM THE ESCROW ACCOUNTS

6.1 General

6.1.1 Payments from the Q2 Escrow Account, the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account, the Project Capital Costs Escrow Account, and the Project O&M Escrow Account (the "**Escrow Accounts**") shall be made in accordance with the procedures set forth in this Section and each Escrow Account's instructions, which instructions shall be jointly approved by Plaintiffs, Whittaker, and AISLIC, and shall be consistent with the terms of this Agreement. The Parties acknowledge and agree that funding of the Escrow Accounts is based on the cost estimates contained in the Exhibits to this Agreement, which estimates were prepared by Plaintiffs' consultants and reviewed but not independently verified by Defendants' and AISLIC's consultants, and that the actual costs and expenses incurred will control all corresponding future payments from the Escrow Accounts. The Parties acknowledge and agree that payments from the Escrow Accounts are to be made solely for reasonable and necessary costs and expenses actually incurred and not paid or reimbursed by other sources, even if less than the sums set forth in any estimate. The Parties shall cooperate in minimizing all costs incurred and paid pursuant to this Agreement. The Parties acknowledge and agree that payments from the Escrow Accounts are to be made only for reasonable capital or operations and maintenance costs for the Project, the Replacement Wells and Associated

Pipelines, Q2 Treatment System, and Distribution Pipelines pursuant to this Agreement, and only to the extent such costs are necessary.

6.1.2 Except as provided in this Agreement, Defendants and AISLIC shall not be entitled to withdraw any funds from the Escrow Accounts or to direct or control the payment of such funds, and shall have no rights with respect to such funds, other than approval rights expressly provided in this Agreement. Reporting and payment of taxes owed on income earned with respect to the escrows shall be the responsibility of Plaintiffs.

6.1.3 Upon termination of the Escrow Accounts in accordance with this Agreement, any balance in the Escrow Accounts shall be refunded to the SF Escrow 1 Account. The Q2 Escrow Account shall terminate as set forth in Section 4.1.6. The Project Capital Costs Escrow Account shall terminate upon completion of the construction of the Project, provided that payment has been made for all Project Capital Costs in accordance with the procedures set forth in this Agreement. The Project O&M Costs Escrow Account shall terminate as set forth in Section 5.1.4. The Replacement Wells/Distribution Pipelines Escrow Account shall terminate upon completion of the construction of the Replacement Wells & Associated Pipelines and Distribution Pipelines, provided that payment has been made for all Replacement Wells & Associated Pipelines and Distribution Pipelines in accordance with the procedures set forth in this Agreement. The term "completion" as used in this Section 6.1.3 shall mean satisfactory completion of construction, startup and testing, and formal acceptance by the applicable Plaintiff.

6.2 Payment of Capital Costs

6.2.1 Costs incurred for activities and within the aggregate approved amounts set forth in Exhibit G, with respect to the Project, and Exhibit S, with respect to the Replacement Wells/Distribution Pipelines, following resolution of disputed costs pursuant to Article 7, shall

constitute **"Approved Capital Costs."** Costs incurred for activities or items that are not contained in Exhibits G and S for the applicable Escrow Account, or are in excess of the aggregate amount set forth therein, shall be subject to the approval of Whittaker and AISLIC or confirmation by the Cost Consultant in accordance with Article 7, below, and upon such approval or confirmation, such costs shall also constitute "Approved Capital Costs".

6.2.2 Plaintiffs shall prepare (1) a monthly statement setting forth capital costs incurred by Plaintiffs for the prior period for the Project (the "**Project Monthly Capital Costs Statement**") and paid by Plaintiffs from the Project Capital Costs Escrow Account, (2) a monthly statement setting forth capital costs incurred by Plaintiffs for the prior period for the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account (the "**Replacement Wells/Distribution Pipeline Capital Costs Statement**") and paid by Plaintiffs from the Replacement Wells/Distribution Pipeline Capital Costs Escrow Account, in each case accompanied by copies of relevant underlying invoices and other supporting documentation for such costs. Copies of the Project Monthly Capital Costs Statement, the Replacement Wells/Distribution Pipeline Capital Costs Statement (together, the **"Monthly Capital Costs Statements"**) shall be provided to Whittaker, AISLIC and Steadfast for review at least ten (10) days prior to each monthly Technical Meeting described in Section 8.4, below, and the Parties shall exercise their best efforts to resolve any disputes concerning the invoices included in the Monthly Capital Costs Statements at or prior to the Technical Meeting.

6.2.3 In the event of a dispute concerning items on any invoice, if such dispute is not resolved at or prior to the Technical Meeting, Whittaker or AISLIC shall provide Plaintiffs with written notice of the reason it disputes the invoice within ten (10) days after the Technical Meeting, and the disputed item(s) shall be resolved by the Cost Consultant in accordance with

Article 7, below. Notwithstanding any pending dispute regarding Whittaker or AISLIC's disapproval of an invoice for payment, Plaintiffs may withdraw funds on a monthly basis from the Escrow Accounts to pay for Project Capital Costs, and Replacement Wells/Distribution Pipelines Capital Costs, subject to the provisions of Article 7 of this Agreement, and to pay Escrow Agent's fees, and any fees incurred for the Cost Consultant in accordance with Article 7 below or for arbitrator's fees in accordance with Article 13, Section 13.2 below. Any appropriate adjustment resulting from the determination of the Cost Consultant shall be reconciled in the following Monthly Capital Costs Statement.

6.2.4 Plaintiffs shall provide the tax identification number required to open any Escrow and shall be responsible for fulfilling tax payment, reporting and filing requirements. Interest that accrues on the balances in the Escrow Accounts shall be retained in those Accounts and available for use by Plaintiffs pursuant to the respective agreed uses of each Account until Termination, and credited against Defendants' funding obligations as to the applicable Account.

6.3 Payment of Q2 O&M Costs

6.3.1 Costs incurred for activities and within the approved Q2 Monthly O&M Costs amount shall constitute **"Approved Q2 O&M Costs."**

6.3.2 VWC shall, within ten (10) Working Days after the end of each semi-annual period after Commencement of Operations for the Q2 Treatment System, deliver to Whittaker and AISLIC a statement of invoices for Q2 O&M Costs incurred by VWC during the preceding semi-annual period **("Q2 Semi-Annual O&M Statement"**), accompanied by copies of all of the underlying invoices and other supporting documentation. Copies of the Q2 Semi-Annual O&M Statements shall be provided to Whittaker, AISLIC and Steadfast for review at least twenty (20) days prior to the Technical Meeting following the end of each semi-annual

period. Plaintiffs, Whittaker and AISLIC shall exercise their best efforts to resolve any disputes concerning the invoices included in the Q2 Semi-Annual O&M Statement at or prior to the Technical Meeting; provided, however, that Approved O&M Costs shall not be subject to review or approval.

6.3.3 In the event of a dispute concerning items other than Approved O&M Costs on any invoice, if such dispute is not resolved at or prior to the Technical Meeting, Whittaker or AISLIC shall provide Plaintiffs with written notice of the reason it disputes the invoice within ten (10) days after the Technical Meeting, and the disputed item(s) shall be resolved by the Cost Consultant in accordance with Article 7, below.

6.3.4 Notwithstanding any pending dispute regarding Whittaker's or AISLIC's disapproval of an invoice for payment, Plaintiffs may withdraw funds on a monthly basis from the Q2 Escrow Account to pay Q2 O&M Costs for the Q2 Treatment System, subject to the provisions of Article 7 of this Agreement, and to pay Escrow Agent's fees, and any fees incurred by Plaintiffs for the Cost Consultant in accordance with Article 7, below, or for arbitrator's fees in accordance with Article 13, Section 13.2 below. Any appropriate adjustment resulting from the determination of the Cost Consultant shall be reconciled in the following Q2 Semi-Annual O&M Statement.

6.3.5 Upon request, Plaintiffs shall additionally provide to SCLLC and RFI, or Buyer if the sale has closed, the statement of invoices with copies of the underlying invoices and supporting documentation.

6.4 Payment of Project O&M Costs

6.4.1 Costs incurred for Project O&M activities and within the aggregate amount set forth in the applicable Joint Estimate of Annual Project O&M or Estimate of

Supplemental Project O&M following resolution of any disputed items pursuant to Article 7, shall constitute "**Approved O&M Costs**." Costs incurred for activities or items that are not Approved O&M Costs or are in excess of the aggregate amount set forth in the applicable Joint Estimate of Annual Project O&M or Estimate of Supplemental Project O&M shall be subject to the approval of Whittaker and AISLIC or confirmation by the Cost Consultant in accordance with Article 7, below, and upon such approval or confirmation, such costs shall also constitute "Approved O&M Costs."

6.4.2 Plaintiffs shall, within ten (10) Working Days after the end of each quarterly period following the Commencement of Operations, deliver to Whittaker, AISLIC and Steadfast a statement of invoices for Project O&M Costs incurred and paid by Plaintiffs from the Project O&M Escrow Account during the preceding quarterly period (**"Quarterly Project O&M Statements"**), accompanied by copies of all of the underlying invoices and other supporting documentation. Copies of the Quarterly Project O&M Statements shall be provided to Whittaker and AISLIC for review at least ten (10) days prior to the Technical Meeting following the end of each quarter, and the Parties shall exercise their best efforts to resolve any disputes concerning the invoices included in the Quarterly Project O&M Statement at or prior to the Technical Meeting.

6.4.3 Upon request, Plaintiffs shall additionally provide to SCLLC and RFI, or Buyer if the sale has closed, the Quarterly Project O&M Statements with copies of the underlying invoices and supporting documentation.

6.4.4 In the event of a dispute concerning items on any invoice, if such dispute is not resolved at or prior to the Technical Meeting, Whittaker and/or AISLIC shall provide Plaintiffs with written notice of the reason it disputes the invoice within ten (10) days after the

Technical Meeting, and the disputed item(s) shall be resolved by the Cost Consultant in accordance with Article 7, below.

6.4.5 Notwithstanding any pending dispute regarding Whittaker or AISLIC's disapproval of an invoice for payment, Plaintiffs may withdraw funds on a monthly basis from the Project O&M Escrow Account to pay actual Project O&M Costs, subject to the provisions of Article 7 of this Agreement, and to pay Escrow Agent's fees, and any fees incurred for the Cost Consultant in accordance with Article 7 below or for arbitrator's fees in accordance with Article 13, Section 13.2 below. Any appropriate adjustment resulting from the determination of the Cost Consultant shall be reconciled in the following Quarterly Project O&M Statement.

ARTICLE 7. COST CONSULTANT ARBITRATION

7.1 Cost Consultant

7.1.1 Appointment of Cost Consultant. Michael Kavanaugh shall act as Cost Consultant and perform the functions of Cost Consultant set forth in this Agreement. If Mr. Kavanaugh, any replacement Cost Consultant, or all parties to a disputed issue, determine that the Cost Consultant lacks expertise as to a specific disputed issue, the Cost Consultant (after consultation with the parties to the dispute) shall retain an expert to assist him or her in reaching a determination of that particular dispute.

7.1.2 Functions of Cost Consultant

7.1.2.1 The Cost Consultant, and any replacement Cost Consultant, shall not act as an agent or representative for any Party, and shall exercise independent, neutral judgment in the performance of the Cost Consultant's responsibilities under this Agreement.

7.1.2.2 In the event of a timely demand for arbitration pursuant to Sections 4.1, 4.2, 4.3, 4.4, 5.2 (except as otherwise provided in Sections 5.2.5 and 5.2.6), 6.2,

6.3, 6.4, 8.2, 8.3, 8.4.2, and 9.1 of this Agreement, the Cost Consultant shall resolve the dispute in accordance with this Article 7.

7.1.3 Cost Consultant Fees: The Cost Consultant's fees and costs shall be included in Project O&M Costs.

7.1.4 Replacement of Cost Consultant: The Cost Consultant may only be replaced by mutual agreement of the Plaintiffs, Whittaker and AISLIC or for good cause established to the satisfaction of the arbitrator designated pursuant to Article 13, Section 13.2 of this Agreement. In the event of the resignation, replacement for good cause, or unavailability of the Cost Consultant, Plaintiffs and Whittaker and AISLIC shall jointly retain a replacement Cost Consultant. If the Parties are unable to agree on a replacement, a replacement shall be chosen by the arbitrator designated pursuant to Article 13, Section 13.2 of this Agreement.

7.2 Cost Consultant Dispute Resolution

In the event that the Parties are unable to resolve a dispute arising under the sections listed in Section 7.1.2.2, Plaintiffs, Whittaker and/or AISLIC may, within the time period provided by the applicable section of this Agreement, demand expedited arbitration of the dispute. If no time period is specified in the applicable section, then the demand for expedited arbitration must be made within ten (10) days after the Technical Meeting at which such dispute was addressed and not resolved. Any such demand, accompanied by all materials that Plaintiffs, Whittaker and/or AISLIC consider necessary for resolution of the dispute, shall be served on the other Parties. By the end of the tenth day after their receipt of such a demand for arbitration, the receiving Party may submit to the Cost Consultant and, if so, shall serve upon the other Parties all materials that the receiving Party consider necessary for resolution of the dispute. The Cost Consultant may request further information from the Parties or schedule an arbitration hearing

date (in-person or by telephone conference) and shall render a decision within twenty (20) days after delivery of the demand for arbitration or, if an arbitration hearing is conducted, within ten (10) days of the conclusion of the arbitration hearing, or at such later time as may be agreed by the parties to the dispute and the Cost Consultant. If a Party does not timely demand arbitration, its disapproval shall be deemed waived.

ARTICLE 8. OWNERSHIP, CONSTRUCTION, OPERATION AND MANAGEMENT OF FACILITIES

8.1 Ownership of Facilities

Plaintiffs shall own or lease all Project facilities, all Replacement Wells and Associated Pipelines, all Distribution Pipelines, and the Q2 Treatment System. Plaintiffs represent and warrant that they have reached separate agreement as to their respective ownership of Project facilities, and this Agreement shall remain in full force and effect regardless of any dispute or disagreement that may exist or arise relating to their ownership of Project facilities, all Replacement Wells and Associated Pipelines, all Distribution Pipelines, and the Q2 Treatment System.

8.2 Plaintiffs' Responsibilities

8.2.1 Plaintiffs will be responsible for the planning, development, design, permitting, construction, installation, operation and maintenance of the Project, Q2 Treatment System, and Replacement Wells & Associated Pipelines and Distribution Pipelines consistent with generally accepted industry standards and practices, and subject to review of Project Capital Costs and Project O&M Costs as provided in Articles 4 and 5 of this Agreement, review of Q2 Treatment System as provided in Article 4 of this Agreement, and review of Replacement Wells & Associated Pipelines and Distribution Pipelines as provided in Article 4 of this Agreement, and resolution of disputed items or costs as provided in Articles 6 and 7 of this Agreement.

Subject to dispute resolution by the Cost Consultant in accordance with Article 7, Plaintiffs shall conduct such planning, development, design, permitting, construction and installation of the Project and the Q2 Treatment System through one or more contracts with design professionals and licensed contractors approved by Whittaker and AISLIC, such approval not to be unreasonably withheld.

8.2.2 Whittaker and AISLIC have previously approved of U.S. Filter as the initial Resin Service Contract Vendor for the Project, and the Q2 Treatment System which has already commenced operations. Whittaker and AISLIC shall participate with Plaintiffs in the negotiation of the initial Resin Service Contract with U.S. Filter for the Project, and shall be participants in Plaintiffs' negotiation of any renewal or substitute Resin Service Contract(s) for the Project prior to payment of the Lump Sum. Prior to an arbitration determination of the Lump Sum, all Plaintiff/Whittaker/AISLIC negotiations on Resin Service Contract(s) will include consideration and negotiation of insurance that the Vendor is able to obtain for Plaintiffs and Defendants and obtaining Vendor Labor in connection with operations, monitoring, sampling and maintenance of the Project, and comparison with alternative options of Plaintiffs' costs for substantially same Labor and insurance, liability exposure considerations, and all associated costs. The Parties agree that Plaintiffs will have the option of performing all or certain of the operations, monitoring, sampling and maintenance of the Project and to secure their own insurance policies in accordance with Article 11 "Project Insurance", provided, however, that Defendants' Project O&M payment obligations for such labor and insurance costs will be limited to the cost of reasonably comparable, efficient and effective alternatives available by means of a bid for a resin service contract selected through a competitive bidding process in accordance with CLWA bid procedures and applicable law.

8.2.3 The Project shall be designed, constructed and installed in accordance with Exhibit F (subject to Project Modification pursuant to Article 9 of this Agreement) and all applicable state, federal and local government laws, regulations, ordinances and other applicable legal requirements.

8.3 Operation, Maintenance and Management of Project

8.3.1 Plaintiffs shall, in consultation with each other, operate, maintain and manage the Project (a) in accordance with all applicable state, federal and local government laws, regulations, ordinances, other applicable legal requirements (including the DTSC-approved IRAP), and generally accepted industry standards and practices, and (b) to perform its intended function of providing containment of perchlorate as defined in Section 9.1 of this Agreement, until exhaustion of any Lump Sum determined and paid pursuant to Section 5.2.6 of this Agreement; provided, however, that if there is no Lump Sum determination and payment, Plaintiffs shall operate, maintain, and manage the Project until Defendants cease funding Project O&M Costs pursuant to Section 5.2.4 of this Agreement or any other reason. In fulfilling their obligations hereunder, Plaintiffs shall not be required to fund any Project Modification.

8.3.1.1 Plaintiffs shall provide accounting services necessary for accurately tracking Project Capital and O&M Costs, invoice payments, budget process, deposits to and disbursements from the Escrow Accounts, and credits for funds received from Public Funding Sources.

8.3.2 Monitoring and Reporting

8.3.2.1 As contemplated by the DTSC approved IRAP, Plaintiffs shall arrange for and supervise the required groundwater monitoring and promptly after receipt

provide sampling data to Whittaker, AISLIC, and upon request, to SCLLC, RFI, or if the sale has closed, the Buyer.

8.3.2.2 Plaintiffs shall ensure timely, complete, and satisfactory preparation and submission of any reports and other deliverables that may be required by any state, federal or local government law, regulation, ordinance or other applicable legal requirement, including the DTSC-approved IRAP, and provide copies of such reports to Whittaker and AISLIC. Copies of such reports shall, upon request, be made available to SCLLC, RFI, or if the sale has closed, the Buyer. This obligation can be met by an electronic posting of the requested materials.

8.3.2.3 Plaintiffs shall maintain any and all books, records, accounts and supporting documentation **("Records")** either required by or necessary to document (i) compliance with all applicable state, federal and local government laws, regulations, ordinances and other applicable legal requirements; and (ii) responsible financial management of the Project. Financial Records shall be maintained in accordance with generally accepted accounting principles and shall be retained until the later of (a) five (5) years from the "as of" date or period applicable to the financial Record; or (b) the Internal Revenue Service retention period for such Records. All other Records shall be retained for a minimum of ten (10) years after the record was created. All Records shall be subject to audit pursuant to Section 8.5 of this Agreement.

8.3.2.4 Plaintiffs shall provide Whittaker, AISLIC, and Steadfast on a semi-annual basis, copies of the Plaintiffs' cost estimates for the Project, the Replacement Wells/Distribution Pipelines and the Q2 Treatment System, showing expenditures against such budgets, and shall provide copies of any reports, contracts or other materials to be considered at

the Technical Meeting, in accordance with Section 8.4, below. Plaintiffs shall make available such reports to SCLLC, RFI, or if the sale has closed, the Buyer, upon request.

8.4 Monthly Technical Meetings

8.4.1 Plaintiffs shall hold monthly meetings to consider technical, financial and other issues related to the planning, development, design, permitting, construction, installation, operation and management of the Project, the Q2 Treatment System, and the Replacement Wells/Distribution Pipelines ("Technical Meetings").

8.4.2 Participation in Technical Meetings

8.4.2.1 Each Plaintiff and Whittaker and AISLIC shall designate one or more representative(s) to participate in Technical Meetings in furtherance of planning, development, design, permitting, construction, installation, operation and management of the Project and the Q2 Treatment System, and the planning, development, design, permitting, construction, and installation of the Distribution Pipelines and Replacement Wells & Associated Pipelines. Such meetings shall be held monthly, or more or less frequently if agreed to by all Plaintiffs and Whittaker and AISLIC, upon no less than ten (10) days written notice from Plaintiffs. After Defendants' payment of the Lump Sum as described in Section 5.2.6 and installation of the Distribution Pipelines and Replacement Wells & Associated Pipelines, such meetings will no longer be held, unless otherwise requested by Whittaker and/or AISLIC, with reasonable compensation payable to Plaintiffs as agreed by the Parties.

8.4.2.2 Except for those contracts, proposals, and/or solicitation materials listed in Exhibit T attached to this Agreement, no contract, request for proposal, solicitation of bid package or other solicitation for planning, development, design, permitting, construction or installation of the Project, the Q2 Treatment System or the Distribution Pipelines

and Replacement Wells & Associated Pipelines shall be made by any Plaintiff unless approved by Whittaker and AISLIC, or -- if disapproved by Whittaker and/or AISLIC-- approved by the Cost Consultant. Copies of any contract, request for proposal, solicitation of bid package, report or other document to be considered at any Technical Meeting held pursuant to Section 8.4.2.1 of this Agreement shall be provided to each designated representative at least ten (10) days before the meeting, unless such document or report was then not available, in which event the document or report shall be distributed as long in advance of the meeting as possible. Whittaker and AISLIC shall notify Plaintiffs as soon as possible, but in any event within ten (10) Working Days after receipt, whether they respectively approve each contract, request for proposal, solicitation of bid package or other solicitation for planning, development, design, permitting, construction or installation of the Project, the Q2 Treatment System, or the Distribution Pipelines and Replacement Wells & Associated Pipelines. Absent such timely notice, approval shall be presumed. If Whittaker and/or AISLIC gives timely notice of disapproval of any such contract, request for proposal, solicitation of bid package or other solicitation for planning, development, design, permitting, construction or installation, such notice must be accompanied by a written explanation of the reason for disapproval and, if possible, a proposed revision that is approved.

8.4.2.3 Whittaker's and/or AISLIC's disapproval of any contract, request for proposal, solicitation of bid package or other solicitation for planning, development, design, permitting, construction or installation of the Project, the Q2 Treatment System, or the Distribution Pipelines and Replacement Wells & Associated Pipelines will be subject to binding arbitration, pursuant to Article 7 of this Agreement. The arbitration shall be conducted by the Cost Consultant. Within fifteen (15) Days after Whittaker and/or AISLIC's timely notice of disapproval of any contract, request for proposal, solicitation of bid package or other solicitation

for planning, development, design, permitting, construction or installation of the Project, the Q2 Treatment System, or the Distribution Pipelines and Replacement Wells & Associated Pipelines, Whittaker and/or AISLIC may demand such expedited arbitration. Any such demand, accompanied by all materials that Whittaker and/or AISLIC considers necessary for resolution of the dispute, shall be served on Plaintiffs within that fifteen (15) day period. By the end of the tenth day after their receipt of such a demand for arbitration, Plaintiffs may submit to the Cost Consultant and, if so, shall serve upon Whittaker and AISLIC, all materials that Plaintiffs consider necessary for resolution of the dispute. The Cost Consultant may request further information from the Parties and AISLIC or schedule an arbitration hearing date (in-person or by telephone conference) and shall render a decision within twenty (20) days after delivery of the demand for arbitration or, if an arbitration hearing is conducted, within ten (10) days of the conclusion of the arbitration hearing, or at such later time as may be agreed by the parties to the dispute and the Cost Consultant. If Whittaker and/or AISLIC does not timely demand arbitration, its disapproval shall be deemed waived.

8.4.2.4 Plaintiffs shall make available to Whittaker, AISLIC and Steadfast (i) copies of all notices, documents and other written communications (including, without limitation, drafts and revisions) concerning planning, development, design, permitting, construction or installation of the Project or the Q2 Treatment System sent by Plaintiffs or their consultants to DTSC, DHS, Regional Water Quality Control Board ("**RWQCB**"), California Public Utilities Commission ("**CPUC**"), U.S. Environmental Protection Agency ("**EPA**") and/or any other regulatory agency with jurisdiction at the same time and by the same manner of delivery by which such notices, documents or other written communications are sent; and (ii) promptly following receipt, all notices, documents and other written communications concerning

planning, development, design, permitting, construction or installation of the Project or the Q2 Treatment System received by Plaintiffs or their consultants from DTSC, DHS, RWQCB, CPUC, EPA and/or any other regulatory agency with jurisdiction. Plaintiffs shall additionally make all of such information available upon request to SCLLC, RFI, or if the sale has closed, to the Buyer.

8.4.2.5 Whittaker shall make available to Plaintiffs, AISLIC and Steadfast copies of all public or non-public and non-confidential notices, reports, documents and other written communications to or from Whittaker and DTSC, DHS, RWQCB, EPA and the Buyer (with the Buyer's consent) concerning the Site and groundwater remediation activities and obligations, at the same time and by the same manner of delivery by which such notices, documents or other written communications are sent, or promptly upon receipt by Whittaker.

8.5 Audits

Whittaker and/ or AISLIC may, upon reasonable notice and no more frequently than once a year, audit Plaintiffs' Records, including all invoices and supporting documentation for Project expenditures. The costs of any such audit shall be paid by the requesting party. Any dispute arising from an audit shall be resolved by the arbitrator designated pursuant to Section 13.2.2. Whittaker and/or AISLIC may demand arbitration of such a dispute within thirty (30) Days after receipt of the audit report triggering the dispute. Failure to demand arbitration within that time period shall be a waiver of any dispute triggered by the audit report.

ARTICLE 9. PROJECT MODIFICATION

9.1 Project Modification

9.1.1 The Parties acknowledge that the effectiveness of the remedy contemplated by the Project is not guaranteed by the Plaintiffs, although the Parties believe that the implementation of the Project represents a reasonable approach to providing containment of

perchlorate as defined below and restoring water production. In the event that within the first three (3) years after Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage), a modification of the Project relating to perchlorate remediation is required (1) because of any regulatory requirement or directive or court order; (2) because of a change in water quality standards or regulations; (3) because of an increase in concentration levels of perchlorate in the Subject Wells; (4) to achieve containment of downgradient perchlorate migration; (5) to restore the contemplated capability of the Project to provide water for potable purposes; or (6) to improve Project efficiency or cost effectiveness, Plaintiffs, Whittaker, and/or AISLIC may develop and implement the necessary modification of the Project ("**Project Modification**") in accordance with this Article 9. Any Project Modification will be funded separately from and is not included in the amounts deposited into the Project Capital Costs Escrow Account as described in Section 1.56. For the purposes of this Agreement, containment is achieved when groundwater monitoring and modeling demonstrates (subject to agreement by representatives of Plaintiffs, Whittaker and AISLIC at the monthly Technical Meetings or there is a determination by the Cost Consultant) that hydraulic control of Saugus Formation groundwater in the vicinity of Saugus 1 and 2 is such that future perchlorate migration from the Site in the Saugus Formation will not result in impacts to existing Saugus Formation production wells identified in Exhibit U above an applicable Notification Level or Maximum Contaminant Level ("MCL"). The groundwater modeling and evaluation of containment will also consider other contaminant mass removal and contaminant containment measures implemented on and in the vicinity of the Site.

9.1.2 Promptly upon the occurrence of any of the circumstances described in Section 9.1.1, above, Plaintiffs may provide Whittaker, AISLIC and Steadfast with written

notification of the need for a Project Modification (**"Project Modification Notice"**), with a proposal for the required modification and/or a procedure for developing, implementing and funding such a modification, and the Plaintiffs, Whittaker and AISLIC shall exercise their best efforts to develop an appropriate and mutually acceptable Project Modification. Any proposed Project Modification shall incorporate the use of best available, cost efficient and effective technology upon consultation with the technical representatives of Whittaker and AISLIC. If, within 60 days after the receipt of the Project Modification Notice, the Plaintiffs, Whittaker and AISLIC are unable to agree upon a Project Modification, Plaintiffs may demand arbitration. In that event, the matter will be resolved by the Cost Consultant in accordance with Article 7.

9.1.3 In addition to the foregoing, within the first three (3) years after Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage), Whittaker or AISLIC may propose a Project Modification based upon the occurrence of any of the circumstances described in Section 9.1.1 above, and deliver the proposal, including all appropriate documentation, to the other Parties for consideration at the next Technical Meeting. If the Plaintiffs, Whittaker and AISLIC are unable to agree on the proposed Project Modification within 60 days after delivery of the proposal and documentation, the proposing party may demand arbitration. In that event, the matter will be resolved by the Cost Consultant in accordance with Article 7.

9.1.4 Following the first three (3) years after Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of remedy stoppage requiring Project Modification), and prior to determination of a Lump Sum pursuant to Section 5.2.6, Whittaker or AISLIC may propose a Project Modification and deliver the proposal, including all appropriate documentation, to the other Parties for consideration at the

next Technical Meeting, if Whittaker or AISLIC are willing to pay for the capital costs and O&M costs associated with such Project Modification. If the Parties are unable to agree on the proposed Project Modification within 60 days after delivery of the proposal and documentation, the matter will be resolved by arbitration in accordance with Article 7.

9.1.5 Following the first three (3) years after Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage, and prior to determination of a Lump Sum pursuant to Section 5.2.6, Plaintiffs may propose a Project Modification and deliver the proposal, including all appropriate documentation, to the other Parties for consideration at the next Technical Meeting, if Plaintiffs are willing to pay for the capital costs associated with such Project Modification. Defendants, subject to Section 2.5, will retain the obligation to pay Project O&M Costs, including any increase in such costs resulting from the Project Modification. If the Parties are unable to agree on the proposed Project Modification within 60 days after delivery of the proposal and documentation, the matter will be resolved by arbitration in accordance with Article 7.

9.1.6 Funding By Defendants

Once a Project Modification has been agreed upon or resolved by arbitration, the Project Modification shall become incorporated in the Project, and shall be handled in all respects as a part of the Project, with Defendants obligated on a joint and several basis subject to Section 2.5 to pay for all reasonable and necessary Project Capital Costs and Project O&M Costs associated with the Project Modification, including costs of replacement water in the event of a Remedy Stoppage within the first three years after Commencement of Operation of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage). This Project Modification funding obligation for Project Capital Costs is in addition to the obligation

for funding Project Capital Costs as defined in Section 1.5.4, for which an amount of ten million dollars ($10,000,000) has been allocated. In the event that a modification of the Project is required or desired after the first three (3) years following Commencement of Operations of the Project (which time period will be tolled during any period in excess of one week of Remedy Stoppage), Plaintiffs will bear all Project Capital Costs associated with the Project Modification, except for Project Modifications proposed by Whittaker or AISLIC pursuant to Section 9.1.4. Any increase in O&M costs resulting from such Project Modification will be included in Project O&M Costs required to be paid by Defendants pursuant to the applicable provisions of this Agreement.

9.1.7 Newhall County Well NC13

9.1.7.1 Notwithstanding any other provisions of this Agreement, the provisions of this Section shall govern matters relating to Newhall County Well NC13 in the event of any conflict.

9.1.7.2 The Parties recognize that perchlorate contamination reportedly found in Newhall County Well NC13 may require well-head or equivalent treatment, or well replacement, in the future. If NCWD reasonably believes that well-head or equivalent treatment or replacement of Newhall County Well NC13 is in fact required, then such proposed measures may, in NCWD's sole discretion, be treated as a request for a Project Modification subject to the provisions of Section 9.1.2, even if the proposal is not made until later than three (3) years after Commencement of Operations of the Project; provided, however, that Whittaker and AISLIC retain expressly all rights under the Project Modification provisions of Article 9, including the right to object based on the cost-ineffectiveness of the proposal or on other grounds, and provided that the proposal shall not be treated as a Project Modification unless it is made no later

than July 1, 2017. The funding by Defendants of a Project Modification pursuant to this Section shall include capital costs even if it does not occur until later than three (3) years after Commencement of Operations of the Project.

9.1.7.3 If NCWD seeks and obtains a Project Modification with respect to NC13, then NC13 shall be treated as a Subject Well; however, unless and until NCWD obtains a Project Modification with respect to NC13, it shall not be deemed a Subject Well and there shall be no release of any liability in connection therewith.

9.1.7.4 Any Lump Sum Arbitration conducted at a time when NC13 is not part of a Project Modification shall have no impact on the obligations created in this Section. If NC13 is a Project Modification and is undergoing well head or equivalent treatment at the time a Lump Sum Arbitration for Saugus 1 and 2 Treatment Plant Operations and Maintenance is conducted, the Lump Sum Arbitration shall also determine a separate lump sum for the operation and maintenance of NC13 for the remainder of the up to thirty (30) year period after the commencement of well-head or equivalent treatment at NC13, deducting that portion of the Lump Sum determined for Saugus 1 and 2 Treatment Plant Operations and Maintenance costs allocable to NC13 from such separate lump sum to the extent NC13 is being treated through the Saugus 1 and 2 Treatment Plant.

9.1.7.5 In the event that NC13 becomes a Project Modification after a Lump Sum Arbitration for Saugus 1 and 2 Treatment Plant Operations and Maintenance costs has occurred, the obligation to pay for Project Modification costs shall continue for a period of up to thirty (30) years after the commencement of well-head or equivalent treatment at NC13, unless, beginning three (3) years after such Project Modification, Plaintiffs, Whittaker, or AISLIC, demand binding arbitration as provided in Article 13 of this Agreement and consistent

with this Section, to determine a lump sum payment of NC13 operation and maintenance costs for the remainder of the up to thirty (30) year period.

9.1.7.6 Prior to NC13 becoming a Project Modification, Plaintiffs' rights under the Rapid Response Fund will not be impaired.

ARTICLE 10. DISPUTES REGARDING POSSIBLE FUTURE PERCHLORATE CONTAMINATION

10.1 Process for Addressing Possible Future Perchlorate Contamination

The Parties acknowledge that the remedy contemplated by the Project and Distribution Pipelines, the Q2 Treatment System, and the Replacement Wells and Associated Pipelines does not specifically address possible future impacts of perchlorate on wells other than the Subject Wells.

10.1.1 In the event that there is detection of perchlorate contamination confirmed by subsequent sample above the Notification Level or MCL that affects water production from Presently Existing Saugus Production Wells or Alluvial Wells, other than one of the Subject Wells (hereinafter referred to as a "**Non-Subject Well Future Perchlorate Circumstance**" or "**Circumstance**"), one or more of the affected Plaintiffs shall provide written notice to all other Parties that a Non-Subject Well Future Perchlorate Circumstance exists. Such written notice shall include the facts relevant to such Circumstance, as well as documents relevant to such Circumstance, and shall specify whether any action, payment, or relief is being demanded. The sender of the Notice shall provide such other and further information and documentation, and updates regarding the Circumstance, as may be reasonably appropriate. In the event that an action, payment, or other relief is being demanded of Whittaker, Whittaker shall, within fifteen (15) days of receipt of the Notice, forward such Notice to AISLIC seeking a determination of coverage with respect to such demand, if Whittaker believes that coverage exists for such

demand. In its letter to AISLIC requesting a determination of coverage, and thereafter, Whittaker shall provide to AISLIC all information and documents relating to the Circumstance as have been provided to Whittaker, and Whittaker shall request that AISLIC provide a determination of coverage as soon as possible, and AISLIC shall respond no later than sixty (60) days following AISLIC's receipt of information and documents reasonably necessary to make a coverage determination. In the event that an action, payment, or other relief is being requested, the sender of the Notice shall meet and confer in good faith with such Party that is a subject of the Notice and, as appropriate, its insurers, to attempt to negotiate a resolution of the issues presented by the Circumstance. In the event that after 90 days from the date of receipt of the Notice (the "**Notice Period**"), the issues presented in the Notice are not resolved through such meeting or meetings, then any Plaintiff may elect to initiate the arbitration process for Future Perchlorate Contamination Disputes under Section 13.3.2.1 of this Agreement, provided that the AISLIC Future Perchlorate Determination of Coverage has been received by Whittaker, and Whittaker satisfies itself, at its discretion exercised in good faith, that AISLIC's determination of coverage is acceptable to allow the arbitration to go forward. Whittaker shall notify such Party and AISLIC in writing of Whittaker's decision within 15 days of receiving AISLIC's determination of coverage. If Whittaker provides such notice indicating that AISLIC's determination of coverage is not acceptable to Whittaker, or if AISLIC fails to provide any determination of coverage within the requisite sixty (60) period, then no Plaintiff may elect to initiate the arbitration process.. Where arbitration may be initiated hereunder and a Plaintiff elects to initiate the arbitration process, said Future Perchlorate Contamination Dispute will be resolved through the procedures for Future Perchlorate Contamination Disputes set forth in Section 13.3 of this Agreement.

10.1.2 Unless arbitration may be initiated pursuant to Section 10.1.1 above, and a Plaintiff elects in its sole discretion to initiate the arbitration process pursuant to Section 13.3.2.1 with respect to a Future Perchlorate Contamination Dispute, such dispute will not be subject to the procedures set forth in Section 13.3 and may instead be heard in its entirety by a court of competent jurisdiction.

10.1.3 Except as provided herein, each Party agrees that execution of this Agreement shall constitute their respective consents to jurisdiction of the Federal District Court, Central District of California, or the Superior Court of the County of Los Angeles with regard to Future Perchlorate Contamination Disputes. Notwithstanding the foregoing, the venue for any action against the Debtors, or the reorganized Debtors pursuant to a plan of reorganization approved by the Bankruptcy Court, shall be the Bankruptcy Court to the fullest extent that the Bankruptcy Court has subject matter jurisdiction over such action.

10.1.4 Notwithstanding the foregoing, in the event that Plaintiffs have obtained funds from the Rapid Response Fund pursuant to Section 11.2 to address a Circumstance as defined herein, any disputes over the use of the Rapid Response Fund for the Circumstance for which arbitration is initiated under Section 10.1.1 will be handled in accordance with Section 13.3.

ARTICLE 11. PROJECT INSURANCE; RAPID RESPONSE FUND

11.1 Project Insurance

11.1.1 Plaintiffs shall obtain and maintain in force the following policies of insurance for the Project or obtain additional insured status on policies offered by the Resin Service Contract Vendor throughout the first thirty years of operation of the Project (including any renewals with same or substantially similar coverage):

- a comprehensive general liability policy of insurance, including contractual liability, in substantially the form of Exhibit V to this Agreement (the "**CGL Policy**");
- an Environmental Impairment Liability policy in substantially the form of Exhibit W to this Agreement (the "**EIL Policy**") if obtainable for a commercially reasonable premium as agreed by the Parties and AISLIC or determined by the Cost Consultant;
- an earthquake policy of insurance in substantially the form of Exhibit X to this Agreement (the "**Earthquake Policy**")
- a First-Party Property Insurance policy in substantially the form of Exhibit Y to this Agreement (the **"Property Policy"**).

The CGL Policy, the EIL Policy, the Earthquake Policy and the Property Policy must be obtained by Plaintiffs with Plaintiffs and, other than the Earthquake and Property Policies, Defendants and the Buyer, identified as named insureds or additional insureds, and with coverages, policy limits, and deductibles or self-insured retentions as set forth on Exhibits V, W, X, and Y or as provided on substantially similar coverage, or alternatively, as provided on less expensive similar insurance offered through the Resin Service Contract Vendor. In the event that the Resin Service Contract Vendor is retained to provide operations and maintenance Labor for the Project, no cost of EIL coverage shall be paid by Defendants as Project O&M Costs or otherwise, so long as EIL coverage substantially similar to Exhibit W is provided to Plaintiffs by the Resin Service Contract Vendor.

11.1.2 Incremental costs of the Project Insurance coverage, in excess of the Plaintiffs' non-Project costs of such coverage, will constitute Project O&M Costs.

11.1.3 Duties of Named Insureds

11.1.3.1 Each Party that is named as an insured or additional insured under the CGL Policy, the EIL Policy, or substitute insurance obtained through Resin Service Contract Vendor, Earthquake Policy and Property Policy, shall perform its duties as an insured as set forth in each such policy of insurance.

11.1.3.2 No Party that is named as an insured or additional insured under the CGL Policy or EIL Policy shall act on behalf of any other Party also insured under said insurance policies with respect to (a) giving or receiving of notice of cancellation; or (b) receipt or acceptance of any endorsement issued to or for a part of any of said insurance policies. No Party insured under the CGL Policy or EIL Policy shall cancel, or assign the right to cancel, any of said policies without first obtaining the written consent of all other Parties, which shall not be unreasonably withheld.

11.1.4 The Parties agree not to make a claim against Plaintiffs, Whittaker, AISLIC, the Buyer, Debtors, Steadfast, or SF Escrow 1 or SF Escrow 2 for any sums paid by any insurance policy referenced in this Article 11. The insurance obtained pursuant to this Article 11 shall contain a waiver of subrogation against Plaintiffs, Whittaker, AISLIC, the Buyer, Debtors, Steadfast, and SF Escrow 1 and SF Escrow 2.

11.2 Rapid Response Fund

11.2.1 The Parties acknowledge that the remedy contemplated by the Project and Q2 Treatment System may not effectively contain downgradient movement immediately of perchlorate contamination in the Alluvial Aquifer or portions of the Saugus Formation. Accordingly, Plaintiffs may submit to AISLIC and AISLIC shall process and pay, as soon as practicable from the SF Escrow 1 Account in accordance with this Section 11.2 and the

Coverage and Claims Settlement Agreement, costs incurred to respond on an expedited basis to perchlorate contamination that is confirmed to be present by subsequent sampling, with split samples to be provided to Defendants, in concentrations exceeding the applicable Notification Level or MCL, in VWC wells N, N-7, N-8, S6, S7, S8, 201, and 205, and NCWD wells NC-10, NC-12 and/or NC-13 (the **"Threatened Wells"**) up to a total amount of ten million dollars ($10,000,000) (the **"Rapid Response Fund"**). Plaintiffs shall be entitled to seek such payment and/or reimbursement only for the period ending July 1, 2017.

11.2.2 Pending agreement between Plaintiffs, Whittaker and AISLIC, or a final determination of the appropriate remedy and amounts payable, allowable uses of the Rapid Response Fund by Plaintiffs include, (a) the additional costs of providing consumers with water from alternative water sources ("**Replacement Water**"), if and to the extent that Replacement Water is necessary and not otherwise available, from existing sources without negative impact to Plaintiffs or any of them, and (b) any costs for rental equipment and resin, including the costs of operating and maintaining leased treatment equipment, or for associated site acquisition, preparation and installation costs. Capital Costs for purchase of capital equipment or permanent capital improvements, and operations and maintenance costs associated with purchased capital equipment or permanent capital improvements, are not allowable uses of the Rapid Response Funds absent later agreement by both AISLIC and Whittaker on a case by case basis.

11.2.3 The Rapid Response Fund obligation will be paid from the funds maintained in the SF Escrow 1 Account. The Defendants and AISLIC agree, and the Defendants represent and warrant that they have obtained the agreement of the "Zurich Parties" and the "AISLIC Parties" (as defined in the Coverage and Claims Settlement Agreement) that

the funding of the Rapid Response Fund from the SF Escrow 1 Account falls within the Uses of SF Escrow 1 Funds, Section IV.F.5.a.(i) of the Coverage and Claims Settlement Agreement.

11.2.4 To obtain payment and/or reimbursement from the Rapid Response Fund, Plaintiffs must directly tender their written request(s) for payment for a ninety day period of time, along with a sworn statement describing the need for specified funds due to confirmed perchlorate contamination in concentrations exceeding the applicable Notification Level or MCL in one or more of the Threatened Wells, and identifying the last date, if any, that the Well for which funding is sought may have been disinfected and the product or solution that may have been used, to AISLIC, with courtesy copies to Defendants. All written requests for payment shall state the need for said specified funds within a ninety day period. Any request for additional ninety day funding shall require a new written request for payment accompanied by a new supporting statement as described above and supporting cost documentation. Within fifteen (15) days of receipt of such written request and sworn statement, AISLIC will instruct Wells Fargo Bank or other agreed bank to make payment of the required Rapid Response Funds to Plaintiffs from the SF Escrow 1 Account.

11.2.5 In the event that the SF Escrow 1 Account Terminates (as defined in Section 5 of the SF Escrow 1 Instructions) prior to the expiration of the time period described in Section 11.2.1 above and in the further event that the $10,000,000 Rapid Response Funds have not been fully paid, the AISLIC Policy Coverages A-F, to the extent that limits remain thereunder, will be available to Whittaker to provide Plaintiffs with a rapid response for the remainder of the time period described in Section 11.2.1 above for the remaining unpaid amount of the agreed $10,000,000 in Rapid Response Funds. In the aforementioned circumstances, Plaintiffs must directly submit their written request(s) for payment for a ninety day period of

time, along with a sworn statement describing the need for specified funds due to confirmed perchlorate contamination in concentrations exceeding the applicable Notification Level or MCL in one or more of the Threatened Wells as described in Section 11.2.4, to Whittaker, with courtesy copies to AISLIC. Within seven (7) Working Days of receipt of such written request and sworn statement, Whittaker, in turn, shall submit a claim pursuant to this Agreement to AISLIC under Coverages A-F for the aforementioned Rapid Response Funds, and Whittaker's payment shall be due within twenty-eight (28) Working Days of receipt of Plaintiff's written request to the extent that limits remain under AISLIC Policy Coverages A-F. Upon receipt of said claim from Whittaker ("Whittaker Rapid Response Claim") and provided that the CLWA Plaintiffs have provided a written request and sworn statement to Whittaker pursuant to and in accordance with Section 11.2 "Rapid Response Fund" of this Agreement, AISLIC shall: (1) treat any Whittaker Rapid Response Claim as a covered claim under AISLIC Policy Coverages A, B, C, D, E, or F, and respond to said claim pursuant to the terms of the AISLIC Policy Coverages A-F and without reservation of coverage rights to the extent that limits remain under AISLIC Policy Coverages A-F, but with reservation of AISLIC's rights, to the full extent of the rights set forth herein (a) to assert disputes, claims or controversies under this Agreement and (b) to assert all of Whittaker's substantive defenses to payment of Rapid Response Funds as provided in this Agreement and (2) make payment on Whittaker's Rapid Response Claim to CLWA Plaintiffs on behalf of Whittaker within twenty one (21) Working Days of AISLIC's receipt of a Whittaker Rapid Response Claim that is fully compliant with Section 11.2 of the Castaic Lake Water Agency Litigation Settlement to the extent that limits remain under AISLIC Policy Coverages A-F. Nothing in this Section 11.2.5 of this Agreement is intended or shall be construed to be agreement as to which Coverage(s) (i.e., A, B, C, D, E, or F) apply to Whittaker's Rapid

Response Claim(s). This Section 11.2.5 is unique and specific to Whittaker's Rapid Response obligation and nothing in this Section 11.2.5 is intended to be or shall be of precedential value or construed to be agreement as to treatment or handling of any other current or future claims that Whittaker may assert under or Plaintiffs may assert with respect to the AISLIC Policy.

11.2.6 Any dispute, claim or controversy concerning payment of costs or losses under this Section, including any disputes as to the reasonableness and necessity of said costs, will be resolved by expedited binding arbitration in accordance with Section 13.2 or Section 13.3, as appropriate.

11.2.7 This Rapid Response Fund remedy is in addition to any remedy otherwise available to Plaintiffs at law or in equity, or pursuant to this Agreement, provided that Plaintiffs will not seek duplicate recovery from Defendants or their insurers or AISLIC or SF Escrow 1 for any losses, costs, expenses, or damages paid by the Rapid Response Funds. Defendants and their insurers reserve all defenses they may have with respect to payment of Rapid Response Funds, including but not limited to the defense that Plaintiffs' disinfection or other operation and maintenance procedures carried out after the Effective Date hereof have contributed to or caused the perchlorate detection and the defense that Defendants are not otherwise legally or factually responsible or liable for the perchlorate contamination. In the event that Rapid Response Funds are determined by binding arbitration to have been improperly requested by or paid to Plaintiffs in whole or in part based upon defenses the Defendants or their insurers or AISLIC may have with respect to payment of Rapid Response Funds, Plaintiffs shall be required to reimburse those funds in whole or in part to the SF Escrow 1 or the AISLIC Coverages A-F limits, as appropriate, which Escrow and/or Policy shall be replenished to the extent of the reimbursement.

ARTICLE 12. RELEASES AND DISMISSAL OF UNDERLYING ACTION

12.1 Plaintiffs' Releases

12.1.1 In consideration of Defendants' payments, promises, and covenants herein, including funding provided by or on behalf of Defendants pursuant to the Coverage and Claims Settlement Agreement and the Related Settlement, each Plaintiff, on behalf of itself and its predecessors, successors and assigns, hereby forever releases, acquits and forever discharges Whittaker and its insurers (including but not limited to AISLIC, The Insurance Company of the State of Pennsylvania ("ISOP"), and Steadfast), SCLLC, RFI, RFI Realty, BRLLC, the Buyer, and Steadfast Santa Clarita Holdings, LLC (**"SSCH"**), and their respective officers, directors, shareholders, members, employees, agents, representatives, contractors, reinsurers, consultants, subsidiaries, affiliates, predecessors, successors and assigns from any and all actions, causes of action, claims, demands, liabilities, damages, penalties, fines, debts, losses, costs, expenses and fees (including, without limitation, litigation costs and attorney and consultant fees) of every kind and nature whatsoever, in law and in equity, whether known or unknown, suspected or unsuspected, foreseen or unforeseen, arising out of or relating to the past, present or future detection of perchlorate in the Subject Wells, (except for claims addressed in Section 12.1.2 and Section 12.1.3 which are not released in this Section 12.1.1) including (without limitation) all claims for past and future purchase of replacement water as a result of the detection of perchlorate in the Subject Wells (except for the costs of providing consumers with water from alternative water sources during the first three years after Project operations commence if there is a Remedy Stoppage during said time period), all Plaintiffs' Past Environmental Claims, all Plaintiffs' Past Design Costs Claims, all Plaintiffs' claims relating to the V-206 Replacement Well, including, but not limited to, construction and installation of VWC's well V-206 and associated pipelines, and permanent closure and abandonment of VWC's well V-157, all claims

with respect to the Capital Costs for Q2, and all claims for past or future response costs and other costs incurred as a result of perchlorate detection in the Subject Wells, including attorneys' and consultants' fees and costs. However, excluded from the release provided in this section are any claims or causes of action arising out of or relating to any future claims, causes of action, suits, legal or administrative proceedings by third parties (or by Defendants where the proceeding is initiated by a third party) against Plaintiffs for actual bodily injury, property damage or response costs allegedly suffered or incurred by such third-parties, including but not limited to any and all third party claims, causes of action, suits, legal or administrative proceedings against Plaintiffs and any resulting damages, losses, penalties, fines or liabilities , after the Effective Date arising out of or related to alleged exposure to or release of perchlorate or other chemicals caused by Plaintiffs' operation of the Project, (collectively, **"Third Party Claims"**) but not excluding any Third Party Claims resulting from the Plaintiffs' negligence or willful misconduct in operation of the Project. Plaintiffs represent and warrant that, as of the Effective Date of this Agreement, they are not aware of any Third Party Claims brought against any of them. The releases provided in this Section 12.1.1 shall be effective upon payment of all funds required to be paid within thirty (30) days after the Effective Date of this Agreement..

12.1.2 Release For Costs Applied Against Escrows. Upon each payment from the Escrow Accounts for Project Capital and O&M Costs, Q2 O&M Costs, and Replacement Wells/Distribution Pipeline Capital Costs (and following any adjustment for a disputed item), and upon each payment of Rapid Response Funds from the SF Escrow 1 Account or the AISLIC Policy, as applicable, each Plaintiff, on behalf of itself and its predecessors, successors and assigns, hereby forever releases, acquits and forever discharges Whittaker and its insurers (including but not limited to AISLIC, ISOP and Steadfast), SCLLC, RFI, RFI Realty, BRLLC,

the Buyer, and SSCH, and their respective officers, directors, shareholders, members, employees, agents, representatives, contractors, reinsurers, consultants, subsidiaries, affiliates, predecessors, successors and assigns from any and all actions, causes of action, claims, demands, liabilities, damages, penalties, debts, losses, costs, expenses and fees (including, without limitation, litigation costs and attorney and consultant fees) of every kind and nature whatsoever, in law and in equity, in connection with the Project, the Q2 Treatment System, the Replacement Wells and the Distribution Pipelines, and the Rapid Response Funds, but only to the extent of such payment.

12.1.3 As to Project O&M Costs, and subject to Section 9.1.7 hereof, upon the sooner of payment by Defendants of a Lump Sum determined by arbitration pursuant to Section 5.2.6 hereinabove or of payment of all Project O&M pursuant to Article 5, each Plaintiff, on behalf of itself and its predecessors, successors and assigns, hereby forever releases, acquits and forever discharges Whittaker and its insurers (including but not limited to AISLIC, ISOP and Steadfast), SCLLC, RFI, RFI Realty, BRLLC, the Buyer, and SSCH and their respective officers, directors, shareholders, employees, agents, representatives, contractors, reinsurers consultants, subsidiaries, affiliates, predecessors, successors and assigns from any and all actions, causes of action, claims, demands, liabilities, damages, penalties, debts, losses, costs, expenses and fees (including, without limitation, litigation costs and attorney and consultant fees) of every kind and nature whatsoever, in law and in equity, in connection with the Project. The releases provided in this Section 12.1.3 exclude any Third Party Claims arising after the Effective Date related to alleged exposure to or release of perchlorate or other chemicals caused by Plaintiffs' operation of the Project, other than Third Party Claims resulting from the Plaintiffs' negligence or willful misconduct in operation of the Project.

12.1.4 Plaintiffs agree that the Steadfast PLC policy no. PLC 3598792-00 issued by Steadfast to Defendants has been exhausted by Steadfast's deposit into the SF Escrow 1 Account and the SF Escrow 2 Account of the remaining limits of this pollution liability coverage (**"Steadfast PLC Policy"**) insurance policy, with Plaintiffs waiving any and all purported rights and claims they have or may have against such PLC Policy. Plaintiffs waive and release any and all purported rights and claims they have or may have against the Steadfast EOC policy no. 3554336.

12.1.5 Each of the Plaintiffs has filed a proof of claim in each of the Bankruptcy Cases in which RFI and SCLLC are the debtors asserting the liquidated and unliquidated claims alleged by them against RFI and SCLLC in the Underlying Action (**"Proofs of Claim"**). In place of the Proofs of Claim, Plaintiffs shall have a single allowed claim against the Debtors, and each of them, in the Bankruptcy Cases in an amount equal to the obligations of Debtors pursuant to this Agreement (**"Allowed Claim"**) and the Final Approval Order shall so provide. Except to the extent that certain funds in SF Escrow 1 will be paid on behalf of Defendants to Plaintiffs and to fund escrow accounts for the benefit of Plaintiffs pursuant to this Agreement, and the Coverage and Claims Settlement Agreement, Plaintiffs waive any right to any payment or distribution of assets, property or funds of the estates of the Debtors in the Bankruptcy Cases by reason of their Allowed Claim and such Proofs of Claim shall be deemed satisfied by the consideration furnished by Debtors pursuant to this Agreement. Plaintiffs further agree that, notwithstanding any other provision of this Agreement, their sole recourse against the Debtors and any reorganized Debtors pursuant to a plan of reorganization approved by the Bankruptcy Court, for any and all actions, causes of action, claims, demands, liabilities, damages, penalties, debts, losses, costs, expenses and fees (including, without limitation, litigation costs and attorney

and consultant fees) of every kind and nature whatsoever, in law and in equity against the Debtors shall be the SF Escrow 1 Account.

12.1.6 Plaintiffs agree that this Settlement does not compromise, release, diminish or adversely affect the rights of Debtors or their successors in interest to enforce obligations, if any, of SCWC and/or NCWD to provide water to the Property pursuant to the documents attached collectively as Exhibit Z.

12.1.7 Plaintiffs agree that: (i) the Steadfast PLC Policy is released by all such Plaintiffs such that no Plaintiff can assert any claim against the Steadfast PLC Policy; and (ii) the Steadfast EOC Policy is released by all such Plaintiffs such that no Plaintiff can assert any claim against the Steadfast EOC Policy.

12.2 Bankruptcy Releases.

Debtors, acting on behalf of themselves and on behalf of each of their bankruptcy estates, shall release the Plaintiffs from any and all claims, obligations, causes of action and liabilities (i) under any of sections 542, 544, 545, 547, 548, 549, or 553 of the Bankruptcy Code to avoid any alleged transfer to or seek turnover from a Plaintiff, (ii) under section 550 of the Bankruptcy Code to recovery any such alleged transfer, (iii) under section 510(c) of the Bankruptcy Code to subordinate any claim of a Plaintiff, and (iv) under Section 502(d) or 502(j) of the Bankruptcy Code.

12.3 Civil Code Section 1542

12.3.1 The Parties to this Agreement have read and fully understand the statutory language of Section 1542 of the Civil Code of State of California ("Section 1542"), which reads as follows: "A general release does not extend to claims which the creditor does not know or

suspect to exist in his favor at the time of executing the release, which if known by him must have materially affected his settlement with the debtor."

12.3.2 As to the releases given in Section 12.1 and 12.2, each Party hereto acknowledges that it may hereafter discover facts different from, or in addition to, the facts which it now knows or believes to be true with respect to the perchlorate groundwater contamination in the area of the Site or Subject Wells, and that it is each Party's intention to specifically waive and relinquish any and all protections, privileges, rights and benefits under Section 1542 as to the claims to be specifically released under Sections 12.1 and 12.2.

12.4 Dismissal of Underlying Action

Within forty-five (45) Days after the Effective Date, and provided that the Defendants have paid to Plaintiffs the full amount required to be paid within thirty (30) days after the Effective Date of this Agreement, the Plaintiffs shall file a request for dismissal, with prejudice to the extent expressly released herein and otherwise without prejudice, of the claims asserted in the Underlying Action and, thereafter, shall do whatever is required to effectuate such dismissal.

12.4.1 With respect to any claims dismissed without prejudice, the Parties agree not to assert any statute of limitation or equitable defense based on the passage of any period of time prior to, at a minimum, one year after the Effective Date of this Agreement (the "Tolled Period"). The Tolled Period will be extended automatically for an additional three years (the "Extended Period") unless a Party determines to terminate the Tolled Period at that Party's sole discretion, and provides written notice at any time within the Extended Period, of a specific date, set no earlier than ten days from the date of such written notice. Any applicable statutes of limitation or equitable defense based on the passage of time shall begin to run after four years have elapsed from the Effective Date, or after an earlier date that may be set in accordance with

the foregoing termination of the Extended Period. Notwithstanding anything in this Section, and unless the Extended Period is terminated by a Party, the Parties agree to meet and confer before the expiration of the Extended Period to consider renewal of the tolling period for up to an additional four years in accordance with California Code of Civil Procedure Section 360.5.

12.4.2 With respect to any claims Plaintiffs may allege to have with respect to or arising out of the presence of perchlorate or other hazardous substances, wastes or materials in the groundwater, soil or surface water at or in the vicinity of the Site, Plaintiffs agree to forebear from bringing any action in any court based on such claims for the Tolled Period of one year after the Effective Date of this Agreement and for any additional period of time that the Extended Period is in effect in accordance with subsection 12.4.1 (the "Forbearance Period"). The Forbearance Period shall run concurrently with the Tolling Period and any Extended Period, and the Parties may, by mutual agreement, renew the Tolling and/or Extended Periods in accordance with subsection 12.4.1. Subsections 12.4.1 and 12.4.2 expressly do not apply to any claims that may be asserted in accordance with the provisions of Section 11.2 (Rapid Response Fund), above, and any defenses thereto.

12.5 Notification Regarding Use of Well Disinfectant

Prior to performing any disinfection of any of the Subject Wells or Threatened Wells, Plaintiffs agree to provide Whittaker and AISLIC with 10 days written notice. Prior to applying any disinfecting product or solution down-hole, one water sample will be collected from the Well and analyzed for perchlorate. After all down-hole operations are completed, and prior to putting the Well back into service, one water sample will be collected and analyzed for perchlorate. In addition, one sample of the product or solution to be used for down-hole disinfection will be collected and analyzed for perchlorate. Plaintiffs further agree that in all

other respects, they will follow the American Water Works Association's "AWWA Standard For Disinfection Of Wells", dated November 1, 2003, attached hereto as Exhibit CC, and that Plaintiffs will timely provide Whittaker and AISLIC with the analytic results of the above-referenced three samplings, as well as copies of a completed Worksheet containing the information called for in the AWWA's sample Worksheet that is attached hereto as part of Exhibit CC. All three (3) samples will be tested for perchlorate using the approved United States Environmental Protection Agency (EPA) and DHS Method 314.0 and report the results using a detection limit for reporting (DLR) of 4 ppb. Plaintiffs agree to use the most current perchlorate test method and DLR approved by DHS for drinking water in the event Method 314 is revised in the future.

ARTICLE 13. DISPUTE RESOLUTION

13.1 Disputes Governed by Article 13

All disputes between Parties to this Agreement arising out of or related to this Agreement, including the interpretation, enforcement or breach of this Agreement, (excluding disputes to be decided by the Cost Consultant, which are to be resolved pursuant to Article 7), are subject to the dispute resolution procedures contained in this Article 13.

13.1.1 Procedures Applicable To All Disputes Governed by Article 13

13.1.1.1 Additional Procedural Requirements. The procedural rules of the arbitration herein shall be supplemented by any non-conflicting arbitration procedures of the Judicial Arbitration and Mediation Service (**"JAMS"**) Comprehensive Arbitration Rules & Procedures, or such other alternative dispute resolution provider as may be agreed upon by the parties to the dispute in writing, applicable to commercial arbitration and may be modified by agreement of the parties to the dispute (the "Rules"). If any provision of this Agreement conflicts with the Rules, then this Agreement shall govern.

13.1.1.2 Retention of Consultants. The arbitrator may seek the approval of the parties to the dispute to retain a consultant. The arbitrator shall provide to all parties to the dispute an explanation for the need for the consultant, the consultant's identity, hourly rate, and the estimated costs of the service. All parties to the dispute must approve the retention of the consultant and, if retention of the consultant is approved, the parties to the dispute shall share equally the costs of the consultant. The consultant's cost shall not exceed ten thousand ($10,000) without the prior written consent of the parties to the dispute.

13.2 Expedited Arbitration Procedures

13.2.1 Notice of Dispute; Good Faith Meeting; Demand for Arbitration

Any Party who perceives that a dispute has arisen which is subject to the dispute resolution procedures contained in this Article 13, other than Future Perchlorate Contamination Arbitration or Lump Sum Arbitration governed by Section 13.3 below, may give written notice of such dispute to all other Parties. The Parties shall meet to resolve the dispute within seven (7) Working Days after receipt of such written notice by the last Party to receive it. If the Parties are unable to resolve the dispute in good faith within fifteen (15) Days after receipt of such written notice by the last party to receive it, the Party that gave written notice of the dispute may initiate the arbitration procedure described below by delivery of a Demand for Arbitration to all other Parties (excluding any that no longer legally exist) no later than thirty (30) Days after receipt of the written notice of such dispute by the last party to receive it.

13.2.2 Approved Arbitrators

Disputes subject to the expedited arbitration procedure set forth in this section 13.2 shall be decided by one impartial arbitrator qualified to serve as an arbitrator. The list in Exhibit AA consists of five (5) approved arbitrators; however, on or about the third

anniversary of the effective date of this agreement, the parties shall meet and agree to a list of five arbitrators for the next three year period, and the same process shall take place on each third anniversary thereafter. The list of arbitrators may be supplemented by mutual agreement of the Parties in writing. An arbitrator shall be chosen by agreement of the parties involved in the dispute. If the parties involved in the dispute are unable to reach agreement, the one arbitrator shall be selected by each side (Defendants and AISLIC being considered one side for purposes of such strikes) striking one arbitrator from the list in succession (beginning with Plaintiffs) until only one arbitrator remains. Plaintiffs shall strike one arbitrator within two (2) Working Days of notice of the arbitration. Each successive strike shall take place within two (2) Working Days thereafter. Notice shall be given pursuant to the provisions of Section 15.4 hereof. If the list of five (5) approved arbitrators needs to be supplemented in order to assure a complete list of five (5) available arbitrators before such a selection, the parties to the dispute shall supplement the list by mutual agreement, or in the absence of such agreement, the list shall be supplemented by the Judicial Arbitration and Mediation Service ("JAMS") in Los Angeles (or a mutually agreeable substitute). If the method described above does not identify a person available to act as arbitrator for any particular dispute, the parties involved in the dispute shall use their best efforts to select an arbitrator by mutual agreement. If the parties to the dispute are unable to reach agreement, the listing process set forth by JAMS Rule 15 shall govern.

13.2.3 Expedited Arbitration

Plaintiffs and Defendants and AISLIC shall, within fifteen (15) Working Days after receipt of a Demand for Arbitration pursuant to Section 13.2.1, above, provide written statements of position to the arbitrator, with copies to the other Parties, setting forth their respective positions. Within ten (10) Working Days after receipt of such a written statement of

position, any party may provide a rebuttal to the arbitrator, with copies to the other Parties. Evidentiary hearing and oral argument of the disputed matter shall be held no earlier than fifteen (15) Working Days after delivery of the rebuttal summaries, and should be scheduled at the earliest available convenient time for the parties to the dispute and the arbitrator. The arbitrator shall render a binding written opinion, including detailed findings of fact and conclusions of law, within ten (10) Working Days after the conclusion of the evidentiary hearing and oral argument.

In any such arbitration in which the written opinion is rendered by the arbitrator prior to the arbitrator's determination of the Lump Sum pursuant to Section 5.2.6 and 13.3, the arbitrator's fees shall be a Project O&M Cost. The award by the arbitrator may include the award of reasonable attorney's fees to the prevailing party, if the arbitrator finds that there is a "prevailing" party. The arbitrator will inter alia be empowered to award response costs or damages. The arbitrator will not be empowered to award injunctive or declaratory relief or award punitive damages or determine coverage issues under the AISLIC Policy. In awarding damages resulting from a breach of the Agreement, the arbitrator may take into consideration, among other things, any disruption to the Project, lost production capacity in the Subject Wells, and costs of replacement water resulting from Defendants' breach of their funding obligations hereunder. Any arbitration award against the Debtors is subject to Section 2.5 herein. The Parties acknowledge and agree that each of the Plaintiffs, in its sole discretion, reserves the right to seek declaratory and/or injunctive relief in a state or federal court action against Defendants, notwithstanding the initiation or resolution of any arbitration proceeding under this Article 13. The Plaintiffs agree that they will refrain from pursuing any claim or lawsuit for injunctive or declaratory relief against Defendants based on the same factual circumstances, pending receipt of the arbitrator's determination. The Parties understand and agree that the record from any

arbitration will be admissible in any future claim or lawsuit by Plaintiffs against Defendants or AISLIC, or by Defendants or AISLIC against Plaintiffs, for injunctive or declaratory relief based on the same factual circumstances.

13.3 Procedures Applicable To Arbitration of Future Perchlorate Contamination Disputes And Arbitration of Lump Sum

13.3.1 Panel of Arbitrators. Future Perchlorate Contamination Disputes pursuant to Article 10 hereof and Arbitration of Lump Sum pursuant to Section 5.2.6 and 9.1.7 hereof shall be decided by a panel of three impartial arbitrators qualified to serve as arbitrators. The list in Exhibit "BB" consists of eleven (11) approved arbitrators. The list of arbitrators may be supplemented or amended by mutual agreement of the Parties in writing. An arbitration panel of three (3) shall be chosen by agreement of the parties involved in the dispute. If the parties involved in the dispute are unable to reach agreement, the panel of three (3) arbitrators shall be selected by each side striking one arbitrator from the list in succession (beginning with Plaintiffs) until only a panel of three arbitrators remains. Plaintiffs shall strike one arbitrator within five (5) Working Days of notice of the arbitration. (Defendants and AISLIC being considered one side for purposes of such strikes.) Each successive strike shall take place within two (2) Working Days thereafter. Notice shall be given pursuant to the provisions of Section 15.4 hereof. If the list of eleven (11) approved arbitrators needs to be supplemented in order to assure a complete list of eleven (11) available arbitrators before such a selection, the parties to the dispute shall supplement the list by mutual agreement, or in the absence of such agreement, the list shall be supplemented by the Judicial Arbitration and Mediation Service ("JAMS") in Los Angeles (or a mutually agreeable substitute). If the method described above, does not identify a person available to act as arbitrator for any particular dispute, the parties involved in the dispute shall

use their best efforts to select an arbitrator by mutual agreement. If the parties to the dispute are unable to reach agreement, the listing process set forth by JAMS Rule 15 shall govern.

13.3.2 Election to Arbitrate.

13.3.2.1 Future Perchlorate Contamination Disputes

If there is a dispute with respect to Future Perchlorate Contamination pursuant to Article 10 hereof, any Plaintiff may elect, in its sole discretion, to arbitrate said Future Perchlorate Contamination dispute in accordance with the provisions of Article 10 and this Section 13.3.2. A Plaintiff electing to arbitrate shall initiate the arbitration procedure described below by delivery of a Demand for Arbitration to all other Parties (excluding any that no longer legally exist) no later than thirty (30) Days either (i) after receipt of Whittaker's decision regarding an acceptable AISLIC Future Perchlorate Determination of Coverage as required by Section 10.1.1, or (ii) the expiration of the Notice Period under Section 10.1.1, whichever is later. Within fifteen (15) days of the selection or determination of the panel of arbitrators pursuant to Article 13.2.1 hereof, each party to the dispute shall submit to the arbitrators, and serve on all parties to the arbitration, a short statement of the dispute, their respective positions, and a proposed discovery and hearing schedule. The arbitrators shall be empowered to resolve all issues of law and fact relating to the dispute, including without limitation any issues relating to liability, compensatory damages, response costs and/or the nature and scope of the remedy associated with the presence of perchlorate, but shall not be empowered to award injunctive or declaratory relief. However, the arbitrators designated for any Future Perchlorate Contamination Dispute, may retain continuing jurisdiction after they render a final, binding decision to resolve any additional response cost and damage claims thereafter arising from the same, continuous or related pollution conditions that are involved in the dispute

for which they originally were designated. The Parties acknowledge and agree that each of the Plaintiffs, in its sole discretion, reserves the right to seek declaratory and/or injunctive relief in a state or federal court action against Defendants respecting any Future Perchlorate Contamination Dispute, notwithstanding the initiation or resolution of any arbitration proceeding under this Article 13. The Plaintiffs agree that they will refrain from pursuing any claim or lawsuit for injunctive or declaratory relief against Defendants based on the same factual circumstances, pending receipt of the arbitrator's determination.

13.3.2.2 Lump Sum Arbitration

If Plaintiffs, Whittaker, or AISLIC desire to initiate Lump Sum Arbitration pursuant to Section 5.2.6 and/or 9.1.7, the requesting party shall give written notice to all other Parties. The Parties shall meet and confer to resolve the dispute within fifteen (15) days after receipt of such written notice by the last Party to receive it. If the Parties are unable to resolve the dispute in good faith, the party that gave written notice of the dispute may initiate the arbitration procedure described below by delivery of a Demand for Arbitration to all other Parties (excluding any that no longer legally exist) no later than fifty (50) Days after receipt of the written notice of such dispute by the last party to receive it. Within fifteen (15) days after the selection or determination of the panel of arbitrators pursuant to Article 13.3.1 hereof, Plaintiffs, Whittaker and AISLIC shall submit to the arbitrators and serve on all parties to the arbitration a short statement of the dispute, their respective positions, and a proposed discovery and hearing schedule. The arbitrators shall be empowered to resolve all issues of fact and law relating to said Lump Sum Arbitration.

13.3.3 Preliminary Hearing. Within thirty (30) days after selection or determination of the panel of arbitrators, the arbitrators shall schedule a preliminary hearing. At

the preliminary hearing, the arbitrators shall decide any discovery and briefing issues and set dates, including a hearing date. In resolving discovery issues, the arbitrators shall consider expedition, cost effectiveness, fairness, and the needs of the Parties for adequate information with respect to the dispute.

13.3.4 Commencement of Arbitration. The arbitration hearing shall be scheduled no later than ninety (90) days after the initial preliminary hearing, unless the parties to the dispute mutually agree in writing to extend the date or the arbitrators extend the date.

13.3.5 Decision of Panel Of Arbitrators Final. The arbitrators shall make a written decision, specifying the reasons for the decision, including detailed findings of fact and conclusions of law, within sixty (60) days after the hearing. The decision of at least two (2) of the three (3) panel members shall be binding and final, and there shall be no right to appeal the decision; provided, however, any party to the dispute may seek vacation or correction of the Panel's decision pursuant to California Code of Civil Procedure Section 1286.2 (Grounds for vacation of award) or Section 1286.6 (Grounds for correction of award). Plaintiffs and Defendants, each collectively, shall equally share the expense of the three arbitrators and the arbitration proceeding. The arbitrators will be empowered *inter alia* to award response costs and damages. The arbitrators will not be empowered to award injunctive or declaratory relief or award punitive damages or determine coverage issues under the AISLIC Policy. Any arbitration award against the Debtors is subject to Section 2.5 herein. The Parties understand and agree that the record from any arbitration will be admissible in any future claim or lawsuit by Plaintiffs against Defendants for injunctive or declaratory relief based on the same factual circumstances.

13.3.6 Time Period to Complete Arbitration. The arbitration shall be completed within one hundred fifty (150) days of the preliminary hearing, unless the parties to the dispute mutually agree in writing to extend the date or the arbitrators extend the date.

13.4 Entry of Judgment.

Judgment on the award rendered by the arbitrator(s) may be entered in and enforced by any court of competent jurisdiction.

13.5 Location.

Arbitration proceedings, including hearings, good faith meetings and settlement conferences, shall take place in Los Angeles, California, unless otherwise agreed to by the parties in writing. The Parties shall have the right to participate in any of the arbitration proceedings by telephone.

13.6 Governing Law.

The arbitration, including any proceedings to enforce, confirm, modify or vacate an award, and any proceedings to enforce the terms of this Agreement, shall be governed by the laws of the State of California and applicable federal law.

ARTICLE 14. INSURANCE ISSUES RELATED TO THE AISLIC POLICY

14.1 Condition M of AISLIC Policy

The Parties acknowledge and agree that Condition M of the AISLIC Policy provides as follows:

> Action Against Company – No action shall lie against the Company, unless as a condition precedent thereto, there shall have been full compliance with all of the terms of this Policy, nor until the amount of the Insured's obligation to pay shall have been finally determined either by judgment against the Insured after actual trial or by written agreement of the Insured, the claimant and the Company.
>
> Any person or organization or the legal representative thereof who has secured such judgment or written agreement shall thereafter be entitled to recover under this Policy to the extent of the insurance afforded by the Policy. No person or organization

shall have any right under this Policy to join the Company as a party to any action against the Insured to determine the Insured's liability, nor shall the Company be impleaded by the Insured or his legal representative. Bankruptcy or insolvency of the Insured or of the Insured's estate shall not relieve the Company of its obligations hereunder.

14.2 Effect of This Agreement Under Condition M

Solely to resolve the effect of this Agreement under Condition M of the AISLIC Policy, and not to apply to or affect any other provision of the AISLIC Policy, or affect the terms of the Coverage and Claims Settlement Agreement, nor to affect any other claims for coverage by Whittaker, the Parties agree as set forth in this Section 14.2 as follows. Provided that an arbitration award or Cost Consultant determination is issued pursuant to and in accordance with this Agreement, including but not limited to Articles 7 and 13, and that (a) the time for filing a petition to vacate or correct the arbitrator's or Cost Consultant's decision has expired or such filing has been waived by agreement or (b) any petition filed to vacate or correct the arbitrator's or Cost Consultant's decision, pursuant to Cal. Code of Civil Procedure Section 1286.2 (Grounds for vacation of award) or Section 1286.6 (Grounds for correction of award), is finally adjudicated or dismissed (hereinafter referred to as "Final Arbitration Awards"), AISLIC and Whittaker agree as follows:

i) a Final Arbitration Award issued in favor of Plaintiffs and against Whittaker pursuant to and in accordance with this Agreement shall be deemed to be "a judgment against Insured [Whittaker] after actual trial"; and

ii) any written settlement agreement executed by Plaintiffs, Whittaker, and AISLIC or executed by Plaintiffs and Whittaker (with written consent of AISLIC) on issues or disputes presented to or which could properly be presented to an arbitrator(s) or Cost Consultant pursuant to this Agreement shall be deemed to be

"written agreement of the Insured [Whittaker], the claimant [Plaintiffs] and the Company [AISLIC]", as those quoted phrases are used in Condition M “Action Against Company” of the AISLIC Policy**.**

14.3 Written Agreement

This Agreement shall be deemed to be "written agreement of the Insured [Whittaker], the claimant [Plaintiffs] and the Company [AISLIC]" as that quoted phrase is used in Condition M “Action Against Company” of the AISLIC Policy.

14.4 Full Compliance

AISLIC agrees that, as of the date that AISLIC executes this Agreement, Whittaker’s actions have been in “full compliance with all of the terms of [the AISLIC] Policy” with respect to this Agreement, as said quoted phrase is used in Condition M “Action Against Company” of the AISLIC Policy.

14.5 Covered Claims

Except with respect to the negotiation, arbitration, or litigation of a Non-Subject Well Future Perchlorate Circumstance, AISLIC agrees that (1) all costs, expenses, and obligations incurred by Whittaker pursuant to this Agreement shall be treated as a covered claim under AISLIC Policy Coverages A, B, C, D, E, or F, without reservation of coverage rights to the extent that limits remain under AISLIC Policy Coverages A-F and (2) all costs, expenses, and obligations incurred by Whittaker pursuant to this Agreement shall be paid from either SF Escrow 1, from SF Escrow 2 (under Section IV.F.6.a(iii) of the Coverage and Claims Settlement Agreement), or from any remaining applicable limits of the AISLIC Policy under Coverages A, B, C, D, E, or F, as provided in the Coverage and Claims Settlement Agreement.

14.6 Proceedings Under Article 10

With respect to the negotiation, arbitration, or litigation of a Non-Subject Well Future Perchlorate Circumstance pursuant to Article 10 of this Agreement, AISLIC affirms that it agrees to abide by the obligations set forth in that Article 10. In the event that AISLIC makes a determination of coverage and Whittaker notifies of its satisfaction with such determination pursuant to Article 10 of this Agreement, then the agreements, rights and obligations set forth in Section 14.2 of this Article 14 shall apply with respect to the arbitration of such Non-Subject Well Future Perchlorate Circumstance.

14.7 AISLIC Reservation of Rights

AISLIC reserves all rights of subrogation or contribution pursuant to the AISLIC policy and law with respect to any payments made hereunder, except any claims of subrogation or contribution against the Plaintiffs.

14.8 No Amendment or Waiver

Without limiting the obligations of Whittaker and AISLIC as set forth in this Article 14 of this Agreement, nothing herein shall constitute an amendment of any terms or conditions of the Coverage and Claims Settlement Agreement (including but not limited to, those terms related to funding of settlement of the Underlying Action), or a waiver or amendment of any duties, obligations, reservations, or rights, if any, of AISLIC or Whittaker under the Coverage and Claims Settlement Agreement. In particular, but not by way of limitation, AISLIC and Whittaker disagree over whether Section VI.C.3 of the Coverage and Claims Settlement Agreement independently obligates AISLIC to cover future perchlorate claims without reservation of rights and whether and to what extent, if any, AISLIC has reserved its defenses to

coverage. Nothing in this Article 14, is intended to affect, or shall affect, the resolution of that dispute.

14.9 Coverages K and L

Reference in this Article 14 to Coverages A-F shall not under any circumstances be deemed to affect any duties, obligations, reservations, or rights, if any, of AISLIC or Whittaker with respect to Coverages K and L. In particular, but not by way of limitation, the Parties agree that Coverages K and L are under all circumstances limits of liability that are "inapplicable" to Loss sustained for Clean-up Costs incurred after the Termination Date of the AISLIC Policy.

14.10 Additional Clarifications Regarding AISLIC Policy and Other Agreements

14.10.1 Nothing in this Agreement confers the status of an insured or additional insured or the rights of an insured or additional insured with respect to the AISLIC Policy on any person or entity.

14.10.2 Except as expressly set forth in this Article 14, this Agreement does not alter the rights, duties and obligations between Whittaker and AISLIC under (a) the AISLIC Policy or (b) any other agreements, including but not limited to the Coverage and Claims Settlement Agreement.

14.10.3 The parties agree that nothing in this Agreement shall under any circumstances require AISLIC to make any payment or fulfill any duty or obligation after its applicable limit of liability is exhausted.

14.10.4 Nothing herein shall be deemed or interpreted to alter or amend, nor waive or affect, the terms of Condition C of Section VII, Conditions of the AISLIC Policy.

14.10.5 Nothing herein shall be construed to affect any rights of Whittaker against any of its insurers other than AISLIC or under any of its insurance policies other than the AISLIC Policy.

ARTICLE 15. PUBLIC AND OTHER FUNDING SOURCES

15.1 Background of Intent of the Parties

In entering into this Agreement, the Parties are aware that federal and state Public Funding Sources may be or become available to assist in implementing the Project as well as remedial and/or source control activities to be conducted at or in the vicinity of the Site respecting perchlorate contamination. Federal funds may be available by virtue of the United States Department of Defense involvement and activities conducted at or in the vicinity of the Site. State funds may be available to assist in evaluating and implementing an investigatory/remedial program that may be regionally based, including but not limited to the restoration/containment work contemplated under this Agreement and remedial source control activities to be conducted at the Site.

15.2 Obtaining Funds from Public Funding Sources

The Plaintiffs shall use good faith efforts, in a manner consistent with each of the Plaintiffs' and their representatives' individual and unique obligations under applicable law, to obtain funds from Public Funding Sources so as to provide for reasonable and necessary: (1) costs associated with the Project, including costs to implement the Project, Project Modification, and cost overruns, as identified by Plaintiffs; (2) continued off-Site groundwater monitoring with respect to perchlorate contamination; (3) off-Site response activities in the alluvium and Saugus Formation that address perchlorate contamination; and (4) on-Site source removal activities with respect to perchlorate contamination. To the extent permissible under all applicable laws and the requirements of specific funding authorizations, funding from Public Funding Sources shall

be allocated, credited, and utilized to cover any of the aforementioned categories of reasonable and necessary costs in the above order of priority. The Parties shall comply with all applicable laws, rules and regulations regarding lobbying disclosures in their efforts to obtain funding from Public Funding sources. Whittaker shall cooperate in seeking such funds.

Prior to determination of the Lump Sum pursuant to Section 5.2.6, the reasonable and necessary outside consultant lobbying costs incurred by Plaintiffs and Whittaker that are directly related to the perchlorate contamination and seeking of funding under this Article, shall be Project O&M Costs, and will be included in the Estimate of Project O&M, subject to an annual cap of two hundred thousand dollars ($200,000) on Plaintiffs' outside fees and costs and one hundred thousand dollars ($100,000) on Whittaker's outside fees and costs. In no event shall such "outside fees and costs" include campaign donations or similar donations. Upon request of any Party, a full accounting of such costs shall be provided. The obligation to reimburse lobbying costs shall cease in the year 2011, but such costs may be requested thereafter upon a showing of both good cause and positive results, but in no event later than January 1, 2019.

15.3 Administration of Funds from Public Funding Sources

Plaintiffs shall document, account for, and administer all Public Funding Sources funds received by them in conformity with all applicable laws and all requirements of the administrators of Public Funding Sources.

15.4 Conformity with Public Funding Sources Requirements

Plaintiffs shall design, build, operate and maintain their respective restoration/containment work projects contemplated under this Agreement in conformity with all applicable requirements of the Public Funding Sources from which funds have been secured. If Public Funding Sources have requirements which conflict with this Agreement, the Parties shall

meet and negotiate in good faith to amend this Agreement to conform to the requirements of the Public Funding Sources in a manner that preserves the purposes for the use of such funds as much as possible in a manner consistent with the Parties' intent as contemplated in this Agreement. Notwithstanding any of the provisions of this Article 15 or any other provision of this Agreement, nothing in this Agreement is intended to waive or otherwise effectuate a release, nor shall any Party provide a release of the United States Department of Defense or any other agency or instrumentality of the United States in connection with any alleged liability same may have under federal or state law arising out of or relating to any involvement in operations, waste disposal, or other activities at or in the vicinity of the Site.

ARTICLE 16. MISCELLANEOUS

16.1 Governing Law

This Agreement shall be construed and enforced in accordance with the substantive laws of the State of California, without reference to choice of law rules.

16.2 Waiver

No waiver by a Party of any provision of this Agreement shall be valid unless in writing and signed by an authorized representative of such Party. The waiver by any Party of any failure on the part of another Party to perform any of its obligations under this Agreement shall not be construed as a waiver of any future or continuing failure or failures.

16.3 Amendment of the Agreement

No amendment of this Agreement shall be binding upon the Parties unless it is in writing and executed by all of the Parties (excluding any that no longer legally exist or that do not respond to communications directed to the address for that Party specified below or to such other address as has been designated in accordance with Section 16.4). This Agreement and the

exhibits attached hereto set forth all of the covenants, provisions, agreements, conditions and understandings with respect to the matters addressed in this Agreement and constitute a complete integration.

16.4 Notices

All notices and communications required or permitted to be delivered to the Parties, Steadfast and any Buyer pursuant to this Agreement shall be in writing and (a) delivered personally or (b) sent by a recognized overnight mail or courier service, with delivery receipt requested, or (c) sent by facsimile communication with receipt confirmed by telephone, to the following addresses (or to such other address as may from time to time be specified in writing by the addressee):

Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350-2173
Attn: Dan Masnada, General Manager
Telephone: (661) 297-1600
Facsimile: (661) 297-1610
E-mail: dmasnada@clwa.org

Valencia Water Company
24631 Rockefeller Ave.
P. O. Box 5904
Valencia, CA 91385-5904
Attn: Robert J. DiPrimio, President
Telephone: (661) 294-1150
Facsimile: (661) 294-3806
E-mail: rdiprimio@valencia.com

Newhall County Water District
23780 North Pine St.
P. O. Box 220970
Santa Clarita, CA 91321-0970
Attn: Stephen L. Cole, General Manager
Telephone: (661) 259-3610
Facsimile: (661) 259-9673
E-mail: scole@ncwd.org

Santa Clarita Water Company
22722 West Soledad Canyon Road
P. O. Box 903
Santa Clarita, CA 91380-9003
Attn: William J. Manetta, President
Telephone: (661) 259-2737
Facsimile: (661) 286-4333
E-mail: wmanetta@scwater.org

with a copy for all of the above to:

Nossaman, Guthner, Knox & Elliott LLP
445 South Figueroa Street, 31st Floor
Los Angeles, CA 90071-1602
Attn: Frederic A. Fudacz, Esq.
Telephone: (213) 612-7823
Facsimile: (213) 612-7801
E-mail: ffudacz@nossaman.com

Whittaker Corporation
Eric Lardiere, Esq.
Vice-President, Secretary and General Counsel
Whittaker Corporation
1955 N. Surveyor Ave.
Simi Valley, CA 93063-3349
E-mail: elardiere@wkr.com

with copies for Whittaker Corporation to:

Reynold L. Siemens, Esq.
Heller Ehrman LLP
333 S. Hope Street
Suite 3900
Los Angeles, CA 90071-3043
Fax: 213-614-1868
Email: rsiemens@hewm.com

and

Richard A. Dongell, Esq.
Dongell Lawrence Finney Claypool LLP
707 Wilshire Boulevard, 45th Floor
Los Angeles, CA 90017
213-943-6100 telephone
213-943-6101 facsimile

American International Specialty Lines Insurance Company as Administrator of SF Escrow 1:

Stacy Parker, Complex Claim Director
AIG Domestic Claims, Inc.
Pollution Insurance Products High Profile Unit
175 Water Street, 12th Floor
New York, New York 10038
Telephone: (212) 458-2910
Fax: (866) 261-3935

with a copy to:

Richard W. Bryan, Esq.
Erin N. McGonagle, Esq.
Jackson & Campbell, P.C.
1120 20th Street, N.W.
Washington, DC 20036-3437
Telephone: (202) 457-1600
Fax: (202) 457-1678

Santa Clarita, L.L.C.
Remediation Financial, Inc.
Remediation Financial, Inc., Managing Member
Great American Tower
3200 N. Central Avenue, Suite 1570
Phoenix, Arizona 85296
Attn: Myla D. Bobrow, Pres. & CEO
Remediation Financial, Inc.

with a copy for Santa Clarita, L.L.C. and Remediation Financial, Inc. to:

Lawrence J. Hilton, Esq./William E. Halle, Esq.
Hewitt & O'Neil LLP
19900 MacArthur Boulevard, Suite 1050
Irvine, California 92612

Bermite Recovery LLC
Remediation Financial, Inc., Managing Member
Great American Tower
3200 N. Central Avenue, Suite 1570
Phoenix, Arizona 85296
Attn: Myla D. Bobrow, Pres. & CEO
Remediation Financial, Inc.

with a copy for Santa Clarita, L.L.C., Remediation Financial, Inc., and Bermite Recovery LLC to:

Avion Holdings, Inc.
Re: Remediation Financial Inc.
Suite B-204
15290 N. 78th Way
Scottsdale, AZ 85260
Fax: 480-905-0469

and

Alisa C. Lacey, Esq.
Stinson Morrison Hecker, LLP
1850 N. Central Avenue, Suite 2100
Phoenix, AZ 85004-6925
Telephone: (602) 212-8628
Facsimile: (602) 586-5237
E-Mail: alacey@stinson.com

American International Specialty Lines Insurance Company

Stacy B. Parker, Complex Claim Director
AIG Domestic Claims, Inc.
P & C Severity Claims
Pollution Insurance Products High Profile Unit
175 Water Street, 12th Floor
New York, NY 10038
Telephone: (212) 458-6364
Facsimile: (866) 253-0395

with a copy to:

Richard W. Bryan, Esq.
Erin N. McGonagle, Esq.
Jackson & Campbell, P.C.
1120 20th Street, N.W.
Washington, DC 20036-3437
Telephone: (202) 457-1600
Facsimile: (202) 457-1678
E-mail: rbryan@jackscamp.com
emcgonagle@jackscamp.com

Steadfast Insurance Company

Zurich North America
1400 American Lane
Schaumberg, IL 60196
Attn: General Counsel
E claim # 912-0038512

with a copy for Steadfast to:

Terry D. Avchen, Esq.
Christensen, Miller, Fink, Jacobs, Glaser, Weil & Shapiro
10250 Constellation Boulevard, 19th Floor
Los Angeles, California 90067
Telephone: (310) 556-2920
Fax: (310) 556-2920

and

Neil Selman, Esq.
Selman Breitman, LLP
11766 Wilshire Blvd
6th Floor
Los Angeles, California 90025-6538
Telephone: (310) 689-7070
Fax: (310) 473-2525

Buyer:

SunCal Santa Clarita LLC
c/o SunCal Companies
21900 Burbank Blvd.
Woodland Hills, CA 12367
Attn: Frank Faye
Telephone: (818) 444-1600
Fax: (818) 444-5501

with copies to:

SunCal Companies
2392 Morse Avenue
Irvine, CA 92614
Attn: Mr. Bruce Elieff
Bruce V. Cook, Esq.
Telephone: (949) 777-4000
Facsimile: (949) 7774280

Cherokee Santa Clarita, LLC
c/o Cherokee Investment Partners
4600 Ulster Street
Suite 500
Denver, Colorado 80237
Attn: Mr. Dwight Stenseth
Mr. Guy Arnold
Telephone: (303) 689-1460
Facsimile: 303-689-1461

16.5 Computation of Time

In computing any period of time under this Agreement, where the last day would fall on a Saturday, Sunday, or federal or California state holiday, the period shall run until 5 p.m. Pacific Time on the next Working Day.

16.6 Counterparts

This Agreement will be executed in counterparts, each of which shall be deemed an original, and all of which, taken together, shall constitute one and the same instrument.

16.7 Assignment

No Party shall assign or otherwise transfer its rights or obligations hereunder without the other Parties' prior written consent, which shall not be unreasonably withheld. This Agreement shall be binding upon and inure to the benefit of the respective successors and permitted assigns of the Parties.

16.8 Cooperation

Each Party agrees to execute and deliver such further documents and to perform such further acts as may be reasonable and necessary to carry out the provisions of this Agreement or to effectuate its intent.

16.9 Joint Drafting and Negotiation/Legal Counsel

This Agreement has been jointly negotiated and drafted. The language of this Agreement shall be construed as a whole according to its fair meaning and without regard to or aid of Civil Code Section 1654 and similar judicial rules of construction. Each Party has been advised in connection herewith by counsel of its own choosing.

16.10 Article and Section Headings and Captions

Article and Section headings and captions used in this Agreement are for reference only and shall not be considered in any way in connection with the interpretation or enforcement of this Agreement.

16.11 No Third Party Beneficiaries

No third party shall be entitled to claim or enforce any rights hereunder except (1) Buyer and BRLLC, but only to the extent expressly provided in this Agreement, and (2) persons specifically released in Section 12.1 are entitled to claim the benefit of and enforce such releases.

16.12 Severability

In the event that any provision of this Agreement is determined by a court to be invalid, the court shall reform the provision in a manner that is both consistent with the intent of the Parties and legally valid. The remainder of this Agreement shall not be affected thereby.

16.13 Successors and Assigns

All covenants and agreements contained in this Agreement by or on behalf of any of the Parties hereto shall bind and inure to the benefit of their respective successors and permitted assigns, whether so expressed or not, including any Trustee appointed in the Bankruptcy Cases or a subsequently converted Chapter 7 case or cases.

16.14 Organization/Authorization

Each of the Parties to this Agreement hereby respectively represents and warrants to the others that each of them is a duly organized or constituted entity, with all requisite power to carry out its obligations under this Agreement, and that the execution, delivery and performance of this Agreement have been duly authorized by all necessary action of the board of directors or other governing body of such Party, and will not result in a violation of such Party's organizational documents. RFI and SCLLC represent and warrant that, upon the Effective Date, this Agreement will have received any and all approvals required by the Bankruptcy Court in their respective bankruptcy cases to make this Agreement enforceable as against them.

16.15 No Assignment of Claims

Other than the assignment provided in Section VII of the Coverage and Claims Settlement Agreement and the assignment provided in the Purchase & Sales Agreement between RFI Parties and Whittaker, there has been no assignment of claims.

16.16 No Admission /Not Insurance

This Agreement effectuates settlement of claims that are disputed, contested and denied. Neither this Agreement nor any Party's performance under this Agreement is intended to be or shall be asserted by any other Party to be an admission of any kind or character whatsoever, nor

shall it be deemed to have precedential effect in any other dealings between or among the Parties in any other context. Nothing herein shall be deemed to constitute an insurance policy.

16.17 No Prejudice to Buyer

Nothing in this Agreement shall be construed to prejudice any rights, claims, or defenses, that a Buyer, as defined herein, of the Site may have under applicable federal or state law, or to impose any monetary obligations or liability on the Buyer.

16.18 Entire Agreement

Except as expressly provided herein, this Agreement is the entire agreement between the Parties with respect to the subject matter hereof and supersedes all prior agreements between the Parties with respect thereto. In the event of any conflict between the terms of this Agreement and the Interim Agreement or the First Amendment, the terms of this Agreement shall control.

16.19 Survival

Except as expressly set forth herein, each and all of the releases, representations, warranties, covenants, and agreements in this Agreement and in the Interim Agreement shall survive the execution and delivery of this Agreement.

IN WITNESS WHEREOF, this Agreement has been executed by the undersigned, effective as of the date first written above.

CASTAIC LAKE WATER AGENCY

_____

By:_____
Its: _____

NEWHALL COUNTY WATER DISTRICT

_____

By:_____
Its: _____

SANTA CLARITA WATER COMPANY

_____

By:_____
Its: _____

VALENCIA WATER COMPANY

_____

By:_____
Its: _____

WHITTAKER CORPORATION

_____

By:_____
Its: _____

SANTA CLARITA L.L.C.
By: Remediation Financial, Inc.,
Its: Managing Member

_____

By: Myla D. Bobrow
Its: President & CEO

REMEDIATION FINANCIAL, INC.

_____

By: Myla D. Bobrow
Its: President & CEO

AIG DOMESTIC CLAIMS, INC., the duly authorized claims handling agent of:

AMERICAN INTERNATIONAL SPECIALTY LINES INSURANCE COMPANY, in its capacity as "Administrator" of "SF Escrow 1 Account" and as insurer of Whittaker

_____

By:_____
Its: _____

REVIEWED AND APPROVED:

AVION HOLDINGS, LLC, in its limited capacity as designated representative for the Bankruptcy Estates.

_____

By: G. Neil Elsey
Its: Managing Member

LIST OF EXHIBITS

Exhibit A	Description of SCLLC Property
Exhibit B	Description of BRLLC Property
Exhibit C	Description of Distribution Pipelines
Exhibit D	Pro-Forma Joint Estimate of Project O&M Costs
Exhibit E	Past Design Costs
Exhibit F	Project Description
Exhibit G	Estimate of Project Capital Costs
Exhibit H-1	Project Capital Costs Escrow Instructions
Exhibit H-2	Project O&M Costs Escrow Instructions
Exhibit I	Estimate of Q2 Capital Costs
Exhibit J	Q2 Capital Costs Joint Escrow Agreement and Instructions
Exhibit K-1	Amendment No. 1 to Joint Q2 Escrow Agreement and Instructions
Exhibit K-2	Amendment No. 2 to Joint Q2 Escrow Agreement and Instructions
Exhibit L	Estimate of Q2 O&M Costs
Exhibit M	Description of Magic Mountain Wells
Exhibit N	Description of Well Closure
Exhibit O	Description of Stadium Replacement Well
Exhibit P	Replacement Well/Distribution Pipeline Capital Costs Escrow Instructions
Exhibit Q	Description of V-206 Replacement Well and Closure of V157 Well
Exhibit R	Cost Allocation for Distribution Pipelines and Replacement Wells & Associated Pipelines
Exhibit S	Estimate of Distribution Pipelines and Replacement Wells Capital Costs
Exhibit T	List of Approved Contracts
Exhibit U	Identification of Presently Existing Saugus and Alluvial Production Wells
Exhibit V	Form of CGL Policy

Exhibit W	Form of EIL Policy
Exhibit X	Form of Earthquake Policy
Exhibit Y	Form of First Party Property Insurance Policy
Exhibit Z	Section 12.1.6 Documents
Exhibit AA	List of Approved Arbitrators
Exhibit BB	List of Approved Arbitrators for Future Perchlorate Contamination Disputes and Lump Sum Arbitration
Exhibit CC	AWWA Standard for Disinfection of Wells and Sample Worksheet

FREDERIC A. FUDACZ (SBN 050546)
ALFRED E. SMITH (SBN 186257)
BYRON P. GEE (SBN 190919)
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asmith@nossaman.com
bgee@nossaman.com

Attorneys for Plaintiffs and Counter-Defendants
Castaic Lake Water Agency; Newhall County Water District;
Santa Clarita Water Company; and Valencia Water Company

FILED
CLERK, U.S. DISTRICT COURT
JUL 13 2007
CENTRAL DISTRICT OF CALIFORNIA
BY DEPUTY

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UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

CASTAIC LAKE WATER AGENCY; NEWHALL COUNTY WATER DISTRICT; SANTA CLARITA WATER COMPANY; and VALENCIA WATER COMPANY,

Plaintiffs,

vs.

WHITTAKER CORPORATION; SANTA CLARITA LLC; REMEDIATION FINANCIAL, INC.; and DOES 1-10, Inclusive,

Defendants.

AND RELATED ACTIONS

Case No.: CV 00-12613 AHM(RZx)

[PROPOSED] ORDER GRANTING JOINT MOTION FOR COURT APPROVAL, GOOD FAITH SETTLEMENT DETERMINATION AND ENTRY OF CONSENT ORDER

Hearing Date: **July 16, 2007**
Time: **10:00 a.m.**
Place: **Courtroom 14**
Hon. A. Howard Matz

The motion of Plaintiffs and Counter-Defendants Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Company and Valencia Water Company (collectively, "Plaintiffs" or "Counter-Defendants"), Defendants and Counter Claimants Whittaker Corporation ("Whittaker") and Santa Clarita LLC ("SCLLC"), and Defendant Remediation Financial, Inc. ("RFI") (collectively, "Defendants"), (the foregoing Plaintiffs, Defendants collectively referred to herein as the "Parties"), for approval of the settlement agreement of Plaintiffs' claims ("Claims Settlement") and the settlement agreement of Defendants' counterclaims ("Counterclaim Settlement") and a determination that the settlements were in good faith came before this Court regularly for possible hearing after notice to all counsel. No hearing was necessary nor was a hearing held, in part because no opposition was filed. ATM

Having considered the papers submitted by the Parties, the proposed settlement agreements, and good cause appearing, the Court enters the following findings of fact:

1. The Claims Settlement and Counterclaim Settlement (collectively, the "Settlements") were reached by counsel experienced in similar litigation;
2. The Settlements were reached through the oversight of the Court appointed mediator, the Honorable (ret.) Eugene Lynch;
3. The Settlements were reached through arm's length negotiations without fraud or collusion;
4. Investigation and discovery were and are sufficient to allow counsel, the mediator and the Court to act intelligently; ATM
5. The amounts being paid by the Parties and other consideration being exchanged are fair and reasonable in order to end significant litigation costs and avoid the litigation risks by all Parties in having the unresolved issues determined at trial; ATM

Based on these findings of fact, IT IS HEREBY ORDERED that:

1. The proposed Claims Settlement and Counterclaims Settlement are hereby approved by this Court; and

2. The Claims Settlement and Counterclaims Settlement are in good faith and any and all claims against the settling Defendants and the settling Counter-Defendants that are addressed in the Claims Settlement and the Counterclaims Settlement, and the releases of the claims therein, regardless of when asserted or by whom, are barred; such claims are barred regardless of whether they are brought pursuant to CERCLA, or pursuant to common law or other federal or state laws.

3. The Court commends counsel for their exemplary professionalism.

DATED: July 13, 2007

The Honorable Howard A. Matz
United States District Court Judge

Stipulation to Dismiss Plaintiffs' Claims and Defendants' Counterclaim, August 20, 2007

FREDERIC A. FUDACZ (SBN 050546)
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Attorneys for Plaintiffs and Counter-Defendants Castaic Lake Water Agency; Newhall County Water District; Santa Clarita Water Company; and Valencia Water Company

FILED
CLERK, U.S. DISTRICT COURT
AUG 20 2007
CENTRAL DISTRICT OF CALIFORNIA
BY DEPUTY

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UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

CASTAIC LAKE WATER AGENCY; NEWHALL COUNTY WATER DISTRICT; SANTA CLARITA WATER COMPANY; and VALENCIA WATER COMPANY,

Plaintiffs,

vs.

WHITTAKER CORPORATION; SANTA CLARITA LLC; REMEDIATION FINANCIAL, INC.; and DOES 1-10, Inclusive,

Defendants.

AND RELATED ACTIONS.

Case No.: 00-12613AHM(RZx)

STIPULATION TO DISMISS PLAINTIFFS' CLAIMS AND DEFENDANTS' COUNTERCLAIMS

Hearing Date: **N/A**
Time: **N/A**
Place: **Courtroom 14**
Hon. A. Howard Matz

ENTERED
CLERK, U.S. DISTRICT COURT
AUG 21 2007
CENTRAL DISTRICT OF CALIFORNIA
BY DEPUTY

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This Stipulation to dismiss plaintiffs' claims and defendants' counterclaims, entered into by and among Plaintiffs and Counter Defendants Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Company and Valencia Water Company (collectively, "Plaintiffs"), Defendants and Counter Claimants Whittaker Corporation ("Whittaker") and Santa Clarita LLC ("SCLLC") and Defendant Remediation Financial, Inc. ("RFI") (collectively, "Defendants"), (the foregoing Plaintiffs, and Defendants are collectively referred to herein as the "Parties"), is made with reference to the following facts and recitals:

RECITALS

1. **WHEREAS,** Whittaker is the former owner of approximately 960 acres of real property located in the City of Santa Clarita, County of Los Angeles, California, (the "Site"). The Site is currently owned by SCLLC.

2. **WHEREAS,** Plaintiff Santa Clarita Water Company is the operator of wells commonly designated as Saugus 1, Saugus 2, and the Stadium Well. Plaintiff Newhall County Water District is the owner and operator of a water well commonly designated as NC11. Plaintiff Valencia Water Company is the owner and operator of water wells commonly designated as V157 and Q2. Saugus 1, Saugus 2, the Stadium Well, NC11, V157 and Q2 are collectively referred to at all times herein the "Subject Wells."

3. **WHEREAS,** on or about November 29, 2000, a civil action was brought in the United States District Court for the Central District of California ("Court"), Case No. CV 00-12613 AHM (RZx) by Plaintiffs (the "CLWA action"). Whittaker, SCLLC and RFI were named as defendants in the CLWA action. In the CLWA action, Plaintiffs vdldsflkdsfkl;alleged, among other things, that 1) the groundwater in and around the Site has been contaminated by perchlorate and other hazardous materials; 2) perchlorate contamination has been found in Subject Wells owned by Plaintiffs; and 3) Whittaker, SCLLC, and RFI caused and/or permitted the contamination. Plaintiffs further alleged that they have incurred "response costs" in addressing this contamination, including the costs of engaging consultants to undertake environmental assessment, water treatment

studies, groundwater analysis and characterization work in connection with the alleged perchlorate contamination.

4. **WHEREAS,** on or about January 19, 2001, Whittaker answered the allegations of Plaintiffs and filed its affirmative defenses in support thereof, and filed its own counter-claims against Plaintiffs alleging, among other things, that Plaintiffs were responsible for the release or threatened release of hazardous substances in and around the Site and as a result Whittaker was entitled to a Declaratory Judgment pursuant to the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") §113(g)(2), contribution pursuant to CERCLA §113(f), and response costs pursuant to the Hazardous Substances Account Act ("HSAA"). The action commenced by Whittaker's filing of its counter-claims is hereinafter referred to as the "Whittaker Action." On or about January 18, 2001, SCLLC answered the allegations of Plaintiffs and filed its affirmative defenses in support thereof, and SCLLC filed a counter-claim against Plaintiffs (the "SCLLC Action") alleging substantially identical facts as the Whittaker Action and seeking declaratory relief under CERCLA §§ 107(a), contribution under CERCLA §113(f), and recovery of response costs under the HSAA.

5. **WHEREAS,** Whittaker, SCLLC and RFI, and Plaintiffs have entered into the Interim Settlement and Funding Agreement dated as of July 28, 2003 (the "Interim Agreement") and the First Amendment to the Interim Settlement and Funding Agreement dated October 11, 2004, which, among other things, extended the term of the Interim Agreement through January 2005.

6. **WHEREAS,** in or around July, 2004, SCLLC and two of its affiliates filed voluntary Chapter 11 bankruptcy petitions, and the cases thereby commenced are pending in the United States Bankruptcy Court for the District of Arizona (the "Arizona Bankruptcy Court"), denominated Cases Nos. 2-04-BK-11910 CGC, 2-04-BK 11911 CGC and 2-04-BK-17294 CGC, respectively, which cases are jointly administered with a bankruptcy case previously commenced by a petition filed by a third affiliate of SCLLC, RFI, and denominated as Case No. 2-04-BK-10486 CGC. Case Nos. 2-04-BK-11910

CGC, 2-04-BK 11911 CGC, 2-04-BK-17294 CGC and 2-04-BK-10486 are jointly administered under Case No. 2-04-BK-10486 CGC and are collectively referred to as the "Bankruptcy Cases."

7. **WHEREAS,** on April 6, 2007, Plaintiffs and Defendants entered into two settlement agreements that resolve Plaintiffs' claims and Defendants' counterclaims. The settlement agreements require that a joint stipulation to dismiss the claims and counterclaims be filed with the court after the settlement agreements are funded. The claims settlement agreement was funded on or about August 9, 2007 and the counterclaim settlement was funded on or about August 10, 2007.

NOW, THEREFORE, the parties hereby stipulate to dismiss Plaintiffs' claims against Defendants in accordance with the "Castaic Lake Water Agency Litigation Settlement Agreement," (previously filed as Exhibit 1 to the Parties' June 18, 2007 Joint Motion for Court Approval of Settlement Agreements and Good Faith Settlement Determination) with prejudice to the extent expressly released therein, and otherwise without prejudice, as to the claims asserted in the underlying complaint.

The Parties further stipulate to dismiss defendants Whittaker Corporation's and Santa Clarita, LLC's counterclaims against Plaintiffs in accordance with the Counterclaim Settlement Agreement and Release (previously filed as Exhibit 2 to the Parties' June 18, 2007 Joint Motion for Court Approval of Settlement Agreements and Good Faith Settlement Determination) with prejudice to the extent expressly released therein, and otherwise without prejudice, as to the claims asserted in the underlying counter-complaints.

Dated: August 17, 2007

FREDERIC A. FUDACZ
ALFRED E. SMITH
BYRON P. GEE
NOSSAMAN, GUTHNER, KNOX & ELLIOTT, LLP

By: _____
Attorneys for Plaintiffs and Counter-Defendants Castaic Lake Water Agency; Newhall County Water District; Santa Clarita Water Company; and Valencia Water Company

IT IS SO ORDERED
Dated August 20, 2007

_____
United States District Judge

344788_2 DOC

Dated: August 16, 2007

LAWRENCE J. HILTON
WILLIAM E. HALLE
HEWITT & O'NEIL LLP

By: _____
Attorneys for Defendant and Counter-Claimant Santa Clarita, LLC and Defendant Remediation Financial, Inc.

Dated: August ___, 2007

JOSEPH J. ARMAO
HELLER EHRMAN WHITE & McAULIFFE, LLP
RICHARD A. DONGELL
THOMAS F. VANDENBURG
DONGELL LAWRENCE FINNEY LLP

By: _____
Attorneys for Defendant Whittaker Corporation

Dated: August ___, 2007

LAWRENCE J. HILTON
WILLIAM E. HALLE
HEWITT & O'NEIL LLP

By: _____
Attorneys for Defendant and Counter-Claimant Santa Clarita, LLC and Defendant Remediation Financial, Inc.

Dated: August 17, 2007

JOSEPH J. ARMAO
HELLER EHRMAN WHITE & McAULIFFE, LLP
RICHARD A. DONGELL
THOMAS F. VANDENBURG
DONGELL LAWRENCE FINNEY LLP

By: _____
Attorneys for Defendant Whittaker Corporation

PROOF OF SERVICE

The undersigned declares:

I am employed in the County of , State of California. I am over the age of 18 and am not a party to the within action; my business address is c/o Nossaman, Guthner, Knox & Elliott, LLP, 445 S. Figueroa Street, 31st Floor Los Angeles, California 90071-1602.

On August 17, 2007, I served the foregoing

STIPULATION TO DISMISS PLAINTIFFS' CLAIMS AND DEFENDANTS' COUNTERCLAIMS

on parties to the within action by placing ( ) the original (x) a true copy thereof enclosed in a sealed envelope, addressed as shown on the attached service list.

(XX) (By U.S. Mail) On the same date, at my said place of business, said correspondence was sealed and placed for collection and mailing following the usual business practice of my said employer. I am readily familiar with my said employer's business practice for collection and processing of correspondence for mailing with the United States Postal Service, and, pursuant to that practice, the correspondence would be deposited with the United States Postal Service, with postage thereon fully prepaid, on the same date at Los Angeles, California.

( ) (By Facsimile) I served a true and correct copy by facsimile pursuant to C.C.P. 1013(e), to the number(s) listed on the attached sheet. Said transmission was reported complete and without error. A transmission report was properly issued by the transmitting facsimile machine, which report states the time and date of sending and the telephone number of the sending facsimile machine. A copy of that transmission report is attached hereto.

( ) (By Overnight Service) I served a true and correct copy by overnight delivery service for delivery on the next business day. Each copy was enclosed in an envelope or package designated by the express service carrier; deposited in a facility regularly maintained by the express service carrier or delivered to a courier or driver authorized to receive documents on its behalf; with delivery fees paid or provided for; addressed as shown on the accompanying service list.

Executed on August 17, 2007.

( ) (STATE) I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

(XX) (FEDERAL) I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Mina Munoz

SERVICE LIST

CASTAIC LAKE WATER AGENCY, et al. v. WHITTAKER CORPORATION, et al.
USDC Case No. CV 00-12613 AHM (RZx)

Lawrence Hilton, Esq. William Halle, Esq. **HEWITT & O'NEIL, LLP** 19900 MacArthur Boulevard, Suite 1050 Irvine, CA 92612	Telephone: (949) 798-0500 Facsimile: (949) 798-0511 **Attorneys for Defendants Santa Clarita, L.L.C. and Remediation Financial, Inc.**
Reynold L. Siemens, Esq. **HELLER EHRMAN, LLP** 333 South Hope Street, Suite 3900 Los Angeles, CA 90071	Telephone: (213) 689-0200 Facsimile: (213) 614-1868 **Attorneys for Defendant Whittaker Corporation**
Richard A. Dongell, Esq. Matthew Clark Bures, Esq. Thomas Vandenburg, Esq. **DONGELL LAWRENCE & FINNEY** 707 Wilshire Blvd, 45th Floor Los Angeles, CA 90017	Telephone: (213) 943-6100 Facsimile: (213) 943-6101 **Attorneys for Defendant Whittaker Corporation**
Joseph J. Armao, Esq. **HELLER EHRMAN, LLP** 333 Bush Street San Francisco, CA 94104-2878	Telephone: (415) 772-6000 Facsimile: (415) 772-6268 **Attorneys for Defendant Whittaker Corporation**
Steven L. Crane, Esq. Steven L. Feldman, Esq. **GOLDFARB, STURMAN & AVERBACH** 15760 Ventura Blvd, Suite 1900 Encino, CA 91436	Telephone: (818) 990-4414 Facsimile: (818) 905-7173 **Attorneys for Third Party Defendant and Third Party Counter-Claimant Hasa Chemicals, Inc.**

AMEC Geomatrix, Progress Letter Report from Hassan Amini, Ph.D., Project Coordinator, to DTSC, September 15, 2009

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By

September 15, 2009

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Mr. Jose Diaz
Department of Toxic Substances Control
Site Mitigation Branch
9211 Oakdale Avenue
Chatsworth, CA 91311

Re: Former Whittaker-Bermite Facility, Santa Clarita, CA
Summary Report for Month of August 2009

Dear Mr. Diaz:

This letter constitutes a progress report for the month of August 2009, prepared pursuant to Task 4 and Section 6.3 of the "Imminent and Substantial Endangerment Determination and Order and Remedial Action Order" (the Order) that the Department of Toxic Substances Control (DTSC) issued on November 22, 2002, for the former Whittaker-Bermite facility (site) in Santa Clarita, California.

SECTION I – SOIL ISSUES

Specific actions taken on behalf of the respondent, actions expected to be undertaken, and planned activities for soil issues are summarized in the following sections:

OU1 REMEDIATION

Activities for This Report Period (1)

All excavation, bio-treatment, backfilling, and slope restoration activities for the OU1 remediation program were completed during previous reporting periods. During this reporting period, CDM worked on the preparation of the closure report documenting the soil remediation operations for OU1.

Anticipated Activities for This Month

Work on the closure report documenting the soil remediation operations for OU1.

Long-Term Actions

Complete the closure report documenting the soil remediation operations for OU1 and submit to DTSC for review.

Activities for This Report Period (2)

Operated the primary soil vapor extraction (SVE) system at Area 43 and the secondary (hi-vacuum) SVE system at Building 329.

AMEC Geomatrix, Inc.
510 Superior Avenue, Suite 200
Newport Beach, CA
USA 92663-3627
Tel (949) 642-0245
Fax (949) 642-4474
www.amecgeomatrixinc.com

Anticipated Activities for This Month

Continue operation and optimization of SVE systems at Building 329 and Area 43.

Long-Term Actions

Continue the SVE operations until volatile organic compound levels are eliminated or reduced to appropriate levels or until asymptotic levels are reached.

REMEDIAL ACTION PLAN

Activities for This Report Period

CDM completed the third draft of the Remedial Action Plan (RAP) for OU2 through OU6 soils (Site-Wide Soils RAP), which was submitted to DTSC on August 14, 2009. The DTSC issued preliminary review comments via email on August 24, 2009. DTSC's preliminary review comments were incorporated and the third draft of the RAP was resubmitted to DTSC on August 31, 2009.

Anticipated Activities for This Month

Allow DTSC review of the Site-Wide Soils RAP. Address DTSC's comments, if any received.

Long-Term Actions

Work with DTSC to finalize the Site-Wide Soils RAP and present for public review.

PILOT STUDIES (SVE)

Activities for This Report Period

CDM had previously prepared a pilot study work plan for SVE. DTSC approved the revised SVE work plan in a letter dated October 22, 2008.

The field pilot programs for Areas 2, 4, 27, 31/45, 53/54/72, Area 14-South, and Hula Bowl Canyon I were completed during prior reporting periods. During this reporting period the field pilot program for Area 14-Central was completed. However, due to the large amount of VOC mass removal achieved for both Area 14-South and 14-Central using the G.E.O. cryogenic/condenser system, the operations in Area 14 were extended for an additional two months while evaluations are completed to determine if further operation of the G.E.O. system with the existing well configuration is warranted prior to scale up of the pilot study operations.

Anticipated Activities for This Month

Prepare the report documenting the results of the pilot studies, and extended SVE pilot operations in Area 14.

Long-Term Actions

Complete planned pilot study activities and prepare documentation reports for submittal to DTSC. Incorporate the results of the SVE Pilot Study to the Site-Wide RAP and the Remedial Design document.

PILOT STUDIES (GEDIT)

Activities for This Report Period

CDM had previously prepared pilot study work plan for in-situ bioremediation of perchlorate impact to deep soils via Gaseous Electron Donor Injection Technology (GEDIT). DTSC provided conditional approval of the GEDIT work plan on November 14, 2008.

The laboratory bench-scale treatability study for the GEDIT pilot study was initiated at CDM's laboratory in Bellevue, Washington, during a previous reporting period. The bench-scale study was continued during this reporting period.

Anticipated Activities for This Month

Continue tracking and monitoring of bench-scale study.

Long-Term Actions

Complete planned pilot study activities and prepare documentation reports for submittal to DTSC. Incorporate the results of the GEDIT Pilot Study to the Site-Wide RAP and the Remedial Design document.

SOILS INTERIM REMEDIAL MEASURES (IRMS) AND REMOVAL ACTIONS

Depleted Uranium (DU) Investigation and Clearance Activities

Activities for this Report Period

Continued to maintain close contact with California Department of Public Health-Radiological Health Branch (CDPH-RHB) regarding the review of the Work Plan and have provided preliminary information to address requests made by CDPH-RHB. Site visit by CDPH-RHB has not been scheduled at this time and is being coordinated by Mr. Jerry Hensley at RHB along with Mr. Jose Diaz at DTSC. Meeting with California Department of Fish and Game representative was completed on August 24th resulting in approval of permit for brush removal as described in our notification. Development of the project Health and Safety Plan (HASP) as well as the Final Status Survey Plan (FSSP) have also been started during this period. Finalization of both plans will be pending information received from CDPH-RHB review of Work Plan.

Anticipated Activities for this Month

It is anticipated that a site visit will be scheduled by CDPH-RHB and DTSC as part of the Work Plan review process. This visit will provide supporting information pertinent to the review of the submitted Work Plan. Pending comments from CDPH-RBH, changes may be necessary to the Work Plan. Work on both the HASP and FSSP will be continued during this period. We are awaiting approval from ACOE and RWQCB prior to moving forward with the brush removal. We expect to initiate coordination for brush removal during this period.

Long Term Actions

Once approval is confirmed with ACOE and RWQCB the brush removal and UXO clearance survey can be coordinated. Pending necessary changes to the Work Plan, submittal of the FSSP to CDPH-RHB will be required. A specific schedule will be developed for brush removal, UXO clearance, DU removal and Final Status Surveys.

UXO/OE Investigation and Clearance Activities

Activities for This Report Period

EODT completed the following activities during this reporting period.

Work Plan Addendum (WPA) Further Investigation and No Further Action Areas
The EODT Work Plan Addendum (WPA) and associated Conceptual Site Model were submitted for DTSC and stakeholders review on July 23, 2009. The WPA field work will characterize the Further Investigations Areas and confirm the No Further Action status of the areas not affected by Munitions and Explosives of Concerns (MEC) as originally referenced in the 2006 Historical Site Assessment (HSA) Report.

Munitions and Explosives of Concern Clearance Activities at Hula Bowl II and III Associated Drainage Area, and the Depleted Uranium (DU) Impacted Area
The Hula Bowl II and III and DU Work Plan Addenda were approved with comments by DTSC in June 2008. EODT continues to coordinate with the DU-Impacted Area contractor Energy Solutions and AMEC Geomatrix to refine a phased removal plan consisting of an initial surface clearance to be followed by a removal to depth in the footprint of the DU excavation. After the MEC surface clearance is complete and actual site conditions are known, along with DTSC, the subsurface removal action alternatives will be planned and completed. Fish and Game permit application has been submitted and approved for brush clearance in the DU clearance area.

Hula Bowl II and III Drainage
EODT is tracking the landfill drainage so the clearance is completed after the drainage 'dam' is in place (so new items do not enter the drainage).

Anticipated Activities for This Month

Work Plan Addendum Further Investigation and No Further Action Areas
Anticipate planning for the field work execution and staffing in coordination with DTSC and the stakeholders.

Munitions and Explosives of Concern Clearance Activities at Hula Bowl II and III Associated Drainage Area, and the Depleted Uranium Impacted Area
Track the progress on the Hula Bowl II and III drainage 'dam' to determine the appropriate time for surface removal.

DU area MEC clearance
EODT will continue to track the progress of the review and approval process and refine the schedule for the surface clearance.

SECTION III – GROUNDWATER AND SURFACE WATER ISSUES

Specific actions taken on behalf of the respondent, action expected to be undertaken and planned activities for groundwater and surface water issues are summarized in the following sections:

GROUNDWATER (OU7) FEASIBILITY STUDY (FS)

Activities for This Report Period (1)

The Draft OU-7 FS report has been prepared and is under internal review. To support the OU-7 FS evaluations, step drawdown testing was conducted in selected OU2/OU6 perched zone wells to assess hydraulic properties.

Anticipated Activities for This Month

Continue the OU-7 FS evaluations. The Draft OU-7 FS report is under review and will be submitted to DTSC in October 2009.

Review the step drawdown testing results for selected OU2/OU6 perched zone wells. This information will be used in the OU-7 FS evaluation of groundwater extraction and dewatering options for the perched groundwater zone.

Long-Term Actions

Prepare the Remedial Action Plan for OU-7.

INTERIM REMEDIAL MEASURES (IRMS) AND PILOT PROGRAMS FOR GROUNDWATER

SAUGUS AQUIFER EXTRACTION PILOT PROGRAM

Activities for This Report Period

The Work Plan, Saugus Aquifer Pilot Remediation Well Network, Operable Unit 7 was submitted to DTSC on September 22, 2008. DTSC provided comments on November 18, 2008 and subsequently provided conditional approval of the Work Plan on December 31, 2008. A request for qualifications and proposals (RFQ/RFP) for implementation of the Saugus Extraction Pilot program was issued during March and a site tour was given to the bidders on March 25th. Responses to RFQ/RFP were received from five firms on the proposal deadline of April 23. Following review of the proposals, presentations and interviews were conducted with the five companies on May 27, 2009. Whittaker team has entered into contract negotiations with the front runner firm for implementation of the Saugus Extraction Pilot program.

Anticipated Activities for This Month

Whittaker team will continue negotiations with the front runner firm and execute a mutually agreeable contract so that the scope of work outlined in the Work Plan, Saugus Aquifer Pilot Remediation Well Network is implemented. DTSC comments on the Pilot Saugus Groundwater Remediation Work Plan will be incorporated as the Work Plan is implemented.

Long-Term Actions

Implement the Saugus Aquifer Extraction Pilot Program. Incorporate the results of the pilot work to the groundwater (OU7) RAP and design document.

NORTHERN ALLUVIUM GROUNDWATER TREATMENT SYSTEM OPERATION

Activities for This Report Period (1)

A Pilot Remediation Pumping Program was started in Northern Alluvium Areas 11, 67, and 75, in 2006. An alternate extraction well 75-MW-35 for higher groundwater extraction and six hot spot wells were connected to the new higher capacity groundwater treatment system in 2007. Sustained pumping of the extraction well 75-MW-35 that began in mid-October 2007 continues to date, with the exception of a brief period of shut down for treatment system maintenance. As of August 31, 2009, approximately 23,017,700 gallons of impacted water have been treated and discharged.

The August monthly compliance sample was collected on August 3, 2009. The sampling results indicated that the system was in compliance during May. Media were replaced in the treatment vessels as follows:

- August 6, 2009 – Removed/replaced perchlorate media in lead vessel.

- August 31, 2009 – Removed/replaced nitrate medial in lead vessel.

After replacement, the nitrate and perchlorate treatment vessels were reconfigured to have the old lag vessel as the lead and the new vessel with fresh media as the lag vessel. Because of a cracked valve on the GAC manifold, only the lead GAC vessel is in operation. Siemens is working on a solution to repair the leaky manifold.

The system was operated routinely throughout the month. The low flow wells were shut down during the routine quarterly sampling event (August 5 to August 12, 2009), however, the high flow well remained on during this time. As of August 31, 2009, approximately 23,017,700 gallons of impacted water have been treated and discharged. Approximately 91 percent of the treated volume was from the extraction wells of the Northern Alluvium pumping system; the remaining 9 percent is from IDW water collected during the quarterly sampling events, storm water collected from various areas of the site, and Saugus well development water.

Anticipated Activities for This Month

Continue the pumping, treatment, and discharge system operation and routine weekly and monthly NPDES compliance sampling and media change outs as needed.

Monitoring of the aquifer response to pumping from the alternate extraction well 75-MW-35 and the downgradient site boundary low flow extraction wells will continue.

Repair GAC manifold and put the second GAC treatment vessel back into service.

Long-Term Actions

Continue operating the extraction and treatment system and conduct additional performance monitoring.

Activities for This Report Period (2)

Potential application of remedial technologies for Northern Alluvium groundwater hot spots, including evaluation of the Area 75 boundary containment established by sustained operation of the low flow pumping wells is being addressed in the OU7 FS.

Anticipated Activities for This Month

Evaluation of potential pilot studies for the Northern Alluvium area of the site will continue. The results presented in the Shaw Technology Demonstration Summary Report for Area 11 will be reviewed for potential applicability to other areas in the Northern Alluvium.

Long-Term Actions

Additional source control measures in Northern Alluvium will be considered and recommended where determined to be necessary.

GROUNDWATER AND MONITORING

Activities for This Report Period (1)

Data review and preparation of the report is in progress for the Second Quarter 2009 quarterly groundwater monitoring. Sampling for the Third Quarter 2009 monitoring event was conducted during August.

Anticipated Activities for This Month

Data review and preparation of the report is in progress for the Second Quarter 2009 quarterly groundwater monitoring.

Long-Term Actions

Continue monitoring and reporting of the proposed network of monitoring wells on the updated schedule presented in Technical Memorandum No. 8.

Activities for This Report Period (2)

RCRA groundwater monitoring of the Area 1 (former Building 317) continues on schedule. Data from the Second Quarter 2009 groundwater monitoring event conducted in May 2009 is being reviewed. Sampling for the Third Quarter 2009 monitoring event was conducted during August.

Anticipated Activities for This Month

Data from the Second Quarter 2009 groundwater monitoring event conducted in May 2009 is being reviewed and report preparation is in progress.

Long-Term Actions

The current RCRA groundwater monitoring program will be modified to include the proposed wells and frequency and DTSC input to the monitoring plan.

STORM WATER MONITORING

Activities for This Report Period

Pursuant to the site Storm Water Pollution Prevention Plan, Environ continued coordinating the implementation of short-term surface water run-off mitigation measures. Implementation of the short-term mitigation measures is being coordinated with CDM, particularly in the areas of the site where soil remediation activities have occurred.

Anticipated Activities for This Month

Upgrades to the short-term mitigation measures will continue as necessary. CDM is working on a plan for upgrading the short-term mitigation measures. Surface water run-off sampling will be conducted following significant rainfall events in accordance with the site-wide surface water runoff sampling plan.

Long-Term Actions

Long-term mitigation of the drainages and excavations will be conducted in conjunction with the soil remediation.

SECTION IV – REQUIREMENTS UNDER THE ORDER THAT WERE NOT COMPLETED

All requirements of the Order were completed. Whittaker has met or exceeded all the substantive requirements of the Order.

SECTION V – PROBLEMS OR ANTICIPATED PROBLEMS IN COMPLYING WITH THE ORDER

Following DTSC's agreement with Whittaker's proposed modifications to implementation plans in compliance with the Order reflected in the letter dated September 28, 2004, DTSC's letter dated July 11, 2005, included a schedule for submitting a number of documents. All deadlines have been met and documents have been submitted per requested schedule.

SECTION VI – RESULTS OF SAMPLE ANALYSIS, TESTS, AND OTHER DATA

Whittaker has instructed its contractors to continue to provide DTSC staff with raw data sets for ongoing quarterly groundwater monitoring events and RI/FS work upon receipt from the lab.

Sincerely yours,
AMEC Geomatrix, Inc.

Hassan Amini, PhD, CHG
Project Coordinator

cc: Eric Lardiere, Esq., Whittaker Corp; Joseph Armao, Winston & Strawn, LLP; William Weaver, CDM; Jessica Donovan, ENVIRON; Paul Bergstrom, Knight Piésold; Larry Sievers, EODT; Tim Bricker, Santa Clarita L.L.C.; Megan Trend, Chubb Financial Solutions; Cindy Hunter, MariKay Fish, Julie Diebenow, AIG Insurance; Vitthal Hosangadi, NOREAS; John Carty, Zurich North America; Hal Dash, Cerrell Associates; Jeff Hogan, City of Santa Clarita; Yueh

Chuang, CH2M Hill; Kathy Stryker Anderson, US Army Corps of Engineers; Robert DiPrimio, Valencia Water Company; Lynn Takaichi, and Meredith Durant, Kennedy Jenks; David Bacharowski, RWQCB; James Leserman, Castaic Lake Water Agency; Steve Cole, Newhall County Water District; Mauricio Guardado, Santa Clarita Water; Neil Elsey, Avion Holdings LLC; Alisa Lacey, Stinson Morrison Hecker LLP; Jeff O'Keefe, Department of Public Health.

NEWS RELEASE
DATE: September 14, 2009
FOR IMMEDIATE RELEASE

CONTACT: Dan Masnada (661) 297-1600 ext. 239
Brian Folsom (661) 297-1600 ext. 270

CASTAIC LAKE WATER AGENCY

CLWA TO CELEBRATE COMPLETION OF PROJECT TO RESTORE GROUNDWATER PRODUCTION CAPACITY IMPACTED BY PERCHLORATE CONTAMINATION

The Castaic Lake Water Agency (CLWA), in partnership with the CLWA Santa Clarita Water Division, Newhall County Water District, Valencia Water Company and the City of Santa Clarita, will be holding an event celebrating completion of a project to restore groundwater production capacity impacted by perchlorate contamination and stop migration of a contaminant plume emanating from the former Whittaker-Bermite site in the center of the Santa Clarita Valley. The event is scheduled for Tuesday, September 22, 2009 at 9:30 a.m. at CLWA Rio Vista Intake Pump Station (RVIPS) located at 26401 Bouquet Canyon Road. The RVIPS is the stucco building to the left of In-N-Out Burger near Lowe's Home Improvement Warehouse.

After years of negotiations and studies, regulatory agencies, property owners and water suppliers agreed on the process to clean up ammonium perchlorate contaminating a portion of the local groundwater basin. The contamination is a result of manufacturing and storing explosives, fireworks and munitions over 50 years at the approximate 996 site.

The project to restore the well production capacity and mitigate the migration of the perchlorate plume began in 2007. Pumping and treatment operations will occur on a continuous basis over a number of decades. The affected groundwater will be pumped from two existing wells through a dedicated underground pipeline to the new perchlorate treatment plant located at CLWA's RVIPS. The project will remove the perchlorate from the pumped groundwater using ion exchange technology. The treated groundwater will then be disinfected and pumped into the CLWA distribution system.

Other activities on the project include continual monitoring of the wells and further characterization of the groundwater contamination to ensure migration of the contaminate plume is fully contained. The entire process will be overseen by State regulatory agencies to ensure public health and safety. The successful completion of the project would not be possible without the mutual cooperation of many parties in addition to the four water agencies and the City, including the U.S. Army Corps of Engineers, California Department of Public Health, California Department of Toxic Substances Control, Los Angeles County Department of Public Works, community groups, Whittaker Corporation, and numerous consultants, contractors, and suppliers.

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AMEC Geomatrix, Progress Letter Report from Hassan Amini, Ph.D., Project Coordinator, to DTSC, June 8, 2009

June 8, 2009

Project 9967

Mr. Jose Diaz
Department of Toxic Substances Control
Site Mitigation Branch
9211 Oakdale Avenue
Chatsworth, California 91311

Re: Request for Deadline Extension for OU2-6 RAP
Former Whittaker Bermite Facility, Santa Clarita, CA

Dear Mr. Diaz:

Confirming our discussions of May 22 and June 2, this letter presents Whittaker's formal request to extend the deadline for submitting the Remedial Action Plan (RAP) for Operable Units 2 through 6 of the former Whittaker Bermite site (the site) from May 29, 2009, to August 14, 2009.

As you are aware, the Whittaker team prepared and submitted the second draft of the RAP to the Department of Toxic Substance Control (DTSC) on January 30, 2009. DTSC provided comments on April 10, 2009, and referenced the February 18, 2009, letter from the City of Santa Clarita (City) and raised concern that modifications to the terms and conditions of the Porta Bella Development Plan that was referenced in the City letter would significantly delay cleanup of the site. Based on that concern DTSC requested that the RAP should be revised to remove any reference to the Porta Bella Plan. As requested, the Whittaker team is currently revising the RAP and removing specific references to the Porta Bella Plan. Nonetheless, we wish to maintain the references to the integration of site remediation with potential future development on a conceptual level to allow flexibility for any potential future development.

As we discussed during our telephone conversations on May 22nd and June 2nd, 2009, a technical meeting between the DTSC and Whittaker teams will be highly beneficial to discuss application of the selected remedial measures to specific areas referenced in the RAP. To that end, I will contact you to coordinate that meeting. Following our technical meeting and discussions with DTSC, we will make appropriate changes to the text, figures, tables, and appendixes as necessary.

The April 10, 2009, DTSC letter also provided comments related to the Resource Conservation and Recovery Act (RCRA) unit (OU6). DTSC requested a revised "Closure Plan" for the RCRA unit to incorporate pilot and field studies proposed for that area. DTSC anticipates that the revisions to the Closure Plan will trigger Class 2 or 3 modifications to the RCRA Interim Status Hazardous Waste Facility Permit. As I briefed you during our telephone conversations, we are currently reviewing the available closure options for the RCRA unit (i.e., clean closure vs. closure with waste in place). Based on the review of the DTSC comments and our telephone conversations, we understand that modifications to the Closure Plan can be proposed at this time while the pilot and field studies are underway. However, the determination of "clean" vs. "waste in place" closure will need to be made based on the results of the studies as well as an

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assessment of the risks to human health and environment that may be posed by any residual chemicals beneath the RCRA unit. Although we have already started review of this matter, development of modifications to the Closure Plan will require additional time. Therefore, I respectfully request a revised deadline of September 15 for the proposed modifications.

As you are aware, we are making good progress in implementing the work plan for the soil vapor extraction pilot study that has been approved by the DTSC. We have also started the laboratory scale testing portion of our pilot study work plan for Gaseous Electron Donor Injection Technology potentially applicable to deep soil treatment at the site. Meanwhile, we will continue our focus on expediting on-site groundwater containment through implementation of the pilot scale extraction and treatment operation that was approved by DTSC. To that end, we have finished review of the contractors' proposals and have conducted interviews to select a qualified firm. We will make that selection in the next two weeks. In addition, Energy Solutions results of characterization of the depleted uranium (DU) impact in the Areas 57 and 14 and their work plan for DU removal has been finalized and will be submitted to DTSC and the Radiological Health Branch of the California Department of Public Health shortly. In summary, we are making good progress in all areas of compliance with the DTSC order, as I regularly summarize in my monthly project progress summary reports.

Please call me at (949) 642-0245 if you need any additional information. Thank you for your continuous attention and support.

Sincerely,
AMEC Geomatrix, Inc.

Hassan Amini, Ph.D. C.HG.
Project Coordinator

cc: Eric Lardiere, Whittaker Corp; William Weaver, CDM; Jessica Donovan, ENVIRON; Paul Bergstrom, Knight Piésold; Larry Sievers, EODT; Tim Bricker, Santa Clarita L.L.C.; Megan Trend, Chubb Financial Solutions; Cindy Hunter, MariKay Fish, Julie Diebenow, AIG Insurance; Vitthal Hosangadi, NOREAS; John Carty, Zurich North America; Hal Dash, Cerrell Associates; Jeff Hogan, City of Santa Clarita; Yueh Chuang, CH2M Hill; Kathy Stryker Anderson, US Army Corps of Engineers; Robert DiPrimio, Valencia Water Company; Lynn Takaichi, and Meredith Durant, Kennedy Jenks; David Bacharowski, RWQCB; James Leserman, Castaic Lake Water Agency; Steve Cole, Newhall County Water District; Mauricio Guardado, Santa Clarita Water; Neil Elsey, Avion Holdings LLC; Alisa Lacey, Stinson Morrison Hecker LLP; Jeff O'Keefe, Department of Public Health

CLWA Memorandum from Brian J. Folsom to CLWA Board of Directors, October 1, 2009

Castaic Lake Water Agency
Memorandum

ITEM NO. 4.1

October 1, 2009

To: CLWA Board of Directors

From: Brian J. Folsom BJF
Engineering and Operations Manager

Subject: Engineering and Operations Department Report

TREATMENT PLANT OPERATIONS AND MAINTENANCE

Completed Work:

Deliveries to the purveyors in September totaled 4,663 acre-feet (AF), for an average daily flow rate of 51 million gallons per day (MGD). September 2009 deliveries were 8.7% above September 2008 deliveries. The fiscal-year-to-date (FYTD) deliveries for FY 2009/2010 are 15,036 AF, which is 2.2% above FYTD 2008/2009. Monthly flows for 2006, 2007, 2008 and 2009 are presented in the attached table. *(FY 09/10 Action A1.1. Meet all purveyor water demands and Action B3.9: Meet all applicable water quality regulations.)*

FYTD electrical use for FY 2009/10 at the Agency's major facilities is shown in the attached "Energy Usage at Major Facilities" table and equals 2,990,433 kWh at a total cost of $343,452.77.

Inspection and maintenance activities during September included cleaning wash water return basins, chemical feed pump monthly maintenance, on-line analyzer maintenance and fabrication of clarifier screens at RVWTP.

Distribution system maintenance activities during September included preventive maintenance on air release and vacuum valves and pump outs, and exercising of valves. Grading at Sand Canyon Reservoir was completed.

Inspector Activities

Pressure recorders/data loggers readings and GPS coordinates were gathered at various points throughout the system.

Magic Mountain Pipeline/Recycled Water Pipeline Modification: Performed inspections of Security Paving's construction of the Magic Mountain Pipeline Vault Replacement.

Rio Vista Water Treatment Plant Expansion: Inspected soil borings, located underground facilities and collected GPS coordinates of existing utilities throughout jobsite.

Completed 50 dig alerts.

Work in Progress:

Maintenance of air release and vacuum valves and pump-outs throughout the distribution system continues. Ozone injector preventive maintenance is ongoing. At RVWTP, a leak was discovered near the plant water line and the area was excavated to determine the source of the leak. Repair of the leak is nearly complete. Electrical switch gear preventive maintenance and testing at all facilities continues.

Planned Actions:

Install ozone generator cooling water closed loop system. Perform repairs on plant water tank at Rio Vista Water Treatment Plant.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT

(FY 2009/10 Action A4.1: Complete construction of the Groundwater Production Restoration Project; Action A4.2: Complete construction and startup of the Perchlorate Treatment Project; Action A4.8: Develop replacement wells for capacity lost due to perchlorate contamination.)

SUMMARY

Work continues on multiple tasks to address the groundwater contamination stemming from past manufacturing activities on the Whittaker-Bermite site. The Agency and purveyors are proceeding to restore the production capacity of the groundwater supply wells contaminated by perchlorate, while working on the objectives of containing the downgradient migration of perchlorate and recovering costs incurred in responding to the perchlorate contamination.

PERCHLORATE CONTAMINATION PROGRAM MANAGEMENT

The following table provides a status report on the activities and tasks:

Task Group	Tasks	Consultant	Status
Settlement Activities	Project Description	K/J	Complete.
	Final Settlement	K/J, Nossaman	Settlement agreement took effect on 7/13/07 with U.S. District Court approval.
DTSC Approval Activities	Remedial Investigation (RI)	K/J	DTSC approved 8/16/05.
	Feasibility Study (FS)	K/J	DTSC approved 8/16/05.
	Final Remedial Action Plan	K/J	Public hearing held 9/7/05. DTSC approved 1/20/06.
U.S. Army Corps of Engineers Feasibility Phase Study	Conceptual Hydrogeology Technical Memorandum	CH2MHill	Final distributed 1/19/05. Progress report with model construction calibration distributed 10/11/05.
DPH Approval Activities (97-005)	Source Water Assessment	B&V, CE	Received comments on revised document from DPH 4/27/06.
	Effective Monitoring and Treatment	B&V, CE, CH2MHill	Received comments on revised document from DPH 4/27/06.
	Water Quality Investigation	B&V, CE	Received comments on revised document from DPH 4/27/06.
	Human Health Risk	B&V	Received comments on revised document from DPH 4/27/06.
	Source Protection Plan	B&V	Received comments on revised document from DPH 4/27/06.

Task Group	Tasks	Consultant	Status
	Alternatives Evaluation	B&V, CE	Received comments on revised document from DPH 5/10/06. Revised document will be returned to DPH with Engineer's Report.
	Engineers Report	B&V	Final submitted to DPH 1/29/09.
	CEQA	B&V	Mitigated Negative Declaration certified 9/14/05.
	Operations and Maintenance Report	K/J	Staff is reviewing K/J draft report submitted on 8/19/09.
	Permit Application	B&V	Will be submitted with documents.
	Public Hearing	B&V	Will take place upon approval of all documents.
	DPH Evaluation and Permit	B&V	Awaiting response from DPH.
Implementation Activities	Easements and Right of Way	K/J	Easement and right-of-way acquisition completed 1/08.
	Treatment Project	K/J	Project is 96% complete.
	Pipeline Project	K/J	Project is 98% complete.
	Well Rehabilitation	SCP/GPC	General Pump completed the rehabilitation work on 2/3/09 and installed the new pumps.
	Start-up and Monitoring	K/J	Scheduled fall 2009.
	Sentinel Wells	Environ	Wells have been installed. Disposal of investigation derived wastes awaits results of laboratory analyses.

The monthly Technical Committee Meeting was held on September 9, 2009. The next Technical Committee Meeting is scheduled for October 13, 2009. The next Whittaker-Bermite Multi-Jurisdictional Task Force meeting is scheduled for December 9, 2009. A ribbon cutting event was held at the new Perchlorate Treatment Facility on September 22, 2009.

FINANCIAL STATUS

The Settlement Agreement among CLWA, the purveyors, Whittaker-Bermite and insurance carriers is in effect. Reimbursement requests have been submitted and payments have been made for expenses through July 31, 2009.

CAPITAL IMPROVEMENT PROJECTS

Sand Canyon Pipeline and Reservoir

Completed Work:

Nye and Nelson, Inc. completed construction work on July 31, 2009. The Agency approved the Certificate of Acceptance for the project on August 26, 2009 and recorded the Notice of Completion on September 2, 2009.

Work In Progress:

Construction contract is in close-out phase.

Planned Actions:

Close out project and process final payment to contractor.

Rio Vista Water Treatment Plant Expansion

(FY 2009/10 Action B1.26: Complete construction of the RVWTP Expansion Project.)

Completed Work:

The contractor has installed the foundation rebar for the new washwater return basin and the formwork for a portion of the chlorine building walls. The contractor has also constructed a portion of the ozone injection sample stations and prepared the subgrade for the new clarifier structure.

Work In Progress:

The contactor is working on the remaining submittals and Kennedy/Jenks Consultants (K/J) is reviewing the submitted submittals. The contractor is installing the formwork for the chlorine building walls and preparing the clarifier structure area for rebar installation. The contractor is also installing electrical duct banks.

Planned Actions:

The contractor will continue to prepare and submit his construction submittals and K/J will continue to review them. Construction activities will continue.

Modification to MWDSC Foothill Feeder Connection

(FY 2009/10 Action B1.25: Complete construction of the permanent raw water connection to MWDSC's Foothill Feeder pipeline.)

Completed Work:

The connection agreement has been executed. The 60% design submittal has been completed.

Work in Progress:

MWDSC and staff are reviewing the 60% submittal.

Planned Actions:

MWDSC and staff will be submitting comments to K/J for action.

Honby Parallel Phase II

(FY 2009/10 Action B1.3: Complete design of the Honby Parallel Pipeline Phase 2; Action B1.24: Complete construction of the Honby Parallel Pipeline Phase 2.)

Completed Work:

The City has approved the pipeline alignment and geotechnical data.

Work in Progress:

Permits, license agreements and easements are in the process of being acquired. K/J is revising the plans and specifications to address LADWP comments.

Planned Actions:

Complete and submit the traffic control plans to the City for approval. Mail notification letters to businesses along the project route to inform them of the project. Acquire permits, license agreement and easements. Submit the revised plans and specifications to LADWP.

RVWTP Relocate Entrance Gate and Security Kiosk

(FY 2009/10 Action B6.2: Complete design of RVWTP entrance gate and security kiosk relocation.)

Completed Work:

Lee & Ro completed the PDR.

Work In Progress:

Staff is in the process of requesting Board approval of the final design services.

Planned Actions:

Start final design.

RVWTP Warehouse and Storage Facilities

(FY 2009/10 Action B1.16: Complete design of the RVWTP Maintenance Facility Expansion Project.)

Completed Work:

Lee & Ro completed the preliminary plans.

Work in Progress:

Staff is reviewing the preliminary plans.

Planned Actions:

Staff will meet with Lee & Ro to discuss staff's comments to the preliminary plans.

ESFP Chemical Storage and Delivery

Completed Work:

SoCal Pacific Construction completed 99% of the construction contract. Remaining work was evaluated and credits and liquidated damages were issued as deductive contract change orders. Notice of Completion for the project was recorded in the Los Angeles County Recorder's Office on August 20, 2009 and the final payment was released on September 30, 2009.

ESFP Chemical Storage and Delivery

(Continued from previous page...)

Work in Progress:

Construction contract is in closeout phase.

Planned Actions:

Agency staff will complete the remaining construction items.

ESFP Drainage and Paving Improvements

(FY 2009/10 Action B1.23: Complete construction of the ESFP Drainage and Paving Improvements Project.)

a) Planning and Preliminary Design for ESFP Drainage and Paving Improvements.

b) ESFP Ozone Injection Station Canopy, Lighting and Pavement Improvements.

Completed Work:

a) Notice to Proceed was issued to Civiltec Engineering, Inc. on November 13, 2008. Civiltec completed topographic survey, subsurface investigations, initial Base Map and submitted the Geotechnical Investigation Report and a draft of a Preliminary Design Report. On September 30, 2009, Civiltec submitted recommended alternatives for discussion.

b) Design drawings have been completed.

Work in Progress:

a) Civiltec Engineering, Inc. is finalizing the recommendations for a Preliminary Design Report draft.

b) The specifications are being finalized.

Planned Actions:

a) Staff will review the proposed design alternatives.

b) Advertise the project for construction bids.

ESFP Railing and Platform Modifications

(FY 2009/10 Action B2.16: Complete modifications of the ESFP railings and platforms.)

Completed Work:

The topographic survey has been completed. Construction drawings for the railing and platform improvements at washwater basin are being finalized. The design of railing and platform improvements at filter gallery was added to the project scope in April 2009. Hilts Consulting Group, Inc. collected and reviewed record drawings information and conducted field investigations and provided 90% submittals plans and specifications for staff review and comments.

Work in Progress:

Hilts Consulting Group is reviewing the comments and modifying the plans and specifications.

ESFP Railing and Platform Modifications

(Continued from previous page...)

Planned Actions:

On October 5, 2009, meet with the consultant to field verify proposed design details. Consultant anticipates submitting final plans and specifications for staff review and approval in October 2009.

Recycled Water Program Phase II

(FY 2009/10 Action B1.27: Complete design and construct Recycled Water Program Phase II.)

Completed Work:

The draft initial study for Phase 2A has been completed. The draft evaluation for the old Honby Pump Station has been completed. The draft design has been completed for the installation of inspection access structures for the old Honby Pipeline.

Work in Progress:

Staff is reviewing the draft initial study for Phase 2A and the draft evaluation of the old Honby Pump Station for Phase 2B. K/J is analyzing potential recycled water facilities near Lost Canyon for Phase 2B. Staff is reviewing the draft design of the inspection access structures for the old Honby Pipeline.

Planned Actions:

Complete the draft environmental documentation for Phase 2A. Finalize the evaluation of the old Honby Pump Station.

Kennedy/Jenks Consultants' General Engineering Services Work Authorization

During September, K/J assisted the Agency staff with various engineering tasks including coordinating with the Los Angeles County Sanitation District regarding the treatment and availability of recycled water at the Saugus Water Reclamation Plant and coordinating with Civiltec Engineering, Inc. on the development of the water system hydraulic model and the system emergency storage study.

FACILITY CAPACITY FEES

(Goal C1.: Fairness Doctrine - Apply all costs using the Fairness Doctrine by applying costs to those who benefit from an expenditure and ensuring that existing and future users will pay their fair share.)

Completed Work:

During September, 20 new certificates were issued and $145,894 was collected in facility capacity fees, representing approximately 11.7 acre-feet of water demand. For the fiscal year, 54 new certificates have been issued and $1,129,853 has been collected in developer impact fees representing 100.26 acre-feet of water demand.

Attachments

CASTAIC LAKE WATER AGENCY

SWP Water Deliveries to Purveyors (Acre-Feet)

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SCWC	807	775	428	545	1,603	2,051	2,648	2,410	2,183	1,495	1,267	936	17,146
VWC	821	875	622	887	1,736	2,050	2,360	1,412	1,614	1,574	1,327	1,035	16,313
NCWD	490	347	158	245	589	454	828	625	647	464	597	455	5,898
LACo	68	75	52	55	113	146	178	161	143	112	105	81	1,289
Total	2,186	2,072	1,260	1,732	4,041	4,701	6,013	4,608	4,586	3,644	3,295	2,508	**40,646**
Cum. YTD	2,186	4,258	5,518	7,250	11,291	15,992	22,005	26,613	31,199	34,843	38,138	40,646	
Cum. FYTD	26,700	28,772	30,032	31,763	35,804	**40,505**	6,013	10,622	15,207	18,852	22,146	24,654	
2007	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC	984	684	1,217	1,423	2,023	2,370	2,732	2,773	2,229	1,906	1,403	926	20,669
VWC	983	640	1,212	908	1,871	2,003	2,046	1,857	1,767	1,428	1,270	922	16,906
NCWD	436	185	397	578	712	586	765	910	630	443	420	418	6,478
LACo	83	63	92	102	137	151	174	168	138	122	107	69	1,406
Total	2,485	1,572	2,918	3,012	4,742	5,110	5,717	5,707	4,764	3,899	3,200	2,334	**45,459**
Cum. YTD	2,485	4,056	6,974	9,986	14,729	19,838	25,555	31,262	36,026	39,925	43,125	45,459	
Cum. FYTD	27,139	28,711	31,629	34,641	39,383	**44,493**	5,717	11,424	16,188	20,087	23,286	25,621	
2008	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC	764	707	1,203	1,273	1,795	2,333	2,446	2,283	2,064	2,044	1,162	638	18,712
VWC	815	583	1,631	1,443	1,640	1,845	2,159	1,761	1,577	1,419	1,000	547	16,419
NCWD	414	300	270	344	505	640	767	671	505	493	302	217	5,427
LACo	56	53	92	116	134	158	167	163	144	127	82	62	1,353
Total	2,049	1,642	3,196	3,175	4,074	4,975	5,539	4,879	4,290	4,083	2,546	1,465	**41,912**
Cum. YTD	2,049	3,692	6,887	10,062	14,136	19,111	24,650	29,529	33,819	37,901	40,447	41,912	
Cum. FYTD	27,670	29,312	32,508	35,683	39,757	**44,732**	5,539	10,418	14,708	18,790	21,336	22,801	
2009	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC	910	367	1,106	1,448	2,135	1,896	2,073	2,300	2,032	0	0	0	14,267
VWC	518	364	923	1,242	1,135	996	2,102	2,063	2,011	0	0	0	11,353
NCWD	242	132	210	415	467	427	937	599	477	0	0	0	3,904
LACo	75	38	73	102	134	121	152	149	143	0	0	0	986
Total	1,744	901	2,312	3,207	3,870	3,440	5,263	5,110	4,663	0	0	0	**30,510**
Cum. YTD	1,744	2,645	4,957	8,164	12,034	15,474	20,737	25,847	30,510	30,510	30,510	30,510	
Cum. FYTD	24,545	25,446	27,758	30,965	34,835	**38,275**	5,263	10,373	15,036	15,036	15,036	15,036	

10/1/2009

CASTAIC LAKE WATER AGENCY

Recycled Water Deliveries to Purveyors (Acre-Feet)

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SCWC													0
VWC	14	16	6	12	42	66	75	63	67	33	20	12	427
NCWD													0
LACo													0
Total*	14	16	6	12	42	66	75	63	67	33	20	12	**426**
Cum. YTD	14	30	36	48	90	156	231	294	361	394	414	426	
Cum. FYTD	284	300	306	318	360	**426**	75	142	209	242	262	274	
2007	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC													0
VWC	17	14	43	38	58	63	78	67	55	37	25	7	501
NCWD													0
LACo													0
Total*	17	14	43	38	58	63	78	67	55	37	25	7	**501**
Cum. YTD	17	32	74	112	170	233	311	378	433	469	494	501	
Cum. FYTD	291	306	348	386	444	**507**	78	133	187	224	249	256	
2008	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC													0
VWC	4	11	39	37	56	34	26	63	44	38	4	1	358
NCWD													0
LACo													0
Total*	4	11	39	37	56	34	26	63	44	38	4	1	**358**
Cum. YTD	4	16	54	92	147	182	208	271	315	353	357	358	
Cum. FYTD	260	271	310	348	403	**438**	26	89	133	171	175	176	
2009	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
SCWC													0
VWC	8	3	24	39	30	46	71	59	17	0	0	0	298
NCWD													0
LACo													0
Total*	8	3	24	39	30	46	71	59	17	0	0	0	**298**
Cum. YTD	8	11	35	74	104	150	221	280	298	298	298	298	
Cum. FYTD	184	187	211	250	280	**326**	71	88	105	105	105	105	

10/1/2009

FY 2009/10
Energy Usage at Major Facilities

Service Date From	Service Date To	Usage kWh Total	Usage kVarh Total	Total $ Amount
Earl Schmidt Intake Pump Station				
07/01/09	07/29/09	4,008	4,302	$489.20
07/29/09	08/27/09	7,226	10,163	$6,311.53
		Total		**$6,800.73**
Earl Schmidt Filtration Plant				
07/01/09	07/28/09	118,668	89,844	$12,575.44
07/28/09	08/26/09	124,925	97,018	$13,573.19
		Total		**$26,148.63**
Honby Pump Station				
07/01/09	07/22/09	0		$67.28
07/22/09	08/20/09	0		$94.80
		Total		**$162.08**
Recycled Water Meter				
07/01/09	07/10/09	10,987	4,197	$1,617.58
07/10/09	08/10/09	37,110	14,067	$5,325.10
		Total		**$6,942.68**
Rio Vista Intake Pump Station				
07/01/09	07/29/09	578,750	206	$73,917.27
06/29/09	07/29/09			$10.00
07/29/09	08/27/09	632,506	142,890	$80,482.94
		Total		**$154,410.21**
Rio Vista Water Treatment Plant				
07/01/09	07/29/09	183,775		$15,847.44
07/29/09	08/27/09	190,833		$16,335.09
		Total		**$32,182.53**
Sand Canyon Pump Station				
07/01/09	07/29/09	467,599	168,661	$53,803.10
07/29/09	08/27/09	574,056	202,627	$63,002.81
				$116,805.91
	TOTAL	**2,930,443**		**$343,452.77**

MANAGEMENT OF THE

CALIFORNIA STATE WATER PROJECT

BULLETIN 132-06 | *DECEMBER 2007*

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Publishing Information

Cover photo shows an aerial view of Del Valle Dam and Lake del Valle.
Cover design was provided by Xiaojun Li, Graphic Designer, Graphic Services.
Photos were provided by the Public Affairs Office Photography Unit.

Copies of this document are available for $20.00 per book and $5.00 per CD ROM from:

Publication Sales
Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001
(916) 653-1097

Printed on recycled paper

Bulletin 132-06

Management of the California State Water Project

Covers Activities during Calendar Year 2005

Published December 2007

Arnold Schwarzenegger *Governor*
State of California

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The Resources Agency

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Foreword

Bulletin 132-06, Management of the California State Water Project, continues the Bulletin 132 annual series begun in 1963. Bulletin 132-06 updates water supply planning, construction, financing, management, and operation activities of the State Water Project. Appendix B contains data and computations used to determine the State Water Project contractors' Statement of Charges for 2007. Appendix B was previously published as a separate document.

The Bulletin discusses significant events and issues that affect SWP management and operations. The Bulletin covers the period from January 1, 2005, to December 31, 2005.

Bulletin 132-06 also discusses water supply and delivery; Delta resources and environmental issues, including the CALFED Bay-Delta Authority; Oroville facilities relicensing; financial analysis of the SWP; and the update of business systems in the Department.

Lester A. Snow
Director

Contents

Foreword iii

Organization and Acknowledgements xxi
Departmental Divisions and Offices xxiii
California Water Commission xxiv
Abbreviations and Acronyms xxv

Executive Summary xxxiii

2005 SWP Highlights xxxv
2005 Precipitation and Water Storage xxxv
Precipitation and Snowpack in Water Year 2004–2005 xxxvi
Runoff xxxvi
Water Year 2004–2005 Storage Totals xxxvi
Calendar Year 2005 Storage Totals xxxvi
Water Year 2005–2006 October–December Water Conditions xxxvi
2005 Water Supplies, Contracts, and Deliveries xxxvii
2005 Water Deliveries xxxvii
Non-SWP Water Conveyance xxxvii
Dry Year Water Purchase Program xxxvii
Power Resources xxxvii
Oroville Facilities Relicensing xxxix
Financial Analysis xl
California Water Plan Update 2005 xl
Monterey Amendment xli
Delta Resources and Environmental Issues xli

California Bay-Delta Authority xlii
Status of Threatened or Endangered Species Listings xliv
Pelagic Organism Decline in the Upper San Francisco Estuary xliv
Flood Protection xlv
Arroyo Pasajero xlv
Security Measures for the State Water Project after September 11, 2001 xlv
SWP Milestones through the Decades xlvi
Forty Years Ago – 1965 xlvi
Thirty Years Ago – 1975 xlvi
Twenty Years Ago – 1985 xlvi
Ten Years Ago – 1995 xlvi

Chapter 1 The State Water Project 1

Precipitation and Runoff 3
Water Delivery Facilities 4
Project Design 4
Additional Construction 7
Methods of Financing 10
Long-Term Contracting Agencies 11

Chapter 2 Delta Resources 15

Delta Water Management Programs 17
South Delta Improvements Program 19
West Delta Program 20
North Delta Program 21
Delta Flood Control 22
CALFED Levee System Integrity Program 23
Delta Levee Maintenance Subventions Program 24

Delta Special Flood Control Projects 24
Delta Levees Habitat Improvement 25
Reuse of Dredged Material for Delta Levees 26
Levee Upgrades 27
Subsidence Investigations 27
Delta Agricultural Water Users 28
South Delta Water Agency Contract 28
Western Delta Municipal Water Users 29

Chapter 3 Environmental Programs 31

Operations for Species of Concern 33
San Joaquin River Activities 33
Piru Creek/Pyramid Dam Operations 34
Biological Opinions Issued on the Revised CVP/SWP Operating Plan 35
USFWS Biological Opinion 35
NOAA Fisheries Biological Opinion 35
Delta Export Curtailment 36
Decisions on Endangered Species 36
North American Green Sturgeon 36
Trends in Fish Abundance 37
Feather River Fish Studies 40
Pelagic Organism Decline in the Upper San Francisco Estuary 41
Fish-Related Mitigation Projects 42

Chapter 4 Water Quality Programs 45

Delta Activities 47
Water Supply Conditions 47
Water Year Classifications and Water Supply Indexes 47

Operations under the State Water Resources Control Board Water Right Decision 1641 49
Delta Cross Channel Gates 51
Water Quality Standards 51
Municipal and Industrial Objectives 51
Agricultural Objectives 51
Estuarine Habitat Protection Standard 52
Net Delta Outflow Index Standard 53
Flow Standards 53
Export Standards 54
South Delta Temporary Barriers 54
Special Study and Biological Surveys 55
Fall Dissolved Oxygen Study in the Stockton Ship Channel 55
Phytoplankton and Chlorophyll *a* Survey 58
Activities Outside the Delta 59
Water Quality Monitoring 59
Nonproject Water Turn-ins 60
Municipal Water Quality Investigations Program 60
Bryte Chemical Laboratory 64
Suisun Marsh Activities 65
Revised Suisun Marsh Preservation Agreement 66
Operation and Maintenance 67
Monitoring 68
Suisun Marsh Expenditure History 68

Chapter 5 Local Assistance 73

Davis-Grunsky Act Program 75
Water Use Efficiency 75
California Irrigation Management Information System (CIMIS) 75
Water Recycling and Desalination Branch 76

Agricultural Water Management Plans 77
Urban Water Management Plans 78
Draft Senate Bill 610 and Senate Bill 221 Guidebook 78
Outreach 78
Agricultural Drainage Program 79
Proposition 204 (Drainage Management Subaccount) 79
San Joaquin Valley Agricultural Drainage Program 80
Management of Contracts 85
Environmental Services 86
San Joaquin River Water Quality Improvement Program 86
On-Farm and Regional Drainage Management Activities 87
Real-Time Water Quality Monitoring Program 87
Environmental Impact Documents Review 89
Water Conservation Bond Laws 90
Propositions 25, 44, and 204 90
Proposition 82 90
Proposition 13 90
Proposition 50 91

Chapter 6 Legislation and Litigation 93

Legislation 95
State Legislation 95
Federal Legislation 96
Litigation 96
Sacramento-San Joaquin Delta 96
Hydropower 99

Chapter 7 Water Supply Development and Reliability 107

Supply Development and Reliability 109

Water Conveyance Through the SWP 109

SWP Delivery Reliability Report 111

Conjunctive Use and Groundwater Substitution 112

Watershed Management 115

SWP Water Rights Activities 115

Water Rights Permits 115

SWP Bay-Delta Proceedings—2005 Activities 116

Cease and Desist Order Hearings 116

Sacramento Valley Water Management Agreement 116

Periodic Review of the 1995 San Francisco Bay / Sacramento-San Joaquin Delta Estuary Water Quality Control Plan 117

CALFED Bay-Delta Program 119

Storage Program 119

Conveyance Program 122

Environmental Water Account 123

Chapter 8 Water Supply 125

Water Year 2004–2005 127

Precipitation and Snowpack 127

Runoff and Storage 129

Water Year 2005–2006 October–December Water Conditions 131

SWP Storage 131

Water Year 2004–2005 Storage Totals 131

Calendar Year 2005 Storage Totals 132

Lake Oroville 132

Calendar Year 2005 Inflow and Storage 132

2004–2005 Water Year San Luis Reservoir Operations 132
2004–2005 Water Year Lake Del Valle Operations 132
2004–2005 Water Year Southern Reservoir Operations 135
Diversions from the Delta 135

Chapter 9 Water Contracts and Deliveries 139

Amendments to Long-Term SWP Water Supply Contracts 141
2005 Amendments to Long-Term Water Supply Contracts 143
Monterey Amendments 144
Miscellaneous Agreements with Long-Term SWP Contractors 144
2005 Water Conveyance and Exchange Agreements..... 144
Water Conveyance and Exchange Agreements Prior to 2005 147
Turnout Agreements 148
Agreements and Activities Related to the Monterey Amendments ... 149
Article 21 Water Program 152
Flexible Storage Program 153
Extended Carryover Program 153
Environmental Water Account 153
Purchase Assets 154
Operational Assets..... 155
Miscellaneous Agreements with Other Agencies..... 155
Water Conveyance Agreements—CVP Water..... 155
Water Deliveries 157
Approved Table A Deliveries 157
SWP Deliveries 157
Water Deliveries to Long-Term SWP Contractors 158
Water Delivered in 2005 by Month..... 160
Non-SWP Water 160
Annual Table A Water and Water Delivered Since 1962..... 161

Chapter 10 Power Resources 177

Power Resources Program 179
- Major Electric Utility Industry Developments 179
- DWR Participation in Electric Utility Industry Activities 180
- Oroville Facilities Relicensing 182
- Existing SWP Power Facilities 183
- Future SWP Power Facilities 185
- Contractual Resource Arrangements 185
- Contractual Transmission Agreements 186
- Load Management 186

SWP Power Operation in 2005 187
- Energy Consumed 187
- Energy Generated 187
- Contractual Resource Arrangements 187

Sales of Excess Power 188

Forecasting Power Operations 188
- Criteria 189

Chapter 11 Facilities Maintenance 195

Inspecting and Maintaining Project Dams 197
- Routine Inspections 197
- Joint-Use Facility Inspection 197
- Underwater Inspection 197
- Independent Reviews 198

Arroyo Pasajero Program 199
- DWR and DWR/Reclamation Alternative Long-term Solution 199
- Related Activities 201

Repairs and Modifications 201

Chapter 12 Engineering and Right of Way.....207

Design Activities.....209

Environmental Activities.....211

Excavation, Inspection, and Repair–Phase III, Santa Ana Pipeline–State Water Facilities California Aqueduct, Southern Field Division, San Bernardino and Riverside Counties, California.....211

Tehachapi East Afterbay–Completion–Phase II, Antelope Valley–State Water Facilities, California Aqueduct, East Branch, Mojave Division, Kern County, California.....211

Construction Activities.....212

Oroville Division.....212

Delta Facilities.....212

North San Joaquin Division.....213

San Luis Division.....214

Tehachapi Division.....215

West Branch.....216

Santa Ana Division.....217

East Branch Extension.....217

Construction Activities in Multiple Divisions.....218

Miscellaneous Construction Activities.....219

Upper Jones Tract Levee Breach.....219

Real Estate Branch Activities.....220

Chapter 13 Recreation.....225

Recreation Areas.....227

Recreation Days.....227

Facilities.....227

Planning.....227

New Facilities.....229

Improvements to Facilities.....229

Oroville Recreation Plan 230
Fish Plantings 230
Recreation Financing 230
Capital Cost Allocations 232
Accrued Interest Charges 232

Chapter 14 Financial Analysis 235

Capital Requirements and Financing 237
Capital Requirements 238
Capital Financing 243
Capital Financing Sources 245
Annual Revenues and Expenditures 247
SWP Revenues 247
Project Expenses 254
Future Costs of Water Service 256

Chapter 15 SWP Education and Information 263

Media Outreach 265
Relicensing Oroville Facilities 265
Snow Surveys 265
California Bay-Delta Authority 265
News Events 265
Community Relations 266
Oroville 266
California Lakes and Reservoirs Appreciation Week 266
Video 267
Photography 267
Audio-Visual 267
Community Outreach 268

SWP Tours..... 268
Displays and Exhibits 268
Oroville Field Division..... 268
Delta Field Division..... 268
San Luis Field Division..... 268
Oral History Program 268
School Education Program 268
Water Awareness Month Activities 270

Appendix A: Annual Financial Report (discontinued)

Appendix B: Data and Computations Used to Determine 2007 Water Charges

Appendix D: Costs of Recreation and Fish and Wildlife Enhancement (discontinued)

Appendix E: Water Operations in the Sacramento-San Joaquin Delta (bound separately)

Appendix F: San Joaquin Valley Post-Project Economic Impact (discontinued)

Tables

Table ES-1 SWP Water Delivered by Category, 1962-2005..... xxxviii

Table 1-1 Physical Characteristics of Primary Storage Facilities..... 7

Table 1-2 Physical Characteristics of Primary Dams 8

Table 1-3 Pumping Plant Characteristics 8

Table 1-4 Power Plant Characteristics, by Type and Facility 9

Table 1-5 Total Miles of Aqueducts 9

Table 1-6 Long-Term Water Supply Contracting Agencies, by Area, as of December 31, 2005..... 12

Table 4-1 2005 Mean Water Quality at Selected State Water Project Locations 61

Table 4-2 Suisun Marsh Expenditures and Reimbursements Administered by DWR..... 71

Table 5-1 Water Conservation Bond Laws - Projects and Funding 92

Table 9-1 2005 Turn-Back Water Pool Program (Acre-feet)..... 150

Table 9-2 Article 21 Water Deliveries (Acre-feet) 152

Table 9-3 Water Delivered to Long-Term Contractors through 2005 (Acre-Feet) 163

Table 9-4 Total Amounts of Water Delivered in 2005, by Month..... 164

Table 9-5 Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-2005 (Acre-Feet) 174

Table 10-1 Energy Used at Pumping Plants and Power Plants in 2005, by Month..... 190

Table 10-2 Energy Generated and Purchased in 2005, by Month..... 191

Table 10-3 Power, Transmission, and Other Services Purchased in 2005 and Costs of Purchases, by Area 192

Table 10-4 Energy Sold in 2005 and Revenue from Sales, by Area.... 193

Table 11-1 Outages for Maintenance and Repair of Facilities in 2005, by Month..... 202

Tables, continued

Table 12-1 Design Activities, January 1, 2005, through December 31, 2005, by Division 221

Table 12-2 Construction Activities, January 1, 2005, through December 31, 2005, by Division 222

Table 13-1 Recreation-Days Recorded in 2005, by Field Division and Facility 229

Table 13-2 Fish Planted in 2005 (Thousands) 231

Table 13-3 Recreation and Enhancement Costs of the State Water Project 233

Table 13-4 Calculation of Interest Accruals on California Water Resources Development Bond Fund Disbursements (in dollars at 4.608% per annum) 234

Table 14-1 Capital Requirements and Financing, December 31, 2005 (Thousands of Dollars) 259

Table 14-2 State Water Project Revenues and Expenditures, December 31, 2005 260

Table 14-3 Allocation of Capital Expenditures 239

Table 14-4 East Branch Enlargement Capital Costs by Facility 242

Table 14-5 Estimated Capital Costs for Power Generation and Transmission Facilities 242

Table 14-6 Estimated Future Costs for Planning Additional Conservation Facilities 242

Table 14-7 Application of Revenue Bond Proceeds 244

Table 14-8 Revenue Bond Proceeds Affecting Project Interest Rate .. 249

Table 14-9 Actual Bond Sales and Project Interest Rates, by Date of Sale 250

Table 14-10 Operations, Maintenance, Power, and Replacement Costs, by Facility, Composition, and Purpose 261

Table 14-11 Annual Debt Service on Bonds Sold through December 31, 2005 262

Figures

Figure 1-1 Names and Locations of Primary Water Delivery Facilities, December 31, 2005 5

Figure 1-2 Names, Locations, and First Year of Service of Long-Term Contracting Agencies, December 31, 2005 13

Figure 2-1 The North, West, and South Delta Water Management Programs 18

Figure 3-1 Delta Smelt Fall Midwater Trawl Abundance Index, 1967–2005 38

Figure 3-2 Estimated Total Adult Winter-Run Chinook Salmon Escapement,1967–2005 38

Figure 3-3 Estimated Spring-Run Chinook Salmon Escapement, 1990–2005 39

Figure 4-1 Decision 1641 Water Quality Compliance and Monitoring Stations in the Sacramento-San Joaquin Delta 50

Figure 4-2 Compliance and Monitoring Stations in the Suisun Bay and Marsh 70

Figure 5-1 San Joaquin River Input-Output Day Modeling Forecasts Example 88

Figure 7-1 Projected SWP System Delivery Capability (Scenario 2025, Annual Table A) 113

Figure 8-1 Statewide Precipitation by Hydrologic Region, 2004–2005 Water Year, Percentage Average 130

Figure 8-2 Monthly Lake Oroville Inflow, 2003–2005 133

Figure 8-3 Cumulative Maximum, Minimum, and Current Lake Oroville Inflow 133

Figure 8-4 End-of-Month Storage in Lake Oroville, 2004 and 2005 Calendar Years 134

Figure 8-5 End-of-Month Storage in San Luis Reservoir, 2004 and 2005 Calendar Years 134

Figure 8-6 Water Pumped at Banks Pumping Plant, 2005 by Month .. 136

Figure 8-7 Sacramento-San Joaquin Delta Exports by State Water Project and Central Valley Project, 2005 136

Figures, continued

Figure 8-8 Water Pumped At Dos Amigos Pumping Plant, 2005 by Month 137

Figure 8-9 Water Pumped at Edmonston Pumping Plant, 2005 by Month 137

Figure 9-1 Water Delivered in 2005 and Delivery Locations of Long-Term Water Supply Contractors and Feather River Area Districts with Water Right Agreements with DWR 159

Figure 10-1 Names, Locations, and Nameplate Capacities of Primary Power Facilities 184

Figure 13-1 Names and Locations of SWP Recreation Areas 228

Figure 15-1 Visitors Centers on the SWP 269

Sidebars

State Water Project Power Generation and Consumption in 2005 xxxix
2005 Income Statement for the State Water Project xli
Endangered Species Acts 37
State Water Resources Control Board 48
Suisun Marsh Preservation Agreement 66
Water Code Section 1810–1811 103
Water Code Section 1812–1814 104
Environmental Review Acts 105
Environmental Review Acts, Continued 106
CALFED Bay-Delta Program 118
Long-Term SWP Water Supply Contracts 142

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California Water Commission

The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resources matters. The citizen commission provides a water resources forum for the people of the State, acts as a liaison between the legislative and executive branches of State government, and coordinates federal, State, and local water resources efforts. As of March 2004, all members had either resigned or their terms had expired. New members have not been appointed by the Governor at the time of printing of this bulletin.

Abbreviations and Acronyms

A

AB Assembly Bill
ACWA Association of California Water Agencies
ADA Americans with Disabilities Act
af acre-feet
AFRP Anadromous Fish Restoration Plan
Ag Council Agricultural Water Management Council
ASCE American Society of Civil Engineers
AWMP Agricultural Water Management Plan

B

BDAC Bay-Delta Advisory Council
BDPAC Bay-Delta Public Advisory Committee
BOD biochemical oxygen demand

C

CAISO California Independent System Operator
CALFED State (CAL) and federal (FED) agencies participating in the Bay-Delta Accord
CalPX California Power Exchange
CAMAL California Association of Mutual Aid Laboratories
C.A.S.T. Catch a Special Thrill
CBDA California Bay-Delta Authority
CCSG Cantua Creek Stream Group
CCWA Central Coast Water Authority
CD Conservation District
CDEC California Date Exchange Center
CEA Capacity Exchange Agreement
CEQA California Environmental Quality Act
CESA California Endangered Species Act
cfs cubic feet per second
CIDH cast in drill hole
CIMIS California Irrigation Management Information System
COA Coordinated Operation Agreement
Corps U.S. Army Corps of Engineers

CPUC California Public Utilities Commission
CUSE Catholic University of Santiago del Estero
CVC Cross Valley Canal
CVHJV Central Valley Habitat Joint Venture
CVP Central Valley Project
CVPIA Central Valley Project Improvement Act
CVRWQCB Central Valley Regional Water Quality Control Board

D

D-1485 State Water Resources Control Board Water Right Decision 1485
D-1641 State Water Resources Control Board Water Right Decision 1641
DBPs disinfection by-products
DBW California Department of Boating and Waterways
DCC Delta Cross Channel
DCVCW Direct Cross Valley Canal Wheeling
DEIR draft environmental impact report
DFG California Department of Fish and Game
DHS California Department of Health Services
DLRD Delta Lands Reclamation District
DO dissolved oxygen
DOC dissolved organic carbon
DOE Department of Energy or Division of Engineering
DOI U.S. Department of the Interior or Delta Outflow Index
DPR California Department of Parks and Recreation
DPS Distinct Population Segment
DSM2 Delta Simulation Model 2
DSOD Division of Safety of Dams
DWR California Department of Water Resources

E

EA/IS Environmental Assessment/Initial Study
EBRPD East Bay Regional Park District
ECAT Environmental Coordination Advisory Team
EHV extra-high voltage
E/I Export/Import
EIR environmental impact report
EIS environmental impact statement
EPA U.S. Environmental Protection Agency
ESA Endangered Species Act
ESO Environmental Services Office
ESU Evolutionarily Significant Unit
ETo Reference Evapotranspiration
EWA Environmental Water Account

F

FERC Federal Energy Regulatory Commission
FLIMS Field and Laboratory Information Management System

G

GBP Grasslands Bypass Project
gpm gallons per minute

H

HMP Hazard Mitigation Plan

I

ICR Information Collection Rule
IEP Interagency Ecological Program
IFDM Integrated on-Farm Drainage Management
IHSim Integrated Hydrological Simulator
INDP Interim North Delta Plan
ISDP Interim South Delta Program
ISI Integrated Storage Investigation
ITRC Irrigation Training and Research Center

J

JWR&DTF Joint Water Reuse & Desalination Task Force

K

kV kilovolt
KWB Kern Water Bank
kWh kilowatt hour

L

LADWP Los Angeles Department of Water and Power
LSEs Load Serving Entities

M

maf million acre-feet
MCL maximum contaminant level
MCWA Mokelumne-Cosumnes Watershed Alliance

MD02 Market Design 2002
MFP Middle Fork Project
mg/L milligrams per liter
MIB Methylisoborneal
MIDS Morrow Island Distribution System
MRTU Market Redesign and Technology Upgrade
MTBE methyl tertiary butyl ether
MWh megawatt hour
MWQI Municipal Water Quality Investigations

N

NBA North Bay Aqueduct
NDOI Net Delta Outflow Index
NEMDC Natomas East Main Drainage Canal
NEPA National Environmental Policy Act
NOAA Fisheries National Marine Fisheries Service
NODOS north-of-the-Delta offstream storage
NOP/NOI Notice of Preparation/Notice of Intent
NPC Nevada Power Company
NPDES National Pollutant Discharge Elimination System

O

OBS optical backscatter
OCAP Operating Criteria and Plan
O&M Division of Operations and Maintenance
OM&P operations, maintenance, and power
OMP&R operations, maintenance, power, and replacement
OM&R operations, maintenance, and replacement

P

PCL Planning and Conservation League
PG&E Pacific Gas and Electric Company
pH [p(otential) of H(ydrogen)]
ppt parts per thousand
PAO Public Affairs Office
PDEA Preliminary Draft Environmental Assessment
PFMA Potential Failure Mode Analysis
PM particulate matter
POD pelagic organism decline
PSA Public Service Announcement
PSP Proposal Solicitation Packet

Q

QA/QC Quality Assurance/Quality Control

R

RCRC Regional Council of Rural Counties
RD reclamation district
Reclamation Bureau of Reclamation
RMR Reliability Must-Run
RMS Reliability Management System
ROD Record of Decision
RRR Red Rock Ranch
RTWQMP Real-time Water Quality Monitoring Program

S

SAP System Application Products
SB Senate Bill
SCE Southern California Edison
SDG&E San Diego Gas and Electric
SDIP South Delta Improvements Program
SDTBP South Delta Temporary Barriers Project
SDWA South Delta Water Agency
Se Selenium
SEW Suisun Ecological Workgroup
SGA Sacramento Groundwater Authority
SJVDIP San Joaquin Valley Drainage Implementation Program
SJRA San Joaquin River Agreement
SJREC San Joaquin River Exchange Contractors Water Authority
SJRIODAY San Joaquin River Input-Output Day
SLFD San Luis Field Division
SMPA Suisun Marsh Preservation Agreement
SMSCG Suisun Marsh Salinity Control Gates
SNL Sandia National Laboratories
SPPC Sierra Pacific Power Company
SRB State Reclamation Board
SRCD Suisun Resource Conservation District
STID Supporting Technical Information Document
SVUR Sacramento Valley Unimpaired Runoff
SVWMA Sacramento Valley Water Management Agreement
SVWMP Sacramento Valley Water Management Program
SWP State Water Project
SWRCB State Water Resources Control Board
SWT Sephton Water Technology

T

taf thousand acre-feet
TDF through-Delta facilities
TEAM Transmission Economic Assessment Methodology
THM trihalomethane
TOC total organic carbon

U

UCLA University of California at Los Angeles
USFWS U.S. Fish and Wildlife Service
USGS U.S. Geological Survey
UWMP Urban Water Management Plan

V

VAMP Vernalis Adaptive Management Plan
VTE vertical tube evaporation

W

WAM Water Awareness Month
WECC Western Electricity Coordinating Council
WET Water Education for Teachers
WQA water quality assessment
WQCP Water Quality Control Plan
WR 95-06 SWRCB Water Right Order 95-06
WSCC Western Systems Coordinating Council
WSDB West Side Detention Basin

The State Water Project long-term water supply contractors are listed below, followed by shortened forms of their names that are used in Bulletin 132 instead of acronyms.

Alameda County Flood Control and Water Conservation District, Zone 7	Alameda-Zone 7
Alameda County Water District	Alameda County
Antelope Valley-East Kern Water Agency	AVEK
Castaic Lake Water Agency	Castaic Lake
City of Yuba City	Yuba City
Coachella Valley Water District	Coachella
County of Butte	Butte
County of Kings	Kings
Crestline-Lake Arrowhead Water Agency	Crestline
Desert Water Agency	Desert
Dudley Ridge Water District	Dudley Ridge
Empire-West Side Irrigation District	Empire
Kern County Water Agency	Kern
Littlerock Creek Irrigation District	Littlerock
Metropolitan Water District of Southern California	Metropolitan
Mojave Water Agency	Mojave
Napa County Flood Control and Water Conservation District	Napa
Oak Flat Water District	Oak Flat
Palmdale Water District	Palmdale
Plumas County Flood Control and Water Conservation District	Plumas
San Bernardino Valley Municipal Water District	San Bernardino
San Gabriel Valley Municipal Water District	San Gabriel
San Gorgonio Pass Water Agency	San Gorgonio
San Luis Obispo County Flood Control and Water Conservation District	San Luis Obispo
Santa Barbara County Flood Control and Water Conservation District	Santa Barbara
Santa Clara Valley Water District	Santa Clara
Solano County Water Agency	Solano
Tulare Lake Basin Water Storage District	Tulare
Ventura County Watershed Protection District	Ventura

The non-SWP water contractors are listed below, followed by shortened forms of their names that are used in Bulletin 132 instead of acronyms.

Arvin-Edison Water Storage District	Arvin-Edison
Belridge Water Storage District	Belridge
Berrenda Mesa Water District	Berrenda Mesa
Buena Vista Water Storage District	Buena Vista
Byron-Bethany Irrigation District	Byron-Bethany
Cawelo Water District	Cawelo
Contra Costa Water District	Contra Costa
County of Tulare	Tulare
East Contra Costa Irrigation District	East Contra Costa
Fresno County Public Works	Fresno
Hills Valley Irrigation District	Hills Valley
Kern-Tulare Water District	Kern-Tulare
Lost Hills Water District	Lost Hills
Lower Tule River Irrigation District	Lower Tule
Merced Irrigation District	Merced
Pixley Irrigation District	Pixley
Placer County Water Agency	Placer
Rag Gulch Water District	Rag Gulch
Rosedale-Rio Bravo Water Storage District	Rosedale-Rio
San Luis & Delta-Mendota Water Authority	San Luis & Delta-Mendota
Semitropic Water Storage District	Semitropic
South Feather Water and Power Agency	South Feather
Tranquility Irrigation District	Tranquility
Tri-Valley Water District	Tri-Valley
United Water Conservation District	United
West Kern Water District	West Kern
Western Hills Water District	Western Hills
Westlands Water District	Westlands
Westside Mutual Water Company	Westside
Wheeler Ridge-Maricopa Water Storage District	Wheeler Ridge-Maricopa
Yuba County Water Agency	Yuba

Executive Summary

Part of the North Bay Aqueduct, the Cordelia Pumping Plant serves the cities of Benecia, Vallejo, and Napa.

The Bulletin 132 series began in 1963 and reported the first deliveries of water by the new State Water Project (SWP), which was still under construction. Bulletin 132-06, Management of the California State Water Project, continues this series with the forty-fourth edition. It reports planning, construction, financing, managing, and operating activities of the SWP in 2005. The SWP is operated and maintained by the California Department of Water Resources (DWR).

2005 SWP Highlights

The SWP is one of the largest water and power systems in the world. It conveys an average annual 2.4 million af of water through its 17 pumping plants, 8 hydroelectric power plants, 3 pumping-generating plants, 29 dams and reservoirs, and about 675 miles of aqueducts and pipelines.

California experienced higher-than-average rainfall and mountain snowpack during water year 2004–2005. The State received precipitation at 140 percent of average. The Sacramento Valley Water Year Hydrologic Classification (40-30-30 Index) was above normal and the San Joaquin Valley Water Year Hydrologic Classification (60-20-20 Index) was wet. The Northern Sierra Eight Station Index finished with 57.5 inches of precipitation, or 115 percent of average.

Water storage in all SWP reservoirs at the end of water year 2004–2005 was 4.52 maf, or 83 percent of average. Total water storage in major SWP reservoirs at the end of calendar year 2005 was about 4.64 maf, as compared with 3.07 maf in 2004.

The project provides water for approximately 24 million people throughout the State, irrigation for 750,000 acres of farmland, and environmental benefits to wildlife refuges, as well as environmental mitigation programs. In 2005, the SWP delivered 4,732,633 af of water to 27 of its 29 long-term contractors and 26 other agencies. Ten non-SWP agencies in the Feather River area received 1,074,706 af.

DWR continued to be its own energy scheduling coordinator with the California Independent System Operator (CAISO) and to schedule the purchase and sale of energy to operate the SWP. In 2005, energy used at the 28 SWP pumping and generating plants totaled 8.29 million MWh. DWR sold 2.15 million MWh of energy to 20 utilities and 22 power marketers, for total revenues of $148.62 million in 2005.

The project continued to pay bondholders as scheduled and remained financially viable. The long-term water contractors continued to repay project construction bonds and operating expenses. In 2005, the SWP handled approximately $789 million each in revenues and expenses, with General Fund contributions limited to recreation facilities.

2005 Precipitation and Water Storage

The water stored and delivered by the SWP conservation and transportation facilities originates from rainfall and snowmelt in Northern and Central California watersheds, where most of the State's

precipitation occurs. DWR monitors and records annual precipitation and runoff during each water year, which begins on October 1 and ends on September 30.

Precipitation and Snowpack in Water Year 2004–2005

California experienced higher-than-average rainfall and mountain snowpack during water year 2004–2005. The State received precipitation at 140 percent of average in 2004–2005, as compared to 85 percent of average in 2003–2004. During the second week of April 2005, the statewide average snowpack peaked at 40 inches of snow water content. This amount of mountain snowpack is 146 percent of normal. These snowpack conditions are in stark contrast to snowpack levels in 2003–2004. During that time period, the statewide snow water content peaked at 30 inches in the first week of March. The Northern Sierra Eight Station Index finished the 2004–2005 water year with 57.5 inches of precipitation, which was 115 percent of average.

Runoff

Statewide river runoff totaled 105 percent of average in water year 2004–2005. Runoff in the Sacramento River and San Joaquin River regions was 95 percent and 150 percent of average, respectively.

The Sacramento River Index for water year 2004–2005 was 18.5 maf (95 percent of average). The Sacramento Valley Water Year Hydrologic Classification (40-30-30 Index) was above normal, based on observed data for water year 2004-2005.

The San Joaquin River system unimpaired runoff from the Stanislaus, Tuolumne, Merced, and San Joaquin rivers was 9.2 maf (155 percent of average). The San Joaquin Valley Water Year Hydrologic Classification (60-20-20 Index) was wet, based on observed data for water year 2004-2005.

Water Year 2004–2005 Storage Totals

Total water storage in all SWP reservoirs at the end of water year 2004–2005 was 4.52 maf, or 83 percent of average, compared to 2.99 maf or 76 percent of average at the end of water year 2003–2004. The average end-of-month total storage in major SWP reservoirs was 4.19 maf. End-of-water-year storage on September 30, 2005, at Lake Oroville was 2.88 maf, which was about 1.13 maf more than water year 2003-2004.

Calendar Year 2005 Storage Totals

Total water storage in major SWP reservoirs at the end of calendar year 2005 was about 4.64 maf, as compared with 3.07 maf in 2004.

Water Year 2005–2006 October–December Water Conditions

The last three months of calendar year 2005 mark the beginning of a new water year, 2005–2006. By the end of October, the runoff was near 80 percent of average in the Northern Sierra and closer to average in the central and southern regions of the Sierra. November provided lower percentages of average runoff. By the end of November, statewide runoff since October 1 had fallen to near 70 percent of average. December, however, resulted in near 200 percent of normal precipitation statewide and, in addition, the statewide water year-to-date runoff rose to nearly 200 percent of average.

2005 Water Supplies, Contracts, and Deliveries

2005 Water Deliveries

DWR approved deliveries of 1.65 million af on November 30, 2004, resulting in initial approved Table A amounts of 40 percent of most SWP contractor requests. DWR increased the 2005 approved Table A amounts to 2.48 million af, or 60 percent on January 14, 2005. As water conditions improved, approved Table A amounts were increased to 2.89 million af (70 percent) on April 1, 2005, 3.30 million af (80 percent) on April 21, 2005, and 3.30 million af (90 percent) on May 27, 2005.

In 2005, 4,732,633 af of water were conveyed to 27 long-term contractors and 26 other agencies. That amount includes:

- 2,828,406 af of approved Table A water;
- 731,083 af of Article 21 water;
- 1,506 af of SWP water for recreation and fish and wildlife;
- 1,101,429 af of water delivered to satisfy water rights settlement agreements and agreements with SWP contractors for local water supplies; and
- 70,209 af of water delivered to satisfy agreements between the SWP and the Central Valley Project (CVP).

Table ES-1 on page 6 shows SWP water deliveries by category for 1962–2005.

Non-SWP Water Conveyance

In 2005, DWR conveyed 67,792 af of CVP water through SWP facilities for the Bureau of Reclamation (Reclamation).

Dry Year Water Purchase Program

Due to the wet hydrology of 2005, there was no need for a dry year water purchase program.

Power Resources

In 2005, energy used at the 29 SWP pumping and generating plants totaled 8.29 million MWh.

The Hyatt-Thermalito power complex in Oroville generated 1.83 million MWh of energy in 2005. Energy generated at SWP aqueduct recovery plants—Gianelli, Alamo, Devil Canyon, Mojave Siphon, and Warne—totaled 1.74 million MWh. The SWP share of energy generated at the coal-fired Reid Gardner Unit 4 in Nevada totaled 1.58 million MWh of energy.

DWR sold 2.15 million MWh of energy to 20 utilities and 22 power marketers, for total revenues of $148.62 million in 2005. DWR also received $33.50 million in revenues for capacity, including $21.03 million for transactions made through CAISO.

DWR purchased 4.74 million MWh of energy at a cost of $232.07 million. Other SWP power costs, including transmission, operation, maintenance, and CAISO ancillary services totaled $123.83 million. This amount includes $4.95 million for debt service and $3.81 million for operations and maintenance costs at Pine Flat Power Plant. It also includes $3.42 million for transmission at Reid Gardner Unit 4 and $59.33 million for costs associated with operations and maintenance, fuel, insurance, and property taxes at Reid Gardner Unit 4.

Table ES-1. SWP Water Delivered by Category, 1962–2005 (Acre-feet)

	Table A Water			Other SWP Water Deliveries					
				Article 21/Unscheduled					
Year	Municipal and Industrial (1)	Agricultural (2)	Total (3)	Municipal and Industrial (4)	Agricultural (5)	Other Water[a] (6)	Feather River Diversions[b] (7)	Fish and Wildlife/ Recreation Water (8)	Total Deliveries (9)
1962	---	---	---	---	---	18,289	---	---	18,289
1963	---	---	---	---	---	22,456	---	---	22,456
1964	---	---	---	---	---	32,507	---	---	32,507
1965	---	---	---	---	---	44,105	---	---	44,105
1966	---	---	---	---	---	67,928	---	---	67,928
1967	5,747	5,791	11,538	0	0	53,605	---	---	65,143
1968	46,472	125,237	171,709	10,000	111,534	14,777	866,926	---	1,174,946
1969	34,434	158,586	193,020	0	72,397	18,829	794,374	---	1,078,620
1970	47,996	185,997	233,993	0	133,024	38,080	759,759	---	1,164,856
1971	85,286	272,054	357,340	2,400	293,619	44,119	778,362	8	1,475,848
1972	181,066	430,735	611,801	22,205	401,759	66,638	817,398	6,489	1,926,290
1973	293,824	400,564	694,388	3,161	293,255	42,511	800,743	1,155	1,835,213
1974	418,521	455,556	874,077	4,753	412,923	46,224	911,613	2,118	2,251,708
1975	641,621	582,369	1,223,990	21,043	601,859	63,793	862,218	3,377	2,776,280
1976	818,588	554,414	1,373,002	32,488	547,622	115,217	946,440	1,745	3,016,514
1977	280,919	293,236	574,155	0	0	389,065	581,994	1,111	1,546,325
1978	742,385	710,314	1,452,699	3,566	13,348	121,225	786,517	1,691	2,379,046
1979	690,659	969,237	1,659,896	66,081	582,308	187,630	882,549	1,766	3,380,230
1980	730,545	799,204	1,529,749	19,722	384,835	46,459	875,045	2,131	2,857,941
1981	1,057,273	852,289	1,909,562	12,000	896,428	279,161	838,557	4,688	3,940,396
1982	928,721	821,303	1,750,024	0	215,873	154,882	776,330	4,646	2,901,755
1983	483,499	701,370	1,184,869	0	13,019	181,453	602,905	7,849	1,990,095
1984	725,925	862,694	1,588,619	3,663	259,254	381,024	832,332	7,040	3,071,932
1985	992,538	1,002,915	1,995,453	9,638	298,034	404,842	870,008	4,033	3,582,008
1986	998,611	997,025	1,995,636	2,595	34,025	193,606	791,737	3,865	3,021,464
1987	1,096,368	1,033,718	2,130,086	6,949	107,958	377,592	831,947	7,672	3,462,204
1988	1,316,820	1,068,302	2,385,122	0	0	507,076	794,834	4,889	3,691,921
1989	1,602,454	1,251,293	2,853,747	0	0	474,559	830,500	8,135	4,166,941
1990	1,876,072	706,079	2,582,151	0	90	424,697	875,099	9,262	3,891,299
1991	536,669	12,444	549,113	3,521	0	551,051	565,395	4,879	1,673,959
1992	961,649	509,805	1,471,454	1,156	0	144,789	613,978	2,605	2,233,982
1993	1,064,866	1,250,369	2,315,235	0	0	254,854	822,589	2,609	3,395,287
1994	1,134,992	614,359	1,749,351	48,150	64,475	236,739	874,018	8,200	2,980,933
1995	801,570	1,165,523	1,967,093	17,984	46,346	78,425	860,077	2,575	2,972,500
1996	1,145,638	1,369,187	2,514,825	12,091	16,556	251,391	934,997	3,907	3,733,767
1997	1,258,456	1,067,319	2,325,775	2,814	18,618	322,000	993,211	4,146	3,666,564
1998	864,795	860,724	1,725,519	9,982	10,306	134,682	872,738	2,108	2,755,335
1999	1,405,299	1,333,592	2,738,891	61,191	96,879	85,312	1,108,672	4,324	4,095,269
2000	2,022,703	1,177,974	3,200,677	170,302	138,483	332,654	1,085,886	4,030	4,932,032
2001	1,162,897	383,845	1,546,742	10,261	33,174	535,160	1,078,656	2,929	3,206,922
2002	1,808,017	765,013	2,573,030	15,478	27,637	309,094	1,132,938	3,694	4,061,871
2003	2,118,150	782,891	2,901,041	23,019	36,809	251,447	1,008,093	2,846	4,223,255
2004	1,950,407	649,129	2,599,536	103,890	114,606	385,088	1,174,672	2,865	4,380,657
2005	1,959,162	869,244	2,828,406	199,834	531,249	96,932	1,074,706	1,506	4,732,633
Total	**36,291,614**	**28,051,700**	**64,343,314**	**899,937**	**6,808,302**	**8,781,967**	**32,908,813**	**136,893**	**113,879,226**

[a] Includes water conveyed for SWP and non-SWP water contractors.
[b] Includes amounts of water diverted according to various water rights agreements.

State Water Project Power Generation and Consumption in 2005

Power Generation and Consumption	Millions of Megawatt Hours
Energy generation by SWP facilities	5.151
Energy sources and firm purchases under long-term agreeements and exchanges	5.367
Total Energy Available to the SWP	**10.518**
Energy sales	(2.210)
Net Power Consumption of the SWP	**8.308**

The sidebar above shows 2005 power generation and consumption.

Oroville Facilities Relicensing

The existing 50-year term FERC hydropower license, Project Number 2100 for operation of the Oroville Facilities, will expire January 31, 2007. To obtain a new license, DWR must file a new application with FERC by January 31, 2005.

On January 26, 2005, DWR submitted its Application for New License for the Oroville Facilities with FERC. On September 12, 2005, following DWR's successful compliance with FERC's May 2005 Additional Information Request, FERC accepted DWR's Application for a New License for operating the Oroville Facilities. FERC's acceptance of DWR's license application marked the conclusion of the multiyear collaborative Alternative Licensing Process (ALP) involving federal and State agencies, Indian tribes, local agencies, environmental organizations, and other interested parties that worked to assist DWR in completing a comprehensive license application and accompanying Preliminary Draft Environmental Assessment (PDEA). While this procedurally completed the ALP phase of FERC relicensing, settlement negotiations and completion of all federal and State environmental documentation was still ongoing at the end of 2005 in pursuit of a new FERC license at the Oroville Facilities.

During 2005, primary achievements included:

- completing all 165 technical reports resulting from the 72 collaboratively developed and approved study plans. These roughly 40,000 pages of supporting documentation were submitted to FERC in support of DWR's application for license;
- completing a package of responses addressing deficiencies, clarifications, additional information requests, and revisions to the January 2005 license application;
- receiving notification that the Oroville Facilities New License Application was accepted for filing by FERC;

- submitting the application for water quality certification to the State Water Resources Control Board;
- continuing settlement agreement negotiations meetings with Indian tribes, Butte County, local governmental agencies, State and federal agencies, and other interested stakeholders; and
- continuing to prepare and update the recreation management plan submitted with the Application for License to reflect additional enhancements derived from the Settlement Agreement negotiations.

As an interim settlement activity, DWR obtained approval to provide $3 million to the Feather River Recreation and Park District to fund recreation improvements at Riverbend Park in Oroville through calendar year 2007.

The following SWP facilities will be subject to new license terms and conditions:

- Oroville Dam and Reservoir;
- Hyatt Pumping-Generating Plant;
- Thermalito Pumping-Generating Plant;
- Thermalito Diversion Dam Power Plant;
- Thermalito Diversion Dam;
- Fish Barrier Dam;
- Feather River Fish Hatchery;
- Thermalito Power Canal;
- Thermalito Forebay; and
- Thermalito Afterbay.

Financial Analysis

In 2005, DWR continued to pay bondholders as scheduled. The SWP was financially viable and was indirectly paid for by the approximately 24 million water users who were served by the project. Direct payment was through the 29 long-term water contractors. In 2005, the SWP handled approximately $789 million in revenues and $789 million in expenses. The sidebar on page 9 shows the 2005 income statement for the SWP.

California Water Plan Update 2005

On April 13, 2005, DWR released the public review draft of the *California Water Plan Update 2005*, a proposed strategic plan to meet the State's water needs through 2030.

California Water Plan Update 2005 is the product of unprecedented public input from a 65-member advisory committee representing agriculture, urban water districts, businesses, environmentalists, Native Americans, environmental justice advocacy, cities, counties, federal and State agencies, the California Bay-Delta Authority, academia, and different regions of California. The plan also incorporates input from a 350-member extended review forum, and more than 2,000 interested members of the public.

For the first time, the *California Water Plan* includes a short- and long-term implementation strategy, and details 25 actions, such as water conservation and recycling, conjunctive management and groundwater storage, surface storage and conveyance, system reoperation and water transfers, and desalination; as well as other strategies.

Public hearings on the review draft were held in June, and the final *California Water Plan Update 2005* and the *Water Plan Highlights* briefing book were completed in December 2005.

2005 Income Statement for the State Water Project

Revenues	Thousands of Dollars
Water Contract Payments	836,533
Revenue Bond Cover Adjustments	(37,121)
Rate Management Adjustments	(36,584)
Other Revenues	26,513
Total Operating Revenues	**789,341**
Expenses	
Project Operations, Maintenance, Power, and Replacement	571,073
Deposits to Reserves	(39,719)
Water Bond Principal	108,282
Water Bond Interest	149,705
Total Operating Expense and Debt Service	**789,341**
Net System Revenues	**0**

DWR first published the *California Water Plan* in 1957 and has updated it eight times in the Bulletin 160 series.

Monterey Amendment

The Monterey Amendment, based on Principles of Agreement released on December 16, 1994, was designed to increase the reliability of existing water supplies, provide stronger financial management for the SWP, and increase water management flexibility by providing more tools for local water agencies. In accordance with terms of the May 5, 2003, Monterey Settlement Agreement, the SWP continues to operate pursuant to the Monterey Amendments while the new EIR is being prepared. The draft EIR is expected to be released in 2007.

Delta Resources and Environmental Issues

The 738,000-acre Delta is the heart of California's water environment. The Delta, at the convergence of the Sacramento and San Joaquin rivers, is a network of islands, sloughs, marshes, and reclaimed farmland that stretches from Sacramento to San Francisco Bay. A source of drinking water for about two-thirds of California's population, the Delta also provides irrigation for the Central Valley. The State Water Resources Control Board has adopted water quality control plans and policies to protect the Delta's water quality

and ecosystem while at the same time maintaining SWP water supply reliability.

California Bay-Delta Authority

The California Bay-Delta Act of 2003 established the California Bay-Delta Authority as a new governance structure. The Authority oversees the 25 State and federal agencies working cooperatively through the CALFED Bay-Delta Program to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem. The Authority is charged with tracking and assessing the CALFED Bay-Delta Program progress, using sound science, providing accountability and ensuring balanced implementation of the program, assuring public involvement and outreach, and coordinating and integrating related government programs.

Environmental Water Account

The Environmental Water Account (EWA) is designed to provide water at critical times to meet environmental needs while providing water supply reliability to SWP and CVP water users. To do that, EWA buys water from willing sellers or diverts surplus water when safe for fish. EWA then banks, stores, conveys, and releases the water as needed to protect fish and compensate water users.

In 2005, EWA's fifth operational year, exports were periodically curtailed at the SWP and CVP export facilities between December 15, 2004, and June 8, 2005. These actions resulted in an EWA debt of about 328,681 af at the SWP (December—4,163 af; February—33,967 af; April—121,888 af; May—133,997 af; June—34,666 af) and 11,400 af at the CVP in February.

During water year 2005, DWR and Reclamation acquired 171,917 af and 28,568 af, respectively, in operational assets and 154,560 af of purchase assets through contract agreements. All purchase asset acquisitions in 2005 were made by DWR and were covered under the EWA environmental impact statement/environmental impact report (EIS/EIR) in compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). A source shift was not implemented because there was no risk of a low-point problem at San Luis Reservoir.

In fall 2004, EWA carried a debt of 14,927 af to water year 2005. EWA ended with no debt at the end of December 2005.

North Delta Program

The North Delta Program is part of CALFED's Conveyance Program. Three North Delta conveyance facilities improvements are being evaluated. One is to improve operational procedures for the Delta Cross Channel (DCC) to address fishery and water quality concerns; the second is a screened Through-Delta Facility on the Sacramento River; and the third is the Franks Tract Project, which involves installation of operable gates either on Three Mile Slough or West False River to improve water quality and benefit fisheries. DWR is leading all three studies in cooperation with other agencies. DWR is in the process of initiating the preparation of an EIR/EIS for the Franks Tract Project.

In 2005, projects relating to the DCC Reoperation Project and Through-Delta Facility were limited to completing analyses and writing reports on field work. These activities included reevaluating project funding and schedules. For

example, the Flooded Islands Pre-Feasibility Study, initiated in April 2004, to develop and evaluate conceptual alternatives for modifying Franks Tract, Lower Sherman Lake, and Big Break was completed in June 2005. It provides conceptual modification alternatives on the three flooded islands, with their respective benefits and costs.

The Franks Tract 2005 modifications study showed significant Delta water quality improvements—at a relatively modest cost. This study recommends that operations of the proposed gates are refined for these alternatives to optimize water quality benefits. The report also recommends conducting a pilot project to evaluate, implement, and demonstrate the effectiveness and impacts of the facility before considering a full-scale project. Subsequently, in 2006 and 2007, DWR will continue to refine and evaluate the operation and design of several pilot project alternatives in the Franks Tract area. The scope of the proposed pilot project is currently under development. In mid-2007, an EIR/EIS will be initiated for the pilot project.

South Delta Improvements Program

The South Delta Improvements Program (SDIP) is the second component of CALFED's Conveyance Program. The purpose of SDIP is to do the following:

- improve the reliability of existing SWP facilities;
- ensure that water of adequate quantity and quality is available for diversion to the South Delta Water Agency's service area for beneficial use; and
- reduce the effects of SWP exports on both aquatic resources and direct losses of fish in the South Delta.

In November 2005, a draft EIS/EIR was released for the SDIP. The decision to proceed with the proposed project addresses a precipitous decline in the populations of pelagic (open water) fish in the Bay-Delta environment. One of the fish species is the delta smelt, which is an endangered fish. Stage 1 addresses the physical and structural component of the program, which is not expected to affect fish populations. Stage 2 is the operational component of the program. This stage will increase water deliveries and delivery reliability by increasing the Clifton Court Forebay diversion limit to 8,500 cfs. Only Stage 1 is being sought at this time, while Stage 2 is being deferred. Stage 1 of the SDIP includes the construction and operation of the following projects:

- three permanent operable gates to improve local water levels and circulation in South Delta channels;
- one permanent operable gate to prevent straying of salmon migrating to the San Joaquin River;
- extensive dredging in the South Delta to improve channel capacity for local agricultural users; and
- modifications to existing agricultural diversion intakes.

Several ways of operating the Clifton Court Forebay diversion at 8500 cfs are available, but a preferred operation is not identified in the draft EIR/EIS. DWR is committed to issuing a supplemental environmental document on Stage 2, and circulating this document for a minimum of 45 days, prior to making any decisions.

Status of Threatened or Endangered Species Listings

Delta Export Curtailment

SWP and CVP operated under a new Delta Smelt Biological Opinion in 2005, which was signed in August 2004. This biological opinion set new incidental take limits, based on the most recent 10 years of data (1993–2003). The new take limits are based on two categories of water year type: wet or above normal and below normal, dry, or critical. The Delta Smelt Risk Assessment Matrix (DSRAM) adult concern level is set at 892, and the reconsultation level varies by month, ranging from 100 to 44,800. When the incidental take is exceeded, a team of interagency scientists, known as the Delta Smelt Working Group, will convene a meeting to review smelt distribution, abundance, projected project operations, and other information. This work group will recommend any actions that should be taken to reduce salvage.

On January 24, 2005, the incidental take of pre-spawning adult delta smelt at SWP and CVP exceeded the concern level of 892. The Delta Smelt Working Group met to discuss possible actions. As a result, combined exports were reduced to 3,000 cfs for seven days.

In 2005, 2,922 delta smelt were salvaged by SWP and 818 were salvaged by CVP. These fish compare to 20,470 delta smelt salvaged at both facilities in 2004.

Pelagic Organism Decline in the Upper San Francisco Estuary

There have been marked declines of numerous pelagic fishes in the upper San Francisco Estuary. The major resident pelagic fishes sampled in the upper estuary include delta smelt, longfin smelt, striped bass, and threadfin shad. Historically, low populations of these fishes have been the result of dry years, such as the drought in 1987–1992. Abundance indices for 2002–2005 indicate record and near-record lows for these populations, which are unexpected given the moderate winter-spring flows of the past several years. In response to the Pelagic Organism Decline (POD), the Interagency Ecological Program (IEP) formed a work team to evaluate the potential causes. An interdisciplinary, multiagency research effort was undertaken in 2005 to identify the most likely causes of the POD. The overall approach was based on a "triage" model to identify the most likely causes and assign priorities to projects, based on funding and resources. The 2005 work fell into four general types: an expansion of existing monitoring; analysis of existing data; new studies; and ongoing studies. A conceptual model was developed to describe possible mechanisms, by which a combination of long-term and recent changes in the ecosystem could produce the observed declines in the abundance indices.

Possible stressors influencing the POD included entrainment, toxic effects on fish, toxic effects on fish food, harmful algal blooms, clam effects on food availability, disease, and parasites. Narrative explanations in the context of long-term trends have been developed for four major components: (1) prior fish abundance—which describes how the continued low abundance of adults leads to reduced juvenile production; (2) habitat—which describes how water quality variables, including contaminants and toxic algal blooms, affect estuarine species; (3) top-down effects—which posit that predation and water project entrainment affect mortality rates; and (4) bottom-up effects—

which focus on how food web interactions in Suisun Bay and the West Delta have affected fish abundance. These narrative explanations will be developed for 2006–2007 to cover each component of the conceptual model.

Flood Protection

Arroyo Pasajero

The Arroyo Pasajero and its tributaries drain the coastal mountains west of the California Aqueduct in Fresno County. During heavy rainfall, high flows in the Arroyo Pasajero carry heavy sediment loads. Over eons, this flood sediment has formed an alluvial fan that extends from Tulare Lake to Fresno Slough. The alluvial fan is traversed by the California Aqueduct, which forms a barrier to Arroyo flood flows. Flood control facilities constructed to solve this problem include the West Side Detention Basin, designed to store floodwaters and sediment, an evacuation culvert to release floodwaters east of the California Aqueduct, and drain inlets to release floodwaters into the California Aqueduct. Since the floods of 1969, when nearly all the West Side Detention Basin's planned 50-year sediment storage space was filled, DWR and Reclamation have worked to minimize the effects of heavy flooding. In 1990, DWR asked the U.S. Army Corps of Engineers to help identify solutions to the Arroyo Pasajero flooding and sediment problems. Two candidate plans were prepared and released to the public in 1999; however, due to prohibitive costs, neither plan was adopted. Since then, DWR and Reclamation have been working on an alternate plan. This plan would rely on increased storage in the existing West Side Detention Basin, possibly combined with a reservoir to be constructed in the western Tulare Lakebed east of the California Aqueduct. The State Water Contractors asked DWR to develop the least costly alternative that would still provide a 100-year level of flood protection to the California Aqueduct. In 2004, DWR finished its feasibility investigation into a more cost-effective plan and proceeded with final design, environmental documentation, and other procedural steps leading to construction. Construction started in fall 2004 and included implementing improvements to increase the storage capacity of the West Side Detention Basin. The plan also included both adding new and improving the existing flood control structures.

Security Measures for the State Water Project after September 11, 2001

Security and protection of the SWP is a primary goal for DWR. Since September 2001, DWR has taken action to further increase security, regulate access, and closely monitor activities at SWP facilities and DWR's offices. For example, SWP operations are monitored more closely now, and staff exercise vigilance in maintaining a secure environment. Security patrols are more frequent and planning is in place to address potential or actual acts of terrorism. Improvements to existing security systems are ongoing and done in conjunction with Reclamation and other federal and State agencies. In 2005, DWR continued to implement recommended actions from a security assessment completed by an independent consultant in 2004. While DWR does not discuss details of its security program, it does coordinate very closely on security issues and emergency preparedness with federal and State public safety and law enforcement agencies, Reclamation,

utilities, regional and municipal water entities, and others.

SWP Milestones through the Decades

Forty Years Ago – 1965

Construction begins on the Edmonston Pumping Plant, the largest pumping facility of the State Water Project. Edmonston lifts water almost 2,000 feet up and over the Tehachapi Mountains into Southern California. At peak capacity, the plant pumps almost 2 million gallons a minute through 10 miles of pipeline across the Tehachapi Mountains.

Thirty Years Ago – 1975

Governor Edmund G. Brown, Jr. appoints Ronald E. Robie, an attorney and legislative consultant on water law and policy, as DWR Director. Robie serves until 1983.

Twenty Years Ago – 1985

In March 1985, a groundbreaking ceremony is held for the North Bay Aqueduct, Phase Two.

Ten Years Ago – 1995

DWR relocates operational headquarters for the SWP from the Resources Building in downtown Sacramento to a renovated building north of downtown. The new Joint Operations Center is shared with Reclamation, operators of the CVP, and the National Weather Service, a partner in DWR's new Flood Center.

Chapter 1
The State Water Project

The State Water Project is the largest state-built, multipurpose water project in the country.

Information in this chapter was contributed by the Division of Operations and Maintenance and the State Water Project Analysis Office.

California's diverse geography contains both the highest and lowest elevations in the coterminous United States, with a resulting diversity of climate that ranges from desert to alpine to subtropical. In a typical year, some areas receive as little as 2 inches of rain, while others receive more than 100 inches. This diversity of geography and climate creates an intricate and constantly changing pattern of water supplies, which, in turn, creates enormous challenges in managing this vital resource.

Like present-day Californians, the earliest settlers faced the problem of how best to conserve, control, and deliver water. Remains of aqueducts, canals, and dams are still found near some of California's original missions. The first recorded aqueduct was 6 miles long; it was built in 1770 to serve the San Diego mission. In the early twentieth century, several cities—San Francisco and Los Angeles among them—built aqueducts to convey water from the Sierra Nevada to other parts of the State.

In 1951, after many years of discussion and study, the Legislature authorized construction of a water storage and supply system to capture and store runoff in Northern California and deliver it to areas of need throughout the State. Eight years later, the Legislature passed the Burns-Porter Act, which provided the mechanism for obtaining funds necessary to construct the initial facilities. In 1960, California voters approved an issue of $1.75 billion in general obligation bonds, as authorized in the act, thereby obtaining funds to build the State Water Project (SWP). In 1962, the first water was delivered through a portion of the South Bay Aqueduct to two long-term contracting agencies in Alameda County.

Today the SWP, managed by the Department of Water Resources (DWR), is the largest state-built, multipurpose water project in the country. It was designed and built to deliver water, control floods, generate power, provide recreational opportunities, and enhance habitat for fish and wildlife. SWP water irrigates about 750,000 acres of farmland, mainly in the south San Joaquin Valley. About 24 million of California's estimated 36 million residents benefit from SWP water.

Precipitation and Runoff

The water stored and delivered by the SWP originates from rainfall and snowmelt runoff in Northern and Central California's watersheds, where most of the State's precipitation occurs.

Since 1968, DWR has monitored and recorded annual precipitation and runoff, because precipitation, snowpack, and the rate and amount of snowmelt help determine how much water the SWP can deliver in any given year. The water year, as designated by DWR, is October 1 through September 30.

Water Delivery Facilities

The SWP depends on a complex system of dams, reservoirs, power plants, pumping plants, canals, and aqueducts to deliver water. Although initial transportation facilities were essentially completed in 1973, other facilities have since been built, and still others are either under construction or are planned to be built, as needed.

The SWP facilities include 25 dams and reservoirs, 29 pumping and generating plants, and approximately 700 miles of aqueducts in total. Figure 1-1 shows the names and locations of primary water delivery facilities.

Existing long-term SWP water supply contracts call for the annual delivery of up to 4,125,686 af of Table A water during 2005 through SWP facilities, gradually increasing to a maximum of up to 4,172,786 af by 2021. Some changes have occurred since the long-term water contracts were signed in the 1960s. These changes include population growth variations, differences in local use, local water conservation programs, and conjunctive-use programs. The SWP delivered 2,828,406 af of approved Table A water to long-term contractors' service areas in 2005. Demands for SWP water are expected to increase as California's population continues to grow.

Project Design

Water from rainfall and snowmelt runoff is stored in SWP conservation facilities and delivered via SWP transportation facilities to water agencies and districts in the Southern California, Central Coastal, San Joaquin Valley, South Bay, North Bay, and Upper Feather River areas.

Three small reservoirs—Lake Davis, Frenchman Lake, and Antelope Lake—are the northernmost SWP facilities. Situated on Feather River tributaries in Plumas County, these lakes are used primarily for recreation. They also provide water to the City of Portola and local agencies that have water rights agreements with DWR.

Downstream from these three lakes lies Lake Oroville, the keystone of the SWP. Lake Oroville conserves water from the Feather River watershed. Created by Oroville Dam, the tallest earthfill dam in the Western Hemisphere, Lake Oroville is the project's largest storage facility, with a capacity of about 3.5 million af (an acre-foot is about 326,000 gallons).

Releases from Lake Oroville flow down the Feather River into the Sacramento River, which drains the northern portion of California's great Central Valley. The Sacramento River flows into the Sacramento-San Joaquin Delta, comprised of 738,000 acres of land interlaced with channels that receive runoff from 40 percent of the State's land area. The SWP, federal Central Valley Project (CVP), and local agencies all divert water from the Delta.

From the northern Delta, Barker Slough Pumping Plant diverts water for delivery to Napa and Solano counties through the North Bay Aqueduct, which was completed in 1988. Near Byron, in the southern Delta, the SWP diverts water into Clifton Court Forebay for delivery south of the Delta. Banks Pumping Plant lifts water from Clifton Court Forebay into the California Aqueduct, which flows to Bethany Reservoir. From Bethany Reservoir, the South Bay Pumping Plant lifts water into

Figure 1-1. Names and Locations of Primary Water Delivery Facilities, December 31, 2005

the South Bay Aqueduct to supply Alameda and Santa Clara counties. The South Bay Aqueduct provided initial deliveries in 1962 and has been fully operational since 1965.

Most of the water delivered to Bethany Reservoir from Banks Pumping Plant flows into the California Aqueduct. This 444-mile-long main aqueduct conveys water to the agricultural lands of the San Joaquin Valley and the urban regions of Southern California.

The California Aqueduct winds along the west side of the San Joaquin Valley. It transports water to O'Neill Forebay, Gianelli Pumping-Generating Plant, and San Luis Reservoir. San Luis Reservoir has a storage capacity of more than 2 million af and is jointly owned by DWR and the Bureau of Reclamation (Reclamation). DWR's share of gross storage in the reservoir is about 1,062,000 af. Generally, water is pumped into San Luis Reservoir during late fall through early spring, where it is temporarily stored for release back to the California Aqueduct to meet summertime peaking demands of SWP and CVP contractors.

SWP water not stored in San Luis Reservoir, as well as water eventually released from San Luis, flow south through the San Luis Canal, a portion of the California Aqueduct jointly owned by DWR and Reclamation.

As the water flows through the San Joaquin Valley, numerous turnouts convey the water to farmlands within the service areas of the SWP and CVP. Along its journey, water is lifted more than 1,000 feet by four pumping plants—Dos Amigos, Buena Vista, Teerink, and Chrisman—before reaching the foot of the Tehachapi Mountains.

In the San Joaquin Valley, near Kettleman City, Phase I of the Coastal Branch Aqueduct serves agricultural areas west of the California Aqueduct. In August 1997, completion of Phase II extended this branch to serve municipal and industrial water users in San Luis Obispo and Santa Barbara counties.

The remaining water conveyed by the California Aqueduct is delivered to Southern California, which is home to about two-thirds of California's population. Before this water can be delivered, it must first cross the Tehachapi Mountains. Pumps at Edmonston Pumping Plant, situated at the foot of the mountains, raise the water 1,926 feet—the highest single lift of any pumping plant in the world. The water enters 8.5 miles of tunnels and siphons as it flows into Antelope Valley, where the California Aqueduct divides into two branches: the East Branch and the West Branch.

The East Branch carries water through Alamo Power Plant, Pearblossom Pumping Plant, and Mojave Siphon Power Plant into Silverwood Lake in the San Bernardino Mountains. From Silverwood Lake, water flows through the San Bernardino Tunnel into Devil Canyon Power Plant. Water continues down the East Branch through the Santa Ana Pipeline to Lake Perris, the southernmost SWP reservoir.

The East Branch Extension is a nearly 33-mile pipeline linking parts of service areas for San Bernardino Valley Municipal Water District and San Gorgonio Pass Water Agency to the California Aqueduct. The East Branch Extension, Phase I, carries water from Devil Canyon Power Plant

Afterbay to Cherry Valley, bringing water to Yucaipa, Calimesa, Beaumont, Banning, and other communities. Phase II, when completed, will assist with delivery.

Water in the West Branch flows through Oso Pumping Plant, Quail Lake, and then through Warne Power Plant into Pyramid Lake in Los Angeles County. From there it flows through the Angeles Tunnel, Castaic Power Plant, Elderberry Forebay, and into Castaic Lake, terminus of the West Branch. Castaic Power Plant is operated by the Los Angeles Department of Water and Power.

The energy needed to operate the SWP, the largest single user of electrical power in California, comes from a combination of its own hydroelectric and coal-fired generation plants and power purchased and exchanged from other utilities. The coal-fired plant and the project's eight hydroelectric power plants, including three pumping-generating plants, produce enough electricity in a normal year to supply about two-thirds of the necessary operating power.

Tables 1-1 through 1-5 present statistical information about primary reservoirs, primary dams, pumping plants, power plants, and aqueducts. Additional information regarding operation of the plants under full development can be found in Chapter 10.

Additional Construction

SWP aqueduct facilities were initially designed and constructed to provide service to all agencies to meet their water delivery needs up to 1990. Project water conservation reservoirs were planned to be constructed in stages as water demands increased. Oroville and San Luis were the first SWP conservation reservoir facilities constructed. Additional SWP facilities were scheduled to meet increased demands. It was anticipated that population growth in delivery service areas and water supply areas of origin would influence the final schedule for the additional SWP facilities. However, increased costs, environmental issues, and increased non-SWP demands for limited water supplies delayed the construction schedule for some of the planned additional facilities.

Table 1-1. Physical Characteristics of Primary Storage Facilities

Facility	Gross Capacity at Absolute Maximum Elevation (Acre-feet)	Surface Area (Acres)	Shore-line (Miles)
Antelope Lake	22,600	930	15
Frenchman Lake	55,500	1,580	21
Lake Davis	84,400	4,030	32
Lake Oroville	3,537,600	15,800	167
Thermalito Forebay	11,800	630	10
Thermalito Afterbay	57,000	4,300	26
Thermalito Diversion Pool	13,400	320	10
Clifton Court Forebay	31,300	2,180	8
Bethany Reservoir	5,100	180	6
Lake del Valle	77,100	1,060	16
San Luis Reservoir	2,027,800	12,520	65
SWP storage, 1,062,180 af			
O'Neill Forebay	56,100	2,700	12
SWP storage, 29,500 af			
Los Banos Reservoir	34,600	620	12
Little Panoche Reservoir	5,580	190	6
Quail Lake	7,600	290	3
Pyramid Lake	171,200	1,300	21
Elderberry Forebay	32,500	500	7
Castaic Lake	323,700	2,240	29
Silverwood Lake	75,000	980	13
Lake Perris	131,500	2,320	10

Table 1-2. Physical Characteristics of Primary Dams

Facility	Crest Elevation (Feet)	Structural Height (Feet)	Crest Length (Feet)	Structural Volume (Thousands Cubic Yards)
Antelope	5,025	120	1,320	380
Frenchman	5,607	139	720	537
Grizzly Valley	5,785	132	800	253
Oroville	922	770	6,920	80,000
Thermalito Diversion	233	143	1,300	154
Thermalito Forebay	231	91	15,900	1,840
Thermalito Afterbay	142	39	42,000	5,020
Clifton Court Forebay	14	30	36,500	2,440
Bethany	250	121	3,940	1,400
Del Valle	773	235	880	4,180
Sisk	554	385	18,600	77,645
O'Neill	233	88	14,350	3,000
Los Banos Detention	384	167	1,370	2,100
Little Panoche Detention	676	152	1,440	1,210
Pyramid	2,606	400	1,090	6,800
Elderberry Forebay	1,550	200	1,990	6,000
Castaic	1,535	425	4,900	46,000
Cedar Springs	3,378	249	2,230	7,600
Perris	1,600	128	11,600	20,000
Crafton Hills	2,932	95	500	144

Table 1-3. Pumping Plant Characteristics

Facility	Number Of Units	Normal Static Head (Feet)	Total Flow at Design Head (cfs)	Total Motor Rating (hp)
Thermalito	3 (p-g)[a]	85-102	9,120	120,000
Hyatt	3 (p-g)[a]	500-625	5,610	519,000
Barker Slough	9	95-120	228	4,800
Cordelia	11	110-376	138	5,600
Banks	11	236-252	10,670	333,000
South Bay	9	566	330	27,750
Del Valle	4	0-38	120	1,000
Gianelli	8 (p-g)[a]	99-327	11,000	504,000
Dos Amigos	6	107-125	15,450	240,000
Las Perillas	6	55	461	4,050
Badger Hill	6	151	454	11,750
Devil's Den[b]	6	521	134	10,500
Bluestone[b]	6	484	134	10,500
Polonio Pass[b]	6	533	134	10,500
Buena Vista[b]	10	205	5,405	144,500
Teerink[b]	9	233	5,445	150,000
Chrisman[b]	9	518	4,995	330,000
Edmonston[b]	14	1,926	4,480	1,120,000
Oso	8	231	3,252	93,800
Pearblossom	9	540	2,525	203,200
Greenspot	4	382	50	3,900
Crafton Hills	3	613	40	4,000
Cherry Valley	2	75	16	300

[a] The term p-g indicates pumping-generating units.
[b] These plants have one unit in reserve.

Table 1-4. Power Plant Characteristics, by Type and Facility

Type and Facility	Number of Units	Normal Static Head (Feet)	Total Flow at Design Head (cfs)	Net Dependable Capacity	Nameplate Capacity
Hydro					
Thermalito Diversion Dam	1	63-77	615	3.3	3.3
Thermalito	4 (3 p-g)[a]	85-102	17,400	128	126.1
Hyatt	6 (3 p-g)[a]	410-676	16,950	639	714
Gianelli (total)	8 p-g[a]	99-327	16,960	362	424
Alamo	1	115-141	1,740	18	18
Warne	2	719-739	1,600	76	78.2
Mojave Siphon	3	81-136	2,880	14	30
Devil Canyon	4	1,406	2,940	235	291
Castaic	7 (6 p-g)[a]	900-1,050	20,820		1,319.7
Coal					
Reid Gardner, Unit 4 (total)	1[b]			275	265
SWP share of generation[c]					

[a] The term p-g indicates pumping-generating units.
[b] Life of the plants is expected to extend through 2013.
[c] SWP ownership share in Reid Gardner, Unit 4, is 67.8%.

Table 1-5. Total Miles of Aqueducts

Facility	Channel and Reservoir	Canal and Siphon	Pipeline and Discharge Line	Tunnel	Total
Grizzly Valley Pipeline	0.0	0.0	6.0	0.0	6.0
Thermalito Power Canal and Tail Channel	1.5	1.9	0.0	0.0	3.4
North Bay Aqueduct	0.0	0.0	27.6	0.0	27.6
South Bay Aqueduct (including Del Valle Branch)	0.3	10.7	31.9	1.7	44.6
Subtotal	*1.8*	*12.6*	*65.5*	*1.7*	*81.6*
California Aqueduct					
Clifton Court Forebay to O'Neill Forebay	4.5	61.9	0.3	0.0	66.7
O'Neill Forebay to Kettleman City	4.1	101.4	0.2	0.0	105.7
Kettleman City to Edmonston Pumping Plant	0.0	120.1	0.9	0.0	121.0
Edmonston Pumping Plant to Tehachapi Afterbay	0.0	0.2	1.9	7.9	10.0
Tehachapi Afterbay to Lake Perris	4.0	97.8	34.3	3.9	140.0
Subtotal	*12.6*	*381.4*	*37.6*	*11.8*	*443.4*
California Aqueduct Branches					
Coastal Branch	0.0	14.1	98.7	2.7	115.5
West Branch	9.7	9.3	5.8	7.1	31.9
East Branch Extension					
Devil Canyon Power Plant to Greenspot Pumping Station	0.0	0.0	15.8	0.0	15.8
Greenspot Pumping Station to Noble Creek Terminus	0.0	0.0	13.3	0.0	13.3
Subtotal	*9.7*	*23.4*	*133.6*	*9.8*	*176.5*
Total	**24.1**	**417.4**	**236.7**	**23.3**	**701.5**

In response to changes in water management policy, DWR continues to reassess plans for the additional facilities that will incorporate increased environmental safeguards while also increasing the SWP delivery yield. Developing these plans involves the time-consuming process of finding technically suitable projects and satisfying the many complex and dynamic environmental procedures, laws, and regulations.

In the mid-1980s, DWR began planning an offstream storage complex, Los Banos Grandes, in Merced County. Initial plans for Los Banos Grandes were completed, but additional planning has been suspended until environmental concerns have been addressed.

DWR also developed alternative methods of storing water, including the Kern Water Bank, a conjunctive-use groundwater storage facility located in Kern County.

The signing of the Monterey Agreement in December 1994 set the principles for permanently transferring the State-owned Kern Fan Element of the Kern Water Bank from DWR to two agricultural contractors, Kern County Water Agency and Dudley Ridge Water District. The transfer occurred August 9, 1996.

DWR continues to plan, design, and construct transportation and power-producing facilities for the SWP. The enlarged Devil Canyon Power Plant and the new Devil Canyon Power Plant Second Afterbay became operational in 1995. Mojave Siphon Power Plant was completed in 1996. Phase II of the Coastal Branch of the California Aqueduct began operation in August 1997. The Coastal Branch can transport about 50,000 af of water annually to San Luis Obispo and Santa Barbara counties.

Methods of Financing

Project facilities have been constructed with several general types of financing: general obligation bonds and tideland oil revenues (under the Burns-Porter Act, which was approved by the Legislature in 1959, and the bond issue approved by voters in 1960); revenue bonds; and capital resources revenues. Repayment of these funds, and the operations, maintenance, power, and replacement costs associated with water supply, are paid by the 29 agencies and districts that have long-term contracts with DWR for SWP water. Costs are repaid as debt service on the bonds is due.

The contracts initially provided for a combined maximum annual Table A amount of 4,230,000 af of water supply. As a result of contract amendments in the 1980s and the Monterey Amendment, the current combined maximum annual Table A by 2021 totals 4,172,786 af. The contracts are in effect for the longest of the following periods:

- the project repayment period, which extends to the year 2035;
- 75 years from the date of the contract; or
- the period ending with the latest maturity date of any bond used to finance the construction costs of project facilities.

Long-Term Contracting Agencies

From 1963 through 1967, 32 agencies or districts signed long-term water supply contracts with DWR. However, in 1965, the City of West Covina was annexed to the Metropolitan Water District of Southern California, and in 1981, Hacienda Water District was assigned to Tulare Lake Basin Water Storage District. On January 1, 1992, Castaic Lake Water Agency assumed all rights and obligations granted to Devil's Den Water District according to its long-term water supply contract. Therefore, only 29 agencies and districts now have long-term contracts with DWR as of December 31, 2005. These 29 are listed in Figure 1-2 and Table 1-6.

Figure 1-2 shows the name and location of each contracting agency and district and lists the first year of SWP delivery service for each. Table 1-6 presents information about each contracting agency.

Table 1-6. Long-Term Water Supply Contracting Agencies, by Area, as of December 31, 2005

Contracting Agency	Cumulative Deliveries (Acre-Feet)[a]	Annual Table A (Acre-Feet)	Payments (Dollars)	Gross Area (Acres)	Assessed Valuation (Dollars)[b]	Estimated Population
Upper Feather River Area						
City of Yuba City	17,158	9,600	3,770,255	5,888	1,680,000,000	47,144
County of Butte	12,923	1,200	1,080,462	1,069,000	13,000,000,000	214,119
Plumas County Flood Control and WCD	10,472	0	1,447,821	1,676,056[c]	2,060,744,342	21,200
Subtotal	*40,553*	*10,800*	*6,298,538*	*2,750,944*	*16,740,744,342*	*282,463*
North Bay Area						
Napa County Flood Control and WCD	215,830	22,225	67,690,686	510,010	20,782,359,897	132,765
Solano County Water Agency	544,599	47,256	93,244,608	537,600	32,733,946,293	421,657
Subtotal	*760,429*	*69,481*	*160,935,294*	*1,047,610*	*53,516,306,190*	*554,422*
South Bay Area						
Alameda County Flood Control and WCD–Zone 7	1,124,978	80,619	119,370,083	275,900	30,029,886,413	191,100
Alameda County WD	1,030,610	42,000	85,361,945	67,072	37,558,158,090	324,796
Santa Clara Valley WD	3,348,193	100,000	270,119,989	849,000	147,074,863,200	1,715,374
Subtotal	*5,503,781*	*222,619*	*474,852,017*	*1,191,972*	*214,662,907,703*	*2,231,270*
San Joaquin Valley Area						
County of Kings	89,970	9,000	4,605,001	893,300	7,300,545,655	147,729
Castaic Lake Water Agency	468,638	12,700	---	8,700	4,654,458	0
Dudley Ridge WD	1,985,178	57,343	64,752,959	37,568	45,390,000	36
Empire West Side Irrigation District	105,989	3,000	3,238,607	7,400	[d]	50
Kern County Water Agency	30,246,989	998,730	1,460,535,128	5,161,000	58,600,000,000	756,825
Oak Flat WD	187,876	5,700	5,187,714	4,500	[d]	10
Tulare Lake Basin Water Storage District	4,348,958	96,227	131,856,689	189,519	152,288,305	23
Subtotal	*37,433,598*	*1,182,700*	*1,670,176,098*	*6,301,987*	*66,102,878,418*	*904,673*
Central Coastal Area						
San Luis Obispo County Flood Control and WCD	34,003	25,000	54,652,638	2,122,240	34,023,607,303	255,478
Santa Barbara County Flood Control and WCD	196,549	45,486	331,148,234	1,775,296	49,196,921,210	421,625
Subtotal	*230,552*	*70,486*	*385,800,871*	*3,897,536*	*83,220,528,513*	*677,103*
Southern California Area						
Antelope Valley–East Kern Water Agency	1,482,392	141,400	352,527,421	1,525,547	18,000,000,000	365,000
Castaic Lake Water Agency[e]	600,560	82,500	199,994,142	133,500	26,243,095,000	249,000
Coachella Valley WD	726,423	121,100	177,217,908	639,857	40,703,747,303	264,869
Crestline-Lake Arrowhead Water Agency	44,789	5,800	20,380,365	55,100	1,500,527,807	25,000
Desert Water Agency	1,009,525	50,000	193,019,545	209,760	7,520,537,310	66,310
Littlerock Creek Irrigation District	18,995	2,300	5,213,975	10,000	375,160,450	2,900
Metropolitan WD of Southern California	25,975,429	1,911,500	7,309,242,182	3,328,000[f]	1,563,002,519,611	18,300,000
Mojave Water Agency	213,318	75,800	176,117,355	3,136,000	18,666,247,597	358,800
Palmdale WD	179,238	21,300	51,917,434	119,680	1,470,701,596	109,845
San Bernardino Valley Municipal WD	508,680	102,600	386,485,871	210,000	20,296,330,129	600,000
San Gabriel Valley Municipal WD	321,620	28,800	112,118,625	18,297	11,720,110,333	210,145
San Gorgonio Pass Water Agency	1,649	6,500	65,774,794	140,800	3,664,061,473	65,000
Ventura County Flood Control District	40,955	20,000	44,247,916	308,252	21,957,265,429	457,000
Subtotal	*31,123,573*	*2,569,600*	*9,094,257,534*	*9,834,793*	*1,735,120,304,038*	*21,073,869*
Total	**75,092,486**	**4,125,686**	**11,792,320,354**	**25,024,842[g]**	**2,169,363,669,204**	**25,723,800**

[a]All water delivered to long-term SWP contractors, including carryover, Article 21, surplus, unscheduled, exchange, permit, purchased, local, and non-SWP water.
[b]Statutes of 1978, Chapter 1207, added Section 135 to the Revenue and Taxation Code, requiring assessment at 100% of full value for the 1981–82 fiscal year and fiscal years thereafter.
[c]Total of all Plumas County Flood Control and Water Conservation District, including Last Chance Creek Water District.
[d]Assessed valuation not available on an agency area breakdown.
[e]District includes land in the San Joaquin Valley Area formerly known as Devil's Den Water District.
[f]Total for Metropolitan, including Calleguas Municipal Water District, which is common to Metropolitan and Ventura County Flood Control District.
[g]Includes duplicate values. Some areas that are within two or more agencies are included in each agency's total.

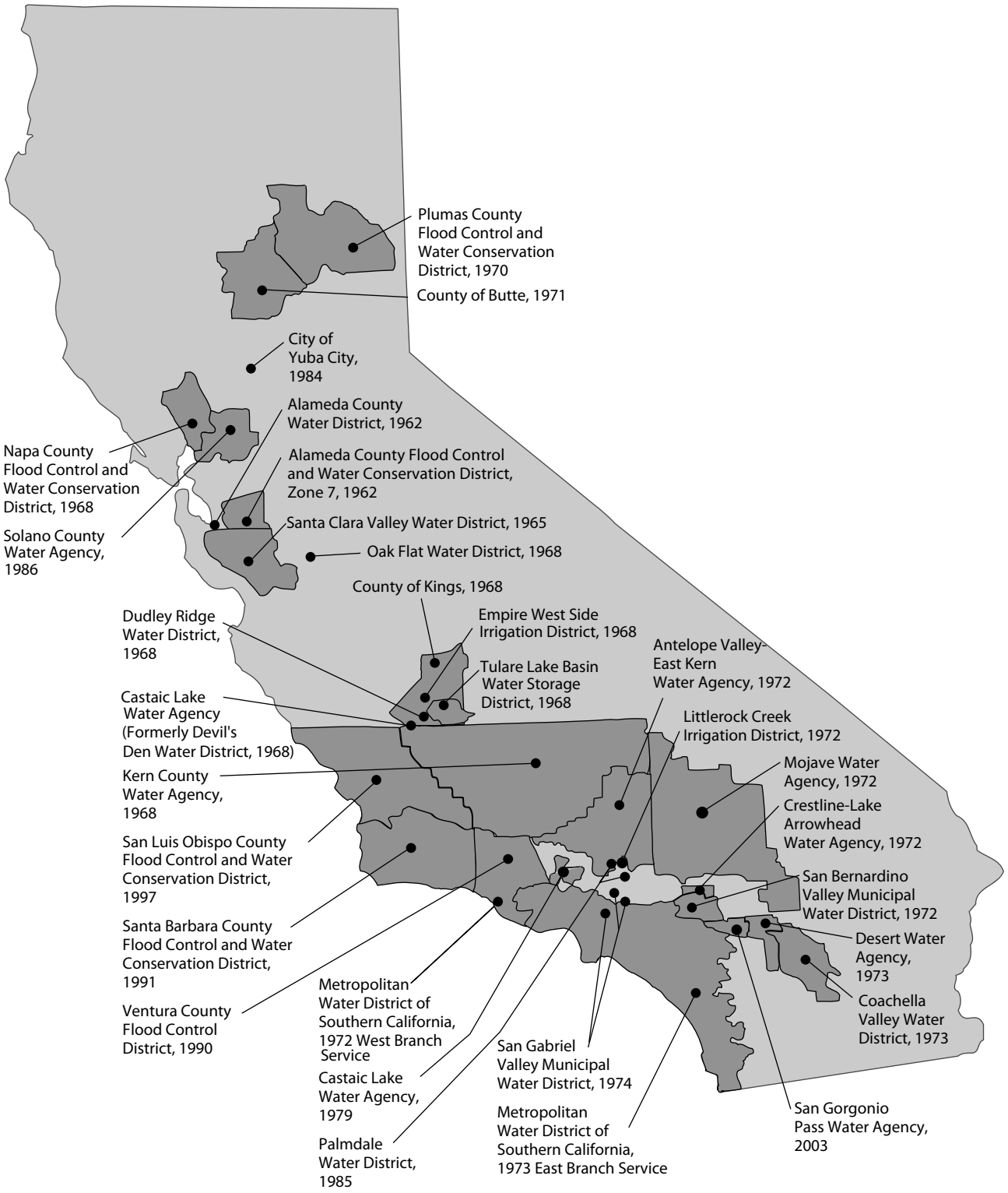


Figure 1-2. Names, Locations, and First Year of Service of Long-Term Contracting Agencies, December 31, 2005

Chapter 2
Delta Resources

An aerial view of the Sacramento River and oxbow formations.

Significant Events in 2005

In November 2005, a draft environmental impact statement/ environmental impact report (EIS/EIR) was released for the South Delta Improvements Program (SDIP). The decision to proceed with the proposed project addresses a precipitous decline in the populations of pelagic (open water) fish in the Bay-Delta environment. One of the fish species is the delta smelt, which is an endangered fish.

The CALFED Record of Decision (ROD) calls for various modifications. These modifications include changes in the North Delta's conveyance facilities to improve Delta water quality, fisheries, and water supply reliability, as well as other modifications to improve flood protection and ecosystem health.

The Franks Tract 2005 modifications study showed significant Delta water quality improvements—at a relatively modest cost. This study recommends that operations of the proposed gates are refined for these alternatives to optimize water quality benefits. The report also recommends conducting a pilot project to evaluate, implement, and demonstrate the effectiveness and impacts of the facility before considering a full-scale project.

Information for this chapter was contributed by the Division of Planning and Local Assistance, the Central District, and the Bay-Delta Office.

The Sacramento-San Joaquin Delta is a unique environmental resource and a major source of water for millions of Californians. Over the past 40 years, the Department of Water Resources (DWR), and other State and federal agencies, have developed and implemented numerous programs to manage the Delta.

DWR's water management programs focus on solving problems in three distinct areas of the Sacramento-San Joaquin Delta: the North Delta, West Delta, and South Delta (see Figure 2-1).

These programs share the following common goals:

- to improve water supply reliability to the State Water Project (SWP), Central Valley Project (CVP), and Delta water users;
- to determine levels of flow and salinity necessary to protect fish and wildlife habitat;
- to devise methods to control flooding;
- protect fish and wildlife; and
- to provide recreational activities.

Delta Water Management Programs

During the last decade, water management issues in the Delta have been complicated by the listing of native species under the federal Endangered Species Act (ESA); the creation of new Delta standards by the U.S. Environmental Protection Agency (EPA); the issuance of biological opinions under the ESA; and the implementation of 800,000 af of CVP yield for fish and wildlife protection (1992 Central Valley Improvement Act). Some of DWR's programs were deferred while solutions were sought.

In June 1994, a Framework Agreement between federal and State governments was established which defined a joint federal-State cooperative process for developing a long-term solution to water supply, water quality, and ecosystem problems of the Delta. Hence, the CALFED Bay-Delta Program was created with the goal of developing a long-term Delta solution. It put into place an extensive public outreach and input program as an important element of its planning methods.

In June 2000, the CALFED Bay-Delta Program issued a final programmatic Environmental Impact Report (EIR)/ Environmental Impact Statement (EIS). The associated decision documents, primarily a Record of Decision (ROD), were published in August 2000. The ROD defined the approach and projects to be undertaken by the CALFED Program over a 30-year period.

The first stage of the CALFED Program (2000–2007) focuses on conveying water supply through the Delta. Specific projects and studies will be undertaken during Stage 1 to determine the feasibility of a through-Delta approach. DWR is the lead State agency for the projects and studies contained in the CALFED Conveyance Program and the Levee System Integrity Program. Actions contained in the CALFED Conveyance and Levee programs affect the North, West, and South Delta regions.

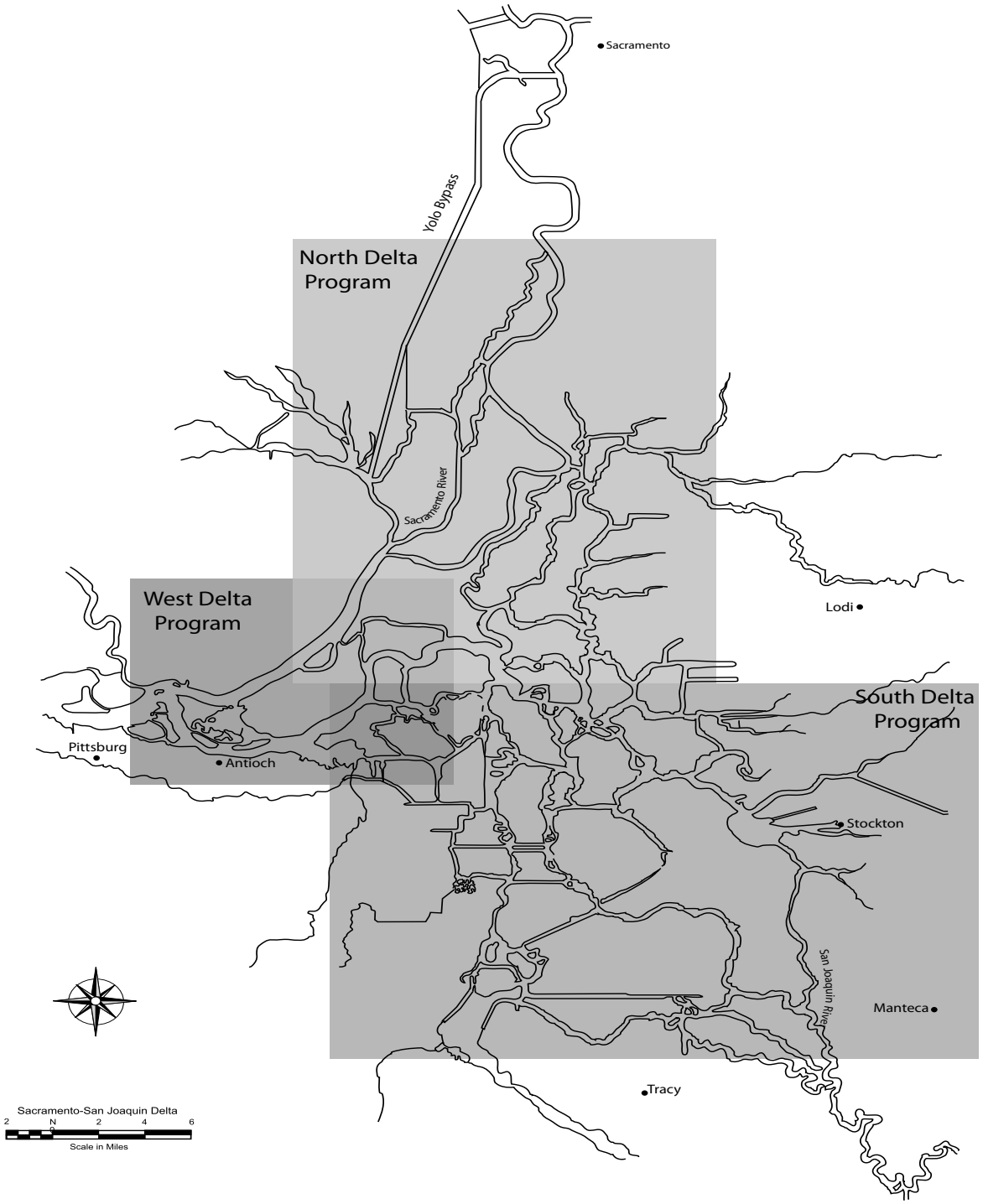


Figure 2-1. The North, West, and South Delta Water Management Programs

South Delta Improvements Program

During the late 1990s, DWR pursued the Interim South Delta Program (ISDP), which accelerated construction of South Delta facilities to improve Delta water conditions. During the same period, the CALFED Bay-Delta Program worked on an independent long-term solution. DWR released a draft EIS/EIR for the ISDP in July 1996; however, a final EIS/EIR was never produced. In 1999, the South Delta facilities became a key component of the CALFED Bay-Delta Program. Subsequently, the program was renamed the South Delta Improvements Program (SDIP). The purpose of SDIP is slightly different than that of the ISDP.

In October 2005, a draft EIS/EIR was released for the SDIP. The decision to proceed with the proposed project addresses a precipitous decline in the populations of pelagic (open water) fish in the Bay-Delta environment. One of the fish species is the delta smelt, an endangered species. Stage 1 addresses the physical and structural component of the program, which is not expected to affect fish populations. Stage 2 is the operational component of the program. This stage will increase water deliveries and delivery reliability by increasing the Clifton Court Forebay diversion limit to 8,500 cfs. Only Stage 1 is being sought at this time, while Stage 2 is being deferred. Stage 1 of the SDIP includes the construction and operation of the following projects:

- three permanent operable gates to improve local water levels and circulation in South Delta channels;
- one permanent operable gate to prevent straying of salmon migrating to the San Joaquin River;
- extensive dredging in the South Delta to improve channel capacity for local agricultural users; and
- modifications to existing agricultural diversion intakes.

Several ways of operating the Clifton Court Forebay diversion at 8,500 cfs are available, but a preferred operation is not identified in the draft EIR/EIS. DWR is committed to issuing a supplemental environmental document on Stage 2, and circulating this document for a minimum of 45 days, prior to making any decisions.

SDIP elements originally placed in the ROD included increasing diversions through Clifton Court Forebay (first to 8,500 cfs and then to 10,300 cfs), dredging and installing operable tidal barriers in the South Delta, installing a fish barrier at Head of Old River, and constructing the first phase of a new intake and fish screen into Clifton Court Forebay. DWR deferred the increase in diversions of up to 10,300 cfs and the associated new fish screens as components of the SDIP due to major funding issues, as well as significant technical uncertainties associated with the design and construction of the new fish screens.

The SDIP continues to implement its original purposes:

- to reduce the movement of Central Valley fall and late fall juvenile Chinook salmon runs into the South Delta via Old River;
- to maintain adequate water levels and water quality, through improved circulation, to provide water for agricultural diversions in the South Delta downstream of the Head of Old River;

- to increase water deliveries and delivery reliability to SWP and CVP water contractors south of the Delta; and
- to provide opportunities to convey water for fish and wildlife by increasing the maximum permitted level of daily diversion through the existing intake gates at Clifton Court Forebay to 8,500 cfs.

Preferred Plan

The preferred plan for SDIP is to construct the physical/structural component as soon as permitting is complete and defer the operational component until more is known about the project's potential effects on the delta smelt.

Temporary Barrier Facilities

Temporary rock barriers are being installed annually, during low flow conditions, until the four permanent gates are operational. These barriers are being installed at four sites, as follows:

1) Head of Old River, in Old River where it splits from the San Joaquin River;
2) Old River near Tracy, one-half mile east of the Tracy Pumping Plant intake, and about eight miles northwest of Tracy;
3) Middle River, just south of the confluence of Middle River, Trapper Slough, and North Canal; and
4) Grant Line Canal, 420 feet east of the Tracy Boulevard Bridge.

The Head of Old River barrier prevents the San Joaquin River flow from entering Old River and flowing toward export facilities. This additional flow in the San Joaquin River helps guide San Joaquin salmon to the ocean in the spring and improves dissolved oxygen levels for upstream salmon migration in the fall. The other barriers have culverts with flap gates that improve water levels and circulation in South Delta channels during the irrigation season.

Since 1963, the Head of Old River barrier has been installed in the fall. Since 1992, this barrier has also been installed intermittently in the spring, although high San Joaquin River flows sometimes prevent installation. The Old River barrier near Tracy has been seasonally installed since 1991; the Middle River barrier has been seasonally installed since 1987; and the Grant Line Canal barrier has been seasonally installed since 1996.

West Delta Program

The objectives of the West Delta Program include the following goals:

- to effectively manage SWP-owned lands on Sherman and Twitchell islands (approximately 12,000 acres total);
- to improve the integrity of local levees;
- to implement land-use management techniques to control subsidence and soil erosion on Sherman and Twitchell islands;
- to implement mitigation requirements associated with the Temporary Barriers Program and proposed SDIP; and
- to provide diverse habitat for wildlife and waterfowl.

DWR contracted with a consultant to develop preliminary wildlife management plans for Sherman and Twitchell islands. These plans are designed to benefit wildlife species that occupy wetland, upland, and riparian habitats; as well as provide

recreational opportunities for hunting and viewing wildlife. Property acquired and habitat developed by DWR could mitigate impacts associated with current and future Delta water management programs, including programs proposed by DWR and the CALFED Bay-Delta Program. (See Chapter 7 for more information.)

DWR is a major landowner on Twitchell and Sherman islands and holds two of the three trustees' positions for Reclamation Districts 1601 (Twitchell Island) and 341 (Sherman Island). Consequently, DWR participates in the management and operation of each district, with the goal of improving conditions and accountability. The reclamation districts provide levee maintenance, island drainage, and some internal water supply. These districts assess the landowners for the operational needs of the public districts.

North Delta Program

The CALFED ROD calls for various modifications. These modifications include changes in the North Delta's conveyance facilities to improve Delta water quality, fisheries, and water supply reliability, as well as other modifications to improve flood protection and ecosystem health.

Mitigations include the following:

1) evaluation and implementation of improved operational procedures for the Delta Cross Channel (DCC) to address fishery and water quality concerns;
2) evaluation of a screened Through-Delta Facility on the Sacramento River of up to 4,000 cfs; and
3) design and construction of floodway improvements to provide conveyance, flood control, and ecosystem health.

The DCC Reoperation Project involves an evaluation of improved operational procedures for the DCC, which maintains high-quality water in the Central Delta, while reducing juvenile fish entrainment. The Through-Delta Facility is a diversion facility with a capacity of up to 4,000 cfs on the Sacramento River. Operation of the Through-Delta Facility is considered only after three separate assessments are satisfactorily completed: first, a thorough assessment of DCC operation strategies and the confirmation of continued concern over water quality impacts from its operations; second, a thorough evaluation of the technical viability of a diversion facility; and third, satisfactory resolution of the fisheries' concerns about a diversion facility.

The Franks Tract Project evaluates the restoration of remnant levees and the construction of tidal gates to inhibit salt trapping and mixing in Franks Tract. This process improves water quality in the Delta. Other benefits of restoring Franks Tract include the restoration of tidal marsh habitat and increased recreational opportunities.

In 2003, DWR became actively involved in the DCC Reoperation Project and Through-Delta Facilities (DCC/TDF) projects. DWR took the lead in managing the on-going DCC/TDF projects, as well as administering and funding all DCC/TDF contracts. DWR also initiated the Franks Tract Project in 2003 as part of the North Delta Convergence improvement project.

The purpose of the Franks Tract Project is to evaluate the feasibility of rehabilitating

Franks Tract's remnant levees for water quality, ecosystem, and recreation improvements. DWR is the implementing agency for the Franks Tract Project, Through-Delta Facility evaluation, and the design and construction of floodway improvements. DWR is a participating agency on the DCC Reoperation Project.

In 2005, projects relating to the DCC Reoperation Project and Through-Delta Facility were limited to completing analyses and writing reports on field work. These activities included reevaluating project funding and schedules. For example, the Flooded Islands Pre-Feasibility Study, initiated in April 2004, to develop and evaluate conceptual alternatives for modifying Franks Tract, Lower Sherman Lake, and Big Break, was completed in June 2005. It provides conceptual modification alternatives on the three flooded islands, with their respective benefits and costs.

The Franks Tract 2005 modifications study showed significant Delta water quality improvements—at a relatively modest cost. This study recommends that operations of the proposed gates are refined for these alternatives to optimize water quality benefits. The report also recommends conducting a pilot project to evaluate, implement, and demonstrate the effectiveness and impacts of the facility before considering a full-scale project. Subsequently, in 2006 and 2007, DWR will continue to refine and evaluate the operation and design of several pilot project alternatives in the Franks Tract area. The scope of the proposed pilot project is currently under development. In mid-2007, an EIR/EIS will be initiated for the pilot project.

North Delta Flood Control and Ecosystem Restoration Improvements, a Stage 1 action under the CALFED Bay-Delta Program, provides flood control and ecosystem restoration in the North Delta area. These improvements support other CALFED goals, which include water supply reliability, recreation, and agricultural land preservation. DWR is the State implementing agency, and many of the proposed CALFED elements for the project are similar to elements of earlier North Delta planning efforts. These earlier projects were suspended in deference to the CALFED program.

DWR is overseeing the preparation of an EIR and has engaged stakeholders and interested agencies in the North Delta planning process, through the North Delta Improvements Group and the Mokelumne-Cosumnes Watershed Alliance. DWR has worked cooperatively with stakeholders to develop and incorporate phases in project alternatives. These plans include implementation flexibility, complete hydraulic modeling analysis of phased alternatives, and significant progress on project impact analysis and cost estimates. DWR staff has also worked with federal regulatory agency scientists and academic experts. They are continuing the academic science panel project review and the provision of science advisement through alternatives refinement and project planning. Project environmental documentation is scheduled for completion in 2006.

Delta Flood Control

Many of the important assets in the Sacramento-San Joaquin Delta are protected from flooding by levees. Without the levees, the Delta as we know

it today would be an inland sea. The levees serve many needs: they protect valuable wildlife habitat, farms, homes, urban areas, recreational developments, highways, railroads, natural gas fields, utility lines, major aqueducts, and other public developments. They are critical to the protection of in-Delta water quality and water quality for approximately 24 million Californians who receive their water from the State's export system. The State Legislature recognized the importance of the Delta and enacted the Delta Flood Protection Act of 1988 (Senate Bill (SB) 34 [Water Code Sections 12310 et seq., and 12980 et seq.]). With SB 34, the Legislature declared that "...the Delta is endowed with many invaluable and unique resources and that these resources are of major statewide significance."

In SB 34, the Legislature declared its intent to appropriate $12 million annually for the Delta Flood Protection Fund. Six million dollars of the appropriation are for local assistance under the Delta Levee Maintenance Subventions Program. The remaining $6 million are for Delta Special Flood Control Projects, including subsidence studies and monitoring on Bethel, Bradford, Jersey, Sherman, and Twitchell islands; Holland, Hotchkiss, and Webb tracts; and the towns of Thornton and Walnut Grove.

Since 1988, the program has managed $202 million in appropriated funds and, combined with local funds, has realized $275 million in levee improvements. In 1996, Assembly Bill (AB) 360 was signed into law and expanded the area covered by the Delta Special Flood Control Projects Program to include the remainder of the legal Delta and the northern Suisun Bay from Van Sickle Island to Montezuma Slough. Bond appropriations of $25 million from Proposition 204 (enacted in 1996) and $30 million from Proposition 13 (enacted in 2000) provide supplemental funding. In November 2002, Proposition 50 was approved. It provides $70 million in additional funding to implement the Delta Flood Protection Program as adopted in CALFED, where the program is known as the Levee System Integrity Program.

CALFED Levee System Integrity Program

The goals and objectives for the Levee System Integrity Program are listed as follows.

Base Level Protection

This program provides funding to help local reclamation districts reconstruct all Delta levees to a base level of protection (Public Law 84-99 standard). About 520 out of 1,100 miles of Delta levees initially do not meet this standard. During Stage 1, about 200 additional miles of levees are planned to be brought up to a base level of protection, provided there is sufficient funding.

Special Improvement Projects

This program will enhance levee stability on levees that have particular importance in the State. Priorities include protecting life and personal property (more than 400,000 people live in Delta towns and cities), water quality (preventing salinity intrusion), the Delta ecosystem, and agricultural production.

Suisun Marsh Flood Protection and Ecosystem Enhancement

This program provides levee integrity, ecosystem restoration, and water quality benefits by supporting maintenance

and improvement of the levee system in the Suisun Marsh. The Suisun Marsh Levee Investigation was undertaken in January 1999, at the request of the CALFED Policy Group, to determine if adding Suisun Marsh levees into the Levee System Integrity Program would contribute to CALFED program goals. The team has identified significant links between Suisun Marsh levee maintenance and achievement of CALFED drinking water quality and ecosystem restoration goals. Furthermore, modeling research indicates a significant risk of negative water quality impacts in the Delta if Suisun Marsh levees are inadequately maintained and allowed to fail. When adopted, the CALFED Suisun Marsh Charter will help guide future actions.

Levee Emergency Response Plan

The emergency response plan for the Delta has been improved recently to better coordinate response agency activities, and the distribution of materials, when combined with local agency efforts. This will enhance the combined ability to respond to levee emergencies.

Delta Levee Maintenance Subventions Program

The Delta Levee Maintenance Subventions Program provides matching funds for levee work critical to the long-term survival of Delta islands and the State water supply. This program assures the continuance of the Delta's ability to provide its many statewide and local benefits. Within CALFED's Levee System Integrity Program, the Delta Levee Maintenance Subventions Program provides funding, as a reimbursement, to local Delta reclamation districts for levee maintenance and improvement. Each year up to 65 participating districts prepare work plans and file applications with the State Reclamation Board (SRB) for funding.

The applications and work plans are reviewed by DWR, which then makes a recommendation and requests the approval of SRB for the program funding level. SRB approves each district's maximum possible reimbursement—up to 75 percent for levee work and habitat mitigation—and maximum advanced reimbursement amount. The reimbursement amount may be up to 75 percent of eligible costs. After SRB approval, agreements are executed between SRB and each participating district. These agreements state that eligible work will be completed during the current fiscal year. All work must be in compliance with appropriate State and federal laws, including the California Environmental Quality Act, the State and federal ESA, Section 1600 of the Fish and Game Code, and Section 404 of the Clean Water Act, and must have confirmation from the Department of Fish and Game (DFG) that a net long-term habitat improvement of riparian, fisheries, and wildlife habitat will result.

Delta Special Flood Control Projects

The Special Flood Control Projects Program under CALFED assists the eight western islands, portions of the Suisun Marsh, the towns of Thornton and Walnut Grove, and other locations in the Delta with flood protection and levee stability repairs. The California Water Commission approved a report of initial actions in September 1989, and it approved the long-term actions and priorities in May 1990. The long-term actions and priorities serve as a guide for DWR to determine how best to use appropriations to protect these

islands. Long-term actions and priorities include the following:

- rehabilitation of threatened levees through the use of imported dredged material;
- verification of elevations in the Delta through the use of Global Positioning System equipment;
- upgrading levees to the standards included in Bulletin 192-82, Delta Levees Investigation; and
- projects to achieve net long-term habitat improvement for fish and wildlife.

While DWR always seeks cost sharing for all projects, the actual reimbursement depends on each reclamation district's ability to pay. DWR provides up to 100 percent of the cost of these activities. Districts receiving these funds are required to participate in a habitat improvement program to ensure net long-term habitat enhancement.

Levee restoration projects in 2005 include the following:

- initiation of two large-scale levee rehabilitation projects on Sherman Island;
- initiation of the phase III levee rehabilitation project on Bethel Island;
- development of a 50-acre mitigation project on Bradford Island;
- completion of large scale rehabilitation projects on Jersey Island;
- continuation of a large scale rehabilitation project on New Hope Tract; and
- initiation of a Delta-wide program to conduct magnetic anomaly surveys of district levees.

Delta Levees Habitat Improvement

The Delta Suisun Marsh Office, as part of the CALFED Levee System Integrity Program, continues to make significant strides in its efforts to create valuable habitat in the Delta. By the end of 2005, the program had developed 247.4 acres of various types of habitat, 9,410 linear feet of shaded riverine aquatic habitat for mitigation, and 14.4 acres and 14,328 linear feet for enhancement. During 2005, the program continued to develop almost 36 acres of habitat for levee project mitigation and 10 acres for enhancement.

Completed mitigation and enhancement projects include the following:

- Medford, Bethel, and Kimball islands;
- Terminous, Wright Elmwood, Palm, and Thornton-New Hope (Grizzly Slough) tracts;
- Twitchell Island setback levee;
- Twitchell Island mitigation areas;
- Staten Island berm and channel islands;
- Canal Ranch attached berm;
- Lower Sacramento River revegetation, Grand Island, in participation with the U.S. Army Corps of Engineers (Corps);
- Webb Tract Sites 3 and 1, and Little Tinsley Island in-channel island protection and restoration;
- Decker Island Phase I and Phase II construction, and tidal wetlands restoration at Horseshoe Bend along the lower Sacramento River;
- Tyler Island bank stabilization demonstration; and

- purchase of 666 acres at Meins Landing in the Suisun Marsh for tidal wetland restoration.

Projects underway include the following:

- fish monitoring of Decker Island restoration site;
- construction of a setback levee on Sherman Island;
- Sherman Island Parcel 11 Revegetation Project;
- Dutch Slough feasibility study concepts; and
- Bradford Island Tract 19 mitigation area development.

Projects proposed include the following:

- Delta levees habitat mitigation; and
- Tidal restoration of Dutch Slough.

DWR, DFG, and reclamation districts are successfully providing avoidance or mitigation of habitat losses and net long-term habitat improvement in the Delta. Reclamation districts have been very cooperative in helping DWR meet its mitigation and enhancement needs. Decker Island Habitat Restoration Area, completed in 2004, is targeted specifically for the needs of endangered Sacramento splittail and delta smelt, providing 26 acres of tidal aquatic area. Continued monitoring is determining the amount of fishery use of the restoration site, evaluating the hydrogeomorphic performance of the site, and providing valuable data for future restoration work.

DWR and DFG will continue to work with the reclamation districts to preserve existing habitat and to improve the quantity and quality of newly developed habitat in the Delta.

Reuse of Dredged Material for Delta Levees

As local sources of fill material for levee repair are depleted, new economical sources must be located. During the last 15 years, DWR, in coordination with the Corps, local reclamation districts, and the Central Valley Regional Water Quality Control Board (CVRWQCB) implemented three pilot projects at Sherman, Twitchell, and Jersey islands to demonstrate the viability of relocating material from the San Francisco Bay Area to the Delta. Extensive monitoring and testing programs for salinity impact were required; no salinity impact was demonstrated. More recently, CVRWQCB has started looking at other constituents of dredged material and is becoming more stringent in its requirements. The addition of new monitoring and preparation requirements has raised the cost of reuse. If these costs continue to rise, DWR will reevaluate the practicality of participating in this portion of the program. Based on the assumption that reuse will remain economically beneficial, DWR has worked to find more opportunities to reuse clean, bay-dredged materials in the Sacramento-San Joaquin Delta. Current efforts for beneficial reuse of dredged material from the Bay area principally consist of the following:

- participation in the multiagency Delta Long Term Management Strategy (LTMS) for the beneficial reuse of dredged material;
- coordination with CVRWQCB to address water quality concerns;
- discussions with the Corps to promote identification and acquisition of federal funds to support beneficial reuse

projects;
- participation in a large regional meeting with various stakeholders in the Delta to address dredging and dredged material reuse issues;
- coordination with the Corps, CVRWQCB, CALFED, and Reclamation District 341 to stockpile dredged material from Suisun Bay and New York Slough on Sherman Island; this long-term project could consist of 200,000 cubic yards of material dredged annually for five years. This project will be initiated by a demonstration project with 150,000 cubic yards coupled with an intense monitoring program;
- levee restoration and habitat projects proposed or under construction;
- obtaining waste discharge requirements for the demonstration project on Sherman Island;
- obtaining 54,000 cubic yards of dredged material on Sherman Island; and
- reusing dredged material on Sherman Island to construct the set-back levee.

Levee Upgrades

Upgrading the Delta levees is an integral part of the CALFED Levee System Integrity Program plan being implemented through the DWR Delta Flood Control Program. According to the CALFED ROD, all Delta levees should be built to the Corps' Delta-specific Public Law 84-99 levee standard. This standard is comparable to DWR's Bulletin 192-82 standard and provides protection against flooding in a 100-year flood event. The minimum freeboard is 1.5 feet for levees protecting agricultural land, and 3 feet for levees protecting urban areas. A typical improved levee section would have a 16-foot crown width, a waterside slope of 2 horizontal to 1 vertical, and a landside slope designed for the depth of peat soils under the levee. Generally, the landside slope would be between 2:1 and 5:1.

DWR and the Corps signed an agreement in 2001 to co-manage the CALFED Levee System Integrity Program, including the Delta Flood Protection Program. This agreement allows close coordination of efforts and assures compatibility with CALFED goals and objectives.

Subsidence Investigations

Historically, draining and cultivating Sacramento-San Joaquin Delta marshlands caused the peat soil to break down and compact. The peat has oxidized and subsided since the mid-1800s, when the land was first drained and levees constructed. The surface of organic soils in the Delta is now between 10 and 29 feet below sea level. The Legislature recognized the problem and, with the initiation of the Delta Flood Protection Act of 1988, DWR began monitoring subsidence and studying its causes and the means for reversing its effects.

DWR and the U.S. Geological Survey conduct an ongoing subsidence investigation in the Delta. Preliminary data indicate the following:

- land management practices substantially influence subsidence rates;
- cultivation practices that raise soil temperature and lower the water table dramatically increase oxidation of the peat soils;
- conversion of highly organic peat soils to carbon dioxide gas (oxidation) appears to be the recent primary cause

of subsidence;
- permanently flooded shallow wetlands decrease release of gaseous carbon by as much as 80 percent, thereby mitigating subsidence; and
- permanently flooded shallow wetlands also promote the growth of wetland vegetation that adds biomass back into the system.

Current studies of subsidence mitigation and growth of wetland vegetation suggest that shallow permanent flooding will be part of the process to reverse subsidence through biomass accretion.

In 1999, CALFED granted Category III funds to DWR to construct a Subsidence Reversal Demonstration Project on Twitchell Island. To date, field monitoring, determination of hydrologic and tidal boundary conditions, and sediment modeling have been completed; construction, monitoring, and instrumentation installation continues at the field test sites. Water quality, soils, and hydraulic and carbon release data were collected from the test sites, and the preliminary model for groundwater has been completed. The contract amendments were completed in 2005, and work on the study was resumed. The study is to be completed by the end of 2006.

DWR will also work with the CALFED Science Program to develop best management practices to control and reverse subsidence and will work with local districts and landowners to implement cost-effective measures.

The U.S. Geological Survey and area consultants have set up a learning laboratory to study ways to reverse subsidence at Oulton Point on Twitchell Island. This project will combine the cultivation of tules and other aquatic vegetation in shallow ponds with application of thin layers of sediment. Land surface accretion and organic soil oxidation rates will be measured.

Delta Agricultural Water Users

In 1974, the Delta Water Agency was replaced by six Delta agricultural water agencies: North Delta, South Delta, and Central Delta water agencies; Contra Costa County Water Agency, East Contra Costa Irrigation District, and Byron-Bethany Irrigation District. In 1981, North Delta Water Agency and East Contra Costa Irrigation District signed water rights management contracts with DWR. The department negotiated contracts and requested negotiations with other agencies to provide water level, circulation, and quality needs in certain areas.

South Delta Water Agency Contract

In September 1990, DWR completed negotiations for a long-term agreement with the South Delta Water Agency and Reclamation. Under this proposal, the South Delta contract, the parties agreed to proceed with the design, construction, and operation of certain barrier facilities in the South Delta channels. These facilities resolved those portions of the lawsuit that South Delta filed in 1982, regarding the alleged effects of export pumping by SWP and CVP on water levels, quality, and circulation in the South Delta.

DWR has installed and operated temporary barrier facilities in the South Delta to improve area conditions, as well as collect data needed to design and operate

permanent barrier facilities. Data collected in the Temporary Barriers Program was used to assess the barriers' ability to reduce or eliminate adverse water levels and improve local hydraulic circulation patterns.

Western Delta Municipal Water Users

DWR signed contracts with Contra Costa Water District in 1967 and Antioch in 1968. These contracts compensated Contra Costa and Antioch for purchasing water of usable quality, when such water was not available from Mallard Slough and the San Joaquin River.

According to the terms of these contracts, DWR compensates each agency for the additional costs of purchasing a substitute water supply from the Contra Costa Canal. This water is purchased to replace water supplies of usable quality, which are lost due to SWP operations. Credits for the number of days of above-average water supplies of usable quality, from Mallard Slough and the San Joaquin River, accrue to offset the number of below-average days in future years.

Chapter 3
Environmental Programs

Pelicans take flight over a waterway in the Sacramento-San Joaquin Estuary.

Significant Events in 2005

In April 2005, the National Marine Fisheries Services (NOAA Fisheries) issued a proposed listing of the southern population of North American green sturgeon (*Acipenser medirostris*) as threatened under the Endangered Species Act (ESA). This listing was based on a March 2004 U.S. District Court decision. The court remanded a NOAA Fisheries finding that the North American green sturgeon does not warrant listing as a threatened or endangered species.

On September 2, 2005, NOAA Fisheries issued a final rule designating Critical Habitat for California salmonids. Approximately 8,935 miles of riverine habitat and 470 square miles of estuarine habitat were designated as Critical Habitat Area for seven Evolutionarily Significant Units (ESUs) of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) in California. This rule will become effective on January 2, 2006.

On October 20, 2005, the Resources Agency released the Delta Smelt Action Plan, a researched-based, scientific approach to counteract the decline of pelagic fish in the Delta. During 2004, Interagency Ecological Program (IEP) scientists detected sharp population declines in pelagic fish species, including delta smelt, which are considered a key indicator of the health of the Delta ecosystem. The State will research potential causes of this decline, including pollutants, contaminants, invasive species, food chain disruptions, and water operations of State and federal projects. The Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) increased the IEP 2005 budget by $1.7 million to support research to identify causes for the decline of pelagic fish in the Delta.

In April 2005, the Lower Yuba River Accord was announced. This collaborative proposal settled long-standing litigation over instream flow requirements in the lower Yuba River. The accord is based on three proposed agreements: a water purchase agreement, including water for the Environmental Water Account (EWA); a conjunctive use agreement; and a fisheries agreement. The fisheries agreement is intended to benefit some of the last wild populations of salmon and steelhead in the Central Valley by establishing instream flow requirements. On November 29, 2005, DWR and the Department of Fish and Game (DFG) announced their support for the proposed Lower Yuba River Accord pilot program. The Lower Yuba River Accord will formally take effect in late 2006.

On December 23, 2005, NOAA Fisheries published a final listing that recognized 10 Distinct Population Segments (DPSs) of West Coast Steelhead as either threatened or endangered under ESA. This listing confirmed the threatened status of all California steelhead DPSs.

Information in this chapter was contributed by the State Water Project Analysis Office, the Division of Environmental Services, and the Division of Operations and Maintenance.

The Department of Water Resources (DWR) has developed and implemented several programs to avoid, minimize, or offset adverse environmental impacts, which may result from the operation of State Water Project (SWP) facilities.

Operations for Species of Concern

A primary consideration in the operation of the SWP is avoiding, minimizing, and off-setting adverse environmental impacts to species of concern. A species of concern is listed (or proposed for listing) as threatened or endangered by a State or federal agency. The legal authority for listing is the federal Endangered Species Act (ESA) or the California ESA. A key to avoiding and minimizing adverse impacts to these species is maintaining flexibility in SWP operations, which is done mainly through the Environmental Water Account (EWA). EWA provides protection to Delta fisheries through changes in SWP and CVP operations, while maintaining water supply reliability to the projects' water users. Operational responses can include Delta Cross Channel gate closure, export curtailments, changes in delivery schedules, increased reservoir releases, preferential use of certain facilities, or a combination of these actions. (Additional information about EWA can be found in Chapters 7 and 9.)

San Joaquin River Activities

DWR coordinated with the Bureau of Reclamation (Reclamation) to increase flows in the San Joaquin River, from mid-April through mid-May (pulse flow period), to benefit fall-run Chinook salmon emigrating from the San Joaquin River Basin. This plan, known as the Vernalis Adaptive Management Plan (VAMP), is a 12-year federal and State research program, which is associated with the San Joaquin River Agreement. VAMP calls for intensive fisheries sampling in the lower San Joaquin River. Several studies were coordinated with the fisheries collection efforts to estimate the relative survival of marked salmon moving through the Delta under VAMP during the pulse flow period. The goal is to conduct operational changes and associated studies over a number of years (to determine if a relationship exists between river flow, Delta exports, and salmon survival) throughout the southern Delta. The resulting information will be used to determine if changing San Joaquin River flows and Delta exports in the spring can significantly benefit San Joaquin River fall-run Chinook salmon.

Temporary Barriers

VAMP-participating agencies use temporary barriers as a tool to facilitate the following goals:

- provide an adequate water supply for South Delta water diverters;
- improve water quality conditions in the Stockton Deep Water Channel; and
- prevent young Chinook salmon from entering Old River, thereby reducing the likelihood of entrainment at the South Delta facilities.

In 2005, the Spring Head of Old River barrier was not installed, due to high flows on the San Joaquin River. This spring season barrier will help improve conditions for juvenile Chinook salmon,

which migrate out of the San Joaquin River Basin. The barrier was installed in the fall, between September 30 and November 15. The purpose of this barrier is to help with low dissolved oxygen levels in the lower San Joaquin River and prevent migrating adult Chinook salmon from entering the area.

Temporary barriers were installed on Middle River and Old River near Tracy, on May 17 and June 6, respectively, and the Grant Line Canal barrier was completed on June 18. The primary purpose of these barriers is to increase water levels in the South Delta for local water users. The barriers were removed in mid- to late-November, due to the lack of need for irrigation water and possible conflicts with winter-run salmon.

Piru Creek/Pyramid Dam Operations

The original Federal Energy Regulatory Commission (FERC) License for the Castaic Power plant project, FERC Project No. 2426, contained a provision that specified continuous minimum releases from Pyramid Lake to Piru Creek (5 cfs from November 1 thorough March 31 and 10 cfs for the remainder of the year) for the maintenance of a trout fishery, located in middle Piru Creek. This requirement was amended in 1982 to require a continuous minimum flow (5 cfs from November 16 through April 30 and 10 cfs for the remainder of the year). Additional releases were stipulated, based on the daily ambient air temperature, to maintain water temperatures suitable for the trout fishery.

The daily flow fluctuations were found to be detrimental to the Arroyo toad, which is known to breed along middle Piru Creek. In 1994, the Arroyo toad was listed as a federally endangered species. Since 1995, at the request of the California Department of Fish and Game (DFG), the summer releases to Piru Creek were maintained at 25 cfs (April 1 through August 31). This release schedule provided water temperatures protective of the trout fishery and eliminated the flow fluctuations thought to be detrimental to the Arroyo toad.

Concerns were raised regarding the impact of the flow release schedule on the Arroyo toad population at a series of interagency meetings held in 2003 with representative from the U.S. Fish and Wildlife Service (USFWS), DWR, DFG, and other organizations. It was concluded that the higher summer maintenance flows were contributing to conditions in middle Piru Creek that were detrimental to the Arroyo toad and had resulted in incidental take. New operational criteria were developed to simulate the natural hydrology of middle Piru Creek, to the extent operationally feasible, to provide the greatest benefit to the Arroyo toad. DWR agreed to alter Pyramid operations to avoid further incidental take.

New operational guidelines for Pyramid Dam releases to Piru Creek were adopted in 2005. These guidelines were released after the certification of the Final EIR in February 2005 and FERC approval of a temporary waiver of the minimum flow requirements (Article 52 of the license for project 2426) in April 2005. Under the new criteria, releases to Piru Creek from Pyramid Dam will match natural surface inflow into Pyramid Lake to the extent operationally feasible.

DWR holds a water rights permit authorizing the appropriation of water from Piru Creek, at Pyramid Lake, when flows are greater than the demands of the downstream water users. DWR has appropriated water from Piru Creek in only seven years since 1978.

The operational revisions will limit future SWP appropriations from Piru Creek to those flows in excess of the safe release from Pyramid Dam. The new guidelines, consistent with the Final EIR, also allow for the delivery of up to 3,150 af of SWP water, via Piru Creek, to Ventura County Watershed Protection District, under the provisions of the long-term water supply contract for United Water Conservation District. The SWP water deliveries will occur only between November 1 and the end of February each year.

Biological Opinions Issued on the Revised CVP/SWP Operating Plan

USFWS Biological Opinion

On August 6, 2004, USFWS issued a non-jeopardy biological opinion on impacts to threatened delta smelt by proposed revised operations of CVP and SWP. The USFWS concluded that any adverse effects from the Operating Criteria and Plan (OCAP) for the two jointly operated projects will be avoided or minimized by conservation measures and the adaptive management measures which were newly incorporated into the project plan. This Biological Opinion was renewed in 2005.

OCAP addressed the operational impacts on delta smelt by committing the two projects to take early protective actions for the species. These actions will occur before high numbers of the fish reach the major export pumps, where losses often occur. OCAP incorporated the EWA into the delta smelt protective actions.

The biological opinion also set new incidental take limits for delta smelt. The new USFWS take limits are based on the most recent 11 years of data (1993–2003), using more recent information. The new take limits are based on two categories of water year type: (1) wet or above normal, and (2) below normal, dry, or critical. The Delta Smelt Risk Assessment Matrix (DSRAM) adult concern level is set at 892, and the reconsultation level varies by month, ranging from 100 to 44,800. When the incidental take is exceeded, a team of interagency scientists, called the Delta Smelt Working Group, will convene a meeting to review smelt distribution, abundance, projected project operations, and other information. This work group will recommend any actions that should be taken to reduce salvage. The adaptive management measures in OCAP are intended to provide better protection for the species.

NOAA Fisheries Biological Opinion

In its supplemental biological opinion, issued February 27, 2004, NOAA Fisheries concluded that the continuation of OCAP, through March 2006, is not likely to jeopardize the continued existence of spring-run Chinook salmon or steelhead in the Central Valley. This opinion was issued to provide an ESA take exemption for project operations, while work continued on the long-term consultation project. Notwithstanding this conclusion,

an incidental take statement and several reasonable and prudent measures were issued to minimize take.

Reasonable and prudent measures to protect spring-run Chinook salmon and steelhead in the Central Valley include the following:

- continuing research on the effects of flow and water temperature;
- operating to meet temperature objectives;
- minimizing adverse effects of Delta Cross Channel operations;
- minimizing Delta exports during fisheries' sensitive times;
- conducting research to improve facility operations at fish salvage collection facilities;
- conducting weekly scientific reviews of current data; and
- minimizing take from unscreened diversions that are part of interim water contract renewals.

Delta Export Curtailment

SWP and CVP operated under a new Delta Smelt Biological Opinion in 2005, which was signed in August 2004.

On January 24, 2005, the incidental take of pre-spawning adult delta smelt at SWP and CVP exceeded the concern level of 892. The Delta Smelt Working Group met to discuss possible actions. As a result, combined exports were reduced to 3,000 cfs for seven days.

In 2005, 2,922 delta smelt were salvaged by SWP and 818 were salvaged by CVP. This compares to 20,470 delta smelt salvaged at both facilities in 2004.

Decisions on Endangered Species

North American Green Sturgeon

In 2001, NOAA Fisheries received a petition from the Environmental Protection Information Center, the Center for Biological Diversity, and Waterkeepers Northern California that requested a listing of the North American green sturgeon (*Acipenser medirostris*) as either a threatened or an endangered species under ESA. The petition also noted a request for the designation of critical habitat for the species, concurrently with any listing determination.

In January 2003, NOAA Fisheries issued a 12-month determination that listing of the species was not warranted. However, on April 7, 2003, the plaintiffs challenged the NOAA Fisheries determination. The initial finding was set aside by the U.S. District Court, and the matter was remanded to NOAA Fisheries in March 2004. The court was not satisfied with the NOAA Fisheries examination of whether purported lost spawning habitat constituted a significant portion of either Distinct Population Segment's (DPS's) range.

On April 5, 2005, NOAA Fisheries filed a proposed rule with the Federal Register to list the southern DPS of North American green sturgeon, the population occurring south of the Eel River, as threatened under the ESA. The biological review team used previous studies of salmon in the Central Valley to examine the likelihood that spawning habitat has been lost within the range of the southern green sturgeon DPS. It was determined that dams built on the upper Sacramento and Feather rivers likely block migration of green sturgeon,

Endangered Species Acts

In planning, constructing, and operating the SWP, DWR must consider the effects its actions will have on organisms, including plants, birds, reptiles, fish, and mammals, listed as threatened or endangered according to the Federal Endangered Species Act (Title 16, United States Code sections 1531–1544 [1973]) and the California Endangered Species Act (California Fish and Game Code sections 2050–2098 [1984]).

An endangered species is one in danger of extinction in all or a significant portion of its range; a threatened species is one likely to become endangered. These acts are designed to protect threatened and endangered species by

- ensuring federal and State agencies adopt measures to protect the species during the design, construction, and operation of projects and in taking other forms of agency action; and
- prohibiting the unauthorized take of endangered species.

One important aspect of the acts is preserving habitat critical to the survival of the species.

significantly reducing the historical habitat of the southern DPS.

Trends in Fish Abundance

Figure 3-1 shows the abundance index for delta smelt, from 1967 through 2005, based on fall midwater trawl sampling. Using the first two tow net surveys only, delta smelt abundance indices are calculated as the product of the total catch at each site and a weighting factor that represents the estimated water volume for the site, divided by 1,000. The fall abundance index provides one of the best indicators of the status of the adult delta smelt population. The 2005 index was the lowest index on record. Since 2002, abundance indices for this species have been lower than expected, given moderate flow conditions of the past several years. The Delta Smelt Action Plan was implemented in October 2005 to help understand and counteract the causes of the decline of delta smelt.

Figure 3-2 shows estimates of returning adult winter-run Chinook salmon, from 1967–2005. These estimates are referred to as escapement estimates—the number of adults that escape mortality and return to spawn. The Sacramento River winter-run Chinook salmon escapement estimates are generated using data from the DFG carcass survey. DFG has been using the carcass survey data to generate escapement estimates since 2002. Prior to 2002, Red Bluff Diversion Dam counts were used to generate the escapement estimate. Winter-run escapement has continued to increase since 2002. The estimated winter-run Chinook escapement for 2005 was 15,839, which was substantially more than the estimated 7,464 adults in the parent stock of 2002, and the highest escapement since 1981. Factors such as improved spawning

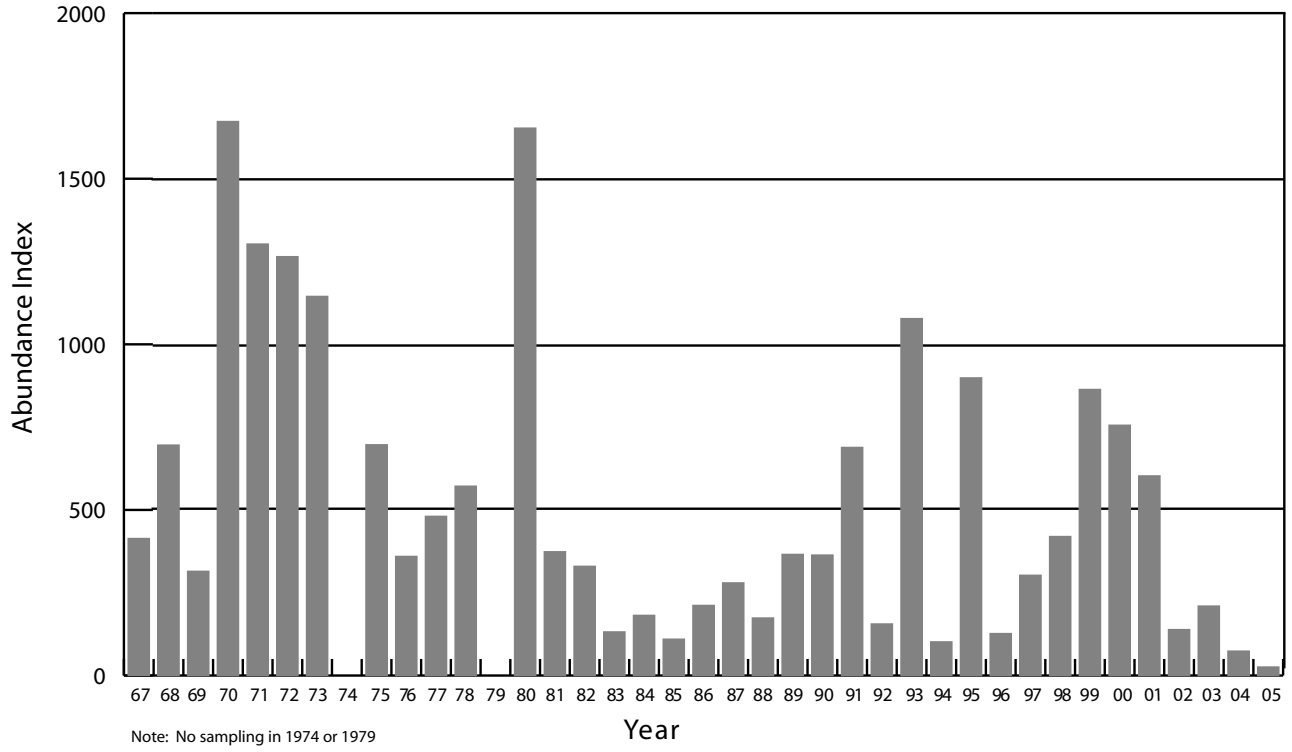


Figure 3-1. Delta Smelt Fall Midwater Trawl Abundance Index, 1967-2005

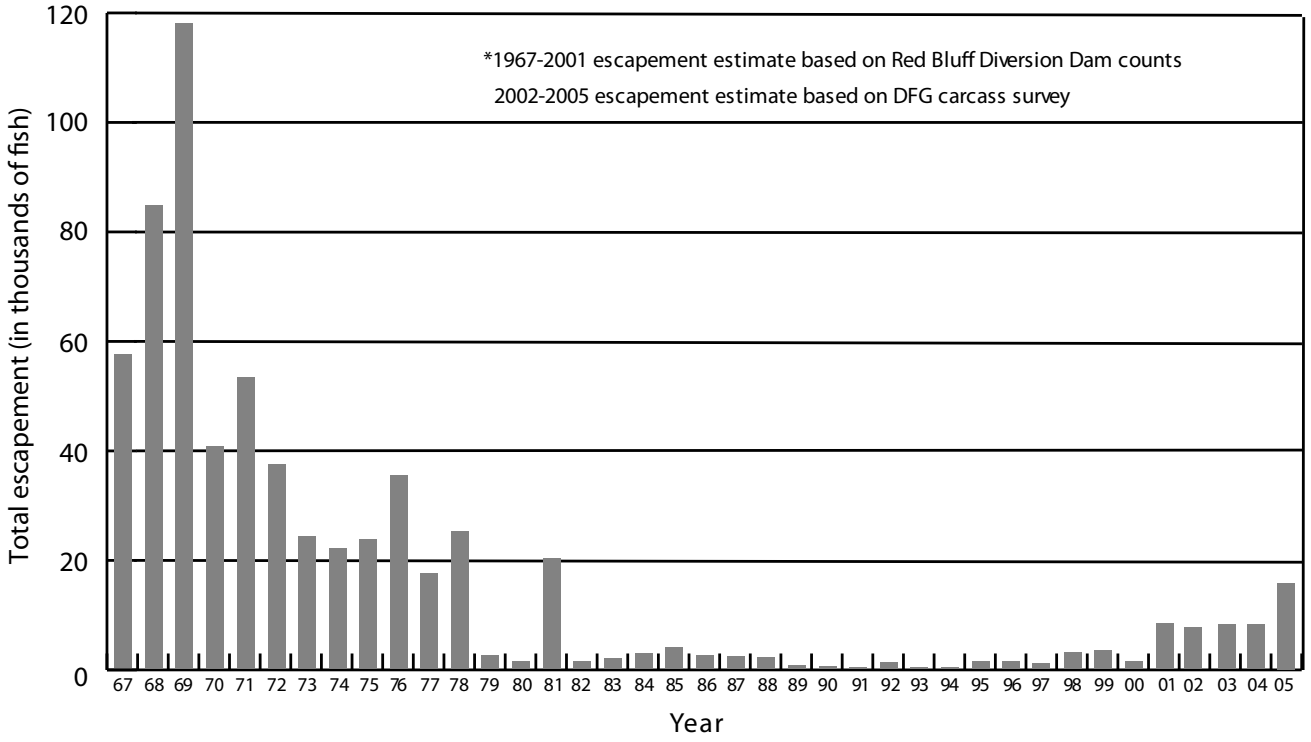


Figure 3-2. Estimated Total Adult Winter-Run Chinook Salmon Escapement, 1967-2005

and rearing habitat, reduced losses in the Delta, reduced commercial fishing losses, and changing ocean conditions are likely to benefit winter-run Chinook salmon.

Figure 3-3 shows estimates of returning adult spring-run Chinook salmon, from 1990–2005. Individual estimates are shown for Mill Creek, Deer Creek, Butte Creek, and the Feather River—the principal spawning streams for this race of salmon. The escapement estimates are shown separately for each stream, because the Feather River estimate is based on returns to the Feather River Hatchery, where the genetic integrity of spring-run Chinook salmon is uncertain. The estimated escapement for 2005 was 1,820 for the Feather River Hatchery and about 14,000 for the other streams combined.

Spring-run escapement in 2005 increased about 24 percent, as compared to 2004 statistics.

Counting methods for returning adult spring-run Chinook salmon from the Feather River Hatchery changed in 2004. From May 17 through June 30, 2005, the fish ladder was opened, allowing adult spring-run Chinook salmon to enter the Feather River Fish Hatchery. During this time period, 5,950 fish entered the hatchery. In an effort to better estimate spring-run Chinook salmon abundance, and to distinguish fall- from spring-run, the fish were tagged with an external "floy" tag and released back into the Feather River. When spawning commenced in the fall, a total of 2,991 spring-run fish were recaptured: 1,835 at the hatchery, 1,049 in

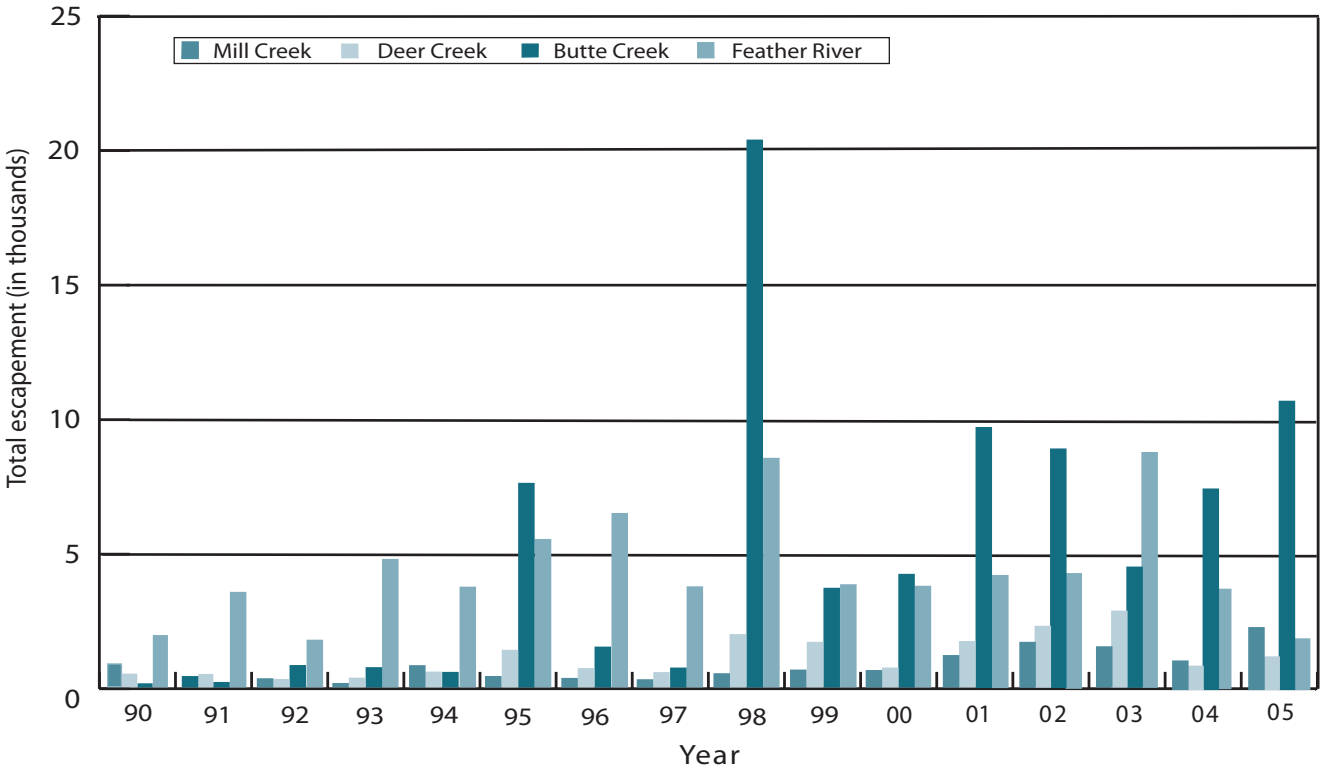


Figure 3-3. Estimated Spring-Run Chinook Salmon Escapement, 1990-2005

the river escapement survey, and 107 by anglers.

The Feather River Hatchery successfully spawned 1,830 (99.7 percent) of the fish returning to the hatchery. Four hundred twenty-three (89 percent) of the 474 female salmon recovered in the river escapement survey were classified as spent (and are thus assumed to have spawned successfully). Based on the escapement survey recapture data, the sex ratio of the marked spring-run was 2.24:1—females to males. While these methods do not yet provide a complete population estimate for Feather River spring-run Chinook salmon, future refinements may make such an estimate possible.

The return numbers for spring-run Chinook salmon remain consistently higher than the early 1990s statistics. Like winter-run Chinook salmon, factors such as improved spawning and rearing habitat, reduced losses in the Delta, and reduced commercial fishing losses likely benefited spring-run Chinook salmon.

Due to lack of comprehensive monitoring programs and the difficulty in conducting that monitoring, there are no reliable escapement estimates for wild Central Valley steelhead.

Feather River Fish Studies

In the early 1990s, the Feather River fish studies were initiated to document and monitor fish populations in the lower Feather River. Early efforts focused on studies to identify flow requirements for Chinook salmon and steelhead. This program has progressively expanded since the mid-1990s in preparation for the FERC relicensing of the SWP Oroville-Thermalito Complex. Field program elements include the operation of rotary screw traps, snorkeling, salmon spawning surveys, radiotelemetry, and spring-run Chinook tagging.

Rotary screw traps capture juvenile salmon and steelhead as they emigrate from the Feather River. Data collected from the traps are used to monitor the timing and abundance of salmonid emigrants. This long-term monitoring effort yields valuable baseline information about juvenile salmon production in the Feather River and the effects of project operations on abundance and migration timing. Snorkel surveys monitor juvenile and adult steelhead abundance, distribution, and habitat use in the Feather River. This information is used to identify major habitats used by steelhead and evaluate the impacts of project operations on the natural production of steelhead. Steelhead redd surveys are conducted to determine the distribution and physical characteristics of natural steelhead spawning sites in the Feather River. Salmon spawning surveys estimate the number and distribution of adult Chinook salmon that returned to spawn in the river. Radiotelemetry gathers baseline information on the migration and holding patterns of adult Chinook salmon in river.

Data from the Feather River sampling programs revealed several significant trends. For example, steelhead redd surveys show that in-river spawning continues at low levels. Juvenile steelhead first appear in March and are most abundant in well-vegetated side channels of the low-flow channel. Water temperatures do not appear to limit the abundance of juvenile steelhead within the low-flow channel. Rotary screw traps

show that the peak of salmon emigration occurs in February or March, indicating that flows do not cue or influence the timing of salmon emigration. Salmon spawning surveys demonstrated that two-thirds of all spawning occurs within the low-flow channel. In fall 2005, more than 43,738 adults and 4,838 grilse spawned in the Feather River, from the Fish Barrier Dam downstream to Gridley. These estimates include both fall- and spring-run Chinook salmon, since their spawning is currently not fully segregated on the Feather River.

Twenty-six adult salmon were captured and radio tagged in 2005 to assess patterns of holding habitat use for adult Chinook salmon which up-migrate in the spring. A combination of manual tracking and fixed station data logging was used to assess the location of adult Chinook salmon. The Chinook salmon were detected anywhere from 81 to 153 days after being tagged. The total observed distance traveled by tagged Chinook salmon ranged from 0.3 to 25.1 river miles. The largest surveyed net movement was 11.2 river miles, which was navigated downstream. Of the 25 fish successfully tracked, only three fish were detected at the Thermalito Outlet. These fish spent a total of one to six days at the outlet throughout the entire survey season. Twenty-three of the 25 fish were last detected or recovered in the low-flow channel above the Thermalito Outlet, while the remaining two fish were detected downstream of the outlet.

Pelagic Organism Decline in the Upper San Francisco Estuary

Abundance indices calculated by the Interagency Ecological Program (IEP) suggest recent marked declines in numerous pelagic fishes in the upper San Francisco Estuary. The major resident pelagic fishes sampled in the upper estuary include delta smelt, longfin smelt, striped bass, and threadfin shad. Historically, low populations of these fishes have been the result of dry years, such as the drought in 1987–1992. Abundance indices for 2002–2005 indicate record and near-record lows for these populations, which are unexpected given the moderate winter-spring flows of the past several years. In response to the Pelagic Organism Decline (POD), the IEP formed a work team to evaluate the potential causes. An interdisciplinary, multiagency research effort was undertaken in 2005 to identify the most likely causes of the POD. The overall approach was based on a "triage" model to identify the most likely causes and assign priorities to projects on the basis of where funds and resources can best be used. The 2005 work fell into four general types: an expansion of existing monitoring; analysis of existing data; new studies; and ongoing studies. A conceptual model was developed to describe possible mechanisms by which a combination of long-term and recent changes in the ecosystem could produce the observed declines in the abundance indices.

Possible stressors influencing the POD studied in this initial effort were: entrainment, toxic effects on fish, toxic effects on fish food, harmful algal blooms, clam *Corbula* effects on food availability, disease, and parasites. Narrative explanations in the context of long-term trends have been developed for four major components: (1) prior fish abundance—which describes how the continued low abundance of adults leads to reduced juvenile production; (2) habitat—which describes how water quality variables,

including contaminants and toxic algal blooms, affect estuarine species; (3) top-down effects—which posit that predation and water project entrainment affect mortality rates; and (4) bottom-up effects—which focus on how food web interactions in Suisun Bay and the West Delta have affected fish abundance. Based on the product of the 2005 effort, a suite of 47 proposals were developed, and several studies begun, for 2006–2007 to cover each component of the conceptual model.

Fish-Related Mitigation Projects

In 1986, DWR and DFG signed the Four Pumps Agreement to annually provide funds to replace fish lost at Banks Pumping Plant. This agreement provided a $15 million lump sum for additional projects to compensate for losses prior to 1986. The agreement focuses on Chinook salmon, striped bass, and steelhead, and considers other fish.

Since 1986, DWR has spent $42 million on mitigation projects, which were developed under the Four Pumps Agreement. These projects include the following:

- improving salmon spawning and rearing habitat and migration pathways in the San Joaquin Basin;
- planting hatchery-reared and net-pen-reared striped bass;
- expanding the Merced River Fish Facility to increase salmon production and cost-sharing in annual operating costs;
- implementing a conjunctive-use project to improve salmon migration flows in Mill and Deer creeks in Tehama County;
- constructing fish ladders and screens on Butte Creek;
- constructing fish screens in Suisun Marsh and in the San Joaquin Basin;
- operating an acclimation pen to improve the survival of hatchery-reared salmon during their release into San Pablo Bay; and
- enhancing the enforcement of fish and game laws in the Delta and upstream to benefit salmon, steelhead, and striped bass, as well as increasing protection for spring-run Chinook salmon.

In 1996, DWR and DFG amended the agreement to include the following:

- allow another five years to spend the remaining $9 million of the $15 million lump sum provided in the agreement, because of difficulties in developing mitigation projects; and
- specify the likely allocation of the remaining funds.

DWR could not spend the full $15 million lump sum in the 10 years required by the original agreement. The remaining funds were tentatively allocated to provide the following:

- $2 million for screening diversions in Suisun Marsh;
- $1 million for predator-isolation projects on San Joaquin River tributaries;
- $2 million for a conjunctive-use project to improve spring-run salmon migration in Deer Creek in Tehama County; and
- $4 million for a salmon conservation hatchery on the Tuolumne River.

In December 2001, the five-year extension expired with only $4 million of the remaining $9 million spent, due to difficulties in implementing several of the mitigation projects. Approximately $1.4 million remained of the allocations under Amendment 1, and $3.6 million became available for other projects when DFG halted planning for a conservation salmon hatchery in the San Joaquin Basin. DWR and DFG amended the agreement again, to provide three more years to spend the remaining $5 million of the $15 million lump sum, and to specify the likely allocation of the remaining unallocated funds.

The $3.6 million in available remaining funds were tentatively allocated to provide the following:

- $950,000 for a revised conjunctive-use project to improve spring-run salmon migration in Deer Creek in Tehama County;
- $300,000 for screening diversions on the San Joaquin River tributaries;
- $500,000 for salmon spawning habitat and floodplain restoration on the Stanislaus River;
- $700,000 for two salmon spawning habitat and channel restoration projects on the Tuolumne River;
- $1.1 million for salmon habitat and river restoration on the Merced River; and
- $68,000 for salmon spawning gravel replenishment at wing deflector sites on the Merced River.

In December 2004, about $3.6 million of the funds allocated in the previous two extensions were still unexpended, and the agreement was amended with a three-year extension, through December 2007. Much of this funding is currently encumbered in contracts.

Other mitigation projects approved in 2005, for implementation from the agreement's annual mitigation funds and the $15 million lump sum, included the following:

- $228,000 for the operations and maintenance of 14 fish screens in Suisun Marsh, to be completed by the Suisun Resource Conservation District (SRCD) over the next 12 years;
- $313,000 for the Expansion of the Robinson Reach Conservation Easement, Merced River Salmon Habitat Enhancement Project, to cost share with the Wildlife Conservation Board to complete funding for the $1.3 million estimated total easement cost; and
- $160,480 to complete design scenarios for the Upper Western Stones Reach, Merced River Salmon Habitat Enhancement Project.

Chapter 4
Water Quality Programs

Suisun Marsh salinity control gates help control the water quality of the marsh.

Significant Events in 2005

On March 23, 2005, a landslide occurred in Posey Canyon near Pyramid Lake that broke a 14-inch crude oil pipeline spilling about 120,000 gallons of oil. Within hours, crews from the Department of Water Resources (DWR) and Los Angeles County's Fire and Sheriff's departments built earthen dikes in the canyon to contain the oil. DWR staff deployed oil booms to contain the oil which had entered the small cove that receives runoff from Posey Canyon.

The bulk of the oil was contained within the canyon, and a light wind helped ensure that the oil that did make it into the lake remained isolated in the narrow cove. Water deliveries from Pyramid Lake were cancelled immediately after the spill and during the cleanup. Water quality monitoring began the morning after the spill and continued until it was determined that the water was safe to move.

On May 5, 2005, the State Water Resources Control Board (SWRCB) issued a draft cease and desist order to DWR and the Bureau of Reclamation (Reclamation) regarding alleged threatened noncompliance of their licenses and permits that pertain to the operation of the State Water Project (SWP) and the Central Valley Project (CVP). If the SWRCB adopts the draft order, it will find that DWR and Reclamation are threatening to violate the conditions of their licenses and permits, which require that they meet the 0.7 millimhos per centimeter electrical conductivity (EC) objective at three of the southern Delta compliance locations between April 1 and August 31. The SWRCB conducted a public hearing on October 24, 2005, to receive evidence relevant to determining whether to adopt the draft cease and desist order, but SWRCB did not adopt the draft order in 2005. The 0.7 millimhos objective was not exceeded in 2005.

Information in this chapter was contributed by the Division of Environmental Services and the Division of Operations and Maintenance.

The State Water Project (SWP) provides many Californians with part or all of their daily residential water needs. This includes water for agriculture, industry, power generation, recreation, and fish and wildlife. The water provided by the SWP is monitored by the Department of Water Resources (DWR) for quality throughout the system. This assurance of quality is made possible by the use of an automated network of continually operating recorders and laboratory analyses of field samples collected weekly, monthly, quarterly, and annually.

Delta Activities

The State Water Resources Control Board (SWRCB) sets water quality objectives for beneficial water uses in California, and the Department of Health Services (DHS) establishes maximum contaminant levels for treated drinking water. Additional water quality objectives are set at points of delivery by Article 19 of the long-term SWP water supply contracts. Water quality in the Delta and Suisun Marsh is protected under SWRCB's Decision 1641 (D-1641), adopted in December 1999 (see sidebar). SWRCB's issuance of D-1641 is part of its implementation of the 1995 Bay-Delta Water Quality Control Plan and, accordingly, this decision amends certain water rights of the water rights holders to help achieve the plan's objectives.

Water Supply Conditions

Water Year Classifications and Water Supply Indexes

DWR conducts extensive monitoring to protect beneficial uses of water in the Delta and Suisun Marsh, as required by D-1641. Figure 4-1 shows water quality compliance stations throughout the Sacramento-San Joaquin Delta required by D-1641.

SWRCB's D-1641 contains water quality and flow standards that are conditioned by water year type, which generally become less stringent in years with less precipitation. The water year classification system provides relative estimates of a basin's available water supply based on the amounts of rainfall, snowmelt runoff, and groundwater accretion rates. Water year types are classified as "wet," "above normal," "below normal," "dry," or "critical."

Water year 2005 was classified as above normal for California under criteria set forth by SWRCB in D-1641. (For a detailed discussion of water year 2005, see Chapter 8.)

D-1641 applies the Sacramento Valley 40-30-30 Index, a water supply forecasting tool which largely replaced the Sacramento River Index. SWRCB first introduced the Sacramento Valley 40-30-30 Index in its 1991 *Bay-Delta Water Quality Control Plan for Salinity*.

The Sacramento Valley unimpaired runoff is a sum of the major flows into the Sacramento Basin. The factors used in the Sacramento Valley 40-30-30 Index are: (1) the current year's April-through-July Sacramento Valley unimpaired runoff

State Water Resources Control Board

The State Water Resources Control Board (SWRCB), established by the California Legislature in 1967, oversees water rights and water quality for California. Among its many responsibilities, SWRCB issues permits for the use of all water except groundwater and riparian water; distributes State and federal loans and grants for constructing sewage facilities; adopts water quality control plans, regulations, and policies; and sets water quality standards for the Delta.

In 1978, to implement its mandate to set Delta water quality standards, SWRCB issued Water Right Decision 1485 (D-1485): Sacramento-San Joaquin Delta and Suisun Marsh. That decision focused on SWP and CVP water right permits and operations, requiring SWP and CVP to maintain Delta water quality as it would have existed without the projects. However, after D-1485 was adopted, various water users and the federal government challenged it in court. Since then, SWRCB updated its Water Quality Control Plan (WQCP), adopted on May 22, 1995. Water Right Order 95-06 amended D-1485 to be consistent with the plan on June 8, 1995. WR 95-06 modified the standards for Suisun Marsh and allowed the SWP and CVP to use either project's Delta pumping plant to pump project water to increase fish protection and maintain project delivery capability. Water Right Order 98-09, adopted by SWRCB on December 3, 1998, extended the terms and conditions of WR 95-06 to allow time for the issuance of a comprehensive Water Right Decision.

On December 29, 1999, SWRCB issued Decision 1641 (D-1641), replacing D-1485, and conditioning the water right permits of the SWP and CVP to implement the objectives of the Bay-Delta Water Quality Control Plan. D-1641 covers Phases 1-7 of the Bay-Delta Water Rights Hearings. On March 15, 2000, SWRCB adopted Water Right Order 2000-02, which denies the petitions for reconsideration of D-1641, clarifies findings, and amends several conditions of D-1641. On April 26, 2001, SWRCB adopted Water Right Order 2001-05, which facilitates negotiations to settle the potential responsibilities for implementing the WQCP. This order stayed Phase 8 for 18 months, and automatically dismisses it at the end of that period, unless SWRCB receives notice requesting its resumption. SWRCB dismissed Phase 8 on January 31, 2003.

(40 percent); (2) current October-through-March Sacramento Valley unimpaired runoff (30 percent); and (3) the previous year's 40-30-30 Index (30 percent, with a cap of 10 maf).

D-1641 also includes another water supply forecasting tool, the San Joaquin Valley 60-20-20 Index, which uses methods similar to the Sacramento Valley 40-30-30 Index.

The Eight River Index is a sum of the runoff from the eight major rivers of the Sacramento and San Joaquin valleys. This index determines the duration of the fish and wildlife salinity and flow standards at Chipps Island or Port Chicago from February through June.

The April-through-July Sacramento Valley unimpaired runoff forecast for May 1, 2005, was 6.63 maf (99 percent of average). The resulting Sacramento Valley 40-30-30 Index forecast was 7.4, resulting in the forecast classification of below normal for water year 2005. The forecast of the San Joaquin Valley 60-20-20 Index on May 1 was 4.3, resulting in the water year being classified as wet in the San Joaquin Basin. The Eight River Index forecast on May 1 was 12.1 maf for April through July.

Operations under the State Water Resources Control Board Water Right Decision 1641

During 2005, DWR and the U.S. Bureau of Reclamation (Reclamation) operated joint projects in accordance with SWRCB's D-1641, which includes water quality, flow, and operational criteria for the Delta. Operations of the SWP and Central Valley Project (CVP) were coordinated with various objectives of CALFED, the Bay-Delta Plan, Central Valley Project Improvement Act, and biological opinions for fish species listed under the federal and State Endangered Species Acts (ESA).

As mentioned above, the water quality and flow criteria contained within D-1641 are conditioned by water year type. Specifically, the 40-30-30 Index water year type forecast on May 1 of each year determines the water year type for the implementation of flow and water quality criteria contained within D-1641. During most years, the water year type forecast and the actual water year type (calculated at the end of the water year) are in agreement, but this was not the case in 2005. Due to late-season precipitation, the 2005 water year ended with an above normal classification; but on May 1, 2005, the forecast was for a below normal water year. It is important to mention that in 2005, the SWP and CVP were operated using water quality and flow criteria based on the May 1 forecast of below normal, as required by D-1641.

CALFED's Record of Decision mandates an Environmental Water Account (EWA) managed by DWR, Reclamation, the Department of Fish and Game (DFG), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NOAA Fisheries) for the protection of listed fish species. Fish species currently listed under the federal and State ESA include the winter and spring runs of Chinook salmon, delta smelt, and steelhead.

Real-time monitoring of fish movement and conditions in the estuary aids daily water management and provides more

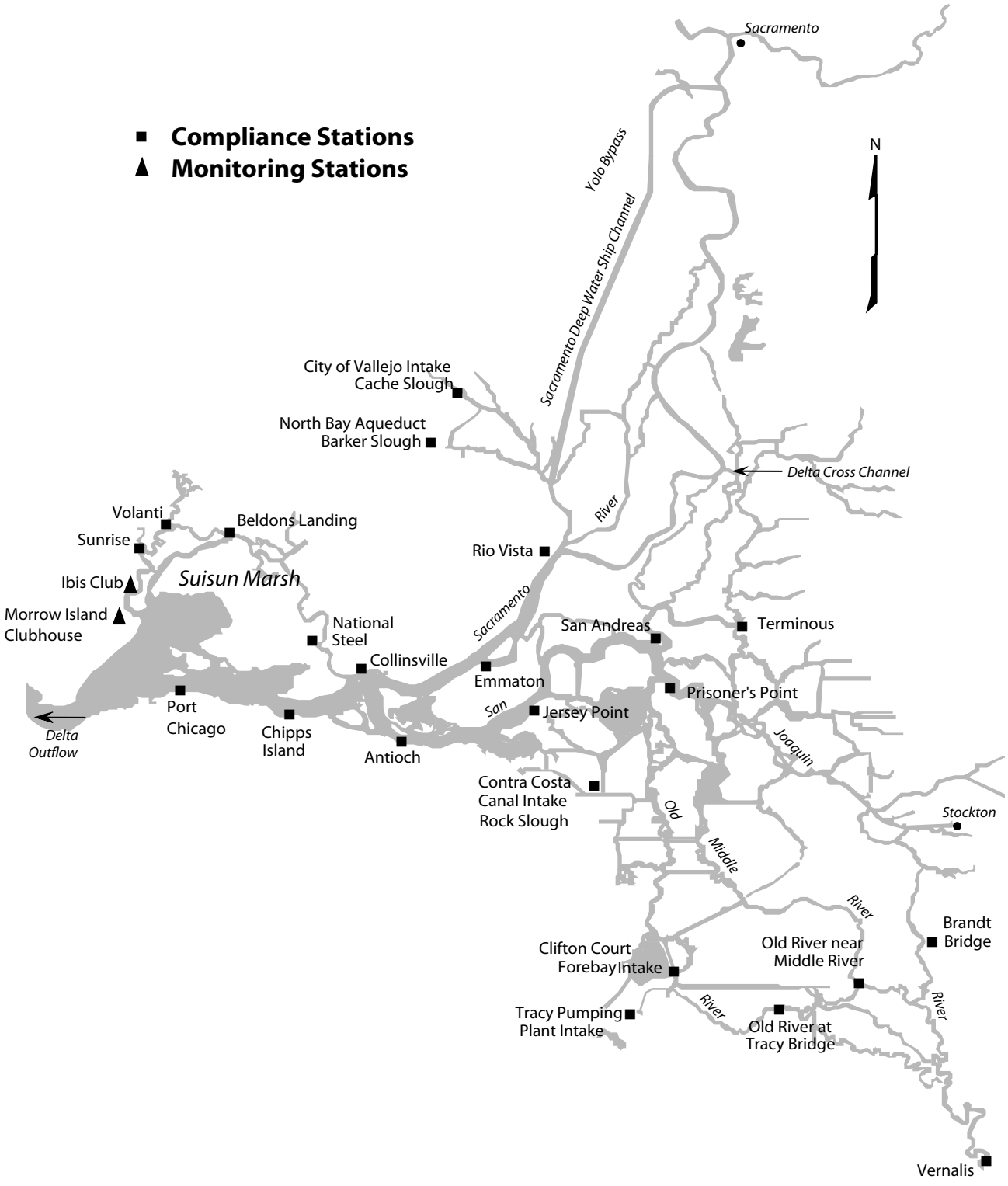


Figure 4-1. Decision 1641 Water Quality Compliance and Monitoring Stations in the Sacramento-San Joaquin Delta

timely protection of targeted fish species from entrainment at the Delta pumping facilities. (See Chapter 3 for a discussion of other environmental issues.)

Delta Cross Channel Gates

The Delta Cross Channel gates allow fresher Sacramento River water to flow into interior Delta channels toward the export facilities of the SWP and CVP. During 2005, the gates were open for 157 days. Reclamation's standard operating procedures call for gate closure any time the Sacramento River flow at Freeport reaches between 20,000 cfs and 25,000 cfs to reduce flooding potential on the Mokelumne River and to prevent scouring on the downstream side of the gate structure. D-1641 contains measures that require closure of the gates from February 1 until May 20, during peak migration of winter-, spring-, and fall-run Chinook salmon smolts and steelhead, and the spawning season for delta smelt, longfin smelt, Sacramento splittail, and striped bass.

During 2005, the gates remained closed from January 1 through late June. On June 25, the gates were opened, and they remained open until November 16, when the gates were closed to protect out-migrating winter-run salmon. The gates were reopened on November 20 and then were closed again on December 3, 2005, for fishery protection. The gates remained closed through the end of December.

Water Quality Standards

DWR attempts to meet D-1641 water quality and flow standards through releases from upstream reservoirs and Delta export operations, but D-1641 also contains a salinity standard for the San Joaquin River at Vernalis. San Joaquin River flows are not influenced by SWP upstream reservoirs, but they may be influenced by SWP exports and placement of South Delta barriers.

High river outflows, export restrictions, and water releases to benefit migrating fish (both pulse and attraction flows) help maintain most electrical conductivity (EC) values below standards.

Municipal and Industrial Objectives

D-1641 includes a year-round 250 mg/L chloride objective that is in effect at Delta export locations (Contra Costa Canal Pumping Plant No. 1, Clifton Court Forebay, Tracy Pumping Plant, Cache Slough at the City of Vallejo intake, and Barker Slough). Chloride levels remained below the objective throughout 2005.

An additional municipal and industrial water quality objective for chloride at the Contra Costa Canal Intake, near Rock Slough, specifies that the chloride level must be below 150 mg/L for a given number of days during the year, dependent upon the water year forecast. The below normal year requirement of 175 days was met on July 14, 2005.

Agricultural Objectives

D-1641 contains an agricultural EC objective, which varies by location, based on both water year type and a 14-day running average during the irrigation season, from April to mid-August, set at Emmaton, Jersey Point, Terminous, and San Andreas in the western and central Delta. The agricultural salinity objective at these Delta locations is also based on

water year type, becoming less stringent under dryer conditions. The agricultural EC objective was met at all four stations during 2005. An additional salinity objective is applied year round in the southern Delta at two locations on the San Joaquin River (Brandt Bridge and Vernalis) and two locations on Old River (Tracy Road Bridge and the head of Middle River). The SWP and CVP are jointly required by D-1641 to meet agricultural EC objectives imposed at these South Delta compliance locations. Meeting these objectives has sometimes been problematic. The SWRCB recognized in the 1995 Bay-Delta Water Quality Control Plan that elevated salinity in the South Delta is caused by multiple factors, including locally derived salts. On February 18, 2005, DWR and Reclamation jointly filed a petition with the SWRCB to change the effective date of the southern Delta water quality objective of 0.7 EC from April 1, 2005, to December 31, 2008, and to require that DWR and Reclamation continue to meet the 1.0 EC objective during these months. The request was made because installation of permanent operable gates in the South Delta had been delayed, and the gates are necessary for DWR and Reclamation to effectively implement the objective. A draft initial study and proposed negative declaration was submitted to the Office of Planning and Research on November 1, 2005. The SWRCB did not take action on the change petition by the end of the year.

Estuarine Habitat Protection Standard

The estuarine habitat protection standard incorporates modified X2 criteria (geographic isohaline) first established in the *1994 Delta Smelt Biological Opinion*. The upstream movement of 2 ppt isohaline (2 parts per thousand of salt in the water), measured as 2.64 mS/cm at the surface, is maintained within a certain range of positions in the estuary by adequate Delta outflow. These positions at Chipps Island or Port Chicago, from February through June, are associated with an abundance of fish and biota.

The number of days per month when the daily averaged EC maximum (2.64 mS/cm) is in effect at Chipps Island or Port Chicago is conditioned by the previous month's Eight River Index. This may alternately be met with a maximum 14-day running average EC of 2.64 mS/cm or with specific Delta outflow, set as a 3-day average Net Delta Outflow Index of 11,400 cfs or 29,200 cfs, when the X2 position is at Chipps Island or Port Chicago, respectively. The Port Chicago standard becomes effective when the Port Chicago 14-day EC average, immediately prior to the first day of the month, is less than or equal to 2.64 mS/cm. The Eight River Index, from December 2004 through May 2005, in af, was 1.56 million, 2.49 million, 2.01 million, 3.75 million, 3.18 million, and 7.23 million, respectively. On the last day of January 2005, the 14-day EC average at Port Chicago exceeded 2.64 mS/cm, triggering compliance at Chipps Island for February. Twenty-eight days were required for X2 at Chipps Island during February; all three criteria were met for 28 days. During March, the required 31 days were also met at Chipps Island, with all three criteria in compliance. During April, X2 was met at Port Chicago, and all criteria surpassed the required 18 days. In May, X2 was met for the required 31 days at Chipps Island. On the last day of May, due to above average May precipitation, the 14-day EC average at Port Chicago was less than 2.64 mS/cm, triggering X2 compliance at Port Chicago for June. The X2 requirement of 28 days was met for the entire month of June.

Net Delta Outflow Index Standard

Delta outflow cannot be measured directly due to the tidal influence in the Delta. Instead, an approximation of Delta outflow is calculated using measured inflows, exports, and estimated Delta water use. The Net Delta Outflow Index (NDOI), introduced in the 1995 Bay-Delta Plan, now part of D-1641, guided operations in 2005. NDOI calculates Delta outflow by including inflows of the Sacramento River, the Yolo Bypass system, the eastside stream system (consisting of the Mokelumne, Cosumnes, and Calaveras rivers), the Sacramento Regional Treatment Plant, and a measurement of San Joaquin River flow at Vernalis.

Excess outflow conditions, as defined by the Coordinated Operation Agreement, allow for greater flexibility in project operations. During 2005, Delta water conditions began and ended in excess, totaling an accumulated 306 days.

D-1641 sets specific minimum monthly NDOI standards, based upon water year type, between 3,000 and 8,000 cfs for the protection of fish and wildlife during January and from July to December. During below normal water years, July's NDOI objective of 6,500 cfs is the most stringent of all months. In 2005, the monthly mean NDOI was highest in May, averaging 59,442 cfs. This was unusual, because in most years, this occurs during the winter months. The monthly mean NDOI remained above 4,700 cfs during all months of the year, with the lowest monthly mean NDOI occurring in October with 4,749 cfs. All NDOI standards were met in 2005.

Flow Standards

D-1641 includes minimum flow requirements measured in the Sacramento River at Rio Vista. These flow standards, incorporated from the *Winter-Run Salmon Biological Opinion*, set flow requirements based on the May 1 water year classification forecast. Water year 2005 was forecast to be below normal, requiring mean monthly flows of 3,000 cfs for September; 4,000 cfs for October; and 4,500 cfs for November to December. During these periods, the seven-day running average could not be more than 1,000 cfs below the monthly standard. The actual mean monthly flows were 7,817 cfs for September; 8,487 cfs for October; and 38,232 cfs for November to December. All Rio Vista flow objectives were met during 2005.

D-1641 contains minimum San Joaquin River base and pulse flows measured at Vernalis from the *Winter-Run Salmon Biological Opinion*. These flows vary depending on the San Joaquin Valley water year type. Water year 2005 was forecast to be wet in the San Joaquin Valley.

If the X2 objective is required to be at or west of the Chipps Island location, wet year base flows are set at 3,420 cfs from February to April 14 and from May 16 through June 30. The base flow objective is relaxed to 2,130 cfs when X2 is required to be east of Chipps Island.

D-1641 requires the San Joaquin River spring pulse flow for April 15 to May 15 at Vernalis. This spring pulse flow requirement varies based on the location of X2 during April. However, the CALFED Operations Group may vary the actual timing and duration of the pulse attraction

flow based on real-time monitoring data. The Vernalis Adaptive Management Plan (VAMP), part of the San Joaquin River Agreement and approved in D-1641, contains SWRCB-approved alternate spring pulse flow and export limits. Typically, Reclamation and DWR use this alternate in lieu of D-1641 limits. The pulse flow objective for the spring 2005 VAMP period was 7,020 cfs. During October, D-1641 also requires a pulse attraction flow of up to 2,000 cfs at Vernalis to benefit salmon.

Export Standards

D-1641 includes an export limitation for SWP and CVP. It limits Delta exports to a ratio of Delta inflow to combined water project exports and is expressed as a maximum export rate in percentage of Delta inflow. The maximum percentage of Delta inflow diverted varies by month; for example, in February, it is conditioned by the previous month's Eight River Index. During the San Joaquin River spring pulse flow season, VAMP export rates are typically used as an alternative to the D-1641 spring export limitation, and the CALFED Operations Group may impose additional export restrictions.

The actual export amount is calculated using the three-day average that combines the inflow rate for Clifton Court Forebay (excluding Byron-Bethany Irrigation District diversions from Clifton Court Forebay) added to the Tracy Pumping Plant diversion. The export to inflow ratio limit is reported as either a 3-day or 14-day running average. A 14-day running average of inflows is used unless storage withdrawals from upstream reservoirs are being made for export, in which case a 3-day average of inflows is used. In all water year types, the maximum combined export rate from February through June is 35 percent of Delta inflow. This rate may be relaxed in February, during years with less precipitation, to between 35 and 45 percent. From July through January, the export to inflow ratio rises to 65 percent.

During January 2005, combined SWP and CVP exports averaged about 30 percent of Delta inflow, far below the 65 percent limitation. Excess conditions during January were beneficial to Delta water quality and prevented the need for export curtailments for water quality protection.

During the more restrictive period from February through June (35 percent objective), exports averaged about 19 percent. Combined exports were curtailed from February 2 through February 7 for the protection of delta smelt. Following the April 15 to May 15 VAMP period, exports continued to be restricted through the end of May due to concern over the level of delta smelt salvage.

From July through the following January, the SWP and CVP are allowed to export at 65 percent of Delta inflow. From July through December 2005, the combined inflow diverted averaged 52 percent. Exports were halted on June 22 to allow for pondweed eradication spraying on Clifton Court Forebay.

South Delta Temporary Barriers

The South Delta Temporary Barriers Project was initiated as a test project in 1991, was extended for five years in 1996, and extended again for seven years in 2001. The project was created partially in response to a 1982 lawsuit filed by the

South Delta Water Agency and consists of four rock barriers across South Delta channels.

These temporary seasonal barriers are designed to improve local water levels and circulation patterns, protect fishery resources, and improve water quality. They are placed across Middle River, Old River at Tracy, Grant Line Canal, and at Head of Old River.

The installation of the Middle River barrier was completed on May 17, 2005, and the Old River barrier near Tracy installation was completed on June 6. The spring barrier at Head of Old River, which functions as part of VAMP, was not installed in 2005 due to high flows on the San Joaquin River. The Grant Line Canal barrier was partially installed by May 2, with the installation completed on July 18. The Middle River barrier was notched on September 15, and removal was completed by November 9. The Old River near Tracy barrier and the Grant Line Canal barrier were both removed by November 30.

The barrier placed at Head of Old River in the fall, which helps keep upstream migrating adult salmon from straying out of the San Joaquin River into interior Delta channels, can help improve dissolved oxygen conditions in the Stockton Ship Channel. The Head of Old River barrier installation was completed on September 30 and removal was completed on November 15.

Special Study and Biological Surveys

DWR conducts several special studies and biological surveys each year. This includes a special study in the Stockton Ship Channel during the late summer and early fall to monitor the occurrence of low dissolved oxygen (DO) levels. Low DO levels can potentially cause physiological stress to fish and block the migration of salmon into the San Joaquin River. DWR also conducts biological surveys of benthic organism density and diversity, and of phytoplankton biomass and community composition in the Sacramento-San Joaquin Delta, Suisun Bay, and San Pablo Bay.

Fall Dissolved Oxygen Study in the Stockton Ship Channel

Historically, during the late summer and early fall, DO levels in the eastern and central portions of the Stockton Ship Channel have dropped below both the 5.0 mg/L and 6.0 mg/L water quality objectives set by SWRCB and the Regional Water Quality Control Board, respectively. These low DO levels are a result of several factors, including low San Joaquin River inflows, warm water temperatures, high biochemical oxygen demand, reduced tidal circulation, and intermittent reverse flow conditions in the San Joaquin River at Stockton.

To help reduce the severity of these low DO conditions, DWR normally installs a temporary rock barrier across the Head of Old River during periods of projected low fall flows in the San Joaquin River. The barrier increases net flows in the San Joaquin River past Stockton by reducing the upstream diversion of flows down Old River.

During the late summer and early fall of 2005, flows in the Stockton Ship Channel were not projected to be sufficient to

alleviate low DO concerns, and in-water construction of the barrier began on September 19. The barrier was in place and fully operational on September 30. Barrier removal began on November 7 and was completed by November 15.

Methods

Monitoring of DO concentrations in the Stockton Ship Channel was conducted by boat on eight monitoring runs, from August 3 to November 15, 2005. During each of the runs, 14 sites were sampled at low water slack tide from Prisoner's Point in the Central Delta to the Stockton Turning Basin at the terminus of the ship channel.

Because monitoring results differ within the channel, sampling stations were grouped into western, central, and eastern regions. The findings of previous fall studies have shown that fall DO levels are typically robust and high (7.0 to 9.0 mg/L) in the western channel; transitional, variable (4.0 to 7.0 mg/L), and stratified in the central channel; and low (3.0 to 5.0 mg/L) and stratified in the eastern channel. The western channel begins at Prisoner's Point and ends at Columbia Cut. The central channel begins one half mile east of Columbia Cut and ends at Fourteen Mile Slough. Finally, the eastern channel begins at Buckley Cove and ends at Rough and Ready Island. The Turning Basin is unique within the channel because it is east of the entry point of the San Joaquin River into the channel and isolated from down-channel flows.

Results

During the period of this study (August 3 to November 15), DO levels varied considerably between regions within the channel (not including the turning basin) from a low of 4.1 mg/L to a high of 8.9 mg/L. In the western channel, DO concentrations were relatively high and stable, ranging from 6.5 to 8.9 mg/L. The robustness of DO concentrations in this portion of the channel, in comparison to the east and central channels, is apparently due to greater tidal mixing, the absence of conditions creating biochemical oxygen demand, and shorter hydrological residence time. In the central channel, DO concentrations were more variable, ranging from 4.1 to 8.2 mg/L. In the eastern channel, DO levels were the most variable and stratified, ranging from a low of 4.5 mg/L to a high of 8.7 mg/L.

DO concentrations in the Stockton Ship Channel fell below both the State's 5.0 mg/L and 6.0 mg /L objectives in August, September, and the beginning of October 2005. This period coincided with warm temperatures and relatively low net flows in the San Joaquin River past Stockton.

Higher inflows in October coincided with improved DO conditions, with most stations showing levels above the 6.0 mg/L objective, except for DO levels in the central channel and in the turning basin, which were slightly below State objectives. DO levels remained high through the first half of November until the barrier was removed on November 15. The removal of the barrier coincided with a reduction in net flows at Vernalis. Further monitoring operations for the fall 2005 special study were suspended after November 15, 2005.

Benthic Survey

The benthic monitoring program documents changes in the composition, abundance, density, and distribution

of the benthic biota within the upper San Francisco Estuary. Benthic biota are relatively long-lived and can respond to changes in physical factors within the estuary, such as fresh water inflows, salinity, and substrate composition. As a result, benthic data can provide an indication of physical changes occurring within the upper estuary. Because the operation of the SWP can impact flow characteristics of the estuary, and subsequently influence the density and distribution of benthic biota, benthic monitoring is an important biological survey conducted by DWR. In addition, benthic monitoring data are also used to detect and document the presence of newly introduced species within the upper estuary.

Benthic monitoring was conducted at 10 sampling sites distributed throughout the major habitat types within the estuary. The sampling stations are as follows:

- Clifton Court Forebay Intake;
- San Joaquin River at Buckley Cove;
- San Joaquin River at Twitchell Island;
- Old River opposite Rancho del Rio;
- Sacramento River below the Rio Vista Bridge;
- Sacramento River above Point Sacramento;
- Suisun Bay at Bulls Head;
- Grizzly Bay at Dolphin near Suisun Slough;
- San Pablo Bay near Pinole Point; and
- San Pablo Bay near the mouth of the Petaluma River.

Four bottom grab samples for benthic analysis and one sample for sediment analysis were collected monthly at each site during 2005. Samples were analyzed to identify organisms to the lowest possible identifiable taxon and to count all organisms collected.

DWR maintains a database of benthic organisms located within the upper estuary. The benthic database is dynamic and regularly undergoes peer review and update. When a new organism is identified at any of the sampling stations it is added to the database. In addition, the taxonomic names of organisms on the list are updated when sufficient evidence is produced to warrant such changes.

A total of 152 species of benthic macrofauna were collected in 2005 at the 10 sampling sites. Of the 152 species, 10 species represented 88 percent of all organisms collected. The 10 dominant species were

- the amphipods: *Americorophium stimpsoni, Corophium alienense, Ampelisca abdita,* and *Gammarus daiberi;*
- the aquatic oligochaete: *Varichaetadrilus angustipenis;*
- the turbificid worm: *Limnodrilus hoffmeisteri;*
- the sabellide polychaetes: *Laonome* sp. A and *Manayunkia speciosa;* and
- the Asian clams: *Corbula amurensis,* and *Corbicula fluminea*.

Of the 10 dominant species, *Ampelisca abdita* and *Corbula amurensis* represent macrofauna that inhabit a typically high saline environment and were found in San Pablo Bay, Suisun Bay, and Grizzly Bay. *Corophium alienense, Americorophium stimpsoni, Limnodrilus hoffmeisteri,* and *Laonome* sp. A tolerate a wider range of salinity. They were collected both in the

higher saline western sites, and the more brackish to fresh water eastern sites, such as the San Joaquin River at Twitchell Island and the Sacramento River above Point Sacramento. The remaining four species, *Manayunkia speciosa, Gammarus daiberi, Varichaetadrilus angustipenis,* and *Corbicula fluminea* are predominantly fresh water species and were collected at sites east of Suisun Bay.

Phytoplankton and Chlorophyll *a* Survey

Monthly sampling of chlorophyll *a* concentrations and phytoplankton was conducted in 2005 by DWR's Bay-Delta Monitoring Branch at 13 stations throughout the upper San Francisco Estuary. These stations are

- Sacramento River at Greene's Landing/ Hood and above Point Sacramento;
- San Joaquin River at Vernalis, Buckley Cove, and Potato Point;
- Old River opposite Rancho Del Rio;
- Disappointment Slough near Bishop Cut;
- Frank's Tract near Russo's Landing;
- Suisun Bay at Bull's Head near Martinez and off Middle Point near Nichols;
- Grizzly Bay at Dolphin near Suisun Slough; and
- San Pablo Bay near Pinole Point and near Mouth of Petaluma River.

Chlorophyll *a* is one of the main groups of pigments contained in the algal species that make up phytoplankton. Phytoplankton are small, free-floating or attached algae that can be tiny, single-celled organisms (less than 5 µm in diameter) or larger colonial organisms. Phytoplankton are an important source of food in the estuary for zooplankton, invertebrates, and some species of fish. Phytoplankton biomass is an indicator of the status of primary productivity in the estuary. Chlorophyll *a* concentration was measured for each of the 13 monitoring stations to estimate overall phytoplankton biomass in the estuary. Phytoplankton samples were collected and analyzed separately to determine which species were present in the estuary.

Monthly chlorophyll *a* concentrations throughout much of the estuary were relatively low when compared to historical data. Of the 156 samples taken in 2005, 95.5 percent had chlorophyll *a* levels below 15 µg/L, and 85.9 percent of the samples were below 5 µg/L. The mean chlorophyll *a* concentration for all samples in 2005 was 3.48 µg/L, and the median value was 1.88 µg/L. In 2004, median chlorophyll *a* concentrations were higher, with a mean of 5.3 µg/L and a median of 2.0 µg/L. The maximum chlorophyll *a* concentration in 2005 was 21.5 µg/L, recorded in August at the San Joaquin River at Vernalis monitoring site. This maximum was considerably lower than the 2004 peak of 94.2 µg L. The minimum chlorophyll *a* concentration in 2005 was 0.4 µg/L, recorded in February at the San Joaquin River at Potato Point monitoring station.

The samples with chlorophyll *a* levels above 15 µg/L were all measured in the San Joaquin River at Vernalis, Buckley Cove, and Disappointment Slough near Bishop Cut. These three monitoring sites also had the highest chlorophyll *a* concentrations measured in 2004.

Phytoplankton biomass and resulting chlorophyll *a* concentrations in some areas of the estuary may be influenced by

extensive filtration of the water column by the introduced Asian clam, *Corbula amurensis*. Well-established benthic populations of *C. amurensis* in Suisun and San Pablo bays are thought to have contributed to the low chlorophyll *a* concentrations (and increased water clarity) measured in these westerly bays since the mid-1980s.

In addition to monitoring for chlorophyll *a*, water samples were analyzed for pheophytin. Pheophytin is a primary degradation product of chlorophyll *a*, and its relative concentration is useful for estimating the general physiological state of phytoplankton populations. When phytoplankton are actively growing, the concentrations of pheophytin are normally expected to be low in relation to chlorophyll *a*. The mean pheophytin *a* concentration for all samples in 2005 was 1.53 µg/L, and the median value was 0.97 µg/L. The maximum pheophytin *a* concentration was 15.10 µg/L, recorded at the San Joaquin River near Vernalis monitoring station. The minimum pheophytin *a* concentration was 0.13 µg/L, recorded at the San Pablo Bay near the mouth of Petaluma River.

Phytoplankton populations consisted of (families in order of abundance): Bacillariophyceae (diatoms), Chlorophyceae (green algae), Cryptophyceae (cryptomonads), Cyanophyceae (blue-green algae), unidentified flagellates, Euglenophyceae (euglenoids), Chrysophyceae (yellow-brown algae), and Dinophyceae (dinoflagellates). Of the genera identified, the following were the 10 most common, in order of abundance: *Cyclotella*, *Skeletonema*, *Monoraphidium*, *Cryptomonas*, *Rhodomonas*, *Aulacoseira*, unidentified flagellates, unidentified centric diatoms, *Aphanizomenon*, and *Pseudanabaena*.

Activities Outside the Delta

Activities conducted outside the Delta included scheduled routine SWP water quality monitoring, as well as special studies. Most of these special studies were in response to fish and wildlife and water quality issues of importance to agencies that provide domestic water supply. These agencies face increasingly stringent regulations and rely on SWP deliveries of high quality raw water.

Water Quality Monitoring

The Division of Operations and Maintenance collects detailed water quality information on the concentration and distribution of chemical, biological, and physical parameters at 40 aqueduct and reservoir sites located throughout SWP facilities. Stations are situated south of the Delta at reservoirs, pumping plants, power plants, and check structures of the South Bay, Coastal Branch, and California Aqueduct. Other monitoring activities are conducted on the North Bay Aqueduct, Feather River, and at State reservoirs north of the Delta—Lake Oroville, Antelope Lake, Frenchman Lake, and Lake Davis.

The SWP Water Quality Program was established in 1968 when the California Aqueduct was completed. More than 200 different chemical constituents are monitored monthly or quarterly. In addition, 13 automated stations are maintained for continuous monitoring of aqueduct water.

DWR maintains a staff at its own Bryte Laboratory in West Sacramento, who process and analyze most SWP laboratory water quality samples. DWR also contracts for some laboratory services. Water samples from 15 SWP stations are analyzed monthly to determine concentrations of dissolved solids, nutrients, chloride, sulfate, sodium, trace metals, and other constituents. Herbicides, pesticides, organic substances, and phytoplankton are monitored three times per year.

During 2005, bromide, total and dissolved organic carbon, taste and odor producing algae, and turbidity were factors in defining water quality. Dissolved metals, pesticides, and other constituents were at very low levels, well below treated drinking water standards, and were not a factor in water treatment. Bromide levels at SWP locations were lowest from February through August, and peaked in the early fall and winter, until winter runoff in the Delta increased outflow. Dissolved and total organic carbon are the lowest from March through October and increase, often significantly, with the first heavy Delta outflow event in winter. Turbidity, taste, and odor events are sporadic and usually seasonal. Selected SWP water quality data are available electronically through DWR's website at http://www.omwq.water.ca.gov. Table 4-1 presents laboratory results of sampling at several representative stations in 2005.

Nonproject Water Turn-ins

Turn-ins are authorized during periods of reductions in approved Table A amounts. DWR previously accepted turn-ins in the early 1990s in response to the 1987–1992 drought. Nonproject groundwater was accepted into SWP facilities provided it did not result in the degradation of SWP water quality, toxicity to fish and wildlife, or adverse changes in the suitability of the water for beneficial uses.

In 2001, DWR established new interim criteria to review the water quality of the turn-ins using a two-tiered approach. Tier 1 programs have a "no adverse impact" criteria and are tied to historical water quality levels in California. Programs meeting Tier 1 criteria are generally approved by DWR without referral to the State Water Contractor facilitation group. Tier 2 programs involve water quality levels that exceed the historical water quality in the California Aqueduct and have the potential to cause adverse impacts to the State Water Contractors. Tier 2 programs are referred to the State Water Contractor facilitation group for review and recommendations to DWR. DWR considers all factors before making a decision on the proposed water turn-in.

Turn-ins not only add versatility to SWP water operations, but can also improve SWP water quality for some constituents. Turn-ins can reduce total dissolved solids, conductivity, bromide, and organic carbon in the California Aqueduct. Slight increases in nitrate, sulfate, and arsenic often result. During 2005, there were no water turn-ins to the SWP.

Municipal Water Quality Investigations Program

The Sacramento-San Joaquin Delta provides drinking water for more than 24 million people in California. Because the Delta and its tributaries are located in a relatively unprotected watershed, water quality degradation is possible from many sources, including industrial and municipal

Table 4-1. 2005 Mean Water Quality at Selected State Water Project Locations

Constituent	Units[a]	Detection Limit	Thermalito Afterbay at Outlet	North Bay Aqueduct Barker Slough Pumping Plant	Delta-Mendota Canal Upstream of McCabe Rd	California Aqueduct					
						Banks Delta Pumping Plant	O'Neill Forebay Outlet (Check 13)	Kettleman City (Check 21)	Near Highway 119 (Check 29)	Tehachapi Afterbay (Check 41)	Devil Canyon Afterbay Near San Bernardino
Alkalinity	mg/L as $CaCO_3$	1	41	102	70	65	71	71	72	70	71
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NR	NR
Arsenic	mg/L	0.001	<0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.1	<0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
Bromide	mg/L	0.01	<0.01	0.05	0.17	0.16	0.18	0.19	0.19	0.18	0.17
Calcium	mg/L	1	8	16	20	18	20	20	20	19	20
Chloride	mg/L	1	<1	24	58	53	61	64	63	59	57
Chromium	mg/L	0.001	<0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Copper	mg/L	0.001	<0.001	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Fluoride	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hardness	mg/L as $CaCO_3$	1	35	98	97	86	96	96	97	93	94
Iron	mg/L	0.005	<0.005	0.048	0.010	0.021	0.021	0.010	0.010	0.012	0.007
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	mg/L	1	4	14	11	10	12	12	12	11	11
Manganese	mg/L	0.005	<0.005	0.068	<0.005	0.016	0.005	<0.005	<0.005	<0.005	0.010
Nitrite + Nitrate	mg/L as N	0.01	<0.01	0.24	NR	0.66	0.80	0.78	0.79	0.76	0.79
Organic Carbon, Dissolved	mg/L as C	0.1	NR	6.8	3.7	3.7	4.0	3.8	3.6	3.4	3.7
Organic Carbon, Total	mg/L as C	0.1	NR	7.6	3.9	3.9	4.1	3.7	3.8	3.7	3.9
Phosphate-Ortho	mg/L as P	0.01	<0.01	0.12	NR	0.07	0.09	0.09	0.15	0.08	0.09
Phosphorus-Total	mg/L	0.01	0.01	0.25	NR	0.12	0.12	0.12	0.12	0.12	0.11
Selenium	mg/L	0.001	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001
Sodium	mg/L	1	3	30	46	40	44	46	46	42	42
Specific Conductance	µS/cm	1	87	323	423	364	418	423	423	402	403
Sulfate	mg/L	1	2	25	46	33	38	39	39	35	36
Total Dissolved Solids	mg/L	1	57	188	240	212	239	242	246	228	221
Turbidity	N.T.U.	1	3	56	19	13	8	7	9	10	3
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Note: All reported constituents are the yearly mean of laboratory analytical values sampled monthly. Nondetectable values were not used in the calculation of the yearly mean.
[a]mg/L = milligrams per liter; µS/cm = microSiemens per centimeter; N.T.U. = nephelometric turbidity unit; NR = No data recorded at this location.

wastewater discharges, storm water runoff from cities, agricultural discharges, recreational activities, abandoned mines, and illegal dumping. The Municipal Water Quality Investigations Program (MWQI) was established to evaluate the suitability of Delta water as a drinking water source, to identify sources of water quality degradation, and to evaluate means of eliminating or preventing degradation.

Participants in the program include the municipal water contractors of the SWP and Contra Costa Water District. Program advisors include representatives of participating agencies, including the U.S. Environmental Protection Agency (EPA), DHS, and California Urban Water Agencies.

Components of the MWQI Program include the following:

- Evaluation of the water quality impacts at drinking water intakes from the proposed Delta wetlands storage project;
- The study and fractionation of organic carbon molecules from Delta carbon sources;
- Evaluation of proposed CALFED restoration actions in terms of drinking water impacts;
- Working with the State and regional water quality control boards to develop drinking water policy as part of the basin plan;
- Evaluation of water quality effects from the Jones Tract Flood;
- Development of models to predict water quality based on sources and loads; and
- Investigation of new and increasing sources of pollution, including urban sources.

Collectively, these and other MWQI studies and activities are designed and conducted to address major water quality and water supply issues. Each study or activity serves to discover, test, and assess possible solutions to problems in the Delta and other watersheds of the SWP. Overall, the results of these studies and activities are intended to assure that future demands for safe, potable water supplies can be met.

Because water quality concerns change rapidly with new drinking water regulations and water quality issues, the MWQI Program must be flexible enough to adapt to changing requirements. The former Delta Health Aspects Monitoring and Delta Island Drainage Investigations Programs merged into the MWQI Program in 1990, and the program continues to evolve.

The program's initial focus was to compile a comprehensive database on the quality of drinking water in the Delta. Since then, it has investigated ways of managing Delta lands and waters to minimize adverse impacts on drinking water quality. It has also identified sources of contaminants in the Delta and assessed their significance for drinking water quality and water treatment. Drinking water standards are more difficult to meet using Delta source waters because natural organic materials from agricultural drainage and watershed runoff potentially contain contaminants of concern.

The current MWQI Program has progressed from monitoring, problem identification, and assessment stages to the development of studies on source water improvement and management. The MWQI Program also continues to provide CALFED with expertise for assessing potential effects

from proposed Delta projects. The *2001 California State Water Project Watershed Sanitary Survey Report*, the third in a series for the SWP, provides this information in the latest five-year update from the original sanitary survey required by DHS in 1990. A searchable CD-ROM version of the report is available on the MWQI website at http://www.wq.water.ca.gov/mwqi/pubs.cfm. The next update of the sanitary survey will be available in mid-2007.

DWR, the Bureau of Land Management, Ducks Unlimited, DFG, and the Nature Conservancy partnered on a CALFED grant to develop a wildlife friendly farm management project on the Delta's Staten Island. The MWQI Program is responsible for the project's water quality monitoring component. Monitoring water quality on Staten Island provides a unique opportunity to examine the effects of agriculture management practices on water quality, the quantity of carbon exported off the island, and the effects of water management practices on agricultural lands under different soil regimes found in the Delta. Access to the island's pump facilities provides an unprecedented opportunity to measure carbon loads directly. Results from these experiments will provide direct measurement of carbon quantities discharged off a Delta island.

Starting at the end of October 2004, when the fields were first flooded, samples were collected weekly from two fields. Sampling continued until the fields were drained of water in early 2005. Carbon loading studies began in fall 2005 and will continue through fall 2007. Following the completion of this second portion of monitoring, a report on the results will be prepared for Ducks Unlimited.

It is anticipated that the carbon loading studies may be submitted to a journal for publication and wider dissemination in the scientific community.

The MWQI Program received a CALFED grant in 2000 to purchase and install three automated carbon analyzers in the Delta. In summer 2001, the first analyzer began operating at Banks Pumping Plant. The analyzer automatically samples the exported water, determines the total organic carbon and dissolved organic carbon levels, and sends the data to Sacramento, where it is posted on the California Data Exchange Center (CDEC) website.

The second analyzer started operation in winter 2002, and is located at the Hood water quality monitoring station on the Sacramento River. The third analyzer started operation in March 2005 at the new San Joaquin River monitoring station near Vernalis (McCune Station). Construction of this station was partially funded by a 2002 CALFED grant.

Automated carbon analyzers can sample every hour compared to the historical grab-sample program that only sampled weekly or monthly. The more frequent data, coupled with flow measurements, will allow for the calculation of mass transport and loading of carbon from the two main Delta tributaries. These data, currently posted to DWR's CDEC website, will also be used by modelers to refine the Delta Simulation Model 2 (DSM2) for calculation of organic carbon transport through the Delta.

The MWQI Program, in partnership with the Dry Creek Conservancy, also received Proposition 13 and CALFED grant funding

of $595,000 in 2004 to assess water quality and loads of parameters of concern from an urban drain in metropolitan Sacramento in a watershed that includes several areas of rapid development. The Natomas East Main Drainage Canal (NEMDC), also known as Steelhead Creek, has been part of the routine MWQI monitoring program since 1997. The grant project expanded the scope of monitoring to include installation of a real-time stage recorder to determine daily flows, installation of an autosampler station to more accurately determine loads, and preparation of a GIS of land use and impervious cover in the NEMDC watershed to serve as a basis for change detection analysis in subsequent years.

From 2003 to 2004, MWQI staff conducted a collaborative special study on trihalomethane (THM) reactivity of organic carbon for carbon-rich soils of the Delta. Organic carbon of soil origin in Delta waterways results in elevated organic carbon levels in Delta waterways. Elevated organic carbon in drinking water source waters represents a major public health concern because organic carbon reacts with chlorine, a disinfectant currently used by most water utilities with entitlement to Delta source waters, and forms harmful disinfection by-products (DBPs), such as THMs. To date, the nature and properties of reactive organic carbon has been poorly characterized. MWQI staff collected representative soils from various Delta islands from the soil surface down to 10 feet. Organic carbon from the soils was extracted with different extractants and fractionated into relatively homogeneous isolates of distinct properties for determination of THM reactivity. MWQI staff has summarized findings of this study into three peer-reviewed manuscripts, one of which appeared in *Water Research* in May 2005. The other two manuscripts are being revised for publication in *The Journal of Environmental Quality*.

A two-year MWQI data summary report, entitled *The Municipal Water Quality Investigations Program Summary and Findings from Data Collected from October 2001 through September 2003*, was distributed in August 2005. This report summarizes and interprets MWQI grab-sampling data collected from 11 MWQI stations. The report is available in hard copy and searchable CD-ROM, as well as online on the MWQI website at http://www.wq.water.ca.gov/mwq/.

Bryte Chemical Laboratory

Bryte Chemical Laboratory was established in 1951 and certified in 1990 by the DHS Environmental Laboratory Accreditation Program to perform drinking water and wastewater analyses. The laboratory continues to perform the vast majority of chemical and other related analyses required to support DWR's water quality programs. Every year, thousands of water samples are routinely analyzed for minerals, nutrients, metals, pesticides, herbicides, volatile organic compounds, and many other chemical constituents.

In 2005, Bryte Chemical Laboratory upgraded the lab's capability to detect and analyze trace metals in water and wastewater with the purchase of a Perkin Elmer, ICP/MS, DRCe instrument system. The ICP/MS, DRCe is equipped with new collision cell technology that removes matrix and polyatomic interferences normally encountered when analyzing trace metals in water and wastewater. Removal of these interferences allows for lower detection limits, in the parts

per trillion ranges, for trace metals such as arsenic, selenium, vanadium, and chromium. The new ICP/MS, DRCe instrumentation became fully operational and was certified in October 2005 to perform trace metal analyses using EPA Method 200.8. The new instrumentation also performs EPA Method 1643, an ultra-low level trace metal analysis requirement for Northern District water quality programs. These specialized analyses were formerly performed through Bryte Lab's contract laboratories. The program savings in analytical costs alone for Northern District will be well over $150,000 per year.

Bryte Chemical Laboratory has continued to manage a variety of analytical contracts with other State agencies and several outside laboratories in accordance with the master contract policy approved in fiscal year 1994–1995. The laboratory works in conjunction with the Quality Assurance and Quality Control Section to replace these contracts as they expire each fiscal year. In 2005, no significant contracts expired or were required to be replaced.

Security and protection of the SWP has continued to be a primary goal for DWR since September 11, 2001. To help protect the SWP from biochemical and chemical agents, Bryte Laboratory has continued in 2005 to be an active member in a group of laboratories called the California Association of Mutual Aid Laboratories Network (CAMAL Net) headed by DHS. The laboratory network's main objective is to voluntarily assist DHS in the analysis of chemical agents in water quality samples should a natural disaster or terrorist event occur in California. The assistance to DHS is only required should the analytical capacity of DHS be exceeded or to confirm the presence or absence of chemical agents in water quality samples provided by DHS. Should DHS activate CAMAL Net, members will be notified, and water quality samples that are determined to be safe to handle by DHS will be shipped to the participating CAMAL Net laboratories. In 2005, Bryte Laboratory was classified as a Level II participating laboratory in the CAMAL Net organization.

Suisun Marsh Activities

Suisun Marsh consists of approximately 59,000 acres of tidal and managed brackish water wetlands and 30,000 acres of bays and sloughs. It is the largest contiguous brackish marsh remaining in the United States. Situated in southern Solano County, west of the Sacramento-San Joaquin Delta and north of Suisun Bay, the marsh encompasses more than 10 percent of California's remaining natural wetlands. In addition, the marsh is the resting and feeding ground for thousands of waterfowl migrating on the Pacific Flyway.

Since the early 1970s, the California Legislature, SWRCB, Reclamation, DFG, Suisun Resource Conservation District (SRCD), DWR, and other agencies have focused on preserving the Suisun Marsh as a unique environmental resource. As part of its responsibility for protecting Suisun Marsh, SWRCB included water quality standards for the marsh in Term 10 of D-1641, which applies to SWP and CVP operations. D-1641 was adopted by SWRCB on December 29, 1999. In 1987, DWR, Reclamation, DFG, and SRCD signed the Suisun Marsh Preservation Agreement (SMPA) (see sidebar). SMPA contains provisions for actions to control channel water and soil salinity to mitigate impacts of the SWP, CVP, and other upstream

Suisun Marsh Preservation Agreement

In 1986, federal legislation (Public Law 99-546) authorized funds to Reclamation to protect Suisun Marsh. On March 2, 1987, DWR, Reclamation, DFG, and SRCD signed the Suisun Marsh Preservation Agreement (SMPA). The objective of SMPA is to assure that Reclamation and DWR mitigate for any adverse effects of the CVP and SWP on managed wetlands in the marsh, as well as a portion of the adverse effects of other upstream diversions. Under the original agreement, this objective is primarily accomplished by constructing large-scale facilities in the marsh to maintain a dependable supply of adequate quality water within Suisun Marsh channels. A component of the large-scale facilities is the Suisun Marsh Salinity Control Gates facility, which began operating in November 1988.

On August 4, 1995, the Suisun Marsh Coordinators, representing the four agencies party to SMPA, began discussions directed at updating the agreement, pursuant to SMPA Articles 4 and 17. Representatives from Reclamation, DWR, DFG, and SRCD established an ad hoc Negotiating Team, Technical Group, Drafting Committee, and Environmental Documentation Team. Beginning September 1995, the SMPA Negotiating Team met monthly in Sacramento and made significant progress in developing the basis to amend the agreement. Representatives from the SWP and CVP contractors actively participated in the negotiations. Updating SMPA will reflect future hydrologic and salinity conditions in the Suisun Marsh as prescribed by the SWRCB 1995 Water Quality Control Plan and will place more emphasis on improving water and land management practices and facilities on managed wetlands.

diverters on managed wetlands in Suisun Marsh.

Revised Suisun Marsh Preservation Agreement

In 2005, SMPA parties completed the Revised SMPA. This agreement includes only those actions that would not cause any taking of listed species, as identified by the regulatory agencies. The Revised SMPA includes the following actions: operation of the initial facilities and Suisun Marsh Salinity Control Gates; channel water salinity standards consistent with D-1641; water manager program; portable pumps program; Individual Ownership Adaptive Management Habitat Plan updates; drought response fund; and replacing turnouts on the Roaring River Distribution System. The SMPA parties also completed the Revised Suisun Marsh Monitoring and Suisun Marsh Mitigation agreements.

Operation and Maintenance

Initial Facilities Maintenance

Several facilities constructed by DWR and Reclamation operate in the Suisun Marsh. They are identified in the *Plan of Protection for the Suisun Marsh* and the 1987 SMPA. These facilities provide lower salinity water to managed wetlands. The initial facilities, including the Roaring River Distribution System, Morrow Island Distribution System (MIDS), and Goodyear Slough Outfall, were constructed in 1979 and 1980. The Suisun Marsh Salinity Control Gates were installed and became operational in 1988. During 2005, DWR's Delta Field Division performed routine maintenance on all initial facilities in the Suisun Marsh, including MIDS.

Morrow Island Distribution System (MIDS) Fish Screen and Alternatives

In 1997, the USFWS issued a biological opinion requiring Reclamation and DWR to install a fish screen at the intake of MIDS on Goodyear Slough. Reclamation requested USFWS reinitiate consultation in a November 2002 memorandum and committed to reinitiate Section 7 consultation on the MIDS maintenance project after completion of the Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh programmatic Environmental Impact Statement/Report. In March 2003, the USFWS reinitiated consultation and amended Term and Condition number 3, granting Reclamation and DWR until May 9, 2006, to begin construction of a screen or implement an approved mitigation or conservation alternative.

Because the cost of adding a fish screen to the MIDS intake structure is likely to be high, and the effectiveness of such screening to conserve Suisun Marsh fish populations is unknown, DWR and Reclamation proposed to investigate fish entrainment at the MIDS intake with regard to fishery populations in Goodyear Slough and to evaluate whether screening the diversion would provide substantial benefits to local populations of listed fish species. The objectives of this sampling project are: (1) to determine what species of fish and what life stages are entrained by the MIDS intake facility; and (2) to quantitatively assess whether certain species of fish are more likely to be entrained than others.

Sampling for the first year of the study began in September 2004 and continued through May 2005. The second year of sampling began in October 2005 and will continue through May 2006. A final report is anticipated by early 2007.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates are operated from October 1 of the current year through May 31 of the following year, as needed, to meet salinity standards; otherwise, they are placed in an open position to minimize fish concerns related to predation and impedance. In the past, the gates' operation and installation or removal of the flashboards has varied due to salinity conditions, fisheries agencies' requests for sensitive species concerns, or special studies and repairs.

Gates Status for 2004–2005

During the 2004–2005 control season (October 2004 through May 2005), the fall 2004 fish passage study continued with modification to the boat lock in its fourth and final year as an alternative for passage, instead of flashboards as in previous years. The gates were operated for both the fish

study and for salinity control during this control season.

From September 28 through October 11, 2004, Phase I was carried out with gates open, flashboards out, and boat lock gates closed. From October 12 through October 25, Phase II was in action with gates operated to full-bore, boat lock open, and flashboards installed. In Phase III, from October 26 through November 9, the gates were operated full-bore with flashboards installed and boat lock closed for fish passage study. Thereafter, the gates were operated to control salinity with the boat lock gates held open until February 9, 2005, when salinity levels were not a concern any longer and the gates were held open. However, the flashboards remained installed until May 20, when conditions were so fresh that flashboard removal was ordered. During the 2004–2005 control season, many gate problems occurred. Gate #1 was in a closed position due to cable failure at the start of the fish study in late September, and the Gate #3 cable failed on January 14, 2005, leaving only Gate #2 functional thereafter to control salinity. Repair on both gates was not completed until late summer of 2005. Despite these issues, compliance was met at all stations.

Monitoring

Water Quality and Compliance

Suisun Marsh channel water salinity standards were specified in SWRCB WR 98-09 for seven compliance stations. Four of these—National Steel (S-64), Beldon's Landing (S-49), Volanti (S 42), and Sunrise (S-21)—are located within the marsh. A fifth, Collinsville (C-2), is located in the western Delta (Figure 4-2). Two remaining sites located in the western marsh, Morrow Island (S-35) and Ibis (S-97), are specified as baseline monitoring stations because of the SWP's minimal control on salinity levels at these locations. In 2000, SWRCB amended D-1641 to remove the compliance monitoring requirement for these stations. However, both remain active as water salinity monitoring stations. To be consistent with D-1641, the June 2005 Revised SMPA Monitoring Agreement had the same specification for S97 and S35 to become monitoring stations, instead of compliance stations. Details of the agreement can be viewed online at: http://iep/suisun/smpa/RevisedSMPAMonitoringAgreement_20JUN2005.pdf.

Salinity levels remained well within compliance during the period from October 1, 2004, through May 31, 2005. (See DWR's annual report to SWRCB, *Suisun Marsh Monitoring Program Data Summary: 2005 Water Year*, for details.)

Suisun Marsh Expenditure History

Suisun Marsh expenditures and reimbursements administered by DWR for calendar years 1968 through 2005 are summarized in Table 4-2. From 1968 through December 31, 2005, DWR disbursed more than $113.9 million SWP funds for planning, design, environmental documentation, construction, maintenance, monitoring, mitigation, and permit compliance in support of implementing the plan of protection for Suisun Marsh through the SMPA and for meeting standards set by SWRCB. Reclamation has reimbursed DWR about $44.8 million (40 percent), and the State's General Fund has reimbursed about $9.4 million (8 percent). These figures do not include up-front payments made by Reclamation for staff and other direct costs, as well as about $5.7 million in

Reclamation interest payments during 1988 and 1989.

Annual figures are reported in Table 4-2 for DWR's up-front payments, Reclamation reimbursements, General Fund reimbursements, and DWR's cumulative expenditure balance.

Figure 4-2. Compliance and Monitoring Stations in the Suisun Bay and Marsh

Table 4-2. Suisun Marsh Expenditures and Reimbursements Administered by DWR (in dollars)

Year [1]	Reach 305 Costs [2]	General Fund Payment [3]	Adjustment for General Fund Payment[a] [4]	USBR Invoice Payment [5]	Interest Payment Credited Back to Contractors [6]	Net SWP Costs [2] through [6] [7]	Recreation Costs [8]	SWP Contractors' Costs [7] minus [8] [9]
1968	10,571					10,571	1,480	9,091
1969	34,181					34,181	4,785	29,396
1970	23,343					23,343	3,268	20,075
1971	1,042					1,042	146	896
1972	47					47	7	40
1973	0					0	0	0
1974	0					0	0	0
1975	2,709					2,709	379	2,330
1976	32,960					32,960	4,614	28,346
1977	37,475					37,475	5,246	32,229
1978	350,831					350,831	49,117	301,714
1979	3,660,099					3,660,099	512,568	3,147,531
1980	5,005,759					5,005,759	701,227	4,304,532
1981	2,964,974					2,964,974	415,096	2,549,878
1982	2,955,705			(2,500,000)		455,705	413,801	41,904
1983	2,754,094					2,754,094	385,574	2,368,520
1984	2,418,344					2,418,344	338,567	2,079,777
1985	2,332,773					2,332,773	326,587	2,006,186
1986	6,495,322					6,495,322	909,344	5,585,978
1987	13,600,701					13,600,701	1,904,099	11,696,602
1988	7,456,364			(17,368,725)[b]	(2,039,752)	(11,952,113)	1,043,891	(12,996,004)
1989	2,341,960	(9,478,000)	6,634,600	(1,219,691)[b]	(283,857)	(2,004,988)	327,874	(2,332,862)
1990	3,030,010			(695,450)		2,334,560	424,202	1,910,358
1991	6,223,042			(2,925,429)		3,297,613	871,226	2,426,387
1992	2,737,259			(1,174,655)		1,562,604	383,218	1,179,386
1993	2,979,255			(238,130)		2,741,125	417,100	2,324,025
1994	3,192,213			(1,962,549)		1,229,664	446,914	782,750
1995	2,721,978			(647,138)		2,074,840	381,079	1,693,761
1996	3,391,678			(1,482,396)		1,909,282	474,838	1,434,444
1997	3,634,267			(1,520,219)		2,114,048	508,800	1,605,248
1998	5,342,834			(1,107,501)		4,235,333	748,000	3,487,333
1999	8,867,742			(2,696,200)		6,171,542	1,241,486	4,930,056
2000	2,857,534			(3,300,053)		(442,519)	400,055	(842,574)
2001	2,623,227			(444,009)		2,179,218	367,252	1,811,966
2002	3,752,265			(791,319)		2,960,946	525,317	2,435,629
2003	3,258,583			(2,389,979)		868,604	456,202	412,402
2004	2,874,629			(952,940)		1,921,689	402,448	1,519,241
2005	3,940,876			(1,409,296)		2,531,580	551,723	1,979,857
Total	113,906,645	(9,478,000)	6,634,600	(44,825,679)	(2,323,609)	63,913,957	15,947,529	47,966,428

[a]Under State Assembly Bill 1442 the General Fund paid 20% of the Suisun Marsh costs through 6/88 which amounts to $9,478,000. This payment includes $2,843,400, which represents 6% of the costs through 6/88 paid by the General Fund. This amount has reduced the costs billed to the SWP contractors. The remaining $6,634,600 received from the General Fund represents our Recreation project purpose share of 14%.
[b]Excludes interest payments made by USBR.

Chapter 5
Local Assistance

Reverse osmosis is a way to increase water supply.

Significant Events in 2005

By the end of 2005, 69 water districts, three environmental interest groups, and more than 55 other interested groups had signed the Agricultural Water Management Memorandum of Understanding (MOU) as members of the Agricultural Water Management Council (Ag Council).

DWR received 148 urban water management plans.

Southern Illinois University completed a report under contract with DWR. The report evaluated methods of removing selenium from agricultural subsurface drainage water using absorbent materials

Information in this chapter was contributed by the Division of Planning and Local Assistance and the Office of Water Use Efficiency.

The Department of Water Resources (DWR) manages water use efficiency, the Davis-Grunsky Act, agricultural drainage, environmental impact document review, and Water Conservation Bond Law programs, and participates in several other programs that assist local agencies and benefit State Water Project (SWP) contractors.

Davis-Grunsky Act Program

The Davis-Grunsky Act, authorized in 1960 as part of the Burns-Porter Act, provides construction loans for local domestic water projects and agricultural water conservation projects. It also provides grants for recreation and fish and wildlife enhancement. Loans and grants may be given to rehabilitate dams and reservoirs.

DWR's ongoing administration of the program provides oversight of the 32 recreation grant projects to ensure compliance with the contracts. Administration costs are recovered from the revenues provided by the repayment of Davis-Grunsky Act loans. The recreation grant contracts are being amended to reflect actual facilities constructed and the modification of DWR's fee oversight function.

Water Use Efficiency

The Water Conservation Office was reorganized and a new Office of Water Use Efficiency (OWUE) was created in 2001. OWUE activities include providing technical assistance to local agencies; managing water use efficiency financial assistance programs; managing the California Irrigation Management Information System; reviewing, tracking, and reporting on urban and agricultural water management plans; and managing drainage and water recycling/desalination projects.

California Irrigation Management Information System (CIMIS)

CIMIS is a network of automated weather stations that collects weather data and transmits it to a central repository in Sacramento each day. After performing quality control and calculations, the data are made available to the public for such diverse purposes as irrigation scheduling, resource planning, research, and modeling.

DWR's CIMIS network remained at 130 stations in 2005. Approximately 70 percent of the stations on the network belong to local cooperators. The demand for CIMIS data has been increasing steadily since its establishment in 1982. For example, the number of registered data users has grown from 661 in 1989, to more than 7,000 in 2005.

Due to the growing demand for data and information, the CIMIS database and the Web application were upgraded to increase performance and enhance content in 2004. Further enhancements will take place in 2007.

More than 196,000 reports were generated from the database with more than

20,000,000 visits to the website (http://wwwcimis.water.ca.gov), for information in 2005. Users can register online, access archived data, download data files, and peruse content about the CIMIS program and other helpful meta data and information. A separate but concurrently-operating database and a Web application were developed to keep pace with the rapidly evolving program. A Web administrative module was also created to make the website more dynamic.

Other ongoing enhancements for CIMIS include the non-ideal site weather station network study and the incorporation of the GOES model producing statewide daily evapotranspiration (ET_o) maps.

In addition, staff is updating CIMIS brochures, evapotranspiration calculation, other methods of data acquisition and dissemination, data quality refinements, and technical assistance.

Water Recycling and Desalination Branch

The Water Recycling and Desalination Branch of OWUE was established in 2001. The branch's goal is to improve water use efficiency and to promote increased use of nonconventional water sources through planning, technical, and financial assistance. As part of a balanced water portfolio, nonconventional water will help meet existing and future water supply and environmental needs, by increasing safe and beneficial use of recycled water. It will also encourage economically and environmentally acceptable use of desalinated brackish and sea waters.

In 2005, the Water Recycling and Desalination Branch activities included the following:

- awarding proposition 50 funds of $25 million for the first desalination grant cycle to fund 24 different projects, including: three constructions, six pilots and demonstrations, seven research and development projects, and eight feasibility studies.
- developing and managing grant agreements for the 24 different projects, which were awarded through the initial 2005 cycle of the desalination grant program.
- the Housing And Community Development, at the request of DWR and DHS, initiated recommendation 3.3.1 of the recycled water task force, which states that the "Housing And Community Development Department should submit a code change to remove the requirement for the skull and crossbones symbol in Sections 601.2.2 and 601.2.3 of the California Plumbing Code." The Housing And Community Development Department submitted this on September 24, 2004, and updated it on November 15, 2004 for the 2004 California Plumbing Code, and updated it again on March 1, 2005.
- disseminated information regarding AB 334 (Goldberg, Chapter 172, Statutes of 2003), which gives communities additional flexibility to regulate water softeners as a source-control measure. For example, on July 8, 2005, conducted a joint workshop between DWR and the Santa Clara Valley Water District entitled "A Salinity Management Strategy-Water Softener Replacement Rebate Program."
- presented a water fact brochure entitled *Water Recycling* (DWR water

facts no. 23) and Water Recycling 2030 at several workshops statewide.
- served as a member on the Executive Management Team of the Southern California Water Recycling Projects Initiative sponsored by Reclamation.
- participated on the Project Advisory Committee to design an activity booklet for upper elementary students, entitled *Give Water A Second Chance… Recycle It*, which provides information on the process and the need for recycled water and its similarity to the water cycle.

Agricultural Water Management Plans

By the end of 2005, 69 water districts, three environmental interest groups, and more than 55 other interested groups had signed the Agricultural Water Management Memorandum of Understanding (MOU) as members of the Agricultural Water Management Council (Ag Council). The agricultural signatories represent more than 4.75 million acres of irrigated agricultural land statewide.

In 2005, the council endorsed an additional three agricultural water management plans that had been submitted by agricultural water suppliers to the Ag Council. Subsequently, these plans have become the basis for the districts' water conservation efforts. The districts with endorsed water management plans are expected to prepare and submit a biannual progress report to the Ag Council from the date their plan was endorsed. DWR staff provides technical review and evaluation of these plans. DWR also reviewed four biannual progress reports for the Ag Council.

DWR staff provided technical assistance to water districts to prepare water management plans and helped implement efficient water management practices, as well as administrative and programmatic assistance to both the Council and water districts.

Three-Way Cooperative Agreement–Ag Council

In 2001, DWR set up a three-way cooperative agreement between itself, Reclamation, and CALFED, and has been managing the State-funded portion of the agreement. This agreement provides funding to the Ag Council for a period of three years to help implement the MOU. The management and implementation of tasks in the agreement are closely coordinated with Reclamation Mid-Pacific Region. This activity, with a $1.2 million budget, is shared equally between DWR and Reclamation. By the end of 2005, all DWR funds were spent for relevant tasks identified in the three-way cooperative agreement. The work continued with federal share of funds and tasks.

The Ag Council is making progress on tasks identified in this cooperative agreement. The Ag Council has hired additional staff to help with technical issues as well as with database development, and the enhancement of web-based applications related to the water management planning process. It is also making significant progress in implementing all tasks identified in the agreement. The council provided technical and financial assistance to the signatories of the MOU to develop water management plans, since development of a model water management plan and refinement of net benefit analysis are important tasks of the agreement.

Urban Water Management Plans

DWR received 148 urban water management plans in 2005. The 2005 Urban Water Management Plan Guidebook and DWR 2005 UWMP Review Sheets were published. In addition, a series of ten workshops on how to prepare an UWMP were conducted around the State.

Three-Way Cooperative Agreement—Urban Council

DWR set up a three-way cooperative agreement between itself, Reclamation, and CALFED and has been managing the State-funded portion of the agreement. This agreement provides funding to the California Urban Water Conservation Council, for a period of three years to provide technical assistance to urban water suppliers to implement the first four years of the CALFED incentive-driven Water Use Efficiency Program. The management and implementation of tasks in the agreement are closely coordinated with Reclamation's Mid-Pacific Region. This is a $1.5 million, three-year activity, of which $600,000 is funded by Reclamation.

The Urban Council continues to make progress on tasks identified in this cooperative agreement, including timely achievement of tasks outlined in the CALFED Water Use Efficiency Program Budget Change Proposal. In 2005, five of the tasks in the three-way cooperative agreement between DWR, Reclamation, and CALFED were performed for DWR.

Draft Senate Bill 610 and Senate Bill 221 Guidebook

Senate Bill 610 became effective on January 1, 2002. It expands the requirement for public water systems to prepare water supply assessments for large-scale projects, requires that additional information be included in assessments, and makes related changes. The draft Senate Bill 610/Senate Bill 221 Guidebook was published to provide assistance to water suppliers, cities, and counties in integrating water and land use planning.

Outreach

OWUE outreach extends to presentations, workshops, trade shows, expositions, and exhibits.

In 2005, OWUE staff performed outreach that included the following:

- organized staff meeting with University California Rice Workgroup;
- presented water and resource conservation exhibit at Genentech in Vacaville;
- met with several University of California Cooperative Extension;
- attended the Sacramento Valley Exposition Trade Show;
- participated in various California Urban Water Conservation Council committees, Steering Committee and Plenary Meetings, League of California Cities meeting, the Association of California Water Agencies Spring and Fall conferences; and
- participated in California Energy Commission workshops on water-energy efficiency; and
- conducted nine Urban Water Management Plan (UWMP) workshops around the state.

Water Conservation News continues to be the primary water conservation outreach newsletter. The quarterly publication

reaches more than 8,000 California subscribers.

Agricultural Drainage Program

The Agricultural Drainage Program mission is to seek in-valley solutions to the surface and subsurface agricultural drainage water problems in the State and, in particular, the San Joaquin Valley, and improve water quality in the San Joaquin River by promoting measures to reduce salinity and discharge of harmful elements.

Even though the San Joaquin Valley Drainage Implementation Program (SJVDIP) has been idle since 2003, DWR continues to implement many of its recommendations through its Agricultural Drainage Program. DWR works in partnership with California universities, CALFED, Reclamation, resource conservation districts, watershed groups, water and drainage districts and many other local, State and federal entities. DWR works with these organizations to develop, educate, and promote the use of Integrated On-Farm and Regional Drainage Management Systems (IFDM) in the San Joaquin Valley;

- provide technical assistance and collaborate with water and drainage districts, and local entities to reduce and control surface and subsurface agricultural drainage water;
- maintain research and demonstration projects to develop drainage reuse systems, including the development of cost-effective salt tolerant crops (including energy crops), drainage treatment, disposal technologies, and salt separation and utilization;
- monitor the quality and distribution of shallow groundwater water levels in drainage-impaired areas of the San Joaquin Valley;
- promote agricultural water and energy use efficiency programs in drainage-impaired lands to reduce the volume of surface and subsurface drainage water and expand regional water supplies;
- maintain programs to help improve water quality on the San Joaquin River; and
- provide grants for control of agricultural drainage water and the reduction of its toxic elements, using Propositions 13, 50, 204, and DWR project fund monies.

The Agricultural Drainage Program was divided into two major activities: management of Proposition 204 (Drainage Subaccount) and the San Joaquin Valley Agricultural Drainage Program.

Proposition 204 (Drainage Management Subaccount)

In 1996, Proposition 204, The Safe, Clean, Reliable Water Supply Act, authorized the transfer of approximately $6.1 million from the State Water Resources Control Board (SWRCB) to the California Department of Food and Agriculture (CDFA). In 1997, CDFA, SWRCB, and DWR signed an MOU that established a process for utilizing the funds designated for agricultural drainage activities. In 1999, CDFA and DWR signed an interagency agreement to transfer the funds to DWR for developing and implementing programs consistent with Water Code Section 78645, as outlined in the MOU. The funds are distributed throughout the duration of the six-year Proposition 204 program. The goal of the program is to develop methods of using

and concentrating salts and reducing contaminants in the California's subsurface agricultural drainage water.

Each year, DWR solicits proposals from public entities seeking funding for research activities. A technical review committee reviews and screens the proposals. DWR then submits the proposal packages to an oversight committee, comprised of representatives from DWR, CDFA, and SWRCB for final approval. Ultimately, DWR is responsible for preparing and managing contracts for the approved proposals.

In 2005, the Proposition 204 program funded the following projects:

- characterization of forages growing in saline drainage water reuse systems: influence of management practices on forage productivity and nutritional value, California State University Fresno (CSUF);
- wetland drainage management technology development in support of San Joaquin River real-time water quality management, University of California, at Merced;
- concentration of mineral salts from membrane desalting of agricultural drainage in the San Joaquin Valley, University of California, at Los Angeles;
- predicting water use, crop growth, and quality of Bermuda grass under saline irrigation, University of California, at Davis; and
- the production of biofuel and selenium-enriched feed from canola irrigated with agricultural drainage water on the west side of California's San Joaquin Valley, U.S. Department of Agriculture, and CSUF, partial funding.

San Joaquin Valley Agricultural Drainage Program

This program consists of several activities, including drainage monitoring and evaluation, drainage treatment, integrated on-farm drainage management, drainage reduction and reuse, environmental services activities and the San Joaquin River Water Quality Improvement Program.

Drainage Monitoring and Evaluation

Drainage monitoring and evaluation involves collecting and evaluating information on the quality, quantity, and movement of drainage water. The following activities were conducted:

- monitoring and collecting shallow groundwater levels, flows, and water quality data for drainage water from Westside San Joaquin Valley tile drain sumps;
- publishing an annual drainage report in December 2005, The San Joaquin Valley Drainage Monitoring Program 2002 Report;
- preparing shallow groundwater and irrigation methods maps of drainage-impaired areas, using drainage monitoring data in conjunction with land use and irrigation methods data;
- providing assistance for the collecting of groundwater, soil, and operational data for the integrated on-farm drainage management project, at Red Rock Ranch in western Fresno County; and
- maintaining a website that includes information on drainage programs and activities, salinity and shallow groundwater maps, Proposition 204 grants, and links related to other agricultural drainage programs: (www.dpla.water.ca.gov/sjd/waterquality/index.html).

Drainage Treatment

Development of Membrane Treatment of Agricultural Drainage Water. DWR continues to fund research under a contract with University of California, Los Angeles, (Department of Chemical Engineering) to explore the use of membrane treatment desalting agricultural drainage water. Under this multi-year contract, UCLA is performing fundamental work to: (1) evaluate the relationships between anti-scalant dose and membrane mineral salt scale prevention; (2) evaluate the potential for enhanced crystallization of membrane concentrate by crystal seeding and pH control; and (3) reducing membrane fouling due to scale formation. A final progress report entitled "Recovery Enhancement and Brine Minimization" for tasks nine through 18 in the contract were submitted in September 2005.

Grasslands Area Farmers: In-Valley Drainage Reuse Plan. DWR continues to participate in a multi-agency cooperative effort with Grasslands Area farmers to comply with the objectives of the California Regional Water Quality Control Board's (CRWQCB) Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and the San Joaquin River (SJR). DWR developed an economic model to evaluate all possible options, costs for subsurface drainage water treatment, and active land management alternatives.

Agricultural Subsurface

Drainage: Salt Recovery, Purification, and Utilization. DWR continues to support investigations of processes for concentrating and purifying drainage salts for marketing purposes. These activities are performed on two fronts. The first, with University of California Davis, involves recovering sodium sulfate from farm drainage water and using it in the reactive dye process of cotton. It also involves separating and purifying agricultural salts and brines to produce value-added salt products, while mitigating environmental impacts of salt accumulation. The university developed a pilot salt separation unit for field testing. The second area of investigation involves pilot scale research at Red Rock Ranch using a solar still to demonstrate various ways of using solar energy to recover potable water from drainage water.

Selenium Removal from Agricultural Subsurface Water. Southern Illinois University completed a report under contract with DWR. The report evaluated methods of removing selenium from agricultural subsurface drainage water using absorbent materials. One of the most prominent results indicated that nano-sized zerovalent Ni-Fe and Fe particles can rapidly reduce and immobilize selenate from the drainage water, despite the presence of sulfates. Nearly 100 percent removal was obtained in five hours under most conditions. The report is available at the DWR/DPLA San Joaquin District website.

DWR continues to participate in cooperative research with the University of California Salinity/Drainage Program (http://www.waterresources.ucr.edu). Activities include a multi-year study for mitigating selenium ecotoxic risk in agricultural drainage systems.

Integrated On-Farm Drainage Management. The Integrated Drainage Management Section, created in 2001, provides technical assistance on Integrated On-Farm Drainage Management (IFDM) systems through advisory, technical, and

oversight committees. IFDM is a drainage management system based on sequential reuse of saline drainage water to irrigate crops of progressively increasing salt tolerance. Each sequential reuse reduces the volume of drainage water and increases the salt concentration. Drainage water too saline for irrigation can be applied to a variety of discharge points. The IFDM program funds, administers, and monitors contracts with State, federal, university, and local entities to learn more about IFDM systems. Findings indicate that IFDM systems have less significant environmental impacts than other options and reduce the volume of drainage water. Staff working on activities investigate the use of accelerated evaporation systems (solar evaporators) for zero discharge systems and evaluate the feasibility of using salt-gradient solar pond systems as a way of removing salt and generating heat or electricity for agricultural use.

IFDM Program staff also:

- coordinate IFDM research activities and data collection with other agencies;
- assist growers and local agencies in planning and developing IFDM system;
- worked with the Westside Resources Conservation District and SWRCB to improve the design, management, and operation of IFDM systems;
- investigate new techniques for zero discharge, including enhanced evaporation techniques and extraction of salts from reused drainage water at a solar still facility at Red Rock Ranch;
- participate in joint investigations with Reclamation to determine the feasibility of nanofiltration as a pretreatment for desalination of subsurface drainage water, using reverse osmosis technology and the feasibility of using a patent biotreatment process to remove selenium from agricultural subsurface drainage water;
- provide assistance to research projects for the development of crops, including research being performed at Red Rock Ranch by CSUF to assess the suitability of various salt-tolerant forages and halophytes for the sequential reuse of drainage water, forage quality, productivity, and water use; and
- cooperate with U.S. Department of Agriculture in an investigation to determine crop production using an active drainage management system that employs insitu use of shallow groundwater and subsurface drainage water.

DWR continues to work cooperatively with Reclamation to investigate the long-term interaction of irrigation, rainfall, and local and regional groundwater with the movement of salts and selenium in the soils of Red Rock Ranch. The project will use a three-dimensional numerical model for fully-integrated subsurface and surface flow and solute transport. DWR continues to monitor a series of observation wells at Red Rock Ranch and surrounding areas collect water quality samples, and measure groundwater levels to provide data for the model. Other activities include the following:

- assisting growers, water and drainage districts, and regional entities, by providing information on salt-tolerant grasses and IFDM design specifications;
- assisting SWRCB to develop policies for the management of drainage water, salt, and selenium;
- constructing a pilot solar evaporator to collect data on evaporation rates of subsurface drainage water, using

nozzles, screens, and other devices and materials. The purpose is to develop design specifications for evaporating and recovering salts from drainage water in the solar evaporator, to determine optimum weather parameters to operate it, and to study methods to minimize and control potential salt drift. The results and conclusions from the pilot model will be used to scale a solar evaporator for the 640-acre IFDM system at Red Rock Ranch and future IFDM systems in the Central Valley.

IFDM Manual. DWR contributed to the publication of a *Technical Advisor's Manual, a Guide for Designing IFDM systems*. Published in 2005, it serves as a companion to the landowner's manual, *A Landowner's Manual Managing Agricultural Irrigation Drainage Water: A Guide for Developing Integrated On-Farm Drainage Management Systems.* DWR held two seminars in Five Points and Bakersfield to educate growers and professionals. The seminars included field trips to farms that have implemented IFDM systems. Participants toured Red Rock Ranch in Fresno County and AndrewsAg in Kern County. AndrewsAg is unique in that the owner closed evaporation basins and converted the system to include a solar evaporator.

DWR staff continues to assist Reclamation on performing project tasks for the HydroGeoSphere project at Red Rock Ranch. To facilitate development of the conceptual model, DWR staff collected topographic survey data of Red Rock Ranch and surrounding area to determine elevation points and to locate fixed works, such as sumps, pumps, and wells. The model results from this case study will be useful for the formulation of optimal design and management guidelines for IFDM systems.

Researchers at California State University Fresno (CSU, Fresno) and Center for Irrigation Technology studied the particle emissions produced by the operation of a pilot module solar evaporator at Red Rock Ranch. Information is needed to determine if the salt emissions from the solar evaporator are significant or of a threshold subject to air quality regulations. The principal air quality concerns arising from particle emissions produced by the operation of the solar evaporator are those related to particulate matter (PM) standards, PM10 or PM2.5. Field sampling involved collecting data during nine sampling periods of various weather and water quality conditions to determine the salt deposition patterns. From this data, researchers measured salt deposition and used characteristic equations to model the deposition pattern. The study concluded that the particles small enough to be regulated are a very small fraction of the total emissions. Among the findings, to prevent significant salt deposition from occurring on salt sensitive crops, 200 meters appears to be the maximum amount of buffer zone needed downwind of the solar evaporator (or 100 meters if crop is salt tolerant). Information from this study offers a framework to solar evaporator designers and operators for adhering to air quality and emission standards.

DWR staff used GIS technology to map more than 100 locations of salt-tolerant tree plantations and plant materials and link to information on growth, salinity tolerances, and survival. These plantings began in the mid 1980s,

with the origination of the agriforestry concept, while new plantings continue as components of the IFDM system. Salt-tolerant trees and plant materials are used to lower shallow groundwater, intercept regional groundwater, and in agricultural subsurface drainage reuse. The GIS database will be used to disseminate geographic locations of these plantings and will serve as the central information system for anyone seeking site-specific information on performance of salt-tolerant plantings in the San Joaquin Valley.

DWR is continuing research on *Prosopis alba* in cooperation the Forestry Research Station, at Catholic University of Santiago del Estero (CUSE) in Argentina. Prosopis alba is a highly salt-tolerant tree species and holds promise of ameliorating subsurface drainage problems in the soils of the western San Joaquin Valley. There is good potential for investment of the agriforestry component in an IFDM system. The lumber is coveted by the furniture industry and has a value of $1,000 ton-1 of sawn lumber. Research and development is needed to perfect the process for the reliability of massive production of elite Prosopis alba for large-scale reforestation. The CUSE provided approximately 2,000 scarified Prosopis alba seeds to initiate plantation trials in the San Joaquin Valley. After inspection and quarantine in a USDA facility, the seeds were taken to a plant nursery to produce plants needed for trials at five locations within drainage-impaired lands.

Feasibility Analysis of Solar Evaporation and Recovery of Dissolved Salts from Agricultural Drainage Water in the San Joaquin Valley:

1) The evaluation of the data from the pilot test at Red Rock Ranch demonstrates that accumulated salt can be leached from soil and that future buildup of salt in the soil can be prevented.
2) Proposed control of the brine chemistry during evaporation includes remedial removal of scale, equipment replacement, or to prevent scale deposition. Separation of boric acid, magnesium oxide, sodium chloride, and potassium nitrate may be useful in dealing with scaling and provide for the potential of salable quality products.
3) The brine recovered from agricultural drainage water is well-suited for use in a salt gradient solar pond for electric power generation, refrigeration, or any other use for low-grade heat.
4) Onsite storage of mixed agricultural salts will be necessary until all the detailed design data is developed for a large-scale plant design. Researches and engineers initiated the process of developing the fundamental solubility data for specific salt mixtures present in drainage waters in the San Joaquin Valley.

DWR staff continues to collect operational data from IFDM projects at Red Rock Ranch and AndrewsAg for analysis of performance. DWR staff provided technical information and assistance on an agriforestry planting program in Kern County on farms with salinity and shallow groundwater problems.

Drainage Reduction and Reuse Program. DWR's Drainage Reduction and Reuse Program, managed by Office of Water Use Efficiency (OWUE), offers technical assistance, information, and other resources to growers and irrigators for

applying irrigation water efficiently to reduce both excessive deep percolation and drainage water from the immediate on-farm source, while maintaining salt balance in the root zone.

The program objective is being achieved through on-farm demonstration projects, studies, research, training, and workshops on scheduling irrigation, management, advances in irrigation technologies, evaluating irrigation systems, reusing drainage water, and managing salinity.

Several on-farm demonstrations and other studies for salinity and irrigation management are ongoing. They help improve and advance irrigation management, fine-tune the performance of irrigation hardware, and increase grower and irrigator knowledge.

Staff is presently involved in managing in-progress contracts and preparing technical reports on the on-farm demonstrations projects and studies. Staff is also preparing semi-technical summary reports of findings and results of completed projects.

Management of Contracts

In-progress contracts for research and demonstration projects and contracts for workshops are designed to disseminate state-of-the-art irrigation technologies and management practices to reduce and manage drainage water. The following contracts were developed from a Request for Proposals process, which was targeted for State water contract areas. The contracts include the following:

- *Integrated Management of Irrigation and Shallow Groundwater*—field demonstration at Westlake Farms of irrigation management techniques to optimize crop use of shallow groundwater.
- *Using Forage Grasses and Livestock to Manage Subsurface Drainage Water in the San Joaquin Valley*—field demonstration at Westlake Farms to evaluate the feasibility of growing Bermuda, Elephant, and other salt-tolerant grasses with subsurface drainage water as livestock forage.
- *Center for Irrigation Technology Irrigation/ Drainage Management Workshops*—training and educational workshops on recent advances in irrigation and drainage management at CSU, Fresno.
- *Irrigation Management Education and Training Workshop Through the Use of Demonstration Farms*—workshops that provide practical methods of irrigation management at on- farm demonstration sites, effectiveness of various practices will be determined through the use of a mobile irrigation lab.
- *Educational and Training Workshops for all Prevalent Irrigation Systems in California*—workshops designed for staff from irrigation/water districts, farming communities, consultants, and the public.
- *Irrigation System Evaluation short courses conducted by Cal Poly.* These two workshops, each two-half day, are designed to provide hands–on training and education for irrigators, and those that are involved in irrigation decision process.

Environmental Services

The Environmental Services Section investigates and reports on short- and long-term use and operation of evaporation ponds, IFDM, and other systems used for disposal and/or management of drainage water. During 2005, the section continued to assist CVRWQCB in assessing the biological implications of proposed and implemented modifications to evaporation basins. Environmental investigations include the following:

- Red Rock Ranch research projects that involve required biological monitoring activities in accordance with Waste Discharge Requirements;
- IFDM wildlife monitoring and development of BMP. DWR continues to monitor avian wildlife at the existing Red Rock Ranch IFDM terminal reuse areas, which include a solar evaporator, halophyte plots, and salt tolerant grasses. DWR biological staff, in cooperation with the United States Fish and Wildlife Service (USFWS) completed a study to determine adequate long-term wildlife impact and avoidance assessment and BMP for current and future IFDM projects. This information is crucial because IFDM systems that are not managed can result in selenium-induced avian teratogenesis (developmental defects). IFDM appears to be a viable drainage management tool, when managed in a way that avoids or minimizes wildlife impacts posed by other drainage water management techniques, such as evaporation ponds assisting in evaporation pond studies. DWR continues to provide assistance with invertebrate collection and species identification at San Joaquin Valley evaporation ponds. This information is being used by several UC studies that are evaluating food chain transfer of selenium and insitu volatilization.
- Assisting landowners in locating information for preparing California Environmental Quality Act (CEQA) documentation necessary for obtaining permits and authorization for implementing, monitoring, and operating drainage reduction, treatment, and disposal projects;
- Mapping agriforestry and herbaceous plots in drainage-impacted areas, using Global Positioning System technology. Information was then imported into a Geographic Information System format linked to a database created to track key information associated with development of the vegetation plots;
- Responding to information requests from landowners wanting a better understanding of the CEQA and National Environmental Policy Act (NEPA) public review process, so they would be able to more meaningfully comment on upcoming State and federal drainage related projects; and
- Reviewing quarterly and annual environmental monitoring reports related to evaporation pond operation and investigation.

San Joaquin River Water Quality Improvement Program

DWR Agricultural Drainage Program, in collaboration with other agencies, continues to make significant efforts to improve water quality in the San Joaquin River to benefit the State and DWR water contractors. These efforts are aimed to control salinity and selenium discharges upstream of Vernalis. They include promoting on-farm and regional

water management activities to reduce subsurface drainage, real-time water quality management to maximize the assimilative capacity of the San Joaquin River, and efforts to time wetlands discharges when there is assimilative capacity in the San Joaquin River.

On-Farm and Regional Drainage Management Activities

Drainage management activities involving source control and drainage reuse have proven to be effective in reducing salt loads in the San Joaquin River.

This is demonstrated by the efforts of the Grasslands Area farmers on the Grasslands Bypass Project (GBP). Since the implementation of the GBP, drainage discharges have decreased from 58,000 af to about 30,000 af, and salt loads have been reduced from 210,000 tons to 117,000 tons. The reductions are possible because DWR funded through Proposition 13, an important component of the GBP, the San Joaquin River Improvement Project. It consists of about 4,000 acres of lands dedicated for reuse of subsurface drainage water, generated by Grasslands Area Farmers to grow salt-tolerant crops. DWR continues to provide technical assistance to continue improving and developing this important part of the GBP project.

DWR continues to collaborate with many entities in efforts proposed to control, reduce, or eliminate drainage water discharges into the San Joaquin River, such as the West Side Regional Plan, Reclamation's San Luis Drainage Feature Reevaluation to provide drainage service to the San Luis Unit of the Central Valley Project and by promoting Integrated On-Farm Drainage Management Program that DWR and collaborating agencies maintain.

DWR collaborated with the San Joaquin River Water Quality Management Group to develop a paper with ideas, information, and concepts to assist policy makers in deciding what actions will be implemented, strategies to meet water quality objectives in the San Joaquin River, specifically salinity at Vernalis and dissolved oxygen in the Stockton Deep Water Channel.

Real-Time Water Quality Monitoring Program

The Real-time Water Quality Monitoring Program (RTWQMP) provides information on existing water quality conditions and forecasts flow and water quality conditions to San Joaquin River water managers and stakeholders. The information provided is important for improving the management and coordination of reservoir releases, agricultural and wetland drainage flows, and eastside tributary releases to achieve water quality objectives at the San Joaquin River compliance points. In the early stages, the RTWQMP was funded by Reclamation and then by CALFED. Currently, DWR has assumed responsibility for funding most of the RTWQMP for the San Joaquin River.

One important activity of this program is forecasting flow and salinity conditions on the San Joaquin River, so decision makers can take advantage of assimilative capacity of the river when available. For this purpose, DWR collects data from the network of stations and inputs it into the San Joaquin River Input-Output Day (SJRIODAY) model. The model forecasts salinity and flow conditions on the River

near Vernalis, and other upstream stations on a biweekly basis. DWR publishes the information on its website on a weekly basis. Figure 5-1 shows an example of the information displayed.

Efforts to Improve Wetlands Discharges

As per Central Valley Regional Water Quality Control Board (CVRWQCB) data, wetlands discharges contributed about nine percent of the total salt load in the San Joaquin River at Vernalis. The contribution is likely to be higher today, as additional water supply and land are acquired for wetlands wildlife refuges, through Central Valley Project Improvement Act (CVPIA), Environmental Water Account (EWA), and other programs. The timing of wetland releases with assimilative capacity of the San Joaquin River could result in significant water quality improvements. However, little has been done in this regard, due to concerns over disrupting existing, proven wetland management practices.

Research is undergoing to determine if improved wetlands management practices can be achieved for the benefit of both wildlife and San Joaquin River water quality. Current research has focused on real-time water quality monitoring and adaptive management. Research goals are to coordinate the timing of wetland discharges, when assimilative capacity is available. In addition to funds provided

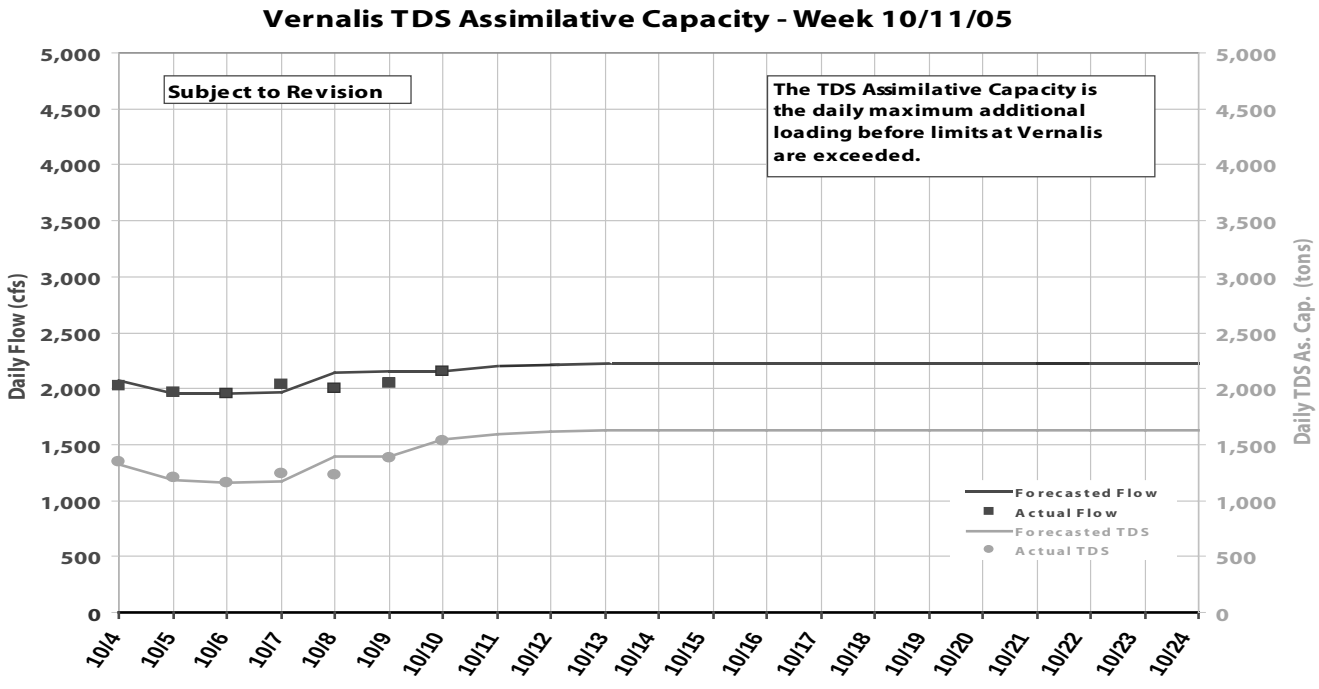


Figure 5-1. San Joaquin River Input-Output Day Modeling Forecasts Example

by CALFED for the study of the *Effect of Delayed Wetland Drawdown on Moist Soil Plants*, staff from DWR is collaborating with the Department of Fish and Game (DFG) and private wetlands, in a study to assess other aspects of delayed wetland drawdown. The studies on delayed wetland drawdown will be complemented by a study funded by DWR, under Proposition 204 (drainage subaccount). Real-time Water Quality Monitoring Program staff manages the contract.

The ADP prepared information for DWR to submit, as part of its testimony for the hearing on the cease and desist order issued by the SWRCB in 2005 against DWR. The referred testimony describes Decision 1641 actions that DWR has been implementing to improve salinity conditions in the San Joaquin River upstream Vernalis.

Environmental Impact Documents Review

The Environmental Review Section in the Division of Planning and Local Assistance screens State Clearinghouse documents and circulates SWP-related materials for review by DWR's four districts, as well as DPLA, Division of Operations and Maintenance, and the Division of Engineering. In addition, other divisions and offices are notified of activities and are asked to comment when their expertise is required.

Some environmental impact documents handled by the State Clearinghouse concern proposed activities that would affect the SWP. State Clearinghouse documents are regularly reviewed to identify any public safety or liability issues arising from the proposed activities.

From January through December, about 4,714 documents were screened by the Environmental Review Section; 1,056 were referred for detailed review. Of these referrals, 794 were made when the projects were at the Notice of Preparation or Early Consultation stage and 262 assignments were for negative declarations, environmental impact reports, and NEPA environmental assessments. O&M received 136 formal referrals and two for information. The State Water Project Analysis Office (SWPAO) received 11 formal referrals and 20 for information. In addition to the information referrals made to O&M and SWPAO, 749 other information referrals were made to other DWR staff.

Comments submitted to the lead agencies addressed a number of issues, including runoff from proposed developments, safety and water supply, encroachment on physical facilities, and water quality. During 2005, several requests for additional data were made to lead agencies when the environmental document did not contain enough information. Additional departmental actions, involving such items as encroachment permit submittals and informal comments took place, but are not tracked by the Environmental Review Section. During 2005,12 documents involving tribal gaming issues were assigned to the districts for review. These projects are of special concern to the State and require a specific review process. While none of these projects affected the SWP in 2005, they have a potential for causing future concerns.

During 2005, the Environmental Review Section tracked documents related to development along the California

Aqueduct, levee encroachment, water transfers and other water supply issues, wastewater treatment, quarry development, and electrical transmission lines near SWP facilities.

While the additional emphasis on preliminary screening started in 2004 was continued in 2005, several factors contributed to a higher number of referrals in 2005. These factors included an increase in overall documents circulated through the State Clearinghouse and a continued increase in development near State Water Project facilities, including the East, West and Coastal Branches of the California Aqueduct.

Water Conservation Bond Laws

To assist local agencies in obtaining financing for their water management programs, California voters approved six bond laws between 1984 and 2002, authorizing DWR to provide low-interest loans and grants to fund project feasibility studies or construction activities.

- The Clean Water Bond Law of 1984 (Proposition 25) authorized $10.5 million for water conservation projects.
- The Water Conservation and Water Quality Bond Law of 1986 (Proposition 44) authorized $75 million for water conservation and groundwater recharge projects.
- The Water Conservation Bond Law of 1988 (Proposition 82) authorized $60 million for water conservation, groundwater recharge, and new local water supply improvements.
- The Safe, Clean, Reliable Water Supply Act of 1996 (Proposition 204) authorized $55 million for water conservation, groundwater recharge, and local water supply projects.
- The Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13) authorized $535 million for agricultural and urban water conservation, groundwater recharge, infrastructure rehabilitation, groundwater storage, and interim reliable water supply projects and studies.
- The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50, Chapter 8) authorized $500 million for the Integrated Regional Water Management Grant Program to be implemented jointly by DWR and SWRCB.

Under these programs, grants are available and construction loans are also available with repayment of up to 20 years, at reduced interest rates for most programs.

Propositions 25, 44, and 204

Funding is fully obligated.

Proposition 82

Water supply loan funding is still available.

Proposition 13

Agricultural water conservation loan funding is still available.

All loan and grant funds for the Groundwater Recharge, Infrastructure Rehabilitation, Urban Water Conservation, Groundwater Storage and Interim Reliable Water Supply programs has been obligated.

Proposition 50

DWR, in collaboration with the SWRCB, conducted the first funding cycle for the Integrated Regional Water Management program. Proposal Solicitation Packages were prepared and issued for Planning Grants and the Implementation Grants. Program staff conducted regional workshops to assist potential applicants in completion of the applications. Planning grant applications were reviewed and evaluated and preliminary funding recommendations were developed and released for public comment. Step 1 Implementation grant proposals were reviewed. Also funded from Proposition 50 funds, the Local Groundwater Assistance program reviewed and evaluated applications, held a Technical Advisory Panel and public meeting, developed recommendations, and awarded $6.4 million in grants to 30 local public agencies for groundwater data collection, modeling, monitoring and management studies; monitoring programs and installation of equipment; basin management; and development of information systems.

Among other approval criteria for most of the Water Conservation Bond Law programs, applicants must demonstrate that project benefits equal or exceed project costs. Typical projects fall under the following categories:

Agricultural Water Conservation

- improvements to, or replacement of, distribution and storage systems;
- lining and piping ditches;
- lining or covering reservoirs; and
- capital outlay features of agricultural water conservation programs

Local Water Supply

- new conveyance and/or storage facilities groundwater extraction facilities, well-field development
- groundwater extraction facilities, well-field development
- desalination (ocean or brackish groundwater recovery)

Integrated Regional Water Management

- projects to protect communities from drought, protect and improve water quality, and improve water security by reducing dependence on imported water. Table 5-1 summarizes the number of projects and funds committed for each of the six bond laws through December 2005.

Table 5-1. Water Conservation Bond Laws - Projects and Funding

Bond Law	Type of Project	Number of Projects [a]	Funding [a] (millions of dollars)
Clean Water Bond Law of 1984	Water Conservation	7	9.74
Water Conservation and Water Quality Bond Law of 1986	Water Conservation	24	41.60
	Groundwater Recharge	10	28.04
	Subtotal	*34*	*69.64*
Water Conservation Bond Law of 1988	Water Conservation	7	17.44
	Groundwater Recharge	8	24.30
	Local Water Supply	4	9.00
	Subtotal	*19*	*50.74*
Safe, Clean, Reliable Water Supply Act of 1996	Water Conservation	2	7.00
	Groundwater Recharge	5	22.10
	Local Water Supply	23	23.48
	Subtotal	*30*	*52.58*
Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000	Agricultural Water Conservation	13	1.18
	Urban Water Conservation	54	28.00
	Groundwater Recharge	24	28.30
	Infrastructure Rehabilitation	42	56.40
	Groundwater Storage	41	180.00
	Interim Reliable Water Supply	13	169.31
	Subtotal	*187*	*463.19*
Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002	Local Groundwater Assistance	84	18.40
	Integrated Regional Water Management	1	6.89
	Subtotal	*85*	*25.29*
	All Water Conservation	107	104.96
	All Groundwater Recharge	47	102.74
	All Local Water Supply	27	32.48
	All Infrastructure Rehabilitation	42	56.40
	All Groundwater Storage	41	180.00
	All Interim Reliable Water Supply	13	169.31
	All Local Groundwater Assistance	84	18.40
	All Integrated Regional Water Management	1	6.89
	Total of All Projects	**362**	**671.18**

[a] Construction and feasibility study loan and grant commitments as of December 31, 2005

Chapter 6
Legislation and Litigation

The California State Capitol, located in Sacramento, California.

Significant Events in 2005

AB 1200 requires DWR to prepare a report evaluating the impacts on Sacramento-San Joaquin Delta water supplies of various possible future events, including levee subsidence, earthquakes, floods, and climate change no later than January 1, 2008.

On April 29, 2005, 14 of the 29 State Water Contractors brought suit against DWR. These contractors claimed the method used by DWR to allocate costs and revenue of its Hyatt and Thermalito Power Plants (Hyatt-Thermalito) at Lake Oroville violated the terms of long-term water supply contracts. (Alameda County Flood Control & Water Conservation District, Zone 7 et al. v. State of California Department of Water Resources (Sacramento County Superior Court, Case No. 05ASO1775).) In December 2005, entities representing 13 other contractors intervened in the lawsuit in opposition to the claims of the plaintiffs and in support of DWR's method of allocating costs and revenue. If the water contractors who filed the lawsuit are ultimately successful, this could result in contractors requiring the most pumping for delivery of their State Water Project water to pay more to DWR, while those contractors requiring less pumping would pay less.

Information for this chapter was provided by the Assistant Director, Legislative Affairs Office, and the Office of the Chief Counsel.

The Department of Water Resources (DWR) monitors State and federal legislation that affects the management of the State Water Project (SWP). Legislative bill tracking involves reviewing legislation at its introduction, evaluating amendments in State Assembly and Senate committee hearings, and monitoring its enactment into law. The DWR Assistant Director for Legislation monitors proposed legislation. The Office of the Chief Counsel tracks State and federal litigation that impacts management of the SWP. The DWR Chief Counsel also manages legal cases that involve SWP operations.

Legislation

State Legislation

AB 1200 (Laird) Sacramento-San Joaquin Delta (Chapter 573, Statutes of 2005).

AB 1200 requires DWR to prepare a report evaluating the impacts on Sacramento-San Joaquin Delta water supplies of various possible future events, including levee subsidence, earthquakes, floods, and climate change no later than January 1, 2008. The report also requires DWR, in cooperation with the Department of Fish and Game (DFG), to comparatively rate the options available to prevent disruption of Delta water supplies, improve Delta drinking water quality, reduce the salts in Delta water, maintain Delta water quality, preserve Delta lands, protect area of origin water rights, protect infrastructure located in the Delta, and restore salmon and other fisheries in the Delta.

AB 1328 (Wolk) Wild and Scenic Rivers: Cache Creek (Chapter 576, Statutes of 2005).

AB 1328 includes various sections of Cache Creek, which is located in Lake and Yolo counties, within the California Wild and Scenic Rivers system. This bill protects existing and future water rights for various public water agencies within the Cache Creek watershed; provides that the wild and scenic designation would not hinder efforts to remove invasive plant species or toxic substances from the river; and prohibits the State from petitioning for a federal wild and scenic designation of the river.

SB 264 (Machado) Delta Flood Protection Fund (Chapter 583, Statutes of 2005).

SB 264 extends the Delta Flood Protection Fund until July 1, 2008, to help implement the Delta Levee Maintenance Subventions Program.

SB 543 (Margett) State Water Project (Chapter 263, Statutes of 2005).

SB 543 requires individuals and entities to obtain a permit before construction, improvement, excavation, work, or other use is conducted within SWP right of way. This bill requires DWR to issue a general encroachment permit for routine operation and maintenance activities to public agencies that have a water delivery contract with DWR. The general encroachment permit would be issued for a period not to exceed 10 years. This bill provides that any person or entity responsible for an unauthorized encroachment would be guilty of a misdemeanor and liable for a $1,000 per day penalty.

Federal Legislation

The Energy Policy Act of 2005 was signed into law on August 8, 2005, by the president. One major element of the act includes the development of energy corridors. The U.S. Secretary of Energy was ordered to conduct a study of electric transmission congestion. This study must be completed within a year and be updated every three years after the original study's implementation.

The act designates the construction of National Interest Electric Transmission Corridors to meet the criteria of: (1) economic vitality; (2) economic growth; (3) energy independence; (4) interest of national energy policy; and (5) enhanced national defense and homeland security.

Another major element of the act was the creation of an Electric Reliability Organization by the Federal Energy Regulatory Commission (FERC). In addition, FERC is directed by the act to conduct investigations on transmission rate reform and demand response.

The act further requires FERC to establish, within one year, an incentive-based rate treatment for transmission. The purpose of this rate treatment is for consumers to receive the reduction of the cost of delivered power and the benefits of reliable transmission. These savings are due to the reduction of transmission congestion. The changes are anticipated to provide additional economic incentives for the construction of transmission. Higher transmission rates are anticipated to be partially offset by lower energy rates, which will be made available to the typical customer.

FERC is required by the act to prepare an annual report, by region, to assess electricity demand response resources. This report will include resources available from all consumer classes. FERC will determine the potential for demand response, as a resource for planning purposes, and to ensure that demand resources are provided equitable treatment.

Litigation

As of December 31, 2005, DWR was involved in, or closely monitored, a number of court cases and other actions related to the management of the SWP.

Sacramento-San Joaquin Delta

Delta Smelt

A coalition of environmental groups challenged the Biological Opinion issued by the U.S. Fish and Wildlife Service (USFWS). This opinion finds that SWP and Central Valley Project (CVP) operations will not jeopardize the continued existence of the delta smelt. (*Natural Resources Defense Council, et al. v. Gale A. Norton, et al.* (U.S. District Court for the Eastern District of California, 2005, Case No. 05 CV 01207 OWW (LJO)).) The plaintiffs claim the opinion fails to adequately consider or address the effects of the U.S. Bureau of Reclamation's (Reclamation's) delivery of water on delta smelt. This water delivery will be provided in soon-to-be renewed long-term water service contracts. The plaintiffs seek to have the U.S. Department of the Interior and USFWS withdraw the opinion and not take any action in reliance upon it. DWR filed a motion to intervene to protect its interests in the biological opinion, relevant to the operations of the SWP. The court granted this motion on December 12, 2005.

State Water Resources Control Board Hearing

In February 2005, DWR and Reclamation petitioned the State Water Resources Control Board (SWRCB). This petition called for a temporary change and delay of the effective date to implement the southern Delta agricultural objective in Decision 1641 (D-1641). This objective was scheduled to begin on April 1, 2005. A second petition was submitted to request a change of the implementation date to April 1, 2008. (This date matches the date when the South Delta permanent gates are scheduled for operation.) SWRCB denied the first petition. No action was taken on the second petition.

On May 3, 2005, SWRCB notified DWR and Reclamation of its intention to issue a cease and desist order. This order regarded a threatened violation of the southern Delta agricultural water quality objective of 0.7 electrical conductivity. This water quality objective was scheduled to be in effect annually, from April 1 through August 31, beginning in 2005. SWRCB D-1641 conditioned the operation of the SWP and CVP with implementation of this agricultural objective. DWR and Reclamation requested a hearing on the cease and desist order. In October and November 2005, DWR and Reclamation presented evidence and argued that the cease and desist order should not be issued.

On December 30, 2005, SWRCB issued a proposed draft cease and desist order. The draft order requires DWR and Reclamation to construct permanent gates in the southern Delta—or take alternative measures for achieving water quality objectives—by 2009. In addition, the draft order requires DWR and Reclamation to report to SWRCB if they violate or threaten to violate the water quality requirements and to report the reasons for the violation. SWRCB would then determine if enforcement actions are necessary. SWRCB set a hearing date to consider adoption of this proposed order in January 2006.

Decision 1641

The SWRCB implemented D-1641, which created certain long-term water quality objectives. These objectives were published in the May 1995 Water Quality Control Plan (1995 Plan) for the Sacramento-San Joaquin Bay-Delta Estuary. Eleven different lawsuits were filed and coordinated in this action, which challenged D-1641 on three grounds: (1) whether D-1641 complied with the California Environmental Quality Act (CEQA); (2) whether the changes in D-1641 injured certain Delta water users; and (3) whether D-1641 was consistent with area of origin laws. (Coordinated Special Proceedings, State Water Resources Control Board Cases, Court of Appeals, Third District, Case No. C044714 (Sacramento County Superior Court; Case No. JC 4118).) The Sacramento County Superior Court upheld D-1641. The Superior Court found that D-1641 improperly limited the place of use for Westlands Water District, and it improperly implemented the San Joaquin River flow objectives under the San Joaquin River Agreement. This matter is on appeal.

Delta Wetlands

A private initiative to develop two Delta islands into water storage facilities was challenged. (*Central Delta Water Agency, et al., v. State Water Resources Control Board, et al.* (2004) 124 Cal. App.4th 245.) This proposal stated that once the project was built, purchasers of the stored water

would be identified, and likely purchasers would be users within CVP or SWP service areas. The appellate court found that the SWRCB issued an invalid Delta wetlands water right permit. The court held that the State Constitution and Water Code require SWRCB to determine the actual intended beneficial use of the impounded water before issuing a permit. The court found it insufficient for SWRCB to issue a general statement of potential beneficial use with limiting conditions. On March 16, 2005, the California Supreme Court denied review of this case, and the decision of the Third District Court of Appeals is now law.

CALFED Litigation

The CALFED Record of Decision (ROD) issued on August 28, 2000, was challenged by environmental groups and agricultural interests in both State and federal courts. The ROD established program measures to help resolve conflicts over the use of water in the Delta. Initially, three complaints were filed in State courts: *Laub v. Davis, et al.* (California Farm Bureau Federation (Farm Bureau) and three individuals); *Regional Council of Rural Counties v. State, et al.* (RCRC and South and Central Delta); and *Municipal Water District of Orange County v. Resources Agency*. Subsequently, these cases were coordinated in the Sacramento County Superior Court. The parties to the third suit settled, based on an agreement that emphasizes the importance of the CALFED Science Program. This agreement also provides notice to the water district about the CALFED stakeholders' opportunity to participate in offering information about these issues.

The remaining parties claimed the CALFED programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR) violates CEQA, National Environmental Policy Act (NEPA), and the federal Administrative Procedure Act. The Superior Court found in favor of the plaintiffs. The State agencies appealed, and oral argument was held on August 30, 2005. The two cases were consolidated on appeal, and the Appellate Court reversed the lower court (*In Re Bay-Delta Programmatic Environmental Impact Report Coordinated Proceedings*, Court of Appeals, Third District, Consolidated Case Nos. C044267 and C044577).

The court rejected the vast majority of arguments by the Farm Bureau, Regional Council of Rural Counties, and the South and Central Delta water agencies. However, the court reversed the trial court's judgment in favor of the State CALFED agencies. The court found programmatic EIR/EIS was required to identify the sources of water for the CALFED program. Specifically, programmatic EIR/EIS should have considered whether reducing current exports would restrict projected growth and the subsequent need for that water. The court found that programmatic EIR/EIS should have provided more information on the entire CALFED program. The court emphasized that programmatic EIR/EIS should have provided more information on the Environmental Water Account (EWA) component of the CALFED program.

The California Supreme Court filed a Petition for Review on November 16, 2005. The issue of whether federal agencies violated NEPA is pending in federal district court.

Environmental Water Account

On April 16, 2004, the Farm Bureau challenged the adoption of a final EIS/EIR. The Farm Bureau filed a CEQA claim against DWR (*California Farm Bureau Federation v. Mike Chrisman, et al.* (Sacramento County Superior Court, Case No. 04CS00490)). The EIS/EIR covered the operation of the EWA through 2007—the end of the first stage of implementation of the CALFED Program. The Farm Bureau contends that the EIS/EIR does not adequately address "agricultural resources" when analyzing impacts, alternatives, mitigation, and other issues regarding EWA operations. The parties have reached a settlement in this matter and have filed a request for dismissal with prejudice.

Term 91

Two lawsuits were filed in 2004 that challenged SWRCB Decision 2001-22. This decision approved an application by El Dorado Irrigation District to divert water for urban purposes. (*El Dorado Irrigation District v. State Water Resources Control Board*); California Court of Appeal, Third District, Case No. C046211. See also (*El Dorado Irrigation District v. State Water Resources Control Board*); Sacramento County Superior Court, Case No. 01CS01319 and consolidated cases, filed June 18, 2002. El Dorado Irrigation District and El Dorado County Water Agency challenged the imposition of Term 91, which protects SWP stored water, as part of the decision. Another lawsuit was filed by an environmental group, the League to Save Sierra Lakes, which alleged CEQA violations. The court issued its final decision in December 2003, finding that Term 91 was improperly applied to the El Dorado Irrigation District. SWRCB appealed the decision, and the cases are pending on appeal.

Hydropower

Hyatt-Thermalito

On April 29, 2005, 14 of the 29 State Water Contractors brought suit against DWR. These contractors claimed the method used by DWR to allocate costs and revenue of its Hyatt and Thermalito Power Plants (Hyatt-Thermalito) at Lake Oroville violated the terms of long-term water supply contracts. (Alameda County Flood Control & Water Conservation District, Zone 7 et al. v. State of California Department of Water Resources (Sacramento County Superior Court, Case No. 05ASO1775).) In December 2005, entities representing 13 other contractors intervened in the lawsuit in opposition to the claims of the plaintiffs and in support of DWR's method of allocating costs and revenue. If the water contractors who filed the lawsuit are ultimately successful, this could result in contractors requiring the most pumping for delivery of their State Water Project water to pay more to DWR, while those contractors requiring less pumping would pay less.

Refunds on Power Sales

In 2000, FERC initiated an investigation in response to a complaint filed by San Diego Gas & Electric (SDG&E). This complaint claimed that the California Independent System Operator (CAISO) and California Power Exchange electric energy markets were producing unjust and unreasonable prices. As a result, FERC ordered public entities to provide refunds for the sales of ancillary services to the CAISO markets in 2000 and 2001. This order was challenged by large numbers of participants, including DWR and State Water Contractors. In September 2005, the 9th Circuit Court of Appeals ruled that FERC lacked jurisdiction under the Federal Power Act to order governmental agencies, such as DWR,

to provide refunds. (*Bonneville Power Administration, et al. v. Federal Energy Regulatory Commission et al.*, (9th.Cir. 2005) 422 F.3d 908.) Any party wishing to challenge this decision must request an "en banc" hearing before the full 9th Circuit Court by January 2007. DWR should have no refund obligation, unless the 9th Circuit Court order is reversed.

In December 2005, a group of California entities filed separate claims with the Victim Compensation and Government Claims Board. These claims were filed as a result of the 9th Circuit Court ruling. The organizations filing these suits included the Pacific Gas & Electric Company (PG&E), Southern California Edison (SCE), SDG&E, and the California Oversight Board. The suits are against a number of California government entities, including DWR. These claims seek partial refunds from the sellers of energy and related services in the years 2000 and 2001. The suits contained similar allegations regarding partial refunds as those made in the original complaint to FERC.

Other Cases

Several cases pending resolution may affect SWP operations and costs. The first case involves a FERC ruling that the cost of certain PG&E transmission facilities should be integrated into grid-wide charges to CAISO customers, including DWR. The department has appealed these charges on the basis that the facilities primarily benefit PG&E—not the grid as a whole—and the cost allocation mechanism should reflect this fact. (*California Department of Water Resources v. Federal Energy Regulatory Commission*, U.S. Court of Appeals for the Ninth Circuit (No. 04-76131).)

The *California Department of Water Resources v. Federal Energy Regulatory Commission* (U.S. Court of Appeals for the Ninth Circuit (No. 04-73577)) case involves a challenge to the manner in which the costs for the transfer of transmission facilities are allocated. FERC approved the transfer of transmission facilities at Anaheim and Riverside to CAISO. As part of this transfer, costs for the facilities were spread to the users of the grid, including DWR. The department is contesting the cost allocation mechanism in a current FERC proceeding. This appeal preserves the ability of DWR to contest costs in the administrative cost allocation proceeding.

The *California Department of Water Resources v. Federal Energy Regulatory Commission* (U.S. Court of Appeals for the Ninth Circuit (No. 05-74488)) case involves a challenge to the FERC decision concerning transmission access charge methodology. This charge is imposed on users of the CAISO grid to recover the embedded costs of the grid. DWR has appealed these charges, primarily on the basis that FERC failed to use time-of-use methodology.

The *California Department of Water Resources v. Federal Energy Regulatory Commission* (U.S. Court of Appeals for the District of Columbia, Case No. 04-7290) case involves a DWR challenge to a FERC order that gives CAISO the ability to dispatch (request to turn off or on) SWP generation and pumps based on economic criteria and without regard to water management needs.

DWR intervened in *Sacramento Municipal Utility District (SMUD) v. Federal Energy Regulatory Commission*, (D.C. Cir.) No. 04-1171, to support the SMUD claim

that SMUD has renewal rights to its extra-high voltage contract with PG&E. This high voltage contract terminated in 2005. DWR contended that its similar contract with PG&E provided renewal rights. The court ruled in favor of FERC, finding that SMUD did not have a right to an automatic renewal of the contract under federal energy law. This case is now final.

Colorado River

Two lawsuits related to the Colorado River have potential implications for California water supply. The first lawsuit is *Imperial Irrigation District v. All Interested Persons* and eight related cases (Judicial Council Coordination Proceeding No. 4353, Sacramento County Superior Court). This lawsuit is a series of nine claims, which have been coordinated into a single proceeding, before the Sacramento County Superior Court. These lawsuits challenge the Quantification Settlement Agreement (QSA) and associated actions taken to implement the QSA. The QSA is a collection of 38 agreements that resolve disputes among water users in Southern California, regarding their rights to California's shrinking share of Colorado River water. The QSA facilitates California's plan to reduce its use by settling disputes regarding priority and use. For example: (1) transferring of conserved agricultural water from the Imperial Irrigation District (IID) to San Diego County Water Agency (SDCWA) for urban uses; (2) establishing water budgets for the parties; and (3) providing for the mitigation of environmental impacts and the restoration of the Salton Sea. Proceedings in the superior court have been stayed, pending oral argument before the Third District Court of Appeal, on Imperial County's petition for writ of mandate.

Consejo de Desarrollo Economico de Mexicali, A.C. et al. v. Norton, et al. (U.S. District Court, District of Nevada, Las Vegas, Case No. CV-S-05-0870-KJD-PAL), is a challenge to Reclamation lining the All American Canal. The All American Canal lining is a water conservation project that is an integral part of the QSA. The State, through DWR, is contributing $220 million to the canal lining project. Mexican business leaders and California environmental groups filed a lawsuit that challenges the Secretary of the Interior and the Commissioner of the Bureau of Reclamation actions to authorize the All American Canal improvement project. This complaint seeks declaratory and injunctive relief. The plaintiffs assert a deprivation of water rights, including claims based on prior appropriation, estoppel, constitutional violations, Mexican federal law, and international and equitable concepts of apportionment and comity. The plaintiffs also challenge the action based on violations of NEPA, the Administrative Procedure Act, the Endangered Species Act, the Migratory Bird Treaty Act, and environmental mitigation obligations under the authorizing legislation (San Luis Rey Act (P.L. 100-675)) for the conservation project.

In November, the State of California filed a brief to: (1) request the court to grant a special appearance without submitting to the court's jurisdiction; and (2) move to dismiss the lawsuit, based on the fact that California is a necessary and indispensable party with 11th Amendment immunity from suit in federal court. This brief argues that California is an indispensable party because the plaintiffs are attempting to stake a claim to a portion of California's Colorado River apportionment. Opposition and response briefs were filed on the

California motion, and the parties are awaiting a ruling from the court.

Castaic Lake Water Agency

California Water Impact Network (CWIN) and the Friends of the Santa Clara River, both nonprofit environmental organizations, filed a Petition for Writ of Mandate against Castaic Lake Water Agency (Castaic Lake). This Petition for Writ of Mandate challenged Castaic Lake approval of a project to store up to 24,000 af of allocated 2002 Table A water, in the Semitropical Groundwater Storage Program, before the end of 2004. The plaintiffs alleged the approval of the project violated CEQA, the Urban Water Management Planning Act, and the Public Trust Doctrine. The CEQA process followed by DWR was upheld by the lower court. This matter is on appeal. The Friends of the Santa Clara River also filed a Reverse Validation Action in Sacramento County, which seeks to set aside the agreement. This case is stayed, pending the resolution of the CEQA case.

CWIN and the Planning and Conservation League (PCL) are also challenging the new EIR. This EIR is certified by Castaic Lake for the permanent transfer of 41,000 af of SWP Table A water to Castaic Lake, from Kern County Water Agency (Kern) member unit, Wheeler Ridge-Maricopa Water District. These lawsuits were filed on January 24 and 26, 2005. The original EIR, which was certified by Castaic Lake for this transaction, was successfully challenged in *Friends of the Santa Clara River v. Castaic Lake*. This EIR was challenged on the grounds that it tiered off the decertified Monterey Agreement EIR. In response to the Los Angeles Superior Court's Order on remand in that case, Castaic Lake decertified its original EIR on December 27, 2002, and issued a Notice of Preparation for a new EIR on January 22, 2003. The new EIR, which does not tier off any EIR for the Monterey Agreement, was certified on December 23, 2004. DWR entered into contract amendments with both Castaic Lake and Kern, which implemented this transfer in 1999. DWR has been basing its SWP allocations to Castaic Lake on the increased Table A amount reflecting the transfer.

DWR is primarily concerned with the CWIN and PCL arguments that: (1) DWR, and not Castaic Lake, should be the lead agency under CEQA for this transaction; and (2) the EIR should tier off of the not-yet-complete DWR Monterey Plus EIR. Other issues raised by CWIN and PCL are that the EIR is inadequate under CEQA for a number of reasons, including that it violates the Urban Water Management Planning Act and the Public Trust Doctrine, and that it represents a prejudicial abuse of discretion.

These two cases were consolidated in May. No further action has occurred.

Water Code Section 1810–1811

1810. Notwithstanding any other provision of law, neither the state, nor any regional or local public agency may deny a bona fide transferor of water the use of a water conveyance facility which has unused capacity, for the period of time for which that capacity is available, if fair compensation is paid for that use, subject to the following:

(a) Any person or public agency that has a long-term water service contract with or the right to receive water from the owner of the conveyance facility shall have the right to use any unused capacity prior to any bona fide transferor.

(b) The commingling of transferred water does not result in a diminution of the beneficial uses or quality of the water in the facility, except that the transferor may, at the transferor's own expense, provide for treatment to prevent the diminution, and the transferred water is of substantially the same quality as the water in the facility.

(c) Any person or public agency that has a water service contract with or the right to receive water from the owner of the conveyance facility who has an emergency need may utilize the unused capacity that was made available pursuant to this section for the duration of the emergency.

(d) This use of a water conveyance facility is to be made without injuring any legal user of water and without unreasonably affecting fish, wildlife, or other instream beneficial uses and without unreasonably affecting the overall economy or the environment of the county from which the water is being transferred.

1811. As used in this article, the following terms shall have the following meanings:

(a) "Bona fide transferor" means a person or public agency as defined in Section 20009 of the Government Code with a contract for sale of water which may be conditioned upon the acquisition of conveyance facility capacity to convey the water that is the subject of the contract.

(b) "Emergency" means a sudden occurrence such as a storm, flood, fire, or an unexpected equipment outage impairing the ability of a person or public agency to make water deliveries.

(c) "Fair compensation" means the reasonable charge incurred by the owner of the conveyance system, including capital, operation, maintenance, and replacement costs, increased costs from any necessitated purchase of supplemental power, and including reasonable credit for any offsetting benefits for the use of the conveyance system.

(d) "Replacement costs" means the reasonable portion of costs associated with material acquisition for the correction of unrepairable wear or other deterioration of conveyance facility parts which have an anticipated life which is less than the conveyance facility repayment period and which costs are attributable to the proposed use.

(e) "Unused capacity" means space that is available within the operational limits of the conveyance system and which the owner is not using during the period for which the transfer is proposed and which space is sufficient to convey the quantity of water proposed to be transferred.

Water Code Section 1812–1814

1812. The state, regional, or local public agency owning the water conveyance facility shall in a timely manner determine the following:

(a) The amount and availability of unused capacity.

(b) The terms and conditions, including operation and maintenance requirements and scheduling, quality requirements, term or use, priorities, and fair compensation.

1813. In making the determinations required by this article, the respective public agency shall act in a reasonable manner consistent with the requirements of law to facilitate the voluntary sale, lease, or exchange of water and shall support its determinations by written findings. In any judicial action challenging any determination made under this article the court shall consider all relevant evidence, and the court shall give due consideration to the purposes and policies of this article. In any such case the court shall sustain the determination of the public agency if it finds that the determination is supported by substantial evidence.

1814. This article shall apply to only 70 percent of the unused capacity.

Environmental Review Acts

The National Environmental Policy Act (NEPA) (Title 42 United States Code sections 4321-4370 [1970]) and the California Environmental Quality Act (CEQA) (California Public Resources Code sections 21000-21177 [1970]) require government agencies to document and consider environmental consequences of their actions in their decision-making process. NEPA states that it is the goal of the federal government to use all practicable means consistent with other considerations of national policy to protect and enhance the quality of the environment. All federal agencies must prepare an environmental impact statement, including a discussion of mitigation measures and alternatives, for actions significantly affecting environmental quality.

CEQA is patterned after NEPA. According to CEQA, agencies are required to (1) disclose, through an environmental impact report, the significant effects proposed projects would have on the environment; and (2) search for ways to reduce or avoid environmental damage.

CEQA applies to projects directly undertaken, funded, or approved by State or local agencies. NEPA applies to projects directly undertaken, funded, or approved by federal agencies. The Department conducts many projects in cooperation with federal agencies. In those cases both CEQA and NEPA must be followed.

NEPA requires that mitigation measures and alternatives be disclosed to the public in the Environmental Impact Statement, but it does not generally require federal agencies to adopt such mitigation measures or alternatives. CEQA, on the other hand, does impose substantive duties on all California government agencies approving projects with significant environmental impacts to adopt alternatives or mitigation measures that they find to be feasible to substantially lessen these impacts, unless there are overriding reasons why they cannot. When a project is subject to both CEQA and NEPA, both laws encourage the agencies to cooperate in planning the project and preparing joint environmental documents.

Through the environmental review process, citizens can learn about those significant effects and, if the project is approved, the reasons for approving the project. The review process requires agencies to

- describe the proposed project;
- identify the lead and cooperating agencies involved in the project;
- determine the scope of study with responsible agencies and/or the public;
- prepare and distribute a draft EIS or EIR;
- respond to comments received on the draft;
- prepare the final EIS or EIR;

Environmental Review Acts, Continued

- make findings and adopt feasible alternatives or mitigation measures to avoid significant effects, if applicable;
- adopt a monitoring plan to ensure compliance with mitigation measures; and
- prepare a list of permits required to implement the project if the project is approved.

The scoping phase, which occurs early in the review process, is particularly important because it enables government agencies to identify issues and topics to be considered when preparing the report.

Information gathered in the scoping phase helps agencies identify and evaluate reasonable alternatives, identify potential environmental impacts of the project, determine data and information needed, develop a work schedule, and allocate resources for preparing and distributing the draft environmental document for public review and comment.

NEPA requires a lead agency to involve the public during scoping, while CEQA does not. CEQA, however, does encourage public involvement at this stage. Members of the public may raise issues during the scoping phase and not just after the draft environmental document is prepared. Thus, the CEQA process leads to changes in projects through the development, consideration, and adoption of alternatives or enforceable mitigation measures to avoid or reduce any potential significant adverse effects on the environment.

Chapter 7
Water Supply Development and Reliability

The Delta is the critical link between water supplies and water deliveries.

Significant Events in 2005

During 2005, the Department of Water Resources (DWR), the U.S. Bureau of Reclamation (Reclamation), Sacramento Valley upstream water users, and certain downstream water users continued work to implement the Sacramento Valley Water Management Agreement (SVWMA) settlement.

To assist local agencies assessing their overall water supplies, DWR provided current data on the SWP's ability to deliver water under 2005 conditions and for projected conditions through a report entitled *The State Water Project Delivery Reliability Report–2005*.

In 2005, DWR and Reclamation continued with the feasibility study and NEPA/CEQA process for the North of the Delta Off-Stream Storage Investigation.

Information in this chapter was contributed by the State Water Project Analysis Office, the Division of Planning and Local Assistance, and the Bay-Delta Office.

The Department of Water Resources (DWR) is working to improve the reliability of State Water Project (SWP) supplies and the annual Table A water allocations delivered to SWP contractors. Staff is engaged in planning activities to develop additional water supplies and storage capacity.

Developing new water supply and storage projects that are economically, environmentally, and technically sound, while satisfying institutional requirements and political concerns, presents significant challenges. Many concerns center on the possible adverse effects that additional storage and delivery facilities may have locally and on the Sacramento-San Joaquin Delta. In the SWP conveyance system, the Delta is the critical link between water supplies in the Sacramento Valley and deliveries to the Central Valley and Southern California.

The CALFED Bay-Delta Program is a component of a process defined in the State-federal Framework Agreement, signed in June 1994, which calls for a cooperative and coordinated process to solve long-term water quality and ecosystem problems in the Bay-Delta Estuary. The signatories of the agreement, known collectively as CALFED, became responsible for developing long-term solutions for fish and wildlife, water supply reliability, flood control, and water quality problems in the estuary. On August 28, 2000, CALFED released its Record of Decision, formalizing State and federal agreement on the CALFED Bay-Delta Program plan to address major Delta water issues, including establishment of the Environmental Water Account (EWA).

As a CALFED agency, DWR is working with the federal government, local agencies, and public interest stakeholder groups to ensure water supply reliability now and in the future. To meet SWP contractors' needs for reliable, sufficient water supplies, DWR is engaged in planning, development, and local assistance to augment future SWP water supplies.

Supply Development and Reliability

Some of these activities that DWR is engaged in, include the following:

- implementing programs to transfer water, such as the Dry Year Water Purchase Program, EWA, and facilitating transfers between SWP long-term contractors and other agencies, including Central Valley Project (CVP) contractors;
- assisting in the development and implementation of local and regional conjunctive use programs in the Sacramento Valley;
- using SWP funds to assist in monitoring and developing local water supplies;
- managing the Feather River watershed above Lake Oroville to reduce sedimentation in the lake to preserve storage capacity; and
- investigating and evaluating storage projects (see CALFED Bay-Delta Program section below).

Water Conveyance Through the SWP

DWR encourages and arranges for temporary transfers of water using SWP

conveyance facilities for long-term SWP contractors and various agencies to help meet local, State, and environmental water supply needs. As a practical matter, SWP facilities are often needed to convey transfer water to the place of use of the transferee. State law requires DWR to make unused SWP capacity available for transfers upon payment of fair compensation, provided that: (1) no legal user of water would be injured; (2) there would be no unreasonable effect on fish, wildlife, or other instream beneficial uses; and (3) there would be no unreasonable effect on the overall economy or the environment of the county from which the water is being transferred. Water transfers can occur in three different ways:

1) water exchanges among the SWP long-term contractors or between contractors and non-SWP contracting entities;
2) water transfers among long-term SWP contractors; and
3) transfers of non–SWP water to the non-SWP and SWP agencies.

The transferability of water depends on the source of the water right being transferred. For example, provisions in the California Water Code authorize "temporary transfers" (Sections 1725-1732), "transfers by water suppliers" (Sections 1745-1745.11), "irrigation districts" (Section 22228), and California Water Districts (Section 34525). Before allowing the use of SWP conveyance facilities by other agencies, DWR makes determinations regarding the use of surplus conveyance capacity (Section 1810). (For information regarding specific transfers or exchanges, please see Chapter 9.)

Transfer and Exchange Evaluations

An important element of any water transfer is determining what quantity, if any, is transferable. Some provisions of the Water Code (e.g., CWC Sections 1702, 1706, and 1725), are intended to protect other legal users of water and fish and wildlife from possible adverse effects of a water transfer. Such protections reflect the "no injury" rule, which originates in the common law. Basically, the rationale for the no injury rule in state water law is to protect senior water users (those with the oldest water rights) from junior diverters, while protecting junior water right holders from the expansion of senior water rights. Hence, under the no injury rule, only "new water" is transferable; i.e., water that is added to the downstream water supply as a result of the transfer. Further, a transfer would not be authorized to the extent that it reduced the availability of water for downstream users, regardless of the water priority of those users.

Water Code Section 1810(d) requires DWR to consider all three types of third-party impacts (i.e., to legal users, to instream uses, and to the economy of the area from which the water would be transferred). DWR must determine whether to allow use of its surplus water conveyance capacity for a water transfer. Other provisions in the law specify the requirements that must be met for DWR to allow use of its conveyance facilities.

Generally, transfer water is developed through four methods: (1) surplus water released from storage facilities; (2) substituting groundwater for transferred surface water; (3) idling agricultural land to make water available for transfer; and (4) undertaking conservation activities that develop surplus water (e.g., under

CWC Section 1011). Transfers that involve groundwater substitution or fallowing may cause third party impacts; so provisions of state law limits their extent. For example, Water Code Sections 1745.10 and 1745.11 generally require a water supplier that increases groundwater use to replace transferred surface water so that the groundwater use: (1) would be consistent with a groundwater management plan adopted pursuant to State law for the affected area; or (2) would not create or contribute to conditions of long-term overdraft in the affected groundwater basin.

Groundwater substitution transfers have the potential to cause injury to other local groundwater users due to the additional pumping needed to allow the surface water transfer to take place. Injury can also occur due to stream depletion induced by pumping wells near the stream. The amount of water credit given such a transfer is the amount of the increased pumping that takes place to support the transfer, which assumes there is no stream depletion by the additional pumping. If there is pumping-induced stream depletion, then the groundwater pumped is not truly an alternative source to the surface water supply, and the net surface water flows will not increase as assumed. Consequently, in order to evaluate possible impacts to SWP supplies by groundwater substitution transfers that propose using SWP conveyances, DWR requires information necessary to support the assumption that the additional groundwater pumping does not affect the surface water system.

Water transfers are subject to compliance with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA).

The State Water Project Analysis Office, Division of Operations and Maintenance, and the Office of the Chief Counsel perform evaluations of the effects of proposed non-SWP water transfers on the SWP. This team develops formal responses to specific issues, projects, or programs. The Office of Water Transfers evaluates possible impacts to the SWP by proposed water transfers (with technical assistance from the Division of Planning and Local Assistance.) The team also identifies and evaluates water transfer proposals and water acquisitions by Reclamation and other water agencies, and proposes settlement agreements for potential impacts on the SWP.

Emphasis on early intervention allows DWR to tailor proposals to maximize benefits or minimize adverse effects to the SWP, other legal water users, and the environment. The team monitors Reclamation contract renewal processes to evaluate potential impact. These activities help DWR understand the potential cumulative impact of other agencies' actions on the SWP and to proactively address those actions.

This team also explores potential transfer options available to the SWP and individual contractors. Analysis of contractor profiles helps DWR facilitate transfers and exchanges between individual contractors.

SWP Delivery Reliability Report

To assist local agencies assessing their overall water supplies, DWR provided current data on the SWP's ability to

deliver water under 2005 conditions and for projected conditions through a report entitled *The State Water Project Delivery Reliability Report–2005*. A draft report underwent a 30-day public review during November and December 2005. The information contained in this report was recommended by DWR in May 2005 for use by SWP water supply contractors in developing their 2005 Urban Water Management plans. The 2005 report will be finalized in 2006, and the next report in this biennial series is expected in 2007.

Water delivery reliability depends on three factors: the availability of water at the source; the ability to convey water from the source to the desired point of delivery, and the level of demand. Information in The State Water Project Delivery Reliability Report–2005 is based on the assumption that future weather patterns will be similar to those in the past. As more information becomes available on the impact of global warming upon SWP water supply, it will be analyzed in future editions of this report. In addition, the analysis of the ability to convey water from the source to the point of delivery assumes only SWP facilities and permits existing in 2005 would be used. No planned facility improvements to the SWP are assumed to provide a conservative estimate of water delivery reliability. Lastly, the level of demand for SWP water, the amount and pattern of demand, were derived from historical data and information received from SWP contractors.

The probability that a given level of SWP Annual Table A amount will be delivered from the Delta for conditions projected to exist in year 2025 is shown in Figure 7-1. The following can be deduced:

- In 75 percent of the years, annual SWP water delivery is estimated to be at or above 2.7 million af per year (65 percent of 4.13 million af);
- In 50 percent of the years, it is estimated to be at or above 3.5 million af per year (85 percent of 4.13 million af); and
- In 25 percent of the years, it is at 4.13 million af per year.

Detailed information on the assumptions, data, and results of additional studies, as well as the other scenarios for annual Table A amounts can be found in the reliability report, published on the Internet at http://baydeltaoffice.water.ca.gov/swpreliability/index.cfm.

Conjunctive Use and Groundwater Substitution

Conjunctive use refers to the planned and coordinated management of surface water and groundwater to improve water supply reliability. A typical conjunctive use project recharges a groundwater basin with surface water in years when excess surface water is available. That project will then extract the stored water for use by pumping additional groundwater in years when additional water supply is needed. By using a groundwater basin as a reservoir in this manner, surface water that would otherwise be lost can be added to the available water supply.

In the 1990s, groundwater substitution water transfers, a form of conjunctive use, became increasingly controversial in some regions of the State. Some counties, particularly in the Sacramento Valley, adopted ordinances designed to regulate water transfers that involve groundwater

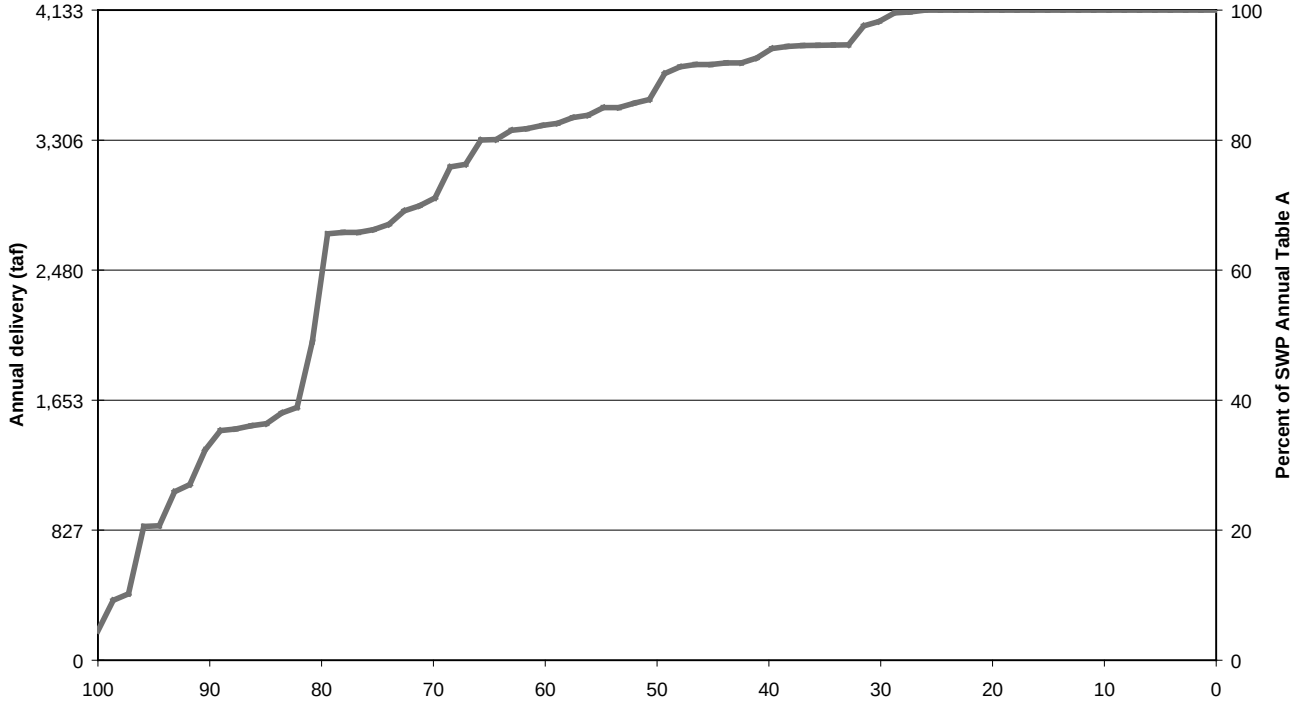


Figure 7-1. Projected SWP System Delivery Capability (Scenario 2025, Annual Table A)

substitution. Groundwater substitution refers to the practice of increasing groundwater pumping to replace an available surface water supply. The surface water becomes available to be used elsewhere. One possibility is to sell that newly-available surface water to willing buyers downstream.

Conjunctive use projects can be operated with negligible impacts to the environment and third parties. However, the effects of implementing conjunctive use projects varies as the pre-existing condition of groundwater basins vary. For instance, Sacramento Valley groundwater basins tend to refill completely after an average winter season. Therefore, additional groundwater withdrawals associated with groundwater substitution water transfers, typically during the irrigation season, result in additional loss to streamflow during the following wet season, or even later. A successful conjunctive use operation in the Sacramento Valley operates so that the aquifer refills by depleting streamflow during wet winter months, when streamflow reductions have no detrimental effect on water supply.

Due to the potential for conjunctive use projects and groundwater substitution water transfers to deplete streamflow and impact State Water Project operations, DWR's Sacramento Valley Groundwater Program evaluates water transfers, conjunctive use, and other water management proposals in the Sacramento Valley.

Sacramento Valley Groundwater Program

Local agencies are increasingly active in developing groundwater management programs and asserting control over water supply development and management activities. DWR works with local agencies and interested parties by providing technical and other assistance to improve groundwater monitoring and management to study and develop water management alternatives, help alleviate local anxieties, and build consensus for local and regional conjunctive use.

The Sacramento Valley Groundwater Program, a component of the SWP Future Supply Program, originally identified and implemented individual conjunctive use projects to augment SWP supplies. Now this program focuses on implementing the Sacramento Valley Water Management Agreement (often referred to as Phase 8) and evaluating water transfers. It also supports EWA Program components and implementation of the Yuba Accord Conjunctive Use component. It coordinates these efforts with DWR's Conjunctive Water Management Program in the geographic areas in which they overlap.

In 2005, Sacramento Valley Groundwater Program activities involving local agencies included the following:

Yuba County. DWR, in cooperation with the Yuba County Water Agency (Yuba) operated an adaptive long-term groundwater monitoring and measurement program. Specific activities focused on evaluating the interaction between the Yuba River, the Bear River, and its local groundwater basin, and impacts to other groundwater users. With the development of the Yuba Accord, the operations of the Yuba River system are becoming intertwined with those of the SWP. Monitoring activities are focused on incorporating conjunctive use into Yuba operations to meet the agency's Phase 8 and Yuba Accord objectives.

Lower Colusa Basin. DWR assisted Reclamation District 108 and River Garden Farms with groundwater monitoring that will be used to determine the effects of implementing conjunctive use projects for the Sacramento Valley Water Management Program. These projects are expected to provide up to 25,000 af of capacity to the program.

Butte Basin. DWR's efforts in Butte County improved the technical understanding of the Butte Basin groundwater system, especially as it relates to groundwater resources in adjacent Glenn and Tehama Counties. Additionally, DWR assisted the Butte County in collecting and evaluating groundwater monitoring data.

Glenn County. DWR provided technical assistance to Glenn County and its local irrigation districts. This included assisting in developing groundwater level, groundwater quality, and subsidence monitoring networks in the county to facilitate future water transfers and the development of Sacramento Valley Water Management Program (SVWMP) conjunctive-use projects that will benefit the SWP. These activities are coordinated with related investigations by DWR's storage program. Recently, SVWMP participants have expressed interest in building wells that develop deep groundwater aquifers as a means of avoiding groundwater level impacts to other groundwater users. DWR is assisting local participants determine the feasibility

of this groundwater management technique.

Watershed Management

This continuing effort evaluates the state of the Feather River watershed above Lake Oroville, and it identifies actions that can be taken within the watershed to increase base-flow runoff and reduce sedimentation. The initial effort explored ways to improve local water supplies without adversely affecting SWP supply or operations. Early activities included installing monitoring equipment and gathering pertinent data on stream flows, water quality, erosion, and land use. This data will be used to formulate reports and studies for future actions. The work continues to receive strong local support.

SWP Water Rights Activities

Water Rights Permits

Operations of the SWP are governed by the terms and conditions contained in DWR's water rights permits and licenses along with other state and federal regulatory restrictions including biological opinions for the protection of endangered species. DWR currently holds 15 water rights for the operation of the State Water Project and upper Feather facilities, five of which specifically authorize SWP operations at the Oroville/Thermalito and Delta facilities, including the North Bay Aqueduct, for water supply purposes. Each permit specifies the authorized quantities of direct diversion and diversion to storage, place of use and time within which the permitted quantities must be put to beneficial use. A change in any of the terms and conditions contained in the water rights permits and licenses requires the approval of the SWRCB.

Diversion and use of SWP water throughout the SWP service area has steadily increased since initial operations in the 1960s. However due to a number of factors including operational and regulatory constraints, the beneficial use of water has not yet reached the maximum quantities anticipated for full development of the SWP. When the full permitted quantity of water authorized under the water rights permits has not been utilized by the date specified in the permit, a petition for time extension must be submitted to the SWRCB. In 2005, DWR submitted a Petition for Extension of Time to the SWRCB for permit 16483 (Application 17514A) authorizing diversions at the North Bay Aqueduct in order to allow additional time to fully develop the diversion and use of water within the NBA service area.

In addition, in 2005, DWR submitted to the SWRCB a Petition for Change in Place of Use in four permits authorizing diversions at the Banks pumping plant. The Petition requests the SWRCB to correct an error in the DWR water rights to include Oak Flat Water District within the authorized SWP place of use. Since the 1960s, Oak Flat has received SWP water under its long-term water supply contract with DWR. In the 1990s during review of DWR's water rights, it became apparent that the Oak Flat service area was inadvertently omitted from the authorized SWP place of use. The petition explains that correcting the error and adding Oak Flat to the SWP place of use will not result in any changes to SWP operations or deliveries.

SWP Bay-Delta Proceedings—2005 Activities

DWR has worked intensely for more than 40 years to develop the appropriate water quality standards for the San Francisco Bay and Sacramento–San Joaquin Delta Estuary and identify which water sources are required to meet those standards. SWRCB has received and reviewed numerous testimony and evidence to establish water quality objectives for the Bay-Delta Estuary to protect urban, agricultural, and fish and wildlife uses.

Cease and Desist Order Hearings

In February 2005, DWR and Reclamation petitioned SWRCB to temporarily change, and delay, the effective date for implementation of the southern Delta agricultural objective in Decision 1641, scheduled to begin in April 1, 2005. A second petition was submitted requesting a long-term change of the date to April 1, 2008, the date when the South Delta permanent gates were scheduled to be operating. The SWRCB denied the temporary change petition, and no action was taken on the long-term change petition.

On May 3, 2005, SWRCB notified DWR and Reclamation of the its intention to issue a cease and desist order because of a threatened violation of the southern Delta agricultural water quality objective of 0.7 electrical conductivity (EC), scheduled to be in effect annually between April 1 and August 31, beginning 2005. The SWRCB D-1641 conditions the operation of the SWP and the CVP, with implementation of the agricultural objective. DWR and Reclamation requested a hearing on the cease and desist order. In October and November, DWR and Reclamation presented evidence and argued that the cease and desist order should not be issued.

On December 30, 2005, SWRCB issued a proposed draft cease and desist order requiring DWR and Reclamation to construct permanent gates in the southern Delta or take alternative measures for achieving the water quality objective by 2009. Additionally, the draft order would require DWR and Reclamation to report to SWRCB if there is a threat of non-compliance of the water quality requirements, and to report the reasons for the non-compliance. The Board will then determine if enforcement actions are necessary. SWRCB has set a hearing date to consider adoption of the proposed order in January 2006. The 0.7 millimhos/cm objective was not exceeded in 2005.

Sacramento Valley Water Management Agreement

During 2005, DWR, Reclamation, Sacramento Valley upstream water users, and certain downstream water users continued work to implement the Sacramento Valley Water Management Agreement (SVWMA) settlement, in lieu of continuing with SWRCB Phase 8 hearings. SVWMA avoided the adversarial issues of Phase 8 and was developed to promote better management of California's water resources.

SVWMA provides that DWR and Reclamation will continue to be responsible for meeting the flow-related water quality objectives of D-1641, and a series of local projects, owned and operated by Sacramento Valley water users, will be developed to provide up to

185,000 af of water supplies for use by the sponsoring local agencies as well as water to the SWP and CVP for Delta water quality and supply. A key element in developing the agreement was the preparation of a short-term workplan for investigating short-term projects to meet the goals of SVWMA. The short-term workplan was adopted with approximately 45 projects falling into the following general categories:

- water management—conjunctive use;
- reservoir reoperation;
- system improvements;
- surface water and groundwater planning; and
- regulatory/institutional arrangements.

It is anticipated that short-term projects will operate for 10 years. Consultants were hired to work on the Environmental Impact Report/Environmental Impact Statement (EIR/EIS). DWR and Reclamation, in cooperation with the Sacramento Valley water users and downstream water users, are preparing environmental analysis and documentation for the projects, as required prior to implementation.

SVWMA establishes a Technical Measurement and Monitoring Committee responsible for developing monitoring programs for the projects being developed, assessing their accomplishments and impacts, and recommending remediation activities if needed. The local agencies, DWR, and Reclamation will enter into specific implementation agreements for each project.

SVWMA also provides for the possible development of a long-term workplan and settlement agreement, that could continue certain short-term projects and other projects, which could meet the goals of the Phase 8 settlement.

Periodic Review of the 1995 San Francisco Bay / Sacramento-San Joaquin Delta Estuary Water Quality Control Plan

SWRCB previously received comments from agencies and members of the public regarding any elements of the 1995 Bay-Delta Water Quality Control Plan that SWRCB should consider amending. DWR presented its comments to the Board regarding the scope of issues, supporting the Board's review and urged them to consider the issues in context with recently proposed Delta actions and progress that could provide useful information to help evaluate whether modifications to existing water quality objectives were needed. SWRCB extended the comment period and encouraged the participants to provide the Board with their remarks.

The SWRCB staff prepared a report summarizing comments received from agencies. This report, adopted on September 20, 2004, recommended the following issues be considered during the upcoming workshops:

- Delta outflow;
- river flows: Sacramento River at Rio Vista;
- river flows: San Joaquin River at Airport Way Bridge, Vernalis: February to April 14, and May 16 to June;
- export limits;
- flow objectives in the San Joaquin River at Airport Way Bridge, Vernalis: 31-day pulse flow April 15 through May 15;

CALFED Bay-Delta Program

The San Francisco Bay/Sacramento-San Joaquin Delta (Bay/Delta) Estuary is the largest estuary on the West Coast. It is a maze of tributaries, sloughs, and islands, and a haven for over 750 plants and wildlife species. It is also the hub of California's two largest water distribution systems—the Central Valley Project, operated by the U.S. Bureau of Reclamation, and the State Water Project, operated by the Department of Water Resources. Together, these water development projects divert approximately 20 to 70 percent of the natural flow in the system, depending on the amount of runoff available in a given year. This, along with other issues, such as population growth and pollution, have had a serious impact on water supply and quality, and on the fish and wildlife resources in the estuary. Although there was consensus that the Bay-Delta estuary is important as both a reliable source of water and as a fish and wildlife habitat, there was none for solving conflicts regarding methods of management, conservation, increasing capacity of the system, and protecting the ecology of the region.

In June 1994, in the quest for solutions to the resource problems in the Bay-Delta, State and federal agencies signed an agreement to (1) coordinate their actions to meet water quality standards to protect the Bay-Delta estuary; (2) coordinate the operation of the State Water Project and the Central Valley Project more closely with recent environmental mandates; and (3) develop a process to establish a long-term Bay-Delta solution to address four categories of problems—ecosystem quality, water quality, water supply reliability, and levee system vulnerability. This agreement laid the foundation for the Principles of Agreement signed in December 1994 by the State and federal governments, detailing interim measures for both environmental protection and regulatory stability. This Accord led to the CALFED Bay-Delta Program, which began in May 1995, and the Record of Decision, which was signed on August 28, 2000.

The California Bay-Delta Act of 2003 established the California Bay-Delta Authority as the new governance structure and charged it with providing accountability, ensuring balanced implementation, tracking and assessing the CALFED Bay-Delta Program progress, using sound science, assuring public involvement and outreach, and coordinating and integrating related government programs.

The Program is designed to address the complex issues that surround the Bay-Delta and is a cooperative interagency effort involving 18 State and federal agencies with management or regulatory responsibilities for the Bay-Delta. It is an unprecedented effort to build a framework for managing California's most precious natural resource—water. The establishment of the CALFED Bay-Delta Program represents State and federal government in partnership, launching the largest, most comprehensive water management program in the world.

- southern Delta electrical conductivity;
- chloride objectives, compliance location at Contra Costa Canal at Pumping Plant No. 1, and potential new objectives;
- salmon protection;
- Delta Cross Channel gates closure;
- changes to the water quality compliance and baseline monitoring program; and
- recommended changes to the program of implementation.

On August 31, 2005, SWRCB convened a workshop to receive additional evidence on the Delta outflow objectives. A panel consisting of federal and State agencies presented its comments on issues revolving causes and effects of the pelagic organism decline (POD). The scientists were still at early stages of understanding the causes of such decline. The State Water Contractors and California Urban Water Agencies suggested performing operational flexibility for both SWP and CVP. Bay-Delta Institute and Central Delta Water Agencies were against such actions. SWRCB recommended that one of the Board staff, working under the division chief, be directly involved in the above process and report future progress to the Board.

CALFED Bay-Delta Program

The California Bay-Delta Authority (CBDA) oversees the implementation of the CALFED Bay-Delta Program for the 25 State and federal agencies working cooperatively to improve the quality and reliability of California's water supplies, while restoring the Bay-Delta ecosystem.

The California Bay-Delta Act of 2003 established the CBDA as the new governance structure and charged it with providing accountability, ensuring balanced implementation, tracking and assessing the CALFED Bay-Delta Program progress, using sound science, assuring public involvement and outreach, and coordinating and integrating related government programs.

The mission of the CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta. DWR has vigorously supported this effort, seeing it as a means to develop and manage the State's water resources to meet the water delivery commitments of the SWP, and to benefit both the public and the environment.

The CALFED Bay-Delta Program was envisioned as a 30-year plan and is implemented through 11 major program elements. The first 7-year phase of implementation, Stage 1, includes planning for proposed large facilities and implementation of lesser facilities. DWR is the State lead agency for the storage program element, which consists of surface storage studies and groundwater programs and projects.

Storage Program

This is a comprehensive program with potential benefit for the SWP, consisting of actions related to surface and groundwater storage. The Division of Planning and Local Assistance has been working with the CALFED agencies to enhance storage as well as conjunctive-use programs that support local project development via

loans and grants. The Storage Program is part of an ongoing evaluation of the appropriate role of storage, both groundwater conjunctive use and surface storage.

Surface Storage Investigations

The Surface Storage Investigations are developing environmental documentation and feasibility studies for four of the five surface storage projects identified for further study in the CALFED Record of Decision (ROD.)

In-Delta Storage Program. In 2001, DWR, in coordination with the CBDA and Reclamation, began a planning study to evaluate the Delta Wetlands Project and other In-Delta storage options. This study, completed in May 2002, concluded that the project concepts proposed by Delta Wetlands were generally well planned. However, design modifications and further evaluations were needed before considering public ownership of the project.

The In-Delta Storage Project would provide capacity to store approximately 217,000 af of water in the South Delta for a wide array of water supply, water quality, and ecosystem benefits. The project would include two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), similar to that proposed by Delta Wetlands, over a decade.

DWR, in coordination with CBDA and with technical assistance from Reclamation, completed the Draft In-Delta Storage Program State Feasibility Study in 2004. The State Draft Feasibility Report addresses the technical feasibility of the proposed In-Delta Storage Project. In response to public comments on the report, new studies were conducted in 2005 on a broad array of issues, including water supply and quality, project design, risk analysis, environmental evaluations, and construction costs. New information gathered during the response to the June 2004 Middle River levee breach and flooding of Jones Tract was also incorporated in these studies.

Los Vaqueros Reservoir Expansion. Contra Costa Water District owns and operates the 100,000 af Los Vaqueros Reservoir just northwest of the Sacramento-San Joaquin Delta. The Los Vaqueros Reservoir Expansion would increase the reservoir storage up to 400,000 af, for a potential storage capability of 500,000 af.

The objectives of the Los Vaqueros Reservoir Expansion are: (1) improve Bay Area water supply reliability; (2) provide an environmental water supply to the long-term EWA or similar program; and (3) improve water quality for Bay Area water users.

Contra Costa Water District ratepayers voted to support further studies of the Los Vaqueros Reservoir Expansion in the March 2004 advisory vote. In 2005, Reclamation, in coordination with DWR and Contra Costa Water District, completed the Initial Alternatives Information Report. Also in 2005, Reclamation filed a Notice of Intent under NEPA for preparation of an EIS. Contra Costa County Water District is the lead agency under CEQA and, in conjunction with Reclamation and DWR, will continue with the feasibility study and environmental documentation.

Shasta Lake Enlargement. Reclamation, in coordination with DWR and other agencies, is conducting a feasibility study of expanding Shasta Dam and Reservoir, primarily to promote increased survival of anadromous fish populations in the upper Sacramento River and to increase water supply reliability. An enlargement of Shasta Dam would inundate additional lands around the existing reservoir and affect a portion of the McCloud River. California Public Resources Code Section 5093.542(c), the Wild and Scenic Rivers Act, states that, "except for participation by the Department of Water Resources in studies involving the technical and economic feasibility of enlargement of Shasta Dam, no department or agency of the state shall assist or cooperate with, whether by loan, grant, license, or otherwise, any agency of the federal, state, or local government in the planning or construction of any dam, reservoir, diversion, or impoundment facility that could have an adverse effect on the free-flowing condition of the McCloud River, or on its wild trout fishery."

The State's fiscal year 2005-2006, budget did not include funding for DWR to continue to participate in this study. However, Reclamation continues to work on this project. In 2005, Reclamation filed a Notice of Intent to prepare the EIS consistent with requirements of NEPA for the Shasta Lake Water Resources Investigation. Six public scoping meetings were held to solicit public input on topics to be addressed in the EIS, including resources to be evaluated, alternatives to be considered, and significant concerns and issues.

North-of-the-Delta Offstream Storage. DWR and Reclamation are working in partnership with local and other State and federal agencies to further study north-of-the-Delta offstream storage opportunities. The North-of-the-Delta Offstream Storage (NODOS) Investigation focuses on potential projects on the west side of the Sacramento Valley, including Sites Reservoir.

Storing water in offstream reservoirs during excess flow periods provides opportunities to increase water storage in an environmentally-sensitive manner. The stored water could then be made available for beneficial uses, including enhancing water management flexibility in the Sacramento Valley and the Bay-Delta, reducing water diversions on the Sacramento River during critical fish migration periods, increasing the reliability of supplies for the Sacramento Valley and statewide, and providing storage and operational benefits for other CALFED programs, including Delta water quality and EWA.

In 2005, DWR and Reclamation continued with the feasibility study and NEPA/CEQA process for the NODOS Investigation. Accomplishments for NODOS in 2005 included completion of engineering feasibility studies on dams and appurtenant structures, conveyance facilities, and road relocations, and on reverse flow facilities, for releasing water back to the river.

Upper San Joaquin River Basin Storage Investigation. DWR and Reclamation, in coordination with other State and federal agencies, are evaluating increased storage in the upper San Joaquin River watershed. This additional storage could be added by

expanding Millerton Lake by raising Friant Dam, or a functionally-equivalent storage program. Potential benefits of the Upper San Joaquin River Basin Investigation are: (1) contribute to restoration of the San Joaquin River; (2) improve water quality of the San Joaquin River; and (3) facilitate additional conjunctive management and water exchanges that improve the quality of water deliveries for urban communities. Other benefits could include hydropower, flood control, and recreation.

In 2005, DWR and Reclamation continued with the feasibility study and the NEPA/CEQA process for the Upper San Joaquin River Basin Storage Investigation. Accomplishments for the Upper San Joaquin River Basin Storage Investigation in 2005 included completion of the Federal Initial Alternatives Information Report.

Conjunctive-Use Programs

The CALFED Storage Program component, like DWR's Conjunctive Water Management Program, emphasizes the importance of forming partnerships with local agencies and stakeholders to assist in planning and developing conjunctive water management projects. Six principles guide the implementation of this component:

- local planning process;
- local control of proposed projects;
- voluntary implementation of projects;
- priority for in-basin water needs;
- compensation for out-of-basin transfers; and
- basin-wide planning and monitoring the Water Transfer Program.

DWR actively participated in the formulation of CALFED's Water Transfer Program through the Bay-Delta Advisory Council Water Transfer Work Group and the Transfers Agency Group. The program proposed a framework of actions, policies, and processes to facilitate water transfers and further develop a statewide water transfer market. The program document describes the relationship of water transfers to other water management actions and programs, discusses existing laws and statutes, and identifies issues and problems related to transfers. It also makes recommendations to resolve these issues and suggests strategies to implement them.

As part of the Water Transfer Work Group, DWR staff, along with other agencies, assisted SWRCB in the formulation and publication of A Guide to Water Transfers (July 1999 draft) in order to provide a resource for information.

In 2002, DWR drafted transfer white papers based on SWRCB's Guide and discussions with Sacramento Valley water agencies. The white papers are updated as information becomes available.

Conveyance Program

The Conveyance Program consists of projects proposed in the North and South Delta. The North Delta Program is comprised of studies related to the Delta Cross Channel, a potential through-Delta facility, and a project to improve flood management and the ecosystem along the Mokelumne River and Franks Tract.

North Delta. Three North Delta conveyance facilities improvements are being evaluated. One is to improve operational procedures for the Delta Cross Channel to address fishery and water quality concerns, the second is a screened through-Delta

facility on the Sacramento River, and the third is the Franks Tract Project, which involves installation of operable gates either on Three Mile Slough or West False River to improve water quality and benefit fisheries. DWR is leading all three studies in cooperation with other agencies. DWR is in the process of initiating the preparation of an EIR/EIS for the Franks Tract Project.

With the North Delta Flood Control and Ecosystem Restoration Project, solutions to improve flood management and the ecosystem are being considered, including setback levees, detention basins, dredging, and levee degradation for floodplain expansion.

South Delta. Actions in the South Delta include the South Delta Improvement Program, implementing flood/ecosystem improvements in the lower San Joaquin River, and potential interties between the SWP and CVP.

SDIP is a key component of the CALFED Bay-Delta Program. The purpose of SDIP is to do the following:

- improve the reliability of existing SWP facilities;
- ensure that water of adequate quantity and quality is available for diversion to the South Delta Water Agency's service area for beneficial use; and
- reduce the effects of SWP exports on both aquatic resources and direct losses of fish in the South Delta.

The proposed project is likely to consist of the following:

- three flow-control structures to improve local water levels and circulation in South Delta channels;
- a fish-control structure to improve fish migration in the San Joaquin River;
- some dredging in West Canal to improve conveyance capacity to Clifton Court Forebay;
- extensive dredging in the South Delta to improve channel capacity for local agricultural users;
- modifications to existing agricultural diversion intakes; and
- planning to build a new intake to Clifton Court Forebay and increase the export limit to 8,500 cfs.

For more information on the North and South Delta, see Chapter 2, *Delta Resources.*

Environmental Water Account

EWA is a cooperatively managed program intended to provide protection to the fish of the Bay-Delta Estuary through environmentally beneficial changes and increased flexibility in the operations of the SWP and CVP, while maintaining water supply reliability to the projects' water users. Responsibility for implementing EWA rests with National Marine Fisheries Service (NOAA Fisheries), U.S. Fish and Wildlife Service (USFWS), and Department of Fish and Game (DFG) (management agencies), as well as with Reclamation and DWR (project agencies).

The management agencies are responsible for managing EWA assets and recommending SWP/CVP operational changes beneficial to the Bay-Delta ecosystem and the long-term survival of fish species. The project agencies are responsible for acquiring EWA assets and cooperating with the management agencies in administering EWA and

implementing operational changes proposed by the management agencies, as appropriate.

Under EWA, fish protection is achieved by periodic curtailment of project water delivery from the Bay-Delta to project water users south of the Delta and replacing it at a later date within the same calendar year. This necessitates the acquisition of EWA assets, which are used to replace the project water supply. EWA assets consist of variable assets, which are acquired through changes in operations; fixed assets, which are acquired through water purchases from willing water sellers; source shifting, which involves deferral of scheduled delivery of water by willing participants; and other nonwater assets, such as 500 cfs dedicated pumping capacity at Banks Pumping Plant. EWA is considered operational for any year when these assets are in place and Endangered Species Act commitments are provided by the management agencies. EWA was operational starting in 2001.

In 2001, DWR and Reclamation initiated work on a joint EIS/EIR document for EWA, which takes into consideration the environmental impacts associated with use of EWA, on both SWP and CVP operations through December 2007, and will allow for multiyear EWA contracts with willing water sellers.

The EWA Project and Management Agencies completed and approved a joint EIS/EIR for the short-term EWA pertaining to the acquisition and management of EWA assets between 2004 and 2007. In July 2004, the Agencies began the process of developing a long-term EWA EIS/EIR.

For more details on EWA deliveries, see Chapter 9, *Water Contracts and Deliveries*.

Chapter 8
Water Supply

Snowpack in the Sierras

Significant Events in 2005

California experienced higher than average rainfall and mountain snowpack during water year 2004–2005. The State received precipitation at 140 percent of average in 2004–2005, as compared to 85 percent of average in 2003–2004.

Statewide river runoff totaled 105 percent of average in the 2004–2005 water year. Runoff in the Sacramento River and San Joaquin River regions was 95 percent and 150 percent of average, respectively. Feather River unimpaired inflow to Lake Oroville was 4.3 maf (90 percent of average) for the water year, compared to 3.8 maf (80 percent of average) the previous year.

Information from this chapter was contributed by the Division of Flood Management, the Division of Operations and Maintenance, and the State Water Project Analysis Office.

The Department of Water Resources (DWR) monitors precipitation, calculates runoff, and operates storage facilities during each water year. The official California water year runs from October 1 through September 30. DWR works during the water year to fulfill its key contractual obligations to the State Water Project (SWP) long-term water supply contractors.

Water Year 2004–2005

Precipitation and Snowpack

California experienced higher than average rainfall and mountain snowpack during water year 2004–2005. The State received precipitation at 140 percent of average in 2004–2005, as compared to 85 percent of average in 2003–2004. During the second week of April 2005, the statewide average snowpack peaked at 40 inches of snow water content. This amount of mountain snowpack is 146 percent of normal. These snowpack conditions are in stark contrast to snowpack levels in 2003–2004. During that time, the statewide snow water content peaked at 30 inches in the first week of March. The Northern Sierra Eight Station Index finished the 2004–2005 water year with 57.5 inches of precipitation, which was 115 percent of average.

The water year kicked off October 1, 2004, with a wet start for most of the State. Heavy precipitation fell throughout the month, which resulted in significant snowpack accumulation in the Sierras. The Northern Sierra Eight Station Index registered 7.1 inches of precipitation for the month of October, which was 237 percent of average. Some locations in the San Joaquin River Basin received monthly precipitation totals exceeding 500 percent of average. By November 1, the statewide snowpack stood at 5 inches of snow water content. This amount represented approximately 16 percent of the statewide historical average for April 1 testing of the State snow water content.

Wet conditions in October were offset by a dry November. Consequently, by the end of November, the snowpack had grown only slightly beyond the value achieved at the beginning of the month. The average snow water content increased statewide from 5 inches on November 1, to 6 inches on December 1. By the end of November, the State snowpack measured 133 percent of normal.

Significant precipitation returned in December, with a major event taking place in Southern California, as the calendar year drew to a close. A series of storms occurred from December 26 to January 5, producing nearly 20 inches of cumulative rainfall at some locations. Most of the heavy precipitation fell from Point Conception south; however, the entire California coast experienced above-average precipitation for the month. By the end of the month, the Northern Sierra Eight Station Index stood at 10.9 inches, 130 percent of average, and precipitation totaling 155 percent of average fell in the San Joaquin River Basin. As a result of these widespread wet conditions, the State snowpack increased to 16 inches of snow water content by the end of the month, 57 percent of the April 1 snow water

content and 159 percent of the year-to-date average.

Precipitation during the month of January varied widely throughout the State. Southern California experienced another extreme storm from Point Conception south to the San Gabriel and San Bernardino mountains. From January 7 to January 11, some locations in this area received 30 inches of cumulative rainfall. In contrast, most of Northern California received slightly below average precipitation for the month. This resulted in a Northern Sierra Eight Station Index value of 8.3 inches, 92 percent of average, while the American River Basin received precipitation at 95 percent of average. Precipitation falling in the San Joaquin River Basin was significantly above average, with several locations recording total values exceeding 200 percent of average. The statewide snowpack remained well above average by the end of the month: 28 inches, 101 percent of April 1 snow water content and 163 percent of normal. Corresponding with the north-to-south precipitation gradient, the Northern Sierra snowpack totaled 142 percent of average, and the Southern Sierra snowpack equaled 200 percent of average.

The wet conditions experienced in Southern California during December and January continued into February, while Northern California experienced precipitation totals falling well below historical monthly averages. Between February 17 and February 23, a very cold storm passed through the State from Point Conception south. The southern coast received 4 to 8 inches of rainfall during this period, while the adjacent mountain regions received 8 to 18 inches. Due to the cold temperatures associated with this storm, snowfall ranging from 8 to 10 feet was received in the mountains above Los Angeles. Northern California, on the other hand, received well below average precipitation for the month. The Klamath Basin, for example, received precipitation totaling 20 percent of average, while the Northern Sierra Eight Station Index totaled 4.4 inches, which is only 55 percent of average. As an exception to the dry conditions experienced in the northern half of the State, parts of the San Joaquin River Basin continued to receive above average precipitation. The end of February statewide snowpack remained well above average with 32 inches of snow water content, which is 115 percent of the April 1 average and 131 percent of the water year-to-date average.

By contrast, Northern California experienced more significant precipitation during March. The month began with warm and dry conditions, which resulted in some melt of the Sierra snowpack. However, the final two weeks of March ushered in a cold, wet weather pattern, which resulted in considerable precipitation. All of the major water supply basins in Northern California experienced above-average precipitation for the month. The Northern Sierra Eight Station Index was 9.3 inches, which is 135 percent of average. Above-average precipitation was experienced at all locations within the San Joaquin region. By the end of the month, average snow water content stood at 39 inches, which is 138 percent of normal. Snowpack totals in the North Sierra, Central Sierra, and South Sierra were 124 percent, 135 percent, and 158 percent of average, respectively. These increasing percentages reflect the fact that Southern California received more

precipitation throughout the winter months than Northern California.

The month of April brought average precipitation for most of the State. Rainfall along the North Coast was generally above average, with some locations receiving total precipitation exceeding 200 percent. The Northern Sierra Eight Station Index was 3.5 inches, or 90 percent of average. Statewide snowpack peaked at 40 inches on April 9, about a week later than usual. As the month progressed, cool weather prevented major snowmelt at higher elevations, although lower elevations experienced some pronounced melt. By the end of the month, 34 inches of snow water remained statewide.

In May, an atypically large, late-season storm occurred in Northern California. From May 17 through May 19, much of California north of Interstate 80 received 72 hour totals that allowed historical records for the month to be broken at many locations. While storm totals throughout the northern portion of the State were generally between 2 and 5 inches, the Feather River Basin was particularly impacted, with totals between 5 and 10 inches. The Eight Station Index reached a May record of 8.3 inches, or 395 percent of average. Throughout the month, the average statewide snowpack decreased from 34 inches on May 1 to only 13 inches on June 1. The May storm was a major factor in the elevated rate of snowmelt. (See Figure 8-1 for 2004–2005 statewide precipitation percentages by hydrologic region.)

Runoff and Storage

Statewide river runoff totaled 105 percent of average in the 2004–2005 water year. Runoff in the Sacramento River and San Joaquin River regions was 95 percent and 150 percent of average, respectively. Feather River unimpaired inflow to Lake Oroville was 4.3 maf (90 percent of average) for the water year, compared to 3.8 maf (80 percent of average) the previous year.

The Sacramento River Index for water year 2004–2005 was 18.5 maf (95 percent of average). The Sacramento Valley Water Year Hydrologic Classification (40-30-30 Index) was above normal, based on observed data for water year 2005.

The San Joaquin River system unimpaired runoff from the Stanislaus, Tuolumne, Merced, and San Joaquin rivers was 9.2 maf (155 percent of average). The San Joaquin Valley Water Year Hydrologic Classification (60-20-20 Index) was wet, based on observed data for water year 2005.

The water year began with statewide runoff about 110 percent of average in October. Below normal runoff during November, especially in the Sacramento River region, lowered the statewide runoff to 65 percent of average for the first 2 months of the water year. Season-to-date statewide runoff totals rose to 70 percent of average by the end of December, with statewide storage increasing by 1.4 maf to 19.9 maf.

The variation in precipitation amounts during January was reflected in runoff totals. The Sacramento River region experienced about 65 percent of average January runoff, while the San Joaquin and Tulare Lake regions had flows near 155 percent of average. This pattern, observed in January, continued through February. The Sacramento, San Joaquin,

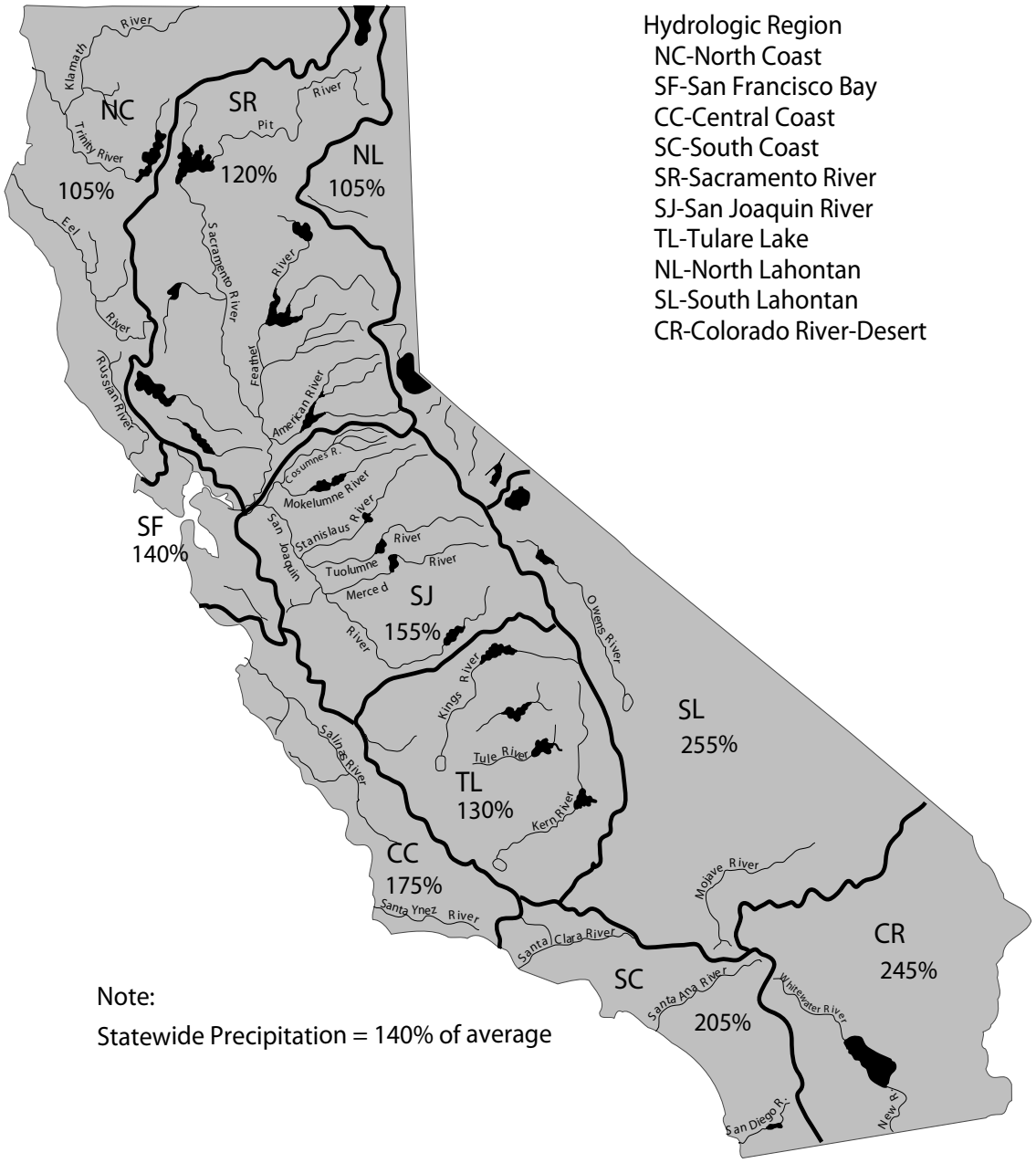


Figure 8-1. Statewide Precipitation by Hydrologic Region, 2004–2005 Water Year, Percentage Average

and Tulare Lake regions received average flows of 55 percent, 110 percent, and 90 percent, respectively. The storm track and water supply patterns changed slightly during March. The Sacramento region received near normal runoff for the month, while well above average runoff persisted in the Central and Southern Sierra.

From a water supply perspective, the most closely monitored period is April through July. The month of April concluded with near normal runoff over most of the Sierra. The month of May was very wet, and it ended with statewide runoff volumes at nearly 190 percent of average for the month. During May, the statewide reservoir storage rose from about 105 percent of average to almost 115 percent of average.

By the end of July, the water year runoff volumes were 95 percent, 150 percent, and 145 percent of average for the Sacramento, San Joaquin, and Tulare Lake regions, respectively.

Water Year 2005–2006 October–December Water Conditions

The last three months of calendar year 2005 mark the beginning of the new 2005–2006 water year. By the end of October, the runoff was near 80 percent of average in the Northern Sierra and closer to average in the central and southern regions of the Sierra. November provided lower percentages of average runoff. By the end of November, statewide runoff since October 1 had fallen to near 70 percent of average. December, however, received nearly 200 percent of normal precipitation statewide and, in addition, the statewide water year-to-date runoff rose to nearly 200 percent of average.

SWP Storage

The SWP operates a complex system of 29 dams and reservoirs to collect and store water for future deliveries. Lake Oroville is the first of two primary SWP conservation facilities. Inflow into Lake Oroville comes from the Feather River.

The San Luis Reservoir is the second primary SWP conservation facility. This Central California facility derives its inflow from pumping at the Gianelli Pumping-Generating Plant. San Luis is an off-stream reservoir. Most of the water is pumped into the reservoir from late fall to early spring. This water is temporarily stored, then released to the California Aqueduct to meet water contractor peaking demands in the summer months. The remaining 27 dams and reservoirs regulate the stored water supply in water delivery patterns that are designed to fit local needs.

Water Year 2004–2005 Storage Totals

At the end of the 2004–2005 water year, water storage in all SWP reservoirs was 4.52 maf or 83 percent of average, compared to 2.99 maf or 76 percent of average at the end of water year 2003–2004. The average end-of-month total storage for the 2004–2005 water year in major SWP reservoirs was 4.19 maf. End-of-water-year storage on September 30, 2005, at Lake Oroville was 2.88 maf, which was about 1.13 maf more than the previous water year. The State's share of San Luis Reservoir storage at the end of the 2004–2005 water year was 925,701 af, as compared to 513,406 af in the previous

water year. The combined storage in southern reservoirs was 620,933 af on September 30, 2005, as compared to 646,828 af at the end of the 2003–2004 water year.

Calendar Year 2005 Storage Totals

The total storage in major SWP reservoirs was about 4.64 maf at the end of calendar year 2005, as compared with 3.07 maf in 2004. The State's share of San Luis Reservoir storage was 1,167,613 af on December 31, 2005, as compared to about 672,181 af at the same time in 2004. The combined storage in the southern reservoirs was 566,207 af on December 31, 2005, as compared to 642,042 af at the same time in 2004.

Lake Oroville

Lake Oroville is the keystone of SWP. It has a maximum water storage capacity of 3,537,580 af. Runoff from Feather River drainage is collected and stored in this reservoir. This water is released to the Sacramento-San Joaquin Delta through Oroville Dam, Thermalito Diversion Dam, and Thermalito Afterbay.

Water Year 2004–2005 Inflow

Lake Oroville inflow for the 2004–2005 water year totaled about 3.87 maf, which was 91 percent of the 30-year average (4.24 maf). Maximum daily inflow occurred on May 19, 2005, at 105,055 af. Minimum daily inflow occurred on October 11, 2004, at 1,640 af. The maximum total in 30 years was in water year 1982–1983 at 8,853,572 af. The minimum total in 30 years was in water year 1991–1992 at 1,555,774 af. (See Figures 8-2 and 8-3 for monthly and cumulative inflows, respectively, into Lake Oroville.)

Calendar Year 2005 Inflow and Storage

Total inflow into Lake Oroville during the calendar year was 4,762,959 af. Minimum storage on January 1, 2005, was 1,654,440 af, which was 47 percent of its capacity. Maximum storage on June 15, 2005, was 3,529,207 af. End-of-year Lake Oroville storage was 2,924,684 af. (Figure 8-4 compares end-of-month storage in Lake Oroville Reservoir for the 2004 and 2005 calendar years.)

2004–2005 Water Year San Luis Reservoir Operations

San Luis Reservoir is operated jointly by DWR and the U.S. Bureau of Reclamation (Reclamation), per operating procedures that were adopted in June 1981. San Luis Reservoir has a normal operating capacity of 2,027,840 af. The SWP share of this capacity is 1,062,183 af.

San Luis Reservoir reached its maximum water year total storage on March 25, 2005, at 2,031,395 af, 100 percent of its normal maximum operating capacity. At the beginning of the water year, San Luis Reservoir contained 670,634 af, 33 percent of its capacity. SWP storage share in the beginning of the water year was 522,041 af. On February 28, 2005, the highest end-of-month SWP share of water storage was 1,099,886 af for the 2004–2005 water year (Figure 8-5).

2004–2005 Water Year Lake Del Valle Operations

Lake del Valle, which is situated off the South Bay Aqueduct, functions primarily as a storage facility for later water delivery in Santa Clara and Alameda counties. At the beginning of the water year, Lake del Valle

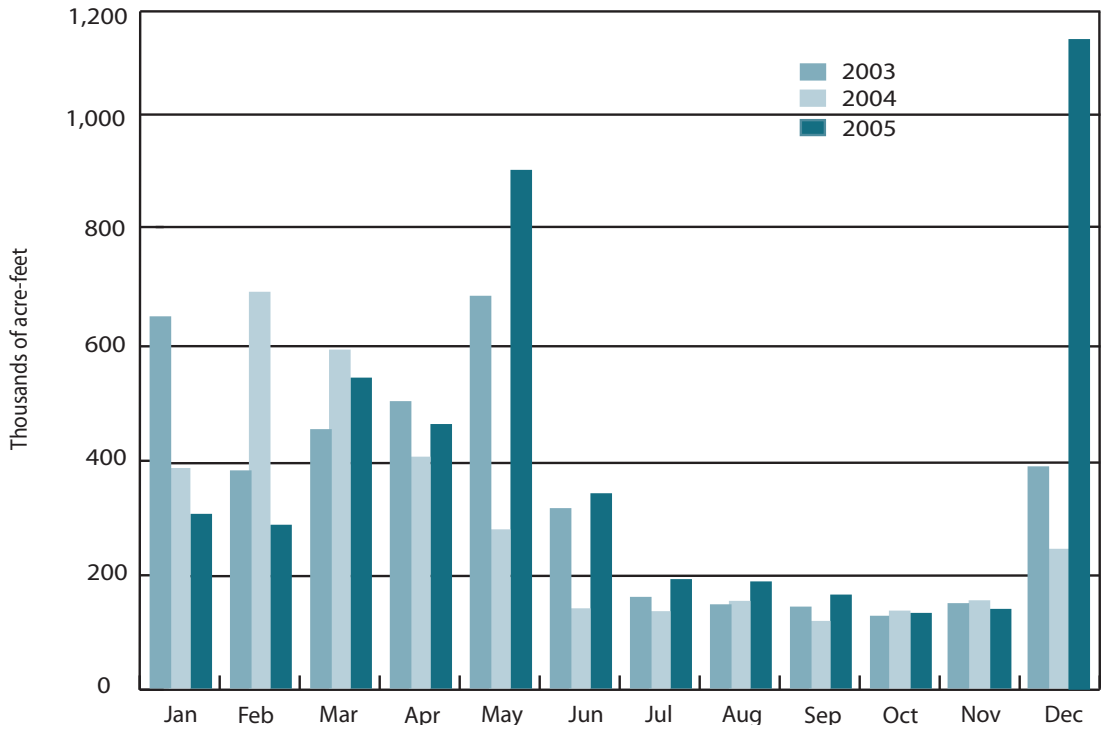


Figure 8-2. Monthly Lake Oroville Inflow, 2003-2005

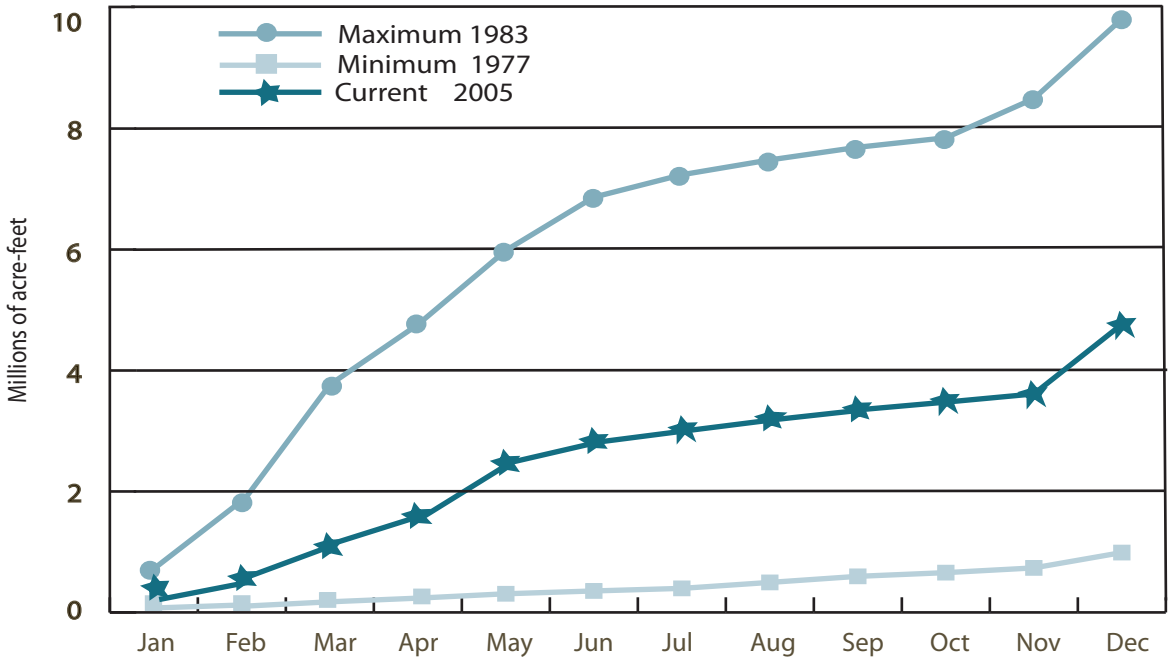


Figure 8-3. Cumulative Maximum, Minimum, and Current Lake Oroville Inflow

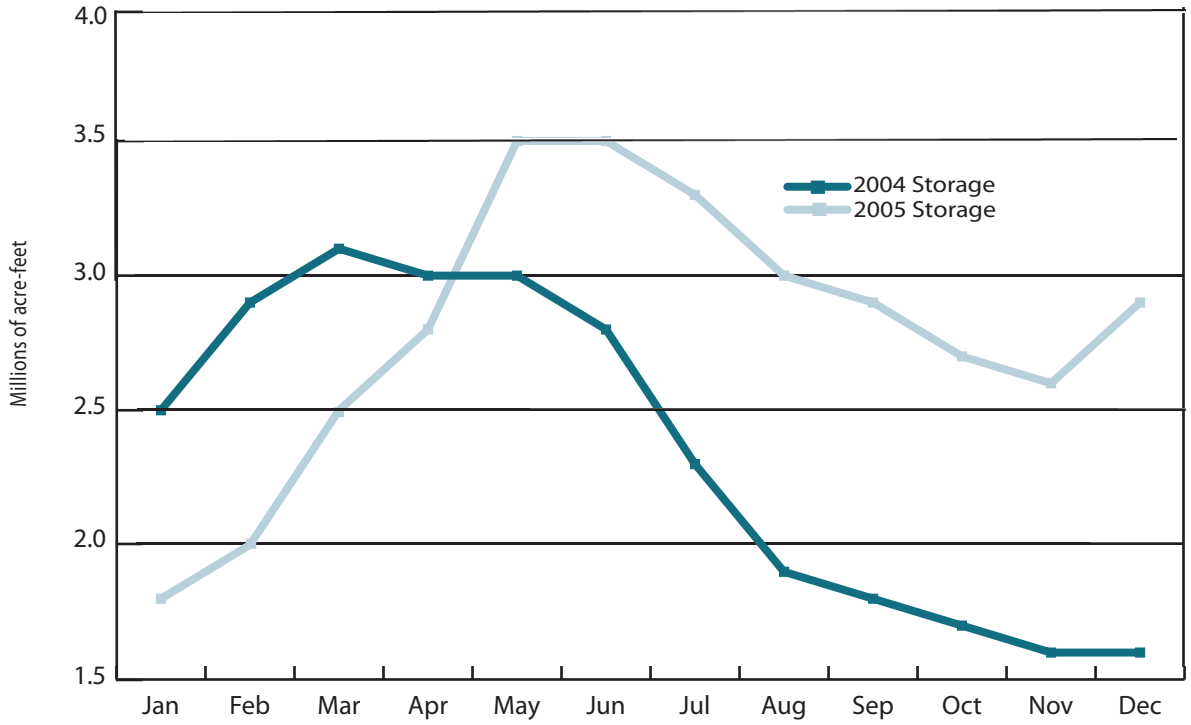


Figure 8-4. End-of-Month Storage in Lake Oroville, 2004 and 2005 Calendar Years

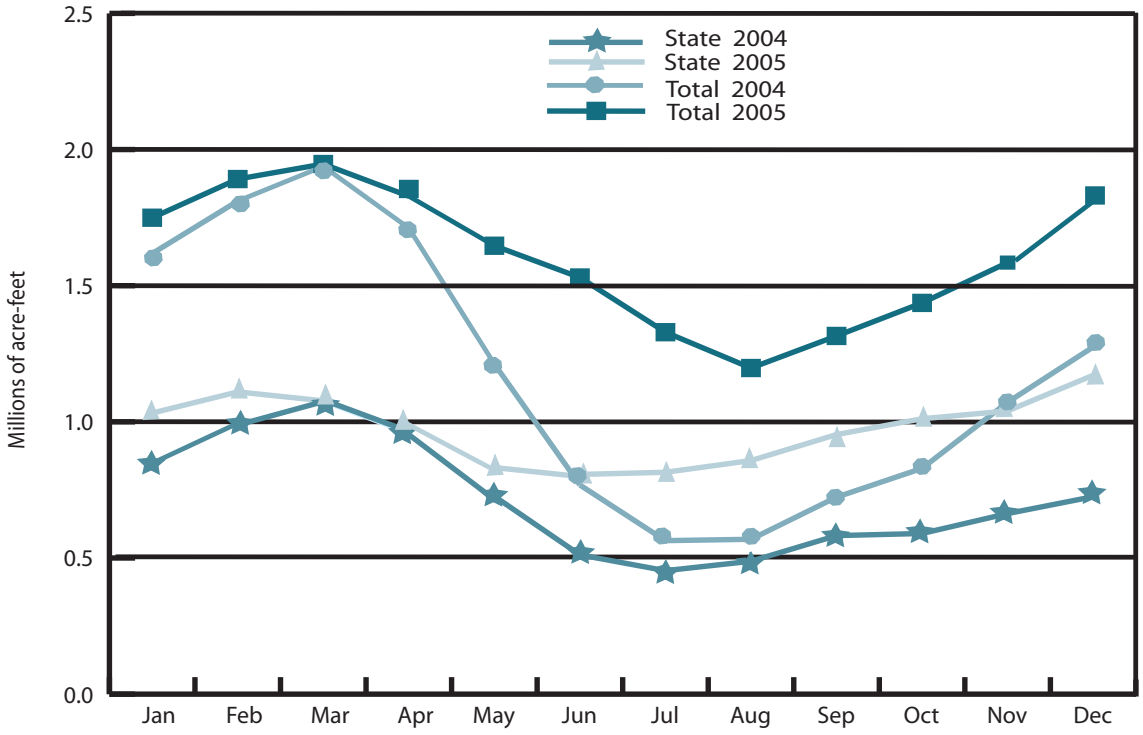


Figure 8-5. End-of-Month Storage in San Luis Reservoir, 2004 and 2005 Calendar Years

held 29,770 af, which was about 39 percent of its maximum capacity of 77,106 af. Its highest storage occurred during the 2004–2005 water year on February 21, 2005, with 41,367 af. Its lowest storage occurred on December 26, 2004, with 25,569 af.

By the end of the water year, on September 30, 2005, storage in Lake del Valle was 33,716 af, 44 percent of maximum capacity. Water year releases to Arroyo Valle and South Bay Aqueduct from Lake Del Valle totaled 27,948 af.

2004–2005 Water Year Southern Reservoir Operations

During normal operating conditions, DWR maintains its four southern reservoirs—Pyramid, Castaic, Silverwood, and Perris—at or near full operating capacity to ensure uninterrupted delivery of water to Southern California contractors.

At the beginning of the water year, these reservoirs held 646,828 af, with 93.9 percent of their combined normal maximum operating capacity of 689,021 af. At the end of the water year, the reservoirs held 620,933 af, 90.1 percent of combined normal maximum operating capacity.

Diversions from the Delta

SWP diverts water from the Sacramento-San Joaquin Delta, through Banks and Barker Slough pumping plants, for delivery to SWP contractors' storage facilities. In 2005, the SWP diverted 4,042,013 af at Banks Pumping Plant, including a combined total of 5,091 af of Central Valley Project (CVP) and Cross Valley Canal water, which was wheeled by DWR. In 2005, CVP diverted 2,705,849 af at the Tracy Pumping Plant and 123,477 af at the Contra Costa Pumping Plant. The combined Delta exports include all of these plants. (Figure 8-6 shows the amounts of water pumped each month in 2005 at the Banks Pumping Plant. Figure 8-7 shows the monthly amounts of water diverted from the Delta in 2005 by the SWP and CVP. CVP diverts water to similar areas from the Delta through Tracy Pumping Plant and Contra Costa Pumping Plant.)

Water is delivered from Banks Pumping Plant to the South Bay area through the South Bay Aqueduct and to the San Joaquin Valley, Central Coastal, and Southern California areas through the California Aqueduct. The SWP diverts water from Barker Slough Pumping Plant to the North Bay Aqueduct. In 2005, a total of 46,424 af were diverted.

Dos Amigos Pumping Plant diverts water from O'Neill Forebay to the California Aqueduct. (Figure 8-8 shows monthly total amounts pumped at Dos Amigos Pumping Plant for the calendar year 2005.) Pumping peaked in July 2005, at 642,712 af.

Maximum daily Delta exports occurred on December 30, 2005, at 25,960 af. Combined SWP and CVP monthly Delta exports in 2005 varied from a low of 203,773 af in May, to a high of 744,362 af in January. In 2005, Delta exports totaled approximately 6.87 million af.

In 2005, water pumped through the Edmonston Pumping Plant for delivery to Southern California totaled 1,561,036 af. (Figure 8-9 shows the amount of water pumped each month in 2005.)

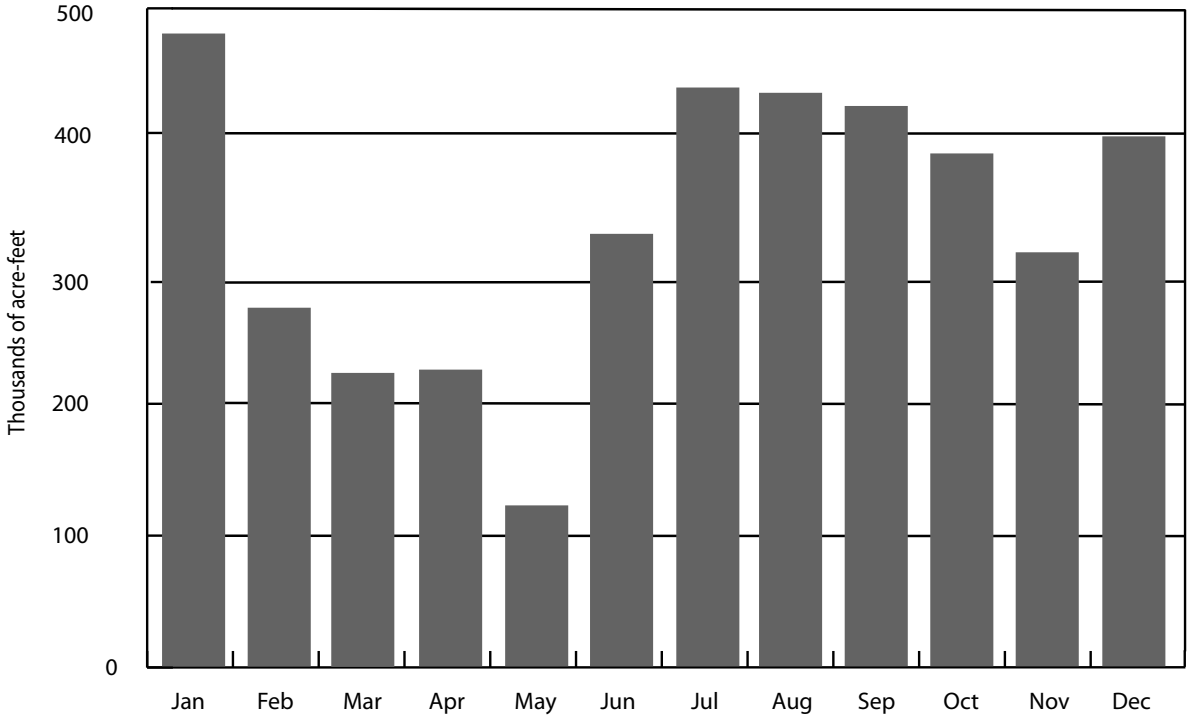


Figure 8-6. Water Pumped at Banks Pumping Plant, 2005 by Month

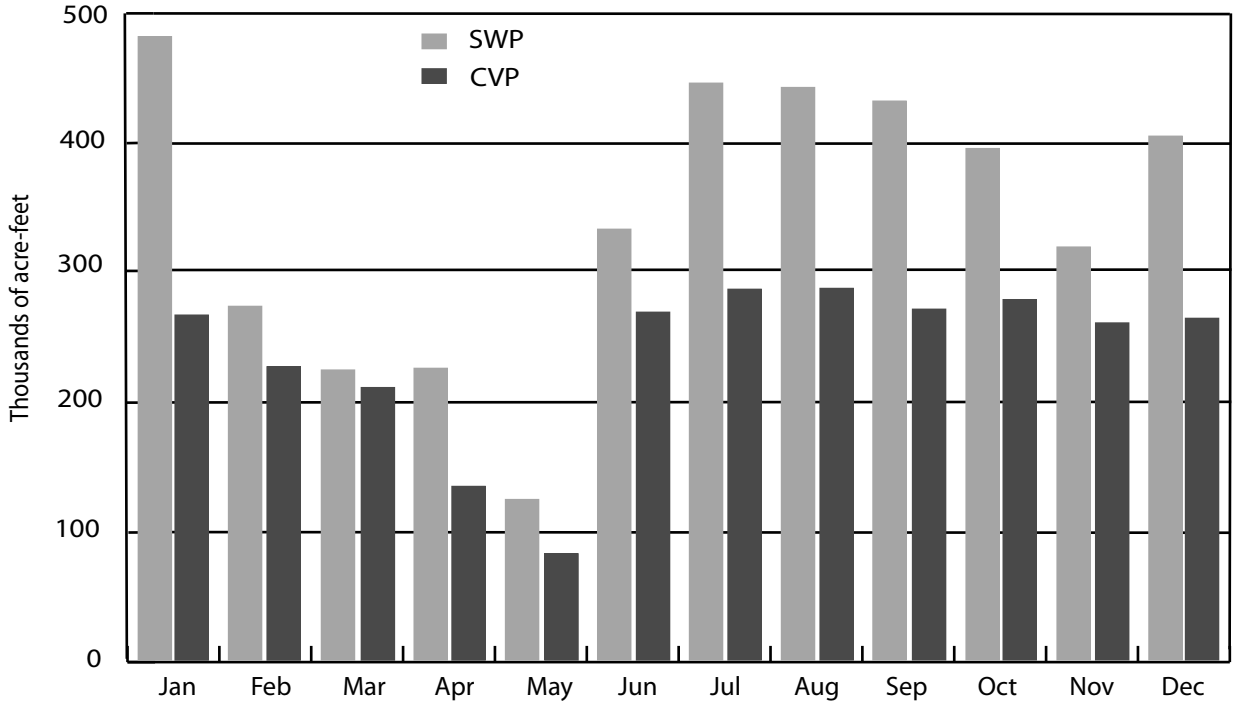


Figure 8-7. Sacramento-San Joaquin Delta Exports by State Water Project and Central Valley Project, 2005

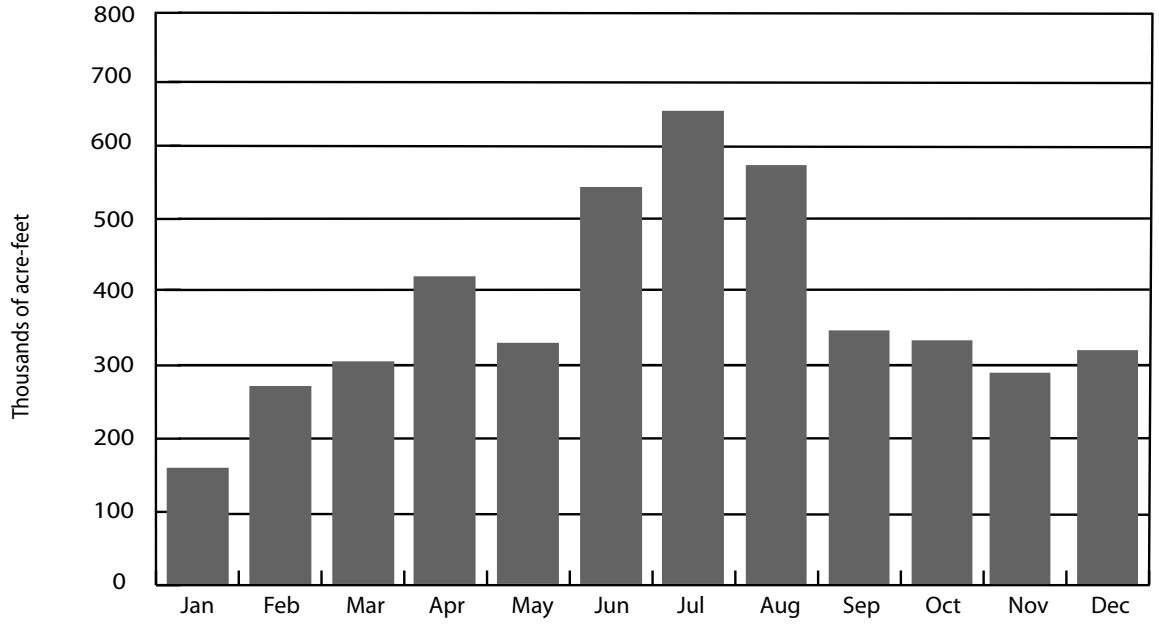


Figure 8-8. Water Pumped At Dos Amigos Pumping Plant, 2005 by Month

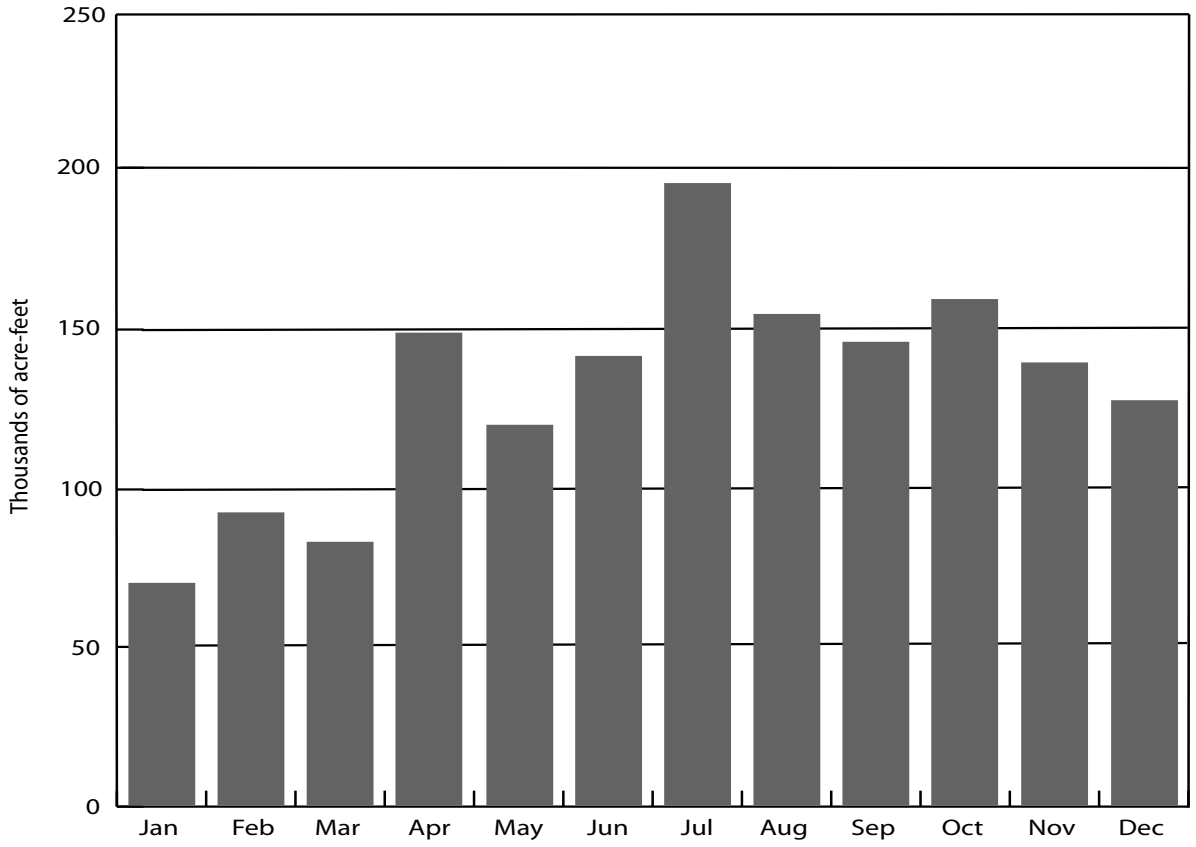


Figure 8-9. Water Pumped at Edmonston Pumping Plant, 2005 by Month

Chapter 9
Water Contracts and Deliveries

Clifton Court Forebay

Significant Events in 2005

During 2005,the Department of Water Resources (DWR) executed seven water conveyance and exchange agreements, 27 Turn-Back Water Pool Program agreements,14 Article 21 Water Program agreements with SWP contractors.

DWR also delivered water pursuant to seven conveyance and exchange agreements and eight storage agreements pending execution, and six conveyance and exchange agreements and three storage agreements executed prior to 2005.

In 2005, 4,732,633 af of water were conveyed to 27 long-term contractors and 26 other agencies.

The Environmental Water Account curtailed pumping at SWP and CVP by 681 af and 11,400 af, respectively. All EWA debt was paid back to the projects by the end of 2005.

Information for this chapter was provided by the State Water Project Analysis Office.

The long-term water supply contracts for water service from the State Water Project (SWP) between the Department of Water Resources (DWR) and 29 local agencies are basic to the project's construction and operation. In return for State financing, constructing, operating, and maintenance of facilities, the agencies contractually agreed to repay all associated SWP capital and operating costs.

DWR delivers water to SWP contractors in accordance with their long-term water supply contracts. These contracts set forth Table A amounts, which determine how much water a contractor may request each year from DWR. Table A amounts also are used as a factor for apportioning available supply to each contractor. Contracts can be found at http:// www.swpao.water.ca.gov/wsc/index.cfm.

"Approved Table A or approved Table A water" represents a portion or all of the annual Table A requested by the contractors and approved for delivery by DWR, based on hydrologic conditions, current reservoir storage, and combined requests from the SWP water contractors. DWR is not always able to deliver the quantity of water requested by contractors. In these cases, and under certain conditions, a lesser amount is allocated and delivered according to the long-term water supply contracts and the process noted above.

Approved Table A amounts may also be referred to in this chapter as "approved amounts" or "approved water".

The Water Supply Contracts are amended as needed. During 2005, two amendments were executed.

DWR also enters into miscellaneous agreements with SWP contractors and other agencies—which may be amended periodically—to convey SWP and non-SWP water through the California Aqueduct and to approve the construction, operation, and maintenance of turnouts along SWP facilities. During 2005, DWR executed seven water conveyance and exchange agreements, 27 Turn-back Water Pool Program agreements,14 Article 21 Water Program agreements with SWP contractors. DWR also delivered water pursuant to seven conveyance and exchange agreements and eight storage agreements pending execution, and six conveyance and exchange agreements and three storage agreements executed prior to 2005.

The State Water Project Analysis Office has developed a numbering system for contracts, amendments, and agreements executed by DWR. These numbers, called SWPAO numbers and designated in text as "SWPAO #XXXXX," are located in parentheses after each contract, amendment, or agreement. These numbers can be used as an identifier for anyone who contacts DWR staff for more detailed information on a particular document.

Amendments to Long-Term SWP Water Supply Contracts

All the original contracts signed by DWR and local agencies have been previously amended to incorporate mutually desired

Long-Term SWP Water Supply Contracts

The first water supply contract was signed with the Metropolitan Water District of Southern Cali¬fornia on November 4, 1960. The contract was negotiated by DWR and Metropolitan according to terms of the contracting principles for water service contracts announced by Governor Edmund G. Brown on January 20, 1960.

The Metropolitan contract became the prototype for all water contracts; by the end of 1967, 31 agencies had contracted for water. In addition, a water supply contract was executed with the City of West Covina in December 1963, but was terminated in August 1965; the city's Table A amount was transferred to Metropolitan through an amendment to the district's long-term contract with DWR. Long-term contracts with Hacienda Water District and Devil's Den Water District were also terminated when those districts transferred their Table A amounts, through contract amendments, to Tulare Lake Basin Water Storage District (1981) and Castaic Lake Water Agency (1992), respectively. Today the SWP has long-term water supply contracts with 29 agencies. Those contracts have been amended periodically to incorporate mutually agreed upon modifications.

All water contracts signed in the 1960s included an estimate of the date water would first be delivered and a schedule of the amount of water the agency could expect to be delivered annually (annual Table A amounts). That amount was designed to increase gradually until the maximum amount of annual Table A was reached. The total combined maximum annual Table A amount for all water contracting agencies was initially 4,230,000 acre-feet, assuming full development of the SWP.

The contracts were initially designed to be valid for 75 years or until all bonds sold as part of the California Water Resources Development Bond Act were repaid, whichever period was longer. As a result of amendments to contracts in the 1990s, the current combined maximum annual Table A amount totals 4,172,786 acre-feet, and the contracts are in effect for the longest of the following periods: (1) the project repayment period, which extends to the year 2035; (2) 75 years from the date of the contract; or (3) the period ending with the latest maturity date of any bond used to finance the construction costs of project facilities.

changes. Most amendments fall under the following five general categories:

1) revision of annual Table A amounts in the water supply contracts;
2) allocation of costs and benefits for the enlargement or extension of the East Branch and extension of the Coastal Branch of the California Aqueduct;
3) purchase of excess capacity in the California Aqueduct;
4) provisions to allow contractors, under certain conditions, to carry over undelivered SWP approved Table A

water from one year for delivery in the next year; and

5) implementation of Monterey Agreement principles.

2005 Amendments to Long-Term Water Supply Contracts

The following Water Supply Contracts were amended during 2005.

County of Kings

DWR executed Amendment No. 17 to the Water Supply Contract between County of Kings and DWR on September 23, 2005. The amendment provided for the permanent transfer of 305 af of SWP Table A water from Tulare Lake Basin Water Storage District to County of Kings, and set forth the conditions of the transfer. The transfer becomes effective January 1, 2006. (SWPAO #05014)

Tulare Lake Basin Water Storage District

DWR executed Amendment No. 32 to the Water Supply Contract between Tulare and DWR on September 23, 2005. The amendment provided for the permanent transfer of 305 af of Table A water from Tulare to County of Kings, and set forth the conditions of the transfer. The transfer becomes effective January 1, 2006. (SWPAO #05013)

The following long-term Water Supply Contract amendments (part of the 2003 Colorado River Quantification Settlement Agreement) were executed in 2003, and became effective in 2005. The amendments are a result of the 2003 Exchange Agreement that became effective on November 9, 2004, among Coachella Valley Water District, Metropolitan Water District of Southern California, and Desert Water Agency. The exchange agreement provides for the transfer of 88,100 af of Metropolitan's Table A amounts to Coachella and 11,900 af of Metropolitan's Table A amounts to Desert. The transfers are consistent with the implementation of the 2003 Colorado River Quantification Settlement Agreement.

Coachella Valley Water District

DWR executed Amendment No. 18 to the Water Supply Contract between Coachella and DWR on October 10, 2003. The amendment provided for the permanent transfer of 88,100 af of Table A amounts from Metropolitan to Coachella and set forth conditions for the transfer. The transfer became effective January 1, 2005. (SWPAO #04009)

Desert Water Agency

DWR executed Amendment No. 18 to the Water Supply Contract between Desert and DWR on November 3, 2003. The amendment provided for the permanent transfer of 11,900 af of Table A amounts from Metropolitan to Desert and set forth conditions for the transfer. The transfer became effective on January 1, 2005. (SWPAO #04011)

Metropolitan Water District of Southern California

DWR executed Amendment No. 27 to the Water Supply Contract between Metropolitan and DWR on October 24, 2003. The amendment provided for the permanent transfer of 88,100 af of Table A amounts from Metropolitan to Coachella, and set forth conditions for the transfer. The transfer became effective January 1, 2005. (SWPAO #04008)

DWR executed Amendment No. 28 to the Water Supply Contract between

Metropolitan and DWR on October 24, 2003. The amendment provided for the permanent transfer of 11,900 af of Table A amounts from Metropolitan to Desert, and set forth conditions for the transfer. The transfer became effective January 1, 2005. (SWPAO #04010)

Monterey Amendments

The Monterey Amendments increase the reliability of existing water supplies; provide stronger financial management for the SWP; and increase water management flexibility, providing more tools for local water agencies to maximize use of existing facilities.

The Monterey Amendments include changes in allocation of approved Table A water, the transfer of Table A amounts and land, financial restructuring, and increased operational flexibility. The Monterey Amendments are discussed in detail in Chapter 1, "Summary of Significant Events", of Bulletin 132-95 (available online at http://www.swpao.water.ca.gov/publications/index.cfm).

Plumas and Empire remain the only long-term SWP contractors who have not signed the Monterey Amendment.

In accordance with the terms of the May 5, 2003, Monterey Settlement Agreement, the SWP continues to operate pursuant to the Monterey Amendments, while the new Environmental Impact Report (EIR) is being prepared. The draft EIR is expected to be released in 2007. The settlement agreement is discussed in detail in Chapter 9, "Water Contracts and Deliveries," of Bulletin 132-04, (available online at http://www.swpao.water.ca.gov/publications/index.cfm.)

Miscellaneous Agreements with Long-Term SWP Contractors

2005 Water Conveyance and Exchange Agreements

During 2005, water conveyance and exchange agreements were executed or pending execution with long-term SWP contractors as described below.

Dudley Ridge Water District

A letter agreement dated June 20, 2005 and executed July 5, 2005, between DWR and Dudley Ridge approved the conveyance of Central Valley Project (CVP) Section 215 water to Dudley Ridge from March 1, 2005 through May 31, 2010. The CVP section 215 water will be made available at O'Neill Forebay. Dudley Ridge requested this water to be delivered to Dudley Ridge through SWP facilities pursuant to Article 55 of its long-term Water Supply Contract. During 2005, a total of 576 af of CVP Section 215 water was delivered to Dudley Ridge from Reach 8D of the California Aqueduct. (SWPAO #05005)

A letter agreement, pending execution among DWR, Dudley Ridge, and Kern County Water Agency, will provide for the delivery of up to 12,000 af of Dudley Ridge's 2005 Table A water to Kern for delivery to Berrenda Mesa Water District. In exchange, Kern will return a portion of its Table A water, equal to two-thirds (66.7 per cent) of Dudley Ridge's 2005 Table A water delivery to Kern. All return water is to be delivered to Dudley Ridge by December 31, 2018. During 2005, a total of 4,684 af was delivered to Kern from Reach 31A of the Coastal Branch. (SWPAO #05015)

A letter agreement, pending execution among DWR, Dudley Ridge, and San Gabriel Valley Municipal Water District, will provide for the delivery of a portion of Dudley Ridge's 2005 and 2006 approved SWP water supplies to San Gabriel's service area. In exchange, San Gabriel will return a like amount of its future SWP water supplies to Dudley Ridge by December 31, 2016. During 2005, a total of 3,484 af of Dudley Ridge's approved SWP water was delivered to San Gabriel at Reach 1 of the East Branch Extension, of which 2,988 af were 2005 Table A water, and 496 af were 2004 extended carryover water. (SWPAO #05017)

Empire West Side Irrigation District

An agreement executed December 13, 2005, between DWR and Empire, provided for the delivery of unscheduled water (Article 21) to Empire in 2005, at times when SWP water was not needed for fulfilling approved Table A deliveries, or for meeting project operational commitments. A total of 1,799 af of unscheduled water was delivered to Empire in 2005 at Reach 8C. (SWPAO #05002)

Kern County Water Agency

A letter agreement pending execution between DWR and Kern, will provide for the delivery of up to 27,000 af of Kern's approved 2005 Table A water to Westlands Water District. In return, Kern will receive a like amount of Kern River water from CVP contractors. This is to facilitate a sale of CVP water from an "eastside" Friant–Kern CVP contractor to Westlands, a "westside" CVP contractor. DWR petitioned the State Water Resources Control Board on May 25, 2005, and received approval on July 20, 2005, for a temporary change of place of use for the delivery of SWP water to Westlands. During 2005, a total of 7,000 af was delivered to Westlands at Reach 4. (SWPAO #05012)

A letter agreement dated August 9, 2005, and executed August 22, 2005, between DWR and Kern, approved the delivery of up to 20,000 af of Kern's 2005 Table A water to the U.S. Bureau of Reclamation (Reclamation) in O'Neill Forebay during 2005. This is to facilitate the delivery of up to 20,000 af of Kern–Tulare Water District's Friant–Kern water to Reclamation by in-lieu exchange, with a portion of Kern's approved Table A water. A portion of the 20,000 af was delivered to Kern National Wildlife Refuge located within Kern's service area. Reclamation was responsible for delivering the remaining portion to wildlife refuges in the San Joaquin Valley via the CVP Delta-Mendota Canal, or CVP side of the joint use facilities of the California Aqueduct. DWR petitioned SWRCB on April 21, 2005, and received approval on August 11, 2005 for such temporary change of place of use. During 2005, a total of 20,000 af was delivered to Reclamation in O'Neill Forebay. (SWPAO #05004)

A letter agreement, pending execution between DWR and Kern, will provide for the delivery of up to 25,000 af of Westlands' 2005 CVP water to Kern for storage in the Semitropic Groundwater Banking and Exchange Program. In exchange, Kern will return a like amount to Westlands in a future year. Westlands' approved CVP water will be made available at O'Neill Forebay for delivery to Kern. During 2005, a total of 11,284 af was delivered to Kern at Reach 10A. (SWPAO #05020)

A letter agreement dated September 14, 2005, and executed October 28, 2005,

between DWR and Kern, approved the delivery of up to 53,300 af of 2004 CVP water to Kern. Kern acquired this water from two CVP/Cross Valley Canal contractors (Kern–Tulare and Rag Gulch Water Districts) and requested the water to be delivered pursuant to Article 55 of Kern's Water Supply Contract. A portion of Kern–Tulare and Rag Gulch Water Districts' service area is within Kern County. During 2005, a total of 7,932 af was delivered to Kern. (SWPAO #04025)

A long-term agreement executed February 23, 2005, among DWR, Kern, and West Kern Water District, approved the introduction of local water from the West Kern Turn-in into Reach 13B of the California Aqueduct. The local water will be delivered concurrently by exchange with SWP water supplies to West Kern Turnout in Reach 12D of the California Aqueduct for use by La Paloma Power Plant. No water was moved under this agreement in 2005. (SWPAO #04015)

Mojave Water Agency

A letter agreement, pending execution among DWR, Mojave, and Solano County Water Agency will provide for the delivery of up to 2,000 af of Solano's approved 2005 SWP water supplies to Mojave, in exchange for up to 1,000 af of Mojave's future SWP water supplies during a dry year. All return water is to be delivered to Solano by December 31, 2015. Similar agreements were approved by DWR in 1998, 1999, 2000, and 2004. During 2005, a total of 2,000 af of Solano's Table A water was delivered to Mojave at Reach 22B. (SWPAO #05019)

Santa Clara Valley Water District

A letter agreement, pending execution among DWR, Santa Clara, and Kern, will provide for the delivery of up to 20,000 af of Santa Clara's 2005 CVP water to Semitropic Water Storage District, a member unit of Kern, in exchange for Kern's Table A water in the future. The water will be delivered to Kern in accordance to Article 55 of Kern's long–term Water Supply Contract. During 2005, a total of 20,000 af of Santa Clara's CVP water was delivered to Semitropic at Reach 10A. (SWPAO #06012)

A letter agreement dated January 31, 2005, and executed March 7, 2005, between DWR and Santa Clara, approved the delivery of up to 3,100 af of Brown's Valley Irrigation District's non-SWP water to Santa Clara in 2004. This water, which is under Brown's Valley pre-1914 water rights, was made available at Banks Pumping Plant and conveyed to Santa Clara at Reach 9 of the South Bay Aqueduct. Santa Clara requested this water be delivered pursuant to Article 55 of its Water Supply Contract. During 2004, a total of 3,100 af of non-SWP water was delivered to Santa Clara. (SWPAO #04026)

Tulare Lake Basin Water Storage District

A letter agreement dated June 20, 2005, and executed June 29, 2005, between DWR and Tulare, approved the transfer of up to 5,500 af of Tulare's 2005 Table A water to Westlands at Reaches 5, 6, and 7 of the California Aqueduct. The transfer was made on behalf of two land owners, Hansen Ranches (called Vista Verde Farms in Westlands) for up to 3,500 af, and Newton Farms for up to 2,000 af, both of which operate in Tulare's and Westlands' service areas. DWR petitioned the SWRCB on April 19, 2005, and received approval on June 29, 2005, for a temporary change of place of use. During 2005, a total of

3,000 af were delivered to Westlands at Reaches 5 and 7. (SWPAO #05001)

A letter agreement dated June 29, 2005, and executed August 15, 2005, among DWR, Tulare, and Westlands, approved the delivery and re-regulation of up to 500 af of CVP water from Westlands to Tulare in March 2005. In exchange, Tulare would return a like amount of its 2005 approved SWP Table A water to Westlands at Reaches 5, 6, and 7 of the California Aqueduct by December 31, 2005. The point of delivery for the exchange was at O'Neill Forebay. DWR petitioned SWRCB on April 19, 2005, and received approval on June 29, 2005, for a temporary change of place of use for the delivery of return water. During 2005, a total of 277 af was delivered to Tulare at O'Neill Forebay and a total of 277 af of Tulare's 2005 Table A water was returned from O'Neill Forebay to Westlands. (SWPAO #05003)

A letter agreement, pending execution between DWR and Tulare, will provide for the delivery of up to 2,000 af of Tulare's 2005 Table A water to Westlands at Reach 7 of the California Aqueduct, on behalf of Westlake Farms Inc. operates in both contractors' service areas. The water is to be delivered to Westlands for use on lands within the Kings County portion of Westlands' service area. During 2005, a total of 2,000 af was delivered to Westlands at Reach 7. (SWPAO #05011)

Water Conveyance and Exchange Agreements Prior to 2005

During 2005, water was delivered pursuant to agreements with SWP contractors that were executed prior to 2005. These water conveyance and exchange agreements are described below.

Kern County Water Agency

An agreement executed on June 8, 2000, among DWR, Kern, and Western Hills Water District approved delivery of 8,000 af of pre-1914 Lower Kern River rights water banked in Kern's share of the Pioneer Groundwater Banking Project. A portion of Kern's approved Table A water will be delivered annually to Western Hills from Reach 2A of the California Aqueduct. In exchange, Kern will take a like amount of banked local water from the Pioneer Groundwater Bank. DWR petitioned SWRCB and by an SWRCB order dated April 21, 2000, Western Hills' service area was included within the authorized SWP place of use. During 2005, a total of 1,046 af of Kern's Table A water was delivered to Western Hills at Reach 2A. (SWPAO #01001)

A letter agreement executed October 11, 2002, between DWR and Kern approved the delivery to Kern in 2000, of up to 30,000 af of non-SWP water from four CVP contractors, members of the San Luis and Delta Mendota Water Authority. In exchange, Kern would return a like amount of its approved Table A water to the Water Authority by December 31, 2003. A total of 23,941 af of CVP water was delivered to Kern in 2000. Kern requested an extension of the return period in 2003, and a total of 2,000 af was returned to the Water Authority by the end of 2004, leaving a balance of 21,941 af to be returned to the CVP contractors. The Water Authority, Kern and Santa Clara entered into an exchange agreement dated June 28, 2005, to facilitate the return of the remaining 21,941 af to the Water Authority. Pursuant to the exchange agreement, Santa Clara, a contractor who has both SWP and CVP water supplies, will deliver 21,941 af of its CVP water supplies to the Water Authority. In return, a like amount of Kern's approved

SWP water supplies will be delivered to Santa Clara's account in the Semitropic Water Banking Program for later recovery. During 2005, a total of 21,941 af of Kern's Table A water was delivered to Semitropic from Reach 10A, thereby completing the exchange. (SWPAO #00032)

Mojave Water Agency

An agreement executed November 13, 1997, among AVEK, Mojave, and DWR, approved a change in point of delivery through 2019 of up to 2,250 af annually of Mojave's approved Table A amount to AVEK's Fairmont Turnout in Reach 19 of the California Aqueduct. Mojave does not have conveyance facilities to provide service to a solar energy generating station located within its service area. AVEK has conveyance capability and has agreed to provide service. During 2005, DWR delivered 973 af of Mojave's 2005 Table A water and 43 af of Mojave's 2004 extended carryover water through AVEK's turnout at Reach 19. (SWPAO #97003)

Napa County Flood Control and Water Conservation District

A change in point of delivery agreement executed December 26, 2001, among DWR, Napa County Flood Control and Water Conservation District and Solano County Water Agency, approved the delivery of up to 628 af of Napa's annual Table A water to the City of Vallejo Water Treatment Plant at Reach 3A of the North Bay Aqueduct, in Solano's service area. This water is further conveyed to the City of American Canyon, a member agency of Napa. During 2005, a total of 160 af of Napa's Table A water was delivered to Solano from Reach 3A. (SWPAO #00029)

Solano County Water Agency

A settlement agreement was executed May 19, 2003, among DWR, Solano, and the cities of Fairfield, Vacaville, and Benicia. Concurrently, a conveyance agreement was executed between DWR and Solano. Together, these agreements approved the delivery of up to 31,620 af annually of settlement water to Solano for delivery to the three cities to help meet their current and future municipal and industrial water needs through the North Bay Aqueduct. During 2005, a total of 1,132 af of settlement water was delivered to the three cities through Reach 1 of the North Bay Aqueduct. (SWPAO #03017)

San Bernardino Valley Municipal Water District

San Bernardino and Metropolitan entered into a coordinated use agreement for conveyance facilities and SWP water supplies on May 14, 2001. DWR responded on February 27, 2002, concurring with the agreement and acknowledging the coordinated use of local facilities currently existing within San Bernardino's jurisdictional boundaries. This coordinated use involves delivery of San Bernardino's SWP water to Metropolitan's facilities within San Bernardino's service area, as permitted under Article 10 of the Water Supply Contract. During 2005, a total of 20,000 af of San Bernardino's approved Table A water was delivered to Metropolitan, of which 15,834 af was delivered to Reach 26A and 4,166 af was delivered to Reach 1 of the East Branch Extension. (SWPAO #02035)

Turnout Agreements

Antelope Valley–East Kern Water Agency.

An agreement dated March 28, 2000, between DWR and Antelope Valley–

East Kern Water Agency, allowed the construction, operation, and maintenance of the Rancho Vista Turnout at Milepost 339.68, Reach 20B of the California Aqueduct. The turnout has a design capacity of 5 cfs. Construction was completed in March 2000, but was not formally accepted in 2005.

New Point of Delivery for Ventura County Watershed Protection District

United Water Conservation District (United) currently contracts for 5,000 af per year of SWP water from Ventura County Watershed Protection District. Of the 5,000 af, 1,850 af are allocated to the Port Hueneme Water Agency and delivered through Castaic Lake. In February 2002, United released an Initial Study and Negative Declaration for the delivery of its SWP water from Pyramid Lake via Piru Creek. The proposal to deliver Ventura's SWP water for United via Piru Creek was included as an objective in the EIR for the revised operations guidelines for Pyramid Lake. The new guidelines, consistent with the final EIR, allow for the delivery of up to 3,150 af of SWP water to United between November 1 and the end of February each year.

Agreements and Activities Related to the Monterey Amendments

Turn-Back Water Pool Program

Pursuant to Article 56(d) of the Monterey Amendments, the tenth year of the Turn-Back Water Pool Program was initiated through Notice to State Water Project Contractors No. 05-04, dated February 2, 2005. All SWP contractors who signed Monterey Amendments were permitted to participate in the program. The program allowed SWP contractors to offer a portion of their approved 2005 Table A water for sale in a Turn-back pool for use by interested SWP contractors. Based on Table A supply and demand, the Turn-back water was allocated among the selling and purchasing contractors. In 2005, 38,275 af of water were purchased under the Turn-Back Water Pool Program.

Transactions for Pool A and Pool B of the Turn-Back Water Pool Program occurred in February and March 2005, respectively. In 2005, the program was extended to June 1 to allow for changes in the percentage of Table A allocations between April 1 and June 1. Only SWP contractors who were already committed to purchase water through Pool B were allowed to continue with the program until June. Turn-back water sold for $12.24 per acre-foot—50 percent of the Delta Water Rate—through Pool A, and for $6.12 per acre-foot—25 percent of the Delta Water Rate—through Pool B. All money collected through the Turn-Back Water Pool Program was paid to the selling contractors. The 2005 Turn-Back Water Pool Program closed on June 1, 2005. Notices to State Water Project Contractors describing the Turn-Back Water Pool Program are available online at http://www.swpao.water.ca.gov/notices/index.cfm.

Table 9–1 lists contractors who participated in Pool A and Pool B of the Turn-Back Water Pool Program.

Storage of Water Outside Service Area

Pursuant to Article 56 of the Monterey Amendments, seven SWP contractors have agreements with DWR to deliver or store SWP water outside their service area for later use within their service area. The following agreements include provisions concerning the conveyance and points of delivery of such water.

Table 9-1. 2005 Turn-Back Water Pool Program (Acre-feet)

Contractor	Sold	Purchased
	Pool A	
City of Yuba City	2,160	
Littlerock	880	
Ventura County	9,000	
Alameda County		144
Coachella		414
Desert		171
Dudley Ridge		196
Kern		3,412
Kings		31
Metropolitan		6,530
Oak Flat		19
San Gorgonio		22
Santa Barbara		155
Santa Clara		342
Tulare		329
Zone 7		275
Total	**12,040**	**12,040**
	Pool B	
City of Yuba City	3,480	
San Gabriel	15,420	
Ventura	7,335	
Alameda County		799
Coachella		2,302
Desert		951
Dudley Ridge		1,090
Kern		18,985
Kings		171
Oak Flat		108
Tulare		1,829
Total	**26,235**	**26,235**

Alameda County Flood Control and Water Conservation District, Zone 7. A long-term change in point of delivery agreement pending execution, among DWR, Alameda-Zone 7, and Kern, will provide for the delivery of a portion of Alameda-Zone 7's approved 2004 through 2020 SWP water supplies, for storage in Semitropic, and for the return of such water by future exchange of a like amount of Kern's Table A water, in accordance with the Alameda-Zone 7 and Semitropic Water Banking and Exchange Program Agreement. All return water is to be delivered to Alameda-Zone 7 by December 31, 2035. During 2005, DWR delivered a total of 5,740 af of Alameda-Zone 7's 2004 extended carryover water to Semitropic. (SWPAO #04017)

Alameda County Water District. A change in point of delivery agreement pending execution, among DWR, Alameda, and Kern, will provide for the delivery of a portion of Alameda's 2005 approved SWP water supplies for storage in and later recovery from Semitropic, in accordance with the Alameda County and Semitropic Water Banking and Exchange Program Agreement. During 2005, DWR delivered 25,700 af of Alameda's 2005 Table A water and 4,600 af of Alameda's 2004 extended carryover water to Semitropic. (SWPAO #07005)

Castaic Lake Water Agency. A long-term change in point of delivery agreement, pending execution, among DWR, Castaic, and Kern, will provide for the delivery of a portion of Castaic's approved 2005 and future SWP water supplies for storage in and later recovery from the groundwater basin underlying Rosedale–Rio Bravo Water Storage District, a member unit of Kern. This is in accordance with the Castaic and Rosedale–Rio Bravo Water Banking and Exchange Program Agreement. During 2005, DWR delivered 20,000 af of Castaic's approved 2005 Table A water to Reach 12E for subsequent delivery to Rosedale–Rio. (SWPAO #05016)

County of Kings. A change in point of delivery agreement, executed March 24, 2004, among DWR, Kings, and Westlands,

provides for the delivery of up to 5,000 af of County of Kings' Table A water through Westlands' turnouts at Reach 6 and Reach 7. Water will be conveyed through Westlands and into Kings County for use at LeMoore Naval Air Station. The agreement became effective January 1, 2004, and remains in effect until December 31, 2035. During 2005, DWR delivered a total of 2,439 af of Kings' Table A water to Westlands at Reach 6. (SWPAO #04005)

A change in point of delivery agreement, pending execution, among DWR, County of Kings, and Westlands, will provide for the delivery of a portion of Kings' approved 2005 and 2006 SWP water supplies through Westlands' turnouts at Reaches 6 and 7 of the California Aqueduct. County of Kings requested the SWP water supplies be delivered to Westlands' agricultural lands within King's county. During 2005, DWR delivered a total of 170 af of County of Kings' 2005 Table A water and 11,248 af of Article 21 water to Reaches 6 and 7. (SWPAO #05026)

A long-term agreement, pending execution, among DWR, County of Kings, Tulare, and Westlands, will provide for a change in point of delivery of up to 200 af of Kings annual approved Table A water and other SWP water supplies to Westlands' turnouts at Reaches 6 and 7 of the California Aqueduct. The water is conveyed to GWF Energy, LLP, for use within Kings' service area; however, GWF Energy relies on CVP water supplies before SWP water supplies. During 2005, one af was delivered to Reach 6. (SWPAO #02031)

Dudley Ridge Water District. A change in point of delivery agreement, pending execution, among DWR, Dudley Ridge, and Kern, will provide for the delivery of a portion of Dudley Ridge's approved SWP water supplies for storage in and later recovery from the Kern Water Bank (KWB). During 2005, DWR delivered a total of 15,694 af of Dudley Ridge's approved SWP water supplies for storage in KWB, of which 2,500 af were 2005 Table A water, 48 af were 2004 extended carryover water, and 13,146 af were Article 21 water. (SWPAO #07001)

Metropolitan Water District of Southern California. A long-term change in point of delivery agreement executed August 30, 2004, among DWR, Metropolitan, and Kern, approved the delivery of a portion of Metropolitan's approved SWP supplies for storage in and later recovery from the groundwater basin underlying Kern Delta Water District, a member unit of Kern, in accordance with the Metropolitan and Kern Delta Water Management Program Agreement. During 2005, a total of 15,576 af of Metropolitan's Table A water was delivered to Reaches 12E and 13B. (SWPAO #03019)

A change in point of delivery agreement pending execution, among DWR, Metropolitan, and Mojave, will provide for the delivery of up to 75,000 af of Metropolitans' 2003, 2004, and 2005 approved SWP water supplies for storage in the Mojave River Basin within Mojave, in accordance with the Metropolitan and Mojave Water Banking Demonstration Agreement. The water is to be returned to Metropolitan, by exchange of Mojave's Table A water, by January 15, 2010. During 2005, DWR delivered a total of 20,000 af of Metropolitan's 2005 Table A water to Mojave at Reaches 22B and 24. (SWPAO #03057)

A long-term agreement, executed on August 21, 1995, among DWR, Metropolitan, and Kern, approved the annual delivery of a portion of Metropolitan's annual approved Table A and other water supplies for storage in and later recovery from Semitropic, in accordance with the Metropolitan and Semitropic Water Banking Program Agreement. The long-term agreement remains in effect until November 4, 2035. During 2005, a total of 31,210 af of Metropolitan's Table A water was delivered to Semitropic from Reach 10A. (SWPAO #95010)

Santa Clara Valley Water District. A change in point of delivery agreement, pending execution among DWR, Santa Clara and Kern, will provide for the delivery of a portion of Santa Clara's approved 2005 SWP water supplies for storage in and later recovery from Semitropic, in accordance to the Santa Clara and Semitropic Water Banking and Exchange Program Agreement. During 2005, DWR delivered a total of 47,081 af of Santa Clara's approved SWP water supplies to Semitropic, of which 32,333 af were 2005 Table A water, 11,633 af were 2004 extended carryover water, and 3,115 af were Article 21 water. (SWPAO #05008)

Article 21 Water Program

Pursuant to Monterey Amendments, the Article 21 water replaces unscheduled, surplus, wet weather, and Article 12(d) water. The Article 21 water program allows a contractor to take delivery of water over the approved and scheduled Table A amounts for the current year. Article 21 water is available for delivery on a short-term basis as determined by DWR when water is still available after operational requirements for SWP water deliveries, water quality, and Delta requirements are met.

The conditions for the Article 21 Water Program for 2005 were described in the January 12, 2005, Notice to State Water Project Contractors No. 05-01. Thirteen participants signed the notice, which indicated their acceptance of the criteria, procedures, and charges for the program. They collectively received a total of 729,284 af of Article 21 water. (Table 9-2)

During the Article 21 water program period, unscheduled water was also made available to Empire pursuant to its long-term water supply contract. Empire received 1,799 af of unscheduled water in 2005 for agricultural purposes.

Table 9-2. Article 21 Water Deliveries (Acre-feet)

Contractor	Amount
Alameda County WD	846
Castaic Lake	2,451
Kings	11,504
Dudley Ridge	28,197
Kern	453,078
Napa	606
San Bernardino	56
San Gorgonio	15
San Luis Obispo	245
Santa Clara	6,298
Solano	10,421
Metropolitan	168,300
Tulare	47,267
Subtotal	729,284
Empire [a]	1,799
Total	**731,083**

a) Unscheduled agricultural water

Flexible Storage Program

No SWP contractor participated in the Flexible Storage Program in 2005.

Extended Carryover Program

Pursuant to Article 56 of the Monterey Amendments, contractors can elect to store project water outside of their service area for later use within their service area. Qualified contractors can request Table A water carried over for delivery in the following year to the extent that such deliveries do not adversely affect current or future project operations. Factors that influence how much extended carryover water can be delivered include operational constraints of project facilities, filling of SWP conservation storage facilities, flood control releases, and water quality restrictions. If storage requests exceed the available storage capacity, the amount available is allocated among the contractors requesting storage in proportion to their annual Table A water for that year. Fifteen SWP contractors took delivery of 169,171 af of approved 2004 Table A water carried over into 2005, as extended carryover.

Dry Year Water Purchase Program

Due to the wet hydrology of 2005, there was no need for a dry year water purchase program this year.

Environmental Water Account

EWA is a cooperatively managed program intended to provide (1) protection to fish of the Bay-Delta Estuary through environmentally beneficial changes and (2) water supply reliability to SWP and CVP water users through increased flexibility in operations (SWP and CVP). Responsibility for implementing EWA rests with the NOAA Fisheries, U.S.. Fish and Wildlife Service, and the Department of Fish and Game (management agencies), and Reclamation and DWR (project agencies).

Under EWA, fish protection is achieved by periodically curtailing project water delivery from the Bay-Delta to project water users south of the Delta and replacing it at a later date within the same calendar year. EWA operates on a water year basis, which begins October 1 and ends September 30 of the following year. However, EWA has the entire water year, plus the three remaining months of the calendar year, to replace curtailed water. This necessitates the acquisition of alternative sources of water, which are used to replace the project water supply (i.e., the undelivered water). EWA assets consist of "operational assets", which are acquired through changes in operations as defined in the August 28, 2000 CALFED ROD; "purchase assets," which are acquired water through purchases from willing water sellers; "source shifting," which involves deferral of scheduled delivery of water by willing participants; and other non-water assets including dedicated pumping capacity at Banks Pumping Plant during the summer. EWA is considered operational for any year when these assets are in place and Endangered Species Act commitments are provided by the management agencies.

In 2005, EWA's fifth operational year, exports were periodically curtailed at the SWP and CVP export facilities between December 15, 2004 and June 8, 2005. These actions resulted in an EWA debt of about 328,681 af at the SWP (December—4,163 af; February—33,967 af; April—121,888 af; May—133,997 af; June—34,666 af) and 11,400 af at the CVP in February.

During water year 2005, DWR and Reclamation acquired 171,917 af and 28,568 af, respectively, in operational assets and 154,560 af of purchase assets through contract agreements. All purchase asset acquisitions in 2005 were made by DWR and were covered under the EWA EIS/EIR in compliance with NEPA and CEQA. A source shift was not implemented because there was no risk of a low-point problem at San Luis Reservoir.

In fall 2004, EWA carried a debt of 14,927 af to water year 2005. EWA ended with no debt at the end of December 2005.

Purchase Assets

The following SWP contractors and non-SWP contractors participated in the EWA Program in 2005. The purchase asset water amounts below represent the total amounts of water acquired for EWA from various sources. These amounts have not been adjusted to reflect conveyance losses.

Kern County Water Agency

DWR and Kern County Water Agency executed an amendment, on May 20, 2005, to a 2003 agreement for selling previously stored groundwater to EWA and exchanging it for Kern's approved 2005 Table A water. The amendment approved the purchase of 29,712 af of groundwater to be exchanged in June 2005 (SWPAO #04-715). The purchased groundwater consisted of 5,432 af of previously stored Kern River Flood water and 24,280 af of previously stored Table A water (11,584 af stored in 1993; 8,631 af stored in 1995; 2,664 af stored in 1997; 532 af stored in 1998; and 869 af stored in 2000).

A multi-year groundwater purchase agreement was also executed on September 23, 2005, which expires December 31, 2007. In 2005, 60,000 af of water was purchased and exchanged for Kern's approved 2005 Table A water: 30,000 af of water in August and 30,000 af of water in September (SWPAO #05-705). A total of 89,712 af of Kern's groundwater was purchased in 2005. The purchased groundwater consisted of 8,879 af of previously stored Kern River Flood water and 51,121 af of previously stored Table A water (1,064 af stored in 1993, 15,075 af stored in 1995; 3,685 af stored in 1996; 3,802 stored in 1998; and 27,495 af stored in 2000).

Yuba County Water Agency. An agreement executed on April 7, 2005, between DWR and Yuba County Water Agency approved the transfer of up to 125,000 af of water from storage in New Bullards Bar Reservoir and groundwater substitution for support of EWA. Due to the wet hydrology of 2005, only 6,044 af of Yuba's water was purchased (SWPAO #04-716).

Placer County Water Agency. An agreement executed on October 26, 2004, between DWR and Placer County Water Agency approved the transfer of up to 20,000 af of water. DWR purchased a total of 18,700 af water from Placer for EWA in 2004. Since EWA was not able to use the Placer water in 2004, EWA applied 15,372 af of Placer's water for lower American River in stream temperature improvement benefits for fisheries in January 2005, and the remaining 3,328 af of Placer water spilled from Folsom Dam during flood control operations in February, 2005 (SWPAO #04-705).

South Feather Water and Power Agency

DWR and South Feather Water and Power Agency executed an agreement on December 15, 2004, for South Feather to transfer up to 10,000 af of water to DWR for EWA. South Feather released a total of 6,200 af water into Lake Oroville in December 2004 for use by EWA in 2005. This water later spilled out of Lake Oroville in June 2005, resulting in no purchase of water for EWA from South Feather (SWPAO #04-709).

Santa Clara Valley Water District

An amendment to a 2003 agreement was executed on May 4, 2005, among DWR, Santa Clara Valley Water District, and Kern. The amendment facilitated the purchase of up to 10,800 af of water stored in Santa Clara's portion of Semitropic Groundwater Bank that could then be exchange for Santa Clara's approved 2005 Table A water for support of EWA. Under the amendment, a portion or all of the purchased water could be Santa Clara's CVP water. A total of 8,804 af of Santa Clara's CVP water was purchased and exchanged for Santa Clara's 2005 Table A water for EWA (SWPAO #04-714).

The exchange of CVP water for Table A water was covered under a separate letter agreement dated July 26, 2005 (SWPAO #05-706). In compliance with CEQA, DWR approved an Addendum to an Initial Study and Negative Declaration, State Clearinghouse Number 2003042104, in July 2005.

Metropolitan Water District of Southern California

An agreement executed on September 16, 2005, between DWR and Metropolitan Water District of Southern California, approved up to 50,000 af of water for a wet-dry exchange. EWA receives water from Metropolitan in a wet year in exchange for returning water to Metropolitan in a drier year, where Metropolitan pays half of the returned water costs. Metropolitan delivered to EWA 20,000 af of water in August, 20,000 af of water in September, and 10,000 af of water in October (SWPAO #05-701).

Operational Assets

Project Pumping of excess flows in the Delta was don to reduce EWA Debt. In 2005, DWR pumped at total of 171,917 af of water to reduce EWA debt (February–34,477 af; July–29,649 af; August–28,493 af; September–27,898 af; and December–51,400 af.) Reclamation pumped 28,568 af of water to reduce EWA debt in March. The combined total project pumping to reduce EWA debt was 200,485 af in 2005. EWA had 500 cfs dedicated pumping capacity available at Banks Pumping Plant during July, August, and September. No other operational assets were available to EWA in 2005.

Miscellaneous Agreements with Other Agencies

In addition to negotiating agreements with SWP contractors to provide for specified water deliveries, DWR also entered into several agreements with other agencies for water conveyance, or exchange, between January 1, 2005, and December 31, 2005.

Water Conveyance Agreements—CVP Water

DWR regularly enters into agreements to convey CVP water such as agreements with contractors receiving water from Reclamation through the Cross Valley

Canal, a water conveyance facility that connects with the Aqueduct near Tupman in Kern County. Other agencies or corporations receive CVP water through agreements between DWR and Reclamation, including the U.S. Department of Veterans Affairs, USFWS, and Musco Family Olive Company. Occasionally, DWR also enters into agreements with Reclamation to convey CVP or SWP water from the Delta to O'Neill Forebay through CVP or SWP facilities. Some of these agreements allow Reclamation to make up for curtailed water exports from Tracy Pumping Plant associated with improving conditions for fish in the Delta. Other agreements allow replacing water exports foregone during maintenance and repair of Tracy and Banks Pumping Plants and CVP and SWP conveyance facilities between the Delta and O'Neill Forebay.

Cross Valley Canal

Eight CVP water contractors use CVC to obtain water from the California Aqueduct either by exchange with other agencies or by direct delivery. The eight water contractors are: County of Fresno, County of Tulare, Hills Valley Irrigation District, Kern–Tulare Water District, Lower Tule River Irrigation District, Pixley Irrigation District, Rag Gulch Water District, and Tri–Valley Water District. These agencies have had water conveyance service by DWR since 1976 through

- long-term 3-party contracts with DWR and Reclamation, executed in 1976, and amendments extending the contracts through February 29, 1996; and
- interim renewal contracts: (1) March 1, 1996, through February 28, 1998; (2) March 1, 1998, through February 28, 2000; (3) March 1, 2000, through November 30, 2000; (4) December 1, 2000, through February 28, 2001; (5) March 1, 2001, through February 28, 2002; (6) March 1, 2002 through February 28, 2003; and (7) March 1, 2003 through February 29, 2004, and (8) March 1, 2005 through February 28, 2005, and (9) March 1, 2005 through February 28, 2006.

Between January 1, 2005, and December 31, 2005, DWR delivered CVP water to the CVC contractors as follows:

On June 13, 2005, Lower Tule River Irrigation District requested that DWR and Reclamation approve a change in the point of delivery for up to 5,000 af of their 2005 approved CVP water from the CVC turnout in Reach 12E to Reach 3 of the California Aqueduct (O'Neill Forebay) for delivery to Reclamation's Level 4 Refuge Program. Under this agreement, which was executed on November 9, 2005, DWR conveyed 2,469 af of water in October of 2005. (SWPAO #05312)

On June 13, 2005, Pixley Irrigation District requested that DWR and Reclamation approve a change in the point of delivery for up to 5,000 af of their 2005 approved CVP water from the CVC turnout in Reach 12E to Reach 3 of the California Aqueduct (O'Neill Forebay) for delivery to Reclamation's Level 4 Refuge Program. Under this agreement, which was executed on November 9, 2005, DWR conveyed 2,469 af of water in October of 2005. (SWPAO #05313)

Musco Family Olive Company

A pending agreement among Musco Family Olive Company, Plain View Water District, DWR, and Reclamation provides for the conveyance of up to 800 af of

Plain View's CVP water to Reach 2A of the California Aqueduct for use by Musco Family Olive Company. A total of 569 af was delivered in 2005 under this pending agreement (SWPAO #04300). Construction of a permanent turnout is currently being pursued.

U.S. Department of Veterans Affairs

A pending letter agreement among the U.S. Department of Veterans Affairs, DWR, and Reclamation, provides for the conveyance of up to 450 af of CVP-approved water to Reach 2B of the California Aqueduct to the U.S. Department of Veterans Affairs' San Joaquin Valley National Cemetery. A total of 52 af was delivered to the National Cemetery in Reach 2B of the California Aqueduct in 2005 under this pending agreement. (SWPAO #02322)

U.S. Fish and Wildlife Service Cooperative Agreement

Reclamation initiated a cooperative agreement with DWR to deliver CVP water to the Kern National Wildlife Refuge for USFWS. Under the terms of this cooperative agreement, dated September 28, 2004, up to 30,500 af of CVP water would be delivered from Check 21 to the Buena Vista Water Storage District Turnout BV-1B, on Reach 10A of the California Aqueduct, from May 1, 2002, to May 31, 2009. DWR conveyed 22,947 af of CVP water to Kern National Wildlife Refuge in 2005.

Water Deliveries

Approved Table A Deliveries

Each year, by October 1, the SWP long-term water contractors submit initial requests for approved Table A deliveries allocated to contractors for use in the subsequent calendar year. Initial approved Table A amounts for the coming year are made by DWR in December. They are based on operations studies that assume 90 per cent exceedence of historic water supply (where exceedence refers to the possibility that water supply in the coming year will be exceeded by the historic water supply), current reservoir storage, and total requests by the SWP water contractors. Forecasts for the year are updated as hydrological conditions change. Approved Table A amounts are increased or decreased depending on both actual and projected hydrologic conditions.

On October 1, 2004, SWP long-term contractors submitted initial requests for 2005.

DWR approved deliveries of 1.65 million af on November 30, 2004, resulting in initial approved Table A amounts of 40 percent of most SWP contractor requests. DWR increased the 2005 approved Table A amounts to 2.48 million af, or 60 percent on January 14, 2005. As water conditions improved, approved Table A amounts were increased to 2.89 million af (70 percent) on April 01, 2005, 3.30 million af (80 percent) on April 21, 2005 and 3.30 million af (90 percent) on May 27, 2005.

Notices to State Water Project Contractors informing them of increases or decreases in approved Table A amounts are online at http:// www.swpao.water.ca.gov/notices/index.cfm.

SWP Deliveries

The SWP delivers water for a variety of beneficial uses. In addition to delivering approved Table A water to long-term water supply contractors, the SWP

- conveys water to other public agencies through special contracts and agreements;
- provides water for wildlife and recreational uses; and
- stores, releases, and delivers local runoff water from SWP facilities to agencies that hold local water rights.

In 2005, 4,732,633 af of water were conveyed to 27 long-term contractors and 26 other agencies. That amount includes

- 2,828,406 af of approved Table A water;
- 731,083 af of Article 21 water;
- 1,506 af of SWP water for recreation and fish and wildlife; and
- 1,101,429 af of water delivered to satisfy water rights settlement agreements and agreements with SWP contractors for local water supplies.
- 70,209 af of water delivered to satisfy agreements between the SWP and CVP

Figure 9-1, shows amounts of water delivered to various locations during 2005.

Specific information about water deliveries made to long-term contractors and other agencies during 2005 and historical deliveries from 1962 through 2005 are presented in the following three sections, each with a corresponding table, located at the end of the chapter:

- Water Delivered to Long-term Water Supply Contractors in 2005, by Service Area (Table 9-3);
- Water Delivered in 2005, by Month (Table 9-4); and
- Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-2005 (Table 9-5).

Water Deliveries to Long-Term SWP Contractors

Table 9-3 shows amounts of water delivered in 2005. The following information is arranged by column number.

2005 Approved Table A Water Delivered

Columns 1 through 6 show a detailed breakdown of approved Table A water delivered for long-term water supply contractors in 2005.

Turn-Back Pool Water

Column 4 shows 38,275 af of Turn-Back pool water was delivered to long-term water supply contractors in 2005.

2004 Carryover Approved Table A Water Delivered During 2005

Column 6 shows 185,587 af of water was carried over from 2004 for delivery in 2005. For several years, DWR has offered contractors the opportunity to carry over a portion of their approved Table A water for delivery in the current year to be delivered during the next year.

The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The SWP contractors' long-term contracts and amendments state the criteria for carrying over approved Table A water from one year to the next.

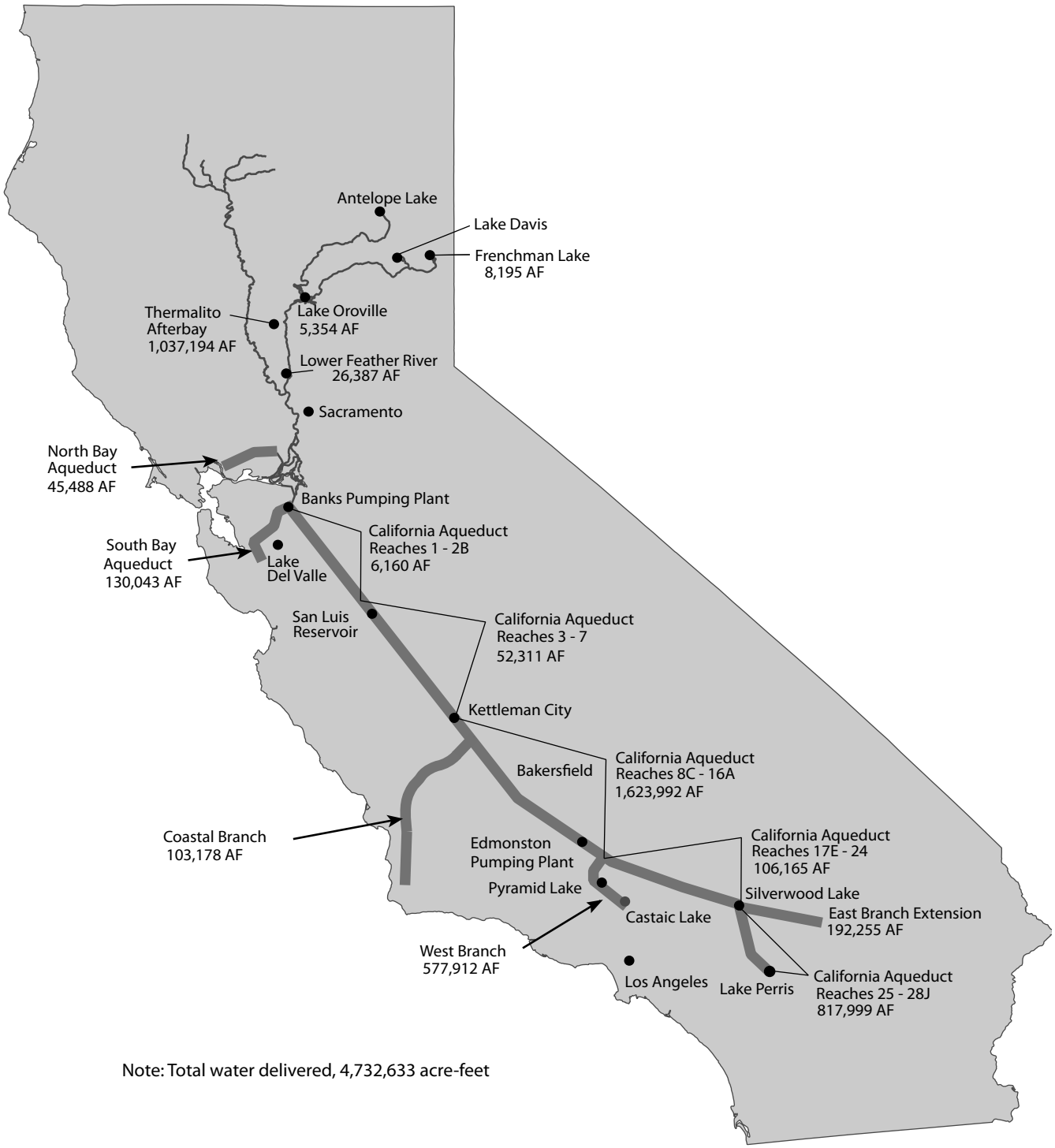


Figure 9-1. Water Delivered in 2005 and Delivery Locations of Long-Term Water Supply Contractors and Feather River Area Districts with Water Right Agreements with DWR

Total Table A Water Delivered
Column 6 shows all approved Table A water delivered in 2005—a total of 2,828,406 af.

2005 Article 21 and Unscheduled Water
Column 8 shows 731,083 af of 2005 Article 21 water delivered to long-term water supply contractors (includes 729,284 af of Article 21 and 1,799 af of unscheduled water to Empire Westside ID). Long-term water supply contractors who have not signed the Monterey Amendment receive unscheduled water.

Total SWP Water Delivered
Column 9 shows 3,559,489 af of total SWP water delivered in 2005. This includes total approved Table A water, water bank recoveries, flexible storage withdrawal, and Article 21 and unscheduled water.

Non-SWP Water Deliveries
Column 10 includes deliveries of non-SWP water to long-term water contractors. Non-SWP water is generally local, settlement, and permit water that a SWP contractor has a water right to, or water purchased from, exchanged with, or transferred from non-SWP agencies. In 2005, non-SWP water deliveries totaled 67,792 af.

Total Deliveries
Column 11 shows total amounts of water delivered to long-term contractors. In 2005, the SWP delivered 3,627,281 af to 27 long-term contractors.

Water Delivered in 2005 by Month

During 2005, the SWP provided water service to 53 agencies, including 27 SWP long-term water contractors. Those agencies and the amounts of water delivered to them by month are listed in Table 9-4, and are summarized below as SWP water and non-SWP water.

SWP Water
SWP water as defined in the long-term water supply contracts, includes Article 21 water, carryover approved Table A water, current year approved Table A amounts, flexible storage water, transfer and exchange of approved Table A water, and Turn-back pools A and B. Detailed information concerning those conveyances is found under the Miscellaneous Agreements with Long-Term SWP Contractors section in this chapter.

Non-SWP Water

In 2005, DWR used SWP facilities to convey non-SWP water for various agencies according to the terms of water rights and water transfer and exchange agreements. Detailed information concerning those conveyances is found under the Miscellaneous Agreements with Other Agencies section in this chapter.

Floodwater
Occasionally, during wet years, DWR accepts floodwater from the Kern River into the California Aqueduct through the Kern River-California Aqueduct Intertie under an agreement entitled Agreement among the State of California, Kern County Water Agency, and the Kern River Interests for Diversions of Floodwaters through the Kern River-California Aqueduct Intertie, dated November 18, 1975. In 2005, DWR did not accept any floodwater into the California Aqueduct.

Water Rights Water

Water in this category is transported through SWP facilities to long-term SWP contractors and other agencies according to terms of various local water rights agreements. Some water simply passes through SWP transportation facilities; a portion is stored in SWP reservoirs for release later. In 2005, 1,101,429 af of water in this category were delivered to the Feather River, South Bay, North Bay, and Southern California, and are summarized below.

Feather River Area. Ten non-SWP agencies in the Feather River area received 1,074,706 af. Those agencies are

- Last Chance Creek Water District, 8,195 af
- Thermalito Irrigation District, 2,355 af
- South Feather Water and Power Agency, formerly Oroville-Wyandotte Irrigation District, 5,354 af
- Western Canal Water District, 283,181 af
- Joint Water Districts Board, 751,128 af
- Oswald Water District, 560 af
- Tudor Mutual Water Company, 3,497 af
- Garden Highway Mutual Water Company, 13,987 af
- Plumas Mutual Water Company, 6,449 af

North Bay Area. In the North Bay Area, 3,668 af of Vallejo permit and 1,132 af of water pursuant to the May 19, 2003 Settlement Agreement among DWR, Solano County Water Agency (Solano), and the Cities of Fairfield Vacaville, and Benicia, were delivered.

South Bay Area. In the South Bay Area, a total of 21,753 af of local water was delivered to Alameda-Zone 7 and Alameda County. These two South Bay Aqueduct contractors hold water rights to runoff from Lake Del Valle watershed.

Southern California. In Southern California, 170 af of local runoff from the Houston Creek watershed were stored and delivered to Crestline under water rights held by DWR on Houston Creek. The authorized place of use is limited to Crestline.

Annual Table A Water and Water Delivered Since 1962

Information about annual Table A water and water conveyed for the past 40 years is contained in Table 9-5. The following discussion of conveyed Table A water is arranged according to column numbers.

Annual Table A

Columns 1 through 7 of Table 9-5 show the amount of long-term contractors' annual Table A water by area for years 1962 through 2005 as specified in the Table A schedules of the long-term water supply contracts.

In some instances Table A schedules—projections of each contractor's need for water to 2035—have been amended to meet the needs of individual contractors. The amounts of annual Table A water each contractor may request for years 1962 through 2035 can be found in Table B-4 in Appendix B.

Water Delivered

Columns 8 through 16 show water delivered or conveyed, including initial

fill water and operational losses and storage changes.

Approved Table A Water
Column 8 shows amounts of approved Table A water delivered each year from 1962 through 2005.

Article 21 and Unscheduled Water
Column 9 shows amounts of Article 21 water, as defined under SWP Deliveries, and unscheduled water delivered from 1962 through 2005.

Article 21 and unscheduled water is water in excess of that required to meet all demands for the year's approved Table A water and water to be stored in SWP reservoirs.

Other Water
Column 10 includes amounts of water classified as other water delivered in 2005, including non-SWP water conveyed through SWP facilities and regulated delivery of local supply.

In 2005, a total of 96,932 af of other water was delivered.

Feather River Diversions
Column 11 includes amounts of water from the Feather River delivered according to agreements for water rights water. In 2005, a total of 1,074,706 af in this category was delivered to agencies in the Feather River area.

Recreation Water
Column 12 shows water conveyed for recreational use or to provide water to improve water quality for fish and wildlife. In 2005, a total of 1,604 af of SWP water was conveyed for this purpose.

Initial Fill Water
The quantities listed in Column 14 represent the amounts used to initially fill the aqueducts and reservoirs south of the Delta to maximum operating capacities. Initial filling began in 1962 with the filling of the South Bay Aqueduct, and was completed in 1979 when Lake Perris reached its maximum operating capacity of 127,000 af. In 1996 and 1997, the Coastal Aqueduct was initially filled.

Operational Losses
Column 15 includes the total amounts of water lost through evaporation and seepage, net storage changes in reservoirs south of the Delta, and amounts of inflow from local drainage areas, including inflows into San Luis Canal and from the Kern River Intertie.

Negative values are indicated for years when withdrawals and evaporation from reservoirs south of the Delta exceed the amounts of water added to the reservoirs.

Table 9-3. Water Delivered to Long-Term Contractors through 2005 (Acre-Feet)

SWP Contractor	Table A Water Deliveries							2005 Article 21 (8)	Total SWP Water (9)	Non-SWP Water (10)	Total (11)
	2005 Table A not Transfered, Exchanged,or Stored (1)	2005 Table A Transfered or Exchanged (2)	2005 Table A Stored (3)	2005 Turnback Pool (4)	Total 2005 Table A (5)	2004 Carryover (6)	Total Table A (7)				
Feather River											
County of Butte	527				527		527		527		527
Plumas County FC&WCD											
City of Yuba City	1,894				1,894		1,894		1,894		1,894
North Bay											
Napa County FC&WCD	5,322				5,322	1,741	7,063	606	7,669		7,669
Solano County WA	22,515	2,000			24,515	83	24,598	10,421	35,019	4,800	39,819
South Bay											
Alameda County FC&WCD, Zone 7	38,388			275	38,663	7,849	46,512		46,512	11,901	58,413
Alameda County WD	10,769		25,700	943	37,412	6,341	43,753	846	44,599	10,852	55,451
Santa Clara Valley WD	48,339		32,333	342	81,014	12,133	93,147	6,298	99,445	20,000	119,445
San Joaquin Valley											
Castaic Lake WA	258		20,000		20,258		20,258	2,451	22,709		22,709
County of Kings	8,100			202	8,302		8,302	11,504	19,806		19,806
Dudley Ridge WD	41,437	7,672	2,500	1,286	52,895	821	53,716	28,197	81,913	576	82,489
Empire West Side ID	1,448				1,448	587	2,035	1,799	3,834		3,834
Kern County WA	754,786	48,941		22,397	826,124	9,851	835,975	453,078	1,289,053	19,216	1,308,269
Oak Flat WD	4,067			127	4,194		4,194		4,194		4,194
Tulare Lake Basin WSD	81,327	5,277		2,158	88,762	3,973	92,735	47,267	140,002	277	140,279
Central Coastal											
San Luis Obispo County FC&WCD	4,006				4,006		4,006	245	4,251		4,251
Santa Barbara County FC&WCD	22,981			155	23,136	208	23,344		23,344		23,344
Southern California											
Antelope Valley-East Kern WA	57,205				57,205	2,626	59,831		59,831		59,831
Castaic Lake WA	34,045				34,045	2,702	36,747		36,747		36,747
Coachella Valley WD	26,984			2,716	29,700	12,819	42,519		42,519		42,519
Crestline-Lake Arrowhead WA	807				807		807		807	170	977
Desert WA	33,168			1,122	34,290	14,799	49,089		49,089		49,089
Littlerock Creek ID											
Metropolitan WDSC	1,130,397	20,000	46,786	6,530	1,203,713	106,032	1,309,745	168,300	1,478,045		1,478,045
Mojave WA	10,360				10,360	1,201	11,561		11,561		11,561
Palmdale WD	10,174				10,174	1,538	11,712		11,712		11,712
San Bernardino Valley MWD	11,211	20,000			31,211	283	31,494	56	31,550		31,550
San Gabriel Valley MWD	10,500				10,500		10,500		10,500		10,500
San Gorgonio Pass WA	655			22	677		677	15	692		692
Ventura County FCD	1,665				1,665		1,665		1,665		1,665
Totals	**2,373,335**	**103,890**	**127,319**	**38,275**	**2,642,819**	**185,587**	**2,828,406**	**731,083**	**3,559,489**	**67,792**	**3,627,281**

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
FEATHER RIVER AREA														
City of Yuba City														
Approved Table A water	0	0	0	0	0	0	939	955	0	0	0	0	1,894	9,600
Pool A water sale*	2,160	0	0	0	0	0	0	0	0	0	0	0	2,160	
Pool B water sale*	0	3,480	0	0	0	0	0	0	0	0	0	0	3,480	
Agency Total (* excluded water)	0	0	0	0	0	0	939	955	0	0	0	0	1,894	
County of Butte														
Approved Table A water	83	6	9	119	36	5	20	105	29	4	2	109	527	1,200
Agency Total	83	6	9	119	36	5	20	105	29	4	2	109	527	
Plumas County Flood Control and Water Conservation District														
Approved Table A water	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation/Fish and Wildlife (SWP)														
Recreation/fish and wildlife water	0	0	0	0	1	0	1	1	0	0	0	0	3	
Last Chance Creek Water District														
Regulated delivery of local supply	0	0	0	0	1,164	1,880	2,091	2,142	603	196	119	0	8,195	
Thermalito Irrigation District														
Regulated delivery of local supply	91	66	88	126	202	275	405	421	316	219	118	28	2,355	
South Feather Water & Power Agency														
Regulated delivery of local supply	0	0	0	78	511	783	924	1,050	1,010	701	176	121	5,354	
Western Canal Water District														
Regulated delivery of local supply	1,560	0	0	4,170	41,467	40,431	62,104	49,426	12,079	26,760	30,630	14,554	283,181	
Joint Water Districts Board														
Regulated delivery of local supply	45,810	0	0	9,770	104,058	104,886	129,418	114,896	53,920	45,470	77,020	65,880	751,128	
Oswald WD														
Regulated delivery of local supply	0	0	0	1	78	158	246	32	45	0	0	0	560	
Tudor Mutual Water Company														
Regulated delivery of local supply	0	0	0	189	290	953	1,115	505	443	2	0	0	3,497	
Garden Highway Water Company														
Regulated delivery of local supply	0	0	0	883	1,748	1,220	6,505	1,882	865	884	0	0	13,987	
Plumas Mutual Water Company														
Regulated delivery of local supply	0	0	0	0	866	1,295	1,633	1,430	1,225	0	0	0	6,449	
SWP	83	6	9	119	37	5	960	1,061	29	4	2	109	2,424	
Non-SWP	47,461	66	88	15,217	150,384	151,881	204,441	171,784	70,506	74,232	108,063	80,583	1,074,706	
Feather River Area Total	***47,544***	***72***	***97***	***15,336***	***150,421***	***151,886***	***205,401***	***172,845***	***70,535***	***74,236***	***108,065***	***80,692***	***1,077,130***	***10,800***
NORTH BAY AREA														
Napa County Flood Control and Water Conservation District (NCFCWCD)														
Approved Table A water	0	0	4	236	371	577	628	607	556	409	883	891	5,162	22,225

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Approved Table A water delivered from Solano's service area*	3	2	3	3	4	23	33	18	30	25	3	13	160	
Article 21 water	0	0	606	0	0	0	0	0	0	0	0	0	606	
Article 56C extended carryover	900	841	0	0	0	0	0	0	0	0	0	0	1,741	
Vallejo Permit water from Solano	0	0	0	0	0	0	200	200	100	0	0	0	500	
Agency Total (* excluded water)	900	841	610	236	371	577	828	807	656	409	883	891	8,009	
Solano County Water Agency														
Approved Table A water	0	0	18	73	326	3,873	4,323	4,437	2,631	3,427	2,391	1,016	22,515	47,256
Napa's approved Table A water delivered through Solano's service area	3	2	3	3	4	23	33	18	30	25	3	13	160	
Article 21 water	791	403	289	705	1,406	0	1,162	1,846	2,644	1,175	0	0	10,421	
Article 56C extended carryover	47	36	0	0	0	0	0	0	0	0	0	0	83	
Approved Table A water exchange to Mojave*	0	0	0	0	0	0	0	0	0	0	0	2000	2,000	
Settlement water	0	0	0	0	0	0	0	0	0	349	783	0	1,132	
Vallejo Permit water	0	0	0	0	0	502	198	0	1025	223	686	534	3,168	
Vallejo Permit water delivered to Napa*	0	0	0	0	0	0	200	200	100	0	0	0	500	
Agency Total (* excluded water)	841	441	310	781	1,736	4,398	5,716	6,301	6,330	5,199	3,863	1,563	37,479	
SWP	1,741	1,282	920	1,017	2,107	4,473	6,146	6,908	5,861	5,036	3,277	1,920	40,688	
Non-SWP	0	0	0	0	0	502	398	200	1,125	572	1,469	534	4,800	
North Bay Area Total	***1,741***	***1,282***	***920***	***1,017***	***2,107***	***4,975***	***6,544***	***7,108***	***6,986***	***5,608***	***4,746***	***2,454***	***45,488***	***69,481***
SOUTH BAY AREA														
Alameda County Flood Control and Water Conservation District, Zone 7														
Approved Table A water	0	0	1,093	1,231	1,950	6,283	3385	6,208	6,260	5,307	4,087	2,584	38,388	80,619
Article 56C extended carryover	1,654	455	0	0	0	0	0	0	0	0	0	0	2,109	
Article 56C extended carryover to Semitropic*	845	4,895	0	0	0	0	0	0	0	0	0	0	5,740	
Pool A water	0	0	0	0	0	0	275	0	0	0	0	0	275	
Local water	186	1,144	1,006	1,389	2,059	141	3,890	370	176	287	85	168	10,901	
Transfer water from BBID	0	0	0	0	0	0	0	1,000	0	0	0	0	1,000	
Agency Total (* excluded water)	1,840	1,599	2,099	2,620	4,009	6,424	7,550	7,578	6,436	5,594	4,172	2,752	52,673	
Alameda County Water District														
Approved Table A water	0	844	0	0	0	1,188	83	690	2,273	2,400	1,724	1,567	10,769	42,000
Approved Table A water to Semitropic*	0	0	0	0	0	0	10,100	15,600	0	0	0	0	25,700	
Article 21 water	0	0	0	0	0	846	0	0	0	0	0	0	846	
Article 56C extended carryover	1,400	341	0	0	0	0	0	0	0	0	0	0	1,741	
Article 56C extended carryover to Semitropic*	1,952	2,648	0	0	0	0	0	0	0	0	0	0	4,600	
Local water	0	0	1,341	1,503	1,831	1,372	1,936	2,248	621	0	0	0	10,852	

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Pool A water	0	0	0	0	0	0	0	144	0	0	0	0	144	
Pool B water	0	0	0	0	0	0	799	0	0	0	0	0	799	
Agency Total (* excluded water)	1,400	1,185	1,341	1,503	1,831	3,406	2,818	3,082	2,894	2,400	1,724	1,567	25,151	
Santa Clara Valley Water District														
Approved Table A water	67	1,105	588	4,195	6,130	7,432	6,876	3,981	3,526	3,990	7,068	3,381	48,339	100,000
Approved Table A water to Semitropic*	0	0	0	0	0	0	23,041	7,792	0	0	0	1,500	32,333	
Approved Table A water to EWA*	0	0	0	0	0	0	0	8,804	0	0	0	0	8,804	
Article 21 water	0	873	2,310	0	0	0	0	0	0	0	0	0	3,183	
Article 21 water to Semitropic*	0	0	0	0	764	2,351	0	0	0	0	0	0	3,115	
Article 56C extended carryover	500	0	0	0	0	0	0	0	0	0	0	0	500	
Article 56C extended carryover to Semitropic*	4,554	7,079	0	0	0	0	0	0	0	0	0	0	11,633	
CVP water to Semitropic*	0	0	0	0	0	0	0	0	0	19,000	1,000	0	20,000	
Pool A water	0	0	0	0	0	0	0	0	342	0	0	0	342	
Approved Table A water transfer from KCWA to Semitropic*	0	0	0	0	0	0	0	0	21,941	0	0	0	21,941	
Agency Total (* excluded water)	567	1,978	2,898	4,195	6,130	7,432	6,876	3,981	3,868	3,990	7,068	3,381	52,364	
Recreation/Fish And Wildlife (SWP)														
Recreation/fish and Wildlife water, Lake Del Valle	5	4	7	8	12	16	20	20	20	18	16	8	154	
SWP	3,626	3,622	3,998	5,434	8,092	15,765	11,438	11,043	12,421	11,715	12,895	7,540	107,589	
Non-SWP	186	1,144	2,347	2,892	3,890	1,513	5,826	3,618	797	287	85	168	22,753	
South Bay Area Total	***3,812***	***4,766***	***6,345***	***8,326***	***11,982***	***17,278***	***17,264***	***14,661***	***13,218***	***12,002***	***12,980***	***7,708***	***130,342***	***222,619***
SAN JOAQUIN VALLEY AREA														
Castaic Lake Water Agency														
Approved Table A water	0	0	0	0	0	0	0	0	0	0	64	194	258	
Approved Table A water to Rosedale Rio Bravo*	0	0	0	0	0	0	0	0	0	0	12,869	7,131	20,000	
Article 21 water	0	916	533	0	0	0	0	0	0	0	0	1,002	2,451	
Agency Total (* excluded water)	0	916	533	0	0	0	0	0	0	0	64	1196	2709	
County of Kings														
Approved Table A water	0	0	0	0	0	0	278	849	630	1,161	502	2,070	5,490	9,000
Approved Table A water to WWD for Kings County*	0	1	0	0	433	391	378	517	376	236	174	104	2,610	
Article 21 water	256	0	0	0	0	0	0	0	0	0	0	0	256	
Article 21 water to WWD for Kings County*	319	1298	150	172	2,309	7,000	0	0	0	0	0	0	11,248	
Pool A water	0	0	0	0	0	0	0	31	0	0	0	0	31	
Pool B water	0	0	0	0	0	0	0	171	0	0	0	0	171	
Agency Total (* excluded water)	256	0	0	0	0	0	278	1,051	630	1,161	502	2,070	5,948	
Dudley Ridge Water District														

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Approved Table A water	0	0	100	2,205	3,014	6,576	10,109	8,341	5,292	2,791	212	2,797	41,437	57,343
Approved Table A water to Kern Water Bank*	0	0	0	0	0	0	0	0	0	1,500	1,000	0	2,500	
Article 21 water	1765	4,941	2811	0	0	0	0	0	0	0	0	5,534	15,051	
Article 21 water to Kern Water Bank*	845	2323	3377	2954	649	1064	0	0	0	0	0	1934	13,146	
Article 56C extended carryover	177	100	0	0	0	0	0	0	0	0	0	0	277	
Article 56C extended carryover to Kern Water Bank*	48	0	0	0	0	0	0	0	0	0	0	0	48	
Approved Table A water exchange to San Gabriel WA*	0	0	0	0	0	0	0	0	0	0	1,271	1,717	2,988	
Exchange approved Art 56C extended carryover water to San Gabriel WA*	316	180	0	0	0	0	0	0	0	0	0	0	496	
Approved Table A water exchange to KCWA*	0	0	0	0	0	0	0	0	0	4,684	0	0	4,684	
Pool A water	0	0	0	0	0	0	0	196	0	0	0	0	196	
Pool B water	0	0	0	0	0	0	0	1,090	0	0	0	0	1,090	
Transfer of Bureau water to DRWD from USBR	0	0	0	576	0	0	0	0	0	0	0	0	576	
Agency Total (* excluded water)	1,942	5,041	2,911	2,781	3,014	6,576	10,109	9,627	5,292	2,791	212	8,331	58,627	
Empire West Side Irrigation District														
Approved Table A water	0	0	0	37	0	0	0	0	0	140	214	1,057	1,448	3,000
Article 12E carryover	353	234	0	0	0	0	0	0	0	0	0	0	587	
Article 21 unscheduled water	0	0	568	1,231	0	0	0	0	0	0	0	0	1,799	
Agency Total	353	234	568	1,268	0	0	0	0	0	140	214	1,057	3,834	
Kern County Water Agency														
Approved Table A water	0	5,931	15,961	34,192	40,474	123,770	113,387	162,910	92,113	80,049	59,177	25,776	753,740	998,730
Approved Table A water for Western Hills	5	15	14	53	76	131	158	194	121	119	132	28	1,046	
Approved Table A water to EWA*	0	0	0	0	0	29,712	0	30,000	30,000	0	0	0	89,712	
Article 21 water	29101	85,722	120,563	122,343	15,517	34,659	0	0	0	0	0	45,173	453,078	
Article 55 carryover from Kern-Tulare WD (to San Luis in Oct 2004)	7,932	0	0	0	0	0	0	0	0	0	0	0	7,932	
Article 56C extended carryover	7045	2,806	0	0	0	0	0	0	0	0	0	0	9,851	
Exchange Table A to USBR*	0	0	0	0	0	0	0	0	20,000	0	0	0	20,000	
Exchange water from Westlands	0	0	0	0	0	0	0	0	0	0	10,717	567	11,284	
Approved Table A water exchange from DRWD	0	0	0	0	0	0	0	0	0	4,684	0	0	4,684	
Pool A water	0	0	0	0	0	0	3,412	0	0	0	0	0	3,412	
Pool B water	0	0	0	0	0	0	18,985	0	0	0	0	0	18,985	
Approved Table A transfer to SCVWD in Semitropic*	0	0	0	0	0	0	0	0	21,941	0	0	0	21,941	
Transfer Table A to Westlands*	0	0	0	0	0	0	0	7,000	0	0	0	0	7,000	
Water Bank Deliveries														
Article 56C extended carryover from ACFC&WCD to Semitropic	845	4,895	0	0	0	0	0	0	0	0	0	0	5,740	
Approved Table A water from ACWD to Semitropic	0	0	0	0	0	0	10,100	15,600	0	0	0	0	25,700	

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Article 56C extended carryover from ACWD to Semitropic	1952	2,648	0	0	0	0	0	0	0	0	0	0	4,600	
Approved Table A water from SCVWD to Semitropic	0	0	0	0	0	0	23,041	7,792	0	0	0	1,500	32,333	
Article 21 water from SCVWD to Semitropic	0	0	0	0	764	2,351	0	0	0	0	0	0	3,115	
Article 56C extended carryover from SCVWD to Semitropic	4554	7,079	0	0	0	0	0	0	0	0	0	0	11,633	
Conveyance of SCVWD water to Semitropic	0	0	0	0	0	0	0	0	0	19,000	1,000	0	20,000	
Transfer of Table A water from KCWA to SCVWD	0	0	0	0	0	0	0	0	21,941	0	0	0	21,941	
Approved Table A water from CLWA to Semitropic	0	0	0	0	0	0	0	0	0	0	12,869	7,131	20,000	
Approved Table A water from DRWD to Kern Water Bank	0	0	0	0	0	0	0	0	0	1,500	1,000	0	2,500	
Article 21 water from DRWD to Kern Water Bank	845	2323	3377	2954	649	1064	0	0	0	0	0	1934	13,146	
Article 56C extended carryover from DRWD to Kern Water Bank	48	0	0	0	0	0	0	0	0	0	0	0	48	
Approved Table A water from MWDSC to Semitropic	0	0	0	0	25,036	0	6,174	0	0	0	0	0	31,210	
Approved Table A water from MWDSC to Arvin Edison	0	0	0	0	1,138	1,324	9,808	2,538	0	576	0	0	15,384	
Approved Table A water from MWDSC Kern Delta	0	0	0	0	0	0	192	0	0	0	0	0	192	
Water Bank Delivery Subtotal	8,244	16,945	3,377	2,954	27,587	4,739	49,315	25,930	21,941	21,076	14,869	10,565	207,542	
Agency Total (* excluded water)	52,327	111,419	139,915	159,542	83,654	163,299	185,257	189,034	114,175	105,928	84,895	82,109	1,471,554	
Oak Flat Water District														
Approved Table A water	0	10	31	156	536	716	867	923	389	302	122	15	4,067	5,700
Pool A water	0	0	0	0	0	0	19	0	0	0	0	0	19	
Pool B water	0	0	0	0	0	0	108	0	0	0	0	0	108	
Agency Total	0	10	31	156	536	716	994	923	389	302	122	15	4,194	
Tulare Lake Basin Water Storage District														
Approved Table A water	0	0	0	0	377	181	2,299	18,186	11,419	3,701	16,523	28,641	81,327	96,227
Article 21 water	3646	3,564	5,817	18,706	1,111	2,837	0	0	0	0	0	11,586	47,267	
Article 12E carryover	158	3,815	0	0	0	0	0	0	0	0	0	0	3,973	
Exchange Table A water to Westlands Water District*	0	0	0	0	0	0	0	277	0	0	0	0	277	
Exchange water from Westlands Water District	0	0	177	100	0	0	0	0	0	0	0	0	277	
Pool A water	0	0	0	0	0	0	0	329	0	0	0	0	329	
Pool B water	0	0	0	0	0	0	0	1,829	0	0	0	0	1,829	
Transfer approved Table A water to Westlands Water District *	0	0	0	0	0	100	2,400	1,200	750	550	0	0	5,000	
Agency Total (* excluded water)	3,804	7,379	5,994	18,806	1,488	3,018	2,299	20,344	11,419	3,701	16,523	40,227	135,002	
Westlands Water District														
Approved Table A water from County of Kings to Kings County	0	1	0	0	433	391	378	517	376	236	174	104	2,610	
Article 21 water from County of Kings to Kings County	319	1298	150	172	2,309	7,000	0	0	0	0	0	0	11,248	
Approved Table A transfer from KCWA	0	0	0	0	0	0	0	7,000	0	0	0	0	7,000	

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Exchange water to KCWA*	0	0	0	0	0	0	0	0	0	0	10,717	567	11,284	
Approved Table A water exchange from TLBWSD	0	0	0	0	0	0	0	277	0	0	0	0	277	
Exchange water to TLBWSD*	0	0	177	100	0	0	0	0	0	0	0	0	277	
Approved Table A water transfer from TLBWSD	0	0	0	0	0	100	2,400	1,200	750	550	0	0	5,000	
Agency Total (* excluded water)	319	1,299	150	172	2,742	7,491	2,778	8,994	1,126	786	174	104	26,135	
Recreation/Fish and Wildlife (SWP)														
Department of Fish & Game, O'Neill/Lateral 4	71	38	5	44	95	27	40	52	45	44	47	52	560	
Parks and Recreation, O'Neill/San Luis/Cattle	1	1	1	1	5	12	10	12	5	1	2	2	53	
RF&W Total	72	39	6	45	100	39	50	64	50	45	49	54	613	
Environmental Water Account Program														
Approved Table A water from Kern County WD	0	0	0	0	0	29,712	0	0	0	0	0	0	29,712	
Approved Table A water from Kern County WD	0	0	0	0	0	0	0	30,000	30,000	0	0	0	60,000	
Approved Table A water from MWDSC	0	0	0	0	0	0	0	20,000	20,000	10,000	0	0	50,000	
Approved Table A water from SCVWD	0	0	0	0	0	0	0	8,804	0	0	0	0	8,804	
Yuba County Water Agency	0	0	0	0	0	0	0	0	0	4,549	1,495	0	6,044	
EWA program Total *	0	0	0	0	0	29,712	0	58,804	50,000	14,549	1,495	0	154,560	
US Bureau of Reclamation (CVP Water Conveyed)														
Plain View WD/Musco Olive Products, Inc (Annual Contract)	46	39	47	47	40	38	48	65	65	77	55	2	569	
US Dept of Veterans Affairs, SJV National Cemetery (Annual Contract)	1	1	1	1	5	10	12	9	6	3	2	1	52	
Transfer water to DRWD*	0	0	0	576	0	0	0	0	0	0	0	0	576	
Exchange Table A water from KCWA	0	0	0	0	0	0	0	0	20,000	0	0	0	20,000	
Kern National Wildlife Refuge	411	0	620	849	506	0	0	1,602	5,130	5,367	5,222	3,240	22,947	
Recreation water	0	1	1	1	5	9	7	10	4	1	0	4	43	
Fish and wildlife water	64	31	5	36	77	22	33	42	37	36	39	160	582	
USBR Total (* excluded water)	522	72	674	934	633	79	100	1,728	25,242	5,484	5,318	3,407	44,193	
Cross Valley Canal Contracts														
Lower Tule River CVP water to the USBR	0	0	0	0	0	0	0	0	0	2,469	0	0	2,469	
Pixley Irrigation District CVP water to the USBR	0	0	0	0	0	0	0	0	0	2,469	0	0	2,469	
CVC Total	0	0	0	0	0	0	0	0	0	4,938	0	0	4,938	
SWP	51,141	126,337	149,931	182,094	91,534	181,139	201,765	230,037	153,081	95,854	91,038	134,596	1,688,547	
Non-SWP	8,454	72	851	1,610	633	79	100	1,728	5,242	29,422	17,035	3,974	69,200	
San Joaquin Valley Area Total	***59,595***	***126,409***	***150,782***	***183,704***	***92,167***	***181,218***	***201,865***	***231,765***	***158,323***	***125,276***	***108,073***	***138,570***	***1,757,747***	***1,170,000***
CENTRAL COASTAL AREA														
San Luis Obispo County Flood Control and Water Conservation District														
Approved Table A water	157	321	347	257	370	402	410	431	423	419	177	292	4,006	25,000

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Article 21 water	0	0	0	145	42	34	0	0	0	0	0	24	245	
Agency Total	157	321	347	402	412	436	410	431	423	419	177	316	4,251	
Santa Barbara County Flood Control and Water Conservation District														
Approved Table A water	839	972	1,253	1,803	2,258	2,689	3,009	2,753	2,654	2,179	999	1,573	22,981	45,486
Carryover 14B	208	0	0	0	0	0	0	0	0	0	0	0	208	
Pool A water	0	0	0	0	0	0	0	155	0	0	0	0	155	
Agency Total	1,047	972	1,253	1,803	2,258	2,689	3,009	2,908	2,654	2,179	999	1,573	23,344	
SWP	1,204	1,293	1,600	2,205	2,670	3,125	3,419	3,339	3,077	2,598	1,176	1,889	27,595	
Non-SWP	0	0	0	0	0	0	0	0	0	0	0	0	0	
Central Coastal Area Total	***1,204***	***1,293***	***1,600***	***2,205***	***2,670***	***3,125***	***3,419***	***3,339***	***3,077***	***2,598***	***1,176***	***1,889***	***27,595***	***70,486***
SOUTHERN CALIFORNIA AREA														
Antelope Valley-East Kern Water Agency														
Approved Table A water	0	0	2,075	3,583	4,883	6,625	8,993	9,674	7,287	5,294	4,439	4,352	57,205	141,400
Article 12E carryover	1,450	1,176	0	0	0	0	0	0	0	0	0	0	2,626	
MWA's Approved Table A water delivered through AVEK's service area	0	0	53	111	118	148	181	136	123	82	0	21	973	
MWA's Article 56C carryover water delivered through AVEK's service area	19	24	0	0	0	0	0	0	0	0	0	0	43	
Agency Total	1,469	1,200	2,128	3,694	5,001	6,773	9,174	9,810	7,410	5,376	4,439	4,373	60,847	
Castaic Lake Water Agency														
Approved Table A water	0	0	1,250	2,018	2,952	4,324	5,512	5,204	4,815	2,989	2,762	2,219	34,045	95,200
Article 56C extended carryover	1,557	1,145	0	0	0	0	0	0	0	0	0	0	2,702	
Agency Total	1,557	1,145	1,250	2,018	2,952	4,324	5,512	5,204	4,815	2,989	2,762	2,219	36,747	
Coachella Valley Water District														
Approved Table A water	0	0	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	584	0	26,984	121,000
Article 12E carryover	3,932	0	0	0	0	0	0	0	0	0	0	0	3,932	
Article 56C extended carryover	8,887	0	0	0	0	0	0	0	0	0	0	0	8,887	
Pool A water	0	0	0	0	0	0	414	0	0	0	0	0	414	
Pool B water	0	0	0	0	0	0	2,302	0	0	0	0	0	2,302	
Agency Total	12,819	0	3,300	3,300	3,300	3,300	6,016	3,300	3,300	3,300	584	0	42,519	
Crestline-Lake Arrowhead Water Agency														
Approved Table A water	0	0	18	28	73	85	136	146	116	85	75	45	807	5,800
Local water	103	47	20	0	0	0	0	0	0	0	0	0	170	
Agency Total	103	47	38	28	73	85	136	146	116	85	75	45	977	
Desert Water Agency														

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Approved Table A water	0	0	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	2,688	0	33,168	
Article 12E carryover	7,716	0	0	0	0	0	0	0	0	0	0	0	7,716	
Article 56C extended carryover	7,083	0	0	0	0	0	0	0	0	0	0	0	7,083	
Pool A water	0	0	0	0	0	0	0	171	0	0	0	0	171	
Pool B water	0	0	0	0	0	0	0	951	0	0	0	0	951	
Agency Total (* excluded water)	14,799	0	3,810	3,810	3,810	3,810	3,810	4,932	3,810	3,810	2,688	0	49,089	
Littlerock Creek Irrigation District														
Approved Table A water	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pool A water sale*	880	0	0	0	0	0	0	0	0	0	0	0	880	
Agency Total (* excluded water)	0	0	0	0	0	0	0	0	0	0	0	0	0	2,300
Metropolitan Water District of Southern California														
Approved Table A water	0	0	0	101,572	104,118	120,176	135,913	143,652	144,053	132,988	115,572	132,353	1,130,397	1,911,500
Approved Table A water to Semitropic*	0	0	0	0	25,036	0	6,174	0	0	0	0	0	31,210	
Approved Table A water to Kern Delta*	0	0	0	0	1,138	1,324	10,000	2,538	0	576	0	0	15,576	
Approved Table A water transfer from SBVMWD	0	0	0	0	0	0	0	0	0	0	10,000	10,000	20,000	
Approved Table A water to EWA *	0	0	0	0	0	0	0	20,000	20,000	10,000	0	0	50,000	
Article 21 water	18,664	66,664	82,972	0	0	0	0	0	0	0	0	0	168,300	
Article 56C extended carryover	73,283	32,749	0	0	0	0	0	0	0	0	0	0	106,032	
Approved Table A water exchange to Mojave*	0	0	0	0	0	0	0	0	0	0	9,725	10,275	20,000	
Pool A water	0	0	0	0	0	0	6,530	0	0	0	0	0	6,530	
Agency Total (* excluded water)	91,947	99,413	82,972	101,572	104,118	120,176	142,443	143,652	144,053	132,988	125,572	142,353	1,431,259	
Mojave Water Agency														
Approved Table A water	0	0	297	585	669	1,166	1,791	2,139	1,191	761	376	412	9,387	75,800
Approved Table A water through AVEK's service area*	0	0	53	111	118	148	181	136	123	82	0	21	973	
Article 56C extended carryover	345	813	0	0	0	0	0	0	0	0	0	0	1,158	
Article 56C carryover water delivered through AVEK's service area*	19	24	0	0	0	0	0	0	0	0	0	0	43	
Approved Table A water exchange from MWD	0	0	0	0	0	0	0	0	0	0	9,725	10,275	20,000	
Approved Table A water exchange from Solano	0	0	0	0	0	0	0	0	0	0	0	2000	2,000	
Agency Total (* excluded water)	345	813	297	585	669	1,166	1,791	2,139	1,191	761	10,101	12,687	32,545	
Palmdale Water District														
Approved Table A water	0	0	339	1,045	1,063	1,018	1,380	1,392	1,067	1,296	899	675	10,174	21,300
Article 56C extended carryover	1,459	79	0	0	0	0	0	0	0	0	0	0	1,538	
Agency Total	1,459	79	339	1,045	1,063	1,018	1,380	1,392	1,067	1,296	899	675	11,712	
San Bernardino Valley Municipal Water District														
Approved Table A water	0	0	0	127	300	772	1,902	1,508	693	1,437	1,668	2,804	11,211	102,600
Article 21 water	0	0	56	0	0	0	0	0	0	0	0	0	56	
Article 56C extended carryover	22	261	0	0	0	0	0	0	0	0	0	0	283	

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Approved Table A water transfer to MWD *	0	0	0	0	0	0	0	0	0	0	10,000	10,000	20,000	
Agency Total (* excluded water)	22	261	56	127	300	772	1,902	1,508	693	1,437	1,668	2,804	11,550	
San Gabriel Valley Municipal Water District														
Approved Table A water	0	0	0	12	0	2,407	961	0	2,384	3,111	1,625	0	10,500	28,800
Approved Table A water from DRWD	0	0	0	0	0	0	0	0	0	0	1,271	1,717	2,988	
Exchange approved Art 56C extended carryover water from DRWD	316	180	0	0	0	0	0	0	0	0	0	0	496	
Pool B water sale*	0	15,420	0	0	0	0	0	0	0	0	0	0	15,420	
Agency Total	316	180	0	12	0	2,407	961	0	2,384	3,111	2,896	1,717	13,984	
San Gorgonio Pass Water Agency														
Approved Table A water	0	16	0	53	46	57	28	42	95	116	108	94	655	6,500
Article 21 water	0	0	15	0	0	0	0	0	0	0	0	0	15	
Pool A water	0	0	0	0	0	0	0	22	0	0	0	0	22	
Agency Total (* excluded water)	0	16	15	53	46	57	28	64	95	116	108	94	692	
Ventura County Flood Control District														
Approved Table A water	0	0	0	0	231	231	231	231	231	231	231	48	1,665	20,000
Pool A water sale*	9,000	0	0	0	0	0	0	0	0	0	0	0	9,000	
Pool B water sale*	0	7,335	0	0	0	0	0	0	0	0	0	0	7,335	
Agency Total (* excluded water)	0	0	0	0	231	231	231	231	231	231	231	48	1,665	
Recreation/Fish And Wildlife (SWP)														
Castaic Lake	28	27	30	33	32	10	72	90	54	42	18	36	472	
Castaic Lake to Lagoon	0	0	0	0	0	0	0	112	68	0	0	0	180	
Silverwood Lake	4	4	4	4	6	14	13	14	7	5	4	5	84	
Agency Total	32	31	34	37	38	24	85	216	129	47	22	41	736	
Recreation/Fish And Wildlife (CVP)														
USFS Recreation/Fish and Wildlife water (Pyramid Lake)	0	0	0	0	0	0	5	1	1	1	0	1	9	
SWP	124,765	103,138	94,219	116,281	121,601	144,143	173,469	172,594	169,294	155,547	152,045	167,056	1,694,152	
Non-SWP	103	47	20	0	0	0	5	1	1	1	0	1	179	
Southern California Area Total	***124,868***	***103,185***	***94,239***	***116,281***	***121,601***	***144,143***	***173,474***	***172,595***	***169,295***	***155,548***	***152,045***	***167,057***	***1,694,331***	***2,582,300***
SWP Water														
SWP Approved Table A water														
Agriculture and M&I approved water	1,154	9,223	30,563	160,804	204,092	299,680	360,635	409,269	297,887	264,235	239,350	223,762	2,500,654	
Agriculture and M&I approved water for EWA*	0	0	0	0	0	29,712	0	58,804	50,000	10,000	0	0	148,516	
Article 21 water	55,387	166,704	219,499	145,025	21,798	48,791	1,162	1,846	2,644	1,175	0	65,253	729,284	
Article 12E carryover	12,159	4,049	0	0	0	0	0	0	0	0	0	0	16,208	
Article 14B carryover	208	0	0	0	0	0	0	0	0	0	0	0	208	
Article 56C extended carryover	113,227	55,448	0	0	0	0	0	0	0	0	0	0	168,675	

Table 9-4. Total Amounts of Water Delivered in 2005, by Month

Contracting Agency and Type of Service	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2005 Deliveries	2005 Table A
Article 56C extended carryover exchange	316	180	0	0	0	0	0	0	0	0	0	0	496	
Article 21 unscheduled water	0	0	568	1,231	0	0	0	0	0	0	0	0	1,799	
Transfer approved water	0	0	0	0	0	100	2,400	8,200	22,691	550	10,000	10,000	53,941	
Exchange approved water	0	0	0	0	0	0	0	0	20,000	4,684	10,996	13,992	49,672	
Pool A water	0	0	0	0	0	0	10,650	1,048	342	0	0	0	12,040	
Pool B water	0	0	0	0	0	0	22,194	4,041	0	0	0	0	26,235	
Pool A water sale*	12,040	0	0	0	0	0	0	0	0	0	0	0	12,040	
Pool B water sale*	0	26,235	0	0	0	0	0	0	0	0	0	0	26,235	
Supply approved water	0	0	0	0	0	0	0	277	0	0	0	0	277	
Agency Total (* excluded water)	182,451	235,604	250,630	307,060	225,890	348,571	397,041	424,681	343,564	270,644	260,346	313,007	3,559,489	
SWP Table A-related water														
Recreation/Fish and Wildlife water	109	74	47	90	151	79	156	301	199	110	87	103	1,506	
SWP Total	***182,560***	***235,678***	***250,677***	***307,150***	***226,041***	***348,650***	***397,197***	***424,982***	***343,763***	***270,754***	***260,433***	***313,110***	***3,560,995***	
NON-SWP WATER														
Other water														
Local	47,750	1,257	2,455	18,109	154,274	153,394	210,267	174,402	71,303	74,519	108,148	80,751	1,096,629	
Solano Settlement water	0	0	0	0	0	0	0	0	0	349	783	0	1,132	
Vallejo Permit water	0	0	0	0	0	502	398	200	1,125	223	686	534	3,668	
Subtotal (Other water)	47,750	1,257	2,455	18,109	154,274	153,896	210,665	174,602	72,428	75,091	109,617	81,285	1,101,429	
CVP/USBR water														
Water to DWR	0	0	0	0	0	0	0	0	0	4,938	0	0	4,938	
Annual Contract water	47	40	48	48	45	48	60	74	71	80	57	3	621	
Kern National Wildlife Refuge water	411	0	620	849	506	0	0	1,602	5,130	5,367	5,222	3,240	22,947	
Recreation/Fish& Wildlife water	64	32	6	37	82	31	45	53	42	38	39	165	634	
Water exchange to SWP contractor	7,932	0	177	100	0	0	0	0	0	0	0	0	8,209	
Water transfer to SWP contractor	0	0	0	576	0	0	0	1,000	0	0	0	0	1,576	
General Conveyance	0	0	0	0	0	0	0	0	0	19,000	11,717	567	31,284	
Subtotal (CVP water)	8,454	72	851	1,610	633	79	105	2,729	5,243	24,485	17,035	3,975	70,209	
Non-SWP Total	***56,204***	***1,329***	***3,306***	***19,719***	***154,907***	***153,975***	***210,770***	***177,331***	***77,671***	***99,576***	***126,652***	***85,260***	***1,171,638***	
Grand total	**238,764**	**237,007**	**253,983**	**326,869**	**380,948**	**502,625**	**607,967**	**602,313**	**421,434**	**370,330**	**387,085**	**398,370**	**4,732,633**	**4,125,686**

Table 9-5. Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-2005 (Acre-Feet)

Year	Annual Table Amounts According to Long-Term Water Supply Contracts							Water Conveyed								Total
								Deliveries								
	Upper Feather River Area (1)	North Bay Area (2)	South Bay Area (3)	San Joaquin Valley Area (4)	Central Coastal Area (5)	Southern California Area (6)	Total (7)	Table A Water (8)	Article 21, Surplus, and Unscheduled Water (a (9)	Other Water (b (10)	Feather River Diversions (c (11)	Wildlife/ Recreation Water (12)	Subtotal (13)	Initial Fill Water (14)	Losses and Storage Changes (d (15)	(16)
1962	0	0	0	0	0	0	0	0	0	18,289	0	0	18,289	9	272	18,570
1963	0	0	0	0	0	0	0	0	0	22,456	0	0	22,456	71	185	22,712
1964	0	0	0	0	0	0	0	0	0	32,507	0	0	32,507	171	152	32,830
1965	0	0	0	0	0	0	0	0	0	44,105	0	0	44,105	93	729	44,927
1966	0	0	0	0	0	0	0	0	0	67,928	0	0	67,928	0	1,746	69,674
1967	0	0	11,538	0	0	0	11,538	11,538	0	53,605	0	0	65,143	8,328	4,212	77,683
1968	550	0	109,900	77,350	0	3,700	191,500	171,709	121,534	14,777	866,926	0	1,174,946	498,926	117,906	1,791,778
1969	620	0	98,700	163,075	0	5,000	267,395	193,020	72,397	18,829	794,374	0	1,078,620	510,614	72,196	1,661,430
1970	700	0	114,200	202,000	0	5,700	322,600	233,993	133,024	38,080	759,759	0	1,164,856	23,947	2,435	1,191,238
1971	890	0	116,200	251,800	0	6,700	375,590	357,340	296,019	44,119	778,362	8	1,475,848	7,853	5,812	1,489,513
1972	970	0	118,300	413,066	0	209,423	741,759	611,801	423,964	66,638	817,398	6,489	1,926,290	100,274	53,062	2,079,626
1973	1,100	0	120,400	383,652	0	481,100	986,252	694,388	296,416	42,511	800,743	1,155	1,835,213	204,638	53,798	2,093,649
1974	1,230	0	122,400	460,650	0	597,920	1,182,200	874,077	417,676	46,224	911,613	2,118	2,251,708	237,554	10,657	2,499,919
1975	1,610	0	124,500	545,809	0	714,950	1,386,869	1,223,990	622,902	63,793	862,218	3,377	2,776,280	103,352	(94,606)	2,785,026
1976	1,990	0	126,500	543,417	0	836,480	1,508,387	1,373,002	580,110	115,217	946,440	1,745	3,016,514	61,122	(681,025)	2,396,611
1977	2,420	0	128,600	581,400	0	954,901	1,667,321	574,155	0	389,065	581,994	1,111	1,546,325	0	(131,151)	1,415,174
1978	1,850	0	130,700	635,900	0	1,049,584	1,818,034	1,452,699	16,914	121,225	786,517	1,691	2,379,046	64,443	717,370	3,160,859
1979	2,130	0	132,700	702,685	0	1,190,573	2,028,088	1,659,896	648,389	187,630	882,549	1,766	3,380,230	12,302	(83,430)	3,309,102
1980	1,810	500	134,800	758,100	1,946	1,317,614	2,214,770	1,529,749	404,557	46,459	875,045	2,131	2,857,941	0	(26,606)	2,831,335
1981	1,940	650	137,000	818,000	2,813	1,432,065	2,392,468	1,909,562	908,428	279,161	838,557	4,688	3,940,396	0	(802,263)	3,138,133
1982	1,970	800	139,200	876,500	5,626	1,550,449	2,574,545	1,750,024	215,873	154,882	776,330	4,646	2,901,755	0	480,752	3,382,507
1983	2,000	950	141,400	867,118	8,439	1,681,257	2,701,164	1,184,869	13,019	181,453	602,905	7,849	1,990,095	0	(90,997)	1,899,098
1984	3,630	1,100	143,600	979,211	12,698	1,744,098	2,884,337	1,588,619	262,917	381,024	832,332	7,040	3,071,932	0	(140,182)	2,931,750
1985	3,760	1,250	145,800	1,019,049	21,138	1,864,849	3,055,846	1,995,453	307,672	404,842	870,008	4,033	3,582,008	0	92,885	3,674,893
1986	4,190	1,400	148,100	1,091,946	28,210	1,983,890	3,257,736	1,995,636	36,620	193,606	791,737	3,865	3,021,464	0	284,380	3,305,844
1987	4,620	1,550	150,300	1,188,500	35,204	2,103,941	3,484,115	2,130,086	114,907	377,592	831,947	7,672	3,462,204	0	(390,413)	3,071,791
1988	5,060	15,471	152,500	1,246,100	43,722	2,225,482	3,688,335	2,385,122	0	507,076	794,834	4,889	3,691,921	0	(92,850)	3,599,071
1989	5,500	24,615	156,700	1,290,400	56,342	2,424,633	3,958,190	2,853,747	0	474,559	830,500	8,135	4,166,941	0	447,917	4,614,858
1990	6,040	28,190	160,900	1,313,450	70,486	2,500,600	4,079,666	2,582,151	90	424,697	875,099	9,262	3,891,299	0	(528,869)	3,362,430
1991	11,880	29,590	166,400	1,338,011	70,486	2,510,200	4,126,567	549,113	3,521	551,051	565,395	4,879	1,673,959	0	167,435	1,841,394

Table 9-5. Total Amounts of Annual Table A Water and Water Conveyed, by Type, 1962-2005 (Acre-Feet)

Year	Annual Table Amounts According to Long-Term Water Supply Contracts							Water Conveyed								
								Deliveries								
	Upper Feather River Area (1)	North Bay Area (2)	South Bay Area (3)	San Joaquin Valley Area (4)	Central Coastal Area (5)	Southern California Area (6)	Total (7)	Table A Water (8)	Article 21, Surplus, and Unscheduled Water (a (9)	Other Water (b (10)	Feather River Diversions (c (11)	Wildlife/ Recreation Water (12)	Subtotal (13)	Initial Fill Water (14)	Losses and Storage Changes (d (15)	Total (16)
1992	11,920	32,010	171,900	1,342,300	70,486	2,510,200	4,138,816	1,471,454	1,156	144,789	613,978	2,605	2,233,982	0	(63,541)	2,170,441
1993	11,960	34,620	177,400	1,342,300	70,486	2,510,200	4,146,966	2,315,235	0	254,854	822,589	2,609	3,395,287	0	726,123	4,121,410
1994	12,000	37,215	182,000	1,342,300	70,486	2,510,200	4,154,201	1,749,351	112,625	236,739	874,018	8,200	2,980,933	0	(295,405)	2,685,528
1995	12,050	44,030	184,000	1,342,300	70,486	2,510,200	4,163,066	1,967,093	64,330	78,425	860,077	2,575	2,972,500	0	69,536	3,042,036
1996	12,100	48,225	186,000	1,301,630	70,486	2,492,900	4,111,341	2,514,825	28,647	251,391	934,997	3,907	3,733,767	86	491,550	4,225,403
1997	12,150	49,315	188,000	1,297,300	45,201	2,492,900	4,084,866	2,325,775	21,432	322,000	993,211	4,146	3,666,564	527	(11,806)	3,655,285
1998	12,200	50,420	188,000	1,272,300	45,201	2,517,900	4,086,021	1,725,519	20,288	134,682	872,738	2,108	2,755,335	0	(132,491)	2,622,844
1999	12,250	51,500	188,000	1,272,300	70,486	2,519,900	4,114,436	2,738,891	158,070	85,312	1,108,672	4,324	4,095,269	0	(189,525)	3,905,744
2000	14,000	55,945	210,000	1,205,300	70,486	2,565,900	4,121,631	3,200,677	308,785	332,654	1,085,886	4,030	4,932,032	0	(20,103)	4,911,929
2001	14,670	66,561	220,000	1,185,519	70,486	2,566,900	4,124,136	1,690,926	43,435	477,835	1,078,656	2,929	3,293,781	0	159,983	3,453,764
2002	14,730	67,396	220,000	1,195,219	70,486	2,557,200	4,125,031	2,573,030	37,165	307,162	1,132,938	3,694	4,053,989	0	80,709	4,134,698
2003	14,790	68,231	220,400	1,194,819	70,486	2,558,200	4,126,926	2,901,041	59,828	251,447	1,008,093	2,846	4,223,255	0	459,377	4,682,632
2004	13,100	69,056	222,619	1,182,700	70,486	2,569,100	4,127,061	2,599,536	218,496	385,088	1,174,672	2,865	4,380,657	0	108,840	4,489,497
2005	10,800	69,481	222,619	1,170,000	70,486	2,582,300	4,125,686	2,828,406	731,083	96,932	1,074,706	1,506	4,732,633	0	529,347	5,261,980
Total	**236,380**	**780,590**	**5,789,657**	**34,223,476**	**1,222,858**	**62,276,809**	**104,529,770**	**64,487,498**	**7,702,289**	**8,722,710**	**32,908,813**	**136,893**	**113,958,203**	**1,834,310**	**1,364,103**	**117,156,616**

a) Values include amounts of deliveries to short-term contractors (Mustang Water District, 1970-1972; Tracy Golf and Country Club 1974, 1979, and 1980; Green Valley Water District, 1974,1975, 1978, 1979, 1980, and 1985; Granite Construction Company, 1980).
b) Includes amounts of SWP and non-SWP water conveyed for SWP and non-SWP water contractors.
c) Includes amounts of water diverted under various water rights agreements.
d) Amounts reflect net effect of (1) operational losses from SWP transportation facilities; (2) changes in reservoir storage south of Delta; (3) storable local inflows to SWP reservoirs; (4) side inflow to San Luis Canal; and (5) inflow into California Aqueduct from Kern River Intertie.

Chapter 10
Power Resources

Delivery of a new runner for Oroville's Hyatt Power Plant refurbishment project.

Significant Events in 2005

On January 26, 2005, the Department of Water Resources (DWR) submitted its Application for New License for the Oroville Facilities with the Federal Energy Regulatory Commission (FERC).

In August 2005, the federal Energy Policy Act of 2005 was signed into law. The law authorized an Electric Reliability Organization with the statutory authority to enforce compliance with mandatory reliability standards applicable to all market participants throughout the United States' bulk electric system.

On September 12, 2005, following DWR's successful compliance with FERC's May 2005 Additional Information Request, FERC accepted DWR's Application for a New License for operating the Oroville Facilities. FERC's acceptance of DWR's license application marked the conclusion of the multiyear collaborative Alternative Licensing Process (ALP) involving federal and State agencies, Indian tribes, local agencies, environmental organizations, and other interested parties that worked to assist DWR in completing a comprehensive license application and accompanying Preliminary Draft Environmental Assessment. While this procedurally completed the ALP phase of FERC relicensing, settlement negotiations and completion of all federal/State environmental documentation was still ongoing at the end of 2005 in pursuit of a new FERC license at the Oroville Facilities.

Information for this chapter was provided by the State Water Project Analysis Office.

Long-term State Water Project (SWP) contractors depend on the SWP to provide economical sources of power to deliver affordable water. In response to that need, the Department of Water Resources (DWR) developed and administers a comprehensive power resources program. Key elements of the program include the strategic timing of generation and pumping schedules, purchase of power resources and transmission services, short-term sales of power surpluses, and studies of power resources for future needs.

Power Resources Program

The goals of the SWP power resources program are to

- obtain reliable, environmentally sensitive, and competitively priced power resources and transmission services sufficient to operate the SWP;
- develop and manage power resources to minimize the cost of water deliveries to SWP contractors;
- meet responsibilities and criteria of the Western Electricity Coordinating Council (WECC); and
- conform to regulations of the Federal Energy Regulatory Commission (FERC).

To achieve these goals, DWR constructed its own generating, pumping, and pumped-storage facilities; and enters into long-term and short-term contracts with other electric utilities for transmission access and power purchases, sales, and exchanges.

In addition, DWR participates in the California Independent System Operator (CAISO) supplemental energy market to help CAISO maintain its control area demand and supply balance. DWR generators and pumps also participate in CAISO ancillary services markets by providing spinning and non-spinning reserves to the CAISO controlled grid. In the case of system emergencies or contingencies, DWR can drop its pump load to help CAISO maintain reliable system operation.

The power resources program takes advantage of SWP water storage and conveyance capacities that allow DWR to operate the SWP in a cost-effective manner. This control of pumping loads and generation allows DWR to enter into advantageous agreements with other electric utilities that complement the use of SWP generation to meet SWP power requirements.

Major Electric Utility Industry Developments

In August 2005, the federal Energy Policy Act of 2005 was signed into law. The law authorized an Electric Reliability Organization with the statutory authority to enforce compliance with mandatory reliability standards applicable to all market participants throughout the United States' bulk electric system.

During 2005, CAISO continued work on proposals for major redesign of its

markets that became necessary as a result of the California energy crisis in 2000 and 2001. Initially termed Market Design 2002 (MD02), the proposal was renamed Market Redesign and Technology Upgrade (MRTU).

During 2005, the California Public Utilities Commission (CPUC) issued Decision 05-10-042, which reaffirmed and clarified the policy framework CPUC established under its *Order Instituting Rulemaking to Promote Policy and Program Coordination and Integration in Electric Utility Planning* (OIR.04-04-003). Key program determinants included monthly system obligations based on coincident peaks, supply contracts with specific resources for qualifying capacity, deferred local capacity requirements, noncompliance penalties of three times the cost for new capacity, and retention of the FERC Must Offer Obligation and waiver process until 2007.

In late 2005, CPUC issued its *Ruling Regarding Next Steps in Procurement Proceeding*. It also initiated two successor rulemakings to consider future resource adequacy issues such as the implementation of existing and multiyear requirements and mandates in local areas; and the biennial long-term procurement planning cycle and other procurement issues.

In September 2005, California Assembly Bill (AB) 380 was passed by the Legislature and signed by the Governor. AB 380 contains two sections that address resource adequacy requirements for entities subject to CPUC jurisdiction and publicly owned utilities. SWP is specifically exempted from AB 380 requirements.

DWR Participation in Electric Utility Industry Activities

In 2005, DWR participated in CAISO's MRTU stakeholder processes and litigation before FERC (ER02-1656) to help ensure that MRTU was fully functional and cost allocations were appropriately structured. DWR's participation focused on the following primary elements:

- congestion revenue rights allocations;
- generation and import deliverability;
- hour-ahead scheduling process, day-ahead schedules;
- integrated forward market;
- residual unit commitment;
- real-time market;
- local area reliability contracts;
- local regulatory authority resource adequacy criteria for the SWP;
- locational marginal pricing;
- management of use-limited resources;
- market power mitigation;
- must-offer obligation for curtailable loads and resource adequacy requirements;
- participating load nodal settlement and functionality;
- perfect hedge for existing transmission contracts;
- pricing ancillary services in HASP and RT;
- trading hubs and load aggregation points; and
- marginal losses.

In 2005, DWR participated in a number of CAISO and non-CAISO electric utility stakeholder processes and FERC proceedings to help ensure that various market requirements or cost allocation mechanisms were appropriately

structured. The major processes and litigations included the following (with FERC docket number given in parenthesis):

- FERC assessment of demand response resources (AD06-2);
- FERC Opinion 478: transmission access charges/time-of-use rates (ER00-2019);
- FERC Opinion 479: transmission entitlements costs not under CAISO operational control included in jurisdictional rates (EL00-105, ER00-2019);
- FERC Order 2003: CAISO large generator interconnection agreements and procedures (ER04-445);
- FERC voltage support from non-reliability must run resources (AD05-1-000);
- CAISO Tariff Amendment 60: minimum load reliability cost allocation (ER02-1656-024, ER04-835, EL04-103);
- CAISO Tariff Amendment 66: interim solution for import and export bids under MRTU Phase 1B (ER05-718);
- CAISO Tariff Amendment 67: revisions to revise the deadline for submitting supplemental energy bids and provide for a deadline of 62 minutes prior to the operating hour (ER05-796);
- CAISO Tariff Amendment 68: station power protocol (ER05-849);
- CAISO Tariff Amendment 72: 95% DA scheduling requirement (ER05-1502);
- CAISO Tariff Amendment 73: bid caps (ER06-354);
- CAISO grid management charge (ER05-346, ER05-367);
- CAISO and Independent Energy Producer's Association joint motion on capacity generation charged for must-offer obligations energy (EL05-146);
- City of Pasadena transmission control agreement (ER05-381, EL05-18);
- southern cities transmission owner tariffs (EL03-15 and EL03-20);
- CPUC order instituting rulemaking to promote policy and program coordination and integration in electric utility resource planning: Phase IIB workshops (R.04-04-003);
- CPUC order instituting rulemaking to consider refinements to and further development of the resource adequacy requirements program (R.05-12-013);
- CPUC transmission infrastructure to access renewable energy resources (OII.05-09-005);
- Pacific Gas & Electric (PG&E) 8th transmission owner tariff (ER05-1284);
- PG&E reliability service tariff (ER06-34);
- PG&E transmission revenue balancing account adjustment, reliability services rates and transmission access charge balancing account adjustment (ER04-337, ER05-82, ER05-378);
- PG&E agreement with the City and County of San Francisco and PG&E's wholesale distribution tariff (ER05-1190);
- Southern California Edison (SCE) 3rd transmission owner tariff (ER06-186);
- SCE reliability service tariff: cost allocation-coincident peak methodology (ER05-410);
- SCE reliability service tariff: 2005 summer true-up using ER05-410 methodology (ER05-1154);
- SCE petition for declaratory order concerning transmission projects to interconnect potential wind generation in the Antelope Valley/Tehachapi Region (EL05-80);
- SCE reliability services costs associated with CAISO M-438 operating procedure (ER05-763, ER05-1154);

- SCE contracts to secure additional capacity for system reliability in SP-15 (A.05-06-003);
- San Diego Gas & Electric (SDG&E) revision to transmission owner tariff: transmission congestion costs (ER05-853); and
- U.S. Department of Energy demand response in CAISO/regional transmission organizations systems.

DWR also participated in litigation before the DC Circuit Court on several electric utility matters, including FERC Opinion No. 466, 466-A, and 466-B: approval of rolled-in rate compensation for PG&E generation plants connecting to the transmission grid (Case 04-76131); termination of extra high voltage agreements (Case 04-1171); and FERC Order 478: time differentiated rates (Case 06-74506).

Oroville Facilities Relicensing

The existing 50-year term FERC hydropower license, Project Number 2100 for operation of the Oroville Facilities, will expire January 31, 2007. FERC offers three relicensing procedures—traditional, hybrid, and alternative—that allow applicants to accommodate their unique interests and operations while seeking license renewal. The traditional procedures require minimal FERC involvement, while the alternative procedures allow for more FERC involvement and encourage collaborative stakeholder interaction throughout the multiyear relicensing process. DWR selected the alternative licensing procedures. Participants in the relicensing activities indicated support for the collaborative approach, and on November 16, 2000, DWR submitted a request to FERC to use the alternative procedures. On January 11, 2001, FERC approved DWR's request. On January 26, 2005, DWR submitted its Application for New License for the Oroville Facilities with FERC.

On September 12, 2005, following DWR's successful compliance with FERC's May 2005 Additional Information Request, FERC accepted DWR's Application for a New License for operating the Oroville Facilities. FERC's acceptance of DWR's license application marked the conclusion of the multiyear collaborative Alternative Licensing Process (ALP) involving federal and State agencies, Indian tribes, local agencies, environmental organizations, and other interested parties that worked to assist DWR in completing a comprehensive license application and accompanying Preliminary Draft Environmental Assessment. While this procedurally completed the ALP phase of FERC relicensing, settlement negotiations and completion of all federal/State environmental documentation was still ongoing at the end of 2005 in pursuit of a new FERC license at the Oroville Facilities.

During 2005, primary achievements included

- completing all 165 technical reports resulting from the 72 collaboratively developed and approved study plans. These roughly 40,000 pages of supporting documentation were submitted to FERC in support of DWR's application for license;
- completing a package of responses addressing deficiencies, clarifications, additional information requests, and revisions to the January 2005 license application;

- receiving notification that the Oroville Facilities New License Application was accepted for filing by FERC;
- submitting the application for water quality certification to the State Water Resources Control Board;
- continuing settlement agreement negotiations meetings with Indian tribes, Butte County, local governmental agencies, State and federal agencies, and other interested stakeholders; and
- continuing to prepare and update the recreation management plan submitted with the Application for License to reflect additional enhancements derived from the Settlement Agreement negotiations.

As an interim settlement activity, DWR obtained approval to provide $3 million to the Feather River Recreation and Park District to fund recreation improvements at Riverbend Park in Oroville through calendar year 2007.

The following SWP facilities will be subject to new license terms and conditions:

- Oroville Dam and Reservoir;
- Hyatt Pumping-Generating Plant;
- Thermalito Pumping-Generating Plant;
- Thermalito Diversion Dam Power Plant;
- Thermalito Diversion Dam;
- Fish Barrier Dam;
- Feather River Fish Hatchery;
- Thermalito Power Canal;
- Thermalito Forebay; and
- Thermalito Afterbay.

Existing SWP Power Facilities

Figure 10-1 shows the names, locations, and nominal capacities of DWR's primary power facilities.

Hydroelectric

Economic hydroelectric generation provides the largest share of SWP power resources. The combined Hyatt Pumping-Generating Plant and Thermalito Pumping-Generating Plant (Hyatt-Thermalito) generate about 2.2 billion kWh of energy in a median water year, while the 3 MW from Thermalito Diversion Dam Power Plant adds another 24 million kWh of energy a year.

Generation at California Aqueduct recovery plants—Alamo, Devil Canyon, Gianelli, Mojave Siphon, and Warne—varies with the amount of water conveyed. These five plants generate about one-sixth of the total energy used by the SWP.

Coal

Since July 1983, under the "Participation Agreement Reid Gardner Unit No. 4" between DWR and Nevada Power Company (NPC), DWR has received energy from Reid Gardner Power Plant, a coal-fired facility near Las Vegas, Nevada. Reid Gardner consists of four units. DWR owns 67.8 percent of Unit 4, while NPC owns the remainder of Unit 4, as well as all of Units 1, 2, and 3. Under the agreement, DWR receives up to 235 MW from Unit 4, subject to NPC's limited right to interrupt DWR's energy deliveries. Whenever NPC interrupts DWR's scheduled energy, DWR receives payment based on NPC's combustion turbine costs.

In June 1990, DWR began receiving an additional 15 MW of power from Reid

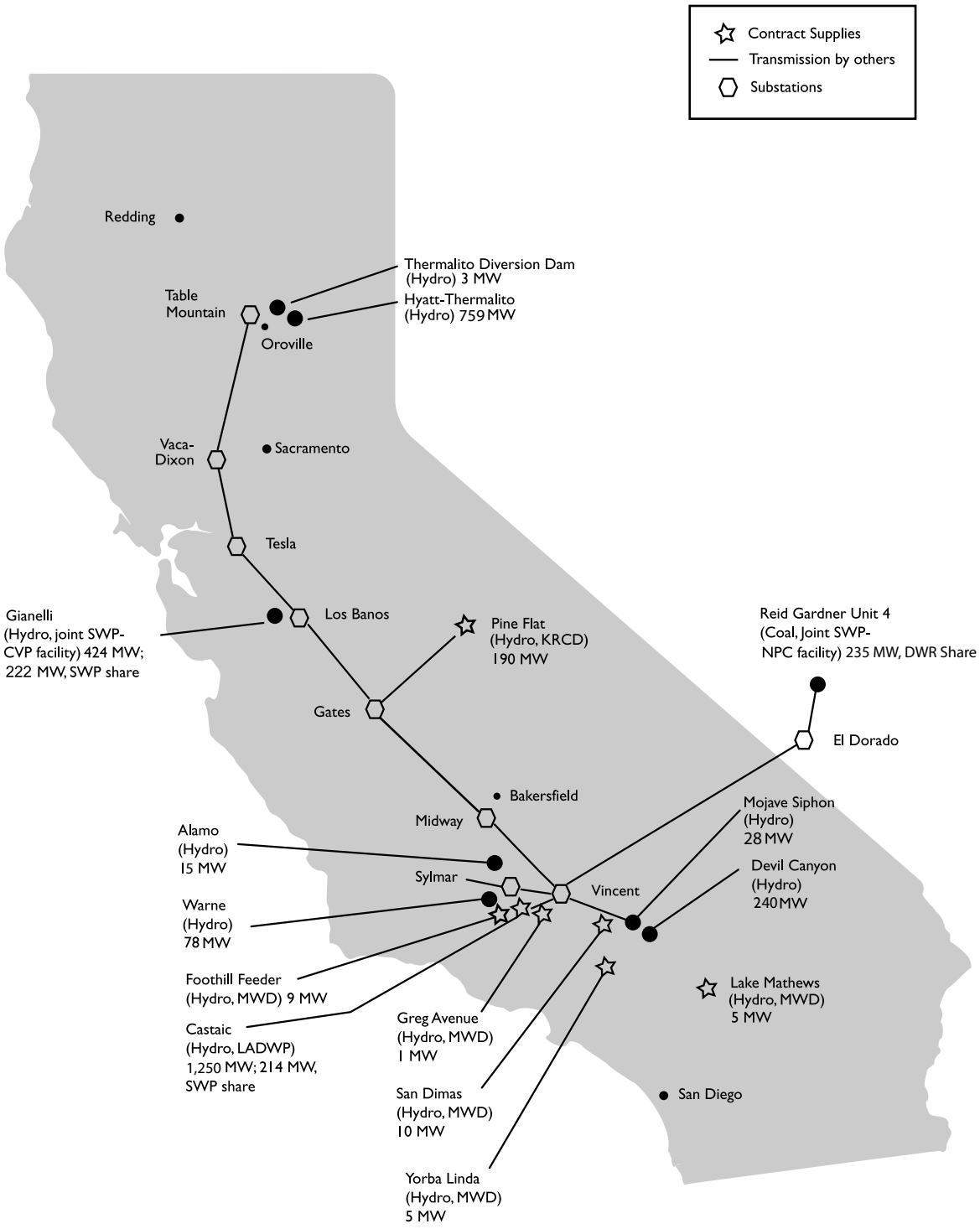


Figure 10-1. Names, Locations, and Nameplate Capacities of Primary Power Facilities

Gardner Unit 4 due to plant capacity upgrades. However, beginning in August 2004, new environmental restrictions in Nevada were imposed which reduced Reid Gardner Unit 4 production back to its original capacity of 260 MW. Consequently, DWR is currently not receiving the energy associated with this upgraded capacity.

Future SWP Power Facilities

To meet future SWP power requirements, DWR evaluates new power resources. Factors considered include

- the anticipated power requirements for pumping;
- transmission access;
- anticipated water deliveries to contractors;
- cost of the resource;
- availability and cost of financing;
- environmental impacts and costs of mitigation; and
- operating characteristics.

In addition, DWR continues to consider several potential power resources at existing plants, including a second unit at Alamo Power Plant and a third unit at Warne Power Plant.

Contractual Resource Arrangements

Through joint development, exchanges, and purchases, DWR obtains a significant amount of capacity and energy for SWP operations from other utilities throughout California, the Northwest, and the Southwest. Under these agreements, DWR can sell, buy, or exchange energy.

Some agreements allow DWR to sell, buy, and exchange energy on an hourly, daily, weekly, or monthly basis. Those agreements permit more economical use of DWR's generating resources and more efficient scheduling of energy deliveries.

Joint Developments

In 1966, DWR entered into a contract with the Los Angeles Department of Water and Power (LADWP) for joint development of the West Branch of the California Aqueduct. LADWP constructed and operates Castaic Power Plant, which is connected to the LADWP transmission system at the Sylmar Substation. DWR receives capacity and energy at the Sylmar Substation based on weekly water schedules through the West Branch.

Gianelli Pumping-Generating Plant is a joint SWP (222 MW) and U.S. Bureau of Reclamation (Reclamation) (202 MW) facility.

Purchases

DWR obtains a significant amount of energy through long-term and short-term purchase agreements.

Long-Term Purchase Agreements. DWR purchases hydroelectric energy generated by other utilities. The output of the 165 MW Pine Flat Power Plant, owned and operated by Kings River Conservation District, supplies the SWP with about 400 million kWh of energy in median water years.

DWR contracts for the energy output of five hydroelectric plants owned and operated by Metropolitan Water District of Southern California (Metropolitan). The total capacity of these plants is 30 MW.

Short-Term Purchase Agreements. Through the Western Systems Power Pool Agreement, DWR transacts with member utilities and energy marketers on a short-term basis. Additionally, according to the terms of the 1988 Coordination Agreement between DWR and Metropolitan, DWR may purchase surplus energy from Metropolitan's Colorado River Aqueduct system. The Coordination Agreement provides for coordinated operation between the SWP and Metropolitan's Colorado River Aqueduct system. It also provides for monthly surplus firm energy sales to Metropolitan, economy energy sales to Metropolitan, surplus energy purchases from the Colorado River Aqueduct system, and energy exchanges between DWR and Metropolitan.

Contractual Transmission Agreements

Although able to acquire transmission independently, DWR depends on other sources for transmission services. PG&E and SCE are the primary providers of transmission service between SWP power resources and pumping loads and also with interconnected utilities for purchases, sales, and exchanges of power.

Under the Comprehensive Agreement with PG&E, DWR receives 1,300 MW of firm transmission service over the PG&E transmission system between SWP pump loads and power resources in Northern and Central California.

Previously, under the power contract with SCE, DWR received transmission service over SCE's transmission system to interconnect the SWP loads and resources in Southern California. Upon termination of the power contract at the end of 2004, DWR began receiving transmission service for these loads and resources through CAISO. Additionally, DWR has interconnection and wholesale distribution service agreements with SCE for service over its distribution facilities from the CAISO interchange points to SWP loads and resources.

Under the Participation Agreement with NPC, DWR receives 235 MW of firm transmission service over NPC's transmission system between Reid Gardner Unit 4 and the El Dorado Substation. Under the Firm Transmission Service Agreement between SCE and DWR, DWR receives 235 MW of firm transmission service over SCE's transmission system between the El Dorado Substation and the Vincent Substation.

Load Management

The SWP controls the timing of its pumping load through an extensive computerized network. This control system allows DWR to minimize the cost of power it purchases by maximizing pumping during off-peak periods when power costs are lower—usually at night—and selling power to other utilities and energy marketers during on-peak periods when power costs are higher. Taking advantage of this flexibility in scheduling, SWP pumping load and generation reduces the net cost of power needed for SWP water deliveries.

Sales of Excess Power

When generation from SWP power resources exceeds requirements, DWR sells or exchanges the excess power through contracts with utilities and marketers.

SWP Power Operation in 2005

Tables 10-1 through 10-4, at the end of this chapter, present historical information about SWP power operation for calendar year 2005, including energy consumed, generated, exchanged, purchased, and sold.

Energy Consumed

In 2005, energy used at the 29 SWP pumping and generating plants totaled 8.29 million MWh. According to the terms and conditions of various water conveyance contracts and exchange agreements, some water belonging to the Central Valley Project is pumped through Banks and Dos Amigos Pumping Plants and Gianelli Pumping-Generating Plant. Reclamation furnishes additional energy for this purpose.

Table 10-1 shows the amount of energy used each month at SWP pumping and generating plants to operate the SWP in 2005, excluding transmission losses.

Energy Generated

Table 10-2 shows the amounts of energy generated at SWP facilities in 2005, as well as energy purchased for SWP operations.

Hydroelectric and Coal

The Hyatt-Thermalito power complex in Oroville generated 1.83 million MWh of energy in 2005.

Energy generated at SWP aqueduct recovery plants—Gianelli, Alamo, Devil Canyon, Mojave Siphon, and Warne—totaled 1.74 million MWh.

The SWP share of energy generated at the coal-fired Reid Gardner Unit 4 in Nevada totaled 1.58 million MWh of energy.

Contractual Resource Arrangements

SWP power operations rely on contractual arrangements as well as SWP facilities. These contractual arrangements include joint development projects, energy exchanges, and energy purchases.

Joint Development

Through the West Branch Cooperative Development Agreement with LADWP, DWR receives energy based on the amount of water scheduled through the West Branch. In 2005, LADWP provided 510,093 MWh of energy for DWR's share of energy generated at Castaic Power Plant.

DWR's share of Gianelli Pumping-Generating Plant used 363,023 MWh and generated 125,080 MWh of energy.

Energy Exchanges

DWR has an energy exchange agreement with Sacramento Municipal Utility District (SMUD). Under this agreement, DWR provides SMUD with energy during peak periods from May through September. In return, SMUD provides DWR with energy during off-peak periods from January through March and from September through December. The exchange ratio of off-peak energy to on-peak energy is 1.8.

Purchases and Costs

Table 10-3 shows amounts of power, transmission, and other services purchased in 2005 and the costs of purchases, by area. Amounts shown include short-term and long-term purchases. It also reflects

the restructuring of the electric industry through transactions with CAISO and through new charges (grid management and ancillary services charges).

DWR purchased 4.74 million MWh of energy at a cost of $232.07 million. Other SWP power costs, including transmission, operation, maintenance, and CAISO ancillary services totaled $123.83 million. This amount includes $4.95 million for debt service and $3.81 million for operations and maintenance costs at Pine Flat Power Plant. It also includes $3.42 million for transmission at Reid Gardner Unit 4 and $59.33 million for costs associated with operations and maintenance, fuel, insurance, and property taxes at Reid Gardner Unit 4.

Long-Term Purchase Agreements. According to the terms of the Kings River Conservation District contract, DWR receives the total output of the 165 MW Pine Flat Power Plant. In 2005, the power plant provided 594,002 MWh of energy to the SWP at a total cost of $4.57 million.

Under the Metropolitan Small Hydro Contract, DWR purchased 174,225 MWh of energy in 2005 from five small hydroelectric power plants on the Metropolitan system at a cost of $9.24 million.

DWR purchased 686 MWh of energy at a cost of $2,313, under the Reid Gardner Unit 4 Participation Agreement, associated with plant capacity upgrade.

Short-Term Purchase Agreements. Existing resources and long-term power and transmission contracts ensure that the SWP has enough power to meet long-term needs. When SWP power requirements exceed resources during daily operations, short-term purchases meet the difference. In 2005, the SWP purchased short-term energy from 20 marketers. The short-term energy purchases totaled 2.84 million MWh at a cost of $158.82 million. Also, DWR purchased additional amounts of short-term energy from electric utilities.

Sales of Excess Power

DWR sold 2.15 million MWh of energy to 20 utilities and 22 power marketers, for total revenues of $148.62 million in 2005. DWR also received $33.50 million in revenues for capacity, including $21.03 million for transactions made through CAISO. See Table 10-4 for information about energy and other services sold and revenue received, including those sold to CAISO.

Forecasting Power Operations

Each year, after reviewing the water contractors' water delivery requests and the construction schedule for future facilities, DWR forecasts SWP power requirements through 2035.

Actual SWP power requirements may vary significantly from the amounts forecast. Those variations are due to the amount of water available and delivered in a given year. For example, dry conditions in Northern California could result in a reduction of the amount of water available for delivery. If full deliveries could not be made, less power would be used. Power requirements could also decrease during a wet year because of the availability of local water in the San Joaquin Valley or Southern California.

Conversely, power requirements could exceed the amount originally forecast if actual water deliveries are greater than the amounts estimated. For example, if additional pumping is needed to refill reservoirs south of the Delta after an unexpectedly dry year, then more power would be used.

Criteria

DWR bases its forecast of power operations primarily on the amount of energy necessary to deliver approved Table A water requested by water contractors. The forecast includes losses in reservoirs and aqueducts, recreation water, and water to replace storage in reservoirs south of the Delta.

Short-term power requirements, based on actual water supply and reservoir storage levels, are determined for the current and two ensuing years of operation. Long-term operational studies for the remaining years are based on median-year water supply conditions and optimal reservoir storage levels.

Table 10-1. Energy Used at Pumping Plants and Power Plants in 2005, by Month (Millions of Kilowatt-Hours)

Pumping Plants and Power Plants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Hyatt-Thermalito Pumping-Generating Plant (pumpback and station service)	0.150	0.002	0.112	0.005	0.066	0.145	0.480	0.111	1.526	0.731	0.206	0.665	4.200
North Bay Interim Pumping Plant	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cordelia Pumping Plant	0.646	0.576	0.414	0.343	0.701	0.847	1.127	1.258	1.231	0.907	0.983	0.840	9.872
Barker Slough Pumping Plant	0.312	0.231	0.174	0.185	0.379	0.985	1.428	1.641	1.611	1.175	0.953	0.451	9.524
South Bay Pumping Plant	2.825	1.794	2.749	5.949	8.866	13.209	14.449	12.435	7.679	5.221	8.760	6.343	90.279
Del Valle Pumping Plant	0.005	0.005	0.007	0.015	0.021	0.019	0.014	0.006	0.013	0.015	0.013	0.019	0.153
Banks Pumping Plant	136.880	77.667	62.675	62.658	34.219	91.648	122.175	121.274	118.172	106.698	87.682	111.943	1,133.692
Gianelli Pumping-Generating Plant (SWP share)	118.886	41.923	4.300	0.434	1.110	7.867	18.021	26.375	35.942	25.421	21.609	61.135	363.023
Dos Amigos Pumping Plant (SWP share)	17.297	25.660	34.671	45.790	32.765	46.677	55.389	48.170	40.386	40.656	35.414	31.148	454.022
Buena Vista Pumping Plant	16.773	22.610	22.002	37.980	31.963	40.000	53.237	43.392	38.293	39.872	34.434	31.572	412.128
Teerink Pumping Plant	18.859	25.010	22.946	40.812	33.761	41.168	54.922	43.908	40.571	43.543	37.950	34.951	438.400
Chrisman Pumping Plant	42.314	56.067	50.685	90.118	73.512	88.990	119.723	95.710	89.338	96.737	84.740	78.312	966.247
Edmonston Pumping Plant	155.984	206.947	185.009	331.643	268.423	322.962	436.404	345.398	325.500	355.350	313.355	287.135	3,534.110
Alamo Power Plant (station service)	0.016	0.013	0.003	0.001	0.002	0.000	0.001	0.002	0.004	0.004	0.032	0.017	0.095
Pearblossom Pumping Plant	36.178	42.053	51.564	49.450	50.961	59.305	72.433	60.841	52.529	57.205	55.539	57.579	645.638
Pine Flat Power Plant (station service)	0.234	0.209	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.240	0.767
Mojave Siphon Power Plant (station service)	0.017	0.007	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.004	0.030
Devil Canyon Power Plant (station Service)	0.001	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.002	0.000	0.033	0.039
Oso Pumping Plant	3.109	7.206	0.358	17.907	9.015	11.367	18.686	12.905	14.730	16.769	12.819	9.577	134.449
Warne Power Plant (station service)	0.140	0.078	0.172	0.025	0.141	0.272	0.135	0.123	0.037	0.014	0.112	0.290	1.541
Las Perillas Pumping Plants	0.160	0.277	0.284	0.559	0.865	1.225	1.403	1.312	0.834	0.581	0.168	0.360	8.028
Badger Hill Pumping Plant	0.406	0.735	0.752	1.461	2.258	3.224	3.579	3.395	2.171	1.511	0.427	0.952	20.871
Devil's Den Pumping Plant	0.875	0.925	1.113	1.556	1.846	2.209	2.458	2.371	2.183	1.851	0.850	1.313	19.549
Bluestone Pumping Plant	0.812	0.864	1.043	1.474	1.752	2.133	2.372	2.290	2.097	1.753	0.794	1.238	18.622
Polonio Pass Pumping Plant	0.888	0.940	1.137	1.581	1.857	2.212	2.468	2.359	2.165	1.847	0.858	1.342	19.653
Greenspot Pumping Station	0.217	0.021	0.039	0.098	0.093	0.194	0.255	0.367	0.241	0.448	0.218	0.159	2.350
Crafton Hills Pumping Station	0.143	0.022	0.040	0.107	0.101	0.181	0.155	0.155	0.214	0.337	0.187	0.143	1.786
Cherry Valley Pumping Station	0.000	0.002	0.002	0.008	0.006	0.008	0.004	0.008	0.013	0.003	0.016	0.013	0.081
Subtotal	*554.128*	*511.844*	*442.318*	*690.160*	*554.686*	*736.846*	*981.319*	*825.804*	*777.480*	*798.653*	*698.138*	*717.773*	*8,289.149*
High Voltage Transmission Line Losses and Deviation	14.747	(4.122)	(15.095)	(10.544)	(3.467)	12.846	11.080	16.087	6.937	(5.407)	(10.509)	6.196	18.750
Total Energy Required for SWP	**568.875**	**507.722**	**427.223**	**679.616**	**551.219**	**749.692**	**992.400**	**841.891**	**784.417**	**793.246**	**687.629**	**723.969**	**8,307.899**

Table 10-2. Energy Generated and Purchased in 2005, by Month (Millions of Kilowatt-Hours)

Sources of Energy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
SWP Energy Sources													
Hyatt-Thermalito Power Plant	67.247	37.043	54.212	39.800	152.664	224.191	258.224	253.026	192.072	158.690	155.752	240.636	1,833.559
Gianelli Pumping-Generating Plant (SWP share)	0.000	2.436	0.335	35.384	35.324	15.072	15.248	11.071	0.602	1.428	5.980	2.200	125.080
Alamo Power Plant	6.242	6.824	8.750	8.788	9.073	10.628	11.744	10.447	9.295	9.741	5.263	8.209	105.003
Mojave Siphon Power Plant	4.029	4.675	5.813	5.372	5.683	6.863	8.360	6.832	5.837	6.451	6.181	6.427	72.525
Devil Canyon Power Plant	72.550	83.338	86.439	90.760	93.486	106.885	127.857	109.858	95.478	103.834	92.552	89.716	1,152.752
Reid Gardner Unit 4 [a]	119.108	124.479	141.980	105.768	51.690	159.798	156.880	128.767	134.719	159.927	144.844	149.945	1,577.905
Warne Power Plant	5.875	16.102	(0.170)	37.519	22.076	23.235	38.000	28.086	32.096	35.863	26.742	18.838	284.261
Subtotal	*275.051*	*274.896*	*297.359*	*323.391*	*369.996*	*546.673*	*616.314*	*548.088*	*470.099*	*475.934*	*437.314*	*515.971*	*5,151.085*
Energy Sources from Long-Term Agreements													
Castaic Power Plant	28.122	42.059	0.000	68.219	34.882	38.031	61.801	47.034	50.510	59.924	51.699	27.810	510.093
Metropolitan Small Hydro Generation	10.598	9.671	9.263	14.398	15.235	17.027	18.254	17.771	16.071	14.843	15.830	15.265	174.227
Pine Flat Power Plant KRCD	0.000	0.000	6.222	35.182	106.963	143.526	144.437	95.771	38.801	21.588	1.512	0.000	594.002
Power Exchange Delivered to other entities [b]	0.000	(0.336)	0.000	0.000	(31.000)	(30.000)	(33.000)	(33.160)	(32.000)	0.000	0.000	0.000	(159.496)
Power Exchange Received from other entities [b]	43.400	39.200	43.400	0.000	0.000	0.000	3.000	3.240	27.000	43.575	42.000	43.400	288.215
Power Exchange Delivered to SCE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Power Exchange Received from SCE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Energy to MWD for CRA Pumping	0.000	0.000	0.000	0.000	0.000	0.000	(20.160)	(15.775)	(26.505)	0.000	0.000	0.000	(62.440)
Energy from Metropolitan for CRA	30.600	8.800	0.000	0.000	0.000	0.000	0.000	6.930	4.950	0.000	0.000	2.880	54.160
Power System Imbalances	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Purchases													
Purchases (Power Contracts)	303.622	253.498	229.904	348.832	283.696	290.518	404.261	412.864	424.998	380.633	312.615	322.814	3,968.255
Subtotal	*416.342*	*352.892*	*288.789*	*466.630*	*409.776*	*459.103*	*578.592*	*534.675*	*503.826*	*520.563*	*423.657*	*412.170*	*5,367.016*
Total Resources	691.393	627.789	586.148	790.021	779.772	1,005.775	1,194.906	1082.763	973.925	996.497	860.971	928.141	10,518.101
Less Energy Sales	(122.518)	(120.067)	(158.925)	(110.405)	(228.553)	(256.083)	(202.506)	(240.872)	(189.508)	(203.251)	(173.342)	(204.172)	(2,210.202)
Total Energy Provided to the SWP	**568.875**	**507.722**	**427.223**	**679.616**	**551.219**	**749.692**	**992.400**	**841.891**	**784.417**	**793.246**	**687.629**	**723.969**	**8,307.899**

[a] The upgraded energy of 686 MWh from Reid Gardner Unit 4 is included.
[b] Amounts show actual energy available for SWP use and include transmission losses.

Table 10-3. Power, Transmission, and Other Services Purchased in 2005 and Costs of Purchases, by Area

Name of Supplier	Type of Service Purchased	Power (MWH)	Power Cost (Dollars)	Total Cost (Dollars)
Power Purchases				
Northwest Area				
Bonneville Power Administration		147	8,967.00	8,967.00
Northern California Area				
Kings River Conservation District		594,002	4,574,843.88	4,574,843.88
Sacramento Municipal Utility District		5,550	315,286.75	315,286.75
City and County of San Francisco		505	24,970.00	24,970.00
Northern California Power Agency		5,066	381,260.00	381,260.00
Pacific Gas & Electric Company		118,733	4,537,095.00	4,537,095.00
Southern California Area				
Metropolitan Water District of Southern California		197,308	11,296,121.85	11,296,121.85
Southern California Edison		321,415	19,660,218.00	19,660,218.00
City of Azusa		107	5,273.00	5,273.00
City of Riverside		1,412	91,098.00	91,098.00
City of Vernon		1,805	121,180.00	121,180.00
San Diego Gas and Electric		165,506	10,003,148.50	10,003,148.50
Arizona Public Services		419,600	19,324,600.00	19,324,600.00
Public Service of New Mexico		61,058	2,895,759.97	2,895,759.97
Nevada Power (Upgrade Energy)		686	2,313.33	2,313.33
Energy Marketers (20) AEP,AVST,BPEC,CALP,CECO,CNCO,CORP,CPSC, DETM,ECH1,MSCG,OPSI,PAC1,PWRX,PW,SEES,SETC,TEMU,UBSW,WESC		2,844,268	158,823,615.67	158,823,615.67
Subtotal		*4,737,168*	*232,065,750.95*	*232,065,750.95*
Transmission and Other Purchases				
California Independent System Operator	Ancillary and other services			36,604,391.82
	FERC charges			374,796.65
California Power Exchange	Wind up fees			140,357.78
Kings River Conservation District	Pine Flat operation and maintenance			3,805,268.00
	Pine Flat debt service and refinance fees (bonds)			4,951,058.21
Los Angeles Department of Water and Power	Hydro Power plant scheduling for Greg Ave.			1,150.00
	Sylmar transmission service			73,907.61
Nevada Power Company [a]	Reid Gardner Unit 4 transmission service			1,672,932.00
	Operations and maintenance			26,600,913.78
	Coal and diesel fuel			31,248,696.51
	Insurance			561,048.94
	Property taxes			919,716.80
Pacific Gas and Electric Company	Midway-Wheeler Ridge, transmission operation and maintenance			98,066.40
	Cost of ownership for Pine Flat			12,076.00
	Transmission			10,619,652.86
	Cost of ownership, special facilities			76,076.00
	Castle Rock Junction—Lakeville ownership charges			102,594.00
	Costal Branch: ownership charges			156,463.00
Southern California Edison Company	East Branch Extension Plants—transmission			576,013.68
	East Branch Extension Plants—interconnection charges			39,817.70
	Additional facilities charges (D.C. and Mojave)			1,259,927.04
	Mojave Siphon and Devil Canyon firm transmission			369,120.00
	East Branch Extension reliability charges			2,189.48
	Reliability services (Edmonston, Oso, Pearblossom)			1,401,258.80
	Firm transmission El Dorado-Vincent			1,551,000.00
	Interconnection charge (WW,AL,ED,OSO,PB)			525,585.74
FERC Charges for Government Lands				86,541.62
Miscellaneous Fees				**3,755.31**
Subtotal				*123,834,375.73*
Total		**4,737,168**	**73,242,135.28**	**355,900,126.68**

[a] NPC amounts are subject to adjustments

Table 10-4. Energy Sold in 2005 and Revenue from Sales, by Area

Name of Supplier	Energy Sold (MWH)	Revenue from Energy Sales (Dollars)	Revenue from Exchanges, Capacity, and other Energy Services (Dollars)	Total Power Sales (Dollars)
Pacific Northwest Area				
Bonneville Power Administration	3,150	106,800.00		106,800.00
Northern California Area				
CAISO—ancillary and other services			21,025,418.29	21,025,418.29
California Power Authority	15,200	1,216,000.00	7,700,000.00	8,916,000.00
City of Redding	175	9,000.00		9,000.00
City of Santa Clara			19,275.23	19,275.23
Northern California Power Agency	3,273	222,027.50	14,922.76	236,950.26
Pacific Gas and Electric Company	156,224	10,761,416.00		10,761,416.00
Sacramento Municipal Utility District	46,931	3,654,158.00	1,284,000.00	4,938,158.00
Southern California Area				
City of Azusa	7,860	484,767.35		484,767.35
City of Banning	8,640	656,640.00		656,640.00
City of Riverside	152,453	6,474,583.76	1,976,820.00	8,451,403.76
City of Vernon	5,148	274,735.00		274,735.00
Los Angeles Department of Water and Power	240	17,760.00	587,100.00	604,860.00
San Diego Gas and Electric	201,928	15,077,255.25		15,077,255.25
Southern California Edison	78,797	5,817,660.00		5,817,660.00
Metropolitan Water District of Southern California	400	3,570.00		3,570.00
Southwest Area				
Arizona Public Service	39,571	2,912,386.00		2,912,386.00
Nevada Power Company	185,162	20,400,398.87	889,338.60	21,289,737.47
Public Service Company of New Mexico	5,850	324,696.00		324,696.00
Salt River Project	2,200	73,808.00		73,808.00
Energy Marketers				
American Electric Power	2,800	160,600.00		160,600.00
Avista Energy	800	38,360.00		38,360.00
BP Energy Company	146,200	8,588,026.00		8,588,026.00
Calpine Energy Services	39,213	1,668,778.50		1,668,778.50
Conoco Phillips	29,053	1,443,919.10		1,443,919.10
Constellation Power Source	58,157	4,788,302.57		4,788,302.57
Coral Power	342,337	23,033,926.50		23,033,926.50
Duke Energy	86,725	4,315,562.20		4,315,562.20
Dynegy Power Marketing	7,200	351,052.00		351,052.00
J. Aron & Company	30,800	2,556,400.00		2,556,400.00
Mirant Americas Energy Marketing	800	46,560.00		46,560.00
Morgan Stanley Capital Group	32,250	1,436,250.00		1,436,250.00
Occidental Power Services	7,200	409,152.00		409,152.00
PacifiCorp	400	11,800.00		11,800.00
Pinacle West	3,800	234,594.00		234,594.00
PPM Energy	45,186	3,015,429.10		3,015,429.10
Powerex	35,321	1,868,021.00		1,868,021.00
Sempra Energy Solutions	800	40,504.00		40,504.00
Sempra Energy Trading	133,678	6,931,442.00		6,931,442.00
Transalta Energy Marketers	180,016	14,670,002.40		14,670,002.40
UBS Energy	35,376	3,492,764.00		3,492,764.00
Williams Energy Marketers	18,725	1,028,176.00		1,028,176.00
Total	**2,150,039[a]**	**148,617,283.10**	**33,496,874.88**	**182,114,157.98**

Chapter 11
Facilities Maintenance

Crafton Hills Reservoir

Significant Events in 2005

The Part 12D Safety Inspection and Potential Failure Mode Analysis (PFMA) for Cedar Springs Dam, Devil Canyon Second Afterbay, Peace Valley Intake Embankment (Quail Dam), and Pyramid Dam were performed in January.

Part 12D Safety Inspection, PFMA and Supporting Technical Information Document (STID) reports for FERC Project #2100, the Oroville-Thermalito Complex, were completed in March.

Part 12D Safety Inspection, PFMA and STID reports for FERC Project #2426 the Castaic-Devil Canyon Power Complex were completed in July 2005.

Information for this chapter was provided by the Division of Operations and Maintenance, the Division of Safety of Dams, and the State Water Project Analysis Office.

The Department of Water Resources (DWR), through the Division of Operations and Maintenance (O&M), monitors all State Water Project (SWP) facilities to ensure safety and reliability. DWR is required, under federal and State law, to contract periodically with independent consultants to review the safety of SWP dams and power facilities.

Inspecting and Maintaining Project Dams

DWR conducts several types of inspections of SWP facilities to ensure that each dam is safe for continued operation. O&M staff collect and evaluate data about the performance of each facility. Engineers from the Division of Safety of Dams (DSOD) review instrumentation data and inspect jurisdictional SWP dams, either semi-annually or annually. They evaluate proposed modifications to existing dams, as well as the design and construction of new jurisdictional dams. The Federal Energy Regulatory Commission (FERC) inspects all licensed SWP facilities annually. These inspections include a review of significant events, instrumentation data, and the visual appearance of each dam, penstock, or power plant. In addition, under FERC and California Water Code requirements, consulting engineers and geologists are retained to evaluate SWP dam facilities every five years.

DWR contracts periodically with independent consultants to review the safety of SWP dams and power facilities, except Pearblossom Spill Basin. The four dams in the San Luis Field Division (San Luis, O'Neill Forebay, Los Banos Detention, and Little Panoche Detention) are used jointly with the U.S. Bureau of Reclamation (Reclamation), and are not under the jurisdiction of DSOD. Pearblossom Spill Basin Dam was originally designed to be used during misoperation at the Pearblossom Pumping Plant; the spill basin was never fully completed and has never been used.

Routine Inspections

During 2005, DSOD, along with O&M staff, inspected Frenchman, Antelope, and Grizzly Valley dams in the Upper Feather River area; Oroville, Bidwell Bar, Parish Camp, and Thermalito Afterbay dams in the Oroville Field Division; Clifton Court Forebay, Bethany, Patterson, and Del Valle dams in the Delta Field Division; and Pyramid, Castaic, Cedar Springs, Devil Canyon Power Plant Second Afterbay, Perris, and Crafton Hills dams in the Southern Field Division.

Joint-Use Facility Inspection

Every six years, Reclamation conducts a comprehensive facility review of the four joint-use facility dams in the San Luis Field Division. The last comprehensive facility review was conducted from April 28 through May 2, 2003.

Underwater Inspection

In May 2005, U.S. Environmental Protection Agency divers inspected the left abutment for Pyramid Dam. The inspection was to ensure clean-up efforts were satisfactory after Pacific Pipeline

No. 63 broke in April 2005, releasing oil into Pyramid Lake, and depositing oil on the left abutment and the upstream rip-rap of Pyramid Dam. In September 2005, DWR divers inspected stoplog slots and sacrificial anodes on Pyramid Dam's radial gate.

Independent Reviews

California Water Code Reviews

To comply with the California Water Code and the California Code of Regulations, DWR is required to retain a consulting board to review

1) the adequacy of the design of any dam or reservoir DWR proposes to construct, and
2) the safety of the completed construction, including the terms and conditions for the Certificate of Approval.

These provisions require DWR to retain a board of three consultants to meet at least once every five years to review the operational performance of DWR-owned dams and more often when consulting on new dams. The board of consultants independently reviews and assesses safety conditions of SWP dams.

Consultants are selected based on their knowledge of geotechnical, structural, and civil engineering, including their experience in evaluating dam performance. Their independent assessments include the review of dam performance during earthquakes, evaluation of instrumentation data, inspection of each dam, and evaluation of studies performed by DWR. The consultants then prepare reports on each dam, approving dams safe for continued operation and making recommendations. Based on these recommendations, DWR prepares action plans.

In June 2003, DSOD and O&M agreed to allow the substitution of FERC Part 12 independent review board reports, in lieu of independent review board reports required by the California Water Code and California Code of Regulations for the following dams, Oroville, Feather River Fish Hatchery, Thermalito Diversion, Thermalito Forebay, Thermalito Afterbay, Cedar Springs, Devil Canyon Second Afterbay, and Pyramid. However, DSOD reserved the right to impose additional requirements not presented by the FERC independent review board.

An independent consulting board met several times in 2004 and again in July 2005, to review the proposed Dyer Dam, located on the East Bay Aqueduct in Alameda County. On September 2005, a construction application for Dyer Dam was filed with DSOD. An independent consulting board also reviewed the safety of Perris Dam in October 2005.

FERC Reviews

Theses reviews and the FERC Part 12D safety inspections, which may be conducted by one or more consultants, are scheduled every five years. As a supplement to FERC Part 12D safety inspection, FERC's Dam Safety Performance Monitoring Program requires that a Potential Failure Mode Analysis (PFMA) be performed for FERC-licensed dams. The PFMA involves document review and site visits to develop a comprehensive list of potential failure modes at each dam. From this review process, three documents are generated, the FERC Part 12D safety inspection report;

PFMA report; and Supporting Technical Information Document (STID), which summarizes the project elements and details that do not change significantly over time.

The Part 12D Safety Inspection, PFMA and STID reports for FERC Project #2100, the Oroville-Thermalito Complex, were completed in March 2005. The Part 12D Safety Inspection and PFMA for Cedar Springs Dam, Devil Canyon Second Afterbay, Peace Valley Intake Embankment (Quail Dam), and Pyramid Dam were performed in January 2005. The Part 12D Safety Inspection, PFMA and STID reports for FERC Project #2426 , the Castaic-Devil Canyon Power Complex were completed in July 2005.

Arroyo Pasajero Program

The Arroyo Pasajero and its tributaries drain approximately 530 square miles of the Diablo Range of the coastal mountains, west of the California Aqueduct in Fresno County. Its downstream juncture with the San Luis Canal segment of the California Aqueduct, between Highway 198 and Avenal Cutoff Road, poses a particularly difficult operational and maintenance problem for the SWP. Reclamation designed and constructed the San Luis Canal segment of the California Aqueduct, while DWR operates and maintains it, with all costs shared 45 percent and 55 percent, respectively.

During periods of heavy rainfall, high flows in the Arroyo Pasajero and its tributaries transport heavy sediment loads eroded from the Diablo range of the coastal mountains. Over eons, sediment transported by Arroyo floods formed a 450-square-mile alluvial fan extending from its apex at the eastern margin of Pleasant Valley (Anticline Ridge) to the San Joaquin Valley trough. The California Aqueduct traverses the Arroyo's alluvial fan and forms a barrier to Arroyo flood flows. Flood control facilities, designed to accommodate Arroyo Pasajero floodwaters, include the West Side Detention Basin (designed to store floodwaters and sediment west of the Aqueduct), an evacuation culvert to release floodwater east of the Aqueduct, and drain inlets to release floodwater into the Aqueduct. The volume of runoff and sediment transported by the Arroyo Pasajero is roughly 400 percent greater than was originally estimated during the design of the detention basin in the mid-1960s.

Since the floods of 1969, when nearly all of the detention basin's planned 50-year sediment storage capacity was filled by deposition, DWR and Reclamation have worked to mitigate the effects of heavy flooding and the diminished storage capacity of the detention basin. In 1980, asbestos discovered in the Metropolitan Water District of Southern California's water supply was traced to runoff from the Arroyo Pasajero and other Diablo range streams. This discovery, in conjunction with the high cost of removing sediment from the aqueduct, led DWR to adjust operating procedures to minimize runoff entering the Aqueduct.

DWR and DWR/Reclamation Alternative Long-term Solution

Since the demise of the two candidate plans that were presented in the March 1999 draft Feasibility Report, the investigation has focused on a new alternative, made possible by the availability of relatively low-productivity

farmland in the western Tulare Lakebed. This plan would rely on some increased storage in the existing West Side Detention Basin, used in conjunction with a flood control reservoir that would be constructed in the western Tulare Lakebed, east of the aqueduct near Kettleman City. It would fully utilize the design philosophy of the San Luis Canal by taking excess floodwaters from detention basins along the San Luis Canal, designed to accommodate cross drainage, into the canal southward, and finally diverting them from Pool 21 into a western Tulare Lakebed reservoir. This plan has the added benefit of accommodating the largely unregulated inflows to the canal upstream of the Arroyo Pasajero.

DWR and Reclamation's version of the western Tulare Lakebed plan provides sufficient and acceptable levels of flood protection to the aqueduct at considerably lower cost. This effort was in response to the State Water Contractors' proposal that DWR develop the least costly alternative that would provide a 100-year level of flood protection to the aqueduct. To be consistent with other SWP flood protection facilities, this level of protection would be based on a single four-day flood, as opposed to the larger flood volume that would be expected from a series of six floods over 30 days, that is used by the Corps.

By applying the lower and more traditional four-day flood volume to the flood control improvements needed at the Arroyo Pasajero, a 100-year level of flood protection can be achieved, at an estimated cost of $51 million. Of this amount, about $13 million is estimated for specific improvements to the existing West Side Detention Basin, such as raised embankments, drain inlet modifications, and facilities to protect adjacent non-SWP infrastructure and private properties. The remaining $38 million is the estimated cost of a 45,000 af reservoir located in the western Tulare Lakebed, as well as an aqueduct floodwater turnout structure and chute, connecting the Aqueduct to the proposed western Tulare Lakebed reservoir. By the end of 2003, DWR had almost finished its feasibility investigation into this cost-effective plan and was planning to proceed with the final design, environmental documentation, and other procedural steps leading to construction. The project will be implemented in two phases, Phase 1 will be the construction of the planned improvements within the West Side Detention Basin; and Phase 2 will be the construction of the reservoir at the western Tulare Lakebed.

DWR is exploring alternative locations for the western Tulare Lakebed reservoir that may lead to a less expensive project.

DWR's feasibility investigation on West Side Detention Basin improvements and the western Tulare Lake reservoir plan is intended to work in conjunction with the interim flood control measures constructed at the Cantua and Salt Creek Detention basins in 1999. In addition to these measures, DWR purchased flood easement on approximately 700 acres of land west of the aqueduct near the Cantua and Salt Creek inlets. This easement purchase provides additional land for detention basins at the newly constructed Salt Creek and Cantua Creek inlet weirs. The detention basins allow sediment-laden floodwaters to decant before entering the aqueduct, thus reducing the amount of suspended solids entering the aqueduct.

In 2004, DWR finalized its plan to restore the storage capacity of the West Side Detention Basin. Construction started in August 2004, to implement the designed improvements and was partially completed in 2005. These improvements will restore the storage capacity to the detention basin and add control over releases of flood water into the aqueduct and onto private farmland. DWR is also negotiating with local landowners to acquire the necessary easements and fee property interests required for the project. Arroyo Pasajero West Side Detention Basin improvements provide a 50-year level of protection to the aqueduct from Arroyo Pasajero flooding. This protection is achieved by raising levees, adding a control structure equipped with a rubber dam, armoring the railroad embankment, installing flood gates, and acquiring flood easements.

Related Activities

DWR, with the support of the State Water Contractors, continued during 2005 to provide funds and staff support to a Coordinated Resource Management Plan group, called the Stewards of the Arroyo Pasajero Watershed. The mission of this group is "to improve the Arroyo Pasajero watershed through erosion and sediment control, by implementing improved land management practices that will sustain and promote the aesthetics, environmental quality, and economic viability of the watershed." It is believed that this watershed management plan will increase watershed infiltration and decrease erosion, complementing any structural flood control improvements, and reducing the threat Arroyo Pasajero poses to the California Aqueduct and surrounding communities.

Repairs and Modifications

DWR continually monitors all SWP facilities and performs repairs and modifications as necessary to ensure safe, reliable, water delivery.

Table 11-1 presents information, arranged chronologically, about significant scheduled and unscheduled outages at SWP pumping and power plants in 2005. The table includes information about incidents resulting in outages exceeding 14 days.

Table 11-1. Outages for Maintenance and Repair of Facilities in 2005, by Month

Month	Facility	Units Out of Service
January	Hyatt Power Plant	Unit 2 from January 4 to January 20 to perform weld repair on scroll case access door
	Banks Pumping Plant	Unit 1 from January 6 to January 25 for annual maintenance and to replace discharge valve o-ring Unit 4 from January 26 to March 4 for annual maintenance, to replace automatic voltage regulator, and remove hot water bypass line
	Buena Vista Pumping Plant	Unit 8 from January 31 to May 12 to overhaul unit, repair and upgrade cooling water system, and repair oil tub leak and pump case
	Mojave Siphon Power Plant	Unit 2 from January 31 to February 24 for annual maintenance and to repair trashrack
	Warne Power Plant	Unit 1 from January 2 to April 7 for annual maintenance, to rewind motor, and clean and modify cooling water sump Unit 2 from January 11 to January 28 to adjust needle timing, calibrate needle limit switches, and clean cooling water sump
February	Gianelli Pumping-Generating Plant	Unit 8 from February 23 to March 28 to adjust loose fasteners on pump/turbine guide bearing and replace brake packing
	Dos Amigos Pumping Plant	Unit 3 from February 22 to April 6 for biennial maintenance
March	Banks Pumping Plant	Unit 4 from March 19 to May 7 to replace unit breakers, station service feeder breaker, and discharge valve o-rings, and repair discharge valve hydraulic system and discharge line Unit 5 from March 19 to May 12 for annual maintenance, to replace unit breakers and station service feeder breaker, repair discharge valve hydraulic system and discharge line, and remove hot water bypass line
	Gianelli Pumping-Generating Plant	Unit 3 from March 13 to May 9 for biennial maintenance, to install automatic voltage regulator, and recoat scrollcase Unit 4 from March 13 to May 12 for biennial maintenance, to install automatic voltage regulator, refurbish pump/turbine, adjust bearings, and recoat scrollcase Unit 6 from March 16 to April 13 to adjust loose fasteners on pump/turbine guide bearing and repair bearing
	Edmonston Pumping Plant	Unit 4 from March 28 to June 30 to repair pump first stage impeller and rewedge motor
	Pearblossom Pumping Plant	Unit 7 from March 7 to March 22 to replace pump mechanical seal and discharge valve o-rings
April	Banks Pumping Plant	Unit 6 from April 29 to May 31 for annual maintenance, to replace unit breakers, and remove hot water bypass line Unit 7 from April 29 to June 16 for annual maintenance, to replace automatic

Table 11-1. Outages for Maintenance and Repair of Facilities in 2005, by Month

Month	Facility	Units Out of Service
		voltage regulator, overhaul exciter, machine pump guide bearing, and remove hot water bypass line
	Dos Amigos Pumping Plant	Unit 2 from April 18 to May 24 for biennial maintenance
	Pearblossom Pumping Plant	Unit 7 from April 7 to April 25 to replace failed pump mechanical seal
	Reid Gardner Power Plant	Unit 4 from April 22 to May 15 for annual maintenance
May	Hyatt Power Plant	Unit 5 from May 9 to June 25 for annual maintenance and to repair damaged impeller wear rings
	Gianelli Pumping-Generating Plant	Units 7 and 8 from May 16 to June 18 for biennial maintenance, to repair penstock, and recoat stay vanes
June	Banks Pumping Plant	Unit 3 from June 20 to July 22 for annual maintenance, to replace automatic voltage regulator, and repair amortisseur straps
July	Badger Hill Pumping Plant	Unit 5 from July 12 to July 28 to repair damaged motor
	Edmonston Pumping Plant	Unit 3 from July 9 to August 4 to replace damaged thrust bearing
	Oso Pumping Plant	Unit 7 from July 25 to expected completion date in 2006 to rewind damaged motor and replace cooling water piping
August	Banks Pumping Plant	Unit 10 from August 23 to December 27 to repair damaged amortisseur winding
	Del Valle Pumping Plant	Unit 2 from August 22 to expected completion date in 2006 to overhaul motor and pump
	Gianelli Pumping-Generating Plant	Unit 7 from August 28 to October 5 for biennial maintenance, to install automatic voltage regulator, and recoat pump/turbine
	Chrisman Pumping Plant	Unit 8 from August 4 to August 18 to resurface damaged pump shaft and refurbish damaged pump guide bearing
	Edmonston Pumping Plant	Unit 11 from August 8 to expected completion date in 2006 to overhaul motor and pump and replace lower pump labyrinth seal
September	Banks Pumping Plant	Unit 2 from September 18 to expected completion date in 2006 to rewind motor, refurbish pump, replace discharge valve and station service feeder breakers, remove hot water bypass line, and modify CO2 system
	Dos Amigos Pumping Plant	Unit 1 from September 12 to October 25 for biennial maintenance, to replace CO2 system, and recoat pump

Table 11-1. Outages for Maintenance and Repair of Facilities in 2005, by Month

Month	Facility	Units Out of Service
	Buena Vista Pumping Plant	Unit 7 from September 6 to expected completion date in 2006 to overhaul motor, pump, and discharge valve
	Teerink Pumping Plant	Unit 4 from September 11 to September 26 to repair oil leak from thrust bearing oil pump and damaged amortisseur winding
	Devil Canyon Power Plant	Unit 2 from September 19 to October 26 for annual maintenance, to replace cooling water strainer and piping, and perform weld repair on turbine shutoff valve piping
October	Hyatt Power Plant	Unit 2 from October 2 to expected completion date in 2006 to refurbish unit and replace turbine runner
	South Bay Pumping Plant	Unit 7 from October 25 to November 23 to replace motor and pump with previously refurbished components
	Del Valle Pumping Plant	Units 1, 3, and 4 from October 22 to November 22 for work on Unit 2
	Gianelli Pumping-Generating Plant	Unit 5 from October 3 to expected completion date in 2006 to work on automatic voltage regulator, penstock, and transformer K6A, and install new CO2 system Unit 6 from October 3 to expected completion date in 2006 for biennial maintenance, to work on automatic voltage regulator, penstock, and transformer K6A, and install new CO2 system
	Chrisman Pumping Plant	Unit 6 from October 24 to expected completion date in 2006 to overhaul motor and pump, replace corroded and damaged piping, perform weld repair on pump case and discharge line, and recoat pump
	Devil Canyon Power Plant	Unit 4 from October 31 to November 18 for annual maintenance, to rebuild needles, and install new cooling water strainer
	Warne Power Plant	Unit 2 from October 11 to October 28 for biennial maintenance and to replace station service breakers
November	Hyatt Power Plant	Unit 4 from November 28 to December 22 to recoat waterway
	Badger Hill Pumping Plant	Unit 5 from November 3 to November 22 to replace bad DTU card and adjust motor breaker linkage
	Polonio Pass Pumping Plant	Unit 2 from November 7 to November 22 to fix starting sequence problems and work in switchyard
	Chrisman Pumping Plant	Units 1 and 2 from November 28 to December 17 for annual maintenance, to repair discharge valve seats, replace discharge line mandoor gasket, and work on transformer KYA

Table 11-1. Outages for Maintenance and Repair of Facilities in 2005, by Month

Month	Facility	Units Out of Service
		Unit 3 from November 28 to December 17 for annual maintenance, to replace discharge line mandoor gasket, and work on transformer KYA
	Alamo Power Plant2221	Unit 1 from November 17 to December 8 to replace shaft mechanical seal and seal water filtration system and repair cooling water return line
	Pearblossom Pumping Plant	Units 1 and 3 from November 28 to expected completion date in 2006 to repair discharge line, replace discharge valve o-rings, and work on transformer KYA Unit 2 from November 21 to expected completion date in 2006 for annual maintenance, to repair rotor poles and discharge line, replace discharge valve o-rings, and work on transformer KYA
	Pine Flat Power Plant	Unit 1 from November 7 to expected completion date in 2006 for annual maintenance, to work in switchyard, and repair concrete encasing penstock Unit 2 from November 7 to December 13 for annual maintenance and to work in switchyard Unit 3 from November 7 to December 19 for annual maintenance and to work in switchyard

Chapter 12
Engineering and Right of Way

Construction at East Branch Extension Reach 5.

Significant Events in 2005

In 2005, work to enhance, expand, and repair water delivery in the State Water Project (SWP) continued. Increased water deliveries were more efficient within the confines of legal constraints, environmental restraints, and power availability. Significant projects included South Bay Aqueduct Enlargement, Tehachapi East Afterbay construction, and East Branch Enlargement.

The Department of Water Resources (DWR) has spent a net total of $251 million to acquire rights of way, recreation, and mitigation land for the SWP, from its inception to December 31, 2005.

Information for this chapter was provided by the Division of Engineering.

Initial construction of the State Water Project (SWP) facilities began in 1957 with the relocation of the Western Pacific Railroad facilities and Highway 70 near the City of Oroville to accommodate the SWP Oroville facilities. Oroville Dam was constructed between 1961 and 1967. Construction of the South Bay Aqueduct (SBA) facilities was started in 1960, and the first SWP water was delivered through the SBA in 1965 to serve Alameda and Santa Clara counties.

In 1963, work began on the California Aqueduct, and by 1968, SWP was delivering water to long-term contractors in the San Joaquin Valley to the foot of the Tehachapi Mountains. By 1973, with the completion of Edmonston Pumping Plant at the foot of the Tehachapi Mountains and other East Branch conveyance facilities, SWP was delivering water to Lake Perris at the southernmost point in Los Angeles County.

In 1974, SWP water was delivered to Los Angeles County through the West Branch Facilities. SWP water was delivered to Napa County in 1968, through the first phase facilities of the North Bay Aqueduct, and to Solano County in 1988 by the second phase facilities. The first SWP water delivery through the Coastal Branch (Phase I) was made in 1968 to Kings and Kern counties.

Prior to the completion of the initial facilities in 1973, work began on the Upper Feather River facilities to supply local water, recreation, and fish enhancement. Power plants, additional pumping units, and turbine-generators that had been deferred from the initial construction of the SWP were built to ensure water quality and fish enhancement in the Delta.

From the 1980s through 2004, design and construction activities shifted to repairing concrete lining failures or potential failures of the canal system and concrete pipeline sections; replacing equipment components of existing facilities; enlarging or extending aqueduct reaches; adding pumps and motors to existing facilities; constructing the Devil Canyon Second Afterbay; constructing Phase II of the Coastal Branch to deliver water to San Luis Obispo and Santa Barbara counties in August 1997; and extending the SWP through the East Branch Extension to San Gorgonio Pass service area in San Bernardino and Riverside counties. The East Branch Extension became operational in local/manual mode in 2003, while the remote control system is still being completed.

Design Activities

In 2005, work to enhance, expand, and repair water delivery in the SWP continued. Increased water deliveries were more efficient within the confines of legal constraints, environmental restraints, and power availability. Significant projects included South Bay Aqueduct Enlargement, Tehachapi East Afterbay construction, and East Branch Enlargement. (Table 12-1 provides a list of completed and ongoing design work that was undertaken in 2005.) (Table 12-2 provides a list of projects that were constructed to replace turbines and pumps, repair pipelines, upgrade trashracks at fish hatcheries, and improve recreational and maintenance facilities at dam and reservoir sites.)

The Department of Water Resources (DWR) designed projects for development into construction contracts. Division of Engineering (DOE) staff worked with the Division of Operations and Maintenance (O&M), Division of Flood Management, Division of Environmental Services, Department of Fish and Game (DFG), Department of Boating and Waterways (DBW), Department of Transportation (Caltrans), SWP contractors, California water districts, Sacramento/San Joaquin River and Delta Levee Maintenance Districts, CALFED, U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), Federal Energy Regulatory Commission (FERC), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NOAA Fisheries), and other entities concerned with water resources activities. DOE staff prepared preliminary designs and estimates, as well as conducted special studies of dams, canal embankments, and other SWP facilities. The studies, reports, and activities continued from previous reporting periods, or initiated in 2005, include the following:

- stability analysis for Oroville, Parish Camp Saddle, Bidwell Canyon Saddle, and Thermalito Dams;
- North Bay Aqueduct reliability study;
- geologic faulting and seismicity re-evaluation of the Clifton Court Intake Structure;
- South Bay Aqueduct reliability study;
- Gianelli Pumping-Generating Plant power transformer second containment basin;
- Gianelli pump/turbine runner replacement feasibility study;
- Devil's Den Pumping Plant trashrack/ traveling screen modification;
- evaluate capacity of cross-drainage structure between Buena Vista and Teerink Pumping Plants;
- evaluate hydrology and capacity of cross-drainage facilities Buena Vista and Teerink Pumping Plants;
- develop pump refurbishing pilot program for Edmonston Pumping Plant;
- Warne Power Plant Penstock cooling water transient study;
- Castaic, Pyramid, and Perris dams—Emergency Release Facilities;
- Castaic Dam and Perris Dam Breach Inundation study;
- Castaic Dam Low Intake Tower Analysis;
- Pearblossom Disposal Area assessment study, Phase II;
- Devil Canyon Second Afterbay Outlet Structure modification;
- Hesperia Master Drainage Plan for Antelope Wash and adjacent area;
- East Branch Enlargement, Phase II study activities;
- East Branch Extension, Phase II—Citrus Reservoir pre-feasibility study; and
- Seismic Safety Retrofit Program—seismic analysis of 24 SWP bridges.

DOE staff completed the following studies and activities:

- Thermalito Afterbay Temperature Control and Palermo Canal Diversion to Feather River Fish Hatchery, as part of the Oroville Facilities Relicensing Program;
- North Bay Aqueduct capacity enlargement reports;
- Delta seismicity study program;
- Clifton Court Forebay and Dam re-evaluation report prepared for O&M;
- Clifton Court Forebay radial gates rehabilitation;

- Skinner Fish Protection Facility—evaluation of wing gate system;
- Gianelli Pumping-Generating Plant runner replacement feasibility study;
- San Luis Dam trashrack access bridge vehicle load study;
- Vista del Lago landslide study; and
- Perris Dam foundation study.

Environmental Activities

Environmental issues have concerned DWR since the inception of the SWP. These issues have increased in magnitude with the enactment of numerous federal and State laws. DWR has complied with these laws by incorporating environmental requirements and conditions into the design and construction phases of projects. A section dealing with environmental requirements and the protection of listed species has become an integral part of contract specifications for construction contracts. Contracts are reviewed to ensure compliance with requirements outlined in environmental permits. In 2005, two contracts required continuing environmental review.

Excavation, Inspection, and Repair–Phase III, Santa Ana Pipeline–State Water Facilities California Aqueduct, Southern Field Division, San Bernardino and Riverside Counties, California

In 2005, the Santa Ana Pipeline, which conveys water from the Devil Canyon Power Plant to Lake Perris via buried pipeline, was repaired at locations known by DWR to contain anomalies. Pipe sections 2034, 327, 590, and 144 required repairs. These repairs were located in San Bernardino and Riverside counties. Without repairs, the Santa Ana Pipeline had the potential to fail, causing potentially catastrophic impacts to human life and property, as well as water outage to millions of people.

Several actions were taken during these repairs to mitigate potential environmental impacts:

The contractor was required to submit an Air Quality Plan, a Water Quality Control Plan, a Fire Prevention and Control Plan, and a Storm Water Pollution Prevention Plan to DWR prior to the Notice to Begin Work.

The contractor and the contractor's employees were required to attend an environmental training meeting, prior to the start of construction, which addressed potential cultural resources and sensitive species that could be found in areas, exclusion zones, and environmental permit conditions relevant to the project.

Sensitive species known or suspected to occur on or very near portions of the project route included one federally listed species and eight non-federal/State listed species. These project areas were environmentally cleared of any sensitive species by qualified biologists prior to the start of construction.

Tehachapi East Afterbay–Completion–Phase II, Antelope Valley–State Water Facilities, California Aqueduct, East Branch, Mojave Division, Kern County, California

This project was located at the newly constructed Tehachapi East Afterbay, north of the Alamo Power Plant. Thousands of cubic yards of material were excavated

in the existing natural drainage channel for construction of the bypass to the Cottonwood Canal Tie-In. The construction activities had the potential to impact several known special status species such as the Coast horned lizard, the Burrowing owl, and the Pallid bat; as well as flora, fauna, and vegetation communities in the area, including the Round-leaved Filaree and Southern Cottonwood Willow riparian forest. Exclusion zones were installed to protect sensitive sites from any contractor activity. In addition, environmental training meetings were conducted on a regular basis by biologists familiar with the biological resources of the area, keeping the contractor's employees and DWR personnel briefed on the biological resources at the work site.

Construction Activities

DOE worked on 43 construction contracts in 2005. Table 12-2 shows contract title, specification number, date the contractor received the Notice to Begin Work, the expected or actual acceptance date (physical completion date is discussed in narratives below), and the actual or estimated contract cost (including change orders for added work). Resolution of contract claims may extend the actual contract closeout beyond the completion or acceptance date.

Oroville Division

Hyatt Power Plant

The refurbishment of turbine Units 1, 3, and 5, which started in February 1999 (Specification No. 98-22), continued throughout the year, with approximately 99 percent of the work completed by the end of 2005. Due to warranty issues, completion of this project is projected for July 2007. The refurbishment of pump-turbine Units 2, 4, and 6, which started in November 2001 (Specification No. 01-11), continued with approximately 40 percent of the work completed by the end of 2005. The estimated completion date is September 2007.

Oroville Operations and Maintenance Center

Work on a contract to replace the roofs at the Oroville Operations and Maintenance Center planner scheduler and mobile equipment buildings, the Feather River Fish Hatchery, and the Beckworth Subcenter (Specification No. 05-09) began in August 2005 and was completed in November 2005. Work included removal of existing roofing, installation of new roofing, removal and replacement or reinstallation of existing equipment, and painting.

Delta Facilities

Temporary Rock Barriers

Work on a multiyear, 2004 through 2006, contract (Specification No. 03-07) to install and remove seasonal temporary rock barriers in designated South Delta waterways (Middle River, Old River, and Grant Line Canal) continued throughout the year with approximately 64 percent of the work completed by the end of December 2005. The temporary barriers were installed to enhance water levels and circulation in the South Delta for local agricultural diversion, to assist fish migration, and to gather hydraulic data for the design of future permanent barriers. Contract change order work included the following:

- constructing two divider walls in the intake channel at Skinner Fish Facility;
- providing South Bay Aqueduct testing and security;

- removing pond weed at Clifton Court Forebay;
- purchasing and installing piles, support beams, and catwalk for the new Water Quality Monitoring Station at Vernalis;
- purchasing equipment for the new Water Quality Monitoring Station at Vernalis;
- removing and replacing flashboards at Montezuma;
- dredging; and
- providing geologic exploration.

North San Joaquin Division

Skinner Fish Facility

Replacement of the trash rake and trashrack systems (Specification No. 04-02) began in March 2004. Although these systems were installed and provisionally operational by November 2004, work added at the request of the Delta Field Division delayed acceptance until September 2005. Contract work included furnishing and installing the trashrack; an automatic monorail traveling trash rake system; and metal catwalks and handrails.

Added work included the following:

- fabricating and installing a cover plate system and manual control system;
- installing additional differential sensors;
- disposing of the existing trashracks and trash rake mechanical system;
- modifying the trash rake hydraulic system; and
- purchasing and delivering spare parts for the automated trash rake system.

South Bay Aqueduct

A contract to repair the pipeline at Milepost 39 (Specification No. 04-07) began in July 2004. This contract was completed in January 2005 and accepted in April 2005.

South Bay Aqueduct Enlargement/ Improvement

The South Bay Aqueduct Enlargement Project will enlarge the South Bay Pumping Plant to accommodate four additional units, construct a third discharge line, construct Dyer Reservoir, enlarge the canal, and modify associated structures.

A contract (Specification No. 04-05) to furnish 45 cfs pump and motor units for Unit Nos. 10 through 13 and one spare pump and motor for the South Bay Pumping Plant began in November 2004 and is expected to be completed in February 2008.

A contract to furnish power transformers (Specification No. 04-19) began in April 2005 and is expected to be completed in April 2008. In December, the contractor was directed to suspend all contract work for an estimated 150 days, due to a pending feasibility study and environmental permits.

Work on a contract to furnish valves, actuators, and hydraulic power units (Specification No. 04-20) that began in May 2005, is in the submittal stage with completion expected in December 2007.

A contract to furnish switchyard equipment (Specification No. 05-10) began in September 2005, and a contract to furnish 5 kV switchgear (Specification No. 05-05) began in October 2005. In December, both the contractors were directed to suspend all contract work for an estimated 150 days due to a pending

feasibility study and environmental permits. Completion of these two contracts is expected in January 2008.

San Luis Division

Gianelli Pumping-Generating Plant and Dos Amigos Pumping Plant

In July 2004, work began on a contract (Specification No. 04-08) to refurbish the existing carbon dioxide (CO_2) fire suppression system for Motor-Generator Unit Nos. 1 through 8 and the Oil Purifier Room at Gianelli, as well as Motor Unit Nos. 1 through 6 and the Oil Purifier Room at Dos Amigos. This project was approximately 96 percent complete by December 2005. The work included removing the existing devices and CO_2 cylinders, inspecting piping and nozzles, providing required welding and coating, furnishing, and installing the following:

- a fire alarm system, including a fire alarm control panel to provide fully integrated automatic and remote monitoring;
- new motor air housing smoke and temperature detectors;
- audible and visual alarms;
- new fully charged CO_2 cylinders;
- LCD annunciators and new manual pull stations; and
- new discharge heads, manual release station, lockout valves with enclosure, relief vents, bleeder valves, equipment nameplates, CO_2 flexible hoses, and router valves.

Contract change orders included replacing and refurbishing fire extinguishers at the San Luis Field Division, installing an escape platform at Dos Amigos, and installing safety platforms at Gianelli.

The approximate completion date is December 2007 due to a one-year CO_2 service maintenance contract.

San Luis Canal. Work on a contract to restore the West Side Detention Basin (Specification No. 04-03) began in August 2004. This contract work was essentially completed by December 2005, except for punch list items. Subsequently, the contractor was directed to fabricate and install a protective cover over the rubber dam, which will delay acceptance until 2007. Work included the following:

- earthwork;
- concrete and steel reinforcement;
- gravel surfacing on the embankment road;
- chip sealing on the operations and maintenance road;
- erosion protection;
- construction of a concrete weir with inflatable rubber dam, control system, and appurtenances; and
- rehabilitation of the existing drain inlets and evacuation culverts.

Contract change order work included the following:

- repairing MP 166R and MP 122R canal embankment;
- sealing and paving roads at Reaches 6 and 7;
- cleaning the toe drain at O'Neill Dam;
- installing gates at San Joaquin Field Division;
- installing gates at Lost Hills; and
- installing a protective cover over the rubber dam.

Tehachapi Division

Tehachapi East Afterbay

The Tehachapi East Afterbay Project is located near the bifurcation of the East and West Branches of the California Aqueduct, in southern Kern County. The project will provide additional storage to the existing Tehachapi Afterbay. The principal features of this project include: an inlet channel, isolation weir, reservoir, flow barrier, spoil embankment, outlet channel, bypass, drainage culvert, control building, improvements to the existing canal, and site work.

The contract to furnish roller gates (Specification No. 04-18) began in February 2005, and it was approximately 80 percent complete in December 2005. Work included furnishing two roller gates with hydraulic actuators and one hydraulic power unit, metalwork, coatings, and electrical work.

The initial afterbay contract (Specification No. 04-17) began in February 2005, and it was 95 percent completed by December 2005. Features include the following:

- drainage culvert facilities, including a reinforced box culvert;
- inlet channel facilities, including a reinforced concrete weir;
- concrete canal lining and a new inlet tie-in to the existing aqueduct;
- a reservoir;
- an outlet channel with a cofferdam;
- a bypass turnout construction area, access road, and drainage culverts; and
- a cofferdam and water level measurement system.

The last phase of the Tehachapi East Afterbay Project began in May 2005, with the afterbay completion contract (Specification No. 05-03). Work included the following:

- constructing bypass facilities;
- constructing the control building;
- furnishing a propane tank;
- constructing a flow barrier in the reservoir;
- constructing an aqueduct plug, which included a rockfill plug, waterproof membrane, and fabric-formed concrete canal lining;
- constructing an outlet channel; and
- removing the cofferdam at the outlet channel.

This completion contract was terminated due to default, and the remaining work was divided into three contracts—Specification Nos. 05-17, 05-16, and 06-14.

Work began on Specification No. 05-17 (Completion Phase IA) in December 2005, with acceptance anticipated in March 2006. This work included constructing the Cottonwood Canal tie-in and installing Cofferdam No. 2.

Work on Specification No. 05-16 (Completion Phase II) is anticipated to begin in January 2006, and it will include the bypass facilities, control building, flow barrier, removal of Cofferdam No. 2, and miscellaneous roadwork.

The scope of work in Specification No. 06-14 (Completion Phase III), which will be awarded later in 2006, includes the outlet channel completion, aqueduct plug, Cofferdam No. 1 removal, and site work.

Edmonston Pumping Plant

A contract to replace pump Units W2, W4, W6, and W8 (Specification No. 02-10) began in June 2003, and continued throughout 2005, with completion scheduled for March 2011. This work consists of the following:

- designing, fabricating, and testing a four-stage pump model and a single-stage pump model; as well as furnishing a pump model test program report;
- designing, manufacturing, delivering, storing, and installing four pumps to replace existing pumps;
- furnishing spare parts, auxiliary equipment, tools, and templates;
- modifying existing pump foundations, if required, for the new pumps;
- applying coatings; and
- providing liaison services.

A contract to furnish spare impellers and diffusers (Specification No. 04-09) was awarded in June 2004, and was approximately 65 percent completed by December 2005. Work consists of the manufacture and delivery of the following:

- two complete sets of pump impellers and two additional impellers;
- one complete set of diffusers;
- two complete sets of stationary and rotating wearing rings;
- one complete set of upper and lower wear plates; and
- one complete set of interstage bushings and templates.

Work on a contract to refurbish the adit for the Edmonston Pumping Plant discharge lines (Specification No. 05-02) began in March 2005. This project was completed in June 2005. The work consisted of the following:

- blasting metal surfaces, concrete footings, and rock surfaces;
- removing and disposing of corroded steel and rockfall;
- installing chain link fabric;
- providing and placing shotcrete and additional rock bolt anchorage;
- providing hazardous waste removal;
- coatings;
- installing an adit entrance gate; and
- replacing ducts, ventilation, and electrical systems.

West Branch

Castaic Dam

A contract to repair the spillway wall (Specification No. 05-12) began in August 2005, and is expected to be completed in January 2006. Work consists of the following:

- removing and replacing five concrete panels;
- removing and reconstructing damaged V-ditches;
- excavating, backfilling, and regrading;
- placing drain rock; and
- replacing topsoil and seeding disturbed areas.

Oso Pumping Plant

Work on a contract to furnish automatic voltage regulators began in May 2000 (Specification No. 00-06). Although this work was originally scheduled for completion in June 2002, a contract change order to furnish and deliver six additional automatic voltage regulators for Pearblossom Pumping Plant extended the completion date. The contract was

accepted in May 2005, after DWR installed the automatic voltage regulators, and the contractor provided erecting engineer services.

Santa Ana Division

Santa Ana Pipeline

A contract to excavate, inspect, and repair pipe sections of the Santa Ana Pipeline (Specification No. 05-14) began in October 2005, and is scheduled for completion in January 2006.

A contract to widen the concrete encasement under State Route 60 (Specification No. 05-15) began in November 2005, and was completed in December 2005, 30 days prior to the original contract completion date.

East Branch Extension

Construction of the East Branch Extension began with the issuance of a Notice to Begin Work on February 26, 1999, for pipeline Reaches 1 and 2. Phase I of this project will convey 8,650 af of SWP water annually to the San Gorgonio Pass Water Agency service area, with provisions to provide San Bernardino deliveries to the Yucaipa Valley. Located in San Bernardino and Riverside counties, the project facilities will consist of existing pipelines, three new pipeline reaches, three new pump stations, and a new reservoir. The official groundbreaking ceremony for site work took place in Yucaipa on August 23, 1999. Below are brief descriptions of the remaining construction contracts.

Pump Stations

Work began in October 1999, on a contract to design, manufacture, test, and deliver 5 kV switchgear for Greenspot and Crafton Hills Pump Stations. This contract includes work that will design, manufacture, test, and deliver programmable logic controllers for the Cherry Valley Pump Station (Specification No. 99-15). Site acceptance testing was completed in June 2004, and the contract was accepted in July 2005, after the contractor submitted final programming and a global database.

In November 1999, work began on a contract to design, manufacture, shop test, and deliver three 4,500-gpm and one 9,000-gpm vertical turbine pumps for Greenspot Pump Station; two 4,500-gpm and one 9,000-gpm vertical turbine pumps for Crafton Hills Pump Station; and two 3,600-gpm vertical turbine pumps for Cherry Valley Pump Station (Specification No. 99-17). The contract calls for electric motors, variable frequency drives, appurtenant equipment, and associated training programs. Completion of this contract was scheduled for December 2003; however, it was extended to 2007 due to a change order for additional pump units for Greenspot and Crafton Hills Pump Stations.

A contract to construct Greenspot, Crafton Hills, and Cherry Valley Pump Stations (Specification No. 99-27) was awarded in May 2000, and it was accepted in July 2005.

An October 2001 contract to furnish and install the control and communications systems for Greenspot, Crafton Hills, and Cherry Valley Pump Stations (Specification No. 01-05) was 99 percent completed by December 2005. Extensive punch list items and training will delay completion and acceptance, which is projected for December 2007.

Valves

Three separate contracts were awarded to furnish East Branch Extension valves. In October 1999, work began on contracts to furnish ANSI ball valves (Specification No. 99-20) and AWWA butterfly valves (Specification No. 99-22). A contract to furnish ANSI butterfly valves began in November 1999 (Specification No. 99-23). Work on the three contracts was 99 percent completed by December 2005. Acceptance will be delayed until corrective work is finished.

Construction Activities in Multiple Divisions

A May 2003 contract to design, manufacture, deliver, and install automatic digital voltage regulators for Banks Pumping Plant and Gianelli Pumping-Generating Plant (Specification No. 02-12) continued, with approximately 95 percent of the work completed by the end of December 2005.

In July 2005, work began on a contract to monitor, test, and repair copper communications cable and voice and data equipment along 440 miles of the California Aqueduct (Specification No. 05-07). Work on this three-year contract consists of the following:

- troubleshooting, repairing, and testing pressurized underground copper cable;
- interfacing copper cable technology to other technologies of radio, microwave, and multiplexers;
- furnishing and installing, or refurbishing and repairing compressor equipment used to pressurize the communications cable; and
- performing biannual electronic work to voice and data equipment.

Completion of this work is scheduled for April 2007.

Work on a contract that fulfills FERC permit requirements for revegetation of disturbed areas at Mojave Siphon Power Plant and Devil Canyon Second Afterbay (Specification No. 99-21) began in November 1999, and was completed in December 2005. Due to the extensive fires in late 2003, erosion control at the areas surrounding Silverwood Lake, Devil Canyon Second Afterbay, and Mojave Siphon Power Plant was added by change order. Other change order work included revegetation at Crafton Hills.

In September 2005, work began on a contract to apply asphalt seal coat and asphalt concrete to paved areas in the Oroville and Southern Field Divisions (Specification No. 05-11). Approximately 66 percent of this contract work was completed by December 2005. Work added by change order included the following:

- repairing storm damage on North Adit Road;
- furnishing and installing a modular office;
- removing the Devil Canyon Creek culvert bridge; and
- furnishing, installing, and repairing an irrigation system at Lake Perris.

A contract to repair pipeline at Pearblossom Pumping Plant and modify the weir at Devil Canyon Power Plant Afterbay (Specification No. 05-13) began in September 2005, and is expected to be completed in February 2006. This work includes the following:

- repairing 315 interior pipe joints in 108-inch inside diameter prestressed

concrete cylinder pipe;
- repairing damaged coating of a 6-foot long steel pipe section;
- removing and disposing of old joint material;
- fabricating a reinforced concrete cap for the existing weir; and
- setting weir segments in place, installing dowels, and placing shotcrete.

In August 2004, work began on a contract to apply asphalt seal coat and asphalt concrete to paved areas in the San Luis and Southern Field Divisions (Specification No. 04-10). Approximately 99 percent of the contract work was completed by December 2005. Work added by change order included the following:

- providing a temporary construction field office and soils and concrete testing laboratory;
- placing rocks along Piru Creek Road, Osito Adit Channel, Devil Canyon Headquarters Road, Smokey Bear Road, and the South Adit Access Road to stop continuing erosion from high storm flows;
- restoring corrosion test stations; and
- installing an anode bed in the vicinity of Pearblossom Pumping Plant.

A contract to furnish spare coils for Warne Power Plant and Devil Canyon Power Plant (Specification No. 01-13) started in October 2001. By the end of 2005, approximately 99 percent of the original contract work was completed. The anticipated change order for a set of stator bars for Warne Unit 2 will delay completion of all contract work until February 2006.

Miscellaneous Construction Activities

The following non-SWP construction activities are categorized as miscellaneous:

A contract with the DWR Bay-Delta Office to install a demonstration aeration facility on Dock 20 at Rough and Ready Island in the Port of Stockton (Specification No. 05-06) began in December 2005. It is scheduled for completion in September 2006. Work includes installing the following equipment:

- two 30-inch diameter steel U-tube casings and two 20-inch diameter U-tubes to a depth 205 feet below ground surface;
- 24-inch steel piping and 30-inch HDPE diffuser piping;
- two vertical turbine pump-motor units;
- four fish screens with two air burst systems; and
- electrical items, including a programmable logic controller, water flow meter, instrumentation, and a distribution panel and meter.

Upper Jones Tract Levee Breach

Due to a breach in the levee at the Upper Jones Tract, the Governor officially declared a State of Emergency on June 4, 2004, for flooding at Upper and Lower Jones Tracts. In response, the following four emergency contracts were awarded in June 2004 and completed in 2005:

Specification No. 04-13 to close a levee breach at Upper Jones Tract. The breach was closed in October 2004, but work continued until May 2005.

Specification No. 04-14 to provide levee protection support activities and other emergency work at Lower Jones Tract. Work was completed in February 2005.

Specification No. 04-15 to provide levee slope protection by placing riprap on the interior levee slopes of Lower Jones Tract. Work was completed in February 2005. Work was also performed at Trapper Slough levee to mitigate potential impacts from dredge spoil fill material.

Specification No. 04-16 to dewater Upper and Lower Jones Tracts. Work began in July 2004 and was completed in December 2004, with acceptance in October 2005. This work consisted of installing, operating, and maintaining two temporary pump stations, 24 hours a day, 7 days a week, until the flood water was pumped to an elevation established by the engineer.

Real Estate Branch Activities

DWR has spent a net total of $251 million to acquire rights of way, recreation, and mitigation land for the SWP from its inception to December 31, 2005. DWR conducted the following real estate activities from January 1 through December 31, 2005:

- Acquired one parcel (665.93 acres in fee and 1.74 acres in permanent easement) for a cost of $885,700 for Suisun Marsh Mitigation, Meins Landing.
- Acquired one parcel (340.6 in fee) for a cost of $220,000, California Aqueduct, East Branch, Tehachapi East Afterbay.
- Renewed 11 leases on SWP properties.
- SWP income produced $448,882.
- Processed 37 Encroachment Permit applications; issued 29.
- Collected fees of $151,642 for review and inspection costs related to Encroachment Permit applications.
- Received six encroachment reviews where applicant had prior property rights; completed five.
- Received five Encroachment Permit amendments; completed five.
- Coordinated review of 20 tentative tract map developments within one mile of the California Aqueduct.
- Completed four appraisals and ten appraisal reviews.

In addition, DWR obtained 59 temporary permits:

- twenty for Calaveras River Fish Passage Study;
- eight for South Bay Aqueduct Improvement and Enlargement, Bethany Reservoir;
- five each for the East Branch Extension Phase II and Santa Ana Pipeline Repair;
- two each for the Calaveras River Migration Barrier Assessment Study and the South Delta Improvement Program; and
- one for each of the following: American River Watershed, Berryessa Creek Landslide Repair, Cache Creek Erosion Damage Repair, CIMIS Weather Station, Delta Peripheral Canal, Former Cruise 'N Tarry Marina, Gauging Station at Orestimbra Creek, Milepost 62.26 to 64.46 Oil Pipeline Relocation, Old River at the Head of San Joaquin River, South Delta Barriers—Old River Project, South Delta Temporary Barriers, Suisun Marsh Monitoring, Montezuma Harbor, Tehachapi East Afterbay, Tejon Ranch Corp., and York Creek Dam.

Table 12-1. Design Activities, January 1, 2005, through December 31, 2005, by Division

Construction Division and Facility	Design Activity	Date Design Began	Design Actual/ Estimated Completion Date
Oroville Division			
Oroville O&M Center, Feather River Fish Hatchery and Beckworth Subcenter	Roof replacement	April 2004	May 2005
Oroville Recreation Facilities	Brad B. Freeman bike trail realignment	December 2004	September 2005
Delta Field Division			
North Bay Rehabilitation/Seismic Retrofit	NBA rehabilitation/seismic retrofit—pipeline	March 2004	September 2005
Skinner Fish Facility	Trashrake and trashrack replacement	August 2003	April 2005
South Bay Aqueduct Enlargement (subcomponents below)			
South Bay Pumping Plant	Initial plant structure	April 2003	May 2006
	Furnish valves and actuators	July 2003	April 2005
	Furnish power transformers (re-bid)	December 2003	February 2007
	Furnish switchyard equipment	December 2003	July 2005
	Furnish switchgear	December 2003	August 2005
	Furnish and install SCADA equipment	February 2004	June 2007
	Completion contract	January 2005	June 2007
Discharge Line and Pipelines	Plant discharge line and Brushy Creek Pipeline No. 3	May 2003	October 2006
Surge Tank No. 3	New surge tank	July 2004	July 2007
Canal	Canal modification	July 2003	July 2007
Dyer Reservoir	New 425 af reservoir	September 2003	June 2007
San Joaquin Field Division			
Lost Hills Domestic and Fire Water Supply	Domestic and fire water supply	September 2004	September 2007
Tehachapi Division			
Edmonston Pumping Plant	Adit refurbishment	August 2004	March 2005
Tehachapi East Afterbay	Completion contract[a]	June 2004	February 2005
	Completion Phase IA contract	December 2005	December 2005
	Completion Phase II contract	December 2005	January 2006
Mojave Division			
Pearblossom Pumping Plant	Repair 315 interior pipe joints in 108 inch diameter PCCP—Discharge No. 1	June 2005	August 2005
Santa Ana Division			
Devil Canyon Power Plant	Weir modifications	June 2005	July 2005
Santa Ana Valley Pipeline	Repair of sections with broken wires	May 2005	October 2005
	Concrete encasement of sections under Hwy. 60 expansion	June 2005	October 2005
West Branch			
Castaic Dam	Remove and replace damaged spillway wall	March 2005	June 2005
Multiple Divisions			
Oso Pumping Plant and Cedar Springs Dam Maintenance Station	Civil maintenance and mobile equipment buildings	May 2005	March 2007
Delta and San Luis Field Divisions	Roof replacement and recoating at Banks PP, Dos Amigos PP, and Coalinga O&M subcenter structures	April 2005	January 2006
Miscellaneous			
Yolo Bypass and Fremont Weir	Floodway sediment removal	November 2004	March 2005
Stockton Deep Water Channel	Demonstration aeration facility	December 2004	September 2005
Permanent South Delta Control	Old River control structure	September 2003	December 2005
	Old River flow control structure	September 2003	December 2005
	Grant Line Canal flow control structure	September 2003	December 2005
	Middle River flow control structure	September 2003	December 2005

[a]Contract terminated.

Table 12-2. Construction Activities, January 1, 2005, through December 31, 2005, by Division

Construction Division and Facility	Construction Contract (Specification Number)	Starting Date (NTBW[a])	Acceptance Date (Expected or Actual)	Contract Costs (In Thousands of Dollars)
Oroville Division				
Hyatt Power Plant	Refurbish turbine Units 1, 3, and 5 (98-22)	February 1999	September 2007	10,825
	Refurbish pump-turbine Units 2, 4, and 6 (01-11)	November 2001	November 2007	14,966
Oroville Operations and Maintenance Center	Replace roof (05-09)	August 2005	June 2006	602
Delta Facilities				
Temporary Rock Barriers	Construct temporary rock barriers: Middle River, Old River, and Grant Line Canal (03-07)	November 2003	April 2007	17,378
North San Joaquin Division				
Skinner Fish Facility	Replace trashrack and trashrake systems (04-02)	March 2004	September 2005	1,643
South Bay Aqueduct				
	Repair pipeline, Milepost 39 (04-07)	July 2004	April 2005	2,176
South Bay Aqueduct Enlargement	Furnish 45 cfs pump and motor units (04-05)	November 2004	April 2008	7,150
	Furnish power transformers (04-19)	April 2005	June 2008	1,287
	Furnish valves, actuators, and hydraulic power units (04-20)	May 2005	February 2008	2,178
	Furnish switchyard equipment (05-10)	September 2005	March 2008	847
	Furnish 5 kV switchgear (05-05)	October 2005	March 2008	2,971
San Luis Division				
Gianelli Pumping-Generating Plant and Dos Amigos Pumping Plant	Refurbish CO_2 system (04-08)	July 2004	February 2008	1,176
San Luis Canal	Restore West Side Detention Basin (04-03)	August 2004	April 2007	7,162
Tehachapi Division				
Tehachapi East Afterbay	Furnish roller gates (04-18)	February 2005	April 2006	640
	Construct afterbay, initial (04-17)	February 2005	April 2006	20,626
	Complete afterbay (05-03)	May 2005	terminated	4,639
	Complete afterbay phase IA (05-17)	December 2005	March 2006	2,179
Edmonston Pumping Plant	Replace pumps (02-10)	June 2003	May 2011	32,900
	Furnish spare impellers and diffusers (04-09)	July 2004	June 2007	3,900
	Refurbish adit and discharge lines (05-02)	March 2005	August 2005	1,216
West Branch				
Castaic Dam	Repair spillway wall (05-12)	August 2005	February 2006	432
Oso Pumping Plant	Furnish automatic voltage regulators (00-06)	May 2000	May 2005	1,177
Santa Ana Division				
Santa Ana Pipeline	Excavate, inspect, and repair pipeline (05-14)	October 2005	January 2006	3,264
	Widen concrete encasement under State Route 60 (05-15)	November 2005	March 2006	1,183
East Branch Extension				
Pump Stations				
Greenspot, Crafton Hills, and Cherry Valley	Furnish 5kV switchgear, Greenspot and Crafton Hills Pump Stations, and furnish PLC cubicle, Cherry Valley Pump Station (99-15)	October 1999	July 2005	641
	Furnish pumps, motors, and variable frequency drives (99-17)	November 1999	August 2007	4,748
	Construct pump stations (99-27)	June 2000	July 2005	24,300
	Furnish and install supervisory control and communications systems (01-05)	October 2001	December 2007	5,500

Table 12-2. Construction Activities, January 1, 2005, through December 31, 2005, by Division

Construction Division and Facility	Construction Contract (Specification Number)	Starting Date (NTBW[a])	Acceptance Date (Expected or Actual)	Contract Costs (In Thousands of Dollars)
Valve Facilities				
Carter Street and Morton Canyon	Furnish ANSI ball valves (99-20)	October 1999	August 2007	1,145
	Furnish AWWA butterfly valves (99-22)	October 1999	August 2007	862
	Furnish ANSI butterfly valves (99-23)	November 1999	August 2007	1,417
Multiple Divisions				
Banks Pumping Plant and Gianelli Pumping-Generating Plant	Design, manufacture, deliver and install digital voltage regulators (02-12)	May 2003	June 2007	2,284
California Aqueduct	Monitor, test and repair copper communications equipment (05-07)	July 2005	June 2008	1,804
Mojave Siphon Power Plant and Devil Canyon Second Afterbay	Revegetation (99-21)	November 1999	February 2006	761
Oroville and Southern Field Divisions	Seal and pave roads 2005 (05-11)	September 2005	June 2007	2,318
Pearblossom Pumping Plant and Devil Canyon Powerplant Afterbay	Repair discharge line and modify weir (05-13)	September 2005	February 2006	1,443
San Luis and Southern Field Divisions	Seal and pave roads (04-10)	August 2004	June 2005	6,109
Warne and Devil Canyon Power Plants	Furnish spare coils and materials (01-13)	October 2001	May 2006	2,009
Miscellaneous Activities				
Rough and Ready Island Dock 20	Install demonstration aeration facility, Port of Stockton (05-06)	December 2005	November 2006	3,541
Upper and Lower Jones Tracts	Close levee breach at Upper Jones Tract (04-13)	June 2004	July 2005	10,947
	Support levee protection activities at Lower Jones Tract (04-14)	June 2004	April 2005	509
	Protect levee slope at Lower Jones Tract (04-15)	June 2004	April 2005	1,543
	Dewater Upper and Lower Jones Tract (14-16)	July 2004	October 2005	4,803

[a]Notice to Begin Work.

Chapter 13
Recreation

With its many reservoirs and hundreds of miles of aqueducts, the State Water Project offers a variety of recreational activities.

Significant Events in 2005

The Department of Fish and Game (DFG) continued its fish-planting activities at 10 of the 12 SWP facilities. Total plantings of trout was 522.3 thousand compared to the 531.6 thousand planted in 2004.

SWP facilities recorded 4.79 million recreation days of use a 12 percent increase from the 4.27 million recreation days recorded in 2004.

At Lake Oroville, the North Forebay Aquatic Center was completed and opened in July.

Information for this chapter was provided by the Division of Planning and Local Assistance, Central District, Public Affairs Office, and the State Water Project Analysis Office.

The State Water Project (SWP) is a multipurpose project that benefits millions of Californians. In addition to providing water supply, flood control, and habitat for fish and wildlife, the State Water Project offers extensive and varied recreational opportunities—tours, sightseeing, fishing, hunting, camping, boating, water skiing, bicycling, and swimming. These recreational opportunities, as well as fish and wildlife enhancement, are financed by appropriations from several legislative provisions and other funding sources.

Recreation Areas

The SWP has 37 developed recreation areas, or sites, throughout California, including 18 developed fishing access sites. Figure 13-1 shows the names and locations of each area.

Recreation Days

In 2005, SWP facilities recorded 4.79 million recreation days of use (Table 13-1), a 12 percent increase from the 4.27 million recreation days recorded in 2004. Recreational use at the fishing access sites and along the California Aqueduct Bikeway nearly equaled that of 2004. A recreation day is defined as one individual user visiting a recreation site along the SWP during a 1-day period.

Most SWP recreation use is concentrated at the major reservoirs with 41 percent occurring at the Lakes in Oroville Field Division and an equal 41 percent of the total SWP recreational use in 2005 occurring at the four major reservoirs in Southern California: Pyramid Lake, Castaic Lake, Silverwood Lake, and Lake Perris. Since the SWP began delivering water in 1962, more than 185 million recreation days have been recorded at SWP recreational facilities. In addition to the recreation use, visitation totaled 211,00 at the three following DWR visitors centers:

- Kelly Ridge, Lake Oroville, 87,100
- Romero Overlook, San Luis Reservoir, 112,100
- Vista Del Lago, Pyramid Lake, 11,800 (Usage recorded from January 1 through February 22. Facility closed February 23, 2005 through October 31, 2006 due to rain caused landslides.)

Facilities

Planning

During 2005, the Department of Boating and Waterways began plans for the following projects:

- Lake Davis: Honker Cove Ramp Extension.
- Lake Oroville: Boat launching facility at Feather River Outlet Wilbur Road Boat launching facility.
- Lake Perris: Alessudro Island rehabilitation.

1. Antelope Lake Recreation Area
2. Frenchman Lake Recreation Area
3. Lake Davis Recreation Area
4. Lake Oroville State Recreation Area
5. White Slough Wildlife Area
6. Bethany Reservoir
7. Lake del Valle State Recreation Area
8. Bikeway from Bethany Reservoir to O'Neill Forebay (70 miles)
9. Grant Line Road Fishing Access Site
10. Niels Hansen Fishing Access Site
11. Orestimba Fishing Access Site
12. Access Walk-in Fishing (63 miles)
13. Cottonwood Road Fishing Access Site
14. San Luis Reservoir State Recreation Area
15. Los Banos Reservoir
16. Canyon Road Fishing Access Site
17. Mervel Avenue Fishing Access Site
18. Fairfax Fishing Access Site
19. Access to Walk-in Fishing (208 miles accessible along the aqueduct)
20. Three Rocks Fishing Access Site
21. Huron Fishing Access Site
22. Avenal Cutoff Fishing Access Site
23. Kettleman City Fishing Access Site
24. Lost Hills Fishing Access Site
25. Buttonwillow Fishing Access Site
26. Pyramid Lake State Recreation Area
27. Castaic Lake State Recreation Area
28. Munz Ranch Road Fishing Access Site
29. Bikeway from Quail Lake to Silverwood Lake (107 miles, not all accessible)
30. 70th Street West Fishing Access Site
31. Access Walk-in Fishing (83 miles)
32. Avenue S Fishing Access Site
33. 77th Street East Fishing Access Site
34. Longview Road Fishing Access Site
35. Silverwood Lake State Recreation Area
36. Lake Perris State Recreation Area
37. San Jacinto Wildlife Area

Figure 13-1. Names and Locations of SWP Recreation Areas

Table 13-1. Recreation-Days Recorded in 2005, by Field Division and Facility

Field Division and Facility	Number of Recreation Days
Oroville Field Division	
Frenchman Lake	240,000
Antelope Lake	70,000
Lake Davis	138,000
Lake Oroville and Thermalito Forebays	1,072,000
Thermalito Afterbay and Oroville Wildlife Area	353,500
Lake Oroville Visitor Center	88,500
Subtotal	*1,962,000*
Delta Field Division	
Lake Del Valle	268,100
Bethany Reservoir	28,000
Fishing Access Sites:	
Neils Hansen	100
California Aqueduct:	
Walk-in fishing	600
Bikeway	100
White Slough Wildlife Area	12,000
Subtotal	*308,800*
San Luis Field Division	
San Luis Reservoir SRA, includes San Luis Reservoir, O'Neill Forebay, and Los Banos Reservoir	532,000
California Aqueduct:	
Walk-in fishing	12,000
Wildlife Areas	11,000
Subtotal	*555,000*
San Joaquin Field Division	
Fishing Access Sites:	
Kettleman City	1,000
Lost Hills	1,000
Buttonwillow	1,000
California Aqueduct:	
Walk-in fishing	9,500
Subtotal	*12,500*
Southern Field Division	
Silverwood Lake	245,700
Lake Perris	1, 020,700
Pyramid Lake	100,000
Castaic Lake	581,000
Fishing Access Sites:	
Quail Lake	1,300
77th Street East	400
Longview Road	100
California Aqueduct:	
Walk-In fishing	2,500
Bikeway	400
Subtotal	*1,952,100*
Total	**4,790,300**

New Facilities

Lake Oroville

The North Forebay Aquatic Center was completed and opened in July 2005. Bidwell Canyon restroom facility was completed.

Silverwood Lake

Vault toilets at Boat-in Sites Sycamore, Chamise and Live Oak.

Lake Perris

New restroom facilities at ramps 6 and 7.

Lake Del Valle

A new recycling project was initiated by installing six recycling bins on concrete pads. New trail marker discs were installed on major trails. A new check valve, clear well, chlorine generation system, and SCADA system was installed and operating at water treatment plant.

Improvements to Facilities

Improvements were made at the following facilities:

Lake Del Valle

Water faucets were replaced with new metal ones. A second metering pump and a second chlorine analyzer were installed at the water treatment plant. Two group picnic area BBQ pits were replaced with upgraded concrete ones. Major culvert on Deer Jaw Trail was replaced.

Silverwood Lake

Boat-in site renovation project was bid and awarded with construction scheduled for completion in 2005.

Pyramid Lake

Emigrant Landing eroded slopes were repaired. Emergency repairs of docks at boat-in sites were completed.

Oroville Recreation Plan

The Federal Energy Regulatory Commission (FERC) Order 2100-052, issued on October 1, 1992, required DWR to prepare a revised recreation plan for Lake Oroville, replacing the original *Oroville Reservoir, Thermalito Forebay, and Thermalito Afterbay: Water Resources Recreation Report* (Bulletin 117-06). Another plan, FERC Order 2100-054, submitted June 1, 1993, and approved September 22, 1994, included additional recreation facilities and addressed concerns raised by local residents regarding recreation and fishery-related issues.

In 1995, the Lake Oroville Recreation Advisory Committee was established. This committee, comprised of local government, citizens' groups, and State agencies, was formed to advise DWR on recreation plan implementation, which included the following projects:

- ten floating campsites constructed and moored at various locations on the lake;
- an en route RV camping area added at the North Thermalito Forebay area;
- construction completed on a duck brood pond and restroom and picnic facilities at Thermalito Afterbay;
- buoys deployed around the water-ski slalom course;
- construction completed on the 41-mile bike trail main loop;
- construction completed on the Lime Saddle Boat Ramp improvements, an equestrian campground at Loafer Creek Recreation Area, and lighting on Oroville Dam; and
- fishery and fishing improvements completed, including development of a fish management and stocking plan, stocking Chinook salmon, and development of fish shelters.

Most recreation and fish facilities have been completed; however, certain elements of the plan may require time extensions to complete.

Fish Plantings

In 2005, the Department of Fish and Game continued its fish-planting activities at 10 of the 12 SWP facilities. Total plantings of trout was 522.3 thousand compared to the 531.6 thousand planted in 2004 (see Table 13–2).

Recreation Financing

Previously, DWR reported capital costs allocated to fish and wildlife enhancement and recreation in Appendix D to Bulletin 132, *Costs of Recreation and Fish and Wildlife Enhancement*. This report is no longer mandated by the Legislature, and these capital costs, starting with fiscal year 2000-2001, are reported in this bulletin.

The financing of recreation and fish and wildlife enhancement in connection with the SWP was provided for by the Davis-Dolwig Act, Assembly Bill 12, and the Environmental Water Act, Assembly Bills 1441 and 1442. The Davis-Dolwig Act declared the Legislature's intent to provide DWR with General Fund appropriations for SWP fish and wildlife enhancement

Table 13-2. Fish Planted in 2005 (Thousands)

Location and Size	Eagle Lake Trout	Brook Trout	Rainbow Trout	Brown Trout	Coho Salmon	Total
Antelope Lake		Yearling	Yearling			
Adv. Fingerlings	25.1	6.0	10.7			41.8
Lake Davis						
Catchables	47.2					47.2
Frenchman Reservoir						
Adv. Fingerlings	143.1					
Catchables	54.1					197.2
Lake Oroville						
Fingerlings	---	---	No Fish Planted		---	---
Thermalito Forebay						
Catchables			17.9			17.9
Lake Del Valle						
Catchables	---	---	No Fish Planted		---	---
Los Banos Reservoir						
Catchables	2.0		7.2			9.2
Pyramid Lake						
Catchables	1.8		26.1			27.9
Castaic Lake						
Catchables			57.2			57.2
Castaic Lagoon						
Catchables			38.8			38.8
Silverwood Lake						
Catchables			33.0			33.0
Lake Perris						
Catchables	3.4		48.7			52.1
Lake Skinner [a]						
Catchables	---	---	No Fish Planted		---	---
California Aqueduct	---	---	No Fish Planted		---	---
TOTAL	**276.7**	**6.0**	**239.6**			**522.3**

[a] Included in the SWP fish planting program, but not an SWP facility.

and recreation. For fiscal years 1983-1984 through 2004-2005, no funds were appropriated for these purposes.

AB 12 provided for a $5 million annual appropriation from tideland oil and gas revenues to be used for recreation, enhancement of fish and wildlife, and purchases of land for recreational uses. DWR received $90 million from these revenues; there have been no appropriations since 1985.

Legislation enacted in 1989 (AB 1441 and AB 1442) offset a portion of the amount owed by the State for fish and wildlife enhancement and recreational costs against the amount the SWP owed to the California Water Fund (see Chapter 14, *Financial Analysis,* for more details).

Capital Cost Allocations

Table 13-3 shows capital costs allocated to fish and wildlife enhancement and recreation and overall costs of lands acquired for recreation development through 2005. Costs have increased by $814,225 since last reported. These costs are budgeted by DWR from funds available for financing project construction costs. Recreation and enhancement costs not reported in this table are budgeted by several State departments and are financed by appropriations from a variety of funds.

Accrued Interest Charges

Table 13-4 details accrued interest charges included in the costs shown in Table 13-3, and reimbursements through December 2005. These interest accruals are calculated through December 31, 2005, on the portion of annual disbursements financed by the California Water Resources Development Bond Fund, and based on the weighted average interest costs of Burns-Porter and Water System Revenue bonds sold to date. The reimbursements were included in DWR's budget as appropriations from the General Fund and are used by DWR to pay for operations, maintenance, power, and replacement costs associated with operating the SWP for fish and wildlife enhancement and recreation.

For a more detailed discussion of these legislative provisions, and DWR's procedures for reporting and tabulating recreation and enhancement costs, please see the last Appendix D (to Bulletins 132-98, 132-99, 132-00, and 132-01). This report can be found on the Web at http://www.swpao.water.ca.gov/publications/index.cfm.

Table 13-3. Recreation and Enhancement Costs of the State Water Project

Facility	1952-2004 Updated	2005	Subtotal	Interest	Total	B132-05 Costs	Increase/ Decrease
	Joint Costs Allocated to Recreation and Enhancement						
Frenchman Dam and Lake (78.5%)							
California Water Resources Development Bond Fund	102,997	0	102,997	2,097	105,094	105,094	0
All Other Funds	2,839,227	(16,485)	2,822,742	0	2,822,742	2,736,262	86,480
Antelope Dam and Lake (100%)							
California Water Resources Development Bond Fund	1,033,261	0	1,033,261	113,788	1,147,049	1,147,049	0
All Other Funds	4,625,735	0	4,625,735	0	4,625,735	4,413,790	211,945
Grizzly Valley Dam and Lake Davis (99.0%)							
California Water Resources Development Bond Fund	4,003,092	0	4,003,092	486,754	4,489,846	4,489,846	0
All Other Funds	2,602,805	0	2,602,805	0	2,602,805	2,602,436	369
San Luis Dam and Reservoir , O'Neill Forebay and Los Banos Reservoir (3.4%)							
California Water Resources Development Bond Fund	988,910	0	988,910	169,085	1,157,995	1,157,995	0
All Other Funds	3,502,492	536	3,503,028	0	3,503,028	3,501,256	1,772
California Aqueduct Delta to Dos Amigos P.P. (3.4%)							
California Water Resources Development Bond Fund	4,467,667	0	4,467,667	897,406	5,365,073	5,365,073	0
All Other Funds	4,549,626	16,074	4,565,700	0	4,565,700	4,546,926	18,774
Oroville Division (2.9%)							
California Water Resources Development Bond Fund	5,725,216	0	5,725,216	1,790,491	7,515,707	7,515,707	0
All Other Funds	4,823,279	3,096	4,826,375	0	4,826,375	4,822,640	3,735
Del Valle Dam and Lake Del Valle (48.0%)							
California Water Resources Development Bond Fund	10,546,762	0	10,546,762	6,813,560	17,360,322	17,360,322	0
All Other Funds	4,184,406	(2,716)	4,181,690	0	4,181,690	4,184,520	(2,830)
California Aqueduct Dos Amigos P.P. to Termini (5.7%)							
California Water Resources Development Bond Fund	48,382,162	0	48,382,162	75,353,773	123,735,935	123,735,935	0
All Other Funds	58,996,454	492,208	59,488,662	0	59,488,662	58,994,736	493,926
Subtotal	*161,374,091*	*492,713*	*161,866,804*	*85,626,954*	*247,493,758*	*246,679,587*	*814,171*
	Specific Costs of Acquiring Land for Recreation Development						
Frenchman Dam and Lake							
California Water Resources Development Bond Fund	3,379	0	3,379	160	3,539	3,539	0
All Other Funds	49,947	0	49,947	0	49,947	49,947	0
Grizzly Valley Dam and Lake Davis							
California Water Resources Development Bond Fund	204,475	0	204,475	17,573	222,048	222,048	0
All Other Funds	554,260	0	554,260	0	554,260	554,260	0
Abbey Bridge Dam and Reservoir							
California Water Resources Development Bond Fund	9	0	9	0	9	9	0
All Other Funds	9,921	0	9,921	0	9,921	9,921	0
San Luis Dam and Reservoir, O'Neill Forebay and Los Banos Reservoir							
California Water Resources Development Bond Fund	395,284	0	395,284	33,467	428,751	428,751	0
All Other Funds	415,610	0	415,610	0	415,610	415,610	0
California Aqueduct Delta to Dos Amigos P.P.							
California Water Resources Development Bond Fund	461,086	0	461,086	158,456	619,542	619,542	0
All Other Funds	(137,494)	0	(137,494)	0	(137,494)	(137,494)	0
Oroville Division							
California Water Resources Development Bond Fund	7,809,509	0	7,809,509	3,673,041	11,482,550	11,482,550	0
All Other Funds	3,100,347	0	3,100,347	0	3,100,347	3,100,347	0
Del Valle Dam and Lake Del Valle							
California Water Resources Development Bond Fund	519,425	0	519,425	448,292	967,717	967,717	0
All Other Funds	(32,200)	0	(32,200)	0	(32,200)	(32,200)	0
California Aqueduct Dos Amigos P.P. to Termini							
California Water Resources Development Bond Fund	478,971	0	478,971	915,217	1,394,188	1,394,188	0
All Other Funds	398,349	0	398,349	0	398,349	398,349	0
Castaic Dam and Lake							
California Water Resources Development Bond Fund	1,954,297	0	1,954,297	3,856,203	5,810,500	5,810,500	0
All Other Funds	952,352	0	952,352	0	952,352	952,325	27
Cedar Springs Dam and Silverwood Lake							
California Water Resources Development Bond Fund	424,966	0	424,966	817,173	1,242,139	1,242,139	0
All Other Funds	370,164	0	370,164	0	370,164	370,137	27
Perris Dam and Lake Perris							
California Water Resources Development Bond Fund	1,022,313	0	1,022,313	2,033,799	3,056,112	3,056,112	0
All Other Funds	4,939,979	0	4,939,979	0	4,939,979	4,939,979	0
Subtotal	*23,894,949*	*0*	*23,894,949*	*11,953,381*	*35,848,330*	*35,848,276*	*54*
Total Recreation and Enhancement Costs							
California Water Resources Development Bond Fund	88,523,781	0	88,523,781	97,580,335	186,104,116	186,104,116	0
All Other Funds	96,745,259	492,713	97,237,972	0	97,237,972	96,423,747	814,225
Total	**185,269,040**	**492,713**	**185,761,753**	**97,580,335**	**283,342,088**	**282,527,863**	**814,225**

Table 13-4. Calculation of Interest Accruals on California Water Resources Development Bond Fund Disbursements (in dollars at 4.608% per annum)

	1952-2004					2005					2006 Beginning of Year Balance to be Reimbursed				
	Disbursements		Reimbursements			Disbursements		Reimbursements			Disbursements		Reimbursements		
Facility	WRD Bond Funds	All Other Funds	WRD Bond Funds	All Other Funds	**Interest Accrual**	WRD Bond Funds	All Other Funds	WRD Bond Funds	All Other Funds	**Interest Accrual**	WRD Bond Funds	All Other Funds	WRD Bond Funds	All Other Funds	**Interest Accrual**
	t					**Joint Costs Allocated to Recreation and Enhancement**									
Frenchman Dam and Lake	102,997	2,839,227	104,900	2,719,468	2,097	0	(16,485)	0	0	0	102,997	2,822,742	104,900	2,719,468	2,097
Antelope Dam and Lake	1,033,261	4,625,735	1,140,322	4,478,932	113,788	0	0	0	0	0	1,033,261	4,625,735	1,140,322	4,478,932	113,788
Grizzly Valley Dam and Lake Davis	4,003,092	2,602,805	4,444,594	2,568,667	486,754	0	0	0	0	0	4,003,092	2,602,805	4,444,594	2,568,667	486,754
Sisk Dam, San Luis Res., O'Neill Forebay, & Los Banos Reservoir	988,910	3,502,492	1,938,244	2,725,578	169,085	0	536	0	0	0	988,910	3,503,028	1,938,244	2,725,578	169,085
California Aqueduct Delta to Dos Amigos P.P.	4,467,667	4,549,626	5,267,351	4,092,435	897,406	0	16,074	0	0	0	4,467,667	4,565,700	5,267,351	4,092,435	897,406
Oroville Division	5,725,216	4,823,279	7,324,529	4,570,269	1,790,491	0	3,096	0	0	0	5,725,216	4,826,375	7,324,529	4,570,269	1,790,491
Del Valle Dam and Lake Del Valle	10,546,762	4,184,406	16,463,934	3,130,016	6,813,560	0	(2,716)	0	0	0	10,546,762	4,181,690	16,463,934	3,130,016	6,813,560
California Aqueduct Dos Amigos P.P. to Termini	48,382,162	58,996,454	113,035,518	49,410,851	75,353,773	0	492,208	0	0	0	48,382,162	59,488,662	113,035,518	49,410,851	75,353,773
Subtotal	*75,250,067*	*86,124,024*	*149,719,392*	*73,696,216*	*85,626,954*	*0*	*492,713*	*0*	*0*	*0*	*75,250,067*	*86,616,737*	*149,719,392*	*73,696,216*	*85,626,954*
						Specific Costs of Acquiring Land for Recreation Development									
Frenchman Dam and Lake	3,379	49,947	3,520	49,947	160	0	0	0	0	0	3,379	49,947	3,520	49,947	160
Grizzly Valley Dam and Lake Davis	204,475	554,260	220,423	554,244	17,573	0	0	0	0	0	204,475	554,260	220,423	554,244	17,573
Abbey Bridge Dam and Reservoir	9	9,921	9	9,921	0	0	0	0	0	0	9	9,921	9	9,921	0
Sisk Dam, San Luis Res., O'Neill Forebay, & Los Banos Reservoir	395,284	415,610	425,700	415,610	33,467	0	0	0	0	0	395,284	415,610	425,700	415,610	33,467
California Aqueduct Delta to Dos Amigos P.P.	461,086	(137,494)	603,887	(137,494)	158,456	0	0	0	0	0	461,086	(137,494)	603,887	(137,494)	158,456
Oroville Division	7,809,509	3,100,347	11,028,039	649,733	3,673,041	0	0	0	0	0	7,809,509	3,100,347	11,028,039	649,733	3,673,041
Del Valle Dam and Lake Del Valle	519,425	(32,200)	917,078	(32,200)	448,292	0	0	0	0	0	519,425	(32,200)	917,078	(32,200)	448,292
California Aqueduct Dos Amigos P.P. to Termini	478,971	398,349	1,271,912	398,349	915,217	0	0	0	0	0	478,971	398,349	1,271,912	398,349	915,217
Castaic Dam and Lake	1,954,297	952,352	5,291,258	951,070	3,856,203	0	0	0	0	0	1,954,297	952,352	5,291,258	951,070	3,856,203
Cedar Springs Dam and Silverwood Lake	424,966	370,164	1,132,207	370,137	817,173	0	0	0	0	0	424,966	370,164	1,132,207	370,137	817,173
Perris Dam and Lake Perris	1,022,313	4,939,979	2,780,487	4,867,247	2,033,799	0	0	0	0	0	1,022,313	4,939,979	2,780,487	4,867,247	2,033,799
Subtotal	*13,273,714*	*10,621,235*	*23,674,520*	*8,096,564*	*11,953,381*	*0*	*0*	*0*	*0*	*0*	*13,273,714*	*10,621,235*	*23,674,520*	*8,096,564*	*11,953,381*
Total	**88,523,781**	**96,745,259**	**173,393,912**	**81,792,780**	**97,580,335**	**0**	**492,713**	**0**	**0**	**0**	**88,523,781**	**97,237,972**	**173,393,912**	**81,792,780**	**97,580,335**

Chapter 14
Financial Analysis

The California Aqueduct delivers water for irrigation and urban use, benefiting more than 24 million Californians.

Significant Events in 2005

On July 7, the Department of Water Resources issued $112.390 million of Water System Revenue bonds, Series AD. The proceeds were pre-sold on June 14 to refinance $104.750 million of previously issued bonds, finance long-term construction expenditures, and pay bond financing costs.

Information for this chapter was provided by the State Water Project Analysis Office in conjunction with the Division of Fiscal Services.

This chapter presents both a summary and a detailed explanation of State Water Project (SWP) current financial analysis, capital costs and requirements, revenues and expenses, and bond activities for years 2006 through 2020.

The Department of Water Resources (DWR) performs financial analysis annually to ensure that the SWP financing program will have sufficient funds to meet construction obligations; project operation, maintenance, power, and replacement costs; and debt service payments for bonds expended for construction. The results of the current financial analysis, dated December 31, 2005, are presented in Tables 14-1 and 14-2 located at the end of this chapter.

Future contingencies may change the financial analysis, some of which include:

- alterations in schedules of currently planned construction for future facilities;
- changes in economic conditions, including changes in interest rates and in SWP contractor Table A amounts due to changes in amounts of water needed, conserved, or reclaimed;
- completion of Delta transfer facilities;
- development of additional sources of water not foreseen at this time;
- deviations from the assumptions regarding actual rates of price escalations for future construction from those currently assumed for cost estimates;
- increases in capital costs related to additional conservation facilities; and
- outcome of lawsuits now pending before the courts.

Capital Requirements and Financing

In conducting the current analysis, DWR projected that future construction costs through the year 2020 plus reimbursement of $65 million interim financing for prior expenditures will total $1.12 billion. Special capital requirements for revenue bond financing of these construction costs are projected at $124 million for a total capital requirement of $1.31 billion. This projection includes construction and financing costs for the following significant SWP facilities planned for completion by 2020:

- Interim South Delta facilities;
- extension of the East Branch of the California Aqueduct;
- Phase II enlargement of the East Branch;
- enlargement of the South Bay Aqueduct; and
- a new intake at Clifton Court Forebay.

Most of these capital requirements will be financed from the projected sale of $1.24 billion of revenue bonds. The remaining $67 million will be financed from capital resources revenues and the transfer of excess revenues not needed for operation costs or debt service.

The analysis of capital requirements and financing presented in Table 14-1

does not include the costs and financing of all facilities needed to develop the remaining yield necessary to meet the total 4.2 million af contractual commitment to long-term SWP water contractors. Table 14-1 also does not include the costs of associated work essential for realizing full benefits from the SWP, but financed and constructed by local interests or State agencies other than DWR. Those facilities include on-shore recreational developments at SWP facilities and local distribution facilities.

The allocation of capital expenditures for various SWP purposes is detailed in Table 14-3.

Capital Requirements

Lines 1 through 20 in Table 14-1 show actual and projected SWP capital requirements through 2020. Estimates of future capital expenditures include allowances for construction cost escalation of 3 percent per year from 2006 through 2020. Right-of-way costs are escalated at 4 percent per year from 2006 through 2020. Capital expenditures for the SWP also include requirements other than those for construction, such as disbursements made as part of the Davis-Grunsky Act Program (Line 16) and special capital requirements under revenue bond financing (Line 17). DWR will decide whether to construct facilities only after examining alternatives and completing environmental documentation and other review processes.

Line 1, Initial Project Facilities, includes only those facilities completed before 1974 (see Bulletin 132-74, Chapter 2). Additional costs after 1973, and estimated costs of remaining work on the initial SWP facilities, are not included.

Line 2, North Bay Aqueduct, consists of the estimated costs for improvements and the historical costs for Phase II. Phase II, which became operational in May 1988, connected with the Phase I facilities, which were completed in 1968 (Phase I costs are included in the initial project facilities discussed in Line 1). Phase II included costs for pipelines, pumping plants, and a small reservoir necessary to divert water from the western Delta to Napa and Solano counties for urban use. The improvements consist of replacing the existing tank with two five million gallon tanks. Construction is anticipated to begin in 2007 and to be completed in May 2009.

Line 3, Delta and Suisun Marsh Facilities, shows historical costs in Column 1 that include planning for general Delta facilities and the previously planned peripheral canal and overland water delivery facilities for the western Delta. Also included are historical planning costs for Suisun Marsh as well as construction costs for the Suisun Marsh Salinity Control Gates and an access road. The projected amounts include projected planning costs plus projected costs for constructing four permanent barriers in the Delta.

Line 4, Final Four Units at Banks Pumping Plant, includes costs of the final four 1,067-cfs units, which became operational in spring 1992.

Line 5, Coastal Branch Aqueduct, includes all costs for the planning, design, and construction of Phase II of the Coastal Branch of the California Aqueduct. Phase II construction began in October 1993 and

Table 14-3. Allocation of Capital Expenditures (Thousands of Dollars)

Facilities and Construction Divisions	Expenditures Incurred Through 2005	Future Expenditures	Total	Preliminary Allocation Among Project Purposes			
				Water Supply and Power Generation	*Flood Control*[a]	*Recreation and Fish and Wildlife Enhancement*	*Other*[b]
Project Construction Expenditures							
Upper Feather Division	18,275	1	18,276	1,411	0	16,865	0
Oroville Division	591,016	2,771	593,787	500,240	71,792	21,755	0
Delta Facilities Division	400,457	41,760	442,217	395,366	0	46,851	0
North Bay Aqueduct	94,579	10,866	105,445	105,445	0	0	0
South Bay Aqueduct	118,986	124,400	243,386	219,970	8,189	15,227	0
California Aqueduct							
North San Joaquin Division	217,969	13,729	231,698	223,526	0	8,172	0
San Luis Division	266,185	4,247	270,431	258,018	0	12,413	0
South San Joaquin Division	288,752	4,421	293,173	275,558	0	17,614	0
Tehachapi Division	324,817	12,995	337,812	318,744	0	19,068	0
Mojave Division	290,180	15,678	305,858	267,026	0	38,832	0
Santa Ana Division	259,116	49,589	308,705	273,930	0	34,775	0
West Branch	470,591	5,883	476,474	444,727	0	31,747	0
Coastal Branch	490,694	4,213	494,907	494,907	0	0	0
Subtotal, California Aqueduct	*2,608,304*	*110,754*	*2,719,058*	*2,556,437*	*0*	*162,621*	*0*
Other Project Facilities							
Small Hydroelectric Power Generating Facilities	97,368	0	97,368	97,368	0	0	0
Off-Aqueduct Power Generating Facilities	455,369	30,544	485,913	485,913	0	0	0
East Branch Enlargement	453,459	455,771	909,230	909,230	0	0	0
East Branch Extension	128,473	177,930	306,403	306,403	0	0	0
Coastal Power Allocation	30,708	0	30,708	30,708	0	0	0
Agricultural Drainage Facilities	66,440	50,880	117,320	0	0	0	117,320
Planning and Preoperations	145,886	61,615	207,501	207,501	0	0	0
Unassigned/Miscellaneous	101,448	50,891	152,339	0	0	0	152,339
Subtotal, Project Construction Expenditures	*5,310,768*	*1,118,183*	*6,428,951*	*5,815,992*	*79,981*	*263,319*	*269,659*
Other Capital Requirements							
Davis-Grunsky Act Program	130,000	0	130,000	0	0	0	130,000
Total Capital Expenditures	**5,440,768**	**1,118,183**	**6,558,951**	**5,815,992**	**79,981**	**263,319**	**399,659**

[a]Reflects DWR's allocation to this purpose, irrespective of federal payments.
[b]Includes costs currently unassigned to purpose, planning costs of deleted features of project facilities, initial costs of inventoried items, and costs assigned to the Davis-Grunsky Act Program.

was completed in 1997. Water deliveries from Phase II facilities began in July 1997.

Line 6, West Branch Aqueduct, shows costs for all facilities on the West Branch except Warne Power Plant, whose costs are included in Line 11.

Line 7, East Branch Enlargement, includes expenditures for Phases I and II of the East Branch Enlargement. Phase I included the enlargement share of power plant costs at Mojave Siphon and Devil Canyon. (The remaining power plant costs are included in Line 11.) East Branch Enlargement costs for Phase I, by facility, are presented in Table 14-4. Costs for Alamo Power Plant consist of expenditures for Unit 1 facilities allocated to enlargement. Construction of Unit 2 was deferred.

Construction of Phase II of the enlargement is anticipated to begin in March 2007. Project costs include raising the canal embankment and concrete lining, constructing additional siphon barrels, adding bays to check structures, constructing Unit 2 at Alamo Power Plant, and adding two pump/motor units and a discharge line at Pearblossom Pumping Plant.

All costs in Line 7 are allocated to and repaid by the seven Southern California contractors participating in the East Branch Enlargement.

Line 8, East Branch Improvements, shows all aqueduct costs on the East Branch not allocated to the enlargement project. Those costs include improvements constructed concurrently with the enlargement work, the reconstruction of the San Bernardino Tunnel Intake, and the construction of the Tehachapi East Afterbay. Costs for power plant construction at Alamo, Mojave Siphon, and Devil Canyon are not included in this line.

Line 9, East Branch Extension, shows expenditures for Phase I of the extension of the East Branch of the California Aqueduct. The East Branch Extension extends the California Aqueduct east from the Devil Canyon Power Plant to a terminus at Noble Creek near Beaumont in Riverside County. The extension provides water service to the San Gorgonio Pass Water Agency and the San Bernardino Valley Municipal Water District. Construction began in February 1999 and was completed in 2003. Construction of Phase II is anticipated to commence in 2008. All costs in Line 9 will be allocated to and repaid by the two participating contractors.

Line 10, South Bay Aqueduct Enlargement, shows expenditures for providing additional capacity required to meet increases in water demands for the service area of Alameda County Flood Control and Water Conservation District, Zone 7, and increasing the existing capacity of the South Bay Aqueduct to its original design capacity. Construction includes creating a third discharge line, creating a 500 af Dyer Reservoir, modifying the canal, and enlarging the South Bay Pumping Plant. Construction is expected to be completed in 2009.

Line 11, Power Generation and Transmission Facilities, does not include the East Branch Enlargement share of costs for Alamo, Mojave Siphon, and Devil Canyon power plants shown in Line 7 of Table 14-1. The capital costs for facilities included in Line 11 are shown in Table 14-5.

Line 12, Additional Conservation Facilities, shows projected costs to plan and study additional conservation facilities. Specific planning activities and projected spending amounts for 2006 through 2020 are shown in Table 14-6. Expenditures for these items are being reviewed. Construction costs of additional conservation facilities are not included in the financial analysis.

Line 12 does not include CALFED program costs. CALFED expenditures for preliminary planning and environmental impact report preparation are currently financed by appropriations from the General Fund. DWR assumes that future costs of the CALFED program will continue to be financed from the General Fund.

Line 13, Agricultural Drainage Facilities, includes projected costs of the Agricultural Drainage Program. The activities in this program are monitoring, evaluating, reducing, and treating drainage, as well as investigating treatment and reuse of drainage water.

DWR assumes that future costs of the drainage program will be financed by revenue transfers (Line 35).

Line 14, Other Costs, includes items such as general design and construction costs, costs of completing operation and maintenance facilities, and costs of other completion activities for the initial facilities of the California Aqueduct. Portions of those costs ultimately will be allocated to California Aqueduct units described in the preceding paragraphs.

Line 15, Subtotal Project Construction Expenditures, is the total of Lines 1 through 14.

Line 16, Davis-Grunsky Act Program Costs, shows costs of the Davis-Grunsky Act Program, a financial assistance program to provide grants and loans to public agencies for constructing local water projects.

As of December 31, 2005, DWR had disbursed $130 million (including $8.5 million for administration) in grants and loans to local agencies throughout the State.

Line 17, Special Capital Requirements Under Revenue Bond Financing, presents special capital requirements at the time revenue bonds are sold. The financial analysis assumes that proceeds from any future revenue bonds will be used to pay for bond discounts, bond issuance costs, and debt service reserve requirements.

Information about the application of proceeds to these special requirements for actual and assumed revenue bond sales is presented in Table 14-7.

Line 18, Total Capital Requirements, is the total of Lines 15, 16, and 17.

Line 19, Power Facilities Capital Requirements, shows the total capital requirements for power facilities included in Line 18.

Line 20, Water Facilities Capital Requirements, shows the total capital requirements for water facilities included in Line 18.

Table 14-4. East Branch Enlargement Capital Costs by Facility

Facility	Amount (Millions of Dollars)
Aqueduct and Siphons	128.1
Pearblossom Pumping Plant	70.1
Alamo Power Plant	5.0
Mojave Siphon Power Plant	47.3
Devil Canyon Power Plant and Second Afterbay	202.9
Total	**453.4**

Table 14-5. Estimated Capital Costs for Power Generation and Transmission Facilities

Facility	Amount (Millions of Dollars)
Power Plants	
Reid Gardner, Unit 4	308.5
Bottle Rock	120.9
South Geyers	49.6
Devil Canyon	36.8
Warne	84.5
Alamo	44.9
Mojave Siphon	38.4
Thermalito Diversion Dam	14.1
Subtotal	*697.7*
Transmission Lines	
Midway-Wheeler Ridge	10.7
Geysers-Lakeville	6.9
Total	**715.3**

Table 14-6. Estimated Future Costs for Planning Additional Conservation Facilities

Activity	Amount (Millions of Dollars)
SWP Future Water Supply	41.8
Other Planning Costs	19.8
Total	**61.6**

Capital Financing

The SWP was constructed with three general types of financing: Burns-Porter Act, revenue bonds, and capital resources. Lines 21 through 36 of Table 14-1 present specific information about those sources of financing.

Burns-Porter Act

Burns-Porter financing is derived from the sale of California Water Resources Development Bonds (general obligation bonds) and State Tideland Oil Revenues deposited in the California Water Fund as authorized by the Burns-Porter Act (California Water Code Sections 12930-12944), approved by voters in November 1960. The Burns-Porter Act authorized an issuance of $1.75 billion of general obligation State bonds, which are repaid by revenues received according to the water supply contracts. Of that authorization, $130 million were reserved specifically for the Davis-Grunsky Act Program.

Proceeds from the sale of general obligation bonds were deposited in the California Water Resources Development Bond Fund–Bond Proceeds Account, from which monies were expended only for the construction of SWP facilities and for the Davis-Grunsky Act Program. Approximately 29 percent of the expenditures through 2005 for construction and the Davis-Grunsky Act Program were financed with general obligation bonds.

Monies deposited in the California Water Fund were appropriated for purposes outlined in the Burns-Porter Act. Such deposits were derived from a portion of the State Tideland Oil Revenues, according to a continuing authorization. The California Water Fund was used to finance $508 million, or approximately 8 percent, of the construction expenditures through 2005.

Revenue Bonds

Revenue bond financing is derived from the sale of revenue bonds as authorized by the Central Valley Project Act (California Water Code Sections 11100-11925). DWR's authority to issue revenue bonds was confirmed by a decision of the California Supreme Court in 1963 (Warne v. Harkness, 60 Cal. 2d 579).

Proceeds from the sale of revenue bonds are deposited in the Central Valley Water Project Construction Fund, from which money is expended only for purposes specified in the resolution authorizing each bond sale. Those purposes, in addition to paying construction, planning, and right-of-way costs, may include funding the Debt Service Reserve Account, paying interest on bonds, and paying water system operating expenses during a specified period.

As of December 31, 2005, DWR had sold $7.0 billion of revenue bonds. That amount includes $3.6 billion of refunded bonds, leaving a total principal obligation of $3.4 billion.

Capital Resources

Capital resources financing is derived from payments and appropriations (including a portion of the State Tideland Oil Revenues) authorized by a variety of special contracts, cost-sharing agreements, and legislative actions concerning the SWP, plus accrued interest on these funds. Capital resources revenues are deposited in the Central Valley Water Project Construction Fund and may be expended

Table 14-7. Application of Revenue Bond Proceeds (Millions of Dollars)

Bond Series[a]	Construction Expenditures	Other Capital Requirements					Total Principal Amount of Bonds
		Reimbursement of General Fund	*Capitalized Interest*	*Capitalized Operating Costs*	*Bond Financing and Refunding Costs*[b]	*Subtotal*	
Oroville	218.0	2.6	19.9	1.5	3.0	27.0	245.0
Devil Canyon-Castaic	126.4	0.0	10.0	0.7	2.1	12.8	139.2
Pyramid Series A	74.0	0.0	19.2	1.0	1.6	21.8	95.8
Reid Gardner Series B	146.1	0.0	41.9	0.0	12.0	53.9	200.0
Reid Gardner Series C	91.1	0.0	17.9	7.9	8.1	33.9	125.0
Small Hydro-South Geysers Series D	49.6	0.0	19.9	0.0	5.5	25.4	75.0
Bottle Rock Series E	96.9	0.0	22.0	3.7	2.4	28.1	125.0
Alamo-South Geysers Series F	59.1	0.0	14.2	0.0	1.7	15.9	75.0
Reid Gardner Series G	1.6	0.0	0.0	0.0	237.9	237.9	239.5
Power Facilities Series H	22.2	0.0	0.0	0.0	184.5	184.5	206.7
East Branch Enlargement Series A	108.3	0.0	12.6	0.0	11.1	23.7	132.0
Water System Facilities Series B	97.4	0.0	0.0	0.0	2.6	2.6	100.0
Water System Facilities Series C	0.6	0.0	0.0	0.0	8.4	8.4	9.0
Water System Facilities Series D	95.9	0.0	2.9	0.0	1.2	4.1	100.0
Water System Facilities Series E	0.4	0.0	0.0	0.0	8.6	8.6	9.0
Water System Facilities Series F	0.0	0.0	0.0	0.0	160.0	160.0	160.0
Water System Facilities Series G	86.8	0.0	4.6	0.0	8.6	13.2	100.0
Water System Facilities Series H	85.5	0.0	5.7	0.0	8.8	14.5	100.0
Water System Facilities Series I	158.9	0.0	5.8	0.0	15.3	21.1	180.0
Water System Facilities Series J	0.0	0.0	0.0	0.0	649.8	649.8	649.8
Water System Facilities Series K	88.6	0.0	3.1	0.0	8.3	11.4	100.0
Water System Facilities Series L	0.0	0.0	0.0	0.0	537.8	537.8	537.8
Water System Facilities Series M	166.3	0.0	9.9	0.0	13.8	23.7	190.0
Water System Facilities Series N	137.4	0.0	6.0	0.0	8.6	14.6	152.0
Water System Facilities Series O	156.5	0.0	8.4	0.0	170.1	178.5	335.0
Water System Facilities Series P	141.6	0.0	5.2	0.0	13.2	18.4	160.0
Water System Facilities Series Q	135.0	0.0	8.0	0.0	123.6	131.6	266.6
Water System Facilities Series R	0.0	0.0	0.0	0.0	20.7	20.7	20.7
Water System Facilities Series S	78.2	0.0	5.8	0.0	116.2	122.0	200.2
Water System Facilities Series T	0.0	0.0	0.0	0.0	135.7	135.7	135.7
Water System Facilities Series U	98.7	0.0	5.3	0.0	103.2	108.5	207.2
Water System Facilities Series V	0.0	0.0	0.0	0.0	20.6	20.6	20.6
Water System Facilities Series W	41.0	0.0	1.3	0.0	218.7	220.0	261.0
Water System Facilities Series X	0.0	0.0	0.0	0.0	160.2	160.2	160.2
Water System Facilities Series Y	0.0	0.0	0.0	0.0	329.9	329.9	329.9
Water System Facilities Series Z	0.0	0.0	0.0	0.0	170.7	170.7	170.7
Water System Facilities Series AA	0.0	0.0	0.0	0.0	108.7	108.7	108.7
Water System Facilities Series AB	92.2	0.0	3.9	0.0	93.6	97.5	189.7
Water System Facilities Series AC	13.7	0.0	0.6	0.0	257.7	258.3	272.0
Water System Facilities Series AD	12.4	0.0	0.9	0.0	99.1	100.0	112.4
Subtotal	*2,680.4*	*2.6*	*255.0*	*14.8*	*4,043.6*	*4,316.0*	*6,996.4*[c]
Future East Branch Extension Bonds	180.0	0.0	9.0	0.0	11.0	20.0	200.0
Future So. Bay AB. Enlargement Bonds	126.9	0.0	6.3	0.0	7.7	14.0	140.9
Future Water System Facilities Bonds	808.5	0.0	40.4	0.0	49.4	89.8	898.3
Total	**3,795.8**	**2.6**	**310.7**	**14.8**	**4,111.7**	**4,439.8**	**8,235.6**

[a]Actual bond issue for all except Future Water System facilities and Future East Branch Extension bonds.
[b]Bond financing and refunding costs include funds applied to debt service reserve requirements.
[c]Includes $3,581.9 million of refunded principal, leaving a net principal obligation of $3,414.5 million.

for interest on general obligation bonds and costs of constructing SWP facilities.

According to DWR's financial management policy, the capital resources revenues are used first to cover any general obligation bond debt service that exceeds available revenues.

Capital Financing Sources

Capital financing sources include power revenue bonds, East Branch Enlargement bonds, East Branch Extension bonds, South Bay Aqueduct Enlargement bonds, water system facilities bonds, initial project facilities bonds, bond proceeds from the Davis-Grunsky Act Program, California Water Fund monies, and capital resources revenues.

Line 21, Power Revenue Bonds through Series H, includes the proceeds applied from power revenue bonds for Oroville, Devil Canyon, Castaic, Warne, Reid Gardner, Bottle Rock, Alamo, South Geysers, and small hydro projects.

No future power revenue bond sales are projected for this financial analysis.

Line 22, East Branch Enlargement, Current Bonds, shows that $474 million of Water System Revenue Bond proceeds have been applied to the East Branch Enlargement project through December 31, 2005. Of this total amount, $417 million was used for construction expenditures and $57 million for bond discounts, interest costs, and debt service reserves.

No future East Branch Enlargement revenue bond sales are projected for the financial analysis.

Line 23, East Branch Extension, Current Bonds, shows that $140 million of Water System Revenue Bond proceeds had been spent through December 31, 2005.

Line 24, East Branch Extension, Future Bonds, shows DWR's estimate of $200 million of additional bonds required to complete construction of the East Branch Extension and to pay for bond discounts, capitalized interest, and debt service reserve requirements.

Line 25, South Bay Aqueduct Enlargement, Current Bonds, shows that $17 million of Water System Revenue Bond proceeds had been spent through December 31, 2005.

Line 26, South Bay Aqueduct Enlargement, Future Bonds, shows DWR's estimate of $141 million of bonds required to complete construction of the South Bay Aqueduct Enlargement and to pay for bond discounts, capitalized interest, and debt service reserve requirements.

Line 27, Water System Facilities, Current Bonds, shows that through December 31, 2005, $1.5 billion of proceeds from Water System Revenue Bonds, Series A through Series AD, were applied to SWP projects other than the East Branch Enlargement, the East Branch Extension, and the South Bay Aqueduct Enlargement. Of this total amount, $1.3 billion was used to pay for construction expenditures, and $0.2 billion was used to pay for bond discounts, capitalized interest, and debt service reserve requirements.

Line 28, Water System Facilities, Future Bonds, shows that $898 million of future water revenue bonds are needed to provide $809 million for construction

of SWP water system facilities and $89 million for bond discounts, interest costs, and debt service reserve requirements.

Line 29, Subtotal, Water Revenue Bonds, is the total of Lines 22 through 28.

Line 30, Initial Project Facilities Bond Proceeds, shows the amount of general obligation bonds sold to provide financing costs for initial SWP facilities and for costs of planning certain additional conservation facilities.

Financing initial facilities from general obligation bonds was completed in mid-1972 and totaled $1.444 billion—$1.750 billion Burns-Porter Act authorization less $130 million reserved for the Davis-Grunsky Act Program and $176 million "offset" for additional conservation facilities. (The Burns-Porter Act provides that to the extent California Water Fund monies are expended, an equal amount of general obligation bonds are reserved [offset] for financing the construction of additional conservation facilities in certain watersheds.)

In mid-1972, the reservation of offset bonds was effectively limited to $176 million, the total amount of California Water Fund monies expended up to that time. By mid-1972, all general obligation bonds authorized by the Burns-Porter Act had been offset, reserved for the Davis-Grunsky Act Program, or used for SWP construction.

Approximately $8.5 million of the offset bonds was used to finance planning studies of the Middle Fork Eel River Development. This financial analysis is not based on the use of any offset bond proceeds to meet capital requirements. If, at some time, the State constructs an additional conservation facility, as specified in Water Code Section 12938, the remaining offset bonds could be sold.

Line 31, Davis-Grunsky Act Program Bond Proceeds, shows, for simplification, the entire $130 million of capital expenditures authorized for the Davis-Grunsky Act Program, according to the Burns-Porter Act, as being funded by proceeds from the sale of general obligation bonds. In fact, $28 million from the California Water Fund was used for the program in lieu of bond proceeds prior to 1969.

Line 32, Application of California Water Fund Monies, shows the amount of SWP costs financed under the Burns-Porter Act. The act provides that any available money in the California Water Fund must be used for construction in lieu of proceeds from the sale of general obligation bonds.

When the Burns-Porter Act became effective in late 1960, approximately $97 million had been accumulated in the fund. That balance, plus subsequent appropriations, interest earnings, and other miscellaneous income to the fund through December 31, 2005, was used to finance a total of $508 million of SWP costs.

Line 33, Interim Financing, shows the net annual amounts of funds flowing into and out of the Water Revenue Commercial Paper Notes program. This program was established in March 1993 to provide an ongoing source of interim financing for Water System Projects prior to permanent financing from the sale of long-term revenue bonds. DWR has authority to issue up to $94.4 million of Water Revenue

Commercial Paper Notes. A positive number indicates money borrowed from the program to finance construction costs. A negative number indicates money repaid to the program. The financial analysis assumes that all funds borrowed from the program will be repaid before the end of the analysis period.

Line 34, Application of Capital Resources Revenues to Construction, presents the Capital Resources Revenues applied for capital expenditures.

Line 35, Revenue Transfers Applied, shows monies assumed to be transferred to the California Water Fund, according to provisions of the Burns-Porter Act, and subsequently reappropriated to construction (see Line 40 of Table 14-2). Projected amounts for 2006 through 2020 include funds to finance expenditures for agricultural drainage facilities, as indicated in Line 13 of Table 14-1, and expenditures for additional conservation facilities, as indicated in Line 12.

Line 36, Subtotal, Other Capital Financing, is the total of Lines 30 through 35.

Line 37, Total Financing of Capital Requirements, totals Lines 21, 29, and 36.

Annual Revenues and Expenditures

After financial analysis of SWP operations, DWR concluded that projected payments by contractors and other revenues will be adequate to pay annual operations, maintenance, power, and replacement costs and meet all repayment obligations on funds used to finance SWP construction and other authorized costs during the period 2006 through 2020. Data on annual revenues and expenditures are presented in Table 14-2. A detailed discussion of each line item is presented below.

SWP Revenues

SWP revenues consist primarily of SWP contractor payments required under their individual long-term water supply contracts. Those revenues are deposited in two funds: the Central Valley Water Project Revenue Fund, where all revenues pledged to revenue bonds are placed; and the California Water Resources Development Bond Fund-Systems Revenue Account, where all other SWP operating revenues are placed. Use of those funds is limited to paying operating costs and debt service; except that revenues in excess of those costs may be deposited to a reserve for future SWP construction, since the California Water Fund has been repaid (see Line 39).

Line 1, Capital Resources Revenues, includes the following:

- federal payments for SWP capital expenditures;
- appropriations for capital costs allocated to recreation;
- appropriations for SWP capital expenditures prior to passage of the Burns-Porter Act and according to Senate Bill 261 (1968);
- payments from Los Angeles Department of Water and Power for Castaic power development;
- advances from water contractors for construction of requested work;
- investment earnings on the Capital Resources Account; and
- investment earnings on unexpended revenue bond proceeds.

Historically, appropriations for capital costs allocated to recreation and fish and wildlife enhancement have amounted to $5 million per year, which have been appropriated by the California Legislature from the State Tideland Oil Revenues. There have been no appropriations since 1985, and no appropriations are indicated in the financial analysis for the period 2006-2020. Legislation enacted in 1989 offset a portion of the amount owed to the SWP by the State for costs allocated to recreation and fish and wildlife enhancement against the amount the SWP owed to the California Water Fund (see Line 39).

Lines 2 through 12, Water Contractor Payments, show amounts of the separate elements of water contractor payments.

Amounts in Line 4 also include revenues sufficient to cover costs associated with sales of excess power. Appendix B of this bulletin presents a detailed explanation of payments identified in Lines 2 through 12.

Operations, maintenance, power, and replacement (OMP&R) costs are repaid as they are incurred as part of the Transportation Charge; therefore, no interest charges are included. Construction costs included in the Transportation Charge, and all construction and annual OMP&R costs included in the Delta Water Charge, are to be repaid with interest at the Project Interest Rate.

The Project Interest Rate, as defined in Article 1(r) of the standard provisions for water supply contracts, is the weighted average of the rates paid on certain securities issued and loans obtained to finance SWP facilities, as described below.

According to the original contract provisions, the basis for determining the Project Interest Rate was the weighted average of rates paid on general obligation bond sales only. In 1969, after Oroville Revenue Bonds were issued, the contract was amended to expand the basis to include rates on all other securities sold and loans obtained thereafter for financing SWP facilities, including revenue bonds (see Bulletin 132-70, page 28).

However, not all proceeds from the sale of revenue bonds are melded into the calculation of the Project Interest Rate. Only those proceeds applied to construction costs (the only application of general obligation bonds permitted by law) and those consumed by the bond discount (a component of the total interest cost of a revenue bond issue) are included in the calculation (see Table 14-8).

Calculations for determining the Project Interest Rate do not include proceeds from the sale of revenue bonds for Off-Aqueduct Power Facilities, the East Branch Enlargement facilities, or water system facilities defined in the Water Revenue Bond Amendment. Table 14-9 lists all bond sales by date and presents basic information used in the calculation of the Project Interest Rate.

Information about contractor water charges in Appendix B is based on known conditions and substantiates DWR's determination of 2007 water charges to be billed on July 1, 2006. However, information about significant differences between the sum of future charges included in Lines 2 through 12 of Table 14-2 and the substantiation of 2007

Table 14-8. Revenue Bond Proceeds Affecting Project Interest Rate (in Millions of Dollars)

Project	Proceeds Included in Project Interest Rate				Total Principal Amount of Bonds	Percentage of Total Amount Included in Calculating Project Interest Rate
	Applied to Construction Costs	*Less Portion of Proceeds Derived from Interest Earnings Prior to Delivery of Bonds*	*Plus Bond Financing and Refunding Costs*	*Subtotal, Proceeds Included in Calculating Project Interest Rate*		
Devil Canyon-Castaic Project Revenue Bonds	125.3	1.5	1.4	125.2	139.2	90%
Pyramid Project Revenue Bonds (Series A)	71.2	0.5	1.1	71.8	95.8	75%
Alamo Project Bond Anticipation Note	16.8	0.1	0.3	17.0	24.4	70%
Small Hyrdo Project I Revenue Bonds (Series D)	25.4	0.2	1.5	26.7	37.5	71%
Alamo Project Revenue Bonds (Series F)	38.9	0.3	0.7	39.3	50.0	79%
Power Facilities Revenue Bonds (Series H)						
Pyramid Project	5.0	0.0	0.1	5.1	5.1	100%
Alamo Project	1.7	0.0	0.0	1.7	1.7	100%
Small Hydro Project I	25.2[a]	0.2	0.4	25.4	35.6	71%
Water System Revenue Bonds (Series J)						
Pyramid Project	0.0	0.0	75.9[b]	75.9	99.2[b]	77%
Alamo Project	0.0	0.0	45.6[b]	45.6	57.1[b]	80%
Small Hydro Project I	0.0	0.0	27.8[b]	27.8	38.8[b]	72%
Water System Revenue Bonds (Series L)						
Small Hydro Project I	0.0	0.0	1.5[b]	1.5	2.1[b]	71%
Water System Revenue Bonds (Series Q)						
Pyramid Project	0.0	0.0	3.0[b]	3.0	3.9[b]	77%
Alamo Project	0.0	0.0	4.8[b]	4.8	6.0[b]	80%
Water System Revenue Bonds (Series S)						
Pyramid Project	0.0	0.0	8.0[b]	8.0	10.4[b]	77%
Alamo Project	0.0	0.0	7.6[b]	7.6	9.5[b]	80%
Water System Revenue Bonds (Series U)						
Pyramid Project	0.0	0.0	2.4[b]	2.4	3.2[b]	75%
Alamo Project	0.0	0.0	3.2[b]	3.2	4.0[b]	80%
Water System Revenue Bonds (Series W)						
Pyramid Project	0.0	0.0	27.7[b]	27.7	36.0[b]	77%
Alamo Project	0.0	0.0	11.8[b]	11.8	14.7[b]	80%
Small Hydro Project (construction)	3.4	0.0	0.0	3.4	3.7	92%
Small Hydro Project (refunding)	0.0	0.0	16.3[b]	16.3	22.7[b]	72%
Water System Revenue Bonds (Series X)						
Pyramid Project	0.0	0.0	8.5[b]	8.5	11.0[b]	77%
Alamo Project (Series H refunding)	0.0	0.0	0.3[b]	0.3	0.3[b]	100%
Alamo Project (Series F refunding)	0.0	0.0	3.9[b]	3.9	4.9[b]	79%
Small Hydro Project	0.0	0.0	4.6[b]	4.6	6.4[b]	72%
Water System Revenue Bonds (Series AC)						
Pyramid Project	0.0	0.0	3.8[b]	3.8	5.0[b]	76%
Alamo Project	0.0	0.0	2.8[b]	2.8	3.6[b]	80%
Small Hydro Project	0.0	0.0	1.2[b]	1.2	1.6[b]	72%
Water System Revenue Bonds (Series AD)						
Pyramid Project	0.0	0.0	3.2[b]	3.2	4.2[b]	76%
Alamo Project	0.0	0.0	2.6[b]	2.6	3.3[b]	80%
Small Hydro Project	0.0	0.0	0.7[b]	0.7	1.0[b]	72%

[a]Amount consists of 71 percent of proceeds deposited in escrow to refund portion of Series D bonds ($35.1 million plus deposits to construction account ($0.3 million)).
[b]Represents amount of principal used to refund portions of prior bond issues.

Table 14-9. Actual Bond Sales and Project Interest Rates, by Date of Sale

Bond Sales	Date of Sale	Dollar-Years[a] (Thousands)	Interest Cost (Thousands)	Issue Interest Rate[b] (Percent)	Project Interest Rate[c] (Percent)
$ 50,000,000 Bond Anticipation Notes	11/21/63	26,944	531	1.971	1.971
$100,000,000 Series A Water Bonds	2/18/64	3,402,000	119,750	3.520	3.508
$ 50,000,000 Series B Water Bonds	5/05/64	1,726,000	60,986	3.533	3.516
$100,000,000 Series C Water Bonds	10/07/64	3,452,000	123,764	3.585	3.544
$100,000,000 Series D Water Bonds	2/16/65	3,497,900	122,403	3.499	3.531
$100,000,000 Series E Water Bonds	11/23/65	3,497,900	130,029	3.717	3.573
$100,000,000 Series F Water Bonds	6/08/66	3,497,900	137,359	3.927	3.638
$100,000,000 Series G Water Bonds	11/22/66	3,497,900	143,788	4.111	3.711
$100,000,000 Series H Water Bonds	3/21/67	3,497,900	129,261	3.695	3.709
$100,000,000 Series J Water Bonds	7/18/67	3,497,900	143,199	4.094	3.754
$100,000,000 Series K Water Bonds	11/14/67	3,497,900	163,887	4.685	3.853
$150,000,000 Revenue Bonds, Oroville Division, Series A	4/03/68	5,228,700	270,289	5.169	
$100,000,000 Series L Water Bonds	7/11/68	3,497,900	166,918	4.772	3.941
$100,000,000 Series M Water Bonds	10/22/68	3,497,900	169,989	4.860	4.021
$ 94,995,000 Revenue Bonds, Oroville Division, Series B	4/01/69	3,423,460	195,902	5.722	
$ 46,761,000 Cumulative 1970 General Fund Borrowing, repaid 7/10/70	---	4,938	346	7.007	
$200,000,000 Series N and P Bond Anticipation Notes	6/16/70	200,000	11,660	5.830	4.030
$100,000,000 Series N Water Bonds	2/02/71	3,447,900	190,292	5.519	4.148
$100,000,000 Series Q Bond Anticipation Notes	3/10/71	100,000	2,349	2.349	4.143
$100,000,000 Series P Water Bonds	4/21/71	3,397,900	193,377	5.691	4.255
$150,000,000 Series Q and R Water Bonds	11/09/71	5,171,850	265,734	5.138	4.342
$ 40,000,000 Series S Water Bonds	3/28/72	1,399,160	76,509	5.468	4.371
$139,165,000 Devil Canyon-Castaic Revenue Bonds	8/08/72	4,776,204	258,839	5.419	4.457
$ 10,000,000 Series T Water Bonds	3/20/73	185,265	9,491	5.123	4.459
$ 10,000,000 Series U Water Bonds	1/13/76	158,750	8,731	5.500	4.462
$ 10,000,000 Series V Water Bonds	11/15/77	158,750	7,573	4.770	4.462
$ 95,800,000 Pyramid Hydroelectric Revenue Bonds	10/23/79	2,260,072	172,495	7.632	4.584
$150,000,000 Reid Gardner Project, Series A Bond Anticipation Notes	7/1/81	347,906	29,572	8.500	
$ 75,600,000 Bottle Rock Project, Bond Anticipation Notes	12/1/81	264,600	25,137	9.500	
$ 24,400,000 Alamo Project, Bond Anticipation Notes	12/1/81	24,266	2,305	9.499	4.589
$200,000,000 Reid Gardner Project, Series B Revenue Bonds	7/07/82	4,623,137	553,793	11.979	
$125,000,000 Reid Gardner Project, Series C Revenue Bonds	11/16/82	2,720,045	255,744	9.402	
$ 37,500,000 Small Hydro Project I, Series D Revenue Bonds	11/16/82	837,769	84,587	10.097	4.666
$ 37,500,000 South Geysers Project, Series D Revenue Bonds	11/16/82	930,325	90,021	9.676	
$125,000,000 Bottle Rock Project, Series E Revenue Bonds	4/27/83	2,624,805	225,102	8.576	
$ 50,000,000 Alamo Project, Series F Revenue Bonds	4/27/83	1,190,763	100,836	8.468	4.727
$ 25,000,000 South Geysers Project, Series F Revenue Bonds	4/27/83	608,550	52,578	8.640	

[a]A unit equivalent to one dollar of principal amount outstanding for one year.
[b]The total interest cost (without regard to discounts paid or to premiums received) divided by the total dollar-years, expressed as a percent.
[c]Determined by dividing cumulative interest costs by cumulative dollar-years, expressed as a percent. Excluding Oroville Division bonds and revenue bonds for Off-Aqueduct Power Facilities, the East Branch Enlargement Facilities, East Branch Extension Facilities, Water System Facilities as defined in the Water Revenue Bond Amendment, Coastal Extension Facilities, or South Bay Enlargement Facilities.

Table 14-9. Actual Bond Sales and Project Interest Rates, by Date of Sale

Bond Sales	Date of Sale	Dollar-Years[a] (Thousands)	Interest Cost (Thousands)	Issue Interest Rate[b] (Percent)	Project Interest Rate[c] (Percent)
$239,505,000 Reid Gardner Project, Series G Revenue Bonds	3/15/85	4,524,136	425,840	9.413	
$206,690,000 Power Facilities Series H Revenue Bonds	6/20/86	4,430,520	347,745	7.849	4.713
$132,000,000 East Branch Enlargement, Series A Water System Revenue Bonds	7/15/86	3,427,165	254,915	7.438	
Water System Revenue Bonds					
$100,000,000 Series B Water System Revenue Bonds	5/05/87	2,564,012	194,817	7.598	
$ 9,000,000 Series C Water System Revenue Bonds	12/01/87	324,000	31,995	9.875	
$100,000,000 Series D Water System Revenue Bonds	6/14/88	2,640,510	201,253	7.622	
$ 9,000,000 Series E Water System Revenue Bonds	11/29/88	324,000	31,995	9.875	
$160,030,000 Series F Water System Revenue Bonds	3/15/89	2,779,838	189,261	6.808	
$100,000,000 Series G Water System Revenue Bonds	3/06/90	2,434,175	172,277	7.077	
$100,000,000 Series H Water System Revenue Bonds	1/10/91	2,459,172	168,857	6.866	
$180,000,000 Series I Water System Revenue Bonds	5/14/91	4,366,680	294,090	6.735	
$649,835,000 Series J Water System Revenue Bonds	1/16/92	12,422,222	745,198	5.999	
$100,000,000 Series K Water System Revenue Bonds	5/12/92	2,366,783	147,064	6.214	
$ 9,000,000 Series W Water Bonds	8/19/92	95,250	6,172	6.480	4.621
$537,830,000 Series L Water System Revenue Bonds	5/19/93	11,414,859	640,518	5.611	4.620
$ 2,000,000 Series X Water Bonds	9/01/93	26,000	1,247	4.796	
$ 1,400,000 Series Y Water Bonds	11/30/94	19,483	1,249	6.411	
$190,000,000 Series M Water System Revenue Bonds	12/19/93	3,911,846	194,981	4.984	
$152,000,000 Series N Water System Revenue Bonds	3/03/95	2,241,606	122,658	5.472	
$335,000,000 Series O Water System Revenue Bonds	12/05/95	7,528,890	375,667	4.990	
$160,000,000 Series P Water System Revenue Bonds	5/07/96	3,553,823	204,524	5.755	
$266,630,000 Series Q Water System Revenue Bonds	11/05/96	5,481,815	299,846	5.470	
$20,700,000 Series R Water System Revenue Bonds	3/10/97	564,125	36,627	6.493	
$200,205,000 Series S Water System Revenue Bonds	8/04/97	4,093,110	203,755	4.978	
$135,665,000 Series T Water System Revenue Bonds	8/04/97	1,310,620	66,942	5.108	
$207,180,000 Series U Water System Revenue Bonds	12/01/98	4,032,075	200,758	4.979	
$ 20,580,000 Series V Water System Revenue Bonds	12/01/98	525,100	32,819	6.250	
$260,995,000 Series W Water System Revenue Bonds	5/01/01	3,659,312	195,822	5.351	4.613
$160,225,000 Series X Water System Revenue Bonds	5/01/02	2,732,785	139,109	5.090	4.610
$329,885,000 Series Y Water System Revenue Bonds	7/05/02	4,422,973	222,654	5.034	
$170,655,000 Series Z Water System Revenue Bonds	10/02/02	1,706,132	75,696	4.437	
$108,705,000 Series AA Water System Revenue Bonds	10/04/02	2,114,341	104,220	4.929	
$189,625,000 Series AB Water System Revenue Bonds	3/09/04	4,344,942	173,788	4.000	
$272,070,000 Series AC Water System Revenue Bonds	12/15/04	4,479,436	209,150	4.669	
$272,070,000 Series AD Water System Revenue Bonds	6/14/05	1,827,449	90,461	4.950	
Total		**199,322,344**	**11,499,096**		
Portion allocated to Project Interest Rate		**63,912,154**	**2,945,036**	**4.608**	**4.608**

[a]A unit equivalent to one dollar of principal amount outstanding for one year.
[b]The total interest cost (without regard to discounts paid or to premiums received) divided by the total dollar-years, expressed as a percent.
[c]Determined by dividing cumulative interest costs by cumulative dollar-years, expressed as a percent. Excluding Oroville Division bonds and revenue bonds for Off-Aqueduct Power Facilities, the East Branch Enlargement Facilities, East Branch Extension Facilities, Water System Facilities as defined in the Water Revenue Bond Amendment, Coastal Extension Facilities, or South Bay Enlargement Facilities.

charges included in Appendix B are as described below.

- Future capital costs in Appendix B are based on the prevailing prices as of December 31, 2005. Those costs presented in the financial analysis include allowances for price escalation.
- Pre-2006 charges in Appendix B represent charges as they should have been, according to currently known conditions. Pre-2006 charges included in Table 14-2 are those actually paid as part of previously determined bills.
- Charges in Appendix B are unadjusted for past overpayments or underpayments. Charges included in Table 14-2 for 2006 and thereafter have been adjusted for any apparent overpayments or underpayments of pre-2006 charges.
- Charges in Appendix B for East Branch Enlargement costs include the amounts for debt service and 25 percent cover for the East Branch Enlargement share of the Series A through Series AD bonds. Charges in Table 14-2 apply to Series A through Series AD bonds and also include amounts of the debt service and cover for assumed future bonds.
- The water revenue bond surcharge in Appendix B applies only to the Series B through Series AD bonds. Surcharge values included in Table 14-2 apply to Series B through Series AD bonds and to assumed future issues required to finance SWP construction costs included in Table 14-1.

Line 13, Subtotal, Water Contractor Payments, is the total of Lines 2 through 12.

Line 14, Revenue Bond Cover Adjustments, represents the credit to contractors resulting from the cover of 25 percent of one year's debt service for Off-Aqueduct Power Facility Bonds and Water System Revenue Bonds. Cover is collected as required by the bond resolutions to provide security to the bondholders. If not needed to meet annual bond service, the cover is credited to the contractors in the following year. The annual charges for the following cost components include an amount for bond cover:

- minimum OMP&R component of the Transportation Charge for Off-Aqueduct Power Facilities;
- Water System Revenue Bond Surcharge;
- capital cost component of the Transportation Charge for East Branch Enlargement Facilities;
- capital cost component of the Transportation Charge for Coastal Branch Extension Facilities;
- capital cost component of the Transportation Charge for East Branch Extension Facilities;
- capital cost component of the Transportation Charge for Tehachapi Afterbay; and
- capital cost component of the Transportation Charge for South Bay Aqueduct Enlargement.

Line 15, Rate Management Adjustments, shows the projected amount of revenue reductions allocated to SWP contractors after repayment of the California Water Fund (see Line 39). Under provisions of the Monterey Amendment, the reduction amount allocated to agricultural contractors is deposited into a trust fund to stabilize payments in water-short years. The urban contractor allocation is applied as a direct reduction in charges.

Line 16, Federal Payments for Project Operating Costs, shows federal payments made according to the December 31, 1961, agreement between California and the United States providing for DWR to operate and maintain the San Luis Joint-Use Facilities. According to the January 12, 1972, supplement to the agreement, the Bureau of Reclamation (Reclamation) initially paid 45 percent of operations, maintenance, and replacement (OM&R) costs for those activities. (The percentage does not apply to power costs; Reclamation and DWR each provide their own power to pump water through the joint facilities.)

The percentage paid by Reclamation is periodically reviewed by Reclamation and DWR. The most recent review of the percentage paid by Reclamation was completed in 1987 and resulted in a federal share of 44.09 percent. The amounts in Line 13 are based on the assumption that the federal share will continue at this level for calendar years 2006 through 2020.

Line 17, Appropriations for Operating Costs Allocated to Recreation, shows appropriations made under the Davis-Dolwig Act. In passing the Davis-Dolwig Act, the California Legislature declared its intent that except for funds provided according to Assembly Bill 12 (1966), DWR's budget will include appropriations of monies from the General Fund necessary for enhancement of fish and wildlife and recreation in connection with State water projects.

Annual OMP&R costs allocated to recreation and fish and wildlife enhancement are to be paid by annual appropriations from the General Fund. Through fiscal year 1982–1983, these appropriations totaled $16.657 million. There have been no additional appropriations since the 1982–1983 fiscal year, and none are indicated for 2006 through 2020.

Legislation enacted in 1989 offset a portion of the amount owed to the SWP by the State for costs allocated to recreation and to fish and wildlife enhancement against the amount the SWP owed to the California Water Fund (see line 36).

Line 18, Davis-Grunsky Loan Repayments, shows the repayments by local agencies of $54.2 million of loans disbursed as of December 31, 2005. Repayment on any future loans was assumed to be beyond the period covered by the financial analysis.

Line 19, Revenue Bond Proceeds, includes bond proceeds classified as special reserves according to the description of revenue bond financing in Line 17 of Table 14-1. Those proceeds, used for capitalized OMP&R costs, revenue bond debt service, and debt service reserves, are not classified as revenue but are included in this line to simplify the financial presentation.

Line 20, Interest Earnings on Operating Revenues, includes interest earnings on unexpended proceeds from the sale of general obligation bonds, interest on operating reserves, and other short-term investment earnings on SWP revenues.

Line 21, Oroville-Thermalito Payments, shows payments from Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric Company for power generation at the

Oroville facilities. Those utilities purchased all power generation from Hyatt and Thermalito power plants before April 1, 1983, according to a power sale contract dated November 29, 1967. The 1952–2005 entry includes the amounts of final settlement of payments made according to the contract.

Line 22, Miscellaneous Revenues, includes all other operating revenues not included in Lines 2 through 21.

Line 23, Subtotal, Other Revenues, is the total of Lines 16 through 22.

Line 24, Total Operating Revenues, is the total of Lines 13, 14, 15, and 23.

Line 25, Total Operating Revenues and Capital Resources Revenues, is the total of Lines 1 and 24.

Project Expenses

Project expenses include the following:

- operations, maintenance, and power costs;
- deposits to replacement reserves;
- deposits to special reserves;
- capital resources expenditures; and
- debt service.

Revenue bond proceeds earmarked for debt service during construction and the first year's operating expenses are deposited in the Central Valley Water Project Construction Fund and disbursed according to resolutions authorizing the issuance of such bonds.

Water contractor revenues associated with operating costs and debt service attributable to projects financed by revenue bonds are deposited in the Central Valley Water Project Revenue Fund for appropriate disbursement. All other operating revenues are deposited in the California Water Resources Development Bond Fund-Systems Revenue Account and are disbursed according to the following four priorities of use, as specified in the Burns-Porter Act:

- SWP operations, maintenance, power, and replacement costs;
- general obligation bond debt service;
- repayment of expenditures from the California Water Fund; and
- deposits to a reserve for future SWP construction.

Project expenses are presented in Lines 26 through 36 of Table 14-2.

Line 26, Project Operations, Maintenance, Power, and Replacement Costs, shows the OMP&R portion of the historical and projected costs presented in Table 14-10 at the end of the chapter.

Table 14-10 and Line 26 of Table 14-2 also include the amounts of the operations and maintenance costs for the federal share of joint facilities and those OMP&R costs allocated to recreation, which are intended to be offset by revenues listed in Lines 16 and 17.

Allowances for cost escalations are included in OMP&R costs through 2008. Allowances for additional long-term price escalations in the future are not included in these estimates, because changes in OMP&R costs do not substantially affect

the overall results of the financial analysis. (For the most part, changes in OMP&R costs cause direct offsetting changes in operating revenues.)

Power costs make up the major item of annual operating expenses for the SWP. Assumptions about future power sources and costs are discussed in Chapter 10. Line 26 also includes costs associated with power transactions that result in the sale of power not required for the delivery of water.

Line 27, Deposits to Replacement Reserves, shows funds set aside as required by contract for replacing existing SWP facilities. By December 31, 2005, $93.7 million had been spent for replacement costs; the balance of the replacement reserve as of that date was $17.1 million.

Line 28, Deposits to Special Reserves Under Revenue Bond Financing, includes two significant components: special reserve deposits related to revenue bonds; and capital resources revenue carryover from prior years used for construction in the current year. Special reserve deposits are the net of several income and expenditure items. Income items related to revenue bonds are as follows:

- proceeds set aside to pay bond interest during construction (capitalized interest);
- proceeds set aside for first year operating costs (capitalized operations and maintenance);
- water contractor payments or bond proceeds set aside for debt service reserves;
- water contractor payments for revenue bond cover requirements; and
- deposits to and withdrawals from operating reserves to meet day-to-day cash flow requirements.

The 1952–2005 column also includes advances to DWR's revolving fund for working funds to purchase mobile equipment and to meet day-to-day operating expenses.

The expenditure items related to revenue bonds are as follows:

- debt service cover payments returned to water contractors;
- debt service reserve interest payments returned to water contractors;
- surplus account funds returned to water contractors or applied to meet expenses;
- total capitalized interest paid out; and
- total capitalized operations and maintenance paid out.

Special reserves, reduced over time as reserved amounts, are used for their respective purposes. The amount indicated each year in Line 25 indicates the change from the previous year. A negative number indicates a withdrawal of special reserves to meet expenses, while a positive number indicates a deposit.

Line 29, Capital Resources Expenditures, includes the amount of capital resources revenues applied to construction that is shown in Line 34 of Table 14-1. In Table 14-2, these expenditures are funded out of withdrawals from the reserves in Line 28 and do not affect net revenues shown in Line 38.

Lines 30 and 31, Payment of Debt Service on Bonds Sold through December 31, 2005, show the total principal and interest payments on bonds sold to date. Table 14-11, at the end of this chapter, summarizes payments on general obligation bonds (Series A through Y water bonds), power revenue bonds by project, and water system revenue bonds (Series A through AD).

Lines 32 and 33, Payments on Projected Future Water Bonds, include the projected annual debt service amounts for future water revenue bonds included on Lines 24, 26, and 28 of Table 14-1 for the East Branch Extension, South Bay Aqueduct Enlargement, and other water system facilities. Assumptions about the service on these future bonds are that interest costs for the water revenue bonds average 5.5 percent; and that bonds are to be repaid by the end of the project repayment period (2035) or sooner with maturities commencing in the year following the date of sale and with equal annual bond service for the principal repayment period.

Lines 34 and 35, Total Payments of Bond Debt Service, show the total of principal payments indicated on Lines 30 and 32, and the total of interest repayments indicated on Lines 31 and 33.

Line 36, Subtotal, Debt Service, is the total of Lines 34 and 35.

Line 37, Total Operating Expenses and Debt Service, is the total of Lines 26, 27, 28, 29, and 36.

Line 38, Net System Revenues, shows the annual amounts of revenues remaining after the payment of operating costs and bond debt service costs.

Line 39, California Water Fund Repayment, shows the total amount of repayments made to the California Water Fund to reimburse the fund for monies expended for construction of the State Water Resources Development System.

Repayment of the California Water Fund was completed in 1998 after reimbursements totaling $508 million. In addition to the $296 million of repayments shown in Line 39, $211 million of reimbursement were credited to the SWP as offsets for recreation and fish and wildlife enhancement expenditures.

Line 40, Revenues Used for Capital Expenditures, includes the amounts required annually for financing scheduled capital expenditures. Revenues not needed for operating costs or debt services are available for financing SWP capital expenditures.

Future Costs of Water Service

Estimates of future water costs are useful to SWP contractors for short-range and long-range planning of water needs, operations, and budgets. Unit water charges shown in Table 14-12 represent both unescalated and escalated costs of water according to service areas for years 2007 and 2012. The unit rates include costs of existing and future SWP facilities accounted for in Table 14-1 and Table 14-7. The unit charges are based on the assumption that in 2007 and 2012, the SWP will be able to deliver the entire amounts of water requested by contractors. The unit water charges included in Table 14-12 are listed both as

unescalated 2005 dollars and as escalated rates reflecting assumed future inflation.

DWR's estimates of future capital expenditures include allowances for escalation of construction costs at 3 percent per year for 2006 through 2020. The escalation rates for future power sources vary, depending on the source of energy.

Table 14-12. Estimated Unit Water Charges for 2007 and 2012, by Service Area (Dollars per Acre-Foot)

	2007		2012	
Service Area and Charge	*Unescalated*	*Escalated*	*Unescalated*	*Escalated*
Feather River Area				
Capital; Operations, Maintenance, and Replacement (OM&R)	36	36	28	29
North Bay Area				
Capital; OM&R	204	204	154	154
Power	41	41	25	26
Total	**245**	**245**	**179**	**180**
South Bay Area				
Capital; OM&R	113	113	105	105
Power	52	52	53	55
Total	**165**	**165**	**158**	**160**
Coastal Area				
Capital; OM&R	719	719	494	494
Power	151	153	146	153
Total	**870**	**872**	**640**	**647**
San Joaquin Area				
Capital; OM&R	55	55	53	53
Power	25	25	24	25
Total	**80**	**80**	**77**	**78**
Southern California Area				
Capital; OM&R	160	160	126	126
Power	184	184	166	173
Total	**344**	**344**	**292**	**299**

Table 14-1. Capital Requirements and Financing, December 31, 2005 (Thousands of Dollars)

Line Number/Item	Calendar Year																	
	1952-2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2006-2020	1952-2020
Capital Requirements																		
1. Initial Project Facilities	2,202,316	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,202,316
2. North Bay Aqueduct	90,363	620	5,123	5,123	0	0	0	0	0	0	0	0	0	0	0	0	10,866	101,229
3. Delta and Suisun Marsh Facilities	249,571	10,260	10,260	10,260	3,660	3,660	3,660	0	0	0	0	0	0	0	0	0	41,760	291,331
4. Final 4 Units at Banks Pumping Plant	43,673	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,673
5. Coastal Branch Aqueduct	507,048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507,048
6. West Branch Aqueduct	193,498	11	45	600	332	4,195	480	220	0	0	0	0	0	0	0	0	5,883	199,381
7. East Branch Enlargement	453,459	603	4,381	6,921	23,618	23,807	60,302	67,620	70,792	70,796	70,723	52,132	4,076	0	0	0	455,771	909,230
8. East Branch Improvements	270,420	33,705	4,451	3,120	4,320	2,300	0	0	0	0	0	0	0	0	0	0	47,896	318,316
9. East Branch Extension	128,473	2,710	4,855	44,685	77,270	36,740	11,670	0	0	0	0	0	0	0	0	0	177,930	306,403
10. South Bay Aqueduct	18,102	25,910	62,647	25,843	10,000	0	0	0	0	0	0	0	0	0	0	0	124,400	142,502
11. Power Generation and Transmission Facilities	684,678	5,544	10,000	2,500	2,500	2,500	2,500	2,500	2,500	0	0	0	0	0	0	0	30,544	715,222
12. Additional Conservation Facilities	145,886	3,849	3,894	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	4,144	61,615	207,501
13. Agricultural Drainage Facilities	66,440	2,934	3,063	3,198	3,339	3,486	3,486	3,486	3,486	3,486	3,486	3,486	3,486	3,486	3,486	3,486	50,880	117,320
14. Other Costs	256,841	18,527	24,480	15,681	19,275	20,775	8,275	3,625	0	0	0	0	0	0	0	0	110,638	367,479
15. Total Project Construction Expenditures	**5,310,768**	**104,673**	**133,199**	**122,075**	**148,458**	**101,607**	**94,517**	**81,595**	**80,922**	**78,426**	**78,353**	**59,762**	**11,706**	**7,630**	**7,630**	**7,630**	**1,118,183**	**6,428,951**
16. Davis-Grunsky Act Program Costs	130,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	130,000.0
17. Special Capital Requirements Under Revenue Bond Financing	597,040	18,191	7,498	19,928	9,730	17,105	1,330	17,258	0	16,752	0	16,189	0	0	0	0	123,981	721,021.0
18. Total Capital Requirements	**6,037,808**	**122,864**	**140,697**	**142,003**	**158,188**	**118,712**	**95,847**	**98,853**	**80,922**	**95,178**	**78,353**	**75,951**	**11,706**	**7,630**	**7,630**	**7,630**	**1,242,164**	**7,279,972**
19. Power Facilities Capital Requirements	684,678	5,544	10,000	2,500	2,500	2,500	2,500	2,500	2,500	0	0	0	0	0	0	0	30,544	715,222
20. Water Facilities Capital Requirements	5,353,130	117,320	130,697	139,503	155,688	116,212	93,347	96,353	78,422	95,178	78,353	75,951	11,706	7,630	7,630	7,630	1,211,620	6,564,750
Financing Of Capital Requirements																		
Power Revenue Bond Proceeds																		
21. Power Revenue Bonds through Series H	1,162,458	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,162,458
Water Revenue Bond Proceeds																		
22. East Branch Enlargement, Current Bonds	473,606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	473,606
23. East Branch Extension, Current Bonds	139,520	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139,520
24. East Branch Extension, Future Bonds		5,200	5,400	49,700	85,900	40,800	13,000	0	0	0	0	0	0	0	0	0	200,000	200,000
25. South Bay Aqueduct Improvement and Enlargement, Current Bonds	16,938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16,938
26. South Bay Aqueduct Improvement and Enlargement, Future Bonds		31,500	69,600	28,700	11,100	0	0	0	0	0	0	0	0	0	0	0	140,900	140,900
27. Water System Facilities, Current Bonds	1,455,083	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,455,083
28. Water System Facilities, Future Bonds	0	146,200	0	120,300	0	130,100	0	172,700	0	167,100	0	161,900	0	0	0	0	898,300	898,300
29. Subtotal, Water Revenue Bonds	*2,085,147*	*182,900*	*75,000*	*198,700*	*97,000*	*170,900*	*13,000*	*172,700*	*0*	*167,100*	*0*	*161,900*	*0*	*0*	*0*	*0*	*1,239,200*	*3,324,347*
Other Capital Financing																		
30. Initial Project Facilities Bond Proceeds	1,452,452	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,452,452
31. Davis-Grunsky Act Program Bond Proceeds	130,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	130,000
32. Application of California Water Fund Monies (Tideland Oil Revenues)	508,056	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	508,056
33. Interim Financing	64,536	(64,536)	61,197	(61,197)	56,688	(56,688)	78,347	(78,347)	76,422	(76,422)	73,853	(90,449)	7,206	3,130	3,130	3,130	(64,536)	0
34. Application of Capital Resources Revenues to Construction	566,269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	566,269
35. Revenue Transfers Applied	68,890	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	67,500	136,390
36. Subtotal, Other Capital Financing	*2,790,203*	*(60,036)*	*65,697*	*(56,697)*	*61,188*	*(52,188)*	*82,847*	*(73,847)*	*80,922*	*(71,922)*	*78,353*	*(85,949)*	*11,706*	*7,630*	*7,630*	*7,630*	*2,964*	*2,793,167*
37. Total Financing Of Capital Requirements	**6,037,808**	**122,864**	**140,697**	**142,003**	**158,188**	**118,712**	**95,847**	**98,853**	**80,922**	**95,178**	**78,353**	**75,951**	**11,706**	**7,630**	**7,630**	**7,630**	**1,242,164**	**7,279,972**

Table 14-2. State Water Project Revenues and Expenditures, December 31, 2005 (Thousands of Dollars)

	Calendar Year																	
Line Number/Item	**1952-2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2006-2020**	**1952-2020**
PROJECT REVENUES																		
1. Capital resources revenues	814,701	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	814,701
Water Contractor Payments																		
2. Transportation capital	3,504,827	136,238	137,991	141,014	145,609	146,080	146,319	146,546	145,092	144,003	142,218	139,700	134,528	125,852	116,235	107,043	2,054,468	5,559,295
3. Transportation minimum	2,712,564	146,684	134,773	157,919	131,165	130,946	131,628	131,350	131,259	132,323	130,891	132,823	132,138	132,030	133,744	131,777	2,021,450	4,734,014
4. Transportation variable	3,314,516	238,873	312,665	349,613	300,014	327,478	323,698	348,515	398,092	429,383	441,875	470,301	443,417	474,352	495,864	460,855	5,814,995	9,129,511
5. Off-Aqueduct power facilities	2,200,965	106,859	124,268	135,600	135,835	136,657	133,497	133,707	78,185	20,080	11,901	10,195	9,909	4,210	4,175	4,498	1,049,576	3,250,541
6. Delta water charge	2,015,022	111,009	108,112	108,622	108,848	109,078	109,312	109,552	109,563	109,576	109,599	109,619	109,635	109,651	109,668	109,683	1,641,527	3,656,549
7. East Branch Enlargement	582,138	44,623	44,961	42,664	43,602	43,331	44,417	44,479	44,004	44,194	45,233	45,341	46,335	45,362	46,520	44,764	669,830	1,251,968
8. East Branch Extension	39,018	10,376	10,793	8,418	14,429	22,363	26,080	27,318	28,858	28,119	28,286	28,810	29,583	29,082	29,138	29,291	350,944	389,962
9. Coastal Extension	21,790	3,094	4,051	2,935	2,931	6,174	4,090	4,093	4,383	4,966	5,026	4,961	4,700	3,686	2,903	3,902	61,895	83,685
10. South Bay Aqueduct Enlargement	310	706	3,646	9,830	12,406	13,420	13,420	13,420	13,425	13,423	13,422	13,427	13,423	13,422	13,420	13,426	174,236	174,546
11. Tehachapi East Afterbay	185	259	260	260	260	260	260	260	260	260	260	260	260	260	260	260	3,899	4,084
12. Water revenue bond surcharge	392,609	62,374	62,400	58,712	59,603	57,031	61,565	61,630	64,960	67,362	70,842	71,562	70,510	62,181	67,055	61,746	959,533	1,352,142
13. Subtotal, water contractor payments	*14,783,944*	*861,095*	*943,920*	*1,015,587*	*954,702*	*992,818*	*994,286*	*1,020,870*	*1,018,081*	*993,689*	*999,553*	*1,026,999*	*994,438*	*1,000,088*	*1,018,982*	*967,245*	*14,802,353*	*29,586,297*
14. Revenue bond cover adjustments	(500,958)	(41,599)	(42,565)	(44,159)	(46,461)	(47,928)	(49,835)	(50,170)	(45,357)	(45,132)	(45,086)	(45,009)	(44,860)	(40,332)	(42,427)	(40,136)	(671,056)	(1,172,014)
15. Rate management adjustments	(259,514)	(24,746)	0	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(40,470)	(550,856)	(810,370)
Other Revenues																		
16. Federal payments for project operating costs	236,681	11,827	11,827	11,827	11,827	11,827	11,839	11,839	11,839	11,839	11,839	11,839	11,839	11,839	11,839	11,839	177,525	414,206
17. Appropriations for operating costs allocated to recreation	16,657	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16,657
18. Davis-Grunsky loan repayments	54,187	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	21,000	75,187
19. Revenue bond proceeds	652,977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	652,977
20. Interest earnings on operating revenues	572,493	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	60,000	632,493
21. Oroville-Thermalito payments	249,279	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	249,279
22. Miscellaneous revenues	184,264	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	184,264
23. Subtotal, other revenues	*1,966,538*	*17,227*	*17,227*	*17,227*	*17,227*	*17,227*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*17,239*	*258,525*	*2,225,063*
24. Total operating revenues	**15,990,010**	**811,977**	**918,582**	**948,185**	**884,998**	**921,647**	**921,220**	**947,469**	**949,493**	**925,326**	**931,236**	**958,759**	**926,347**	**936,525**	**953,324**	**903,878**	**13,838,966**	**29,828,976**
25. Total operating revenues and capital resources revenues	**16,804,711**	**811,977**	**918,582**	**948,185**	**884,998**	**921,647**	**921,220**	**947,469**	**949,493**	**925,326**	**931,236**	**958,759**	**926,347**	**936,525**	**953,324**	**903,878**	**13,838,966**	**30,643,677**
PROJECT EXPENSES																		
26. Project operations, maintenance, power, and replacement costs	7,887,020	522,292	638,078	666,096	572,871	599,314	595,205	618,274	645,606	623,789	632,905	666,879	638,506	669,763	691,873	652,490	9,433,941	17,320,961
27. Deposits to replacement reserves	132,950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	132,950
28. Deposits to special reserves	755,953	16,696	(6,603)	(15,601)	(9,104)	(12,025)	(25,482)	(23,388)	(45,434)	(42,914)	(53,152)	(49,870)	(57,906)	(44,685)	(47,590)	(47,877)	(464,935)	291,018
29. Capital resources expenditures	686,932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	686,932
Payments of Debt Service																		
30. Principal repayments on bonds sold through December 31, 2005 (current bonds)	1,936,270	119,134	125,298	131,475	141,339	147,005	155,434	162,364	153,940	156,265	157,070	154,917	152,547	125,862	129,773	126,600	2,139,023	4,075,293
31. Interest on bonds sold through December 31, 2005 (current bonds)	5,035,909	149,355	143,601	137,386	131,125	124,388	117,315	109,495	101,242	94,048	86,662	79,081	71,500	63,886	57,569	50,965	1,517,618	6,553,527
32. Future water bond principal repayments	0	0	3,825	6,369	11,377	15,489	20,436	22,061	27,143	28,586	34,528	36,373	43,360	45,685	48,136	50,719	394,087	394,087
33. Future water bond interest payments	0	0	9,883	17,960	32,890	42,976	53,812	54,163	62,496	61,052	68,723	66,879	73,840	71,514	69,063	66,481	751,732	751,732
34. Total principal	**1,936,270**	**119,134**	**129,123**	**137,844**	**152,716**	**162,494**	**175,870**	**184,425**	**181,083**	**184,851**	**191,598**	**191,290**	**195,907**	**171,547**	**177,909**	**177,319**	**2,533,110**	**4,469,380**
35. Total interest	**5,035,909**	**149,355**	**153,484**	**155,346**	**164,015**	**167,364**	**171,127**	**163,658**	**163,738**	**155,100**	**155,385**	**145,960**	**145,340**	**135,400**	**126,632**	**117,446**	**2,269,350**	**7,305,259**
36. Subtotal, debt service	*6,972,179*	*268,489*	*282,607*	*293,190*	*316,731*	*329,858*	*346,997*	*348,083*	*344,821*	*339,951*	*346,983*	*337,250*	*341,247*	*306,947*	*304,541*	*294,765*	*4,802,460*	*11,774,639*
NET REVENUES																		
37. Total Operating Expenses and Debt Service	**16,435,034**	**807,477**	**914,082**	**943,685**	**880,498**	**917,147**	**916,720**	**942,969**	**944,993**	**920,826**	**926,736**	**954,259**	**921,847**	**932,025**	**948,824**	**899,378**	**13,771,466**	**30,206,500**
38. Net system revenues	369,677	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	67,500	437,177
Application of Net System Revenues																		
39. California Water Fund repayment	296,287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	296,287
40. Revenues used for capital expenditures	73,390	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	67,500	140,890

Table 14-10. Operations, Maintenance, Power, and Replacement Costs, by Facility, Composition, and Purpose (Thousands of Dollars)

	Calendar year												
Feature	**1962-2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016-2035**	**TOTAL**
Project Facility													
Feather River facilities	748,383	28,943	28,551	32,398	26,251	26,098	26,416	26,442	26,438	26,374	26,228	592,560	1,615,083
North Bay Aqueduct	41,849	3,179	3,963	4,355	3,580	3,628	3,674	3,736	3,881	3,998	4,032	86,453	166,329
Delta facilities	576	0	0	0	0	0	0	0	0	0	0	0	576
Suisun Marsh	24,854	2,387	2,988	3,390	2,747	2,731	2,223	2,225	2,224	2,217	2,205	49,817	100,009
South Bay Aqueduct	134,825	12,335	15,309	16,605	13,663	13,867	13,999	14,233	14,871	15,357	15,395	315,965	596,424
California Aqueduct													
Delta to Edmonston	2,875,008	179,806	222,540	240,389	196,159	211,063	208,477	213,122	239,695	246,660	253,379	5,449,361	10,535,658
Edmonston to Perris	2,509,685	206,730	258,374	265,635	228,045	238,926	239,939	255,926	281,567	304,523	306,696	6,440,233	11,536,278
West Branch	(69,791)	(8,162)	(12,495)	(13,706)	(11,639)	(11,338)	(10,921)	(9,098)	(10,365)	(10,550)	(10,304)	(316,757)	(495,125)
Coastal Branch	189,185	12,877	15,845	17,014	14,048	14,321	14,450	14,741	15,548	16,173	16,236	334,847	675,285
East Branch Enlargement	38,491	4,830	5,025	4,968	4,968	4,968	4,968	4,968	4,968	4,968	4,968	99,369	187,461
Off-Aqueduct power-generating facilities	1,090,115	62,815	80,983	78,053	78,053	78,053	78,013	78,013	52,813	103	103	515	1,677,632
Recreation, planning, and CVP negotiations	3,298	683	683	683	683	683	683	683	683	683	683	13,669	23,797
Water quality monitoring	349,887	15,270	15,712	15,712	15,712	15,712	12,683	12,683	12,683	12,683	12,683	227,572	718,992
Davis-Grunsky Act Program	10,505	600	600	600	600	600	600	600	600	600	600	12,000	28,505
Subtotal	*7,946,868*	*522,292*	*638,078*	*666,096*	*572,871*	*599,314*	*595,205*	*618,274*	*645,606*	*623,789*	*632,905*	*13,305,605*	*27,366,903*
Payments to/credits from PG&E under Comprehensive Agreement	(59,848)	0	0	0	0	0	0	0	0	0	0	0	(59,848)
Total OMP&R Costs	**7,887,020**	**522,292**	**638,078**	**666,096**	**572,871**	**599,314**	**595,205**	**618,274**	**645,606**	**623,789**	**632,905**	**13,305,605**	**27,307,055**
Composition													
Salaries and expenses of headquarters personnel	2,223,395	72,503	112,779	139,101	90,759	89,819	87,532	93,774	92,912	92,375	90,153	1,629,495	4,814,598
Salaries and expenses of field personnel	3,283,348	77,213	135,939	170,330	115,756	114,955	112,046	120,534	119,323	120,575	117,604	2,853,538	7,341,161
Pumping power													
Used by pumping plants	1,846,651	363,373	362,682	355,476	357,343	386,374	389,475	396,786	453,346	485,061	499,835	10,401,133	16,297,536
Produced by generation plants	(387,188)	(53,890)	(54,581)	(77,141)	(69,317)	(70,165)	(72,138)	(71,110)	(73,065)	(74,602)	(75,067)	(1,585,028)	(2,663,294)
Payments to\credits from PG&E under Comprehensive Agreement	(59,848)	0	0	0	0	0	0	0	0	0	0	0	(59,848)
Off-Aqueduct power generating facilities requirement	1,090,117	62,815	80,983	78,053	78,053	78,053	78,013	78,013	52,813	103	103	927	1,678,046
Oroville-Thermalito insurance premiums	11,597	277	277	277	277	277	277	277	277	277	277	5,540	19,907
Less: Portion of costs incurred during construction	(121,051)	0	0	0	0	0	0	0	0	0	0	0	(121,051)
Total OMP&R Costs	**7,887,020**	**522,292**	**638,078**	**666,096**	**572,871**	**599,314**	**595,205**	**618,274**	**645,606**	**623,789**	**632,905**	**13,305,605**	**27,307,055**
Project Purpose													
Water supply and power generation	7,571,002	499,369	615,155	643,172	549,947	576,391	572,281	595,349	622,680	600,860	609,976	12,847,025	26,303,207
Payments to\credits from PG&E under Comprehensive Agreement	(59,848)	0	0	0	0	0	0	0	0	0	0	0	(59,848)
Recreation and fish and wildlife enhancement	151,839	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	200,000	451,839
Flood control	4,714	323	323	324	324	323	324	325	326	329	329	6,580	14,544
Miscellaneous purposes													
Federal share, San Luis, and Delta facilities	208,808	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	240,000	568,808
Other (Davis-Grunsky, drainage, City of Los Angeles)	10,505	600	600	600	600	600	600	600	600	600	600	12,000	28,505
Total OMP&R Costs	**7,887,020**	**522,292**	**638,078**	**666,096**	**572,871**	**599,314**	**595,205**	**618,274**	**645,606**	**623,789**	**632,905**	**13,305,605**	**27,307,055**

Table 14-11. Annual Debt Service on Bonds Sold through December 31, 2005 (Thousands of Dollars)

Calendar Year	Series A through Y Water Bonds		Oroville Revenue Bonds[a]		Pyramid Project Revenue Bonds[b]		Alamo Project Revenue Bonds[b]		Small Hydro Project Revenue Bonds[b]		Water System Facilities Water System Revenue Bonds[c]		*Subtotal*		Devil Canyon-Castaic Project Revenue Bonds		Reid Gardner Project Revenue Bonds[b,c]		South Geysers Project Revenue Bonds[b]		Bottle Rock Project Revenue Bonds[b]		East Branch Enlargement Project Water System Revenue Bonds[c]		Coastal Extension Facilities Water System Revenue Bonds		East Branch Extension Facilities Water System Revenue Bonds[c]		South Bay Enlargement Facilities Water System Revenue Bonds[c]		Tehachapi 2nd Afterbay Facilities Water System Revenue Bonds[c]		Grand Total	
	Principal	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*	*Principal*	*Interest*
1964	0	3,333	0	0	0	0	0	0	0	0	0	0	*0*	*3,333*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,333
1965	0	11,114	0	0	0	0	0	0	0	0	0	0	*0*	*11,114*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11,114
1966	0	18,764	0	0	0	0	0	0	0	0	0	0	*0*	*18,764*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,764
1967	0	26,911	0	0	0	0	0	0	0	0	0	0	*0*	*26,911*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,911
1968	0	37,761	0	3,876	0	0	0	0	0	0	0	0	*0*	*41,637*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41,637
1969	0	47,460	0	10,448	0	0	0	0	0	0	0	0	*0*	*57,908*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57,908
1970	0	53,290	0	13,145	0	0	0	0	0	0	0	0	*0*	*66,435*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66,435
1971	0	63,035	0	13,145	0	0	0	0	0	0	0	0	*0*	*76,180*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76,180
1972	0	69,149	1,260	13,112	0	0	0	0	0	0	0	0	*1,260*	*82,261*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,260	82,261
1973	1,200	69,347	1,330	13,042	0	0	0	0	0	0	0	0	*2,530*	*82,389*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,530	90,097
1974	3,000	69,533	1,400	12,969	0	0	0	0	0	0	0	0	*4,400*	*82,502*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,400	90,210
1975	5,000	69,366	1,475	12,893	0	0	0	0	0	0	0	0	*6,475*	*82,259*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,475	89,967
1976	7,000	69,657	1,555	12,811	0	0	0	0	0	0	0	0	*8,555*	*82,468*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,555	90,176
1977	10,200	69,298	1,635	12,727	0	0	0	0	0	0	0	0	*11,835*	*82,025*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11,835	89,733
1978	12,700	69,286	5,775	12,537	0	0	0	0	0	0	0	0	*18,475*	*81,823*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,475	89,531
1979	13,650	68,660	11,585	12,275	0	0	0	0	0	0	0	0	*25,235*	*80,935*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25,235	88,643
1980	16,050	67,941	3,265	11,739	0	7,900	0	0	0	0	0	0	*19,315*	*87,580*	0	7,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19,315	95,288
1981	18,050	67,078	4,885	11,444	0	7,292	0	0	0	0	0	0	*22,935*	*85,814*	0	7,708	0	5,312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22,935	98,834
1982	19,250	66,130	17,920	10,968	0	7,292	0	0	0	0	0	0	*37,170*	*84,390*	0	7,708	0	14,347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37,170	106,445
1983	20,520	65,111	21,110	10,147	0	7,292	0	2,449	0	3,727	0	0	*41,630*	*88,726*	900	7,708	0	35,719	0	4,777	0	6,017	0	0	0	0	0	0	0	0	0	0	42,530	142,947
1984	21,785	64,036	10,005	9,013	640	7,292	0	4,198	0	3,727	0	0	*32,430*	*88,266*	955	7,647	0	35,719	0	5,647	0	10,315	0	0	0	0	0	0	0	0	0	0	33,385	147,594
1985	22,555	62,892	12,700	8,628	675	7,238	0	4,198	0	3,727	0	0	*35,930*	*86,683*	1,010	7,583	9,425	27,209	0	5,647	0	10,315	0	0	0	0	0	0	0	0	0	0	46,365	137,437
1986	23,830	61,705	11,435	7,859	715	7,377	0	4,263	0	3,537	0	0	*35,980*	*84,741*	1,070	7,515	3,805	32,882	0	5,516	1,240	10,315	0	4,021	0	0	0	0	0	0	0	0	42,095	144,990
1987	25,495	60,452	11,715	7,188	790	7,513	265	4,329	0	3,348	0	4,952	*38,265*	*87,782*	1,135	7,442	4,860	32,605	0	5,386	1,305	10,253	0	9,651	0	0	0	0	0	0	0	0	45,565	153,119
1988	26,770	59,120	6,685	6,664	830	7,447	280	4,314	345	3,348	710	11,037	*35,620*	*91,930*	1,205	7,366	5,065	32,295	580	5,521	1,390	10,849	995	9,875	0	0	0	0	0	0	0	0	44,855	157,836
1989	28,145	57,790	33,705	5,513	875	7,378	295	4,298	365	3,328	1,148	14,373	*64,533*	*92,680*	1,275	7,284	7,820	27,557	709	5,646	1,565	11,592	1,078	10,104	0	0	0	0	0	0	0	0	76,980	154,863
1990	29,385	56,436	10,385	4,301	930	7,305	320	4,279	405	3,304	1,227	19,555	*42,652*	*95,180*	1,355	7,198	6,675	29,781	761	5,596	1,678	11,491	1,134	10,048	0	0	0	0	0	0	0	0	54,255	159,294
1991	30,365	55,034	12,055	3,922	980	7,227	335	4,257	430	3,276	2,129	27,569	*46,294*	*101,285*	1,435	7,107	7,170	29,302	818	5,535	1,791	11,376	1,197	16,856	0	0	0	0	0	0	0	0	58,705	171,461
1992	31,745	54,193	14,135	2,985	2,395	5,308	1,260	3,086	960	2,553	5,108	28,411	*55,603*	*96,536*	1,520	7,010	8,950	27,188	1,934	4,136	4,575	7,942	2,583	22,241	0	0	0	0	0	0	0	0	75,165	165,053
1993	33,390	52,670	13,755	2,237	1,525	5,688	755	3,300	445	2,640	4,577	29,965	*54,447*	*96,500*	1,610	6,907	8,820	26,953	901	4,256	3,264	8,385	3,040	21,428	0	0	0	0	0	0	0	0	72,082	164,429
1994	35,075	51,231	35,225	934	1,580	5,634	780	3,274	695	2,569	5,910	38,223	*79,265*	*101,865*	1,705	6,799	77,105	26,273	1,588	4,072	3,374	8,270	4,567	20,752	0	0	0	0	0	0	0	0	167,604	168,031
1995	36,280	49,703	0	0	1,635	5,570	805	3,242	745	2,536	8,064	37,879	*47,529*	*98,930*	1,810	6,684	5,420	19,230	1,695	4,004	3,521	8,133	4,979	20,499	0	0	0	0	0	0	0	0	64,954	157,480
1996	37,520	48,024	0	0	2,320	5,486	1,055	3,203	3,135	2,464	10,459	58,170	*54,489*	*117,347*	1,920	6,561	49,465	18,130	3,043	3,908	3,682	7,974	4,771	23,240	0	0	0	0	0	0	0	0	117,370	177,160
1997	37,215	46,365	0	0	1,695	5,274	875	3,073	585	2,283	14,375	67,910	*54,745*	*124,905*	2,035	6,432	7,515	15,255	1,825	3,696	3,861	7,741	6,300	23,702	0	1,981	0	76	0	0	0	0	76,281	183,788
1998	37,295	44,736	0	0	1,770	5,237	910	3,059	625	2,258	16,754	68,585	*57,354*	*123,875*	2,155	6,295	5,045	16,144	1,935	3,637	4,030	7,508	6,760	23,966	0	1,829	0	229	0	0	0	0	77,279	183,483
1999	38,220	43,132	0	0	1,845	5,141	960	3,005	680	2,229	18,701	68,085	*60,406*	*121,592*	2,285	6,160	9,310	11,659	2,081	3,549	4,240	7,318	7,518	25,033	0	1,808	65	2,931	0	0	0	0	85,905	180,050
2000	39,510	41,469	0	0	1,925	5,045	1,010	2,955	610	2,197	19,536	66,901	*62,591*	*118,567*	2,420	6,040	9,870	11,194	1,950	3,448	4,470	7,096	8,974	24,652	0	1,808	915	2,928	0	0	0	0	91,190	175,733
2001	40,600	39,751	0	0	2,250	4,949	1,155	2,901	780	2,272	20,944	66,418	*65,729*	*116,291*	2,565	5,912	10,365	10,757	2,045	3,344	4,720	6,855	9,425	24,187	0	2,131	950	2,889	0	0	0	0	95,799	172,366
2002	41,740	37,984	0	0	2,460	4,619	1,280	2,758	950	2,192	23,918	63,128	*70,348*	*110,681*	2,720	5,773	11,185	10,011	2,225	3,075	5,265	6,323	9,817	23,098	335	2,311	1,245	3,481	0	0	0	0	103,140	164,753
2003	43,590	36,159	0	0	2,500	4,429	1,315	2,672	940	2,110	23,442	60,439	*71,787*	*105,809*	2,885	5,626	2,135	9,314	2,335	2,890	5,445	5,939	9,988	18,444	245	2,310	1,105	4,277	0	0	0	0	95,925	154,609
2004	45,730	34,244	0	0	2,500	4,291	1,330	2,598	970	2,059	26,396	60,952	*76,926*	*104,144*	3,055	5,470	2,210	9,228	2,425	2,758	5,610	5,634	9,883	20,820	220	2,298	2,045	5,538	0	232	0	139	102,374	156,261
2005	46,985	32,242	0	0	2,727	3,992	1,461	2,406	1,327	1,963	23,064	57,886	*75,564*	*98,489*	3,240	5,305	8,825	9,127	2,759	2,563	5,959	5,237	3,669	20,105	305	2,155	2,124	5,968	0	559	0	197	102,445	149,705
2006	48,275	30,186	0	0	2,868	3,986	1,527	2,437	1,371	1,924	28,901	60,190	*82,942*	*98,723*	3,435	5,130	9,340	8,624	2,920	2,453	6,326	4,958	11,627	20,469	240	2,235	2,222	6,105	82	734	0	209	119,134	149,640
2007	49,765	28,060	0	0	3,023	3,817	1,622	2,346	1,451	1,846	30,342	58,856	*86,203*	*94,925*	3,640	4,945	9,835	8,083	3,101	2,278	6,731	4,578	12,229	19,899	1,015	2,225	2,305	6,028	239	734	0	210	125,298	143,905
2008	51,755	25,871	0	0	2,794	3,639	1,618	2,251	1,161	1,763	26,432	57,337	*83,760*	*90,861*	3,860	4,749	23,839	7,507	2,765	2,092	5,637	4,176	11,062	19,274	179	2,169	126	5,925	247	727	0	210	131,475	137,690
2009	54,095	23,583	0	0	2,945	3,481	1,740	2,155	1,168	1,699	28,949	56,225	*88,897*	*87,143*	4,090	4,540	25,334	6,198	2,906	1,938	5,975	3,853	12,339	18,749	185	2,159	1,364	5,919	249	720	0	210	141,339	131,429
2010	55,785	21,206	0	0	3,525	3,315	2,078	2,051	1,399	1,635	25,958	54,892	*88,745*	*83,099*	4,335	4,319	26,851	4,894	3,221	1,776	6,611	3,512	12,718	18,153	2,790	2,149	1,478	5,867	256	713	0	210	147,005	124,692
2011	57,275	18,749	0	0	2,599	3,121	1,465	1,933	1,045	1,561	35,151	53,644	*97,535*	*79,008*	4,595	4,085	26,835	3,511	2,917	1,598	6,366	3,138	14,212	17,527	1,237	2,034	1,473	5,803	264	705	0	210	155,434	117,619
2012	58,615	16,199	0	0	2,761	2,941	1,574	1,831	1,060	1,491	36,995	51,929	*101,005*	*74,391*	4,875	3,837	28,461	2,023	3,116	1,396	6,845	2,695	14,957	16,831	1,294	1,980	1,539	5,740	272	696	0	210	162,364	109,799
2013	60,455	13,650	0	0	4,223	2,748	2,615	1,720	2,191	1,419	42,770	50,070	*112,254*	*69,607*	5,165	3,574	515	413	4,831	1,177	11,125	2,215	15,339	16,071	1,587	1,920	2,839	5,671	285	688	0	210	153,940	101,546
2014	57,985	11,222	0	0	4,859	2,522	3,137	1,583	2,404	1,299	48,292	47,943	*116,677*	*64,569*	5,475	3,303	215	387	4,177	913	8,643	1,624	16,276	15,285	2,130	1,842	2,377	5,543	295	676	0	210	156,265	94,352
2015	53,775	8,806	0	0	5,274	2,265	3,123	1,419	2,745	1,169	56,012	45,567	*120,929*	*59,226*	5,805	3,015	810	376	3,833	689	2,553	1,155	17,936	14,456	2,281	1,740	2,618	5,435	305	664	0	210	157,070	86,966
2016	46,215	6,588	0	0	5,712	1,980	3,228	1,251	3,110	1,019	59,898	42,683	*118,163*	*53,521*	6,150	2,710	1,020	332	2,237	482	2,964	1,019	18,954	13,526	2,344	1,625	2,764	5,308	321	652	0	210	154,917	79,385
2017	38,145	4,652	0	0	6,414	1,672	3,586	1,080	3,299	849	61,112	39,597	*112,556*	*47,850*	6,520	2,388	1,185	277	1,452	361	3,598	858	20,732	12,541	2,255	1,506	3,917	5,174	332	639	0	210	152,547	71,804
2018	25,435	3,011	0	0	4,928	1,329	2,882	889	2,563	669	52,739	36,419	*88,547*	*42,317*	6,910	2,045	50	212	705	284	1,242	666	22,793	11,464	1,559	1,389	3,708	4,981	348	622	0	210	125,862	64,190
2019	16,975	1,804	0	0	4,639	1,081	2,812	744	2,256	540	63,464	33,745	*90,146*	*37,914*	7,325	1,682	50	209	754	249	1,277	603	24,908	10,294	1,013	1,309	3,936	4,798	364	605	0	210	129,773	57,873
2020	17,405	956	0	0	5,651	838	3,403	599	2,863	420	57,749	30,530	*87,071*	*33,343*	7,765	1,298	55	207	887	212	1,488	539	22,828	9,016	1,865	1,257	4,255	4,601	386	586	0	210	126,600	51,269
2021	8,595	318	0	0	2,789	548	1,741	425	1,317	271	64,232	27,692	*78,674*	*29,254*	8,230	890	1,010	204	972	167	2,457	463	24,690	7,887	2,260	1,162	4,667	4,389	403	567	0	210	123,363	45,193
2022	1,885	60	0	0	5,556	408	5,218	338	1,378	205	61,749	24,545	*75,786*	*25,556*	8,725	458	1,060	154	909	118	2,420	341	25,624	6,665	3,070	1,048	4,866	4,155	425	547	0	210	122,885	39,252
2023	85	7	0	0	1,122	128	594	75	764	134	68,724	21,501	*71,289*	*21,845*	0	0	550	99	589	71	2,006	217	21,529	5,394	2,303	890	4,885	3,909	443	526	0	210	103,594	33,161
2024	35	3	0	0	716	70	404	45	534	95	68,843	18,045	*70,532*	*18,258*	0	0	310	71	460	40	1,567	104	23,518	4,329	2,420	771	5,092	3,662	466	506	0	210	104,365	27,951
2025	0	0	0	0	144	35	102	25	247	68	63,906	14,589	*64,399*	*14,717*	0	0	65	55	60	15	59	14	28,618	3,166	2,007	647	5,192	3,408	485	485	0	210	100,885	22,717
2026	0	0	0	0	151	28	108	20	259	55	58,784	11,496	*59,302*	*11,599*	0	0	185	52	63	12	61	11	10,180	1,754	2,115	542	11,385	3,148	1,569	460	630	210	85,490	17,788
2027	0	0	0	0	405	20	289	14	353	42	69,425	8,742	*70,472*	*8,818*	0	0	255	45	170	8	165	8	10,862	1,268	2,085	432	15,333	2,638	2,223	393	1,005	185	102,570	13,795
2028	0	0	0	0	0	0	0	0	230	24	51,907	5,512	*52,137*	*5,536*	0	0	370	34	0	0	0	0	7,106	755	3,160	327	21,093	1,966	3,273	298	1,615	145	88,754	9,061
2029	0	0	0	0	0	0	0	0	245	13	60,491	3,117	*60,736*	*3,130*	0	0	380	18	0	0	0	0	7,774	412	3,340	168	21,987	1,063	3,404	162	1,685	80	99,306	5,033
Total	**1,582,400**	**2,386,523**	**244,995**	**246,522**	**108,660**	**199,188**	**61,312**	**103,348**	**50,405**	**83,857**	**1,449,287**	**1,705,299**	*3,497,059*	*4,724,737*	**139,165**	**283,872**	**419,620**	**567,184**	**74,654**	**116,936**	**157,101**	**229,625**	**505,489**	**637,902**	**45,839**	**52,157**	**139,870**	**139,558**	**16,936**	**14,892**	**4,935**	**5,155**	**5,000,668**	**6,772,019**

[a]Principal and interest schedule adjusted to reflect early redemption of bonds.
[b]Allocated portions of Power Facilities Revenue Bonds and Water System Revenue Bonds.
[c]Interest includes a minimum fee for Water System Revenue Bonds Series AB.

Chapter 15
SWP Education and Information

Vista del Lago Visitors Center

Significant Events in 2005

The Department of Water Resources (DWR) welcomed 27 foreign tours with 362 visitors to State Water Project (SWP) and other facilities; there also were a number of domestic and school tours to the SWP Delta Facilities. Tour groups came from all over the United States and nine foreign countries.

The Public Affairs Office (PAO) began coverage of the historic process to renew the federal license to operate Oroville facilities, the heart of the SWP. Director Snow signed the application, which was the culmination of five years of collaboration between stakeholders.

During May, DWR observed Water Awareness Month for the eighteenth consecutive year, highlighting activities at DWR facilities and answering media inquiries regarding water awareness.

DWR NEWS/People initiated the State Water Contractors Profile feature.

Brochures for Lake Oroville Recreation, Lake Oroville Recreation Sports Version, and the California State Water Project were revised and reprinted.

Information for this chapter was provided by the Public Affairs Office

The Public Affairs Office (PAO) serves as liaison between the Department of Water Resources (DWR), the news media and the public. One role of the PAO is to provide education to those from the outside about DWR's mission and programs. Sophisticated graphics, video, and photography units play an important role in the outreach process, as do publications, websites, visitors centers, tours, exhibits, and special events.

Media Outreach

Relicensing Oroville Facilities

PAO began coverage of the historic process to renew its federal license to operate the Oroville Facilities, the heart of the State Water Project (SWP). Director Snow signed the application, which was the culmination of five years of collaboration between stakeholders.

Snow Surveys

PAO continued to provide media outreach for the Division of Flood Management Snow Surveys Section.

California Bay-Delta Authority

PAO assisted the California Bay-Delta Authority (CBDA) in media and outreach activities. This included providing public address system support for public hearings, meetings, and conferences.

News Events

- In January, DWR increased the 2005 allocation to 60 percent for water delivery to the SWP contractors. The initial allocation was 40 percent of requested water delivery amounts.
- In February, DWR accepted 168 of 174 proposals seeking grants through the 2004 Water Use Efficiency Proposal Solicitation Package.
- In March, DWR was forced to delay the re-opening of Vista del Lago Visitors Center at Pyramid Lake because of a landslide. It had been closed temporarily to repair damage due to previous mudslides.
- In April, DWR announced the results of the final snow survey for 2005. Snow depth and water content ranged from 168 percent to 190 percent of average.
- In May, DWR closely monitored river conditions throughout Northern California. Heavy rainfall and snowmelt pushed many rivers to near or above flood stage.
- In June, DWR and the Oroville Area Chamber of Commerce held a ribbon-cutting ceremony for the Oroville Forebay Aquatic Center grand opening. The Aquatic Center offers aquatic programs for the public, including boat rentals and camps for kids.
- In July, DWR provided emergency response assistance at Wheeler Island, in the Suisun Marsh, following a levee break. The marshy area is under the jurisdiction of Reclamation District 2127, and there were no residences or other significant structures affected during the incident.
- In August, DWR launched the Salton Sea Ecosystem Restoration website to document the development of a restoration plan for the Salton Sea ecosystem, and accompanying Environmental Impact Report (EIR).
- In early September, DWR co-sponsored the Sacramento Flood Conference.

Officials from California, Nevada, and Hawaii gathered to discuss structural and non-structural solutions to flood challenges.

- In October, DWR and the Department of Fish and Game (DFG) released the Delta Smelt Action Plan, prepared to identify causes and find solutions for pelagic organism decline in the Delta. DWR also announced it would move forward with plans to repair seismic instability found in Perris Dam. This decision was made after an independent panel concurred with DWR's findings.
- In November, DWR launched the South Delta Improvements Program (SDIP) website to provide information and a means for the public to provide feedback on hearings held through January 2006.
- On December 27, DWR announced a flood alert. By New Year's Eve, major storms forced evacuations on Twitchell Island.

Community Relations

Oroville

PAO staff continued to provide media outreach for Oroville community meetings related to DWR's application for a new federal license to operate Oroville facilities. PAO maintained the Lake Oroville recreation website, http://www.lakeoroville.water.ca.gov, which provides information about the lake's recreational opportunities and other area facilities and attractions. In addition, PAO provided photography for the City of Oroville and the Oroville Area Chamber of Commerce for various community events.

The PAO design group produced promotional materials for Oroville area activities including the Fourth of July community celebration, Feather River Fiesta Days, and September Salmon Festival. Products included posters, interactive educational displays, promotional displays, and informative handouts. The photography unit captured event activities for use in various publications, including DWR NEWS/People. Audio-visual staff assisted the public in using a fishing simulator (an interactive device complete with fishing pole and video screen that provided participants with a virtual reality fishing experience). The video group created public service announcements about events and distributed them to radio and television stations in the Oroville and Chico areas.

California Lakes and Reservoirs Appreciation Week

DWR collaborated with the Department of Boating and Waterways (DBW) to share expenses in publicizing California Lakes and Reservoirs Appreciation Week. DWR distributed promotional flyers and wristbands designed to highlight the week and educate water users at California state parks and reservoirs operated by DWR, U.S. Army Corps of Engineers (the Corps), and U.S. Bureau of Reclamation (Reclamation). The message for 2005 focused on clean water.

SWP Publications

In 2005, brochures for Lake Oroville Recreation, Lake Oroville Recreation Sports Version, and the California State Water Project were revised and reprinted.

E-News

PAO continued to distribute "clips" of newspaper articles on California water

issues, via e-mail. These clips were e-mailed to DWR employees under the heading of California Water News. DWR answered a wide range of questions from the public and government agencies through its web-based "comment line." PAO administered Recent News at http://www.dwr.water.ca.gov; posted news releases; news advisories; and new web sites.

DWR NEWS/People

DWR's quarterly magazine, *DWR NEWS/People,* spotlighted DWR programs, projects, individual and team accomplishments, skills, awards, promotions, retirements, and other news items. In addition to initiating the State Water Contractors Profile feature, articles featured in 2005 included the Eureka Flood Center, Federal Energy Regulatory Commission (FERC) Seventh Part 12 Dam Safety Inspection Report, Oroville Relicensing Application Signing, New Runner at Oroville's Hyatt Power Plant, Skinner Fish Facility Trash Racks, Mudslides and Oil Spill in Southern California, South Bay Enlargement Project, Colorado River Basin Drought, Lower Yuba River Accord, McCune Station Open House, Global Warming's Possible Impacts, Lake Kaweah Project, and Oroville's Aquatic Boathouse Opening. In summer 2005, staff began story selection and photo research for DWR's 50th Anniversary edition, to be printed in 2006.

DWR NEWS/People is circulated to all elements of the California water community, including SWP contractors and current and retired employees of DWR. All 2005 issues of *DWR NEWS/People* magazine were placed on DWR's website at http://www.publicaffairs.water.ca.gov/dwrnewsletter/.

Video

The video group released *Water for Tomorrow*, a companion video to California Water Plan Update 2005, and *Rough Water Ahead* to complement the 2005 Flood White Paper, Flood Warnings: Responding to California's Flood Crisis. *The Power of Water* was produced for the Division of SWP Planning and Management. In addition, a 30-second public service announcement (PSA) was produced for the annual salmon festival in Oroville, as well as an educational piece on the Oroville Fish Hatchery, which ran eight minutes. The video group worked with DWR's webmaster to place video clips on DWR's "Aquanet" website, including a promotional video for the "Catch A Special Thrill for Kids" (C.A.S.T.) program. The Aquatic Adventure Camps at San Luis, Oroville, and Lake Perris were also documented on film. In and ongoing effort, the video group continued transitioning the video tape library to DVD.

Photography

Photographs were taken throughout the State to supplement articles for *DWR NEWS/People*. Photos were taken of the Salton Sea and Colorado River for use in departmental reports and presentations. In addition, photographs were taken to document the December 2005 New Year's Eve flood event.

Also continuing in 2005 were digital imaging and photographic support for Oroville facilities relicensing.

Audio-Visual

PAO's audio-visual unit provided public address system support for numerous meetings.

Community Outreach

As one of the agencies supporting the C.A.S.T. program, DWR employees continued to promote and volunteer at events throughout the state.

SWP Tours

During 2005, DWR welcomed 27 foreign tours with 362 visitors to the SWP and other facilities; there also were a number of domestic and school tours to the SWP Delta Facilities. Tour groups came from all over the United States and nine foreign countries: Afghanistan, Argentina, Australia, Brazil, China, Germany, Iraq, Japan, and South Korea. The Delta Tour program for DWR employees, part of the DWR Training Program, was suspended for 2005 because of the lack of 15 passenger vans in the General Services Garage. Figure 15-1 shows SWP visitors centers.

Displays and Exhibits

Oroville Field Division

In 2005, new aluminum based interpretive display panels were installed at the fish hatchery. These panels replaced the previous ones damaged through material failure. Displays offer the hatchery visitor a self-guided tour of the facility and facility operations.

Bidwell Toll House was converted into a small museum with artifacts, and low-tech and static displays on the history of the toll house and bridge. The work was done for the Department of Parks and Recreation (DPR) under the FERC relicensing agreement.

Delta Field Division

In 2005, PAO staff installed Phase 1 exhibits for the Delta Field Division Administration. The exhibit features the history of the Sacramento-San Joaquin Delta, SWP, Banks Pumping Plant, hydropower, environmental programs, Skinner Fish Facility, and salinity control. Phase 2 is expected to be completed in 2006, and will include a new map of the Delta.

San Luis Field Division

In 2005, PAO staff installed Phase 1 exhibits for DPR at Romero Visitors Center. Display panels and cabinetry featured artifacts of local California Native Americans in and around the San Luis area and recreation and wildlife in the San Luis Recreation Area. Phase 2 is expected to be completed in 2006. Replicated Native American artifacts and a diorama for wildlife display will be included.

Oral History Program

Retired annuitants Art Winslow and Ernie James have traveled hundreds of miles to compile oral histories of persons significant in DWR's development and history. PAO staff continues work on this project by writing biographies and completing a catalog from 150 interviews.

School Education Program

The School Education Program's goal is to provide students and educators with a statewide perspective on water issues such as conservation, conveyance systems, and the water cycle. PAO staff develops and promotes high quality materials, and provides them free of charge to schools, educators, and water districts.

Figure 15-1. Visitors Centers on the SWP

Program achievements for 2005 include providing a display of DWR's Interactive Children's Exhibits at the Urban Creeks Council's Creek Week event held at the Sacramento Discovery Center (April); assisting at DWR's Oroville Fourth of July booth; State Fair booth (August/ September); and Salmon Festival (September); conducting water safety activities for children at Preparedness Day Event at Office of Emergency Services (September); staffing exhibit for the California Native American Days event at the Sacramento Convention Center (September); and exhibiting DWR's educational materials and videos at the California Science Teachers Association Conference in Palm Springs (October).

Additional program achievements for 2005 include providing curriculum materials and children's videos to California teachers and water agencies through the Water Facts and Fun online ordering catalog and promotional events; revising and reprinting the *Water Facts and Fun* catalog of materials for teachers and students; purchasing 12,000 Captain Hydro Water Conservation books and 10,000 Water Fun books for students; reprinting 10,000 *California Water Works and Why It Does…* books for students; providing Project WET books to teachers who participate in Project WET training workshops.

In 2005, the School Education Program was actively involved in presenting DWR's School Education Program to the California Regional Environmental Education Community (CREEC) Conference in Santa Barbara (January); participating on the Water Awareness Education Subcommittee and providing the printing of Unit #4 on Water Use Efficiency for elementary students; participating and assisting at Water Education Committee meeting, hosted by the Contra Costa Water District in April, and the Marina Coast Water District in October; and participating on the Project Water Education for Teachers (WET) Advisory Committee, the Creek Week Planning Committee, and CEEIN Committee.

In 2005, PAO staff worked on producing brochures for the California Environmental Education Interagency Network (CEEIN) and providing artwork for a poster, brochures, and a bookmark for the Creek Week Event.

The School Education Program also co-sponsored and provided support for the following:

- the development of the Discover Storm Water booklet for students in cooperation with Project WET and others;
- the Environmentality Campaign for fifth grade students, in conjunction with the State of California and the Walt Disney Corporation;
- the California Department of Education's Regional Environmental Education Coordinators Network; and
- the Delta Studies Institute for teachers, co-sponsored with the San Joaquin County Office of Education.

Water Awareness Month Activities

During May 2005, DWR observed Water Awareness Month for the eighteenth consecutive year. PAO news releases highlighted activities at DWR facilities, and public information officers answered media inquiries regarding water awareness.

Appendix B
Data and Computations
Used to
Determine 2007 Water Charges

Contents

Page

Types of Water Charges B-1
Composition and Timing of Water Charges B-4
Bases for Allocating Reimbursable Costs Among Contractors B-6
- Capital and Minimum OMP&R Costs B-8
- Variable OMP&R Costs B-8
- Water Conveyance B-9

Bases for Reimbursable Costs B-11
- Capital Costs B-11
- Annual Operating Costs B-12
- Transportation and Devil Canyon-Castaic Contract Costs B-12
- Conservation Capital and Operating Costs B-13

Project Water Charges B-13
- Transportation Charges B-13
- Delta Water Charges B-17
- Water System Revenue Bond Surcharge B-17
- Total Water Charges B-17
- Equivalent Total Water Charges B-20
- Equivalent Water Costs by Reach B-20
- East Branch Enlargement Facility Charges B-20

Short-Term Agreements B-22

Figures

B-1 Relationships of Data Used to Substantiate Statements of Charges B-2
B-2 Relationships of Data Used to Substantiate East Branch Enlargement Charges B-3
B-3 Composition of Delta Water Charge and Transportation Charge B-5
B-4 Repayment Reaches and Descriptions B-7

Tables

1 Summary of Permanent Aqueduct Capacity Transfers B-9
2 Project Purpose Cost Allocation Factors B-11
3 Criteria for Amortizing Capital Costs of Transportation Facilities B-14
4 Minimum OMP&R Costs of Reach 31A Assigned Directly to Kern County Water Agency B-15
5 Summary of Off-Aqueduct Power Facility Charges and Credits B-15

Tables (continued)

		Page
6	Projected Charges for Off-Aqueduct Power Facilities	B-16
7	Kilowatt-Hour Per Acre-Foot Factors for Allocating Off-Aqueduct Power Facility Costs	B-16
8	Extra Peaking Charges for Additional Power, by Pumping Plant	B-18
9	Extra Peaking Charges for Additional Power, by Contractor	B-19
10	Determination of Factors for Distributing Capital and Minimum OMP&R Costs of East Branch Enlargement Facilities Among Participating Contractors	B-21
B-1	Factors for Distributing Reach Capital Costs Among Contractors	B-24
B-2	Factors for Distributing Reach Minimum OMP&R Costs Among Contractors	B-26
B-3	Power Costs and Credits, Transmission Costs, and Annual Replacement Deposits for Each Aqueduct Pumping and Power Recovery Plant	B-28
B-4	Annual Table A Amounts to Project Water	B-30
B-5A	Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor	B-34
B-5B	Annual Water Quantities Delivered to Each Contractor	B-50
B-6	Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities	B-54
B-7	Reconciliation of Capital Costs Allocated to Water Supply and Power Generation(data not available)	B-64
B-8	SWP Capital Costs of Requested Delivery Structures	B-65
B-9	Capital Costs of Requested Excess Peaking Capacity	B-66
B-10	Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge	B-68
B-11	Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge	B-76
B-12	Variable OMP&R Costs to be Reimbursed Through Variable OMP&R Component of Transportation Charge	B-84
B-13	Capital and Operating Costs of Project Conservation Facilities to be Reimbursed Through Delta Water Charge	B-87
B-14	Capital Costs of Transportation Facilities Allocated to Each Contractor	B-88
B-15	Capital Cost Component of Transportation Charge for Each Contractor	B-92
B-16A	Minimum OMP&R Component of Transportation Charge for Each Contractor	B-96
B-16B	Minimum OMP&R Component of Transportation Charge for Each Contractor for Off-Aqueduct Power Facilities	B-100
B-17	Unit Variable OMP&R Component of Transportation Charge	B-104
B-18	Variable OMP&R Component of Transportation Charge for Each Contractor	B-108
B-19	Total Transportation Charge for Each Contractor	B-112
B-20A	Calculation of Delta Water Rates	B-116
B-20B	Delta Water Rates by Facility	B-117
B-21	Total Delta Water Charge for Each Contractor	B-118
B-22	Water System Revenue Bond Surcharge for Each Contractor	B-122
B-23	Total Transportation and Delta Water Charge for Each Contractor	B-126
B-24	Equivalent Unit Charge for Water Supply for Each Contractor	B-130
B-25	Equivalent Unit Transportation Costs of Water Delivered From or Through Each Aqueduct Reach	B-131

Tables (continued)

		Page
B-26	Capital Costs of Each Aqueduct Reach to be Reimbursed Through the Capital Cost Component of the East Branch Enlargement Transportation Charge	B-132
B-27	Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of the East Branch Enlargement Transportation Charge	B-134
B-28	Capital Costs of East Branch Enlargement Transportation Facilities Allocated to Each Contractor	B-136
B-29	Capital Cost Component of the East Branch Enlargement Facilities Transportation Charge for Each Contractor.	B-137
B-30	Minimum OMP&R Component of East Branch Enlargement Facilities Transportation Charge for Each Contractor	B-138
B-31	Total East Branch Enlargement Facilities Transportation Charge for Each Contractor	B-139

Appendix B
Data and Computations
Used to
Determine 2007 Water Charges

Appendix B
Data and Computations
Used to
Determine 2007 Water Charges

The Department of Water Resources (DWR) annually furnishes Statements of Charges to the 29 long-term State Water Project (SWP) water supply contractors. Article 29(e) of the Standard Provisions for Water Supply Contracts, approved August 3, 1962, describes those statements:

> *All such statements shall be accompanied by the latest revised copies of the document amendatory to Article 22 and of Tables B, C, D, E, F, and G of this contract, together with such other data and computations used by the State in determining the amounts of the above charges as the State deems appropriate.*

To comply with Article 29(e), DWR performs an annual comprehensive review and redetermination of all water supply and financial aspects of the SWP for the entire project repayment period. This annual redetermination is performed in accordance with Article 22(f) and Article 28 of the water supply contracts, which concern the Delta Water Rate and annual transportation charges, respectively.

Appendix B includes data used to document the redetermination of water charges to be paid by contractors during calendar year 2007. The information is based on established data about the SWP, both known and projected, as of June 30, 2006.

The computational procedures and interrelationships between tabulations in this appendix are outlined in Figure B-1 and Figure B-2. All tables referenced in Figures B-1 and B-2 follow this text.

Types of Water Charges

Charges to SWP water supply contractors include the costs of facilities for the conservation and development of a water supply and the conveyance of such supply to SWP service areas. These facilities are classified as "Project Conservation Facilities" and "Project Transportation Facilities" in the Standard Provisions for Water Supply Contract. The names of the main facilities in each classification follow.

Project Conservation Facilities

- Frenchman Dam and Lake
- Grizzly Valley Dam and Lake Davis
- Antelope Dam and Lake
- Oroville Dam and Lake Oroville
- Oroville power facilities
- Delta Facilities
- A portion of the California Aqueduct from the Delta to Dos Amigos Pumping Plant
- Sisk Dam, San Luis Reservoir, and Gianelli Pumping-Generating Plant

Project Transportation Facilities

- Grizzly Valley Pipeline
- North Bay Aqueduct
- South Bay Aqueduct, including Del Valle Dam and Lake Del Valle
- Remainder of the California Aqueduct from the Delta to Dos Amigos Pumping Plant and all facilities south, including dams and lakes in Southern California
- Off-Aqueduct Power Facilities (Reid Gardner Unit No. 4, Bottle Rock Power Plant, and South Geysers Power Plant)

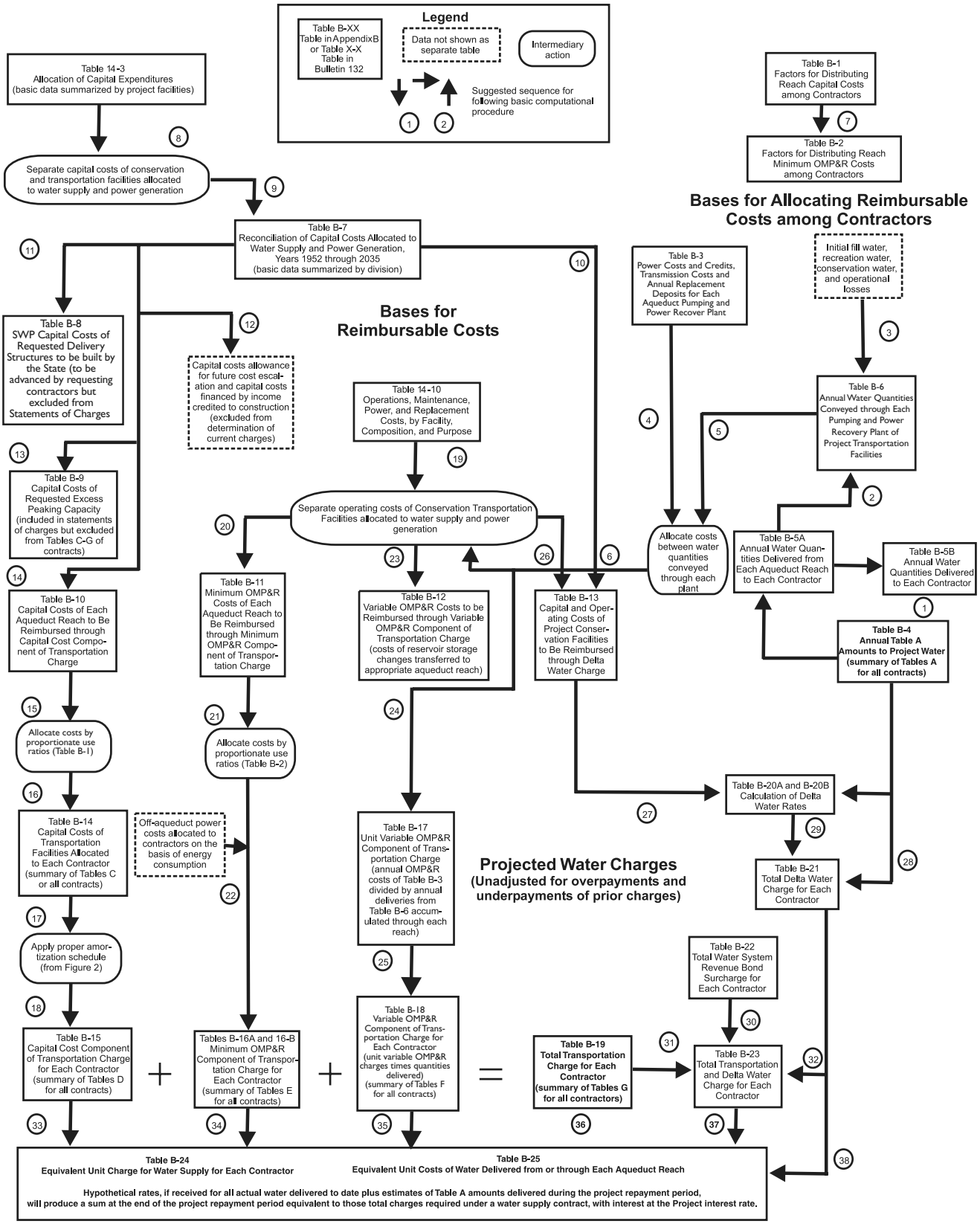


Figure B-1. Relationships of Data Used to Substantiate Statements of Charges

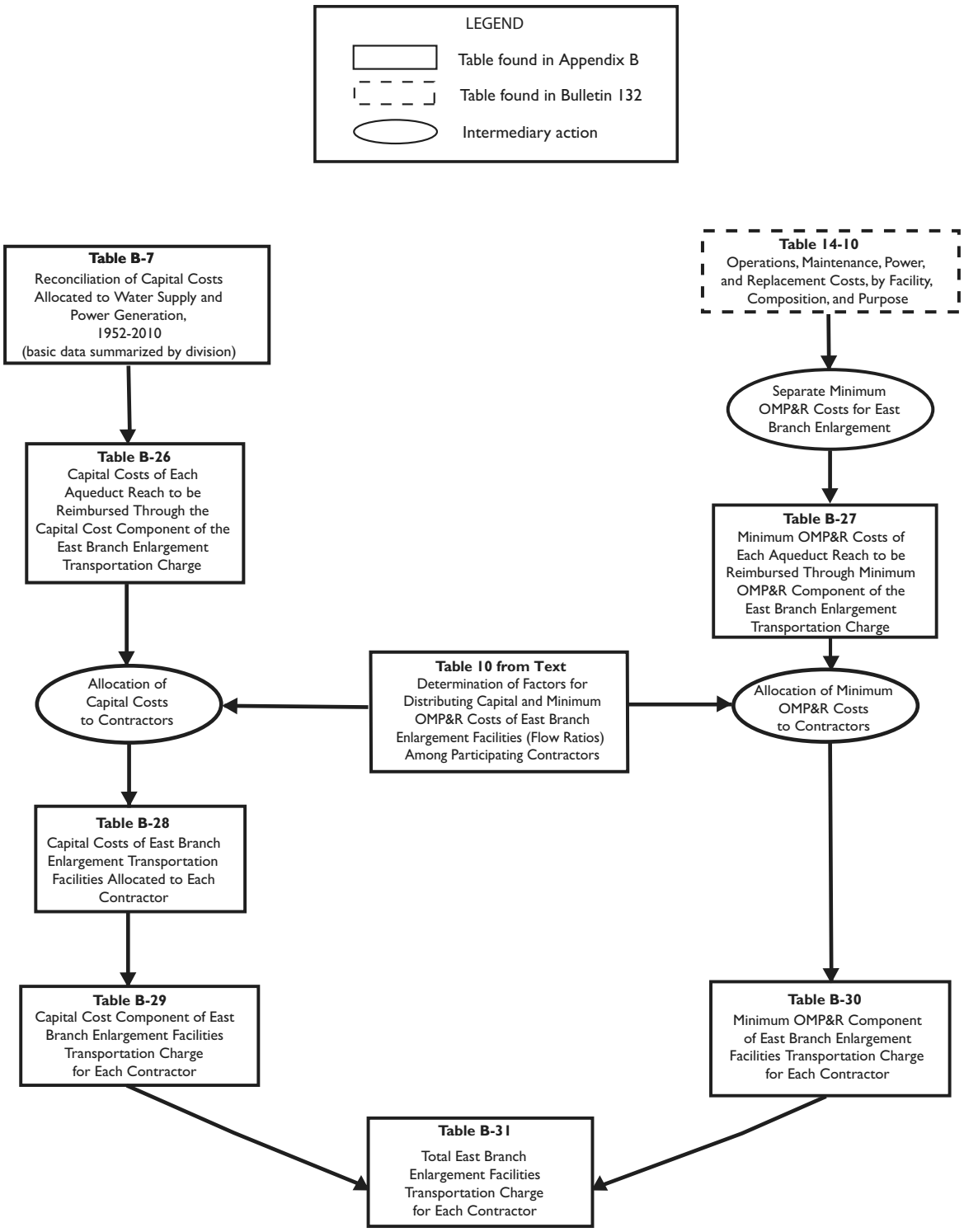


Figure B-2. Relationships of Data Used to Substantiate East Branch Enlargement Charges

The standard provisions provide for a Delta Water Charge and a Transportation Charge for project water.

The Delta Water Charge is a unit charge applied to each acre-foot of SWP water the contractors are entitled to receive according to their contracts. The unit charge, if applied to each acre-foot of all such allocations for the remainder of the project repayment period, is calculated to result in repayment of all outstanding reimbursable costs of the Project Conservation Facilities, with appropriate interest, by the end of the repayment period (2035).

The Transportation Charge is for use of facilities to transport water to the vicinity of each contractor's turnout. Generally, the annual charge represents each contractor's proportionate share of the reimbursable capital costs and operating costs of the Project Transportation Facilities.

Each contractor's allocated share of those reimbursable capital costs is amortized for repayment to the State; and certain variations are allowed in the amortization methods. Essentially, the contractors' shares of reimbursable operating costs are repaid in the year such costs are incurred by the State.

The East Branch Enlargement Transportation Charge is paid by the seven Southern California contractors participating in the enlargement. San Bernardino Valley Municipal Water District advanced funds to pay the district's allocated capital costs for the East Branch Enlargement. The remaining six contractors pay an allocated share of the debt service on revenue bonds sold to finance the enlargement. Each contractor also will pay an allocated share of the minimum operation, maintenance, power, and replacement costs of the East Branch Enlargement.

Transportation charges for the Coastal Branch Extension, East Branch Extension, and South Bay Enlargement are being repaid by contractors in their respective service areas.

Transportation charges for the Tehachapi Afterbay is repaid by those contractors using electrical power for delivery of their Table A water.

Composition and Timing of Water Charges

As shown in Figure B-3, the Delta Water Charge and the Transportation Charge consist of the following three components:

(1) Conservation and Transportation capital cost components, which will return to the State all reimbursable capital costs;

(2) Conservation and Transportation minimum OMP&R components, which will return to the State all reimbursable operating costs that do not depend on or vary with quantities of water actually delivered to the contractors; and

(3) A Transportation variable OMP&R component, which will return to the State all reimbursable operating costs that depend on, and vary with, quantities of water actually delivered to the contractors.

The formula for computing the Delta Water Rate, Article 22(f) of the Standard Provisions for Water Supply Contract, was designed to ensure that all adjustments for prior overpayments or underpayments of the Delta Water Charge are accounted for in a redetermination of the rate. Since the redetermined rate applies to all future allocations, such adjustments are amortized during the remainder of the project repayment period. This appendix includes a redetermination of the Delta Water Rate for 2007.

Article 28 of the standard provisions stipulates that Transportation Charges be redetermined each year. The tables in Appendix B include the numerical data used in this redetermination. Transportation Charges for prior years through 2005 included in those tables are the redetermined amounts and do not equal the amounts actually paid by contractors.

As provided under the Water System Revenue Bond Amendment to the water supply contracts, differences between actual payments under the Transportation capital cost component and amounts computed in this redetermination are accumulated with interest and

Delta Water Charge

Capital Cost Component

1. Planning, design, right-of-way, and construction costs of Conservation Facilities
2. Operations and maintenance costs for newly constructed Conservation Facilities prior to initial operations
3. Activation costs for newly constructed Conservation Facilities
4. Power costs allocated to initial filling of San Luis Reservoir
5. Capitalized O&M costs (major repair work and so forth) for Conservation Facilities
6. Program costs (portion) to mitigate impacts on current Delta fishery population due to SWP pumping prior to 1986 (Department of Water Resources-Department of Fish and Game agreement)

Minimum OMP&R Component

1. Direct O&M costs of Conservation Facilities
   a. Headquarters and field divisions (portion)
   b. Insurance and FERC costs (portion)
2. General O&M costs allocated to Conservation Facilities
   a. Contractor Accounting Office (portion)
   b. Financial and contract administration (portion)
   c. Water rights
   d. Power planning for SWP facilities (portion)
3. Replacement deposits for SWP control centers (portion)
4. Credits for a portion of Hyatt-Thermalito power generation
5. Power costs and credits related to pumping water to San Luis Reservoir for project operations (storage changes)
6. Value of power used and generated by Gianelli Pumping-Generating Plant
7. Program costs (portion) to offset annual fish losses resulting from pumping at Banks Pumping Plant (Department of Water Resources-Department of Fish and Game agreement)

Transportation Charge

Capital Cost Component

1. Planning, design, right-of-way, and construction costs of Transportation Facilities
2. O&M costs for newly constructed Transportation Facilities prior to initial operation
3. Activation costs for newly constructed Transportation Facilities
4. Power costs allocated to initial filling of Southern California reservoirs
5. Capitalized O&M costs (major repair work and so forth) for Transportation Facilities
6. Program costs (portion) to mitigate impacts on current Delta fishery population due to SWP pumping prior to 1986 (Department of Water Resources-Department of Fish and Game agreement)

Minimum OMP&R Component

1. Direct O&M costs of Transportation Facilities
   a. Headquarters and field divisions (portion)
   b. Insurance and FERC costs (portion)
2. General O&M costs related to Transportation Facilities
   a. Contractor Accounting Office (portion)
   b. Financial and contract administration (portion)
   c. Power planning for SWP facilities (portion)
3. Power costs and credits related to pumping water to Southern California reservoirs for project operations (storage changes)
4. Power costs for pumping water to replenish losses from Transportation Facilities
5. Other power costs
   a. Station service at Transportation Facility power and pumping plants
   b. Transmission service costs related to “backbone” Transportation Facilities
6. Replacement deposits for SWP control centers (portion)
7. Off-Aqueduct Power Facility costs–bond service, bond cover costs (25 percent of bond service), bond reserves, transmission costs to provide service to “backbone,” fuel costs taxes, and O&M-less power sales allocated to Off-Aqueduct Power Facilities
8. Program costs (portion) to offset annual fish losses resulting from pumping at Banks Pumping Plant (Department of Water Resources-Department of Fish and Game agreement)

Variable OMP&R Component

1. Power purchase costs
   a. Capacity
   b. Energy
   c. Pine Flat bond service, O&M, and transmission costs allocated to aqueduct pumping plants
2. Alamo, Devil Canyon, Warne, and Castaic power generation credited at the power plant reach and charged to aqueduct pumping plants
3. Hyatt-Thermalito Diversion Dam power plant generation charged to aqueduct pumping plants (credits for this generation are reflected in the Delta Water Rate)
4. Replacement deposits for equipment at pumping plants and power plants
5. Credits from sale of excess SWP system power
6. Program costs (portion) to offset annual fish losses resulting from pumping at Banks Pumping Plant (Department of Water Resources-Department of Fish and Game agreement)

Note: Excludes costs recovered under the East Branch Enlargement Transportation Charge.

Figure B-3. Composition of Delta Water Charge and Transportation Charge

amortized during the remaining years of the contract repayment period. All computations for adjustments are included in the attachments accompanying each contractor's Statement of Charges and are reflected in revised copies of Table C through Table G of the contract, which are also furnished to each long-term water supply contractor in the annual Statements of Charges.

These redeterminations exclude four charges associated with water service other than the Delta Water Charge and the Transportation Charge. The excluded charges (and the manner in which such excluded charges are treated in this appendix) are:

(1) Advances of funds pursuant to Article 24(d) of the standard provisions for excess capacity constructed by the State at the request of contractors.

(2) Advances of funds pursuant to Article 10(d) of the standard provisions for delivery structures (turnouts) constructed by the State at the request of contractors. Partial information concerning actual and projected capital costs of such delivery structures is included in this appendix. Statements concerning these costs and data are furnished to the appropriate contractors at various times and are not part of the annual statements.

(3) Payments for sale and service of surplus water to entities other than contractors, pursuant to Article 21 of the standard provisions, are also excluded. Those payments are generally based on the unit rates shown in Table B-25. Net revenues resulting from noncontractor service are applied as indicated on page 24 of Bulletin 132-71.

(4) Payments under the Devil Canyon-Castaic contract for costs of the Devil Canyon-Castaic facilities allocable to power generation. Charges billed as a result of the contract are billed separately from those billed as a result of the water supply contract. Information about the treatment of such charges in relation to redetermined Transportation Charges is included in special attachments to the bills of the six participating contractors.

The time and method of payment for corresponding components of the Delta Water Charge and the Transportation Charge are as follows:

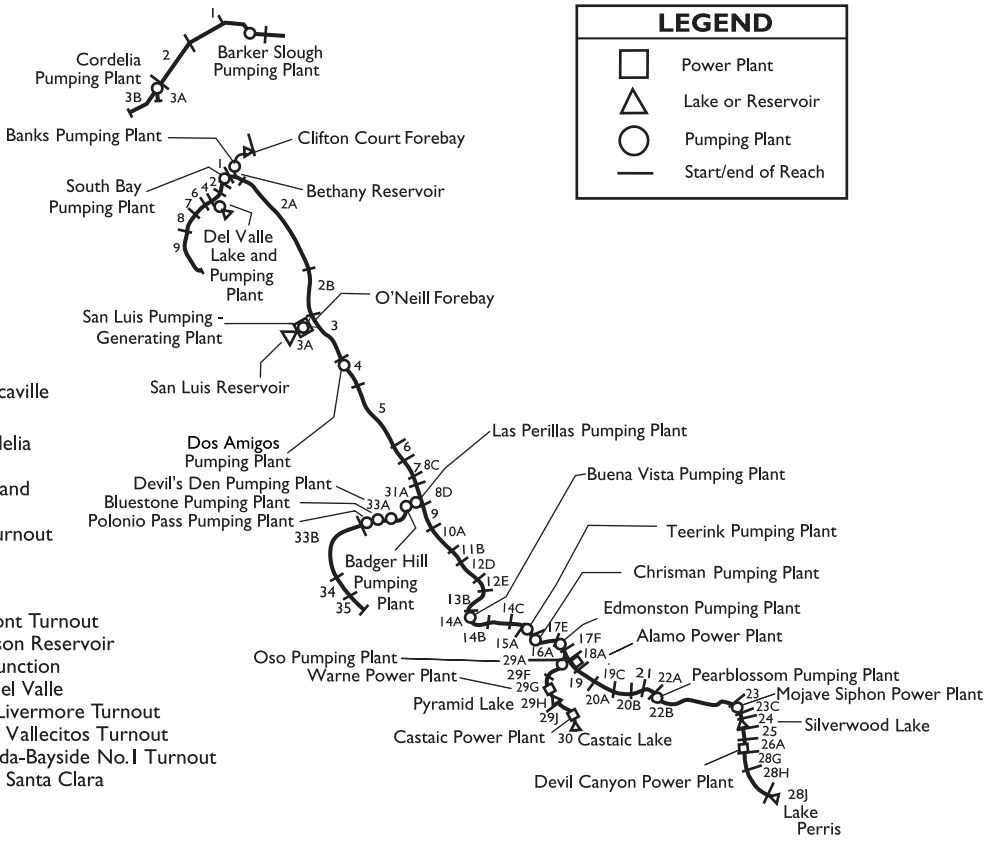
(1) The capital cost components of the Delta Water Charge and the Transportation Charge are paid in two semiannual installments, due January 1 and July 1 of each year, based on statements furnished by the State on or before July 1 of the preceding year.

(2) The minimum OMP&R components of the Delta Water Charge and the Transportation Charge are paid in 12 equal installments, due the first of each month and based on statements furnished by the State on or before July 1 of the preceding year.

(3) The variable OMP&R component of the Transportation Charge is paid in varying monthly amounts and is due the fifteenth day of the second month following actual water delivery. The charges are projected based on a unit charge per acre-foot established on or before July 1 of the preceding year. Those unit charges may be revised during the year to reflect current power costs and revenues. The unit charges are applied to actual monthly delivery quantities as determined by the State on or before the fifteenth day of the month following actual delivery.

Bases for Allocating Reimbursable Costs Among Contractors

This section describes the procedures for allocating reimbursable costs of Project Transportation Facilities among contractors (see upper right portion of Figure B-1). Those costs do not include annual costs of Off-Aqueduct Power Facilities, which are explained in the section "Project Water Charges."



North Bay Aqueduct

1	Barker Slough through Fairfield/Vacaville Turnout
2	Fairfield/Vacaville Turnout to Cordelia Forebay
3A	Cordelia Forebay through Benicia and Vallejo Turnouts
3B	Cordelia Forebay through Napa Turnout Reservoir

South Bay Aqueduct

1	Bethany Reservoir through Altamont Turnout
2	Altamont Turnout through Patterson Reservoir
4	Patterson Reservoir to Del Valle Junction
5	Del Valle Junction through Lake Del Valle
6	Del Valle Junction through South Livermore Turnout
7	South Livermore Turnout through Vallecitos Turnout
8	Vallecitos Turnout through Alameda-Bayside No. 1 Turnout
9	Alameda-Bayside Turnout through Santa Clara Terminal Facilities

California Aqueduct

North San Joaquin Division

1	Delta through Bethany Reservoir
2A	Bethany Reservoir to Orestimba Creek
2B	Orestimba Creek to O'Neill Forebay

San Luis Division

3A	Sisk Dam, San Luis Reservoir, Gianelli Pumping-Generating Plant
3	O'Neill Forebay to Dos Amigos Pumping Plant
4	Dos Amigos Pumping Plant to Panoche Creek
5	Panoche Creek to Five Points
6	Five Points to Arroyo Pasajero
7	Arroyo Pasajero to Kettleman City

South San Joaquin Division

8C	Kettleman City through Milham Avenue
8D	Milham Avenue through Avenal Gap
9	Avenal Gap through Twisselman Road
10A	Twisselman Road through Lost Hills
11B	Lost Hills to 7th Standard Road
12D	7th Standard Road through Elk Hills Road
12E	Elk Hills Road through Tupman Road
13B	Tupman Road to Buena Vista Pumping Plant
14A	Buena Vista Pumping Plant through Santiago Creek
14B	Santiago Creek through Old River Road
14C	Old River Road to Teerink Pumping Plant
15A	Teerink Pumping Plant to Chrisman Pumping Plant
16A	Chrisman Pumping Plant to Edmonston Pumping Plant

Tehachapi Division

17E	Edmonston Pumping Plant to Porter Tunnel
17F	Porter Tunnel to Junction, West Branch

Mojave Division

18A	Junction, West Branch through Alamo Power Plant
19	Alamo Power Plant to Fairmont
19C	Buttes Junction through Buttes Reservoir
20A	Fairmont through 70th Street West
20B	70th Street West to Palmdale
21	Palmdale to Littlerock Creek
22A	Littlerock Creek to Pearblossom Pumping Plant
22B	Pearblossom Pumping Plant to West Fork Mojave River
23	West Fork Mojave River to Silverwood Lake
23C	Mojave Siphon Power Plant
24	Cedar Springs Dam and Silverwood Lake

Santa Ana Division

25	Silverwood Lake to South Portal, San Bernardino Tunnel
26A	South Portal, San Bernardino Tunnel through Devil Canyon Power Plant
28G	Devil Canyon Power Plant to Barton Road
28H	Barton Road to Lake Perris
28J	Perris Dam and Lake Perris

West Branch, California Aqueduct

29A	Junction, California Aqueduct through Oso Pumping Plant
29F	Oso Pumping Plant through Quail Embankment
29G	Quail Embankment through Warne Power Plant
29H	Pyramid Dam and Lake
29J	Pyramid Lake through Castaic Power Plant
30	Castaic Dam and Lake

Coastal Branch, California Aqueduct

31A	Avenal Gap to Devil's Den Pumping Plant
33A	Devil's Den Pumping Plant through Tank 1
33B	Tank 1 through Chorro Valley Turnout
34	Chorro Valley Turnout through Lopez Turnout
35	Lopez Turnout through Guadalupe Turnout

Figure B-4. Repayment Reaches and Descriptions

Capital and Minimum OMP&R Costs

Figure B-4 includes information about the repayment reaches that form the basis for allocating reimbursable costs of the Project Transportation Facilities among contractors.

Allocations of reimbursable capital costs and minimum OMP&R costs of each reach are based on the proportionate maximum use of that reach by respective contractors under planned conditions of full development.

The derivation of ratios that represent the proportionate maximum use of each aqueduct reach by the respective contractors was first reported in Bulletin 132-70. The ratios in Bulletin 132-70 were subsequently revised for the North Bay Aqueduct, the South Bay Aqueduct, the California Aqueduct from the Delta to Castaic Lake, and the Coastal Branch.

All the revisions reported in previous bulletins regarding the derivation of ratios that represent the proportionate maximum use of each aqueduct reach by the respective contractors were last reported in Tables B-1 and B-2 of Bulletin 132-91. Under Article 53 of the Monterey Amendment, Agricultural contractors may sell up to 130,000 acre-feet of aqueduct capacity to Municipal and Industrial contractors. The first permanent transfer occurred in 1998. Currently, 114,000 acre-feet of the allowable capacity has been transferred. Table 1 shows the permanent capacity transfers that have taken place since 1995.

Table B-1 presents the reach ratios currently applicable to reimbursable capital costs.

Table B-2 presents corresponding ratios for allocating 2007 and after reimbursable minimum OMP&R costs among contractors. Requested excess capacity is omitted when deriving ratios applicable to capital costs because the capital costs for the excess capacity are paid on an incremental-cost basis and not a proportionate-use basis. However, requested excess capacity is accounted for in the ratios applicable to minimum OMP&R costs.

Variable OMP&R Costs

Article 26(a) includes provisions to ensure that the variable OMP&R component of the Transportation Charge will result in a return to the State of those costs that depend on and vary with the amount of SWP water deliveries. (The minimum OMP&R component results in a return of those operating costs that do not vary with deliveries.) Under Article 26(a) all such costs for a reach for a given year will be allocated among contractors in proportion to the actual annual use of that reach by the respective contractors.

Table B-3 summarizes the total power costs, credits, and transmission costs for each aqueduct pumping and power recovery plant. Those variable costs consist of:

- Costs of capacity and energy used exclusive of associated power transmission and station service charges (transmission and station service costs that are not, depend and vary with power usage classified as minimum OMP&R costs);
- Credits for capacity and energy produced at aqueduct power recovery plants (treated as negative costs);
- Payments for replacement of major plant machinery components having economic lives shorter than the project repayment period. In 1997, DWR discontinued charging for a sinking fund for replacements. Replacement costs for 1999 and thereafter are to be paid on an annual basis as the costs are incurred; and
- Starting in 2005, a portion of transmission expenditures will depend and vary with water and power usage; these costs will be included as part of the variable component.

Table 1. Summary of Permanent Aqueduct Capacity Transfers

Contractor		Capacity Transfer		
Seller	*Buyer*	*Amount (acre-feet)*	*Effective Year*	**Transfer Description**
Transfers under Monterey Amendment				
Kern	Mojave	25,000	1998	Purchased capacity upstream of Reach 31A
Kern	Castaic Lake	41,000	2000	Purchased capacity upstream of Reach 16A
Kern	Palmdale	4,000	2000	Purchased capacity upstream of Reach 11B
Kern	Alameda Zone-7	7,000	2000	Purchased capacity upstream of Reach 10A
Kern	Alameda Zone-7	15,000	2000	Purchased capacity upstream of Reach 10A
Kern	Alameda Zone-7	10,000	2001	Purchased capacity upstream of Reach 11B
Kern	Solano	5,756	2001	Purchased capacity upstream of Reach 11B and Reach 31A
Kern	Napa	4,025	2001	Purchased capacity upstream of Reach 11B and Reach 31A
Kern	Alameda Zone-7	2,219	2004	Purchased capacity upstream of Reach 11B
Subtotal Under Article 53		114,000		
Transfers outside of Monterey Amendment				
Tulare	Dudley Ridge	3,973	2002	Purchased capacity upstream of Reach 8D
Tulare	AVEK	3,000	2002	Purchased capacity upstream of Reach 8D
Tulare	Alameda Zone-7	400	2003	Purchased capacity upstream of Reach 8D
Tulare	Kings	5,000	2004	Purchased capacity upstream of Reach 8D
Tulare	Coachella	9,900	2004	Purchased capacity upstream of Reach 8D
MWDSC	Coachella	88,100	2005	Purchased capacity upstream of Reach 28J
MWDSC	Desert	11,900	2005	Purchased capacity upstream of Reach 28J
Tulare	Kings	305	2006	Purchased capacity upstream of Reach 31A
Subtotal Outside of Article 53		122,578		

Table B-3 excludes plant capacity and energy costs associated with surplus and unscheduled water service after May 1, 1973. Prior to that date, surplus water service was charged the same unit variable OMP&R component as allocated water service. An amendment to the long-term water supply contracts in 1973 significantly changed the rate structure for surplus water service. Capacity and energy costs for pumping surplus and unscheduled water were allocated directly to those water contractors receiving surplus and unscheduled water service. A contract amendment in 1991 again revised the rate structure to provide for payment of costs through a melded power rate. These revisions to charges for surplus and unscheduled water are effective from the date of the amendments and are not applied to past charges.

An interruptible water program was established in 1994. This program is based on individual annual contracts; costs for interruptible water actually delivered are included in Table B-3.

Water Conveyance

The water conveyance quantities that form the basis for allocating costs are presented in Tables B-4, B-5A, B-5B, and B-6.

Table B-4 presents the schedules of annual allocations as set forth in Table A and Article 6(a) of each water supply contract.

Table B-5A shows amounts of actual and projected allocated water quantities delivered from each aqueduct reach to each contractor. Projected deliveries for years 2006 through 2035 are based on contractors' requests for future water deliveries. The quantities included in Table B-5A also include nonproject water delivered to contractors and surplus water deliveries prior to May 1, 1973, and actual interruptible water deliveries in 1994 and after.

Table B-5B presents a summary of actual and projected annual allocated water quantities delivered or to be delivered to each contractor. The quantities also include amounts of nonproject water and surplus water delivered prior to May 1, 1973, and actual deliveries of interruptible water in 1994 and after.

Table B-6 summarizes the annual allocated water quantities conveyed or to be conveyed through each aqueduct pumping plant or power plant for each of the following functions:

- *Deliveries-Water Supply.* Water made available to contractors at down aqueduct delivery structures, including certain hypothetical quantities to facilitate cost allocations, for those years when deliveries are made from net annual storage withdrawals. The net annual amounts of storage withdrawals are hypothetically added to the actual amounts conveyed from the Delta to the reservoirs, since deliveries made from storage withdrawals bear the same variable OMP&R costs per acre-foot as they would if the deliveries were actually conveyed from the Delta in that year. The hypothetical increases in the deliveries made from reservoir storage withdrawals are offset by equal credits to the minimum OMP&R costs of the respective reservoirs. Thus, the variable OMP&R components per acre-foot (Table B-17) may be applied to the total annual quantities delivered either from aqueduct reservoir storage or from the Delta.
- *Initial Fill Water.* Water required for initial filling of down aqueduct reaches and reservoirs or for repayment of pre-consolidation water used during construction.
- *Deliveries-Recreation.* Water delivered to down-aqueduct recreation developments or used for fish and wildlife mitigation or enhancement.
- *Operational Losses*. Water lost through evaporation and seepage from all down aqueduct reaches.
- *Reservoir Storage Changes*. Water placed in down-aqueduct reservoir storage after initial filling of the reservoirs, including projected net annual storage accretions (positive values) and withdrawals (negative values) for all down-aqueduct reservoirs of the Project Transportation Facilities.

Those variable OMP&R costs (Table B-12) that are allocable to storage accretions are assigned to the minimum OMP&R costs of the respective reservoirs. With the exception of Banks Pumping Plant, "Reservoir Storage Changes" also includes SWP water placed into Southern California groundwater storage from 1978 through 1982 (as positive amounts); and water withdrawn from storage and delivered to contractors in 1979, 1982, 1987, 1988, and 1989 (as negative amounts). At Banks Pumping Plant, groundwater additions and withdrawals are included in "Conservation Water."

Table B-6 also summarizes the following two amounts under the heading "Conservation Water" (Column 25):

(1) net annual water amounts stored and projected to be stored in San Luis Reservoir; and

(2) water lost and projected to be lost through evaporation and seepage from San Luis Reservoir and from the water conservation portion of the California Aqueduct.

"Conservation Water" includes initial fill water, operational losses, and net annual storage changes associated with San Luis Reservoir and the portion of the California Aqueduct that is allocated to conservation. The same allocation procedure outlined above for Transportation Facilities also applies to water delivered from storage in Conservation Facilities, except that the hypothetical cost increases are added to the variable OMP&R cost to be reimbursed through the Transportation Charge and deducted from the minimum OMP&R costs to be reimbursed through the Delta Water Charge.

San Luis Reservoir is operated to conserve water for future delivery to downstream contractors. To account for costs associated with reservoir storage, those power and replacement costs of Banks Pumping Plant (a joint Transportation-Conservation Facility) that are allocated to the conveyance of annual conservation water quantities are transferred to the capital costs of San Luis Reservoir (during initial fill) or to the minimum OMP&R costs of San Luis Reservoir (subsequent to initial fill).

In years of net storage withdrawal from San Luis Reservoir, a portion of the minimum OMP&R cost of

Table 2. Project Purpose Cost Allocation Factors (Percentages)

Project Facilities	Water Supply and Power Generation		All Other Purposes (Nonreimbursable)	
	Capital Costs	*Minimum OMP&R Costs*	*Capital Costs*	*Minimum OMP&R Costs*
Project Conservation Facilities				
Frenchman Dam and Lake	21.5	0.0	78.5	100.0
Antelope Dam and Lake	0.0	0.0	100.0	100.0
Grizzly Valley Dam and Lake Davis	1.0	1.8	99.0	98.2
Oroville Division[a]	97.1	99.5	2.9	0.5
California Aqueduct, Delta to Dos Amigos Pumping Plant	96.6	96.7	3.4	3.3
Delta Facilities	86.0	86.0	14.0	14.0
Transportation Facilities				
Grizzly Valley Pipeline	100.0	100.0	0.0	0.0
North Bay Aqueduct	100.0	100.0	0.0	0.0
South Bay Aqueduct				
Del Valle Dam and Lake Del Valle	25.2	22.0	74.8 [b]	78.0 [c]
Remainder of South Bay Aqueduct	100.0	100.0	0.0	0.0
California Aqueduct				
Delta to Dos Amigos Pumping Plant	96.6	96.7	3.4	3.3
Dos Amigos Pumping Plant to termini (excluding Coastal Branch)	94.3	96.9	5.7	3.1
Coastal Branch	100.0	100.0	0.0	0.0

[a] Percentages indicated are applicable to the remaining costs of division after excluding costs allocated to flood control that are reimbursed by the federal government (22 percent of capital costs) and excluding specific power costs of Hyatt and Thermalito power plants and switchyards.
[b] Percentage indicated consists of 48.8 percent of costs allocated to recreation and 26.8 percent to flood control.
[c] Percentage indicated consists of 44.9 percent of costs allocated to recreation and 33.1 percent to flood control.

the reservoir is transferred to the variable OMP&R cost of Banks Pumping Plant. That transfer is equal to the variable OMP&R cost per acre-foot of delivery through Banks Pumping Plant for that year, multiplied by the acre-feet of deliveries derived from San Luis Reservoir storage for that year. Table B-6 also includes amounts of nonproject water and surplus water delivered prior to May 1, 1973, and actual deliveries of interruptible water in 1994 and after.

Bases for Reimbursable Costs

This section describes the methods used to derive the costs allocated by the procedures outlined in the preceding section. A diagram of the cost derivation process is shown in the upper-left quadrant of Figure B-1.

First, the capital and minimum OMP&R costs of all SWP facilities are allocated among the various project purposes according to the allocation percentages in Table 2. Those percentages may be subject to revision in the future.

The redeterminations in this appendix involve only the SWP costs that are allocated to water supply and power generation.

Capital Costs

Capital costs used in the redeterminations in this appendix reflect prices prevailing on December 31, 2005; future cost escalation will be reflected in subsequent bulletins.

Table B-7 presents a reconciliation of estimated total capital costs of each Project Conservation Facility and each Project Transportation Facility. This table shows the relationship of Project Conservation and Transportation costs allocated to contractors (Tables B-8, B-9, B-10, and B-13) to the total SWP capital costs projected by DWR.

Table B-8 shows costs incurred and projected to be incurred by the State in connection with each contractor's turnouts. Costs incurred by the State for both State-constructed and contractor-constructed delivery structures are paid directly by the contractors for which the structures are

built. (The State incurs design review and construction inspection costs in connection with contractor-constructed turnouts.)

Table B-9 lists costs and payments for excess capacity built into SWP Transportation Facilities according to amendments to contracts with Metropolitan Water District of Southern California, San Gabriel Valley Municipal Water District, and AVEK as follows:

- additional costs incurred by the State for requested excess capacity;
- advances by water contractors of funds for such costs; and
- credits for advances in excess of costs, which were applied to respective contractors' installments of the capital cost component of the Transportation Charge in 1981.

Under Amendment 2 of Metropolitan's contract, 809 cfs of excess capacity was originally constructed in reaches of the West Branch at Metropolitan's request. That capacity was reclassified as basic capacity of SWP Transportation Facilities under Amendment 7. Metropolitan paid $16.3 million as a prepayment of the capital cost component of the Transportation Charge in lieu of advancing funds for the original requested capacity.

Amendment 5 to Metropolitan's contract requires that additional costs for modifications to the Santa Ana Pipeline (required for enlargement of Lake Perris) will be allocated to Metropolitan and returned to the State through payments of the Transportation Charge. The additional costs to be repaid through Metropolitan's capital cost component for the aqueduct reach from Devil Canyon Power Plant to Barton Road total about $6.7 million (see Bulletin 132-72, page 98).

Table B-10 presents the actual and projected annual capital costs of each aqueduct reach that will eventually be returned to the State, with interest, through contractors' payments of the capital cost component of the Transportation Charge and payment of debt service under the Devil Canyon-Castaic contracts.

Annual Operating Costs

Annual operating costs allocable to water supply and power generation are returned to the State through the minimum and variable OMP&R components of Delta Water and Transportation Charges and through a portion of the revenues from energy sales. All reimbursable operating costs of Conservation Facilities are included in the minimum OMP&R component of the Delta Water Charge.

Transportation and Devil Canyon-Castaic Contract Costs

Table B-11 shows the amounts of the actual and projected costs to be reimbursed through payments of the minimum OMP&R component of the Transportation Charge and allocated operating costs under the Devil Canyon-Castaic contract. The table includes the following seven types of operating costs incurred annually that do not vary with water quantities delivered to the contractors:

(1) all direct labor charges for field operation and maintenance personnel, including associated indirect costs;

(2) a distributed share of general operating costs that cannot be identified solely with one facility or aqueduct reach;

(3) all of electric power transmission and station service costs up to 2004, and electric power transmission and station service costs for 2005 and after that do not vary with power usage allocable to aqueduct pumping and recovery plants;

(4) all costs for equipment, materials, and supplies;

(5) portions of the power and replacement costs of all up-aqueduct pumping plants and power plants that are allocable to the annual conveyance of water lost to evaporation and seepage from respective aqueduct reaches or placed into storage in

respective reservoirs of the project transportation facilities (after initial fill);

(6) credits, which offset those costs in (5) above, for deliveries drawn from reservoir storage; and

(7) escalation of projected operating costs at 5 percent per year for 2006, 2007, and 2008.

Table B-12 shows the portions of variable OMP&R costs in Table B-3 that are allocable to the water supply delivery quantities included in Table B-6 and reimbursed through payments of the variable OMP&R component of the Transportation Charge.

The following five adjustments are made to Table B-3 costs to derive Table B-12 costs:

(1) Part of the variable OMP&R costs of each plant is allocated to recreation. The allocation to recreation is in proportion to the quantity of water conveyed through each plant each year for delivery to on-shore recreational developments.That portion of variable plant costs attributable to the initial fill of aqueduct reaches is allocated to the joint capital costs of respective down-aqueduct reaches and reservoirs.

(2) That portion of costs attributable to evaporation and seepage is allocated to the joint minimum OMP&R costs of respective down-aqueduct reaches and reservoirs.

(3) Adjustments are made for additions or withdrawals from storage in aqueduct reservoirs. In years when water is added to storage in aqueduct reservoirs, the cost of conveying this water into storage is charged to the minimum OMP&R costs of the corresponding reservoir. In years when storage in aqueduct reservoirs is decreased for the purpose of making deliveries, a credit is applied to the minimum OMP&R costs of the reservoir from which the storage is released. This credit is equal to the number of acre-feet of storage reduction times the variable OMP&R unit rate for the year storage is released. The unit rate is equal to the variable OMP&R unit rate for the year the water is taken from storage.

(4) That portion of costs attributable to pumping water to replace evaporation and seepage losses and for additions or withdrawals from storage in San Luis Reservoir is charged to the minimum OMP&R component of the Delta Water Rate.

The remaining costs are allocated to Transportation water supply and repaid by the contractors.

Conservation Capital and Operating Costs

Table B-13 is a summary of actual and projected capital and operating costs of the initial Project Conservation Facilities. These costs are reimbursed through payments by contractors under the Delta Water Charge, Oroville power sales, and Gianelli Generating Plant credits. Table B-13 also shows credits applied to the reimbursable capital costs of the Project Conservation Facilities according to negotiated settlements concerning incurred planning costs for the period from 1952 through 1978.

Project Water Charges

This section describes the redetermination of past and projected components of the Transportation Charge for annual revision of Tables C through G of each water supply contract. This section also describes the derivation of the unit Delta Water Rates and the Water System Revenue Bond Surcharge.

A summary of equivalent unit charges for each acre-foot of allocated water service is also included for each contractor and each aqueduct reach. A diagram of all calculations may be found in the lower half of Figure B-1.

Transportation Charges

The accumulation of allocated costs of each aqueduct reach to each contractor is the basis for the Transportation Charge components.

Table B-14 summarizes each contractor's share of the capital costs of aqueduct reaches presented in Table B-10. Those amounts are determined by applying proportionate-use ratios set forth in Table B-1 to the costs in Table

B-10. The resulting allocated costs are set forth in Table C of the respective water supply contracts.

Prepayments of the capital cost component, required under Metropolitan's Amendment 7, are included as negative capital costs in Table B-14 and Table C of Metropolitan's Statement of Charges. Solano, Empire-West Side Irrigation District, and Crestline also prepaid capital costs (see Table B-14 footnotes). Table B-14 includes costs of the planned East Branch Extension to provide water service to San Bernardino Valley Municipal Water District and San Gorgonio Pass Water Agency.

Both Table B-14 and Table C of the six contractors for project water service below Devil Canyon Power Plant and Castaic Power Plant include the capital costs reimbursable under the Devil Canyon-Castaic contract.

Table B-15 summarizes capital cost components of the Transportation Charge for each contractor for each year of the project repayment period. By the year 2035, the capital cost components shown in Table B-15 will recover the costs shown in Table B-14, with interest at the Project Interest Rate of 4.608 percent per annum and based on the amortization schedules included in Table 3.

Those estimated components, subsequently adjusted for prior overpayments or underpayments, are included in Table D of the water supply contracts. Costs of excess capacity are billed separately and are not included in Table B-15.

Table B-15 includes the debt service payments due from the six contractors down aqueduct from Devil Canyon Power Plant and Castaic Power Plant according to terms of the Devil Canyon-Castaic contract.

Table B-16A summarizes the minimum OMP&R components of the Transportation Charge for each year of the project repayment period. Those estimated components, subsequently adjusted for prior overpayments or underpayments, are included in Table E of the respective contracts.

The total amounts included in Table B-16A are determined by applying the proportionate-use ratios in Table B-2 to the reach costs in Table B-11.

Table 3. Criteria for Amortizing Capital Costs of Transportation Facilities

Contractor	Year of Initial Payment [a]
Alameda County Flood Control and Water Conservation District - Zone 7	1963 [b]
Alameda County Water District	1963
Antelope Valley-East Kern Water Agency	1963
Castaic Lake Water Agency	1964
City of Yuba City	[c]
Coachella Valley Water District	1964
County of Butte	[c]
County of Kings	1968
Crestline-Lake Arrowhead Water Agency	1964
Desert Water Agency	1963 [d]
Dudley Ridge Water District	1968 [e]
Empire-West Side Irrigation District	1968 [e]
Kern County Water Agency	
Agricultural Use	1968 [e]
Municipal and Industrial Use	1965
Littlerock Creek Irrigation District	1964
Metropolitan Water District of Southern California	1963
Mojave Water Agency	1964
Napa County Flood Control and Water Conservation District	1966
Oak Flat Water District	1968 [e]
Palmdale Water District	1964
Plumas County Flood Control and Water Conservation District	1970
San Bernardino Valley Municipal Water District	1963
San Gabriel Valley Municipal Water District	1963 [d]
San Gorgonio Pass Water Agency	1963 [d]
San Luis Obispo County Flood Control and Water Conservation District	1964 [f]
Santa Barbara County Flood Control and Water Conservation District	1964
Santa Clara Valley Water District	1963
Solano County Water Agency	1973
Tulare Lake Basin Water Storage District	1968 [e]
Ventura County Flood Control District	1964

[a] Allocated capital costs of transportation facilities amortized in equal annual installments unless otherwise noted.

[b] Principal payments on each annual capital cost prior to 1971 delayed until calendar year 1972, except payments for 1963.

[c] For Yuba City and Butte County payments for Delta Water Charge only.

[d] Payment deferred for 1963 and added to 1964 payment with accrued interest.

[e] For Dudley Ridge, Empire, Kern (agricultural use), Oak Flat, and Tulare, according to Article 45 of the contracts for supply of agricultural water, capital costs of transportation facilities allocated to agricultural water supply are amortized by using an equivalent unit rate per acre-foot applied to the annual allocations (Table B-4) through the project repayment period.

[f] For San Luis Obispo and Santa Barbara County, all principal and interest payments for costs of the Coastal Stub were deferred until 1976.

Table B-16A excludes charges for Off-Aqueduct Power Facilities, which are included separately in Table B-16B. Both Table B-16A and Table E include the operating costs payable under the Devil Canyon-Castaic contract for the six

contractors down aqueduct from Devil Canyon Power Plant and Castaic Power Plant.

Table 4. Minimum OMP&R Costs of Reach 31A Assigned Directly to Kern County Water Agency (in dollars)

Year	Direct Charges
1969	46,511
1970	46,302
1971	140,074
1972	95,017
1973	72,454
1974	100,692
1975	127,456
1976	138,504
1977	120,753
1978	157,652
1979	121,231
1980	150,728
1981	75,866
1982	82,805
1983	90,007
1984	107,468
1985	159,406
1986	137,241
1987	127,073
1988	130,924
1989	128,468
1990	138,234
1991	139,527
1992	185,370
1993	219,344
1994	364,196
1995	272,341
1996	322,123
Total	**3,997,767**

As part of operating agreements with DWR, Kern was billed from 1963 through 1987 for any additional operating costs caused by early installation of units in Las Perillas and Badger Hill Pumping Plants by Berrenda Mesa Water Storage District (see Bulletin 132-71, page 7). Under those agreements, a portion of minimum OMP&R costs of Reach 31A were assigned directly to Kern, as shown in Table 4, with the remaining reach costs allocated by application of the proportionate-use ratios. DWR purchased the last unit, Unit No. 6, at Las Perillas and Badger Hill Pumping Plants in early 1997 to provide pumping capacity for deliveries to Coastal Area contractors, which began in 1997. As a result of the Monterey Amendment Litigation, the costs related to this settlement are to be allocated among all SWP contractors in proportion to their maximum Table A. As costs are incurred, related charges will be included in the contractors' annual Statements of Charges as part of the minimum. It is estimated that between 2002 and 2010, the total Monterey Amendment Litigation costs will be just under $16 million.

Table B16-B summarizes the annual charges for Off-Aqueduct Power Facilities allocated to each water contractor, adjusted for prior overpayments or underpayments of charges. Those charges are to repay all Off-Aqueduct Power costs, including bond service, deposits for reserves, operation and maintenance costs, fuel costs, taxes, and insurance.

Adopted October 1, 1979, the General Bond Resolution requires that sufficient revenues be collected each year to repay all of those costs. In addition, an amount totaling 25 percent of the annual bond service is collected each year to ensure that sufficient funds are available to cover all annual costs. Any revenues collected and not needed during the year are refunded to the contractors in the next year.

Table 5 summarizes Off-aqueduct Power Facility charges and credits related to deliveries for 2005.

Table 5. Summary of Off-Aqueduct Power Facility Charges and Credits (in dollars)

Charges by Item	
Reid Gardner Power Plant	83,573,694
Bottle Rock Power Plant	14,147,680
South Geysers Power Plant	6,662,758
Subtotal	*104,384,132*
Credits by Item	
Power sales	21,323,935
Miscellaneous water (wheeling)	0
Subtotal	21,323,935
Net Total Charge	**83,060,197**

Table 6 shows projected charges for Off-Aqueduct Power Facilities and an amount equal to 25 percent of annual bond service for 2006 and each year thereafter.

The annual charges for Off-Aqueduct Power Facilities are allocated among contractors in

proportion to the electrical energy required to pump allocated water for the year. The initial allocation for the Statements of Charges is based on estimates of energy to pump requested allocated water deliveries.

Table 6. Projected Charges for Off-Aqueduct Power Facilities (in dollars)

Year	Total Annual Cost	25% Bond Cover
2006	110,217,000	8,629,583
2007	124,268,132	8,677,943
2008	135,600,482	11,530,413
2009	135,835,148	11,577,346
2010	136,657,372	11,741,790
2011	133,497,475	11,117,811
2012	133,706,645	11,159,645
2013	78,184,633	5,095,243
2014	20,080,442	4,016,404
2015	11,900,893	2,380,495
2016	10,195,501	2,039,416
2017	9,909,157	2,074,413
2018	4,210,068	947,183
2019	4,175,070	927,936
2020	4,498,201	1,007,352
2021	6,696,392	1,318,209
2022	6,354,573	1,249,845
2023	4,520,053	882,941
2024	3,292,943	637,519
2025	244,343	48,399
2026	390,273	77,585
2027	596,893	118,909
2028	504,350	100,400
2029	497,350	99,000

An interim adjustment in the allocation of Off-Aqueduct Power costs may be made in May of each year based on updated cost estimates and April revisions in water delivery schedules. An additional adjustment is made the following year based on actual water deliveries and actual costs for the year.

The energy required to pump each contractor's water is calculated using the kilowatt-hour per acre-foot factors (shown in Table 7) for the pumping plants upstream from the delivery turnouts. The amounts include transmission losses.

Table B-17 presents a summary of actual and projected total variable OMP&R costs for each acre-foot of water conveyed through each aqueduct pumping plant and power plant for each year of the project repayment period. Those data are derived according to the following

Table 7. Kilowatt-Hour per Acre-Foot Factors for Allocating Off-Aqueduct Power Facility Costs

Pumping Plant	kWh per acre-foot[a]	
	At Plant	*Cumulative from Delta*
Barker Slough	223	223
Cordelia-Benicia	434	657
Cordelia-Vallejo	178	401
Cordelia-Napa	563	786
Banks	296	296
South Bay (including Del Valle)	869	1,165
Dos Amigos	138	434
Buena Vista	242	676
Teerink	295	971
Chrisman	639	1,610
Edmonston	2,236	3,846
Pearblossom	703	4,549
Greenspot	871	5,420
Crafton Hills	1,087	6,507
Cherry Valley	224	6,731
Oso	280	4,126
Las Perillas	77	511
Badger Hill	200	711
Devil's Den	705	1,416
Bluestone	705	2,121
Polonio Pass	705	2,826

[a] Includes transmission losses

procedures specified in Article 26(a) of the Standard Provisions for calculating the variable OMP&R component of the Transportation Charge:

- An annual charge per acre-foot of projected water deliveries to all contractors served from or through each reach is determined so the projected variable OMP&R costs to be incurred for each reach will be returned to the State.
- The total annual variable OMP&R component for any contractor for a given reach is obtained by multiplying the unit charge associated with that reach by the quantity of water actually delivered from or through the reach to the contractor.

The data summarized in Table B-17 are derived by dividing the costs shown in Table B-3 by the quantities of water shown in Table B-6. However, certain costs included in Table B-3 for

extra peaking service, which would otherwise constitute variable OMP&R costs, are assigned directly to contractors requesting this type of service (see Bulletin 132-71, page 21, and Water Service Contractors Council Memo No. 593, July 10, 1970). Those costs are excluded from the unit charges shown in Table B-17. Peaking charges based on additional capacity ceased in 1983. Since 1984, costs are based on market energy rates. The amounts of extra peaking charges for additional power costs are shown in Tables 8 and 9 on pages B-18 and B-19.

The unit rates shown in Table B-17 constitute the rates for the pumping plants and power plants listed. The cumulative rates constitute the total rates, cumulative from the Sacramento-San Joaquin Delta, and are applicable to deliveries from or downstream of the pumping plants and power plants. Extra peaking service costs are excluded.

Table B-18 shows the variable OMP&R components of the Transportation Charge for each contractor for each year of the project repayment period. Table B-18 is developed from the costs per acre-foot included in Table B-17 and the delivery quantities for each contractor from each reach as indicated in Table B-5A, plus any costs for extra peaking service. Those estimated components, subsequently adjusted for prior overpayments or underpayments, are included in Table F of the respective water supply contracts.

Table B-19 summarizes the annual Transportation Charges for each contractor (the sums of the corresponding amounts included in Tables B-15, B-16A, B-16B, and B-18). Those estimated payments, subsequently adjusted for prior overpayments or underpayments, are set forth in Table G of the respective water supply contracts.

Both Table B-19 and Table G for the six contractors down-aqueduct from Devil Canyon Power Plant and Castaic Power Plant include amounts of debt service and operating cost payments due according to provisions of the Devil Canyon-Castaic contract.

Delta Water Charges

Table B-20A presents the calculation of the Delta Water Rate for the initial Conservation Facilities applicable in 2007 according to the amended Article 22(e) and 22(g) of all 29 contracts. The Delta Water Rate was calculated at a Project Interest Rate of 4.608 percent based on Conservation Facility costs shown in Table B-13. That Delta Water Rate is used to compute projected Delta Water Charges under Article 53(i) for the contractors who have executed the Monterey Amendment. Included in Table B-20A is the Delta Water Rate for the two contractors who have not executed the Monterey Amendment (Plumas County and Empire).

Table B-20B shows each component of the 2007 Delta Water Rate from Table B-20A.

Table B-21 summarizes the annual Delta Water Charge for each contractor. The projected charges in Table B-21 are developed by multiplying the total rate per acre-foot, as shown in Table B-20A, by the amount of allocated water for each contractor as shown in Table B-4.

Water System Revenue Bond Surcharge

Table B-22 summarizes the Water System Revenue Bond Surcharge to the Delta Water Charge and the Transportation capital cost component of each contractor. The surcharge shown in Table B-22 includes the financing costs of WSRB Series B through AD. This surcharge is levied according to an amendment to the water supply contracts for repaying WSRB Surcharge financing costs. All long-term water supply contractors signed that amendment.

Total Water Charges

Table B-23 summarizes the total annual charges to each contractor (the sum of the Transportation Charge in Table B-19, the Delta Water Charge in Table B-21, and the Water System Revenue Bond Surcharge in Table B-22). The charges do not reflect past payments by contractors and are unadjusted for prior overpayments or underpayments.

Table 8. Extra Peaking Charges for Additional Power, by Pumping Plant (Dollars)

Year	Cordelia Napa	Cordelia Solano	Barker Slough	South Bay	Banks	Dos Amigos	Las Perillas and Badger Hill	Buena Vista	Teerink	Chrisman	Edmonston	Pearblossom	Oso	Total
1972	0	0	0	0	0	10,579	24,700	0	0	0	0	0	0	35,279
1973	0	0	0	0	0	0	6,016	0	0	0	0	0	0	6,016
1974	0	0	0	0	0	0	7,140	0	0	0	0	0	0	7,140
1975	0	0	0	0	0	494	6,397	0	0	0	0	0	0	6,891
1976	0	0	0	0	0	0	1,981	0	0	0	0	0	0	1,981
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	45,145	3,680	0	0	0	0	0	0	48,825
1979	0	0	0	0	0	0	3,306	0	0	0	0	0	0	3,306
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	12,126	0	0	0	0	0	0	0	12,126
1982	0	0	0	0	0	89,339	0	0	0	0	0	0	0	89,339
1983	0	0	0	35	7,594	3,534	152	0	0	0	0	0	0	11,315
1984	0	0	0	2,096	84,396	38,607	7,203	11,173	3,823	3,593	0	0	0	150,891
1985	0	0	0	1,480	19,612	8,841	763	4,488	4,412	8,929	28,353	0	0	76,878
1986	0	0	0	0	1,864	863	0	291	354	766	2,683	0	0	6,821
1987	0	0	0	604	17,129	7,838	835	2,295	1,806	3,460	11,058	0	0	45,025
1988	639	39	287	894	43,475	20,082	2,213	5,792	4,367	8,272	25,886	0	0	111,946
1989	2,491	566	1,483	70	40,251	18,642	1,935	3,401	1,531	2,058	3,793	0	0	76,221
1990	45	0	18	343	19,524	9,044	0	150	145	314	643	0	0	30,226
1991	903	0	281	0	21	8	0	15	17	39	139	41	0	1,464
1992	208	117	203	0	7,070	2,502	0	182	190	435	0	0	0	10,907
1993	0	681	889	4,483	123,080	54,741	0	8,898	5,458	10,900	35,068	11,139	0	255,337
1994	0	366	393	679	6,566	2,795	454	1,083	155	357	1,121	0	132	14,101
1995	0	0	0	1,717	24,464	9,422	27	1,865	3,475	782	1,104	400	0	43,256
1996	4	0	1	1,983	10,031	4,976	0	391	432	1,015	3,404	1,160	0	23,397
1997	0	1,780	2,152	3,107	337,357	165,774	1,753	34,604	12,296	15,910	21,028	0	0	595,761
1998	0	0	0	20,966	235,693	106,251	2,354	697	848	1,836	6,426	0	0	375,071
1999	0	0	0	0	63,196	26,235	0	3,394	4,136	8,959	31,350	7,740	0	145,010
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**4,290**	**3,549**	**5,707**	**38,457**	**1,041,323**	**637,838**	**70,909**	**78,719**	**43,445**	**67,625**	**172,056**	**20,480**	**132**	**2,184,530**

Table 9. Extra Peaking Charges for Additional Power, by Contractor (Dollars)

Year	Napa	Solano	Alameda Zone 7	Alameda County	Santa Clara	Dudley Ridge	Empire	Kern County	Kings	Oak Flat	Tulare	AVEK	Castaic Lake	Coachella	Desert	Littlerock	Palmdale	San Gabriel	Total
1972	0	0	0	0	0	0	0	35,269	0	0	10	0	0	0	0	0	0	0	35,279
1973	0	0	0	0	0	0	0	6,016	0	0	0	0	0	0	0	0	0	0	6,016
1974	0	0	0	0	0	0	0	7,140	0	0	0	0	0	0	0	0	0	0	7,140
1975	0	0	0	0	0	0	0	6,891	0	0	0	0	0	0	0	0	0	0	6,891
1976	0	0	0	0	0	0	0	1,981	0	0	0	0	0	0	0	0	0	0	1,981
1977	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	2,035	0	44,484	42	0	0	2,264	0	0	0	0	0	0	48,825
1979	0	0	0	0	0	0	0	2,821	0	0	0	0	485	0	0	0	0	0	3,306
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	11,951	0	0	0	0	0	0	0	175	0	0	12,126
1982	0	0	0	0	0	2,173	0	80,945	0	0	0	4,671	1,128	0	0	0	0	422	89,339
1983	0	0	0	0	48	9,511	0	0	1,365	0	0	0	391	0	0	0	0	0	11,315
1984	0	0	0	0	2,874	0	0	144,021	281	809	0	0	2,906	0	0	0	0	0	150,891
1985	0	0	0	2,029	0	0	64	25,664	0	98	0	48,767	256	0	0	0	0	0	76,878
1986	0	0	0	0	0	0	0	0	0	13	2,194	4,614	0	0	0	0	0	0	6,821
1987	0	0	229	0	599	313	84	24,141	0	95	0	18,207	545	0	0	812	0	0	45,025
1988	892	73	665	561	0	1,853	1,404	58,905	0	72	2,368	44,526	627	0	0	0	0	0	111,946
1989	3,478	1,062	96	0	0	13	403	55,085	0	239	8,278	0	1,043	0	0	1,035	5,489	0	76,221
1990	63	0	470	0	0	0	0	28,587	0	0	0	0	0	0	0	81	1,025	0	30,226
1991	1,184	0	0	0	0	0	0	0	0	0	0	0	0	0	0	280	0	0	1,464
1992	271	257	0	0	0	0	49	10,109	221	0	0	0	0	0	0	0	0	0	10,907
1993	0	1,570	6,122	0	0	0	3,757	97,812	504	0	74,577	0	0	24,983	41,156	0	4,856	0	255,337
1994	0	759	896	0	0	0	7	9,933	0	0	0	0	2,450	0	0	56	0	0	14,101
1995	0	0	2,353	0	0	10,197	0	28,085	310	0	0	0	27	0	0	0	2,284	0	43,256
1996	5	0	81	2,612	0	334	205	4,552	969	0	7,809	0	0	0	0	0	3,598	3,232	23,397
1997	0	3,932	3,999	0	0	6,190	0	546,733	0	40	0	0	0	0	0	0	34,867	0	595,761
1998	0	0	19,666	8,442	0	22,631	1	312,626	0	651	0	0	0	0	0	0	11,054	0	375,071
1999	0	0	0	0	0	0	0	76,425	0	0	6,922	0	0	0	0	0	11,576	50,087	145,010
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**5,893**	**7,653**	**34,577**	**13,644**	**3,521**	**55,250**	**5,974**	**1,620,176**	**3,692**	**2,017**	**102,158**	**123,049**	**9,858**	**24,983**	**41,156**	**2,439**	**74,749**	**53,741**	**2,184,530**

Equivalent Total Water Charges

Table B-24 presents the Transportation Charge and Delta Water Charge in terms of the equivalent unit charge for each acre-foot of allocated water now projected for delivery to the respective contractors.

These equivalent charges would provide the same principal sum at the end of the project repayment period as annual payments to be made as part of the Delta Water Charge and Transportation Charge, plus interest at the Project Interest Rate, if applied to each acre-foot of allocated water delivered to date; all surplus water delivered prior to May 1, 1973; all interruptible water deliveries in 1994 and after; and all allocated water now projected to be delivered during the remainder of the project repayment period (Table B-5B).

The equivalent unit Delta Water Charges included in Table B-24 are greater than those in Table B-20A because current projections of allocated water service are less for most contractors than the amounts shown in Table A.

Equivalent Water Costs by Reach

Table B-25 presents a summary of the equivalent unit Transportation cost of conveying allocated water through respective aqueduct reaches of the Project Transportation Facilities.

Those unit costs provide the basis of charges assessed for extra service (such as for delivery of allocations down-aqueduct from a contractor's turnout) and for wheeling service to entities other than the long-term water supply contractors.

The cumulative unit conveyance costs indicated for reaches in Table B-25 do not necessarily equal the equivalent unit Transportation Charges to contractors served from such reaches. The unit charges in Table B-24 account for the rate of water demand buildup and cost allocation factors of the individual contractors; however, the unit costs included in Table B-25 reflect the effect of melding the respective buildups and allocation criteria of all contractors whose allocations are conveyed through a given reach. Table B-25 also includes surplus water delivered prior to May 1, 1973, and interruptible water deliveries in 1994 and after.

East Branch Enlargement Facility Charges

Table B-26 reflects DWR's projection of annual capital costs of the East Branch Enlargement Facilities for each aqueduct reach. Those projections will be redetermined in future bulletins to include:

- a reallocation of costs of constructing the present east branch facilities between Alamo Power Plant and Silverwood Lake;
- a reallocation of costs of Silverwood Lake to reflect additional use as a result of East Branch Enlargement operation;
- reallocation of costs of San Bernardino Tunnel to reflect redistribution of flow capacities necessary for the East Branch Enlargement facilities; and
- actual construction costs of the enlargement.

These costs will be recovered with interest from the seven Southern California water contractors participating in the enlargement, according to their amended water supply contracts (see Table 10).

Table B-27 lists the projected minimum OMP&R costs for each reach of the enlargement to be repaid by the seven contractors participating in the East Branch Enlargement. Currently, this table includes only minimum OMP&R costs attributable to the East Branch Enlargement. According to Article 49(e)(1), the contractors participating in the East Branch Enlargement will also share in the remaining minimum OMP&R costs of the affected reaches according to a formula developed by DWR in consultation with the affected contractors.

Table B-28 shows each participating contractor's share of the estimated capital costs of the East Branch Enlargement shown in Table B-26.

Table 10. Determination of Factors for Distributing Capital and Minimum OMP&R Costs of East Branch Enlargement Facilities among Participating Contractors

Reach Number	Description
18A	Junction, West Branch, California Aqueduct, through Alamo Power Plant
19	Alamo Power Plant to Fairmont
20A	Fairmont through 70th Street West
20B	70th Street West to Palmdale
21	Palmdale to Littlerock Creek
22A	Littlerock Creek to Pearblossom Pumping Plant
22B	Pearblossom Pumping Plant to West Fork Mojave River
23B	West Fork Mojave River to Silverwood Lake (excluding Mojave Siphon Power Plant facilities)
23C	Mojave Siphon Power Plant facilities
24	Cedar Springs Dam and Silverwood Lake
25	Silverwood Lake to South Portal, San Bernardino Tunnel
26A	South Portal, San Bernardino Tunnel through Devil Canyon Power Plant
26B	Devil Canyon Power Plant Bypass

Share of Enlargement Capacity (cfs)

Reach Number	Antelope Valley-East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	Metropolitan Water District of Southern California	Total
18A		151	13	136	6		1,200	1,506
19		151	13	136	6		1,200	1,506
20A	35	151	13	136	6		1,200	1,541
20B	35	151	13	136	6		1,200	1,541
21	35	151	13	136			1,200	1,535
22A	35	151	13	136			1,200	1,535
22B		151	13	136			1,200	1,500
23B		184	67	212			1,200	1,663
23C		184	67				1,200	1,451
24		190	78				1,200	1,468
25		193	83			63	1,200	1,539
26A		193	83			63	1,200	1,539
26B							300	300

Factors for Distributing Capital and Minimum OMP&R Costs of East Branch Enlargement Facilities (flow ratios)

Reach Number	Antelope Valley-East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	Metropolitan Water District of Southern California	Total
18A	0.00000000	0.10026560	0.00863214	0.09030544	0.00398406	0.00000000	0.79681276	1.00000000
19	0.00000000	0.10026560	0.00863214	0.09030544	0.00398406	0.00000000	0.79681276	1.00000000
20A	0.02271252	0.09798832	0.00843608	0.08825438	0.00389358	0.00000000	0.77871512	1.00000000
20B	0.02271252	0.09798832	0.00843608	0.08825438	0.00389358	0.00000000	0.77871512	1.00000000
21	0.02280130	0.09837134	0.00846906	0.08859935	0.00000000	0.00000000	0.78175895	1.00000000
22A	0.02280130	0.09837134	0.00846906	0.08859935	0.00000000	0.00000000	0.78175895	1.00000000
22B	0.00000000	0.10066667	0.00866667	0.09066667	0.00000000	0.00000000	0.79999999	1.00000000
23B	0.00000000	0.11064342	0.04028863	0.12748046	0.00000000	0.00000000	0.72158749	1.00000000
23C	0.00000000	0.12680910	0.04617505	0.00000000	0.00000000	0.00000000	0.82701585	1.00000000
24	0.00000000	0.12942779	0.05313351	0.00000000	0.00000000	0.00000000	0.81743870	1.00000000
25	0.00000000	0.12540611	0.05393112	0.00000000	0.00000000	0.04093567	0.77972710	1.00000000
26A	0.00000000	0.12540611	0.05393112	0.00000000	0.00000000	0.04093567	0.77972710	1.00000000
26B	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	1.00000000	1.00000000

Table B-29 shows the amounts of the annual capital cost components of the East Branch Enlargement Transportation Charge for each participating contractor. This component consists of each contractor's allocated share of debt service on bonds sold to finance the enlargement.

Table B-30 shows the minimum OMP&R components of the East Branch Enlargement Transportation Charge for each participating contractor for each year of the project repayment period. The amounts shown in Table B-30 will recover the minimum OMP&R costs shown in Table B-27.

Table B-31 shows the annual East Branch Enlargement Transportation charges for each participating contractor (the sum of the corresponding amounts included in Tables B-29 and B-30).

Short-Term Agreements

The long-term water supply contractors and DWR have executed short-term agreements that affects the contractors' charges. A 5-year agreement was executed in late 1997 between DWR and 16 Municipal and Industrial contractors, who agreed to pay their allocated shares of Municipal Water Quality Investigations costs. In 2002 and 2006, additional amendments were executed extending the program. The MWQI charges under this agreement are included in the Transportation minimum OMP&R components shown in Table B-16A.

Nine contractors executed a short-term agreement (1997 and 1998) to participate in the feasibility study for the American Basin conjunctive-use program. Costs of the feasibility study are included in Table B-16A.

Contractors have agreed to participate in the Delta Vision Improvement programs, which will initially incur costs for the next two to four years. Associated cost will be charged as part of Conservation.

Tables B-1 through B-6 Follow

TABLE B-1. Factors for Distributing Reach Capital Costs Among Contractors

Reach No.	Reach Description	NORTH BAY AREA		SOUTH BAY AREA				Total
		Napa County FC&WCD	Solano County WA	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Future Contractor	
	NORTH BAY AQUEDUCT							
1	Barker Slough thru Fairfield/Vacaville Turnout	0.29667896	0.70332104					1.00000000
2	Fairfield/Vacaville Turnout to Cordelia Forebay	0.38414552	0.61585448					1.00000000
3A	Cordelia Forebay thru Benicia and Vallejo Turnouts		1.00000000					1.00000000
3B	Cordelia Forebay thru Napa Turnout Reservoir	1.00000000						1.00000000
	SOUTH BAY AQUEDUCT							
1	Bethany Reservoir thru Altamont Turnout			0.22599612	0.20663021	0.49237700	0.07499667	1.00000000
2	Altamont Turnout thru Patterson Reservoir			0.22599658	0.20663059	0.49237783	0.07499500	1.00000000
4	Patterson Reservoir to Del Valle Junction			0.19504795	0.21450017	0.51113249	0.07931939	1.00000000
5	Del Valle Junction thru Lake Del Valle			0.14436367	0.12972254	0.33715573	0.38875806	1.00000000
6	Del Valle Junction thru South Livermore Turnout			0.14599918	0.21144710	0.50574745	0.13680627	1.00000000
7	South Livermore Turnout thru Vallecitos Turnout				0.25176680	0.60218448	0.14604872	1.00000000
8	Vallecitos Turnout thru Alameda-Bayside Turnout				0.27934645	0.72065355		1.00000000
9	Alameda-Bayside Turnout thru Santa Clara Terminal Facilities					1.00000000		1.00000000
	CALIFORNIA AQUEDUCT							
1	Delta thru Bethany Reservoir			0.00954737	0.00872917	0.02080118	0.00342507	N/A

Reach No.	Reach Description	CENTRAL COASTAL AREA		SOUTHERN CALIFORNIA AREA				
		San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency
	CALIFORNIA AQUEDUCT							
1	Delta thru Bethany Reservoir	0.00533010	0.00983337	0.02939084	0.01285827	0.00528315	0.00133612	0.00871300
2A	Bethany Reservoir to Orestimba Creek	0.00557213	0.01027988	0.03072531	0.01343201	0.00552068	0.00139620	0.00910474
2B	Orestimba Creek to O'Neill Forebay	0.00557824	0.01029119	0.03075915	0.01345351	0.00552831	0.00139814	0.00911733
3	O'Neill Forebay to Dos Amigos Pumping Plant	0.00557719	0.01028923	0.03075332	0.01345294	0.00552772	0.00139798	0.00911637
4	Dos Amigos Pumping Plant to Panoche Creek	0.00557607	0.01028717	0.03074719	0.01345233	0.00552710	0.00139784	0.00911536
5	Panoche Creek to Five Points	0.00557467	0.01028462	0.03073954	0.01345157	0.00552633	0.00139763	0.00911409
6	Five Points to Arroyo Pasajero	0.00557257	0.01028074	0.03072799	0.01345042	0.00552517	0.00139733	0.00911216
7	Arroyo Pasajero to Kettleman City	0.00557189	0.01027949	0.03072428	0.01345006	0.00552480	0.00139723	0.00911154
8C	Kettleman City thru Milham Avenue	0.00557103	0.01027792	0.03071961	0.01344960	0.00552432	0.00139712	0.00911076
8D	Milham Avenue thru Avenal Gap	0.00568611	0.01049020	0.03135418	0.01373353	0.00563986	0.00142632	0.00930130
9	Avenal Gap thru Twisselman Road			0.03426625	0.01356094	0.00616886	0.00156011	0.01017373
10A	Twisselman Road thru Lost Hills			0.03481391	0.01377767	0.00626946	0.00158556	0.01033963
11B	Lost Hills to 7th Standard Road			0.03835043	0.01517717	0.00691699	0.00174933	0.01140749
12D	7th Standard Road thru Elk Hills Road			0.04031661	0.01595523	0.00727790	0.00184059	0.01200265
12E	Elk Hills Road thru Tupman Road			0.04037074	0.01597665	0.00728878	0.00184332	0.01202059
13B	Tupman Road to Buena Vista Pumping Plant			0.04379882	0.01733322	0.00791595	0.00200194	0.01305492
14A	Buena Vista Pumping Plant thru Santiago Creek			0.04599268	0.01820137	0.00831952	0.00210399	0.01372049
14B	Santiago Creek thru Old River Road			0.04682530	0.01853084	0.00847388	0.00214303	0.01397505
14C	Old River Road to Wheeler Ridge Pumping Plant			0.04825217	0.01909545	0.00873768	0.00220973	0.01441013
15A	Wheeler Ridge Pumping Plant to Chrisman Pumping Plant			0.04905609	0.01941356	0.00888679	0.00224744	0.01465600
16A	Chrisman Pumping Plant to Edmonston Pumping Plant			0.05089794	0.02014241	0.00922722	0.00233351	0.01521742
17E	Edmonston Pumping Plant to Porter Tunnel			0.05329388	0.02109050	0.00967107	0.00244575	0.01594937
17F	Porter Tunnel to Junction, West Branch, Calif. Aqueduct			0.05340725	0.02113537	0.00969176	0.00245098	0.01598349
18A	Junction, West Branch, Calif. Aqueduct thru Alamo Pwp.			0.13238112		0.02399391	0.00606795	0.03957043
19	Alamo Powerplant to Fairmont			0.13237766		0.02399451	0.00606811	0.03957141
19C	Buttes Junction thru Buttes Reservoir			1.00000000				
20A	Fairmont thru 70th Street West			0.06847931		0.02576425	0.00651573	0.04249001
20B	70th Street West to Palmdale			0.02276024		0.02702917	0.00683555	0.04457607
21	Palmdale to Littlerock Creek			0.02318952		0.02754716	0.00696651	0.04543034
22A	Littlerock Creek to Pearblossom Pumping Plant			0.01181870		0.02794143	0.00706621	0.04608043
22B	Pearblossom Pumping Plant to West Fork Mojave River					0.02827552	0.00715074	0.04663153
23	West Fork Mojave River to Silverwood Lake					0.00324449	0.00818122	0.00535117
24	Cedar Springs Dam and Silverwood Lake					0.01024605	0.01251569	0.01690478
25	Silverwood Lake to South Portal San Bernardino Tunnel							
26A	South Portal, San Bernardino Tunnel thru Devil Canyon Pwp.							
28G	Devil Canyon Powerplant to Barton Road							
28H	Barton Road to Lake Perris							
28J	Perris Dam and Lake Perris							
29A	Junction, West Branch, Calif. Aqueduct thru Oso P. P.				0.03544337			
29F	Oso Pumping Plant thru Quail Embankment				0.03544339			
29G	Quail Embankment thru Warne Powerplant				0.03544339			
29H	Pyramid Dam and Lake				0.02817144			
29J	Pyramid Lake thru Castaic Powerplant				0.03544338			
30	Castaic Dam and Lake				0.02927284			
31A	Avenal Gap to Devil's Den Pumping Plant	0.10560301	0.19482503		0.07364766			
33A	Devil's Den Pumping Plant through Tank 1	0.10101221	0.89898779					
33B	Tank 1 through Chorro Valley Turnout	0.09912818	0.90087182					
34	Chorro Valley Turnout through Lopez Turnout	0.05479573	0.94520427					
35	Lopez Turnout through Guadalupe Turnout		1.00000000					

Note: Proportionate use factors **do not** reflect permanent water transfer as a result of the Monterey Amendment.

TABLE B-1. Factors for Distributing Reach Capital Costs Among Contractors

Reach No.	SAN JOAQUIN VALLEY AREA							
				Kern County Water Agency				
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Municipal and Industrial	Agricultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District
	CALIFORNIA AQUEDUCT							
1	0.01707770	0.00088678	0.00254693	0.02741768	0.30629913	0.00090695	0.00167121	0.03504975
2A	0.01781031	0.00092482	0.00266258	0.02864263	0.31945188	0.00094747	0.00174288	0.03655331
2B	0.01785838	0.00092731	0.00266550	0.02868743	0.32030556	0.00094896		0.03665201
3	0.01786337	0.00092757	0.00266499	0.02868589	0.32039254	0.00094892		0.03666225
4	0.01786863	0.00092785	0.00266446	0.02868428	0.32048398	0.00094886		0.03667303
5	0.01787517	0.00092819	0.00266380	0.02868227	0.32059816	0.00094879		0.03668649
6	0.01788508	0.00092870	0.00266279	0.02867923	0.32077093	0.00094868		0.03670685
7	0.01788826	0.00092887	0.00266246	0.02867825	0.32082633	0.00094864		0.03671338
8C	0.01789228	0.00092909	0.00266205	0.02867702	0.32089625	0.00094859		0.03672162
8D	0.01828779		0.00271703	0.02928147	0.32798200			0.01820857
9				0.03204523	0.32739538			
10A				0.03257442	0.31658608			
11B				0.03597398	0.24684668			
12D				0.03787171	0.20804762			
12E				0.03793198	0.20695175			
13B				0.01458796	0.16600071			
14A				0.00620338	0.13319181			
14B				0.00632023	0.11741558			
14C				0.00651962	0.09039633			
15A				0.00663252	0.07516317			
16A				0.00688973	0.04028829			
17E				0.00212516				
31A			0.05046240		0.57546190			

Reach No.	SOUTHERN CALIFORNIA AREA (continued)								Total
	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Municipal Water District	San Gabriel Valley Municipal Water District	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	
1	0.00049180	0.01101147	0.00369131	0.02362857	0.00650354	0.00398392	0.43929350	0.00429212	1.00000000
2A	0.00051413	0.01151136	0.00385891	0.02469101	0.00679699	0.00416304	0.45921072	0.00448701	1.00000000
2B	0.00051469	0.01152409	0.00386317	0.02472511	0.00680570	0.00416880	0.45973548	0.00449194	1.00000000
3	0.00051461	0.01152193	0.00386244	0.02472246	0.00680478	0.00416835	0.45965407	0.00449108	1.00000000
4	0.00051451	0.01151965	0.00386167	0.02471968	0.00680380	0.00416787	0.45956848	0.00449019	1.00000000
5	0.00051440	0.01151681	0.00386070	0.02471620	0.00680259	0.00416730	0.45946161	0.00448907	1.00000000
6	0.00051419	0.01151251	0.00385926	0.02471095	0.00680076	0.00416640	0.45929991	0.00448738	1.00000000
7	0.00051413	0.01151113	0.00385879	0.02470927	0.00680016	0.00416612	0.45924807	0.00448685	1.00000000
8C	0.00051405	0.01150938	0.00385821	0.02470716	0.00679941	0.00416576	0.45918261	0.00448616	1.00000000
8D	0.00052466	0.01174718	0.00393793	0.02522383	0.00694100	0.00425288	0.46868533	0.00457883	1.00000000
9	0.00057339	0.01283841	0.00430367	0.02758959	0.00758975	0.00465175	0.51227887	0.00500407	1.00000000
10A	0.00058254	0.01304366	0.00437246	0.02803943	0.00771262	0.00472760	0.52049091	0.00508405	1.00000000
11B	0.00064171	0.01436906	0.00481665	0.03093503	0.00850448	0.00521581	0.57349473	0.00560046	1.00000000
12D	0.00067463	0.01510596	0.00506361	0.03254889	0.00894541	0.00548790	0.60297374	0.00588755	1.00000000
12E	0.00067553	0.01512626	0.00507040	0.03259749	0.00895830	0.00549608	0.60379667	0.00589546	1.00000000
13B	0.00073290	0.01641098	0.00550099	0.03540212	0.00972547	0.00596896	0.65516902	0.00639604	1.00000000
14A	0.00076961	0.01723325	0.00577656	0.03720681	0.01021819	0.00627322	0.68807273	0.00671639	1.00000000
14B	0.00078354	0.01754538	0.00588113	0.03789703	0.01040613	0.00638960	0.70057530	0.00683798	1.00000000
14C	0.00080743	0.01808019	0.00606036	0.03907670	0.01072763	0.00658850	0.72199174	0.00704634	1.00000000
15A	0.00082089	0.01838154	0.00616135	0.03974336	0.01090913	0.00670088	0.73406357	0.00716371	1.00000000
16A	0.00085171	0.01907194	0.00639271	0.04126559	0.01132404	0.00695754	0.76170731	0.00743264	1.00000000
17E	0.00089182	0.01997003	0.00669365	0.04325018	0.01186455	0.00729213	0.79767940	0.00778251	1.00000000
17F	0.00089372	0.02001251	0.00670788	0.04334270	0.01188988	0.00730773	0.79937767	0.00779906	1.00000000
18A	0.00221525	0.04960424	0.01662680	0.10730448	0.02944860	0.01809192	0.57469530		1.00000000
19	0.00221522	0.04960300	0.01662640	0.10730707	0.02944876	0.01809230	0.57469556		1.00000000
19C									1.00000000
20A	0.00237800	0.05324853	0.01784830	0.11522152	0.03161798	0.01942666	0.61700971		1.00000000
20B	0.00249470	0.05586076	0.01872390	0.12087843	0.03316986	0.02038045	0.64729087		1.00000000
21	0.00254199	0.05692053		0.12319480	0.03380324	0.02077093	0.65963498		1.00000000
22A		0.05773082		0.12495766	0.03428605	0.02106816	0.66905054		1.00000000
22B		0.05842136		0.12645207	0.03469614	0.02132008	0.67705256		1.00000000
23				0.14467451	0.03969010	0.02439237	0.77446614		1.00000000
24				0.22243002	0.04339444	0.02843498	0.66607404		1.00000000
25				0.14947726	0.03997502	0.02520426	0.78534346		1.00000000
26A				0.14947726	0.03997502	0.02520426	0.78534346		1.00000000
28G				0.05126137			0.94873863		1.00000000
28H							1.00000000		1.00000000
28J							1.00000000		1.00000000
29A							0.95147783	0.01307880	1.00000000
29F							0.95147785	0.01307876	1.00000000
29G							0.95147785	0.01307876	1.00000000
29H							0.96278381	0.00904475	1.00000000
29J							0.95147787	0.01307875	1.00000000
30							0.96212388	0.00860328	1.00000000
31A									1.00000000
33A									1.00000000
									1.00000000
34									1.00000000
35									1.00000000

TABLE B-2. Factors for Distributing Reach Minimum OMP&R Costs Among Contractors

Reach No.	Reach Description	NORTH BAY AREA		SOUTH BAY AREA				Total
		Napa County FC&WCD	Solano County WA	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Future Contractor	
	NORTH BAY AQUEDUCT							
1	Barker Slough thru Fairfield/Vacaville Turnout	0.29251728	0.70748272					1.00000000
2	Fairfield/Vacaville Turnout to Cordelia Forebay	0.42000793	0.57999207					1.00000000
3A	Cordelia Forebay thru Benicia and Vallejo Turnouts		1.00000000					1.00000000
3B	Cordelia Forebay thru Napa Turnout Reservoir	1.00000000						1.00000000
	SOUTH BAY AQUEDUCT							
1	Bethany Reservoir thru Altamont Turnout			0.33980110	0.19515838	0.46504052		1.00000000
2	Altamont Turnout thru Patterson Reservoir			0.33978741	0.19516252	0.46505007		1.00000000
4	Patterson Reservoir to Del Valle Junction			0.31610985	0.20216089	0.48172926		1.00000000
5	Del Valle Junction thru Lake Del Valle			0.53312173	0.12972254	0.33715573		1.00000000
6	Del Valle Junction thru South Livermore Turnout			0.32478705	0.19906896	0.47614399		1.00000000
7	South Livermore Turnout thru Vallecitos Turnout			0.14604872	0.25176680	0.60218448		1.00000000
8	Vallecitos Turnout thru Alameda-Bayside Turnout				0.27934645	0.72065355		1.00000000
9	Alameda-Bayside Turnout thru Santa Clara Terminal Facilities					1.00000000		1.00000000
	CALIFORNIA AQUEDUCT							
1	Delta thru Bethany Reservoir				0.00870649	0.02074717		N/A

Reach No.	Reach Description	CENTRAL COASTAL AREA		SOUTHERN CALIFORNIA AREA				
		San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency
	CALIFORNIA AQUEDUCT							
1	Delta thru Bethany Reservoir	0.00531803	0.00981112	0.03024584	0.02544226	0.02816849	0.00133276	0.01137611
2A	Bethany Reservoir to Orestimba Creek	0.00557057	0.01027704	0.03167950	0.02660598	0.02949522	0.00139543	0.01191224
2B	Orestimba Creek to O'Neill Forebay	0.00557667	0.01028833	0.03171597	0.02666336	0.02953453	0.00139736	0.01192791
3	O'Neill Forebay to Dos Amigos Pumping Plant	0.00557562	0.01028637	0.03171043	0.02666656	0.02953095	0.00139720	0.01192641
4	Dos Amigos Pumping Plant to Panoche Creek	0.00557450	0.01028431	0.03170463	0.02666994	0.02952719	0.00139705	0.01192482
5	Panoche Creek to Five Points	0.00557309	0.01028175	0.03169736	0.02667416	0.02952249	0.00139687	0.01192284
6	Five Points to Arroyo Pasajero	0.00557099	0.01027787	0.03168637	0.02668054	0.02951539	0.00139656	0.01191985
7	Arroyo Pasajero to Kettleman City	0.00557031	0.01027662	0.03168285	0.02668259	0.02951311	0.00139646	0.01191888
8C	Kettleman City thru Milham Avenue	0.00551445	0.01017357	0.03136136	0.02635185	0.02920164	0.00138158	0.01179354
8D	Milham Avenue thru Avenal Gap	0.00562665	0.01038055	0.03200083	0.02691146	0.02980153	0.00141001	0.01203564
9	Avenal Gap thru Twisselman Road			0.03436980	0.02785985	0.03125286	0.00153069	0.01306310
10A	Twisselman Road thru Lost Hills			0.03490578	0.02831966	0.03174218	0.00155504	0.01326985
11B	Lost Hills to 7th Standard Road			0.03824176	0.03115437	0.03478569	0.00170600	0.01455350
12D	7th Standard Road thru Elk Hills Road			0.04009312	0.03274031	0.03647572	0.00179001	0.01526741
12E	Elk Hills Road thru Tupman Road			0.04014397	0.03279589	0.03652306	0.00179253	0.01528847
13B	Tupman Road to Buena Vista Pumping Plant			0.04343323	0.03558110	0.03952321	0.00194122	0.01655295
14A	Buena Vista Pumping Plant thru Santiago Creek			0.04552298	0.03718058	0.04143137	0.00203618	0.01735961
14B	Santiago Creek thru Old River Road			0.04617191	0.03342424	0.04202703	0.00206642	0.01761493
14C	Old River Road to Wheeler Ridge Pumping Plant			0.04735241	0.03220394	0.04310736	0.00212063	0.01807432
15A	Wheeler Ridge Pumping Plant to Chrisman Pumping Plant			0.04804398	0.03267426	0.04374004	0.00215235	0.01834317
16A	Chrisman Pumping Plant to Edmonston Pumping Plant			0.04964403	0.03376234	0.04520241	0.00222537	0.01896287
17E	Edmonston Pumping Plant to Porter Tunnel			0.05163545	0.03511660	0.04702307	0.00231640	0.01973513
17F	Porter Tunnel to Junction, West Branch, Calif. Aqueduct			0.05173926	0.03518719	0.04711769	0.00232108	0.01977493
18A	Junction, West Branch, Calif. Aqueduct thru Alamo Pwp.			0.13485569		0.11344457	0.00605083	0.05154915
19	Alamo Powerplant to Fairmont			0.13485222		0.11344290	0.00605098	0.05154980
19C	Buttes Junction thru Buttes Reservoir			1.00000000				
20A	Fairmont thru 70th Street West			0.06847930		0.12213523	0.00651583	0.05550703
20B	70th Street West to Palmdale			0.02276024		0.12812785	0.00683566	0.05823170
21	Palmdale to Littlerock Creek			0.02318952		0.13056387	0.00696663	0.05934507
22A	Littlerock Creek to Pearblossom Pumping Plant			0.01181870		0.13242454	0.00706632	0.06019328
22B	Pearblossom Pumping Plant to West Fork Mojave River					0.13400843	0.00715085	0.06091324
23	West Fork Mojave River to Silverwood Lake					0.12416451	0.00818135	0.02168414
24	Cedar Springs Dam and Silverwood Lake					0.02651510	0.01251569	0.01910229
25	Silverwood Lake to South Portal San Bernardino Tunnel					0.09751351		0.01317145
26A	South Portal, San Bernardino Tunnel thru Devil Canyon Pwp.					0.12013473		0.01622697
28G	Devil Canyon Powerplant to Barton Road					0.30672992		0.04143095
28H	Barton Road to Lake Perris					0.32330286		0.04366951
28J	Perris Dam and Lake Perris					0.32330202		0.04366970
29A	Junction, West Branch, Calif. Aqueduct thru Oso P. P.			0.00296720	0.05726734			
29F	Oso Pumping Plant thru Quail Embankment			0.00296796	0.05726649			
29G	Quail Embankment thru Warne Powerplant				0.05742327			
29H	Pyramid Dam and Lake				0.03349572			
29J	Pyramid Lake thru Castaic Powerplant				0.05740996			
30	Castaic Dam and Lake				0.03248607			
31A	Avenal Gap to Devil's Den Pumping Plant	0.10542164	0.19449108		0.07351496			
33A	Devil's Den Pumping Plant thru Tank 1	0.10101221	0.89898779					
33B	Tank 1 thru Chorro Valley Turnout	0.10101221	0.89898779					
34	Chorro Valley Turnout through Lopez Turnout	0.05271277	0.94728723					
35	Lopez Turnout throu Guadalupe Turnout		1.00000000					

Note: Proportionate use factors reflect permanent capacity water transfer that have been signed as of February 1, 2006.

TABLE B-2. Factors for Distributing Reach Minimum OMP&R Costs Among Contractors

Reach No.	SAN JOAQUIN VALLEY AREA										
							Kern County Water Agency				
	Napa County FC&WCD	Solano County WA	Alameda County FC&WCD, Zone 7	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Municipal and Industrial	Agricultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District
	CALIFORNIA AQUEDUCT										
1	0.00101503	0.00145926	0.02320270	0.01822142	0.00088480	0.00254117	0.02735295	0.27469072	0.00247193	0.00166749	0.02830375
2A	0.00106167	0.00152624	0.00868437	0.01903859	0.00092448	0.00266184	0.02863089	0.28700500	0.00258450	0.00174223	0.02957310
2B	0.00106383	0.00152939	0.00870009	0.01908995	0.00092696	0.00266476	0.02867562	0.28778222	0.00259040		0.02965288
3	0.00106393	0.00152954	0.00870024	0.01909529	0.00092722	0.00266425	0.02867409	0.28786344	0.00259080		0.02966116
4	0.00106401	0.00152968	0.00870041	0.01910089	0.00092749	0.00266370	0.02867248	0.28794882	0.00259124		0.02966986
5	0.00106413	0.00152986	0.00870062	0.01910789	0.00092783	0.00266303	0.02867046	0.28805544	0.00259177		0.02968073
6	0.00106431	0.00153014	0.00870096	0.01911848	0.00092835	0.00266203	0.02866740	0.28821677	0.00259258		0.02969716
7	0.00106438	0.00153022	0.00870107	0.01912188	0.00092852	0.00266169	0.02866642	0.28826851	0.00259284		0.02970244
8C	0.00105148	0.00151159	0.00859994	0.01886176	0.00091590	0.00263501	0.02834912	0.28434072	0.00255999		0.02929844
8D	0.00107370	0.00154358	0.00878005	0.01927090		0.00268862	0.02893698	0.29051094	0.00165734		0.01089124
9	0.00079826	0.00110157	0.00786471				0.03143148	0.29263291			
10A	0.00081139	0.00111953	0.00799211				0.03193731	0.28144288			
11B	0.00065052	0.00095254	0.00354792				0.03506894	0.21771722			
12D							0.03681479	0.18486151			
12E							0.03687019	0.18374304			
13B							0.01413733	0.14208658			
14A							0.00599913	0.10936622			
14B							0.00609042	0.10066378			
14C							0.00625275	0.07940837			
15A							0.00634765	0.06578229			
16A							0.00656553	0.03434119			
17E							0.00201100				
31A	0.00628695	0.00977801	0.02617705			0.05037550		0.43917148	0.00176551		

Reach No.	SOUTHERN CALIFORNIA AREA (continued)								
	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Municipal Water District	San Gabriel Valley Municipal Water District	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total
1	0.00049056	0.01818303	0.00458550	0.02356891	0.00648711	0.00397380	0.41547239	0.00427921	1.00000000
2A	0.00051386	0.01902951	0.00480271	0.02467716	0.00679322	0.00416065	0.43517158	0.00448242	1.00000000
2B	0.00051442	0.01906116	0.00480833	0.02471121	0.00680191	0.00416639	0.43566900	0.00448735	1.00000000
3	0.00051433	0.01906070	0.00480752	0.02470855	0.00680098	0.00416594	0.43559198	0.00448650	1.00000000
4	0.00051424	0.01906023	0.00480668	0.02470576	0.00680000	0.00416546	0.43551100	0.00448561	1.00000000
5	0.00051412	0.01905962	0.00480562	0.02470229	0.00679878	0.00416487	0.43540988	0.00448450	1.00000000
6	0.00051392	0.01905870	0.00480402	0.02469702	0.00679694	0.00416399	0.43525686	0.00448280	1.00000000
7	0.00051385	0.01905842	0.00480349	0.02469533	0.00679634	0.00416372	0.43520780	0.00448226	1.00000000
8C	0.00050870	0.01884315	0.00475451	0.02443210	0.00672541	0.00411933	0.44227753	0.00443733	1.00000000
8D	0.00051904	0.01923550	0.00485156	0.02493497	0.00686329	0.00420412	0.45134389	0.00452761	1.00000000
9	0.00056296	0.01845645	0.00526337	0.02706903	0.00744835	0.00456392	0.48981993	0.00491076	1.00000000
10A	0.00057175	0.01874332	0.00534585	0.02749934	0.00756597	0.00463648	0.49755423	0.00498733	1.00000000
11B	0.00062640	0.02052979	0.00585888	0.03016888	0.00829640	0.00508658	0.54559067	0.00546394	1.00000000
12D	0.00065673	0.02152073	0.00605960	0.03165452	0.00870248	0.00533707	0.57229756	0.00572844	1.00000000
12E	0.00065758	0.02154749	0.00606732	0.03169920	0.00871431	0.00534461	0.57307663	0.00573571	1.00000000
13B	0.00071145	0.02330931	0.00656455	0.03432822	0.00943394	0.00578787	0.62040339	0.00620565	1.00000000
14A	0.00074569	0.02442760	0.00688049	0.03600736	0.00989269	0.00607098	0.65057491	0.00650421	1.00000000
14B	0.00075633	0.02477336	0.00697864	0.03654173	0.01003745	0.00616108	0.66009578	0.00659690	1.00000000
14C	0.00077566	0.02540391	0.00715715	0.03750028	0.01029837	0.00632270	0.67725661	0.00676554	1.00000000
15A	0.00078697	0.02577340	0.00726173	0.03806102	0.01045107	0.00641723	0.68730050	0.00686434	1.00000000
16A	0.00081317	0.02662897	0.00750366	0.03935225	0.01080332	0.00663493	0.71046704	0.00709292	1.00000000
17E	0.00084580	0.02769354	0.00780477	0.04096189	0.01124220	0.00690630	0.73933042	0.00737743	1.00000000
17F	0.00084750	0.02774917	0.00782046	0.04104458	0.01126486	0.00692025	0.74082077	0.00739226	1.00000000
18A	0.00220895	0.04946256	0.01657935	0.10699871	0.02936451	0.01804030	0.47144538		1.00000000
19	0.00220892	0.04946131	0.01657891	0.10700135	0.02936470	0.01804074	0.47144817		1.00000000
19C									1.00000000
20A	0.00237800	0.05324853	0.01784830	0.11522152	0.03161788	0.01942666	0.50762172		1.00000000
20B	0.00249470	0.05586076	0.01872390	0.12087843	0.03316974	0.02038045	0.53253657		1.00000000
21	0.00254199	0.05692053		0.12319479	0.03380312	0.02077093	0.54270355		1.00000000
22A		0.05773082		0.12495766	0.03428593	0.02106816	0.55045459		1.00000000
22B		0.05842136		0.12645207	0.03469602	0.02132008	0.55703795		1.00000000
23				0.14467451	0.03969010	0.02439237	0.63721302		1.00000000
24				0.22243002	0.04339445	0.02843498	0.64760747		1.00000000
25				0.11825184	0.03722720	0.01993915	0.71389685		1.00000000
26A				0.14947726	0.03997501	0.02520426	0.64898177		1.00000000
28G				0.05126136			0.60057777		1.00000000
28H							0.63302763		1.00000000
28J							0.63302828		1.00000000
29A							0.92702291	0.01274255	1.00000000
29F							0.92702302	0.01274253	1.00000000
29G							0.92979606	0.01278067	1.00000000
29H							0.95753173	0.00897255	1.00000000
29J							0.92980918	0.01278086	1.00000000
30							0.95895422	0.00855971	1.00000000
31A		0.09301782							1.00000000
33A									1.00000000
33B									1.00000000
34									1.00000000
35									1.00000000

TABLE B-3. Power Costs and Credits, Transmission Costs, and Annual Replacement Deposits for Each Aqueduct Pumping and Power Recovery Plant [a]

(in dollars)

	NORTH BAY AQUEDUCT			SOUTH BAY AQUEDUCT	CALIFORNIA AQUEDUCT					
	Reach 1	Reach 3A	Reach 3B	Reach 1 [c]	Reach 1	Reach 4	Reach 14A	Reach 15A	Reach 16A	Reach 17E
Calendar Year	Barker Slough Pumping P.	Cordelia Pumping P. Solano	Cordelia Pumping P. Napa [b]	South Bay & Del Valle Pumping P.	Banks Pumping P.	Dos Amigos Pumping P.	Buena Vista Pumping P.	Teerink Pumping P.	Chrisman Pumping P.	Edmonston Pumping P.
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	37,731	0	0	0	0	0	0
1963	0	0	0	56,414	0	0	0	0	0	0
1964	0	0	0	71,745	0	0	0	0	0	0
1965	0	0	0	138,653	0	0	0	0	0	0
1966	0	0	0	189,402	0	0	0	0	0	0
1967	0	0	0	220,327	28,554	0	0	0	0	0
1968	0	0	7,128	339,261	1,286,777	227,505	0	0	0	0
1969	0	0	8,557	274,851	817,304	119,303	0	0	0	0
1970	0	0	13,666	439,983	330,508	193,720	2,940	0	0	0
1971	0	0	10,626	413,657	559,946	205,206	134,340	7,921	0	0
1972	0	0	14,430	615,164	1,072,833	541,628	305,868	159,125	348,235	1,179,787
1973	0	0	14,453	477,134	880,234	469,676	469,104	472,187	829,325	2,961,697
1974	0	0	17,508	502,473	959,269	536,361	514,168	553,285	993,796	3,522,973
1975	0	0	14,801	373,706	1,315,916	536,495	607,981	664,738	1,340,518	4,675,938
1976	0	0	20,867	580,607	878,728	572,326	658,261	645,377	1,360,502	4,740,176
1977	0	0	22,640	534,087	631,578	178,904	139,856	138,714	291,196	977,258
1978	0	0	21,670	559,981	3,833,011	653,606	966,756	926,444	1,728,268	6,104,186
1979	0	0	16,240	614,117	3,394,344	994,921	805,839	788,539	1,612,105	5,564,009
1980	0	0	19,936	523,445	1,981,918	818,368	857,033	846,757	1,808,192	6,269,482
1981	0	0	23,863	639,976	1,975,220	1,640,814	1,197,553	1,189,437	2,731,775	9,388,367
1982	0	0	12,078	484,808	3,405,761	1,148,258	1,159,605	1,212,973	2,557,070	9,355,533
1983	0	0	2,339	77,394	1,264,426	140,742	276,289	264,076	545,887	1,827,188
1984	0	0	4,797	289,827	1,390,432	555,409	551,468	508,111	1,044,264	3,507,659
1985	0	0	10,220	456,051	2,830,593	1,283,981	1,336,378	1,378,587	2,994,227	10,459,919
1986	0	0	15,484	827,079	7,180,656	2,282,364	2,290,023	2,343,903	5,062,706	17,643,403
1987	0	0	27,223	901,077	3,924,603	1,996,638	1,851,663	1,885,638	4,119,308	14,361,151
1988	18,112	19,927	23,868	932,456	5,377,272	2,072,091	2,100,427	2,142,121	4,724,696	16,562,202
1989	30,783	45,783	26,501	1,211,118	10,887,880	3,334,006	3,427,675	3,553,496	7,936,397	27,756,045
1990	53,484	67,109	40,793	1,881,178	9,523,541	4,754,649	5,990,489	6,327,687	14,254,357	50,152,078
1991	11,254	10,442	5,983	365,808	3,463,154	723,518	1,263,736	1,445,729	3,363,863	12,019,190
1992	14,484	13,070	9,398	327,309	2,700,240	808,067	1,071,702	1,121,273	2,503,167	8,677,102
1993	(12,340)	(8,753)	(5,393)	(159,836)	(333,548)	(609,139)	(461,719)	(459,965)	(1,018,142)	(3,558,718)
1994	54,407	39,608	29,189	823,317	4,438,900	1,938,280	2,325,005	2,375,321	5,337,101	18,723,854
1995	20,699	20,620	11,791	253,482	4,009,296	1,076,372	924,147	887,105	1,948,905	6,847,537
1996	59,545	47,288	23,483	645,189	9,531,541	3,449,781	2,444,752	2,341,848	5,156,434	18,332,558
1997	69,837	52,935	21,955	963,877	7,625,930	3,064,281	2,847,907	2,788,387	6,217,434	22,057,503
1998	(11,058)	(9,488)	(4,554)	(124,695)	296,016	(362,362)	(316,705)	(304,065)	(673,122)	(2,350,976)
1999	30,114	25,288	10,024	516,703	4,988,797	2,287,161	1,553,244	1,241,104	3,232,010	12,564,772
2000	58,591	42,543	15,078	860,785	8,018,823	3,043,577	2,963,119	3,035,444	6,985,916	25,206,823
2001	358,726	248,919	213,001	4,045,747	24,049,006	9,826,265	14,784,423	15,166,621	34,168,448	126,253,823
2002	186,186	102,222	60,093	2,190,992	16,807,227	6,740,615	8,238,545	8,538,761	19,287,643	70,880,768
2003	175,952	115,069	95,023	2,487,701	20,922,559	8,769,499	10,363,118	10,792,509	24,604,453	90,561,341
2004	242,315	134,187	103,360	2,412,375	21,053,063	9,018,396	11,887,828	12,476,791	28,497,369	104,778,231
2005	278,132	143,598	145,812	2,734,374	28,939,713	12,758,363	12,347,806	12,701,242	28,859,501	102,413,846
2006	434,350	542,507	505,614	4,307,767	33,549,833	14,706,333	16,350,132	19,169,010	40,671,891	144,330,419
2007	590,980	738,139	687,942	5,027,189	38,871,852	17,446,618	22,077,197	25,851,676	54,939,980	195,095,796
2008	690,253	862,132	803,503	5,847,863	45,999,986	19,268,723	24,159,113	28,321,071	60,145,210	213,516,519
2009	471,915	374,214	388,904	6,372,608	37,179,973	17,754,325	21,507,786	21,347,482	49,937,709	187,149,290
2010	493,421	391,422	416,605	6,650,471	46,873,631	18,790,901	22,865,042	22,693,320	53,122,285	199,115,814
2011	496,491	391,567	424,332	6,652,823	43,287,706	19,052,728	23,317,369	23,158,954	54,239,007	203,345,555
2012	514,195	404,948	448,548	6,869,338	40,874,428	19,615,395	23,942,931	23,762,637	55,653,070	208,626,569
2013	560,407	444,221	504,428	7,504,849	53,285,819	21,971,197	27,002,796	26,794,891	62,827,735	235,583,646
2014	600,883	476,875	556,466	8,033,282	48,006,529	23,899,101	29,494,794	29,262,346	68,663,917	257,507,932
2015	616,026	484,040	586,096	8,149,207	53,829,633	24,362,286	30,108,161	29,872,480	70,109,581	262,944,031
2016	628,039	488,983	611,913	8,229,208	61,030,991	24,867,340	30,858,377	30,630,396	71,914,894	269,754,725
2017	626,188	481,926	621,252	8,114,990	55,012,291	24,555,395	30,503,508	30,286,455	71,107,577	266,736,485
2018	648,839	495,855	661,961	8,340,400	53,261,487	25,033,184	30,965,041	30,719,149	72,110,589	270,457,478
2019	669,869	508,101	701,793	8,538,566	63,216,351	26,673,162	33,496,642	33,290,481	78,247,055	293,634,371
2020	642,697	480,276	679,785	8,088,278	55,552,002	24,870,075	31,095,807	30,901,927	72,588,036	272,353,992
2021	642,959	479,487	681,858	8,075,528	54,611,697	24,931,695	31,222,790	31,035,297	72,909,894	273,577,740
2022	624,138	463,956	657,583	7,824,210	50,456,450	24,097,177	30,183,194	30,011,662	70,493,638	264,512,334
2023	627,484	466,716	661,896	7,868,867	54,262,566	24,264,404	30,400,110	30,226,692	71,002,595	266,424,794
2024	649,302	484,720	690,036	8,160,210	59,907,056	25,270,792	31,673,659	31,483,793	73,972,371	277,572,996
2025	646,528	482,429	686,457	8,123,162	50,025,808	25,035,573	31,325,609	31,132,100	73,134,690	274,412,906
2026	650,736	485,903	691,887	8,179,360	62,589,049	25,404,461	31,874,475	31,686,968	74,456,792	279,401,955
2027	641,415	478,212	679,865	8,054,893	55,603,610	24,907,148	31,213,982	31,030,218	72,900,791	273,550,492
2028	645,640	481,697	685,313	8,111,316	55,081,163	27,017,012	31,407,606	31,218,882	73,344,757	275,212,510
2029	637,836	475,259	675,250	8,007,124	54,176,019	24,732,992	30,989,057	30,807,296	72,373,724	271,570,563
2030	642,716	479,286	681,543	8,072,261	56,833,870	24,952,106	31,264,952	31,079,264	73,015,818	273,980,140
2031	634,372	472,401	670,781	7,960,854	50,070,394	24,041,101	29,859,163	29,651,745	69,609,093	261,113,474
2032	646,360	482,292	686,244	8,120,937	56,884,724	25,379,100	31,928,310	31,753,716	74,626,050	280,062,751
2033	677,228	507,762	726,051	8,533,081	57,859,184	26,115,385	32,533,252	32,298,632	75,868,894	284,627,172
2034	653,549	488,224	695,514	8,216,921	56,349,428	25,704,409	32,338,344	32,158,092	75,580,908	283,646,528
2035	640,870	477,760	679,160	8,047,612	55,222,480	24,950,395	31,300,312	31,120,579	73,118,589	274,378,059
TOTAL	19,984,909	15,881,677	19,972,511	261,090,005	1,782,008,031	787,460,158	965,140,135	972,914,432	2,257,440,944	8,404,613,741

a) Starting with 2005 transmission costs that vary and depend on Power usage are included, therefore recovered through the variable component.

b) Power costs for the period 1968 through 1987 are for an interim facility.

c) The costs of Del Valle Pumping Plant are combined with those of South Bay Pumping Plant to simplify the cost allocations.

TABLE B-3. Power Costs and Credits, Transmission Costs, and Annual Replacement Deposits for Each Aqueduct Pumping and Power Recovery Plant

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									GRAND TOTAL
	Reach 18A Alamo Powerplant	Reach 22B Pearblossom Pumping Plant	Reach 23 Mojave Siphon Powerplant	Reach 26A Devil Canyon Powerplant	Reach 29A Oso Pumping Plant	Reach 29G Warne Powerplant	Reach 29J Castaic Powerplant	Reach 31A Las Perillas and Badger Hill Pumping Plants	Reach 33A Devil's Den, Bluestone and Polonio Pass Pumping Plants	
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	37.731
1963	0	0	0	0	0	0	0	0	0	56.414
1964	0	0	0	0	0	0	0	0	0	71.745
1965	0	0	0	0	0	0	0	0	0	138.653
1966	0	0	0	0	0	0	0	0	0	189.402
1967	0	0	0	0	0	0	0	0	0	248.881
1968	0	0	0	0	0	0	0	118.578	0	1,979.249
1969	0	0	0	0	0	0	0	76.920	0	1,296.935
1970	0	0	0	0	0	0	0	134.749	0	1,115.566
1971	0	0	0	0	0	0	0	168.689	0	1,500.385
1972	0	81,484	0	(3,112)	157,005	0	(385,696)	213,251	0	4,300,002
1973	0	586,209	0	(956,197)	238,650	0	(1,193,216)	120,014	0	5,369,270
1974	0	566,546	0	(963,572)	286,640	0	(1,823,397)	119,505	0	5,785,555
1975	0	587,227	0	(1,125,945)	421,687	0	(2,835,302)	92,012	0	6,669,772
1976	0	871,540	0	(1,567,312)	278,869	0	(2,512,021)	146,530	0	6,674,450
1977	0	275,980	0	(1,262,960)	17,319	0	(1,701,284)	84,225	0	327,513
1978	0	1,758,473	0	(3,345,147)	215,573	0	(2,361,377)	190,745	0	11,252,189
1979	0	1,770,844	0	(3,381,969)	122,134	0	(2,752,003)	203,143	0	9,752,263
1980	0	1,769,468	0	(3,508,195)	86,893	0	(2,728,494)	182,996	0	8,927,799
1981	0	2,049,947	0	(3,743,153)	382,330	0	(2,854,192)	189,573	0	14,811,510
1982	0	1,614,895	0	(3,149,352)	444,009	(973,898)	(3,476,126)	182,427	0	13,978,041
1983	0	301,180	0	(5,905,161)	59,561	(1,314,237)	(3,904,690)	18,936	0	(6,346,070)
1984	0	633,223	0	(7,865,341)	135,658	(2,285,362)	844,120	117,585	0	(568,150)
1985	0	1,140,057	0	(10,664,136)	739,708	(8,476,552)	(19,162,735)	155,931	0	(15,517,771)
1986	(1,080,970)	2,482,042	0	(12,235,312)	1,037,512	(6,269,528)	(11,462,662)	317,622	0	10,434,322
1987	(1,062,392)	1,822,523	0	(10,871,342)	914,642	(6,757,040)	(11,630,562)	266,825	0	1,749,955
1988	(810,907)	2,373,442	0	(14,772,519)	951,580	(7,448,747)	(12,677,211)	237,272	0	1,826,082
1989	(822,973)	4,130,250	0	(19,098,882)	1,543,985	(8,790,866)	(14,657,167)	309,851	0	20,823,882
1990	(845,641)	6,810,694	0	(21,336,948)	3,032,334	(11,692,826)	(19,863,014)	466,262	0	49,616,226
1991	(351,262)	1,306,263	0	(5,781,948)	778,874	(5,250,121)	(8,731,129)	17,608	0	4,660,962
1992	(997,736)	1,116,809	0	(9,903,370)	541,093	(5,955,563)	(9,599,392)	111,742	0	(7,440,605)
1993	(84,856)	(370,935)	0	(7,956,659)	(244,261)	(4,607,075)	(9,740,511)	(122,190)	0	(29,754,040)
1994	(93,031)	2,529,462	0	(12,122,861)	1,039,474	(6,228,273)	(10,867,596)	226,378	(1,127)	10,567,408
1995	(1,297,179)	951,513	0	(10,256,635)	342,312	(3,827,718)	(7,403,219)	261,423	0	(5,229,549)
1996	(2,959,744)	2,725,712	(941,959)	(13,155,960)	908,180	(5,026,221)	(8,969,945)	321,137	0	14,933,619
1997	(2,876,697)	3,431,693	(1,932,337)	(13,519,660)	990,932	(5,184,788)	(9,027,058)	322,753	208,816	18,123,700
1998	(2,244,105)	(439,496)	(1,385,473)	(10,955,475)	(66,088)	(1,888,975)	(4,963,075)	(56,675)	(87,016)	(25,947,387)
1999	(2,811,928)	1,779,376	(2,482,354)	(14,772,635)	666,901	(5,526,541)	(9,954,674)	156,194	234,077	(6,262,367)
2000	(5,129,549)	3,965,245	(4,429,149)	(25,857,029)	1,215,093	(9,464,490)	(17,958,033)	231,108	380,555	(6,815,550)
2001	(3,298,048)	18,936,837	(3,649,034)	(19,510,279)	6,409,025	(7,987,833)	(13,981,232)	1,080,182	2,152,324	209,266,921
2002	(4,926,146)	10,444,621	(5,255,302)	(24,676,762)	3,719,061	(10,286,902)	(18,455,024)	529,085	1,320,943	85,446,626
2003	(3,431,664)	14,432,726	(6,760,773)	(28,047,969)	4,378,568	(10,281,922)	(17,307,974)	621,149	1,482,405	123,971,770
2004	(6,227,543)	16,376,616	(7,691,607)	(31,246,141)	5,297,989	(12,033,953)	(20,022,179)	651,104	1,718,113	137,426,314
2005	(6,140,331)	18,183,010	(6,778,759)	(30,599,808)	4,111,678	(8,251,156)	(13,698,272)	826,136	1,669,939	160,644,824
2006	(3,764,700)	23,462,935	(7,175,900)	(26,680,000)	7,428,524	(11,210,000)	(19,709,600)	1,163,771	2,964,936	241,047,822
2007	(4,373,715)	30,115,761	(6,756,637)	(25,406,557)	10,742,147	(11,778,965)	(20,915,620)	1,615,020	4,711,056	339,279,859
2008	(6,189,900)	33,639,787	(9,073,900)	(34,110,000)	11,452,528	(15,487,500)	(26,930,000)	1,714,091	4,269,285	358,898,764
2009	(5,582,798)	28,046,158	(6,526,500)	(31,566,025)	10,798,203	(15,056,975)	(25,235,050)	2,060,870	5,630,664	305,052,753
2010	(5,630,503)	30,037,151	(6,596,625)	(31,860,925)	11,368,480	(15,179,275)	(25,547,250)	2,147,558	5,889,638	336,041,161
2011	(5,676,281)	30,367,489	(6,650,250)	(32,188,175)	11,735,942	(15,783,600)	(26,489,900)	2,148,291	5,891,827	337,721,875
2012	(5,769,388)	31,832,503	(6,829,725)	(32,405,200)	11,743,121	(15,166,000)	(25,589,750)	2,215,693	6,093,187	346,836,500
2013	(5,758,155)	35,872,660	(6,846,000)	(32,831,750)	13,191,807	(15,745,900)	(26,533,450)	2,413,537	6,684,231	406,926,969
2014	(5,782,172)	38,710,496	(6,862,800)	(32,782,050)	14,533,787	(16,350,900)	(27,474,150)	2,578,042	7,175,687	440,248,065
2015	(5,871,801)	40,142,387	(7,063,725)	(33,390,200)	14,599,172	(16,195,075)	(27,196,050)	2,614,131	7,283,496	455,983,876
2016	(5,934,499)	41,397,662	(7,156,875)	(34,005,575)	14,899,964	(16,378,000)	(27,521,050)	2,639,035	7,357,905	474,313,433
2017	(5,889,990)	40,650,842	(7,174,350)	(33,978,600)	14,859,536	(16,553,625)	(27,844,950)	2,603,479	7,251,675	461,970,084
2018	(5,952,829)	42,026,567	(7,497,975)	(34,012,075)	14,716,265	(15,866,450)	(26,739,700)	2,673,652	7,461,317	469,502,755
2019	(5,999,923)	44,031,274	(7,434,300)	(34,727,425)	16,605,791	(17,564,050)	(29,744,150)	2,735,345	7,645,616	514,524,569
2020	(5,968,950)	41,544,900	(7,439,925)	(34,666,150)	15,186,007	(16,962,875)	(28,605,000)	2,595,164	7,226,835	470,162,881
2021	(5,995,458)	41,657,103	(7,505,625)	(34,811,350)	15,289,894	(17,103,250)	(28,864,150)	2,591,196	7,214,975	470,642,280
2022	(6,023,188)	40,097,764	(7,496,625)	(34,809,700)	14,887,951	(17,179,400)	(28,996,400)	2,512,957	6,981,242	449,298,943
2023	(6,038,651)	40,457,982	(7,534,575)	(34,804,325)	14,963,422	(17,170,050)	(28,980,700)	2,526,859	7,022,777	456,648,863
2024	(6,012,989)	42,254,501	(7,548,000)	(34,803,550)	15,507,613	(17,174,325)	(28,988,450)	2,617,557	7,293,730	483,011,022
2025	(5,984,836)	41,481,835	(7,450,050)	(34,514,225)	15,438,958	(17,174,375)	(28,988,500)	2,606,023	7,259,276	467,679,368
2026	(6,048,709)	42,714,696	(7,632,075)	(35,124,800)	15,543,198	(17,174,325)	(28,988,450)	2,623,519	7,311,547	488,646,187
2027	(6,006,644)	41,537,726	(7,471,275)	(34,768,475)	15,336,903	(17,206,350)	(29,039,650)	2,584,773	7,195,788	471,223,422
2028	(5,985,400)	41,864,710	(7,494,675)	(34,815,075)	15,392,376	(17,146,300)	(28,938,450)	2,602,335	7,248,262	475,933,679
2029	(5,995,317)	41,260,171	(7,507,125)	(34,810,950)	15,223,639	(17,174,300)	(28,988,500)	2,569,899	7,151,359	466,173,996
2030	(5,985,494)	41,638,163	(7,494,825)	(34,815,050)	15,344,555	(17,174,350)	(28,988,550)	2,590,178	7,211,943	473,328,526
2031	(5,989,113)	40,640,717	(7,813,125)	(34,452,000)	14,252,885	(16,066,325)	(27,113,650)	2,555,496	7,108,328	447,206,591
2032	(6,059,237)	41,989,327	(7,908,300)	(34,774,175)	15,906,565	(17,670,050)	(29,942,350)	2,605,331	7,257,209	481,974,804
2033	(6,024,927)	44,226,118	(7,942,800)	(34,611,900)	15,488,615	(16,256,200)	(27,577,100)	2,733,636	7,640,513	497,422,596
2034	(6,054,396)	42,483,681	(7,981,350)	(34,688,400)	16,111,895	(17,689,125)	(29,983,550)	2,635,212	7,346,477	488,012,361
2035	(6,056,370)	41,725,361	(7,716,375)	(35,001,675)	15,365,079	(17,192,050)	(29,116,400)	2,582,504	7,189,011	471,714,901
TOTAL	(221,899,035)	1,284,903,903	(262,889,034)	(1,390,336,103)	465,069,742	(643,640,552)	(1,123,386,862)	82,145,929	211,048,821	13,887,523,352

TABLE B-4. Annual Table A Amounts to Project Water

(in acre-feet)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA [a]				CENTRAL COASTAL AREA		
	Napa [b] County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	507	5,248	5,783	11,538	0	0	0
1968	0	0	0	6,900	15,000	88,000	109,900	0	0	0
1969	0	0	0	8,200	15,500	75,000	98,700	0	0	0
1970	0	0	0	10,000	16,200	88,000	114,200	0	0	0
1971	0	0	0	11,200	17,000	88,000	116,200	0	0	0
1972	0	0	0	12,400	17,900	88,000	118,300	0	0	0
1973	0	0	0	13,600	18,800	88,000	120,400	0	0	0
1974	0	0	0	14,800	19,600	88,000	122,400	0	0	0
1975	0	0	0	16,000	20,500	88,000	124,500	0	0	0
1976	0	0	0	17,200	21,300	88,000	126,500	0	0	0
1977	0	0	0	18,400	22,200	88,000	128,600	0	0	0
1978	0	0	0	19,600	23,100	88,000	130,700	0	0	0
1979	0	0	0	20,800	23,900	88,000	132,700	0	0	0
1980	0	500	500	22,000	24,800	88,000	134,800	1,000	946	1,946
1981	0	650	650	23,000	26,000	88,000	137,000	1,000	1,813	2,813
1982	0	800	800	24,000	27,200	88,000	139,200	2,000	3,626	5,626
1983	0	950	950	25,000	28,400	88,000	141,400	3,000	5,439	8,439
1984	0	1,100	1,100	26,000	29,600	88,000	143,600	4,500	8,198	12,698
1985	0	1,250	1,250	27,000	30,800	88,000	145,800	7,500	13,638	21,138
1986	0	1,400	1,400	28,000	32,100	88,000	148,100	10,000	18,210	28,210
1987	0	1,550	1,550	29,000	33,300	88,000	150,300	12,500	22,704	35,204
1988	5,745	9,726	15,471	30,000	34,500	88,000	152,500	15,500	28,222	43,722
1989	6,195	18,420	24,615	31,000	35,700	90,000	156,700	20,000	36,342	56,342
1990	6,940	21,250	28,190	32,000	36,900	92,000	160,900	25,000	45,486	70,486
1991	7,290	22,300	29,590	34,000	38,400	94,000	166,400	25,000	45,486	70,486
1992	7,840	24,170	32,010	36,000	39,900	96,000	171,900	25,000	45,486	70,486
1993	8,490	26,130	34,620	38,000	41,400	98,000	177,400	25,000	45,486	70,486
1994	9,135	28,080	37,215	40,000	42,000	100,000	182,000	25,000	45,486	70,486
1995	9,780	34,250	44,030	42,000	42,000	100,000	184,000	25,000	45,486	70,486
1996	10,425	37,800	48,225	44,000	42,000	100,000	186,000	25,000	45,486	70,486
1997	11,065	38,250	49,315	46,000	42,000	100,000	188,000	6,215	38,986	45,201
1998	11,710	38,710	50,420	46,000	42,000	100,000	188,000	6,215	38,986	45,201
1999	15,850	39,170	55,020	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2000	16,325	39,620	55,945	68,000	42,000	100,000	210,000	25,000	45,486	70,486
2001	20,725	45,836	66,561	78,000	42,000	100,000	220,000	25,000	45,486	70,486
2002	21,100	46,296	67,396	78,000	42,000	100,000	220,000	25,000	45,486	70,486
2003	21,475	46,756	68,231	78,400	42,000	100,000	220,400	25,000	45,486	70,486
2004	21,850	47,206	69,056	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2005	22,225	47,256	69,481	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2006	22,550	47,306	69,856	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2007	22,875	47,356	70,231	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2008	23,200	47,406	70,606	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2009	23,525	47,456	70,981	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2010	23,850	47,506	71,356	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2011	24,175	47,556	71,731	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2012	24,500	47,606	72,106	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2013	24,775	47,656	72,431	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2014	25,150	47,706	72,856	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2015	25,825	47,756	73,581	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2016	26,450	47,756	74,206	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2017	27,075	47,756	74,831	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2018	27,700	47,756	75,456	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2019	28,325	47,756	76,081	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2020	28,925	47,756	76,681	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2021	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2022	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2023	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2024	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2025	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2026	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2027	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2028	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2029	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2030	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2031	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2032	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2033	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2034	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2035	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
TOTAL	1,048,440	2,049,856	3,098,296	3,720,815	2,459,248	6,510,783	12,690,846	1,189,430	2,218,494	3,407,924

a) Table A amounts for the South Bay area were supplied by non-Project water from June 1962 through November 1967. Actual delivery quantities of Project water are shown for 1967.

b) District's Table A amounts exclude the amounts supplied by non-Project water from 1968 through 1987.

TABLE B-4. Annual Table A Amounts to Project Water

(in acre-feet)

Calendar Year	SAN JOAQUIN VALLEY AREA								
			Kern County Water Agency						
	Dudley Ridge Water District	Empire West Side Irrigation District	Municipal and Industrial	Agricultural	Total	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	14,300	1,000	0	46,600	46,600	900	2,300	12,250	77,350
1969	14,325	3,000	0	95,700	95,700	1,200	2,500	46,350	163,075
1970	15,700	3,000	28,700	116,400	145,100	1,300	2,600	34,300	202,000
1971	17,900	3,000	35,700	154,600	190,300	1,300	2,800	36,500	251,800
1972	20,000	3,000	39,200	231,500	270,700	1,400	5,366	112,600	413,066
1973	22,000	3,000	43,500	267,000	310,500	1,500	3,100	43,552	383,652
1974	33,390	3,000	48,000	299,000	347,000	1,500	3,471	72,289	460,650
1975	40,555	3,000	52,700	358,120	410,820	1,600	3,576	86,258	545,809
1976	30,921	3,000	56,100	386,050	442,150	1,600	4,039	61,707	543,417
1977	30,400	3,000	60,600	423,000	483,600	1,700	3,700	59,000	581,400
1978	32,500	0	64,100	470,200	534,300	1,900	3,900	63,300	635,900
1979	38,544	3,000	67,600	516,300	583,900	2,000	4,000	71,241	702,685
1980	41,000	3,000	71,100	563,400	634,500	2,200	5,700	71,700	758,100
1981	41,000	3,000	74,800	616,600	691,400	2,300	4,300	76,000	818,000
1982	41,000	3,000	79,600	665,700	745,300	2,500	4,500	80,200	876,500
1983	42,900	3,000	83,500	721,600	805,100	2,800	3,770	9,548	867,118
1984	45,100	3,000	103,600	757,000	860,600	3,100	4,800	62,611	979,211
1985	47,200	3,000	108,900	806,100	915,000	3,400	4,900	45,549	1,019,049
1986	49,300	3,000	113,400	820,246	933,646	3,700	5,100	97,200	1,091,946
1987	51,400	3,000	119,100	904,400	1,023,500	4,000	5,200	101,400	1,188,500
1988	53,500	3,000	123,900	950,700	1,074,600	4,000	5,400	105,600	1,246,100
1989	55,600	3,000	128,200	984,100	1,112,300	4,000	5,600	109,900	1,290,400
1990	28,850	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,313,450
1991	53,411	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,338,011
1992	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1993	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1994	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1995	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1996	53,370	3,000	134,600	982,460	1,117,060	4,000	5,700	118,500	1,301,630
1997	53,370	3,000	134,600	978,130	1,112,730	4,000	5,700	118,500	1,297,300
1998	53,370	3,000	134,600	953,130	1,087,730	4,000	5,700	118,500	1,272,300
1999	53,370	3,000	134,600	953,130	1,087,730	4,000	5,700	118,500	1,272,300
2000	53,370	3,000	134,600	886,130	1,020,730	4,000	5,700	118,500	1,205,300
2001	53,370	3,000	134,600	866,349	1,000,949	4,000	5,700	118,500	1,185,519
2002	57,343	3,000	134,600	866,349	1,000,949	4,000	5,700	111,527	1,182,519
2003	57,343	3,000	134,600	866,349	1,000,949	4,000	5,700	111,127	1,182,119
2004	57,343	3,000	134,600	864,130	998,730	9,000	5,700	96,227	1,170,000
2005	57,343	3,000	134,600	864,130	998,730	9,000	5,700	96,227	1,170,000
2006	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2007	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2008	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2009	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2010	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2011	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2012	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2013	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2014	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2015	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2016	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2017	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2018	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2019	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2020	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2021	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2022	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2023	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2024	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2025	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2026	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2027	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2028	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2029	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2030	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2031	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2032	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2033	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2034	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2035	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
TOTAL	3,361,478	199,000	7,693,900	52,271,303	59,965,203	403,050	352,822	6,173,823	70,455,376

TABLE B-4. Annual Table A Amounts to Project Water

(in acre-feet)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	3,700	0	0	0	0	0	0	0	0
1969	0	5,000	0	0	0	0	0	0	0	0
1970	0	5,700	0	0	0	0	0	0	0	0
1971	0	6,700	0	0	0	0	0	0	0	0
1972	20,000	8,936	5,200	526	8,000	170	8,400	1,620	1,677	122
1973	25,000	12,400	5,800	870	9,000	290	10,700	2,940	48,000	11,500
1974	30,000	15,400	6,400	1,160	10,000	400	13,100	4,260	50,000	12,300
1975	35,000	18,200	7,000	1,450	11,000	520	15,400	5,580	52,500	13,100
1976	44,000	21,200	7,600	1,740	12,000	640	17,800	6,900	55,000	14,000
1977	50,000	24,100	8,421	2,030	13,000	730	20,200	8,220	57,500	14,800
1978	57,000	24,762	9,242	2,320	14,000	920	0	9,340	60,000	15,700
1979	63,000	28,000	10,063	2,610	15,000	1,040	24,900	10,260	62,500	16,600
1980	69,200	30,400	10,884	2,900	17,000	1,150	27,200	11,180	65,500	17,400
1981	75,000	32,800	12,105	3,190	19,000	1,270	23,100	11,700	68,500	18,300
1982	81,300	34,800	13,326	3,480	21,000	1,380	22,843	12,320	71,500	19,100
1983	87,700	37,300	14,547	3,770	23,000	1,500	34,300	12,940	74,500	19,900
1984	35,000	39,600	15,768	4,060	25,000	1,610	36,700	13,560	78,000	20,700
1985	40,000	41,800	16,989	4,350	27,000	1,730	39,000	14,180	81,500	21,800
1986	42,000	43,600	18,210	4,640	29,000	1,840	41,400	14,800	85,000	23,200
1987	44,000	45,600	19,431	4,930	31,500	1,960	43,700	15,420	89,000	24,600
1988	46,000	48,000	20,652	5,220	34,000	2,070	46,000	16,040	93,000	26,000
1989	125,700	50,100	21,873	5,510	36,500	2,190	48,500	16,660	97,000	27,400
1990	132,100	52,000	23,100	5,800	38,100	2,300	50,800	17,300	101,500	28,800
1991	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1992	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1993	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1994	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1995	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1996	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1997	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1998	138,400	54,200	23,100	5,800	38,100	2,300	75,800	17,300	102,600	28,800
1999	138,400	54,200	23,100	5,800	38,100	2,300	75,800	17,300	102,600	28,800
2000	138,400	95,200	23,100	5,800	38,100	2,300	75,800	21,300	102,600	28,800
2001	138,400	95,200	23,100	5,800	38,100	2,300	75,800	21,300	102,600	28,800
2002	141,400	95,200	23,100	5,800	38,100	2,300	75,800	21,300	102,600	28,800
2003	141,400	95,200	23,100	5,800	38,100	2,300	75,800	21,300	102,600	28,800
2004	141,400	95,200	33,000	5,800	38,100	2,300	75,800	21,300	102,600	28,800
2005	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2006	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2007	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2008	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2009	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2010	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2011	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2012	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2013	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2014	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2015	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2016	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2017	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2018	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2019	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2020	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2021	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2022	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2023	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2024	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2025	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2026	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2027	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2028	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2029	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2030	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2031	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2032	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2033	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2034	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2035	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
TOTAL	7,432,000	4,545,098	4,334,011	321,556	2,476,500	127,210	3,760,043	1,127,720	5,909,177	1,641,322

TABLE B-4. Annual Table A Amounts to Project Water

(in acre-feet)

Calendar Year	SOUTHERN CALIFORNIA AREA				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	11,538
1968	0	0	0	3,700	0	300	250	550	0	191,500
1969	0	0	0	5,000	0	350	270	620	0	267,395
1970	0	0	0	5,700	0	400	300	700	0	322,600
1971	0	0	0	6,700	0	450	440	890	0	375,590
1972	0	154,772	0	209,423	0	500	470	970	0	741,759
1973	0	354,600	0	481,100	0	600	500	1,100	0	986,252
1974	0	454,900	0	597,920	0	700	530	1,230	0	1,182,200
1975	0	555,200	0	714,950	0	1,050	560	1,610	0	1,386,869
1976	0	655,600	0	836,480	0	1,400	590	1,990	0	1,508,387
1977	0	755,900	0	954,901	0	1,800	620	2,420	0	1,667,321
1978	0	856,300	0	1,049,584	0	1,200	650	1,850	0	1,818,034
1979	0	956,600	0	1,190,573	0	1,450	680	2,130	0	2,028,088
1980	6,800	1,057,000	1,000	1,317,614	0	1,100	710	1,810	0	2,214,770
1981	7,800	1,157,300	2,000	1,432,065	0	1,200	740	1,940	0	2,392,468
1982	8,800	1,257,600	3,000	1,550,449	0	1,200	770	1,970	0	2,574,545
1983	9,800	1,358,000	4,000	1,681,257	0	1,200	800	2,000	0	2,701,164
1984	10,800	1,458,300	5,000	1,744,098	1,600	1,200	830	3,630	0	2,884,337
1985	11,800	1,558,700	6,000	1,864,849	1,700	1,200	860	3,760	0	3,055,846
1986	12,900	1,659,300	8,000	1,983,890	2,100	1,200	890	4,190	0	3,257,736
1987	14,000	1,759,800	10,000	2,103,941	2,500	1,200	920	4,620	0	3,484,115
1988	15,100	1,860,400	13,000	2,225,482	2,900	1,200	960	5,060	0	3,688,335
1989	16,200	1,961,000	16,000	2,424,633	3,300	1,200	1,000	5,500	0	3,958,190
1990	17,300	2,011,500	20,000	2,500,600	3,800	1,200	1,040	6,040	0	4,079,666
1991	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,080	11,880	0	4,126,567
1992	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,120	11,920	0	4,138,816
1993	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,160	11,960	0	4,146,966
1994	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,200	12,000	0	4,154,201
1995	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,250	12,050	0	4,163,066
1996	0	2,011,500	20,000	2,492,900	9,600	1,200	1,300	12,100	0	4,111,341
1997	0	2,011,500	20,000	2,492,900	9,600	1,200	1,350	12,150	0	4,084,866
1998	0	2,011,500	20,000	2,517,900	9,600	1,200	1,400	12,200	0	4,086,021
1999	2,000	2,011,500	20,000	2,519,900	9,600	2,890	1,450	13,940	0	4,119,646
2000	3,000	2,011,500	20,000	2,565,900	9,600	2,890	1,510	14,000	0	4,121,631
2001	4,000	2,011,500	20,000	2,566,900	9,600	3,500	1,570	14,670	0	4,124,136
2002	4,000	2,011,500	20,000	2,569,900	9,600	3,500	1,630	14,730	0	4,125,031
2003	5,000	2,011,500	20,000	2,570,900	9,600	3,500	1,690	14,790	0	4,126,926
2004	6,000	2,011,500	20,000	2,581,800	9,600	3,500	0	13,100	0	4,127,061
2005	6,500	1,911,500	20,000	2,582,300	9,600	1,200	0	10,800	0	4,125,686
2006	7,000	1,911,500	20,000	2,582,800	9,600	1,200	324	11,124	0	4,126,885
2007	7,500	1,911,500	20,000	2,583,300	9,600	27,500	720	37,820	0	4,154,456
2008	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,020	39,120	0	4,165,931
2009	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,090	39,190	0	4,166,376
2010	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,160	39,260	0	4,166,821
2011	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,240	39,340	0	4,167,276
2012	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,320	39,420	0	4,167,731
2013	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,410	39,510	0	4,168,146
2014	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,500	39,600	0	4,168,661
2015	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,600	39,700	0	4,169,486
2016	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,170,211
2017	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,170,836
2018	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,171,461
2019	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,086
2020	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,686
2021	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2022	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2023	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2024	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2025	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2026	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2027	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2028	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2029	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2030	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2031	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2032	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2033	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2034	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2035	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
TOTAL	747,200	109,260,272	988,000	142,670,109	449,900	852,580	106,474	1,408,954	0	233,731,505

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	Grizzly Valley Pipeline PC FC&WCD	NORTH BAY AQUEDUCT Reach 1 SCWA	Reach 3A SCWA	Reach 3B NC [a] FC&WCD	Total	SOUTH BAY AQUEDUCT Reach 1 ACWD	Reach 1 AC FC&WCD	Reach 2 AC FC&WCD	Reach 4 AC FC&WCD	Reach 5 ACWD	Reach 5 AC FC&WCD
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1962	0	0	0	0	0	8,412	141	353	0	0	0
1963	0	0	0	0	0	10,914	814	917	0	0	0
1964	0	0	0	0	0	19,238	248	1,425	0	0	0
1965	0	0	0	0	0	15,280	637	1,830	138	0	0
1966	0	0	0	0	0	0	2,475	2,537	499	0	0
1967	0	0	0	0	0	0	1,527	2,391	862	0	0
1968	0	0	0	1,214	1,214	0	1,608	3,799	721	0	5
1969	0	0	0	2,687	2,687	0	1,165	3,459	1,851	0	160
1970	70	0	0	3,618	3,618	0	1,345	4,558	3,182	0	164
1971	64	0	0	2,521	2,521	0	546	1,908	2,403	0	160
1972	505	0	0	3,647	3,647	0	1,066	4,605	2,041	1,489	2,777
1973	679	0	0	3,792	3,792	0	430	1,123	1,193	0	229
1974	648	0	0	4,870	4,870	0	177	0	975	0	162
1975	405	0	0	6,840	6,840	0	137	1,783	1,864	0	120
1976	382	0	0	7,122	7,122	0	265	7,204	3,384	0	817
1977	303	0	0	8,226	8,226	0	210	4,491	2,213	0	524
1978	278	0	0	6,034	6,034	0	422	2,426	3,754	0	2,034
1979	329	0	0	6,561	6,561	0	197	4,283	5,567	0	3,937
1980	295	0	0	6,707	6,707	0	77	3,883	6,686	1,508	0
1981	355	0	0	9,001	9,001	0	1,250	4,648	5,273	5,752	1,157
1982	305	0	0	1,213	1,213	0	473	3,043	4,406	0	630
1983	262	0	0	2,287	2,287	0	179	2,712	1,714	0	50
1984	272	0	0	2,923	2,923	0	165	4,219	2,219	0	55
1985	254	0	0	4,039	4,039	0	213	5,199	2,060	0	63
1986	317	1,400	0	3,519	4,919	0	200	6,052	2,062	0	212
1987	452	1,550	0	7,693	9,243	0	218	7,538	2,372	0	285
1988	523	1	9,725	5,392	15,118	0	222	8,302	4,681	0	189
1989	486	10	17,246	6,195	23,451	0	222	8,051	6,562	0	418
1990	548	3,275	15,856	6,940	26,071	0	256	8,160	8,347	0	593
1991	420	3,117	3,855	1,380	8,352	0	162	3,676	3,269	0	359
1992	485	5,553	9,220	4,001	18,774	0	217	5,177	2,188	0	154
1993	444	14,709	14,471	5,286	34,466	0	190	5,843	8,430	1,650	5,964
1994	492	10,343	14,913	6,792	32,048	0	132	4,482	5,427	0	822
1995	308	5,452	15,893	5,182	26,527	0	278	6,236	7,195	0	955
1996	360	12,930	17,069	4,893	34,892	0	277	6,151	5,119	0	388
1997	231	16,029	17,501	4,341	37,871	0	138	6,647	6,501	1,323	1,582
1998	0	11,562	18,204	5,359	35,125	0	106	3,748	2,493	0	1,277
1999	0	15,191	19,562	5,304	40,057	0	148	3,048	8,227	0	1,444
2000	0	15,490	21,525	4,958	41,973	0	110	7,464	9,761	0	946
2001	0	14,849	19,737	9,345	43,931	0	105	7,822	4,879	0	3,010
2002	0	18,841	19,719	6,875	45,435	0	93	7,758	11,619	0	2,446
2003	0	17,260	16,691	7,646	41,597	0	108	7,916	11,348	0	2,887
2004	0	20,951	22,051	8,134	51,136	0	72	11,754	9,737	0	3,763
2005	0	18,290	19,529	7,669	45,488	0	1,430	11,520	10,100	0	1,826
2006	270	18,904	29,212	15,708	63,824	0	605	11,163	12,327	0	4,245
2007	600	19,870	20,975	17,000	57,845	0	112	12,960	17,492	0	4,327
2008	630	43,548	20,975	24,975	89,498	0	11,395	9,798	26,204	0	4,327
2009	2,090	40,831	6,625	23,525	70,981	0	11,395	9,798	26,204	0	4,327
2010	2,160	40,881	6,625	23,850	71,356	0	15,362	9,048	25,255	0	4,327
2011	2,240	29,406	18,150	24,175	71,731	0	2,994	15,717	33,132	0	2,552
2012	2,320	29,456	18,150	24,500	72,106	0	2,994	15,717	33,132	0	2,552
2013	2,410	29,506	18,150	24,775	72,431	0	2,994	15,717	33,132	0	2,552
2014	2,500	29,556	18,150	25,150	72,856	0	2,994	15,717	33,132	0	2,552
2015	2,600	29,606	18,150	25,825	73,581	0	2,994	15,717	33,132	0	2,552
2016	2,700	29,606	18,150	26,450	74,206	0	2,994	15,717	33,132	0	2,552
2017	2,700	29,606	18,150	27,075	74,831	0	2,994	15,717	33,132	0	2,552
2018	2,700	29,606	18,150	27,700	75,456	0	2,994	15,717	33,132	0	2,552
2019	2,700	29,606	18,150	28,325	76,081	0	2,994	15,717	33,132	0	2,552
2020	2,700	29,606	18,150	28,925	76,681	0	2,994	15,717	33,132	0	2,552
2021	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2022	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2023	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2024	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2025	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2026	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2027	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2028	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2029	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2030	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2031	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2032	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2033	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2034	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
2035	2,700	29,606	18,150	29,025	76,781	0	2,994	15,717	33,132	0	2,552
TOTAL	82,292	1,110,487	830,929	1,003,539	2,944,955	53,844	134,170	655,833	1,119,104	11,722	127,917

a) Non-Project water deliveries were pumped from an interim facility from 1968 through 1987.

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	SOUTH BAY AQUEDUCT[b] (Continued)						CALIFORNIA AQUEDUCT NORTH SAN JOAQUIN DIVISION				
	Reach 6	Reach 7		Reach 8	Reach 9	Total	Reach 1	Reach 2A			
	AC FC&WCD	ACWD	AC FC&WCD	ACWD	SCVWD		AC FC&WCD	OFWD[c]	KCWA (M&I)	KCWA (AG)	AC FC&WCD
	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
1962	0	0	0	0	0	8,906	0	0	0	0	0
1963	0	0	0	0	0	12,645	0	0	0	0	0
1964	0	0	0	0	0	20,911	0	0	0	0	0
1965	0	1,127	0	0	15,014	34,026	0	0	0	0	0
1966	0	14,864	0	0	34,538	54,913	0	0	0	0	0
1967	0	12,882	0	0	39,101	56,763	0	0	0	0	0
1968	0	24,817	0	0	70,105	101,055	0	3,084	0	0	0
1969	0	813	0	0	62,264	69,712	0	3,016	0	0	0
1970	0	0	0	0	80,311	89,560	0	5,911	0	0	0
1971	0	5,961	0	0	87,606	98,584	0	7,212	0	0	0
1972	0	26,182	0	0	100,266	138,426	0	8,166	0	0	0
1973	0	2,521	0	0	88,582	94,078	0	3,214	0	0	0
1974	0	0	0	4	88,000	89,318	0	3,471	0	0	0
1975	714	393	0	593	88,000	93,604	0	3,576	0	0	0
1976	5,461	13,774	0	7,526	88,000	126,431	0	4,112	0	0	0
1977	5,206	11,284	0	7,556	76,220	107,704	0	1,472	0	0	0
1978	2,348	854	0	5,009	95,727	112,574	0	3,906	0	0	0
1979	5,341	3,430	0	7,444	91,991	122,190	0	6,149	0	0	0
1980	6,144	2,824	0	6,702	88,000	115,824	0	5,700	0	0	0
1981	7,262	7,595	0	8,570	88,000	129,507	0	4,300	0	0	0
1982	4,571	1,776	0	4,540	88,000	107,439	0	3,838	0	0	0
1983	111	0	0	3,157	86,733	94,656	0	3,822	0	0	0
1984	126	0	0	3,338	88,000	98,122	0	5,700	0	0	0
1985	7,537	11,203	0	7,813	88,000	122,088	0	5,433	0	0	0
1986	2,083	5,311	0	7,068	88,000	110,988	0	5,107	0	0	0
1987	12,993	15,488	0	9,902	88,000	136,796	0	5,625	0	0	0
1988	12,436	24,259	0	9,205	87,961	147,255	0	4,412	0	0	0
1989	10,974	17,340	0	8,702	90,000	142,269	0	6,091	0	0	0
1990	15,678	22,149	0	9,554	91,800	156,537	0	2,922	0	0	0
1991	1,945	9,155	0	3,493	28,200	50,259	0	141	0	0	0
1992	6,933	12,621	0	6,532	42,839	76,661	0	2,239	0	0	0
1993	13,208	1,792	0	6,829	62,065	105,971	0	2,858	0	0	0
1994	9,679	3,379	0	19,532	57,115	100,568	0	3,071	0	0	0
1995	15,427	21	0	17,772	28,756	76,640	0	5,169	0	0	0
1996	6,968	1,871	0	11,591	44,850	77,215	0	4,904	0	0	0
1997	12,654	1,876	0	10,864	60,601	102,186	0	5,238	0	0	0
1998	8,347	3,817	0	11,478	39,610	70,876	0	4,401	0	0	0
1999	13,133	5,326	0	16,226	52,945	100,497	0	4,871	0	0	0
2000	16,396	4,498	0	18,100	78,258	135,533	0	4,508	0	0	0
2001	13,593	0	0	18,004	47,922	95,335	0	3,592	638	0	0
2002	17,058	5,112	0	20,616	58,875	123,577	0	4,885	773	0	0
2003	16,684	5,037	0	12,753	75,981	132,714	0	4,266	917	0	7
2004	21,260	4,968	0	14,916	59,458	125,928	0	4,629	786	0	38
2005	16,597	4,139	0	10,160	52,364	108,136	0	4,194	1,046	0	299
2006	18,505	7,309	0	21,502	60,608	136,264	0	4,928	72	2,760	53
2007	19,315	6,889	0	20,711	51,500	133,306	0	5,700	0	4,800	53
2008	13,102	7,118	0	23,482	59,500	154,926	0	5,700	0	4,800	53
2009	13,102	6,943	0	24,457	59,500	155,726	0	5,700	0	4,800	53
2010	10,834	6,943	0	24,457	59,500	155,726	0	5,700	0	4,800	53
2011	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2012	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2013	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2014	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2015	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2016	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2017	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2018	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2019	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2020	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2021	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2022	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2023	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2024	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2025	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2026	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2027	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2028	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2029	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2030	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2031	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2032	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2033	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2034	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
2035	19,706	4,000	0	30,500	100,000	208,601	50	5,700	0	4,800	0
TOTAL	856,375	425,661	-	1,182,658	5,658,666	10,225,950	1,250	335,433	4,232	141,960	609

b) Deliveries were supplied by non-Project water from June 1962 through November 1967.

c) Includes 425 AF of 1988 advance allocation and 141 AF of 1992 advance allocation.

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									
	NORTH SAN JOAQUIN DIVISION (contd.)		SAN LUIS DIVISION							
	Reach 2A		Reach 3							
	TLBWSD	SCVWD	MWDSC	DRWD	SCVWD	TLBWSD	AC FC&WCD	ACWD	KCWA (M&I)	KCWA (AG)
	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]	[31]	[32]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0
1989	300	0	0	602	0	0	0	0	0	0
1990	0	200	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	11,100	0	0	0	0	0	0	0
1998	0	0	(11,100)	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0		0	3,320	57,825
2001	0	0	0	0	30,000	0	0	0	8,790	131,452
2002	0	0	0	0	0	0	0	0	21,050	50,346
2003	0	0	29,596	0	0	0	0	0	0	151,044
2004	0	0	0	0	0	0	0	0	0	44,877
2005	0	0	50,000	0	8,804	0	0	0	0	109,712
2006	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	30,000	0	0	0	0	0
2008	0	0	0	0	30,000	0	0	0	0	0
2009	0	0	0	0	30,000	0	0	0	0	0
2010	0	0	0	0	30,000	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	300	200	79,596	602	158,804	0	0	0	33,160	545,256

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SAN LUIS DIVISION (continued)										
	Reach 4				Reach 5						
	KCWA					KCWA					
	(M&I)	(AG)	DRWD	TLBWSD	DRWD	(M&I)	(AG)	MWDSC	CLWA	TLBWSD	OFWD
	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]	[41]	[42]	[43]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	1,550	0
1989	0	12,647	1,898	0	0	0	18,831	0	0	0	0
1990	0	0	0	1,500	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	10,823	0	0	0	0	0	0
1993	0	0	0	0	27,200	0	28,200	0	5,095	1,624	2,000
1994	0	0	0	0	0	0	0	0	0	0	0
1995	0	3,500	14,446	0	0	0	21,776	0	0	0	0
1996	1,125	4,162	0	0	0	1,125	81,507	0	0	4,000	0
1997	0	0	0	0	0	9,080	154,940	0	0	3,500	0
1998	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	1,300	0	0	0	21,500	0	8,000	0
2000	1,517	(11,928)	0	0	0	8,130	57,647	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	2,457	0
2002	0	0	0	0	0	0	0	0	0	3,000	0
2003	0	1,351	0	0	0	0	0	0	0	3,900	0
2004	0	0	0	0	0	0	0	0	0	3,850	0
2005	0	7,000	0	0	0	0	0	0	0	1,000	0
2006	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,642	16,732	16,344	2,800	38,023	18,335	362,901	21,500	5,095	32,881	2,000

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SAN LUIS DIVISION (continued)										
	Reach 6					Reach 7					
		KCWA				KCWA					
	CK	(M&I)	(AG)	MWDSC	TLBWSD	(M&I)	(AG)	CLWA	DRWD	TLBWSD	MWDSC
	[44]	[45]	[46]	[47]	[48]	[49]	[50]	[51]	[52]	[53]	[54]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	8,260	0	0	0	5,262	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	31,200	0	0	18,157	10,043	0	0	0	0
1994	0	0	0	0	0	0	0	2,100	0	0	0
1995	0	0	3,932	0	0	10,875	20,595	0	0	0	0
1996	0	0	0	0	0	3,424	69,704	0	0	0	0
1997	0	0	0	0	0	27,079	32,463	0	0	0	0
1998	0	20,400	33,340	0	3,000	3,998	62,081	0	200	0	0
1999	0	0	33,776	11,000	23,000	7,923	19,500	0	0	4,470	500
2000	0	1,457	35,847	0	3,000	0	20,970	1,200	0	17,519	20,000
2001	0	0	0	0	600	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	12,067	0
2003	0	0	0	0	0	0	0	0	0	15,103	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	6,954	0	0	0	0	0	0	0	0	4,000	0
2006	0	0	0	0	0	0	0	0	0	9,600	0
2007	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6,954	21,857	146,355	11,000	29,600	71,456	240,618	3,300	200	62,759	20,500

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SOUTH SAN JOAQUIN DIVISION										
	Reach 7	Reach 8C						Reach 8D			
		KCWA						KCWA			
	CK	(M&I)	(AG)	DRWD	TLBWSD	EWSID	CK	(M&I)	(AG)	DRWD	CK
	[55]	[56]	[57]	[58]	[59]	[60]	[61]	[62]	[63]	[64]	[65]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	25,100	1,978	900	0	0	26,360	0
1969	0	0	0	0	7,081	56	100	0	0	31,375	0
1970	0	0	0	0	0	3,942	0	0	0	40,407	0
1971	0	0	0	0	80,906	5,990	3,700	0	0	41,053	0
1972	0	0	0	0	144,843	5,795	1,400	0	0	42,443	0
1973	0	0	0	0	26,317	3,000	1,500	0	1,500	22,057	0
1974	0	0	0	0	32,603	3,000	1,500	0	0	33,390	0
1975	0	0	0	0	41,536	3,000	1,600	0	0	40,555	0
1976	0	0	0	0	26,595	3,000	1,600	0	0	41,421	0
1977	0	0	0	0	12,984	738	1,530	0	0	11,153	0
1978	0	0	0	0	3,934	454	2,070	0	0	51,747	0
1979	0	0	0	0	74,758	1,739	2,000	0	0	38,544	0
1980	0	0	0	0	35,140	894	2,200	0	0	41,000	0
1981	0	0	0	0	50,888	5,859	2,300	0	0	41,000	0
1982	0	0	0	0	4,405	361	1,536	0	0	41,000	214
1983	0	0	0	0	1,001	0	3,550	0	0	42,900	0
1984	0	0	0	0	3,677	0	3,100	0	0	45,100	0
1985	0	0	0	0	68,638	5,197	3,400	0	0	46,251	0
1986	0	0	0	0	40,017	1,170	3,700	0	0	50,249	0
1987	0	0	0	0	30,359	2,525	4,000	0	0	46,288	0
1988	0	0	0	0	46,281	3,475	4,000	0	0	47,994	0
1989	0	0	0	2,391	63,703	3,000	4,000	0	0	52,158	0
1990	0	0	0	0	23,504	1,279	2,000	0	161	36,296	0
1991	0	0	0	0	1,697	221	0	0	0	927	0
1992	0	0	0	280	15,982	1,354	1,806	0	0	12,667	0
1993	0	0	0	0	57,112	2,741	4,000	0	0	23,221	0
1994	0	0	0	0	21,510	1,666	2,116	0	1,726	28,793	0
1995	0	989	10,527	0	40,934	1,631	4,000	2,959	27,270	45,240	0
1996	0	0	1,500	95	84,130	1,868	4,000	0	1,455	52,722	0
1997	0	0	1,500	0	9,467	0	0	0	0	57,496	0
1998	0	0	1,000	90	8,956	542	15	0	20,000	49,435	0
1999	0	0	400	86	90,334	3,176	4,000	0	9,000	58,290	0
2000	0	0	400	166	63,842	1,799	3,600	0	0	57,920	0
2001	0	0	0	14	23,300	1,360	1,560	0	6,089	39,801	0
2002	0	0	0	0	34,009	1,405	2,854	0	7,522	47,434	0
2003	0	0	0	0	25,317	1,436	3,692	0	8,350	45,732	0
2004	0	0	0	0	30,546	3,562	5,803	0	4,979	45,823	3,250
2005	6,904	0	0	0	42,450	3,834	4,057	0	0	58,627	1,891
2006	0	0	0	0	39,051	4,236	9,445	0	0	55,098	0
2007	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2008	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2009	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2010	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2011	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2012	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2013	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2014	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2015	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2016	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2017	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2018	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2019	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2020	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2021	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2022	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2023	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2024	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2025	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2026	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2027	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2028	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2029	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2030	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2031	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2032	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2033	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2034	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
2035	0	0	0	0	38,369	3,000	9,000	0	0	57,343	0
TOTAL	6,904	989	15,327	3,122	2,545,608	174,283	363,634	2,959	88,052	3,252,914	5,355

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									
	SOUTH SAN JOAQUIN DIVISION (continued)									
	Reach 8D				Reach 9				Reach 10A	
	SBC		SLOC			KCWA			KCWA	
	FC&WCD	SGVMWD	FC&WCD	TLBWSD	DRWD	(M&I)	(AG)	TLBWSD	(M&I)	(AG)
	[66]	[67]	[68]	[69]	[70]	[71]	[72]	[73]	[74]	[75]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	30,951	0	0	0
1969	0	0	0	0	0	0	24,489	0	0	0
1970	0	0	0	3,408	0	0	46,114	1,855	0	158
1971	0	0	0	41,579	0	0	58,356	0	0	9,973
1972	0	0	0	113,550	0	0	75,464	0	0	5,876
1973	0	0	0	24,147	0	0	54,583	0	0	22,948
1974	0	0	0	39,686	0	0	63,814	0	10,019	22,719
1975	0	0	0	44,722	0	0	50,021	0	2,791	72,121
1976	0	0	0	32,216	0	0	53,465	0	74	50,444
1977	0	0	0	5,097	0	0	24,668	0	201	34,451
1978	0	0	0	8,119	0	0	72,231	0	0	161,889
1979	0	0	0	80,363	0	0	74,524	0	285	153,245
1980	0	0	0	40,304	0	0	79,946	0	3,780	131,836
1981	0	0	0	32,550	0	0	76,508	0	341	133,500
1982	0	0	0	14,146	0	0	76,877	0	4,700	164,832
1983	0	0	0	5	0	2,217	84,573	0	0	146,493
1984	0	0	0	2,066	0	4,100	85,732	0	6,910	150,302
1985	0	0	0	41,153	0	0	67,696	0	6,495	153,473
1986	0	0	0	39,338	0	0	79,943	0	5,065	198,099
1987	0	0	0	62,725	0	0	97,732	0	900	226,521
1988	0	0	0	48,035	0	1,100	83,858	0	9,529	212,495
1989	0	0	0	63,947	0	0	91,134	0	21,038	251,979
1990	0	0	0	32,066	0	0	83,108	0	25,189	47,472
1991	0	0	0	483	0	13,683	601	0	1,142	6,820
1992	0	0	0	30,746	0	28	40,183	0	3,685	89,390
1993	0	0	0	65,732	197	5,945	53,597	0	775	233,862
1994	0	0	0	40,852	0	0	44,994	0	5,227	126,792
1995	0	0	0	57,435	0	0	64,076	0	366	229,448
1996	0	0	100	148,745	0	2,236	89,291	0	6,666	199,854
1997	0	0	100	9,402	4,900	0	72,013	0	3,577	157,385
1998	0	0	0	8,721	0	0	57,530	0	2,603	163,587
1999	0	0	0	162,631	0	0	72,734	0	1,657	190,787
2000	0	0	0	113,952	0	2,000	71,562	0	16,880	274,000
2001	0	0	0	58,369	0	0	54,198	0	160	97,623
2002	745	0	0	47,426	0	0	60,957	0	7,645	163,998
2003	0	0	0	61,521	0	0	54,724	0	2,648	172,243
2004	0	0	0	55,625	0	0	54,330	0	65,743	122,099
2005	0	0	0	92,552	0	0	53,206	0	22,087	210,657
2006	0	0	0	50,120	0	0	70,365	0	0	272,186
2007	0	0	0	57,553	0	0	97,971	0	0	210,478
2008	0	0	0	57,553	0	0	104,771	0	0	211,678
2009	0	0	0	57,553	0	0	104,771	0	0	211,678
2010	0	0	0	57,553	0	0	104,771	0	0	211,678
2011	0	0	0	57,553	0	0	104,771	0	0	213,678
2012	0	0	0	57,553	0	0	104,771	0	0	213,678
2013	0	0	0	57,553	0	0	104,771	0	0	213,678
2014	0	0	0	57,553	0	0	104,771	0	0	213,678
2015	0	0	0	57,553	0	0	104,771	0	0	213,678
2016	0	0	0	57,553	0	0	104,771	0	0	213,678
2017	0	0	0	57,553	0	0	104,771	0	0	213,678
2018	0	0	0	57,553	0	0	104,771	0	0	213,678
2019	0	0	0	57,553	0	0	104,771	0	0	213,678
2020	0	0	0	57,553	0	0	104,771	0	0	213,678
2021	0	0	0	57,553	0	0	104,771	0	0	213,678
2022	0	0	0	57,553	0	0	104,771	0	0	213,678
2023	0	0	0	57,553	0	0	104,771	0	0	213,678
2024	0	0	0	57,553	0	0	104,771	0	0	213,678
2025	0	0	0	57,553	0	0	104,771	0	0	213,678
2026	0	0	0	57,553	0	0	104,771	0	0	213,678
2027	0	0	0	57,553	0	0	104,771	0	0	213,678
2028	0	0	0	57,553	0	0	104,771	0	0	213,678
2029	0	0	0	57,553	0	0	104,771	0	0	213,678
2030	0	0	0	57,553	0	0	104,771	0	0	213,678
2031	0	0	0	57,553	0	0	104,771	0	0	213,678
2032	0	0	0	57,553	0	0	104,771	0	0	213,678
2033	0	0	0	57,553	0	0	104,771	0	0	213,678
2034	0	0	0	57,553	0	0	104,771	0	0	213,678
2035	0	0	0	57,553	0	0	104,771	0	0	213,678
TOTAL	745	0	200	3,442,571	5,097	31,309	5,481,707	1,855	238,178	11,249,019

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SOUTH SAN JOAQUIN DIVISION (continued)										
	Reach 10A								Reach 11B		
									KCWA		
	DRWD	AC FC&WCD	CLWA	SCVWD	ACWD	MWDSC	AVEKWA	TLBWSD	(M&I)	(AG)	DRWD
	[76]	[77]	[78]	[79]	[80]	[81]	[82]	[83]	[84]	[85]	[86]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	24.776	0
1969	0	0	0	0	0	0	0	2,842	0	64,682	0
1970	0	0	0	0	0	0	0	4,315	0	72,279	0
1971	0	0	0	0	0	0	0	0	0	63.773	0
1972	0	0	0	0	0	0	0	0	0	72,358	0
1973	0	0	0	0	0	0	0	0	0	67,544	0
1974	0	0	0	0	0	0	0	0	0	87.476	0
1975	0	0	0	0	0	0	0	0	0	85,675	0
1976	0	0	0	0	0	0	0	0	0	85.067	0
1977	0	0	0	0	0	0	0	0	3.981	29,603	0
1978	0	0	0	0	0	0	0	0	0	88.753	0
1979	0	0	0	0	0	0	0	0	484	108.379	0
1980	0	0	0	0	0	0	0	0	3.112	103.207	0
1981	0	0	0	0	0	0	0	0	494	104.395	0
1982	0	0	0	0	0	0	0	0	798	99,081	0
1983	0	0	0	0	0	0	0	0	2,069	94.117	0
1984	0	0	0	0	0	0	0	0	2,349	124,819	0
1985	0	0	0	0	0	0	0	0	10,666	118,646	0
1986	0	0	0	0	0	0	0	0	8,673	124,836	0
1987	0	0	0	0	0	0	0	0	13,074	111,877	0
1988	0	0	0	0	0	0	0	0	13,509	114,031	0
1989	0	0	0	0	0	0	0	0	9,986	127,058	0
1990	0	0	0	0	0	0	0	0	9,319	104,107	0
1991	0	0	0	0	0	0	0	0	6,099	118	0
1992	0	0	0	0	0	0	0	0	7,419	35,093	0
1993	0	0	0	0	0	44,496	0	0	2,696	72,645	0
1994	0	0	0	0	0	0	0	0	3,506	71,202	0
1995	0	0	0	0	0	50,000	0	0	1,154	97,072	0
1996	0	0	0	45,000	6,200	95,000	0	0	1,185	96,250	0
1997	900	0	0	35,000	10,000	125,000	0	0	1,111	104,823	0
1998	0	1,970	0	23,800	3,780	39,500	0	0	1,311	72,646	0
1999	0	22,910	0	30,000	16,100	75,850	0	0	2,127	92,262	0
2000	0	23,940	0	23,730	13,380	9,208	0	0	3,793	89,623	1,500
2001	0	5,000	0	0	0	0	0	0	636	73,105	0
2002	0	14,287	24,000	3,311	2,083	0	0	0	1,457	91,123	0
2003	0	6,500	0	33,000	18,800	70,940	0	0	1,379	87,174	0
2004	0	5,740	32,522	0	8,000	0	0	0	1,299	97,722	0
2005	0	0	0	55,448	28,422	31,210	0	0	824	93,554	0
2006	0	197	0	10,500	13,853	115,434	0	0	94	100,696	0
2007	0	0	0	10,500	14,400	0	1,000	0	1,390	101,500	0
2008	0	5,740	0	10,500	11,400	0	1,000	0	1,390	101,500	0
2009	0	5,740	0	10,500	10,600	0	1,000	0	1,390	101,500	0
2010	0	5,740	0	10,500	10,600	0	1,000	0	1,390	101,500	0
2011	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2012	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2013	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2014	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2015	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2016	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2017	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2018	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2019	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2020	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2021	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2022	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2023	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2024	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2025	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2026	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2027	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2028	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2029	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2030	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2031	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2032	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2033	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2034	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
2035	0	6,468	0	0	7,500	0	0	0	1,390	101,500	0
TOTAL	900	259,464	56,522	301,789	355,118	656,638	4,000	7,157	154,914	6,295,147	1,500

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									
	SOUTH SAN JOAQUIN DIVISION (continued)									
	Reach 12D		Reach 12E							
	KCWA		KCWA			AC				
	(M&I)	(AG)	(M&I)	(AG)	ACWD	FC&WCD	CLWA	SCVWD	DRWD	MWDSC
	[87]	[88]	[89]	[90]	[91]	[92]	[93]	[94]	[95]	[96]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	9,279	0	0	0	0	0	0
1971	0	0	0	28,056	0	0	0	0	0	0
1972	0	0	0	62,342	0	0	0	0	0	0
1973	0	0	0	13,082	0	0	0	0	0	0
1974	0	0	2,651	4,248	0	0	0	0	0	0
1975	0	0	0	10,787	0	0	0	0	0	0
1976	0	0	37,519	20,555	0	0	0	0	0	0
1977	0	0	20,280	1,737	0	0	0	0	0	0
1978	0	0	47,133	15,011	0	0	0	0	0	0
1979	0	0	50,740	61,567	0	0	0	0	0	0
1980	0	0	32,039	22,252	0	0	0	0	0	0
1981	0	0	59,917	58,470	0	0	0	0	0	0
1982	0	0	36,139	75,587	0	0	0	0	0	0
1983	0	0	0	10,950	0	0	0	0	0	0
1984	0	0	63,941	39,929	0	0	0	0	0	0
1985	0	0	69,839	84,117	0	0	0	0	0	0
1986	0	0	62,109	51,540	0	0	0	0	0	0
1987	0	0	95,297	86,223	0	0	0	0	0	0
1988	0	0	86,390	123,249	0	0	0	0	0	0
1989	0	0	83,965	146,544	0	0	0	0	0	0
1990	0	0	82,164	38,973	0	0	0	0	0	0
1991	0	0	8,842	303	0	0	0	0	0	0
1992	0	0	47,181	57,048	0	0	0	0	0	0
1993	0	0	84,822	285,554	0	0	0	0	0	5,504
1994	0	0	66,188	77,839	0	0	0	0	0	0
1995	0	0	107,130	181,097	0	0	0	0	1,000	0
1996	0	0	89,257	134,138	0	0	0	0	4,131	0
1997	0	0	32,061	128,329	0	0	0	0	8,012	1,486
1998	0	0	28,258	88,998	0	0	0	0	5,925	24,234
1999	0	0	110,161	255,343	0	0	0	0	1,321	62,162
2000	21	0	78,285	89,702	0	0	0	0	953	159,731
2001	41	0	5,256	46,205	0	0	0	0	0	0
2002	760	6	39,104	96,231	0	0	0	0	0	0
2003	2,431	152	64,196	87,339	0	0	0	0	0	45,989
2004	3,419	768	52,303	95,893	0	0	0	0	1,600	0
2005	2,841	644	43,835	340,281	1,878	3,419	20,000	2,619	1,154	15,384
2006	5,647	544	65,200	249,906	0	10,000	10,550	0	0	115,435
2007	6,500	0	90,390	148,412	0	10,000	0	0	0	0
2008	6,500	0	90,390	148,412	0	10,000	20,000	0	0	0
2009	6,500	0	104,600	134,202	0	10,000	20,000	0	0	0
2010	6,500	0	104,600	134,202	0	10,000	20,000	0	0	0
2011	6,500	0	104,600	134,202	0	0	0	0	0	0
2012	6,500	0	104,600	134,202	0	0	0	0	0	0
2013	6,500	0	104,600	134,202	0	0	0	0	0	0
2014	6,500	0	104,600	134,202	0	0	0	0	0	0
2015	6,500	0	104,600	134,202	0	0	0	0	0	0
2016	6,500	0	104,600	134,202	0	0	0	0	0	0
2017	6,500	0	104,600	134,202	0	0	0	0	0	0
2018	6,500	0	104,600	134,202	0	0	0	0	0	0
2019	6,500	0	104,600	134,202	0	0	0	0	0	0
2020	6,500	0	104,600	134,202	0	0	0	0	0	0
2021	6,500	0	104,600	134,202	0	0	0	0	0	0
2022	6,500	0	104,600	134,202	0	0	0	0	0	0
2023	6,500	0	104,600	134,202	0	0	0	0	0	0
2024	6,500	0	104,600	134,202	0	0	0	0	0	0
2025	6,500	0	104,600	134,202	0	0	0	0	0	0
2026	6,500	0	104,600	134,202	0	0	0	0	0	0
2027	6,500	0	104,600	134,202	0	0	0	0	0	0
2028	6,500	0	104,600	134,202	0	0	0	0	0	0
2029	6,500	0	104,600	134,202	0	0	0	0	0	0
2030	6,500	0	104,600	134,202	0	0	0	0	0	0
2031	6,500	0	104,600	134,202	0	0	0	0	0	0
2032	6,500	0	104,600	134,202	0	0	0	0	0	0
2033	6,500	0	104,600	134,202	0	0	0	0	0	0
2034	6,500	0	104,600	134,202	0	0	0	0	0	0
2035	6,500	0	104,600	134,202	0	0	0	0	0	0
TOTAL	203,660	2,114	4,757,182	7,098,982	1,878	53,419	90,550	2,619	24,096	429,925

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SOUTH SAN JOAQUIN DIVISION (continued)										
	Reach 13B							Reach 14A		Reach 14B	
	KCWA		AC					KCWA		KCWA	
	(M&I)	(AG)	FC&WCD	SCVWD	MWDSC	DRWD	TLBWSD	(M&I)	(AG)	(M&I)	(AG)
	[97]	[98]	[99]	[100]	[101]	[102]	[103]	[104]	[105]	[106]	[107]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	4,891	0	0	0	0	0	0	0	0	3
1971	0	0	0	0	0	0	0	0	23,844	0	49,929
1972	0	17,388	0	0	0	0	0	0	26,621	0	77,034
1973	0	9,297	0	0	0	0	0	0	15,328	0	47,040
1974	8,038	4,246	0	0	0	0	0	0	7,794	0	32,356
1975	8,538	7,059	0	0	0	0	0	0	10,306	0	27,736
1976	5,626	8,855	0	0	0	0	0	0	268	0	35,296
1977	0	5,024	0	0	0	0	0	0	8,299	0	13,539
1978	21,773	7,601	0	0	0	0	0	0	34,029	0	72,351
1979	5,663	17,766	0	0	0	0	0	3,012	27,356	0	59,413
1980	0	22,515	0	0	0	0	0	4,312	16,876	0	40,513
1981	7,844	14,037	0	0	0	0	0	4,511	13,007	8	42,753
1982	0	25,553	0	0	0	0	0	3,735	24,240	184	57,739
1983	0	3,491	0	0	0	0	0	1,168	20,302	0	57,922
1984	12,117	26,178	0	0	0	0	0	137	35,369	10	79,179
1985	0	67,711	0	0	0	0	0	206	33,103	0	72,855
1986	0	66,551	0	0	0	0	0	180	26,384	0	70,864
1987	5,609	40,374	0	0	0	0	0	610	30,098	9	67,710
1988	9,298	47,167	0	0	0	0	0	622	32,778	19	75,968
1989	5,504	57,114	0	0	0	0	0	721	29,292	7	82,201
1990	7,645	20,423	0	0	0	0	0	673	26,800	13	81,076
1991	0	0	0	0	0	0	0	768	0	0	0
1992	789	17,449	0	0	0	0	0	673	16,238	464	41,143
1993	12,798	88,157	0	0	0	0	0	629	17,832	0	62,493
1994	2,494	33,148	0	0	0	0	0	2,513	16,760	3,000	54,011
1995	8,751	110,685	0	0	0	0	3,500	3	21,234	0	67,391
1996	28,063	64,849	0	0	0	0	0	0	26,978	0	85,936
1997	43,803	49,312	0	0	0	0	0	0	23,035	0	79,790
1998	29,444	40,085	0	0	5,500	0	0	0	15,706	0	58,132
1999	12,969	92,998	0	0	0	0	0	0	21,153	0	67,576
2000	4,066	98,136	0	0	0	0	0	0	19,264	0	70,585
2001	4,044	29,881	0	0	0	1,733	0	1	12,451	0	49,602
2002	15,951	55,493	0	0	0	736	0	0	11,161	0	52,762
2003	35,239	91,739	0	0	1,865	350	0	0	13,685	0	44,576
2004	1,922	73,801	0	0	0	1,657	0	0	13,030	0	52,012
2005	21,781	269,631	2,321	9,014	192	14,540	0	0	15,663	0	56,739
2006	30,297	142,006	0	0	10,500	3,554	0	0	10,352	0	48,570
2007	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2008	18,500	48,050	0	0	0	0	0	0	16,820	0	56,200
2009	18,500	48,050	0	0	0	0	0	0	16,820	0	56,200
2010	18,500	48,050	0	0	0	0	0	0	16,820	0	56,200
2011	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2012	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2013	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2014	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2015	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2016	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2017	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2018	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2019	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2020	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2021	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2022	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2023	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2024	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2025	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2026	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2027	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2028	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2029	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2030	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2031	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2032	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2033	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2034	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
2035	18,500	48,050	0	0	0	0	0	0	16,400	0	55,500
TOTAL	886,566	3,124,061	2,321	9,014	18,057	22,570	3,500	24,474	1,173,496	3,714	3,646,395

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SOUTH SAN JOAQUIN DIVISION								MOJAVE DIVISION		
	Reach 14C			Reach 15A		Reach 16A			Reach 18A	Reach 19	
	KCWA			KCWA		KCWA					
	(M&I)	(AG)	MWDSC	(M&I)	(AG)	(M&I)	(AG)	AVEKWA	AVEKWA	MWA	AVEKWA
	[108]	[109]	[110]	[111]	[112]	[113]	[114]	[115]	[116]	[117]	[118]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	24,187	0	0	3,552	0	0	0	0	0	0
1972	0	35,016	0	0	6,064	0	4,768	0	0	0	0
1973	0	19,043	0	0	19,916	0	1,961	0	0	0	0
1974	0	12,601	0	0	18,000	3,000	1,564	0	0	0	1,223
1975	0	12,783	0	0	35,420	3,200	9,867	0	0	0	7,622
1976	0	9,005	0	0	39,551	3,500	11,667	0	3,808	0	23,063
1977	0	3,757	0	0	6,158	3,420	685	0	1,231	0	8,927
1978	0	24,542	0	0	31,148	7,989	1,655	0	1,321	0	36,333
1979	0	22,372	0	0	38,602	2,813	15,808	0	2,098	0	49,910
1980	0	19,953	0	0	37,817	2,700	16,145	0	2,610	0	61,534
1981	7	18,729	0	0	39,033	2,636	18,156	0	2,340	0	65,690
1982	0	26,479	0	0	47,782	1,921	16,577	0	1,669	0	41,127
1983	0	26,613	0	0	37,426	1,400	17,907	0	43	0	26,377
1984	2	34,996	0	0	49,848	1,338	24,246	0	90	0	22,462
1985	0	31,758	0	0	44,078	1,309	16,820	0	8	0	23,440
1986	0	34,566	0	0	42,461	1,213	15,559	0	8	0	16,898
1987	10	31,019	0	0	34,748	1,665	10,170	0	0	0	15,958
1988	1	37,165	0	16	41,978	1,925	8,987	0	0	0	13,471
1989	5	37,800	0	2	43,239	2,668	8,649	0	0	0	18,007
1990	9	34,174	0	6	36,347	2,819	8,608	0	0	0	17,281
1991	0	0	0	0	0	2,588	343	2,000	0	0	728
1992	0	18,084	0	0	24,243	2,087	8,275	0	0	0	7,238
1993	0	28,103	0	0	27,997	2,494	9,167	0	0	0	13,340
1994	1,000	22,624	0	0	29,511	3,011	13,877	0	0	0	19,122
1995	0	31,285	0	0	26,134	3,188	15,042	0	0	0	20,222
1996	0	38,879	0	0	36,186	2,573	18,142	0	0	0	23,919
1997	0	33,512	0	0	36,281	3,997	17,048	0	0	64	28,834
1998	0	23,097	0	0	28,712	3,751	17,032	0	0	1,345	22,466
1999	0	31,489	0	0	36,801	3,316	24,071	0	0	1,439	30,944
2000	0	33,716	0	0	40,063	3,015	20,919	0	0	1,361	34,786
2001	0	23,557	0	0	31,192	1,894	13,476	0	0	1,385	24,370
2002	0	27,138	0	0	41,552	4,227	14,520	0	0	1,370	14,297
2003	0	24,783	12,911	0	36,602	1,168	16,799	0	0	1,285	12,145
2004	0	30,313	0	0	40,184	2,239	19,714	0	0	1,223	11,201
2005	27	21,952	0	0	39,870	167	18,353	0	11	1,051	11,804
2006	0	23,313	0	0	46,555	2,825	17,808	0	45	1,346	26,517
2007	0	26,800	0	0	48,300	3,610	19,500	0	0	1,235	10,646
2008	0	27,680	0	0	48,300	3,610	19,500	0	0	1,500	81,666
2009	0	27,680	0	0	48,300	3,610	19,500	0	0	1,657	95,048
2010	0	27,680	0	0	48,300	3,610	19,500	0	0	1,235	93,688
2011	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2012	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2013	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2014	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2015	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2016	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2017	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2018	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2019	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2020	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2021	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2022	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2023	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2024	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2025	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2026	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2027	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2028	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2029	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2030	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2031	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2032	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2033	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2034	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
2035	0	26,800	0	0	48,300	3,610	19,500	0	0	1,500	38,329
TOTAL	1,061	1,688,243	12,911	24	2,575,751	192,746	1,019,885	2,000	15,282	54,996	1,990,529

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	MOJAVE DIVISION (continued)										
	Reach 20A			Reach 20B		Reach 21			Reach 22A		Reach 22B
	PWD	MWA	AVEKWA	PWD	AVEKWA	LCID	PWD	AVEKWA	AVEKWA	LCID	MWDSC(d
	[119]	[120]	[121]	[122]	[123]	[124]	[125]	[126]	[127]	[128]	[129]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	338	0	0	0	0	0
1973	0	0	0	0	0	290	0	0	0	0	(14.800)
1974	0	0	0	0	0	400	0	0	0	0	(16.400)
1975	0	0	420	0	0	520	0	0	0	0	(18.000)
1976	0	0	471	0	416	589	0	0	0	0	(19.600)
1977	0	0	773	0	271	111	0	0	0	0	0
1978	0	0	5,549	0	934	208	0	0	0	0	(25,384)
1979	0	0	7,555	0	930	133	0	0	0	0	(25,063)
1980	0	0	7,605	0	655	191	0	0	3	0	(27,884)
1981	0	0	10,333	0	966	1,270	0	0	46	0	(31,105)
1982	0	0	7,313	0	8	0	0	0	174	0	(34,326)
1983	0	0	6,253	0	20	38	0	0	268	0	(37,547)
1984	0	0	9,558	0	2	1	0	0	550	0	(40,768)
1985	1,510	0	11,613	32	217	0	16	0	1,786	0	(43,989)
1986	3,041	0	13,808	45	0	163	10	0	1,735	0	(47,210)
1987	2,389	0	15,493	1,624	151	1,080	1,366	0	2,273	5	(50,931)
1988	366	0	17,117	1,261	281	419	143	0	3,210	0	(54,652)
1989	381	0	23,481	7,848	112	971	780	0	3,591	0	(58,373)
1990	282	0	25,843	8,292	84	1,747	34	0	3,988	0	(61,200)
1991	84	1,391	4,282	3,830	131	522	0	0	2,427	0	(18,360)
1992	185	1,310	18,518	3,850	650	251	0	0	3,859	0	(27,624)
1993	164	1,514	23,662	7,597	996	734	0	0	5,098	0	0
1994	299	1.399	25.250	8.119	124	1.098	0	0	4.657	0	0
1995	328	1.227	22.385	6.633	0	480	0	0	4.679	0	0
1996	354	1.316	26.979	11.080	0	494	0	0	5.458	0	0
1997	313	1.272	27.999	11.548	0	444	0	0	5.549	0	0
1998	195	0	25,985	8.557	0	404	0	0	4.468	0	0
1999	377	0	32,409	12.901	36	342	0	0	5,684	0	0
2000	0	0	37,819	9,060	80	0	0	5,002	5.890	0	0
2001	0	0	33,216	10,427	282	0	0	0	4,989	0	0
2002	0	0	36,311	18.496	1.662	0	0	0	5.404	0	0
2003	0	0	39.532	11,547	2,289	0	0	0	6,063	0	0
2004	0	0	40,408	12,139	1,774	0	23	0	6,095	0	0
2005	0	0	41,496	11,678	1,336	0	34	0	5,184	0	5,942
2006	222	0	41,674	18,062	1,608	800	0	0	4,617	0	0
2007	0	0	36,805	21,300	1,454	2,300	0	0	4,491	0	0
2008	0	0	37,906	21,300	1,498	2,300	0	0	4,625	0	0
2009	0	0	39,043	21,300	1,544	2,300	0	0	4,765	0	0
2010	0	0	40,216	21,300	1,588	2,300	0	0	4,908	0	0
2011	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2012	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2013	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2014	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2015	0	0	88.822	21.300	1.569	2.300	0	0	12.680	0	0
2016	0	0	88.822	21.300	1.569	2.300	0	0	12.680	0	0
2017	0	0	88.822	21.300	1.569	2.300	0	0	12.680	0	0
2018	0	0	88.822	21.300	1.569	2.300	0	0	12.680	0	0
2019	0	0	88.822	21.300	1.569	2,300	0	0	12,680	0	0
2020	0	0	88.822	21.300	1.569	2,300	0	0	12,680	0	0
2021	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2022	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2023	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2024	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2025	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2026	0	0	88.822	21,300	1,569	2,300	0	0	12,680	0	0
2027	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2028	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2029	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2030	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2031	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2032	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2033	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2034	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
2035	0	0	88,822	21,300	1,569	2,300	0	0	12,680	0	0
TOTAL	10,490	9,429	3,015,630	802,326	61,324	80,738	2,406	5,002	433,534	5	(647,274)

d) In accordance with the Exchange Agreement between the noted agencies, MWDSC assumed responsibility for payment of variable OMP&R costs on the exchange water in reaches beyond Reach 22B, and Desert Water Agency and Coachella Valley Water District for such costs from the Delta through Reach 22B.

The adjustment in deliveries in Reach 22B provides for compliance with provisions for the repayment of costs under the agreement. In 1993 and after the exchange takes place in Reach 26A.

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	MOJAVE DIVISION (continued)									SANTA ANA DIV	
	Reach 22B					Reach 23	Reach 24			Reach 26A	
	SCWA	MWA	CVWD(e	DWA(e	AVEKWA(f	MWA	CLAWA	MWA	MWDSC(e	MWDSC(e	SBVMWD(g
	[130]	[131]	[132]	[133]	[134]	[135]	[136]	[137]	[138]	[139]	[140]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	55	0	0	0	0	464	0	0	0	1,275
1973	0	0	5,800	9,000	0	0	389	0	0	444	32,426
1974	0	0	6,400	10,000	0	14	627	0	0	84,981	16,605
1975	0	0	7,000	11,000	0	0	825	0	0	169,960	13,865
1976	0	0	7,600	12,000	0	0	1,002	0	0	215,312	12,273
1977	0	22	0	0	0	58	1,109	0	0	64,823	24,833
1978	0	0	10,084	15,300	0	0	1,209	0	0	297,708	4,055
1979	0	4,000	10,063	15,000	0	0	1,260	0	0	260,903	18
1980	0	4,000	10,884	17,000	0	0	1,239	0	0	300,345	0
1981	0	4,000	12,105	19,000	0	0	1,485	0	0	395,678	16,021
1982	0	10,500	13,326	21,000	0	0	1,238	0	0	214,566	8,409
1983	0	0	14,547	23,000	0	0	911	0	0	175,288	5,994
1984	0	0	15,768	25,000	0	0	1,128	0	0	122,311	5,556
1985	0	0	16,989	27,000	0	0	1,422	0	0	147,599	7,390
1986	0	0	18,210	29,000	0	0	1,506	0	0	215,265	6,421
1987	0	17	19,431	31,500	214	0	1,849	0	0	175,012	18,751
1988	0	9	20,652	34,000	0	0	2,006	0	0	247,101	21,386
1989	0	0	21,873	36,500	89	200	2,170	0	0	326,217	20,782
1990	0	0	23,100	38,100	10	0	1,827	0	0	399,387	18,831
1991	0	0	6,930	11,430	0	0	849	2,032	0	107,182	3,661
1992	0	42	10,427	17,197	0	0	519	9,334	0	219,524	3,358
1993	0	0	0	0	0	0	439	10,000	0	98,291	4,361
1994	0	14,634	0	0	0	0	785	819	0	192,979	9,135
1995	0	7,495	0	0	0	0	409	0	0	107,299	696
1996	0	6,111	0	0	0	0	485	0	0	73,438	6,064
1997	0	9,038	0	0	0	0	651	0	0	157,215	9,654
1998	0	2,580	0	0	0	0	187	0	0	36,770	1,878
1999	0	6,705	0	0	0	0	1,132	0	0	139,752	12,874
2000	0	10,019	0	0	0	0	1,194	0	0	326,647	18,399
2001	0	3,048	0	0	0	0	1,057	0	0	284,007	26,488
2002	0	2,976	0	0	497	0	2,189	0	0	303,127	63,468
2003	0	13,150	0	0	0	0	1,563	0	17,249	532,198	27,415
2004	0	11,953	0	0	253	0	2,006	0	0	548,654	56,150
2005	0	12,169	0	0	0	0	205	341	14,058	361,976	18,835
2006	0	38,072	0	0	0	0	2,900	0	0	509,933	75,002
2007	0	17,220	0	0	0	0	3,340	0	0	535,737	72,600
2008	0	64,985	0	0	0	0	5,920	0	0	21,593	102,600
2009	0	74,143	0	0	0	0	5,800	0	0	21,593	102,600
2010	0	74,565	0	0	0	0	5,800	0	0	21,593	102,600
2011	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2012	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2013	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2014	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2015	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2016	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2017	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2018	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2019	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2020	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2021	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2022	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2023	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2024	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2025	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2026	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2027	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2028	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2029	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2030	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2031	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2032	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2033	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2034	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
2035	0	74,300	0	0	0	0	5,800	0	0	535,737	102,600
TOTAL	0	2,249,008	251,189	402,027	1,063	272	206,096	22,526	31,307	21,805,833	3,517,729

e) In accordance with the Exchange Agreement between the noted agencies, MWDSC assumed responsibility for payment of variable OMP&R costs on the exchange water in reaches beyond Reach 22B, and Desert Water Agency and Coachella Valley Water District for such costs from the Delta through Reach 22B. The adjustment in deliveries in Reach 22B provides for compliance with provisions for the repayment of costs under the agreement. In 1993 and after the exchange takes place in Reach 26A.

f) 1988 advance allocation.

g) Includes 1,650 AF recaptured from ground water storage in 1982, 10,000 AF in 1987, and 8,749 AF in 1988. This water was stored under DWR's Ground Water Demonstration Program.

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	SANTA ANA DIVISION (continued)										
	Reach 26A				Reach 28G	Reach 28H			Reach 28J		
	SGVMWD	SGPWA	CVWD(e	DWA(e	MWDSC	CVWD	DWA	MWDSC	CVWD	DWA	MWDSC
	[141]	[142]	[143]	[144]	[145]	[146]	[147]	[148]	[149]	[150]	[151]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	18,942	0	0	0	0	0	0
1974	612	0	0	0	0	0	0	0	0	0	0
1975	5,450	0	0	0	0	0	0	0	0	0	251
1976	6,071	0	0	0	0	0	0	55	0	0	2,000
1977	8,996	0	0	0	0	0	0	43	0	0	2,442
1978	7,771	0	0	0	0	0	0	48	0	0	64,054
1979	290	0	0	0	0	0	0	1,290	0	0	94,353
1980	1,085	0	0	0	0	0	0	3,013	0	0	91,532
1981	3,619	0	0	0	0	0	0	4,365	0	0	149,405
1982	12,599	0	0	0	0	0	0	3,961	0	0	155,629
1983	734	0	0	0	0	0	0	6,645	0	0	41,616
1984	7,656	0	0	0	0	0	0	109,743	0	0	5,672
1985	5,028	0	0	0	0	0	0	182,781	0	0	6,538
1986	9,454	0	0	0	0	0	0	131,439	0	0	30,071
1987	10,630	0	0	0	0	0	0	144,743	0	0	26,315
1988	8,948	0	0	0	0	0	0	199,641	0	0	22,209
1989	12,839	0	0	0	0	0	0	247,430	0	0	51,462
1990	16,649	0	0	0	0	0	0	257,796	0	0	36,060
1991	5,399	0	0	0	0	0	0	38,832	0	0	5,958
1992	7,908	0	0	0	0	0	0	85,341	0	0	12,223
1993	14,397	0	23,100	38,100	0	0	0	61,841	0	0	4,588
1994	15,230	0	14,102	23,257	0	0	0	134,262	0	0	4,725
1995	12,922	0	23,100	38,100	0	0	0	117,762	0	0	21,099
1996	15,989	0	62,219	102,622	0	0	0	144,906	0	0	12,418
1997	18,175	0	58,100	53,100	0	0	0	107,853	0	0	47,777
1998	9,310	0	78,100	58,100	0	6,582	7,708	77,473	1,027	4,839	50,411
1999	21,729	0	50,480	58,100	0	0	0	206,689	0	0	8,163
2000	15,140	0	42,323	58,234	0	0	0	379,713	0	0	7,864
2001	2,360	0	9,100	15,010	0	0	0	260,984	0	0	33,414
2002	24,851	0	16,755	27,640	0	0	0	340,635	0	0	41,552
2003	21,934	116	14,443	23,819	0	0	0	246,485	0	0	50,776
2004	12,541	841	15,465	21,190	0	0	0	357,995	0	0	20,437
2005	13,984	692	34,356	49,089	0	0	0	242,245	0	0	114,499
2006	15,160	2,690	60,550	25,000	0	0	0	154,125	0	0	323,562
2007	12,000	7,500	104,600	30,950	0	0	0	124,048	0	0	224,480
2008	28,800	17,300	121,100	50,000	0	0	0	136,378	0	0	279,350
2009	28,800	17,300	121,100	50,000	0	0	0	136,378	0	0	279,350
2010	28,800	17,300	121,100	50,000	0	0	0	136,378	0	0	279,350
2011	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2012	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2013	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2014	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2015	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2016	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2017	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2018	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2019	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2020	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2021	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2022	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2023	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2024	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2025	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2026	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2027	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2028	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2029	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2030	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2031	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2032	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2033	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2034	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
2035	28,800	17,300	121,100	50,000	0	0	0	124,048	0	0	224,480
TOTAL	1,163,860	496,239	3,997,593	2,022,311	18,942	6,582	7,708	7,884,516	1,027	4,839	8,213,605

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)										
	WEST BRANCH									COASTAL BRANCH	
	Reach 29F	Reach 29H	Reach 30							Reach 31A	
	AVEKWA	VCFCD	CVWD	DWA	MWDSC(h	VCFCD	SBVMWD(g	CLWA	SBCFC&WCD	DRWD	CK
	[152]	[153]	[154]	[155]	[156]	[157]	[158]	[159]	[160]	[161]	[162]
1962	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	53	0	0	0	71,938	0	0	0	0	0	0
1973	20	0	0	0	155,297	0	0	0	0	0	0
1974	36	0	0	0	209,136	0	0	0	0	0	0
1975	26	0	0	0	374,280	0	0	0	0	0	0
1976	24	0	0	0	420,684	0	0	0	0	0	0
1977	0	0	0	0	122,447	0	0	0	0	0	0
1978	0	0	0	0	171,139	0	0	0	0	0	0
1979	0	0	0	0	145,591	0	0	7	0	0	0
1980	0	0	0	0	164,721	0	0	1,210	0	0	0
1981	0	0	0	0	277,503	0	0	5,761	0	0	0
1982	0	0	0	0	351,362	0	0	9,516	0	0	0
1983	0	0	0	0	157,519	0	0	9,476	0	0	0
1984	0	0	0	0	260,624	0	0	11,477	0	0	0
1985	0	0	0	0	390,696	0	0	12,401	0	0	0
1986	0	0	0	0	379,275	0	0	13,928	0	0	0
1987	0	0	0	0	417,285	0	0	16,167	0	0	0
1988	0	0	0	0	488,265	0	0	18,904	0	0	0
1989	0	0	0	0	589,962	0	0	21,719	0	0	0
1990	0	4,836	0	0	764,380	0	0	22,139	0	0	0
1991	0	988	0	0	257,835	0	0	3,846	1,240	0	0
1992	0	0	0	0	420,849	0	0	14,812	0	0	0
1993	6	0	0	0	437,470	0	0	13,787	0	0	0
1994	0	0	0	0	475,900	0	0	14,919	0	0	0
1995	0	0	0	0	139,882	0	0	17,747	0	0	0
1996	0	0	0	0	267,618	0	0	18,448	0	0	0
1997	11	0	10,240	16,890	271,379	1,850	0	22,842	0	0	0
1998	7	0	0	0	187,277	1,850	0	19,782	0	0	0
1999	0	0	0	0	327,001	1,850	0	28,813	0	0	0
2000	0	2,200	0	0	632,991	1,850	0	31,085	0	0	0
2001	0	0	0	0	444,764	1,850	0	30,701	0	0	0
2002	0	3,148	0	0	723,605	1,850	8,601	42,080	0	0	0
2003	0	3,150	0	0	678,964	1,850	0	51,735	0	0	0
2004	0	4,047	0	0	797,294	1,203	0	47,463	0	0	0
2005	0	0	0	0	538,839	1,665	0	36,747	0	4,684	0
2006	0	0	0	0	755,908	5,000	0	42,877	0	0	305
2007	0	3,150	0	0	827,235	16,850	0	50,000	0	0	305
2008	0	3,150	0	0	926,068	16,850	0	69,200	0	0	305
2009	0	3,150	0	0	926,068	16,850	0	69,200	0	0	305
2010	0	3,150	0	0	926,068	16,850	0	69,200	0	0	305
2011	0	3,150	0	0	1,027,235	16,850	0	89,177	0	0	305
2012	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2013	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2014	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2015	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2016	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2017	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2018	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2019	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2020	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2021	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2022	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2023	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2024	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2025	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2026	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2027	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2028	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2029	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2030	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2031	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2032	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2033	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2034	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
2035	0	3,150	0	0	1,027,235	16,850	0	95,200	0	0	305
TOTAL	183	109,719	10,240	16,890	42,555,994	509,468	8,601	3,211,966	1,240	4,684	9,150

h) Deliveries exclude 6,171 AF of 1982 exchange water.

TABLE B-5A. Annual Water Quantities Delivered from Each Aqueduct Reach to Each Contractor

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								GRAND TOTAL
	COASTAL BRANCH							TOTAL	
	Reach 31A				Reach 34	Reach 35			
	KCWA (M&I)	KCWA (AG)	CLWA	MWDSC	SLOCFC&WCD	SLOCFC&WCD	SBCFC&WCD		
	[163]	[164]	[165]	[166]	[167]	[168]	[169]	[170]	[171]
1962	0	0	0	0	0	0	0	0	8,906
1963	0	0	0	0	0	0	0	0	12,645
1964	0	0	0	0	0	0	0	0	20,911
1965	0	0	0	0	0	0	0	0	34,026
1966	0	0	0	0	0	0	0	0	54,913
1967	0	0	0	0	0	0	0	0	56,763
1968	0	71,657	7,382	0	0	0	0	192,188	294,457
1969	0	52,094	9,970	0	0	0	0	195,705	268,104
1970	0	71,910	11,739	0	0	0	0	276,211	369,459
1971	0	98,481	12,490	0	0	0	0	553,081	654,250
1972	0	107,850	13,905	0	0	0	0	895,006	1,037,584
1973	0	69,227	9,418	0	0	0	0	638,930	737,479
1974	0	68,474	9,700	0	0	0	0	783,984	878,820
1975	0	74,516	10,700	0	0	0	0	1,129,728	1,230,577
1976	0	78,358	11,700	0	0	0	0	1,245,662	1,379,597
1977	0	35,504	5,075	0	0	0	0	465,442	581,675
1978	0	81,242	11,362	0	0	0	0	1,339,268	1,458,154
1979	0	104,017	19,138	0	0	0	0	1,537,075	1,666,155
1980	0	97,497	13,882	0	0	0	0	1,413,363	1,536,189
1981	0	97,054	12,700	0	0	0	0	1,779,479	1,918,342
1982	0	83,076	12,700	0	0	0	0	1,641,571	1,750,528
1983	0	87,859	12,659	0	0	0	0	1,089,626	1,186,831
1984	0	119,098	12,741	0	0	0	0	1,489,814	1,591,131
1985	0	110,124	12,099	0	0	0	0	1,863,544	1,989,925
1986	0	118,298	13,301	0	0	0	0	1,882,290	1,998,514
1987	0	116,259	11,821	0	0	0	0	1,984,570	2,131,061
1988	0	109,435	11,534	0	0	0	0	2,221,538	2,384,434
1989	0	102,156	14,645	0	0	0	0	2,686,838	2,853,044
1990	0	103,362	6,440	0	0	0	0	2,398,121	2,581,277
1991	0	780	716	0	0	0	0	489,489	548,520
1992	0	73,748	5,887	0	0	0	0	1,374,775	1,470,695
1993	0	90,764	4,157	0	0	0	0	2,173,352	2,314,233
1994	200	77,536	9,422	0	0	0	0	1,727,504	1,860,612
1995	0	85,050	9,486	0	0	0	0	1,926,835	2,030,310
		1,996							
1996	0	100,578	14,052	0	0	0	0	2,429,928	2,542,395
1997	0	97,020	4,870	0	1,099	0	7,439	2,263,966	2,404,254
1998	0	86,879	311	0	3,592	0	18,618	1,657,381	1,763,382
1999	0	92,095	4,086	0	0	3,743	20,137	2,755,025	2,895,579
2000	0	87,554	8,395	5,662	0	3,962	22,741	3,360,734	3,538,240
2001	0	63,448	1,238	0	0	4,283	18,946	2,033,444	2,172,710
2002	0	65,055	2,737	0	0	4,355	27,636	2,742,315	2,911,327
2003	0	65,691	4,001	0	0	4,453	26,968	3,138,285	3,312,596
2004	0	66,498	3,776	0	4,165	0	29,705	3,054,577	3,231,641
2005	0	68,190	2,709	0	0	4,251	23,344	3,422,451	3,576,075
2006	0	78,771	5,089	0	0	25,528	34,664	3,801,777	4,002,135
2007	0	90,629	6,000	0	0	4,824	45,486	3,390,204	3,581,955
2008	0	90,629	6,000	0	0	25,000	45,486	3,329,268	3,574,322
2009	0	90,629	6,000	0	0	25,000	45,486	3,352,368	3,581,165
2010	0	90,629	6,000	0	0	25,000	45,486	3,352,368	3,581,610
2011	0	90,629	6,023	0	0	25,000	45,486	3,847,604	4,130,176
2012	0	90,629	0	0	0	25,000	45,486	3,847,604	4,130,631
2013	0	90,629	0	0	0	25,000	45,486	3,847,604	4,131,046
2014	0	90,629	0	0	0	25,000	45,486	3,847,604	4,131,561
2015	0	90,629	0	0	0	25,000	45,486	3,847,604	4,132,386
2016	0	90,629	0	0	0	25,000	45,486	3,847,604	4,133,111
2017	0	90,629	0	0	0	25,000	45,486	3,847,604	4,133,736
2018	0	90,629	0	0	0	25,000	45,486	3,847,604	4,134,361
2019	0	90,629	0	0	0	25,000	45,486	3,847,604	4,134,986
2020	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,586
2021	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2022	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2023	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2024	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2025	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2026	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2027	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2028	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2029	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2030	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2031	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2032	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2033	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2034	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
2035	0	90,629	0	0	0	25,000	45,486	3,847,604	4,135,686
TOTAL	200	5,887,442	378,056	5662	8,856	755,399	1,549,292	177,669,180	190,922,377

TABLE B-5B. Annual Water Quantities Delivered to Each Contractor

(in acre-feet)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA [b]				CENTRAL COASTAL AREA		
	Napa [a] County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1962	0	0	0	494	8,412	0	8,906	0	0	0
1963	0	0	0	1,731	10,914	0	12,645	0	0	0
1964	0	0	0	1,673	19,238	0	20,911	0	0	0
1965	0	0	0	2,605	16,407	15,014	34,026	0	0	0
1966	0	0	0	5,511	14,864	34,538	54,913	0	0	0
1967	0	0	0	4,780	12,882	39,101	56,763	0	0	0
1968	1,214	0	1,214	6,133	24,817	70,105	101,055	0	0	0
1969	2,687	0	2,687	6,635	813	62,264	69,712	0	0	0
1970	3,618	0	3,618	9,249	0	80,311	89,560	0	0	0
1971	2,521	0	2,521	5,017	5,961	87,606	98,584	0	0	0
1972	3,647	0	3,647	10,489	27,671	100,266	138,426	0	0	0
1973	3,792	0	3,792	2,975	2,521	88,582	94,078	0	0	0
1974	4,870	0	4,870	1,314	4	88,000	89,318	0	0	0
1975	6,840	0	6,840	4,618	986	88,000	93,604	0	0	0
1976	7,122	0	7,122	17,131	21,300	88,000	126,431	0	0	0
1977	8,226	0	8,226	12,644	18,840	76,220	107,704	0	0	0
1978	6,034	0	6,034	10,984	5,863	95,727	112,574	0	0	0
1979	6,561	0	6,561	19,325	10,874	91,991	122,190	0	0	0
1980	6,707	0	6,707	16,790	11,034	88,000	115,824	0	0	0
1981	9,001	0	9,001	19,590	21,917	88,000	129,507	0	0	0
1982	1,213	0	1,213	13,123	6,316	88,000	107,439	0	0	0
1983	2,287	0	2,287	4,766	3,157	86,733	94,656	0	0	0
1984	2,923	0	2,923	6,784	3,338	88,000	98,122	0	0	0
1985	4,039	0	4,039	15,072	19,016	88,000	122,088	0	0	0
1986	3,519	1,400	4,919	10,609	12,379	88,000	110,988	0	0	0
1987	7,693	1,550	9,243	23,406	25,390	88,000	136,796	0	0	0
1988	5,392	9,726	15,118	25,830	33,464	87,961	147,255	0	0	0
1989	6,195	17,256	23,451	26,227	26,042	90,000	142,269	0	0	0
1990	6,940	19,131	26,071	33,034	31,703	92,000	156,737	0	0	0
1991	1,380	6,972	8,352	9,411	12,648	28,200	50,259	0	1,240	1,240
1992	4,001	14,773	18,774	14,669	19,153	42,839	76,661	0	0	0
1993	5,286	29,180	34,466	33,635	10,271	62,065	105,971	0	0	0
1994	6,792	25,256	32,048	20,542	22,911	57,115	100,568	0	0	0
1995	5,182	21,345	26,527	30,091	17,793	28,756	76,640	0	0	0
1996	4,893	29,999	34,892	18,903	19,662	89,850	128,415	100	0	100
1997	4,341	33,530	37,871	27,522	24,063	95,601	147,186	1,199	7,439	8,638
1998	5,359	29,766	35,125	17,941	19,075	63,410	100,426	3,592	18,618	22,210
1999	5,304	34,753	40,057	48,910	37,652	82,945	169,507	3,743	20,137	23,880
2000	4,958	37,015	41,973	58,617	35,978	101,988	196,583	3,962	22,741	26,703
2001	9,345	34,586	43,931	34,409	18,004	77,922	130,335	4,283	18,946	23,229
2002	6,875	38,560	45,435	53,261	27,811	62,186	143,258	4,355	28,381	32,736
2003	7,646	33,951	41,597	45,450	36,590	108,981	191,021	4,453	26,968	31,421
2004	8,134	43,002	51,136	52,364	27,884	59,458	139,706	4,165	29,705	33,870
2005	7,669	37,819	45,488	47,512	44,599	128,249	220,360	4,251	23,344	27,595
2006	15,708	48,116	63,824	57,095	42,664	71,108	170,867	25,528	34,664	60,192
2007	17,000	40,845	57,845	64,259	42,000	92,000	198,259	4,824	45,486	50,310
2008	24,975	64,523	89,498	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2009	23,525	47,456	70,981	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2010	23,850	47,506	71,356	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2011	24,175	47,556	71,731	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2012	24,500	47,606	72,106	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2013	24,775	47,656	72,431	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2014	25,150	47,706	72,856	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2015	25,825	47,756	73,581	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2016	26,450	47,756	74,206	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2017	27,075	47,756	74,831	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2018	27,700	47,756	75,456	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2019	28,325	47,756	76,081	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2020	28,925	47,756	76,681	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2021	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2022	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2023	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2024	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2025	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2026	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2027	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2028	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2029	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2030	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2031	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2032	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2033	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2034	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
2035	29,025	47,756	76,781	80,619	42,000	100,000	222,619	25,000	45,486	70,486
TOTAL	1,003,539	1,941,416	2,944,955	3,210,462	2,030,881	6,131,092	11,372,435	764,455	1,551,277	2,315,732

a) Non-Project water deliveries were pumped through an interim facility from 1968 through 1987.

b) Non-Porject water deliveries were supplied from June 1962 through November 1967.

TABLE B-5B. Annual Water Quantities Delivered to Each Contractor

(in acre-feet)

Calendar Year	SAN JOAQUIN VALLEY AREA								
	Dudley Ridge Water District	Empire West Side Irrigation District	Kern County Water Agency			County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
			Municipal and Industrial	Agricultural	Total				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	26,360	1,978	0	127,384	127,384	900	3,084	25,100	184,806
1969	31,375	56	0	141,265	141,265	100	3,016	9,923	185,735
1970	40,407	3,942	0	204,634	204,634	0	5,911	9,578	264,472
1971	41,053	5,990	0	360,151	360,151	3,700	7,212	122,485	540,591
1972	42,443	5,795	0	490,781	490,781	1,400	8,166	258,393	806,978
1973	22,057	3,000	0	341,469	341,469	1,500	3,214	50,464	421,704
1974	33,390	3,000	23,708	323,292	347,000	1,500	3,471	72,289	460,650
1975	40,555	3,000	14,529	396,291	410,820	1,600	3,576	86,258	545,809
1976	41,421	3,000	46,719	392,531	439,250	1,600	4,112	58,811	548,194
1977	11,153	738	27,882	163,425	191,307	1,530	1,472	18,081	224,281
1978	51,747	454	76,895	590,452	667,347	2,070	3,906	12,053	737,577
1979	38,544	1,739	62,997	683,049	746,046	2,000	6,149	155,121	949,599
1980	41,000	894	45,943	588,557	634,500	2,200	5,700	75,444	759,738
1981	41,000	5,859	75,758	615,642	691,400	2,300	4,300	83,438	828,297
1982	41,000	361	47,477	697,823	745,300	1,750	3,838	18,551	810,800
1983	42,900	0	6,854	587,653	594,507	3,550	3,822	1,006	645,785
1984	45,100	0	90,904	769,696	860,600	3,100	5,700	5,743	920,243
1985	46,251	5,197	88,515	800,381	888,896	3,400	5,433	109,791	1,058,968
1986	50,249	1,170	77,240	829,101	906,341	3,700	5,107	79,355	1,045,922
1987	46,288	2,525	117,174	852,731	969,905	4,000	5,625	93,084	1,121,427
1988	47,994	3,475	122,409	887,111	1,009,520	4,000	4,412	95,866	1,165,267
1989	57,049	3,000	123,896	1,022,166	1,146,062	4,000	6,091	127,950	1,344,152
1990	36,296	1,279	127,837	584,611	712,448	2,000	2,922	57,070	812,015
1991	927	221	33,122	8,965	42,087	0	141	2,180	45,556
1992	23,770	1,354	62,326	420,894	483,220	1,806	2,239	46,728	559,117
1993	50,618	2,741	128,316	1,039,614	1,167,930	4,000	4,858	124,468	1,354,615
1994	28,793	1,666	87,139	570,020	657,159	2,116	3,071	62,362	755,167
1995	60,686	1,631	135,415	1,016,114	1,151,529	4,000	5,169	101,869	1,324,884
1996	56,948	1,868	135,654	1,049,409	1,185,063	4,000	4,904	236,875	1,489,658
1997	71,308	0	120,708	987,451	1,108,159	0	5,238	22,369	1,207,074
1998	55,650	542	89,765	768,825	858,590	15	4,401	20,677	939,875
1999	59,697	3,176	138,153	1,039,985	1,178,138	4,000	4,871	289,735	1,539,617
2000	60,539	1,799	122,484	1,055,885	1,178,369	3,600	4,508	198,313	1,447,128
2001	41,548	1,360	21,460	632,279	653,739	1,560	3,592	84,726	786,525
2002	48,170	1,405	90,967	737,864	828,831	2,854	4,885	96,502	982,647
2003	46,082	1,436	107,978	856,252	964,230	3,692	4,266	105,841	1,125,547
2004	49,080	3,562	127,711	716,220	843,931	9,053	4,629	90,021	1,000,276
2005	79,005	3,834	92,608	1,305,452	1,398,060	19,806	4,194	140,002	1,644,901
2006	58,652	4,236	104,135	1,063,832	1,167,967	9,750	4,928	98,771	1,344,304
2007	57,343	3,000	120,390	868,340	988,730	9,305	5,700	95,922	1,160,000
2008	57,343	3,000	120,390	878,340	998,730	9,305	5,700	95,922	1,170,000
2009	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2010	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2011	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2012	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2013	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2014	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2015	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2016	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2017	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2018	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2019	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2020	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2021	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2022	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2023	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2024	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2025	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2026	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2027	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2028	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2029	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2030	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2031	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2032	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2033	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2034	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
2035	57,343	3,000	134,600	864,130	998,730	9,305	5,700	95,922	1,170,000
TOTAL	3,370,052	174,283	6,649,658	50,797,447	57,447,105	391,997	337,433	6,129,031	67,849,901

TABLE B-5B. Annual Water Quantities Delivered to Each Contractor

(in acre-feet)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency [c]	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	7,382	0	0	0	0	0	0	0	0
1969	0	9,970	0	0	0	0	0	0	0	0
1970	0	11,739	0	0	0	0	0	0	0	0
1971	0	12,490	0	0	0	0	0	0	0	0
1972	53	13,905	0	464	0	338	55	0	1,275	0
1973	20	9,418	5,800	389	9,000	290	0	0	32,426	0
1974	1,259	9,700	6,400	627	10,000	400	14	0	16,605	612
1975	8,068	10,700	7,000	825	11,000	520	0	0	13,865	5,450
1976	27,782	11,700	7,600	1,002	12,000	589	0	0	12,273	6,071
1977	11,202	5,075	0	1,109	0	111	80	0	24,833	8,996
1978	44,137	11,362	10,084	1,209	15,300	208	0	0	4,055	7,771
1979	60,493	19,145	10,063	1,260	15,000	133	4,000	0	18	290
1980	72,407	15,092	10,884	1,239	17,000	191	4,000	0	0	1,085
1981	79,375	18,461	12,105	1,485	19,000	1,270	4,000	0	16,021	3,619
1982	50,291	22,216	13,326	1,238	21,000	0	10,500	0	8,409	12,599
1983	32,961	22,135	14,547	911	23,000	38	0	0	5,994	734
1984	32,662	24,218	15,768	1,128	25,000	1	0	0	5,556	7,656
1985	37,064	24,500	16,989	1,422	27,000	0	0	1,558	7,390	5,028
1986	32,449	27,229	18,210	1,506	29,000	163	0	3,096	6,421	9,454
1987	34,089	27,988	19,431	1,849	31,500	1,085	17	5,379	18,751	10,630
1988	34,079	30,438	20,652	2,006	34,000	419	9	1,770	21,386	8,948
1989	45,280	36,364	21,873	2,170	36,500	971	200	9,009	20,782	12,839
1990	47,206	28,579	23,100	1,827	38,100	1,747	0	8,608	18,831	16,649
1991	9,568	4,562	6,930	849	11,430	522	3,423	3,914	3,661	5,399
1992	30,265	20,699	10,427	519	17,197	251	10,686	4,035	3,358	7,908
1993	43,102	23,039	23,100	439	38,100	734	11,514	7,761	4,361	14,397
1994	49,153	26,441	14,102	785	23,257	1,098	16,852	8,418	9,135	15,230
1995	47,286	27,233	23,100	409	38,100	480	8,722	6,961	696	12,922
1996	56,356	32,500	62,219	485	102,622	494	7,427	11,434	6,064	15,989
1997	62,393	27,712	68,340	651	69,990	444	10,374	11,861	9,654	18,175
1998	52,926	20,093	85,709	187	70,647	404	3,925	8,752	1,878	9,310
1999	69,073	32,899	50,480	1,132	58,100	342	8,144	13,278	12,874	21,729
2000	83,577	40,680	42,323	1,194	58,234	0	11,380	9,060	18,399	15,140
2001	62,857	31,939	9,100	1,057	15,010	0	4,433	10,427	26,488	2,360
2002	58,171	68,817	16,755	2,189	27,640	0	4,346	18,496	72,069	24,851
2003	60,029	55,736	14,443	1,563	23,819	0	14,435	11,547	27,415	21,934
2004	59,731	83,761	15,465	2,006	21,190	0	13,176	12,162	56,150	12,541
2005	59,831	59,456	34,356	205	49,089	0	13,561	11,712	18,835	13,984
2006	74,461	58,516	60,550	2,900	25,000	800	39,418	18,284	75,002	15,160
2007	54,396	56,000	104,600	3,340	30,950	2,300	18,455	21,300	72,600	12,000
2008	126,695	95,200	121,100	5,920	50,000	2,300	66,485	21,300	102,600	28,800
2009	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2010	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2011	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2012	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2013	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2014	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2015	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2016	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2017	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2018	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2019	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2020	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2021	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2022	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2023	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2024	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2025	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2026	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2027	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2028	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2029	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2030	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2031	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2032	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2033	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2034	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
2035	141,400	95,200	121,100	5,800	50,000	2,300	75,800	21,300	102,600	28,800
TOTAL	5,528,547	3,745,489	4,266,631	206,096	2,453,775	80,743	2,336,231	815,222	3,526,330	1,163,860

c) Devil's Den Water District merged with Castaic Lake Water Agency effective January 1, 1992.

TABLE B-5B. Annual Water Quantities Delivered to Each Contractor

(in acre-feet)

Calendar Year	SOUTHERN CALIFORNIA AREA (contd.)				FEATHER RIVER AREA				South Bay Area Future Contractor	GRAND TOTAL
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total		
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1962	0	0	0	0	0	0	0	0	0	8,906
1963	0	0	0	0	0	0	0	0	0	12,645
1964	0	0	0	0	0	0	0	0	0	20,911
1965	0	0	0	0	0	0	0	0	0	34,026
1966	0	0	0	0	0	0	0	0	0	54,913
1967	0	0	0	0	0	0	0	0	0	56,763
1968	0	0	0	7,382	0	0	0	0	0	294,457
1969	0	0	0	9,970	0	0	0	0	0	268,104
1970	0	0	0	11,739	0	0	70	70	0	369,459
1971	0	0	0	12,490	0	0	64	64	0	654,250
1972	0	71,938	0	88,028	0	0	505	505	0	1,037,584
1973	0	159,883	0	217,226	0	0	679	679	0	737,479
1974	0	277,717	0	323,334	0	0	648	648	0	878,820
1975	0	526,491	0	583,919	0	0	405	405	0	1,230,577
1976	0	618,451	0	697,468	0	0	382	382	0	1,379,597
1977	0	189,755	0	241,161	0	0	303	303	0	581,675
1978	0	507,565	0	601,691	0	0	278	278	0	1,458,154
1979	0	477,074	0	587,476	0	0	329	329	0	1,666,155
1980	0	531,727	0	653,625	0	0	295	295	0	1,536,189
1981	0	795,846	0	951,182	0	0	355	355	0	1,918,342
1982	0	691,192	0	830,771	0	0	305	305	0	1,750,528
1983	0	343,521	0	443,841	0	0	262	262	0	1,186,831
1984	0	457,582	0	569,571	0	0	272	272	0	1,591,131
1985	0	683,625	0	804,576	0	0	254	254	0	1,989,925
1986	0	708,840	0	836,368	0	0	317	317	0	1,998,514
1987	0	712,424	0	863,143	0	0	452	452	0	2,131,061
1988	0	902,564	0	1,056,271	0	0	523	523	0	2,384,434
1989	0	1,156,698	0	1,342,686	0	0	486	486	0	2,853,044
1990	0	1,396,423	4,836	1,585,906	0	0	548	548	0	2,581,277
1991	0	391,447	988	442,693	0	0	420	420	0	548,520
1992	0	710,313	0	815,658	0	0	485	485	0	1,470,695
1993	0	652,190	0	818,737	0	0	444	444	0	2,314,233
1994	0	807,866	0	972,337	0	0	492	492	0	1,860,612
1995	0	436,042	0	601,951	0	0	308	308	0	2,030,310
1996	0	593,380	0	888,970	0	0	360	360	0	2,542,395
1997	0	721,810	1,850	1,003,254	0	0	231	231	0	2,404,254
1998	0	410,065	1,850	665,746	0	0	0	0	0	1,763,382
1999	0	852,617	1,850	1,122,518	1,096	286	0	1,382	0	2,896,961
2000	0	1,541,816	4,050	1,825,853	901	586	0	1,487	0	3,539,727
2001	0	1,023,169	1,850	1,188,690	1,065	513	0	1,578	0	2,174,288
2002	0	1,408,919	4,998	1,707,251	1,181	419	0	1,600	0	2,912,927
2003	116	1,686,973	5,000	1,923,010	1,324	551	0	1,875	0	3,314,471
2004	841	1,724,380	5,250	2,006,653	1,434	1,440	0	2,874	0	3,234,515
2005	692	1,374,345	1,665	1,637,731	1,894	527	0	2,421	0	3,578,496
2006	2,690	1,984,897	5,000	2,362,678	5,480	1,200	270	6,950	0	4,008,815
2007	7,500	1,711,500	20,000	2,114,941	9,600	1,183	600	11,383	0	3,592,738
2008	17,300	1,363,389	20,000	2,021,089	9,600	1,200	630	11,430	0	3,585,122
2009	17,300	1,363,389	20,000	2,044,989	9,600	27,500	2,090	39,190	0	3,618,265
2010	17,300	1,363,389	20,000	2,044,989	9,600	27,500	2,160	39,260	0	3,618,710
2011	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,240	39,340	0	4,167,276
2012	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,320	39,420	0	4,167,731
2013	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,410	39,510	0	4,168,146
2014	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,500	39,600	0	4,168,661
2015	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,600	39,700	0	4,169,486
2016	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,170,211
2017	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,170,836
2018	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,171,461
2019	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,086
2020	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,686
2021	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2022	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2023	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2024	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2025	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2026	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2027	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2028	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2029	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2030	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2031	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2032	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2033	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2034	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
2035	17,300	1,911,500	20,000	2,593,100	9,600	27,500	2,700	39,800	0	4,172,786
TOTAL	496,239	81,118,712	619,187	106,357,062	292,775	750,405	82,292	1,125,472	0	191,965,557

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	NORTH BAY AQUEDUCT											
	Barker Slough Pumping Plant				Cordelia Pumping Plant Solano County WA				Cordelia Pumping Plant Napa County FC&WCD			
	Initial Fill Water	Operational Losses	Water Supply Delivery	Total	Initial Fill Water	Operational Losses	Water Supply Delivery	Total	Initial Fill Water	Operational Losses	Water Supply Delivery [a]	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	24	(10)	1,214	1,228
1969	0	0	0	0	0	0	0	0	0	2	2,687	2,689
1970	0	0	0	0	0	0	0	0	0	18	3,618	3,636
1971	0	0	0	0	0	0	0	0	0	4	2,521	2,525
1972	0	0	0	0	0	0	0	0	0	(10)	3,647	3,637
1973	0	0	0	0	0	0	0	0	0	1	3,792	3,793
1974	0	0	0	0	0	0	0	0	0	10	4,870	4,880
1975	0	0	0	0	0	0	0	0	0	10	6,840	6,850
1976	0	0	0	0	0	0	0	0	0	4	7,122	7,126
1977	0	0	0	0	0	0	0	0	0	2	8,226	8,228
1978	0	0	0	0	0	0	0	0	0	(6)	6,034	6,028
1979	0	0	0	0	0	0	0	0	0	1	6,561	6,562
1980	0	0	0	0	0	0	0	0	0	(3)	6,707	6,704
1981	0	0	0	0	0	0	0	0	0	8	9,001	9,009
1982	0	0	0	0	0	0	0	0	0	(8)	1,213	1,205
1983	0	0	0	0	0	0	0	0	0	(12)	2,287	2,275
1984	0	0	0	0	0	0	0	0	0	(15)	2,923	2,908
1985	0	0	0	0	0	0	0	0	0	13	4,039	4,052
1986	0	0	0	0	0	0	0	0	0	(4)	3,519	3,515
1987	0	0	0	0	0	0	0	0	0	0	7,693	7,693
1988	1	283	15,118	15,402	0	0	9,725	9,725	1	(1)	5,392	5,392
1989	0	758	23,451	24,209	0	0	17,246	17,246	0	(4)	6,195	6,191
1990	0	3	26,071	26,074	0	(634)	15,856	15,222	0	3	6,940	6,943
1991	0	667	8,352	9,019	0	124	3,855	3,979	0	198	1,380	1,578
1992	0	1,643	18,774	20,417	0	0	9,220	9,220	0	0	4,001	4,001
1993	0	1,153	34,466	35,619	0	0	14,471	14,471	0	0	5,286	5,286
1994	0	780	32,048	32,828	0	(6)	14,913	14,907	0	0	6,792	6,792
1995	0	908	26,527	27,435	0	0	15,893	15,893	0	0	5,182	5,182
1996	0	1,354	34,892	36,246	0	0	17,069	17,069	0	0	4,893	4,893
1997	0	1,422	37,871	39,293	0	0	17,501	17,501	0	0	4,341	4,341
1998	0	1,343	35,125	36,468	0	0	18,204	18,204	0	0	5,359	5,359
1999	0	2,522	40,057	42,579	0	0	19,562	19,562	0	0	5,304	5,304
2000	0	1,853	41,973	43,826	0	4	21,525	21,529	0	180	4,958	5,138
2001	0	1,760	43,931	45,691	0	0	19,737	19,737	0	0	9,345	9,345
2002	0	496	45,435	45,931	0	0	19,719	19,719	0	0	6,875	6,875
2003	0	3,991	41,597	45,588	0	0	16,691	16,691	0	0	7,646	7,646
2004	0	2,181	51,136	53,317	0	0	22,051	22,051	0	0	8,134	8,134
2005	0	935	45,488	46,423	0	0	19,189	19,189	0	0	8,009	8,009
2006	0	51	63,824	63,875	0	0	29,212	29,212	0	5	15,708	15,713
2007	0	51	57,845	57,896	0	0	20,975	20,975	0	5	17,000	17,005
2008	0	51	89,498	89,549	0	0	20,975	20,975	0	5	24,975	24,980
2009	0	51	70,981	71,032	0	0	6,625	6,625	0	5	23,525	23,530
2010	0	51	71,356	71,407	0	0	6,625	6,625	0	5	23,850	23,855
2011	0	51	71,731	71,782	0	0	18,150	18,150	0	5	24,175	24,180
2012	0	51	72,106	72,157	0	0	18,150	18,150	0	5	24,500	24,505
2013	0	51	72,431	72,482	0	0	18,150	18,150	0	5	24,775	24,780
2014	0	51	72,856	72,907	0	0	18,150	18,150	0	5	25,150	25,155
2015	0	51	73,581	73,632	0	0	18,150	18,150	0	5	25,825	25,830
2016	0	51	74,206	74,257	0	0	18,150	18,150	0	5	26,450	26,455
2017	0	51	74,831	74,882	0	0	18,150	18,150	0	5	27,075	27,080
2018	0	51	75,456	75,507	0	0	18,150	18,150	0	5	27,700	27,705
2019	0	51	76,081	76,132	0	0	18,150	18,150	0	5	28,325	28,330
2020	0	51	76,681	76,732	0	0	18,150	18,150	0	5	28,925	28,930
2021	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2022	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2023	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2024	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2025	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2026	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2027	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2028	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2029	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2030	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2031	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2032	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2033	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2034	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030
2035	0	51	76,781	76,832	0	0	18,150	18,150	0	5	29,025	29,030

a) Non-Project water deliveries were pumped through an interim facility from 1968 through 1987.

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	SOUTH BAY AQUEDUCT						CALIFORNIA AQUEDUCT							
	South Bay Pumping Plant						North San Joaquin Division Banks Pumping Plant Transportation Water							
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply [b]	Deliveries: Recreation	Total	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total	Conservation Water	Total
	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	9	272	0	8,906	0	9,187	0	0	0	0	0	0	0	0
1963	71	185	0	12,645	0	12,901	0	0	0	0	0	0	0	0
1964	171	152	0	20,911	0	21,234	0	0	0	0	0	0	0	0
1965	93	729	0	34,026	0	34,848	0	0	0	0	0	0	0	0
1966	0	1,746	0	54,913	0	56,659	0	0	0	0	0	0	0	0
1967	0	1,677	0	56,763	0	58,440	5,746	1,183	0	11,538	0	18,467	2,957	21,424
1968	0	1,847	0	101,055	0	102,902	11,079	74,464	0	293,243	0	378,786	531,275	910,061
1969	3,449	2,668	0	69,712	0	75,829	7,336	44,287	0	265,417	0	317,040	531,185	848,225
1970	16,279	1,086	(5,355)	89,560	0	101,570	23,947	20,767	(5,355)	365,771	0	405,130	(12,995)	392,135
1971	0	1,815	8,854	98,584	0	109,253	23,207	(10,754)	8,854	651,665	8	672,980	7,708	680,688
1972	0	3,557	2,273	138,426	0	144,256	145,066	9,057	(4,285)	1,033,432	6,489	1,189,759	48,300	1,238,059
1973	0	(33)	(1,510)	94,078	0	92,535	214,941	(4,951)	2,902	733,008	1,155	947,055	55,846	1,002,901
1974	0	1,287	(10,056)	89,318	0	80,549	247,894	(11,526)	(32,510)	873,302	2,118	1,079,278	54,683	1,133,961
1975	0	320	8,550	93,604	0	102,474	110,149	(8,092)	16,101	1,223,332	3,377	1,344,867	(102,625)	1,242,242
1976	0	2,431	1,391	126,431	141	130,394	67,834	5,443	(244,124)	1,372,093	1,745	1,202,991	(442,348)	760,643
1977	0	2,866	2,685	107,704	112	113,367	0	39,897	(157,543)	573,146	1,111	456,611	(13,507)	443,104
1978	0	2,165	(11,249)	112,574	126	103,616	67,457	(36,898)	35,129	1,451,842	1,177	1,518,707	752,075	2,270,782
1979	0	2,401	1,069	122,190	89	125,749	17,397	60,958	(32,307)	1,659,265	1,398	1,706,711	(112,053)	1,594,658
1980	0	1,758	(6,563)	115,824	123	111,142	3,159	58,484	(275,538)	1,529,187	2,131	1,317,423	186,601	1,504,024
1981	0	2,627	13,742	129,507	121	145,997	46,060	85,350	40,536	1,908,986	4,974	2,085,906	(931,878)	1,154,028
1982	0	2,344	(23,928)	107,439	129	85,984	5,979	61,556	99,897	1,743,145	4,646	1,915,223	347,983	2,263,206
1983	0	2,151	(22,886)	94,656	132	74,053	6,071	47,022	(310,477)	1,184,282	7,853	934,751	835,771	1,770,522
1984	0	2,088	8,442	98,122	158	108,810	38,649	97,143	(108,548)	1,587,936	5,874	1,621,054	21,875	1,642,929
1985	0	2,817	(1,607)	122,088	152	123,450	0	110,469	137,783	1,985,632	5,452	2,239,336	(110,569)	2,128,767
1986	0	2,299	(1,850)	110,988	130	111,567	0	90,799	20,177	1,993,278	3,865	2,108,119	200,298	2,308,417
1987	0	2,625	(584)	136,796	137	138,974	0	91,427	(23,116)	2,121,366	7,672	2,197,349	(458,725)	1,738,624
1988	0	2,884	(698)	147,255	142	149,583	0	107,249	(35,484)	2,368,793	4,889	2,445,447	(303,583)	2,141,864
1989	0	2,673	3,296	142,269	152	148,390	0	117,603	(38,058)	2,829,107	8,135	2,916,787	421,131	3,337,918
1990	0	894	1,982	156,537	168	159,581	0	99,059	(290,965)	2,554,658	9,262	2,372,014	(374,027)	1,997,987
1991	0	2,637	(4,532)	50,259	150	48,514	0	80,106	(79,038)	539,748	4,879	545,695	554,904	1,100,599
1992	0	2,881	756	76,661	147	80,445	0	91,391	(218,170)	1,451,436	2,605	1,327,262	61,343	1,388,605
1993	0	1,940	(20,051)	105,971	143	88,003	0	149,372	(273,789)	2,279,323	2,609	2,157,515	849,249	3,006,764
1994	0	1,981	1,714	100,568	168	104,431	0	148,712	(120,985)	1,828,072	3,803	1,859,602	(324,640)	1,534,962
1995	0	1,188	(12,333)	76,640	146	65,641	0	173,074	(397,605)	2,003,475	2,575	1,781,519	293,159	2,074,678
1996	0	981	(1,990)	77,215	150	76,356	0	123,502	78,123	2,507,143	3,902	2,712,670	288,576	3,001,246
1997	0	1,575	5,016	102,186	155	108,932	527	135,106	(98,334)	2,366,152	2,594	2,406,045	(50,000)	2,356,045
1998	0	1,551	3,595	70,876	114	76,136	0	91,319	(346,039)	1,728,257	2,107	1,475,644	120,886	1,596,530
1999	0	2,166	12,313	100,497	139	115,115	0	135,809	(17,569)	2,855,522	4,301	2,978,063	(307,839)	2,670,224
2000	0	2,346	(20,958)	135,533	145	117,066	0	115,895	(13,232)	3,471,397	5,182	3,579,242	(15,487)	3,563,755
2001	0	2,784	1,301	95,335	196	99,616	0	222,144	(17,529)	1,903,190	1,978	2,109,783	86,928	2,196,711
2002	0	2,534	(13,938)	123,577	146	112,319	0	225,032	36,404	2,807,771	4,672	3,073,879	(151,719)	2,922,160
2003	0	2,920	(1,399)	132,714	131	134,366	0	226,713	(49,580)	3,198,537	11,362	3,387,032	328,334	3,715,366
2004	0	2,982	(7,240)	125,928	150	121,820	0	40,711	(4,079)	2,979,181	1,337	3,017,150	146,888	3,164,038
2005	0	2,823	(3,565)	108,136	154	107,548	0	120,419	(163,243)	3,667,793	1,270	3,626,239	571,155	4,197,394
2006	0	3,301	(2,807)	136,264	400	137,158	0	136,198	(63,771)	3,938,041	8,660	4,019,128	0	4,019,128
2007	0	3,298	193	133,306	400	137,197	0	132,919	80,228	3,523,510	8,660	3,745,317	0	3,745,317
2008	0	3,298	193	154,926	400	158,817	0	125,910	190	3,484,194	8,660	3,618,954	30,977	3,649,931
2009	0	3,351	0	155,726	400	159,477	0	129,619	(15,186)	3,508,094	8,660	3,631,187	(140,708)	3,490,479
2010	0	3,351	0	155,726	400	159,477	0	128,523	4,288	3,508,094	8,660	3,649,565	182,970	3,832,535
2011	0	3,351	0	208,601	400	212,352	0	128,364	64,678	4,056,205	8,660	4,257,907	137,242	4,395,149
2012	0	3,351	0	208,601	400	212,352	0	128,100	(67,943)	4,056,205	8,660	4,125,022	(260,827)	3,864,195
2013	0	3,351	0	208,601	400	212,352	0	128,264	9,749	4,056,205	8,660	4,202,878	145,525	4,348,403
2014	0	3,351	0	208,601	400	212,352	0	130,280	16,625	4,056,205	8,660	4,211,770	(186,678)	4,025,092
2015	0	3,351	0	208,601	400	212,352	0	130,445	32,003	4,056,205	8,660	4,227,313	(31,516)	4,195,797
2016	0	3,351	0	208,601	400	212,352	0	128,415	(28,401)	4,056,205	8,660	4,164,879	205,134	4,370,013
2017	0	3,351	0	208,601	400	212,352	0	128,602	61,309	4,056,205	8,660	4,254,776	119,885	4,374,661
2018	0	3,351	0	208,601	400	212,352	0	128,369	(80,817)	4,056,205	8,660	4,112,417	(194,534)	3,917,883
2019	0	3,351	0	208,601	400	212,352	0	128,613	50,179	4,056,205	8,660	4,243,657	77,224	4,320,881
2020	0	3,351	0	208,601	400	212,352	0	128,690	(366)	4,056,205	8,660	4,193,189	(8,687)	4,184,502
2021	0	3,351	0	208,601	400	212,352	0	128,769	10,725	4,056,205	8,660	4,204,359	(1,095)	4,203,264
2022	0	3,351	0	208,601	400	212,352	0	128,846	(3,483)	4,056,205	8,660	4,190,228	(185,907)	4,004,321
2023	0	3,351	0	208,601	400	212,352	0	128,818	(18,971)	4,056,205	8,660	4,174,712	115,791	4,290,503
2024	0	3,351	0	208,601	400	212,352	0	128,625	11,289	4,056,205	8,660	4,204,779	79,858	4,284,637
2025	0	3,351	0	208,601	400	212,352	0	130,380	(12,518)	4,056,205	8,660	4,182,727	(247,205)	3,935,522
2026	0	3,351	0	208,601	400	212,352	0	128,700	24,308	4,056,205	8,660	4,217,873	246,850	4,464,723
2027	0	3,351	0	208,601	400	212,352	0	128,692	(17,799)	4,056,205	8,660	4,175,758	(12,304)	4,163,454
2028	0	3,351	0	208,601	400	212,352	0	128,783	12,291	4,056,205	8,660	4,205,939	15,430	4,221,369
2029	0	3,351	0	208,601	400	212,352	0	128,671	(9,046)	4,056,205	8,660	4,184,490	(10,778)	4,173,712
2030	0	3,351	0	208,601	400	212,352	0	128,777	20,756	4,056,205	8,660	4,214,398	124,586	4,338,984
2031	0	3,351	0	208,601	400	212,352	0	128,134	(97,726)	4,056,205	8,660	4,095,273	(259,831)	3,835,442
2032	0	3,351	0	208,601	400	212,352	0	128,005	84,999	4,056,205	8,660	4,277,869	138,527	4,416,396
2033	0	3,351	0	208,601	400	212,352	0	127,876	(94,652)	4,056,205	8,660	4,098,089	(184,372)	3,913,717
2034	0	3,351	0	208,601	400	212,352	0	127,725	69,593	4,056,205	8,660	4,262,183	120,375	4,382,558
2035	0	3,351	0	208,601	400	212,352	0	127,379	(242,659)	4,056,205	8,660	3,949,585	(587,531)	3,362,054

b) Non-Project water deliveries were supplied from June 1962 through November 1967.

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)											
	San Luis Division						South San Joaquin Division					
	Dos Amigos Pumping Plant						Buena Vista Pumping Plant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total
	[27]	[28]	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	11,079	25,126	0	189,104	0	225,309	0	0	0	0	0	0
1969	3,887	9,922	0	192,689	0	206,498	0	0	0	0	0	0
1970	7,668	1,901	0	270,300	0	279,869	4,779	1,012	0	3	0	5,794
1971	23,207	(12,030)	0	545,869	0	557,046	7,853	8,399	0	101,512	0	117,764
1972	145,066	(6,635)	(6,558)	886,840	6,481	1,025,194	100,274	20,044	(6,558)	223,626	6,481	343,867
1973	214,941	(6,778)	1,329	635,716	1,147	846,355	204,638	35,695	1,329	311,096	1,147	553,905
1974	247,894	(16,765)	(15,295)	780,513	2,108	998,455	237,554	19,672	(15,295)	388,949	2,108	632,988
1975	110,149	(12,144)	(693)	1,126,152	3,358	1,226,822	103,352	26,342	(693)	672,531	3,358	804,890
1976	67,834	(456)	(152,171)	1,241,550	1,581	1,158,338	61,122	29,428	(152,171)	785,055	1,581	725,015
1977	0	26,359	(116,219)	463,970	737	374,847	0	25,173	(116,219)	271,944	560	181,458
1978	67,457	1,905	79,308	1,335,362	680	1,484,712	65,027	17,751	121,904	762,043	674	967,399
1979	17,397	33,884	(51,299)	1,530,926	685	1,531,593	12,302	46,157	(51,299)	737,714	502	745,376
1980	3,159	34,391	(272,825)	1,407,663	1,514	1,173,902	0	49,025	(134,009)	778,059	1,262	694,337
1981	46,060	36,962	23,359	1,775,179	4,348	1,885,908	0	38,942	23,359	1,077,322	4,112	1,143,735
1982	5,979	57,146	116,086	1,631,868	4,205	1,815,284	0	29,059	117,174	990,863	4,045	1,141,141
1983	6,071	63,583	(101,155)	1,085,804	7,475	1,061,778	0	40,205	(101,155)	593,920	7,291	540,261
1984	38,649	109,263	(112,744)	1,484,114	5,391	1,524,673	0	38,487	(114,984)	781,955	5,244	710,702
1985	0	86,772	138,898	1,858,111	4,936	2,088,717	0	42,838	139,689	992,606	4,804	1,179,937
1986	0	51,963	19,989	1,877,183	3,426	1,952,561	0	36,751	37,546	1,014,294	3,285	1,091,876
1987	0	64,827	(25,707)	1,978,945	7,121	2,025,186	0	30,495	(25,522)	1,027,361	6,937	1,039,271
1988	0	72,679	(34,592)	2,217,126	4,490	2,259,703	0	38,804	(29,747)	1,244,196	4,360	1,257,613
1989	0	90,090	(29,411)	2,679,845	7,652	2,748,176	0	29,594	(60,826)	1,532,625	7,490	1,508,883
1990	0	115,074	(11,323)	2,394,999	8,922	2,507,672	0	46,865	(15,092)	1,769,991	8,879	1,810,643
1991	0	92,227	9,325	489,348	4,605	595,505	0	39,274	96,506	446,916	4,560	587,256
1992	0	118,796	(225,603)	1,372,536	2,079	1,267,808	0	28,138	(98,271)	920,978	1,995	852,840
1993	0	136,432	(220,537)	2,170,494	1,864	2,088,253	0	14,186	(128,363)	908,200	1,676	795,699
1994	0	152,414	(78,957)	1,724,433	3,098	1,800,988	0	35,083	(88,211)	1,107,122	2,918	1,056,912
1995	0	137,937	(12,473)	1,921,666	1,711	2,048,841	0	33,963	(16,431)	706,742	1,669	725,943
1996	0	45,591	14,927	2,425,024	2,998	2,488,540	0	31,304	15,438	988,612	2,928	1,038,282
1997	527	107,033	(66,814)	2,247,628	2,090	2,290,464	0	42,670	40,852	1,054,461	2,076	1,140,059
1998	0	95,185	(338,076)	1,664,080	1,589	1,422,778	0	41,910	(106,487)	753,731	1,585	690,739
1999	0	95,262	(2,778)	2,750,154	3,285	2,845,923	0	48,502	(2,807)	1,131,826	3,279	1,180,800
2000	0	134,231	7,726	3,270,211	4,222	3,416,390	0	37,514	7,726	1,809,219	4,216	1,858,675
2001	0	150,830	(18,830)	1,614,870	1,218	1,748,088	0	31,361	(18,830)	1,318,987	1,211	1,332,729
2002	0	92,905	50,342	2,625,006	3,968	2,772,221	0	41,565	50,342	1,831,874	3,961	1,927,742
2003	0	85,360	(48,181)	2,879,993	10,656	2,927,828	0	43,352	(48,181)	1,895,852	10,645	1,901,668
2004	0	25,865	3,161	2,807,789	652	2,837,467	0	41,551	3,161	2,102,335	649	2,147,696
2005	0	62,569	(159,678)	3,425,394	581	3,328,866	0	35,020	(159,678)	1,848,005	559	1,723,906
2006	0	73,012	(60,964)	3,793,964	7,210	3,813,222	0	43,550	(60,964)	2,255,093	7,010	2,244,689
2007	0	72,986	80,035	3,349,651	7,210	3,509,882	0	43,524	80,035	2,278,051	7,010	2,408,620
2008	0	73,635	(3)	3,288,715	7,210	3,369,557	0	44,173	(3)	2,166,199	7,010	2,217,379
2009	0	70,102	(15,186)	3,311,815	7,210	3,373,941	0	40,640	(15,186)	2,190,099	7,010	2,222,563
2010	0	70,198	4,288	3,311,815	7,210	3,393,511	0	40,736	4,288	2,190,099	7,010	2,242,133
2011	0	70,389	64,678	3,837,054	7,210	3,979,331	0	40,927	64,678	2,757,187	7,010	2,869,802
2012	0	70,279	(67,943)	3,837,054	7,210	3,846,600	0	40,817	(67,943)	2,763,210	7,010	2,743,094
2013	0	70,217	9,749	3,837,054	7,210	3,924,230	0	40,755	9,749	2,763,210	7,010	2,820,724
2014	0	70,525	16,625	3,837,054	7,210	3,931,414	0	41,063	16,625	2,763,210	7,010	2,827,908
2015	0	70,654	32,003	3,837,054	7,210	3,946,921	0	41,192	32,003	2,763,210	7,010	2,843,415
2016	0	70,354	(28,401)	3,837,054	7,210	3,886,217	0	40,892	(28,401)	2,763,210	7,010	2,782,711
2017	0	70,586	61,309	3,837,054	7,210	3,976,159	0	41,124	61,309	2,763,210	7,010	2,872,653
2018	0	70,740	(80,817)	3,837,054	7,210	3,834,187	0	41,278	(80,817)	2,763,210	7,010	2,730,681
2019	0	70,564	50,179	3,837,054	7,210	3,965,007	0	41,102	50,179	2,763,210	7,010	2,861,501
2020	0	70,628	(366)	3,837,054	7,210	3,914,526	0	41,166	(366)	2,763,210	7,010	2,811,020
2021	0	70,711	10,725	3,837,054	7,210	3,925,700	0	41,249	10,725	2,763,210	7,010	2,822,194
2022	0	70,705	(3,483)	3,837,054	7,210	3,911,486	0	41,243	(3,483)	2,763,210	7,010	2,807,980
2023	0	70,696	(18,971)	3,837,054	7,210	3,895,989	0	41,234	(18,971)	2,763,210	7,010	2,792,483
2024	0	70,575	11,289	3,837,054	7,210	3,926,128	0	41,113	11,289	2,763,210	7,010	2,822,622
2025	0	70,638	(12,518)	3,837,054	7,210	3,902,384	0	41,176	(12,518)	2,763,210	7,010	2,798,878
2026	0	70,650	24,308	3,837,054	7,210	3,939,222	0	41,188	24,308	2,763,210	7,010	2,835,716
2027	0	70,563	(17,799)	3,837,054	7,210	3,897,028	0	41,101	(17,799)	2,763,210	7,010	2,793,522
2028	0	70,703	12,291	3,837,054	7,210	3,927,258	0	41,241	12,291	2,763,210	7,010	2,823,752
2029	0	70,630	(9,046)	3,837,054	7,210	3,905,848	0	41,168	(9,046)	2,763,210	7,010	2,802,342
2030	0	70,694	20,756	3,837,054	7,210	3,935,714	0	41,232	20,756	2,763,210	7,010	2,832,208
2031	0	70,566	(97,726)	3,837,054	7,210	3,817,104	0	41,104	(97,726)	2,763,210	7,010	2,713,598
2032	0	70,168	84,999	3,837,054	7,210	3,999,431	0	40,706	84,999	2,763,210	7,010	2,895,925
2033	0	70,373	(94,652)	3,837,054	7,210	3,819,985	0	40,911	(94,652)	2,763,210	7,010	2,716,479
2034	0	69,865	69,593	3,837,054	7,210	3,983,722	0	40,403	69,593	2,763,210	7,010	2,880,216
2035	0	69,205	(242,659)	3,837,054	7,210	3,670,810	0	39,743	(242,659)	2,763,210	7,010	2,567,304

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)											
	South San Joaquin Division (continued)											
	Teerink Pumping Plant						Chrisman Pumping Plant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries		Total	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries		Total
				Water Supply	Recreation					Water Supply	Recreation	
	[39]	[40]	[41]	[42]	[43]	[44]	[45]	[46]	[47]	[48]	[49]	[50]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	198	2	0	0	0	200	0	0	0	0	0	0
1971	7,533	(112)	0	3,552	0	10,973	7,366	(159)	0	0	0	7,207
1972	100,274	12,765	(6,558)	84,955	6,481	197,917	100,274	13,160	(6,558)	78,891	6,481	192,248
1973	204,638	21,543	1,329	229,685	1,147	458,342	204,638	32,414	1,329	209,769	1,147	449,297
1974	237,554	11,843	(15,295)	336,198	2,108	572,408	237,554	17,655	(15,295)	318,198	2,108	560,220
1975	103,352	19,763	(693)	621,706	3,358	747,486	103,352	25,326	(693)	586,286	3,358	717,629
1976	61,122	18,552	(152,171)	740,486	1,581	669,570	61,122	21,468	(152,171)	700,935	1,581	632,935
1977	0	16,415	(116,219)	246,349	560	147,105	0	15,698	(116,219)	240,191	560	140,230
1978	65,027	28,820	121,904	631,121	674	847,546	65,027	26,705	121,904	599,973	674	814,283
1979	12,302	50,663	(51,299)	625,561	502	637,729	12,302	50,580	(51,299)	586,959	502	599,044
1980	0	48,825	(134,009)	696,405	1,262	612,483	0	58,085	(134,009)	658,588	1,262	583,926
1981	0	51,600	23,359	998,307	4,112	1,077,378	0	48,844	23,359	959,274	4,112	1,035,589
1982	0	44,353	117,332	878,486	4,045	1,044,216	0	33,541	117,277	830,704	4,045	985,567
1983	0	43,961	(101,155)	487,915	7,291	438,012	0	34,698	(101,155)	450,489	7,291	391,323
1984	0	45,999	(115,088)	632,262	5,244	568,417	0	33,132	(115,092)	582,414	5,244	505,698
1985	0	50,106	139,973	854,684	4,804	1,049,567	0	54,831	139,954	810,606	4,804	1,010,195
1986	0	38,747	37,546	882,300	3,285	961,878	0	41,421	37,546	839,839	3,285	922,091
1987	0	47,815	(25,522)	897,905	6,937	927,135	0	33,195	(25,522)	863,157	6,937	877,767
1988	0	53,815	(29,747)	1,097,643	4,360	1,126,071	0	39,775	(29,747)	1,055,649	4,360	1,070,037
1989	0	49,088	(60,826)	1,382,599	7,490	1,378,351	0	42,307	(60,826)	1,339,358	7,490	1,328,329
1990	0	66,868	(15,092)	1,627,246	8,879	1,687,901	0	56,663	(15,092)	1,590,893	8,879	1,641,343
1991	0	40,564	105,176	446,148	4,560	596,448	0	34,016	105,176	446,148	4,560	589,900
1992	0	31,820	(92,123)	844,376	1,995	786,068	0	34,477	(92,123)	820,133	1,995	764,482
1993	0	27,158	(127,738)	799,143	1,676	700,239	0	28,614	(127,738)	771,146	1,676	673,698
1994	0	50,802	(88,211)	1,007,214	2,918	972,723	0	57,203	(88,211)	977,703	2,918	949,613
1995	0	48,705	(16,431)	586,829	1,669	620,772	0	36,309	(16,431)	560,695	1,669	582,242
1996	0	58,437	15,438	836,819	2,928	913,622	0	43,710	15,438	800,633	2,928	862,709
1997	0	73,656	40,852	918,124	2,076	1,034,708	0	62,275	40,852	881,843	2,076	987,046
1998	0	61,137	(106,487)	656,796	1,585	613,031	0	47,523	(106,487)	628,084	1,585	570,705
1999	0	77,334	(2,807)	1,011,608	3,279	1,089,414	0	55,514	(2,807)	974,807	3,279	1,030,793
2000	0	87,084	7,726	1,685,654	4,216	1,784,680	0	49,690	7,726	1,645,591	4,216	1,707,223
2001	0	71,588	(18,830)	1,234,014	1,211	1,287,983	0	54,742	(18,830)	1,202,822	1,211	1,239,945
2002	0	108,309	50,342	1,740,813	3,961	1,903,425	0	69,443	50,342	1,699,261	3,961	1,823,007
2003	0	106,973	(48,181)	1,812,277	10,645	1,881,714	0	57,291	(48,181)	1,775,675	10,645	1,795,430
2004	0	122,559	3,161	2,032,492	649	2,158,861	0	60,847	3,161	1,992,308	649	2,056,965
2005	0	99,523	(159,678)	1,753,624	559	1,694,028	0	53,502	(159,678)	1,713,754	559	1,608,137
2006	0	39,920	(60,964)	2,172,858	7,010	2,158,824	0	39,670	(60,964)	2,126,303	7,010	2,112,019
2007	0	39,894	80,035	2,179,351	7,010	2,306,290	0	39,644	80,035	2,131,051	7,010	2,257,740
2008	0	40,543	(3)	2,065,499	7,010	2,113,049	0	40,293	(3)	2,017,199	7,010	2,064,499
2009	0	37,010	(15,186)	2,089,399	7,010	2,118,233	0	36,760	(15,186)	2,041,099	7,010	2,069,683
2010	0	37,106	4,288	2,089,399	7,010	2,137,803	0	36,856	4,288	2,041,099	7,010	2,089,253
2011	0	37,297	64,678	2,658,487	7,010	2,767,472	0	37,047	64,678	2,610,187	7,010	2,718,922
2012	0	37,187	(67,943)	2,664,510	7,010	2,640,764	0	36,937	(67,943)	2,616,210	7,010	2,592,214
2013	0	37,125	9,749	2,664,510	7,010	2,718,394	0	36,875	9,749	2,616,210	7,010	2,669,844
2014	0	37,433	16,625	2,664,510	7,010	2,725,578	0	37,183	16,625	2,616,210	7,010	2,677,028
2015	0	37,562	32,003	2,664,510	7,010	2,741,085	0	37,312	32,003	2,616,210	7,010	2,692,535
2016	0	37,262	(28,401)	2,664,510	7,010	2,680,381	0	37,012	(28,401)	2,616,210	7,010	2,631,831
2017	0	37,494	61,309	2,664,510	7,010	2,770,323	0	37,244	61,309	2,616,210	7,010	2,721,773
2018	0	37,648	(80,817)	2,664,510	7,010	2,628,351	0	37,398	(80,817)	2,616,210	7,010	2,579,801
2019	0	37,472	50,179	2,664,510	7,010	2,759,171	0	37,222	50,179	2,616,210	7,010	2,710,621
2020	0	37,536	(366)	2,664,510	7,010	2,708,690	0	37,286	(366)	2,616,210	7,010	2,660,140
2021	0	37,619	10,725	2,664,510	7,010	2,719,864	0	37,369	10,725	2,616,210	7,010	2,671,314
2022	0	37,613	(3,483)	2,664,510	7,010	2,705,650	0	37,363	(3,483)	2,616,210	7,010	2,657,100
2023	0	37,604	(18,971)	2,664,510	7,010	2,690,153	0	37,354	(18,971)	2,616,210	7,010	2,641,603
2024	0	37,483	11,289	2,664,510	7,010	2,720,292	0	37,233	11,289	2,616,210	7,010	2,671,742
2025	0	37,546	(12,518)	2,664,510	7,010	2,696,548	0	37,296	(12,518)	2,616,210	7,010	2,647,998
2026	0	37,558	24,308	2,664,510	7,010	2,733,386	0	37,308	24,308	2,616,210	7,010	2,684,836
2027	0	37,471	(17,799)	2,664,510	7,010	2,691,192	0	37,221	(17,799)	2,616,210	7,010	2,642,642
2028	0	37,611	12,291	2,664,510	7,010	2,721,422	0	37,361	12,291	2,616,210	7,010	2,672,872
2029	0	37,538	(9,046)	2,664,510	7,010	2,700,012	0	37,288	(9,046)	2,616,210	7,010	2,651,462
2030	0	37,602	20,756	2,664,510	7,010	2,729,878	0	37,352	20,756	2,616,210	7,010	2,681,328
2031	0	37,474	(97,726)	2,664,510	7,010	2,611,268	0	37,224	(97,726)	2,616,210	7,010	2,562,718
2032	0	37,076	84,999	2,664,510	7,010	2,793,595	0	36,826	84,999	2,616,210	7,010	2,745,045
2033	0	37,281	(94,652)	2,664,510	7,010	2,614,149	0	37,031	(94,652)	2,616,210	7,010	2,565,599
2034	0	36,773	69,593	2,664,510	7,010	2,777,886	0	36,523	69,593	2,616,210	7,010	2,729,336
2035	0	36,113	(242,659)	2,664,510	7,010	2,464,974	0	35,863	(242,659)	2,616,210	7,010	2,416,424

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)											
	Tehachapi Division						Mojave Divsion					
	Edmonston Pumping Plant						Alamo Powerplant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries			Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries		
				Water Supply	Recreation	Total				Water Supply	Recreation	Total
	[51]	[52]	[53]	[54]	[55]	[56]	[57]	[58]	[59]	[60]	[61]	[62]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	5,446	8	0	0	0	5,454	0	0	0	0	0	0
1972	100,274	16,067	(6,558)	74,123	6,481	190,387	0	0	0	0	0	0
1973	204,638	34,051	1,329	207,808	1,147	448,973	0	0	0	0	0	0
1974	237,554	18,181	(15,295)	313,634	2,108	556,182	0	0	0	0	0	0
1975	103,352	20,183	(693)	573,219	3,358	699,419	0	0	0	0	0	0
1976	61,122	21,096	(152,171)	685,768	1,581	617,396	0	0	0	0	0	0
1977	0	18,424	(116,219)	236,086	560	138,851	0	0	0	0	0	0
1978	65,027	20,887	121,904	590,329	674	798,821	0	0	0	0	0	0
1979	12,302	46,332	(51,299)	568,338	502	576,175	0	0	0	0	0	0
1980	0	52,967	(134,009)	639,743	1,262	559,963	0	0	0	0	0	0
1981	0	40,602	23,359	938,482	4,112	1,006,555	0	0	0	0	0	0
1982	0	37,244	117,296	812,206	4,045	970,791	0	0	0	0	0	0
1983	0	40,690	(101,155)	431,182	7,291	378,008	0	0	0	0	0	0
1984	0	42,112	(115,214)	556,830	5,244	488,972	0	0	0	0	0	0
1985	0	45,265	139,988	792,477	4,804	982,534	0	0	0	0	0	0
1986	0	36,918	37,546	823,067	3,285	900,816	0	14,735	12,258	429,864	1,508	458,365
1987	0	29,580	(25,522)	851,322	6,937	862,317	0	11,665	(15,270)	417,870	1,239	415,504
1988	0	42,017	(29,747)	1,044,737	4,360	1,061,367	0	21,696	1,101	537,568	971	561,336
1989	0	32,270	(60,826)	1,328,041	7,490	1,306,975	0	4,686	(20,363)	716,360	1,407	702,090
1990	0	42,198	(15,092)	1,579,466	8,879	1,615,451	0	8,898	(5,916)	788,111	1,388	792,481
1991	0	33,999	105,176	441,217	4,560	584,952	0	17,908	34,422	177,308	394	230,032
1992	0	23,121	(92,123)	809,771	1,995	742,764	0	14,873	(17,115)	374,110	423	372,291
1993	0	11,946	(127,738)	759,485	1,676	645,369	0	9,304	(3,455)	308,222	443	314,514
1994	0	40,808	(88,211)	960,815	2,918	916,330	0	21,837	3,395	469,996	430	495,658
1995	0	36,001	(16,431)	542,465	1,669	563,704	0	14,139	(30,761)	384,836	427	368,641
1996	0	37,357	15,438	779,918	2,928	835,641	0	7,247	(11,410)	493,852	565	490,254
1997	0	51,475	40,852	860,798	2,076	955,201	0	20,725	38,960	537,586	507	597,778
1998	0	48,601	(106,487)	607,301	1,585	551,000	0	21,456	16,361	398,385	363	436,565
1999	0	52,726	(2,807)	947,420	3,279	1,000,618	0	26,644	(8,486)	589,756	396	608,310
2000	0	43,072	7,726	1,621,657	4,216	1,676,671	0	8,983	(10,472)	953,531	449	952,491
2001	0	39,544	(18,830)	1,187,452	1,211	1,209,377	0	14,526	3,478	710,137	452	728,593
2002	0	60,037	50,342	1,680,514	3,961	1,794,854	0	15,190	8,398	901,230	490	925,308
2003	0	53,320	(48,181)	1,757,708	10,645	1,773,492	0	13,676	(20,787)	1,022,009	355	1,015,253
2004	0	57,962	3,161	1,970,355	649	2,032,127	0	15,581	17,207	1,120,348	171	1,153,307
2005	0	40,949	(159,678)	1,695,234	559	1,577,064	0	2,561	(50,014)	1,117,983	84	1,070,614
2006	0	38,120	(60,964)	2,105,670	7,010	2,089,836	0	20,809	2,964	1,301,885	1,630	1,327,288
2007	0	38,094	80,035	2,107,941	7,010	2,233,080	0	20,811	(39)	1,210,706	1,630	1,233,108
2008	0	38,743	(3)	1,994,089	7,010	2,039,839	0	21,350	(73)	978,821	1,630	1,001,728
2009	0	35,210	(15,186)	2,017,989	7,010	2,045,023	0	20,905	(9,404)	1,002,721	1,630	1,015,852
2010	0	35,306	4,288	2,017,989	7,010	2,064,593	0	21,001	3,921	1,002,721	1,630	1,029,273
2011	0	35,497	64,678	2,587,077	7,010	2,694,262	0	20,971	26,001	1,450,665	1,630	1,499,267
2012	0	35,387	(67,943)	2,593,100	7,010	2,567,554	0	20,962	(41,797)	1,450,665	1,630	1,431,460
2013	0	35,325	9,749	2,593,100	7,010	2,645,184	0	20,835	4,742	1,450,665	1,630	1,477,872
2014	0	35,633	16,625	2,593,100	7,010	2,652,368	0	21,002	2,759	1,450,665	1,630	1,476,056
2015	0	35,762	32,003	2,593,100	7,010	2,667,875	0	21,066	22,604	1,450,665	1,630	1,495,965
2016	0	35,462	(28,401)	2,593,100	7,010	2,607,171	0	20,829	(21,084)	1,450,665	1,630	1,452,040
2017	0	35,694	61,309	2,593,100	7,010	2,697,113	0	20,895	33,266	1,450,665	1,630	1,506,456
2018	0	35,848	(80,817)	2,593,100	7,010	2,555,141	0	20,998	(50,078)	1,450,665	1,630	1,423,215
2019	0	35,672	50,179	2,593,100	7,010	2,685,961	0	20,924	31,508	1,450,665	1,630	1,504,727
2020	0	35,736	(366)	2,593,100	7,010	2,635,480	0	20,947	(3,398)	1,450,665	1,630	1,469,844
2021	0	35,819	10,725	2,593,100	7,010	2,646,654	0	20,946	(1,117)	1,450,665	1,630	1,472,124
2022	0	35,813	(3,483)	2,593,100	7,010	2,632,440	0	20,940	(3,434)	1,450,665	1,630	1,469,801
2023	0	35,804	(18,971)	2,593,100	7,010	2,616,943	0	20,939	(18,638)	1,450,665	1,630	1,454,596
2024	0	35,683	11,289	2,593,100	7,010	2,647,082	0	20,881	21,309	1,450,665	1,630	1,494,485
2025	0	35,746	(12,518)	2,593,100	7,010	2,623,338	0	20,965	(11,624)	1,450,665	1,630	1,461,636
2026	0	35,758	24,308	2,593,100	7,010	2,660,176	0	20,930	13,030	1,450,665	1,630	1,486,255
2027	0	35,671	(17,799)	2,593,100	7,010	2,617,982	0	20,861	(6,161)	1,450,665	1,630	1,466,995
2028	0	35,811	12,291	2,593,100	7,010	2,648,212	0	20,961	4,006	1,450,665	1,630	1,477,262
2029	0	35,738	(9,046)	2,593,100	7,010	2,626,802	0	20,955	(913)	1,450,665	1,630	1,472,337
2030	0	35,802	20,756	2,593,100	7,010	2,656,668	0	20,930	8,528	1,450,665	1,630	1,481,753
2031	0	35,674	(97,726)	2,593,100	7,010	2,538,058	0	20,956	(31,057)	1,450,665	1,630	1,442,194
2032	0	35,276	84,999	2,593,100	7,010	2,720,385	0	20,865	43,953	1,450,665	1,630	1,517,113
2033	0	35,481	(94,652)	2,593,100	7,010	2,540,939	0	20,854	(37,929)	1,450,665	1,630	1,435,220
2034	0	34,973	69,593	2,593,100	7,010	2,704,676	0	20,769	28,588	1,450,665	1,630	1,501,652
2035	0	34,313	(242,659)	2,593,100	7,010	2,391,764	0	20,892	(49,219)	1,450,665	1,630	1,423,968

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued) — Mojave Division (continued) — Pearblossom Pumping Plant						Mojave Siphon Powerplant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total
	[63]	[64]	[65]	[66]	[67]	[68]	[69]	[70]	[71]	[72]	[73]	[74]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	21	0	0	0	0	21	0	0	0	0	0	0
1972	35,243	5,282	(153)	1,794	0	42,166	0	0	0	0	0	0
1973	80,177	21,522	(2,700)	52,201	72	151,272	0	0	0	0	0	0
1974	76,694	10,847	(11,149)	102,839	44	179,275	0	0	0	0	0	0
1975	10,000	2,364	(8,397)	190,351	70	194,388	0	0	0	0	0	0
1976	4,168	7,040	(16,055)	236,713	152	232,018	0	0	0	0	0	0
1977	0	11,398	(17,534)	102,326	580	96,770	0	0	0	0	0	0
1978	19,922	5,696	69,130	374,845	498	470,091	0	0	0	0	0	0
1979	12,302	6,836	(32,518)	362,114	502	349,236	0	0	0	0	0	0
1980	0	16,200	6,159	401,214	781	424,354	0	0	0	0	0	0
1981	0	4,992	(36,278)	574,573	933	544,220	0	0	0	0	0	0
1982	0	5,251	55,232	401,037	1,919	463,439	0	0	0	0	0	0
1983	0	11,745	(26,847)	231,188	1,180	217,266	0	0	0	0	0	0
1984	0	18,228	23,230	252,066	1,494	295,018	0	0	0	0	0	0
1985	0	25,292	(2,815)	350,758	1,076	374,311	0	0	0	0	0	0
1986	0	30,876	12,258	394,156	1,508	438,798	0	0	0	0	0	0
1987	0	27,552	(15,270)	377,531	1,239	391,052	0	0	0	0	0	0
1988	0	32,209	1,101	501,300	971	535,581	0	1,977	1,101	501,291	971	505,340
1989	0	31,500	(20,363)	661,189	1,407	673,733	0	29,110	(20,363)	661,100	1,407	671,254
1990	0	32,672	(5,916)	730,560	1,388	758,704	0	23,692	(5,916)	730,550	1,388	749,714
1991	0	15,209	34,774	163,913	394	214,290	0	(543)	34,774	163,913	394	198,538
1992	0	13,989	(17,451)	338,249	423	335,210	0	(13,193)	(17,451)	338,207	423	307,986
1993	0	9,779	(3,455)	255,117	443	261,884	0	(11,922)	(3,455)	255,117	443	240,183
1994	0	150	3,395	409,928	430	413,903	0	1,601	3,395	395,294	430	400,720
1995	0	6,820	(29,282)	328,882	427	306,847	0	10,458	(29,282)	321,387	427	302,990
1996	0	9,514	(11,410)	424,252	565	422,921	0	(5,577)	(11,410)	418,141	565	401,719
1997	0	(1,124)	38,960	461,563	507	499,906	0	5,171	38,960	452,525	507	497,163
1998	0	(2,087)	16,361	334,965	363	349,602	0	11,496	16,361	332,385	363	360,605
1999	0	(1,154)	(8,486)	505,624	396	496,380	0	11,065	(8,486)	498,919	396	501,894
2000	0	(23,296)	(10,472)	859,533	449	826,214	0	4,896	(10,472)	849,514	449	844,387
2001	0	(9,304)	3,478	635,468	452	630,094	0	7,403	3,478	632,420	452	643,753
2002	0	3,810	8,398	823,690	490	836,388	0	9,300	8,398	820,217	490	838,405
2003	0	2,814	(20,787)	949,148	355	931,530	0	(6,586)	(20,787)	935,998	355	908,980
2004	0	(15,558)	17,207	1,047,485	171	1,049,305	0	5,034	17,207	1,035,279	171	1,057,691
2005	0	(18,967)	(50,014)	1,045,389	84	976,492	0	827	(50,014)	1,027,278	84	978,175
2006	0	15,459	2,964	1,206,994	1,430	1,226,847	0	11,989	2,964	1,168,922	1,430	1,185,305
2007	0	15,461	(39)	1,132,475	1,430	1,149,327	0	11,991	(39)	1,115,255	1,430	1,128,637
2008	0	16,000	(73)	828,026	1,430	845,383	0	12,530	(73)	763,041	1,430	776,928
2009	0	15,555	(9,404)	837,064	1,430	844,645	0	12,085	(9,404)	762,921	1,430	767,032
2010	0	15,651	3,921	837,486	1,430	858,488	0	12,181	3,921	762,921	1,430	780,453
2011	0	15,621	26,001	1,284,165	1,430	1,327,217	0	12,151	26,001	1,209,865	1,430	1,249,447
2012	0	15,612	(41,797)	1,284,165	1,430	1,259,410	0	12,142	(41,797)	1,209,865	1,430	1,181,640
2013	0	15,485	4,742	1,284,165	1,430	1,305,822	0	12,015	4,742	1,209,865	1,430	1,228,052
2014	0	15,652	2,759	1,284,165	1,430	1,304,006	0	12,182	2,759	1,209,865	1,430	1,226,236
2015	0	15,716	22,604	1,284,165	1,430	1,323,915	0	12,246	22,604	1,209,865	1,430	1,246,145
2016	0	15,479	(21,084)	1,284,165	1,430	1,279,990	0	12,009	(21,084)	1,209,865	1,430	1,202,220
2017	0	15,545	33,266	1,284,165	1,430	1,334,406	0	12,075	33,266	1,209,865	1,430	1,256,636
2018	0	15,648	(50,078)	1,284,165	1,430	1,251,165	0	12,178	(50,078)	1,209,865	1,430	1,173,395
2019	0	15,574	31,508	1,284,165	1,430	1,332,677	0	12,104	31,508	1,209,865	1,430	1,254,907
2020	0	15,597	(3,398)	1,284,165	1,430	1,297,794	0	12,127	(3,398)	1,209,865	1,430	1,220,024
2021	0	15,596	(1,117)	1,284,165	1,430	1,300,074	0	12,126	(1,117)	1,209,865	1,430	1,222,304
2022	0	15,590	(3,434)	1,284,165	1,430	1,297,751	0	12,120	(3,434)	1,209,865	1,430	1,219,981
2023	0	15,589	(18,638)	1,284,165	1,430	1,282,546	0	12,119	(18,638)	1,209,865	1,430	1,204,776
2024	0	15,531	21,309	1,284,165	1,430	1,322,435	0	12,061	21,309	1,209,865	1,430	1,244,665
2025	0	15,615	(11,624)	1,284,165	1,430	1,289,586	0	12,145	(11,624)	1,209,865	1,430	1,211,816
2026	0	15,580	13,030	1,284,165	1,430	1,314,205	0	12,110	13,030	1,209,865	1,430	1,236,435
2027	0	15,511	(6,161)	1,284,165	1,430	1,294,945	0	12,041	(6,161)	1,209,865	1,430	1,217,175
2028	0	15,611	4,006	1,284,165	1,430	1,305,212	0	12,141	4,006	1,209,865	1,430	1,227,442
2029	0	15,605	(913)	1,284,165	1,430	1,300,287	0	12,135	(913)	1,209,865	1,430	1,222,517
2030	0	15,580	8,528	1,284,165	1,430	1,309,703	0	12,110	8,528	1,209,865	1,430	1,231,933
2031	0	15,606	(31,057)	1,284,165	1,430	1,270,144	0	12,136	(31,057)	1,209,865	1,430	1,192,374
2032	0	15,515	43,953	1,284,165	1,430	1,345,063	0	12,045	43,953	1,209,865	1,430	1,267,293
2033	0	15,504	(37,929)	1,284,165	1,430	1,263,170	0	12,034	(37,929)	1,209,865	1,430	1,185,400
2034	0	15,419	28,588	1,284,165	1,430	1,329,602	0	11,949	28,588	1,209,865	1,430	1,251,832
2035	0	15,542	(49,219)	1,284,165	1,430	1,251,918	0	12,072	(49,219)	1,209,865	1,430	1,174,148

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)											
	Santa Ana Division						West Branch, California Aqueduct					
	Devil Canyon Powerplant						Oso Pumping Plant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries			Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries		
				Water Supply	Recreation	Total				Water Supply	Recreation	Total
	[75]	[76]	[77]	[78]	[79]	[80]	[81]	[82]	[83]	[84]	[85]	[86]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	2,444	133	0	0	0	2,577
1972	37	0	0	1,275	0	1,312	63,883	6,557	(6,405)	71,991	6,481	142,507
1973	40,848	14,745	0	51,812	0	107,405	124,461	16,995	4,029	155,317	1,075	301,877
1974	74,666	8,367	(4,925)	102,198	0	180,306	160,860	12,702	(4,146)	209,172	2,064	380,652
1975	10,000	1,995	(6,719)	189,526	0	194,802	93,352	23,008	7,704	374,306	3,288	501,658
1976	4,168	5,180	(9,182)	235,711	23	235,900	56,954	15,845	(136,116)	420,708	1,429	358,820
1977	0	8,082	(5,235)	101,137	469	104,453	0	4,407	(98,685)	122,447	(20)	28,149
1978	14,820	3,754	21,686	373,636	481	414,377	45,105	9,061	52,774	171,139	176	278,255
1979	12,302	5,620	(27,107)	356,854	485	348,154	0	25,355	(18,781)	145,598	0	152,172
1980	0	9,468	12,714	395,975	742	418,899	0	24,576	(140,168)	165,931	481	50,820
1981	0	8,401	(23,448)	569,088	807	554,848	0	15,254	59,637	283,264	3,179	361,334
1982	0	6,012	44,469	399,799	1,798	452,078	0	23,824	61,685	360,878	2,126	448,513
1983	0	8,597	5,188	230,277	1,078	245,140	0	23,601	(74,308)	166,995	6,111	122,399
1984	0	12,861	(850)	250,938	1,414	264,363	0	12,461	(138,146)	272,101	3,750	150,166
1985	0	14,325	(8,791)	349,336	956	355,826	0	28,257	142,219	403,097	3,728	577,301
1986	0	9,486	8,339	392,650	1,378	411,853	0	22,387	25,288	393,203	1,777	442,655
1987	0	7,923	(11,335)	375,451	1,118	373,157	0	18,164	(10,252)	433,452	5,698	447,062
1988	0	11,090	2,238	499,285	861	513,474	0	20,461	(30,848)	507,169	3,389	500,171
1989	0	13,116	(5,487)	658,730	1,301	667,660	0	27,914	(40,463)	611,681	6,083	605,215
1990	0	13,439	(4,622)	728,723	1,281	738,821	0	33,666	(9,176)	791,355	7,491	823,336
1991	0	10,836	18,308	161,032	340	190,516	0	16,460	70,754	263,909	4,166	355,289
1992	0	9,157	(9,084)	328,354	371	328,798	0	8,238	(75,008)	435,661	1,572	370,463
1993	0	5,602	5,593	244,678	364	256,237	0	2,674	(124,283)	451,263	1,233	330,887
1994	0	10,915	(11,045)	393,690	357	393,917	0	18,688	(91,606)	490,819	2,488	420,389
1995	0	11,268	2,331	320,978	358	334,935	0	21,775	14,330	157,629	1,242	194,976
1996	0	9,496	13,015	417,656	494	440,661	0	30,121	26,848	286,066	2,363	345,398
1997	0	8,087	(19,685)	451,874	416	440,692	0	30,468	1,892	323,212	1,569	357,141
1998	0	6,700	16,643	332,198	310	355,851	0	26,851	(122,848)	208,916	1,222	114,141
1999	0	9,784	(4,177)	497,787	341	503,735	0	25,690	5,679	357,664	2,883	391,916
2000	0	7,407	(11,040)	848,320	375	845,062	0	33,658	18,198	668,126	3,767	723,749
2001	0	9,324	8,183	631,363	374	649,244	0	24,551	(22,308)	477,315	759	480,317
2002	0	10,315	9,682	818,028	413	838,438	0	44,692	41,944	779,284	3,471	869,391
2003	0	9,198	(18,298)	917,186	260	908,346	0	39,495	(27,394)	735,699	10,290	758,090
2004	0	11,166	15,150	1,033,273	85	1,059,674	0	41,947	(14,046)	850,007	478	878,386
2005	0	4,500	(63,441)	1,012,674	0	953,733	0	37,432	(109,664)	577,251	475	505,494
2006	0	7,806	3,964	1,166,022	1,250	1,179,042	0	17,261	(63,928)	803,785	5,380	762,498
2007	0	7,809	(39)	1,111,915	1,250	1,120,935	0	17,233	80,074	897,235	5,380	999,922
2008	0	8,348	(73)	757,121	1,250	766,646	0	17,343	70	1,015,268	5,380	1,038,061
2009	0	8,508	3,506	757,121	1,250	770,385	0	14,255	(5,782)	1,015,268	5,380	1,029,121
2010	0	8,504	10,523	757,121	1,250	777,398	0	14,255	367	1,015,268	5,380	1,035,270
2011	0	8,519	1,352	1,204,065	1,250	1,215,186	0	14,476	38,677	1,136,412	5,380	1,194,945
2012	0	8,482	(22,894)	1,204,065	1,250	1,190,903	0	14,375	(26,146)	1,142,435	5,380	1,136,044
2013	0	8,499	16,733	1,204,065	1,250	1,230,547	0	14,440	5,007	1,142,435	5,380	1,167,262
2014	0	8,522	(4,585)	1,204,065	1,250	1,209,252	0	14,581	13,866	1,142,435	5,380	1,176,262
2015	0	8,499	2,964	1,204,065	1,250	1,216,778	0	14,646	9,399	1,142,435	5,380	1,171,860
2016	0	8,483	(1,269)	1,204,065	1,250	1,212,529	0	14,583	(7,317)	1,142,435	5,380	1,155,081
2017	0	8,502	9,828	1,204,065	1,250	1,223,645	0	14,749	28,043	1,142,435	5,380	1,190,607
2018	0	8,484	(19,777)	1,204,065	1,250	1,194,022	0	14,800	(30,739)	1,142,435	5,380	1,131,876
2019	0	8,492	17,408	1,204,065	1,250	1,231,215	0	14,698	18,671	1,142,435	5,380	1,181,184
2020	0	8,483	(17,305)	1,204,065	1,250	1,196,493	0	14,739	3,032	1,142,435	5,380	1,165,586
2021	0	8,486	(398)	1,204,065	1,250	1,213,403	0	14,823	11,842	1,142,435	5,380	1,174,480
2022	0	8,486	13,735	1,204,065	1,250	1,227,536	0	14,823	(49)	1,142,435	5,380	1,162,589
2023	0	8,482	(8,417)	1,204,065	1,250	1,205,380	0	14,815	(333)	1,142,435	5,380	1,162,297
2024	0	8,462	689	1,204,065	1,250	1,214,466	0	14,752	(10,020)	1,142,435	5,380	1,152,547
2025	0	8,489	4,591	1,204,065	1,250	1,218,395	0	14,731	(894)	1,142,435	5,380	1,161,652
2026	0	8,475	(3,819)	1,204,065	1,250	1,209,971	0	14,778	11,278	1,142,435	5,380	1,173,871
2027	0	8,479	745	1,204,065	1,250	1,214,539	0	14,760	(11,638)	1,142,435	5,380	1,150,937
2028	0	8,481	(5,355)	1,204,065	1,250	1,208,441	0	14,800	8,285	1,142,435	5,380	1,170,900
2029	0	8,481	2,909	1,204,065	1,250	1,216,705	0	14,733	(8,133)	1,142,435	5,380	1,154,415
2030	0	8,480	296	1,204,065	1,250	1,214,091	0	14,822	12,228	1,142,435	5,380	1,174,865
2031	0	8,475	(1,976)	1,204,065	1,250	1,211,814	0	14,668	(66,669)	1,142,435	5,380	1,095,814
2032	0	8,449	18,821	1,204,065	1,250	1,232,585	0	14,361	41,046	1,142,435	5,380	1,203,222
2033	0	8,449	(23,419)	1,204,065	1,250	1,190,345	0	14,577	(56,723)	1,142,435	5,380	1,105,669
2034	0	8,443	21,651	1,204,065	1,250	1,235,409	0	14,154	41,005	1,142,435	5,380	1,202,974
2035	0	8,451	(31,434)	1,204,065	1,250	1,182,332	0	13,371	(193,440)	1,142,435	5,380	967,746

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (contiued)											
	West Branch, California Aqueduct (continued)											
	Warne Powerplant						Castaic Powerplant					
	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total	Initial Fill Water	Operational Losses	Reservoir Storage Changes	Deliveries: Water Supply	Deliveries: Recreation	Total
	[87]	[88]	[89]	[90]	[91]	[92]	[93]	[94]	[95]	[96]	[97]	[98]
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	57,364	1,788	(6,162)	71,938	6,481	131,409
1973	0	0	0	0	0	0	37,198	6,430	4,542	155,297	1,075	204,542
1974	0	0	0	0	0	0	82,364	1,772	(950)	209,136	541	292,863
1975	0	0	0	0	0	0	90,460	5,002	(1,534)	374,280	1,563	469,771
1976	0	0	0	0	0	0	55,990	(7,695)	(132,036)	420,684	1,429	338,372
1977	0	0	0	0	0	0	0	(1,485)	(102,532)	122,447	(20)	18,410
1978	0	0	0	0	0	0	45,105	(2,264)	129,523	171,139	176	343,679
1979	0	0	0	0	0	0	0	(2,339)	(20,400)	145,598	0	122,859
1980	0	0	0	0	0	0	0	991	(118,026)	165,931	481	49,377
1981	0	0	0	0	0	0	0	(44,416)	47,244	283,264	2,704	288,796
1982	0	24,468	61,169	360,878	2,126	448,641	0	(60,135)	59,069	360,878	1,187	360,999
1983	0	20,780	(74,308)	166,995	6,111	119,578	0	(33,418)	(46,904)	166,995	2,618	89,291
1984	0	13,572	(139,219)	275,212	2,208	151,773	0	(29,618)	(139,545)	275,212	2,201	108,250
1985	0	29,286	141,492	403,097	874	574,749	0	(4,622)	135,007	403,097	844	534,326
1986	0	21,579	25,288	393,203	1,777	441,847	0	(6,664)	21,520	393,203	623	408,682
1987	0	20,885	(10,252)	433,452	5,698	449,783	0	(519)	(6,241)	433,452	2,734	429,426
1988	0	23,253	(31,453)	507,169	3,389	502,358	0	12,650	(28,498)	507,169	1,359	492,680
1989	0	27,131	(40,463)	611,681	6,083	604,432	0	634	(40,154)	611,681	3,161	575,322
1990	0	34,208	(9,176)	791,355	7,491	823,878	0	(14,012)	(15,101)	786,519	3,419	760,825
1991	0	16,908	70,754	263,909	4,166	355,737	0	(871)	89,637	262,921	2,283	353,970
1992	0	9,638	(75,008)	435,661	1,572	371,863	0	(609)	(71,795)	435,661	1,543	364,800
1993	0	1,922	(124,283)	451,257	1,233	330,129	0	21,959	(77,428)	451,257	1,211	396,999
1994	0	23,151	(91,606)	490,819	2,488	424,852	0	5,205	(95,738)	490,819	2,465	402,751
1995	0	15,860	14,330	157,629	1,242	189,061	0	20,400	75,863	157,629	1,223	255,115
1996	0	21,191	26,848	286,066	2,363	336,468	0	(5,621)	19,088	286,066	2,362	301,895
1997	0	23,437	1,892	323,201	1,569	350,099	0	11,119	(1,802)	323,201	1,566	334,084
1998	0	26,864	(122,848)	208,909	1,222	114,147	0	24,544	(57,726)	208,909	1,222	176,949
1999	0	21,822	8,120	357,664	2,883	390,489	0	(3,670)	6,280	357,664	2,865	363,139
2000	0	27,237	18,198	668,126	3,767	717,328	0	(19,645)	9,320	665,926	1,556	657,157
2001	0	17,404	(22,308)	477,315	759	473,170	0	(5,949)	(16,588)	477,315	746	455,524
2002	0	35,058	41,944	779,284	3,471	859,757	0	10,071	35,623	776,136	305	822,135
2003	0	28,167	(27,394)	735,699	10,290	746,762	0	9,075	(17,034)	732,549	356	724,946
2004	0	31,034	(14,046)	850,007	478	867,473	0	9,120	(11,440)	845,960	456	844,096
2005	0	29,111	(109,664)	577,251	475	497,173	0	21,155	(61,490)	577,251	472	537,388
2006	0	15,351	(63,928)	803,785	5,380	760,588	0	9,626	(63,928)	803,785	2,330	751,813
2007	0	15,323	80,074	897,235	5,380	998,012	0	9,598	80,074	894,085	2,330	986,087
2008	0	15,433	70	1,015,268	5,380	1,036,151	0	9,708	70	1,012,118	2,330	1,024,226
2009	0	12,345	(5,782)	1,015,268	5,380	1,027,211	0	6,060	(5,782)	1,012,118	2,330	1,014,726
2010	0	12,345	367	1,015,268	5,380	1,033,360	0	6,060	367	1,012,118	2,330	1,020,875
2011	0	12,566	38,677	1,136,412	5,380	1,193,035	0	6,281	38,677	1,133,262	2,330	1,180,550
2012	0	12,465	(26,146)	1,142,435	5,380	1,134,134	0	6,180	(26,146)	1,139,285	2,330	1,121,649
2013	0	12,530	5,007	1,142,435	5,380	1,165,352	0	6,245	5,007	1,139,285	2,330	1,152,867
2014	0	12,671	13,866	1,142,435	5,380	1,174,352	0	6,386	13,866	1,139,285	2,330	1,161,867
2015	0	12,736	9,399	1,142,435	5,380	1,169,950	0	6,451	9,399	1,139,285	2,330	1,157,465
2016	0	12,673	(7,317)	1,142,435	5,380	1,153,171	0	6,388	(7,317)	1,139,285	2,330	1,140,686
2017	0	12,839	28,043	1,142,435	5,380	1,188,697	0	6,554	28,043	1,139,285	2,330	1,176,212
2018	0	12,890	(30,739)	1,142,435	5,380	1,129,966	0	6,605	(30,739)	1,139,285	2,330	1,117,481
2019	0	12,788	18,671	1,142,435	5,380	1,179,274	0	6,503	18,671	1,139,285	2,330	1,166,789
2020	0	12,829	3,032	1,142,435	5,380	1,163,676	0	6,544	3,032	1,139,285	2,330	1,151,191
2021	0	12,913	11,842	1,142,435	5,380	1,172,570	0	6,628	11,842	1,139,285	2,330	1,160,085
2022	0	12,913	(49)	1,142,435	5,380	1,160,679	0	6,628	(49)	1,139,285	2,330	1,148,194
2023	0	12,905	(333)	1,142,435	5,380	1,160,387	0	6,620	(333)	1,139,285	2,330	1,147,902
2024	0	12,842	(10,020)	1,142,435	5,380	1,150,637	0	6,557	(10,020)	1,139,285	2,330	1,138,152
2025	0	12,821	(894)	1,142,435	5,380	1,159,742	0	6,536	(894)	1,139,285	2,330	1,147,257
2026	0	12,868	11,278	1,142,435	5,380	1,171,961	0	6,583	11,278	1,139,285	2,330	1,159,476
2027	0	12,850	(11,638)	1,142,435	5,380	1,149,027	0	6,565	(11,638)	1,139,285	2,330	1,136,542
2028	0	12,890	8,285	1,142,435	5,380	1,168,990	0	6,605	8,285	1,139,285	2,330	1,156,505
2029	0	12,823	(8,133)	1,142,435	5,380	1,152,505	0	6,538	(8,133)	1,139,285	2,330	1,140,020
2030	0	12,912	12,228	1,142,435	5,380	1,172,955	0	6,627	12,228	1,139,285	2,330	1,160,470
2031	0	12,758	(66,669)	1,142,435	5,380	1,093,904	0	6,473	(66,669)	1,139,285	2,330	1,081,419
2032	0	12,451	41,046	1,142,435	5,380	1,201,312	0	6,166	41,046	1,139,285	2,330	1,188,827
2033	0	12,667	(56,723)	1,142,435	5,380	1,103,759	0	6,382	(56,723)	1,139,285	2,330	1,091,274
2034	0	12,244	41,005	1,142,435	5,380	1,201,064	0	5,959	41,005	1,139,285	2,330	1,188,579
2035	0	11,461	(193,440)	1,142,435	5,380	965,836	0	5,176	(193,440)	1,139,285	2,330	953,351

TABLE B-6. Annual Water Quantities Conveyed Through Each Pumping and Power Recovery Plant of Project Transportation Facilities

(in acre-feet)

Calendar Year	CALIFORNIA AQUEDUCT (continued)							
	Coastal Branch, California Aqueduct							
	Las Perillas and Badger Hill Pumping Plants				Devil's Den, Bluestone, and Polonio Pass Pumping Plants			
	Initial Fill Water	Operational Losses	Water Supply Delivery	Total	Initial Fill Water	Operational Losses	Water Supply Delivery	Total
	[99]	[100]	[101]	[102]	[103]	[104]	[105]	[106]
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	210	873	79,039	80,122	0	0	0	0
1969	0	1,042	62,064	63,106	0	0	0	0
1970	0	638	83,649	84,287	0	0	0	0
1971	0	3,455	110,971	114,426	0	0	0	0
1972	0	1,745	121,755	123,500	0	0	0	0
1973	0	5,479	78,645	84,124	0	0	0	0
1974	0	7,344	78,174	85,518	0	0	0	0
1975	0	5,819	85,216	91,035	0	0	0	0
1976	0	6,562	90,058	96,620	0	0	0	0
1977	0	5,777	40,579	46,356	0	0	0	0
1978	0	9,085	92,604	101,689	0	0	0	0
1979	0	10,896	123,155	134,051	0	0	0	0
1980	0	9,449	111,379	120,828	0	0	0	0
1981	0	13,232	109,754	122,986	0	0	0	0
1982	0	7,984	95,776	103,760	0	0	0	0
1983	0	5,710	100,518	106,228	0	0	0	0
1984	0	5,740	126,387	132,127	0	0	0	0
1985	0	7,563	120,823	128,386	0	0	0	0
1986	0	8,719	131,599	140,318	0	0	0	0
1987	0	11,363	128,080	139,443	0	0	0	0
1988	0	12,831	120,969	133,800	0	0	0	0
1989	0	11,454	116,801	128,255	0	0	0	0
1990	0	13,022	109,802	122,824	0	0	0	0
1991	0	5,802	1,496	7,298	0	0	0	0
1992	0	7,893	79,635	87,528	0	0	0	0
1993	0	9,282	94,921	104,203	0	0	0	0
1994	0	8,515	87,158	95,673	0	0	0	0
1995	0	6,986	94,536	101,522	0	0	0	0
1996	0	9,663	114,630	124,293	0	0	0	0
1997	527	8,343	110,428	119,298	527	0	8,538	9,065
1998	0	8,415	109,400	117,815	0	0	22,210	22,210
1999	0	2,453	120,061	122,514	0	303	23,880	24,183
2000	0	(429)	122,652	122,223	0	0	26,703	26,703
2001	0	(742)	87,915	87,173	0	0	23,229	23,229
2002	0	638	99,783	100,421	0	(151)	31,991	31,840
2003	0	161	101,113	101,274	0	284	31,421	31,705
2004	0	492	104,144	104,636	0	480	33,870	34,350
2005	0	1,484	103,178	104,662	0	573	27,595	28,168
2006	0	802	144,357	145,159	0	212	60,192	60,404
2007	0	802	147,244	148,046	0	212	50,310	50,522
2008	0	802	167,420	168,222	0	212	70,486	70,698
2009	0	802	167,420	168,222	0	212	70,486	70,698
2010	0	802	167,420	168,222	0	212	70,486	70,698
2011	0	802	167,443	168,245	0	212	70,486	70,698
2012	0	802	161,420	162,222	0	212	70,486	70,698
2013	0	802	161,420	162,222	0	212	70,486	70,698
2014	0	802	161,420	162,222	0	212	70,486	70,698
2015	0	802	161,420	162,222	0	212	70,486	70,698
2016	0	802	161,420	162,222	0	212	70,486	70,698
2017	0	802	161,420	162,222	0	212	70,486	70,698
2018	0	802	161,420	162,222	0	212	70,486	70,698
2019	0	802	161,420	162,222	0	212	70,486	70,698
2020	0	802	161,420	162,222	0	212	70,486	70,698
2021	0	802	161,420	162,222	0	212	70,486	70,698
2022	0	802	161,420	162,222	0	212	70,486	70,698
2023	0	802	161,420	162,222	0	212	70,486	70,698
2024	0	802	161,420	162,222	0	212	70,486	70,698
2025	0	802	161,420	162,222	0	212	70,486	70,698
2026	0	802	161,420	162,222	0	212	70,486	70,698
2027	0	802	161,420	162,222	0	212	70,486	70,698
2028	0	802	161,420	162,222	0	212	70,486	70,698
2029	0	802	161,420	162,222	0	212	70,486	70,698
2030	0	802	161,420	162,222	0	212	70,486	70,698
2031	0	802	161,420	162,222	0	212	70,486	70,698
2032	0	802	161,420	162,222	0	212	70,486	70,698
2033	0	802	161,420	162,222	0	212	70,486	70,698
2034	0	802	161,420	162,222	0	212	70,486	70,698
2035	0	802	161,420	162,222	0	212	70,486	70,698

Tables B–7 through B–31 Follow

TABLE B-7. Reconciliation of Capital Costs Allocated to Water Supply and Power Generation

(in thousands of dollars)

Item	Project Costs Allocated to Water Supply and Power Generation							Capital Costs Allocated to Other Purposes	Total State Water Project Capital Cost
	Misc. Income Credited to Construction a	Allowance for Future Price Escalation b	Costs of Construc-tion of Delivery Structures c	Costs of Requested Excess Capacity and Future Enlargement d	Capital Cost Component of Delta Water Charge e	Capital Cost Component of Trans-portation Water Charge f	Water Supply and Power Total		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
CONSERVATION FACILITIES									
Upper Feather Division									
Frenchman Dam and Lake	180	0	0	0	599	0	779	2,888	3,667
Grizzly Valley Dam and Lake Davis	65	0	0	0	39	0	104	7,378	7,482
Antelope Dam and Lake	1	0	0	0	0	0	1	5,534	5,535
Abbey Bridge Dam and Reservoir	0	0	0	0	0	0	0	519	519
Dixie Refuge Dam and Reservoir	0	0	0	0	0	0	0	236	236
Total, Upper Feather Division	246	0	0	0	638	0	884	16,555	17,439
Oroville Division									
Multipurpose Facilities	3,152	0	0	0	366,418	0	369,570	86,922	456,492
Specific Power Facilities	29,463	0	0	0	101,274	0	130,737	6,558	137,295
Total, Oroville Division	32,615	0	0	0	467,692	0	500,307	93,480	593,787
California Aqueduct									
North San Joaquin Division	1,210	0	0	0	79,995	0	81,205	2,880	84,085
San Luis Division	13,152	0	0	0	104,953	0	118,105	3,827	121,932
Total, California Aqueduct	14,362	0	0	0	184,948	0	199,310	6,707	206,017
Delta Facilities	37,311	0	0	0	286,347	0	323,658	42,268	365,926
Planning and Pre-operation	5,302	0	0	0	72,731	0	78,033	0	78,033
TOTAL, CONSERVATION FACILITIES	89,836	0	0	0	1,012,356	0	1,102,192	159,010	1,261,202
TRANSPORTATION FACILITIES									
Upper Feather Division									
Grizzly Valley Pipeline	305	0	190	0	0	342	837	0	837
North Bay Aqueduct	150	0	676	0	0	104,619	105,445	0	105,445
South Bay Aqueduct	107,766	0	1,768	0	0	112,386	221,920	21,466	243,386
California Aqueduct									
North San Joaquin Division	(46,894)	0	81	0	0	188,009	141,196	6,417	147,613
San Luis Division	8,187	0	0	0	0	133,799	141,986	6,513	148,499
South San Joaquin Division	(23,154)	0	3,733	2,093	0	293,172	275,844	17,329	293,173
Tehachapi Division	(4,955)	0	0	5,230	0	319,247	319,522	18,290	337,812
Mojave Division	(38,754)	0	813	0	0	305,858	267,917	37,941	305,858
Santa Ana Division	(1,966)	0	6,022	5,331	0	267,922	277,309	31,396	308,705
West Branch	(57,451)	0	455	37	0	502,107	445,148	31,326	476,474
Coastal Branch	(182)	0	181	0	0	494,908	494,907	0	494,907
Total, California Aqueduct	(165,169)	0	11,285	12,691	0	2,505,022	2,363,829	149,212	2,513,041
TOTAL, TRANSPORTATION FACILITIES	(56,948)	0	13,919	12,691	0	2,722,369	2,692,031	170,678	2,862,709
EAST BRANCH ENLARGEMENT	0	0	0	0	0	909,230	909,230	0	909,230
EAST BRANCH EXTENSION	0	0	0	0	0	306,403	306,403	0	306,403
COASTAL POWER ALLOCATION	0	0	0	0	0	30,708	30,708	0	30,708
SAN JOAQUIN DRAINAGE FACILITIES	0	0	0	0	0	0	0	117,320	117,320
OFF-AQUEDUCT POWER GENERATION FACILITIES	0	0	0	0	0	485,913	485,913		485,913
SMALL HYDRO POWER GENERATION FACILITIES	0	0	0	0	14,095	83,273	97,368	0	97,368
LAND PURCHASE - KERN WATER BANK	0	0	0	0	34,686	0	34,686	0	34,686
UNASSIGNED/MISCELLANEOUS	0	0	0	0	0	0	0	152,339	152,339
DAVIS- GRUNSKY	0	0	0	0	0	0	0	130,000	130,000
Subtotal	0	0	0	0	48,781	1,815,527	1,864,308	399,659	2,263,967
TOTAL THROUGH 2015	32,888	0	13,919	12,691	1,061,137	4,537,896	5,658,531	729,347	6,387,878

a) Miscellaneous project receipts that are applied for accounting purposes to reduce the capital costs of the particular facilities.
b) These allowances are included for planning the future financial program, but not for determining current water charges.
c) See Table B-8.
d) See Table B-9.
e) See Table B-13.
f) See Table B-10. Mojave Division total reduced by $83,273,000 for costs included in "Small Hydro Power Generation Facilities" line

TABLE B-8. SWP Capital Costs of Requested Delivery Structures

(in dollars)

Project Service Area and Water Supply Contractor	Calendar Year Capital Costs [a]						
	1952-2003	2004	2005	2006	2007	2008	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
FEATHER RIVER AREA							
County of Butte	136,546	0	0	0	0	0	136,546
Plumas County Flood Control and Water Conservation District	645	0	0	8,000	1,000	0	9,645
Thermalito Irrigation District [b]	43,939	0	0	0	0	0	43,939
Subtotal	181,130	0	0	8,000	1,000	0	190,130
NORTH BAY AREA							
Napa County Flood Control and Water Conservation District	13,590	0	0	0	0	0	13,590
Solano County Water Agency	662,113	0	0	0	0	0	662,113
Subtotal	675,703	0	0	0	0	0	675,703
SOUTH BAY AREA							
Alameda County Flood Control and Water Conservation District, Zone 7	378,023	6,142	11,515	34,800	10,000	0	440,480
Alameda County Water District	239,579	0	0	0	0	0	239,579
Santa Clara Valley Water District	21,500	0	0	0	0	0	21,500
San Francisco Water Department [b]	1,066,680	0	0	0	0	0	1,066,680
Subtotal	1,705,782	6,142	11,515	34,800	10,000	0	1,768,239
CENTRAL COASTAL AREA							
San Luis Obispo County Flood Control and Water Conservation District	26,204	0	0	0	0	0	26,204
Santa Barbara County Flood Control and Water Conservation District	67,058	0	0	0	0	0	67,058
Subtotal	93,262	0	0	0	0	0	93,262
SAN JOAQUIN VALLEY AREA							
Castaic Lake Water Agency	82,567	0	0	0	0	0	82,567
Dudley Ridge Water District	304,541	0	0	0	0	0	304,541
Empire West Side Irrigation District	6,358	0	0	0	0	0	6,358
Green Valley Water District [c]	5,292	0	0	0	0	0	5,292
Kern County Water Agency	3,017,846	12,082	30,054	59,950	25,000	0	3,144,932
Oak Flat Water District	46,882	0	0	18,400	5,000	0	70,282
Tracy Golf and Country Club [c]	6,932	0	0	0	0	0	6,932
Tulare Lake Basin Water Storage District	277,483	0	0	0	0	0	277,483
Veterans Administration Cemetery (b	3,342	0	0	0	0	0	3,342
Subtotal	3,751,243	12,082	30,054	78,350	30,000	0	3,901,729
SOUTHERN CALIFORNIA AREA							
Antelope Valley-East Kern Water Agency	402,882	13,029	3,003	30,000	31,000	0	479,914
Castaic Lake Water Agency	354,745	4,830	15,518	500	0	0	375,593
Coachella Valley Water District	14,206	0	0	0	0	0	14,206
Crestline-Lake Arrowhead Water Agency	25,298	0	0	0	0	0	25,298
Desert Water Agency	23,438	0	0	0	0	0	23,438
Littlerock Creek Irrigation District	23,732	0	0	0	0	0	23,732
Mojave Water Agency	211,765	0	0	0	0	0	211,765
Palmdale Water District	34,173	0	0	0	0	0	34,173
San Bernardino Valley Municipal Water District	960,685	0	0	0	0	0	960,685
San Gabriel Valley Municipal Water District	131,052	0	0	0	0	0	131,052
San Gorgonio Pass Water Agency	66,530	0	0	30,000	20,000	0	116,530
The Metropolitan Water District of Southern California	4,814,078	0	0	0	0	0	4,814,078
Ventura County Flood Control District	79,699	0	0	0	0	0	79,699
Subtotal	7,142,283	17,859	18,521	60,500	51,000	0	7,290,163
TOTAL	13,549,403	36,083	60,090	181,650	92,000	0	13,919,226

a) Approximate only, not to be construed as invoice amounts.
b) Not a SWP water supply contractor.
c) Not a SWP water supply contractor, but has contracted for water.

TABLE B-9. Capital Costs of Requested Excess Peaking Capacity

(in dollars unless otherwise indicated)

Calendar Year	Total Advance Payments and Credits for Excess Capacity	Total Incremental Costs for Excess Capacity	Over payment (+) or Under payment (-) [a]	Annual Surplus Money Investment Fund Interest Rate [b]		Net Over or Underpayment with Interest [c]
				Jan-Jun	Jul-Dec	
	[1]	[2]	[3]	[4]	[5]	[6]
	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA					
1965	0	158,000	(158,000)	3.968%	4.184%	(163,412)
1966	8,056,000	435,800	7,620,200	4.540%	5.057%	7,701,103
1967	9,094,963	1,878,270	7,216,693	4.815%	4.744%	15,524,533
1968	1,523,252	2,887,351	(1,364,099)	5.330%	5.540%	14,959,187
1969	8,310,651	3,059,310	5,251,341	5.946%	6.389%	21,369,973
1970	3,426,736	2,397,102	1,029,634	7.071%	7.125%	23,986,083
1971	1,086,045	1,146,648	(60,603)	5.154%	5.580%	25,238,017
1972	(4,244,807)	487,394	(4,732,201)	4.477%	4.977%	21,532,965
1973	(15,913,829)	25,041	(15,938,870)	6.023%	8.717%	6,014,116
1974	0	37,775	(37,775)	9.222%	10.351%	6,576,393
1975	0	2,085	(2,085)	7.089%	6.791%	7,038,515
1976	0	0	0	6.048%	6.021%	7,469,662
1977	0	0	0	5.788%	6.182%	7,923,403
1978	0	0	0	7.171%	8.096%	8,539,736
1979	0	0	0	8.979%	9.671%	9,354,605
1980	0	0	0	11.500%	11.500%	10,461,314
Total	11,339,011	12,514,776	(1,175,765)	-	-	10,461,314
	SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT					
1967	0	25,730	(25,730)	4.815%	4.744%	(26,611)
1968	184,422	44,053	140,369	5.330%	5.540%	117,587
1969	49,052	38,075	10,977	5.946%	6.389%	136,751
1970	44,911	17,959	26,952	7.071%	7.125%	175,186
1971	61,588	5,900	55,688	5.154%	5.580%	242,927
1972	(20,263)	6,835	(27,098)	4.477%	4.977%	226,230
1973	(180,465)	0	(180,465)	6.023%	8.717%	49,198
1974	0	0	0	9.222%	10.351%	54,130
1975	0	0	0	7.089%	6.791%	57,952
1976	0	0	0	6.048%	6.021%	61,501
1977	0	0	0	5.788%	6.182%	65,237
1978	0	0	0	7.171%	8.096%	70,312
1979	0	0	0	8.979%	9.671%	77,021
1980	0	0	0	11.500%	11.500%	86,133
Total	139,245	138,552	693	-	-	86,133
	ANTELOPE VALLEY-EAST KERN WATER AGENCY					
1968	85,495	1,645	83,850	5.330%	5.540%	86,962
1969	52,625	6,326	46,299	5.946%	6.389%	140,964
1970	101,648	15,076	86,572	7.071%	7.125%	243,222
1971	34,062	11,748	22,314	5.154%	5.580%	279,673
1972	(12,794)	2,018	(14,812)	4.477%	4.977%	277,552
1973	(205,354)	308	(205,662)	6.023%	8.717%	77,288
1974	0	96	(96)	9.222%	10.351%	84,933
1975	0	0	0	7.089%	6.791%	90,929
1976	0	190	(190)	6.048%	6.021%	96,300
1977	0	0	0	5.788%	6.182%	102,150
1978	0	0	0	7.171%	8.096%	110,096
1979	0	0	0	8.979%	9.671%	120,601
1980	0	0	0	11.500%	11.500%	134,869
Total	55,682	37,407	18,275	-	-	134,869

a) Overpayment or underpayment for each calendar year - column [1] minus column [2].

b) Interest rates shown are annual rates. Interest is credited daily at applicable rates on funds deposited in the State's Surplus Money Investment Fund.

c) Amounts shown are end-of-year balances. Interest on overpayments is credited at applicable Surplus Money Investment Fund Interest Rates Shown in columns [4] and [5]. Interest on underpayments is charged at the 1980 Project Interest Rate of 4.584 percent.

TABLE B-9. Capital Costs of Requested Excess Peaking Capacity

(in dollars)

Reach Number	ANNUAL REQUIRED ADVANCE OF FUNDS Incremental Costs and Advance Payments by Calendar Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1981	Reach Total
	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA													
	Incremental Costs													
8C		1,000	1,000											2,000
8D		43,500	43,500											87,000
9		27,000	27,000	13,500										67,500
10A		29,700	29,700	14,800										74,200
11B	10,100	18,300	18,300	9,200										55,900
12D	1,800		19,300	25,800	12,900									59,800
12E	1,800		12,400	18,800	10,800									43,800
13B			12,600	37,800	31,600									82,000
14A	2,500	500	11,100	80,216	107,504	124,069	37,519	6,413	381	87				370,289
14B	1,200	1,800		19,100	19,100	12,800								54,000
14C	1,800	900		13,500	13,500	9,000								38,700
15A	700		14,000	66,947	133,357	128,099	54,821	5,327	946	2,076				406,273
16A	700		18,900	137,894	182,000	211,608	133,927	26,203	5,767	6,156				723,155
17E		51,500	444,600	537,247	860,024	998,985	699,281	193,286	17,947	29,456	2,085			3,834,411
17F	109,100	261,600	261,600	261,600	261,600	239,500								1,395,000
25			964,270	1,650,947	1,426,925	673,041	221,100	256,165						5,192,448
28J		304,612	13,706	296,668	65,966	230,169	1,209,586	2,017,134	235,900	4,900				4,378,641
Total	129,700	740,412	1,891,976	3,184,019	3,125,276	2,627,271	2,356,234	2,504,528	260,941	42,675	2,085			16,865,117
	Current Adjustment													
8C through 25	1. Advance Payments Applied to Incremental Costs Amendment 2 [d]													
	0	8,056,000	9,094,963	1,523,252	8,310,651	3,426,736	1,086,045	(4,244,807)	(14,381,396)				(356,668)	12,514,776
	2. Interest Credits-Amendment 2 [e]													
28J									(1,532,433)				(10,104,646)	(11,637,079)
	3. Advance Payments Applied to Incremental Costs Amendment 5 [f]													
	0	1,240,000	1,483,180	2,469,325	(927,035)	1,729,160	3,215,258	2,967,475	1,690,000	(9,488,722)				4,378,641
	4. Interest Credits-Amendment 5 [g]													
										(2,721,803)				(2,721,803)
	5. Net Required Advance of Funds													
	0	9,296,000	10,578,143	3,992,577	7,383,616	5,155,896	4,301,303	(1,277,332)	(14,233,829)	(12,210,525)			(10,461,314)	2,524,535
	SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT													
	Incremental Costs													
25			25,730	44,053	38,075	17,959	5,900	6,835						138,552
	Total Unadjusted Incremental Costs for Past Payments													
			25,730	44,053	38,075	17,959	5,900	6,835						138,552
	Current Adjustments													
	1. Advance Payments Applied to Incremental Costs [d]													
			0	184,422	49,052	44,911	61,588	(20,263)	(174,133)				(7,025)	138,552
	2. Interest Credit													
									(6,332)				(79,108)	(85,440)
	3. Net Required Advance of Funds												[h]	
			0	184,422	49,052	44,911	61,588	(20,263)	(180,465)				(86,133)	53,112
	ANTELOPE VALLEY-EAST KERN WATER AGENCY													
	Incremental Costs													
29A				1,645	6,326	13,376	10,048	2,018	308	96		190		34,007
29F						1,700	1,700							3,400
	Total Unadjusted Incremental Costs for Past Payments													
				1,645	6,326	15,076	11,748	2,018	308	96		190		37,407
	Current Adjustments													
	1. Advance Payments Applied to Incremental Costs [d]													
				85,495	52,625	101,648	34,062	(12,794)	(189,120)	0		0	(34,509)	37,407
	2. Interest Credit													
									(16,234)				(100,360)	(116,594)
	3. Net Required Advance of Funds												[h]	
				85,495	52,625	101,648	34,062	(12,794)	(205,354)	0		0	(134,869)	(79,187)

d) Actual payments are shown for 1965 through 1976 with 1981 adjusted to reflect overpayments and underpayments without interest for prior years.
e) Interest for overpayments and underpayments under provisions of Amendment 2 of the contract.
f) Actual payments are shown for 1965 through 1973 with 1974 adjusted to reflect overpayments and underpayments without interest for prior years
g) Interest for overpayments and underpayments under provisions of Amendment 5 of the contract.
h) Amounts in excess of incremental costs, under the provisions of the contract, reduce the Transportation Charge capital cost component of the Agency's Statement of Charges for January 1981.

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	UPPER FEATHER DIVISION	NORTH BAY AQUEDUCT					SOUTH BAY AQUEDUCT			
		Reach 1	Reach 2	Reach 3A	Reach 3B	Total	Reach 1	Reach 2	Reach 4	Reach 5
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1952	0	0	0	0	0	0	97	34	30	57
1953	0	0	0	0	0	0	477	166	144	297
1954	0	0	0	0	0	0	1,466	508	437	959
1955	0	0	0	0	0	0	1,944	674	560	1,266
1956	0	0	0	0	0	0	18,789	6,515	5,090	12,545
1957	0	13,290	3,391	0	9,953	26,634	45,090	15,639	12,285	33,218
1958	2	19,202	5,011	0	25,798	50,011	195,985	80,961	7,714	21,930
1959	14	7,517	2,118	0	17,653	27,288	496,140	148,516	24,945	17,118
1960	28	8,797	4,292	0	4,838	17,927	1,130,378	67,351	71,779	68,028
1961	10	1,551	10,318	0	2,526	14,395	3,273,247	180,596	307,885	74,398
1962	32	217	(1,751)	0	414	(1,120)	1,548,884	203,535	695,446	35,102
1963	51	2,510	(1,063)	0	983	2,430	480,716	69,182	2,284,291	206,587
1964	7,791	39,879	12,046	0	21,934	73,859	2,549,118	15,903	181,900	264,410
1965	3,139	72,793	17,900	0	170,361	261,054	807,505	153,454	85,425	447,830
1966	(48)	59,615	12,972	0	438,949	511,536	898,074	149,529	142,096	1,690,200
1967	47	47,257	11,597	0	1,551,023	1,609,877	607,614	50,423	293,304	3,496,284
1968	51,573	70,586	19,560	0	831,158	921,304	965,119	19,543	89,300	2,931,101
1969	234,232	63,650	23,628	0	46,428	133,706	455,173	9,618	3,860	896,727
1970	16,227	59,090	42,733	0	9,415	111,238	52,481	3,380	10,517	154,358
1971	27,204	20,819	31,516	0	8,480	60,815	24,505	4,645	5,035	20,395
1972	9	15,538	12,952	0	10,058	38,548	26,918	825	2,945	26,090
1973	25	18,488	29,018	0	39,878	87,384	24,468	4,010	6,016	12,708
1974	45	67,352	29,978	0	134,332	231,662	17,108	1,192	1,765	65,587
1975	21	62,855	73,112	0	45,091	181,058	57,619	561	1,165	7,291
1976	51	52,419	75,611	218	13,168	141,416	104,242	2,846	8,915	12,701
1977	28	53,274	65,662	2,240	23,138	144,314	176,062	3,625	3,225	16,158
1978	38	61,936	57,158	2,955	28,987	151,036	264,581	4,494	3,668	14,028
1979	23	316,620	91,367	3,953	62,240	474,180	111,106	17,151	8,515	31,725
1980	26	422,804	111,600	19,910	96,125	650,439	368,942	17,708	8,249	38,045
1981	34	430,992	147,295	(10,752)	43,157	610,692	(145,428)	3,600	6,533	12,448
1982	11	934,812	357,720	(7,165)	134,408	1,419,775	(44,778)	18,971	7,451	37,824
1983	19	1,091,091	1,076,627	2,628	517,615	2,687,961	429,225	73,925	38,185	72,415
1984	26	1,875,968	2,317,661	3,290	1,068,363	5,265,282	506,951	36,354	9,610	92,846
1985	29	2,248,491	7,849,886	27,815	3,416,370	13,542,562	34,103	2,822	5,034	27,138
1986	31	16,420,238	10,020,277	1,309,599	1,819,349	29,569,463	85,732	14,715	17,144	13,982
1987	32	11,873,826	7,214,307	1,628,932	1,670,596	22,387,661	126,377	15,693	27,881	32,931
1988	55	3,287,756	1,648,431	1,015,971	686,821	6,638,979	290,505	36,744	51,786	25,078
1989	44	1,056,583	950,985	224,567	374,886	2,607,021	130,609	16,848	35,518	12,582
1990	63	493,522	537,881	145,694	71,938	1,249,035	275,732	32,387	99,251	40,263
1991	54	76,599	17,130	24,846	70,542	189,117	1,153,109	26,900	53,613	21,889
1992	42	56,492	6,525	18,333	37,778	119,128	401,906	53,036	61,799	51,386
1993	30	104,317	24,579	40,129	82,032	251,057	313,476	55,679	79,149	39,293
1994	14	68,065	13,463	27,107	45,909	154,544	(211,712)	29,017	362,585	36,350
1995	3	26,002	5,920	7,337	20,617	59,876	265,751	42,516	48,189	21,436
1996	0	14,790	3,334	6,614	14,606	39,344	139,573	13,049	25,751	10,677
1997	3	67,264	35,545	38,585	(13,571)	127,823	203,476	31,135	36,986	16,906
1998	7	15,410	6,392	6,797	10,396	38,995	67,974	6,120	14,731	4,616
1999	2	71,817	35,374	33,879	32,533	173,603	162,077	25,320	35,680	24,336
2000	24	29,750	8,069	11,711	4,012	53,542	100,502	15,672	24,079	19,630
2001	20	8,959	2,162	3,892	980	15,993	435,729	4,161	118,393	4,062
2002	14	25,376	17,224	15,254	3,637	61,491	3,067,506	5,536	328,799	64,277
2003	0	11,131	5,411	4,658	44,172	65,372	4,463,309	199,879	198,483	360,063
2004	0	22,864	973	2,387	144,614	170,838	6,088,707	120,308	291,114	99,170
2005	0	89,100	4	9	33,810	122,923	6,791,256	119,278	260,833	(1,426)
2006	209	30,103	15,358	12,976	1,487,637	1,546,074	3,261,067	12,810	29,641	50,685
2007	201	37,620	19,430	16,614	4,278,278	4,351,942	9,688,368	15,705	35,528	63,814
2008	196	35,478	18,299	15,622	5,007,944	5,077,343	6,882,024	14,853	33,646	60,137
2009	190	14,880	7,261	5,782	5,700	33,623	81,529	6,953	16,594	24,485
2010	190	14,880	7,261	5,782	5,700	33,623	81,529	6,953	16,594	24,485
2011	190	14,880	7,261	5,782	5,700	33,623	81,529	6,953	16,594	24,485
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
TOTAL	342,301	42,107,115	33,118,771	4,673,951	24,719,459	104,619,296	59,911,561	2,296,476	6,653,680	11,985,406

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	SOUTH BAY AQUEDUCT (continued)					CALIFORNIA AQUEDUCT NORTH SAN JOAQUIN DIVISION			
	Reach 6	Reach 7	Reach 8	Reach 9	Total	Reach 1	Reach 2A	Reach 2B	Subtotal
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1952	8	66	72	132	496	4,012	3,279	1,499	8,790
1953	38	327	336	640	2,425	10,559	8,589	3,964	23,112
1954	123	1,005	1,003	1,954	7,455	13,796	11,163	5,179	30,138
1955	160	1,293	1,149	2,454	9,500	7,370	5,952	2,760	16,082
1956	1,559	11,959	11,043	28,372	95,872	9,880	5,020	2,398	17,298
1957	3,659	28,675	27,385	563,114	729,065	11,953	5,456	2,612	20,021
1958	2,243	17,872	17,385	560,904	904,994	18,585	17,191	7,994	43,770
1959	357	3,200	3,568	149,874	843,718	123,170	100,306	45,510	268,986
1960	1,102	2,944	4,498	359,749	1,705,829	191,408	102,136	48,968	342,512
1961	4,726	18,325	22,765	(1,367)	3,880,575	153,765	195,947	42,843	392,555
1962	17,295	160,939	178,242	209,042	3,048,485	612,258	491,225	168,218	1,271,701
1963	265,414	1,250,386	939,832	129,902	5,626,310	1,993,284	1,525,734	684,095	4,203,113
1964	100,603	1,716,371	2,327,770	2,947,522	10,103,597	4,674,280	2,369,858	700,074	7,744,212
1965	42,345	368,476	637,266	1,921,844	4,464,145	5,877,189	6,873,699	2,975,719	15,726,607
1966	17,663	34,915	140,350	777,887	3,850,714	8,553,362	14,112,820	5,677,099	28,343,281
1967	(41,567)	137,856	147,183	379,764	5,070,861	9,678,607	10,672,113	6,646,739	26,997,459
1968	84,553	2,130	68,057	253,152	4,412,955	6,392,664	891,681	1,303,186	8,587,531
1969	4,279	11,572	162,300	32,000	1,575,529	3,542,767	792,259	443,924	4,778,950
1970	2,487	6,820	20,086	(15,718)	234,411	2,236,607	149,692	115,578	2,501,877
1971	4,350	6,923	17,750	39,084	122,687	98,138	215,512	69,410	383,060
1972	1,084	203	4,800	32,199	95,064	159,608	43,721	7,744	211,073
1973	288	989	7,449	9,693	65,621	105,581	25,496	22,418	153,495
1974	527	6,020	30,628	11,433	134,260	177,700	16,627	45,707	240,034
1975	126	679	1,086	3,464	71,991	239,144	14,680	169,676	423,500
1976	701	3,529	8,362	26,186	167,482	641,860	45,533	65,943	753,336
1977	270	1,310	8,651	24,938	234,239	274,381	20,283	22,568	317,232
1978	231	1,204	1,631	17,123	306,960	801,265	36,221	9,714	847,200
1979	1,367	1,721	2,134	7,322	181,041	1,051,792	59,695	26,106	1,137,593
1980	1,321	1,718	2,182	7,102	445,267	4,173,603	96,760	38,789	4,309,152
1981	308	1,462	1,398	5,077	(114,602)	(502,921)	1,487,516	38,451	1,023,046
1982	716	1,561	1,746	6,074	29,565	700,738	46,501	22,308	769,547
1983	407	5,721	8,143	23,367	651,388	706,104	84,435	211,619	1,002,158
1984	269	1,853	1,667	13,301	662,851	1,559,539	41,352	48,478	1,649,369
1985	402	1,657	2,129	6,750	80,035	677,955	24,812	19,404	722,171
1986	1,119	2,744	3,313	12,234	150,983	398,788	63,830	35,420	498,038
1987	1,496	3,081	3,560	21,842	232,861	799,672	88,945	41,659	930,276
1988	5,706	6,689	7,603	33,728	457,839	2,898,156	(128,051)	(56,448)	2,713,657
1989	2,641	3,878	4,755	14,489	221,320	6,898,872	346,589	173,993	7,419,454
1990	5,092	19,899	36,584	87,796	597,004	13,483,785	112,002	2,446,232	16,042,019
1991	1,942	5,059	7,357	31,682	1,301,551	13,914,632	133,121	114,981	14,162,734
1992	1,184	2,042	2,250	35,464	609,067	6,260,482	241,456	239,437	6,741,375
1993	3,618	6,028	8,873	42,200	548,316	2,542,869	257,330	200,072	3,000,271
1994	2,897	4,781	5,346	89,991	319,255	1,145,666	148,396	88,357	1,382,419
1995	11,556	3,635	14,769	24,750	432,602	1,462,211	217,940	131,995	1,812,146
1996	3,092	2,271	2,699	12,522	209,634	874,227	74,153	41,215	989,595
1997	1,454	4,141	3,655	20,589	318,342	2,064,446	146,851	84,303	2,295,600
1998	363	1,134	(6,005)	5,776	94,709	729,475	33,695	16,670	779,840
1999	1,530	3,283	12,698	31,555	296,479	2,208,773	88,790	90,527	2,388,090
2000	2,400	4,907	5,279	10,611	183,080	(706,522)	57,209	39,982	(609,331)
2001	91,681	68,598	403,873	1,189,678	2,316,175	371,372	89,809	7,549	468,730
2002	229,369	453,007	1,107,226	2,976,962	8,232,682	388,747	42,554	21,259	452,560
2003	67,127	509,412	477,150	1,407,084	7,682,507	178,078	18,416	10,537	207,031
2004	3,176	2,933	39,088	3,276,225	9,920,721	878,781	7,621	73,527	959,929
2005	5,237	5,239	4,803	731,389	7,916,609	226,629	11,640	84,213	322,482
2006	1,892	3,535	3,179	12,542	3,375,351	535,047	68,719	1,198,638	1,802,404
2007	2,718	4,522	4,035	14,606	9,829,296	1,168,391	80,838	2,872,533	4,121,762
2008	2,527	4,264	3,808	13,900	7,015,159	1,130,011	76,827	1,703,897	2,910,735
2009	433	1,757	1,648	7,976	141,375	259,632	42,324	16,952	318,908
2010	433	1,757	1,648	7,976	141,375	259,632	42,324	16,952	318,908
2011	433	1,757	1,648	7,976	141,375	259,632	42,324	16,952	318,908
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	970,530	4,942,034	6,970,888	18,655,877	112,386,452	115,601,487	42,998,916	29,408,098	188,008,501

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SAN LUIS DIVISION						SOUTH SAN JOAQUIN DIVISION		
	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Subtotal	Reach 8C	Reach 8D	Reach 9
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
1952	2,492	3,549	3,987	1,010	1,390	12,428	13	727	1,109
1953	6,999	10,144	10,986	2,834	3,869	34,832	45	2,671	4,185
1954	8,704	12,545	13,693	3,520	4,766	43,228	50	2,719	4,026
1955	4,273	6,055	6,813	1,728	2,325	21,194	19	888	1,100
1956	3,295	5,600	5,857	1,445	3,556	19,753	98	3,850	4,376
1957	3,543	6,115	6,357	1,565	3,998	21,578	234	10,604	13,209
1958	11,927	19,393	22,037	5,509	7,512	66,378	375	19,033	25,073
1959	21,979	37,358	39,689	9,813	19,679	128,518	436	20,578	25,697
1960	207,025	45,419	41,044	12,074	37,633	343,195	1,673	44,565	25,290
1961	184,443	292,639	170,559	38,338	70,068	756,047	3,949	75,726	30,852
1962	495,836	549,984	252,698	22,397	26,967	1,347,882	6,131	159,481	62,375
1963	2,772,189	2,034,351	2,498,712	66,353	30,647	7,402,252	5,861	161,252	81,343
1964	4,348,311	4,932,301	1,053,227	161,422	251,461	10,746,722	4,014	90,622	117,907
1965	3,860,997	5,688,252	2,869,931	1,072,111	667,768	14,159,059	15,049	491,042	564,036
1966	2,312,372	8,527,843	5,765,798	4,230,221	7,708,334	28,544,568	201,274	5,197,322	2,539,278
1967	(44,527)	2,062,305	6,942,522	222,885	6,675,398	15,858,583	212,285	4,982,844	3,363,650
1968	119,884	395,689	973,956	179,917	461,031	2,130,477	64,234	611,192	940,074
1969	(6,065)	126,946	98,492	107,486	160,668	487,527	58,960	116,146	85,130
1970	32,387	(20,243)	105,385	(827,457)	1,215,966	506,038	23,011	106,810	84,116
1971	99,945	230,624	305,227	26,995	341,010	1,003,801	8,813	33,099	23,088
1972	15,990	90,852	17,053	14,621	281,343	419,859	10,818	13,349	16,603
1973	6,753	103,707	41,549	13,810	41,427	207,246	5,145	11,089	13,249
1974	6,618	117,165	55,978	16,199	71,796	267,756	5,434	24,433	16,567
1975	18,921	107,275	23,671	8,797	152,574	311,238	5,424	15,960	12,966
1976	17,485	79,554	13,041	5,138	41,687	156,905	19,931	76,280	62,164
1977	35,707	84,669	9,412	4,028	9,655	143,471	21,096	70,005	97,952
1978	8,539	428,395	7,006	3,536	6,994	454,470	7,584	40,453	17,395
1979	(35,394)	543,225	19,463	9,485	(242,253)	294,526	10,474	6,181	6,227
1980	66,622	3,450,695	191,307	75,209	185,384	3,969,217	2,158	17,492	17,706
1981	28,491	(2,244,127)	(44,017)	(15,456)	918,984	(1,356,125)	1,151	9,642	9,541
1982	100,629	(1,616,569)	20,184	10,359	3,525,738	2,040,341	2,469	8,283	6,956
1983	75,639	33,881	11,785	6,638	1,811,638	1,939,581	7,955	13,782	11,090
1984	31,748	87,083	26,712	12,754	3,053,662	3,211,959	26,489	9,959	6,268
1985	53,251	56,732	13,685	6,934	582,910	713,512	7,220	9,762	7,688
1986	73,979	201,509	50,668	19,223	1,282,469	1,627,848	8,902	25,011	20,503
1987	(7,829)	116,268	40,009	15,946	518,349	682,743	12,744	18,927	56,042
1988	(149,385)	224,154	(406,398)	(137,353)	923,622	454,640	9,833	(119,741)	(60,639)
1989	39,652	594,894	232,852	80,090	575,855	1,523,343	5,279	91,501	278,061
1990	39,270	259,895	79,589	29,606	461,219	869,579	5,814	41,345	2,016,434
1991	4,916,134	397,959	98,847	35,860	511,519	5,960,319	4,588	43,140	41,348
1992	(757,001)	545,729	211,854	74,544	396,398	471,524	3,546	103,695	109,225
1993	110,233	724,929	186,271	70,815	720,283	1,812,531	15,016	101,634	90,929
1994	1,151,976	288,018	63,862	27,812	710,770	2,242,438	6,770	42,455	40,696
1995	285,776	441,479	130,761	58,640	1,914,186	2,830,842	12,548	49,963	43,251
1996	31,942	(110,471)	34,529	12,219	588,712	556,931	6,444	29,863	27,050
1997	73,224	513,793	(277,781)	42,881	5,016,215	5,368,332	11,497	49,111	43,799
1998	19,692	304,115	34,319	16,542	2,819,556	3,194,224	2,562	11,115	8,955
1999	18,187	158,843	99,981	41,672	1,901,201	2,219,884	5,706	25,138	23,475
2000	101,618	373,593	77,891	36,152	1,138,744	1,727,998	3,922	23,516	29,216
2001	(10,513)	(47,832)	518,046	(3,777)	59,373	515,297	2,279	16,521	20,761
2002	12,237	23,712	6,078,355	3,222	(2,455,712)	3,661,814	3,626	43,500	19,786
2003	8,863	78,058	(5,374,663)	7,414	2,178,907	(3,101,421)	2,127	17,675	15,759
2004	(15,306)	(18,715)	(55,386)	(4,006)	(463,578)	(556,991)	22,527	3,056	2,185
2005	261	(9,056)	110,561	(2,763)	982,735	1,081,738	26,296	0	0
2006	50,316	504,426	63,461	31,691	93,337	743,231	4,116	21,572	21,434
2007	177,611	894,201	86,954	41,652	102,944	1,303,362	5,172	31,382	30,106
2008	183,909	713,879	93,667	44,176	104,627	1,140,258	5,442	34,236	32,595
2009	27,741	190,182	38,070	21,795	75,769	353,557	2,905	11,643	12,384
2010	27,741	190,182	38,070	21,795	75,769	353,557	2,905	11,643	12,384
2011	27,741	190,182	38,070	21,795	75,769	353,557	2,905	11,643	12,384
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	21,315,077	34,033,332	23,886,258	6,119,861	48,444,623	133,799,151	935,343	13,197,385	11,246,409

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SOUTH SAN JOAQUIN DIVISION (continued)								
	Reach 10A	Reach 11B	Reach 12D	Reach 12E	Reach 13B	Reach 14A	Reach 14B	Reach 14C	Reach 15A
	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]
1952	695	1,279	1,980	995	1,663	794	212	212	1,911
1953	2,569	4,790	7,480	3,745	6,236	2,599	733	741	7,016
1954	2,821	4,855	7,565	3,792	6,319	2,880	810	817	7,073
1955	1,097	1,557	2,404	1,211	2,025	1,183	325	327	2,253
1956	4,428	6,223	9,233	4,737	8,054	7,026	1,638	1,584	9,939
1957	13,269	18,772	29,082	14,615	24,411	15,651	3,834	3,864	26,871
1958	25,086	48,191	78,564	39,087	61,715	33,726	12,330	11,813	49,499
1959	25,787	67,246	107,781	53,836	86,478	64,824	22,102	21,828	70,838
1960	47,492	66,317	77,936	39,867	63,517	84,363	23,260	22,305	73,305
1961	68,505	46,073	88,274	51,457	28,015	242,753	91,290	65,565	150,205
1962	57,705	56,056	69,189	44,851	49,179	208,180	61,489	47,608	133,653
1963	52,585	91,914	173,985	86,405	67,733	425,626	104,436	77,970	102,072
1964	124,014	333,621	291,013	174,469	86,271	1,093,795	684,005	485,033	571,173
1965	622,257	1,053,029	1,524,848	1,044,851	196,487	3,385,205	1,655,024	1,436,258	476,830
1966	2,800,056	3,709,779	673,429	466,228	418,141	4,916,319	974,862	724,354	1,829,852
1967	3,652,342	4,636,627	1,881,333	1,244,265	1,238,428	2,788,299	525,653	400,183	1,721,304
1968	1,025,969	1,323,302	4,726,074	3,145,775	8,343,706	10,210,266	1,330,361	1,405,117	7,522,015
1969	145,111	229,185	706,272	529,080	3,704,065	15,112,041	1,223,457	1,134,395	9,523,012
1970	74,366	85,151	70,725	72,798	320,797	11,031,255	987,213	738,955	8,836,897
1971	15,595	45,006	43,988	42,624	339,078	2,925,191	193,255	36,514	3,275,227
1972	19,736	32,657	43,939	24,748	81,937	1,388,348	101,784	20,165	1,003,380
1973	14,283	16,448	9,980	16,320	25,090	680,834	19,584	13,469	798,805
1974	22,111	14,951	19,555	32,240	29,582	524,504	30,735	16,333	778,696
1975	15,865	13,479	10,793	13,678	25,827	269,197	25,164	21,048	370,265
1976	76,202	54,217	37,464	59,842	105,332	507,519	59,753	42,776	434,574
1977	75,628	52,919	22,826	54,444	81,293	301,515	49,972	30,152	235,514
1978	48,754	16,469	(2,816)	27,331	43,126	348,674	(653)	1,500	297,817
1979	241	6,906	13,401	14,229	25,411	293,786	9,846	7,856	245,590
1980	18,165	18,813	15,608	27,498	34,190	1,676,267	29,169	23,023	1,719,775
1981	10,309	14,885	26,473	20,972	25,515	(1,076,221)	27,551	33,674	(1,142,721)
1982	8,237	6,608	7,680	8,346	16,339	(745,914)	9,886	29,393	(804,147)
1983	14,488	9,792	14,174	13,050	35,872	419,650	17,389	24,933	115,983
1984	7,533	27,613	87,907	49,271	22,732	54,590	75,453	63,060	63,537
1985	9,215	6,949	5,263	8,013	8,875	(49,408)	9,523	5,867	54,782
1986	22,335	16,664	16,014	25,031	20,483	140,642	25,960	13,913	154,089
1987	16,704	13,512	12,369	20,023	15,435	101,453	20,411	8,581	227,047
1988	(159,357)	(73,648)	(151,040)	(51,401)	(120,104)	161,077	(75,276)	(75,307)	144,369
1989	70,153	65,216	63,382	120,925	73,037	2,778,880	119,559	36,660	2,952,046
1990	34,841	29,230	27,269	49,082	34,048	715,031	44,187	14,537	440,017
1991	36,888	32,195	30,146	55,119	34,144	423,235	50,345	12,116	353,596
1992	103,321	99,765	98,178	192,455	97,638	991,603	185,311	9,210	387,615
1993	90,291	70,131	63,247	118,440	80,530	687,462	109,792	38,960	942,211
1994	65,737	29,221	26,997	50,234	35,154	400,534	44,481	17,426	324,942
1995	435,909	32,487	25,516	49,885	41,733	524,524	48,740	29,125	450,952
1996	253,433	19,489	15,020	30,202	29,333	403,125	26,945	16,405	253,622
1997	73,458	30,890	25,368	48,767	40,900	451,910	47,815	29,878	809,848
1998	14,618	7,107	5,773	10,697	9,676	288,667	10,799	6,819	119,562
1999	47,323	16,974	13,322	34,382	31,525	260,362	24,603	14,842	264,415
2000	43,393	21,100	32,408	40,128	25,095	168,350	15,186	11,034	151,288
2001	42,281	13,886	21,836	34,646	7,862	68,435	4,153	4,177	65,401
2002	87,355	19,039	6,666	78,249	47,340	272,942	22,247	35,169	163,075
2003	21,957	7,992	7,857	17,345	14,945	129,370	5,827	10,101	107,153
2004	3,575	1,471	1,013	5,388	4,371	45,849	2,510	1,698	47,933
2005	0	0	0	0	0	0	0	0	0
2006	36,461	12,947	7,140	21,229	23,190	196,493	11,021	11,615	160,943
2007	47,943	17,228	9,007	29,956	30,297	266,442	13,657	16,470	217,043
2008	51,096	18,401	9,461	32,484	32,213	285,919	14,246	17,841	232,275
2009	23,708	8,333	5,159	12,059	15,375	122,272	8,329	6,756	102,938
2010	23,708	8,333	5,159	12,059	15,375	122,272	8,329	6,756	102,938
2011	23,708	8,333	5,159	12,059	15,375	122,272	8,329	6,756	102,938
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	10,613,355	12,647,975	11,265,828	8,484,113	16,268,409	67,274,438	9,158,951	7,250,230	47,841,051

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SOUTH SAN JOAQUIN (contd.)		TEHACHAPI DIVISION			MOJAVE DIVISION			
	Reach 16A	Subtotal	Reach 17E	Reach 17F	Subtotal	Reach 18A	Reach 19	Reach 19C	Reach 20A
	[38]	[39]	[40]	[41]	[42]	[43]	[44]	[45]	[46]
1952	4,440	16,030	9,703	4,072	13,775	4,090	1,520	0	2,561
1953	16,513	59,323	31,337	13,284	44,621	12,610	4,685	0	7,246
1954	16,601	60,328	46,243	20,010	66,253	16,642	6,184	0	9,506
1955	5,223	19,612	25,880	11,362	37,242	5,612	2,086	0	2,529
1956	21,754	82,940	47,487	17,609	65,096	6,038	2,244	0	2,440
1957	62,657	237,073	119,673	49,130	168,803	22,348	8,304	0	9,035
1958	133,083	537,575	164,056	72,091	236,147	37,917	14,166	123	15,391
1959	205,748	773,179	151,389	57,883	209,272	38,620	23,450	1,102	23,605
1960	204,788	774,678	203,222	45,323	248,545	21,356	26,093	5,318	40,523
1961	206,305	1,148,969	387,819	85,558	473,377	35,664	32,281	2,262	34,918
1962	171,396	1,127,293	353,119	82,610	435,729	68,508	266,284	1,841	10,323
1963	481,941	1,913,123	1,191,633	124,757	1,316,390	37,379	435,881	4,137	39,706
1964	1,778,952	5,834,889	1,866,000	775,005	2,641,005	95,693	706,369	8,564	43,342
1965	1,268,176	13,733,092	2,574,824	2,284,869	4,859,693	121,060	716,092	9,156	108,519
1966	2,896,274	27,347,168	5,537,412	9,323,517	14,860,929	366,116	1,644,699	13,373	159,282
1967	3,442,021	30,089,234	26,239,390	12,398,708	38,638,098	1,312,022	903,880	24,103	645,078
1968	7,578,498	48,226,583	33,363,479	7,416,464	40,779,943	136,804	7,109,653	71,388	1,889,601
1969	13,136,056	45,702,910	40,368,425	6,883,206	47,251,631	213,805	2,465,641	7,423	5,939,151
1970	13,890,751	36,322,845	35,446,706	6,786,231	42,232,937	2,211,077	1,210,665	6,217	3,652,478
1971	7,903,937	14,885,415	20,141,395	6,835,303	26,976,698	1,496,843	284,738	6,994	1,074,759
1972	3,025,555	5,783,019	10,002,935	34,791	10,037,726	129,417	409,903	3,620	471,963
1973	1,472,313	3,096,609	3,090,140	36,207	3,126,347	23,931	75,638	2,539	88,416
1974	1,031,843	2,546,984	4,798,348	152,494	4,950,842	28,399	205,581	2,703	138,673
1975	489,545	1,289,211	2,144,178	411,404	2,555,582	44,774	70,652	5,066	68,157
1976	618,049	2,154,103	1,124,357	174,629	1,298,986	121,043	84,593	6,786	59,967
1977	580,209	1,673,525	655,047	31,512	686,559	261,400	133,767	7,521	117,878
1978	582,775	1,428,409	1,900,843	27,956	1,928,799	553,014	57,150	5,872	51,615
1979	542,554	1,182,702	2,099,385	61,381	2,160,766	626,615	339,536	10,831	37,085
1980	3,772,498	7,372,362	17,433,610	6,046	17,439,656	1,130,429	1,073,430	3,604	308,188
1981	(2,527,211)	(4,566,440)	(3,848,206)	6,908	(3,841,298)	1,218,824	845,702	4,498	48,625
1982	(1,850,736)	(3,296,600)	11,370,112	6,054	11,376,166	6,968,683	746,900	3,920	33,869
1983	166,232	864,390	8,862,914	8,269	8,871,183	10,909,386	64,660	2,596	40,793
1984	119,387	613,799	3,227,937	31,701	3,259,638	8,340,371	309,491	3,124	17,505
1985	82,117	165,866	1,926,289	10,460	1,936,749	5,264,156	227,986	3,885	68,422
1986	186,348	675,895	1,381,955	33,788	1,415,743	2,049,111	2,069,663	4,261	2,331,707
1987	194,936	718,184	671,183	13,807	684,990	1,347,722	(6,453)	4,684	562,540
1988	262,334	(308,900)	1,408,760	(49,734)	1,359,026	847,954	(104,961)	13,409	(159,892)
1989	5,955,356	12,610,055	504,715	64,660	569,375	376,980	207,150	50,953	31,173
1990	640,283	4,092,118	783,219	25,218	808,437	202,065	(402,573)	61,192	(637,062)
1991	774,129	1,890,989	691,578	33,405	724,983	273,021	22,218	81,545	(188,732)
1992	731,512	3,113,074	741,986	24,369	766,355	620,962	384,568	86,644	225,398
1993	857,038	3,265,681	1,223,402	35,370	1,258,772	1,131,166	248,287	72,746	110,869
1994	853,328	1,937,975	806,213	16,681	822,894	998,126	164,096	60,147	51,340
1995	628,941	2,373,574	1,538,497	19,443	1,557,940	390,433	157,481	45,990	92,925
1996	388,064	1,498,995	2,571,039	10,797	2,581,836	91,593	69,281	22,188	35,656
1997	481,458	2,144,699	1,009,249	18,265	1,027,514	135,402	92,607	13,590	65,433
1998	440,746	937,096	925,574	6,843	932,417	47,486	36,170	4,164	29,900
1999	361,308	1,123,375	661,104	12,023	673,127	113,032	49,062	5,329	171,867
2000	372,619	937,255	406,462	14,073	420,535	119,903	89,985	936	83,355
2001	165,140	467,378	254,030	9,132	263,162	63,118	185,890	2,223	342,940
2002	284,187	1,083,181	235,166	7,823	242,989	33,319	(140,419)	1,374	(112,511)
2003	154,356	512,464	160,899	8,472	169,371	79,020	(21,430)	0	(13,203)
2004	311,101	452,677	362,265	2,069	364,334	14,426	12,464	0	12,567
2005	0	26,296	2,264,058	0	2,264,058	10,573	0	0	0
2006	249,519	777,680	3,582,288	10,828	3,593,116	95,272	23,633	0	35,480
2007	331,047	1,045,750	4,200,581	15,205	4,215,786	161,318	29,968	0	43,217
2008	353,513	1,119,722	4,224,879	16,470	4,241,349	181,619	31,545	0	44,996
2009	160,332	492,193	308,861	6,214	315,075	32,088	16,820	0	26,694
2010	160,332	492,193	308,861	6,214	315,075	32,088	16,820	0	26,694
2011	160,332	492,193	308,861	6,214	315,075	32,088	16,820	0	26,694
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	76,988,503	293,171,990	264,592,766	54,654,453	319,247,219	51,360,531	23,758,596	759,941	18,501,194

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	MOJAVE DIVISION (continued)							SANTA ANA DIVISION	
	Reach 20B	Reach 21	Reach 22A	Reach 22B	Reach 23	Reach 24	Subtotal	Reach 25	Reach 26A
	[47]	[48]	[49]	[50]	[51]	[52]	[53]	[54]	[55]
1952	892	5,788	35	2,013	2,074	2,413	21,386	3,334	5,599
1953	3,402	17,846	71	5,752	6,886	7,438	65,936	10,275	17,264
1954	4,548	23,558	369	8,560	7,849	9,820	87,036	13,566	22,790
1955	2,213	7,947	178	2,754	2,725	3,313	29,357	4,575	7,687
1956	2,655	8,542	216	2,905	2,961	3,561	31,562	4,917	8,264
1957	9,826	31,616	800	10,757	10,962	13,177	116,825	18,205	30,586
1958	16,752	53,569	1,397	18,717	18,578	22,627	199,237	31,001	52,019
1959	18,604	56,724	1,844	25,421	20,372	45,646	255,388	39,325	58,137
1960	37,179	43,893	11,029	136,751	17,152	109,816	449,110	65,655	93,700
1961	37,102	21,532	14,517	215,859	9,546	373,473	777,154	26,979	56,734
1962	10,730	8,197	4,186	164,168	4,336	279,421	817,994	9,964	36,235
1963	40,865	26,670	17,081	237,695	7,228	358,503	1,205,145	31,013	112,271
1964	71,116	33,912	22,793	262,996	6,863	244,003	1,495,651	69,669	202,642
1965	343,506	91,095	65,689	827,655	11,836	621,566	2,916,174	279,237	206,356
1966	1,311,628	160,388	178,538	1,746,245	31,078	1,018,628	6,629,975	415,066	364,004
1967	1,718,942	498,257	367,961	3,146,128	62,135	2,331,106	11,009,612	3,184,296	638,539
1968	2,291,691	1,141,929	1,145,768	4,588,850	102,207	2,600,293	21,078,184	8,264,126	1,268,194
1969	5,626,284	2,358,737	1,515,147	7,750,478	260,659	11,131,406	37,268,731	6,807,783	1,768,456
1970	5,304,372	3,232,911	2,081,810	23,451,612	1,240,798	16,885,193	59,277,133	2,169,051	7,229,429
1971	1,091,123	825,070	432,464	16,772,680	1,922,115	5,385,721	29,292,507	1,135,248	9,811,736
1972	635,507	484,772	324,865	3,788,894	48,049	788,479	7,085,469	1,095,740	5,528,987
1973	83,840	63,774	36,179	1,623,274	24,333	4,225,877	6,247,801	136,994	1,810,729
1974	118,639	103,545	54,198	5,699,605	130,567	766,562	7,248,472	68,180	1,922,999
1975	169,294	167,240	19,453	4,793,580	19,467	373,783	5,731,466	166,653	3,787,797
1976	102,909	44,896	24,732	3,103,916	84,188	204,705	3,837,735	475,176	1,494,750
1977	120,160	71,389	49,445	1,654,122	60,112	232,230	2,708,024	76,255	776,085
1978	68,838	32,855	18,183	677,448	36,484	210,198	1,711,657	57,463	131,076
1979	36,225	18,948	10,675	560,506	10,634	103,615	1,754,670	29,960	80,482
1980	284,545	133,526	121,171	2,239,224	60,229	559,963	5,914,309	31,462	181,638
1981	32,214	13,223	6,466	(774,614)	138,917	203,941	1,737,796	5,864	69,031
1982	77,988	13,158	14,459	432,274	346,905	79,819	8,717,975	9,224	159,280
1983	58,714	25,900	10,363	451,428	2,029,405	58,989	13,652,234	4,304	528,764
1984	35,378	845,423	6,052	(83,811)	1,290,740	34,764	10,799,037	3,850	270,455
1985	(232,549)	(481,017)	1,945,477	608,583	966,160	51,634	8,422,737	5,555	62,571
1986	(2,046,222)	(1,334,975)	3,260,280	1,097,122	230,510	51,994	7,713,451	9,927	114,561
1987	(344,829)	55,519	64,264	3,631,282	146,850	91,223	5,552,802	4,908	27,208
1988	(147,290)	(70,564)	351,489	552,546	558,557	197,761	2,039,009	7,358	161,957
1989	60,657	30,217	534,658	4,161,037	1,496,776	433,072	7,382,673	8,092	(2,297,399)
1990	(403,413)	(635,623)	(97,841)	8,794,258	1,394,698	344,367	8,620,068	176,854	(1,657,576)
1991	(18,809)	(147,369)	(17,234)	7,985,326	3,624,824	139,105	11,753,895	202,286	(1,316,160)
1992	338,098	(263,897)	75,210	4,849,560	8,364,426	127,829	14,808,798	333,934	(1,878,502)
1993	180,598	133,941	49,144	2,094,764	15,390,366	159,211	19,571,092	1,506,787	3,979,221
1994	114,273	65,260	26,546	933,021	8,082,401	81,869	10,577,079	2,104,588	2,493,097
1995	121,499	66,503	30,918	1,096,953	5,924,175	123,653	8,050,530	3,310,564	500,791
1996	48,699	44,953	17,787	1,736,686	2,181,669	96,339	4,344,851	19,019,751	(100,474)
1997	39,973	55,881	27,865	809,666	(342,563)	102,390	1,000,244	7,645,602	(662,524)
1998	27,626	20,285	12,816	273,139	3,392,776	36,135	3,880,497	993,619	1,613,505
1999	58,327	37,630	18,087	1,007,117	2,208,411	123,902	3,792,764	223,882	843,461
2000	75,113	44,803	20,567	725,557	1,251,238	84,653	2,496,110	128,725	1,285,316
2001	121,114	77,432	57,140	555,712	339,949	32,066	1,777,584	70,116	445,110
2002	(83,458)	(7,737)	(40,809)	275,268	266,115	77,094	268,236	51,893	1,751,376
2003	(9,309)	(4,047)	2,740	392,726	140,027	41,878	608,402	80,322	346,217
2004	7,838	7,871	6,249	254,106	43,526	17,075	376,122	11,503	268,226
2005	0	0	0	0	90,480	143,825	244,878	16,594	90,632
2006	35,613	25,438	7,538	1,312,062	1,107,218	886,767	3,529,021	87,637	230,110
2007	42,004	30,933	11,099	4,259,811	1,135,686	855,785	6,569,821	87,528	314,044
2008	43,514	32,285	12,119	3,422,639	231,707	72,627	4,073,051	86,351	337,965
2009	26,897	18,651	4,078	260,725	81,164	35,159	502,276	77,036	139,078
2010	26,897	18,651	4,078	260,725	81,164	35,159	502,276	77,036	139,078
2011	26,897	18,651	4,078	260,725	81,164	35,159	502,276	77,036	139,078
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	17,877,439	8,506,505	12,946,477	135,154,958	66,497,864	53,767,780	389,131,285	61,149,894	46,102,682

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SANTA ANA DIVISION (continued)				WEST BRANCH				
	Reach 28G (a	Reach 28H	Reach 28J	Subtotal	Reach 29A	Reach 29F	Reach 29G	Reach 29H	Reach 29J
	[56]	[57]	[58]	[59]	[60]	[61]	[62]	[63]	[64]
1952	4,785	4,055	3,020	20,793	2,924	136	175	459	553
1953	15,580	11,511	9,476	64,106	9,093	344	237	1,754	1,683
1954	18,015	18,100	12,160	84,631	7,389	1,201	2,229	2,350	4,162
1955	6,052	6,081	4,151	28,546	1,019	585	1,086	1,147	2,029
1956	6,496	6,525	4,480	30,682	490	698	1,297	1,366	2,420
1957	24,044	24,156	16,585	113,576	1,809	2,583	4,792	5,057	8,952
1958	40,844	41,033	28,470	193,367	3,256	4,516	8,714	8,878	15,847
1959	45,746	45,946	44,331	233,485	7,953	9,150	19,414	18,243	35,583
1960	59,102	58,548	118,969	395,974	21,753	14,990	34,447	29,764	69,752
1961	32,226	34,382	674,787	825,108	22,442	12,775	21,559	20,086	39,761
1962	21,383	20,530	47,484	135,596	40,237	28,729	86,938	58,215	108,962
1963	43,884	41,698	1,506,440	1,735,306	91,959	69,162	163,347	110,015	211,592
1964	89,710	45,762	98,569	506,352	150,670	66,420	207,977	143,340	291,404
1965	96,956	76,899	146,095	805,543	361,811	77,914	403,115	127,430	589,638
1966	170,878	308,756	589,107	1,847,811	489,512	203,497	1,233,640	348,918	3,231,797
1967	233,968	283,126	987,832	5,327,761	1,589,715	882,096	1,117,243	891,607	31,088,491
1968	871,337	266,295	780,587	11,450,539	3,899,363	300,921	396,190	1,104,832	36,157,768
1969	1,117,873	1,444,654	756,442	11,895,208	6,592,580	336,480	693,348	1,184,454	9,655,871
1970	1,843,621	1,013,468	2,829,523	15,085,092	7,986,733	6,089,401	2,624,747	3,002,968	8,463,475
1971	16,095,702	6,401,303	12,111,623	45,555,612	4,247,037	3,768,699	1,120,231	8,244,651	5,844,024
1972	1,537,880	11,960,791	21,542,747	41,666,145	1,871,831	426,932	985,512	18,787,722	(23,015,734)
1973	209,664	247,769	3,673,344	6,078,500	775,824	168,064	399,856	9,408,706	1,821,206
1974	162,178	101,638	1,980,991	4,235,986	560,657	168,878	169,717	3,901,261	(3,454,239)
1975	157,365	124,399	1,626,274	5,862,488	353,670	421,176	925,693	664,113	609,891
1976	178,287	118,748	1,497,465	3,764,426	396,809	650,417	1,274,484	706,244	650,209
1977	127,106	89,036	323,091	1,391,573	390,637	3,018,637	2,152,961	196,012	1,135,148
1978	147,112	153,867	347,482	837,000	1,427,190	2,219,135	6,694,615	57,817	149,932
1979	29,723	19,225	225,947	385,337	940,013	2,168,382	19,813,742	597,858	331,313
1980	137,833	154,821	1,077,900	1,583,654	1,276,793	4,108,143	24,537,814	550,337	204,751
1981	28,815	22,654	61,349	187,713	(711,751)	2,699,873	19,806,531	94,944	28,852
1982	16,069	58,900	55,841	299,314	(465,217)	351,251	17,964,617	215,678	42,587
1983	18,213	89,581	(264,804)	376,058	100,394	180,971	6,751,649	220,029	24,295
1984	14,462	12,259	49,547	350,573	71,759	68,930	2,870,259	335,942	17,285
1985	17,816	11,481	54,070	151,493	142,244	25,386	2,126,670	102,366	21,971
1986	31,564	25,037	86,794	267,883	133,914	62,294	274,660	141,894	36,149
1987	17,141	8,005	45,528	102,790	13,936	453,949	711,773	192,511	27,931
1988	41,892	21,113	90,784	323,104	427,544	118,010	1,660,959	203,130	95,930
1989	28,708	12,619	51,556	(2,196,424)	207,067	430,662	584,186	241,811	97,472
1990	27,478	12,817	55,408	(1,385,019)	197,428	355,480	386,882	813,211	54,269
1991	142,139	15,524	62,794	(893,417)	219,321	344,386	453,336	1,132,520	55,176
1992	34,185	13,422	69,479	(1,427,482)	541,026	295,312	464,421	4,402,524	47,182
1993	44,300	27,047	162,854	5,720,209	464,987	320,182	643,189	3,361,457	74,198
1994	16,351	11,673	54,581	4,680,290	203,666	231,527	362,717	306,148	33,758
1995	35,402	28,202	164,254	4,039,213	344,358	392,647	536,253	468,656	34,007
1996	76,723	73,629	344,747	19,414,376	150,901	161,394	427,223	203,201	15,357
1997	50,662	20,720	268,293	7,322,753	298,002	71,310	432,940	276,180	50,095
1998	10,268	8,970	479,138	3,105,500	346,973	21,003	2,028,979	181,951	49,377
1999	84,563	45,203	324,045	1,521,154	296,367	37,791	1,080,369	125,121	50,944
2000	63,878	41,167	113,901	1,632,987	211,896	34,019	238,107	116,129	12,752
2001	18,724	12,527	86,471	632,948	41,401	8,288	100,282	107,743	7,430
2002	52,314	11,508	194,758	2,061,849	169,305	32,612	249,057	57,031	4,565
2003	1,093,434	2,479,743	174,660	4,174,376	46,382	13,185	94,703	50,878	43,728
2004	1,735,372	855,876	23,119	2,894,096	47,098	5,681	22,334	104,380	213,639
2005	2,049,472	409,829	270,555	2,837,082	273,707	0	39,668	0	51,947
2006	1,087,474	2,031,708	380,558	3,817,487	1,419,133	729,392	194,358	162,832	437,982
2007	32,550	1,681,603	11,474,286	13,590,011	1,411,290	733,691	750,501	1,107,857	17,711
2008	33,901	32,041	30,809,223	31,299,481	195,625	27,426	508,894	1,119,740	18,805
2009	20,076	22,233	35,511	293,934	101,394	16,805	4,052,486	76,090	9,112
2010	20,076	22,233	35,511	293,934	101,394	16,805	549,241	76,090	9,112
2011	20,076	22,233	35,511	293,934	101,394	16,805	304,061	76,090	9,112
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
TOTAL	30,489,448	31,264,679	98,915,694	267,922,397	40,624,107	33,477,128	131,766,425	66,249,738	75,948,971

a) Includes excess capacity costs (not shown in Table B-9) allocated to MWDSC in the following years and repaid under Article 24(c) of its contract: 1970 - $362,000; 1971 - $6,198,000; 1972 - $139,000.

TABLE B-10. Capital Costs of Each Aqueduct Reach to be Reimbursed Through Capital Cost Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)											GRAND TOTAL
	WEST BRANCH (cont.)		COASTAL BRANCH									
	Reach 30	Subtotal	Reach 31A	Reach 33A	Reach 33B	Reach 34	Reach 35	Reach 37	Reach 38	Subtotal	Total	
	[65]	[66]	[67]	[68]		[69]	[70]	[71]	[72]	[73]	[74]	[75]
1952	1,408	5,655	0	0	0	0	0	0	0	0	98,857	99,353
1953	4,346	17,457	0	0	0	0	0	0	0	0	309,387	311,812
1954	5,743	23,074	0	0	0	0	0	0	0	0	394,688	402,143
1955	1,943	7,809	0	0	0	0	0	0	0	0	159,842	169,342
1956	2,077	8,348	0	0	0	0	0	0	0	0	255,679	351,551
1957	7,684	30,877	0	0	0	0	0	0	0	0	708,753	1,464,452
1958	13,931	55,142	0	0	0	0	0	0	0	0	1,331,616	2,286,623
1959	44,384	134,727	28,046	49,114	0	7,441	8,236	0	0	92,837	2,096,392	2,967,412
1960	84,703	255,409	34,404	70,450	0	8,507	14,265	0	0	127,626	2,937,049	4,660,833
1961	123,330	239,953	13,801	17,868	0	1,501	3,931	0	0	37,101	4,650,264	8,545,244
1962	348,366	671,447	10,121	7,798	0	524	1,689	0	0	20,132	5,827,774	8,875,171
1963	521,491	1,167,566	20,470	14,299	0	880	2,943	0	0	38,592	18,981,487	24,610,278
1964	1,372,464	2,232,275	315,418	26,963	0	1,687	5,639	0	0	349,707	31,550,813	41,736,060
1965	3,383,950	4,943,858	747,023	36,178	0	2,118	7,060	0	0	792,379	57,936,405	62,664,743
1966	9,364,753	14,872,117	2,258,915	35,864	0	1,736	5,764	0	0	2,302,279	124,748,128	129,110,330
1967	17,618,827	53,187,979	6,310,419	38,331	0	1,891	6,213	0	0	6,356,854	187,465,580	194,146,365
1968	15,736,691	57,595,765	2,707,580	30,784	0	1,324	4,369	0	0	2,744,057	192,593,079	197,978,911
1969	16,228,175	34,690,908	423,797	26,549	0	907	2,905	0	0	454,158	182,530,023	184,473,490
1970	22,330,328	50,497,652	269,194	24,368	0	851	2,787	0	0	297,200	206,720,774	207,082,650
1971	16,890,503	40,115,145	164,446	32,230	0	1,315	3,804	0	0	201,795	158,414,033	158,624,739
1972	3,818,001	2,874,264	131,332	17,601	0	522	1,660	0	0	151,115	68,228,670	68,362,291
1973	13,426,222	25,999,878	182,493	16,154	0	542	1,758	0	0	200,947	45,110,823	45,263,853
1974	2,988,318	4,334,592	190,866	18,799	0	463	1,405	0	0	211,533	24,036,199	24,402,166
1975	1,808,235	4,782,778	64,582	36,012	0	2,255	6,656	0	0	109,505	21,065,768	21,318,838
1976	1,253,067	4,931,230	198,266	68,898	0	5,088	14,988	0	0	287,240	17,183,961	17,492,910
1977	345,023	7,238,418	918,473	81,305	0	1,834	5,387	0	0	1,006,999	15,165,801	15,544,382
1978	763,445	11,312,134	52,994	83,300	0	1,302	3,852	0	0	141,448	18,661,117	19,119,151
1979	282,145	24,133,453	38,182	108,951	0	1,505	4,433	0	0	153,071	31,202,118	31,857,362
1980	2,055,206	32,733,044	189,070	376,036	0	1,152	3,449	0	0	569,707	73,891,101	74,986,833
1981	275,460	22,193,909	19,897	(157,537)	0	1,427	4,261	0	0	(131,952)	15,246,649	15,742,773
1982	351,376	18,460,292	(16,381)	(96,449)	0	588	1,787	0	0	(110,455)	38,256,580	39,705,931
1983	566,545	7,843,883	85,496	67,106	0	794	2,398	0	0	155,794	34,705,281	38,044,649
1984	1,118,954	4,483,129	28,568	54,074	0	986	2,959	0	0	86,587	24,454,091	30,382,250
1985	284,243	2,702,880	36,834	54,314	0	2,111	6,263	0	0	99,522	14,914,930	28,537,556
1986	213,353	862,264	82,358	223,134	0	17,458	51,279	0	0	374,229	13,435,351	43,155,828
1987	158,313	1,558,413	53,817	1,061,939	0	92,506	272,968	0	0	1,481,230	11,711,428	34,331,982
1988	222,068	2,727,641	183,853	1,141,272	0	99,456	293,612	0	0	1,718,193	11,026,370	18,123,243
1989	148,674	1,709,872	84,678	893,765	0	77,283	228,038	0	0	1,283,764	30,302,112	33,130,497
1990	119,438	1,926,708	133,868	1,100,167	0	103,785	277,889	0	0	1,615,709	32,589,619	34,435,721
1991	229,315	2,434,054	164,610	1,635,283	0	123,603	363,889	0	0	2,287,385	38,320,942	39,811,664
1992	206,495	5,956,960	183,240	1,220,510	1,495,646	566,230	240,553	102,051	74,162	3,882,392	34,312,996	35,041,233
1993	296,349	5,160,362	344,928	5,274,657	5,052,431	1,345,211	688,935	268,937	358,367	13,333,467	53,122,385	53,921,788
1994	168,426	1,306,242	282,150	15,905,886	21,341,196	8,915,445	2,363,238	678,753	1,315,559	50,802,227	73,751,564	74,225,377
1995	304,983	2,080,904	1,196,326	45,172,271	62,947,362	23,975,738	20,849,939	7,029,108	7,117,197	168,287,940	191,033,089	191,525,570
1996	98,522	1,056,598	948,730	42,987,442	54,300,990	26,475,298	18,790,572	7,213,823	6,616,310	157,333,164	187,776,346	188,025,324
1997	233,956	1,362,483	562,583	11,209,633	13,893,576	10,456,863	4,149,105	545,378	798,606	41,615,744	62,137,369	62,583,537
1998	67,874	2,696,157	248,671	2,355,322	4,159,441	3,368,320	952,615	192,567	280,779	11,557,715	27,083,446	27,217,157
1999	117,470	1,708,062	288,155	2,913,031	4,398,199	2,617,504	357,331	36,680	51,648	10,662,548	24,089,004	24,559,088
2000	186,940	799,843	132,288	241,661	2,964,598	2,747,810	19,670	0	0	6,106,027	13,511,424	13,748,070
2001	17,175	282,319	102,285	79,245	559,917	15,389	11,334	0	0	768,170	5,175,588	7,507,776
2002	55,993	568,563	97,023	234,364	96,896	88,726	25,599	0	0	542,608	8,881,800	17,175,987
2003	19,607	268,483	39,881	233,536	11,802	50,867	33,642	0	0	369,728	3,208,434	10,956,313
2004	9,071	402,203	26,208	80,285	14,941	13,081	12,548	0	0	147,063	5,039,433	15,130,992
2005	580,754	946,076	29,204	(287,866)	37,518	0	0	0	0	(221,144)	7,501,466	15,540,998
2006	347,830	3,291,527	157,641	431,914	0	113,900	45,723	0	0	749,178	18,303,644	23,225,278
2007	4,804,679	8,825,729	196,592	448,845	0	109,735	44,051	0	0	799,223	40,471,444	54,652,883
2008	11,871,602	13,742,092	206,890	448,894	0	106,875	42,903	0	0	805,562	59,332,250	71,424,948
2009	46,715	4,302,602	109,984	365,173	0	103,363	41,493	0	0	620,013	7,198,558	7,373,746
2010	46,715	799,357	109,984	365,173	0	103,363	41,493	0	0	620,013	3,695,313	3,870,501
2011	46,715	554,177	109,984	365,173	0	103,363	41,493	0	0	620,013	1,174,190	1,174,190
2012	0	0	0	0	0	0	0	0	0	0	2,275,943	2,451,131
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	154,040,369	502,106,738	21,500,237	137,240,069	171,274,513	81,842,423	50,370,773	16,067,297	16,612,628	494,907,940	2,588,295,221	2,805,643,270

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	UPPER FEATHER DIVISION	NORTH BAY AQUEDUCT					SOUTH BAY AQUEDUCT			
		Reach 1	Reach 2	Reach 3A	Reach 3B	Total	Reach 1	Reach 2	Reach 4	Reach 5
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	37,396	5,522	0	0
1963	0	0	0	0	0	0	147,719	20,639	0	0
1964	0	0	0	0	0	0	149,750	15,574	19,405	0
1965	0	0	0	0	0	0	259,939	45,718	46,485	0
1966	0	0	0	0	0	0	270,890	23,799	63,921	0
1967	0	0	0	0	0	0	438,050	32,798	108,127	0
1968	0	0	0	0	130	130	410,919	44,277	66,973	706
1969	0	0	0	0	80,875	80,875	487,377	48,339	75,644	706
1970	0	0	0	0	94,872	94,872	381,734	44,852	64,833	71,376
1971	54	0	0	0	45,579	45,579	357,850	25,666	50,344	38,735
1972	40	0	0	0	37,895	37,895	347,941	30,606	56,800	100,106
1973	1	0	0	0	32,993	32,993	386,897	36,172	58,288	28,810
1974	143	0	0	0	46,498	46,498	456,381	57,081	83,120	61,623
1975	1,069	0	0	0	37,707	37,707	624,989	46,111	81,361	36,682
1976	139	0	0	0	60,786	60,786	614,362	47,862	123,838	91,096
1977	892	0	0	0	78,400	78,400	511,065	48,926	104,280	102,083
1978	39	0	0	0	56,318	56,318	671,195	125,224	176,855	50,289
1979	3,235	0	0	0	73,852	73,852	650,826	76,849	212,826	91,380
1980	416	0	0	0	81,769	81,769	1,128,840	212,974	242,118	110,786
1981	3,847	0	0	0	101,340	101,340	884,763	130,126	167,118	204,772
1982	11,075	0	0	0	191,987	191,987	1,156,605	141,718	249,447	96,020
1983	1,928	0	0	0	80,215	80,215	1,258,144	84,360	373,875	152,255
1984	3,765	0	0	0	139,121	139,121	1,998,984	113,797	340,344	34,461
1985	2,888	0	0	0	259,515	259,515	2,044,121	207,478	427,930	247,308
1986	2,787	0	0	0	229,508	229,508	1,834,838	285,908	305,149	159,054
1987	2,388	0	0	0	310,683	310,683	2,118,974	163,714	400,547	283,067
1988	545	0	(94)	0	330,156	330,062	2,068,655	186,275	299,934	370,212
1989	1,800	473,408	178,069	237,480	373,427	1,262,384	2,164,688	163,481	320,734	497,038
1990	788	556,610	244,897	123,144	427,257	1,351,908	2,233,036	251,434	355,022	571,415
1991	3,654	651,307	302,327	205,516	428,470	1,587,620	1,806,699	152,509	95,745	93,986
1992	647	443,912	189,330	265,462	280,505	1,179,209	2,064,907	405,932	409,435	363,964
1993	3,630	435,240	294,416	213,267	289,206	1,232,129	3,925,050	621,712	480,832	399,558
1994	2,279	430,112	198,322	206,594	365,646	1,200,674	4,673,275	302,115	404,709	408,066
1995	2,906	428,313	282,898	151,703	295,326	1,158,240	3,849,620	316,905	566,447	330,706
1996	8,007	796,526	272,743	240,106	260,001	1,569,376	3,526,989	254,075	664,485	493,300
1997	7,449	504,476	210,763	213,211	315,374	1,243,824	3,010,809	189,269	591,540	230,371
1998	798	405,029	227,562	204,964	251,183	1,088,738	2,965,468	426,872	532,042	303,325
1999	416	668,954	326,989	296,605	288,169	1,580,717	3,701,631	472,798	429,082	414,830
2000	505	920,906	255,241	658,168	414,700	2,249,015	3,817,480	542,905	442,515	552,538
2001	319	1,072,623	229,820	455,870	181,522	1,939,835	2,909,692	272,876	290,330	391,186
2002	3,627	1,588,349	416,749	411,379	399,274	2,815,751	3,865,610	343,132	468,352	543,895
2003	3,393	1,777,686	545,908	567,866	354,483	3,245,943	2,352,996	366,393	576,229	964,901
2004	3,455	1,602,507	635,773	738,104	818,511	3,794,895	3,345,983	511,123	747,800	701,961
2005	3,451	1,059,738	323,279	774,767	414,332	2,572,116	3,330,782	263,543	428,970	813,898
2006	3,100	1,521,394	504,829	709,233	531,591	3,267,047	2,992,891	400,332	616,170	905,468
2007	3,200	1,584,868	530,095	739,756	554,856	3,409,575	3,194,621	430,935	658,467	1,072,722
2008	3,250	1,643,049	551,084	770,722	574,417	3,539,272	3,383,584	455,510	692,695	1,126,744
2009	3,300	926,412	258,366	462,833	390,187	2,037,798	4,099,129	478,799	772,701	667,221
2010	3,300	926,147	258,396	462,691	390,135	2,037,369	4,099,299	478,827	772,712	666,869
2011	3,300	929,708	259,272	464,465	391,454	2,044,899	4,112,664	480,495	775,451	672,068
2012	3,300	929,963	259,311	464,597	391,544	2,045,415	4,113,390	480,578	775,597	672,302
2013	3,300	930,782	259,328	465,023	391,775	2,046,908	4,114,257	480,663	775,808	673,220
2014	3,300	931,443	259,183	465,382	391,870	2,047,878	4,112,906	480,483	775,632	674,205
2015	3,300	932,136	259,387	465,727	392,165	2,049,415	4,116,091	480,855	776,230	674,691
2016	3,300	930,864	259,113	465,084	391,676	2,046,737	4,111,515	480,326	775,348	673,647
2017	3,300	931,398	259,210	465,356	391,871	2,047,835	4,113,197	480,519	775,676	674,112
2018	3,300	932,358	259,229	465,857	392,141	2,049,585	4,114,217	480,620	775,926	675,191
2019	3,300	930,957	258,990	465,142	391,633	2,046,722	4,109,973	480,134	775,091	673,944
2020	3,300	931,721	259,262	465,521	391,989	2,048,493	4,114,125	480,623	775,861	674,407
2021	3,300	932,052	259,463	465,676	392,188	2,049,379	4,116,993	480,968	776,377	674,478
2022	3,300	932,124	259,191	465,737	392,056	2,049,108	4,113,513	480,539	775,788	674,979
2023	3,300	930,912	259,147	465,106	391,710	2,046,875	4,111,990	480,384	775,433	673,648
2024	3,300	931,429	259,145	465,377	391,846	2,047,797	4,112,376	480,417	775,539	674,247
2025	3,300	932,362	259,444	465,839	392,259	2,049,904	4,116,988	480,959	776,399	674,863
2026	3,300	930,683	258,916	465,005	391,520	2,046,124	4,108,800	479,998	774,870	673,741
2027	3,300	933,603	259,817	466,458	392,799	2,052,677	4,122,843	481,646	777,498	675,719
2028	3,300	930,658	258,849	464,998	391,478	2,045,983	4,107,909	479,889	774,715	673,815
2029	3,300	931,724	259,312	465,515	392,016	2,048,567	4,114,779	480,704	775,973	674,331
2030	3,300	930,740	259,116	465,018	391,646	2,046,520	4,111,450	480,319	775,327	673,498
2031	3,300	934,100	259,761	466,721	392,901	2,053,483	4,122,521	481,594	777,482	676,377
2032	3,300	930,149	258,691	464,746	391,253	2,044,839	4,105,445	479,599	774,254	673,474
2033	3,300	931,719	259,421	465,506	392,077	2,048,723	4,116,210	480,878	776,218	674,155
2034	3,300	932,090	259,340	465,706	392,128	2,049,264	4,115,432	480,775	776,112	674,709
2035	3,300	930,268	258,736	464,803	391,309	2,045,116	4,106,118	479,681	774,381	673,542
TOTAL	181,025	43,703,509	13,718,396	20,743,806	20,766,075	98,931,786	195,849,145	22,417,488	34,909,562	31,698,852

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar	SOUTH BAY AQUEDUCT (continued)					CALIFORNIA AQUEDUCT NORTH SAN JOAQUIN DIVISION			
Year	Reach 6	Reach 7	Reach 8	Reach 9	Total	Reach 1	Reach 2A	Reach 2B	Subtotal
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	42,918	0	0	0	0
1963	0	0	0	0	168,358	0	0	0	0
1964	0	0	0	0	184,729	0	0	0	0
1965	2,634	6,490	4,704	12,904	378,874	0	0	0	0
1966	4,707	10,328	9,233	25,519	408,397	0	0	0	0
1967	2,712	7,659	10,812	34,347	634,505	0	0	0	0
1968	3,109	7,960	10,166	40,372	584,482	1,001,998	228,359	103,116	1,333,473
1969	3,944	5,975	8,795	38,566	669,346	933,116	301,596	188,194	1,422,906
1970	2,464	(1,991)	6,870	28,210	598,348	971,602	306,198	151,539	1,429,339
1971	3,116	9,394	9,895	31,068	526,068	1,103,021	254,786	113,694	1,471,501
1972	5,125	10,247	12,054	44,699	607,578	1,107,855	230,906	110,109	1,448,870
1973	4,178	7,500	4,890	43,816	570,551	1,150,864	221,445	100,221	1,472,530
1974	7,812	7,564	5,523	48,054	727,158	1,272,034	231,383	117,156	1,620,573
1975	18,120	14,683	18,325	68,377	908,648	1,434,736	455,110	201,075	2,090,921
1976	10,873	5,557	19,920	49,921	963,429	1,519,801	217,348	453,400	2,190,549
1977	(240)	2,228	8,391	89,579	866,312	1,913,643	292,380	196,564	2,402,587
1978	(1,404)	16,766	(5,313)	104,078	1,137,690	1,860,456	306,503	188,214	2,355,173
1979	1,269	29,294	7,351	106,835	1,176,630	1,848,109	231,339	145,205	2,224,653
1980	3,621	24,270	17,404	110,852	1,850,865	2,365,292	472,660	247,608	3,085,560
1981	4,038	20,109	17,586	98,143	1,526,655	2,649,730	435,226	154,191	3,239,147
1982	2,236	22,870	21,919	202,590	1,893,405	3,192,710	599,793	244,664	4,037,167
1983	(2,047)	48,781	45,573	216,434	2,177,375	4,244,937	802,908	273,081	5,320,926
1984	4,449	44,017	23,563	455,054	3,014,669	4,373,157	808,917	290,728	5,472,802
1985	13,097	74,565	57,920	238,067	3,310,486	4,717,323	629,825	189,199	5,536,347
1986	11,614	31,084	46,864	363,350	3,037,861	5,217,491	929,919	359,365	6,506,775
1987	15,273	25,182	37,949	416,375	3,461,081	5,292,200	958,927	362,065	6,613,192
1988	30,207	41,047	49,156	335,408	3,380,894	5,329,317	822,300	360,336	6,511,953
1989	9,740	54,881	114,203	179,323	3,504,088	5,753,966	851,745	907,609	7,513,320
1990	31,161	69,416	119,309	247,781	3,878,574	6,788,986	1,066,314	883,822	8,739,122
1991	22,434	(18,690)	99,577	262,052	2,514,312	6,796,247	1,067,078	585,008	8,448,333
1992	26,787	332,012	98,670	186,640	3,888,347	9,415,121	1,419,603	673,833	11,508,557
1993	24,845	181,592	94,169	316,045	6,043,803	10,274,070	1,371,074	900,996	12,546,140
1994	28,383	90,791	80,942	416,061	6,404,342	8,451,199	1,325,511	802,217	10,578,927
1995	29,298	64,012	80,278	373,657	5,610,923	10,406,784	2,386,507	959,685	13,752,976
1996	(1,020)	60,610	11,672	312,097	5,322,208	10,246,985	2,604,651	628,177	13,479,813
1997	18,428	95,321	15,691	335,566	4,486,995	10,429,338	1,098,381	2,084,859	13,612,578
1998	26,323	54,255	611,290	658,090	5,577,665	11,410,436	1,449,411	5,364,368	18,224,215
1999	49,762	34,829	426,694	2,030,604	7,560,230	11,446,675	1,365,947	1,301,570	14,114,192
2000	135,909	87,815	185,985	641,445	6,406,592	12,637,999	905,934	648,421	14,192,354
2001	112,970	188,989	197,745	1,048,191	5,411,979	17,559,077	1,375,177	752,734	19,686,988
2002	143,886	171,491	501,630	2,781,431	8,819,427	14,429,951	861,125	622,521	15,913,597
2003	78,084	97,968	248,068	987,782	5,672,421	16,535,948	1,724,007	749,673	19,009,628
2004	156,691	179,277	205,603	454,479	6,302,917	14,177,440	1,308,095	733,356	16,218,891
2005	143,175	202,435	135,636	224,528	5,542,967	12,551,578	1,935,671	873,917	15,361,166
2006	131,191	165,321	204,183	581,861	5,997,417	14,805,852	1,332,319	703,409	16,841,580
2007	136,411	172,607	222,778	630,651	6,519,192	15,666,838	1,434,005	804,192	17,905,035
2008	140,856	178,739	237,550	669,594	6,885,272	16,586,177	1,515,807	882,669	18,984,653
2009	90,837	84,173	102,317	502,075	6,797,252	11,356,421	2,164,030	721,285	14,241,736
2010	90,848	84,184	102,329	502,136	6,797,204	11,355,782	2,163,388	721,092	14,240,262
2011	91,155	84,471	102,675	503,834	6,822,813	11,392,790	2,171,770	723,555	14,288,115
2012	91,169	84,483	102,690	503,909	6,824,118	11,394,497	2,172,253	723,710	14,290,460
2013	91,171	84,488	102,696	503,934	6,826,237	11,398,180	2,174,015	724,252	14,296,447
2014	91,120	84,439	102,636	503,642	6,825,063	11,398,634	2,175,753	724,759	14,299,146
2015	91,190	84,503	102,717	504,036	6,830,313	11,404,761	2,176,876	725,136	14,306,773
2016	91,096	84,416	102,610	503,507	6,822,465	11,395,071	2,174,621	724,401	14,294,093
2017	91,129	84,448	102,646	503,693	6,825,420	11,398,842	2,175,604	724,716	14,299,162
2018	91,135	84,452	102,652	503,721	6,827,914	11,403,168	2,177,675	725,352	14,306,195
2019	91,051	84,374	102,558	503,260	6,820,385	11,393,469	2,175,070	724,519	14,293,058
2020	91,146	84,463	102,668	503,793	6,827,086	11,401,016	2,176,213	724,910	14,302,139
2021	91,218	84,529	102,748	504,185	6,831,496	11,405,600	2,176,536	725,043	14,307,179
2022	91,121	84,439	102,637	503,645	6,826,661	11,401,546	2,177,233	725,213	14,303,992
2023	91,107	84,428	102,622	503,571	6,823,183	11,395,800	2,174,655	724,416	14,294,871
2024	91,105	84,425	102,620	503,563	6,824,292	11,397,931	2,175,800	724,766	14,298,497
2025	91,209	84,522	102,738	504,144	6,831,822	11,406,579	2,177,255	725,260	14,309,094
2026	91,025	84,352	102,530	503,117	6,818,433	11,391,153	2,174,611	724,366	14,290,130
2027	91,342	84,645	102,887	504,872	6,841,452	11,417,750	2,179,250	725,929	14,322,929
2028	91,002	84,330	102,502	502,985	6,817,147	11,389,977	2,174,690	724,378	14,289,045
2029	91,164	84,480	102,688	503,891	6,828,010	11,401,827	2,176,111	724,889	14,302,827
2030	91,097	84,417	102,611	503,512	6,822,231	11,394,591	2,174,340	724,315	14,293,246
2031	91,322	84,626	102,864	504,757	6,841,543	11,418,937	2,180,445	726,284	14,325,666
2032	90,945	84,277	102,440	502,676	6,813,110	11,385,321	2,173,886	724,107	14,283,314
2033	91,203	84,516	102,732	504,109	6,830,021	11,403,573	2,175,884	724,838	14,304,295
2034	91,174	84,489	102,697	503,941	6,829,329	11,403,798	2,176,862	725,124	14,305,784
2035	90,961	84,292	102,458	502,763	6,814,196	11,386,528	2,174,058	724,166	14,284,752
TOTAL	4,056,263	5,214,911	7,112,191	30,137,767	331,396,179	597,563,601	96,855,074	45,973,541	740,392,216

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SAN LUIS DIVISION						SOUTH SAN JOAQUIN DIVISION		
	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Subtotal	Reach 8C	Reach 8D	Reach 9
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	120,038	428,308	130,105	44,591	104,033	827,075	0	0	0
1969	90,033	460,907	184,467	35,696	235,322	1,006,425	22,013	134,760	86,103
1970	89,547	484,300	226,002	66,070	192,582	1,058,501	26,207	156,981	128,273
1971	99,917	541,574	175,592	64,193	158,170	1,039,446	32,312	190,753	118,372
1972	116,708	647,979	174,519	73,670	154,783	1,167,659	35,031	187,242	130,396
1973	116,791	611,705	158,145	58,344	153,955	1,098,940	51,150	225,747	127,530
1974	120,309	671,455	150,835	63,905	150,230	1,156,734	34,752	199,127	131,298
1975	133,593	839,285	178,974	81,478	157,586	1,390,916	78,523	250,377	159,006
1976	54,938	883,956	220,832	90,305	174,835	1,424,866	39,348	133,933	123,424
1977	73,331	1,114,465	270,734	98,132	196,311	1,752,973	38,086	121,348	178,078
1978	45,867	898,992	203,261	106,938	203,079	1,458,137	45,552	178,805	129,928
1979	223,973	842,508	144,055	99,670	180,734	1,490,940	69,973	150,679	129,756
1980	243,507	1,176,463	222,942	127,625	281,860	2,052,397	57,726	274,848	185,155
1981	265,766	1,065,358	193,048	90,533	1,612,157	3,226,862	80,121	198,256	144,187
1982	279,250	1,241,285	209,371	114,421	1,433,180	3,277,507	59,424	269,086	233,494
1983	214,468	1,949,017	339,809	131,377	2,143,678	4,778,349	49,448	383,476	223,078
1984	241,273	2,233,969	335,166	163,858	2,111,386	5,085,652	42,062	458,489	300,924
1985	322,068	2,882,583	360,431	176,577	1,603,532	5,345,191	58,820	495,500	213,368
1986	416,027	2,996,792	472,551	252,188	601,250	4,738,808	90,730	478,786	596,800
1987	362,738	3,104,592	424,107	236,349	439,232	4,567,018	113,962	412,042	446,067
1988	365,209	2,954,186	456,864	231,754	639,242	4,647,255	96,728	379,073	417,991
1989	263,171	3,182,472	393,589	332,986	633,419	4,805,637	83,282	389,698	400,853
1990	397,353	4,011,110	579,073	464,639	729,132	6,181,307	111,019	436,849	515,611
1991	256,473	4,388,184	543,760	728,156	765,765	6,682,338	104,414	496,794	465,940
1992	302,021	3,792,401	795,587	363,134	815,590	6,068,733	118,315	511,982	417,871
1993	439,725	4,337,616	1,008,394	551,849	734,796	7,072,380	230,338	745,885	490,159
1994	282,579	4,376,461	816,129	396,768	492,860	6,364,797	125,398	602,404	572,557
1995	107,995	5,026,076	1,066,971	440,006	1,356,668	7,997,716	185,681	657,282	432,072
1996	1,003,229	4,738,221	931,944	683,323	1,034,376	8,391,093	112,062	416,294	472,350
1997	859,665	5,761,996	924,289	254,934	646,209	8,447,093	128,190	449,316	728,436
1998	690,845	5,522,567	1,242,589	534,931	654,538	8,645,470	115,748	457,845	429,433
1999	697,893	5,684,969	1,219,793	531,972	670,006	8,804,633	104,822	396,623	409,411
2000	712,071	5,849,518	1,033,992	528,537	876,030	9,000,148	104,381	467,347	513,824
2001	(558,917)	7,151,253	851,983	373,030	679,856	8,497,205	58,436	553,295	603,147
2002	1,071,739	5,193,633	673,240	255,190	738,467	7,932,269	55,252	729,942	417,109
2003	1,026,535	6,040,701	750,339	304,182	620,749	8,742,506	62,618	674,449	643,946
2004	655,509	7,033,601	725,042	344,853	606,863	9,365,868	37,161	484,074	337,980
2005	543,326	6,052,036	975,929	396,253	792,532	8,760,076	26,876	389,759	285,162
2006	900,505	6,872,937	1,103,796	449,812	801,602	10,128,652	44,509	512,149	416,311
2007	922,828	7,049,871	1,482,975	462,406	826,715	10,744,795	46,041	529,672	430,539
2008	896,429	7,428,878	1,857,947	473,214	848,446	11,504,914	47,371	544,972	442,974
2009	809,554	4,574,988	979,216	461,417	630,100	7,455,275	273,491	1,039,646	852,726
2010	808,748	4,572,037	979,333	461,182	629,812	7,451,112	273,514	1,039,295	852,382
2011	817,259	4,598,204	984,364	463,987	633,594	7,497,408	274,454	1,043,544	855,949
2012	817,614	4,599,964	984,515	464,147	633,802	7,500,042	274,500	1,043,847	856,215
2013	819,431	4,607,370	984,564	464,760	634,579	7,510,704	274,532	1,044,873	857,169
2014	821,880	4,615,848	983,992	465,409	635,372	7,522,501	274,404	1,045,783	858,090
2015	822,253	4,619,118	984,762	465,747	635,834	7,527,714	274,618	1,046,556	858,720
2016	820,960	4,611,545	983,728	465,032	634,882	7,516,147	274,320	1,045,085	857,469
2017	821,615	4,615,016	984,091	465,350	635,301	7,521,373	274,427	1,045,713	858,011
2018	823,752	4,623,708	984,148	466,070	636,214	7,533,892	274,466	1,046,917	859,134
2019	821,949	4,614,380	983,247	465,223	635,101	7,519,900	274,201	1,045,267	857,700
2020	822,057	4,617,229	984,284	465,549	635,562	7,524,681	274,484	1,046,096	858,345
2021	821,583	4,617,139	985,053	465,607	635,673	7,525,055	274,689	1,046,410	858,547
2022	823,438	4,622,114	984,000	465,926	636,024	7,531,502	274,422	1,046,638	858,890
2023	820,859	4,611,441	983,857	465,034	634,893	7,516,084	274,355	1,045,125	857,492
2024	822,093	4,616,339	983,839	465,438	635,398	7,523,107	274,364	1,045,784	858,112
2025	822,430	4,620,342	984,972	465,864	635,991	7,529,599	274,677	1,046,809	858,931
2026	821,758	4,612,973	982,968	465,084	634,912	7,517,695	274,122	1,044,956	857,442
2027	823,033	4,626,057	986,396	466,461	636,813	7,538,760	275,069	1,048,193	860,051
2028	822,116	4,613,794	982,710	465,130	634,956	7,518,706	274,057	1,044,959	857,478
2029	821,744	4,616,444	984,478	465,500	635,508	7,523,674	274,535	1,046,069	858,299
2030	820,649	4,610,335	983,740	464,932	634,758	7,514,414	274,321	1,044,929	857,318
2031	824,537	4,631,567	986,172	466,894	637,350	7,546,520	275,024	1,048,846	860,692
2032	821,903	4,611,536	982,108	464,892	634,626	7,515,065	273,890	1,044,396	857,023
2033	821,051	4,614,662	984,905	465,390	635,391	7,521,399	274,642	1,046,010	858,190
2034	822,432	4,619,425	984,579	465,755	635,836	7,528,027	274,570	1,046,519	858,707
2035	821,905	4,611,945	982,278	464,939	634,696	7,515,763	273,936	1,044,523	857,120
TOTAL	37,624,928	262,049,700	50,771,470	23,834,568	45,394,734	419,675,400	10,431,966	43,948,727	36,785,115

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SOUTH SAN JOAQUIN DIVISION (continued)								
	Reach 10A	Reach 11B	Reach 12D	Reach 12E	Reach 13B	Reach 14A	Reach 14B	Reach 14C	Reach 15A
	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0
1969	83,706	59,077	0	0	0	0	0	0	0
1970	118,046	85,758	94,171	123,374	152,424	0	0	0	0
1971	129,811	80,282	95,075	91,389	167,142	691,791	151,979	111,623	529,723
1972	117,625	84,287	98,647	115,592	146,096	877,535	124,831	101,479	609,058
1973	117,706	92,257	74,238	114,843	221,385	961,855	120,106	99,429	692,748
1974	141,658	98,103	74,914	193,523	141,540	898,272	143,866	115,649	853,098
1975	207,908	124,105	61,799	117,194	108,154	1,156,757	180,614	119,889	988,045
1976	139,134	69,715	33,655	147,908	134,063	1,124,051	177,086	114,133	1,037,799
1977	194,086	108,644	91,547	175,039	137,975	1,397,006	203,837	119,467	1,339,196
1978	168,634	106,702	72,585	170,578	151,120	1,254,043	139,662	132,224	1,265,813
1979	175,107	85,942	56,331	174,147	150,029	1,490,461	201,935	260,981	1,216,126
1980	284,207	120,896	123,120	167,249	164,749	1,988,619	189,132	238,607	1,437,614
1981	199,927	76,965	33,322	113,202	171,669	1,741,488	163,934	161,182	1,799,832
1982	264,947	158,178	142,631	224,170	224,051	1,793,867	195,086	15,768	1,933,859
1983	308,801	136,350	124,724	203,733	217,324	2,421,794	199,708	181,879	2,550,842
1984	396,448	163,331	108,212	188,724	245,764	3,312,127	329,490	204,332	3,215,901
1985	298,337	198,368	154,995	194,327	360,308	3,463,178	237,127	180,068	3,427,049
1986	422,493	248,170	242,660	346,410	349,369	3,781,427	320,984	360,156	3,574,451
1987	488,226	334,059	325,697	469,378	322,824	3,731,912	463,757	238,813	4,080,465
1988	532,489	290,881	220,658	374,653	318,253	3,451,893	411,110	313,806	3,746,920
1989	733,030	268,025	207,487	595,433	380,883	3,512,884	333,996	220,978	3,751,081
1990	651,465	363,652	225,171	480,738	677,729	4,021,727	439,953	212,851	4,381,643
1991	716,328	328,683	269,873	371,312	433,313	4,309,082	424,704	273,169	4,566,702
1992	574,145	334,579	270,768	409,314	423,717	4,734,368	729,211	571,412	4,270,793
1993	723,450	413,722	278,375	496,851	594,201	5,182,830	664,063	423,780	5,266,124
1994	703,493	346,600	239,873	482,301	445,909	4,012,614	414,899	254,393	3,727,019
1995	881,902	405,045	242,253	622,654	507,102	4,607,154	309,283	315,905	3,973,757
1996	984,784	367,570	238,622	519,560	604,736	4,892,967	214,773	187,784	4,331,630
1997	1,864,113	309,696	254,080	516,115	429,771	5,094,202	261,221	275,610	4,011,366
1998	1,011,284	295,927	170,556	384,226	484,072	4,753,508	309,440	248,178	4,695,541
1999	1,125,514	373,814	171,495	399,331	504,020	5,041,004	351,551	231,583	4,753,855
2000	924,210	407,081	329,756	651,715	567,781	5,957,878	343,438	141,041	5,385,171
2001	870,742	413,016	893,071	519,027	660,369	4,701,148	(133,796)	(94,419)	6,007,151
2002	1,309,728	381,311	295,967	959,788	862,655	5,969,394	39,304	256,180	5,598,378
2003	817,168	338,931	233,756	690,414	612,296	6,183,504	(128,254)	24,819	6,974,920
2004	609,367	244,096	173,363	623,894	584,409	7,283,893	(107,944)	(142,634)	8,848,430
2005	884,677	212,724	119,691	851,556	469,679	6,312,322	(169,616)	(182,745)	5,900,809
2006	779,349	259,016	155,809	735,600	545,429	6,846,089	247,423	208,109	7,734,486
2007	806,084	267,872	161,061	760,885	564,124	7,300,049	255,825	215,190	8,166,971
2008	829,373	275,610	165,708	782,871	580,421	7,614,095	263,210	221,403	8,471,420
2009	866,629	648,969	589,638	917,194	964,134	5,962,564	813,829	562,199	5,679,840
2010	866,734	648,784	589,284	917,029	963,862	5,961,567	813,474	561,935	5,679,527
2011	869,659	651,382	591,931	920,549	967,722	5,982,017	816,922	564,345	5,698,023
2012	869,791	651,562	592,153	920,774	967,987	5,983,449	817,184	564,530	5,699,191
2013	869,834	652,136	593,057	921,383	968,832	5,987,257	818,153	565,239	5,701,520
2014	869,331	652,595	594,073	921,725	969,511	5,989,245	819,123	565,970	5,701,391
2015	870,011	653,081	594,495	922,420	970,233	5,993,763	819,721	566,380	5,705,755
2016	869,096	652,189	593,538	921,234	968,909	5,986,134	818,504	565,526	5,698,987
2017	869,418	652,564	593,976	921,717	969,465	5,989,210	819,036	565,900	5,701,594
2018	869,467	653,235	595,034	922,432	970,459	5,993,680	820,176	566,731	5,704,324
2019	868,670	652,253	593,868	921,186	969,002	5,985,694	818,763	565,732	5,697,646
2020	869,589	652,792	594,250	922,000	969,801	5,991,023	819,366	566,138	5,703,082
2021	870,267	653,021	594,262	922,430	970,145	5,993,891	819,529	566,227	5,706,485
2022	869,338	653,069	594,837	922,223	970,213	5,992,338	819,934	566,562	5,703,212
2023	869,210	652,221	593,530	921,303	968,959	5,986,573	818,523	565,532	5,699,534
2024	869,194	652,585	594,127	921,678	969,496	5,988,900	819,152	565,994	5,700,845
2025	870,196	653,238	594,650	922,634	970,465	5,995,155	819,923	566,521	5,707,038
2026	868,425	652,063	593,689	920,917	968,716	5,983,950	818,519	565,560	5,696,003
2027	871,452	654,109	595,393	923,892	971,761	6,003,344	820,983	567,249	5,715,005
2028	868,196	652,044	593,780	920,835	968,689	5,983,375	818,567	565,604	5,695,087
2029	869,759	652,789	594,158	922,048	969,802	5,991,375	819,306	566,088	5,703,726
2030	869,107	652,101	593,390	921,149	968,781	5,985,586	818,351	565,411	5,698,695
2031	871,255	654,454	596,057	924,201	972,270	6,005,198	821,648	567,742	5,715,582
2032	867,665	651,687	593,487	920,316	968,158	5,979,986	818,139	565,312	5,691,760
2033	870,136	652,788	593,957	922,150	969,803	5,992,119	819,173	565,974	5,705,117
2034	869,848	653,047	594,526	922,340	970,181	5,993,218	819,717	566,386	5,705,023
2035	867,814	651,770	593,539	920,444	968,282	5,980,831	818,229	565,374	5,692,634
TOTAL	46,059,593	26,941,568	23,354,395	40,437,221	40,982,493	305,530,230	31,120,872	22,204,233	299,022,412

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to Be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SOUTH SAN JOAQUIN DIVISION (continued)		TEHACHAPI DIVISION			MOJAVE DIVISION			
	Reach 16A	Subtotal	Reach 17E	Reach 17F	Subtotal	Reach 18A	Reach 19	Reach 19C	Reach 20A
	[38]	[39]	[40]	[41]	[42]	[43]	[44]	[45]	[46]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0
1969	0	385.659	0	0	0	0	0	0	0
1970	0	885.234	0	0	0	0	0	0	0
1971	10.291	2,400.543	3,471	0	3,471	0	0	0	0
1972	1,106.884	3,734.703	1,424.782	28,127	1,452.909	36,699	135.675	0	130.711
1973	1,243.941	4,142.935	1,777.260	49.949	1,827.209	36,207	146.739	0	161.838
1974	1,343.972	4,369.772	2,298.091	16.259	2,314.350	30.525	90.404	0	115.571
1975	1,537.862	5,090.233	2,403.430	35.193	2,438.623	40.588	122.584	0	137.684
1976	1,727.428	5,001.677	2,776.194	126.653	2,902.847	118.610	201.215	0	182.927
1977	1,961.081	6,065.390	3,845.464	83.936	3,929.400	93.565	226.906	0	180.884
1978	1,922.950	5,738.596	2,954.313	42.637	2,996.950	91.815	200.759	0	215.673
1979	1,798.566	5,960.033	3,539.402	45.997	3,585.399	99.670	307.386	0	261.205
1980	2,231.456	7,463.378	4,749.245	54.806	4,804.051	116.487	446.175	0	290.719
1981	2,762.773	7,646.858	5,485.957	64.886	5,550.843	316.590	585.003	0	325.112
1982	2,961.383	8,475.944	6,349.080	55.997	6,405.077	447.739	638.615	0	275.763
1983	4,302.165	11,303.322	14,153.033	96.397	14,249.430	345.229	564.698	0	368.139
1984	5,077.824	14,043.628	18,448.383	77.201	18,525.584	267.497	563.588	0	413.443
1985	5,683,454	14,964,899	18,134,698	137,928	18,272,626	298,932	475,028	0	450,444
1986	5,780.666	16,593.102	19,297.129	109,938	19,407.067	703.413	350,906	0	347,690
1987	5,636,043	17,063,245	17,398,908	98,355	17,497,263	1,261,056	558,996	0	818,475
1988	5,150.238	15,704.693	17,697,838	138,405	17,836,243	1,242,139	560,911	0	585.014
1989	5,458.633	16,336.263	17,641,151	88,488	17,729,639	1,049,615	283.065	0	366,590
1990	6,440.643	18,959.051	19,995.760	99,868	20,095.628	1,298,537	229.083	0	469.502
1991	5,805.189	18,565.503	19,903.346	131,558	20,034,904	1,432,360	665,443	0	1,025,089
1992	6,471,964	19,838,439	18,194,788	279,610	18,474,398	1,167,898	738,238	0	666,181
1993	7,583,165	23,092,943	19,051,939	199,640	19,251,579	1,868,745	606,763	0	1,232,409
1994	7,142,378	19,069,838	17,354,702	204,963	17,559,665	1,699,479	763,493	0	1,145,700
1995	6,540,575	19,680,665	19,360,033	191,516	19,551,549	1,284,146	614,314	0	1,941,939
1996	7,065,052	20,408,184	19,041,451	237,846	19,279,297	1,163,708	576,674	0	1,335,804
1997	7,387,904	21,710,020	19,724,881	176,120	19,901,001	1,330,450	730,628	0	1,401,562
1998	7,531,886	20,887,644	23,229,552	182,754	23,412,306	1,513,824	309,052	0	7,568,901
1999	8,717,679	22,580,702	19,690,120	152,644	19,842,764	3,104,013	632,659	0	5,313,388
2000	12,484,909	28,278,532	23,258,426	245,010	23,503,436	1,876,491	740,777	0	1,382,646
2001	15,785,706	30,836,893	24,056,649	618,258	24,674,907	2,440,376	2,549,692	0	1,843,160
2002	11,475,179	28,350,187	20,789,485	472,793	21,262,278	1,405,443	800,065	0	758,244
2003	11,512,641	28,641,208	20,865,522	283,196	21,148,718	3,734,791	673,419	0	707,540
2004	14,644,290	33,620,379	26,619,990	244,908	26,864,898	1,819,685	1,349,413	0	1,303,773
2005	13,904,817	29,005,711	16,556,912	1,498,186	18,055,098	5,650,484	1,487,019	0	1,529,919
2006	14,204,922	32,689,201	20,116,620	656,919	20,773,539	2,752,334	900,927	0	1,109,718
2007	14,101,850	33,606,163	20,806,857	679,568	21,486,425	2,844,236	930,542	0	1,142,027
2008	14,750,686	34,990,114	21,274,592	699,209	21,973,801	2,839,232	938,819	0	1,013,192
2009	8,201,150	27,372,009	23,256,250	341,348	23,597,598	1,962,373	1,050,623	0	1,579,321
2010	8,199,684	27,367,071	23,256,149	341,282	23,597,431	1,961,828	1,047,087	0	1,577,159
2011	8,226,121	27,462,618	23,304,514	342,599	23,647,113	1,969,724	1,056,301	0	1,586,117
2012	8,228,118	27,469,301	23,308,938	342,681	23,651,619	1,970,265	1,057,664	0	1,587,131
2013	8,233,567	27,487,552	23,316,044	342,915	23,658,959	1,971,983	1,065,412	0	1,592,155
2014	8,236,619	27,497,860	23,311,776	343,048	23,654,824	1,973,346	1,076,576	0	1,598,802
2015	8,242,826	27,518,579	23,329,727	343,305	23,673,032	1,974,816	1,077,135	0	1,599,872
2016	8,232,265	27,483,256	23,302,969	342,865	23,645,834	1,972,133	1,073,227	0	1,596,406
2017	8,236,547	27,497,578	23,313,034	343,045	23,656,079	1,973,267	1,075,547	0	1,598,231
2018	8,242,934	27,518,989	23,321,377	343,313	23,664,690	1,975,275	1,084,522	0	1,604,048
2019	8,231,814	27,481,796	23,295,770	342,851	23,638,621	1,972,326	1,078,278	0	1,599,207
2020	8,239,084	27,506,050	23,318,682	343,151	23,661,833	1,973,950	1,077,200	0	1,599,467
2021	8,242,925	27,518,828	23,333,830	343,308	23,677,138	1,974,659	1,074,112	0	1,598,194
2022	8,241,075	27,512,751	23,317,116	343,239	23,660,355	1,974,789	1,083,652	0	1,603,354
2023	8,232,861	27,485,218	23,305,439	342,890	23,648,329	1,972,243	1,072,786	0	1,596,241
2024	8,236,206	27,496,437	23,309,134	343,032	23,652,166	1,973,334	1,078,099	0	1,599,637
2025	8,244,760	27,524,997	23,334,887	343,388	23,678,275	1,975,305	1,077,834	0	1,600,513
2026	8,229,421	27,473,783	23,289,094	342,752	23,631,846	1,971,751	1,077,994	0	1,598,766
2027	8,255,986	27,562,487	23,367,789	343,854	23,711,643	1,977,940	1,078,352	0	1,602,155
2028	8,228,694	27,471,365	23,284,670	342,722	23,627,392	1,971,686	1,079,782	0	1,599,678
2029	8,239,518	27,507,472	23,321,879	343,169	23,665,048	1,973,964	1,075,709	0	1,598,693
2030	8,231,489	27,480,628	23,302,201	342,832	23,645,033	1,971,888	1,072,108	0	1,595,696
2031	8,258,726	27,571,695	23,367,952	343,972	23,711,924	1,978,972	1,085,146	0	1,606,316
2032	8,224,049	27,455,868	23,270,866	342,529	23,613,395	1,970,607	1,079,715	0	1,599,079
2033	8,240,433	27,510,492	23,328,840	343,203	23,672,043	1,973,967	1,072,173	0	1,596,812
2034	8,242,126	27,516,208	23,326,347	343,278	23,669,625	1,974,727	1,078,449	0	1,600,545
2035	8,225,194	27,459,690	23,274,570	342,578	23,617,148	1,970,870	1,079,690	0	1,599,218
TOTAL	473,573,237	1,400,392,062	1,179,639,298	17,864,867	1,197,504,165	101,080,596	51,680,846	0	81,631,389

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	MOJAVE DIVISION (continued)							SANTA ANA DIVISION	
	Reach 20B	Reach 21	Reach 22A	Reach 22B	Reach 23	Reach 24	Subtotal	Reach 25	Reach 26A
	[47]	[48]	[49]	[50]	[51]	[52]	[53]	[54]	[55]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0
1972	120,271	75,768	80,436	1,036,831	51,520	362,153	2,030,064	26	578
1973	148,631	60,641	66,539	1,283,816	65,475	353,262	2,323,148	20,541	679,328
1974	88,200	65,007	77,667	1,477,946	96,340	334,302	2,375,962	24,380	799,400
1975	118,898	135,462	77,825	1,630,554	111,141	419,450	2,794,186	29,337	885,021
1976	151,555	106,314	131,007	1,598,071	107,787	304,638	2,902,124	51,356	1,103,139
1977	112,589	98,757	86,279	1,882,080	71,228	48,359	2,800,647	62,584	1,412,740
1978	120,584	109,271	71,763	2,211,965	72,179	637,401	3,731,410	67,186	1,159,950
1979	194,104	203,078	121,586	2,104,832	76,960	202,566	3,571,387	84,462	1,235,189
1980	237,250	156,794	117,274	2,670,387	147,009	688,605	4,870,700	72,651	1,532,535
1981	292,081	181,062	119,602	3,030,407	134,895	47,750	5,032,502	35,662	1,575,444
1982	330,502	186,109	125,429	3,248,883	299,712	623,755	6,176,507	26,852	1,822,250
1983	326,767	219,943	140,523	3,899,769	223,626	384,292	6,472,986	19,017	1,663,599
1984	329,933	266,919	146,866	4,783,997	59,337	1,104,149	7,935,729	11,319	2,325,661
1985	388,327	799,514	125,780	5,330,501	261,135	811,346	8,941,007	17,764	2,707,662
1986	315,566	242,158	178,847	6,190,812	156,053	515,945	9,001,390	31,012	2,768,728
1987	357,971	298,190	236,263	5,731,239	151,796	732,607	10,146,593	19,362	2,847,390
1988	400,005	331,099	149,876	6,910,472	253,833	970,052	11,403,401	36,576	3,087,873
1989	345,614	194,047	138,825	5,963,386	349,544	1,242,144	9,932,830	30,881	3,190,809
1990	202,412	273,748	49,174	6,905,442	436,785	1,891,053	11,755,736	25,518	3,330,913
1991	516,257	478,555	231,223	7,488,366	263,723	1,561,051	13,662,067	32,172	3,847,589
1992	696,623	585,072	168,251	7,076,997	317,042	622,116	12,038,418	55,819	4,043,878
1993	818,675	509,309	207,818	7,765,751	359,632	1,708,915	15,078,017	72,464	5,638,325
1994	957,350	873,215	241,679	7,691,548	1,220,795	1,245,936	15,839,195	105,373	5,139,991
1995	2,411,412	355,198	179,930	6,994,639	842,041	746,371	15,369,990	96,781	4,357,648
1996	1,713,145	790,618	136,397	8,590,347	889,842	(78,782)	15,117,753	156,395	4,051,744
1997	2,043,179	640,177	189,241	8,138,580	1,586,227	3,355,446	19,415,490	177,217	4,585,198
1998	508,030	297,621	115,100	8,888,912	1,925,089	1,134,837	22,261,366	142,703	4,857,213
1999	1,583,887	1,344,804	158,127	9,548,762	2,027,154	1,340,712	25,053,506	189,880	5,957,072
2000	1,437,269	974,362	165,942	9,541,048	1,711,994	1,520,219	19,350,748	353,640	4,203,640
2001	1,526,739	1,071,309	476,330	7,684,613	1,893,231	25,579	19,511,029	298,329	2,435,173
2002	583,717	1,157,056	281,096	11,281,918	1,694,767	946,719	18,909,025	509,094	3,423,421
2003	621,363	467,741	278,116	13,347,106	2,096,392	(411,897)	21,514,571	368,565	3,749,154
2004	1,025,345	1,043,564	404,058	10,436,430	2,128,942	947,017	20,458,227	427,842	5,453,713
2005	867,477	670,615	347,499	7,415,415	2,415,177	2,156,058	22,539,663	451,980	5,594,543
2006	618,066	609,184	240,529	13,667,694	2,190,675	1,792,091	23,881,218	435,685	4,578,654
2007	637,847	629,324	248,333	14,686,551	2,255,878	1,986,231	25,360,969	450,706	4,712,702
2008	626,462	630,664	247,891	13,796,170	2,187,071	1,974,832	24,254,333	463,733	4,828,948
2009	926,052	696,094	383,756	8,316,496	451,120	2,170,794	17,536,629	68,306	6,085,251
2010	923,812	694,848	382,756	8,307,583	450,520	1,775,016	17,120,609	68,315	6,085,115
2011	930,638	699,270	385,699	8,345,989	451,944	2,235,186	17,660,868	68,546	6,104,073
2012	931,553	699,811	386,101	8,350,443	452,211	1,908,890	17,344,069	68,556	6,105,268
2013	936,542	702,638	388,309	8,371,551	453,573	1,006,099	16,488,262	68,559	6,107,354
2014	943,569	706,510	391,443	8,398,521	455,389	2,632,579	18,176,735	68,519	6,106,589
2015	944,125	706,963	391,670	8,404,267	455,681	1,000,463	16,554,992	68,573	6,111,280
2016	941,349	705,210	390,467	8,387,862	454,696	2,869,710	18,391,060	68,501	6,104,183
2017	942,933	706,170	391,159	8,396,115	455,195	1,675,966	17,214,583	68,527	6,106,876
2018	948,712	709,447	393,719	8,420,663	456,791	1,975,079	17,568,256	68,530	6,109,328
2019	944,469	706,889	391,865	8,398,670	455,425	2,854,227	18,401,356	68,469	6,102,459
2020	944,039	706,829	391,645	8,401,609	455,527	1,745,801	17,296,067	68,539	6,108,398
2021	942,256	705,956	390,834	8,397,575	455,194	775,758	16,314,538	68,593	6,112,249
2022	948,116	709,083	393,458	8,417,307	456,556	1,825,161	17,411,476	68,519	6,108,184
2023	941,099	705,093	390,353	8,387,266	454,624	2,819,195	18,338,900	68,510	6,104,808
2024	944,506	707,014	391,864	8,401,458	455,545	1,670,166	17,221,623	68,509	6,105,934
2025	944,627	707,279	391,885	8,407,161	455,826	1,857,600	17,418,030	68,588	6,112,639
2026	944,215	706,698	391,762	8,396,251	455,276	2,922,216	18,464,929	68,449	6,100,706
2027	945,323	707,929	392,159	8,416,516	456,304	1,505,034	17,081,712	68,686	6,121,228
2028	945,300	707,263	392,247	8,399,700	455,536	808,664	16,359,856	68,431	6,099,614
2029	943,136	706,353	391,237	8,398,604	455,302	2,758,754	18,301,752	68,553	6,109,182
2030	940,632	704,809	390,148	8,384,751	454,465	2,869,648	18,384,145	68,502	6,103,943
2031	949,631	710,321	394,072	8,433,538	457,424	225,891	15,841,311	68,671	6,121,476
2032	945,101	707,047	392,174	8,396,167	455,363	2,733,783	18,279,036	68,388	6,096,014
2033	940,970	705,204	390,267	8,391,431	454,792	1,439,736	16,965,352	68,584	6,110,886
2034	944,922	707,382	392,030	8,406,578	455,816	1,234,473	16,794,922	68,560	6,110,430
2035	945,129	707,092	392,182	8,396,890	455,368	4,221,893	19,768,332	68,400	6,096,973
TOTAL	49,196,859	36,177,471	17,104,382	468,463,199	43,413,490	87,765,062	936,513,294	7,304,747	280,437,255

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	SANTA ANA DIVISION (continued)				WEST BRANCH				
	Reach 28G	Reach 28H	Reach 28J	Subtotal	Reach 29A	Reach 29F	Reach 29G	Reach 29H	Reach 29J
	[56]	[57]	[58]	[59]	[60]	[61]	[62]	[63]	[64]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0
1972	109	30	0	743	719,255	159,249	199,145	234,196	88,198
1973	136,352	79	0	836,300	779,949	339,363	122,664	264,850	119,743
1974	155,262	34,693	854,637	1,868,372	883,312	158,366	112,458	350,160	(4,525)
1975	110,729	69,082	723,814	1,817,983	1,049,990	176,676	194,724	801,457	75,870
1976	138,575	100,400	635,853	2,029,323	1,220,429	215,588	202,591	624,614	98,268
1977	127,543	92,647	825,880	2,521,394	1,268,813	116,939	218,129	684,679	184
1978	166,919	68,363	835,082	2,297,500	1,174,708	342,479	267,308	415,641	17,764
1979	142,586	92,812	265,525	1,820,574	1,366,942	285,575	284,188	972,584	29,850
1980	158,340	129,897	1,120,131	3,013,554	1,698,215	224,472	455,619	874,259	288,303
1981	160,053	111,722	333,550	2,216,431	1,783,405	123,264	615,047	2,305,110	8,794
1982	205,350	135,463	1,518,759	3,708,674	1,919,979	190,500	702,265	2,208,264	414,230
1983	244,720	124,651	412,806	2,464,793	2,739,814	149,333	888,475	745,939	579,882
1984	240,496	190,924	769,068	3,537,468	3,463,038	81,260	2,358,495	537,207	719,282
1985	451,600	182,242	871,492	4,230,760	3,866,946	295,836	3,047,591	975,729	614,735
1986	439,048	256,526	982,332	4,477,646	3,791,427	457,604	2,893,171	1,480,015	1,032,216
1987	278,094	218,717	1,118,529	4,482,092	3,423,494	213,106	2,933,342	944,604	459,398
1988	271,868	200,811	1,176,659	4,773,787	3,447,403	255,113	3,017,463	883,714	446,468
1989	230,953	281,861	1,130,035	4,864,539	4,025,641	405,583	2,738,143	1,398,165	865,738
1990	437,812	308,144	1,538,449	5,640,836	4,088,481	383,655	3,232,445	3,153,869	777,713
1991	843,388	632,912	1,630,321	6,986,382	3,862,056	304,143	3,550,063	639,527	763,037
1992	281,864	5,636,464	1,102,519	11,120,544	4,286,050	327,802	3,892,480	1,014,551	872,953
1993	382,195	570,563	994,721	7,658,268	3,969,075	343,304	4,515,385	1,670,952	852,208
1994	617,136	415,603	1,022,412	7,300,515	3,649,861	293,376	3,359,381	1,879,417	872,624
1995	1,308,828	704,154	894,338	7,361,749	4,137,046	883,315	4,750,275	1,588,080	754,904
1996	1,001,063	1,041,697	1,316,493	7,567,392	4,511,858	966,044	3,593,671	4,208,195	877,111
1997	493,841	949,188	953,590	7,159,034	4,543,506	1,030,809	2,429,066	3,755,901	1,597,361
1998	379,997	991,426	(67,444)	6,303,895	4,872,244	464,376	3,474,463	2,398,630	1,996,114
1999	493,493	1,964,137	845,343	9,449,925	4,768,390	4,338,174	4,924,176	1,391,028	1,000,370
2000	844,558	1,004,569	1,130,423	7,536,830	5,460,691	782,887	4,277,874	2,361,194	171,261
2001	1,668,195	811,163	5,688,912	10,901,772	5,908,798	1,533,322	5,137,414	4,393,983	240,853
2002	1,251,118	424,389	2,197,952	7,805,974	5,341,880	1,480,328	4,082,857	4,442,291	(51,885)
2003	535,209	376,265	1,279,384	6,308,577	4,461,737	1,289,703	3,728,632	3,336,304	(627,530)
2004	1,206,016	440,811	3,465,088	10,993,470	8,918,901	1,317,754	3,491,206	5,059,781	(615,239)
2005	1,439,765	684,382	(1,750,113)	6,420,557	5,794,901	2,491,755	9,043,269	(472,624)	2,762,038
2006	1,098,598	517,408	2,723,264	9,353,609	6,248,004	681,464	4,474,550	3,919,482	(84,714)
2007	1,136,475	535,247	2,390,346	9,225,476	6,445,534	703,745	4,623,674	4,053,603	(93,667)
2008	1,169,322	550,717	2,525,195	9,537,915	6,705,848	724,003	4,753,040	4,172,827	(101,430)
2009	634,233	442,191	2,019,362	9,249,343	6,147,456	657,334	2,999,231	3,633,656	725,264
2010	634,310	442,245	2,338,564	9,568,549	6,147,397	653,418	2,998,377	3,620,567	725,352
2011	636,345	443,739	1,924,294	9,176,997	6,165,794	661,813	3,009,000	3,654,696	726,900
2012	636,442	443,805	2,106,287	9,360,358	6,166,978	663,140	3,009,826	3,659,334	727,012
2013	636,473	443,827	2,370,896	9,627,109	6,168,928	671,448	3,012,470	3,687,862	727,048
2014	636,104	443,569	1,985,769	9,240,550	6,167,911	683,884	3,014,603	3,729,713	726,625
2015	636,603	443,917	2,237,728	9,498,101	6,172,657	684,032	3,016,840	3,731,264	727,193
2016	635,933	443,451	1,919,345	9,171,413	6,165,550	680,234	3,012,726	3,716,661	726,429
2017	636,170	443,614	2,528,148	9,783,335	6,168,236	682,533	3,014,453	3,725,033	726,699
2018	636,205	443,640	2,047,929	9,305,632	6,170,525	692,263	3,017,555	3,758,325	726,741
2019	635,622	443,233	2,549,057	9,798,840	6,163,704	685,834	3,013,021	3,734,828	726,074
2020	636,294	443,701	1,797,397	9,054,329	6,169,746	684,223	3,015,494	3,730,397	726,841
2021	636,790	444,047	2,110,597	9,372,276	6,173,717	680,499	3,016,564	3,718,810	727,409
2022	636,110	443,573	2,931,790	10,188,176	6,169,394	691,181	3,016,786	3,754,039	726,632
2023	636,018	443,509	2,052,381	9,305,226	6,166,203	679,589	3,012,873	3,714,193	726,526
2024	636,004	443,501	2,371,214	9,625,162	6,167,233	685,315	3,014,549	3,733,777	726,512
2025	636,737	444,010	1,725,337	8,987,311	6,174,031	684,551	3,017,557	3,732,354	727,348
2026	635,442	443,108	2,852,622	10,100,327	6,161,939	685,557	3,012,131	3,733,285	725,868
2027	637,657	444,652	1,456,605	8,728,828	6,182,724	684,375	3,021,589	3,733,648	728,400
2028	635,276	442,991	2,290,598	9,536,910	6,160,787	687,755	3,012,056	3,741,004	725,679
2029	636,418	443,788	2,163,631	9,421,572	6,170,572	682,392	3,015,494	3,724,111	726,985
2030	635,942	443,456	2,228,881	9,480,724	6,165,344	678,871	3,012,320	3,711,540	726,440
2031	637,514	444,552	2,973,431	10,245,644	6,182,830	691,773	3,023,185	3,758,886	728,234
2032	634,886	442,720	1,636,352	8,878,360	6,157,143	688,001	3,010,408	3,741,030	725,234
2033	636,694	443,980	2,407,724	9,667,868	6,172,375	678,343	3,015,485	3,710,942	727,299
2034	636,483	443,834	2,181,758	9,441,065	6,171,781	685,364	3,016,683	3,735,014	727,060
2035	634,997	442,797	2,893,328	10,136,495	6,158,117	687,633	3,010,783	3,739,342	725,359
TOTAL	37,421,172	32,825,609	103,556,370	461,545,153	303,106,693	42,901,620	183,946,798	170,032,489	37,437,643

TABLE B-11. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									GRAND TOTAL
	WEST BRANCH (cont.)		COASTAL BRANCH							
	Reach 30	Subtotal	Reach 31A [a]	Reach 33A	Reach 33B	Reach 34	Reach 35	Subtotal	Total	
	[65]	[66]	[67]	[68]	[69]	[70]	[71]	[72]	[73]	[74]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	42,918
1963	0	0	0	0	0	0	0	0	0	168,358
1964	0	0	0	0	0	0	0	0	0	184,729
1965	0	0	0	0	0	0	0	0	0	378,874
		0								
1966	0	0	0	0	0	0	0	0	0	408,397
1967	0	0	0	0	0	0	0	0	0	634,505
1968	0	0	0	0	0	0	0	0	2,160,548	2,745,160
1969	0	0	509,728	0	0	0	0	509,728	3,324,718	4,074,939
1970	0	0	609,988	0	0	0	0	609,988	3,983,062	4,676,282
1971	0	0	699,052	0	0	0	0	699,052	5,614,013	6,185,714
1972	420,789	1,820,832	697,576	0	0	0	0	697,576	12,353,356	12,998,869
1973	621,431	2,248,000	641,626	0	0	0	0	641,626	14,590,688	15,194,233
1974	723,949	2,223,720	669,279	0	0	0	0	669,279	16,598,762	17,372,561
1975	841,991	3,140,708	806,429	0	0	0	0	806,429	19,569,999	20,517,423
1976	(650,944)	1,710,546	840,927	0	0	0	0	840,927	19,002,859	20,027,213
1977	634,581	2,923,325	872,169	0	0	0	0	872,169	23,267,885	24,213,489
1978	3,088,954	5,306,854	934,119	0	0	0	0	934,119	24,818,739	26,012,786
1979	958,068	3,897,207	871,688	0	0	0	0	871,688	23,421,881	24,675,598
1980	222,549	3,763,417	1,047,396	4,790	0	30	75	1,052,291	30,105,348	32,038,398
1981	1,093,897	5,929,517	1,037,469	4,790	0	30	75	1,042,364	33,884,524	35,516,366
1982	978,624	6,413,862	1,015,555	4,790	0	30	75	1,020,450	39,515,188	41,611,655
1983	3,698,681	8,802,124	1,146,269	4,957	0	30	77	1,151,333	54,543,263	56,802,781
1984	755,136	7,914,418	1,427,192	5,051	0	31	78	1,432,352	63,947,633	67,105,188
1985	1,753,355	10,554,192	1,849,827	5,051	0	31	78	1,854,987	69,700,009	73,272,898
1986	1,338,657	10,993,090	1,714,723	5,051	0	31	78	1,719,883	73,437,761	76,707,917
1987	1,406,519	9,380,463	1,689,141	4,324	0	26	67	1,693,558	71,443,424	75,217,576
1988	1,452,589	9,502,750	1,964,428	4,509	0	28	70	1,969,035	72,349,117	76,060,618
1989	1,505,029	10,938,299	1,768,942	4,509	0	28	70	1,773,549	73,894,076	78,662,348
1990	847,500	12,483,663	2,274,772	0	0	0	0	2,274,772	86,130,115	91,361,385
1991	1,191,090	10,309,916	2,187,841	0	0	0	0	2,187,841	86,877,284	90,982,870
1992	2,259,032	12,652,868	2,465,364	0	0	0	0	2,465,364	94,167,321	99,235,524
1993	1,157,876	12,508,800	2,811,441	0	0	0	0	2,811,441	100,019,568	107,299,130
1994	1,674,576	11,729,235	3,894,639	0	0	0	0	3,894,639	92,336,811	99,944,106
1995	(421,879)	11,691,741	3,481,049	0	0	0	0	3,481,049	98,887,435	105,659,504
1996	1,574,098	15,730,977	5,144,684	0	0	0	0	5,144,684	105,119,193	112,018,784
1997	1,521,491	14,878,134	2,523,741	(33)	0	0	0	2,523,708	107,647,058	113,385,326
1998	1,291,185	14,497,012	4,303,206	1,878,551	1,386	160,400	88,026	6,431,569	120,663,477	127,330,678
1999	2,059,968	18,482,106	4,186,890	1,950,758	16,646	184,325	87,373	6,425,992	124,753,820	133,895,183
2000	1,529,054	14,582,961	2,887,384	2,533,121	20,756	253,532	109,322	5,804,115	122,249,124	130,905,236
2001	(942,708)	16,271,662	3,113,399	2,241,933	14,426	153,879	58,875	5,582,512	135,962,968	143,315,101
2002	3,419,111	18,714,582	3,187,937	2,686,101	49,670	189,442	81,720	6,194,870	125,082,782	136,721,587
2003	968,853	13,157,699	3,338,003	2,777,886	41,188	200,985	85,013	6,443,075	124,965,982	133,887,739
2004	1,515,533	19,687,936	3,542,320	2,668,727	70,179	240,426	109,830	6,631,482	143,841,151	153,942,418
2005	(1,119,961)	18,499,378	3,871,812	2,984,019	120,182	292,253	137,816	7,406,082	126,047,731	134,166,265
2006	(3,426,344)	11,812,442	3,712,424	2,953,567	15,191	272,839	132,183	7,086,204	132,566,445	141,834,009
2007	2,605,969	18,338,858	3,837,608	3,047,983	15,714	282,227	136,691	7,320,223	143,987,944	153,919,911
2008	2,702,596	18,956,884	3,961,204	3,159,814	16,169	290,383	140,638	7,568,208	147,770,822	158,198,616
2009	3,018,521	17,181,462	4,006,112	1,941,533	0	1,680	4,465	5,953,790	122,587,842	131,426,192
2010	2,926,467	17,071,578	4,005,748	1,941,422	0	1,619	4,303	5,953,092	122,369,704	131,207,577
2011	3,094,243	17,312,446	4,020,078	1,946,835	0	1,721	4,576	5,973,210	123,018,775	131,889,787
2012	2,922,167	17,148,457	4,020,945	1,947,235	0	1,740	4,629	5,974,549	122,738,855	131,611,688
2013	3,330,006	17,597,762	4,022,885	1,948,040	0	1,869	4,969	5,977,763	122,644,558	131,521,003
2014	3,015,532	17,338,268	4,023,255	1,948,014	0	2,067	5,490	5,978,826	123,708,710	132,584,951
2015	2,875,790	17,207,776	4,026,318	1,949,503	0	2,062	5,478	5,983,361	122,270,328	131,153,356
2016	3,433,233	17,734,833	4,021,431	1,947,186	0	2,010	5,345	5,975,972	124,212,608	133,085,110
2017	3,255,898	17,572,852	4,023,343	1,948,080	0	2,042	5,429	5,978,894	123,523,856	132,400,411
2018	3,165,776	17,531,185	4,025,617	1,949,026	0	2,193	5,829	5,982,665	123,411,504	132,292,303
2019	3,704,072	18,027,533	4,020,694	1,946,734	0	2,102	5,583	5,975,113	125,136,217	134,006,624
2020	3,508,436	17,835,137	4,024,449	1,948,592	0	2,067	5,493	5,980,601	123,160,837	132,039,716
2021	2,722,842	17,039,841	4,026,696	1,949,749	0	2,003	5,323	5,983,771	121,738,626	130,622,801
2022	2,744,304	17,102,336	4,024,795	1,948,644	0	2,177	5,787	5,981,403	123,691,991	132,571,060
2023	3,102,909	17,402,293	4,021,786	1,947,373	0	2,000	5,312	5,976,471	123,967,392	132,840,750
2024	3,877,069	18,204,455	4,022,920	1,947,827	0	2,088	5,545	5,978,380	123,999,827	132,875,216
2025	2,117,073	16,452,914	4,027,233	1,949,942	0	2,067	5,493	5,984,735	121,884,955	130,769,981
2026	3,905,316	18,224,096	4,019,533	1,946,174	0	2,099	5,577	5,973,383	125,676,189	134,544,046
2027	37,231	14,387,967	4,032,815	1,952,665	0	2,051	5,454	5,992,985	119,327,311	128,224,740
2028	7,076,969	21,404,250	4,018,969	1,945,866	0	2,133	5,671	5,972,639	126,180,163	135,046,593
2029	1,775,892	16,095,446	4,024,832	1,948,809	0	2,036	5,417	5,981,094	122,798,885	131,678,762
2030	3,122,256	17,416,771	4,021,173	1,947,085	0	1,989	5,287	5,975,534	124,190,495	133,062,546
2031	95,358	14,480,266	4,033,494	1,952,866	0	2,170	5,761	5,994,291	119,717,317	128,615,643
2032	7,059,493	21,381,309	4,016,646	1,944,728	0	2,143	5,696	5,969,213	127,375,560	136,236,809
2033	2,083,681	16,388,125	4,025,658	1,949,280	0	1,969	5,236	5,982,143	122,011,717	130,893,761
2034	3,035,981	17,371,883	4,025,852	1,949,255	0	2,083	5,534	5,982,724	122,610,238	131,492,131
2035	3,962,643	18,283,877	4,017,243	1,945,027	0	2,137	5,677	5,970,084	127,036,141	135,898,753
TOTAL	126,220,053	863,645,296	196,139,761	81,517,739	381,507	2,575,303	1,312,589	281,926,899	6,301,594,485	6,732,103,475

a) Includes certain costs to be assigned directly to Kern County Water Agency. Refer to Appendix B text discussion of Table B-16A under "Project Water Charges."

TABLE B-12. Variable OMP&R Costs to be Reimbursed through Variable OMP&R Component of Transportation Charge [a]

(in dollars)

Calendar Year	NORTH BAY AQUEDUCT				SOUTH BAY AQUEDUCT	CALIFORNIA AQUEDUCT			
	Reach 1	Reach 3A	Reach 3B		Reach 1	Reach 1	Reach 4	Reach 14A	Reach 15A
	Barker Slough Pumping Plant	Cordelia Pumping Plant (Solano)	Cordelia Pumping Plant (Napa) [b]	Total	South Bay & Del Valle Pumping Plants [c]	Banks Pumping Plant	Dos Amigos Pumping Plant	Buena Vista Pumping Plant	Wheeler Ridge Pumping Plant
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
1962	0	0	0	0	36,970	0	0	0	0
1963	0	0	0	0	57,711	0	0	0	0
1964	0	0	0	0	74,134	0	0	0	0
1965	0	0	0	0	142,609	0	0	0	0
1966	0	0	0	0	192,605	0	0	0	0
1967	0	0	0	0	223,117	13,881	0	0	0
1968	0	0	6,989	6,989	336,671	452,630	202,947	0	0
1969	0	0	8,551	8,551	257,579	293,741	135,425	0	0
1970	0	0	13,598	13,598	396,358	346,215	211,197	1	0
1971	0	0	10,609	10,609	381,662	574,015	225,188	138,001	17,664
1972	0	0	14,434	14,434	598,702	933,292	502,196	241,714	97,004
1973	0	0	14,449	14,449	493,490	688,030	381,232	306,268	278,923
1974	0	0	17,473	17,473	565,575	783,562	447,772	358,739	367,266
1975	0	0	14,779	14,779	349,758	1,341,019	518,816	550,860	595,252
1976	0	0	20,856	20,856	571,361	1,638,453	641,115	755,747	756,175
1977	0	0	22,635	22,635	512,996	1,013,307	284,828	298,300	337,889
1978	0	0	21,692	21,692	586,355	2,339,502	607,042	732,036	658,404
1979	0	0	16,237	16,237	605,136	3,554,256	1,008,564	818,816	791,488
1980	0	0	19,945	19,945	523,369	2,083,336	1,129,152	1,051,629	1,047,495
1981	0	0	23,842	23,842	567,692	3,952,931	1,939,189	1,336,867	1,319,739
1982	0	0	12,157	12,157	605,780	3,082,031	1,363,705	1,200,226	1,213,660
1983	0	0	2,342	2,342	82,222	879,916	343,597	341,584	304,715
1984	0	0	4,822	4,822	271,543	1,695,568	885,941	678,307	602,408
1985	0	0	10,188	10,188	451,020	3,171,920	1,613,745	1,397,490	1,397,098
1986	0	0	15,501	15,501	807,984	6,601,752	2,627,407	2,405,224	2,432,322
1987	0	0	27,223	27,223	886,956	5,753,132	2,523,544	2,240,552	2,223,371
1988	17,813	0	24,020	41,833	909,300	6,280,898	2,611,297	2,562,330	2,560,462
1989	29,819	43,846	26,519	100,184	1,161,160	9,748,180	3,910,492	3,964,188	3,974,290
1990	52,210	67,109	40,775	160,094	1,834,626	10,467,177	4,501,309	5,785,069	6,019,952
1991	10,429	10,118	5,252	25,799	378,966	1,923,595	490,766	903,923	1,031,345
1992	13,319	13,070	9,406	35,795	311,251	3,211,086	1,168,304	1,255,567	1,314,358
1993	(11,941)	(8,753)	(5,392)	(26,086)	(158,214)	532,899	345,215	(124,821)	(102,311)
1994	46,538	39,910	29,105	115,553	799,370	5,658,038	2,298,300	2,504,629	2,516,185
1995	20,014	20,620	11,791	52,425	247,645	4,017,881	1,513,362	919,965	841,178
1996	57,320	47,288	23,483	128,091	718,807	8,112,547	3,969,388	2,430,979	2,231,167
1997	67,416	52,935	21,955	142,306	1,038,568	6,900,694	2,845,506	2,589,077	2,417,154
1998	(10,647)	(9,488)	(4,554)	(24,689)	(121,313)	238,073	(314,172)	(245,259)	(219,762)
1999	31,618	25,288	10,570	67,476	514,166	5,319,699	2,316,189	1,587,062	1,295,067
2000	58,591	42,543	15,078	116,212	860,785	8,018,823	3,043,577	2,963,119	3,035,444
2001	358,726	248,919	213,001	820,646	4,045,747	24,049,006	9,826,265	14,784,423	15,166,621
2002	186,186	102,222	60,093	348,501	2,190,992	16,807,227	6,740,615	8,238,545	8,538,761
2003	175,952	115,069	95,023	386,044	2,487,701	20,922,559	8,769,499	10,363,118	10,792,509
2004	242,315	134,187	103,360	479,862	2,412,375	21,059,461	9,018,396	11,887,828	12,476,791
2005	278,132	143,598	145,812	567,542	2,734,374	28,939,713	12,758,363	12,347,806	12,701,242
2006	434,003	542,507	505,453	1,481,963	4,279,689	32,872,956	14,632,061	16,425,914	19,293,623
2007	590,459	738,139	687,740	2,016,338	4,884,615	36,569,764	16,650,156	20,880,413	24,428,791
2008	689,860	862,132	803,342	2,355,334	5,704,591	44,287,072	18,806,430	23,601,489	27,683,761
2009	471,576	374,214	388,821	1,234,611	6,222,720	35,919,615	17,427,406	21,193,631	21,056,894
2010	493,069	391,422	416,518	1,301,009	6,494,048	45,056,631	18,338,525	22,334,405	22,179,499
2011	496,138	391,567	424,244	1,311,949	6,535,307	41,237,117	18,371,517	22,402,363	22,246,938
2012	513,832	404,948	448,456	1,367,236	6,747,998	40,192,527	19,566,716	24,118,512	23,976,313
2013	560,013	444,221	504,326	1,508,560	7,372,283	51,426,238	21,483,111	26,452,214	26,263,763
2014	600,463	476,875	556,355	1,633,693	7,891,382	46,233,371	23,325,486	28,820,000	28,606,708
2015	615,599	484,040	585,983	1,685,622	8,005,259	51,650,783	23,684,134	29,258,892	29,037,962
2016	627,608	488,983	611,797	1,728,388	8,083,847	59,438,512	24,552,753	30,642,124	30,449,028
2017	625,762	481,926	621,137	1,728,825	7,971,646	52,444,860	23,696,330	29,341,378	29,129,658
2018	648,401	495,855	661,842	1,806,098	8,193,075	52,533,464	25,051,903	31,333,909	31,141,761
2019	669,420	508,101	701,669	1,879,190	8,387,740	60,423,941	25,812,404	32,346,051	32,148,359
2020	642,270	480,276	679,668	1,802,214	7,945,406	53,737,217	24,377,874	30,566,928	30,397,902
2021	642,532	479,487	681,741	1,803,760	7,932,881	52,687,280	24,368,714	30,570,232	30,403,674
2022	623,724	463,956	657,470	1,745,150	7,686,003	48,842,618	23,638,630	29,701,958	29,555,328
2023	627,067	466,716	661,782	1,755,565	7,729,871	52,722,222	23,897,354	30,081,432	29,938,566
2024	648,871	484,720	689,917	1,823,508	8,016,067	57,790,267	24,697,461	31,006,976	30,838,190
2025	646,099	482,429	686,339	1,814,867	7,979,674	48,512,593	24,616,451	30,926,406	30,762,216
2026	650,304	485,903	691,768	1,827,975	8,034,879	60,190,056	24,745,569	31,059,481	30,888,518
2027	640,989	478,212	679,748	1,798,949	7,912,611	54,011,665	24,523,835	30,875,285	30,722,567
2028	645,211	481,697	685,195	1,812,103	7,968,037	53,120,240	26,396,467	30,734,219	30,566,014
2029	637,413	475,259	675,134	1,787,806	7,865,686	52,515,131	24,297,368	30,556,325	30,402,216
2030	642,289	479,286	681,426	1,803,001	7,929,672	54,700,535	24,326,610	30,503,278	30,335,059
2031	633,951	472,401	670,665	1,777,017	7,820,233	49,592,734	24,166,751	30,405,070	30,256,324
2032	645,931	482,292	686,126	1,814,349	7,977,488	53,937,159	24,348,708	30,465,093	30,286,457
2033	676,778	507,762	725,926	1,910,466	8,382,352	57,267,841	26,232,078	33,092,914	32,920,858
2034	653,115	488,224	695,394	1,836,733	8,071,777	53,626,236	24,758,054	31,024,630	30,845,599
2035	640,445	477,760	679,043	1,797,248	7,905,458	56,713,224	26,080,351	33,688,778	33,639,744
TOTAL	19,957,002	15,859,791	19,968,644	55,785,437	256,877,956	1,733,653,914	780,276,480	953,980,209	961,433,616

a) Excludes extra peaking costs assigned directly to contractors. Refer to Appendix B text discussion of Table B-17 under "Project Water Charges."
b) Costs for 1968 through 1987 are for an interim facility.
c) The relatively minor costs of Del Valle Pumping Plant have been combined with those of South Bay Pumping Plant to simplify the allocation procedures.

TABLE B-12. Variable OMP&R Costs to be Reimbursed through Variable OMP&R Component of Transportation Charge [a]

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)								
	Reach 16A Chrisman Pumping Plant	Reach 17E Edmonston Pumping Plant	Reach 18A Alamo Powerplant	Reach 22B Pearblossom Pumping Plant	Reach 23 Mojave Siphon Powerplant	Reach 24 Silverwood Lake [d]	Reach 26A Devil Canyon Powerplant	Reach 28J Lake Perris [d]	Reach 29A Oso Pumping Plant
	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0
1972	180,602	542,625	0	25,568	0	0	(3,024)	0	102,315
1973	441,598	1,548,428	0	231,389	0	0	(436,768)	0	158,587
1974	618,864	2,164,223	0	354,093	0	0	(521,656)	0	193,311
1975	1,149,731	4,010,395	0	604,161	0	0	(1,071,023)	0	350,436
1976	1,561,385	5,443,936	0	932,444	0	0	(1,519,156)	0	362,767
1977	703,802	2,360,624	0	358,028	0	0	(1,175,966)	0	111,135
1978	1,186,696	4,180,131	0	1,551,015	0	0	(3,038,194)	0	125,183
1979	1,581,250	5,475,688	0	1,881,587	0	0	(3,419,581)	0	138,384
1980	2,102,439	7,028,235	0	1,762,063	0	0	(3,318,152)	0	236,768
1981	2,838,773	9,351,931	0	2,296,771	0	0	(3,842,971)	0	444,280
1982	2,424,920	8,352,207	0	1,498,620	0	0	(2,736,072)	0	539,245
1983	540,330	1,582,582	0	341,957	0	384,275	(5,478,830)	0	71,197
1984	1,129,131	3,448,759	0	622,123	0	0	(7,326,265)	(10,080)	240,134
1985	2,781,953	9,261,674	0	1,195,768	0	0	(10,477,567)	(56,570)	874,069
1986	4,999,949	16,956,023	(1,013,756)	2,359,599	0	0	(11,484,996)	0	1,269,590
1987	4,456,059	14,684,476	(1,026,193)	1,831,238	0	131,606	(10,814,483)	53,242	1,325,936
1988	5,126,229	16,819,159	(744,374)	2,375,784	0	0	(14,495,967)	0	1,421,097
1989	8,369,623	28,090,313	(766,443)	4,102,557	0	686,468	(18,532,961)	89,890	2,013,335
1990	13,630,073	48,369,421	(834,673)	6,504,876	0	89,075	(20,911,839)	147,163	2,857,409
1991	2,426,220	8,641,086	(269,625)	996,352	0	0	(4,884,013)	0	534,818
1992	2,642,161	8,854,347	(934,311)	1,167,670	0	156,847	(9,513,281)	(61,233)	717,740
1993	(582,580)	(2,649,876)	(56,908)	(253,503)	0	(34,870)	(7,502,549)	0	68,719
1994	5,276,189	18,302,830	(58,712)	2,572,826	0	0	(11,662,318)	147,989	1,203,006
1995	1,677,210	5,571,517	(1,242,189)	1,025,717	0	467,095	(9,742,248)	0	247,869
1996	4,723,600	16,483,976	(2,644,648)	2,487,165	(857,876)	1,959,474	(12,358,465)	0	895,929
1997	5,424,334	19,413,834	(2,488,338)	3,037,087	(1,680,469)	0	(13,293,791)	111,776	897,657
1998	(488,690)	(1,683,606)	(1,969,187)	(402,338)	(1,217,950)	(144,207)	(10,183,555)	0	(25,895)
1999	3,326,334	12,889,920	(2,811,928)	1,795,375	(2,482,354)	(4)	(14,772,635)	(4)	677,032
2000	6,985,918	25,206,821	(5,129,549)	3,965,245	(4,429,149)	(4)	(25,857,029)	(4)	1,215,093
2001	34,168,450	126,253,821	(3,298,048)	18,936,837	(3,649,034)	(3)	(19,510,279)	(3)	6,409,025
2002	19,287,645	70,880,766	(4,926,146)	10,444,621	(5,255,302)	(2)	(24,676,762)	(2)	3,719,061
2003	24,604,455	90,561,339	(3,431,664)	14,432,726	(6,760,773)	(1)	(28,047,969)	(1)	4,378,568
2004	28,497,371	104,778,229	(6,227,543)	16,376,616	(7,691,607)	0	(31,246,141)	0	5,297,989
2005	28,859,498	102,413,847	(6,140,331)	18,183,010	(6,778,759)	0	(30,599,808)	0	4,111,678
2006	40,946,961	145,423,964	(3,692,647)	23,083,255	(7,076,716)	0	(26,385,376)	0	7,830,756
2007	51,857,122	184,162,871	(4,294,257)	29,674,189	(6,676,525)	0	(25,202,114)	0	9,638,982
2008	58,767,212	208,727,721	(6,048,353)	32,949,111	(8,911,711)	0	(33,686,209)	0	11,201,062
2009	49,248,027	184,675,289	(5,510,634)	27,794,433	(6,491,520)	0	(31,022,541)	0	10,652,848
2010	51,897,900	194,621,177	(5,485,254)	29,302,324	(6,448,439)	0	(31,029,891)	0	11,148,835
2011	52,069,886	195,255,920	(5,492,272)	29,382,434	(6,439,573)	0	(31,893,599)	0	11,161,070
2012	56,168,246	210,702,310	(5,846,792)	32,458,204	(6,992,862)	0	(32,763,346)	0	11,809,184
2013	61,565,599	230,944,976	(5,652,150)	35,277,714	(6,744,613)	0	(32,125,194)	0	12,911,225
2014	67,103,976	251,753,837	(5,682,708)	38,121,500	(6,771,177)	0	(32,641,434)	0	14,115,824
2015	68,122,187	255,574,256	(5,693,994)	38,937,128	(6,858,073)	0	(33,041,336)	0	14,232,592
2016	71,488,045	268,298,853	(5,928,879)	41,532,691	(7,202,386)	0	(33,768,201)	0	14,736,837
2017	68,349,692	256,449,909	(5,671,857)	39,120,319	(6,907,326)	0	(33,434,896)	0	14,258,319
2018	73,128,292	274,475,377	(6,067,643)	43,135,035	(7,731,018)	0	(34,298,153)	0	14,853,549
2019	75,521,711	283,482,631	(5,784,357)	42,428,451	(7,167,463)	0	(33,961,637)	0	16,061,034
2020	71,389,307	267,974,386	(5,891,065)	41,108,609	(7,377,974)	0	(34,885,535)	0	14,884,381
2021	71,405,903	268,042,003	(5,908,063)	41,147,345	(7,429,243)	0	(34,543,452)	0	14,872,718
2022	69,408,812	260,559,379	(5,944,769)	39,677,985	(7,434,464)	0	(34,144,124)	0	14,629,862
2023	70,320,061	263,997,398	(6,022,332)	40,509,053	(7,566,401)	0	(34,766,355)	0	14,707,718
2024	72,434,864	271,912,441	(5,836,681)	41,031,696	(7,336,963)	0	(34,505,483)	0	15,371,555
2025	72,256,736	271,249,878	(5,939,914)	41,307,459	(7,438,056)	0	(34,108,290)	0	15,183,554
2026	72,553,633	272,356,870	(5,903,866)	41,738,327	(7,468,068)	0	(34,953,352)	0	15,126,955
2027	72,171,632	270,950,594	(5,939,780)	41,191,938	(7,426,405)	0	(34,468,637)	0	15,223,609
2028	71,789,931	269,485,056	(5,877,637)	41,189,627	(7,387,351)	0	(34,689,003)	0	15,018,182
2029	71,411,489	268,086,300	(5,907,069)	40,748,594	(7,429,433)	0	(34,449,309)	0	15,065,655
2030	71,242,576	267,424,422	(5,859,915)	40,826,257	(7,360,568)	0	(34,527,546)	0	14,920,997
2031	71,062,053	266,776,153	(6,024,291)	41,089,346	(7,927,736)	0	(34,231,695)	0	14,859,269
2032	71,123,577	266,958,800	(5,793,849)	40,088,252	(7,549,932)	0	(33,969,558)	0	15,102,962
2033	77,365,540	290,470,067	(6,089,764)	44,961,195	(8,106,728)	0	(35,010,839)	0	16,003,647
2034	72,448,217	271,945,261	(5,848,825)	41,031,870	(7,713,779)	0	(33,808,308)	0	15,301,073
2035	79,163,918	297,474,893	(6,169,917)	42,800,126	(7,951,103)	0	(35,645,057)	0	18,138,648
TOTAL	2,226,434,627	8,285,802,673	(217,824,100)	1,269,239,514	(260,126,879)	3,695,749	(1,372,416,784)	422,163	462,206,369

d) These values represent a proportionate allocation of the total variable OMP&R costs of pumping and recovery plants (Table B-3) associated with net annual withdrawals from storage for Project Transportation Facilities. The allocation is determined annually by applying the following ratio, calculated from the data shown in Table B-6: "Reservoir Storage Changes" (withdrawals, as a positive value) conveyed through each plant, divided by "Total" annual quantity conveyed through each plant, in acre-feet. The costs so determined are accumulated for all upstream plants for each year, for each respective reservoir.

TABLE B-12. Variable OMP&R Costs to be Reimbursed through Variable OMP&R Component of Transportation Charge [a]

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)							GRAND TOTAL
	Reach 29G Warne Powerplant	Reach 29H Pyramid Lake [d]	Reach 29J Castaic Powerplant	Reach 30 Castaic Lake [d]	Reach 31A Las Perillas & Badger Hill Pumping Plants	Reach 33A Devil's Den, Bluestone & Polonio Pumping Plants	Total	
	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
1962	0	0	0	0	0	0	0	36,970
1963	0	0	0	0	0	0	0	57,711
1964	0	0	0	0	0	0	0	74,134
1965	0	0	0	0	0	0	0	142,609
1966	0	0	0	0	0	0	0	192,605
1967	0	0	0	0	0	0	13,881	236,998
1968	0	0	0	0	118,676	0	774,253	1,117,913
1969	0	0	0	0	78,350	0	507,516	773,646
1970	0	0	0	0	136,429	0	693,842	1,103,798
1971	0	0	0	0	166,296	0	1,121,164	1,513,435
1972	0	0	(211,144)	0	237,638	0	2,648,786	3,261,922
1973	0	0	(1,057,564)	0	120,913	0	2,661,036	3,168,975
1974	0	0	(1,547,884)	0	118,582	0	3,336,872	3,919,920
1975	0	0	(2,455,461)	0	94,848	0	5,689,034	6,053,571
1976	0	0	(2,827,557)	0	141,260	0	7,886,569	8,478,786
1977	0	0	(3,734,462)	0	71,311	0	628,796	1,164,427
1978	0	0	(1,542,479)	0	179,925	0	6,979,261	7,587,308
1979	0	0	(2,773,323)	0	192,126	0	9,249,255	9,870,628
1980	0	0	(3,408,863)	0	168,458	0	9,882,560	10,425,874
1981	0	0	(2,834,322)	0	169,177	0	16,972,365	17,563,899
1982	(783,626)	0	(3,463,971)	0	168,390	0	12,859,335	13,477,272
1983	(495,041)	65,741	(3,260,764)	(3,176,515)	17,920	0	(7,537,336)	(7,452,772)
1984	(2,027,345)	0	(2,336,089)	(2,151,129)	112,679	0	(4,435,858)	(4,159,493)
1985	(5,930,176)	0	(15,698,638)	0	146,843	0	(10,322,391)	(9,861,183)
1986	(5,579,301)	0	(11,072,448)	0	297,886	0	10,799,251	11,622,736
1987	(6,304,539)	68,410	(11,562,269)	(41,897)	245,082	0	5,787,267	6,701,446
1988	(6,993,235)	54,038	(12,292,638)	(211,526)	214,519	0	5,288,073	6,239,206
1989	(8,235,085)	14,390	(14,514,469)	126,791	282,180	0	23,323,739	24,585,083
1990	(11,011,065)	0	(20,116,506)	245,180	416,832	0	46,159,453	48,154,173
1991	(3,600,495)	439,068	(6,579,194)	0	3,610	0	2,057,456	2,462,221
1992	(5,508,780)	0	(9,493,502)	(935,650)	101,665	0	(5,857,012)	(5,509,966)
1993	(4,525,955)	(13,291)	(9,266,007)	(446,527)	(111,306)	0	(24,723,671)	(24,907,971)
1994	(5,813,538)	20,518	(10,547,914)	(86,993)	206,258	0	12,537,293	13,452,216
1995	(1,934,202)	0	(4,049,615)	0	243,434	0	(443,026)	(142,956)
1996	(4,248,531)	0	(8,457,232)	0	296,170	0	15,023,643	15,870,541
1997	(4,797,589)	0	(8,727,328)	(897)	298,483	208,816	13,156,006	14,336,880
1998	(740,480)	(931,305)	(3,360,851)	(2,108,804)	(51,634)	(87,016)	(23,936,638)	(24,082,640)
1999	(5,526,541)	(4)	(9,954,674)	(4)	159,358	234,077	(5,948,035)	(5,366,393)
2000	(9,464,490)	(4)	(17,958,033)	(4)	231,108	380,555	(7,792,563)	(6,815,566)
2001	(7,987,833)	(3)	(13,981,232)	(3)	1,080,182	2,152,324	204,400,516	209,266,909
2002	(10,286,902)	(2)	(18,455,024)	(2)	529,085	1,320,943	82,907,125	85,446,618
2003	(10,281,922)	(1)	(17,307,974)	(1)	621,149	1,482,525	121,098,141	123,971,886
2004	(12,033,953)	0	(20,022,179)	0	651,104	1,718,113	134,540,475	137,432,712
2005	(8,251,156)	0	(13,698,272)	0	826,136	1,669,939	157,342,906	160,644,822
2006	(11,846,663)	0	(21,072,103)	0	1,157,341	2,954,530	234,547,856	240,309,508
2007	(10,589,552)	0	(18,964,191)	0	1,606,271	4,691,288	314,433,208	321,334,161
2008	(15,175,359)	0	(26,611,644)	0	1,705,919	4,256,483	341,552,984	349,612,909
2009	(14,881,913)	0	(25,170,192)	0	2,051,045	5,613,779	292,556,167	300,013,498
2010	(14,913,517)	0	(25,328,107)	0	2,137,319	5,871,977	319,683,384	327,478,441
2011	(15,034,490)	0	(25,428,823)	0	2,138,050	5,874,159	315,850,697	323,697,953
2012	(15,277,004)	0	(25,992,105)	0	2,204,739	6,074,916	340,399,558	348,514,792
2013	(15,436,252)	0	(26,220,858)	0	2,401,605	6,664,187	389,211,565	398,092,408
2014	(15,906,509)	0	(26,940,164)	0	2,565,297	7,154,169	419,858,176	429,383,251
2015	(15,814,198)	0	(26,768,889)	0	2,601,207	7,261,655	432,184,306	441,875,187
2016	(16,225,521)	0	(27,487,248)	0	2,625,988	7,335,841	460,488,437	470,300,672
2017	(15,909,387)	0	(26,970,762)	0	2,590,608	7,229,930	433,716,775	443,417,246
2018	(16,041,534)	0	(27,261,438)	0	2,660,434	7,438,943	464,352,881	474,352,054
2019	(17,015,372)	0	(29,043,009)	0	2,721,822	7,622,689	485,597,255	495,864,185
2020	(16,653,246)	0	(28,309,158)	0	2,582,334	7,205,164	451,107,124	460,854,744
2021	(16,663,697)	0	(28,346,624)	0	2,578,386	7,193,340	450,378,516	460,115,157
2022	(16,909,368)	0	(28,771,413)	0	2,500,533	6,960,308	432,271,275	441,702,428
2023	(16,904,417)	0	(28,763,149)	0	2,514,367	7,001,718	441,667,235	451,152,671
2024	(17,051,903)	0	(29,017,307)	0	2,604,616	7,271,859	461,211,588	471,051,163
2025	(16,918,079)	0	(28,787,066)	0	2,593,139	7,237,508	451,454,535	461,249,076
2026	(16,741,641)	0	(28,483,648)	0	2,610,549	7,289,622	465,009,005	474,871,859
2027	(17,107,637)	0	(29,109,736)	0	2,571,994	7,174,210	455,365,134	465,076,694
2028	(16,756,801)	0	(28,507,565)	0	2,589,469	7,226,527	454,897,375	464,677,515
2029	(17,024,240)	0	(28,969,810)	0	2,557,194	7,129,914	448,990,325	458,643,817
2030	(16,727,478)	0	(28,459,349)	0	2,577,373	7,190,317	451,112,568	460,845,241
2031	(16,779,107)	0	(28,564,483)	0	2,542,862	7,087,012	444,310,262	453,907,512
2032	(16,804,031)	0	(28,694,562)	0	2,592,451	7,235,447	449,326,974	459,118,811
2033	(16,825,821)	0	(28,790,365)	0	2,720,121	7,617,602	493,828,346	504,121,164
2034	(16,825,644)	0	(28,740,041)	0	2,622,184	7,324,447	457,990,974	467,899,484
2035	(20,335,543)	0	(34,795,031)	0	2,569,737	7,167,454	492,540,222	502,242,928
TOTAL	(625,457,704)	(282,445)	(1,112,938,722)	(8,787,981)	81,476,076	210,437,271	13,371,224,046	13,683,887,439

TABLE B-13. Capital and Operating Costs of Project Conservation Facilities to be Reimbursed through Delta Water Charge

(in dollars)

Calendar Year	Initial Project Conservation Facilities (Portions of Upper Feather Lakes, Oroville-Thermalito and California Aqueduct Facilities)					Planning and Pre-operating Costs [a] [f]	Total
				Application of Oroville Power Revenues to:			
	Capital Costs [a]	Capital Cost Credits [b]	Operating Costs [c]	Capital Costs [d]	Operating Costs [e]		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
1952	171.322	0	0	0	0	0	171.322
1953	312.190	0	0	0	0	0	312,190
1954	308.624	0	0	0	0	0	308.624
1955	194,645	0	0	0	0	0	194,645
1956	1,357,077	0	0	0	0	0	1,357,077
1957	6,210,709	0	0	0	0	0	6,210,709
1958	9,510,916	0	0	0	0	0	9,510,916
1959	11,390,586	0	0	0	0	0	11,390,586
1960	14,456,356	(4,850,000)	0	0	0	0	9,606,356
1961	18,682,616	(431,527)	0	0	0	0	18,251,089
1962	9,012,960	(479,280)	0	0	0	0	8,533,680
1963	72,965,728	(478,743)	(14,000)	0	0	0	72,472,985
1964	62,493,755	(751,330)	(14,000)	0	0	107,780	61,836,205
1965	70,920,988	(763,541)	(14,000)	0	0	551,850	70,695,297
1966	125,265,788	(748,649)	(14,000)	0	0	1,081,023	125,584,162
1967	94,374,172	(812,145)	(13,446)	0	0	1,189,212	94,737,793
1968	39,889,088	(431,574)	1,303,821	(951,000)	0	793,399	40,603,734
1969	5,279,981	(259,015)	2,890,772	(11,007,000)	0	601,867	(2,493,395)
1970	4,130,490	(203,733)	4,818,634	(14,650,000)	(1,500,000)	516,659	(6,887,950)
1971	3,877,493	(193,631)	6,026,480	(14,650,000)	(1,500,000)	408,754	(6,030,904)
1972	4,569,024	(196,361)	5,393,011	(14,650,000)	(1,500,000)	287,374	(6,096,952)
1973	3,985,414	(136,997)	6,135,774	(14,650,000)	(1,500,000)	203,384	(5,962,425)
1974	6,660,000	(137,503)	6,944,723	(17,950,000)	(1,500,000)	201,907	(5,780,873)
1975	8,084,450	(234,567)	7,697,390	(14,650,000)	(1,500,000)	146,188	(456,539)
1976	5,870,531	(204,944)	7,067,037	(14,650,000)	(1,500,000)	205,234	(3,212,142)
1977	21,285,849	(150,214)	10,547,977	(14,650,000)	(1,500,000)	857,419	16,391,031
1978	7,713,252	(64,566)	12,851,158	(14,650,000)	(1,500,000)	2,131,286	6,481,130
1979	9,030,801	0	9,547,014	(14,650,000)	(1,500,000)	2,131,884	4,559,699
1980	10,372,763	0	13,258,298	(14,650,000)	(1,500,000)	3,638,851	11,119,912
1981	11,194,479	0	10,326,538	(14,650,000)	(1,500,000)	4,597,474	9,968,491
1982	16,634,428	0	16,154,872	(14,650,000)	(1,500,000)	4,594,682	21,233,982
1983	12,037,206	0	22,253,515	(34,705,000)	(8,735,000)	3,751,993	(5,397,286)
1984	8,706,748	0	22,700,224	(14,650,000)	(10,348,000)	2,979,126	9,388,098
1985	11,921,382	0	23,464,019	(14,650,000)	(8,198,000)	2,069,024	14,606,425
1986	20,464,281	0	26,479,379	(14,650,000)	(9,107,000)	1,602,419	24,789,079
1987	30,814,266	0	23,514,665	(14,650,000)	(9,451,000)	1,762,179	31,990,110
1988	31,587,615	0	26,003,911	(14,650,000)	(8,677,000)	1,808,899	36,073,425
1989	10,125,424	0	28,442,946	(14,650,000)	(8,102,000)	2,678,007	18,494,377
1990	27,882,191	0	37,255,751	(14,650,000)	(8,498,000)	1,436,712	43,426,654
1991	35,966,870	0	76,428,061	(14,650,000)	(9,487,000)	1,727,664	89,985,595
1992	27,622,044	0	32,284,164	(14,650,000)	(8,526,000)	1,707,822	38,438,030
1993	21,156,123	0	36,071,890	(14,650,000)	(8,768,000)	1,708,490	35,518,503
1994	13,755,771	0	39,321,477	(14,650,000)	(7,484,000)	2,134,392	33,077,640
1995	14,253,704	0	44,519,764	(14,650,000)	(4,976,939)	2,042,481	41,189,010
1996	10,536,189	0	49,167,138	(14,650,000)	(5,503,289)	2,448,692	41,998,730
1997	13,959,817	0	50,303,842	(14,650,000)	(5,740,515)	1,699,730	45,572,874
1998	3,706,236	0	53,230,282	(14,650,000)	(8,135,000)	1,193,198	35,324,716
1999	5,756,399	0	54,083,724	(14,650,000)	(9,198,000)	9,686	36,001,809
2000	8,946,372	0	55,770,292	(14,650,000)	(10,452,028)	13,491	39,628,127
2001	7,763,464	0	75,262,091	(14,650,000)	(15,231,433)	23,866	53,167,988
2002	13,395,718	0	67,824,612	(14,650,000)	(22,034,770)	24,426	44,559,986
2003	14,733,270	0	77,483,994	(14,650,000)	(30,910,299)	9,833	46,666,798
2004	12,424,830	0	91,278,920	(14,650,000)	(34,155,125)	7,548	54,906,173
2005	(7,126,781)	0	99,112,650	(14,650,000)	(23,020,957)	0	54,314,912
2006	20,564,429	0	77,707,728	(14,650,000)	(16,279,103)	3,129,000	70,472,054
2007	23,840,166	0	81,207,038	(14,650,000)	(15,464,828)	3,129,000	78,061,376
2008	22,544,551	0	81,634,854	(14,650,000)	(15,646,347)	3,129,000	77,012,058
2009	6,810,473	0	58,176,083	(14,650,000)	(9,040,000)	3,129,000	44,425,556
2010	3,800,473	0	57,374,045	(14,650,000)	(9,040,000)	3,129,000	40,613,518
2011	1,736,473	0	56,401,919	(14,650,000)	(9,040,000)	0	34,448,392
2012	396,699	0	54,930,760	(14,650,000)	(9,040,000)	0	31,637,459
2013	396,699	0	57,975,624	(14,650,000)	(9,040,000)	0	34,682,323
2014	396,699	0	56,510,610	(14,650,000)	(9,040,000)	0	33,217,309
2015	396,699	0	54,566,848	(14,650,000)	(9,040,000)	0	31,273,547
2016	396,699	0	58,183,091	(14,650,000)	(9,040,000)	0	34,889,790
2017	396,699	0	57,379,283	(14,650,000)	(9,040,000)	0	34,085,982
2018	396,699	0	57,808,862	(14,650,000)	(9,040,000)	0	34,515,561
2019	396,699	0	56,691,638	(14,650,000)	(9,040,000)	0	33,398,337
2020	396,699	0	54,284,698	(14,650,000)	(9,040,000)	0	30,991,397
2021	396,699	0	58,353,702	(14,650,000)	(9,040,000)	0	35,060,401
2022	396,699	0	57,148,280	(14,650,000)	(9,040,000)	0	33,854,979
2023	396,699	0	54,244,306	(14,650,000)	(9,040,000)	0	30,951,005
2024	396,699	0	55,164,940	(14,650,000)	(9,040,000)	0	31,871,639
2025	396,699	0	59,588,504	(14,650,000)	(9,040,000)	0	36,295,203
2026	396,699	0	57,021,041	(14,650,000)	(9,040,000)	0	33,727,740
2027	396,699	0	53,832,562	(14,650,000)	(9,040,000)	0	30,539,261
2028	396,699	0	54,279,666	(14,650,000)	(9,040,000)	0	30,986,365
2029	396,699	0	60,178,188	(14,650,000)	(9,040,000)	0	36,884,887
2030	396,699	0	56,025,284	(14,650,000)	(9,040,000)	0	32,731,983
2031	396,699	0	54,186,355	(14,650,000)	(9,040,000)	0	30,893,054
2032	396,699	0	53,706,811	(14,650,000)	(9,040,000)	0	30,413,510
2033	396,699	0	58,612,551	(14,650,000)	(9,040,000)	0	35,319,250
2034	396,699	0	55,440,673	(14,650,000)	(9,040,000)	0	32,147,372
2035	396,699	0	55,972,771	(14,650,000)	(9,040,000)	0	32,679,470
TOTAL	1,095,412,955	(11,528,320)	2,997,740,079	(1,002,213,000)	(585,729,633)	72,730,905	2,566,412,986

a) Reimbursed through the capital cost component of the Delta Water Charge.

b) Negotiated settlements as to the magnitude of SWP planning costs from 1952 through 1978.

c) Reimbursed through the minimum OMP&R component of the Delta Water Charge. Credits for Gianelli power generation are reflected in these net costs.

d) Revenues credited through the capital cost component of the Delta Water Charge.

e) Revenues credited through the minimum OMP&R component of the Delta Water Charge.

f) Under amendments of Articles 22(e) and 22(g), planning and pre-operating costs of additional Project Conservation Facilities incurred through the previous year (2005) reflected in the Delta Water Charge.

TABLE B-14. Capital Costs of Transportation Facilities Allocated to Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA (a	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1952	0	0	0	83	114	410	607	122	224	346
1953	0	0	0	323	479	1,808	2,610	336	620	956
1954	0	0	0	819	1,306	5,150	7,275	421	777	1,198
1955	0	0	0	977	1,570	6,297	8,844	211	390	601
1956	0	0	0	8,844	14,459	63,816	87,119	227	418	645
1957	15,199	11,436	26,635	21,564	35,240	649,596	706,400	291	536	827
1958	33,420	16,591	50,011	67,764	71,717	733,414	872,895	720	1,328	2,048
1959	20,697	6,591	27,288	154,255	143,730	493,050	791,035	10,636	69,139	79,775
1960	9,097	8,830	17,927	296,492	275,610	1,018,661	1,590,763	15,255	99,794	115,049
1961	6,950	7,445	14,395	853,506	802,675	1,914,709	3,570,890	10,163	36,681	46,844
1962	(194)	(926)	(1,120)	545,123	615,141	1,686,041	2,846,305	17,281	39,570	56,851
1963	1,319	1,111	2,430	657,426	1,281,271	3,243,838	5,182,535	68,821	140,841	209,662
1964	38,393	35,466	73,859	712,650	1,747,783	7,251,800	9,712,233	138,614	282,003	420,617
1965	198,833	62,221	261,054	360,779	606,025	3,414,457	4,381,261	250,706	497,152	747,858
1966	461,619	49,917	511,536	592,714	592,598	2,245,215	3,430,527	587,951	1,117,486	1,705,437
1967	1,569,498	40,379	1,609,877	796,995	803,951	2,401,862	4,002,808	936,412	1,762,694	2,699,106
1968	859,613	61,691	921,304	736,470	696,075	1,997,924	3,430,469	351,131	675,220	1,026,351
1969	74,388	59,318	133,706	269,698	293,275	764,950	1,327,923	76,966	164,583	241,549
1970	43,361	67,877	111,238	58,676	61,200	135,569	255,445	47,891	109,224	157,115
1971	26,763	34,052	60,815	12,086	18,227	84,089	114,402	28,638	80,715	109,353
1972	19,643	18,905	38,548	12,293	12,763	63,610	88,666	19,289	50,230	69,519
1973	56,510	30,874	87,384	10,494	12,136	39,380	62,010	23,010	56,178	79,188
1974	165,830	65,832	231,662	15,722	24,402	73,119	113,243	25,037	61,383	86,420
1975	91,824	89,234	181,058	16,730	15,806	41,394	73,930	14,740	61,416	76,156
1976	57,765	83,651	141,416	34,004	34,663	109,610	178,277	33,638	130,440	164,078
1977	64,167	80,147	144,314	46,229	45,115	133,375	224,719	108,324	264,720	373,044
1978	69,319	81,717	151,036	71,234	66,008	174,898	312,140	21,415	103,822	125,237
1979	191,273	282,907	474,180	45,468	42,943	110,665	199,076	22,941	125,669	148,610
1980	264,433	386,006	650,439	134,522	124,352	304,614	563,488	103,258	462,895	566,153
1981	227,606	383,086	610,692	(33,738)	(29,856)	(65,637)	(129,231)	(15,416)	(135,240)	(150,656)
1982	549,164	870,611	1,419,775	7,876	8,321	27,065	43,262	4,102	(58,882)	(54,780)
1983	1,254,900	1,433,061	2,687,961	138,413	131,515	339,246	609,174	32,196	110,287	142,483
1984	2,547,878	2,750,040	5,297,918	152,992	140,971	351,921	645,884	35,448	107,723	143,171
1985	7,143,123	6,443,613	13,586,736	19,776	19,245	53,491	92,512	17,424	78,896	96,320
1986	10,565,937	16,926,630	27,492,567	32,034	31,581	88,070	151,685	44,135	306,452	350,587
1987	7,979,832	12,599,507	20,579,339	50,153	48,675	138,959	237,787	126,995	1,342,116	1,469,111
1988	2,312,909	4,343,513	6,656,422	116,181	112,294	302,461	530,936	156,473	1,479,545	1,636,018
1989	1,224,538	1,553,352	2,777,890	108,320	102,804	260,092	471,216	152,173	1,210,940	1,363,113
1990	443,002	824,055	1,267,057	224,283	224,188	625,213	1,073,684	222,208	1,559,457	1,781,665
1991	99,848	89,269	189,117	413,426	383,368	946,246	1,743,040	298,398	2,184,088	2,482,486
1992	57,045	62,083	119,128	182,231	169,968	442,055	794,254	361,210	3,504,755	3,865,965
1993	122,423	128,634	251,057	129,344	125,312	342,416	597,072	1,170,649	11,997,954	13,168,603
1994	71,274	83,270	154,544	46,042	58,050	229,649	333,741	4,260,734	46,401,596	50,662,330
1995	30,605	29,271	59,876	97,808	97,063	257,484	452,355	12,268,787	155,255,849	167,524,636
1996	20,275	19,069	39,344	49,854	48,056	127,493	225,403	11,284,548	145,409,409	156,693,957
1997	20,039	107,784	127,823	82,598	78,996	209,517	371,111	3,184,506	38,158,718	41,343,224
1998	17,309	21,447	38,756	27,114	23,949	62,646	113,709	883,014	10,563,182	11,446,196
1999	67,542	106,333	173,875	74,358	73,714	208,601	356,673	929,800	9,604,289	10,534,089
2000	15,937	37,603	53,540	27,390	28,767	80,015	136,172	489,386	5,542,764	6,032,150
2001	4,469	11,525	15,994	140,023	269,536	1,854,608	2,264,167	80,654	631,609	712,263
2002	17,782	43,709	61,491	805,106	1,189,094	5,874,598	7,868,798	71,502	468,992	540,494
2003	49,553	15,819	65,372	1,156,057	1,330,130	4,614,252	7,100,439	15,686	280,419	296,105
2004	151,772	19,068	170,840	1,483,165	1,378,279	6,565,455	9,426,899	15,251	119,668	134,919
2005	60,245	62,677	122,922	1,615,351	1,489,435	4,280,795	7,385,581	(14,358)	(204,694)	(219,052)
2006	1,502,468	43,606	1,546,074	758,367	696,264	1,673,269	3,127,900	80,728	598,596	679,324
2007	4,296,903	55,039	4,351,942	2,220,777	2,034,093	4,863,653	9,118,523	102,289	645,252	747,541
2008	5,025,499	51,844	5,077,343	1,585,069	1,452,657	3,477,332	6,515,058	95,587	629,360	724,947
2009	12,904	20,719	33,623	29,310	28,279	76,145	133,734	57,933	495,857	553,790
2010	12,904	20,719	33,623	29,310	28,279	76,145	133,734	57,933	495,857	553,790
2011	12,904	20,719	33,623	29,310	28,279	76,145	133,734	57,933	495,857	553,790
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
TOTAL	50,258,309	50,758,947	101,017,256	18,332,240	20,241,940	67,622,721	106,196,901	39,442,353	445,676,820	485,119,173

Note: Allocated capital costs as a result of permanent water transfes under Monterey are not reflected on this Table

a) Costs from Table B-10 allocated to Solano County Water Agency are reduced herein by $2,102,700 in 1986 and $1,823,500 in 1987 under provisions of Amendment No. 10 to its water supply contract.

TABLE B-14. Capital Costs of Transportation Facilities Allocated to Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA									
				Kern County Water Agency						
	Dudley Ridge Water District	Empire West Side Irrigation District (b	Future Contractor San Joaquin Valley	Municipal and Industrial	Municipal and (c Industrial	Agri-cultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
1952	389	20	58	938	119	9,129	20	12	785	11,470
1953	1,076	53	161	2,887	345	27,383	55	33	2,157	34,150
1954	1,350	68	201	3,373	417	32,369	69	43	2,718	40,608
1955	677	34	101	1,497	197	14,721	35	23	1,371	18,656
1956	726	34	108	2,702	273	24,255	35	25	1,416	29,574
1957	932	38	139	6,048	494	49,932	39	29	1,707	59,358
1958	2,308	102	344	14,374	1,153	119,049	104	61	4,368	141,863
1959	7,384	364	2,517	26,218	2,597	253,891	372	381	14,757	308,481
1960	12,940	630	3,666	34,054	4,155	352,166	644	498	25,696	434,449
1961	21,848	1,063	3,954	51,407	6,500	538,707	1,087	598	43,377	668,541
1962	49,320	2,410	7,867	94,933	13,834	1,017,146	2,465	1,879	98,141	1,287,995
1963	208,757	10,687	32,172	364,014	55,715	3,934,636	10,932	5,990	425,330	5,048,233
1964	328,286	16,961	64,890	600,152	88,904	6,636,279	17,350	11,942	672,013	8,436,777
1965	538,215	27,481	117,996	1,098,999	152,930	11,999,892	28,116	21,802	1,095,126	15,080,557
1966	1,107,757	52,586	279,172	2,218,832	339,222	24,857,487	53,789	38,891	2,173,090	31,120,826
1967	852,537	39,537	445,562	2,012,744	286,990	23,629,026	40,444	34,775	1,653,429	28,995,044
1968	198,739	9,739	166,267	1,104,132	70,086	11,544,942	9,962	12,238	396,075	13,512,180
1969	94,436	4,793	35,473	616,516	27,216	6,416,147	4,903	7,302	191,574	7,398,360
1970	54,344	2,720	21,686	414,659	15,520	4,145,046	2,782	3,999	109,470	4,770,226
1971	25,462	1,291	12,094	190,552	7,114	1,622,274	1,320	540	51,618	1,912,265
1972	11,589	589	8,354	82,886	3,409	723,623	602	343	23,526	854,921
1973	6,657	335	10,201	39,973	1,980	458,527	343	221	13,448	531,685
1974	9,478	469	11,044	45,420	2,766	483,866	479	326	18,979	572,827
1975	13,329	677	5,246	36,467	3,710	382,743	692	425	27,048	470,337
1976	17,506	837	12,615	53,085	5,621	654,026	856	1,152	34,455	780,153
1977	9,672	436	47,790	36,478	3,753	886,672	446	494	18,497	1,004,238
1978	23,499	(30,406)	6,178	54,219	6,579	575,169	1,209	1,402	47,446	685,295
1979	25,051	1,295	5,664	53,866	6,610	559,746	1,325	1,862	51,293	706,712
1980	144,980	(4,617)	31,160	321,890	38,126	3,211,810	7,682	7,144	297,215	4,055,390
1981	(5,427)	(15,464)	200	(44,773)	(1,223)	(385,275)	(296)	1,752	(11,324)	(461,830)
1982	49,916	2,584	6,600	83,283	13,142	654,692	2,638	1,252	102,287	916,394
1983	52,429	(35,295)	12,125	110,465	13,872	1,073,500	2,769	1,327	107,337	1,338,529
1984	86,345	4,474	14,303	154,799	22,764	1,617,225	4,572	2,678	177,020	2,084,180
1985	25,435	1,311	5,649	47,055	6,766	484,485	1,341	1,176	52,013	625,231
1986	38,309	(41,067)	9,862	71,661	10,320	796,097	2,009	778	78,142	966,111
1987	28,769	1,476	7,004	55,537	7,969	616,845	1,509	1,491	58,679	779,279
1988	52,329	2,831	17,078	70,572	12,049	909,046	2,894	4,620	109,713	1,181,132
1989	156,099	8,019	27,551	352,103	42,943	3,834,481	8,201	12,134	318,604	4,760,135
1990	292,361	15,142	50,360	553,394	87,199	6,094,021	15,487	22,729	599,233	7,729,926
1991	349,413	18,103	60,419	580,572	91,765	6,447,565	18,515	23,486	716,292	8,306,130
1992	125,891	6,439	28,019	241,559	34,559	2,711,639	6,585	10,883	256,370	3,421,944
1993	86,113	4,375	30,245	174,630	23,840	2,059,168	4,474	4,698	174,772	2,562,315
1994	64,762	3,323	23,894	124,518	17,633	1,488,418	3,398	2,173	132,095	1,860,214
1995	82,969	(1,000)	72,734	167,698	24,390	2,472,332	4,355	2,824	169,318	2,995,620
1996	27,611	(61,913)	51,990	68,870	8,812	1,233,548	1,437	1,590	56,092	1,388,037
1997	136,503	7,041	48,721	241,400	36,417	2,951,687	7,195	3,706	279,205	3,711,875
1998	70,585	(121,012)	23,037	122,493	18,582	1,470,316	3,734	1,278	144,651	1,733,664
1999	82,290	4,249	26,824	144,882	21,945	1,736,415	4,343	3,856	168,404	2,193,208
2000	21,067	1,072	9,811	45,646	6,006	547,273	1,094	(1,081)	42,783	673,671
2001	17,632	900	7,790	35,687	5,017	428,254	920	777	35,867	532,844
2002	74,060	3,804	15,942	132,582	20,004	1,494,264	3,891	724	151,158	1,896,429
2003	(51,492)	(2,691)	(5,668)	(76,971)	(13,187)	(832,512)	(2,752)	330	(106,022)	(1,090,965)
2004	6,953	358	2,362	15,272	1,853	164,896	367	1,482	14,211	207,754
2005	25,401	1,319	5,257	45,551	6,627	465,754	1,348	399	52,133	603,789
2006	45,518	2,343	14,745	88,610	12,259	977,008	2,397	1,014	93,003	1,236,897
2007	96,650	4,989	24,340	174,767	25,731	1,931,510	5,104	2,094	197,755	2,462,940
2008	72,196	3,716	21,210	136,295	19,388	1,513,050	3,802	2,022	147,511	1,919,190
2009	12,075	616	7,350	25,027	3,391	328,279	630	508	24,557	402,433
2010	12,075	616	7,350	25,027	3,391	328,279	630	508	24,557	402,433
2011	12,075	616	7,350	25,027	3,391	328,279	630	508	24,557	402,433
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
TOTAL	5,916,156	(38,500)	1,967,134	13,576,553	1,733,950	151,101,198	301,378	268,146	11,887,098	186,713,113

b) Costs from Table B-10 allocated to Empire West Side Irrigation District are reduced herein by $31,588 in 1978; $12,129 in 1980; $15,173 in 1981; $38,004 in 1983; $43,033 in 1986; $5,261 in 1995; $63,318 in 1996 and $124,667 in 1998 in accordance with letters of agreement with the district.

c) Costs related to maximum annual entitlement of 15,000 acre-feet under Amendment No. 18 of the water supply contract with Kern County Water Agency.

TABLE B-14. Capital Costs of Transportation Facilities Allocated to Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency (d	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
1952	3,158	1,042	850	254	1,402	70	1,695	418	6,079	1,550
1953	10,026	3,327	2,668	799	4,401	222	5,318	1,328	19,058	4,852
1954	12,742	4,193	3,465	1,031	5,714	285	6,908	1,691	24,608	6,290
1955	5,411	1,881	1,374	401	2,267	115	2,756	715	9,229	2,377
1956	9,775	3,590	2,196	612	3,622	191	4,449	1,267	13,138	3,438
1957	26,306	9,255	6,343	1,816	10,461	540	12,767	3,450	40,646	10,534
1958	49,204	17,599	11,581	3,290	19,099	991	23,360	6,414	72,708	18,898
1959	70,247	29,740	15,869	4,616	26,171	1,347	31,759	9,030	98,596	25,519
1960	84,552	38,760	22,068	6,797	36,395	1,547	43,260	10,772	147,170	37,469
1961	126,542	54,262	34,613	12,530	57,086	2,245	63,709	16,437	236,164	57,707
1962	198,558	85,352	43,719	13,861	72,102	3,344	84,709	24,943	253,435	64,330
1963	580,138	255,252	116,797	33,149	192,624	9,828	234,926	73,256	610,277	160,624
1964	1,094,365	501,858	209,462	55,445	345,446	18,442	429,605	137,769	1,026,066	276,118
1965	1,908,076	947,523	385,533	103,757	635,825	32,819	786,986	244,587	1,913,090	512,862
1966	3,960,302	2,150,972	812,655	215,858	1,340,235	69,325	1,664,584	517,269	3,943,586	1,062,417
1967	4,976,538	4,100,531	1,077,422	296,069	1,776,892	88,301	2,182,240	653,250	5,821,681	1,550,239
1968	5,924,474	3,998,942	1,350,742	368,156	2,227,646	107,350	2,738,009	783,940	7,982,824	2,122,940
1969	5,822,708	3,079,426	1,690,259	539,851	2,787,631	121,303	3,256,507	865,455	10,898,185	2,769,647
1970	5,032,959	3,277,778	2,050,788	695,345	3,382,251	106,381	3,872,367	736,775	13,795,809	3,457,109
1971	2,577,507	2,146,954	1,071,523	338,581	1,767,179	48,337	2,087,223	347,057	8,137,053	1,987,120
1972	973,436	283,257	331,759	92,079	547,138	19,134	668,550	134,360	2,691,137	697,957
1973	354,407	914,303	158,579	82,223	261,557	6,304	238,094	46,102	1,760,570	403,582
1974	451,450	280,861	259,175	74,113	427,433	8,143	518,453	59,145	1,617,394	425,927
1975	253,438	246,492	193,632	52,821	319,337	4,954	392,110	33,995	1,533,664	407,913
1976	237,539	255,238	136,751	37,235	225,529	4,245	277,807	31,002	962,280	255,901
1977	199,554	371,469	91,384	25,858	150,711	3,757	183,609	26,834	591,445	155,537
1978	302,111	470,176	78,573	22,226	129,584	5,233	157,815	38,654	428,989	111,769
1979	357,678	938,985	81,807	21,795	134,915	5,965	166,931	44,410	403,569	108,408
1980	1,867,517	1,777,294	423,755	113,166	698,855	32,435	864,104	240,899	2,040,757	548,085
1981	(158,728)	610,795	(47,102)	(8,865)	(77,678)	(2,576)	(102,568)	(19,588)	(143,875)	(43,557)
1982	1,557,934	861,928	298,770	78,903	492,728	26,237	613,587	196,672	1,421,407	388,261
1983	2,062,512	521,349	396,033	115,678	653,134	34,699	803,945	259,939	2,126,313	581,672
1984	1,518,361	295,783	297,559	85,097	490,731	27,272	606,124	188,562	1,546,628	423,408
1985	896,226	158,810	217,115	62,532	358,064	13,104	441,299	107,533	1,115,498	304,903
1986	841,555	104,860	221,194	58,152	364,790	9,038	454,702	93,309	1,048,625	286,302
1987	333,052	105,625	166,099	43,992	273,928	5,566	340,485	40,716	783,725	213,202
1988	259,234	174,155	65,831	22,723	108,570	3,384	128,339	26,743	429,498	113,644
1989	1,045,999	434,394	323,138	97,036	532,920	16,777	649,616	125,344	1,375,722	372,048
1990	678,053	374,313	332,566	97,789	548,468	7,335	672,344	67,179	1,509,745	409,710
1991	831,687	401,961	367,196	120,925	605,579	11,966	733,443	92,625	1,979,364	540,210
1992	633,272	356,952	270,826	131,328	446,647	9,556	501,634	76,760	2,093,387	573,386
1993	634,283	332,089	222,347	171,095	366,700	10,194	353,470	73,955	3,848,084	1,046,752
1994	467,409	165,607	132,599	93,839	218,685	7,255	218,494	53,209	2,347,599	637,733
1995	459,990	293,308	132,690	78,390	218,835	7,436	232,377	54,544	1,959,986	530,656
1996	299,764	206,742	110,520	44,965	182,270	4,885	211,872	35,808	4,004,066	972,829
1997	438,898	249,699	103,382	24,640	170,497	7,397	214,534	54,452	2,819,566	397,103
1998	231,375	201,318	61,853	40,974	102,009	3,938	104,688	29,174	3,547,590	302,471
1999	272,187	177,666	88,999	38,450	146,777	4,878	169,400	35,895	5,453,212	228,739
2000	138,739	77,710	54,773	23,902	90,332	2,660	103,134	19,109	13,635,919	171,058
2001	128,753	43,584	50,665	15,634	83,557	2,951	101,850	20,674	19,270,173	95,921
2002	165,050	106,305	34,254	11,387	56,492	2,415	67,803	18,275	9,602,339	126,093
2003	(50,046)	(14,093)	2,633	2,112	4,342	(883)	3,341	(6,547)	3,747,303	26,514
2004	57,468	36,689	18,594	5,192	30,665	1,009	37,809	7,426	2,043,583	36,088
2005	165,714	98,956	31,766	10,127	52,389	2,773	62,093	20,813	920,041	50,953
2006	324,880	248,999	110,655	44,935	182,498	5,609	202,678	41,612	1,952,465	215,406
2007	468,605	470,067	220,171	72,533	363,110	8,048	429,711	59,815	1,345,304	353,266
2008	434,273	584,819	179,499	47,821	296,029	7,482	368,180	55,538	910,903	247,820
2009	69,451	184,392	22,065	6,526	36,389	1,291	44,381	9,336	148,784	39,713
2010	69,451	60,225	22,065	6,526	36,389	1,291	44,381	9,336	148,784	39,713
2011	69,451	51,535	22,065	6,526	36,389	1,291	44,381	9,336	148,784	39,713
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
TOTAL	52,815,570	34,222,854	15,196,162	4,864,598	25,061,743	947,431	29,858,137	6,948,778	160,219,728	26,968,849

d) Costs from Table B-10 allocated to Castaic Lake Water Agency are reduced herein by $14,088 in 1978 in accordance with a letter of agreement with the district.

TABLE B-14. Capital Costs of Transportation Facilities Allocated to Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California (e	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]
1952	962	69,020	370	86,870	0	0	0	0	59	99,352
1953	3,011	217,634	1,187	273,831	0	0	0	0	264	311,811
1954	3,904	279,967	1,496	352,294	0	0	0	0	766	402,141
1955	1,474	111,602	670	140,272	0	0	0	0	969	169,342
1956	2,127	179,335	1,299	225,039	0	0	0	0	9,172	351,549
1957	6,526	516,050	3,367	648,061	0	0	0	0	23,172	1,464,453
1958	11,701	945,684	6,390	1,186,919	0	0	2	2	32,888	2,286,626
1959	15,815	1,364,298	9,894	1,702,901	0	0	14	14	57,918	2,967,412
1960	23,307	1,914,521	12,798	2,379,416	0	0	28	28	123,202	4,660,834
1961	36,153	3,212,125	18,770	3,928,343	0	0	10	10	316,220	8,545,243
1962	40,012	3,543,471	29,069	4,456,905	0	0	32	32	228,202	8,875,170
1963	99,266	11,185,928	86,807	13,638,872	0	0	51	51	528,496	24,610,279
1964	170,012	18,065,455	164,709	22,494,752	0	0	7,791	7,791	590,034	41,736,063
1965	316,082	33,763,577	307,475	41,858,192	0	0	3,139	3,139	332,680	62,664,741
1966	654,194	74,485,027	681,898	91,558,322	0	0	(48)	(48)	783,728	129,110,328
1967	958,406	130,599,417	1,279,076	155,360,062	0	0	47	47	1,479,421	194,146,365
1968	1,314,841	147,502,290	1,360,687	177,782,841	0	0	51,573	51,573	1,254,192	197,978,910
1969	1,726,891	140,096,646	1,085,026	174,739,535	0	0	234,232	234,232	398,183	184,473,488
1970	2,160,122	161,983,078	1,147,609	201,698,371	0	0	16,227	16,227	74,028	207,082,650
1971	1,237,573	133,903,316	738,822	156,388,245	0	0	27,204	27,204	12,457	158,624,741
1972	434,507	43,931,880	66,878	50,872,072	0	0	9	9	13,182	51,936,917
1973	256,711	39,723,010	290,020	44,495,462	0	0	25	25	8,099	45,263,853
1974	264,349	18,896,593	86,362	23,369,398	0	0	45	45	28,570	24,402,165
1975	253,838	16,732,939	83,975	20,509,108	0	0	21	21	8,226	21,318,836
1976	158,850	13,545,451	84,623	16,212,451	0	0	51	51	16,486	17,492,912
1977	96,517	11,769,352	110,833	13,776,860	0	0	28	28	21,181	15,544,384
1978	69,152	15,781,696	174,876	17,770,854	0	0	38	38	28,876	19,073,476
1979	66,847	27,627,424	343,361	30,302,095	0	0	23	23	26,668	31,857,364
1980	337,811	59,493,774	641,586	69,080,038	0	0	26	26	59,169	74,974,703
1981	(26,356)	15,661,179	224,257	15,865,338	0	0	34	34	(6,746)	15,727,601
1982	238,792	30,873,857	316,107	37,365,183	0	0	11	11	16,086	39,705,931
1983	357,812	25,056,047	187,121	33,156,254	0	0	19	19	72,225	38,006,645
1984	260,327	16,317,441	103,160	22,160,453	0	0	26	26	83,252	30,414,884
1985	187,454	10,236,155	56,162	14,154,855	0	0	29	29	16,338	28,572,021
1986	176,057	8,365,310	34,777	12,058,671	0	0	31	31	16,248	41,035,900
1987	131,163	6,955,356	36,142	9,429,051	0	0	32	32	29,062	32,523,661
1988	70,260	6,626,545	57,117	8,086,043	0	0	55	55	50,083	18,140,689
1989	227,772	18,531,680	153,200	23,885,646	0	0	44	44	43,324	33,301,368
1990	251,185	17,430,869	125,376	22,504,932	0	0	63	63	96,419	34,453,746
1991	331,235	20,792,168	132,558	26,940,917	0	0	54	54	149,922	39,811,666
1992	351,492	21,196,762	116,999	26,759,001	0	0	42	42	80,900	35,041,234
1993	646,980	29,471,748	105,693	37,283,390	0	0	30	30	59,324	53,921,791
1994	394,936	16,392,019	50,941	21,180,325	0	0	14	14	34,208	74,225,376
1995	331,399	16,078,395	72,214	20,450,220	0	0	3	3	42,395	191,525,105
1996	1,100,219	23,237,696	49,282	30,460,918	0	0	0	0	21,388	188,829,047
1997	1,987,864	13,530,777	72,335	20,071,144	0	0	3	3	34,976	65,660,156
1998	3,351,560	11,234,515	65,270	19,276,735	0	0	7	7	11,162	32,620,229
1999	6,135,848	8,999,050	55,105	21,806,206	0	0	2	2	34,683	35,098,736
2000	17,011,956	5,386,696	23,952	36,739,940	0	0	0	0	16,879	43,652,352
2001	24,660,997	2,944,670	12,652	47,432,081	0	0	0	0	67,794	51,025,143
2002	11,951,414	5,253,452	34,427	27,429,706	0	0	0	0	380,408	38,177,326
2003	4,685,945	3,859,509	(5,032)	12,255,098	0	0	0	0	589,637	19,215,686
2004	2,390,732	4,170,999	12,482	8,848,736	0	0	0	0	531,172	19,320,320
2005	837,616	6,245,799	33,769	8,532,809	0	0	0	0	540,659	16,966,708
2006	1,504,446	13,869,050	85,407	18,788,640	0	0	0	0	270,193	25,649,028
2007	218,782	33,048,396	153,495	37,211,303	0	0	0	0	760,434	54,652,683
2008	152,630	53,174,437	180,654	56,640,085	0	0	0	0	548,129	71,424,752
2009	24,594	5,579,851	64,527	6,231,300	0	0	0	0	18,676	7,373,556
2010	24,594	2,246,591	18,709	2,728,055	0	0	0	0	18,676	3,870,311
2011	24,594	2,013,308	15,502	2,482,875	0	0	0	0	18,676	3,625,131
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
TOTAL	90,715,261	1,566,220,887	11,464,293	2,025,504,291	0	0	341,067	341,067	11,103,090	2,915,994,891

e) Costs from Table B-10 allocated to MWDSC are reduced herein by $16,425,374 in 1972 under provisions of Amendment No. 7 to its water contract.

TABLE B-15. Capital Cost Component of Transportation Charge for Each Contractor [a] [b] [c]

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	153,725	105,637	364,698	624,060	0	0	0
1964	0	0	0	216,131	170,872	529,854	916,857	6,694	21,659	28,353
1965	0	0	0	284,275	259,858	899,072	1,443,205	13,751	36,017	49,768
1966	18,057	0	18,057	320,279	290,714	1,072,916	1,683,909	26,516	61,329	87,845
1967	41,560	0	41,560	391,134	320,885	1,187,229	1,899,248	56,450	118,225	174,675
1968	121,469	0	121,469	507,646	361,817	1,309,517	2,178,980	104,127	207,970	312,097
1969	165,236	0	165,236	609,761	397,257	1,411,240	2,418,258	122,004	242,348	364,352
1970	169,023	0	169,023	644,078	412,189	1,450,186	2,506,453	125,923	250,728	376,651
1971	171,231	0	171,231	650,897	415,305	1,457,089	2,523,291	128,361	256,289	384,650
1972	172,593	0	172,593	652,206	416,233	1,461,370	2,529,809	129,819	260,399	390,218
1973	173,593	31,353	204,946	653,539	416,883	1,464,608	2,535,030	130,802	262,956	393,758
1974	176,471	32,924	209,395	654,523	417,501	1,466,613	2,538,637	131,973	265,816	397,789
1975	184,914	36,276	221,190	656,819	418,743	1,470,336	2,545,898	133,248	268,941	402,189
1976	189,589	40,819	230,408	658,140	419,548	1,472,444	2,550,132	133,998	272,068	406,066
1977	192,530	45,078	237,608	660,803	421,313	1,478,024	2,560,140	135,711	278,710	414,421
1978	195,797	49,159	244,956	664,373	423,610	1,484,815	2,572,798	141,226	292,188	433,414
1979	199,326	53,320	252,646	669,666	426,971	1,493,720	2,590,357	142,316	297,474	439,790
1980	209,065	67,724	276,788	673,449	429,157	1,499,354	2,601,960	143,484	303,872	447,356
1981	222,528	87,377	309,905	683,589	435,488	1,514,863	2,633,940	148,742	327,440	476,182
1982	234,116	106,881	340,997	681,463	433,968	1,511,522	2,626,953	147,957	320,554	468,511
1983	262,076	151,207	413,284	682,698	434,392	1,512,899	2,629,989	148,166	317,556	465,722
1984	325,968	224,170	550,139	693,786	441,088	1,530,172	2,665,046	149,805	323,171	472,976
1985	455,691	364,186	819,877	706,190	448,265	1,548,090	2,702,545	151,610	328,656	480,266
1986	819,376	692,256	1,511,632	708,078	449,245	1,550,813	2,708,136	152,497	332,673	485,170
1987	1,360,258	1,558,749	2,919,007	710,649	450,862	1,555,321	2,716,832	154,756	348,360	503,116
1988	1,771,094	2,207,426	3,978,520	714,860	453,368	1,562,476	2,730,704	161,294	417,458	578,752
1989	1,890,890	2,432,396	4,323,286	723,738	459,184	1,578,141	2,761,063	169,399	494,091	663,490
1990	1,954,717	2,513,362	4,468,079	731,780	464,542	1,591,698	2,788,020	177,331	557,209	734,540
1991	1,977,962	2,556,601	4,534,563	748,884	476,306	1,624,504	2,849,694	188,990	639,036	828,026
1992	1,983,238	2,561,318	4,544,556	779,473	496,563	1,674,504	2,950,540	204,758	754,445	959,203
1993	1,986,275	2,564,623	4,550,898	793,829	505,611	1,698,036	2,997,476	223,986	941,012	1,164,998
1994	1,992,843	2,571,524	4,564,367	804,257	512,334	1,716,406	3,032,997	286,790	1,584,690	1,871,480
1995	1,996,698	2,576,028	4,572,726	808,731	515,474	1,728,829	3,053,034	517,259	4,094,617	4,611,876
1996	1,998,368	2,577,625	4,575,993	816,633	520,770	1,742,877	3,080,280	1,186,671	12,565,710	13,752,381
1997	1,999,484	2,578,675	4,578,160	820,682	523,416	1,749,898	3,093,996	1,808,036	20,572,448	22,380,484
1998	2,000,598	2,584,668	4,585,266	827,410	527,808	1,761,546	3,116,764	1,985,088	22,693,988	24,679,076
1999	2,001,570	2,585,873	4,587,443	829,627	529,153	1,765,065	3,123,845	2,034,685	23,287,300	25,321,985
2000	2,005,405	2,591,910	4,597,315	987,275	533,338	1,776,909	3,297,522	2,087,476	23,832,603	25,920,079
2001	2,324,657	2,779,862	5,104,519	1,115,353	534,991	1,781,504	3,431,848	2,115,581	24,150,915	26,266,496
2002	2,324,954	2,780,566	5,105,521	1,129,701	550,658	1,889,305	3,569,664	2,120,269	24,187,628	26,307,897
2003	2,326,155	2,783,237	5,109,392	1,214,305	620,665	2,235,168	4,070,138	2,124,478	24,215,240	26,339,718
2004	2,329,518	2,784,225	5,113,743	1,347,155	700,044	2,510,537	4,557,736	2,125,415	24,231,974	26,357,389
2005	2,339,962	2,785,469	5,125,431	1,491,998	783,488	2,908,024	5,183,510	2,126,338	24,239,219	26,365,557
2006	2,343,771	2,789,399	5,133,170	1,621,784	875,049	3,171,180	5,668,013	2,125,455	24,226,636	26,352,091
2007	2,450,415	2,792,246	5,242,661	1,698,190	918,551	3,275,725	5,892,466	2,130,499	24,264,036	26,394,535
2008	2,760,691	2,795,901	5,556,592	1,924,110	1,047,852	3,584,892	6,556,854	2,137,001	24,305,052	26,442,053
2009	3,130,307	2,799,408	5,929,715	2,088,650	1,141,906	3,810,036	7,040,592	2,143,190	24,345,801	26,488,991
2010	3,131,281	2,800,840	5,932,121	2,092,244	1,143,773	3,815,063	7,051,080	2,147,015	24,378,541	26,525,556
2011	3,132,276	2,802,303	5,934,579	2,095,911	1,145,680	3,820,197	7,061,788	2,150,921	24,411,973	26,562,894
2012	3,133,294	2,803,798	5,937,092	2,099,663	1,147,630	3,825,447	7,072,740	2,154,916	24,446,161	26,601,077
2013	3,133,294	2,803,798	5,937,092	1,926,260	1,041,992	3,460,749	6,429,001	2,154,916	24,446,161	26,601,077
2014	3,133,294	2,803,798	5,937,092	1,856,328	976,758	3,295,593	6,128,679	2,148,222	24,424,502	26,572,724
2015	3,133,294	2,803,798	5,937,092	1,781,030	887,771	2,926,375	5,595,176	2,141,164	24,410,144	26,551,308
2016	3,112,728	2,803,798	5,916,526	1,742,211	856,916	2,752,531	5,351,658	2,128,400	24,384,832	26,513,232
2017	3,086,015	2,803,798	5,889,813	1,667,974	826,744	2,638,218	5,132,936	2,098,465	24,327,936	26,426,401
2018	2,995,233	2,803,798	5,799,031	1,548,440	785,812	2,515,930	4,850,182	2,050,789	24,238,191	26,288,980
2019	2,945,498	2,803,798	5,749,296	1,442,997	750,372	2,414,207	4,607,576	2,032,911	24,203,813	26,236,724
2020	2,941,177	2,803,798	5,744,975	1,407,235	735,440	2,375,261	4,517,936	2,028,992	24,195,433	26,224,425
2021	2,938,646	2,803,798	5,742,444	1,400,048	732,324	2,368,358	4,500,730	2,026,554	24,189,872	26,216,426
2022	2,937,086	2,803,798	5,740,884	1,398,683	731,396	2,364,077	4,494,156	2,025,096	24,185,762	26,210,858
2023	2,935,944	2,770,280	5,706,224	1,397,277	730,747	2,360,839	4,488,863	2,024,114	24,183,205	26,207,319
2024	2,932,664	2,768,646	5,701,310	1,396,224	730,129	2,358,834	4,485,187	2,022,942	24,180,345	26,203,287
2025	2,923,052	2,765,070	5,688,122	1,393,891	728,886	2,355,111	4,477,888	2,021,668	24,177,220	26,198,888
2026	2,917,710	2,760,318	5,678,028	1,392,419	728,082	2,353,003	4,473,504	2,020,917	24,174,093	26,195,010
2027	2,914,339	2,755,885	5,670,224	1,389,439	726,317	2,347,423	4,463,179	2,019,205	24,167,451	26,186,656
2028	2,910,601	2,751,627	5,662,228	1,385,439	724,020	2,340,632	4,450,091	2,013,689	24,153,973	26,167,662
2029	2,906,565	2,747,261	5,653,826	1,379,455	720,659	2,331,727	4,431,841	2,012,599	24,148,687	26,161,286
2030	2,895,412	2,731,803	5,627,215	1,375,300	718,473	2,326,093	4,419,866	2,011,431	24,142,289	26,153,720
2031	2,880,000	2,710,744	5,590,744	1,363,861	712,141	2,310,584	4,386,586	2,006,174	24,118,721	26,124,895
2032	2,866,708	2,689,805	5,556,513	1,366,387	713,661	2,313,925	4,393,973	2,006,959	24,125,607	26,132,566
2033	2,834,658	2,642,370	5,477,028	1,365,189	713,238	2,312,548	4,390,975	2,006,750	24,128,605	26,135,355
2034	2,761,585	2,565,777	5,327,362	1,352,945	706,542	2,295,275	4,354,762	2,005,111	24,122,990	26,128,101
2035	2,613,488	2,419,522	5,033,010	1,339,187	699,364	2,277,357	4,315,908	2,003,306	24,117,505	26,120,811
TOTAL	130,995,881	133,057,851	264,053,732	78,962,360	44,423,739	149,689,382	273,075,481	86,503,151	966,780,519	1,053,283,670

a) Unadjusted for prior overpayments or underpayments of charges.
b) Determined at the current Project Interest Rate of 4.608 percent per annum.
c) Reflects the transfers of permanent aqueduct capacity among contractors.

TABLE B-15. Capital Cost Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA									
				Kern County Water Agency						
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Municipal and Industrial	Municipal and Industrial [a]	Agri-cultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	2.724	0	0	0	0	0	0	2.724
1965	0	0	6.027	64.262	9.281	0	0	0	0	79.570
1966	0	0	12.035	120.217	17.068	0	0	0	0	149.320
1967	0	0	26.249	233.186	34.339	0	0	0	0	293.774
1968	77.385	1.747	48.934	335.663	48.951	423.377	9.404	4.715	65.265	1.015.441
1969	77.520	5.241	57.399	391.879	52.519	869.466	10.154	5.125	246.939	1.716.243
1970	84.961	5.241	59.206	423.268	53.905	1.057.532	10.442	5.330	182.739	1.882.625
1971	96.866	5.241	60.310	444.380	54.695	1.404.594	10.608	5.740	194.461	2.276.896
1972	108.230	5.241	60.925	454.082	55.057	2.103.256	10.690	11.000	599.896	3.408.378
1973	119.053	5.241	61.351	458.302	55.231	2.425.783	10.733	6.355	232.030	3.374.079
1974	180.691	5.241	61.870	460.337	55.331	2.716.516	10.766	7.116	385.132	3.883.000
1975	219.464	5.241	62.432	462.650	55.472	3.253.641	10.808	7.331	459.555	4.536.594
1976	167.329	5.241	62.700	464.506	55.661	3.507.395	10.849	8.280	328.756	4.610.718
1977	164.510	5.241	63.342	467.209	55.947	3.843.095	10.911	7.585	314.333	4.932.173
1978	175.874	0	65.775	469.066	56.138	4.271.925	11.016	7.995	337.242	5.395.031
1979	208.581	5.241	66.090	471.827	56.473	4.690.758	11.082	8.200	379.551	5.897.803
1980	221.872	5.241	66.378	474.569	56.810	5.118.678	11.153	11.685	381.996	6.348.383
1981	221.872	5.241	67.964	490.958	58.751	5.602.017	11.561	8.815	404.903	6.872.083
1982	221.872	5.241	67.975	488.679	58.689	6.048.107	11.548	9.225	427.281	7.338.617
1983	232.154	5.241	68.311	492.919	59.358	6.555.977	11.681	7.728	50.869	7.484.239
1984	244.059	5.241	68.928	498.543	60.064	6.877.598	11.830	9.840	333.572	8.109.675
1985	255.424	5.241	69.656	506.425	61.223	7.323.689	12.065	10.045	242.672	8.486.440
1986	266.788	5.241	69.944	508.820	61.568	7.452.205	12.137	10.455	517.853	8.905.011
1987	278.152	5.241	70.449	512.489	62.096	8.216.777	12.247	10.660	540.229	9.708.340
1988	289.516	5.241	70.809	515.348	62.506	8.637.427	12.330	11.070	562.606	10.166.853
1989	300.880	5.241	71.694	519.003	63.130	8.940.876	12.497	11.480	585.513	10.510.314
1990	156.122	5.241	73.130	537.356	65.369	9.256.140	12.932	11.685	631.333	10.749.308
1991	289.034	5.241	75.772	566.393	69.944	9.256.140	13.757	11.685	631.333	10.919.300
1992	312.244	5.241	78.965	597.071	74.793	9.256.140	14.752	11.685	631.333	10.982.224
1993	312.244	5.241	80.456	609.930	76.633	9.256.140	15.120	11.685	631.333	10.998.782
1994	312.244	5.241	82.079	619.299	77.912	9.256.140	15.392	11.685	631.333	11.011.325
1995	312.244	5.241	83.371	626.034	78.865	9.256.140	15.603	11.685	631.333	11.020.517
1996	288.814	5.241	87.340	635.184	80.196	8.938.429	15.956	11.685	631.333	10.694.178
1997	288.814	5.241	90.203	638.976	80.681	8.872.915	16.128	11.685	631.333	10.635.976
1998	288.819	5.241	92.912	652.398	82.706	8.613.754	16.583	11.685	631.333	10.395.431
1999	288.819	5.241	94.205	659.278	83.750	8.613.754	16.818	11.685	631.333	10.404.882
2000	288.819	5.241	95.728	667.504	84.996	7.970.205	17.093	11.685	631.333	9.772.604
2001	288.819	5.241	96.292	670.125	85.341	7.841.428	17.169	11.685	631.333	9.647.434
2002	310.715	5.241	96.745	672.199	85.632	7.841.428	17.233	11.685	592.910	9.633.789
2003	310.715	5.241	97.683	680.005	86.810	7.841.428	17.473	11.685	590.704	9.641.744
2004	310.715	5.241	97.345	675.412	86.023	7.829.467	44.666	11.685	508.926	9.569.479
2005	310.715	5.241	97.488	676.336	86.135	7.829.467	44.691	11.685	508.926	9.570.684
2006	310.715	5.241	97.811	679.136	86.543	7.829.467	46.442	11.685	507.258	9.574.299
2007	334.140	5.241	98.732	684.673	87.309	8.202.741	46.609	11.685	507.258	9.978.388
2008	334.140	5.241	100.280	695.782	88.944	8.202.740	46.956	11.685	507.258	9.993.026
2009	334.140	5.241	101.653	704.607	90.200	8.202.740	47.225	11.685	507.258	10.004.749
2010	334.140	5.241	102.138	706.259	90.423	8.202.740	47.280	11.685	507.258	10.007.164
2011	334.140	5.241	102.634	707.947	90.652	8.202.740	47.335	11.685	507.258	10.009.632
2012	334.140	5.241	103.141	709.672	90.886	8.202.740	47.393	11.685	507.258	10.012.156
2013	334.140	5.241	103.141	709.672	90.886	8.202.740	47.393	11.685	507.258	10.012.156
2014	334.140	5.241	100.417	709.672	90.886	8.202.740	47.393	11.685	507.258	10.009.432
2015	334.140	5.241	97.113	645.410	81.605	8.202.740	47.393	11.685	507.258	9.932.585
2016	334.140	5.241	91.105	589.455	73.818	8.202.740	47.393	11.685	507.258	9.862.835
2017	334.140	5.241	76.892	476.486	56.547	8.202.740	47.393	11.685	507.258	9.718.382
2018	334.140	5.241	54.206	374.009	41.935	8.202.740	37.989	11.685	507.258	9.569.203
2019	334.140	5.241	45.741	317.793	38.367	8.202.740	37.238	11.685	507.258	9.500.203
2020	334.140	5.241	43.935	286.404	36.981	8.202.740	36.951	11.685	507.258	9.465.335
2021	334.140	5.241	42.831	265.292	36.191	8.202.740	36.785	11.685	507.258	9.442.163
2022	334.140	5.241	42.215	255.590	35.829	8.202.740	36.703	11.685	507.258	9.431.401
2023	334.140	5.241	41.790	251.370	35.655	8.202.740	36.660	11.685	507.258	9.426.539
2024	334.140	5.241	41.270	249.335	35.555	8.202.740	36.627	11.685	507.258	9.423.851
2025	334.140	5.241	40.708	247.022	35.414	8.202.740	36.584	11.685	507.258	9.420.792
2026	334.140	5.241	40.441	245.166	35.225	8.202.740	36.544	11.685	507.258	9.418.440
2027	334.140	5.241	39.799	242.463	34.939	8.202.740	36.482	11.685	507.258	9.414.747
2028	334.140	5.241	37.366	240.606	34.748	8.202.740	36.377	11.685	507.258	9.410.161
2029	334.140	5.241	37.051	237.845	34.413	8.202.740	36.310	11.685	507.258	9.406.683
2030	334.140	5.241	36.763	235.103	34.076	8.202.740	36.240	11.685	507.258	9.403.246
2031	334.140	5.241	35.176	218.714	32.135	8.202.740	35.832	11.685	507.258	9.382.921
2032	334.140	5.241	35.166	220.994	32.197	8.202.740	35.845	11.685	507.258	9.385.266
2033	334.140	5.241	34.830	216.753	31.528	8.202.740	35.711	11.685	507.258	9.379.886
2034	334.140	5.241	34.213	211.129	30.822	8.202.740	35.563	11.685	507.258	9.372.791
2035	334.140	5.241	33.484	203.248	29.663	8.202.740	35.328	11.685	507.258	9.362.787
TOTAL	18,883,724	347.662	4,781,233	33,449,696	4,250,421	484,778,732	1,779,852	723.283	32,768,595	581,763,198

d) Charges under Amendment No. 18 of the water supply contract with Kern County Water Agency.

TABLE B-15. Capital Cost Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	33,309	0	0	0	0	0	0	0	51,711	0
1964	62,847	27,438	16,286	4,369	37,145	1,142	28,427	8,202	82,782	34,973
1965	118,565	52,989	28,459	7,191	40,756	2,081	50,300	15,217	135,023	35,333
1966	215,713	101,232	51,184	12,474	73,129	3,752	90,369	27,670	232,426	61,445
1967	417,348	210,746	98,904	23,464	141,365	7,282	175,119	54,006	433,210	115,536
1968	679,132	419,579	164,991	38,538	231,834	11,777	286,701	87,265	729,615	194,465
1969	986,308	623,243	249,378	57,283	345,252	17,243	426,589	127,179	1,136,053	302,553
1970	1,288,041	780,054	352,336	84,769	487,182	23,419	592,598	171,243	1,690,923	443,566
1971	1,548,953	946,985	471,194	120,171	659,386	28,835	790,147	208,755	2,394,267	619,582
1972	1,682,697	1,056,391	533,559	137,410	749,360	31,296	897,191	226,425	2,824,733	720,754
1973	1,733,186	1,070,858	553,392	142,098	777,217	32,271	931,585	233,266	2,962,112	756,290
1974	1,751,576	1,117,449	562,610	146,284	790,534	32,592	944,027	235,613	3,051,750	776,837
1975	1,774,997	1,131,822	577,197	150,058	812,296	33,006	971,021	238,624	3,134,098	798,523
1976	1,788,124	1,144,406	587,768	152,747	828,555	33,258	991,263	240,355	3,212,183	819,292
1977	1,800,420	1,157,448	595,329	154,643	840,037	33,475	1,005,782	241,933	3,261,176	832,321
1978	1,810,750	1,176,420	600,379	155,959	847,711	33,666	1,015,604	243,300	3,291,289	840,240
1979	1,826,394	1,200,415	604,990	157,091	854,308	33,932	1,024,100	245,268	3,313,131	845,930
1980	1,844,919	1,248,282	609,777	158,201	861,177	34,236	1,033,076	247,529	3,333,678	851,450
1981	1,941,660	1,338,837	636,015	163,962	896,759	35,887	1,077,612	259,794	3,437,581	879,355
1982	1,933,412	1,369,996	632,062	163,511	892,804	35,756	1,072,876	258,797	3,430,256	877,137
1983	2,014,262	1,413,950	648,871	167,528	917,891	37,092	1,104,681	268,810	3,502,625	896,905
1984	2,121,326	1,440,538	670,884	173,418	951,144	38,859	1,142,162	282,045	3,610,884	926,520
1985	2,200,039	1,455,659	686,764	177,751	976,129	40,247	1,173,518	291,645	3,689,629	948,078
1986	2,246,544	1,463,805	698,218	180,934	994,360	40,914	1,205,255	297,120	3,746,498	963,621
1987	2,290,309	1,469,235	709,928	183,911	1,013,034	41,377	1,220,251	301,897	3,800,178	978,277
1988	2,307,717	1,474,730	718,732	186,176	1,027,137	41,664	1,238,246	303,993	3,840,527	989,254
1989	2,321,324	1,483,792	722,401	187,353	1,032,760	41,839	1,245,234	305,378	3,862,773	995,140
1990	2,376,618	1,506,478	741,616	192,411	1,060,538	42,713	1,279,437	311,911	3,934,480	1,014,532
1991	2,412,406	1,526,119	759,874	197,542	1,089,317	43,098	1,314,716	315,436	4,013,699	1,036,030
1992	2,456,548	1,547,359	779,790	203,932	1,121,316	43,730	1,353,471	320,331	4,118,290	1,064,576
1993	2,490,605	1,566,360	794,895	210,923	1,145,092	44,239	1,380,175	324,417	4,229,726	1,095,098
1994	2,525,075	1,584,177	807,651	220,102	1,164,765	44,786	1,399,138	328,384	4,436,172	1,151,256
1995	2,550,681	1,593,135	815,344	225,178	1,176,594	45,178	1,410,957	331,262	4,563,157	1,185,751
1996	2,576,074	1,609,138	823,318	229,455	1,188,534	45,584	1,423,636	334,239	4,670,098	1,214,705
1997	2,592,836	1,620,522	830,201	231,931	1,198,571	45,853	1,435,302	336,210	4,890,575	1,268,272
1998	2,617,453	1,634,405	836,569	233,300	1,208,050	46,264	1,960,073	339,238	5,047,337	1,290,351
1999	2,630,574	1,645,712	840,426	235,602	1,213,780	46,486	1,966,884	340,876	5,246,597	1,307,340
2000	2,646,159	2,799,550	845,840	237,785	1,222,113	46,763	1,977,372	404,656	5,556,215	1,320,327
2001	2,654,237	2,805,476	849,253	239,158	1,227,301	46,915	1,983,935	405,856	6,339,304	1,330,150
2002	2,678,268	2,808,670	852,342	240,066	1,232,158	47,087	1,990,197	407,112	7,459,404	1,335,726
2003	2,688,045	2,816,210	854,621	240,737	1,235,484	47,229	1,994,810	408,286	8,024,736	1,343,149
2004	2,685,105	2,815,909	909,067	240,863	1,235,743	47,176	1,995,319	407,946	8,248,366	1,344,732
2005	2,688,639	2,819,157	6,519,065	241,177	1,995,193	47,238	1,998,034	408,466	8,372,090	1,346,917
2006	2,698,852	2,826,122	6,566,877	241,800	2,004,596	47,408	2,002,065	409,781	8,428,648	1,350,049
2007	2,719,463	2,849,642	6,678,936	244,607	2,030,065	47,758	2,017,179	412,786	8,550,637	1,363,507
2008	2,749,645	2,889,891	7,027,291	249,218	2,098,144	48,270	2,047,499	417,084	8,636,154	1,385,963
2009	2,778,172	2,936,665	7,734,783	252,314	2,211,133	48,754	2,074,440	421,192	8,695,131	1,402,009
2010	2,782,819	2,955,702	7,745,767	252,745	2,214,798	48,840	2,077,815	421,880	8,704,955	1,404,631
2011	2,787,566	2,961,387	7,756,984	253,185	2,218,540	48,927	2,081,262	422,584	8,714,986	1,407,308
2012	2,792,420	2,966,216	7,768,455	253,635	2,222,367	49,016	2,084,787	423,302	8,725,244	1,410,047
2013	2,759,111	2,966,216	7,706,625	253,635	2,200,654	49,016	2,084,787	423,302	8,673,534	1,396,950
2014	2,729,574	2,932,085	7,641,305	249,266	2,184,224	47,874	2,051,899	414,404	8,642,462	1,388,772
2015	2,673,855	2,901,274	7,583,859	246,444	2,160,520	46,935	2,026,381	406,811	8,590,221	1,374,714
2016	2,576,708	2,844,157	7,479,874	241,161	2,117,172	45,264	1,978,918	393,223	8,492,818	1,348,602
2017	2,375,073	2,710,302	7,255,521	230,171	2,025,076	41,734	1,879,436	364,792	8,292,034	1,294,510
2018	2,113,287	2,422,579	6,938,079	215,097	1,900,656	37,238	1,741,905	327,582	7,995,629	1,215,581
2019	1,806,113	2,126,632	6,509,468	196,352	1,740,742	31,773	1,564,632	281,489	7,589,192	1,107,494
2020	1,504,380	1,895,996	5,989,464	168,866	1,542,480	25,597	1,357,585	230,574	7,034,322	966,480
2021	1,243,467	1,648,994	5,342,622	133,464	1,298,959	20,180	1,125,176	187,197	6,330,978	790,465
2022	1,109,723	1,489,510	4,448,578	116,225	1,096,646	17,719	999,846	166,354	5,900,511	689,293
2023	1,059,234	1,481,787	3,750,167	111,537	977,130	16,745	958,630	158,320	5,763,132	653,757
2024	1,040,844	1,422,932	3,635,628	107,351	949,586	16,424	943,720	155,510	5,673,495	633,209
2025	1,017,422	1,405,074	3,522,836	103,577	914,558	16,010	913,930	151,935	5,591,147	611,523
2026	1,004,296	1,386,832	3,420,242	100,888	885,870	15,757	892,231	149,916	5,513,062	590,755
2027	992,000	1,368,326	3,344,957	98,992	865,239	15,541	876,645	148,105	5,464,068	577,726
2028	981,670	1,340,500	3,308,442	97,676	853,317	15,350	866,351	146,589	5,433,955	569,807
2029	966,026	1,302,198	3,277,187	96,544	843,120	15,084	856,834	144,377	5,412,114	564,116
2030	947,501	1,225,009	3,251,693	95,434	833,453	14,780	846,818	141,863	5,391,567	558,597
2031	850,761	1,082,000	3,121,249	89,673	783,797	13,128	791,447	127,705	5,287,663	530,692
2032	859,008	1,030,512	3,131,338	90,124	788,580	13,260	800,469	129,338	5,294,989	532,909
2033	778,157	957,984	3,052,617	86,107	755,131	11,924	765,333	118,675	5,222,619	513,142
2034	671,094	915,761	2,943,321	80,217	710,087	10,157	719,890	104,691	5,114,360	483,526
2035	592,381	894,047	2,860,693	75,884	676,086	8,769	687,252	94,796	5,035,615	461,969
TOTAL	133,969,812	119,211,005	192,436,341	11,939,645	81,896,536	2,362,469	90,712,349	19,042,107	365,536,588	65,730,392

TABLE B-15. Capital Cost Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	690,539	0	775,559	0	0	0	0	0	1,399,620
1964	21,728	1,260,042	9,375	1,594,755	0	0	0	0	0	2,542,689
1965	21,859	2,179,810	17,761	2,705,344	0	0	405	405	0	4,278,292
1966	37,952	3,898,819	33,415	4,839,578	0	0	564	564	0	6,779,273
1967	71,260	7,691,085	68,133	9,507,458	0	0	562	562	0	11,917,277
1968	120,056	14,340,331	133,256	17,437,540	0	0	564	564	0	21,066,091
1969	187,000	21,850,137	202,534	26,510,751	0	0	3,190	3,190	0	31,178,029
1970	274,923	28,982,865	257,777	35,429,696	0	0	15,116	15,116	0	40,379,563
1971	384,903	37,229,879	316,207	45,719,265	0	0	15,942	15,942	0	51,091,274
1972	447,913	44,047,132	353,823	53,708,683	0	0	17,327	17,327	0	60,227,008
1973	470,035	46,283,635	357,228	56,303,173	0	0	17,327	17,327	0	62,828,313
1974	483,106	48,306,053	371,994	58,570,424	0	0	17,329	17,329	0	65,616,575
1975	496,565	49,268,119	376,391	59,762,717	0	0	17,331	17,331	0	67,485,918
1976	509,488	50,120,026	380,667	60,808,133	0	0	17,332	17,332	0	68,622,789
1977	517,576	50,809,655	384,975	61,634,771	0	0	17,335	17,335	0	69,796,447
1978	522,490	51,408,868	390,618	62,337,293	0	0	17,336	17,336	0	71,000,828
1979	526,011	52,212,368	399,522	63,243,460	0	0	17,338	17,338	0	72,441,394
1980	529,414	53,618,983	417,004	64,787,725	0	0	17,339	17,339	0	74,479,550
1981	546,614	56,648,010	449,669	68,311,754	0	0	17,341	17,341	0	78,621,204
1982	545,272	57,445,385	461,087	69,118,350	0	0	17,342	17,342	0	79,910,771
1983	557,430	59,017,274	477,181	71,024,500	0	0	17,343	17,343	0	82,035,076
1984	575,647	60,292,946	486,708	72,713,081	0	0	17,344	17,344	0	84,528,260
1985	588,902	61,123,708	491,961	73,844,031	0	0	17,345	17,345	0	86,350,503
1986	598,458	61,644,854	494,820	74,575,401	0	0	17,347	17,347	0	88,202,697
1987	607,471	62,073,067	496,600	75,185,534	0	0	17,348	17,348	0	91,050,177
1988	614,224	62,431,147	498,461	75,672,007	0	0	17,350	17,350	0	93,144,185
1989	617,863	62,774,359	501,420	76,091,636	0	0	17,353	17,353	0	94,367,142
1990	629,735	63,740,269	509,405	77,340,143	0	0	17,355	17,355	0	96,097,445
1991	642,915	64,654,870	515,984	78,522,006	0	0	17,358	17,358	0	97,670,947
1992	660,417	65,753,514	522,988	79,946,261	0	0	17,361	17,361	0	99,400,146
1993	679,128	66,881,843	529,216	81,371,717	0	0	17,363	17,363	0	101,101,234
1994	713,838	68,462,914	534,886	83,373,145	0	0	17,365	17,365	0	103,870,679
1995	735,201	69,349,548	537,642	84,519,627	0	0	17,366	17,366	0	107,795,145
1996	753,283	70,226,791	541,582	85,636,436	0	0	17,366	17,366	0	117,756,635
1997	813,864	71,506,285	544,296	87,314,718	0	0	17,366	17,366	0	128,020,700
1998	924,386	72,258,544	548,317	88,944,285	0	0	17,366	17,366	0	131,738,189
1999	1,112,635	72,889,545	551,983	90,028,440	0	0	17,366	17,366	0	133,483,962
2000	1,461,010	73,400,470	555,112	92,473,372	0	0	17,367	17,367	0	136,078,258
2001	2,437,980	73,709,810	556,488	94,585,863	0	0	17,367	17,367	0	139,053,526
2002	3,871,429	73,880,967	557,223	97,360,648	0	0	17,367	17,367	0	141,994,884
2003	4,575,059	74,190,253	559,250	98,977,868	0	0	17,367	17,367	0	144,156,226
2004	4,854,707	74,420,558	558,950	99,764,440	0	0	17,367	17,367	0	145,380,154
2005	4,999,448	68,308,736	559,705	100,303,866	0	0	17,367	17,367	0	146,566,415
2006	5,050,938	68,640,735	561,781	100,829,652	0	0	17,367	17,367	0	147,574,592
2007	5,144,935	69,389,059	567,117	102,015,691	0	0	17,367	17,367	0	149,541,107
2008	5,158,843	71,435,700	576,875	104,720,577	0	0	17,367	17,367	0	153,286,469
2009	5,168,725	74,090,116	588,571	108,402,005	0	0	17,367	17,367	0	157,883,419
2010	5,170,349	74,447,933	592,832	108,821,066	0	0	17,367	17,367	0	158,354,354
2011	5,172,007	74,588,576	594,093	109,007,405	0	0	17,367	17,367	0	158,593,665
2012	5,173,702	74,716,314	595,162	109,180,667	0	0	17,367	17,367	0	158,821,099
2013	5,165,553	74,095,931	595,162	108,370,476	0	0	17,367	17,367	0	157,367,169
2014	5,160,499	73,582,068	585,787	107,610,219	0	0	17,367	17,367	0	156,275,513
2015	5,151,843	72,713,673	577,401	106,453,931	0	0	16,962	16,962	0	154,487,054
2016	5,135,750	71,086,870	561,747	104,302,264	0	0	16,802	16,802	0	151,963,317
2017	5,102,443	67,495,033	527,028	99,593,153	0	0	16,805	16,805	0	146,777,490
2018	5,053,646	61,131,002	461,906	91,554,187	0	0	16,802	16,802	0	138,078,385
2019	4,986,703	54,011,793	392,628	82,345,011	0	0	14,177	14,177	0	128,452,987
2020	4,898,780	47,352,292	337,385	73,304,201	0	0	2,251	2,251	0	119,259,123
2021	4,788,799	39,686,903	278,955	62,876,159	0	0	1,425	1,425	0	108,779,347
2022	4,725,790	33,513,981	241,339	54,515,515	0	0	40	40	0	100,392,854
2023	4,703,667	32,040,758	237,934	51,912,798	0	0	39	39	0	97,741,782
2024	4,690,597	30,137,849	223,168	49,630,313	0	0	38	38	0	95,443,986
2025	4,677,138	29,287,218	218,771	48,431,139	0	0	36	36	0	94,216,865
2026	4,664,214	28,539,731	214,495	47,378,289	0	0	34	34	0	93,143,305
2027	4,656,126	27,926,950	210,187	46,544,862	0	0	32	32	0	92,279,700
2028	4,651,212	27,363,438	204,544	45,832,851	0	0	30	30	0	91,523,023
2029	4,647,691	26,590,172	195,640	44,911,103	0	0	29	29	0	90,564,768
2030	4,644,288	25,207,056	178,158	43,336,217	0	0	27	27	0	88,940,291
2031	4,627,089	22,296,272	145,493	39,746,969	0	0	26	26	0	85,232,141
2032	4,628,431	21,491,934	134,075	38,924,967	0	0	24	24	0	84,393,309
2033	4,616,273	19,990,297	117,981	36,986,240	0	0	24	24	0	82,369,508
2034	4,598,055	18,813,667	108,453	35,273,279	0	0	23	23	0	80,456,318
2035	4,584,801	18,058,646	103,201	34,134,140	0	0	21	21	0	78,966,677
TOTAL	187,338,078	3,661,005,978	28,439,483	4,959,620,785	0	0	868,230	868,230	0	7,132,665,096

TABLE B-16A. Minimum OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	9.699	8.868	21.132	39.699	0	0	0
1963	0	0	0	38.048	34.788	82.896	155.732	0	0	0
1964	0	0	0	41.148	38.323	91.320	170.791	0	0	0
1965	0	0	0	78.529	75.616	195.793	349.938	0	0	0
1966	0	0	0	79.753	78.779	218.543	377.075	0	0	0
1967	0	0	0	127.896	123.667	335.224	586.787	0	0	0
1968	130	0	130	126.058	120.563	333.506	580.127	11.800	21.770	33.570
1969	80.875	0	80.875	145.411	138.050	372.585	656.046	63.113	116.435	179.548
1970	94.872	0	94.872	128.993	120.245	320.664	569.902	74.187	136.867	211.054
1971	45.579	0	45.579	113.071	108.346	296.004	517.421	74.011	136.541	210.552
1972	37.895	0	37.895	122.407	117.483	334.366	574.256	79.196	146.107	225.303
1973	32.993	0	32.993	122.738	116.785	325.726	565.249	75.714	139.683	215.397
1974	46.498	0	46.498	154.435	146.929	403.080	704.444	76.530	141.189	217.719
1975	37.707	0	37.707	189.175	182.087	513.823	885.085	92.605	170.845	263.450
1976	60.786	0	60.786	203.064	193.435	524.813	921.312	94.935	175.144	270.079
1977	78.400	0	78.400	179.869	169.065	500.101	849.035	102.945	189.922	292.867
1978	56.318	0	56.318	239.301	228.855	647.828	1.115.984	104.060	191.978	296.038
1979	73.852	0	73.852	236.986	232.105	666.742	1.135.833	100.748	185.868	286.616
1980	81.769	0	81.769	389.575	372.185	1.010.830	1.772.590	126.328	233.105	359.433
1981	101.340	0	101.340	317.408	302.272	834.257	1.453.937	140.208	258.712	398.920
1982	191.987	0	191.987	386.742	369.633	1.098.844	1.855.219	142.045	262.101	404.146
1983	80.215	0	80.215	438.536	428.973	1.269.373	2.136.882	171.001	315.523	486.524
1984	106.485	0	106.485	591.243	565.721	1.817.629	2.974.593	201.768	372.284	574.052
1985	215.341	0	215.341	674.975	655.490	1.840.211	3.170.676	242.935	448.233	691.168
1986	203.704	0	203.704	613.273	583.077	1.784.056	2.980.406	233.000	429.904	662.904
1987	295.505	0	295.505	687.629	652.468	2.000.817	3.340.914	230.484	463.838	694.322
1988	312.677	(58)	312.619	676.847	655.274	1.910.092	3.242.213	258.807	561.030	819.837
1989	403.330	688.185	1.091.515	716.831	712.354	1.897.149	3.326.334	244.772	668.476	913.248
1990	658.942	674.944	1.333.886	782.589	780.305	2.129.966	3.692.860	310.222	677.025	987.247
1991	726.717	860.903	1.587.620	543.178	524.741	1.520.569	2.588.488	302.369	673.858	976.227
1992	483.580	712.313	1.195.893	796.058	855.050	2.253.496	3.904.604	346.220	736.477	1.082.697
1993	524.000	708.129	1.232.129	1.280.736	1.261.431	3.338.742	5.880.909	386.060	734.138	1.120.198
1994	573.815	658.277	1.232.092	1.368.651	1.312.740	3.560.294	6.241.685	481.022	888.288	1.369.310
1995	539.407	660.770	1.200.177	1.232.272	1.187.201	3.216.470	5.635.943	477.929	881.323	1.359.252
1996	604.992	1.011.298	1.616.290	1.185.220	1.124.968	3.007.330	5.317.518	649.161	1.197.179	1.846.340
1997	563.579	741.881	1.305.460	1.029.670	968.999	2.667.649	4.666.318	406.652	749.805	1.156.457
1998	461.929	661.478	1.123.407	1.064.804	1.174.966	3.502.898	5.742.668	810.178	2.963.766	3.773.944
1999	605.754	993.840	1.599.594	1.221.279	1.262.915	5.074.641	7.558.835	793.094	3.042.686	3.835.780
2000	776.091	1.492.976	2.269.067	2.174.362	1.295.738	3.755.201	7.225.301	714.603	3.446.638	4.161.241
2001	650.709	1.442.691	2.093.400	2.031.962	1.037.198	3.542.165	6.611.325	732.910	3.127.544	3.860.454
2002	1.097.797	1.872.282	2.970.079	2.451.182	1.358.411	6.061.824	9.871.417	770.413	3.588.248	4.358.661
2003	1.168.105	2.246.243	3.414.348	2.255.838	1.056.691	3.546.786	6.859.315	816.900	3.745.271	4.562.171
2004	1.618.445	2.345.386	3.963.831	2.583.387	1.278.759	3.533.253	7.395.399	821.144	3.751.765	4.572.909
2005	917.325	1.801.406	2.718.731	2.396.749	1.132.232	2.953.491	6.482.472	878.460	4.206.062	5.084.522
2006	1.256.135	2.187.625	3.443.760	2.510.725	1.184.819	3.442.338	7.137.882	871.307	4.057.667	4.928.974
2007	1.311.373	2.281.548	3.592.921	2.725.851	1.275.964	3.714.055	7.715.870	903.832	4.197.826	5.101.658
2008	1.344.867	2.339.566	3.684.433	2.821.795	1.319.240	3.858.521	7.999.556	922.744	4.353.138	5.275.882
2009	820.615	1.344.204	2.164.819	2.683.059	1.302.918	3.631.480	7.617.457	743.922	2.761.942	3.505.864
2010	820.489	1.343.879	2.164.368	2.682.874	1.302.916	3.631.526	7.617.316	743.836	2.761.491	3.505.327
2011	823.419	1.348.980	2.172.399	2.693.598	1.307.630	3.644.624	7.645.852	746.443	2.770.518	3.516.961
2012	823.611	1.349.332	2.172.943	2.694.148	1.307.873	3.645.284	7.647.305	746.605	2.771.171	3.517.776
2013	824.121	1.350.394	2.174.515	2.695.297	1.308.255	3.646.248	7.649.800	746.995	2.772.915	3.519.910
2014	824.368	1.351.165	2.175.533	2.695.377	1.308.014	3.645.404	7.648.795	747.127	2.773.829	3.520.956
2015	824.986	1.352.171	2.177.157	2.697.367	1.308.998	3.648.161	7.654.526	747.676	2.775.886	3.523.562
2016	823.950	1.350.379	2.174.329	2.694.239	1.307.533	3.644.106	7.645.878	746.781	2.772.407	3.519.188
2017	824.366	1.351.122	2.175.488	2.695.452	1.308.083	3.645.618	7.649.153	747.135	2.773.809	3.520.944
2018	824.963	1.352.369	2.177.332	2.696.804	1.308.534	3.646.751	7.652.089	747.594	2.775.856	3.523.450
2019	823.881	1.350.429	2.174.310	2.693.686	1.307.133	3.642.912	7.643.731	746.679	2.772.212	3.518.891
2020	824.615	1.351.567	2.176.182	2.696.150	1.308.392	3.646.465	7.651.007	747.342	2.774.640	3.521.982
2021	825.016	1.352.105	2.177.121	2.697.660	1.309.226	3.648.850	7.655.736	747.724	2.775.945	3.523.669
2022	824.782	1.352.045	2.176.827	2.696.283	1.308.301	3.646.113	7.650.697	747.441	2.775.246	3.522.687
2023	824.015	1.350.460	2.174.475	2.694.481	1.307.669	3.644.495	7.646.645	746.841	2.772.609	3.519.450
2024	824.321	1.351.124	2.175.445	2.695.140	1.307.867	3.644.975	7.647.982	747.074	2.773.670	3.520.744
2025	825.181	1.352.492	2.177.673	2.697.955	1.309.280	3.648.948	7.656.183	747.842	2.776.524	3.524.366
2026	823.643	1.350.034	2.173.677	2.692.935	1.306.768	3.641.891	7.641.594	746.469	2.771.418	3.517.887
2027	826.304	1.354.301	2.180.605	2.701.588	1.311.086	3.654.012	7.666.686	748.840	2.780.253	3.529.093
2028	823.561	1.349.965	2.173.526	2.692.540	1.306.523	3.641.176	7.640.239	746.380	2.771.157	3.517.537
2029	824.666	1.351.596	2.176.262	2.696.423	1.308.569	3.646.983	7.651.975	747.401	2.774.801	3.522.202
2030	823.880	1.350.220	2.174.100	2.694.090	1.307.492	3.644.009	7.645.591	746.728	2.772.160	3.518.888
2031	826.545	1.354.907	2.181.452	2.701.934	1.311.090	3.653.925	7.666.949	748.999	2.781.099	3.530.098
2032	823.095	1.349.222	2.172.317	2.691.025	1.305.765	3.639.048	7.635.838	745.966	2.769.615	3.515.581
2033	824.776	1.351.653	2.176.429	2.697.012	1.308.953	3.648.114	7.654.079	747.527	2.775.131	3.522.658
2034	824.912	1.352.084	2.176.996	2.697.047	1.308.811	3.647.621	7.653.479	747.599	2.775.641	3.523.240
2035	823.211	1.349.399	2.172.610	2.691.421	1.305.970	3.639.625	7.637.016	746.071	2.769.998	3.516.069
TOTAL	40,773,112	62,849,281	103,622,393	113,041,533	64,233,453	184,735,457	362,010,443	35,503,449	127,656,202	163,159,651

TABLE B-16A. Minimum OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA								
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Kern County Water Agency		County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
				Municipal and Industrial	Agricultural				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	37,806	1,963	5,639	60,701	678,086	2,008	2,073	77,591	865,867
1969	45,479	2,235	30,158	80,554	1,197,126	2,286	2,085	90,773	1,450,696
1970	46,969	2,292	35,450	96,673	1,381,493	2,344	2,158	93,408	1,660,787
1971	47,997	2,314	35,366	106,654	1,643,163	2,366	2,288	94,874	1,935,022
1972	49,866	2,414	37,844	122,313	1,729,169	2,469	2,254	98,777	2,045,106
1973	50,006	2,385	36,180	125,553	1,719,873	2,440	2,310	98,330	2,037,077
1974	52,818	2,556	36,570	135,661	1,823,065	2,614	2,529	104,609	2,160,422
1975	66,963	3,243	44,251	162,738	2,235,242	3,317	3,191	132,663	2,651,608
1976	66,504	3,328	45,364	159,303	2,215,999	3,404	2,919	133,940	2,630,761
1977	75,595	3,812	49,192	189,661	2,522,290	3,898	3,708	152,838	3,000,994
1978	70,688	3,503	49,725	174,897	2,427,163	3,583	3,644	141,672	2,874,875
1979	68,879	3,436	48,142	173,677	2,378,315	3,514	3,492	138,493	2,817,948
1980	95,898	4,722	59,551	235,741	3,146,570	4,830	4,777	191,582	3,743,671
1981	118,448	5,965	66,183	266,353	3,440,557	6,099	5,187	239,323	4,148,115
1982	134,083	6,711	67,061	311,879	3,848,922	6,862	6,382	270,061	4,651,961
1983	184,902	9,242	80,869	426,485	5,030,031	9,450	8,494	372,182	6,121,655
1984	194,228	9,656	95,555	471,854	5,636,134	9,874	8,719	389,892	6,815,912
1985	200,694	9,957	115,227	486,162	6,042,593	10,182	8,982	402,457	7,276,254
1986	207,028	10,302	110,479	530,803	6,372,710	10,536	10,341	415,776	7,667,975
1987	205,002	10,259	109,401	533,451	6,378,437	10,493	10,517	412,889	7,670,449
1988	203,711	10,223	122,903	516,432	6,388,497	10,455	10,341	410,868	7,673,430
1989	224,049	11,269	116,197	564,169	6,747,046	11,526	11,102	452,406	8,137,764
1990	271,051	13,666	148,238	664,040	8,111,616	13,976	13,206	547,974	9,783,767
1991	275,748	13,854	144,486	662,755	8,111,610	14,168	13,218	556,474	9,792,313
1992	317,889	16,027	162,466	764,224	9,115,453	16,393	18,209	642,672	11,053,333
1993	359,879	17,989	184,477	831,662	10,372,245	18,399	19,560	724,397	12,528,608
1994	309,099	15,487	224,254	738,622	9,789,905	15,840	16,434	622,912	11,732,553
1995	395,441	19,918	220,899	898,339	11,190,121	20,373	21,551	799,070	13,565,712
1996	392,055	19,968	301,835	902,162	12,199,788	20,424	21,664	796,711	14,654,607
1997	396,222	20,154	186,450	942,987	10,974,350	20,613	19,344	806,084	13,366,204
1998	489,209	24,563	288,941	1,098,336	12,675,458	25,125	21,596	995,325	15,618,553
1999	409,335	20,884	272,299	963,313	11,345,079	21,360	21,509	832,557	13,886,336
2000	414,557	21,089	207,531	1,020,792	10,386,585	21,569	22,694	841,923	12,936,740
2001	499,979	25,444	231,676	1,208,436	11,751,169	26,023	31,679	1,015,604	14,790,010
2002	457,889	21,551	224,731	1,079,700	10,693,217	22,041	25,564	812,862	13,337,555
2003	529,663	25,088	242,320	1,173,085	11,744,825	25,660	30,579	940,416	14,711,636
2004	486,184	23,155	246,564	1,139,332	11,300,426	63,079	25,920	748,385	14,033,045
2005	457,614	21,856	259,209	1,009,776	10,750,554	59,437	24,302	705,662	13,288,410
2006	512,780	24,420	258,532	1,170,293	11,786,416	75,629	27,010	786,760	14,641,840
2007	544,467	25,943	269,257	1,227,111	12,416,935	80,132	28,623	835,647	15,428,115
2008	579,116	27,611	280,315	1,204,684	13,090,546	85,037	30,298	889,177	16,186,784
2009	429,519	19,884	261,723	972,167	10,717,619	64,350	22,707	647,384	13,135,353
2010	429,406	19,879	261,689	971,939	10,715,267	64,334	22,705	647,215	13,132,434
2011	431,271	19,965	262,671	975,864	10,758,692	64,608	22,781	650,031	13,185,883
2012	431,371	19,970	262,729	976,094	10,761,201	64,623	22,785	650,181	13,188,954
2013	431,706	19,985	262,873	976,815	10,768,830	64,671	22,794	650,682	13,198,356
2014	431,997	19,998	262,932	977,374	10,774,432	64,710	22,798	651,117	13,205,358
2015	432,256	20,010	263,123	978,010	10,781,554	64,750	22,810	651,504	13,214,017
2016	431,768	19,988	262,808	976,855	10,768,811	64,677	22,790	650,773	13,198,470
2017	431,975	19,997	262,934	977,337	10,774,095	64,708	22,798	651,084	13,204,928
2018	432,369	20,015	263,103	978,183	10,783,051	64,764	22,809	651,672	13,215,966
2019	431,822	19,990	262,779	976,918	10,769,228	64,683	22,788	650,855	13,199,063
2020	432,102	20,003	263,007	977,628	10,777,270	64,726	22,803	651,273	13,208,812
2021	432,211	20,008	263,135	977,946	10,781,027	64,745	22,811	651,437	13,213,320
2022	432,276	20,011	263,049	977,969	10,780,720	64,750	22,805	651,534	13,213,114
2023	431,782	19,988	262,828	976,900	10,769,356	64,679	22,791	650,795	13,199,119
2024	431,996	19,998	262,915	977,355	10,774,152	64,710	22,797	651,116	13,205,039
2025	432,341	20,014	263,181	978,214	10,783,817	64,763	22,814	651,631	13,216,775
2026	431,719	19,986	262,706	976,667	10,766,430	64,667	22,783	650,700	13,195,658
2027	432,804	20,035	263,526	979,358	10,796,647	64,834	22,836	652,324	13,232,364
2028	431,717	19,985	262,677	976,636	10,765,959	64,666	22,781	650,697	13,195,118
2029	432,095	20,003	263,025	977,636	10,777,454	64,726	22,804	651,264	13,209,007
2030	431,716	19,985	262,788	976,746	10,767,665	64,669	22,789	650,696	13,197,054
2031	433,015	20,045	263,590	979,784	10,801,028	64,864	22,840	652,640	13,237,806
2032	431,528	19,977	262,534	976,167	10,760,690	64,637	22,772	650,415	13,188,720
2033	432,079	20,002	263,065	977,648	10,777,812	64,726	22,806	651,240	13,209,378
2034	432,242	20,010	263,097	977,961	10,780,938	64,748	22,808	651,484	13,213,288
2035	431,571	19,979	262,570	976,277	10,761,944	64,643	22,775	650,479	13,190,238
TOTAL	22,204,444	1,060,164	12,848,844	51,009,811	573,584,468	2,516,259	1,165,833	37,388,239	701,778,062

TABLE B-16A. Minimum OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	65,074	28,085	11,697	2,958	19,291	1,089	24,380	8,173	52,315	14,399
1969	86,339	70,342	15,522	3,925	25,598	1,445	32,348	10,844	69,419	19,106
1970	107,807	84,577	19,392	4,904	31,981	1,804	40,391	13,540	86,727	23,865
1971	178,820	105,979	32,228	8,150	53,151	2,992	66,999	22,459	144,136	39,636
1972	363,555	202,625	106,740	30,967	176,037	6,601	213,032	48,102	548,123	144,113
1973	404,661	222,765	121,341	34,674	200,116	7,346	243,320	53,975	724,535	190,156
1974	434,868	235,528	130,627	37,062	215,432	7,677	262,735	56,383	786,107	207,019
1975	504,791	289,501	151,031	43,176	249,082	9,082	303,108	65,580	905,424	238,842
1976	559,013	262,420	160,686	44,454	265,004	10,030	325,512	73,253	964,524	256,570
1977	675,504	335,749	184,813	47,743	304,792	11,890	381,161	87,355	1,069,446	289,793
1978	600,343	376,946	187,028	54,156	308,449	10,711	373,192	78,304	1,148,279	300,751
1979	661,123	349,072	196,264	52,211	323,677	12,124	401,469	87,126	1,125,452	302,508
1980	858,039	415,571	253,090	71,921	417,398	15,435	508,379	112,853	1,518,405	401,223
1981	1,001,503	511,087	284,970	73,534	469,970	18,046	588,024	131,992	1,548,350	420,523
1982	1,128,643	557,494	320,938	89,560	529,292	20,193	649,204	148,012	1,870,559	497,871
1983	1,744,932	832,687	450,049	119,275	742,218	30,643	922,072	225,793	2,373,149	639,682
1984	2,105,780	943,524	548,784	150,179	905,055	36,810	1,112,196	271,187	3,018,294	803,394
1985	2,157,936	1,055,744	584,697	157,841	964,282	38,972	1,191,309	277,250	3,230,403	860,780
1986	2,311,841	1,102,466	618,750	162,748	1,020,438	40,051	1,268,806	295,987	3,318,638	893,069
1987	2,366,343	1,032,918	628,222	167,262	1,036,061	41,773	1,283,836	307,844	3,400,838	913,933
1988	2,303,274	1,042,113	649,276	175,694	1,070,784	40,604	1,321,553	298,438	3,587,873	960,968
1989	2,280,051	1,088,176	613,266	169,993	1,011,401	39,501	1,240,888	292,775	3,499,964	932,519
1990	2,636,186	1,275,150	708,829	201,242	1,169,006	45,472	1,424,445	336,069	4,084,211	1,078,392
1991	2,737,441	1,454,172	763,989	210,644	1,259,974	48,936	1,546,583	358,165	4,348,900	1,150,633
1992	2,781,586	1,579,025	750,248	198,232	1,237,307	49,829	1,538,733	362,844	4,131,745	1,115,632
1993	3,109,819	1,689,775	850,589	234,719	1,402,796	56,125	1,722,415	411,539	5,023,595	1,338,111
1994	2,825,181	1,609,511	795,078	225,270	1,311,244	51,258	1,634,795	376,175	4,797,440	1,268,058
1995	3,121,440	1,720,649	848,101	231,718	1,398,686	58,749	1,766,297	444,998	4,828,432	1,272,345
1996	3,093,678	1,966,634	862,720	228,008	1,422,789	56,813	1,817,427	423,444	4,707,473	1,256,549
1997	3,250,394	1,810,292	918,428	281,067	1,514,687	59,547	1,853,224	446,127	5,705,741	1,477,757
1998	3,876,893	2,050,491	1,070,620	299,667	1,765,661	73,841	3,208,176	561,294	6,077,011	1,635,115
1999	3,757,844	2,077,696	1,097,945	308,176	1,810,727	74,274	3,177,408	538,581	6,389,002	1,718,172
2000	3,753,245	3,381,437	1,035,666	291,684	1,708,021	68,473	3,000,250	594,938	5,873,262	1,571,225
2001	4,457,941	3,768,942	1,110,674	297,870	1,831,713	80,824	3,284,565	699,672	5,752,335	1,554,602
2002	3,642,409	3,495,416	1,018,470	282,635	1,679,659	62,597	3,002,723	549,856	5,635,219	1,511,997
2003	4,060,267	3,386,319	1,121,573	298,335	1,849,687	67,913	3,289,616	607,514	5,906,716	1,602,981
2004	4,454,661	4,040,877	1,440,024	320,549	1,902,951	76,867	3,426,241	678,148	6,597,217	1,755,989
2005	4,216,104	3,658,879	6,193,536	303,509	2,377,681	73,029	3,039,129	628,576	6,333,028	1,668,667
2006	4,155,326	3,540,504	8,022,820	335,035	2,828,454	70,084	3,418,049	626,718	6,718,868	1,776,711
2007	4,305,820	3,871,198	8,243,539	352,356	2,946,130	72,655	3,572,917	649,392	7,049,137	1,863,361
2008	4,355,289	3,961,701	8,308,309	347,258	2,948,669	74,742	3,559,581	655,662	6,979,549	1,862,020
2009	3,710,389	3,427,980	6,619,424	272,649	2,345,267	65,711	2,932,427	569,675	5,774,016	1,531,927
2010	3,709,181	3,423,932	6,709,202	267,539	2,350,345	65,682	2,931,072	569,465	5,683,199	1,513,987
2011	3,722,280	3,441,214	6,610,069	274,282	2,349,817	65,929	2,942,235	571,520	5,805,911	1,539,498
2012	3,723,342	3,436,554	6,662,295	270,294	2,352,362	65,951	2,943,211	571,692	5,735,213	1,525,852
2013	3,726,921	3,452,950	6,731,739	259,393	2,350,036	66,032	2,946,887	572,293	5,541,762	1,488,692
2014	3,730,088	3,445,500	6,658,603	280,205	2,368,037	66,114	2,950,672	572,857	5,911,448	1,561,448
2015	3,732,755	3,443,347	6,701,033	259,951	2,349,437	66,161	2,952,771	573,265	5,552,211	1,491,654
2016	3,727,717	3,456,931	6,638,770	282,950	2,367,753	66,065	2,948,453	572,473	5,959,891	1,570,563
2017	3,729,888	3,453,100	6,807,971	268,195	2,373,152	66,108	2,950,391	572,819	5,698,059	1,519,768
2018	3,734,063	3,453,858	6,669,766	272,402	2,361,809	66,202	2,954,673	573,519	5,773,155	1,535,096
2019	3,728,398	3,466,267	6,844,528	282,917	2,396,235	66,089	2,949,590	572,614	5,959,001	1,570,598
2020	3,731,220	3,462,467	6,576,107	269,188	2,343,605	66,135	2,951,607	573,033	5,715,931	1,523,437
2021	3,732,283	3,437,936	6,652,326	257,038	2,338,788	66,145	2,952,037	573,171	5,500,606	1,481,454
2022	3,733,151	3,439,304	6,949,885	270,450	2,396,880	66,184	2,953,869	573,375	5,738,286	1,528,175
2023	3,727,892	3,446,329	6,680,573	282,318	2,372,614	66,067	2,948,530	572,496	5,948,745	1,568,394
2024	3,730,185	3,473,492	6,758,310	268,200	2,366,805	66,119	2,950,928	572,883	5,697,992	1,519,856
2025	3,733,679	3,419,471	6,559,726	270,750	2,344,067	66,178	2,953,558	573,410	5,744,338	1,529,250
2026	3,727,361	3,471,847	6,942,802	283,698	2,410,165	66,071	2,948,764	572,455	5,972,623	1,573,140
2027	3,738,417	3,356,165	6,470,895	266,634	2,328,310	66,260	2,957,230	574,131	5,672,507	1,515,739
2028	3,727,360	3,574,905	6,705,602	257,288	2,345,568	66,076	2,948,984	572,469	5,503,084	1,481,586
2029	3,731,150	3,406,103	6,720,809	281,826	2,378,642	66,130	2,951,370	573,011	5,940,664	1,567,233
2030	3,727,210	3,446,341	6,737,723	282,892	2,380,786	66,054	2,947,926	572,388	5,958,822	1,570,271
2031	3,740,713	3,360,057	6,932,953	250,923	2,372,599	66,316	2,959,812	574,531	5,393,296	1,461,690
2032	3,725,426	3,572,598	6,542,151	281,265	2,352,690	66,042	2,947,503	572,175	5,928,645	1,564,409
2033	3,730,925	3,415,934	6,763,325	265,220	2,363,347	66,117	2,950,763	572,950	5,645,824	1,509,591
2034	3,732,695	3,448,436	6,689,450	262,906	2,351,661	66,163	2,952,883	573,266	5,604,599	1,501,904
2035	3,725,905	3,472,360	6,988,716	299,917	2,436,266	66,051	2,947,862	572,248	6,260,282	1,629,157
TOTAL	192,162,358	154,589,415	232,755,322	14,291,651	108,552,394	3,410,999	141,662,496	28,377,121	297,549,951	79,203,406

TABLE B-16A. Minimum OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	3,219	42,918
1963	0	0	0	0	0	0	0	0	12,626	168,358
1964	0	0	0	0	0	0	0	0	13,938	184,729
1965	0	0	0	0	0	0	0	0	28,937	378,875
1966	0	0	0	0	0	0	0	0	31,321	408,396
1967	0	0	0	0	0	0	0	0	47,718	634,505
1968	8,821	972,734	9,504	1,218,520	0	0	0	0	46,945	2,745,159
1969	11,704	1,295,607	12,610	1,654,809	0	0	0	0	52,963	4,074,937
1970	14,623	1,624,569	15,746	2,069,926	0	0	0	0	69,744	4,676,285
1971	24,302	2,716,584	26,118	3,421,554	0	0	54	54	55,532	6,185,714
1972	89,131	8,038,463	68,369	10,035,858	0	0	40	40	80,412	12,998,870
1973	117,779	9,890,316	78,313	12,289,297	0	0	1	1	54,219	15,194,233
1974	128,169	11,581,491	83,453	14,166,551	0	0	143	143	76,783	17,372,560
1975	147,899	13,584,548	101,893	16,593,957	0	0	1,069	1,069	84,547	20,517,423
1976	158,664	12,862,489	94,799	16,037,418	0	0	139	139	106,717	20,027,212
1977	178,774	16,203,699	121,966	19,892,685	0	0	892	892	98,618	24,213,491
1978	186,384	17,811,770	132,435	21,568,748	0	0	39	39	100,786	26,012,788
1979	186,688	16,414,289	126,756	20,238,759	0	0	3,235	3,235	119,352	24,675,595
1980	248,399	20,926,898	154,096	25,901,707	0	0	416	416	178,812	32,038,398
1981	259,244	23,731,024	186,592	29,224,859	0	0	3,847	3,847	185,347	35,516,365
1982	307,955	27,994,510	209,141	34,323,372	0	0	11,075	11,075	173,894	41,611,654
1983	394,524	38,953,367	326,258	47,754,649	0	0	1,928	1,928	220,926	56,802,779
1984	496,808	45,597,671	382,104	56,371,786	0	0	3,765	3,765	225,959	67,072,552
1985	531,765	50,064,444	416,652	61,532,075	0	0	2,888	2,888	340,322	73,228,724
1986	551,066	52,858,915	442,334	64,885,109	0	0	2,787	2,787	279,227	76,682,112
1987	564,352	50,737,631	411,276	62,892,289	0	0	2,388	2,388	345,116	75,240,983
1988	593,787	51,262,231	406,248	63,712,843	0	0	545	545	365,207	76,126,694
1989	576,852	52,638,942	431,020	64,815,348	0	0	1,800	1,800	422,329	78,708,338
1990	667,687	61,053,824	494,721	75,175,234	0	0	788	788	474,284	91,448,066
1991	711,803	60,874,529	470,139	75,935,908	0	0	3,654	3,654	214,683	91,098,893
1992	688,558	67,460,598	502,131	82,396,468	0	0	647	647	443,676	100,077,318
1993	828,208	68,749,547	538,751	85,955,989	0	0	3,630	3,630	599,571	107,321,034
1994	784,017	63,928,225	474,133	80,080,385	0	0	2,279	2,279	609,932	101,268,236
1995	785,191	68,079,888	523,512	85,080,006	0	0	2,906	2,906	534,971	107,378,967
1996	773,653	72,757,439	561,100	89,927,727	0	0	8,007	8,007	571,857	113,942,346
1997	917,372	75,655,465	564,455	94,454,556	0	0	7,449	7,449	428,638	115,385,082
1998	1,000,665	80,549,464	608,366	102,777,264	0	0	798	798	465,140	129,501,774
1999	1,054,800	84,857,717	627,858	107,490,200	0	0	416	416	559,344	134,930,505
2000	964,052	82,467,206	635,833	105,345,292	0	0	505	505	0	131,938,146
2001	948,812	92,865,248	708,297	117,361,495	0	0	319	319	0	144,717,003
2002	923,393	85,334,068	657,014	107,795,456	0	0	3,627	3,627	0	138,336,795
2003	987,904	82,216,721	620,034	106,015,580	0	0	3,393	3,393	0	135,566,443
2004	1,086,161	99,273,497	762,493	125,815,675	0	0	3,455	3,455	0	155,784,314
2005	1,032,743	77,179,085	676,642	107,380,608	0	0	3,451	3,451	0	134,958,194
2006	1,100,491	80,245,197	641,197	113,479,454	0	0	3,100	3,100	0	143,635,010
2007	1,154,410	89,081,067	717,166	123,879,148	0	0	3,200	3,200	0	155,720,912
2008	1,148,769	90,101,936	745,224	125,048,709	0	0	3,250	3,250	0	158,198,614
2009	948,363	76,162,042	639,529	104,999,399	0	0	3,300	3,300	0	131,426,192
2010	936,639	75,986,086	638,505	104,784,834	0	0	3,300	3,300	0	131,207,579
2011	953,139	76,447,358	642,141	105,365,393	0	0	3,300	3,300	0	131,889,788
2012	944,176	76,209,618	640,852	105,081,412	0	0	3,300	3,300	0	131,611,690
2013	919,746	76,273,661	645,010	104,975,122	0	0	3,300	3,300	0	131,521,003
2014	967,331	76,875,747	642,960	106,031,010	0	0	3,300	3,300	0	132,584,952
2015	921,557	75,894,449	642,201	104,580,792	0	0	3,300	3,300	0	131,153,354
2016	973,350	77,332,925	646,104	106,543,945	0	0	3,300	3,300	0	133,085,110
2017	940,027	76,822,158	644,964	105,846,600	0	0	3,300	3,300	0	132,400,413
2018	949,976	76,730,676	644,973	105,720,168	0	0	3,300	3,300	0	132,292,305
2019	973,343	78,009,170	648,582	107,467,332	0	0	3,300	3,300	0	134,006,627
2020	942,405	76,675,943	647,355	105,478,433	0	0	3,300	3,300	0	132,039,716
2021	914,892	75,502,210	640,770	104,049,656	0	0	3,300	3,300	0	130,622,802
2022	945,457	76,768,224	641,195	106,004,435	0	0	3,300	3,300	0	132,571,060
2023	971,928	77,068,582	643,292	106,297,760	0	0	3,300	3,300	0	132,840,749
2024	940,069	77,327,515	650,350	106,322,704	0	0	3,300	3,300	0	132,875,214
2025	946,177	75,415,231	635,851	104,191,686	0	0	3,300	3,300	0	130,769,983
2026	975,025	78,417,853	650,126	108,011,930	0	0	3,300	3,300	0	134,544,046
2027	937,256	73,110,322	618,824	101,612,690	0	0	3,300	3,300	0	128,224,738
2028	915,025	79,741,621	677,305	108,516,873	0	0	3,300	3,300	0	135,046,593
2029	971,110	75,895,480	632,489	105,116,017	0	0	3,300	3,300	0	131,678,763
2030	973,170	77,216,694	643,337	106,523,614	0	0	3,300	3,300	0	133,062,547
2031	901,779	73,361,600	619,769	101,996,038	0	0	3,300	3,300	0	128,615,643
2032	969,323	80,521,985	676,840	109,721,052	0	0	3,300	3,300	0	136,236,808
2033	933,357	75,475,512	635,049	104,327,914	0	0	3,300	3,300	0	130,893,758
2034	928,269	76,166,029	643,565	104,921,826	0	0	3,300	3,300	0	131,492,129
2035	1,011,744	79,318,620	650,393	109,379,521	0	0	3,300	3,300	0	135,898,754
TOTAL	48,941,012	4,081,220,224	33,149,080	5,415,865,429	0	0	181,025	181,025	8,723,612	6,755,340,615

TABLE B-16B. Minimum OMP&R Component of Transportation Charge for Each Contractor for Off-Aqueduct Power Facilities

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	10,070	0	10,070	47,473	31,446	863,937	942,856	0	0	0
1984	29,957	0	29,957	157,280	77,388	2,040,188	2,274,856	0	0	0
1985	54,709	0	54,709	458,427	582,679	2,696,450	3,737,556	0	0	0
1986	45,887	0	45,887	312,938	365,147	2,595,765	3,273,850	0	0	0
1987	90,385	0	90,385	622,029	674,111	2,306,079	3,602,219	0	0	0
1988	115,970	114,196	230,166	616,865	804,606	2,116,236	3,537,707	0	0	0
1989	64,584	138,240	202,824	407,353	396,069	1,389,347	2,192,769	0	0	0
1990	77,126	138,805	215,931	535,269	514,372	1,490,250	2,539,891	0	0	0
1991	35,178	245,181	280,359	355,578	477,883	1,065,488	1,898,949	0	165,930	165,930
1992	74,573	230,716	305,289	405,244	529,119	1,183,466	2,117,829	0	0	0
1993	89,214	247,977	337,191	841,383	256,930	1,552,562	2,650,875	0	0	0
1994	111,942	229,598	341,540	501,812	559,683	1,395,238	2,456,733	0	0	0
1995	96,842	235,605	332,447	833,227	492,578	796,524	2,122,329	0	0	0
1996	63,698	205,414	269,112	367,297	304,845	1,189,291	1,861,433	711	105	816
1997	48,518	193,255	241,773	455,751	294,951	1,220,497	1,971,199	44,788	298,986	343,774
1998	82,317	251,217	333,534	380,321	380,282	1,103,662	1,864,265	198,376	1,028,220	1,226,596
1999	58,017	195,562	253,579	559,900	446,655	1,039,572	2,046,127	147,204	791,946	939,150
2000	28,759	128,393	157,152	374,808	237,138	748,820	1,360,766	82,628	474,268	556,896
2001	81,300	156,491	237,791	394,562	232,158	860,678	1,487,398	133,971	592,623	726,594
2002	40,384	128,219	168,603	384,774	230,122	521,729	1,136,625	91,976	586,079	678,055
2003	38,551	95,034	133,585	309,137	185,287	659,690	1,154,114	80,724	488,877	569,601
2004	50,258	128,102	178,360	447,529	209,965	546,009	1,203,503	92,779	661,706	754,485
2005	65,505	165,913	231,418	501,846	295,003	842,594	1,639,443	115,120	669,867	784,987
2006	119,936	226,400	346,336	573,936	384,893	730,995	1,689,824	701,594	952,682	1,654,276
2007	163,361	222,650	386,011	825,308	469,513	897,792	2,192,613	166,669	1,571,541	1,738,210
2008	277,105	331,613	608,718	1,162,734	573,067	1,168,174	2,903,975	997,305	1,814,537	2,811,842
2009	259,103	188,581	447,684	1,154,210	577,061	1,159,610	2,890,881	989,994	1,801,235	2,791,229
2010	264,257	189,869	454,126	1,161,129	580,520	1,166,562	2,908,211	995,929	1,812,033	2,807,962
2011	206,746	201,094	407,840	969,991	472,730	1,267,577	2,710,298	768,707	1,398,615	2,167,322
2012	209,498	201,189	410,687	969,864	472,668	1,267,411	2,709,943	768,606	1,398,432	2,167,038
2013	123,876	117,714	241,590	567,115	276,386	741,102	1,584,603	449,432	817,715	1,267,147
2014	32,296	30,250	62,546	145,651	70,984	190,335	406,970	115,426	210,011	325,437
2015	19,654	17,938	37,592	86,318	42,067	112,799	241,184	68,406	124,460	192,866
2016	17,244	15,367	32,611	73,945	36,038	96,631	206,614	58,601	106,621	165,222
2017	17,155	14,935	32,090	71,866	35,024	93,914	200,804	56,953	103,622	160,575
2018	7,457	6,345	13,802	30,532	14,880	39,899	85,311	24,196	44,024	68,220
2019	7,561	6,292	13,853	30,277	14,756	39,566	84,599	23,994	43,656	67,650
2020	8,319	6,779	15,098	32,619	15,897	42,626	91,142	25,850	47,033	72,883
2021	12,426	10,091	22,517	48,559	23,666	63,457	135,682	38,483	70,017	108,500
2022	11,792	9,576	21,368	46,081	22,458	60,218	128,757	36,518	66,443	102,961
2023	8,388	6,812	15,200	32,777	15,974	42,833	91,584	25,976	47,261	73,237
2024	6,111	4,962	11,073	23,879	11,638	31,205	66,722	18,924	34,431	53,355
2025	453	368	821	1,772	864	2,315	4,951	1,404	2,555	3,959
2026	724	588	1,312	2,830	1,379	3,698	7,907	2,243	4,081	6,324
2027	1,108	900	2,008	4,328	2,109	5,656	12,093	3,430	6,241	9,671
2028	936	760	1,696	3,657	1,782	4,779	10,218	2,898	5,273	8,171
2029	923	750	1,673	3,607	1,758	4,713	10,078	2,858	5,200	8,058
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	3,230,173	5,039,741	8,269,914	18,293,788	12,696,529	39,457,939	70,448,256	7,332,673	18,246,326	25,578,999

TABLE B-16B. Minimum OMP&R Component of Transportation Charge for Each Contractor for Off-Aqueduct Power Facilities

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA							
			Kern County Water Agency					
	Dudley Ridge Water District	Empire West Side Irrigation District	Municipal and Industrial	Agricultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	159,191	0	34,366	2,964,185	13,174	9,673	3,733	3,184,322
1984	389,518	0	816,103	9,095,509	26,774	33,576	49,601	10,411,081
1985	527,952	59,322	1,053,957	11,978,046	38,810	42,297	1,253,257	14,953,641
1986	552,172	12,858	885,988	11,788,714	40,659	38,275	872,008	14,190,674
1987	450,941	24,936	1,192,388	10,448,063	39,134	37,538	911,938	13,104,938
1988	425,261	31,146	1,130,988	9,910,050	35,851	26,779	850,225	12,410,300
1989	331,852	17,226	607,908	7,400,983	22,959	24,306	754,007	9,159,241
1990	219,381	7,731	428,482	5,216,562	12,089	12,046	344,943	6,241,234
1991	13,048	3,111	570,942	146,276	0	1,354	30,685	765,416
1992	244,630	13,395	706,155	5,788,599	18,587	15,716	480,903	7,267,985
1993	471,706	25,543	1,202,455	11,405,212	37,276	36,803	1,159,908	14,338,903
1994	262,029	15,161	901,463	6,786,208	19,257	19,061	567,521	8,570,700
1995	626,214	16,830	1,486,494	12,489,555	41,275	36,377	1,051,178	15,747,923
1996	407,919	13,446	1,226,968	9,219,091	28,668	24,001	1,691,135	12,611,228
1997	423,144	(6)	794,476	7,471,645	(31)	22,025	137,304	8,848,557
1998	471,993	4,597	837,228	8,366,817	127	25,458	175,371	9,881,591
1999	360,554	19,182	874,948	7,723,883	24,159	20,065	1,749,925	10,772,716
2000	193,895	5,762	392,659	4,215,772	11,530	9,847	667,127	5,496,592
2001	201,286	6,533	226,283	2,840,015	7,494	11,768	286,120	3,579,499
2002	153,869	4,557	309,688	2,803,477	9,257	10,806	301,042	3,592,696
2003	128,292	3,998	255,374	2,744,723	10,279	8,100	292,016	3,442,782
2004	167,903	12,186	431,994	2,937,167	30,970	10,800	278,035	3,869,055
2005	333,319	15,889	390,336	5,934,322	78,555	11,863	567,567	7,331,851
2006	247,554	17,879	471,737	5,338,967	41,974	14,186	416,884	6,549,181
2007	304,261	15,918	690,690	5,795,693	50,405	20,627	508,960	7,386,554
2008	351,306	18,379	797,486	6,759,933	58,199	23,817	587,657	8,596,777
2009	348,731	18,244	878,058	6,623,961	57,772	23,642	583,349	8,533,757
2010	350,822	18,354	883,321	6,663,670	58,118	23,784	586,846	8,584,915
2011	270,781	14,166	681,791	5,138,080	44,859	18,358	452,956	6,620,991
2012	270,746	14,165	681,701	5,137,406	44,853	18,355	452,897	6,620,123
2013	158,315	8,283	398,616	3,004,030	26,227	10,733	264,826	3,871,030
2014	40,660	2,127	102,375	771,517	6,736	2,757	68,014	994,186
2015	24,096	1,261	60,671	457,228	3,992	1,634	40,308	589,190
2016	20,642	1,080	51,975	391,691	3,420	1,399	34,530	504,737
2017	20,062	1,050	50,513	380,675	3,324	1,360	33,559	490,543
2018	8,523	446	21,461	161,730	1,412	578	14,258	208,408
2019	8,452	442	21,281	160,379	1,400	573	14,138	206,665
2020	9,106	476	22,927	172,785	1,509	617	15,232	222,652
2021	13,556	709	34,131	257,220	2,246	919	22,676	331,457
2022	12,864	673	32,389	244,090	2,131	872	21,518	314,537
2023	9,150	479	23,039	173,623	1,516	620	15,306	223,733
2024	6,666	349	16,784	126,488	1,104	452	11,151	162,994
2025	495	26	1,245	9,386	82	34	827	12,095
2026	790	41	1,989	14,991	131	54	1,322	19,318
2027	1,208	63	3,042	22,928	200	82	2,021	29,544
2028	1,021	53	2,571	19,373	169	69	1,708	24,964
2029	1,007	53	2,535	19,104	167	68	1,684	24,618
2030	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0
TOTAL	9,996,883	448,119	22,689,971	207,519,822	958,799	654,124	18,628,176	260,895,894

TABLE B-16B. Minimum OMP&R Component of Transportation Charge for Each Contractor for Off-Aqueduct Power Facilities

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	1,083,881	411,247	565,798	35,432	894,572	1,250	0	0	233,134	28,548
1984	2,499,848	1,122,640	1,427,428	102,114	2,263,172	77	0	0	502,967	693,074
1985	3,749,257	1,572,025	2,032,672	170,137	3,230,451	0	0	157,601	884,188	601,583
1986	3,159,857	1,694,487	2,097,408	173,460	3,340,188	15,873	0	301,486	739,563	1,088,901
1987	3,167,759	1,694,698	1,991,841	190,149	3,230,424	95,994	1,786	258,719	1,951,799	1,091,691
1988	2,688,113	1,776,471	1,940,156	187,156	3,194,137	30,395	846	126,639	2,000,664	839,774
1989	2,357,669	1,348,806	1,326,863	132,076	2,218,516	50,948	13,206	493,424	1,257,332	792,087
1990	2,528,625	1,335,341	1,463,452	115,746	2,413,745	110,678	0	545,342	1,192,997	1,054,762
1991	1,048,414	531,160	1,022,405	125,256	1,686,304	65,111	473,291	488,207	540,119	796,531
1992	2,760,199	1,548,472	1,124,775	55,985	1,855,065	22,891	1,130,876	367,996	362,232	853,047
1993	3,559,487	1,332,392	2,256,338	29,498	3,721,492	60,615	1,101,799	640,919	425,969	1,406,255
1994	3,963,982	1,450,328	1,345,145	74,879	2,218,411	88,549	1,371,116	678,876	871,358	1,452,741
1995	4,324,009	1,901,361	2,498,462	44,237	4,120,837	43,892	881,146	636,541	75,278	1,397,623
1996	3,572,856	1,507,542	4,652,945	77,384	7,674,388	31,691	760,763	723,670	458,246	1,201,941
1997	3,411,379	1,468,949	4,294,703	42,135	4,319,206	24,319	891,191	648,652	625,340	1,175,556
1998	3,977,988	1,599,394	7,554,910	16,624	6,174,031	30,365	508,248	657,806	166,952	827,650
1999	3,696,973	1,694,851	3,195,685	71,662	3,678,076	18,305	501,486	710,674	815,001	1,375,575
2000	2,372,130	994,396	1,420,806	40,083	1,954,947	0	374,972	257,146	617,664	508,258
2001	2,668,867	1,411,816	458,191	53,221	755,763	0	212,427	443,872	1,333,688	118,828
2002	1,674,587	1,389,921	569,606	74,418	939,655	0	140,550	531,620	2,422,881	844,839
2003	1,480,979	1,405,892	488,863	47,681	806,231	0	637,929	284,877	807,486	640,047
2004	1,812,210	1,676,067	554,535	71,930	759,819	0	465,681	368,704	2,071,504	449,688
2005	2,242,606	1,592,527	2,076,562	21,114	2,095,696	2,433	587,884	433,365	1,931,459	599,331
2006	2,785,063	1,800,201	2,678,718	120,396	1,105,994	29,922	1,734,640	683,876	3,324,970	670,675
2007	2,516,000	2,574,329	5,817,326	185,754	1,721,283	108,147	1,015,760	1,001,532	4,424,193	667,380
2008	6,830,190	4,213,175	7,776,352	380,149	3,210,715	124,869	4,254,402	1,156,391	6,588,387	1,849,372
2009	7,572,613	4,182,290	7,719,347	369,713	3,187,179	123,953	4,815,440	1,147,914	6,540,091	1,835,815
2010	7,618,008	4,207,362	7,765,621	371,929	3,206,285	124,696	4,848,489	1,154,795	6,579,296	1,846,820
2011	5,917,075	4,050,008	5,993,886	287,073	2,474,767	96,247	3,740,273	891,327	5,078,222	1,425,466
2012	5,916,300	4,273,244	5,993,100	287,035	2,474,443	96,234	3,739,783	891,211	5,077,557	1,425,279
2013	3,459,478	2,498,722	3,504,386	167,840	1,446,898	56,272	2,186,789	521,124	2,969,034	833,413
2014	888,488	641,740	900,022	43,106	371,603	14,452	561,627	133,839	762,529	214,043
2015	526,549	380,317	533,384	25,546	220,225	8,565	332,840	79,317	451,901	126,849
2016	451,077	325,805	456,932	21,884	188,659	7,337	285,132	67,949	387,128	108,668
2017	438,391	316,642	444,081	21,269	183,353	7,131	277,113	66,038	376,241	105,611
2018	186,250	134,525	188,668	9,036	77,897	3,030	117,731	28,056	159,846	44,869
2019	184,694	133,402	187,092	8,961	77,247	3,004	116,748	27,822	158,511	44,494
2020	198,981	143,721	201,564	9,654	83,222	3,237	125,779	29,974	170,772	47,936
2021	296,218	213,953	300,063	14,371	123,891	4,818	187,244	44,621	254,224	71,361
2022	281,097	203,032	284,746	13,638	117,567	4,572	177,686	42,344	241,247	67,718
2023	199,947	144,418	202,542	9,701	83,626	3,252	126,389	30,119	171,600	48,169
2024	145,665	105,211	147,556	7,067	60,923	2,369	92,077	21,942	125,014	35,092
2025	10,809	7,807	10,949	524	4,521	176	6,832	1,628	9,276	2,604
2026	17,264	12,469	17,488	838	7,220	281	10,913	2,601	14,816	4,159
2027	26,404	19,071	26,747	1,281	11,043	429	16,690	3,977	22,661	6,361
2028	22,310	16,114	22,600	1,082	9,331	363	14,103	3,361	19,147	5,375
2029	22,001	15,891	22,286	1,067	9,202	358	13,907	3,314	18,882	5,300
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	110,312,547	63,074,232	97,555,005	4,311,291	84,002,220	1,517,100	38,853,584	17,791,208	66,213,366	31,331,159

TABLE B-16B. Minimum OMP&R Component of Transportation Charge for Each Contractor for Off-Aqueduct Power Facilities

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA				TOTAL STATE WATER PROJECT [a]
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	
	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]
1971	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	0	12,791,358	0	16,045,220	0	0	0	0	20,182,468
1984	0	39,229,567	0	47,840,887	0	0	0	0	60,556,781
1985	0	77,446,523	0	89,844,437	0	0	0	0	108,590,343
1986	0	77,581,287	0	90,192,510	0	0	0	0	107,702,921
1987	0	68,939,195	0	82,614,055	0	0	0	0	99,411,597
1988	0	79,936,309	0	92,720,660	0	0	0	0	108,898,833
1989	0	68,311,546	0	78,302,473	0	0	0	0	89,857,307
1990	0	83,964,409	277,885	95,002,982	0	0	0	0	104,000,038
1991	0	54,214,229	132,209	61,123,236	0	0	0	0	64,233,890
1992	0	72,401,054	0	82,482,592	0	0	0	0	92,173,695
1993	0	55,312,615	0	69,847,379	0	0	0	0	87,174,348
1994	0	72,838,621	0	86,354,006	0	0	0	0	97,722,979
1995	0	40,862,813	0	56,786,199	0	0	0	0	74,988,898
1996	0	36,536,259	401	57,198,086	0	0	0	0	71,940,675
1997	0	37,121,379	108,559	54,131,368	0	0	0	0	65,536,671
1998	0	30,341,609	149,170	52,004,747	0	0	0	0	65,310,733
1999	0	42,257,580	106,226	58,122,094	0	0	0	0	72,133,666
2000	0	43,977,877	123,318	52,641,597	0	0	0	0	60,213,003
2001	0	49,183,605	84,487	56,724,765	0	0	0	0	62,756,047
2002	0	45,579,833	154,113	54,322,023	0	0	0	0	59,898,002
2003	3,385	42,982,970	132,336	49,718,676	0	0	0	0	55,018,758
2004	44,621	58,640,223	170,747	67,085,729	0	0	0	0	73,091,132
2005	62,042	61,362,119	65,360	73,072,498	0	0	0	0	83,060,197
2006	458,220	81,025,875	200,630	96,619,180	0	0	0	0	106,858,797
2007	617,187	90,906,983	1,008,870	112,564,744	0	0	0	0	124,268,132
2008	1,110,907	82,019,400	1,164,863	120,679,172	0	0	0	0	135,600,484
2009	1,102,764	81,418,153	1,156,324	121,171,596	0	0	0	0	135,835,147
2010	1,109,374	81,906,226	1,163,256	121,902,157	0	0	0	0	136,657,371
2011	856,269	89,882,553	897,858	121,591,024	0	0	0	0	133,497,475
2012	856,157	89,870,772	897,740	121,798,855	0	0	0	0	133,706,646
2013	500,627	52,550,742	524,942	71,220,267	0	0	0	0	78,184,637
2014	128,575	13,496,461	134,819	18,291,304	0	0	0	0	20,080,443
2015	76,198	7,998,472	79,899	10,840,062	0	0	0	0	11,900,894
2016	65,276	6,852,021	68,446	9,286,314	0	0	0	0	10,195,498
2017	63,440	6,659,314	66,521	9,025,145	0	0	0	0	9,909,157
2018	26,953	2,829,206	28,262	3,834,329	0	0	0	0	4,210,070
2019	26,727	2,805,575	28,026	3,802,303	0	0	0	0	4,175,070
2020	28,795	3,022,597	30,193	4,096,425	0	0	0	0	4,498,200
2021	42,866	4,499,658	44,948	6,098,236	0	0	0	0	6,696,392
2022	40,678	4,269,972	42,654	5,786,951	0	0	0	0	6,354,574
2023	28,935	3,037,261	30,340	4,116,299	0	0	0	0	4,520,053
2024	21,079	2,212,702	22,103	2,998,800	0	0	0	0	3,292,944
2025	1,564	164,187	1,640	222,517	0	0	0	0	244,343
2026	2,498	262,245	2,620	355,412	0	0	0	0	390,273
2027	3,821	401,084	4,007	543,576	0	0	0	0	596,892
2028	3,229	338,899	3,385	459,299	0	0	0	0	504,348
2029	3,184	334,196	3,338	452,926	0	0	0	0	497,353
2030	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0
TOTAL	7,285,371	1,960,577,534	9,110,495	2,491,935,112	0	0	0	0	2,857,128,175

a) Costs allocated to contractors in 1989 through 2002 are reduced by credits for Off-Aqueduct Power Facility costs allocated to the pumping of non-Project water.

TABLE B-17. Unit Variable OMP&R Component of Transportation Charge

(in dollars per acre-foot)

Calendar Year	NORTH BAY AQUEDUCT						SOUTH BAY AQUEDUCT		CALIFORNIA AQUEDUCT	
	Reach 1 Barker Slough Pumping Plant		Reach 3A Cordelia Pumping Plant Solano County WA		Reach 3B Cordelia Pumping Plant Napa County FC&WCD [a]		Reach 1 South Bay and Del Valle Pumping Plants [b]		Reach 1 Banks Pumping Plant	
	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	4.1511341	4.1511341	0	0
1963	0	0	0	0	0	0	4.5639383	4.5639383	0	0
1964	0	0	0	0	0	0	3.5452154	3.5452154	0	0
1965	0	0	0	0	0	0	4.1911773	4.1911773	0	0
1966	0	0	0	0	0	0	3.5074573	3.5074573	0	0
1967	0	0	0	0	0	0	3.9306767	4.1752198	0.2445431	0.2445431
1968	0	0	0	0	5.7570016	5.7570016	3.3315620	4.8750942	1.5435322	1.5435322
1969	0	0	0	0	3.1823595	3.1823595	3.6949019	4.8016170	1.1067151	1.1067151
1970	0	0	0	0	3.7584301	3.7584301	4.4256141	5.3721490	0.9465349	0.9465349
1971	0	0	0	0	4.2082507	4.2082507	3.8714396	4.7522833	0.8808437	0.8808437
1972	0	0	0	0	3.9577735	3.9577735	4.3250690	5.2281686	0.9030996	0.9030996
1973	0	0	0	0	3.8103903	3.8103903	5.2455409	6.1841800	0.9386391	0.9386391
1974	0	0	0	0	3.5878850	3.5878850	6.3321503	7.2293909	0.8972406	0.8972406
1975	0	0	0	0	2.1606725	2.1606725	3.7365711	4.8327731	1.0962020	1.0962020
1976	0	0	0	0	2.9283909	2.9283909	4.5191527	5.7132795	1.1941268	1.1941268
1977	0	0	0	0	2.7516411	2.7516411	4.7630172	6.5309908	1.7679736	1.7679736
1978	0	0	0	0	3.5949619	3.5949619	5.2086183	6.8245097	1.6158914	1.6158914
1979	0	0	0	0	2.4747752	2.4747752	4.9524184	7.1045026	2.1520842	2.1520842
1980	0	0	0	0	2.9737588	2.9737588	4.5186576	5.8960239	1.3773663	1.3773663
1981	0	0	0	0	2.6488168	2.6488168	4.3834851	6.4662961	2.0828110	2.0828110
1982	0	0	0	0	10.0222589	10.0222589	5.6383622	7.4121096	1.7737474	1.7737474
1983	0	0	0	0	1.0240490	1.0240490	0.8686507	1.7250802	0.8564295	0.8564295
1984	0	0	0	0	1.6524119	1.6524119	2.7719370	3.9566693	1.1847323	1.1847323
1985	0	0	0	0	2.5219114	2.5219114	3.6942124	5.3128683	1.6186559	1.6186559
1986	0	0	0	0	4.4046604	4.4046604	7.2799131	10.6056639	3.3257508	3.3257508
1987	0	0	0	0	3.5386715	3.5386715	6.4837861	9.2421280	2.7583419	2.7583419
1988	1.1792022	1.1792022	0	1.1792022	4.4545623	5.6337645	6.1749958	8.7900561	2.6150603	2.6150603
1989	1.2712038	1.2712038	2.5418648	3.8130686	4.2795803	5.5507841	8.1600349	11.6976286	3.5375937	3.5375937
1990	2.0024548	2.0024548	4.2324041	6.2348589	5.8752161	7.8776709	11.7200790	15.8670513	4.1469723	4.1469723
1991	1.2488027	1.2488027	2.6241245	3.8729272	3.8050725	5.0538752	7.5402614	11.2642636	3.7240022	3.7240022
1992	0.7095451	0.7095451	1.4174620	2.1270071	2.3506623	3.0602074	4.0600957	6.4118184	2.3517227	2.3517227
1993	-0.3463994	-0.3463994	-0.6048649	-0.9512643	-1.0204313	-1.3668307	-1.4929839	-1.2402745	0.2527094	0.2527094
1994	1.4607776	1.4607776	2.6575471	4.1183247	4.2850412	5.7458188	7.9485622	11.2592004	3.3106382	3.3106382
1995	0.7544766	0.7544766	1.2974895	2.0519661	2.2753763	3.0298529	3.2312761	5.2800374	2.0487613	2.0487613
1996	1.6427835	1.6427835	2.7704025	4.4131860	4.7993051	6.4420886	8.0186492	11.3633990	3.3447498	3.3447498
1997	1.7801484	1.7801484	3.0246843	4.8048327	5.0575904	6.8377388	9.6521246	12.6148371	2.9627125	2.9627125
1998	-0.3031174	-0.3031174	-0.5212041	-0.8243215	-0.8497854	-1.1529028	-1.7656471	-1.6140875	0.1515596	0.1515596
1999	0.7893362	0.7893362	1.2927037	2.0820399	1.9928526	2.7821888	5.1162295	6.9791811	1.8629516	1.8629516
2000	1.3959233	1.3959233	1.9764390	3.3723623	3.0411557	4.4370790	6.3511103	8.6610803	2.3099700	2.3099700
2001	8.1656675	8.1656675	12.6117906	20.7774581	22.7930551	30.9587226	42.4371629	55.0733192	12.6361563	12.6361563
2002	4.0978448	4.0978448	5.1839120	9.2817568	8.7407898	12.8386346	17.7297693	23.7157370	5.9859677	5.9859677
2003	4.2299106	4.2299106	6.8941022	11.1240128	12.4277426	16.6576532	18.7448272	25.2861174	6.5412902	6.5412902
2004	4.7386444	4.7386444	6.0853109	10.8239553	12.7072043	17.4458487	19.1567803	26.2235278	7.0667475	7.0667475
2005	6.1143976	6.1143976	7.3530754	13.4674730	19.0132129	25.1276105	25.2864316	33.5767244	8.2902928	8.2902928
2006	6.8000000	6.8000000	18.5713748	25.3713748	32.1780691	38.9780691	31.4073332	39.7548735	8.3475403	8.3475403
2007	10.2076137	10.2076137	35.1913707	45.3989844	40.4552779	50.6628916	36.6421205	47.0209087	10.3787882	10.3787882
2008	7.7081039	7.7081039	41.1028367	48.8109406	32.1658527	39.8739566	36.8213919	49.5322432	12.7108513	12.7108513
2009	6.6436958	6.6436958	56.4851321	63.1288279	16.5280068	23.1717026	39.9594174	50.1984861	10.2390687	10.2390687
2010	6.9099808	6.9099808	59.0825660	65.9925468	17.4640537	24.3740345	41.7017564	54.5453778	12.8436214	12.8436214
2011	6.9166504	6.9166504	21.5739394	28.4905898	17.5488834	24.4655338	31.3292222	41.4956505	10.1664283	10.1664283
2012	7.1260585	7.1260585	22.3111846	29.4372431	18.3043461	25.4304046	32.3488265	42.2577259	9.9088994	9.9088994
2013	7.7316713	7.7316713	24.4749862	32.2066575	20.3562550	28.0879263	35.3415508	48.0199628	12.6784120	12.6784120
2014	8.2417738	8.2417738	26.2741047	34.5158785	22.1214868	30.3632606	37.8300275	49.2282114	11.3981839	11.3981839
2015	8.3662810	8.3662810	26.6688705	35.0351515	22.6905149	31.0567959	38.3759371	51.1097075	12.7337704	12.7337704
2016	8.4576404	8.4576404	26.9412121	35.3988525	23.1303345	31.5879749	38.7526748	53.4063997	14.6537249	14.6537249
2017	8.3623301	8.3623301	26.5523967	34.9147268	22.9413589	31.3036890	38.2148037	51.1443424	12.9295387	12.9295387
2018	8.5930973	8.5930973	27.3198347	35.9129320	23.8931962	32.4862935	39.2762960	52.2276789	12.9513829	12.9513829
2019	8.7987837	8.7987837	27.9945455	36.7933292	24.7720791	33.5708628	40.2094918	55.1061602	14.8966684	14.8966684
2020	8.3758667	8.3758667	26.4614876	34.8373543	23.4975804	31.8734471	38.0890126	51.3371638	13.2481512	13.2481512
2021	8.3683752	8.3683752	26.4180165	34.7863917	23.4880469	31.8564221	38.0289708	51.0182748	12.9893040	12.9893040
2022	8.1234121	8.1234121	25.5623141	33.6857262	22.6518429	30.7752550	36.8454736	48.8869305	12.0414569	12.0414569
2023	8.1669617	8.1669617	25.7143802	33.8813419	22.8004134	30.9673751	37.0557706	50.0536890	12.9979184	12.9979184
2024	8.4509319	8.4509319	26.7063361	35.1572680	23.7697554	32.2206873	38.4277520	52.6751253	14.2473733	14.2473733
2025	8.4148272	8.4148272	26.5801102	34.9949374	23.6464692	32.0612964	38.2532870	50.2133810	11.9600940	11.9600940
2026	8.4695960	8.4695960	26.7715152	35.2411112	23.8335171	32.3031131	38.5179325	53.3569400	14.8390075	14.8390075
2027	8.3482794	8.3482794	26.3477686	34.6960480	23.4193937	31.7676731	37.9317972	51.2476096	13.3158124	13.3158124
2028	8.4032695	8.4032695	26.5397796	34.9430491	23.6070617	32.0103312	38.1975023	51.2935465	13.0960442	13.0960442
2029	8.3016972	8.3016972	26.1850689	34.4867661	23.2604203	31.5621175	37.7068452	50.6537083	12.9468631	12.9468631
2030	8.3652124	8.3652124	26.4069422	34.7721546	23.4771960	31.8424084	38.0135859	51.4992296	13.4856437	13.4856437
2031	8.2566118	8.2566118	26.0276033	34.2842151	23.1064761	31.3630879	37.4889523	49.7153397	12.2263874	12.2263874
2032	8.4126406	8.4126406	26.5725620	34.9852026	23.6391319	32.0517725	38.2428091	51.5402532	13.2974441	13.2974441
2033	8.8144003	8.8144003	27.9758678	36.7902681	25.0103686	33.8247689	40.1836620	54.3022387	14.1185767	14.1185767
2034	8.5062084	8.5062084	26.8993939	35.4056023	23.9584568	32.4646652	38.6948133	51.9156037	13.2207904	13.2207904
2035	8.3411860	8.3411860	26.3228650	34.6640510	23.3951085	31.7362945	37.8975098	51.8793535	13.9818437	13.9818437

a) Rates are for an interim facility from 1968 through 1987.

b) The relatively minor costs of Del Valle Pumping Plant have been combined with those of South Bay Pumping Plant to simplify the allocation procedure.

TABLE B-17. Unit Variable OMP&R Component of Transportation Charge

(in dollars per acre-foot)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									
	Reach 4 Dos Amigos Pumping Plant		Reach 14A Buena Vista Pumping Plant		Reach 15A Teerink Pumping Plant		Reach 16A Chrisman Pumping Plant		Reach 17E Edmonston Pumping Plant	
	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	1.0745886	2.6181208	0	0	0	0	0	0	0	0
1969	0.7051830	1.8118981	0	0	0	0	0	0	0	0
1970	0.7838143	1.7303492	0.3333333	2.0636825	0	0	0	0	0	0
1971	0.4151197	1.2959634	1.3603318	2.6562952	4.9729730	7.6292682	0	0	0	0
1972	0.5689843	1.4720839	1.0818018	2.5538857	1.1418280	3.6957137	2.2892599	5.9849736	7.3206022	13.3055758
1973	0.6025584	1.5411975	0.9854386	2.5266361	1.2143719	3.7410080	2.1051633	5.8461713	7.4512435	13.2974148
1974	0.5766848	1.4739254	0.9233319	2.3972573	1.0924098	3.4896671	1.9449022	5.4345693	6.9004732	12.3350425
1975	0.4638166	1.5600186	0.8201332	2.3801518	0.9574493	3.3376011	1.9610412	5.2986423	6.9962702	12.2949125
1976	0.5196472	1.7137740	0.9637643	2.6775383	1.0211874	3.6987257	2.2275746	5.9263003	7.9384515	13.8647518
1977	0.6172856	2.3852592	1.0980643	3.4833235	1.3715867	4.8549102	2.9301764	7.7850866	9.9990004	17.7840870
1978	0.4578324	2.0737238	0.9617095	3.0354333	1.0432294	4.0786627	1.9992416	6.0779043	7.1214594	13.1993637
1979	0.6624709	2.8145551	1.1111583	3.9257134	1.2652451	5.1909585	2.7288840	7.9198425	9.6837428	17.6035853
1980	0.8090774	2.1864437	1.3528383	3.5392820	1.5041463	5.0434283	3.2274062	8.2708345	11.0353314	19.3061659
1981	1.0965610	3.1793720	1.2422925	4.4216645	1.3219771	5.7436416	2.9988606	8.7425022	10.0207633	18.7632655
1982	0.8365509	2.6102983	1.2049224	3.8152207	1.3715109	5.1867316	2.9378063	8.1245379	10.2606361	18.3851740
1983	0.3691099	1.2255394	0.7604543	1.9859937	0.8857383	2.8717320	1.8026411	4.6743731	5.5653668	10.2397399
1984	0.6642414	1.8489737	1.0562168	2.9051905	1.2202995	4.1254900	2.5897300	6.7152200	8.3105777	15.0257977
1985	0.8780315	2.4966874	1.4221464	3.9188338	1.6516280	5.5704618	3.5176053	9.0880671	11.8858945	20.9739616
1986	1.4047267	4.7304775	2.3730496	7.1035271	2.7567993	9.8603264	6.0029982	15.8633246	20.6708919	36.5342165
1987	1.2966188	4.0549607	2.2362590	6.2912197	2.5459999	8.8372196	5.3658848	14.2031044	17.8358435	32.0389479
1988	1.2001961	3.8152564	2.1148911	5.9301475	2.4017135	8.3318610	5.0600095	13.3918705	16.6769503	30.0688208
1989	1.4991710	5.0367647	2.6962512	7.7330159	3.0078924	10.7409083	6.6054692	17.3463775	22.2552075	39.6015850
1990	1.9023461	6.0493184	3.3101004	9.3594188	3.7483042	13.1077230	8.7425943	21.8503173	31.1242008	52.9745181
1991	1.0592185	4.7832207	2.1212585	6.9044792	2.4222131	9.3266923	5.7602628	15.0869551	20.6196938	35.7066489
1992	0.9064819	3.2582046	1.4858303	4.7440349	1.7077285	6.4517634	3.6067199	10.0584833	12.1335007	22.1919840
1993	0.1664878	0.4191972	-0.1384508	0.2807464	-0.1312944	0.1494520	-0.7173389	-0.5678869	-3.5014056	-4.0692925
1994	1.4294391	4.7400773	2.5099528	7.2500301	2.7989861	10.0490162	6.1401376	16.1891538	21.5691939	37.7583477
1995	0.8047106	2.8534719	1.3496693	4.2031412	1.4945512	5.6976924	3.1864400	8.8841324	10.8322270	19.7163594
1996	1.6726383	5.0173881	2.5952092	7.6125973	2.8425227	10.4551200	6.3087407	16.7638607	22.6420778	39.4059385
1997	1.2769880	4.2397005	2.5012144	6.7409149	2.6893394	9.4302543	6.2890095	15.7192638	23.0714697	38.7907335
1998	-0.2050857	-0.0535261	-0.3945877	-0.4481138	-0.4188957	-0.8670095	-0.9854414	-1.8524509	-3.5434867	-5.3959376
1999	0.8422034	2.7051550	1.4022138	4.1073688	1.2802066	5.3875754	3.4122984	8.7998738	13.6052879	22.4051617
2000	0.9306975	3.2406675	1.6377891	4.8784566	1.8007516	6.6792082	4.2452324	10.9244406	15.5438684	26.4683090
2001	6.0848645	18.7210208	11.2089222	29.9299430	12.2904776	42.2204206	28.4069032	70.6273238	106.3233062	176.9506300
2002	2.5678475	8.5538152	4.4973316	13.0511468	4.9050420	17.9561888	11.3506067	29.3067955	42.1780286	71.4848241
2003	3.0449725	9.5862627	5.4662061	15.0524688	5.9552204	21.0076892	13.8563946	34.8640838	51.5224036	86.3864874
2004	3.2119300	10.2786775	5.6545833	15.9332608	6.1386667	22.0719275	14.3036966	36.3756241	53.1773366	89.5529607
2005	3.9275885	12.2178813	7.3894399	19.6073212	8.0559637	27.6632849	18.7794943	46.4427792	67.4558144	113.8985936
2006	3.8566685	12.2042088	7.2839186	19.4881274	8.8793760	28.3675034	19.2573509	47.6248543	69.0630361	116.6878904
2007	4.9707136	15.3495018	9.1659112	24.5154130	11.2092044	35.7246174	24.3340597	60.0586771	87.3662368	147.4249139
2008	5.7184737	18.4293250	10.8953467	29.3246717	13.4029410	42.7276127	29.1330778	71.8606905	104.6732213	176.5339118
2009	5.2621919	15.5012606	9.6770197	25.1782803	10.0779669	35.2562472	24.1281921	59.3844393	91.5145160	150.8989553
2010	5.5373037	18.3809251	10.1978973	28.5788224	10.6152531	39.1940755	25.4264491	64.6205246	96.4431314	161.0636560
2011	4.7879224	14.9543507	8.1250794	23.0794301	8.3682704	31.4477005	19.9487175	51.3964180	75.4735638	126.8699818
2012	5.0994112	15.0083106	8.7284399	23.7367505	8.9983948	32.7351453	21.4693193	54.2044646	81.2549878	135.4594524
2013	5.5988556	18.2772676	9.5730018	27.8502694	9.8568828	37.7071522	23.5323618	61.2395140	89.0613455	150.3008595
2014	6.0790090	17.4771929	10.4298987	27.9070916	10.7361983	38.6432899	25.6493085	64.2925984	97.0860499	161.3786483
2015	6.1724788	18.9062492	10.5887326	29.4949818	10.8980495	40.3930313	26.0385031	66.4315344	98.5593519	164.9908863
2016	6.3988552	21.0525801	11.0893215	32.1419016	11.4276276	43.5695292	27.3250425	70.8945717	103.4664489	174.3610206
2017	6.1756572	19.1051959	10.6185843	29.7237802	10.9324635	40.6562437	26.1254620	66.7817057	98.8970373	165.6787430
2018	6.5289419	19.4803248	11.3396772	30.8200020	11.6876129	42.5076149	27.9519967	70.4596116	105.8483575	176.3079691
2019	6.7271412	21.6238096	11.7059690	33.3297786	12.0653925	45.3951711	28.8668372	74.2620083	109.3219042	183.5839125
2020	6.3532788	19.6014300	11.0621081	30.6635381	11.4084399	42.0719780	27.2872992	69.3592772	103.3413238	172.7006010
2021	6.3508916	19.3401956	11.0633039	30.4034995	11.4106062	41.8141057	27.2936443	69.1077500	103.3673990	172.4751490
2022	6.1606195	18.2020764	10.7490773	28.9511537	11.0922189	40.0433726	26.5302917	66.5736643	100.4818093	167.0554736
2023	6.2280474	19.2259658	10.8864083	30.1123741	11.2360494	41.3484235	26.8786017	68.2270252	101.8076412	170.0346664
2024	6.4365686	20.6839419	11.2213605	31.9053024	11.5736814	43.4789838	27.6869440	71.1659278	104.8599915	176.0259193
2025	6.4154560	18.3755500	11.1922024	29.5677524	11.5451681	41.1129205	27.6188615	68.7317820	104.6044795	173.3362615
2026	6.4491062	21.2881137	11.2403622	32.5284759	11.5925698	44.1210457	27.7323427	71.8533884	105.0313795	176.8847679
2027	6.3913187	19.7071311	11.1737019	30.8808330	11.5302877	42.4111207	27.5863288	69.9974495	104.4890652	174.4865147
2028	6.8793576	19.9754018	11.1226503	31.0980521	11.4715329	42.5695850	27.4404300	70.0100150	103.9238966	173.9339116
2029	6.3322976	19.2791607	11.0582709	30.3374316	11.4100589	41.7474905	27.2957802	69.0432707	103.3844816	172.4277523
2030	6.3399185	19.8255622	11.0390734	30.8646356	11.3848546	42.2494902	27.2312145	69.4807047	103.1292356	172.6099403
2031	6.2982567	18.5246441	11.0035322	29.5281763	11.3553052	40.8834815	27.1622133	68.0456948	102.8792384	170.9249332
2032	6.3456777	19.6431218	11.0252545	30.6683763	11.3666140	42.0349903	27.1857292	69.2207195	102.9496748	172.1703943
2033	6.8365151	20.9550918	11.9762575	32.9313493	12.3553141	45.2866634	29.5716104	74.8582738	112.0165309	186.8748047
2034	6.4523601	19.6731505	11.2277496	30.9009001	11.5764621	42.4773622	27.6920496	70.1694118	104.8726457	175.0420575
2035	6.7969726	20.7788163	12.1918994	32.9707157	12.6251145	45.5958302	30.2590063	75.8548365	114.7178647	190.5727012

TABLE B-17. Unit Variable OMP&R Component of Transportation Charge

(in dollars per acre-foot)

Calendar Year	CALIFORNIA AQUEDUCT (continued)									
	Reach 18A Alamo Powerplant		Reach 22B Pearblossom Pumping Plant		Reach 23 Mojave Siphon Powerplant		Reach 26A Devil Canyon Powerplant		Reach 29A Oso Pumping Plant	
	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate
	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	14.2519509	27.5575267	0	0	-2.3717647	25.1857620	1.4212193	14.7267951
1973	0	0	4.4326545	17.7300693	0	0	-8.4298618	9.3002075	1.0210537	14.3184685
1974	0	0	3.4431782	15.7782207	0	0	-5.1043660	10.6738547	0.9241725	13.2592150
1975	0	0	3.1739313	15.4688438	0	0	-5.6510611	9.8177827	0.9362286	13.2311411
1976	0	0	3.9391330	17.8038848	0	0	-6.4449941	11.3588907	0.8622774	14.7270292
1977	0	0	3.4988957	21.2829827	0	0	-11.6274558	9.6555269	0.9076172	18.6917042
1978	0	0	4.1619043	17.3612680	0	0	-8.1314274	9.2298406	0.7314697	13.9308334
1979	0	0	5.2283922	22.8319775	0	0	-9.5825772	13.2494003	0.9509677	18.5545530
1980	0	0	4.4253989	23.7315648	0	0	-11.5446606	12.1869042	1.4272378	20.7334037
1981	0	0	4.0325337	22.7957992	0	0	-6.7528607	16.0429385	1.5690769	20.3323424
1982	0	0	3.7143664	22.0995404	0	0	-6.9141441	15.1853963	1.4949290	19.8801030
1983	0	0	1.7592652	11.9990051	0	0	-23.7923414	-11.7933363	1.2824635	11.5222034
1984	0	0	2.5203002	17.5460979	0	0	-29.2940447	-11.7479468	1.7818310	16.8076287
1985	0	0	3.5406919	24.5146535	0	0	-30.7672356	-6.2525821	2.1691578	23.1431194
1986	-2.3583180	34.1758985	6.0306655	40.2065640	0	0	-29.2499580	10.9566060	3.2296473	39.7638638
1987	-2.5482255	29.4907224	5.0997322	34.5904546	0	0	-29.7006533	4.8898013	3.1281318	35.1670797
1988	-1.3847067	28.6841141	4.7880132	33.4721273	0	0	-29.0334518	4.4386755	2.9887414	33.0575622
1989	-1.1019487	38.4996363	6.4559997	44.9556360	0	0	-28.3706997	16.5849363	3.5266078	43.1281928
1990	-1.0673268	51.9071913	9.0317647	60.9389560	0	0	-28.8797266	32.0592294	3.6820302	56.6565483
1991	-1.5206590	34.1859899	6.1338271	40.3198170	0	0	-30.3294563	9.9903607	2.1966277	37.9032766
1992	-2.6080003	19.5839837	3.6796265	23.2636102	0	0	-29.7938993	-6.5302891	1.9058052	24.0977892
1993	-0.1885524	-4.2578449	-0.9592579	-5.2171028	0	0	-30.6629489	-35.8800517	0.1578038	-3.9114887
1994	-0.1279266	37.6304211	6.5139903	44.1444114	0	0	-30.4781656	13.6662458	3.0574815	40.8158292
1995	-3.4425314	16.2738280	3.4305039	19.7043319	0	0	-30.3517624	-10.6474305	1.5732257	21.2895851
1996	-5.9839345	33.4220040	6.6794995	40.1015035	-2.3423415	37.7591620	-29.5900574	8.1691046	3.1318961	42.5378346
1997	-4.7847600	34.0059735	6.8397922	40.8457657	-3.8632009	36.9825648	-30.6066647	6.3759001	2.7928728	41.5836063
1998	-5.0614104	-10.4573480	-1.2355351	-11.6928831	-3.7700558	-15.4629389	-30.6550762	-46.1180151	-0.3008626	-5.6968002
1999	-4.7679511	17.6372106	3.5508098	21.1880204	-4.9754645	16.2125559	-29.6766184	-13.4640625	1.8929287	24.2980904
2000	-5.3795304	21.0887786	4.6132547	25.7020333	-5.2137446	20.4882887	-30.4802775	-9.9919888	1.8186581	28.2869671
2001	-4.6442419	172.3063881	29.7998271	202.1062152	-5.7699535	196.3362617	-30.9018409	165.4344208	13.4272431	190.3778731
2002	-5.4660253	66.0187988	12.6802813	78.6990801	-6.4072093	72.2918708	-30.1661581	42.1257127	4.7724074	76.2572315
2003	-3.3577630	83.0287244	15.2059804	98.2347048	-7.2230635	91.0116413	-30.5804591	60.4311822	5.9515747	92.3380621
2004	-5.5585791	83.9943816	15.6342250	99.6286066	-7.4295016	92.1991050	-30.2399666	61.9591384	6.2328767	95.7858374
2005	-6.5254292	107.3731644	20.9387356	128.3119000	-7.9723844	120.3395156	-36.6168324	83.7226832	7.1228596	121.0214532
2006	-2.8363852	113.8515052	19.1245811	132.9760863	-6.0540536	126.9220327	-22.6285408	104.2934919	9.7423521	126.4302425
2007	-3.5469034	143.8780105	26.2029527	170.0809632	-5.9865457	164.0944175	-22.6655042	141.4289133	10.7429850	158.1678989
2008	-6.1792223	170.3546895	39.7923628	210.1470523	-11.6792032	198.4678491	-44.4925037	153.9753454	11.0326156	187.5665274
2009	-5.4956805	145.4032748	33.2046694	178.6079442	-8.5087715	170.0991727	-40.9743505	129.1248222	10.4926466	161.3916019
2010	-5.4703689	155.5932871	34.9884343	190.5817214	-8.4523027	182.1294187	-40.9840584	141.1453603	10.9811740	172.0448300
2011	-3.7860374	123.0839444	22.8805757	145.9645201	-5.3225547	140.6419654	-26.4882701	114.1536953	9.8213240	136.6913058
2012	-4.0304221	131.4290303	25.2757267	156.7047570	-5.7798695	150.9248875	-27.2106125	123.7142750	10.3368540	145.7963064
2013	-3.8962474	146.4046121	27.4713246	173.8759367	-5.5746825	168.3012542	-26.6806144	141.6206398	11.3014962	161.6023557
2014	-3.9173121	157.4613362	29.6858266	187.1471628	-5.5966388	181.5505240	-27.1093618	154.4411622	12.3559097	173.7345580
2015	-3.9250925	161.0657938	30.3209700	191.3867638	-5.6684615	185.7183023	-27.4414889	158.2768134	12.4581196	177.4490059
2016	-4.0870079	170.2740127	32.3421761	202.6161888	-5.9530494	196.6631394	-28.0451643	168.6179751	12.8994971	187.2605177
2017	-3.9098321	161.7689109	30.4636235	192.2325344	-5.7091712	186.5233632	-27.7683479	158.7550153	12.4806389	178.1593819
2018	-4.1826632	172.1253059	33.5899478	205.7152537	-6.3899838	199.3252699	-28.4853001	170.8399698	13.0016583	189.3096274
2019	-3.9873831	179.5965294	33.0397193	212.6362487	-5.9241840	206.7120647	-28.2058170	178.5062477	14.0585980	197.6425105
2020	-4.0609412	168.6396598	32.0119372	200.6515970	-6.0981792	194.5534178	-28.9731323	165.5802855	13.0286457	185.7292467
2021	-4.0726583	168.4024907	32.0421015	200.4445922	-6.1405551	194.3040371	-28.6890258	165.6150113	13.0184371	185.4935861
2022	-4.0979616	162.9575120	30.8978872	193.8553992	-6.1448703	187.7105289	-28.3573761	159.3531528	12.8058592	179.8613328
2023	-4.1514283	165.8832381	31.5450534	197.4282915	-6.2539219	191.1743696	-28.8741517	162.3002179	12.8740090	182.9086754
2024	-4.0234522	172.0024671	31.9520438	203.9545109	-6.0642824	197.8902285	-28.6574923	169.2327362	13.4550808	189.4810001
2025	-4.0946145	169.2416470	32.1667845	201.4084315	-6.1478393	195.2605922	-28.3276154	166.9329768	13.2905190	186.6267805
2026	-4.0697653	172.8150026	32.5023082	205.3173108	-6.1726456	199.1446652	-29.0294561	170.1152091	13.2409762	190.1257441
2027	-4.0945225	170.3919922	32.0768264	202.4688186	-6.1382094	196.3306092	-28.6268905	167.7037187	13.3255799	187.8120946
2028	-4.0516848	169.8822268	32.0750269	201.9572537	-6.1059301	195.8513236	-28.8099088	167.0414148	13.1457648	187.0796764
2029	-4.0719733	168.3557790	31.7315877	200.0873667	-6.1407122	193.9466545	-28.6108383	165.3358162	13.1873191	185.6150714
2030	-4.0394681	168.5704722	31.7920651	200.3625373	-6.0837927	194.2787446	-28.6758159	165.6029287	13.0606963	185.6706366
2031	-4.1527790	166.7721542	31.9969366	198.7690908	-6.5525791	192.2165117	-28.4301056	163.7864061	13.0066645	183.9315977
2032	-3.9939260	168.1764683	31.2173683	199.3938366	-6.2403091	193.1535275	-28.2123951	164.9411324	13.2199752	185.3903695
2033	-4.1979118	182.6768929	35.0120079	217.6889008	-6.7005230	210.9883778	-29.0772003	181.9111775	14.0083651	200.8831698
2034	-4.0318236	171.0102339	31.9521789	202.9624128	-6.3757357	196.5866771	-28.0784744	168.5082027	13.3933859	188.4354434
2035	-4.2531644	186.3195368	33.3291486	219.6486854	-6.5718930	213.0767924	-29.6039310	183.4728614	15.8771816	206.4498828

TABLE B-17. Unit Variable OMP&R Component of Transportation Charge

(in dollars per acre-foot)

Calendar Year	CALIFORNIA AQUEDUCT (continued)							
	Reach 29G Warne Powerplant		Reach 29J Castaic Powerplant		Reach 31A Las Perillas and Badger Hill Pumping Plants		Reach 33A Devil's Den, Bluestone, and Polonio Pass Pumping Plants	
	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate	Unit Rate	Cumulative Unit Rate
	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	1.5014866	4.1196074	0	0
1969	0	0	0	0	1.2624065	3.0743046	0	0
1970	0	0	0	0	1.6309699	3.3613191	0	0
1971	0	0	0	0	1.4985537	2.7945171	0	0
1972	0	0	-2.9350830	11.7917121	1.9517720	3.4238559	0	0
1973	0	0	-6.8099448	7.5085237	1.5374531	3.0786506	0	0
1974	0	0	-7.4013274	5.8578876	1.5168982	2.9908236	0	0
1975	0	0	-6.5604921	6.6706490	1.1130304	2.6730490	0	0
						0.0000000		
1976	0	0	-6.7213324	8.0056968	1.5685447	3.2823187	0	0
1977	0	0	-30.4985994	-11.8068952	1.7573375	4.1425967	0	0
1978	0	0	-9.0130187	4.9178147	1.9429506	4.0166744	0	0
1979	0	0	-19.0478097	-0.4932567	1.5600341	4.3745892	0	0
1980	0	0	-7.4485479	13.2848558	1.5124754	3.6989191	0	0
1981	0	0	-10.0059379	10.3264045	1.5414199	4.7207919	0	0
1982	-2.1714430	17.7086600	-9.5987314	8.1099286	1.7581649	4.3684632	0	0
1983	-8.9130752	2.6091282	-39.8193120	-37.2101838	0.1783064	1.4038458	0	0
1984	-15.0246012	1.7830275	-17.3126964	-15.5296689	0.8560669	2.7050406	0	0
1985	-14.7115359	8.4315835	-38.9450653	-30.5134818	1.2075223	3.7042097	0	0
1986	-14.1893653	25.5744985	-28.1596224	-2.5851239	2.2635962	6.9940737	0	0
1987	-14.8696165	20.2974632	-27.0536484	-6.7561852	1.9135150	5.9684757	0	0
1988	-14.7032843	18.3542779	-25.6857024	-7.3314245	1.7733304	5.5885868	0	0
1989	-14.4231503	28.7050425	-25.3986130	3.3064295	2.4154074	7.4521721	0	0
1990	-14.1850383	42.4715100	-26.0776141	16.3938959	3.7962241	9.8455425	0	0
1991	-14.7813217	23.1219549	-25.1420394	-2.0200845	2.4124332	7.1956539	0	0
1992	-14.6199453	9.4778439	-25.1951380	-15.7172941	1.2766497	4.5348543	0	0
1993	-10.3386629	-14.2501516	-21.1218951	-35.3720467	-1.1726278	-0.7534306	0	0
1994	-14.7696788	26.0461504	-26.7435205	-0.6973701	2.3664953	7.1065726	0	0
1995	-12.2705911	9.0189940	-25.6908056	-16.6718116	2.5750190	5.4284909	0	0
1996	-14.8515762	27.6862584	-29.5639188	-1.8776604	2.5837041	7.6010922	0	0
1997	-14.9272063	26.6564000	-27.1541858	-0.4977858	2.7029648	6.9426653	24.4572499	31.3999152
1998	-8.6041243	-14.3009245	-22.2303491	-36.5312736	-0.4719744	-0.5255005	-3.9178748	-4.4433753
1999	-15.4517685	8.8463219	-27.8324731	-18.9861512	1.3273109	4.0324659	9.8021998	13.8346657
2000	-14.1657262	14.1212409	-26.9670099	-12.8457690	1.8842617	5.1249292	14.2514058	19.3763350
2001	-16.7349298	173.6429433	-29.2914155	144.3515278	12.2866597	31.0076805	92.6567756	123.6644561
2002	-13.2004532	63.0567783	-23.7780801	39.2786982	5.3023584	13.8561736	41.2910941	55.1472677
2003	-13.9757183	78.3623438	-23.6270529	54.7352909	6.1431169	15.7293796	47.1787833	62.9081629
2004	-14.1574752	81.6283622	-23.6679973	57.9603649	6.2519570	16.5306345	50.7266903	67.2573248
2005	-14.2938791	106.7275741	-23.7301832	82.9973909	8.0069021	20.2247834	60.5160134	80.7407968
2006	-14.7385970	111.6916455	-26.2160936	85.4755519	8.0172156	20.2214244	49.0850937	69.3065181
2007	-11.8024282	146.3654707	-21.2107248	125.1547459	10.9089067	26.2584085	93.2476149	119.5060234
2008	-14.9471457	172.6193817	-26.2930252	146.3263565	10.1894580	28.6187830	60.3876347	89.0064177
2009	-14.6581131	146.7334888	-24.8688316	121.8646572	12.2508947	27.7521553	79.6438938	107.3960491
2010	-14.6892419	157.3555881	-25.0248561	132.3307320	12.7662137	31.1471388	83.3069960	114.4541348
2011	-13.2297879	123.4615179	-22.4386091	101.0229088	12.7688252	27.7231759	83.3379586	111.0611345
2012	-13.3723176	132.4239888	-22.8144009	109.6095879	13.6584002	28.6667108	86.1861297	114.8528405
2013	-13.5117115	148.0906442	-23.0151874	125.0754568	14.8779882	33.1552558	94.5462531	127.7015089
2014	-13.9233382	159.8112198	-23.6465534	136.1646664	15.8920615	33.3692544	101.4977369	134.8669913
2015	-13.8425360	163.6064699	-23.4962180	140.1102519	16.1145282	35.0207774	103.0226598	138.0434372
2016	-14.2025771	173.0579406	-24.1267536	148.9311870	16.2680463	37.3206264	104.0751506	141.3957770
2017	-13.9258575	164.2335244	-23.6734109	140.5601135	16.0488651	35.1540610	102.5725622	137.7266232
2018	-14.0415287	175.2680987	-23.9285500	151.3395487	16.4814390	35.9617638	105.5378794	141.4996432
2019	-14.8939517	182.7485588	-25.4923127	157.2562461	16.8617389	38.4855485	108.1447283	146.6302768
2020	-14.5769742	171.1522725	-24.8481790	146.3040935	15.9976082	35.5990382	102.2212085	137.8202467
2021	-14.5861228	170.9074633	-24.8810648	146.0263985	15.9731479	35.3133435	102.0534527	137.3667962
2022	-14.8011638	165.0601690	-25.2539205	139.8062485	15.4908520	33.6929284	98.7473762	132.4403046
2023	-14.7968307	168.1118447	-25.2466674	142.8651773	15.5765494	34.8025152	99.3348751	134.1373903
2024	-14.9259280	174.5550721	-25.4697527	149.0853194	16.1356475	36.8195894	103.1674163	139.9870057
2025	-14.8087894	171.8179911	-25.2676602	146.5503309	16.0645474	34.4400974	102.6800758	137.1201732
2026	-14.6543486	175.4713955	-25.0013368	150.4700587	16.1723996	37.4605133	103.4194320	140.8799453
2027	-14.9747134	172.8373812	-25.5508815	147.2864997	15.9335540	35.6406851	101.7820589	137.4227440
2028	-14.6676191	172.4120573	-25.0223302	147.3897271	16.0418131	36.0172149	102.5242864	138.5415013
2029	-14.9017141	170.7133573	-25.4280627	145.2852946	15.8418649	35.1210256	101.1536253	136.2746509
2030	-14.6419513	171.0286853	-24.9800081	146.0486772	15.9668726	35.7924348	102.0105661	137.8030009
2031	-14.6871435	169.2444542	-25.0722893	144.1721649	15.7530791	34.2777232	100.5449659	134.8226891
2032	-14.7089599	170.6814096	-25.1864653	145.4949443	16.0602816	35.7034034	102.6508388	138.3542422
2033	-14.7280339	186.1551359	-25.2705553	160.8845806	16.8512039	37.8062957	108.0725480	145.8788437
2034	-14.7278788	173.7075646	-25.2263838	148.4811808	16.2444798	35.9176303	103.9135053	139.8311356
2035	-17.8001752	188.6497076	-30.5411124	158.1085952	15.9195670	36.6983833	101.6862005	138.3845838

TABLE B-18. Variable OMP&R Component of Transportation Charge for Each Contractor [a]

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	2.051	34.919	0	36.970	0	0	0
1963	0	0	0	7.900	49.811	0	57.711	0	0	0
1964	0	0	0	5.931	68.203	0	74.134	0	0	0
1965	0	0	0	10.918	68.765	62.926	142.609	0	0	0
1966	0	0	0	19.330	52.135	121.141	192.606	0	0	0
1967	0	0	0	19.958	53.785	163.255	236.998	0	0	0
1968	6.989	0	6.989	29.899	120.985	341.768	492.652	0	0	0
1969	8.551	0	8.551	31.859	3.904	298.968	334.731	0	0	0
1970	13.598	0	13.598	49.687	0	431.443	481.130	0	0	0
1971	10.609	0	10.609	23.842	28.328	416.329	468.499	0	0	0
1972	14.434	0	14.434	54.838	144.669	524.208	723.715	0	0	0
1973	14.449	0	14.449	18.398	15.590	547.807	581.795	0	0	0
1974	17.473	0	17.473	9.499	29	636.186	645.714	0	0	0
1975	14.779	0	14.779	22.318	4.765	425.284	452.367	0	0	0
1976	20.856	0	20.856	97.874	121.693	502.769	722.336	0	0	0
1977	22.635	0	22.635	82.578	123.044	497.792	703.414	0	0	0
1978	21.692	0	21.692	74.911	39.986	652.860	767.757	0	0	0
1979	16.237	0	16.237	137.101	77.145	652.629	866.875	0	0	0
1980	19.945	0	19.945	98.743	64.891	517.531	681.165	0	0	0
1981	23.842	0	23.842	126.437	141.456	567.968	835.861	0	0	0
1982	12.157	0	12.157	97.117	46.742	651.246	795.105	0	0	0
1983	2.342	0	2.342	8.171	5.412	148.743	162.326	0	0	0
1984	4.822	0	4.822	26.707	13.141	349.314	389.162	0	0	0
1985	10.188	0	10.188	79.863	102.790	466.291	648.944	0	0	0
1986	15.501	0	15.501	112.370	131.118	932.090	1.175.578	0	0	0
1987	27.223	0	27.223	216.211	234.290	812.631	1.263.132	0	0	0
1988	31.265	11.533	42.798	229.578	297.129	779.537	1.306.244	0	0	0
1989	37.874	66.850	104.724	306.533	304.275	1.051.562	1.662.370	0	0	0
1990	54.736	105.421	160.157	524.114	502.545	1.456.008	2.482.667	0	0	0
1991	8.159	18.824	26.983	105.736	142.105	316.839	564.680	0	(2.636)	(2.636)
1992	12.515	23.808	36.323	93.772	122.436	273.849	490.057	0	0	0
1993	(7.223)	(17.293)	(24.516)	(36.162)	(12.912)	(78.024)	(127.098)	0	0	0
1994	39.106	77.257	116.363	231.800	257.533	642.006	1.131.339	0	0	0
1995	15.701	36.724	52.425	160.663	93.610	151.287	405.560	0	0	0
1996	31.526	96.570	128.096	214.883	186.694	735.431	1.137.008	502	0	502
1997	29.683	116.555	146.238	351.185	219.799	912.861	1.483.845	34.932	233.584	268.516
1998	(6.178)	(18.511)	(24.689)	(6.218)	(16.448)	(65.208)	(87.874)	(15.961)	(82.727)	(98.688)
1999	14.757	52.720	67.477	243.434	193.968	450.667	888.069	51.783	278.589	330.372
2000	21.999	94.213	116.212	377.922	239.083	754.700	1.371.705	76.769	440.637	517.406
2001	289.309	531.337	820.646	1.679.427	991.540	2.835.762	5.506.729	529.655	2.342.947	2.872.602
2002	88.266	260.234	348.500	1.044.099	626.264	1.420.252	3.090.615	240.166	1.530.422	1.770.588
2003	127.364	258.679	386.043	1.047.074	630.062	2.237.611	3.914.747	280.147	1.696.611	1.976.758
2004	141.905	337.958	479.863	1.281.030	603.718	1.559.326	3.444.074	280.136	1.997.943	2.278.079
2005	192.704	374.839	567.543	1.465.137	850.315	2.484.981	4.800.433	343.229	1.884.813	2.228.042
2006	612.268	869.696	1.481.964	1.987.206	1.314.443	2.537.608	5.839.257	1.769.257	2.402.441	4.171.698
2007	861.269	1.155.069	2.016.338	2.702.860	1.518.810	2.894.110	7.115.780	576.497	5.435.851	6.012.348
2008	995.852	1.359.482	2.355.334	3.501.728	1.725.781	3.522.002	8.749.511	2.225.160	4.048.546	6.273.706
2009	545.114	689.497	1.234.611	3.498.700	1.740.546	3.456.745	8.695.991	2.684.901	4.885.017	7.569.918
2010	581.321	719.688	1.301.009	3.825.955	1.907.563	3.823.758	9.557.276	2.861.353	5.206.061	8.067.414
2011	591.454	720.495	1.311.949	3.172.102	1.543.758	4.149.565	8.865.425	2.776.528	5.051.727	7.828.255
2012	623.045	744.191	1.367.236	3.228.909	1.570.454	4.225.773	9.025.136	2.871.321	5.224.196	8.095.517
2013	695.878	812.682	1.508.560	3.677.179	1.793.768	4.801.996	10.272.943	3.192.538	5.808.631	9.001.169
2014	763.636	870.057	1.633.693	3.761.472	1.829.452	4.922.821	10.513.745	3.371.675	6.134.560	9.506.235
2015	802.042	883.580	1.685.622	3.910.203	1.905.082	5.110.971	10.926.256	3.451.086	6.279.044	9.730.130
2016	835.502	892.886	1.728.388	4.094.368	2.000.415	5.340.640	11.435.423	3.534.894	6.431.528	9.966.422
2017	847.547	881.277	1.728.824	3.914.066	1.907.769	5.114.434	10.936.269	3.443.166	6.264.633	9.707.799
2018	899.870	906.227	1.806.097	3.996.770	1.947.957	5.222.768	11.167.495	3.537.491	6.436.253	9.973.744
2019	950.895	928.296	1.879.191	4.224.029	2.063.341	5.510.616	11.797.986	3.665.757	6.669.625	10.335.382
2020	921.939	880.274	1.802.213	3.931.580	1.918.143	5.133.716	10.983.439	3.445.506	6.268.892	9.714.398
2021	924.633	879.127	1.803.760	3.906.247	1.905.182	5.101.827	10.913.256	3.434.170	6.248.266	9.682.436
2022	893.252	851.898	1.745.150	3.740.904	1.823.115	4.888.693	10.452.712	3.311.008	6.024.180	9.335.188
2023	898.828	856.737	1.755.565	3.834.032	1.871.047	5.005.369	10.710.448	3.353.435	6.101.373	9.454.808
2024	935.205	888.303	1.823.508	4.037.776	1.972.421	5.267.513	11.277.710	3.499.675	6.367.449	9.867.124
2025	930.579	884.287	1.814.866	3.840.313	1.870.178	5.021.338	10.731.829	3.428.004	6.237.048	9.665.052
2026	937.598	890.377	1.827.975	4.092.236	2.000.475	5.335.694	11.428.405	3.521.999	6.408.065	9.930.064
2027	922.057	876.892	1.798.949	3.925.631	1.915.846	5.124.761	10.966.238	3.435.569	6.250.811	9.686.380
2028	929.100	883.004	1.812.104	3.930.759	1.919.443	5.129.355	10.979.557	3.463.538	6.301.699	9.765.237
2029	916.090	871.715	1.787.805	3.878.835	1.892.147	5.065.371	10.836.353	3.406.866	6.198.589	9.605.455
2030	924.226	878.775	1.803.001	3.945.050	1.925.415	5.149.923	11.020.388	3.445.075	6.268.107	9.713.182
2031	910.314	866.704	1.777.018	3.804.385	1.854.114	4.971.534	10.630.033	3.370.567	6.132.545	9.503.112
2032	930.303	884.046	1.814.349	3.946.901	1.925.462	5.154.025	11.026.388	3.458.856	6.293.181	9.752.037
2033	981.764	928.702	1.910.466	4.160.094	2.030.590	5.430.224	11.620.908	3.646.971	6.635.445	10.282.416
2034	942.287	894.446	1.836.733	3.974.905	1.938.637	5.191.560	11.105.102	3.495.778	6.360.359	9.856.137
2035	921.146	876.102	1.797.248	3.979.408	1.945.679	5.187.935	11.113.022	3.459.615	6.294.561	9.754.176
TOTAL	26,846,804	28,952,230	55,799,034	123,203,121	63,456,345	171,433,271	358,092,737	96,959,614	186,988,866	283,948,480

a) Table B-18 includes extra peaking charges for additional power shown in Table 9.

TABLE B-18. Variable OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA								
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Kern County Water Agency		County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
				Municipal and Industrial	Agricultural				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	68,977	5,176	0	0	440,922	2,355	4,760	65,680	587,870
1969	56,774	101	0	0	321,387	181	3,338	17,956	399,737
1970	69,818	6,811	0	0	470,867	0	5,595	16,550	569,641
1971	53,097	7,747	0	0	769,054	4,785	6,353	158,419	999,455
1972	62,365	8,515	0	0	1,151,788	2,057	7,375	379,686	1,611,786
1973	33,931	4,615	0	0	770,121	2,307	3,017	77,630	891,621
1974	49,114	4,413	0	46,752	677,660	2,206	3,114	106,332	889,591
1975	63,140	4,671	0	34,580	848,249	2,491	3,920	134,295	1,091,346
1976	70,851	5,132	0	94,653	966,820	2,737	4,910	100,597	1,245,701
1977	26,565	1,758	0	84,875	498,624	3,644	2,602	43,067	661,135
1978	108,944	938	0	190,675	1,616,975	4,319	6,294	24,901	1,953,046
1979	107,956	4,871	0	194,048	2,371,175	5,602	13,172	434,472	3,131,297
1980	88,746	1,935	0	121,603	1,731,588	4,762	7,766	163,301	2,119,701
1981	129,687	18,533	0	263,077	2,398,339	7,275	8,904	263,922	3,089,737
1982	108,561	937	0	145,246	2,375,404	4,541	6,763	48,137	2,689,589
1983	61,443	0	0	13,954	929,183	5,662	3,232	1,218	1,014,692
1984	82,423	0	0	216,437	1,996,259	5,946	7,475	10,496	2,319,036
1985	114,571	12,938	0	242,645	2,567,184	8,422	8,815	271,970	3,226,545
1986	236,756	5,513	0	377,798	4,876,960	17,433	16,927	376,088	5,907,475
1987	187,090	10,273	0	504,168	4,230,949	16,140	15,529	375,604	5,339,753
1988	188,170	14,894	0	524,965	4,250,194	15,528	11,928	374,528	5,380,207
1989	285,261	15,450	0	681,238	6,158,648	20,063	21,693	649,604	7,831,957
1990	218,786	7,710	0	845,877	4,778,185	12,056	12,072	344,008	6,218,694
1991	4,393	1,047	0	185,013	47,869	0	521	10,331	249,174
1992	76,840	4,426	0	227,332	1,699,824	6,059	5,222	151,055	2,170,758
1993	20,064	4,843	0	78,585	340,588	2,090	1,467	123,913	571,550
1994	135,626	7,854	0	471,316	3,417,815	9,967	10,102	293,748	4,346,428
1995	181,772	4,611	0	409,656	3,437,735	11,619	10,492	288,010	4,343,895
1996	286,064	9,577	0	715,404	6,328,965	21,039	16,403	1,196,303	8,573,755
1997	308,515	0	0	650,416	5,627,735	0	15,559	94,838	6,697,063
1998	19,652	(28)	0	63,221	63,450	(1)	1,318	(1,107)	146,505
1999	161,490	8,592	0	470,360	3,349,552	10,821	9,074	790,700	4,800,589
2000	196,187	5,830	0	417,007	4,033,798	11,666	10,413	642,667	5,317,568
2001	777,821	25,461	0	442,707	11,535,052	29,205	45,389	1,115,061	13,970,696
2002	418,442	12,018	0	809,800	7,293,812	24,413	29,241	793,881	9,381,607
2003	441,754	13,766	0	1,061,838	9,252,120	35,392	27,905	1,014,620	11,847,395
2004	504,583	36,620	0	1,368,881	8,654,665	93,072	32,722	835,324	11,525,867
2005	998,003	46,843	0	1,133,280	17,846,799	241,987	34,769	1,710,528	22,012,209
2006	715,801	51,697	0	1,370,671	15,586,354	121,436	41,137	1,205,422	19,092,518
2007	880,186	46,049	0	2,009,327	17,054,013	146,154	59,159	1,472,355	21,667,243
2008	1,056,793	55,288	0	2,411,594	20,395,905	174,593	72,452	1,767,778	25,934,403
2009	888,889	46,504	0	2,244,888	17,264,496	147,976	58,363	1,486,912	22,138,028
2010	1,054,017	55,143	0	2,640,997	19,947,794	174,928	73,209	1,763,135	25,709,223
2011	857,527	44,863	0	2,144,411	16,365,941	143,045	57,949	1,434,451	21,048,187
2012	860,622	45,025	0	2,161,617	16,664,530	143,818	56,481	1,439,627	21,371,720
2013	1,048,073	54,832	0	2,615,214	19,836,520	174,608	72,267	1,753,192	25,554,706
2014	1,002,195	52,432	0	2,521,434	19,478,323	167,472	64,970	1,676,447	24,963,273
2015	1,084,141	56,719	0	2,716,347	20,777,935	180,838	72,582	1,813,525	26,702,087
2016	1,207,218	63,158	0	3,013,607	22,789,812	200,856	83,526	2,019,406	29,377,583
2017	1,095,549	57,316	0	2,743,672	20,952,884	182,669	73,698	1,832,609	26,938,397
2018	1,117,060	58,441	0	2,806,087	21,521,431	186,291	73,823	1,868,592	27,631,725
2019	1,239,974	64,871	0	3,100,589	23,511,636	206,352	84,911	2,074,199	30,282,532
2020	1,124,005	58,804	0	2,817,978	21,504,971	187,271	75,514	1,880,208	27,648,751
2021	1,109,025	58,021	0	2,782,851	21,277,495	184,832	74,039	1,855,150	27,341,413
2022	1,043,762	54,606	0	2,624,621	20,162,424	174,095	68,636	1,745,980	25,874,124
2023	1,102,475	57,678	0	2,764,709	21,094,050	183,648	74,088	1,844,193	27,120,841
2024	1,186,079	62,052	0	2,966,299	22,498,024	197,385	81,210	1,984,045	28,975,094
2025	1,053,709	55,127	0	2,655,135	20,488,816	175,884	68,173	1,762,620	26,259,464
2026	1,220,724	63,864	0	3,047,921	23,028,708	203,018	84,582	2,041,998	29,690,815
2027	1,130,066	59,121	0	2,834,128	21,622,995	188,235	75,900	1,890,347	27,800,792
2028	1,145,449	59,926	0	2,869,314	21,846,956	190,764	74,647	1,916,080	28,103,136
2029	1,105,525	57,837	0	2,774,623	21,212,110	184,224	73,797	1,849,296	27,257,412
2030	1,136,857	59,477	0	2,847,776	21,689,401	189,347	76,868	1,901,708	27,901,434
2031	1,062,259	55,574	0	2,672,188	20,536,796	177,177	69,690	1,776,921	26,350,605
2032	1,126,396	58,929	0	2,822,939	21,535,762	187,678	75,795	1,884,208	27,691,707
2033	1,201,628	62,865	0	3,015,146	23,010,700	200,127	80,476	2,010,054	29,580,996
2034	1,128,117	59,019	0	2,830,298	21,635,709	188,013	75,359	1,887,088	27,803,603
2035	1,191,520	62,336	0	2,995,653	22,841,732	198,202	79,697	1,993,146	29,362,286
TOTAL	39,179,873	2,021,965	0	92,909,441	748,260,537	6,008,777	2,589,149	67,329,025	958,298,768

TABLE B-18. Variable OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	30.401	0	0	0	0	0	0	0	0
1969	0	30.627	0	0	0	0	0	0	0	0
1970	0	39.430	0	0	0	0	0	0	0	0
1971	0	34.871	0	0	0	0	0	0	0	0
1972	780	47.571	0	12.785	0	4.496	1.515	0	32.107	0
1973	286	28.968	102.812	6.896	159.536	3.855	0	0	301.444	0
1974	15.558	28.982	100.955	9.890	157.742	4.932	221	0	177.173	5.961
1975	99.186	28.568	108.253	12.758	170.111	6.391	0	0	136.066	50.723
1976	385.090	38.365	135.276	17.835	213.594	8.164	0	0	139.354	65.476
1977	199.166	21.006	0	23.598	0	1.974	1.702	0	239.663	74.838
1978	581.729	45.550	174.116	20.875	264.178	2.731	0	0	37.043	67.462
1979	1,058.904	83.940	228.437	28.603	340.510	2.328	90.803	0	236	3.668
1980	1,390.117	51.143	256.759	29.229	401.038	3.667	94.362	0	0	16.504
1981	1.480.362	118.583	274.149	33.632	430.304	23.861	90.590	0	254.649	57.523
1982	923.973	132.575	292.674	27.190	461.216	0	230.608	0	126.461	189.895
1983	333.772	(335.712)	172.336	10.792	272.477	385	0	0	(71.602)	(8.768)
1984	485.847	(142.910)	273.597	19.572	433.785	15	0	0	(66.353)	(91.433)
1985	821.069	(335.343)	413.406	34.603	657.011	0	0	32.464	(47.544)	(32.348)
1986	1,109.047	54.812	728.808	60.274	1,160.650	5.548	0	105.375	69.170	101.843
1987	1.019.605	(40.745)	668.383	63.601	1.083.530	32.651	585	157.843	88.076	49.930
1988	1,019.793	(74.006)	688.891	66.914	1,134.141	11.991	300	50.654	92.465	38.688
1989	1,736.901	178.359	978.885	97.114	1,633.489	38.269	8.951	350.953	340.460	210.334
1990	2,442.558	422.502	1,402.619	110.934	2,313.410	90.472	0	446.408	599.573	530.099
1991	286.485	(3.054)	277.078	33.945	456.999	17.978	128.405	132.700	35.339	52.116
1992	587.340	(208.900)	240.119	11.952	396.022	4.871	241.338	78.306	(22.718)	(53.500)
1993	(190.611)	(491.161)	(809.033)	(2.389)	(1.334.429)	(3.246)	(61.112)	(29.466)	(157.452)	(519.798)
1994	1.841.902	66.338	189.616	34.480	312.714	41.201	731.185	315.446	122.829	204.783
1995	761.209	(247.735)	(251.547)	7.960	(414.889)	7.727	165.622	114.342	(7.579)	(140.714)
1996	1,883.530	72.171	508.274	18.313	838.330	16.510	289.044	385.745	49.537	133.848
1997	2,121.818	22.440	365.342	24.076	330.153	15.099	414.596	438.212	61.553	115.882
1998	(553.432)	(722.825)	(3,952.729)	(2.892)	(3,258.099)	(4.225)	(44.233)	(80.469)	(86.610)	(429.359)
1999	1.218.255	(530.571)	(679.666)	18.353	(782.262)	6.032	167.446	245.763	(173.336)	(242.474)
2000	1.762.537	(352.398)	(422.891)	24.463	(581.873)	0	286.211	191.064	(183.843)	(151.279)
2001	10.827.817	4.470.124	1.505.453	207.527	2.483.171	0	854.664	1.796.639	4.382.027	390.425
2002	3.846.682	1.896.064	705.816	158.247	1.164.355	0	324.654	1.221.084	3.011.471	1.046.866
2003	4,984.131	2.894.664	872.808	142.251	1.439.410	0	1.398.478	958.733	1.656.721	1.325.498
2004	5,021.152	3.147.856	958.231	184.956	1,312.960	0	1,293.614	1,021.566	3.479.126	777.056
2005	6.424.244	3.349.052	2.876.377	24.670	4.109.863	0	1.715.312	1.257.555	1.576.917	1.170.778
2006	8,477.497	3.896.596	6.314.971	368.074	2,607.337	91.081	5.215.910	2,081.661	7,822.220	1.581.089
2007	7,697.860	6.415.288	14.793.464	548.075	4.377.225	330.919	3.106.484	3.064.602	10.267.739	1.697.147
2008	21.431.162	10.666.083	18.646.414	1.174.930	7.698.767	391.816	13.911.938	3.628.555	15.797.870	4.434.490
2009	20.430.121	8.909.572	15.637.016	986.575	6.456.241	334.428	13.483.462	3.097.090	13.248.207	3.718.795
2010	21.863.678	9.711.788	17.092.703	1.056.351	7.057.268	357.865	14.402.884	3.314.137	14.481.514	4.064.986
2011	17.404.070	9.175.897	13.824.012	815.723	5.707.685	283.093	11.029.790	2.621.688	11.712.169	3.287.626
2012	18.584.065	10.434.833	14.981.799	875.364	6.185.714	302.287	11.840.307	2.799.438	12.693.085	3.562.971
2013	20.701.612	11.907.183	17.150.259	976.147	7.081.032	336.731	13.138.589	3.118.418	14.530.278	4.078.674
2014	22.265.033	12.962.876	18.702.825	1.052.993	7.722.058	362.161	14.141.226	3.353.926	15.845.663	4.447.905
2015	22,774.703	13.338.496	19,167.322	1.077.166	7,913.841	370.451	14.461.635	3,430.701	16.239.201	4.558.372
2016	24,076.745	14,178.249	20,419.637	1.140.646	8,430.899	391.630	15.309.794	3.626.836	17.300.204	4.856.198
2017	22.874.124	13.381.323	19.225.232	1.081.836	7.937.751	372.069	14.525.531	3.445.678	16.288.265	4.572.144
2018	24,338.518	14,407.525	20.688.720	1.156.087	8,541.998	395.888	15.542.831	3.666.269	17.528.181	4.920.191
2019	25,394.949	14,970.795	21,617.107	1.198.930	8,925.312	413.072	16.068.268	3,825.406	18,314.741	5.140.980
2020	23.845.648	13.928.150	20.051.773	1.128.410	8.279.014	387.871	15.161.373	3.592.025	16.988.537	4.768.712
2021	23,812.112	13,901.713	20,055.978	1.126.963	8,280.751	387.326	15.145.637	3,586.973	16.992.100	4.769.712
2022	23,042.192	13,309.555	19,297.667	1.088.721	7,967.658	374.802	14.647.892	3,470.995	16.349.633	4.589.371
2023	23.455.890	13.600.765	19.654.556	1.108.811	8.115.011	381.531	14.917.747	3.533.313	16.652.002	4.674.246
2024	24,321.149	14,192.922	20,494.084	1.147.763	8,461.637	395.606	15,411.824	3,663.653	17,363.279	4.873.903
2025	23.930.769	13.951.592	20,215.583	1.132.511	8,346.649	389.256	15,218.509	3.604.847	17.127.323	4.807.670
2026	24,436.041	14,324.750	20,600.952	1.155.039	8,505.760	397.475	15.514.299	3.680.960	17.453.820	4.899.318
2027	24,093.428	14,021.675	20,308.920	1.138.718	8,385.186	391.902	15.299.021	3.629.349	17.206.402	4.829.867
2028	24,021.347	14,031.502	20,228.715	1.135.938	8,352.071	390.729	15.260.247	3.618.491	17.138.449	4.810.793
2029	23.805.507	13.831.160	20.022.167	1.124.891	8.266.791	387.218	15.119.025	3.585.978	16.963.455	4.761.672
2030	23,835.865	13,903.834	20,054.515	1.126.817	8,280.146	387.712	15.139.792	3,590.551	16.990.860	4.769.364
2031	23.581.583	13.725.190	19,834.534	1.114.856	8.189.320	383.576	15.018.702	3.552.247	16.804.485	4.717.048
2032	23.780.153	13.851.119	19.974.371	1.120.290	8.247.057	386.806	15.067.227	3.582.159	16.922.960	4.750.305
2033	25.830.513	15.316.212	22.029.444	1.223.733	9.095.559	420.157	16.448.301	3.891.018	18.664.087	5.239.042
2034	24,180.847	14,135.408	20,406.343	1,140.203	8,425,410	393,324	15,336.623	3,642,518	17,288.942	4.853.036
2035	26,345.582	15,051,938	22,218,564	1,235,845	9,173,643	428,535	16,599,377	3,968,606	18,824,316	5,284,018
TOTAL	720,559,566	393,283,591	573,093,251	33,331,413	248,773,939	11,360,994	429,909,106	112,459,005	493,992,410	137,330,168

TABLE B-18. Variable OMP&R Component of Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	36,970
1963	0	0	0	0	0	0	0	0	0	57,711
1964	0	0	0	0	0	0	0	0	0	74,134
1965	0	0	0	0	0	0	0	0	0	142,609
1966	0	0	0	0	0	0	0	0	0	192,606
1967	0	0	0	0	0	0	0	0	0	236,998
1968	0	0	0	30,401	0	0	0	0	0	1,117,912
1969	0	0	0	30,627	0	0	0	0	0	773,646
1970	0	0	0	39,430	0	0	0	0	0	1,103,799
1971	0	0	0	34,871	0	0	0	0	0	1,513,434
1972	0	848,011	0	947,266	0	0	0	0	0	3,297,202
1973	0	1,083,328	0	1,687,126	0	0	0	0	0	3,174,991
1974	0	1,872,297	0	2,373,712	0	0	0	0	0	3,926,489
1975	0	3,887,152	0	4,499,209	0	0	0	0	0	6,057,701
1976	0	5,485,263	0	6,488,418	0	0	0	0	0	8,477,311
1977	0	(796,686)	0	(234,739)	0	0	0	0	0	1,152,444
1978	0	3,696,428	0	4,890,112	0	0	0	0	0	7,632,606
1979	0	4,021,960	0	5,859,389	0	0	0	0	0	9,873,798
1980	0	5,362,245	0	7,605,064	0	0	0	0	0	10,425,875
1981	0	10,862,932	0	13,626,585	0	0	0	0	0	17,576,025
1982	0	7,685,168	0	10,069,760	0	0	0	0	0	13,566,611
1983	0	(8,994,497)	0	(8,620,817)	0	0	0	0	0	(7,441,457)
1984	0	(7,633,741)	0	(6,721,621)	0	0	0	0	0	(4,008,601)
1985	0	(15,213,299)	0	(13,669,981)	0	0	0	0	0	(9,784,304)
1986	0	1,135,478	0	4,531,005	0	0	0	0	0	11,629,559
1987	0	(3,007,097)	0	116,362	0	0	0	0	0	6,746,470
1988	0	(3,407,929)	0	(378,098)	0	0	0	0	0	6,351,151
1989	0	9,488,536	0	15,062,251	0	0	0	0	0	24,661,302
1990	0	30,759,725	204,582	39,322,882	0	0	0	0	0	48,184,400
1991	0	184,870	22,623	1,625,484	0	0	0	0	0	2,463,685
1992	0	(9,471,028)	0	(8,196,198)	0	0	0	0	0	(5,499,060)
1993	0	(21,473,875)	0	(25,072,572)	0	0	0	0	0	(24,652,636)
1994	0	4,059,683	0	7,920,177	0	0	0	0	0	13,514,307
1995	0	(4,895,977)	0	(4,901,581)	0	0	0	0	0	(99,701)
1996	0	1,859,275	0	6,054,577	0	0	0	0	0	15,893,938
1997	0	2,428,729	(921)	6,336,979	0	0	0	0	0	14,932,641
1998	0	(14,440,371)	(67,583)	(23,642,827)	0	0	0	0	0	(23,707,573)
1999	0	(10,520,287)	(35,124)	(11,307,871)	0	0	0	0	0	(5,221,364)
2000	0	(14,717,733)	7,302	(14,138,440)	0	0	0	0	0	(6,815,549)
2001	0	158,911,350	267,050	186,096,247	0	0	0	0	0	209,266,920
2002	0	57,208,907	271,168	70,855,314	0	0	0	0	0	85,446,624
2003	7,010	89,819,141	348,102	105,846,947	0	0	0	0	0	123,971,890
2004	52,109	102,056,117	400,088	119,704,831	0	0	0	0	0	137,432,714
2005	57,936	108,335,701	138,191	131,036,596	0	0	0	0	0	160,644,823
2006	280,549	170,559,710	427,378	209,724,073	0	0	0	0	0	240,309,510
2007	1,060,717	228,593,024	2,569,909	284,522,453	0	0	0	0	0	321,334,162
2008	2,663,773	202,844,808	3,009,350	306,299,956	0	0	0	0	0	349,612,910
2009	2,233,859	169,323,956	2,515,630	260,374,952	0	0	0	0	0	300,013,500
2010	2,441,815	184,273,086	2,725,443	282,843,518	0	0	0	0	0	327,478,440
2011	1,974,859	204,716,385	2,091,140	284,644,137	0	0	0	0	0	323,697,953
2012	2,140,257	221,991,008	2,264,057	308,655,185	0	0	0	0	0	348,514,794
2013	2,450,037	253,712,062	2,574,007	351,755,029	0	0	0	0	0	398,092,407
2014	2,671,832	276,440,025	2,797,780	382,766,303	0	0	0	0	0	429,383,249
2015	2,738,189	283,884,801	2,876,218	392,831,096	0	0	0	0	0	441,875,191
2016	2,917,091	302,090,302	3,054,623	417,792,854	0	0	0	0	0	470,300,670
2017	2,746,462	284,769,772	2,885,774	394,105,961	0	0	0	0	0	443,417,250
2018	2,955,531	306,529,087	3,102,166	423,772,992	0	0	0	0	0	474,352,053
2019	3,088,158	319,385,947	3,225,426	441,569,091	0	0	0	0	0	495,864,182
2020	2,864,539	296,705,536	3,004,354	410,705,942	0	0	0	0	0	460,854,743
2021	2,865,140	296,450,985	2,998,903	410,374,293	0	0	0	0	0	460,115,158
2022	2,756,810	284,524,287	2,875,675	394,295,258	0	0	0	0	0	441,702,432
2023	2,807,794	290,272,512	2,936,831	402,111,009	0	0	0	0	0	451,152,671
2024	2,927,726	302,792,243	3,061,936	419,107,725	0	0	0	0	0	471,051,161
2025	2,887,941	298,154,618	3,010,600	412,777,868	0	0	0	0	0	461,249,079
2026	2,942,993	304,995,036	3,088,155	421,994,598	0	0	0	0	0	474,871,857
2027	2,901,274	299,592,376	3,026,215	414,824,333	0	0	0	0	0	465,076,692
2028	2,889,816	299,112,763	3,026,615	414,017,476	0	0	0	0	0	464,677,510
2029	2,860,310	295,442,815	2,985,804	409,156,793	0	0	0	0	0	458,643,818
2030	2,864,931	296,463,187	2,999,661	410,407,235	0	0	0	0	0	460,845,240
2031	2,833,505	292,929,280	2,962,421	405,646,747	0	0	0	0	0	453,907,515
2032	2,853,482	295,309,169	2,989,236	408,834,334	0	0	0	0	0	459,118,815
2033	3,147,063	326,123,959	3,297,294	450,726,382	0	0	0	0	0	504,121,168
2034	2,915,192	301,530,972	3,049,087	417,297,905	0	0	0	0	0	467,899,480
2035	3,174,081	324,653,312	3,258,376	450,216,193	0	0	0	0	0	502,242,925
TOTAL	78,972,781	8,710,646,800	86,245,542	12,029,958,568	0	0	0	0	0	13,686,097,586

TABLE B-19. Total Transportation Charge for Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	11,750	43,787	21,132	76,669	0	0	0
1963	0	0	0	199,673	190,236	447,594	837,503	0	0	0
1964	0	0	0	263,210	277,398	621,174	1,161,782	6,694	21,659	28,353
1965	0	0	0	373,722	404,239	1,157,791	1,935,752	13,751	36,017	49,768
1966	18,057	0	18,057	419,362	421,628	1,412,600	2,253,590	26,516	61,329	87,845
1967	41,560	0	41,560	538,988	498,337	1,685,708	2,723,033	56,450	118,225	174,675
1968	128,588	0	128,588	663,603	603,365	1,984,791	3,251,759	115,927	229,740	345,667
1969	254,662	0	254,662	787,031	539,211	2,082,793	3,409,035	185,117	358,783	543,900
1970	277,493	0	277,493	822,758	532,434	2,202,293	3,557,485	200,110	387,595	587,705
1971	227,419	0	227,419	787,810	551,979	2,169,422	3,509,211	202,372	392,830	595,202
1972	224,922	0	224,922	829,451	678,385	2,319,944	3,827,780	209,015	406,506	615,521
1973	221,035	31,353	252,388	794,675	549,258	2,338,141	3,682,074	206,516	402,639	609,155
1974	240,442	32,924	273,366	818,457	564,459	2,505,879	3,888,795	208,503	407,005	615,508
1975	237,400	36,276	273,676	868,312	605,595	2,409,443	3,883,350	225,853	439,786	665,639
1976	271,231	40,819	312,050	959,078	734,676	2,500,026	4,193,780	228,933	447,212	676,145
1977	293,565	45,078	338,643	923,250	713,422	2,475,917	4,112,589	238,656	468,632	707,288
1978	273,807	49.159	322.966	978.585	692.451	2.785.503	4,456.539	245.286	484.166	729,452
1979	289.415	53.320	342.735	1,043.753	736.221	2.813.091	4.593.065	243.064	483.342	726.406
1980	310.779	67.724	378,502	1,161.767	866,233	3.027.715	5.055.715	269.812	536,977	806.789
1981	347,710	87,377	435,087	1,127,434	879,216	2,917,088	4,923,738	288,950	586,152	875,102
1982	438,260	106,881	545,141	1,165,322	850,343	3,261,612	5,277,277	290,002	582,655	872,657
1983	354,703	151,207	505,911	1,176,878	900,223	3,794,952	5,872,053	319,167	633,079	952,246
1984	467,232	224,170	691,403	1,469,016	1,097,338	5,737,303	8,303,657	351,573	695,455	1,047,028
1985	735,929	364,186	1,100,115	1,919,455	1,789,224	6,551,042	10,259,721	394,545	776,889	1,171,434
1986	1,084,468	692,256	1,776,724	1,746,659	1,528,587	6,862,724	10,137,970	385,497	762,577	1,148,074
1987	1,773,371	1,558,749	3,332,120	2,236,518	2,011,731	6,674,848	10,923,097	385,240	812,198	1,197,438
1988	2,231,006	2,333,097	4,564,103	2,238,150	2,210,377	6,368,341	10,816,868	420,101	978,488	1,398,589
1989	2,396,678	3,325,671	5,722,349	2,154,455	1,871,882	5,916,199	9,942,536	414,171	1,162,567	1,576,738
1990	2,745,521	3,432,532	6,178,053	2,573,752	2,261,764	6,667,922	11,503,438	487,553	1,234,234	1,721,787
1991	2,748,016	3,681,509	6,429,525	1,753,376	1,621,035	4,527,400	7,901,811	491,359	1,476,188	1,967,547
1992	2,553,906	3,528,155	6,082,061	2,074,547	2,003,168	5,385,315	9,463,030	550,978	1,490,922	2,041,900
1993	2,592,266	3,503,436	6,095,702	2,879,786	2,011,060	6,511,316	11,402,162	610,046	1,675,150	2,285,196
1994	2,717,706	3,536,656	6,254,362	2,906,520	2,642,290	7,313,944	12,862,754	767,812	2,472,978	3,240,790
1995	2,648,648	3,509,127	6,157,775	3,034,893	2,288,863	5,893,110	11,216,866	995,188	4,975,940	5,971,128
1996	2,698,584	3,890,907	6,589,491	2,584,033	2,137,277	6,674,929	11,396,239	1,837,045	13,762,994	15,600,039
1997	2,641,264	3,630,366	6,271,631	2,657,288	2,007,165	6,550,905	11,215,358	2,294,408	21,854,823	24,149,231
1998	2,538,666	3,478,852	6,017,518	2,266,317	2,066,608	6,302,898	10,635,823	2,977,681	26,603,247	29,580,928
1999	2,680.098	3.827.995	6.508.093	2,854,240	2,432,691	8.329.945	13.616.876	3.026,766	27.400.521	30.427.287
2000	2.832.254	4.307.492	7.139.746	3.914.367	2.305.297	7.035.630	13.255.294	2.961.476	28.194.146	31.155.622
2001	3,345.975	4,910.381	8,256.356	5,221.304	2,795.887	9.020.109	17,037.300	3,512.117	30,214.029	33.726.146
2002	3.551.401	5,041.301	8.592.703	5.009.756	2.765.455	9.893.110	17.668.321	3.222.824	29.892.377	33.115.201
2003	3,660.175	5,383.193	9,043.368	4,826.354	2,492.705	8,679.255	15,998.314	3.302.249	30.145.999	33.448.248
2004	4,140,126	5,595,671	9,735,797	5,659,101	2,792,486	8,149,125	16,600,712	3,319,474	30,643,388	33,962,862
2005	3,515,496	5,127,627	8,643,123	5,855,730	3,061,038	9,189,090	18,105,858	3,463,147	30,999,961	34,463,108
2006	4,332,110	6,073,120	10,405,230	6,693,651	3,759,204	9,882,121	20,334,976	5,467,613	31,639,426	37,107,039
2007	4,786,418	6,451,513	11,237,931	7,952,209	4,182,838	10,781,682	22,916,729	3,777,497	35,469,254	39,246,751
2008	5,378,515	6,826,562	12,205,077	9,410,367	4,665,940	12,133,589	26,209,896	6,282,210	34,521,273	40,803,483
2009	4,755,139	5,021,690	9,776,829	9,424,619	4,762,431	12,057,871	26,244,921	6,562,007	33,793,995	40,356,002
2010	4,797,348	5,054,276	9,851,624	9,762,202	4,934,772	12,436,909	27,133,883	6,748,133	34,158,126	40,906,259
2011	4,753,895	5,072,872	9,826,767	8,931,602	4,469,798	12,881,963	26,283,363	6,442,599	33,632,833	40,075,432
2012	4,789,448	5,098,510	9,887,958	8,992,584	4,498,625	12,963,915	26,455,124	6,541,448	33,839,960	40,381,408
2013	4,777,169	5,084,588	9,861,757	8,865,851	4,420,401	12,650,095	25,936,347	6,543,881	33,845,422	40,389,303
2014	4,753,594	5,055,270	9,808,864	8,458,828	4,185,208	12,054,153	24,698,189	6,382,450	33,542,902	39,925,352
2015	4,779,976	5,057,487	9,837,463	8,474,918	4,143,918	11,798,306	24,417,142	6,408,332	33,589,534	39,997,866
2016	4,789,424	5,062,430	9,851,854	8,604,763	4,200,902	11,833,908	24,639,573	6,468,676	33,695,388	40,164,064
2017	4,775,083	5,051,132	9,826,215	8,349,358	4,077,620	11,492,184	23,919,162	6,345,719	33,470,000	39,815,719
2018	4,727,523	5,068,739	9,796,262	8,272,546	4,057,183	11,425,348	23,755,077	6,360,070	33,494,324	39,854,394
2019	4,727,835	5,088,815	9,816,650	8,390,989	4,135,602	11,607,301	24,133,892	6,469,341	33,689,306	40,158,647
2020	4,696.050	5,042.418	9,738.468	8,067.584	3,977.872	11,198.068	23,243.524	6,247.690	33,285.998	39.533.688
2021	4,700.721	5,045.121	9,745.842	8,052.514	3,970.398	11,182.492	23,205.404	6,246.931	33,284.100	39.531.031
2022	4,666.912	5,017.317	9,684.229	7,881.951	3,885.270	10,959.101	22,726.322	6,120.063	33,051.631	39.171.694
2023	4,667.175	4,984.289	9,651.464	7,958.567	3,925.437	11,053.536	22,937.540	6,150.366	33,104.448	39.254.814
2024	4,698.301	5,013.035	9,711.336	8,153.019	4,022.055	11,302.527	23,477.601	6,288.615	33,355.895	39.644.510
2025	4,679,265	5,002,217	9,681,482	7,933,931	3,909,208	11,027,712	22,870,851	6,198,918	33,193,347	39,392,265
2026	4,679,675	5,001,317	9,680,992	8,180,420	4,036,704	11,334,286	23,551,410	6,291,628	33,357,657	39,649,285
2027	4,663,808	4,987,978	9,651,786	8,020,986	3,955,358	11,131,852	23,108,196	6,207,044	33,204,756	39,411,800
2028	4,664,198	4,985,356	9,649,554	8,012,395	3,951,768	11,115,942	23,080,105	6,226,505	33,232,102	39,458,607
2029	4,648,244	4,971,322	9,619,566	7,958,320	3,923,133	11,048,794	22,930,247	6,169,724	33,127,277	39,297,001
2030	4,643,518	4,960,798	9,604,316	8,014,440	3,951,380	11,120,025	23,085,845	6,203,234	33,182,556	39,385,790
2031	4,616,859	4,932,355	9,549,214	7,870,180	3,877,345	10,936,043	22,683,568	6,125,740	33,032,365	39,158,105
2032	4,620,106	4,923,073	9,543,179	8,004,313	3,944,888	11,106,998	23,056,199	6,211,781	33,188,403	39,400,184
2033	4,641,198	4,922,725	9,563,923	8,222,295	4,052,781	11,390,886	23,665,962	6,401,248	33,539,181	39,940,429
2034	4,528,784	4,812,307	9,341,091	8,024,897	3,953,990	11,134,456	23,113,343	6,248,488	33,258,990	39,507,478
2035	4,357,845	4,645,023	9,002,868	8,010,016	3,951,013	11,104,917	23,065,946	6,208,992	33,182,064	39,391,056
TOTAL	201,845,970	229,899,103	431,745,073	333,500,802	184,810,066	545,316,049	1,063,626,917	226,298,887	1,299,671,913	1,525,970,800

TABLE B-19. Total Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA								
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Kern County Water Agency		County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
				Municipal and Industrial	Agri-cultural				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	2,724	0	0	0	0	0	2,724
1965	0	0	6,027	73,543	0	0	0	0	79,570
1966	0	0	12,035	137,285	0	0	0	0	149,320
1967	0	0	26,249	267,525	0	0	0	0	293,774
1968	184,168	8,886	54,573	445,315	1,542,385	13,767	11,548	208,536	2,469,178
1969	179,773	7,577	87,557	524,952	2,387,979	12,621	10,548	355,668	3,566,676
1970	201,748	14,344	94,656	573,846	2,909,892	12,786	13,083	292,697	4,113,053
1971	197,960	15,302	95,676	605,729	3,816,811	17,759	14,381	447,754	5,211,373
1972	220,461	16,170	98,769	631,452	4,984,213	15,216	20,629	1,078,359	7,065,270
1973	202,990	12,241	97,531	639,086	4,915,777	15,480	11,682	407,990	6,302,777
1974	282,623	12,210	98,440	698,081	5,217,241	15,586	12,759	596,073	6,933,013
1975	349,567	13,155	106,683	715,440	6,337,132	16,616	14,442	726,513	8,279,548
1976	304,684	13,701	108,064	774,124	6,690,214	16,990	16,109	563,293	8,487,179
1977	266,670	10,811	112,534	797,692	6,864,009	18,453	13,895	510,238	8,594,301
1978	355,506	4,441	115,500	890,776	8,316,063	18,918	17,933	503,815	10,222,952
1979	385,416	13,548	114,232	896,025	9,440,248	20,198	24,864	952,516	11,847,048
1980	406,516	11,898	125,929	888,723	9,996,836	20,745	24,228	736,879	12,211,755
1981	470,007	29,739	134,147	1,079,139	11,440,913	24,935	22,906	908,148	14,109,935
1982	464,516	12,889	135,036	1,004,493	12,272,433	22,951	22,370	745,479	14,680,167
1983	637,690	14,483	149,180	1,027,082	15,479,376	39,967	29,127	428,002	17,804,908
1984	910,228	14,897	164,483	2,063,001	23,605,500	54,424	59,610	783,561	27,655,704
1985	1,098,641	87,458	184,883	2,350,412	27,911,512	69,479	70,139	2,170,356	33,942,880
1986	1,262,744	33,914	180,423	2,364,977	30,490,589	80,765	75,998	2,181,725	36,671,135
1987	1,121,185	50,709	179,850	2,804,592	29,274,226	78,014	74,244	2,240,660	35,823,480
1988	1,106,658	61,504	193,712	2,750,239	29,186,168	74,164	60,118	2,198,227	35,630,790
1989	1,142,042	49,186	187,891	2,435,448	29,247,553	67,045	68,581	2,441,530	35,639,276
1990	865,340	34,348	221,368	2,541,124	27,362,503	51,053	49,009	1,868,258	32,993,003
1991	582,223	23,253	220,258	2,055,047	17,561,895	27,925	26,778	1,228,823	21,726,203
1992	951,603	39,089	241,431	2,369,575	25,860,016	55,791	50,832	1,905,963	31,474,300
1993	1,163,893	53,616	264,933	2,799,265	31,374,185	72,885	69,515	2,639,551	38,437,843
1994	1,018,998	43,743	306,333	2,808,612	29,250,068	60,456	57,282	2,115,514	35,661,006
1995	1,515,671	46,600	304,270	3,499,388	36,373,551	88,870	80,105	2,769,591	44,678,047
1996	1,374,852	48,232	389,175	3,559,914	36,686,273	86,087	73,753	4,315,482	46,533,768
1997	1,416,695	25,389	276,653	3,107,536	32,946,645	36,710	68,613	1,669,559	39,547,800
1998	1,269,673	34,373	381,853	2,733,889	29,719,479	41,834	60,057	1,800,922	36,042,080
1999	1,220,198	53,899	366,504	3,051,649	31,032,268	73,158	62,333	4,004,515	39,864,523
2000	1,093,458	37,922	303,259	2,582,958	26,606,360	61,858	54,639	2,783,050	33,523,504
2001	1,767,905	62,679	327,968	2,632,892	33,967,664	79,891	100,521	3,048,118	41,987,639
2002	1,340,915	43,367	321,476	2,957,019	28,631,934	72,944	77,296	2,500,695	35,945,647
2003	1,410,424	48,093	340,003	3,257,112	31,583,096	88,804	78,269	2,837,756	39,643,557
2004	1,469,385	77,202	343,909	3,701,642	30,721,725	231,787	81,127	2,370,670	38,997,446
2005	2,099,651	89,829	356,697	3,295,863	42,361,142	424,670	82,619	3,492,683	52,203,154
2006	1,786,850	99,237	356,343	3,778,380	40,541,204	285,481	94,018	2,916,324	49,857,838
2007	2,063,054	93,151	367,989	4,699,110	43,469,382	323,300	120,094	3,324,220	54,460,300
2008	2,321,355	106,519	380,595	5,198,490	48,449,124	364,785	138,252	3,751,870	60,710,990
2009	2,001,279	89,873	363,376	4,889,920	42,808,816	317,323	116,397	3,224,903	53,811,887
2010	2,168,385	98,617	363,827	5,292,939	45,529,471	344,660	131,383	3,504,454	57,433,736
2011	1,893,719	84,235	365,305	4,600,665	40,465,453	299,847	110,773	3,044,696	50,864,693
2012	1,896,879	84,401	365,870	4,619,970	40,765,877	300,687	109,306	3,049,963	51,192,953
2013	1,972,234	88,341	366,014	4,791,203	41,812,120	312,899	117,479	3,175,958	52,636,248
2014	1,808,992	79,798	363,349	4,401,741	39,227,012	286,311	102,210	2,902,836	49,172,249
2015	1,874,633	83,231	360,236	4,482,043	40,219,457	296,973	108,711	3,012,595	50,437,879
2016	1,993,768	89,467	353,913	4,705,710	42,153,054	316,346	119,400	3,211,967	52,943,625
2017	1,881,726	83,604	339,826	4,304,555	40,310,394	298,094	109,541	3,024,510	50,352,250
2018	1,892,092	84,143	317,309	4,221,675	40,668,952	290,456	108,895	3,041,780	50,625,302
2019	2,014,388	90,544	308,520	4,454,948	42,643,983	309,673	119,957	3,246,450	53,188,463
2020	1,899,353	84,524	306,942	4,141,918	40,657,766	290,457	110,619	3,053,971	50,545,550
2021	1,888,932	83,979	305,966	4,096,411	40,518,482	288,608	109,454	3,036,521	50,328,353
2022	1,823,042	80,531	305,264	3,926,398	39,389,974	277,679	103,998	2,926,290	48,833,176
2023	1,877,547	83,386	304,618	4,051,673	40,239,769	286,503	109,184	3,017,552	49,970,232
2024	1,958,881	87,640	304,185	4,245,328	41,601,404	299,826	116,144	3,153,570	51,766,978
2025	1,820,685	80,408	303,889	3,917,030	39,484,759	277,313	102,706	2,922,336	48,909,126
2026	1,987,373	89,132	303,147	4,306,968	42,012,869	304,360	119,104	3,201,278	52,324,231
2027	1,898,218	84,460	303,325	4,093,930	40,645,310	289,751	110,503	3,051,950	50,477,447
2028	1,912,327	85,205	300,043	4,123,875	40,835,028	291,976	109,182	3,075,743	50,733,379
2029	1,872,767	83,134	300,076	4,027,052	40,211,408	285,427	108,354	3,009,502	49,897,720
2030	1,902,713	84,703	299,551	4,093,701	40,659,806	290,256	111,342	3,059,662	50,501,734
2031	1,829,414	80,860	298,766	3,902,821	39,540,564	277,873	104,215	2,936,819	48,971,332
2032	1,892,064	84,147	297,700	4,052,297	40,499,192	288,160	110,252	3,041,881	50,265,693
2033	1,967,847	88,108	297,895	4,241,075	41,991,252	300,564	114,967	3,168,552	52,170,260
2034	1,894,499	84,270	297,310	4,050,210	40,619,387	288,324	109,852	3,045,830	50,389,682
2035	1,957,231	87,556	296,054	4,204,841	41,806,416	298,173	114,157	3,150,883	51,915,311
TOTAL	90,264,924	3,877,910	17,630,077	204,309,340	2,014,143,559	11,263,687	5,132,389	156,114,035	2,502,735,921

TABLE B-19. Total Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline - Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	33.309	0	0	0	0	0	0	0	51,711	0
1964	62,847	27,438	16,286	4,369	37,145	1,142	28,427	8,202	82,782	34,973
1965	118,565	52,989	28,459	7,191	40,756	2,081	50,300	15,217	135,023	35,333
1966	215,713	101,232	51,184	12,474	73,129	3,752	90,369	27,670	232,426	61,445
1967	417,348	210,746	98,904	23,464	141,365	7,282	175,119	54,006	433,210	115,536
1968	744,206	478,065	176,688	41,496	251,125	12,866	311,081	95,438	781,930	208,864
1969	1,072,647	724,212	264,900	61,208	370,850	18,688	458,937	138,023	1,205,472	321,659
1970	1,395,848	904,061	371,728	89,673	519,163	25,223	632,989	184,783	1,777,650	467,431
1971	1,727,773	1,087,835	503,422	128,321	712,537	31,827	857,146	231,214	2,538,403	659,218
1972	2,047,032	1,306,587	640,299	181,162	925,397	42,393	1,111,738	274,527	3,404,963	864,867
1973	2,138,133	1,322,591	777,545	183,668	1,136,869	43,472	1,174,905	287,241	3,988,091	946,446
1974	2,202,002	1,381,959	794,192	193,236	1,163,708	45,201	1,206,983	291,996	4,015,030	989,817
1975	2,378,974	1,449,891	836,481	205,992	1,231,490	48,479	1,274,129	304,204	4,175,588	1,088,088
1976	2,732,227	1,445,191	883,730	215,036	1,307,153	51,452	1,316,775	313,608	4,316,061	1,141,338
1977	2,675,090	1,514,203	780,142	225,984	1,144,829	47,339	1,388,646	329,288	4,570,285	1,196,952
1978	2,992,822	1,598,916	961,523	230,990	1,420,338	47,108	1,388,796	321,604	4,476,611	1,208,453
1979	3,546,421	1,633,427	1,029,691	237,905	1,518,496	48,384	1,516,371	332,394	4,438,819	1,152,106
1980	4,093,075	1,714,996	1,119,626	259,351	1,679,613	53,338	1,635,817	360,382	4,852,083	1,269,177
1981	4,423.525	1,968,507	1,195,134	271,128	1,797,033	77,794	1,756,226	391,786	5,240,580	1,357,401
1982	3,986.028	2,060,065	1,245,674	280,261	1,883,312	55,949	1,952,688	406,809	5,427,276	1,564,903
1983	5,176.847	2,322,172	1,837,054	333,027	2,827,158	69,370	2,026,753	494,603	6,037,306	1,556,367
1984	7,212.801	3,363,792	2,920,693	445,283	4,553,156	75,761	2,254,358	553,232	7,065,792	2,331,555
1985	8,928.301	3,748,085	3,717,539	540,332	5,827,873	79,219	2,364,827	758,960	7,756,676	2,378,093
1986	8,827,289	4,315,570	4,143,184	577,416	6,515,636	102,386	2,474,061	999,968	7,873,869	3,047,434
1987	8,844,016	4,156,106	3,998,374	604,923	6,363,049	211,795	2,506,458	1,026,303	9,240,891	3,033,831
1988	8,318,897	4,219,308	3,997,055	615,940	6,426,199	124,654	2,560,945	779,724	9,521,529	2,828,684
1989	8,695,945	4,099,133	3,641,415	586,536	5,896,166	170,557	2,508,279	1,442,530	8,960,529	2,930,080
1990	9,983,987	4,539,471	4,316,516	620,333	6,956,699	289,335	2,703,882	1,639,730	9,811,261	3,677,785
1991	6,484,746	3,508,397	2,823,346	567,387	4,492,594	175,123	3,462,995	1,294,508	8,938,057	3,035,310
1992	8,585,673	4,465,956	2,894,932	470,101	4,609,710	121,321	4,264,418	1,129,477	8,589,549	2,979,755
1993	8,969,300	4,097,366	3,092,789	472,751	4,934,951	157,733	4,143,277	1,347,409	9,521,838	3,319,666
1994	11,156,140	4,710,354	3,137,490	554,731	5,007,134	225,794	5,136,234	1,698,881	10,227,799	4,076,838
1995	10,757,339	4,967,410	3,910,360	509,093	6,281,228	155,546	4,224,022	1,527,143	9,459,288	3,715,005
1996	11,126,138	5,155,485	6,847,257	553,160	11,124,041	150,598	4,290,870	1,867,098	9,885,354	3,807,043
1997	11,376,427	4,922,203	6,408,674	579,209	7,362,617	144,818	4,594,313	1,869,201	11,283,209	4,037,467
1998	9,918,902	4,561,465	5,509,370	546,699	5,889,643	146,245	5,632,264	1,477,869	11,204,690	3,323,757
1999	11,303,646	4,887,688	4,454,390	633,793	5,920,321	145,097	5,813,224	1,835,894	12,277,264	4,158,613
2000	10,534,071	6,822,985	2,879,421	594,015	4,303,208	115,236	5,638,805	1,447,804	11,863,298	3,248,531
2001	20.608.862	12.456.358	3.923.571	797.776	6.297.948	127.739	6.335.591	3.346.039	17.807.354	3.394.005
2002	11.841.946	9.590.071	3.146.234	755.366	5.015.827	109.684	5.458.124	2.709.672	18.528.975	4.739.428
2003	13.213.422	10.503.085	3.337.865	729.004	5.330.812	115.142	7.320.833	2.259.410	16.395.659	4.911.675
2004	13.973.128	11.680.709	3.861.857	818.298	5.211.473	124.043	7.180.855	2.476.364	20.396.213	4.327.465
2005	15.571.593	11.419.615	17.665.540	590.470	10.578.433	122.700	7.340.359	2.727.962	18.213.494	4.785.693
2006	18,116,738	12,063,423	23,583,386	1,065,305	8,546,381	238,495	12,370,664	3,802,036	26,294,706	5,378,524
2007	17,239,143	15,710,457	35,533,265	1,330,792	11,074,703	559,479	9,712,340	5,128,312	30,291,706	5,591,395
2008	35,366,286	21,730,850	41,758,366	2,151,555	15,956,295	639,697	23,773,420	5,857,692	38,001,960	9,531,845
2009	34,491,295	19,456,507	37,710,570	1,881,251	14,199,820	572,846	23,305,769	5,235,871	34,257,445	8,488,546
2010	35,973,686	20,298,784	39,313,293	1,948,564	14,828,696	597,083	24,260,260	5,460,277	35,448,964	8,830,424
2011	29,830,991	19,628,506	34,184,951	1,630,263	12,750,809	494,196	19,793,560	4,507,119	31,311,288	7,659,898
2012	31,016,127	21,110,847	35,405,649	1,686,328	13,234,886	513,488	20,608,088	4,685,643	32,231,099	7,924,149
2013	30,647,122	20,825,071	35,093,009	1,657,015	13,078,620	508,051	20,357,052	4,635,137	31,714,608	7,797,729
2014	29,613,183	19,982,201	33,902,755	1,625,570	12,645,922	490,601	19,705,424	4,475,026	31,162,102	7,612,168
2015	29,707,862	20,063,434	33,985,598	1,609,107	12,644,023	492,112	19,773,627	4,490,094	30,833,534	7,551,589
2016	30,832,247	20,805,142	34,995,213	1,686,641	13,104,483	510,296	20,522,297	4,660,481	32,140,041	7,884,031
2017	29,417,476	19,861,367	33,732,805	1,601,471	12,519,332	487,042	19,632,471	4,449,327	30,654,599	7,492,033
2018	30,372,118	20,418,487	34,485,233	1,652,622	12,882,360	502,358	20,357,140	4,595,426	31,456,811	7,715,737
2019	31,114,154	20,697,096	35,158,195	1,687,160	13,139,536	513,938	20,699,238	4,707,331	32,021,445	7,863,566
2020	29,280,229	19,430,334	32,818,908	1,576,118	12,248,321	482,840	19,596,344	4,425,606	29,909,562	7,306,565
2021	29,084,080	19,202,596	32,350,989	1,531,836	12,042,389	478,469	19,410,094	4,391,962	29,077,908	7,112,992
2022	28.166.163	18.441.401	30.980.876	1.489.034	11.578.751	463.277	18.779.293	4.253.068	28.229.677	6.874.557
2023	28.442.963	18.673.299	30.287.838	1.512.367	11.548.381	467.595	18.951.296	4.294.248	28.535.479	6.944.566
2024	29.237.843	19.194.557	31.035.578	1.530.381	11.838.951	480.518	19.398.549	4.413.988	28.859.780	7.062.060
2025	28.692.679	18.783.944	30.309.094	1.507.362	11.609.795	471.620	19.092.829	4.331.820	28.472.084	6.951.047
2026	29,184.962	19,195.898	30,981.484	1,540.463	11,809.015	479.584	19,366.207	4,405.932	28,954.321	7,067.372
2027	28,850,249	18,765,237	30,151,519	1,505,625	11,589,778	474,132	19,149,586	4,355,562	28,365,638	6,929,693
2028	28,752,687	18,963,021	30,265,359	1,491,984	11,560,287	472,518	19,089,685	4,340,910	28,094,635	6,867,561
2029	28,524,684	18,555,352	30,042,449	1,504,328	11,497,755	468,790	18,941,136	4,306,680	28,335,115	6,898,321
2030	28,510,576	18,575,184	30,043,931	1,505,143	11,494,385	468,546	18,934,536	4,304,802	28,341,249	6,898,232
2031	28,173,057	18,167,247	29,888,736	1,455,452	11,345,716	463,020	18,769,961	4,254,483	27,485,444	6,709,430
2032	28,364,587	18,454,229	29,647,860	1,491,679	11,388,327	466,108	18,815,199	4,283,672	28,146,594	6,847,623
2033	30,339,595	19,690,130	31,845,386	1,575,060	12,214,037	498,198	20,164,397	4,582,643	29,532,530	7,261,775
2034	28,584,636	18,499,605	30,039,114	1,483,326	11,487,158	469,644	19,009,396	4,320,475	28,007,901	6,838,466
2035	30,663,868	19,418,345	32,067,973	1,611,646	12,285,995	503,355	20,234,491	4,635,650	30,120,213	7,375,144
TOTAL	1,157,004,284	730,158,243	1,095,839,919	63,874,000	523,225,089	18,651,562	701,137,535	177,669,441	1,223,292,316	313,595,125

TABLE B-19. Total Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	3,219	79,888
1963	0	690,539	0	775,559	0	0	0	0	12,626	1,625,689
1964	21,728	1,260,042	9,375	1,594,755	0	0	0	0	13,938	2,801,552
1965	21,859	2,179,810	17,761	2,705,344	0	0	405	405	28,937	4,799,776
1966	37.952	3.898.819	33.415	4,839,578	0	0	564	564	31,321	7,380,275
1967	71,260	7,691,085	68,133	9,507,458	0	0	562	562	47,718	12,788,780
1968	128,877	15,313,065	142,760	18,686,461	0	0	564	564	46,945	24,929,162
1969	198.704	23.145.744	215.144	28.196.187	0	0	3.190	3.190	52,963	36.026,612
1970	289,546	30,607,434	273,523	37,539,052	0	0	15,116	15,116	69,744	46,159,647
1971	409.205	39.946.463	342,325	49.175.690	0	0	15.996	15.996	55.532	58.790.422
1972	537,044	52,933,606	422,192	64,691,808	0	0	17,367	17,367	80,412	76,523,080
1973	587,814	57,257,279	435,541	70,279,596	0	0	17,328	17,328	54,219	81,197,537
1974	611,275	61,759,841	455,447	75,110,687	0	0	17,472	17,472	76,783	86,915,624
1975	644,464	66,739,819	478,284	80,855,883	0	0	18,400	18,400	84,547	94,061,042
1976	668,152	68,467,779	475,466	83,333,969	0	0	17,471	17,471	106,717	97,127,311
1977	696,350	66,216,668	506,941	81,292,717	0	0	18,227	18,227	98,618	95,162,383
1978	708.874	72.917.066	523,053	88.796.153	0	0	17,375	17,375	100,786	104,646,223
1979	712,699	72,648,617	526,278	89,341,608	0	0	20,573	20,573	119,352	106,990,787
1980	777,813	79,908,126	571,100	98,294,496	0	0	17,755	17,755	178,812	116,943,823
1981	805,858	91,241,966	636,261	111,163,198	0	0	21,188	21,188	185,347	131,713,594
1982	853,227	93,125,063	670,228	113,511,482	0	0	28,417	28,417	173,894	135,089,036
1983	951.954	101.767.502	803.439	126,203.552	0	0	19.271	19.271	220.926	151.578.866
1984	1,072,455	137,486,443	868,812	170,204,133	0	0	21,109	21,109	225,959	208,148,992
1985	1,120,667	173,421,376	908,613	211,550,562	0	0	20,233	20,233	340,322	258,385,266
1986	1,149,524	193,220,534	937,154	234,184,025	0	0	20,134	20,134	279,227	284,217,289
1987	1,171,823	178,742,796	907,876	220,808,240	0	0	19,736	19,736	345,116	272,449,227
1988	1,208,011	190,221,758	904,709	231,727,412	0	0	17,895	17,895	365,207	284,520,863
1989	1,194,715	193,213,383	932,440	234,271,708	0	0	19,153	19,153	422,329	287,594,089
1990	1,297,422	239,518,227	1,486,593	286,841,241	0	0	18,143	18,143	474,284	339,729,949
1991	1,354,718	179,928,498	1,140,955	217,206,634	0	0	21,012	21,012	214,683	255,467,415
1992	1,348,975	196,144,138	1,025,119	236,629,123	0	0	18,008	18,008	443,676	286,152,099
1993	1,507,336	169,470,130	1,067,967	212,102,513	0	0	20,993	20,993	599,571	270,943,980
1994	1,497,855	209,289,443	1,009,019	257,727,713	0	0	19,644	19,644	609,932	316,376,201
1995	1,520,392	173,396,272	1,061,154	221,484,251	0	0	20,272	20,272	534,971	290,063,309
1996	1,526,936	181,379,764	1,103,083	238,816,826	0	0	25,373	25,373	571,857	319,533,594
1997	1,731,236	186,711,858	1,216,389	242,237,621	0	0	24,815	24,815	428,638	323,875,094
1998	1,925,051	168,709,246	1,238,270	220,083,469	0	0	18,164	18,164	465,140	302,843,123
1999	2,167.435	189,484.555	1,250,943	244,332,863	0	0	17,782	17,782	559,344	335,326,769
2000	2,425,062	185,127,820	1,321,565	236,321,821	0	0	17,872	17,872	0	321,413,858
2001	3,386,792	374,670,013	1,616,322	454,768,370	0	0	17,686	17,686	0	555,793,496
2002	4,794,822	262,003,775	1,639,518	330,333,441	0	0	20,994	20,994	0	425,676,305
2003	5,573,358	289,209,085	1,659,722	360,559,071	0	0	20,760	20,760	0	458,713,317
2004	6,037.598	334,390.395	1,892,278	412,370,675	0	0	20,821	20,821	0	511,688,314
2005	6,152,169	315,185,641	1,439,898	411,793,568	0	0	20,818	20,818	0	525,229,629
2006	6,890,198	400,471,517	1,830,986	520,652,359	0	0	20,467	20,467	0	638,377,909
2007	7,977,249	477,970,133	4,863,062	622,982,036	0	0	20,567	20,567	0	750,864,313
2008	10,082,292	446,401,844	5,496,312	656,748,414	0	0	20,617	20,617	0	796,698,477
2009	9,453,711	400,994,267	4,900,054	594,947,952	0	0	20,667	20,667	0	725,158,258
2010	9,658,177	416,613,331	5,120,036	618,351,575	0	0	20,667	20,667	0	753,697,744
2011	8,956,274	445,634,872	4,225,232	620,607,959	0	0	20,667	20,667	0	747,678,881
2012	9,114,292	462,787,712	4,397,811	644,716,119	0	0	20,667	20,667	0	772,654,229
2013	9,035.963	456,632.396	4,339.121	636,320,894	0	0	20,667	20,667	0	765,165,216
2014	8,928,237	440,394,301	4,161,346	614,698,836	0	0	20,667	20,667	0	738,324,157
2015	8,887,787	440,491,395	4,175,719	614,705,881	0	0	20,262	20,262	0	739,416,493
2016	9,091,467	457,362,118	4,330,920	637,925,377	0	0	20,102	20,102	0	765,544,595
2017	8,852,372	435,746,277	4,124,287	608,570,859	0	0	20,105	20,105	0	732,504,310
2018	8,986,106	447,219,971	4,237,307	624,881,676	0	0	20,102	20,102	0	748,932,813
2019	9,074,931	454,212,485	4,294,662	635,183,737	0	0	17,477	17,477	0	762,498,866
2020	8,734.519	423.756.368	4,019.287	593.585.001	0	0	5.551	5.551	0	716.651.782
2021	8,611,697	416,139,756	3,963,576	583,398,344	0	0	4,725	4,725	0	706,213,699
2022	8,468.735	399,076.464	3,800.863	560,602.159	0	0	3,340	3,340	0	681,020.920
2023	8,512,324	402,419,113	3,848,397	564,437,866	0	0	3,339	3,339	0	686,255,255
2024	8,579,471	412,470,309	3,957,557	578,059,542	0	0	3,338	3,338	0	702,663,305
2025	8.512.820	403.021.254	3.866.862	565.623.210	0	0	3.336	3.336	0	686.480.270
2026	8,584,730	412,214,865	3,955,396	577,740,229	0	0	3,334	3,334	0	702,949,481
2027	8,498,477	401,030,732	3,859,233	563,525,461	0	0	3,332	3,332	0	686,178,022
2028	8,459,282	406,556,721	3,911,849	568,826,499	0	0	3,330	3,330	0	691,751,474
2029	8,482.295	398,262.663	3,817,271	559.636.839	0	0	3,329	3,329	0	681,384,702
2030	8,482,389	398,886,937	3,821,156	560,267,066	0	0	3,327	3,327	0	682,848,078
2031	8,362,373	388,587,152	3,727,683	547,389,754	0	0	3,326	3,326	0	667,755,299
2032	8,451,236	397,323,088	3,800,151	557,480,353	0	0	3,324	3,324	0	679,748,932
2033	8,696,693	421,589,768	4,050,324	592,040,536	0	0	3,324	3,324	0	717,384,434
2034	8,441.516	396,510.668	3,801.105	557,493.010	0	0	3,323	3,323	0	679,847.927
2035	8,770,626	422,030,578	4,011,970	593,729,854	0	0	3,321	3,321	0	717,108,356
TOTAL	322,537,242	18,413,450,536	156,944,600	24,897,379,894	0	0	1,049,255	1,049,255	8,723,612	30,431,231,472

TABLE B-20A: Calculation of Delta Water Rates

Calculation in accordance with Article 53(i) of the Monterey Amendment

(Values in millions of dollars [$] or millions of acre-feet [AF] discounted to 2006 at 4.608 percent per annum)

Procedure	Capital Cost Component		Minimum Operation, Maintenance, Power and Replacement Component [a]		Total Delta Water Rate	
	[1]		[2]		[3]	
Commencing in 2007						
Total Costs of "Initial" Project Conservation Facilities to be Reimbursed and Project Water Entitlements during the Project Repayment Period.	$4,762.55 [b]	296.98 AF	$3,234.99 [c]	296.98 AF	$7,997.54	296.98 AF
Less, Project Power Revenues to be Realized During the Project Repayment Period.	(1,731.49)		(689.61)		(2,421.10)	
Less, Delta Water Charges Paid and Project Water Entitlements, Prior to 2007	(2,228.97) [d]	(231.00) AF	(1,630.64)	(231.00) AF	(3,859.61)	(231.00) AF
TOTAL	$802.09	65.98 AF	$914.74	65.98 AF	$1,716.83	65.98 AF
Rate Applicable in 2007	$12.16 per acre-foot		$13.86 per acre-foot		$26.02 per acre-foot	

Calculation under original provisions, without the Monterey Amendment

(for Plumas County and Empire)

Procedure	Capital Cost Component		Minimum Operation, Maintenance, Power and Replacement Component [a]		Total Delta Water Rate	
	[4]		[5]		[6]	
Commencing in 2007						
Total Costs of "Initial" Project Conservation Facilities to be Reimbursed and Project Water Entitlements during the Project Repayment Period.	$4,750.63 [b]	296.98 AF	$3,221.00 [c]	296.98 AF	$7,971.62	296.98 AF
Less, Project Power Revenues to be Realized During the Project Repayment Period.	(1,731.49)		(689.61)		(2,421.10)	
Less, Delta Water Charges Paid and Project Water Entitlements, Prior to 2007	(2,228.97) [d]	(231.00) AF	(1,630.64)	(231.00) AF	(3,859.61)	(231.00) AF
TOTAL	$790.17	65.98 AF	$900.75	65.98 AF	$1,690.91	65.98 AF
Rate Applicable in 2007	$11.98 per acre-foot		$13.65 per acre-foot		$25.63 per acre-foot	

a) Considering that all operating costs of Project Conservation Facilities will not vary with annual amounts of Project water delivered, and therefore are properly classified as "Minimum" OMP&R Costs. OMP&R costs exclude amounts for Conservation RAS.
b) Including net credits of $4,850,000 for settlements as to the magnitude of Project Capital costs incurred prior to December 31, 1960, and net credits of $6,678,320 for settlement as to the magnitude of Project Capital costs incurred from 1961 through 1978.
c) Includes conservation power costs and credits at San Luis.
d) Applying all Delta Water Charges paid prior to 1970 to reimburse Capital costs (the charge was not divided into components until 1970)

TABLE B-20B. Delta Water Rates, by Facility

(in dollars per acre-foot)

Item	Capital Cost Component	Minimum Operation, Maintenance, Power and Replacement Component	Total Delta Water Rate
	[1]	[2]	[3]
Initial Conservation Facilities			
Oroville Division			
Water Supply and power costs [a]	43.82	24.66	68.49
Less, Oroville Power Revenues	-26.24	-10.45	-36.69
Subtotal	17.58	14.21	31.79
Delta Facilities [b]	12.51	12.11	24.62
California Aqueduct, portion			
Reach 1	2.80	4.57	7.38
Reach 2A	1.67	0.74	2.41
Reach 2B	0.88	0.40	1.29
Reach 3	0.60	0.23	0.84
Subtotal	5.96	5.95	11.91
San Luis Facilities	8.44	6.10	14.54
Planning and preoperating costs through 2001	2.45	0.00	2.45
45,000 AF relinquished costs	0.18	0.21	0.39
Less, Capital Cost Credits	-1.18	0.00	-1.18
Less, Delta Water Charges paid prior to 2007	-33.78	-24.71	-58.50
Rate applicable in 2007	12.16	13.86	26.02

a) Includes revenue received from non-contractors.
b) Includes (1) Delta Facility planning costs, (2) Delta Studies costs, and (3) Suisun Marsh Facilities Costs.
Note: The OMP&R unit rates do not includes amounts for Conservation RAS.

TABLE B-21. Total Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	14,000	50,050	177,100	241,150	0	0	0
1968	0	0	0	19,156	29,701	193,245	242,102	0	0	0
1969	0	0	0	30,324	44,096	215,483	289,903	0	0	0
1970	0	0	0	80,908	107,730	585,200	773,838	0	0	0
1971	0	0	0	57,320	123,080	637,120	817,520	0	0	0
1972	0	0	0	99,668	143,877	707,328	950,873	0	0	0
1973	0	0	0	120,880	167,099	782,167	1,070,146	0	0	0
1974	0	0	0	137,684	182,339	818,664	1,138,687	0	0	0
1975	0	0	0	146,204	187,324	804,123	1,137,651	0	0	0
1976	0	0	0	168,489	208,652	862,036	1,239,177	0	0	0
1977	0	0	0	172,931	208,645	827,062	1,208,638	0	0	0
1978	0	0	0	206,378	243,231	926,594	1,376,203	0	0	0
1979	0	0	0	237,771	273,208	1,005,955	1,516,934	0	0	0
1980	0	18,325	18,325	272,717	307,426	1,090,867	1,671,010	12,396	3,479	15,875
1981	0	25,440	25,440	415,564	469,768	1,589,984	2,475,316	18,068	10,414	28,482
1982	0	34,917	34,917	457,988	519,053	1,679,289	2,656,330	38,166	99,788	137,954
1983	0	12,035	12,035	316,703	359,775	1,114,795	1,791,273	38,004	68,902	106,906
1984	0	22,453	22,453	334,587	380,914	1,132,448	1,847,949	57,909	105,498	163,407
1985	0	22,001	22,001	381,970	435,728	1,244,939	2,062,637	106,103	192,937	299,040
1986	35,358	21,767	57,125	423,378	485,372	1,330,615	2,239,365	151,206	275,347	426,553
1987	0	22,984	22,984	430,024	493,786	1,304,900	2,228,710	185,355	336,664	522,019
1988	88,878	150,466	239,344	464,114	533,731	1,361,400	2,359,245	239,792	436,607	676,399
1989	102,688	305,328	408,016	513,853	591,760	1,491,833	2,597,446	331,518	602,402	933,920
1990	112,723	355,132	467,855	534,787	616,676	1,537,512	2,688,975	417,802	760,166	1,177,968
1991	129,296	395,515	524,811	603,028	681,067	1,667,194	2,951,289	443,403	806,745	1,250,148
1992	158,879	489,808	648,687	729,545	808,579	1,945,453	3,483,577	506,628	921,780	1,428,408
1993	172,457	530,778	703,235	771,894	840,958	1,990,673	3,603,525	507,825	923,957	1,431,782
1994	177,824	546,610	724,434	778,647	817,579	1,946,615	3,542,841	486,654	885,437	1,372,091
1995	203,738	713,497	917,235	874,946	874,946	2,083,205	3,833,097	520,801	947,567	1,468,368
1996	213,506	774,152	987,658	901,129	860,168	2,048,020	3,809,317	512,005	931,562	1,443,567
1997	250,558	866,141	1,116,699	1,041,633	951,056	2,264,420	4,257,109	566,105	1,029,994	1,596,099
1998	266,952	882,469	1,149,421	1,048,658	957,470	2,279,691	4,285,819	141,683	888,760	1,030,443
1999	290,688	923,459	1,214,147	1,084,480	990,178	2,357,566	4,432,224	589,391	1,072,362	1,661,753
2000	390,936	948,784	1,339,720	1,628,402	1,005,778	2,394,709	5,028,889	598,677	1,089,257	1,687,934
2001	496,412	1,097,880	1,594,292	1,868,283	1,005,998	2,395,234	5,269,515	598,809	1,089,496	1,688,305
2002	512,928	1,125,429	1,638,357	1,896,134	1,020,996	2,430,942	5,348,072	607,736	1,105,738	1,713,474
2003	511,059	1,112,692	1,623,751	1,856,232	999,510	2,379,785	5,235,527	594,946	1,082,469	1,677,415
2004	569,615	1,441,431	2,011,046	2,043,834	1,094,911	2,606,931	5,745,676	651,732	1,185,788	1,837,520
2005	573,730	1,219,893	1,793,623	2,081,144	1,084,212	2,581,456	5,746,812	645,364	1,174,201	1,819,565
2006	606,342	1,272,002	1,878,344	2,167,747	1,129,330	2,688,880	5,985,957	672,220	1,223,064	1,895,284
2007	595,224	1,232,237	1,827,461	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2008	603,681	1,233,538	1,837,219	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2009	612,137	1,234,839	1,846,976	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2010	620,594	1,236,140	1,856,734	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2011	629,051	1,237,441	1,866,492	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2012	637,508	1,238,742	1,876,250	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2013	644,663	1,240,043	1,884,706	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2014	654,421	1,241,344	1,895,765	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2015	671,985	1,242,645	1,914,630	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2016	688,248	1,242,645	1,930,893	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2017	704,511	1,242,645	1,947,156	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2018	720,774	1,242,645	1,963,419	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2019	737,037	1,242,645	1,979,682	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2020	752,649	1,242,645	1,995,294	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2021	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2022	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2023	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2024	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2025	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2026	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2027	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2028	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2029	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2030	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2031	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2032	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2033	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2034	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
2035	755,251	1,242,645	1,997,896	2,097,764	1,092,870	2,602,072	5,792,706	650,518	1,183,578	1,834,096
TOTAL	26,465,815	51,321,257	77,787,072	88,248,290	53,978,987	134,941,521	277,168,798	29,105,320	53,574,143	82,679,463

TABLE B-21. Total Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA								
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Kern County Water Agency		County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
				Municipal and Industrial	Agri-cultural				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	40,695	10,469	0	0	165,522	3,177	8,073	98,608	326,544
1969	61,267	3,281	0	0	337,686	4,200	8,805	102,478	517,717
1970	104,405	19,950	0	0	964,915	8,645	17,290	228,095	1,343,300
1971	129,596	21,720	0	0	1,377,772	9,412	20,272	264,260	1,823,032
1972	160,756	24,113	0	0	2,175,835	11,253	43,131	905,057	3,320,145
1973	195,541	26,664	0	386,638	2,373,167	13,333	27,553	373,307	3,396,203
1974	224,202	27,909	0	446,545	2,781,595	13,954	29,770	445,138	3,969,113
1975	329,688	27,413	0	481,560	3,041,048	14,620	33,702	827,591	4,755,622
1976	414,245	29,388	0	549,549	3,931,785	15,673	35,966	877,151	5,853,757
1977	312,532	28,195	0	569,545	4,071,218	15,977	40,289	626,210	5,663,966
1978	342,208	31,588	0	674,939	4,950,959	20,006	41,065	666,516	6,727,281
1979	395,523	34,294	0	772,757	5,901,986	22,863	45,725	771,613	7,944,761
1980	555,341	37,679	0	881,371	6,984,026	27,272	70,658	933,481	9,489,828
1981	740,789	54,204	0	1,351,487	11,140,730	41,556	77,692	1,373,168	14,779,626
1982	782,396	57,248	0	1,518,993	12,703,436	47,707	85,873	1,530,443	16,726,096
1983	543,462	38,004	0	1,057,789	9,141,315	35,471	58,273	78,506	10,952,820
1984	580,379	13,572	0	1,333,200	9,741,623	39,893	61,770	756,132	12,526,569
1985	667,740	42,441	0	1,540,611	11,403,920	48,100	69,320	644,383	14,416,515
1986	745,447	45,362	0	1,714,679	12,925,113	55,946	77,115	1,469,725	17,033,387
1987	762,180	44,485	0	1,766,065	13,410,817	59,314	77,108	1,503,601	17,623,570
1988	827,669	46,411	0	1,916,790	14,707,763	61,882	83,540	1,633,680	19,277,735
1989	921,621	49,728	0	2,125,033	16,312,361	66,304	92,825	1,821,693	21,389,565
1990	964,288	50,136	0	1,998,766	17,276,959	66,848	95,259	1,980,383	22,432,639
1991	1,023,374	53,208	0	2,121,239	18,335,590	70,944	101,096	2,101,729	23,807,180
1992	1,169,299	60,795	0	2,727,688	20,646,125	81,061	115,511	2,401,419	27,201,898
1993	1,172,060	60,939	0	2,734,129	20,694,874	81,252	115,784	2,407,089	27,266,127
1994	1,123,198	58,398	0	2,156,809	20,295,455	77,865	110,957	2,306,739	26,129,421
1995	1,202,009	62,497	0	2,803,995	21,223,694	83,328	118,743	2,468,598	27,962,864
1996	534,818	69,191	0	2,756,635	19,492,814	81,921	102,219	2,426,904	25,464,502
1997	1,208,521	67,162	0	3,047,908	22,148,973	90,576	129,072	2,683,338	29,375,550
1998	1,216,671	77,807	0	2,726,511	22,070,376	91,188	129,942	2,820,148	29,132,643
1999	1,258,233	69,974	0	2,819,648	22,824,299	94,303	134,381	2,793,715	29,994,553
2000	1,278,056	70,943	0	3,223,279	21,220,235	95,788	136,498	2,837,730	28,862,529
2001	1,278,336	71,058	0	2,864,700	21,110,372	95,809	136,528	2,838,352	28,395,155
2002	1,393,975	72,121	0	3,272,056	21,060,431	97,237	138,564	2,711,156	28,745,540
2003	1,364,640	70,550	0	3,203,191	20,617,243	95,192	135,648	2,654,103	28,140,567
2004	1,494,892	77,810	0	3,845,137	22,248,916	104,277	148,595	2,897,005	30,816,632
2005	1,480,284	77,153	0	3,653,945	22,127,832	232,331	147,143	2,739,621	30,458,309
2006	1,541,885	80,379	0	3,619,232	23,235,419	242,000	153,266	2,587,429	31,459,610
2007	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2008	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2009	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2010	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2011	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2012	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2013	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2014	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2015	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2016	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2017	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2018	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2019	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2020	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2021	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2022	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2023	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2024	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2025	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2026	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2027	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2028	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2029	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2030	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2031	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2032	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2033	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2034	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
2035	1,492,106	77,741	0	3,502,388	22,485,282	242,123	148,318	2,495,959	30,443,917
TOTAL	73,813,295	4,118,728	0	170,231,671	1,159,247,377	9,440,045	7,556,243	133,969,105	1,558,376,464

TABLE B-21. Total Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline-Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	13,060	0	0	0	0	0	0	0	0
1969	0	17,804	0	0	0	0	0	0	0	0
1970	0	37,905	0	0	0	0	0	0	0	0
1971	0	48,508	0	0	0	0	0	0	0	0
1972	160,756	74,751	41,797	4,662	64,303	1,367	67,518	13,021	369,739	85,202
1973	222,207	107,163	51,552	7,279	79,994	2,577	95,104	26,131	54,908	14,338
1974	279,090	143,266	59,539	10,791	93,030	3,721	121,869	39,631	465,150	114,427
1975	319,822	166,307	63,964	13,250	100,515	4,752	140,722	50,989	479,733	119,705
1976	431,018	207,673	74,449	17,045	117,550	6,269	174,366	67,591	538,772	137,142
1977	469,922	226,502	79,144	19,079	122,180	6,861	189,848	77,255	540,410	139,097
1978	600,180	274,819	97,313	24,428	147,413	9,687	236,913	98,345	631,768	165,313
1979	720,173	320,077	115,033	29,836	171,470	11,889	284,640	117,285	714,457	189,760
1980	857,818	376,845	134,920	35,949	210,736	14,256	337,177	138,590	811,952	215,694
1981	1,355,100	592,631	218,713	57,637	343,292	22,946	534,813	211,396	1,237,658	330,644
1982	1,551,434	664,082	254,298	66,408	400,739	26,335	313,057	235,100	1,341,923	364,482
1983	1,110,994	472,521	184,283	47,759	291,367	19,002	434,517	163,925	943,775	252,096
1984	450,405	509,602	202,914	52,247	321,718	20,719	472,282	174,500	1,003,760	266,383
1985	565,881	591,346	240,344	61,540	381,970	24,474	551,734	200,605	1,152,983	308,405
1986	635,066	659,259	275,347	70,160	438,498	27,822	625,994	223,785	1,285,253	350,799
1987	652,450	676,176	288,131	73,104	467,095	29,064	648,002	228,654	1,319,729	364,779
1988	711,641	742,582	319,496	80,756	525,996	32,024	711,641	248,146	1,438,752	402,232
1989	2,083,593	830,453	362,565	91,333	605,021	36,301	803,932	276,155	1,607,864	454,180
1990	2,207,667	869,029	386,049	96,930	636,731	38,438	848,974	289,119	1,696,277	481,308
1991	2,454,678	961,298	409,704	102,869	675,746	40,793	900,994	306,835	1,819,725	510,800
1992	2,804,695	1,098,371	468,125	117,538	772,102	46,610	1,029,469	350,587	2,079,203	583,636
1993	2,811,318	1,100,964	469,230	117,815	773,925	46,720	1,031,900	351,415	2,084,113	585,014
1994	2,694,116	1,055,065	449,668	112,905	741,661	44,772	988,880	336,766	1,997,227	560,625
1995	2,883,156	1,129,097	481,220	120,826	793,702	47,914	1,058,269	360,394	2,137,369	599,963
1996	2,834,460	1,110,027	473,093	118,785	780,296	47,104	1,040,394	354,307	2,101,269	589,830
1997	3,133,957	1,227,316	523,081	131,336	862,744	52,082	1,150,325	391,745	2,323,295	652,153
1998	3,155,093	1,235,593	526,609	132,222	868,562	52,433	1,728,006	394,387	2,338,963	656,551
1999	3,262,870	1,277,800	544,598	136,739	898,233	54,224	1,787,034	407,859	2,418,863	678,979
2000	3,314,278	2,279,763	553,178	138,893	912,384	55,078	1,815,190	510,073	2,456,972	689,676
2001	3,315,004	2,280,263	553,299	138,924	912,584	55,090	1,815,587	510,185	2,457,510	689,827
2002	3,437,351	2,314,256	561,548	140,995	926,188	55,912	1,842,654	517,791	2,494,146	700,112
2003	3,365,016	2,265,555	549,731	138,028	906,698	54,735	1,803,877	506,894	2,441,659	685,379
2004	3,686,201	2,481,798	602,201	151,202	993,241	59,960	1,976,053	555,277	2,674,711	750,797
2005	3,650,179	2,457,547	596,316	149,725	983,535	59,374	2,018,049	549,850	2,648,574	743,459
2006	3,802,076	2,559,814	3,256,234	155,955	1,344,441	61,844	2,038,172	572,731	2,758,791	774,398
2007	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2008	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2009	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2010	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2011	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2012	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2013	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2014	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2015	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2016	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2017	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2018	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2019	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2020	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2021	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2022	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2023	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2024	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2025	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2026	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2027	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2028	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2029	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2030	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2031	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2032	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2033	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2034	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
2035	3,679,329	2,477,172	3,151,109	150,920	1,301,036	59,848	1,972,370	554,241	2,669,726	749,397
TOTAL	172,690,206	107,294,876	105,849,847	7,341,630	57,395,704	2,908,741	88,816,686	25,930,308	132,289,307	36,939,698

TABLE B-21. Total Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	241,150
1968	0	0	0	13,060	0	1,050	875	1,925	0	583,631
1969	0	0	0	17,804	0	1,225	929	2,154	0	827,578
1970	0	0	0	37,905	0	3,848	1,995	5,843	0	2,160,886
1971	0	0	0	48,508	0	4,546	3,186	7,732	0	2,696,792
1972	0	2,043,211	0	2,926,327	0	4,929	3,778	8,707	0	7,206,052
1973	0	2,317,893	0	2,979,146	0	7,059	4,444	11,503	0	7,456,998
1974	0	4,231,933	0	5,562,447	0	8,336	4,931	13,267	0	10,683,514
1975	0	5,073,286	0	6,533,045	0	9,416	5,117	14,533	0	12,440,851
1976	0	6,422,167	0	8,194,042	0	7,004	5,780	12,784	0	15,299,760
1977	0	7,104,278	0	8,974,576	0	16,917	5,827	22,744	0	15,869,924
1978	0	9,016,389	0	11,302,568	0	12,635	6,844	19,479	0	19,425,531
1979	0	10,935,192	0	13,609,812	0	16,575	7,773	24,348	0	23,095,855
1980	84,294	13,102,796	12,396	16,333,423	0	19,834	8,801	28,635	0	27,557,096
1981	140,930	20,910,099	36,136	25,991,995	0	21,682	13,370	35,052	0	43,335,911
1982	167,929	23,998,560	57,248	29,441,595	0	16,117	14,694	30,811	0	49,027,703
1983	124,148	17,203,307	50,672	21,298,366	0	15,202	10,134	25,336	0	34,186,736
1984	138,982	18,766,458	64,344	22,444,314	20,590	15,442	10,681	46,713	0	37,051,405
1985	166,935	22,050,974	84,882	26,382,073	24,050	16,976	12,166	53,192	0	43,235,458
1986	195,056	25,089,658	120,965	29,997,662	31,753	18,145	13,457	63,355	0	49,817,447
1987	207,598	26,095,043	148,284	31,198,109	37,071	17,794	13,642	68,507	0	51,663,899
1988	233,604	28,781,238	201,116	34,429,224	46,722	18,565	14,852	80,139	0	57,062,086
1989	268,530	32,505,376	265,215	40,190,518	61,184	19,891	16,576	97,651	0	65,617,116
1990	289,119	33,616,369	334,242	41,790,252	63,506	20,055	17,381	100,942	0	68,658,631
1991	306,835	35,676,185	354,722	44,521,184	170,267	21,283	19,155	210,705	0	73,265,317
1992	350,587	40,763,329	405,303	50,869,555	194,545	24,318	22,697	241,560	0	83,873,685
1993	351,415	40,859,579	406,260	50,989,668	195,005	24,376	23,563	242,944	0	84,237,281
1994	336,766	39,156,173	389,323	48,863,947	186,875	23,360	23,360	233,595	0	80,866,329
1995	360,394	41,903,674	416,641	52,292,619	199,987	24,999	26,040	251,026	0	86,725,209
1996	0	41,195,923	409,604	51,055,092	196,610	24,576	26,624	247,810	0	83,007,946
1997	0	45,548,810	447,746	56,444,590	214,918	27,173	30,223	272,314	0	93,062,361
1998	0	45,855,992	450,529	57,394,940	107,459	27,356	31,537	166,352	0	93,159,618
1999	47,152	47,422,430	466,491	59,403,272	226,327	28,291	33,820	288,438	0	96,994,387
2000	71,841	48,169,576	478,942	61,445,844	229,892	69,207	35,708	334,807	0	98,699,723
2001	95,809	48,180,135	479,047	61,483,264	229,942	83,833	37,187	350,962	0	98,781,493
2002	97,237	48,898,394	486,188	62,472,772	233,371	85,083	39,185	357,639	0	100,275,854
2003	118,989	47,869,376	475,957	61,181,894	228,460	83,293	39,743	351,496	0	98,210,650
2004	156,416	52,438,420	521,386	67,047,663	250,266	92,048	0	342,314	0	107,800,851
2005	167,795	51,925,988	516,291	66,466,682	247,820	31,300	0	279,120	0	106,564,111
2006	188,222	51,397,939	537,775	69,448,392	258,133	32,607	50,485	341,225	0	111,008,812
2007	195,155	49,738,600	520,414	67,219,317	249,799	723,749	18,703	992,251	0	108,109,748
2008	450,158	49,738,600	520,414	67,474,320	249,799	723,749	52,472	1,026,020	0	108,408,278
2009	450,158	49,738,600	520,414	67,474,320	249,799	723,749	54,290	1,027,838	0	108,419,853
2010	450,158	49,738,600	520,414	67,474,320	249,799	723,749	56,108	1,029,656	0	108,431,429
2011	450,158	49,738,600	520,414	67,474,320	249,799	723,749	58,186	1,031,734	0	108,443,265
2012	450,158	49,738,600	520,414	67,474,320	249,799	723,749	60,264	1,033,812	0	108,455,101
2013	450,158	49,738,600	520,414	67,474,320	249,799	723,749	62,602	1,036,150	0	108,465,895
2014	450,158	49,738,600	520,414	67,474,320	249,799	723,749	64,940	1,038,488	0	108,479,292
2015	450,158	49,738,600	520,414	67,474,320	249,799	723,749	67,538	1,041,086	0	108,500,755
2016	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,519,615
2017	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,535,878
2018	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,552,141
2019	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,568,404
2020	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,584,016
2021	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2022	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2023	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2024	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2025	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2026	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2027	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2028	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2029	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2030	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2031	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2032	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2033	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2034	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
2035	450,158	49,738,600	520,414	67,474,320	249,799	723,749	70,135	1,043,683	0	108,586,618
TOTAL	17,466,162	2,478,945,550	23,709,711	3,257,578,426	10,898,924	21,985,067	2,534,363	35,418,354	0	5,289,008,577

TABLE B-22. Water System Revenue Bond Surcharge for Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County	Santa Barbara County	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	29,131	40,505	69,636	25,436	30,176	100,035	155,647	13,126	24,392	37,518
1989	48,804	69,621	118,425	43,343	51,681	170,303	265,327	26,828	49,634	76,462
1990	41,166	60,482	101,648	38,407	51,185	149,440	239,032	27,956	51,795	79,751
1991	63,389	92,401	155,790	62,470	81,991	235,712	380,173	44,887	83,709	128,596
1992	84,320	126,227	210,547	89,247	115,208	325,629	530,084	61,137	113,925	175,062
1993	90,152	137,473	227,625	98,432	125,174	347,457	571,063	67,725	126,662	194,387
1994	91,785	141,222	233,007	102,021	126,216	352,415	580,652	81,420	159,156	240,576
1995	108,311	181,787	290,098	126,000	149,378	416,955	692,333	131,674	270,727	402,401
1996	132,304	232,343	364,647	158,514	180,787	505,043	844,344	242,654	534,448	777,102
1997	135,556	237,492	373,048	171,263	187,162	522,127	880,552	141,810	846,616	988,426
1998	130,346	228,366	358,712	164,682	179,971	502,065	846,718	136,361	814,087	950,448
1999	182,507	316,416	498,923	227,072	248,031	691,830	1,166,933	188,835	1,124,110	1,312,945
2000	238,571	364,418	602,989	260,766	284,875	794,730	1,340,371	218,359	1,364,019	1,582,378
2001	234,773	358,616	593,389	561,965	280,341	782,078	1,624,384	214,883	1,342,304	1,557,187
2002	257,520	391,851	649,371	610,230	288,977	806,174	1,705,381	221,503	1,383,661	1,605,164
2003	268,151	408,027	676,178	635,422	300,907	839,455	1,775,784	230,647	1,440,782	1,671,429
2004	268,425	408,444	676,869	636,070	301,214	840,312	1,777,596	230,883	1,442,252	1,673,135
2005	253,413	385,602	639,015	610,756	284,369	793,318	1,688,443	217,970	1,361,594	1,579,564
2006	466,224	709,422	1,175,646	1,123,655	523,176	1,459,528	3,106,359	401,017	2,505,032	2,906,049
2007	466,420	709,718	1,176,138	1,124,125	523,395	1,460,139	3,107,659	401,185	2,506,080	2,907,265
2008	438,849	667,766	1,106,615	1,057,676	492,456	1,373,828	2,923,960	377,470	2,357,941	2,735,411
2009	445,514	677,908	1,123,422	1,073,741	499,936	1,394,695	2,968,372	383,204	2,393,756	2,776,960
2010	426,290	648,656	1,074,946	1,027,408	478,363	1,334,513	2,840,284	366,668	2,290,464	2,657,132
2011	460,176	700,218	1,160,394	1,109,078	516,389	1,440,595	3,066,062	395,815	2,472,535	2,868,350
2012	460,666	700,964	1,161,630	1,110,259	516,939	1,442,129	3,069,327	396,237	2,475,168	2,871,405
2013	485,554	738,834	1,224,388	1,170,242	544,867	1,520,041	3,235,150	417,644	2,608,891	3,026,535
2014	503,510	766,157	1,269,667	1,213,518	565,016	1,576,253	3,354,787	433,088	2,705,369	3,138,457
2015	529,520	805,734	1,335,254	1,276,205	594,203	1,657,677	3,528,085	455,460	2,845,120	3,300,580
2016	534,898	813,918	1,348,816	1,289,167	600,238	1,674,514	3,563,919	460,086	2,874,018	3,334,104
2017	527,034	801,952	1,328,986	1,270,214	591,414	1,649,896	3,511,524	453,322	2,831,765	3,285,087
2018	464,783	707,229	1,172,012	1,120,182	521,559	1,455,017	3,096,758	399,778	2,497,289	2,897,067
2019	501,213	762,661	1,263,874	1,207,981	562,438	1,569,061	3,339,480	431,112	2,693,025	3,124,137
2020	461,530	702,279	1,163,809	1,112,341	517,908	1,444,833	3,075,082	396,980	2,479,809	2,876,789
2021	466,529	709,884	1,176,413	1,124,388	523,517	1,460,481	3,108,386	401,279	2,506,666	2,907,945
2022	450,746	685,869	1,136,615	1,086,350	505,806	1,411,073	3,003,229	387,704	2,421,865	2,809,569
2023	450,394	685,333	1,135,727	1,085,501	505,411	1,409,971	3,000,883	387,401	2,419,974	2,807,375
2024	432,595	658,251	1,090,846	1,042,605	485,439	1,354,252	2,882,296	372,092	2,324,342	2,696,434
2025	389,979	593,405	983,384	939,895	437,617	1,220,841	2,598,353	335,436	2,095,365	2,430,801
2026	350,547	533,404	883,951	844,860	393,368	1,097,398	2,335,626	301,519	1,883,497	2,185,016
2027	389,346	592,440	981,786	938,368	436,906	1,218,857	2,594,131	334,891	2,091,960	2,426,851
2028	288,127	438,423	726,550	694,419	323,323	901,990	1,919,732	247,829	1,548,111	1,795,940
2029	317,838	483,632	801,470	766,026	356,663	995,000	2,117,689	273,384	1,707,748	1,981,132
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	13,366,906	20,475,350	33,842,256	30,430,300	15,283,990	42,697,660	88,411,950	11,709,259	70,069,663	81,778,922

TABLE B-22. Water System Revenue Bond Surcharge for Each Contractor

(in dollars)

Calendar Year	SAN JOAQUIN VALLEY AREA								
				Kern County Water Agency					
	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Municipal and Industrial	Agri-cultural	County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1971	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0
1988	33,986	1,657	0	67,288	726,501	2,228	2,851	66,748	901,259
1989	59,273	2,785	0	116,689	1,251,452	3,733	4,927	116,736	1,555,595
1990	53,349	2,419	0	287,811	947,351	3,248	4,367	109,118	1,407,663
1991	82,252	3,731	0	359,380	1,564,983	5,035	6,771	168,217	2,190,369
1992	112,566	5,127	0	452,691	2,153,423	6,927	9,285	230,217	2,970,236
1993	119,670	5,459	0	272,449	2,491,672	7,381	9,894	244,813	3,151,338
1994	118,265	5,379	0	244,671	2,485,820	7,300	9,766	241,933	3,113,134
1995	139,227	6,339	0	317,885	2,894,182	8,598	11,490	284,798	3,662,519
1996	169,333	7,703	0	354,341	2,722,241	10,460	13,978	346,366	3,624,422
1997	165,364	7,980	0	366,285	2,673,847	10,826	14,465	357,986	3,596,753
1998	159,011	7,672	0	352,211	2,571,110	10,410	13,909	344,232	3,458,555
1999	218,784	10,373	0	485,897	3,371,115	14,376	19,166	476,017	4,595,728
2000	251,339	11,735	0	557,296	3,620,348	16,500	21,990	546,406	5,025,614
2001	247,338	11,547	0	548,424	3,461,158	16,238	21,640	537,707	4,844,052
2002	273,542	11,904	0	565,321	3,496,023	16,737	22,306	521,659	4,907,492
2003	284,834	12,395	0	588,659	3,640,346	17,428	23,227	543,193	5,110,082
2004	285,125	12,408	0	589,259	3,644,059	17,446	23,251	543,748	5,115,296
2005	269,179	11,714	0	556,305	3,431,851	39,485	21,951	488,483	4,818,968
2006	495,230	21,551	0	1,023,478	6,313,845	72,643	40,384	814,866	8,781,997
2007	495,438	21,560	0	1,023,907	6,316,488	75,257	40,401	812,623	8,785,674
2008	466,151	20,285	0	963,382	5,943,110	70,809	38,013	764,588	8,266,338
2009	473,232	20,594	0	978,014	6,033,379	71,884	38,590	776,201	8,391,894
2010	452,811	19,705	0	935,812	5,773,035	68,782	36,925	742,707	8,029,777
2011	488,806	21,271	0	1,010,201	6,231,938	74,250	39,860	801,746	8,668,072
2012	489,326	21,294	0	1,011,277	6,238,574	74,329	39,903	802,600	8,677,303
2013	515,763	22,444	0	1,065,912	6,575,620	78,345	42,058	845,961	9,146,103
2014	534,836	23,274	0	1,105,330	6,818,788	81,242	43,614	877,245	9,484,329
2015	562,464	24,477	0	1,162,428	7,171,028	85,438	45,867	922,561	9,974,263
2016	568,177	24,725	0	1,174,234	7,243,862	86,306	46,333	931,931	10,075,568
2017	559,824	24,362	0	1,156,971	7,137,366	85,037	45,651	918,230	9,927,441
2018	493,700	21,484	0	1,020,315	6,294,331	74,993	40,259	809,773	8,754,855
2019	532,395	23,168	0	1,100,286	6,787,676	80,871	43,415	873,242	9,441,053
2020	490,244	21,334	0	1,013,173	6,250,274	74,468	39,977	804,105	8,693,575
2021	495,553	21,565	0	1,024,146	6,317,964	75,275	40,410	812,813	8,787,726
2022	478,789	20,835	0	989,499	6,104,228	72,728	39,043	785,316	8,490,438
2023	478,415	20,819	0	988,726	6,099,461	72,671	39,013	784,702	8,483,807
2024	459,509	19,996	0	949,654	5,858,424	69,800	37,471	753,693	8,148,547
2025	414,242	18,026	0	856,101	5,281,295	62,923	33,780	679,444	7,345,811
2026	372,356	16,204	0	769,538	4,747,289	56,561	30,364	610,744	6,603,056
2027	413,568	17,997	0	854,710	5,272,713	62,821	33,725	678,340	7,333,874
2028	306,053	13,318	0	632,510	3,901,961	46,489	24,957	501,992	5,427,280
2029	337,612	14,692	0	697,733	4,304,320	51,283	27,531	553,756	5,986,927
2030	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0
TOTAL	14,416,931	633,307	0	30,590,199	192,164,451	1,939,561	1,182,778	24,827,556	265,754,783

TABLE B-22. Water System Revenue Bond Surcharge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley-East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	64,266	57,111	27,032	7,656	44,492	2,154	55,996	16,240	151,182	39,907
1989	205,668	98,720	46,993	13,263	78,104	3,763	97,138	27,981	259,860	69,104
1990	185,010	87,808	42,449	11,905	69,970	3,385	87,327	24,956	231,650	61,851
1991	296,854	140,371	65,947	18,548	108,704	5,236	135,623	38,641	363,310	96,172
1992	402,015	234,421	89,358	25,192	147,297	7,053	183,813	52,160	491,537	130,372
1993	424,871	247,076	93,981	26,566	154,919	7,437	193,361	55,045	517,379	137,298
1994	424,023	247,222	94,502	26,865	155,776	7,431	194,191	54,968	525,394	139,422
1995	500,083	290,999	111,729	31,823	184,169	8,769	229,530	64,852	623,848	165,594
1996	606,387	353,131	135,428	38,635	223,236	10,640	278,178	78,696	760,333	201,821
1997	626,151	362,776	139,565	39,802	230,058	10,972	286,779	81,146	808,482	207,472
1998	602,091	348,838	134,202	38,273	221,218	10,550	275,761	78,028	777,418	199,501
1999	826,108	479,470	184,524	52,650	304,166	14,475	642,815	107,060	1,041,566	277,200
2000	940,325	1,150,965	210,453	60,212	346,906	16,486	736,157	121,898	1,191,538	316,860
2001	925,355	1,132,642	207,102	59,254	341,384	16,224	724,438	135,581	1,172,568	311,816
2002	974,814	1,167,539	213,483	61,079	351,902	16,724	746,758	139,071	1,208,696	321,423
2003	1,015,056	1,215,738	222,296	63,601	366,429	17,415	777,586	144,812	1,258,593	334,692
2004	1,016,092	1,216,978	222,523	63,666	366,803	17,432	778,379	144,960	1,259,877	335,033
2005	959,268	1,148,920	210,078	60,105	346,290	16,457	734,849	136,853	1,189,420	316,297
2006	1,764,840	2,113,756	2,063,426	110,581	852,281	30,278	1,351,959	251,779	2,188,268	581,916
2007	1,765,578	2,114,641	2,064,289	110,627	852,637	30,290	1,352,525	251,885	2,189,184	582,159
2008	1,661,212	1,989,641	1,942,266	104,087	802,237	28,500	1,272,575	236,995	2,059,777	547,747
2009	1,686,444	2,019,862	1,971,767	105,668	814,422	28,933	1,291,904	240,595	2,091,063	556,067
2010	1,613,673	1,932,703	1,886,684	101,109	779,279	27,684	1,236,157	230,213	2,000,833	532,072
2011	1,741,945	2,086,335	2,036,658	109,146	841,224	29,885	1,334,420	248,513	2,159,880	574,367
2012	1,743,800	2,088,557	2,038,826	109,262	842,120	29,917	1,335,841	248,778	2,162,180	574,978
2013	1,838,010	2,201,394	2,148,976	115,165	887,616	31,533	1,408,011	262,218	2,278,994	606,042
2014	1,905,981	2,282,802	2,228,446	119,424	920,441	32,699	1,460,080	271,915	2,363,272	628,454
2015	2,004,438	2,400,725	2,343,561	125,593	967,988	34,388	1,535,504	285,961	2,485,352	660,918
2016	2,024,797	2,425,108	2,367,364	126,869	977,820	34,737	1,551,100	288,866	2,510,595	667,631
2017	1,995,029	2,389,456	2,332,560	125,004	963,444	34,227	1,528,296	284,619	2,473,686	657,816
2018	1,759,385	2,107,223	2,057,048	110,239	849,646	30,184	1,347,780	251,001	2,181,504	580,117
2019	1,897,284	2,272,386	2,218,278	118,879	916,241	32,550	1,453,418	270,674	2,352,489	625,586
2020	1,747,070	2,092,474	2,042,650	109,467	843,699	29,973	1,338,346	249,244	2,166,235	576,057
2021	1,765,991	2,115,135	2,064,772	110,653	852,837	30,297	1,352,841	251,943	2,189,695	582,295
2022	1,706,248	2,043,581	1,994,921	106,909	823,985	29,272	1,307,074	243,420	2,115,618	562,596
2023	1,704,915	2,041,985	1,993,363	106,826	823,342	29,250	1,306,053	243,230	2,113,966	562,157
2024	1,637,541	1,961,290	1,914,590	102,604	790,805	28,094	1,254,441	233,618	2,030,427	539,942
2025	1,476,222	1,768,078	1,725,978	92,496	712,901	25,326	1,130,863	210,604	1,830,404	486,751
2026	1,326,957	1,589,303	1,551,460	83,144	640,818	22,765	1,016,518	189,309	1,645,327	437,534
2027	1,473,823	1,765,205	1,723,173	92,346	711,742	25,285	1,129,025	210,262	1,827,430	485,960
2028	1,090,672	1,306,303	1,275,199	68,339	526,710	18,712	835,511	155,600	1,352,351	359,624
2029	1,203,139	1,441,005	1,406,693	75,386	581,023	20,641	921,667	171,645	1,491,802	396,708
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	51,529,431	58,529,673	49,844,593	3,238,918	23,617,081	888,023	38,210,588	7,285,835	64,092,983	17,027,329

TABLE B-22. Water System Revenue Bond Surcharge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1971	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	24,019	2,642,354	18,118	3,150,527	1,336	552	853	2,741	0	4,317,328
1989	42,040	4,587,641	34,565	5,564,840	0	918	1,454	2,372	0	7,583,021
1990	38,023	4,037,980	34,994	4,917,308	2,535	800	1,283	4,618	0	6,750,020
1991	59,122	6,259,893	54,115	7,642,536	9,945	1,243	2,027	13,215	0	10,510,679
1992	80,131	8,435,312	72,892	10,351,553	13,671	1,710	2,806	18,187	0	14,255,669
1993	84,371	8,885,273	76,858	10,904,435	14,608	1,827	3,026	19,461	0	15,068,309
1994	85,698	8,926,755	76,794	10,959,041	14,409	1,801	3,070	19,280	0	15,145,690
1995	101,792	10,539,433	90,436	12,943,057	16,957	2,119	3,704	22,780	0	18,013,188
1996	124,074	12,810,361	109,783	15,730,703	20,640	2,580	4,621	27,841	0	21,369,059
1997	28,259	13,168,230	112,960	16,102,652	21,382	2,674	4,872	28,928	0	21,970,359
1998	27,174	12,662,268	108,619	15,483,941	20,562	2,571	4,685	27,818	0	21,126,192
1999	53,545	17,454,651	149,123	21,587,353	28,348	3,543	6,765	38,656	0	29,200,538
2000	70,117	19,805,800	168,259	25,135,976	32,271	9,794	7,996	50,061	0	33,737,389
2001	69,001	19,490,499	165,580	24,751,444	31,757	9,638	7,869	49,264	0	33,419,720
2002	71,126	20,091,004	170,682	25,534,301	32,736	9,935	8,112	50,783	0	34,452,492
2003	74,063	20,920,403	177,728	26,588,412	34,087	10,345	8,446	52,878	0	35,874,763
2004	74,138	20,941,743	177,910	26,615,534	34,121	10,356	8,456	52,933	0	35,911,363
2005	69,992	19,770,593	167,960	25,127,082	32,213	9,776	7,983	49,972	0	33,903,044
2006	128,769	34,565,228	309,009	46,312,090	59,265	17,986	14,686	91,937	0	62,374,078
2007	128,823	34,579,696	309,139	46,331,473	59,290	17,994	14,692	91,976	0	62,400,185
2008	121,208	32,535,632	290,865	43,592,742	55,785	16,930	13,824	86,539	0	58,711,605
2009	123,049	33,029,814	295,283	44,254,871	56,633	17,187	14,034	87,854	0	59,603,373
2010	117,740	31,604,556	282,541	42,345,244	54,189	16,446	13,428	84,063	0	57,031,446
2011	127,099	34,116,825	305,001	45,711,298	58,497	17,753	14,495	90,745	0	61,564,921
2012	127,234	34,153,155	305,325	45,759,973	58,559	17,772	14,511	90,842	0	61,630,480
2013	134,108	35,998,315	321,821	48,232,203	61,723	18,732	15,295	95,750	0	64,960,129
2014	139,068	37,329,538	333,722	50,015,842	64,005	19,425	15,860	99,290	0	67,362,372
2015	146,251	39,257,886	350,961	52,599,526	67,311	20,428	16,680	104,419	0	70,842,127
2016	147,737	39,656,614	354,526	53,133,764	67,995	20,636	16,849	105,480	0	71,561,651
2017	145,565	39,073,603	349,314	52,352,619	66,995	20,332	16,601	103,928	0	70,509,585
2018	128,371	34,458,396	308,054	46,168,948	59,082	17,931	14,641	91,654	0	62,181,294
2019	138,433	37,159,223	332,199	49,787,640	63,713	19,336	15,788	98,837	0	67,055,021
2020	127,473	34,217,205	305,898	45,845,791	58,669	17,805	14,538	91,012	0	61,746,058
2021	128,853	34,587,775	309,211	46,342,298	59,304	17,998	14,696	91,998	0	62,414,766
2022	124,494	33,417,678	298,750	44,774,546	57,298	17,389	14,198	88,885	0	60,303,282
2023	124,397	33,391,581	298,517	44,739,582	57,253	17,375	14,187	88,815	0	60,256,189
2024	119,481	32,072,021	286,720	42,971,574	54,991	16,689	13,627	85,307	0	57,875,004
2025	107,711	28,912,517	258,475	38,738,326	49,573	15,045	12,284	76,902	0	52,173,577
2026	96,820	25,989,098	232,340	34,821,393	44,561	13,524	11,042	69,127	0	46,898,169
2027	107,536	28,865,534	258,055	38,675,376	49,493	15,020	12,264	76,777	0	52,088,795
2028	79,580	21,361,337	190,968	28,620,906	36,626	11,115	9,076	56,817	0	38,547,225
2029	87,786	23,564,050	210,660	31,572,205	40,403	12,262	10,012	62,677	0	42,522,100
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
TOTAL	4,134,271	1,025,327,470	9,064,730	1,352,790,925	1,722,791	495,292	425,336	2,643,419	0	1,825,222,255

TABLE B-23. Total Transportation and Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	NORTH BAY AREA			SOUTH BAY AREA				CENTRAL COASTAL AREA		
	Napa County FC&WCD	Solano County WA	Total	Alameda County FC&WCD, Zone 7	Alameda County Water District	Santa Clara Valley Water District	Total	San Luis Obispo County FC&WCD	Santa Barbara County FC&WCD	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	11,750	43,787	21,132	76,669	0	0	0
1963	0	0	0	199,673	190,236	447,594	837,503	0	0	0
1964	0	0	0	263,210	277,398	621,174	1,161,782	6,694	21,659	28,353
1965	0	0	0	373,722	404,239	1,157,791	1,935,752	13,751	36,017	49,768
1966	18,057	0	18,057	419,362	421,628	1,412,600	2,253,590	26,516	61,329	87,845
1967	41,560	0	41,560	552,988	548,387	1,862,808	2,964,183	56,450	118,225	174,675
1968	128,588	0	128,588	682,759	633,066	2,178,036	3,493,861	115,927	229,740	345,667
1969	254,662	0	254,662	817,355	583,307	2,298,276	3,698,938	185,117	358,783	543,900
1970	277,493	0	277,493	903,666	640,164	2,787,493	4,331,323	200,110	387,595	587,705
1971	227,419	0	227,419	845,130	675,059	2,806,542	4,326,731	202,372	392,830	595,202
1972	224,922	0	224,922	929,119	822,262	3,027,272	4,778,653	209,015	406,506	615,521
1973	221,035	31,353	252,388	915,555	716,357	3,120,308	4,752,220	206,516	402,639	609,155
1974	240,442	32,924	273,366	956,141	746,798	3,324,543	5,027,482	208,503	407,005	615,508
1975	237,400	36,276	273,676	1,014,516	792,919	3,213,566	5,021,001	225,853	439,786	665,639
1976	271,231	40,819	312,050	1,127,567	943,328	3,362,062	5,432,957	228,933	447,212	676,145
1977	293,565	45,078	338,643	1,096,181	922,067	3,302,979	5,321,227	238,656	468,632	707,288
1978	273,807	49,159	322,966	1,184,963	935,682	3,712,097	5,832,742	245,286	484,166	729,452
1979	289,415	53,320	342,735	1,281,524	1,009,429	3,819,046	6,109,999	243,064	483,342	726,406
1980	310,779	86,049	396,827	1,434,484	1,173,659	4,118,582	6,726,725	282,208	540,456	822,664
1981	347,710	112,817	460,527	1,542,998	1,348,984	4,507,072	7,399,054	307,018	596,566	903,584
1982	438,260	141,798	580,058	1,623,310	1,369,396	4,940,901	7,933,607	328,168	682,443	1,010,611
1983	354,703	163,242	517,946	1,493,581	1,259,998	4,909,747	7,663,326	357,171	701,981	1,059,152
1984	467,232	246,623	713,856	1,803,603	1,478,252	6,869,751	10,151,606	409,482	800,953	1,210,435
1985	735,929	386,187	1,122,116	2,301,425	2,224,952	7,795,981	12,322,358	500,648	969,826	1,470,474
1986	1,119,826	714,023	1,833,849	2,170,037	2,013,959	8,193,339	12,377,335	536,703	1,037,924	1,574,627
1987	1,773,371	1,581,733	3,355,104	2,666,542	2,505,517	7,979,748	13,151,807	570,595	1,148,862	1,719,457
1988	2,349,015	2,524,068	4,873,083	2,727,700	2,774,284	7,829,776	13,331,760	673,019	1,439,487	2,112,506
1989	2,548,170	3,700,620	6,248,790	2,711,651	2,515,323	7,578,335	12,805,309	772,517	1,814,603	2,587,120
1990	2,899,410	3,848,146	6,747,556	3,146,946	2,929,625	8,354,874	14,431,445	933,311	2,046,195	2,979,506
1991	2,940,701	4,169,425	7,110,126	2,418,874	2,384,093	6,430,306	11,233,273	979,649	2,366,642	3,346,291
1992	2,797,105	4,144,190	6,941,295	2,893,339	2,926,955	7,656,397	13,476,691	1,118,743	2,526,627	3,645,370
1993	2,854,875	4,171,687	7,026,562	3,750,112	2,977,192	8,849,446	15,576,750	1,185,596	2,725,769	3,911,365
1994	2,987,315	4,224,488	7,211,803	3,787,188	3,586,085	9,612,974	16,986,247	1,335,886	3,517,571	4,853,457
1995	2,960,697	4,404,411	7,365,108	4,035,839	3,313,187	8,393,270	15,742,296	1,647,663	6,194,234	7,841,897
1996	3,044,394	4,897,402	7,941,796	3,643,676	3,178,232	9,227,992	16,049,900	2,591,704	15,229,004	17,820,708
1997	3,027,378	4,733,999	7,761,378	3,870,184	3,145,383	9,337,452	16,353,019	3,002,323	23,731,433	26,733,756
1998	2,935,964	4,589,687	7,525,651	3,479,657	3,204,049	9,084,654	15,768,360	3,255,725	28,306,094	31,561,819
1999	3,153,293	5,067,870	8,221,163	4,165,792	3,670,900	11,379,341	19,216,033	3,804,992	29,596,993	33,401,985
2000	3,461,761	5,620,694	9,082,455	5,803,535	3,595,950	10,225,069	19,624,554	3,778,512	30,647,422	34,425,934
2001	4,077,160	6,366,877	10,444,037	7,651,552	4,082,226	12,197,421	23,931,199	4,325,809	32,645,829	36,971,638
2002	4,321,849	6,558,581	10,880,431	7,516,120	4,075,428	13,130,226	24,721,774	4,052,063	32,381,776	36,433,839
2003	4,439,385	6,903,912	11,343,297	7,318,008	3,793,122	11,898,495	23,009,625	4,127,842	32,669,250	36,797,092
2004	4,978,166	7,445,546	12,423,712	8,339,005	4,188,611	11,596,368	24,123,984	4,202,089	33,271,428	37,473,517
2005	4,342,639	6,733,122	11,075,761	8,547,630	4,429,619	12,563,864	25,541,113	4,326,481	33,535,756	37,862,237
2006	5,404,676	8,054,544	13,459,220	9,985,053	5,411,710	14,030,529	29,427,292	6,540,850	35,367,522	41,908,372
2007	5,848,062	8,393,468	14,241,530	11,174,098	5,799,103	14,843,893	31,817,094	4,829,200	39,158,912	43,988,112
2008	6,421,045	8,727,866	15,148,911	12,565,807	6,251,266	16,109,489	34,926,562	7,310,198	38,062,792	45,372,990
2009	5,812,790	6,934,437	12,747,227	12,596,124	6,355,237	16,054,638	35,005,999	7,595,729	37,371,329	44,967,058
2010	5,844,232	6,939,072	12,783,304	12,887,374	6,506,005	16,373,494	35,766,873	7,765,319	37,632,168	45,397,487
2011	5,843,122	7,010,531	12,853,653	12,138,444	6,079,057	16,924,630	35,142,131	7,488,932	37,288,946	44,777,878
2012	5,887,622	7,038,216	12,925,838	12,200,607	6,108,434	17,008,116	35,317,157	7,588,203	37,498,706	45,086,909
2013	5,907,386	7,063,465	12,970,851	12,133,857	6,058,138	16,772,208	34,964,203	7,612,043	37,637,891	45,249,934
2014	5,911,525	7,062,771	12,974,296	11,770,110	5,843,094	16,232,478	33,845,682	7,466,056	37,431,849	44,897,905
2015	5,981,481	7,105,866	13,087,347	11,848,887	5,830,991	16,058,055	33,737,933	7,514,310	37,618,232	45,132,542
2016	6,012,570	7,118,993	13,131,563	11,991,694	5,894,010	16,110,494	33,996,198	7,579,280	37,752,984	45,332,264
2017	6,006,628	7,095,729	13,102,357	11,717,336	5,761,904	15,744,152	33,223,392	7,449,559	37,485,343	44,934,902
2018	5,913,080	7,018,613	12,931,693	11,490,492	5,671,612	15,482,437	32,644,541	7,410,366	37,175,191	44,585,557
2019	5,966,085	7,094,121	13,060,206	11,696,734	5,790,910	15,778,434	33,266,078	7,550,971	37,565,909	45,116,880
2020	5,910,229	6,987,342	12,897,571	11,277,689	5,588,650	15,244,973	32,111,312	7,295,188	36,949,385	44,244,573
2021	5,922,501	6,997,650	12,920,151	11,274,666	5,586,785	15,245,045	32,106,496	7,298,728	36,974,344	44,273,072
2022	5,872,909	6,945,831	12,818,740	11,066,065	5,483,946	14,972,246	31,522,257	7,158,285	36,657,074	43,815,359
2023	5,872,820	6,912,267	12,785,087	11,141,832	5,523,718	15,065,579	31,731,129	7,188,285	36,708,000	43,896,285
2024	5,886,147	6,913,931	12,800,078	11,293,388	5,600,364	15,258,851	32,152,603	7,311,225	36,863,815	44,175,040
2025	5,824,495	6,838,267	12,662,762	10,971,590	5,439,695	14,850,625	31,261,910	7,184,872	36,472,290	43,657,162
2026	5,785,473	6,777,366	12,562,839	11,123,044	5,522,942	15,033,756	31,679,742	7,243,665	36,424,732	43,668,397
2027	5,808,405	6,823,063	12,631,468	11,057,118	5,485,134	14,952,781	31,495,033	7,192,453	36,480,294	43,672,747
2028	5,707,576	6,666,424	12,374,000	10,804,578	5,367,961	14,620,004	30,792,543	7,124,852	35,963,791	43,088,643
2029	5,721,333	6,697,599	12,418,932	10,822,110	5,372,666	14,645,866	30,840,642	7,093,626	36,018,603	43,112,229
2030	5,398,769	6,203,443	11,602,212	10,112,204	5,044,250	13,722,097	28,878,551	6,853,752	34,366,134	41,219,886
2031	5,372,110	6,175,000	11,547,110	9,967,944	4,970,215	13,538,115	28,476,274	6,776,258	34,215,943	40,992,201
2032	5,375,357	6,165,718	11,541,075	10,102,077	5,037,758	13,709,070	28,848,905	6,862,299	34,371,981	41,234,280
2033	5,396,449	6,165,370	11,561,819	10,320,059	5,145,651	13,992,958	29,458,668	7,051,766	34,722,759	41,774,525
2034	5,284,035	6,054,952	11,338,987	10,122,661	5,046,860	13,736,528	28,906,049	6,899,006	34,442,568	41,341,574
2035	5,113,096	5,887,668	11,000,764	10,107,780	5,043,883	13,706,989	28,858,652	6,859,510	34,365,642	41,225,152
TOTAL	241,678,691	301,695,710	543,374,401	452,179,392	254,073,043	722,955,230	1,429,207,665	267,113,466	1,423,315,719	1,690,429,185

TABLE B-23. Total Transportation and Delta Water Charge for Each Contractor

(in dollars)

SAN JOAQUIN VALLEY AREA

Calendar Year	Dudley Ridge Water District	Empire West Side Irrigation District	Future Contractor San Joaquin Valley	Kern County Water Agency		County of Kings	Oak Flat Water District	Tulare Lake Basin Water Storage District	Total
				Municipal and Industrial	Agri-cultural				
	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
1961	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	2,724	0	0	0	0	0	2,724
1965	0	0	6,027	73,543	0	0	0	0	79,570
1966	0	0	12,035	137,285	0	0	0	0	149,320
1967	0	0	26,249	267,525	0	0	0	0	293,774
1968	224,863	19,355	54,573	445,315	1,707,907	16,944	19,621	307,144	2,795,722
1969	241,040	10,858	87,557	524,952	2,725,665	16,821	19,353	458,146	4,084,393
1970	306,153	34,294	94,656	573,846	3,874,807	21,431	30,373	520,792	5,456,353
1971	327,556	37,022	95,676	605,729	5,194,583	27,171	34,653	712,014	7,034,405
1972	381,217	40,283	98,769	631,452	7,160,048	26,469	63,760	1,983,416	10,385,415
1973	398,531	38,905	97,531	1,025,724	7,288,944	28,813	39,235	781,297	9,698,980
1974	506,825	40,119	98,440	1,144,626	7,998,836	29,540	42,529	1,041,211	10,902,126
1975	679,255	40,568	106,683	1,197,000	9,378,180	31,236	48,144	1,554,104	13,035,170
1976	718,929	43,089	108,064	1,323,673	10,621,999	32,663	52,075	1,440,444	14,340,936
1977	579,202	39,006	112,534	1,367,237	10,935,227	34,430	54,184	1,136,448	14,258,267
1978	697,714	36,029	115,500	1,565,715	13,267,022	38,924	58,998	1,170,331	16,950,233
1979	780,939	47,842	114,232	1,668,782	15,342,234	43,061	70,589	1,724,129	19,791,809
1980	961,857	49,577	125,929	1,770,094	16,980,862	48,017	94,886	1,670,360	21,701,583
1981	1,210,796	83,943	134,147	2,430,626	22,581,643	66,491	100,598	2,281,316	28,889,561
1982	1,246,912	70,137	135,036	2,523,486	24,975,869	70,658	108,243	2,275,922	31,406,263
1983	1,181,152	52,487	149,180	2,084,871	24,620,691	75,438	87,400	506,508	28,757,728
1984	1,490,607	28,469	164,483	3,396,201	33,347,123	94,317	121,380	1,539,693	40,182,273
1985	1,766,381	129,899	184,883	3,891,023	39,315,432	117,579	139,459	2,814,739	48,359,395
1986	2,008,191	79,276	180,423	4,079,656	43,415,702	136,711	153,113	3,651,450	53,704,522
1987	1,883,365	95,194	179,850	4,570,657	42,685,043	137,328	151,352	3,744,261	53,447,050
1988	1,968,313	109,572	193,712	4,734,317	44,620,432	138,274	146,509	3,898,655	55,809,784
1989	2,122,936	101,699	187,891	4,677,170	46,811,366	137,082	166,333	4,379,959	58,584,436
1990	1,882,977	86,903	221,368	4,827,701	45,586,813	121,149	148,635	3,957,759	56,833,305
1991	1,687,849	80,192	220,258	4,535,666	37,462,468	103,904	134,645	3,498,769	47,723,752
1992	2,233,468	105,011	241,431	5,549,954	48,659,564	143,779	175,628	4,537,599	61,646,434
1993	2,455,623	120,014	264,933	5,805,843	54,560,731	161,518	195,193	5,291,453	68,855,308
1994	2,260,461	107,520	306,333	5,210,092	52,031,343	145,621	178,005	4,664,186	64,903,561
1995	2,856,907	115,436	304,270	6,621,268	60,491,427	180,796	210,338	5,522,987	76,303,430
1996	2,079,003	125,126	389,175	6,670,890	58,901,328	178,468	189,950	7,088,752	75,622,692
1997	2,790,580	100,531	276,653	6,521,729	57,769,465	138,112	212,150	4,710,883	72,520,103
1998	2,645,355	119,852	381,853	5,812,611	54,360,965	143,432	203,908	4,965,302	68,633,278
1999	2,697,215	134,246	366,504	6,357,194	57,227,682	181,837	215,880	7,274,247	74,454,804
2000	2,622,853	120,600	303,259	6,363,533	51,446,943	174,146	213,127	6,167,186	67,411,647
2001	3,293,579	145,284	327,968	6,046,016	58,539,194	191,938	258,689	6,424,177	75,226,846
2002	3,008,432	127,392	321,476	6,794,396	53,188,388	186,918	238,166	5,733,510	69,598,679
2003	3,059,898	131,038	340,003	7,048,962	55,840,685	201,424	237,144	6,035,052	72,894,206
2004	3,249,402	167,420	343,909	8,136,038	56,614,700	353,510	252,973	5,811,423	74,929,374
2005	3,849,114	178,696	356,697	7,506,113	67,920,825	696,486	251,713	6,720,787	87,480,431
2006	3,823,965	201,167	356,343	8,421,090	70,090,468	600,124	287,668	6,318,619	90,099,445
2007	4,050,598	192,452	367,989	9,225,405	72,271,152	640,680	308,813	6,632,802	93,689,891
2008	4,279,612	204,545	380,595	9,664,260	76,877,516	677,717	324,583	7,012,417	99,421,245
2009	3,966,617	188,208	363,376	9,370,322	71,327,477	631,330	303,305	6,497,063	92,647,698
2010	4,113,302	196,063	363,827	9,731,139	73,787,788	655,565	316,626	6,743,120	95,907,430
2011	3,874,631	183,247	365,305	9,113,254	69,182,673	616,220	298,951	6,342,401	89,976,682
2012	3,878,311	183,436	365,870	9,133,635	69,489,733	617,139	297,527	6,348,522	90,314,173
2013	3,980,103	188,526	366,014	9,359,503	70,873,022	633,367	307,855	6,517,878	92,226,268
2014	3,835,934	180,813	363,349	9,009,459	68,531,082	609,676	294,142	6,276,040	89,100,495
2015	3,929,203	185,449	360,236	9,146,859	69,875,767	624,534	302,896	6,431,115	90,856,059
2016	4,054,051	191,933	353,913	9,382,332	71,882,198	644,775	314,051	6,639,857	93,463,110
2017	3,933,656	185,707	339,826	8,963,914	69,933,042	625,254	303,510	6,438,699	90,723,608
2018	3,877,898	183,368	317,309	8,744,378	69,448,565	607,572	297,472	6,347,512	89,824,074
2019	4,038,889	191,453	308,520	9,057,622	71,916,941	632,667	311,690	6,615,651	93,073,433
2020	3,881,703	183,599	306,942	8,657,479	69,393,322	607,048	298,914	6,354,035	89,683,042
2021	3,876,591	183,285	305,966	8,622,945	69,321,728	606,006	298,182	6,345,293	89,559,996
2022	3,793,937	179,107	305,264	8,418,285	67,979,484	592,530	291,359	6,207,565	87,767,531
2023	3,848,068	181,946	304,618	8,542,787	68,824,512	601,297	296,515	6,298,213	88,897,956
2024	3,910,496	185,377	304,185	8,697,370	69,945,110	611,749	301,933	6,403,222	90,359,442
2025	3,727,033	176,175	303,889	8,275,519	67,251,336	582,359	284,804	6,097,739	86,698,854
2026	3,851,835	183,077	303,147	8,578,894	69,245,440	603,044	297,786	6,307,981	89,371,204
2027	3,803,892	180,198	303,325	8,451,028	68,403,305	594,695	292,546	6,226,249	88,255,238
2028	3,710,486	176,264	300,043	8,258,773	67,222,271	580,588	282,457	6,073,694	86,604,576
2029	3,702,485	175,567	300,076	8,227,173	67,001,010	578,833	284,203	6,059,217	86,328,564
2030	3,394,819	162,444	299,551	7,596,089	63,145,088	532,379	259,660	5,555,621	80,945,651
2031	3,321,520	158,601	298,766	7,405,209	62,025,846	519,996	252,533	5,432,778	79,415,249
2032	3,384,170	161,888	297,700	7,554,685	62,984,474	530,283	258,570	5,537,840	80,709,610
2033	3,459,953	165,849	297,895	7,743,463	64,476,534	542,687	263,285	5,664,511	82,614,177
2034	3,386,605	162,011	297,310	7,552,598	63,104,669	530,447	258,170	5,541,789	80,833,599
2035	3,449,337	165,297	296,054	7,707,229	64,291,698	540,296	262,475	5,646,842	82,359,228
TOTAL	178,495,150	8,629,945	17,630,077	405,131,210	3,365,555,387	22,643,293	13,871,410	314,910,696	4,326,867,168

TABLE B-23. Total Transportation and Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA									
	Antelope Valley - East Kern Water Agency	Castaic Lake Water Agency	Coachella Valley Water District	Crestline - Lake Arrowhead Water Agency	Desert Water Agency	Littlerock Creek Irrigation District	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	San Gabriel Valley Municipal Water District
	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0
1963	33.309	0	0	0	0	0	0	0	51.711	0
1964	62.847	27.438	16.286	4.369	37.145	1.142	28.427	8.202	82.782	34.973
1965	118.565	52.989	28.459	7.191	40.756	2.081	50.300	15.217	135.023	35.333
1966	215.713	101.232	51.184	12.474	73.129	3.752	90.369	27.670	232.426	61.445
1967	417.348	210.746	98.904	23.464	141.365	7.282	175.119	54.006	433.210	115.536
1968	744.206	491.125	176.688	41.496	251.125	12.866	311.081	95.438	781.930	208.864
1969	1.072.647	742.016	264.900	61.208	370.850	18.688	458.937	138.023	1.205.472	321.659
1970	1.395.848	941.966	371.728	89.673	519.163	25.223	632.989	184.783	1.777.650	467.431
1971	1,727,773	1,136,343	503,422	128,321	712,537	31,827	857,146	231,214	2,538,403	659,218
1972	2.207.788	1.381.338	682.096	185.824	989.700	43.760	1.179.256	287.548	3.774.702	950.069
1973	2.360.340	1.429.754	829.097	190.947	1.216.863	46.049	1.270.009	313.372	4.042.999	960.784
1974	2.481.092	1.525.225	853.731	204.027	1.256.738	48.922	1.328.852	331.627	4.480.180	1.104.244
1975	2.698.796	1.616.198	900.445	219.242	1.332.005	53.231	1.414.851	355.193	4.655.321	1.207.793
1976	3.163.245	1.652.864	958.179	232.081	1.424.703	57.721	1.491.141	381.199	4.854.833	1.278.480
1977	3.145.012	1.740.705	859.286	245.063	1.267.009	54.200	1.578.494	406.543	5.110.695	1.336.049
1978	3.593.002	1.873.735	1.058.836	255.418	1.567.751	56.795	1.625.709	419.949	5.108.379	1.373.766
1979	4.266.594	1.953.504	1.144.724	267.741	1.689.966	60.273	1.801.011	449.679	5.153.276	1.341.866
1980	4.950.893	2.091.841	1.254.546	295.300	1.890.349	67.594	1.972.994	498.972	5.664.035	1.484.871
1981	5.778.625	2.561.138	1.413.847	328.765	2.140.325	100.740	2.291.039	603.182	6.478.238	1.688.045
1982	5.537.462	2.724.147	1.499.972	346.669	2.284.051	82.284	2.265.745	641.909	6.769.199	1.929.385
1983	6,287,841	2,794,693	2,021,337	380,786	3,118,525	88,372	2,461,270	658,528	6,981,081	1,808,463
1984	7,663,206	3,873,394	3,123,607	497,530	4,874,874	96,480	2,726,640	727,732	8,069,552	2,597,938
1985	9.494.182	4.339.431	3.957.883	601.872	6.209.843	103.693	2.916.561	959.565	8.909.659	2.686.498
1986	9.462.355	4.974.829	4.418.531	647.576	6.954.134	130.208	3.100.055	1.223.753	9.159.122	3.398.233
1987	9.496.466	4.832.282	4.286.505	678.027	6.830.144	240.859	3.154.460	1.254.957	10.560.620	3.398.610
1988	9.094.804	5.019.001	4.343.583	704.352	6.996.687	158.832	3.328.582	1.044.110	11.111.463	3.270.823
1989	10.985.206	5.028.306	4.050.973	691.132	6.579.291	210.621	3.409.349	1.746.666	10.828.253	3.453.364
1990	12.376.664	5.496.308	4.745.014	729.168	7.663.400	331.158	3.640.183	1.953.805	11.739.188	4.220.944
1991	9.236.278	4.610.066	3.298.997	688.804	5.277.044	221.152	4.499.612	1.639.984	11.121.092	3.642.282
1992	11,792,383	5,798,748	3,452,415	612,831	5,529,109	174,984	5,477,700	1,532,224	11,160,289	3,693,763
1993	12.205.489	5.445.406	3.656.000	617.132	5.863.795	211.890	5.368.538	1.753.869	12.123.330	4.041.978
1994	14.274.279	6.012.641	3.681.660	694.501	5.904.571	277.997	6.319.305	2.090.615	12.750.420	4.776.885
1995	14.140.578	6.387.506	4.503.309	661.742	7.259.099	212.229	5.511.821	1.952.389	12.220.505	4.480.562
1996	14.566.985	6.618.643	7.455.778	710.580	12.127.573	208.342	5.609.442	2.300.101	12.746.956	4.598.694
1997	15.136.535	6.512.295	7.071.320	750.347	8.455.419	207.872	6.031.417	2.342.092	14.414.986	4.897.092
1998	13.676.086	6.145.896	6.170.181	717.194	6.979.423	209.228	7.636.031	1.950.284	14.321.071	4.179.809
1999	15.392.624	6.644.958	5.183.512	823.182	7.122.720	213.796	8.243.073	2.350.813	15.737.693	5.114.792
2000	14.788.674	10.253.713	3.643.052	793.120	5.562.498	186.800	8.190.152	2.079.775	15.511.808	4.255.067
2001	24,849,221	15,869,263	4,683,972	995,954	7,551,916	199,053	8,875,616	3,991,805	21,437,432	4,395,648
2002	16.254.111	13.071.866	3.921.265	957.440	6.293.917	182.320	8.047.536	3.366.534	22.231.817	5.760.963
2003	17.593.494	13.984.378	4.109.892	930.633	6.603.939	187.292	9.902.296	2.911.116	20.095.911	5.931.746
2004	18.675.421	15.379.485	4.686.581	1.033.166	6.571.517	201.435	9.935.287	3.176.601	24.330.801	5.413.295
2005	20.181.040	15.026.082	18.471.934	800.300	11.908.258	198.531	10.093.257	3.414.665	22.051.488	5.845.449
2006	23.683.654	16.736.993	28.903.046	1.331.841	10.743.103	330.617	15.760.795	4.626.546	31.241.765	6.734.838
2007	22.684.050	20.302.270	40.748.663	1.592.339	13.228.376	649.617	13.037.235	5.934.438	35.150.616	6.922.951
2008	40.706.827	26.197.663	46.851.741	2.406.562	18.059.568	728.045	27.018.365	6.648.928	42.731.463	10.828.989
2009	39.857.068	23.953.541	42.833.446	2.137.839	16.315.278	661.627	26.570.043	6.030.707	39.018.234	9.794.010
2010	41.266.688	24.708.659	44.351.086	2.200.593	16.909.011	684.615	27.468.787	6.244.731	40.119.523	10.111.893
2011	35.252.265	24.192.013	39.372.718	1.890.329	14.893.069	583.929	23.100.350	5.309.873	36.140.894	8.983.662
2012	36.439.256	25.676.576	40.595.584	1.946.510	15.378.042	603.253	23.916.299	5.488.662	37.063.005	9.248.524
2013	36.164.461	25.503.637	40.393.094	1.923.100	15.267.272	599.432	23.737.433	5.451.596	36.663.328	9.153.168
2014	35.198.493	24.742.175	39.282.310	1.895.914	14.867.399	583.148	23.137.874	5.301.182	36.195.100	8.990.019
2015	35.391.629	24.941.331	39.480.268	1.885.620	14.913.047	586.348	23.281.501	5.330.296	35.988.612	8.961.904
2016	36.536.373	25.707.422	40.513.686	1.964.430	15.383.339	604.881	24.045.767	5.503.588	37.320.362	9.301.059
2017	35.091.834	24.727.995	39.216.474	1.877.395	14.783.812	581.117	23.133.137	5.288.187	35.798.011	8.899.246
2018	35.810.832	25.002.882	39.693.390	1.913.781	15.033.042	592.390	23.677.290	5.400.668	36.308.041	9.045.251
2019	36.690.767	25.446.654	40.527.582	1.956.959	15.356.813	606.336	24.125.026	5.532.246	37.043.660	9.238.549
2020	34.706.628	23.999.980	38.012.667	1.836.505	14.393.056	572.661	22.907.060	5.229.091	34.745.523	8.632.019
2021	34.529.400	23.794.903	37.566.870	1.793.409	14.196.262	568.614	22.735.305	5.198.146	33.937.329	8.444.684
2022	33.551.740	22.962.154	36.126.906	1.746.863	13.703.772	552.397	22.058.737	5.050.729	33.015.021	8.186.550
2023	33.827.207	23.192.456	35.432.310	1.770.113	13.672.759	556.693	22.229.719	5.091.719	33.319.171	8.256.120
2024	34.554.713	23.633.019	36.101.277	1.783.905	13.930.792	568.460	22.625.360	5.201.847	33.559.933	8.351.399
2025	33.848.230	23.029.194	35.186.181	1.750.778	13.623.732	556.794	22.196.062	5.096.665	32.972.214	8.187.195
2026	34.191.248	23.262.373	35.684.053	1.774.527	13.750.869	562.197	22.355.095	5.149.482	33.269.374	8.254.303
2027	34.003.401	23.007.614	35.025.801	1.748.891	13.602.556	559.265	22.250.981	5.120.065	32.862.794	8.165.050
2028	33.522.688	22.746.496	34.691.667	1.711.243	13.388.033	551.078	21.897.566	5.050.751	32.116.712	7.976.582
2029	33.407.152	22.473.529	34.600.251	1.730.634	13.379.814	549.279	21.835.173	5.032.566	32.496.643	8.044.426
2030	32.189.905	21.052.356	33.195.040	1.656.063	12.795.421	528.394	20.906.906	4.859.043	31.010.975	7.647.629
2031	31.852.386	20.644.419	33.039.845	1.606.372	12.646.752	522.868	20.742.331	4.808.724	30.155.170	7.458.827
2032	32.043.916	20.931.401	32.798.969	1.642.599	12.689.363	525.956	20.787.569	4.837.913	30.816.320	7.597.020
2033	34.018.924	22.167.302	34.996.495	1.725.980	13.515.073	558.046	22.136.767	5.136.884	32.202.256	8.011.172
2034	32.263.965	20.976.777	33.190.223	1.634.246	12.788.194	529.492	20.981.766	4.874.716	30.677.627	7.587.863
2035	34.343.197	21.895.517	35.219.082	1.762.566	13.587.031	563.203	22.206.861	5.189.891	32.789.939	8.124.541
TOTAL	1,381,223,921	895,982,792	1,251,534,359	74,454,548	604,237,874	22,448,326	828,164,809	210,885,584	1,419,674,606	367,562,152

TABLE B-23. Total Transportation and Delta Water Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA (continued)				FEATHER RIVER AREA					
	San Gorgonio Pass Water Agency	The Metropolitan Water District of Southern California	Ventura County Flood Control District	Total	City of Yuba City	County of Butte	Plumas County FC&WCD	Total	South Bay Area Future Contractor	GRAND TOTAL
	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]
1961	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	3,219	79,888
1963	0	690,539	0	775,559	0	0	0	0	12,626	1,625,689
1964	21,728	1,260,042	9,375	1,594,755	0	0	0	0	13,938	2,801,552
1965	21,859	2,179,810	17,761	2,705,344	0	0	405	405	28,937	4,799,776
1966	37,952	3,898,819	33,415	4,839,578	0	0	564	564	31,321	7,380,275
1967	71,260	7,691,085	68,133	9,507,458	0	0	562	562	47,718	13,029,930
1968	128,877	15,313,065	142,760	18,699,521	0	1,050	1,439	2,489	46,945	25,512,793
1969	198,704	23,145,744	215,144	28,213,991	0	1,225	4,119	5,344	52,963	36,854,190
1970	289,546	30,607,434	273,523	37,576,957	0	3,848	17,111	20,959	69,744	48,320,533
1971	409,205	39,946,463	342,325	49,224,198	0	4,546	19,182	23,728	55,532	61,487,214
1972	537,044	54,976,817	422,192	67,618,135	0	4,929	21,145	26,074	80,412	83,729,132
1973	587,814	59,575,172	435,541	73,258,742	0	7,059	21,772	28,831	54,219	88,654,535
1974	611,275	65,991,774	455,447	80,673,134	0	8,336	22,403	30,739	76,783	97,599,138
1975	644,464	71,813,105	478,284	87,388,928	0	9,416	23,517	32,933	84,547	106,501,893
1976	668,152	74,889,946	475,466	91,528,011	0	7,004	23,251	30,255	106,717	112,427,071
1977	696,350	73,320,946	506,941	90,267,293	0	16,917	24,054	40,971	98,618	111,032,307
1978	708,874	81,933,455	523,053	100,098,721	0	12,635	24,219	36,854	100,786	124,071,754
1979	712,699	83,583,809	526,278	102,951,420	0	16,575	28,346	44,921	119,352	130,086,642
1980	862,107	93,010,922	583,496	114,627,919	0	19,834	26,556	46,390	178,812	144,500,919
1981	946,788	112,152,065	672,397	137,155,193	0	21,682	34,558	56,240	185,347	175,049,505
1982	1,021,156	117,123,623	727,476	142,953,077	0	16,117	43,111	59,228	173,894	184,116,739
1983	1,076,102	118,970,809	854,111	147,501,918	0	15,202	29,405	44,607	220,926	185,765,602
1984	1,211,437	156,252,901	933,156	192,648,447	20,590	15,442	31,790	67,822	225,959	245,200,397
1985	1,287,602	195,472,350	993,495	237,932,635	24,050	16,976	32,399	73,425	340,322	301,620,724
1986	1,344,580	218,310,192	1,058,119	264,181,687	31,753	18,145	33,591	83,489	279,227	334,034,736
1987	1,379,421	204,837,839	1,056,160	252,006,349	37,071	17,794	33,378	88,243	345,116	324,113,126
1988	1,465,634	221,645,350	1,123,943	269,307,163	48,058	19,117	33,600	100,775	365,207	345,900,277
1989	1,505,285	230,306,400	1,232,220	280,027,066	61,184	20,809	37,183	119,176	422,329	360,794,226
1990	1,624,564	277,172,576	1,855,829	333,548,801	66,041	20,855	36,807	123,703	474,284	415,138,600
1991	1,720,675	221,864,576	1,549,792	269,370,354	180,212	22,526	42,194	244,932	214,683	339,243,411
1992	1,779,693	245,342,779	1,503,314	297,850,231	208,216	26,028	43,511	277,755	443,676	384,281,453
1993	1,943,122	219,214,982	1,551,085	273,996,616	209,613	26,203	47,582	283,398	599,571	370,249,570
1994	1,920,319	257,372,371	1,475,136	317,550,701	201,284	25,161	46,074	272,519	609,932	412,388,220
1995	1,982,578	225,839,379	1,568,231	286,719,927	216,944	27,118	50,016	294,078	534,971	394,801,706
1996	1,651,010	235,386,048	1,622,470	305,602,621	217,250	27,156	56,618	301,024	571,857	423,910,599
1997	1,759,495	245,428,898	1,777,095	314,784,863	236,300	29,847	59,910	326,057	428,638	438,907,814
1998	1,952,225	227,227,506	1,797,418	292,962,350	128,021	29,927	54,386	212,334	465,140	417,128,933
1999	2,268,132	254,361,636	1,866,557	325,323,488	254,675	31,834	58,367	344,876	559,344	461,521,694
2000	2,567,020	253,103,196	1,968,766	322,903,641	262,163	79,001	61,576	402,740	0	453,850,970
2001	3,551,602	442,340,647	2,260,949	541,003,078	261,699	93,471	62,742	417,912	0	687,994,709
2002	4,963,185	330,993,173	2,296,388	418,340,514	266,107	95,018	68,291	429,416	0	560,404,651
2003	5,766,410	357,998,864	2,313,407	448,329,377	262,547	93,638	68,949	425,134	0	592,798,730
2004	6,268,152	407,770,558	2,591,574	506,033,872	284,387	102,404	29,277	416,068	0	655,400,528
2005	6,389,956	386,882,222	2,124,149	503,387,332	280,033	41,076	28,801	349,910	0	665,696,784
2006	7,207,189	486,434,684	2,677,770	636,412,841	317,398	50,593	85,638	453,629	0	811,760,799
2007	8,301,227	562,288,429	5,692,615	736,532,826	309,089	741,743	53,962	1,104,794	0	921,374,246
2008	10,653,658	528,676,076	6,307,591	767,815,476	305,584	740,679	86,913	1,133,176	0	963,818,360
2009	10,026,918	483,762,681	5,715,751	706,677,143	306,432	740,936	88,991	1,136,359	0	893,181,484
2010	10,226,075	497,956,487	5,922,991	728,171,139	303,988	740,195	90,203	1,134,386	0	919,160,619
2011	9,533,531	529,490,297	5,050,647	733,793,577	308,296	741,502	93,348	1,143,146	0	917,687,067
2012	9,691,684	546,679,467	5,223,550	757,950,412	308,358	741,521	95,442	1,145,321	0	942,739,810
2013	9,620,229	542,369,311	5,181,356	752,027,417	311,522	742,481	98,564	1,152,567	0	938,591,240
2014	9,517,463	527,462,439	5,015,482	732,188,998	313,804	743,174	101,467	1,158,445	0	914,165,821
2015	9,484,196	529,487,881	5,047,094	734,779,727	317,110	744,177	104,480	1,165,767	0	918,759,375
2016	9,689,362	546,757,332	5,205,860	758,533,461	317,794	744,385	107,086	1,169,265	0	945,625,861
2017	9,448,095	524,558,480	4,994,015	728,397,798	316,794	744,081	106,841	1,167,716	0	911,549,773
2018	9,564,635	531,416,967	5,065,775	738,524,944	308,881	741,680	104,878	1,155,439	0	919,666,248
2019	9,663,522	541,110,308	5,147,275	752,445,697	313,512	743,085	103,400	1,159,997	0	938,122,291
2020	9,312,150	507,712,173	4,845,599	706,905,112	308,468	741,554	90,224	1,140,246	0	886,981,856
2021	9,190,708	500,466,131	4,793,201	697,214,962	309,103	741,747	89,556	1,140,406	0	877,215,083
2022	9,043,387	482,232,742	4,620,027	672,851,025	307,097	741,138	87,673	1,135,908	0	849,910,820
2023	9,086,879	485,549,294	4,667,328	676,651,768	307,052	741,124	87,661	1,135,837	0	855,098,062
2024	9,149,110	494,280,930	4,764,691	688,505,436	304,790	740,438	87,100	1,132,328	0	869,124,927
2025	9,070,689	481,672,371	4,645,751	671,835,856	299,372	738,794	85,755	1,123,921	0	847,240,465
2026	9,131,708	487,942,563	4,708,150	680,035,942	294,360	737,273	84,511	1,116,144	0	858,434,268
2027	9,056,171	479,634,866	4,637,702	669,675,157	299,292	738,769	85,731	1,123,792	0	846,853,435
2028	8,989,020	477,656,658	4,623,231	664,921,725	286,425	734,864	82,541	1,103,830	0	838,885,317
2029	9,020,239	471,565,313	4,548,345	658,683,364	290,202	736,011	83,476	1,109,689	0	832,493,420
2030	8,932,547	448,625,537	4,341,570	627,741,386	249,799	723,749	73,462	1,047,010	0	791,434,696
2031	8,812,531	438,325,752	4,248,097	614,864,074	249,799	723,749	73,461	1,047,009	0	776,341,917
2032	8,901,394	447,061,688	4,320,565	624,954,673	249,799	723,749	73,459	1,047,007	0	788,335,550
2033	9,146,851	471,328,368	4,570,738	659,514,856	249,799	723,749	73,459	1,047,007	0	825,971,052
2034	8,891,674	446,249,268	4,321,519	624,967,330	249,799	723,749	73,458	1,047,006	0	788,434,545
2035	9,220,784	471,769,178	4,532,384	661,204,174	249,799	723,749	73,456	1,047,004	0	825,694,974
TOTAL	344,137,675	21,917,723,556	189,719,041	29,507,749,245	12,621,715	22,480,359	4,008,954	39,111,028	8,723,612	37,545,462,304

TABLE B-24. Equivalent Unit Charge for Water Supply for Each Contractor [a]

(in dollars per acre-foot)

Project Service Area and Water Supply Contractor	Transportation Charge					Delta Water Charge	Water System Revenue Bond Surcharge	Total Equivalent Unit Charge
	Capital Cost Component	Minimum OMP&R Component	Off-Aqueduct Component	Variable OMP&R Component	Total			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
FEATHER RIVER AREA								
City of Yuba City	0.00	0.00	0.00	0.00	0.00	55.51	8.13	63.63
County of Butte	0.00	0.00	0.00	0.00	0.00	33.84	0.94	34.78
Plumas County Flood Control and Water Conservation District	26.70	3.41	0.00	0.00	30.11	32.63	5.01	67.75
Feather River Area	2.86	0.37	0.00	0.00	3.22	39.51	3.30	46.03
NORTH BAY AREA								
Napa County Flood Control and Water Conservation District	135.62	42.90	4.36	17.44	200.32	20.20	11.27	231.79
Solano County Water Agency	83.62	34.22	4.35	11.76	133.96	26.63	10.49	171.07
North Bay Area	103.21	37.49	4.36	13.90	158.96	24.21	10.78	193.95
SOUTH BAY AREA								
Alameda County Flood Control and Water Conservation District, Zone 7	36.18	33.99	8.08	25.72	103.98	25.89	7.36	137.22
Alameda County Water District	24.74	25.90	7.02	16.78	74.44	21.70	4.44	100.58
Santa Clara Valley Water District	22.15	19.42	6.37	13.28	61.21	15.63	3.22	80.06
South Bay Area	25.19	23.21	6.80	16.18	71.37	18.55	4.19	94.12
SAN JOAQUIN VALLEY AREA								
County of Kings	5.10	5.21	3.40	9.86	23.58	20.54	3.51	47.63
Dudley Ridge Water District	5.13	4.78	3.16	6.03	19.10	16.23	2.26	37.59
Empire West Side Irrigation District	1.99	4.00	2.43	5.46	13.89	17.54	1.72	33.14
Kern County Water Agency	9.26	9.24	4.87	8.22	31.59	19.05	2.39	53.03
Oak Flat Water District	2.00	2.26	1.96	3.73	9.95	15.98	1.71	27.64
Tulare Lake Basin Water Storage District	5.19	4.67	3.10	5.70	18.66	16.59	2.16	37.41
San Joaquin Valley Area	8.54	8.46	4.57	5.76	27.32	16.71	2.19	46.22
CENTRAL COASTAL AREA								
San Luis Obispo County Flood Control and Water Conservation District	167.69	80.38	14.76	118.09	380.93	58.68	20.98	460.59
Santa Barbara County Flood Control and Water Conservation District	733.75	113.82	17.96	107.18	972.71	48.37	53.01	1,074.09
Central Coastal Area	559.43	103.52	16.97	110.54	790.46	51.55	43.14	885.15
SOUTHERN CALIFORNIA AREA								
Antelope Valley-East Kern Water Agency	45.13	40.28	29.32	85.09	199.82	32.99	7.89	240.71
Castaic Lake Water Agency	49.33	41.05	23.25	60.67	174.30	27.98	12.45	214.73
Coachella Valley Water District	51.57	49.30	37.49	97.10	235.46	22.35	10.21	268.02
Crestline-Lake Arrowhead Water Agency	109.60	87.56	32.61	110.75	340.52	42.55	14.44	397.51
Desert Water Agency	43.39	39.41	48.20	57.65	188.65	20.22	6.64	215.51
Littlerock Creek Irrigation District	60.68	53.51	28.96	95.98	239.14	43.28	10.21	292.63
Mojave Water Agency	96.15	97.86	27.10	161.62	382.73	58.15	20.26	461.13
Palmdale Water District	51.29	47.37	36.24	109.30	244.20	41.84	9.20	295.24
San Bernardino Valley Municipal Water District	175.21	118.24	27.22	101.16	421.83	52.34	18.67	492.84
San Gabriel Valley Municipal Water District	98.25	80.15	41.51	71.20	291.10	36.76	12.61	340.47
San Gorgonio Pass Water Agency	588.92	199.27	22.72	154.21	965.12	59.63	13.74	1,038.49
The Metropolitan Water District of Southern California	77.53	56.34	35.33	60.90	230.10	32.33	10.16	272.59
Ventura County Flood Control District	136.13	99.90	23.25	128.46	387.74	58.64	19.78	466.17
Southern California Area	71.58	52.89	32.01	61.52	218.00	31.40	9.77	259.18
ALL AREAS	47.24	33.65	19.06	37.05	137.00	25.66	6.70	169.37

a) Hypothetical charges, which, if assessed on all Table A water delivered to date, all surplus water delivered prior to May 1, 1973, and all Table A water estimated to be delivered during the remainder of the project repayment period (Table B-5B), would provide a sum at the end of the period financially equivalent to all Transportation Charge and Delta Water Charge payments required under a water supply contract, considering interest at the Project Interest Rate, 4.608 percent per annum.

TABLE B-25. Equivalent Unit Transportation Costs of Water Delivered From or Through Each Aqueduct Reach [a]

(in dollars per acre-foot)

Aqueduct Reach	Unit Costs of Reach [b]						Cumulative Unit Costs from the Delta					
	Capital Costs	Water System Revenue Bond Surcharge [c]	Minimum OMP&R	Off-Aqueduct Costs	Variable OMP&R	Total	Capital Costs	Water System Revenue Bond Surcharge [c]	Minimum OMP&R	Off-Aqueduct Costs	Variable OMP&R	Total
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
North Bay Aqueduct												
1	39.97	13.26	11.65	1.31	3.81	70.00	39.97	13.26	11.65	1.31	3.81	70.00
2	42.54	14.11	5.09	0.00	0.00	61.74	82.51	27.37	16.74	1.31	3.81	131.74
3A	7.58	2.51	10.13	2.45	6.17	28.84	90.09	29.88	26.87	3.76	9.98	160.58
3B	48.77	16.18	22.90	3.15	13.69	104.69	131.28	43.55	39.64	4.46	17.50	236.43
South Bay Aqueduct												
1	6.99	2.32	13.66	5.39	14.28	42.64	8.94	2.97	16.35	7.15	20.95	56.36
2	0.66	0.22	1.54	0.00	0.00	2.42	9.60	3.19	17.89	7.15	20.95	58.78
4	2.20	0.73	2.63	0.00	0.00	5.56	11.80	3.92	20.52	7.15	20.95	64.34
5	4.61	1.53	2.06	0.00	0.00	8.20	16.41	5.45	22.58	7.15	20.95	72.54
6	0.27	0.09	0.22	0.00	0.00	0.58	16.68	5.54	22.80	7.15	20.95	73.12
7	2.04	0.68	0.40	0.00	0.00	3.12	18.72	6.22	23.20	7.15	20.95	76.24
8	2.77	0.92	0.66	0.00	0.00	4.35	21.49	7.14	23.86	7.15	20.95	80.59
9	5.73	1.90	2.48	0.00	0.00	10.11	27.22	9.04	26.34	7.15	20.95	90.70
California Aqueduct												
1	1.95	0.65	2.69	1.76	6.67	13.72	1.95	0.65	2.69	1.76	6.67	13.72
2A	1.24	0.41	0.53	0.00	0.00	2.18	3.19	1.06	3.22	1.76	6.67	15.90
2B	0.64	0.21	0.27	0.00	0.00	1.12	3.83	1.27	3.49	1.76	6.67	17.02
3	0.55	0.18	0.20	0.00	0.00	0.93	4.38	1.45	3.69	1.76	6.67	17.95
4	0.88	0.29	1.33	0.82	3.01	6.33	5.26	1.74	5.02	2.58	9.68	24.28
5	0.68	0.23	0.27	0.00	0.00	1.18	5.94	1.97	5.29	2.58	9.68	25.46
6	0.17	0.06	0.13	0.00	0.00	0.36	6.11	2.03	5.42	2.58	9.68	25.82
7	1.02	0.34	0.32	0.00	0.00	1.68	7.13	2.37	5.74	2.58	9.68	27.50
8C	0.02	0.01	0.06	0.00	0.00	0.09	7.15	2.38	5.80	2.58	9.68	27.59
8D	0.39	0.13	0.26	0.00	0.00	0.78	7.54	2.51	6.06	2.58	9.68	28.37
9	0.33	0.11	0.24	0.00	0.00	0.68	7.87	2.62	6.30	2.58	9.68	29.05
10A	0.35	0.12	0.31	0.00	0.00	0.78	8.22	2.74	6.61	2.58	9.68	29.83
11B	0.51	0.17	0.20	0.00	0.00	0.88	8.73	2.91	6.81	2.58	9.68	30.71
12D	0.48	0.16	0.18	0.00	0.00	0.82	9.21	3.07	6.99	2.58	9.68	31.53
12E	0.34	0.11	0.30	0.00	0.00	0.75	9.55	3.18	7.29	2.58	9.68	32.28
13B	0.73	0.24	0.35	0.00	0.00	1.32	10.28	3.42	7.64	2.58	9.68	33.60
14A	2.81	0.93	2.70	1.39	5.68	13.51	13.09	4.35	10.34	3.97	15.36	47.11
14B	0.44	0.15	0.33	0.00	0.00	0.92	13.53	4.50	10.67	3.97	15.36	48.03
14C	0.37	0.12	0.25	0.00	0.00	0.74	13.90	4.62	10.92	3.97	15.36	48.77
15A	2.09	0.69	2.81	1.68	6.17	13.44	15.99	5.31	13.73	5.65	21.53	62.21
16A	3.45	1.14	4.35	3.63	14.39	26.96	19.44	6.45	18.08	9.28	35.92	89.17
17E	11.65	3.86	12.23	12.70	53.14	93.58	31.09	10.31	30.31	21.98	89.06	182.75
17F	3.02	1.00	0.15	0.00	0.00	4.17	34.11	11.31	30.46	21.98	89.06	186.92
18A	2.71	0.90	1.47	0.00	-5.58	(0.50)	36.82	12.21	31.93	21.98	83.48	186.42
19	2.00	0.66	0.89	0.00	0.00	3.55	38.82	12.87	32.82	21.98	83.48	189.97
19C	2.18	0.72	0.00	0.00	0.00	2.90	41.00	13.59	32.82	21.98	83.48	192.87
20A	1.59	0.53	1.47	0.00	0.00	3.59	42.59	14.12	34.29	21.98	83.48	196.46
20B	1.93	0.64	0.97	0.00	0.00	3.54	44.52	14.76	35.26	21.98	83.48	200.00
21	0.98	0.33	0.67	0.00	0.00	1.98	45.50	15.09	35.93	21.98	83.48	201.98
22A	1.02	0.34	0.35	0.00	0.00	1.71	46.52	15.43	36.28	21.98	83.48	203.69
22B	9.98	3.31	9.47	4.10	17.52	44.38	56.50	18.74	45.75	26.08	101.00	248.07
23	2.74	0.91	0.65	0.00	-7.12	(2.82)	59.24	19.65	46.40	26.08	93.88	245.25
24	5.32	1.76	1.84	0.00	0.00	8.92	64.56	21.41	48.24	26.08	93.88	254.17
25	3.88	1.29	0.10	0.00	0.00	5.27	68.44	22.70	48.34	26.08	93.88	259.44
26A	4.24	1.41	6.13	0.00	-48.59	(36.81)	72.68	24.11	54.47	26.08	45.29	222.63
28G	7.90	2.62	2.32	0.00	0.00	12.84	80.58	26.73	56.79	26.08	45.29	235.47
28H	7.60	2.52	2.43	0.00	0.00	12.55	88.18	29.25	59.22	26.08	45.29	248.02
28J	85.27	28.28	33.82	0.00	0.00	147.37	173.45	57.53	93.04	26.08	45.29	395.39
West Branch												
29A	3.95	1.31	7.02	1.56	6.24	20.08	38.06	12.62	37.48	23.54	95.30	207.00
29F	2.89	0.96	0.84	0.00	0.00	4.69	40.95	13.58	38.32	23.54	95.30	211.69
29G	9.58	3.18	3.99	0.00	-22.46	(5.71)	50.53	16.76	42.31	23.54	72.84	205.98
29H	5.97	1.98	3.79	0.00	0.00	11.74	56.50	18.74	46.10	23.54	72.84	217.72
29J	10.01	3.32	1.09	0.00	-42.01	(27.59)	66.51	22.06	47.19	23.54	30.83	190.13
30	16.06	5.33	3.40	0.00	0.00	24.79	82.57	27.39	50.59	23.54	30.83	214.92
Coastal Branch												
31A	7.26	2.41	16.04	1.73	5.37	32.81	14.80	4.92	22.10	4.31	15.05	61.18
33A	271.38	90.02	30.24	14.69	70.17	476.50	286.18	94.94	52.34	19.00	85.22	537.68
34	193.89	64.31	0.84	0.00	0.00	259.04	480.07	159.25	53.18	19.00	85.22	796.72
35	0.00	0.00	0.00	0.00	0.00	0.00	480.07	159.25	53.18	19.00	85.22	796.72

a) Representative of transportation unit costs only; does not include a unit cost of conservation. The Delta Water Rate should be added to these values to approximate unit costs at canalside. Includes surplus water prior to May 1, 1973.

b) Hypothetical charges which, if assessed on all Table A water delivered to date, all surplus water delivered prior to May 1, 1973, and all Table A water estimated to be delivered during the remainder of the Project repayment period (Table B-5B), would provide a sum at the end of the period financially equivalent to all Transportation Charges required under the water supply contract considering interest rate at the Project Interest Rate of 4.608 percent per annum.

c) The Water System Revenue Bond Surcharge equivalent unit rate is calculated by multiplying Column [1] by the ratio of the 2004 WSRB surcharge to the sum of the Transportation Capital and the Capital component of the Delta Water Charge.

TABLE B-26. Capital Costs of Each Aqueduct Reach to be Reimbursed Through the Capital Cost Component of the East Branch Enlargement Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT MOJAVE DIVISION							
	Reach 18A	Reach 19	Reach 20A	Reach 20B	Reach 21	Reach 22A	Reach 22B	Reach 23B
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1952	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	117,000	0	0	0	0	0	0	0
1980	200,000	0	0	0	0	0	0	74,000
1981	135,000	0	0	0	0	0	0	385,000
1982	1,503,000	0	0	0	0	0	0	1,586,000
1983	2,260,000	0	0	0	0	0	0	2,965,000
1984	735,000	0	0	0	0	0	796,000	1,380,000
1985	93,000	435,000	75,000	544,000	859,000	703,000	970,000	146,000
1986	784,000	4,477,000	3,144,000	2,234,000	1,569,000	1,203,000	1,808,000	34,000
1987	11,000	951,000	1,076,000	666,000	399,000	47,000	16,421,000	43,000
1988	1,000	125,000	1,681,000	1,730,000	2,024,000	40,000	13,326,000	70,000
1989	0	206,000	2,089,000	2,174,000	2,510,000	61,000	11,242,000	229,000
1990	1,000	577,000	903,000	735,000	928,000	194,000	20,131,000	887,000
1991	1,000	280,000	413,000	333,000	422,000	93,000	20,702,000	1,215,000
1992	0	40,000	41,000	39,000	35,000	13,000	9,599,000	3,719,000
1993	0	19,000	16,000	19,000	12,000	6,000	2,319,000	19,654,000
1994	0	2,000	3,000	2,000	4,000	3,000	803,000	3,173,000
1995	0	0	0	0	0	0	223,000	1,465,000
1996	0	0	0	0	0	0	6,014,000	478,000
1997	0	0	0	0	0	0	404,000	1,327,000
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
TOTAL	5,841,000	7,112,000	9,441,000	8,476,000	8,762,000	2,363,000	104,758,000	38,830,000

TABLE B-26. Capital Costs of Each Aqueduct Reach to be Reimbursed Through the Capital Cost Component of the East Branch Enlargement Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)							GRAND TOTAL
	MOJAVE DIVISION (continued)			SANTA ANA DIVISION				
	Reach 23C	Reach 24	Total	Reach 25	Reach 26A	Reach 26B	Total	
	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
1952	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	117,000	0	0	0	0	117,000
1980	0	0	274,000	0	0	0	0	274,000
1981	0	0	520,000	0	0	0	0	520,000
1982	0	0	3,089,000	0	0	0	0	3,089,000
1983	0	0	5,225,000	0	0	0	0	5,225,000
1984	0	0	2,911,000	0	0	0	0	2,911,000
1985	0	0	3,825,000	0	528,000	89,000	617,000	4,442,000
1986	25,000	0	15,278,000	0	1,926,000	154,000	2,080,000	17,358,000
1987	178,000	0	19,792,000	0	3,699,000	437,000	4,136,000	23,928,000
1988	632,000	0	19,629,000	0	5,667,000	3,329,000	8,996,000	28,625,000
1989	1,130,000	0	19,641,000	0	40,879,000	1,650,000	42,529,000	62,170,000
1990	2,066,000	0	26,422,000	0	29,853,000	1,650,000	31,503,000	57,925,000
1991	4,980,000	0	28,439,000	0	26,027,000	999,000	27,026,000	55,465,000
1992	11,920,000	0	25,406,000	0	15,317,000	299,000	15,616,000	41,022,000
1993	16,303,000	0	38,348,000	0	4,878,000	0	4,878,000	43,226,000
1994	7,081,000	0	11,071,000	0	3,151,000	0	3,151,000	14,222,000
1995	5,350,000	0	7,038,000	0	2,137,000	0	2,137,000	9,175,000
1996	1,706,000	0	8,198,000	0	9,181,000	0	9,181,000	17,379,000
1997	1,905,000	0	3,636,000	0	175,000	0	175,000	3,811,000
1998	28,000	0	28,000	0	0	0	0	28,000
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
TOTAL	53,304,000	0	238,887,000	0	143,418,000	8,607,000	152,025,000	390,912,000

TABLE B-27. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of the East Branch Enlargement Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT MOJAVE DIVISION							
	Reach 18A	Reach 19	Reach 20A	Reach 20B	Reach 21	Reach 22A	Reach 22B	Reach 23B
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	1,048,625	0
1995	0	0	0	0	0	0	953,814	0
1996	0	0	0	0	0	0	1,171,411	0
1997	0	0	0	0	0	0	1,110,038	0
1998	0	0	0	0	0	0	1,213,002	0
1999	1,229	517	646	409	383	169	668,466	0
2000	4,452	1,875	2,340	1,484	1,386	614	1,315,920	0
2001	347	146	183	116	108	48	1,045,627	0
2002	1,639	690	861	546	510	226	1,539,859	0
2003	0	0	0	0	0	0	1,814,089	0
2004	2,132	27,868	18,579	18,731	10,355	8,528	1,485,104	0
2005	1,205	15,752	10,502	10,588	5,853	4,820	1,045,785	0
2006	0	0	0	0	0	0	1,839,222	0
2007	0	0	0	0	0	0	1,963,545	0
2008	0	0	0	0	0	0	1,862,750	0
2009	0	0	0	0	0	0	1,862,750	0
2010	0	0	0	0	0	0	1,862,750	0
2011	0	0	0	0	0	0	1,862,750	0
2012	0	0	0	0	0	0	1,862,750	0
2013	0	0	0	0	0	0	1,862,750	0
2014	0	0	0	0	0	0	1,862,750	0
2015	0	0	0	0	0	0	1,862,750	0
2016	0	0	0	0	0	0	1,862,750	0
2017	0	0	0	0	0	0	1,862,750	0
2018	0	0	0	0	0	0	1,862,750	0
2019	0	0	0	0	0	0	1,862,750	0
2020	0	0	0	0	0	0	1,862,750	0
2021	0	0	0	0	0	0	1,862,750	0
2022	0	0	0	0	0	0	1,862,750	0
2023	0	0	0	0	0	0	1,862,750	0
2024	0	0	0	0	0	0	1,862,750	0
2025	0	0	0	0	0	0	1,862,750	0
2026	0	0	0	0	0	0	1,862,750	0
2027	0	0	0	0	0	0	1,862,750	0
2028	0	0	0	0	0	0	1,862,750	0
2029	0	0	0	0	0	0	1,862,750	0
2030	0	0	0	0	0	0	1,862,750	0
2031	0	0	0	0	0	0	1,862,750	0
2032	0	0	0	0	0	0	1,862,750	0
2033	0	0	0	0	0	0	1,862,750	0
2034	0	0	0	0	0	0	1,862,750	0
2035	0	0	0	0	0	0	1,862,750	0
TOTAL	11,004	46,848	33,111	31,874	18,595	14,405	70,371,507	0

TABLE B-27. Minimum OMP&R Costs of Each Aqueduct Reach to be Reimbursed Through Minimum OMP&R Component of the East Branch Enlargement Transportation Charge

(in dollars)

Calendar Year	CALIFORNIA AQUEDUCT (continued)							TOTAL
	MOJAVE DIVISION (continued)			SANTA ANA DIVISION				
	Reach 23C	Reach 24	Subtotal	Reach 25	Reach 26A [a]	Reach 26B	Subtotal	
	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	1,048,625	0	1,713,260	0	1,713,260	2,761,885
1995	0	0	953,814	0	1,452,549	0	1,452,549	2,406,363
1996	0	0	1,171,411	0	1,350,581	0	1,350,581	2,521,992
1997	679,826	0	1,789,864	0	1,528,509	0	1,528,509	3,318,373
1998	825,038	0	2,038,040	0	1,619,068	0	1,619,068	3,657,108
1999	382,178	0	1,053,997	0	956,229	0	956,229	2,010,226
2000	735,803	0	2,063,874	0	1,409,109	0	1,409,109	3,472,983
2001	812,634	0	1,859,209	0	811,400	0	811,400	2,670,609
2002	727,751	0	2,272,082	0	1,143,205	0	1,143,205	3,415,287
2003	899,739	0	2,713,828	0	1,248,051	0	1,248,051	3,961,879
2004	913,701	0	2,484,998	0	1,815,458	0	1,815,458	4,300,456
2005	1,036,550	0	2,131,055	0	1,862,342	0	1,862,342	3,993,397
2006	1,091,151	0	2,930,373	0	1,899,216	0	1,899,216	4,829,589
2007	1,117,178	0	3,080,723	0	1,943,971	0	1,943,971	5,024,694
2008	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2009	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2010	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2011	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2012	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2013	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2014	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2015	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2016	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2017	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2018	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2019	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2020	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2021	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2022	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2023	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2024	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2025	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2026	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2027	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2028	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2029	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2030	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2031	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2032	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2033	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2034	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
2035	1,109,728	0	2,972,478	0	1,995,971	0	1,995,971	4,968,449
TOTAL	40,293,933	0	110,821,277	0	76,640,136	0	76,640,136	187,461,413

a) Units 3 and 4 at Devil Canyon Powerplant were operational in 1993. These minimum OMP&R costs for Reach 26A will be revised to reflect operational date of those units.

TABLE B-28. Capital Costs of East Branch Enlargement Transportation Facilities Allocated to Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA							Total
	Antelope Valley-East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	The Metropolitan Water District of Southern California	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	11,731	1,010	10,566	466	0	93,227	117,000
1980	0	28,241	4,708	27,495	797	0	212,759	274,000
1981	0	56,134	16,676	61,271	538	0	385,381	520,000
1982	0	326,180	76,872	337,913	5,988	0	2,342,047	3,089,000
1983	0	554,658	138,964	582,070	9,004	0	3,940,304	5,225,000
1984	0	306,514	68,842	314,468	2,928	0	2,218,248	2,911,000
1985	49,675	447,266	65,773	347,262	4,514	21,614	3,505,896	4,442,000
1986	185,353	1,757,633	236,324	1,363,586	41,900	78,842	13,694,362	17,358,000
1987	49,735	2,455,279	378,535	1,774,447	10,615	151,421	19,107,968	23,928,000
1988	124,534	2,689,959	500,466	1,712,431	13,783	231,982	23,351,845	28,625,000
1989	155,446	7,118,094	2,423,000	1,671,088	17,419	1,673,409	49,111,544	62,170,000
1990	62,786	6,459,229	1,943,918	2,234,452	8,680	1,222,053	45,993,882	57,925,000
1991	28,686	6,265,822	1,875,066	2,168,712	4,024	1,065,433	44,057,257	55,465,000
1992	2,911	4,826,764	1,610,921	1,359,335	471	627,012	32,594,586	41,022,000
1993	1,205	5,094,237	1,828,410	2,722,156	212	199,684	33,380,096	43,226,000
1994	273	1,726,376	631,816	478,543	27	128,988	11,255,977	14,222,000
1995	0	1,130,963	423,243	206,978	0	87,480	7,326,336	9,175,000
1996	0	2,025,987	645,296	606,205	0	375,830	13,725,682	17,379,000
1997	0	451,011	154,366	205,796	0	7,164	2,992,663	3,811,000
1998	0	3,551	1,293	0	0	0	23,156	28,000
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
TOTAL	660,604	43,735,629	13,025,499	18,184,774	121,366	5,870,912	309,313,216	390,912,000

TABLE B-29. Capital Cost Component of East Branch Enlargement Facilities Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA							Total
	Antelope Valley - East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District [a]	The Metropolitan Water District of Southern California	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	18,266	1,209,293	360,156	502,810	3,356	0	8,552,529	10,646,410
1989	19,175	1,269,524	378,094	527,854	3,523	0	8,978,504	11,176,674
1990	19,186	1,270,244	378,308	528,153	3,525	0	8,983,597	11,183,013
1991	19,187	1,270,261	378,314	528,160	3,525	0	8,983,717	11,183,164
1992	38,420	2,543,616	757,549	1,057,606	7,059	0	17,989,315	22,393,565
1993	40,122	2,662,533	793,256	1,105,728	7,371	0	18,827,641	23,436,651
1994	39,705	2,628,706	782,890	1,092,986	7,295	0	18,591,099	23,142,681
1995	39,632	2,623,828	781,438	1,090,958	7,281	0	18,556,603	23,099,740
1996	39,856	2,639,103	786,038	1,097,172	7,323	0	18,664,309	23,233,801
1997	41,743	2,763,629	823,074	1,149,085	7,669	0	19,545,322	24,330,522
1998	42,642	2,823,126	840,793	1,173,823	7,834	0	19,966,107	24,854,325
1999	44,738	2,961,887	882,120	1,231,519	8,219	0	20,947,475	26,075,958
2000	49,031	3,246,109	966,768	1,349,695	9,008	0	22,957,586	28,578,197
2001	49,048	3,247,263	967,111	1,350,175	9,011	0	22,965,748	28,588,356
2002	47,729	3,159,931	941,102	1,313,862	8,769	0	22,348,105	27,819,498
2003	40,383	2,662,845	792,431	1,109,474	7,418	0	18,837,475	23,450,026
2004	43,914	2,907,364	865,881	1,208,849	8,068	0	20,561,864	25,595,940
2005	32,275	2,136,768	636,380	888,444	5,929	0	15,111,947	18,811,743
2006	53,494	3,625,410	1,090,816	1,472,551	9,828	0	25,568,477	31,820,576
2007	67,152	4,549,811	1,368,792	1,848,518	12,337	0	32,088,918	39,935,528
2008	63,426	4,294,213	1,291,490	1,745,954	11,653	0	30,288,880	37,695,616
2009	64,886	4,402,364	1,325,221	1,786,139	11,921	0	31,043,916	38,634,447
2010	64,638	4,369,374	1,313,198	1,779,328	11,876	0	30,824,799	38,363,213
2011	66,186	4,495,818	1,354,017	1,821,963	12,159	0	31,698,616	39,448,759
2012	66,292	4,502,964	1,356,182	1,824,822	12,179	0	31,748,937	39,511,376
2013	65,590	4,447,846	1,338,611	1,805,535	12,049	0	31,366,580	39,036,211
2014	66,192	4,466,570	1,341,392	1,822,113	12,161	0	31,517,083	39,225,511
2015	67,935	4,584,990	1,377,059	1,870,091	12,481	0	32,351,999	40,264,555
2016	68,121	4,597,374	1,380,759	1,875,207	12,516	0	32,439,514	40,373,491
2017	69,782	4,710,625	1,414,919	1,920,940	12,822	0	33,237,674	41,366,762
2018	68,169	4,599,566	1,381,283	1,876,526	12,525	0	32,455,860	40,393,929
2019	70,046	4,732,262	1,421,907	1,928,227	12,868	0	33,387,185	41,552,495
2020	67,201	4,531,071	1,360,289	1,849,913	12,347	0	31,975,270	39,796,091
2021	68,717	4,635,694	1,392,023	1,891,612	12,624	0	32,711,490	40,712,160
2022	68,003	4,595,810	1,381,133	1,871,915	12,494	0	32,423,016	40,352,371
2023	56,498	3,833,714	1,154,094	1,555,264	10,380	0	27,033,673	33,643,623
2024	58,473	3,965,053	1,193,302	1,609,579	10,743	0	27,961,930	34,799,080
2025	66,907	4,524,191	1,359,911	1,841,799	12,293	0	31,915,814	39,720,915
2026	24,538	1,703,639	517,840	675,475	4,508	0	11,981,129	14,907,129
2027	25,000	1,731,166	525,631	688,200	4,593	0	12,178,439	15,153,029
2028	16,319	1,120,310	338,928	449,230	2,998	0	7,889,128	9,816,913
2029	17,026	1,166,423	352,574	468,679	3,128	0	8,215,818	10,223,648
2030	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0
TOTAL	2,055,643	138,212,288	41,443,074	56,585,933	377,666	0	975,673,088	1,214,347,692

a) Under Article 49(d)(4)(A) of its contract, San Bernardino Valley Municipal Water District elected to pay a portion of its allocated costs of East Branch Enlargement in advance rather than to participate in payment of Water System Revenue Bonds. This election made via a letter of agreement signed June 1, 1987. As of June 1999, $6,347,938 has been received from the San Bernardino Valley Municipal Water District.

TABLE B-30. Minimum OMP&R Component of East Branch Enlargement Facilities Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA							Total
	Antelope Valley-East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	The Metropolitan Water District of Southern California	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	320,415	101,486	95,075	0	70,133	2,174,776	2,761,885
1995	0	278,176	86,604	86,479	0	59,461	1,895,643	2,406,363
1996	0	287,293	82,991	106,208	0	55,287	1,990,213	2,521,992
1997	0	389,636	123,446	100,643	0	62,571	2,642,077	3,318,373
1998	0	429,772	135,927	109,979	0	66,278	2,915,152	3,657,108
1999	37	236,006	75,040	60,907	11	39,144	1,599,081	2,010,226
2000	132	403,693	121,479	120,396	40	57,683	2,769,559	3,472,982
2001	10	310,158	90,353	94,888	3	33,215	2,141,981	2,670,608
2002	49	391,107	108,642	140,014	15	46,798	2,728,663	3,415,288
2003	0	453,227	124,576	164,477	0	51,090	3,168,508	3,961,878
2004	1,278	501,557	153,704	142,324	265	74,317	3,427,009	4,300,454
2005	722	475,085	157,779	99,156	150	76,236	3,184,268	3,993,396
2006	0	561,690	168,751	166,756	0	77,746	3,854,647	4,829,590
2007	0	583,118	173,444	178,028	0	79,578	4,010,527	5,024,695
2008	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2009	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2010	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2011	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2012	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2013	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2014	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2015	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2016	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2017	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2018	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2019	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2020	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2021	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2022	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2023	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2024	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2025	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2026	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2027	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2028	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2029	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2030	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2031	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2032	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2033	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2034	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2035	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
TOTAL	2228	21,820,249	6,605,090	6,394,222	484	3,137,305	149,501,804	187,461,382

TABLE B-31. Total East Branch Enlargement Facilities Transportation Charge for Each Contractor

(in dollars)

Calendar Year	SOUTHERN CALIFORNIA AREA							Total
	Antelope Valley-East Kern Water Agency	Coachella Valley Water District	Desert Water Agency	Mojave Water Agency	Palmdale Water District	San Bernardino Valley Municipal Water District	The Metropolitan Water District of Southern California	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	18,266	1,209,293	360,156	502,810	3,356	0	8,552,529	10,646,410
1989	19,176	1,269,524	378,094	527,854	3,523	0	8,978,504	11,176,675
1990	19,186	1,270,244	378,308	528,153	3,525	0	8,983,597	11,183,013
1991	19,187	1,270,261	378,314	528,160	3,525	0	8,983,717	11,183,164
1992	38,420	2,543,616	757,549	1,057,606	7,059	0	17,989,315	22,393,565
1993	40,122	2,662,533	793,256	1,105,728	7,371	0	18,827,641	23,436,651
1994	39,705	2,949,121	884,376	1,188,061	7,295	70,133	20,765,875	25,904,566
1995	39,632	2,902,004	868,042	1,177,437	7,281	59,461	20,452,246	25,506,103
1996	39,856	2,926,396	869,029	1,203,380	7,323	55,287	20,654,522	25,755,793
1997	41,743	3,153,265	946,520	1,249,728	7,669	62,571	22,187,399	27,648,895
1998	42,642	3,252,898	976,720	1,283,802	7,834	66,278	22,881,259	28,511,433
1999	44,775	3,197,893	957,160	1,292,426	8,230	39,144	22,546,556	28,086,184
2000	49,163	3,649,802	1,088,247	1,470,090	9,048	57,683	25,727,147	32,051,180
2001	49,058	3,557,421	1,057,465	1,445,063	9,014	33,215	25,107,729	31,258,965
2002	47,778	3,551,037	1,049,744	1,453,876	8,784	46,798	25,076,769	31,234,786
2003	40,383	3,116,071	917,007	1,273,952	7,418	51,090	22,005,983	27,411,904
2004	45,192	3,408,921	1,019,585	1,351,173	8,333	74,317	23,988,874	29,896,395
2005	32,997	2,611,853	794,159	987,600	6,078	76,236	18,296,215	22,805,138
2006	53,494	4,187,099	1,259,566	1,639,307	9,828	77,746	29,423,124	36,650,164
2007	67,152	5,132,928	1,542,235	2,026,546	12,337	79,578	36,099,445	44,960,221
2008	63,426	4,872,761	1,466,521	1,914,844	11,653	81,706	34,253,155	42,664,066
2009	64,886	4,980,911	1,500,251	1,955,027	11,921	81,706	35,008,191	43,602,893
2010	64,638	4,947,921	1,488,229	1,948,217	11,876	81,706	34,789,076	43,331,663
2011	66,186	5,074,365	1,529,048	1,990,851	12,159	81,706	35,662,891	44,417,206
2012	66,292	5,081,511	1,531,212	1,993,711	12,179	81,706	35,713,212	44,479,823
2013	65,590	5,026,393	1,513,642	1,974,423	12,049	81,706	35,330,855	44,004,658
2014	66,192	5,045,117	1,516,422	1,991,002	12,161	81,706	35,481,359	44,193,959
2015	67,934	5,163,538	1,552,090	2,038,981	12,481	81,706	36,316,275	45,233,005
2016	68,121	5,175,922	1,555,790	2,044,097	12,516	81,706	36,403,789	45,341,941
2017	69,782	5,289,172	1,589,949	2,089,830	12,821	81,706	37,201,950	46,335,210
2018	68,169	5,178,114	1,556,313	2,045,414	12,524	81,706	36,420,136	45,362,376
2019	70,046	5,310,809	1,596,937	2,097,115	12,869	81,706	37,351,460	46,520,942
2020	67,201	5,109,618	1,535,320	2,018,803	12,347	81,706	35,939,545	44,764,540
2021	68,717	5,214,241	1,567,052	2,060,501	12,625	81,706	36,675,766	45,680,608
2022	68,003	5,174,357	1,556,164	2,040,804	12,494	81,706	36,387,291	45,320,819
2023	56,498	4,412,262	1,329,124	1,724,153	10,380	81,706	30,997,948	38,612,071
2024	58,473	4,543,598	1,368,333	1,778,468	10,743	81,706	31,926,205	39,767,526
2025	66,907	5,102,739	1,534,942	2,010,688	12,293	81,706	35,880,090	44,689,365
2026	24,538	2,282,187	692,870	844,365	4,508	81,706	15,945,406	19,875,580
2027	25,000	2,309,713	700,661	857,090	4,593	81,706	16,142,714	20,121,477
2028	16,319	1,698,858	513,959	618,120	2,998	81,706	11,853,404	14,785,364
2029	17,026	1,744,970	527,604	637,568	3,128	81,706	12,180,094	15,192,096
2030	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2031	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2032	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2033	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2034	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
2035	0	578,547	175,031	168,889	0	81,706	3,964,275	4,968,448
TOTAL	2,057,871	160,032,539	48,048,151	62,980,158	378,149	3,137,305	1,125,174,908	1,401,809,081

Conversion Factors

Quantity	To convert from customary unit	To metric unit	Multiply customary unit by	To convert to customary unit, multiply metric unit by
Length	inches (in)	millimeters (mm)●	25.4	0.03937
	inches (in)	centimeters (cm)	2.54	0.3937
	feet (ft)	meters (m)	0.3048	3.2808
	miles (mi)	kilometers (km)	1.6093	0.62139
Area	square inches (in^2)	square millimeters (mm^2)	645.16	0.00155
	square feet (ft^2)	square meters (m^2)	0.092903	10.764
	acres (ac)	hectares (ha)	0.40469	2.4710
	square miles (mi^2)	square kilometers (km^2)	2.590	0.3861
Volume	gallons (gal)	liters (L)	3.7854	0.26417
	million gallons (10^6 gal)	megaliters (ML)	3.7854	0.26417
	cubic feet (ft^3)	cubic meters (m^3)	0.028317	35.315
	cubic yards (yd^3)	cubic meters (m^3)	0.76455	1.308
	acre-feet (ac-ft)	thousand cubic meters ($m^3 \times 10^3$)	1.2335	0.8107
	acre-feet (ac-ft)	hectare-meters (ha - m)■	0.1234	8.107
	thousand acre-feet (taf)	million cubic meters ($m^3 \times 10^6$)	1.2335	0.8107
	thousand acre-feet (taf)	hectare-meters (ha - m)■	123.35	0.008107
	million acre-feet (maf)	billion cubic meters ($m^3 \times 10^9$)◆	1.2335	0.8107
	million acre-feet (maf)	cubic kilometers (km^3)	1.2335	0.8107
Flow	cubic feet per second (ft^3/s)	cubic meters per second (m^3/s)	0.028317	35.315
	gallons per minute (gal/min)	liters per minute (L/min)	3.7854	0.26417
	gallons per day (gal/day)	liters per day (L/day)	3.7854	0.26417
	million gallons per day (mgd)	megaliters per day (ML/day)	3.7854	0.26417
	acre-feet per day (ac-ft/day)	thousand cubic meters per day ($m^3 \times 10^3$/day)	1.2335	0.8107
Mass	pounds (lb)	kilograms (kg)	0.45359	2.2046
	tons (short, 2,000 lb)	megagrams (Mg)	0.90718	1.1023
Velocity	feet per second (ft/s)	meters per second (m/s)	0.3048	3.2808
Power	horsepower (hp)	kilowatts (kW)	0.746	1.3405
Pressure	pounds per square inch (psi)	kilopascals (kPa)	6.8948	0.14505
	head of water in feet	kilopascals (kPa)	2.989	0.33456
Specific capacity	gallons per minute per foot of drawdown	liters per minute per meter of drawdown	12.419	0.08052
Concentration	parts per million (ppm)	milligrams per liter (mg/L)	1.0	1.0
Electrical conductivity	micromhos per centimeter	millisiemens per centimeter (µS/cm)	1.0	1.0
Temperature	degrees Fahrenheit (˚F)	degrees Celsius (˚C)	(˚F - 32)/1.8	(1.8 x ˚C) + 32

● When using "dual units," inches are normally converted to millimeters (rather than centimeters).

■ Not used often in metric countries, but is offered as a conceptual equivalent of customary western U.S. practice (a standard depth of water over a given area of land).

◆ ASTM Manual E380 discourages the use of billion cubic meters since that magnitude is represented by giga (a thousand million) in other countries. It is shown here for potential use for quantifying large reservoir volumes (similar to million acre-feet).

Other Common Conversion Factors

1 cubic foot=7.48 gallons=62.4 pounds of water

1 cubic foot per second (cfs)=450 gallons per minute (gpm)

1 cfs=646,320 gallons a day=1.98 ac-ft a day

1 acre-foot=325,900 gallons=43,560 cubic feet

1 million gallons=3.07 acre-feet

1 million gallons a day (mgd)=1,120 ac-ft a year

United States Department of the Interior

FISH AND WILDLIFE SERVICE
California and Nevada Region
2800 Cottage Way, Room W-2606
Sacramento, California 95825-1846

In reply refer to:
81420-2008-F-1481-5

DEC 15 2008

Memorandum

To: Operation Manager, Bureau of Reclamation, Central Valley Operations Office, Sacramento, California

From: Regional Director, U.S. Fish and Wildlife Service, Region 8, Sacramento, California

Subject: Transmittal of Formal Endangered Species Act Consultation on the Coordinated Operations of the Central Valley Project and State Water Project

With this memorandum, the U.S. Fish and Wildlife Service (Service) is transmitting the biological opinion on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California. We transmitted the official draft biological opinion on November 21, 2008, and subsequently refined the opinion based on input and comments from the Service's Internal Peer Review Team, our contracted peer review, the California Department of Water Resources (DWR), and the Bureau of Reclamation (Reclamation). Additionally, we additionally met numerous times with DWR, Reclamation, the California Department of Fish and Game (DFG) and the National Marine Fisheries Service on development of the biological opinion.

We want to extend our appreciation to Reclamation and DFG for their technical assistance in developing the biological opinion.

If you have any questions, please contact Susan Moore, Cay C. Goude, Steven Detwiler, or Ryan Olah of our Sacramento Fish and Wildlife Office at 414-6600.

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FISH AND WILDLIFE SERVICE
California and Nevada Region
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Sacramento, California 95825-1846

In reply refer to:
81420-2008-F-1481-5

DEC 15 2008

Memorandum

To: Operation Manager, Bureau of Reclamation, Central Valley Operations Office Sacramento, California

From: Regional Director, Fish and Wildlife Service, Region 8, Sacramento, California

Subject: Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)

This is in response to the Bureau of Reclamation's (Reclamation) May 16, 2008, request for formal consultation with the Fish and Wildlife Service (Service) on the coordinated operations of the CVP and SWP in California. Reclamation is the lead Federal agency and the California Department of Water Resources (DWR) is the Applicant for this consultation. Your revised biological assessment was received in our office on August 20, 2008. This document represents the Service's biological opinion on the effects of the subject action to the threatened delta smelt (*Hypomesus transpacificus*) and its designated critical habitat. This response is provided in accordance with the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Reclamation also requested consultation on the effects of the proposed action on the endangered riparian brush rabbit (*Sylvilagus bachmani riparius*), endangered riparian woodrat (*Neotoma fuscipes riparia*), endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), endangered California clapper rail (*Rallus longirostris obsoletus*), threatened giant garter snake (*Thamnophis gigas*), threatened California red-legged frog (*Rana aurora draytonii*), threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), endangered soft bird's-beak (*Cordylanthus mollis ssp. Mollis*), and the endangered Suisun thistle (*Cirsium hydrophilum var. hydrophilum*). Reclamation determined that the proposed continued operations of the CVP and SWP are not likely to adversely affect these listed species. The Service concurs with Reclamation's determination that the coordinated operations of the CVP and SWP are not likely to adversely affect these species.

The Service conducted a comprehensive peer review of this biological opinion. We formed an Internal Peer Review Team (IPRT), which consisted of individuals from throughout the Service who are experts in the development of complex biological opinions under the ESA. The IPRT reviewed the biological opinion and provided substantive input and comments. Additionally, the Service assembled a team of delta smelt experts from within the Service, California Department

of Fish and Game, Environmental Protection Agency, Reclamation and other academics to provide scientific and technical expertise into the review of the biological assessment and the development of the biological opinion. The Service also contracted with PBS&J, an environmental consulting firm, who formed an independent review team consisting of experts on aquatic ecology and fishery biology to conduct a concurrent review of the draft Effects Section of the biological opinion at the same that we provided the Effects Section to Reclamation and DWR for their review. The Service received the results of the independent review of the draft Effects Section on October 23, 2008; DWR and Reclamation provided the results of their review on October 24, 2008. The Service modified the Effects Section of the biological opinion, as appropriate, based on the comments received from the IPRT, the independent review team, Reclamation and DWR. The Service also contracted with PBS&J to conduct an independent review of the draft Actions (Final shown in Attachment B), as well as a review of DWR's proposed actions. The Service simultaneously provided the draft Actions to Reclamation and DWR for their review. The Service received Reclamation's and DWR's comments on the draft Actions on November 5, 2008. The Service received the results of the independent review of both the Service's and DWR's draft Actions on November 19, 2008. The Service's actions were then modified to respond to comments from the independent review team and in consideration of comments received from DWR. A draft biological opinion was provided to Reclamation on November 21, 2008. Comments were received back from Reclamation and DWR on December 2, 2008. The Service has incorporated all comments and edits, as appropriate, into this biological opinion.

This biological opinion is based on information provided in Reclamation's biological assessment dated August 20, 2008, associated appendices, and input from the various internal and external review processes that the Service has utilized in this consultation, described immediately above. A complete administrative record is on file at the Sacramento Fish and Wildlife Office (SFWO).

Consultation History

July 30, 2004	The Service issued a biological opinion addressing *Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operations Criteria and Plan to Address Potential Critical Habitat Issues* (Service file # 1-1-04-F-0140).
February 15, 2005	The Department of the Interior is sued on the July 30, 2004 biological opinion.
February 16, 2005	The Service issued its *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* (Service file # 1-1-05-F-0055).
May 20, 2005	The Department of the Interior is sued on the February 16, 2005 biological opinion.
February 2006 through September 2008	Staff from the California Department of Fish and Game (DFG), DWR, National Marine Fisheries Service (NMFS), Reclamation, and the Service (OCAP Working Team) met monthly to bi-weekly to discuss the development of the biological assessment.
July 6, 2006	Reclamation requested informal consultation on coordinated operations of the CVP and SWP and their effects to delta smelt.
May 25, 2007	Judge Wanger issued a summary judgment that invalidated the 2005 biological opinion and ordered a new biological opinion be developed by September 15, 2008.
May 31, 2007	The Service provided Reclamation with guidance and recommendations concerning the project description used in the 2004 biological opinion.
August 20, 2007	The Service provided a memorandum to Reclamation containing a species list for the proposed action and clarification of the formal consultation timeline.
October 29, 2007	The Service received an electronic version of the draft project description for the biological assessment (Chapter 2) dated August 2007.
December 4, 2007	DFG, NMFS, and the Service received a draft project description dated December 4, 2007.

December 6, 2007	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for part of the draft project description of CVP operations received on December 4, 2007.
December 14, 2007	Judge Wanger issued an interim order to direct actions at the export facilities to protect delta smelt until a new biological opinion is completed.
December 20, 2007	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for parts of the draft project description of SWP operations received on December 4, 2007.
January 17, 2008	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for the remaining portion of the draft project description received on December 4, 2007.
January 21, 2008	The Service sent to Reclamation an electronic version of the entire draft project description with guidance and recommendations developed jointly by DFG, NMFS, and the Service.
January 22, 2008	Reclamation provided DFG, NMFS and the Service with an electronic version of the description of operations of the Suisun Marsh Salinity Control Gates (SMSCG) dated August 2007.
January 23, 2008	DFG, NMFS, and the Service provided DWR with joint preliminary guidance and recommendations on the December 4, 2007, draft project description.
March 4, 2008	The Service provided DWR with joint DFG and Service guidance and recommendations for the August 2007 version of the proposed Suisun Marsh Salinity Control Gate (SMSCG) operations description.
March 6, 2008	DWR provided the Service with an updated description of proposed operations of the SMSCG.
March 10, 2008	The Service received a draft description and effects analysis of aquatic weed management in Clifton Court Forebay.
March 24, 2008	DFG, NMFS, and the Service provided Reclamation with guidance and recommendations on the aquatic weed management section of the biological assessment.
April 21, 2008	Reclamation provided the Service with a revised draft project description for the biological assessment.

April 28 through May 2, 2008	Reclamation conducted an external technical review of their draft biological assessment.
May 2008 through December 2008	Numerous meeting between the Service, Reclamation, DWR, DFG and NMFS on the development of the biological assessment and the biological opinion.
May 8, 2008	The fisheries agencies provided Reclamation and DWR with guidance and recommendations on the draft project description dated April 21, 2008.
May 16, 2008	The Service received a letter from Reclamation dated May 16, 2008, requesting formal consultation on the proposed action. A biological assessment also dated May 16, 2008, was enclosed with the letter.
May 17, 2008	Reclamation provided the Service with a number of revisions and addenda to the May 16, 2008 biological assessment.
May 28, 2008	Reclamation and DWR provided the Service with additional revisions to the May 16, 2008 biological assessment.
May 29, 2008	The Service sent a memo to Reclamation stating that with the revisions provided on May 28, 2008, the Service had received enough information to start the 30-day review period.
June 27, 2008	The Service provided Reclamation with a memo requesting additional information.
July 2, 2008	The Service received a memorandum from Reclamation informing the Service that Reclamation is committed to providing a response to the Services' June 27, 2008, request for additional information by early August, 2008.
August 11, 2008	The Service received Reclamation's August 8, 2008, letter transmitting the revised biological assessment.
August 20, 2008	The Service received the revised biological assessment on electronically from Reclamation.
August 29, 2008	Judge Wanger extended the completion date for the coordination of the CVP and SWP biological opinion to December 15, 2008.
September 25, 2008	The Service received a letter dated September 24, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on the biological assessment.
October 17, 2008	The Service received DWR's October 16, 2008 draft conservation actions.

October 17 through 24, 2008	Review of the draft Effects section of the biological opinion by the Service's Internal Peer Review Team (IPRT).
October 17 through 24, 2008	Independent Review of the draft Effects section of the biological opinion conducted by PBS&J.
October 23, 2008	The Service received a letter dated October 20, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on fall X2.
October 24, 2008	The Service received comments from Reclamation and DWR on the draft Effects section.
October 24 through November 19, 2008	Review of entire preliminary draft biological opinion by IPRT.
October 24 through November 19, 2008	Independent Review of the Service's draft conservation actions and DWR's draft conservation actions conducted by PBS&J. The Service's draft actions were also submitted to Reclamation.
November 21, 2008	The Service transmitted the draft biological opinion to Reclamation.
November 24, 2008	The Service received a letter dated November 19, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on the Effects section and the review conducted by PBS&J.
December 2, 2008	The Service received comments from Reclamation and DWR on the draft biological opinion.

Table of Contents

Consultation History iii

Project Description 1

COORDINATED OPERATIONS OF THE CVP AND SWP 19

Coordinated Operations Agreement 19

Implementing the COA 19

Obligations for In-Basin Uses 19

Accounting and Coordination of Operations 20

State Water Resources Control Board Water Rights 21

1995 Water Quality Control Plan 21

Decision 1641 21

Joint Points of Diversion 26

Revised WQCP (2006) 27

REAL TIME DECISION-MAKING TO ASSIST FISHERY MANAGEMENT 27
Introduction 27
Framework for Actions 28
Water Operations Management Team 28
Process for Real Time Decision- Making to Assist Fishery Management 28
Groups Involved in Real Time Decision-Making to Assist Fishery Management and Information Sharing 29
Information Teams 29
CALFED Ops and Subgroups 29
Data Assessment Team (DAT) 29
Integrated Water Operations and Fisheries Forum 29
B2 Interagency Team (B2IT) 30
Technical Teams 30
The Sacramento River Temperature Task Group (SRTTG) 30
Smelt Working Group (SWG) 30
Delta Smelt Risk Assessment Matrix (DSRAM) 31
The Salmon Decision Process 31
American River Group 31
San Joaquin River Technical Committee (SJRTC) 31
Operations Technical Teams 32
Delta Cross Channel Project Work Team 32
Gate Operations Review Team 32
Uses of Environmental Water Accounts 32
CVPIA Section 3406 (b)(2) 32
CVPIA 3406 (b)(2) Operations on Clear Creek 33
CVPIA 3406 (b)(2) Operations on the Upper Sacramento River 33
CVPIA 3406 (b)(2) Operations on the Lower American River 33
CVPIA 3406 (b)(2) Operations in the Delta 34
500 CFS DIVERSION INCREASE DURING JULY, AUGUST, AND SEPTEMBER 35
CENTRAL VALLEY PROJECT 37
Central Valley Project Improvement Act 37
Water Service Contracts, Allocations and Deliveries 37
Water Needs Assessment 37
Future American River Operations - Water Service Contracts and Deliveries 38
Water Allocation – CVP 38
CVP M&I Water Shortage Operational Assumptions 38
Project Facilities 39
Trinity River Division Operations 39
Safety of Dams at Trinity Reservoir 42
Fish and Wildlife Requirements on Trinity River 42
Transbasin Diversions 43
Whiskeytown Reservoir Operations 45
Spillway Flows below Whiskeytown Lake 45
Fish and Wildlife Requirements on Clear Creek 46
Spring Creek Debris Dam Operations 47
Shasta Division and Sacramento River Division 48
Flood Control 49
Fish and Wildlife Requirements in the Sacramento River 50
Minimum Flow for Navigation – Wilkins Slough 51
Water Temperature Operations in the Upper Sacramento River 52
SWRCB Water Rights Order 90-05 and Water Rights Order 91-01 52
Shasta Temperature Control Device 53
Reclamation's Proposed Upper Sacramento River Temperature Objectives 54
Anderson-Cottonwood Irrigation District (ACID) Diversion Dam 54
Red Bluff Diversion Dam Operations 55
American River Division 55
Flood Control 57
Fish and Wildlife Requirements in the Lower American River 59

Delta Division and West San Joaquin Division 63
CVP Facilities 63
Delta Cross Channel Operations 65
Jones Pumping Plant 66
Tracy Fish Collection Facility 66
Contra Costa Water District Diversion Facilities 68
Water Demands—Delta Mendota Canal (DMC) and San Luis Unit 70
East Side Division 70
New Melones Operations 70
Flood Control 72
Requirements for New Melones Operations 72
Water Rights Obligations 73
In-stream Flow Requirements 73
Dissolved Oxygen Requirements 74
Vernalis Water Quality Requirement 74
Bay-Delta Vernalis Flow Requirements 74
CVP Contracts 74
New Melones Operations 75
New Melones Reservoir – Future Operations 76
San Joaquin River Agreement/Vernalis Adaptive Management Plan (VAMP) 78
Water Temperatures 79
San Felipe Division 80
Friant Division 81
STATE WATER PROJECT 82
Project Management Objectives 83
Clifton Court Forebay 83
Water Service Contracts, Allocations, and Deliveries 86
Monterey Agreement 88
Changes in DWR's Allocation of Table A Water and Article 21 Water 89
Historical Water Deliveries to Southern California 89
Project Facilities 90
Oroville Field Division 90
Current Operations - Minimum Flows and Temperature Requirements 92
Feather River Flow Requirements 95
Low Flow Channel 95
High Flow Channel 95
Temperature Requirements 96
Low Flow Channel 96
High Flow Channel 96
Flood Control 100
Feather River Ramping Rate Requirements 100
Proposed Operational Changes with the Federal Energy Regulatory Commission (FERC) Relicensing of the Oroville Project– Near Term and Future Operations 101
Minimum Flows in the Low Flow and High Flow Channels 102
Water Temperatures for the Feather River Fish Hatchery 102
Water Temperatures in the Lower Feather River 104
Habitat Expansion Agreement 106
Anadromous Fish Monitoring on the Lower Feather River 107
Delta Field Division 107
Clifton Court Forebay Aquatic Weed Control Program 108
Proposed Measures to Reduce Fish Mortality 110
North Bay Aqueduct Intake at Barker Slough 111
COORDINATED FACILITIES OF THE CVP AND SWP 112
Joint Project Facilities 112
Suisun Marsh 112
CALFED Charter for Development of an Implementation Plan for Suisun Marsh Wildlife Habitat Management and Preservation 113
Suisun Marsh Salinity Control Gates 114
SMSCG Fish Passage Study 116

Roaring River Distribution System ... 117
Morrow Island Distribution System ... 118
South Delta Temporary Barriers Project ... 119
Proposed Installation and Operations of the Temporary Barriers ... 119
Conservation Strategies and Mitigation Measures ... 120
San Luis Complex ... 120
San Luis Unit Operation ... 123
Transfers ... 126
Transfer Capacity ... 128
Proposed Exports for Transfers ... 129
OTHER PROJECTS ... 129
DMC/CA Intertie Proposed Action ... 129
Location ... 130
Operations ... 130
Freeport Regional Water Project ... 131
Alternative Intake Project ... 132
Red Bluff Diversion Dam Pumping Plant ... 133
South Delta Improvements Program Stage 1 ... 133
South Delta Gates ... 134
Head of Old River Fish Control Gate ... 136
Spring Operations/ Real Time Decision Making ... 136
Summer and Fall Operations ... 136
Flow Control Gates ... 137
Spring Operations ... 137
Summer and Fall Operations ... 137
Gate Operations and Jones and Banks Exports ... 138
State Water Project Oroville Facilities ... 138
Analytical Framework for the Jeopardy Determination ... 138
Analytical Framework for the Adverse Modification Determination ... 139
Status of the Species/Environmental Baseline ... 140
DELTA SMELT ... 140
Delta Smelt Species Description and Taxonomy ... 140
Existing Monitoring Programs ... 143
Overview of Delta Smelt's Life Cycle ... 145
Biology and Life History ... 147
Spawning ... 147
Larval Development ... 148
Juveniles ... 150
Foraging Ecology ... 151
Habitat ... 152
Delta Smelt Population Dynamics and Abundance Trends ... 153
FACTORS AFFECTING THE SPECIES ... 159
Water Diversions and Reservoir Operations ... 159
Banks and Jones Export Facilities ... 159
Environmental Water Account ... 166
500 cfs Diversion at Banks ... 166
CVP/SWP Actions Taken since the 2005 OCAP Biological Opinion was Issued ... 167
Water Year 2008 Interim Remedial Order Following Summary Judgment and Evidentiary Hearing (Wanger Order) ... 168
Water Transfers ... 169
Article 21 and changes to Water Deliveries to Southern California ... 169

Vernalis Adaptive Management Plan 169
Other SWP/CVP Facilities 170
North Bay Aqueduct 170
Contra Costa Water District (CCWD) 171
Other Delta Diversions and Facilities 172
Delta Power Plants 173
Delta Cross Channel 174
South Delta Temporary Barriers 174
Susiun Marsh Salinity Control Gates 175
Upstream Diversion and Reservoir Operations 176
Trinity River 176
Seasonal Life History of Delta Smelt 177
Winter (December-February) 177
Spring (March-May) 177
Summer (June-August) 178
Fall 178
Other Stressors 182
Aquatic Macrophytes 182
Predators 183
Competition 183
Delta Smelt Feeding 184
Delta Food Web 184
Suisun Bay Region 184
Delta 185
Microcystis 186
Contaminants 186
Climate Change 188
SUMMARY OF DELTA SMELT STATUS AND ENVIRONMENTAL BASELINE 189
SURVIVAL AND RECOVERY NEEDS OF DELTA SMELT 189
DELTA SMELT CRITICAL HABITAT 190
Description of the Primary Constituent Elements 190
Conservation Role of Delta Smelt Critical Habitat 191
Overview of Delta Smelt Habitat Requirements and the Primary Constituent Elements 192
Conservation Function of Primary Constituent Elements by Life History Stage 192
Spawning 192
Larval and Juvenile Transport 193
Juvenile Rearing 194
Adult Migration 195
Current Condition of Delta Smelt Critical Habitat and Factors that Contribute to that Condition 195
PCE #1 - Physical Habitat for Spawning 196
PCE #2 - Water for All Life Stages (Suitable Quality) 196
Factors that Impair/Degrade the Function of PCE #2 197
CVP and SWP 197
Aquatic Macrophytes 198
Contaminants 198
Nonnative Species 198
PCE #3 - River Flow for Larval and Juvenile Transport, Rearing, and Adult Migration 198
Factors that Impair/Degrade the Function of PCE #3 199
CVP and SWP 199
Environmental Water Account 199
Special Management for PCE #3 200
Vernalis Adaptive Management Plan 200

PCE #4 - Salinity for Rearing 200
Factors that Impair/Degrade the Function of PCE #4 200
CVP and SWP 200
Environmental Water Account 201
Other Factors that May Influence the Condition of PCE #4 201
Aquatic Macrophytes 201
Nonnative Species 202
Climate Change 202

Effects of the Proposed Action 202

INTRODUCTION 202
DATA AND MODELS USED IN THE ANALYSIS 204
EFFECTS ANALYSIS METHODS 208
MIGRATING AND SPAWNING ADULTS (~ DECEMBER THROUGH MARCH) 209
Water Diversions and Reservoir Operations 209
Upstream Reservoirs and Diversions 209
Banks and Jones Pumping Plants 209
Entrainment 209
Adult Entrainment 210
OMR Flows 211
Salvage and Entrainment Loss Predictions 211
Predicted Salvage and Entrainment 212
Article 21 215
DMC-CA Intertie 216
NBA Diversion 216
CCWD Diversions 217
Old River intake 217
Rock Slough 217
Alternative Intake 218
Suisun Marsh Salinity Control Gates 218
LARVAL AND JUVENILE DELTA SMELT (~ MARCH-JUNE) 219
Water Diversions and Reservoir Operations 219
Banks and Jones 219
Historical Data (1967-2007) 221
Combined Old and Middle River Flow 221
Delta Outflow 221
Predicted entrainment 221
Proposed Action 222
Combined Old and Middle River Flow 222
X2 222
Effects of Forecasted Operations 222
Article 21 223
VAMP 223
Intertie 224
NBA Diversion 224
CCWD Diversions 224
Old River Intake 224
Rock Slough 225
Alternative Intake 225
South Delta Temporary Barriers 225
Hydrodynamic Effects 225
Vulnerability to Local Agricultural Diversions 226
Effects to Potential Fish Prey Items 226
South Delta Permanent Operable Gates 226
Hydrodynamic Effects 226
Vulnerability to Local Agricultural Diversions 227
Effects to Potential Fish Prey Items 227

Suisun Marsh Salinity Control Gates ... 227
American River Demands ... 227
Delta Cross Channel ... 227
JUVENILES AND ADULTS (~ JULY-DECEMBER) ... 228
Entrainment of *Pseudodiaptomus forbesi* (June-September) ... 228
Water Transfers ... 229
Post-processing of Model Data for Transfers ... 229
Limitations ... 230
Proposed Exports for Transfers ... 230
JPOD ... 231
500 cfs at Banks ... 231
NBA Diversion ... 231
CCWD Diversions ... 232
Temporary Agricultural Barriers ... 232
Permanent Operable Gates ... 232
American River Demands ... 232
Delta Cross Channel ... 232
Entrainment Effects ... 233
Water Diversions and Reservoir Operations ... 233
Banks and Jones ... 233
Intertie ... 233
Suisun Marsh Salinity Control Gates ... 233
Habitat Suitability (Sept-Dec) ... 233
X2 ... 235
Area of Suitable Abiotic Habitat ... 235
Effect on Delta Smelt Abundance ... 236
Additional Long-term Trends and Potential Mechanisms ... 236
American River Demands ... 238
Komeen Treatment ... 238
Effects to Delta Smelt Critical Habitat ... 239
PRIMARY CONSTITUENT ELEMENTS ... 239
Spawning Habitat ... 239
PCE 1 – Physical Habitat ... 239
PCE 2 – Water ... 239
PCE 3 – River Flow ... 240
PCE 4 – Salinity ... 240
Larval and Juvenile Transport ... 240
PCE 1 – Physical Habitat ... 240
PCE 2 – Water ... 240
PCE 3 – River Flows ... 241
PCE 4 – Salinity ... 241
Rearing Habitat ... 242
PCE 1 – Physical Habitat ... 242
PCE 2 – Water ... 242
PCE 3 – River Flows ... 242
PCE 4 – Salinity ... 243
Adult Migration ... 243
PCE 1 – Physical Habitat ... 243
PCE 2 – Water ... 243
PCE 3 – River Flows ... 243
PCE 4 – Salinity ... 244
Summary of Effects of the Action on Delta Smelt Critical Habitat ... 244
CUMULATIVE EFFECTS ... 244

CONCLUSION 276
Delta Smelt 276
Delta Smelt Critical Habitat 278
Reasonable and Prudent Alternative 279
Incidental Take Statement 285
REASONABLE AND PRUDENT MEASURES 294
Terms and Conditions 294
MONITORING REQUIREMENTS 295
REPORTING REQUIREMENTS 295
Conservation Recommendations 295
Reinitiation-Closing Statement 296
Literature Cited 298
Attachment A-Delta Smelt Risk Assessment Matrix 311
Attachment B, Supplemental Information related to the Reasonable and Prudent Alternative 324
Attachment C: Methods Used in Developing the Incidental Take Statement 382

Project Description

The proposed action is the continued long-term operation of the CVP and SWP. The proposed action includes the operation of the temporary barriers project in the South Delta and the 500 cubic feet per second (cfs) increase in SWP Delta export limit from July through September. In addition to current day operations, several other actions are included in this consultation. These actions are: (1) an intertie between the California Aqueduct (CA) and the Delta-Mendota Canal (DMC), (2) Freeport Regional Water Project (FRWP), (3) the operation of permanent gates that will replace the temporary barriers in the South Delta, (4) changes in the operation of the Red Bluff Diversion Dam (RBDD), and (5) Alternative Intake Project for the Contra Costa Water District (CCWD). A detailed summary of all operational components and associated modeling assumptions are included in the biological assessment in Chapter 9.

Table P-1 Assumptions for the Base and Future Studies

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	OCAP BA 2004 Today CVPIA 3406 (b)(2) with EWA	**Today-OCAP BA 2004 Assumptions in Revised CalSim-II Model - EWA**	**Today-OCAP BA 2004 Assumptions in Revised CalSim-II Model - CVPIA (b)(2) - CONV**	**Today-Existing Conditions, (b)(2), EWA**	**Near Future-Existing Conditions and OCAP BA 2004 Consulted Projects, (b)(2), Limited EWA**	**Future - (b)(2), Limited EWA**	**Future Climate Change-D1641**	**Model Revisions since OCAP BA 2004**
OCAP Base model: Common Assumptions: Common Model Package (Version 8D) *"Same" indicates an assumption from a column to the left*								
Planning horizon	2001	2005[a]	Same	Same	Same	2030[a]	Same	
Period of Simulation	73 years (1922-1994)	82 years (1922-2003)	Same	Same	Same	Same	Same	Extended hydrology timeseries
HYDROLOGY							Inflows are modified based on alternative climate inputs[b]	Revised level of detail in the Yuba and Colusa Basin including rice decomposition operations
Level of development (Land Use)	2001 Level	2005 level	Same	Same	Same	2030 level[c]	Same	
Sacramento Valley (excluding American R.)	Land-use based, limited by contract amounts[d]	Same	Same	Same	Same	CVP Land-use based, Full build out of CVP contract amounts[d]	Same	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	SWP (FRSA)	Land-use based, limited by contract amounts[e]	Same	Same	Same	Same	Same	Same	
	Non-project	Land-use based	Same	Same	Same	Same	Same	Same	
	refuges	Firm Level 2	Same	Same	Recent Historical Firm Level 2 water needs[f]	Same	Firm Level 2 water needs[f]	Same	
American River									
	Water rights	2001[g]	Same	Same	2005[g]	Same	2025[g]	Same	
	CVP (PCWA American River Pump Station)	No project	Same	Same	CVP (PCWA modified)[g]	Same	Same	Same	
Federal **San Joaquin River**[h]									
	Friant Unit	Regression of Historical Demands	Limited by contract amounts, based on current allocation policy	Same	Same	Same	Same	Same	Developed land-use based demands, water quality calculations, and revised accretions/depletions in the East-Side San Joaquin Valley
	Lower Basin	Fixed Annual Demands	Land-use based, based on district level operations and constraints	Same	Same	Same	Same	Same	
	River	New Melones Interim Operations Plan	Same	Same	Same	Draft Transitional Operations Plan[r]	Same	Same	Initial storage conditions for New Melones Reservoir were
Stanislaus									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
									increased.
South of Delta									
	project facilities)	CVP Demand based on contracts amounts[d]	Same	Same	Same	Same	Same	Same	
	Contra Costa Water District	124 TAF/yr annual average	135 TAF/yr annual average CVP contract supply and water rights[i]	Same	Same	Same	195 TAF/yr annual average CVP contract supply and water rights[i]	Same	
(CVP/SWP	SWP Demand - Table A	Variable 3.1-4.1 MAF/Yr	Same	Same	Variable 3.1-4.2 MAF/Yr [e,j]	Same	Full Table A	Same	Revised SWP delivery logic. Three patterns with Art 56 and more accurately defined Table A / Article 21 split modeled
	SWP Demand - North Bay Aqueduct (Table A)	48 TAF/Yr	Same	Same	71 TAF/Yr[u]	Same	Same	Same	
	SWP Demand - Article 21 demand	Up to 134 TAF/month December to March, total of other demands up to 84 TAF/month in all months	Same	Same	Up to 314 TAF/month from December to March, total of demands up to 214 TAF/month in all other months[e,jw]	Same	Same	Same	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Federal refuges	Firm Level 2	Same	Same	Recent Historical Firm Level 2 water needs[f]	Same	Firm Level 2 water needs[f]	Same	
FACILITIES									
Systemwide		Existing facilities[a]	Same	Same	Same	Same	Same	Same	
Sacramento Valley									
	Red Bluff Diversion Dam	No diversion constraint	Same	Same	Diversion Dam operated May 15 - Sept 15 (diversion constraint)	Same	Diversion Dam operated July - August (diversion constraint)	Same	
	Colusa Basin	Existing conveyance and storage facilities	Same	Same	Same	Same	Same	Same	
	American River	No project	Same	Same	PCWA American River pump station[k]	Same	Same	Same	
	River Water Reliability	No project	Same	Same	Same	Same	American/Sacramento River Diversions[t]	Same	
	Lower Sacramento River	No project	Same	Same	Same	Freeport Regional Water Project (Full Demand)[l]	Same	Same	
Upper									
Delta Region									
Sacramento	SWP Banks Pumping Plant	South Delta Improvements Program Temporary Barriers, 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through Mar 15[a]	Same	Same	Same	South Delta Improvements Program Permanent Operable Gates (Stage 1). 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through	Same	Same	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL Mar 15 [a]	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	CVP C.W. Bill Jones (Tracy) Pumping Plant	4,200 cfs + deliveries upstream of DMC constriction	Same	Same	Same	4,600 cfs capacity in all months (allowed for by the Delta-Mendota Canal–California Aqueduct Intertie)	Same	Same	
	City of Stockton Delta Water Supply Project (DWSP)	No project	Same	Same	DWSP WTP 0 mgd	Same	DWSP WTP 30 mgd	Same	
	Contra Costa Water District	Existing pump locations	Same	Same	Same	Same	Same[m]	Same	
South of Delta (CVP/SWP project facilities)									
	South Bay Aqueduct (SBA)	Existing capacity 300 cfs	Same	Same	SBA Rehabilitation: 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same	Same	Same	
REGULATORY STANDARDS									
Trinity River									
	Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same	Same	Same	Same	Same	Same	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same	Same	Same	Same	
Clear Creek									
	Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
Upper Sacramento River									
	Shasta Lake	NMFS 2004 BO: 1.9 MAF end of Sep. storage target in non-critical years	Same	Same	Same	Same	Same	Same	
	Minimum flow below Keswick Dam	Flows for SWRCB WR 90-5 temperature control, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
Feather River									
	Minimum flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 cfs)	Same	Same	Same	2006 Settlement Agreement (700 / 800 cfs)	Same	Same	
	Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same	Same	Same	Same	Same	Same	
Yuba River									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Minimum flow below Daguerre Point Dam	Available Yuba River Data[p]	D-1644 Interim Operations[p]	Same	Yuba Accord Adjusted Data[p]	Same	Same	Same	
American River									
	Minimum flow below Nimbus Dam	SWRCB D-893 (see Operations Criteria), and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	(b)(2) Minimum Instream Flow management[s]	Same	American River Flow Management [s]	Same	
	Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same	Same	Same	Same	
Lower Sacramento River									
	Minimum flow near Rio Vista	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
Mokelumne River									
	Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same	Same	Same	Same	Same	Same	
	Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same	Same	Same	Same	Same	Same	
Stanislaus River									
	Minimum flow below Goodwin Dam	1987 USBR, DFG agreement, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
	dissolved oxygen	SWRCB D-1422	Same	Same	Same	Same	Same	Same	
Merced River									

Minimum

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement	Same	Same	Same	Same	Same	Same	
	Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same	Same	Same	Same	Same	Same	
Tuolumne River									
	Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/year)	Same	Same	Same	Same	Same	Same	
San Joaquin River									
	Maximum salinity near Vernalis	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
	Minimum flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Plan per San Joaquin River Agreement	Same	Same	Same	Same	Same	Same	
Sacramento River–San Joaquin River Delta									
	Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same	Same	Same	Same	Revised Delta ANN (salinity estimation)[v]
	Delta Cross Channel gate operation	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
	Delta exports	SWRCB D-1641, USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
OPERATIONS CRITERIA: RIVER-SPECIFIC									
Upper Sacramento River									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Flow objective for navigation (Wilkins Slough)	3,250 - 5,000 cfs based on CVP water supply condition	Same	Same	Same	Same	Same	Same	
American River									
	Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same	Same	Same	Same	Same	Same	
	Flow below Nimbus Dam	Discretionary operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	(b)(2) Minimum Instream Flow management[s]	Same	American River Flow Management [s]	Same	
	Area Water Forum "Replacement " Water	"Replacement " water is not implemented	Same	Same	Same	Same	Same	Same	
Stanislaus River									
	Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same	Draft Transitional Operations Plan[r]	Same	Same	
Sacramento **San Joaquin River**									
	Flow at Vernalis	D1641	Same	Same	Same	Same	Same[q]	Same	
OPERATIONS CRITERIA: SYSTEMWIDE									
CVP water allocation									
	Settlement and Exchange	100% (75% in Shasta critical years)	Same	Same	Same	Same	Same	Same	
	CVP refuges	100% (75% in Shasta critical years)	Same	Same	Same	Same	Same	Same	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	CVP agriculture	100%-0% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same	Same	Same	Same	
	CVP municipal & industrial	100%-50% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same	Same	Same	Same	
SWP water allocation									
	North of Delta (FRSA)	Contract specific	Same	Same	Same	Same	Same	Same	
	South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement	Same	Same	Same	Same	Same	Same	
CVP-SWP coordinated operations									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions are considered as Delta Export, 1/3 of the North Bay Aqueduct diversion is considered as in-basin-use)	Same	Same	Same	Same	Same	Same	
	Sharing of surplus flows	1986 Coordinated Operations Agreement	Same	Same	Same	Same	Same	Same	
	Sharing of Export/Inflow Ratio	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) restricts only CVP and/or SWP exports	Same	Same	Same	Same	Same	Same	
	Sharing of export capacity for lesser priority and wheeling related pumping	Cross Valley Canal wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion (JPOD)	Same	Same	Same	Same	Same	Same	
Study assumptions from above apply			**Study 6a**	**Study 7a**	**Study 7a**	**Study 7.1a**	**Study 8a**	**NA**	

CVPIA 3406(b)(2): Per May 2003 Dept. of Interior

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Decision									
	Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years[n]	Same	Same	Same	Same	Same	NA	
Study assumptions from above apply			**Study 6b**	**Study 7b**	**Study 7b**	**Study 7.1b**	**Study 8b**	**NA**	
CALFED Environmental Water Account / Limited Environmental Water Account									
	Actions	Dec-Feb reduce total exports by 50 TAF/mon relative to total exports without EWA; VAMP (Apr 15 - May 16) export restriction on SWP; Post (May 16-31) VAMP export restriction on SWP and potentially on CVP if B2 Post-VAMP action is not taken; Ramping of exports (Jun)	Dec/Jan 50 TAF/mon export reduction, Feb 50 TAF export reduction in Wet/AN years, Feb/Mar 100, 75, or 50 TAF reduction dependent on species habitat conditions; VAMP (Apr 15 - May 16) export restriction on SWP; Pre (Apr 1-14) VAMP export reduction in Dry/Crit years; Post (May 16-31) export restriction; June ramping restriction if PostVAMP action was done. Pre- and Post-VAMP and June actions done if foreseeable October debt at San Luis does not exceed 150 TAF.	NA	Same	VAMP (Apr 15 - May 16) 31-day export restriction on SWP; If stored assets and purchases from the Yuba are sufficient, Post (May 16-31) VAMP export restrictions apply to SWP[pq]	Same	NA	The EWA actions, assets, and debt were revised and vetted as part of the Long Term Environmental Water Account EIS/R project

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Assets	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. The purchases range from 0 TAF in Wet years to approximately 153 TAF in Critical years NOD, and 57 TAF in Critical years to 250 TAF in Wet years SOD. Variable assets include the following: use of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, flexing of Delta E/I Ratio (post-processed from CalSim-II results), additional 500 CFS pumping capacity at Banks in Jul-Sep	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. NOD share of annual purchase target ranges from 90% to 50% based on SWP Ag Allocation as an indicator of conveyance capacity. Variable/operational assets include use of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, additional 500 CFS pumping capacity at Banks in Jul-Sep, source shifting, Semitropic Groundwater Bank, “spill” of San Luis carryover debt, and backed-up stored water from Spring EWA actions.	NA	Same	Purchase of Yuba River stored water under the Lower Yuba River Accord (average of 48 TAF/yr), use of 50% of any CVPIA 3406 (b)(2) releases pumped by SWP, additional 500 CFS pumping capacity at Banks in Jul-Sep.	Same	NA	

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	Debt	Delivery debt paid back in full upon assessment; Storage debt paid back over time based on asset/action priorities; SOD and NOD debt carryover is explicitly managed or spilled; NOD debt carryover must be spilled; SOD and NOD asset carryover is allowed	Same	NA	Same	No Carryover Debt	Same	NA	
Post Processing Assumptions									
WATER MANAGEMENT ACTIONS (CALFED)									
Water Transfers									
	Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users	Same	NA	Same	Same	Same	NA	
	Phase 8[o]	available capacity	Same	NA	Same	Same	Same		
	Refuge Level 4 water	Evaluate Evaluate available capacity	Same	NA	Same	Same	Same		
	Notes:								

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II

[a] The OCAP BA project description is presented in Chapter 2.

[b] Climate change sensitivity analysis assumptions and documentation are presented in Appendix R.

[c] The Sacramento Valley hydrology used in the CALSIM II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of 2030 land-use assumptions are being coordinated with the California Water Plan Update for future models.

[d] CVP contract amounts have been reviewed and updated according to existing and amended contracts as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are documented in Table 3A (North of Delta) and 5A (South of Delta) of Appendix D: Delivery Specifications section of the Technical Appendix.

[e] SWP contract amounts have been reviewed and updated as appropriate. Assumptions regarding SWP agricultural and M&I contract amounts are documented in Table 1A (North of Delta) and Table 2A (South of Delta) of Appendix D: Delivery Specifications section.

[f] Water needs for federal refuges have been reviewed and updated as appropriate. Assumptions regarding firm Level 2 refuge water needs are documented in Table 3A (North of Delta) and 5A (South of Delta) of Appendix D:Delivery Specifications. Incremental Level 4 refuge water needs have been documented as part of the assumptions of future water transfers.

[g] PCWA demand in the foreseeable existing condition is 8.5 TAF/yr of CVP contract supply diverted at the new American River PCWA Pump Station. In the future scenario, PCWA is allowed 35 TAF/yr. Assumptions regarding American River water rights and CVP contracts are documented in Table 5 of Appendix D: Delivery Specifications section.

[h] The new CalSim-II representation of the San Joaquin River has been included in this model package (CalSim-II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of on-going groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to on-going groundwater overdraft problems. In addition, a dynamic groundwater simulation is not yet developed for San Joaquin River Valley. Groundwater extraction/ recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of results.

[i] Study 6.0 demands for CCWD are assumed equal to Study 7.0 due to data availablity with the revised CalSim-II model framework. For all Studies, Los Vaqueros Reservoir storage capacity is 100 TAF.

[j] Table A deliveries into the San Francisco Bay Area Region for existing cases are based on a variable demand and a full Table A for future cases. The variable demand is dependent on the availability of other water during wet years resulting in less demand for Table A. In the future cases it is assumed that the demand for full Table A will be independent of other water sources. Article 21 demand assumes MWD demand of 100 TAF/mon (Dec-Mar), Kern demand of 180 TAF/mon (Jan-Dec), and other contractor demand of 34 TAF/mon (Jan-Dec).

[k] PCWA American River pumping facility upstream of Folsom Lake is under construction.

[l] Mokelumne River flows reflect EBMUD supplies associated with the Freeport Regional Water Project.

[m] The CCWD Alternate Intake Project (AIP), an intake at Victoria Canal, which operates as an alternate Delta diversion for Los Vaqueros Reservoir is not included in Study 8.0. AIP is included as a separate consultation. AIP will be further evaluated after regulatory and operational managment assumptions have been determined.

[n] The allocation representation in CalSim-II replicates key processes, shortage changes are checked by post-processing.

[o] This Phase 8 requirement is assumed to be met through Sacramento Valley Water Management Agreement Implementation.

[p] OCAP BA 2004 modeling used available hydrology at the time which was data developed based on 1965 Yuba County Water Agency -Department of Fish of Game Agreement. Since the OCAP BA 2004 modeling, Yuba River hydrology was revised. Interim D-1644 is assumed to be fully implemented with or without the implementation of the Lower Yuba River Accord. This is consistent with the future no-action condition being assumed by the Lower Yuba River Accord EIS/EIR study team. For studies with the Lower Yuba River Accord, an adjusted hydrology is used.

[q] It is assumed that either VAMP, a functional equivalent, or D-1641 requirements would be in place in 2030.

[r] The Draft Transitional Operations Plan assumptions are discussed in Chapter 2.

[s] For Studies 7.0, 7.1, and 8.0 the flow components of the proposed American River Flow Management are included and applied using the CVPIA 3406(b)(2). For Study 8.0 the American River Flow Management is assumed to be the new minimum instream flow.

[t] OCAP assumes the flexibility of diversion location but does not assume the Sacramento Area Water Forum Water Forum "replacement water" in drier water year types.

[u] Aqueduct improvements that would allow an increase in South Bay Aqueduct demand at the time of model development were expected to be operational within 6 months. However, a delay in the construction has postponed the completion.

[v] The Artificial Neural Network (ANN) was updated for both salinity and X2 calculations. Study 3a does not include an updated ANN, Study 6.1 has an updated salinity but not X2, and all remaining Studies include both the updated salinity and X2.

[w] North Bay Article 21 deliveries are dependent on excess conditions rather than being dependent on San Luis storage.

Figure P-1 Map of California CVP and SWP Service Areas

Coordinated Operations of the CVP and SWP

Coordinated Operations Agreement

The CVP and SWP use a common water supply in the Central Valley of California. The DWR and Reclamation (collectively referred to as Project Agencies) have built water conservation and water delivery facilities in the Central Valley in order to deliver water supplies to affected water rights holders as well as project contractors. The Project Agencies' water rights are conditioned by the State Water Resources Control Board (SWRCB) to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The Project Agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards, as the standards existed in SWRCB Decision 1485 (D-1485) and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the CVP/SWP, and provides for periodic review of the agreement.

Implementing the COA

Obligations for In-Basin Uses

In-basin uses are defined in the COA as legal uses of water in the Sacramento Basin, including the water required under the SWRCB D-1485 Delta standards (D-1485 ordered the CVP and SWP to guarantee certain conditions for water quality protection for agricultural, municipal and industrial [M&I], and fish and wildlife use). The Project Agencies are obligated to ensure water is available for these uses, but the degree of obligation is dependent on several factors and changes throughout the year, as described below.

Balanced water conditions are defined in the COA as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equals the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports. Reclamation's Central Valley Operations Office (CVOO) and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist.

During excess water conditions, sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to supplement the supply with water from reservoir storage. Under Article 6(g) of the COA, Reclamation and DWR have the responsibility (during excess water conditions) to store and export as much water as possible, within physical, legal and contractual limits. In excess water conditions, water accounting is not required. However, during balanced water conditions, the Projects share the responsibility in meeting in-basin uses.

When water must be withdrawn from reservoir storage to meet in-basin uses, 75 percent of the responsibility is borne by the CVP and 25 percent is borne by the SWP[1]. When unstored water is available for export (i.e., Delta exports exceed storage withdrawals while balanced water conditions exist), the sum of CVP stored water, SWP stored water, and the unstored water for export is allocated 55/45 to the CVP and SWP, respectively.

Accounting and Coordination of Operations

Reclamation and DWR coordinate on a daily basis to determine target Delta outflow for water quality, reservoir release levels necessary to meet in-basin demands, schedules for joint use of the San Luis Unit facilities, and for the use of each other's facilities for pumping and wheeling.

During balanced water conditions, daily water accounting is maintained of the CVP and SWP obligations. This accounting allows for flexibility in operations and avoids the necessity of daily changes in reservoir releases that originate several days travel time from the Delta. It also means adjustments can be made "after the fact" using actual data rather than by prediction for the variables of reservoir inflow, storage withdrawals, and in-basin uses.

The accounting language of the COA provides the mechanism for determining the responsibility of each project for Delta outflow-influenced standards; however, real time operations dictate actions. For example, conditions in the Delta can change rapidly. Weather conditions combined with tidal action can quickly affect Delta salinity conditions, and therefore, the Delta outflow required to maintain joint standards. If, in this circumstance, it is decided the reasonable course of action is to increase upstream reservoir releases, then the response will likely be to increase Folsom releases first. Lake Oroville water releases require about three days to reach the Delta, while water released from Lake Shasta requires five days to travel from Keswick to the Delta. As water from the other reservoirs arrives in the Delta, Folsom releases can be adjusted downward. Any imbalance in meeting each project's designed shared obligation would be captured by the COA accounting.

Reservoir release changes are one means of adjusting to changing in-basin conditions. Increasing or decreasing project exports can immediately achieve changes to Delta outflow. As with changes in reservoir releases, imbalances in meeting each project's designed shared obligations are captured by the COA accounting.

During periods of balanced water conditions, when real-time operations dictate project actions, an accounting procedure tracks the designed sharing water obligations of the CVP and SWP. The Projects produce daily and accumulated accounting balances. The account represents the imbalance resulting from actual coordinated operations compared to the COA-designed sharing of obligations and supply. The project that is "owed" water (i.e., the project that provided more or exported less than its COA-defined share) may request the other project adjust its operations to reduce or eliminate the accumulated account within a reasonable time.

The duration of balanced water conditions varies from year to year. Some very wet years have had no periods of balanced conditions, while very dry years may have had long continuous periods of balanced conditions, and still other years may have had several periods of balanced

[1] These percentages were derived from negotiations between Reclamation and DWR for SWRCB D-1485 standards

conditions interspersed with excess water conditions. Account balances continue from one balanced water condition through the excess water condition and into the next balanced water condition. When the project that is owed water enters into flood control operations, at Shasta or Oroville, the accounting is zeroed out for that respective project. The biological assessment provides a detailed description of the changes in the COA.

State Water Resources Control Board Water Rights

1995 Water Quality Control Plan

The SWRCB adopted the 1995 Bay-Delta Water Quality Control Plan (WQCP) on May 22, 1995, which became the basis of SWRCB Decision-1641. The SWRCB continues to hold workshops and receive information regarding processes on specific areas of the 1995 WQCP. The SWRCB amended the WQCP in 2006, but to date, the SWRCB has made no significant changes to the 1995 WQCP framework.

Decision 1641

The SWRCB imposes a myriad of constraints upon the operations of the CVP and SWP in the Delta. With Water Rights Decision 1641, the SWRCB implements the objectives set forth in the SWRCB 1995 Bay-Delta WQCP and imposes flow and water quality objectives upon the Projects to assure protection of beneficial uses in the Delta. The SWRCB also grants conditional changes to points of diversion for the Projects with D-1641.

The various flow objectives and export restraints are designed to protect fisheries. These objectives include specific outflow requirements throughout the year, specific export restraints in the spring, and export limits based on a percentage of estuary inflow throughout the year. The water quality objectives are designed to protect agricultural, municipal and industrial, and fishery uses, and they vary throughout the year and by the wetness of the year.

Figure P-2 and Figure P-3 summarize the flow and quality objectives in the Delta and Suisun Marsh for the Projects from D-1641. These objectives will remain in place until such time that the SWRCB revisits them per petition or as a consequence to revisions to the SWRCB Water Quality Plan for the Bay-Delta (which is to be revisited periodically).

On December 29, 1999, SWRCB adopted and then revised (on March 15, 2000) Decision 1641, amending certain terms and conditions of the water rights of the SWP and CVP. Decision 1641 substituted certain objectives adopted in the 1995 Bay-Delta Plan for water quality objectives that had to be met under the water rights of the SWP and CVP. In effect, D-1641 obligates the SWP and CVP to comply with the objectives in the 1995 Bay-Delta Plan. The requirements in D-1641 address the standards for fish and wildlife protection, M&I water quality, agricultural water quality, and Suisun Marsh salinity. SWRCB D-1641 also authorizes SWP and CVP to jointly use each other's points of diversion in the southern Delta, with conditional limitations and required response coordination plans. SWRCB D-1641 modified the Vernalis salinity standard under SWRCB Decision 1422 to the corresponding Vernalis salinity objective in the 1995 Bay-Delta Plan. The criteria imposed upon the CVP and SWP are summarized in Figure P-2 (Summary Bay-Delta Standards), Figure P-3 (Footnotes for Summary Bay-Delta Standards), and Figure P-4 (CVP/SWP Map).

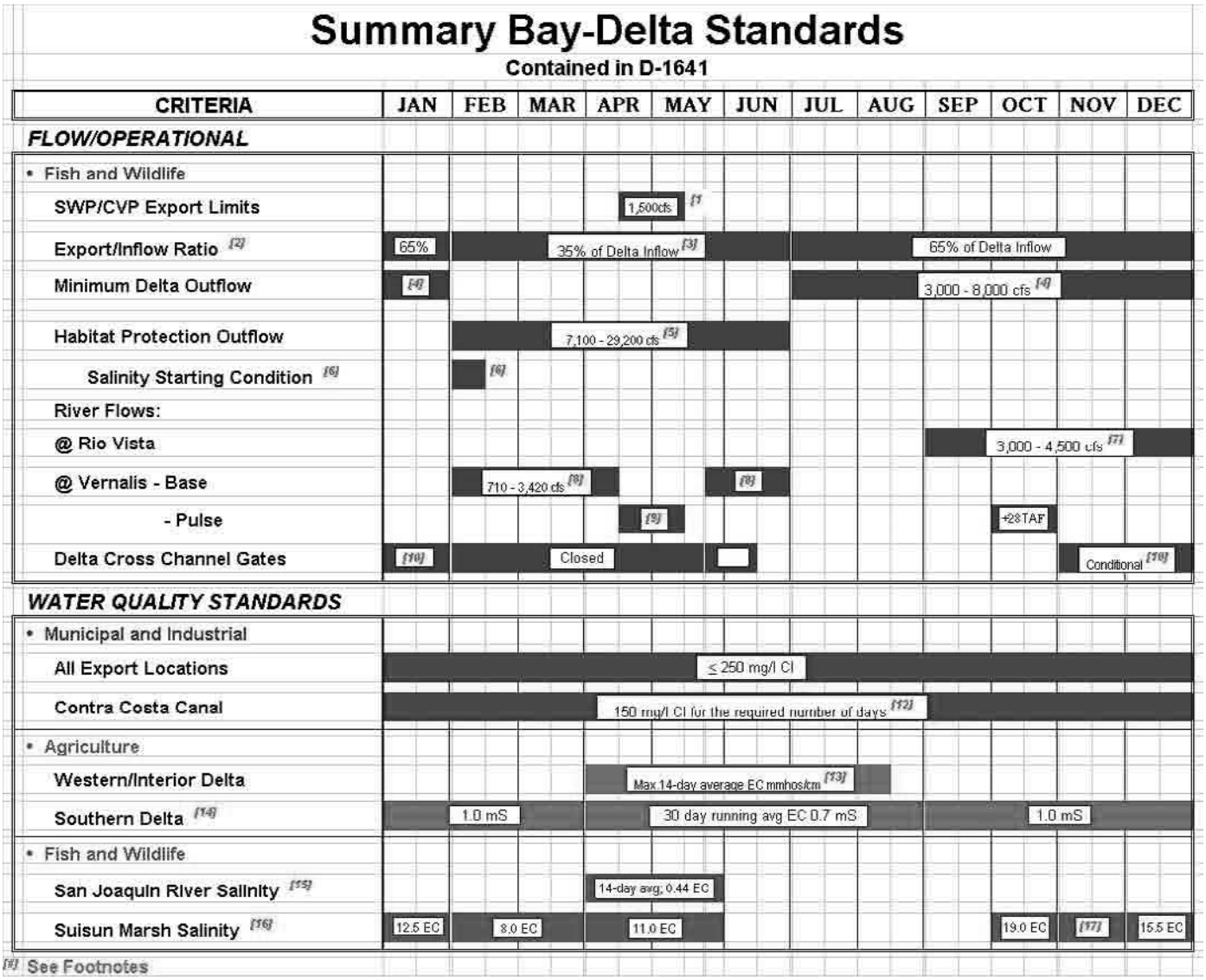

Figure P-2 Summary Bay Delta Standards (See Footnotes below)

Footnotes

[1] Maximum 3-day running average of combined export rate (cfs) which includes Tracy Pumping Plant and Clifton Court Forebay Inflow less Byron-Bethany pumping.

Year Type	All
Apr15 - May15*	The greater of 1,500 or 100% of 3-day avg. Vernalis flow

* This time period may need to be adjusted to coincide with fish migration. Maximum export rate may be varied by CalFed Op's group.

[2] The maximum percentage of average Delta inflow (use 3-day average for balanced conditions with storage withdrawal, otherwise use 14-day average) diverted at Clifton Court Forebay (excluding Byron-Bethany pumping) and Tracy Pumping Plant using a 3-day average. (These percentages may be adjusted upward or downward depending on biological conditions, providing there is no net water cost.)

[3] The maximum percent Delta inflow diverted for Feb may vary depending on the January 8RI.

Jan 8RI	Feb exp. limit
≤ 1.0 MAF	45%
between 1.0 & 1.5 MAF	35%-45%
> 1.5 MAF	35%

[4] Minimum monthly average Delta outflow (cfs). If monthly standard ≤ 5,000 cfs, then the 7-day average must be within 1,000 cfs of standard; if monthly standard > 5,000 cfs, then the 7-day average must be ≥ 80% of standard.

Year Type	All	W	AN	BN	D	C
Jan	4,500*					
Jul		8,000	8,000	6,500	5,000	4,000
Aug		4,000	4,000	4,000	3,500	3,000
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

* Increase to 6,000 if the Dec 8RI is greater than 800 TAF

[5] Minimum 3-day running average of daily Delta outflow of 7,100 cfs OR: either the daily average or 14-day running average EC at Collinsville is less than 2.64 mmhos/cm (This standard for March may be relaxed if the Feb 8RI is less than 500 TAF. The standard does not apply in May and June if the May estimate of the SRI IS < 8.1 MAF at the 90% exceedence level in which case a minimum 14-day running average flow of 4,000 cfs is required.) For additional Delta outflow objectives, see **TABLE A**.

[6] February starting salinity: If Jan 8RI > 900 TAF, then the daily or 14-day running average EC @ Collinsville must be ≤ 2.64 mmhos/cm for at least one day between Feb 1-14. If Jan 8RI is between 650 TAF and 900 TAF, then the CalFed Op's group will determine if this requirement must be met.

[7] Rio Vista minimum monthly average flow rate in cfs (the 7-day running average shall not be less than 1,000 below the monthly objective).

Year Type	All	W	AN	BN	D	C
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

[8] BASE Vernalis minimum monthly average flow rate in cfs (the 7-day running average shall not be less than 20% below the objective). Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Feb-Apr14 and May16-Jun		2,130 or 3,420	2,130 or 3,420	1,420 or 2,280	1,420 or 2,280	710 or 1,140

[9] PULSE Vernalis minimum monthly average flow rate in cfs. Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Apr15 - May15		7,330 or 8,620	5,730 or 7,020	4,620 or 5,480	4,020 or 4,880	3,110 or 3,540
Oct	1,000*					

* Up to an additional 28 TAF pulse/attraction flow to bring flows up to a monthly average of 2,000 cfs except for a critical year following a critical year. Time period based on real-time monitoring and determined by CalFed Op's group.

[10] For the Nov-Jan period, Delta Cross Channel gates may be closed for up to a total of 45 days.

[11] For the May 21-June 15 period, close Delta Cross Channel gates for a total of 14 days per CALFED Op's group. During the period the Delta cross channel gates may close 4 consecutive days each week, excluding weekends.

[12] Minimum # of days that the mean daily chlorides ≤ 150 mg/l must be provided in intervals of not less than 2 weeks duration. Standard applies at Contra Costa Canal Intake or Antioch Water Works Intake.

Year Type	W	AN	BN	D	C
# Days	240	190	175	165	155

Figure P-3 Footnotes for Summary Bay Delta Standards ***(continued on next page)***

[13] The maximum14-day running average of mean daily EC (mmhos/cm) depends on water year type

	WESTERN DELTA				INTERIOR DELTA			
	Sac River @ Emmaton		SJR @ Jersey Point		Mokelumne R @ Terminous		SJR @ San Andreas	
Year Type	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value fro date shown Aug15 *
W	Aug 15		Aug 15		Aug 15		Aug 15	
AN	Jul 1	0.63	Aug 15		Aug 15		Aug 15	
BN	Jun 20	1.14	Jun 20	0.74	Aug 15		Aug 15	
D	Jun 15	1.67	Jun 15	1.35	Aug 15		Jun 25	0.58
C		2.78		2.20		0.54		0.87

* When no date is shown, EC limit continues from April 1

[14] As per D-1641, for San Joaquin River at Vernalis; however, the April through August maximum 30- day running average EC for San Joaquin River at Brandt Bridge,Old River near Middle River, and Old River at Tracy Road Bridge shall be 1.0 EC until April 1, 2005 when the value will be 0.7 EC.

[15] Compliance will be determined between Jersey Point & Prisoners Point.
Does not apply in critical years or in May when the May 90% forecast of SRI ≤ 8.1 MAF.

[16] During deficiency period, the maximum monthly average mhtEC at Western Suisun Marsh stations as per SMPA is:

Month	mhtEC
Oct	19.0
Nov	16.5
Dec-Mar	15.6
Apr	14.0
May	12.5

[17] In November, maximum monthly average mhtEC = 10.5 for Western Marsh stations and maximum monthly average mhtEC = 15.5 for Eastern Marsh stations in all periods types.

TABLE A

Number of Days When Max. Daily Average Electrical Conductivity of 2.64 mmhos/cm Must Be Maintained. (This can also be met with a maximum 14-day running average EC of 2.64 mmhos/cm, or 3-day running average Delta outflows of 11,400 cfs and 29,200 cfs, respectively.) Port Chicago Standard is triggered only when the 14-day average EC for the last day of the previous month is 2.64 mmhos/cm or less. PMI is previous month's 8RI. If salinity/flow objectives are met for a greater number of days than required for any month, the excess days shall be applied towards the following month's requirement. The number of day's for values of the PMI between those specified below shall be determined by linear interpolation.

PMI (TAF)	Chipps Island (Chipps Island Station D10)				
	FEB	MAR	APR	MAY	JUN
≤ 500	0	0	0	0	0
750	0	0	0	0	0
1000	28*	12	2	0	0
1250	28	31	6	0	0
1500	28	31	13	0	0
1750	28	31	20	0	0
2000	28	31	25	1	0
2250	28	31	27	3	0
2500	28	31	29	11	1
2750	28	31	29	20	2
3000	28	31	30	27	4
3250	28	31	30	29	8
3500	28	31	30	30	13
3750	28	31	30	31	18
4000	28	31	30	31	23
4250	28	31	30	31	25
4500	28	31	30	31	27
4750	28	31	30	31	28
5000	28	31	30	31	29
5250	28	31	30	31	29
≥ 5500	28	31	30	31	30

*When 800 TAF < PMI < 1000 TAF, the number of days is determined by linear interpolation between 0 and 20 days.

PMI (TAF)	Port Chicago (continuous recorder at Port Chicago)				
	FEB	MAR	APR	MAY	JUN
0	0	0	0	0	0
250	1	0	0	0	0
500	4	1	0	0	0
750	8	2	0	0	0
1000	12	4	0	0	0
1250	15	6	1	0	0
1500	18	9	1	0	0
1750	20	12	2	0	0
2000	21	15	4	0	0
2250	22	17	5	1	0
2500	23	19	8	1	0
2750	24	21	10	2	0
3000	25	23	12	4	0
3250	25	24	14	6	0
3500	25	25	16	9	0
3750	26	26	18	12	0
4000	26	27	20	15	0
4250	26	27	21	18	1
4500	26	28	23	21	2
4750	27	28	24	23	3
5000	27	28	25	25	4
5250	27	29	25	26	6
5500	27	29	26	28	9
5750	27	29	27	28	13
6000	27	29	27	29	16
6250	27	30	27	29	19
6500	27	30	28	30	22
6750	27	30	28	30	24
7000	27	30	28	30	26
7250	27	30	28	30	27
7500	27	30	29	30	28
7750	27	30	29	31	28
8000	27	30	29	31	29
8250	28	30	29	31	29
8500	28	30	29	31	29
8750	28	30	29	31	30
9000	28	30	29	31	30
9250	28	30	29	31	30
9500	28	31	29	31	30
9750	28	31	29	31	30
10000	28	31	30	31	30
> 10000	28	31	30	31	30

Figure P-3 Footnotes for Summary Bay Delta Standards

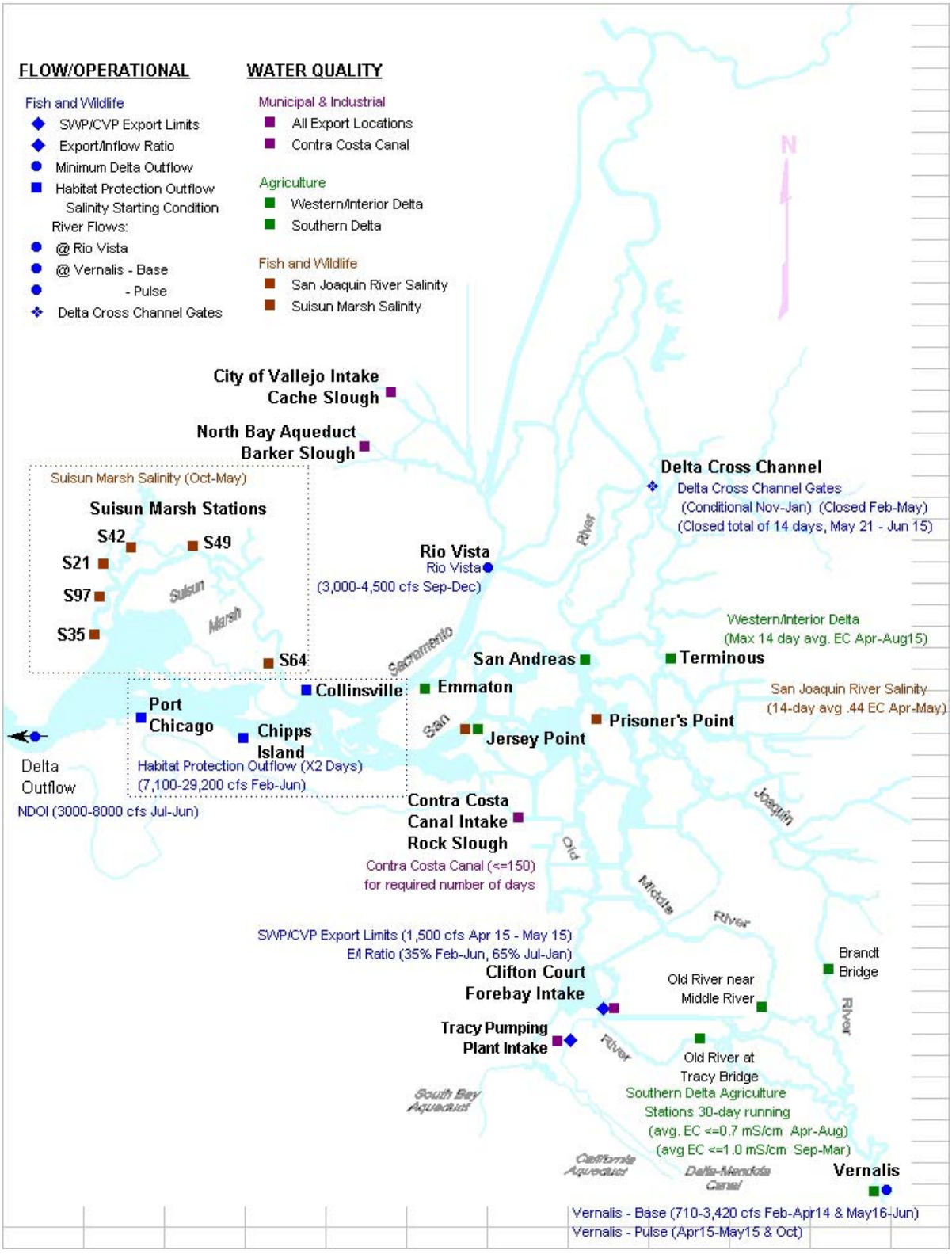

Figure P-4 CVP/SWP Delta Map

Joint Points of Diversion

SWRCB D-1641 granted Reclamation and DWR the ability to use/exchange each Project's diversion capacity capabilities to enhance the beneficial uses of both Projects. The SWRCB conditioned the use of Joint Point of Diversion (JPOD) capabilities based on a staged implementation and conditional requirements for each stage of implementation. The stages of JPOD in SWRCB D-1641 are:

- Stage 1 – for water service to Cross Valley Canal contractors, Tracy Veterans Cemetery and Musco Olive, and to recover export reductions taken to benefit fish.
- Stage 2 – for any purpose authorized under the current project water right permits.
- Stage 3 – for any purpose authorized up to the physical capacity of the diversion facilities. Stage 3 is not part of the project description.

Each stage of JPOD has regulatory terms and conditions which must be satisfied in order to implement JPOD.

All stages require a response plan to ensure water levels in the southern Delta will not be lowered to the injury of local riparian water users (Water Level Response Plan). All stages require a response plan to ensure the water quality in the southern and Central Delta will not be significantly degraded through operations of the JPOD to the injury of water users in the southern and Central Delta.

All JPOD diversion under excess conditions in the Delta is junior to Contra Costa Water District (CCWD) water right permits for the Los Vaqueros Project, and must have an X2 (the two parts per thousand (ppt) isohaline location in kilometers from the Golden Gate Bridge) located west of certain compliance locations consistent with the 1993 Los Vaqueros biological opinion for delta smelt.

Stage 2 has an additional requirement to complete an operations plan that will protect fish and wildlife and other legal users of water. This is commonly known as the Fisheries Response Plan. A Fisheries Response Plan was approved by the SWRCB in February 2007, but since it relied on the 2004 and 2005 biological opinions, the Fisheries Response Plan will need to be revised and re-submitted to the SWRCB at a future date.

Stage 3 has an additional requirement to protect water levels in the southern Delta under the operational conditions of Phase II of the South Delta Improvements Program, along with an updated companion Fisheries Response Plan.

Reclamation and DWR intend to apply all response plan criteria consistently for JPOD uses as well as water transfer uses.

In general, JPOD capabilities will be used to accomplish four basic CVP-SWP objectives:

- When wintertime excess pumping capacity becomes available during Delta excess conditions and total CVP-SWP San Luis storage is not projected to fill before the spring pulse flow period, the project with the deficit in San Luis storage may elect to use JPOD

capabilities. Concurrently, under the CALFED Record of Decision (ROD), JPOD may be used to create additional water supplies for the Environmental Water Account (EWA) or reduce debt for previous EWA actions.

- When summertime pumping capacity is available at Banks Pumping Plant and CVP reservoir conditions can support additional releases, the CVP may elect to use JPOD capabilities to enhance annual CVP south of Delta water supplies.
- When summertime pumping capacity is available at Banks or Jones Pumping Plant to facilitate water transfers, JPOD may be used to further facilitate the water transfer.
- During certain coordinated CVP-SWP operation scenarios for fishery entrainment management, JPOD may be used to shift CVP-SWP exports to the facility with the least fishery entrainment impact while minimizing export at the facility with the most fishery entrainment impact.

Revised WQCP (2006)

The SWRCB undertook a proceeding under its water quality authority to amend the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) adopted in 1978 and amended in 1991 and in 1995. Prior to commencing this proceeding, the SWRCB conducted a series of workshops in 2004 and 2005 to receive information on specific topics addressed in the Bay-Delta Plan.

The SWRCB adopted a revised Bay-Delta Plan on December 13, 2006. There were no changes to the Beneficial Uses from the 1995 Plan to the 2006 Plan, nor were any new water quality objectives adopted in the 2006 Plan. A number of changes were made simply for readability. Consistency changes were also made to assure that sections of the 2006 Plan reflected the current physical condition or current regulation. The SWRCB continues to hold workshops and receive information regarding Pelagic Organism Decline (POD), Climate Change, and San Joaquin salinity and flows, and will coordinate updates of the Bay-Delta Plan with on-going development of the comprehensive Salinity Management Plan.

Real Time Decision-Making to Assist Fishery Management

Introduction

Real time decision-making to assist fishery management is a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. For the proposed action high uncertainty exists for how to best manage water operations while protecting listed species. Sources of uncertainty relative to the proposed action include:

- Hydrologic conditions
- Ocean conditions
- Listed species biology

Under the proposed action the goals for real time decision-making to assist fishery management are:

- Meet contractual obligations for water delivery
- Minimize adverse effects for listed species

Framework for Actions

Reclamation and DWR work closely with the Service, NMFS, and DFG to coordinate the operation of the CVP and SWP with fishery needs. This coordination is facilitated through several forums in a cooperative management process that allows for modifying operations based on real-time data that includes current fish surveys, flow and temperature information, and salvage or loss at the project facilities, (hereinafter "triggering event").

Water Operations Management Team

The Water Operations Management Team (WOMT) is comprised of representatives from Reclamation, DWR, the Service, NMFS, and DFG. This management-level team was established to facilitate timely decision-support and decision-making at the appropriate level. The WOMT first met in 1999, and will continue to meet to make management decisions as part of the proposed action. Routinely, it also uses the CALFED Ops Group to communicate with stakeholders about its decisions. Although the goal of WOMT is to achieve consensus on decisions, the participating agencies retain their authorized roles and responsibilities.

Process for Real Time Decision- Making to Assist Fishery Management

Decisions regarding CVP and SWP operations to avoid and minimize adverse effects on listed species must consider factors that include public health, safety, water supply reliability, and water quality. To facilitate such decisions, the Project Agencies and the Service, NMFS, and DFG have developed and refined a set of processes for various fish species to collect data, disseminate information, develop recommendations, make decisions, and provide transparency. This process consists of three types of groups that meet on a recurring basis. Management teams are made up of management staff from Reclamation, DWR, the Service, NMFS, and DFG. Information teams are teams whose role is to disseminate and coordinate information among agencies and stakeholders. Fisheries and Operations Technical Teams are made up of technical staff from state and Federal agencies. These teams review the most up-to-date data and information on fish status and Delta conditions, and develop recommendations that fishery agencies' management can use in identifying actions to protect listed species.

The process to identify actions for protection of listed species varies to some degree among species but follows this general outline: A Fisheries or Operations Technical Team compiles and assesses current information regarding species, such as stages of reproductive development, geographic distribution, relative abundance, and physical habitat conditions; it then provides a recommendation to the agency with statutory obligation to enforce protection of the species in question. The agency's staff and management will review the recommendation and use it as a basis for developing, in cooperation with Reclamation and DWR, a modification of water

operations that will minimize adverse effects to listed species by the Projects. If the Project Agencies do not agree with the action, then the fishery agency with the statutory authority will make a final decision on an action that they deem necessary to protect the species.

The outcomes of protective actions that are implemented will be monitored and documented, and this information will inform future recommended actions.

Groups Involved in Real Time Decision-Making to Assist Fishery Management and Information Sharing

Information Teams

CALFED Ops and Subgroups

The CALFED Ops Group consists of the Project agencies, the fishery agencies, SWRCB staff, and the U.S. Environmental Protection Agency (EPA). The CALFED Ops Group generally meets eleven times a year in a public setting so that the agencies can inform each other and stakeholders about current the operations of the CVP and SWP, implementation of the CVPIA and State and Federal endangered species acts, and additional actions to contribute to the conservation and protection of State- and Federally-listed species. The CALFED Ops Group held its first public meeting in January 1995, and during the next six years the group developed and refined its process. The CALFED Ops Group has been recognized within SWRCB D-1641, and elsewhere, as one forum for coordination on decisions to exercise certain flexibility that has been incorporated into the Delta standards for protection of beneficial uses (e.g., E/I ratios, and some DCC closures). Several teams were established through the Ops Group process. These teams are described below:

Data Assessment Team (DAT)

The DAT consists of technical staff members from the Project and fishery agencies as well as stakeholders. The DAT meets frequently[2] during the fall, winter, and spring. The purpose of the meetings is to coordinate and disseminate information and data among agencies and stakeholders that is related to water project operations, hydrology, and fish surveys in the Delta.

Integrated Water Operations and Fisheries Forum

The Integrated Water Operations and Fisheries Forum (IWOFF) provides the forum for executives and managers of Reclamation, DWR, DFG, the Service, NMFS, USEPA and the SWRCB to meet and discuss current and proposed action planning, permitting, funding, and Endangered Species Act compliance, which affect the workloads and activities of these organizations. IWOFF provides a forum for elevation of these matters if staff is unable to reach resolution on process/procedures requiring interagency coordination. IWOFF may also elevate such decisions up to the Director level at their discretion.

[2] The DAT holds weekly conference calls and may have additional discussions during other times as needed.

B2 Interagency Team (B2IT)

The B2IT was established in 1999 and consists of technical staff members from the Project and fisheries agencies. The B2IT meets weekly to discuss implementation of section 3406 (b)(2) of the CVPIA, which mandates the dedication of CVP water supply for environmental purposes. B2IT communicates with WOMT to ensure coordination with the other operational programs or resource-related aspects of project operations, including flow and temperature issues.

Technical Teams

Fisheries Technical Teams

Several fisheries specific teams have been established to provide guidance and recommendations on resource management issues. These teams include:

The Sacramento River Temperature Task Group (SRTTG)

The SRTTG is a multiagency group formed pursuant to SWRCB Water Rights Orders 90-5 and 91-1, to assist with improving and stabilizing Chinook population in the Sacramento River. Annually, Reclamation develops temperature operation plans for the Shasta and Trinity Divisions of the CVP. These plans consider impacts on winter-run and other races of Chinook salmon, and associated Project operations. The SRTTG meets initially in the spring to discuss biological, hydrologic, and operational information, objectives, and alternative operations plans for temperature control. Once the SRTTG has recommended an operation plan for temperature control, Reclamation then submits a report to the SWRCB, generally on or before June 1st each year.

After implementation of the operation plan, the SRTTG may perform additional studies and commonly holds meetings as needed, typically monthly through the summer and into fall, to develop revisions based on updated biological data, reservoir temperature profiles, and operations data. Updated plans may be needed for summer operations protecting winter-run, or in fall for fall-run spawning season. If there are any changes in the plan, Reclamation submits a supplemental report to SWRCB.

Smelt Working Group (SWG)

The SWG evaluates biological and technical issues regarding delta smelt and develops recommendations for consideration by the Service. Since the longfin smelt (*Spirinchus thaleichthys*) became a state candidate species in 2008, the SWG has also developed for DFG recommendations to minimize adverse effects to longfin smelt. The SWG consists of representatives from the Service, DFG, DWR, EPA, and Reclamation. The Service chairs the group, and members are assigned by each agency.

The SWG compiles and interprets the latest near real-time information regarding state- and federally-listed smelt, such as stages of development, distribution, and salvage. After evaluating available information and if they agree that a protection action is warranted, the SWG will submit their recommendations in writing to the Service and DFG.

The SWG may meet at any time at the request of the Service, but generally meets weekly during the months of December through June, when smelt salvage at Jones and Banks has occurred historically. However, the Delta Smelt Risk Assessment Matrix (see below) outlines the

conditions when the SWG will convene to evaluate the necessity of protective actions and provide the Service with a recommendation. Further, with the State listing of longfin smelt, the group will also convene based on longfin salvage history at the request of DFG.

Delta Smelt Risk Assessment Matrix (DSRAM)

The SWG will employ a delta smelt risk assessment matrix to assist in evaluating the need for operational modifications of SWP and CVP to protect delta smelt. This document will be a product and tool of the SWG and will be modified by the SWG with the approval of the Service, in consultation with Reclamation, DWR and DFG, as new knowledge becomes available. The currently approved DSRAM is Attachment A.

If an action is taken, the SWG will follow up on the action to attempt to ascertain its effectiveness. The ultimate decision-making authority rests with the Service. An assessment of effectiveness will be attached to the notes from the SWG's discussion concerning the action.

The Salmon Decision Process

The Salmon Decision Process is used by the fishery agencies and Project agencies to facilitate the often complex coordination issues surrounding DCC gate operations and the purposes of fishery protection closures, Delta water quality, and/or export reductions. Inputs such as fish lifestage and size development, current hydrologic events, fish indicators (such as the Knight's Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions. The coordination process has worked well during the recent fall and winter DCC operations in recent years and is expected to be used in the present or modified form in the future.

American River Group

In 1996, Reclamation established a working group for the Lower American River, known as American River Group (ARG). Although open to the public, the ARG meetings generally include representatives from several agencies and organizations with on-going concerns and interests regarding management of the Lower American River. The formal members of the group are Reclamation, the Service, NMFS, and DFG.

The ARG convenes monthly or more frequently if needed, with the purpose of providing fishery updates and reports to Reclamation to help manage Folsom Reservoir for fish resources in the Lower American River.

San Joaquin River Technical Committee (SJRTC)

The SJRTC meets for the purposes of planning and implementing the Vernalis Adaptive Management Plan (VAMP) each year and oversees two subgroups: the Biology subgroup, and the Hydrology subgroup. These two groups are charged with certain responsibilities, and must also coordinate their activities within the San Joaquin River Agreement (SJRA) Technical Committee.

Operations Technical Teams

An operations specific team is established to provide guidance and recommendations on operational issues and one is proposed for the South Delta Improvement Program (SDIP) operable gates. These teams are:

Delta Cross Channel Project Work Team

The DCC Project Work Team is a multiagency group under CALFED. Its purpose is to determine and evaluate the affects of DCC gate operations on Delta hydrodynamics, water quality, and fish migration.

Gate Operations Review Team

When the gates proposed under SDIP Stage 1 are in place and operational, a federal and state interagency team will be convened to discuss constraints and provide input to the existing WOMT. The Gate Operations Review Team (GORT) will make recommendations for the operations of the fish control and flow control gates to minimize impacts on resident threatened and endangered species and to meet water level and water quality requirements for South Delta water users. The interagency team will include representatives of DWR, Reclamation, the Service, NMFS, and DFG. DWR will be responsible for providing predictive modeling, and SWP Operations Control Office will provide operations forecasts. Reclamation will be responsible for providing CVP operations forecasts, including San Joaquin River flow, and data on current water quality conditions. Other members will provide the team with the latest information related to South Delta fish species and conditions for crop irrigation. Operations plans would be developed using the Delta Simulation Model 2 (DSM2), forecasted tides, and proposed diversion rates of the projects to prepare operating schedules for the existing CCF gates and the four proposed operable gates. The Service will use the SWG for recommendations regarding gate operations.

Uses of Environmental Water Accounts

CVPIA Section 3406 (b)(2)

On May 9, 2003, the Department of the Interior issued its Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Dedication of (b)(2) water occurs when Reclamation takes a fish, wildlife, or habitat restoration action based on recommendations of the Service (and in consultation with NMFS and DFG), pursuant to Section 3406 (b)(2). Dedication and management of (b)(2) water may also assist in meeting WQCP fishery objectives and help meet the needs of fish listed under the ESA as threatened or endangered since the enactment of the CVPIA.

The May 9, 2003, decision describes the means by which the amount of dedicated (b)(2) water is determined. Planning and accounting for (b)(2) action is done cooperatively and occurs primarily through weekly meetings of the B2IT. Actions usually take one of two forms: in-stream flow augmentation below CVP reservoirs or CVP Jones pumping reductions in the Delta. Chapter 9 of the biological assessment contains a more detailed description of (b)(2) operations, as characterized in the CALSIM II modeling assumptions and results of the modeling are summarized.

CVPIA 3406 (b)(2) Operations on Clear Creek

Dedication of (b)(2) water on Clear Creek provides actual in-stream flows below Whiskeytown Dam greater than those that would have occurred under pre-CVPIA regulations, e.g., the fish and wildlife minimum flows specified in the 1963 proposed release schedule. In-stream flow objectives are usually taken from the AFRP's plan, in consideration of spawning and incubation of fall-run Chinook salmon. Augmentation in the summer months is usually in consideration of water temperature objectives for steelhead and in late summer for spring-run Chinook salmon.

Reclamation will provide Townsend with up to 6,000 AF of water annually. If the full 6,000 AF is delivered, then 900 AF will be dedicated to (b)(2) according to the August 2000 agreement.

CVPIA 3406 (b)(2) Operations on the Upper Sacramento River

Dedication of (b)(2) water on the Sacramento River provides actual in-stream flows below Keswick Dam greater than those that would have occurred under pre-CVPIA regulations, e.g., the fish and wildlife requirements specified in WR 90-5 and the criteria formalized in the 1993 NMFS Winter-run biological opinion as the base. In-stream flow objectives from October 1 to April 15 (typically April 15 is when water temperature objectives for winter-run Chinook salmon become the determining factor) are usually selected to minimize dewatering of redds and provide suitable habitat for salmonid spawning, incubation, rearing, and migration.

CVPIA 3406 (b)(2) Operations on the Lower American River

Dedication of (b)(2) water on the American River provides actual in-stream flows below Nimbus Dam greater than those that would have occurred under pre-CVPIA regulations, (e.g. the fish and wildlife requirements previously mentioned in the American River Division). In-stream flow objectives from October through May generally aim to provide suitable habitat for salmon and steelhead spawning, incubation, and rearing, while considering impacts to American River operations the rest of the year. In-stream flow objectives for June to September endeavor to provide suitable flows and water temperatures for juvenile steelhead rearing while balancing the effects on temperature operations into October and November.

- Flow Fluctuation and Stability Concerns:

  Through CVPIA, Reclamation has funded studies by DFG to better define the relationships of Nimbus release rates and rates of change criteria in the Lower American River to minimize the negative effects of necessary Nimbus release changes on sensitive fishery objectives. Reclamation is presently using draft criteria developed by DFG. The draft criteria have helped reduce the incidence of anadromous fish stranding relative to past historic operations. The primary operational coordination for potentially sensitive Nimbus Dam release changes is conducted through the B2IT process.

CVPIA 3406 (b)(2) Operations on the Stanislaus River

Dedication of (b)(2) water on the Stanislaus River provides actual in-stream flows below Goodwin Dam greater than the fish and wildlife requirements discussed in the East Side Division, and in the past has been generally consistent with the Interim Plan of Operation (IPO) for New Melones. In-stream fishery management flow volumes on the Stanislaus River, as part of the IPO, are based on the New Melones end-of-February storage plus forecasted March to

September inflow as shown in the IPO. The volume determined by the IPO is a combination of fishery flows pursuant to the 1987 DFG Agreement and the Service AFRP in-stream flow goals. The fishery volume is then initially distributed based on modeled fish distributions and patterns used in the IPO.

Actual in-stream fishery management flows below Goodwin Dam will be determined in accordance with the Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Reclamation has begun a process to develop a long-term operations plan for New Melones. The ultimate long-term plan will be coordinated with B2IT members, along with the stakeholders and the public before it is finalized.

CVPIA 3406 (b)(2) Operations in the Delta

Export curtailments at the CVP Jones Pumping Plant and increased CVP reservoir releases required to meet SWRCB D-1641's Objectives for Fish and Wildlife Beneficial Uses, as well as direct export reductions for fishery management using dedicated (b)(2) water at the CVP Jones Pumping Plant, will be determined in accordance with the Interior Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Direct Jones Pumping Plant export curtailments for fishery management protection will be based on coordination with the weekly B2IT meetings and vetted through WOMT, as necessary.

Environmental Water Account

The original Environmental Water Account (EWA) was established in 2000 by the CALFED ROD, and operating criteria area described in detail in the EWA Operating Principles Agreement attachment to the ROD. In 2004, the EWA was extended to operate through the end of 2007. Reclamation, the Service, and NMFS have received Congressional authorization to participate in the EWA at least through September 30, 2010, per the CALFED Bay-Delta Authorization Act (PL-108-361). However, for these Federal agencies to continue participation in the EWA beyond 2010, additional authorization will be required.

The original purpose of the EWA was to enable diversion of water by the SWP and CVP from the Delta to be reduced at times when at risk fish species may be harmed while preventing the uncompensated loss of water to SWP and CVP contractors. Typically the EWA replaced water loss due to curtailment of pumping by purchase of surface or groundwater supplies from willing sellers and by taking advantage of regulatory flexibility and certain operational assets. Under past operations, from 2001 through 2007, when there were pumping curtailments at Banks Pumping Plant to protect Delta fish the EWA often owed a debt of water to the SWP, usually reflected in San Luis Reservoir.

The EWA agencies (the Project and fisheries agencies) are currently undertaking environmental review to determine the future of EWA. Because no decision has yet been made regarding EWA, for the purposes of this project description, EWA is analyzed with limited assets, focusing on providing assets to support VAMP and in some years, the "post – VAMP shoulder". The EWA assets include the following:

- Implementation of the Yuba Accord Component 1 Water, which is an average 60,000 AF of water released annually from the Yuba River to the Delta, is an EWA asset through 2015, with a possible extension through 2025. The 60,000 AF is expected to be reduced

by carriage water costs in most years, estimated at 20 percent, leaving an EWA asset of 48,000 AF per year. The SWP will provide the 48,000 AF per year asset from Project supplies beyond 2015 in the event that Yuba Accord Component 1 Water is not extended.

- Purchases of assets to the extent funds are available.
- Operational assets granted the EWA in the CALFED ROD:
  - A 50 percent share of SWP export pumping of (b)(2) water and ERP water from upstream releases;
  - A share of the use of SWP pumping capacity in excess of the SWP's needs to meet contractor requirements with the CVP on an equal basis, as needed (such use may be under Joint Point of Diversion);
  - Any water acquired through export/inflow ratio flexibility; and
  - Use of 500 cubic-feet per second (cfs) increase in authorized Banks Pumping Plant capacity in July through September (from 6,680 to 7,180 cfs).
  - Storage in Project reservoirs upstream of the Delta as well as in San Luis Reservoir, with a lower priority than Project water. Such stored water will share storage priority with water acquired for Level 4 refuge needs.

Operational assets averaged 82,000 AF from 2001-2006, with a range from 0 to 150,000 AF.

500 cfs Diversion Increase During July, August, and September

Under this operation, the maximum allowable daily diversion rate into Clifton Court Forebay (CCF) during the months of July, August, and September increases from 13,870 AF to 14,860 AF and three-day average diversions from 13,250 AF to 14,240 AF (500 cfs per day equals 990 AF). The increase in diversions has been permitted and in place since 2000. The current permit expired on September 30, 2008. An application has been made to the U.S. Army Corps of Engineers (Corps) for permitting the implementation of this operation. The description of the 500 cfs increased diversion in the permit application to the Corps will be consistent with the following description:

The purpose of this diversion increase into CCF for use by the SWP is to recover export reductions made due to the ESA or other actions taken to benefit fisheries resources. The increased diversion rate will not result in any increase in water supply deliveries than would occur in the absence of the increased diversion rate. This increased diversion over the three-month period would result in an amount not to exceed 90 TAF each year. Increased diversions above the 48 TAF discussed previously could occur for a number of reasons including:

1) Actual carriage water loss on the 60 TAF of current year's Yuba Accord Component 1 Water is less than the assumed 20 percent.

2) Diversion of Yuba Accord Component 1 Water exceeds the current year's 60 TAF allotment to make up for a Yuba Accord Component 1 deficit from a previous year.

3) In very wet years, the diversion of excess Delta outflow goes above and beyond the Yuba Accord Component 1 Water allotment.

Variations to hydrologic conditions coupled with regulatory requirements may limit the ability of the SWP to fully utilize the proposed increased diversion rate. Also, facility capabilities may limit the ability of the SWP to fully utilize the increased diversion rate.

In years where the accumulated export under the 500 cfs increased diversion exceeds 48 TAF, the additional asset will be held in the SWP share of San Luis Reservoir, as long as space is available, to be applied to an export reduction specified by the fish agencies for the immediate water year (WY). For example, if 58 TAF were exported under the increased diversion during July through September, then 10 TAF of additional asset would be in San Luis Reservoir on September 30. The fish agencies may choose to apply this asset to an export reduction during the early winter or take a risk that space for storing the asset will remain in the SWP share of San Luis Reservoir and be available to be applied to the VAMP or post-VAMP export reduction in the spring. If the asset remains available for the VAMP and post-VAMP shoulder, it would increase the export reduction during that period by an equal amount. In this example, the export would be reduced an additional 10 TAF.

As the winter and spring progress, the SWP share of San Luis Reservoir may fill and the space will no longer be available to store the asset. If this happens, the asset will be converted to SWP supply stored in San Luis Reservoir and the SWP exports from the Delta will be reduced at that time by the same volume as the asset. Any reductions in exports resulting from this situation are expected to occur in the December-March period.

Implementation of the proposed action is contingent on meeting the following conditions:

1. The increased diversion rate will not result in an increase in annual SWP water supply allocations other than would occur in the absence of the increased diversion rate. Water pumped due to the increased capacity will only be used to offset reduced diversions that occurred or will occur because of ESA or other actions taken to benefit fisheries.

2. Use of the increased diversion rate will be in accordance with all terms and conditions of existing biological opinions governing SWP operations.

3. All three temporary agricultural barriers (Middle River, Old River near Tracy and Grant Line Canal) must be in place and operating when SWP diversions are increased. When the temporary barriers are replaced by the permanent operable flow-control gates, proposed as Stage 1 of the South Delta Improvements Program, the gates must be operating to their specified criteria.

4. Between July 1 and September 30, prior to the start of or during any time at which the SWP has increased its diversion rate in accordance with the approved operations plan, if the combined salvage of listed fish species reaches a level of concern, real-time decision making will be implemented. The relevant fish regulatory agency will determine whether the 500 cfs increased diversion is or continues to be implemented.

Central Valley Project

Central Valley Project Improvement Act

On October 30, 1992, Public Law 102-575, (Reclamation Projects Authorization and Adjustment Act of 1992) was passed. Included in the law was Title 34, the Central Valley Project Improvement Act (CVPIA). The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having an equal priority with power generation. Changes mandated by the CVPIA include:

- Dedicating 800,000 AF annually to fish, wildlife, and habitat restoration
- Authorizing water transfers outside the CVP service area
- Implementing an anadromous fish restoration program
- Creating a restoration fund financed by water and power users
- Providing for the Shasta Temperature Control Device
- Implementing fish passage measures at Red Bluff Diversion Dam (RBDD)
- Calling for planning to increase the CVP yield
- Mandating firm water supplies for Central Valley wildlife refuges
- Improving the Tracy Fish Collection Facility (TFCF)
- Meeting Federal trust responsibility to protect fishery resources (Trinity River)

The CVPIA is being implemented as authorized. The Final Programmatic Environmental Impact Statement (PEIS) for the CVPIA analyzed projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final PEIS was released in October 1999 and the CVPIA Record of Decision (ROD) was signed on January 9, 2001. The biological opinions were issued on November 21, 2000.

Water Service Contracts, Allocations and Deliveries

Water Needs Assessment

Water needs assessments have been performed for each CVP water contractor eligible to participate in the CVP long-term contract renewal process. Water needs assessments confirm a contractor's past beneficial use and determine future CVP water supplies needed to meet the contractor's anticipated future demands. The assessments are based on a common methodology used to determine the amount of CVP water needed to balance a contractor's water demands with available surface and groundwater supplies. All of the contractor assessments have been finalized.

Future American River Operations - Water Service Contracts and Deliveries

Surface water deliveries from the American River are made to various water rights entities and CVP contractors. Total American River Division annual demands on the American and Sacramento Rivers are estimated to increase from about 324,000 acre-feet in 2005 and 605,000 acre-feet in 2030 without the Freeport Regional Water Project maximum of 133,000 acre-feet during drier years. Reclamation is negotiating the renewal of 13 long-term water service contracts, four Warren Act contracts, and has a role in six infrastructure or Folsom Reservoir operations actions influencing the management of American River Division facilities and water use.

Water Allocation – CVP

The water allocation process for CVP begins in the fall when preliminary assessments are made of the next year's water supply possibilities, given current storage conditions combined with a range of hydrologic conditions. These preliminary assessments may be refined as the WY progresses. Beginning February 1, forecasts of WY runoff are prepared using precipitation to date, snow water content accumulation, and runoff to date. All of CVP's Sacramento River Settlement water rights contracts and San Joaquin River Exchange contracts require that contractors be informed no later than February 15 of any possible deficiency in their supplies. In recent years, February 20th has been the target date for the first announcement of all CVP contractors' forecasted water allocations for the upcoming contract year. Forecasts of runoff and operations plans are updated at least monthly between February and May.

Reclamation uses the 90 percent probability of exceedance forecast as the basis of water allocations. Furthermore, NMFS reviews the operations plans devised to support the initial water allocation, and any subsequent updates to them, for sufficiency with respect to the criteria for Sacramento River temperature control.

CVP M&I Water Shortage Operational Assumptions

The CVP has 253 water service contracts (including Sacramento River Settlement Contracts). These water service contracts have had varying water shortage provisions (e.g., in some contracts, municipal and industrial (M&I) and agricultural uses have shared shortages equally; in most of the larger M&I contracts, agricultural water has been shorted 25 percent of its contract entitlement before M&I water was shorted, after which both shared shortages equally).

The M&I minimum shortage allocation does not apply to contracts for the (1) Friant Division, (2) New Melones interim supply, (3) Hidden and Buchanan Units, (4) Cross Valley contractors, (5) San Joaquin River Exchange settlement contractors, and (6) Sacramento River settlement contractors. Any separate shortage-related contractual provisions will prevail.

There will be a minimum shortage allocation for M&I water supplies of 75 percent of a contractor's historical use (i.e., the last three years of water deliveries unconstrained by the availability of CVP water). Historical use can be adjusted for growth, extraordinary water conservation measures, and use of non-CVP water as those terms are defined in the proposed policy. Before the M&I water allocation is reduced, the irrigation water allocation would be reduced below 75 percent of contract entitlement.

When the allocation of irrigation water is reduced below 25 percent of contract entitlement, Reclamation will reassess the availability of CVP water and CVP water demand; however, due to limited water supplies during these times, M&I water allocation may be reduced below 75 percent of adjusted historical use during extraordinary and rare times such as prolonged and severe drought. Under these extraordinary conditions allocation percentages for both South of Delta and North of Delta irrigation and M&I contractors are the same.

Reclamation will deliver CVP water to all M&I contractors at not less than a public health and safety level if CVP water is available, if an emergency situation exists, but not exceeding 75 percent on contract total (and taking into consideration water supplies available to the M&I contractors from other sources). This is in recognition, however, that the M&I allocation may, nevertheless, fall to 50 percent as the irrigation allocation drops below 25 percent and approaches zero due to limited CVP supplies.

Allocation Modeling Assumptions:

Ag 100% to 75% then M&I is at 100%

Ag 70%	M&I 95%
Ag 65%	M&I 90%
Ag 60%	M&I 85%
Ag 55%	M&I 80%
Ag 50% to 25%	M&I 75%

Dry and Critical Years:

Ag 20%	M&I 70%
Ag 15%	M&I 65%
Ag 10%	M&I 60%
Ag 5%	M&I 55%
Ag 0%	M&I 50%

Project Facilities

Trinity River Division Operations

The Trinity River Division, completed in 1964, includes facilities to store and regulate water in the Trinity River, as well as facilities to divert water to the Sacramento River Basin. Trinity Dam is located on the Trinity River and regulates the flow from a drainage area of approximately 720 square miles. The dam was completed in 1962, forming Trinity Lake, which has a maximum storage capacity of approximately 2.4 million acre-feet (MAF). See map in Figure P-5.

The mean annual inflow to Trinity Lake from the Trinity River is about 1.2 MAF per year. Historically, an average of about two-thirds of the annual inflow has been diverted to the Sacramento River Basin (1991-2003). Trinity Lake stores water for release to the Trinity River and for diversion to the Sacramento River via Lewiston Reservoir, Clear Creek Tunnel, Whiskeytown Reservoir, and Spring Creek Tunnel where it commingles in Keswick Reservoir with Sacramento River water released from both the Shasta Dam and Spring Creek Debris Dam.

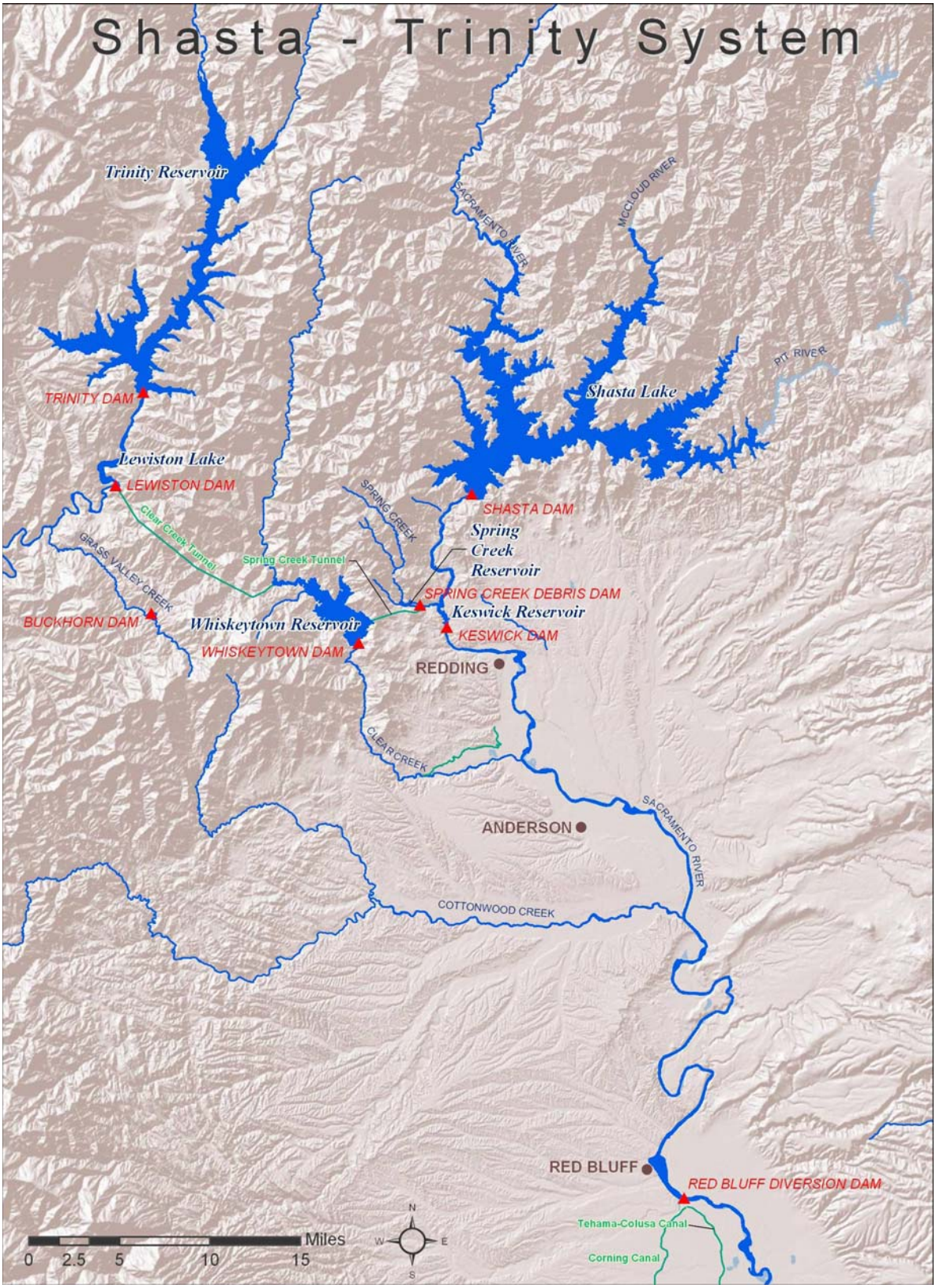

Figure P-5 Shasta-Trinity System

Safety of Dams at Trinity Reservoir

Periodically, increased water releases are made from Trinity Dam consistent with Reclamation Safety of Dams criteria intended to prevent overtopping of Trinity Dam. Although flood control is not an authorized purpose of the Trinity River Division, flood control benefits are provided through normal operations.

The Safety of Dams release criteria specifies that Carr Powerplant capacity should be used as a first preference destination for Safety of Dams releases made at Trinity Dam. Trinity River releases are made as a second preference destination. During significant Northern California high water flood events, the Sacramento River water stages are also at concern levels. Under such high water conditions, the water that would otherwise move through Carr Powerplant is routed to the Trinity River. Total river release can reach up to 11,000 cfs below Lewiston Dam (under Safety of Dams criteria) due to local high water concerns in the flood plain and local bridge flow capacities. The Safety of Dam criteria provides seasonal storage targets and recommended releases November 1 to March 31. During May 2006 the river flows were over 10,000 cfs for several days.

Fish and Wildlife Requirements on Trinity River

Based on the Trinity River Mainstem Fishery Restoration ROD, dated December 19, 2000, 368,600 to 815,000 AF is allocated annually for Trinity River flows. This amount is scheduled in coordination with the Service to best meet habitat, temperature, and sediment transport objectives in the Trinity Basin.

Temperature objectives for the Trinity River are set forth in SWRCB order WR 90-5 (Also see Table P-2 below). These objectives vary by reach and by season. Between Lewiston Dam and Douglas City Bridge, the daily average temperature should not exceed 60 degrees Fahrenheit (°F) from July 1 to September 14, and 56°F from September 15 to October 1. From October 1 to December 31, the daily average temperature should not exceed 56°F between Lewiston Dam and the confluence of the North Fork Trinity River. Reclamation consults with the Service in establishing a schedule of releases from Lewiston Dam that can best achieve these objectives.

For the purpose of determining the Trinity Basin WY type, forecasts using the 50 percent exceedance as of April 1st are used. There are no make-up/or increases for flows forgone if the WY type changes up or down from an earlier 50 percent forecast. In the modeling, actual historic Trinity inflows were used rather than a forecast. There is a temperature curtain in Lewiston Reservoir that provides for lower temperature water releases into the Trinity River.

Table P-2 Water temperature objectives for the Trinity River during the summer, fall, and winter as established by the CRWQCB-NCR (California Regional Water Quality Control Board North Coast Region)

Date	Temperature Objective (°F)	
	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)
July 1 through Sept 14	60	-
Sept 15 through Sept 30	56	-
Oct 1 through Dec 31	-	56

Transbasin Diversions

Diversion of Trinity water to the Sacramento Basin provides limited water supply and hydroelectric power generation for the CVP and assists in water temperature control in the Trinity River and upper Sacramento River. The amounts and timing of the Trinity exports are determined by subtracting Trinity River scheduled flow and targeted carryover storage from the forecasted Trinity water supply.

The seasonal timing of Trinity exports is a result of determining how to make best use of a limited volume of Trinity export (in concert with releases from Shasta) to help conserve cold water pools and meet temperature objectives on the upper Sacramento and Trinity rivers, as well as power production economics. A key consideration in the export timing determination is the thermal degradation that occurs in Whiskeytown Lake due to the long residence time of transbasin exports in the lake.

To minimize the thermal degradation effects, transbasin export patterns are typically scheduled by an operator to provide an approximate 120,000 AF volume to occur in late spring to create a thermal connection to the Spring Creek Powerhouse before larger transbasin volumes are scheduled to occur during the hot summer months (Figure P-6). Typically, the water flowing from the Trinity Basin through Whiskeytown Lake must be sustained at fairly high rates to avoid warming and to function most efficiently for temperature control. The time period for which effective temperature control releases can be made from Whiskeytown Lake may be compressed when the total volume of Trinity water available for export is limited.

Export volumes from Trinity are made in coordination with the operation of Shasta Reservoir. Other important considerations affecting the timing of Trinity exports are based on the utility of power generation and allowances for normal maintenance of the diversion works and generation facilities.

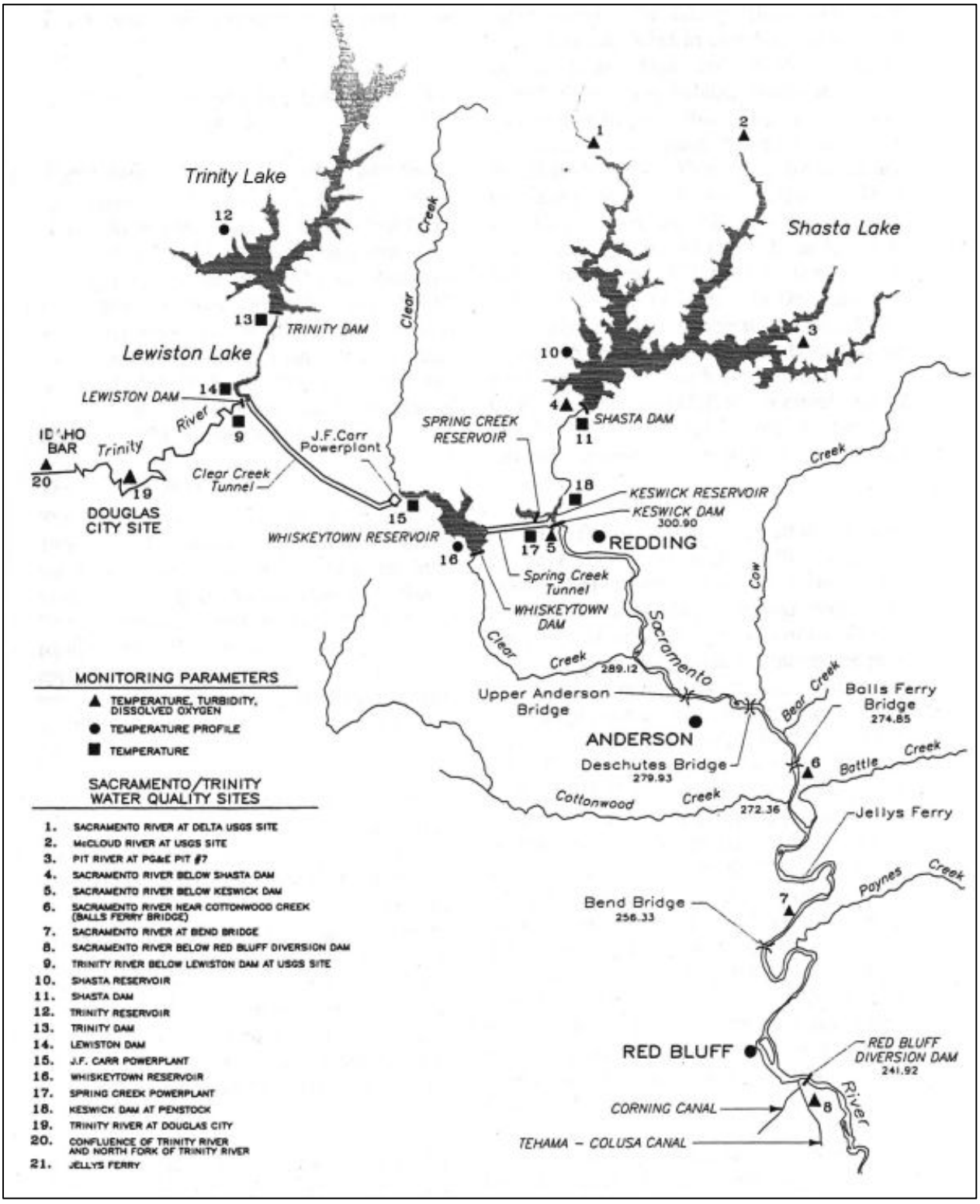

Figure P-6 Sacramento-Trinity Water Quality Network (with river miles [RM])

Trinity Lake historically reached its greatest storage level at the end of May. With the present pattern of prescribed Trinity releases, maximum storage may occur by the end of April or in early May.

Reclamation maintains at least 600,000 AF in Trinity Reservoir, except during the 10 to 15 percent of the years when Shasta Reservoir is also drawn down. Reclamation will address end of WY carryover on a case-by-case basis in dry and critically dry WY types with the Service and NMFS through the WOMT and B2IT processes.

Whiskeytown Reservoir Operations

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through the CVP facilities. Water is diverted from the Trinity River at Lewiston Dam via the Clear Creek Tunnel and passes through the Judge Francis Carr Powerhouse as it is discharged into Whiskeytown Lake on Clear Creek. From Whiskeytown Lake, water is released through the Spring Creek Power Conduit to the Spring Creek Powerplant and into Keswick Reservoir. All of the water diverted from the Trinity River, plus a portion of Clear Creek flows, is diverted through the Spring Creek Power Conduit into Keswick Reservoir.

Spring Creek also flows into the Sacramento River and enters at Keswick Reservoir. Flows on Spring Creek are partially regulated by the Spring Creek Debris Dam. Historically (1964-1992), an average annual quantity of 1,269,000 AF of water has been diverted from Whiskeytown Lake to Keswick Reservoir. This annual quantity is approximately 17 percent of the flow measured in the Sacramento River at Keswick.

Whiskeytown is normally operated to (1) regulate inflows for power generation and recreation; (2) support upper Sacramento River temperature objectives; and (3) provide for releases to Clear Creek consistent with the CVPIA Anadromous Fish Restoration Program (AFRP) objectives. Although it stores up to 241,000 AF, this storage is not normally used as a source of water supply. There is a temperature curtain in Whiskeytown Reservoir.

Spillway Flows below Whiskeytown Lake

Whiskeytown Lake is drawn down approximately 35,000 AF per year of storage space during November through April to regulate flows for power generation. Heavy rainfall events occasionally result in spillway discharges to Clear Creek, as shown in Table P-3 below.

Table P-3 Days of Spilling below Whiskeytown and 40-30-30 Index from Water Year 1978 to 2005, WY Types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critical

Water Year	Days of Spilling	40-30-30 Index
1978	5	AN
1979	0	BN
1980	0	AN
1981	0	D
1982	63	W
1983	81	W
1984	0	W
1985	0	D

Water Year	Days of Spilling	40-30-30 Index
1986	17	W
1987	0	D
1988	0	C
1989	0	D
1990	8	C
1991	0	C
1992	0	C
1993	10	AN
1994	0	C
1995	14	W
1996	0	W
1997	5	W
1998	8	W
1999	0	W
2000	0	AN
2001	0	D
2002	0	D
2003	8	AN
2004	0	BN
2005	0	AN
2006	4	W
2007	0	D

Operations at Whiskeytown Lake during flood conditions are complicated by its operational relationship with the Trinity River, Sacramento River, and Clear Creek. On occasion, imports of Trinity River water to Whiskeytown Reservoir may be suspended to avoid aggravating high flow conditions in the Sacramento Basin.

Fish and Wildlife Requirements on Clear Creek

Water rights permits issued by the SWRCB for diversions from Trinity River and Clear Creek specify minimum downstream releases from Lewiston and Whiskeytown Dams, respectively. Two agreements govern releases from Whiskeytown Lake:

- A 1960 Memorandum of Agreement (MOA) with the DFG established minimum flows to be released to Clear Creek at Whiskeytown Dam, Table P-4 .
- A 1963 release schedule for Whiskeytown Dam was developed with the Service and implemented, but never finalized. Although this release schedule was never formalized, Reclamation has operated according to this proposed schedule since May 1963.

Table P-4 Minimum flows at Whiskeytown Dam from 1960 MOA with the DFG

Period	Minimum flow (cfs)
1960 MOA with the DFG	
January 1 - February 28(29)	50
March 1 - May 31	30
June 1 - September 30	0
October 1 - October 15	10
October 16 - October 31	30
November 1 - December 31	100
1963 FWS Proposed Normal year flow (cfs)	
January 1 - October 31	50
November 1 - December 31	100
1963 FWS Proposed Critical year flow (cfs)	
January 1 - October 31	30
November 1 - December 31	70

Spring Creek Debris Dam Operations

The Spring Creek Debris Dam (SCDD) is a feature of the Trinity Division of the CVP. It was constructed to regulate runoff containing debris and acid mine drainage from Spring Creek, a tributary to the Sacramento River that enters Keswick Reservoir. The SCDD can store approximately 5,800 AF of water. Operation of SCDD and Shasta Dam has allowed some control of the toxic wastes with dilution criteria. In January 1980, Reclamation, the DFG, and the SWRCB executed a Memorandum of Understanding (MOU) to implement actions that protect the Sacramento River system from heavy metal pollution from Spring Creek and adjacent watersheds.

The MOU identifies agency actions and responsibilities, and establishes release criteria based on allowable concentrations of total copper and zinc in the Sacramento River below Keswick Dam. The MOU states that Reclamation agrees to operate to dilute releases from SCDD (according to these criteria and schedules provided) and that such operation will not cause flood control parameters on the Sacramento River to be exceeded and will not unreasonably interfere with other project requirements as determined by Reclamation. The MOU also specifies a minimum schedule for monitoring copper and zinc concentrations at SCDD and in the Sacramento River below Keswick Dam. Reclamation has primary responsibility for the monitoring; however, the DFG and the RWQCB also collect and analyze samples on an as-needed basis. Due to more extensive monitoring, improved sampling and analyses techniques, and continuing cleanup efforts in the Spring Creek drainage basin, Reclamation now operates SCDD targeting the more stringent Central Valley Region Water Quality Control Plan (Basin Plan) criteria in addition to the MOU goals. Instead of the total copper and total zinc criteria contained in the MOU,

Reclamation operates SCDD releases and Keswick dilution flows to not exceed the Basin Plan standards of 0.0056 mg/L dissolved copper and 0.016 mg/L dissolved zinc. Release rates are estimated from a mass balance calculation of the copper and zinc in the debris dam release and in the river.

In order to minimize the build-up of metal concentrations in the Spring Creek arm of Keswick Reservoir, releases from the debris dam are coordinated with releases from the Spring Creek Powerplant to keep the Spring Creek arm of Keswick Reservoir in circulation with the main water body of Keswick Lake.

The operation of SCDD is complicated during major heavy rainfall events. SCDD reservoir can fill to uncontrolled spill elevations in a relatively short time period, anywhere from days to weeks. Uncontrolled spills at SCDD can occur during major flood events on the upper Sacramento River and also during localized rainfall events in the Spring Creek watershed. During flood control events, Keswick releases may be reduced to meet flood control objectives at Bend Bridge when storage and inflow at Spring Creek Reservoir are high.

Because SCDD releases are maintained as a dilution ratio of Keswick releases to maintain the required dilution of copper and zinc, uncontrolled spills can and have occurred from SCDD. In this operational situation, high metal concentration loads during heavy rainfall are usually limited to areas immediately downstream of Keswick Dam because of the high runoff entering the Sacramento River adding dilution flow. In the operational situation when Keswick releases are increased for flood control purposes, SCDD releases are also increased in an effort to reduce spill potential.

In the operational situation when heavy rainfall events will fill SCDD and Shasta Reservoir will not reach flood control conditions, increased releases from CVP storage may be required to maintain desired dilution ratios for metal concentrations. Reclamation has voluntarily released additional water from CVP storage to maintain release ratios for toxic metals below Keswick Dam. Reclamation has typically attempted to meet the Basin Plan standards but these releases have no established criteria and are dealt with on a case-by-case basis. Since water released for dilution of toxic spills is likely to be in excess of other CVP requirements, such releases increase the risk of a loss of water for other beneficial purposes.

Shasta Division and Sacramento River Division

The CVP's Shasta Division includes facilities that conserve water in the Sacramento River for (1) flood control, (2) navigation maintenance, (3) agricultural water supplies, (4) M&I water supplies (5) hydroelectric power generation, (6) conservation of fish in the Sacramento River, and (7) protection of the Sacramento-San Joaquin Delta from intrusion of saline ocean water. The Shasta Division includes Shasta Dam, Lake, and Powerplant; Keswick Dam, Reservoir, and Powerplant, and the Shasta Temperature Control Device.

The Sacramento River Division was authorized after completion of the Shasta Division. Total authorized diversions for the Sacramento River Division are approximately 2.8 MAF. Historically the total diversion has varied from 1.8 MAF in a critically dry year to the full 2.8 MAF in wet year. It includes facilities for the diversion and conveyance of water to CVP contractors on the west side of the Sacramento River. The division includes the Sacramento

Canals Unit, which was authorized in 1950 and consists of the RBDD, the Corning Pumping Plant, and the Corning and Tehama-Colusa Canals.

The unit was authorized to supply irrigation water to over 200,000 acres of land in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo counties. Black Butte Dam, which is operated by the U.S. Army Corps of Engineers (Corps), also provides supplemental water to the Tehama-Colusa Canals as it crosses Stony Creek. The operations of the Shasta and Sacramento River divisions are presented together because of their operational inter-relationships.

Shasta Dam is located on the Sacramento River just below the confluence of the Sacramento, McCloud, and Pit Rivers. The dam regulates the flow from a drainage area of approximately 6,649 square miles. Shasta Dam was completed in 1945, forming Shasta Lake, which has a maximum storage capacity of 4,552,000 AF. Water in Shasta Lake is released through or around the Shasta Powerplant to the Sacramento River where it is re-regulated downstream by Keswick Dam. A small amount of water is diverted directly from Shasta Lake for M&I uses by local communities.

Keswick Reservoir was formed by the completion of Keswick Dam in 1950. It has a capacity of approximately 23,800 AF and serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Powerplant. All releases from Keswick Reservoir are made to the Sacramento River at Keswick Dam. The dam has a fish trapping facility that operates in conjunction with the Coleman National Fish Hatchery on Battle Creek.

Flood Control

Flood control objectives for Shasta Lake require that releases be restricted to quantities that will not cause downstream flows or stages to exceed specified levels. These include a flow of 79,000 cfs at the tailwater of Keswick Dam, and a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station, which corresponds to a flow of approximately 100,000 cfs. Flood control operations are based on regulating criteria developed by the Corps pursuant to the provisions of the Flood Control Act of 1944. Maximum flood space reservation is 1.3 MAF, with variable storage space requirements based on an inflow parameter.

Flood control operation at Shasta Lake requires the forecasting of runoff conditions into Shasta Lake, as well as runoff conditions of unregulated creek systems downstream from Keswick Dam, as far in advance as possible. A critical element of upper Sacramento River flood operations is the local runoff entering the Sacramento River between Keswick Dam and Bend Bridge.

The unregulated creeks (major creek systems are Cottonwood Creek, Cow Creek, and Battle Creek) in this reach of the Sacramento River can be very sensitive to a large rainfall event and produce large rates of runoff into the Sacramento River in short time periods. During large rainfall and flooding events, the local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs.

The travel time required for release changes at Keswick Dam to affect Bend Bridge flows is approximately 8 to 10 hours. If the total flow at Bend Bridge is projected to exceed 100,000 cfs, the release from Keswick Dam is decreased to maintain Bend Bridge flow below 100,000 cfs. As the flow at Bend Bridge is projected to recede, the Keswick Dam release is increased to

evacuate water stored in the flood control space at Shasta Lake. Changes to Keswick Dam releases are scheduled to minimize rapid fluctuations in the flow at Bend Bridge.

The flood control criteria for Keswick releases specify releases should not be increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period. The restriction on the rate of decrease is intended to prevent sloughing of saturated downstream channel embankments caused by rapid reductions in river stage. In rare instances, the rate of decrease may have to be accelerated to avoid exceeding critical flood stages downstream.

Fish and Wildlife Requirements in the Sacramento River

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet (to the extent possible) the provisions of SWRCB Order 90-05. If Reclamation cannot meet the SWRCB order an exception will be requested. An April 5, 1960, MOA between Reclamation and the DFG originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critically dry years (Table P-5). Since October 1981, Keswick Dam has operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between Reclamation and DFG. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and RBDD from September through the end of February in all water years, except critically dry years.

Table P-5 Current Minimum Flow Requirements and Objectives (cfs) on the Sacramento River below Keswick Dam

Water Year Type	MOA	WR 90-5	MOA and WR 90-5	Proposed Flow Objectives below Keswick
Period	Normal	Normal	Critically Dry	All
January 1 - February 28(29)	2600	3250	2000	3250
March 1 - March 31	2300	2300	2300	3250
April 1 - April 30	2300	2300	2300	---*
May 1 - August 31	2300	2300	2300	---*
September 1 - September 30	3900	3250	2800	---*
October 1 - November 30	3900	3250	2800	3250
December 1 - December 31	2600	3250	2000	3250

Note: * No regulation.

The 1960 MOA between Reclamation and the DFG provides that releases from Keswick Dam (from September 1 through December 31) are made with minimum water level fluctuation or change to protect salmon to the extent compatible with other operational requirements. Releases

from Shasta and Keswick Dams are gradually reduced in September and early October during the transition from meeting Delta export and water quality demands to operating the system for flood control and fishery concerns from October through December.

Reclamation proposes a minimum flow of 3,250 cfs from October 1 through March 31 and ramping constraints for Keswick release reductions from July 1 through March 31 as follows:

- Releases must be reduced between sunset and sunrise.
- When Keswick releases are 6,000 cfs or greater, decreases may not exceed 15 percent per night. Decreases also may not exceed 2.5 percent in one hour.
- For Keswick releases between 4,000 and 5,999 cfs, decreases may not exceed 200 cfs per night. Decreases also may not exceed 100 cfs per hour.
- For Keswick releases between 3,250 and 3,999 cfs, decreases may not exceed 100 cfs per night.
- Variances to these release requirements are allowed under flood control operations.

Reclamation usually reduces releases from Keswick Dam to the minimum fishery requirement by October 15 each year and to minimize changes in Keswick releases between October 15 and December 31. Releases may be increased during this period to meet unexpected downstream needs such as higher outflows in the Delta to meet water quality requirements, or to meet flood control requirements. Releases from Keswick Dam may be reduced when downstream tributary inflows increase to a level that will meet flow needs. Reclamation attempts to establish a base flow that minimizes release fluctuations to reduce impacts to fisheries and bank erosion from October through December.

A recent change in agricultural water diversion practices has affected Keswick Dam release rates in the fall. This program is generally known as the Rice Straw Decomposition and Waterfowl Habitat Program. Historically, the preferred method of clearing fields of rice stubble was to systematically burn it. Today, rice field burning has been phased out due to air quality concerns and has been replaced by a program of rice field flooding that decomposes rice stubble and provides additional waterfowl habitat. The result has been an increase in water demand to flood rice fields in October and November, which has increased the need for higher Keswick releases in all but the wettest of fall months.

The changes in agricultural practice over the last decade related to the Rice Straw Decomposition and Waterfowl Habitat Program have been incorporated into the systematic modeling of agricultural use and hydrology effects as described in the biological assessment.

Minimum Flow for Navigation – Wilkins Slough

Historical commerce on the Sacramento River resulted in a CVP authorization to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. Currently, there is no commercial traffic between Sacramento and Chico Landing, and the Corps has not dredged this reach to preserve channel depths since 1972. However, long-time water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough, (gauging station on the

Sacramento River), under all but the most critical water supply conditions, to facilitate pumping and use of screened diversions.

At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters are able to operate for extended periods at flows as low as 4,000 cfs at Wilkins Slough, but pumping operations become severely affected and some pumps become inoperable at flows lower than this. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough, but using the 3,500 cfs rate as a target level for an extended period would have major impacts on diverters.

No criteria have been established specifying when the navigation minimum flow should be relaxed. However, the basis for Reclamation's decision to operate at less than 5,000 cfs is the increased importance of conserving water in storage when water supplies are not sufficient to meet full contractual deliveries and other operational requirements.

Water Temperature Operations in the Upper Sacramento River

Water temperature in the upper Sacramento River is governed by current water right permit requirements. Water temperature on the Sacramento River system is influenced by several factors, including the relative water temperatures and ratios of releases from Shasta Dam and from the Spring Creek Powerplant. The temperature of water released from Shasta Dam and the Spring Creek Powerplant is a function of the reservoir temperature profiles at the discharge points at Shasta and Whiskeytown, the depths from which releases are made, the seasonal management of the deep cold water reserves, ambient seasonal air temperatures and other climatic conditions, tributary accretions and water temperatures, and residence time in Keswick, Whiskeytown and Lewiston Reservoirs, and in the Sacramento River.

SWRCB Water Rights Order 90-05 and Water Rights Order 91-01

In 1990 and 1991, the SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights on the Sacramento River. The orders stated Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Powerplant to meet a daily average water temperature of 56°F as far downstream in the Sacramento River as practicable during periods when higher temperature would be harmful to fisheries. The optimal control point is the RBDD.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBDD. In addition, Order 90-05 modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam. The water right orders also recommended the construction of a Shasta Temperature Control Device (TCD) to improve the management of the limited cold water resources.

Pursuant to SWRCB Orders 90-05 and 91-01, Reclamation configured and implemented the Sacramento-Trinity Water Quality Monitoring Network to monitor temperature and other parameters at key locations in the Sacramento and Trinity Rivers. The SWRCB orders also required Reclamation to establish the Sacramento River Temperature Task Group (SRTTG) to formulate, monitor, and coordinate temperature control plans for the upper Sacramento and Trinity Rivers. This group consists of representatives from Reclamation, SWRCB, NMFS, the Service, DFG, Western, DWR, and the Hoopa Valley Indian Tribe.

Each year, with finite cold water resources and competing demands usually an issue, the SRTTG will devise operation plans with the flexibility to provide the best protection consistent with the CVP's temperature control capabilities and considering the annual needs and seasonal spawning distribution monitoring information for winter-run and fall-run Chinook salmon. In every year since the SWRCB issued the orders, those plans have included modifying the RBDD compliance point to make best use of the cold water resources based on the location of spawning Chinook salmon. Reports are submitted periodically to the SWRCB over the temperature control season defining our temperature operation plans. The SWRCB has overall authority to determine if the plan is sufficient to meet water right permit requirements.

Shasta Temperature Control Device

Construction of the TCD at Shasta Dam was completed in 1997. This device is designed for greater flexibility in managing the cold water reserves in Shasta Lake while enabling hydroelectric power generation to occur and to improve salmon habitat conditions in the upper Sacramento River. The TCD is also designed to enable selective release of water from varying lake levels through the power plant in order to manage and maintain adequate water temperatures in the Sacramento River downstream of Keswick Dam.

Prior to construction of the Shasta TCD, Reclamation released water from Shasta Dam's low-level river outlets to alleviate high water temperatures during critical periods of the spawning and incubation life stages of the winter-run Chinook stock. Releases through the low-level outlets bypass the power plant and result in a loss of hydroelectric generation at the Shasta Powerplant. The release of water through the low-level river outlets was a major facet of Reclamation's efforts to control upper Sacramento River temperatures from 1987 through 1996.

The seasonal operation of the TCD is generally as follows: during mid-winter and early spring the highest elevation gates possible are utilized to draw from the upper portions of the lake to conserve deeper colder resources (see Table P-6). During late spring and summer, the operators begin the seasonal progression of opening deeper gates as Shasta Lake elevation decreases and cold water resources are utilized. In late summer and fall, the TCD side gates are opened to utilize the remaining cold water resource below the Shasta Powerplant elevation in Shasta Lake.

Table P-6 Shasta Temperature Control Device Gates with Elevation and Storage

TCD Gates	Shasta Elevation with 35 feet of Submergence	Shasta Storage
Upper Gates	1035	~3.65 MAF
Middle Gates	935	~2.50 MAF
Pressure Relief Gates	840	~0.67 MAF
Side Gates	720*	~0.01 MAF

* Low Level intake bottom.

The seasonal progression of the Shasta TCD operation is designed to maximize the conservation of cold water resources deep in Shasta Lake, until the time the resource is of greatest management value to fishery management purposes. Recent operational experience with the Shasta TCD has demonstrated significant operational flexibility improvement for cold water

conservation and upper Sacramento River water temperature and fishery habitat management purposes. Recent operational experience has also demonstrated the Shasta TCD has significant leaks that are inherent to TCD design.

Reclamation's Proposed Upper Sacramento River Temperature Objectives

Reclamation will continue a policy of developing annual operations plans and water allocations based on a conservative 90 percent exceedance forecast. Reclamation is not proposing a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir.

In continuing compliance with Water Rights Orders 90-05 and 91-01 requirements, Reclamation will implement operations to provide year round temperature protection in the upper Sacramento River, consistent with the intent of Order 90-05 that protection be provided to the extent controllable. Among factors that affect the extent to which river temperatures will be controllable include Shasta TCD performance, the availability of cold water, the balancing of habitat needs for different species in spring, summer, and fall, and the constraints on operations created by the combined effect of the projects and demands assumed to be in place in the future.

Under all but the most adverse drought and low Shasta Reservoir storage conditions, Reclamation proposes to continue operating CVP facilities to provide water temperature control at Ball's Ferry or at locations further downstream (as far as Bend Bridge) based on annual plans. Reclamation and the SRTTG will take into account projections of cold water resources, numbers of expected spawning salmon, and spawning distribution (as monitoring information becomes available) to make the decisions on allocation of the cold water resources.

Locating the target temperature compliance at Ball's Ferry (1) reduces the need to compensate for the warming effects of Cottonwood Creek and Battle Creek during the spring runoff months with deeper cold water releases and (2) improves the reliability of cold water resources through the fall months. Reclamation proposes Sacramento River temperature control point to be consistent with the capability of the CVP to manage cold water resources and to use the process of annual planning in coordination with the SRTTG to arrive at the best use of that capability.

Anderson-Cottonwood Irrigation District (ACID) Diversion Dam

ACID holds senior water rights and has diverted into the ACID Canal for irrigation along the west side of the Sacramento River between Redding and Cottonwood since 1916. The United States and ACID signed a contract providing for the project water service and agreement on diversion of water. ACID diverts to its main canal (on the right bank of the river) from a diversion dam located in Redding about five miles downstream from Keswick Dam.

Close coordination is required between Reclamation and ACID for regulation of river flows to ensure safe operation of ACIDs diversion dam during the irrigation season. The irrigation season for ACID runs from April through October.

Keswick release rate decreases required for the ACID operations are limited to 15 percent in a 24-hour period and 2.5 percent in any one hour. Therefore, advance notification is important when scheduling decreases to allow for the installation or removal of the ACID diversion dam.

Red Bluff Diversion Dam Operations

The Red Bluff Diversion Dam (RBDD), located on the Sacramento River approximately two miles southeast of Red Bluff, is a gated structure with fish ladders at each abutment. When the gates are lowered, the impounded water rises about 13 feet, creating Lake Red Bluff and allowing gravity diversions through a set of drum fish screens into the stilling basin servicing the Tehama-Colusa and Corning canals. Construction of RBDD was completed in 1964.

The Tehama-Colusa Canal is a lined canal extending 111 miles south from the RBDD and provides irrigation service on the west side of the Sacramento Valley in Tehama, Glenn, Colusa, and northern Yolo counties. Construction of the Tehama-Colusa Canal began in 1965, and it was completed in 1980.

The Corning Pumping Plant lifts water approximately 56 feet from the screened portion of the settling basin into the unlined, 21 mile-long Corning Canal. The Corning Canal was completed in 1959, to provide water to the CVP contractors in Tehama County that could not be served by gravity from the Tehama-Colusa Canal. The Tehama-Colusa Canal Authority (TCCA) operates both the Tehama-Colusa and Corning canals.

Since 1986, the RBDD gates have been raised during winter months to allow passage of winter-run Chinook salmon. As documented in the 2004 NMFS biological opinion addressing the long-term CVP and SWP operations, the gates are raised from approximately September 15 through May 14, each year. In the near term, Reclamation proposes the continued operation of the RBDD using the eight-month gate-open procedures of the past ten years, and to use the research pumping plant to provide water to the canals during times when the gates-out configuration precludes gravity diversions during the irrigation season. Additionally, although covered under a separate NMFS biological opinion, Reclamation proposes the continued use of rediversions of CVP water stored in Black Butte Reservoir to supplement the water pumped at RBDD during the gates-out period. This water is rediverted with the aid of temporary gravel berms through an unscreened, constant head orifice (CHO) into the Tehama-Colusa Canal.

In addition to proposing to operate the RBDD with the gates in for 8 months annually to enable gravity diversion of water into the Tehama-Colusa Canal, Reclamation proposes retention of the provision for a 10-day emergency gate closure, as necessary, contingent upon a case-by-case consultation with NMFS. Reclamation most recently coordinated such an emergency gate closure with NMFS in the spring of 2007. Around that time, dead green sturgeon were discovered in the vicinity of the dam, and Reclamation worked with the other resource agencies to review the gate operation protocol to try and reduce future potential adverse affects to adult green sturgeon that pass the dam. The resulting, new protocol for all gates in operation is to open individual gates to a minimum height of 12 inches to substantially reduce the possibility of injury should adult green sturgeon pass beneath the gates.

American River Division

Reclamation's Folsom Lake, the largest reservoir in the watershed, has a capacity of 977,000 AF. Folsom Dam, located approximately 30 miles upstream from the confluence with the Sacramento River, is operated as a major component of the CVP. The American River Division includes facilities that provide conservation of water on the American River for flood control, fish and wildlife protection, recreation, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water

supplies, and hydroelectric power generation. Initially authorized features of the American River Division included Folsom Dam, Lake, and Powerplant; Nimbus Dam and Powerplant, and Lake Natoma. See map in Figure P-7.

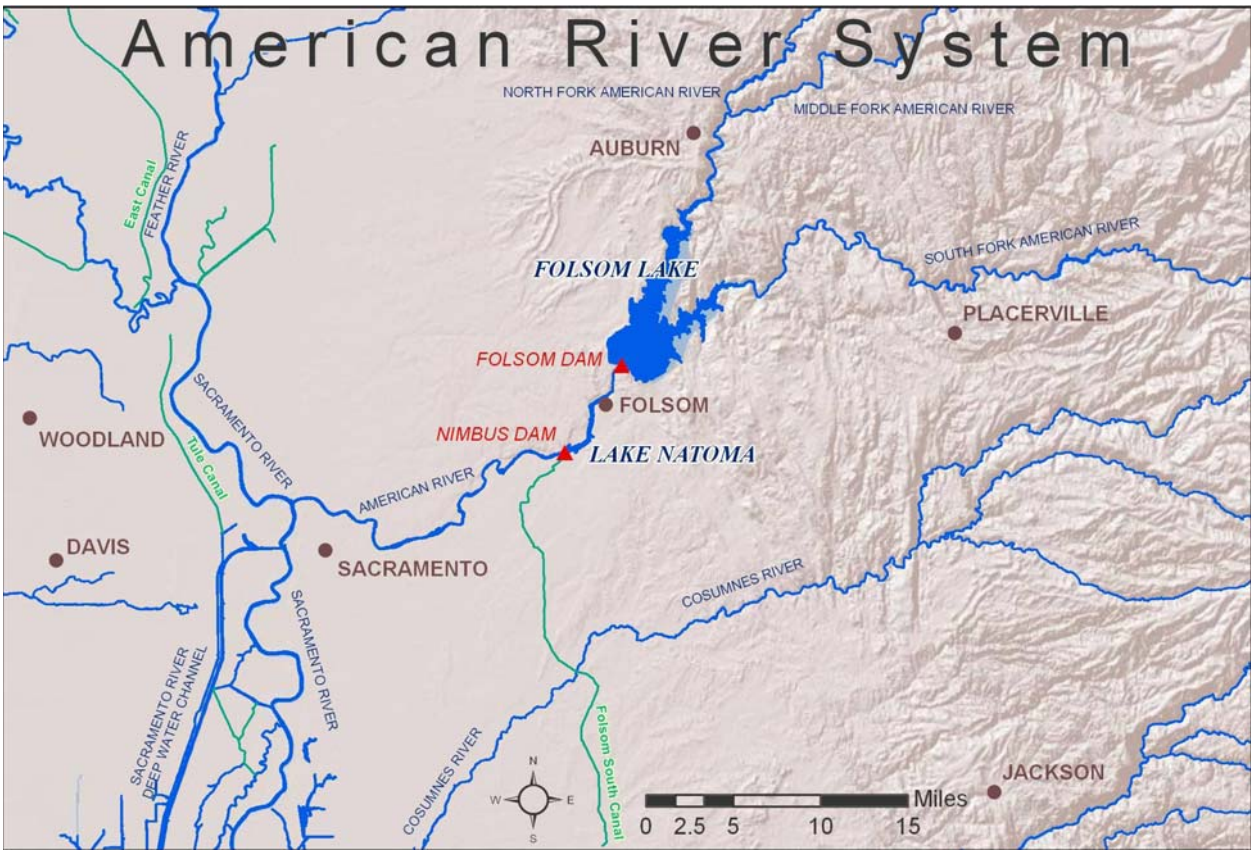

Figure P-7 American River System

Table P-7 provides Reclamation's annual water deliveries for the period 2000 through 2006 in the American River Division. The totals reveal an increasing trend in water deliveries over that period. Present level of American River Division water demands are about 325 TAF per year. Future level (2030) water demands are modeled at near 800 TAF per year. The modeled deliveries vary depending on modeled annual water allocations.

Table P-7 Annual Water Delivery - American River Division

Year	Water Delivery (TAF)
2000	196
2001	206
2002	238
2003	271
2004	266
2005	297
2006	282

Releases from Folsom Dam are re-regulated approximately seven miles downstream by Nimbus Dam. This facility is also operated by Reclamation as part of the CVP. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. This CVP facility serves water to M&I users in Sacramento County. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant, or, at flows in excess of 5,000 cfs, the spillway gates.

Although Folsom Lake is the main storage and flood control reservoir on the American River, numerous other small reservoirs in the upper basin provide hydroelectric generation and water supply. None of the upstream reservoirs have any specific flood control responsibilities. The total upstream reservoir storage above Folsom Lake is approximately 820,000 AF. Ninety percent of this upstream storage is contained by five reservoirs: French Meadows (136,000 AF); Hell Hole (208,000 AF); Loon Lake (76,000 AF); Union Valley (271,000 AF); and Ice House (46,000 AF). Reclamation has agreements with the operators of some of these reservoirs to coordinate operations for releases.

French Meadows and Hell Hole reservoirs, located on the Middle Fork of the American River, are owned and operated by the Placer County Water Agency (PCWA). The PCWA provides wholesale water to agricultural and urban areas within Placer County. For urban areas, the PCWA operates water treatment plants and sells wholesale treated water to municipalities that provide retail delivery to their customers. The cities of Rocklin and Lincoln receive water from the PCWA. Loon Lake (also on the Middle Fork), and Union Valley and Ice House reservoirs on the South Fork, are all operated by the Sacramento Municipal Utilities District (SMUD) for hydropower purposes.

Flood Control

Flood control requirements and regulating criteria are specified by the Corps and described in the Folsom Dam and Lake, American River, California Water Control Manual (Corps 1987). Flood control objectives for Folsom require the dam and lake are operated to:

- Protect the City of Sacramento and other areas within the Lower American River floodplain against reasonable probable rain floods.
- Control flows in the American River downstream from Folsom Dam to existing channel capacities, insofar as practicable, and to reduce flooding along the lower Sacramento River and in the Delta in conjunction with other CVP projects.
- Provide the maximum amount of water conservation storage without impairing the flood control functions of the reservoir.
- Provide the maximum amount of power practicable and be consistent with required flood control operations and the conservation functions of the reservoir.

From June 1 through September 30, no flood control storage restrictions exist. From October 1 through November 16 and from April 20 through May 31, reserving storage space for flood control is a function of the date only, with full flood reservation space required from November 17 through February 7. Beginning February 8 and continuing through April 20, flood reservation space is a function of both date and current hydrologic conditions in the basin.

If the inflow into Folsom Reservoir causes the storage to encroach into the space reserved for flood control, releases from Nimbus Dam are increased. Flood control regulations prescribe the following releases when water is stored within the flood control reservation space:

- Maximum inflow (after the storage entered into the flood control reservation space) of as much as 115,000 cfs, but not less than 20,000 cfs, when inflows are increasing.
- Releases will not be increased more than 15,000 cfs or decreased more than 10,000 cfs during any two-hour period.
- Flood control requirements override other operational considerations in the fall and winter period. Consequently, changes in river releases of short duration may occur.

In February 1986, the American River Basin experienced a significant flood event. Folsom Dam and Reservoir moderated the flood event and performed the flood control objectives, but with serious operational strains and concerns in the Lower American River and the overall protection of the communities in the floodplain areas. A similar flood event occurred in January 1997. Since then, significant review and enhancement of Lower American River flooding issues has occurred and continues to occur. A major element of those efforts has been the Sacramento Area Flood Control Agency (SAFCA) sponsored flood control plan diagram for Folsom Reservoir.

Since 1996, Reclamation has operated according to modified flood control criteria, which reserve 400 to 670 TAF of flood control space in Folsom and in a combination of three upstream reservoirs. This flood control plan, which provides additional protection for the Lower American River, is implemented through an agreement between Reclamation and the SAFCA. The terms of the agreement allow some of the empty reservoir space in Hell Hole, Union Valley, and French Meadows to be treated as if it were available in Folsom.

The SAFCA release criteria are generally equivalent to the Corps plan, except the SAFCA diagram may prescribe flood releases earlier than the Corps plan. The SAFCA diagram also relies on Folsom Dam outlet capacity to make the earlier flood releases. The outlet capacity at

Folsom Dam is currently limited to 32,000 cfs based on lake elevation. However, in general the SAFCA plan diagram provides greater flood protection than the existing Corps plan for communities in the American River floodplain.

Required flood control space under the SAFCA diagram will begin to decrease on March 1. Between March 1 and April 20, the rate of filling is a function of the date and available upstream space. As of April 21, the required flood reservation is about 225,000 AF. From April 21 to June 1, the required flood reservation is a function of the date only, with Folsom storage permitted to fill completely on June 1.

Fish and Wildlife Requirements in the Lower American River

The minimum allowable flows in the Lower American River are defined by SWRCB Decision 893 (D-893), which states that in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times. D-893 minimum flows are rarely the controlling objective of CVP operations at Nimbus Dam. Nimbus Dam releases are nearly always controlled during significant portions of a WY by either flood control requirements or are coordinated with other CVP and SWP releases to meet downstream Sacramento-San Joaquin Delta WQCP requirements and CVP water supply objectives. Power regulation and management needs occasionally control Nimbus Dam releases. Nimbus Dam releases are expected to exceed the D-893 minimum flows in all but the driest of conditions.

Reclamation continues to work with the Sacramento Water Forum, the Service, NMFS, DFG, and other interested parties to integrate a revised flow management standard for the Lower American River into CVP operations and water rights. This project description and modeling assumptions include the operational components of the recommended Lower American River flows and is consistent with the proposed flow management standard. Until this action is adopted by the SWRCB, the minimum legally required flows will be defined by D-893. However, Reclamation intends to operate to the proposed flow management standard using releases of additional water pursuant to Section 3406 (b)(2) of the CVPIA. Use of additional (b)(2) flows above the proposed flow standard is envisioned on a case-by-case basis. Such additional use of (b)(2) flows would be subject to available resources and such use would be coupled with plans to not intentionally cause significantly lower river flows later in a WY. This case-by-case use of additional (b)(2) for minimum flows is not included in the modeling results.

Water temperature control operations in the Lower American River are affected by many factors and operational tradeoffs. These include available cold water resources, Nimbus release schedules, annual hydrology, Folsom power penstock shutter management flexibility, Folsom Dam Urban Water Supply TCD management, and Nimbus Hatchery considerations. Shutter and TCD management provide the majority of operational flexibility used to control downstream temperatures.

During the late 1960s, Reclamation designed a modification to the trashrack structures to provide selective withdrawal capability at Folsom Dam. Folsom Powerplant is located at the foot of Folsom Dam on the right abutment. Three 15-foot-diameter steel penstocks for delivering water to the turbines are embedded in the concrete section of the dam. The centerline of each penstock intake is at elevation 307.0 feet and the minimum power pool elevation is 328.5 feet. A reinforced concrete trashrack structure with steel trashracks protects each penstock intake.

The steel trashracks, located in five bays around each intake, extend the full height of the trashrack structure (between 281 and 428 feet). Steel guides were attached to the upstream side of the trashrack panels between elevation 281 and 401 feet. Forty-five 13-foot steel shutter panels (nine per bay) and operated by the gantry crane, were installed in these guides to select the level of withdrawal from the reservoir. The shutter panels are attached to one another, in a configuration starting with the top shutter, in groups of three, two, and four.

Selective withdrawal capability on the Folsom Dam Urban Water Supply Pipeline became operational in 2003. The centerline to the 84-inch-diameter Urban Water Supply intake is at elevation 317 feet. An enclosure structure extending from just below the water supply intake to an elevation of 442 feet was attached to the upstream face of Folsom Dam. A telescoping control gate allows for selective withdrawal of water anywhere between 331 and 401 feet elevation under normal operations.

The current objectives for water temperatures in the Lower American River address the needs for steelhead incubation and rearing during the late spring and summer, and for fall–run Chinook spawning and incubation starting in late October or early November.

Establishing the start date requires a balancing between forecasted release rates, the volume of available cold water, and the estimated date at which time Folsom Reservoir turns over and becomes isothermic. Reclamation will work to provide suitable spawning temperatures as early as possible (after November 1) to help avoid temperature related pre-spawning mortality of adults and reduced egg viability. Operations will be balanced against the possibility of running out of cold water and increasing downstream temperatures after spawning is initiated and creating temperature related effects to eggs already in the gravel.

The cold water resources available in any given year at Folsom Lake needed to meet the stated water temperature goals are often insufficient. Only in wetter hydrologic conditions is the volume of cold water resources available sufficient to meet all the water temperature objectives. Therefore, significant operational tradeoffs and flexibilities are considered part of an annual planning process for coordinating an operation strategy that realistically manages the limited cold water resources available. Reclamation's coordination on the planning and management of cold water resources is done through the B2IT and ARG groups.

The management process begins in the spring as Folsom Reservoir fills. All penstock shutters are put in the down position to isolate the colder water in the reservoir below an elevation of 401 feet. The reservoir water surface elevation must be at least 25 feet higher than the sill of the upper shutter (426 feet) to avoid cavitation of the power turbines. The earliest this can occur is in the month of March, due to the need to maintain flood control space in the reservoir during the winter. The pattern of spring run-off is then a significant factor in determining the availability of cold water for later use. Folsom inflow temperatures begin to increase and the lake starts to stratify as early as April. By the time the reservoir is filled or reaches peak storage (sometime in the May through June period), the reservoir is highly stratified with surface waters too warm to meet downstream temperature objectives. There are, however, times during the filling process when use of the spillway gates can be used to conserve cold water.

In the spring of 2003, high inflows and encroachment into the allowable storage space for flood control required releases that exceeded the available capacity of the power plant. Under these conditions, standard operations of Folsom calls for the use of the river outlets that would draw

upon the cold water pool. Instead, Reclamation reviewed the release requirements, Safety of Dams issues, reservoir temperature conditions, and the benefits to the cold water pool and determined that it could use the spillway gates to make the incremental releases above powerplant capacity, thereby conserving cold water for later use. The ability to take similar actions (as needed in the future) will be evaluated on a case-by-case basis.

The annual temperature management strategy and challenge is to balance conservation of cold water for later use in the fall, with the more immediate needs of steelhead during the summer. The planning and forecasting process for the use of the cold water pool begins in the spring as Folsom Reservoir fills. Actual Folsom Reservoir cold water resource availability becomes significantly more defined through the assessment of reservoir water temperature profiles and more definite projections of inflows and storage. Technical modeling analysis begins in the spring for the projected Lower American River water temperature management plan. The significant variables and key assumptions in the analysis include:

- Starting reservoir temperature conditions
- Forecasted inflow and outflow quantities
- Assumed meteorological conditions
- Assumed inflow temperatures
- Assumed Urban Water Supply TCD operations

A series of shutter management scenarios are then incorporated into the model to gain a better understanding of the potential for meeting both summer steelhead and fall salmon temperature needs. Most annual strategies contain significant tradeoffs and risks for water temperature management for steelhead and fall–run salmon goals and needs due to the frequently limited cold water resource. The planning process continues throughout the summer. New temperature forecasts and operational strategies are updated as more information on actual operations and ambient conditions is gained. This process is shared with the ARG.

Meeting both the summer steelhead and fall salmon temperature objectives without negatively impacting other CVP project purposes requires the final shutter pull be reserved for use in the fall to provide suitable fall-run Chinook salmon spawning temperatures. In most years, the volume of cold water is not sufficient to support strict compliance with the summer temperature target at the downstream end of the compliance reach (Watt Avenue Bridge) while at the same time reserving the final shutter pull for salmon, or in some cases, continue to meet steelhead objectives later in the summer. A strategy that is used under these conditions is to allow the annual compliance location water temperatures to warm towards the upper end of the annual water temperature design value before making a shutter pull. This management flexibility is essential to the annual management strategy to extend the effectiveness of cold water management through the summer and fall months.

The Urban Water Supply TCD has provided additional flexibility to conserve cold water for later use. Initial studies are being conducted evaluating the impact of warmer water deliveries to the water treatment plants receiving the water. It is expected that the TCD will be operated during the summer months and deliver water that is slightly warmer than that which could be used to

meet downstream temperatures (60°F to 62°F), but not so warm as to cause significant treatment issues.

Water temperatures feeding the Nimbus Fish Hatchery were historically too high for hatchery operations during some dry or critical years. Temperatures in the Nimbus Hatchery are generally in the desirable range of 42°F to 55°F, except for the months of June, July, August, and September. When temperatures get above 60°F during these months, the hatchery must begin to treat the fish with chemicals to prevent disease. When temperatures reach the 60°F to 70°F range, treatment becomes difficult and conditions become increasingly dangerous for the fish. When temperatures climb into the 60°F to 70°F range, hatchery personnel with Reclamation to determine a compromise operation of the temperature shutter at Folsom Dam for the release of cooler water.

Reclamation operates Nimbus to maintain the health of the hatchery fish while minimizing the loss of the cold water pool for fish spawning in the river during fall. This is done on a case-by-case basis and is different in various months and year types. Temperatures above 70°F in the hatchery usually mean the fish need to be moved to another hatchery. The real time implementation of CVPIA AFRP objective flows and meeting SWRCB D-1641 Delta standards with the limited water resources of the Lower American River requires a significant coordination effort to manage the cold water resources at Folsom Lake. Reclamation consults with the Service, NMFS, and DFG through B2IT when these types of difficult decisions are needed. In addition, Reclamation communicates with ARG on real time data and operational trade offs.

A fish diversion weir at the hatchery blocks Chinook salmon from continuing upstream and guides them to the hatchery fish ladder entrance. The fish diversion weir consists of eight piers on 30-foot spacing, including two riverbank abutments. Fish rack support frames and walkways are installed each fall via an overhead cable system. A pipe rack is then put in place to support the pipe pickets (¾-inch steel rods spaced on 2½-inch centers). The pipe rack rests on a submerged steel I-beam support frame that extends between the piers and forms the upper support structure for a rock filled crib foundation. The rock foundation has deteriorated with age and is subject to annual scour which can leave holes in the foundation that allow fish to pass if left unattended.

Fish rack supports and pickets are installed around September 15, of each year and correspond with the beginning of the fall-run Chinook salmon spawning season. A release equal to or less than 1,500 cfs from Nimbus Dam is required for safety and to provide full access to the fish rack supports. It takes six people approximately three days to install the fish rack supports and pickets. In years after high winter flows have caused active scour of the rock foundation, a short period (less than eight hours) of lower flow (approximately 500 cfs) is needed to remove debris from the I-beam support frames, seat the pipe racks, and fill holes in the rock foundation. Compete installation can take up to seven days, but is generally completed in less time. The fish rack supports and pickets are usually removed at the end of fall-run Chinook salmon spawning season (mid-January) when flows are less than 2,000 cfs. If Nimbus Dam releases are expected to exceed 5,000 cfs during the operational period, the pipe pickets are removed until flows decrease.

Delta Division and West San Joaquin Division

CVP Facilities

The CVP's Delta Division includes the Delta Cross Channel (DCC), the Contra Costa Canal and Pumping Plants, Contra Loma Dam, Martinez Dam, the Jones Pumping Plant, the Tracy Fish Collection Facility (TFCF), and the Delta Mendota Canal (DMC). The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The Contra Costa Water District (CCWD) diversion facilities use CVP water resources to serve district customers directly and to operate CCWD's Los Vaqueros Project. The Jones Pumping Plant diverts water from the Delta to the head of the DMC. See map in Figure P-8.

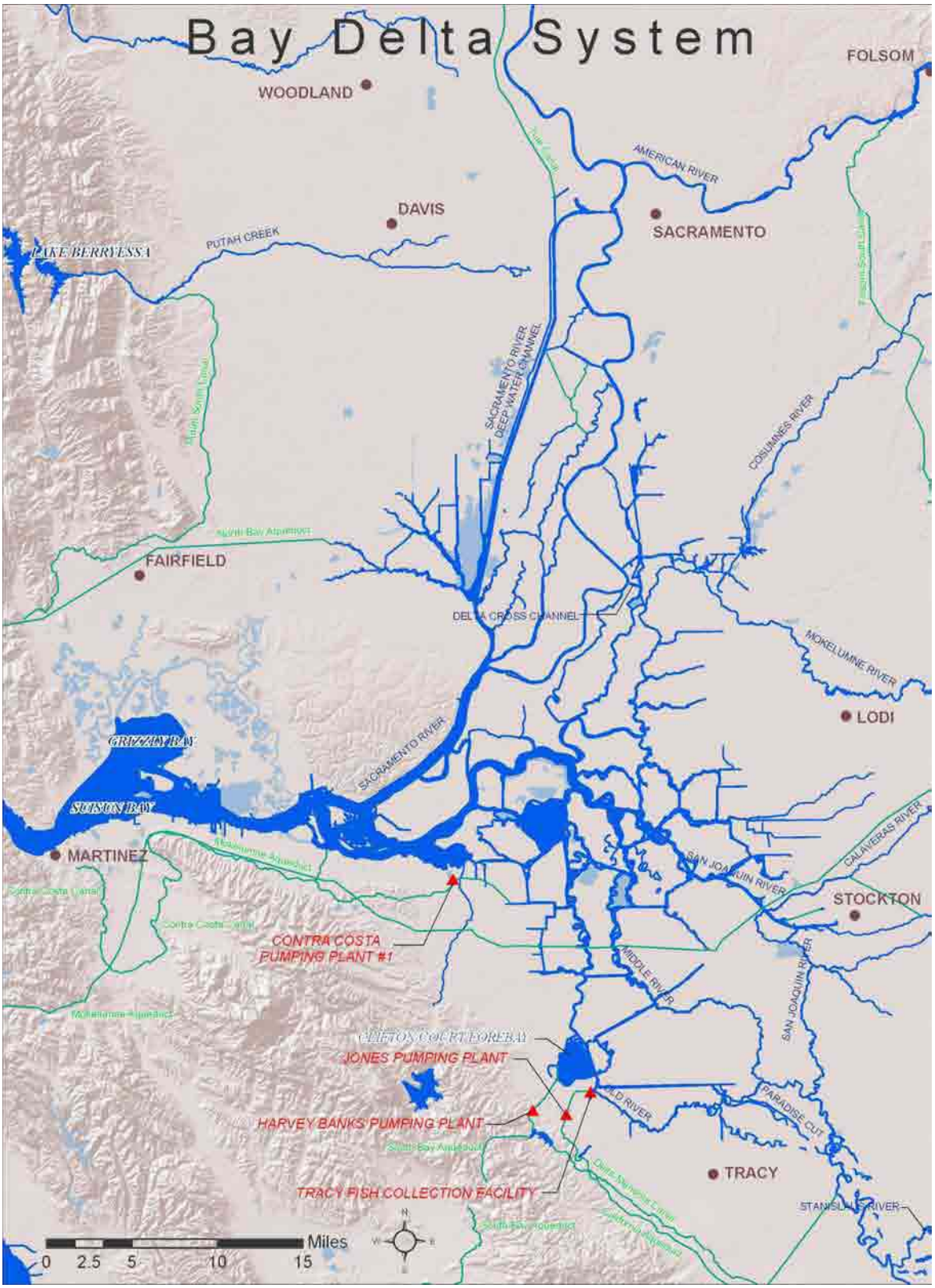

Figure P-8 Bay Delta System

Delta Cross Channel Operations

The DCC is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough. Flows into the DCC from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. When the gates are open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin Rivers toward the interior Delta. The DCC operation improves water quality in the interior Delta by improving circulation patterns of good quality water from the Sacramento River towards Delta diversion facilities.

Reclamation operates the DCC in the open position to (1) improve the transfer of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce salt water intrusion rates in the western Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect out-migrating salmonids from entering the interior Delta. In addition, whenever flows in the Sacramento River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis) the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates.

Flow rates through the gates are determined by Sacramento River stage and are not affected by export rates in the South Delta. The DCC also serves as a link between the Mokelumne River and the Sacramento River for small craft, and is used extensively by recreational boaters and fishermen whenever it is open.

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days for fishery protection purposes. From February 1 through May 20, the gates are closed for fishery protection purposes. The gates may also be closed for 14 days for fishery protection purposes during the May 21 through June 15 time period. Reclamation determines the timing and duration of the closures after discussion with the Service, DFG, and NMFS. These discussions will occur through WOMT.

WOMT typically relies on monitoring for fish presence and movement in the Sacramento River and Delta, the salvage of salmon at the Tracy and Skinner facilities, and hydrologic cues when considering the timing of DCC closures. However, the overriding factors are current water quality conditions in the interior and western Delta. From mid-June to November, Reclamation usually keeps the gates open on a continuous basis. The DCC is also usually opened for the busy recreational Memorial Day weekend, if this is possible from a fishery, water quality, and flow standpoint.

The Salmon Decision Process (as provided in the biological assessment) includes “Indicators of Sensitive Periods for Salmon” such as hydrologic changes, detection of spring-run salmon or spring-run salmon surrogates at monitoring sites or the salvage facilities, and turbidity increases at monitoring sites to trigger the Salmon Decision Process.

The Salmon Decision Process is used by NMFS, DFG, the Service and Reclamation to facilitate the often complex coordination issues surrounding DCC gate operations and the purposes of fishery protection closures, Delta water quality, and/or export reductions. Inputs such as fish lifestage and size development, current hydrologic events, fish indicators (such as the Knight’s

Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions.

Jones Pumping Plant

The CVP and SWP use the Sacramento River, San Joaquin River, and Delta channels to transport water to export pumping plants located in the South Delta. The CVP's Jones Pumping Plant, about five miles north of Tracy, consists of six available pumps. The Jones Pumping Plant is located at the end of an earth-lined intake channel about 2.5 miles in length. At the head of the intake channel, louver screens (that are part of the Tracy Fish Collection Facility) intercept fish, which are then collected, held, and transported by tanker truck to release sites far away from the pumping plants.

Jones Pumping Plant has a permitted diversion capacity of 4,600 cfs with maximum pumping rates typically ranging from 4500 to 4300 cfs during the peak of the irrigation season and approximately 4,200 cfs during the winter non-irrigation season until construction and full operation of the proposed DMC/California Aqueduct Intertie, described later in the project description. The winter-time constraints at the Jones Pumping Plant are the result of a DMC freeboard constriction near O'Neill Forebay, O'Neill Pumping Plant capacity, and the current water demand in the upper sections of the DMC.

Tracy Fish Collection Facility

The Tracy Fish Collection Facility (TFCF) is located in the south-west portion of the Sacramento-San Joaquin Delta and uses behavioral barriers consisting of primary and secondary louvers as illustrated in Figure P-9, to guide entrained fish into holding tanks before transport by truck to release sites within the Delta. The original design of the TFCF focused on smaller fish (<200 mm) that would have difficulty fighting the strong pumping plant induced flows since the intake is essentially open to the Delta and also impacted by tidal action.

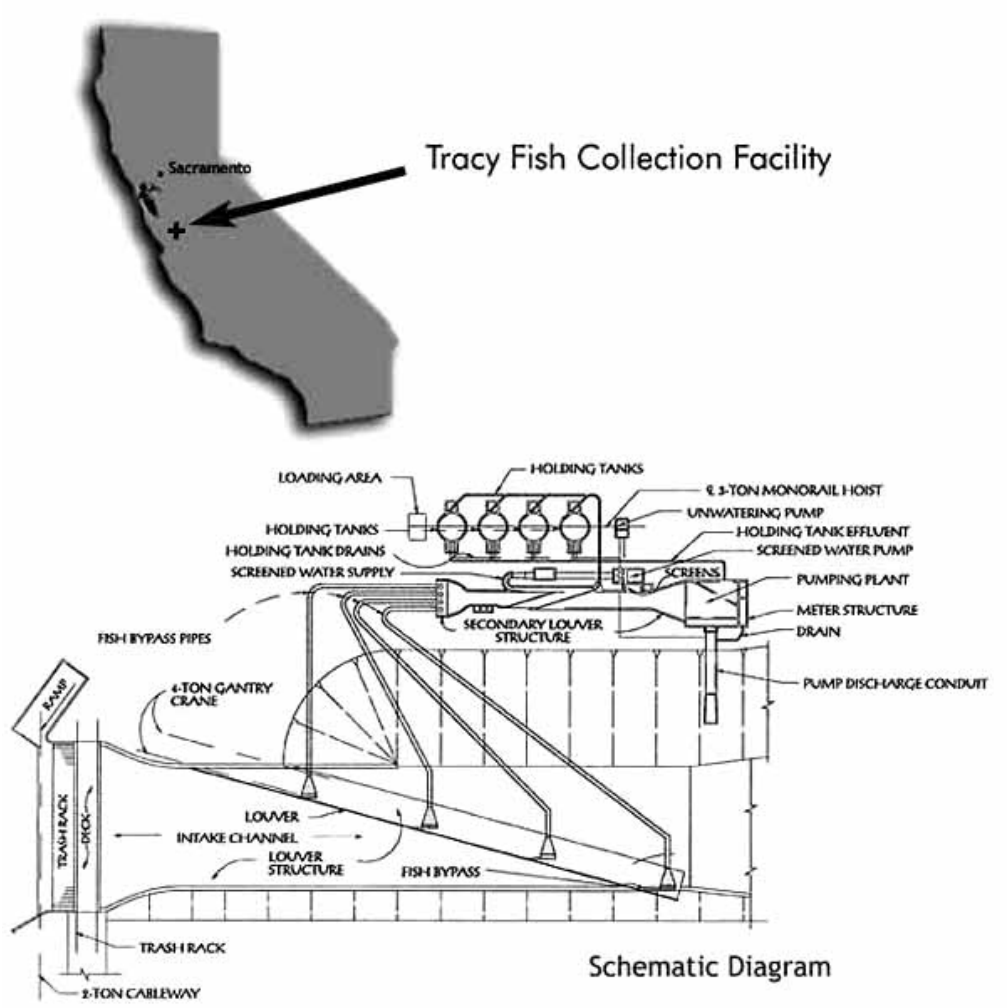

Figure P-9 Tracy Fish Collection Facility Diagram

The primary louvers are located in the primary channel just downstream of the trashrack structure. The secondary louvers are located in the secondary channel just downstream of the traveling water screen. The louvers allow water to pass through onto the pumping plant but the openings between the slats are tight enough and angled against the flow of water such a way as to prevent most fish from passing between them and instead enter one of four bypass entrances along the louver arrays.

There are approximately 52 different species of fish entrained into the TFCF per year; however, the total numbers are significantly different for the various species salvaged. Also, it is difficult if not impossible to determine exactly how many safely make it all the way to the collection tanks awaiting transport back to the Delta. Hauling trucks used to transport salvaged fish to release sites inject oxygen in the tanks and contain an eight parts per thousand salt solution to reduce stress. The CVP uses two release sites, one on the Sacramento River near Horseshoe Bend and the other on the San Joaquin River immediately upstream of the Antioch Bridge. During a facility inspection a few years ago, TFCF personnel noticed significant decay of the transition boxes and conduits between the primary and secondary louvers. The temporary rehabilitation of these transition boxes and conduits was performed during the fall and winter of

2002. Extensive rehabilitation of the transition boxes and conduits was completed during the San Joaquin pulse period of 2004.

When South Delta hydraulic conditions allow, and within the original design criteria for the TFCF, the louvers are operated with the D-1485 and the following water velocities: for striped bass of approximately 1 foot per second (ft/s) from May 15 through October 31, and for salmon of approximately 3 ft/s from November 1 through May 14. Channel velocity criteria are a function of bypass ratios through the facility. Due to changes in South Delta hydrology over the past fifty years, the present-day TFCF is able to meet these conditions approximately 55 percent of the time.

Fish passing through the facility will be sampled at intervals of no less than 20 minutes every 2 hours when listed fish are present, generally December through June. When fish are not present, sampling intervals will be 10 minutes every 2 hours. Fish observed during sampling intervals are identified to species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites in the North Delta away from the pumps. In addition, Reclamation will monitor for the presence of spent female delta smelt in anticipation of expanding the salvage operations to include sub 20 mm larval delta smelt detection.

Contra Costa Water District Diversion Facilities

CCWD diverts water from the Delta for irrigation and M&I uses under CVP contract, under its own permit and license at Mallard Slough, and under its own Los Vaqueros water right permit at Old River near State Route 4. CCWD's system includes intake facilities at Mallard Slough, Rock Slough, and Old River near State Route 4; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. CCWD will be adding a fourth diversion point on Victoria Canal (the Alternative Intake Project described below) to help meet its water quality goals. The Rock Slough intake facilities, the Contra Costa Canal, and the shortcut pipeline are owned by Reclamation, and operated and maintained by CCWD under contract with Reclamation. Mallard Slough Intake, Old River Intake, and Los Vaqueros Reservoir are owned and operated by CCWD.

The Mallard Slough Intake is located at the southern end of a 3,000-foot-long channel running due south from Suisun Bay, near Mallard Slough (across from Chipps Island). The Mallard Slough Pump Station was refurbished in 2002, which included constructing a positive barrier fish screen at this intake. The Mallard Slough Intake can pump up to 39.3 cfs. CCWD's permit issued by the SWRCB authorizes diversions of up to 26,780 acre-feet per year at Mallard Slough. However, this intake is rarely used due to the generally high salinity at this location. Pumping at the Mallard Slough Intake since 1993 has on average accounted for about 3 percent of CCWD's total diversions. When CCWD diverts water at the Mallard Slough Intake, CCWD reduces pumping of CVP water at its other intakes, primarily at the Rock Slough Intake.

The Rock Slough Intake is located about four miles southeast of Oakley, where water flows through a trash rack into the earth-lined portion of the Contra Costa Canal. This section of the canal is open to tidal influence and continues for four miles to Pumping Plant 1, which has capacity to pump up to 350 cfs into the concrete-lined portion of the canal. Prior to completion of the Los Vaqueros Project in 1997, this was CCWD's primary diversion point. Pumping Plant 1 is not screened. Reclamation, in collaboration with CCWD, is responsible for constructing a

fish screen as authorized by CVPIA and required by the 1993 Service biological opinion for the Los Vaqueros Project. Reclamation has received an extension on fish screen construction until December 2008, and is preparing to request a further extension until 2013 because the requirements for screen design will change when CCWD completes the Contra Costa Canal Replacement Project, which will replace the earth-lined section of canal from Rock Slough to Pumping Plant 1 with a pipeline. When completed, the Canal Replacement project will eliminate tidal flows into the Canal intake section and should significantly reduce entrainment impacts and improve the feasibility of screening Rock Slough. Typically, CCWD diverts about 17 percent of its total supply through the Rock Slough intake.

Construction of the Old River Intake was completed in 1997 as a part of the Los Vaqueros Project. The Old River Intake is located on Old River near State Route 4. It has a positive-barrier fish screen and a pumping capacity of 250 cfs, and can pump water via pipeline either to the Contra Costa Canal or to Los Vaqueros Reservoir. Pumping to storage in Los Vaqueros Reservoir is limited to 200 cfs by the terms of the Los Vaqueros Project biological opinions and by D-1629, the State Board water right decision for the Project. Typically, CCWD diverts about 80 percent of its total supply through the Old River Intake.

As described above, the first four miles of the Contra Costa Canal is earth-lined; after Pumping Plant 1, the Contra Costa Canal is concrete-lined and continues for 44 miles to its termination point in Martinez Reservoir. Pumping Plants 1 through 4 lift the water to an elevation of 127 feet. A blending facility just downstream of Pumping Plant 4 allows water from the Los Vaqueros Project pipeline and water from the Contra Costa Canal to mix to maintain CCWD's delivered water quality goals for salinity. Canal capacity is 350 cfs at this blending facility and decreases to 22 cfs at the terminus at Martinez Reservoir, which provides flow regulation. The Contra Loma Reservoir is connected to the Canal and provides flow regulation and emergency storage. Two short canals, Clayton Canal and Ygnacio Canal, are integrated into the distribution system. The Clayton Canal is no longer in service.

Los Vaqueros Reservoir is an off-stream reservoir with a capacity of 100 thousand acre-feet (TAF). Construction was completed and filling started in 1998 as part of the Los Vaqueros Project to improve delivered water quality and emergency storage reliability for CCWD's customers. Releases from Los Vaqueros Reservoir are conveyed to the Contra Costa Canal via a pipeline.

CCWD diverts approximately 127 TAF per year in total, of which approximately 110 TAF is CVP contract supply. In winter and spring months when the Delta is relatively fresh (generally January through July), demand is supplied by direct diversion from the Delta. In addition, when salinity is low enough, Los Vaqueros Reservoir is filled at a rate of up to 200 cfs from the Old River Intake. However, the biological opinions for the Los Vaqueros Project and the Alternative Intake Project, CCWD's memorandum of understanding with the DFG, and SWRCB D-1629 of the State Water Resources Control Board include fisheries protection measures consisting of a 75-day period during which CCWD does not fill Los Vaqueros Reservoir and a concurrent 30-day period during which CCWD halts all diversions from the Delta, provided that Los Vaqueros Reservoir storage is above emergency levels. The default dates for the no-fill and no-diversion periods are March 15 through May 31 and April 1 through April 30, respectively. The Service, NMFS and DFG can change these dates to best protect the subject species. During the no-diversion period, CCWD customer demand is met by releases from Los Vaqueros Reservoir.

In the late summer and fall months, CCWD releases water from Los Vaqueros Reservoir to blend with higher-salinity direct diversions from the Delta to meet CCWD water quality goals.

In addition to the existing 75-day no-fill period (March 15-May 31) and the concurrent no-diversion 30-day period , beginning in the February following the first operation of the Alternative Intake Project, CCWD shall not divert water to store in Los Vaqueros Reservoir for 15 days from February 14 through February 28, provided that reservoir storage is at or above 90 TAF on February 1; if reservoir storage is at or above 80 TAF on February 1 but below 90 TAF, CCWD shall not divert water to storage in Los Vaqueros Reservoir for 10 days from February 19 through February 28; if reservoir storage is at or above 70 TAF on Feb 1, but below 80 TAF CCWD shall not divert water to storage in Los Vaqueros Reservoir for 5 days from February 24 through February 28.

Water Demands—Delta Mendota Canal (DMC) and San Luis Unit

Water demands for the DMC and San Luis Unit are primarily composed of three separate types: CVP water service contractors, exchange contractors, and wildlife refuge contractors. A significantly different relationship exists between Reclamation and each of these three groups. Exchange contractors "exchanged" their senior rights to water in the San Joaquin River for a CVP water supply from the Delta. Reclamation thus guaranteed the exchange contractors a firm water supply of 840,000 AF per annum, with a maximum reduction under the Shasta critical year criteria to an annual water supply of 650,000 AF.

Conversely, water service contractors did not have water rights. Agricultural water service contractors also receive their supply from the Delta, but their supplies are subject to the availability of CVP water supplies that can be developed and reductions in contractual supply can exceed 25 percent. Wildlife refuge contractors provide water supplies to specific managed lands for wildlife purposes and the CVP contract water supply can be reduced under critically dry conditions up to 25 percent.

To achieve the best operation of the CVP, it is necessary to combine the contractual demands of these three types of contractors to achieve an overall pattern of requests for water. In most years sufficient supplies are not available to meet all water demands because of reductions in CVP water supplies which are due to restricted Delta pumping capability. In some dry or critically dry years, water deliveries are limited because there is insufficient storage in northern CVP reservoirs to meet all in-stream fishery objectives including water temperatures, and to make additional water deliveries via the Jones Pumping Plant. The scheduling of water demands, together with the scheduling of the releases of water supplies from the northern CVP to meet those demands, is a CVP operational objective that is intertwined with the Trinity, Sacramento, and American River operations.

East Side Division

New Melones Operations

The Stanislaus River originates in the western slopes of the Sierra Nevada and drains a watershed of approximately 900 square miles. The average unimpaired runoff in the basin is approximately 1.2 MAF per year; the median historical unimpaired runoff is 1.1 MAF per year. Snowmelt contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of April, May, and June. See map in Figure P-10.

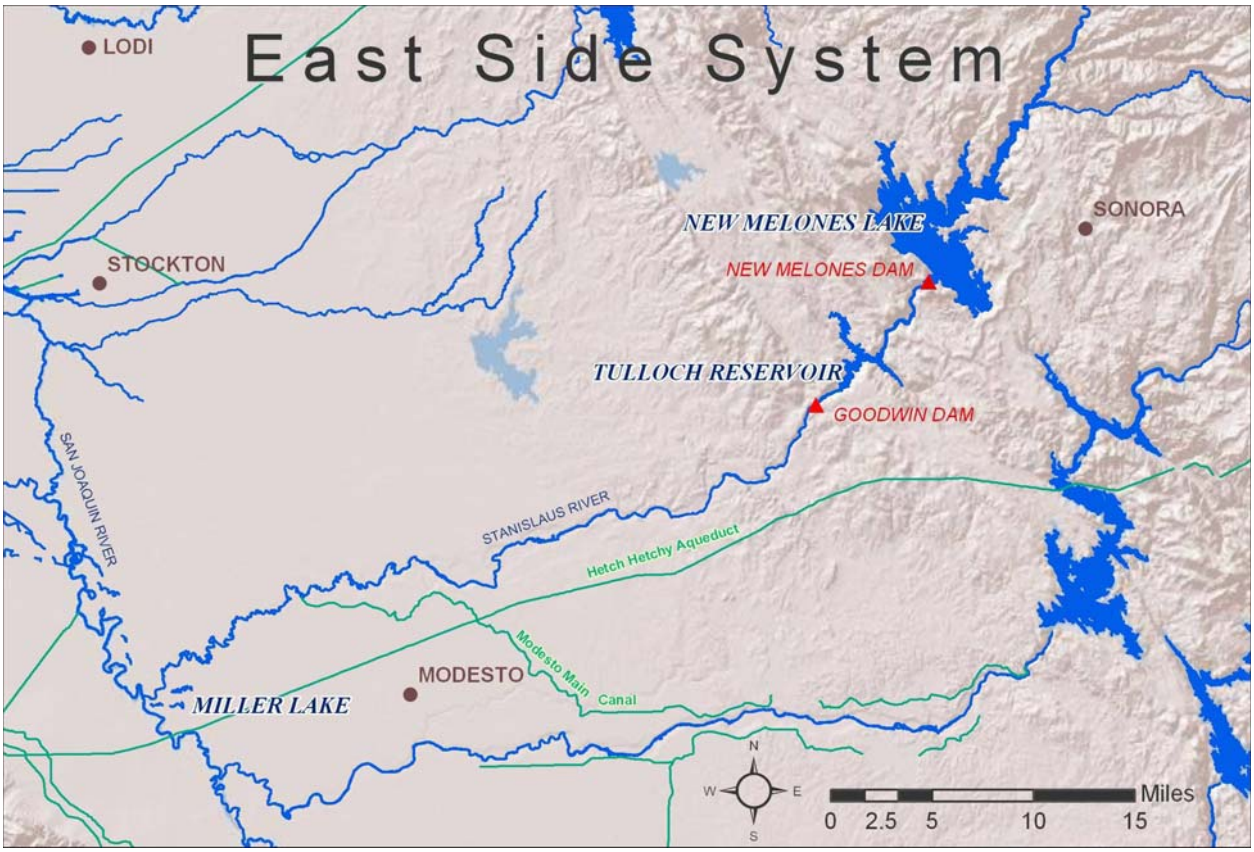

Figure P-10 East Side System

Currently, the flow in the lower Stanislaus River is primarily controlled by New Melones Reservoir, which has a storage capacity of about 2.4 MAF. The reservoir was completed by the Corps in 1978 and approved for filling in 1983. New Melones Reservoir is located approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River and is operated by Reclamation. Congressional authorization for New Melones integrates New Melones Reservoir as a financial component of the CVP, but it is authorized to provide water supply benefits within the defined Stanislaus Basin per the 1980 ROD before additional water supplies can be used out of the defined Stanislaus Basin.

New Melones Reservoir is operated primarily for purposes of water supply, flood control, power generation, fishery enhancement, and water quality improvement in the lower San Joaquin River. The reservoir and river also provide recreation benefits. Flood control operations are conducted in conformance with the Corps' operational guidelines.

Another major water storage project in the Stanislaus River watershed is the Tri-Dam Project, a power generation project that consists of Donnells and Beardsley Dams, located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant, located approximately 6 miles downstream of New Melones Dam on the main stem Stanislaus River. New Spicer Reservoir on the north fork of the Stanislaus River has a storage capacity of 189,000 AF and is used for power generation.

Releases from Donnells and Beardsley Dams affect inflows to New Melones Reservoir. Under contractual agreements between Reclamation, the Oakdale Irrigation District (OID), and South San Joaquin Irrigation District (SSJID), Tulloch Reservoir provides afterbay storage to re-regulate power releases from New Melones Powerplant. The main water diversion point on the Stanislaus River is Goodwin Dam, located approximately 1.9 miles downstream of Tulloch Dam.

Goodwin Dam, constructed by OID and SSJID in 1912, creates a re-regulating reservoir for releases from Tulloch Powerplant and provides for diversions to canals north and south of the Stanislaus River for delivery to OID and SSJID. Water impounded behind Goodwin Dam may be pumped into the Goodwin Tunnel for deliveries to the Central San Joaquin Water Conservation District and the Stockton East Water District.

Twenty ungaged tributaries contribute flow to the lower portion of the Stanislaus River, below Goodwin Dam. These streams provide intermittent flows, occurring primarily during the months of November through April. Agricultural return flows, as well as operational spills from irrigation canals receiving water from both the Stanislaus and Tuolumne Rivers, enter the lower portion of the Stanislaus River. In addition, a portion of the flow in the lower reach of the Stanislaus River originates from groundwater accretions.

Flood Control

The New Melones Reservoir flood control operation is coordinated with the operation of Tulloch Reservoir. The flood control objective is to maintain flood flows at the Orange Blossom Bridge at less than 8,000 cfs. When possible, however, releases from Tulloch Dam are maintained at levels that would not result in downstream flows in excess of 1,250 cfs to 1,500 cfs because of seepage problems in agricultural lands adjoining the river associated with flows above this level. Up to 450,000 AF of the 2.4 MAF storage volume in New Melones Reservoir is dedicated for flood control and 10,000 AF of Tulloch Reservoir storage is set aside for flood control. Based upon the flood control diagrams prepared by the Corps, part or all of the dedicated flood control storage may be used for conservation storage, depending on the time of year and the current flood hazard.

Requirements for New Melones Operations

The operating criteria for New Melones Reservoir are affected by (1) water rights, (2) in-stream fish and wildlife flow requirements (3) SWRCB D-1641 Vernalis water quality requirements, (4) dissolved oxygen (DO) requirements on the Stanislaus River, (5) SWRCB D-1641 Vernalis flow requirements, (6) CVP contracts, and (7) flood control considerations. Water released from New Melones Dam and Powerplant is re-regulated at Tulloch Reservoir and is either diverted at Goodwin Dam or released from Goodwin Dam to the lower Stanislaus River.

Flows in the lower Stanislaus River serve multiple purposes concurrently. The purposes include water supply for riparian water right holders, fishery management objectives, and DO requirements per SWRCB D-1422. In addition, water from the Stanislaus River enters the San Joaquin River where it contributes to flow and helps improve water quality conditions at Vernalis. Requirement D-1422, issued in 1973, provided the primary operational criteria for New Melones Reservoir and permitted Reclamation to appropriate water from the Stanislaus River for irrigation and M&I uses. D-1422 requires the operation of New Melones Reservoir

include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus and San Joaquin Rivers.

Water Rights Obligations

When Reclamation began operations of New Melones Reservoir in 1980, the obligations for releases (to meet downstream water rights) were defined in a 1972 Agreement and Stipulation among Reclamation, OID, and SSJID. The 1972 Agreement and Stipulation required Reclamation release annual inflows to New Melones Reservoir of up to 654,000 AF per year for diversion at Goodwin Dam by OID and SSJID, in recognition of their prior water rights. Actual historical diversions prior to 1972 varied considerably, depending upon hydrologic conditions. In addition to releases for diversion by OID and SSJID, water is released from New Melones Reservoir to satisfy riparian water rights totaling approximately 48,000 AF annually downstream of Goodwin Dam.

In 1988, following a year of low inflow to New Melones Reservoir, the Agreement and Stipulation among Reclamation, OID, and SSJID was superseded by an agreement that provided for conservation storage by OID and SSJID. The new agreement required Reclamation to release New Melones Reservoir inflows of up to 600,000 AF each year for diversion at Goodwin Dam by OID and SSJID.

In years when annual inflows to New Melones Reservoir are less than 600,000 AF, Reclamation provides all inflows plus one-third the difference between the inflow for that year and 600,000 AF per year. The 1988 Agreement and Stipulation created a conservation account in which the difference between the entitled quantity and the actual quantity diverted by OID and SSJID in a year may be stored in New Melones Reservoir for use in subsequent years. This conservation account has a maximum storage limit of 200,000 AF, and withdrawals are constrained by criteria in the agreement.

In-stream Flow Requirements

Under D-1422, Reclamation is required to release 98,000 AF of water per year, with a reduction to 69,000 AF in critical years, from New Melones Reservoir to the Stanislaus River on a distribution pattern to be specified each year by DFG for fish and wildlife purposes. In 1987, an agreement between Reclamation and DFG provided for increased releases from New Melones to enhance fishery resources for an interim period, during which habitat requirements were to be better defined and a study of Chinook salmon fisheries on the Stanislaus River would be completed.

During the study period, releases for in-stream flows would range from 98,300 to 302,100 AF per year. The exact quantity to be released each year was to be determined based on a formulation involving storage, projected inflows, projected water supply, water quality demands, projected CVP contractor demands, and target carryover storage. Because of dry hydrologic conditions during the 1987 to 1992 drought period, the ability to provide increased releases was limited. The Service published the results of a 1993 study, which recommended a minimum in-stream flow on the Stanislaus River of 155,700 AF per year for spawning and rearing.

Dissolved Oxygen Requirements

SWRCB D-1422 requires that water be released from New Melones Reservoir to maintain DO standards in the Stanislaus River. The 1995 revision to the WQCP established a minimum DO concentration of 7 milligrams per liter (mg/L), as measured on the Stanislaus River near Ripon. .

Vernalis Water Quality Requirement

SWRCB D-1422 also specifies that New Melones Reservoir must operate to maintain average monthly level total dissolved solids (TDS), commonly measured as a conversion from electrical conductivity, in the San Joaquin River at Vernalis as it enters the Delta. SWRCB D-1422 specifies an average monthly concentration of 500 parts per million (ppm) TDS for all months. Historically, releases were made from New Melones Reservoir for this standard, but due to shortages in water supply and high concentrations of TDS upstream of the confluence of the Stanislaus River, the D-1422 standard was not always met during the 1987-1992 drought. Reclamation has always met the D-1641 standard since 1995.

In the past, when sufficient supplies were not available to meet the water quality standards for the entire year, the emphasis for use of the available water was during the irrigation season, generally from April through September. SWRCB D-1641 modified the water quality objectives at Vernalis to include the irrigation and non-irrigation season objectives contained in the 1995 Bay-Delta WQCP. The revised standard is an average monthly electric conductivity 0.7 milliSiemens per centimeter (mS/cm) (approximately 455 ppm TDS) during the months of April through August, and 1.0 mS/cm (approximately 650 ppm TDS) during the months of September through March.

Bay-Delta Vernalis Flow Requirements

SWRCB D-1641 sets flow requirements on the San Joaquin River at Vernalis from February to June. These flows are commonly known as San Joaquin River base flows.

Table P-8 San Joaquin base flows-Vernalis

Water Year Class	February-June Flow (cfs)*
Critical	710-1140
Dry	1420-2280
Below Normal	1420-2280
Above Normal	2130-3420
Wet	2130-3420
*the higher flow required when X2 is required to be at or west of Chipps Island	

Since D-1641 has been in place, the San Joaquin base flow requirements have at times, been an additional demand on the New Melones water supply beyond that provided for in the Interim Plan of Operation (IPO).

CVP Contracts

Reclamation entered into water service contracts for the delivery of water from New Melones Reservoir, based on a 1980 hydrologic evaluation of the long-term availability of water in the

Stanislaus River Basin. Based on this study, Reclamation entered into a long-term water service contract for up to 49,000 AF per year of water annually (based on a firm water supply), and two long-term water service contracts totaling 106,000 AF per year (based on an interim water supply). Water deliveries under these contracts were not immediately available prior to 1992 for two reasons: 1) new diversion facilities were required to be constructed and prior to 1992 were not yet fully operational; and 2) water supplies were severely limited during the 1987 to 1992 drought.

New Melones Operations

Since 1997, the New Melones IPO has guided CVP operations on the Stanislaus River. The IPO was developed as a joint effort between Reclamation and the Service, in conjunction with the Stanislaus River Basin Stakeholders (SRBS). The process of developing the plan began in 1995 with a goal to develop a long-term management plan with clear operating criteria, given a fundamental recognition by all parties that New Melones Reservoir water supplies are over-committed on a long-term basis, and consequently, unable to meet all the potential beneficial uses designated as purposes. Reclamation will continue to use the interim plan.

The IPO defines categories of water supply based on storage and projected inflow. It then allocates annual water quantities for in-stream fishery enhancement (1987 DFG Agreement and CVPIA Section 3406(b)(2) management), SWRCB D-1641 San Joaquin River water quality requirements (Water Quality), SWRCB D-1641 Vernalis flow requirements (Bay-Delta), and use by CVP contractors.

Table P-9 Inflow characterization for the New Melones IPO

Annual water supply category	March-September forecasted inflow plus end of February storage (TAF)
Low	0 – 1400
Medium-low	1400 – 2000
Medium	2000 – 2500
Medium-high	2500 – 3000
High	3000 – 6000

Table P-10 New Melones IPO flow objectives (in thousand AF)

Storage plus inflow		Fishery		Vernalis water quality		Bay-Delta		CVP contractors	
From	To	From	To	From	To	From	To	From	To
1400	2000	98	125	70	80	0	0	0	0
2000	2500	125	345	80	175	0	0	0	59
2500	3000	345	467	175	250	75	75	90	90
3000	6000	467	467	250	250	75	75	90	90

When the water supply condition is determined to be in the "Low" IPO designation, the IPO proposes no operations guidance. In this case, Reclamation would meet with the SRBS group to coordinate a practical strategy to guide annual New Melones Reservoir operations under this very limited water supply condition. In addition, the IPO is limited in its ability to fully provide for the D-1641 Vernalis salinity and base flow objectives using Stanislaus River flows in all year types. If the Vernalis salinity standard cannot be met using the IPO designated Goodwin release pattern, then an additional volume of water is dedicated to meet the salinity standard. This permit obligation is met before an allocation is made to CVPIA (b)(2) uses or CVP Eastside contracts.

CVPIA Section 3406 (b)(2) releases from New Melones Reservoir consist of the portion of the fishery flow management volume utilized that is greater than the 1987 DFG Agreement and the volume used in meeting the Vernalis water quality requirements and/or Ripon dissolved oxygen requirements.

New Melones Reservoir – Future Operations

To provide a basis to develop a long-term operating plan, Reclamation sponsored updates to the San Joaquin River Basin component of CALSIM II to better represent and model how river flows and water quality in the San Joaquin River are likely to affect operations at New Melones Reservoir.

This new information and the resulting CALSIM II model improvements were peer reviewed in 2004 and additional refinements were made to the model based on that review. The resulting model is considered by Reclamation to be the best representation of the significant hydrologic and water quality dynamics that currently affect New Melones operations.

The relationships developed for the current model are significantly different than the assumptions used to develop the 1997 IPO. Given that the 1997 IPO was only meant to be a temporary management tool and that water quality conditions are changing in the basin, the fundamental operating assumptions of the 1997 IPO are not entirely consistent with the improved CALSIM II model.

As an important first step in evaluating the effects of a permanent operating plan for New Melones, Reclamation concludes that the following general assumptions best represents future New Melones operations for the purpose of this consultation. These operational parameters recognize existing priorities in beneficial uses, and the 1928 to 1934 drought is used as the basis to evaluate risks associated with successive dry years. The current analysis of future New Melones operations is based on two sets of project beneficial uses: a primary set of uses tied to pre-existing water rights and long-standing permit terms, and a secondary set of uses that came into effect after the primary set.

The operational parameters for allocation to Eastside Division water service contracts and CVPIA (b)(2) are based on available yield over the 1928-34 drought period. The available project quantity is allocated between water service contracts and CVPIA (b)(2) use.

Table P-11 Fundamental considerations used to define the New Melones Reservoir operations parameters.

CVP Beneficial Uses (Prior to 1992). The pre-1992 long-term beneficial uses for Reclamation's water supply/water rights at New Melones Reservoir are as follows:

- Existing OID/SSJID Settlement Contract
- D-1641 Vernalis Salinity Objective
- Stanislaus River Dissolved Oxygen
- 1987 DFG Fishery Agreement

CVP Beneficial Uses (After 1992). The beneficial uses for Reclamation's water supply/water rights at New Melones Reservoir established after 1992 are as follows:

- D-1641 Vernalis Feb-June Base Flow objective
- CVPIA (b)(2) water to increase Goodwin Dam releases for AFRP instream flow objectives
- CVP Eastside Division water services contracts

Basic Allocation Bands. Similar to the 1997 IPO, the representation of future New Melones operations defines categories of water supply based on projected storage and inflows.

1) High Allocation Years (Projected New Melones Carryover Storage greater than 1.7 MAF End of September)

- DFG allocation is 302 TAF
- Vernalis flow objectives are met
- CVPIA (b)(2) water allocation is 155 TAF
- CVP Eastside contract allocation is 155 TAF
- Vernalis Salinity and Stanislaus River DO objectives are met

2) Mid-Allocation Years

- DFG allocation is 98.3 TAF
- Vernalis flow objectives are met
- CVPIA B2 water allocation to meet instream fishery needs is to be determined in coordination with USFWS, DFG and NMFS in a collaborative planning process
- Vernalis Salinity and Stanislaus River DO objectives are met
- CVP Eastside contract allocation is to be determined after all the instream needs are met

3) "Conference Year" conditions - New Melones Index is less than 1.0 MAF.

- As with the IPO, if the projected end of September New Melones Index (i.e. projected inflow plus storage) is less than 1.0 MAF, Reclamation would meet with USFWS stakeholders, DFG, and NMFS to coordinate a practical strategy to guide New Melones Reservoir operations to meet the most basic needs associated with Stanislaus River instream flows, DO, and Vernalis salinity. Allocation for CVPIA (b)(2) flows would be determined in coordination with USFWS, DFG and NMFS.

San Joaquin River Agreement/Vernalis Adaptive Management Plan (VAMP)

Adopted by the SWRCB in D-1641, the San Joaquin River Agreement (SJRA) includes a 12-year program providing for flows and exports in the lower San Joaquin River during a 31-day pulse flow period during April and May. It also provides for the collection of experimental data during that time to further the understanding of the effects of flows, exports, and the barrier at the head of Old River on salmon survival. This experimental program is commonly referred to as the VAMP (Vernalis Adaptive Management Plan). The SWRCB indicates that VAMP experimental data will be used to create permanent objectives for the pulse flow period. Reclamation and DWR intend to continue a VAMP-like action for the foreseeable future or until the SWRCB adopts new permanent objectives that replace the current program. It is anticipated that new SWRCB objectives will be as protective as the current program and that such protections will remain in place through 2030.

Continuation of the VAMP operations for a period of time after the expiration of SJRA may be considered reasonably foreseeable because it could be accomplished using well established capabilities and authorities already available to Reclamation and DWR. Specifically, flow increases to achieve VAMP targets could be provided using CVPIA section 3406 (b)(1), (b)(2), and (b)(3). Export reductions would be provided by Reclamation using CVPIA section 3406 (b)(1) or (b)(2), and by DWR using the substitution of the water supply acquired from the Yuba Accord flows. The combination of those operations elements would enable Reclamation and DWR to meet VAMP objectives in most years. Chapter 9 of the biological assessment contains an analysis of the capability of DWR to provide for export reduction during the VAMP pulse flow period, using the 48,000 acre feet of substitute supply assumed to be available from the Yuba Accord.

Within the SJRA, the 1997 IPO has been assumed as the baseline operation for New Melones Reservoir, which forms part of the existing flow condition. The existing flow condition is used to compute the supplemental flows which will be provided on the San Joaquin River to meet the target flows for the 31-day pulse during April and May. These supplemental flows that will be provided from other sources in the San Joaquin River Basin under the control of the parties to the SJRA.

The parties to the SJRA include several agencies that contribute flow to the San Joaquin, divert from or store water on the tributaries to the San Joaquin, or have an element of control over the flows in the lower San Joaquin River. These include Reclamation; OID; SSJID; Modesto ID; Turlock ID; Merced ID; and the San Joaquin River Exchange Contractors. The VAMP is based on coordination among these participating agencies in carrying out their operations to meet a steady target flow objective at Vernalis.

The target flow at Vernalis for the spring pulse flow period is determined each year according to the specifications contained in the SJRA. The target flow is determined prior to the spring pulse flows as an increase above the existing flows, and so “adapts” to the prevailing hydrologic conditions. Possible target flows specified in the agreement are (1) 2000 cfs, (2) 3200 cfs, (3) 4450 cfs, (4) 5700 cfs, and (5) 7000 cfs.

The Hydrology Group of the SJRTC develops forecasts of flow at Vernalis, determines the appropriate target flow, devises an operations plan including flow schedules for each contributing agency, coordinates implementation of the VAMP flows, monitors conditions that may affect the objective of meeting the target flow, updates and adjusts the planned flow contributions as needed, and accounts for the flow contributions. The Hydrology Group includes designees with technical expertise from each agency that contributes water to the VAMP. During VAMP, the Hydrology group communicates via regular conference calls, shares current information and forecasts via e-mail and an internet website. The Hydrology group has two lead coordinators, one from Reclamation and one designated by the SJRG. Subsequent to the end of the VAMP, a group similar to the Hydrology Group, with the same or similar role, will be maintained as part of the ongoing coordination of operations in the San Joaquin River basin.

CVP-SWP operations forecasts include Vernalis flows that meet the appropriate pulse flow targets for the predicted hydrologic conditions. The flows in the San Joaquin River upstream of the Stanislaus River are forecasted for the assumed hydrologic conditions. The upstream of the Stanislaus River flows are then adjusted so when combined with the forecasted Stanislaus River flow based on the 1997 IPO, the combined flow would provide the appropriate Vernalis flows consistent with the pulse flow target identified in the SJRA. An analysis of how the flows are produced upstream of the Stanislaus River is included in the SJRA Environmental Impact Statement /Environmental Impact Report. For purposes of CVP/SWP operations forecasts, the VAMP target flows are simply assumed to exist at the confluence of the Stanislaus and San Joaquin Rivers. The assessment of the effects of CVP/SWP operations in the Delta begins downstream of that point.

The VAMP program has two distinct components, a flow objective and an export restriction. The flow objectives were designed to provide similar protection to those defined in the WQCP. Fishery releases on the Stanislaus above that called for in the 1987 DFG Agreement are typically considered WQCP (b)(2) releases. The export reduction involves a combined State and Federal pumping limitation on the Delta pumps. The combined export targets for the 31 days of VAMP are specified in the SJRA: 1500 cfs (when target flows are 2000, 3200, 4450, or 7000 cfs), and 2250 cfs (when target flow is 5700 cfs, or 3000 cfs [alternate export target when flow target is 7000 cfs]). Pumping reductions which cannot be recovered by adjustments in CVP operations are considered a WQCP (b)(2) expense. Reductions of SWP pumping are limited to the amount that can be recovered through operations adjustments and the export of up to 48 TAF of transferred water made available from the Yuba Accord.

Water Temperatures

Water temperatures in the lower Stanislaus River are affected by many factors and operational tradeoffs. These include available cold water resources in New Melones reservoir, Goodwin release rates for fishery flow management and water quality objectives, as well as residence time in Tulloch Reservoir, as affected by local irrigation demand.

Reclamation intends to plan and manage flows to meet a 65° F water temperature objective at Orange Blossom Bridge for steelhead incubation and rearing during the late spring and summer. However, during critically dry years and low reservoir storages this objective cannot be met. The Service, in coordination with NMFS and DFG, identifies the schedule for Reclamation to provide fall pulse attraction flows for salmon. The pulse flows are a combination of water

purchased under the San Joaquin River Agreement and CVPIA (b)(2) and (3) water. This movement of water also helps to transport cold water from New Melones Reservoir into Tulloch Reservoir before the spawning season begins.

San Felipe Division

Construction of the San Felipe Division of the CVP was authorized in 1967 (Figure P-11). The San Felipe Division provides a supplemental water supply (for irrigation, M&I uses) in the Santa Clara Valley in Santa Clara County, and the north portion of San Benito County.

The San Felipe Division delivers both irrigation and M&I water supplies. Water is delivered within the service areas not only by direct diversion from distribution systems, but also through in-stream and offstream groundwater recharge operations being carried out by local interests. A primary purpose of the San Felipe Division in Santa Clara County is to provide supplemental water to help prevent land surface subsidence in the Santa Clara Valley. The majority of the water supplied to Santa Clara County is used for M&I purposes, either pumped from the groundwater basin or delivered from treatment plants. In San Benito County, a distribution system was constructed to provide supplemental water to about 19,700 arable acres.

The facilities required to serve Santa Clara and San Benito counties include 54 miles of tunnels and conduits, two large pumping plants, and one reservoir. Water is conveyed from the Delta of the San Joaquin and Sacramento Rivers through the DMC. It is then pumped into the San Luis Reservoir and diverted through the 1.8-mile long of Pacheco Tunnel inlet to the Pacheco Pumping Plant. Twelve 2,000-horse-power pumps lift a maximum of 490 cfs a height varying from 85 feet to 300 feet to the 5.3-mile-long Pacheco Tunnel. The water then flows through the tunnel and without additional pumping, through 29 miles of concrete, high-pressure pipeline, varying in diameter from 10 feet to 8 feet, and the mile-long Santa Clara Tunnel. In Santa Clara County, the pipeline terminates at the Coyote Pumping Plant, which is capable of pumping water to into Anderson Reservoir or Calero Reservoir for further distribution at treatment plants or groundwater recharge.

Santa Clara Valley Water District is the non-Federal operating entity for all the San Felipe Division facilities except for the Hollister Conduit and San Justo Reservoir. The San Benito County Water District operates San Justo Reservoir and the Hollister Conduit

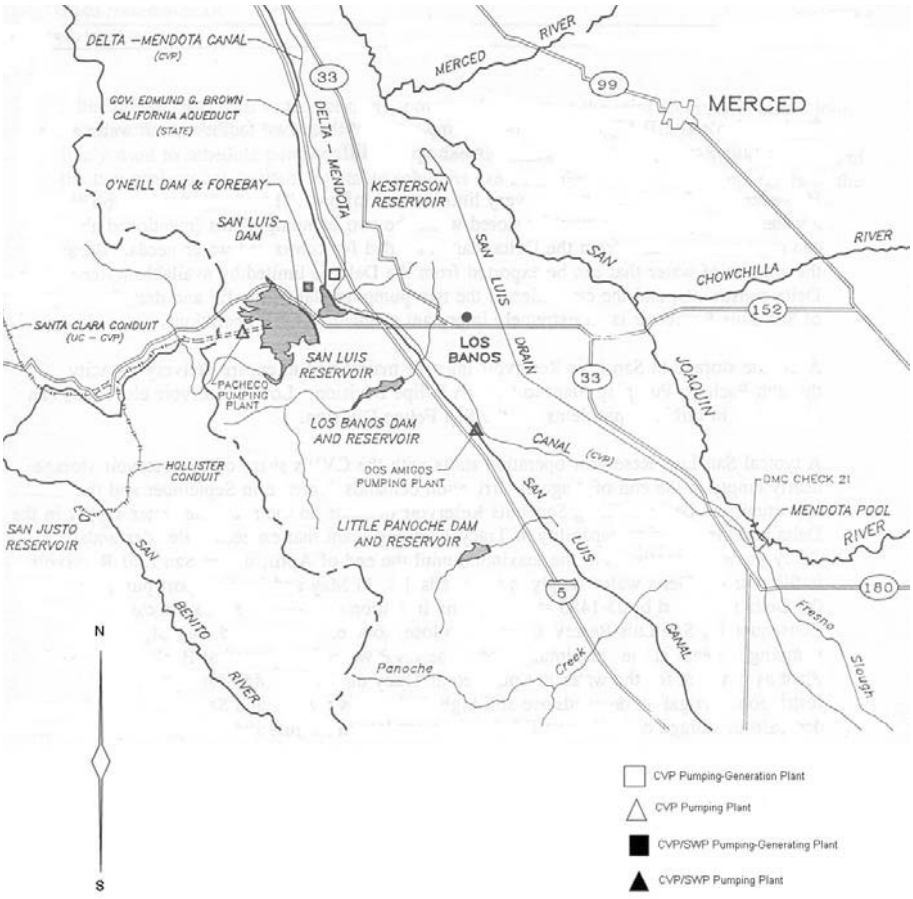

Figure P-11 West San Joaquin Division and San Felipe Division

The Hollister Conduit branches off the Pacheco Conduit 8 miles from the outlet of the Pacheco Tunnel. This 19.1-mile-long high-pressure pipeline, with a maximum capacity of 83 cfs, terminates at the San Justo Reservoir.

The 9,906 AF capacity San Justo Reservoir is located about three miles southwest of the City of Hollister. The San Justo Dam is an earthfill structure 141 feet high with a crest length of 722 feet. This project includes a dike structure 66 feet high with a crest length of 918 feet. This reservoir regulates San Benito County's import water supplies, allows pressure deliveries to some of the agricultural lands in the service area, and provides storage for peaking of agricultural water.

Friant Division

This division operates separately from the rest of the CVP and is not integrated into the CVP OCAP. Friant Dam is located on the San Joaquin River, 25 miles northeast of Fresno where the San Joaquin River exits the Sierra foothills and enters the valley. The drainage basin is 1,676 square miles with an average annual runoff of 1,774,000 AF. Completed in 1942, the dam is a concrete gravity structure, 319-feet high, with a crest length of 3,488 feet. Although the dam was completed in 1942, it was not placed into full operation until 1951.

The dam provides flood control on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Mendota Pool, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals. Water is delivered to a million acres of agricultural land in Fresno, Kern, Madera, and Tulare counties in the San Joaquin Valley via the Friant-Kern Canal south into Tulare Lake Basin and via the Madera Canal northerly to Madera and Chowchilla IDs. A minimum of 5 cfs is required to pass the last water right holding located about 40 miles downstream near Gravelly Ford.

Flood control storage space in Millerton Lake is based on a complex formula, which considers upstream storage in the Southern California Edison reservoirs. The reservoir, Millerton Lake, first stored water on February 21, 1944. It has a total capacity of 520,528 AF, a surface area of 4,900 acres, and is approximately 15-miles long. The lake's 45 miles of shoreline varies from gentle slopes near the dam to steep canyon walls farther inland. The reservoir provides boating, fishing, picnicking, and swimming.

At this time, the Friant Division is generally hydrologically disconnected from the Delta as the San Joaquin River is dewatered in two reaches between Friant Dam and the confluence of the Merced River, except in extremely wet years. Under flood conditions, water is diverted into two bypass channels that carry flood flows to the confluence of the Merced River.

In 2006, parties to NRDC v. Rodgers executed a stipulation of settlement that calls for, among other things, restoration of flows from Friant Dam to the confluence of the Merced River. Implementation of the settlement is not included in this consultation as it is a large project which has not been sufficiently developed to allow for analysis of the effects of implementation of settlement action on listed aquatic species at this time. At some point in the future, consultation may need to be reinitiated to evaluate the effects of the Restoration Program on continued CVP and SWP operations.

State Water Project

The DWR holds contracts with 29 public agencies in Northern, Central and Southern California for water supplies from the SWP. Water stored in the Oroville facilities, along with excess water available in the Sacramento-San Joaquin Delta is captured in the Delta and conveyed through several facilities to SWP contractors.

The SWP is operated to provide flood control and water for agricultural, municipal, industrial, recreational, and environmental purposes. Water is conserved in Oroville Reservoir and released to serve three Feather River area contractors and two contractors served from the North Bay Aqueduct, and to be pumped at the Harvey O. Banks Pumping Plant (Banks) in the Delta and delivered to the remaining 24 contractors in the SWP service areas south of the Delta. In addition to pumping water released from Oroville Reservoir, the Banks pumps water from other sources entering the Delta.

Project Management Objectives

Clifton Court Forebay

Inflows to Clifton Court Forebay (CCF) are controlled by radial gates, whose real-time operations are constrained by a scouring limit (i.e. 12,000 cfs) at the gates and by water level concerns in the South Delta for local agricultural diverters. An interim agreement between DWR and South Delta Water Agency specifies three modes, or "priorities" for CCF gate operation. Of the three priorities, Priority 1 is the most protective of South Delta water levels. Under Priority 1, CCF gates are only opened during the ebb tides, allowing the flood tides to replenish South Delta channels. Priority 2 is slightly less protective because the CCF gates may be open as in Priority 1, but also during the last hour of the higher flood tide and through most of the lower flood tide. Finally, Priority 3 requires that the CCF gates be closed during the rising limb of the higher flood tide and also during the lowest part of the lower tide, but permits the CCF gates to be open at all other times.

When a large head differential exists between the outside and the inside of the gates, theoretical inflow can be as high as 15,000 cfs for a very short time. However, existing operating procedures identify a maximum design flow rate of 12,000 cfs, to minimize water velocities in surrounding South Delta channels, to control erosion, and to prevent damage to the facility.

The SWP is managed to maximize the capture of water in the Delta and the usable supply released to the Delta from Oroville storage. The maximum daily pumping rate at Banks is controlled by a combination of the D-1641, the real-time decision making to assist in fishery management process described previously, and permits issued by the Corps that regulate the rate of diversion of water into Clifton Court Forebay (CCF) for pumping at Banks. This diversion rate is normally restricted to 6,680 cfs as a three-day average inflow to CCF and 6,993 cfs as a one-day average inflow to CCF. CCF diversions may be greater than these rates between December 15 and March 15, when the inflow into CCF may be augmented by one-third of the San Joaquin River flow at Vernalis when those flows are equal to or greater than 1,000 cfs. Additionally, the SWP has a permit to export an additional 500 cfs between July 1 and September 30 (further details on this pumping are found later in the Project Description). The purpose for the current permitted action is to replace pumping foregone for the benefit of Delta fish species, making the summer limit effectively 7,180 cfs.

The hourly operation of the CCF radial gates is governed by agreements with local agricultural interests to protect water levels in the South Delta area. The radial gates controlling inflow to the forebay may be open during any period of the tidal cycle with the exception of the two hours before and after the low-low tide and the hours leading up to the high-high tide each day. CCF gate operations are governed by agreements and response plans to protect South Delta water users, and a more detailed discussion of these operations and agreement will follow under CCF and JPOD sections.

Banks is operated to minimize the impact to power loads on the California electrical grid to the extent practical, using CCF as a holding reservoir to allow that flexibility. Generally more pump units are operated during off-peak periods and fewer during peak periods. Because the installed capacity of the pumping plant is 10,300 cfs, the plant can be operated to reduce power grid

impacts, by running all available pumps at night and a reduced number during the higher energy demand hours, even when CCF is admitting the maximum permitted inflow.

There are years (primarily wetter years) when Banks operations are demand limited, and Banks is able to pump enough water from the Delta to fill San Luis Reservoir and meet all contractor demands without maximizing its pumping capability every day of the year. This has been less likely in recent years, where the contractors request all or nearly all of their contract Table A amount every year. Consequently, current Banks operations are more often supply limited. Under these current full demand conditions, Banks pumping plant is almost always operated to the maximum extent possible to maximize the water captured, subject to the limitations of water quality, Delta standards, and a host of other variables, until all needs are satisfied and all storage south of the Delta is full.

San Luis Reservoir is an offstream storage facility located along the California Aqueduct downstream of Banks. San Luis Reservoir is used by both projects to augment deliveries to their contractors during periods when Delta pumping is insufficient to meet downstream demands.

San Luis Reservoir operates like a giant regulator on the SWP system, accepting any water pumped from Banks that exceeds contractor demands, then releasing that water back to the aqueduct system when Banks pumping is insufficient to meet demands. The reservoir allows the SWP to meet peak-season demands that are seldom balanced by Banks pumping.

San Luis Reservoir is generally filled in the spring or even earlier in some years. When it and other SWP storage facilities south of the Delta are full or nearly so, when Banks pumping is meeting all current Table A demands, and when the Delta is in excess conditions, DWR will use any available excess pumping capacity at Banks to deliver Article 21 water to the SWP contractors.

Article 21 water is one of several types of SWP water supply made available to the SWP contractors under the long-term SWP water supply contracts between DWR and the SWP contractors. As its name implies, Article 21 water is provided for under Article 21 of the contracts[3]. Unlike Table A water, which is an allocated annual supply made available for scheduled delivery throughout the year, Article 21 water is an interruptible water supply made available only when certain conditions exist. As with all SWP water, Article 21 water is supplied under existing SWP water rights permits, and is pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

When Article 21 water is available, DWR may only offer it for a short time, and the offer may be discontinued when the necessary conditions no longer exist. Article 21 deliveries are in addition to scheduled Table A deliveries; this supply is delivered to contractors that can, on relatively short notice, put it to beneficial use. Typically, contractors have used Article 21 water to meet

[3]Article 21 provides, in part: "Each year from water sources available to the project, the State shall make available and allocate interruptible water to contactors. Allocations of interruptible water in any one year may not be carried over for delivery in a subsequent year, nor shall the delivery of water in any year impact a contractor's approved deliveries of annual [Table A water] or the contractor's allocation of water for the next year. Deliveries of interruptible water in excess of a contractor's annual [Table A water] may be made if the deliveries do not adversely affect the State's delivery of annual [Table A water] to other contractors or adversely affect project operations…"

needs such as additional short-term irrigation demands, replenishment of local groundwater basins, and storage in local surface reservoirs, all of which provide contractors with opportunities for better water management through more efficient coordination with their local water supplies. When Article 21 of the long-term water supply contracts was developed, both DWR and the contractors recognized that DWR was not capable of meeting the full contract demands in all years because not all of the planned SWP facilities had been constructed.

Article 21 water is typically offered to contractors on a short-term (daily or weekly) basis when all of the following conditions exist: the SWP share[4] of San Luis Reservoir is physically full, or projected to be physically full within approximately one week at permitted pumping rates; other SWP reservoirs south of the Delta are at their storage targets or the conveyance capacity to fill these reservoirs is maximized; the Delta is in excess condition; current Table A demand is being fully met; and Banks has export capacity beyond that which is needed to meet current Table A and other SWP operational demands. The increment of available unused Banks capacity is offered as the Article 21 delivery capacity. Contractors then indicate their desired rate of delivery of Article 21 water. It is allocated in proportion to their Table A contractual quantities if requests exceed the amount offered. Deliveries can be discontinued at any time, when any of the above factors change. In the modeling for Article 21, deliveries are only made in months when the State share of San Luis Reservoir is full. In actual operations, Article 21 may be offered a few days in advance of actual filling. Article 21 water will not be offered until State storage in San Luis Reservoir is either physically full or projected to be physically full within approximately one week at permitted pumping rates. Also, any carried-over EWA water asset stored in the State share of San Luis Reservoir (whether it be from the use of the 500 cfs or other operational assets) will not be considered part of the SWP storage when determining the availability of Article 21. This will ensure that the carried-over EWA water asset does not result in increased Article 21 deliveries.

During parts of April and May, the VAMP takes effect as described in the CVP section above. The state and federal pumps reduce their export pumping to benefit fish in the San Joaquin River system. Around this same time, water demands from both agricultural and M&I contractors are increasing, Article 21 water is usually discontinued, and San Luis supplies are released to the SWP facilities to supplement Delta pumping at Banks, thereby meeting contractor demands. The SWP intends to continue VAMP-type export reductions through 2030 to the extent that the limited EWA assets, (as described in an earlier section) will meet the associated water costs. Chapter 9 of the biological assessment includes an analysis of modeling results that illustrates the frequency on which assets are available under a limited EWA to meet the SWP portion of VAMP.

Immediately following VAMP, a "post –VAMP shoulder" may occur. This action is an extension of the reduced pumping levels that occur during VAMP depending on the availability of EWA and limited EWA assets. Chapter 9 includes an analysis of modeling results that illustrates the frequency on which assets are available under a limited EWA to meet the "post – VAMP shoulder".

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[4] Not including any carried-over EWA or limited EWA asset which may reside in the SWP share of San Luis Reservoir.

After VAMP and the "post-VAMP shoulder", Delta pumping at Banks can be increased depending on Delta inflow and Delta standards. By late May, demands usually exceed the restored pumping rate at Banks, and continued releases from San Luis Reservoir are needed to meet contractor demands for Table A water.

During this summer period, DWR is also releasing water from Oroville Reservoir to supplement Delta inflow and allow Banks to export the stored Oroville water to help meet demand. These releases are scheduled to maximize export capability and gain maximum benefit from the stored water while meeting fish flow requirements, temperature requirements, Delta water quality, and all other applicable standards in the Feather River and the Delta.

DWR must balance storage between Oroville and San Luis Reservoirs carefully to meet flood control requirements, Delta water quality and flow requirements, and optimize the supplies to its contractors consistent with all environmental constraints. Oroville Reservoir may be operated to move water through the Delta to San Luis Reservoir via Banks under different schedules depending on Delta conditions, reservoir storage volumes, and storage targets. Predicting those operational differences is difficult, as the decisions reflect operator judgment based on many real-time factors as to when to move water from Oroville Reservoir to San Luis Reservoir.

As San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low point in late August or early September. From September through early October, demand for deliveries usually drops below the ability of Banks to divert from the Delta, and the difference in Banks pumping is then added to San Luis Reservoir, reversing its spring and summer decline. From early October until the first major storms in late fall or winter unregulated flow continues to decline and releases from Lake Oroville are restricted (due to flow stability agreements with DFG) resulting in export rates at Banks that are somewhat less than demand typically causing a second seasonal decrease in the SWP's share of San Luis Reservoir. Once the fall and winter storms increase runoff into the Delta, Banks can increase its pumping rate and eventually fill (in all but the driest years) the state portion of San Luis Reservoir before April of the following year.

Water Service Contracts, Allocations, and Deliveries

The following discussion presents the practices of DWR in determining the overall amount of Table A water that can be allocated and the allocation process itself. There are many variables that control how much water the SWP can capture and provide to its contractors for beneficial use.

The allocations are developed from analysis of a broad range of variables that include:

- Volume of water stored in Oroville Reservoir
- Flood operation restrictions at Oroville Reservoir
- End-of-water-year (September 30) target for water stored in Oroville Reservoir
- Volume of water stored in San Luis Reservoir
- End-of-month targets for water stored in San Luis Reservoir
- Snow survey results

- Forecasted runoff
- Feather River flow requirements for fish habitat
- Feather River service area delivery obligations
- Feather River flow for senior water rights river diversions
- Anticipated depletions in the Sacramento River basin
- Anticipated Delta conditions
- Precipitation and streamflow conditions since the last snow surveys and forecasts
- Contractor delivery requests and delivery patterns

From these and other variables, the Operations Control Office within DWR estimates the water supply available to allocate to contractors and meet other project needs. The Operations Control Office transmits these estimates to the State Water Project Analysis Office, where staff enters the water supply, contractor requests, and Table A amounts into a spreadsheet and computes the allocation percentage that would be provided by the available water supply.

The staffs of the Operations Control Office and State Water Project Analysis Office meet with DWR senior management, usually including the Director, to make the final decision on allocating water to the contractors. The decision is made, and announced in a press release followed by Notices to Contractors.

The initial allocation announcement is made by December 1 of each year. The allocation of water is made with a conservative assumption of future precipitation, and generally in graduated steps, carefully avoiding over-allocating water before the hydrologic conditions are well defined for the year.

Both the DWR and the contractors are conservative in their estimates, leading to the potential for significant variations between projections and actual operations, especially under wet hydrologic conditions.

Other influences affect the accuracy of estimates of annual demand for Table A and the resulting allocation percentage. One factor is the contractual ability of SWP contractors to carry over allocated but undelivered Table A from one year to the next if space is available in San Luis Reservoir. Contractors will generally use their carryover supplies early in the calendar year if it appears that San Luis reservoir will fill. By using the prior year's carryover, the contractors reduce their delivery requests for the current year's Table A allocation and instead schedule delivery of carryover supplies.

Carryover supplies left in San Luis Reservoir by SWP contractors may result in higher storage levels in San Luis Reservoir at December 31 than would have occurred in the absence of carryover. If there were no carryover privilege, contractors would seek to store the water within their service areas or in other storage facilities outside of their service areas. As project pumping fills San Luis Reservoir, the contractors are notified to take or lose their carryover supplies. If

they can take delivery of and use or store the carryover water, San Luis Reservoir storage then returns to the level that would have prevailed absent the carryover program.

If the contractors are unable to take delivery of all of their carryover water, that water then converts to project water as San Luis Reservoir fills, and Article 21 water becomes available for delivery to contractors.

Article 21 water delivered early in the calendar year may be reclassified as Table A later in the year depending on final allocations, hydrology, and contractor requests. Such reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules. The total water exported from the Delta and delivered by the SWP in any year is a function of a number of variables that is greater than the list of variables shown above that help determine Table A allocations.

If there are no carryover or Article 21 supplies available, Table A requests will be greater in the January-April period, and there would be a higher percentage allocation of Table A for the year than if carryover and Article 21 were available to meet demand.

Monterey Agreement

In 1994, DWR and certain representatives of the SWP contractors agreed to a set of principles known as the Monterey Agreement, to settle long-term water allocation disputes, and to establish a new water management strategy for the SWP. This project description only includes the system-wide water operations consistent with the Monterey Agreement and not the specific actions by DWR and State Water Contractors needed to implement the agreement.

The Monterey Agreement resulted in 27 of the 29 SWP contractors signing amendments to their long-term water supply contracts in 1995, and the Monterey Amendment has been implemented as part of SWP operations for these 27 SWP contractors since 1996. The original Environmental Impact Report prepared for the Monterey Agreement was challenged, and the EIR was required to be decertified. DWR is currently preparing an EIR on the Monterey Amendment following that litigation and approval of a settlement agreement with the plaintiffs in May 2003. A draft of the new EIR was released in October 2007, the comment period closed in January 2008, and a final EIR is scheduled for completion in the fall of 2008.

The alternatives evaluated in the EIR include continuation of the Monterey Amendment, certain No Project alternatives that would revert some contract terms to pre-Monterey Amendment terms, and two "court ordered no-project" alternatives that would impose a reduction in Table A supplies by implementing a permanent shortage provision together with an offsetting increase in the supply of Article 21 water.

Adoption of any of the alternatives would not measurably change SWP Delta operations, although the internal classification of water provided to SWP contractors could change as to the balance between Table A and Article 21 water, as could the relative allocation of water between urban and agricultural contractors. The Monterey Amendment provides for certain transfers of water from agricultural to urban contractors; impacts from those transfers are all south of the Delta and have no effect on the Delta.

The only impact of Monterey Amendment operations on Delta exports is identified in the draft EIR as the facilitation of approval for out-of-service-area storage programs. Because DWR had

previously approved water storage programs outside of individual SWP contractor's service areas and many such storage programs now exist, this water management method is unlikely to be voided by future actions of DWR. These increased exports can only occur if they are within the diversions permitted at the time. None of the alternatives being considered would result in demand for added Delta diversions above currently assumed levels and all are subject to whatever regulatory restrictions are in force at the time.

Changes in DWR's Allocation of Table A Water and Article 21 Water

The Monterey Amendment revised the temporary shortage provision that specified an initial reduction of supplies for agricultural use when requests for SWP water exceeded the available supply. The Amendment specifies that whenever the supply of Table A water is less than the total of all contractors' requests, the available supply of Table A water is allocated among all contractors in proportion to each contractor's annual Table A amount.

The Monterey Amendment amended Article 21 by eliminating the category of scheduled "surplus water," which was available for scheduled delivery and by renaming "unscheduled water" to "interruptible water." Surplus water was scheduled water made available to the contractors when DWR had supplies beyond what was needed to meet Table A deliveries, reservoir storage targets, and Delta regulatory requirements. Surplus water and unscheduled water were made available first to contractors requesting it for agricultural use or for groundwater replenishment. Because of the contractors' increasing demands for Table A water and the increasing regulatory requirements imposed on SWP operations, DWR is now able to supply water that is not Table A water only on an unscheduled, i.e., interruptible basis.

Pursuant to the revised Article 21, DWR allocates the available interruptible supply to requesting contractors in proportion to their annual Table A amounts.

The result of these contractual changes are that DWR now allocates Table A and interruptible water among contractors in proportion to annual Table A amounts without consideration of whether the water would be used for M&I or agricultural purposes. Agricultural and M&I contractors share any reductions in deliveries or opportunities for surplus water in proportion to their annual Table A amounts.

Historical Water Deliveries to Southern California

The pumping from the Delta to serve southern California has been influenced by changes in available water supply sources to serve the region. The Colorado River and the SWP have been the major supply sources for southern California.

The Quantification Settlement Agreement (QSA) signed in 2003 resulted in a decrease in the amount of Colorado River water available to California. To illustrate the impact of that decrease on demand from the Sacramento-San Joaquin Delta, it is instructive to look at the magnitude of the two imported supply sources available to MWDSC.

During part of this period, MWDSC was also filling Diamond Valley Lake (810,000 acre-feet, late 1998-early 2002) and adding some water to groundwater storage programs. In wetter years, demand for imported water may often decrease because local sources are augmented and local rainfall reduces irrigation demand. Table P-12 below illustrates the effects of the wet years from

1995-1998 on demand for imported water and the effect of reduced Colorado River diversions under the QSA on MWDSC deliveries from the Delta.

Table P-12 Wet Year effects

Calendar Year	Sacramento Valley Water Year Type	Delta Supplies	Colorado Supplies	Total
1994	Critically Dry	807,866	1,303,212	2,111,078
1995	Wet	436,042	997,414	1,433,456
1996	Wet	593,380	1,230,353	1,823,733
1997	Wet	721,810	1,241,821	1,963,631
1998	Wet	410,065	1,073,125	1,483,190
1999	Wet	852,617	1,215,224	2,067,841
2000	Above Normal	1,541,816	1,303,148	2,844,964
2001	Dry	1,023,169	1,253,579	2,276,748
2002	Dry	1,408,919	1,241,088	2,650,007
2003	Above Normal	1,686,973	688,043	2,375,016
2004	Below Normal	1,724,380	733,095	2,457,475
2005	Above Normal	1,616,710	839,704	2,456,414
2006	Wet	1,521,681*	594,544	2,116,225
2007	Dry	1,395,827*	713,456*	2,109,283

* - These figures are preliminary.

Project Facilities

Oroville Field Division

Oroville Dam and related facilities comprise a multipurpose project. The reservoir stores winter and spring runoff, which is released into the Feather River to meet the Project's needs. It also provides pumpback capability to allow for on-peak electrical generation, 750,000 acre-feet of flood control storage, recreation, and freshwater releases to control salinity intrusion in the Sacramento-San Joaquin Delta and for fish and wildlife protection.

The Oroville facilities are shown in Figure P-12. Two small embankments, Bidwell Canyon and Parish Camp Saddle Dams, complement Oroville Dam in containing Lake Oroville. The lake has a surface area of 15,858 acres, a storage capacity of 3,538,000 AF, and is fed by the North, Middle, and South forks of the Feather River. Average annual unimpaired runoff into the lake is about 4.5 million AF.

A maximum of 17,000 cfs can be released through the Edward Hyatt Powerplant, located underground near the left abutment of Oroville Dam. Three of the six units are conventional

generators driven by vertical-shaft, Francis-type turbines. The other three are motor-generators coupled to Francis-type, reversible pump turbines. The latter units allow pumped storage operations. The intake structure has an overflow type shutter system that determines the level from which water is drawn.

Approximately four miles downstream of Oroville Dam and Edward Hyatt Powerplant is the Thermalito Diversion Dam. Thermalito Diversion Dam consists of a 625-foot-long, concrete gravity section with a regulated ogee spillway that releases water to the low flow channel of the Feather River. On the right abutment is the Thermalito Power Canal regulating headwork structure.

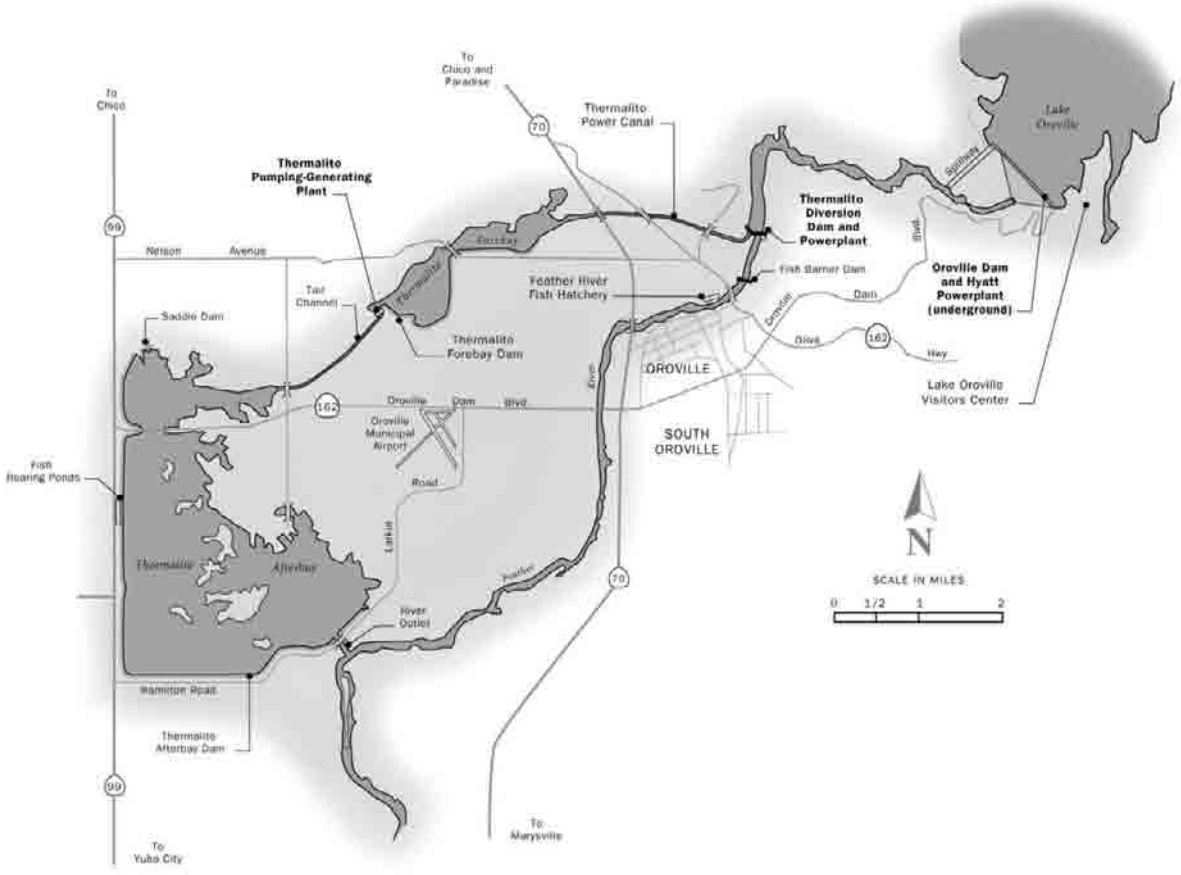


Figure P-12 Oroville Facilities on the Feather River

The purpose of the diversion dam is to divert water into the 2-mile long Thermalito Power Canal that conveys water in either direction and creates a tailwater pool (called Thermalito Diversion Pool) for Edward Hyatt Powerplant. The Thermalito Diversion Pool acts as a forebay when Hyatt is pumping water back into Lake Oroville. On the left abutment is the Thermalito Diversion Dam Powerplant, with a capacity of 600 cfs that releases water to the low-flow section of the Feather River.

Thermalito Power Canal hydraulically links the Thermalito Diversion Pool to the Thermalito Forebay (11,768 AF), which is the off-stream regulating reservoir for Thermalito Powerplant. Thermalito Powerplant is a generating-pumping plant operated in tandem with the Edward Hyatt Powerplant. Water released to generate power in excess of local and downstream requirements is conserved in storage and, at times, pumped back through both powerplants into Lake Oroville during off-peak hours. Energy price and availability are the two main factors that determine if a pumpback operation is economical. A pumpback operation most commonly occurs when energy prices are high during the weekday on-peak hours and low during the weekday off-peak hours or on the weekend. The Oroville Thermalito Complex has a capacity of approximately 17,000 cfs through the powerplants, which can be returned to the Feather River via the Afterbay's river outlet.

Local agricultural districts divert water directly from the afterbay. These diversion points are in lieu of the traditional river diversion exercised by the local districts whose water rights are senior to the SWP. The total capacity of afterbay diversions during peak demands is 4,050 cfs.

The Feather River Fish Hatchery (FRFH), mitigation for the construction of Oroville Dam, produces Chinook salmon and steelhead and is operated by DFG. The FRFH program, operations and production, is detailed in the FERC biological assessment for the Oroville Project and will be detailed in the NMFS FERC biological opinion. Both indirect and direct take resulting from FRFH operations will be authorized through section 4(d) of the Endangered Species Act, in the form of NMFS-approved Hatchery and Genetic Management Plans (HGMPs). DWR is preparing HGMPs for the spring and fall-run Chinook and steelhead production programs at the Feather River Fish Hatchery.

Current Operations - Minimum Flows and Temperature Requirements

Operation of Oroville will continue under existing criteria, consistent with past project descriptions, until a final decision is made in the FERC relicensing process. The release temperatures from Oroville Dam are designed to meet Feather River Fish Hatchery and Robinson Riffle temperature schedules included in the 1983 DFG Agreement, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife", concerning the operations of the Oroville Division of the State Water Project for Management of Fish and Wildlife while also conserving the coldwater pool in Lake Oroville. Current operation indicates that water temperatures at Robinson Riffle are almost always met when the hatchery objectives are met. Due to temperature requirements of endangered fish species and the hatchery and overriding meteorological conditions, the temperature requests for agriculture can be difficult to satisfy.

Water is withdrawn from Lake Oroville at depths that will provide sufficiently cold water to meet the Feather River Fish Hatchery and Robinson Riffle temperature targets. The reservoir depth from which water is released initially determines the river temperatures, but atmospheric conditions, which fluctuate from day to day, modify downstream river temperatures. Altering the reservoir release depth requires installation or removal of shutters at the intake structures. Shutters are held at the minimum depth necessary to release water that meets the Feather River Fish Hatchery and Robinson Riffle criteria. In order to conserve the coldwater pool during dry years, DWR has strived to meet the Robinson Riffle temperatures by increasing releases to the LFC rather than releasing colder water.

Additionally, DWR maintains a minimum flow of 600 cfs within the Feather River Low Flow Channel (LFC) (except during flood events when flows are governed by the Flood Operations Manual and under certain other conditions as described in the 1984 FERC order). Downstream of the Thermalito Afterbay Outlet, in the High Flow Channel (HFC), a minimum release for flows in the Feather River is to be 1,000 cfs from April through September and 1,700 cfs from October through March, when the April-to-July unimpaired runoff in the Feather River is greater than 55 percent of normal. When the April-to-July unimpaired runoff is less than 55 percent of normal, the License requires minimum flows of 1,000 cfs from March to September and 1,200 cfs from October to February (Table P-13). In practice, flows are maintained below 2,500 cfs from October 15 to November 30 to prevent spawning in the overbank areas.

According to the 1983 Agreement, if during the period of October 15 to November 30, the average highest 1-hour flow of combined releases exceeds 2,500 cfs; with the exception of flood management, accidents, or maintenance; then the minimum flow must be no lower than 500 cfs less than that flow through the following March 31. The 1983 Agreement also states that if the April 1 runoff forecast in a given year indicates that the reservoir level will be drawn down to 733 feet, water releases for fish may be reduced, but not by more than 25 percent.

Table P-13 Combined Minimum Instream Flow Requirements in the Feather River Below Thermalito Afterbay Outlet When Lake Oroville Elevation is Projected to be Greater vs. Less Than 733' in the Current Water Year

Conditions	Period	Minimum Flows
When Lake Oroville Elevation is Projected to be Greater Than 733' & the **Preceding** Water Year's April – July Water Conditions are ≥ 55% of Normal (1)	October - February	1,700 cfs
	March	1,700 cfs
	April - September	1,000 cfs
When Lake Oroville Elevation is Projected to be Greater Than 733' & the Preceding Water Year's April – July Water Conditions are < 55% of Normal (1)	October - February	1,200 cfs
	March	1,000 cfs
	April - September	1,000 cfs
When Lake Oroville Elevation is Projected to be Less Than 733' in the **Current** Water Year (2)	October - February	900 cfs < Q < 1,200 cfs
	March	750 cfs < Q < 1,000 cfs
	April - September	750 cfs < Q < 1,000 cfs

Notes:

1) Normal is defined as the Mean April – July Unimpaired Runoff of the Feather River near Oroville of 1,942,000 AF (1911 – 1960).
2) In accordance with FERC's Order Amending License dated September 18, 1984, Article 53 was amended to provide a third tier of minimum flow requirements defined as follows: If the April 1 runoff forecast in a given water year indicates that, under normal operation of Project 2100, the reservoir level will be drawn to elevation 733 feet (approximately 1,500,000 AF), releases for fish life in the above schedule may suffer monthly deficiencies in the same proportion as the respective monthly deficiencies imposed upon deliveries of water for agricultural use from the Project. However, in no case shall the fish water releases in the above schedule be reduced by more than 25 percent.

Current operations of the Oroville Facilities are governed by water temperature requirements at two locations: the FRFH and in the LFC at Robinson Riffle. DWR has taken various temperature management actions to achieve the water temperature requirements, including curtailing pumpback operations, removing shutters at intakes of the Hyatt Pumping-Generating Plant, releasing flow through the river valves (for FRFH only), and redirecting flows at the Thermalito Diversion Dam to the LFC (for Robinson Riffle only).

To date, the river valves have been used infrequently. Prior to 1992, they were used twice: first in 1967 during the initial construction of the dam, and second in 1977 during the drought of record. Since 1992, the river valves have only been used twice for temperature control: in 2001 and 2002. To ensure that the river valves will operate reliably, DWR exercises them annually. When operated to meet temperature criteria, DWR can and does operate the river valves at a flow rate up to the 1,500 cfs needed for FRFH temperature management purposes.

Other than local diversions, outflow from the Oroville Complex is to the Feather River, combining flows from the LFC and Thermalito Afterbay. Outflow typically varies from spring seasonal highs averaging 8,000 cfs to about 3,500 cfs in November. The average annual outflow from the Project is in excess of 3 MAF to support downstream water supply, environmental, and water quality needs.

Table P-14 shows an example of releases from Oroville for various downstream uses during dry hydrologic conditions (WYs 2001 and 2002). As a practical matter, water supply exports are met with water available after Delta requirements are met. Some of the water released for instream and Delta requirements may be available for export by the SWP after Delta standards have been met.

Table P-14 Historical Records of Releases from the Oroville Facilities in 2001 and 2002, by Downstream Use

Downstream Use	Water Year 2001 Release		Water Year 2002 Release	
	Volume (TAF)	Percentage	Volume (TAF)	Percentage
Feather River Service Area	1,024	46	925	34
Instream and Delta Requirements	1,099	50	1,043	38
Flood Management	0	0	0	0
Support of Exports	93	4	773	28
Total	2,216	100	2,741	100

Source: DWR SWP Operations Control Office

Feather River Flow Requirements

The existing Feather River flow requirements below Oroville Dam are based on an August 1983 Agreement between the DWR and DFG. The 1983 Agreement established criteria and objectives for flow and temperatures in the LFC, FRFH, and HFC. This agreement includes the following:

- Established minimum flows between the Thermalito Afterbay Outlet and Verona that vary by WY type
- Required flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except flood management operations
- Required flow stability during the peak of the fall-run Chinook spawning season
- Set an objective of suitable water temperature conditions during the fall months for salmon and during the later spring/summer months for shad and striped bass
- Established a process whereby DFG would recommend each year, by June 1, a spawning gravel maintenance program to be implemented during that calendar year

Low Flow Channel

The 1983 Agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fishery purposes. This is the total volume of flows from the Diversion Dam Outlet, Diversion Dam Powerplant, and FRFH Pipeline.

High Flow Channel

Based on the 1983 Agreement, Table P-15 summarizes the minimum flow requirement for the HFC when releases would not draw Oroville Reservoir below elevation 733 feet above mean sea level (ft msl).

Table P-15 High Flow Channel minimum flow requirements as measured downstream from the Thermalito Afterbay Outlet.

Forecasted April-through-July unimpaired runoff (percent of normal[1])	Minimum Flow in HFC (cfs)		
	October through February	March	April through September
55 percent or greater	1,700	1,700	1,000
Less than 55 percent	1,200	1,000	1,000

Source: 1983 Agreement

[1] The preceding water year's unimpaired runoff shall be reported in Licensee's Bulletin 120, "*Water Conditions in California-Fall Report*." The term "normal" is defined as the April-through-July mean unimpaired runoff near Oroville of 1,942,000 AF in the period of 1911 through 1960.

Key:

cfs – cubic feet per second

HFC – High Flow Channel

If the April 1 forecast in a given WY indicates that Oroville Reservoir would be drawn down to elevation 733 ft msl, minimum flows in the HFC may be diminished on a monthly average basis,

in the same proportion as the respective monthly deficiencies imposed on deliveries for agricultural use of the Project. However, in no case shall the minimum flow releases be reduced by more than 25 percent. If between October 15 and November 30, the highest total 1-hour flow exceeds 2,500 cfs, DWR shall maintain a minimum flow within 500 cfs of that peak flow, unless such flows are caused by flood flows, or an inadvertent equipment failure or malfunction.

Temperature Requirements

Low Flow Channel

NMFS has established a water temperature requirement for steelhead trout and spring-run Chinook salmon at Feather River RM 61.6 (Robinson Riffle in the LFC) from June 1 through September 30. The water temperature should be maintained at less than or equal to 65°F on a daily average basis.

High Flow Channel

While no numeric temperature requirement currently exists for the HFC, the 1983 Agreement requires DWR to provide suitable Feather River water temperatures for fall-run salmon not later than September 15, and to provide for suitable water temperatures below the Thermalito Afterbay Outlet for shad, striped bass, and other warm water fish between May 1 and September 15.

Current FRFH intake water temperature, as required by the 1983 DFG and DWR Agreement are in Table P-16.

Table P-16 Feather River Fish Hatchery Temperature Requirements

Period		Degrees F (± 4 ºF allowed)
April 1 – November 30		
	April 1 – May 15	51
	May 16 – May 31	55
	June 1 – June 15	56
	June 16 – August 15	60
	August 16 – August 31	58
	September 1 – September 30	52
	October 1 – November 30	51
December 1 – March 31		No greater than 55

Table P-17 summarizes current flow and temperature management in the Feather River Fish Hatchery and the Lower Feather River below Oroville Dam. These operational measures are in place in compliance with FERC license terms, agency agreements or ESA biological opinions and are provided to fully describe the baseline conditions.

Table P-17 Lower Feather River Flows and Temperature Management under Existing Conditions

Type of Measure	Title	Description
Minimum Flows	Minimum Release to Low Flow Channel (this includes water that returns from hatchery)	Maintain minimum flow of 600 cubic feet per second (cfs) within the Feather River downstream of the Thermalito Diversion Dam and the Feather River Fish Hatchery. FERC 1984. [Low Flow Channel Flow Standard]
	Minimum Release to High Flow Channel	Release water necessary to maintain flows in the Feather River below the Thermalito Afterbay Outlet in accordance with the minimum flow schedule presented in the Federal Energy Regulatory Commission (FERC) order, provided that releases will not cause Lake Oroville to be drawn below elevation 733 feet (ft) (approximately 1.5 million acre-feet [maf] of storage). If the April 1 runoff forecast in a given year indicates that the reservoir level will be drawn to 733 ft, water releases for fish may be reduced, but not by more than 25 percent.
Maximum Flows (non-flood control)	Maximum Flow into Feather River Fish Hatchery	Maximum flow into Feather River Fish Hatchery from the Diversion Pool is 115 cfs year round.
	Maximum Flow in the High Flow Channel	Maximum flow at Feather River below Thermalito Afterbay Outlet is **10,000 cfs** when Lake Oroville inflow is less than 10,000 cfs. [High Flow Channel Flow Standard] When Lake Oroville inflow is greater than 10,000 cfs, the maximum flow in the river below Thermalito Afterbay Outlet will be limited to inflow. If higher flow releases coincide with Chinook spawning activity, the ramping rate used to return to the minimum flow requirement will be chosen to avoid redd dewatering.
Ramping Rates	Ramping Rate Criteria	Flows less than 2,500 cfs cannot be reduced more than **300 cfs** during any 24-hour period, except for flood releases, failures, etc.
Water Supply	Releases from Lake Oroville	Releases for water supply, flood control, Sacramento–San Joaquin Delta (Delta) water quality requirements, and instream flow requirements of an average of 3 million acre-feet per year (maf/year) and approximately 1 maf/year to the Feather River Service Area (FRSA) for agricultural, municipal, and industrial uses in accordance with SWP contracts, DWR agreements, and water rights.
	Diversions from Feather River	Diversion of an estimated 60–70 thousand acre-feet per year (TAF/year) from the Feather River by senior water right holders per State Water Resources Control Board (SWRCB) licenses or permits for appropriative users.

Type of Measure	Title	Description
Flood Protection/Management	Flood Protection	The Oroville Facilities are operated for flood control purposes in conformance with the flood management regulations prescribed by the Secretary of the Army under the provisions of an Act of Congress (58 Stat. 890; 33 United States Code [USC] 709). - During floods, water releases from Oroville Dam and Thermalito Afterbay Dam will not increase floodflows above those prior to project existence. Operation of the project in the interest of flood control shall be in accordance with Section 204 of the Flood Control Act of 1958. - At high flows, fluctuate releases at least every couple of days to avoid riverbank/levee damage at one level. - Avoid extended periods of flow over the quantities listed above as much as possible to minimize the risk of seepage damage to orchards adjacent to the Feather River. - Maximum allowable flow is 180,000 cfs year round at the Feather River above the Yuba River. Maximum allowable flow is 300,000 cfs year round at the Feather River below the Yuba River. - Maximum allowable flow is 320,000 cfs year round at the Feather River below the Bear River.

Type of Measure	Title	Description
Temperature Criteria/Targets	At the Feather River Fish Hatchery and Robinson Riffle	Water temperature at Robinson Riffle must be less than 65 degrees between June and September. Water temperature during the fall months, after September 15, should be suitable for fall-run Chinook salmon. Water temperature from May through August should be suitable for American shad, striped bass, etc. At the Feather River Fish Hatchery Temperature (+/- 4°F) April 1–May 15 51° May 16–May 31 55° June 1–June 15 56° June 16–August 15 60° August 16–August 31 58° September 1–September 30 52° October 1–November 30 51° December 1–March 31 no greater than 55°
	Thermalito Afterbay Temperature Control	Operate facilities pursuant to the May 1968 Joint Water Agreement.
Natural Salmonid Spawning and Rearing Habitat	Salmonid Habitat Improvement – Endangered Species Act (ESA) Species Recovery Measures	Maintain conditions in the Low Flow Channel pursuant to 1983 Operating Agreement between DFG and DWR which is to prevent damage to fish and wildlife resources from operations and construction of the project.

Excerpt from Appendix B of the FERC Preliminary Draft Environmental Assessment, Oroville Facilities—FERC Project No. 2100

Flood Control

Flood control operations at Oroville Dam are conducted in coordination with DWR's Flood Operations Center and in accordance with the requirements set forth by the Corps. The Federal Government shared the expense of Oroville Dam, which provides up to 750,000 AF of flood control space. The spillway is located on the right abutment of the dam and has two separate elements: a controlled gated outlet and an emergency uncontrolled spillway. The gated control structure releases water to a concrete-lined chute that extends to the river. The uncontrolled emergency spill flows over natural terrain.

Table P-18 Water Year/Days in Flood Control/40-30-30 Index

Water Year	Days in Flood Control	40-30-30 Index
1981	0	D
1982	35	W
1983	51	W
1984	16	W
1985	0	D
1986	25	W
1987	0	D
1988	0	C
1989	0	D
1990	0	C
1991	0	C
1992	0	C
1993	8	AN
1994	0	C
1995	35	W
1996	22	W
1997	57	W
1998	0	W
1999	58	W
2000	0	AN
2001	0	D
2002	0	D

Feather River Ramping Rate Requirements

Maximum allowable ramp-down release requirements are intended to prevent rapid reductions in water levels that could potentially cause redd dewatering and stranding of juvenile salmonids and other aquatic organisms. Ramp-down release requirements to the

LFC during periods outside of flood management operations, and to the extent controllable during flood management operations, are shown in Table P-19.

Table P-19 Lower Feather River Ramping Rates

Releases to the Feather River Low Flow Channel (cfs)	Rate of Decrease (cfs)
5,000 to 3,501	1,000 per 24 hours
3,500 to 2,501	500 per 24 hours
2,500 to 600	300 per 24 hours

Key:
cfs = cubic feet per second
Source: NMFS 2004a

Proposed Operational Changes with the Federal Energy Regulatory Commission (FERC) Relicensing of the Oroville Project– Near Term and Future Operations

Until FERC issues the new license for the Oroville Project, DWR will not significantly change the operations of the facilities and when the FERC license is issued, it is assumed that downstream of Thermalito Afterbay Outlet, the future flows will remain the same.

There is a great deal of uncertainty as to when the license will be issued and what conditions will be imposed by FERC and the State Water Resources Control Board (SWRCB). The process that DWR has to go through to get the new license is as follows: DWR will finalize the Final Environment Impact Report in May 2008, the SWRCB will prepare the Clean Water Act Section 401 Certification (401 Cert) for the project which may take up to a year and the 401 Cert may have additional requirements for DWR operations of Oroville. Once the 401 Cert is issued, FERC can issue the new license; however, in the interim, the documents or process may be challenged in court. When the new FERC license is issued, additional flow or temperature requirements may be required. At this time, DWR can only assume that the flow and temperature conditions required will be those in the FERC Settlement Agreement (SA); therefore, those are what DWR proposes for the near-term and future Oroville operations.

The proposed future operations in the SA described in the Project Description include 100-200 cfs increase in flows in the LFC of the Lower Feather River and reduced water temperatures at the Feather River Hatchery and in the Low Flow and High Flow channels, after further analysis of alternatives and construction of one or more temperature control facilities. These are described in more detail in the SA. The flows in the HFC downstream of the TAO will not change. It is unlikely that either the proposed minor flow changes in the LFC or the reduced water temperatures will affect conditions in the Sacramento River downstream of the confluence but if they were detectable, they would be beneficial to anadromous fish in the Sacramento River.

The original FERC license to operate the Oroville Project expired in January 2007 and until a new license is issued, DWR will operate to the existing FERC license. FERC has and will continue to issue an annual license until it is prepared to issue the new 50-year license. In preparation for the expiration of the FERC license, DWR began working on the relicensing process in 2001. As part of the process, DWR entered into a SA with State, federal and local agencies, State Water Contractors, Non-Governmental Organizations, and Tribal governments to implement improvements within the FERC Boundary. The FERC boundary includes all of the Oroville Project facilities, extends upstream into the tributaries of Lake Oroville, includes portions of the LFC on the lower Feather River and downstream of the Thermalito Afterbay Outlet into the HFC. In addition to the Settlement Agreement signed in 2006, a Habitat Expansion Agreement was negotiated to address the fish passage issue over Oroville Dam and NMFS and the Service' Section 18 Authority under the Federal Power Act. FERC prepared an EIS for the proposed license and DWR prepared and EIR and biological assessments for FERC based on the terms and conditions in the Settlement Agreement. The SWRCB is working on the Section 401 Certification process and when all the environmental documents and permits are complete, the new 50-year FERC license will be issued for the Oroville Project, possibly in 2009.

FERC requested consultation with NMFS on the Oroville Project SA and DWR prepared and submitted the FERC biological assessment in June 2007 to NMFS and FERC. The SA does not change the flows in the HFC although there will be a proposed increase in minimum flows in the LFC. The SA includes habitat restoration actions such as side-channel construction, structural habitat improvement such as boulders and large woody debris, spawning gravel augmentation, a fish counting weir, riparian vegetation and floodplain restoration, and facility modifications to improve coldwater temperatures in the low and high flow channels. The SA and the FERC biological assessment provide substantial detail on the restoration actions in the Lower Feather River.

Below is a summary of articles in the SA referred to by number and is by no means a complete description of the terms and conditions therein. The numbering of the tables in this section is consistent with the numbering in the SA for direct comparison.

Minimum Flows in the Low Flow and High Flow Channels

When the FERC license is issued, DWR will release a minimum flow of 700 cfs into the LFC. The minimum flow shall be 800 cfs from September 9 to March 31 of each year to accommodate spawning of anadromous fish, unless the NMFS, the Service, DFG, and California SWRCB provide a written notice that a lower flow (between 700 cfs and 800 cfs) substantially meets the needs of anadromous fish. If the DWR receives such a notice, it may operate consistent with the revised minimum flow. HFC flows will remain the same as the existing license, consistent with the 1983 DWR and DFG Operating Agreement to continue to protect Chinook salmon from redd dewatering.

Water Temperatures for the Feather River Fish Hatchery

When the FERC license is issued, DWR will use the temperatures in Table P-20 as targets, and will seek to achieve them through the use of operational measures described below.

Table P-20 Maximum Mean Daily Temperatures,

September 1-September 30	56 °F
October 1 – May 31	55 °F
June 1 – August 31	60°F

The temperatures in Table P-20 are Maximum Mean Daily Temperatures, calculated by adding the hourly temperatures achieved each day and dividing by 24. DWR will strive to meet Maximum Mean Daily Temperatures through operational changes including but not limited to (i) curtailing pump-back operation and (ii) removing shutters on Hyatt intake and (iii) after river valve refurbishment. DWR will consider the use of the river valve up to a maximum of 1500 cfs; however these flows need not exceed the actual flows in the HFC, and should not be less than those specified in HFC minimum flows described above, which will not change with the new FERC license. During this interim period, DWR shall not be in violation if the Maximum Mean Daily Temperatures are not achieved through operational changes.

Prior to FERC license implementation, DWR agreed to begin the necessary studies for the refurbishment or replacement of the river valve. On October 31, 2006, DWR submitted to specific agencies a Reconnaissance Study of Facilities Modification to address temperature habitat needs for anadromous fisheries in the Low Flow Channel and the HFC. Under the provisions of Settlement Agreement Appendix B Section B108(a), DWR has begun a study to evaluate whether to refurbish or replace the river valve that may at times be used to provide cold water for the Feather River Fish Hatchery.

Upon completion of Facilities Modification(s) as provided in A108, and no later than the end of year ten following license issuance, Table P-20 temperatures shall become requirements, and DWR shall not exceed the Maximum Mean Daily Temperatures in Table P-20 for the remainder of the License term, except in Conference Years as referenced in A107.2(d).

During the term of the FERC license, DWR will not exceed the hatchery water temperatures in Table P-21. There will be no minimum temperature requirement except for the period of April 1 through May 31, during which the temperatures shall not fall below 51 ºF.

Table P-21 Hatchery Water Temperatures

September 1-September 30	56 °F
October 1 – November 30	55 °F
December 1 – March 31	55 °F

April 1 – May 15	55 °F
May 16-May 31	59°F
June 1-June 15	60°F
June 16- August 15	64°F
August 16 – August 31	62°F

Upon completion of Facilities Modification(s) as provided in A108 (discussed below), DWR may develop a new table for hatchery temperature requirements that is at least as protective as Table P-21. If a new table is developed, it shall be developed in consultation with the Ecological Committee, including specifically the Service, NMFS, DFG, California SWRCB, and RWQCB. The new table shall be submitted to FERC for approval, and upon approval shall become the temperature requirements for the hatchery for the remainder of the license term.

During Conference Years, as defined in A108.6, DWR shall confer with the Service, NMFS, DFG, and California SWRCB to determine proper temperature and hatchery disease management goals.

Water Temperatures in the Lower Feather River

Under the SA, DWR is committing to a Feasibility Study and Implementation Plan to improve temperature conditions (Facilities Modification(s)) for spawning, egg incubation, rearing and holding habitat for anadromous fish in the Low Flow Channel and HFC (A108.4). The Plan will recommend a specific alternative for implementation and will be prepared in consultation with the resource agencies.

Prior to the Facilities Modification(s) described in Article A108.4, if DWR does not achieve the applicable Table P-22 Robinson Riffle temperature upon release of the specified minimum flow, DWR shall singularly, or in combination perform the following actions:

(1) Curtail pump-back operation,

(2) Remove shutters on Hyatt Intake, and

(3) Increase flow releases in the LFC up to a maximum of 1500 cfs, consistent with the minimum flow standards in the HFC. Table P-22 temperatures are targets and if they are not met there is no license violation.

If in any given year DWR anticipates that these measures will not achieve the temperatures in Table P-22, DWR shall consult with the NMFS, the Service, DFG, and California SWRCB to discuss potential approaches to best managing the remaining coldwater pool in Lake Oroville, which may result in changes in the way Licensee performs actions (1), (2), and (3) listed above.

Table P-22 LFC as Measured at Robinson Riffle.

(all temperatures are in daily mean value (degrees F))

Month	Temperature (° F)
January	56
February	56
March	56
April	56
May 1-15	56-63*
May 16-31	63
June 1 – 15	63
June 16 – 30	63
July	63
August	63
September 1-8	63-58*
September 9 – 30	58
October	56
November	56
December	56
* Indicates a period of transition from the first temperature to the second temperature.	

After completion of the Facilities Modification(s), DWR shall no longer be required to perform the measures listed in (1), (2), and (3), unless Table P-22 temperatures are exceeded. DWR shall operate the project to meet temperature requirements in Table P-22 in the LFC, unless it is a Conference Year as described in Article 108.6. The proposed water temperature objectives in Table P-23 (in Article 108), measured at the southern FERC project boundary, will be evaluated for potential water temperature improvements in the HFC. DWR will study options for Facilities Modification(s) to achieve those temperature benefits.

There would be a testing period of at least five years in length to determine whether the HFC temperature benefits are being realized (A108.5). At the end of the testing period, DWR will prepare a testing report that may recommend changes in the facilities, compliance requirements for the HFC and the definition of Conference Years (those

years where DWR may have difficulties in achieving the temperature requirements due to hydrologic conditions.) The challenges of implementing Table P-23 temperatures will require the phased development of the Table P-23 water temperature objective and likely, a revision to Table P-23 prior to Table P-23 becoming a compliance obligation.

Table P-23 HFC as measured at Downstream Project Boundary

(all temperatures are in daily mean value (degrees F))

Month	Temperature
January	56
February	56
March	56
April	61
May	64
June	64
July	64
August	64
September	61
October	60
November	56
December	56

Habitat Expansion Agreement

The Habitat Expansion Agreement is a component of the 2006 SA to address DWR obligations in regard to blockage and fish passage issues in regard to the construction of Oroville Dam. Because it deals with offsite mitigation it will not included in the new FERC license.

Construction of the Oroville Facilities and Pacific Gas and Electric Company's construction of other hydroelectric facilities on the upper Feather River tributaries blocked passage and reduced available habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead. The reduction in spring-run habitat resulted in spatial overlap with fall-run Chinook salmon and has led to increased redd superimposition, competition for limited habitat, and genetic introgression. FERC relicensing of hydroelectric projects in the Feather River basin has focused attention on the desirability of expanding spawning, rearing and adult holding habitat available for Central Valley spring-run and steelhead. The SA Appendix F includes a provision to establish a habitat enhancement program with an approach for identifying, evaluating, selecting and implementing the most promising action(s) to expand such spawning, rearing and adult holding habitat in the Sacramento River Basin as a contribution to the

conservation and recovery of these species. The specific goal of the Habitat Expansion Agreement is to expand habitat sufficiently to accommodate an estimated net increase of 2,000 to 3,000 spring-run or steelhead for spawning (Habitat Expansion Threshold). The population size target of 2,000 to 3,000 spawning individuals was selected because it is approximately the number of spring-run and steelhead that historically migrated to the upper Feather River. Endangered species issues will be addressed and documented on a specific project-related basis for any restoration actions chosen and implemented under this Agreement.

Anadromous Fish Monitoring on the Lower Feather River

Until the new FERC license is issued and until a new monitoring program is adopted, DWR will continue to monitor anadromous fish in the Lower Feather River in compliance with the project description set out in Reclamation's 2004 OCAP biological assessment.

As required in the FERC SA (Article A101), within three years following the FERC license issuance, DWR will develop a comprehensive Lower Feather River Habitat Improvement Plan that will provide an overall strategy for managing the various environmental measures developed for implementation, including the implementation schedules, monitoring, and reporting. Each of the programs and components of the Lower Feather River Habitat Improvement Plan shall be individually evaluated to assess the overall effectiveness of each action within the Lower Feather River Habitat Improvement Plan.

Delta Field Division

SWP facilities in the southern Delta include Clifton Court Forebay, John E. Skinner Fish Facility, and the Banks Pumping Plant. CCF is a 31,000 AF reservoir located in the southwestern edge of the Delta, about ten miles northwest of Tracy. CCF provides storage for off-peak pumping, moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels, and collects sediment before it enters the California Aqueduct. Diversions from Old River into CCF are regulated by five radial gates.

The John E. Skinner Delta Fish Protective Facility is located west of the CCF, two miles upstream of the Banks Pumping Plant. The Skinner Fish Facility screens fish away from the pumps that lift water into the California Aqueduct (CA). Large fish and debris are directed away from the facility by a 388-foot long trash boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers, while the main flow of water continues through the louvers and towards the pumps. These fish pass through a secondary system of screens and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks.

The Banks Pumping Plant is in the South Delta, about eight miles northwest of Tracy and marks the beginning of the CA. By means of 11 pumps, including two rated at 375 cfs capacity, five at 1,130 cfs capacity, and four at 1,067 cfs capacity, the plant provides the

initial lift of water 244 feet into the CA. The nominal capacity of the Banks Pumping Plant is 10,300 cfs.

Other SWP operated facilities in and near the Delta include the North Bay Aqueduct (NBA), the Suisun Marsh Salinity Control Gates (SMSCG), Roaring River Distribution System (RRDS), and up to four temporary barriers in the South Delta. Each of these facilities is discussed further in later sections.

Clifton Court Forebay Aquatic Weed Control Program

DWR will apply copper based herbicide complexes including copper sulfate pentahydrate, Komeen,® and Nautique® on an as-needed basis to control aquatic weeds and algal blooms in Clifton Court Forebay (Forebay). Komeen® is a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate) and Nautique® is a copper carbonate compound (see Sepro product labels). These products are used to control algal blooms so that such algae blooms do not degrade drinking water quality through tastes and odors and production of algal toxins. Dense growth of submerged aquatic weeds, predominantly *Egeria densa*, can cause severe head loss and pump cavitation at Banks Pumping Plant when the stems of the rooted plant break free and drift into the trashracks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trashracks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the State Water Project.

Herbicide treatments will occur only in July and August on an as needed basis in the Forebay dependent upon the level of vegetation biomass in the enclosure. However, the frequency of herbicide applications is not expected to occur more than twice per year. Herbicides are typically applied early in the growing season when plants are susceptible to the herbicides due to rapid growth and formation of plant tissues, or later in the season, when plants are mobilizing energy stores from their leaves towards their roots for over wintering senescence. Past use of aquatic herbicides is presented in Table P-24.

Table P-24 Aquatic herbicide applications in Clifton Court Forebay, 1995- Present.

Note: The past applications are provided to give the reader an indication of the frequency of herbicide applications in the past (baseline).

Year	Date	Aquatic Herbicide
1995	5/15/1995	Komeen®
1995	8/21/1995	Komeen®
1996	6/11/1996	Komeen®
1996	9/10/1996	Komeen®

Year	Date	Aquatic Herbicide
1997	5/23/1997	Komeen®
1997	7/14/1997	Komeen®
1998	7/13/1998	Komeen®
1999	6/11/1999	Komeen®
2000	7/31/2000	Komeen®
2001	6/29/2001	Nautique
2002	6/24/2002	Komeen®
2003	5/12/2003	Nautique
2003	8/13/2003	Copper Sulfate
2004	6/3/2004	Komeen®
2004	7/22/2004	Copper Sulfate
2005	5/3/2005	Komeen®
2005	6/21/2005	Komeen®
2006	6/1/2006	Komeen®
2006	6/29/2006	Komeen®

Additionally, copper sulfate pentahydrate was applied once in 2003 and 2004 by helicopter to control taste and odor producing benthic cyanobacteria.

Aquatic weed management problems in the Forebay have to date been limited to about 700 acres of the 2,180 total water surface acres. Application of the herbicide is limited to only those areas in the Forebay that require treatment. The copper based herbicides, Komeen® or Nautique, are applied by helicopter or boat to only those portions where aquatic weeds present a management problem to the State.

To date, algal problems in the Forebay have been caused by attached benthic cyanobacteria which produce unpleasant tastes and odors in the domestic drinking water derived from the SWP operations. Copper sulfate is applied to the nearshore areas of the Forebay when results of Solid phase microextraction (SPME) (APHA, 2005) analysis exceed the control tolerances (MIB < 5 ng/L and geosmin < 10 ng/L are not detected by consumers in drinking water supplies)(Aquatic Pesticide Application Plan, 2004). Highest biomass of taste and odor producing cyanobacteria was present in the nearshore areas but not limited to shallow benthic zone. Annually, application areas may vary considerably based on the extent of the algal infestation in the Forebay.

DWR receives Clean Water Act pollutant discharge coverage under the National Pollutant Discharge Elimination System (NPDES) Permit No. CAG990005 (General Permit) issued by the SWRCB for application of aquatic pesticides to the SWP aqueducts, forebays, and reservoirs when necessary to achieve management goals. The State Board functions as the Environmental Protection Agency's non-federal representative for implementation of the Clean Water Act in California.

A Mitigated Negative Declaration was prepared by DWR to comply with CEQA requirements associated with regulatory requirements established by the SWRCB. DWR, a public entity, was granted a Section 5.3 Exception by the SWRCB (Water Quality Order 2004-0009-DWQ) and is not required to meet the copper limitation in receiving waters during the exception period from March 1 to November 30 as described in the DWR's Aquatic Pesticide Application Plan. .

Proposed Measures to Reduce Fish Mortality

Komeen® will be applied according to the product label directions as required by state and federal law. The Forebay elevation will be raised to +2 feet above mean sea level for an average depth of about 6 feet within the 700-water surface acre treatment zone. The herbicide will be applied at a rate of 13 gallons per surface acre to achieve a final operational concentration in the water body of 0.64 mg/L Cu^{2+}. (640 ppb). Application rate of 13 gallons per surface area is calculated based on mean depth. The product label allows applications up to 1 mg/L (1000 ppb or 1 ppm). DWR applies Komeen in accordance with the specimen label that states, "If treated water is a source of potable water, the residue of copper must not exceed 1 ppm (mg/L)".

In 2005, 770 surface acres were treated with Komeen®. Clifton Court Forebay has a mean depth of 6 feet at 2 feet above mean sea level; thus the volume treated is 4620 acre-feet.

The concentration of the active ingredient (Cu^{2+}) is calculated from the following equation:

Cu^{2+} (ppm) = Komeen (gallon)/ (Mean Depth (feet) * 3.34)) Source: Komeen® Specimen Label EPA reg No. 67690-25

The calculated concentration of Cu^{2+} for the 2005 application was 0.65 mg/L Cu^{2+}. The copper level required to control *Egeria densa* (the main component of the Clifton Court Forebay aquatic plant community) is 0.5 - 0.75 mg/L Cu^{2+}. Source: Komeen® Specimen Label.

Prior to application of copper based herbicides, toxicity testing and literature review of LC-50 levels for salmon, steelhead, delta smelt, and green sturgeon may be conducted. Once applied, the initial stock copper concentration is reduced rapidly (hours) by dilution (Komeen® applied according to the Specimen Label (SePro Corporation) of the product in the receiving water to achieve final concentration levels. Based on the treatment elevation of +2 feet, only about 20 percent (4,630 AF) of the 22,665 AF Forebay will be treated (AF = Acre-feet= volume). The copper will be applied beginning on one side of

the Forebay allowing fish to move out of the treatment area. In addition, Komeen® will be applied by boats at a slower rate than in previous years when a helicopter was used.

In 2006 DWR proposed the following actions to reduce fish mortality in coordination with DFG and NMFS. Also, the hydroacoustical aquatic plant survey was continued in 2007 when no Komeen application was done. A survey in 2008 is also planned. These actions will continue to be followed in the future.

1. Komeen® or copper sulfate will only be applied in July and August.
2. The salvage of listed fish species at Skinner Fish Facility will be monitored prior to the Komeen® application.
3. The intake (radial) gates at Clifton Court Forebay will be closed 24 hours prior to the scheduled application to improve fish passage out of the designated treatment areas.
4. The radial gates will not be re-opened to allow inflow into the Forebay for 24 hours following the end of the aquatic herbicide application. The Clifton Court intake gates will therefore be closed for 48 hours. The Komeen® Specimen Label recommends a 12-24 hours contact with target weeds to provide effective control. Twenty-four hours is at the high end for recommended contact time according to the Komeen® Specimen Label.
5. Komeen® will be applied by boat, first to the nearshore areas and then outwards in transects away from the shore. The application will be conducted by a private contractor and supervised by a California Certified Pest Control Advisor.
6. The herbicide treatment will be scheduled and planned for minimizing the treatment area by using hydroacoustical plant mapping technology to locate and estimate the area of submerged vegetation beds. The smallest possible area will be treated to minimize both the volume of aquatic herbicide applied and lessen the impacts to fish in the Forebay. Examples of figures from the 2005 hydroacoustical survey are enclosed.
7. Copper monitoring and analysis will follow the procedures described in the DWR Quality Assurance Project Plan submitted to the State Water Resources Control Board in February 2002. There are no plans to measure sediment and detrial copper concentrations. The Quality Assurance Plan was submitted to the SWRCB on February 26, 2002 and no comments were received.

North Bay Aqueduct Intake at Barker Slough

The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct (NBA) for delivery in Napa and Solano Counties. Maximum pumping capacity is 175 cfs (pipeline capacity). During the past few years, daily pumping rates have ranged between 0 and 140 cfs. The current maximum pumping rate is 140 cfs because an additional pump is required to be installed to reach 175 cfs. In addition, growth of biofilm in a portion of the pipeline is also limiting the NBA ability to reach its full capacity.

The NBA intake is located approximately 10 miles from the main stem Sacramento River at the end of Barker Slough. Per salmon screening criteria, each of the ten NBA pump bays is individually screened with a positive barrier fish screen consisting of a series of flat, stainless steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude fish approximately one inch or larger from being entrained. The bays tied to the two smaller units have an approach velocity of about 0.2 ft/s. The larger units were designed for a 0.5 ft/s approach velocity, but actual approach velocity is about 0.44 ft/s. The screens are routinely cleaned to prevent excessive head loss, thereby minimizing increased localized approach velocities.

Delta smelt monitoring was required at Barker Slough under the March 6, 1995 OCAP BO. Starting in 1995, monitoring was required every other day at three sites from mid-February through mid-July, when delta smelt may be present and continued monitoring was stopped in 2005. As part of the Interagency Ecological Program (IEP), DWR has contracted with the DFG to conduct the required monitoring each year since the biological opinion was issued. Details about the survey and data are available on DFG's website (http://www.delta.dfg.ca.gov/data/NBA).

Beginning in 2008, the NBA larval sampling will be replaced by an expanded 20-mm survey (described at http://www.delta.dfg.ca.gov/data/20mm) that has proven to be fairly effective at tracking delta smelt distribution and reducing entrainment. The expanded survey covers all existing 20-mm stations, in addition to a new suite of stations near NBA. The expanded survey also has an earlier seasonal start and stop date to focus on the presence of larvae in the Delta. The gear type was a surface boom tow, as opposed to oblique sled tows that have traditionally been used to sample larval fishes in the San Francisco Estuary.

Coordinated Facilities of the CVP and SWP

Joint Project Facilities

Suisun Marsh

Since the early 1970's, the California Legislature, SWRCB, Reclamation, DFG, Suisun Resource Conservation District (SRCD), DWR, and other agencies have worked to preserve beneficial uses of Suisun Marsh in mitigation for perceived impacts of reduced Delta Outflow on the salinity regime. Early on, salinity standards set by the SWRCB to protect alkali bulrush production, a primary waterfowl plant food. The most recent standard under SWRCB D-1641 acknowledges that multiple beneficial uses deserve protection.

A contractual agreement between DWR, Reclamation, DFG and SRCD contains provisions for DWR and Reclamation to mitigate the effects on Suisun Marsh channel water salinity from the SWP and CVP operations and other upstream diversions. The Suisun Marsh Preservation Agreement (SMPA) requires DWR and Reclamation to meet salinity standards (Figure P-13), sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. In addition to the contractual

agreement, SWRCB D-1485 codified salinity standards in 1978, which have been carried forward to SWRCB D-1641.

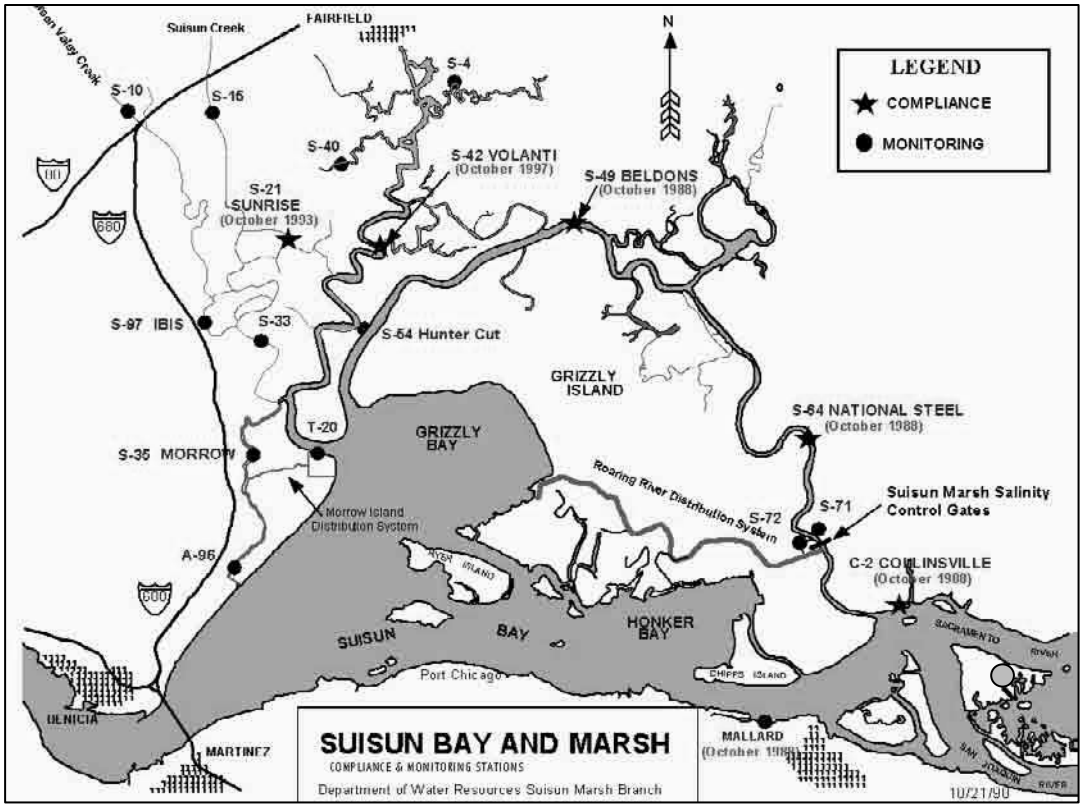


Figure P-13 Compliance and monitoring stations and salinity control facilities in Suisun Marsh.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641 and the SMPA: (1) the implementation and operation of physical facilities in the Marsh; and (2) management of Delta outflow (i.e. facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since the early 1980s and have proven to be a highly reliable method for meeting standards. However, since Delta outflow cannot be actively managed by the Suisun Marsh Program, Marsh facility operations must be adaptive in response to changing salinity levels in the Delta.

CALFED Charter for Development of an Implementation Plan for Suisun Marsh Wildlife Habitat Management and Preservation

The goal of the CALFED Charter is to develop a regional plan that balances implementation of the CALFED Program, SMPA, and other management and restoration programs within Suisun Marsh. This is to be conducted in a manner that is responsive to the concerns of stakeholders and based upon voluntary participation by private land owners. The Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh (Suisun Marsh Plan) and its accompanying Programmatic Environmental Impact Statement/Report will develop, analyze, and evaluate potential effects of various actions

in the Suisun Marsh. The actions are intended to preserve and enhance managed seasonal wetlands, implement a comprehensive levee protection/improvement program, and protect ecosystem and drinking water quality, while restoring habitat for tidal marsh-dependent sensitive species, consistent with the CALFED Bay-Delta Program's strategic goals and objectives. The Service and Reclamation are NEPA co-leads while DFG is the lead state CEQA agency.

Suisun Marsh Salinity Control Gates

The SMSCG are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. Operation of the SMSCG began in October 1988 as Phase II of the Plan of Protection for the Suisun Marsh. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough The facility, spanning the 465 foot width of Montezuma Slough, consists of a boat lock, a series of three radial gates, and removable flashboards. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west.

When Delta outflow is low to moderate and the gates are not operating, tidal flow past the gate is approximately +/- 5,000-6,000 cfs while the net flow is near zero. When operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000-6,000 cfs. The net flow in Montezuma Slough becomes approximately 2,500-2,800 cfs. The Corps of Engineers permit for operating the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards. Historically, the gate has been operated as early as October 1, while in some years (e.g. 1996) the gate was not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the flashboards are removed and the gates raised to allow unrestricted movement through Montezuma Slough. Details of annual gate operations can be found in “Summary of Salinity Conditions in Suisun Marsh During WYs 1984-1992", or the “Suisun Marsh Monitoring Program Data Summary” produced annually by DWR, Division of Environmental Services.

The approximately 2,800 cfs net flow induced by SMSCG operation is effective at moving the salinity downstream in Montezuma Slough. Salinity is reduced by roughly one-hundred percent at Beldons Landing, and lesser amounts further west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow (measured nominally at Chipps Island) is reduced by gate operation (Figure P-14). Net outflow through Carquinez Strait is not affected. Figure P-14 indicates the approximate position of X2 and how is transported upstream when the gate is operated.

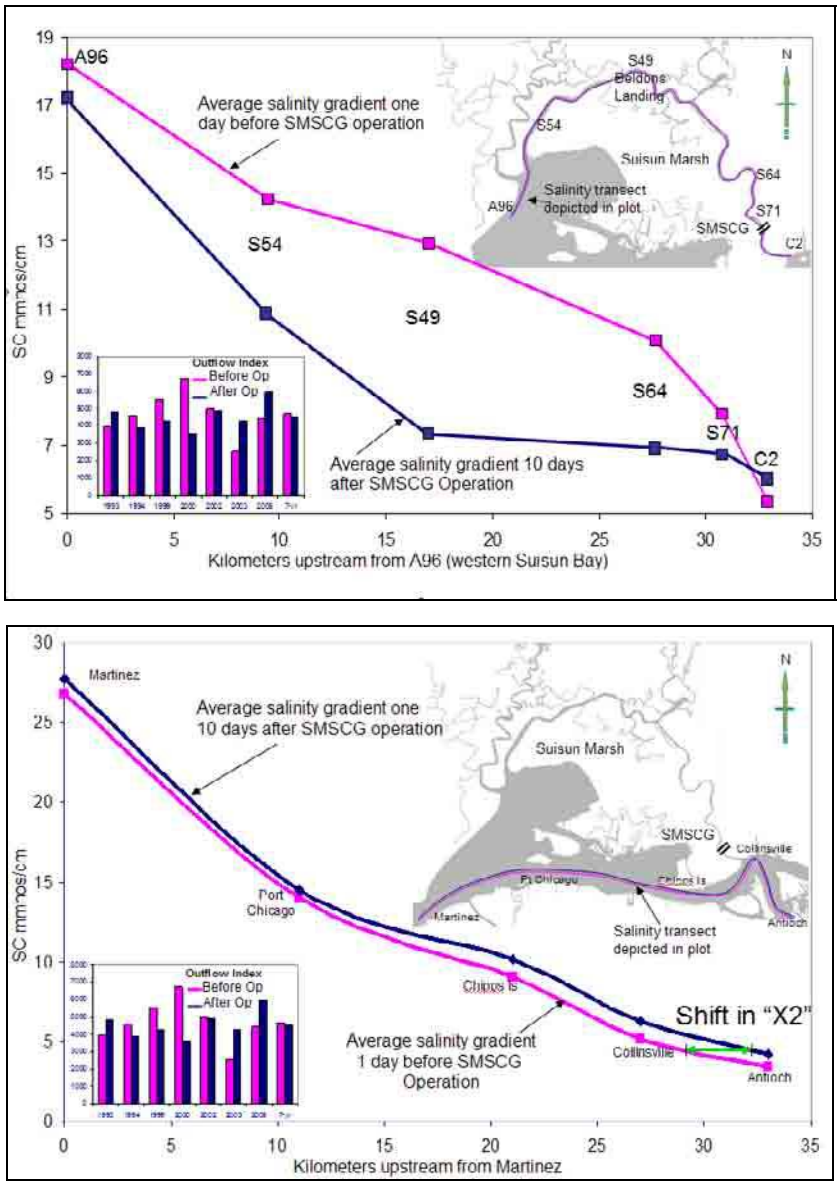


Figure P-14 Average of seven years salinity response to SMSCG gate operation in Montezuma Slough and Suisun Bay.

Note: Magenta line is salinity profile 1 day before gate operation, blue line is salinity 10 days after gate operation.

It is important to note that historical gate operations (1988 – 2002) were much more frequent than recent and current operations (2006 – May 2008). Operational frequency is affected by many drivers (hydrologic conditions, weather, Delta outflow, tide, fishery considerations, etc). The gates have also been operated for scientific studies. Figure P-15 shows that the gates were operated between 60 and 120 days between October and December during the early years (1988-2004). Salmon passage studies between 1998 and 2003 increased the number of operating days by up to 14 to meet study requirements. After discussions with NMFS based on study findings, the boat lock portion of the gate is now held open at all times during SMSCG operation to allow for continuous salmon

passage opportunity. With increased understanding of the effectiveness of the gates in lowering salinity in Montezuma Slough, salinity standards have been met with less frequent gate operation since 2006. Despite very low outflow in the fall of the two most recent WYs, gate operation was not required at all in fall 2007 and was limited to 17 days in winter 2008. Assuming no significant, long-term changes in the drivers mentioned above, this level of operational frequency (10 – 20 days per year) can generally be expected to continue to meet standards in the future except perhaps during the most critical hydrologic conditions and/or other conditions that affect Delta outflow.

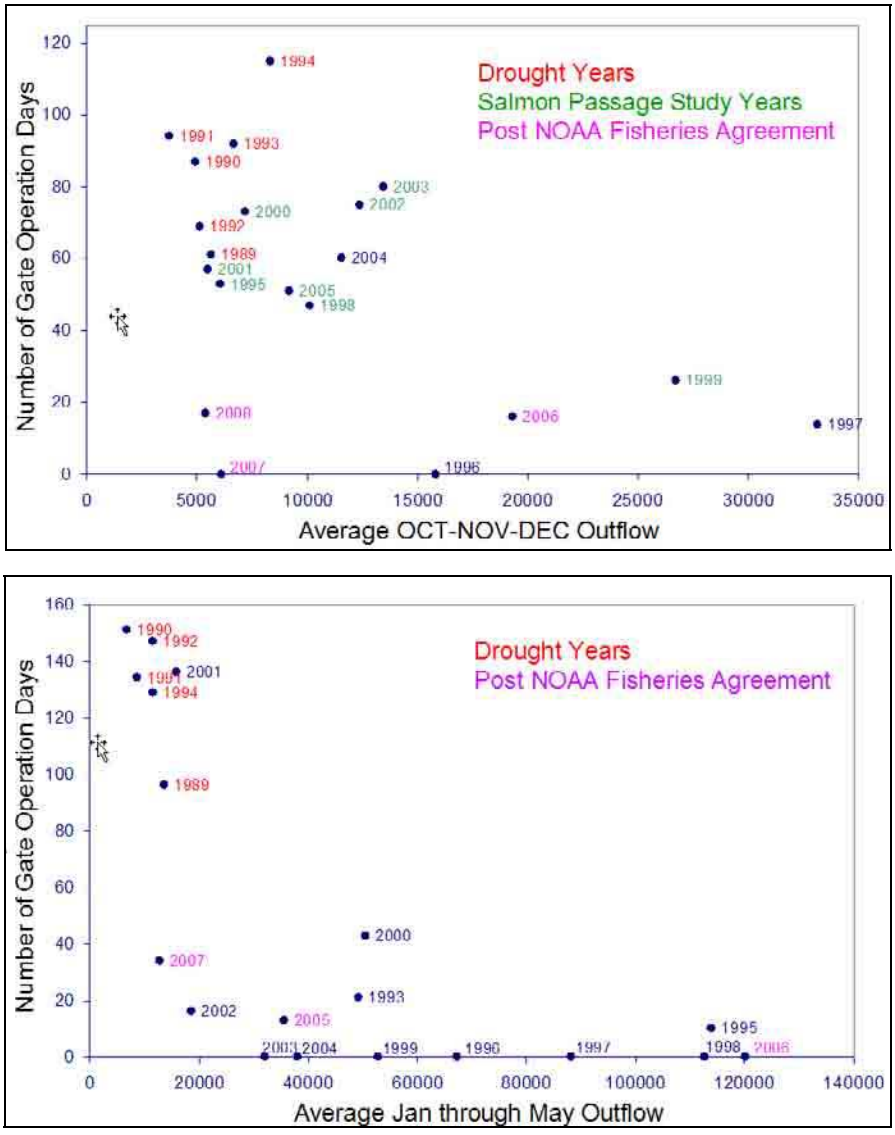


Figure P-15 SMSCG operation frequency versus outflow since 1988.

SMSCG Fish Passage Study

The SMSCG were constructed and operate under Permit 16223E58 issued by the Corps, which includes a special condition to evaluate the nature of delays to migrating fish.

Ultrasonic telemetry studies in 1993 and 1994 showed that the physical configuration and operation of the gates during the Control Season have a negative effect on adult salmonid passage (Tillman et al 1996: Edwards et al 1996).

DWR coordinated additional fish passage studies in 1998, 1999, 2001, 2002, 2003, and 2004. Migrating adult fall-run Chinook salmon were tagged and tracked by telemetry in the vicinity of the SMSCG to assess potential measures to increase the salmon passage rate and decrease salmon passage time through the gates.

Results in 2001, 2003, and 2004 indicate that leaving the boat-lock open during the Control Season when the flashboards are in place at the SMSCG and the radial gates are tidally operated provides a nearly equivalent fish passage to the Non-Control Season configuration when the flashboards are out and the radial gates are open. This approach minimizes delay and blockage of adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead migrating upstream during the Control Season while the SMSCG is operating. However, the boat-lock gates may be closed temporarily to stabilize flows to facilitate safe passage of watercraft through the facility.

Reclamation and DWR are continuing to coordinate with the SMSCG Steering Committee in identifying water quality criteria, operational rules, and potential measures to facilitate removal of the flashboards during the Control Season that would provide the most benefit to migrating fish. However, the flashboards would not be removed during the Control Season unless it was certain that standards would be met for the remainder of the Control Season without the flashboards installed.

Roaring River Distribution System

The Roaring River Distribution System (RRDS) was constructed during 1979 and 1980 as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The system was constructed to provide lower salinity water to 5,000 acres of private and 3,000 acres of DFG managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands.

The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond control flows through the culverts into the pond. A manually operated flap gate and flashboard riser are located at the confluence of Roaring River and Montezuma Slough to allow drainage back into Montezuma Slough for controlling water levels in the distribution system and for flood protection. DWR owns and operates this drain gate to ensure the Roaring River levees are not compromised during extremely high tides.

Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in RRDS above the adjacent managed wetlands. Managed wetlands north and south of the RRDS receive water, as needed, through publicly and privately owned turnouts on the system.

The intake to the RRDS is screened to prevent entrainment of fish larger than approximately 25 mm. DWR designed and installed the screens based on DFG criteria. The screen is a stationary vertical screen constructed of continuous-slot stainless steel wedge wire. All screens have 3/32-inch slot openings. After the listing of delta smelt, RRDS diversion rates have been controlled to maintain an average approach velocity below 0.2 ft/s at the intake fish screen. Initially, the intake culverts were held at about 20 percent capacity to meet the velocity criterion at high tide. Since 1996, the motorized slide gates have been operated remotely to allow hourly adjustment of gate openings to maximize diversion throughout the tide.

Routine maintenance of the system is conducted by DWR and primarily consists of maintaining the levee roads and fish screens. RRDS, like other levees in the marsh, have experienced subsidence since the levees were constructed in 1980. In 1999, DWR restored all 16 miles of levees to design elevation as part of damage repairs following the 1998 flooding in Suisun Marsh. In 2006, portions of the north levee were repaired to address damage following the January 2006 flooding.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) was constructed in 1979 and 1980 in the south-western Suisun Marsh as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The contractual requirement for the Reclamation and DWR is to provide water to the ownerships so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough (GYS).

The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor through three 48-inch culverts. Drainage water from Morrow Island is discharged into Grizzly Bay by way of the C-Line Outfall (two 36-inch culverts) and into the mouth of Suisun Slough by way of the M-Line Outfall (three 48-inch culverts), rather than back into Goodyear Slough. This helps prevent increases in salinity due to drainage water discharges into Goodyear Slough. The M-Line ditch is approximately 1.6 miles in length and the C-Line ditch is approximately 0.8 miles in length.

The 1997 Service biological opinion issued for dredging of the facility included a requirement for screening the diversion to protect delta smelt. Due to the high cost of fish screens and the lack of certainty surrounding their effectiveness at MIDS, DWR and Reclamation proposed to investigate fish entrainment at the MIDS intake with regard to fishery populations in Goodyear Slough and to evaluate whether screening the diversion would provide substantial benefits to local populations of listed fish species.

To meet contractual commitments, the typical MIDS annual operations are described in detail in the biological assessment. There are currently no plans to modify operations.

South Delta Temporary Barriers Project

The South Delta Temporary Barrier Project (TBP) was initiated by DWR in 1991. Permit extensions were granted in 1996 and again in 2001, when DWR obtained permits to extend the Temporary Barriers Project through 2007. The Service has approved the extension of the permits through 2008. Continued coverage by the Service for the TBP will be assessed under this biological opinion for the operational effects and under a separate Section 7 consultation for the construction and demolition effects. The NMFS recently submitted a biological opinion to the Corps which provides incidental take coverage for the continuation of the TBP through 2010.

The project consists of four rock barriers across South Delta channels. In various combinations, these barriers improve water levels and San Joaquin River salmon migration in the South Delta. The existing TBP consists of installation and removal of temporary rock barriers at the following locations:

- Middle River near Victoria Canal, about 0.5 miles south of the confluence of Middle River, Trapper Slough, and North Canal
- Old River near Tracy, about 0.5 miles east of the DMC intake
- Grant Line Canal near Tracy Boulevard Bridge, about 400 feet east of Tracy Boulevard Bridge
- The head of Old River at the confluence of Old River and San Joaquin River

The barriers on Middle River, Old River near Tracy, and Grant Line Canal are flow control facilities designed to improve water levels for agricultural diversions and are in place during the growing season. Under the Service biological opinion for the Temporary Barriers, operation of the barriers at Middle River and Old River near Tracy can begin May 15, or as early as April 15 if the spring barrier at the head of Old River is in place. From May 16 to May 31 (if the barrier at the head of Old River is removed) the tide gates are tied open in the barriers in Middle River and Old River near Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and Grant Line Canal are permitted to be operational until they are completely removed by November 30.

During the spring, the barrier at the head of Old River is designed to reduce the number of out-migrating salmon smolts entering Old River. During the fall, this barrier is designed to improve flow and DO conditions in the San Joaquin River for the immigration of adult fall-run Chinook salmon. The barrier at the head of Old River barrier is typically in place between April 15 to May 15 for the spring, and between early September to late November for the fall. Installation and operation of the barrier also depends on San Joaquin flow conditions.

Proposed Installation and Operations of the Temporary Barriers

The installation and operation of the TBP will continue until the permanent gates are constructed. The proposed installation schedule through 2010 will be identical to the current schedule. However, because of recent court rulings to protect Delta smelt, the installation of the spring HOR barrier was prohibited in 2008. As a result, the

agricultural barriers installations were delayed according to the current permits until mid-May.

To improve water circulation and quality, DWR in coordination with the South Delta Water Agency and Reclamation, began in 2007 to manually tie open the culvert flap gates at the Old River near Tracy barrier to improve water circulation and untie them when water levels fell unacceptably. This operation is expected to continue in subsequent years as needed to improve quality. Adjusting the barrier weir heights is being considered to improve water quality and circulation. DWR will consult with the Service and NMFS if changes in the height of any or all of the weirs is sought.

As the permanent gates are being constructed, temporary barrier operations will continue as planned and permitted. Computer model forecasts, real time monitoring, and coordination with local, State, and federal agencies and stakeholders will help determine if the temporary rock barriers operations need to be modified during the transition period.

Conservation Strategies and Mitigation Measures

Various measures and conditions required by regulatory agencies under past and current permits to avoid, minimize, and compensate for the TBP impacts have been complied with by DWR. An ongoing monitoring plan is implemented each year the barriers are installed and an annual monitoring report is prepared to summarize the activities. The monitoring elements include fisheries monitoring and water quality analysis, Head of Old River fish entrainment and Kodiak trawling study, salmon smolt survival investigations, barrier effects on SWP and CVP entrainment, Swainson's Hawk monitoring, water elevation, water quality sampling, and hydrologic modeling. DWR operates fish screens at Sherman Island.

San Luis Complex

Water in the mainstem of the California Aqueduct flows south by gravity into the San Luis Joint-Use Complex (Figure P-16), which was designed and constructed by the federal government and is operated and maintained by the DWR. This section of the California Aqueduct serves both the SWP and the federal CVP.

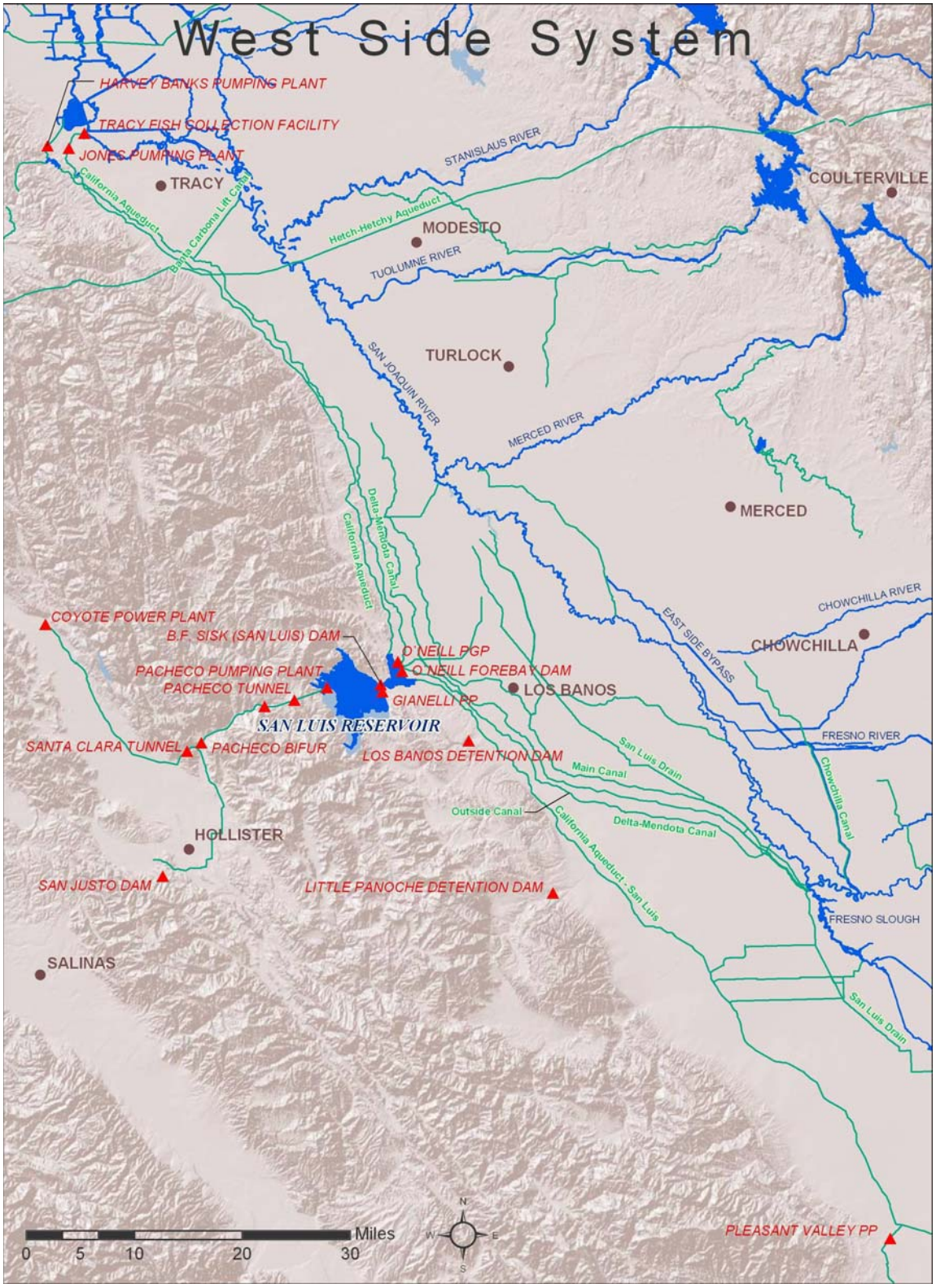


Figure P-16 San Luis Complex

San Luis Reservoir, the nation's largest offstream reservoir (it has no natural watershed), is impounded by Sisk Dam, lies at the base of the foothills on the west side of the San Joaquin Valley in Merced County, about two miles west of O'Neill Forebay. The reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage. The reservoir can hold 2,027,840 AF, of which 1,062,180 AF is the state's share, and 965,660 AF is the federal share. Construction began in 1963 and was completed in 1967. Filled in 1969, the reservoir also provides a variety of recreational activities as well as fish and wildlife benefits.

In addition to the Sisk Dam, San Luis Reservoir and O'Neill Dam and Forebay, the San Luis Complex consists of the following: (1) O'Neill Pumping-Generating Plant (Federal facility); (2) William R. Gianelli Pumping-Generating Plant (joint Federal-State facilities); (3) San Luis Canal (joint Federal-State facilities); (4) Dos Amigos Pumping Plant (joint Federal-State facilities); (5) Coalinga Canal (Federal facility); (6) Pleasant Valley Pumping Plant (Federal facility); and (7) the Los Banos and Little Panoche Detention Dams and Reservoirs (joint Federal-State facilities).

The O'Neill Pumping-Generating Plant pumps water from the Delta-Mendota Canal to the O'Neill Forebay where it mixes with water from the California Aqueduct. From O'Neill Forebay, the water can either be pumped up into San Luis Reservoir via Gianelli Pumping-Generating Plant or leave via the San Luis Canal. The Dos Amigos Pumping Plant is located on the San Luis Canal and 18 miles southeast of Sisk Dam. It lifts water 113 feet from the Aqueduct as it flows south from O'Neill Forebay.

Los Banos Detention Dam and Reservoir provide flood protection for San Luis Canal, Delta Mendota Canal, the City of Los Banos, and other downstream developments. Between September and March, 14,000 AF of space is maintained for flood control under specified conditions. Little Panoche Detention Dam and Reservoir provide flood protection for San Luis Canal, Delta Mendota Canal and other downstream developments. Water is stored behind the dam above dead storage of 315 AF only during the period that inflow from Little Panoche Creek exceeds the capacity of the outlet works.

To provide water to CVP and SWP contractors: (1) water demands and anticipated water schedules for water service contractors and exchange contractors must be determined; (2) a plan to fill and draw down San Luis Reservoir must be made; and (3) Delta pumping and San Luis Reservoir use must be coordinated.

The San Luis Reservoir has very little natural inflow. Water is redirected during the fall, winter and spring months when the two pumping plants can divert more water from the Delta than is needed for scheduled demands. Because the amount of water that can be diverted from the Delta is limited by available water supply, Delta constraints, and the capacities of the two pumping plants, the fill and drawdown cycle of San Luis Reservoir is an extremely important element of Project operations.

Reclamation attempts to maintain adequate storage in San Luis Reservoir to ensure delivery capacity through Pacheco Pumping Plant to the San Felipe Division. Delivery capacity is significantly diminished as reservoir levels drop to the 326 ft elevation (79,000 acre-feet), the bottom of the lowest Pacheco Tunnel Inlet pipe. Lower reservoir

elevations can also result in turbidity and algal treatment problems for the San Felipe Division water users. These conditions of reduced or impending interruption in San Felipe Division deliveries require operational responses by Santa Clara Valley Water District to reduce or eliminate water deliveries for in-stream and offstream groundwater recharge, and to manage for treatment plant impacts. Depending on availability of local supplies, prolonged reduction or interruption in San Felipe Division deliveries may also result in localized groundwater overdraft.

A typical San Luis Reservoir annual operation cycle starts with the CVP's share of the reservoir storage nearly empty at the end of August. Irrigation demands decrease in September and the opportunity to begin refilling San Luis Reservoir depends on the available water supply in the northern CVP reservoirs and the pumping capability at Jones Pumping Plant that exceeds water demands. Jones Pumping Plant operations generally continue at the maximum diversion rates until early spring, unless San Luis Reservoir is filled or the Delta water supply is not available. As outlined in the Interior's Decision on Implementation of Section 3406 (b)(2) of the CVPIA, Jones Pumping Plant diversion rates may be reduced during the fill cycle of the San Luis Reservoir for fishery management.

In April and May, export pumping from the Delta is limited during the SWRCB D-1641 San Joaquin River pulse period standards as well as by the Vernalis Adaptive Management Program. During this same time, CVP-SWP irrigation demands are increasing. Consequently, by April and May the San Luis Reservoir has begun the annual drawdown cycle. In some exceptionally wet conditions, when excess flood water supplies from the San Joaquin River or Tulare Lake Basin occur in the spring, the San Luis Reservoir may not begin its drawdown cycle until late in the spring.

In July and August, the Jones Pumping Plant diversion is at the maximum capability and some CVP water may be exported using excess Banks Pumping Plant capacity as part of a Joint Point of Diversion operation. Irrigation demands are greatest during this period and San Luis continues to decrease in storage capability until it reaches a low point late in August and the cycle begins anew.

San Luis Unit Operation

The CVP operation of the San Luis Unit requires coordination with the SWP since some of its facilities are entirely owned by the State and others are joint State and Federal facilities. Similar to the CVP, the SWP also has water demands and schedules it must meet with limited water supplies and facilities. Coordinating the operations of the two projects avoids inefficient situations (for example, one entity pumping water at the San Luis Reservoir while the other is releasing water).

Total CVP San Luis Unit annual water supply is contingent on coordination with the SWP needs and capabilities. When the SWP excess capacity is used to support additional pumping for the CVP JPOD allowance it may be of little consequence to SWP operations, but extremely critical to CVP operations. The availability of excess SWP capacity for the CVP is contingent on the ability of the SWP to meet its SWP contractors' water supply commitments. Generally, the CVP will utilize excess SWP capacity; however, there are times when the SWP may need to utilize excess CVP capacity.

Additionally, close coordination by CVP and SWP is required during this type of operation to ensure that water pumped into O'Neill Forebay does not exceed the CVP's capability to pump into San Luis Reservoir or into the San Luis Canal at the Dos Amigos Pumping Plant.

Although secondary to water management concerns, power scheduling at the joint facilities also requires close coordination. Because of time-of-use power cost differences, both entities will likely want to schedule pumping and generation simultaneously. When facility capabilities of the two projects are limited, equitable solutions are achieved between the operators of the SWP and the CVP.

From time to time, coordination between the Projects is also necessary to avoid sustained rapid drawdown limit at San Luis Reservoir which can cause sloughing of the bank material into the reservoir, resulting in water quality degradation and requiring additional maintenance on the dam.

With the existing facility configuration, the operation of the San Luis Reservoir could impact the water quality and reliability of water deliveries to the San Felipe Division, if San Luis Reservoir is drawn down too low. Reclamation has an obligation to address this condition and may solicit cooperation from DWR, as long as changes in SWP operations to assist with providing additional water in San Luis Reservoir (beyond what is needed for SWP deliveries and the SWP share of San Luis Reservoir minimum storage) does not impact SWP allocations and/or deliveries. If the CVP is not able to maintain sufficient storage in San Luis Reservoir, there could be potential impacts to resources in Santa Clara and San Benito Counties. Solving the San Luis low point problem or developing an alternative method to deliver CVP water to the San Felipe Division would allow Reclamation to utilize the CVP share of San Luis Reservoir fully without impacting the San Felipe Division water supply. If Reclamation pursues changes to the operation of the CVP (and SWP), such changes would have to be consistent with the operating criteria of the specific facility. If alternate delivery methods for the San Felipe Division are implemented, it may allow the CVP to utilize more of it available storage in San Luis Reservoir, but may not change the total diversions from the Delta. For example, any changes in Delta pumping that would be the result of additional effective storage capacity in San Luis Reservoir would be consistent with the operating conditions for the Banks and Jones Pumping Plants.

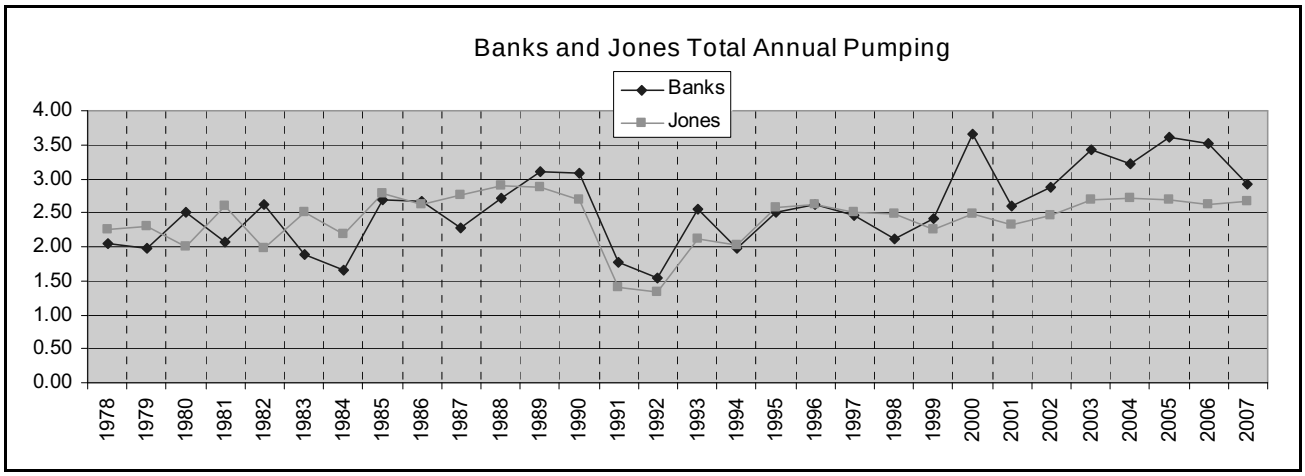


Figure P-17 Total Annual Pumping at Banks and Jones Pumping Plant 1978-2007 (MAF)

Table P-25 Total Annual Pumping at Banks and Jones Pumping Plant 1978-2007 (MAF)

	Hydrologic	Banks			Jones			Contra	CVP Total	SWP Total	CVP	Shasta
	Index	SWP	CVP	Total	SWP	CVP	Total	Costa	Delta	Delta	SOD-Ag	Index
WY	40-30-30								Pumping	Pumping	Allocation	Critical
1978	AN	2.01	0.04	2.05	0.00	2.26	2.26	0.08	2.38	2.01	100%	
1979	BN	1.76	0.23	1.98	0.00	2.30	2.30	0.09	2.61	1.76	100%	
1980	AN	2.17	0.34	2.52	0.00	2.00	2.00	0.09	2.43	2.17	100%	
1981	D	1.97	0.10	2.07	0.00	2.60	2.60	0.11	2.80	1.97	100%	
1982	W	2.43	0.20	2.63	0.00	1.97	1.97	0.08	2.25	2.43	100%	
1983	W	1.76	0.13	1.89	0.00	2.51	2.51	0.08	2.72	1.76	100%	
1984	W	1.40	0.25	1.65	0.00	2.19	2.19	0.10	2.54	1.40	100%	
1985	D	2.16	0.53	2.68	0.00	2.79	2.79	0.11	3.43	2.16	100%	
1986	W	2.46	0.21	2.67	0.00	2.62	2.62	0.11	2.94	2.46	100%	
1987	D	2.01	0.27	2.28	0.00	2.76	2.76	0.13	3.16	2.01	100%	
1988	C	2.32	0.38	2.71	0.00	2.90	2.90	0.14	3.42	2.32	100%	
1989	D	2.70	0.39	3.10	0.00	2.87	2.87	0.13	3.40	2.70	100%	
1990	C	2.85	0.24	3.09	0.00	2.70	2.70	0.14	3.07	2.85	50%	
1991	C	1.64	0.14	1.78	0.00	1.41	1.41	0.11	1.65	1.64	25%	C
1992	C	1.51	0.04	1.55	0.00	1.34	1.34	0.10	1.49	1.51	25%	C
1993	AN	2.53	0.02	2.56	0.00	2.11	2.11	0.10	2.22	2.53	50%	
1994	C	1.73	0.24	1.97	0.00	2.02	2.02	0.11	2.37	1.73	35%	C
1995	W	2.48	0.03	2.50	0.00	2.58	2.58	0.09	2.70	2.48	100%	
1996	W	2.60	0.01	2.61	0.06	2.57	2.63	0.10	2.68	2.66	95%	
1997	W	2.12	0.34	2.46	0.00	2.51	2.51	0.11	2.96	2.12	90%	
1998	W	2.07	0.04	2.11	0.01	2.46	2.47	0.16	2.66	2.09	100%	
1999	W	2.37	0.04	2.41	0.00	2.26	2.26	0.13	2.44	2.37	70%	
2000	AN	3.45	0.22	3.66	0.00	2.49	2.49	0.13	2.83	3.45	65%	

WY	Hydrologic Index 40-30-30	Banks			Jones			Contra Costa	CVP Total Delta Pumping	SWP Total Delta Pumping	CVP SOD-Ag Allocation	Shasta Index Critical
		SWP	CVP	Total	SWP	CVP	Total					
2001	D	2.37	0.23	2.60	0.01	2.31	2.32	0.10	2.65	2.38	49%	
2002	D	2.70	0.17	2.87	0.00	2.46	2.46	0.12	2.75	2.70	70%	
2003	AN	3.39	0.04	3.43	0.00	2.68	2.68	0.14	2.86	3.39	75%	
2004	BN	3.14	0.09	3.23	0.00	2.72	2.72	0.12	2.93	3.14	70%	
2005	AN	3.58	0.03	3.61	0.00	2.68	2.68	0.12	2.83	3.58	85%	
2006	W	3.50	0.01	3.51	0.00	2.62	2.62	0.12	2.74	3.50	100%	
2007	D	2.82	0.11	2.93	0.00	2.67	2.67	0.11	2.90	2.82	50%	

Source: CVO Operations Data Base

Transfers

Parties seeking water transfers generally acquire water from sellers who have surplus reservoir storage water, sellers who can pump groundwater instead of using surface water, or sellers who will fallow crops or substitute a crop that uses less water in order to reduce normal consumptive use of surface diversions.

Water transfers (relevant to this document) occur when a water right holder within the Delta or Sacramento-San Joaquin watershed undertakes actions to make water available for transfer by export from the Delta. With the exception of the Component 1 water pursuant to the Yuba River Accord, this biological opinion does not address the upstream operations that may be necessary to make water available for transfer. Also, this document does not address the impacts of water transfers to terrestrial species. The flows for the Yuba River Accord may provide up to 60,000 acre feet annually for EWA, in the lower Yuba River (estimated to provide up to 48,000 acre feet of additional Delta export), and may provide additional water to the CVP and SWP and their contractors in drier years. The upstream effects of other transfers and effects to terrestrial species would require a separate ESA consultation.

Transfers requiring export from the Delta are done at times when pumping and conveyance capacity at Banks or Jones is available to move the water. Additionally, operations to accomplish these transfers must be carried out in coordination with CVP and SWP operations, such that the capabilities of the Projects to exercise their own water rights or to meet their legal and regulatory requirements are not diminished or limited in any way.

In particular, parties to the transfer are responsible for providing for any incremental changes in flows required to protect Delta water quality standards. All transfers will be in accordance with all existing regulations and requirements.

Purchasers of water for water transfers may include Reclamation, DWR, SWP contractors, CVP contractors, other State and Federal agencies, or other parties. DWR

and Reclamation have operated water acquisition programs in the past to provide water for environmental programs and additional supplies to SWP contractors, CVP contractors, and other parties. The DWR programs include the 1991, 1992, and 1994 Drought Water Banks and Dry Year Programs in 2001 and 2002. Reclamation operated a forbearance program in 2001 by purchasing CVP contractors' water in the Sacramento Valley for CVPIA in-stream flows, and to augment water supplies for CVP contractors south of the Delta and wildlife refuges. Reclamation administers the CVPIA Water Acquisition Program for Refuge Level 4 supplies and fishery in-stream flows. The CALFED Ecosystem Restoration Program will, in the future, acquire water for fishery and ecosystem restoration. DWR, and potentially Reclamation in the future, has agreed to participate in a Yuba River Accord that will provide fish flows on the Yuba River and also water supply that may be transferred at DWR and Reclamation Delta Facilities. It is anticipated that Reclamation will join in the Accord and fully participate in the Yuba Accord upon completion of this consultation. The Yuba River Accord water would be transferred to offset VAMP water costs.

Also in the past, CVP and SWP contractors have also independently acquired water and arranged for pumping and conveyance through SWP facilities. State Water Code provisions grant other parties access to unused conveyance capacity, although SWP contractors have priority access to capacity not being used by the DWR to meet SWP contract amounts.

The Yuba River Accord includes three separate but interrelated agreements that would protect and enhance fisheries resources in the lower Yuba River, increase local water supply reliability, and provide DWR with increased operational flexibility for protection of Delta fisheries resources through Project re-operation, and provision of added dry-year water supplies to state and federal water contractors. These proposed agreements are the:

- Principles of Agreement for Proposed Lower Yuba River Fisheries Agreement (Fisheries Agreement)
- Principles of Agreement for Proposed Conjunctive Use Agreements (Conjunctive Use Agreements)
- Principles of Agreement for Proposed Long-term Transfer Agreement (Water Purchase Agreement)

The Fisheries Agreement was developed by state, federal, and consulting fisheries biologists, fisheries advocates, and policy representatives. Compared to the interim flow requirements of the SWRCB Revised Water Right Decision 1644, the Fisheries Agreement would establish higher minimum instream flows during most months of most WYs.

To assure that Yuba County Water Agency's (YCWA) water supply reliability would not be reduced by the higher minimum instream flows, YCWA and its participating Member Units would implement the Conjunctive Use Agreements. These agreements would establish a comprehensive conjunctive use program that would integrate the surface water and groundwater supplies of the local irrigation districts and mutual water companies that

YCWA serves in Yuba County. Integration of surface water and groundwater would allow YCWA to increase the efficiency of its water management.

Under the Water Purchase Agreement, DWR would enter into an agreement with YCWA to purchase water from YCWA to off-set water costs resulting from VAMP as long as operational and hydrological conditions allow. Additional water purchased by DWR would be available for south-of-Delta CVP and SWP contractors in drier years. The limited EWA would take delivery of 60,000 AF (48,000 AF export) of water in every year; the CVP/SWP would receive additional water in the drier years. In the future Reclamation may become a party to the Water Purchase Agreement.

The Fisheries Agreement is the cornerstone of the Yuba Accord Alternative. To become effective, however, all three agreements (Fisheries, Conjunctive Use, and Water Purchase) must undergo CEQA and NEPA review and be fully approved and executed by the individual parties to each agreement. Also, implementation of the Yuba Accord Alternative would require appropriate SWRCB amendments of YCWA's water-right permits and SWRCB D-1644.

Transfer Capacity

Reclamation assumes as part of the project description that the water transfer programs for environmental and water supply augmentation will continue in some form, and that in most years (all but the driest), the scope of annual water transfers will be limited by available Delta pumping capacity, and exports for transfers will be limited to the months July-September. As such, looking at an indicator of available transfer capacity in those months is one way of estimating an upper boundary to the effects of transfers on an annual basis.

The CVP and SWP may provide Delta export pumping for transfers using pumping capacity at Banks and Jones beyond that which is being used to deliver project water supply, up to the physical maximums of the pumps, consistent with prevailing operations constraints such as E/I ratio, conveyance or storage capacity, and any protective criteria in effect that may apply as conditions on such transfers. For example, pumping for transfers may have conditions for protection of Delta water levels, water quality, fisheries, or other beneficial uses.

The surplus capacity available for transfers will vary a great deal with hydrologic conditions. In general, as hydrologic conditions get wetter, surplus capacity diminishes because the CVP and SWP are more fully using export pumping capacity for Project supplies. CVP's Jones Pumping Plant, with no forebay for pumped diversions and with limited capability to fine tune rates of pumping, has little surplus capacity, except in the driest hydrologic conditions. SWP has the most surplus capacity in critical and some dry years, less or sometimes none in a broad middle range of hydrologic conditions, and some surplus again in some above normal and wet years when demands may be lower because contractors have alternative supplies.

The availability of water for transfer and the demand for transfer water may also vary with hydrologic conditions. Accordingly, since many transfers are negotiated between willing buyers and sellers under prevailing market conditions, price of water also may be

a factor determining how much is transferred in any year. This document does not attempt to identify how much of the available and useable surplus export capacity of the CVP and SWP will actually be used for transfers in a particular year, but recent history, the expectations for the future limited EWA, and the needs of other transfer programs suggest a growing reliance on transfers.

Under both the present and future conditions, capability to export transfers will often be capacity-limited, except in Critical and some Dry years. In these Critical and some Dry years, both Banks and Jones have more available capacity for transfers, so export capacity is less likely to limit transfers. Rather, either supply or demand for transfers may be a limiting factor. During such years, low project exports and high demand for water supply could make it possible to transfer larger amounts of water.

Proposed Exports for Transfers

Although transfers may occur at any time of year, proposed exports for transfers apply only to the months July through September. For transfers outside those months, or in excess of the proposed amounts, Reclamation and DWR would request separate consultation. In consideration of the estimates of available capacity for export of transfers during July-September, and in recognition of the many other possible operations contingencies and constraints that may limit actual use of that capacity for transfers, the proposed use of SWP/CVP export capacity for transfers is as follows:

Water Year Class	Maximum Transfer Amount
Critical	up to 600 TAF
Dry (following Critical)	up to 600 TAF
Dry (following Dry)	up to 600 TAF
All other Years	up to 360 TAF

Other Projects

The following projects may not have final approval. However, Reclamation believes they may be implemented in the near term. Reclamation is including these actions in the project description so that the effects of these actions on aquatic species may be analyzed as it pertains to operations. The analysis does not include any effects to terrestrial species. These will be addressed in separate construction consultation.

DMC/CA Intertie Proposed Action

The proposed action, known as the DMC and CA Intertie (DMC/CA Intertie), consists of construction and operation of a pumping plant and pipeline connections between the

DMC and the CA. The DMC/CA Intertie alignment is proposed for DMC milepost 7.2 where the DMC and the CA are about 500 feet apart.

The DMC/CA Intertie would be used in a number of ways to achieve multiple benefits, including meeting current water supply demands, allowing for the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies. The Intertie would allow flow in both directions, which would provide additional flexibility to both CVP and SWP operations. The Intertie includes a 467 cfs pumping plant at the DMC that would allow up to 467 cfs to be pumped from the DMC to the CA. Up to 900 cfs flow could be conveyed from the CA to the DMC using gravity flow. The intertie will not be used to increase total CVP exports until certain criteria are in place.

The DMC/CA Intertie will be operated by the San Luis and Delta-Mendota Water Authority (Authority). A three-way agreement among Reclamation, DWR, and the Authority would identify the responsibilities and procedures for operating the Intertie. The Intertie would be owned by Reclamation. A permanent easement would be obtained by Reclamation where the Intertie alignment crossed State property.

Location

The site of the proposed action is an unincorporated area of Alameda County, west of the City of Tracy. The site is situated in a rural area zoned for general agriculture and is under Federal and State ownership. The DMC/CA Intertie would be located at milepost 7.2 of the DMC, connecting with milepost 9.0 of the CA.

Operations

The Intertie would be used under three different scenarios:

1. Up to 467 cfs would be pumped from the DMC to the CA to help meet water supply demands of CVP contractors. This would allow Jones Pumping Plant to pump to its authorized capacity of up to 4,600 cfs, subject to all applicable export pumping restrictions for water quality and fishery protections.

2. Up to 467 cfs would be pumped from the DMC to the CA to minimize impacts to water deliveries due to temporary restrictions in flow or water levels on the lower DMC (south of the Intertie) or the upper CA (north of the Intertie) for system maintenance or due to an emergency shutdown.

3. Up to 900 cfs would be conveyed from the CA to the DMC using gravity flow to minimize impacts to water deliveries due to temporary restrictions in flow or water levels on the lower CA (south of the Intertie) or the upper DMC (north of the Intertie) for system maintenance or due to an emergency shutdown.

The DMC/CA Intertie provides operational flexibility between the DMC and CA. It would not result in any changes to authorized pumping capacity at Jones Pumping Plant or Banks Delta Pumping Plant.

Water conveyed at the Intertie to minimize reductions to water deliveries during system maintenance or an emergency shutdown on the DMC or CA could include pumping of CVP water at Banks Pumping Plant or SWP water at Jones Pumping Plant through use of JPOD. In accordance with COA Articles 10(c) and 10(d), JPOD may be used to replace conveyance opportunities lost because of scheduled maintenance, or unforeseen outages. Use of JPOD for this purpose could occur under Stage 2 operations defined in SWRCB D-1641, or could occur as a result of a Temporary Urgency request to the SWRCB. Use of JPOD in this case does not result in any net increase in allowed exports at CVP and SWP export facilities. When in use, water within the DMC would be transferred to the CA via the Intertie. Water diverted through the Intertie would be conveyed through the CA to O'Neill Forebay.

Freeport Regional Water Project

The Freeport Regional Water Project (FRWP) is currently under construction. Once completed FRWP will divert up to a maximum of about 286 cubic feet per second (cfs) from the Sacramento River near Freeport for Sacramento County (deliveries expected in 2011) and East Bay Municipal Utility District (EBMUD) deliveries expected in late 2009. EBMUD will divert water pursuant to its amended contract with Reclamation. The County will divert using its water rights and its CVP contract supply. This facility was not in the 1986 COA, and the diversions will result in some reduction in Delta export supply for both the CVP and SWP contractors. Pursuant to an agreement between Reclamation, DWR, and the CVP and SWP contractors in 2003, diversions to EBMUD will be treated as an export in the COA accounting and diversions to Sacramento County will be treated as an in-basin use.

Reclamation proposes to deliver CVP water pursuant to its respective water supply contracts with SCWA and EBMUD through the FRWP, to areas in central Sacramento County. SCWA is responsible for providing water supplies and facilities to areas in central Sacramento County, including the Laguna, Vineyard, Elk Grove, and Mather Field communities, through a capital funding zone known as Zone 40.

The FRWP has a design capacity of 286 cfs (185 millions of gallons per day [mgd]). Up to 132 cfs (85 mgd) would be diverted under Sacramento County's existing Reclamation water service contract and other anticipated water entitlements and up to 155 cfs (100 mgd) of water would be diverted under EBMUD's amended Reclamation water service contract. Under the terms of its amendatory contract with Reclamation, EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 AF. When this condition is met, the amendatory contract entitles EBMUD to take up to 133,000 AF annually. However, deliveries to EBMUD are subject to curtailment pursuant to CVP shortage conditions and project capacity (100 mgd), and are further limited to no more than 165,000 AF in any 3-consecutive-year period that EBMUD's October 1 storage forecast remains below 500,000 AF. EBMUD would take delivery of its entitlement at a maximum rate of 100 mgd (112,000 AF per year). Deliveries would start at the beginning of the CVP contract year (March 1) or any time afterward. Deliveries would cease when EBMUD's CVP allocation for that year is reached, when the 165,000 AF

limitation is reached, or when EBMUD no longer needs the water (whichever comes first). Average annual deliveries to EBMUD are approximately 23,000 AF. Maximum delivery in any one WY is approximately 99,000 AF.

The primary project components are (1) an intake facility on the Sacramento River near Freeport, (2) the Zone 40 Surface Water Treatment Plant (WTP) located in central Sacramento County, (3) a terminal facility at the point of delivery to the Folsom South Canal (FSC), (4) a canal pumping plant at the terminus of the FSC, (5) an Aqueduct pumping plant and pretreatment facility near Comanche Reservoir, and (6) a series of pipelines carrying water from the intake facility to the Zone 40 Surface WTP and to the Mokelumne Aqueducts. The existing FSC is part of the water conveyance system. See Chapter 9 for modeling results on annual diversions at Freeport in the American River Section, Modeling Results Section subheading.

Alternative Intake Project

CCWD's Alternative Intake Project (AIP) consists of a new 250 cfs screened intake in Victoria Canal, and a pump station and ancillary structures, utilities, and access and security features; levee improvements; and a conveyance pipeline to CCWD's existing conveyance facilities.

CCWD will operate the intake and pipeline together with its existing facilities to better meet its delivered water quality goals and to better protect listed species. Operations with the AIP will be similar to existing operations: CCWD will deliver Delta water to its customers by direct diversion when salinity at its intakes is low enough, and will blend Delta water with releases from Los Vaqueros Reservoir when salinity at its intakes exceeds the delivered water quality goal. Los Vaqueros Reservoir will be filled from the existing Old River intake or the new Victoria Canal intake during periods of high flow in the Delta, when Delta salinity is low. The choice of which intake to use at any given time will be based in large part upon salinity, consistent with fish protection requirements in the biological opinions; salinity at the Victoria Canal intake site is at times lower than salinity at the existing intakes. The no-fill and no-diversion periods described above will continue as part of CCWD operations, as will monitoring and shifting of diversions among the four intakes to minimize impacts to listed species.

The AIP is a water quality project, and will not increase CCWD's average annual diversions from the Delta. However, it will alter the timing and pattern of CCWD's diversions in two ways: winter and spring diversions will decrease while late summer and fall diversions increase because Victoria Canal salinity tends to be lower in the late summer and fall than salinity at CCWD's existing intakes; and diversions at the unscreened Rock Slough Intake will decrease while diversions at screened intakes will increase. It is estimated that with the AIP, Rock Slough intake diversions will fall to about 10 percent of CCWD's total diversions, with the remaining diversions taking place at the other screened intakes. About 88 percent of the diversions will occur at the Old River and Victoria Canal intakes, with the split between these two intakes largely depending on water quality.

The effects of the AIP are covered by the April 27, 2007 Service biological opinion for delta smelt (amended on May 16, 2007).

Red Bluff Diversion Dam Pumping Plant

Reclamation signed the ROD July 16, 2008 for RBDD pumping plant and plans to change the operation of the RBDD to improve fish passage problems. The project features construction of a new pumping plant and operation of the RBDD gates in the out position for approximately 10 months of the year. Reclamation is calling for the construction of a pumping plant upstream from the dam that could augment existing capabilities for diverting water into the Tehama-Colusa Canal during times when gravity diversion is not possible due to the RBDD gates being out. Reclamation completed ESA section 7 consultations with the Service and the NMFS to address construction of a new pumping plant at maximum capacity of 2,500 cfs.

The new pumping plant would be capable of operating throughout the year, providing both additional flexibility in dam gate operation and water diversions for the Tehama-Colusa Canal Authority (TCCA) customers. In order to improve adult green sturgeon passage during their spawning migrations (generally March through July) the gates could remain open during the early part of the irrigation season and the new pumping plant could be used alone or in concert with other means to divert water to the Tehama-Colusa and Corning canals.

Green sturgeon spawn upstream of the diversion dam and the majority of adult upstream and downstream migrations occur prior to July and after August. After the new pumping plant has been constructed and is operational, Reclamation proposes to operate the Red Bluff Diversion Dam with the gates in during the period from four days prior to the Memorial Day weekend to three days after the holiday weekend (to facilitate the Memorial Day boat races in Lake Red Bluff), and between July 1 and the end of the Labor Day weekend. This operation would provide for improved sturgeon and salmon passage.

The pumping plant project will occur in three phases. The first, completion of the NEPA/CEQA process has already been accomplished. The design and permitting phase is commencing, subject to the availability of funding, and is anticipated to take about 18-36 months. As funding permits, property acquisition will also occur during this phase, and further funding commitments would be secured during this time. The final phase, facilities construction, is anticipated to take approximately 18-36 months but this timeline will be updated during final design and permitting.

South Delta Improvements Program Stage 1

The objectives of the SDIP are to: 1) reduce the movement of outmigrating salmon from the San Joaquin River into Old River, 2) maintain adequate water levels and circulation

in South Delta channels, and 3) increase water delivery and reliability to the SWP and CVP by increasing the diversion limit at Clifton Court Forebay to 8500 cfs.[5]

The decision to implement the proposed action is being done in two stages. Stage 1 will address the first two objectives and involves the construction and operation of gates at four locations in the South Delta channels. A decision to implement Stage 2 would address increasing the water delivery reliability of the SWP and CVP by increasing the diversion limit at Clifton Court Forebay. This decision has been deferred indefinitely.

The Final EIR/EIS was completed in December 2006. DWR certified the final EIR as meeting the requirements of the California Environmental Quality Act at that time. The Department plans to issue a Notice of Determination to proceed with implementing Stage 1 of the SDIP once the biological opinions on the continued long term operations of the CVP/SWP and the biological opinions for the dredging and construction of the gates are received.

Reclamation and DWR are seeking to construct and operate the gates proposed for the four locations. Key operational features of these gates are included as part of this project description. Separate biological opinions will be conducted for the impacts of constructing the gates and the channel dredging contained in Stage 1.

The permanent operable gates, which are planned to be constructed in the South Delta in late 2012, will be operated within an adaptive management framework, as described below under "Gate Operations Review Team," so that the benefits from these gate operations can be maximized. The gates can be opened or closed at any time in response to the local tidal level and flow conditions within the South Delta. In this regard, they are very different from the temporary barriers that have been installed for the past several years.

Because these operable gates are designed as "lift gates" that are hinged at the bottom of the channel, "closure" of the gates can be specified at any tidal level, leaving a weir opening for some tidal flow over the gate. The ability to operate the tidal gates to a specified weir crest elevation (i.e., top of the gates) that is relatively precise provides a great deal of flexibility. The top elevation of each individual gate can be slightly different (i.e., steps) to provide less weir flow as the tidal level declines. The top elevation of the gates can also be slowly raised or lowered to adjust the tidal level and/or tidal flow in response to local South Delta conditions.

South Delta Gates

The proposed management of South Delta tidal level and tidal flow conditions involves the use of five gates:

- CCF intake tidal gate (existing),

[5] This project description does not include any aspect of the SDIP that is not explicitly identified in the text. Examples of SDIP actions that are not included are construction of the four permanent gates and dredging. Both of these activities will be covered by subsequent consultation.

- Grant Line Canal (at western end) flow control gate,
- Old River at DMC flow control gate,
- Middle River flow control gate, and
- Head of Old River fish control gate.

The CCF intake gate already exists and has been used since SWP began Banks operations in 1972 to control flows from Old River and maintain the water level inside of CCF. Unlike the existing CCF intake gate, the four other gates are proposed by SDIP and are not in place. The operation of the CCF intake gate is directly related to SWP export operations, but the operation of the fish and flow control gates, will serve the primary purpose of protecting fisheries and beneficial uses.

These five gates in the South Delta would be operated to accomplish the following purposes:

1. Maintain a relatively high water level within the CCF to allow SWP to maximize Banks pumping during the off-peak (nighttime) hours. The CCF level cannot be allowed to fall below –2 feet msl because of cavitation concerns at the SWP's Banks pumps. The CCF gates are closed when the outside tidal level in Old River drops below the CCF level (to avoid outflow from CCF). As described earlier in this chapter, the CCF gates are also operated under three "gate priorities" to reduce water level impacts to other South Delta water users.

2. Control the inflow to CCF below the design flow of about 15,000 cfs to prevent excessive erosion of the entrance channel. The CCF gates are partially closed when the difference between the CCF level and Old River tidal level is more than 1.0 foot to avoid inflow velocities of greater than 10 feet/sec.

3. Maintain the high-tide conditions in the South Delta by not diverting into CCF during the flood-tide period that precedes the higher-high tide each day. The CCF intake gates are closed for about 6 hours each day to preserve the high-tide level in Old River to supply sufficient water for Tom Paine Slough siphons. This CCF tidal gate operation is referred to as priority 3 by DWR, as described earlier in this chapter.

4. Control the minimum tidal level elevation upstream of the flow-control gates to be greater than a selected target elevation (i.e., 0.0 feet msl). The flow-control gates can be closed (raised) to maintain a specified top elevation (e.g., 0.0 feet msl) as the upstream tidal level declines during ebb tide.

5. Control the tidal flushing upstream of the flow-control gates with relatively low-salinity water from Old River and Middle River downstream of the gates (i.e., high fraction of Sacramento River water). The flow-control gates would remain fully open during periods of flood tide (i.e., upstream flow) and then two of the gates would be fully closed (i.e., top elevation of gates above upstream water surface) during periods of ebb tide (i.e., downstream flow). The remaining gate (i.e., Grant Line) would be maintained at a lower elevation (i.e., 0.0 feet msl) to

allow the ebb tide flow to exit from the South Delta channels so that the flood-tide flow over the gates can be maximized during each tidal cycle.

Control the San Joaquin River flow diversion into Old River. This could increase the flow past Stockton and raise the low DO concentrations in the San Joaquin Deep Water Ship Channel. Reduced flow to Old River might also reduce salinity in the South Delta channels by limiting the volume of relatively high-salinity water from the San Joaquin River that enters the South Delta channels. The head of Old River temporary barrier has been installed in October and November of many years to improve flow and DO conditions in the San Joaquin Deep Water Ship Channel for up-migrating Chinook salmon. In recent years, the barrier has also been installed in April and/or May during a portion of the outmigration period to reduce the percentage of Chinook salmon smolts that are diverted into Old River and toward Banks and Jones. The proposed SDIP gate operations will increase the tidal circulation in the South Delta channels. Gate operations to promote circulation would raise the Old River at Tracy and Middle River gates at each high tide to produce a circulation of water in the South Delta channels down Grant Line Canal. The Old River at Tracy and Middle River gates remain raised (closed) until the next flood-tide period when the downstream level is above the upstream water level. These gates are then lowered (opened) to allow flood-tide (upstream) flows across the gates. Gate operations to promote circulation use a Grant Line gate weir crest at -0.5 feet msl during most periods of ebb tide (downstream flow) to protect the minimum level elevation of 0.0 feet msl. All gates are lowered (i.e., opened) during floodtide periods as soon as the downstream tidal level is above the upstream water level.

Head of Old River Fish Control Gate

Spring Operations/ Real Time Decision Making

Operation (closing) of the head of Old River fish control gate is proposed to begin on April 15. Spring operation is generally expected to continue through May 15, to protect outmigrating salmon and steelhead. During this time, the head of Old River gate would be fully closed, unless the San Joaquin River is flowing above 10,000 cfs or the GORT recommends a partial opening for other purposes. The real time decision making process is described in detail previously.

Summer and Fall Operations

When the Spring operation is completed and through November 30, the head of Old River fish control gate would be operated to improve flow in the San Joaquin River, thus helping to avoid historically-present low dissolved oxygen conditions in the lower San Joaquin River near Stockton. During this period, partial operation of the gate (partial closure to restrict flows from the San Joaquin River into Old River to approximately 500 cfs) may also be warranted to protect water quality in the South Delta channels. Generally, water quality in the South Delta channels is acceptable through June.

Operations during the months of October and November to improve flow and water quality conditions (i.e., low dissolved oxygen) in the San Joaquin River for adult migrating Chinook salmon is expected to provide a benefit similar to that achieved with the temporary barrier. Operations would not occur if the San Joaquin River flow at

Vernalis is greater than 5,000 cfs because it is expected that this flow would maintain sufficient DO in the San Joaquin River.

When the gate is not operated, it is fully lowered in the channel. Operation of the gate is not proposed during the period December through March.

Flow Control Gates

The flow control gates in Middle River, Grant Line Canal, and Old River near the DMC, would be operated (closed during some portion of the tidal cycle) throughout the agricultural season of April 15 through November 30. As with the head of Old River fish control gate, when the gates are not operated, they are fully lowered in the channel. Operation of the gates is not proposed during the period December through March. Any operation of the gates proposed for the December-March period would require re-initiation of ESA consultation.

Spring Operations

During April 15 through May 15 (or until the Spring operation of the head of Old River gate is completed), water quality in the South Delta is acceptable for the beneficial uses, but closure of the head of Old River fish control gate has negative impacts on water levels in the South Delta. Therefore, the flow control gates would be operated to control minimum water levels in most year types. In the less frequent year types, dry or critically dry, when water quality in the South Delta is threatened by this static use of the gates, circulation may be induced to improve water quality in the South Delta channels. Circulation using the flow control gates is described in the summer operations section which follows. During these times, Reclamation and DWR have committed to maintaining 0.0 foot msl water levels in Old River near the CVP Tracy facility and at the west end of Grant Line Canal.

Summer and Fall Operations

When the Spring operation of the head of Old River fish control gate is completed and through November 30, the gates would be operated to control minimum water levels and increase water circulation to improve water quality in the South Delta channels. Reclamation and DWR have committed to maintaining water levels during these times at 0.0 foot msl in Old River near the CVP Tracy facility, 0.0 foot msl at the west end of Grant Line Canal, and 0.5 foot msl in Middle River at Mowry Bridge. It is anticipated that the target level in Middle River would be lowered to 0.0 foot msl following extension of some agricultural diversions.

The proposed gate operations will increase the tidal circulation in the South Delta channels. This is accomplished by tidal flushing upstream of the flow-control gates with relatively low-salinity water from Old River and Middle River downstream of the gates (i.e., high fraction of Sacramento River water). The flow-control gates would remain fully open during periods of flood tide (i.e., upstream flow) and then two of the gates would be fully closed (i.e., top elevation of gates above upstream water surface) during periods of ebb tide (i.e., downstream flow). The remaining gate (i.e., Grant Line) would be maintained at a lower elevation (i.e., 0.0 feet msl) to allow the ebb tide flow to exit from the South Delta channels so that the flood-tide flow over the gates can be

maximized during each tidal cycle. This is the same operation described as Purpose 5 earlier in the description of the SDIP gates.

Gate Operations and Jones and Banks Exports

Because of the hydraulic interconnectivity of the South Delta channels, the CCF, and the export facilities, the permanent operable gates would not be operated entirely independent of Banks and Jones exports. The flow control gate opening and closing frequencies and durations would be adjusted to meet the water level and circulation objectives. Furthermore, the head of Old River Fish Control Gate operation period and duration would be adjusted to address the presence of fish species and the water quality conditions in the San Joaquin River. Opportunities to adjust gate operations in a manner that reduces entrainment and impingement of aquatic species or improves in-Delta water supply conditions that are associated with Delta exports could result.

As described in the Flow Control Gates operations sections, the Middle River, Grant Line Canal, and Old River near DMC flow control gates are operated to improve stage and water quality in the South Delta. The flow control gates increase the stage upstream of the barriers while Banks and Jones are all downstream of the permanent operable gates. The gates are designed to capture the flood tide upstream of the structures, and the operation of the flow control gates is not based on exports.

ESA coverage for the SDIP operable gates is being accomplished through two consultation processes. A separate biological opinion will address terrestrial and aquatic effects from channel dredging and construction and will be included in a separate consultation process.

State Water Project Oroville Facilities

Implementation of the new FERC license for the Oroville Project will occur when FERC issues the new license. Because it is not known exactly when that will occur, it is considered a near term and future project. The current, near term and future operations for the Oroville Facilities were previously described.

Analytical Framework for the Jeopardy Determination

The following analysis relies on four components to support the jeopardy determination for the delta smelt: (1) the *Status of the Species*, which evaluates the delta smelt's range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the delta smelt in the action area, the factors responsible for that condition, and the role of the action area in the delta smelt's survival and recovery; in this case the action area covers nearly the entire range of the delta smelt so the *Status of the Species/Environmental Baseline* sections are combined into one section; (3) the *Effects of the Action*, which determines

the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the delta smelt; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the delta smelt.

In accordance with the implementing regulations for section 7 and Service policy, the jeopardy determination is made in the following manner: the effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the delta smelt's current status and, for non-Federal activities in the action area, those actions likely to affect the delta smelt in the future, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the delta smelt in the wild.

The following analysis places an emphasis on using the range-wide survival and recovery needs of the delta smelt and the role of the action area in providing for those needs as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework for the Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

The following analysis relies on four components to support the adverse modification determination: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the delta smelt in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall, as well as the intended recovery function of discrete critical habitat units; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; in this case the action area covers nearly the entire range of delta smelt critical habitat so the *Status of the Critical Habitat/Environmental Baseline* sections are combined into one section; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

In accordance with Service policy and guidance, the adverse modification determination is made in the following manner: the effects of the proposed Federal action on critical habitat are evaluated in the context of the aggregate effects of all factors that have contributed to the current status of the critical habitat range-wide and, for non-Federal activities in the action area, those actions likely to affect the critical habitat in the future, to determine if the critical habitat would remain functional (or retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve the intended recovery role for the species with implementation of the proposed Federal action.

The following analysis places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species/Environmental Baseline

The action area for this consultation covers the entire range of the delta smelt, except for the Napa River. For that reason, the Status of the Species and Environmental Baseline sections are combined into one section in this document.

Delta Smelt

Delta Smelt Species Description and Taxonomy

The Service proposed to list the delta smelt as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The Service listed the delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1995). A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004); that review affirmed the need to retain the delta smelt as a threatened species. The Service is currently considering information to determine if the listing status of delta smelt should be upgraded from threatened to endangered.

The delta smelt is a member of the Osmeridae family (northern smelts) (Moyle 2002) and is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). The delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002) (Figure S-1). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

The delta smelt is a slender-bodied fish, generally about 60 to 70 millimeters (mm) (2 to 3 inches (in)) long, although they can reach lengths of up to 120 mm (4.7 in) (Moyle 2002). Live delta smelt are nearly translucent and have a steely blue sheen to their sides. Delta smelt usually aggregate but do not appear to be a strongly schooling species.

Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998). The most closely-related species is the surf smelt (*H. pretiosis*), a marine species common along the western coast of North America. Despite its morphological similarity, the delta smelt is less-closely related to wakasagi (*H. nipponensis*), an anadromous western Pacific species introduced into California Central Valley reservoirs in 1959 and now distributed in the historic range of the delta smelt (Trenham et al. 1998). Genetic introgression among *H. transpacificus* and *H. nipponensis* is low.

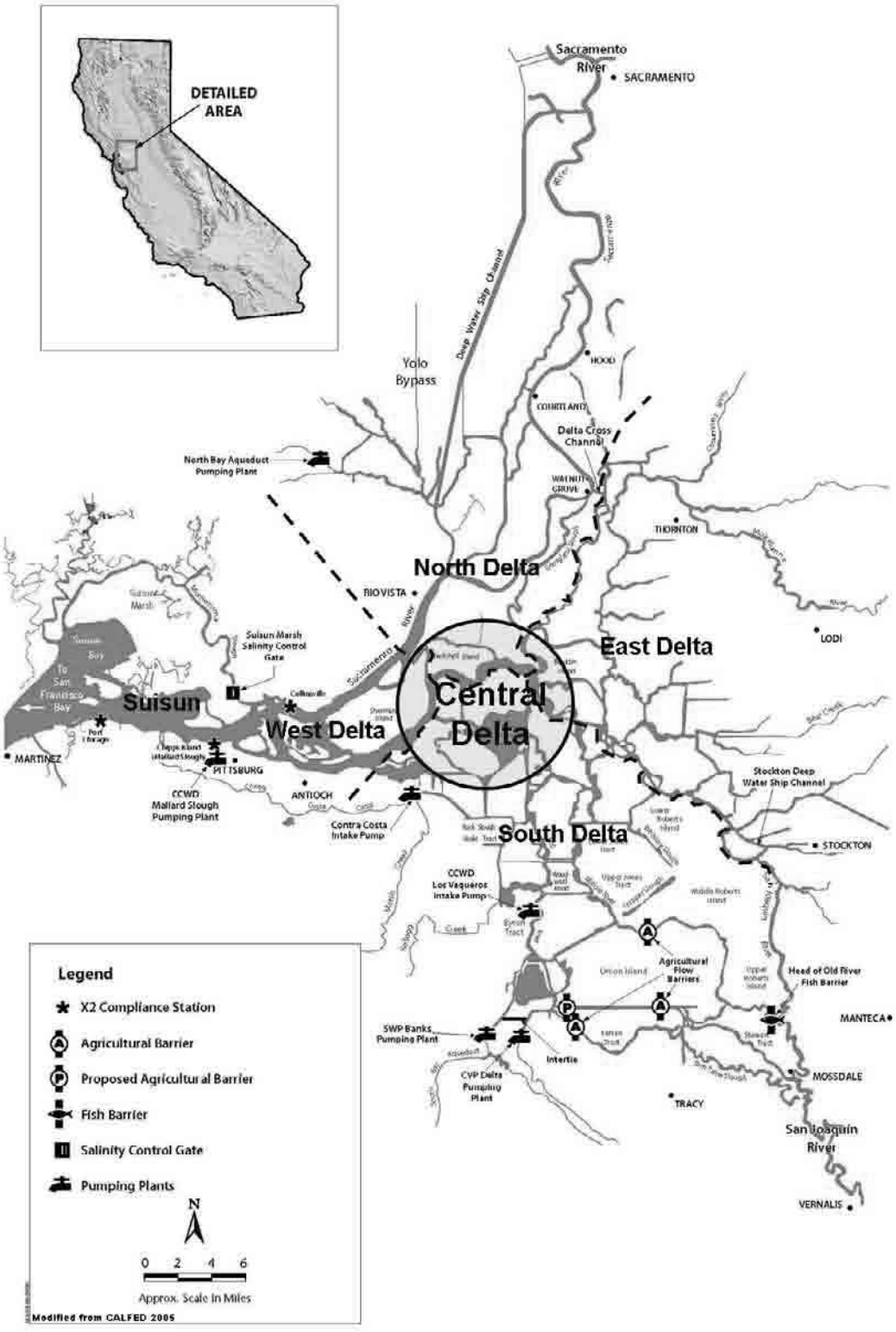


Figure S-1 Map of the Delta with Delta Regions Identified

Existing Monitoring Programs

Most research and monitoring of fish populations in the Bay-Delta is coordinated through the Interagency Ecological Program (IEP). The IEP is a cooperative effort led by state and federal agencies with university and private partners. There are currently 16 fish monitoring programs that are implemented year-round across the entire Bay-Delta system (Honey et al. 2004). Figure S-2 shows the monitoring stations that are sampled in the Bay-Delta Estuary. Each of these programs captures delta smelt to some degree, however, only a select few are commonly used to index the abundance or distribution of delta smelt, and only two are designed specifically to capture delta smelt.

The Fall Midwater Trawl Survey (FMWT) and the Summer Townet Survey (TNS) are the two longest running IEP fish monitoring programs that are used to index delta smelt abundance. They work well because they were originally designed to target age-0 striped bass, which have similar habitat requirements to delta smelt. Two more recent programs, the 20-mm Survey and the Spring Kodiak Trawl Survey (SKT), were designed specifically to sample delta smelt and are also commonly used to evaluate relative abundance and distribution. Each of these four sampling programs targets different life stages and encompasses the entire distribution of delta smelt for the given life stage and time of year. The efficiency of sampling gears used for delta smelt is unknown. However, they were all designed to target open-water pelagic fishes and data from these programs have been used extensively in prior studies of delta smelt abundance and distribution (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007).

Data from the FMWT are used to calculate indices of relative abundance for delta smelt. The program has been conducted each year since 1967, except that no sampling was done in 1974 or 1979. Samples (10-minute tows) are collected at 116 sites each month from September to December throughout the Bay-Delta. Detailed descriptions of the sampling program are available from Stevens and Miller (1983) and Feyrer et al. (2007). The delta smelt recovery index includes distribution and abundance components and is calculated from a subset of the September and October FMWT sampling (http://www.delta.dfg.ca.gov/). The details on the calculation of the recovery index can be found in the Delta Native Fishes Recovery Plan (Service 1995).

Data from the TNS are used to calculate indices of abundance for young-of-year delta smelt during the summer. The TNS has been conducted annually since 1959 (Turner and Chadwick 1972). It involves sampling at up to 32 stations with three replicate tows to complete a survey. A minimum of two surveys is conducted each year. The delta smelt index is generated from the first two TNS surveys (Moyle et al. 1992). The TNS sampling has had an average survey starting date of July 13, but surveys have been conducted as early as June 4 and as late as August 28 in some years (Nobriga et al. 2008).

Data from the 20-mm survey are used to examine the abundance and distribution of young post-larval/early juvenile delta smelt during the spring (Dege and Brown 2004). The survey has been conducted each year since 1995, and involves the collection of three replicate samples at up to 48 sites; additional sites have been added in recent years. A complete set of samples from each site is termed a survey and 5-9 surveys are completed

each year from approximately March though June. This survey also simultaneously samples zooplankton with a Clarke-Bumpus net during one of the three sampling tows at each site.

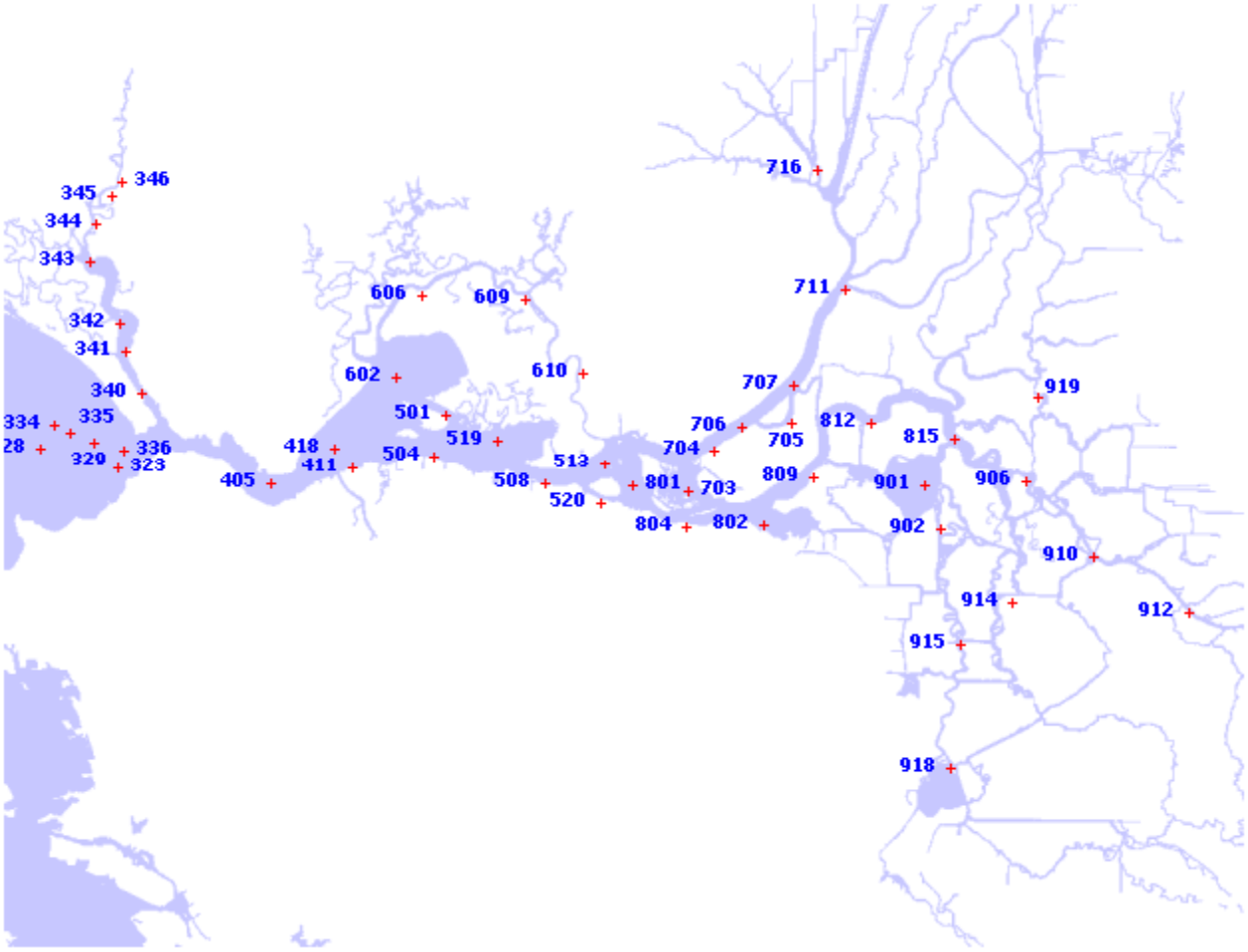


Figure S-2 Map of Bay Delta Estuary Sampling Locations for the TNS and 20-mm Survey (DFG Bay Delta website 2008)

Data from the SKT are used to monitor and provide information on the pre-spawning and spawning distributions of delta smelt. The survey also quantifies the reproductive maturity status of all adult delta smelt collected. SKT sampling has been done since 2002 at approximately 39 stations. Sampling at each station is completed five or more times per year from January to May. Supplemental surveys are often completed when additional information is requested by managers to assist with decisions relating to water project operations.

An additional source of information on delta smelt comes from salvage operations at the Banks and Jones fish facilities. Banks and Jones are screened with fish-behavioral louvers designed to salvage young Chinook salmon and striped bass before they enter the pumps (Brown et al. 1996). In general, the salvage process consists of fish capture,

transport, and ultimately release at locations where they are presumed safe from further influence of Banks and Jones. However, unlike some species, it is commonly acknowledged that delta smelt often do not survive the salvage process. Data on the salvage of delta smelt is typically used to provide an index of entrainment into the diversion pumps, but not as an index of general population abundance. However, there are a number of caveats with these data including unknown sampling efficiency, unknown pre-screen mortality in Clifton Court Forebay, and no sampling of fish smaller than 20mm (Kimmerer 2008). Fortunately, some of this information may become available in the future because of targeted studies on efficiency and pre-screen mortality being conducted by the IEP and Reclamation. Although monitoring from Banks and Jones is limited in geographic range compared to the other surveys, they sample substantially larger volumes of water, and therefore may have a greater likelihood to detect low densities of delta smelt larger than 20mm.

Delta smelt entrainment is presently estimated (or indexed) by extrapolating catch data from periodic samples of salvaged fish (≥ 20 mm). Fish are counted from a sub-sample of water from the facility holding tanks and numbers are extrapolated based on the volume of water diverted during collection of that sample to estimate the number of fish entrained into Banks and Jones during the sampling interval. Intervals typically range from 1-24 hours depending on time of year, debris loads, etc.

Overview of Delta Smelt's Life Cycle

The delta smelt life cycle is completed within the freshwater and brackish LSZ of the Bay-Delta. Figure S-3 portrays the conceptual model used for delta smelt. Delta smelt are moderately euryhaline (Moyle 2002). However, salinity requirements vary by life stage. Delta smelt are a pelagic species, inhabiting open waters away from the bottom and shore-associated structural features (Nobriga and Herbold, 2008). Although delta smelt spawning has never been observed in the wild, clues from the spawning behavior of related osmerids suggests delta smelt use bottom substrate and nearshore features during spawning. However, apart from spawning and egg-embryo development, the distribution and movements of all life stages are influenced by transport processes associated with water flows in the estuary, which also affect the quality and location of suitable open-water habitat (Dege and Brown 2004; Feyrer et al. 2007; Nobriga et al. 2008).

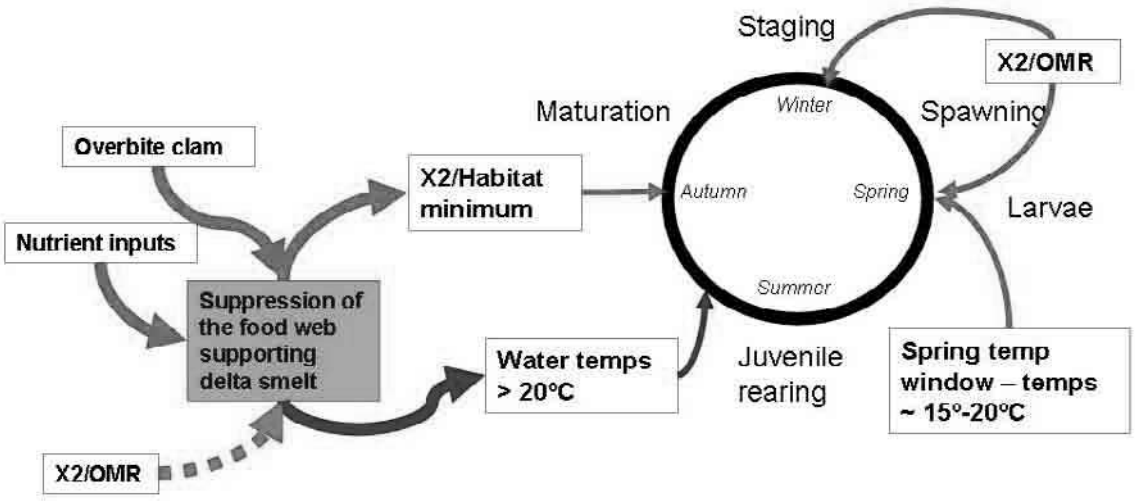


Figure S-3 Lifecycle Conceptual Model For Delta Smelt. The Larger the Arrow Size, the Stronger the Influence on the Process Box

Delta smelt are weakly anadromous and undergo a spawning migration from brackish water to freshwater annually (Moyle 2002). In early winter, mature delta smelt migrate from brackish, downstream rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin rivers upstream to freshwater spawning areas in the Delta. Delta smelt historically have also spawned in the freshwater reaches of Suisun Marsh. In winters featuring high Delta outflow, the spawning range of delta smelt shifts west to include the Napa River (Hobbs et al. 2007).

The upstream migration of delta smelt, which ends with their dispersal into river channels and sloughs in the Delta (Radtke 1966; Moyle 1976, 2002; Wang 1991), seems to be triggered or cued by abrupt changes in flow and turbidity associated with the first flush of winter precipitation (Grimaldo et al, accepted manuscript) but can also occur after very high flood flows have receded. Grimaldo et al (accepted manuscript) noted salvage often occurred when total inflows exceeded over 25,000 cfs or when turbidity elevated above 12 NTU (CCF station). Delta smelt spawning may occur from mid-winter through spring; most spawning occurs when water temperatures range from about 12^0C to 18^0C (Moyle 2002). Most adult delta smelt die after spawning (Moyle 2002). However, some fraction of the population may hold over as two-year-old fish and spawn in the subsequent year.

During and after a variable period of larval development, the young fish migrate downstream until they reach the low-salinity zone (LSZ) (indexed as X2) where they reside until the following winter (Moyle 2002). The location of the delta smelt population follows changes in the location of the LSZ which depends primarily on delta outflow.

Biology and Life History

Spawning

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Although spawning may occur at temperatures up to 22°C, hatching success of the larvae is very low (Bennett 2005).

Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). Moyle et al. (1992) considered delta smelt fecundity to be "relatively low." However, based on Winemiller and Rose (1992), delta smelt fecundity is fairly high for a fish its size. In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004); field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-samii 2008). Captive delta smelt can spawn up to 4-5 times. While most adults do not survive to spawn a second season, a few (<5 percent) do (Moyle 2002; Bennett 2005). Those that do survive are typically larger (90-110 mm SL) females that may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein). Two-year-old females may have 3-6 times as many ova as first year spawners.

Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the SKT and 20-mm survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations and the landlocked Lake Washington longfin smelt, are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory and eggs have not been found in the wild. Consequently, what is known about the mechanics of delta smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 mm diameter and are adhesive and negatively buoyant (Moyle 1976, 2002; Mager et al. 2004; Wang 1986, 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the

bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 2003; Wang 2007).

The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may move ("tumble") with water currents and turbulence (Hay 2007; slideshow available at http://www.science.calwater.ca.gov/pdf/workshops/workshop_smelt_presentation_Hay_111508.pdf). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

Presence of newly hatched larvae likely indicates regions where spawning has occurred. The 20-mm trawl has captured small (~5 mm Standard Length [SL]) larvae in Cache Slough, the lower Sacramento River, San Joaquin River, and at the confluence of these two rivers (e.g., 20-mm trawl survey 1 in 2005). Larger larvae and juveniles (size > 23 mm SL), which are more efficiently sampled by the 20-mm trawl gear, have been captured in Cache Slough (Sacramento River) and the Sacramento Deep Water Channel in July (e.g. 20-mm trawl survey 9 in 2008). Because they are small fish inhabiting pelagic habitats with strong tidal and river currents, delta smelt larval distribution depends on both the spawning area from which they originate and the effect of transport processes caused by flows. Larval distribution is further affected by water salinity and temperature. Hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson et al 2007). This could result in rapid dispersion of larvae away from spawning sites.

Sampling of larval delta smelt in the Bay-Delta in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman's Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).

Larval Development

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16º C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17º C. Lindberg et al. (2003) reported high hatching rates of delta smelt eggs in the laboratory at 15º C, and Wang (2007) reported high hatching rates at temperatures between 14-17º C. Bennett (2005) showed hatching success peaks near 15º C. Swim bladder inflation occurring at 60-70 days post-hatch at 16-17º C (Mager et al. 2004).

At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As

development continues, newly hatched delta smelt become semi-buoyant and sink in stagnant water. However, larvae are unlikely to encounter stagnant water in the wild.

In the laboratory, a turbid environment (>25 Nephelometric Turbidity Units [NTU]) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges *et al.* 2000; Mager et al. 2004; Baskerville-Bridges *et al.* 2004).

Growth rates of wild-caught delta smelt larvae are faster than laboratory-cultured individuals. Mager et al. (2004) reported growth rates of captive-raised delta smelt reared at near-optimum temperatures (16ºC-17ºC). Their fish were about 12 mm long after 40 days and about 20 mm long after 70 days. In contrast, analyses of otoliths indicated that wild delta smelt larvae were 15-25 mm, or nearly twice as long at 40 days of age (Bennett 2005). By 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987).

Laboratory-cultured delta smelt larvae have generally been fed rotifers at first-feeding (Baskerville-Bridges et al. 2004; Mager et al. 2004). However, rotifers rarely occur in the guts of wild delta smelt larvae (Nobriga 2002). The most common first prey of wild delta smelt larvae is the larval stages of several copepod species. These copepod 'nauplii' are larger and have more calories than rotifers. This difference in diet may enable the faster growth rates observed in wild-caught larvae.

The food available to larval fishes is constrained by mouth gape and status of fin development. Larval delta smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval delta smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, delta smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval delta smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding delta smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the delta smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for and duration of delta smelt larval movement from spawning areas to rearing areas are not known. Hay (2007) noted that eulachon larvae are probably flushed into estuaries from upstream spawning areas within the first day after hatching, but downstream movement of delta smelt larvae occurs much later. Most larvae gradually move downstream toward the two parts per thousand (ppt) isohaline (X2). X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995). It is a

physical attribute of the Bay-Delta that is used as a habitat indicator and as a regulatory standard in the SWRCB D-1641, as described in the project description.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet WYs), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish but the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Juveniles

Young-of-the-year delta smelt rear in the LSZ from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm SL long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm SL) by early fall (Moyle 2002). Delta smelt growth during the fall months slows considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al*. 1950; Radtke 1966).

Nobriga et al. (2008) found that delta smelt capture probabilities in the TNS are highest at specific conductance levels of 1,000 to 5,000 μS cm^{-1} (approximately 0.6 to 3.0 practical salinity unit [psu]). Similarly, Feyrer et al. (2007) found a decreasing relationship between abundance of delta smelt in the FMWT and specific conductance during September through December. The location of the LSZ and changes in delta smelt habitat quality in the San Francisco Estuary can be indexed by changes in X2 (see effects section). The LSZ historically had the highest primary productivity and is where zooplankton populations (on which delta smelt feed) were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). However, this has not always been true since the invasion of the overbite clam (Kimmerer and Orsi 1996). The abundance of many local aquatic species has tended to increase in years when winter-spring outflow was high and X2 was pushed seaward (Jassby et al. 1995), implying that the quantity and quality (overall suitability) of estuarine habitat increases in years when outflows are high. However, delta smelt is not one of the species whose abundance has statistically covaried with winter-spring freshwater flows (Stevens and Miller 1983; Moyle et al. 1992; Kimmerer 2002; Bennett 2005). As presented in this biological opinion, there is evidence that X2 in the fall influences delta smelt population dynamics.

Delta smelt seem to prefer water with high turbidity, based on a negative correlation between the frequency of delta smelt occurrence in survey trawls during summer, fall and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer et al. 2007, Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over one half meter and capture probabilities for delta smelt are highest at 0.40 m depth or less. The delta smelt's preference for turbid water

may be related to increased foraging efficiency (Baskerville-Bridges et al. 2004) and reduced risk of predation.

Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008).

Foraging Ecology

Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Juvenile-stage delta smelt prey upon copepods, cladocerans, amphipods, and insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta, especially in summer, when it replaces *E. affinis* in the plankton community (Moyle 2002). Another smaller copepod, *Limnoithona tetraspina*, which was introduced into the Bay-Delta in the mid-1990s, is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains a dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). In contrast, higher residence times, which result from low tributary flows, can result in higher plankton biomass but water diversions, overbite clam grazing (Jassby et al. 2002) and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. These factors all affect food availability for planktivorous fishes that utilize the zooplankton in Delta channels. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated LSZ zooplankton densities (see effects section).

The delta smelt compete with and are prey for several native and introduced fish species in the Delta. The introduced inland silverside may prey on delta smelt eggs and/or larvae and compete for copepod prey (Bennett and Moyle 1996; Bennett 2005). Young striped bass also use the LSZ for rearing and may compete for copepod prey and eat delta smelt. Centrarchid fishes and coded wire tagged Chinook salmon smolts released in the Delta for survival experiments since the early 1980s may potentially also prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000). Studies during the

early 1960s found delta smelt were only an occasional prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). However, delta smelt were a comparatively rare fish even then, so it is not surprising they were a rare prey. Striped bass appear to have switched to piscivorous feeding habits at smaller sizes than they historically did, following severe declines in the abundance of mysid shrimp (Feyrer et al. 2003). Nobriga and Feyrer (in press) showed that inland silverside, which is similar in size to delta smelt, was only eaten by subadult striped bass less than 400 mm fork length. While largemouth bass are not pelagic, they have been shown to consume some pelagic fishes (Nobriga and Feyrer 2007).

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002b). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River (DWR Delta Overview). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades (see Effects section).

Channelization, conversion of Delta islands to agriculture, and water operations have substantially changed the physical appearance, water salinity, water clarity, and hydrology of the Delta. As a consequence of these changes, most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Feyrer et al. 2007). Wang (1991) noted in a 1989 and 1990 study of delta smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Though not restricting spawning *per se*, based on particle tracking modeling, export of water by the CVP and SWP would usually restrict reproductive success of spawners in the San Joaquin River by entraining most larvae during downstream transport from spawning sites to rearing areas (Kimmerer and Nobriga 2008). There is one, non-wet year exception to this generalization: in 2008, delta smelt entrainment was managed under a unique system of restrictions imposed by the Court in NRDC v Kempthorne. In 2008, CVP/SWP operations were constrained in accordance with recommendations formulated by the Service expressly to limit entrainment of delta smelt from the Central Delta.

Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to Hyalella azteca (Werner et al. 2008). The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects. The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta. Flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations entering the Delta from wastewater treatment plants.

The distribution of juvenile delta smelt has also changed over the last several decades. During the years 1970 through 1978, delta smelt catches in the TNS survey declined rapidly to zero in the Central and South Delta and have remained near zero since. A similar shift in FMWT catches occurred after 1981 (Arthur et al. 1996). This portion of the Delta has also had a long-term trend increase in water clarity during July through December (Arthur et al. 1996; Feyrer et al. 2007; Nobriga et al. 2008).

The position of the LSZ where delta smelt rear has also changed over the years. Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. These changes may be due to increased upstream water diversions for flooding rice fields (Kawakami et. al. 2008). The confluence of the Sacramento and San Joaquin rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 FMWT survey were captured at statistically significantly higher salinities than what would be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (*Microcystis aeruginosa*) spread far downstream to the west Delta and beyond during the summer (Peggy Lehman, pers comm). This has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (Reclamation 2008).

Delta Smelt Population Dynamics and Abundance Trends

The FMWT provides the best available long-term index of the relative abundance of delta smelt (Moyle et al. 1992; Sweetnam 1999). The indices derived from these surveys closely mirror trends in catch per unit effort (Kimmerer and Nobriga 2005), but do not at present support statistically reliable population abundance estimates, though substantial progress has recently been made (Newman 2008). FMWT derived data are generally

accepted as providing a reasonable basis for detecting and roughly scaling interannual trends in delta smelt abundance.

The FMWT derived indices have ranged from a low of 27 in 2005 to 1,653 in 1970 (Figure S-5). For comparison, TNS-derived indices have ranged from a low of 0.3 in 2005 to a high of 62.5 in 1978 (Figure S-4). Although the peak high and low values have occurred in different year, the TNS and FMWT indices show a similar pattern of delta smelt relative abundance; higher prior to the mid-1980s and very low in the past seven years.

From 1969-1981, the mean delta smelt TNS and FMWT indices were 22.5 and 894, respectively. Both indices suggest the delta smelt population declined abruptly in the early 1980s (Moyle et al. 1992). From 1982-1992, the mean delta smelt TNS and FMWT indices dropped to 3.2 and 272 respectively. The population rebounded somewhat in the mid-1990s (Sweetnam 1999); the mean TNS and FMWT indices were 7.1 and 529, respectively, during the 1993-2002 period. However, delta smelt numbers have trended precipitously downward since about 2000.

Figure S-4. TNS abundance indices for delta smelt.

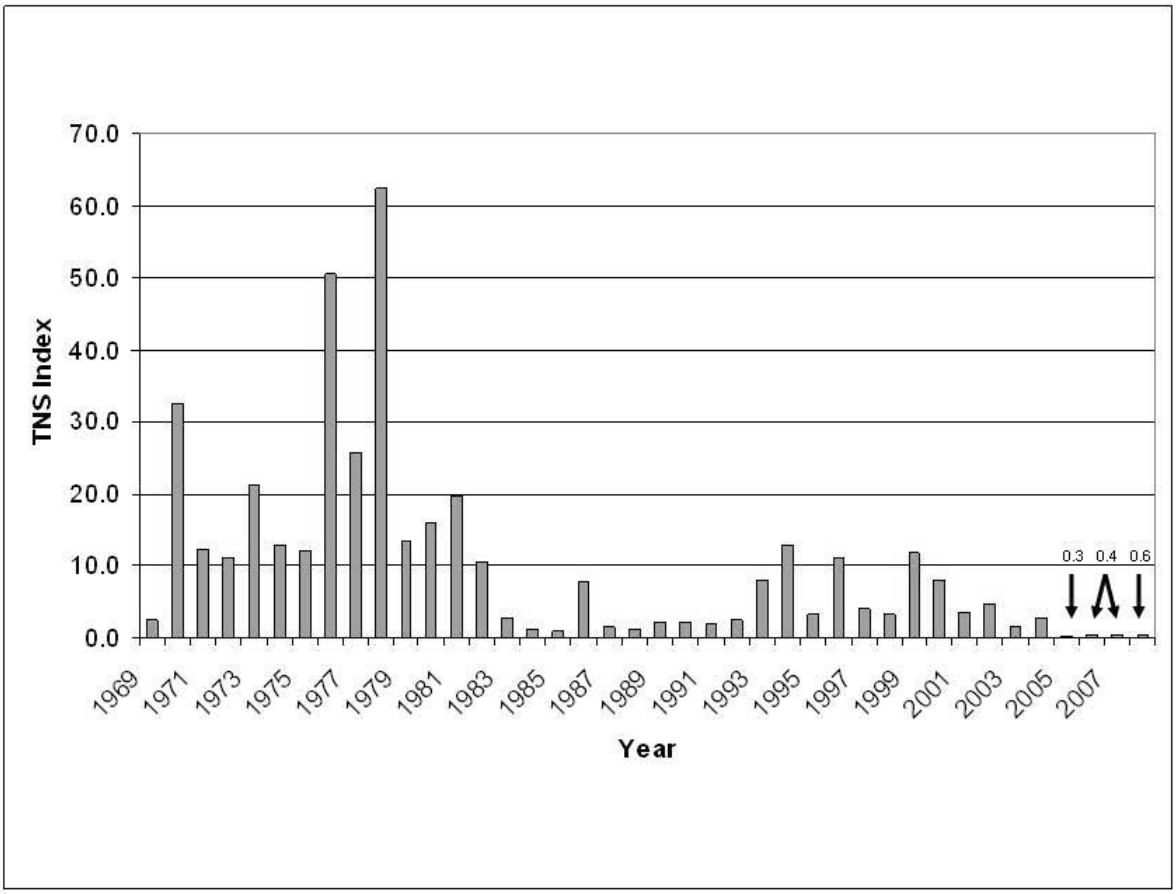
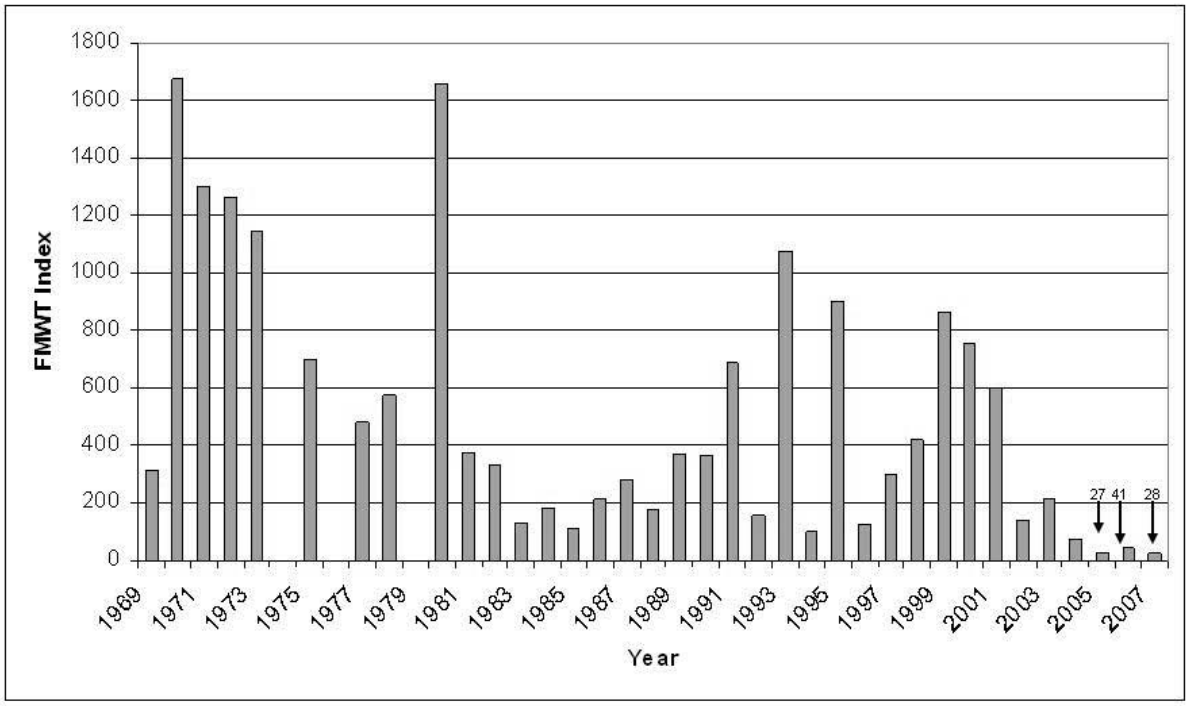


Figure S-4. FMWT abundance indices for delta smelt.



Currently, the delta smelt population indices are two orders of magnitude smaller than historical highs (Figures S-4 and S-5) and recent population abundance estimates are up to three orders of magnitude below historical highs (Newman 2008). After 1999 both the FMWT and the TNS population indices showed declines, and from 2000 through 2007 the median FMWT index was 106.5. The lowest FMWT abundance indices ever obtained were recorded during 2004-2007 (74, 27, 41, and 28, respectively; Figure S-5). The median TNS index during the period from 2000 through 2008 fell similarly to 1.6, and has also dropped to its lowest levels during the last four years with indexes of 0.3, 0.4, 0.4, and 0.6 during 2005 through 2008, respectively (Figure S-4). It is highly unlikely that the indices from 2004-2007 can be considered statistically different from one another (see Sommer et al. 2007), but they are very likely lower than at any time prior in the period of record.

The total number of delta smelt collected in the 20-mm Survey decreased substantially during the years from 2002 to 2008 (4917 to 587 fish) compared to the period 1995 through 2001 (98 to 1084 fish) (Figure S-6). Similarly, the number of delta smelt caught in the SKT has decreased steadily since the survey started in 2002 (Figure S-6)

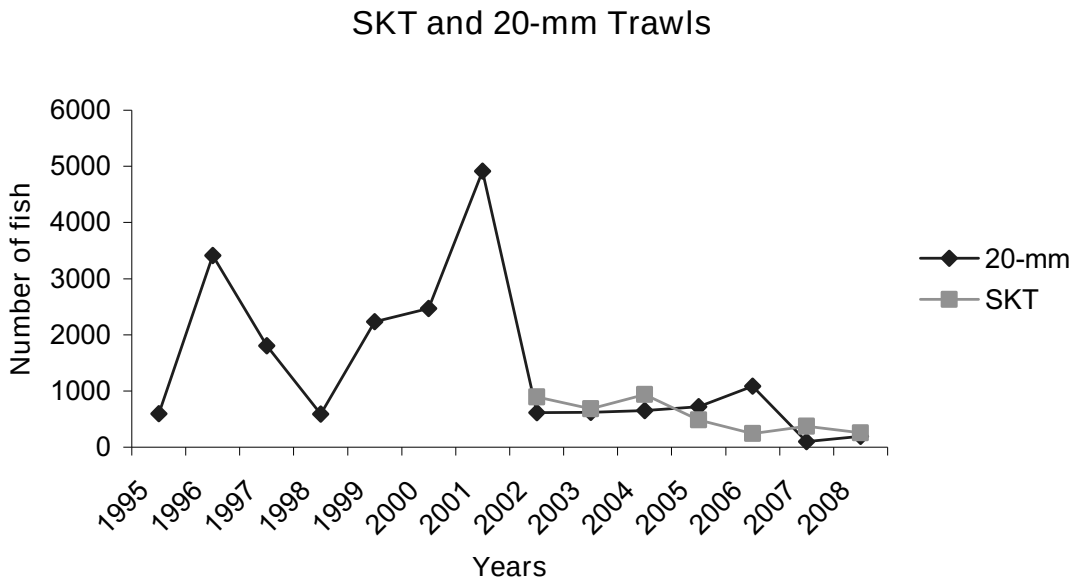


Figure S-6. Number of fish collected in the Spring Kodiak Trawl and the 20-mm surveys. Only the eight first 20-mm trawl surveys are included and only data from the four first full surveys of the SKT. SKT data from DFG at http://www.delta.dfg.ca.gov/ and 20-mm trawl catch data provided by DFG.

Since about 2002, delta smelt is one of four pelagic fish species subject to what has been termed the Pelagic Organism Decline or POD (Sommer et al. 2007). The POD denotes the sudden, overlapping declines of San Francisco Estuary pelagic fishes first recognized in data collected from 2002-2004. The POD species include delta smelt, longfin smelt, threadfin shad (*Dorosoma petenense*), and (age-0) striped bass (*Morone saxatillis*), which together account for the bulk of the resident pelagic fish biomass in the tidal water upstream of X2. The year 2002 is often recognized as the start of the POD because of the striking declines of three of the four POD species between 2001 and 2002; however, statistical review of the data (e.g., Manly and Chotkowski 2006) has revealed that for at least delta smelt, the POD downtrend really began earlier (around 1999). Post-2001 abundance indices for the POD species have included record lows for all but threadfin shad. The causes of the POD and earlier declines are not fully understood, but appear to be layered and multifactorial (Baxter et al. 2008). Several analyses have concluded that the shift in pelagic fish species abundance in the early 1980s was caused by a decrease in habitat carrying capacity or production potential (Moyle et al. 1992, Bennett 2005; Feyrer et al. 2007).

There is some evidence that the recruitment of delta smelt may have sometimes responded to springtime flow variation (Herbold et al. 1992; Kimmerer 2002). However, the weight of evidence suggests that delta smelt abundance does not (statistically)

respond to springtime flow like the abundance of the species mentioned above (Stevens and Miller 1983; Jassby et al. 1995; Bennett 2005). The number of days of suitable spawning temperature during spring is correlated with subsequent abundance indices in the autumn (Bennett 2005). This is evidence that cool springs, which allow for multiple larval cohorts, can contribute to population resilience. However, these relationships do not explain a large proportion of variance in autumn abundance. Depending on which abundance index is used, the r^2 are 0.24-0.29.

The relationship between numbers of spawning fish and the numbers of young subsequently recruiting to the adult population is known as a stock-recruit relationship. Analysis of stock-recruit relationships using delta smelt survey data indicate that a weak density dependent effect has occurred during late summer/fall (Bennett 2005, Reclamation 2008), suggesting that delta smelt year-class strength has often been set during late summer and fall. This is supported by studies suggesting that the delta smelt is food limited (Bennett 2005; IEP 2005) and evidence for density dependent mortality has been presented by Brown and Kimmerer (2001). However, the number of days during the spring that water temperature remained between 15 ºC and 20 ºC, with a density-dependence term to correct for the saturating TNS-FMWT relationship (described above), predicts FMWT indices fairly well ($r^2 \approx 0.70$; $p < 0.05$; Bennett, unpublished presentation at the 2003 CALFED Science Conference). This result shows that of the quantity of young delta smelt produced also contributes to future spawner abundance. Bennett (2005) analyzed the relationship between delta smelt spawner population and spawner recruits using data before and after the 1980s decline. He concluded that density dependence pre-1982 may have occurred at FMWT values of 600 to 800 and at FMWT values of 400 to 500 for the period 1982 through 2002.

Bennett (2005) also conducted extensive stock-recruit analyses using the TNS and FMWT indices. He provided statistical evidence that survival from summer to fall is nonlinear (= density-dependent). He also noted that carrying capacity had declined. Bennett (2005) surmised that density-dependence and lower carrying capacity during the summer and fall could happen in a small population if habitat space was smaller than it was historically. This hypothesis was recently demonstrated to be true (Feyrer et al. 2007). Reduced Delta outflow during autumn has led to higher salinity in Suisun Bay and the Western Delta while the proliferation of submerged vegetation has reduced turbidity in the South Delta. Together, these mechanisms have led to a long-term decline in habitat suitability for delta smelt. High summer water temperatures also limit delta smelt distribution (Nobriga et al. 2008) and impair health (Bennett et al. 2008).

A minimum amount of suitable habitat during summer-autumn may interact with a suppressed pelagic food web to create a bottleneck for delta smelt (Bennett 2005; Feyrer et al. 2007; Bennett et al. 2008). Prior to the overbite clam invasion, the relative abundance of maturing adults collected during autumn was unrelated to the relative abundance of juveniles recruiting the following summer (i.e., the stock-recruit relationship was density-vague). Since the overbite clam became established, autumn relative abundance explains 40 percent of the variability in subsequent juvenile abundance (Feyrer et al. 2007). When autumn salinity is factored in, 60 percent of the variance in subsequent juvenile abundance is accounted for statistically.

Since 2000, the stock-recruit relationship for delta smelt has been stronger still ($r^2 = 0.88$ without autumn habitat metrics factored in; Baxter et al. 2008). This has led to speculation about Allee effects. Allee effects occur when reproductive output per fish declines at low population levels (Allee 1931, Berec et al. 2006). Below a certain threshold the individuals in a population can no longer reproduce rapidly enough to replace themselves and the population spirals to extinction. For delta smelt, possible mechanisms for Allee effects include mechanisms directly related to reproduction and genetic fitness such as difficulty finding enough males to maximize egg fertilization during spawning (e.g., Purchase et al. 2007). Genetic problems arising from small population sizes like inbreeding and genetic drift also can contribute to Allee effects, but genetic bottlenecks occur after demographic problems like the example of finding enough mates (Lande 1988). Other mechanisms related to survival such as increased vulnerability to predation are also possible based on studies of other species.

These data provide evidence that factors affecting juvenile delta smelt during summer-autumn are also impairing delta smelt reproductive success. Thus, the interaction of warm summer water temperatures, suppression of the food web supporting delta smelt, and spatially restricted suitable habitat during autumn affect delta smelt health and ultimately survival and realized fecundity (Figure S-3).

Another possible contributing driver of reduced delta smelt survival, health, fecundity, and resilience that occurs during winter is the "Big Mama Hypothesis" (Bill Bennett, UC Davis, pers. comm. and various oral presentations). As a result of his synthesis of a variety of studies, Bennett proposed that the largest delta smelt (whether the fastest growing age-1 fish or fish that manage to spawn at age-2) could have a large influence on population trends. Delta smelt larvae spawned in the South Delta have high risk of entrainment under most hydrologic conditions (Kimmerer 2008), but water temperatures often warm earlier in the South Delta than the Sacramento River (Nobriga and Herbold 2008). Thus, delta smelt spawning often starts and ends earlier in the Central and South Delta than elsewhere. This differential warming may contribute to the "Big Mama Hypothesis" by causing the earliest ripening females to spawn disproportionately in the South Delta, putting their offspring at high risk of entrainment. Although water diversion strategies have been changed to better protect the 'average' larva, the resilience historically provided by variable spawn timing may be reduced by water diversions and other factors that covary with Delta inflows and outflows.

Substantial increases in winter salvage at Banks and Jones that occurred contemporaneously with recent declines in delta smelt and other POD species (Kimmerer 2008, Grimaldo et al. accepted manuscript) support the interpretation that entrainment played a role in the POD-era depression of delta smelt numbers. Increased winter entrainment of delta smelt represents a loss of pre-spawning adults and all their potential progeny (Sommer et al. 2007). Note that winter salvage levels subsequently decreased to very low levels for all POD species during the winters of 2005-2006 and 2006-2007, possibly due to the very low population sizes during those periods. Reduced pumping for protection of delta smelt also substantially reduced OMR flow towards the pumps and subsequently reduced number of delta smelt entrained during the winters of 2006-2007 and 2007-2008.

The hydrologic and statistical analyses of relationships between OMR flows and salvage suggest a reasonable mechanism by which winter entrainment increased with increased exports during the POD years; however, entrainment is not a substantial source of mortality every year. Manly and Chotkowski (2006; IEP 2005) found that monthly or semi-monthly measures of exports or Old and Middle rivers flow had a reliable, statistically significant effect on delta smelt abundance; however, individually they explained a small portion (no more than a few percent) of the variability in the fall abundance index of delta smelt across the entire survey area and time period. Kimmerer (2008) addressed delta smelt entrainment by means of particle tracking, and estimated historical entrainment rates for larvae and juvenile delta smelt to be as high as 40 percent; however, he concluded that non-entrainment mortality in the summer had effects on FMWT delta smelt numbers. Hence, there are other factors that often mask the effect of entrainment loss on delta smelt fall abundance in these analyses. Among them, availability and quality of summer and fall habitat (see Effects section) are clearly affected by CVP/SWP operations.

We conclude that entrainment and habitat availability/quality jointly contribute to downward pressure on spawner recruitment in and one or both of these general mechanisms is operating throughout the year. The intensity of constraints of the other threats affecting the delta smelt carrying capacity varies between years, and the importance of contributing stressors changes as outflow, export operations, weather, and the abundances of other ecosystem elements vary. For instance, Bennett (2005) noted that seasonally low outflow and warmer water temperatures may concentrate delta smelt and other planktivorous fishes into relatively small patches of habitat during late summer. This would increase competition and limit food availability during low outflow. Higher outflow that expands and moves delta smelt habitat downstream of the Delta is expected to improve conditions for delta smelt (Feyrer et al. 2007). The high proportion of the delta smelt population that has been entrained during some years (Kimmerer 2008) would be expected to reduce the ability of delta smelt to respond to the improved conditions, thereby limiting the potential for increased spawner recruitment. Further, the smaller sizes of maturing adults during fall may have affected delta smelt fecundity (Bennett, 2005). This would further reduce the species' ability to respond to years with improved conditions.

Factors Affecting the Species

Water Diversions and Reservoir Operations

Banks and Jones Export Facilities

In 1951, the Tracy Pumping Plant (now referred to as the Jones Pumping Plant), with a capacity of 4,600 cfs, was completed along with the Delta Mendota Canal which conveys water from the Jones Pumping Plant (Jones) for use in the San Joaquin Valley. Simultaneously, Reclamation also constructed the Delta Cross Channel to aid in transferring water from the Sacramento River across the Delta to the Jones Pumping Plant. From its inception and formulation, the CVP (inclusive of upstream reservoirs, river and Delta conveyance, the Jones Pumping Plant, Delta-Mendota Canal, and San

Luis Reservoir) was intended to function as an integrated system to deliver and export water, not as a grouping of separate or independent units.

In 1968 the first stage of the Banks Pumping Plant for the SWP was completed with seven units having a combined capacity of 6,400 cfs. In 1973, the California Aqueduct was completed. In 1974 Clifton Court Forebay was completed. In 1991 an additional four pumping units were added, increasing Banks Pumping plant capacity to 10,300 cfs. However, this diversion rate has historically been restricted to 6,680 cfs as a three-day average inflow to Clifton Court Forebay, although between December 15 and March 15, when the San Joaquin River is above 1,000 cfs, pumping in excess of 6680 at a rate equal to one-third of the San Joaquin River flow at Vernalis has historically been permissible. Furthermore, under the EWA, the SWP has been permitted to pump an additional 500 cfs between July 1 and September 30 to offset water costs associated with fisheries actions making the summer limit effectively 7,180 cfs. The Army Corps of Engineers' permit for increased pumping at Banks expired and is no longer authorized. The completion and operation of the Jones and Banks pumping plants have increased Delta water exports (Figure P-18).

Export of water from the Delta has long been recognized to have multiple effects on the estuarine ecosystem upon which species such as the delta smelt depend (Stevens and Miller 1983; Arthur et al. 1996; Bennett and Moyle 1996). In general, water is conveyed to Jones and Banks via the Old and Middle River channels resulting in a net (over a tidal cycle or tidal cycles) flow towards Jones and Banks. When combined water export exceeds San Joaquin River inflows, the additional water is drawn from the Sacramento River through the Delta Cross Channel, Georgina Slough, and Three-Mile Slough. At high pumping rates, net San Joaquin River flow is toward Banks and Jones (Arthur et al. 1996). Combined flow in the Old and Middle Rivers is measured as "OMR" flows while flow in the San Joaquin River at Jersey Island is calculated as "Qwest" (Dayflow at http://www.iep.ca.gov/dayflow/). Flow towards the pumps is characterized as negative flow for both measurements. Further, OMR flow towards the pumps is increased seasonally by installation of the South Delta Temporary Barriers. In particular, the Head of Old River barrier reduces flow from the San Joaquin River downstream into Old River so more water is drawn from the Central Delta via Old and Middle Rivers.

Because large volumes of water are drawn from the Estuary, water exports and fish entrainment at Jones and Banks are among the best-studied sources of fish mortality in the San Francisco Estuary (Sommer et al. 2007). As described in the Project Description, the Tracy Fish Collection Facility (CVP) and the Skinner Fish Facility (SWP) serve to reduce the mortality of fish entrained at Jones and Banks. The export facilities are known to entrain all species of fish inhabiting the Delta (Brown et al. 1996), and are of particular concern in dry years, when the distribution of young striped bass, delta smelt, and longfin smelt shift upstream, closer to the diversions (Stevens et al. 1985; Sommer et al. 1997). As an indication of the magnitude of entrainment effects caused by Banks and Jones, approximately 110 million fish were salvaged at the Skinner Fish Facility screens and returned to the Delta over a 15-year period (Brown et al. 1996). However, this number greatly underestimates the actual number of fish entrained. It does not include losses through the guidance louvers at either facility. For Banks in particular, it does not

account for high rates of predation on fish in CCF (Gingras 1997). Fish less than 30 mm forklength (FL) are not efficiently collected by the fish screens (Kimmerer 2008).

The entrainment of adult delta smelt at Jones and Banks occurs mainly during their upstream spawning migration between December and April (Figure S-7). Entrainment risk depends on the location of the fish relative to the export facilities and the level of exports (Grimaldo et al. accepted manuscript). The spawning distribution of adult delta smelt varies widely among years. In some years a large proportion of the adult population migrates to the Central and South Delta, placing both spawners and their progeny in relatively close proximity to the export pumps and increasing entrainment risk. In other years, the bulk of adults migrate to the North Delta, reducing entrainment risk. In very wet periods, some spawning occurs west of the Delta.

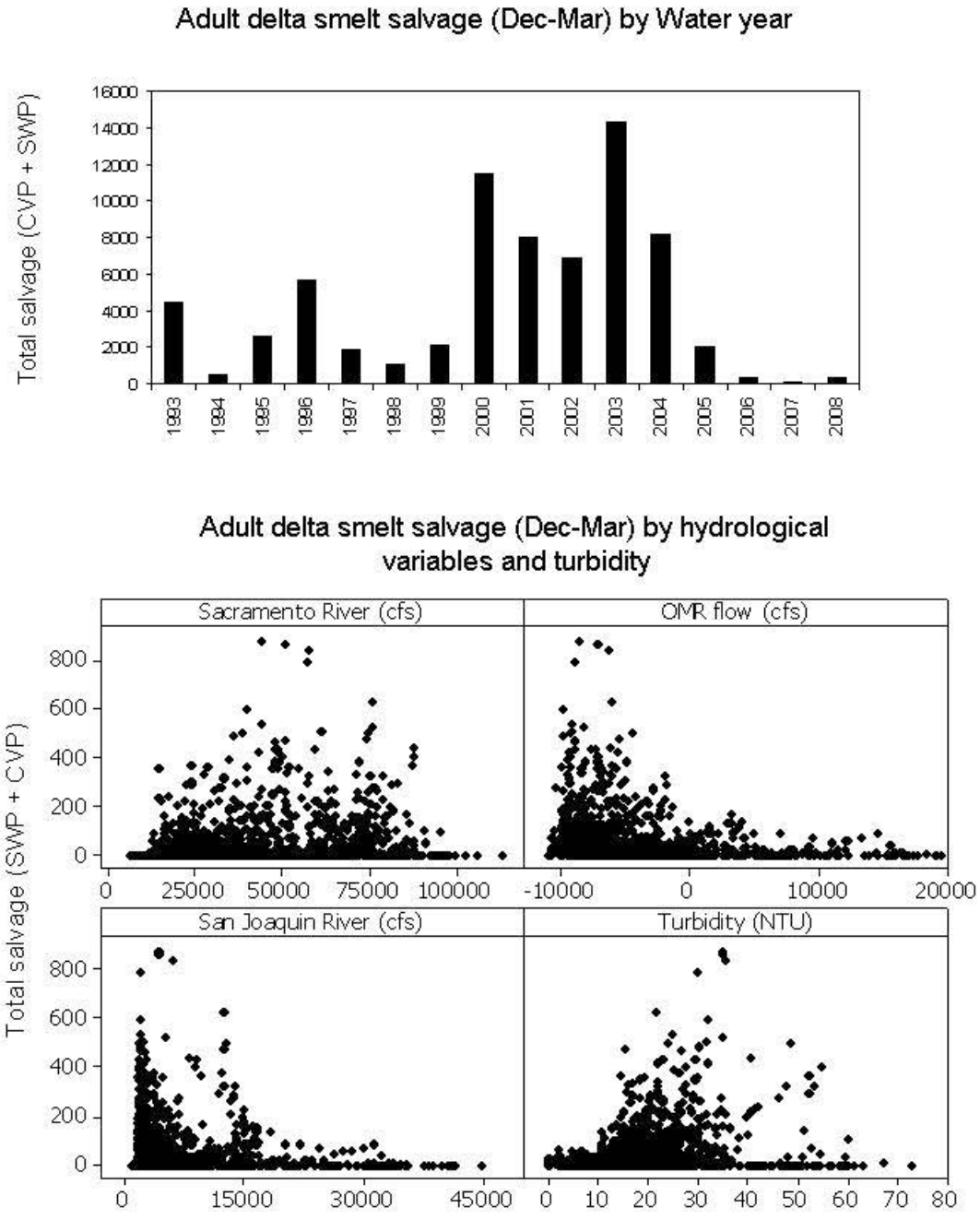


Figure S-7, Adult delta smelt salvage December through March by WY and by hydrological variables and turbidity

The CVP and SWP water operations are thought to have a minor impact on delta smelt eggs because they remain attached to substrates or at least strongly negatively buoyant due to attached sand grains (see Spawning section above). Shortly after hatching, larvae become subject to flow-mediated transport, and are vulnerable to entrainment. However, delta smelt and other fish are not officially counted at Banks or Jones unless they are 20 mm or greater in total length and transitioning to the juvenile stage. Juvenile delta smelt are vulnerable to entrainment and are counted in salvage operations once they reach 20-25 mm in length, but the fish facilities remain inefficient collectors of delta smelt until they surpass 30 mm in length (Kimmerer 2008). Most salvage of juvenile delta smelt occurs from April-July with a peak in May-June (Grimaldo et al, accepted manuscript).

High winter entrainment has been suspected as a contributing cause of both the early 1980s (Moyle et al. 1992) and the POD-era declines of delta smelt (Baxter et al. 2008). To address the increases in winter salvage during 2002-2004, three key issues were evaluated. First, there was an increase in exports during winter as compared to previous years, attributable to the SWP (Figure P-17). Second, the proportion of tributary inflows shifted. Specifically, San Joaquin River inflow decreased as a fraction of total inflow around 2000, while Sacramento River inflow increased (Figure 7-12, Reclamation 2008).

Overall, these operational changes may have contributed to a shift in Delta hydrodynamics that increased fish entrainment. The hydrodynamic change can be indexed using tidally averaged net flows through OMR that integrate changes in inflow, exports, and barrier operations (Monsen et al. 2007, Peter Smith, USGS, unpublished data). Several analyses have revealed strong, non-linear inverse relationships between net OMR flow and winter salvage of delta smelt at the Banks and Jones (Fig. 7-6 in Reclamation 2008; P. Smith, unpublished data; Grimaldo et al accepted manuscript; Kimmerer 2008) (See Figure S-8). While the specific details of these relationships vary by species and life stage, net OMR flow generally works very well as a binary switch: negative OMR is associated with some degree of entrainment, while positive OMR is usually associated with no, or very low, entrainment. Particle tracking modeling (PTM) also shows that entrainment of particles and residence time is highly related to the absolute magnitude of negative OMR flows, and that the zone of influence of the pumps increases as OMR becomes more negative. The rapid increase in the extent of the zone of entrainment at high negative OMR likely accounts for the faster-than-linear increase in entrainment as OMR becomes more negative. Adult delta smelt do not behave as passive particles, but they still use tidal flows to seek suitable staging habitats prior to spawning. When the water being exported is suitable staging habitat, for instance, when turbidity is > 12 NTU, delta smelt do not have a reason to avoid net southward transport toward the pumps so the OMR/entrainment relationship reinforces that tidally averaged net flow is an important determinant of the migratory outcome for delta smelt.

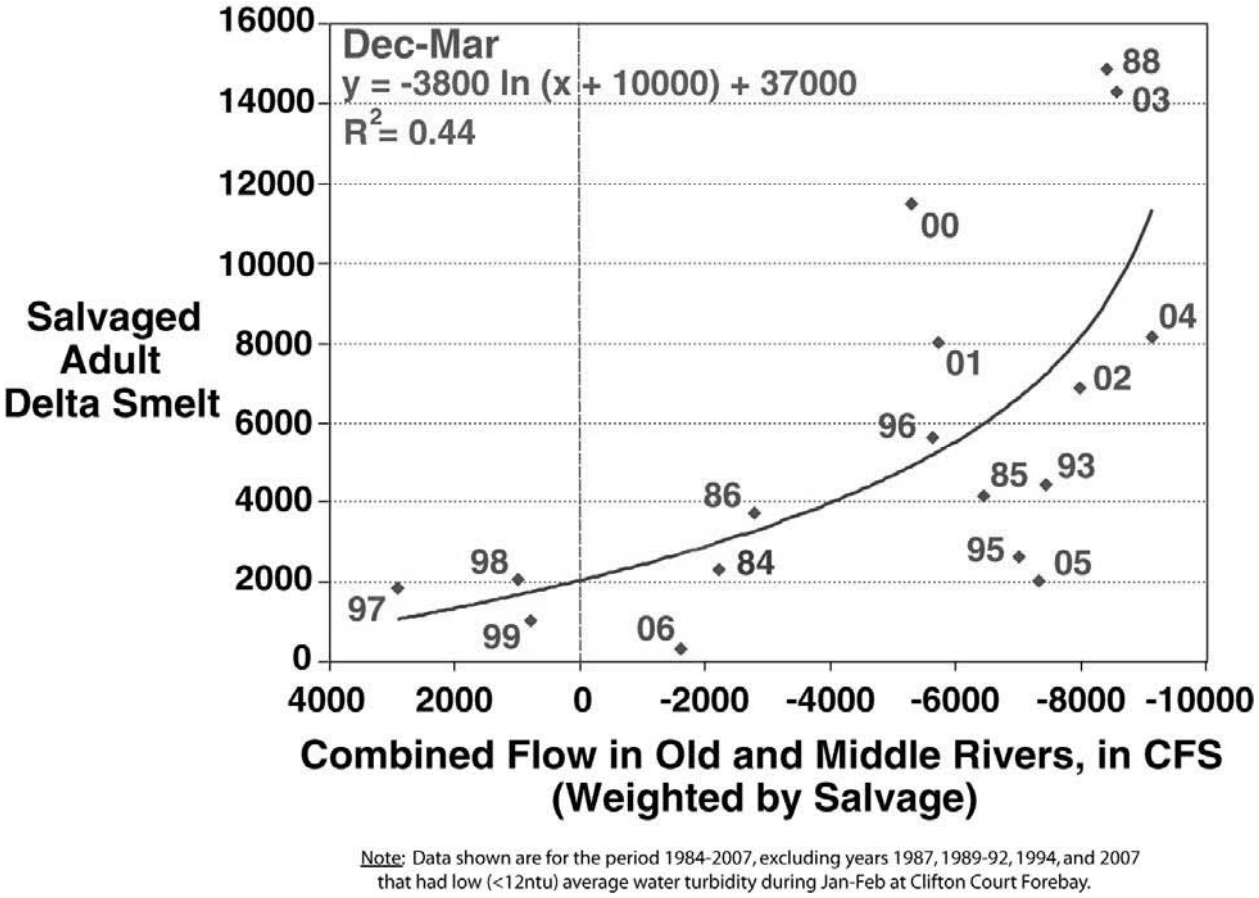


Figure S-8 – Relationship for the total number of adult delta smelt salvaged at the State and Federal fish facilities in the south Delta during the winter months of December through March with the combined, tidally averaged flow in Old and Middle Rivers near Bacon Island (***AVG_OMR$_i$***).

PTM that simulates water movement using particles injected at various stations in the Delta gives a fairly good representation of the relative likelihood of larval and juvenile delta smelt entrainment (Kimmerer 2008; Kimmerer and Nobriga 2008). Predicted entrainment is high for the San Joaquin River region given recent winter and spring operations. Depending on Delta conditions, up to 70 percent of small organisms in the Old River south of Franks Tract would be entrained within 30 days at moderate flows in San Joaquin River and an OMR of negative 3,000 cfs (SWG notes 2008). Ten to twenty percent of larval delta smelt located in the San Joaquin River at Fisherman's Cut would be expected to be entrained during the same period and OMR flows. This percentage increases to about 30 percent if OMR net flow is negative 5,000 cfs (DWR March 4, 2008, PTM runs: http://www.fws.gov/sacramento/).

Larvae are not currently sampled effectively at the fish-screening facilities and very small larvae (< 15-20 mm) are not sampled well by IEP either. Kimmerer and Nobriga (2008) and Kimmerer (2008) addressed larval delta smelt entrainment by coupling PTM with 20-mm survey results to estimate historical larval entrainment. These approaches suggest

that larval entrainment losses could exceed 50 percent of the population if low flow and high export conditions coincide with a spawning distribution that includes the San Joaquin River. Although this does not occur every year, the effect of larval entrainment is substantial when it does. Since delta smelt are an annual fish, one year with distribution within the footprint of entrainment by the pumps can lead to a serve reduction in that year's production. In order to minimize the entrainment of undetected larval delta smelt, export reductions have recently focused on the time period when larval smelt are thought to be in the South Delta (based on adult distributions) to proactively protect these fish.

Salvage of delta smelt has historically been greatest in drier years when a high proportion of young of the year (YOY) rear in the Delta (Moyle et al. 1992; Reclamation and DWR 1994; and Sommer et al. 1997). In recent years however, salvage also has been high in moderately wet conditions (Nobriga et al. 2000; 2001; Grimaldo et al., accepted manuscript: springs of 1996, 1999, and 2000) even though a large fraction of the population was downstream of the Sacramento-San Joaquin River confluence. Nobriga et al. (2000; 2001) attributed recent high wet year salvage to a change in operations for the VAMP that began in 1996. The VAMP provides a San Joaquin River pulse flow from mid-April to mid-May each year that probably improves rearing conditions for delta smelt larvae and also slows the entrainment of fish rearing in the Delta. The high salvage events may have resulted from smelt that historically would have been entrained as larvae and therefore not counted at the fish salvage facilities growing to a salvageable size before being entrained. However, a more recent analysis provides an additional explanation. Delta smelt salvage in 1996, 1999, and 2000 was not outside of the expected historical range when three factors are taken into account, (1) delta smelt distribution as indexed by X2, and (2) delta smelt abundance as indexed by the TNS. Herbold, B. et al. (unpublished: http://198.31.87.66/pdf/ewa/EWA_Herbold_historical_patterns_113005.pdf) showed that salvage during 2003 through 2005 was relatively high compared to previous years given the low abundance indicated by the FMWT index (Figure S-9). Therefore, it is uncertain that operations changes for VAMP have influenced delta smelt salvage dynamics as suggested by Nobriga et al. (2000). In addition, assets from the EWA are often used during this time of year to further reduce delta smelt entrainment, though the temporary export curtailments from EWA have not likely decreased delta smelt entrainment by more than a few percent (Brown et al. 2008). Although the population level benefits of these actions are ultimately sometimes minor, they have been successful at keeping delta smelt salvage under the limits set in the Service's OCAP biological opinions (Brown and Kimmerer 2002).

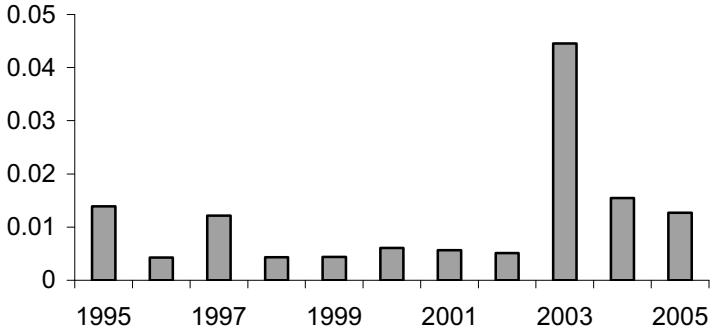


Figure S-9. Ratio of salvage density to the previous FMWT index.

In 2007 and 2008, CVP and SWP implemented actions to reduce entrainment at the pumps, including maintaining higher (less negative) OMR flows (Smelt Working Group Notes and Water Operations Management Team Notes at http://www.fws.gov/). During these two years estimated number of delta smelt salvaged decreased considerably. Estimated adult salvage was 60 and 350 in 2007 and 2008, respectively. Total (adults and young-of-the-year) estimated salvage was 2,327 and 2,038 delta smelt, respectively. These were down from a high of 14,338 in 2003.

Environmental Water Account

The EWA, as described in the Project Description, was established in 2000. The EWA agencies acquired assets and determined how the assets should be used to benefit the at-risk native fish species of the Bay-Delta estuary. The EWA reduced diversions of water at Banks and Jones when listed fish species were present in the Delta and prevented the uncompensated loss of water to SWP and CVP contractors. Typically the EWA replaced water lost due to curtailment of pumping by purchase of surface or groundwater supplies from willing sellers and by taking advantage of regulatory flexibility and certain operational assets. These assets were moved through the Delta during the summer and fall, when entrainment effects to listed fish were minimal.

Generally, under past actions, the EWA has reduced water exports out of the Delta during the winter and spring and increased exports during the summer and early winter. These actions reduced entrainment at the facilities, but only by modest amounts (Brown et al. 2008). The movement of water in the summer and fall may have negatively influenced habitat suitability and prey availability (see effects section).

500 cfs Diversion at Banks

This operation allowed the maximum allowable daily diversion rate into CCF during the months of July, August, and September to increase from 13,870 AF to 14,860 AF and three-day average diversions from 13,250 AF to 14,240 AF. The increase in diversions was permitted by the U.S. Army Corps of Engineers and has been in place since 2000.

The current permit expired on September 30, 2008 and DWR is currently seeking an extension.

The purpose of this diversion increase into CCF was for the SWP to recover export reductions made due to the ESA or other actions like the EWA taken to benefit fisheries resources. This increased capacity allowed EWA assets to be moved through the Delta during the summer, when entrainment of listed species was minimal. This additional diversion rate was included as part of the EWA operating principles. This additional pumping occurred during the summer and likely did not result in much direct entrainment of delta smelt, but did likely result in entrainment of food for delta smelt, such as *Pseudodiaptomus* and contributed to lower habitat suitability as summer-fall export to inflow ratios increased to high levels regardless of preceding winter-spring flows.

CVP/SWP Actions Taken since the 2005 OCAP Biological Opinion was Issued

After the issuance of the 2005 biological opinion, the SWG used the DSRAM (Attachment A) to provide guidance for when the group needed to meet to analyze the most recent real-time delta smelt abundance and distribution data. Using the latest data, the SWG then determined if a recommendation to the Service to protect delta smelt from excessive entrainment was warranted. For the 2006 WY, a wet WY, based on the Service's recommendations, the Projects reduced exports to protect delta smelt by operating to an E/I ratio limit. The export curtailment operated to an E/I ratio of 15 percent beginning January 3 until February 21, 2006, when the E/I was expected to increase above 20 percent due to wet hydrologic conditions. No further actions were taken to protect fish that season as the E/I ratio was maintained at about 10 percent because of high spring flows. VAMP was implemented in May 2006, although the HORB was not installed due to high flows on the San Joaquin River.

For the 2007 WY, a dry year, the Service recommended a winter pulse flow increasing OMR flows to a daily average of negative 3500 cfs or if there were not Sacramento River flows above 25,000 cfs for three days, to moderate OMR to a range of negative 5000 cfs to negative 3500 cfs until February 15th . This action was implemented by the Projects, but since the Sacramento River never achieved 25,000 cfs for three days, the Projects operated to not exceed a 5-day average OMR flow of negative 4,000 cfs starting on January 15. To protect pre-spawning adult delta smelt from becoming entrained and based on the Service's recommendation, the Projects maintained OMR above negative 4,000 cfs and on March 13 the Project operated to a 5-day average OMR of negative 5,000 cfs.

To protect larval and juvenile delta smelt from entrainment the Projects operated the export facilities to achieve a non-negative daily net OMR flow. The Projects implemented the following actions: reduced combined Banks and Jones exports from 1,500 cfs to combined 1,200 cfs (850 cfs at the CVP and 350 cfs at the SWP) and evaluated increasing New Melones releases to 1,500 cfs for steelhead emigration. VAMP was then implemented and the HORB was removed on May15. The South Delta agricultural barriers maintained their flap gates in the open position and Reclamation increased exports from 850 cfs to 1,200 cfs on June 13 while DWR maintained an export level of 400 cfs.

Water Year 2008 Interim Remedial Order Following Summary Judgment and Evidentiary Hearing (Wanger Order)

For the 2008 WY, a dry WY, the Service, Reclamation and DWR implemented the direction contained in the Wanger Order.

A modified Adaptive Process was used during 2008. The SWG continued to use the DSRAM to identify the most recent delta smelt data and to help and provide a framework for the level of protection needed to protect delta smelt from entrainment. The SWG provided guidance to the Service, who then made a recommendation to WOMT. If WOMT did not agree to the Service's determination, WOMT would develop a counter proposal which was then sent back to Service, who would decide if WOMT's action was adequate to protect delta smelt or if the Service's original determination should be implemented instead.

For 2008, the fist action to protect delta smelt was a 10-day winter pulse flow that was implemented based on a turbidity trigger. The turbidity trigger was exceeded on December 25 and by December 28, the CVP and SWP began to operate such that a daily OMR flow would not be more negative than 2,000 cfs. This action was completed on January 6, 2008.

Second, OMR flow was limited to provide a net daily upstream OMR flow not to exceed 5,000 cfs to protect pre-spawning adult delta smelt from entrainment. This flow was calculated based on a 7-day running average. On January 7, 2008, immediately following the termination of the 10-day winter pulse flow, the CVP and SWP started to operate to achieve an average net upstream flow in OMR not to exceed 5,000 cfs over a 7-day running average period.

Next, OMR was limited to provide a net daily net upstream OMR flow of 750 to 5000 cfs to protect larval and juvenile delta smelt. These flows were determined by the Service, in consultation with Reclamation and DWR, on a weekly basis and were based upon the best available scientific and commercial information concerning delta smelt distribution and abundance. The Service used a control point method using PTM to limit predicted entrainment at Station 815 to 1 percent. When delta smelt abundances are low (the 2007 delta smelt FMWT Index was 28), the control point method is an appropriate method to protect delta smelt from entrainment at Banks and Jones. This is due in part because when delta smelt abundance is low, an accurate delta smelt distribution may not be determined from survey results. The control point method also sets a limit of entrainment from the Central Delta and it does not need distributional data to be protective. The CVP and SWP maintained OMR flow between -2000 and -3000 cfs, with an OMR flow agreed upon each week until June 20 (details on the OMR flow for each week can be found on the Sacramento Fish and Wildlife's website at http://www.fws.gov/sacramento/Delta_popup.htm). The CVP and SWP also implemented VAMP during this period, with San Joaquin River flows of 3,000 cfs and 1,500 cfs export flows. The HORB was not installed in 2008 and the SDTB maintained their flap gates in the open position.

Water Transfers

As described in the Project Description, purchasers of water for transfers have included Reclamation, DWR, SWP contractors, CVP contractors, other State and Federal agencies, or other parties. To date, transfers requiring export from the Delta have been done at times when pumping and conveyance capacity at Banks or Jones is available to move the water. Exports for transfers can not infringe upon the capability of the Projects to comply with the terms of SWQCP D-1641 and the existing biological opinions. Parties to the transfer are responsible for providing for any incremental changes in flows required to protect Delta water quality standards. All transfers have been in accordance with all existing regulations and requirements. Recent transfer amounts were 1,000 TAF in 2001-02, 608 TAF in 2002-03, 700 TAF in 2003-04, and 851 TAF in 2004-05 (DWR website: http://www.watertransfers.water.ca.gov). Generally, water transfers occur in the summer (July-September), when entrainment of listed fish is minimized. Most transfers have occurred at Banks because reliable capacity is generally only available at Jones in the driest 20 percent of years.

Article 21 and changes to Water Deliveries to Southern California

Changes in pumping in accordance with Article 21 and the associated changes in water deliveries have lead to recent increases in SWP water exports from the Delta. Article 21 deliveries are made when San Luis Reservoir is physically full or projected to be full and may result in export levels that are higher than if Article 21 was not employed. Recent changes in how Article 21 is invoked and used have increased the amount of Article 21 and Table A SWP water that has been pumped from the Delta.

Diamond Valley Lake was completed in 1999 and provided Metropolitan Water District of Southern California (MWDSC) an additional location for water storage in Southern California. Diamond Valley Lake holds 800,000 acre-feet of water, which makes it the largest reservoir in Southern California. MWDSC began filling the reservoir in November 1999 and the lake was filled by early 2002. Another factor involving water deliveries in southern California that changed Delta diversions is the Quantification Settlement Agreement (QSA) signed in 2003, which resulted in a decrease in the amount of Colorado River water available to California.

Since 1999, MWDSC was filling Diamond Valley Lake and adding water to groundwater storage programs. Generally, in wetter years, demand for imported water decreases because local sources are augmented and local rainfall reduces irrigation demands. However, with the increased storage capacity in Southern California, the recent wet years did not result in lower exports from the Delta or the Colorado River. Table P-12 illustrates the demands for imported water during the recent wet years and the effect of reduced Colorado River diversions under the QSA on MWDSC deliveries from the Delta.

Vernalis Adaptive Management Plan

As described in the project description, VAMP was initiated in 2000 as part of the SWRCB D- 1641. VAMP schedules and maintains pulse flows in the San Joaquin River and reduced exports at Banks and Jones for a one month period, typically from April 15-May 15 (May 1-31 in 2005/06). Tagged salmon smolts released in the San Joaquin River are monitored as they move through the Delta in order to determine their fate. While

VAMP-related studies attempt to limit CVP and SWP impacts to salmonids, the associated reduction in exports reduces the upstream flows that occur in the South and Central Delta. This reduction limits the southward draw of water from the Central Delta, and thus reduces the Projects' entrainment of delta smelt.

Based on Bennett's unpublished analysis, reduced spring exports resulting from VAMP have selectively enhanced the survival of delta smelt larvae spawned in the Central Delta that emerge during VAMP by reducing their entrainment. Initial otolith studies by Bennett's lab suggest that these spring-spawned fish dominate subsequent recruitment to adult life stages. By contrast, delta smelt spawned prior to and after the VAMP have been poorly-represented in the adult stock in recent years. The data suggests that the differential fate of early, middle and late cohorts affects sizes of delta smelt in fall because the later cohorts have a shorter growing season. These findings suggest that direct entrainment of larvae and juvenile delta smelt during the spring are relevant to population dynamics.

Other SWP/CVP Facilities

North Bay Aqueduct

The North Bay Aqueduct (NBA) diverts Sacramento River water from Barker Slough through Lindsay Slough. The 1995 OCAP biological opinion included monitoring delta smelt at the three stations in Barker Slough and the surrounding areas on a "recent-time" (within 72 hours) basis, and the posting of delta smelt information on the internet so that interested parties can use the information for water management decisions.

DWR contracted with DFG for the monitoring from 1995-2004 to estimate and evaluate larval delta smelt loss at the NBA due to entrainment, and to monitor the abundance and distribution of larval delta smelt in the Cache Slough complex and near Prospect Island. The sampling season for this monitoring was mid-February to mid-July with high priority stations (Barker and Lindsey Sloughs) sampled every two days and the remaining stations (Cache and Miner sloughs, and the Sacramento Deep Water Channel) sampled every four days.

NBA pumping was regulated by a weighted mean of the actual catch of delta smelt at the three Barker Slough stations. The weight assigned to each station was dependent on its proximity to the NBA intake. Station 721 had a 50 percent weighting, 727 had a 30 percent weighting and station 720 had a 20 percent weighting. As stated in the Service's 1995 OCAP biological opinion, the diversions at NBA were restricted to a 5-day running average of 65 cfs for five days when delta smelt were detected. In mathematical terms, the NBA restrictions were in place when the following equation was true:

$$0.5*(\text{Catch at } 721) + 0.3*(\text{Catch at } 727) + 0.2*(\text{Catch at } 720) >= 1.0$$

An entrainment estimate was then calculated as the weighted mean density of delta smelt multiplied by the total water exported for the sampling day and the day after. Based on this method, estimated annual entrainment of delta smelt at NBA was as follows: 1995 = 375; 1996 = 12,817; 1997 = 18,964; 1998 = 1,139; 1999 = 1,578; 2000 = 10,650; 2001 = 32,323; 2002 = 10,814; 2003 = 9,978; and 2004 = 8,246. However, a study of a fish

screen in Horseshoe Bend built to delta smelt standards excluded 99.7 percent of fish from entrainment even though most of these were only 15-25 mm long (Nobriga et al. 2004). Thus, the fish screen at NBA may protect many of the delta smelt larvae that do hatch and rear in Barker Slough, so actual entrainment was probably lower.

In the Service's 2005 OCAP biological opinion, a broader larval smelt survey was included in the Project Description in lieu of the NBA monitoring. This change was suggested due to the low numbers of delta smelt caught in the NBA monitoring and it was thought that a broader sampling effort would be more helpful in determining where larval delta smelt are located. This broader monitoring effort was conducted during the spring of 2006, and used a surface boom tow at the existing 20-mm survey stations. The sampling was successful, and helped show that larval delta smelt could be caught in the Delta. However, this monitoring was not continued after 2006. Starting in 2009, an expanded larval survey in the Delta will be conducted. As discussed above, the number of delta smelt entrained at the NBA is unknown, but it may be low so long as the fish screen is maintained properly. There may be years, however, that large numbers of delta smelt are in the Cache Slough complex and could be subject the entrainment at the NBA.

Contra Costa Water District (CCWD)

CCWD diverts water from the Delta for irrigation and municipal and industrial uses in the Bay Area. CCWD's system includes intake facilities at Mallard Slough, Rock Slough, and Old River near State Route 4; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir as described in the Project Description. The total diversion by CCWD is approximately 127 TAF per year. Most CCWD diversions are made through facilities that are screened; the Old River (80 percent of CCWD diversions) and Mallard Slough (3 percent of CCWD diversions) facilities have fish screens to protect delta smelt. However, the fish screens on these facilities may not protect larval fish from becoming entrained. For that reason, in part, there are also no-fill and no-diversion periods at the CCWD facilities.

Before 1998, the Rock Slough Intake was CCWD's primary diversion point. It has been used less since 1998 when Los Vaqueros Reservoir and the Old River Pumping Plant began operating and now only accounts for 17 percent of CCWD's diversions. To date, the Rock Slough Intake is not screened. Reclamation, as described in the Project Description, is responsible for constructing a fish screen at this facility under the authority of the CVPIA. Reclamation has received an extension for construction of the screen until 2008 and is seeking a further extension until 2013. The diversion at the Rock Slough Intake headworks structure is currently sampled with a sieve net three times per week from January through June and twice per week from July through December. A plankton net is fished at the headworks structure twice per week during times when larval delta smelt could be present in the area (generally March through June). A sieve net is fished at Pumping Plant #1 two times per week from the time the first Sacramento River winter-run Chinook salmon is collected at the Jones and Banks (generally January or February) through June. The numbers of delta smelt entrained by the facility since 1998 have been extremely low, with only a single fish observed in February 2005 (Reclamation 2008).

Other Delta Diversions and Facilities

In 2006, the Service issued a biological opinion on the construction and operation of the Stockton Delta Water Supply Facility located on Empire Tract along the San Joaquin River. This facility is expected to be completed and online by 2010. The maximum diversion rate for this facility will be 101 AF per day. Fish screens and pumping restrictions in the spring are expected to considerably limit entrainment of delta smelt. However, limited pumping will occur during the spring and the fish screens are not expected to fully exclude fish smaller than 20 mm TL, so delta smelt may be entrained at this facility.

There are 2,209 known agricultural diversions in the Delta and an additional 366 diversions in Suisun Marsh used for enhancement of waterfowl habitat (Herren and Kawasaki 2001). The vast majority of these diversions do not have fish screens to protect fish from entrainment. It has been recognized for many years that delta smelt are entrained in these diversions (Hallock and Van Woert 1959). Determining the effect of this entrainment has been limited because previous studies either (1) did not quantify the volumes of water diverted (Hallock and Van Woert 1959, Pickard et al. 1982) or (2) did not sample at times when, or locations where, delta smelt were abundant (Spaar 1994, Cook and Buffaloe 1998). Delta smelt primarily occur in large open-water habitats, but early life stages move downstream through Delta channels where irrigation diversions are concentrated (Herren and Kawasaki 2001). At smaller spatial scales, delta smelt distribution can be influenced by tidal and diel cycles (Bennett et al. 2002), which also may influence vulnerability to shore-based diversions.

In the early 1980s, delta smelt were commonly entrained in the Roaring River diversion in Suisun Marsh (Pickard et al. 1982), suggesting that it and similar diversions can adversely affect delta smelt. However, delta smelt may not be especially vulnerable to many Delta agricultural diversions for several reasons. First, adult delta smelt move into the Delta to spawn during winter-early spring when agricultural diversion operations are at a minimum. Second, larval delta smelt only occur transiently in most of the Delta and now avoid the South Delta during summer when diversion demand peaks. Third, Nobriga et al. (2004) examined delta smelt entrainment at an agricultural diversion in Horseshoe Bend during July 2000 and 2001, when much of the YOY population was rearing within one tidal excursion of the diversion. Delta smelt entrainment was an order of magnitude lower than density estimates from the DFG 20-mm Survey. Low entrainment was attributed to the offshore distribution of delta smelt, and the extremely small hydrodynamic influence of the diversion relative to the channel it was in. Because Delta agricultural diversions are typically close to shore and probably take small amounts of water relative to what is in the channels they draw water from, delta smelt vulnerability may be low despite their small size and their poor performance near simulated fish screens in laboratory settings (Swanson et al. 1998; White et al. 2007).

The impact on fish populations of individual diversions is likely highly variable and depends upon size, location, and operations (Moyle and Israel 2005). Given that few studies have evaluated the effectiveness of screens in preventing losses of fish, much less declines in fish populations, further research is needed to examine the likely population-level effects of delta smelt mortality attributed to agricultural diversions (Nobriga et al.

2004; Moyle and Israel 2005). Note however, that most of the irrigation diversions are in the Delta, so low flow conditions that compel delta smelt to rear in the Delta fundamentally mediate loss to these irrigation diversions. PTM evidence for this covariation of Delta hydrodynamics and cumulative loss to irrigation diversions was provided by Kimmerer and Nobriga (2008).

Delta Power Plants

There are two major power plants located near the confluence of the Sacramento and San Joaquin Rivers. The upstream-most facility is commonly referred to as the Contra Costa Power Plant while the downstream-most facility is commonly referred to as the Pittsburg Power Plant. Both facilities are located in the low salinity rearing habitats of delta smelt. The following assessment of the Contra Costa and Pittsburg Power Plants comes from information collected by Matica and Sommer (2005).

The Contra Costa Power Plant is located 2.5 miles upstream from the city of Antioch. The first units were operational in June 1951. By 1975, with expansions, the power plant incorporated 7 main power-generating units and 3 smaller house units. In 1995, Units 1-5 were decommissioned. When all units were operating, the cooling water flows into Units 1-5 and Units 6-7 were up to 946 and 681 cfs, respectively. Cooling water was diverted by two separate intake arrangements. Water for Units 1-5 was taken from near the river bottom 410 feet offshore and for Units 6-7 from a shoreline intake system. Water was carried at 3.8 ft/sec to five recessed onshore traveling trash screens, with 3/8-inch square-opening wire mesh. Calculated screen approach velocities averaged about 1.3 ft/sec with velocities of 2.0 ft/sec through the mesh. Discharge canals return the heated water to the river. For Units 1-5 water was returned 750 ft west of its uptake and for Units 6-7 it is returned 750 ft east of its uptake. Under normal full-load operation the temperature of the discharge water was raised a mean of 16.2 °F and at peak loads the maximum differential between intake and discharge temperature was 21 °F, creating a thermal plume, concentrated near the surface and shoreline, extending over an area of approximately 100 acres.

The Pittsburg Power Plant is located on the south shore of Suisun Bay just west of Pittsburg. This steam generation plant consists of 7 power generating units. Construction began in 1953 and the 7 units were commissioned in 3 phases: Units 1-4 in 1954; Units 5 and 6 in 1960; and Unit 7 in 1961. Units 1-6 withdraw and return cooling water to Suisun Bay. Their intake structures are located on the shoreline about 1,000 feet to the west of the discharge structure. Discharge is located 10-30 feet offshore in about 10 feet of water. Total cooling water flow for Units 1-6 when all pumps are running is 1,612 cfs. Entrainment effects may occur at the plants from large pressure decreases across the condenser at both power plants, and impingement on fish screens.

Overall, the total maximum non-consumptive intake of cooling water for the two facilities is 3,240 cfs, which can exceed 10 percent of the total net outflow of the Sacramento and San Joaquin rivers, depending on hydrology. However, pumping rates are often significantly lower under normal operation. Potential impacts to aquatic species include chemical and thermal pollution, and entrainment. Chemical impacts may occur as a result of chlorination for control of “condenser slime”, which was historically

conducted weekly. This treatment at Contra Costa Power Plant consumed a little over 1 ton of chlorine a month, or 13 tons per year. The discharge water was not historically dechlorinated or subject to regular monitoring for residual chlorine.

Thermal pollution represents an additional concern for aquatic species. Temperature objectives set by the California Regional Water Quality Control Board include: "No discharge shall cause a surface water temperature rise greater than 4 ºF above the natural temperature of the receiving water at any time or place"; and "The maximum temperature of thermal waste discharge shall not exceed 86 ºF." Both plants discharge water at temperatures in excess of 86 °F 10 percent of the time, and surface water temperature plumes in the receiving water at each plant exceed +4 °F for areas up to 100 acres. The previous owner of these two plants, Pacific Gas and Electric (PG&E), sought and received exemptions to the above limitations.

In 1951, DFG recognized the power plants presented a potential issue for the salmon and striped bass resources of the area as both plants were originally equipped with inefficient fish barriers. At the time, DFG estimated that as many as 19 million small striped bass might pass through the Contra Costa plant and be killed each year between April and mid-August. As a result of these concerns, DFG and PG&E conducted a monitoring study to evaluate entrainment. In 1979, consultants estimated the total average annual entrainment to be 86 million smelt (delta smelt and longfin smelt not differentiated). The total average annual impingement was estimated to be 178,000 smelt. It's unclear whether these numbers are relevant to current entrainment trends. Further, power plant operations have been reduced such that the plants only operate to meet peak power needs. The current owner of the power plants, Mirant, is currently undergoing a monitoring program that is sampling entrainment and impingement at the Contra Costa and Pittsburg powerplants to compile more recent information on how many delta smelt are affected by the two plants.

Delta Cross Channel

When the DCC is open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin Rivers toward the Central Delta. The closures for salmonid protection, as described in the Project Description, are likely to create more natural hydrologies in the Delta, by keeping Sacramento River flows in the Sacramento River and in Georgiana Slough, which may provide flow cues for migrating adult delta smelt. Larval and juvenile delta smelt are probably not strongly affected by the DCC if it is closed or open. Previous PTM modeling done for the SWG has shown that having the DCC open or closed does not significantly affect flows in the Central Delta (Kimmerer and Nobriga 2008). There could be times, however, when the DCC closure affects delta smelt by generating flows that draw them into the South Delta.

South Delta Temporary Barriers

The SDTB was initiated by DWR in 1991. The U.S. Army Corps of Engineers (Corps) permit extensions for this project were granted in 1996 and again in 2001, when DWR obtained permits to extend the Project through 2007. The Service has approved the extension of the permits through 2008. Continued coverage by Service for the SDTB will

be assessed in this biological opinion for the operational effects and under a separate Section 7 consultation for the construction and demolition effects.

Under the Service's 2001 biological opinion for the SDTB, operation of the barriers at Middle River and Old River near Tracy can begin May 15 or as early as April 15 if the spring barrier at the head of Old River is in place. From May 16 to May 31 (if the barrier at the head of Old River is removed) the tide gates are tied open in the barriers in Middle River and Old River near Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and Grant Line Canal are permitted to be operational until they are completely removed by November 30.

During the spring, the HORB is designed to reduce the number of out-migrating salmon smolts entering Old River. During the fall, this barrier is designed to improve flow and DO conditions in the San Joaquin River for the immigration of adult fall-run Chinook salmon. The HORB is typically in place from April 15 to May 15 in the spring, and from early September to late November in the fall. Installation and operation of the barrier also depends on San Joaquin River flow conditions.

The SDTB cause changes in the hydraulics of the Delta that affect fish. The SDTB cause hydrodynamic changes within the interior of the Delta. When the HORB is in place, most water flow is effectively blocked from entering Old River. This, in turn, increases the flow to the west in Turner and Columbia cuts, two major Central Delta channels that flow toward Banks and Jones.

Susiun Marsh Salinity Control Gates

When Delta outflow is low to moderate and the SMSCG are not operating, tidal flow past the gates is approximately +/- 5,000-6,000 cfs while the net flow is near zero. When these gates are operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000-6,000 cfs. The net flow moves into Suisun Marsh via Montezuma Slough at approximately 2,500-2,800 cfs. The Army Corps of Engineers permit for operating the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards set forth in SWRCB D-1641. Historically, the gates have been operated as early as October 1, while in some years (e.g., 1996) the gates were not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the flashboards are removed and the gates are raised to allow unrestricted fish movement through Montezuma Slough.

The approximately 2,800 cfs net flow induced by SMSCG operation is effective at repelling the salinity in Montezuma Slough. Salinity is reduced by roughly one-hundred percent at Beldons Landing, and lesser amounts further west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow is reduced by SMSCG operation. Net outflow through Carquinez Strait is not demonstratably affected.

It is important to note that historical gate operations (1988-2002) were much more frequent than recent and current operations (2006-May 2008). Operational frequency is affected by many factors (e.g., hydrologic conditions, weather, Delta outflow, tide, fishery considerations, etc). The gates have also been operated for scientific studies.

Salmon passage studies between 1998 and 2003 increased the number of operating days by up to 14 to meet study requirements. After discussions with NMFS based on study findings, the boat lock portion of the gates are now held open at all times during SMSCG operation to allow for continuous salmon passage opportunity. With increased understanding of the effectiveness of the gates in lowering salinity in Montezuma Slough, salinity standards have been met with less frequent gate operation since 2006. Despite very low outflow in the fall of the two most recent WYs, gate operation was not required at all in fall of 2007 and was limited to 17 days in the winter 2008. When the SMSCG are operated or closed frequently, delta smelt may become trapped behind the gates in Montezuma Slough, which may prevent delta smelt from migrating upstream into the Delta to spawn. Salinity changes in Montezuma Slough could also affect delta smelt by changing or masking flow cues in the Delta which delta smelt use to migrate. However, the recent reduced operations likely have resulted in few adverse effects to delta smelt, since the reduced closures have minimized the migration blockage and salinity changes.

Upstream Diversion and Reservoir Operations

Construction and operation of reservoirs and water delivery systems upstream of the Delta, including CVP and SWP reservoirs, have changed the historical timing and quantity of flows through the Delta. The past and current operations of upstream diversions and reservoirs combined with the Delta water diversions affect the net Delta outflow and the location of the LSZ.

Delta smelt lives its entire life in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). It is an open-water species and does not associate strongly with structure. It may use nearshore habitats for spawning, but free-swimming life stages mainly occupy offshore waters. Thus, the population is strongly influenced by river flows because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity, open-water habitat (Feyrer et al. 2007; Nobriga and Herbold 2008). Outflow plays a prominent role in delta smelt population dynamics year-round (Nobriga and Herbold 2008). X2 is an indicator of delta outflow (Jassby et al. 1995) and a useful metric by which to determine effects on delta smelt distribution and habitat suitability.

Trinity River

The Trinity River Division includes facilities to divert water to the Sacramento River Basin. The mean annual inflow to Trinity Lake from the Trinity River is about 1.2 MAF per year. Historically, an average of about two-thirds of the annual inflow has been diverted to the Sacramento River Basin (1991-2003).

Diversion of Trinity water to the Sacramento Basin provides limited water supply and hydroelectric power generation for the CVP and assists in water temperature control in the Trinity River and upper Sacramento River. The seasonal timing of Trinity exports is a result of determining how to make best use of a limited volume of Trinity export (in concert with releases from Shasta) to help conserve cold water pools and meet

temperature objectives on the upper Sacramento and Trinity rivers, as well as power production economics.

The diversions from the Trinity River have been reduced in recent years after the Trinity River Main-stem Fishery Restoration ROD, dated December 19, 2000, which mandated 368,600 to 815,000 AF is allocated annually for Trinity River flows. This amount is scheduled in coordination with the Service to best meet habitat, temperature, and sediment transport objectives in the Trinity Basin. These higher flows in the Trinity River system mean less water diverted to the Sacramento River. This reduced water results in less flexibility in releases for Sacramento River flows and can result in increased releases from Shasta Lake.

Seasonal Life History of Delta Smelt

Winter (December-February)

Adult delta smelt are generally distributed in low salinity habitats of the greater Suisun Bay region and the Sacramento and San Joaquin River confluence during fall. Variation in outflow appears to initiate their migration from Suisun Bay upstream to freshwater habitats for spawning. This is because initial catches upstream normally occur in close association with increased turbidity associated with the first strong flow pulse of the winter (Grimaldo et al. accepted manuscript). As a result, entrainment of adult delta smelt at Banks and Jones is also closely associated with factors controlled by outflow or X2 (Grimaldo et al. accepted manuscript). Specifically, salvage of adult delta smelt is significantly negatively associated with flows in OMR flows, and when the flows are highly negative the starting location of the fish indexed by X2 the month prior to entrainment also has an effect (Grimaldo et al. accepted manuscript).
Outflow during winter also affects the entrainment of early-spawned larvae when their distribution is within the hydrodynamic zone affected by pumping operations (Kimmerer 2008). Winter outflow also affects the distribution of spawning fish in major regions. For example, the Napa River is used for spawning only in years when outflow is sufficient to connect the Napa River with low salinity habitat in the estuary (Hobbs et al. 2007).

Spring (March-May)

During spring, YOY delta smelt generally move from upstream spawning locations downstream into low salinity rearing habitats. There is some evidence that recruitment variability of delta smelt may have sometimes responded to springtime flow variation (Herbold et al. 1992; Kimmerer 2002). For example, the number of days X2 is in Suisun Bay during spring is weakly positively correlated with abundance as measured by the FMWT index. However, the weight of evidence suggests that delta smelt abundance does not statistically respond to springtime flow in a similar manner to other species for which the spring X2 requirements were developed (Stevens and Miller 1983; Jassby et al. 1995; Bennett 2005).

However, studies have demonstrated that outflow has a strong effect on the distribution of YOY delta smelt (Dege and Brown 2004) and that it therefore also ultimately influences entrainment at Jones and Banks (Kimmerer 2008). Dege and Brown (2004) found that X2 had a strong influence on the geographic distribution of delta smelt, but distribution with respect to X2 was not affected, indicating that distribution is closely associated with habitat conditions proximal to X2. YOY delta smelt are consistently located just upstream of X2 in freshwater until they become juveniles and enter the low salinity habitats of Suisun Bay later in the year.

Outflow affects the entrainment of YOY delta smelt at the Jones and Banks facilities in several ways. First, because outflow affects adult spawning migration and juvenile distribution, it affects their position relative to the hydrodynamic influence of the diversions (Kimmerer 2008). Second, OMR is the best predictor of salvage and entrainment for adult delta smelt and it is also relevant to larval and juvenile entrainment when considered in the context of X2 (see effects section). In general, the more water that is exported relative to that which is dedicated to outflow enhances negative flows in OMR flow towards the diversions, which in turn increases salvage (Baxter et al. 2008; Kimmerer 2008; Grimaldo et al accepted manuscript).

Summer (June-August)

Summer represents a primary growing season for delta smelt while they are distributed in low salinity habitats of the estuary. X2 affects delta smelt distribution during summer (Sweetnam 1999). Food supply and habitat suitability are currently believed to be important factors for delta smelt during summer (Bennett 2005; Baxter et al. 2008; Nobriga and Herbold 2008). The CVP/SWP affect summer habitat suitability and might affect summer prey co-occurrence through their effect on Delta hydrodynamics.

Fall

During fall, delta smelt are typically fully distributed in low salinity rearing habitats located around the confluence of the Sacramento and San Joaquin Rivers. Suitable abiotic habitat for delta smelt during fall has been defined as relatively turbid water (Secchi depths < 1.0 m) with a salinity of approximately 0.6-3.0 psu (Feyrer et al. 2007). The amount of suitable abiotic habitat available for delta smelt, measured as hectares of surface area, is negatively related to X2 (see effects section). The average X2 during fall has exhibited a long-term increasing trend (movement further upstream), which has resulted in a corresponding reduction the amount and location of suitable abiotic habitat (Feyrer et al. 2007, 2008).

The available data provide evidence to suggest that the amount of suitable abiotic habitat available for delta smelt during fall affects the population in a measurable way. There is a statistically significant stock-recruit relationship for delta smelt in which pre-adult abundance measured by the FMWT positively affects the abundance of juveniles the following year in the TNS (Bennett 2005; Feyrer et al. 2007). Incorporating suitable abiotic habitat into the stock-recruit model as a covariate improves the model by

increasing the amount of variability explained by 43 percent, r-squared values improved from 46 percent to 66 percent (Feyrer et al. 2007).

It is likely that changes in X2 and the corresponding amount of suitable abiotic habitat are important to the long-term decline of delta smelt but may have been of lesser importance in the more recent POD. Over the long-term, the amount of suitable abiotic habitat for delta smelt during fall has decreased anywhere from 28 percent to 78 percent, depending on the specific habitat definitions that are considered (Feyrer et al. 2008). The majority of this habitat loss has occurred along the periphery, limiting the distribution of delta smelt mainly to a core region in the vicinity of the confluence of the Sacramento and San Joaquin Rivers (Feyrer et al. 2007). Concurrently, delta smelt abundance as measured by the FMWT decreased by 63 percent. This correspondence and the significant stock-recruit relationship with the habitat covariate strongly suggest that delta smelt have been negatively affected by long-term changes in X2 and habitat. However, at the onset of the POD, delta smelt abundance and suitable abiotic habitat had already declined to a point where it was unlikely that Feyrer's two variable definition of habitat was the primary limiting factor constraining the population.

Nevertheless, X2 (Figure S-10) and inflow-corrected X2 (Figure S-11) during fall in the years following the POD (2000-2005) was several km upstream compared to that for the pre-pod years (1995-1999). This suggests that operations in the Delta have exported more water relative to inflow, which has had a negative effect on X2 by moving it upstream. This is confirmed by a long-term positive trend in the E:I ratio for all months from June through December (Figure S-12). In fact, long-term trends in X2 (Figure S-13), inflow-corrected X2 Figure S-14), and the E:I ratio (Figure S-12) indicate this pattern has been in effect for many years and likely one of the factors responsible for the long-term decline in habitat suitability for delta smelt.

Figure S-10. X2 in years preceding and immediately following the Pelagic Organism Decline.

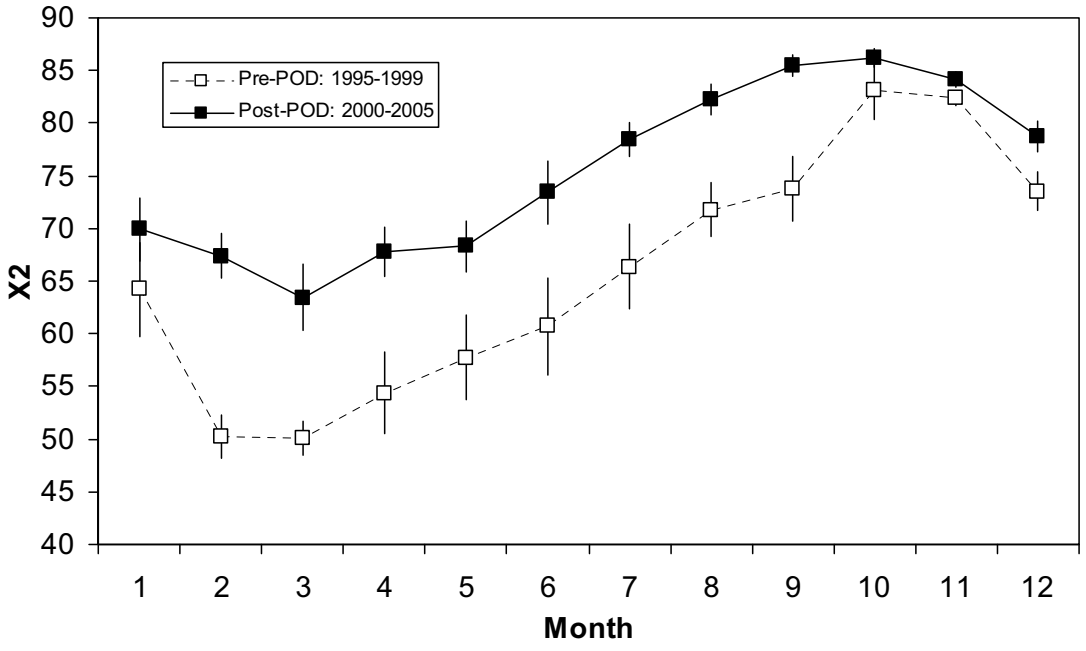


Figure S-11. Inflow-corrected X2 in years preceding and immediately following the Pelagic Organism Decline.

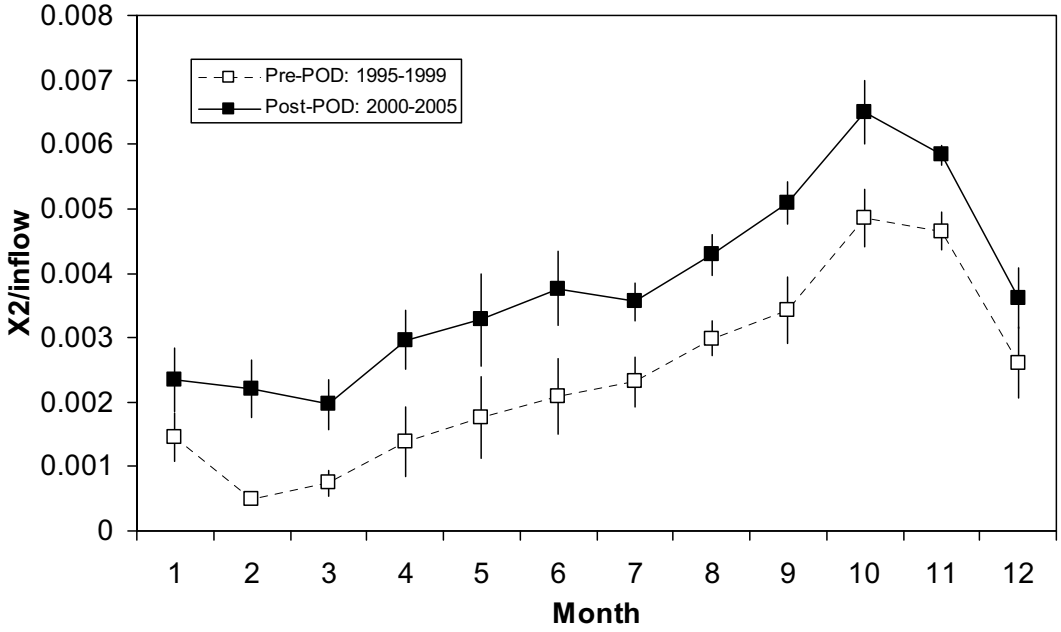


Figure S-12. Monthly time trends of the ratio of project exports to Delta inflow.

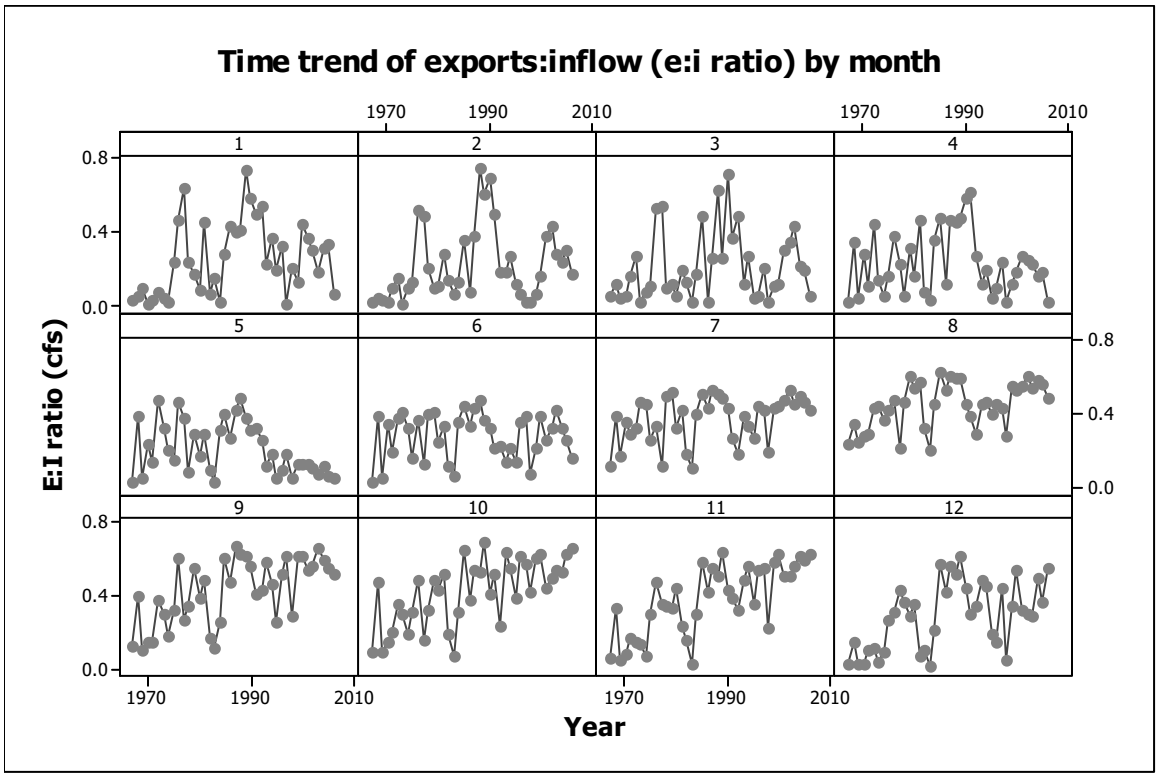


Figure S-13. Monthly time trends of X2.

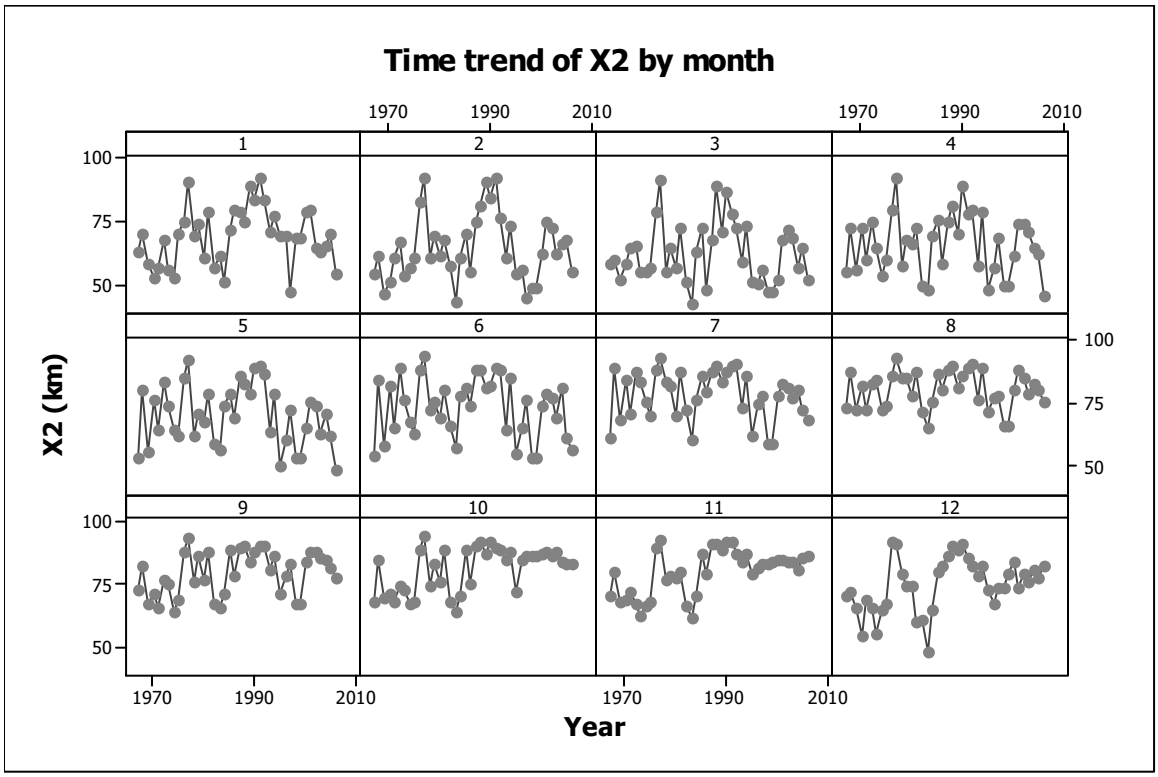
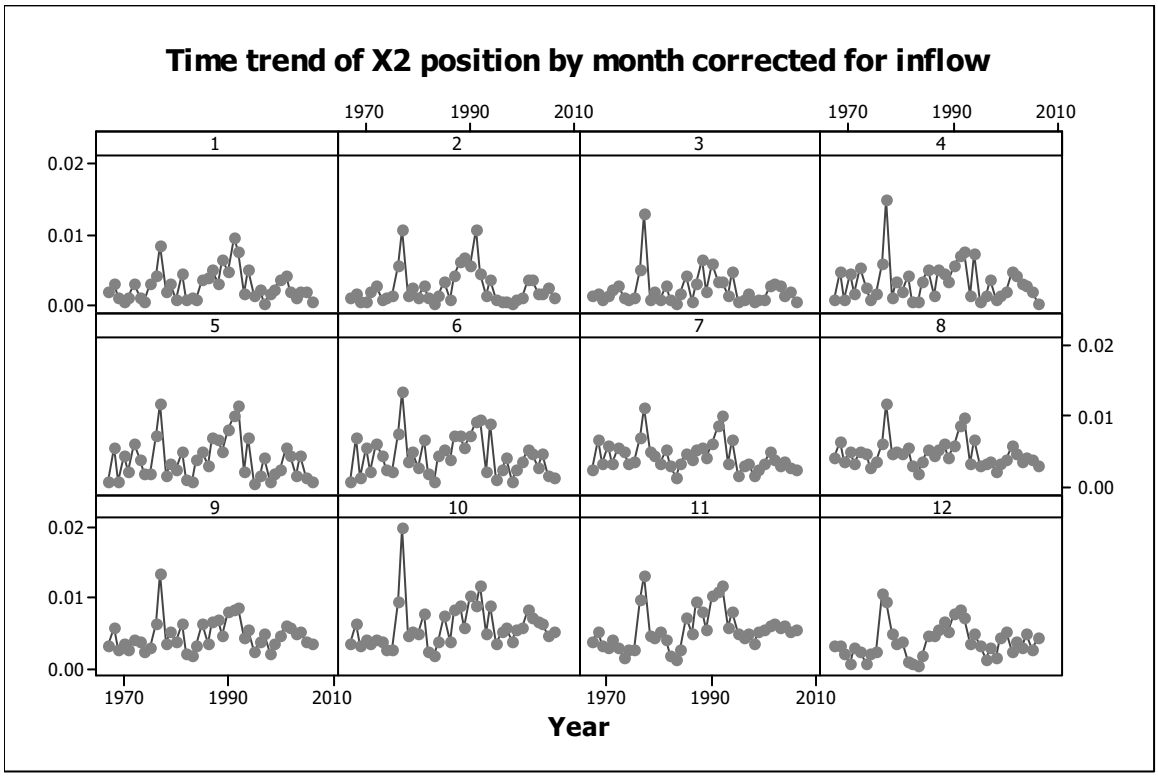


Figure S-14. Monthly time trends of inflow-corrected X2.



Other Stressors

Aquatic Macrophytes

In the last two decades, the interior Delta has been extensively colonized by submerged aquatic vegetation. The dominant submerged aquatic vegetation is *Egeria densa*, a non-native from South America that thrives under warm water conditions. Research suggests that *Egeria densa* has altered fish community dynamics in the Delta, including increasing habitat for centrarchid fishes including largemouth bass (Nobriga et al. 2005; Brown and Michniuk 2007), reducing habitat for native fishes (Brown 2003; Nobriga et al. 2005; Brown and Michniuk 2007), and supporting a food web pathway for centrarchids and other littoral fishes (Grimaldo et al in review). *Egeria densa* has increased its surface area coverage by up to 10 percent per year depending on hydrologic conditions and water temperature (Erin Hestir personal communication University of California Davis).

Egeria densa and other non-native submerged aquatic vegetation (e.g., *Myriophyllum spicatum*) can affect delta smelt in direct and indirect ways. Directly, submerged aquatic vegetation can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning. Indirectly, submerged aquatic

vegetation decreases turbidity (by trapping suspended sediment) which has contributed to a decrease in both juvenile and adult smelt habitat (Feyrer et al. 2007; Nobriga et al. 2008). Increased water transparency may delay feeding and may also make delta smelt more susceptible to predation pressure.

Predators

Delta smelt is a rare fish and has been a rare fish (compared to other species) for at least the past several decades (Nobriga and Herbold 2008). Therefore, it has also been rare in examinations of predator stomach contents. Delta smelt were occasional prey fish for striped bass, black crappie and white catfish in the early 1960s (Turner and Kelley 1966) but went undetected in a recent study of predator stomach contents (Nobriga and Feyrer 2007). Striped bass are likely the primary predator of juvenile and adult delta smelt given their spatial overlap in pelagic habitats. Despite major declines in age-0 abundance, there remains much more biomass of striped bass in the upper estuary than delta smelt. This means it is not possible for delta smelt to support any significant proportion of the striped bass population. It is unknown whether incidental predation by striped bass (and other lesser predators) represents a substantial source of mortality for delta smelt.

Delta smelt may experience high predation mortality around water diversions where smelt are entrained and predators aggregate. The eggs and newly-hatched larvae of delta smelt are thought to be prey for inland silversides in littoral habitats (Bennett 2005). Other potential predators of eggs and larvae of smelt in littoral habitats are yellowfin goby, centrarchids, and Chinook salmon.

The Delta-wide increase in water transparency may have intensified predation pressures on delta smelt and other pelagic fishes in recent years. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm 2002; Horpilla et al. 2004). There has been limited research to address predation of pelagic fishes in offshore habitats. Stevens (1966) examined diets of striped bass in pelagic habitats, finding that they varied by geographical area and prey abundance but no information was provided on the physical variables that may have influenced predation rates. Research is underway to determine the specific factors responsible for increased water transparency in the Delta (David Schoelhammer, personal communication, University of California at Davis) but recent findings suggest the trend is related to the submerged aquatic vegetation invasion in recent years.

Competition

It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including inland silversides, (Bennett and Moyle 1995) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with inland silversides (Bennett 2005) but there is no empirical evidence to support the conclusion that competition between these species is a factor that influences the abundance of delta smelt in the wild. There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008). It is unknown how intensively overbite clam grazing and delta smelt directly compete for food, but overbite clam consumption of

shared prey resources does have other ecosystem consequences that appear to have affected delta smelt indirectly.

Delta Smelt Feeding

The DRERIP conceptual model for delta smelt (summarized in figure S-3) provides a thorough summary of delta smelt feeding behavior (Nobriga and Herbold 2008), much of which is described in this section and the Delta food web section. Delta smelt are visual feeders that select prey individually rather than by filtering-feeding. Juvenile and adult smelt primarily eat copepods, but they are also known to prey on cladocerans, mysids, amphipods, and larval fish (Moyle et al. 1992; Lott 1998; Feyrer et al. 2003). During the 1970s and 1980s, delta smelt diets were dominated by *Eurytemora affinis*, *Neomysis mercedis*, and *Bosmina longirostus* (Moyle et al. 1992; Feyrer et al. 2003), however, none of these are important prey now (Steve Slater personal communication California Department of Fish and Game). When delta smelt diets were examined again between 1988 and 1996, they were consistently dominated by the copepod *Pseudodiaptomus forbesi*, which was introduced and became abundant following the overbite clam invasion (Lott 1998). *Pseudodiaptomus forbesi* was introduced into the San Francisco Bay-Delta in 1988 and became a significant part of the summertime zooplankton assemblage and is now an important prey item for Delta smelt and other small fishes (Kimmerer and Orsi 1996; Nobriga 2002; Hobbs et al. 2006; Bryant and Arnold 2007). Recent diet studies have shown that *Pseudodiaptomus forbesi* (all lifestages) remains an important prey for juvenile delta smelt during summer, but that several other copepods introduced into the system in the mid-1990s, are also frequently being eaten (Steven Slater unpublished data California Department of Fish and Game).

Delta Food Web

Suisun Bay Region

Following the introduction of the overbite clam into the lower Estuary in 1986, a dramatic decline in primary production in the Estuary was documented (Alpine and Cloern 1992; Jassby et al 2002). The overbite clam is a highly efficient grazer with a wide salinity range. It does not encroach into freshwater but its grazing effect does, presumably due to tides (Jassby et al. 2002). With a high metabolism, the overbite clam has been able to reduced standing stocks of phytoplankton to fractions of historic levels. As a consequence, many zooplankton and fish species experienced sharp declines in abundance (Kimmerer and Orsi 1996, Kimmerer 2002, Kimmerer 2007). Clam grazing on copepod nauplii also may affect copepods directly. Despite its impact on the estuarine pelagic food web, to date, there is no direct evidence linking the effects of overbite clam grazing to adverse effects to delta smelt (Kimmerer 2002; Bennett 2005). It has been noted that delta smelt fork lengths have decreased since 1990, but it is uncertain whether this is a direct consequence of the overbite clam. The Feyrer (2007) effect of fall habitat assumes delta smelt have been chronically food-limited since the overbite clam invasion.

There have been two notable zooplankton introductions into the estuarine food web in recent years that have the potential to adversely affect delta smelt trophic dynamics. In the mid 1990s, the estuary was invaded by *Limnoithona tetraspina* and *Acartiella*

sinensis, both which originated from Asia and are believed to have been introduced via ballast water. *Limnoithona tetraspina* is now the most abundant copepod in the LSZ but evidence suggests that it is not an important food item for delta smelt and other pelagic fishes because of its small size, generally sedentary behavior, and predator-avoidance capability (Bouley and Kimmerer 2006). The consequences of these copepod invasions on the diet of delta smelt feeding remains unknown, but the likely effect is fewer calories per unit when delta smelt prey on *Limnoithona tetraspina*. Experimental studies are currently under way to determine the feeding dynamics of delta smelt on the newly introduced invaders in relation to the current zooplankton fauna of the Delta/Estuary (Lindsay Sullivan RTC 2008 CALFED Science Conference Presentation).

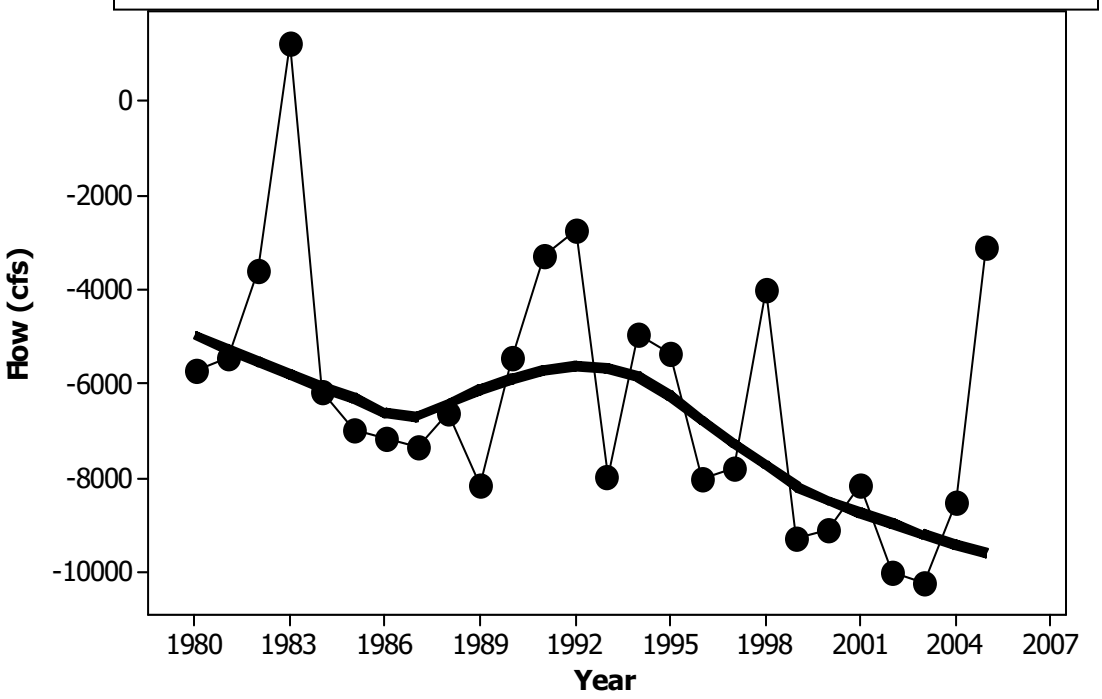
Delta

Water diversions represent one of the major factors controlling lower trophic level production in the Delta (Jassby et al. 2002). Water diversions directly entrain zooplankton and phytoplankton biomass which might impact food availability to delta smelt. Entrainment impacts to lower trophic level production are of concern during the spring and summer when newly hatched delta smelt larvae and juveniles are vulnerable to starvation and thermal stress; food limitation may lead to disease, poor growth, or death (Bennett 2005; Bennett et al. 2008).

Water diversions can also influence the residence time of water in the Eastern and Central Delta that can greatly influence phytoplankton production (Jassby 2005). Low export conditions can result in a doubling of primary production in the Eastern Delta. However, during periods of high exports, such as the summer (Figure S-15), much of the lower trophic level production is entrained rather than dispersed downstream to Suisun Bay. Summer entrainment of phytoplankton and zooplankton could therefore adversely affect delta smelt if food supplies are not transported to the LSZ. Preliminary evidence shows that the abundance of *Pseudodiaptomus forbesi*, a dominant prey of delta smelt in the summer, has steadily declined in the lower Estuary since 1995, while its numbers have increased in the South Delta (Figure 7-19 in the biological assessment; Kimmerer et al. in prep.). This copepod has blooms that originate in the Delta. Thus, its availability to delta smelt rearing to the west of the summer blooms may be impaired by high export to inflow ratios.

As stated above, clam grazing represents another major factor influencing primary and secondary production in the Delta. In the Western Delta, the food web may be compromised by overgrazing effects of the overbite clam (Kimmerer and Orsi 1996, Jassby et al. 2002). Within the Central Delta, grazing by the introduced river clam (*Corbicula fluminea*) can deplete resident phytoplankton biomass, especially in flooded island areas (Lucas et al 2002; Lopez et al 2006). Given that the food web supporting delta smelt depends on phytoplankton, these effects are likely to adversely affect its survival and reproduction by limiting food resources.

Figure S-15 Combined OMR flow (June-August)



Microcystis

Large blooms of toxic blue-green alga, *Microcystis aeruginosa*, were first detected in the Delta during the summer of 1999 (Lehman et al. 2005). Since then, *M. aeruginosa* has bloomed each year, forming large colonies throughout most of the Delta and increasingly down into eastern Suisun Bay. Blooms typically occur between late spring and early fall (peak in the summer) when temperatures are above 20 ^{o}C. *Microcystis aeruginosa* can produce natural toxins that pose animal and human health risks if contacted or ingested directly. Preliminary evidence indicates that the toxins produced by local blooms are not toxic to fishes at current concentrations. However, it appears that *M. aeruginosa* is toxic to copepods that delta smelt eat (Ali Ger 2008 CALFED Science Conference). In addition, *M. aeruginosa* could out-compete diatoms for light and nutrients. Diatoms are a rich food source for zooplankton in the Delta (Mueller-Solger et al. 2002). Studies are underway to determine if zooplankton production is compromised during *M. aerguinosa* blooms to an extent that is likely to adversely affect delta smelt. *Microcystis* blooms may also decrease dissolved oxygen to lethal levels for fish (Saiki et al. 1998), although delta smelt do not strongly overlap the densest *Microcystis* concentrations, so dissolved oxygen is not likely a problem. *Microcystis* blooms are a symptom of eutrophication and high ammonia to nitrate ratios in the water.

Contaminants

Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated

during the POD years, concern over contaminants in the Delta is not new. There are long-standing concerns related to mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville et al. 2002; Davis et al. 2003). Phytoplankton growth rate may, at times, be inhibited by high concentrations of herbicides (Edmunds et al. 1999). New evidence indicates that phytoplankton growth rate is chronically inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson et al. 2006, Dugdale et al. 2007). Contaminant-related toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995, Giddings 2000, Werner et al. 2000, Weston et al. 2004). Undiluted drainwater from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki et al. 1992). Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey et al. 1994) led to new regulations for water discharges. Bioassays using caged Sacramento sucker (*Catostomus occidentalis*) have revealed deoxyribonucleic acid strand breakage associated with runoff events in the watershed and Delta (Whitehead et al. 2004). Kuivila and Moon (2004) found that peak densities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

The POD investigators initiated several studies beginning in 2005 to address the possible role of contaminants and disease in the declines of Delta fish and other aquatic species. Their primary study consists of twice-monthly monitoring of ambient water toxicity at fifteen sites in the Delta and Suisun Bay. In 2005 and 2006, standard bioassays using the amphipod *Hyalella azteca* had low (<5 percent) frequency of occurrence of toxicity (Werner et al. 2008). However, preliminary results from 2007, a dry year, suggest the incidence of toxic events was higher than in the previous (wetter) years. Parallel testing with the addition of piperonyl butoxide, an enzyme inhibitor, indicated that both organophosphate and pyrethroid pesticides may have contributed to the pulses of toxicity. Most of the tests that were positive for *H. azteca* toxicity have come from water samples from the lower Sacramento River. Pyrethroids are of particular interest because use of these insecticides has increased within the Delta watershed (Ameg et al. 2005, Oros and Werner 2005) as use of some organophosphate insecticides has declined. Toxicity of sediment-bound pyrethroids to macroinvertebrates has also been observed in small, agriculture-dominated watersheds tributary to the Delta (Weston et al. 2004, 2005). The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern.

In conjunction with the POD investigation, larval delta smelt bioassays were conducted simultaneously with a subset of the invertebrate bioassays. The water samples for these tests were collected from six sites within the Delta during May-August of 2006 and 2007. Results from 2006 indicate that delta smelt are highly sensitive to high levels of ammonia, low turbidity, and low salinity. There is some preliminary indication that reduced survival may be due to disease organisms (Werner et al. 2008). No significant mortality of larval delta smelt was found in the 2006 bioassays, but there were two

instances of significant mortality in June and July of 2007. In both cases, the water samples were collected from sites along the Sacramento River and had relatively low turbidity and salinity levels and moderate levels of ammonia. It is also important to note that no significant *H. azteca* mortality was detected in these water samples. While the *H. azteca* tests are very useful for detecting biologically relevant levels of water column toxicity for zooplankton, interpretation of the *H. azteca* test results with respect to fish should proceed with great caution. The relevance of the bioassay results to field conditions remains to be determined.

The POD investigations into potential contaminant effects also include the use of biomarkers that have been used previously to evaluate toxic effects on POD fishes (Bennett et al. 1995, Bennett 2005). The results to date have been mixed. Histopathological and viral evaluation of young longfin smelt collected in 2006 indicated no histological abnormalities associated with exposure to toxics or disease (Foott et al. 2006). There was also no evidence of viral infections or high parasite loads. Similarly, young threadfin shad showed no histological evidence of contaminant effects or of viral infections (Foott et al. 2006). Parasites were noted in threadfin shad gills at a high frequency but the infections were not considered severe. Both longfin smelt and threadfin shad were considered healthy in 2006. Adult delta smelt collected from the Delta during the winter of 2005 also were considered healthy, showing little histopathological evidence for starvation or disease (Teh et al., unpublished data). However, there was some evidence of low frequency endocrine disruption. In 2005, 9 of 144 (6 percent) of adult delta smelt males sampled were intersex, having immature oocytes in their testes (Teh et al., unpublished data).

In contrast, preliminary histopathological analyses have found evidence of significant disease in other species and for POD species collected from other areas of the estuary. Massive intestinal infections with an unidentified myxosporean were found in yellowfin goby *Acanthogobius flavimanus* collected from Suisun Marsh. Severe viral infection was also found in inland silverside and juvenile delta smelt collected from Suisun Bay during summer 2005. Lastly, preliminary evidence suggests that contaminants and disease may impair survival of age-0 striped bass. Baxter et al. 2008 found high occurrence and severity of parasitic infections, inflammatory conditions, and muscle degeneration in young striped bass collected in 2005; levels were lower in 2006. Several biomarkers of contaminant exposure including P450 activity (i.e., detoxification enzymes in liver), acetylcholinesterase activity (i.e., enzyme activity in brain), and vitellogenin induction (i.e., presence of egg yolk protein in blood of males) were also reported from striped bass collected in 2006 (Ostrach 2008).

Climate Change

There is currently no quantitative analysis of how ongoing climate change is currently affecting delta smelt and the Delta ecosystem. Climate change could have caused shifts in the timing of flows and water temperatures in the Delta which could lead to a change in the timing of migration of adult and juvenile delta smelt.

Summary of Delta Smelt Status and Environmental Baseline

Given the long list of stressors discussed, the rangewide status of the delta smelt is currently declining and abundance levels are the lowest ever recorded. This abundance trend has been influenced by multiple factors, some of which are affected or controlled by CVP and SWP operations and others that are not. Although it is becoming increasingly clear that the long-term decline of the delta smelt was very strongly affected by ecosystem changes caused by non-indigenous species invasions and other factors influenced, but not controlled by CVP and SWP operations, The CVP and SWP have played an important direct role in that decline, especially in terms of entrainment and habitat-related impacts that add increments of additional mortality to the stressed delta smelt population. Further, past CVP and SWP operations have played an indirect role in the decline of the delta smelt by creating an altered environment in the Delta that has fostered both the establishment of non-indigenous species and habitat conditions that exacerbate their adverse influence on delta smelt population dynamics. Past CVP and SWP operations have been a primary factor influencing delta smelt abiotic and biotic habitat suitability, health, and mortality.

Survival and Recovery Needs of Delta Smelt

Based on the above discussion of the current condition of the delta smelt, the factors responsible for that condition, and the final *Recovery Plan for the Delta Smelt* (Service 1995), the Service has identified the following survival and recovery needs for this species:

- Increase the abundance of the adult population and the potential for recruitment of juveniles into the adult population.

- Increase the quality and quantity of spawning, rearing, and migratory habitat with respect to turbidity, temperature, salinity, freshwater flow, and adequate prey availability by mimicking natural (i.e., pre-water development) water and sediment transport processes in the San Francisco Bay-Delta watershed to enhance reproduction and increase survival of adults and juveniles.

- Reduce levels of contaminants and other pollutants in smelt habitat to increase health, fecundity and survival of adults and juveniles.

- Reduce delta smelt exposure to disease and toxic algal blooms to increase health, fecundity and survival of adults and juveniles.

- Reduce entrainment of adult, larval, and juvenile delta smelt at CVP-SWP pumping facilities, over and above reductions achieved under the Vernalis Adaptive Management Plan and the Environmental Water Account, to increase

the abundance of the spawning adult population and the potential for recruitment of juveniles into the adult population. Best available information indicates that delta smelt entrainment at CVP-SWP pumping facilities can be substantially reduced by maintaining a positive flow in the Old and Middle rivers. Entrainment reduction at other water diversion-related structures within the Bay-Delta where delta smelt adults or juveniles are known or likely to be entrained might also be needed to increase the adult population and the potential for recruitment of juveniles into the adult population, but there are secondary to reducing Banks and Jones entrainment.

- Restore the structure of the food web in the Bay-Delta to a condition that enhances diatom-based pelagic food chains in the LSZ.

- Maximize the resilience of the delta smelt population to the adverse effects of ongoing climate change. Achieving the above conditions should help with this need. In general, the management of CVP-SWP water storage and delivery facilities could have an important role to play in tempering the adverse effects of climate change on the Bay-Delta ecosystem upon which the delta smelt depends.

Delta Smelt Critical Habitat

The action area for this consultation covers nearly the entire range of delta smelt critical habitat. For that reason, the Status of Critical Habitat and Environmental Baseline sections are combined into one section in this document.

The Service designated critical habitat for the delta smelt on December 19, 1994 (59 FR 65256). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (USFWS 1994).

Description of the Primary Constituent Elements

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species:

1. “Physical habitat” is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary’s LSZ (Bennett et al. 2002).

2. "Water" is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species/Environmental Baseline section, above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

3. "River flow" is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and OMR influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones (refer to Status of the Species/Environmental Baseline section, above). River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

4. "Salinity" is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 psu (parts per thousand salinity; Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995; Kimmerer 2002). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low.

   During the past 40 years, monthly average X2 has varied from as far downstream as San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle (see Biology and Life History section above). In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful spawning, larval and juvenile transport, rearing, and adult migration. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Delta must

provide suitable habitat all year, every year. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The entire Delta and Suisun Bay are designated as critical habitat; over the course of a year, the entire habitat is occupied.

Overview of Delta Smelt Habitat Requirements and the Primary Constituent Elements

As previously described in the Status of the Species/Environmental Baseline section, Delta smelt live their entire lives in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). Delta smelt are an open-water, or pelagic, species. They do not associate strongly with structure. They may use nearshore habitats for spawning (PCE #1), but free-swimming life stages mainly occupy offshore waters (PCE #2). Thus, the distribution of the population is strongly influenced by river flows through the estuary (PCE #3) because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity, open-water habitat (PCE #4). This is true for all life stages. During periods of high river flow into the estuary, delta smelt distribution can transiently extend as far west as the Napa River and San Pablo Bay. Delta smelt distribution is highly constricted near the Sacramento-San Joaquin river confluence during periods of low river flow into the estuary (Feyrer et al. 2007).

In the 1994 designation of critical habitat, the best available science held that the delta smelt population was responding to variation in spring X2. In the intervening 14 years, the scientific understanding of delta smelt habitat has improved. The current understanding is that X2 and OMR both must be considered to manage entrainment and that X2 indexes important habitat characteristics throughout the year.

Conservation Function of Primary Constituent Elements by Life History Stage

The conservation function and important attributes of each constituent element in each life stage are further described below.

Spawning

Spawning delta smelt require all four PCEs, but spawners and embryos are the only life stages of delta smelt that are known to require specific structural components of habitat (PCE # 1; see Biology and Life History section). Spawning delta smelt require sandy or small gravel substrates for egg deposition. Migrating, staging, and spawning delta smelt also require low-salinity and freshwater habitats, turbidity, and water temperatures less than 20ºC (68ºF) (attributes of PCE #2 and #4 for spawning). The developing embryos likewise may remain associated with sandy substrate until they hatch. Hatching success is only about 20 percent at 20ºC in the laboratory and declines to zero at higher temperatures (Bennett 2005).

Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand or pebble (DWR and Reclamation 1994; Lindberg et al. 2003; Wang 2007). Rather than stick to immobile substrates, the adhesive eggs might adhere to sand particles, which keeps them negatively buoyant but not immobile (Hay 2007).

Spawning occurs primarily during April through mid-May (Moyle 2002) in sloughs and shallow edge areas in the Delta. Spawning also has been recorded in Suisun Marsh and the Napa River (Hobbs et al. 2007). Historically, delta smelt ranged as far up the San Joaquin River as Mossdale, indicating that areas of the lower San Joaquin and its tributaries support conditions appropriate for spawning. Little data exists on delta smelt spawning activity in the lower San Joaquin region. Larval and young juvenile delta smelt collected at South Delta stations in DFG's 20-mm Survey, indicate that appropriate spawning conditions exist there. However, the few delta smelt that are collected in the lower San Joaquin region is a likely indicator that changes in flow patterns entrain spawning adults and newly-hatched larvae into water diversions (Moyle et al 1992).

Once the eggs have hatched, larval distribution depends on both the spawning area from which they originate (PCE#1 and PCE#2) and the effect of Delta hydrodynamics on transport (PCE#3). Larval distribution is further affected by salinity and temperature (attributes of PCE#4 and #3). Tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson et al. 2007), which in some cases might result in rapid dispersal of larvae away from spawning sites.

In the laboratory, a turbid environment (>25 NTU) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004) (attribute of PCE#2). Successful feeding depends on a high density of food organisms and turbidity. The ability of delta smelt larvae to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Their diet is comprised of small planktonic crustaceans that inhabit the estuary's turbid, low-salinity, open-water habitats (attribute of PCE#2).

Larval and Juvenile Transport

Delta smelt larvae require PCEs # 2-4. The distribution of delta smelt larvae follows that of the spawners; larvae emerge near where they are spawned. Thus, they are distributed more widely during high outflow periods. Delta smelt larvae mainly inhabit tidal freshwater at temperatures between 10ºC-20ºC (Bennett 2005). The center of distribution for delta smelt larvae < 20 mm is usually 5-20 km upstream of X2, but larvae move closer to X2 as the spring progresses into summer (Dege and Brown 2004). The primary influences the water projects have on larval delta smelt critical habitat are that they influence water quality, the extent of the LSZ, and larval transport via capture of runoff in reservoirs and subsequent manipulation of Delta inflows and exports that affect OMR flows, and resultant Delta outflows that affect X2.

Changes to delta smelt larval and juvenile transport attributable to the SWP and CVP include water diversions that create net reverse flows in the Delta that entrain larval and

juvenile delta smelt; permanent and temporary barrier installations and operation that change Delta hydrology and salinity and increase entrainment risk; and diminished river inflows that seasonally bring the LSZ into the Delta for increasingly longer periods of time, resulting in lower quality and quantity of rearing habitat.

Juvenile Rearing

Rearing juvenile delta smelt mainly require PCEs # 2 and # 4. Juvenile delta smelt are most abundant in the LSZ, specifically at the upstream edge of the LSZ where salinity is < 3 psu, water transparency is low (Secchi disk depth < 0.5 m), and water temperatures are cool (< 24ºC) (Feyrer et al. 2007; Nobriga et al. 2008). Because high freshwater inflows that push X_2 well into Suisun Bay are not sustained through the juvenile stage (July-December), many juvenile delta smelt rear near the Sacramento-San Joaquin river confluence. This reflects a long-term change in distribution. During surveys in the latter 1940s, juvenile delta smelt reared throughout the Delta during summer (Erkkila 1950). Currently, young delta smelt rear throughout the Delta into June or the first week of July, but thereafter, distribution shifts to the Sacramento-San Joaquin river confluence where water temperatures are cooler and water transparencies are lower (Feyrer et al. 2007; Nobriga et al. 2008). Note that this change in distribution has often been mischaracterized as a migration into brackish water.

- The primary influences the water projects have on juvenile delta smelt critical habitat are that they influence water quality, the extent of the LSZ, and early summer (June) transport via capture of runoff in reservoirs and subsequent manipulation of Delta inflows and exports that affect OMR flows, and resultant Delta outflows that affect X2. The projects are the primary influence on freshwater inflows and outflows during the juvenile stage. The SWP and CVP control almost all Delta inflow during summer-fall. The primary effects these highly controlled flows have on juvenile delta smelt are a possible impact on summertime prey availability in the LSZ and a strong effect on the extent of the LSZ and dilution flows and thus, habitat suitability during fall (see Effects section).

- Estuarine turbidity varies with Delta outflow and it is higher during periods of high outflow (Kimmerer 2004). The interannual variation in peak flows to the estuary is not always controlled by the projects, so they have little effect on interannual variation in estuary turbidity during delta smelt's spawning season. The CVP/SWP have had a long-term influence on turbidity in the estuary because project dams have retained sediment originating in project tributaries, especially in the Sacramento River basin (Wright and Schoelhamer 2004). However, the CVP/SWP have not been shown to have influenced shorter-term decreases in turbidity due to the proliferation of aquatic plants like *Egeria densa*.

- The water projects have little if any ability to affect water temperatures in the Estuary (Kimmerer 2004). Estuarine and Delta water temperatures are driven by air temperature. Water temperatures at Freeport can be cooled up to about 3ºC by high Sacramento River flows, but only by very high river flows that cannot be sustained by the projects. Note also that the cooling effect of the Sacramento

River is not visible in data from the west Delta at Antioch (Kimmerer 2004) so the area of influence is limited.

Adult Migration

Successful delta smelt adult migration habitat is characterized by conditions that attract migrating adult delta smelt, attributes of PCE #2, #3, and #4, and that help them migrate to spawning habitats (PCE #3). Delta smelt are weakly anadromous and move from the LSZ into freshwater to spawn, beginning in late fall or early winter and likely extending at least though May (see Delta Smelt Life Cycle section in the Status and Baseline). Although the physiological trigger for the movement of delta smelt up the Estuary is unknown, movement is associated with pulses of freshwater inflow, which are cool, less saline and turbid (attributes of PCE #2 and #4 for adult migration). As they migrate, delta smelt increase their vulnerability to entrainment if they move closer to Banks and Jones (Grimaldo et al accepted manuscript). Analyses indicate that delta smelt become less vulnerable to entrainment when reverse flows in the Delta are minimized. Inflows in early winter must be of sufficient magnitude to provide the cool, fresh and highly turbid conditions needed to attract migrating adults and of sufficient duration to allow connectivity with the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries (attributes of PCE #2 for adult migration). These areas are vulnerable to physical disturbance and flow disruption during migratory periods. Once adults have moved into the Delta, freshwater inflows must remain of sufficient magnitude to minimize their vulnerability to entrainment.

Changes to delta smelt adult migration habitat include water diversions that have increased net negative OMR flows that entrain migrating adult smelt and reservoir operations that reduce seasonal inflow that provides flow and turbidity cues for migration. In addition, the proliferation of nonnative aquatic plants that trap sediment has reduced overall turbidity and may have increased the deposition of fine sediments in historical spawning habitats.

Current Condition of Delta Smelt Critical Habitat and Factors that Contribute to that Condition

As stated in the previous section on the status of the delta smelt, the physical appearance, salinity, water clarity, and hydrology of the Delta have been modified significantly by channelization, conversion of Delta islands to agriculture, and water operations. As a consequence of these changes, most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Baxter et al. 2008).

In general, the CVP/SWP operations have decreased springtime flows (PCE #3) relative to the natural hydrograph, as reservoir operations change over from flood management to water storage (Kimmerer 2004). Further, summer and early fall inflows (PCE #2, #3, and #4) may be increased over the natural hydrograph as reservoirs release stored water to support export operations. Changes in inflow affect the location of the historically highly-productive LSZ, affecting habitat volume and quality (effect on PCE #2, #3 and

#4). The combined influence of these changes since the 1980s and earlier has had the effect of distributing delta smelt narrowly and in areas with high risk of mortality from many known sources (e.g., entrainment in water diversions large and small) and plausible sources (intensified predation loss, sublethal contaminant exposure, etc.) (combined effect on the condition of PCE #2, #3, and #4). Second, a more upstream distribution of maturing adult delta smelt places them at greater vulnerability to entrainment by CVP and SWP export operations once they begin their spawning migration (Grimaldo et al, accepted manuscript) (combined effect on the condition of PCE #2, #3, and #4).

PCE #1 - Physical Habitat for Spawning

We are aware of no conditions attributable to SWP and CVP operations that limit the availability of spawning substrate.

Routine dredging of various Delta channels to facilitate shipping periodically may disrupt or eliminate spawning substrate availability, but is not known to substantially modify location, extent, or quality of available spawning substrate (PCE #1) for delta smelt.

Nonnative submerged aquatic vegetation, particularly *Egeria densa*, overwhelms littoral habitats (inter-tidal shoals and beaches) where delta smelt spawn, possibly making them unsuitable for spawning.

The cumulative effects of locally small or isolated losses or degradations of physical habitat associated with construction and maintenance of water conveyance facilities, together with increasing exposure in physical habitat to chemical pollutants from other sources, and the increase of nonnative submerged aquatic vegetation likely have reduced both the quality and extent of physical habitat. Overall, this primary constituent element remains capable of fulfilling its intended conservation function, but the trend is downward and will likely remain so unless ways are found to control *Egeria*.

PCE #2 - Water for All Life Stages (Suitable Quality)

The condition of PCE #2 has been substantially reduced. Pelagic habitat in the Delta has been highly altered and degraded by many factors discussed in the Baseline and Effects Sections. The historic Delta consisted primarily of tidal freshwater marshes, tributary river channels and their associated floodplains, and sloughs. The current Delta has little (< 1 percent) of its historic intertidal marsh habitat, its patterns of sloughs and channels have been modified, changing its hydrodynamic characteristics, and the pattern and quantity and inflow to, through and out of the estuary has been altered. When compared to estuaries around the world, the Delta is unique in its low levels of productivity (Clipperton and Kratville, in review). Current conditions for larval and juvenile transport, rearing, and adult migration in particular have been modified to an extent that this primary constituent element is substantially impaired in its ability to fulfill its conservation function at least seasonally in all water year-types. Special management is needed to address the degraded condition of this primary constituent element. Many factors that have contributed to the current condition are described below.

Factors that Impair/Degrade the Function of PCE #2

CVP and SWP

Operations of the Banks and Jones (inclusive of 500 cfs diversion at Banks, Article 21, upstream diversion and reservoir operations, North Bay Aqueduct, South Delta Temporary Barriers and Permanent Operable Gates, pumping plants water transfers) have diminished the ability of PCE #2 to fulfill its intended conservation purpose. Disconnecting inflow and outflow via water exports in the South Delta probably represents the single largest stressor for this primary constituent element. The manipulation of inflow and outflow with a goal of maintaining "balanced conditions" also has adversely affected the functionality of the other primary constituent elements and is discussed in more detail under each of the primary constituent elements. Though not restricting spawning *per se*, export of water by the CVP and SWP has usually restricted reproductive success of spawners in the San Joaquin River portion of the Delta as many adults and most larvae have been entrained and lost during transport to and from spawning sites to rearing areas (see Effects Section). Persistent confinement of the effective spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawning population could be adversely affected by catastrophic event or localized chronic threat, such as localized contaminant releases.

The additional interaction of PCE #2 with salinity, PCE #4, has resulted in a lengthening seasonal shift in the distribution of delta smelt to areas that are generally upstream of where they once occurred. See additional discussion below in the section on Rearing.

Preliminary evidence shows that the abundance of *Pseudodiaptomus forbesi*, a dominant prey of delta smelt in the summer, has steadily declined in the lower Estuary since 1995, while its numbers have increased in the Southern Delta (Kimmerer et al. in prep.). This copepod has blooms that originate in the Delta. Its availability to delta smelt rearing to the west of the summer blooms may be impaired by pumping at Banks and Jones.

The operation of upstream diversions and reservoirs can, depending on how they are managed, substantially influence the pelagic environment in the Delta by controlling timing and volume of releases. Over time, the operation of project dams and diversions has had the additional effect of making water in the Delta more clear by trapping sediment behind dams and diverting sediment that otherwise would be transported to the Delta (effect on the condition of PCE #2). Delta smelt seem to prefer water with high turbidity (see Baseline Section). In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin River was highly seasonal and more strongly and reliably affected by precipitation that it is today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of Delta water was larger then than now (Kimmerer 2002b). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows, but through time more and more of the summer-fall inflow and been exported, reducing outflows.

Aquatic Macrophytes

As stated in the Status and Baseline Section, research suggests that the nonnative South American aquatic plant *Egeria densa* has altered fish community dynamics in the Delta. In addition to the above-mentioned effect of overwhelming spawning habitat (PCE #1), *Egeria* and other submerged aquatic vegetation decreases turbidity by trapping suspended sediment, thereby decreasing juvenile and adult smelt habitat (Feyrer et al. 2007; Nobriga et al. 2008). Increased water transparency may also make delta smelt more susceptible to predation. It appears that aquatic macrophytes may have a role in degrading pelagic habitat to the extent that the Delta's ability to fulfill its intended conservation purpose continues to diminish. *Egeria* has the additional effect of decreasing turbidity, described above as important to successful feeding of newly-hatched larval delta smelt. However, there is still enough turbidity in the Central and South Delta to initiate larval feeding responses because larvae collected in the South Delta have comparatively high growth rates. So while *Egeria* may reduce or eliminate the extent and quality of spawning habitat for delta smelt, it is not at this time considered to have detectable effects on spawning or early feeding success.

Contaminants

While contaminants are thought to reduce habitat quality and thus reduce the ability of PCE #2 to fulfill its intended conservation function, contaminant loading and its ecosystem effects within the Delta are still not well understood. There are long-standing concerns related to methyl mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville et al. 2002; Davis et al. 2003). There is evidence that contaminants may inhibit phytoplankton growth rates at times (Wilkerson et al. 2006; Dugdale et al. 2007). Pulses of sediment-bound pesticides can co-occur in space and time with delta smelt reproduction (Kuivila and Moon 2004). There is also recent evidence of low frequency of intersex delta smelt suggesting exposure to estrogenic chemicals (Teh 2008).

Nonnative Species

Within the Delta, grazing by the introduced clams *Corbula amurensis* and *Corbicula fluminea* can deplete resident phytoplankton biomass (Jassby et al. 2002; Lucas et al. 2002; Lopez et al. 2006). The former has had a demonstrable effect on phytoplankton standing stock and zooplankton abundance throughout the estuary (Kimmerer and Orsi 1996), but the effect of the latter is mainly limited to freshwater flooded island areas (Lucas et al. 2002; Lopez et al. 2006). Given that phytoplankton help support the production of prey items eaten by delta smelt, these nonnative species are likely to adversely affect the ability of PCE #2 to fulfill its intended conservation function, which results in degraded condition.

PCE #3 - River Flow for Larval and Juvenile Transport, Rearing, and Adult Migration

Management of Delta inflows results in conditions for river flow that frequently do not meet the intended conservation function of this primary constituent element in certain

WYs. PCE #3 is probably the most significantly degraded of all the PCEs, and requires the most intensive management in order for it to continue to fulfill its intended conservation role. The primary factors that have contributed to this condition are discussed below.

Factors that Impair/Degrade the Function of PCE #3

CVP and SWP

Operations of the CVP and SWP manipulate inflows, outflows and OMR flows. This probably represents the single largest stressor for PCE #3. Banks and Jones entrain delta smelt and delta smelt food items, thereby affecting the quality of PCE #2 as well. While tides and climate affect flow into and within the Delta, Banks and Jones are the single most prominent factor in determining whether transport flows are sufficient to allow larval and juvenile delta smelt to move out of the Central and South Delta before water temperatures reach lethal levels. Baseline operation of the CVP/SWP represents a downward trend in the ability of this primary constituent element to fulfill its intended conservation function.

Management of Article 21 water at the SWP has changed since 2000. The result is more water exported than historically during the late fall and winter months, and increasing SWP exports overall relative to historic conditions (Table P-12). This additional pumping has contributed to the downward trend in the ability of PCE #3 to meet its intended conservation function by increasing the entrainment risk of adults migrating upstream to spawn.

Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows. Reservoir operations have played a significant role in modifying conditions in the Delta to the extent that this primary constituent element is unable to fulfill its intended conservation purpose in most years. The SWRCB D-1641 has helped provide Delta outflow during the spring, but outflows are reduced during other times by increased pumping at Jones and Banks.

Environmental Water Account

Implementation of the EWA provided brief export cutbacks in winter and spring, but also increased exports during early winter and summer, and it contributed to increased exports in summer and fall to levels that would not have occurred if EWA assets had not been purchased. This may have negatively affected habitat suitability and prey availability for delta smelt (see Effects Section). So while EWA was intended to moderate effects of CVP and SWP operations, its ability to do so measured over time was small (Brown et al. 2008). While EWA may have provided short-term transport opportunities in the early part of the year, it contributed to low outflows during other times of the year, which diminished the ability of this primary constituent element to fulfill its intended conservation purpose.

Special Management for PCE #3

Vernalis Adaptive Management Plan

VAMP represents one of the management measures that has been applied to CVP and SWP operations to assist this primary constituent element in fulfilling its intended conservation role. VAMP flows are thought to have selectively enhanced survival of delta smelt larvae that emerge in the Central Delta during VAMP by reducing entrainment. VAMP has enhanced the ability of this primary constituent element to fulfill its intended conservation purpose for 31 days each year.

PCE #4 - Salinity for Rearing

Summer and fall environmental quality, represented by PCE #4, has decreased overall in the Delta, but less so for the Sacramento River-San Joaquin River confluence. The rivers' confluence has, as a result, become increasingly important as a rearing location, as delta smelt's range has been restricted to an increasingly small area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that juvenile and maturing adult delta smelt are exposed to chronic and cyclic environmental stressors, or localized catastrophic events. The many changes imposed on the Delta have had the effect of concentrating the distribution of delta smelt to an area that is generally upstream of where they once were. This upstream location of rearing habitat has reduced habitat quantity and quality, making larval and juvenile delta smelt more susceptible to marginal water temperatures, cyanobacterium blooms, and other habitat-related effects.

Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated historical delta smelt prey in the LSZ. A minimum amount of suitable habitat during summer-autumn may interact with a suppressed pelagic food web to create a bottleneck for delta smelt (Bennett 2005; Feyrer et al. 2007; Bennett et al. 2008). As discussed in the preceding section on Population Dynamics-Abundance Trends, there is evidence that factors affecting juvenile delta smelt during summer-autumn are strongly impairing delta smelt reproductive success. The interaction of warm summer water temperatures, suppression of the food web supporting delta smelt, and spatially restricted suitable habitat during autumn all affect delta smelt health and ultimately survival and realized fecundity. The preceding factors have contributed to the current condition of seasonally low outflow and the inability of PCE #4 to fulfill its intended conservation purpose in most years.

Factors that Impair/Degrade the Function of PCE #4

CVP and SWP

Operations of the CVP and SWP pumping plants manipulate outflow and represent probably the single largest factor affecting the condition of this primary constituent

element. The facilities entrain delta smelt and delta smelt food items. While tides and climate affect flow into and within the Delta, the export facilities are the single most prominent factor in determining whether transport flows for migrating larvae, juveniles, and adults are sufficient to move fish out of the Central Delta before water temperatures reach lethal levels, are sufficient to maintain rearing habitat at a more downstream position where smelt also are not at risk of entrainment from export facilities, and are sufficient to cue adults to migrate to upstream spawning habitat without being entrained at the export facilities. Baseline operation of these facilities represents a downward trend in the ability of this primary constituent element to fulfill its intended conservation purpose with the possible exception of specific actions taken recently, the results of which, however, remain uncertain.

Management of Article 21 water at the SWP has changed since 2000. The result is more water exported than historically during the late fall and winter months when Article 21 water normally is moved, and increasing SWP exports overall relative to historic conditions. This additional pumping has contributed considerably to the downward trend in the ability of this primary constituent element to meet its intended conservation purpose.

Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage and in some years may increase late summer and fall inflows. Reservoir operations have played a significant role in modifying conditions in the Delta to the extent that this primary constituent element is unable to fulfill its intended conservation purpose in most years.

Environmental Water Account

Implementation of the EWA provided brief export cutbacks in winter and spring, but also increased exports during early winter and summer, and it contributed to increased exports in summer and fall to levels that would not have occurred if EWA assets had not been purchased. This may have negatively affected habitat suitability and prey availability for delta smelt (see Effects Section). So while EWA was intended to moderate effects of CVP and SWP operations, its ability to do so measured over time was small (Brown et al. 2008). While EWA may have provided short-term transport opportunities in the early part of the year, it contributed to low outflows during other times of the year, which diminished the ability of this primary constituent element to fulfill its intended conservation purpose.

Other Factors that May Influence the Condition of PCE #4

Aquatic Macrophytes

As stated in the preceding section on Other Stressors, research suggests that the nonnative South American aquatic plant *Egeria densa* has altered fish community dynamics in the Delta. However, we are not aware of evidence that aquatic macrophytes such as *Egeria*,

affect flows. Thus, this factor is considered to have no influence on the current condition of PCE #4

Nonnative Species

A dramatic decline in primary production in the Estuary was documented following the introduction of the overbite clam into the lower Estuary in 1986 (Alpine and Cloern 1992; Jassby et al 2002).

In the Western Delta, the food web may be compromised by overgrazing by overbite clam that can suppress phytoplankton biomass, and the abundance of delta smelt's prey (Kimmerer and Orsi 1996, Jassby et al 2002). The chronic low outflow conditions during summer and fall may increase the reproductive success and upstream range of overbite clam.

Climate Change

There are currently no published analyses of how ongoing climate change has affected the current condition of any of the primary constituent elements of delta smelt critical habitat. Climate change could have caused shifts in the timing of flows and water temperatures in the Delta which could lead to a change in the timing of migration of adult and juvenile delta smelt.

Effects of the Proposed Action

Introduction

The Status of the Species/Environmental Baseline section of this document described the multitude of factors that affect delta smelt population dynamics including predation, contaminants, introduced species, entrainment, habitat suitability, food supply, aquatic macrophytes, and *microcystis*. The extent to which these factors adversely affect delta smelt is related to hydrodynamic conditions in the Delta, which in turn are controlled to a large extent by CVP and SWP operations. Other sources of water diversion (NBA, CCWD, local agricultural diversions, power plants) adversely affect delta smelt largely through entrainment (see following discussion), but when taken together do not control hydrodynamic conditions throughout the Delta to any degree that approaches the influence of the Banks and Jones export facilities. So while many of the other stressors that have been identified as adversely affecting delta smelt were not caused by CVP and SWP operations, the likelihood and extent to which they adversely affect delta smelt is highly influenced by how the CVP/SWP are operated in the context of annual and seasonal hydrologic conditions. While research indicates that there is no single primary driver of delta smelt population dynamics, hydrodynamic conditions driven or influenced by CVP/SWP operations in turn influence the dynamics of delta smelt interaction with these other stressors (Bennett and Moyle 1996).

The following analysis focuses on the subset of factors that is affected or controlled by CVP/SWP operations, and includes a discussion of other factors to the extent they modulate or otherwise affect the CVP/SWP-related factors affecting delta smelt. Although it is becoming increasingly clear that the long-term decline of delta smelt has been affected by ecosystem changes caused by non-indigenous species invasions and other non-CVP/SWP factors, the CVP and SWP have played an important direct role in that decline. The CVP and SWP have also played an indirect role in the delta smelt's decline by creating an altered environment in the Delta that has fostered the establishment of non-indigenous species and exacerbates these and other stressors that are adversely impacting delta smelt. This analysis and others show that every day the system is in balanced conditions, the CVP and SWP are a primary driver of delta smelt abiotic and biotic habitat suitability, health, and mortality. However, the Service is relying on the findings of Bennett and Moyle (1996) and Bennett (2005), and the consensus emerging from the POD investigation (Sommer et al. 2007, Baxter et al. 2008), by assuming that delta smelt abundance trends have been driven by multiple factors, some of which are affected or controlled by CVP/SWP operations and others that are not. The decline of delta smelt cannot be explained solely by the effects of CVP/SWP operations.

This analysis of the effects of proposed CVP/SWP operations on delta smelt differs from the 2005 biological opinion in that it analyzes CVP/SWP-related effects in the context of a life-cycle model for delta smelt (Table E-1). In the following discussion, the effects of proposed CVP/SWP operations on delta smelt are organized in a seasonal context from winter through fall over the course of the annual delta smelt life cycle. Although all types of effects are covered, there is a specific focus on three major seasonally-occurring categories of effects: entrainment of delta smelt, habitat restriction, and entrainment of *Pseudodiaptomus forbesi*, the primary prey of delta smelt during summer-fall.

The following analysis assumes that the proposed CVP/SWP operations affect delta smelt throughout the year either directly through entrainment or indirectly through influences on its food supply and habitat suitability. During December-June, when delta smelt are commonly entrained at Banks and Jones, their habitat and co-occurring food supply also are being entrained, so CVP/SWP-related effects on habitat and food supply are only examined explicitly during July-December when delta smelt entrainment is rare. Delta smelt entrainment is rare from about mid-July through mid-December each year mainly because environmental conditions in the San Joaquin River and its distributaries are not appropriate to support delta smelt. The water is too warm and clear, so delta smelt actively avoid the Central and South Delta during summer and fall (Feyrer et al. 2007; Nobriga et al. 2008).

Our analysis also assumes that any of these three major categories of effects described above will adversely affect delta smelt, either alone or in combinations. This approach is also consistent with Rose (2000), who used several different individual-based models to show how multiple interacting stressors can result in fish population declines that would not be readily discernable using linear regression-based approaches.

Table E-1. The distribution of three categories of effects caused by proposed CVP/SWP operations over the life cycle of delta smelt.

Season	Delta smelt entrainment	Pseudodiaptomus entrainment/retention	Habitat suitability
Winter	X (adults)[a]		
Spring	X (larvae/juveniles)[b]		
Summer		X[c]	
Fall			X[d]

[a] Historical hydrodynamic data are DAYFLOW 1967-2007; OMR was measured 1993-2007 and estimated using regression on DAYFLOW variables by Cathy Ruhl (USGS) for 1967-1992; historical delta smelt salvage data are 1993-2007, the period when the data are considered most reliable.
[b] Historical hydrodynamic data are DAYFLOW 1967-2007 (except OMR as noted in the previous footnote); direct estimates of larval-juvenile entrainment are 1995-2005. (Kimmerer 2008); Entrainment was estimated statistically for 1967-1994 and 2006-2007
[c] Historical hydrodynamic data (DAYFLOW; except OMR 1988-1992, see footnote a) and Pseudodiaptomus density data (IEP monitoring) are 1988-2006 because Pseudodiaptomus was introduced in 1988.
[d] Historical hydrodynamic data are DAYFLOW 1967-2007.

Data and Models used in the Analysis

This analysis of the effects of proposed CVP and SWP operations on the delta smelt and its critical habitat uses a combination of available tools and data, including the CALSIM II model outputs provided in the appendices of Reclamation's 2008 biological assessment, historical hydrologic data provided in the DAYFLOW database, statistical summaries derived from 936 unique 90-day particle tracking simulations published by Kimmerer and Nobriga (2008), and statistical summaries and derivative analyses of hydrodynamic and fisheries data published by Feyrer et al. (2007), Kimmerer (2008), and Grimaldo et al. (accepted manuscript).

The biological assessment suggested using CALSIM II study 7.0 as the current baseline, and 6.1 as the historical baseline but the CALSIM monthly simulation model does not capture a precise Delta operation. When Study 6.1 was modeled, changes were expected between Study 6.1 and Studies 7.0 and 7.1 but the results in the August 2008 biological assessment were nearly identical (which differed from the May 2008 biological assessment model outputs where there had been a difference between those study runs). On page 9-32 of the 2008 biological assessment there is discussion of the various studies, including study 6.1 taken from the text: **"**Study 6.1 – This study represents the previous

OCAP biological assessment 2004 assumptions also within the new CALSIM II model framework. Conditions for water demands, facilities, and water project-operational policy are duplicated, to the extent possible, to Study 3a, but this is simulated only through the CVPIA (b)(2) step. This study is identical to Study 6.0 in the OCAP biological assessment May 2008 issue and is included to emulate pre-POD conditions. Study 6.1 is an imperfect representation of the pre-POD and supplemental analysis should be evaluated to compensate for this modeling limitation (discussed in Chapter 13: CVP and SWP Delta Effects). " The modeling done in the 2004 OCAP biological assessment is shown in Table E-2.

Table E-2. Summary of assumptions in the 2004 OCAP CALSIM II runs.

	Level of Development	Article 21	Refuge Deliveries	Trinity Required Flows	D1485	Winter-Run B.O.	D1641	CVPIA 3406 (b)(2)	EWA
Study A D1485 (1991)	2001		Historical Level 2	340,000 af/yr	X				
Study B D1485 w/ Refuge Firm Level 2 (1992)	Same as above		Firm Level 2	Same as above	X				
Study C D1485 w/ Refuge Firm Level 2, and Winter Run B.O. (1993)	Same as above		Same as above	Same as above	X	X			
Study D D1641 (1994)	Same as above		Same as above	Same as above		X	X		
Study 1 D1641 w/ CVPIA 3406 (b)(2) (1997)	Same as above	X	Same as above	Same as above		X	X	X	
Study 3 Today CVPIA 3406 (b)(2) with EWA (2004)	Same as above	X	Same as above	369,000-453,000 af/yr		X	X	X	X

A number of CALSIM II model updates and changes in assumptions have been revised from the 2004 biological assessment to the 2008 biological assessment. A summary of these changes are provided the Table E-3.

Table E-3. Changes in CALSIM II model updates and assumptions from 2004 to 2008.

Major Model updates		
Area	**2004 BA**	**2008 BA**
Hydrology	73 years (1922-1994)	82 years (1922-2003)
San Joaquin River	Derived from older logic	Water Quality and hydrology Updated
Yuba	Timeseries from DWR's HEC-5 external model	Timeseries from updated, YCWA external model

Colusa Basin	Colusa Basin within Hydrology	Improved Hydrology and more explicit operation
Sacramento River Hydrology	No explicit rice decomposition, within hydrology	Included Rice Decomposition water
State Project	Assumed variable Table A demand and some Article 21	Updated 3 pattern with Article 56 and more accurate Table A and Article 21 split
ANN – Delta Salinity Estimate	2004 version of ANN	Training of ANN improved between DSM2 by including tidal energy and now using DSM2 trained X2
Level of Development	Current 2001 & Future 2020	Current 2005 & Future 2030
Major Assumptions	**2004 BA**	**2008 BA**
American River Demands	Future demands based on Water Forum assumptions	Future demands based on full contract amounts
State Demands	Future Table A 3.3-4.1 MAF and Article 21 demand 134 TAF/month (Dec-Mar)	Future Full Table A (4.2 MAF) and Article 21 demand 314 TAF/month (Dec-Mar)
EWA	Future with Full EWA and different logic for assets, debts, and actions	Future with Limited EWA with updated more explicit asset, debt, and action logic
Refuge	Firm Level 2	Recent Historic (existing), Firm Level 2 (future)
San Joaquin River	Fixed Annual demands	Updated land based demand
Trinity Note	Flows 340 TAF in current or 369-453 TAF and 369-815 in ROD for future	Trinity current level is 369-815 from the ROD

The inaccuracies in CALSIM lead us to use actual data to develop an empirical baseline. We also developed historical time series data for hydrologic variables used in this effects analysis based on the DAYFLOW database (http://iep.water.ca.gov/dayflow/index.html) and OMR data obtained from USGS. We calculated monthly or multiple month averages or medians based on these daily hydrology data sets. The historical time series are intended to show where changes in water project operations have caused or contributed to changed Delta hydrology and to serve as an empirical baseline of SWP and CVP operations for comparison to proposed futures modeled using CALSIM II. We used WYs 1967-2007 as the "historical" period for all hydrologic variables. Note that OMR has only been measured empirically since 1987. The OMR data for 1981-1986 were estimated by Ruhl et al. (2006). The OMR flows for 1967-1980 were estimated using DAYFLOW variables with the following equation: (-600) – (0.0065*EAST) – (0.851*EXPORT) + (0.506*SJR). The equation used by Ruhl et al. (2006) did not

include the "EAST" term accounting for flows from the Delta's east side tributaries. Note however that the r^2 between the Ruhl equation and the one including the "EAST" term is 0.99.

The CALSIM II model is a mathematical simulation model developed for statewide water planning. It has the ability to estimate water supply, streamflows, and Delta water export capability, keeping within "rules" such as water quality standards that limit model outputs to plausibly achievable system operations. CALSIM II is DWR's and Reclamation's official SWP and CVP planning tool. The CALSIM II model is applied to the SWP, the CVP, and the Sacramento and San Joaquin Delta. The model is used to evaluate the performance of the CVP and SWP systems for: existing or future levels of land development, potential future facilities, and current or alternative operational policies and regulatory environments. Key model output includes reservoir storage levels, instream river flow, water delivery, Delta exports and conditions, biological indicators such as X2, and operational and regulatory metrics.

CALSIM II simulates 82 years of hydrology for the Central Valley region spanning WYs 1922-2003. The model employs an optimization algorithm to find ways to move water through the SWP and CVP in order to meet assumed water demands on a monthly time step. The movement of water in the system is governed by an internal weighting structure that ensures regulatory and operational priorities are met. The Delta is also represented in CALSIM II by DWR's Artificial Neural Network (ANN), which simulates flow and salinity relationships. Delta flow and electrical conductivity are output for key regulatory locations. Details of the level of land development (demands) and hydrology are discussed in Appendix D of the biological assessment (Reclamation 2008), as are details of how the model simulates flexible operations like (b)(2) and EWA allocations. Most of the model data used in this analysis were direct output from CALSIM II simulations for the biological assessment. However, certain Delta flow indicators, most notably OMR flows, were estimated by inputting CALSIM II outputs into the DSM-2 HYDRO model, which can predict OMR based on the hydrologic data output by CALSIM II.

This effects analysis analyzes outputs from the following subset of studies presented in the biological assessment: 7.0, 7.1, 8.0, and 9.0-9.5.

Study 7.0 was the model run that Reclamation and DWR thought best represented current operations, and was thus intended as a "current baseline." However, due to limitations of CALSIM II to accurately model actual operations, we also used the 1967-2007 DAYFLOW summaries described above to compare against CALSIM II outputs. Study 7.0 modeled represents a 2005 level of development with (b)(2) allocations and a full EWA. The full EWA was represented in the CALSIM II framework as up to 50,000 acre-feet of water export reductions during December-February, the VAMP pulse flow, and export reductions following VAMP (mid-May into June) when CALSIM II predicted the EWA had surplus water (i.e., collateral exceeded debt).

Study 7.1 also represents a 2005 level of development with (b)(2) allocations, but with a limited EWA, which as described in the Project Description above consists mainly of

water provided under the Yuba Accord. In the limited EWA, there were no export reductions in February and June, but export reductions were possible during December to January and late May. The VAMP pulse flow was modeled in the same way as in the full EWA.

Study 8.0 estimates SWP and CVP operations with a 2030 level of development, (b)(2) allocations and the limited EWA. Note that the 2030 level asked CALSIM II to try to provide 100 percent of the CVP's contract demand and 100 percent of the SWP's Table A contract demand, in all WY types but deliveries are shorted based on hydrology.

Study 9.0 represents a future condition to serve as a basis of comparison of the effects of climate change to sea level rise for the sensitivity evaluation. Neither (b)(2) actions or EWA were added to these steps.

Study 9.1 represents a future scenario in which sea level is assumed to be one foot higher than present, resulting in a four-inch higher tidal elevation at Martinez, California.

Studies 9.2-9.5 represent 'bookends' of climate change scenarios with the 2030 level of development. These bookends cannot be summarized simply except in qualitative terms. The bookends represent 10th and 90th percentiles of predicted changes in precipitation and temperature for the period 2010 to 2030 relative to 1971 to 2000 conditions. Generally, climate change models outputs indicate that the Central Valley will be warmer in the future, but are indeterminate as to whether precipitation will increase or decrease (e.g., Dettinger 2005). Thus, the climate change bookends include drier and wetter possibilities, but do not include cooler futures relative to current conditions. Thus, the temperature bookends can be called 'less warming' and 'more warming' or 'warmer' and 'warmer still'. Study 9.2 is a wetter and warmer simulation, 9.3 is a wetter and warmer still simulation, 9.4 is a drier and warmer simulation, and 9.5 is a drier and warmer still simulation. These climate change scenarios were not intended to be directly compared to studies 7.0-8.0. However, for simplicity all model output summaries were plotted together.

Study 9.5 represents the "worst-case scenario" among all simulations presented in the biological assessment because drier conditions are expected to result in more frequent conflicts over limited water resources. Further, springtime water temperatures influence the length of the spawning season for delta smelt (Bennett 2005) and summertime water temperature conditions already can be marginal for delta smelt (e.g., Nobriga et al. 2008). For those reasons, all warmer future scenarios are expected to further stress delta smelt, but the warmer still scenarios have the highest potential for detrimental effects.

Effects Analysis Methods

The effects analyses range from qualitative descriptions and conceptual models of project effects to quantitative analyses. The effects of Banks and Jones pumping on adult delta smelt entrainment, larval-juvenile delta smelt entrainment, and fall habitat suitability and its predicted effect on the summer townet survey abundance index are quantitatively

analyzed. The remainder of proposed action elements and effects are not analyzed quantitatively because data are not available to do so or it is the opinion of the FWS that they have minor effects on delta smelt. For maximum clarity, analytical details are provided in the relevant sections.

Migrating and Spawning Adults (~ December through March)

Water Diversions and Reservoir Operations

Upstream Reservoirs and Diversions

The following CVP/SWP project elements are included in the modeling results and are not specifically discussed in this analysis, rather the effects of these project elements are included in the "Adult Entrainment Effects" and the "Habitat Suitability Effects" sections below: Trinity River Operations, Whiskeytown Operations, Clear Creek Operations, Shasta Lake and Keswick Dam Operations, Red Bluff Diversion Dam Operations, Oroville Dam and Feather River Operations, Folsom and Nimbus Dam Operations, New Melones Reservoir Operations, and Freeport Diversion Operations.

Banks and Jones Pumping Plants

Entrainment

The entrainment of delta smelt into the Banks and Jones pumping plants is a direct effect of SWP and CVP operations. See Brown et al. (1996) for a description of fish salvage operations. Total entrainment is calculated based upon estimates of the number of fish salvaged (Kimmerer 2008). However, these estimates are indices - most entrained fish are not observed (Table E-4), so most of the fish are not salvaged and therefore do not survive. Many, if not most, of the entrained delta smelt likely die due (Bennett 2005). Recent studies also indicate that delta smelt predation and mortality across CCF may be high (Castillo et al. 2008). Additional studies will further explore this issue. The effects of NBA and CCWD operations on delta smelt are presented separately below.

Table E-4. Factors affecting delta smelt entrainment and salvage.

	Adults	Larvae < 20 mm	Larvae > 20 mm and juveniles
Predation prior to encountering fish salvage facilities	unquantified	unquantified	unquantified
Louver efficiency (based on Kimmerer 2008)	Limited data indicate an efficiency of about 13 percent for the CVP facility; no equivalent data are available for the SWP facility	~ 0 percent	Likely < 13 percent at any size; << 13 percent at less than 30 mm
Collection screens efficiency	~ 100 percent	~ 0 percent	< 100 percent until at least 30 mm
Identification protocols	Identified from subsamples, then expanded in salvage estimates	Not identified	Identified from subsamples, then expanded in salvage estimates
Fish survival after Handling, trucking and release back into the Delta	Study in progress	0 percent	Study in progress

The population-level effects of delta smelt entrainment vary; delta smelt entrainment can best be characterized as a sporadically significant influence on population dynamics. Kimmerer (2008) estimated that annual entrainment of the delta smelt population (adults and their progeny combined) ranged from approximately 10 percent to 60 percent per year from 2002-2006. Major population declines during the early 1980s (Moyle et al. 1992) and during the recent POD years (Sommer et al. 2007) were both associated with hydrodynamic conditions that greatly increased delta smelt entrainment losses as indexed by numbers of fish salvaged. However, currently published analyses of long-term associations between delta smelt salvage and subsequent abundance do not support the hypothesis that entrainment is driving population dynamics year in and year out (Bennett 2005; Manly and Chotkowski 2006; Kimmerer 2008).

Adult Entrainment

Adult delta smelt have been salvaged at Banks and Jones as early in the WY as November and as late as June, but most of the recent historical salvage has occurred between mid-December and March (www.delta.dfg.ca.gov). Delta smelt salvage usually occurs in a prolonged event that has one major peak. This is evidence that the maturing population makes a spawning migration into the Delta. The migration is cued by pulses of freshwater flow into the estuary, otherwise known as “first flush” events (Grimaldo et al. accepted manuscript). The physiological mechanism that cues migration is unknown

but salvage of adults typically begins when turbidities elevate over 12 NTU (Clifton Court Forebay Station) and total Delta inflow generally increases to over 25,000 cfs. During extreme flow events (total inflow > 100,000 cfs), delta smelt spawn downstream of the Delta and in critically dry years they often spawn in the North Delta.

Annual winter salvage is best explained by OMR flow, whereby salvage increases with reverse OMR flow (Figure E-1). Kimmerer (2008) calculated that entrainment losses of adult delta smelt in the winter removed 1 to 50 percent of the estimated population and were proportional to OMR flow, though the high entrainment case might overstate actual entrainment. Given there are demonstrated relationships between smelt entrainment and salvage with OMR flows (Kimmerer 2008; Grimaldo et al. accepted manuscript), this effects analysis evaluates the proposed action operations by comparing the long-term trends in OMR flows to OMR flows in the CALSIM II modeling presented in the biological assessment. For both approaches, predictions of salvage and total entrainment losses were made using OMR flow since it was the best explanatory variable of each. The effects of proposed operations were determined by comparing actual salvage and entrainment losses with predictions of these parameters under modeled OMR flows. As was done in the biological assessment (Reclamation 2008, Chapter 13), we have not attempted to separate the effects of SWP and CVP. The hydrodynamic effects of pumping that cause reverse OMR flow result from the combined action of both facilities.

The salvage and adult effects analysis was determined for each December to March period (i.e., winter period). We defined the December to March period to be consistent with recent analyses (Kimmerer 2008, Grimaldo et al. accepted manuscript) as this is the period when the majority of adults migrate upstream to spawn And therefore vulnerable to export operations. We compared salvage and population losses over the full winter period and not on a month-by-month basis to account for the cumulative effects of the proposed operations on the adult life stage of delta smelt.

OMR Flows

Overall, there has been a downward trend in average winter OMR flows in these years (Figure E-2a). In contrast, winter total inflows have remained constant (Figure E-2b). The increase in negative OMR flow is mostly driven by a steady increase in winter exports over the last four decades (Figure E-2c). The modeling results show OMR flows much more negative than historic years for all WY types except for critical dry years (Figure E-3).

Salvage and Entrainment Loss Predictions

Salvage loss estimates were derived from the linear model from Grimaldo et al. (accepted manuscript). In that paper, the authors identified that OMR flow was the best explanatory variable of salvage between 1993 and 2005. The equation from this relationship (salvage = 3757 – 0.4657*OMR flow; adjusted $R^2 = 0.31$) was used to generate salvage for the proposed action operations by WY type (Table E-5b). Predicted

salvage numbers are not reported since it is unknown how the population size will vary in future years. Instead, the predicted percentage increase or decrease in salvage are reported as a more meaningful method to assess effects of proposed operations on salvage given an OMR value.

To quantitatively predict population losses of delta smelt, a suite of hydrodynamic variables were explored with adult entrainment loss estimates from Kimmerer (2008; Kimmerer (2008) calculated adult entrainment losses (Dec-Mar) using Kodiak trawl data for 2002-2005 and FMWT (November-December) for 1995-2005. For this analysis, the adult entrainment estimates from the FMWT estimates were used since they encompass a longer period by which to explore meaningful relationships. The model that explained adult entrainment losses (Dec-Mar) was the following: adult entrainment loss = 6.243 – 0.000957*OMR Flow (Dec-Mar). The adjusted R^2 for this model was 0.36. For comparative analyses, predictions of population losses from 1967-1994 were generated from this equation, (Figure E-4) whereby loss estimates from 1995-2006 were taken from Kimmerer (2008). Note much of the variability in both the salvage and population loss model is left unexplained but the predictions in the models do follow the trend that salvage and population losses increase as OMR flows decrease. In part, the variation is not captured because adult salvage and entrainment is not solely explained by OMR flows. Entrainment is also related to the number of adults that migrate into the vicinity of Banks and Jones. Although WY type may sometimes affect the spawning distribution (Sweetnam 1999), there is wide, apparently random variation in the use of the Central and South Delta by spawning delta smelt. For example, there are years when a greater proportion of the smelt population moves into the vicinity of the export facilities, which may lead to larger salvage and population loss. Leaving aside differences due to spawning migration variability, the approach used here provides expected salvage and entrainment losses given an OMR flow. The percent differences between historic winter salvage and predicted winter salvage from modeled studies were examined for each WY.

Predicted Salvage and Entrainment

The median OMR flows from the CALSIM II modeled scenarios were more negative than historic OMR flow for all WY types except critically dry years (Figure E-3; see Table E-5b for all differences). Overall, proposed OMR flows are likely to generate increases in population losses compared to historic years (Figure E-5 and Figure E-6). For example, the frequency of years when population losses are less than 10 percent from most modeled studies (except studies 7.0 and 8.0) is less than 24 percent compared to historic estimates that only exceed 10 percent in approximately half of the years.

The most pronounced differences occur during wet years, where median OMR flows are projected to be approximately 400 to 600 percent (-7100 to -3678 cfs) higher than historical wet years (-1032 cfs). Generally, wet years are marked by low salvage and population losses. However, the proposed operations during wet year are predicted to cause up to a 65 percent increase in smelt salvage and lower probability that population losses will be below 10 percent.

The proposed operation conditions likely to have the greatest impact on delta smelt are those modeled during above normal WYs. The modeled OMR flows for the above normal WYs ranged between -8155 and -6242 cfs, a 33 to 57 percent decrease from the historic median of -5178 cfs. Though the predicted salvage would only be about 15-20 percent higher than historic salvage during these years (Table E-5c), the modeled OMR flows in these years would increase population losses compared to historic years.

In below normal and dry WYs, proposed OMR flows are also modeled to decrease from historic medians. Predicted salvage levels are likely to increase between 2 and 44 percent. More importantly, the modeled median flows from all studies in these WY types range between -5747 and -7438 cfs. Modeled OMR flows at these levels are predicted to increase salvage and increase the population losses from historic levels as well.

During critically dry years, the median OMR flows for studies 7.0, 7.1, 8.0, 9.1, 9.4, and 9.5 are less than -5,000 cfs. These studies have predicted salvage lower than historic salvage and are not likely to generate larger population losses compared to historic years. The models might overestimate salvage during critical dry years when smelt are unlikely to migrate towards the Central Delta due to lack of turbidity or first flush. Thus, the effects of critical dry operations on delta smelt take are probably small and lower than estimated.

In summary, adult entrainment is likely to be higher than it has been in the past under most operating scenarios, resulting in lower potential production of early life history stages in the spring in some years. While the largest predicted effects occur in Wet and Above Normal WYs, there are also likely adverse effects in Below Normal and Dry WYs. Only Critically Dry WYs are generally predicted to have lower entrainment than what has occurred in the recent past.

Table E-5a. Historic and CALSIM II modeled median winter (Dec-Mar) OMR flows by water year type

Water year type	Historic	7	7.1	8	9	9.1	9.2	9.3	9.4	9.5
Wet	-1033	-5256	-5498	-5699	-5684	-5500	-3999	-3678	-7066	-6100
Above Normal	-5178	-7209	-7923	-8073	-8156	-7595	-6863	-6934	-7861	-7723
Below Normal	-2405	-6461	-7208	-7009	-6599	-6420	-5647	-6736	-6721	-6343
Dry	-5509	-6443	-6931	-6692	-6620	-6353	-6831	-7438	-5785	-5760
Critical	-5037	-4547	-4931	-4980	-5051	-4588	-5320	-5194	-4260	-3845

Table E-5b. Winter OMR Flow percent difference from historic median value to CALSIM II model median value

Water year type	7	7.1	8	9	9.1	9.2	9.3	9.4	9.5
Wet	408.92%	432.37%	451.84%	450.36%	432.50%	287.16%	256.13%	584.15%	490.63%
Above Normal	39.21%	53.01%	55.90%	57.49%	46.67%	32.53%	33.91%	51.80%	49.13%
Below Normal	168.62%	199.68%	191.41%	174.35%	166.90%	134.75%	180.05%	179.42%	163.72%
Dry	16.95%	25.81%	21.48%	20.17%	15.32%	24.01%	35.02%	5.01%	4.57%
Critical	-9.74%	-2.12%	-1.14%	0.27%	-8.92%	5.61%	3.11%	-15.44%	-23.68%

Table E-5c. Percent difference from historic median salvage to predicted salvage based on Dec-Mar OMR flows from CALSIM II studies

Water year type	Study 7	Study 7.1	Study 8	Study 9	Study 9.1	Study 9.2	Study 9.3	Study 9.4	Study 9.5
Wet	45.64%	48.26%	50.43%	50.26%	48.27%	32.05%	28.59%	65.20%	54.76%
Above Normal	15.15%	20.49%	21.60%	22.22%	18.04%	12.57%	13.10%	20.02%	18.99%
Below Normal	38.17%	45.20%	43.33%	39.46%	37.78%	30.50%	40.76%	40.61%	37.06%
Dry	6.80%	10.36%	8.62%	8.09%	6.15%	9.63%	14.05%	2.01%	1.83%
Critical	-3.70%	-0.81%	-0.43%	0.10%	-3.39%	2.13%	1.18%	-5.87%	-9.00%

Article 21

The analysis of Banks Article 21 pumping is qualitative because the CALSIM II modeling, as shown in the biological assessment, does not simulate two major South of the Delta storage facilities, the Kern Water Bank and Diamond Valley Lake. Both of these facilities have been used to store water moved under Article 21. As such, the full effects of Article 21 pumping is underestimated by the modeling. The modeling assumptions assume that Article 21 water demand would be 314 TAF for each month December through March and up to 214 TAF per month in all other months. As shown in Figure P-17 and Table P-12, there has been an increase in SWP pumping corresponding to an increase of the use of Article 21. This increased pumping at the SWP from the year 2000 to present corresponds to the recent declines in the delta smelt population, currently being studied by the IEP. This pumping is included in the exports at Banks, so Article 21 effects to delta smelt are included in the adult entrainment, larval-juvenile entrainment, and fall habitat effects sections. However, as described above, the modeling underestimates these effects and the amounts of water that would be moved to south of Delta storage facilities. The previous section showed that the proposed action would result in increased adult entrainment during winter. As shown below, Article 21 pumping in the fall contributes to habitat degradation and Article 21 pumping in the spring (if it occurred) would contribute to higher larval-juvenile entrainment than what occurred from 1995-2007.

The export of Article 21 appears to be one of the factors that increase entrainment in the months of December through March, demonstrated by the large increases of pumping at Banks. The highest amounts of Article 21 water are pumped in the months when adult delta smelt entrainment is also highest.

The Service is concerned with the WY type in which Article 21 water is pumped. In the 2004 OCAP biological assessment and the Service's 2005 biological opinion, Article 21 pumping was only assumed to occur during wet and above normal WYs. In the modeling for the 2004 biological assessment, Article 21 was assumed to be 50 TAF/month for MWDSC in December through March and up to 84 TAF/month for other water users for a total of 134 TAF/month from December through March. The 2005 biological opinion stated this would be an infrequent occurrence. However, from 2004 to 2007, Article 21 has been used in more than in the wet years. In 2004, a below normal WY when Article 21 should not have been pumped according to the 2005 biological opinion, 209 TAF (which was higher than the maximum assumed amount of 134 TAF) of Article 21 was pumped in March. The maximum assumed Article 21 pumping from the biological opinion was also exceeded in 2005 (167 TAF in February, 219 TAF in March and 147 TAF in April) and 2006 (260 TAF in February and 184 TAF in March).

The effects of pumping of Article 21 water to adult delta smelt would be most severe during below normal and dry years. Even though Article 21 may not be called often in these water types, San Luis Reservoir can be filled in dryer years (for example if the preceding year was wet). It is during these types of years that the increased pumping

associated with Article 21 would have the most detrimental effects to delta smelt and significant adult entrainment may occur.

DMC-CA Intertie

As described in the Project Description, the DMC-CA Intertie would provide operational flexibility between the DMC and the CA. CALSIM II-modeling results show that the Jones pumping plant capacity increases from 4,200 cfs in Study 7.0 to 4,600 cfs in Study 8.0. While the specific effects of the intertie on delta smelt cannot be analytically distinguished, the increased capacity of the Jones pumping plant is included in the adult entrainment effects discussion above and can result in higher entrainment of adult, larval and juvenile delta smelt at Jones. In addition, increased pumping at Jones can have indirect effects to delta smelt by entraining their food source and reducing their available habitat, as discussed below in the habitat suitability section.

NBA Diversion

North Bay Aqueduct diversions have had no clear trend in most months since 2000 (Source: Dayflow), though annualized average NBA pumping was higher (83 cfs) in WY 2007 than in any previous year. Seasonal pumping rates during 2005-2007 were 109 cfs in Summer (Jun-Aug), 94 in Fall (Sep-Nov), 39 in Winter (Dec-Feb), and 36 in Spring (Mar-May). These recent historical numbers are substantially below values produced by CALSIMII Study 7.0 in the Winter and Spring months. For example, the 2005-2007 December pumping rate of 52 cfs is 44 percent of the Study 7.0 December pumping rate (116 cfs); the historical April pumping rate during the same period was 31 cfs, or 23 percent of the Study 7.0 rate of 133 cfs. Because some of these differences are large, the actual historical values are discussed in each seasonal subsection below.

Modeled North Bay Aqueduct diversions are highest during the winter months. The diversion rate for study 8 in December (142 cfs) was higher than diversion rate for studies 7.0 (116 cfs). The actual average December through February pumping in 2005-2007 was 39 cfs. The SCWA hydrodynamic modeling of NBA diversions indicates that the majority of water diverted under historical pumping rates originates from Campbell Lake and Calhoun Cut during the winter. As previously mentioned, delta smelt migrate up into the Delta during the winter months. Modeled diversion rates in Studies 7.0 and 8.0 for the winter months may create hydrodynamic conditions that entrain substantial numbers of delta smelt into Barker Slough if delta smelt are present in that region.

In some years, delta smelt will begin spawning in February when temperatures reach about 12 ^{o}C (Bennett 2005). In some years, delta smelt larvae may be entrained at the NBA diversions. However since the majority of water diverted originates from Campbell Lake during the winter under historical pumping conditions, these effects were likely minimal. During years when the Yolo Bypass floods, the entrainment risk of larvae into the NBA was also probably extremely localized under historical pumping conditions because of a hydrodynamic “plug” that forms between Barker and Lindsay sloughs with

Cache Slough. When this happens, hydrodynamic mixing between Cache Slough and Lindsay/Barker sloughs decreases, causing spikes in turbidity and organic carbon in Barker and Lindsay Sloughs (DWR, North Bay Aqueduct Water Quality Report). Entrainment vulnerability would be greatest during dry years when the NBA diversions entrain a large portion of water from Barker and Lindsay Sloughs and are often years when delta smelt will spawn in the North Delta (Sweetnam 1999). This vulnerability could be higher under pumping rates associated with Studies 7.0 and 8.0. The fish screen at the NBA diversion was designed to exclude delta smelt larger than 25 mm. However, a study of a fish screen in Horseshoe Bend built to delta smelt standards excluded 99.7 percent of fish from entrainment even though most of these were only 15-25 mm long (Nobriga et al. 2004). On that basis, the fish screen at NBA may protect many, if not most, of the delta smelt larvae that do hatch and rear in Barker Slough.

CCWD Diversions

As described in the Project Description, CCWD diverts water from three different intakes in the Delta. All CCWD facilities are subject to no-fill and no-diversion periods to protect delta smelt from entrainment. With implementation of proposed CVP/SWP operations, water demands of the CCWD are anticipated to increase from 135 TAF/year in study 7.0 to 195 TAF/year in study 8.0.

Old River intake

CCWD currently diverts water using the Old River intake for its supplies directly from the Delta. In addition, when salinity is low enough, Los Vaqueros Reservoir is filled at a rate of up to 200 cfs from the Old River Intake. However, since this facility is fully screened to meet delta smelt fish screening criteria, adult entrainment is not a concern. Diversion from this facility may affect OMR flows.

Rock Slough

The Rock Slough Intake is presently unscreened. As described in the Project Description, Reclamation is required to screen this diversion and is seeking an extension for the completion of the fish screen.

Catches of delta smelt at the Rock Slough diversion are low based on sampling conducted using a sieve net three times per week from January through June and twice per week from July through December and using a plankton net at the headworks structure twice per week during times when larval delta smelt could be present in the area (generally March through June). The numbers of delta smelt entrained by the facility since 1998 have been extremely low based on this monitoring, with only a single fish taken in February 2005. Most water diversions at the Rock Slough intake now occur during the summer months, so adult delta smelt entrainment is not likely to be high. In addition, Rock Slough is a dead-end slough with poor habitat for delta smelt, so the numbers of delta smelt using Rock Slough are usually low.

Alternative Intake

Total entrainment at CCWD's facilities is likely to be reduced when the CCWD's Alternative Intake Project is completed. This diversion is going to be screened according to delta smelt fish screening criteria and will likely reduce diversions from the unscreened Rock Slough diversion. Because the Alternative Intake diversion is fully screened, adult delta smelt entrainment is not likely to be high. Diversion from this facility may affect OMR flows.

Suisun Marsh Salinity Control Gates

The SMSCG are generally operated, as needed, from September through May to meet State salinity standards in the marsh. The number of days the SMSCG are operated in any given year varies. Historically, the SMSCG were operated 60-120 days between October and May (for the period 1988-2004). With an increased understanding of the effectiveness of the SMSCG in lowering salinity in Montezuma Slough, salinity standards have been met with less frequent gate operations. In 2006 and 2007, the gates were operated periodically between 10-20 days annually. It is expected that this level of operational frequency (10-20 days per year) will continue in the future.

It is possible for delta smelt and other fishes to be entrained behind the SMSCG in Montezuma Slough and Suisun Marsh when the SMSCG is closed. Fish may enter Montezuma Slough from the Sacramento River when the gates are open to draw freshwater into the marsh and then may not be able to move back out when the gates are closed. It is not known whether this harms delta smelt in any way, but they could be exposed to predators hovering around the SMSCG or they could have an increased risk of exposure to water diversions in the marsh (Culberson et al. 2004). It is possible that if delta smelt are indeed entrained into Montezuma Slough and Suisun Marsh that they may be more vulnerable to water diversion such as DWR's MIDS. Entrainment into MIDS from the Sacramento River may be unlikely based on particle tracking studies that have demonstrated low entrainment vulnerability for particles released at random locations throughout Suisun Marsh (3.7 percent), and almost no vulnerability (<0.1 percent) to particles released at Rio Vista (Culberson et al. 2004). Moreover, fish entrainment monitoring at MIDS showed very low entrainment of delta smelt (one larva in 2.3 million m^3 of water sampled over a two-year period) because salinity in Suisun Slough was usually too high for delta smelt when the MIDS diversion needed to operate (Enos et al. 2007). The degree to which movement of delta smelt around the LSZ is constrained by opening and closing the SMSCG is also unknown.

Indirectly, operations of the SMSCG may influence delta smelt habitat suitability and entrainment vulnerability. When the SMSCG are opened, the draw of freshwater into the marsh effectively moves the Suisun Bay salinity field upstream. In some years, the salinity field indexed by X2 may be shifted as far as 3 km upstream. Thus, depending on the tidal conditions during and after gate operations, X2 may be transported upstream nominally about 20 days per year. The consequence of this shift decreases the extent of delta smelt habitat and moves the distribution of delta smelt upstream (Feyrer et al. 2007; see delta smelt habitat effects section below for further discussion). Because juvenile

delta smelt production decreases when X2 moves upstream during the fall (Feyrer et al. 2007), any attributable shift in X2 between September to November (December during low outflow years) caused by operation of the SMSCG can be a concern. However, a 3-km shift in X2 happening 20 days per year is far less significant than the 10-20 km shifts that have occurred for up to 120 or more days per year during late summer through early winter due to South Delta diversions (see habitat effects section below).

During January through March, most delta smelt move into spawning areas in the Delta. Grimaldo et al (accepted manuscript) found that prior to spawning entrainment vulnerability of adult delta smelt increased at the SWP and CVP when X2 was upstream of 80 km. Thus, any upstream shift in X2 from SMSCG operations may influence entrainment of delta smelt at the CVP and SWP, especially during years of low outflow or periods of high CVP/SWP exports. However, between January and June the SWP and CVP operate to meet the X2 standards in SWRCB D-1641, thus the effects of the SMSCG on X2 during this period are negligible. Therefore, SMSCG operations from January to May are not likely to affect delta smelt entrainment vulnerability. In addition, because delta smelt move upstream between December and March, operations of the SMSCG are unlikely to adversely affect delta smelt habitat suitability during this period.

Larval and Juvenile Delta Smelt (~ March-June)

Water Diversions and Reservoir Operations

Banks and Jones

As stated previously, larval and juvenile delta smelt are free-swimming and pelagic; they do not associate strongly with structure or shorelines. Delta smelt use a variety of swimming behaviors to maintain position within suitable habitats – even in regions of strong tidal currents and net seaward flows (Bennett et al. 2002). Since the water exported during spring and early summer (mainly March-June) from the Central and South Delta is suitable habitat, young delta smelt do not have a cue to abandon areas where water is flowing toward Banks and Jones. Combinations of Delta inflows and export flows or variables like Delta outflow and OMR are good predictors of larval and young juvenile delta smelt entrainment (Kimmerer 2008). This effects analysis evaluates the proposed action operations by exploring long-term trends in Delta outflow, or X2, and OMR flows during March-June and comparing these to hydrodynamic conditions expected based on CALSIM II modeling presented in the biological assessment. The analysis uses the larval-juvenile entrainment estimates provided by Kimmerer (2008) and flow and export projections from the biological assessment to estimate the annual percentages of the larval/juvenile delta smelt population expected to be entrained.

This section examines the effects of entrainment on larval and juvenile delta smelt during the months of March-June. The analysis is based on comparison of historical (1967-2007) OMR and X2 to the proposed action's predictions of these variables provided in the biological assessment for studies 7.0, 7.1, 8.0, and 9.0-9.5. The hydrologic data are

examined in light of recent estimates of larval/juvenile delta smelt entrainment (Kimmerer 2008) that are reproduced well by Delta outflow (or X2) and OMR (Figure E-7). All analyses examine two sets of spring months; March-June, which encompasses most of the spawning season and April-May, which encompasses the empirical hatch dates of most fish surviving to the fall in recent years (Hobbs and Bennett, 2008). The reason for using two spring averaging periods was to demonstrate that the conclusions are robust with regard to choice of averaging period; the predicted entrainment is very similar.

Kimmerer (2008) proposed a method for estimating the percentage of the larval-juvenile delta smelt population entrained at Banks and Jones each year. These estimates were based on a combination of larval distribution data from the 20-mm survey, estimates of net efficiency in this survey, estimates of larval mortality rates, estimates of spawn timing, particle tracking simulations from DWR's DSM-2 particle tracking model, and estimates of Banks and Jones salvage efficiency for larvae of various sizes. Kimmerer estimated larval-juvenile entrainment for 1995-2005. We used Kimmerer's entrainment estimates to develop multiple regression models to predict the proportion of the larval-juvenile delta smelt population entrained based on a combination of X2 and OMR. Using Kimmerer's method, larval-juvenile is predicted to be 0 during periods of very high outflow. For instance, Kimmerer predicted entrainment loss was 0 percent in 1995 and 1998. For simplicity, we estimated the relationship between X2, OMR, and larval-juvenile entrainment without 1995 and 1998 in the model because the relationship between these variables is linear when only years that had entrainment higher than 0 were modeled. As mentioned above, we developed two separate models, one for the March-June averaging period and one for the April-May averaging period. The reason for using two spring averaging periods was to demonstrate that the conclusions are robust with regard to choice of averaging period; the predicted entrainment is very similar. The equations are: March-June percent entrainment = (0.00933*March-June X2) - (0.0000207*March-June OMR) – 0.556 and April-May percent entrainment = (0.00839*April-May X2) - (0.000029*April-May OMR) – 0.487. The adjusted R^2 on these equations are 0.90 and 0.87, respectively. These equations were used to predict historical springtime entrainment (1967-1994 and 2006-2007). We also used the above-mentioned regression equations to predict larval-juvenile entrainment based on the hydrologic predictions provided in the biological assessment. We used these estimates to compare historical entrainment effects predicted from the CALSIM II studies. Because the equations were based only on data that had non-zero entrainment, they predict entrainment proportions are negative during periods of very high outflow. The negative entrainment predictions were changed to 0 percent before summary analysis.

Historical Data (1967-2007)

Combined Old and Middle River Flow

There has been no clear long term trend in OMR for either the March-June or April-May averaging periods (Figures E-8 and E-9). Since the early 1990s, minimum OMR flows during April-May have been higher (less negative) than 1967-1990 (Figure E-9).

Delta Outflow

Delta outflows generally declined from 1967-1990, but Delta outflows have generally been higher and comparable to 1970s levels since 1990. This is true for both the March-June and April-May averaging periods (Figures E-10 and E-11). Since the early 1990s, minimum Delta outflows flows during April-May have usually been slightly higher than 1967-1990. This is likely due to the combination of the X2 standard and the VAMP pulse flow.

Predicted entrainment

Predicted entrainment is a function of both X2 and OMR, therefore higher flows and lower exports translate into lower entrainment of delta smelt. Predicted larval-juvenile entrainment was often higher prior to the implementation of the X2 standard in 1995 than it has been since (Figure E-16). The predictions for entrainment range from 0 to about 40 percent for 1967-1994 and 0 to about 30 percent for 1995-2007. However, the upper confidence limits reach substantially higher levels, ranging from 0 to about 65 percent between 1967 and 1994 and 0 to about 40 percent during 1995-2007. The effect of the X2 standard on larval-juvenile entrainment can be seen in Figure E-17. The frequency of years in which 0 percent-10 percent of the larval-juvenile population was estimated to have been entrained was similar between 1967-1994 and 1995-2005 because very high spring outflows have always pushed X2 far downstream resulting in delta smelt distributions distant from the influence of Banks and Jones. However, there are substantial differences between the 1967-1994 and 1995-2005 time periods in terms of how frequently larger percentages of the larval-juvenile population were entrained. For instance, it is estimated that less than 20 percent of the larval-juvenile population was entrained in 67 percent of years from 1995-2005, but only 44 percent of years from 1967-1994 (Figure E-17). Further, predicted entrainment sometimes exceeded 30 percent

during 1967-1994, but was never that high during 1995-2005. Note that we did not attempt to carry the confidence limits on entrainment estimates through these calculations. See Figure E-16 for estimates of the confidence intervals.

Proposed Action

Combined Old and Middle River Flow

The biological assessment proposes that Banks and Jones pumping will cause March-June OMR flows to be more negative than 1967-2007 in wet and above normal years and will cause April-May OMR flows to be more negative than 1967-2007 wet years (Figures E-12 and E-13). It is also anticipated there will be less variation in OMR during wet and above normal years than there was historically. The predicted OMR flows are predicted to be higher (hovering near 0 cfs on average) in dry and critical years. This is true for both averaging periods. These patterns do not change in the climate change scenarios (Studies 9.0-9.5).

X2

Most of the projected operations result in average March-June and average April-May X2 that are further downstream than 1967-2007 averages (Figures E-14 and E-15). As stated previously, this is likely due to the full implementation of the X2 standard and VAMP export reduction in projected operations. The exception is wet years. In wet years, projected X2 is generally very similar to historical in both averaging periods except that the boxplots indicate no occurrences of X2 further downstream than 50 km. This is probably due to the proposed decreases in wet year OMR flows (Figures E-8 and E-9). The climate change scenarios predict April and May X2 will be further downstream in dry and critical years, but the differences are modest (< 5 km) and again likely due primarily to the modeling assumptions of meeting the X2 standard and providing an export reduction during VAMP.

Effects of Forecasted Operations

Note that we did not attempt to carry the confidence limits on entrainment estimates through these calculations. See Figure E-16 for estimates of the uncertainty surrounding the following. The biological assessment's assumptions of a continued X2 standard and an EWA-related export reduction during April-May, keep the frequency of years with larval-juvenile entrainment higher than 20 percent consistent with 1995-2005 expectations regardless of operational assumptions (Figure E-18). However, the proposed action will decrease the frequency of years in which estimated entrainment is ≤ 15 percent. Thus, over a given span of years, the project as proposed will increase larval-juvenile entrainment relative to 1995-2005 levels. This will have an adverse effect on delta smelt based on their current low population levels.

Article 21

The effects from Article 21 on larval and juvenile delta smelt would be similar to those described for adult delta smelt (See previous effects discussion on Article 21 in the adult delta smelt section). While Article 21 pumping during March through June is usually lower than in the winter, larval and juvenile delta smelt could become entrained during March through June when Article 21 pumping is occurring.

VAMP

VAMP, as described in the Project Description and the Status of the Species and Environmental Baseline section, has beneficial effects to larval and juvenile delta smelt because it simultaneously provides a pulse flow on the San Joaquin River and an export reduction at Banks and Jones. This combination has provided 31 days of improved transport flows in the Central Delta since 2000. Also as discussed above in the Status of the Species/Environmental Baseline section, Bennett (unpublished analysis) found that most delta smelt that survived to be pre-adults in the FMWT hatched during VAMP. The Service considers this evidence that VAMP has selectively enhanced the survival of delta smelt larvae that emerge during the flow pulse and export reduction by reducing the entrainment of larvae from the Central Delta.

VAMP is an experiment, and it is only projected to continue until 2009. As described in the Project Description, after VAMP ends, Reclamation has committed to maintaining the export curtailment portion of VAMP. However, since VAMP also contains a San Joaquin River flow component, which would not be continued past 2009, maintaining only the export curtailment is not expected to provide the same benefits to larval and juvenile delta smelt as the complete VAMP experiment. In order for delta smelt spawned in the Central Delta during the VAMP period to survive to the fall, the export curtailments and the VAMP flows would be needed.

According to the Project Description, DWR proposes to continue the export reductions at Banks as long as there are assets available from the Yuba Accord Water Transfer to compensate the SWP for lost pumping. Because the export reductions may cost more than the Yuba Accord provides, the export curtailments at Banks may be smaller and therefore provide less benefit to larval and juvenile delta smelt. Also, as mentioned above, the export reductions at Jones and Banks are only part of VAMP, and the San Joaquin River (i.e., Vernalis) flow pulse is also important for protection of delta smelt from entrainment.

Therefore, the reduced protections during VAMP by only providing the export curtailment portion of VAMP and not the San Joaquin River flow component is likely to adversely effect delta smelt. Larval and juvenile delta smelt in the Central and South Delta would be protected from entrainment at Banks and Jones during this period, but the lack of San Joaquin River flow would not help them to move to the Western Delta and

Suisun Bay. Without the flow component, the larval and juvenile delta smelt would remain in the Central and South Delta, where they could be exposed to lethal water temperatures, entrainment at Banks and Jones after the VAMP export curtailment period, or succumb to predation or m*icrocystis* blooms.

Intertie

The effects from the intertie on larval and juvenile delta smelt would be similar to those described for adult delta smelt. See previous effects discussion on the intertie in the adult delta smelt section.

NBA Diversion

The differences in NBA diversions during the spring were as follows: For April, study 8.0 had a diversion rate of 145 cfs, which is approximately 10 percent higher than the April diversion rates in studies 7.0 (133 cfs) (Chapter 12). For May, study 8.0 also had a diversion rate of 145 cfs, which is approximately 25 percent higher than the May diversion rates in studies 7.0 (116 cfs). For June, study 8.0 assumed a diversion rate of 148 cfs, about 18 percent higher than the June diversion rates in studies 7.0 (126 cfs) The actual average March through May pumping in 2005-2007 was 36 cfs. Overall, spring represents the period of greatest entrainment risk for delta smelt larvae at the NBA, especially in dry years when delta smelt spawn in the North Delta (http://www.delta.dfg.ca.gov/data/NBA/). Entrainment risk at the pumping rates modeled in Studies 7.0 and 8.0 could be substantially higher than risks that existed under historical pumping rates. As described above, based on Nobriga et al. 2004, the fish screen at NBA may protect many, if not most of the delta smelt larvae that hatch and rear in Barker Slough. However, as the NBA diversions increase, as proposed in study 8.0, the small effect of the NBA diversion may become more significant.

CCWD Diversions

Old River Intake

In addition to the Old River diversion being screened to protect adult delta smelt, all CCWD diversions implement fishery protection measures to minimize larval delta smelt from becoming entrained at CCWD facilities. These measures consist of a 75-day period during which CCWD does not fill Los Vaqueros Reservoir and a concurrent 30-day period during which CCWD halts all diversions from the Delta, provided that Los Vaqueros Reservoir storage is above emergency levels. The default dates for the no-fill and no-diversion periods are March 15 through May 31 and April 1 through April 30, respectively; the Service, NMFS and DFG can change these dates to best protect the subject species. Larval fish may occur at this facility outside of the no-fill and no-diversion periods, and may be subject to entrainment. However, larval fish monitoring behind the screens has shown very few larval fish become entrained (Reclamation 2008) and, as stated above for the NBA, the fish screens at this facility may protect fish smaller

than intended by the screens' designs. Diversion from this facility may affect OMR flows.

Rock Slough

Although most water diversions at the Rock Slough intake now occur during the summer months, the Rock Slough diversion is also subject to the no-fill and no-diversion periods that all CCWD diversions are operated under. Like the Old River diversion, larval delta smelt may occur at this facility outside of the no-fill and no-diversion periods, and may be subject to entrainment. Since the Rock Slough diversion is not screened, larval fish entrainment at this facility may be a concern. However, larval fish monitoring behind the headworks has not shown that large numbers of larval fish become entrained (Reclamation 2008).

Alternative Intake

Like the Old River diversion, the Alternative intake is screened to protect adult delta smelt from entrainment. Since larval smelt are not protected by these fish screens, the Alternative intake is also proposed to operate in accordance with the no-fill and no-diversion periods to minimize larval fish from entrainment. Like the other two CCWD diversions discussed above, larval delta smelt may occur at this facility outside of the no-fill and no-diversion periods, and may be subject to entrainment. Larval fish may also become entrained at this facility, but as stated above for the NBA, the fish screens at this facility may protect fish smaller than intended by the screens' designs. Diversion from this facility may affect OMR flows.

South Delta Temporary Barriers

Hydrodynamic Effects

The TBP does not alter total Delta outflow, or the position of X2. However, the TBP causes changes in the hydraulics of the Delta, which may affect delta smelt. The HORB blocks San Joaquin River flow, which prevents it from entering Old River at that point. This situation increases the flow toward Banks and Jones from Turner and Columbia cuts, which can increase the predicted entrainment risk for particles in the East and Central Delta by up to about 10 percent (Kimmerer and Nobriga 2008). In most instances, net flow is directed towards the Banks and Jones pumps and local agricultural diversions. Computer simulations have shown that placement of the barriers changes South Delta hydrodynamics, increasing Central Delta flows toward the export facilities (Reclamation 2008). In years with substantial numbers of adult delta smelt moving into the Central Delta, increases in negative OMR flow caused by installation of the SDTBs can increase entrainment. The directional flow towards the Banks and Jones increases the vulnerability of fish to entrainment. Larval and juvenile delta smelt are especially susceptible to these flows.

The varying proposed operational configurations of the TBP, natural variations in fish distribution, and a number of other physical and environmental variables limit statistical confidence in assessing fish salvage when the TBP is operational versus when it is not. In 1996, the installation of the spring HORB caused a sharp reversal of net flow in the South Delta to the upstream direction. Coincident with this change was a strong peak in delta smelt salvage (Nobriga et al. 2000). This observation indicates that short-term salvage can significantly increase when the HORB is installed in such a manner that it causes a sharp change or reversal of positive net daily flow in the South and Central Delta. The physical presence of the TBP may attract piscivorous fishes and influence predation on delta smelt. However, past studies by the DFG TBP Fish Monitoring Program indicated that such predation is negligible (DWR 2000a).

Vulnerability to Local Agricultural Diversions

Fish that may become trapped upstream of the TBP agricultural barriers may suffer increased vulnerability to local agricultural diversions. However, the risk of entrainment (Kimmerer and Nobriga 2008) or death from unsuitable water quality (as inferred from lack of delta smelt occurrence in the South Delta during summer; see Nobriga et al. 2008) is so high for delta smelt trapped in the South Delta that loss to irrigation diversions in this region is likely to be negligible.

Effects to Potential Fish Prey Items

The extent to which the distribution and abundance of delta smelt prey organisms is influenced by the conditions created by the TBP is difficult to determine. Because the TBP does not influence X2, organisms that exhibit a strong abundance-X2 relationship (e.g., mysid shrimp) (Jassby et al.1995), are not likely to be affected. However, the barriers might influence the flux of *Pseudodiaptomus* from the Delta to the LSZ.

South Delta Permanent Operable Gates

Hydrodynamic Effects

As described in the Project Description, the South Delta Permanent Operable Gates (Operable Gates) are expected to be constructed in late 2012. The Operable Gates are expected to operate during similar time periods as the TBP, with the gate closing starting in April and operating thorough the winter. The Head of Old River Gate would operate in April and May and in the fall.

The effects of the Operable Gates on larval and juvenile delta smelt are expected to be similar to those caused by the TBP. The Operable Gates will open daily to maintain water levels at 0.0 foot mean sea level in Old River near the Jones pumping plant, and these daily openings would provide passage for delta smelt. Like the TBP, the operations of the Operable Gates are not expected to decrease Delta outflows, but the risk of larval and juvenile delta smelt entrainment at Banks and Jones is expected to remain about the same as with the TBP. Also, OMR flows would be affected by the Operable Gates and

may result in more negative OMR flows which could increase the risk of larval and juvenile delta smelt entrainment.

If the Operable Gates are operated during periods when the TBP have not been installed, additional effects to delta smelt could occur. For example, if the Operable Gates are closed during the winter (December through March), flow cues from the San Joaquin River may be disrupted and may affect adult delta smelt migration into the Delta. Also, if the Operable Gates are closed during this period, the available habitat for delta smelt would be reduced. The South Delta can be suitable habitat for delta smelt in some years; if this habitat is inaccessible to the delta smelt due to the Operable Gates being closed, adverse effects to the delta smelt and their habitat would occur.

Vulnerability to Local Agricultural Diversions

Under the proposed operations of the Operable Gates, delta smelt are likely to be affected in a manner similar to that caused by operation of the TBP, although delta smelt may be less susceptible to entrainment at local agricultural diversion since the Operable Gates are likely to be opened more often. As discussed above, the risk of entrainment or death from unsuitable water quality is so high for delta smelt trapped in the South Delta that loss to irrigation diversions in this region is likely to be negligible.

Effects to Potential Fish Prey Items

Under the proposed operations of the Operable Gates, delta smelt are likely to be affected in a manner similar to that caused by operation of the TBP, although delta smelt may be less affected because the Operable Gates will be open more than the TBP.

Suisun Marsh Salinity Control Gates

The effects from the SMSCG on larval and juvenile delta smelt would be similar to those described for adult delta smelt. See previous effects discussion on the SMSCG in the adult delta smelt section.

American River Demands

Based on CALSIM II model study 8.0 results, total American River Division annual demands on the American and Sacramento rivers are estimated to increase from about 324,000 acre-feet in 2005 to 605,000 acre-feet in 2030, without the Freeport Regional Water Project maximum of 133,000 acre-feet during drier years. These increases in demands and diversions are included in the modeling results. The effects of these demands on delta smelt are discussed below in the section dealing with the effects of CVP/SWP operation on habitat suitability.

Delta Cross Channel

The DCC will be closed for fishery protection as described in the Project Description. This action is not expected to change in the future. The effects of the DCC on Delta hydrodynamics are included in the CALSIM II modeling results and are discussed below in the section dealing with the effects of CVP/SWP operation on habitat suitability.

Juveniles and Adults (~ July-December)

Entrainment of *Pseudodiaptomus forbesi* (June-September)

Historically, the diet of juvenile delta smelt during summer was dominated by the copepod *Eurytemora affinis* and the mysid shrimp *Neomysis mercedis* (Moyle et al. 1992; Feyrer et al. 2003). These prey bloomed from within the estuary's LSZ and were decimated by the overbite clam *Corbula amurensis* (Kimmerer and Orsi 1996), so delta smelt switched their diet to other prey. *Pseudodiaptomus forbesi* has been the dominant summertime prey for delta smelt since it was introduced into the estuary in 1988 (Lott 1998; Nobriga 2002; Hobbs et al. 2006). Unlike *Eurytemora* and *Neomysis*, *Pseudodiaptomus* blooms originate in the freshwater Delta (John Durand San Francisco State University, oral presentation at 2006 CALFED Science Conference). This freshwater reproductive strategy provides a refuge from overbite clam grazing, but *Pseudodiaptomus* has to be transported to the LSZ during summer to co-occur with most of the delta smelt population. This might make *Pseudodiaptomus* more vulnerable to pumping effects from the export facilities than *Eurytemora* and *Neomysis* were. By extension, the projects might have more effect on the food supply available to delta smelt than they did before the overbite clam changed the LSZ food web. As evidence for this hypothesis, the IEP Environmental Monitoring Program zooplankton data show the summertime density of *Pseudodiaptomus* is generally higher in the South Delta than in Suisun Bay. The ratio of South Delta *Pseudodiaptomus* density to Suisun Bay *Pseudodiaptomus* density was greater than one in 73 percent of the collections from June-September 1988-2006. The average value of this ratio is 22, meaning that on average summer *Pseudodiaptomus* density has been 22 times higher in the South Delta than Suisun Bay. Densities in the two regions are not correlated ($P > 0.30$). This demonstrates that the presence of high copepod densities in the South Delta which delta smelt do not occupy during summer months, do not necessarily occur simultaneously in the LSZ where delta smelt rear.

There is statistical evidence suggesting that the co-occurrence of delta smelt and *Pseudodiaptomus forbesi* has a strong statistical influence on the survival of young delta smelt from summer to fall (Miller 2007). In addition, recent histopathological evaluations of delta smelt have shown possible evidence of food limitation in delta smelt during the summer (Bennett 2005; Bennett et al. 2008). However, the glycogen depletion of the delta smelt livers reported in these studies can also arise from thermal stress due to high summer water temperatures (Bennett et al. 2008).

Water Transfers

Water transfers would increase Delta exports by 0 to 360,000 acre-feet (af) in most years (the wettest 80 percent of years) and by up to 600,000 AF in Critical and some Dry years (approximately the driest 20 percent years). Most transfers will occur at Banks (SWP) because reliable capacity is not likely to be available at Jones except in the driest 20 percent of years. Although transfers can occur at any time of year, the exports for transfers described in this assessment would occur only in the months July-September. Delta smelt are rarely present in the Delta in these months, so no increase in salvage due to water transfers during these months is anticipated, but as described above, these transfers might affect delta smelt prey availability.

Post-processing of Model Data for Transfers

This section shows results from post-processed available pumping capacity at Banks and Jones for the Study 8.0 . Results from the Existing Conditions CVP-OCAP study alternatives do not differ greatly from those of Study 8.0, and produce similar characteristics and tendencies regarding the opportunities for transfers over the range of study years. The assumptions for the calculations are:

- Capacities are for the Late-Summer period July through September total.
- The pumping capacity calculated is up to the allowable E:I ratio and is limited by either the total physical or permitted capacity, and does not include restrictions due to ANN salinity requirements with consideration of carriage water costs.
- The quantities displayed on the graph do not include the additional 500 cfs of pumping capacity at Banks (up to 7,180 cfs) that is proposed to offset reductions previously taken for fish protection. This could provide up to a maximum about 90 TAF of additional capacity for the July-September period, although 60 TAF is a better estimate of the practical maximum available from that 500 cfs of capacity, allowing for some operations contingencies.
- Figure 13-59 and Figure 13-60 in the biological assessment show the available export capacity from Study 8.0 (Future Conditions-2030) at Banks and Jones, respectively, with the 40-30-30 WY type on the x-axis and the WY labeled on the bars. The SWP allocation or the CVP south of Delta Agriculture allocation is the allocation from CALSIM II output from the WY.

From Figure 13-59 of the biological assessment, Banks will have the most ability to move water for transfers in Critical and certain Dry years (driest 20 percent of study years) which generally have the lowest water supply allocations, and reflect years when transfers may be higher to augment water supply to export contractors. For all other study years (generally the wettest 80 percent) the available capacity at Banks for transfer

ranges from about 0 to 500 TAF (not including the additional 60 TAF accruing from the proposed permitted increase of 500 cfs at Banks. But, over the course of the three months July-September other operations constraints on pumping and occasional contingencies would tend to reduce capacity for transfers. In consideration of those factors, proposed transfers would be up to 360 TAF in most years when capacity is limiting. In Critical and some Dry years, when capacity would not be a limiting factor, exports for transfers could be up to 600 TAF (at Banks and Jones combined). Transfers at Jones (Figure 13-60 of the biological assessment) are probably most likely to occur only in the driest of years (Critical years and some Dry years) when there is available capacity and low allocations.

Limitations

The analysis of transfer capacity available derived from the CALSIM II study results shows the capacity at the export pumps and does not reflect the amount of water available from willing sellers or the ability to move through the Delta. The available capacity for transfer at Banks and Jones is a calculated quantity that should be viewed as an indicator, rather than a precise estimate. It is calculated by subtracting the respective project pumping each month from that project's maximum pumping capacity. That quantity may be further reduced to ensure compliance with the Export/Inflow ratio required. In actual operations, other contingencies may further reduce or limit available capacity for transfers: for example, maintenance outages, changing Delta outflow requirements, limitations on upstream operations, water level protection criteria in the South Delta, and fishery protection criteria. For this reason, the available capacity should be treated as an indicator of the maximum available for use in transfers under the assumed study conditions.

Proposed Exports for Transfers

In consideration of the estimated available capacity for transfers, and in recognition of the many other operations contingencies and constraints that might limit actual use of available capacity, for this assessment proposed exports for transfers (months July-September only) are as follows:

Water Year Type	Maximum Amount of Transfer
Critical	up to 600 kaf
Consecutive Dry	up to 600 kaf
Dry after Critical	up to 600 kaf
All other Years	up to 360 kaf

Therefore, effects of water transfers are not expected to have direct entrainment effects to adult delta smelt since the proposed transfer window is a time when delta smelt are distributed the western Delta. However, water transfers could have adverse effects to

delta smelt habitat or food items by increased pumping during the summer or fall. These habitat effects are captured in CALSIM II modeling and the Habitat Suitability Section.

JPOD

JPOD, as described in the Project Description and included in the SWRCB's D-1641, gives Reclamation and DWR the ability to use/exchange each Project's diversion capacity capabilities to enhance the beneficial uses of both Projects. There are a number of requirements outlined in D-1641 that restrict JPOD to protect Delta water quality and fisheries resources. The effects of JPOD are included in the CALSIM II modeling results and in the habitat suitability section.

500 cfs at Banks

Under the 500 cfs increased diversion, the maximum allowable daily diversion rate into CCF during the months of July, August, and September would increase from 13,870 AF up to 14,860 AF and three-day average diversions would increase from 13,250 AF up to 14,240 AF. This increased diversion over the three-month period would result in an amount not to exceed 90,000 AF each year. Maximum average monthly SWP exports during the three-month period from Banks Pumping Plant would increase to 7,180 cfs. Variations to hydrologic conditions coupled with regulatory requirements may limit the ability of the SWP to fully utilize the proposed increased diversion rate. Also, facility capabilities may limit the ability of the SWP to fully utilize the proposed increased diversion rate. This increased pumping may reduce the suitable habitat available for delta smelt and may result in entrainment of *Pseudodiaptomus* as described above.

NBA Diversion

The summer pumping rates of NBA diversions in study 7.0 (average rate was 115 cfs) was 18 percent lower than study 8.0 (average 135 cfs) (Chapter 12). The actual average June-August pumping in 2005-2007 was 109 cfs. Hydrodynamic modeling results from the Solano County Water Agency (SCWA) indicate that at recent (post-2004) actual pumping rates, the major water source pumped by the NBA during normal water years is Campbell Lake, a small non-tidal lake north of Barker Slough that receives local drainage. Thus under most summer-time conditions the entrainment effects are likely to have been low, especially since delta smelt move downstream by July (Nobriga et al. 2008). In dry seasons and at higher pumping rates described in Study 7 and the future Studies, the NBA entrains water from Barker and Lindsay sloughs (SCWA), indicating a potential entrainment risk for delta smelt. Historically, delta smelt densities have been low in Barker and Lindsay sloughs, but the modeling data suggest that delta smelt could exhibit some level of entrainment vulnerability. North Bay aqueduct diversions are

lowest in the fall (Chapter 12), averaging 101 cfs in study 7.0, and 123 in study 8.0. The actual average September through November pumping in 2005-2007 was 94 cfs. As discussed previously, delta smelt reside in the Suisun Bay to Sherman Island region during the fall months and are not likely to be entrained. Thus, there are no expected direct effects of the NBA on delta during this period. Because pumping rates are low and the hydrodynamic models indicate only a small percentage of water entrained enters from Barker Slough, it is unlikely the NBA has any measurable indirect effects during this period.

CCWD Diversions

The effects of CCWD diversions on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on effects of CCWD diversions in the larval and juvenile delta smelt section.

Temporary Agricultural Barriers

The effects of the TBP on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on effects of the TBP in the larval and juvenile delta smelt section.

Permanent Operable Gates

The effects of the permanent gates on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on the effects of the permanent operable gates in the larval and juvenile delta smelt section.

American River Demands

The effects of increased American River demands on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on increased American River demands in the larval and juvenile delta smelt section.

Delta Cross Channel

The effects DCC operations on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on the effects of the DCC in the larval and juvenile delta smelt section.

Entrainment Effects

Water Diversions and Reservoir Operations

Banks and Jones

Entrainment effects during July through November are not expected to be significant. Delta smelt are not present during this time of year, so direct entrainment during this time of year is not likely a concern.

Intertie

The effects the intertie on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on the effects of the intertie in the larval and juvenile delta smelt section.

Suisun Marsh Salinity Control Gates

The effects of the SMSCG on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on the effects of the SMSCG in the larval and juvenile delta smelt section.

Habitat Suitability (Sept-Dec)

All fishes depend on healthy suitable habitats to survive and reproduce. Because the upper San Francisco Estuary constitutes the sole habitat for delta smelt, a healthy suitable estuary and delta are critical to the long-term health and persistence of the species. The biological assessment and the Baseline section of this biological opinion provide details on the habitat requirements for the different life stages of delta smelt. This element of the Effects Analysis covers the effects of habitat for delta smelt during the fall months of September through December. During this time period, delta smelt are maturing pre-adults that rely heavily on suitable habitat conditions in the low salinity portion of the estuary. Suitable habitat for delta smelt during this time period can be briefly defined as the abiotic and biotic components of habitat that allow delta smelt to survive and grow to adulthood. Biotic components of habitat include suitable amounts of food resources and sufficiently low predation pressures. Abiotic components of habitat include the physical characteristics of water quality parameters, especially salinity and turbidity.

Interactions between the amount or area of suitable abiotic habitat available for delta smelt and the biotic components of habitat can have great consequences on density-dependent effects on population dynamics. Density-dependence is a fundamental concept in fish population dynamics. Compensatory density-dependence is a negative feedback on population size and therefore tends to stabilize the population (Rose et al. 2001). Depensatory density-dependence is a positive feedback on the population and

therefore tends to destabilize the population (Liermann and Hilborn 2001). Both of these mechanisms are important in delta smelt population dynamics. Compensatory density-dependence has been statistically detected in delta smelt at high population levels (Bennett 2005). However, the current record low levels of abundance of delta smelt make the species extremely vulnerable to the effects of depensatory density-dependence (Baxter et al. 2008).

Depensatory density-dependence can manifest in four ways: decreased probability of fertilization, impaired group dynamics, conditioning of the environment, and predator saturation (Liermann and Hilborn 2001). Patterns in the stock-recruit relationship since 2000 suggest that impaired group dynamics and the probability of fertilization are likely to be currently affecting the delta smelt population (Allee effects; Baxter et al. 2008). As discussed below, there is substantial evidence to suggest that delta smelt is vulnerable to environmental conditioning and predator saturation because the amount of suitable abiotic habitat for maturing pre-adult delta smelt has been seriously depleted and stabilized by CVP/SWP operations. The fact that delta smelt are subject to the effects of all four elements of depensatory density-dependence creates a situation where it might be extremely difficult for the population to recover under the present environmental conditions in the Estuary.

The Service's examination of habitat suitability during fall is derived from published literature and unpublished information linking X2 to the amount of suitable abiotic habitat for delta smelt (Feyrer et al 2007, 2008). Under balanced conditions, CVP/SWP operations control the position of X2 and therefore are a primary driver of delta smelt habitat suitability. As a result, this analysis relies on the effects of proposed CVP/SWP operations on fall X2, how that affects the surface area of suitable abiotic habitat for delta smelt, and finally how that affects delta smelt abundance given current delta smelt population dynamics. Supporting background material on the effect of fall X2 on the amount of suitable abiotic habitat and delta smelt abundance is available in Feyrer et al. (2007, 2008).

During the fall, when delta smelt are nearing adulthood, the amount of suitable abiotic habitat for delta smelt is positively associated with X2. This results from the effects of Delta outflow on salinity distribution throughout the Estuary. Fall X2 also has a measurable effect on recruitment of juveniles the following summer in that it has been a significant covariate in delta smelt's stock-recruit relationship since the invasion of the overbite clam. Potential mechanisms for the observed effect are two-fold. First, positioning X2 seaward during fall provides a larger habitat area which presumably lessens the likelihood of density-dependent effects (e.g., food availability) on the delta smelt population. Second, a more confined distribution may increase the impact of stochastic events that increase mortality rates of delta smelt. For delta smelt, this includes predation and anthropogenic effects such as contaminants and entrainment (Sommer et al. 2007).

This evaluation of habitat suitability considered three specific elements: X2, total area of suitable abiotic habitat, and the predicted effect on delta smelt abundance the following

summer. Effects of proposed CVP/SWP operations were determined by comparing X2, the area of suitable abiotic habitat, and the effect of these two variables on delta smelt abundance across the operational scenarios characterized by the CALSIM II model runs, and also as they compare to actual historic values from 1967 to the present. The modeled scenarios include: Study 7.0, Study 7.1, Study 8.0, and Studies 9.0-9.5. This section concludes with additional observations of the historic and modeled data with a discussion of the potential underlying mechanisms.

X2

The first step of the evaluation examined the effect of proposed CVP/SWP operations on X2 (km) during fall, as determined by the CALSIM II model results. These model results are presented in a monthly time step and are provided in the appendices to the biological assessment. In order to be consistent with previous analyses (Feyrer 2007, 2008), X2 during the fall was calculated as the average of the monthly X2 values from September through December obtained from the CALSIM II model results. The data were also differentiated by WY type according to that of the previous spring.

The median X2 across the CALSIM II modeled scenarios were 10-15 percent further upstream than actual historic X2 (Figure E-19). Median historic fall X2 was 79km, while median values for the CALSIM II modeled scenarios ranged from 87 to 91km. The CALSIM II modeled scenarios all had an upper range of X2 at about 90km. The consistent upper cap on X2 shows that water quality requirements for the Delta ultimately constrain the upper limit of X2 in the simulations. These results were also consistent across WY types (Figure E-19) with the differences becoming much more pronounced as years became drier. Thus, the proposed action operations will affect X2 by shifting it upstream in all years, and the effect is exacerbated in drier years.

Area of Suitable Abiotic Habitat

The second step of the evaluation used the modeled X2 to estimate the total surface area of suitable abiotic habitat available for delta smelt. Feyrer et al. (2008) examined three different definitions of habitat suitability for delta smelt that were subsequently used to generate the hectares (ha) of suitable abiotic habitat. The three habitat criteria examined by Feyrer et al. (2008) were based on the statistical probability of delta smelt occurring in a sample due to water salinity and clarity characteristics at the time of sampling. The probabilities of occurrence they examined and compared were $\geq$ 10 percent, $\geq$ 25 percent, and $\geq$ 40 percent. This evaluation applied their intermediate definition of 25 percent to avoid potentially over- or under-estimating the effect. The quantitative model relating X2 to area of suitable abiotic habitat is presented in Figure E-20.

The median amounts of suitable abiotic habitat based upon X2 values generated across the CALSIM II modeled scenarios were 49-57 percent smaller than that predicted by actual historic X2 (Figure E-21). The median historic amount of suitable abiotic habitat was 9,164 ha, while median values for the CALSIM II modeled scenarios ranged from 3,995 to 4,631 ha. These results were also consistent across WY types (Figure E-21),

with the differences becoming much more pronounced in drier years. Thus, the proposed action operations affect the amount of suitable abiotic habitat by decreasing it as a result of moving X2 upstream, and the effect is exacerbated in drier years.

Effect on Delta Smelt Abundance

The third step of the evaluation was to use the modeled X2 to estimate the effect on delta smelt abundance. The model relating X2 to delta smelt abundance was updated from that developed by Feyrer et al. (2008) by adding the most recent year of available data (Figure E-22). This model incorporates X2 as a covariate in the standard stock-recruit (FMWT index-TNS index the following year; Bennett (2005)) relationship for delta smelt. The model is based on data available since 1987 and therefore represents current delta smelt population dynamics (Feyrer et al. 2007). Note that although the regression model is highly significant and explains 56 percent of the variability in the data set, the residuals are not normally distributed. The pattern of the residuals suggests that some type of transformation of the data would help to define a better fitting model (Figure E-22). This analysis did not explore different data transformations. For generating predictions, the FMWT values in the model were held constant at 280, the median value over which the model was built. This was done for all iterations in order to make the results comparable across the scenarios examined. In plots that show "historic" TNS categories, the values are those predicted with the model using actual historic X2 values from 1967 to the present. This approach was necessary in order to examine the likely effects of the different scenarios on present-day delta smelt population dynamics.

The median values for the predicted TNS index based upon X2 values generated across the CALSIM II modeled scenarios were 60-80 percent smaller than those predicted from actual historic X2 (Figure E-23). The median value for the TNS index predicted based upon historic X2 was 5, while median values predicted from X2 values generated from the CALSIM II modeled scenarios ranged from 1 to 2. These results were also consistent across WY types (Figure E-23) with the differences becoming much more pronounced as years became drier. Thus, the proposed action operations are likely to negatively affect the abundance of delta smelt.

Additional Long-term Trends and Potential Mechanisms

There has been a long-term shift upstream for actual X2 during fall that is associated with a similar upstream shift in the E:I ratio (Figure E-24). X2 is largely determined by Delta outflow, which in turn is largely determined by the difference between total delta inflow and the total amount of water exported, commonly referred to as the E:I ratio. During fall, the E:I ratio directly affects X2, slightly less so when the E:I ratio reaches approximately 0.45 (Figure E-24). The leveling off is due to the need to meet D-1641 salinity standards. Thus, the long-term positive trend in X2 and the associated negative affects on area of suitable abiotic habitat and predicted delta smelt abundance appear to be related to the long-term positive trend in E:I ratio. X2 in the time series for each of the

CALSIM II model runs is even greater than the peak of the actual historic values (Figure E-25). Based on the proposed operations, the upstream X2 shift will persist.

While the above results demonstrate the likely effects of project operations on X2 averaged over the fall period, the modeling scenarios indicate that X2 in individual months will vary by WY type classification and by the specific modeling scenario (Figure E-26). In wetter years of Studies 7.0, 7.1, and 8.0 (wet and above average WY types), X2 tends to diverge from historic conditions in that it shifts upstream in September, October, and November, and shifts downstream in December. This pattern is much less pronounced in the climate change scenarios, Studies 9.0-9.5. In all model studies there is also a general decrease in interannual variability across all of the months. In drier years (below normal to critical WY types), the model scenarios indicate that for all months X2 will generally be shifted upstream and that much of the interannual historic variability will be lost.

The effects of project operations outlined above on X2 during the fall months have considerably altered the hydrodynamics of the estuary in two important ways other than which have already been described. First, the long-term upstream shift in fall X2 has created a situation where all fall seasons regardless of WY type now resemble dry or critical years (Figure E-27). In other words, all fall seasons have now been converted into uniform, low flow periods. Second, the effects have also manifested in a divergence between X2 during fall and X2 during the previous spring (April-July spring averaging period), and the modeling studies indicate this condition will persist in the future (Figure E-28).

Combined, these effects of project operations on X2 will have significant adverse direct and indirect effects on delta smelt. Directly, these changes will substantially decrease the amount of suitable abiotic habitat for delta smelt, which in turn has the possibility of affecting delta smelt abundance through the depensatory density-dependant mechanisms outlined above. Because current abundance estimates are at such historic low levels, depensatory density-dependence can be a serious threat to delta smelt despite the fact that the population may not be perceived to be habitat limited. It is clear from published research that delta smelt has become increasingly habitat limited over time and that this has contributed to the population declining to record-low abundance levels (Bennett 2005; Baxter et al. 2008; Feyrer et al. 2007, 2008; Nobriga et al. 2008). Therefore, the continued loss and constriction of habitat proposed under future project operations significantly threatens the ability of a self-sustaining delta smelt population to recover and persist in the Estuary at abundance levels higher than the current record-lows.

Indirectly, changes such as the extremely stable low outflow conditions resembling dry or critical years proposed for the fall across all WY types will likely a) contribute to higher water toxicity (Werner et al. 2008) because the proposed flows are always low in all WY types, b) contribute to the potential suppression of phytoplankton production by ammonia entering the system from wastewater treatment plants (Wilkerson et al. 2006; Dugdale et al. 2007) because diluting flows are minimal, c) increase the reproductive success of overbite clams allowing them to establish year-round populations further east because

salinity is consistently high with low variability (Jan Thompson, USGS, unpublished data), d) correspond with high E:I ratios resulting in elevated entrainment of lower trophic levels, e) increase the frequency with which delta smelt encounter unscreened agricultural irrigation diversions in the Delta (Kimmerer and Nobriga 2008) because the eastward movement of X2 will shift the distribution of delta smelt upstream, and provide environmental conditions for nonnative fishes that thrive in stable conditions (Nobriga et al. 2005). Although there is no single driver of delta smelt population dynamics (Baxter et al. 2008), these indirect effects will exacerbate any direct effects on delta smelt and hinder the ability of the population to recover and maintain higher levels of abundance in the future (Bennett and Moyle 1996; Bennett 2005; Feyrer et al. 2007).

American River Demands

The effects of increased American River demands on delta smelt during the summer and fall would be similar to those described for larval and juvenile delta smelt. See previous effects discussion on the effects of increased American River demands in the larval and juvenile delta smelt section.

Komeen Treatment

The Department of Boating and Waterways (DBW) prepared an Environmental Impact Report (2001) for a two-year Komeen research trial in the Delta. They determined there were potential effects to fish from Komeen treatment despite uncertainty as to the likelihood of occurrence. Uncertainties exist as to the direct impact that Komeen and Komeen residues may have on fish species. "The target concentration of Komeen is lower than that expected to result in mortality to most fish species, including delta smelt." However, there is evidence that, at target concentrations, Komeen could adversely impact some fish species. The possibility exists that Komeen concentrations could be lethal to some fish species, especially during the first nine hours following application. Although no tests have examined the toxicity of Komeen to Chinook salmon, LC50 data for rainbow trout suggest that salmonids would not be affected by use of Komeen at the concentrations proposed for the research trials. No tests have been conducted to determine the effect of Komeen on splittail, green sturgeon, pacific lamprey or river lamprey." (DBW, 2001) or delta smelt.

In 2005, no fish mortality or stressed fish were reported during or after the treatment. The contractor, Clean Lakes, Inc was looking for dead fish during the Komeen application. In addition, no fish mortality was reported in any of the previous Komeen or Nautique applications. In 2005, catfish were observed feeding in the treatment zone at about 3 PM on the day of the application (Scott Schuler, SePro). No dead fish were observed. DWR complied with the NPDES permit that requires visual monitoring assessment. Due to the uncertainty of the impact of Komeen on fish that may be in the Forebay, we will assume that all delta smelt in the Forebay at the time of application are taken. The daily loss values vary greatly within treatments, between months and between years. Figure E-29 illustrates the presence of delta smelt in the Forebay during treatments. There are no loss

estimates for delta smelt, so the relationship between salvage and true loss of delta smelt in the Forebay in unknown. However, since the treatments will only be during July and August, delta smelt are not expected to be present in the Forebay during this time, so adverse effects to delta smelt are unlikely.

Effects to Delta Smelt Critical Habitat

Primary Constituent Elements

Due to the interrelationship between the PCEs and the intended conservation role they serve for different delta smelt life stages, some effects are similar and overlap across the PCEs. For instance, Delta outflow determines the extent and location of the LSZ and the areas of physical habitat delta smelt are able to utilize at all times of the year. Therefore, many of the effects described below for the PCEs are difficult to separate so some effects are repeated for multiple PCEs.

Spawning Habitat

PCE 1 – Physical Habitat

Delta smelt require physical habitat only during spawning. The major impact to spawning habitat from the CVP/SWP projects would be from dredging proposed as part of construction of the South Delta Improvements Program Stage 1. However, any dredging activities will be covered through a separate section 7 consultation. Upstream reservoirs such as Shasta, Folsom and Oroville Dams reduce gravel and sediment recruitment into the rivers and estuary. However, this impact is expected to remain relatively unchanged for delta smelt. The TBP will impact the physical habitat during the construction of the barriers which again is not covered within this biological opinion.

PCE 2 – Water

As described in the Effects Section, the CVP/SWP alter the hydrologic conditions within spawning habitat throughout the spawning period for delta smelt by impacting various abiotic factors including the distributions of turbidity, food, and contaminants. Article 21, DMC-CA Intertie, NBA, and CCWD Diversions effects are included within the affects of the CVP/SWP. The TBP and the SMSCG modify circulation within the Delta and Suisun Marsh which may have a small impact on delta smelt spawning habitat. The South Delta Permanent Operable Gates should have less of an impact than the TBP if operated only within the time period, as described in the Project Description.

PCE 3 – River Flow

The CVP and SWP, as analyzed in the Effects Section, directly influence the location and the amount of suitable spawning habitat, especially in drier WYs . Further, through upstream depletions and alteration of river flows, the CVP/SWP has played a role in altering the environment of the Delta. This has resulted in adverse effects to delta smelt spawning habitat availability and may mobilize contaminants. The contaminant effects may be generated or diluted by flow depending on the amount of flow, the type of contaminant, the time of the year, and relative concentrations.

Article 21 has increased in total volume recently (see Baseline section). This increase of pumping for Article 21 has occurred in December through March which coincides with the spawning of delta smelt. The DMC-CA Intertie, NBA, and CCWD Diversions are smaller diversions that are captured within the effects of the CVP/SWP. As described in the Project Description, CCWD operations are managed for fishery concerns during the spawning and rearing period for delta smelt through the no-fill and no-diversion requirements.

PCE 4 – Salinity

The LSZ expands and moves downstream when river flows are high. By capturing river flows, reservoirs can contribute to upstream movement of the LSZ which reduces habitat quality and quantity. Banks and Jones pumping likewise can result in upstream movement of the LSZ. Model results in the biological assessment show that in the future the location of the LSZ will generally be further upstream than occurred historically. This will result in a reduction in the amount and quality of spawning habitat available to delta smelt. These changes are primarily due to proposed future increases in upstream depletions and changes to reservoir operations and export pumping from the CVP/SWP.

Habitat quality will continue to be adversely affected by contaminants and increasing numbers of non-native invasive species.

Larval and Juvenile Transport

PCE 1 – Physical Habitat

Physical habitat is needed only during the spawning season and is not associated with larval and juvenile transport.

PCE 2 – Water

As described in the Effects Section, the CVP/SWP alter the hydrologic conditions within

spawning habitat throughout the spawning period for delta smelt by impacting various abiotic factors including distributions of turbidity, food, and contaminants. Article 21, DMC-CA Intertie, NBA, and CCWD Diversions effects are included within the effects of the CVP/SWP. The TBP and the SMSCG modify circulation within the Delta and Suisun Marsh which may have a small impact on delta smelt spawning habitat. The South Delta Permanent Operable Gates should have less of an impact than the TBP if operated only within the time period, as described in the Project Description.

PCE 3 – River Flows

The CVP/SWP, as analyzed in the Effects Section, directly influence river flows especially in years when releases from CVP/SWP reservoirs make up a higher percentage flows into the Delta from the Sacramento River.

In addition, pumping at Banks and Jones can alter flows within the Delta. This results in a corresponding alteration of larval and juvenile transport. Instead of tidal and downstream transport within suitable rearing areas, operations result in upstream transport that entrains delta smelt. Since the water exported during the spring and early summer (mainly March-June) from the Central and South Delta is suitable habitat, the effect of the action results in loss of suitable habitat. Unfortunately, young delta smelt do not have a cue to abandon areas where water is flowing toward Banks and Jones.

Reservoir releases and export reductions during VAMP have resulted in enhanced survival of delta smelt. However, the future of VAMP is uncertain.

The TBP increases the flux of delta smelt into the zone of entrainment. As described in the Effects Section, significant entrainment of delta smelt has occurred when the TBP operates coincident with high export levels. The South Delta Permanent Operable Gates should have less impact than the TBP if operated only within the time period specified in the Project Description (April 15-May 15 for the HOR Gate and April 15-November 30 for the flow control gates). The SMSCG can alter flows that interrupt the transport of larval and juvenile delta smelt in Montezuma Slough and Suisun Marsh when the SMSCG is closed.

PCE 4 – Salinity

As described previously, the CVP/SWP alters the location of the LSZ by modifying both the Sacramento and San Joaquin river flows which reduces habitat quality and quantity. Model results in the biological assessment show the location of the LSZ will be further upstream in the future than occurred historically. This will result in less suitable habitat for larval and juvenile delta smelt. These changes are primarily due to proposed future increases in upstream depletions and changes to reservoir operations. In addition, habitat quality will continue to be adversely affected by many associated factors like non-native invasive species and contaminants. The SMSCG, when in operation, modifies the salinity within Suisun Marsh and when in operation, there can be upstream movement of X2.

However, the SMSCG have been operated less frequently in recent years.

Rearing Habitat

PCE 1 – Physical Habitat

Physical habitat is needed only during the spawning season and is not associated with rearing habitat.

PCE 2 – Water

As described in the Effects Section, the CVP/SWP alter the hydrologic conditions within rearing habitat throughout the spawning period for delta smelt by impacting various abiotic factors including distributions of turbidity, food, and contaminants. Article 21, DMC-CA Intertie, NBA, and CCWD Diversions effects are included within the effects of the CVP/SWP. As described in the Project Description, CCWD operations are managed during the spawning and rearing period for delta smelt through the no-fill and no-diversion requirements. The TBP and the Suisun Marsh Salinity Control Gates modify circulation within the Delta and Suisun Marsh which may have a small adverse impact on delta smelt rearing habitat. The South Delta Permanent Operable Gates should have less of an adverse impact than the TBP if operated only within the time period (April 15-May 15 for the HOR Gate and April 15-November 30 for the flow control gates), as described in the Project Description.

PCE 3 – River Flows

The CVP and SWP, as analyzed in the Effects Section, directly influence river flows.

Pumping at Banks and Jones alters flows within the Delta. As described in the Effects Section, negative flows can result in an increase risk of entrainment when rearing habitat includes the South Delta. In addition, when rearing habitat includes the Central and South Delta, as temperatures increase in May and June, altered river flows can further degrade rearing habitat suitability. Rearing habitat in the South Delta may also be impacted indirectly through increases in contaminant concentrations and entrainment of zooplankton.

The TBP alter flows within rivers and channels which can increase the risk of entrainment. As described in the Effects Section, in the past with operation of the TBP and with high export levels, significant spikes in delta smelt entrainment have occurred at Jones and Banks. The South Delta Permanent Operable Gates should have less impact than the TBP if operated only within the time period (April15-May 15 for the HOR Gate and April 15-November 30 for the flow control gates), as described in the Project Description. The SMSCG can alter flows that interrupt and alter flows in Montezuma

Slough and Suisun Marsh when the SMSCG is closed.

PCE 4 – Salinity

As stated previously, the CVP/SWP alters the extent and location of the LSZ by modifying both the Sacramento and San Joaquin river flows which reduces habitat quality and quantity. Model results in the biological assessment show that in the future the location of the LSZ will be further upstream in the future than occurred historically. This will result in less suitable habitat for larval and juvenile delta smelt. These changes are primarily due to proposed future increases in upstream depletions and changes to reservoir operations and exports at Banks and Jones. In addition, habitat quality will continue to be adversely affected by mobilizing and concentrating contaminants within the Delta and creating hydrologic conditions that favor non-native invasive species over native species. The SMSCG, when in operation, modifies the salinity within Suisun Marsh and when the SMSCG is in operation there can be upstream movement of X2. However, the Gates have been operated less frequently in recent years.

Adult Migration

PCE 1 – Physical Habitat

Physical habitat is needed only during the spawning season and is not associated with adult migration per se.

PCE 2 – Water

As described previously, the CVP/SWP alters Delta hydrodynamics in ways that adversely affect delta smelt migration. Article 21, DMC-CA Intertie, NBA, and CCWD Diversions effects are included within the affects of the CVP/SWP. The TBP and the SMSCG modify circulation within the Delta and Suisun Marsh which may have a small impact on delta smelt migration. The South Delta Permanent Operable Gates should have less of an impact than the TBP if operated only within the time period, as described in the Project Description.

PCE 3 – River Flows

The CVP and SWP, as analyzed in the Effects Section, directly influence river flows especially during low flow periods when releases from CVP and SWP reservoirs make up a higher percentage of river flows into the Delta from the Sacramento River.

River flows in combination with an increase in turbidity cues the upstream migration of delta smelt for spawning.

In addition, Banks and Jones can alter flows within rivers and channels within the Delta. These alterations can interrupt the migration of pre-spawning and spawning adult delta smelt resulting in entrainment of delta smelt. As described in the Effects Section, adult entrainment is likely to be higher than it has been in the past under most operating scenarios, resulting in lower potential production of larval and juvenile delta smelt.

The South Delta Permanent Operable Gates would only have adverse effect to adult migration if they are operated during the winter months. The SMSCG can alter flows that interrupt movements of adult delta smelt in Montezuma Slough and Suisun Marsh when the gate is closed.

PCE 4 – Salinity

The CVP/SWP alters the location of the LSZ by modifying both the Sacramento and San Joaquin river flows which reduces habitat quality and quantity. Model results in the biological assessment show that in the future the location of the LSZ will be further upstream than occurred historically. This will result in less suitable habitat for pre-spawning and spawning delta smelt. These changes are primarily due to the proposed future increases in upstream depletions and changes to reservoir operations. The SMSCG, when in operation, modifies the salinity within Suisun Marsh and when the Gates is in operation there can be upstream movement of X2. However, the Gates have been operated less frequently in recent years.

Summary of Effects of the Action on Delta Smelt Critical Habitat

Implementation of the proposed action, primarily the volume of diversions at Banks and Jones relative to proposed Delta inflows, will prevent critical habitat from serving its intended conservation role. It is imperative that suitable habitat conditions, as defined by the co-occurring PCEs, immediately be provided over the designated critical habitat. This is based on the extremely low numbers of delta smelt; their annual life cycle, and the fact that delta smelt spend their entire life within the influence of the CVP/SWP. The proposed actions only provide as conservation measures VAMP and flows from the Yuba Water Accord (identified in the Project Description as “limited EWA”). In the past, VAMP has benefited delta smelt. However, equivalent flows may not be provided in all WYs.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

On-going non-Federal diversions of water within the action area (e.g., municipal and industrial uses, as well as diversions through intakes serving numerous small, private agricultural lands) are not likely to entrain very many delta smelt based on the results of a study by Nobriga et al. (2004). Nobriga et al. reasoned that the littoral location and low-flow operational characteristics of these diversions reduced their risk of entraining delta smelt. A study of the Morrow Island Distribution System by DWR produced similar results, with one demersal species and one species that associates with structural environmental features together accounting for 97-98 percent of entrainment; only one delta smelt was observed to be entrained during the two years of the study (DWR 2007).

State or local levee maintenance may also destroy or adversely affect delta smelt spawning or rearing habitat and interfere with natural, long term spawning habitat-maintaining processes. Operation of flow-through cooling systems on the Mirant electrical power generating plants that draw water from and discharge into the action area may also adversely affect delta smelt in the form of entrainment and locally increased water temperatures.

Adverse effects to delta smelt and its critical habitat may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include, but are not limited to ammonia and free ammonium ion, numerous pesticides and herbicides, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into Delta waterways from shipping and boating activities and from urban activities and runoff. Implicated as potential stressors of delta smelt, these contaminants may adversely affect fish reproductive success and survival rates.

Two wastewater treatment plants (one located on the Sacramento River near Freeport and the other on the San Joaquin River near Stockton) have received special attention because of their discharge of ammonia. The Sacramento Regional County Sanitation District (SRCSD) wastewater treatment facility near Freeport discharges more than 500,000 cubic meters of treated wastewater containing more than 10 tons of ammonia into the Sacramento River each day (http://www.sacbee.com/378/story/979721.html). Preliminary studies commissioned by the IEP POD investigation and the Central Valley Regional Water Quality Control Board are evaluating the potential for elevated levels of Sacramento River ammonia associated with the discharge to adversely affect delta smelt and the Delta ecosystem. The Freeport location of the SRCSD discharge places it upstream of the confluence of Cache Slough and the mainstem Sacramento River, a location just upstream of where delta smelt have been observed to congregate in recent years during the spawning season. The potential for exposure of a substantial fraction of delta smelt spawners to elevated ammonia levels has heightened the importance of this investigation. Ammonia discharge concerns have also been expressed with respect to the City of Stockton Regional Water Quality Control Plant, but its remoteness from the parts of the Estuary frequented by delta smelt and its recent upgrades suggest that it is more a potential issue for migrating salmonids than for delta smelt.

Other future, non-Federal actions within the action area that are likely to occur and may adversely affect delta smelt and its critical habitat include: the dumping of domestic and industrial garbage that decreases water quality; construction and maintenance of golf

courses that reduce habitat and introduce pesticides and herbicides into the aquatic environment; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; agricultural activities, including burning or removal of vegetation on levees that reduce riparian and wetland habitats that contribute to the quality of habitat used by delta smelt; and livestock grazing activities that may degrade or reduce riparian and wetland habitats that contribute to the quantity and quality of habitat used by delta smelt.

Future actions that implement planning efforts such as the Bay-Delta Conservation Plan or the Governor's Delta Vision may have adverse effects to delta smelt or its critical habitat, but these projects would have a federal nexus and would be the subject of future ESA consultations, as appropriate.

Figures referenced in the Effects Section

Figure E-1. Relationship between average December-March flow in Old and Middle rivers and the salvage of delta smelt in the same averaging period.

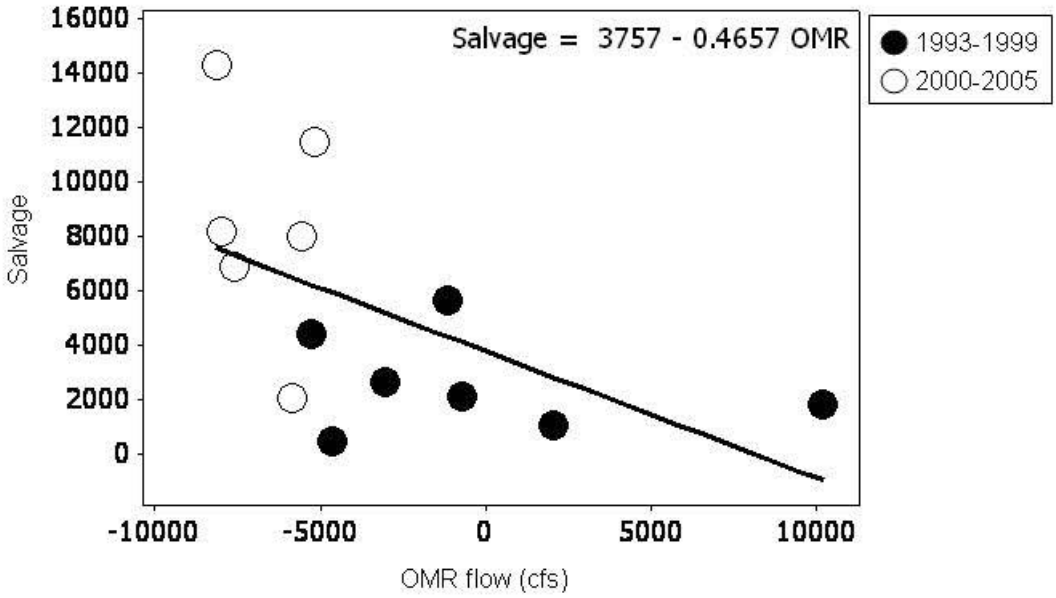


Figure E-2. Average winter (Dec-Mar) OMR flow (A), total Delta inflow (B), and combined SWP/CVP exports (C) by year. The data were fitted with lowess splines to show trends.

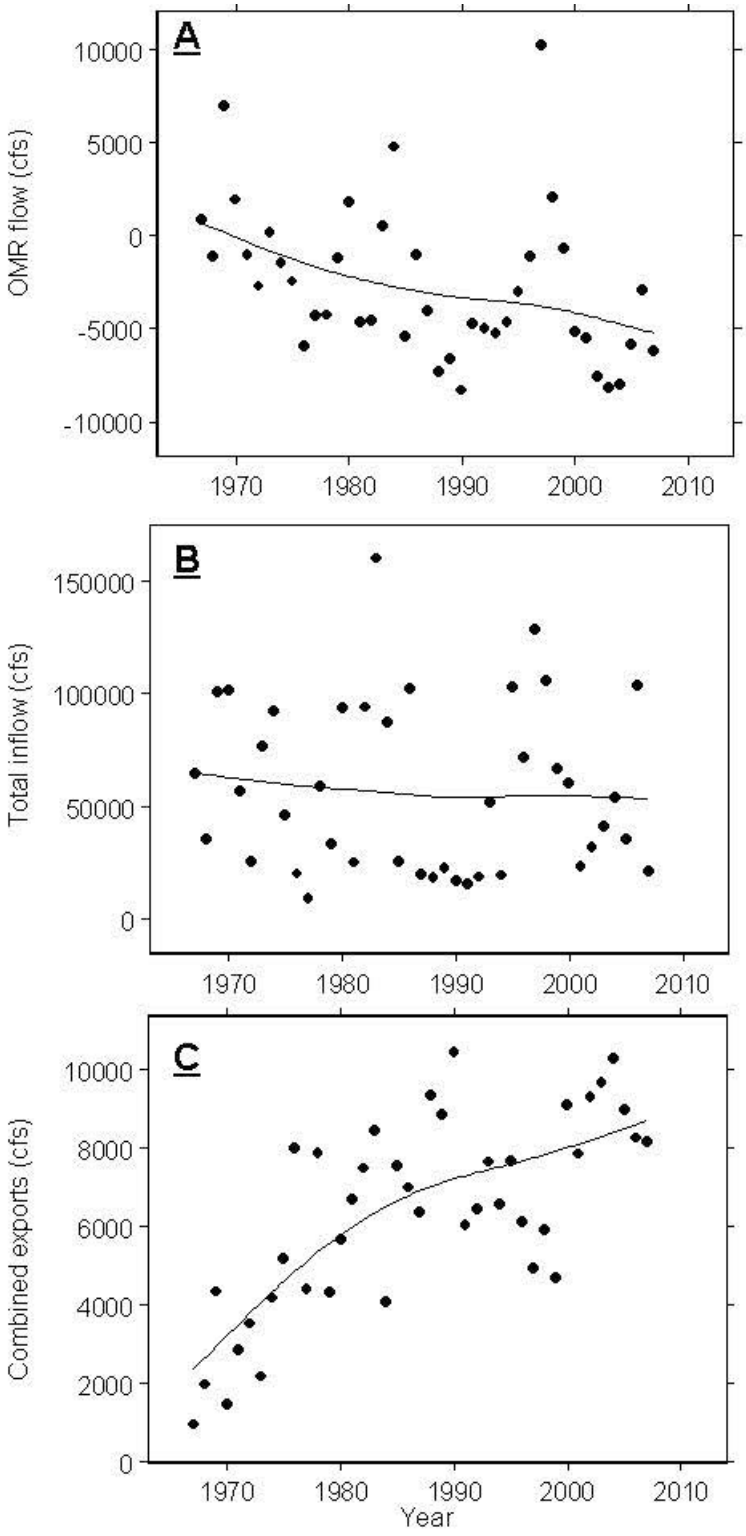


Figure E-3. Boxplot summary of CALSIM II operations study outputs of average winter (Dec-Mar) OMR flow for five water year types and the actual historic data (1967-2007). The boxes depict the interquartile range which is the distance between the 25th and 75th percentiles.

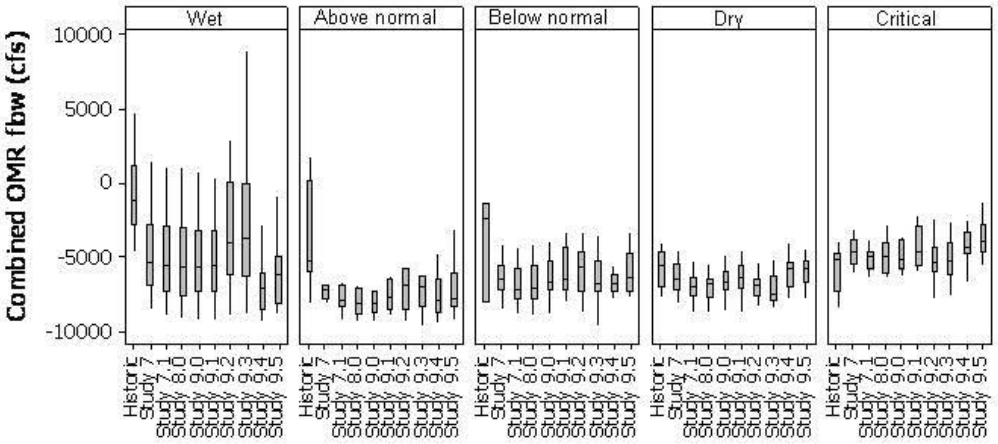


Figure E-4. Time series of estimated percentages (with 95 percent error bars) of the adult delta smelt population entrained in the SWP and CVP South Delta water export diversion facilities estimated from Kimmerer (2008). OMR flow is plotted on the secondary y-axis.

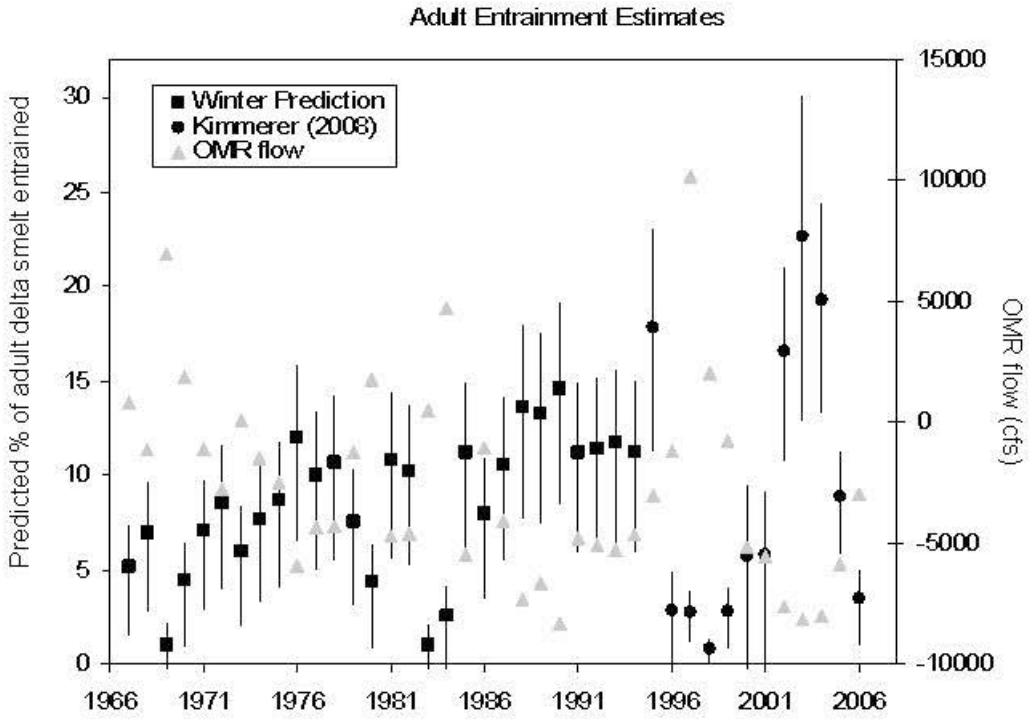


Figure E-5. Frequency distribution of predicted adult delta smelt entrained at Banks and Jones for predicted estimates from historic data (1967-1994), actual estimates from Kimmerer (2008) for years 1995-2006, and those estimated from CALSIM II model data by study.

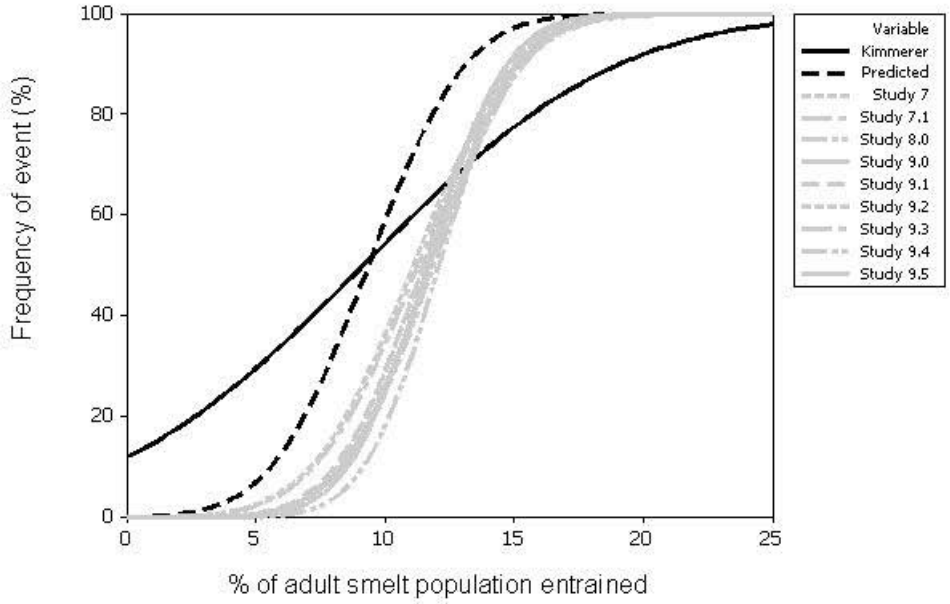


Figure E-6. Same as E-5 but by water year type. Kimmerer (2008) estimates did not include below normal or critical dry water year types.

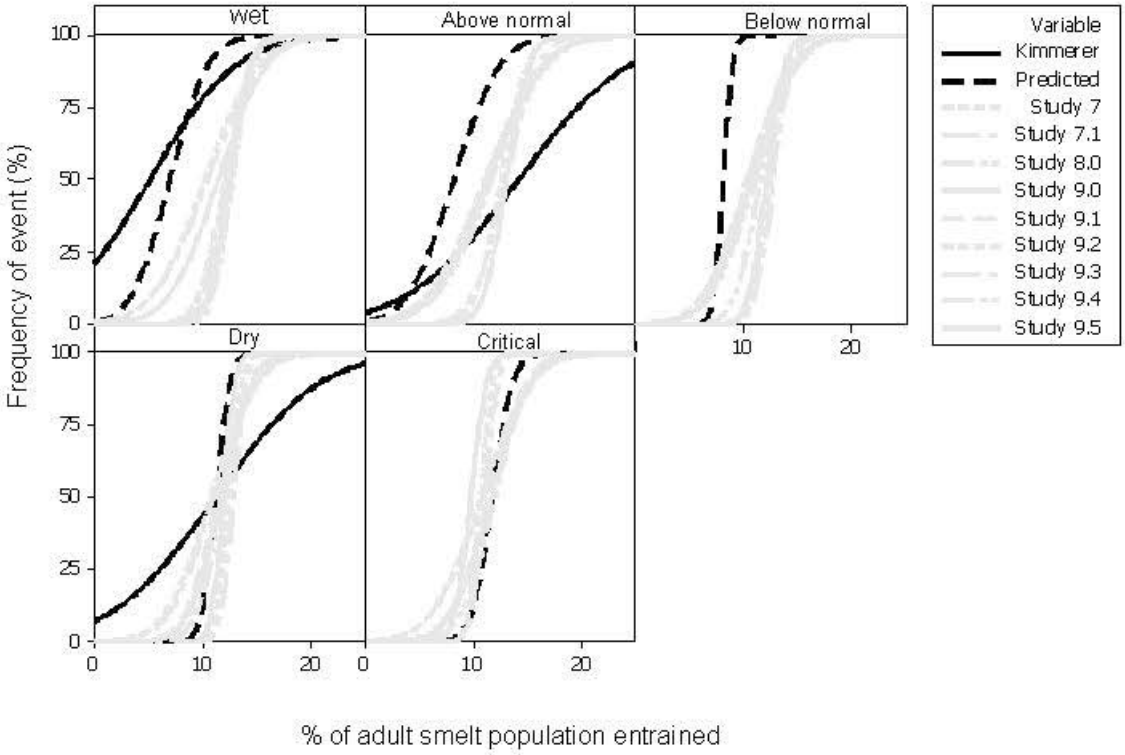


Figure E-7. Scatterplot of average flow in Old and Middle rivers (upper panel = March – June; lower panel = April – May) and the percentage of the larval and juvenile delta smelt population entrained in the SWP and CVP export pumps. The entrainment estimates were taken from Kimmerer (2008). The bubble sizes are scaled to the average Delta outflow for the same averaging periods as the OMR flows.

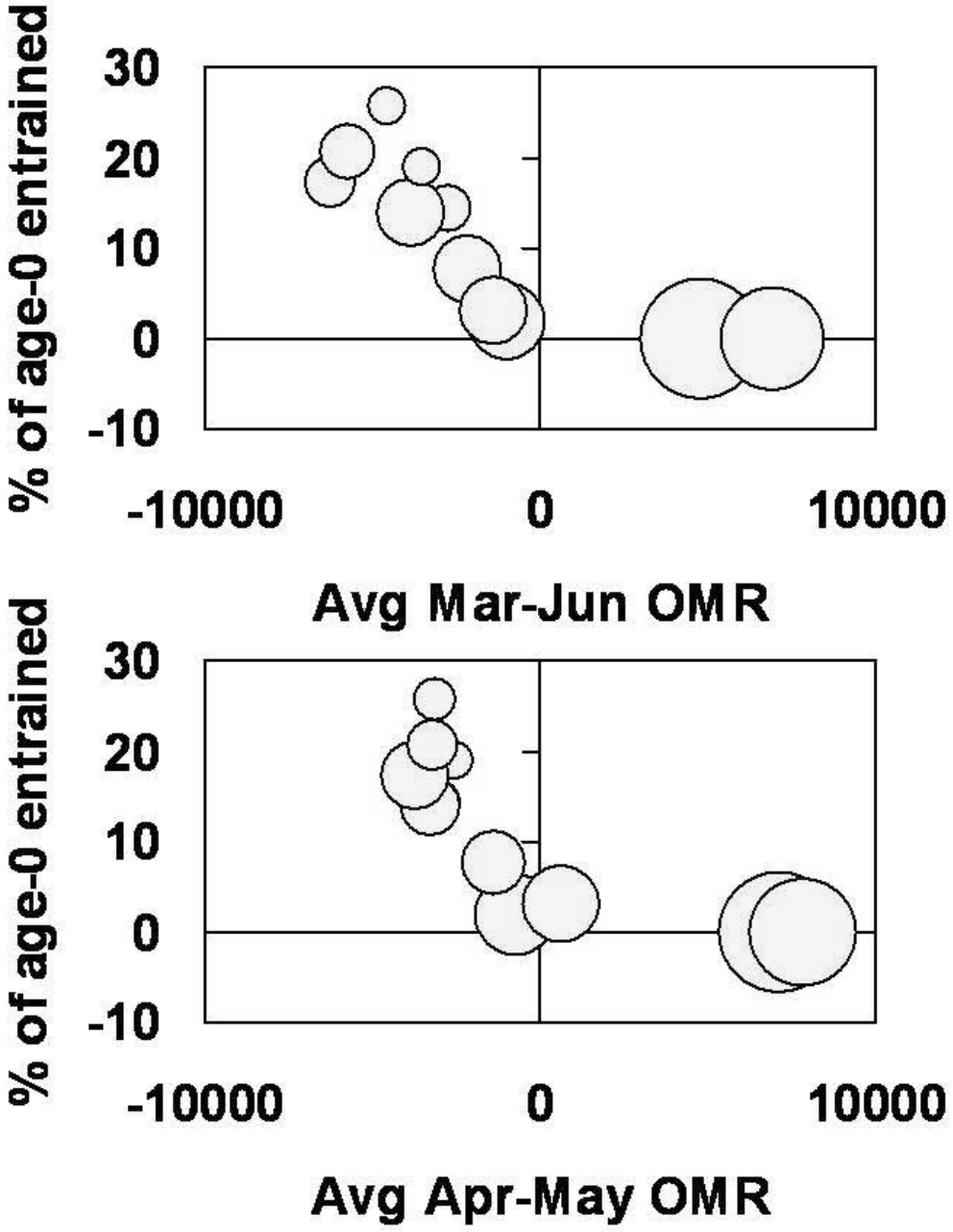


Figure E-8. Time trend in average March – June flow Old and Middle river flow, 1967-2007. Data for 1980-2006 are empirical data based on ADCP measurements. Data for 1967-1979 and 2007 are estimated as described in the text. The spline is a LOWESS regression
line.

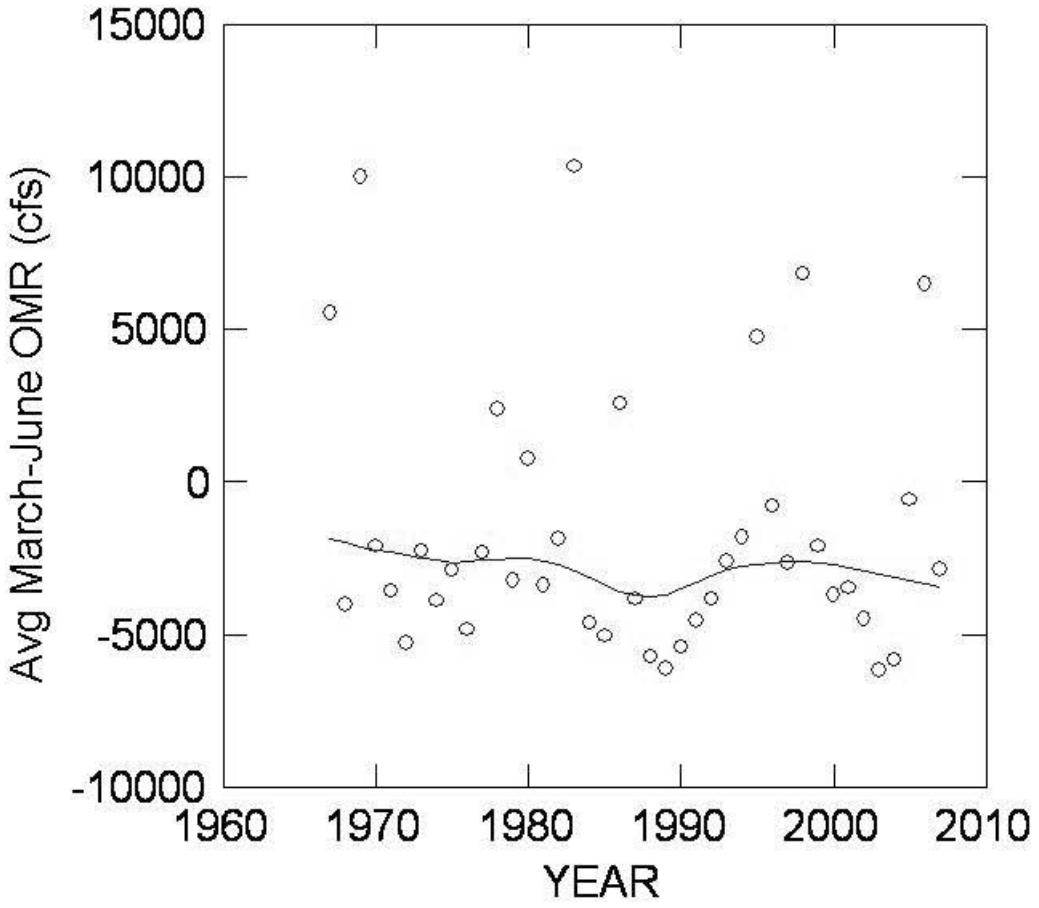


Figure E-9. Time trend in average April-May OMR flow, 1967-2007. Data for 1980-2006 are empirical data based on ADCP measurements. Data for 1967-1979 and 2007 are estimated as described in the text. The spline is a LOWESS regression line.

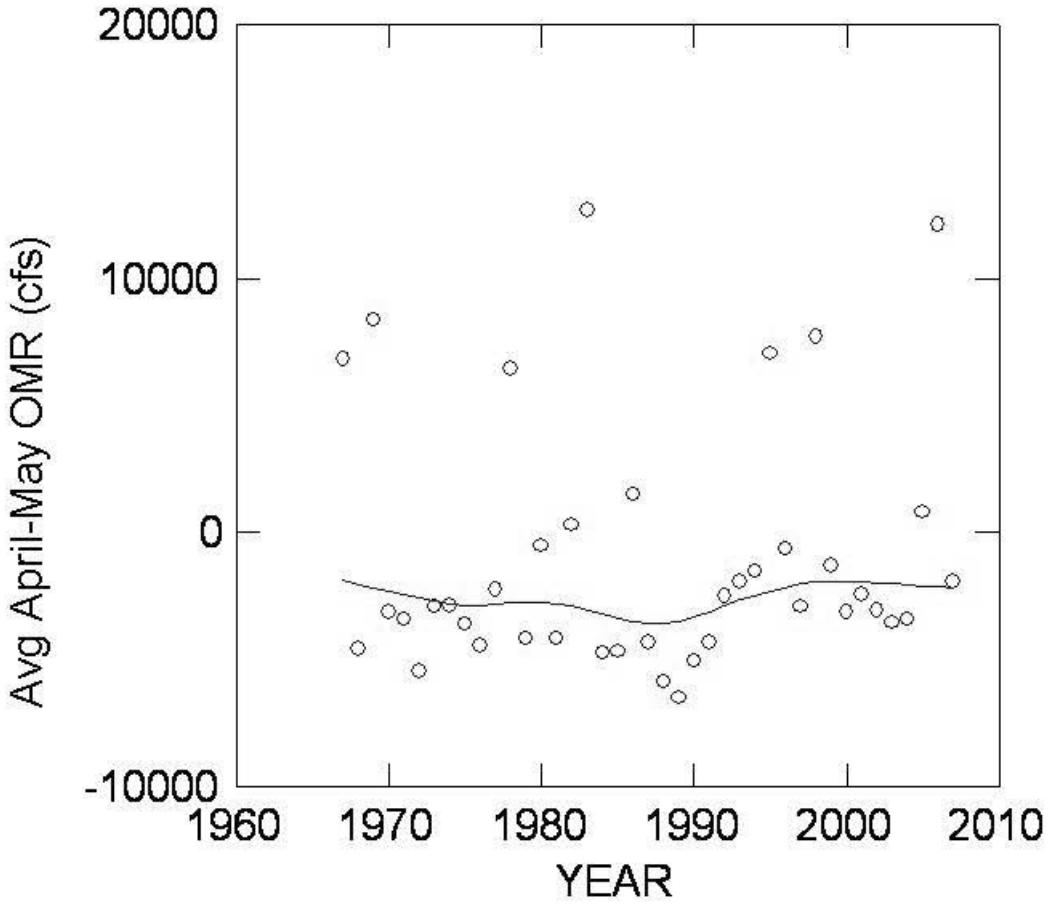


Figure E-10. Time trend in average March – June Delta outflow, 1967-2007. The spline is a LOWESS regression line.

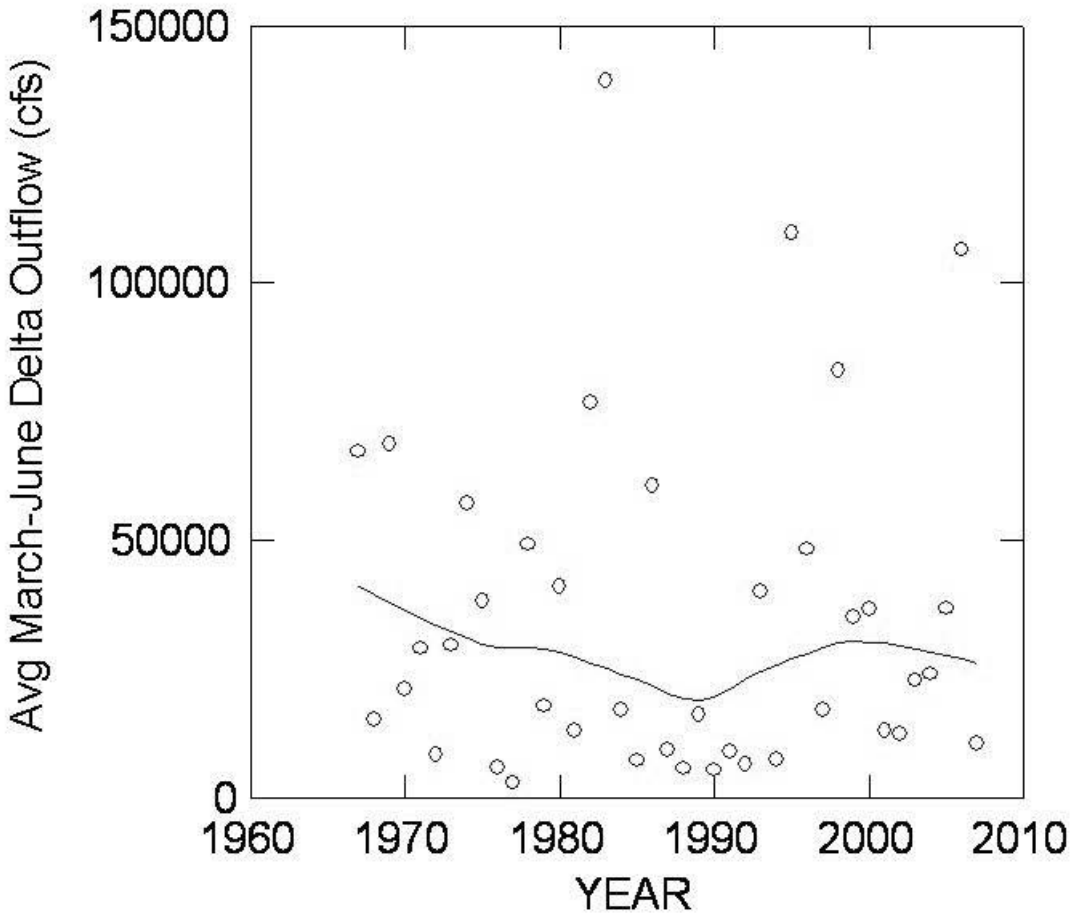


Figure E-11. Time trend in average April - May Delta outflow, 1967-2007. The spline is a LOWESS regression line.

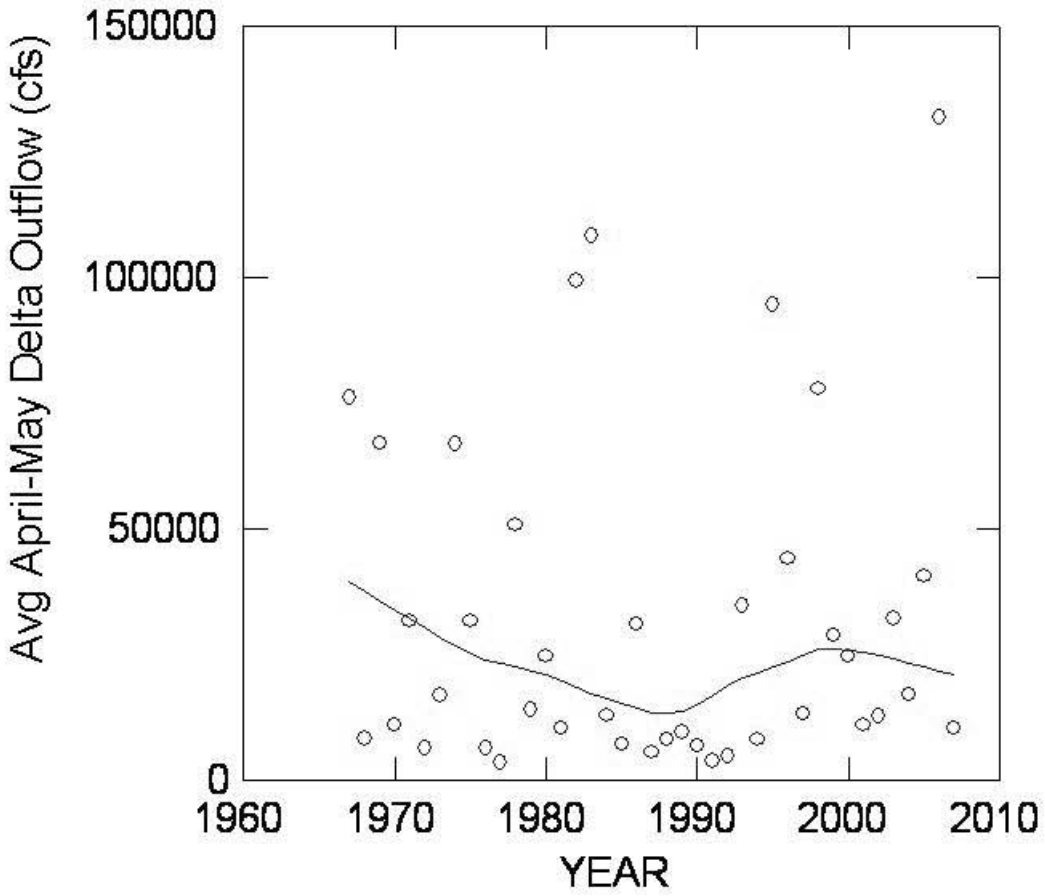


Figure E-12. Boxplot summary of CALSIM II operations study outputs of average March – June flows in Old and Middle rivers for five WY types. The boxes depict the interquartile range which is the distance between the 25th and 75th percentiles. The lines within the boxes show the medians, more extreme values are shown by the lines and asterisks. "Actual" is estimated and measured OMR flows from 1967-2007.

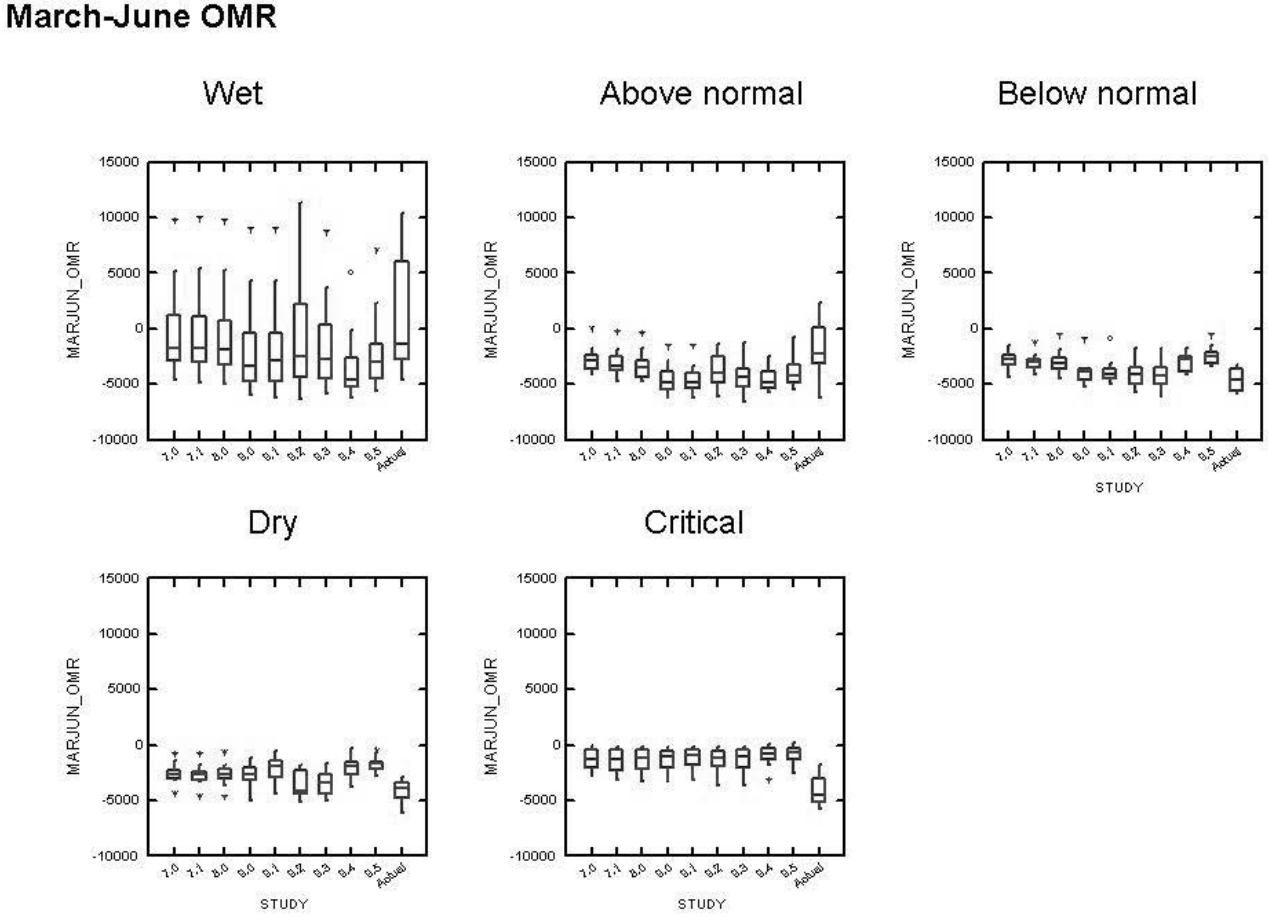


Figure E-13. Boxplot summary of CALSIM II operations study outputs of average April – May flows in Old and Middle rivers for five WY types. The boxes depict the interquartile range which is the distance between the 25th and 75th percentiles. The lines within the boxes show the medians, more extreme values are shown by the lines and asterisks. "Actual" is estimated and measured OMR flows from 1967-2007.

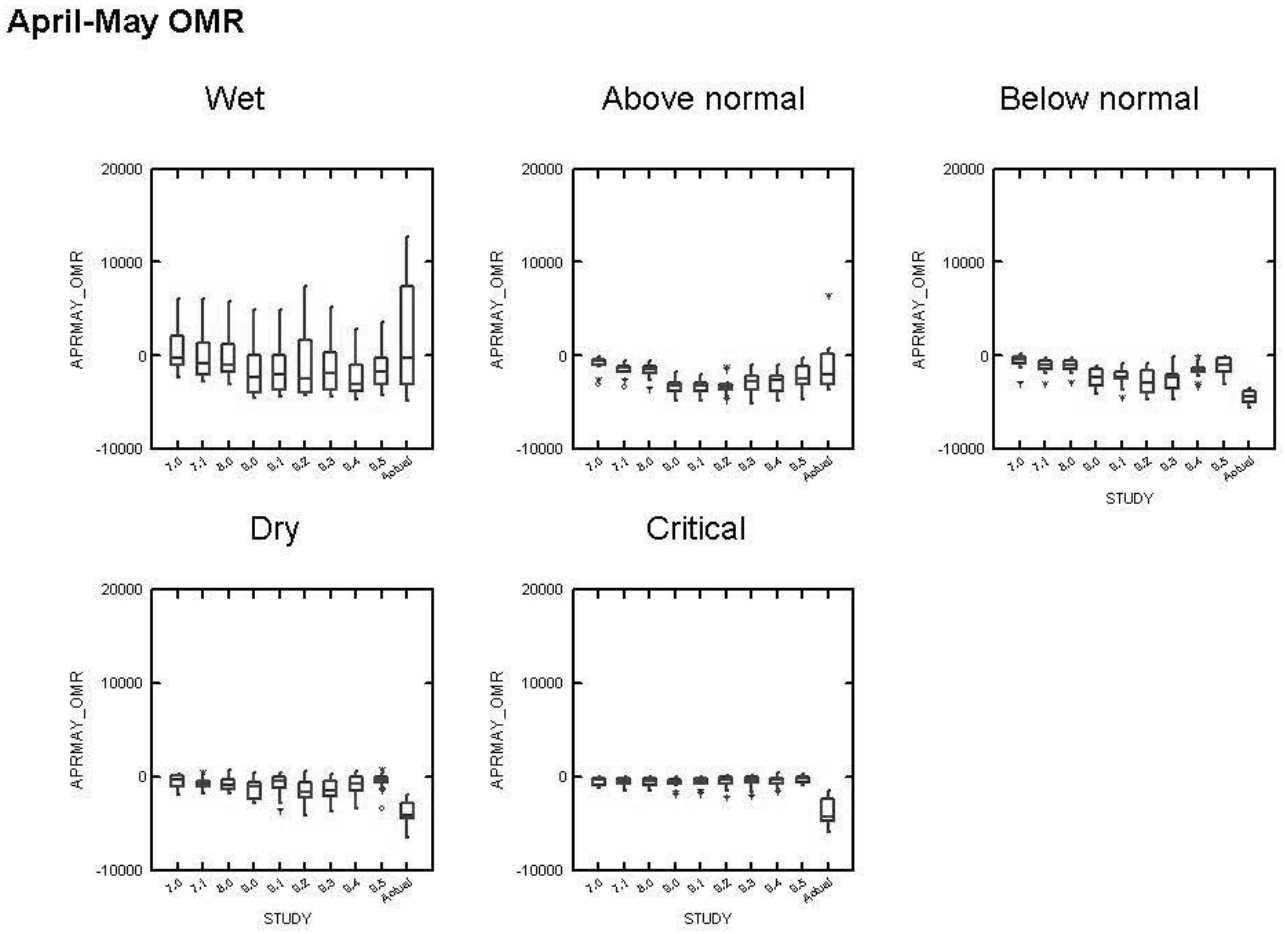


Figure E-14. Boxplot summary of CALSIM II operations study outputs of average March – June X2 positions for five WY types. The boxes depict the interquartile range which is the distance between the 25th and 75th percentiles. The lines within the boxes show the medians, more extreme values are shown by the lines and asterisks. "Actual" is X2 from 1967-2007.

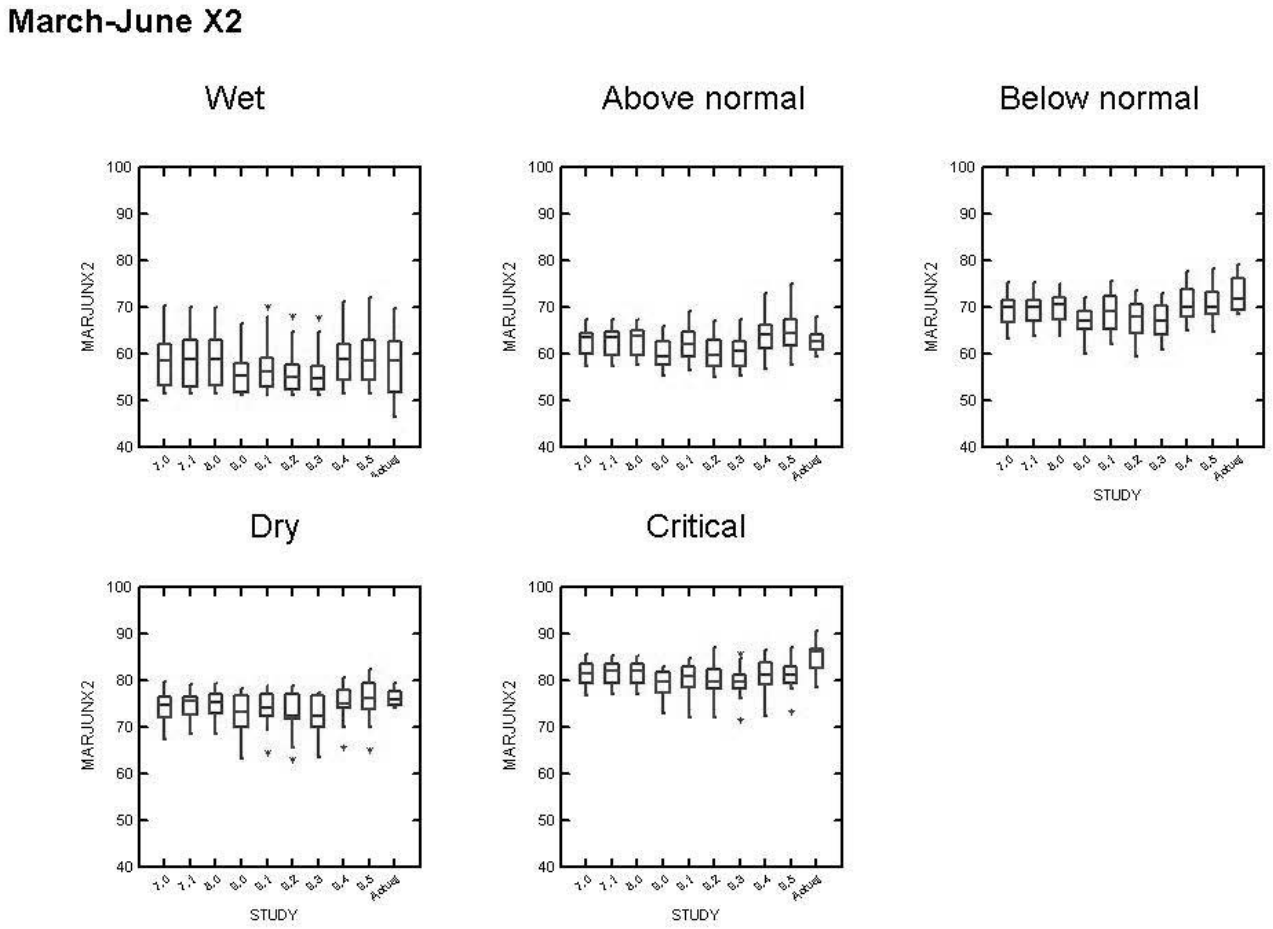


Figure E-15. Boxplot summary of CALSIM II operations study outputs of average April – May X2 positions for five WY types. The boxes depict the interquartile range which is the distance between the 25th and 75th percentiles. The lines within the boxes show the medians, more extreme values are shown by the lines and asterisks. "Actual" is X2 from 1967-2007.

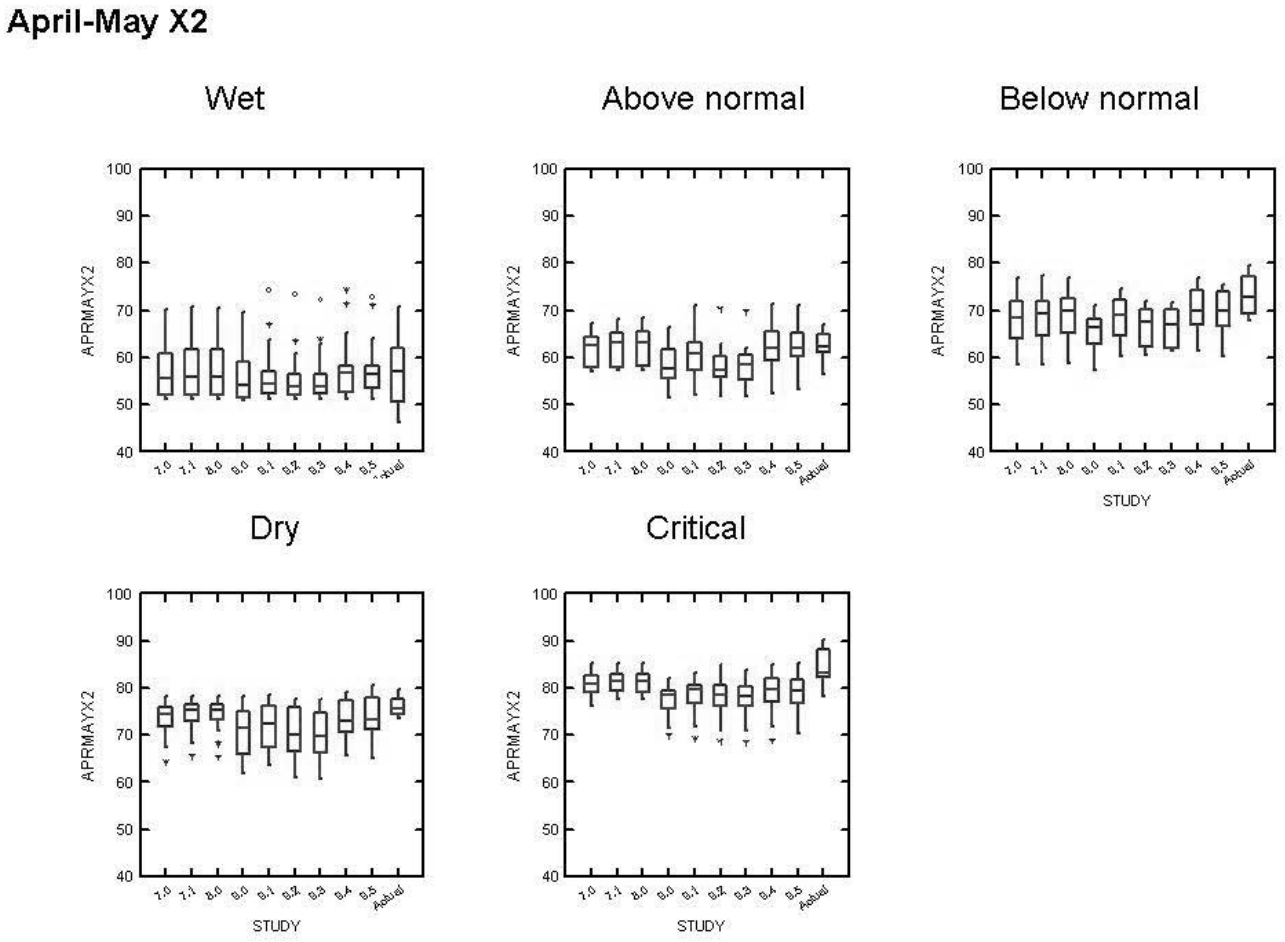


Figure E-16. Time series of estimated percentages of the larval-juvenile delta smelt population entrained in the SWP and CVP South Delta water export diversion facilities. Error bars were estimated by linear regression of Kimmerer's (2008) entrainment estimates versus the upper and lower 95 percent confidence intervals of the estimates.

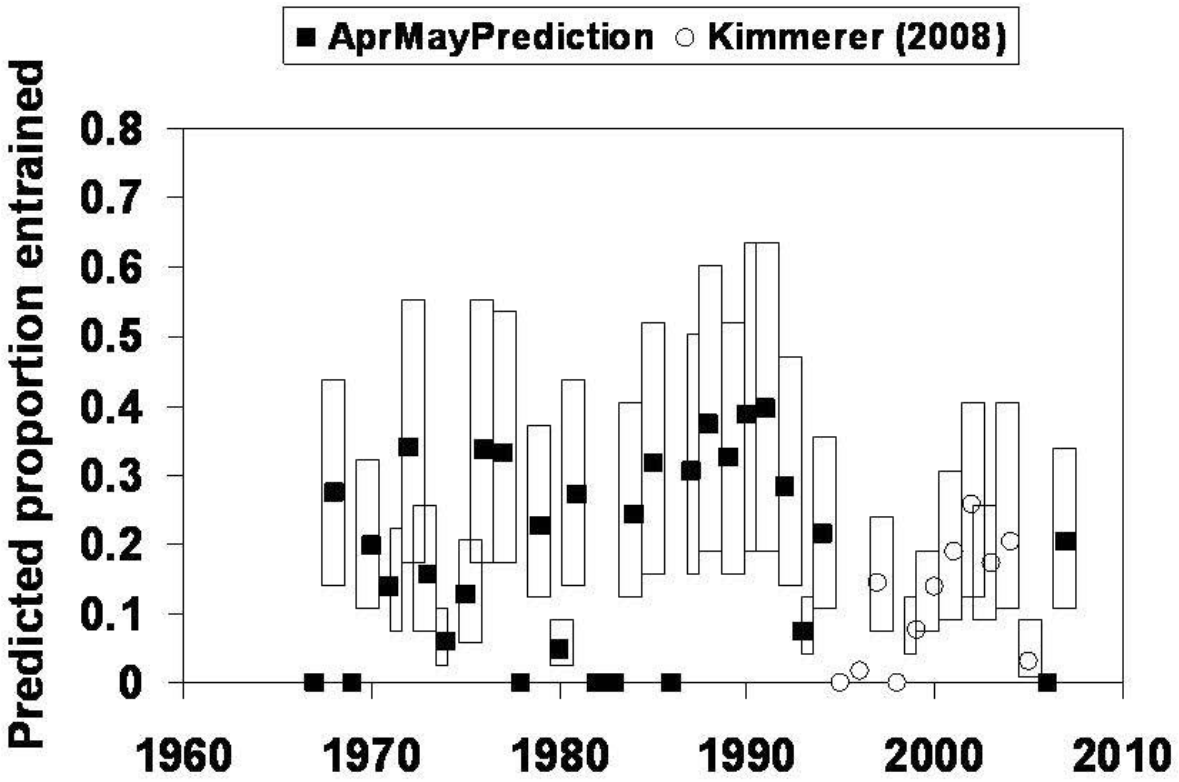


Figure E-17. Frequency distribution of estimated proportions of larval-juvenile delta smelt entrained at Banks and Jones for 1967-1994 and 1995-2007. The data were extrapolated to an 82-year period to make them comparable to the CALSIM II outputs in the biological assessment.

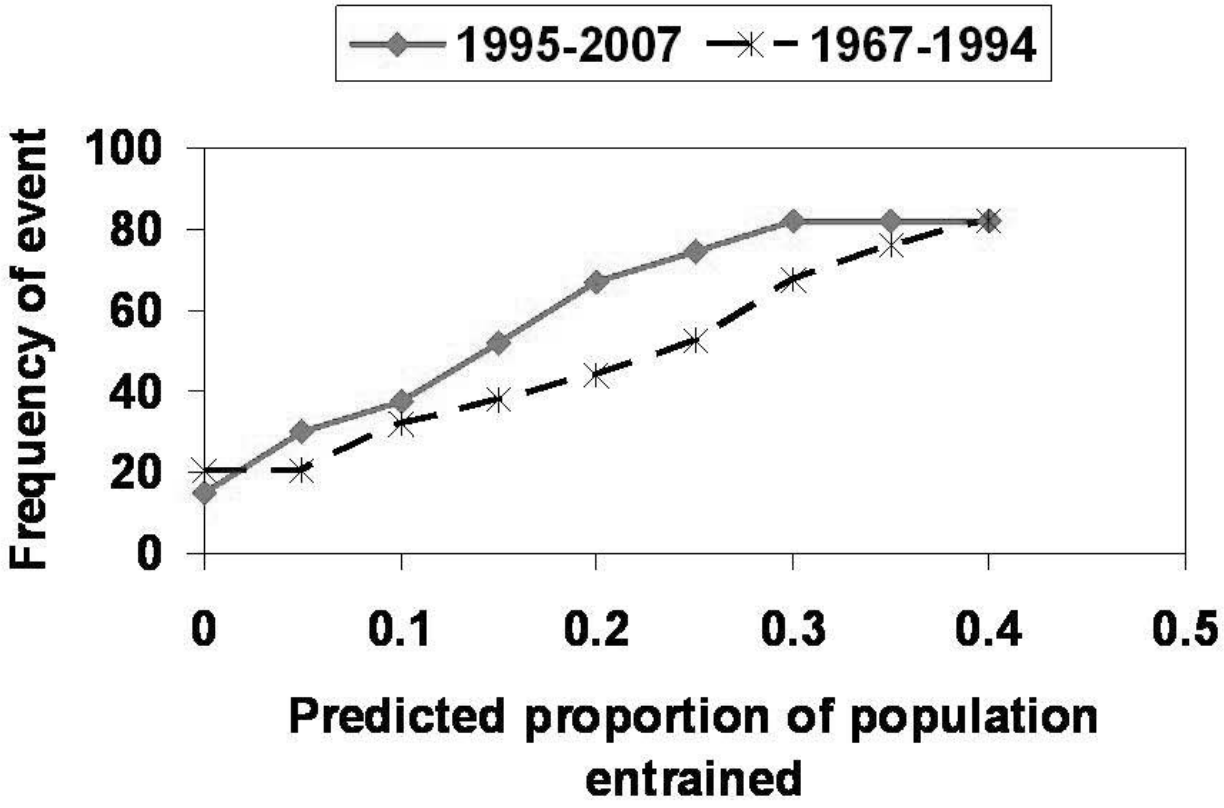


Figure E-18. Same as Figure 17, but including estimates based on X2 and OMR summaries from studies 7.0, 7.1, 8.0, 9.0-9.5 from the biological assessment.

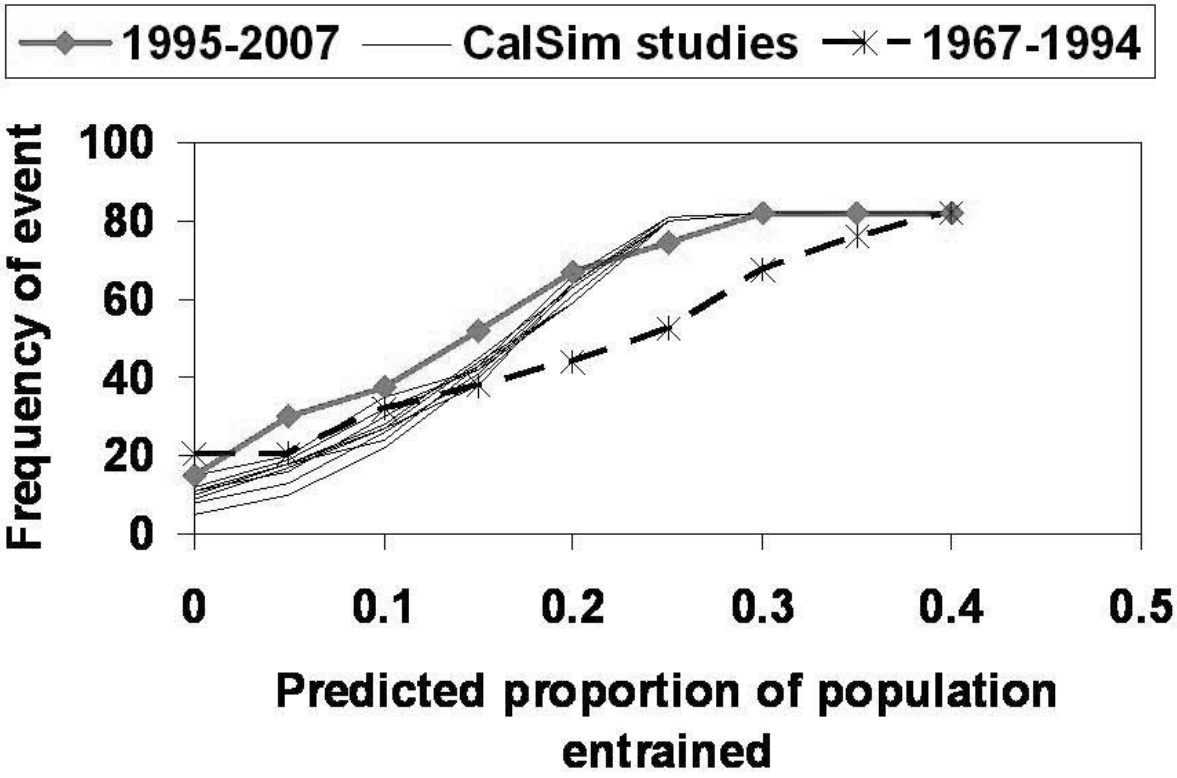


Figure E-19. X2 (km) during September to December based on historic data and CALSIM II model results. The center line in the box is the median and the outer box boundaries are the first and third quartiles.

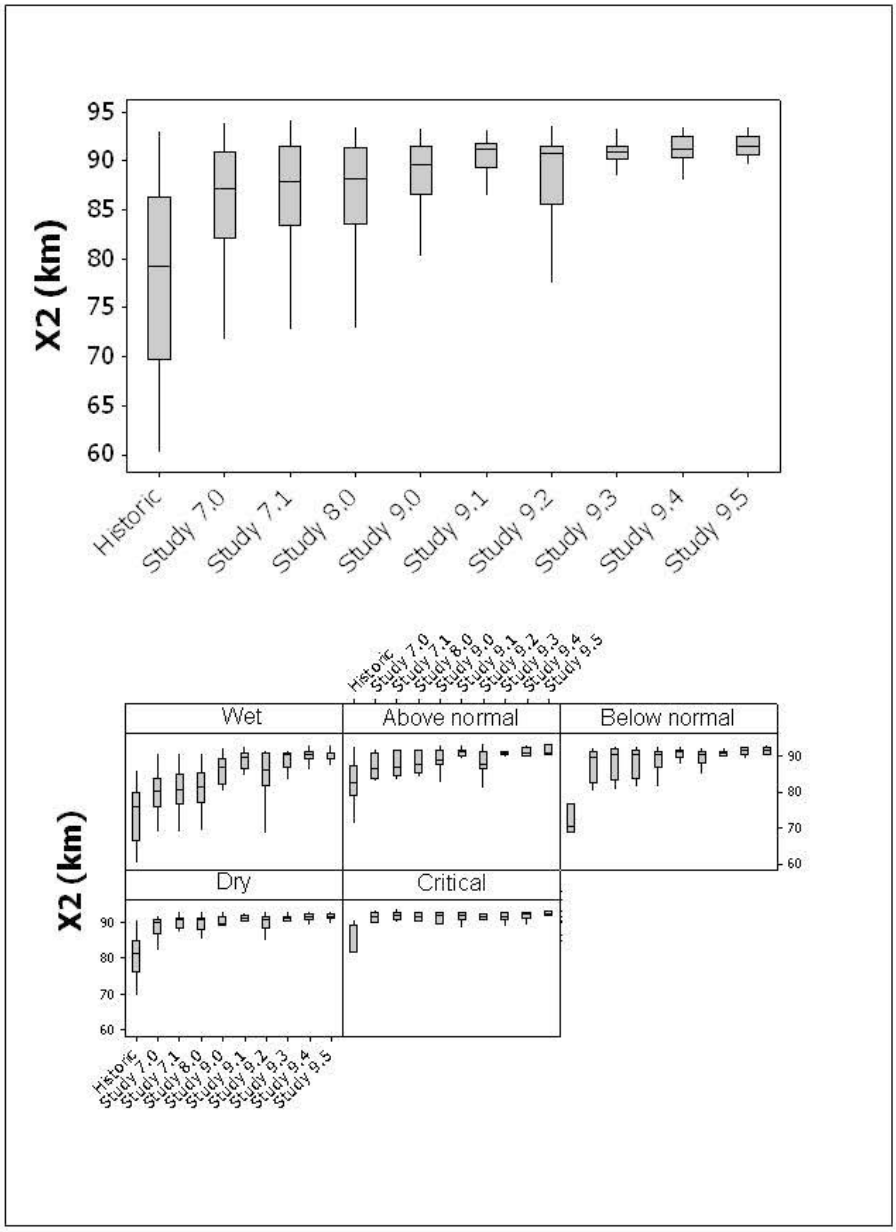
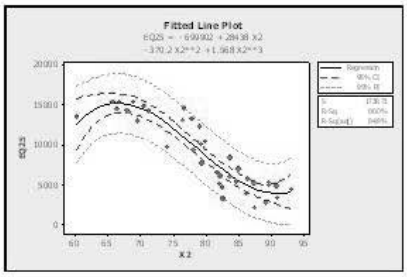
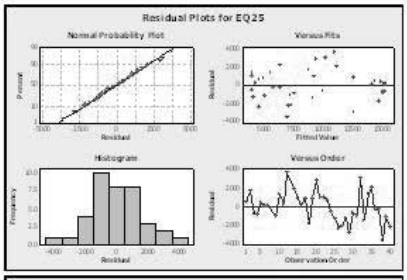
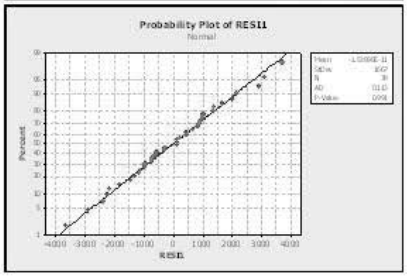


Figure E-20. Summary statistics for the model relating the effect of X2 on the area of suitable abiotic habitat (ha) for delta smelt during September to December.







The regression equation is
EQ25 = - 699902 + 28438 X2 - 370.2 X2**2 + 1.568 X2**3

S = 1738.71 R-Sq = 86.0% R-Sq(adj) = 84.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	630739911	210246637	69.55	0.000
Error	34	102786267	3023126		
Total	37	733526178			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	582964214	139.39	0.000
Quadratic	1	6071691	1.47	0.233
Cubic	1	41704006	13.79	0.001

Figure E-21. Area of suitable abiotic habitat (ha) during September to December) based on historic data and CALSIM II model results for X2. The center line in the box is the median and the outer box boundaries are the first and third quartiles..

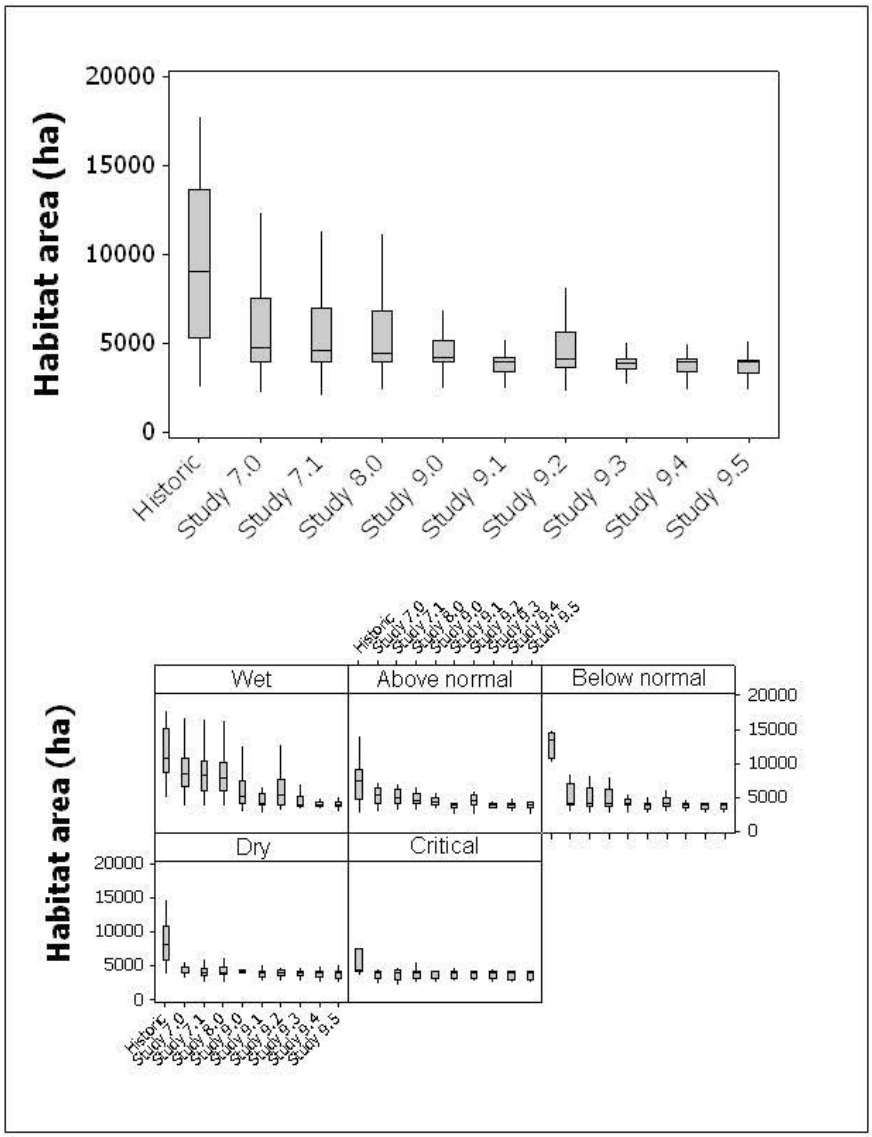
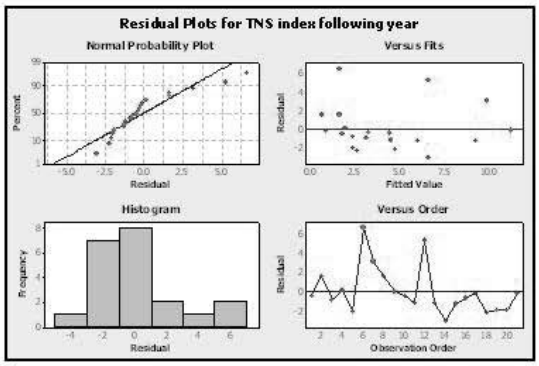
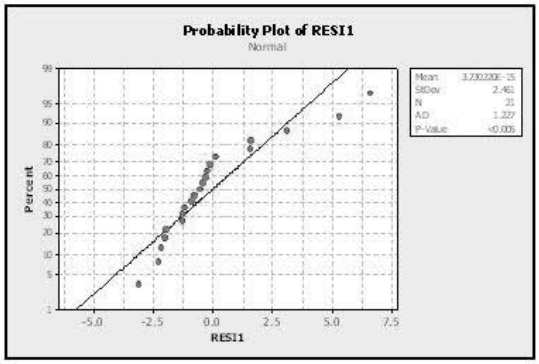


Figure E-22. Summary statistics for the stock-recruit model for delta smelt that incorporates X2 position during September to December as a covariate.





The regression equation is
TNS index following year = 29.1 + 0.00708 FMT index - 0.328 X2

Predictor	Coef	SE Coef	T	P
Constant	29.12	11.63	2.50	0.022
FMT index	0.007078	0.001886	3.75	0.001
X2	-0.3277	0.1354	-2.42	0.026

S = 2.59377 R-Sq = 60.6% R-Sq(adj) = 56.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	186.134	93.067	13.83	0.000
Residual Error	18	121.097	6.728		
Total	20	307.231			

Source	DF	Seq SS
FMT index	1	146.751
X2	1	39.383

Figure E-23. Predicted Summer Townet Index for delta smelt based on historic and CALSIM II-modeled values of X2 position. The center line in the box is the median and the outer box boundaries are the first and third quartiles.

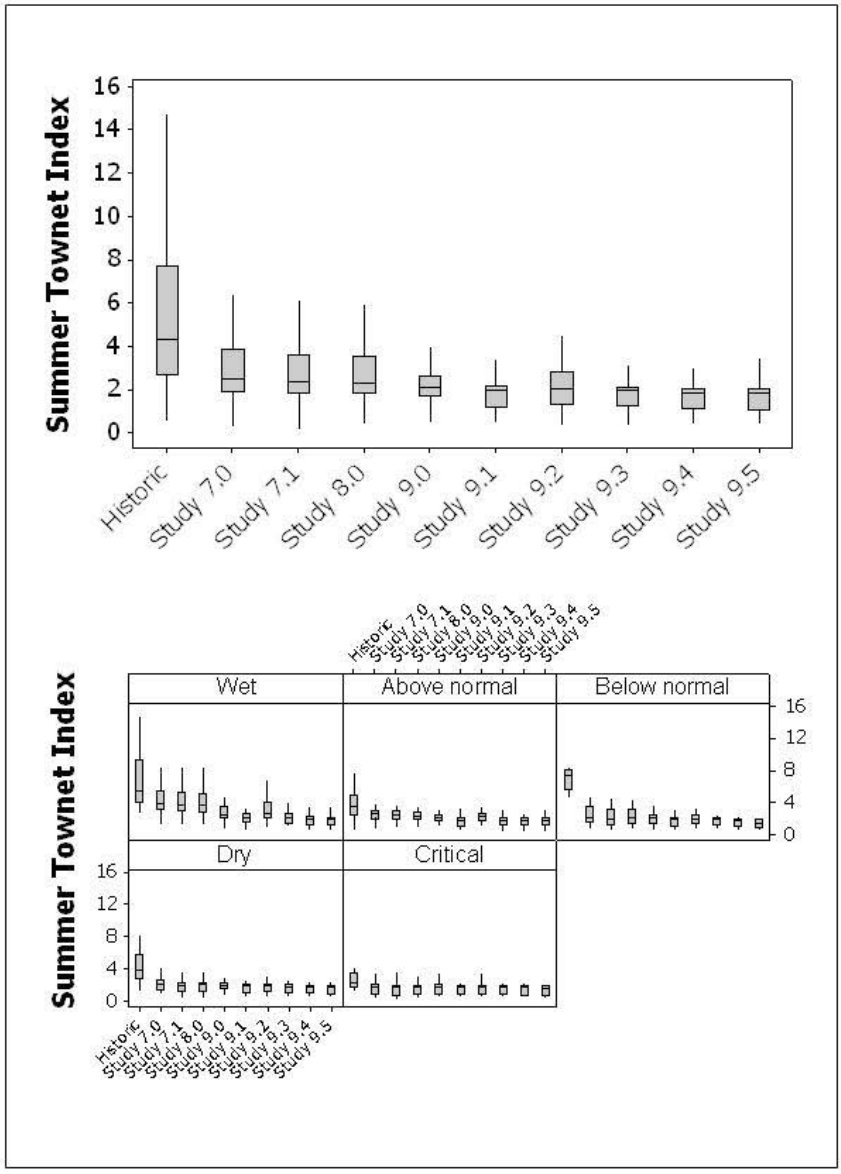


Figure E-24. Time series of historic X2 and E:I ratio for fall (September-December) in the upper panels and their relationship in the lower panel.

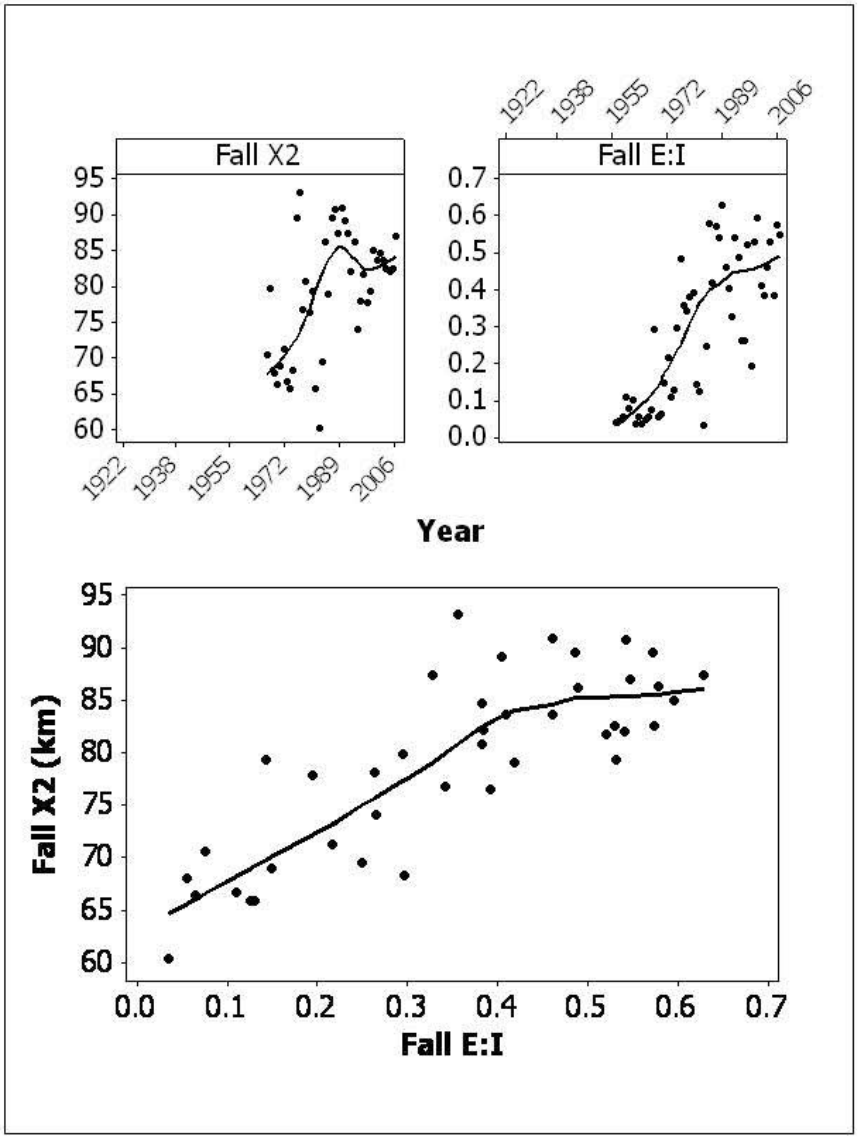


Figure E-25. Smoothed trend lines for the time series of historic and CALSIM II-modeled fall X2.

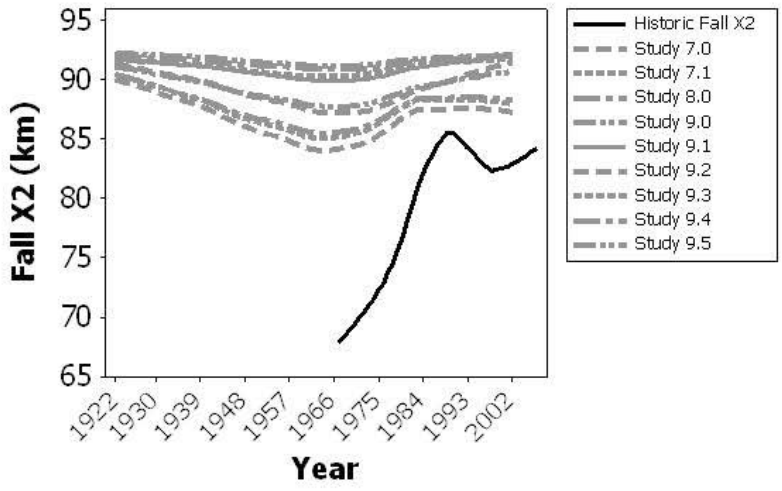


Figure E-26. X2 (km) during individual fall months for historic data and CALSIM II model results. The center line in the box is the median and the outer box boundaries are the first and third quartiles.

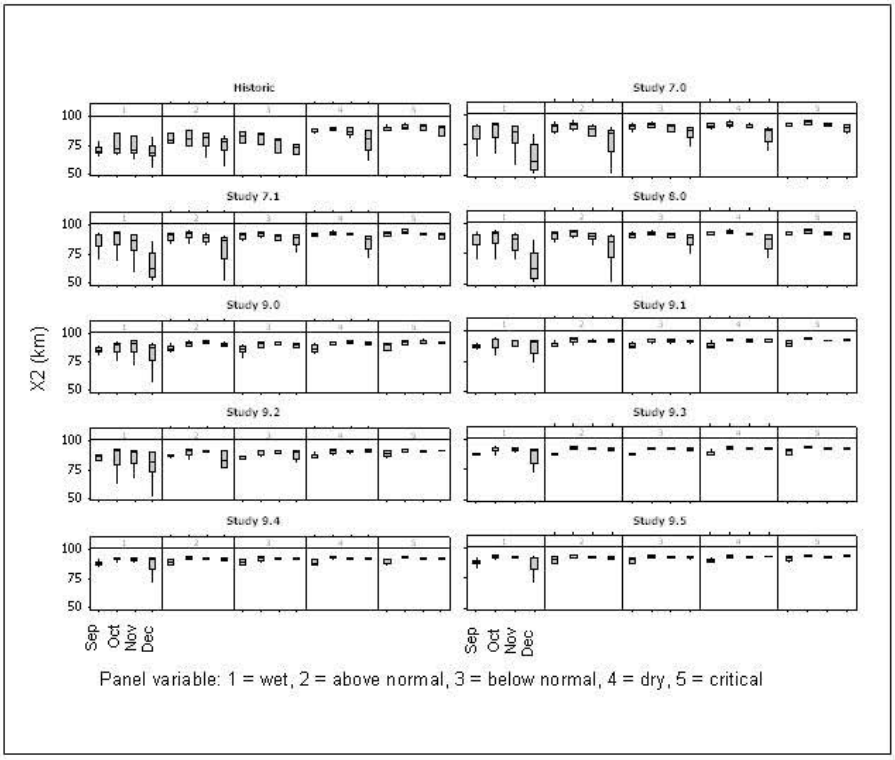


Figure E-27. Time series of fall X2 (September-December) with years noted by WY type for the previous spring.

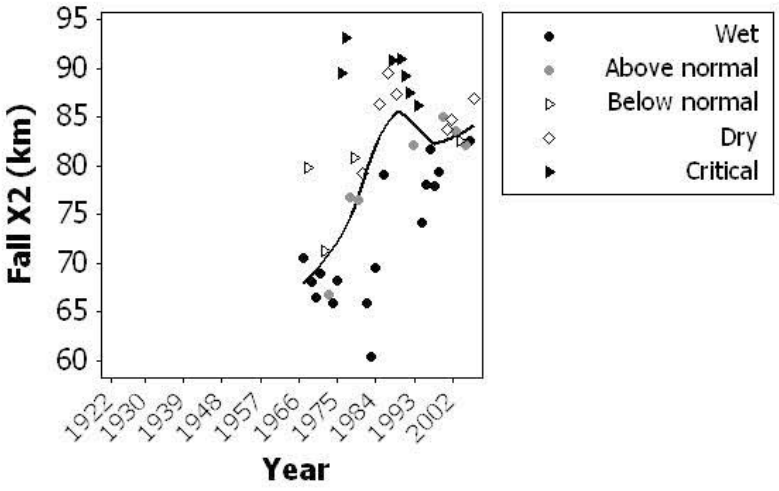


Figure E-28. Top panel: Time series of fall (September-December) and spring (April-July) X2. Lower panel: Smoothed time series of the difference between fall and spring X2 based on historic data and the CALSIM II model results.

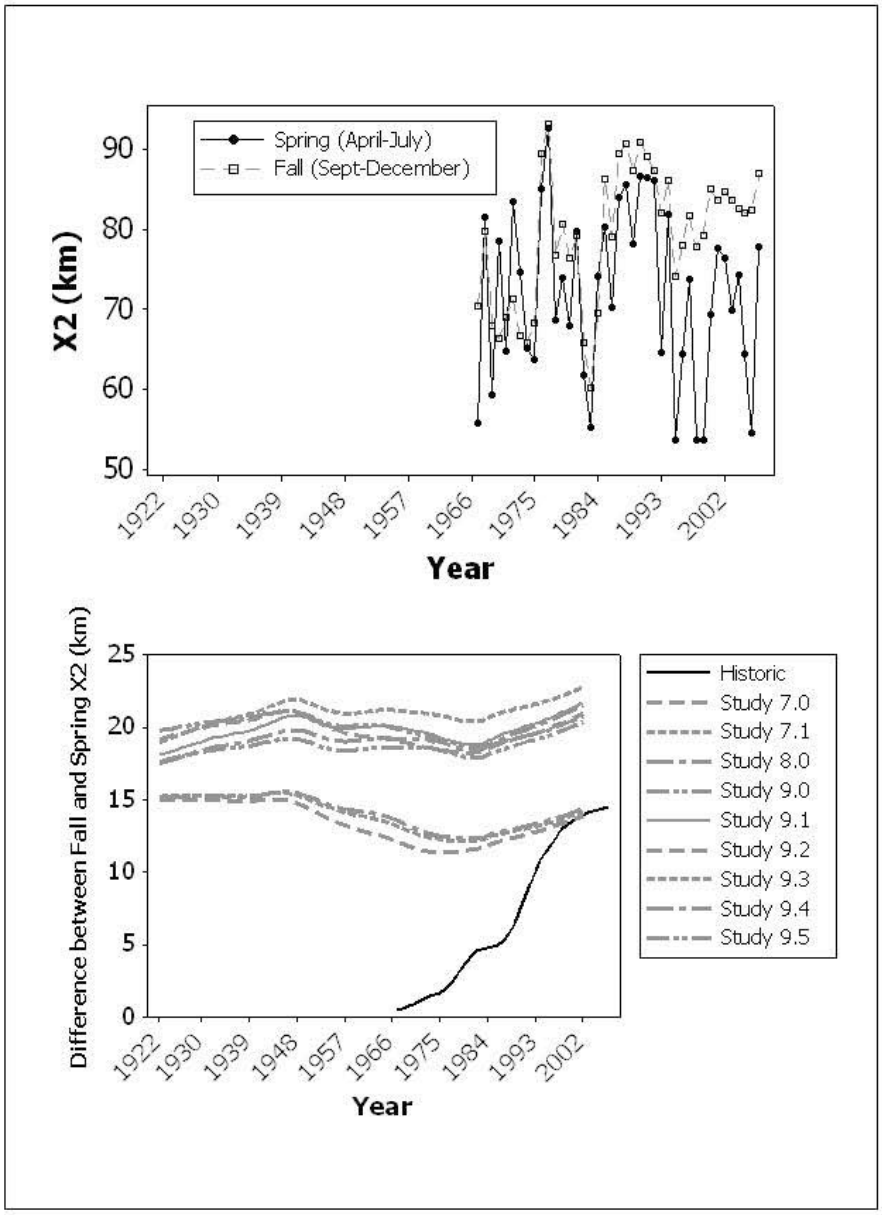
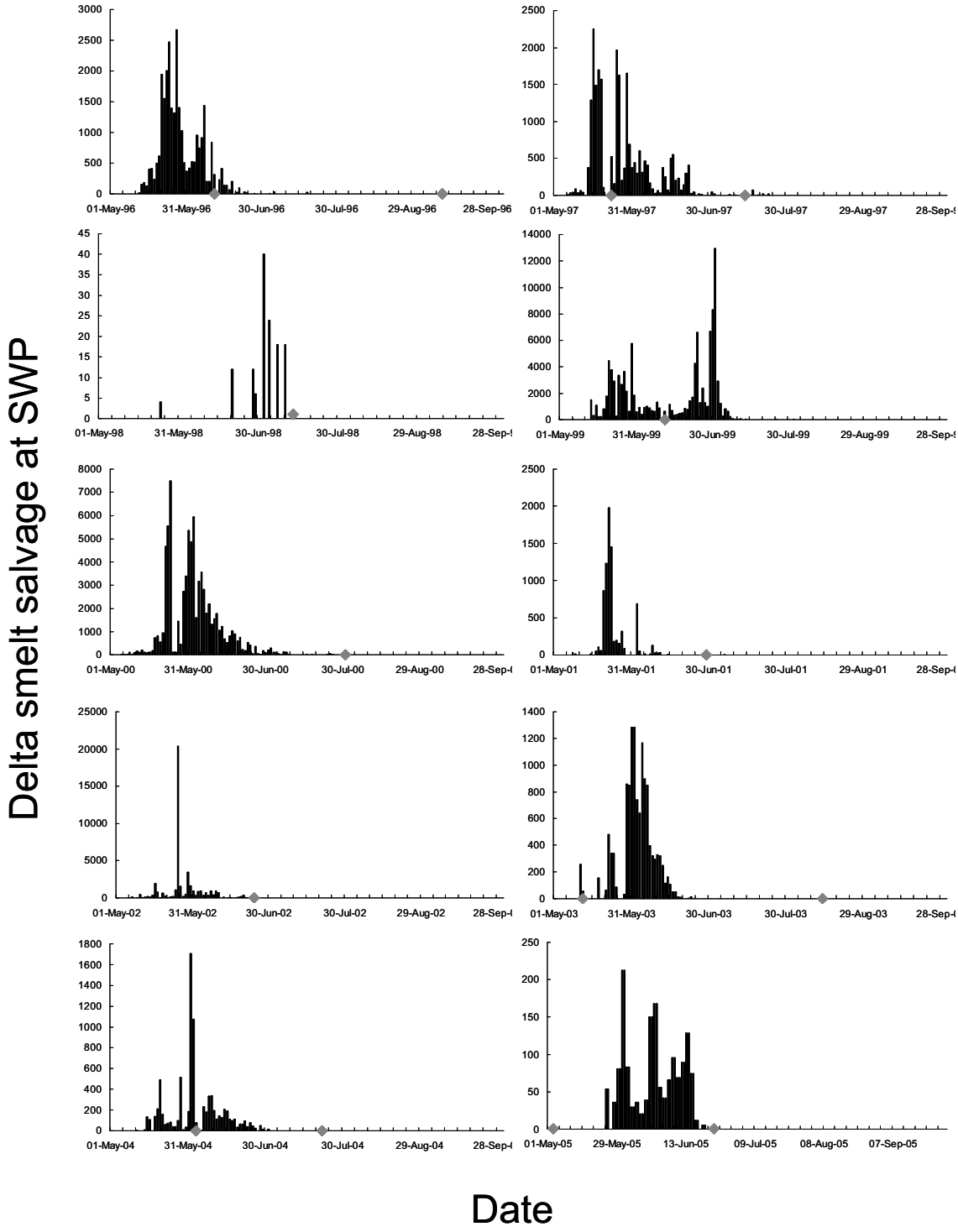


Figure E-29. May-September delta smelt salvage at the SWP Banks Pumping Plant, 1996-2005, with the start and end dates of Komeen or Nautique aquatic weed treatment indicated by the red diamonds.



Conclusion

Delta Smelt

After reviewing the current status of the delta smelt, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the coordinated operations of the CVP and SWP, as proposed, are likely to jeopardize the continued existence of the delta smelt. The Service reached this conclusion based on the following findings, the basis for which is presented in the preceding *Status of the Species/Environmental Baseline*, *Effects of the Action*, and *Cumulative Effects* sections of this document.

1. Diversions of water from the Delta have increased since 1967 when the SWP began operation in conjunction with the CVP. Past and present CVP/SWP operations have significantly altered hydro-dynamics throughout the Bay-Delta ecosystem. This alteration has resulted in numerous direct and indirect adverse effects on the delta smelt, including: (a) entrainment of migrating adults, larvae, and juveniles caused by pumping at the Banks and Jones water export facilities; (b) a reduction in the extent of available rearing and foraging habitat caused by CVP/SWP export of high proportions of Delta inflows that causes net negative flows in the South and Central Delta; and (c) a reduction in the frequency, duration and magnitude of high Delta outflows that has altered the location of the LSZ, which is a crucial component of the delta smelt's habitat, and may have facilitated the invasion of dense populations of exotic species that have significantly changed delta smelt prey dynamics. Increased pumping at the Banks and Jones export facilities (see Table P-12 and Figure P-17 in the biological assessment) corresponds to the decline of the delta smelt population during the period both prior to and following its listing under the Act.

2. The delta smelt is currently at its lowest level of abundance since monitoring began in 1967. A significant decline in the abundance of the delta smelt and other pelagic fish species began in about the year 2000 in conjunction with the POD. Since 2004, the FMWT index has varied from 26 to 74, but at such low levels that true differences in population abundance cannot be determined. On that basis, the Service concludes that resilience of the delta smelt population is currently at or near its lowest level since abundance monitoring began in 1967.

3. Under the proposed CVP/SWP operations, inflows to the Delta are likely to be further reduced, as water demands upstream of the Delta increase, most notably on the American River. Additionally, in Modeling Study 8.0, exports at the Banks and Jones export facilities are projected to increase over Study 7.0. These effects are likely to cause increased relative entrainment of adult delta smelt in the winter and spring, and of larval and juvenile delta smelt in the spring. OMR flows are expected to become more negative as a result of the proposed action. This is expected to result in higher entrainment of delta smelt, as well as affect the transport of larval and juvenile delta smelt into essential

rearing habitat in the Central and South Delta. The full suite of proposed operations will reduce Delta outflows, resulting in chronically lower suitability of delta smelt habitat.

4. Other baseline stressors will continue to adversely affect the delta smelt, such as contaminants, microcystis, aquatic macrophytes, and invasive species. Available information is inconclusive regarding the extent, magnitude and pathways by which delta smelt may be affected by these stressors independent of CVP/SWP operations. However, the operation of the CVP/SWP, as proposed, is likely to reduce or preclude seasonal flushing flows, substantially reduce the natural frequency of upstream and downstream movement of the LSZ, and lengthen upstream shifts of the LSZ to an extent that may increase the magnitude and frequency of adverse effects to the delta smelt from these stressors.

5. To survive and recover, delta smelt need:

(a) a substantially more abundant adult population;

(b) an increase in the quality and quantity of its spawning, rearing, and migratory habitat with respect to turbidity, temperature, salinity, escape cover, freshwater flow, and prey availability as a result of active or passive management of water and sediment processes in the San Francisco Bay-Delta ecosystem that mimics more natural (i.e., pre-water development) conditions. Improved habitat quality within the Bay-Delta should enhance the reproduction of adult delta smelt and increase the survival of both adults and juveniles;

(c) a reduction in the levels of contaminants and other pollutants within its habitat to increase survival of adults, larvae and juveniles;

(d) a reduction in exposure to disease and toxic algal blooms to increase survival of adults, larvae, and juveniles; a reduction in entrainment of adult and juvenile delta smelt at CVP/SWP pumping facilities, over and above reductions achieved under the VAMP and the EWA, to increase the abundance of the spawning adult population and the potential for recruitment of juveniles into the adult population;

(e) a reduction in entrainment at other water diversion-related structures within the Bay-Delta where delta smelt adults, larvae, or juveniles are known or are likely to be entrained to increase the adult population and the potential for recruitment of juveniles into the adult population;

(f) restoration of the structure of the food web in the Bay-Delta to a condition that more closely mimics the natural environment to increase survival of adults and juveniles; and

(g) to maximize its population resilience in the face of the potential adverse effects of ongoing climate change that are occurring in Bay-Delta ecosystem.

Relative to these survival and recovery needs, the effects of the proposed action are likely to: decrease the abundance of delta smelt; decrease the quality and quantity of its habitat; maintain or increase high levels of entrainment; contribute to a degraded food web in the Delta; and reduce the population resilience of delta smelt.

6. On the basis of findings (1)-(5) above, the Service concludes that the effects of the proposed action, taken together with cumulative effects, are likely to appreciably reduce the likelihood of both the survival and recovery of delta smelt in the wild by reducing its reproduction, abundance, and distribution.

Delta Smelt Critical Habitat

After reviewing the current status of delta smelt critical habitat, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the coordinated operations of the CVP and SWP, as proposed, are likely to adversely modify delta smelt critical habitat. The Service reached this conclusion based on the following findings, the basis for which is presented in the preceding *Status of Critical Habitat/Environmental Baseline, Effects of the Action, and Cumulative Effects* sections of this document.

1. The conservation role of delta smelt critical habitat is to provide migration, spawning and rearing habitat conditions necessary for successful delta smelt recruitment at levels that will provide for the conservation of the species. Appropriate physical habitat (PCE 1), water (PCE 2), river flows (PCE 3), and salinity (PCE 4) are essential for successful delta smelt spawning and survival.

2. The past and present operations of the CVP/SWP have degraded these habitat elements (particularly PCEs 2-4) to the extent that their co-occurrence at the appropriate places and times is insufficient to support successful delta smelt recruitment at levels that will provide for the species' conservation.

3. Implementation of the proposed action is expected to perpetuate the very limited co-occurrence of PCEs at appropriate places and times by: (a) altering hydrologic conditions in a manner that adversely affects the distribution of abiotic factors such as turbidity and contaminants; (b) altering river flows to an extent that increases delta smelt entrainment at Banks and Jones, as well as reduces habitat suitability in the Central and South Delta; and (c) altering the natural pattern of seasonal upstream movement of the LSZ to an extent that is likely to reduce available habitat for the delta smelt within areas designated as critical habitat.

The proposed action does include a provision for VAMP to address augmentation of river flow but future implementation of this provision is not well defined, making its beneficial effects on the PCEs of delta smelt critical habitat uncertain.

4. On the basis of findings (1)-(3) above, the Service concludes that implementation of the proposed action is likely to prevent delta smelt critical habitat from serving its intended conservation role.

Reasonable and Prudent Alternative

The regulations (50 CFR 402.02) implementing section 7 of the Act define reasonable and prudent alternatives (RPA) as alternative actions, identified during formal consultation, that: 1) can be implemented in a manner consistent with the intended purpose of the action; 2) can be implemented consistent with the scope of the action agency's (i.e.Reclamation's) legal authority and jurisdiction; 3) are economically and technologically feasible; and, 4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

The Service has developed the following RPA that includes four components to be implemented using an adaptive approach within specific constraints. The fifth component includes monitoring and reporting requirements. The components presented below are based on the best available scientific information regarding what is necessary to adequately provide for successful delta smelt migration and spawning, and larval and juvenile survival, growth, rearing, and recruitment within the Bay-Delta.

The specific flow requirements, action triggers and monitoring stations prescribed in the RPA will be continuously monitored and evaluated consistent with the adaptive process. As new information becomes available, these action triggers may be modified without necessarily requiring re-consultation on the overall proposed action.

The following actions are necessary to ensure that implementation of the long term operations of the CVP/SWP does not appreciably reduce the likelihood of both the survival and recovery of the delta smelt and does not preclude the intended conservation role of its critical habitat through: 1) preventing/reducing entrainment of delta smelt at Jones and Banks; 2) providing adequate habitat conditions that will allow the adult delta smelt to successfully migrate and spawn in the Bay-Delta; 3) providing adequate habitat conditions that will allow larvae and juvenile delta smelt to rear; and 4) providing suitable habitat conditions that will allow successful recruitment of juvenile delta smelt to adulthood. In addition, it is essential to monitor delta smelt abundance and distribution through continued sampling programs through the IEP.

Detailed descriptions of the adaptive process, its framework, and the rationale for each of the RPA components are presented in Attachment B of this biological opinion.

Process for Determining Specific Actions within Components 1 and 2

1. Within one day after the SWG recommends an action should be initiated, changed, suspended or terminated, the SWG shall provide to the Service a written recommendation and a biological justification. The SWG shall use the process described in Attachments A and B to provide a framework for their recommendations. The Service shall determine whether the proposed action should be implemented, modified, or terminated; and the OMR flow needed to achieve the protection. The Service shall present this information to the WOMT.

2. The WOMT shall either concur with the recommendation or provide a written alternative to the recommendation to the Service within one calendar day. The Service shall then make a final determination on the proposed action to be implemented, which shall be documented and posted on the Sacramento Fish and Wildlife Service's webpage.

3. Once the Service makes a final determination to initiate a new action, it shall be implemented within two calendar days by Reclamation and DWR, and shall remain in effect until the need for the action ends or the OMR flow is changed, as determined by the Service, consistent with the RPA and described within Attachment B. Data demonstrating the implementation of the action shall be provided by Reclamation to the Service on a weekly basis.

4. If the Service determines that an OMR flow change is required while an action is ongoing, Reclamation and DWR shall adjust operations to manage to the new OMR flow within two days of receipt of the Service's determination. This new OMR flow shall be used until it is adjusted or the action is changed or terminated based on new information, as described in the RPA and Attachment B.

RPA Component 1: Protection of the Adult Delta Smelt Life Stage

Delta smelt are entrained at the fish facilities each year. These actions are designed to reduce the delta smelt entrainment losses. The objective of Component 1 (Actions 1 and 2 in Attachment B) is to reduce entrainment of pre-spawning adult delta smelt during December to March by controlling OMR flows during vulnerable periods. Action 1 is designed to protect upmigrating delta smelt. Action 2 is designed to protect adult delta smelt that have migrated upstream and are residing in the Delta prior to spawning. Overall, RPA Component 1 will increase the suitability of spawning habitat for delta smelt by decreasing the amount of Delta habitat affected by the projects' export pumping plants' operations prior to, and during, the critical spawning period.

Beginning in December of each year, the Service shall review data on flow, turbidity, salvage, and other parameters that have historically predicted the timing of delta smelt migration into the Delta. On an ongoing basis, and consistent with the parameters outlined below and in Attachment B, the SWG shall recommend to the Service OMR flows that are expected to minimize entrainment of adult delta smelt. Throughout the

implementation of RPA Component 1, the Service will make the final determination as to OMR flows required to protect delta smelt.

OMR flow requirements given below are based on the following understanding: Where a 14-day running average is established, the average daily OMR flow must be no more negative than the required OMR flow. Where a 5-day running average is given, the daily average shall be no more than 25 percent more negative than the requirement. The daily OMR flows used to compute both the 14-day and the 5-day averages shall be the "tidally filtered" values reported by USGS.

Low-entrainment risk period: delta smelt salvage has historically been low between December 1 and December 19, even during periods when first flush conditions (i.e., elevated river inflow and turbidity) occurred. During the low-entrainment risk period, the SWG shall determine if the information generated by physical (i.e. turbidity and river inflow) and biological (e.g., salvage, DFG trawls) monitoring indicates that delta smelt are vulnerable to entrainment or are likely to migrate into a region where future entrainment events may occur. If this occurs, the Service shall require initiation of Action 1 as described in Attachment B. Action 1 shall require the Projects to maintain OMR flows no more negative than -2,000 cfs (14-day average) with a simultaneous 5-day running average flow no more negative than -2,500 cfs to protect adult delta smelt for 14 days.

High-entrainment risk period: delta smelt have historically been entrained when first flush conditions occur in late December. In order to prevent or minimize such entrainment, Action 1 shall be initiated on or after December 20 if the 3 day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 NTU, or if there are three days of delta smelt salvage at either facility or if the cumulative daily salvage count is above the risk threshold based upon the "daily salvage index" approach described in Attachment B. Action 1 shall require the Projects to maintain OMR flows no more negative than -2,000 cfs (14-day running average) with a simultaneous 5-day running average flow no more negative than -2,500 cfs to protect adult delta smelt for 14 days. However, the SWG can recommend a delayed start or interruption based on other conditions such as delta inflow that may affect vulnerability to entrainment.

Winter protection period: recent analyses indicate that cumulative adult entrainment and salvage are lower when OMR flows are no more negative than -5,000 cfs in the December through March period. Action 2 shall commence immediately after Action 1 ends. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt. OMR flows under Action 2 shall be in the range of -3,500 to -5,000 when turbidity and salvage are low. Based on historic conditions, OMR flow would generally be expected to be in the range of -2,000 cfs to -3,500 cfs given recent salvage events. However, at times when turbidity and flow conditions in the Delta may result in increased salvage, the range may be between -1,250 to -2,000 cfs. During the implementation of Action, the maximum negative flow for OMR shall be determined based on the criteria outlined in Attachment B. The OMR flow shall be based on a 14-day running average with simultaneous 5-day running average

within 25 percent of the required OMR flow. The action may be suspended temporarily if the three day flow average is greater than or equal to 90,000 cfs at the Sacramento River at Rio Vista and 10,000 cfs at the San Joaquin River at Vernalis, because there is low likelihood that delta smelt will be entrained during such high inflow conditions. Suspension of this action due to high flow will end when flow drops below the 90,000 cfs and 10,000 cfs threshold. Action 2 ends when spawning begins as defined for Action 3 implementation (Component 2).

RPA Component 2: Protection of Larval and Juvenile Delta Smelt

Delta smelt larvae and juveniles are susceptible to direct mortality by entrainment. Hydrologic conditions resulting from CVP/SWP operations increase the risk of that entrainment. The objective of this RPA component (which corresponds to Action 3 in Attachment B), is to improve flow conditions in the Central and South Delta so that larval and juvenile delta smelt can successfully rear in the Central Delta and move downstream when appropriate.

Upon completion of RPA Component 1 or when Delta water temperatures reach 12˚C (based on a 3-station average of daily average water temperature at Mossdale, Antioch, and Rio Vista) or when a spent female delta smelt is detected in the trawls or at the salvage facilities, the projects shall operate to maintain OMR flows no more negative than -1,250 to -5000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable 14-day OMR flow requirement. Depending on the extant conditions, the SWG shall make recommendations for the specific OMR flows within this range from the onset of implementing RPA Component 2 through its termination. The Service shall make the final determination regarding specific OMR flows. This action shall end June 30 or when the 3-day mean water temperature at Clifton Court Forebay reaches 25° C, whichever occurs earlier.

The Spring HORB shall be installed only if the Service determines delta smelt entrainment is not a concern (Action 5 from Attachment B).

RPA Component 3: Improve Habitat for Delta Smelt Growth and Rearing

The objective of this component is to improve fall habitat for delta smelt through increasing Delta outflow during fall. Increase in fall habitat quality and quantity will both benefit delta smelt.

Subject to adaptive management as described below and in Action 4 in Attachment B, during September and October in years when the preceeding precipitation and runoff period was wet or above normal as defined by the Sacramento Basin 40-30-30 index, Reclamation and DWR shall provide sufficient Delta outflow to maintain monthly average X2 no greater (more eastward) than 74 km (from the Golden Gate) in Wet WYs and 81 km in Above Normal WYs. The monthly X2 target will be separately achieved for the months of September and October. During any November when the preceding

water year was wet or above normal as defined by the Sacramento Basin 40-30-30 index, all inflow into CVP/SWP reservoirs in the Sacramento Basin shall be added to reservoir releases in November to provide an additional increment of outflow from the Delta to augment Delta outflow up to the fall X2 of 74 km for Wet WYs or 81 km for Above Normal WYs, respectively. In the event there is an increase in storage during any November this action applies, the increase in reservoir storage shall be released in December to augment the December outflow requirements in SWRCB D-1641.

Given the nature of this Action and to align its management more closely with the general plan described by the independent review team and developed by Walters (1997), the Service shall oversee and direct the implementation of a formal adaptive management process. The adaptive management process shall include the elements as described in Attachment B. This adaptive management program shall be reviewed and approved by the Service in addition to other studies that are required for delta smelt. In accordance with the adaptive management plan, the Service will review new scientific information when provided and may make changes to the action when the best available scientific information warrants. For example, there may be other ways to achieve the biological goals of this action, such as a Delta outflow target, that will be evaluated as part of the study. This action may be modified by the Service consistent with the intention of this action based on information provided by the adaptive management program in consideration of the needs of other listed species. Other CVP/SWP obligations may also be considered.

The adaptive management program shall have specific implementation deadlines. The creation of the delta smelt habitat study group, initial habitat conceptual model review, formulation of performance measures, implementation of performance evaluation, and peer review of the performance measures and evaluation that are described in steps (1) through (3) of Attachment B shall be completed before September 2009. Additional studies addressing elements of the habitat conceptual model shall be formulated as soon as possible, promptly implemented, and reported as soon as complete.

The Service shall conduct a comprehensive review of the outcomes of the Action and the effectiveness of the adaptive management program ten years from the signing of the biological opinion, or sooner if circumstances warrant. This review shall entail an independent peer review of the Action. The purposes of the review shall be to evaluate the overall benefits of the Action and to evaluate the effectiveness of the adaptive management program. At the end of 10 years or sooner, this action, based on the peer review and Service determination as to its efficacy shall either be continued, modified or terminated.

RPA Component 4: Habitat Restoration

This component of the RPA (Action 6 of Attachment B) is intended to provide benefits to delta smelt habitat to supplement the benefits resulting from the flow actions described above. DWR shall implement a program to create or restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh. These actions

may require separate ESA consultations for their effects on federally listed species. The restoration efforts shall begin within 12 months of signature of this biological opinion and be completed by DWR (the applicant) within 10 years. The restoration sites and plans shall be reviewed and approved by the Service and be appropriate to improve habitat conditions for delta smelt. Management plans shall be developed for each restoration site with an endowment or other secure financial assurance and easement in place held by a third-party or DFG and approved by the Service. The endowment or other secure financial assurance shall be sufficient to fund the monitoring effort and operation and maintenance of the restoration site.

An overall monitoring program shall be developed to focus on the effectiveness of the restoration actions and provided to the Service for review within six months of signature of this biological opinion. The applicant shall finalize the establishment of the funding for the restoration plan within 120 days of final approval of the restoration program by the Service. There is a separate planning effort in Suisun Marsh where the Service is a co-lead with Reclamation on preparation of an Environmental Impact Statement. Restoration actions in Suisun Marsh shall be based on the Suisun Marsh Plan that is currently under development.

RPA Component 5: Monitoring and Reporting

Reclamation and DWR shall ensure that information is gathered and reported to ensure:
1) proper implementation of these actions,
2) that the physical results of these actions are achieved, and
3) that information is gathered to evaluate the effectiveness of these actions on the targeted life stages of delta smelt so that the actions can be refined, if needed.

Essential information to evaluate these actions (and the Incidental Take Statement) includes sampling of the FMWT, Spring Kodiak Trawl, 20-mm Survey, TNS and the Environmental Monitoring Program of the IEP. This information shall be provided to the Service within 14 days of collection. Additional monitoring and research will likely be required, as defined by the adaptive management process.

Information on salvage at Banks and Jones is both an essential trigger for some of these actions and an important performance measure of their effectiveness. In addition, information on OMR flows and concurrent measures of delta smelt distribution and salvage are essential to ensure that actions are implemented effectively. Such information shall be included in an annual report for the WY (October 1 to September 30) to the Service, provided no later than October 15 of each year, starting in 2010.

Reclamation shall implement the RPA based on performance standards, monitoring and evaluation of results from the actions undertaken and adaptive management as described in RPA component 3. RPA component 3 has a robust adaptive management component that requires a separate analysis apart from those required under this component. Some of the data needed for these performance measures are already being collected such as the FMWT abundances and salvage patterns. However, more information on the effect of

these actions on smelt survival and the interactions of project operations with other stressors on delta smelt health, fecundity and survival is needed. This information may provide justificationfor refining these actions to better address the needs of delta smelt. Studies like those of the IEP's POD workteam have provided much useful information on the needs of delta smelt and the stressors affecting them that was integral in the development of these actions.

Avoidance of Jeopardy and Adverse Modification

The conservation needs of the delta smelt at this time are primarily associated with: (1) protective measures for pre-spawning adult delta smelt; (2) improvement of flow conditions in the Central and South Delta so that larval and juvenile delta smelt can successfully rear and move downstream with a minimum entrainment risk; and (3) restoration and enhancement of habitat availability and quality that improves growth and survival of delta smelt.

The RPA components described above and in Attachment B specifically address the above factors to the extent provided by the regulatory criteria that define a RPA. Implementation of this RPA will increase the likelihood that delta smelt habitat conditions and attributes for migration, spawning, recruitment, growth, and survival will be provided during the term of the proposed action. For these reasons, the Service finds that implementation of the RPA described above is likely to avoid jeopardy to the delta smelt and adverse modification of its critical habitat.

Incidental Take Statement

Introduction

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be a prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary and must be implemented by Reclamation, working with DWR under the COA and other interagency agreements, in order for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activities that are covered by this Incidental Take Statement for the life of the proposed action. If Reclamation fails to assume and implement the RPA and terms and conditions or is unable to ensure that DWR adheres to the RPA and terms and conditions of this Incidental Take Statement while jointly operating under the COA and other interagency agreements, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impacts of incidental take, Reclamation must report the progress of the action and its impacts on the delta smelt to the Service as specified in this Incidental Take Statement. [50 CFR §402.14(i)(3)]

The Service developed the following Incidental Take Statement based on the premise that the RPA will be implemented. A detailed description of the rational for the development of the incidental take statement is in Attachment C. This Incidental Take Statement assumes full implementation of the RPA.

Form of Take Anticipated

The Service anticipates that take of the delta smelt is likely to occur in the form of kill, capture (via salvage), wound, harm, and harass as a result of CVP/SWP operations within the action area, inclusive of activities at the NBA and at CCWD facilities, and in conjunction with studies to determine screening criteria and to improve delta smelt handling and survival in the salvage process. The above forms of take will result in the injury or death of delta smelt. This Incidental Take Statement addresses all of the above.

Amount or Extent of Take

Take of Delta Smelt at the NBA and CCWD Facilities

The Service anticipates that incidental take of delta smelt at the NBA and at the CCWD diversions will be difficult to detect since no monitoring program samples for entrainment at these facilities on a regular basis. Incidental take is not expected to be high since the other diversions have fish screens and the unscreened Rock Slough diversion is at a dead end slough where delta smelt are not usually present. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the Service is quantifying incidental take for the NBA and the CCWD diversion to be all delta smelt inhabiting the water diverted at these facilities under the conditions of 71 TAF per year at the NBA and 195 TAF at the CCWD diversions.

Take of Adult Delta Smelt

The Service anticipates that take of adult delta smelt via entrainment will be minimized when OMR flows are limited to -2,000 cfs during the first winter flush when adult smelt move within the zone of entrainment. OMR flows held between -1,250 and -5,000 cfs following the first flush until the onset of spawning will protect later delta smelt migrants and spawners. During frequent intervals within the timeframe for RPA Component 1, the SWG shall provide specific OMR flow recommendations to the Service; and the Service

shall then determine flow requirements using the adaptive process as described in the RPA.

To estimate take with implementation of the RPA, the Service scaled projected salvage to abundance using the estimates provided by the prior year's FMWT Index (further details on the methods used in developing the Incidental Take Statement can be found in Attachment C). The segregation of year types is based upon descriptive statistics comprising quartiles, as expressed in Figure C-1 of Attachment C, and quantified following the approach described below.

The Cumulative Salvage Index (CSI) is calculated as the total year's adult salvage (the aggregate number for expanded salvage at both the Banks and Jones export facilities for the period December through March) divided by the previous year's FMWT Index. Water years 2006 to 2008 were years in which salvage, negative OMR flows, and delta smelt abundance were all lower relative to the historic values. The Service therefore believes these years within the historic dataset best approximate expected salvage under RPA Component 1.

The average CSI value for WYs 2006 to 2008 was 7.25. Projecting this average rate of salvage to the years in which CVP/SWP operations will be conducted within the sideboards established by the RPA would yield estimates of salvage at 7.25 times the prior year's FMWT Index. The Service used this estimator to predict incidental take levels of adult delta smelt during each year that the RPA's will be in effect. This value, which can be calculated upon release of the final FMWT Index within the current water year, is regarded as the incidental take for adult delta smelt under the RPA.

Incidental Take: Cumulative Expanded Salvage = 7.25 * Prior Year's FMWT Index

Delta smelt abundance is critically low, and without habitat quality conditions to appreciably improve juvenile growth and rearing from recent historic levels, is expected to remain so for the foreseeable future. The current population cannot tolerate direct mortality through adult entrainment at levels approaching even "moderate" take as observed through the historic record of recent decades. The method utilized herein to calculate take contains uncertainty within the estimates, and this fact translates into population-level risk. Further, there is a recognized need to provide a quantitative framework so that the Service and CVP/SWP operators have a common analytical methodology for reference and to further guide the adaptive process.

Therefore, the Service is also providing a Concern Level estimate, meant to indicate salvage levels approaching the take threshold, and help guide implementation of the RPA. Reaching this expanded salvage figure within a given season may require that OMR flows be set to a more restrictive level, unless available data indicate some greater level of exports is possible without increasing entrainment (e.g., there is strong reason to presume the pre-spawning migration has passed). Throughout the water year, as the SWG convenes and reviews daily salvage data, reaching the Concern Level for adult salvage requires an immediate specific recommendation to the Service.

The Service believes this Concern Level value should trigger at 75 percent of the calculated adult incidental take, as an indicator that operations may need to be more constrained to avoid exceeding the incidental take.

Concern Level: Cumulative Expanded Salvage = 5.43 * Prior Year's FMWT Index

Table IT-1 lists threshold levels of concern and incidental take for a range of potential FMWT indices. This table is intended to be used as a reference to discern levels of salvage reflecting the range of expected adult delta smelt mortality with implementation of the RPA, and as an indicator of adult delta smelt salvage levels that constitutes an increasing adverse effect to the delta smelt population due to CVP/SWP operations.

Table IT-1: Incidental Take Expanded Salvage Numbers by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take
2	11	15	66	359	479	220	1197	1596	550	2992	3989
4	22	29	72	392	522	240	1305	1741	560	3046	4061
6	33	44	78	424	566	260	1414	1886	570	3100	4134
8	44	58	84	457	609	280	1523	2031	580	3155	4206
10	54	73	90	490	653	300	1632	2176	590	3209	4279
12	65	87	96	522	696	320	1741	2321	600	3264	4351
14	76	102	100	544	725	340	1849	2466	620	3372	4496
16	87	116	102	555	740	360	1958	2611	640	3481	4642
18	98	131	104	566	754	380	2067	2756	660	3590	4787
20	109	145	106	577	769	400	2176	2901	680	3699	4932
22	120	160	108	587	783	420	2285	3046	700	3808	5077
24	131	174	110	598	798	460	2502	3336	720	3916	5222
26	141	189	120	653	870	480	2611	3481	740	4025	5367
28	152	203	130	707	943	500	2720	3626	760	4134	5512
30	163	218	140	762	1015	502	2731	3641	780	4243	5657
34	185	247	150	816	1088	504	2741	3655	800	4351	5802
38	207	276	160	870	1160	506	2752	3670	840	4569	6092
42	228	305	170	925	1233	510	2774	3699	880	4787	6382
48	261	348	180	979	1305	520	2828	3771	920	5004	6672
54	294	392	190	1033	1378	530	2883	3844	960	5222	6962
60	326	435	200	1088	1450	540	2937	3916	1000	5439	7252

Take of Larval and Juvenile Delta Smelt

The Service has largely followed the methodology for estimating incidental take of larval delta smelt similar to that utilized for adults. Specifically, an average of the last four years (2005-2008) cumulative larval/juvenile salvage by month (April through July) was calculated. This can be summarizes as a Juvenile Salvage Index (JSI), calculated as:

Monthly Juvenile Salvage Index = cumulative seasonal ≥ 20 mm salvage by month end divided by current WY FMWT Index

The mean values from 2005-2008 were used as an estimate of take under the RPA. The reason for selecting this span of years is that the apparent abundance of delta smelt since 2005 as indexed by the 20-mm Survey and the TNS is the lowest on record. It was necessary to separate out this abundance variable, but also to account for other poorly understood factors relating salvage to OMR, distribution, and the extant conditions. On a monthly basis (cumulative salvage across the spring), this estimate represents a concern level where entrainment has reached high enough numbers to indicate the need for more protective OMR restrictions. The cumulative salvage figures in the Incidental Take Statement reflect totals beginning with the first seasonal juvenile salvage through the end of the current month (i.e., prior month totals are added to the succeeding month's values). The tables provided cover the full month to the final day of the applicable calendar month.

Concern Level = Monthly JSI 2005-2008 mean * Current WY FMWT

The last four years average monthly cumulative salvage was used to calculate the concern level for larval/juvenile smelt, as opposed to the incidental take under the RPA. It is acknowledged that salvage across years will be variable, as distribution, spawning success, prior entrainment of adults, enhanced survival of <20mm larval delta smelt under the RPA, and extant natural conditions determine. As mentioned above, this constrains predictability of take using this methodology, and is less reliable overall as the method used for adults. Also, it is believed that individuals of the larval/juvenile lifestage are less demographically significant than adults. Given these considerations, the incidental take estimate for ≥ 20 mm larval/juvenile delta smelt under the RPA will be above the four year average by 50 percent.

Larval/Juvenile Incidental Take = 1.5 * Concern Level

Lookup tables relating (current WY) FMWT to concern level and incidental take for cumulative salvage by month appears in Table IT-2 through IT-5, below.

Table IT-2: April Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	1	1
4	1	2
6	2	3
8	2	4
10	3	4
12	4	5
14	4	6
16	5	7
18	5	8
20	6	9
22	6	10
24	7	11
26	8	11
28	8	12
30	9	13
34	10	15
38	11	17
42	12	18
48	14	21
54	16	24
60	18	26
66	19	29
72	21	32
78	23	34
84	25	37
90	26	40
96	28	42
100	29	44

FMWT Index	Concern Level	Incidental Take
102	30	45
104	30	46
106	31	47
108	32	47
110	32	48
120	35	53
130	38	57
140	41	62
150	44	66
160	47	70
170	50	75
180	53	79
190	56	84
200	59	88
220	64	97
240	70	106
260	76	114
280	82	123
300	88	132
320	94	141
340	100	150
360	106	158
380	111	167
400	117	176
420	123	185
460	135	202
480	141	211
500	147	220

FMWT Index	Concern Level	Incidental Take
502	147	221
504	148	222
506	148	223
510	150	224
520	152	229
530	155	233
540	158	237
550	161	242
560	164	246
570	167	251
580	170	255
590	173	259
600	176	264
620	182	273
640	188	281
660	193	290
680	199	299
700	205	308
720	211	317
740	217	325
760	223	334
780	229	343
800	235	352
840	246	369
880	258	387
920	270	405
960	281	422
1000	293	440

Table IT-3: May Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	26	39
4	52	78
6	78	117
8	104	156
10	130	196
12	156	235
14	182	274
16	209	313
18	235	352
20	261	391
22	287	430
24	313	469
26	339	508
28	365	547
30	391	587
34	443	665
38	495	743
42	547	821
48	626	938
54	704	1056
60	782	1173
66	860	1290
72	938	1408
78	1017	1525
84	1095	1642
90	1173	1760
96	1251	1877
100	1303	1955

FMWT Index	Concern Level	Incidental Take
102	1329	1994
104	1356	2033
106	1382	2072
108	1408	2112
110	1434	2151
120	1564	2346
130	1694	2542
140	1825	2737
150	1955	2933
160	2085	3128
170	2216	3324
180	2346	3519
190	2476	3715
200	2607	3910
220	2868	4301
240	3128	4692
260	3389	5083
280	3650	5474
300	3910	5865
320	4171	6256
340	4432	6647
360	4692	7038
380	4953	7429
400	5214	7821
420	5474	8212
460	5996	8994
480	6256	9385
500	6517	9776

FMWT Index	Concern Level	Incidental Take
502	6543	9815
504	6569	9854
506	6595	9893
510	6647	9971
520	6778	10167
530	6908	10362
540	7038	10558
550	7169	10753
560	7299	10949
570	7429	11144
580	7560	11340
590	7690	11535
600	7821	11731
620	8081	12122
640	8342	12513
660	8603	12904
680	8863	13295
700	9124	13686
720	9385	14077
740	9645	14468
760	9906	14859
780	10167	15250
800	10427	15641
840	10949	16423
880	11470	17205
920	11991	17987
960	12513	18769
1000	13034	19551

Table IT-4: June Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	66	99
4	132	198
6	198	297
8	264	396
10	330	495
12	396	594
14	462	694
16	528	793
18	594	892
20	660	991
22	727	1090
24	793	1189
26	859	1288
28	925	1387
30	991	1486
34	1123	1684
38	1255	1882
42	1387	2081
48	1585	2378
54	1783	2675
60	1981	2972
66	2180	3269
72	2378	3567
78	2576	3864
84	2774	4161
90	2972	4458
96	3170	4756
100	3302	4954
102	3369	5053
104	3435	5152
106	3501	5251
108	3567	5350
110	3633	5449
120	3963	5944
130	4293	6440
140	4623	6935
150	4954	7431
160	5284	7926
170	5614	8421
180	5944	8917
190	6275	9412
200	6605	9907
220	7265	10898
240	7926	11889
260	8586	12880
280	9247	13870
300	9907	14861
320	10568	15852
340	11228	16843
360	11889	17833
380	12549	18824
400	13210	19815
420	13870	20806
460	15191	22787
480	15852	23778
500	16512	24769
502	16578	24868
504	16644	24967
506	16711	25066
510	16843	25264
520	17173	25759
530	17503	26255
540	17833	26750
550	18164	27245
560	18494	27741
570	18824	28236
580	19154	28732
590	19485	29227
600	19815	29722
620	20475	30713
640	21136	31704
660	21796	32695
680	22457	33685
700	23117	34676
720	23778	35667
740	24438	36657
760	25099	37648
780	25759	38639
800	26420	39630
840	27741	41611
880	29062	43593
920	30383	45574
960	31704	47556
1000	33025	49537

Table IT-5: July Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take
2	75	112	102	3822	5732	502	18808	28213
4	150	225	104	3897	5845	504	18883	28325
6	225	337	106	3971	5957	506	18958	28437
8	300	450	108	4046	6070	510	19108	28662
10	375	562	110	4121	6182	520	19483	29224
12	450	674	120	4496	6744	530	19857	29786
14	525	787	130	4871	7306	540	20232	30348
16	599	899	140	5245	7868	550	20607	30910
18	674	1012	150	5620	8430	560	20981	31472
20	749	1124	160	5995	8992	570	21356	32034
22	824	1236	170	6369	9554	580	21731	32596
24	899	1349	180	6744	10116	590	22105	33158
26	974	1461	190	7119	10678	600	22480	33720
28	1049	1574	200	7493	11240	620	23229	34844
30	1124	1686	220	8243	12364	640	23979	35968
34	1274	1911	240	8992	13488	660	24728	37092
38	1424	2136	260	9741	14612	680	25477	38216
42	1574	2360	280	10491	15736	700	26227	39340
48	1798	2698	300	11240	16860	720	26976	40464
54	2023	3035	320	11989	17984	740	27725	41588
60	2248	3372	340	12739	19108	760	28475	42712
66	2473	3709	360	13488	20232	780	29224	43836
72	2698	4046	380	14237	21356	800	29973	44960
78	2922	4384	400	14987	22480	840	31472	47208
84	3147	4721	420	15736	23604	880	32971	49456
90	3372	5058	460	17235	25852	920	34469	51704
96	3597	5395	480	17984	26976	960	35968	53952
100	3747	5620	500	18733	28100	1000	37467	56200

Effect of the Take

The Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the RPA is implemented.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the effect of the proposed action on the delta smelt:

1. Minimize adverse effects of the operations of the Permanent Operable Gates.

2. Minimize adverse effects of operations of the NBA.

3. Obtain real time data on the abundance and distribution of delta smelt in the Bay-Delta.

4. Minimize adverse effects of Banks and Jones on delta smelt.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation shall ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

The following Term and Condition implements Reasonable and Prudent Measures one (1):

1. The Service shall have the final decision on the operations of the Permanent Gates. The members of the GORT can provide suggestions to operate the gates, but the ultimate decision on how to operate the gates to protect delta smelt will be made by the Service.

The following Term and Condition implements Reasonable and Prudent Measures two (2):

1. Annual evaluations shall be conducted for the fish screens at the NBA diversion during January through June. A proposed evaluation study shall be submitted to the Service for approval within 3 months of the issuance of this biological opinion. The evaluation shall monitor fish entrained and impinged on the fish screen, the screen approach velocities, cleanliness of the screen and any other pertinent criteria needed to determine the effectiveness of the fish screen.

The following Terms and Conditions implement Reasonable and Prudent Measures three (3):

1. During the months of December through July, when water is being diverted, Reclamation and DWR shall ensure that the frequency of sampling for delta smelt at Banks and Jones will be at least 25 percent of the time.

2. Reclamation and DWR shall develop a methodology for quantitative larval monitoring at Banks and Jones to help refine the triggers for the Actions in the RPA. An interim plan shall be submitted to the Service for approval within 30 days of the issuance of this biological opinion so the monitoring can be implemented this year. A more detailed plan shall be developed and approved by the Service within one year.

The following Term and Condition implements Reasonable and Prudent Measures four (4):

1. Reclamation will develop within 30 days a methodology for dealing with transitions in operations after changes in OMR flow requirements.

Monitoring Requirements

Monitoring requirements in accordance with section 402.14(i)(3) of the implementing regulations for section 7 of the Act have been included as part of the RPA and must be implemented by Reclamation and DWR.

Reporting Requirements

Reclamation or DWR shall immediately report to the Service any information about take or suspected take of federally-listed species not authorized in this biological opinion. Reclamation or DWR must notify the Service within 24 hours of receiving such information. Notification must include the date, time, and location of the incident or of the finding of a dead or injured delta smelt. Any killed delta smelt that have been taken should be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10 percent formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information should be written on 100 percent rag content paper with permanent ink and included in the container with the specimen. The Service contact persons are Chris Nagano, Deputy Assistant Field Supervisor, at telephone (916) 414-6600, and Dan Crum, Resident Agent-in-Charge of the Service's Law Enforcement Division at telephone (916) 414-6660.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

The Service requests notification of the implementation of any conservation recommendations in order to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats. We propose the following conservation recommendations:

1. The Service recommends that Reclamation and DWR develop and implement restoration measures consistent with the current Delta Native Species Recovery Plan.

2. The Service recommends that Reclamation and DWR develop procedures that minimize the effects of all other in-water activities that it conducts within the action area on delta smelt.

3. The Service recommends Reclamation work with willing partners to establish and maintain a diverse population of delta smelt for refuge and research purposes, managed to ensure adequate genetic diversity.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed and proposed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation-Closing Statement

If the Sacramento Valley Water Year Type Index (40-30-30) February 1 50 percent exceedence forecast indicates that the water year will be a second consecutive (or more) dry or critically dry year, Reclamation shall reinitiate consultation with the Service. In order to allow the CVP/SWP to provide health and safety needs, critical refuge supplies, and obligation to senior water rights holders, the combined CVP/SWP export rates will not be required to drop below 1,500 cfs in these circumstances. However, in the unlikely event that salvage approaches the incidental take limit at these low export levels, the Service shall assess the on-going risk to delta smelt and will determine if additional reductions in pumping or other actions are necessary to further minimize effects.

If the subsequent 40-30-30 March 1 50 percent forecast indicates that the water year will no longer be a second consecutive (or more) dry or critically dry year, project operations may resume as described in the RPA. However, if subsequent April or May 75 percent exceedence forecasts move back to a critically dry year, reinitiation will again commence. Forecasts wetter than dry shall result in implementation of actions as described in the RPA.

This concludes formal consultation on the proposed coordinated operations of the CVP and SWP in California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Reclamation involvement or control over the

action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the CVP/SWP that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the CVP/SWP is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the CVP/SWP. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease, pending reinitiation.

If you have questions concerning this biological opinion, please contact Ryan Olah, Steven Detwiler, or Cay C. Goude or Susan Moore of our Sacramento Fish and Wildlife Office at the letterhead address or at telephone (916) 414-6600.

Cc: California Department of Water Resources, Sacramento, CA

California Department of Fish and Game, Sacramento and Yountville, CA

National Marine Fisheries Service, Sacramento, CA

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Attachment A-Delta Smelt Risk Assessment Matrix

Triggers	December	January	February	March	April	May	June	July
Life Stage	Adults	Adults	Adults	Adults and larvae	Adults and larvae	Larvae and juveniles	Larvae and juveniles	Juveniles
Previous Year's Fall Midwater Trawl Recovery Index (1)	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74
Risk of Entrainment (2)				X2 upstream of Chipps Island and temps are ≥ 12°	X2 upstream of Chipps Island and temps are between 12° and 18°C	X2 upstream of Chipps Island and mean delta-wide temps <18°C and south delta temps below 28°C	X2 upstream of Chipps Island and temps are below 28°C	X2 upstream of Chipps Island and temps are below 28°C
Duration of Spawning period (number of days temperatures are between 12 and 18°C) (3)					39 days or less by April 15	50 days or less by May 1		
Spawning Stage as determined by spring Kodiak trawl and/or salvage (4)			Presence of Adults at spawning stage ≥ 4	Adult spawning stage ≥ 4	Adult spawning stage ≥ 4			
smelt distribution (5)	See footnote #5	See footnote #5	See footnote #5	See footnote #5 or negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm/summer townet centroid or low juvenile abundance	Negative 20mm/summer townet centroid or low juvenile abundance
Salvage Trigger (6)	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation		If salvage is above zero	If salvage is above zero	

Delta Smelt Risk Assessment Matrix (DSRAM) **May 2008**

Tools for Change (7)	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**
Export reduction at one or both facilities	X	X	X	X	X	X	X	X
Change in barrier operations						X	X	X
Change in San Joaquin River flows				X	X	X	X	X
Change position of cross channel gates						X	X	

Delta Smelt Risk Assessment Matrix Footnotes

1 The Recovery index is calculated from a subset of the September and October Fall Midwater Trawl sampling (http://www.delta.dfg.ca.gov/). The number in the matrix, 74, is the median value for the 1980-2002 Recovery Index (Figure 1)

2 The temperature range of 12 to 18 °C is the range in which most successful delta smelt spawning occurs. This has been analyzed by using observed cohorts entering the 20-mm Survey length frequency graphs (1996-02). Cohorts were defined by having a noticeable peak or signal and occurring over three or more surveys during the rearing season. Temperature data from DWR's CDEC web site was compiled using three stations representing the South Delta (Mossdale), confluence (Antioch), and North Delta (Rio Vista). Spawning dates for each cohort was back-calculated by applying an average daily growth rate (wild fish) of 0.45 mm/day (Bennett, DFG pers. comm.) and egg incubation period of 8-14 days (Baskerville-Bridges, Lindberg pers. comm.)(Mager et al. 2004) from the median value of the analyzed cohort. Each spawning event was then plotted against temperature over time (Figure 2). While spawning does occur outside of the 12-18 °C range, larval survival is most likely reduced when temperatures are either below (DFG pers. comm.) or above this range (Baskerville-Bridges & DFG pers. comm.).

Critical thermal maxima for delta smelt was reached at 25.4 °C in the laboratory (Swanson et al., 2000); however, in 2007 delta smelt were observed in the delta and in salvage at temperatures up to about 28 °C.

Websites for the temperature data: http://cdec.water.ca.gov/cgi-progs/queryF?MSD
http://cdec.water.ca.gov/cgi-progs/queryF?ANH
http://cdec.water.ca.gov/cgi-progs/queryF?RIV

Mager RC, Doroshov SI, Van Eenennaam JP, and Brown RL. 2004. Early Life Stages of Delta Smelt. American Fisheries Society Symposium 39:169-180.

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3 Figure 3: The working hypothesis for delta smelt is that spawning only occurs when temperatures are suitable during the winter and spring. In years with few days having suitable spawning temperatures, the spawning "window" is limited, so the species produces fewer cohorts of young smelt. Few cohorts increase the risk that mortality sources such as entrainment may have population level effects.

The figures below were used to help define years when there were relatively days with suitable temperatures. For April 15 and May 1, the figures show the cumulative spawning days for each year during 1984-2002. The cumulative spawning days for each year were calculated based on the number of days that the mean water temperature for three Delta stations (Antioch; Mossdale and Rio Vista) was in the 12 - 18 °C range starting on February 1. The results are plotted in terms of the ranks to identify the lower quartile. In other words, years in the lower quartile represent examples of years with relatively few spawning days.

4 The adult spawning stage is determined by the Spring Kodiak Trawl and/or fish salvaged at the pumping facilities (http://www.delta.dfg.ca.gov/). A stage greater than or equal to 4 indicates female delta smelt are ripe and ready to spawn or have already spawned (Mager 1996).

Mager RC. 1996. Gametogenesis, Reproduction and Artificial Propogation of Delta Smelt, *Hypomesus transpacificus.* [Dissertation] Davis: University of California, Davis. 115 pages. Published.

5 The spring kodiak trawl will be used to help generally determine the distribution of adult smelt. However, since the spring kodiak trawl is not intended to be a survey for abundance or distributions, no definitive trigger for concern can be determined at this time.

Juveniles (March-July) – distribution of juvenile delta smelt where the centroid is located upstream (negative) or downstream (positive) of the Sacramento-San Joaquin River confluence (Figure 4). The 20-mm Survey (or Summer Townet Survey) centroid is calculated by multiplying the observed delta smelt station CPUE (fish/10,000 m3) by a distance parameter in km from the confluence. The summed result (summed over a survey) is divided by the survey CPUE which gives the survey centroid position (Figure 5)

Low juvenile abundance will also be a trigger. Abundance (total cumulative count) will be monitored throughout the sampling season with low values based upon median values of historic cumulative 20-mm Survey catch (1995-2003). Each survey within a season has a median value associated with it and when catch is equal to or below that value, concern is high (Table 1).

6 Salvage trigger: the salvage trigger for December through March is determined by calculating the ratio of adult salvage to the fall MWT index. This ratio will increase as fish are salvaged during the winter months. If the ratio exceeds the median of what was observed during December-March 1980-2002, then the trigger was met (see Figure 6 for more explanation of the calculation)

During May and June, if delta smelt salvage at the salvage facilities is greater than zero, then the working group will meet. This is because May and June are the peak of smelt salvage and salvage densities cannot be predicted. Therefore,

during these two months, the SWG will meet proactively to protect these fish by looking at relevant information such as salvage, Delta temperatures, Delta hydrology and smelt distributions.

7 The tools for change are actions that the working group can recommend to the DAT and WOMT group to help protect delta smelt. Exports may be reduced at one or both of the South Delta export facilities and a proposed duration of the reduction would be recommended by the working group. Export reductions and changes in San Joaquin River flows may be covered by (b)(2) or EWA assets. Details of past fish actions can be found at the CALFED Ops website: http://wwwoco.water.ca.gov/calfedops/index.html; >Operations [year]

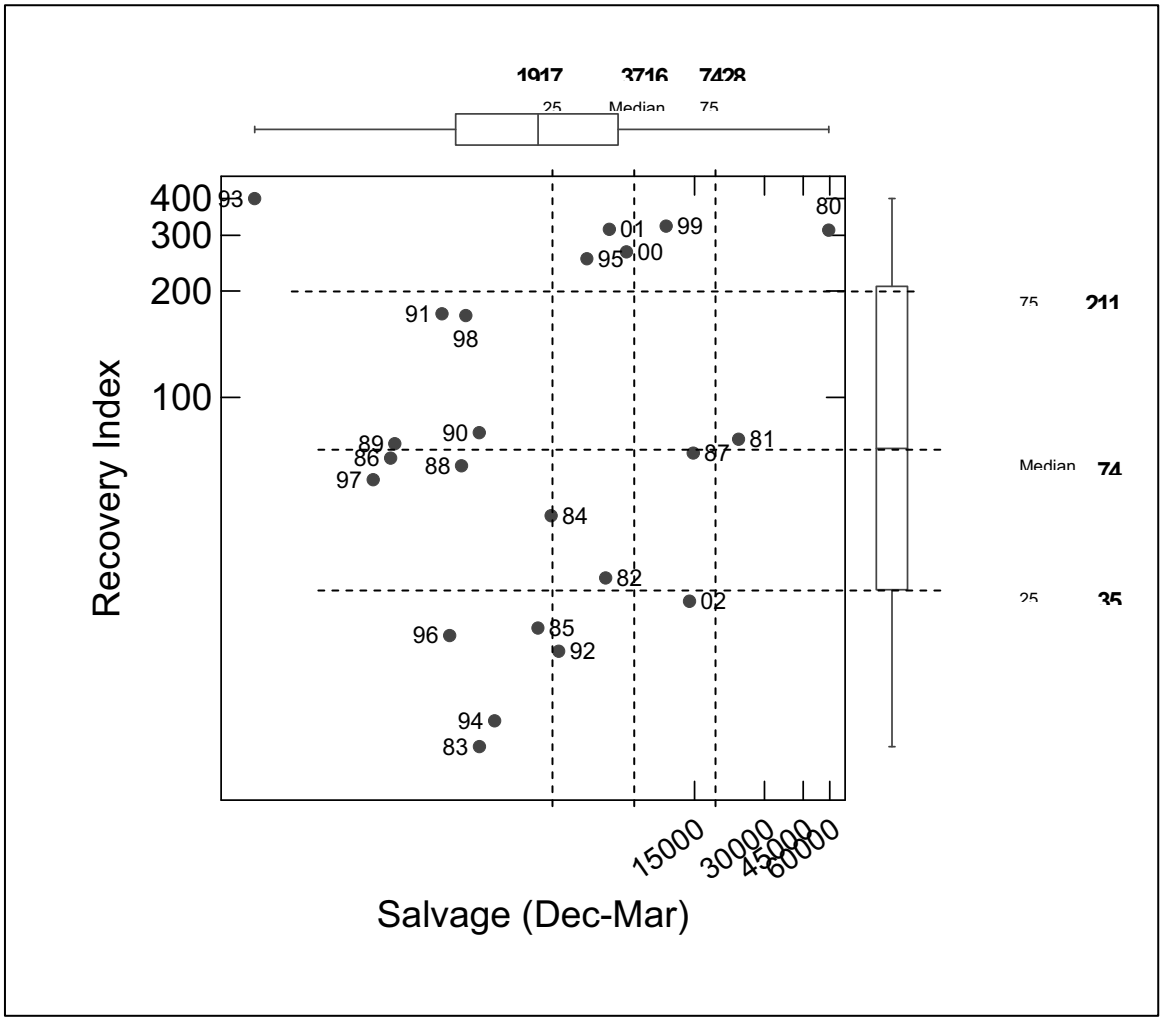


Figure 1 1980-2002 Recovery Index

Figure 1 points are labeled with the year representing the recovery index.
The winter salvage is for this analysis starts in December of the recovery index year and carries through March of the following year.

Figure 2 shows the successful delta smelt spawning periods (black bars) and start and end of spawning season (yellow bars) determined by the 20-mm Survey catch results (1996-2002). Temperature data (^{o}C) was compiled from CDEC using mean daily temperatures from the South Delta (Mossdale), North Delta (Rio Vista), and confluence (Antioch).

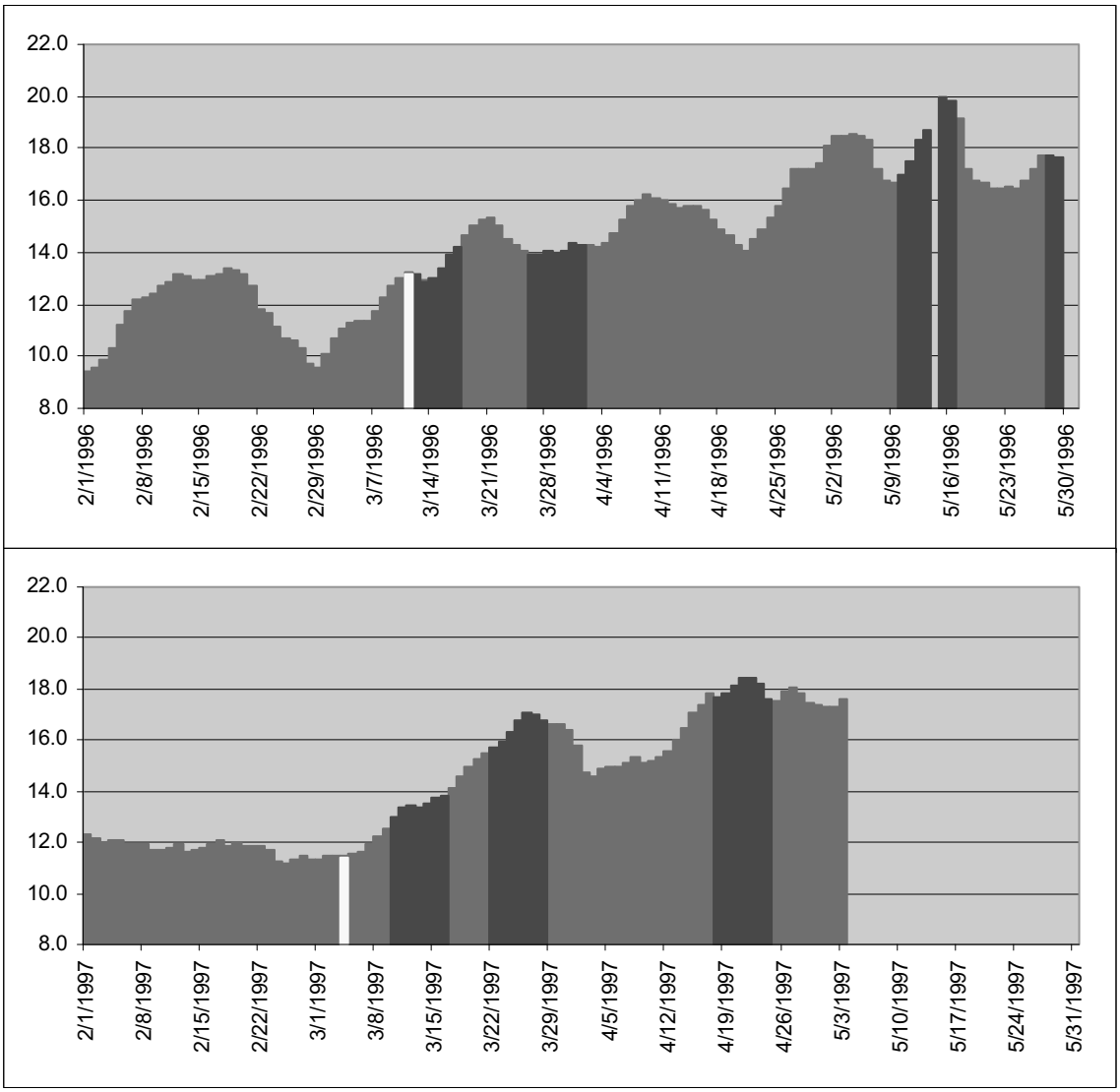
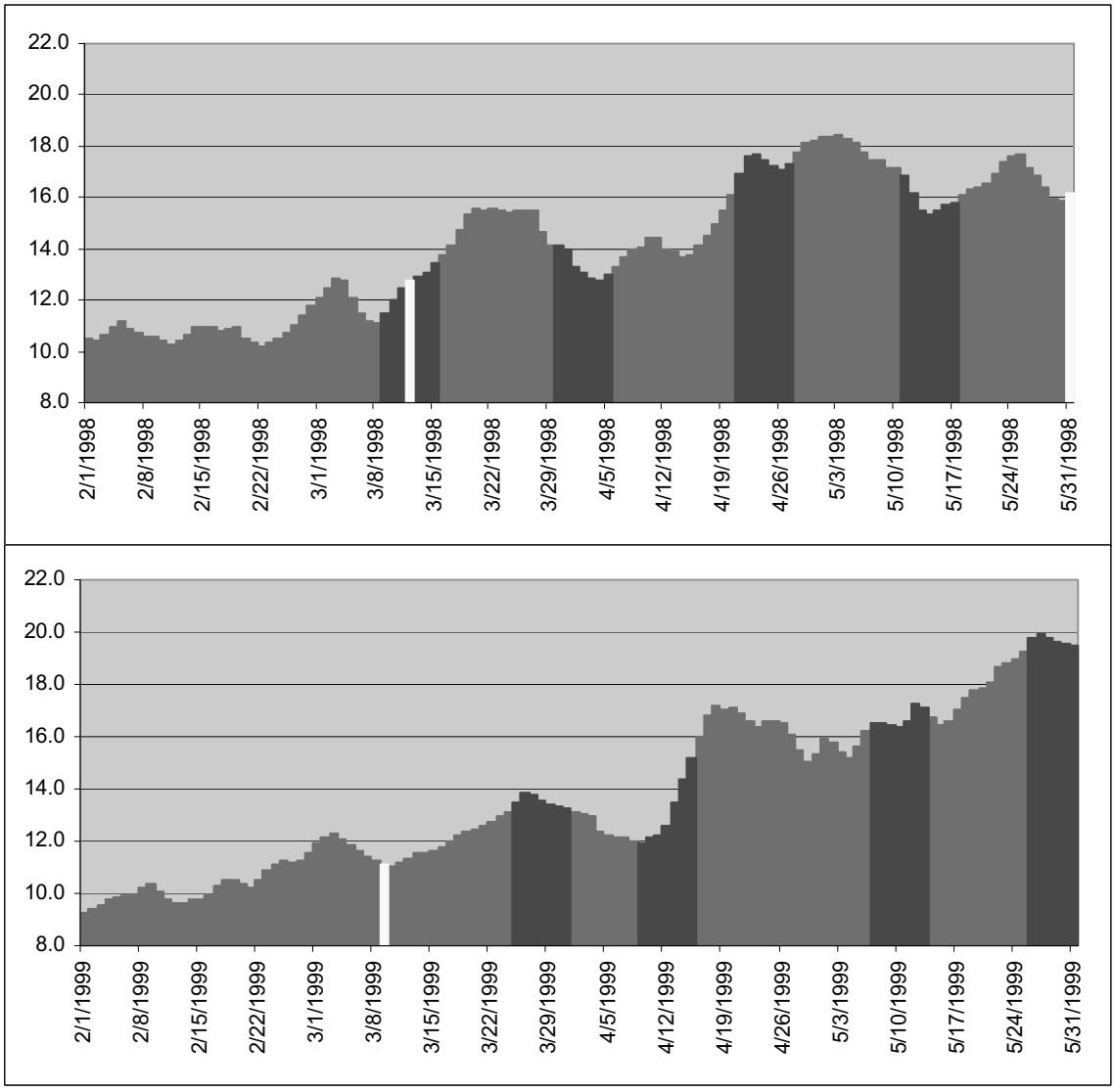


Figure 2 Successful delta smelt spawning periods


22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
2/1/1998
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3/22/1998
3/29/1998
4/5/1998
4/12/1998
4/19/1998
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5/3/1998
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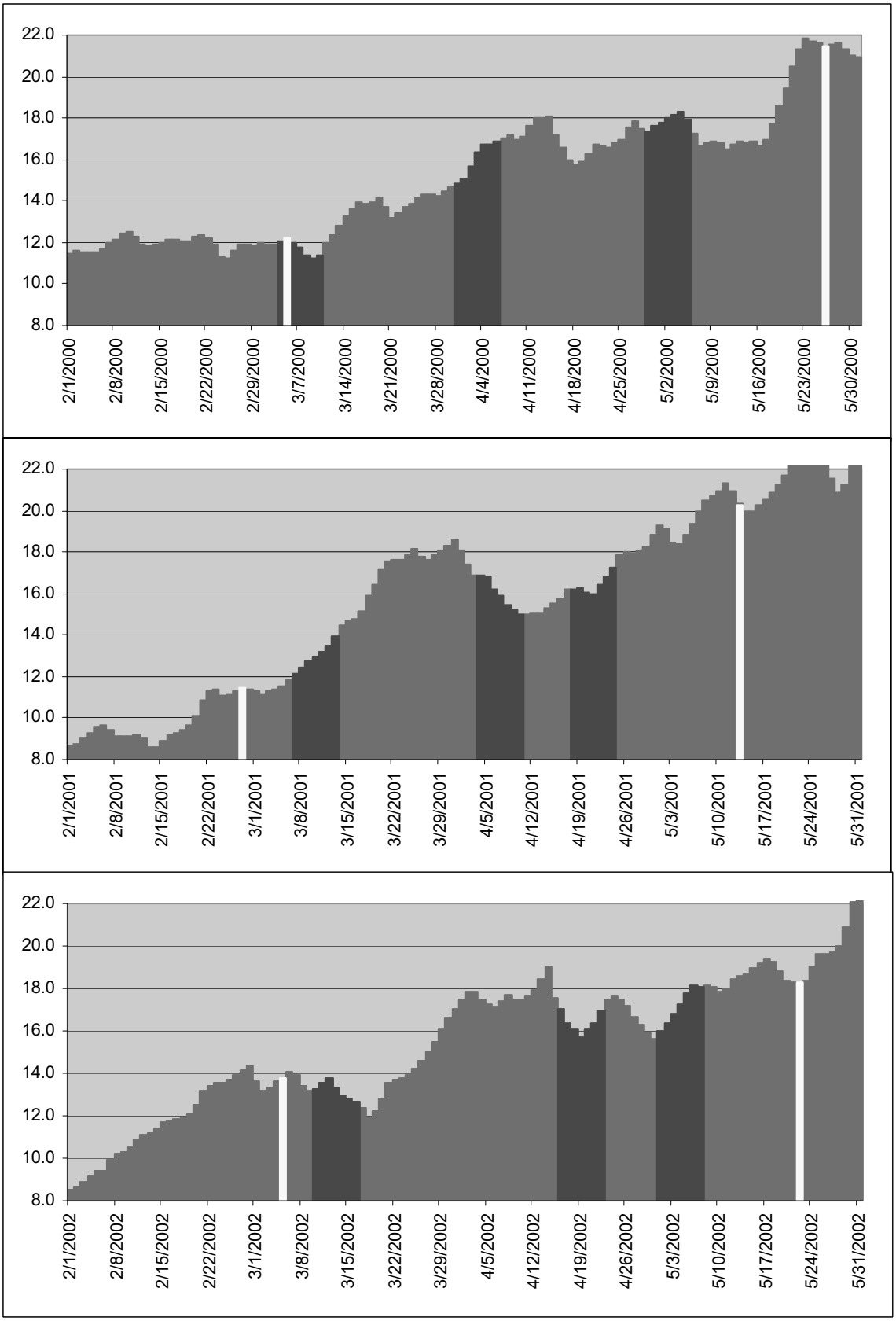
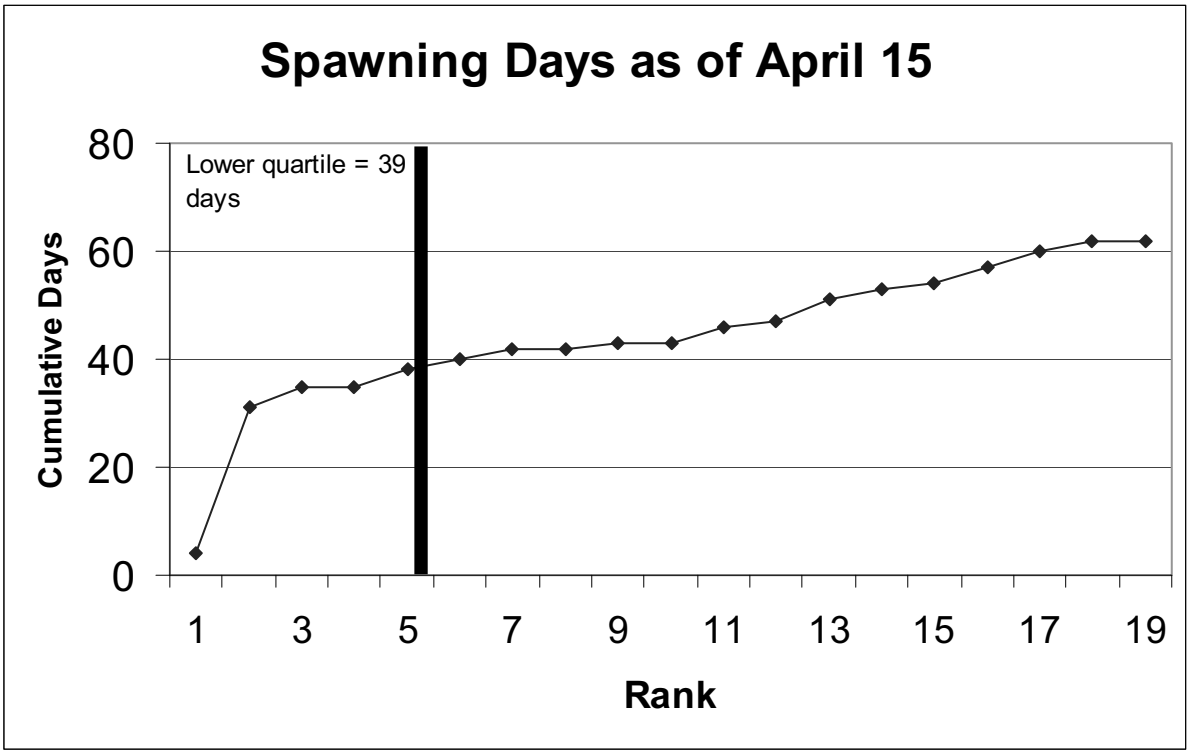


Figure 2 cont.



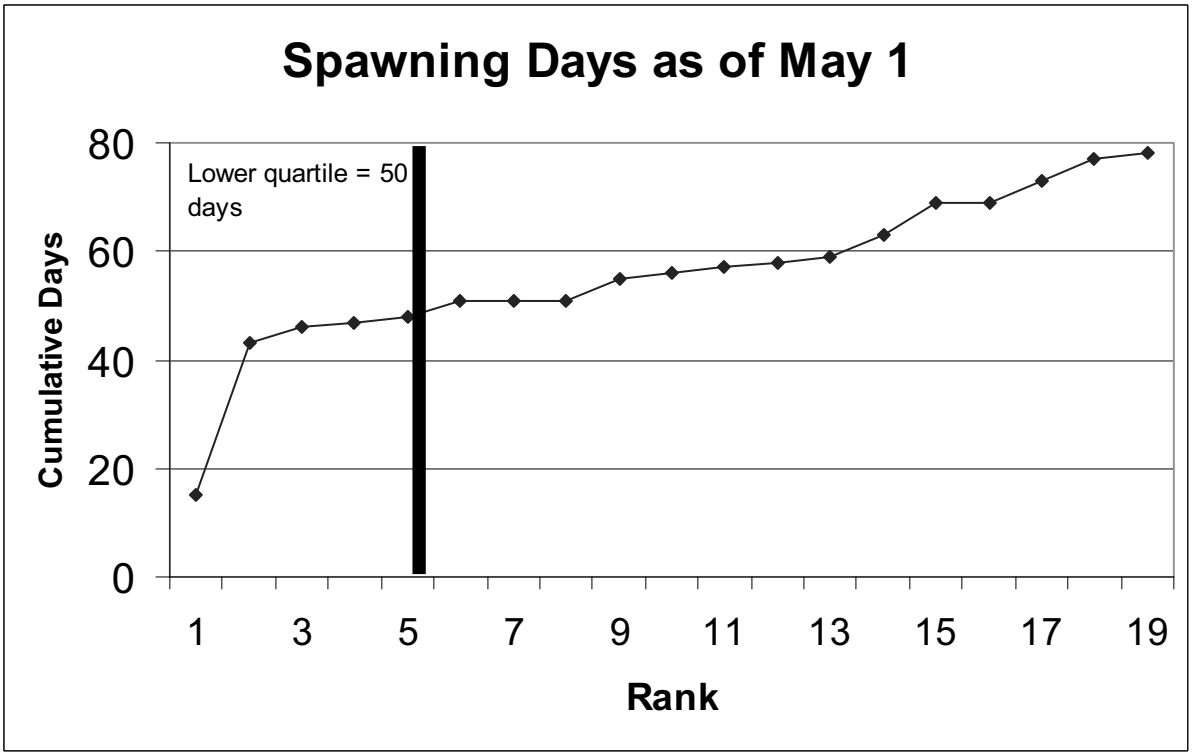


Figure 3 Delta smelt spawning days

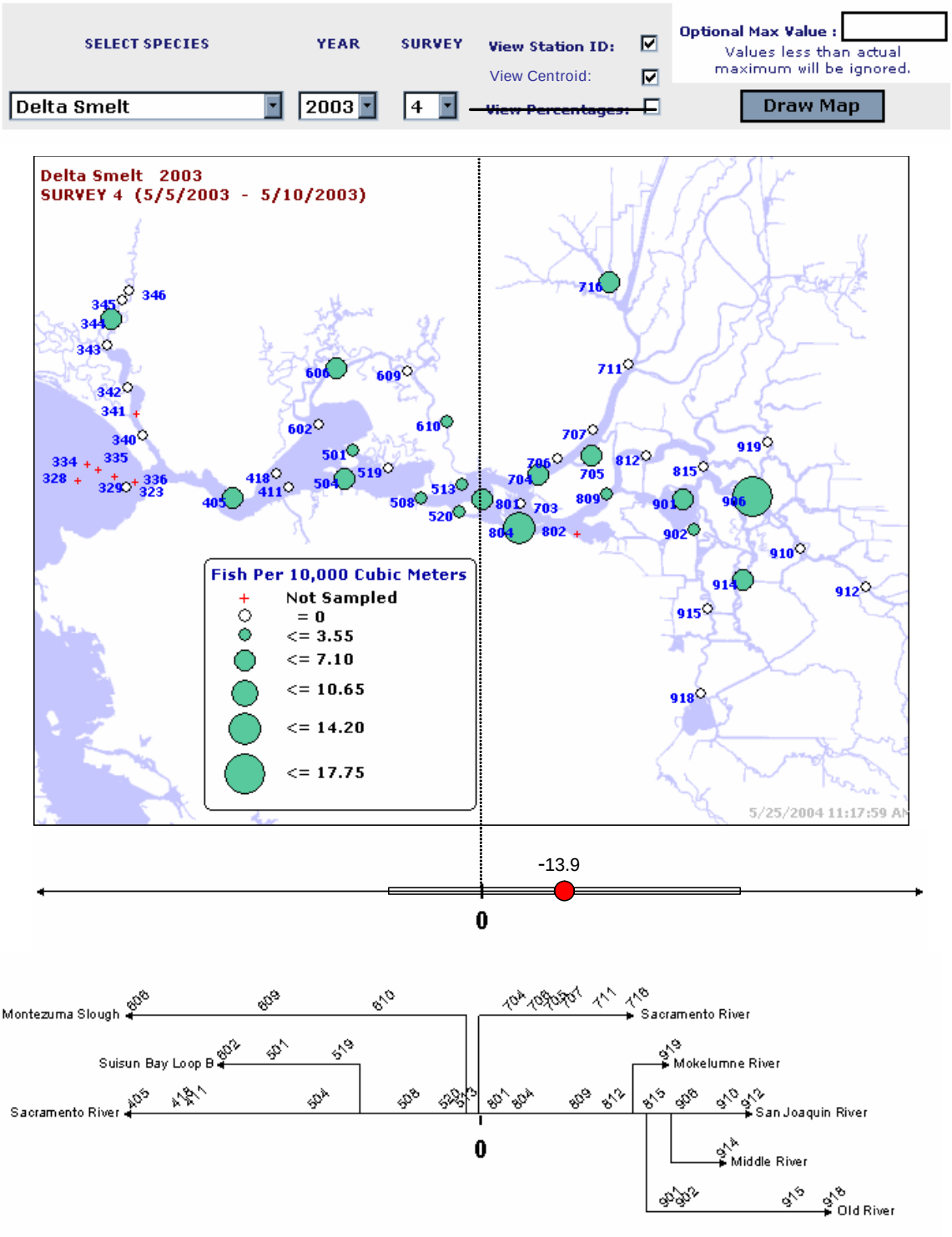


Figure 4 A 20-mm Survey delta smelt bubble plot map with calculated centroid position from the confluence of Sacramento-San Joaquin Rivers with one standard deviation.

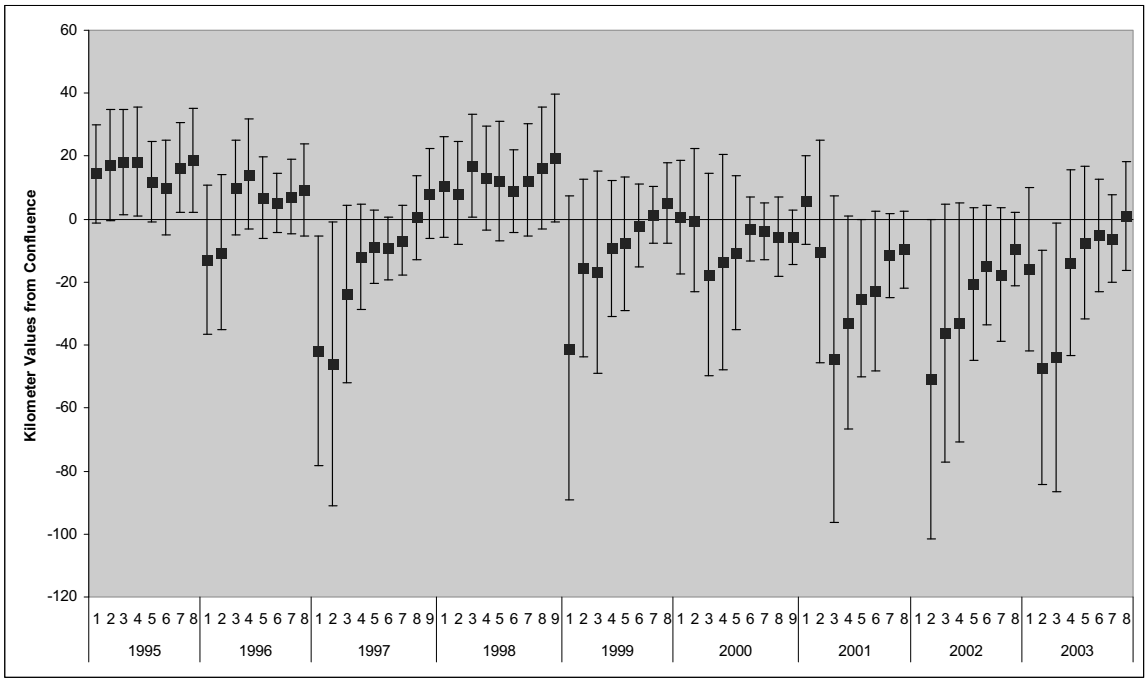


Figure 5 Historic juvenile centroid position (20-mm Survey) with one standard deviation.

Table 6 Lower quartile values of cumulative catch from the 20-mm Survey. When cumulative catch per survey during a season is at or below the calculated value, concern is high.

	survey 1	survey 2	survey 3	survey 4	survey 5	survey 6	survey 7	survey 8
lower quartile	12	40	144	188	346	500	924	1019

In Figure 7**,** the objective is to quantify a level of concern for adult delta smelt during the winter, that is based upon not only the number of fish salvaged but also accounts for the overall abundance of smelt. Whatever quantifier we select should reflect that when the abundance is low and salvage is high concern is high and conversely, when abundance is high and salvage is low that concern is low.

Below is a Quantile plot of the ratio of winter salvage to MWT index (ln (winter salvage/MWT index)). Winter salvage is defined as the total salvage from December through March. In the figure below, the size of the bubbles is proportional to the log of the fall midwater trawl just to give some indication of relative abundance. The resulting quartiles of the ratio are as follows:

25th percentile =: 2.950; 50th percentile = 3.575; 75th percentile = 5.029.

If we were to use this approach to calculate winter concern levels and use the median value, then all years above the 1999 point in the graph would have been years of concern. In other words, these are the years in which we may have recommended some protection. Comparing it to the protection afforded adult delta smelt in the winter by the 1995 biological opinion ("red light" was, or would have been reached in the following winters of 1980, 1981, 1982, 1984 and 1999) .

If the median was selected as the measure of concern it would be calculated by:

concern level = anti ln(3.575)* MWT recovery index

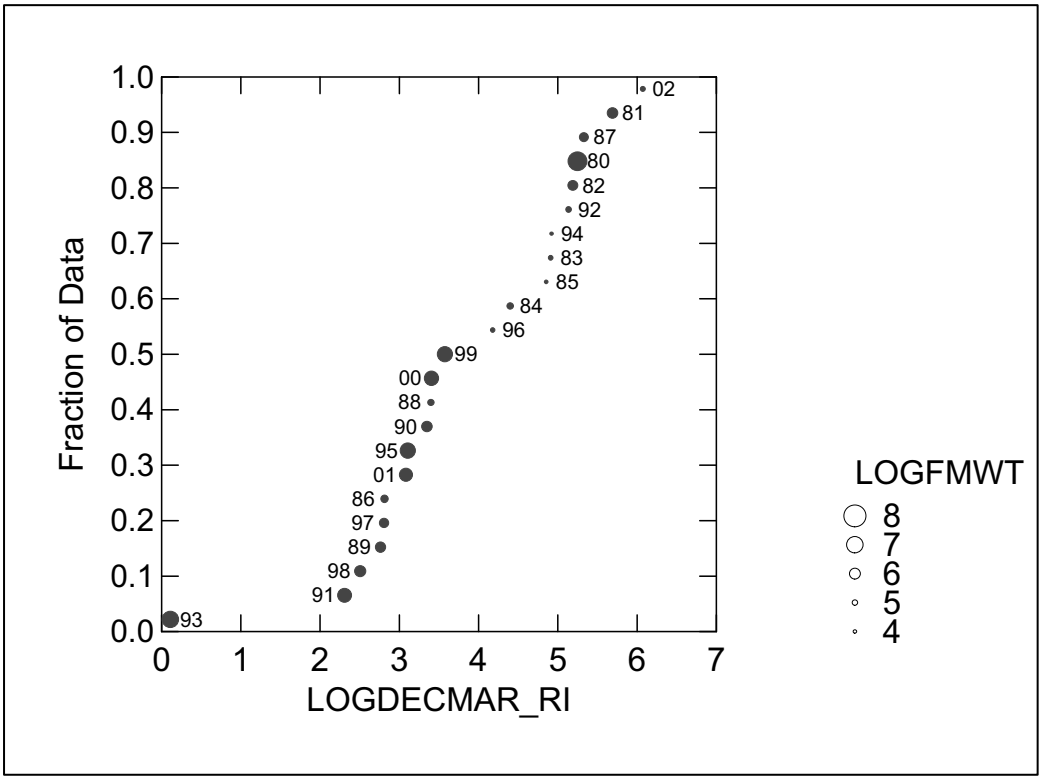


Figure 7 Quantile plot of the ratio of winter salvage to MWT recovery index

The goal for the DSRAM is to avoid the upper quartile of the above graph, in general, to avoid high salvage events when the MWT recovery index is low. Actions would be taken prior to salvage events and ideally, high salvage events would not occur.

Attachment B, Supplemental Information related to the Reasonable and Prudent Alternative

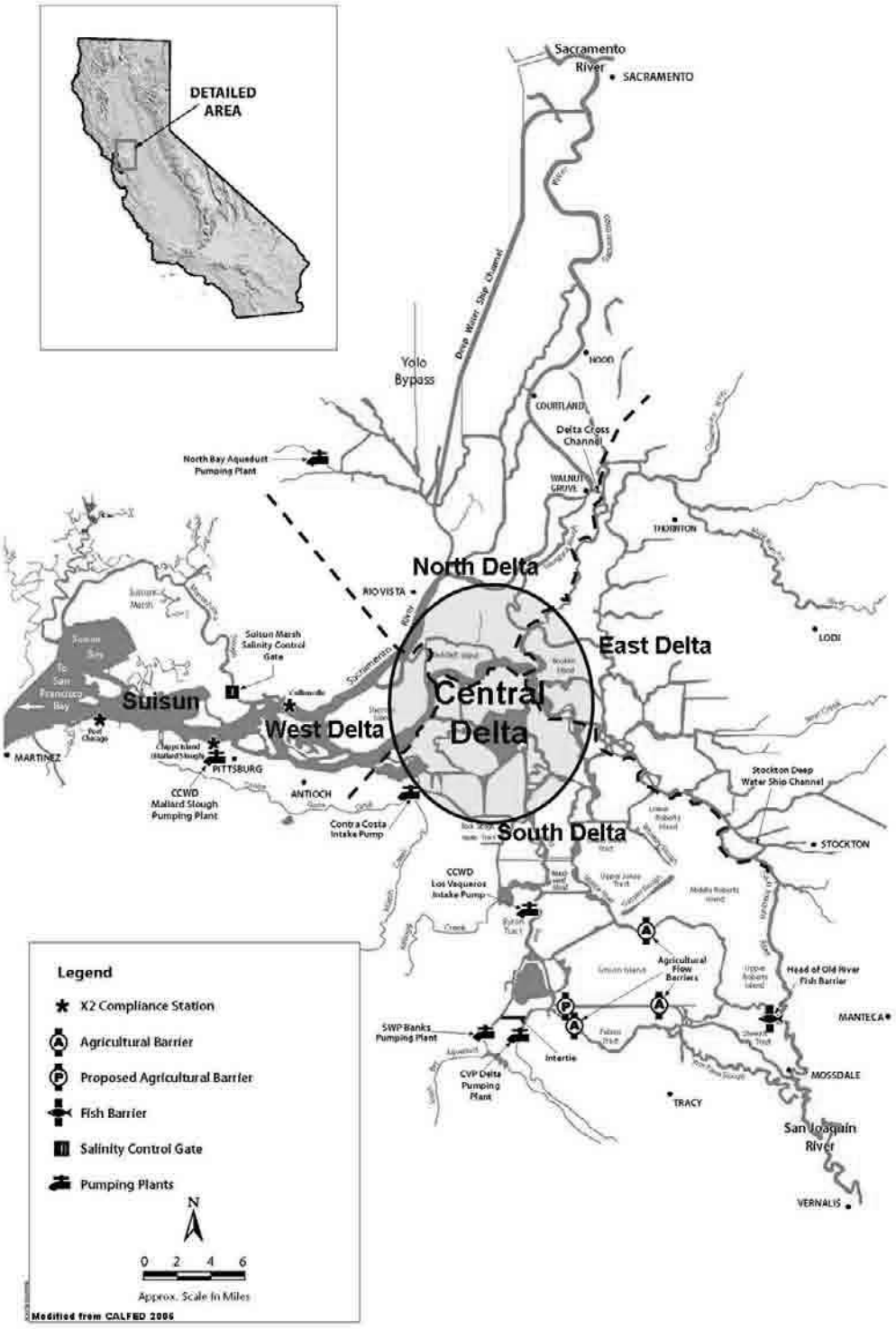
There are three major factors related to operations of the CVP/SWP affecting delta smelt population resilience and long-term viability. It is also recognized that the hydrologic changes from the CVP/SWP result in ecological conditions that influence delta smelt interactions with other stressors within the Delta. The following actions were developed to counter these adverse effects based upon the Baseline and Effects section of the biological opinion.

These three factors are: 1) direct mortality associated with entrainment of pre-spawning adult delta smelt by CVP/SWP operations; 2) direct mortality of larval and early juvenile delta smelt associated with entrainment by CVP/SWP operations; and, 3) indirect mortality and reduced fitness through reductions to and degradation of Delta habitats by CVP/SWP operations, with the fall as a particular concern. The actions below address these factors and will ameliorate the adverse effects that are brought about from the hydrologic modifications that influence delta smelt interactions with other stressors in the Delta.

The metric for monitoring direct mortality of delta smelt is salvage at Banks and Jones during pumping operations. However, this metric alone cannot be used to trigger operational changes in CVP/SWP to prevent entrainment. This is because the combination of tidal cycles, hydrologic and meteorological events, and CVP/SWP operations can draw delta smelt into the South and Central Delta (see Map 1) where they are more susceptible to entrainment by the facilities prior to any observed delta smelt salvage. This necessitates an anticipatory strategy in order to sufficiently protect delta smelt from entrainment.

As discussed in the Baseline and Effects Sections of the biological opinion, there are other impacts to delta smelt through reduction and degradation of habitat. These effects are functional year-round, through mechanisms defined and discussed in those sections. Indirect mortality and reduced fitness of juvenile delta smelt due to degraded environmental quality (habitat suitability) in the fall impacts delta smelt. The mechanism of this impact is habitat constriction, entrainment of primary and secondary productivity leading to food-web deprivation for prey species, decreased dilution flows resulting in increased exposure to lethal and sublethal concentrations of contaminants. Additionally it results in reduced habitat variability that is expected to help control invasive species such as *Corbula* or *Microcystis* that either compete with, or directly impact survival of delta smelt. The operational criteria to restore habitat quality for rearing juveniles in the estuary are related to increasing delta outflows during fall months (September through November) of above-normal and wet WYs to improve habitat variability.

Actions 1 and 2 will reduce the direct mortality of pre-spawning adult delta smelt (Adult Entrainment). Action 3 will reduce the direct mortality of larval and juvenile delta smelt (Larval/Early Juvenile Entrainment). Action 4 will restore habitat quality for rearing juveniles in the estuary that are directly related to increasing Delta outflows during fall months (September through November) of above-normal and wet WYs to restore habitat



Map 1: Delta Regions

suitability. Action 5 describes the installation and operations of the spring temporary Head of Old River Barrier (HORB) and the temporary agricultural barriers to reduce juvenile entrainment. The detailed elements of these prescriptions, including rationale and justification, appear in subsequent sections of this document, by Action.

Delta Smelt Evaluation Team

To develop the initial actions, the Service re-evaluated the Interim Remedies for delta smelt protection as proposed in the Service's declarations of July 3, 2007 and August 3, 2007 (Cay Collette Goude 2007), and implemented in the Federal District Court's Interim Remedies Order. The Service used the CALLite operations model to evaluate different operational scenarios. Different operational parameters were run to evaluate their influence upon predicted entrainment. These parameters included export-inflow (EI) ratios, QWest, X2, and OMR flows, among others.

During these sessions, two clear patterns became evident. First, shifting operations to reduce exports during any one given month resulted in a shift in operations to increase exports in other months. Second, holding one particular parameter steady did not prevent other parameters from adapting to meet similar water supply objectives. For example, modeling Qwest to some static number still allowed considerable variability in negative OMR flows, due to the contribution of other intervening variables to Qwest, including operation of the DCC and Sacramento and San Joaquin River flows. For these reasons, the most logical operational criterion for protecting delta smelt from entrainment is controlling the magnitude of flows in the South and Central Delta towards the export facilities. This is reflected quantitatively as net negative OMR flows during the time periods when delta smelt are present and subject to entrainment.

In July 2008, the Service convened a team of experts comprising members of the Adaptive Management Planning Team (AMPT) of the ERP, technical staff from the Department of Fish and Game and the Service, and an expert hydrodynamicist to conduct evaluations of Interim Remedy actions using the evaluation process and conceptual models developed for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) in light of the current project description.

To the extent practicable, the DRERIP evaluation tools were used in formulating potential actions to ameliorate the anticipated effects of the proposed action. The DRERIP tools include peer reviewed ecosystem and species conceptual models for the Delta drafted by teams of experts. These models represent a compilation of the current state of scientific knowledge regarding specific ecosystems and fish species, including delta smelt.

The full DRERIP evaluation process was not applied to the potential actions for delta smelt, but elements of the process were considered and followed during the initial phases of actions development and evaluation. The nature of the task before the evaluation team finally necessitated direct involvement of technical experts in providing up-to-date

quantitative analysis and detailed evaluation exceeding the level of detail inherent in the current DRERIP conceptual models.

Role of Adaptive Process and Monitoring

As discussed in the Baseline and Effects Sections of this biological opinion, we recognize that there are multiple factors affecting delta smelt population dynamics and that not all are directly influenced by operations of the CVP/SWP. With respect to direct mortality from entrainment, the prescriptions and triggers presented in actions 1, 2, and 3 are based on historical data. Net daily OMR flows serve as a key indicator of overall Delta hydrodynamics and changing OMR flows will change a key underlying driver of future salvage. Based on the low numbers of delta smelt and therefore the difficulties in delta smelt monitoring and the uncertainty in relying on historical data, the use of an adaptive process with regulatory sideboards is essential.

It is very important that the control mechanisms used to implement the actions be functionally protective when delta smelt densities are low. Delta smelt densities are likely to remain low for the foreseeable future. When delta smelt occur at low densities, it becomes difficult to reliably infer distribution and flux towards Banks and Jones based on IEP monitoring data. In circumstances where it is difficult to reliably infer these parameters, automated control mechanisms that assume reliable distribution information are likely to fail.

The real-time monitoring of final flow prescriptions within these actions are necessary parts of the final actions. Such a strategy utilizes weekly review of the sampling data and real-time salvage data at the CVP/SWP. It utilizes the most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity, and thereby adapts to current conditions. This would provide protection to delta smelt and reduce operational constraints when the risk of delta smelt entrainment is low based on distribution and data analysis. Such a strategy would provide necessary protections while utilizing the minimum possible regulatory constraints on the project.

ACTION 1: ADULT MIGRATION AND ENTRAINMENT (FIRST FLUSH)

Objective: A fixed duration action to protect pre-spawning adult delta smelt from entrainment during the first flush, and to provide advantageous hydrodynamic conditions early in the migration period.

Action: Limit exports so that the average daily OMR flow[6] is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent).

Timing:

Part A: December 1 to December 20 – Based upon an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal and salvage data from CVP/SWP (see below), and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, FMWT, and river flows; the SWG may recommend a start date to the Service. The Service will make the final determination.

Part B: After December 20 – The action will begin if the 3 day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 NTU. However the SWG can recommend a delayed start or interruption based on other conditions such as Delta inflow that may affect vulnerability to entrainment.

Triggers (Part B):

Turbidity: 3-day average of 12 NTU or greater @ *all three* stations (Prisoner's Point, Holland Cut, Victoria Canal)

OR

Salvage: Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥0.5 (daily delta smelt salvage > one-half prior year FMWT index value).

The window for triggering Action 1 concludes when either offramp condition described below is met. These offramp conditions may occur without Action 1 ever being

[6] OMR Flows for this and all relevant actions will be measured at the Old River at Bacon Island and Middle River at Middle River stations, as has been established already by the Interim Order.

triggered. If this occurs, then Action 3 is triggered[7], unless the Service concludes on the basis of the totality of available information that Action 2 should be implemented instead.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three station daily mean at Mossdale, Antioch, and Rio Vista

OR

Biological: Onset of spawning (presence of spent females in SKT or at Banks or Jones).

[7] The offramp criteria for Actions 1 and 2 to protect adults from entrainment are identical to the initiation triggers for Action 3 to protect larval/juveniles from entrainment

Background

Adult delta smelt entrainment is characterized by a pulse of pre-spawning migrants entering the Central and South Delta following a "first flush" flow event in winter. This event generally involves a coincident increase in turbidity; which, along with the flows, is a cue for delta smelt migration. The interaction of these migratory cues: flow, turbidity, temperature, and season, leads to migration patterns that are difficult to predict yearly. However, historical salvage of delta smelt at Banks and Jones provides an index of entrainment that can be compared against key general predictors like flow and turbidity. Figures B-1 and B-2 below graphically depict the relationship of these variables against daily smelt salvage at Banks and Jones during two example WYs. Once the initial pulse of pre-spawning migration passes, it is believed that spawning adults moderate their movements to maintain their geographical range to a smaller area (when conditions stay favorable) and to the extent that delta smelt can control their location based on extant flow variables.

Entrainment effects upon delta smelt populations can be substantial (Kimmerer 2008). In one historically common scenario, a tight coincidence between calendar timing, sudden influx of turbid (>12 NTU) fresh water into the Delta, and high Delta exports may lead to very high salvage spikes. These events are seen within the data as high amplitude peaks in the daily adult delta smelt salvage histogram. Such events occurred in WY's 1993 and 2003, as displayed in Figures B-3 and B-4, which plot turbidity and negative OMR on visually convenient scales against total salvage. If this scenario plays out in years where there are few delta smelt, it may be difficult to detect salvage spikes even if they represent substantial proportional entrainment events.

In a second scenario there are no large salvage spikes, but chronic entrainment over a sufficient duration adds up to a relatively large cumulative salvage. Alternatively, there may be multiple entrainment spikes in years where the timing of migratory cues is diffuse or occurs in episodes. This would appear graphically as a histogram with generally low-amplitude over the duration of the entrainment period. Examples of such entrainment years would include WY 2004 and 2005, as displayed in Figures B-5, and B-6.

Total entrainment depends on precipitation patterns, ambient air temperature, controlled and uncontrolled releases from waterways feeding the Delta, specific operation of facilities such as the DCC, and condition of that year's pre-spawning cohort based on current year habitat quality. All of these factors may affect the distribution of delta smelt adults as and after they migrate into the Delta—and it is the migration into the entrainment risk zone and the area of that zone based on operational conditions at the time that determines ultimate mortality. However, the list of variables known or believed to influence delta smelt distribution during this period is not complete, and there is substantial apparently stochastic variation in adult delta smelt habitat use.

Figure B-1: 1995 WY OMR, Turbidity, Salvage

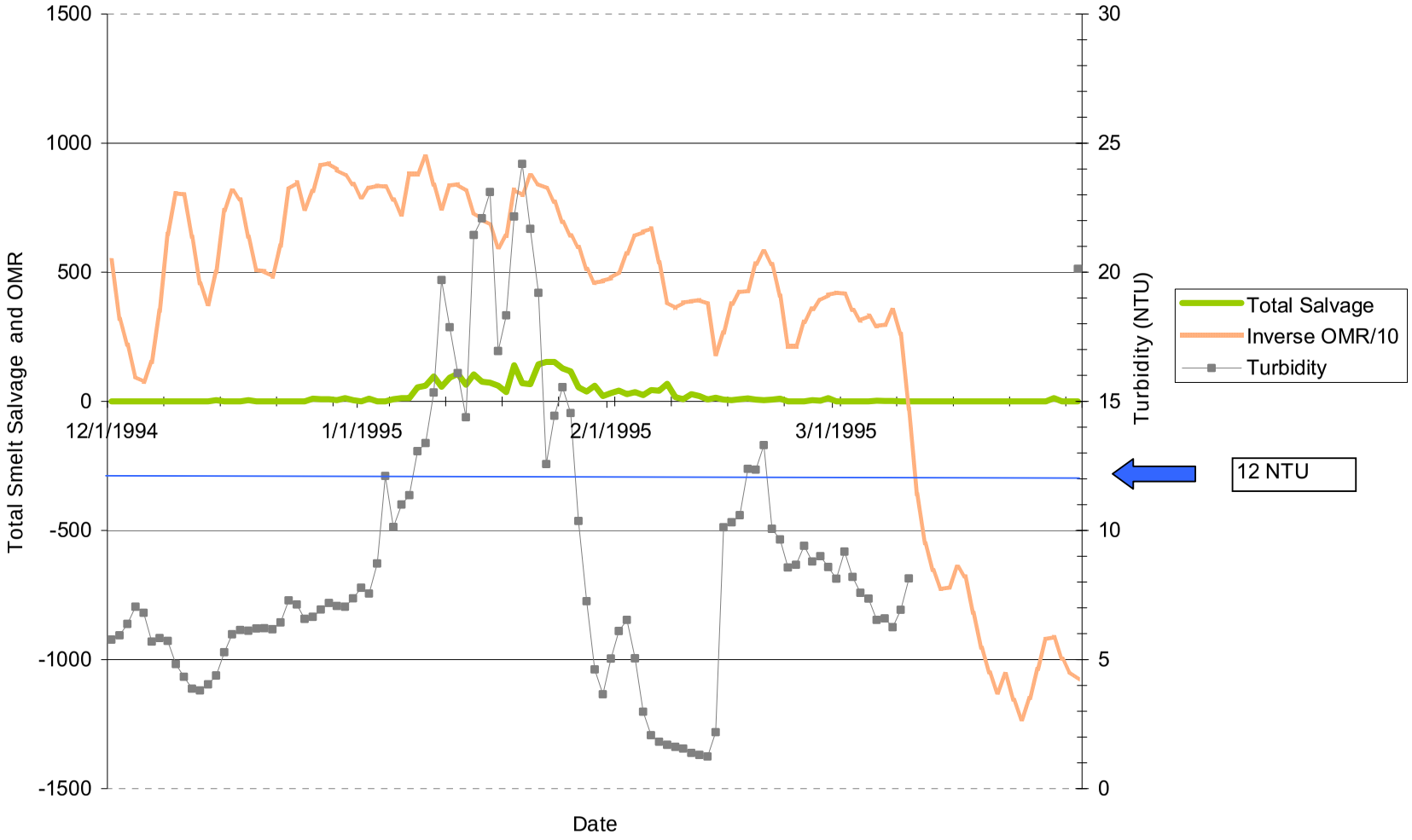


Figure B-2: 2002 WY OMR, Turbidity, Salvage

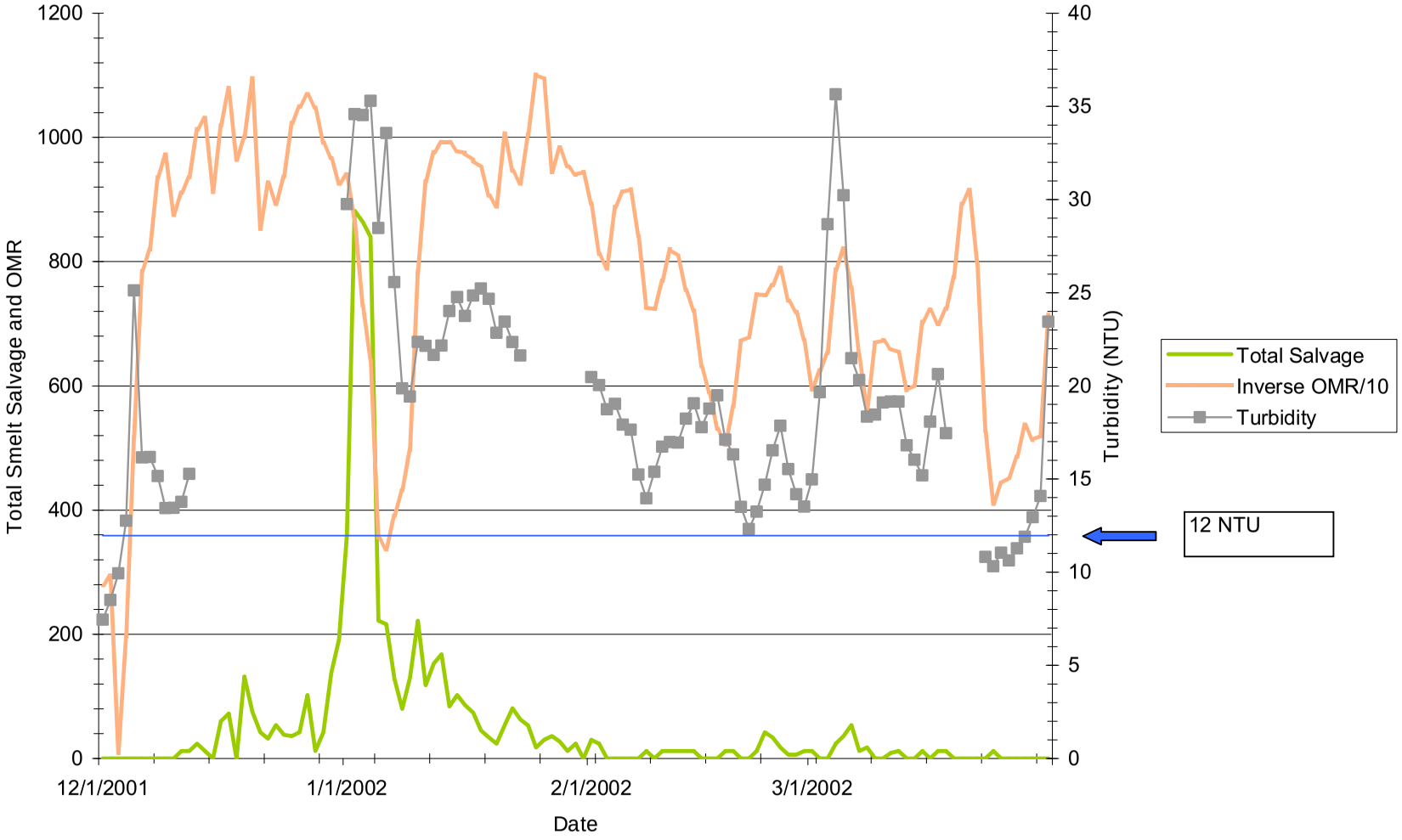


Figure B-3: 1993 WY OMR, Turbidity, Salvage

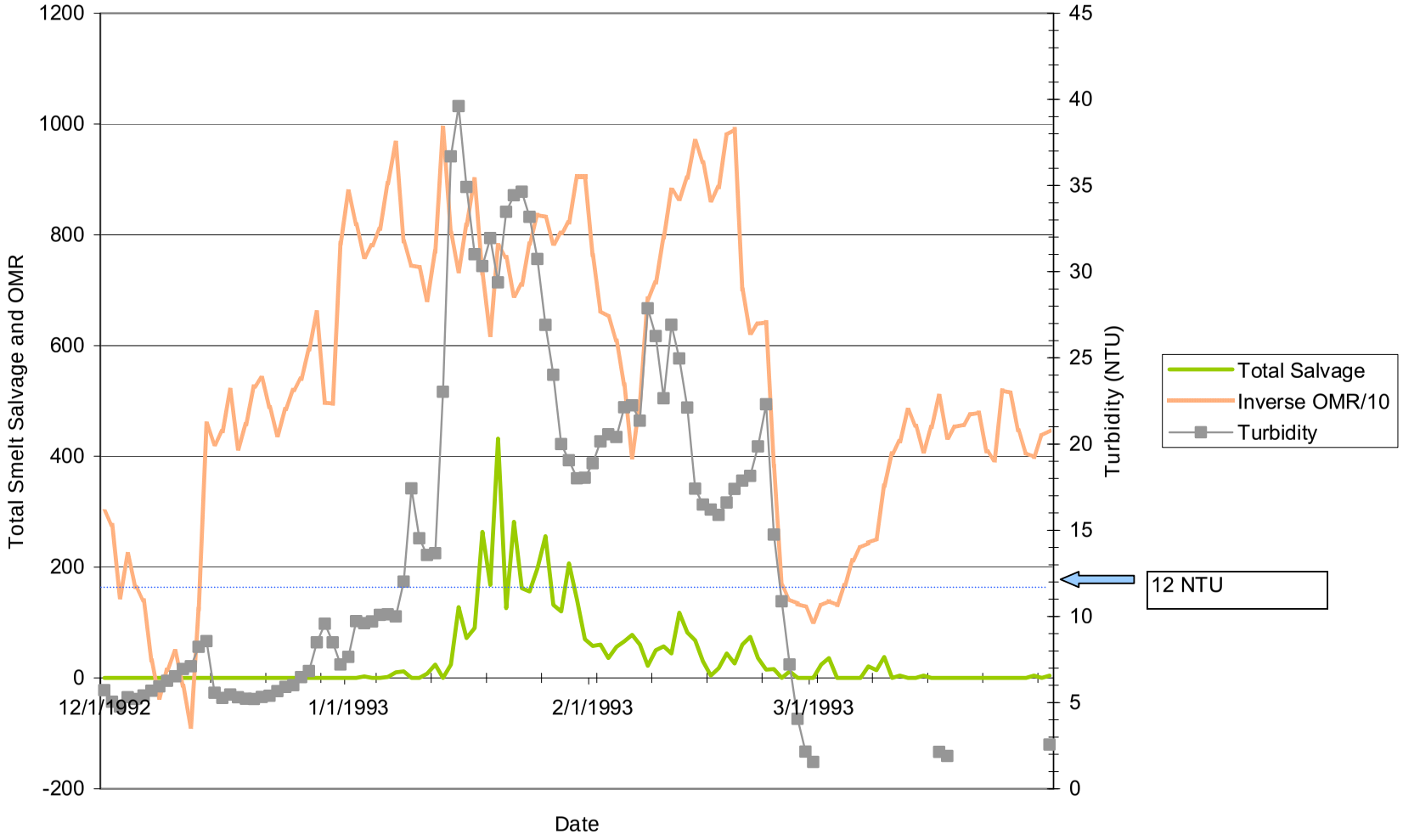


Figure B-4: 2003 WY OMR, Turbidity, Salvage

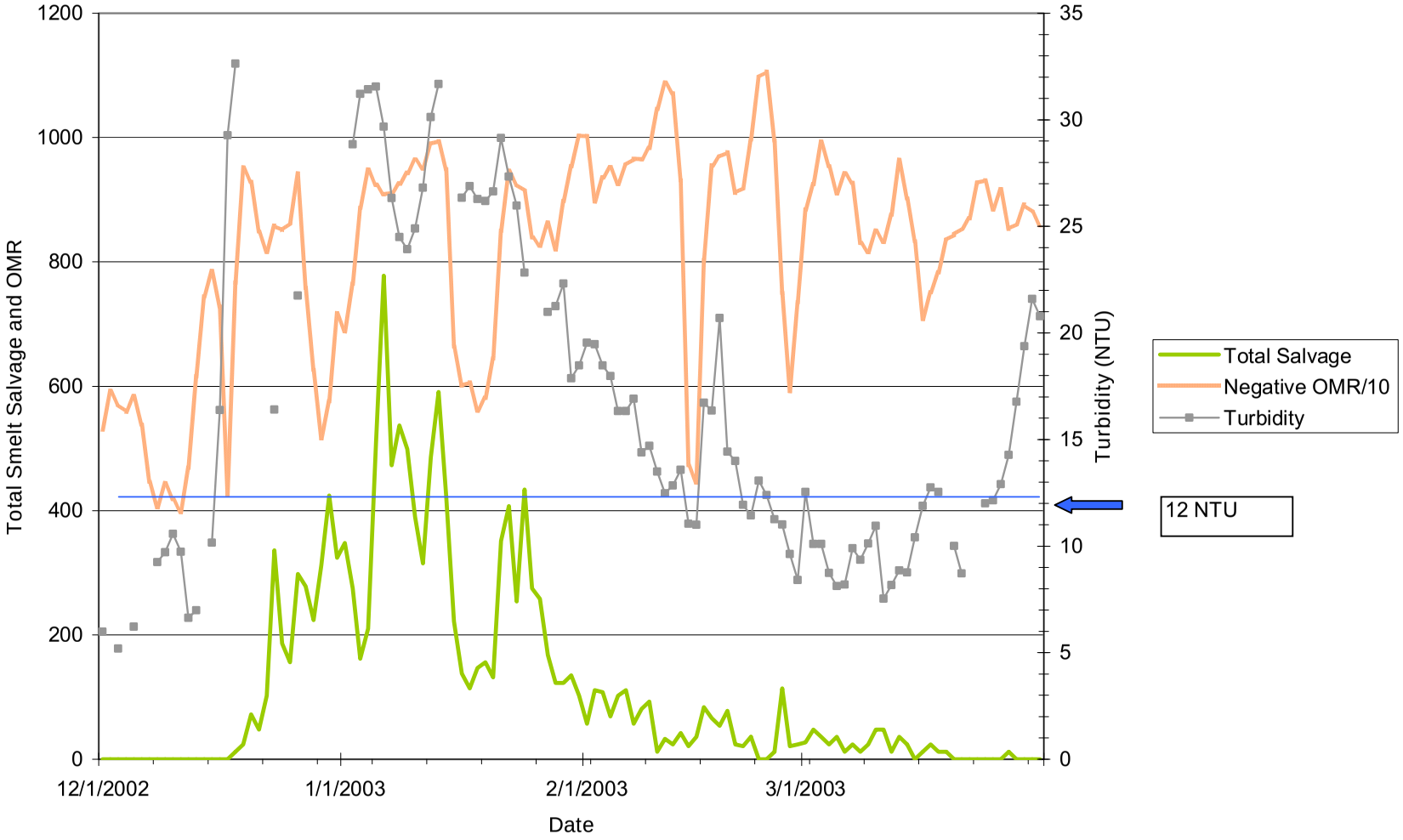


Figure B-5: 2004 WY OMR, Turbidity, Salvage

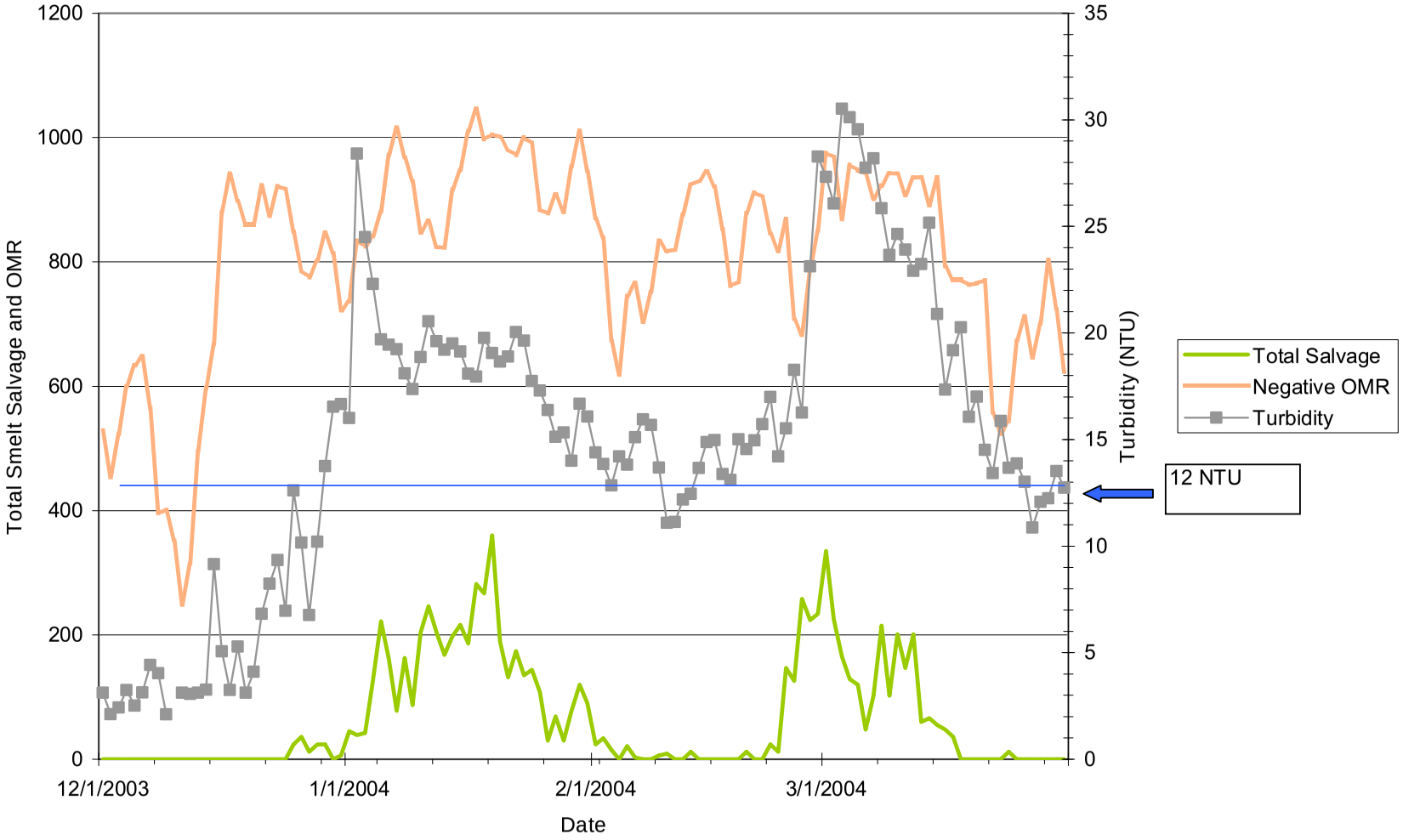
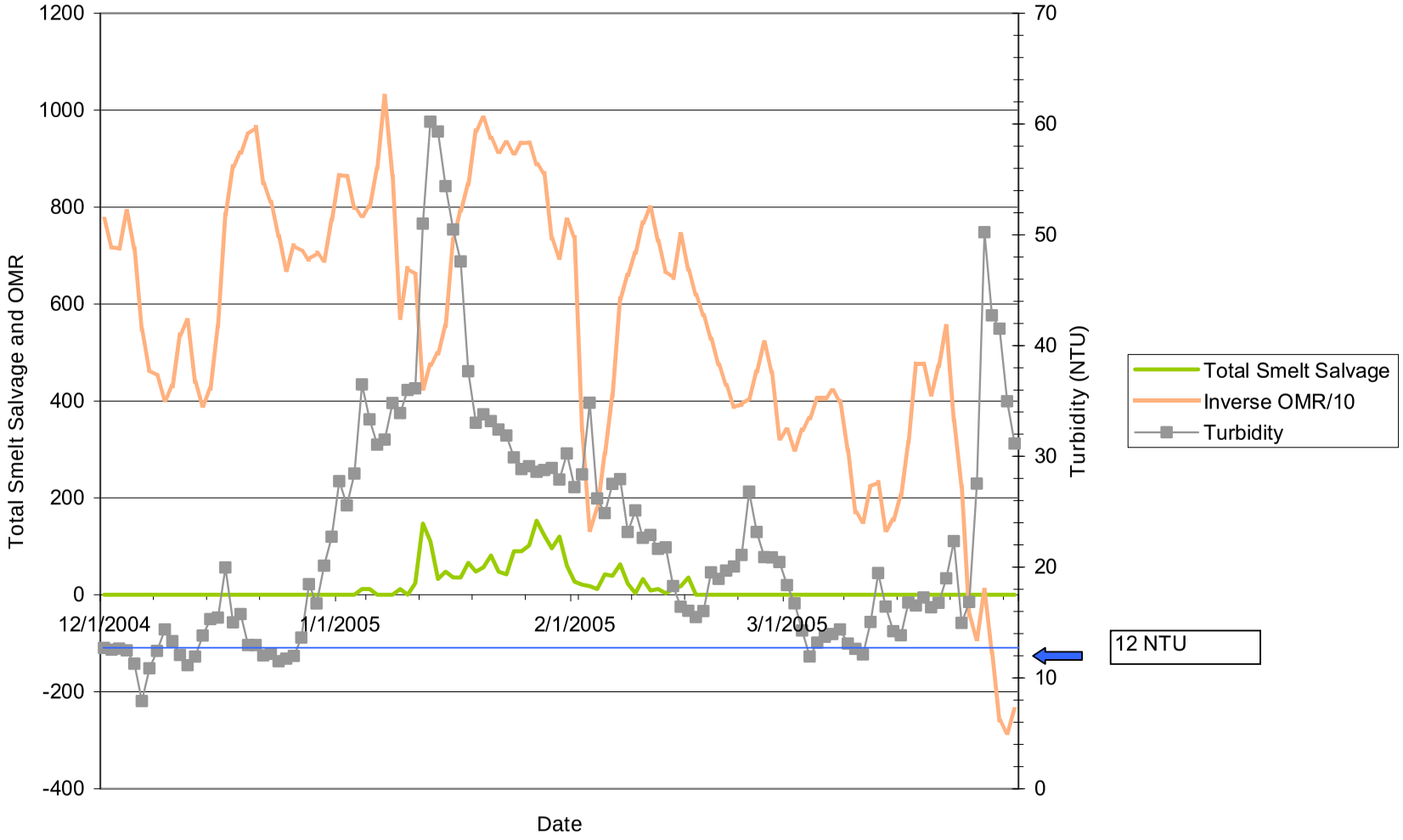


Figure B-6: 2005 WY OMR, Turbidity, Salvage



Up to fifty percent of the pre-spawning adult population has been entrained at the export facilities in recent years, depending on circumstances (Kimmerer 2008). Entrainment risk depends most importantly upon the distribution of delta smelt relative to the entrainment footprint of the CVP/SWP export facilities. Monitoring programs such as the FMWT and SKT provide a useful basis for estimating the abundance and distribution of delta smelt, despite having drawbacks (Newman 2008). The margin of error associated with abundance and distribution inferences increases at low abundances that have characterized the last several years. Abundances near the detection threshold of the sampling techniques makes it very difficult to draw reliable inferences about how many delta smelt there are, and where they are located.

To provide context to determine the magnitude of effect of pre-spawning adult direct mortality through entrainment within any given season (as measured by salvage), it is necessary to consider two important factors. First, although salvage is an index of entrainment, it is not a direct quantitative equivalent. The number of delta smelt that are actually counted at the salvage facilities represents a small percentage of the actual number entrained (See baseline section). Efficiency of sampling methodology is another consideration given the delicate tissues of the delta smelt, and this decreases inversely with fish size (adults are most accurately counted, while juvenile salvage efficiency is much lower, while <20mm smelt are mostly undetectable at the salvage facilities). Finally, although surviving individuals are held and released to the Delta, it is generally thought that they do not survive. Therefore salvage at the Banks and Jones facilities is not a good estimate of actual adult delta smelt mortality through entrainment (See baseline section).

The second factor to consider when relating salvage data to population-level significance is that the total number salvaged at the facilities does not necessarily indicate a negative impact upon the overall delta smelt population. The Salvage Index normalizes salvage to the population size based upon the previous FMWT Index:

Salvage Index = Number of Delta Smelt Salvaged ÷ Prior Year FMWT Index

Summaries of delta smelt salvage are presented by WY in Table B-2. Figures B-7 through B-11 display salvage data normalized to prior-year FMWT for the POD years (WY2002-WY2006). These plots have consistent units on the y-axis, reflecting the Salvage Index. The area under the salvage histogram reflects the total number of smelt salvaged, and this is a metric that can be related to total demographic impacts through entrainment. Review of salvage histograms within Figures B-7 through B-11 gives a sense of the magnitude of entrainment effects for all detectable lifestages of smelt through the water year.

Table B-2: Total Adult Delta Smelt Salvage by Year, including summary statistics

Year	Total Salvage	Prior Year FMWT	Cumulative Salvage Index	Peak Daily Salvage "Amplitude"	Salvage distribution	12 NTU "Trigger Date"	NTU trigger to peak salvage (days)	Total # salvaged before trigger	propn of total season salvage prior to trigger date
1993	4425	156	28.4	2.77	unimodal	10-Jan	12	27	0.0061
1994	398	1078	0.37	0.08	unimodal	4-Jan	52	100	0.25
1995	2600	102	25.5	1.49	unimodal	9-Jan	16	150	0.058
1996*	5634	899	6.27	0.52	unimodal	14-Feb	36	0	0.00
1997	1816	127	14.3	1.12	unimodal	20-Dec	80	12	0.007
1998	1027	303	3.39	0.38	bimodal	20-Dec	10 & 94	75	0.073
1999	2074	420	4.94	0.40	unimodal	14-Jan	36	20	0.0096
2000	11493	864	13.34	0.72	unimodal	23-Jan	28	482	0.042
2001	7991	756	10.6	0.49	unimodal	13-Jan	29	255	0.032
2002	6865	603	11.4	1.46	unimodal	20-Dec	14	324	0.047
2003	14323	139	103	5.60	unimodal	20-Dec	17	108	0.0075
2004	8148	210	38.8	1.71	bimodal	31-Dec	19	126	0.015
2005	2018	74	27.3	2.07	unimodal	20-Dec	39	0	0.00

* 3 NTU sensor malfunctions most of year; date evaluated as Dec 20 using total inflow > 25,000 cfs

Review of salvage data across years for which monitoring data are available indicate some patterns which led to the development of Interim Remedies Action 1; the same logic has been used to develop the present Action 1. First, salvage data during winter generally follows a unimodal distribution, with a defined salvage peak, and short duration. Occasionally, climatic conditions and operational criteria interact to produce bimodal or diffuse salvage distributions, however these year types are the exception, as summarized in Table B-2. Peak salvage usually occurs during the month of January, however this pattern does not hold during all year types, and some years even exhibit low overall adult salvage (wet WY of 1997 and 1998, or dry years with no winter first flush as in WY 1994).

Historic delta smelt salvage data and the current population status suggest a protective strategy for this period that focuses upon prevention of the attraction and subsequent entrainment of pre-spawning adults during the onset of upstream migration. While salvage itself is a useful indicator of distribution after the fact, it has serious drawbacks as a management tool when used on its own, because a large entrainment event may be inevitable by the time an increase in salvage is detected.

Figure B-7: 2002 WY Salvage Index

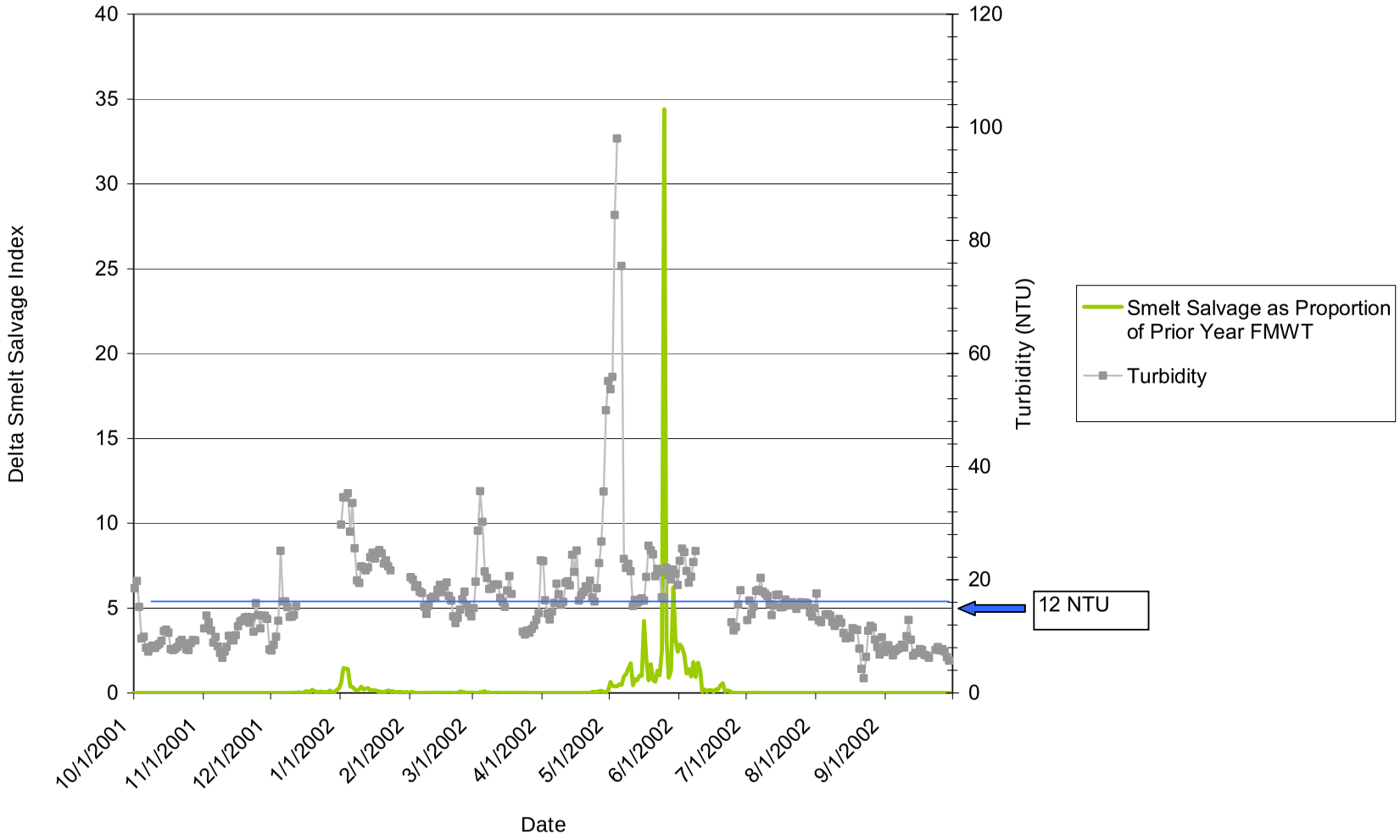


Figure B-8: 2003 WY Salvage Index

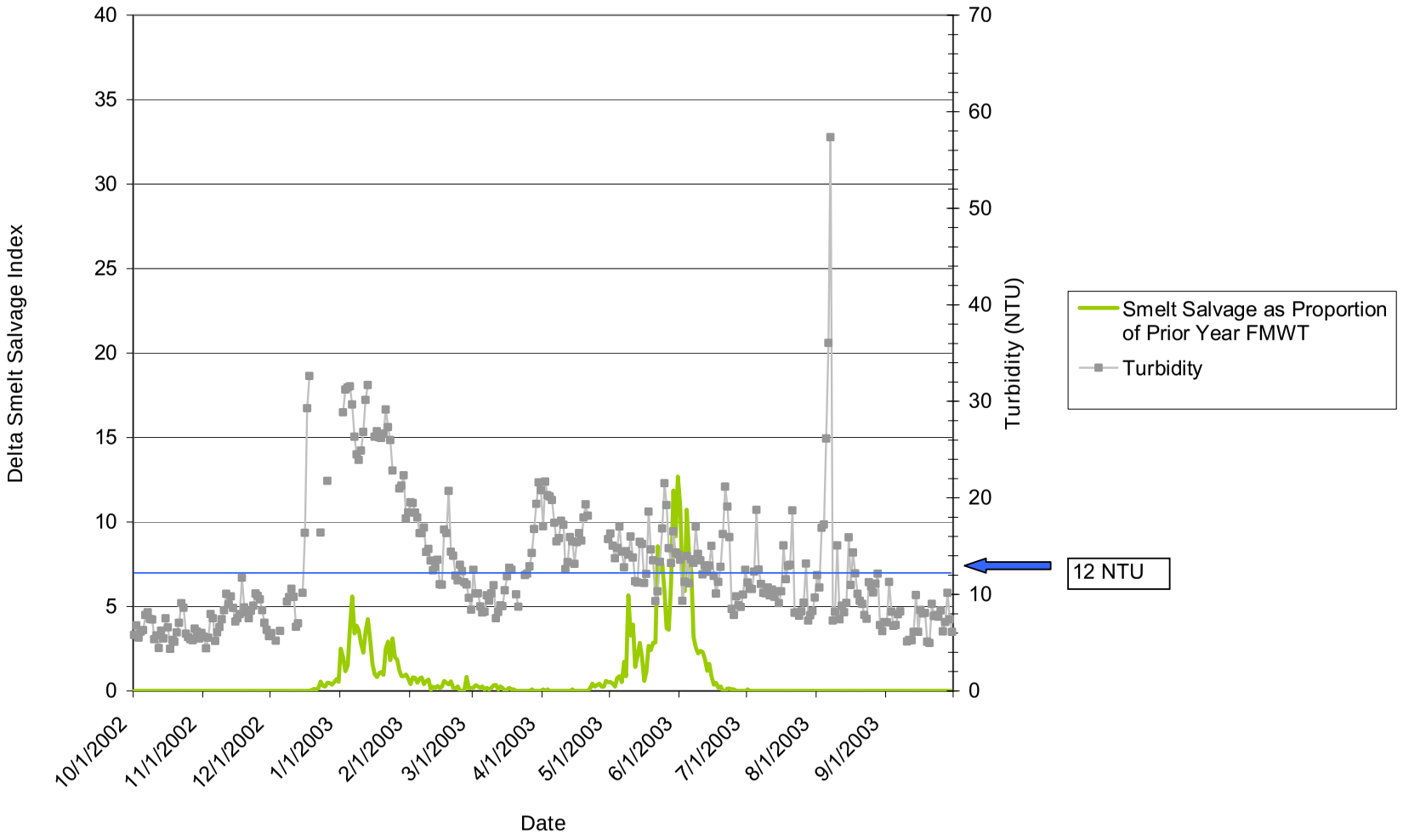


Figure B-9: 2004 WY Salvage Index

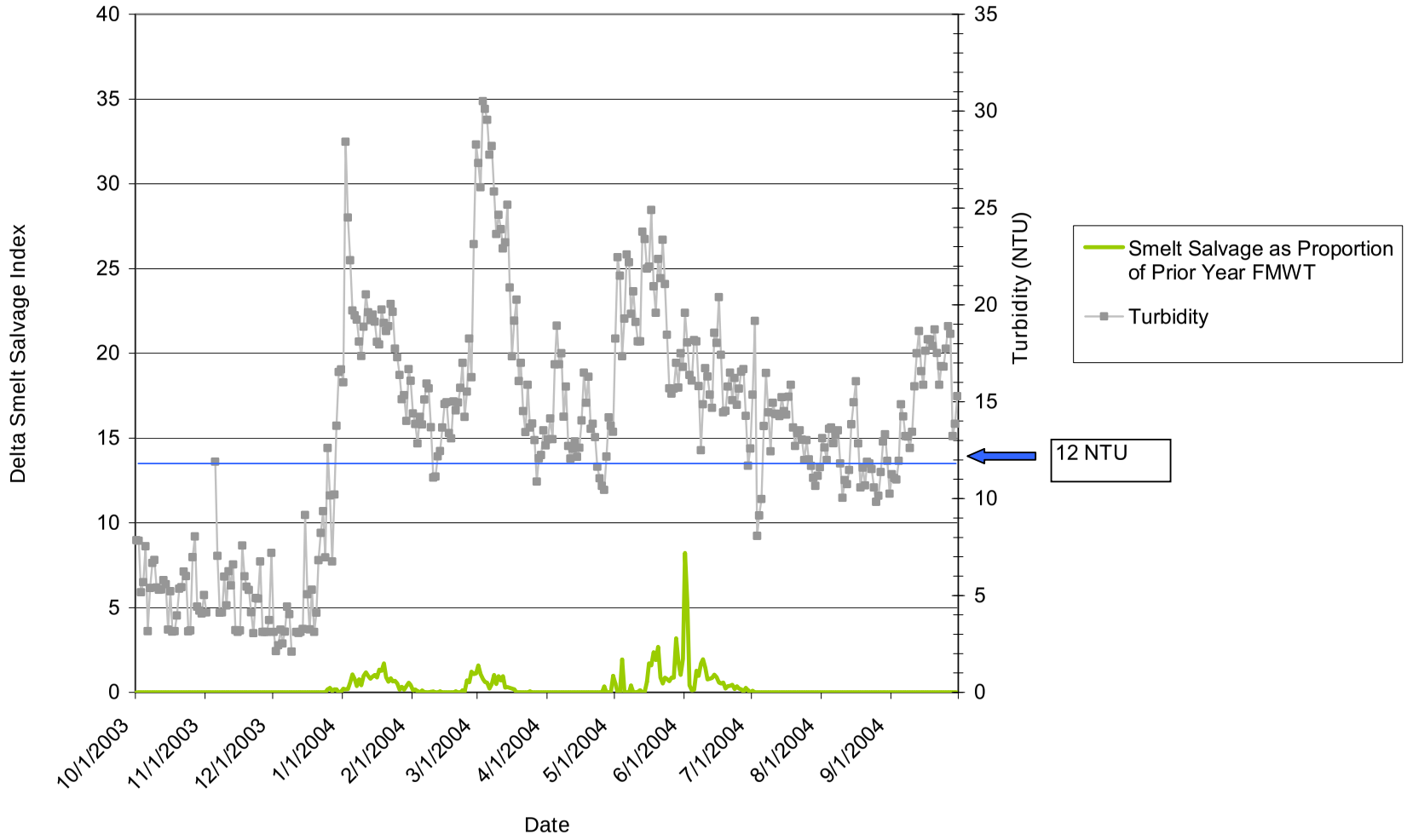


Figure B-10: 2005 WY Salvage Index

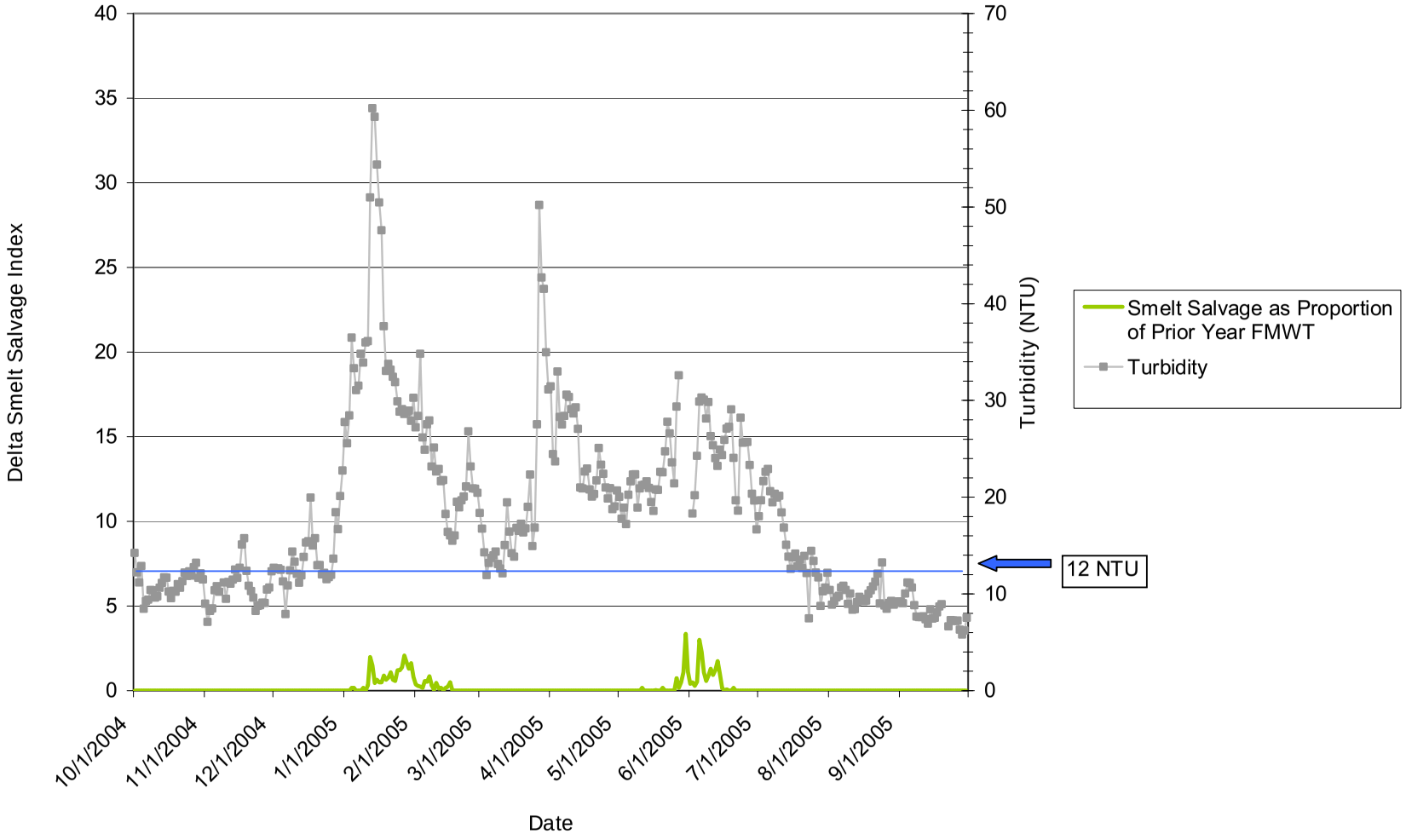
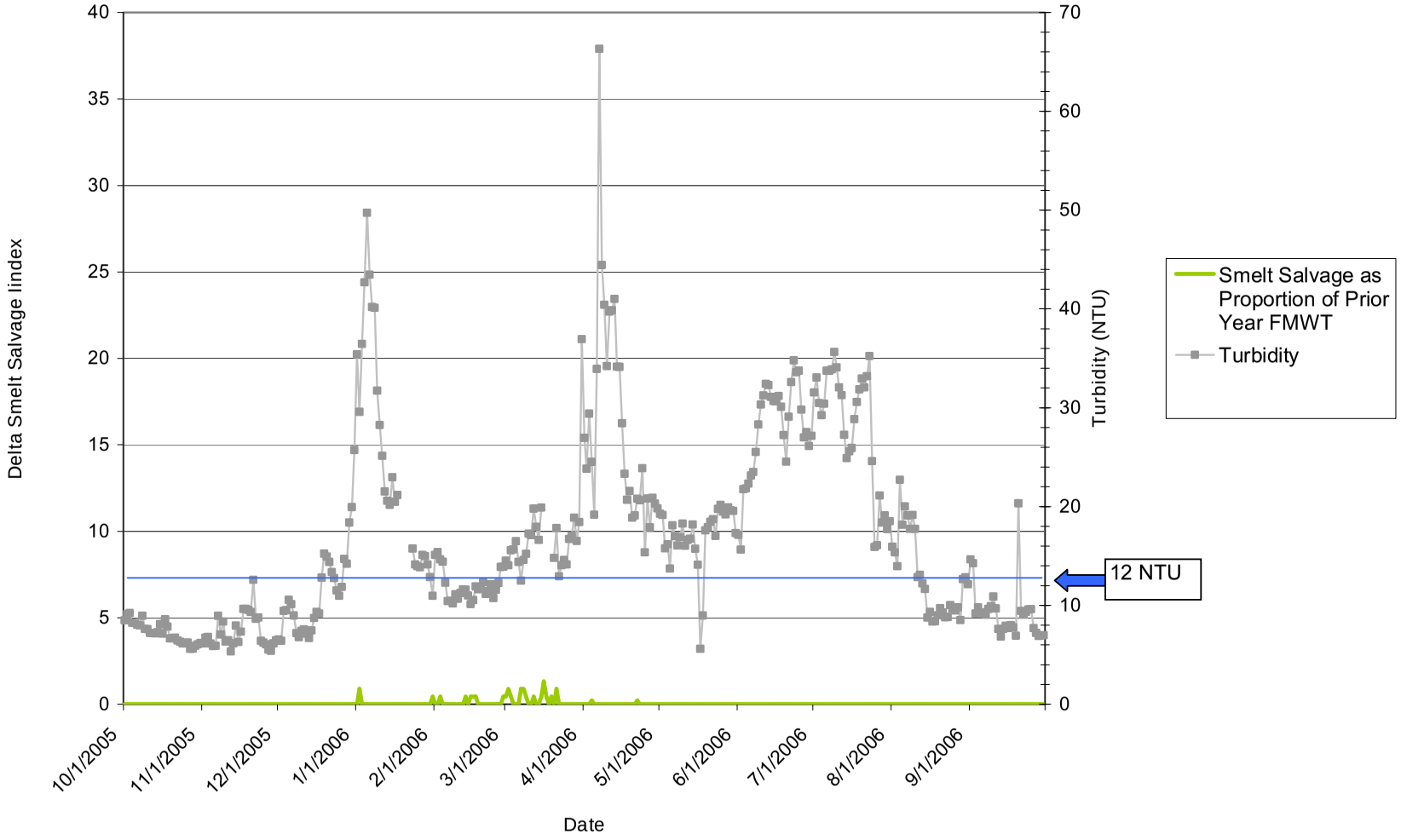


Figure B-11: 2006 WY Salvage Index



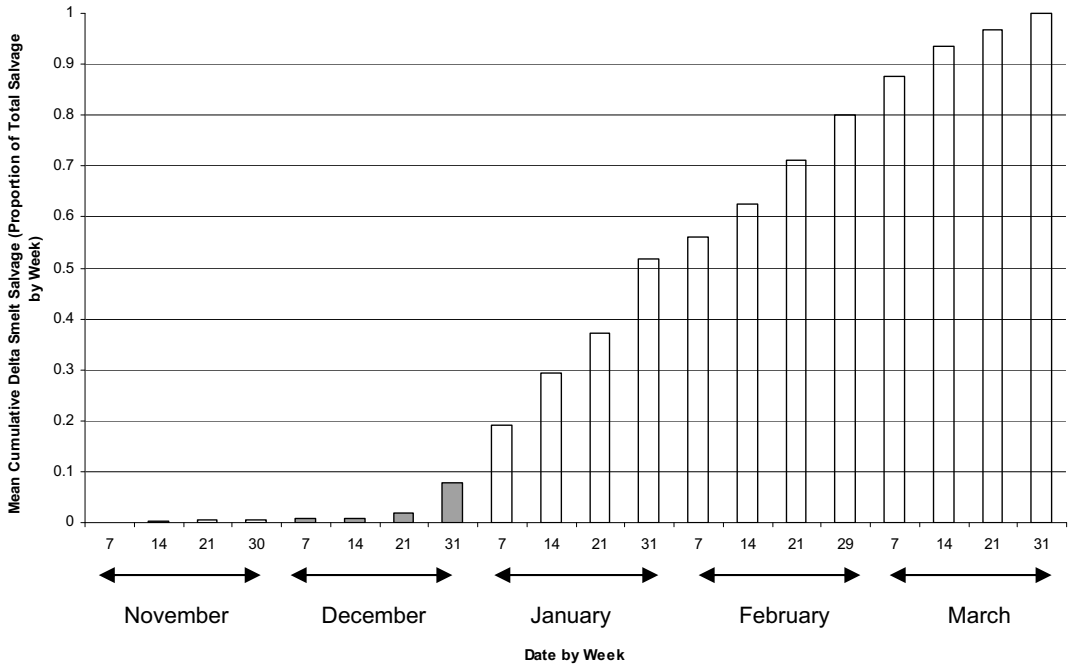
Justification for Timing of Action 1

Action 1, Part A covers the period (December 1 to December 20) when first flush salvage events were historically uncommon (Figure B-12). During this period the SWG will review conditions from week to week and may recommend to the Service that Action 1 be triggered. Part B of Action 1 (December 20 to March) covers a period when first flush salvage events have been historically more common. Part B will be triggered when turbidity increases above 12 NTU. The Service can bypass implementation of the trigger if the SWG concludes that the trigger was met by conditions (i.e., wind-induced turbidity) not likely to initiate smelt migration.

The timing of first flush salvage events is variable in any given WY. Thus, initiation of Action 1 is based on conditions (i.e., turbidity) rather than a specific month. Action 1 is therefore designed to provide flexibility and maximum protection for delta smelt. On average, about 1 percent of cumulative adult delta smelt entrainment occurs by December 21 (Figure B-12). By December 31, cumulative salvage has historically reached 3.2 percent.

Action 1 will be shifted from December 25 (as described in the Interim Remedies) to December 20 because it better reflects the period when protection will be needed. As previously mentioned, the Service will decide to initiate Action 1 before December 20 if the conditions warrant evidence smelt are migrating upstream (i.e., salvage, trawl data). Beginning in December, the SWG will review physical and biological parameters historically associated with smelt migration (i.e., precipitation, operations, turbidity, and salvage data) to make ongoing recommendations to the Service about the need to implement Action 1 at any time.

Figure B-12: Cumulative Proportional Salvage for WY 1993 to 2006 by Week



Duration of Action 1

The Interim Remedies Action 1 has been revised from ten to 14 days to incorporate coverage between spring and neap tidal cycles that may influence migration rate into the interior Delta.

Justification for the Salvage Guideline Action 1

In many years, delta smelt have been salvaged prior to when turbidity elevates above 12 NTU (Table B-2). In the case that salvage begins prior to the trigger, the decision to implement Action 1 will be based on the following: 1) magnitude of salvage scaled to the population size (Table B-2), and 2) the amplitude which represents daily salvage divided by the prior year FMWT.

The 4th column in Table B-2 lists the cumulative seasonal salvage of adult delta smelt divided by the prior year FMWT Index (the Cumulative Salvage Index). This value ranged from a minimum of 0.37 in WY 1994 to a maximum of 103 during WY 2003. The combination of peak (amplitude in the histogram or maximum daily salvage), and Cumulative Salvage Index is a general index of the magnitude of adult entrainment in a given WY.

The median value for the Cumulative Salvage Index for the years presented would be 13.3. The mean value for all years within the range presented in Table B-2 is 22.1. For peak daily salvage, the Salvage Index mean for the WY 1993 through 2005 is 1.45. The median amplitude value is 1.1. Taking these data into account, a Cumulative (seasonal) Salvage Index exceeding 7.25 appears to be indicative of an unacceptable risk threshold based on the current low numbers of delta smelt. A peak Daily Salvage Index of 1.0 is suggested as an index of daily smelt salvage at levels or maintained at existing levels that ongoing or anticipated salvage could rapidly reach unacceptable losses if exports are to increase. These values are carried forward into the prescriptions as pre-emptive triggers, and as releases from Action prescriptions to carry forward through Actions 1 and 2.

Justification for the Turbidity Criterion as a Trigger in Action 1 (Part B)

Onset of Action 1 during Part B

Turbidity associated with freshets of water is a reasonable indicator of when smelt begin to migrate upstream and become vulnerable to salvage. Though this historical trend is based on the turbidity sensor located outside the Clifton Court Forebay, there is no expectation that the relationship between increased flow and turbidity would differ from recently installed sensors identified in the Interim Remedies: Prisoners Point, Holland Cut, and Victoria Canal. It appears that the Holland Cut sensor is sensitive to localized wind conditions at times. On December 25-27, 2007, a three-day rise in turbidity at the Holland Cut monitoring station triggered Action 1. It was unlikely that a wind-associated turbidity event initiated smelt migration. Rather than rely on one of these stations to trigger Action 1 (Interim Remedies), Action 1 will be triggered when turbidities elevate over 12 NTU at all three stations. The use of three stations would better reflect a Delta-wide change in turbidity than one station which may be prone to localized conditions.

Timing and the Protectiveness of the 12 NTU criterion

If the 12 NTU threshold had been used in previous years, Action 1 would have likely provided early protection (i.e., less salvage) during most years. The degree to which it would have minimized the number of smelt entering the South Delta is unknown.

Justification for Flow Prescriptions in Action 1

Understanding the relationship between OMR flows and delta smelt salvage allows a determination of what flows will result in salvage. The OMR-Salvage analysis herein was initiated using the relationship between December to March OMR flow and salvage provided by P. Smith and provided as Figure B-13, below. Visual review of the relationship expressed in Figure B-13 indicates what appears to be a “break” in the dataset at approximately -5,000 OMR; however, the curvilinear fit to the data suggest that the break is not real and that the slope of the curve had already begun to increase by the time that OMR flows reached -5,000 cfs.

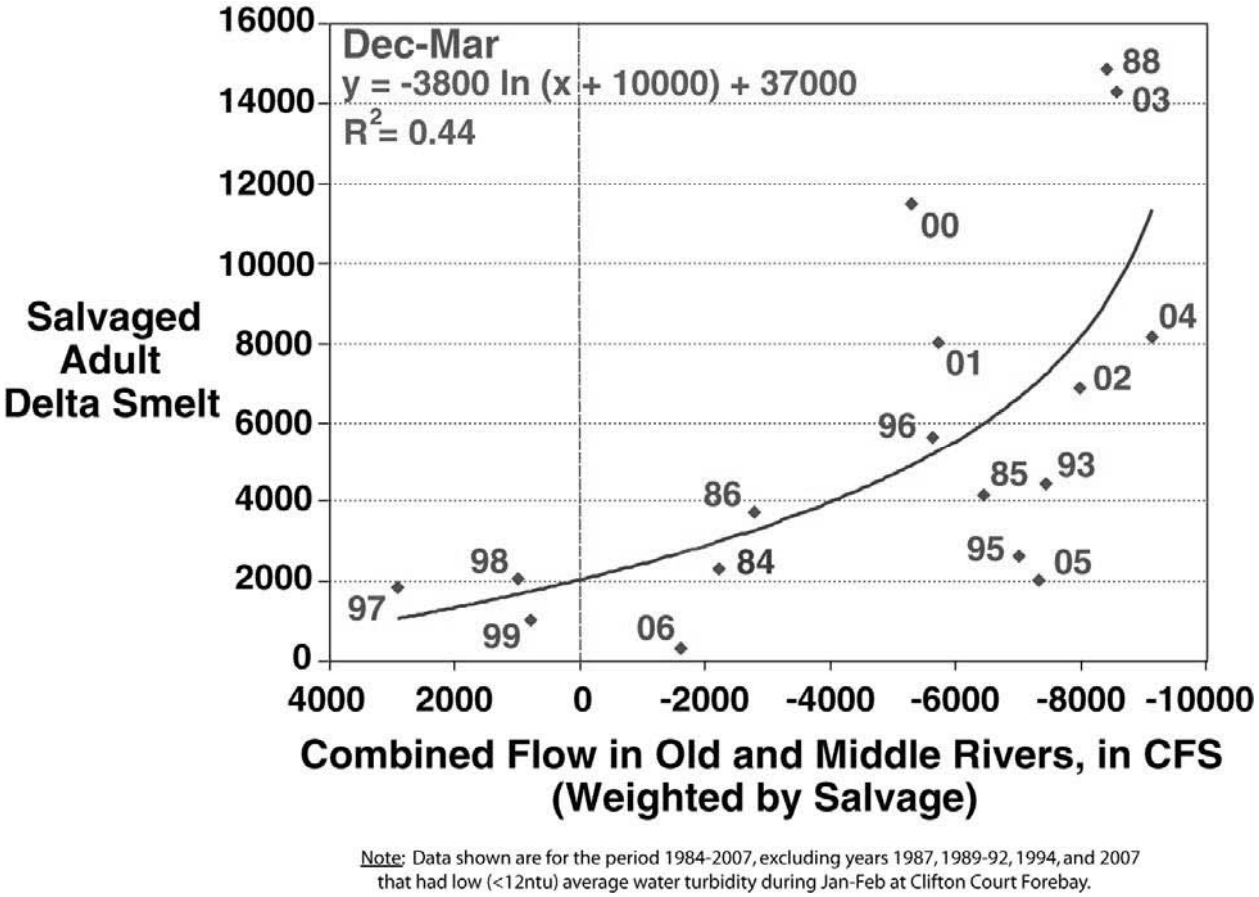


Figure B-13. OMR-Salvage relationship for adult delta smelt. (source, P. Smith). Data from this figure were the raw data used in the piecewise polynomial regression analysis.

Further, a nonlinear regression was performed on the dataset, and the resulting pseudo-R^2 value was 0.44—suggesting that although the curvilinear fit is a reasonable description of the data, other functional relationships also may be appropriate for describing the data. Fitting a different function to the data could also determine the location where salvage increased, i.e. identify the "break point" in the relationship between salvage and OMR flows. Consequently, an analysis was performed to determine if the apparent break at -5,000 cfs OMR was real. A piecewise polynomial regression, sometimes referred to as a multiphase model, was used to establish the change (break) point in the dataset.

A piecewise polynomial regression analysis with a linear-linear fit was performed using data from 1985 to 2006. The linear-linear fit was selected because it was the analysis that required the fewest parameters to be estimated relative to the amount of variation in the salvage data. Piecewise polynomial regressions were performed using Number Cruncher Statistical Systems (© Hintz, J., NCSS and PASS, Number Cruncher Statistical Systems, Kaysville UT).

The piecewise polynomial regression analysis resulted in a change point of -1162, i.e. at -1162 cfs OMR, the slope changed from 0 to positive (Figure B-14). These results indicate that there is a relatively constant amount of salvage at all flows more positive than -1162 cfs but that at flows more negative than -1162, salvage increases. The pseudo-R^2 value was 0.42, a value similar to that obtained by P. Smith in the original analysis.

To verify that there was no natural break at any other point, the analysis was performed using a linear-linear-linear fit (fitting two change points). The linear-linear-linear fit resulted in two change points, -1,500 cfs OMR and -2,930 cfs OMR. The -1,500 cfs value is again the location in the dataset at which the slope changes from 0 to positive. The pseudo-R^2 value is 0.42 indicating that this relationship is not a better description of the data. Because of the additional parameters estimated for the model, it was determined that the linear-linear-linear fit was not the best function to fit the data, and it was rejected. No formal AIC analysis was performed because of the obvious outcome.

A major assumption of this analysis is that as the population of Delta smelt declined, the number of fish at risk of entrainment remained constant. If the number of fish in the vicinity of the pumps declined, fewer fish would be entrained and more negative OMR flows would result in lower salvage. This situation would result in an overestimate, i.e. the change point would be more positive. In fact, if the residuals are examined for the relationship in Figure B-13 above, the salvage for the POD years 2002, 2004, 2005, and 2006 are all below the line. 2003 is above the line although the line is not extended to the points at the top of the figure, and these data points occur when the curve becomes almost vertical. The negative residuals could be a result of a smaller population size available for entrainment and salvage. This could be verified by normalizing the salvage data by the estimated population size based on the FMWT data.

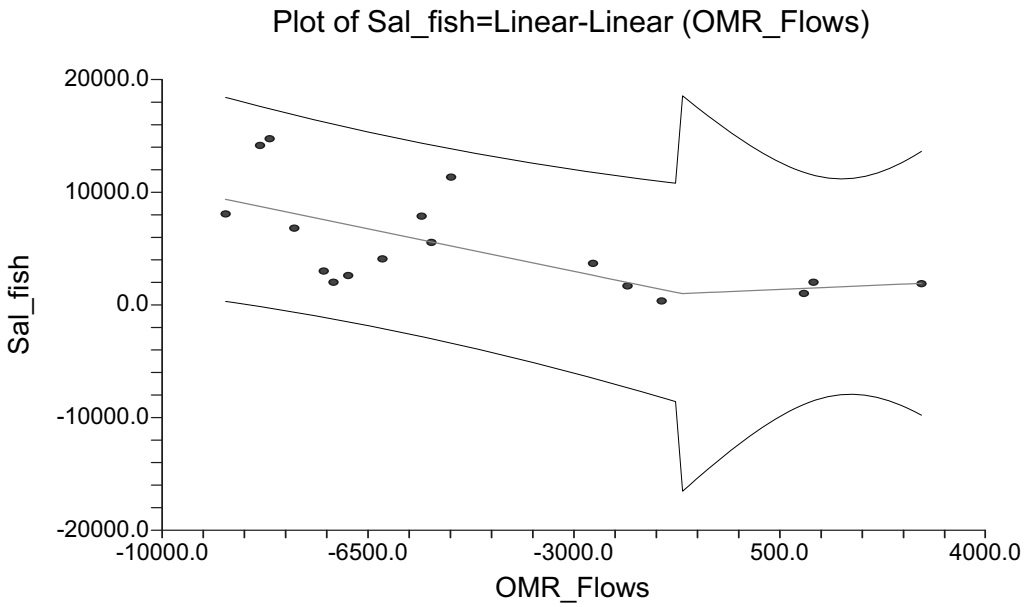


Figure B-14. Piecewise polynomial regression of OMR flows and salvage. The change point is the location at which the two regression lines meet; -1,162 cfs OMR.

The original values of OMR and salvage could have been measured with error due to a number of causes, consequently the values used in the original piecewise polynomial analysis could be slightly different than the "true" values of salvage and OMR flow. Consequently, a second analysis was undertaken to examine the effect of adding stochastic variation to the OMR and salvage values in the piecewise polynomial regression analysis. The correlation between OMR and salvage in the original dataset was -0.61 indicating that the more negative the OMR, the greater the salvage. Consequently, it was necessary to maintain the original covariance structure of the data when adding the error terms and performing the regressions. The original covariance structure of the OMR–salvage data was maintained by adding a random error term to both parameters. The random error term was added to OMR and a correlated error term was added to salvage. The expected value of the correlated errors was -0.61.

The error terms were selected from a normal distribution with a mean of 1.0 and a standard deviation of 0.25 which provided reasonable variability in the original data. Operationally this process generated a normal distribution of OMR and salvage values in which the mean of the distributions were the original data points. Additional analyses were performed with standard deviations of 0.075, 0.025, and 0.125. Smaller standard deviations in the error term resulted in estimates of the change point nearer to the original estimate of -1,162 cfs. This is to be expected as the narrower the distribution of error terms, the more likely the randomly selected values would be close to the mean of the distribution. The process was repeated one hundred times, each time a new dataset was generated and a new piecewise polynomial regression was performed. The software package @Risk (© Palisade Decision Tools) was used to perform the Monte Carlo simulations. Latin hypercube sampling was used to insure that the distributions of OMR and salvage values were sampled from across their full distributions. The parameter of

interest in the simulations was the change point, the value of the OMR flow at which the amount of salvage began to increase. Incorporating uncertainty into the analysis moved the change point to -1,800 cfs OMR, indicating that at flows above -1683, the baseline level of salvage occurred but with flows more negative than -1683, salvage increased.

Justification for Release from Prescriptions of Action 1

Temperature

The Interim Remedies prescribed regulatory release from Action 1 once mean water temperatures at Rio Vista, Antioch, and Mossdale Stations reaches 12°C. This metric is used as a surrogate to indicate time when spawning is likely to have begun based on physiological preferences.

Biological Conditions

The Interim Remedies prescribed regulatory release from Action 1 once spent females are detected in the SKT or at the salvage facilities.

Changing the Timing of the Action

If the SWG recommends a delayed start or interruption to Action 1 based on variations in conditions which may affect vulnerability to entrainment (e.g., no observed salvage and a rapid reduction in turbidity after the first week of Action 1), the Service will weigh such information and make a final determination on protective OMR flow requirements.

ACTION 2: ADULT MIGRATION AND ENTRAINMENT

Objective: An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions.

Action: The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below) specific OMR flows within this range are recommended by the SWG from the onset of Action 2 through its termination (see Adaptive Process in Introduction). The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP and SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The Service will make the final determination.

Timing: Beginning immediately after Action 1. Before this date (in time for operators to implement the flow requirement) the SWG will recommend specific requirement OMR flows based on salvage and on physical and biological data on an ongoing basis. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt.

Suspension of Action:

Flow: OMR flow requirements do not apply whenever a three day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three station daily average (Rio Vista, Antioch, Mossdale)

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility)

Adaptive Process Required Parameters:

Two scenarios span the range of circumstances likely to exist during Action 2. First, the low-entrainment risk scenario. There may be a low risk of adult entrainment because (a) there has been no discernable migration of adults into the South and Central Delta (b) the upstream migration has already occurred but turbidity is low and there is no or little evidence of ongoing adult entrainment. In this scenario, higher negative OMR flow rates as high as -5,000 cfs may be ventured as long as entrainment risk factors and salvage permit.

The second scenario, the high-entrainment risk scenario, is one in which either (a) there is evidence that upstream adult migration is currently occurring, or (b) upstream migration has already occurred and there are adult fish in the South and Central Delta and turbidity is high, increasing the risk of entrainment, or (c) there is evidence of ongoing entrainment, regardless of other risk factors. In this case, OMR flow will be set to reduce entrainment and/or the risk of entrainment as the totality of circumstances warrant.

Generally, if the available distributional information suggests that most of the delta smelt are in the North or North/Central Delta, then OMR flow can be chosen to minimize Central Delta entrainment. However, if the distributional information suggests there are delta smelt in the Central or South Delta, then OMR flow will have to be set lower to reduce entrainment of delta smelt.

The following two paragraphs describe how these action guidelines would be implemented at the start of Action 2 and at other times during Action 2.

1. OMR flow setting at initiation of Action 2

a) If salvage is zero during the final 7 days of Action 1, and three-station mean turbidity is below 15 NTU, then increase negative OMR flow to no more negative than -5,000 cfs on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable required OMR flow[8]; *UNLESS*

b) If salvage is less in the most recent three days than in the preceding three days of Action 1, and the maximum Daily Salvage Index is ≤1 during the prior 7 days, then limit exports to achieve OMR flows no

[8] Both the 14-day and the 5-day running averages will be computed using the "tidally filtered" daily average OMR flows reported by USGS.

more negative than -3,500 cfs on a 14-day running average for 7 days (or until 4 consecutive days of zero salvage or any 5 of 7 days with zero salvage), with a 5-day running average within 25 percent of the applicable required OMR flow; *OR*

c) If salvage is greater or equal in the last three days than in the preceding three days of Action 1, and maximum Daily Salvage Index ≥1 during any of those days, then continue OMR flow at no more negative than -2,000 cfs on a 14-day running average for an additional 7 days (or until 4 succeeding days of zero salvage or any 5 of 7 days zero salvage), with a simultaneous 5-day running average within 25 percent of the applicable requirement OMR; *OR*

d) If circumstances existing at the initiation of Action 2 are, in the judgment of the Service, markedly different from those anticipated in (a) through (c) above, then the OMR flow requirement in (c) will be applied and the SWG will review available data and recommend an initial flow rate to the Service.

2. OMR flow setting after initiation of Action 2

a) The SWG will review all available information and request updated entrainment simulations and/or other information, as needed, on a weekly basis to decide whether the current OMR flow requirement is appropriate or should be changed.

b) Unless OMR flow is grossly positive regardless of water project operations, due to high Delta inflows, then important variables that affect the risk of adult entrainment during Action 2 include (1) salvage or other actual entrainment indicators, (2) turbidity, (3) available monitoring results, hydrologic variables other than export pumping rates that affect OMR flow, (4) apparent population size from the preceding FMWT survey, and (5) particle tracking or other model-based entrainment risk information.

c) As described above, the risk of entrainment is generally higher when there is evidence of ongoing entrainment or turbidity is high, and these two variables are the most likely triggers of decisions to raise or lower OMR flow requirements.

d) Based on historical experience, OMR flow requirements between the limits of -2,000 cfs and -5,000 cfs are likely to be adequate in most years. The exception is years in which there appears, for whatever reasons, to be a substantial fraction of the adult spawning migrant population in the Central and/or South Delta. When this occurs, more stringent OMR limitation (possibly to no more negative than -1,250 cfs) may be required.

Background

Action 2 reflects the period when OMR prescriptions for pre-spawning adult delta smelt are still required to protect parental stock prior to reproduction, however such controls may generally be relaxed because the main pulse of fish migration has occurred and adults are holding more tightly to their selected spawning areas. Action 2 may also be needed to extend protections consistent with Action 1 in years of longer spawning migration periods or changing environmental conditions. Conditions are highly variable in any given year. Rather than provide a prescription that is protective under all circumstances, an adaptive process based on the guidelines outlined herein is warranted. This process can most efficiently and effectively provide protections utilizing analysis of all available data and seasonal conditions.

The OMR flow prescriptions set forth during Action 2 will be based upon analysis of population status in any given year, available monitoring data from the SKT, seasonal variables such as WY type, CVP and SWP reservoir storage levels, temperature, and observed salvage during Action 1. Of these, population status and real-time salvage data are expected to be the primary driving criterion.

Justification for Guidelines in Setting Prescriptions of Action 2

The SWG will apply the following criteria to set the flow prescriptions during Action 2, to be operational until the onset of Action 3.

Zero Salvage or Extended Salvage Index of Low Amplitude

a) If salvage is zero during the final 7 days of Action 1, then increase negative OMR to no more negative than -5,000 cfs on a 14-day running average, with a simultaneous 5-day running average within 25 percent of the applicable requirement OMR; *OR*

Decreasing Salvage or Salvage Index with Low Amplitude

b) If salvage is less in the last three days than in the preceding three days and the maximum daily salvage index is ≤1 during the prior 7 days, then limit exports to achieve OMR flows no more negative than -4,000 cfs on a 14-day running average for 7 more days with average OMR for the period within 25 percent of the requirement (or until 4 succeeding days of zero salvage or any 5 of 7 days zero salvage); *OR*

Rising Salvage or Salvage Index with High Amplitude

c) If salvage is greater or equal in the last three days than in the preceding three days, and maximum daily salvage index ≥1 during any of those days, then continue OMR flow at no more negative than -2000 cfs on a 14-day running average for an additional 7 days (or until 4 succeeding days of zero salvage or any

5 of 7 days zero salvage), with a simultaneous 5-day running average within 25 percent of the applicable OMR requirement.

Flow requirements will be monitored in real-time utilizing salvage data as a check on performance of the Service-recommended requirements, consistent with the objectives and numerical requirements established in the take statement (Attachment C).

Flow requirements defined within Action 2 follow the same protectiveness criterion established during Action 1, as adjusted to reflect real-time conditions and predicted entrainment risk relative to the anticipated distribution and abundance of year-class delta smelt; and reflecting their behavioral propensity to hold in their chosen spawning habitat. These are allowed to vary based upon assessment of available data as described in the adaptive process described in the Introductions to Actions section above.

Justification for Release from Prescriptions of Action 2

Flow

The Interim Remedies provided release from the prescription of Action 2 when the three day average Sacramento River flow at Freeport is greater than 80,000 cfs.
During WY 1982 and 1995, salvage was observed during periods when Sacramento River flows exceeded this criterion. During 1995, Sacramento River flows at Freeport exceeded 90,000 cfs while San Joaquin River flows approximated 5,000 cfs—salvage still occurred. This data suggests that adult delta smelt can still navigate the channels upstream at these flows. During 1997 and 1998, low salvage was observed while flows within both the Sacramento and San Joaquin rivers were high. For these reasons, it was determined that the offramp for prescriptions in Actions 1 and 2 should be Sacramento River flows at *Rio Vista* exceeding a three-day average of *90,000* cfs *and* San Joaquin River flows at Vernalis exceeding 10,000 cfs. Based on historic observations, it is predicted that salvage under these flow conditions will be minimal.

Temperature

The Interim Remedies prescribed regulatory release from Action 1 once mean water temperatures at Rio Vista, Antioch, and Mossdale Stations reaches 12°C. This metric is used as a surrogate to indicate time when spawning is likely to have begun based on physiological preferences.

Biological Conditions

The Interim Remedies prescribed regulatory release from Action 1 once spent females are detected in the SKT or at the salvage facilities.

ACTION 3: ENTRAINMENT PROTECTION OF LARVAL SMELT

Objective: Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt, e.g., by using a VAMP-like action. Because protective OMR flow requirements vary over time (especially between years), the action is adaptive and flexible within appropriate constraints.

Action: Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR.[9] Depending on extant conditions (and the general guidelines below) specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination (see adaptive process in Introduction).[10] The SWG would provide these recommendations based upon weekly review of sampling data, from real-time salvage data at the CVP/SWP, and expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The Service will make the final determination.

Timing: Initiate the action after reaching the triggers below, which are indicative of spawning activity and the probable presence of larval delta smelt in the South and Central Delta. Based upon daily salvage data, the SWG may recommend an earlier start to Action 3. The Service will make the final determination.

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[9] Both the 14-day and the 5-day running averages will be computed using the "tidally filtered" daily average OMR flows reported by USGS.

[10] During most conditions, it is expected that maximum negative OMR flows will range between -2000 and -3500. During certain years of higher or lower predicted entrainment risk, requirements as low as -1,250 or -5,000 will be recommended to the Service by the SWG.

Triggers:

Temperature: When temperature reaches 12°C based on a three station average at Mossdale, Antioch, and Rio Vista.

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility).

Offramps:

Temporal: June 30;

OR

Temperature: Water temperature reaches a daily average of 25°C for three consecutive days at Clifton Court Forebay.

Adaptive Process Required Parameters:

During the larval/juvenile entrainment risk period, the SWG will meet weekly to review available physical and biological data and develop a recommendation to the Service. The Service will determine the specific OMR requirement based upon the SWG recommendation and the strength of the accompanying scientific justification.

Two scenarios span the range of circumstances likely to exist during Action 3. First, the low-entrainment risk scenario. There may be a low risk of larval/juvenile entrainment because there has been no evidence of delta smelt in the South and Central Delta or larval delta smelt are not yet susceptible to entrainment. In this scenario, negative OMR flow rates as high as -5,000 cfs may occur as long as entrainment risk factors permit.

The second scenario, the high-entrainment risk scenario, is one in which either (a) there is evidence of delta smelt in the South and Central Delta from the SKT and/or 20mm survey, or (b) there is evidence of ongoing entrainment, regardless of other risk factors. In this case, OMR should be set to reduce entrainment and/or the risk of entrainment as the totality of circumstances warrant.

Usually, if the available distributional information suggests that most delta smelt are in the North or North/Central Delta, then OMR flow can be chosen to minimize Central Delta entrainment. However, if the distributional information suggests there are delta smelt in the Central or South Delta, then OMR flows will have to be set lower to reduce entrainment of these fish. If delta smelt abundance is low, distribution cannot be reliably inferred. Therefore, the adaptive process is extremely important. The SWG may recommend any specific OMR flow within the specified range above.

Action 3 is initiated when temperature reaches 12°C based on a three station average at Mossdale, Antioch, and Rio Vista, or when spent females or larva are detected;

a) Once larvae are likely to become vulnerable to entrainment, set OMR flows to no more negative than -2,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR;[11]

b) The SWG will use available physical and biological real-time monitoring data to decide whether a large fraction of the delta smelt population is in the Central Delta and therefore at risk of entrainment. If a large portion of the delta smelt population appears to be in the Central Delta, OMR flows would likely be set to no more negative than -1,250 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR; [6]

c) The SWG will use available physical and biological real-time monitoring data to decide whether the delta smelt population is at a lesser entrainment risk. In this circumstance, OMR flows would likely be set to no more negative than -3,500 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR;[6]

d) The SWG will use available physical and biological real-time monitoring data to decide whether the delta smelt population is at a low entrainment risk. In this circumstance, OMR flows to no more negative than -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR;[6]

e) If circumstances existing at the initiation of Action 3 are, in the judgment of the Service, markedly different from those anticipated in (a) through (d) above, then the OMR flow prescription will be set to entrain no more than 1 percent of the particle entrainment at Station 815 (approximately no more than 10 percent of the cumulative population).

[11] Both the 14-day and the 5-day running averages will be computed using the "tidally filtered" daily average OMR flows reported by USGS.

Background

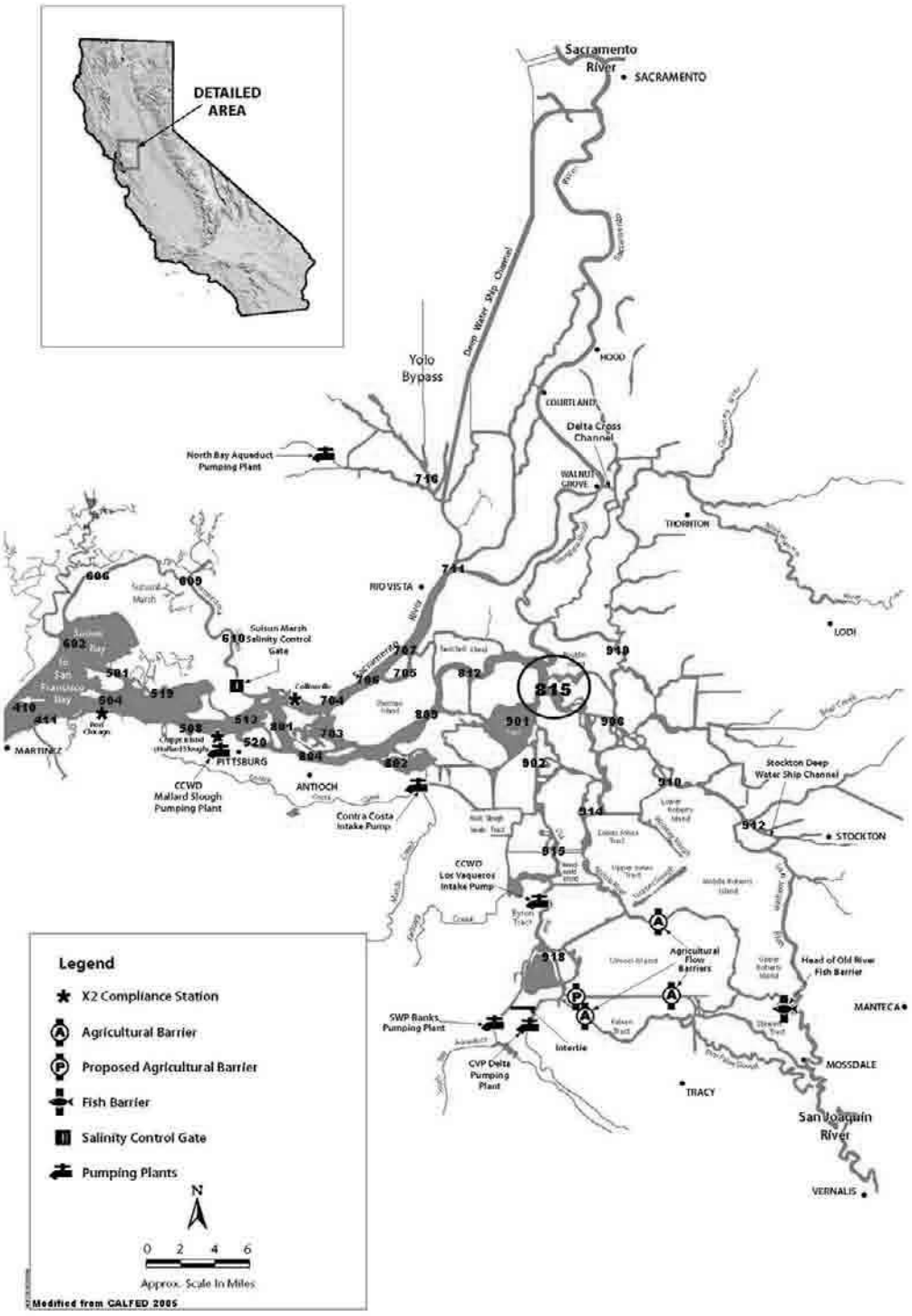
Action 3 is intended to minimize the entrainment of larval/juvenile delta smelt in the Central and South Delta. When the distribution of delta smelt is in the North or North/Central Delta, this will generally be accomplished by holding entrainment to ~1 percent of the individuals utilizing the Central and South Delta (south and east [upstream] of Station 815, see Map 2) across a 14-day particle modeling interval. Preserving larvae and juveniles that are in the Central Delta, or might be in the Central Delta in circumstances where it is difficult to ascertain the distribution of the fish, is critical to ensuring year-to-year stock-recruitment of the population and minimize the risk of localized disturbances that might adversely affect the North Delta.

In circumstances where it is known or suspected that the Central Delta or South Delta is a principal source of emerging larvae, as occurred in WY 2003, OMR restrictions might be calculated using reduction of 14-day Station 815 entrainment below 1 percent, or other methods as needed to ensure protection of the larval population in conditions of such severe vulnerability. The Action utilizes OMR restrictions to achieve the desired end, as OMR flow is a strong predictor of geographical variation in entrainment risk in the Central and North Delta. The OMR flows associated with the protectiveness criteria defined above have been derived from particle tracking modeling with the input assumptions defined below.

These protections are directly tied to presence of vulnerable larval and juvenile delta smelt within the zone of entrainment of Banks and Jones. Therefore, Action 3 must commence no later than the time when larvae are likely to become vulnerable to entrainment.

Data presented in the Effects section of this biological opinion support the conclusion that flow conditions during the VAMP (during the years in which they have been in effect) have been instrumental in protecting delta smelt progeny. Examination of the OMR flow records shows that the combination of increased San Joaquin River flows and reduced pumping during the VAMP generally resulted in OMR flows of approximately -2,000 cfs (Figure B-15).

Protection from entrainment for larval and juvenile delta smelt will be achieved using OMR prescriptions generally ranging between -2,000 to -3,500 cfs on a 14-day running average with a simultaneous 5-day average not more negative by more than 25 percent of the current OMR flow requirement. However, during certain years of unusual smelt distribution (while predicted or measured larval/juvenile delta smelt distribution are in close proximity to the zone of entrainment), maximum negative OMR flows may for a time be set as low as -1,250 cfs. Overall, the OMR flow may be set anywhere between -1,250 to -5,000 cfs on a 14-day running average with a simultaneous 5-day average (from actual daily OMR values) not more negative than the required OMR by more than 25 percent.



Map 2 Biological Monitoring Stations in the Delta

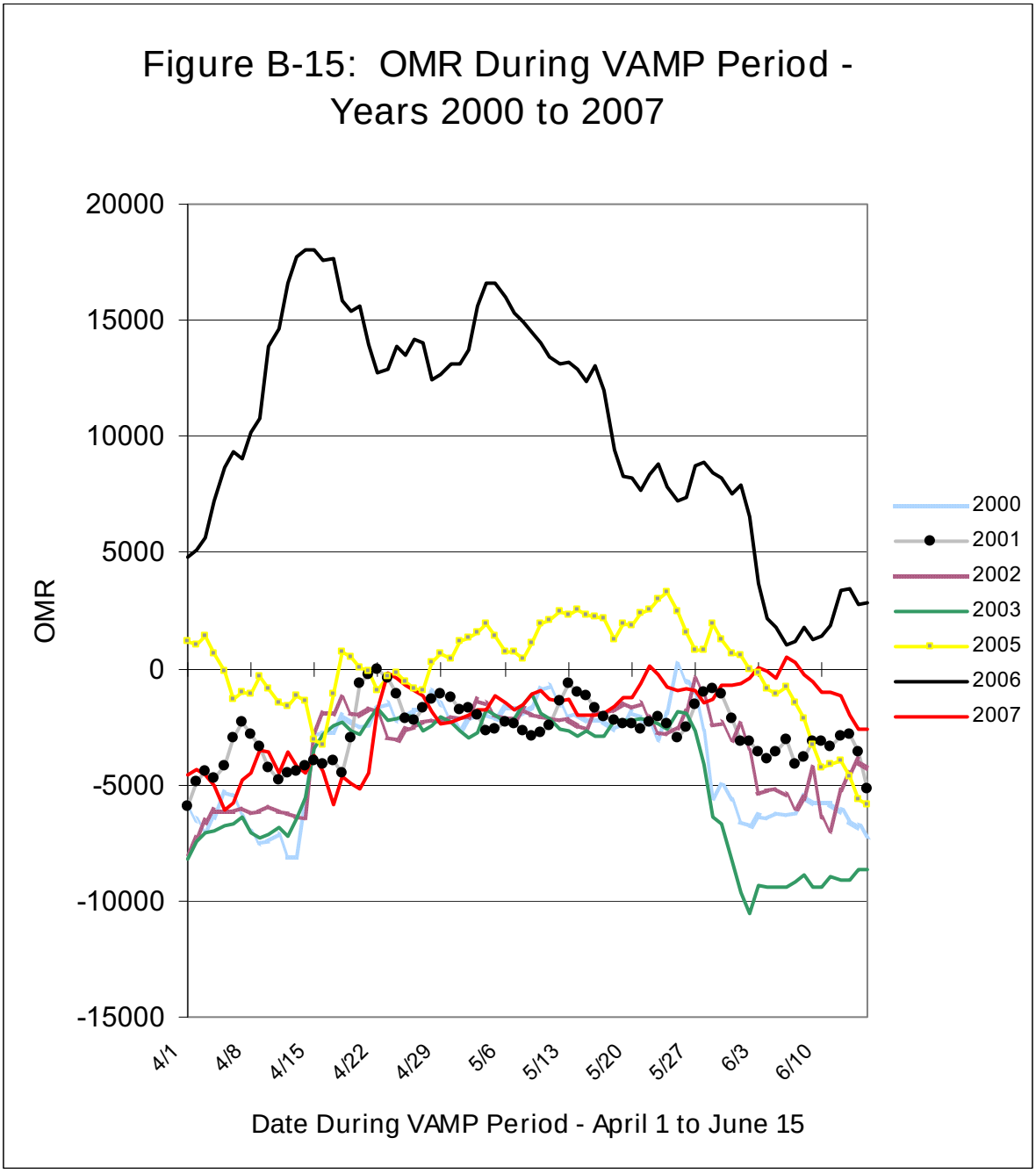


Figure B-15. OMR flows across VAMP period (usually April 15-May 15). Note that although exact VAMP conditions vary across years, the period is easily identified by OMR flows no more negative than -2000 cfs.

The following examples provide the insight on when exceptions to the ranges of OMR flows above would be used. In high risk years, when delta smelt are in the South Delta, suggesting that delta smelt are particularly sensitive to entrainment (as for example in 2003), a stricter limit on OMR flow of -1,250 cfs would be necessary to meet the defined

protectiveness criterion. Alternatively, in years when sampling indicates that it appears that most adults have spawned in the Cache Slough complex and larvae may be at reduced risk of entrainment, an OMR flow of about -3,500 cfs may be possible while still meeting the protectiveness criterion. Later in the season, as more juvenile delta smelt are found seaward and while physical conditions in the Delta become less conducive to smelt larvae, OMR flow requirements could relax further. Once conditions in the Delta are inconsistent with smelt survival (i.e. South Delta waters are too warm), the larval protections of Action 3 cease.

Justification for Timing of Action 3

The window for delta smelt spawning generally begins during February, but is variable based on seasonal conditions of flow, temperature, and physiological condition of the current year spawning cohort. Further, low adult abundances make it very difficult to discern adult spawning distribution using current monitoring methods. Lastly, protective and successful flow restrictions during the winter may reduce the discriminatory power of salvage itself as an indicator of the distribution of spawning smelt and timing to initiate Action 3.

For these reasons, it is believed that an adaptive approach using recommendations from the SWG in real-time is preferred to protective prescriptions that are applied regardless of variation or nuance in actual conditions. By monitoring a combination of these factors, along with tracking of important parameters in real time that are indicative of smelt presence and the timing of smelt spawning activity, the SWG is best situated to judge when OMR actions should be initiated or adjusted in Action 3.

During Action 3 (generally March through June 30), the SWG will recommend OMR flows to the Service. These will be based upon the best-available predictive capacity of the experts within the group given available data in real-time, and will be protective of larval/juvenile delta smelt to the criteria defined above.

Justification for Different OMR Requirements of Action 3

Analysis of the birth dates of delta smelt collected from the Summer Townet Survey (Bennett 2008) indicates that in 2005 the delta smelt found in the summer were almost entirely born during the VAMP period. Collection of spawned adults suggests that larvae were produced throughout much of the February-May period, but only the late produced young survived. Thus, we have determined that managing the hydrodynamics of the Central Delta, e.g., by providing VAMP-like conditions throughout Action 3 will be beneficial to larval and juvenile delta smelt. During most year types, these OMR requirements will range between -2,000 to -3,500 cfs.

If sampling, salvage, or any applicable and available information suggests that delta smelt are at high risk in the Central or South Delta, then the OMR will need to be as low as a 14-day running average of -1,250 cfs. If for example, based on the sampling, minimal to no salvage at the export facilities, increase in temperature, decreases in turbidity or higher

San Joaquin River inflows suggest that delta smelt larvae are at lower risk in the South and Central Delta then flows may be held to no more negative than -3,500 cfs. As temperatures rise, trawl data continue to show no fish in the Central and South Delta, and salvage does not occur, OMR flows will be allowed to become as negative as -5,000 cfs. When temperature rises and turbidity drops to levels likely to be inimical to delta smelt (> 25°C, turbidity <12 NTU), no further restrictions are needed as long as salvage remains at or close to zero.

The Influence-Exposure-Intensity-Response (IEIR) Analysis

On December 13, 2007, the Service requested the SWG to formulate a process to determine protective OMR flow recommendations for delta smelt larvae during the spring. The SWG agreed that a strict decision-tree approach was imprudent because it would be inflexible to real-time conditions. In such circumstances, where dynamic and interacting parameters determine delta smelt risk, static prescriptions tend to be imperfect moderators of such risk.

The process that has been developed is called "influence-exposure-intensity-response analysis" (IEIR Analysis). It involves four steps:

1) Particle tracking modeling of current and/or projected Delta conditions describes Banks and Jones' relevant hydrological influence at different flow rates.

2) Risk exposure of smelt larvae is determined by comparing Banks and Jones' relevant hydrological influence from the PTM results with current knowledge of smelt distribution using real-time data from surveys and salvage.

3) PTM runs are used to predict the probability of delta smelt entrainment at several OMR flow limits using "particle injection" points corresponding to 20mm survey sampling stations.

4) OMR flow recommendations are developed to reduce the projected entrainment risk to the extant delta smelt population, as estimated by the prior-year FMWT Index.

The levels of concern expressed through this analytical real-time adaptive approach have been classified into three categories: High Concern, Medium Concern and Less Concern. These correspond generally to the following realized values of key physical, operational, and biological parameters, and were applied in 2008 such as:

	Factor	***State***
•	Prior Year FMWT	<40 = High Concern; >300 = Less Concern
•	Salvage	high numbers = high concern; low numbers = less concern
•	Distribution	south = high concern; north/northwest = less concern
•	X2 Location	>80 km = high concern; <75 km = less concern

- Temperature $12^{o}C$ to $25^{o}C$ = high concern; >$25^{o}C$ = less concern

These five factors were chosen based on the following:

1. Size of spawning population: A low FMWT index indicates low abundance of potential spawners which makes population growth rate more sensitive to loss of individuals.

2. Salvage: Salvage of delta smelt indicates that larvae and juveniles are located in the Central and South Delta and are vulnerable to entrainment. Future entrainment becomes more demographically significant as cumulative entrainment numbers increase.

3. Fish Distribution: The hydrodynamic influence of Banks and Jones increases when larvae are closer to the intakes. Thus, smelt located in the Central and South Delta are exposed to greater intensity of entrainment risk than those located in the North or West Delta.

4. X2 Location: Estimating the distribution of larval smelt and their exposure to pumping effects from existing survey data includes high inherent uncertainty, with increasing magnitude at low population abundances. However, the majority of smelt larvae and juveniles are often located just inland of X2, and so an easterly X2 would indicate that the smelt are at greater risk of entrainment at Banks and Jones

5. Water Temperature: Laboratory studies of delta smelt temperature tolerance has shown increased mortality at temperatures exceeding $25^{o}C$. An average south Delta water temperature of $25^{o}C$ corresponds in most years to a distribution of delta smelt juveniles towards Suisun Bay, and out of the zone of entrainment risk. Most delta smelt remaining in the San Joaquin River portion of the Delta are not expected to survive as water temperatures increase above $25^{o}C$, so their loss at salvage will not affect recruitment success.

The balance of conditions relative to level of concern within the IEIR analysis determines the foundation upon which a final flow recommendation may be based.

Application of IEIR Analysis: Further Guidelines for the Adaptive Process

In light of the experience in 2008, the IEIR is adjusted to make the following amendments.

As before, the SWG will evaluate data from the 20-mm survey and other parameters and make recommendations for specific timing of the more protective levels of OMR flows based upon real-time assessment of entrainment risk of larval smelt based upon their proximity to Banks and Jones, forecast operations, and particle tracking modeling run

results based on a control-point method using a protectiveness criterion of 1 percent per 14-day time interval salvage threshold at Station 815.

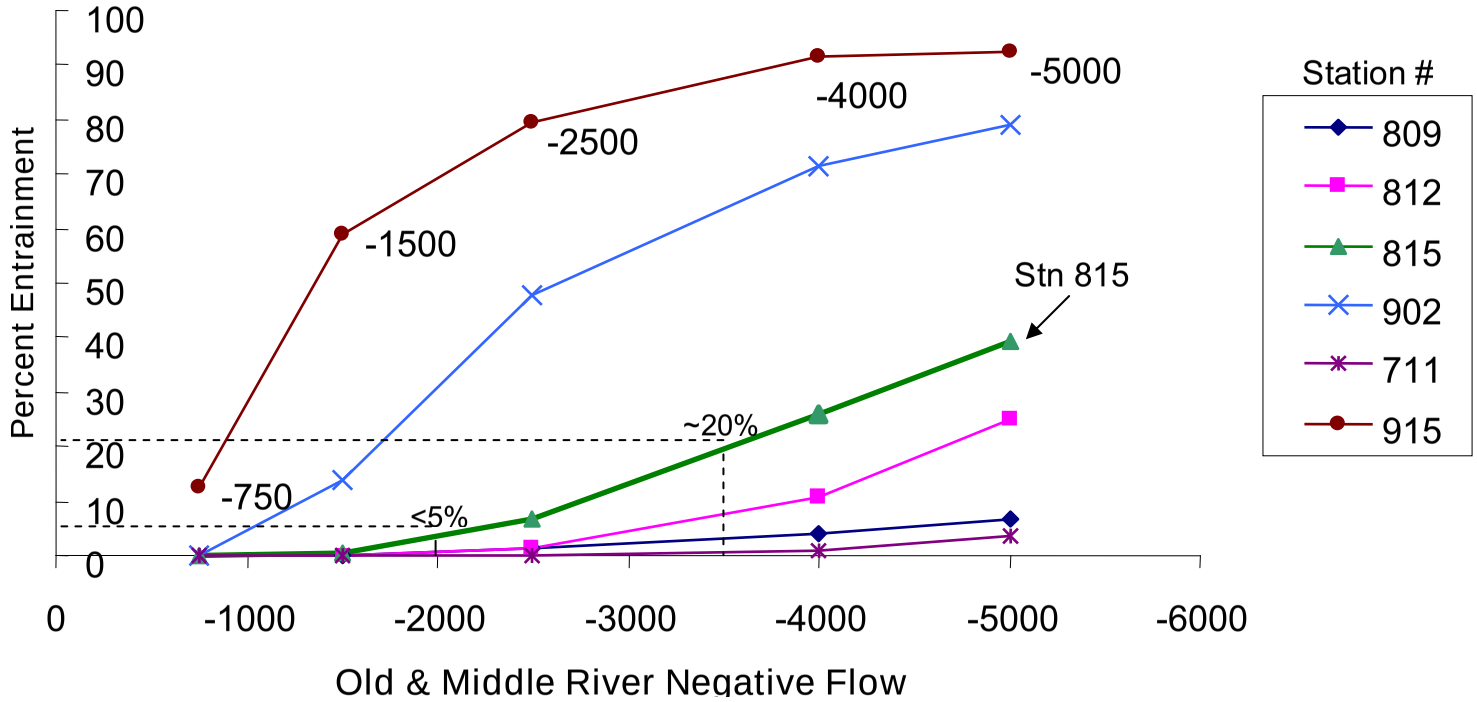
The SWG may recommend using the less stringent level of OMR restriction based on an average Recovery Index (RI) from the preceding two years exceeding 84 (the minimum for a recovery period in the Delta Native Fishes Recovery Plan, Service 1995); however, low San Joaquin River inflows, high cross-Delta flows or other conditions that degrade larval habitat in the Central Delta could preclude such relaxations. During periods of intermediate concern (recovery indices from the preceding year in excess of 239), a reduction to a shorter period of restriction to the -2000 cfs level in the larval period may be supported, if the SWG determines that a large part of the larval population would not be put at risk.

The most efficient protective measure for protecting the resilience and not precluding the recovery of the delta smelt population specific to the larval/juvenile lifestage is to prevent entrainment of fish in as large a portion of the Central Delta as is practical. Results of PTM modeling focusing on protections at station 815 (Prisoner's Point) indicates that precluding entrainment of larval/juvenile delta smelt at this station would also protect fish at station 812 (Fisherman's Cut) and other stations north and west (downstream) of station 815. While the target entrainment at station 815 would ideally also be zero, there appears to be little additional entrainment protection (less than 5 percent) at OMR flows at -750 cfs (the strictest level addressed by Interim Remedies). However, entrainment risk grows exponentially at OMR flows increasingly more negative than -2000 cfs.

Figure B-16 displays injection points for modeled particle tracking runs that were conducted in February 2008 with injection points at Stations 711, 809, 812, 815, 902, 915. This figure plots projected relationships for OMR flows by injection point, including entrainment probabilities for station 815 (over 30 days).

The results from these runs indicate an approximate <5 percent entrainment risk at OMR flow not more negative than -2000 cfs. At a requirement of -3,500 cfs OMR flow, entrainment risk at station 815 is roughly 20 percent over each 30 day interval. Assuming cumulative entrainment is additive, over a roughly four month (~120 days) interval in which Action 3 would be under effect, consistently operating at -3,500 OMR would yield a net entrainment probability placing at risk approximately 80 percent of the larval/juvenile subpopulation utilizing the South Delta at and below Station 815. If immigration of larval smelt from the Central or North Delta into the zone of entrainment during spring

Figure B-16: Pump Entrainment at Various Levels of Negative Flow at Old and Middle River Monitoring



were to occur, the population-level risk would be even greater. Such entrainment levels are potentially a significant adverse risk to delta smelt population.

Justification for Release from Prescriptions of Action 3

Calendar Date

The Interim Remedies specified the duration of Action 3 to extend to *around* June 20, or until the temperature metric below. Based upon salvage data observed during WY 2008 (see Figure B-17, above), this temporal window should be amended (extended) to June 30 in order to provide sufficient protections to late-spawned delta smelt larvae.

Temperature

When South Delta temperatures reach a daily average of 25°C for three consecutive days at Clifton Court Forebay, it is expected that conditions are no longer suitable for smelt survival. This metric is a functionally adequate predictor that viable smelt will not be present within the entrainment zone of Banks and Jones.

ACTION 4: ESTUARINE HABITAT DURING FALL

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81km in the fall following above normal years. The monthly average X2 must be maintained at or seaward of these values for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall target. The action will be evaluated and may be modified or terminated as determined by the Service.

Timing:

September 1 to November 30.

Triggers:

Wet and above normal WY type classification from the 1995 Water Quality Control Plan that is used to implement D-1641.

Adaptive Management of Habitat Action:

To address uncertainties about the efficiency of the Action, it will be adaptively managed under the supervision of the Service. Adaptive management is a mode of operation that provides for learning and feedback to adjust an action undertaken in the face of uncertainty. To improve the efficiency of the Action and align its management more closely with the general plan articulated in Walters (1997) and endorsed by the independent peer review of this BO, the Service will supervise the implementation of a formal adaptive management process.

According to Walters (1997), an adaptive management plan should include a clearly stated conceptual model, predictions of outcomes, a study design to determine the results of actions, a formal process for assessment and action adjustment, and a program of periodic peer review. A conceptual model that is based on the best available scientific information underlying the present Action is described in the Effects section. Expected

outcomes are described in general terms below, though there is a high degree of uncertainty about the quantitative relationship between the size of the Action described above and the expected increment in delta smelt recruitment or production.

The adaptive management plan will include the following new elements to ensure that performance measures and plans to evaluate the outcome of the Action are in place by the time it is implemented and that refinements to the Action can be developed as quickly as possible. These are listed in chronological order of implementation, but steps (2) through (6) are viewed as steps in an adaptive feedback loop that may cycle multiple times. The loop is closed when new information developed in (3) – (5) and/or Service decisions to alter the Action in (6) provide a basis for altering the conceptual model and/or study design in (2) or create a need to alter the performance measures in (3). The process will then continue from the re-entry step.

(1) Delta smelt habitat study group (HSG)

A panel of scientists will be convened by the Service to review and improve the habitat conceptual model, design performance measures for the Action, and prepare a study plan to improve scientific understanding of delta smelt habitat. Products produced by the HSG will be made publicly available by the Service.

(2) Conceptual model review and preparation of study design

In this instance, the conceptual model (summarized below and in the effects section) describes multiple mechanisms potentially contributing to the observed habitat/flow relationship that motivates the Action. Consequently, the study group will develop an improved conceptual model more clearly sorting out component mechanisms as an important goal. With the conceptual model in hand, two lines of investigation will be developed: one line will be designed to evaluate the performance of the specific Action described in Part A above, while the other will address the scientific uncertainties underlying the relationship between summer/fall habitat quality and delta smelt adult recruitment. The second line of investigation will provide new scientific information that is likely to aid in refinement of the Action in Part A.

(3) Performance evaluation of the Action

The study group will develop performance measures for the Action, and these measures will be subject to independent peer review. The study to evaluate the present Action will be implemented in accordance with its design prior to the first September following adoption of the biological opinion.

(4) Studies to elucidate the operative mechanism(s) controlling the relationship between delta smelt habitat features and quality and delta smelt production.

The HSG will develop a habitat investigation, and the plan will be subject to independent peer review. There are several potentially fruitful lines of investigation to pursue,

including studies to elucidate the precise mechanisms by which habitat affects delta smelt and studies intended to develop management tools to improve habitat. The peer review panel provided several useful suggestions in its review of the proposed actions.

(5) Peer review

Studies conducted under the guidance of the study group will be subject to independent peer review both at the design stage (when possible) and after results are obtained. Conclusions regarding the efficiency of the Action and potential alternatives will also be independently peer reviewed prior to receipt for official consideration by the Service.

(6) Service review and Action adjustment

The Service will direct all stages of the adaptive management plan, and will adjust the Action if/when circumstances and improved scientific understanding warrant. The HSG will provide technical assistance in the interpretation of results, but the Service will have ultimate responsibility for drawing conclusions regarding the advisability of any changes to the Action.

The Service will conduct a comprehensive review of the outcomes of the Action and the effectiveness of the adaptive management program ten years from the adoption of the BO, or sooner if circumstances warrant. This review will entail an independent peer review of the full history of the Action. The purposes of the review will be (1) to evaluate the overall benefits of the Action and (2) to evaluate the effectiveness of the adaptive management program.

The adaptive management program will have specific implementation deadlines. The creation of the HSG, initial habitat conceptual model review, and formulation of performance measures, implementation of performance evaluation, and peer review of the performance measures and evaluation that are described in steps (1) through (3) will be completed before the first September following adoption of the BO. This will ensure that measures required to evaluate the effectiveness of the action are in place during the first autumn after adoption. Additional studies addressing elements of the habitat conceptual model will be formulated as soon as possible, promptly implemented, and reported as soon as complete. As described above, there will also be a ten year review of the Action and its consequences.

Background

Delta outflows of as much as 20,000 cfs formerly occurred in fall months of all but drought WYs. Currently, however, fall outflows are similar to historic droughts regardless of WY type. Fall Delta outflows in wet and above normal WYs (i.e., from 1993-98) average 8,000-10,000 cfs; whereas after 1998, monthly averages have been 5,600 cfs across all WY types and monthly outflow variation has been very small. High among-month variability in Delta outflows may be important for restoring estuarine habitat conditions favoring many native species (Lund et. al. 2007).

Habitat parameters for delta smelt have been well described for both the summer and fall seasons as combinations of salinity, temperature, and turbidity. In winter and spring, temperature seems to be a dominant driver of habitat suitability both for adult spawning and for larval occurrence (Bennett 2005). Summer habitat is controlled largely by changes in turbidity due to changes in sediment supply and in the distribution of the sediment-trapping aquatic weed, *Egeria densa*. (Nobriga et al. 2008) Fall habitat (and smelt) shifts in abundance and distribution largely due to fluctuations in salinity (Feyrer et al. 2007). X2, which reflects salinity distribution in the estuary (Jassby et al. 1995), fluctuates mostly in response to fluctuations in outflow, although atmospheric conditions and barrier operations can also affect it.

X2 is strongly influenced by tidal cycles, moving twice daily up and downstream 6-10 km from its average daily location. For example, when the average daily X2 is near Sherman Island, delta smelt habitat can range from Chipps Island to Franks Tract. When the daily average X2 is centered on Browns Island, delta smelt habitat can range from Honker Bay to Big Break. The daily fluctuation in X2 around an upstream point such as Brown's Island confines the population to narrow channels, where delta smelt may be exposed to more stressors (e.g., agricultural diversions, predation) relative to a downstream X2. Adverse effects on adult delta smelt during fall may be a part of the reason that Feyrer et al. (2007) found a statistical association between fall X2 and the production of young delta smelt during the following year.

Other factors can degrade the quality of smelt habitat, principally water quality degradation. In September 2007 all collected delta smelt were found at salinities much higher than ever before. This observation was coincident with a period when their usual salinity range was heavily infested with the cyanobacterium *Microcystis aeruginosa*. *Microcystis* produces toxins in its normal life, but the concentrations of these toxins in water sharply increase when the population dies, usually in September and October (Lehman pers. comm.). In September 2008, delta smelt were in their normal salinity range and *Microcystis* were less abundant than in September 2007 (pers. comm. Randy Baxter DFG and Peggy Lehman DWR). Low flow conditions are among the factors associated with *Microcystis* blooms (Lehman et al. 2008).

Protection and restoration of habitat is an essential element in any conservation strategy where habitat has been lost or degraded. However, identifying the exact role habitat quality and volume play in the growth and survival of a species comes with some

uncertainty. In the case of fall delta smelt, habitat area is a significant covariate in its stock-recruit relationship, indicating evidence of an effect on the population. Westward and variable locations of fall habitat provide increased habitat area and moves the delta smelt population away from the risks of possible future entrainment in the Delta, and distributes it more broadly throughout the estuary.

This action is designed to increase baseline monthly outflows in the fall period of wet and above normal WYs to increase areas of habitat and move the habitat away from Delta impacts and into broader open waters west of Sherman Island; and to increase variability of monthly habitat extent by having 2-3 months above the baseline. This would be expected to distribute smelt into more diverse geographic areas, helping to reduce the risk of localized losses from future entrainment, contaminants, and predation. Finally, it may reduce the proliferation of other factors that reduce habitat suitability such as *Microcystis* and *Egeria* growth.

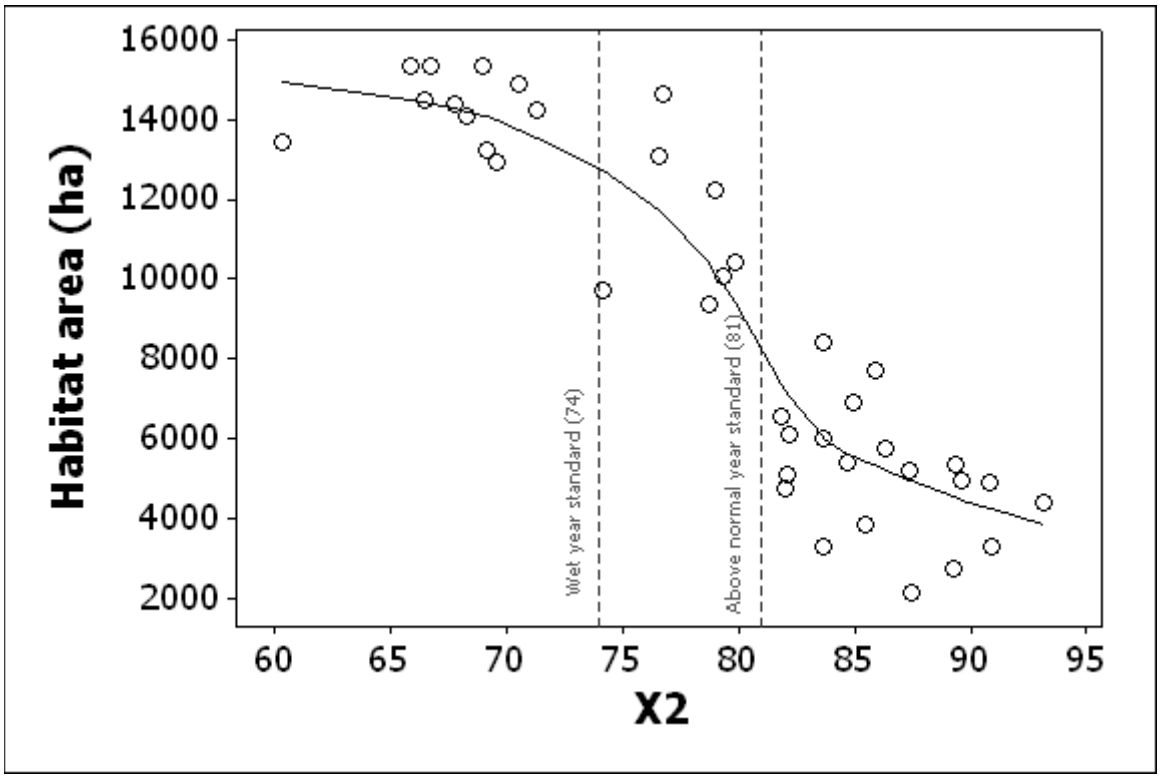
Justification:

The Effects section clearly indicates that there will be significant adverse impacts on X2, which is a surrogate indicator of habitat suitability and availability for delta smelt in all years (Figures E-19 and E-25 in Effects section). Moreover, the results of Feyrer et al. (2007) suggest that adverse effects on adult delta smelt during fall may be part of the reason that there is a statistical association between fall X2 and the production of young delta smelt during the following year. The action is focused on wet and above normal years because these are the years in which project operations have most significantly adversely affected fall (Figure E-27 in Effects section) and therefore, actions in these years are more likely to benefit delta smelt.

The action is designed to be governed by hydrologic conditions and therefore will be ecologically-based. For the purposes of implementation of this action, water year type is defined as the water year that ends in the September of the calendar year in which the action will be implemented. The standards of 74km in wet years and 81km in above normal years are designed to mitigate the effects of X2 encroachment upstream in current and proposed action operations, and provide suitable habitat area for delta smelt (Figure B-17).

The long-term trend in which all falls have Delta outflows indicative of dry or critical years matches long-term upward trends in the E:I ratio and X2 (Figure E-28 in effects

Figure B-17. Relationship between X2 and habitat area for delta smelt during fall, with standard shown for wet and above normal years.



section). The overall effect is readily observed as a substantial divergence in the difference between fall X2 and X2 the preceding spring (April-July). Given that these conditions will persist under the proposed CVP/SWP operations, the modeling also shows they may be exacerbated under various climate change scenarios (Figure E-28 in effects section).

The persistence of this significant hydrologic change to the estuary threatens the recovery and persistence of delta smelt. Outflow during fall determines the location of X2, which determines the amount of suitable abiotic habitat available to delta smelt (Feyrer et al. 2007, 2008). The long-term upstream shift in X2 during fall has caused a long-term decrease in habitat area availability for delta smelt (Feyrer et al. 2007, 2008), and the condition will persist and possibly worsen in the future. This alone is a significant adverse effect on delta smelt.

However, the problem is further complicated because there are several lines of published peer reviewed scientific research that link habitat alteration to the decline of delta smelt (Bennett 2005; Feyrer et al. 2007; Nobriga et al. 2008). An important point regarding this action is that because of the current, extremely low abundance of delta smelt, it is unlikely that habitat space is currently a limiting factor. However, it is clear that delta smelt have become increasingly habitat limited over time and that this has contributed to the population attaining record-low abundance levels (Bennett 2005; Baxter et al. 2008;

Feyrer et al. 2007, 2008; Nobriga et al. 2008). Further, as detailed in the Effects section, persistent degraded or worsened habitat conditions are likely to contribute to depensatory density-dependent effects on the delta smelt population while it is at historical low levels, and would at some point in the proposed term of this project, limit delta smelt recovery.

Therefore, the continued loss and constriction of habitat into areas of low habitat quality under the proposed action significantly threatens the ability of the delta smelt population to recover and persist in the estuary at self-sustaining levels higher than the current record-lows. While it is not yet proven why habitat quality under this constant dry-year fall X2 scenario has been degraded for rearing delta smelt, the coincidence of this pattern with sustained and significant population level losses for this lifestage (as measured in survival rates and smelt physiological condition), along with the increasing body of support ascribing the aforementioned hypothesized mechanisms of action to habitat degradation and smelt condition, and finally the current critically low level of the current population, make the implementation of a fall action essential to the maintenance of the population resilience for delta smelt. In short, the historically high variability in summer/fall survival rates does not negate the need for protection from direct mortality losses due to adult and larval/juvenile entrainment, it actually highlights the need for restoring flow variability to the Delta environment so that smelt populations can recover through allowing these essential periods of population rebound.

Monitoring Component to Assess Performance of Action 4

The Service will require that Action 4 be implemented with an adaptive management program to provide for learning and improvement of the action over time. The adaptive management program will include commissioning studies to clarify the mechanisms underlying the effects of fall habitat on the delta smelt population and should, at the least, focus on the following general study questions:

i. What is the effect of habitat area and distribution on delta smelt distribution?

ii. How does fish condition/health vary across a gradient of habitat quality?

iii. Does fish condition/health in fall affect over-winter survival?

iv. Does fish condition/health affect fecundity and egg viability?

v. Does spatio-temporal salinity variation resulting from this fall action affect *Microcystis*?

vi. Does spatio-temporal salinity variation resulting from this fall action affect *Corbula* and the benthic invertebrate community?

Given the low numbers of delta smelt currently in the estuary, a suite of surrogate species is probably required to address questions ii-iv, although question iv could be examined directly with experiments on fish from the Tracy Fish Culture Facility. It is recommended that studies designed address these research questions be coordinated and

implemented through the IEP and POD Management Teams. The research and monitoring plan will include reporting criteria, data sharing and dissemination requirements, oversight and contractual compliance elements for purposes of quality assurance and ensure the transparency and timely completion of necessary monitoring, research and assessment.

ACTION 5: TEMPORARY SPRING HEAD OF OLD RIVER BARRIER (HORB) AND THE TEMPORARY BARRIER PROJECT (TBP)

Objective: To minimize entrainment of larval and juvenile delta smelt at Banks and Jones or from being transported into the South and Central Delta, where they could later become entrained.

Action: Do not install the HORB if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the TBP flap gates would be tied in the open position until May 15.

Timing: The timing of the action would vary depending on the conditions. The normal installation of the spring temporary HORB and the TBP is in April.

Triggers: For delta smelt, installation of the HORB will only occur when PTM results show that entrainment levels of delta smelt will not increase beyond 1 percent at Station 815 as a result of installing the HORB.

Offramps: If Action 3 ends or May 15, whichever comes first.

Justification for Action 5

The TBP change the hydraulics of the Delta, which can affect delta smelt. The HORB blocks San Joaquin River flow from entering Old River. This increases the flow toward Banks and Jones from Turner and Columbia cuts, which can increase the predicted entrainment risk of particles in the East and Central Delta by up to about 10 percent (Kimmerer and Nobriga 2008). In most instances, net flow is directed towards Banks and Jones and local agricultural diversions. Computer simulations have shown that placement of the barriers changes South Delta hydrodynamics, increasing Central Delta flows toward the export facilities (DWR 2000). In years with substantial numbers of adult delta smelt in the Central Delta, increases in negative OMR flow caused by installation of the TBP can increase entrainment. The directional flow towards Banks and Jones increases the vulnerability of fish to entrainment. Larval and juvenile delta smelt are especially susceptible to these flows.

The varying operational configurations of the TBP, natural variations in fish distribution, and a number of other physical and environmental variables limit statistical confidence in assessing fish salvage when the TBP is operational versus when it is not. In 1996, the installation of the HORB caused a sharp reversal of net flow in the South Delta to the upstream direction. Coincident with this change was a strong peak in delta smelt salvage (Nobriga et al. 2000). This observation indicates that short-term salvage can significantly increase when the HORB is installed in such a manner that it causes a sharp change or reversal of positive net daily flow in the South and Central Delta.

Many of these potential effects to delta smelt would be reduced by the OMR flows provided in Action 3. In order to determine if there will be adverse effects to delta smelt from the installation of the HORB, PTM will be completed during Action 3. The Service may use the control point method of maintaining an entrainment level at Banks and Jones below 1 percent at Station 815. If the PTM results show that entrainment would be higher than 1 percent during the period when the HORB would be installed, and would result in increased risk to juvenile delta smelt, then it would not be installed.

Additionally, the OMR flows provided in Action 3 or high San Joaquin River flows may provide beneficial conditions in the Delta for out-migrating salmonids and sturgeon, which would preclude the need for the HORB installation. This analysis, combined with the PTM results will provide data to help determine if listed fish would be adversely affected by the HORB. If the spring temporary HORB is not installed, the TBP would be operated as described in the Project Description.

Justification for Release from Prescriptions of Action 5

If Action 3 has ended, the entrainment concern has likely abated, and delta smelt larvae and juveniles are not likely to be present in the Central and South Delta. High flows on the San Joaquin River may also preclude the spring temporary HORB from being installed since it is not physically possible during these flows to install the HORB. The concerns for entrainment are reduced during high San Joaquin River flows.

ACTION 6: HABITAT RESTORATION

Objective: To improve habitat conditions for delta smelt by enhancing food production and availability.

Action: A program to create or restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh shall be implemented. A monitoring program shall be developed to focus on the effectiveness of the restoration program.

Timing: The restoration efforts shall begin within 12 months of signature of this biological opinion and be completed within a 10 year period.

Background

The historic Delta was a tidal wetland-floodplain system including about 350,000 acres of tidal wetland. Almost all of the historic wetlands in the Delta have been lost due to conversion to agriculture and urban development. The Delta currently supports less than 10,000 acres of tidal wetland, all of which is small and fragmented. This conversion of the Delta's wetlands beginning in the mid-nineteenth century has resulted in a landscape dominated by agricultural lands intersected by deep and comparatively uniform tidal channels.

Delta smelt feed mainly on zooplankton throughout their life cycle (Nobriga and Herbold 2008) with the copepod Pseudodiaptomus forbesi being the dominant prey item for juvenile delta smelt in the summer (Lott 1998; Nobriga 2002; Hobbs et al. 2006). Diatoms form the base of the pelagic foodweb and primary consumers (e.g. copepods) appear to be food-limited in the Delta and Suisun (Muller-Solger et al. 2002; Sobczak et al. 2002). Pelagic productivity in the Delta and Suisun Bay has been declining for several decades with a steep decline following the introduction of the overbite clam in 1986 (Kimmerer and Orsi 1996). Histopathological evaluations have provided evidence that delta smelt have been food-limited during the summer months (Bennett 2005). This finding has been corroborated by recent work on juvenile delta smelt as part of ongoing studies on the POD. Moreover, recent studies suggest a statistical association between delta smelt survival and the biomass of copepods in the estuary (Kimmerer 2008).

Overall research in other estuaries has indicated that tidal wetlands are highly productive. Although definitive studies have not been done on the type and amount of productivity in freshwater tidal wetlands of the Delta, brackish tidal wetlands of Suisun Marsh are one of the most productive habitats in northern San Francisco Bay-Delta estuary (Sobczak et al. 2002). It is likely that restored freshwater tidal wetlands in the Delta would have higher productivity than the brackish wetlands of Suisun (Odum 1988). A large portion of the production in Suisun Marsh consists of high quality phytoplankton-derived carbon (Sobczak et al. 2002) that is an important food source for zooplankton and therefore can contribute to the base of the pelagic foodweb. Modeling suggests that the tidal wetlands of Suisun currently provide about 6 percent of the organic carbon to the pelagic habitats of Suisun Bay (Jassby et al. 1993). In addition, sampling in Liberty Island shows that these freshwater tidal habitats can be a source of high-quality phytoplankton that contribute to the pelagic food web downstream (Lehman et al. 2008). Thus, restoration of large amounts of intertidal habitat in the Delta and Suisun could enhance the ecosystem's pelagic productivity.

Justification:

Since it was introduced into the estuary in 1988, the zooplankton Pseudodiaptomus forbesi has been the dominant summertime prey for delta smelt (Lott 1998; Nobriga 2002; Hobbs et al. 2006). There is evidence suggesting that the co-occurrence of delta smelt and Pseudodiaptomus forbesi has a strong influence on the survival of young delta smelt from summer to fall (Miller 2007). The Effects Section indicates that

Pseudodiaptomus distribution may be vulnerable to effects of export facilities operations and therefore, the projects have a likely effect on the food supply available to delta smelt.

The near complete loss of tidal wetlands from the Delta threatens the persistence of delta smelt by reducing productivity at the base of the pelagic foodweb. Primary production in tidal wetlands of the Northern San Francisco estuary has been shown to support high zooplankton growth (Muller-Solger et al. 2002). This action should therefore enhance the foodweb on which delta smelt depend. This action is designed to increase high quality primary and secondary production in the Delta and Suisun Marsh through an increase in tidal wetlands. Exchange of water between the tidal wetlands and surrounding channels should distribute primary and secondary production from the wetlands to adjacent pelagic habitats where delta smelt occur. This exchange should be optimized through intertidal habitat restoration designed to incorporate extensive tidal channels supported an appropriately sized vegetated marsh plain which will provide the necessary tidal prism to maintain large tidal exchange.

New evidence indicates how tidal marsh may benefit delta smelt even if they do not occur extensively within the marsh itself. Specifically, monitoring suggests this species is taking advantage of recently-created tidal marsh and open water habitat in Liberty Island. The fact that delta smelt make heavy use of habitat in the Cache Slough complex has been evident in sampling by the DFG's Spring Kodiak trawl and 20 mm surveys (www.delta.dfg.ca.gov). The Spring Kodiak trawls show that delta smelt are present in channels of the Cache Slough complex during winter and spring; the collection of larval delta smelt in subsequent 20-mm surveys indicates that these adult delta smelt eventually spawn in the vicinity. In addition, the use of Cache Slough complex by delta smelt includes habitat on Liberty Island. The island flooded in 1998 and has evolved rapidly into a system of open-water and tidal marsh habitat. Recent sampling of Liberty Island by USFWS biologists (http://www.delta.dfg.ca.gov/jfmp/libertyisland.asp) revealed that delta smelt both spawn and rear in Liberty Island. Light traps collected relatively high numbers of larval delta smelt in several locations of Liberty Island during the 2003 spawning period for this species. Moreover, subsequent beach seine sampling showed that older delta smelt were present at all ten of their sampling stations during 2002-2004 and in all seasons of the year (USFWS, unpublished data). These results are particularly striking because they were from a period when delta smelt was at record low abundance. Collection of delta smelt from shallow inshore areas using seines indicates that the fish do not occupy deeper pelagic habitat exclusively. These results seem reasonable in light of the area's consistently high turbidity (Nobriga et al. 2005; DWR, unpublished data) and zooplankton abundance (e.g. Sommer et al. 2004), both of which are important habitat characteristics for delta smelt (Bennett 2005; Feyrer et al. 2007). In any case, these data suggest that freshwater tidal wetlands can be an important habitat type to delta smelt with proper design and location.

A monitoring program shall be developed to focus on the effectiveness of the restoration program. This program shall be reviewed and modified as new information becomes available.

Attachment C: Methods Used in Developing the Incidental Take Statement

Methods Used in Developing the Incidental Take Statement

The objective adopted by the Service to minimize take of adult delta smelt through entrainment is two-fold. First, adult entrainment shall be minimized during all year types through the RPA. More critically, demographic losses from periodic episodes of high entrainment will be eliminated through implementation of the RPA. These outcomes shall be accomplished through the application of measures as defined in RPA Components 1 and 2.

Adoption of the RPA included in this biological opinion is expected to appreciably reduce the number of delta smelt salvaged during certain years. Implementation of the RPA should avoid significant mortality during those years of high entrainment. The Service believes these high salvage year events (such as in WY 2003 for adult delta smelt) resulted in mortality at levels that were demographically significant to the delta smelt population. Further, at low abundances observed in the last few years, high entrainment events (observed more frequently, for adult delta smelt in 2003, 2004, and 2005, successively) further reduces the resilience of the current delta smelt population.

The Service anticipates that take of adult delta smelt via entrainment will be minimized when OMR flows are limited to -2,000 cfs during the first winter flush when adult smelt move within the zone of entrainment. OMR flows held between -1,250 and -5,000 cfs following the first flush until the onset of spawning will protect later delta smelt migrants and spawners. During frequent intervals within the timeframe for RPA Component 1, the SWG shall provide specific OMR flow recommendations to the Service; and the Service will then determine flow requirements using the adaptive process as described in the RPA.

This approach was adopted because it reflects the most reasonable strategy to allow continued CVP/SWP operations while providing necessary protection to the delta smelt population under real-time conditions. It accounts for uncertainty of adult smelt entrainment risk resulting from variable environmental, demographic, and operational conditions; and adapts operations in response to real-time data.

The specific level of take of adult delta smelt at the CVP/SWP pumping facilities is difficult to definitively project, due to inherent uncertainties. First, the only data available from which to derive population estimates come from monitoring that is not specifically designed to assess the abundance of delta smelt. Distribution of adult smelt is highly variable between years, and is driven by factors that are both inherently difficult to predict and also not completely understood. These factors are, at best, imperfectly controlled. Additionally, salvage data (our most definitive measurement endpoint) reflects only a portion of the total mortality associated with entrainment. Losses to predation and inefficient screening are significant, but unknown. Finally, salvage itself is clearly at least partially a function of abundance. In other words, the more delta smelt there are out there, the higher the salvage numbers will be, given the same operational conditions and delta smelt distribution. In short, entrainment and the population-level

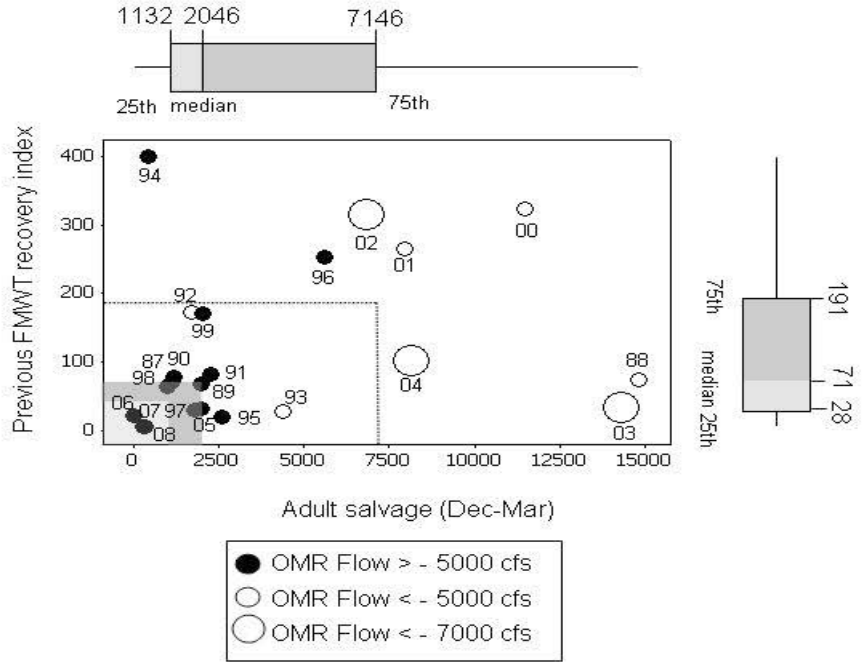
effect from direct mortality attributed to pumping is a multivariate and complex process, and this complexity defies ready predictive modeling.

The Service in past take statements has relied upon historic salvage as the most reasonable predictor of future salvage. Adult delta smelt salvage data (grouped by sorting entrainment years into quartiles by the total number salvaged between December and March) can be plotted by year and related to delta smelt population abundance and flows as shown in Figure C-1. The historic (1987-2007) median salvage levels with 25th and 75th percentiles are plotted versus the preceding FMWT Recovery Index (RI). The RI provides an indication of the status of the delta smelt population based on distributional and abundance criteria from a subset of September and October FWMT sampling data (Service 1995). A low RI indicates the delta smelt population is at a low level, whereas a high RI value (~400) indicates a larger population. Figure 1 uses 1987 to 2007 as the historic baseline dataset for this analysis because these years represent the period after which delta smelt experienced coincident declines in abundance and habitat quality (Feyrer et al. 2007), and because these are years for which salvage data are considered most reliable.

One benchmark for determining the severity of salvage is the 25th percentile (first quartile) of recent historic winter salvage of delta smelt at the CVP/SWP export facilities. For reference, the first quartile historic salvage count for 1987 through 2007 is 1,132 adult delta smelt, while the median value during this same interval is 2,046 individuals. Salvage above these levels is likely to lead to large losses of spawning delta smelt relative to the mean population size. For example, in 2003 and 2004, the projects salvaged 14,323 and 8,148 adult delta smelt respectively. These losses are disproportionately high (i.e., greater than the 75th percentile of historical salvage) for their given RI values, 33 (2003) and 101 (2004), respectively. According to Kimmerer (2008), 2003 and 2004 were years when entrainment accounted for 50 percent and 19 percent losses, respectively, of adults from the population. These are very high loss rates even by commercial fishery standards and for delta smelt, with such low population numbers, it is an even greater concern.

As presented in Figure C-1, using a rough estimate of expected future flows based on implementation of the RPA (i.e., >-5,000 cfs OMR) and when abundance indices are low (based on RI), adult salvage levels during WY's 2006, 2007, and 2008 best approximates adult salvage numbers expected in the future.

Figure C-1. Adult delta smelt salvage levels in relation to OMR flows and the FMWT RI for the period 1987-2007.



To estimate take with implementation of the RPA, the Service scaled projected salvage to abundance using the estimates provided by the prior year's FMWT Index (note that this differs somewhat from Figure C-1, which used the RI, reflecting a subset of FMWT Index data). The segregation of year types is based upon descriptive statistics comprising quartiles, as expressed above in Figure C-1, and quantified following the approach described below.

A *Cumulative Salvage Index*

The Cumulative Salvage Index (CSI) is calculated as the total year's adult salvage (the aggregate number for expanded salvage at both the Banks and Jones export facilities for the period December through March) divided by the previous year's FMWT Index. Taking all water year types together (regardless of abundance or OMR flows in a given year), the median CSI value for the period 1993 to 2008 is 12.0. The first and third quartile CSI values for this period are 6 and 26, respectively. These data are summarized below in Table C-1.

Incidental Take for Adult Entrainment (Salvage)

Water years 2006 to 2008 were years in which salvage, negative OMR flows, and delta smelt abundance were all relatively lower relative to the historic values. These are the

only three years of lower negative OMR flows which coincided with salvage values below the first quartile within the historic range and low overall adult delta smelt abundances (below first quartile FMWT Index). The corresponding CSI values are: 8.3 (2006), 0.88 (2007), and 12.6 (2008). The Service therefore believes these years within the historic dataset best approximate expected salvage under the RPA Component 1.

The mean value for adult salvage during WYs 2006 to 2008 is 247 adult delta smelt. The average CSI value for WYs 2006 to 2008 was 7.25. Projecting this average rate of salvage to the years in which CVP/SWP operations will be conducted within the sideboards established by the RPA would yield estimates of salvage at 7.25 times the prior year's FMWT Index. The Service use this estimator to predict incidental take levels of adult delta smelt during each year that the RPA's will be in effect. This value, which can be calculated upon release of the final FMWT Index within the current water year, is regarded as the incidental take for adult delta smelt under the RPA.

Incidental Take: Cumulative Expanded Salvage = 7.25 * Prior Year's FMWT Index

As indicated in Table C-1, for the entire span of WY's since 1993, this numerical salvage threshold would have been exceeded in WY's 1993, 1995, and 2003-2005.

Table C-1: Adult Salvage Summary Statistics 1993-2008

Year	FMWT Index	Adult Salvage	Cumulative Salvage Index	Take Threshold
1993	156	4425	28.4	X
1994	1078	359	0.33	
1995	102	2608	25.6	X
1996	899	5628	6.3	
1997	127	1828	14.4	
1998	303	1027	3.4	
1999	420	2074	4.9	
2000	864	11505	13.3	
2001	756	8015	10.6	
2002	603	6865	11.4	
2003	139	14338	103	X
2004	210	8058	38.4	X
2005	74	2018	27.3	X
2006	26	216	8.3	
2007	41	36	0.88	
2008	28	352	12.6	
min	26	36	0.33	
max	1078	14338	103	
mean	364	4335	19.3	
25th	95.0	860.0	5.9	
median	183	2341	12.0	
75th	641.3	7152.5	26.0	

High Concern Level for Adult Entrainment (Salvage)

Delta smelt abundance is critically low, and without habitat quality conditions to appreciably improve juvenile growth and rearing from recent historic levels, is expected

to remain so for the foreseeable future. The current population cannot tolerate direct mortality through adult entrainment at levels approaching even "moderate" take as observed through the historic record of recent decades. The method utilized herein to calculate take contains uncertainty within the estimates, and this fact translates into population-level risk. Further, there is a recognized need to provide a quantitative framework so that the Service and CVP/SWP operators have a common analytical methodology for reference and to futher guide the adaptive process.

Therefore, the Service is also providing a Concern Level estimate, meant to indicate salvage levels approaching the take threshold, and help guide implementation of the RPA. Reaching this expanded salvage figure within a given season may require that OMR flows be set to a more restrictive level, unless available data indicate some greater level of exports is possible without increasing entrainment (e.g., there is strong reason to presume the pre-spawning migration has passed). Throughout the water year, as the SWG convenes and reviews daily salvage data, reaching the Concern Level for adult salvage requires an immediate specific recommendation to the Service.

The Service believes this Concern Level value should trigger at 75 percent the adult incidental take, as an indicator that operations need to be more constrained to avoid exceeding the incidental take.

Concern Level: Cumulative Expanded Salvage = 5.43 * Prior Year's FMWT Index

The rationale for a value approaching 75 percent (as opposed to 50 percent, for example), is that the window for adult entrainment, once begun, is generally short (~1 month), and it is not expected that aggressive pumping restrictions would continue for long durations once salvage is occurring and data are available. The SWG will take timing into account during interpretation of salvage within a given season, and recommend OMR restrictions to the Service accordingly.

For reference purposes, the population level losses reported in Kimmerer (2008) appear in Table 2 compared to our CSI metric. Caution is necessary when comparing field data to take estimates from population models due to; (1) their high inherent predictive uncertainty based on broad underlying assumptions and limited monitoring methodology, (2) the crude discriminative capacity of the inherent methodology utilized within the CSI-derived risk thresholds, and (3) the paucity of available data. However, regressing the Kimmerer (2008) estimates against the CSI approach in order to make this comparison ($y = 0.4539x + 1.8905$; $r^2 = 0.9105$) yields an expected take under implementation of the RPA defined herein approximating delta smelt population level losses during the adult lifestage to around 5 percent. The concern level would roughly approximate salvage of 4 percent of the adult pre-spawning population.

Table C-2. Cumulative Salvage Index in comparison to adult take estimates in Kimmerer (2008).

Year	Estimate	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary	FMWT Recovery Index	Total Salvage	CSI
2002	15	5	24	603	6865	11.4
2003	50	19	69	139	14338	103
2004	19	6	31	210	8058	38.4
2005	7	2	12	74	2018	27.3
2006	4	1	6	26	216	8.3

Table C-3 lists threshold levels of high concern and incidental take for a range of potential FMWT indices. This table is intended to be used as a reference to discern levels of salvage reflecting the range of expected adult delta smelt mortality with implementation of the RPA, and an indicator of adult delta smelt salvage levels that constitutes an increasing and adverse effect to the delta smelt population due to CVP/SWP operations.

Table C-3: Incidental Take Expanded Salvage Numbers by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take
2	11	15	66	359	479	220	1197	1596	550	2992	3989
4	22	29	72	392	522	240	1305	1741	560	3046	4061
6	33	44	78	424	566	260	1414	1886	570	3100	4134
8	44	58	84	457	609	280	1523	2031	580	3155	4206
10	54	73	90	490	653	300	1632	2176	590	3209	4279
12	65	87	96	522	696	320	1741	2321	600	3264	4351
14	76	102	100	544	725	340	1849	2466	620	3372	4496
16	87	116	102	555	740	360	1958	2611	640	3481	4642
18	98	131	104	566	754	380	2067	2756	660	3590	4787
20	109	145	106	577	769	400	2176	2901	680	3699	4932
22	120	160	108	587	783	420	2285	3046	700	3808	5077
24	131	174	110	598	798	460	2502	3336	720	3916	5222
26	141	189	120	653	870	480	2611	3481	740	4025	5367
28	152	203	130	707	943	500	2720	3626	760	4134	5512
30	163	218	140	762	1015	502	2731	3641	780	4243	5657
34	185	247	150	816	1088	504	2741	3655	800	4351	5802
38	207	276	160	870	1160	506	2752	3670	840	4569	6092
42	228	305	170	925	1233	510	2774	3699	880	4787	6382
48	261	348	180	979	1305	520	2828	3771	920	5004	6672
54	294	392	190	1033	1378	530	2883	3844	960	5222	6962
60	326	435	200	1088	1450	540	2937	3916	1000	5439	7252

Take of Larval and Juvenile Delta Smelt

In contrast to adult delta smelt, there is no well established index of larval and juvenile abundance to reliably scale the take of this lifestage to abundance. Indices of abundance are constructed from fishery surveys performed by DFG (Figure C-2). The DFG has monitored the distribution and relative abundance of larval and post-larval delta smelt throughout their spring range since 1995. This survey is named the 20-mm survey for the size at which delta smelt are retained and readily identified by the fish salvage facilities, and provides near-real time information on larval abundance and distribution for individuals that have reached this size class. There is no established way to measure and document take of larval smelt below this size. Protection of this age class is afforded through the RPA, when setting OMR restrictions, but there is no reliable means to assess performance until later in the season when >20mm larvae are present. This should be kept in mind in light of salvage numbers, pre-emptive OMR prescriptions based on salvage predictions, and the take statement for the earlier part of the spring season (i.e., April).

Historically, as with adults, larval and juvenile delta smelt salvage has varied widely, as a function of overall abundance, distribution and Delta hydrology (Figures C-3 and C-4). This variability makes prediction of salvage of larvae and juvenile delta smelt difficult. In order for a survey to have significant predictive value, it must precede the period of entrainment with as few confounding variables (intervening factors) between the estimate and the event as possible. Larval and juvenile take cannot be scaled to either the 20-mm Survey Index or the TNS Index because both surveys overlap the period during which the salvage occurs. Further, as migration, spawning distribution and success, adult delta smelt entrainment and mortality (due to quantifiable and unquantified variables) occur between the FMWT (the parental generation) and salvage of their progeny (the following April through July); it is difficult to infer actual larval abundance reliably through the next spring. This dilutes the statistical reliability of the calculation of a larval/juvenile salvage index, corresponding to the CSI for adult delta smelt. However, review of the salvage data relative to actual OMR values within a given year does reveal that a relationship of fall parental abundance to salvage of progeny exists—enough so such that predictability does increase through scaling to current water year FMWT.

The Service has therefore largely followed the methodology for estimating incidental take of larval delta smelt similar to that utilized for adults. Specifically, an average of the last four years (2005-2008) cumulative larval/juvenile salvage by month (April through July) was calculated. This can be summarizes as a Juvenile Salvage Index (JSI), calculated as:

Monthly Juvenile Salvage Index = cumulative seasonal salvage ≥ 20 mm by month end divided by current WY FMWT Index

The mean values from 2005-2008 were used as an initial estimate of take under the RPA. The reason for selecting this span of years is that the apparent abundance of delta smelt since 2005 as indexed by the 20-mm Survey and the TNS is the lowest on record (Table

C-4). It was necessary to separate out this abundance variable, but also to account for other poorly understood factors relating salvage to OMR, distribution, and the extant conditions. In other words, the most recent conditions are our best available reflection of predicted salvage under the RPA. On a monthly basis (cumulative salvage across the spring), this estimate represents a concern level where entrainment has reached high enough numbers to indicate the need for more protective OMR restrictions. The average JSI for the last four spring seasons by month (April through July), equals: 0.29, 13.03, 33.02, and 37.47, respectively.

Concern Level = Monthly JSI 2005-2008 mean * Current WY FMWT

It was determined that the last four years average monthly cumulative salvage was sufficient as an estimate of the concern level for larval/juvenile smelt, as opposed to the incidental take under the RPA. It is acknowledged that salvage across years will be variable, as distribution, spawning success, prior entrainment of adults, enhanced survival of <20mm larval delta smelt under the RPA, and extant natural conditions determine. As mentioned above, this constrains predictability of take using this methodology, and is less reliable overall as the method used for adults. Also, it is believed that individuals of the larval/juvenile lifestage are less demographically significant than adults. Given these considerations, the incidental take estimate for ≥ 20 mm larval/juvenile delta smelt under the RPA will be above the four year average by 50 percent.

Larval/Juvenile Incidental Take = 1.5 * Concern Level

Lookup tables relating (current WY) FMWT to concern level and incidental take for cumulative salvage by month appears in Table C-5 through C-8, below.

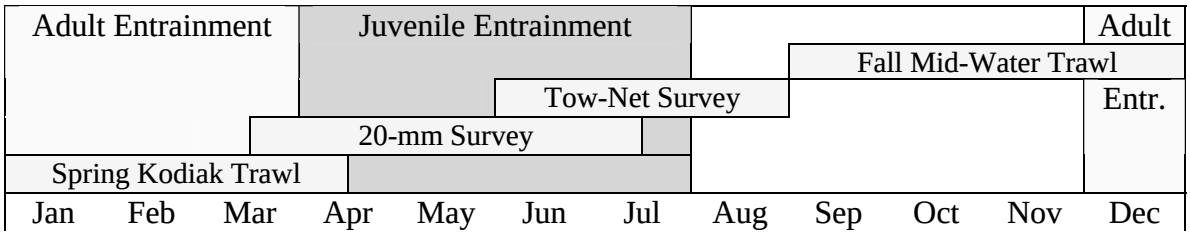


Figure C-2. Fishery surveys conducted by the California Department of Fish and Game that routinely collect delta smelt, and may be used to infer relative abundance.

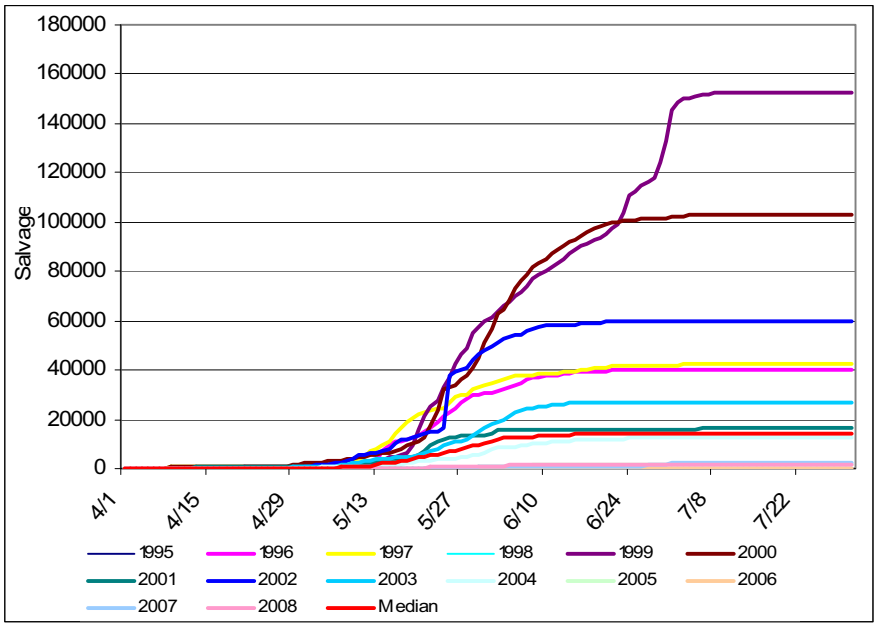


Figure C-3. Cumulative salvage of larval and juvenile delta smelt, 1995 through 2008.

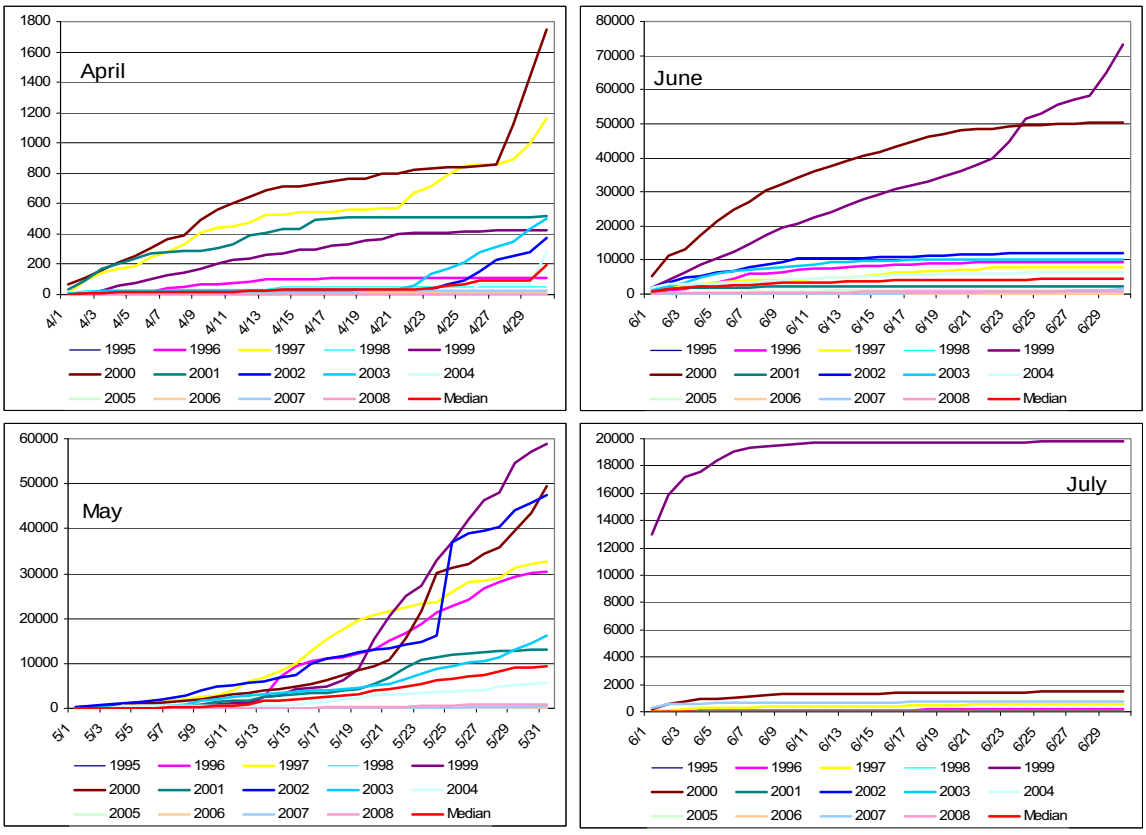


Figure C-4. Cumulative salvage of larval and juvenile delta smelt, 1995-2008, by month.

Table C-4. Larval/juvenile ≥ 20 mm delta smelt abundance and salvage statistics.

Water Year	Prior Year FMWT Index	20-mm Index	STNS	Salvage	Juvenile Salvage Index
1995	102	4.4	3.2	24	0.2
1996	899	33.9	11.1	40099	44.6
1997	127	19.3	4.0	42091	331.4
1998	303	7.7	3.3	242	0.8
1999	420	39.7	11.9	152526	363.2
2000	864	23.8	8.0	101783	117.8
2001	756	11.3	3.5	15984	21.1
2002	603	8	4.7	59652	98.9
2003	139	13.1	1.6	26220	188.6
2004	210	8.2	2.9	12441	59.2
2005	74	15.4	0.3	1734	23.4
2006	27	9.9	0.4	12	0.4
2007	41	1	0.4	2669	65.1
2008	28	2.9	0.6	1705	60.9
min	27	1	0.3	12	0.2
max	899	39.7	11.9	14213	363
mean	328	15.0	4.3	32656	98
25th	81	6.05	0.5	152526	22
median	175	10.6	3.25	1712	60
75th	557	17.3	4.3	41593	363
ITS	**April**	**May**	**June**	**July**	**Total**
Concern Level	0.29*FMWT	13.03*FMWT	33.02*FMWT	37.47*FMWT	37.47*FMWT
Incidental Take	0.44*FMWT	19.6*FMWT	49.5*FMWT	56.2*FMWT	56.2*FMWT

Table C-5: April Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	1	1
4	1	2
6	2	3
8	2	4
10	3	4
12	4	5
14	4	6
16	5	7
18	5	8
20	6	9
22	6	10
24	7	11
26	8	11
28	8	12
30	9	13
34	10	15
38	11	17
42	12	18
48	14	21
54	16	24
60	18	26
66	19	29
72	21	32
78	23	34
84	25	37
90	26	40
96	28	42
100	29	44

FMWT Index	Concern Level	Incidental Take
102	30	45
104	30	46
106	31	47
108	32	47
110	32	48
120	35	53
130	38	57
140	41	62
150	44	66
160	47	70
170	50	75
180	53	79
190	56	84
200	59	88
220	64	97
240	70	106
260	76	114
280	82	123
300	88	132
320	94	141
340	100	150
360	106	158
380	111	167
400	117	176
420	123	185
460	135	202
480	141	211
500	147	220

FMWT Index	Concern Level	Incidental Take
502	147	221
504	148	222
506	148	223
510	150	224
520	152	229
530	155	233
540	158	237
550	161	242
560	164	246
570	167	251
580	170	255
590	173	259
600	176	264
620	182	273
640	188	281
660	193	290
680	199	299
700	205	308
720	211	317
740	217	325
760	223	334
780	229	343
800	235	352
840	246	369
880	258	387
920	270	405
960	281	422
1000	293	440

Table C-6: May Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	26	39
4	52	78
6	78	117
8	104	156
10	130	196
12	156	235
14	182	274
16	209	313
18	235	352
20	261	391
22	287	430
24	313	469
26	339	508
28	365	547
30	391	587
34	443	665
38	495	743
42	547	821
48	626	938
54	704	1056
60	782	1173
66	860	1290
72	938	1408
78	1017	1525
84	1095	1642
90	1173	1760
96	1251	1877
100	1303	1955

FMWT Index	Concern Level	Incidental Take
102	1329	1994
104	1356	2033
106	1382	2072
108	1408	2112
110	1434	2151
120	1564	2346
130	1694	2542
140	1825	2737
150	1955	2933
160	2085	3128
170	2216	3324
180	2346	3519
190	2476	3715
200	2607	3910
220	2868	4301
240	3128	4692
260	3389	5083
280	3650	5474
300	3910	5865
320	4171	6256
340	4432	6647
360	4692	7038
380	4953	7429
400	5214	7821
420	5474	8212
460	5996	8994
480	6256	9385
500	6517	9776

FMWT Index	Concern Level	Incidental Take
502	6543	9815
504	6569	9854
506	6595	9893
510	6647	9971
520	6778	10167
530	6908	10362
540	7038	10558
550	7169	10753
560	7299	10949
570	7429	11144
580	7560	11340
590	7690	11535
600	7821	11731
620	8081	12122
640	8342	12513
660	8603	12904
680	8863	13295
700	9124	13686
720	9385	14077
740	9645	14468
760	9906	14859
780	10167	15250
800	10427	15641
840	10949	16423
880	11470	17205
920	11991	17987
960	12513	18769
1000	13034	19551

Table C-7: June Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take
2	66	99
4	132	198
6	198	297
8	264	396
10	330	495
12	396	594
14	462	694
16	528	793
18	594	892
20	660	991
22	727	1090
24	793	1189
26	859	1288
28	925	1387
30	991	1486
34	1123	1684
38	1255	1882
42	1387	2081
48	1585	2378
54	1783	2675
60	1981	2972
66	2180	3269
72	2378	3567
78	2576	3864
84	2774	4161
90	2972	4458
96	3170	4756
100	3302	4954
102	3369	5053
104	3435	5152
106	3501	5251
108	3567	5350
110	3633	5449
120	3963	5944
130	4293	6440
140	4623	6935
150	4954	7431
160	5284	7926
170	5614	8421
180	5944	8917
190	6275	9412
200	6605	9907
220	7265	10898
240	7926	11889
260	8586	12880
280	9247	13870
300	9907	14861
320	10568	15852
340	11228	16843
360	11889	17833
380	12549	18824
400	13210	19815
420	13870	20806
460	15191	22787
480	15852	23778
500	16512	24769
502	16578	24868
504	16644	24967
506	16711	25066
510	16843	25264
520	17173	25759
530	17503	26255
540	17833	26750
550	18164	27245
560	18494	27741
570	18824	28236
580	19154	28732
590	19485	29227
600	19815	29722
620	20475	30713
640	21136	31704
660	21796	32695
680	22457	33685
700	23117	34676
720	23778	35667
740	24438	36657
760	25099	37648
780	25759	38639
800	26420	39630
840	27741	41611
880	29062	43593
920	30383	45574
960	31704	47556
1000	33025	49537

Table C-8: July Cumulative ≥ 20 mm Juvenile Incidental Take by FMWT Index Lookup Table

FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take	FMWT Index	Concern Level	Incidental Take
2	75	112	102	3822	5732	502	18808	28213
4	150	225	104	3897	5845	504	18883	28325
6	225	337	106	3971	5957	506	18958	28437
8	300	450	108	4046	6070	510	19108	28662
10	375	562	110	4121	6182	520	19483	29224
12	450	674	120	4496	6744	530	19857	29786
14	525	787	130	4871	7306	540	20232	30348
16	599	899	140	5245	7868	550	20607	30910
18	674	1012	150	5620	8430	560	20981	31472
20	749	1124	160	5995	8992	570	21356	32034
22	824	1236	170	6369	9554	580	21731	32596
24	899	1349	180	6744	10116	590	22105	33158
26	974	1461	190	7119	10678	600	22480	33720
28	1049	1574	200	7493	11240	620	23229	34844
30	1124	1686	220	8243	12364	640	23979	35968
34	1274	1911	240	8992	13488	660	24728	37092
38	1424	2136	260	9741	14612	680	25477	38216
42	1574	2360	280	10491	15736	700	26227	39340
48	1798	2698	300	11240	16860	720	26976	40464
54	2023	3035	320	11989	17984	740	27725	41588
60	2248	3372	340	12739	19108	760	28475	42712
66	2473	3709	360	13488	20232	780	29224	43836
72	2698	4046	380	14237	21356	800	29973	44960
78	2922	4384	400	14987	22480	840	31472	47208
84	3147	4721	420	15736	23604	880	32971	49456
90	3372	5058	460	17235	25852	920	34469	51704
96	3597	5395	480	17984	26976	960	35968	53952
100	3747	5620	500	18733	28100	1000	37467	56200

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response reply to:
2008/09022

JUN - 4 2009

Mr. Donald Glaser
Regional Director
Mid-Pacific Region
U.S. Bureau of Reclamation
2800 Cottage Way, MP-3700
Sacramento, California 95825-1898

Dear Mr. Glaser:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) final biological opinion and conference opinion (Opinion, enclosure 1) based on NMFS review of the proposed long-term operations of the Central Valley Project and State Water Project (hereafter referred to as CVP/SWP operations) in the Central Valley, California, and its effects on listed anadromous fishes and marine mammal species, and designated and proposed critical habitats, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This final Opinion is based on information provided in the Bureau of Reclamation's (Reclamation) October 1, 2008, transmittal letter and biological assessment (BA), discussions between NMFS and Reclamation staff, declarations filed pursuant to Pacific Coast Federation of Fishermen Association *et al. v.* Gutierrez *et al.* 1:06-cv-245-OWW-GSA (E.D. Cal. 2008), comments received from Reclamation, peer review reports from CALFED and the Center for Independent Experts, and an extensive literature review completed by NMFS staff. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

Based on the best available scientific and commercial information, NMFS' final Opinion concludes that the CVP/SWP operations are likely to jeopardize the continued existence of Federally listed:

- Endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*),
- Threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*),
- Threatened Central Valley steelhead (*O. mykiss*),
- Threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*), and
- Southern Resident killer whales (*Orcinus orca*).

NMFS also concludes that the proposed action is likely to destroy or adversely modify the designated critical habitats of:

- Sacramento River winter-run Chinook salmon,

- Central Valley spring-run Chinook salmon, and
- Central Valley steelhead, and
- proposed critical habitat for the Southern DPS of North American green sturgeon.

The final Opinion concludes that the CVP/SWP operations are not likely to jeopardize the continued existence of Central California Coast steelhead (O. *mykiss*).

The conference opinion concerning proposed critical habitat for Southern DPS of North American green sturgeon does not take the place of a biological opinion under section 7(a)(2) of the ESA unless and until the conference opinion is adopted as a biological opinion when the proposed critical habitat designation for the Southern DPS of North American green sturgeon becomes final. Adoption may occur if no significant new information is developed, and no significant changes to the project are made that would alter the contents, analyses, or conclusions of this Opinion.

Take of threatened green sturgeon is currently not prohibited by Section 9 of the ESA. When the rule proposed on May 21, 2009 (74 FR 23822) under section 4(d) of the ESA becomes effective as a final rule, all take of threatened green sturgeon not in conformance with that rule will be prohibited under the ESA. Upon the effectiveness of the final green sturgeon take rule, compliance with this Incidental Take Statement provides exemption for take under section 7(o).

The ESA provides that if NMFS has reached a jeopardy or adverse modification conclusion, it must identify a reasonable and prudent alternative (RPA) to the proposed action that is expected to avoid the likelihood of jeopardy to the species and adverse modification of designated and proposed critical habitat, if such an alternative action can be offered. NMFS includes with this Opinion a RPA that we believe meets all four regulatory requirements, as set forth in 50 CFR 402.02. This has been a very challenging consultation for our agencies due to its complexity, long-term nature, and importance to the people of California and the resources we are required to manage. NMFS and Reclamation have had extensive discussions on the preparation of the BA, the draft Opinion, and the draft RPA, and while NMFS understands that Reclamation may have reservations with portions of the Opinion, NMFS understands that it is a package that Reclamation can accept. Because this is a jeopardy Opinion, Reclamation is required (402.15(b)) to notify NMFS "...of its final decision on the action." NMFS, therefore, requests that Reclamation provide NMFS with timely notification as to your agency's final decision.

Also enclosed are Essential Fish Habitat (EFH) Conservation Recommendations for Pacific Coast Salmon species, as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as amended (16 U.S.C. 1801 *et seq.*; enclosure 2). NMFS EFH analysis concludes that the CVP/SWP operations will adversely affect EFH for Pacific Coast Salmon species in the action area. The RPA that was developed for the ESA-listed salmon was designed to avoid jeopardy and adverse modification for those species but it also has substantial benefits to Pacific salmon EFH, and commercially valuable Central Valley fall-run Chinook salmon. Pursuant to the MSFCMA, Conservation Recommendations are also provided to further reduce adverse effects on EFH.

I want to express my sincere appreciation to you and to your staff for their professionalism and commitment to find a solution that comports with our various Federal mandates. You have my commitment that NMFS will continue to be close partner with Reclamation, CA Department of Water Resources, CA Fish and Game, and US Fish and Wildlife Service as we embark on implementation. I also look forward to continuing our participation with Reclamation, partner agencies and stakeholders in the Bay Delta Conservation Planning effort, a very important action to boost habitat improvements in the Delta and counterbalance some of the aging infrastructure limitations. If you have any questions regarding this consultation, please contact Mr. Garwin Yip, of my staff, at (916) 930-3611 or via e-mail at garwin.yip@noaa.gov.

Sincerely,

Rodney R. McInnis

Rodney R. McInnis
Regional Administrator

Enclosures:

Enclosure 1: Biological and conference opinion on the long-term operations of the Central Valley Project and State Water Project

- Appendix 1: Project Description
- Appendix 2: Supporting documents for the RPA
- Appendix 3: Fall-run and late fall-run Chinook salmon analysis
- Appendix 4: Responses to CALFED peer review recommendations
- Appendix 5: Technical memorandum for the San Joaquin actions

Enclosure 2: EFH Conservation Recommendations

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Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION
and CONFERENCE OPINION

on the

LONG-TERM OPERATIONS OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

National Marine Fisheries Service
Southwest Region

June 4, 2009

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Table of Contents

List of Figures 21
List of Tables 27
1.0 BACKGROUND AND CONSULTATION HISTORY 30
1.1 Purpose 30
1.2 Background 31
1.3 Coordinated Operations Agreement 31
1.4 Consultation History 31
1.5 Key Consultation Considerations 34
1.5.1 Southern Oregon/Northern California Coast (SONCC) Coho Salmon 34
1.5.2 ESA Consultation on CVP and SWP Hatcheries 34
1.5.3 ESA Consultation Linkage to the Operation of Oroville Dam 35
1.5.4 Individual Contracts 35
1.5.5 Inspector General's Report for the 2004 CVP/SWP Operations Opinion 36
1.5.6 Independent Peer Reviews of the 2004 CVP/SWP Operations Opinion 37
1.5.7 Reviews throughout the Current Reinitiated CVP/SWP Operations Consultation 37
1.5.7.1 Temperature Management and Modeling Workshop 37
1.5.7.2 Peer Review of NMFS' 2008 Draft CVP/SWP Operations Opinion 38
1.5.7.3 Reclamation's Review of the Draft CVP/SWP Operations Opinion 39
1.5.8 Litigation and Settlement 39
1.5.8.1 USFWS' CVP/SWP Operations Consultation on Delta Smelt 40
1.5.8.2 NMFS' CVP/SWP Operations Consultation 40
1.6 Term of the Opinion 40
2.0 Analytical Approach 41
2.1 Introduction 41
2.2 Legal and Policy Framework 42
2.3 General Overview of the Approach and Models Used 44
2.3.1 Application of the Approach to Listed Species Analyses 45
2.3.1.1 The Viable Salmonid Populations Framework in Listed Salmonid Analyses 51
2.3.1.2 Approach to Southern DPS of Green Sturgeon 53
2.3.1.3 Approach Specific to Southern Resident Killer Whales 54
2.3.2 Application of the Approach to Critical Habitat Analyses 54
2.3.3 Characterization of the Environmental Baseline 57
2.4 Evidence Available for the Analysis 62
2.4.1 Other tools used in the analysis 63
2.4.2 Consideration of a Quantitative Life Cycle Approach to the Analysis 66
2.4.3 Critical Assumptions in the Analysis 68
2.5 Integrating the Effects 68
2.6 Presentation of the Analysis in this Opinion 70
3.0 PROPOSED ACTION 72
3.1 Project Description 73
3.2 Interrelated or Interdependent Actions 73

3.2.1 CVP and SWP Fish Hatcheries 73
3.2.1.1 Nimbus Fish Hatchery 74
3.2.1.2 Trinity River Fish Hatchery 74
3.2 Action Area 74
4.0 STATUS OF THE SPECIES AND CRITICAL HABITAT 74
4.1 Species and Critical Habitat not likely to be Adversely Affected by the Proposed Action 75
4.1.1 Central California Coast Steelhead 75
4.1.2 CCC Steelhead Designated Critical Habitat 76
4.2 Life Histories, Population Trends, Critical Habitat, and Factors Affecting the Status of the Species 76
4.2.1 Chinook Salmon 76
4.2.1.1 General Life History 76
4.2.1.2 Sacramento River Winter-Run Chinook Salmon 79
4.2.1.2.1 Range-Wide (ESU) Status and Trends 81
4.2.1.2.2 Current Viability of the Sacramento River Winter-Run Chinook Salmon ESU 84
4.2.1.2.2.1 Population Size 85
4.2.1.2.2.2 Population Growth Rate 86
4.2.1.2.2.3 Spatial Structure 86
4.2.1.2.2.4 Diversity 87
4.2.1.2.2.5 Summary of the Current Viability of the Sacramento River Winter-Run Chinook Salmon ESU 88
4.2.1.2.3 Status of Sacramento River Winter-Run Chinook Salmon Critical Habitat 88
4.2.1.2.3.1 Summary of Designated Critical Habitat 88
4.2.1.2.3.2 Factors Affecting Critical Habitat 89
4.2.1.2.3.3 Current Condition of Critical Habitat at the ESU Scale 90
4.2.1.2.3.3.1 Access to Spawning Areas in the Upper Sacramento River 90
4.2.1.2.3.3.2 The Availability of Clean Gravel for Spawning Substrate 90
4.2.1.2.3.3.3 Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles 90
4.2.1.2.3.3.4 Water Temperatures for Successful Spawning, Egg Incubation, and Fry Development 91
4.2.1.2.3.3.5 Habitat Areas and Adequate Prey that are not Contaminated 91
4.2.1.2.3.3.6 Riparian Habitat that Provides for Successful Juvenile Development and Survival 91
4.2.1.2.3.3.7 Access Downstream so that Juveniles can Migrate from Spawning Grounds to San Francisco Bay and the Pacific Ocean 92
4.2.1.2.3.3.8 Sacramento River Winter-Run Chinook Salmon Critical Habitat Summary 93
4.2.1.3 Central Valley Spring-Run Chinook Salmon 93
4.2.1.3.1 Range-Wide (ESU) Status and Trends 94

4.2.1.3.2 Current Viability of the Central Valley Spring-Run Chinook Salmon ESU 98
4.2.1.3.2.1 Population Size 99
4.2.1.3.2.2 Population Growth Rate 100
4.2.1.3.2.3 Spatial Structure 100
4.2.1.3.2.4 Diversity 100
4.2.1.3.2.5 Summary of the Current Viability of the Central Valley Spring-Run Chinook Salmon ESU 101
4.2.1.3.3 Status of Central Valley Spring-Run Chinook Salmon Critical Habitat 101
4.2.1.3.3.1 Summary of Designated Critical Habitat 101
4.2.1.3.3.2 Spawning Habitat 102
4.2.1.3.3.3 Freshwater Rearing Habitat 102
4.2.1.3.3.4 Freshwater Migration Corridors 102
4.2.1.3.3.5 Estuarine Areas 103
4.2.1.3.3.6 Central Valley Spring-Run Chinook Salmon Critical Habitat Summary 104
4.2.2 Steelhead 104
4.2.2.1 General Life History 104
4.2.2.2 Central Valley Steelhead 104
4.2.2.2.1 Range-Wide (DPS) Status and Trends 106
4.2.2.2.2 Current Viability of the Central Valley Steelhead DPS 108
4.2.2.2.2.1 Population Size 109
4.2.2.2.2.2 Population Growth Rate 109
4.2.2.2.2.3 Spatial Structure 109
4.2.2.2.2.4 Diversity 109
4.2.2.2.2.5 Summary of the Current Viability of the CV Steelhead DPS 111
4.2.2.2.3 Status of CV Steelhead Critical Habitat 111
4.2.2.2.3.1 Summary of Designated Critical Habitat 111
4.2.2.2.3.2 Spawning Habitat 111
4.2.2.2.3.3 Freshwater Rearing Habitat 111
4.2.2.2.3.4 Freshwater Migration Corridors 112
4.2.2.2.3.5 Estuarine Areas 113
4.2.2.2.3.6 Central Valley Steelhead Critical Habitat Summary 113
4.2.3 Southern DPS of North American Green Sturgeon 113
4.2.3.1 General Life History 113
4.2.3.2 Range-Wide (DPS) Status and Trends 120
4.2.3.3 Current Viability of the Southern DPS of North American Green Sturgeon 124
4.2.3.3.1 Population Size 124
4.2.3.3.2 Population Growth Rate 124
4.2.3.3.3 Spatial Structure 125
4.2.3.3.4 Diversity 125
4.2.3.3.5 Summary of the Current Viability of the Southern DPS of North American Green Sturgeon DPS 126

4.2.3.4 Status of Southern DPS of Green Sturgeon Proposed Critical Habitat 126
4.2.3.4.1 Summary of Proposed Critical Habitat 126
4.2.3.4.2 For Freshwater Riverine Systems 126
4.2.3.4.2.1 Food Resources 126
4.2.3.4.2.2 Substrate Type or Size 127
4.2.3.4.2.3 Water Flow 127
4.2.3.4.2.4 Water Quality 128
4.2.3.4.2.5 Migratory Corridor 128
4.2.3.4.2.6 Depth 129
4.2.3.4.2.7 Sediment Quality 130
4.2.3.4.3 For Estuarine Habitats 130
4.2.3.4.3.1 Food Resources 130
4.2.3.4.3.2 Water Flow 130
4.2.3.4.3.3 Water Quality 131
4.2.3.4.3.4 Migratory Corridor 131
4.2.3.4.3.5 Water Depth 132
4.2.3.4.3.6 Sediment Quality 132
4.2.3.4.4 For Nearshore Coastal Marine Areas 133
4.2.3.4.4.1 Migratory Corridor 133
4.2.3.4.4.2 Water Quality 133
4.2.3.4.4.3 Food Resources 133
4.2.3.4.5 Southern DPS of North American Green Sturgeon Proposed Critical Habitat Summary 134
4.2.4 Factors Responsible for the Current Status of Winter-Run, Spring-Run, CV Steelhead, and the Southern DPS of Green Sturgeon 134
4.2.4.1 Habitat Blockage 134
4.2.4.2 Water Development 135
4.2.4.3 Anderson-Cottonwood Irrigation District (ACID) Dam 136
4.2.4.4 Red Bluff Diversion Dam (RBDD) 137
4.2.4.5 Water Conveyance and Flood Control 138
4.2.4.6 Land Use Activities 139
4.2.4.7 Water Quality 142
4.2.4.8 Hatchery Operations and Practices 143
4.2.4.9 Over Utilization 144
4.2.4.9.1 Ocean Commercial and Sport Harvest – Chinook Salmon and Steelhead 144
4.2.4.9.2 Inland Sport Harvest – Chinook Salmon and Steelhead 145
4.2.4.10 Disease and Predation 146
4.2.4.11 Environmental Variation 148
4.2.4.11.1 Natural Environmental Cycles 148
4.2.4.11.2 Ocean Productivity 149
4.2.4.11.3 Global Climate Change 153
4.2.4.12 Non-Native Invasive Species 154
4.2.4.13 Ecosystem Restoration 154
4.2.4.13.1 CALFED 154

4.2.4.13.2 Central Valley Project Improvement Act 155
4.2.4.13.3 Iron Mountain Mine Remediation 156
4.2.4.13.4 State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement) 156
4.2.4.14 Additional Water Quality 156
4.2.4.15 Summary 157
4.2.5 Southern Resident Killer Whales 158
4.2.5.1 Current Rangewide Status of the Species 158
4.2.5.2 Range and Distribution 159
4.2.5.3 Factors Responsible for the Current Status of Southern Residents 160
4.2.5.3.1 Prey 160
4.2.5.3.1.1 Prey Requirements 163
4.2.5.3.1.2 Percentage of Chinook Salmon 163
4.2.5.3.1.3 River of Origin 164
4.2.5.3.1.4 Age and/or Size 164
4.2.5.3.1.5 Quantity of Prey 165
4.2.5.3.1.6 Quality of Prey 167
4.2.5.3.2 Contaminants 167
4.2.5.3.3 Sound and Vessel Effects 168
4.2.5.3.4 Oil Spills 169
4.2.5.4 Range-Wide Status and Trends 170
4.2.5.5 Extinction Risk 170
5.0 ENVIRONMENTAL BASELINE 171
5.1 Climate Change as Part of the Future Baseline 172
5.2 Status of the Species and Critical Habitat in Clear Creek 174
5.2.1 Spring-Run 174
5.2.1.1 Spring-Run Critical Habitat 175
5.2.2 CV Steelhead 176
5.2.2.1 CV Steelhead Critical Habitat 177
5.2.3 Historical Conditions 177
5.2.4 Future Baseline Excluding CVP/SWP Effects 179
5.3 Status of the Species and Critical Habitat in the Shasta Division and Sacramento River Division 181
Species 181
5.3.1 Winter-Run 181
5.3.1.1 Winter-Run Critical Habitat 181
5.3.2 Spring-Run 183
5.3.2.1 Spring-Run Critical Habitat 184
5.3.3 CV Steelhead 185
5.3.3.1 CV Steelhead Critical Habitat 185
5.3.4 Historical Conditions 187
5.3.5 Future Baseline Excluding CVP/SWP Effects 187
5.3.5.1 Climate Change 189
5.4 Status of the Species and Critical Habitat in the American River Division 191
5.4.1 CV Steelhead 191

5.4.1.1 CV Steelhead Critical Habitat 192
5.4.2 Historical Conditions 193
5.4.3 Future Baseline Excluding CVP/SWP Effects 195
5.5 Status of the Species and Critical Habitat in the East Side Division 197
5.5.1 CV Steelhead 198
5.5.1.1 CV Steelhead Critical Habitat 200
5.5.2 Historical Conditions 201
5.5.3 Future Baseline Excluding CVP/SWP Effects 202
5.6 Status of the Species and Critical Habitat in the Delta Division 203
5.6.1 Critical Habitat 203
5.6.1.1 Status of Winter-Run Critical Habitat 203
5.6.1.2 Status of Spring-Run Critical Habitat 205
5.6.1.3 Status of CV Steelhead Critical Habitat 205
5.6.1.4 Status of Southern DPS Green Sturgeon Proposed Critical Habitat 205
5.6.2 Delta Hydrodynamics 206
5.6.2.1 Historical Hydrograph 206
5.6.2.1.2 Current Flow Patterns in the Delta 207
5.6.3 Future Baseline Excluding CVP/SWP Effects 215
5.7 Southern Resident Killer Whales 216
5.7.1 Natural Mortality 217
5.7.2 Human Related Activities 217
5.7.2.1 Prey Availability 217
5.7.2.2 Prey Quality 219
5.7.2.3 Vessel Activity and Sound 219
5.7.2.4 Non-Vessel Sound 220
5.7.2.5 Oil Spills 220
5.7.2.6 Scientific Research 220
5.7.2.7 Recovery Planning 221
5.7.3 Summary of Southern Residents Environmental Baseline 221
6.0 EFFECTS OF THE PROPOSED ACTION 221
6.1 Approach to the Assessment 221
6.2 Clear Creek and Whiskeytown Dam 222
6.2.1 Deconstruct the Action 222
6.2.2 Assess Species Exposure 222
6.2.3 Assess the Species Response 224
6.2.3.1 Whiskeytown Releases to Clear Creek 226
6.2.3.2 Water Temperatures 228
6.2.3.3 Geomorphic Effects of Altered Hydrology 231
6.2.4 Assess the Risk to Individuals 231
6.2.5 Effects of the Action on Spring-Run and CV Steelhead Critical Habitat in Clear Creek 232
6.3 Shasta Division and Sacramento River Division 233
6.3.1 Red Bluff Diversion Dam 242
6.3.1.1 Deconstruct the Action 242
6.3.1.2 Assess Species Exposure and Response to RBDD 243

6.3.2 Shasta/Keswick Dam Water Releases 249
6.3.2.1 Carryover Storage in Shasta Reservoir 249
6.3.2.1.1 Deconstruct the Action 249
6.3.2.1.2 Assess Species Exposure and Response to Carryover Storage 253
6.3.2.2 Water Temperatures in the Sacramento River 255
6.3.2.2.1 Deconstruct the Action 255
6.3.2.2.2 Assess Species Exposure and Response to Water Temperatures 256
6.3.2.2.2.1 Green Sturgeon 264
6.3.3 Losses from Screened and Unscreened Diversions on the Sacramento River .. 265
6.3.4 Sacramento River Water Reliability Project (SRWRP) 266
6.3.6 Assess the Risk to the Individuals 269
6.3.7 Population Response to Project Effects Using SALMOD Modeling Winter-Run, Spring-Run, and CV Steelhead in the Upper Sacramento River 269
6.3.8 Effects of the Action on Critical Habitat in the Sacramento River 272
6.3.8.1 Spawning Habitat 272
6.3.8.2 Rearing Habitat 273
6.3.8.3 Migratory Corridors 274
6.3.8.4 Green Sturgeon Proposed Critical Habitat 275
6.4 American River Division 277
6.4.1 Deconstruct the Action 277
6.4.2 Assess Species Exposure 277
6.4.3 Assess Species Response 278
6.4.3.1 Folsom/Nimbus Releases 282
6.4.3.2 Water Temperature 284
6.4.3.3 Predation 294
6.4.3.4 Nimbus Fish Hatchery 294
6.4.4 Assess Risk to Individuals 295
6.4.5 Effects of the Action on CV Steelhead Designated Critical Habitat in the American River Division 295
6.5 East Side Division, New Melones Reservoir 296
6.5.1. Deconstruct the Action 296
6.5.2 Assess the Species Exposure 297
6.5.3 Assess the Species Response 300
6.5.3.1 Temperature Effects 302
6.5.3.2 Instream Flow and Seasonal Hydrograph 306
6.5.3.3 Geomorphic Effects of Altered Hydrograph 308
6.5.3.4 Effects of Climate Change 309
6.5.4 Assess Risk to Individuals 309
6.5.5 Effects of the Action on CV Steelhead Critical Habitat 309
6.5.5.1 Spawning Sites 310
6.5.5.2 Temperature 310
6.5.5.3 Spawnable Area 311
6.5.5.4 Spawning Gravel Quality and Quantity 311
6.5.5.5 Spawning Habitat Quality and Geomorphic Processes 311
6.5.5.6 Freshwater Rearing Sites 312

6.5.5.7 Freshwater Migration Corridors 312
6.6 Delta Division 313
6.6.1 Deconstruct Actions in the Delta Division 313
6.6.2 Proposed Delta Exports and Related Hydrodynamics 314
6.6.2.1 Deconstruct the Action 314
6.6.2.2 Elements of the Action 314
6.6.2.2.1 Modeling Results for Proposed Delta Actions 314
6.6.2.2.2 Delta Inflow 314
6.6.2.2.3 Delta Outflow 319
6.6.2.2.4 Exports from the Project Facilities 323
6.6.2.3 Assess Species Exposure 334
6.6.2.3.1 Temporal Occurance 335
6.6.2.3.1.1 Winter-Run 335
6.6.2.3.1.2 Spring-Run 336
6.6.2.3.1.3 CV Steelhead 337
6.6.2.3.1.4 Southern DPS of Green Sturgeon 338
6.6.2.3.2 Spatial Distribution 338
6.6.2.3.2.1 Winter-Run 338
6.6.2.3.2.2 Spring-Run 339
6.6.2.3.2.3 CV Steelhead 339
6.6.2.3.2.4 Southern DPS of Green Sturgeon 340
6.6.2.4 Assess Species Response to the Proposed Action 341
6.6.2.4.1 Direct Entrainment Due to Exports 341
6.6.2.4.1.1 Tracy Fish Collection Facility - Current and Future Operations 341
6.6.2.4.1.2 John E. Skinner Fish Protection Facilities – Current and Future Operations 345
6.6.2.4.1.3 Clifton Court Forebay Predation Losses 347
6.6.2.4.1.4 Collection, Handling, Trucking, and Release Operations 350
6.6.2.4.1.5 Estimates of Direct Loss to Entrainment by the CVP and SWP Export Facilities under the Proposed Action 352
6.6.2.4.1.6 Discussion of Relationship of Exports to Salvage 368
6.6.2.5 Indirect Mortality Within the Delta 374
6.6.2.5.1 Overview of Mortality Sources 374
6.6.2.5.2 Applicable Studies 375
6.6.2.5.3 Environmental Factors 381
6.6.2.5.4 Summary 382
6.6.2.6 Assess Risk to Individuals 382
6.6.3 Clifton Court Aquatic Weed Control Program 386
6.6.3.1 Deconstruct the Action 386
6.6.3.2 Assess the Species Exposure 387
6.6.3.3 Assess Species Response to the Application of Herbicides for the Aquatic Weed Control Program in Clifton Court Forebay 388
6.6.3.4 Assess Risks to Individuals 390
6.6.3.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 391

6.6.4 South Delta Improvement Program – Stage 1 391
6.6.4.1 Deconstruct the Action 391
6.6.4.2 Assess Species Exposure 392
6.6.4.3 Assess Species Response to the Proposed Action 393
6.6.4.4 Assess Risks to Individuals 398
6.6.4.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 399
6.6.5 Delta Cross Channel 401
6.6.5.1 Deconstruct the Action 401
6.6.5.2 Assess the Species Exposure 402
6.6.5.3 Assess Species Response to the Proposed Action 403
6.6.5.4 Assess Risks to Individuals 407
6.6.5.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 410
6.6.6 Contra Costa Water District Diversions 410
6.6.6.1 Deconstruct the Action 410
6.6.6.2 Assess Species Exposure 411
6.6.6.3 Assess Species Response to the Proposed Action 412
6.6.6.4 Assess Risk to Individuals 414
6.6.6.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 415
6.6.7 North Bay Aqueduct at Barker Slough Intake 415
6.6.7.1 Deconstruct the Action 415
6.6.7.2 Assess Species Exposure 416
6.6.7.3 Assess Species Response to the Proposed Action 416
6.6.7.4 Assess Risks to Individuals 417
6.6.7.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 418
6.6.8 Vernalis Adaptive Management Plan 419
6.6.8.1 Deconstruct the Action 419
6.6.8.2 Assess Species Exposure 420
6.6.8.3 Assess Species Response to the Proposed Action 421
6.6.8.4 Assess Risk to Individuals 426
6.6.8.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division 427
6.6.9 Climate Change 428
6.6.10 Summary of the Delta Effects 432
6.7 Suisun Marsh Facilities 433
6.7.1 Suisun Marsh Salinity Control Gates 434
6.7.2 Roaring River Distribution System 437
6.7.3 Morrow Island Distribution System 438
6.7.4 Goodyear Slough Outfall 438
6.8 Effects of the Action on Southern Resident Killer Whales 438
6.8.1 Effects on the Southern Residents' Prey Base 439
6.8.1.1 Prey Reduction of ESA-listed Chinook Salmon ESUs 439

6.8.1.2 Other Effects on Southern Residents' Prey Base 440
6.8.1.2.1 Effects of Artificial Production 440
6.8.1.2.2 Effects of Project Operations 442
6.8.1.2.2.1 Central Valley 442
6.8.1.2.2.2 Trinity River Watershed 444
6.8.1.2.3 Effects of Climate Change 444
7.0 Interrelated or Interdependent Actions 445
7.1 Nimbus Fish Hatchery 445
8.0 CUMULATIVE EFFECTS 445
8.1 Water Diversions 445
8.2 Agricultural Practices 446
8.3 Increased Urbanization 446
8.4 Activities within the Nearshore Pacific Ocean 446
9.0 INTEGRATION AND SYNTHESIS OF THE EFFECTS 447
9.1 Sacramento River Winter-Run Chinook Salmon 448
9.1.1 Status of Sacramento River Winter-Run Chinook Salmon 448
9.1.2 Future Baseline of Winter-Run Chinook Salmon Excluding CVP/SWP Effects 450
9.1.3 Summary of Proposed Action Effects on Winter-Run Chinook Salmon 451
9.1.4 Assess Risk to the Population 461
9.1.5 Assess Risk to the Sacramento River Winter-Run Chinook Salmon ESU 465
9.2 Sacramento River Winter-Run Chinook Salmon Critical Habitat 468
9.2.1 Status of Sacramento River Winter-Run Chinook Salmon Critical Habitat 468
9.2.2 Project Effects on Sacramento River Winter-Run Chinook Salmon Critical Habitat 469
9.2.2.1 Spawning Habitat 469
9.2.2.2 Rearing Habitat 469
9.2.2.3 Migratory Corridors 469
9.2.3 Assess Risk to the Winter-Run Chinook Salmon Critical Habitat 470
9.3 Central Valley Spring-Run Chinook Salmon ESU 471
9.3.1 Status of Central Valley Spring-Run Chinook Salmon ESU 472
9.3.2 Future Baseline of Central Valley Spring-Run Chinook Salmon Excluding CVP/SWP Effects 473
9.3.3 Northwestern California Diversity Group 474
9.3.3.1 Clear Creek Spring-Run Chinook Salmon 474
9.3.3.1.1 Status of Clear Creek Spring-Run Chinook Salmon 474
9.3.3.1.2 Future Baseline of Clear Creek Spring-Run Chinook Salmon Excluding CVP/SWP Effects 474
9.3.3.1.3 Summary of Proposed Action Effects on Clear Creek Spring-Run Chinook Salmon 474
9.3.3.1.4 Assess Risk to Clear Creek Spring-Run Chinook Salmon 483
9.3.3.2 Cottonwood/Beegum and Thomes Creek Spring-Run Chinook Salmon 485
9.3.4 Basalt and Porous Lava Diversity Group 486
9.3.4.1 Mainstem Sacramento River Spring-Run Chinook Salmon 486
9.3.4.1.1 Status of Mainstem Sacramento River Spring-Run Chinook Salmon. 486

9.3.4.1.2 Future Baseline of Mainstem Sacramento River Spring-Run Chinook Salmon Excluding CVP/SWP Effects 486
9.3.4.2 Summary of Proposed Action Effects on Mainstem Sacramento River Spring-Run Chinook Salmon 487
9.3.4.1.4 Assess Risk to Mainstem Sacramento River Spring-Run Chinook Salmon 487
9.3.4.3 Battle Creek Spring-Run Chinook Salmon 497
9.3.5 Northern Sierra Nevada Diversity Group 497
9.3.5.1 Antelope, Mill, Deer, Big Chico, and Butte Creeks and Yuba River Spring-Run Chinook Salmon 497
9.3.6 Assess Risk to the Central Valley Spring-Run Chinook Salmon ESU 498
9.4 Central Valley Spring-Run Chinook Salmon Critical Habitat 500
9.4.1 Status of Central Valley Spring-Run Chinook Salmon Critical Habitat 500
9.4.2 Northwestern California Diversity Group 501
9.4.2.1 Spring-Run Chinook Salmon Critical Habitat in Clear Creek 501
9.4.2.1.1 Status of Spring-Run Chinook Salmon Critical Habitat in Clear Creek 501
9.4.2.1.2 Project Effects on Spring-Run Chinook Salmon Critical Habitat in Clear Creek 501
9.4.2.1.3 Assess Risk to Spring-Run Chinook Salmon Critical Habitat in Clear Creek 501
9.4.2.2 Spring-Run Chinook Salmon Critical Habitat in Cottonwood/Beegum and Thomes Creeks 502
9.4.3 Basalt and Porous Lava Diversity Group 502
9.4.3.1 Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River 502
9.4.3.1.1 Status of Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River 502
9.4.3.1.2 Project Effects on Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River 503
9.4.3.1.3 Assess Risk to Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River 503
9.4.3.2 Spring-Run Chinook Salmon Critical Habitat in Battle Creek 503
9.4.4 Northern Sierra Nevada Diversity Group 504
9.4.5 Assess Risk to Central Valley Spring-Run Chinook Salmon Critical Habitat .. 504
9.5 Central Valley Steelhead 506
9.5.1 Status of the Central Valley Steelhead DPS 506
9.5.2 Baseline Stress Regime for the Central Valley Steelhead DPS 508
9.5.3 Northwestern California Diversity Group 508
9.5.3.1 Clear Creek Steelhead 508
9.5.3.1.1 Status of Clear Creek Steelhead 508
9.5.3.1.2 Future Baseline of Clear Creek Steelhead Excluding CVP/SWP Effects 508
9.5.3.1.3 Proposed Action Effects on Clear Creek Steelhead 509
9.5.3.1.4 Assess Risk to Clear Creek Steelhead 509

9.5.4 Basalt and Porous Lava Diversity Group 518
9.5.4.1 Mainstem Sacramento River Steelhead 518
9.5.4.1.2 Future Baseline of Mainstem Sacramento River Steelhead Excluding CVP/SWP Effects 518
9.5.4.1.3 Proposed Action Effects on Mainstem Sacramento River Steelhead ... 518
9.5.4.1.4 Assess Risk to Mainstem Sacramento River Steelhead 518
9.5.5 Northern Sierra Nevada Diversity Group 527
9.5.5.1 American River Steelhead 527
9.5.5.1.2 Future Baseline of American River Steelhead Excluding CVP/SWP Effects 527
9.5.5.1.3 Proposed Action Effects on American River Steelhead 528
9.5.5.1.4 Assess Risk to American River Steelhead 535
9.5.6 Southern Sierra Nevada Diversity Group 536
9.5.6.1 Stanislaus River Steelhead 536
9.5.6.1.1 Status of Stanislaus River Steelhead 536
9.5.6.1.2 Future Baseline of Stanislaus River Steelhead Excluding CVP/SWP Effects 536
9.5.6.1.3 Proposed Action Effects on Stanislaus River Steelhead 537
9.5.6.1.4 Assess Risk to Stanislaus River Steelhead 537
9.5.7 Assess Risk to the Central Valley Steelhead DPS 546
9.6 Central Valley Steelhead Critical Habitat 548
9.6.1 Status of Central Valley Steelhead Critical Habitat 548
9.6.2 Northwestern California Diversity Group 548
9.6.2.1 Steelhead Critical Habitat in Clear Creek 549
9.6.2.1.1 Status of Steelhead Critical Habitat in Clear Creek 549
9.6.2.1.2 Project Effects on Steelhead Critical Habitat in Clear Creek 549
9.6.2.1.3 Assess Risk to Steelhead Critical Habitat in Clear Creek 549
9.6.3 Basalt and Porous Lava Diversity Group 550
9.6.3.1 Steelhead Critical Habitat in the Mainstem Sacramento River 550
9.6.3.1.1 Status of Steelhead Critical Habitat in the Mainstem Sacramento River 550
9.6.3.1.2 Project Effects on Steelhead Critical Habitat in the Mainstem Sacramento River 550
9.6.3.1.3 Assess Risk to Steelhead Critical Habitat in the Mainstem Sacramento River 550
9.6.4 Northern Sierra Nevada Diversity Group 551
9.6.4.1 Steelhead Critical Habitat in the American River 551
9.6.4.1.1 Status of Steelhead Critical Habitat in the American River 551
9.6.4.1.2 Project Effects on Steelhead Critical Habitat in the American River . 551
9.6.4.1.3 Assess Risk to Steelhead Critical Habitat in the American River 551
9.6.5 Southern Sierra Nevada Diversity Group 552
9.6.5.1 Steelhead Critical Habitat in the Stanislaus River 552
9.6.5.1.1 Status of Steelhead Critical Habitat in the Stanislaus River 552
9.6.5.1.2 Project Effects on Steelhead Critical Habitat in the Stanislaus River . 552
9.6.5.1.3 Assess Risk to Steelhead Critical Habitat in the Stanislaus River 553

9.6.6 Assess Risk to Central Valley Steelhead Critical Habitat 553
9.7 Southern DPS of North American Green Sturgeon 555
9.7.1 Status of Southern DPS of Green Sturgeon 555
9.7.2 Baseline Stress Regime on Southern DPS of Green Sturgeon Excluding CVP/SWP Effects 558
9.7.3 Summary of Proposed Action Effects on Southern DPS of Green Sturgeon 559
9.7.4 Assess Risk to the Population 560
9.7.5 Assess Risk to the Southern DPS of Green Sturgeon 567
9.8 Southern DPS of Green Sturgeon Proposed Critical Habitat 569
9.8.1 Status of Proposed Southern DPS of Green Sturgeon Critical Habitat 569
9.8.1.1 For Freshwater Riverine Systems 569
9.8.1.1.1 Water Quality 569
9.8.1.1.2 Migratory Corridor 569
9.8.1.1.3 Water Depth 569
9.8.1.2 For Estuarine Habitats 570
9.8.1.2.1 Migratory Corridor 570
9.8.2 Project Effects on Proposed Critical Habitat for Southern DPS of Green Sturgeon 570
9.8.3 Assess Risk to the Proposed Southern DPS of Green Sturgeon Critical Habitat 570
9.9 Southern Resident Killer Whales 573
10.0 CONCLUSIONS 574
11.0 REASONABLE AND PRUDENT ALTERNATIVE 575
11.1 OVERVIEW 575
11.1.1 Approach to the RPA 575
11.1.2 Organization of the RPA 580
11.2 Reasonable and Prudent Alternative – Specific Actions 581
11.2.1. Decision-Making Procedures, Monitoring and Adaptive Management Protocols 581
11.2.1.1 Responsibilities and Procedures of Technical Teams 581
11.2.1.2. Research and Adaptive Management 583
11.2.1.3. Monitoring and Reporting 584
11.2.2 Actions Listed by Division 587
I. SACRAMENTO RIVER DIVISION 587
II. AMERICAN RIVER DIVISION 611
III. EAST SIDE DIVISION 619
IV. DELTA DIVISION 628
V. Fish Passage Program 659
11.3 ANALYSIS OF RPA 671
11.3.1 Sacramento River Winter-Run Chinook Salmon and its Designated Critical Habitat 672
11.3.2 Central Valley Spring-Run Chinook Salmon and Its Designated Critical Habitat 683
11.3.3 Central Valley Steelhead and Its Designated Critical Habitat 695
11.3.4 Southern DPS of Green Sturgeon and Its Proposed Critical Habitat 709

11.3.5 Southern Resident Killer Whales 715
11.3.6 Economic and Technological Feasibility of the RPA 718
11.3.7 Consistency with the Intended Purpose of the Action and the Action Agencies' Legal Authority and Jurisdiction 724
12.0 REINITIATION OF CONSULTATION 726
13.0 INCIDENTAL TAKE STATEMENT 727
13.1. Amount or Extent of Anticipated Take 728
13.1.1 Administration of Water Supply Contracts 729
13.1.2 Operation of CVP and SWP Dams and Reservoirs 770
13.1.2.1 Flood Control Operations 770
13.1.2.2 Red Bluff Diversion Dam 770
13.1.2.3 Water Temperatures and Flows 771
13.1.3 Maintenance of Project Facilities 771
13.1.3.1 Screened and Unscreened Water Diversions 771
13.1.4 Monitoring and Research Studies Associated with Project Operations and Facilities 772
13.1.5 Operations in the Delta 773
13.1.6 Quantification of Incidental Take at the CVP and SWP Delta Pumping Facilities 774
13.1.6.1 Juvenile Winter-Run 775
13.1.6.2 Juvenile Spring-Run 775
13.1.6.3 Juvenile Steelhead 776
13.1.6.4 Green Sturgeon 777
13.1.7 Fish Facilities Studies 777
13.1.8 CCWD Diversion 778
13.1.9 Implementation of Sacramento River Basin Salmonid Rearing Habitat Improvements (*i.e.*, RPA Action Suite I.6) 779
13.1.10 Operation of the Nimbus Fish Hatchery Steelhead Program 779
13.1.11 Fish Passage Program 781
13.2 Effect of the Take 781
13.3 Reasonable and Prudent Measures 781
13.4 Terms and Conditions 782
14.0 CONSERVATION RECOMMENDATIONS 785
15.0 LITERATURE CITED 786
15.1 Federal Register Notices Cited 843

List of Figures

Figure 2-1. General Conceptual Model for Conducting Section 7 as Applied to Analyses for Listed Species.
Figure 2-2. Conceptual diagram of the life cycle of a Pacific salmonid.
Figure 2-3. Illustration of cumulative effects associated with different life stages of Pacific salmon. It is possible to increase population size or drive the population to extinction by only slight changes in survivorship at each life history stage. Originally figure 9 in Naiman and Turner (2000, reproduced with permission from the publisher).
Figure 2-4. Population structure of the Central Valley spring-run Chinook salmon ESU. Red crosses indicate populations and diversity groups that have been extirpated. Extant independent populations are identified in all capital letters. It should be noted that all four independent populations which historically occurred in the Feather River watershed tributaries (*i.e.*, north, middle, and south forks, and the west branch) are now extinct, however, a hatchery population does currently occur in the Feather River below Oroville Dam. Chinook salmon exhibiting spring-run characteristics occur in the mainstem Sacramento River below Keswick Dam.
Figure 2-5. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment.
Figure 2-6. General set of information collected to track effects of the proposed action and resulting exposure, response, and risk to listed species.
Figure 2-7. Viable salmonid population (VSP) parameters and their attributes. The quality, quantity and diversity of the habitat (habitat capacity and diversity) available to the species in each of its three main habitat types (freshwater, estuarine and marine environments) is a critical foundation to VSP. Salmon cannot persist in the wild and withstand natural environmental variations in limited or degraded habitats.
Figure 2-8. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment for anadromous salmonids.
Figure 2-9. Conceptual model of the hierarchical structure that is used to organize the destruction or adverse modification assessment for critical habitat. This structure is sometimes collapsed for actions with very large action areas that encompass more than one specific area or feature.
Figure 2-10. General set of information collected to track proposed action effects and resulting exposure, response, and risk to elements of critical habitat.
Figure 2-11. Conceptual diagram of the critical habitat analyses presented in this biological opinion. For illustration purposes, the Rearing Habitat PCE for listed salmonids is pulled out to show the basic flow of the analysis. Full analyses consider the effects to all PCEs and essential features of critical habitat.
Figure 2-12. Conceptual diagram of how the environmental baseline changes in this consultation. The right side of the figure depicts the effects of the proposed action added on top of the baseline into the future (future baseline). Note that the slopes of the curves are only for graphical representation.
Figure 2-13. USFWS Delta smelt Opinion: A conceptual model of the effects of the proposed action added on top of the baseline into the future (future baseline). Note that the slopes of the curves are only for graphical representation.
Figure 2-14. Models used in the development of the CVP/SWP operations BA, and their information flow with respect to each other (CVP/SWP operations BA figure 9-1).
Figure 2-15. Conceptual diagram of the overall analytical approach utilized in this Opinion. The individual level includes exposure, response, and risk to individuals of the species and a consideration of the life cycle and life history strategies. Population level includes consideration of the response of and risk to the population given the risk posed to individuals of the population within the context of the "pyramid" of VSP parameters for the populations. Strata/Diversity Group and Species levels include a consideration of the response of and risk to those levels given the risk posed to the population(s) within the larger context of the VSP "pyramid."
Figure 4-1. Estimated yearly adult natural production and in-river adult escapement of winter-run from 1967 - 2007 based on RBDD ladder counts (Hanson 2008).
Figure 4-2. Annual estimated Central Valley spring-run Chinook salmon escapement population for the Sacramento River watershed for years 1969 through 2006 (PFMC 2002, 2004, CDFG 2004b, Yoshiyama 1998, GrandTab 2006).

Figure 4-3. CV spring-run Chinook salmon diversity groups (replicated from Lindley *et al.* 2007).
Figure 4-4. Estimated natural Central Valley steelhead escapement in the upper Sacramento River based on RBDD counts. Note: Steelhead escapement surveys at RBDD ended in 1993 (from McEwan and Jackson 1996).
Figure 4-5. Annual number of Central Valley steelhead smolts caught while Kodiak trawling at the Mossdale monitoring location on the San Joaquin River (Marston 2004, SJRGA 2007, Speegle 2008a).
Figure 4-6. CV steelhead diversity groups (replicated from Lindley *et al.* 2007).
Figure 4-7. Green sturgeon conceptual life history: Coastal Migrant to Eggs Submodel (Israel and Klimley 2008).
Figure 4-8. Rotary screw trap data of juvenile green sturgeon caught at RBDD and GCID from 1994-2008 (OCAPCVP/SWP operations BA).
Figure 4-9. Juvenile green sturgeon average catch by month at GCID (1994-2005, OCAPCVP/SWP operations BA).
Figure 4-10. Estimated number of juvenile Southern DPS of green sturgeon salvaged from the SWP and the CVP fish collection facilities (Beamesderfer *et al.* 2007, CDFG 2002, and Adams *et al.* 2007). Measured fish lengths from 1981 through 2006 ranged from 136 mm to 774 mm with an average length of 330 mm.
Figure 4-11. Estimated total number of Southern DPS of green sturgeon salvaged monthly from the SWP and the CVP fish collection facilities (CDFG 2002, unpublished CDFG records). Measured fish lengths from 1981 through 2006 ranged from 136 mm to 774 mm with an average length of 330 mm.
Figure 4-12. Geographic Range (light shading) of the Southern Resident Killer Whale DPS. Source: Wiles (2004).
Figure 4-13. Population size and trend of Southern Resident killer whales, 1960-2008. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk *et al.* (1990). Data from 1974-2008 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data). Data for these years represent the number of whales present at the end of each calendar year except for 2008, when data extend only through July.
Figure 5-1. Map of Clear Creek and the distribution of steelhead and late fall-run redds in 2007 (USFWS 2007).
Figure 5-2. Clear Creek spring-run escapement 1993-2008 (CDFG data).
Figure 5-3. Abundance of CV steelhead in Clear Creek based on annual redd counts 2003-2009. Spawning population based on average 1.23 males per female on the American River (Hannon and Deason 2007). 2009 estimate is preliminary based on 4 surveys (USFWS 2008, Brown 2009).
Figure 5-4. Clear Creek monthly flows comparing pre-Whiskeytown Dam (1941-1964) to post dam (1965-2004) flows. The vertical lines represent the range of variability analysis boundaries (CVP/SWP operations BA figure 3-21).
Figure 5-5. Clear Creek long-term average monthly flows as modeled in CALSIM 1923-2003 (CVP/SWP operations BA figure 10-30).
Figure 5-6. Clear Creek historical mean daily water temperatures 1996 – 2006 (CVP/SWP operations BA figure 3-12). Temperature objectives (horizontal dark blue lines) are 60ºF from June 1 through September 15 and 56ºF from September 15 through October 31, pursuant to the 2004 CVP/SWP operations Opinion.
Figure 5-7. Clear Creek average daily flows measured at Igo gage 10/30/07 – 10/30/08 (CDEC data).
Figure 5-8. Map of the upper Sacramento River, including various temperature compliance points and river miles (CVP/SWP operations BA figure 6-2).
Figure 5-9. Estimated yearly spring-run escapement and natural production above RBDD (Hanson 2008).
Figure 5-10. Distribution of spring-run above and below RBDD from 1970 -2001 (CDFG Grand Tab).
Figure 5-11. Spring-run escapement counted at Red Bluff Diversion Dam from 2000 – 2007 (CDFG GrandTab 2008).
Figure 5-12. Estimated yearly number of natural spawning CV steelhead on the Sacramento River upstream of the RBDD 1967-2005. Data from 1992 to 2005 is based on tributary counts from CDFG, Red Bluff (Hanson 2008).
Figure 5-13. Sacramento River at Bend Bridge monthly flows comparing pre-Shasta Dam (1892-1945) and post Shasta (1946 -2004) flows. Vertical lines represent the range of variability analysis boundaries (CVP/SWP operations BA figure 3-20).

Figure 5-14. Conceptual model of future baseline stressors and project-related stressors on listed species in the upper Sacramento River mainstem.
Figure 5-15. Map of lower American River (Modified from Water Forum 2005a).
Figure 5-16. Population estimates of steelhead spawning in the lower American River. Estimates from the early 1990s were reported in Water Forum (2005a), and estimates for 2002 through 2007 were obtained through redd survey monitoring assuming each female steelhead had two redds (Hannon and Deason 2008).
Figure 5-17. Mean monthly flow of the lower American River at the Fair Oaks gage (1904-1955) and after (1956-1967) operation of Folsom and Nimbus dams (Gerstung 1971).
Figure 5-18. Water temperatures recorded at the Fair Oaks gage on the lower American River prior to and after construction of Folsom and Nimbus dams (Gerstung 1971).
Figure 5-19. Conceptual model of the future baseline stressors and proposed project-related stressors affecting naturally-produced American River steelhead.
Figure 5-20. Map of the East Side Division (adapted from the CVP/SWP operations BA figure 2-10).
Figure 5-21. Temporal occurrence of fall-run and steelhead in the Stanislaus River, California. Darker shading indicates peak use.
Figure 5-22. Conceptual model of and future baseline stressors and project-related stressors of CV steelhead and habitat in the Stanislaus River, California.
Figure 5-23. Map of Delta waterways.
Figure 5-24. Average monthly unimpaired (natural) discharge from the upland Sacramento and San Joaquin River watersheds (The Bay Institute 1998).
Figure 5-25. Alteration of median monthly inflow into the lowland Sacramento River at Red Bluff (The Bay Institute 1998).
Figure 5-26. Alteration of median monthly inflow into the lowland Tuolumne and San Joaquin rivers (The Bay Institute 1998).
Figure 5-27. Maximum salinity intrusion for the years 1921 through 1943 (Pre-project conditions in Central Valley –Shasta and Friant Dams non-operational; Sacramento-San Joaquin Delta Atlas, DWR).
Figure 5-28. Maximum salinity intrusion for the years 1944 through 1990 (Project era; Sacramento-San Joaquin Delta Atlas, DWR).
Figure 6-1. Clear Creek minimum flow conditions based on historical conditions (CVP/SWP operations BA).
Figure 6-2. Actual Clear Creek mean daily temperatures at Igo (red), Whiskeytown (blue), and flow (dashed line) measured in 2002, a dry year (CVP/SWP operations BA figure 11-12).
Figure 6-3. Clear Creek September water temperature exceedence plot at Igo gauge (CVP/SWP operations BA figure 10-42).
Figure 6-4. Run timing by month at Red Bluff Diversion Dam for adult winter-run, spring-run, fall-run, late fall-run, CV steelhead, and Southern DPS of green sturgeon (TCCA 2008).
Figure 6-5. Adult female green sturgeon with eggs removed by divers lodged under RBDD gate #6 on May 21, 2007 (USFWS 2007).
Figure 6-6. Red Bluff Diversion Dam gate position and size of openings after May 15 closure, data from Reclamation Daily Reservoir Operations Report May 2007. Note gates #5, 6, and 7 where green sturgeon mortalities were reported by Reclamation (USFWS 2007).
Figure 6-7. Juvenile run timing and exposure by month at Red Bluff Diversion Dam for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon based on USFWS trapping data (TCCA 2008).
Figure 6-8. Presence of predators at RBDD by month from 1994-1996 (TCCA 2008).
Figure 6-9. Exceedance plot of Shasta 1.9 MAF target September storage in Shasta Reservoir. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and study 8.0 represents future operations (CVP/SWP operations BA figure 11-37).
Figure 6-10. Draft exceedance plot of Shasta End of April Storage using selected End of September starting storages and operational assumptions (Supplemental data included with Reclamation's October 1, 2008, transmittal letter).
Figure 6-11. Exceedance plot of Shasta 1.9 MAF target September storage in Shasta Reservoir. Under future climate change scenarios (CVP/SWP operations BA, Appendix R, figure 37).
Figure 6-12. Shasta Lake coldwater pool volume at end of April with climate change scenarios. All studies except 9.0 include 1 foot sea level rise. Study 9.0 is future conditions with D-1641. (CVP/SWP operations BA figure 11-83).

Figure 6-13. Water temperature exceedence at Balls Ferry under Study 8.0 from CALSIM and weekly temperature modeling results (CVP/SWP operations BA figure 11-35). For this analysis, the bold black line indicates the 56°F temperature compliance line.

Figure 6-14. 2008 Winter run average egg mortality by water year type at Balls Ferry. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-39).

Figure 6-15. 2004 winter-run average egg mortality by water year type at Balls Ferry temperature target, with 5 model runs represented (CVP/SWP operations BA).

Figure 6-16. Spring-run egg mortality from Reclamation egg mortality model by water year type. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-41).

Figure 6-17. Juvenile winter-run passage at Red Bluff Diversion Dam 1995 through 2008 (USFWS BDAT 2008).

Figure 6-18. Historical exceedances and temperature control point locations in the upper Sacramento River from 1992 through 2008.

Figure 6-19. Sacramento River mean daily temperature and flow at selected locations in a dry water year, actual measured temperatures in 2001 (CVP/SWP operations BA figure 11-1).

Figure 6-20. Sacramento River average Chinook salmon mortality by run and climate change scenario from Reclamation salmon egg mortality model. All studies except 9.0 include 1-foot sea level rise. Study 9.0 is future conditions with D-1641 (CVP/SWP operations BA figure 11-82).

Figure 6-21. Winter-run Chinook salmon fry mortality due to habitat limitations by water operational scenario, 1923-2002 from SALMOD model. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-49).

Figure 6-22. Sacramento River spring-run egg mortality due to water temperature by operational scenario with 2,400,000 total potential eggs, 1923-2002 from SALMOD model. Study 6.0 represents 2004 operations, 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-53).

Figure 6-23. Reduction in upper Sacramento River juvenile late fall-run Chinook salmon production during each year of the CALSIM II modeling period relative to the maximum production year. Production was based on 12,051 adults and an average of 7 million juveniles produced in most years.

Figure 6-24. Mean daily release rates from Nimbus Dam in January through July of 2004. The timing of the steelhead life stages that are most vulnerable to flow fluctuations during these months are displayed.

Figure 6-25. Dewatered redds at Nimbus Basin and Sailor Bar, February 2006 (figure was modified from Hannon and Deason 2008).

Figure 6-26. Lower American River water temperature during March, April, and May from 1999 through 2008 represented as the mean of the daily average at the Watt Avenue gage (Original data were obtained from http://cdec.water.ca.gov/).

Figure 6-27. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during March (CVP/SWP operations BA appendix I).

Figure 6-28. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during April (CVP/SWP operations BA appendix I).

Figure 6-29. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during May (CVP/SWP operations BA appendix I).

Figure 6-30. Lower American River water temperature during steelhead from 1999 through 2008 represented as the mean of the daily average at the Watt Avenue gage plus 3°F to incorporate potential climate change effects (see Key Assumptions in section 2). Years are labeled in the legend with "CC" to denote the intended application of this figure as an analysis of climate change effects. Original data were obtained from http://cdec.water.ca.gov/.

Figure 6-31. Anal vent inflammation in a juvenile steelhead from the American River (Water Forum 2005a).

Figure 6-32 a, b, and c. Lower American River water temperature during August and September from 1999 through 2007 represented as the daily mean at the Watt Avenue gage (a). Figures b and c show these same water temperatures plus 1°F and 3°F, respectively, to incorporate potential climate change effects (see Key Assumptions in Chapter 2). The 65°F line is indicated in red because visible symptoms of

thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F. Data were obtained from http://cdec.water.ca.gov/.
Figure 6-33a and b. Exceedence plots of modeled water temperatures in the lower American River near Watt Avenue during June (a) and July (b) (CVP/SWP operations BA figures 10-114 and 10-115, respectively). For this analysis, the 65°F line was added in red because visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F.
Figures 6-34a and b. Exceedence plots of modeled water temperatures in the lower American River near Watt Avenue during August (a) and September (b) (CVP/SWP operations BA figures 10-116 and 10-117, respectively). For this analysis, the 65°F line was added in red because visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F.
Figure 6-35. Stanislaus and San Joaquin river temperatures and flow at selected locations in a dry year, actual measured water temperatures (2001, CVP/SWP operations BA figure 11-20).
Figure 6-36. Stanislaus River fall-run Chinook salmon egg mortality with climate change scenarios from Reclamation salmon egg mortality model. All studies except 9.0 include 1-foot sea level rise. Study 9.0 is future conditions with D-1641 (CVP/SWP operations BA figure 11-89).
Figure 6-37. Monthly Delta inflow as measured at the 50th Percentile with 5th and 95th percentile whisker bars shown (CVP/SWP operations BA figure 12-2).
Figure 6-38. Average monthly Total Delta Inflow (CVP/SWP operations BA figure 12-3).
Figure 6-39: Average wet year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-4).
Figure 6-40: Average above normal year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-5).
Figure 6-41: Average below normal year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-6).
Figure 6-42: Average dry year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-7).
Figure 6-43: Average critically dry year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-8).
Figure 6-44. Monthly Delta outflow as measured at the 50th percentile with 5th and 95th percentile whisker bars shown (CVP/SWP operations BA figure 12-10).
Figure 6-45. Average monthly total Delta outflow (CVP/SWP operations BA figure 12-11).
Figure 6-46. Average wet year (40-30-30) monthly delta outflow (CVP/SWP operations BA figure 12-12).
Figure 6-47. Average above normal year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-13).
Figure 6-48. Average below normal year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-14).
Figure 6-49. Average dry year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-15).
Figure 6-50. Average critically dry (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-16).
Figure 6-51. Monthly CVP export pumping rate, 50th percentile with 5th and 95th percentile whisker bars (CVP/SWP operations BA figure 12-18).
Figure 6-52. CVP monthly average export rate (CVP/SWP operations BA figure 12-19).
Figure 6-53. Average wet year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-20).
Figure 6-54. Average above normal year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-21).
Figure 6-55. Average below normal year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-22).
Figure 6-56. Average dry year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-23).
Figure 6-57. Average critically dry year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-24).
Figure 6-58. Monthly SWP export pumping rate, 50th percentile with 5th and 95th percentile whisker bars (CVP/SWP operations BA figure 6-25).
Figure 6-59. SWP monthly average export rate (CVP/SWP operations BA figure 12-26).
Figure 6-60. Average wet year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-27).
Figure 6-61. Average above normal year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-28).

Figure 6-62. Average below normal year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-29).
Figure 6-63. Average dry year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-30).
Figure 6-64. Average critically dry year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-31).
Figure 6-65. Relationship between OMR flows and entrainment at the CVP, 1995-2007 (DWR 2008).
Figure 6-66. Relationship between OMR flows and entrainment at the SWP, 1995-2007 (DWR 2007).
Figure 6-67. Location of particle injection points for the Particle Tracking Model simulations (DWR February 2009).
Figure 6-68. Calculated percentages of entrainment at the CVP and SWP export facilities for different levels of flow in Old and Middle Rivers. Particles are injected at different locations in the Delta (USFWS 2008).
Figure 6-69. Calculated percentage of particles entrained by the CVP and SWP after 31 days at Old and Middle River flows of -3,500 cfs, -2,500 cfs, and -1,250 cfs. Particles were injected at various locations in the Delta. This figure was for March 2005, a "wet" year (DWR February 2009).
Figure 6-70. Calculated percentage of particles entrained by the CVP and SWP after 31 days at Old and Middle River flows of -3,500 cfs, -2,500 cfs, and -1,250 cfs. Particles were injected at various locations in the Delta. This figure was for March 2008, a "dry" year (DWR February 2009)
Figure 6-71. Monthly juvenile Chinook salmon loss versus average exports, December through June, 1993 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-40).
Figure 6-72. Monthly steelhead salvage versus average exports, January through May, 1998 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-45).
Figure 6-73. Monthly steelhead salvage versus average Export/Inflow ratio in TAF, January through May, and January alone, 1998 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-46).
Figure 6-74. Schematic of the mark recapture model used by Perry and Skalski (2008) used to estimate survival (S_{hi}), detection (P_{hi}), and route entrainment (ψ_{hi}) probabilities of juvenile late-fall Chinook salmon migrating through the Sacramento-San Joaquin River Delta for releases made on December 5, 2006, and January 17, 2007.
Figure 9-1. Chinook salmon stressors excluding CVP/SWP-related effects (*i.e.*, the figure represents the general baseline stress regime).
Figure 9-2. General depiction of proposed action-related effects on the temporal distribution of adult and juvenile winter-run during their inland residency.
Figure 9-3. Relative magnitude and location of juvenile salmonids survival throughout the Delta.
Figure 9-4. Chinook salmon stressors, both baseline and those that will result from the proposed action.

List of Tables

Table 2-1. Reasoning and decision-making steps for analyzing the effects of the proposed action on listed species. Acronyms and abbreviations in the action column refer to not likely to adversely affect (NLAA) and not likely/likely to jeopardize (NLJ/LJ).
Table 2-2. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Designated Critical Habitat. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).
Table 2-3. General assumptions, and their bases, made in analyzing the effects of the proposed action.
Table 4-1. The temporal occurrence of (a) adult and (b) juvenile winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.
Table 4-2. Winter-run population estimates from RBDD counts (1986 to 2001) and carcass counts (2001 to 2008), and corresponding cohort replacement rates for the years since 1986 (CDFG 2004a, CDFG 2007).
Table 4-3. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids (reproduced from Lindley *et al.* 2007).
Table 4-4. The temporal occurrence of adult (a-c) and juvenile (d) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance. Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. YOY spring-run Chinook salmon emigrate during the first spring after they hatch.
Table 4-5. Central Valley spring-run Chinook salmon population estimates with corresponding cohort replacement rates (CRR) for years since 1986 (CDFG 2008).
Table 4-6. The temporal occurrence of (a) adult and (b) juvenile Central Valley steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.
Table 4-7. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant Southern DPS of green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.
Table 4-8. The annual occurrence of juvenile Southern DPS of North American green sturgeon at the CVP and SWP fish collection facilities in the South Delta. (Adams *et al.* 2007, CDFG 2002).
Table 4-9. Monthly occurrences of dissolved oxygen depressions below the 5mg/L criteria in the Stockton deep water ship channel (Rough and Ready Island DO monitoring site), water years 2000 to 2004.
Table 4-10. Average number of days spent by Southern Resident killer whales in inland and coastal waters by month, 2003-2007 (Hanson and Emmons, unpubl. report).
Table 4-11. Known sightings of Southern Resident killer whales along the outer Pacific Ocean coast (NMFS 2008a).
Table 4-12. Mean abundance by age class (%) and kills by age class (%).
Table 4-13. Range of extinction and quasi-extinction risk for Southern Resident killer whales in 100 and 300 years, assuming a range in survival rates (depicted by time period), a constant rate of fecundity, between 100 and 400 whales, and a range catastrophic probabilities and magnitudes (Krahn *et al.* 2004).
Table 5-1. Life history timing for anadromous fish species in the upper Sacramento River.
Table 5-2. Comparison of unimpaired average monthly flows, Stanislaus River from various timeframes, with post-New Melones Dam regulated flows (Kondolf *et al.* 2001 table 4.4).
Table 6-1. Summary of proposed action-related effects and responses on Clear Creek spring-run.
Table 6-2. Summary of proposed acton-related effects and responses on Clear Creek steelhead.
Table 6-3. Minimum flow schedule at Whiskeytown Dam from 1963 USFWS proposal and 2001 CVPIA AFRP flow guideline (CVP/SWP operations BA table 2-4).
Table 6-4. Summary of proposed action-related effects and responses on winter-run in the Sacramento River.
Table 6-5. Summary of proposed action-related effects and responses on mainstem Sacramento River spring-run.
Table 6-6. Summary of proposed action-related effects and responses on mainstem Sacramento River steelhead.
Table 6-7. Summary of proposed action-related effects and responses on the Southern DPS of green sturgeon in the Sacramento River.

Table 6-8. Proposed Red Bluff Diversion Dam Gate Closures (CVP/SWP operations BA).
Table 6-9. Estimated monthly hazard estimate used to assess predation in the *E.A. Gobbler* sub-routine of the Fishtastic! juvenile analysis module (Tucker 1998, Vogel *et al.* 1988).
Table 6-10. Percent of juveniles exposed to RBDD gates closed condition (*e.g.*, increased predation, disorientation, *etc*.).
Table 6-11. End of September storage differences for Shasta storage, Spring Creek Tunnel flow, and Keswick release for the long-term annual average and the 1928 to 1934 drought period (CVP/SWP operations BA table 10-3).
Table 6-12. Proposed minimum flow requirements and objectives (cfs) on the Sacramento River below Keswick Dam (project description table 5).
Table 6-13. Temperature targets from the 2004 CVP/SWP operations Opinion used as evaluation criteria. Temperature targets are mean daily degrees F. Target points in the Sacramento and American River are determined yearly with input from the SRTTG and American River Operations Group.
Table 6-14. Relationship between water temperature and mortality of Chinook salmon eggs and pre-emergent fry used in the Reclamation egg mortality model (CVP/SWP operations BA table 6-2).
Table 6-15. Balls Ferry water temperature exceedance by month from SRWQCM.
Table 6-16. Temperature norms for green sturgeon life stages in the Central Valley (Mayfield and Cech 2004, NMFS 2006).
Table 6-17. Estimated entrainment at water diversions based on size (volume of water diverted) and fish monitoring data (RBDD pumping plant) summarized from CVP/SWP operations BA tables 11-12 through 11-16.
Table 6-18. Exposure and summary of responses of American River steelhead to the proposed action.
Table 6-19. Summary of proposed action-related effects on Stanislaus River steelhead.
Table 6-20. CV steelhead temperature requirements by life stage and probability of exceedance under proposed action at relevant locations on the Stanislaus River.
Table 6-21. Comparison of projected monthly Stanislaus River flows (cfs) from September 2008 50 percent forecast and CVP/SWP operations BA Study 7.0, 50 percent projected flows from look-up table.
Table 6-22. Comparison by life stage of instream flows which would provide maximum weighted usable area of habitat for steelhead and Chinook salmon in the Stanislaus River, between Goodwin Dam and Riverbank, California (adapted from Aceituno 1993). No value for Chinook salmon adult migration flows was reported.
Table 6-23. Occurrence of High Allocation, Mid-Allocation and Conference Year types for New Melones Transitional Operation Plan, based on New Melones Operations since 1982 (CDEC data).
Table 6-24. Summary of flow conditions on the Stanislaus River during historical periods from 1904-1998. New Melones Dam construction was completed in 1979. Goodwin Dam was completed in 1912 and the first dam in the basin dates at 1853 (Kondolf *et al.* 2001, table 5.2).
Table 6-25. Differences in long-term average annual Delta inflow and the 1929 – 1934 drought as modeled under the four CVP/SWP operations studies (CVP/SWP operations BA table 12-1).
Table 6-26. Differences in long-term average annual Delta outflow and the 1929 – 1934 drought as modeled under the four CVP/SWP operations studies (CVP/SWP operations BA table 12-2).
Table 6-27. Temporal distribution of anadromous fish species within the Delta (KL = Knights Landing, FW = Fremont Weir).
Table 6-28. Overall survival of fish entrained by the export pumping facilities at the Tracy Fish Collection Facilities and the John E. Skinner Fish Protection Facilities.
Table 6-29. Comparison of predicted monthly total export pumping from the CVP (Jones) and SWP (Banks) facilities for Studies 7.0 (current), 7.1 (near future) and 8.0 (future). The percentage difference is calculated for the percentage change from the near future and future conditions to the current operations. Highlighted cells are where future conditions have less pumping than current conditions.
Table 6-30. Projected Average Old and Middle River Flows by Water Year Types and Months
Table 6-31. Average change in Banks and Jones pumping grouped by water year type. Highlighted cells indicate conditions where pumping is greater than the Study 7.0 current condition during the primary salmonid migration period (November through June).
Table 6-32. Route-specific survival through the Sacramento-San Joaquin Delta ($\hat{S}_h$) and the probability of migrating through each route (Ψ_h) for acoustically tagged juvenile fall-run released on December 5, 2006, (R_1) and January 17, 2007, (R_2). Also shown is the population survival through the delta (S_{Delta}), which is

the average of route specific survival weighted by the probability of migrating through each route (from Perry and Skalski 2008).
Table 6-33. Average estimated Delta survival indices of fall-run Chinook salmon smolts by water year type at different levels of development: unimpaired (no development), and at 1920, 1940, and 1990 levels of development (Table 7 in Kjelson and Brandes 1989).
Table 6-34. The proportion of juvenile Chinook salmon and steelhead production entering the Delta from the Sacramento River by month.
Table 6-35. Summary of listed fish captured at the Rock Slough Headworks and Pumping Plant 1 and amount of water diverted each year, 1998 – 2008.
Table 6-36. Scheduled VAMP target flows and export reductions required under the San Joaquin River Agreement.
Table 6-37. Trends for Average Changes in Flow for Climate Change Scenarios Relative to the Base Case.
Table 6-38. Trends for Average Changes in Delta Velocities for Climate Change Scenarios Relative to the Base Case.
Table 6-39. Percent of Central Valley fall- and late fall-fun annually available to killer whales that are produced by the Nimbus Fish Hatchery program over the duration of the proposed action (Appendix 3).
Table 6-40. Percent annual reduction in hatchery and natural Central Valley fall- and late fall-run available to Southern Residents from project-caused mortality over the duration of the proposed action (Appendix 3).
Table 6-41. Percent annual reduction in natural Central Valley fall- and late fall-run Chinook salmon available to Southern Residents from project-caused mortality over the duration of the proposed action (Appendix 3).
Table 6-42. Percent annual change in Central Valley fall- and late fall-run Chinook available to Southern Residents under a drier, warmer climate scenario (based on Study 9.5, Appendix 3).
Table 9-1. Summary of proposed action-related effects on winter-run.
Table 9-2. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Sacramento River Winter-Run Chinook Salmon ESU.
Table 9-3. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Sacramento River Winter-Run Chinook Salmon Designated Critical Habitat.
Table 9-4. Summary of proposed action-related effects on Clear Creek spring-run.
Table 9-5. Summary of proposed action-related effects on mainstem Sacramento River spring-run.
Table 9-6. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Central Valley Spring-Run Chinook Salmon ESU.
Table 9-7. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Central Valley Spring-Run Chinook Salmon Designated Critical Habitat.
Table 9-8. Summary of proposed action-related effects on Clear Creek steelhead.
Table 9-9. Summary of proposed action-related effects on mainstem Sacramento River steelhead.
Table 9-10. Summary of proposed action-related effects on American River steelhead.
Table 9-11. Summary of proposed action-related effects on Stanislaus River steelhead.
Table 9-12. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the CV steelhead DPS.
Table 9-13. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Central Valley Steelhead Designated Critical Habitat.
Table 9-14. Summary of proposed action-related effects on green sturgeon.
Table 9-15. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Southern DPS of North American Green Sturgeon.
Table 9-16. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Southern DPS of Green Sturgeon Proposed Critical Habitat.

BIOLOGICAL OPINION AND CONFERENCE OPINION

ACTION AGENCY: U.S. Bureau of Reclamation
Central Valley Operations Office

ACTIVITY: Long-Term Operations of the Central Valley Project and State Water Project

CONSULTATION CONDUCTED BY: NOAA's National Marine Fisheries Service
Southwest Region

FILE NUMBER: 2008/09022

DATE ISSUED:

1.0 BACKGROUND AND CONSULTATION HISTORY

1.1 Purpose

The purpose of this document is to present NOAA's National Marine Fisheries Service's (NMFS) biological and conference opinion (Opinion), about whether the U.S. Bureau of Reclamation's (Reclamation) proposed long-term operations of the Central Valley Project (CVP), operated in coordination with the State Water Project (SWP; hereafter referred to as CVP/SWP operations, the proposed action, or the project), is likely to jeopardize the continued existence of the following species:

- Endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*, hereafter referred to as winter-run)
- Threatened Central Valley spring-run Chinook salmon (*O. tshawytscha,* hereafter referred to as spring-run)
- Threatened Central Valley (CV) steelhead (*O. mykiss*)
- Threatened Central California Coast (CCC) steelhead (*O. mykiss*)
- Threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris,* hereafter referred to as Southern DPS of green sturgeon)
- Endangered Southern Resident killer whales (*Orcinus orca,* hereafter referred to as Southern Residents)

or destroy or adversely modify the designated critical habitat of the above salmon and steelhead species, or proposed critical habitat for Southern DPS of green sturgeon. This Opinion is based on the best scientific and commercial information available.

1.2 Background

Alterations to the natural hydrologic systems of the Sacramento and San Joaquin River basins began in the late 1800s, accelerating in the early 1900s, including the construction of three dams owned and operated by Reclamation, a fourth dam owned and operated by the California Department of Water Resources (DWR), and a multitude of pumps and hundreds of miles of gravity-fed water diversions constructed and operated by private water users and by Reclamation and DWR. None of the major dams were constructed with fish ladders to pass anadromous fish and, as a result, salmon and steelhead have effectively been blocked from accessing the upper reaches of the basin. Beginning in 1993, Shasta and Keswick Dam releases on the upper Sacramento River have been managed to provide cold water to the spawning habitat below Keswick Dam as per requirements of NMFS' winter-run biological opinion on the operations of the CVP and SWP.

1.3 Coordinated Operations Agreement

In November 1986, the U.S. Federal government and DWR signed the Coordinated Operation Agreement (COA), which defines the rights and responsibilities of the CVP and SWP with respect to in-basin water needs and provides a mechanism to account for those rights and responsibilities. Congress, through Public Law 99-546, authorized and directed the Secretary of the Interior to execute and implement the COA. Under the COA, Reclamation and DWR agree to operate the CVP and SWP, respectively, under balanced conditions in a manner that meets Sacramento Valley and Delta needs while maintaining their respective water supplies, as identified in the COA. "Balanced conditions" are defined as periods when the CVP and SWP agree that releases from upstream reservoirs, plus unregulated flow, approximately equal water supply needed to meet Sacramento Valley in-basin uses and CVP/SWP exports. The COA is the Federal nexus for ESA section 7 consultation on operations of the SWP. In this CVP/SWP operations consultation, DWR is considered an applicant.

1.4 Consultation History

On October 22, 2004, NMFS issued its biological opinion on the proposed CVP/SWP operations (NMFS 2004c, hereafter referred to as 2004 CVP/SWP operations Opinion). Within that document was a consultation history that dated back to 1991, which is incorporated here by reference.

On April 26 and May 19, 2006, Reclamation requested reinitiation of consultation on CVP/SWP operations based on new species listings and designated critical habitats. In a June 19, 2006, letter to Reclamation, NMFS stated that there was not enough information in Reclamation's request to initiate consultation. NMFS provided a list of information required to fulfill the initiation package requirements [50 CFR 402.14(c)]. From May 2007, until May 29, 2008, NMFS participated in the following interagency forums, along with representatives from Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Game (CDFG), in order to provide technical assistance to Reclamation in its development of a biological assessment (BA) and reinitiation package.

- Biweekly interagency CVP/SWP operations meetings;
- Biweekly five agencies management meetings;
- Weekly directors' meetings; and
- Several modeling meetings.

In addition, NMFS provided written feedback on multiple occasions:

- Multiple e-mails from the USFWS (submitted on behalf of USFWS, NMFS, and CDFG) providing specific comments on various chapters of the draft CVP/SWP operations BA, including the legal setting (Chapter 1) and project description (Chapter 2);
- February 15, 2008, e-mails from NMFS to Reclamation, transmitting comments on species accounts for the anadromous salmonid species and green sturgeon (Chapters 3-6, and 8);
- A February 21, 2008, letter providing comments with regard to the development of the draft CVP/SWP operations BA, and in particular, the draft project description; and
- An April 22, 2008, list of threatened and endangered species and critical habitats that occur within areas affected by the proposed action.

On May 19, 2008, NMFS received Reclamation's May 16, 2008, request to reinitiate formal consultation on CVP/SWP operations. On May 30, 2008, Reclamation hand-delivered a revised BA containing appendices and modeling results. On June 10, 2008, NMFS issued a letter to Reclamation indicating that a reinitiation package was received, and that NMFS would conduct a 30-day sufficiency review of the BA received on May 30, 2008. On July 2, 2008, NMFS issued a letter to Reclamation, indicating that the BA was not sufficient to reinitiate formal consultation. NMFS described additional information necessary to reinitiate consultation. In addition, on July 17, 2008, NMFS offered additional comments on the BA via e-mail. Throughout July 2008, NMFS continued to participate in the interagency forums listed above to continue to provide technical assistance to Reclamation on its development of a final BA and complete reinitiation package. In addition, meetings were held between NMFS and Reclamation staff on August 8, September 9, and September 19, 2008, to discuss and clarify outstanding concerns regarding the modeling, Essential Fish Habitat (EFH), and project description information contained in the draft BA. On August 20 and September 3, 2008, NMFS received additional versions of the draft BA, hand-delivered to the NMFS Sacramento Area Office on digital video disc (DVD).

On October 1, 2008, the Sacramento Area Office received a hand-delivered letter from Reclamation, transmitting the following documents: (1) final BA on a DVD (Reclamation 2008a, hereafter referred to as the CVP/SWP operations BA), (2) Attachment 1: Comment Response Matrix, (3) Attachment 2: errata sheet; (4) Attachment 3: Additional modeling simulation information regarding Shasta Reservoir carryover storage and Sacramento River water temperature performance and exceedances; and (5) Attachment 4: American River Flow Management Standard 2006 Draft Technical Report. The letter and enclosures were provided in response to our July 2, 2008, letter to Reclamation, indicating that the BA was not sufficient to reinitiate formal consultation. In its October 1, 2008, letter, Reclamation also committed to providing, by mid-October 2008, the following: responses to comments and reinitiating consultation related to Pacific Coast Salmon EFH within the Central Valley, and (2) a request for conferencing and an analysis of effects of the continued long-term operation of the CVP and

SWP on proposed critical habitat for green sturgeon. On October 20, 2008, Reclamation provided to NMFS via e-mail the analysis of effects on the proposed critical habitat of Southern DPS of green sturgeon. In addition, on October 22, 2008, Reclamation provided to NMFS via e-mail supplemental information regarding the EFH assessment on fall-run Chinook salmon (hereafter referred to as fall-run). On November 21, 2008, NMFS issued a letter to Reclamation, indicating that Reclamation had provided sufficient information to reinitiate formal consultation on the effects of CVP/SWP operations, with the understandings that: (1) Reclamation is committed to working with NMFS staff to provide any additional information NMFS determines necessary to analyze the effects of the proposed action; and (2) NMFS is required to issue a final Opinion on or before March 2, 2009 (see section 1.5.8.2, below).

On December 11, 2008, NMFS issued a draft CVP/SWP operations Opinion for peer review through the CALFED Bay-Delta Program (CALFED) and the Center for Independent Experts (CIE), and also to Reclamation for review and comment. Details about the reviews are provided below in sections 1.5.6.2 and 1.5.6.3. Beginning the week of January 5, 2009, NMFS hosted weekly meetings with representatives from USFWS, CDFG, Reclamation, and DWR at the directors, managers, and technical levels, in addition to scheduling meetings on specific topics, to address, clarify, and resolve Reclamation's and DWR's comments on the draft Opinion and draft reasonable and prudent alternative (RPA).

On January 15, 2009, Reclamation sent NMFS an e-mail, transmitting an attached file with 2 pages to replace the North Bay Aqueduct section of the CVP/SWP operations BA on pages 13-49 and 13-50. In addition, section 3.1 of this Opinion documents additional changes to the CVP/SWP operations BA, specifically in Chapter 2 (project description).

This document is NMFS' Opinion on the proposed action, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.). The request for formal consultation was received on October 1, 2008. This final Opinion supersedes the 2004 CVP/SWP operations Opinion. This Opinion is based on: (1) the reinitiation package provided by Reclamation, including the CVP/SWP operations BA, received by NMFS on October 1, 2008; (2) the supplemental analysis of effects on the proposed critical habitat of Southern DPS of green sturgeon and supplemental information regarding the EFH assessment on fall-run; (3) other supplemental information provided by Reclamation; (4) declarations submitted in court proceedings pursuant to Pacific Coast Federation of Fishermen Association (PCFFA) *et al*. v. Gutierrez *et al*.; and (5) scientific literature and reports. A complete administrative record of this consultation is on file at the NMFS, Sacramento Area Office.

1.5 Key Consultation Considerations

1.5.1 Southern Oregon/Northern California Coast (SONCC) Coho Salmon

This Opinion analyzes the effects of the proposed action, including the Trinity River Division, on listed Central Valley anadromous fish species and Southern Residents (as it pertains to effects on Central Valley Chinook salmon availability as prey). NMFS is analyzing the effects of the proposed action on SONCC coho salmon in a separate biological opinion. Reclamation is currently in consultation with NMFS on this aspect of its operations.

After consideration of the complexity of the SONCC coho salmon consultation and availability of staff resources, NMFS is committed to completing the SONCC coho salmon consultation by September 30, 2009.

1.5.2 ESA Consultation on CVP and SWP Hatcheries

CVP and SWP hatcheries within the Central Valley include the Livingston Stone National Fish Hatchery (LSNFH), Coleman National Fish Hatchery, Feather River Fish Hatchery (FRFH), and Nimbus Fish Hatchery. The USFWS, which manages the LSNFH and Coleman National Fish Hatchery, has requested a separate ESA section 7 consultation on those hatcheries. Therefore, the effects of the ongoing operations of the LSNFH and Coleman National Fish Hatchery are not analyzed as part of the proposed action in this consultation. The FRFH is a mitigation hatchery for the impacts of DWR's Oroville Dam. Currently, the Federal Energy Regulatory Commission (FERC) is in consultation with NMFS on the effects of relicensing Oroville Dam (including the effects of FRFH). Therefore, the FRFH is not considered in this consultation.

The Trinity River Fish Hatchery is part of the Trinity River Division of the CVP. Consistent with how NMFS will address the effects on SONCC coho salmon (see section 1.5.1, above), NMFS will defer the consideration of effects from Trinity River Fish Hatchery, as it pertains to any effects on SONCC coho salmon, to the separate formal consultation currently in process.

The exception to the above consultation considerations on CVP and SWP hatcheries is that all Chinook salmon production from all Central Valley hatcheries (*i.e.,* Coleman National Fish Hatchery, LSNFH, FRFH, Nimbus Fish Hatchery, Mokelumne Fish Hatchery, and Merced Fish Hatchery), in addition to the Trinity River Fish Hatchery, are considered in the analysis of effects on Southern Residents in this Opinion because these runs provide forage for Southern Residents. The Molelume River Hatchery (funded and operated by CDFG) and Merced Fish Hatchery (funded by the East Bay Municipal Utilities District and operated by CDFG) are not CVP or SWP hatcheries, but they make up a portion of hatchery-produced Chinook salmon from the Central Valley.

In summary, of all the CVP and SWP hatcheries, aside from hatchery production for the Southern Residents, the specific operation of Nimbus Fish Hatchery will be analyzed in this consultation. Overall, the combined effects from hatchery-produced fish in the Central Valley are included in the environmental baseline.

Managers for each CVP and SWP hatchery are currently engaged in discussions with NMFS in their development of a Hatchery and Genetic Management Plan (HGMP), pursuant to section 4 of the ESA. The HGMPs will include long-range planning and management of fish species cultured at the hatcheries. To that end, the consultation and exemption of incidental take related to the continued operation of Nimbus Hatchery will sunset 2 years from the date of issuance of this Opinion. As adoption of an HGMP under section 4 of the ESA is a Federal action, NMFS will conduct an intra-agency section 7 consultation prior to adoption of the HGMP.

1.5.3 ESA Consultation Linkage to the Operation of Oroville Dam

The Oroville Complex (Oroville Dam and related facilities, including the FRFH) is part of the SWP. DWR has been operating the Oroville Complex under a FERC license and is currently undergoing a relicensing process with FERC. The FERC license expired in January 2007, and until a new license is issued, DWR operates to the existing FERC license. FERC is currently in consultation with NMFS regarding the effects of relicensing the Oroville Complex for 50 years. Because the effects of the Oroville Complex are considered in the ongoing FERC consultation, the effects of operation of Oroville Dam on listed fish within the Feather River is not considered in this consultation. The analytical cutoff point of the hydrologic effects in the FERC analysis is at the Feather River's confluence with the Sacramento River. The effects of the flows from the Oroville Complex on all listed fish under NMFS jurisdiction in the Sacramento River and Delta are considered in this consultation.

1.5.4 Individual Contracts

This consultation addresses the long-term operations of the CVP and SWP, and does not satisfy Reclamation's ESA section 7(a)(2) obligations for issuance of individual water supply contracts. Reclamation should consult with NMFS separately on their issuance of individual contracts. The analysis of effects of the proposed actions, however, assumes water deliveries under the contracts, as described and modeled in the BA.

NMFS requests that by June 4, 2010, Reclamation provide written notification to NMFS and the State Water Resources Control Board (SWRCB) of any contract that it believes is creates a nondiscretionary obligation to deliver water, including the basis for this determination and the quantity of nondiscretionary water delivery required by the contract. Any incidental take due to delivery of water to such a contractor is not be exempt from the ESA section 9 take prohibition in this Opinion.

1.5.5 Inspector General's Report for the 2004 CVP/SWP Operations Opinion

On October 8, 2004, 19 members of the U.S. House of Representatives submitted a letter to the inspectors general of the departments of Interior and Commerce, requesting a review of allegations that Reclamation, "…in its haste to finalize water contracts in California, has improperly undermined the required NOAA Fisheries environmental review process for the proposed long-term Operations, Criteria, and Plan (OCAP) for the Central Valley Project (CVP) and the State Water Project (SWP)." Subsequent to that request, the Department of Commerce Office of Inspector General (IG), audited the process used by NMFS to develop the 2004 CVP/SWP operations Opinion, with objectives to: (1) identify the review process used to issue the 2004 CVP/SWP operations Opinion on Reclamation's CVP and DWR's SWP, and (2) determine whether NMFS – in developing the 2004 CVP/SWP operations Opinion – followed the consultation process for issuing biological opinions that is defined by its policies, procedures, and normal practices. On July 8, 2005, Johnnie E. Frazier (Office of Audits, Seattle Regional Office) issued Final Report STL-17242-5-0001 to NMFS, which included the following findings: (1) The NMFS southwest regional office deviated from the agency's established consultation initiation process, and (2) The southwest regional office did not follow its process for ensuring the quality of the biological opinion.

Section 1.4 provides details regarding the consultation history leading up to the issuance of this CVP/SWP operations Opinion. In response to IG finding #1, on November 21, 2008, NMFS issued a letter to Reclamation, indicating that Reclamation had provided sufficient information to reinitiate formal consultation on the effects of CVP/SWP operations, with the understanding that: (1) Reclamation is committed to working with NMFS staff to provide any additional information NMFS determines necessary to analyze the effects of the proposed action.

To address IG finding #2, NMFS issued a series of documents to provide a clear and transparent description of the roles and responsibilities of regional staff in the review and clearance process for consultation documents. The review and clearance process for non-routine formal consultations (which includes highly controversial, novel, or precedent-setting biological opinions, including this CVP/SWP operations Opinion) requires signatures of the Area Fffice Section 7 Coordinator, Area Office Supervisor, Regional Section 7 Coordinator, NOAA General Counsel, and Assistant Regional Administrator for Protected Resources on a clearance sheet acknowledging that proper review procedures were followed, prior to final signature by the Regional Administrator. During the review process, consultation documents were reviewed for consistency with applicable policies, procedures and mandates; scientific accuracy; legal sufficiency; clear, effective, and efficient communication of analysis and reasoning; and compliance with required format, style, and tone.

As provided above, the IG's recommendations have been incorporated into NMFS' review process and current formal consultation on the CVP/SWP operations.

1.5.6 Independent Peer Reviews of the 2004 CVP/SWP Operations Opinion

In 2005, NMFS initiated peer reviews of its 2004 CVP/SWP operations Opinion through CALFED and the CIE. In general, the peer reviewers' charge was to evaluate and comment on the technical information, models, analyses, results, and assumptions that formed the basis for the assessment of the proposed long-term water operations of the CVP and SWP. In December 2005, CALFED issued its report and findings to NMFS. Also in 2005, Dr. Thomas E. McMahon (CIE reviewer) and Dr. Jean-Jacques Maguire (CIE reviewer) issued their report and findings to NMFS. Each of the reports had constructive recommendations for the 2004 CVP/SWP operations Opinion. As an added level of review, NMFS requested the NMFS-Southwest Fisheries Science Center (SWFSC) to evaluate the peer reviews. The NMFS-SWFSC issued a report to NMFS-Protected Resources Division on May 25, 2006, concluding that the three peer reviews offered generally valid and helpful critiques of the science underlying the 2004 CVP/SWP operations Opinion. The CVP/SWP operations BA and this Opinion considered and/or incorporated all of the substantive peer review recommendations, as appropriate.

1.5.7 Reviews throughout the Current Reinitiated CVP/SWP Operations Consultation

1.5.7.1 Temperature Management and Modeling Workshop

The peer reviews of the 2004 CVP/SWP operations Opinion identified several temperature-related concerns, with recommendations on how to address those concerns. In February and March, 2008, NMFS convened an interagency planning team, consisting of representatives from Reclamation, DWR, USFWS, CALFED, and NMFS, to develop the scope and agenda for a workshop intended to provide a forum for discussion of issues related to temperature modeling and management on the upper Sacramento River in support of the CVP/SWP operations BA and NMFS' Opinion. On April 1, 2008, CALFED convened the 1-day public workshop, which consisted of a series of presentations and question-and-answer periods with selected local agency representatives, in Sacramento, California. Topics discussed included anadromous species' temperature needs, recovery approach for listed Central Valley salmonids, operational practices to manage temperature of the Sacramento River, modeling and technical tools presently used for CVP stream management, and case studies of temperature management in other watersheds. Following the workshop, CALFED convened a Review Panel of independent subject matter experts to evaluate the technical and scientific approach used to manage temperature in CVP streams as presented in the workshop. The Review Panel provided a written synthesis of topics discussed during the workshop, their perspective of important issues, and available tools (with recommendations for their use) for addressing water temperature management in the upper Sacramento River, in support of NMFS' Central Valley Recovery Plan temperature objectives (Deas *et al*. 2008). The CVP/SWP operations BA and this Opinion considered and incorporated, as appropriate, the recommendations from Deas *et al*. (2008).

1.5.7.2 Peer Review of NMFS' 2008 Draft CVP/SWP Operations Opinion

NMFS sought peer reviews of its 2008 draft CVP/SWP operations Opinion through CALFED and the CIE. Each review involved a different approach and process.

The CALFED review format involves convening of a Panel of independent subject matter experts who review documents provided, then meet in a public workshop format where the Panel may interact with NMFS and other agency staff, ask questions and clarify information regarding their review charge. Following the workshop, the Panel produces a report of their findings and recommendations. This approach is beneficial in that the Panel has the opportunity to clear up potential misunderstandings regarding the information they have been provided so that their product is most likely to provide relevant feedback to NMFS, and there is the potential to discover useful input from attendees at the workshop, as well as from collaboration among reviewers.

The CALFED peer review of the draft CVP/SWP operations Opinion occurred in two phases. The first phase was to evaluate and comment on NMFS analytical framework that would form the basis for this CVP/SWP operations Opinion. On July 22, 2008, NMFS submitted its analytical framework document to CALFED for peer review. On August 5, 2008, CALFED convened a public workshop in Sacramento, California, which consisted of several presentations from NMFS staff on the ESA section 7 consultation process and the proposed analytical approach, followed by a questions-and-answers session from the peer review Panel to the NMFS presenters. At the end of the workshop, the Panel requested additional information from NMFS in order for it to provide meaningful feedback and recommendations to assist us in the development of the CVP/SWP operations Opinion. Specifically, the Panel requested a copy of the CVP/SWP operations BA, making it clear that their intention was not to peer review the CVP/SWP operations BA, but to understand the information presented in the CVP/SWP operations BA in order to better respond to the peer review charge for the analytical framework. In addition, the peer review panel requested two mock analyses to show them how we intended to utilize our analytical framework, and also how the recommendations from the peer review of the 2004 CVP/SWP operations Opinion were addressed in the current reinitiated CVP/SWP operations consultation. After NMFS fulfilled the peer review panel's requests (at the time, the most recent draft of the CVP/SWP operations BA was August 20, 2008), a follow-up public workshop via conference call was held on August 29, 2008, mainly in the form of a questions-and-answers session. On November 4, 2008, NMFS received a letter from CALFED, transmitting the Panel's October 31, 2008, document, "Independent Review of the 2008 NMFS Analytical Framework for its CVP/SWP operations Biological Opinion."

The second phase of the CALFED peer review was the review of a draft of the CVP/SWP operations Opinion in the current consultation. The purpose of this independent review was to obtain the views of experts not involved in the consultation on the use of the best available scientific and commercial information as it pertains to the development of the CVP/SWP operations Opinion. In addition, CIE peer reviewed a draft of the CVP/SWP operations Opinion in the current consultation. On December 11, 2008, NMFS submitted its draft CVP/SWP operations Opinion to CALFED and the CIE for peer review. As NMFS had draft conclusions of

jeopardy for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon, and adverse modification of designated critical habitats of winter-run, spring-run, CV steelhead, and proposed critical habitat for Southern DPS of green sturgeon, NMFS also provided the draft reasonable and prudent alternative (RPA) to CALFED for review. On January 8, 2009, CALFED convened a public workshop in Sacramento, California, which consisted of several presentations from NMFS staff, summarizing the effects analysis conducted in this consultation, followed by a questions-and-answers session from the Panel to the NMFS presenters. On January 26, 2009, NMFS received a letter from CALFED, transmitting the Panel's January 23, 2009, document, "Independent Review of a Draft Version of the 2009 NMFS CVP/SWP operations Biological Opinion" (Anderson *et al*. 2009).

The CALFED peer review approach also has been criticized for a potential lack of independence, as NMFS is a CALFED member agency. NMFS fully supports the CALFED criteria for independence in its reviews, but also sought independent peer review through the CIE.

The process for the CIE peer review is that CIE identifies a group of reviewers who will receive the materials for review. They conduct their reviews guided by "Terms of Reference," that is, a list of specific questions that NMFS requested to be answered in the peer review. The reviewers work independently, and after the specified review period, they provide individual review reports to CIE and NMFS.

On January 21, 2009, Dr. E. Eric Knudsen, Dr. Ian A. Fleming, and Dr. Richard A. Marston (CIE reviewers) issued their reports and findings to NMFS. Each of the peer review reports had constructive recommendations towards the development of a more scientifically robust final Opinion. However, in general, all of the peer reviewers and their reports acknowledged the incredibly complex proposed action, and that NMFS applied the best available information in its development of the draft Opinion. This Opinion, and its supporting administrative record, considered and/or incorporated all of the substantive peer review recommendations, as appropriate. NMFS also incorporated many of the suggested line edits from the peer review reports to improve the quality of this Opinion.

1.5.7.3 Reclamation's Review of the Draft CVP/SWP Operations Opinion

In addition to the CALFED and CIE peer reviews, on December 11, 2008, NMFS issued the draft CVP/SWP operations Opinion, draft RPA, and EFH Conservation Recommendations to Reclamation for its review and comments. On January 13, 2009, Reclamation provided its comments, in addition to transmitting comments from DWR. On March 3, 2009, NMFS issued a revised draft of its CVP/SWP operations Opinion and draft RPA to Reclamation for its review and comment. On March 20, 2009, Reclamation provided its comments, in addition to transmitting comments from DWR. DWR provided additional comments on April 20, April 28, and May 1, 2009. Many of Reclamation's and DWR's comments were consistent with and echoed those of the peer review reports. NMFS considered and/or incorporated all of Reclamation's and DWR's substantive comments, as appropriate.

1.5.8 Litigation and Settlement

1.5.8.1 USFWS' CVP/SWP Operations Consultation on Delta Smelt

On December 14, 2007, the United States District Court for the Eastern District of California issued an Interim Remedial Order in Natural Resources Defense Council, *et al*. v. Kempthorne, 1:05-cv-1207 OWW GSA (E.D. Cal. 2007), to provide additional protection of the Federally-listed Delta smelt pending completion of a new biological opinion for the continued operation of the CVP and SWP. The Interim Remedial Order remains in effect until the USFWS issues a new biological opinion for the continued operation of the CVP and SWP, which must be completed by September 15, 2008. A motion to extend the time for completion was filed on July 29, 2008. The court granted USFWS' request to extend its court-ordered deadline to complete the biological opinion to December 15, 2008.

The USFWS issued its biological opinion on December 15, 2008 (USFWS 2008a), with a jeopardy finding for Delta smelt, and adverse modification of Delta smelt designated critical habitat. In its biological opinion, the USFWS proposed an RPA for Reclamation to consider. On December 15, 2008, Reclamation issued a memorandum to the USFWS, provisionally accepting the USFWS' RPA, conditioned upon the further development and evaluation of RPA Components 3 and 4.

1.5.8.2 NMFS' CVP/SWP Operations Consultation

On April 16, 2008, the United States District Court for the Eastern District of California issued a Memorandum Decision and Order on the Cross-Motions for Summary Judgment filed in PCFFA *et al*. v. Gutierrez *et al*, 1:06-cv-245-OWW-GSA (E.D. Cal. 2008). The Court found that the Opinion issued by NMFS in 2004 was invalid. An evidentiary hearing followed, resulting in a Remedies Ruling on July 18, 2008. The ruling concluded that the court needed further evidence to consider the Plaintiffs' proposed restrictions on CVP/SWP operations. A Scheduling Order was filed by the court on July 24, 2008, and a further status conference was set for September 4, 2008. On October 21, 2008, Judge Wanger issued a ruling that California's canal water systems are placing wild salmon "unquestionably in jeopardy." However, he did not issue any court-ordered interim remedies pending a final NMFS Opinion, to be issued by March 2, 2009. A motion to extend the time for completion was filed on January 21, 2009. The court granted NMFS' request to extend its court-ordered deadline to complete the biological opinion to June 2, 2009.

1.6 Term of the Opinion

This biological opinion is effective through December 31, 2030.

2.0 Analytical Approach

2.1 Introduction

This section describes the analytical approach used by NMFS to evaluate the effects of the proposed action on listed species under NMFS jurisdiction. The approach is intended to ensure that NMFS comports with the requirements of statute and regulations when conducting and presenting the analysis. This includes the use of the best available scientific and commercial information relating to the status of the species and critical habitat and the effects of the proposed action.

The following sub-sections outline the specific conceptual framework and key steps and assumptions utilized in the listed species jeopardy risk assessment and the critical habitat destruction or adverse modification risk assessment. Wherever possible, these sections were written to apply to all six listed species, and associated designated and proposed critical habitats, occurring in the action area, which include:

- Endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*);
- Threatened Central Valley steelhead (*O. mykiss*);
- Threatened Central California Coast steelhead (*O. mykiss*);
- Threatened Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*);
- Endangered Southern Resident killer whales (*Orcinus orca*)
- Designated critical habitats for listed salmonids; and
- Proposed critical habitat for Southern DPS of green sturgeon.

In the case of listed salmonids, NMFS has additional data and analytical frameworks that are applied as part of the overall approach. These tools are called out in separate sub-sections. Readers are advised that with the exception of these specific sub-sections, the remainder of the discussion should be read as generally applicable to all affected listed species and critical habitats.

The following discussion of our analytical approach is organized into several sub-sections, with the first sub-section describing the legal framework provided by the ESA and case law and policy guidance related to section 7 consultations. Second, a general overview of how NMFS conducts its section 7 analysis is described, including various conceptual models of the overall approach and specific features of the approach are discussed. This includes information on tools used in the analysis specific to this consultation. We first describe our listed species analysis as it pertains to individual fish species and the physical, chemical, and biotic changes to the ecosystem caused by the proposed action. Description of our critical habitat analysis follows. Third, we discuss the evidence available for the analysis, the related uncertainties, and critical assumptions NMFS made to bridge data gaps in the information provided to initiate consultation. Fourth, we diagram the overall conceptual approach in the assessment to address the integration of all available information and decision frameworks to support our assessment of the effects of

the proposed action. Finally, we discuss the presentation of all of these analyses within this Opinion to provide a basic guide to the reader on the relevant sections where the results of specific analytical steps can be reviewed.

2.2 Legal and Policy Framework

The purposes of the ESA, "*…are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section.*" To help achieve these purposes, the ESA requires that, "*Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat…*"

Jeopardy Standard. The "jeopardy" standard has been further interpreted in regulation (50 CFR 402.02) as a requirement that Federal agencies insure that their actions are not likely to result in *appreciable reductions in the likelihood of both the survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution.* It is important to note that the purpose of the analysis is to determine whether or not appreciable reductions are reasonably expected, but not to precisely quantify the amount of those reductions. As a result, our assessment often focuses on whether an appreciable reduction is expected or not, but not on detailed analyses designed to quantify the absolute amount of reduction or the resulting population characteristics (absolute abundance, for example) that could occur as a result of proposed action implementation.

For the purposes of this analysis, NMFS equates a listed species' probability (or risk) of extinction with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. In the case of listed salmonids, we use the Viable Salmonid Populations (VSP) framework (McElhany *et al.* 2000) as a bridge to the jeopardy standard. A designation of "a high risk of extinction" or "low likelihood of becoming viable" indicates that the species faces significant risks from internal and external processes that can drive it to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

For salmonids, the four VSP parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed salmonid species (McElhany *et al*. 2000). The VSP parameters of productivity, abundance, and population spatial structure are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for "numbers, reproduction, and distribution." The VSP parameter of diversity relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is

lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-levels.

NMFS is currently in the process of developing a recovery plan for the listed Central Valley salmon and steelhead species. A technical recovery team (TRT) was established to assist in the effort. One of the TRT products, Lindley *et al*. (2007), provides a "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin." Along with assessing the current viability of the listed Central Valley salmon and steelhead species, Lindley *et al*. (2007) provided recommendations for recovering those species. In addition, a co-managers' review draft of the Central Valley recovery plan was issued, and NMFS received comments from various co-managers. A public review draft of the recovery plan is likely to be issued in 2009. Lindley *et al*. (2007) was relied on to establish the current status of the listed Central Valley salmon and steelhead species, and both Lindley *et al*. (2007) and the draft recovery plan were utilized to evaluate whether the proposed action does not "reduce appreciably the likelihood of survival and recovery."

Destruction or Adverse Modification Standard. For critical habitat, NMFS did not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the analysis with respect to critical habitat. NMFS will evaluate "destruction or adverse modification" of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species.

Additional requirements on the analysis of the effects of an action are described in regulation (50 CFR 402) and our conclusions related to "jeopardy" and "destruction or adverse modification" generally require an expansive evaluation of the direct and indirect consequences of the proposed action, related actions, and the overall context of the impacts to the species and habitat from past, present, and future actions as well as the condition of the affected species and critical habitat [for example, see the definitions of "cumulative effects," "effects of the action," and the requirements of 50 CFR 402.14(g)].

Recent court cases have reinforced the requirements provided in section 7 regulations that NMFS must evaluate the effects of a proposed action within the context of the current condition of the species and critical habitat, including other factors affecting the survival and recovery of the species and the functions and value of critical habitat. In addition, the courts have directed that our risk assessments consider the effects of climate change on the species and critical habitat and our prediction of the future impacts of a proposed action.

Consultations designed to allow Federal agencies to fulfill these purposes and requirements are concluded with the issuance of a biological opinion or a concurrence letter. For biological opinions, section 7 of the ESA and the implementing regulations (50 CFR 402), and associated guidance documents (*e.g.*, USFWS and NMFS 1998) require the opinions to present: (1) a description of the proposed Federal action; (2) a summary of the status of the affected species and its critical habitat; (3) a summary of the environmental baseline within the action area; (4) a detailed analysis of the effects of the proposed action on the affected species and critical habitat;

(5) a description of cumulative effects; and (6) a conclusion as to whether it is reasonable to expect the proposed action is not likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild by reducing its numbers, reproduction, or distribution or result in the destruction or adverse modification of the species designated critical habitat.

2.3 General Overview of the Approach and Models Used

NMFS uses a series of sequential analyses to assess the effects of Federal actions on endangered and threatened species and designated critical habitat. These sequential analyses are illustrated in figure 2-1. The first analysis identifies those physical, chemical, or biotic aspects of proposed actions that are likely to have individual, interactive, or cumulative direct and indirect effects on the environment (we use the term "stressors" for these aspects of an action). As part of this step, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time (the combined spatial extent of these stressors is the "action area" for a consultation).

The second step of our analyses starts by identifying the endangered species, threatened species, or designated or proposed critical habitat that are likely to occur in the same space and at the same time as these potential stressors. Then we try to estimate the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number and age (or life stage) of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent or the specific areas and primary constituent elements of critical habitat that are likely to be exposed.

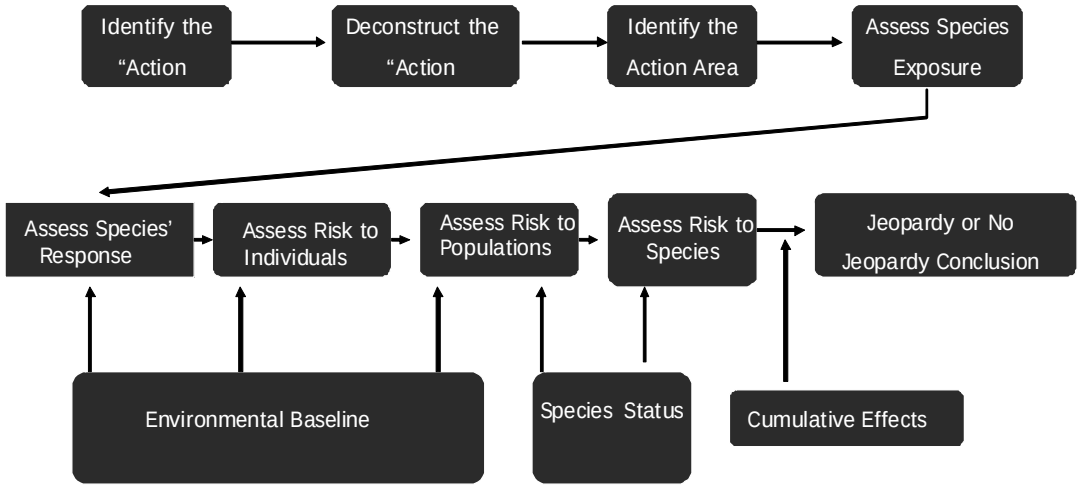


Figure 2-1. General Conceptual Model for Conducting Section 7 as Applied to Analyses for Listed Species.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*). The final steps of our

analyses - establishing the risks those responses pose to listed resources - are different for listed species and designated critical habitat and are further discussed in the following sub-sections (these represent our *risk analyses*).

2.3.1 Application of the Approach to Listed Species Analyses

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species and how those "species" have been listed (*e.g*., as true biological species, subspecies, or distinct population segments of vertebrate species). Because the continued existence of listed species depends on the fate of the populations that comprise them, the probability of extinction, or probability of persistence of listed species depends on the probabilities of extinction and persistence of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. We identify the probable risks that actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individuals risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," which are changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to an action's effects on the environment (which we identify in our *response analyses*) are likely to have consequences for the individual's fitness.

When individuals, whether they are listed plants or animals, are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Stearns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for increases in a population's probability of extinction, which is itself a *necessary* condition for increases in a species' probability of extinction.

If we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment tries to determine if those fitness reductions are likely to be sufficient to increase the probability of extinction of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, diversity, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Status of the Species* section of this Opinion) as our point of reference. Generally, this reference condition is a measure of how near to or far from a species is to extinction or recovery.

An important tool we use in this step of the assessment is a consideration of the life cycle of the species. The consequences on a population's probability of extinction as a result of impacts to different life stages are assessed within the framework of this life cycle and our current knowledge of the transition rates (essentially, survival and reproductive output rates) between stages, the sensitivity of population growth to changes in those rates, and the uncertainty in the available estimates or information. An example of a Pacific salmonid life cycle is provided in figure 2-2.

Various sets of data and modeling efforts are useful to consider when evaluating the transition rates between life stages and consequences on population growth as a result of variations in those rates. These data are not available for all species considered in this Opinion; however data from surrogate species may be available for inference. Where available, information on transition rates, sensitivity of population growth rate to changes in these rates, and the relative importance of impacts to different life stages is used to inform the translation of individual effects to population level effects. Generally, however, we assume that the consequences of impacts to older reproductive and pre-reproductive life stages are more likely to affect population growth rates than impacts to early life stages. But it is not always the adult transition rates that have the largest effect on population growth rate. For example, absolute changes in the number of smolts that survive their migration to the ocean may have the largest impact on Chinook salmon population growth rate (Wilson 2003) followed by the number of alevins that survive to fry stage (POPTOOLS add-in to Microsoft Excel sensitivity analysis of simplified Chinook salmon life table).

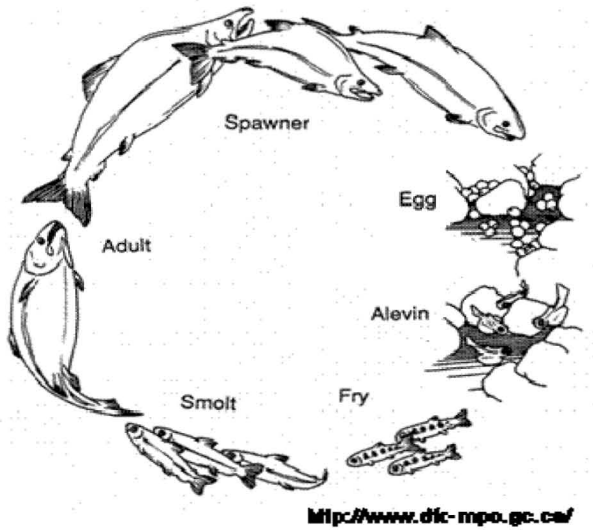


Figure 2-2. Conceptual diagram of the life cycle of a Pacific salmonid.

Similarly, in some sturgeon species, growth rate is most sensitive to young-of-the-year (YOY) and juvenile survival, and less sensitive to annual adult fecundity and survival (Caswell 2001). Thus, habitat alterations that decrease the survival of YOY or any class within the juvenile life

stage will more strongly influence the affected population's growth rate than if the alteration will only affect fecundity or survival of adults (Gross *et al*. 2002).

In addition, we recognize that populations may be vulnerable to small changes in transition rates. As hypothetically illustrated in figure 2-3, small reductions across multiple life stages can be sufficient to cause the extirpation of a population through the reduction of future abundance and reproduction of the species.

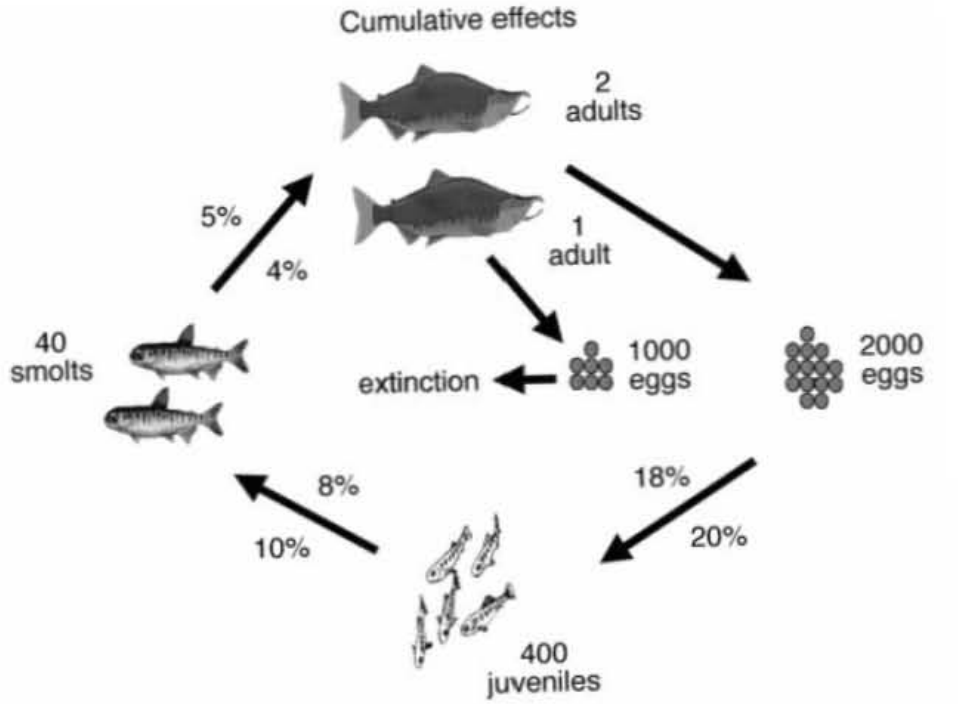
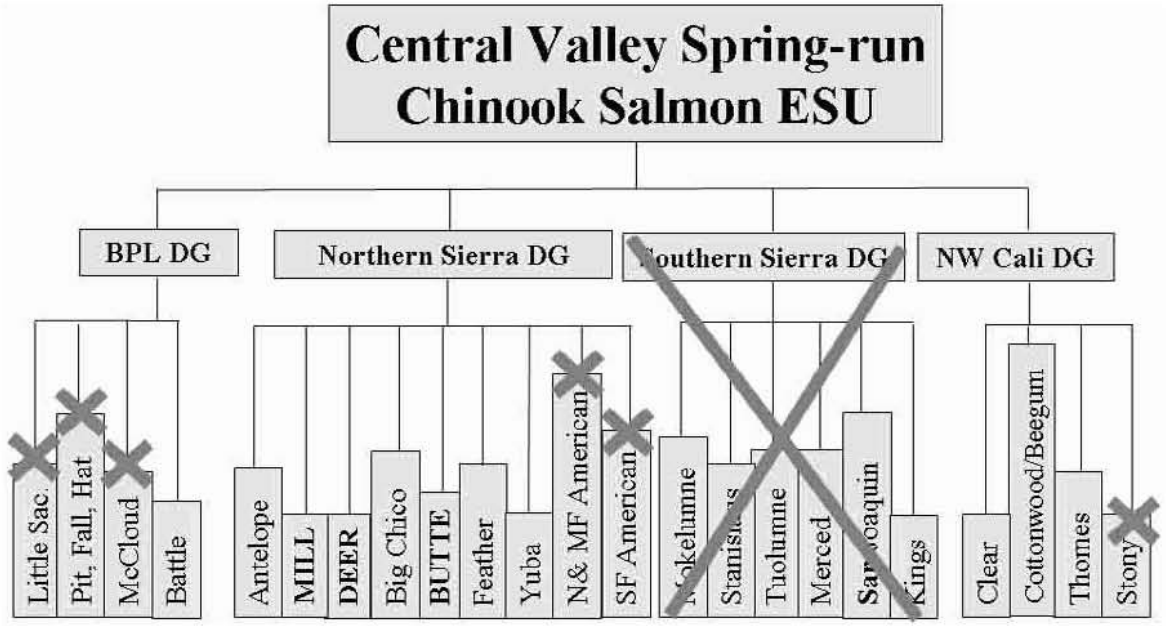


Figure 2-3. Illustration of cumulative effects associated with different life stages of Pacific salmon. It is possible to increase population size or drive the population to extinction by only slight changes in survivorship at each life history stage. Originally figure 9 in Naiman and Turner (2000, reproduced with permission from the publisher).

Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this Opinion) as our point of reference. We also use our knowledge of the population structure of the species to assess the consequences of the increase in extinction risk to one or more of those populations. Our *Status of the Species* section will discuss the available information on the structure and diversity of the populations that comprise the listed species and any available guidance on the role of those populations in the recovery of the species. An example conceptual model of the population structure of spring-run is provided in figure 2-4. This model illustrates the historic structure of the species and notes those populations that have been extirpated to provide a sense of the existing and lost diversity and structure within the species. Both the existing and lost diversity and structure are important considerations when evaluating the

consequences of increases in the extinction risk of an existing population or effects to areas that historically had populations.



BPL – Basalt and Porous Lava
NW Cali - Northwest California
DG – Diversity Group

Figure 2-4. Population structure of the Central Valley spring-run Chinook salmon ESU. Red crosses indicate populations and diversity groups that have been extirpated. Extant independent populations are identified in all capital letters. It should be noted that all four independent populations which historically occurred in the Feather River watershed tributaries (*i.e.*, north, middle, and south forks, and the west branch) are now extinct, however, a hatchery population does currently occur in the Feather River below Oroville Dam. Chinook salmon exhibiting spring-run characteristics occur in the mainstem Sacramento River below Keswick Dam.

NMFS developed a set of tables designed to collect and evaluate the available information on the expected proposed action stressors and the exposure, response and risk posed to individuals of the species. Figure 2-6 outlines the basic set of information we evaluated. We rank the effects to individuals on the basis of the severity of the predicted response and resulting fitness consequence within life stages. As discussed above, in the absence of other information, we assume that fitness consequences to smolts are more likely to have resulting population level effects than impacts to early life stages, like eggs or alevins.

A discussion of the method of determining effects to individuals of the species using listed salmonids.

The first steps in evaluating the potential impacts a project may have on an individual fish would entail: (1) identifying the seasonal periodicity and life history traits and biological requirements of listed salmon and steelhead within the Project area. Understanding the spatial and temporal occurrence of these fish is a key step in evaluating how they are affected by current human activities and natural phenomena; (2) identifying the main variables that define riverine characteristics that may change as the result of project implementation; (3) determining the extent of change in each variable in terms of time, space, magnitude, duration, and frequency; (4) determining if individual listed species will be exposed to potential changes in these variables; and (5) then evaluating how the changed characteristic would affect the individual fish in terms of the fish's growth, survival, and/or reproductive success.

Riverine characteristics may include: flow, water quality, vegetation, channel morphology, hydrology, neighboring channel hydrodynamics, and connectivity among upstream and downstream processes. Each of these main habitat characteristics is defined by several attributes (*i.e*., water quality includes water temperature, dissolved oxygen, ammonia concentrations, turbidity, *etc*.). The degree to which the proposed project may change attributes of each habitat characteristic will be evaluated quantitatively and/or qualitatively, in the context of its spatial and temporal relevance. Not all of the riverine characteristics and associated attributes identified above may be affected by proposed project implementation to a degree where meaningful qualitative or quantitative evaluations can be conducted. That is, if differences in flow with and without the proposed project implementation are not sufficient to influence neighboring channel hydrodynamics, then these hydrodynamics will not be evaluated in detail, either quantitatively or qualitatively. The changed nature of each attribute will then be compared to the attribute's known or estimated habitat requirements for each fish species and life stage. For example, if water temperature modeling results demonstrate that water temperatures during the winter-run spawning season (mid-April through mid-August) would be warmer with implementation of the proposed project, then the extent of warming and associated impact, would be assessed in consideration of the water temperature ranges required for successful winter-run spawning.

NMFS then evaluates the likely response of listed salmonids to such stressors based on the best available scientific and commercial information available, including observations of how similar exposures have affected these species. NMFS assesses whether the conditions that result from the proposed project, in combination with conditions influenced by other past and ongoing activities and natural phenomena as described by the factors responsible for the current status of the listed species, will affect growth, survival, or reproductive success (*i.e.,* fitness) of individual listed salmonids at the life stage scale.

NMFS will then evaluate how the proposed project's effects on riverine characteristics may affect the growth, survival, and reproductive success of individual fish. For example, growth and survival and reproductive success of individual fish may all be affected if the proposed project results in increased water temperatures during multiple life stages. Individual fish growth also may be affected by reduced availability, quantity, and quality of habitats (*e.g*., floodplains, channel margins, intertidal marshes, *etc*.). Survival of an individual fish may be affected by suboptimal water quality, increased predation risk associated with non-native predatory habitats and physical structures (such as gates, weirs), impeded passage, and susceptibility to disease. Reproductive success of individual fish may be affected by impeded or delayed passage to natal streams, suboptimal water quality (*e.g*., temperature), which can increase susceptibility to disease, and reduced quantity and quality of spawning habitats. Instream flow studies (*e.g*., instream flow incremental methodology studies) available in the literature, which describe the relationship between spawning habitat availability and flow, will be used to assess proposed project-related effects on reproductive success. All factors associated with the proposed project that affect individual fish growth, survival, or reproductive success will be identified during the exposure analyses.

For example, the Central Valley Domain TRT recommended that for winter-run, spring-run, and CV steelhead, all extant (still surviving) populations should be secured and that, "…*every extant population be viewed as necessary for the recovery of the ESU [Evolutionarily Significant Unit]*" (Lindley *et al*. 2007). Based on this recommendation, it was assumed that if appreciable reductions in any population's viability are expected to result from implementation of the proposed action, then this would be expected to appreciably reduce the likelihood of both the survival and recovery of the diversity group the population belongs to as well as the listed ESU/DPS.

Figure 2-1 outlined these basic steps in the analysis. Table 2-1 presents the basic set of propositions and consultation outcomes associated with acceptance or rejection of those propositions that we utilize when conducting our evaluation of effects of the proposed action. These follow a logic path and hierarchical structure (figure 2-5) that is used to organize the jeopardy risk assessment.

Table 2-1. Reasoning and decision-making steps for analyzing the effects of the proposed action on listed species. Acronyms and abbreviations in the action column refer to not likely to adversely affect (NLAA) and not likely/likely to jeopardize (NLJ/LJ).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed.	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent.	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species.	True	NLJ
		False	LJ

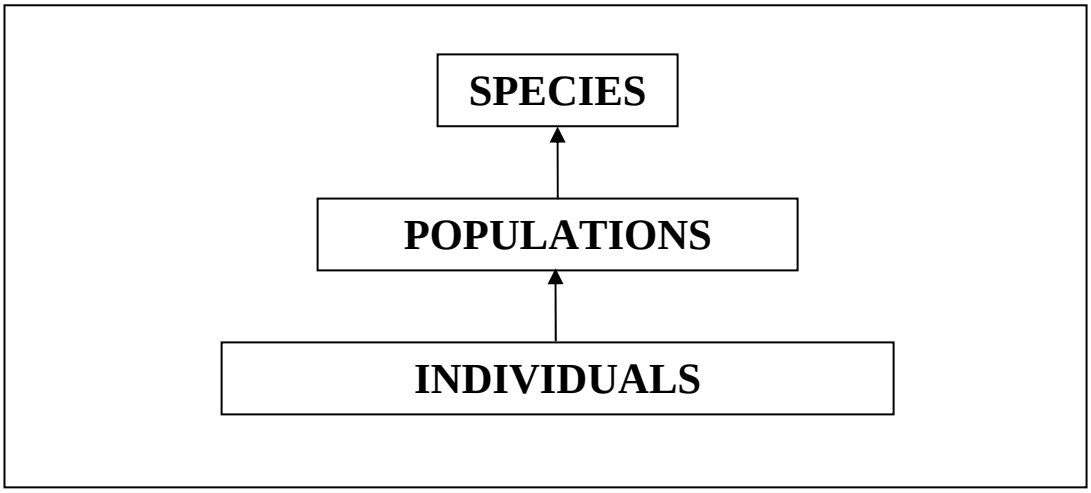


Figure 2-5. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment.

Division of Project, Location, Species	Life history stage	Timing of life history stage	Stressor (freq, intensity, duration)	Existing Stress Regime	Interactions	Response (near term)	Response (long-term)	Probable fitness reduction

Figure 2-6. General set of information collected to track effects of the proposed action and resulting exposure, response, and risk to listed species.

2.3.1.1 The Viable Salmonid Populations Framework in Listed Salmonid Analyses

In order to assess the survival and recovery of any species, a guiding framework that includes the most appropriate biological and demographic parameters is required. This has been generally defined above. For Pacific salmon, McElhany *et al*. (2000) defines VSP as an independent population that has a negligible probability of extinction over a 100-year time frame. The VSP concept provides specific guidance for estimating the viability of populations and larger-scale groupings of Pacific salmonids such as ESU or DPS. Four VSP parameters form the key to evaluating population and ESU/DPS viability: (1) abundance; (2) productivity (*i.e*., population growth rate); (3) population spatial structure; and (4) diversity (McElhany *et al.* 2000). These four parameters and their associated attributes are presented in figure 2-7. In addition, the condition and capacity of the ecosystem upon which the population (and species) depends plays a critical role in the viability of the population or species. Without sufficient space, including accessible and diverse areas the species can utilize to weather variation in their environment, the population and species cannot be resilient to chance environmental variations and localized catastrophes. As discussed in the *Status of the Species*, salmonids have evolved a wide variety of life history strategies designed to take advantage of varying environmental conditions. Loss or impairment of the species' ability to utilize these adaptations increases their risk of extinction.

ABUNDANCE (N)

A population should be large enough to survive and be resilient to environmental variations and catastrophes such as fluctuations in ocean conditions, local contaminant spills, or landslides.

Population size must be sufficient to maintain genetic diversity.

PRODUCTIVITY (POPULATION GROWTH RATE)

Natural productivity should be sufficient to reproduce the population at a level of abundance that is viable.

Productivity should be sufficient throughout freshwater, estuarine, and nearshore life stages to maintain viable abundance levels, even during poor ocean conditions.

A viable salmon population that includes naturally spawning hatchery-origin fish should exhibit sufficient productivity from spawners of natural origin to maintain the population without hatchery subsidy.

A viable salmon population should not exhibit sustained declines that span multiple generations.

N

POP GROWTH

DIVERSITY STRUCTURE

Freshwater
Estuarine
Marine

HABITAT CAPACITY AND DIVERSITY

DIVERSITY

Human-caused factors such as habitat changes, harvest pressures, artificial propagation, and exotic species introduction should not substantially alter variation in traits such as run timing, age structure, size, fecundity (birth rate), morphology, behavior, and genetic characteristics.

The rate of gene flow among populations should not be altered by human caused factors.

Natural processes that cause ecological variation should be maintained.

SPATIAL STRUCTURE

Habitat patches should not be destroyed faster than they are naturally created.

Human activities should not increase or decrease natural rates of straying among salmon sub-populations.

Habitat patches should be close enough to allow the appropriate exchange of spawners and the expansion of population into underused patches.

Some habitat patches may operate as highly productive sources for population production and should be maintained.

Due to the time lag between the appearance of empty habitat and its colonization by fish, some habitat patches should be maintained that appear to be suitable, or marginally suitable, even if they currently contain no fish.

Figure 2-7. Viable salmonid population (VSP) parameters and their attributes. In addition, the quality, quantity and diversity of the habitat (habitat capacity and diversity) available to the species in each of its three main habitat types (freshwater, estuarine and marine environments) is a critical foundation to VSP. Salmon cannot persist in the wild and withstand natural environmental variations in limited or degraded habitats.

As presented in Good *et al*. (2005), criteria for VSP are based upon measures of the VSP parameters that reasonably predict extinction risk and reflect processes important to populations. Abundance is critical, because small populations are generally at greater risk of extinction than large populations. Stage-specific or lifetime productivity (*i.e*., population growth rate) provides information on important demographic processes. Genotypic and phenotypic diversity are important in that they allow species to use a wide array of environments, respond to short-term changes in the environment, and adapt to long-term environmental change. Spatial structure reflects how abundance is distributed among available or potentially available habitats, and can affect overall extinction risk and evolutionary processes that may alter a population's ability to respond to environmental change.

The VSP concept also identifies guidelines describing a viable ESU/DPS. The viability of an ESU or DPS depends on the number of populations within the ESU or DPS, their individual status, their spatial arrangement with respect to each other and to sources of potential catastrophes, and diversity of the populations and their habitat (Lindley *et al*. 2007). Guidelines describing what constitutes a viable ESU are presented in detail in McElhany *et al*. (2000). More specific recommendations of the characteristics describing a viable Central Valley salmon population are found in table 1 of Lindley *et al.* (2007).

Along with the VSP concept, NMFS uses a conceptual model of the species to evaluate the potential impact of proposed actions. For the species, the conceptual model is based on a bottom-up hierarchical organization of individual fish at the life stage scale, population, diversity group, and ESU/DPS (figure 2-8). The guiding principle behind this conceptual model is that the viability of a species (*e.g*., ESU) is dependent on the viability of the diversity groups that compose that species and the spatial distribution of those groups; the viability of a diversity group is dependent on the viability of the populations that compose that group and the spatial distribution of those populations; and the viability of the population is dependent on the four VSP parameters, and on the fitness and survival of individuals at the life stage scale. The anadromous salmonid life cycle (see figure 2-2) includes the following life stages and behaviors, which will be evaluated for potential effects resulting from the proposed action: adult immigration and holding, spawning, embryo incubation, juvenile rearing and downstream movement[1], and smolt outmigration.

2.3.1.2 Approach to Southern DPS of Green Sturgeon

Although McElhany *et al*. (2000) specifically addresses viable populations of salmonids, NMFS believes that the concepts and viability parameters in McElhany *et al*. (2000) can also be applied to the Southern DPS of green sturgeon. Therefore, in this consultation, NMFS applies McElhany *et al*. (2000) and the viability parameters in its characterization of the environmental baseline and analysis of effects of the action to the Southern DPS of green sturgeon.

[1] The juvenile rearing and downstream movement life stage is intended to include fry emergence, and fry and fingerling rearing, which occurs both in natal streams and as these fish are moving downstream through migratory corridors at a pre-smolt stage. The distinction between juveniles and smolts is made because smolts have colder thermal requirements than juveniles that are not undergoing osmoregulatory physiological transformations.

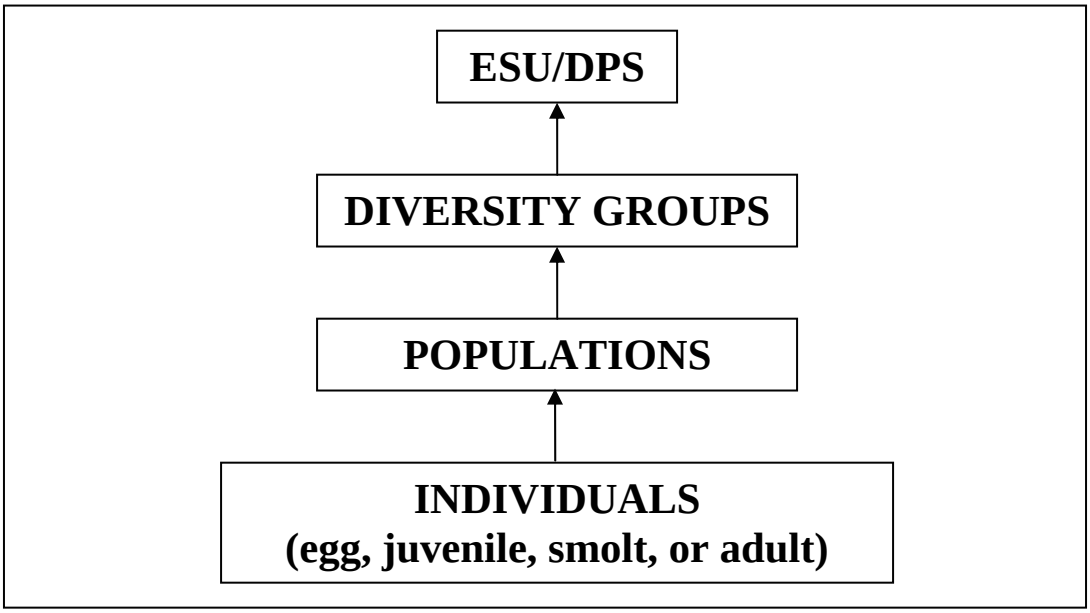


Figure 2-8. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment for anadromous salmonids.

2.3.1.3 Approach Specific to Southern Resident Killer Whales

The General Approach (section 2.3) and Application of the Approach to Listed Species Analysis (section 2.3.1) described above also applies to our approach for Southern Residents. The Southern Resident killer whale DPS is a single population. The population is composed of three pods, or groups of related matrilines, that belong to one clan of a common but older maternal heritage (NMFS 2008a). The Southern Residents population is sufficiently small and the probability of quasi-extinction is sufficiently likely that all individuals of the three pods are important to the survival and recovery of the DPS. Representation from all three pods is necessary to meet biological criteria for Southern Resident downlisting and recovery (NMFS 2008). For these reasons, it is NMFS' opinion that any action that is likely to hinder the reproductive success or result in serious injury or mortality of a single individual is likely to appreciably reduce the survival and recovery of the DPS. Therefore, effects on the Southern Resident killer whale DPS are informed by evaluating effects on individual whales.

2.3.2 Application of the Approach to Critical Habitat Analyses

The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. Our evaluation of habitat conservation value entails an assessment of whether the essential features are functioning to meet the biological requirements of a recovered species, or how far the features are from this condition. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential for the conservation of the species, and not on how individuals of the species will respond to changes in

habitat quantity and quality. If an area encompassed in a critical habitat designation is likely to be exposed to the direct or indirect consequences of the proposed action on the natural environment, we ask if constituent elements included in the designation (if there are any) or physical, chemical, or biotic phenomena that give the designated area value for the conservation of the species are likely to respond to that exposure. In particular we are concerned about responses that are sufficient to reduce the quantity, quality, or availability of those constituent elements or physical, chemical, or biotic phenomena.

To conduct this analysis, NMFS follows the basic exposure-response-risk analytical steps described in figure 2-1 and applies a set of reasoning and decision-making questions designed to aid in our determination. These questions follow a similar logic path and hierarchical approach of the elements and areas within a critical habitat designation. The reasoning and decision-making steps are outlined in table 2-2. Figure 2-9 contains the basic hierarchical organization of critical habitat.

Table 2-2. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Designated Critical Habitat. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct of indirect adverse consequences on the environment	True	End
		False	Go to B
B	Areas of designated critical habitat are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	The quantity, quality, or availability of all constituent elements of critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any reductions in the quantity, quality, or availability of one or more constituent elements of critical habitat are not likely to reduce the conservation value of the exposed area	True	-
		False	Go to E
E	Any reductions in the conservation value of the exposed area of critical habitat are not likely to reduce the conservation value of the critical habitat designation	True	No AD MOD
		False	AD MOD

To aid our analysis, NMFS developed a set of tables designed to track and combine the stressors, exposure, response, and risk related to the various elements of the proposed action. Figure 2-10 contains the basic set of information we evaluated. These tables allow us to determine the expected consequences of the action on elements and areas of critical habitat, sort or rank through those consequences, and determine whether areas of critical habitat are exposed to additive effects of the proposed action and the environmental baseline. We rank the effects to critical habitat on the basis of the severity of the predicted response of the element or area within the functions provided by various areas of critical habitat (effects ranked within spawning habitat or migratory corridors, for example). In the absence of information regarding the relative importance or vulnerability of different habitat types, we did not find it appropriate to attempt to rank effects across habitat types or functions. We recognize that the conservation value of critical habitat is a dynamic property that changes over time in response to changes in land use patterns, climate (at several spatial scales), ecological processes, changes in the dynamics of

biotic components of the habitat, *etc*. For these reasons, some areas of critical habitat might respond to an exposure when others do not. We also considered how areas and functions of designated critical habitat are likely to respond to any interactions and synergisms between or cumulative effects of pre-existing stressors and proposed stressors.

At the heart of the analysis is the basic premise that the conservation value of an overall critical habitat designation is the sum of the values of the components that comprise the habitat. For example, the conservation value of listed salmonid critical habitat is determined by the conservation value of the watersheds that make up the designated area. In turn, the conservation value of the components is the sum of the value of the primary constituent elements (PCEs) that make up the area. PCEs are specific areas or functions, such as spawning or rearing habitat, that support different life history stages or requirements of the species. The conservation value of the PCE is the sum of the quantity, quality, and availability of the essential features of that PCE. Essential features are the specific processes, variables, or elements that comprise a PCE. Thus, an example of a PCE would be spawning habitat and the essential features of that spawning habitat would be conditions such as clean spawning gravels, appropriate timing and duration of certain water temperatures, and water free of pollutants.

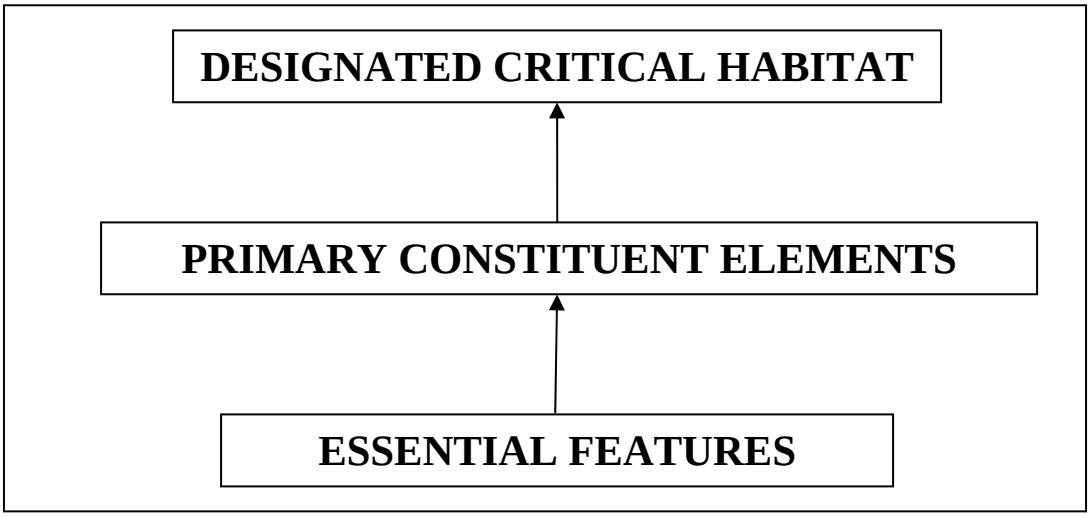


Figure 2-9. Conceptual model of the hierarchical structure that is used to organize the destruction or adverse modification assessment for critical habitat. This structure is sometimes collapsed for actions with very large action areas that encompass more than one specific area or feature.

Division of Project, Location	Critical Habitat Area or Feature	Primary Const. Element	Stressor (freq, intensity, duration)	Existing Stress Regime	Interactions	Response (near term)	Response (long-term)	Probable reduction in quantity, quality, or function

Figure 2-10. General set of information collected to track proposed action effects and resulting exposure, response, and risk to elements of critical habitat.

Therefore, reductions in the quantity, quality, or availability of one or more essential features reduce the value of the PCE, which in turn reduces the function of the sub-area (*e.g.*, watersheds), which in turn reduces the function of the overall designation. In the strictest

interpretation, reductions to any one essential feature or PCE would equate to a reduction in the value of the whole. However there are other considerations. We look to various factors to determine if the reduction in the value of an essential feature or PCE would affect higher levels of organization. For example:

- The timing, duration and magnitude of the reduction
- The permanent or temporary nature of the reduction
- Whether the essential feature or PCE is limiting (in the action area or across the designation) to the recovery of the species or supports a critical life stage in the recovery of the species (for example, juvenile survival is a limiting factor in recovery of the species and the habitat PCE supports juvenile survival).

In our assessment, we combine information about the contribution of critical habitat PCEs (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) to the conservation value of those areas of critical habitat that occur in the action area, given the physical, chemical, biotic, and ecological processes that produce and maintain those PCEs in the action area. We use the conservation value of those areas of designated critical habitat that occur in the action area as our point of reference for this comparison. For example, if the critical habitat in the action area has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment of the consequences of the added effects of the proposed action on that conservation value.

Figure 2-11 illustrates the basic model of the critical habitat analysis following the hierarchical organization of critical habitat and the comparison between the reference (without action) condition of the conservation value of critical habitat and the conservation value of critical habitat with action implementation.

2.3.3 Characterization of the Environmental Baseline

ESA regulations define the environmental baseline as “the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process” (50 CFR 402.02). The "effects of the action” include the direct and indirect effects of the proposed action and of interrelated or interdependent activities, “that will be added to the environmental baseline” (50 CFR 402.02). Implicit in both these definitions is a need to anticipate future effects, including the future component of the environmental baseline. Future effects of Federal projects that have undergone consultation and of contemporaneous State and private actions, as well as future changes due to natural processes, are part of the future baseline, to which effects of the proposed project are added.

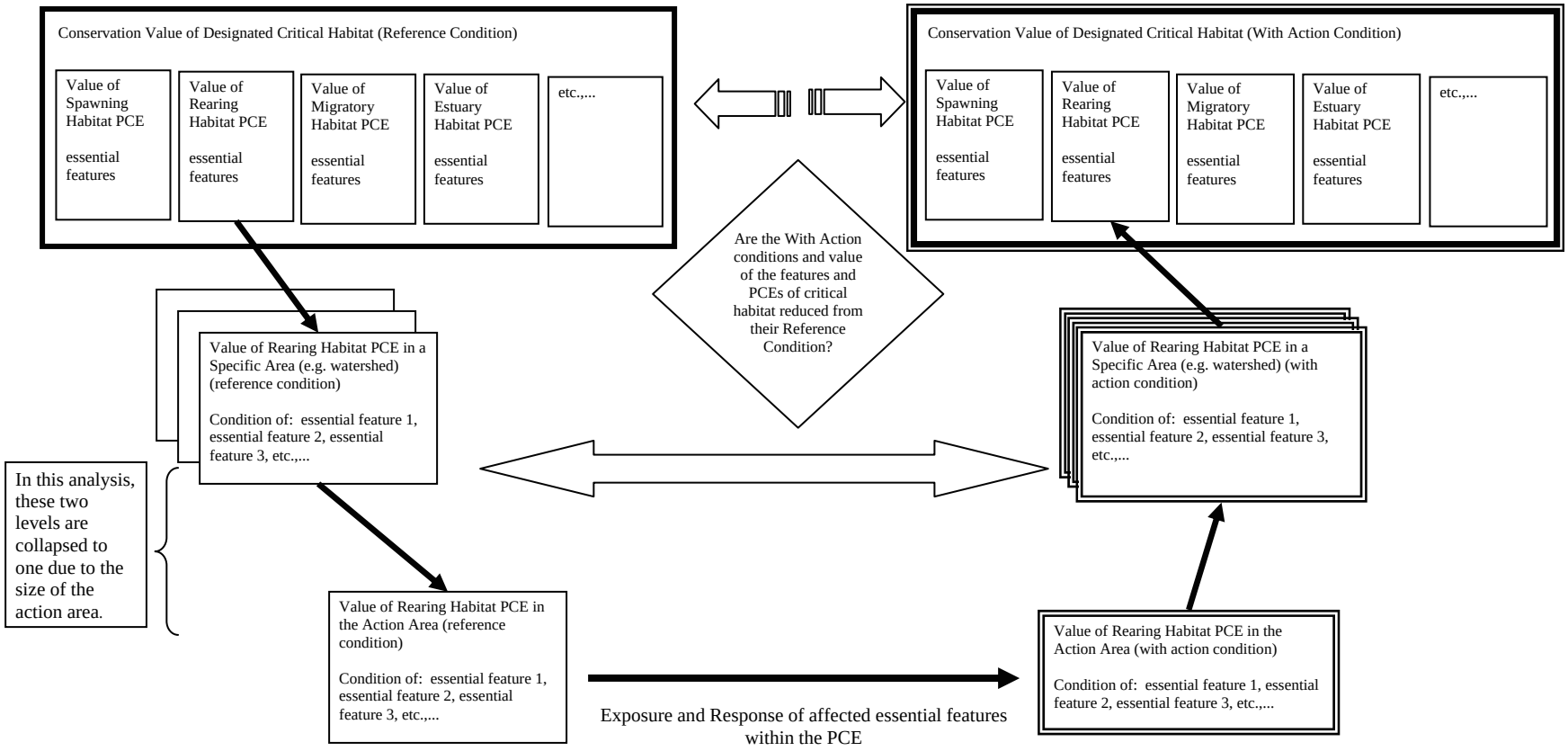


Figure 2-11. Conceptual diagram of the critical habitat analyses presented in this biological opinion. For illustration purposes, the Rearing Habitat PCE for listed salmonids is pulled out to show the basic flow of the analysis. Full analyses consider the effects to all PCEs and essential features of critical habitat.

In consultations on continuing actions such as CVP/SWP operations, it is quite difficult to separate future baseline effects from the anticipated effects of the proposed action. Operations of existing structures, such as dams and gates, for water supply, flood control, and other purposes -- the proposed action -- are integrally related to the existence of the structures themselves, but effects of the mere existence of the structures are not effects of the proposed action. *See National Wildlife Federation v. National Marine Fisheries Service*, 524 F.3d 917, 930-31 (9th Cir. 2008). Similarly, some activities that are part of the proposed project are non-discretionary, and their effects are also not effects of the proposed action. *See id*. at 928-29 (citing *National Ass'n of Home Builders v. Defenders of Wildlife*, 551 U.S. 644 (2007).

Consequently, it is not surprising that in its review of NMFS' December 11, 2008, draft OCAP Opinion, the CALFED Science Review Panel (Anderson *et al*. 2009) commented that a clearly defined baseline was lacking. Reclamation (2009) provided similar comments. NMFS acknowledges that it was not easy to discern a uniform approach to characterizing the environmental baseline in the draft Opinion. NMFS believes, however, that this is due to the nature of the action under consultation and available information, rather than a flawed approach to the analysis. NMFS clarifies its approach here and in relevant sections of the Opinion.

In *National Wildlife Federation*, a case regarding consultation on the effects of operating hydropower dams on the Columbia River, the 9th Circuit Court of Appeals rejected NMFS' attempt to narrow the "effects of the action" by defining the baseline to include operations that NMFS deemed to be "nondiscretionary." The Court observed that many of the actions NMFS deemed "nondiscretionary" actually were subject to the action agencies' discretion, and it held that it was impermissible to create an imaginary "reference operation" excluding these actions, to which the effects of the action could be compared. Rather, the Court said that the regulatory requirement to consider the effects of the action added to the environmental baseline "simply requires NMFS to consider the effects of [the] actions 'within the context of other existing human activities that impact the listed species.' [citations omitted]" *Id*. at 930. In other words, the effects of a particular Federal action are intended to be evaluated not simply on their own, but as they affect the species in combination with other processes and activities.

The question addressed in a consultation is whether the *project* jeopardizes the species' continued existence. As the court stated in *National Wildlife Federation*, even if the baseline itself causes jeopardy to the species, only if the project causes additional harm can the project be found to jeopardize the species' continued existence. *Id.* This determination requires an evaluation of the *project's* effects, separate from the conditions that would exist if the project were not carried out.

NMFS and Reclamation together attempted to isolate the effects of proposed project operations by segregating the activities that are within Reclamation's discretion to change in the future from those that are not. This effort was not fruitful. The CVP/SWP operations BA begins with a summary of legal and statutory authorities, water rights, and other obligations relevant to the action (Chapter 1), all of which are incorporated into the project description (Chapter 2). Neither chapter describes what Reclamation's nondiscretionary operations would be if discretionary aspects of the proposed action were not implemented. In addition, in all of the models and simulations that Reclamation used to prepare the CVP/SWP operations BA, a "no project"

scenario was not run. For example, table 2-1 in the CVP/SWP operations BA identifies the major proposed operational actions for consultation, including implementation of the water quality control plan (WQCP), but it is not clear whether implementing the WQCP, or some portion of it, is a non-discretionary action.

Consequently, we determined that if NMFS were to propose a "no project operations" scenario to characterize the environmental baseline, it would be speculative and not supported by the model runs. Following the 9th Circuit's reasoning, with limited exceptions, NMFS assumed that all CVP and SWP operations are subject to the discretion of the project agencies and, thus, that all effects of future operations are effects of the proposed action. The only project effects considered to be within the future baseline (and thus not effects of the proposed action) are those caused by activities that are clearly outside the agencies' authority. For example, as in *National Wildlife Federation*, it is not within the agencies' discretion to remove dams, so the effects of their existence are part of the baseline. Figure 2-12 provides a conceptual diagram of how NMFS characterizes the past and future components of the environmental baseline for consultations on an ongoing action.

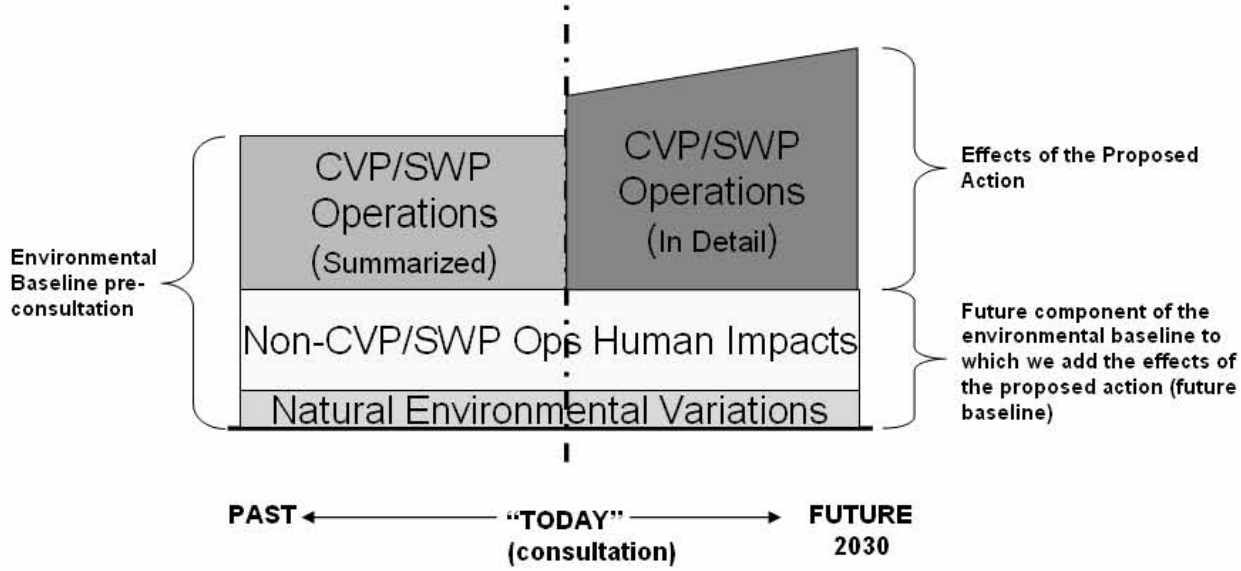


Figure 2-12. Conceptual diagram of how the environmental baseline changes in this NMFS Opinion. The right side of the figure depicts the effects of the proposed action added on top of the baseline into the future (future baseline). Note that the slopes of the curves are only for graphical representation.

In this Opinion, we analyze the entire suite of operational effects, based on the project description and modeled studies. With this approach, we capture as "effects of the action," both the effects of operations that are proposed to continue in the future as they have in the past, and any new effects that result from proposed changes in operation. We then add these effects to the future baseline, in which we have captured anticipated effects of non-project processes and activities.

The analytical approach NMFS used is not different from that which USFWS used in its Delta smelt Opinion (USFWS 2008a). There may be a perceived difference due to the presentation of

the material in the biological opinions. In the Delta smelt Opinion, the USFWS provided a more thorough analysis of the past and present effects of ongoing CVP/SWP operations in its Environmental Baseline section (figure 2-13). In the Effects of the Action section, the USFWS summarized the effects from ongoing CVP/SWP operations, then provided a detailed analysis of the effects resulting from the proposed changes in CVP/SWP operations. In NMFS' Opinion, NMFS summarizes in the Environmental Baseline section the past and present impacts leading to the current status of the species in the action area, including the effects of CVP/SWP operations in the past. Also in the Environmental Baseline section, NMFS sets the stage for the analysis of effects of the action by describing the future non-project stressors to which the listed species and their critical habitats will be exposed. In the Effects of the Action section of the Opinion, NMFS provides a detailed analysis of predicted effects of CVP/SWP operations between the time the biological opinion is issued and December 31, 2030. This difference in presentation is of no consequence to the outcomes of the consultations, since both agencies made their ultimate determinations by (1) finding that proposed operations cause additional harm to listed species, and (2) aggregating all future stressors, as regulations and case law require.

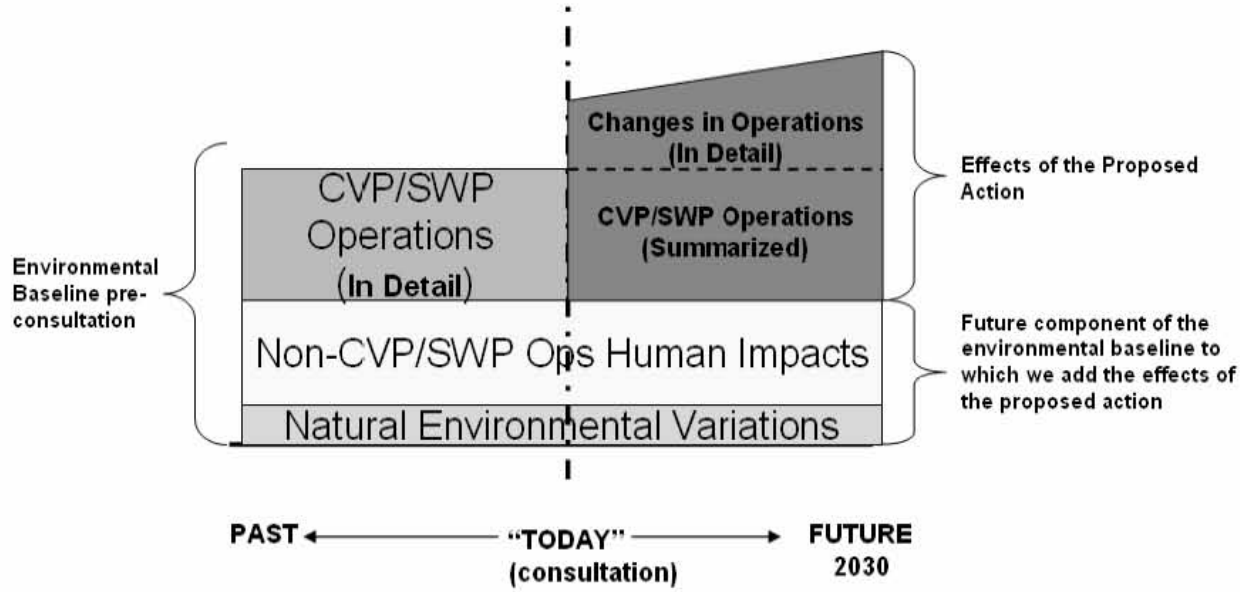


Figure 2-13. USFWS' Delta smelt Opinion baseline: A conceptual model of the effects of the proposed action added on top of the baseline into the future (future baseline). Note that the slopes of the curves are only for graphical representation.

Both Services conduct a separate analysis to determine whether the "effects of the action" reduce either the likelihood of survival and recovery of the species, or the value of critical habitat for the conservation of the species, after the effects of the proposed action have been determined. The Delta smelt opinion states:

> *In accordance with the implementing regulations for section 7 and Service policy, the jeopardy determination is made in the following manner: The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the delta smelt's current status and, for non-Federal activities in the action area, those actions likely to affect the delta smelt in the future, to determine if*

implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the delta smelt in the wild (USFWS 2008a page 139).

This is precisely the approach used in this Opinion.

2.4 Evidence Available for the Analysis

To conduct these analyses, NMFS considered many lines of evidence available through published and unpublished sources that represent evidence of adverse consequences or the absence of such consequences. The following provides a list of resources that we considered in the development of our analyses:

- Final rules listing the species in this consultation as threatened or endangered;
- Final rules designating critical habitat for the Central Valley salmon and steelhead species and proposed critical habitat for Southern DPS of green sturgeon;
- CVP/SWP operations BA (Reclamation 2008a);
- Previously issued NMFS biological opinions;
- Recommendations from the various reviews and peer review reports (see sections 1.5.5 and 1.5.6, above);
- NMFS-SWFSC reviews (*e.g*., ocean productivity, declarations, climate change);
- Declarations pursuant to PCFFA *et al*. *v*. Gutierrez *et al*.;
- NMFS' draft recovery plans for winter-run and Central Valley salmon and steelhead species;
- Various letters submitted to NMFS, including San Luis & Delta-Mendota Water Authority and State Water Contractors, Inc. (2008);
- California Data Exchange Center (CDEC) data (http://cdec.water/ca/gov/; hereafter referred to as CDEC data);
- U.S. Army Corps of Engineers (Corps) data;
- CDFG's Grand Tab database
- Studies conducted within the Delta. NMFS understands that the use of surrogates in the form of hatchery releases (*e.g*., late fall-run to determine spring-run behavior), different species (*e.g*., Chinook salmon to determine steelhead behavior; Atlantic or shovelnose sturgeon to determine effects of contaminant exposures on green sturgeon), and even the same run and species (*e.g*., hatchery fish and laboratory studies to determine wild/natural fish behavior) may not accurately predict or emulate the exact behavior of the species under analysis in its natural environment in order to determine exact fish routing, timing, duration of migration, and export pumping entrainment patterns. However, when direct evidence or similar evaluations are not available for the species under analysis, NMFS has utilized data and results from the use of surrogates that exhibit strong similarities in physiological needs, in life history stages, and in general behaviors. In the absence of data on salmonids and green sturgeon in the wild, NMFS considers these studies one of the best available sources of information used to determine the potential effects of CVP/SWP operations.
- For purposes of incidental take where the origin of races of Chinook salmon or steelhead cannot be differentiated, uniquely-marked hatchery fish (surrogates) that are released at the same time, location, and size as the listed species may best represent the incidental

take of that listed species. The use of surrogates for this purpose minimizes the amount and extent of take associated with tagging or capturing listed species to monitor take.

The primary source of initial project-related information was the CVP/SWP operations BA produced for this consultation. Included with the CVP/SWP operations BA was an extensive bibliography that served as a valuable resource for identifying key unpublished reports available from state and Federal agencies, as well as private consulting firms. It also provided a robust set of key background papers and reports in the published literature on which to base further literature searches.

We conducted electronic literature searches using several electronic databases available through NMFS' Northwest Fisheries Science Center (NWFSC) and U.C. Davis. NMFS' biologists utilized, among others: (1) the Aquatic Sciences and Fisheries Abstracts (ASFA), Fish & Fisheries Worldwide; (2) Oceanic Abstracts; (3) Waves, the Catalogue of the Libraries of Fisheries and Oceans, Canada; (4) the search engine for the journals published by the American Fisheries Society; and (5) Toxline. When references were found that were deemed to be valuable, Scientific Citation Index was utilized to see what other articles had referenced that paper. NMFS' biologists used keyword searchs (*e.g.*, salmon, salmonids, Chinook salmon, Central Valley, migrations, dams, copper toxicity, survival, thermal tolerance, predation, survival models, Sacramento River, Sacramento Delta, steelhead, green sturgeon, *etc*.) to find potential articles and literature. Searches by author were utilized when an author was found to have published numerous articles and papers within a given area of interest. In addition, physical searches of the extensive electronic holdings of agencies were conducted from their websites, such as Reclamation's Central Valley Operations (CVO) website for the Tracy Fish Facility Reports.

We examined the literature that was cited in documents and any articles we collected through our electronic searches. If, based on a reading of the title or abstract of a reference, the reference appeared to comply with the keywords presented in the preceding paragraph, we acquired the reference. If a reference's title did not allow us to eliminate it as irrelevant to this inquiry, we acquired it. We continued this process until we identified all (100 percent) of the relevant references cited by the introduction and discussion sections of the relevant papers, articles, books, and, reports and all of the references cited in the materials and methods, and results sections of those documents. We did not conduct hand searches of published journals for this consultation.

References were collected by individual biologists and shared as a group. Most references were available as electronic copies. However, many of the older reports, articles, or book chapters had to be scanned and converted into electronic copies when feasible.

2.4.1 Other tools used in the analysis

Reclamation and DWR utilized the following models in their analyses and development of the CVP/SWP operations BA. Figure 2-14 provides a schematic of how each model relates to the others.

- Statewide planning model of water supply, stream flow, and Delta export capability:

- CalSim-II: Monthly time step, designed to evaluate the performance of the CVP and SWP systems for: existing and future levels of land development, potential future facilities, current or alternative operational policies and regulatory environments.
- CalLite: A rapid and interactive screening tool that simulates California's water management system for planning purposes.

- Sacramento-San Joaquin Delta hydrodynamics and particle tracking:
  - Delta Simulation Model Version 2 (DSM2): 15-minute time step, used to simulate the flow, velocity, and particle movement in the Delta.

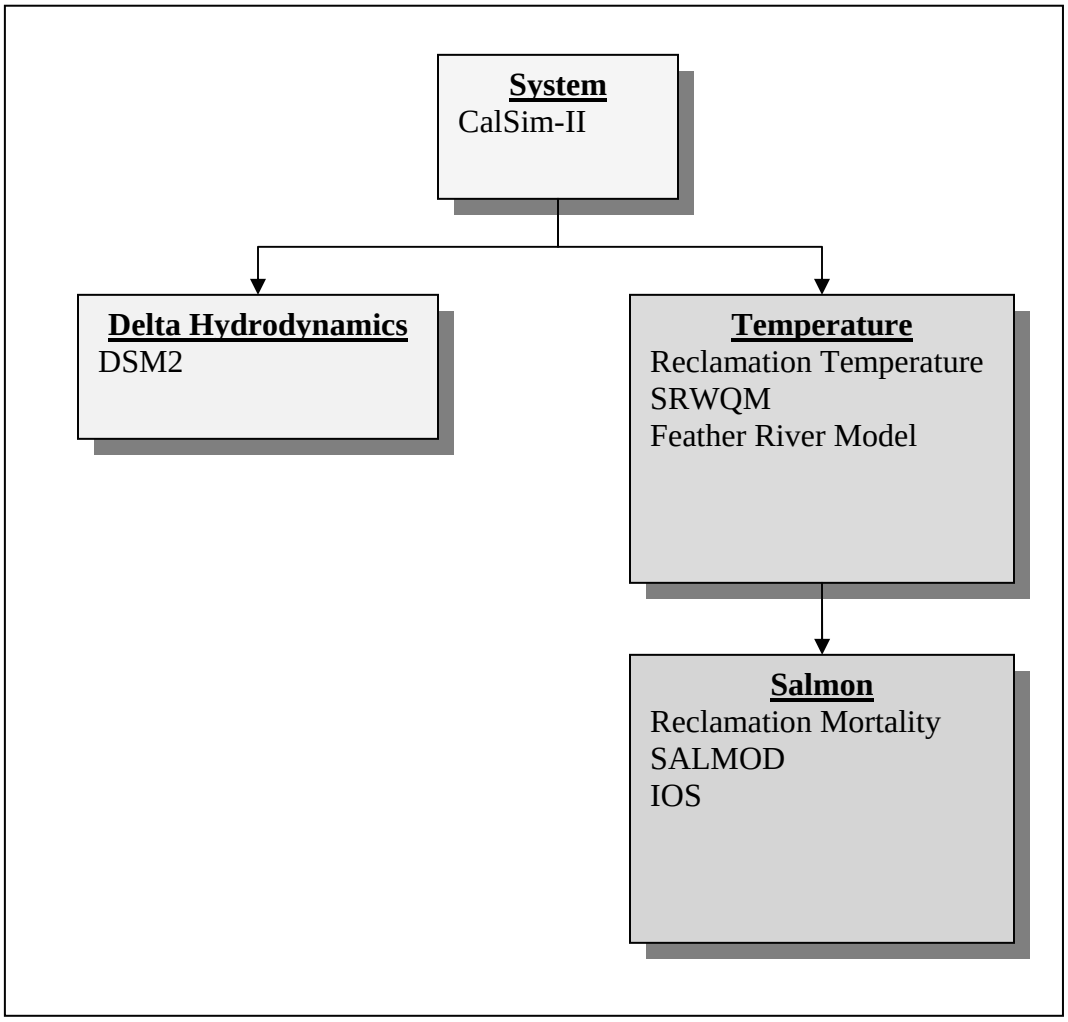


Figure 2-14. Models used in the development of the CVP/SWP operations BA, and their information flow with respect to each other (CVP/SWP operations BA figure 9-1).

- River temperature:
  - Reclamation Temperature: Monthly time step, where the reservoir temperature models simulate monthly mean vertical temperature profiles and release temperatures for Trinity, Whiskeytown, Shasta, Folsom, New Melones, and Tullock Reservoirs based on hydrologic and climatic input data.

- Sacramento River Water Quality Model (SRWQM): 6-hour time step, with mean daily flow inputs, used to simulate daily temperatures on Clear Creek and the Upper Sacramento River.
- Oroville Facilities Water Temperature Modeling: 1-hour time steps that include reservoir simulations of Oroville Reservoir, the Thermalito Diversion Pool, the Thermalito Forebay, and the Thermalito Afterbay, and a river model of the Feather River between the Thermalito Diversion Dam and the Sacramento River confluence.

- Salmon mortality
  - Reclamation Salmon Mortality Model: Daily time step which computes salmon spawning losses for the Trinity, Sacramento, American, and Stanislaus rivers based on the Reclamation Temperature Model estimates. It is limited to temperature effects on early life stages of Chinook salmon, and does not evaluate potential direct or indirect temperature impacts on later life stages, such as emergent fry, smolts, juvenile out-migrants, or adults. Also, it does not consider other factors that may affect salmon mortality, such as in-stream flows, gravel sedimentation, diversion structures, predation, ocean harvest, *etc*.
  - SALMOD: Weekly time step simulates population dynamics for all four runs of Chinook salmon in the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD).
  - Interactive Object-Oriented Salmon simulation (IOS) Winter-Run Life Cycle Model: Daily time step, used to evaluate the influence of different Central Valley water operations on the life cycle of winter-run using simulated historical flow and water temperature inputs.

In addition, NMFS' biologists utilized an interactive spreadsheet model developed by DWR to estimate interior Delta survival of emigrating salmonids from the Sacramento River. This model, the Delta Survival Model (DSM2), utilized user inputs of export rate and Delta inflow to determine absolute and relative survival of salmonids moving throughout the Delta interior and remaining in the main stem Sacramento River as a proportion of the total salmonid population. Additonal inputs to the model were the fraction of particles entrained at the different channel bifurcations as modeled in the Particle Tracking Model (PTM) module of the DSM2 model, as well as the relative survival in the Delta interior and the export related interior mortality, which were calculated internally in the model.

NMFS did not use the results of the IOS model for our analysis in this Opinion because the intended application of the model in the CVP/SWP operations BA was not useful for estimating, in an overall sense, how winter-run might respond to the proposed action. For example, the CVP/SWP operations BA cautions the use of the IOS model results in making inferences related to how winter-run abundance is affected by the proposed action: *"In evaluating effects of the proposed actions, differences between the three studies rather than absolute trends should be examined"* (Appendix O in CVP/SWP operations BA). Thus, it seems that the IOS model results presented in the CVP/SWP operations BA are not intended to reflect either abundance estimates observed in the past or future abundance with implementation of the proposed Project. Estimates based on observations are much different than estimates based on modeling without observation input. Results of the IOS model presented in the CVP/SWP operations BA show an

increasing trend in winter-run escapement throughout the entire simulation period (*i.e*., from 1923 through 2002), such that by 2002, escapement is above 40,000 fish for all CALSIM II studies examined (figure 11-5 in CVP/SWP operations BA). Those results contrast with observed winter-run escapement estimates, which show a dramatic population crash during this period (see Grandtab at http://www.delta.dfg.ca.gov/afrp/), eventually leading to their endangered status under the ESA.

In the Opinion, NMFS must consider how winter-run is expected to respond to implementation of the proposed action. Model results, such as the IOS model results presented in the CVP/SWP operations BA, that are not intended to at least generally approximate past or future conditions, do not inform us in this consideration. If the IOS model results in the CVP/SWP operations BA are intended to be used strictly as an alternatives comparison tool, as the CVP/SWP operations BA indicates, instead of one that produces somewhat meaningful trend information for individual model runs, then the utility of those results for the Opinion is limited, particularly considering that a model alternative representing just baseline conditions does not exist. The CALFED Peer Review Panel stated that, "*The default should be comparing the CALSIM studies of future scenarios (with different scenarios for climate change) to baseline"*(Anderson *et al*. 2009). The context of this statement was that comparisons among alternatives such as those used in the IOS model (*e.g*., CALSIM studies 6, 7, and 8) are inconsistent with the Opinion's analytical approach. As such, NMFS did not use the IOS model results presented in the CVP/SWP operations BA as evidence for analyzing how winter-run will be affected by the proposed action.

Another consideration for not using the IOS model in the Opinion is that the model has not yet been published in peer reviewed scientific literature, and NMFS does not understand either the model's limitations or its extent. As described in Paine *et al*. (2000), mathematical models intended to help guide management of natural populations must be used wisely and with understanding of limitations. One potential limitation associated with applying large scale models over the entire life cycle of a species, as is done in the IOS model, is whether enough data are available to reliably estimate model parameters. Paine *et al*. (2000) state: "*When the data are not available for the needed estimates of parameter values, there is a tendency to insert values based on opinion or expert testimony. This practice is dangerous. The idea that opinion and "expert testimony" might substitute for rigorous scientific methodology is anathema to a serious modeler and clearly represents a dangerous trend.*" With these considerations in mind, NMFS did not utilize the IOS model in this Opinion.

2.4.2 Consideration of a Quantitative Life Cycle Approach to the Analysis

One recommendation made by the CALFED Science Review Panel in its review of NMFS' December 11, 2008, draft Opinion was to analyze the effects of the proposed action using common measures of survival. Ideally, a life cycle approach, in which the effects on individual life stages on the life cycle could be estimated independent of the effects on other stages, would be implemented to assess the relative impacts on abundance. Two potential methods for measuring salmon population levels include the spawner-to-recruit ratio (SRR), which is the ratio of the number of recruits returning to the spawning habitat divided by the number of spawners producing those recruits, and the adult-to-smolt ratio (ASR), which measures the

number of young fish exiting the freshwater system divided by the number of adult spawners that produced those young (Anderson *et al.* 2009). Unlike the SRR, which encompasses the full life cycle, including both freshwater and marine environments, the ASR omits the ocean phase and, thus, would provide a more appropriate method for assessing the effects of freshwater environmental conditions and water operations.

The benefits that this type of integrative analysis would provide towards understanding the relative importance of proposed action-related effects at various life stages on overall abundance are apparent. However, completing such an analysis is not practicable at this time for several reasons. For instance, one of the key components in the process would be the establishment of survival rates at various life stages under both natural conditions (*i.e*., "without project") and those conditions observed with the project in place (*i.e*., "with project"). This information is currently lacking for the Central Valley region of California, and is further discussed in section 5 of this Opinion. Considerable efforts have been made in an attempt to develop life stage specific survival rates in the Columbia River Basin with some level of success (Anderson 2002). However, given the major differences that exist between the Columbia River Basin and California's Central Valley (*e.g.*, flows, temperature, *etc*.), it would not be appropriate to apply any values derived for basins in that region toward this analysis in the Central Valley. Instead, site-specific studies within the Central Valley would have to be conducted to establish suitable values.

Information from MacFarlane *et al.*'s (2008a) acoustic tagging study represents some of the first data to be gathered on migration and survival patterns of juvenile salmonids in the Central Valley. Early results indicate different survival patterns between the Central Valley and those observed in the Columbia River Basin. However, these results are still considered preliminary, and the studies will need to continue for some time to provide a more reliable, long-term data series. Still, these preliminary results underscore the need to develop information specific to the unique conditions of the Central Valley region for this type of life cycle analysis.

An alternative approach recommended by the CALFED Science Review Panel for estimating an ASR for the Central Valley includes the use of computer models. In particular, the IOS model (Cavallo *et al.* 2008) and the *Oncorhynchus* Bayesian Analysis (OBAN) model (Hendrix 2008) were referenced as potentially useful tools. IOS is a detailed mechanistic model that describes the entire life cycle of both winter-run and spring-run in the Sacramento River, while the OBAN model is a Bayesian statistical model for winter-run in the Sacramento River. Although the CALFED Science Review Panel identified these models as potentially viable options either in combination or independently, it acknowledged the necessary refinement and implementation of this type of model by NMFS for the Opinion may not have been practical because of time constraints and the need for additional modeling expertise. Further development of mortality rates at different life stages specific to the Central Valley could be incorporated into the model to reduce the amount of assumptions currently required, and lead to more realistic and informative results. However, as previously mentioned, this type of information will not be available in the near term. Moreover, in order to sufficiently address the issue of fish routing through the Delta, identified as a critical component by the CALFED Science Review Panel, additional data collection and modeling over the long term (*i.e*., beyond the timeline allowed for the development of this Opinion) would be required.

As discussed above, this Opinion equates a listed species' probability or risk of extinction with the likelihood of both the survival and recovery of the species, and uses "likelihood of viability" as a standard to bridge between the VSP framework (McElhany *et al*. 2000) and the jeopardy standard. Assessing the viability of salmonid populations requires the consideration of other parameters in addition to population abundance, including productivity (*i.e*., population growth rate), spatial structure, and genetic and life-history diversity (McElhany *et al*. 2000). All four VSP parameters are deemed important in evaluating a population's ability to persist, especially when faced with catastrophic disturbances (Lindley *et al*. 2007). Although the life cycle modeling approaches discussed above have the potential to provide information on all VSP parameters at some point in the future, it would require substantial data collection and model refinement. Any present attempt to complete such an exercise would only address one of those parameters (*i.e*., abundance), and any results would include making many assumptions. Therefore, although a method for evaluating impacts during a specific life stage in terms of the overall loss in numbers of fish would be useful, there are other potential consequences resulting from project operations that need to be considered. For example, are mortalities at different life stages, or the loss of historical habitats, likely to have effects on the other VSP parameters? The analyses within this Opinion, in an attempt to encompass this broader range of effects, focused on determining whether or not appreciable reductions were expected from the proposed action, rather than trying to quantify the absolute magnitude of those reductions.

2.4.3 Critical Assumptions in the Analysis

To address the uncertainties identified above related to the proposed action and the analysis provided in the CVP/SWP operations BA, NMFS established a set of key assumptions we would need to make to bridge the existing data gaps in the CVP/SWP operations BA that are critical to our analysis of effects. Table 2-3 provides the general assumptions that we made in filling those data gaps.

2.5 Integrating the Effects

The preceding discussions describe the various quantitative and qualitative models, decision frameworks, and ecological foundations for the analyses presented in this Opinion. The purpose of these various methods and tools is to provide a transparent and repeatable mechanism for conducting analyses to determine whether the proposed action is not likely to jeopardize the continued existence of the listed species and not likely to result in the destruction or adverse modification of designated critical habitat.

Table 2-3. General assumptions, and their bases, made in analyzing the effects of the proposed action.

Assumption	Basis
We assume that the effects from the near term analysis (Study 7.1) will be in effect from the issuance of this Opinion through year 2019 (which Reclamation stated is the end of the near term, specifically, "Near term refers to the timeframe between now to 2030, a rough midpoint between the two years"). Likewise, we assume that the effects from the full build-out at 2030 analysis (Study 8.0) will be in effect from the end of the near term in 2019 through year 2030.	The CVP/SWP operations BA does not provide an incremental build-out schedule or analyses of incremental effects by year.
A "soft" target of 1.9 million acre-feet (MAF) end of September carryover storage in Shasta Reservoir is met only when conditions allow.	The project description does not explicitly propose an end of September carryover storage in Shasta Reservoir. However, modeling Chapter 9 of the CVP/SWP operations BA (p.9-41) assumes a 1.9 MAF end of September carryover storage target in Shasta Reservoir in non-critical years.
The following are tools, in order of priority that we used to understand the proposed action. -- CVP/SWP operations BA Chapter 2 (project description). -- CVP/SWP operations BA Chapter 9 (Modeling and Assumptions) -- CDEC data: ~10 years of actual data. When the project description is not explicit in fully describing Reclamation's proposed action, CDEC data on recent past operations will be utilized as a tool to help us understand the proposed action.	Chapter 2 (project description) has many gaps regarding the description of the proposed action.
Central Valley Project Improvement Act (CVPIA) 3406 B(2) [hereafter referred to as "b(2)"] is assumed to be implemented as proposed in the project description.	Although b(2) is proposed, there are no operational rules or certainties in order for us to determine that b(2) is reasonably certain to occur in a given location, timing, quantity, and duration.
Use CDEC data for last ~10 years (or more to get critically dry years) as an approximation of water temperature impacts through 2030.	In most cases, Reclamation and DWR have not proposed to meet specific water temperature targets or or operate the CVP/SWP different than they have in the past with respect to water temperature, so we use recent past data as an indicator of future water temperatures.

Many of the methods described above focus the analyses on particular aspects of the action or affected species. Key to the overall assessment, however, is an integration of the effects of the proposed action with each other and with the baseline set of stressors to which the species and critical habitat are also exposed. In addition, the final steps of the analysis require a consideration of the effects of the action within the context of the reference (or without action) condition of the species and critical habitat. That is, following the hierarchical approaches outlined above, NMFS rolls up the effects of the action to determine if the action is not likely to appreciably reduce the likelihood of both the survival and recovery of the species and not likely to result in the destruction or adverse modification of critical habitat.

Figure 2-15 is intended to capture the overall conceptual model of the analysis and illustrates the analytical steps within each "rung" of the hierarchical analysis. We provide an example utilizing the approach for listed salmonids.

2.6 Presentation of the Analysis in this Opinion

Biological opinions are constructed around several basic sections that represent specific requirements placed on the analysis by the ESA and implementing regulations. These sections contain different portions of the overall analytical approach described here. This section is intended as a basic guide to the reader of the other sections of this Opinion and the analyses that can be found in each section. Every step of the analytical approach described above will be presented in this Opinion in either detail or summary form.

Description of the Proposed Action – This section contains a basic summary of the proposed Federal action and any interrelated and interdependent actions. This description forms the basis of the first step in the analysis where we consider the various elements of the action and determine the stressors expected to result from those elements. The nature, timing, duration, and location of those stressors define the action area and provide the basis for our exposure analyses.

Status of the Species – This section provides the reference condition for the species and critical habitat at the listing and designation scale. For example, NMFS evaluates the current viability of each salmonid ESU/DPS given its exposure to human activities and natural phenomena such as variations in climate and ocean conditions, throughout its geographic distribution. These reference conditions form the basis for the determinations of whether the proposed action is not likely to jeopardize the species or result in the destruction or adverse modification of critical habitat. Other key analyses presented in this section include critical information on the biological and ecological requirements of the species and critical habitat and the impacts to species and critical habitat from existing stressors.

Environmental Baseline – This section provides the reference condition for the species and critical habitat within the action area. By regulation, the baseline includes the impacts of past, present, and future actions (except the effects of the proposed action) on the species and critical habitat. In this Opinion, some of this analysis is contained within the *Status of the Species and Critical Habitat* section due to the large size of the action area (which entirely or almost entirely encompasses the freshwater geographic ranges of the listed fish species). This section also contains summaries of the impacts from stressors that will be ongoing in the same areas and

times as the effects of the proposed action (future baseline). This information forms part of the foundation of our exposure, response, and risk analyses.

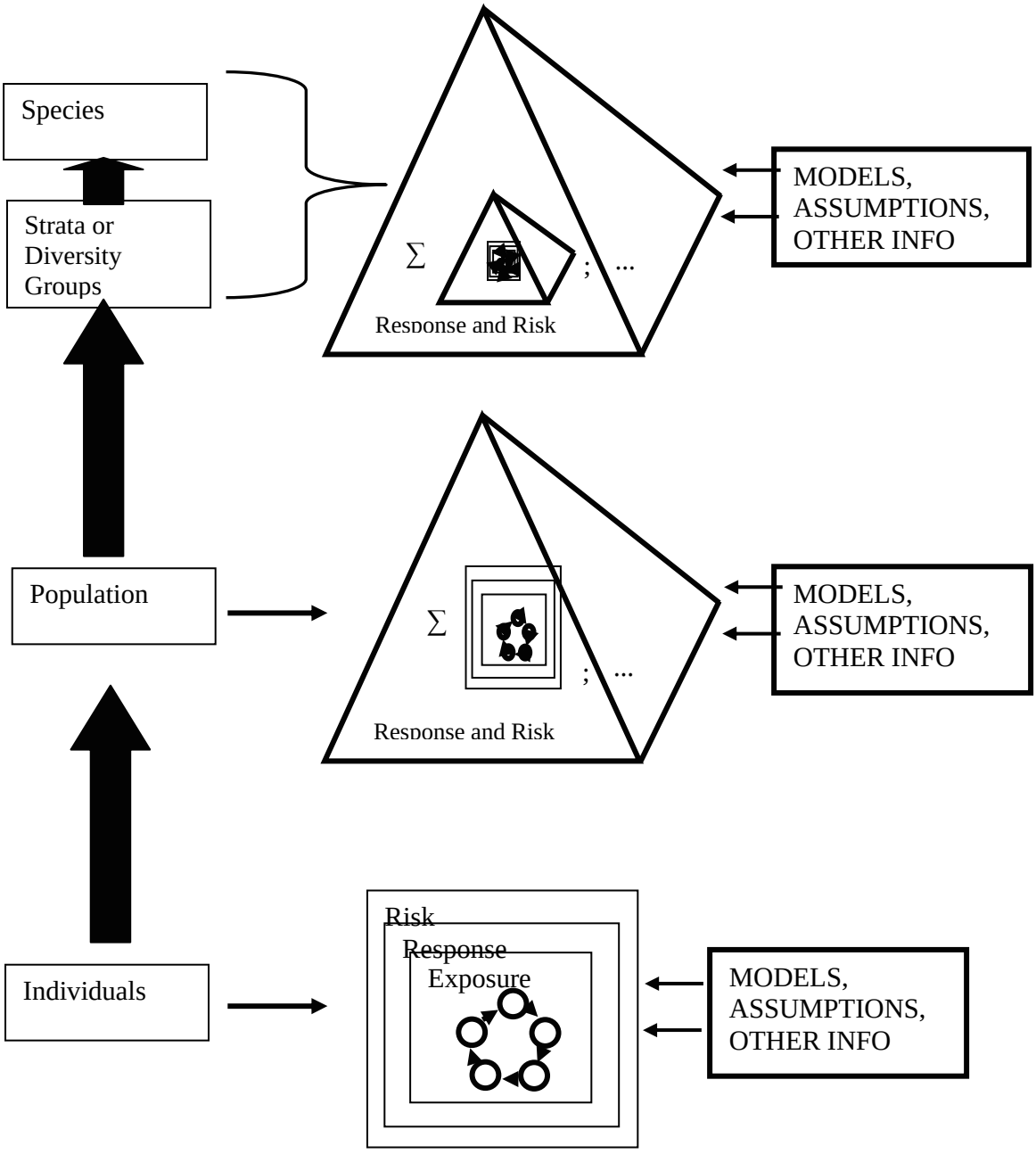


Figure 2-15. Conceptual diagram of the overall analytical approach utilized in this Opinion. The individual level includes exposure, response, and risk to individuals of the species and a consideration of the life cycle and life history strategies. Population level includes consideration of the response of and risk to the population given the risk posed to individuals of the population within the context of the "pyramid" of VSP parameters for the populations. Strata/Diversity Group and Species levels include a consideration of the response of and risk to those levels given the risk posed to the population(s) within the larger context of the VSP "pyramid."

Effects of the Proposed Action – This section details the results of the exposure, response, and risk analyses NMFS conducted for individuals of the listed species and elements, functions, and areas of critical habitat. Given the organization of the proposed action, this section is organized around the various Divisions that comprise the CVP and SWP.

Cumulative Effects – This section summarizes the impacts of future non-Federal actions reasonably certain to occur within the action area, as required by regulation. Similar to the rest of the analysis, if cumulative effects are expected, NMFS determines the exposure, response, and risk posed to individuals of the species and features of critical habitat.

Integration and Synthesis of Effects – In this section of the Opinion, NMFS presents the summary of the effects identified in the preceding sections and then details the consequences of the risks posed to individuals and features of critical habitat to the higher levels of organization. These are the response and risk analyses for the population, diversity group, species, and designated critical habitat. The section is organized around the species and designated or proposed critical habitat and includes the summation of impacts across the proposed action Divisions, as appropriate, and follows the hierarchical organizations of the species and critical habitat summarized in figures 2-8 and 2-9, respectively, of this section.

3.0 PROPOSED ACTION

Reclamation and DWR propose to operate the CVP and SWP, respectively, to divert, store, and convey CVP and SWP (Project) water, consistent with applicable law and contractual obligations, until the year 2030. The CVP and the SWP are two major inter-basin water storage and delivery systems that divert and re-divert water from the southern portion of the Sacramento-San Joaquin Delta (Delta). The CVP's major storage facilities are Shasta, Trinity, Folsom and New Melones reservoirs. The upstream reservoirs release water to provide water for the Delta, that can be exported, a portion through Jones pumping plant to store in the joint San Luis reservoir, or delivered down the Delta Mendota Canal. The SWP owns Lake Oroville upstream and releases water for the Delta that can be exported at Harvey O. Banks Pumping Plant (Banks) for delivery through the California Aqueduct.

The projects are permitted by the California State Water Resources Control Board (SWRCB) to store water during wet periods, divert water that is surplus to the Delta, and re-divert Project water that has been stored in upstream reservoirs. Both projects operate pursuant to water right permits and licenses issued by the SWRCB, authorizing the appropriation of water by diverting to storage or by directly diverting to use and re-diverting releases from storage later in the year. As conditions of the water right permits and licenses, the SWRCB requires the CVP and SWP to meet specific water quality, quantity, and operational criteria within the Delta. Reclamation and DWR closely coordinate the CVP and SWP operations, respectively, to meet these conditions.

In addition to diverting, storing, and conveying water, Reclamation proposed several other actions that are included in this consultation. These actions are: (1) an intertie between the

California Aqueduct (CA) and the Delta-Mendota Canal (DMC); (2) Freeport Regional Water Project (FRWP); (3) the operation of permanent gates, which will replace the temporary barriers in the South Delta; (4) changes in the operation of RBDD; and (5) Alternative Intake Project for the Contra Costa Water District.

3.1 Project Description

Appendix 1 to this Opinion provides a detailed project description of the proposed action. Reclamation and NMFS staff engaged in e-mail exchanges throughout January 2009 to clarify various aspects of the project description, as follows:

- January 15, 2009, for Contra Costa Water District: "In addition to the existing 75-day no-fill period (March 15-May 31) and the concurrent no-diversion 30-day period, beginning in the February following the first operation of the Alternative Intake Project, CCWD shall not divert water to storage in Los Vaqueros Reservoir for 15 days from February 14 through February 28, provided that reservoir storage is at or above 90 TAF on February 1; if reservoir storage is at or above 80 TAF on February 1 but below 90 TAF, CCWD shall not divert water to storage in Los Vaqueros Reservoir for 10 days from February 19 through February 28; if reservoir storage is at or above 70 TAF on Feb 1, but below 80 TAF CCWD shall not divert water to storage in Los Vaqueros Reservoir for 5 days from February 24 through February 28."; and
- January 28, 2009: Confirmation that the Sacramento River Reliability Project is no longer part of the project description.

Appendix 1 to this Opinion reflects the above changes to the project description, has been coordinated with Reclamation and the USFWS, and is consistent with the project description in the USFWS' December 15, 2008, biological opinion on the effects of CVP/SWP operations on Delta smelt. Hereafter, all reference to the project description refers to Appendix 1 to this Opinion, unless otherwise specified.

3.2 Interrelated or Interdependent Actions

3.2.1 CVP and SWP Fish Hatcheries

In the Central Valley, six hatcheries have been established to offset the loss of salmon and steelhead due to construction of dams. Additionally, Trinity River Fish Hatchery mitigates for salmon and steelhead losses on the Trinity River. The Mokelumne River Hatchery, although not directly related to CVP or SWP dams, does influence fall-run and steelhead populations. Added together, Central Valley hatcheries annually produce approximately 250,000 winter-run, 5 million spring-run, 29.76 million fall-run, and 1.5 million steelhead. Currently, most Central Valley hatcheries truck their salmon production to the Bay-Delta region for release. The exception to this is Coleman National Fish Hatchery, which began trucking a small portion of its fall-run production into San Pablo Bay beginning in 2008. Section 1.5.2, above, describes ESA consultation on the CVP and SWP hatcheries. Listed below are the production goals for Nimbus Fish Hatchery and TRFH.

3.2.1.1 Nimbus Fish Hatchery

The Nimbus Fish Hatchery and the American River Trout Hatchery were constructed to mitigate for the loss of riverine habitat caused by the construction of CVP Nimbus and Folsom dams. The American River Trout Hatchery produces fish for stocking inland areas (*i.e.*, above dams) and is, therefore, not considered in the production goals for the Central Valley. Nimbus Fish Hatchery is located below Nimbus Dam and is operated by CDFG to meet annual production goals of 4 million fall-run smolts and 430,000 steelhead yearlings.

3.2.1.2 Trinity River Fish Hatchery

The Trinity River Fish Hatchery was constructed to provide CVP mitigation for the loss of upstream riverine habitat caused by the construction of the Trinity and Lewiston dams. The hatchery, operated by CDFG, produces 1.4 million spring-run, 2.9 million fall-run, 500,000 coho salmon, and 800,000 steelhead annually.

3.2 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this biological opinion, the action area encompasses: (1) Sacramento River from Shasta Lake downstream to and including the Sacramento-San Joaquin Delta; (2) Clear Creek from Whiskeytown Reservoir to its confluence with the Sacramento River; (3) Feather River from Oroville Dam downstream to its confluence with the Sacramento River; (4) American River from Folsom Lake downstream to its confluence with the Sacramento River; (5) Stanislaus River from New Melones Reservoir to its confluence with the San Joaquin River; (6) San Joaquin River from the confluence with the Stanislaus River downstream to and including the Sacramento-San Joaquin Delta; (7) San Francisco Bay; and (8) the nearshore Pacific Ocean on the California, Oregon, and Washington coasts.

4.0 STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species and designated critical habitats occur in the action area and may be affected by CVP/SWP operations in this consultation:

- Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), endangered (June 28, 2005, 70 FR 37160);
- Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212);
- CV spring-run Chinook salmon ESU (*O. tshawytscha*), threatened (June 28, 2005, 70 FR 37160);
- CV spring-run Chinook salmon designated critical habitat (September 2, 2005, 70 FR 52488);
- CV steelhead DPS (*O. mykiss*), threatened (January 5, 2006, 71 FR 834);
- CV steelhead designated critical habitat (September 2, 2005, 70 FR 52488);
- CCC steelhead DPS (*O. mykiss*), threatened (January 5, 2006, 71 FR 834);

- CCC steelhead designated critical habitat (September 2, 2005, 70 FR 52488);
- Southern DPS of North American green sturgeon (*Acipenser medirostris*), threatened (April 7, 2006, 71 FR 17757); and
- Southern DPS of North American green sturgeon proposed critical habitat (September 8, 2008, 73 FR 52084);
- Southern Resident killer whales (*Orcinus orca*), endangered (November 18, 2005, 70 FR 69903).

4.1 Species and Critical Habitat not likely to be Adversely Affected by the Proposed Action

4.1.1 Central California Coast Steelhead

The CCC steelhead DPS (*O. mykiss*) was listed as threatened on January 5, 2006 (71 FR 834), and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. Tributary streams to Suisun Marsh include Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough, excluding the Sacramento-San Joaquin River Basin, as well as two artificial propagation programs: the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery programs.

CCC steelhead adults and smolts travel through the western portion of Suisun Marsh and Suisun Bay as they migrate between the ocean and these natal spawning streams. CVP and SWP water export facilities in the Delta are approximately 40 miles to the southeast of Suisun Marsh. CCC steelhead are unlikely to travel eastward towards the Delta pumping facilities, because their seaward migration takes them westward of their natal streams. Similarly, DWR's Suisun Marsh Salinity Control Gates (SMSCG) in Montezuma Slough are located to the east of these three Suisun Marsh steelhead streams and CCC steelhead are unlikely to travel 10-15 miles eastward through Montezuma Slough to the SMSCG. Therefore, it is unlikely that CCC steelhead will encounter the SMSCG or the Delta pumping facilities during their upstream and downstream migrations, because their spawning streams are located in the western portion of Suisun Marsh.

Operations at CVP and SWP Delta facilities, including the SMSCG, affect water quality and river flow volume in Suisun Bay and Marsh. Delta water exports are expected to cause elevated levels of salinity in Suisun Bay due to reductions in the amount of freshwater inflow from the Sacramento and San Joaquin Rivers. Reduced river flow volumes into Suisun Bay can also affect the transport of larval and juvenile fish. CCC steelhead originating from Suisun Marsh tributary streams will be subject to these changes in salinity and river inflow volumes in Suisun Bay, but are not expected to be negatively affected by these conditions. Estuarine areas, such as Suisun Bay, are transitional habitat between freshwater riverine environments and the ocean. Expected changes in Suisun Bay salinity levels due to CVP and SWP exports are within the range commonly encountered in estuaries by migrating steelhead. River flow volumes may be reduced by water exports, but in an estuary, the tidal cycle of the ocean causes semidiurnal changes to salinity, velocity, temperature, and other conditions. Steelhead generally move through estuaries rapidly (Quinn 2005) and CCC steelhead smolts in Suisun Bay are not

dependent on river flow to transport them to the ocean. Thus, reductions in river flow volumes and changes in salinity in Suisun Bay due to CVP/SWP operations are not expected to negatively impact CCC steelhead estuarine residence or migration. In consideration of the above and the distance separating CCC steelhead streams from the Delta pumping facilities and the SMSCG, the proposed action is not likely to adversely affect CCC steelhead.

4.1.2 CCC Steelhead Designated Critical Habitat

The CVP/SWP operations BA determined that CVP/SWP operations will not influence critical habitat for CCC steelhead because Suisun Bay is not a designated area. CCC steelhead critical habitat includes San Francisco Bay and San Pablo Bay, but does not extend eastward into Suisun Bay (September 2, 2005, 70 FR 52488). PCEs of designated critical habitat for CCC steelhead include water quality and quantity, foraging habitat, natural cover including large substrate and aquatic vegetation, and migratory corridors free of obstructions. Due to the location of CCC steelhead critical habitat in San Pablo Bay and areas westward, NMFS concurs with Reclamation's finding that the habitat effects of CVP/SWP operations in this area are insignificant and discountable. Therefore, NMFS has concluded that CVP/SWP facilities and their operations are not likely to adversely affect essential physical or biological features associated with CCC steelhead critical habitat.

4.2 Life Histories, Population Trends, Critical Habitat, and Factors Affecting the Status of the Species

4.2.1 Chinook Salmon

4.2.1.1 General Life History

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). Adult "stream-type" Chinook salmon enter freshwater months before spawning, and juveniles reside in freshwater for a year or more, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation of the fish at the time of river entry, thermal regime, and flow characteristics of their spawning sites, and the actual time of spawning (Myers *et al.* 1998). Both winter-run and spring-run tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. Fall-run enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are

necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38ºF to 56ºF (Bell 1991, CDFG 1998). Boles (1988) recommends water temperatures below 65°F for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70°F, and that fish can become stressed as temperatures approach 70°F.

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, for several days at a time, while migrating upstream (CALFED 2001a). Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates (2006) showed peak upstream movement of adult spring-run in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55°F to 57°F (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The optimal water temperature for egg incubation ranges from 41°F to 56°F [44°F to 54°F (Rich 1997), 46°F to 56°F (NMFS 1997), and 41°F to 55.4°F (Moyle 2002)]. A significant reduction in egg viability occurs at water temperatures above 57.5°F and total embryo mortality can occur at temperatures above 62°F (NMFS 1997). Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61°F and 37°F, respectively, when the incubation temperature was held constant. As water temperatures increase, the rate of embryo malformations also increases, as well as the susceptibility to fungus and bacterial infestations. The length of development for Chinook salmon embryos is dependent on the ambient water temperature surrounding the egg pocket in the redd. Colder water necessitates longer

development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel.

During the 4 to 6 week period when alevins remain in the gravel, they utilize their yolk-sac to nourish their bodies. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. Fry typically range from 25 mm to 40 mm at this stage. Upon emergence, fry swim or are displaced downstream (Healey 1991). The post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on zooplankton, small insects, and other micro-crustaceans. Some fry may take up residence in their natal stream for several weeks to a year or more, while others are displaced downstream by the stream's current. Once started downstream, fry may continue downstream to the estuary and rear there, or may take up residence in river reaches farther downstream for a period of time ranging from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996a). The benefits of shallow water habitats for salmonid rearing have been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams, may spur outmigration of juveniles from the upper Sacramento River basin when they have reached the appropriate stage of maturation (Kjelson *et al.* 1982, Brandes and McLain 2001).

As fish begin their emigration, they are displaced by the river's current downstream of their natal reaches. Similar to adult movement, juvenile salmonid downstream movement is crepuscular. The daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (Martin *et al.* 2001). Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found Chinook salmon fry to travel as fast as 30 km per day in the Sacramento River, and Sommer *et al.* (2001) found travel rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (ppt, Healey 1980, Levy and Northcote 1981).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975, Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54ºF to 57ºF (Brett 1952). In Suisun and San Pablo bays, water temperatures reach 54ºF by February in a typical year. Other portions of the Delta (*i.e.*, South Delta and Central Delta) can reach 70ºF by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levings 1982, Levy and Northcote 1982, Levings *et al.* 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1989) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

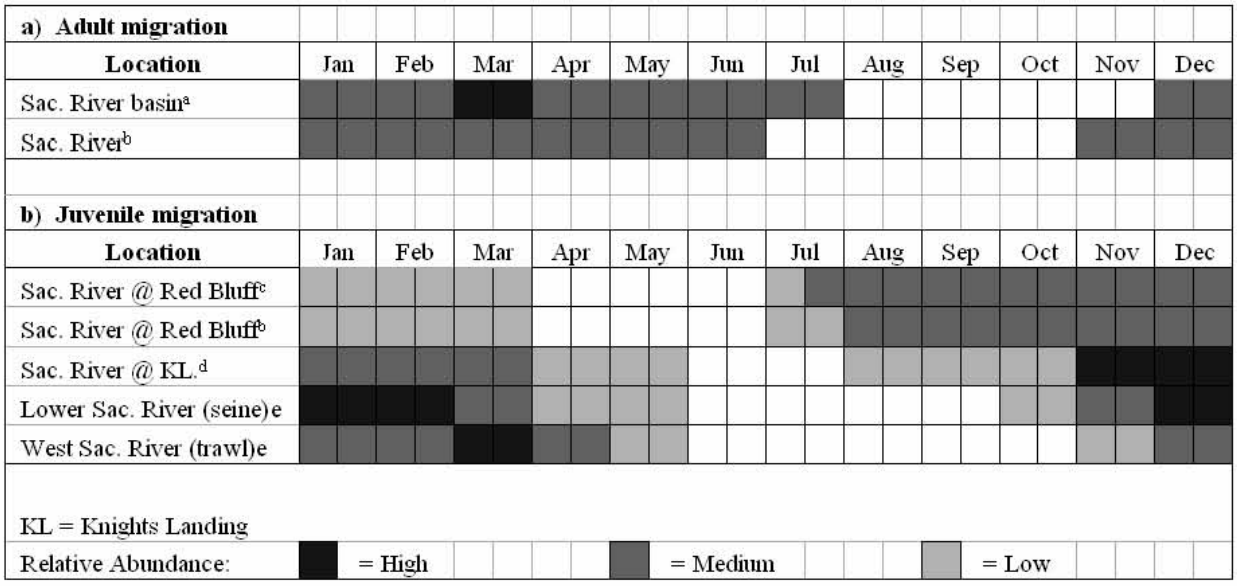
4.2.1.2 Sacramento River Winter-Run Chinook Salmon

The distribution of winter-run spawning and rearing historically is limited to the upper Sacramento River and its tributaries, where spring-fed streams provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento rivers, and Hat and Battle creeks, historically provided clean, loose gravel; cold, well-oxygenated water; and optimal stream flow in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry development and survival, and juvenile rearing over the summer. The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which has its own impediments to

upstream migration (*i.e.*, the fish weir at the Coleman National Fish Hatchery and other small hydroelectric facilities situated upstream of the weir; Moyle *et al.* 1989; NMFS 1997, 1998a, 1998b). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River is now inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the Upper Sacramento had a "potential spawning capacity" of 14,303 redds. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Winter-run exhibit characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run migrate to sea after only 4 to 7 months of river life (ocean-type). Adult winter-run enter San Francisco Bay from November through June (Hallock and Fisher 1985), enter the Sacramento River basin between December and July, the peak occurring in March (table 4-1; Yoshiyama *et al.* 1998, Moyle 2002), and migrate past the RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Yoshiyama *et al*. 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of winter-run spawners are 3 years old.

Table 4-1. The temporal occurrence of (a) adult and (b) juvenile winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.



Sources: [a]Yoshiyama *et al*. (1998); Moyle (2002); [b]Myers *et al*. (1998); Vogel and Marine (1991) ; [c]Martin *et al.* (2001); [d]Snider and Titus (2000); [e]USFWS (2001, 2001a)

Winter-run fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). Emigration of juvenile winter-run past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run outmigrating as fry passed

RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile winter-run occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento [river mile (RM) 57; USFWS 2001, 2001a]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continue through May (Fisher 1994, Myers *et al.* 1998).

4.2.1.2.1 Range-Wide (ESU) Status and Trends

Historical winter-run population estimates, which included males and females, were as high as over 230,000 adults in 1969, but declined to under 200 fish in the 1990s (Good *et al.* 2005, figure 4-1). A rapid decline occurred from 1969 to 1979 after completion of the RBDD (figure 4-1). Over the next 20 years, the population eventually reached a low point of only 186 adults in 1994. At that point, winter-run was at a high risk of extinction, as defined in the most recent guideline for recovery of Central Valley salmonids (Lindley *et al*. 2007). If not for a very successful captive broodstock program, construction of a temperature control device (TCD) on Shasta Dam, having the RBDD gates up for much of the year, and restrictions in the ocean harvest, the population would have likely failed to exist in the wild. In recent years, the carcass survey population estimates of winter-run included a high of 17,205 (table 4-2) in 2006, followed by a precipitous decline in 2007 that continued in 2008, when less than 3,000 adult fish returned to the upper Sacramento River. The preliminary estimate of the winter-run in 2008 is 2,850 (CDFG 2008).

A conservation program at LSNFH located at the base of Keswick Dam annually supplements the in-river production by releasing on average 250,000 winter-run smolts into the upper Sacramento River. The LSNFH operates under strict guidelines for propagation that includes genetic testing of each pair of adults and spawning less than 25 percent of the hatchery returns. This program and the captive broodstock program (phased out in 2007) were instrumental in stabilizing winter-run following very low returns in the 1990s.

The status of winter-run is typical of most endangered species populations, that is, a sharp downward decline followed by years of low abundance (figure 4-1). Since there is only one winter-run population, there are no other populations to act as a reserve should a catastrophic event happen in the mainstem Sacramento River. Four highway bridges cross the upper Sacramento River spawning grounds. One truck overturning could spill enough oil or contaminants to extirpate an entire year class. The winter-run population is completely dependent on coldwater releases from Shasta Dam in order to sustain the remnant population.

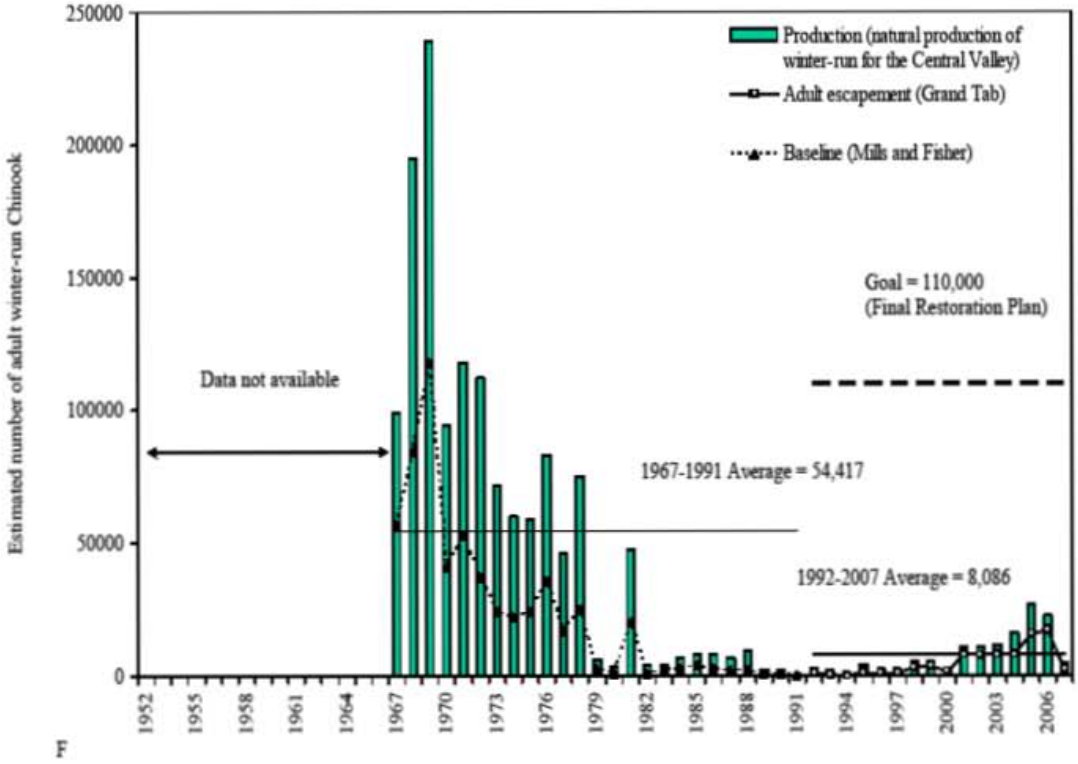


Figure 4-1. Estimated yearly adult natural production and in-river adult escapement of winter-run from 1967 - 2007 based on RBDD ladder counts (Hanson 2008[2]).

The upper Sacramento River is the only spawning area used by winter-run, although occasional strays have been reported in Battle Creek and Clear Creek. Since fish passage was improved in 2001 at the ACID Dam, winter-run spawning has shifted upstream. The majority of winter-run in recent years (*i.e.*, > 50 percent since 2007) spawn in the area from Keswick Dam downstream to the ACID Dam (approximately 5 miles). Keswick Dam re-regulates flows from Shasta Dam and mixes it with water diverted from the Trinity River through the Spring Creek tunnel. When the gates are down at RBDD, or flashboards in at the ACID Dam, access to the upper Sacramento River basin, including tributaries, can only be achieved through the RBDD and ACID Dam fish ladders. Both of these diversions' fish ladders allow salmonids to pass upstream, but completely block green sturgeon.

Table 4-2 provides data on the cohort replacement rate (CRR), which is similar to the SRR recommended by Anderson *et al*. (2009), that is, the ratio of the number of recruits returning to the spawning habitat divided by the number of spawners producing those recruits. As discussed, above, the majority of winter-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning population 3 years prior.

[2] Mohr (2008) stated that the source of the 1992–2007 production values from Hanson (2008) was Chinookprod_33108.xls rather than CDFG Grand Tab.

[3] Upper Sacramento River basin is considered the area upstream of RBDD for purposes of this Opinion.

Table 4-2. Winter-run population estimates from RBDD counts (1986 to 2001) and carcass counts (2001 to 2008), and corresponding cohort replacement rates for the years since 1986 (CDFG 2004a, CDFG 2007).

Year	Population Estimate[a]	5-Year Moving Average of Population Estimate	Cohort Replacement Rate[b]	5-Year Moving Average of Cohort Replacement Rate	NMFS-Calculated Juvenile Production Estimate (JPE)[c]
1986	2,596	-	-	-	
1987	2,186	-	-	-	
1988	2,885	-	-	-	
1989	696	-	0.27	-	
1990	433	1,759	0.20	-	
1991	211	1,282	0.07	-	40,100
1992	1,240	1,092	1.78	-	273,100
1993	387	593	0.90	0.64	90,500
1994	186	491	0.88	0.77	74,500
1995	1,297	664	1.05	0.94	338,107
1996	1,337	889	3.45	1.61	165,069
1997	880	817	4.73	2.20	138,316
1998	3,002	1,340	2.31	2.48	454,792
1999	3,288	1,961	2.46	2.80	289,724
2000	1,352	1,972	1.54	2.90	370,221
2001	8,224	3,349	2.74	2.76	1,864,802
2002	7,441	4,661	2.26	2.22	2,136,747
2003	8,218	5,705	6.08	3.02	1,896,649
2004	7,701	6,587	0.94	2.71	881,719
2005	15,730	9,463	2.11	2.83	3,556,995
2006	17,205	11,259	2.09	2.70	3,890,534
2007	2,488	10,268	0.32	2.31	1,100,067
2008	2,850[d]	9,195	0.18	1.13	1,152,043[e]
median	**2,488**	**1,961**	**1.54**	**2.31**	**370,221**

[a] Population estimates were based on RBDD counts until 2001. Starting in 2001, population estimates were based on carcass surveys.

[b] The majority of winter-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning population 3 years prior.

[c] JPE estimates were derived from NMFS calculations utilizing RBDD winter-run counts through 2001, and carcass counts thereafter for deriving adult escapement numbers. Only estimated to RBDD, does not include survival to the Delta.

[d] CDFG (2008)

[e] NMFS (2009b) preliminary estimate to Reclamation

Two current methods are utilized to estimate juvenile production of winter-run: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of winter-run exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these two estimates yields an estimated population size of 3,782,476 juveniles during that timeframe.

4.2.1.2.2 Current Viability of the Sacramento River Winter-Run Chinook Salmon ESU

One prerequisite for predicting the effects of a proposed action on a species is understanding the likelihood of the species in question becoming viable, and whether the proposed action can be expected to reduce this likelihood. The abundance of spawners is just one of several criteria that must be met for a population to be considered viable. McElhany *et al*. (2000) acknowledged that a viable salmonid population at the ESU scale is not merely a quantitative number that needs to be attained. Rather, for an ESU to persist, populations within the ESU must be able to spread risk and maximize future potential for adaptation. ESU viability depends on the number of populations and subunits within the ESU, their individual status, their spatial arrangement with respect to each other and sources of catastrophic disturbance, and diversity of the populations and their habitats (Lindley *et al*. 2007). Populations comprise diversity groups, which are intended to capture important components of habitat, life history or genetic diversity that contribute to the viability of the ESU (Hilborn et al. 2003 *op. cit*. Lindley *et al.* 2007, Bottom *et al*. 2005 *op. cit*. Lindley *et al*. 2007). Lindley *et al*. (2007) suggest that at least two viable populations within each diversity group are required to ensure the viability of the diversity group, and hence, the ESU.

In order to determine the current likelihood of winter-run becoming viable, we used the historical population structure of winter-run presented in Lindley *et al*. (2004) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al*. (2007) applied the concept to the winter-run ESU. Lindley *et al.* (2004) identified four historical populations within the winter-run ESU, all independent populations, defined as those sufficiently large to be historically viable-in isolation and whose demographics and extinction risk were minimally influenced by immigrants from adjacent populations (McElhany *et al*. 2000). All four independent populations, however, are extinct in their historical spawning ranges. Three (Little Sacramento; Pit, Fall, Hat; and McCloud River) are blocked by the impassable Keswick and Shasta Dams (Lindley *et al*. 2004), and the Battle Creek independent population is no longer self-sustaining (Lindley *et al*. 2007).

Although Lindley *et al*. (2007) did not provide numerical goals for each population of Pacific salmonid to be categorized at low risk for extinction, they did provide various quantitative criteria to evaluate the risk of extinction (table 4-3). A population must meet all the low-risk thresholds to be considered viable. The following provides the evaluation of the likelihood of winter-run becoming viable based on the VSP parameters of population size, population growth rate, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000).

Table 4-3. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids (reproduced from Lindley *et al.* 2007).

	Risk of Extinction		
Criterion	High	Moderate	Low
Extinction risk from PVA	> 20% within 20 years – or any ONE of –	> 5% within 100 years – or any ONE of –	< 5% within 100 years – or ALL of –
Population size[a]	$N_e \leq 50$ –or– $N \leq 250$	$50 < N_e \leq 500$ –or– $250 < N \leq 2500$	$N_e > 500$ –or– $N > 2500$
Population decline	Precipitous decline[b]	Chronic decline or depression[c]	No decline apparent or probable
Catastrophe, rate and effect[d]	Order of magnitude decline within one generation	Smaller but significant decline[e]	not apparent
Hatchery influence[f]	High	Moderate	Low

[a] Census size N can be used if direct estimates of effective size N_e are not available, assuming $N_e/N = 0.2$.
[b] Decline within last two generations to annual run size $\leq$ 500 spawners, or run size $>$ 500 but declining at $\geq$ 10% per year. Historically small but stable population not included.
[c] Run size has declined to $\leq$ 500, but now stable.
[d] Catastrophes occuring within the last 10 years.
[e] Decline < 90% but biologically significant.
[f] See Figure 1 for assessing hatchery impacts.

4.2.1.2.2.1 Population Size

Information about population size provides an indication of the type of extinction risk that a population faces. For instance, smaller populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (McElhany *et al.* 2000). One risk of low population sizes is depensation. Depensation occurs when populations are reduced to very low densities and per capita growth rates decrease as a result of a variety of mechanisms [*e.g.,* failure to find mates and therefore reduced probability of fertilization, failure to saturate predator populations (Liermann

and Hilborn 2001)]. As provided in table 4-2, the winter-run population, as represented by the 5-year moving average for adult escapement, was following an increasing trend from the mid-1990s until 2006. In 2007, the winter-run population declined precipitously. Low adult escapement was repeated in 2008. Likewise, the 5-year moving average cohort replacement rate was relatively stable since the late 1990s, with each cohort approximately doubling in size. However, the cohort replacement rate of 6.08 in 2003 buffered the effect of the significant decline in the cohort replacement rate of 0.32 in 2007. This is evident in the 5-year moving average cohort replacement rate ending in 2008, when the 6.08 cohort replacement rate in 2003 is not factored in. At the time of publication, Lindley *et al*. (2007) indicated that winter-run satisfies the low-risk criteria for population size, population decline, and catastrophe. However, they also acknowledged that the previous precipitous decline to a few hundred spawners per year in the early 1990s would have qualified it as high risk at that time, and the 1976-77 drought would have qualified as a high-risk catastrophe. In consideration of the almost 7-fold decrease in population in 2007, coupled with the dry water year type in 2007, followed by the critically dry water year type in 2008 (which could be qualified as a high-risk catastrophe) and likely a similar forecast for 2009, NMFS concludes that winter-run are at a high risk of extinction based on population size.

4.2.1.2.2.2 Population Growth Rate

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). This guideline seems reasonable in the absence of numeric abundance targets.

Winter-run have declined substantially from historic levels. The one remaining population of winter-run on the mainstem Sacramento River is also the entire current ESU. Although the population growth rate (indicated by the cohort replacement rate) increased since the late 1990s, it drastically decreased in 2007 and 2008, indicating that the population is not replacing itself, and is at a high risk of extinction in the foreseeable future.

4.2.1.2.2.3 Spatial Structure

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany *et al.* 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et al*. 2000). The spatial structure of winter-run resembles that of a panmictic population, where there are no subpopulations, and every mature male is equally likely to mate with every other mature female. The four historical independent populations of winter-run have been reduced to one population, resulting in a

significant reduction in their spatial diversity. An ESU comprised of one population is not viable because it is unlikely to be able to adapt to significant environmental changes. A single catastrophe (*e.g.*, volcanic eruption of Lassen Peak, prolonged drought which depletes the cold water pool at Lake Shasta, or some related failure to manage cold water storage, spill of toxic materials, or a disease outbreak) could extirpate the entire winter-run ESU if its effects persisted for 3 or more years. The majority of winter-run return to spawn in 3 years, so a single catastrophe with effects that persist for at least 3 years would affect all of the winter-run cohorts. Therefore, NMFS concludes that winter-run are at a high risk of extinction based on spatial structure.

4.2.1.2.2.4 Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The primary factor affecting the diversity of winter-run is the limited area of spawning habitat available on the mainstem Sacramento River downstream of Keswick Dam. This specific and narrow spawning habitat limits the flexibility and variation in spawning locations for winter-run to tolerate environmental variation. For example, a catastrophe on the mainstem Sacramento River could affect the entire population, and therefore, ESU. However, with the majority of spawners being 3 years old, winter-run do reserve some genetic and behavioral variation in that in any given year, two cohorts are in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

Although LSNFH is characterized as one of the best examples of a conservation hatchery operated to maximize genetic diversity and minimize domestication of the offspring produced in the hatchery, it still faces some of the same diversity issues as other hatcheries in reducing the diversity of the naturally-spawning population. Therefore, Lindley *et al*. (2007) characterizes hatchery influence as a looming concern with regard to diversity. Even with a small contribution of hatchery fish to the natural spawning population, hatchery contributions could compromise the long term viability and extinction risk of winter-run.

NMFS concludes that the current diversity in this ESU is much reduced compared to historic levels, and that winter-run are at a high risk of extinction based on the diversity VSP parameter.

4.2.1.2.2.5 Summary of the Current Viability of the Sacramento River Winter-Run Chinook Salmon ESU

An age-structured density-independent model of spawning escapement by Botsford and Brittnacker (1998 *op. cit.* Good *et al*. 2005) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al*. 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. This analysis found a biologically significant expected quasi-extinction probability of 28 percent. There is only one population, and it depends on cold-water releases from Shasta Dam, which could be vulnerable to a prolonged drought (Good *et al*. 2005).

Recently, Lindley *et al.* (2007) determined that the winter-run population, which is confined to spawning below Keswick Dam, is at a moderate extinction risk according to population viability analysis (PVA), and at a low risk according to other criteria (*i.e.*, population size, population decline, and the risk of wide ranging catastrophe). However, concerns of genetic introgression with hatchery populations are increasing. Hatchery-origin winter-run from LSNFH have made up more than 5 percent of the natural spawning run in recent years and in 2005, it exceeded 18 percent of the natural run. If this proportion of hatchery origin fish from the LSNFH exceeds 15 percent in 2006-2007, Lindley *et al*. (2007) recommends reclassifying the winter-run population extinction risk as moderate, rather than low, based on the impacts of the hatchery fish over multiple generations of spawners. In addition, data used for Lindley *et al*. (2007) did not include the significant decline in adult escapement numbers in 2007 and 2008, and thus, does not reflect the current status of the population size or the recent population decline. Furthermore, the current drought conditions in the Central Valley were not incorporated into the analysis of the winter-run population status in Lindley *et al*. (2007) as a potential catastrophic event.

Lindley *et al.* (2007) also states that the winter-run ESU fails the "representation and redundancy rule" because it has only one population, and that population spawns outside of the ecoregion in which it evolved. In order to satisfy the "representation and redundancy rule," at least two populations of winter-run would have to be re-established in the basalt- and porous-lava region of its origin. An ESU represented by only one spawning population at moderate risk of extinction is at a high risk of extinction over an extended period of time (Lindley *et al*. 2007). Based on the above descriptions of the population viability parameters, NMFS believes that the winter-run ESU is currently not viable.

4.2.1.2.3 Status of Sacramento River Winter-Run Chinook Salmon Critical Habitat

4.2.1.2.3.1 Summary of Designated Critical Habitat

The designated critical habitat for winter-run includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay

Bridge (June 16, 1993, 58 FR 33212). In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone (limited to those areas above a streambank that provide cover and shade to the nearshore aquatic areas) used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile emigration or adult spawning migration.

In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In addition to these factors, NMFS also focuses on the known physical and biological features (essential features) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Within the range of winter-run, biological features of the designated critical habitat that are considered vital for winter-run include unimpeded adult upstream migration routes, spawning habitat, egg incubation and fry emergence areas, rearing areas for juveniles, and unimpeded downstream migration routes for juveniles.

4.2.1.2.3.2 Factors Affecting Critical Habitat

A wide range of activities may affect the essential habitat requirements of winter-run. Water quantity and quality have been altered by the continued operations of Reclamation's CVP and DWR's SWP. In addition, small and large water diversions by private entities, such as the ACID and the GCID, withdraw incremental amounts of water directly from the Sacramento River, many of which are not screened, resulting in the direct loss of (mostly) juveniles to the diversions.

Habitat quantity and quality have also been altered. Keswick Dam precludes access to all of the historical spawning habitat for three independent populations of winter-run. In addition, access for the Battle Creek independent population has been blocked by the Coleman National Fish Hatchery weir and various hydropower dams and diversions (Lindley *et al*. 2004). Corps permitting activities that authorize dredging and other construction-related activities in the Sacramento River, Sacramento-San Joaquin Delta, and San Francisco Bay have modified aquatic habitat, including increasing sedimentation, simplifying streambank and riparian habitat, reducing connectivity to floodplain habitat, and modifying hydrology. All of these activities result in changes to the value of the essential features of winter run critical habitat that are necessary for their conservation.

4.2.1.2.3.3 Current Condition of Critical Habitat at the ESU Scale

The final rule designating critical habitat for winter-run (June 16, 1993, 58 FR 33212) identifies the following physical and biological features that are essential for the conservation of winter-run: (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River, (2) the availability of clean gravel for spawning substrate, (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles, (4) water temperatures between 42.5 and 57.5^{o}F for successful spawning, egg incubation, and fry development, (5) habitat areas and adequate prey that are not contaminated, (6) riparian habitat that provides for successful juvenile development and survival, and (7) access downstream so that juveniles can migrate from spawning grounds to San Francisco Bay and the Pacific Ocean.

4.2.1.2.3.3.1 Access to Spawning Areas in the Upper Sacramento River

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover/shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate in the winter and spring months to spawning areas. During that time of year, the migration route is mostly free of obstructions. However, during the annual May 15 through September 15 gates in position, RBDD reduces the value of the migratory corridor.

4.2.1.2.3.3.2 The Availability of Clean Gravel for Spawning Substrate

Spawning habitat for winter-run is restricted to the Sacramento River primarily between Keswick Dam and RBDD. This reach was not historically utilized by winter-run for spawning. Because Shasta and Keswick dams preclude spawning gravel recruitment, Reclamation injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the reach of the upper Sacramento River continues to support the current populations of winter-run.

4.2.1.2.3.3.3 Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles

An April 5, 1960, Memorandum of Agreement (MOA) between Reclamation and the DFG originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the flow releases required in Water Rights Order (WRO) 90-05. Table 5 of the project description provides the flow requirements in the 1960 MOA and WRO 90-05. Flow releases for agriculture and other consumptive uses during the winter-run egg incubation, fry development, and emergence life history stages, rather than minimum flow requirements, drive operations of Shasta and Keswick dams.

4.2.1.2.3.3.4 Water Temperatures for Successful Spawning, Egg Incubation, and Fry Development

Reclamation releases cold water from Shasta Reservoir to provide for adult winter-run migration, spawning, and egg incubation. However, the extent winter-run habitat needs are met depends on Reclamation's other operational commitments, including those to settlement contractors, water service contractors, D-1641 requirements, and projected end of September storage volume. Based on these commitments, and Reclamation's modeled February and subsequent monthly forecasts, Reclamation determines how far downstream 56°F can be maintained and sustained throughout the winter-run spawning, egg incubation, and fry development stages. Although WRO 90-05 and 91-1 require Reclamation to operate Keswick and Shasta dams, and the Spring Creek Powerplant, to meet a daily average water temperature of 56°F at RBDD, they also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. In every year since the SWRCB issued WRO 90-05 and 91-1, operations plans have included modifying the RBDD compliance point to make best use of the coldwater resources based on the location of spawning Chinook salmon (CVP/SWP operations BA page 2-40). Once a TCP has been identified and established, it generally does not change, and therefore, water temperatures are typically adequate for successful, egg incubation, and fry development for those redds constructed upstream of the TCP. However, the annual change in TCP has degraded the conservation value of spawning habitat (based on water temperature).

4.2.1.2.3.3.5 Habitat Areas and Adequate Prey that are not Contaminated

Current water quality conditions are better than in previous decades, however legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals, and persistent organochlorine pesticides continue to be found in watersheds throughout the Central Valley. Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column. Exposure to these contaminated food sources may create delayed sublethal effects that reduce fitness at a time when the animal is physiologically stressed, *i.e.*, during smoltification or ocean entry.

Contaminants are typically associated with areas of urban development or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system.

4.2.1.2.3.3.6 Riparian Habitat that Provides for Successful Juvenile Development and Survival

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Juvenile life stages of salmonids are dependant on the function of this habitat for successful survival and recruitment.

Some complex, productive habitats with floodplains remain in the system [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses). Nevertheless, the current condition of riparian habitat for winter-run is degraded.

4.2.1.2.3.3.7 Access Downstream so that Juveniles can Migrate from Spawning Grounds to San Francisco Bay and the Pacific Ocean

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the mainstem of the Sacramento River. These corridors allow the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Currently, when the gates are in, RBDD reduces the value of the migratory corridor for downstream migration. In addition, although predators of juvenile Chinook salmon are prominent throughout the Sacramento River and Delta, they concentrate around structures, and therefore, a higher concentration of striped bass, and especially Sacramento pikeminnow, congregate downstream of RBDD when the gates are in, resulting in increased mortality of juvenile Chinook salmon from predation.

Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River. Although actual entrainment rates are not known, the CVP/SWP operations BA provided calculations of estimated entrainment of salmonids through unscreened diversions along the Sacramento River. According to the calculations, over 7,000 juvenile winter-run are lost to unscreened diversions annually.

D-1641 provides for 45 days of discretionary gate closures of the DCC between November 1 and January 31, which leaves the DCC gates open half the time during those 3 months. When the DCC gates are open during winter-run outmigration, a portion of the flow, and therefore, a portion of the outmigrating winter-run, is entrained through the DCC into the interior Delta, where their chances of survival and successful migration to San Francisco Bay and the Pacific Ocean are reduced.

Based on the impediments caused by the RBDD, unscreened diversions, and the opening of the DCC gates during the winter-run outmigration period, the current condition of the freshwater migration corridor in the Sacramento River is much degraded.

4.2.1.2.3.3.8 Sacramento River Winter-Run Chinook Salmon Critical Habitat Summary

Critical habitat for winter-run is composed of physical and biological features that are essential for the conservation of winter-run, including up and downstream access, and the availability of certain habitat conditions necessary to meet the biological requirements of the species. Currently, many of these physical and biological features are impaired, and provide limited conservation value. For example, when the gates are in, RBDD reduces the value of the migratory corridor for upstream and downstream migration. Unscreened diversions throughout the mainstem Sacramento River, and the DCC when the gates are open during winter-run outmigration, do not provide a safe migratory corridor to San Francisco Bay and the Pacific Ocean.

In addition, the annual change in TCP has degraded the conservation value of spawning habitat (based on water temperature). The current condition of riparian habitat for winter-run rearing is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system. However, some complex, productive habitats with floodplains remain in the system (*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa) and flood bypasses (*i.e.*, Yolo and Sutter bypasses).

Based on the impediments caused by RBDD when the gates are in, unscreened diversions, annual changes to the TCP, the time when the DCC gates are open during the winter-run outmigration period, and the degraded condition of spawning habitat and riparian habitat, the current condition of winter-run critical habitat is degraded, and has low value for the conservation of the species.

4.2.1.3 Central Valley Spring-Run Chinook Salmon

Historically, spring-run occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929).

Spring-run exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Adult spring-run leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (table 4-4; Yoshiyama *et al*. 1998, Moyle 2002). Lindley *et al*. (2007) indicate that adult spring-run migrate from the Sacramento River into spawning tributaries primarily between mid April and mid June. Typically, spring-run utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al*. 1998). Reclamation reports that spring-run holding in upper watershed locations prefer water temperatures below 60°F, although salmon can tolerate temperatures up to 65°F before they experience an increased susceptibility to disease.

Spring-run spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

Spring-run fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as YOY or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al*. 2007). Studies in Butte Creek (Ward *et al*. 2002, 2003; McReynolds *et al*. 2005) found the majority of spring-run migrants to be fry occurring primarily from December through February, and that these movements appeared to be influenced by flow. Small numbers of spring-run remained in Butte Creek to rear and migrated as yearlings later in the year, typically the next fall. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later YOY migration and an earlier yearling migration (Lindley *et al*. 2007).

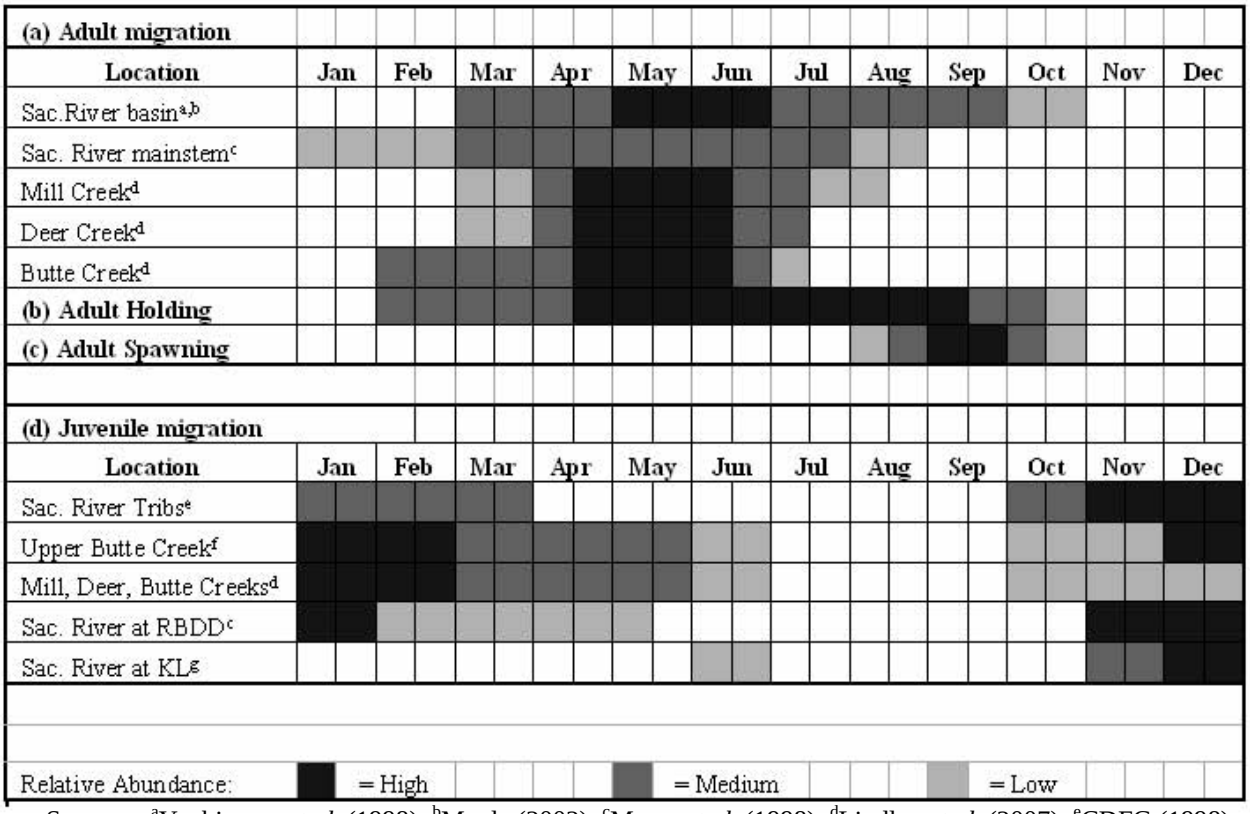
Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster, water as they grow larger. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). The emigration period for spring-run extends from November to early May, with up to 69 percent of the YOY fish outmigrating through the lower Sacramento River and Delta during this period (CDFG 1998). Spring-run juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin *et al.* 1997, Snider 2001). Peak movement of juvenile (yearling) spring-run in the Sacramento River at Knights Landing occurs in December, and again in March and April for YOY juveniles. However, juveniles also are observed between November and the end of May (Snider and Titus 2000). Based on the available information, the emigration timing of spring-run appears highly variable (CDFG 1998). Some fish may begin emigrating soon after emergence from the gravel, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (CDFG 1998).

4.2.1.3.1 Range-Wide (ESU) Status and Trends

Historically, spring-run were the second most abundant salmon run in the Central Valley (CDFG 1998). The Central Valley drainage as a whole is estimated to have supported spring-run runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the foothills of the Sierras on the American, Mokelumne, Stanislaus, Tuolumne, and Merced rivers extirpated spring-run from these watersheds. Naturally-spawning populations of spring-run currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998). However, only Deer, Mill, and Butte creeks are considered to be independent spring-run

populations. The other tributary populations are considered dependent populations, which rely on the three independent populations for continued existence at this time.

Table 4-4. The temporal occurrence of adult (a-c) and juvenile (d) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance. Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. YOY spring-run Chinook salmon emigrate during the first spring after they hatch.



Sources: [a]Yoshiyama *et al*. (1998); [b]Moyle (2002); [c]Myers *et al*. (1998); [d]Lindley *et al*. (2007); [e]CDFG (1998); [f]McReynolds *et al*. (2005); Ward *et al*. (2002, 2003); [g]Snider and Titus (2000)

On the Feather River, significant numbers of spring-run, as identified by run timing, return to the FRFH. From 1986 to 2007, the average number of spring-run returning to the FRFH was 3,992, compared to an average of 12,888 spring-run returning to the entire Sacramento River Basin (table 4-5). CWT information from these hatchery returns indicates substantial introgression has occurred between spring-run and fall-run populations within the Feather River system due to hatchery practices. Because Chinook salmon have not always been temporally separated in the hatchery, spring-run and fall-run have been spawned together, thus compromising the genetic integrity of the spring-run and early fall-run stocks. The number of naturally spawning spring-run in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run (Good *et al*. 2005). For the reasons discussed above, and the importance of genetic diversity as one of the VSP parameters, the Feather River spring-run population numbers are not included in the following discussion of ESU abundance.

The spring-run ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982 (table 4-5, figure 4-2). Sacramento River tributary populations in Mill, Deer, and Butte creeks are probably the best trend indicators for the spring-run ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of spring-run remains well below estimates of historic abundance. In 2008, adult escapement of spring-run declined in several of the region's watersheds. Butte Creek had an estimated 6,000 adults return to the watershed, while more significant decreases occurred on Mill Creek (362 fish), Deer Creek (140 fish), and Antelope Creek (2 fish). In contrast, Clear Creek had a modest increase in returning spring-run adults with an estimated 199 adults returning in 2008. These fluctuations may be attributable to poor ocean conditions that existed when the returning 2008 adults entered the ocean as smolts (spring of 2006) and led to poor ocean survival in the critical ocean entry phase of their life history. Additional factors that have limited adult spawning populations are in-river water quality conditions. In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of columnaris disease (*Flexibacter columnaris*) and ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run in Butte Creek.

Recent actions by fishery management agencies have improved habitat conditions on Clear Creek for spring-run. The Clear Creek population of spring-run appears to be increasing in abundance, albeit modestly. Significant efforts have beeen made to enhance oversummering flows in the upper reaches below Whiskeytown Dam, maintain suitable water temperatures in those reaches, enhance spawning habitat through gravel augmentation, and prevent genetic introgression with fall-run which utilize the same watershed. Concern exists over the timing of the RBDD gate closures and whether this action delays spring-run bound for Clear Creek to the extent that adults cannot access the watershed due to thermal barriers forming in the lower reaches of the creek near its confluence with the Sacramento River.

The Butte, Deer, and Mill Creek populations of spring-run are in the Northern Sierra Nevada diversity group. Lindley *et al*. (2007) indicated that spring-run populations in Butte and Deer Creeks had a low risk of extinction, according to their PVA model and the other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence). The Mill Creek population of spring-run is at moderate extinction risk according to the PVA model, but appears to satisfy the other viability criteria for low-risk status. However, the spring-run ESU fails to meet the "representation and redundancy rule," since the Northern Sierra Nevada is the only diversity group in the spring-run ESU that contains demonstrably viable populations out of at least 3 diversity groups that historically contained them. Independent populations of spring-run only occur within the Northern Sierra Nevada diversity group. The Northwestern California diversity group contains a few ephemeral populations of spring-run that are likely dependent on the Northern Sierra Nevada populations for their

continued existence. The spring-run populations that historically occurred in the Basalt and Porous Lava, and Southern Sierra Nevada, diversity groups have been extirpated. Over the long term, the three remaining independent populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run populations in the Deer, Mill, and Butte Creek watersheds due to their close proximity to each other. One large event could eliminate all three populations.

Table 4-5. Central Valley spring-run Chinook salmon population estimates with corresponding cohort replacement rates (CRR) for years since 1986 (CDFG 2008).

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average of Tributary Population Estimate	Trib CRR[b, c]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	25,696	1,433	24,263						
1987	13,888	1,213	12,675						
1988	18,933	6,833	12,100						
1989	12,163	5,078	7,085		0.29			0.47	
1990	7,683	1,893	5,790	12,383	0.46		15,673	0.55	
1991	5,927	4,303	1,624	7,855	0.13		11,719	0.31	
1992	3,044	1,497	1,547	5,629	0.22		9,550	0.25	
1993	6,075	4,672	1,403	3,490	0.24	0.27	6,978	0.79	0.48
1994	6,187	3,641	2,546	2,582	1.57	0.52	5,783	1.04	0.59
1995	15,238	5,414	9,824	3,389	6.35	1.70	7,294	5.01	1.48
1996	9,082	6,381	2,701	3,604	1.93	2.06	7,925	1.49	1.72
1997	5,086	3,653	1,433	3,581	0.56	2.13	8,334	0.82	1.83
1998	31,471	6,746	24,725	8,246	2.52	2.58	13,413	2.07	2.09
1999	9,835	3,731	6,104	8,957	2.26	2.72	14,142	1.08	2.09
2000	9,234	3,657	5,577	8,108	3.89	2.23	12,942	1.82	1.46
2001	17,698	4,135	13,563	10,280	0.55	1.96	14,665	0.56	1.27
2002	17,409	4,189	13,220	12,638	2.17	2.28	17,129	1.77	1.46
2003	17,570	8,662	8,908	9,474	1.60	2.09	14,349	1.90	1.43
2004	13,986	4,212	9,774	10,208	0.72	1.78	15,179	0.79	1.37
2005	16,117	1,771	14,346	11,962	1.09	1.22	16,556	0.93	1.19
2006	10,652	1,952	8,700	10,990	0.98	1.31	15,147	0.61	1.20
2007	10,571	2,752	7,819	9,909	0.80	1.04	13,779	0.76	1.00
Median	10,652	3,731	7,819	8,246	0.98	1.96	13,413	0.82	1.43

[a] NMFS included both the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River and its tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.

[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

[c] The majority of spring-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning population 3 years prior.

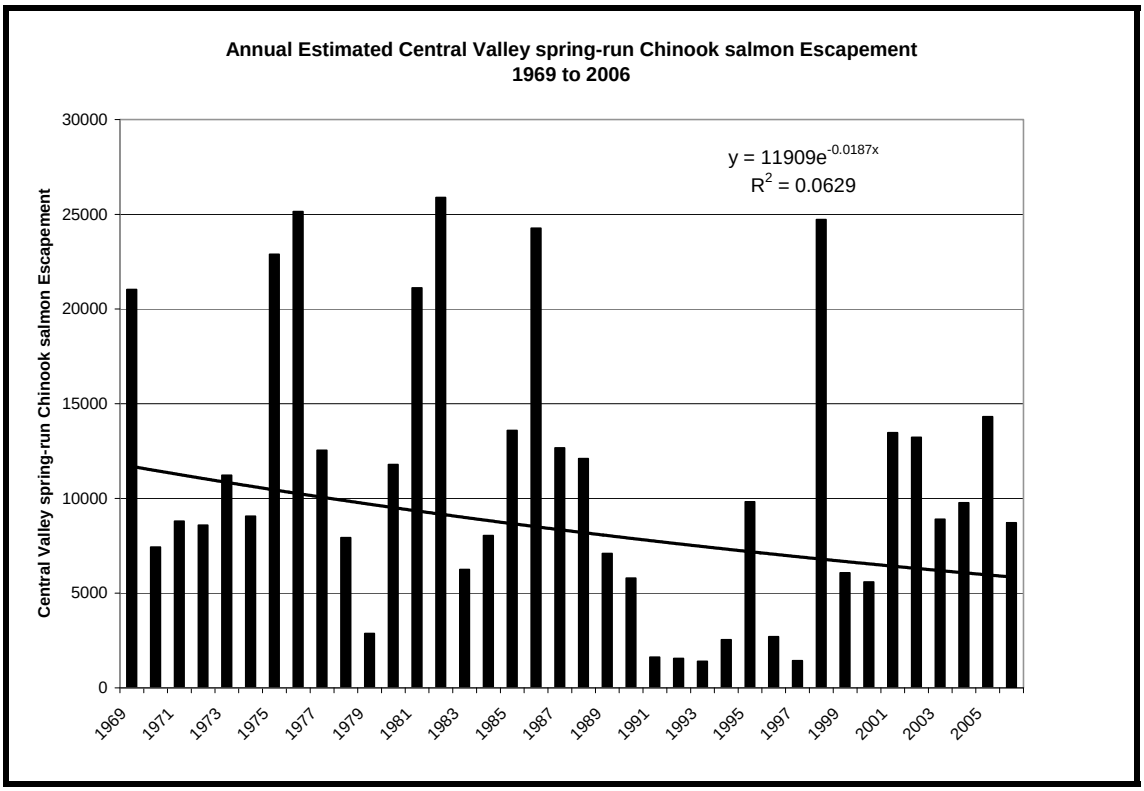


Figure 4-2. Annual estimated Central Valley spring-run Chinook salmon escapement population for the Sacramento River watershed for years 1969 through 2006 (PFMC 2002, 2004, CDFG 2004b, Yoshiyama 1998, GrandTab 2006).

4.2.1.3.2 Current Viability of the Central Valley Spring-Run Chinook Salmon ESU

The earlier analysis to determine the likelihood of winter-run becoming viable described the process that NMFS uses to apply the VSP concept in McElhany *et al*. (2000). In order to determine the current likelihood of the spring-run ESU becoming viable, we used the historical population structure of spring-run presented in Lindley *et al*. (2007, figure 4-3) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al*. (2007) applied the concept to the spring-run ESU. Lindley *et al*. (2004) identified 26 historical populations within the spring-run ESU; 19 were independent populations, and 7 were dependent populations. Of the 19 independent populations of spring-run that occurred historically, only three remain, in Deer, Mill, and Butte creeks. Extant dependent populations occur in Battle, Antelope, Big Chico, Clear, Beegum, and Thomes creeks, as well as in the Yuba River, the Feather River below Oroville Dam, and in the mainstem Sacramento River below Keswick Dam.

Table 4-3 provides various quantitative criteria to evaluate the risk of extinction. The following provides the evaluation of the likelihood of the threatened spring-run ESU becoming viable based on the VSP parameters of population size, population growth rate, spatial structure, and diversity.

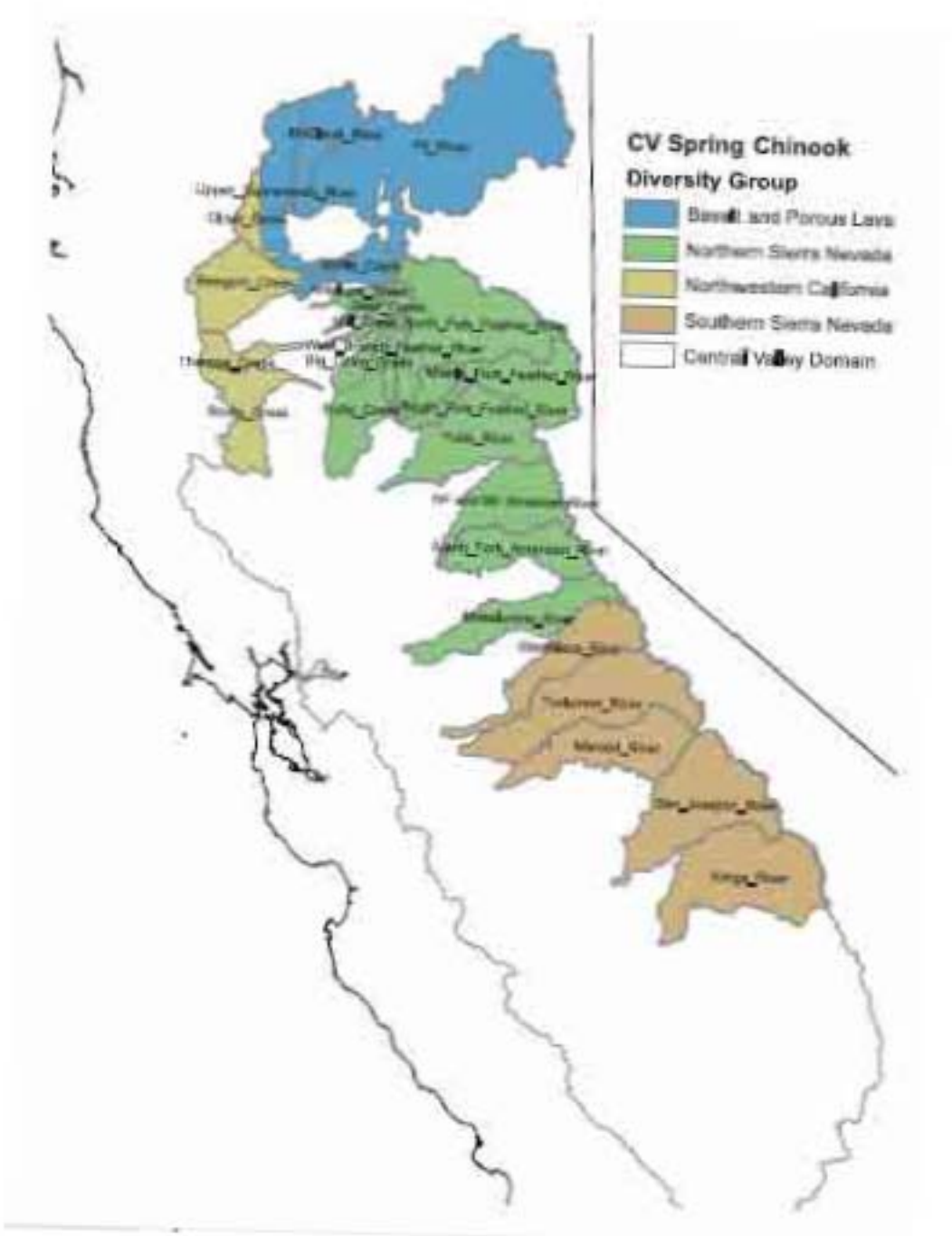


Figure 4-3. CV spring-run Chinook salmon diversity groups (replicated from Lindley *et al.* 2007).

4.2.1.3.2.1 Population Size

As provided in table 4-5, spring-run declined drastically in the mid to late 1980s before stabilizing at very low levels in the early to mid 1990s. Since the late 1990s, there does not appear to be a trend in basin-wide abundance, having fluctuated from approximately 25,000 fish in 1999 to slightly more than 10,000 fish in 2008. Abundance is generally dominated by the Butte Creek population. Other independent and dependent populations are smaller. The cohort

replacement rate behaved similarly, falling below 1.0 in the 3 of the previous 4 years, in parallel with the reduced escapement numbers. The 5-year moving average cohort replacement rate, however, has remained above 1.0 since 1995.

4.2.1.3.2.2 Population Growth Rate

Cohort replacement rates are indications of whether a cohort is replacing itself in the next generation. As mentioned in the previous subsection, the cohort replacement rate since the late 1990s has fluctuated, and does not appear to have a pattern. Since the cohort replacement rate is a reflection of population growth rate, there does not appear to be an increasing or decreasing trend. The 5-year moving average of population estimate indicated an increasing population trend since the mid 1990s until very recently (2006), at which point the population has decreased in two consecutive years.

4.2.1.3.2.3 Spatial Structure

Lindley *et al*. (2007) indicated that of the 19 independent populations of spring-run that occurred historically, only three (Butte, Mill, and Deer creeks) remain, and their current distribution makes the spring-run ESU vulnerable to catastrophic disturbance. Butte, Mill, and Deer Creeks all occur in the same biogeographic region (diversity group), whereas historically, independent spring-run populations were distributed throughout the CV among at least three diversity groups (*i.e*., basalt and porous lava, northern Sierra Nevada, and southern Sierra Nevada). In addition, dependent spring-run populations historically persisted in the Northwestern California diversity group (Lindley *et al*. 2004). Currently, there are dependent populations of spring-run in the Big Chico, Antelope, Clear, Thomes, Battle, and Beegum creeks, and in the Sacramento, Feather, and Yuba rivers. As mentioned earlier, the extant Feather River and mainstem Sacramento River populations probably do not represent historical entities (Lindley *et al*. 2007).

4.2.1.3.2.4 Diversity

Diversity, both genetic and behavioral, provides a species the opportunity to track environmental changes. As a species' abundance decreases, and spatial structure of the ESU is reduced, a species has less flexibility to track changes in the environment. Spring-run have been entirely extirpated from the basalt and porous lava region and the southern Sierra Nevada region. The only viable and independent populations (*i.e*., Mill, Deer, and Butte creeks) of spring-run are limited to the northern Sierra Nevada region, and a few ephemeral or dependent populations are found in the Northwestern California region. A single catastrophe, for example, the eruption of Mount Lassen, a large wildland fire at the headwaters of Mill, Deer, and Butte creeks, or a drought, poses a significant threat to the extinction risk of the ESU that otherwise would not be there if the ESU's spatial structure and diversity were greater. As with winter-run, spring-run do reserve some genetic and behavioral variation in that in any given year, at least two cohorts are in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

Although spring-run produced at the FRFH are part of the spring-run ESU (June 28, 2005, 70 FR 37160), they compromise the genetic diversity of naturally-spawned spring-run. More than

523,000 FRFH spring-run fry were planted at the base of Whiskeytown Dam during the 3-year period 1991−1993 (CDFG 1998 *op. cit*. CVP/SWP operations BA). The fact that these hatchery fish behave more like fall-run (spawn later than spring-run in Deer, Mill, and Butte creeks), likely increases introgression of the spring- and fall- runs, and reduces diversity.

4.2.1.3.2.5 Summary of the Current Viability of the Central Valley Spring-Run Chinook Salmon ESU

Butte Creek and Deer Creek spring-run are at low risk of extinction, satisfying both the population viability analysis (PVA) and other viability criteria. Mill Creek is at moderate extinction risk according to the PVA, but appear to satisfy the other viability criteria for low-risk status (Lindley *et al*. 2007). Spring-run fail the representation and redundancy rule for ESU viability, as the current distribution of independent populations has been severely constricted to only one of their former geographic diversity groups. Therefore, the spring-run ESU are at moderate risk of extinction in 100 years.

4.2.1.3.3 Status of Central Valley Spring-Run Chinook Salmon Critical Habitat

4.2.1.3.3.1 Summary of Designated Critical Habitat

Critical habitat was designated for spring-run on September 2, 2005 (70 FR 52488), and includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series; Bain and Stevenson 1999; September 2, 2005, 70 FR 52488).

In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In addition to these factors, NMFS also focuses on the known physical and biological features (essential features) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Critical habitat for spring-run is defined as specific areas that contain the PCEs and physical habitat elements essential to the conservation of the species. Within the range of the spring-run ESU, biological features of the designated critical habitat that are considered vital for spring-run include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors,

estuarine areas, and nearshore marine areas. The following describe the current conditions of the freshwater PCEs for spring-run.

4.2.1.3.3.2 Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Spring-run spawn in the mainstem Sacramento River between RBDD and Keswick Dam (however, little spawning activity has been recorded in recent years) and in tributaries such as Mill, Deer, and Butte creeks. Operations of Shasta and Keswick Dams on the mainstem Sacramento River that are focused primarily to ensure an adequate quantity and quality of water for successful adult winter-run migration, holding, spawning, and incubation may at the same time be limiting the amount of cold water needed to ensure successful incubation of any spring-run eggs spawned on the mainstem Sacramento River.

4.2.1.3.3.3 Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system are much degraded, and typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. However, some complex, productive habitats with floodplains remain in the system [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses). Juvenile life stages of salmonids are dependant on the function of this habitat for successful survival and recruitment.

4.2.1.3.3.4 Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower reaches of the spawning tributaries, the mainstem of the Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or

behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. The RBDD creates an upstream migratory barrier during its May 15 through September 15 "gates in" configuration. Approximately 10 percent of the spring-run spawn upstream of RBDD. Of those, approximately 72 percent of them attempt to migrate past RBDD during the gates in period [Tehama-Colusa Canal Authority (TCCA) and Reclamation 2002]. Less than 1 percent of spring-run juveniles are potentially impacted by passing under the dam during their downstream migration (TCCA and Reclamation 2002). Juvenile spring-run that try to migrate past RBDD in its gates down position are subjected to disorientation. In addition, although predators of juvenile spring-run are prominent throughout the Sacramento River and Delta, they concentrate around structures, and therefore, a higher concentration of striped bass, and especially Sacramento pikeminnow, reside downstream of RBDD and prey on outmigrating juvenile salmonids.

Significant amounts of flow and many juvenile spring-run enter the DCC (when the gates are open) and Georgiana Slough, especially during increased Delta pumping. Mortality of juvenile salmon entering the central Delta is higher than for those continuing downstream in the Sacramento River. This difference in mortality could be caused by a combination of factors: the longer migration route through the central Delta to the western Delta, exposure to higher water temperatures, higher predation rates, exposure to seasonal agricultural diversions, water quality impairments due to agricultural and municipal discharges, and a more complex channel configuration making it more difficult for salmon to successfully migrate to the western Delta and the ocean. In addition, the State and Federal pumps and associated fish facilities increase mortality of juvenile spring-run through various means, including entrainment into the State and Federal canals, handling, trucking, and release.

The current condition of freshwater migration corridors in the Sacramento River is much degraded.

4.2.1.3.3.5 Estuarine Areas

Ideal estuarine areas are free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels, are necessary for juvenile and adult foraging. Current estuarine areas are degraded as a result of the operations of the CVP and SWP. Spring-run smolts are drawn to the central and south Delta as they outmigrate, and are subjected to the indirect (*e.g.*, predation, contaminants) and direct (*e.g.*, salvage, loss) effects of the Delta and both the Federal and State fish facilities.

The current condition of the estuarine habitat in the project area has been substantially degraded from historic conditions. Over 90 percent of the fringing fresh, brackish, and salt marshes have been lost to human actions. This loss of the fringing marshes reduces the availability of forage species and eliminates the cycling of nutrients from the marsh vegetation into the water column of the adjoining waterways. The channels of the Delta have been modified by the raising of levees and armoring of the levee banks with stone riprap. This reduces habitat complexity by

reducing the incorporation of woody debris and vegetative material into the nearshore area, minimizing and reducing local variations in water depth and velocities, and simplifying the community structure of the nearshore environment. Delta hydraulics has been modified as a result of CVP and SWP actions. Within the central and southern Delta, net water movement is towards the pumping facilities, altering the migratory cues for emigrating fish in these regions. Operations of upstream reservoir releases and diversion of water from the southern Delta have been manipulated to maintain a "static" salinity profile in the western Delta near Chipps Island (the X2 location). This area of salinity transition, the low salinity zone (LSZ), is an area of high productivity. Historically, this zone fluctuated in its location in relation to the outflow of water from the Delta and moved westwards with high Delta inflow (*i.e.*, floods and spring runoff) and eastwards with reduced summer and fall flows. This variability in the salinity transition zone has been substantially reduced by the operations of the projects. The project's long-term water diversions also have contributed to reductions in the phytoplankton and zooplankton populations in the Delta itself as well as alterations in nutrient cycling within the Delta ecosystem. Heavy urbanization and industrial actions have lowered water quality and introduced persistent contaminants to the sediments surrounding points of discharge (*i.e.*, refineries in Suisun and San Pablo bays, creosote factories in Stockton, *etc*.)

4.2.1.3.3.6 Central Valley Spring-Run Chinook Salmon Critical Habitat Summary

The current condition of spring-run critical habitat is degraded, and does not provide the conservation value necessary for the recovery of the species. Spring-run critical habitat has suffered similar types of degradation as winter-run critical habitat.

4.2.2 Steelhead

4.2.2.1 General Life History

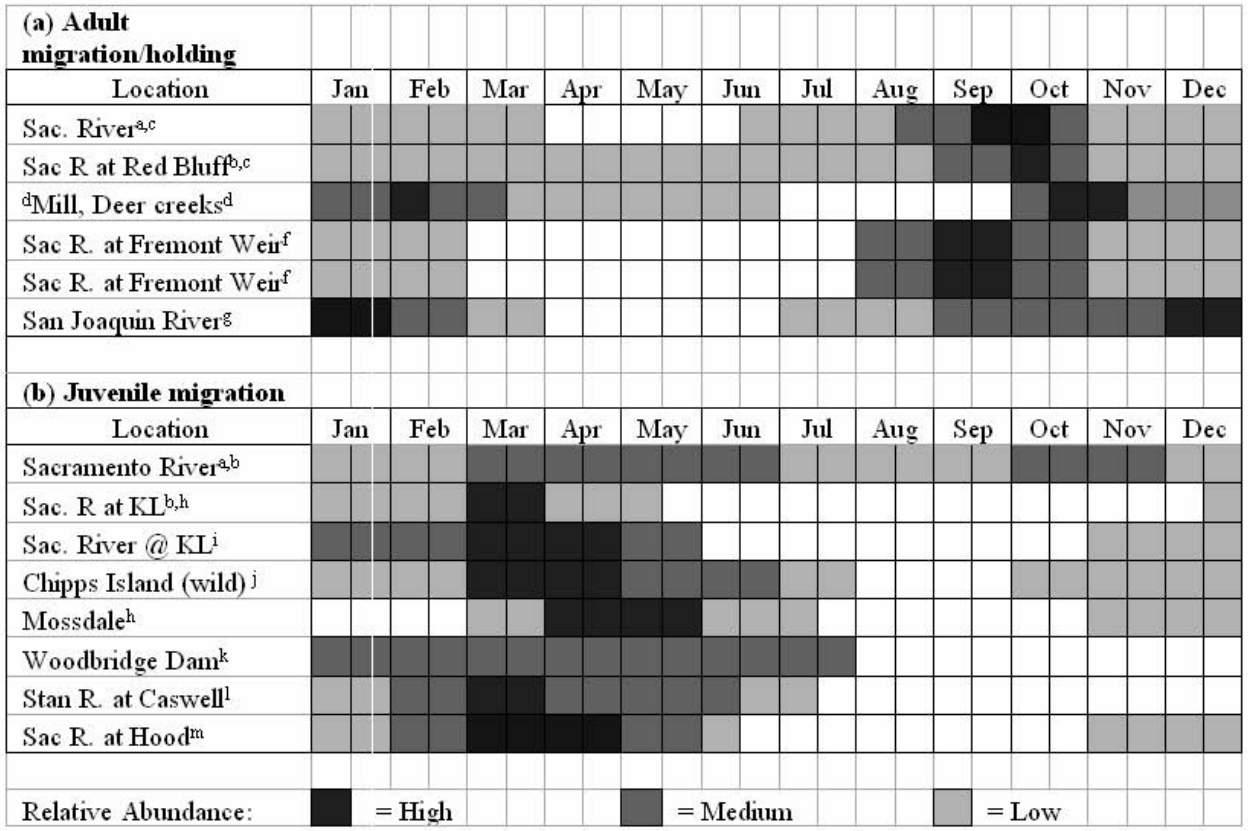
Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

4.2.2.2 Central Valley Steelhead

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January though March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 4-6; Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches at river mouths, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more

than once before death (Barnhart 1986, Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Table 4-6. The temporal occurrence of (a) adult and (b) juvenile Central Valley steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.



Sources: [a]Hallock *et al.* (1961); [b]McEwan (2001); [c]USFWS (unpublished data); [d]CDFG (1995); [e]Hallock *et al.* (1957); [f]Bailey (1954); [g]CDFG Steelhead Report Card Data; [h]CDFG (unpublished data); [i]Snider and Titus (2000); [j]Nobriga and Cadrett (2003); [k]Jones & Stokes Associates, Inc. (2002); [l]S.P. Cramer and Associates, Inc. (2000, 2001); [m]Schaffter (1980, 1997)

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can affect emergence timing (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although YOY also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an

important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating CV steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile CV steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) also have verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

4.2.2.2.1 Range-Wide (DPS) Status and Trends

Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially (figure 4-4). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of approximately 8,000 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. Good *et al.* (2005) made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s."

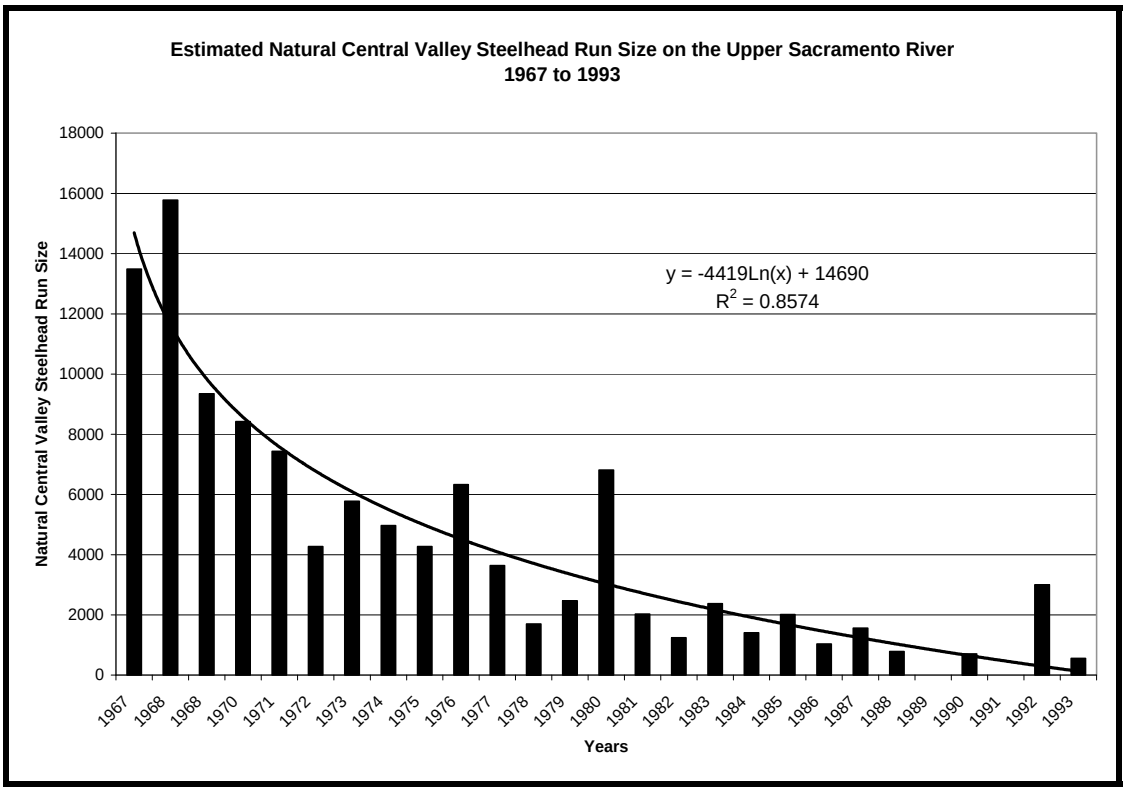


Figure 4-4. Estimated natural Central Valley steelhead escapement in the upper Sacramento River based on RBDD counts. Note: Steelhead escapement surveys at RBDD ended in 1993 (from McEwan and Jackson 1996).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Snorkel surveys from 1999 to 2002 indicate that steelhead are present in Clear Creek (Newton 2002 *op. cit*. Good *et al*. 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Recent monitoring has detected small, self-sustaining populations (*i.e*., non-hatchery origin) of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001). Zimmerman *et al.* (2008) documented CV steelhead in the Stanislaus, Tuolumne and Merced rivers based on otilith microchemistry.

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of juvenile steelhead also have occurred on the Tuolumne and Merced Rivers during fall-run monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al*. 2005). CDFG staff have prepared catch summaries for juvenile migrant CV steelhead on the San Joaquin River near Mossdale, which represents migrants from the Stanislaus, Tuolumne, and Merced rivers. Based

on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River" (figure 4-5). The documented returns on the order of single fish in these tributaries suggest that existing populations of CV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed.

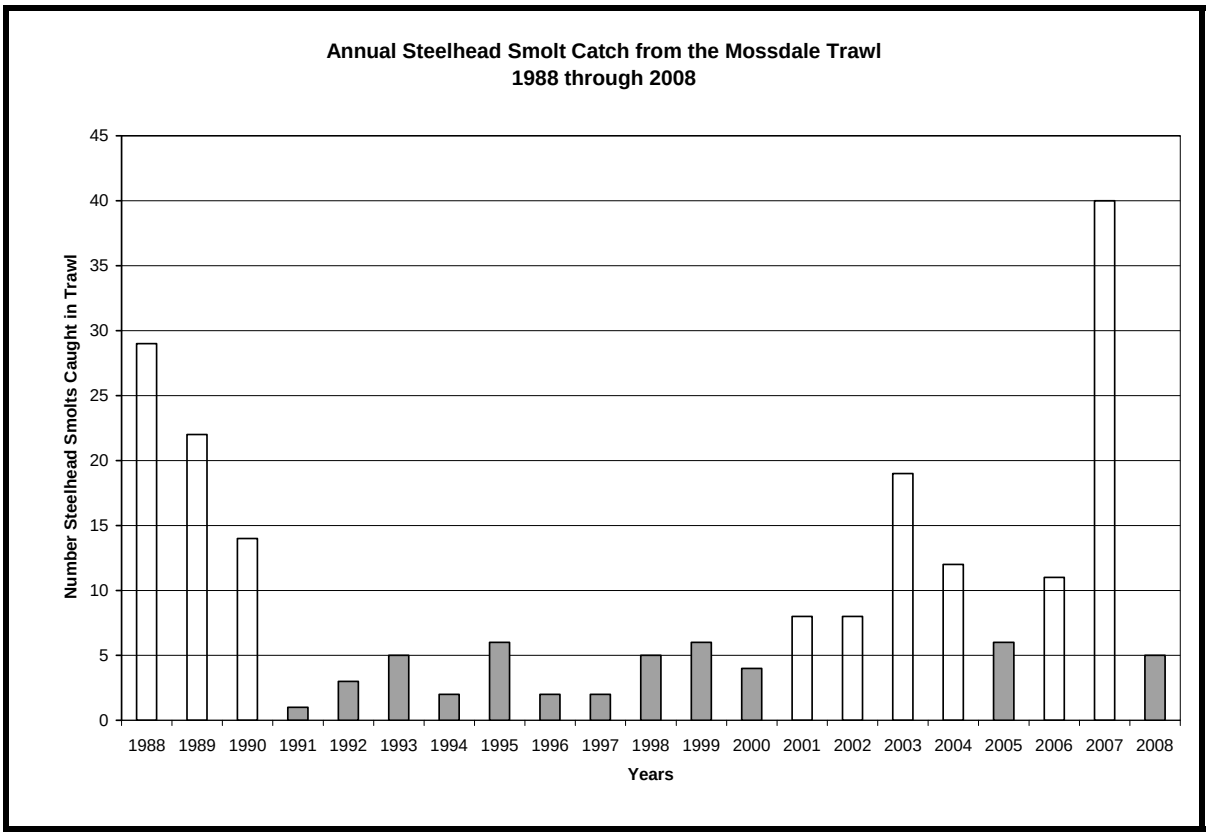


Figure 4-5. Annual number of Central Valley steelhead smolts caught while Kodiak trawling at the Mossdale monitoring location on the San Joaquin River (Marston 2004, SJRGA 2007, Speegle 2008).

4.2.2.2.2 Current Viability of the Central Valley Steelhead DPS

The earlier analysis to determine the likelihood of winter-run becoming viable described the process that NMFS uses to apply the VSP concept in McElhany *et al*. (2000). In order to determine the current likelihood of the CV steelhead DPS becoming viable, we used the historical population structure of CV steelhead presented in Lindley *et al*. (2006, 2007; figure 4-6) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al*. (2007) applied the concept to the CV steelhead DPS.

Table 4-3 provides various quantitative criteria to evaluate the risk of extinction. The following provides the evaluation of the likelihood of the threatened CV steelhead DPS becoming viable based on the VSP parameters of population size, population growth rate, spatial structure, and diversity.

4.2.2.2.2.1 Population Size

As provided above and in figure 4-4, estimated natural CV steelhead escapement in the upper Sacramento River has declined substantially from 1967 through 1993. There is still a nearly complete lack of steelhead monitoring in the Central Valley (Good *et al*. 2005), and therefore, data are lacking regarding a definitive population size for CV steelhead. However, the little data that exist indicate that the CV steelhead population continues to decline (Good *et al*. 2005).

4.2.2.2.2.2 Population Growth Rate

CV steelhead has shown a pattern of a negative growth rate since the late 1960s (figure 4-4). Good *et al*. (2005) provided no indication that this trend has changed since the last CV steelhead population census in 1993.

4.2.2.2.2.3 Spatial Structure

Lindley *et al*. (2006) identified 81 historical and independent populations within the CV steelhead DPS. These populations form 8 clusters, or diversity groups, based on the similarity of the habitats they occupied for spawning and rearing. About 80 percent of the habitat that was historically available to CV steelhead is now behind impassable dams, and 38 percent of the populations have lost all of their habitats. Although much of the habitat has been blocked by impassable dams, or degraded, small populations of CV steelhead are still found throughout habitat available in the Sacramento River and many of the tributaries, and some of the tributaries to the San Joaquin River.

4.2.2.2.2.4 Diversity

Diversity, both genetic and behavioral, provides a species the opportunity to track environmental changes. CV steelhead naturally experience the most diverse life history strategies of the listed Central Valley anadromous salmonid species. In addition to being iteroparous, they reside in freshwater for 2-4 years before emigrating to the ocean. However, as the species' abundance decreases, and spatial structure of the DPS is reduced, it has less flexibility to track changes in the environment. CV steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to CV steelhead (Lindley *et al*. 2006). The genetic diversity of CV steelhead is also compromised by hatchery-origin fish, which likely comprise the majority of the natural spawning run, placing the natural populations at high risk of extinction (Lindley *et al*. 2007). Consistent with the life history strategy of winter-run and spring-run, some genetic and behavioral variation is conserved in that in any given year, there are additional cohorts in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

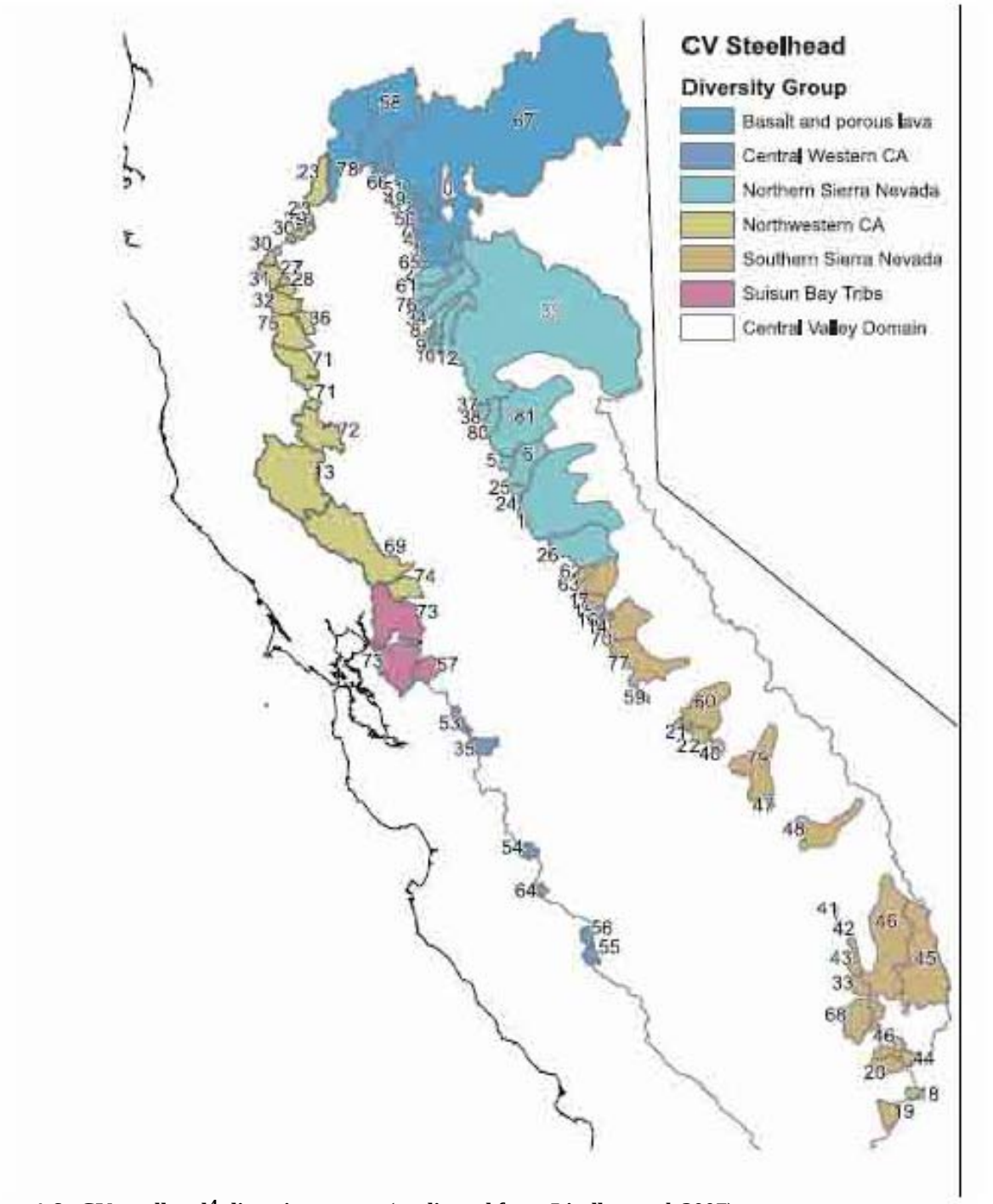


Figure 4-6. CV steelhead[4] diversity groups (replicated from Lindley *et al.* 2007).

[4] Note that the Suisun Bay Tribs identified in the figure (in pink) belong in the CCC steelhead DPS (see section 4.1.1).

4.2.2.2.2.5 Summary of the Current Viability of the CV Steelhead DPS

Lindley *et al*. (2007) indicated that prior population census estimates completed in the 1990s found the CV steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing as evidenced by new information (Chipps Island trawl data). CV steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of CV steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the DPS is at moderate to high risk of extinction.

4.2.2.2.3 Status of CV Steelhead Critical Habitat

4.2.2.2.3.1 Summary of Designated Critical Habitat

Critical habitat was designated for CV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the lower San Joaquin River to the confluence with the Merced River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series; Bain and Stevenson 1999; September 2, 2005, 70 FR 52488). Critical habitat for CV steelhead is defined as specific areas that contain the PCE and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV steelhead.

4.2.2.2.3.2 Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams (*i.e*., above RBDD, but below Keswick Dam, on the Sacramento River) on perennial watersheds throughout the Central Valley. These reaches can be subjected to variations in flows and temperatures, particularly over the summer months, which can have negative effects upon salmonids spawning below them.

4.2.2.2.3.3 Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and

overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Juvenile life stages of salmonids are dependant on the function of this habitat for successful survival and recruitment. Steelhead are more susceptible to the negative effects of degraded rearing habitat, as they rear in freshwater longer than winter-run and spring-run.

4.2.2.2.3.4 Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Currently, RBDD gates are down from May 15 through September 15, and impede the upstream and downstream migration of a portion of each adult and juvenile cohort. Juvenile CV steelhead that try to migrate past RBDD when its gates are down are subjected to disorientation. In addition, although predators of juvenile CV steelhead are prominent throughout the Sacramento River and Delta, they concentrate around structures, and therefore, a higher concentration of striped bass, and especially Sacramento pikeminnow, reside downstream of RBDD and prey on outmigrating juvenile salmonids.

Juvenile CV steelhead that outmigrate from the San Joaquin River tributaries are exposed to degraded migration corridors, just as they are exposed to degraded water quality in the lower San Joaquin River basin and the Stockton DWSC. Significant amounts of flow and many juvenile CV steelhead from the Sacramento River enter the DCC (when the gates are open) and Georgiana Slough into the central Delta. Likewise, some juvenile CV steelhead from the San Joaquin River are diverted into the southern Delta through Old River and Turner and Columbia Cuts. Mortality of juvenile CV steelhead entering the central Delta is higher than for those continuing downstream in the Sacramento and San Joaquin rivers. This difference in mortality could be caused by a combination of factors: the longer migration route through the central Delta to the western Delta, exposure to higher water temperatures, higher predation rates,

exposure to seasonal agricultural diversions, water quality impairments due to agricultural and municipal discharges, and a more complex channel configuration making it more difficult for CV steelhead to successfully migrate to the western Delta and the ocean. In addition, the State and Federal pumps and associated fish facilities increase mortality of juvenile CV steelhead through various means, including entrainment into the State and Federal facilities, handling, trucking, and release. The current condition of freshwater migration corridors in the Sacramento River, San Joaquin River, and Delta are very degraded.

4.2.2.2.3.5 Estuarine Areas

Ideal estuarine areas are free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Current estuarine areas are degraded as a result of the operations of the CVP and SWP. CV steelhead smolts are drawn to the central and south Delta as they outmigrate, and are subjected to the indirect (*e.g.*, predation, contaminants) and direct (*e.g.*, salvage, loss) effects of the Delta and both the Federal and State fish facilities.

The location of X2 has also been modified from natural conditions. Historically, the Delta provided the transitional habitat for CV steelhead to undergo the physiological change to salt water. However, as X2 was modified to control Delta water quality, and competing species' needs (*i.e.*, Delta smelt), the Delta served more as a migratory corridor for outmigrating anadromous salmonids. The current condition of the estuarine area has been described in section 4.2.1.3.3.5 for spring-run critical habitat.

4.2.2.2.3.6 Central Valley Steelhead Critical Habitat Summary

The current condition of CV steelhead critical habitat is degraded, and does not provide the conservation value necessary for the recovery of the species. CV steelhead critical habitat has suffered similar types of degradation as winter-run critical habitat. In addition, the Sacramento-San Joaquin River Delta, as part of CV steelhead designated critical habitat, provides very little function necessary for juvenile CV steelhead rearing and physiological transition to salt water.

4.2.3 Southern DPS of North American Green Sturgeon

4.2.3.1 General Life History

In North America, spawning populations of green sturgeon are currently found in only three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (Erickson and Hightower 2007). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Particularly large concentrations of green sturgeon from both

the northern and southern populations occur in the Columbia River estuary, Willapa Bay, Grays Harbor and Winchester Bay, with smaller aggregations in Humboldt Bay, Tillamook Bay, Nehalem Bay, and San Francisco and San Pablo bays (Emmett *et al* 1991, Moyle *et al.* 1992, and Beamesderfer *et al.* 2007). Lindley *et al.* (2008) reported that green sturgeon make seasonal migratory movements along the west coast of North America, overwintering north of Vancouver Island and south of Cape Spencer, Alaska. Individual fish from the Southern DPS of green sturgeon have been detected in these seasonal aggregations. Information regarding the migration and habitat use of the Southern DPS of green sturgeon has recently emerged. Lindley (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. This work was further expanded by recent tagging studies of green sturgeon conducted by Erickson and Hightower (2007) and Lindley *et al.* (2008). To date, the data indicate that North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River estuary. This information also agrees with the results of previous green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Bay estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of the Oregon and Washington coasts. Eight of the 12 commercial fisheries recoveries were in the Columbia River estuary (CDFG 2002).

The Southern DPS of green sturgeon includes all green sturgeon populations south of the Eel River, with the only known spawning population being in the Sacramento River. Green sturgeon life history can be broken down into four main stages: eggs and larvae, juveniles, sub-adults, and sexually mature adults. Sexually mature adults are those fish that have fully developed gonads and are capable of spawning. Female green sturgeon are typically 13 to 27 years old when sexually mature and have a total body length (TL) ranging between 145 and 205 cm at sexual maturity (Nakamoto *et al*. 1995, Van Eenennaam *et al.* 2006). Male green sturgeon become sexually mature at a younger age and smaller size than females. Typically, male green sturgeon reach sexual maturity between 8 and 18 years of age and have a TL ranging between 120 cm to 185 cm (Nakamoto *et al.* 1995, Van Eenennaam *et al.* 2006). The variation in the size and age of fish upon reaching sexual maturity is a reflection of their growth and nutritional history, genetics, and the environmental conditions they were exposed to during their early growth years. Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid shrimp, grass shrimp, and amphipods (Radtke 1966). Adult sturgeon caught in Washington state waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992). It is unknown what forage species are consumed by adults in the Sacramento River upstream of the Delta.

Adult green sturgeon are gonochoristic (sex genetically fixed), oviparous and iteroparous. They are believed to spawn every 2 to 5 years (Beamesderfer *et al.* 2007). Upon maturation of their gonadal tissue, but prior to ovulation or spermiation, the adult fish enter freshwater and migrate upriver to their spawning grounds. The remainder of the adult's life is generally spent in the ocean or near-shore environment (bays and estuaries) without venturing upriver into freshwater. Younger females may not spawn the first time they undergo oogenesis and subsequently they reabsorb their gametes without spawning. Adult female green sturgeon produce between 60,000

and 140,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al*. 2001). They have the largest egg size of any sturgeon, and the volume of yolk ensures an ample supply of energy for the developing embryo. The outside of the eggs are adhesive, and are more dense than than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009). Adults begin their upstream spawning migrations into freshwater in late February with spawning occuring between March and July (CDFG 2002. Heublin 2006, Heublin *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates with crevices and interstices. Females broadcast spawn their eggs over this substrate, while the male releases its milt (sperm) into the water column. Fertilization occurs externally in the water column and the fertilized eggs sink into the interstices of the substrate where they develop further (Kynard *et al.* 2005, Heublin *et al.* 2009).

Known historic and current spawning occurs in the Sacramento River (Adams *et al.* 2002, Beamesderfer *et al.* 2004, Adams *et al*. 2007). Currently, Keswick and Shasta dams on the mainstem of the Sacramento River block passage to the upper river. Although no historical accounts exist for identified green sturgeon spawning occuring above the current dam sites, suitable spawning habitat existed and based on habitat assessments done for Chinook salmon, the geographic extent of spawning has been reduced due to the impassable barriers constructed on the river.

Spawning on the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. This continued presence of adults below the dam suggests that fish are trying to migrate to upstream spawning areas now blocked by the dam, which was constructed in 1968.

Spawning in the San Joaquin River system has not been recorded historically or observed recently, but alterations of the San Joaquin River and its tributaries (Stanislaus, Tuolumne, and Merced rivers) occurred early in the European settlement of the region. During the latter half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for approximately a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. Additional impacts to the watershed include the increased loads of selenium entering the system through agricultural practices in the western side of the San Joaquin Valley. Green sturgeon have recently been identified by University of California at Davis (U.C. Davis) researchers as being highly sensitive to selenium levels. Currently, only white sturgeon have been encountered in the San Joaquin River system upstream of the Delta, and adults have been captured by sport anglers as far upstream on the San Joaquin River as Hills Ferry and Mud Slough (2007 sturgeon report card - CDFG 2008). These locations are near the confluence of the Merced River with the mainstem San Joaquin River.

Kelly *et al.* (2007) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn (table 4-7). The authors studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with

distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelly *et al*. (2007) surmised that they are related to resource availability and foraging behavior. Recent acoustical tagging studies on the Rogue River (Erickson *et al*. 2002) have shown that adult green sturgeon will hold for as much as 6 months in deep (> 5m), low gradient reaches or off channel sloughs or coves of the river during summer months when water temperatures were between 15°C and 23°C. When ambient temperatures in the river dropped in autumn and early winter (<10°C) and flows increased, fish moved downstream and into the ocean. Erickson *et al.* (2002) surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Benson *et al.* (2007) found similar behavior on the Klamath and Trinity River systems with adult sturgeon acoustically tagged during their spawning migrations. Most fish held over the summer in discrete locations characterized by deep, low velocity pools until late fall or early winter when river flows increased with the first storms of the rainy season. Fish then moved rapidly downstream and out of the system. Recent data gathered from acoustically tagged adult green sturgeon revealed comparable behavior by adult fish on the Sacramento River based on the positioning of adult green sturgeon in holding pools on the Sacramento River above the GCID diversion (RM 205). Recent acoustic tag data indicate that adult green sturgeon migrate upstream as far as the mouth of Cow Creek, near Bend Bridge, in May. Adults prefer deep holes at the mouths of tributary streams, where they spawn and rest on the bottom. After spawning, the adults hold over in the upper Sacramento River between RBDD and GCID until November (Klimley 2007). Heublin (2006, 2009) and Vogel (2008) have documented the presence of adults in the Sacramento River during the spring and through the fall into the early winter months. These fish hold in upstream locations prior to their emigration from the system later in the year. Like the Rogue and Klamath river systems, downstream migration appears to be triggered by increased flows, decreasing water temperatures, and occurs rapidly once initiated. Some adults rapidly leave the system following their suspected spawning activity and re-enter the ocean in early summer (Heublin 2006). This behavior has also been observed on the other spawning rivers (Benson *et al. 2007)* but may have been an artifact of the stress of the tagging procedure in that study.

During the spring and summer, the main processes influencing green sturgeon are in the freshwater environment (figure 4-7). Spawning requires sufficient instream flows for passage of reproductive adults and effective fertilization. Temperature, DO, and suitable in-river habitats influence larval survival. Ecological processes and stressors begin to influence green sturgeon immediately during their first summer (figure 4-7). These stressors are cumulative to the effects of temperature, salinity, and flow during green sturgeon's first fall and winter. Currently spawning appears to occur primarily above RBDD, based on the recovery of eggs and larvae at the dam in monitoring studies (Gaines and Martin 2002, Brown 2007). Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15°C (Van Eenennaam *et al.* 2001, Deng *et al.* 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Van Eenennaam *et al.* (2005) indicated that an optimum range of water temperature for egg development ranged between 14°C and 17°C. Temperatures over 23°C resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5^{o}C and 22 ^{o}C resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14°C, hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so.

Table 4-7. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant Southern DPS of green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c.i]												
SF Bay Estuary[d,h,i]												

(b) Larval and juvenile (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]												
GCID, Sac River[e]												

(c) Older Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta*[f]												
Sac-SJ Delta[f]												
Sac-SJ Delta[e]												
Suisun Bay[e]												

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]												

Relative Abundance: = High = Medium = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al*. (1992); [c]Adams *et al*. (2002) and NMFS (2005); [d]Kelly *et al*. (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al*. (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Card (2007)

Survival of eggs and larvae requires specific water quality parameters like temperature, DO, and turbidity. These parameters likely constrain the current area available as larval nursery and juvenile foraging areas. Increased water quantity has a positive influence on spawning, and since flow in spawning segments of the Sacramento River is controlled by Shasta Dam, the predictability of flows is high, and project operations can directly influence the successful production of larvae and juveniles. Large flow rates of greater than 14,000 cfs between February 1 and May 31 are similar to what are necessary for producing strong year classes of white sturgeon at spawning sites in the Sacramento River, but not in the Feather or Yuba rivers (Neuman *et al*. 2007).

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. These yolksac larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation.

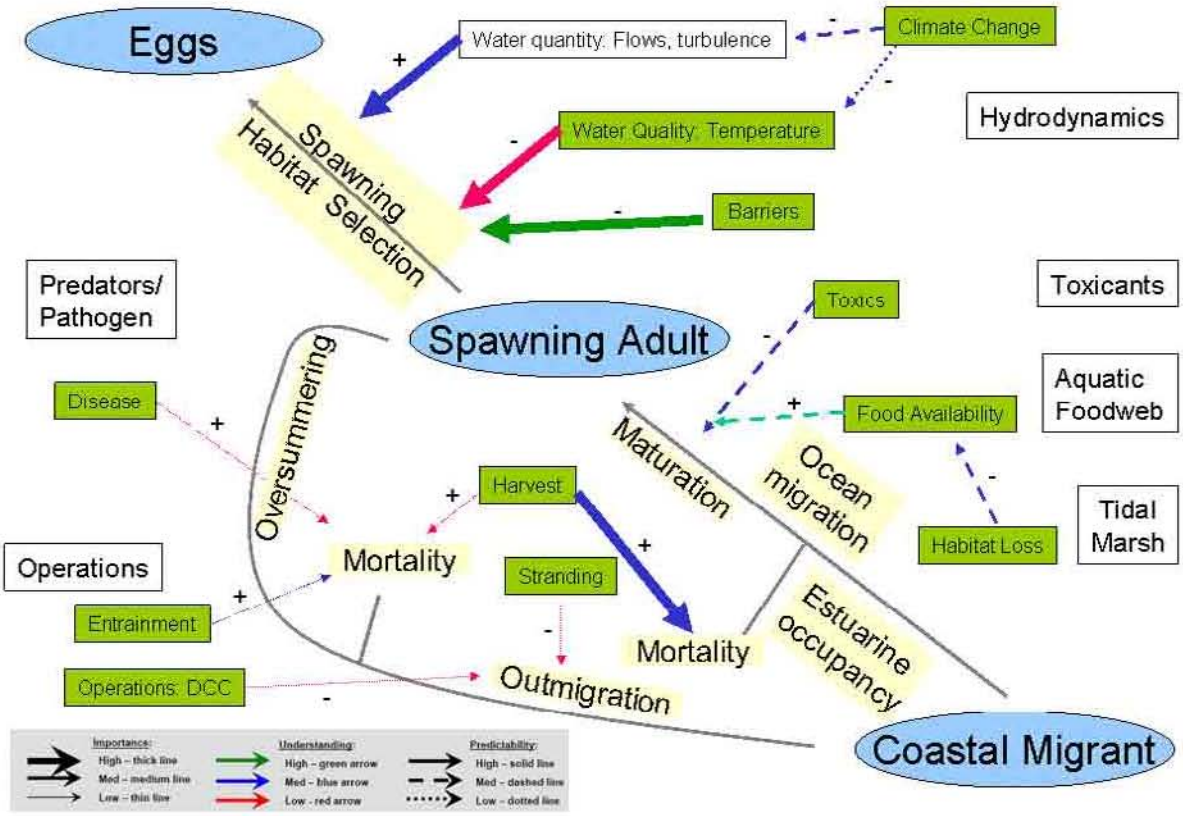


Figure 4-7. Life history conceptual model for green sturgeon: Coastal Migrant to Eggs Submodel (Israel and Klimley 2008).

Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al*. 2002) and are approximately 75 mm TL.

Green sturgeon larvae do not exhibit the initial pelagic swim–up behavior characteristic of other *acipenseridae*. The are strongly oriented to the bottom and exhibit nocturnal activity patterns. After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al*. 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile fish continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al*.'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 8°C, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9 to 10 month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (*i.e.* growth, food conversion, swimming ability) between 15°C and 19°C under either full or reduced rations (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed. Ambient water temperature conditions in the Rogue and Klamath River systems range from 4°C to approximately 24°C. The Sacramento River has similar temperature profiles and, like the previous two rivers, is a regulated system with dams controlling flows on its mainstem (Shasta and Keswick dams), and its tributaries (Whiskeytown, Oroville, Folsom, and Nimbus dams).

Larval and juvenile green sturgeon are subject to predation by both native and introduced fish species. Prickly sculpin (*Cottus asper*) have been shown to be an effective predator on the larvae of sympatric white sturgeon (Gadomski and Parsley 2005). This study also indicated that the lowered turbidity found in tailwater streams and rivers due to dams increased the effectiveness of sculpin predation on sturgeon larvae under laboratory conditions.

Larval and juvenile sturgeon have been caught in traps at two sites in the upper Sacramento River: below RBDD (RM 342) and from the GCID pumping plant (RM 205, CDFG 2002). Larvae captured at the RBDD site are typically only a few days to a few weeks old, with lengths ranging from 24 to 31 mm. This body length is equivalent to 15 to 28 days post hatch as determined by Deng *et al.* (2002). Recoveries of larvae at the RBDD rotary screw traps (RSTs) occur between late April/early May and late August with the peak of recoveries occurring in June (1995-1999 and 2003–2008 data). The mean yearly total length of post-larval green sturgeon captured in the GCID RST, approximately 30 miles downstream of RBDD, ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, 2002) indicating they are approximately 3-4 weeks old (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Taken together, the average length of larvae captured at the two monitoring sites indicate that fish were hatched upriver of the monitoring site and drifted downstream over the course of 2 to 4 weeks of growth. According to the CDFG document commenting on the NMFS proposal to list the Southern DPS (CDFG 2002), some green sturgeon rear to larger sizes above RBDD, or move back to this location after spending time downstream. Two sturgeon between 180 and 400 mm TL were captured in the RST during 1999 and green sturgeon within this size range have been impinged on diffuser screens associated with a fish ladder at RBDD (K. Brown, USFWS, pers. comm. as cited in CDFG 2002).

Juvenile green sturgeon migrate downstream and feed mainly at night. Larvae and YOY are small enough to be entrained in water diversions. During the day, their benthic behavior likely limits this impact. However, their nocturnal swim up behavior may place them at risk for entrainment by local agricultural diversions in the upper river reaches.

Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Collection Facility (Fish Facilities) in the South Delta, and captured in trawling studies by CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm, indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates that juveniles of the

Southern DPS of green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

4.2.3.2 Range-Wide (DPS) Status and Trends

Population abundance information concerning the Southern DPS of green sturgeon is described in the NMFS status reviews (Adams *et al*. 2002, NMFS 2005). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish in 1993 to more than 8,421 in 2001, and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable, since the population estimates are based on small sample sizes, intermittent reporting, and inferences made from white sturgeon catches. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile Southern DPS of green sturgeon per year (Adams *et al*. 2002).

Green sturgeon larvae and juveniles are routinely observed in rotary screw traps at RBDD and GCID, indicating spawning occurs above both these sites. Adults have been observed as far down as Hamilton City (RM 200). RST data from RBDD and GCID show a declining trend in juvenile production since the 1990s (figure 4-8). Recent data indicate that very little production took place in 2007 and 2008 (13 and 3 larval green sturgeon captured in the RST monitoring sites at RBDD, respectively; Poytress 2008, Poytress *et al*. 2009). Newly hatched larvae in the 30-40 mm range peak at RBDD and GCID in July, indicating they are at least 10 days old (figure 4-9). Length data from GCID do not show the same general increase in size over the sampling season as observed at RBDD, which may indicate less favorable growing conditions in the river between RBDD and GCID (CDFG 2002). Juvenile green sturgeon migrate downstream and feed mainly at night. Larvae and YOY are small enough to be entrained in water diversions. During the day, their benthic behavior likely limits this impact. However, their nocturnal swim up behavior may place them at risk for entrainment by local agricultural diversions in the upper river reaches.

The only existing information regarding changes in the abundance of the Southern DPS of green sturgeon includes changes in abundance at the John E. Skinner Fish Collection Facility between 1968 and 2006 (figures 4-10 and 4-11, table 4-8). The average number of Southern DPS of green sturgeon entrained per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (April 5, 2005, 70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (April 5, 2005, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of green sturgeon is declining. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 5, 2005, 70 FR 17386). Catches of sub-adult and adult Northern and Southern DPS of green sturgeon, primarily in San Pablo Bay, by the IEP ranged from 1 to 212 green sturgeon per year between 1996 and 2004 (212 occurred in 2001).

However, the portion of the Southern DPS of green sturgeon is unknown. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate spawning populations of 32 spawner pairs in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71).

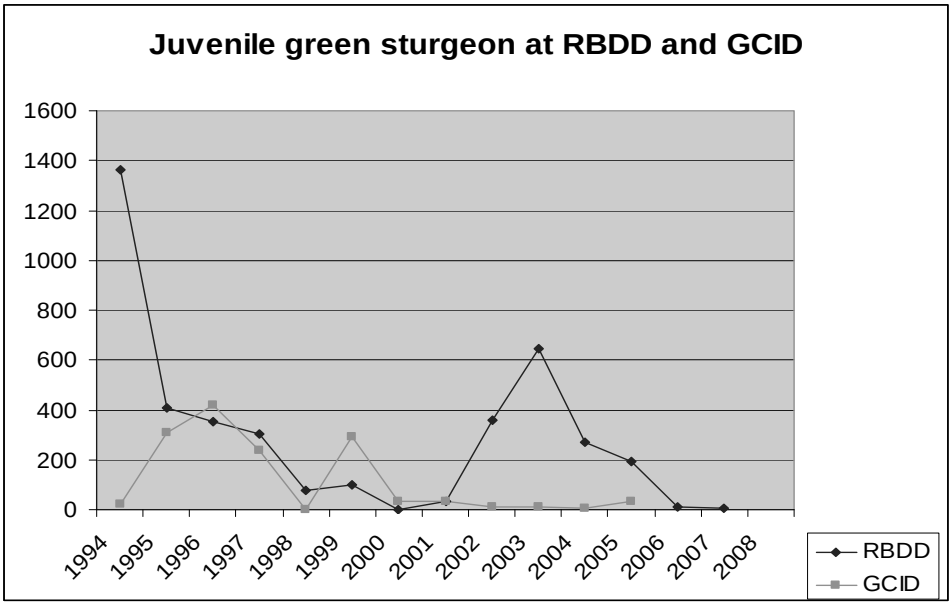


Figure 4-8. Rotary screw trap data of juvenile green sturgeon caught at RBDD and GCID from 1994-2008 (OCAPCVP/SWP operations BA).

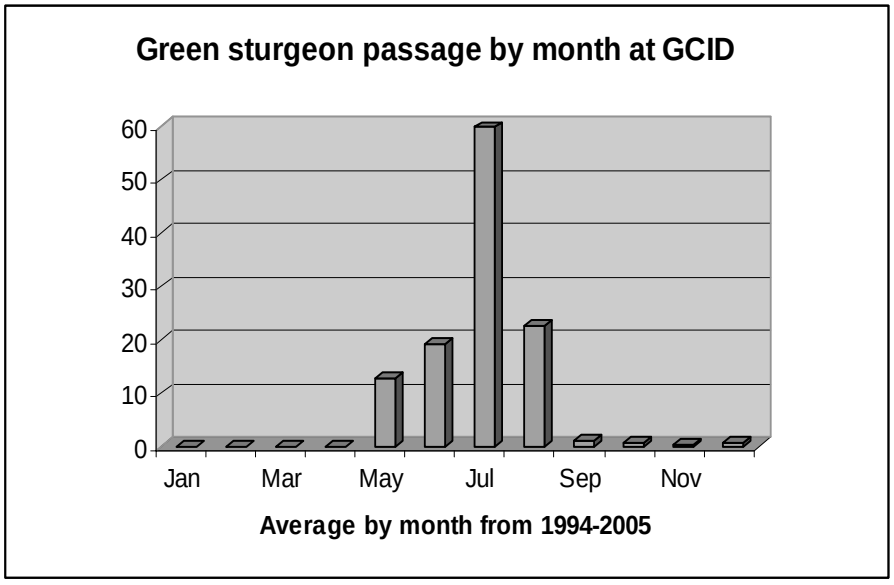


Figure 4-9. Juvenile green sturgeon average catch by month at GCID (1994-2005, CVP/SWP operations BA).

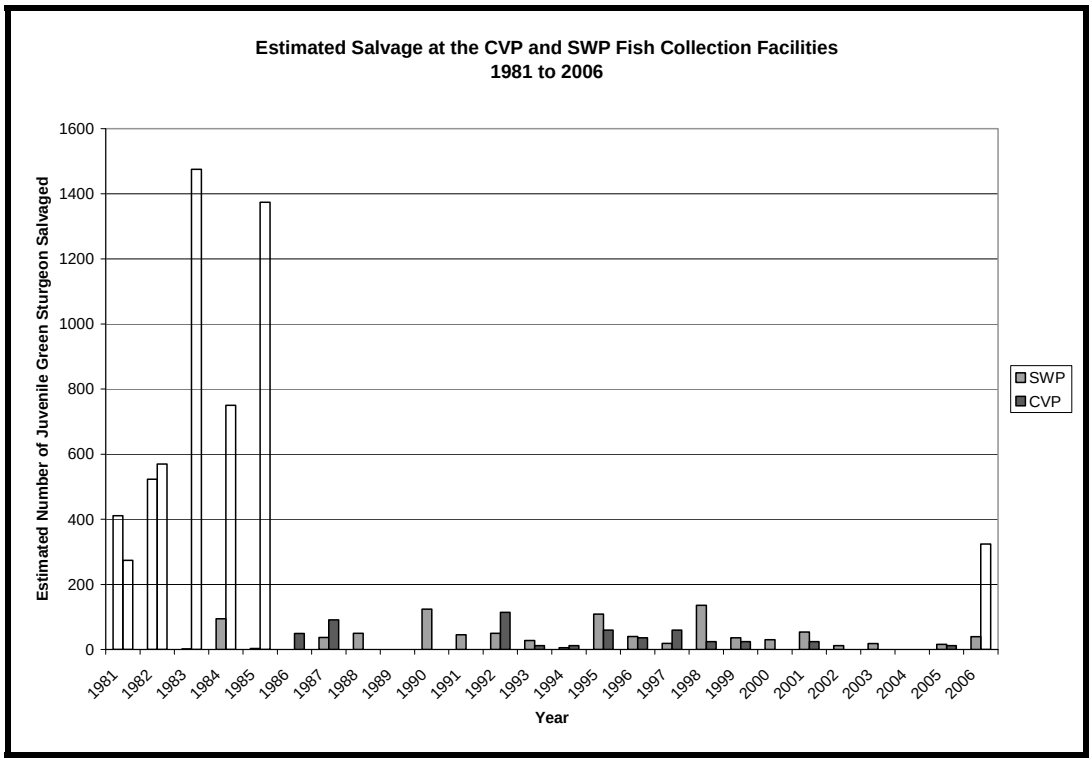


Figure 4-10. Estimated number of juvenile Southern DPS of green sturgeon salvaged from the SWP and the CVP fish collection facilities (Beamesderfer *et al.* 2007, CDFG 2002, and Adams *et al.* 2007). Measured fish lengths from 1981 through 2006 ranged from 136 mm to 774 mm with an average length of 330 mm.

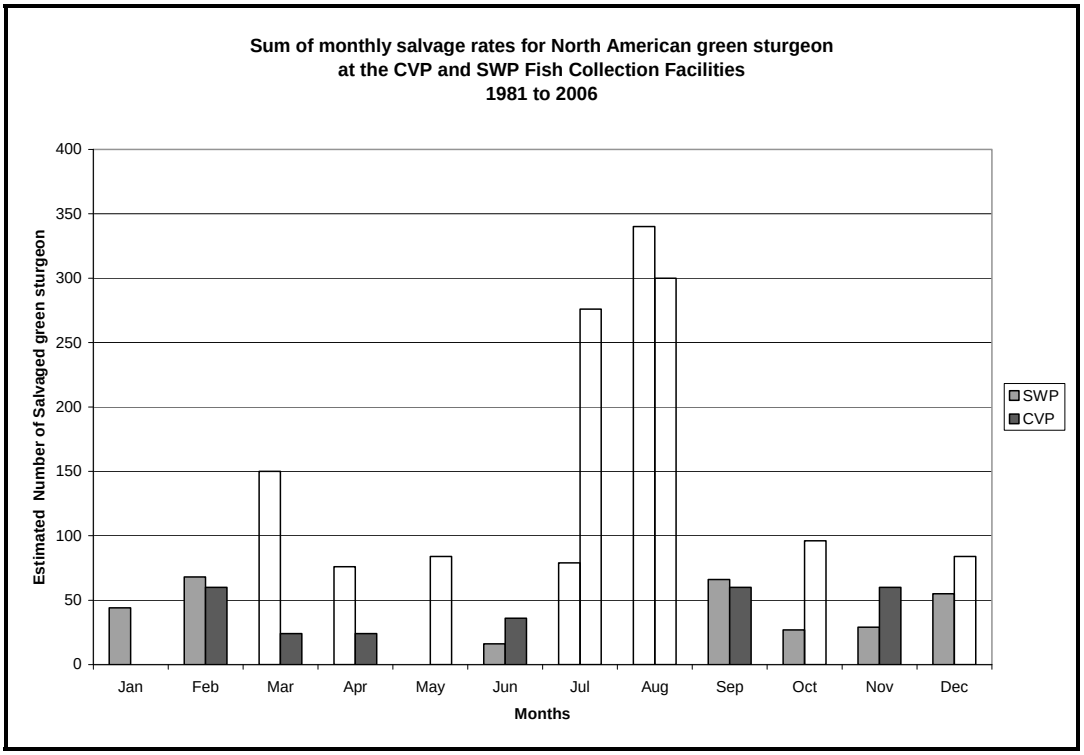


Figure 4-11. Estimated total number of Southern DPS of green sturgeon salvaged monthly from the SWP and the CVP fish collection facilities (CDFG 2002, unpublished CDFG records). Measured fish lengths from 1981 through 2006 ranged from 136 mm to 774 mm with an average length of 330 mm.

Table 4-8. The annual occurrence of juvenile[a] Southern DPS of North American green sturgeon at the CVP and SWP fish collection facilities in the South Delta. (Adams *et al*. 2007, CDFG 2002).

Year	State Facilities		Federal Facilities	
	Salvage Numbers	Numbers per 1000 acre feet	Salvage Numbers	Numbers per 1000 acre feet
1968	12	0.0162		
1969	0	0		
1970	13	0.0254		
1971	168	0.2281		
1972	122	0.0798		
1973	140	0.1112		
1974	7313	3.9805		
1975	2885	1.2033		
1976	240	0.1787		
1977	14	0.0168		
1978	768	0.3482		
1979	423	0.1665		
1980	47	0.0217		
1981	411	0.1825	274	0.1278
1982	523	0.2005	570	0.2553
1983	1	0.0008	1475	0.653
1984	94	0.043	750	0.2881
1985	3	0.0011	1374	0.4917
1985	0	0	49	0.0189
1987	37	0.0168	91	0.0328
1988	50	0.0188	0	0
1989	0	0	0	0
1990	124	0.0514	0	0
1991	45	0.0265	0	0
1992	50	0.0332	114	0.0963
1993	27	0.0084	12	0.0045
1994	5	0.003	12	0.0068
1995	101	0.0478	60	0.0211
1996	40	0.0123	36	0.0139
1997	19	0.0075	60	0.0239
1998	136	0.0806	24	0.0115
1999	36	0.0133	24	0.0095
2000	30	0.008	0	0
2001	54	0.0233	24	0.0106
2002	12	0.0042	0	0
2003	18	0.0052	0	0
2004	0	0	0	0
2005	16	0.0044	12	0.0045
2006	39	0.0078	324	0.1235

[a] Measured fish lengths from 1981 through 2006 ranged from 136 mm to 774 mm with an average length of 330 mm.

As described previously, the majority of spawning by green sturgeon in the Sacramento River system appears to take place above the location of RBDD. This is based on the length and estimated age of larvae captured at RBDD (approximately 2-3 weeks of age) and GCID (downstream, approximately 3-4 weeks of age) indicating that hatching occurred above the sampling location. Note that there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of larvae across channels) and this information should be considered cautiously.

Available information on green sturgeon indicates that, as with winter-run, the mainstem Sacramento River may be the last viable spawning habitat (Good *et al.* 2005) for the Southern DPS of green sturgeon. Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one known population, within the mainstem Sacramento River.

4.2.3.3 Current Viability of the Southern DPS of North American Green Sturgeon

4.2.3.3.1 Population Size

The current population status of Southern DPS green sturgeon is unknown (Beamesderfer *et al.* 2007, Adams *et al.* 2007). It is believed, based on captures of green sturgeon during surveys for the sympatric white sturgeon in the San Francisco Bay estuary that the population is relatively small (USFWS 1995), ranging from several hundred to a few thousand adults. However, these estimates are very uncertain, and limited by the inherent biases of the sampling methods. The sole population of Southern DPS of green sturgeon spawns within the Sacramento River basin and is believed to spawn primarily in the mainstem of the Sacramento River between Keswick Dam (RM 302) and Hamilton City (RM 200). Israel (2006) indicated that between 2002 and 2005, a range of 18 to 42 adult green sturgeon were estimated to have bred above RBDD, based on genetic analysis of captured larvae in the Sacramento River.

4.2.3.3.2 Population Growth Rate

Recruitment data for the Southern DPS of green sturgeon are essentially nonexistent. Incidental catches of larval green sturgeon in the mainstem Sacramento River and juvenile fish at the CVP and SWP pumping facilities in the South Delta suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer *et al*. 2007, Adams *et al*. 2005). Recent declines in the number of larvae captured in the RSTs near the RBDD may indicate a reduction in spawning success in the past several years, with resulting depressions in the year class strengths for those years. Green sturgeon are iteroparous and long-lived, so that spawning failure in any 1 year may be rectified in a succeeding spawning year. This would give the potential for a succesion of multiple, strong year classes, interspersed with weaker year classes.

4.2.3.3.3 Spatial Structure

Like the winter-run population, the Southern DPS of green sturgeon population has been relegated to a single spawning area, which is, for the most part, outside of its historical spawning area. The recent habitat evaluations conducted in the upper Sacramento River for salmonid recovery suggest that significant spawning habitat was made inaccessible or altered by dams (Lindley *et al.* 2004, 2006; Adams *et al.* 2007). The historical spawning habitat may have extended up into the three major branches of the upper Sacramento above the current location of Shasta Dam; the Little Sacramento River, the Pitt River, and the McCloud River. Additional spawning habitat is believed to have once existed above the current location of Oroville Dam on the Feather River. Other watersheds, including the San Joaquin River basin may also have supported opportunistic green sturgeon spawning in the past (Adams *et al.* 2007, Beamesderfer *et al.* 2007)

Green sturgeon are found throughout the Sacramento – San Joaquin Delta and the San Francisco Bay estuary. Coastal migrants, which include both adult and subadult life stages, are found from approximately Central California to southeastern Alaska with aggregations of Southern DPS of green sturgeon occurring in several estuaries along the West Coast from California northwards to Washington during the late summer and early fall. An aggregation of green sturgeon has also recently been identified off of the northwestern tip of Vancouver Island. Although both northern and southern populations mix in the ocean and coastal estuaries, it is believed that each DPS maintains a high fidelity to their natal watershed and little straying occurs between the two DPSs.

The reduction of the Southern DPS of green sturgeon spawning habitat into one reach on the Sacramento River between Keswick Dam and Hamilton City increases the vulnerability of this spawning population to catastrophic events. One spill of toxic materials into this reach of river, similar to the Cantara Loop spill of herbicides on the upper Sacramento River, could remove a significant proportion of the adult spawning broodstock from the population, as well as reduce the recruitment of the exposed year class of juvenile fish. Likewise, the necessary water temperatures required for normal egg development in the spawning reach is reliant on the cold-water releases for winter-run. Extended drought conditions could imperil the spawning success for green sturgeon, particularly those that are restricted to the river reaches below RBDD.

4.2.3.3.4 Diversity

Diversity, both genetic and behavioral, provides a species the opportunity to track and adapt to environmental changes. As a species' abundance decreases, and spatial structure of the ESU/DPS is reduced, a species has less flexibility to track changes in the environment. The reduction of the Southern DPS of green sturgeon population to one extant population reduces the potential variation of life history expression and genetic diversity within this population. Like winter-run, the Southern DPS of green sturgeon face greater risks to long term persistence of the population due to the lack of this flexibilty in their current condition.

4.2.3.3.5 Summary of the Current Viability of the Southern DPS of North American Green Sturgeon DPS

The Southern DPS of green sturgeon is at substantial risk of future population declines (Adams *et al*. 2007). The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, loss of juvenile green sturgeon due to entrainment at the project fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and Delta systems, alterations of food resources due to changes in the Sacramento River and Delta habitats, and exposure to various sources of contaminants throughout the basin to juvenile, sub-adult, and adult life stages.

4.2.3.4 Status of Southern DPS of Green Sturgeon Proposed Critical Habitat

4.2.3.4.1 Summary of Proposed Critical Habitat

Critical habitat was proposed for Southern DPS of green sturgeon on September 8, 2008 (73 FR 52084). Proposed critical habitat for Southern DPS of green sturgeon includes approximately 325 miles of riverine habitat and 1,058 square miles of estuarine habitat in California, Oregon, and Washington, and 11,927 square miles of coastal marine habitat off California, Oregon, and Washington within the geographical area presently occupied by the Southern DPS of green sturgeon. In addition, approximately 136 square miles of habitat within the Yolo and Sutter bypasses, adjacent to the Sacramento River, California, are proposed for designation.

4.2.3.4.2 For Freshwater Riverine Systems

4.2.3.4.2.1 Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages should be present in sufficient amounts to sustain growth (larvae, juveniles, and subadults) or support basic metabolism (adults). Although we lack specific data on food resources for green sturgeon within freshwater riverine systems, nutritional studies on white sturgeon suggest that juvenile green sturgeon most likely feed on macro benthic invertebrates, which can include plecoptera (stoneflies), ephemeroptera (mayflies), trichoptera (caddis flies), chironomid (dipteran fly larvae), oligochaetes (tubifex worms) or decapods (crayfish). These food resources are important for juvenile foraging, growth, and development during their downstream migration to the Delta and bays. In addition, subadult and adult green sturgeon may forage during their downstream post-spawning migration or on non-spawning migrations within freshwater rivers. Subadult and adult green sturgeon in freshwater rivers most likely feed on benthic invertebrates similar to those fed on in bays and estuaries, including freshwater shrimp and amphipods. Many of these different invertebrate groups are endemic to and readily available in the Sacramento River from Keswick Dam downstream to the Delta. Heavy hatches of mayflies, caddis flies, and chironomids occur in the upper Sacramento River, indicating that these groups of invertebrates are present in the river system. NMFS anticipates that the aquatic life stages of these insects

(nymphs, larvae) would provide adequate nutritional resources for green sturgeon rearing in the river.

4.2.3.4.2.2 Substrate Type or Size

Suitable critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development (*e.g.*, cobble, gravel, or bedrock sills and shelves with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adult life stages (*e.g.*, substrates for holding and spawning). For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Deng 2000, Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Both embryos and larvae exhibited a strong affinity for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2007). Recent stream surveys by USFWS and Reclamation biologists have identified approximately a 54 suitable holes and pools between Keswick Dam and approximately GCID that would support spawning or holding activities for green sturgeon, based on the identified physical criteria. Many of these locations are at the confluence of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between Keswick Dam and GCID. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

4.2.3.4.2.3 Water Flow

An adequate flow regime (*i.e.*, magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11-19°C) (Cech *et al.* 2000, Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is most certainly associated with water flow and water temperature compared to other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900-10,800 cfs; Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150-14,725 cfs in the late summer (Vogel 2005) and greater than 3,550 cfs in the winter (Erickson *et al.* 2002, Benson *et al.* 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural

hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions. Continued operations of the project are likely to further attenuate these high flow events. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent flooding downstream of the dam.

4.2.3.4.2.4 Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the proper functioning of the freshwater habitat. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11-17°C (optimal range = 14-16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Due to the temperature management of the releases from Keswick Dam for winter-run in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water [< 3 parts per thousand (ppt)] for larvae and early juveniles [about 100 days post hatch (dph)] to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of DO are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles, Allen and Cech 2007). Current mainstem DO levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free of contaminants (*i.e.*, pesticides, organochlorines, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g.*, reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 2001a, Foster *et al.* 2001b, Kruse and Scarnecchia 2002, Feist *et al.* 2005, and Greenfield *et al.* 2005). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin.

4.2.3.4.2.5 Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g.*, an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick

Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

Green sturgeon adults that migrate upstream in April, May, and June are completely blocked by the ACID diversion dam. Therefore, 5 miles of spawning habitat are inaccessible upstream of the diversion dam. It is unknown if spawning is occurring in this area. Adults that pass upstream of ACID dam before April are forced to wait 6 months until the stop logs are pulled before returning downstream to the ocean. Upstream blockage forces sturgeon to spawn in approximately 12 percent less habitat between Keswick Dam and RBDD. Newly emerged green sturgeon larvae that hatch upstream of the ACID diversion dam would be forced to hold for 6 months upstream of the dam or pass over it and be subjected to higher velocities and turbulent flow below the dam, thus rendering the larvae and juvenile green sturgeon more susceptible to predation.

Closure of the gates at RBDD from May 15 through September 15 precludes all access to spawning grounds above the dam during that time period. Adult green sturgeon that cannot migrate upstream past the RBDD either spawn in what is believed to be less suitable habitat downstream of the RBDD (potentially resulting in lower reproductive success) or migrate downstream without spawning, both of which would reduce the overall reproductive success of the species.

Adult green sturgeon that were successful in passing the RBDD prior to its closure have to negotiate the dam on their subsequent downstream migration following spawning during the gates down period. Recent acoustic tag data indicate that some fish are successful in passing the dam when the gates are in the "closed" position. Typically the gates are raised slightly from the bottom to allow water to flow underneath the radial gates and fish apparently can pass beneath the radial gates during this period. However, recent observed mortalities of green sturgeon during an emergency gate operation (2007) indicate that passage is not without risk if the clearance is too narrow for successful passage.

Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in May, June, and July, during the RBDD gates down period. Juvenile green sturgeon would likely be subjected to the same predation and turbulence stressors caused by RBDD as the juvenile anadromous salmonids, leading to diminished survival through the structure and waters immediately downstream.

4.2.3.4.2.6 Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River above GCID. The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002,

Benson *et al.* 2007). As described above, approximately a 54 pools with adequate depth have been identified in the Sacramento River above the GCID location.

4.2.3.4.2.7 Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), PAHs, and organochlorine pesticides] that can result in negative effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern in the river's watershed.

4.2.3.4.3 For Estuarine Habitats

4.2.3.4.3.1 Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fish, including crangonid shrimp, callianassid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source. The recent spread of the Asian overbite clam has shifted the diet profile of white sturgeon to this invasive species. The overbite clam now makes up a substantial proportion of the white sturgeon's diet in the estuary. NMFS assumes that green sturgeon have also altered their diet to include this new food source based on its increased prevalence in the benthic invertebrate community.

4.2.3.4.3.2 Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. Currently, flows provide the necessary attraction to green sturgeon to enter the

Sacramento River. Nevertheless, these flows are substantially less than what would have been available historically to stimulate the spawning migration.

4.2.3.4.3.3 Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, adequate levels of DO are also required to support oxygen consumption by juveniles (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1}, Allen and Cech 2007). Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Water quality in the areas such as the Stockton turning basin and Port of Stockton routinely have depletions of DO and episodes of first flush contaminants from the surrounding industrial and urban watershed. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo Bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

4.2.3.4.3.4 Migratory Corridor

Safe and unobstructed migratory pathways are necessary for the safe and timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Rearing fish need the ability to freely migrate from the river through the estuarine waterways of the delta and bays and eventually out into the ocean. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP water projects alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities.

Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the DCC facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Hydraulic dredging can result in the entrainment of fish into the dredger's hydraulic cutterhead intake. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

4.2.3.4.3.5 Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays and estuaries as well as within freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia for subadult and adult green sturgeon (Benson *et al*. 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly *et al*. 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3-8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966). Thus, a diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas.

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are comprised of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. The channels are simplified trapezoidal shapes with little topographical variation along the channel alignment. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin River systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

4.2.3.4.3.6 Sediment Quality

Sediment quality (*i.e*., chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g*., elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *Sediment quality* for riverine habitats above).

4.2.3.4.4 For Nearshore Coastal Marine Areas

4.2.3.4.4.1 Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within marine coastal zones along the west coast of North America and between estuarine and marine habitats. Subadult and adult green sturgeon spend as much as 13 years out at sea before returning to their natal rivers to spawn. Safe and unobstructed passage within near shore marine waters is critical for subadult and adult green sturgeon to access over-summering habitats within coastal estuaries and over-wintering habitats within coastal estuaries and coastal waters off of Vancouver Island, British Columbia. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning. Potential conflicts may occur in shipping corridors, areas with commercial bottom trawl fisheries, and coastal discharge of wastewater from sanitation facilities.

4.2.3.4.4.2 Water Quality

Nearshore marine waters should have adequate DO levels and be free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon. Based on studies of tagged subadult and adult green sturgeon in the San Francisco Bay estuary, California, and Willapa Bay, Washington, subadults and adults may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, exposure to and bioaccumulation of contaminants may negatively affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Thus, waters free of such contaminants would benefit the normal development of green sturgeon for optimal survival and spawning success.

4.2.3.4.4.3 Food Resources

Abundant food items for subadults and adults, which may include benthic invertebrates and fish, are important to the growth and viability of subadult and adult green sturgeon. Green sturgeon spend from 3-13 years in marine waters, migrating long distances of up to 100 km per day (NMFS 2005a). Although most tagged individuals swim at speeds too fast for feeding, some individuals swam at slower speeds and resided in areas over several days, indicating that they may be feeding. Abundant food resources are important to support subadults and adults over long-distance migrations, and may be one of the factors attracting green sturgeon to habitats farther to the north (off the coast of Vancouver Island and Alaska) and to the south (Monterey Bay, California, and off the coast of southern California) of their natal habitat. Although direct evidence is lacking, prey species are likely to include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries (*e.g.*, shrimp, clams, crabs, anchovies, sand lances). Concentrations of these species in the near shore environment are likely to attract congregations of adult and sub-adult green sturgeon.

4.2.3.4.5 Southern DPS of North American Green Sturgeon Proposed Critical Habitat Summary

The current condition of proposed critical habitat for the Southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the species, particularly in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as already described for winter-run critical habitat. In addition, the alterations to the Sacramento-San Joaquin River Delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes rearing in the Delta, which can ultimately impact the potential population structure for decades to come.

4.2.4 Factors Responsible for the Current Status of Winter-Run, Spring-Run, CV Steelhead, and the Southern DPS of Green Sturgeon

Although the geographic extent of winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon are different, much of their freshwater habitat overlap, and therefore, most of the factors responsible for their current statuses are similar. Therefore, each of the following factors applies to winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon, unless specified..

4.2.4.1 Habitat Blockage

Hydropower, flood control, and water supply dams of the CVP, SWP, and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. The percentage of habitat loss for steelhead is presumable greater, because steelhead were more extensively distributed upstream than Chinook salmon.

As a result of migrational barriers, winter-run, spring-run, and steelhead populations have been confined to lower elevation mainstems that historically only were used for migration and rearing. Population abundances have declined in these streams due to decreased quantity, quality, and spatial distribution of spawning and rearing habitat (Lindley *et al*. 2009). Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids. According to Lindley *et al.* (2004), of the four independent populations of winter-run that occurred historically, only one mixed stock of winter-run remains below Keswick Dam.

Similarly, of the 19 independent populations[5] of spring-run that occurred historically, only three independent populations remain in Deer, Mill, and Butte Creeks. Dependent populations of spring-run continue to occur in Big Chico, Antelope, Clear, Thomes, and Beegum creeks and the Yuba River, but rely on the extant independent populations for their continued survival. CV steelhead historically had at least 81 independent populations based on Lindley *et al.*'s (2006) analysis of potential habitat in the Central Valley. However, due to dam construction, access to 38 percent of all spawning habitat has been lost, as well as access to 80 percent of the historically available habitat.

Juvenile downstream migration patterns have been altered by the presence of dams. Juvenile winter-run, and spring-run on the mainstem Sacramento River, arrive at any given location downstream of Keswick Dam earlier than historical, since they are hatched much further downstream and have less distance to travel. Therefore, in order smolt at the same size and time as historical, they must rear longer within the Sacramento River. However, as will be discussed in sections 4.2.4.2, 4.2.4.4 through 4.2.4.7, and 4.2.4.10, below, the mainstem Sacramento River is not conducive to the necessary habitat features that provide suitable rearing habitat for listed anadromous fish species, especially for an extended duration of time.

The SMSCG, located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The SMSCG have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996, Tillman *et al.* 1996, DWR 2002a). As a result of the SMSCG fish passage study and a term and condition in NMFS' 2004 CVP/SWP operations Opinion, the boat lock has remained open since the 2001-2002 control season (CVP/SWP operations BA), and adult fish passage has improved.

RBDD impedes adult salmonid passage throughout its May 15 through September 15 gates in period. Although there are fish ladders at the right and left banks, and a temporary ladder in the middle of the dam, they are not very efficient at passing fish. The range of effects resulting from upstream migrational delays at RBDD include delayed, but eventually successful spawning, to prespawn mortality and the complete loss of spawning potential in that fraction of the population.

4.2.4.2 Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and large woody debris (LWD). More uniform flows year round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement

[5] Lindley *et al*. (2007) identified evidence supporting the Deer and Mill Creek populations as individual independent populations, and also as one combined independent population. For the purpose of this Opinion, we treat the Deer and Mill Creek populations as individual independent populations.

(Mount 1995, Ayers 2001), caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams. The storage of unimpeded runoff in these large reservoirs also has altered the normal hydrograph for the Sacramento and San Joaquin River watersheds. Rather than seeing peak flows in these river systems following winter rain events (Sacramento River) or spring snow melt (San Joaquin River), the current hydrology has truncated peaks with a prolonged period of elevated flows (compared to historical levels) continuing into the summer dry season.

Water withdrawals, for agricultural and municipal purposes, have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al*. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run survival in the Sacramento River is also directly related to June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (Herren and Kawasaki 2001).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel (DCC); (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and sunfishes (*Centrarchidae* spp.) within the waterways of the Delta while moving through the Delta under the influence of CVP/SWP pumping.

4.2.4.3 Anderson-Cottonwood Irrigation District (ACID) Dam

The ACID operates a diversion dam across the Sacramento River located 5 miles downstream from Keswick Dam. ACID is one of the 3 largest diversions on the Sacramento River and has senior water rights of 128 thousand acre feet (TAF) of water since 1916 for irrigation along the west side of the Sacramento River. The installation and removal of the diversion dam

flashboards requires close coordination between Reclamation and ACID. The diversion dam is operated from April through October. Substantial reductions in Keswick releases to install or remove the flashboards have resulted in dewatered redds, stranded juveniles, and higher water temperatures. Based on run timing (table 5-1), the diversion dam operations could impact winter-run, spring-run, fall-run and green sturgeon. Redd dewatering would mostly likely affect spring-run and fall-run in October, however, the reductions in flows are usually short-term, lasting less than 8 hours. Such short-term reductions in flows may cause some mortality of incubating eggs and loss of stranded juveniles. Reductions in Keswick releases are limited to 15 percent in a 24-hour period and 2.5 percent in any 1 hour. Experience with real-time operations has shown that the most significant reductions occur during wet years when Shasta releases are higher than 10,000 cubic feet per second (cfs). Average April releases from Keswick are 6,000 to 7,000 cfs. The likelihood of a flow fluctuation occurring (when Shasta storage > 4.5 MAF in April) is 17 percent, or 14 out of the 82-year historical record. During wet years, flows released from Shasta Dam are typically higher than in drier water year types. The amount of flow that needs to be reduced to get to safe operating levels for the installation of the flashboards at the ACID dam is therefore greater and the wetted area reduction downstream of Keswick Dam is thus greater. The likelihood of an October reduction in flows that could dewater redds is even lower, since average releases are 6,000 cfs in all water year types.

Green sturgeon adults that migrate upstream in April, May, and June are are completely blocked by the ACID diversion dam. Therefore, 5 miles of spawning habitat are inaccessible upstream of the diversion dam. It is unknown if spawning is occurring in this area. Adults that pass upstream of the diversion dam before April are forced to wait 6 months until the stop logs are pulled before returning downstream to the ocean. Upstream blockage forces sturgeon to spawn in approximately 12 percent less habitat between Keswick Dam and RBDD. Newly-emerged green sturgeon larvae that hatch upstream of the ACID diversion dam would be forced to hold for 6 months upstream of the dam or pass over it and be subjected to higher velocities and turbulent flow below the dam, thus rendering the larvae and juvenile green sturgeon more susceptible to predation.

The ACID diversion dam was improved in 2001 with the addition of new fish ladders and fish screens around the diversion. Since upstream passage was improved a substantial shift in winter-run spawning has occurred. In recent years, more than half of the winter-run redds have typically been observed above the ACID diversion dam (Killam 2008). This makes flow fluctuations more a concern since such a large proportion of the run is spawning so close to Keswick Dam.

4.2.4.4 Red Bluff Diversion Dam (RBDD)

RBDD is owned and operated by Reclamation. The TCCA operates the Corning Canal and Tehama-Colusa Canal, which divert up to 328 TAF from the Sacramento River. RBDD is located 59 miles downstream of Keswick Dam. It blocks or delays adult salmonids and sturgeon migrating upstream to various degrees, depending on run timing. Based on various studies (Vogel *et al*. 1988; Hallock 1989; and CDFG 1998), the CVP/SWP operations BA states, "Problems in salmonid passage at RBDD provide a well-documented example of a diversion facility impairing salmon migration."

A portion of the winter-run adults encounter the gates down and are forced to use the fish ladders. There are 3 fish ladders on RBDD, one on each side and one temporary ladder in the middle of the dam. The RBDD fish ladders are not efficient at passing adult salmonids due to the inability of salmon to find the entrances. Water released from RBDD flows through a small opening under 11 gates across the river, causing turbulent flows that confuse fish and keep them from finding the ladders. The fish ladders are not designed to allow enough water through them to attract adult salmonids towards them. Previous studies (Vogel, USFWS) have shown that salmon can be delayed up to 20 days in passing the dam. These delays can reduce the fitness of adults that expend their energy reserves fighting the flows beneath the gates, and increase the chance of prespawn mortality. Run timing is critical to salmon, as it is what distinguishes one race from another. Delays of a week or even days in passage likely prevents some spring-run adults (those that encounter gates down in May and June) from entering tributaries above RBDD that dry up or warm up in the spring (*e.g.*, Cottonwood Creek, Cow Creek). These delays have the potential of preventing these fish from accessing summer holding pools in the upper areas of the creeks.

4.2.4.5 Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of armored, rip-rapped levees on more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watershed's supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects, including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al*. 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and to escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Prior to the 1970s, there was so much debris resulting from poor logging practices that many streams were completely clogged and were thought to have been total barriers to fish migration. As a result, in the 1960s and early 1970s it was common practice among fishery management

agencies to remove woody debris thought to be a barrier to fish migration (NMFS 1996b). However, it is now recognized that too much LWD was removed from the streams resulting in a loss of salmonid habitat and it is thought that the large scale removal of woody debris prior to 1980 had major, long-term negative effects on rearing habitats for salmonids in northern California (NMFS 1996b). Areas that were subjected to this removal of LWD are still limited in the recovery of salmonid stocks; this limitation could be expected to persist for 50 to 100 years following removal of the debris.

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996b). LWD influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979, Bilby 1984, Robison and Beschta 1990). Reduction of wood in the stream channel, either from past or present activities, generally reduces pool quantity and quality, alters stream shading which can affect water temperature regimes and nutrient input, and can eliminate critical stream habitat needed for both vertebrate and invertebrate populations. Removal of vegetation also can destabilize marginally stable slopes by increasing the subsurface water load, lowering root strength, and altering water flow patterns in the slope.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al*. 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases, affecting salmonid food supply.

4.2.4.6 Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). Starting with the gold rush, these vast riparian forests were cleared for building materials, fuel, and to clear land for farms on the raised natural levee banks. The degradation and fragmentation of riparian habitat continued with extensive flood control and bank protection projects, together with the conversion of the fertile riparian lands to agriculture outside of the natural levee belt. By 1979, riparian habitat along the Sacramento River diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The clearing of the riparian forests removed a vital source of snags and driftwood in the Sacramento and San Joaquin River basins. This has reduced the volume of LWD input needed to form and maintain stream habitat that salmon depend on in their various life stages. In addition to this loss of LWD sources, removal of snags and obstructions from the active river channel for navigational safety has further reduced the presence of LWD in the Sacramento and San Joaquin Rivers, as well as the Delta.

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is one of the primary causes of salmonid habitat degradation (NMFS 1996a). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and Campbell 1961), burying eggs or alevins, scouring and filling in pools and riffles, reducing primary productivity and

photosynthesis activity (Cordone and Kelley 1961), and affecting intergravel permeability and DO levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and removal of riparian vegetation, resulting in increased streambank erosion (Meehan 1991). Urban stormwater and agricultural runoff may be contaminated with herbicides and pesticides, petroleum products, sediment, *etc*. Agricultural practices in the Central Valley have eliminated large trees and logs and other woody debris that would otherwise be recruited into the stream channel (NMFS 1998a).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Monroe *et al.* 1992, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. In Suisun Marsh, saltwater intrusion and land subsidence gradually has led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for duck clubs, which first were established in the 1870s in western Suisun Marsh (Goals Project 1999). Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin River Basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and riffle segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento Rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of

valuable LWD from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban stormwater and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons (PAHs), and other organics and nutrients [California Regional Water Quality Control Board-Central Valley Region (Regional Board) 1998] that can destroy aquatic life necessary for salmonid survival (NMFS 1996a, b). Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e.*, concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

Past mining activities routinely resulted in the removal of spawning gravels from streams, the straightening and channelization of the stream corridor from dredging activities, and the leaching of toxic effluents into streams from mining operations. Many of the effects of past mining operations continue to impact salmonid habitat today. Current mining practices include suction dredging (sand and gravel mining), placer mining, lode mining and gravel mining. Present day mining practices are typically less intrusive than historic operations (hydraulic mining); however, adverse impacts to salmonid habitat still occur as a result of present-day mining activities. Sand and gravel are used for a large variety of construction activities including base material and asphalt, road bedding, drain rock for leach fields, and aggregate mix for concrete to construct buildings and highways.

Most aggregate is derived principally from pits in active floodplains, pits in inactive river terrace deposits, or directly from the active channel. Other sources include hard rock quarries and mining from deposits within reservoirs. Extraction sites located along or in active floodplains present particular problems for anadromous salmonids. Physical alteration of the stream channel may result in the destruction of existing riparian vegetation and the reduction of available area for seedling establishment (Stillwater Sciences 2002). Loss of vegetation impacts riparian and aquatic habitat by causing a loss of the temperature moderating effects of shade and cover, and habitat diversity. Extensive degradation may induce a decline in the alluvial water table, as the banks are effectively drained to a lowered level, affecting riparian vegetation and water supply (NMFS 1996b). Altering the natural channel configuration will reduce salmonid habitat diversity by creating a wide, shallow channel lacking in the pools and cover necessary for all life stages of anadromous salmonids. In addition, waste products resulting from past and present mining activities, include cyanide (an agent used to extract gold from ore), copper, zinc, cadmium, mercury, asbestos, nickel, chromium, and lead.

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by DWR on water quality in the Delta over the last 30 years show a steady decline in the food sources available for juvenile salmonids and

sturgeon and an increase in the clarity of the water due to a reduction in phytoplankton and zooplankton. These conditions have contributed to increased mortality of juvenile Chinook salmon and steelhead as they move through the Delta.

The following are excerpts from Lindley *et al*. (2009):

> "The long-standing and ongoing degradation of freshwater and estuarine habitats and the subsequent heavy reliance on hatchery production were also likely contributors to the collapse of the [fall-run] stock. Degradation and simplification of freshwater and estuary habitats over a century and a half of development have changed the Central Valley Chinook salmon complex from a highly diverse collection of numerous wild populations to one dominated by fall Chinook salmon from four large hatcheries."
>
> "In conclusion, the development of the Sacramento-San Joaquin watershed has greatly simplified and truncated the once-diverse habitats that historically supported a highly diverse assemblage of populations. The life history diversity of this historical assemblage would have buffered the overall abundance of Chinook salmon in the Central Valley under varying climate conditions."

4.2.4.7 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. Some common pollutants include effluent from wastewater treatment plants and chemical discharges such as dioxin from San Francisco bay petroleum refineries (McEwan and Jackson 1996 *op cit*. CVP/SWP operations BA). In addition, agricultural drain water, another possible source of contaminants, can contribute up to 30 percent of the total inflow into the Sacramento River during the low-flow period of a dry year (CVP/SWP operations BA). The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides [aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene], mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al*. 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids and green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations [Environmental Protection Agency (EPA) 1994]. However, the more likely route of exposure to salmonids or sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids to contaminated sediments is similar to water borne exposures once the contaminant has entered the body of the fish.

4.2.4.8 Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley, and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley are primarily caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels [U.S. Department of the Interior (DOI) 1999]. For example, Nimbus Hatchery on the American River rears Eel River steelhead stock and releases these fish in the Sacramento River basin. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that spring-run and early fall-run were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. Spring-run from the FRFH have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run, an indication that FRFH spring-run may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Fish Hatchery and FRFH, can directly impact spring-run and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd

superimposition occurs in-river due to hatchery overproduction and the inability to physically separate spring-run and fall-run adults. This concurrent spawning has led to hybridization between the spring-run and fall-run in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run often limits the amount if water available for steelhead spawning and rearing the rest of the year.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37 percent naturally-produced fish currently (Nobriga and Cadrett 2003). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001).

Hatcheries also can have some positive effects on salmonid populations. Winter-run produced in the LSNFH are considered part of the winter-run ESU. Spring-run produced in the FRFH are considered part of the spring-run ESU. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios. Artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels, as was the case with the winter-run population during the 1990s. However, relative abundance is only one component of a viable salmonid population.

4.2.4.9 Over Utilization

4.2.4.9.1 Ocean Commercial and Sport Harvest – Chinook Salmon and Steelhead

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Northern and Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI) harvest index. The CVI harvest index is the ocean harvest landed south of Point Arena divided by the CVI. The CVI is the sum of ocean fishery Chinook salmon harvested in the area south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught), plus the Central Valley adult Chinook salmon escapement. Coded wire tag (CWT) returns indicate that Sacramento River salmon congregate off the California coast between Point Arena and Morro Bay.

Since 1970, the CVI harvest index for winter-run generally has ranged between 0.50 and 0.80. In 1990, when ocean harvest of winter-run was first evaluated by NMFS and the Pacific Fisheries Management Council (PFMC), the CVI harvest index was near the highest recorded level at 0.79. NMFS determined in a 1991 biological opinion that continuance of the 1990 ocean

harvest rate would not prevent the recovery of winter-run. In addition, the final rule designating winter-run critical habitat (June 16, 1993, 58 FR 33212) stated that commercial and recreational fishing do not appear to be significant factors in the decline of the species. Through the early 1990s, the ocean harvest index was below the 1990 level (*i.e.*, 0.71 in 1991 and 1992, 0.72 in 1993, 0.74 in 1994, 0.78 in 1995, and 0.64 in 1996). NMFS (1996) and NMFS (1997b) concluded that incidental ocean harvest of winter-run represented a significant source of mortality to the endangered population, even though ocean harvest was not a key factor leading to the decline of the population. As a result of these biological opinions, measures were developed and implemented by the PFMC, NMFS, and CDFG to reduce ocean harvest by approximately 50 percent. In 2001, the CVI harvest index dropped to 0.27, most likely due to the reduction in harvest and the higher abundance of salmonids originating from the Central Valley (Good *et al*. 2005).

Ocean fisheries have affected the age structure of spring-run through targeting large fish for many years and reducing the numbers of 4- and 5-year-old fish (CDFG 1998). Winter-run spawners have also been affected by ocean fisheries, as most spawners return as 3-year olds. As a result of very low returns of fall-run to the Central Valley in 2007, there was a complete closure of the commercial and recreational ocean Chinook salmon fishery in 2008. As a result of not having been subjected to fishing pressure, there will likely be more 4- and 5-year old winter-run and spring-run returning to spawn in 2009.

Harvest rates of spring-run ranged from 0.55 to nearly 0.80 between 1970 and 1995 when harvest rates were adjusted for the protection of winter-run. The drop in the CVI harvest index to 0.27 in 2001 as a result of high fall-run escapement also resulted in reducing the authorized harvest of spring-run. There is essentially no ocean harvest of steelhead.

4.2.4.9.2 Inland Sport Harvest – Chinook Salmon and Steelhead

Historically in California, almost half of the river sport fishing effort was in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett *et al.* 1991). Since 1987, the Fish and Game Commission has adopted increasingly stringent regulations to reduce and virtually eliminate the in-river sport fishery for winter-run. Present regulations include a year-round closure to Chinook salmon fishing between Keswick Dam and the Deschutes Road Bridge and a rolling closure to Chinook salmon fishing on the Sacramento River between the Deschutes River Bridge and the Carquinez Bridge. The rolling closure spans the months that migrating adult winter-run are ascending the Sacramento River to their spawning grounds. These closures have virtually eliminated impacts on winter-run caused by recreational angling in freshwater. In 1992, the California Fish and Game Commission adopted gear restrictions (all hooks must be barbless and a maximum of 5.7 cm in length) to minimize hooking injury and mortality of winter-run caused by trout anglers. That same year, the Commission also adopted regulations, which prohibited any salmon from being removed from the water to further reduce the potential for injury and mortality.

In-river recreational fisheries historically have taken spring-run throughout the species' range. During the summer, adult spring-run are easily targeted by anglers when they congregate and hold in large pools. Poaching also occurs at fish ladders, and other areas where adults

congregate. However, the significance of poaching on the adult population is unknown. Specific regulations for the protection of spring-run in Mill, Deer, Butte, and Big Chico creeks and the Yuba River have been added to the existing CDFG regulations. The current regulations, including those developed for winter-run, provide some level of protection for spring-run (CDFG 1998).

There is little information on steelhead harvest rates in California. Hallock *et al.* (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-1954 through 1958-1959 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. The average annual harvest rate of adult steelhead above RBDD for the 3-year period from 1991-1992 through 1993-1994 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams. Overall, this regulation has greatly increased protection of naturally produced adult steelhead. However, the total number of CV steelhead contacted might be a significant fraction of basin-wide escapement, and even low catch-and-release mortality may pose a problem for wild populations (Good *et al*. 2005).

4.2.4.10 Disease and Predation

Infectious disease is one of many factors that influence adult and juvenile salmonid survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment (NMFS 1996a, 1996b, 1998a). Specific diseases such as bacterial kidney disease, *Ceratomyxosis shasta*, columnaris, furunculosis, infectious hematopoietic necrosis, redmouth and black spot disease, whirling disease, and erythrocytic inclusion body syndrome are known, among others, to affect Chinook salmon and steelhead (NMFS 1996a, 1996b, 1998a). Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases; however, studies have shown that wild fish tend to be less susceptible to pathogens than are hatchery-reared fish. Nevertheless, wild salmonids may contract diseases that are spread through the water column (*i.e*., waterborne pathogens) as well as through interbreeding with infected hatchery fish. The stress of being released into the wild from a controlled hatchery environment frequently causes latent infections to convert into a more pathological state, and increases the potential of transmission from hatchery reared fish to wild stocks within the same waters.

Accelerated predation also may be a factor in the decline of winter-run and spring-run, and to a lesser degree CV steelhead. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the mainstem Sacramento River, high rates of predation are known to occur at the RBDD, ACID diversion dam, Glenn-Colusa Irrigation District (GCID) diversion facility, areas where rock revetment has replaced natural river bank vegetation, and at South Delta water diversion structures (*e*.g., Clifton Court Forebay; CDFG 1998). Predation at RBDD on juvenile winter-run

is believed to be higher than natural due to flow dynamics associated with the operation of this structure. Due to their small size, early emigrating winter-run may be very susceptible to predation in Lake Red Bluff when the RBDD gates remain closed in summer and early fall. In passing the dam, juveniles are subject to conditions which greatly disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate below the dam and prey on juvenile salmon in the tail waters. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker *et al.* (1998) reported that Sacramento pikeminnow predation on juvenile salmonids during the summer months increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow. Striped bass showed a strong preference for juvenile salmonids as prey during this study. This research also indicated that the percent frequency of occurrence for juvenile salmonids nearly equaled other fish species in the stomach contents of the predatory fish. Tucker *et al.* (2003) showed the temporal distribution for these two predators in the RBDD area were directly related to RBDD operations (predators congregated when the dam gates were in, and dispersed when the gates were removed).

USFWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted 10 mark/recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss (Gingras 1997). More recent studies by DWR (2008) have verified this level of predation also exists for steelhead smolts within Clifton Court Forebay, indicating that these predators were efficient at removing salmonids over a wide range of body sizes.

Predation on juvenile salmonids has increased as a result of water development activities which have created ideal habitats for predators and non-native invasive species (NIS). Turbulent conditions near dam bypasses, turbine outfalls, water conveyances, and spillways disorient juvenile salmonid migrants and increase their predator avoidance response time, thus improving predator success. Increased exposure to predators has also resulted from reduced water flow through reservoirs; a condition which has increased juvenile travel time. Other locations in the Central Valley where predation is of concern include flood bypasses, post-release sites for salmonids salvaged at the CVP and SWP Fish Facilities, and the SMSCG. Striped bass and pikeminnow predation on salmon at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967, Pickard *et al.* 1982). However, accurate predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987 to 1993 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were identified in their stomach contents (Edwards *et al.* 1996, Tillman *et al.* 1996, NMFS 1997).

Avian predation on fish contributes to the loss of migrating juvenile salmonids by constraining natural and artificial production. Fish-eating birds that occur in the California Central Valley include great blue herons (*Ardea herodias*), gulls (*Larus spp*.), osprey (*Pandion haliaetus*), common mergansers (*Mergus merganser*), American white pelicans (*Pelecanus erythrorhynchos*), double-crested cormorants (*Phalacrocorax spp*.), Caspian terns (*Sterna caspia*), belted kingfishers (*Ceryle alcyon*), black-crowned night herons (*Nycticorax nycticorax*), Forster's terns (*Sterna forsteri*), hooded mergansers (*Lophodytes cucullatus*), and bald eagles (*Haliaeetus leucocephalus*, Stephenson and Fast 2005). These birds have high metabolic rates and require large quantities of food relative to their body size.

Mammals can also be an important source of predation on salmonids within the California Central Valley. Predators such as river otters (*Lutra canadensis*), raccoons (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and western spotted skunk (*Spilogale gracilis*) are common. Other mammals that take salmonid include: badger (*Taxidea taxus*), bobcat (*Linx rufis*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), mink (*Mustela vison*), mountain lion (*Felis concolor*), red fox (*Vulpes vulpes*), and ringtail (*Bassariscus astutus*). These animals, especially river otters, are capable of removing large numbers of salmon and trout from the aquatic habitat (Dolloff 1993). Mammals have the potential to consume large numbers of salmonids, but generally scavenge post-spawned salmon. In the marine environment, pinnipeds, including harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and Steller's sea lions (*Eumetopia jubatus*) are the primary marine mammals preying on salmonids (Spence *et al*. 1996). Pacific striped dolphin (*Lagenorhynchus obliquidens*) and killer whale (*Orcinus orca*) can also prey on adult salmonids in the nearshore marine environment, and at times become locally important. Southern Residents, in particular, target Chinook salmon as their preferred prey (96 percent of prey consumed during spring, summer and fall, from long-term study of resident killer whale diet; Ford and Ellis 2006). Although harbor seal and sea lion predation primarily is confined to the marine and estuarine environments, they are known to travel well into freshwater after migrating fish and have frequently been encountered in the Delta and the lower portions of the Sacramento and San Joaquin rivers. All of these predators are opportunists, searching out locations where juveniles and adults are most vulnerable, such as the large water diversions in the South Delta.

4.2.4.11 Environmental Variation

4.2.4.11.1 Natural Environmental Cycles

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

"El Niño" is an environmental condition often cited as a cause for the decline of West Coast salmonids (NMFS 1996b). El Niño is an unusual warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean [El Niño Southern Oscillation (ENSO)] resulting in reductions or reversals of the normal trade wind circulation patterns. El Niño ocean conditions are characterized by anomalous warm sea surface temperatures and changes to coastal currents and upwelling patterns. Principal ecosystem alterations include decreased primary and secondary productivity in affected regions and changes in prey and predator species distributions. Cold-water species are displaced towards higher latitudes or move into deeper, cooler water, and their habitat niches are occupied by species tolerant of warmer water that move upwards from the lower latitudes with the warm water tongue.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a sub-adult life stage.

The freshwater life history traits and habitat requirements of juvenile winter-run and fall-run are similar. Therefore, the unusual and poor ocean conditions that caused the drastic decline in returning fall-run populations coast wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run spawning population in 2007 (Oppenheim 2008). Lindley *et al*. (2009) reviewed the possible causes for the decline in Sacramento River fall-run in 2007 and 2008 for which reliable data were available. They concluded that a broad body of evidence suggested that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of fall-run. However, Lindley *et al.* (2009) recognize that the rapid and likely temporary deterioration in ocean conditions acted on top of a long-term, steady degradation of the freshwater and estuarine environment.

4.2.4.11.2 Ocean Productivity

The time at which juvenile salmonids enter the marine environment marks a critical period in their life history. Studies have shown the greatest rates of growth and energy accumulation for Chinook salmon occur during the first 1 to 3 months after they enter the ocean (Francis and Mantua 2003, MacFarlane *et al*. 2008). Emigration periods and ocean entry can vary substantially among, and even within, races in the Central Valley. For example, winter-run typically rear in freshwater for 5-9 months and exhibit a peak emigration period in March and April. Spring-run emigration is more variable and can occur in December or January (soon after emergence as fry), or from October through March (after rearing for a year or more in freshwater; CVP/SWP operations BA). In contrast to Chinook salmon, steelhead tend to rear in freshwater environments longer (anywhere from 1 to 3 years) and their period of ocean entry can span many months. Juvenile steelhead presence at Chipps Island has been documented between at least October and July (CVP/SWP operations BA). While still acknowledging this variability in emigration patterns, the general statement can be made that Chinook salmon typically rear in

freshwater environments for less than a year and enter the marine environment as subyearlings in late spring to early summer. Likewise, although steelhead life histories are more elastic, they typically enter the ocean in approximately the same time frame. This general timing pattern of ocean entry is commonly attributed to evolutionary adaptations that allow salmonids to take advantage of highly productive ocean conditions that typically occur off the California coast beginning in spring and extending into the fall (MacFarlane *et al*. 2008). Therefore, the conditions that juvenile salmonids encounter when they enter the ocean can play an important role in their early marine survival and eventual development into adults.

It is widely understood that variations in marine survival of salmon correspond with periods of cold and warm ocean conditions, with cold regimes being generally favorable for salmon survival and warm ones unfavorable (Behrenfeld *et al.* 2006, Wells *et al.* 2006). Peterson *et al.* (2006) provide evidence that growth and survival rates of salmon in the California Current off the Pacific Northwest can be linked to fluctuations in ocean conditions. An evaluation of conditions in the California Current since the late 1970s reveals a generally warm, unproductive regime that persisted until the late 1990s. This regime has been followed by a period of high variability that began with colder, more productive conditions lasting from 1999 to 2002. In general, salmon populations increased substantially during this period. However, this brief cold cycle was immediately succeeded by a 4-year period of predominantly warm ocean conditions beginning in late 2002, which appeared to have negatively impacted salmon populations in the California Current (Peterson *et al*. 2006). Evidence suggests these regime shifts follow a more or less linear pattern beginning with the amount and timing of nutrients provided by upwelling and passing "up" the food chain from plankton to forage fish and eventually, salmon. There are also indications that these same regime shifts affect the migration patterns of larger animals that prey on salmon (*e.g*., Pacific hake, sea birds) resulting in a "top-down" effect as well (Peterson *et al*. 2006).

Peterson *et al*. (2006) evaluated three sets of ecosystem indicators to identify ecological properties associated with warm and cold ocean conditions and determine how those conditions can affect salmon survival. The three sets of ecosystem indicators include: (1) large-scale oceanic and atmospheric conditions [specifically, the Pacific Decadal Oscillation (PDO) and the Multivariate ENSO Index]; (2) local observations of physical and biological ocean conditions off northern Oregon (*e.g*., upwelling, water temperature, plankton species compositions, *etc*.); and (3) biological sampling of juvenile salmon, plankton, forage fish, and Pacific hake (which prey on salmon). When used collectively, this information can provide a general assessment of ocean conditions in the northern California Current that pertain to multi-year warm or cold phases. It can also be used to develop a qualitative evaluation for a particular year of the effect these ocean conditions have on juvenile salmon when they enter the marine environment and the potential impact to returning adults in subsequent years.

The generally warmer ocean conditions in the California Current that began to prevail in late 2002 have resulted in coastal ocean temperatures remaining 1-2˚C above normal through 2005. A review of the previously mentioned indicators for 2005 revealed that almost all ecosystem indices were characteristic of poor ocean conditions and reduced salmon survival. For instance, in addition to the high sea surface temperatures, the spring transition, which marks the beginning of the upwelling season and typically occurs between March and June, was very late, postponing

upwelling until mid-July. In addition, the plankton species present during that time were the smaller organisms with lower lipid contents associated with warmer water, as opposed to the larger, lipid-rich organisms believed to be essential for salmon growth and survival throughout the winter. The number of juvenile salmon collected during trawl surveys was also lower than any other year previously sampled (going back to 1998, Peterson *et al*. 2006). Furthermore, although conditions in 2006 appeared to have improved somewhat over those observed in 2005 (*e.g*., sea surface temperature was cooler, the spring transition occurred earlier, and coastal upwelling was more pronounced), not all parameters were necessarily "good." In fact, many of the indicators were either "intermediate" (*e.g*., PDO, juvenile Chinook salmon presence in trawl surveys) or "poor" (*e.g*., copepod biodiversity, Peterson *et al.* 2006).

Updated information provided by Peterson *et al*. (2006) on the NWFSC Climate Change and Ocean Productivity website[6] shows the transition to colder ocean conditions, which began in 2007, has persisted throughout 2008. All ocean indicators point toward a highly favorable marine environment for those juvenile salmon that entered the ocean in 2008. After remaining neutral through much of 2007, PDO values became negative (indicating a cold California Current) in late 2007 and remained negative through at least August, 2008, with sea surface temperatures also remaining cold. Coastal upwelling was initiated early and will likely be regarded as average overall. Furthermore, the larger, energy-rich, cold water plankton species have been present in large numbers in 2007 and 2008. Therefore, ocean conditions in the broader California Current appear to have been favorable for salmon survival in 2007 and to a greater extent in 2008, which bodes well for Chinook salmon populations returning in 2009 and 2010[3]. These ecosystem indicators can be used to provide an understanding of ocean conditions, and their relative impact on marine survival of juvenile salmon, throughout the broader, northern portion of the California Current. However, they may not provide an accurate assessment of the conditions observed on a more local scale off the California coast.

Wells *et al*. (2008a) developed a multivariate environmental index that can be used to assess ocean productivity on a finer scale for the central California region. This index (also referred to as the Wells Ocean Productivity Index) has also tracked the Northern Oscillation Index, which can be used to understand ocean conditions in the North Pacific Ocean in general. The divergence of these two indices in 2005 and 2006 provided evidence that ocean conditions were worse off the California coast than they were in the broader North Pacific region. The Wells *et al.* (2008a) index incorporates 13 oceanographic variables and indices and has correlated well with the productivity of zooplankton, juvenile shortbelly rockfish, and common murre production along the California coast (MacFarlane *et al*. 2008). In addition to its use as an indicator of ocean productivity in general, the index may also relate to salmon dynamics due to their heavy reliance on krill and rockfish as prey items during early and later life stages. For instance, not only did the extremely low index values in 2005 and 2006 correlate well with the extremely low productivity of salmon off the central California coast in those years, but the index also appears to have correlated well with maturation and mortality rates of adult salmon from 1990-2006 in that region (Wells and Mohr 2008). Although not all of the data are currently available to determine the Wells *et al*. (2008a) index values for 2007 and 2008, there is sufficient information to provide an indication of the likely ocean conditions for those 2 years, which can then be compared to 2005 and 2006.

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[6] http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm

A review of the available information suggests ocean conditions in 2007 and 2008 have improved substantially over those observed in 2005 and 2006. For instance, the spring transition, which marks the beginning of the upwelling season and typically occurs between March and June, was earlier in 2007 and 2008 compared to 2005 and 2006. An early spring transition is often indicative of greater productivity throughout the spring and summer seasons (Wells and Mohr 2008, Peterson *et al*. 2006). Coastal upwelling, the process by which cool, nutrient rich waters are brought to the surface (perhaps the most important parameter with respect to plankton productivity), was also above average in 2007 and 2008. Moreover, coastal sea surface temperature and sea level height (representative of the strength of the California current and southern transport) values were also characteristic of improved ocean productivity (Wells and Mohr 2008). Thus, contrary to the poor ocean conditions observed in the spring of 2005 and 2006, the Wells *et al*. (2008a) index parameters available at this time indicate spring ocean conditions have been generally favorable for salmon survival off California in 2007 and 2008.

In contrast to the relatively "good" ocean conditions that occurred in the spring, the Wells *et al*. (2008a) index values for the summer of 2007 and 2008 were poor in general, and similar to those observed in 2005 and 2006. Summer sea surface temperature followed a similar pattern in both 2007 and 2008, starting out cool in June, and then rising to well above average in July before dropping back down to average in August (Wells and Mohr 2008). The strong upwelling values observed in the spring of 2007 and 2008 were not maintained throughout the summer, and instead dropped to either at or below those observed in 2005 and 2006. Finally, sea level height and spring curl values (a mathematical representation of the vertical component of wind shear which represents the rotation of the vector field), which are negatively correlated with ocean productivity, were both poor (Wells and Mohr 2008). Therefore, during the spring of 2007 and 2008, ocean conditions off California were indicative of a productive marine environment favorable for ocean salmon survival (and much improved over 2005 and 2006). However, those conditions did not persist throughout the year, as Wells *et al*. (2008a) index values observed in the summer of 2007 and 2008 were similar to those experienced in the summer of 2005 and 2006, 2 years marked by extremely low productivity of salmon off the central California coast.

Evidence exists that suggests early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and local scale, provides an indication of the role they play in salmon survival in the ocean. Moreover, when discussing the potential extinctions of salmon populations, Francis and Mantua (2003) point out that climate patterns would not likely be the sole cause but could certainly increase the risk of extinction when combined with other factors, especially in ecosystems under stress from humans. Thus, the efforts to try and gain a greater understanding of the role ocean conditions play in salmon productivity will continue to provide valuable information that can be incorporated into the management of these species and should continue to be pursued. However, the highly variable nature of these environmental factors makes it very difficult, if not impossible, to accurately predict what they will be like in the future. Because the potential for poor ocean conditions exists in any given year, and there is no way for salmon managers to control these factors, any deleterious effects endured by salmonids in the freshwater environment

can only exacerbate the problem of an inhospitable marine environment. Therefore, in order to ensure viable populations, it is important that any impacts that can be avoided prior to the period when salmonids enter the ocean must be carefully considered and reduced to the greatest extent possible.

4.2.4.11.3 Global Climate Change

Climate change is postulated to have had a negative impact on salmonids throughout the Pacific Northwest due to large reductions in available freshwater habitat (Battin *et al.* 2007). Widespread declines in springtime snow-water equivalents (SWE) have occurred in much of the North American West since the 1920s, especially since mid-century (Knowles and Cayan 2004, Mote 2006). This decrease in SWE can be largely attributed to a general warming trend in the western United States since the early 1900s (Mote *et al.* 2005, Regonda *et al.* 2005, Mote 2006), even though there have been modest upward precipitation trends in the western United States since the early 1900s (Hamlet *et al.* 2005). The largest decreases in SWE are taking place at low to mid elevations (Mote 2006, Van Kirk and Naman 2008) because the warming trend overwhelms the effects of increased precipitation (Hamlet *et al.* 2005, Mote *et al.* 2005, Mote 2006). These climactic changes have resulted in earlier onsets of springtime snowmelt and streamflow across western North America (Hamlet and Lettenmaier 1999, Regonda *et al.* 2005, Stewart *et al.* 2005), as well as lower flows in the summer (Hamlet and Lettenmaier 1999, Stewart *et al.* 2005).

The projected runoff-timing trends over the course of the 21st century are most pronounced in the Pacific Northwest, Sierra Nevada, and Rocky Mountain regions, where the eventual temporal centroid of streamflow (*i.e.* peak streamflow) change amounts to 20–40 days in many streams (Stewart *et al.* 2005). Although climate models diverge with respect to future trends in precipitation, there is widespread agreement that the trend toward lower SWE and earlier snowmelt will continue (Zhu *et al*. 2005, Vicuna *et al*. 2007). Thus, availability of water resources under future climate scenarios is expected to be most limited during the late summer (Gleick and Chalecki 1999, Miles *et al*. 2000). A 1-month advance in timing centroid of streamflow would also increase the length of the summer drought that characterizes much of western North America, with important consequences for water supply, ecosystem, and wildfire management (Stewart *et al.* 2005). These changes in peak streamflow timing and snowpack will negatively impact salmonid populations due to habitat loss associated with lower water flows, higher stream temperatures, and increased human demand for water resources.

The global effects of climate change on river systems and salmon are often superimposed upon the local effects within river systems of logging, water utilization, harvesting, hatchery interactions, and development (Bradford and Irvine 2000, Mayer 2008, Van Kirk and Naman 2008). For example, total water withdrawal in California, Idaho, Oregon and Washington increased 82 percent between 1950 and 2000, with irrigation accounting for nearly half of this increase (MacKichan 1951, Hutson *et al.* 2004), while during the same period climate change was taking place.

4.2.4.12 Non-Native Invasive Species

As currently seen in the San Francisco estuary, non-native invasive species (NIS) can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth and *Egeria densa* plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants have certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

4.2.4.13 Ecosystem Restoration

4.2.4.13.1 CALFED

Two programs included under CALFED, the Ecosystem Restoration Program (ERP) and the Environmental Water Account (EWA), were created to improve conditions for fish, including listed salmonids, in the Central Valley (CALFED 2000). Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for spring-run and steelhead production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program (EWP) has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant in anadromous salmonid reaches of priority streams controlled by dams.

This program is in the development stage and the benefits to listed salmonids are not yet clear. Clear Creek is one of five priority watersheds in the Central Valley that has been targeted for action during Phase I of the EWP.

The EWA is designed to provide water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users, particularly South of Delta water users. In early 2001, the EWA released 290 TAF of water from San Luis Reservoir at key times to offset reductions in South Delta pumping implemented to protect winter-run, Delta smelt, and splittail. However, the benefit derived by this action to winter-run in terms of number of fish saved was very small. The anticipated benefits to other Delta fish from the use of the EWA water are much higher than those benefits ascribed to listed salmonids by the EWA release.

4.2.4.13.2 Central Valley Project Improvement Act

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From the CVPIA act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run and steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Although the above highlights the benefits of the CVPIA, Cummins *et al*. (2008) documented that DOI fell considerably short in implementing the CVPIA. Cummins *et al*. (2008) acknowledge that the specific "doubling" mission itself may make little scientific or policy sense, especially within the time frames demanded (2002). However, they also stated that it is far from clear that the agencies (Reclamation and USFWS) have done what is possible and necessary to improve freshwater conditions to help these species weather environmental variability, halt their decline and begin rebuilding in a sustainable way. In their executive summary, Cummins *et al*. (2008) state the following:

> "The program effectively ignores the larger system problems that inhibit the natural production of anadromous fish:
>
> - headwaters dams that have taken away most of the spawning and rearing capacity in the valley;
> - highly regulated flows and diversions completely out of balance with natural flow regimes to which these species are adapted;

- rivers levied and channeled and disconnected from floodplains to such an extent that natural river habitats and rearing conditions are largely absent; and
- environmentally degraded conditions for fish in the Delta due to water exports, degraded water quality, entrainment, and predation that are a significant source of poorly addressed mortality.

The agencies need to fully use their authorities to understand and address the system problems, or ask Congress for additional authorities and guidance."

4.2.4.13.3 Iron Mountain Mine Remediation

EPA's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s (see Reclamation 2004 Appendix J). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

4.2.4.13.4 State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento and San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run and steelhead include water exchange programs on Mill and Deer creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (see Reclamation 2004 Chapter 15).

4.2.4.14 Additional Water Quality

In addition to the factors, above, the following provides additional information on the effect of water quality resulting from water development in the San Joaquin River basin that affect the current status of CV steelhead. Low DO levels are frequently observed in the portion of the Stockton deep water ship channel (DWSC) extending from Channel Point, downstream to Turner and Columbia Cuts. Over a 5-year period, starting in August 2000, a DO meter has recorded channel DO levels at Rough and Ready Island (Dock 20 of the West Complex). Over the course of this time period, there have been 297 days in which violations of the 5 mg/l DO criteria for the protection of aquatic life in the San Joaquin River between Channel Point and Turner and Columbia Cuts have occurred during the September through May migratory period for salmonids in the San Joaquin River (table 4-9). CDEC data indicate that DO depressions occur during all

migratory months, with significant events occurring from November through March when listed CV steelhead adults and smolts would be utilizing this portion of the San Joaquin River as a migratory corridor (table 4-6).

Table 4-9. Monthly occurrences of dissolved oxygen depressions below the 5mg/L criteria in the Stockton deep water ship channel (Rough and Ready Island DO monitoring site), water years 2000 to 2004.

Month	Water Year					Monthly Sum
	2000-01	2001-02	2002-03	2003-04	2004-05	
September	0	26 [b]	30 [b]	16 [b]	30 [b]	102
October	0	0	7	0	4	11
November	0	0	12	0	3	15
December	6	4*	13	2	13	38
January	3	4	19	7	0	33
February	0	25	28	13	0	66
March	0	7	9	0	0	16
April	0	4	4	0	0	8
May	2 [a]	0	2	4	0	8
Annual Sum	11	70	124	42	50	**Total=297**

[a] Suspect Data – potentially faulty DO meter readings

[b] Wind driven and photosynthetic daily variations in DO level; very low night-time DO levels, high late afternoon levels

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of water in the dredged ship channel. During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowers the DO in the adjacent DWSC near the West Complex. In addition to the negative effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the DWSC as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. Hallock *et al.* (1970) reported that levels of DO below 5 mg/L delay or block fall-run.

4.2.4.15 Summary

For winter-run, spring-run, and CV steelhead, the construction of high dams for hydropower, flood control, and water supply resulted in the loss of vast amounts of upstream habitat (*i.e.*, approximately 80 percent, or a minimum linear estimate of over 1,000 stream miles), and often resulted in precipitous declines in affected salmonid populations. For example, the completion of Friant Dam in 1947 has been linked with the extirpation of spring-run in the San Joaquin River upstream of the Merced River within just a few years. The reduced populations that remain below Central Valley dams are forced to spawn in lower elevation tailwater habitats of the mainstem rivers and tributaries that were previously not used for this purpose. This habitat is entirely dependent on managing reservoir releases to maintain cool water temperatures

suitable for spawning, and/or rearing of salmonids. This requirement has been difficult to achieve in all water year types and for all life stages of affected salmonid species. Steelhead, in particular, seem to require the qualities of small tributary habitat similar to what they historically used for spawning; habitat that is largely unavailable to them under the current water management scenario. Winter-run, spring-run, and CV steelhead have all been negatively affected by the production of hatchery fish associated with the mitigation for the habitat lost to dam construction (*e.g.*, from genetic impacts, increased competition, exposure to novel diseases, *etc*.).

Land-use activities such as road and levee construction, urban development, logging, mining, agriculture, and recreation are pervasive and have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as: alteration of natural flow regimes; installation of bank revetment; and building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek Restoration Project) have not yet been implemented and benefits to listed salmonids from the EWA have been less than anticipated.

Figure 4-12. Geographic Range (light shading) of the Southern Resident Killer Whale DPS. Source: Wiles (2004).

4.2.5 Southern Resident Killer Whales

4.2.5.1 Current Rangewide Status of the Species

The Southern Resident killer whales DPS was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). Southern Residents are designated as

"depleted"[7] under the Marine Mammal Protection Act (MMPA; May 29, 2003, 68 FR 31980). This section summarizes information taken largely from the final recovery plan for Southern Residents (NMFS 2008a), as well as new data that became available more recently.

4.2.5.2 Range and Distribution

Southern Residents are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia (figure 4-12). There is limited information on the distribution and habitat use of Southern Residents along the outer Pacific Coast. Southern Residents are highly mobile and can travel up to 86 nautical miles (nmi, or 10 miles) in a single day (Erickson 1978, Baird 2000). To date, there is no evidence that Southern Residents travel further than 31 miles offshore (Ford *et al*. 2005).

Southern Residents spend considerable time from late spring to early autumn in inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound; Bigg 1982, Ford *et al*. 2000, Krahn *et al*. 2002; table 4-10). Typically, J, K and L pods are increasingly present in May or June and spend considerable time in the core area of Georgia Basin and Puget Sound until at least September. During this time, pods (particularly K and L) make frequent trips from inland waters to the outer coasts of Washington and southern Vancouver Island, which typically last a few days (Ford *et al*. 2000).

Table 4-10. Average number of days spent by Southern Resident killer whales in inland and coastal waters by month, 2003-2007 (Hanson and Emmons, unpubl. report).

Months	Lpod		Jpod		Kpod	
	Days Inland	Days Coastal	Days Inland	Days Coastal	Days Inland	Days Coastal
Jan	5	26	3	29	8	23
Feb	0	28	4	24	0	28
March	2	29	7	24	2	29
April	0	30	13	17	0	30
May	2	29	26	5	0	31
June	14	16	26	5	12	18
July	18	13	24	7	17	14
Aug	17	15	17	15	17	14
Sep	20	10	19	11	17	13
Oct	12	19	14	17	8	24
Nov	5	25	13	17	7	23
Dec	1	30	8	23	10	21

[7] Defined by the MMPA as any case in which (1) the Secretary, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under MMPA title II, determines that a species or population stock is below its optimum sustainable population; (2) a State, to which authority for the conservation and management of a species or population stock is transferred under section 109, determines that such species or stock is below its optimum sustainable population; or (3) a species or population stock is listed as an endangered species or a threatened species under the ESA.

Late summer and early fall movements of Southern Residents in the Georgia Basin have remained fairly consistent since the early 1970s, with strong site fidelity shown to the region as a whole, however presence in inland waters in the fall has increased in recent years (NMFS 2008a). During early autumn, J pod in particular expands their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Osborne 1999). During late fall, winter, and early spring, the ranges and movements of the Southern Residents are less well known. Sightings through the Strait of Juan de Fuca in late fall suggest that activity shifts to the outer coasts of Vancouver Island and Washington (Krahn *et al*. 2002).

The Southern Residents were formerly thought to range southward along the coast to about Grays Harbor (Bigg *et al*. 1990) or the mouth of the Columbia River (Ford *et al*. 2000). However, recent sightings of members of K and L pods in Oregon (in 1999 and 2000) and California (in 2000, 2003, 2005, 2006 and 2008) have considerably extended the southern limit of their known range (NMFS 2008b). There have been 45 verified sightings or strandings of J, K or L pods along the outer coast from 1975 to present with most made from January through April (table 4-11). These include 16 records off Vancouver Island and the Queen Charlottes, 15 off Washington, 4 off Oregon, and 10 off central California. Most records have occurred since 1996, but this may be because of increased viewing effort along the coast in recent years. Some sightings in Monterey Bay, California have coincided with large runs of salmon, with feeding witnessed in 2000 (Black *et al*. 2001). However, when Southern Residents were sighted in Monterey Bay during 2008, salmon runs were expected to be very small. L pod was also seen feeding on unidentified salmon off Westport, Washington, in March 2004 during the spring Chinook salmon run in the Columbia River (M. B. Hanson, pers. obs. *op. cit*. Krahn *et al*. 2004).

4.2.5.3 Factors Responsible for the Current Status of Southern Residents

Several potential factors identified in the final recovery plan for Southern Residents may have caused the decline or may be limiting recovery of the DPS. These are: quantity and quality of prey; toxic chemicals, which accumulate in top predators; and disturbance from sound and vessel effects. Oil spills are also a potential risk factor for this species. Research has yet to identify which threats are most significant to the survival and recovery of Southern Residents. It is likely that multiple threats are acting in concert to impact the whales.

4.2.5.3.1 Prey

Healthy killer whale populations depend on adequate prey levels. A discussion of the prey requirements of Southern Residents is followed by an assessment of threats to the quality and quantity of prey available.

Table 4-11. Known sightings of Southern Resident killer whales along the outer Pacific Ocean coast (NMFS 2008a).

Date	Location	Identification	Source	Comments
British Columbia outer coast				
31 Jan 1982	Barkley Sound, west coast of Vancouver Island	L pod	J. Ford, PBS/DFO	Off shore of Sound
21 Oct 1987	Coal Harbor, north Vancouver Island	Part of L pod	J. Ford, PBS/DFO	Were way up inlet a long distance from open ocean
3 May 1989	Tofino, west coast of Vancouver Island	K pod	WMSA	--
4 July 1995	Hippa Is., south Queen Charlotte Islands	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
May 1996	Cape Scott, north Vancouver Island	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
4 Sep 1997	Off Carmanah Point, sw Vancouver Island	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
14 Apr 2001	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
27 Apr 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
12 May 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
30 May 2003	Langara Is., Queen Charlotte Islands	L pod	M. Joyce, DFO	
17 May 2004	Tofino, west coast of Vancouver Island	K and L pods	M. Joyce, DFO	
9 June 2005	West of Cape Flattery, Washington in Canadian waters	L pod	SWFSC	Whales were exiting the Strait of Juan de Fuca
7 Sep 2005	West of Cape Flattery, Washington in Canadian waters	L pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
18 Mar 2006	North of Neah Bay, Washington in Canadian waters	J pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
8 May 2006	Off Brooks Peninsula, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
1 Dec 2006	Johnstone Strait	L pod	J. Ford PBS/DFO	
Washington Outer Coast				
4 Apr 1986	Off Westport/Grays Harbor	L pod	J. Ford, PBS/DFO	
13 Sep 1989	West of Cape Flattery	L pod	J. Calambokidis, Cascadia Research	

Date	Location	Identification	Source	Comments
17 Mar 1996	3 km offshore Grays Harbor	L pod	J. Calambokidis, Cascadia Research	
20 Sep 1996	Off Sand Point (29 km south of Cape Flattery)	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
15 Apr 2002	Long Beach	L60	D. Duffield, Portland State Univ.	Stranded whale identified by K. Balcomb, CWR
11 Mar 2004 **13 Mar 2004**	Grays Harbor Off Cape Flattery	L pod J pod	B. Hanson, NWFSC B. Hanson, NWFSC	Whales were exiting Strait of Juan de Fuca
22 Mar 2005	Fort Canby-North Head	L pod	J. Zamon, NWFSC	
23 Oct 2005	Off Columbia River	K pod	SWFSC, Cscape	
29 Oct 2005	Off Columbia River	K and L pods	SWFSC, Cscape	
1 Apr 2006	Westport	L pods	PAL	
6 Apr 2006	Westport	K and L pods	Cascadia Research	
13 May 2006	Westport	K and L pods	PAL	
26 May 2006	Westport	K pod	PAL	
29 May 2006	Westport	K pod	PAL	
Oregon				
Apr 1999	Off Depoe Bay	L pod	J. Ford, PBS/DFO	
Mar 2000	Off Yaquina Bay	L pod	J. Ford, PBS/DFO	Seen week of Mar 20
14 Apr 2000	Off Depoe Bay	Southern Residents	K. Balcomb, CWR	
30 Mar 2006	Off Columbia River	K and L pods	B. Hanson, NWFSC	
California				
29 Jan 2000	Monterey Bay	K and L pods	N. Black, MBWW	Seen and photographed feeding on fish
13 Mar 2002	Monterey Bay	L pod	N. Black, MBWW	
16 Feb 2005	Farallon Is	L pod	K. Balcomb, CWR	
26 Jan 2006	Pt. Reyes	L pod	S. Allen	
24 Jan 2007	San Francisco Bay	K pod	N. Black, MBWW	
18 Mar 2007	Fort Bragg	L pod		Reported on CWR website
24-25 Mar 2007	Monterey	K and L pods		Reported on CWR website
30 Oct 2007	Bodega Bay	L pod	Cascadia Research	
27 Jan 2008	Monterey	L pod	N. Black/K. Balcomb	
2 Feb 2008	Monterey	K and L pods	N. Black/K. Balcomb	

4.2.5.3.1.1 Prey Requirements

Southern Residents consume a variety of fish species (22 species) and one species of squid (Scheffer and Slipp 1948; Ford *et al*. 1998, 2000; Ford and Ellis 2006; Saulitis *et al*. 2000), but salmon are identified as their preferred prey (96 percent of prey consumed during spring, summer and fall, from long-term study of resident killer whale diet; Ford and Ellis 2006). Feeding records for Southern and Northern Residents show a strong preference for Chinook salmon (72 percent of identified salmonids) during late spring to fall (Ford and Ellis 2006). Chum salmon (23 percent) are also taken in significant amounts, especially in autumn. Other salmonids eaten include coho salmon (2 percent), pink salmon (3 percent), steelhead (<1 percent), and sockeye salmon (*O. nerka* < 1 percent). The non-salmonids included Pacific herring, sablefish, Pacific halibut, quillback and yelloweye rockfish. Chinook salmon were preferred despite the much lower abundance of Chinook salmon in the study area in comparison to other salmonids (primarily sockeye salmon), probably because of the species' large size, high fat and energy content and year-round occurrence in the area. Killer whales also captured older (*i.e*., larger) than average Chinook salmon (Ford and Ellis 2006).

Southern Residents are the subject of ongoing research, including direct observation, scale sampling and fecal sampling. Preliminary results of this research provide the best available scientific information on diet composition of Southern Residents in inland waters – the results are specific to Southern Residents, are based on direct observation, and produce three different lines of evidence. This research provides information on (1) the percentage of Chinook salmon in the whales' diet, (2) the predominant river of origin of those Chinook salmon, and (3) the age and/or size of the Chinook salmon. Some of this information is supported by other research and analysis. The results are specific to inland waters.

4.2.5.3.1.2 Percentage of Chinook Salmon

From May to September, when Southern Residents spend a high proportion of their time in the "core summer area" (San Juan Islands), their diet consists of approximately 86 percent Chinook salmon and 14 percent other salmon species (n=125 samples; Hanson *et al*. 2007, NWFSC unpubl. data). During all sampling months combined (roughly May to December) their diet is approximately 69 percent Chinook salmon and 31 percent other salmon species (n=160 samples in inland waters). During fall months in inland waters, when some Southern Residents are sighted inside Puget Sound, preliminary results indicate an apparent shift to chum salmon (Hanson *et al.* 2007, NWFSC unpubl. data).

These data on the predominance of Chinook salmon in the killer whales' diet are consistent with all previous studies of Southern and Northern Resident killer whales diet composition, described above. Killer whales may favor Chinook salmon because Chinook salmon have the highest lipid content (Stansby 1976, Winship and Trites 2003), largest size, and highest caloric value per kilogram of any salmonid species (Osborne 1999, Ford and Ellis 2006). The preference of

Chinook salmon may also relate to size-selectivity. When available, Chinook salmon tend to be consumed more often than chum salmon (2nd largest, Ford and Ellis 2006), and chum salmon appear to be favored over pink salmon (Saulitus *et al*. 2000).

4.2.5.3.1.3 River of Origin

The ongoing research provides insight into the river of origin of Chinook salmon consumed by the Southern Residents. Genetic analysis of fecal and prey samples from the research indicates that Southern Residents consume Fraser River origin Chinook salmon, as well as salmon from Puget Sound, Washington and Oregon coasts, the Columbia River, and Central Valley California (Hanson *et al.* 2007, NWFSC unpubl. data).

4.2.5.3.1.4 Age and/or Size

The ongoing research discussed above also collected salmon scales from killer whale feeding events and used them to evaluate the age of the salmon consumed, finding that Southern Residents prefer older (hence larger) Chinook salmon (NWFSC unpubl. data). This finding is consistent with that of Ford and Ellis (2006) who also evaluated the age of prey from killer whale feeding events. Ford and Ellis (2006) estimated size selectivity by comparing the age of fish consumed to the age distribution of fish in the area based on catch data obtained from the Pacific Salmon Commission (table 3 and figure 5 in Ford and Ellis 2006). NWFSC evaluated the age of kills relative to the age distribution of Chinook salmon in a fisheries management model, FRAM (table 4-12; NMFS 2008, Ward *et al.* unpubl. report).

Table 4-12. Mean abundance by age class (%) and kills by age class (%).

Age	NWFSC (n=75)		Ford & Ellis (2006; n=127)	
	% Abundance	% Kills	% Abundance	% Kills
Age 2	59.0	-	9.6	0.7
Age 3	25.8	10.4	35.7	11.3
Age 4	13.4	45.5	48.0	55.9
Age 5	1.7	41.6	6.5	31.5

There is also theoretical support for size-selective prey preferences. Optimal foraging theory predicts that animals maximize the rate and efficiency of energy intake (reviewed by Pyke *et al*. 1977), this is generally done by consuming prey that maximize the energy intake relative to handling time (Charnov 1976). For apex predators, like killer whales, there are few risks associated with foraging (smaller organisms face risk of predation, killer whales do not), and prey choice is likely determined by the encounter rate of preferred species relative to sub-optimal species. Additional empirical evidence supporting the selection of large prey items has been found in a variety of species, including selection of sockeye salmon by brown bears (Ruggerone *et al*. 2000, Carlson and Quinn 2007).

Less is known about diet preferences of Southern Residents off the Pacific Coast. Although there are no fecal or prey samples or direct observations of predation events (where the prey was identified to species) in coastal waters, it is likely that salmon are also important when the whales are in coastal waters. Chemical analyses support the importance of salmon in the year-round diet of Southern Residents (Krahn *et al.* 2002, Krahn *et al.* 2007). Krahn *et al*. (2002) examined the ratios of DDT (and its metabolites) to various PCB compounds in the whales, and concluded that the whales feed primarily on salmon throughout the year rather than other fish species. Krahn *et al*. (2007) analyzed stable isotopes from tissue samples collected in 1996 and 2004/2006. Carbon and nitrogen stable isotopes indicated that J and L pods consumed prey from similar trophic levels in 2004/2006 and showed no evidence of a large shift in the trophic level of prey consumed by L pod between 1996 and 2004/2006. The preference of Southern Residents for Chinook salmon in inland waters, even when other species are more abundant, combined with information indicating that the killer whales consume salmon year round, makes it reasonable to expect that Southern Residents likely prefer Chinook salmon when available in coastal waters.

4.2.5.3.1.5 Quantity of Prey

It is uncertain to what extent long-term or more recent declines in salmon abundance contributed to the decline of the Southern Resident DPS, or whether current salmon levels are adequate to support the survival and recovery of the Southern Residents. When prey is scarce, whales must spend more time foraging than when it is plentiful. Increased energy expenditure and prey limitation could lead to lower reproductive rates and higher mortality rates. Food scarcity could cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function (discussed further below).

Ford *et al*. (2005) correlated coastwide reduction in Chinook salmon abundance (Alaska, British Columbia, and Washington) with decreased survival of resident killer whales (Northern and Southern Residents), but changes in killer whale abundance have not been definitively linked to local areas or changes in specific salmon stock groups. Ward *et al*. (in review) correlated Chinook salmon abundance trends with changes in fecundity of Southern Residents, and reported the probability of calving increased by 50 percent between low and high Chinook salmon abundance years. Results indicate the Chinook salmon abundance indices from the West Coast of Vancouver Island are an important predictor of the relationship.

NMFS estimated that the Southern Resident population could need approximately 3.74 billion kilocalories annually from Chinook salmon across their coastal range (NMFS 2008). This estimate incorporated the 2008 age and sex structure of the Southern Resident population, and assumed a high diet composition of Chinook salmon (86 percent, as referenced above). The size and energy content of Chinook salmon vary by age, stock, and season, amoung other factors. We provide a simplified estimate of Chinook salmon needed by the Southern Resident population in their coastal range based on a size range of Chinook salmon (fork length: 465 to 777 mm) that Southern Residents are likely to select (Table 7.9.2.1-1 in NMFS 2008). We use

the size range to evaluate a range in kilocalories per Chinook salmon (2,121 to 10,531 kilocalories) based on a regression model of fork length to kilocalories (O'Neill *et al*. in prep). Based on these estimates, Southern Residents may need from approximately 356,000 to 1.76 million to Chinook salmon annually across their coastal range.

Human influences have had profound impacts on the abundance of many prey species in the northeastern Pacific during the past 150 years, including salmon. The health and abundance of wild salmon stocks have been negatively affected by altered or degraded freshwater and estuarine habitat (*i.e*., hydro-power systems, urbanization, forestry and agriculture), harmful artificial propagation practices, and overfishing (see Status sections for Chinook salmon, above). Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fish, birds, and marine mammals, including killer whales.

While wild salmon stocks have declined in many areas, hatchery production has been generally strong. Hatchery production contributes a significant component of the salmon prey base returning to watersheds within the range of Southern Residents (Pacific Salmon Commission Joint Chinook Technical Committee 2008). Although hatchery production has off-set some of the historical declines in the abundance of wild salmon within the range of Southern Residents, hatcheries also pose risks to wild salmon populations. In recent decades, managers have been moving toward hatchery reform, and are in the process of reducing risks identified in hatchery programs, through region-wide recovery planning efforts and hatchery program reviews. Healthy wild salmon populations are important to the long-term maintenance of prey populations available to Southern Residents, because it is uncertain whether a hatchery only stock could be sustained indefinitely.

Salmon abundance is also substantially affected by climate variability in freshwater and marine environments, particularly by conditions during early life-history stages of salmon (review in NMFS 2008b). Sources of variability include inter-annual climatic variations (*e.g*., El Niño and La Niña), longer-term cycles in ocean conditions (*e.g*., PDO, Mantua *et al*. 1997), and ongoing global climate change. For example, climate variability can affect ocean productivity in the marine environment and water storage (*e.g*., snow pack) and in-stream flow in the freshwater environment. Early life-stage growth and survival of salmon can be negatively affected when climate variability results in conditions that hinder ocean productivity (*e.g*., Scheurell and Williams 2005) and/or water storage (*e.g*., Independent Scientific Advisory Board 2007) in marine and freshwater systems, respectively. However, severe flooding in freshwater systems may constrain salmon populations (NMFS 2008b). The availability of adult salmon – prey of Southern Residents – may be reduced in years following unfavorable conditions to the early life-stage growth and survival of salmon. The effects of large-scale environmental variation on salmon populations are discussed in more detail in section 4.2.4.11.

4.2.5.3.1.6 Quality of Prey

Contaminant levels in salmon affect the quality of Southern Resident prey. Contaminants enter fresh and marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Recent studies have documented high concentrations of PCBs, DDTs, and polybrominated diphenylethers (PBDE) in killer whales (Ross *et al*. 2000, Ylitalo *et al*. 2001, Reijnders and Aguilar 2002, Krahn *et al*. 2004). As top predators, when killer whales consume contaminated prey they accumulate the contaminants in their blubber. When prey is scarce, killer whales metabolize their blubber and the contaminants are mobilized (Krahn *et al*. 2002). Nursing females transmit large quantities of contaminants to their offspring. The mobilized contaminants can reduce the killer whales' resistance to disease and can affect reproduction. Chinook salmon contain higher levels of some contaminants (*i.e*., PCBs) than other salmon species (O'Neill *et al*. 2005). Only limited information is available for contaminant levels of Chinook salmon along the west coast (*i.e*., higher PCB and PBDE levels may distinguish Puget Sound origin stocks, whereas higher DDT-signature may distinguish California origin stocks; Krahn *et al*. 2007).

Size of individual salmon could affect the foraging efficiency required by Southern Residents. As discussed above, available data suggests that Southern Residents prefer larger prey. In general, the literature indicates a historical decrease in salmon age, size, or size at a given age. Hypotheses advanced to explain declining body size are density-dependent growth and selection of larger, older fish by selective fisheries. Bigler *et al*. (1996) found a decreasing average body size in 45 of 47 salmon populations in the Northern Pacific. They also found that body size was inversely related to population abundance, and speculated that hatchery programs during the 1980s and 1990s increased population sizes, but reduced growth rates due to competition for food in the ocean. Fish size is influenced by factors such as environmental conditions, selectivity in fishing effort through gear type, fishing season or regulations, and hatchery practices. The available information on size is also confounded by factors including inter-population difference, when the size was recorded, and differing data sources and sampling methods (review in Quinn 2005).

Southern Residents likely consume both natural and hatchery salmon (Barre 2008). The best available information does not indicate that Southern Residents would be affected differently by consuming natural or hatchery salmon [*i.e*., no general pattern of differences in size, run-timing, or ocean distribution (*e.g*., Nickum *et al*. 2004, NMFS 2008c, Weitkamp and Neely 2002)]. Therefore, there is no scientific evidence to generally distinguish the quality of hatchery salmon from natural salmon as prey of Southern Residents across their range.

4.2.5.3.2 Contaminants

Many types of chemicals are toxic when present in high concentrations, including organochlorines, PAHs, and heavy metals. Emerging contaminants such as brominated flame

retardants (BFRs) and perfluorinated compounds are increasingly being linked to harmful biological impacts as well.

Persistent contaminants, such as organochlorines, are ultimately transported to the oceans, where they enter the marine food chain. Organochlorines are also highly fat soluble, and accumulate in the fatty tissues of animals (O'Shea 1999, Reijnders and Aguilar 2002). Bioaccumulation through trophic transfer allows relatively high concentrations of these compounds to build up in top-level marine predators, such as marine mammals (O'Shea 1999). Killer whales are candidates for accumulating high concentrations of organochlorines because of their high position in the food web and long life expectancy (Ylitalo *et al*. 2001, Grant and Ross 2002). Their exposure to these compounds occurs exclusively through their diet (Hickie *et al*. 2007).

High levels of persistent organic pollutants (POPs) such as PCBs and DDT are documented in Southern Resident (Ross *et al*. 2000, Ylitalo *et al*. 2001). These and other chemical compounds have the ability to induce immune suppression, impair reproduction, and produce other adverse physiological effects, as observed in studies of other marine mammals (review in NMFS 2008a). Immune suppression may be especially likely during periods of stress and resulting weight loss, when stored organochlorines are released from the blubber and become redistributed to other tissues (Krahn *et al*. 2002). Although the ban of several contaminants, such as DDT, by Canada and the United States in the 1970s resulted in an initial decline in environmental contamination, Southern Residents may be slow to respond to these reductions because of their body size and the long duration of exposure over the course of their life spans, which is up to 80-90 years for females and 60-70 years for males (Hickie *et al*. 2007).

4.2.5.3.3 Sound and Vessel Effects

Vessels have the potential to affect whales through the physical presence and activity of the vessel, increased underwater sound levels generated by boat engines, or a combination of these factors. Vessel strikes are rare, but do occur and can result in injury or mortality (Gaydos and Raverty 2007). In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson *et al*. 1995, Gordon and Moscrop 1996, National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior.

Killer whale mortalities from vessel strikes have been reported in both Northern and Southern Resident killer whale populations. Although rare, collisions between vessels and killer whales could result in serious injury. Other impacts from vessels are less obvious, but may negatively affect the health of killer whales. The presence of vessels may alter killer whale behavior, including faster swimming, less predictable travel paths, shorter or longer dive times, moving into open water, and altering normal behavioral patterns at the surface (Kruse 1991, Williams *et al.* 2002a, Bain *et al*. 2006, Luseau et al. 2009, Williams et al. 2009, Noren In Review). Chemicals such as unburned fuel and exhaust may be inhaled or ingested, which could contribute to toxic loads (Bain *et al*. 2006). Noise from vessel traffic may mask echolocation signals (Bain

and Dahlheim 1994, Holt 2008), which reduces foraging efficiency or interferes with communication. The sound from vessels may also contribute to stress (Romano *et al*. 2003) or affect distribution of animals (Bejder *et al*. 2006).

Southern Residents are the primary driver for a multi-million dollar whale watching industry in the Pacific Northwest. Commercial whale watching vessels from both the U.S. and Canada view Southern Residents when they are in inland waters in summer months. Mid-frequency sonar generated by military vessels also has the potential to disturb killer whales. To date, there are no directed studies concerning the impacts of military mid-frequency sonar on killer whales, but observations of unusual whale behavior during an event that occurred in the Strait of Juan de Fuca and Haro Strait in 2003 illustrate that mid-frequency sonar can cause behavioral disturbance (NMFS 2004).

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. Increased levels of anthropogenic sound from vessels and other sources have the potential to mask echolocation and other signals used by the species, as well as to temporarily or permanently damage hearing sensitivity. Exposure to sound may therefore be detrimental to survival by impairing foraging and other behavior, resulting in a negative energy balance (Bain and Dahlheim 1994; Gordon and Moscrop 1996; Erbe 2002; Williams *et al*. 2002a, 2002b, 2006; Holt 2008). In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano *et al*. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop 1996).

4.2.5.3.4 Oil Spills

Exposure to petroleum hydrocarbons released into the marine environment from oil spills and other discharge sources represents another potentially serious health threat to killer whales in the northeastern Pacific. Oil spills are also potentially destructive to prey populations and therefore may adversely affect killer whales by reducing food availability.

Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks (Grant and Ross 2002). In marine mammals, acute exposure can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci and St. Aubin 1990). Vapors inhaled at the water's surface and hydrocarbons ingested during feeding are the likely pathways of exposure. Matkin (1994) reported that killer whales did not attempt to avoid oil-sheened waters following the Exxon Valdez oil spill in Alaska. Retrospective evaluation shows it is highly likely that oil exposure contributed to deaths of resident and transient pods of killer whales that frequented the area of the massive Exxon Valdez oil spill in Prince William Sound, Alaska, in 1989 (Matkin *et al*. 2008). The cohesive social structure of the Southern Residents puts them at risk for a catastrophic oil spill that could affect the entire DPS when they are all in the same place at the same time.

4.2.5.4 Range-Wide Status and Trends

Southern Residents are a long-lived species, with late onset of sexual maturity (review in NMFS 2008a). Females produce a low number of surviving calves over the course of their reproductive life span (an average of 5.3 surviving calves over an average reproductive lifespan of 25 years; Olesiuk *et al*. 2005). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg *et al*. 1990, Baird 2000, Ford *et al*. 2000). Groups of related matrilines form pods. Three pods – J, K, and L – make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of the J clan.

The historical abundance of Southern Residents is estimated from 140 to 200 whales. The minimum estimate (~140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time of the captures. The maximum estimate (~200) is based on a recent genetic analysis of microsatellite DNA (May 29, 2003, 68 FR 31980).

At present, the Southern Resident population has declined to essentially the same size that was estimated during the early 1960s, when it was likely depleted (Olesiuk *et al*. 1990, figure 4-13). Since censuses began in 1974, J and K pods steadily increased; however, the population suffered an almost 20 percent decline from 1996-2001, largely driven by lower survival rates in L pod. There were increases in the overall population from 2002-2007, however, the population declined in 2008 with 85 Southern Residents counted, 25 in J pod, 19 in K pod and 41 in L pod. Two additional whales have been reported missing since the 2008 census count. Representation from all three pods is necessary to meet biological criteria for Southern Resident killer whale downlisting and recovery (NMFS 2008a).

4.2.5.5 Extinction Risk

A PVA for Southern Residents was conducted by the BRT (Krahn *et al*. 2004). Demographic information from the 1970s to fairly recently (1974-2003, 1990-2003, and 1994-2003) were considered to estimate extinction and quasi-extinction risk. "Quasi-extinction" was defined as the stage at which 10 or fewer males or females remained, or a threshold from which the population was not expected to recover. The model evaluated a range in Southern Resident survival rates, based on variability in mean survival rates documented from past time intervals (highest, intermediate, and lowest survival). The model used a single fecundity rate for all simulations. The study considered seven values of carrying capacity for the population ranging from 100 to 400 whales, three levels of catastrophic event (*e.g*., oil spills and disease outbreaks) frequency ranging from none to twice per century, and three levels of catastrophic event magnitude in which 0, 10, or 20 percent of the animals died per event. Analyses indicated that the Southern Residents have a range of extinction risk from 0.1 to 18.7 percent in 100 years and 1.9 to 94.2 percent in 300 years, and a range of quasi-extinction risk from 1 to 66.5 percent in 100 years and 3.6 to 98.3 percent in 300 years (table 4-13). The population is generally at greater risk of extinction over a longer time horizon (300 years) than over a short time horizon

(100 years). There is a greater extinction risk associated with increased probability and magnitude of catastrophic
events.

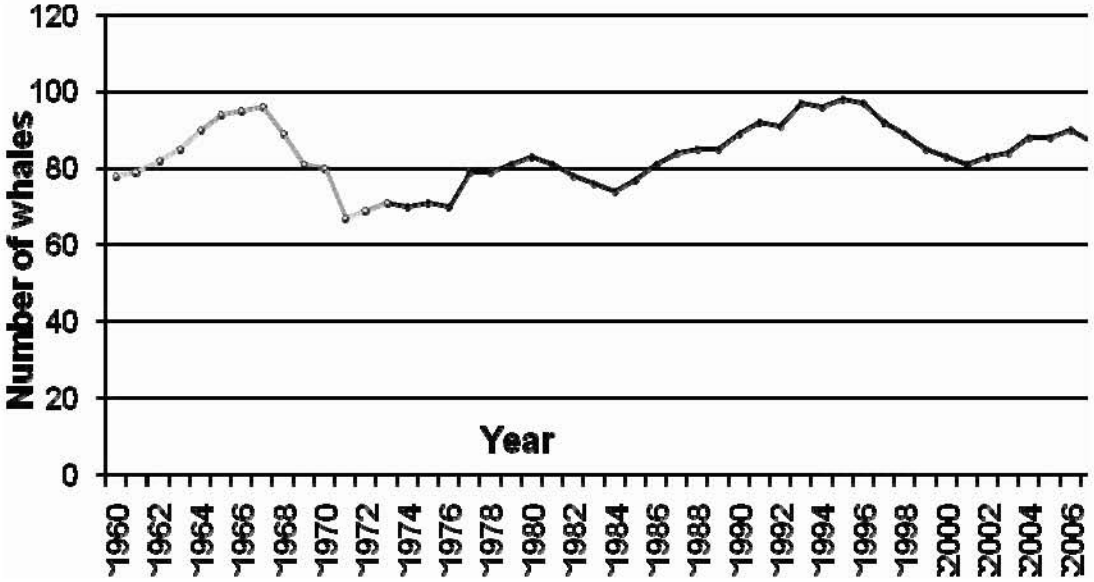


Figure 4-13. Population size and trend of Southern Resident killer whales, 1960-2008. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk *et al*. (1990). Data from 1974-2008 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data). Data for these years represent the number of whales present at the end of each calendar year except for 2008, when data extend only through July.

Table 4-13. Range of extinction and quasi-extinction risk for Southern Resident killer whales in 100 and 300 years, assuming a range in survival rates (depicted by time period), a constant rate of fecundity, between 100 and 400 whales, and a range catastrophic probabilities and magnitudes (Krahn *et al.* 2004).

Time Period	Extinction Risk (%)		Quasi-Extinction Risk (%)	
	100 yrs	300 yrs	100 yrs	300 yrs
highest survival	0.1 – 2.8	1.9 – 42.4	1 – 14.6	3.6 – 67.7
intermediate survival	0.2 – 5.2	14.4 – 65.6	6.1 – 29.8	21.4 – 85.3
lowest survival	5.6 – 18.7	68.2 – 94.2	39.4 – 66.5	76.1 – 98.3

5.0 ENVIRONMENTAL BASELINE

The environmental baseline includes "the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all

proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR 402.02). The environmental baseline provides a past, present, and future condition to which we add the effects of operating the proposed action, as required by regulation ("Effects of the action" in 50 CFR 402.02). Section 2.3.3 describes our approach to characterizing the environmental baseline for the proposed ongoing action.

The action area for the proposed action encompasses the entire freshwater range or a large portion of the freshwater range of the listed fish species and their proposed or designated critical habitat in this consultation. Therefore, we refer the reader to the *Status of the Species* section for general information on the species' biology, ecology, status, and population trends at the species scale. We organized this section of the Opinion consistent with how Reclamation presented the analysis in the CVP/SWP operations BA, that is, by division. The first part of each division section is a description and characterization of the current status of the species and proposed or designated critical habitat. In order to understand the current stress regime that the listed species and their critical habitats are subjected to, the second part of each division section is a description of the historical condition of the species and their habitats. Finally, each division has a section titled "Future Baseline Excluding CVP/SWP Effects." This is not NMFS' attempt to describe a "no project operations" scenario. Rather, this section identifies many of the major existing stressors that the listed species and their proposed or designated critical habitats are exposed to at the same time they will be exposed to the stressors of the proposed operations. The exception to the above organization is climate change, which is a large scale phenomenon that does not fit within the geographic boundaries of the divisions. Therefore, this environmental baseline section begins with a discussion of climate change, which is part of the future baseline. The action area encompasses a portion of the marine range of Southern Residents, however, the status of Southern Residents in the action area is the same as that described for the species as a whole and so is not repeated in this section. The species status section on Southern Residents describes the stressors that affect their likelihood of survival and recovery in the wild.

5.1 Climate Change as Part of the Future Baseline

Climate change is a global environmental phenomenon that would occur irrespective of any operations of the CVP or SWP. Appendix R of the CVP/SWP operations BA provides an analysis of potential climate change implications for the proposed action. The analysis was scoped to illustrate how future operations and system conditions are sensitive to a range of future climate and sea level possibilities that may occur during the consultation horizon of the proposed action (*i.e.*, 2030). The base model for the climate change scenarios is study 8.0, that is, the effects of climate change are added to the effects of the future full build-out scenario in year 2030.

Study 9 suite encompasses a range of the following five climate change projections: (1) Study 9.1: 1 foot sea level rise; (2) Study 9.2: wetter, less warming; (3) Study 9.3: wetter, more warming; (3) Study 9.4: drier, less warming; and (4) Study 9.5: drier, more warming. In general, Study 9.2 shows relatively more available water for storage, instream flows, and Delta pumping. That scenario also shows less negative effects to the listed species and their proposed or designated critical habitats. The other four studies showed more negative effects to the listed

species and their proposed and designated critical habitats relative to the base model of future full buildout in 2030.

The impact of climate change in the future introduces greater uncertainty into the way in which water is managed in California. The historic hydrologic pattern represented by CALSIM II modeling in CVP/SWP operations (past 82 years of record) can no longer be solely relied upon to forecast the future. Precipitation and runoff patterns are changing, creating increased uncertainty for ecosystem functions. The average snowpack in the Sierra Nevada decreased by 10 percent in the last century, which translates into a loss of 1.5 MAF of snowpack storage (DWR 2008). California's air temperature has already increased by 1°F, mostly at night in winter, with the higher elevations experiencing the highest increase. A corresponding increase in water temperature is likely to reduce the available habitat for species that depend on cold water like spring-run that require over summer holding pools. Increasing water temperatures will also accelerate biological processes that impact anadromous fish like increased algae growth and decreased dissolved oxygen. Climate change will affect the entire life cycle of salmonids and sturgeon through warmer ocean periods, changes in age and size at maturity, decline in prespawn survival and fertility due to higher stream temperatures, and a loss of lower elevation habitat (Crozier *et al*. 2008).

Regardless of the base model used to analyze the effects of climate change in the CVP/SWP operations BA, the best available information indicates that climate change will negatively affect the Central Valley listed species and their proposed or designated critical habitats. The following are general statements in Lindley *et al*. (2007), based on their analyses of recent climate change modeling:

- The average precipitation will decline over time, while the variation in precipitation is expected to increase substantially. Extreme discharge events are predicted to become more common, as are critically dry water years. Peak monthly mean flows will generally occur earlier in the season due to a decline in the proportion of precipitation falling as snow, and earlier melting of the (reduced) snowpack (Dettinger *et al*. 2004 *op. cit*. Lindley *et al*. 2007, VanRheenen *et al*. 2004 *op. cit*. Lindley *et al*. 2007);
- Temperatures in the future will warm significantly, total precipitation may decline, and snowfall will decline significantly.
- Spring-run are likely to be negatively impacted by the shift in peak discharge (needed for smolt migration), and juvenile steelhead are likely to be negatively impacted by reduced summer flows. All Central Valley salmonids are likely to be negatively affected by warmer temperatures, especially those that are in freshwater during the summer.
- Increased frequency of scouring floods might be expected to reduce the productivity of populations, as egg scour becomes a more common occurrence. The flip side of frequent flooding is the possibility of more frequent and severe droughts.
- Uncertainties abound at all levels. We have only the crudest understanding of how salmonid habitats will change and how salmonid populations will respond to those changes, given a certain climate scenario.

NMFS agrees with the above general statements, and adopt them as our assessment of the future impacts of climate change for the purposes of the analysis in this Opinion.

5.2 Status of the Species and Critical Habitat in Clear Creek

Clear Creek is a tributary to the upper Sacramento River (figure 5-1) and provides habitat for spring-run, and CV steelhead.

5.2.1 Spring-Run

Since 1998, spring-run have shown an increasing trend in abundance from 50 in 1998 to approximately 200 adults in 2008 (figure 5-2). Juvenile spring-run from the Feather River Fish Hatchery were stocked into Clear Creek in 2002 and 2003 with the hope of imprinting them to return 3 years later. These fish returned as adults in 2005 and 2006. In addition, spring-run strays from Feather River Fish Hatchery have been observed spawning in Clear Creek.

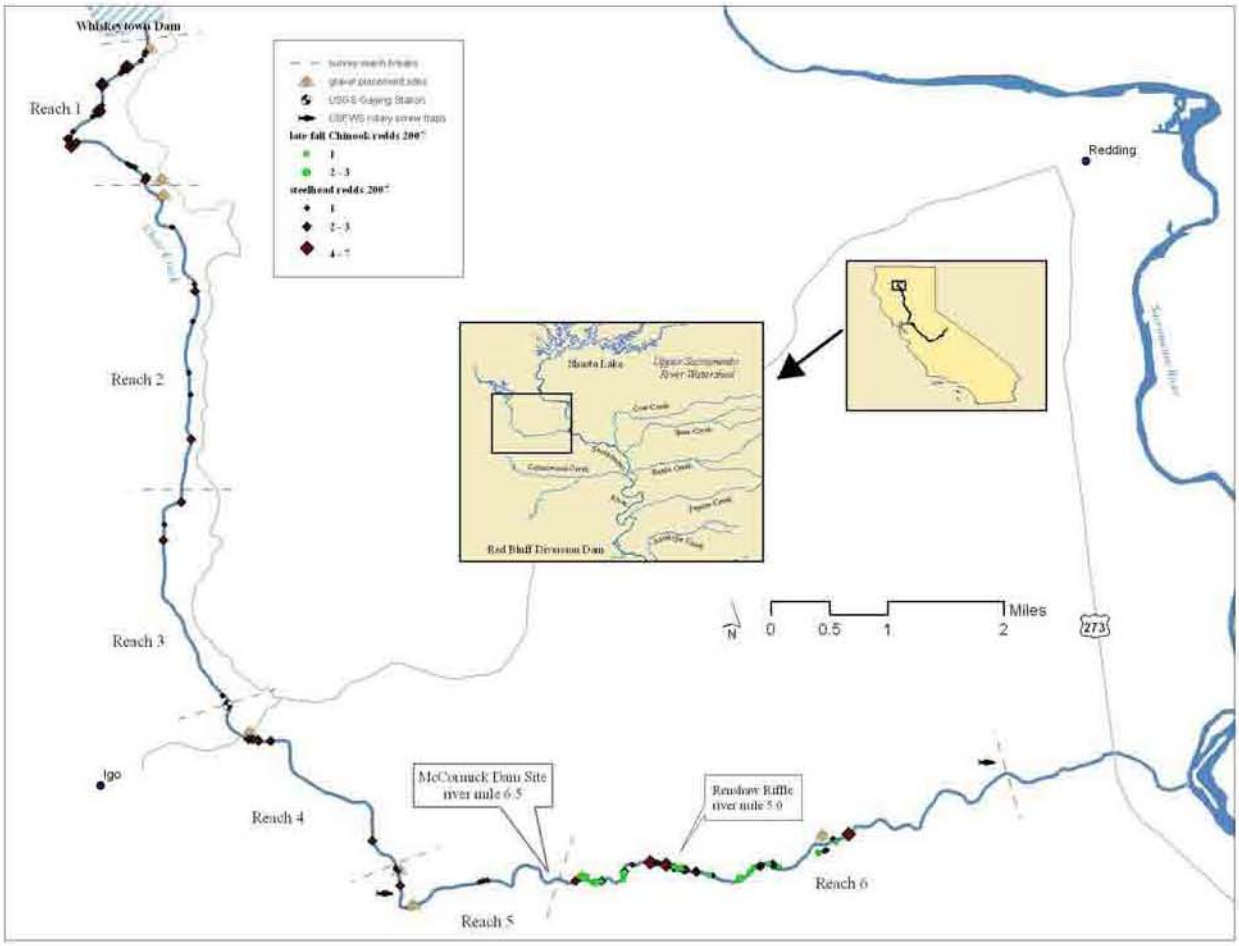


Figure 5-1. Map of Clear Creek and the distribution of steelhead and late fall-run redds in 2007 (USFWS 2008).

5.2.1.1 Spring-Run Critical Habitat

Whiskeytown Dam at RM 18.1 is an impassable barrier to adult anadromous salmonids and marks the upstream extent of potential spring-run habitat. Prior to 2000, the McCormick-Saeltzer Dam presented a barrier to upstream migration for anadromous salmonids. Following removal of the Dam in 2000, access to approximately 12 miles of coldwater habitat upstream to Whiskeytown Dam was restored. The construction of Whiskeytown Dam, gold mining, and significant gravel mining in the Clear Creek watershed has diminished the availability and recruitment of suitable spawning gravels. Gravel injection projects are conducted to make up for this loss of spawning gravel recruitment, but limited spawning habitat availability is a problem in Clear Creek.

Currently the release schedule from Whiskeytown Dam calls for flows of 200 cfs from October 1 to June 1 and 150 cfs, or less, from July through September in order to maintain water temperatures below 60°F. Under dry and warm climate conditions, water temperatures above 60° F occur in Clear Creek. Lindley *et al*. (2004) suggested that Clear Creek appears to offer

habitat of marginal suitability to spring-run, having limited area at higher elevations and being highly dependent on rainfall.

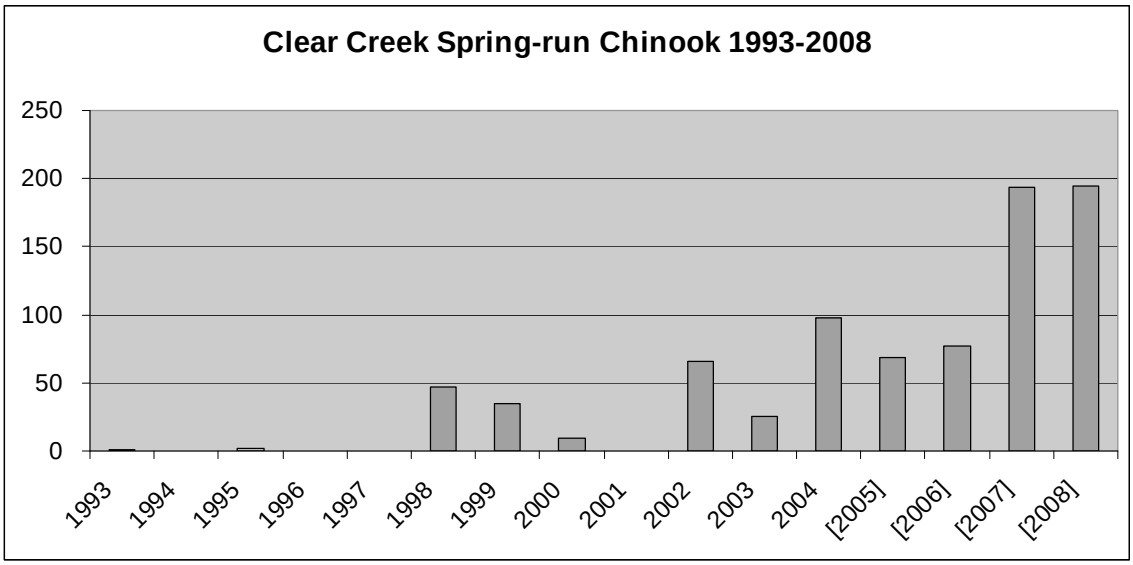


Figure 5-2. Clear Creek spring-run escapement 1993-2008 (CDFG data).

5.2.2 CV Steelhead

CV steelhead in Clear Creek have responded well to restoration efforts, which began in 1995 with increased water releases from Whiskeytown Dam, and gravel augmentation. These efforts have been funded primarily by the CVPIA and CALFED ERP. The McCormick-Saeltzer Dam was removed in 2000, providing access to an additional 12 miles of salmonid habitat. CV steelhead have re-colonized this area and taken advantage of newly added spawning gravels. Recent redd surveys conducted since 2003 indicate a small but increasing population resides in Clear Creek (figure 5-3), with the highest density in the first mile below Whiskeytown Dam (USFWS 2007). Spawning gravel is routinely added every year at various sites to compensate for channel down cutting. Spawning distribution has recently expanded from the upper 4 miles to throughout the 17 miles of Clear Creek, although it appears to be concentrated in areas of newly added spawning gravels. In addition to the anadromous form of *O. mykiss*, many resident trout reside in Clear Creek, making it difficult to identify CV steelhead except when they are spawning (*i.e.*, resident trout spawn in the spring and have smaller-size redds). Large riverine *O. mykiss* that reside in the Sacramento River can migrate up Clear Creek to spawn with either the anadromous or resident forms. No hatchery steelhead (*i.e.*, presence of adipose fin-clip) were observed during the 2003-2007 kayak and snorkel surveys (USFWS 2007, figure 5-3), indicating that straying of hatchery steelhead is probably low in Clear Creek.

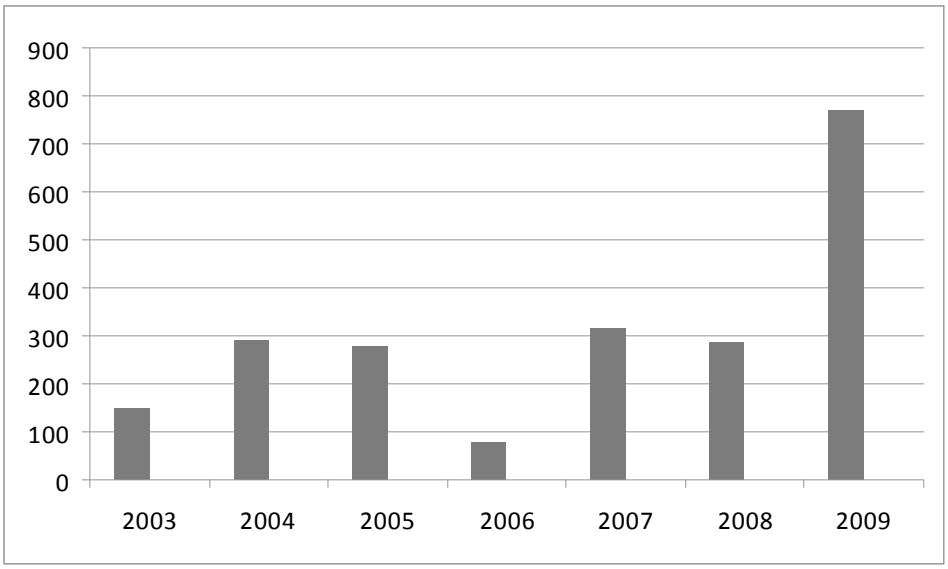


Figure 5-3. Abundance of CV steelhead in Clear Creek based on annual redd counts 2003-2009. Spawning population based on average 1.23 males per female on the American River (Hannon and Deason 2007). 2009 estimate is preliminary based on 4 surveys (USFWS 2008, Brown 2009).

5.2.2.1 CV Steelhead Critical Habitat

Whiskeytown Dam at RM 18.1 is an impassable barrier to adult anadromous salmonids and marks the upstream extent of potential steelhead habitat. Prior to 2000, the McCormick-Saeltzer Dam presented a barrier to upstream migration for anadromous salmonids. Following removal of the Dam in 2000, access to approximately 12 miles of coldwater habitat upstream to Whiskeytown Dam was restored. The construction of Whiskeytown Dam, gold mining, and significant gravel mining in the Clear Creek watershed has diminished the availability and recruitment of suitable spawning gravels. Gravel injection projects are conducted to make up for this loss of spawning gravel recruitment, but limited spawning habitat availability is a problem in Clear Creek.

Currently the release schedule from Whiskeytown Dam calls for flows of 200 cfs from October 1 to June 1 and 150 cfs, or less, from July through September in order to maintain water temperatures below 60°F. Under dry and warm climate conditions, water temperatures above 60°F occur in Clear Creek. Lindley *et al*. (2004) suggested that Clear Creek appears to offer habitat of marginal suitability to steelhead, having limited area at higher elevations and being highly dependent on rainfall.

5.2.3 Historical Conditions

The historic pre-Whiskeytown Dam hydrograph shows a much different flow pattern than the current hydrograph (figure 5-4). Average monthly flows decreased 75 percent in the winter/spring (600 cfs to 150 cfs), and increased 40 percent during the summer/fall (<30 cfs to 50 cfs).

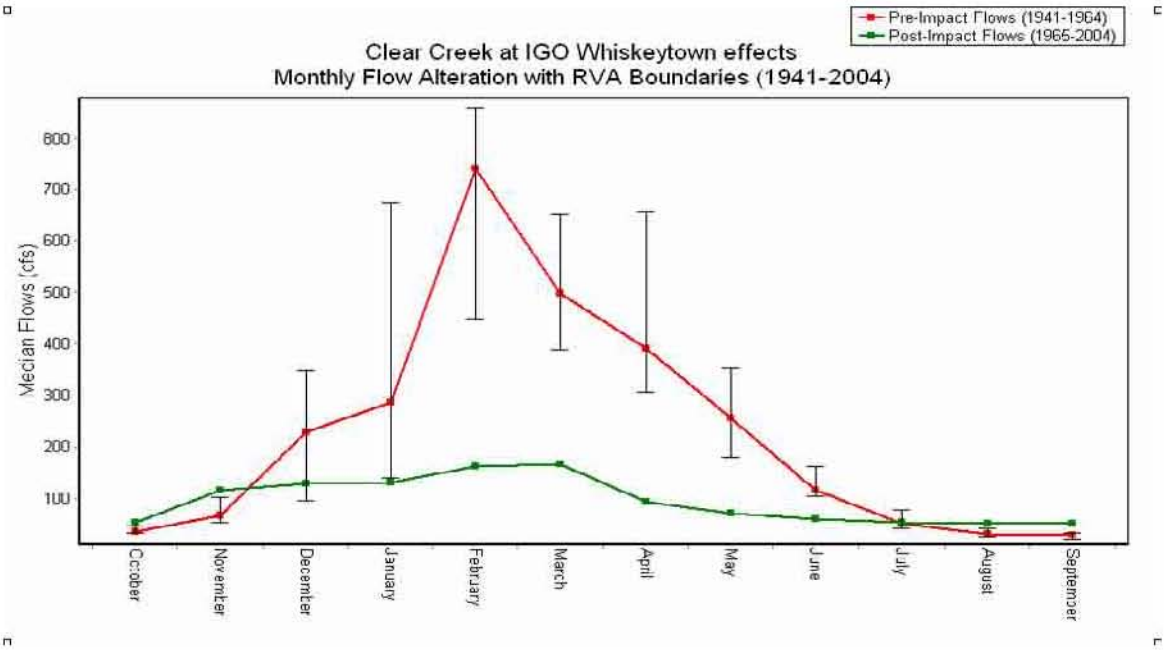


Figure 5-4. Clear Creek monthly flows comparing pre-Whiskeytown Dam (1941-1964) to post dam (1965-2004) flows. The vertical lines represent the range of variability analysis boundaries (CVP/SWP operations BA figure 3-21).

Reclamation operates Whiskeytown Dam to convey water from the Trinity River to the Sacramento River via the Spring Creek tunnel. On average, 1.2 MAF (up to 2,000 cfs) of water from the Trinity River is diverted each year into Keswick Reservoir compared to 200 cfs released to Clear Creek for fishery needs. The Trinity River diversion represented 17 percent of the average flows in the Sacramento River (CVP/SWP operations BA). However, since implementing the Trinity Record of Decision (ROD) flows in 2004, the Trinity River diversion has provided a smaller proportion (than 17 percent) of the average flows to the Sacramento River. Hydroelectric power is generated 5 times from the inter-basin transfer of water: (1) Trinity Dam, (2) Lewiston Dam, (3) through a tunnel to the Carr Powerhouse where water is received into Whiskeytown Reservoir, (4) through another tunnel into Spring Creek Power Plant where water joins the Keswick Reservoir, and (5) Keswick Dam. Reclamation releases water from Whiskeytown Dam into Clear Creek to support anadromous fish. On average, 200 cfs is released during the fall and winter, and is supported by b(2) flows. Releases are reduced to 80 cfs in the summer to install the fish barrier weir (figure 5-5). Since 2004, the USFWS has separated fall-run adults from spring-run adults holding in the upper reaches of Clear Creek with the use of a picket weir located at RM 8.0. The weir is operated from August 1 to November 1 to prevent the hybridization of spring-run and fall-run. After November 1, fall-run have access to the entire river for spawning. Spawning gravel augmentation in the upper reaches has improved suitable habitat for spring-run.

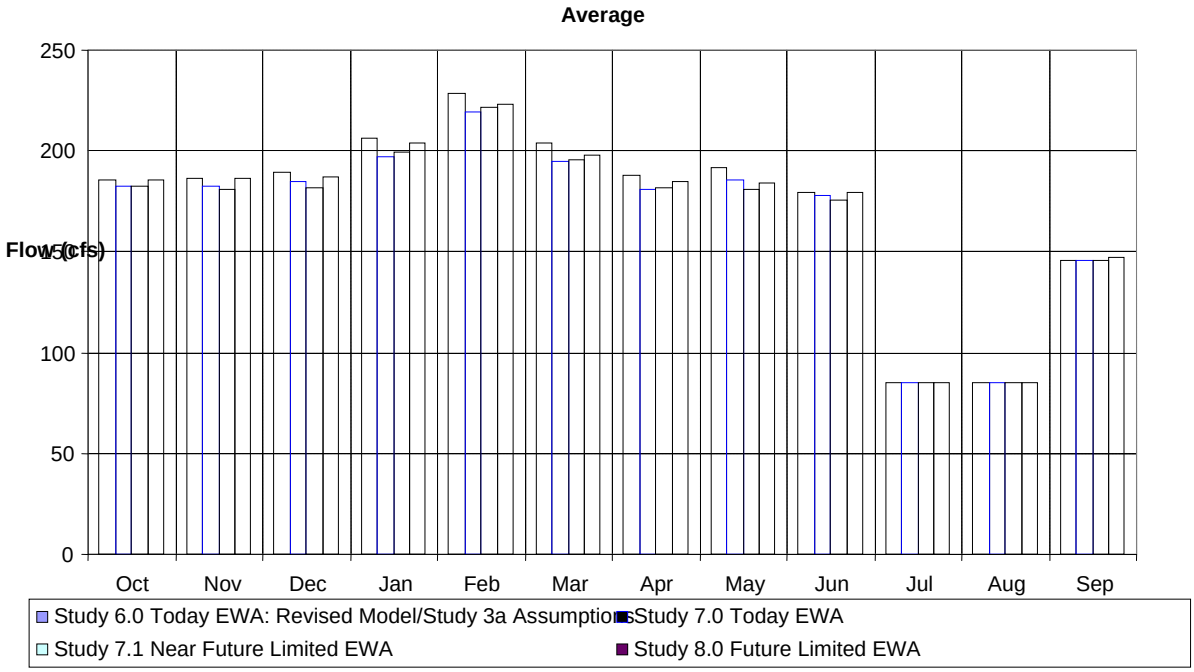


Figure 5-5. Clear Creek long-term average monthly flows as modeled in CALSIM 1923-2003 (CVP/SWP operations BA figure 10-30).

The average mean daily flow from 2003-2007 was 281 cfs (range: 212 - 493 cfs), and the average mean daily water temperatures ranged from 43°F to 52°F during the spawning period (December – June, figure 5-6). Flows increase starting in September for Chinook salmon spawning and to provide cooler water temperatures (*i.e.*, 56°F for spring-run September 15 – October 30 required from the 2004 CVP/SWP operations Opinion). Flows that scour redds and mobilize gravel usually occur at 3,000 cfs or more (CVP/SWP operations BA). Clear Creek flows are managed to maintain water temperatures for juvenile CV steelhead and spring-run adults holding in the upper reaches. Flows are maintained with b(2) water and usually are at the lowest (*i.e.*, 80-90 cfs in a dry year) in the fall (figure 5-7) before spawning starts.

5.2.4 Future Baseline Excluding CVP/SWP Effects

The future baseline for Clear Creek includes the presence of Whiskeytown Dam and its associated stressors, including the loss of natural riverine function and morphology. The effects of habitat blockage were described in section 4.2.4.1. The dam also limits the contribution of course sediment, which result in riffle coarsening, fossilization of alluvial features, loss of fine sediments available for overbank deposition, and considerable loss of spawning gravels, and as such, the availability of spawning habitat. In addition, Whiskeytown Dam modifies the stream channel morphology of Clear Creek, resulting in the lack of suitable habitat during the summer for juvenile rearing and adult holding.

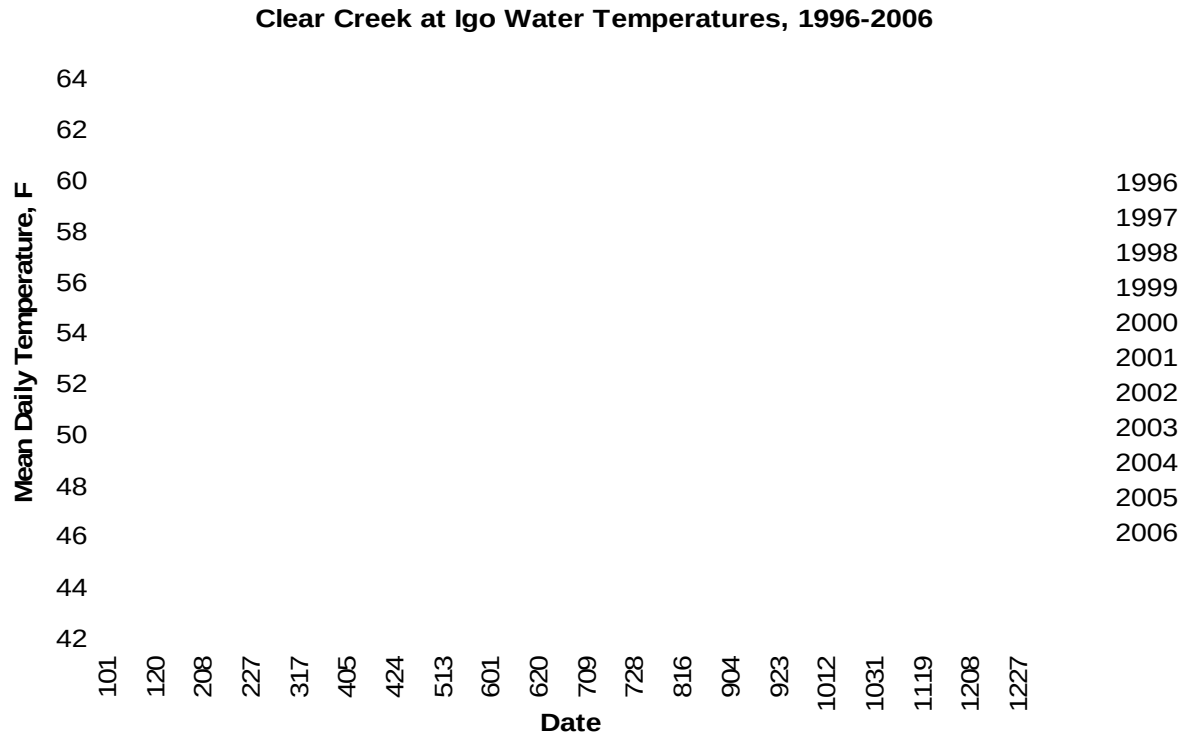


Figure 5-6. Clear Creek historical mean daily water temperatures 1996 – 2006 (CVP/SWP operations BA figure 3-12). Temperature objectives (horizontal dark blue lines) are 60ºF from June 1 through September 15 and 56ºF from September 15 through October 31, pursuant to the 2004 CVP/SWP operations Opinion.

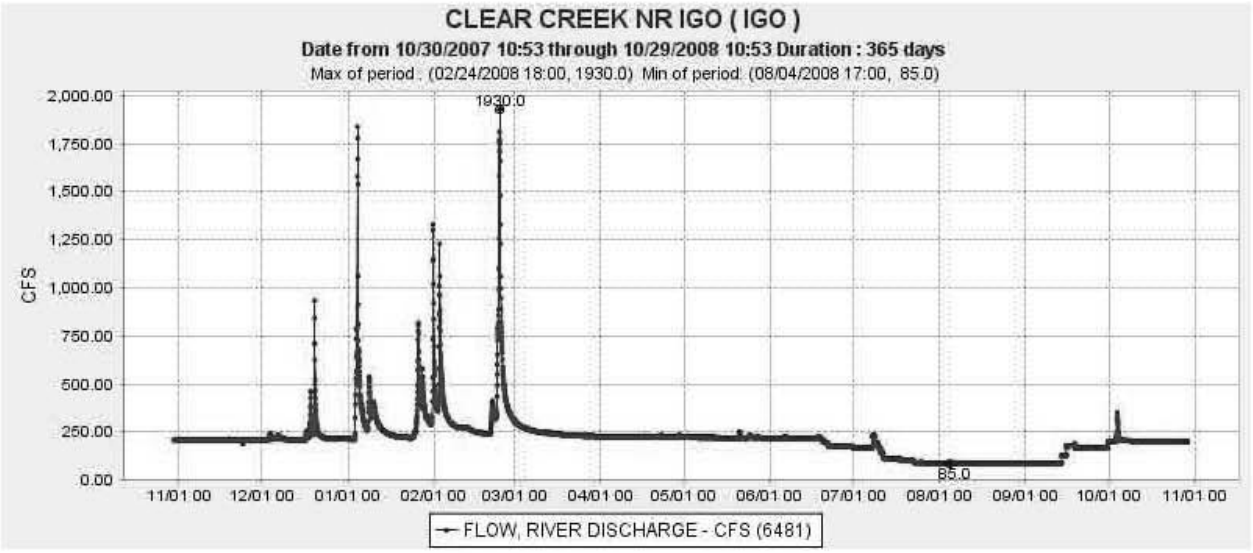


Figure 5-7. Clear Creek average daily flows measured at Igo gage 10/30/07 – 10/30/08 (CDEC data).

Whiskeytown Dam precludes access to historic spring-run and CV steelhead spawning and rearing habitat. In addition, spring-run historically spawned earlier and higher upstream in Clear Creek than fall-run. However, since the construction of Whiskeytown Dam, there was likely a high degree of spatial overlap between spawning spring-run and fall-run, and therefore, a higher probability of introgression of the 2 runs.

5.3 Status of the Species and Critical Habitat in the Shasta Division and Sacramento River Division

The Shasta Division and Sacramento River Division of the CVP are located in the upper Sacramento River (figure 5-8), and provide habitat for winter-run, spring-run, fall-run, late-fall run, CV steelhead, and Southern DPS of green sturgeon. Table 5-1 provides the life history timing of these species in the upper Sacramento River.

Table 5-1. Life history timing for anadromous fish species in the upper Sacramento River.

Species	Adult Immigration	Adult Holding	Typical Spawning	Egg incubation	Juvenile rearing	Juvenile emigration
Winter-run	Dec - Jul	Jan - May	Apr - Aug	Apr - Oct	Jul - Mar	Jul - Mar
Spring-run	Apr - Jul	May - Sept	Aug - Oct	Aug - Dec	Oct - Apr	Oct - May
Fall-run	Jul - Dec	n/a	Oct - Dec	Oct - Mar	Dec - Jun	Dec - Jul
Late fall-run	Oct - Apr	n/a	Jan - Apr	Jan - Jun	Apr - Nov	Apr - Dec
Steelhead	Aug - Mar	Sept - Dec	Dec - Apr	Dec - Jun	year round	Jan - Oct
Green sturgeon	Feb - Jun	Jun - Nov	Mar - Jul	Apr - Jun	May - Aug	May - Dec

5.3.1 Winter-Run

The upper Sacramento River is the only spawning area used by winter-run. The status of winter-run in the Sacramento River Division is the same as its status in the entire winter-run ESU, which was presented in section 4.2.1.2.1.

5.3.1.1 Winter-Run Critical Habitat

Critical habitat for winter-run is composed of physical and biological features that are essential for the conservation of winter-run, including up and downstream access, and the availability of certain habitat conditions necessary to meet the biological requirements of the species. Currently, many of these physical and biological features are impaired, and provide limited conservation value. For example, when the gates are in, RBDD reduces the value of the migratory corridor for upstream and downstream migration. Unscreened diversions throughout the mainstem Sacramento River, and the DCC when the gates are open during winter-run outmigration, do not provide a safe migratory corridor to San Francisco Bay and the Pacific Ocean.

In addition, the annual change in TCP has degraded the conservation value of spawning habitat (based on water temperature). The current condition of riparian habitat for winter-run rearing is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system. However, some complex, productive habitats with floodplains remain in the system (*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa) and flood bypasses (*i.e.*, Yolo and Sutter bypasses).

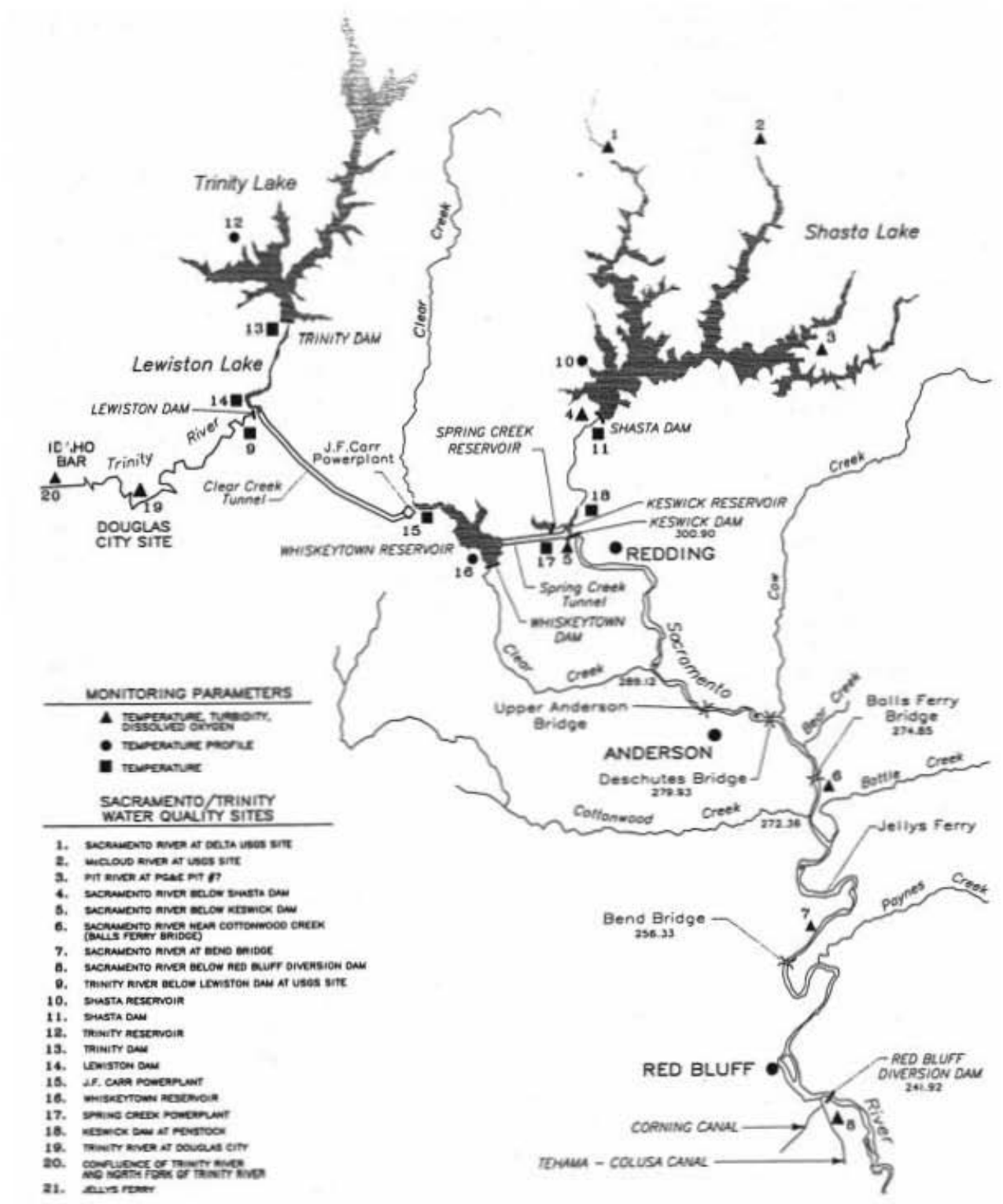


Figure 5-8. Map of the upper Sacramento River, including various temperature compliance points and river miles (CVP/SWP operations BA figure 6-2).

Based on the impediments caused by RBDD when the gates are in, unscreened diversions, when the DCC gates are open during the winter-run outmigration period, and the degraded condition of

spawning habitat and riparian habitat, the current condition of winter-run critical habitat in the Sacramento River Division is degraded, and has low value for the conservation of the species.

5.3.2 Spring-Run

The abundance of the spring-run population within the mainstem Sacramento River has declined from a high of over 75,000 in 1982 to the current low of less than 800 counted at RBDD (figure 5-9). Significant hybridization with fall-run has made identification of spring-run in the mainstem very difficult to determine. There is speculation as to whether a true spring-run still exists in the mainstem below Keswick Dam. The population structure of the ESU has shifted from being mainly made up of Sacramento River fish to one dominated by returns to Butte Creek (figure 5-10). This shift may have been an artifact of the manner in which spring-run were identified at RBDD. Fewer spring-run are counted today at RBDD because an arbitrary date, September 1, is used to determine spring-run, and gates are opened longer for winter-run passage. It is unknown if spring-run still spawn in the Sacramento River mainstem. Current redd surveys have observed 20-40 salmon redds in September, typically when spring-run spawn, however, there is no peak that can be separated out from fall-run spawning. Salmon redds observed in September could be early spawning fall-run. These redds are distributed from Keswick Dam to below RBDD.

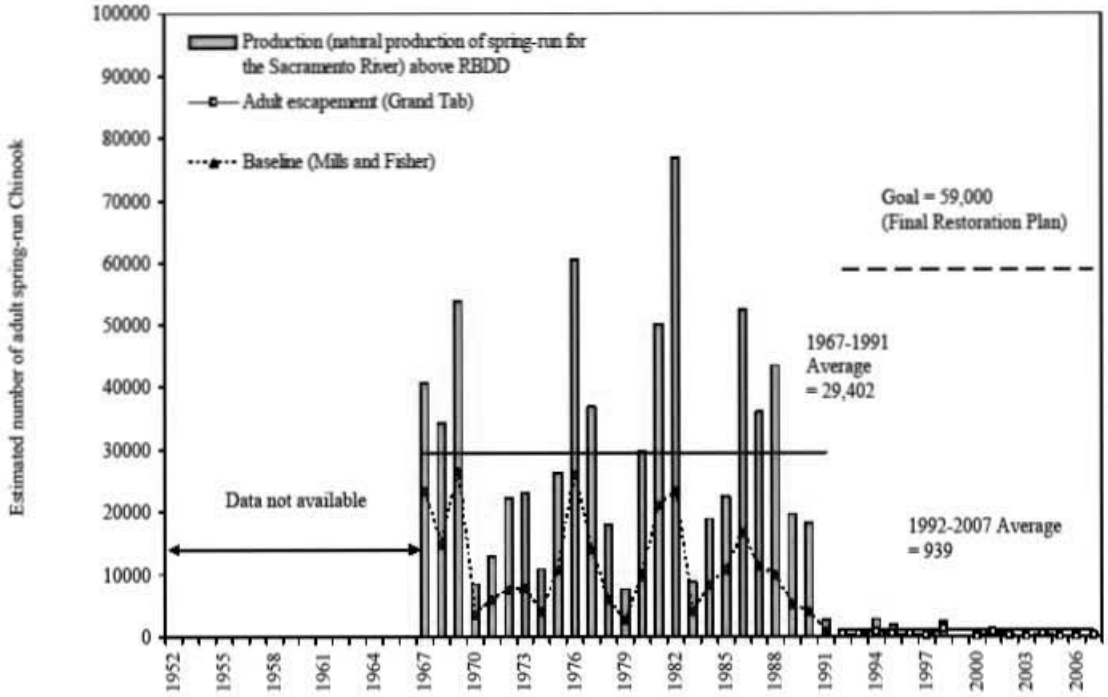


Figure 5-9. Estimated yearly spring-run escapement and natural production above RBDD (Hanson 2008).

Since 2000, the spring-run counts at RBDD have fluctuated after the RBDD gates were installed on May 15, from years where 0 fish were observed (2003 and 2006), to 767 adults in 2007 (figure 5-11). This variability in abundance is typical of random chance events in small salmon populations subjected to large stress regimes. These numbers do not reflect the current abundance of spring-run in the tributaries above RBDD (*i.e.*, Battle Creek, Clear Creek, Cottonwood Creek, and Cow Creek). For example, Clear Creek escapement in 2006 was 197

spring-run, yet the RBDD ladder count was 0 that year. This is because the RBDD gates were open when the majority of those fish entering Clear Creek passed upstream, therefore, none were counted in the fish ladders.

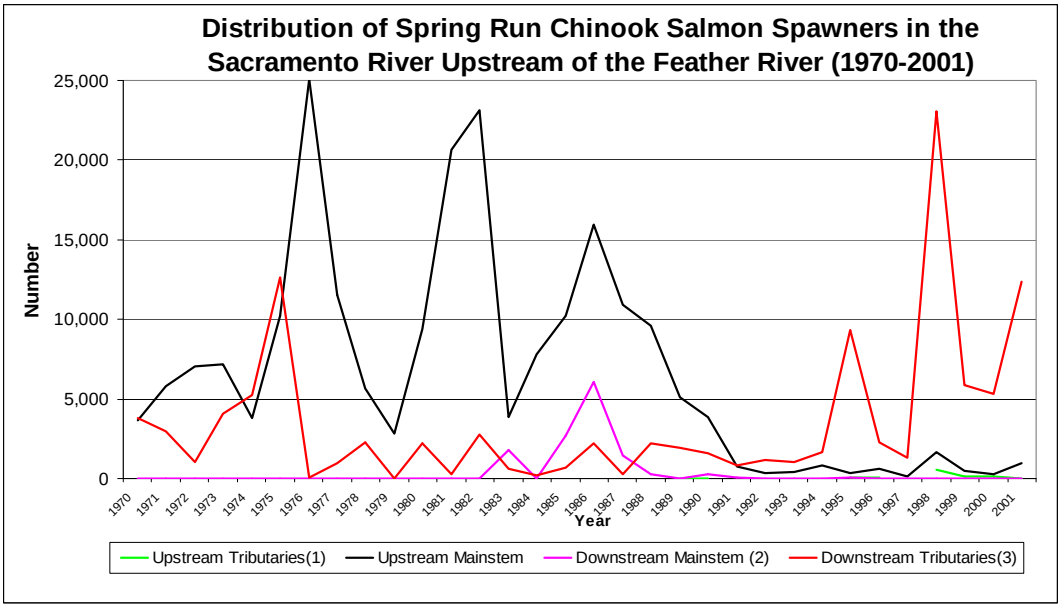


Figure 5-10. Distribution of spring-run above and below RBDD from 1970 -2001 (CDFG Grand Tab).

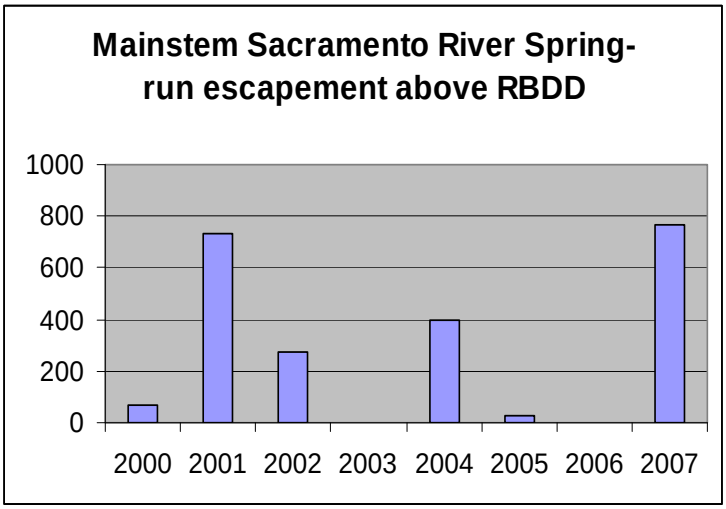


Figure 5-11. Spring-run escapement counted at Red Bluff Diversion Dam from 2000 – 2007 (CDFG GrandTab 2008).

5.3.2.1 Spring-Run Critical Habitat

Within the range of the spring-run ESU, biological features of the designated critical habitat that are considered vital for spring-run include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. As generally described above in section 4.2.1.3.3, the status of critical habitat in each of these biological features is considered to be

highly degraded, particularly with respect to habitats within the mainstem Sacramento River and the Delta. The quality of spawning habitat used by spring-run in the mainstem Sacramento River is diminished when fall-run, which commence spawning later than but still during spring-run spawning, arrive at the spawning grounds and physically disturb spring-run redds during their redd construction. Spawning habitat for spring-run in the mainstem Sacramento River is often adversely affected by operation of the CVP through warm water releases from Shasta Reservoir. Freshwater rearing and migration habitats have been degraded by RBDD operations which delay upstream migration, reduce the availability of quality rearing habitat through the related seasonal creation of Lake Red Bluff, and create improved feeding opportunities for predators such as pikeminnow and striped bass. Additional adverse effects to rearing and migration habitats within the Sacramento River include loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use.

5.3.3 CV Steelhead

Estimates of CV steelhead abundance in the mainstem Sacramento River typically use the RBDD counts from historical trend data. Since 1991, the RBDD gates have been opened after September 15, making estimates of CV steelhead pass RBDD unreliable. Based on counts at RBDD, adult migration into the upper Sacramento River can occur from July through May, but peaks in September, with spawning occurring from December through May (Hallock 1998). Since operation of the RBDD gates started in 1967, the CV steelhead abundance in the upper Sacramento River has declined from almost 20,000 to less than 1,200 (figure 5-12). We note that figure 5-12 shows a definite and continuing decline over time and that there is a change in the species trajectory since 1979, similar to the winter-run decline in the Sacramento River Division.

Actual estimates of CV steelhead spawning in the mainstem Sacramento River below Keswick Dam have never been made, due to high flows and poor visibility during the winter time. Aerial redd surveys conducted for winter-run have observed resident *O. mykiss* spawning in May and late fall-run spawning in January. Since resident trout redds are smaller than steelhead redds, and late fall-run spawn at the same time as steelhead, it would seem likely that CV steelhead redds could be observed. A CV steelhead monitoring plan is being developed by CDFG with a goal of determining abundance in the Sacramento River (Hopelain 2008). CV steelhead prefer to spawn in tributaries, but are known to spawn in mainstem rivers below impassable dams when access to spawning habitat is blocked (*e.g.*, Feather River, American River, Stanislaus River).

5.3.3.1 CV Steelhead Critical Habitat

Within the range of CV steelhead, biological features of the designated critical habitat that are considered vital for steelhead include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. As generally described above in section 4.2.3.4, the status of critical habitat in each of these biological features is considered to be degraded. Freshwater rearing and migration habitats have been degraded by RBDD operations which delay upstream migration, reduce the availability of quality rearing habitat through the related seasonal creation of Lake Red Bluff, and create improved feeding opportunities for

predators such as pikeminnow and striped bass. Additional adverse effects to rearing and migration habitats within the Sacramento River include loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use.

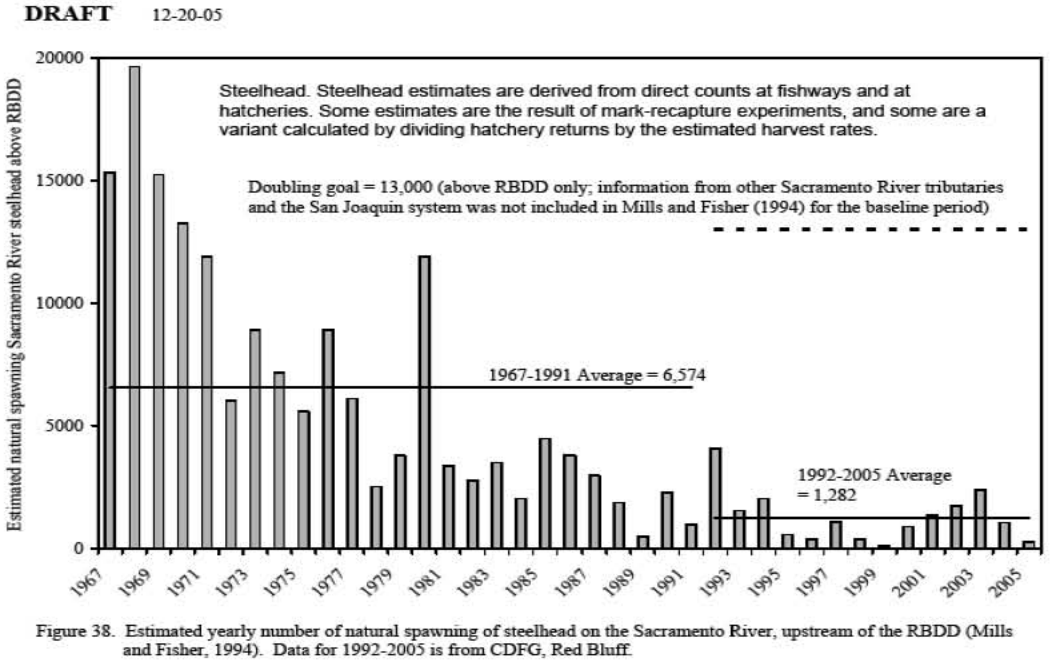


Figure 38. Estimated yearly number of natural spawning of steelhead on the Sacramento River, upstream of the RBDD (Mills and Fisher, 1994). Data for 1992-2005 is from CDFG, Red Bluff.

Figure 5-12. Estimated yearly number of natural spawning CV steelhead on the Sacramento River upstream of the RBDD 1967-2005. Data from 1992 to 2005 is based on tributary counts from CDFG, Red Bluff (Hanson 2008).

5.3.4 Southern DPS of Green Sturgeon

Currently, the installation and operation of the RBDD gates blocks access to 53 miles of upper river with suitable water quality conditions for green sturgeon spawning and rearing from May 15 through September 15 of each year. Water temperature for spawning and egg incubation is near optimal (15°C) from RBDD upriver during the spawning season. Below the RBDD, the water temperature begins to become warmer and exceeds the thermal tolerance level for egg incubation at Hamilton City. The spawning area left for green sturgeon between RBDD and Hamilton City after the gates are lowered has the thermal regime gradually increase from optimal (15°C/59°F) to sub optimal where egg hatching success decreases and malformations in embryos increase above 17°C/62°F.

The installation of the RBDD impairs the function of the Sacramento River as a migratory corridor for both green sturgeon adults and larvae/juveniles. With the RBDD gates closed, there is no longer unobstructed access to river habitat above the RBDD, which changes the function of the river to such an extent that fish survival and viability are compromised. The closed gates block green sturgeon access to approximately 53 river miles above the dam for approximately 35 to 40 percent of the spawning population that arrive after May 15. The closed gates also decrease the conservation value of critical habitat around the dam by: (1) increasing the

potential for predation on downstream emigrating larvae in the slow moving water upstream of the RBDD (Lake Red Bluff), (2) increasing predation below RBDD due to the turbulent boil created below the structure and the concentration of predators in that area, and (3) creating increased potential for adults to be injured while attempting to pass beneath the gates during their downstream migration. The closed gate configuration also has the potential to alter the genetic diversity of the population by separating the population into upstream and downstream spawning groups based on run timing.

The installation of the RBDD blocks green sturgeon from known holding pools above the structure. Although known holding areas exist below the RBDD, such as the hole just above the GCID diversion, the RBDD decreases the number of deep holding pools the adult fish can access through its operation. This affect is a result of blockage of the migratory corridor.

5.3.4 Historical Conditions

The historical pre-Shasta Dam hydrograph shows a much different flow pattern than the current hydrograph (figure 5-13). The current hydrograph shows reduced average monthly springtime flows (historical: 16,000 cfs; current: 12,000 cfs) and much higher average monthly summer flows (historical: 5,000 cfs; current: 12,000 cfs). Releases of water for irrigation and other Project purposes are timed to occur during summer months when demand is high. This dual purpose is practical because it provides benefits to both listed species (which can no longer access the upper Sacramento River basin) and water users, but is also ecologically unsound because it prevents riverine processes and natural succession of riparian communities as well as the full expression of life history strategies in the basin's fish populations that evolved in unison with the natural flow fluctuations. Lindley *et al*. (2006) suggest that dams may exert selective effects on anadromous *O. mykiss*, culling the anadromous offspring produced, and modifying the thermal regime and food web structure of the river below the dam in ways that may provide fitness advantages to resident forms. Recent modeling by The Nature Conservancy (2007) found that the health of the river and ESA-listed species would benefit more from a natural flow regime that mimics the historical hydrograph.

5.3.5 Future Baseline Excluding CVP/SWP Effects

The upper Sacramento River mainstem contains 4 listed anadromous fish that use this area for migration, spawning, and rearing (*i.e*., winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon). These fish will be subjected to a host of future baseline stressors (figure 5-14) to which the project effects are added.

In the Shasta Division and Sacramento River Division, future baseline stressors include the following, followed by references in parentheses to where the effects of these stressors on the listed species and their habitats are described:

- habitat blockage by Shasta and Keswick dams (section 4.2.4.1);
- bank stabilization (rip rap, armoring, revetment), which result in river narrowing, less channel complexity, less food production, less cover and shelter, loss of shaded aquatic habitat, and the loss of LWD recruitment (section 4.2.4.5);

- agricultural return flows, which include pesticides, herbicides, and other contaminants (sections 4.2.4.6 and 4.2.4.7);
- predation (pike minnow, smallmouth bass, striped bass) and competition from introduced species better suited to regulated rivers (section 4.2.4.10); and
- climate change (sections 5.1, 5.3.6.1).

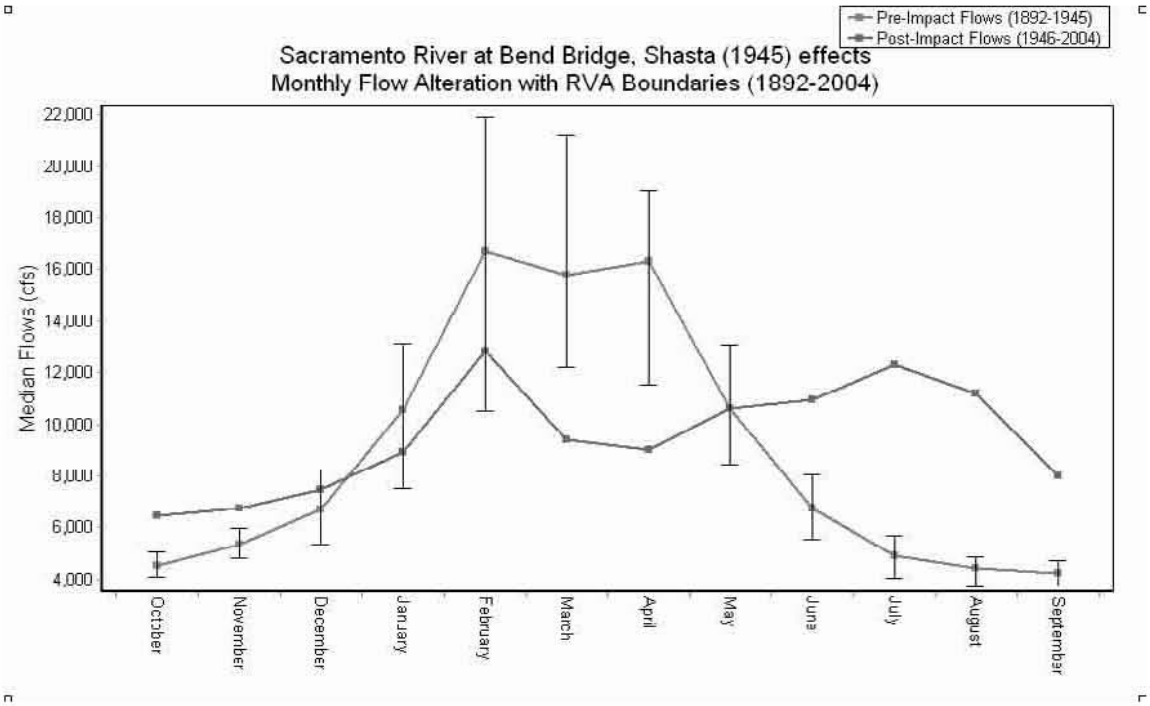


Figure 5-13. Sacramento River at Bend Bridge monthly flows comparing pre-Shasta Dam (1892-1945) and post Shasta (1946 -2004) flows. Vertical lines represent the range of variability analysis boundaries (CVP/SWP operations BA figure 3-20).

Some of the above stressors (*e.g.*, predation) will work individually to affect the fitness of the listed species and critical habitat, while others will work together (*e.g.*, temperature and contaminants) to reduce the ability of the individual to respond to important cues, like when to feed, migrate, or flee a predator. Regardless, the combination of all of the above stressors will result in fitness consequences to individuals of all of the listed species, including, but not limited to: reduced growth from the effects of reduced water quality, lack of rearing habitat, and increased competition from introduced species; reduced survival as a result of predation; and reduced reproductive success resulting from habitat blockage. In addition, although critical habitat is designated or proposed up to Keswick Dam, the other stressors, above, limit the conservation value of the PCEs that the Shasta Division and Sacramento River Division provide, including uncontaminated habitat areas, adequate prey, riparian habitat, freshwater rearing habitat, and suitable water quality.

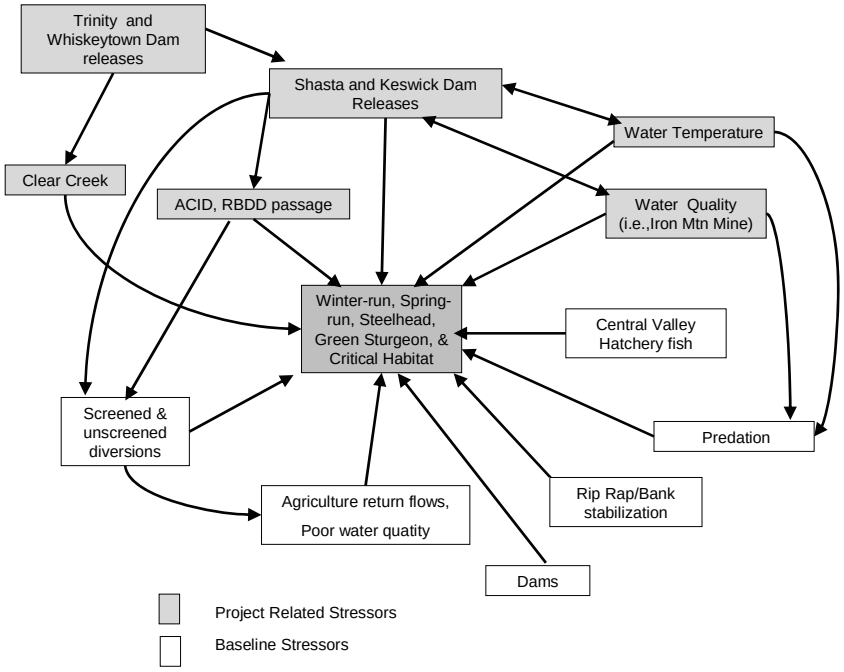


Figure 5-14a. Conceptual model of future baseline stressors and project-related stressors on listed species in the upper Sacramento River mainstem.

5.3.5.1 Climate Change

As discussed in section 2.3.3, a "no project" scenario was not run. Climate change is an environmental phenomenon that is part of the future baseline and would occur irrespective of any operations of the CVP or SWP. The effects of climate change would have certainly been included in a "no project" scenario. Section 5.1 briefly described Reclamation's use of the Study 9 suite, which uses the Study 8.0 future full build out as the base case. NMFS understands that the results of Study 9 suite are not appropriate to use in this discussion of future baseline, as it includes operations. However, NMFS believes that a relative comparison between the various studies within the Study 9 suite will provide valuable insight regarding the effects of climate change on the aquatic ecosystem and fishery resources.

In the Sacramento River, comparing climate change scenarios (Study 9.0 base vs Study 9.5 drier, more warming) shows that average winter-run and fall-run mortality increases from 15 percent to 25 percent, and average spring-run mortality increases from 20 percent to 55 percent (figure 5-14b). Reclamation's mortality model was not run for CV steelhead because steelhead have a shorter incubation period than salmon, and the model would have to be changed. However, late-fall salmon can be used as a surrogate for CV steelhead since they spawn at similar times in the winter. Late fall-run mortality increases in Study 9.5 (drier, more warming) and Study 9.3 (wetter, more warming) under all water year types on average 4 percent over the future full build out scenario (Study 9.0). Under these conditions, winter-run and spring-run would experience a loss of spawning habitat, as water temperatures below dams becomes harder to control and the cold water pool in Shasta diminishes.

CV steelhead would experience less of a loss on the mainstem Sacramento River, since they spawn in the late winter when water temperatures are not as critical to incubation. However, resident forms of *O. mykiss* spawn in May, when water temperatures exceed 56°F at Bend Bridge in 25 percent of future water years (CVP/SWP operations BA figure 10-83). This resident life history pattern represents a reserve that anadromous fish can interbreed with if there are too few CV steelhead (Zimmerman *et al*. 2008). It is likely that given warmer water temperatures resident *O. mykiss* would move upstream closer to Keswick Dam where temperatures are cooler, or into smaller tributaries like Clear Creek, which would limit steelhead life history diversity in Clear Creek.

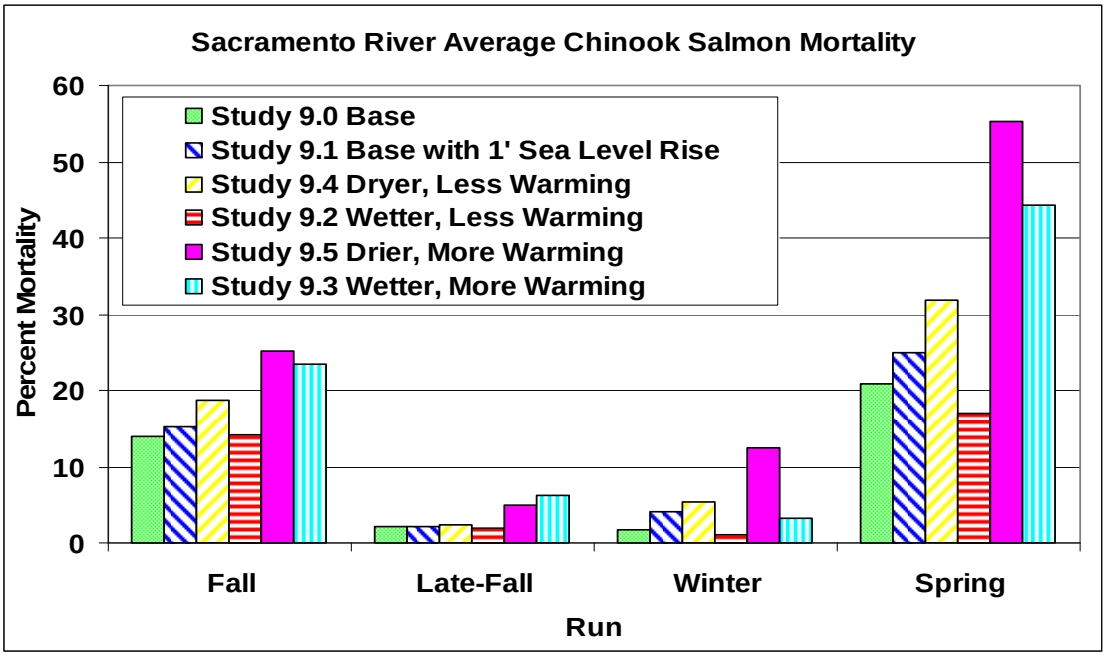


Figure 5-14b. Sacramento River average Chinook salmon mortality by run and climate change scenario from Reclamation salmon egg mortality model. All studies except 9.0 include 1-foot sea level rise. Study 9.0 is future conditions with D-1641 (CVP/SWP operations BA figure 11-82).

Similar climate change modeling was conducted using a quantitative model (WEAP21) of the Sacramento River flow and temperature regime downstream to Hamilton City (Yates *et al*. 2008). This model compared water temperatures at Shasta Dam with and without managed releases for temperature control. In the unmanaged regime, the model assumes that Shasta Dam does not exist and that there is no irrigation demand. Using the observed historical record for years before the TCD was installed, Yates *et al*. (2008) used the WEAP21 model to calculate effects on winter-run, spring-run, and fall-run under a 3.5° F and 7°F water temperature warming change. Under a 3.5°F warming scenario, water temperatures at Keswick would be at or below the optimum upper temperature of 56°F for spawning and rearing, and then increase from that point downstream, except in the driest years. Under a 7°F warming scenario, even in wet years, spawning and rearing water temperature requirements would be exceeded in September and October from Keswick Dam to Hamilton City (Yates *et al*. 2008). The results of the WEAP21 modeling suggest that even with the use of the TCD on Shasta Dam, water managers will be challenged to maintain suitable water temperatures in the upper Sacramento River (*i.e*., Keswick to Hamilton City). Yates *et al*. (2008) concluded that cold water releases from Shasta Reservoir

play a role in maintaining suitable habitat for spawning and rearing Chinook salmon as far downstream as Hamilton City, and that climate change could be a major determinant of the future viability of adult and juvenile reproduction and migration strategies. Winter-run and spring-run were shown to be most at risk due to the timing of their reproduction. Without the cold water releases from Shasta Dam, water temperatures would exceed the physiological tolerances by 5°F or more, and winter-run and spring-run populations would not likely persist in the mainstem. The study also found that the availability of cold water releases is reduced as warming increases the demand for water and evaporative losses in Shasta Reservoir.

5.4 Status of the Species and Critical Habitat in the American River Division

5.4.1 CV Steelhead

The American River (figure 5-15) is a tributary to the Sacramento River and provides habitat for a dependent population of CV steelhead. The CV steelhead DPS includes naturally-spawned steelhead in the American River (and other Central Valley stocks) and excludes steelhead spawned and reared at Nimbus Fish Hatchery. Population abundance estimates of naturally spawning steelhead in the American River were 305, 1,462 and 255 for the 1991, 1992 and 1993 spawning seasons, respectively (Water Forum 2005a), although the methodology for how these estimates were obtained was not stated.

From 2002 through 2007, annual population abundance estimates for American River steelhead spawning in the river have been low, ranging from about 160 to about 240 (Hannon and Deason 2008, figure 5-16). Populations at low abundance levels, such as those estimated for naturally spawning steelhead in the American River, could become extinct due to demographic stochasticity - seemingly random effects of variation in individual survival or fecundity with little or no environmental pressure (Shaffer 1981, Allendorf *et al*. 1997, McElhany *et al*. 2000). The naturally spawning population of steelhead is mostly composed of fish originating from Nimbus Fish Hatchery (Water Forum 2005a). This means that the listed population (*i.e*., naturally-spawned fish) spawning in the lower American River is at an abundance level lower than the estimates provided by Hannon and Deason (2008) and is likely on the order of tens.

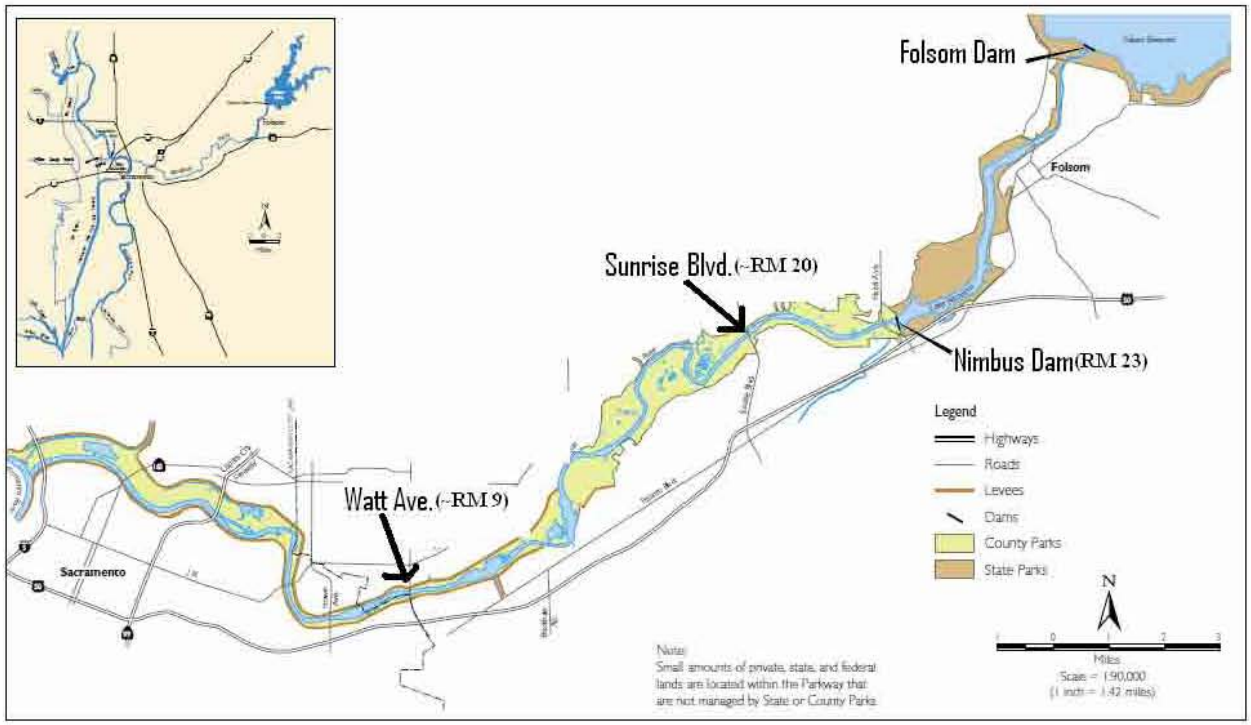


Figure 5-15. Map of lower American River (Modified from Water Forum 2005a).

In addition to small population size, other major factors influencing the status of naturally spawning steelhead in the American River include: (1) a 100 percent blockage of historic spawning habitat resulting from the construction of Nimbus and Folsom dams (Lindley *et al*. 2006), which has obvious and extreme implications for the spatial structure of the population; and (2) the operation of Nimbus Fish Hatchery, which has completely altered the diversity of the population. Specific information on how these factors have affected (and continue to affect) naturally-spawned steelhead in the American River are presented below in section 6.4 titled *American River Division.*

Lindley *et al*. (2007) classifies the listed (*i.e*., naturally spawning) population of American River steelhead at a high risk of extinction because this population is reportedly mostly composed of steelhead originating from Nimbus Fish Hatchery. The small population size and complete loss of historic spawning habitat and genetic composition further support this classification.

5.4.1.1 CV Steelhead Critical Habitat

The PCEs of steelhead critical habitat in the lower American River include freshwater spawning, freshwater rearing, and freshwater migration habitats. There is a general consensus in the available literature suggesting that habitat for steelhead in the American River is impaired (CVP/SWP operations BA; Water Forum 2005a,b; SWRI 2001; CDFG 1991, 2001). Of particular concern are warm water temperatures during embryo incubation, rearing, and migration, flow fluctuations during embryo incubation and rearing, and limited flow-dependent habitat availability during rearing. All of these concerns are related to water management operations of the CVP.

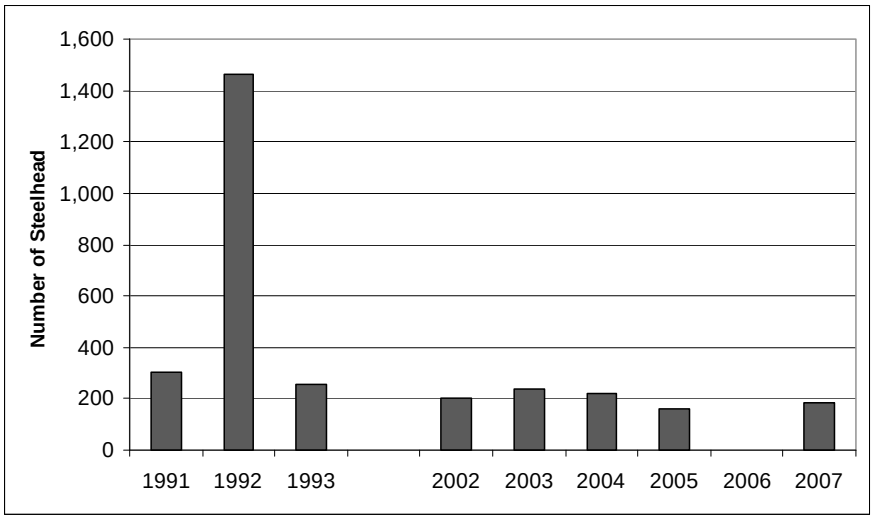


Figure 5-16. Population estimates of steelhead spawning in the lower American River. Estimates from the early 1990s were reported in Water Forum (2005a), and estimates for 2002 through 2007 were obtained through redd survey monitoring assuming each female steelhead had two redds (Hannon and Deason 2008).

5.4.2 Historical Conditions

Including the mainstem, and north, middle, and south forks, historically, over 125 miles of riverine habitat were available for anadromous salmonids in the American River watershed (Yoshiyama *et al*. 1996). Anadromous salmonids that utilized this habitat included spring-run and fall-run Chinook salmon, and summer-run, fall-run and winter-run steelhead (Gerstung 1971). Sumner and Smith (1940 *op. cit.* SWRI 2001) estimated that the American River historically may have supported runs exceeding 100,000 Chinook salmon annually, prior to habitat degradation from mining and creation of migration barriers from dam construction. Composition of the anadromous salmonid runs in the American River has changed over time due to habitat degradation and elimination resulting from the construction of dams (Yoshiyama *et al*. 1996). Between 1850 and 1885, hydraulic mining deposited large amounts of sediment in the American River (Yoshiyama *et al.* 1996). As reported in SWRI (2001), "An estimated 257 million yards of gravel, silt and debris were washed into the river from hydraulic mining (Gilbert 1917 cited in Sumner and Smith 1940)."

Between 1944 and 1947, annual counts of summer-run steelhead passing through the fish ladder at Old Folsom Dam (RM 27) during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead perished in the warm water in areas below Old Folsom Dam. By 1955, summer-run steelhead (and spring-run Chinook salmon) were completely extirpated and only remnant runs of fall- and winter-run steelhead and fall-run Chinook salmon persisted in the American River (Gerstung 1971).

Estimates of historic run sizes for summer-, fall-, and winter-run steelhead in the American River were not identified in the available literature. However, all three runs of steelhead were likely historically abundant in the American River, considering: (1) the extent of available habitat; (2) the historic run size estimates of Chinook salmon before massive habitat degradation occurred;

and (3) the reported historic run size estimates for summer-run steelhead in the 1940s which occurred even after extensive habitat degradation and elimination.

Operation of Sacramento Municipal Utility District's Upper American River Project (UARP) since 1962, as well as Placer County Water Agency's Middle Fork Project (MFP) since 1967, altered inflow patterns to Folsom Reservoir (SWRI 2001). In addition, development of the American River watershed has modified the seasonal flow and temperature patterns that occur in the lower American River. Operation of the Folsom-Nimbus project significantly altered downstream flow and water temperature regimes.

Completion and operation of Folsom and Nimbus dams resulted in higher flows during fall, significantly lower flows during winter and spring, and significantly higher flows during summer (figure 5-17).

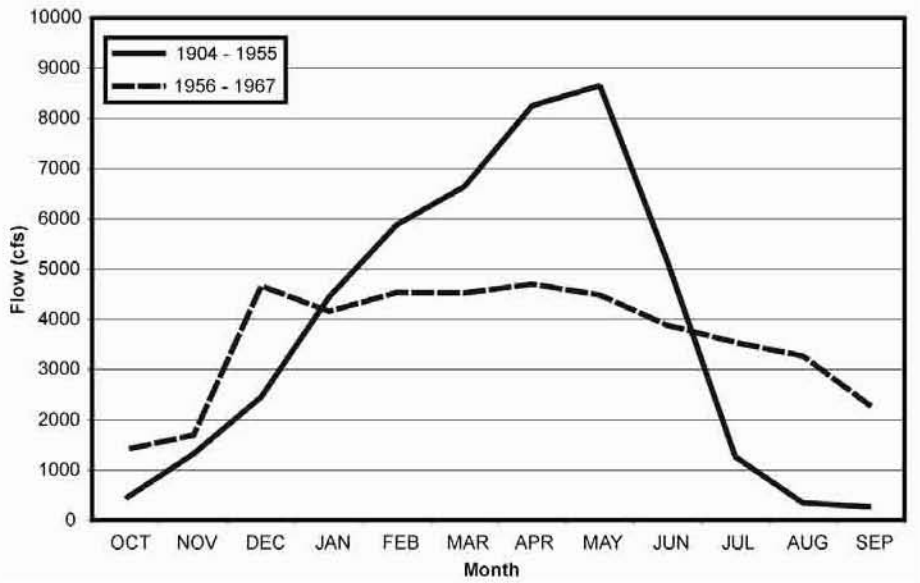


Figure 5-17. Mean monthly flow of the lower American River at the Fair Oaks gage (1904-1955) and after (1956-1967) operation of Folsom and Nimbus dams (Gerstung 1971).

Seasonal water temperature regimes also have changed with development in the American River watershed, particularly with construction and operation of Folsom and Nimbus dams (figure 5-18). Prior to the completion of Folsom and Nimbus dams in 1955, maximum water temperatures during summer frequently reached temperatures as high as 75°F to 80°F in the lower American River (Gerstung 1971). It is important to note that the water temperature data presented in figure 5-18 is from the Fair Oaks gage[8] in the lower part of the river. Although summer water temperatures are cooler in the lower river since Folsom Dam was constructed as compared to the pre-dam conditions, prior to habitat elimination by dams, rearing fish had access to cooler habitats throughout the summer at higher elevations.

[8] Data from the Fair Oaks location is presented because that is the only site where pre-Folsom Dam water temperatures were identified.

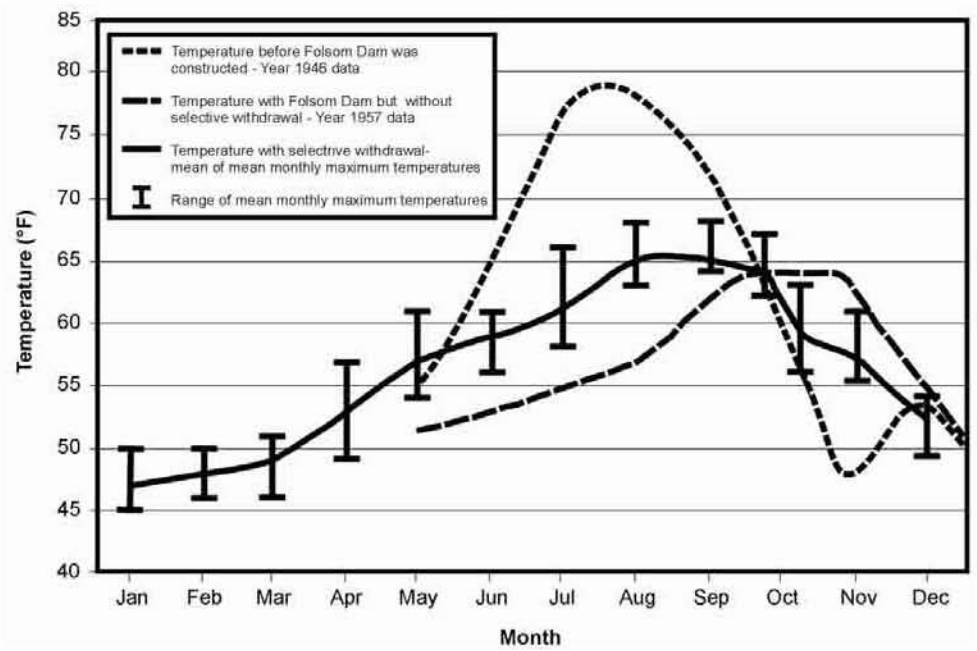


Figure 5-18. Water temperatures recorded at the Fair Oaks gage on the lower American River prior to and after construction of Folsom and Nimbus dams (Gerstung 1971).

5.4.3 Future Baseline Excluding CVP/SWP Effects

Baseline stressors to American River steelhead include the presence of Folsom and Nimbus dams, loss of natural riverine function and morphology, predation, and water quality (figure 5-19).

The physical structures of Folsom and Nimbus dams are part of the future baseline. Dams produce extensive ecological disruptions, including alteration of flow regimes, sedimentation, and nutrient fluxes, modification of stream-channel morphology, spatial decoupling of rivers and their associated floodplains, disruption of food webs, and fragmentation and loss of habitat (Ligon *et al*. 1995, Levin and Tolimieri 2001). Nimbus Dam was completed in 1955, blocking steelhead and spring-run from all of their historic spawning habitat in the American River (Lindley *et al*. 2006). Hydrological and ecological changes associated with the construction of the dams contributed to the extirpation of summer steelhead and spring-run, which were already greatly diminished by the effects of smaller dams (*e.g*., Old Folsom Dam and the North Fork Ditch Company Dam) and mining activities (Yoshiyama *et al*. 1996).

Loss of natural river function and morphology is a major stressor to the aquatic resources of the American River, including steelhead. Past habitat alterations that have taken place within the American River watershed continue to limit natural river processes. The following discussion on the habitat alterations in the American River watershed was slightly modified from Water Forum (2005a). Prior to 1849, the riparian vegetation along the river formed extensive, continuous forests in the floodplain, reaching widths of up to 4 miles. Settlement of the lower American River floodplain by non-indigenous peoples and the resulting modifications of the physical processes shaping the river and its floodplain have drastically altered the habitats along the river. Early settlers removed trees and converted riparian areas to agricultural fields. Hydraulic gold

mining in the watershed caused deposits of 5-30 feet of sand, silt, and fine gravels on the riverbed of the lower American River. These deposits resulted in extensive sand and gravel bars in the lower river and an overall raising of the river channel and surrounding floodplain. This was later exacerbated by gravel extraction activities. As a result, the floodplain's water table has dropped, reducing the growth and regeneration of the riparian forest.

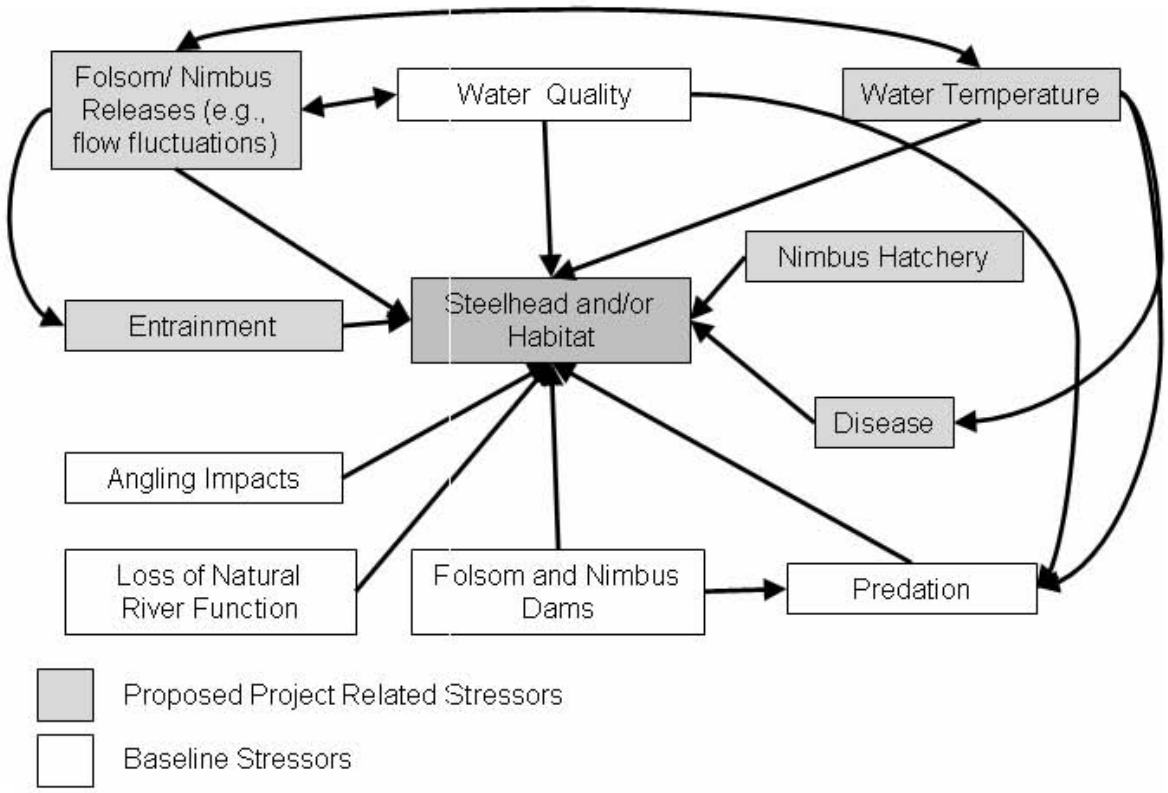


Figure 5-19. Conceptual model of the future baseline stressors and proposed project-related stressors affecting naturally-produced American River steelhead.

Additional habitat impacts resulted from the construction of Folsom and Nimbus dams. These structures have blocked the main upstream sediment supply to the lower American River. This sediment deficit reduces the amount of material that can deposit into bars in the lower reaches, resulting in less substrate for growth of cottonwoods and other riparian vegetation.

Since the 1970s, bank erosion, channel degradation and creation of riprap revetments have contributed to the decline of riparian vegetation along the river's edge, loss of soft bank and channel complexity, and reduced amounts of large woody debris in the river that are used by fish and other species. In particular, there has been a decrease in overhanging bank vegetation called shaded riverine aquatic (SRA) habitat. SRA habitat provides multiple benefits to both fish and wildlife. In particular, it provides shade along the river to moderate water temperatures in the summer. Overhanging vegetation also provides cover to aquatic species, creating areas where they can feed and rest while being sheltered from predators. Living and dead vegetation provides habitat and food for many species of insects and other organisms, which can then be eaten by fish species, including salmonids (Water Forum 2005a).

Predators of juvenile steelhead in the lower American River include both native (*e.g.*, pikeminnow) and non-native (*e.g.*, striped bass) fish, as well as avian species. Striped bass, which were introduced in California in 1879 and 1882 (SWRI 2001), have been shown to be effective predators of steelhead in the Central Valley (DWR 2008). Some striped bass reportedly reside in the lower American River year-round, although their abundance greatly increases in the spring and early summer as they migrate into the river at roughly the same time that steelhead are both emerging from spawning gravels as vulnerable fry and are migrating out of the river as smolts (SWRI 2001).

Poor water quality can affect steelhead in the lower American River. Tierney *et al*. (2008) demonstrated that environmentally observed pesticide mixtures can injure rainbow trout olfactory tissue, thereby affecting their ability to detect predators. Similarly, Sandahl *et al*. (2007) showed that runoff from urban landscapes has the potential to cause chemosensory deprivation and increased predation mortality in exposed salmon. Urbanization throughout the greater Sacramento area has led to a replacement of agricultural land uses within the American River floodplain with urban land uses, and a corresponding increase in urban runoff (SWRI 2001). Based on data from 1992 through 1998 collected by the Ambient Monitoring Program, lower American River water quality exceeded State (California Toxics Rule) or Federal (EPA) criteria with respect to concentrations of four metals – lead, copper, zinc, and cadmium (SWRI 2001).

The open season for angling in the lower American River encompasses nearly the entire steelhead spawning season. The only steelhead spawning potentially occurring during the closed fishing season would occur for early spawners during late-December from Hazel Avenue bridge piers to the SMUD power line crossing at the south-west boundary of Ancil Hoffman Park (CDFG 2008). The entire lower river is open for fishing starting in January, although reach-specific gear and harvest restrictions apply. Although only hatchery steelhead may be harvested, catch and release of wild spawners may result in mortality if hooking injures critical organs (*e.g.*, gills; Cowen *et al*. 2007). Steelhead fishing report card results show that the American River receives the third most angling effort in the State, with only the Trinity and Smith rivers receiving more (CDFG 2007). From 2003 through 2005, over 3,500 steelhead fishing trips were reported for the American River. During those years, anglers reportedly caught 1,840 wild steelhead and illegally harvested 31 of those; 1,440 hatchery steelhead were caught and released and 359 hatchery steelhead were harvested. In addition to the direct effects associated with catch and release fishing, steelhead eggs incubating in redds may be damaged by wading anglers or other recreationalists.

5.5 Status of the Species and Critical Habitat in the East Side Division

The New Melones Dam operates in conjunction with Tulloch Reservoir and Goodwin Dam on the Stanislaus River (figure 5-20). Goodwin Dam, completed in 1912, is an impassible barrier to upstream fish migration at RM 59. Water is released from New Melones to satisfy senior water right entitlements, instream and Delta water quality standards specified under D-1641, CDFG fish agreement flows, CVP water contracts and b(2) or CVPIA 3406(b)(3) [hereafter referred to b(3)] fishery flows.

5.5.1 CV Steelhead

CV steelhead is the only anadromous ESA-listed species that occurs in the Stanislaus River. Fall-run also occur in this river. Spring-run and summer steelhead have been extirpated from this watershed (Yoshiyama *et al*. 1996). Steelhead populations in the Stanislaus, Tuolumne, Merced, and Calaveras rivers are the only remaining representatives of the Southern Sierra Nevada diversity group of the CV steelhead. None of these populations are considered to be viable at this time (Lindley *et al*. 2007). Anadromous *O. mykiss* populations may have been extirpated from their entire historical range in the San Joaquin Valley owing to dam construction, but current populations survive in these rivers in tailwater conditions controlled by the dams. The Calaveras River is not a direct tributary to the mainstem San Joaquin River, in that it enters a network of sloughs and channels in the Delta east of the mainstem of the San Joaquin River. Additionally, the primary flow metric for the San Joaquin River is the flow at Vernalis, and Calaveras River flows enter the Delta further downstream. For the purposes of this document, tributaries to the San Joaquin River are defined as the Merced River, the Tuolumne River and the Stanislaus River. Based on information from a variety of sources (rotary screw trap sampling, trawling at Mossdale, direct and angler observations) in all three tributaries of the San Joaquin River, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single digit numbers of fish into the tributaries suggest that existing populations of CV steelhead on the Stanislaus, Tuolumne, Merced, Calaveras, and lower San Joaquin rivers are severely depressed.

Information regarding steelhead numbers on the Stanislaus River is very limited and has typically been gathered incidental to existing monitoring activities for fall-run. A counting weir for fall-run also has recorded passage of steelhead. In the 2006-7 counting season, 12 steelhead were observed passing through the counting weir, coincidental with the observation of 3,078 adult salmon (Anderson *et al*. 2007). An adipose fin-clipped steelhead was observed at the counting weir, indicating some opportunity for genetic introgression from hatchery operations on other Central Valley rivers. On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001), but the numbers are very low, ranging from 10 to 30 annually, compared to annual catches of fall-run in the range of hundreds. The low juvenile steelhead numbers likely indicate a much smaller steelhead population than fall-run, but steelhead smolts are considerably larger than fall-run smolts, and can avoid capture by the traps (Stillwater Sciences 2000). Most of the steelhead smolts are captured from January to mid-April, and are 175 to 300 mm fork length. The raw data from rotary screw trapping show *O. mykiss* in a smolted stage being trapped in late May at both the Oakdale and Caswell trap locations. These fish are physiologically prepared to leave the river at a time well after the scheduled Vernalis Adaptive Management Plan (VAMP) pulse flows, but not later than when historical unimpaired rain-on-snow events would have provided outmigration flows. Zimmerman *et al.* (2008) have documented CV steelhead in the Stanislaus, Tuolumne and Merced rivers based on otolith microchemistry.

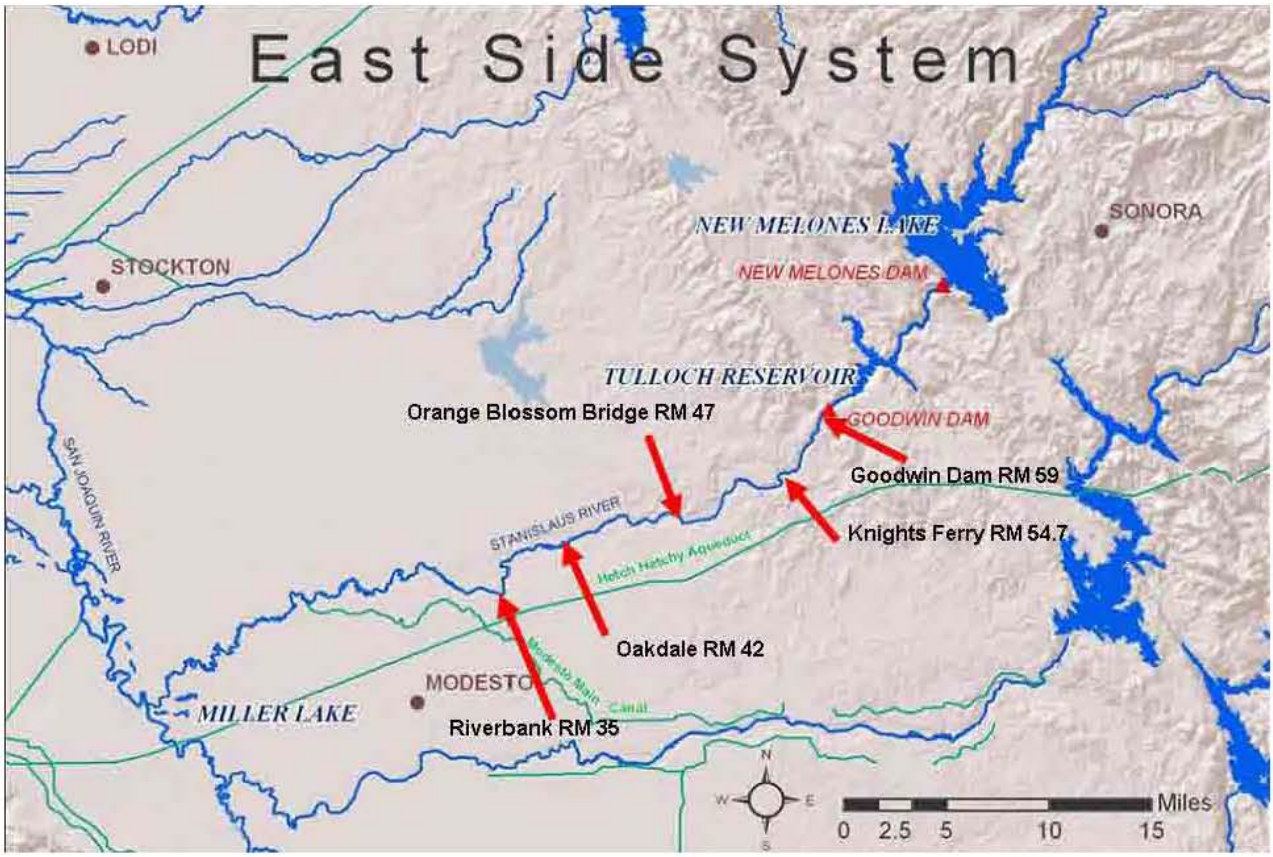


Figure 5-20. Map of the East Side Division (adapted from the CVP/SWP operations BA figure 2-10).

Juvenile steelhead reside in freshwater for a year or more, so they are more dependent on freshwater rearing habitat than are the ocean type fall-run. Steelhead rearing in the Stanislaus River occurs upstream of Orange Blossom Bridge (RM 47) where gradients are highest. The highest rearing densities are upstream of Knights Ferry (RM 54.7, Kennedy and Cannon 2002).

Juvenile steelhead migrate during the winter and spring from the above-described rearing areas downstream through the rivers and the Delta to the ocean. The habitat conditions they encounter from the upstream reaches of the rivers downstream to the Delta become generally further from their preferred habitat requirements with respect to cover, temperature, water quality, and exposure to predatory fishes such as striped bass and non-native black bass. Emigration conditions for juvenile steelhead in the Stanislaus River down through the San Joaquin River and the south Delta tend to be less suitable than conditions for steelhead emigrating from the Sacramento River and its tributaries.

CDFG staff has prepared catch summaries for juvenile migrant steelhead on the San Joaquin River near Mossdale, which represents migrants from the Stanislaus, Tuolumne, and Merced rivers. These trawl recoveries at Mossdale between 1988 and 2002 ranged from a minimum of 1 fish per year to a maximum of 29 fish in 1 year (figure 4-5).

Adult steelhead migrate upstream from the ocean to their spawning grounds near the terminal dams primarily during the fall and winter months. Flows are generally lower during the upstream migrations than during the outmigration period. Adult steelhead may occur in the

Stanislaus River earlier than in other Central Valley rivers when fall attraction flows are released in October for the benefit of fall-run. The general temporal occurrence of steelhead and fall-run in the Stanislaus River at various life history stages is illustrated in figure 5-21.

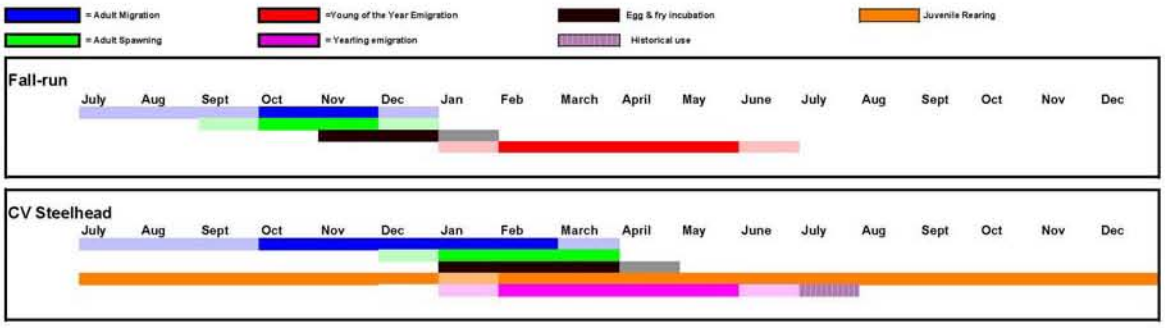


Figure 5-21. Temporal occurrence of fall-run and steelhead in the Stanislaus River, California. Darker shading indicates peak use.

Construction of Goodwin Dam in 1912 has excluded steelhead from 100 percent of its historical spawning and rearing habitat on the Stanislaus River (Lindley *et al*. 2006). Critical habitat has been designated up to Goodwin Dam, to include currently occupied areas. Extension of critical habitat above the dams was deemed premature until recovery planning determines a need for these areas in the recovery of the DPS (September 2, 2005, 70 FR 52488).

The construction of the East Side Division Dams (New Melones, Tulloch, and Goodwin) blocks the downstream transport of spawning gravel that would replenish gravel below the dams. Past East Side Division operations have mobilized gravel remaining below the dams, which has led to a degradation of the quality and quantity of available steelhead spawning gravels (Kondolf *et al*. 2001). Gravel replenishment projects funded by CVPIA have offset some of this habitat loss, but the rate of replenishment is not sufficient to offset ongoing loss rates, nor to offset losses from past years of operations.

Past operations of the East Side Division have eliminated channel forming flows and geomorphic processes that maintain and enhance steelhead spawning beds and juvenile spawning areas associated with floodplains and channel complexity. Since the construction and operation of New Melones Dam, operational criteria have resulted in channel incision, as much as 1-3 feet (Kondolf *et al*. 2001). This downcutting, combined with operational criteria, have effectively cut off overbank flows which would have inundated floodplain rearing habitat, as well as providing areas for fine sediment deposition, rather than within spawning gravels, as occurs now. Operational flow patterns in late spring and summer, combined with lack of overbank flows has severely constrained recolonization of large riparian trees that are needed for riparian shading and LWD contribution.

5.5.1.1 CV Steelhead Critical Habitat

Steelhead critical habitat on the Stanislaus River has been designated up to Goodwin Dam. The PCEs of critical habitat for Stanislaus River steelhead include freshwater spawning, freshwater rearing, freshwater migration, and estuarine habitats. Although Stanislaus River water

temperatures are generally suitable for spawning and rearing, during the smolt emigration life stage (January through June), steelhead are exposed to water temperatures that would prohibit successfully completing transformation to the smolt stage. In addition, steelhead spawning and rearing habitat on the Stanislaus River is affected by the limited occurrence of flows that are sufficient to carry out natural geomorphic processes. As such, sediment deposition on spawning habitats has decreased the availability of suitable spawning areas. The relatively low and uniform releases in the Stanislaus River reduces the conservation value of rearing habitat by reducing habitat complexity and decreasing connectivity with floodplains, which are proven to be high quality rearing habitats (Sommer *et al*. 2005).

5.5.2 Historical Conditions

The unimpaired hydrograph of the Stanislaus River followed the pattern of low flows at the end of the summer, increasing flows in the fall as upstream evapotranspiration rates declined, which continued to increase with the onset of seasonal rainfall in late fall, followed by rain plus snowmelt through the end of spring (table 5-2). The winter hydrograph was punctuated with storm related freshets, peak flows correlated with large storm events, and periodic large instream flow events later in winter and spring, owing to rain-on-snow events in the higher elevations of the watershed.

Table 5-2. Comparison of unimpaired average monthly flows, Stanislaus River from various timeframes, with post-New Melones Dam regulated flows (Kondolf *et al*. 2001 table 4.4).

FLOWS (AF)

Water Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	TOTAL
Pre-dam Flows **:													
AVG 1901-1926 *:	11,777	18,377	32,542	63,746	108,923	166,938	232,181	318,454	230,462	76,638	16,968	7,296	1,304,323
AVG 1901-1957:	9,711	23,199	46,870	70,297	93,698	140,970	216,955	304,186	203,184	62,223	13,850	5,851	1,190,995
AVG 1901-2000:	10,372	26,041	48,973	85,392	101,490	141,154	203,571	292,266	193,353	61,051	14,032	6,962	1,184,657
Post-dam Flows:													
AVG 1979-1998:	38,737	32,670	49,969	71,851	72,881	97,478	77,369	77,732	55,313	51,479	45,059	38,034	708,573
*Δ post NM/preOM **:*	*329%*	*178%*	*154%*	*86%*	*67%*	*58%*	*33%*	*24%*	*24%*	*67%*	*265%*	*521%*	*54%*

FLOWS (cfs)

Water Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	TOTAL
Pre-dam Flows **:													
AVG 1901-1926 *:	192	309	530	1,364	1,965	2,720	3,909	5,188	3,880	1,249	277	123	21,705
Post-dam Flows:													
AVG 1979-1998:	631	550	814	1,171	1,315	1,588	1,303	1,266	931	839	734	640	11,782
*Δ post NM/preOM **:*	*329%*	*178%*	*154%*	*86%*	*67%*	*58%*	*33%*	*24%*	*24%*	*67%*	*265%*	*521%*	*54%*

**: 1901-1926 represents the "Pre - Old Melones" dam flow records and is graphed in Figure 4-9.*

***: Unimpaired flow data from "Full Natural Flow" data, USGS gauge at Stanislaus R-Goodwin (SNS), Sensor #65, Elev. 252'.*

The life history strategy of CV steelhead evolved with this hydrologic pattern. The adults return from the ocean to spawn in the rivers when fall flows have increased and water temperatures in the valley are past their summer peak. Historically they would continue far upstream to spawn, allowing their offspring rearing areas that are cooler year round than lower elevation reaches nearer the valley floor. Young steelhead would rear in these areas for at least a full year, beginning their seaward migration during the winter and spring freshets and storm pulses that helped their seaward movement and created a succinct signature of Stanislaus River water through to the Delta.

5.5.3 Future Baseline Excluding CVP/SWP Effects

Future baseline stressors to CV steelhead include the presence of Goodwin, Tulloch and New Melones dams, loss of natural riverine function and morphology, agricultural and urban land uses, gravel mining, predation, and water quality, particularly temperature, contaminants and suspended sediment (figure 5-22).

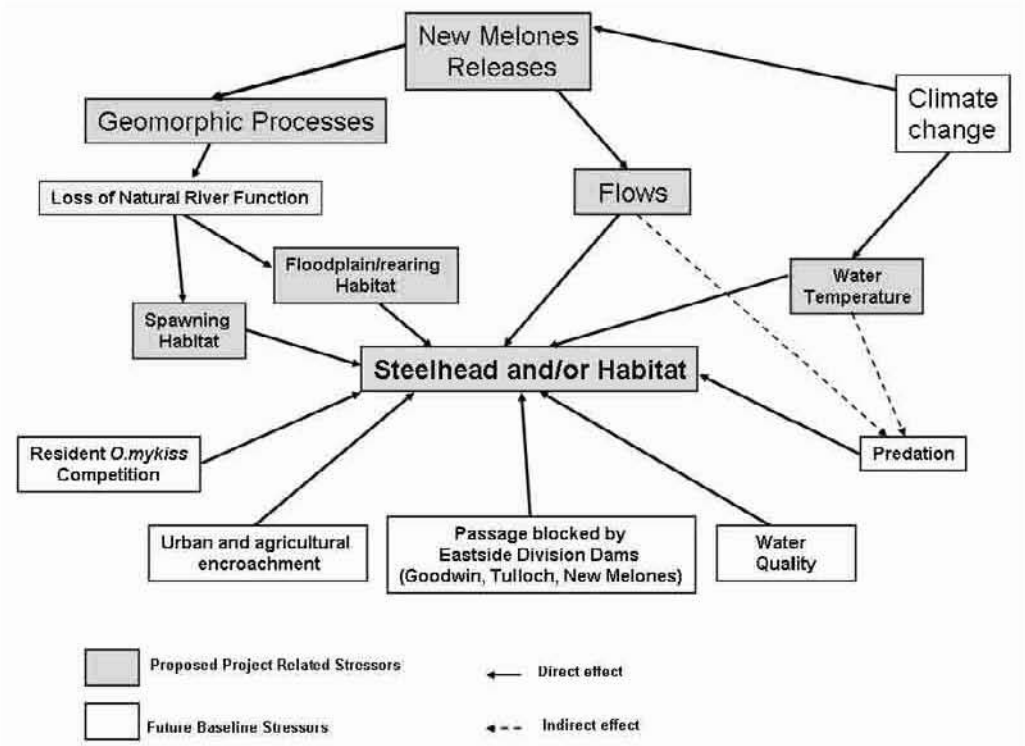


Figure 5-22. Conceptual model of and future baseline stressors and project-related stressors of CV steelhead and habitat in the Stanislaus River, California.

Dams produce extensive ecological disruptions, including sedimentation, and nutrient fluxes, modification of stream-channel morphology, spatial decoupling of rivers and their associated floodplains, disruption of food webs, and fragmentation and loss of habitat (Ligon *et al*. 1995, Levin and Tolimieri 2001). Lindley *et al*. (2006) also suggest that dams may exert selective effects on anadromous *O. mykiss*, culling the anadromous offspring produced, and modifying the thermal regime and food web structure of the river below the dam in ways that may provide fitness advantages to resident forms, which means that the population shifts more towards residency and further from a viable anadromous species.

Loss of natural river function and morphology is a major stressor to the aquatic resources of the Stanislaus River, including steelhead. Bank erosion, channel degradation and creation of riprap revetments have contributed to the decline of riparian vegetation along the river's edge, loss of soft bank and channel complexity, and reduced amounts of LWD in the river that are used by

fish and other species. Living and dead vegetation provide habitat and food for many species of insects and other organisms, which can then be eaten by fish species, including salmonids.

Flood attenuation has allowed for encroachment of agriculture and homes up to the river's edge. Although floodway easements were acquired on many farmed terraces when New Melones Dam was constructed, much of this agricultural activity consists of permanent orchards, which are not flood resistant. This agricultural practice is averse to overbank flooding and creates opposition to dam operational practices that would flood habitat terraces.

Poor water quality can affect steelhead in the lower Stanislaus River. The lower Stanislaus River is considered an impaired water body for Diazinon and Group A pesticides attributed to agricultural uses. Tierney *et al*. (2008) demonstrated that environmentally observed pesticide mixtures can injure rainbow trout olfactory tissue, thereby affecting their ability to detect predators. Similarly, Sandahl *et al*. (2007) showed that runoff from urban landscapes has the potential to cause chemosensory deprivation and increased predation mortality in exposed salmon. There is an increasing trend toward urbanization of the lower Stanislaus River.

Gravel mining, including in-river skimming and flood terrace pit mines, is currently less active in the watershed, but has left a legacy of reduced instream gravel abundance and deep excavation pits captured by the river that provide habitat for non-native predatory fishes, like largemouth bass and striped bass that prey on steelhead. The lower Stanislaus River is considered an impaired water body for mercury as a result of past gravel and gold mining activity [2006 Clean Water Act section 303(d) list], although it is not clear how much of that contaminant is present in the biologically active methylated form.

5.6 Status of the Species and Critical Habitat in the Delta Division

The overall statuses of the four listed species in the Central Valley (winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon) were described in section 4 of this Opinion. Since all of the sub-populations that comprise the listed populations at the ESU or DPS level must pass through the Delta (figure 5-23), further description of the status of each individual sub-population beyond that already given in section 4 is unnecessary.

5.6.1 Critical Habitat

5.6.1.1 Status of Winter-Run Critical Habitat

Critical habitat within the Delta largely serves as a migratory corridor. However, juvenile winter-run likely rear while they migrate downstream, therefore, rearing habitat is an important component within the mainstem Sacramento River in the Delta. The current condition of riparian habitat for winter-run in the Delta is degraded as a result of the channelized, leveed, and riprapped river reaches and sloughs, which typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Some complex, productive habitats with floodplains remain in the system [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypass (*i.e.*, Yolo bypass).

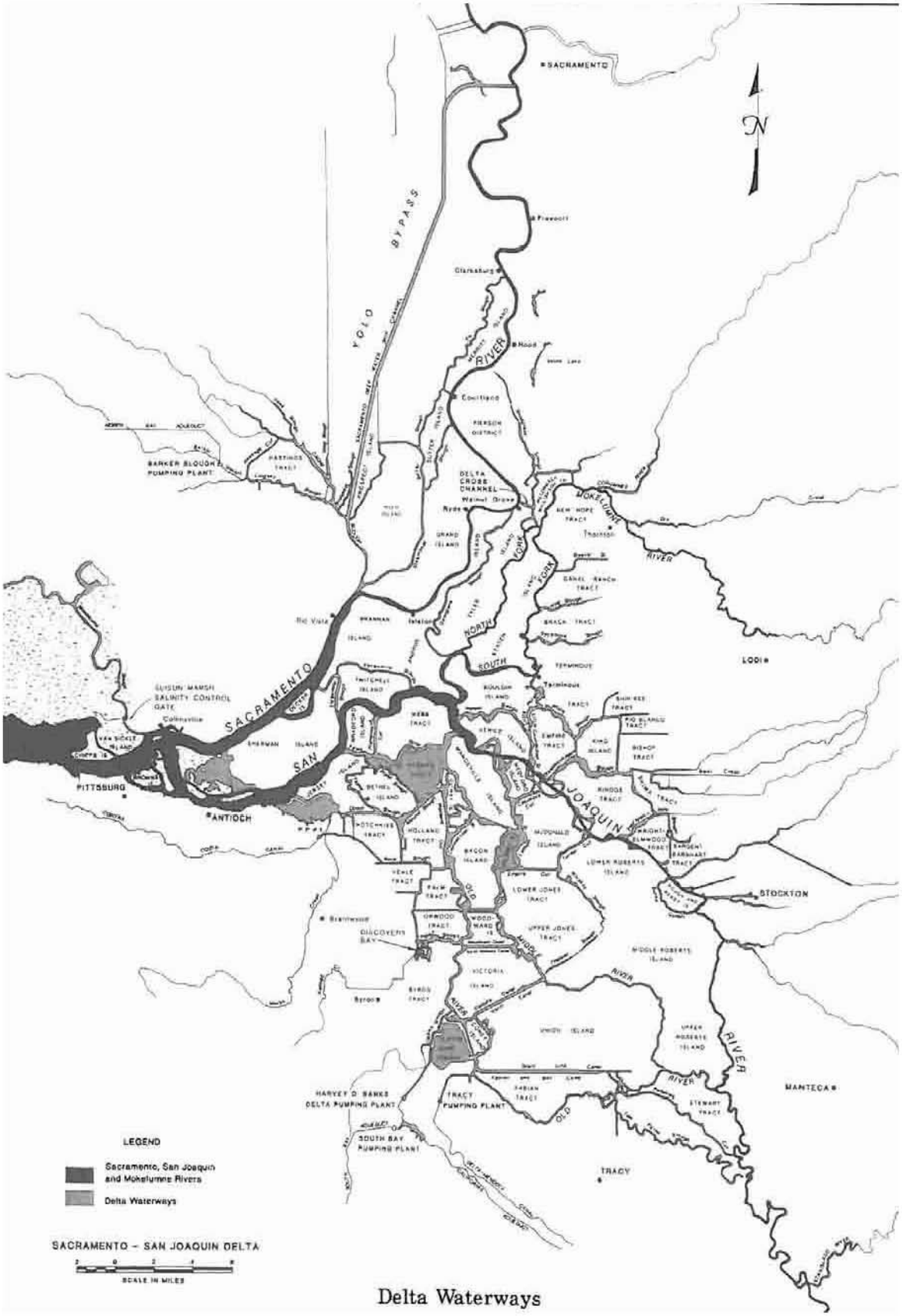


Figure 5-23. Map of Delta waterways.

The final rule designating winter-run critical habitat explicitly excludes the rivers and sloughs of the Delta, with the goal of minimizing diversion of winter-run through the DCC (June 16, 1993, 58 FR 33212). When the DCC gates are open during winter-run outmigration, a portion of the flow, and therefore, a portion of the outmigrating winter-run, is entrained through the DCC into the interior Delta, where their chances of survival and successful migration to San Francisco Bay and the Pacific Ocean are reduced. In addition, unscreened diversions that entrain juvenile salmonids are prevalent throughout the Delta and do not provide a safe migration corridor.

Based on the impediments caused by unscreened diversions, and the opening of the DCC gates during the winter-run outmigration period, the current condition of the migration corridor through the Delta for juvenile winter-run is much degraded.

5.6.1.2 Status of Spring-Run Critical Habitat

The status of estuarine habitats for spring-run also is considered to be highly degraded as is evident by the collapse of pelagic organisms in the Delta (Sommer *et al*. 2007, IEP 2008). It is not immediately clear how the changes in the Delta ecosystem affect spring-run, but it is certain that substantial changes to spring-run estuarine habitat are occurring.

5.6.1.3 Status of CV Steelhead Critical Habitat

In addition, the status of estuarine habitats for steelhead is considered to be highly degraded as is evident by the collapse of the pelagic community in the Delta. This collapse is, in part, related to dramatic habitat changes in recent years related to water quality, toxic algae blooms (*e.g*., Microcystis), and invasive species (*e.g*., the aquatic macrophyte *Egeria densa*). It is not immediately clear how the changes in the Delta ecosystem affect steelhead, but it is certain that substantial alterations to steelhead estuarine habitat are occurring.

5.6.1.4 Status of Southern DPS Green Sturgeon Proposed Critical Habitat

The effects of combined exports present an entrainment issue that could delay migration or decrease survival or population viability through entrainment into the facilities itself. These effects increase in magnitude the closer to the export facilities the fish are located. Likewise, the installation of the barriers under the South Delta Temporary Barriers Program (TBP) enhances the potential to delay movement and migratory behavior in the channels of the South Delta. Juvenile and adult green sturgeon may be trapped behind the barriers after installation/ operation for varying periods of time. The rock barriers of the TBP present the greatest obstacle to movement during their installation and operation, but are removed from the channels each winter.

5.6.2 Delta Hydrodynamics

5.6.2.1 Historical Hydrograph

Substantial changes have occurred in the hydrology of the Central Valley's watersheds over the past 150 years. Many of these changes are linked to the ongoing actions of the CVP and SWP in their pursuit of water storage and delivery of this water to their contractors.

Prior to the construction of dams on the tributaries surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snow melt in the surrounding watersheds. These reservoirs delayed and muted the transmission of floodwaters traveling down the length of the Sacramento and San Joaquin rivers. Historically, there were at least six distinct flood basins in the Sacramento Valley. The east side of the Sacramento Valley was topographically subdivided into the Butte Basin, the Sutter Basin, the American River Basin, and the Sacramento Basin. The west side of the valley contained the Colusa Basin and the Yolo Basin. The Colusa Basin drained through Sycamore Slough above Knight's Landing, the Yolo Basin drained through Cache Slough at the foot of Grand Island, and the eastern basins drained through the Feather and the American rivers. The Sacramento Basin drained southwards towards the San Joaquin River. Some of these basins retained floodwaters for many months after the flood event, allowing the basins to slowly drain back into the river or to evaporate in the summer heat. Others, like the Yolo Basin, drained relatively quickly. Overflow into these basins significantly reduced flood peaks and flow velocities in the bypassed reaches. For example, the Yolo Basin was believed to capture over two-thirds of the flood flows on the Sacramento River and divert them around the main channel near Sacramento towards the Delta. These extensive flood basins created excellent shallow water habitat for fish such as juvenile Chinook salmon, steelhead, and sturgeon to grow and rear before moving downstream into the Delta (The Bay Institute 1998). The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches.

Prior to the construction of dams, there were distinct differences in the natural seasonal flow patterns between the northern Sacramento River watershed and the southern San Joaquin River watershed. Furthermore, the natural unimpaired runoff in the Central Valley watersheds historically showed substantial seasonal and inter-annual variability. Watersheds below 5,000 feet in elevation followed a hydrograph dominated by rainfall events with peak flows occurring in late fall or early winter (northern Sierra Nevada, Cascade Range, and most of the western coastal mountains). Conversely, those watersheds with catchment areas above 5,000 feet, such as the Central and Southern Sierras, had hydrographs dominated by the spring snowmelt runoff period and had their highest flows in the late spring/early summer period. Summertime flows on the valley floor were considerably reduced after the seasonal rain and snowmelt pulses were finished (figures 5-24), with base flows supported by the stored groundwater in the surrounding alluvial plains. Since the construction of the more than 600 dams in the mountains surrounding the Central Valley, the variability in seasonal and inter-annual runoff has been substantially

reduced and the peak flows muted, except in exceptional runoff years. Currently, average winter/spring flows are typically reduced compared to natural conditions, while summer/fall flows have been artificially increased by reservoir releases. Wintertime releases are coordinated for preserving flood control space in the valley's large terminal storage dams, and typically do not reach the levels necessary for bed load transport and reshaping of the river channels below the dams. Summertime flows have been scheduled for meeting water quality goals and consumptive water demands downstream (figures 5-25 and 5-26). Mean outflow from the Sacramento River during the later portion of the 19th century has been reduced from nearly 50 percent of the annual discharge occurring in the period between April and June to only about 20 percent of the total mean annual outflow under current dam operations (The Bay Institute 1998). Currently, the highest mean flows occur in January, February, and March. The San Joaquin River has seen its snowmelt flood peak essentially eliminated, and the total discharge to the valley floor portion of the mainstem greatly reduced during the spring. Only in very wet years is there any marked late spring outflow peak (The Bay Institute 1998).

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. Releases of water to the Delta during the normally low-flow summer period have had several impacts on Delta ecology and hydrology. Prior to dam construction in the Central Valley and operations of the CVP and SWP, the Delta had normal variability in the hydrology. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989, figures 5-27 and 5-28). The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and "unstable" Delta environment.

Furthermore, Delta outflow has been reduced by approximately 14 percent from the pre-dam period (1921-1943) when compared to the project operations period (1968-1994). When differences in the hydrologic year types are accounted for and the "wet" years are excluded, the comparison between similar year types indicates that outflow has been reduced by 30 to 60 percent (The Bay Institute 1998, also see Delta Atlas, DWR), with most of this "lost" water going to exports.

5.6.2.1.2 Current Flow Patterns in the Delta

The Delta is a complex system of over 1,000 miles of waterways (Delta Atlas, DWR). The flow pattern within these waterways is also complex due to the interactions of river flows, tides, and water diversions. In order to explain in general terms the pattern of flows within the Delta, it will be divided into four regions, the North Delta, the Central Delta, the South Delta, and the Western Delta.

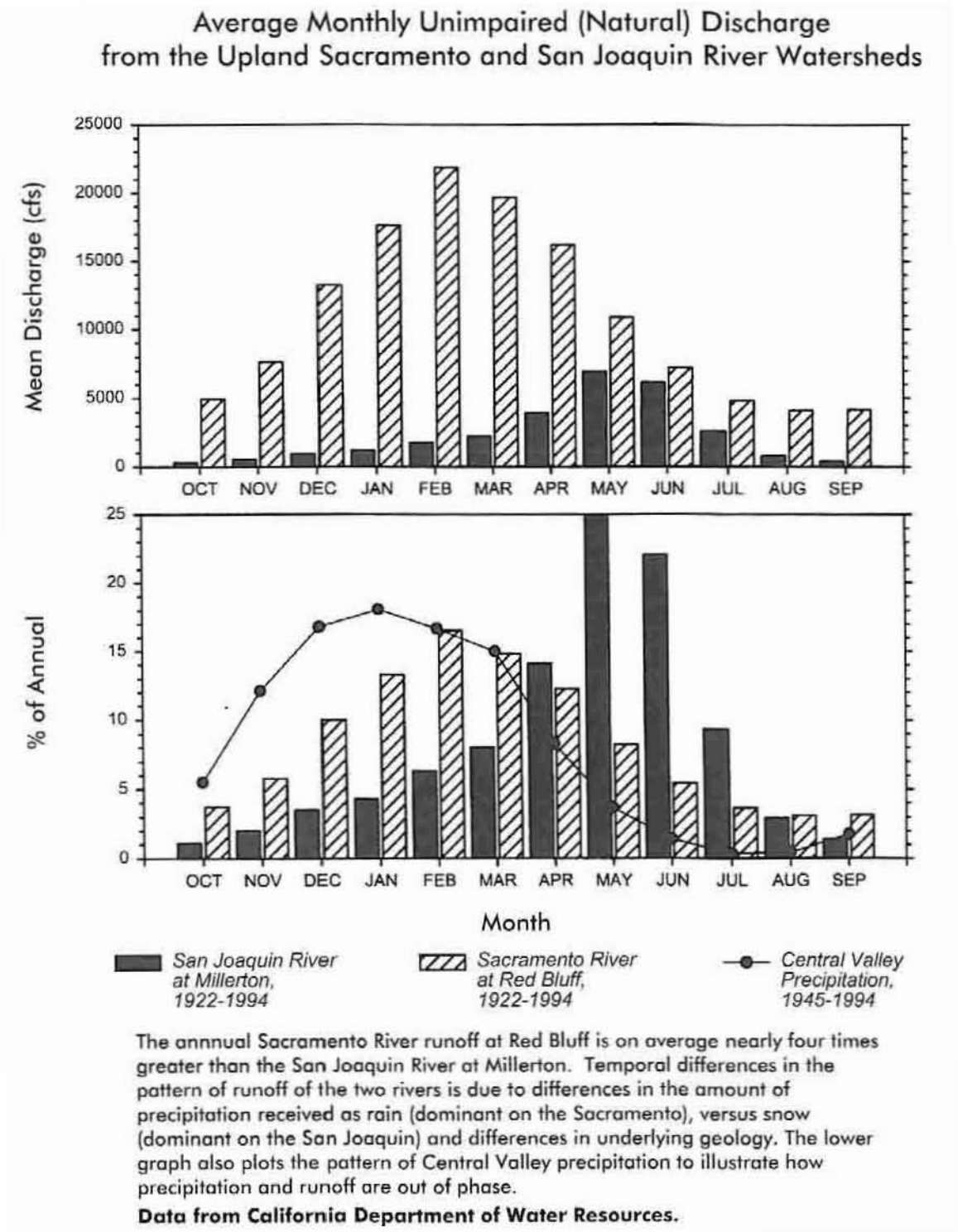


Figure 5-24. Average monthly unimpaired (natural) discharge from the upland Sacramento and San Joaquin River watersheds (The Bay Institute 1998).

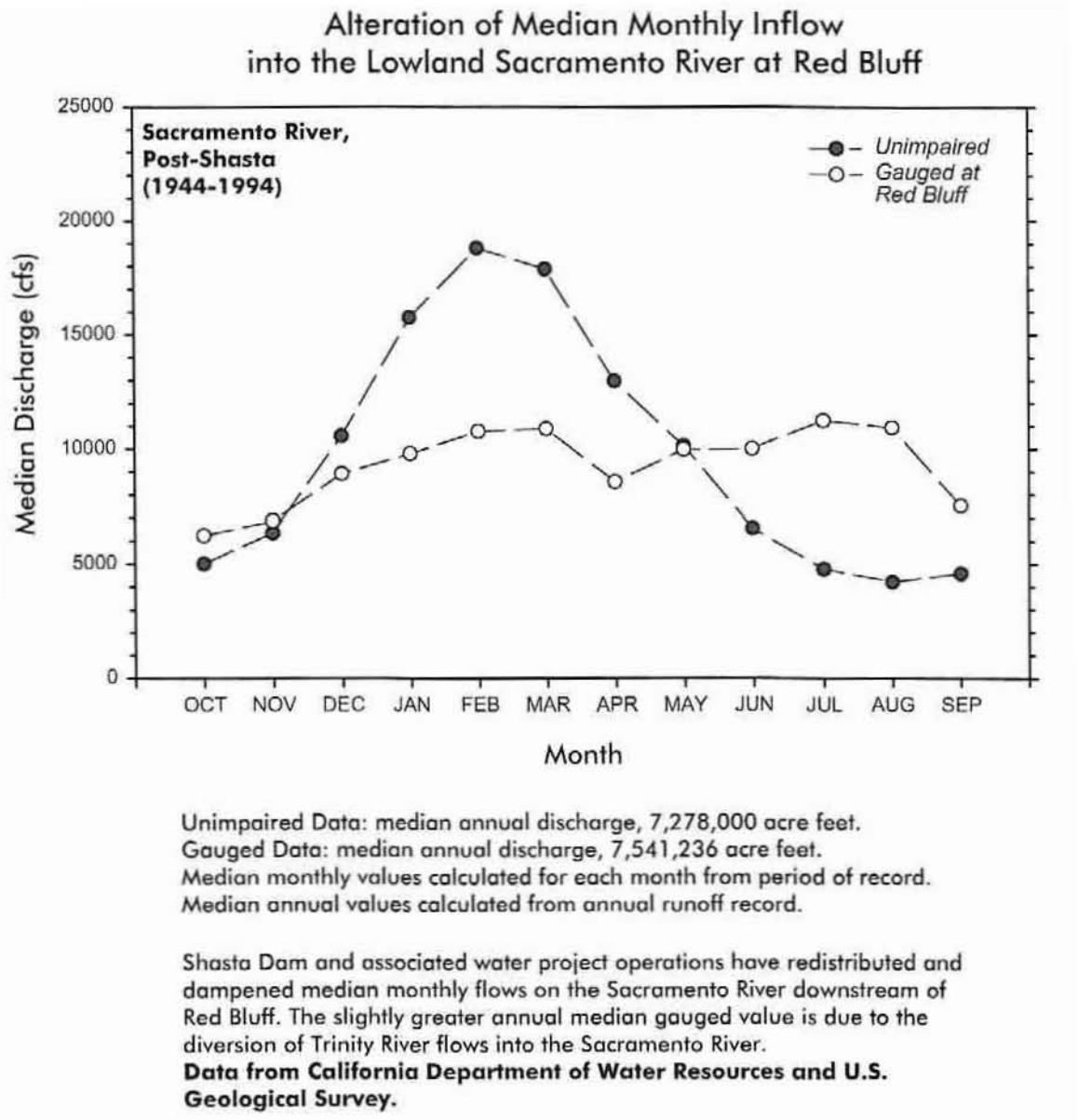


Figure 5-25. Alteration of median monthly inflow into the lowland Sacramento River at Red Bluff (The Bay Institute 1998).

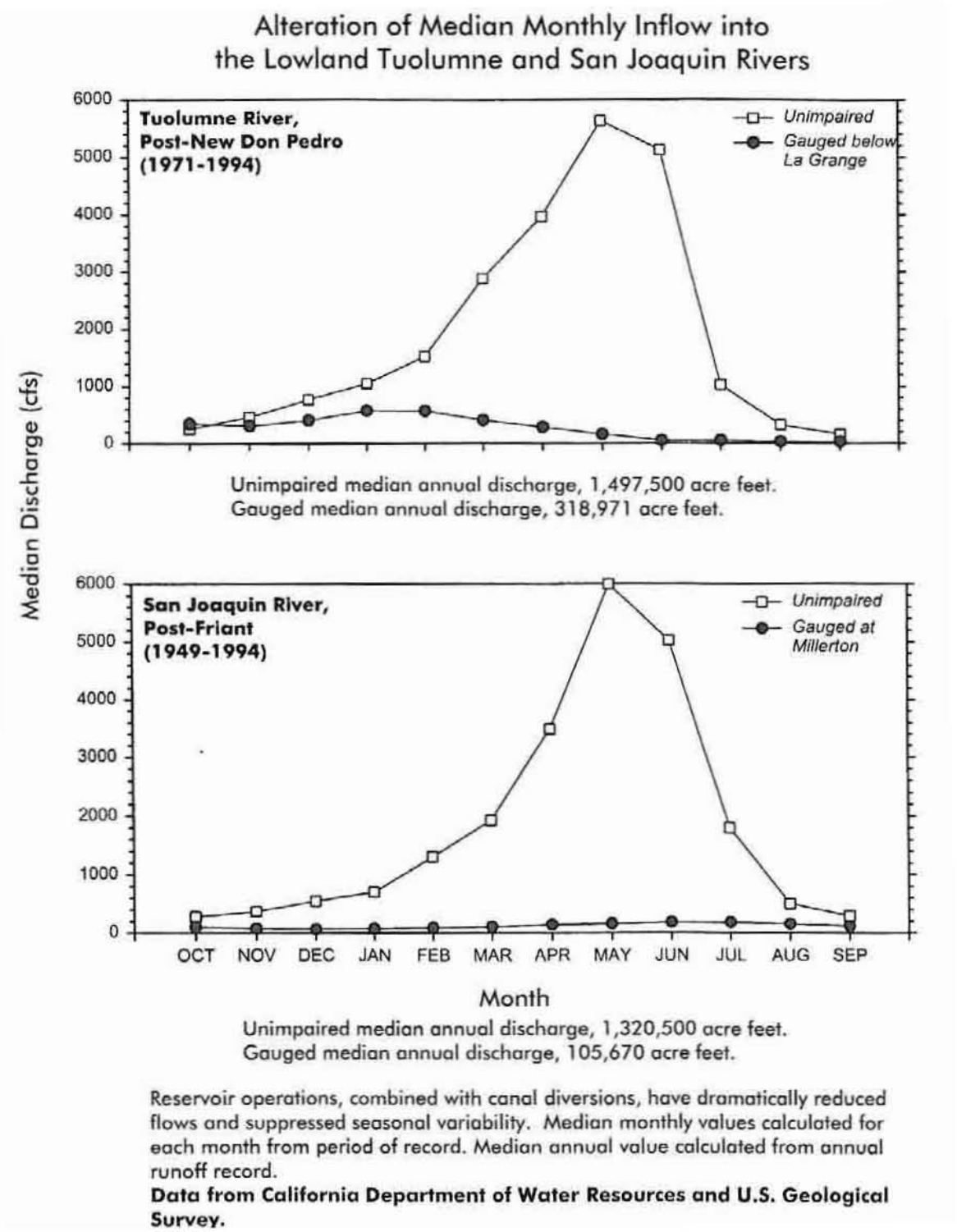


Figure 5-26. Alteration of median monthly inflow into the lowland Tuolumne and San Joaquin rivers (The Bay Institute 1998).

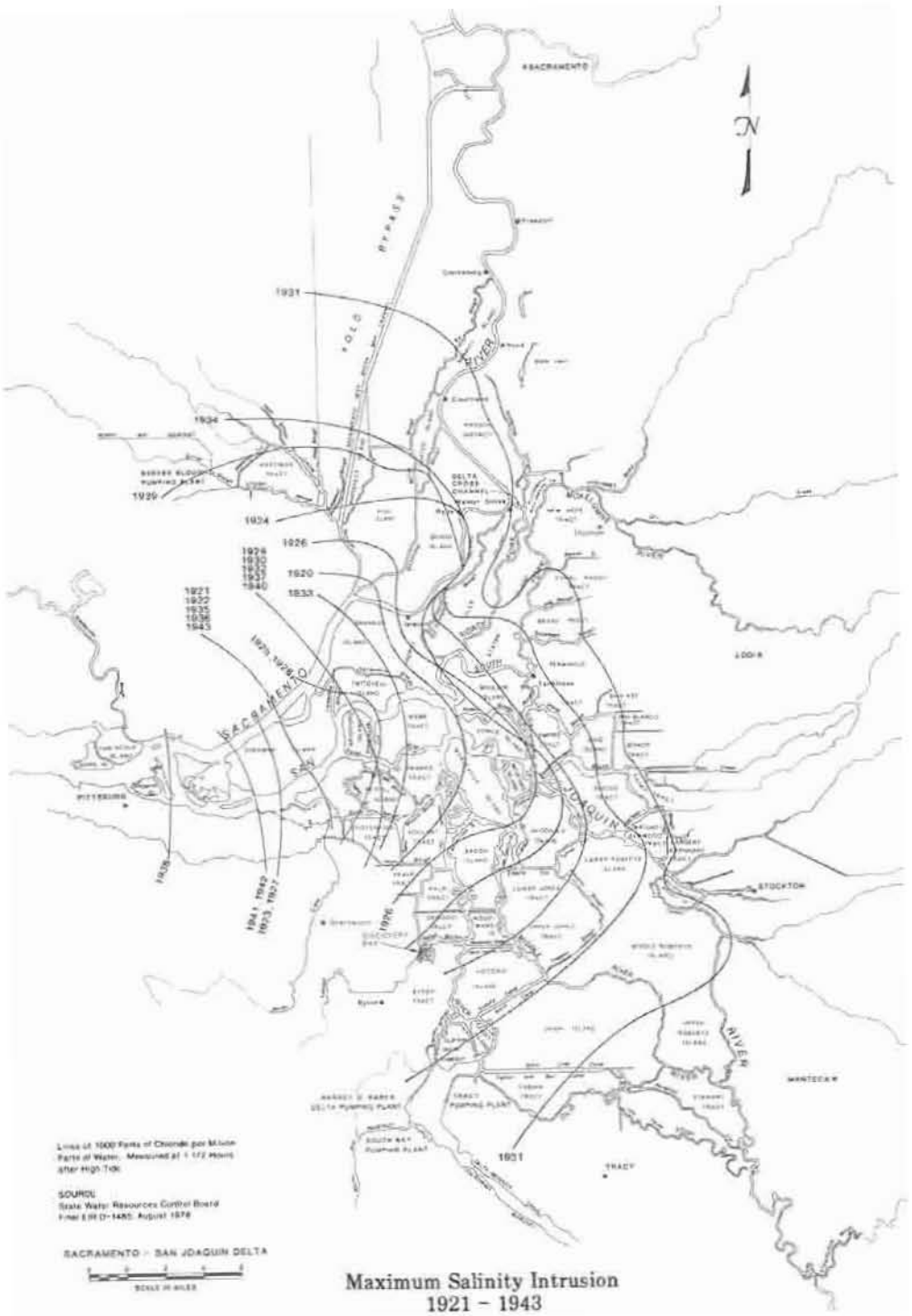


Figure 5-27. Maximum salinity intrusion for the years 1921 through 1943 (Pre-project conditions in Central Valley –Shasta and Friant Dams non-operational; Sacramento-San Joaquin Delta Atlas, DWR).

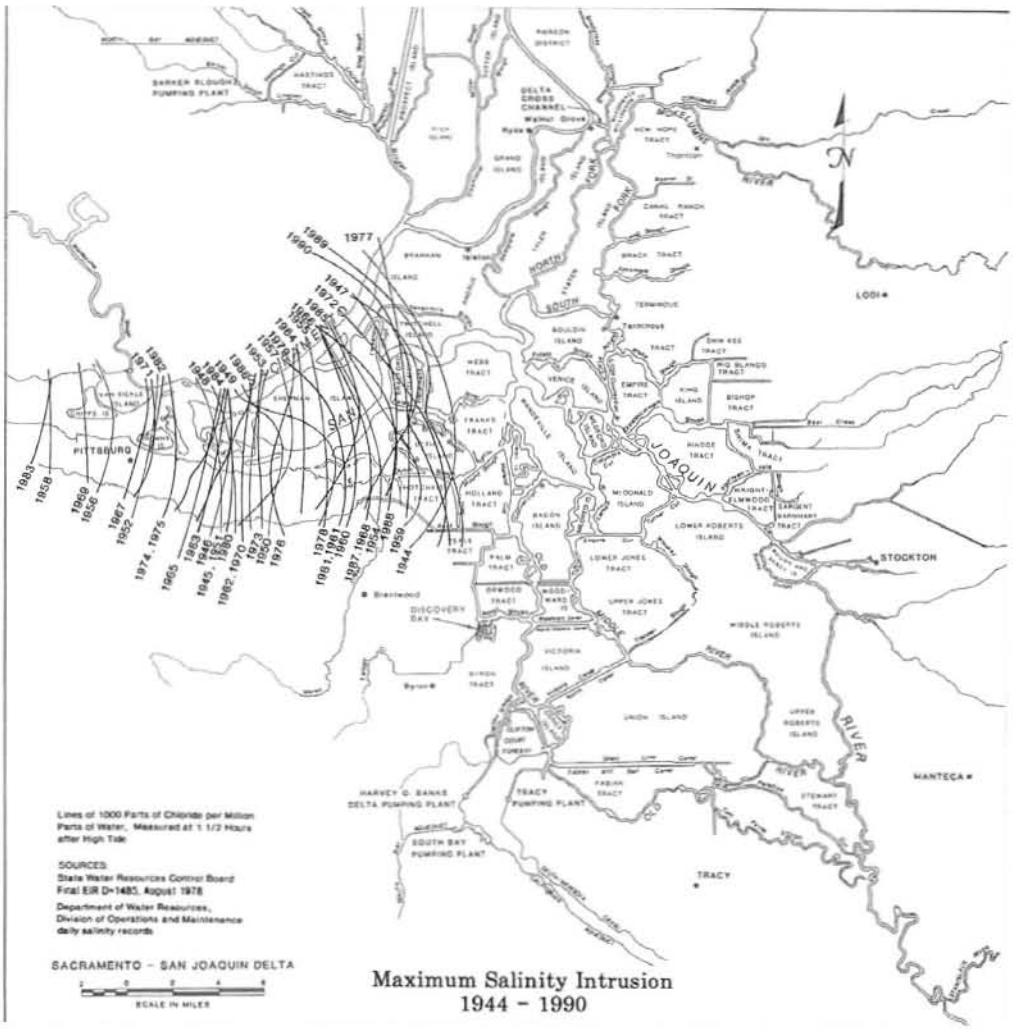


Figure 5-28. Maximum salinity intrusion for the years 1944 through 1990 (Project era; Sacramento-San Joaquin Delta Atlas, DWR).

The North Delta is primarily fed by the Sacramento River, which feeds into the Delta below the community of Freeport in Sacramento County. During high flow events, the Yolo bypass redirects flood flows southwards through the flood bypass, around the reach of the Sacramento River that flows through the City of Sacramento, before discharging the water into Cache Slough near the southern tip of Liberty Island. Downstream of Freeport, small natural channels branch off of the main channel of the Sacramento River and head southwesterly through the north Delta. Although smaller, these channels carry a substantial proportion of the Sacramento River's discharge through several farmed Delta Islands towards the Cache Slough region. Together, Sutter and Steamboat sloughs can convey approximately 35 percent of the Sacramento River's flow at Freeport when the Delta Cross channel gates are open and approximately 45 percent when the gates are closed (Burau *et al.* 2007 appendix A). Elk Slough branches off of the mainstem Sacramento River near the town of Clarksburg and flows in a southwesterly direction, separating Merritt Island from Prospect Island. Its connection to the mainstem Sacramento River is through gated culverts, which are operated on an as needed basis. Typically they are closed. Sutter Slough is the next channel that splits from the Sacramento River near Courtland and flows southwesterly between Sutter Island and Prospect Island. It picks up Elk Slough shortly after

branching off of the Sacramento River. Miner Slough branches off of Sutter Slough at the Northern tip of Ryer Island and flows along the western side of Ryer Island, separating it from Prospect Island. Farther downstream past the community of Painterville, Steamboat Slough branches off of the Sacramento River and travels in a southwesterly direction between Sutter and Grand Islands. Miner Slough discharges into Cache Slough near the entrance to the Sacramento DWSC. Sutter Slough joins Steamboat Slough at the southern tip of Sutter Island and the slough eventually terminates between Cache Slough and the mainstem Sacramento River between Ryer Island and Grand Island (see figure 5-23). The waterways in this region are still tidally influenced and water levels rise with the incoming tide. Flow velocity drops with the corresponding increase in tidal stage, particularly during low flow conditions. Below the confluence of Cache Slough, Steamboat Slough, and the Sacramento River, the main river channel becomes much wider and deeper, partially due to the commercial shipping channel that leads to the Port of Sacramento. Tidal influence is strong in this portion of the North Delta near Rio Vista.

The mainstem of the Sacramento River below the mouth of Steamboat Slough carries the main flow of water southwards into the Delta. Near the town of Walnut Grove, two channels bifurcate from the main Sacramento River channel and flow southwards. The first is an artificial channel, the DCC, constructed in 1953 to transport high quality freshwater from the Sacramento River into the interior Delta (CALFED 2001). Two radial gates are positioned at the head of the channel to block off flow into the channel as needed. When the gates are open, the channel conveys Sacramento River water into Snodgrass Slough and subsequently into the Mokelumne River system. Burau *et al.* (2007) estimated that when the DCC gates are open, approximately 45 percent of the Freeport flow is redirected into the Delta interior through the DCC and Georgiana Slough. This water eventually discharges into the San Joaquin River near RM 22 and is then available to be drawn southwards towards the CVP and SWP pumps in the South Delta. When the radial gates are open, the net water flow moves southwards in the DCC, and into Snodgrass Slough and the Mokelumne River system. This channel however, is still influenced by river and tidal flow and oscillations in flow velocity and stage are tidally driven on a daily basis. Tidal stage and river flow also determine the magnitude and timing of river flows that enter into the DCC from the Sacramento River (Horn and Blake 2004). Maximum flows in the DCC are seen during the incoming flood tide when increasing downstream stage redirects the flow of Sacramento River water into the mouth of the DCC. This physical condition greatly influences the probability of juvenile salmonids entering the DCC channel when the gates are in their open configuration.

When the radial gates of the DCC are closed, flows through the cross channel are prevented and hydraulics in the Sacramento River are altered. With the DCC gates closed, water remains in the main channel of the Sacramento River. Flows increase in Sutter and Steamboat sloughs upstream of the location of the DCC (35 percent of Freeport flows in the open configuration to 45 percent in the DCC closed configuration). Water remaining in the main channel of the Sacramento River flows downstream until it encounters the mouth of Georgiana Slough. Georgiana Slough is a natural channel, which is also located on an outside bend of the Sacramento River. On average, approximately 15 to 20 percent of the natural flow of the Sacramento River (as measured at Freeport) is redirected into Georgiana Slough, depending on tides, river flows, and the status of the DCC gates. As explained previously, percentages of

redirected flow into Georgiana Slough can be much higher during flood stages of the incoming tide, compared to ebb tidal situations. Flows move in a net southerly direction within Georgiana Slough towards the interior of the Delta, although tidal patterns may create periods of upstream flow in the channel during flood tides. Water moving down Georgiana Slough eventually discharges into the lower portion of the Mokelumne River before the combined flows enter the San Joaquin River at RM 22. At this point, depending on flows in the San Joaquin River and the diversion rates of the combined CVP and SWP pumping facilities, a significant portion of the Sacramento River water that entered Georgiana Slough can move southwards through either the Old River or Middle River channels towards the pumps. When pumping rates are low, or the flows in the San Joaquin River are high, "Sacramento River" water will be pushed westwards in the San Joaquin River mainstem and out of the Delta rather than moving southwards towards the pumps.

The Central Delta is roughly regarded as those waterways surrounding the San Joaquin River from Stockton westwards to Webb Tract and Twitchell Island. These waterways include the mainstem of the lower San Joaquin River itself, the lower Mokelumne River complex and its associated waterways (*i.e.*, Potato, Disappointment, and Fourteenmile sloughs as well as other channels) and the lower reaches of Old River and Middle River with their interconnecting waterways and channels. Under natural hydrological conditions, net flow in these channels would always have been in a downstream direction towards the ocean. Those waterways to the north of the San Joaquin River would have had a net southerly flow until they entered the San Joaquin River, after which net flows would have been westward towards Suisun Bay. Likewise, net water movement in channels to the south of the San Joaquin River would have flowed northwards to the main river channel and thence towards the ocean. Overlying this net seaward flow would have been a bidirectional tidal signature. Under current project conditions, net flow in many of these channels is towards the pumps, particularly when river flows are low and pumping rates are high.

Water flow patterns in the South Delta are also determined by the water diversion actions of the CVP and SWP, and the operations of the seasonal temporary barriers, as well as tides and river inflows to the Delta. Under natural conditions with no pumping, water flows downstream in a net positive direction towards the ocean. Under current conditions, the flow patterns have become much more complex. When pumping rates are high at the project facilities, water is drawn towards the two points of diversion, *i.e.*, the SWP's Clifton Court Forebay and the CVP's Tracy intake. Water moves downstream through the Head of Old River and through the channels of Old River and Grantline/ Fabian-Bell Canal towards the pumps. Conversely, water to the north of the two facilities' diversion points moves southwards (upstream) and the net flow is negative. This pattern is further complicated when the temporary barriers are installed from April through November, and internal reverse circulation is created within the channels isolated by the barriers from the rest of the South Delta (discussed later in the Temporary Barriers Section). These conditions are most evident during late spring through fall when river inflows are lower and water diversion rates are high. Dry hydrological years also exacerbate the loss of net downstream flows in the South Delta.

The western Delta is less affected by the actions of the projects due to their downstream location. Typically, net flows in this region of the Delta are positive and flow towards the ocean.

However, under certain conditions, such as low Delta outflow during the summer and fall, high export pumping rates, and negative QWEST (a measurement of flow in the western Delta), particle tracking models have demonstrated that a significant portion of the water in the west Delta can be drawn to the pumps over a period of 10 to 30 days. Water originating in the Sacramento River can be entrained into the lower reaches of the San Joaquin River and be redirected upstream towards the pumps. Water enters the San Joaquin River system from both Three Mile Slough near Decker Island, Sherman Lake (the flooded island at the western terminus of Sherman Island), and through Broad Slough (the confluence of the San Joaquin River with the Sacramento River) farther downstream. Strong tidal influence can then push the water upstream into the zone of influence created by the project's pumping actions near the mouth of Old River and the waterways passing through Franks Tract (False River and Fisherman's Cut).

5.6.3 Future Baseline Excluding CVP/SWP Effects

The Delta is likely to continue experiencing reduced habitat value within the waterways of the Delta due to the ongoing habitat modifications created by the construction and maintenance of the armored levees. The construction of the levees has resulted in the loss of riparian zones and shallow water habitat adjacent to the levees. The placement of rock riprap prevents the establishment of riparian vegetation, particularly woody vegetation. This inherently reduces the incorporation of large woody material from downed trees and brush into the channel margins, and the "armored" levee banks reduce the ability of LWD to become lodged along the banks during high water events when LWD enters the system from upstream. Levees also prevent the rivers from having any connection with the adjacent historical floodplains and, thus, reduce the input of allochthonous material from the upland areas and eliminate the availability of rearing habitat during high water episodes. Levees also enhance the loss of fringing marshlands and emergent vegetation by reducing the shallow water margins along the channels to a narrow band.

Predation of juvenile listed salmonids and green sturgeon will continue at an unknown level due to the presence of native and non-native species present in the Delta ecosystem. Interactions with non-native species will continue. The infestation of Delta waterways with non-native plants such as *Egeria densa* and water hyacinth is likely to continue, unless changes in chemical and biological parameters change to reduce the biomass of these plants (*e.g.*, increased salinity intrusions). The presence of invasive species such as Asian overbite clams, non-native copepods, and non-native gobies is likely to continue.

The discharge of contaminants into Delta waters from urban and agricultural sources is likely to continue into the future. The perimeter of the Delta region is becoming more urbanized, which increases the likelihood of urban discharges entering the Delta waterways. Likewise, regional agriculture will continue to discharge agricultural return waters from irrigation practices into surrounding waterways, which eventually flow into Delta waters. The continued subsidence of Delta islands and the predicted increase in sea level height will place additional pressure on agriculture within the Delta region proper. Many islands are 10 to 20 feet below sea level and, without pumping the soils, would eventually become saturated. Farmers must continue to pump water from the irrigation return ditches on their lands to keep Delta water from seeping in from the surrounding waterways. This practice carries chemicals used on the fields into the irrigation return water and eventually into the Delta.

Entrainment of fish, zooplankton, and phytoplankton by agricultural water diversions not associated with CVP/SWP operations will continue into the future. Screening of all agricultural water diversion intakes in the Delta would be necessary to reduce or eliminate the entrainment of fish due to these diversions. Larger regional water intakes, such as the City of Stockton water intake on Empire Tract, will continue to divert water for consumptive use in the future. These facilities are screened to prevent entrainment of fish.

In support of commercial shipping in the Delta, continued dredging of the Stockton DWSC and the Sacramento Ship Channel will continue into the future. Effects associated with dredging include noise, resuspension of sediments and any associated contaminants and potential entrainment into the dredger head will continue. Impacts to listed salmonids and green sturgeon and their habitats associated with shipping activities, including pollution from shipping, introduction of non-native species via ballast water discharges, ship strikes, and propeller entrainment, are likely to continue.

Recreational boating in the Delta will continue into the future. Impacts to listed salmonids and green sturgeon and their habitats associated with recreational boating, including the installation of boat docks and pilings, noise from boat engines, pollutants (engine combustion byproducts, spilled fuel, refuse, *etc.*), increased turbidity from wakes, increased shore erosion, and the fragmentation of invasive water plants such as *E. densa* that increase the spread of the plant, are likely to continue.

The TBP involves the temporary placement of rock barriers in four separate locations in the South Delta on a seasonal basis that coincides with the agricultural irrigation season, typically running from April through November. This program has been in place since 1991. The temporary rock barriers installed in Old River near Tracy, Middle River near Victoria Canal, Grant Line Canal near the Tracy Boulevard Bridge, and at the Head of Old River. In 2008, NMFS completed formal consultation by issuing a biological opinion for the installation of the barriers through the end of 2010. That consultation was reinitiated based on a change in action to implement a non-physical barrier project. NMFS completed the formal consultation and issued a biological opinion on April 3, 2009 (NMFS 2009). Based on NMFS' analysis, the TBP would likely result in: changes to flow patterns in the South Delta, increasing the potential for migrational delays in conjunction with the barriers placement; hydraulic conditions that will impede free passage of fish through the channels of the South Delta; entrainment of a proportion of the fish that remain in the mainstem of the San Joaquin River into the channels leading southwards under the influence of the CVP/SWP water diversion pumps; increasing the risk of predation on juvenile listed salmonids and green sturgeon; and impacts to the functioning of the South Delta waterways as critical habitat for steelhead and green sturgeon by impacting the value of the channels for migration and rearing. A complete analysis of the effects of the TBP is provided in NMFS (2009).

5.7 Southern Resident Killer Whales

All of the categories of human activities discussed in the *Status of the Species* section (section 4.2.5.3) have contributed to the current status of Southern Residents within the action area. The

following discussion summarizes the principal human and natural factors within the action area (other than the proposed action) that affect the likelihood that Southern Residents will survive and recover in the wild.

5.7.1 Natural Mortality

Seasonal mortality rates among Southern and Northern Residents are believed to be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Olesiuk *et al*. (2005) identified high neonate mortality that occurred outside of the summer field research seasons. At least 12 newborn calves (9 Southern Residents and 3 Northern Residents) were seen outside the summer field season and disappeared by the next field season. Additionally, stranding rates are higher in winter and spring for all killer whales in Washington and Oregon (Norman *et al*. 2004). Southern Residents strandings in coastal waters offshore include three separate events (1995 and 1996 off of Northern Vancouver Island and the Queen Charlotte Islands, and 2002 offshore of Long Beach, Washington State), and the causes of death are unknown (NMFS 2008a).

In recent years, sighting reports indicate anecdotal evidence of thin Southern Residents returning to inland waters in the spring. For example, in March 2006, a thin female from the Southern Residents population (L54) with a nursing calf was sighted off Westport, Washington. The sighting report indicated she had lost so much blubber that her ribs were showing under the skin (Cascadia Research Collective 2008).

The official 2008 census for Southern Residents was 85 whales (annually conducted and reported by The Center for Whale Research, down from 87 whales in 2007). After the official census, two additional whales were observed missing. However, a whale is not declared dead until found missing in the following year during the census. In total, seven Southern Residents were declared dead or suspected missing in the current year (Balcomb 2008). None of these whales were recovered and cause of death is unknown. Two of the seven were calves that by convention had not been counted as part of the population prior to their deaths. Death of calves is not unusual. Two of the mortalities were old whales (K7 and L21, 98 and 56 years old, respectively), and mortality in this age group is not surprising. The remaining dead or declared missing whales were in age groups with typically low mortality. Two were reproductive females (J11 and L67, 35 and 32 years old, respectively). It is more unusual to see mortality of reproductive females. One was a sub-adult male (L101, 5 years old). However, L101's death may have been related to the condition of L67 (mother of L101). Reportedly, L67 did not look well (identified as a thin whale during aerial survey, Durban 2008) when last seen in September.

5.7.2 Human Related Activities

5.7.2.1 Prey Availability

Based on persuasive scientific information that Southern Residents prefer Chinook salmon in inland waters (see further discussion in section 4.2.5.3.1), Southern Residents may also prefer Chinook salmon when available in coastal waters of the action area. This analysis therefore focuses on Chinook salmon abundance in coastal waters. Focusing on Chinook salmon provides

a conservative estimate of potential effects of the proposed action on Southern Residents, because the total abundance of all salmon and other potential prey species is orders of magnitude larger than the total abundance of Chinook salmon.

When prey is scarce, whales must spend more time foraging than when it is plentiful, leading to increased energy expenditure and decreased fitness, which can result in relatively lower reproductive rates and relatively higher mortality rates. Food scarcity would cause whales to draw on fat stores, mobilizing contaminants stored in their fat. It is uncertain to what extent long term or more recent declines in salmon abundance contributed to the decline of the Southern Residents DPS, or whether current levels are adequate to support the survival and recovery of the Southern Residents (more details are available in the section 4.2.5.3.1, which discusses the correlative relationships between Southern Residents survival and fecundity and Chinook salmon abundance).

The availability of Chinook salmon to Southern Residents is affected by a number of natural and human actions. Details regarding baseline conditions of those Chinook salmon affected in the action area that are listed under the ESA are described above in this section. As discussed above, adult salmon are affected by fisheries harvest in fresh and marine waters, dams that impede passage, other habitat modifications, and poor water quality. In addition, climate effects from PDO and the ENSO conditions and events cause changes in ocean productivity which can affect natural mortality of salmon, as described in more detail in section 4.2.4.11. Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals (including Southern Residents).

NMFS has previously consulted on the effects of fishery harvest actions on Southern Residents, including 10-year terms of the Pacific Salmon Treaty (term of biological opinion from 2009-2018, NMFS 2008) and the *United States v. Oregon* 2008 Management Agreement (term of biological opinion from 2008-2017; NMFS 2008d), and the Pacific Coast Salmon Plan fisheries (NMFS 2009a). These are abundance-based harvest programs that allow for increased harvest when runs are abundant and reduced harvest when runs are lower. The Pacific Salmon Treaty and Pacific Coast Salmon Plan harvest programs will reduce Chinook salmon prey available to Southern Residents in any given year. NMFS analyzed the likely reductions based on good and poor years of Chinook salmon abundance, in both the coastal range of the whales and inland waters of Puget Sound. For Pacific Salmon Treaty fisheries, in 6 out of 12 cases (years and locations), using the most conservative assumptions about the whales' prey needs and preferences, the reductions are less than 2 percent of the Chinook salmon that would otherwise have been available to the whales. In 10 out of 12 cases they are less than 5 percent. The greatest reduction of 10.5 percent occurs in coastal waters, July to September, during good Chinook salmon years. For Pacific Coast Salmon Plan fisheries, which were included as part of the Pacific Salmon Treaty analysis, in 7 out of 12 cases (years and locations), using the most conservative assumptions about the whales' prey needs and preferences, the reductions are less than 1 percent of the Chinook salmon that would otherwise have been available to the whales. In 10 out of 12 cases they are less than 2 percent. The greatest reduction of 6.2 percent occurs in coastal waters, July to September, during good Chinook salmon years. The largest reductions in both cases occur when the ratio of prey available compared to prey needed is relatively large. Under the *United States v. Oregon* Agreement, harvest occurs in the Columbia River and does

not affect short-term availability of the whales' prey. In the long term, NMFS concluded that all three of these harvest actions allow sufficient escapement of spawning adults to meet the conservation objectives of listed and unlisted harvested stocks.

We have also previously consulted on the effects of hydro-power dams and flood control programs on Southern Residents (NMFS 2008g, NMFS 2008h). in the action area. As part of the proposed action for the Federal Columbia River Power System and the Willamette Flood Control Program, action agencies proposed funding hatchery programs in addition to their proposals for dam operations and maintenance. For both programs, the proposed actions did not result in a net decrease in Chinook salmon prey for Southern Residents in the short term. To mitigate for the harmful effects of hatchery production on long-term Chinook salmon viability (and thus killer whale prey availability) the action agencies committed to a schedule of future hatchery reforms.

5.7.2.2 Prey Quality

Contaminants enter marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Freshwater contamination is also a concern because it may contaminate salmon that are later consumed by Southern Residents in marine habitats. Chinook salmon contain higher levels of some contaminants than other salmon species, but only limited information is available for contaminant levels of Chinook salmon along the west coast (Krahn *et al*. 2007). As discussed in the *Status of the Species* section, recent studies have documented high concentrations of PCBs, DDTs, and PBDEs in killer whales (Ross *et al*. 2000, Ylitalo *et al*. 2001, Reijnders and Aguilar 2002, Krahn *et al*. 2004). Killer whales accumulate and store the contaminants in their blubber when they consume contaminated prey. The whales can metabolize their blubber when prey is scarce, which mobilizes and redistributes the contaminants to other tissues, increasing risk of immune or reproductive effects during weight loss from reductions in prey (Krahn *et al*. 2002).

5.7.2.3 Vessel Activity and Sound

Commercial, military, recreational and fishing vessels traverse the coastal range of Southern Residents. Vessels may affect foraging efficiency, communication, and/or energy expenditure by their physical presence and by creating underwater sound (Williams *et al*. 2006, Holt 2008). Collisions of killer whales with vessels are rare, but remain a potential source of serious injury and mortality. Large ships that traverse coastal waters of the whales' range move at relatively slow speeds and are likely detected and avoided by Southern Residents.

Vessel sounds in coastal waters are most likely from large ships, tankers and tugs. Sound generated by large vessels is a source of low frequency (5 to 500 Hz) human-generated sound in the world's oceans (National Research Council 2003). While larger ships generate some broadband noise in the hearing range of whales, the majority of energy is below their peak hearing sensitivity. At close range large vessels can still be a significant source of background noise at frequencies important to the whales (Holt 2008). Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (National Research Council 2003). Frequencies

fall between 1 and 500 kHz, which is within the hearing range of some marine mammals, including killer whales, and may have masking effects.

5.7.2.4 Non-Vessel Sound

Anthropogenic (human-generated) sound in the range of Southern Residents is generated by other sources besides vessels, including oil and gas exploration, construction activities, and military operations. Natural sounds in the marine environment include wind, waves, surf noise, precipitation, thunder, and biological noise from other marine species. The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (*e.g.*, hearing, echolocation, communication).

In-water construction activities are permitted by the Corps under section 404 of the CWA and section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval program. Consultations on these permits have been conducted and conservation measures have been included to minimize or eliminate potential effects of in-water activities, such as pile driving, on marine mammals. Military sonar also has the potential to disturb killer whales.

5.7.2.5 Oil Spills

Oil spills have occurred in the coastal range of Southern Residents in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Numerous oil tankers transit through the range of Southern Residents throughout the year. The magnitude of risk posed by oil discharges in the action area is difficult to precisely quantify, but improvements in oil spill prevention procedures since the 1980s likely provide some reduced risk of spill.

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes negative effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci and St. Aubin 1990). In addition, oil spills have the potential to negatively impact habitat and prey populations, and, therefore, may negatively affect Southern Residents by reducing food availability.

5.7.2.6 Scientific Research

Although research activities are typically conducted between May and October in inland waters, some permits include authorization to conduct research in coastal waters. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. In 2006, NMFS issued scientific research permits to seven investigators who intend to study Southern Residents (NMFS 2006). Additionally in 2008, NMFS issued another scientific permit to one investigator intending to study Southern Residents (NMFS 2008i). In the

biological opinions NMFS prepared to assess the impact of issuing the permits, we determined that the effects of these disturbances on Southern Residents were likely to adversely affect, but not likely to jeopardize the continued existence of, the Southern Residents (NMFS 2006, 2008i). A small portion of the authorized take would occur in the coastal range of Southern Residents.

5.7.2.7 Recovery Planning

The final recovery plan for Southern Residents was issued in January 2008 (NMFS 2008a). Implementation of the Southern Residents recovery plan is currently in progress. To date, recovery planning and implementation has incorporated a range of actions, including additional scientific research to better understand threats to recovery, and directed actions to reduce the risk associated with identified threats. Actions that reduce the risk associated with identified threats will benefit Southern Residents. Additionally, recovery planning for salmon will benefit Southern Residents, where actions improve the quantity and quality of prey available to Southern Residents.

5.7.3 Summary of Southern Residents Environmental Baseline

Southern Residents are exposed to a wide variety of past and present state, Federal or private actions and other human activities in the coastal waters that comprise the action area, as well as Federal projects in this area that have already undergone formal section 7 consultation, and state or private actions that are contemporaneous with this consultation. All of the activities discussed in the above section are likely to have some level of impact on Southern Residents when they are in coastal waters of their range.

No single threat has been directly linked to or identified as the cause of the recent decline of the Southern Residents, although the three primary threats are identified as prey availability, environmental contaminants, and vessel effects and sound (Krahn *et al*. 2002). Researchers are unsure about which threats are most significant. There is limited information on how these factors or additional unknown factors may be affecting Southern Residents when in coastal waters. For reasons discussed earlier, it is possible that two or more of these factors may act together to harm the whales. The small size of the population increases the level of concern about all of these risks (NMFS 2008a).

6.0 EFFECTS OF THE PROPOSED ACTION

6.1 Approach to the Assessment

Section 2 of this Opinion describes our approach to analyzing the effects of the action. The primary information used in this assessment include the list of resources provided in section 2.4, fishery information described earlier in the "Status of the Species and Critical Habitat" and "Environmental Baseline" sections of this Opinion; studies and accounts of the impacts of water diversions on anadromous species; and documents prepared in support of the proposed action.

The analysis of effects on Southern Residents considers the short- and long-term effects of CVP/SWP operations on naturally- and hatchery-produced Chinook salmon. The analysis of effects begins by utilizing the analysis of effects on winter-run and spring-run. For short-term effects, NMFS analyzed the effects of the action on naturally- and hatchery-produced Chinook salmon in the Central Valley, and also the production of hatchery-produced Chinook salmon at Nimbus Fish Hatchery and Trinity River Fish Hatchery. For the long-term effects, NMFS considers the sustainability of hatcheries in the production of Chinook salmon.

6.2 Clear Creek and Whiskeytown Dam

6.2.1 Deconstruct the Action

In order to understand the action, certain assumptions have been made (see table 2-3). The assumption for Clear Creek is that the Trinity River Division will continue operations as modeled. As stated in section 1.5.1, NMFS will analyze the effects of the Trinity River Division portion of the proposed action on SONCC coho salmon in a separate biological opinion. All of the water diverted from the Trinity River (1.2 MAF annually), plus a portion of Clear Creek flows (*i.e.*, the flows entering above Whiskeytown Lake) is diverted through the Spring Creek Power Conduit to Keswick Reservoir. Therefore, this section only addresses that portion of the Trinity River Division that is diverted through Whiskeytown Reservoir and becomes a part of the Clear Creek releases. Due to the diversions of Trinity River water, flows are greater during parts of the year and temperatures are cooler than what was present in Clear Creek prior to the construction of Whiskeytown Dam (section 5.2.3, figure 5-5). There is no temperature control device (TCD) on Whiskeytown Dam (however, there is a temperature control curtain that reduces mixing of cold water near the dam). Therefore, water temperature can only be controlled by changing releases.

Reclamation's operations follow the CVPIA AFRP guidelines (USFWS 2001) which, for Clear Creek, are: "200 cfs October 1 to June 1 from Whiskeytown dam for spring-run, fall-run, and late fall-run salmon spawning, egg incubation, emigration, gravel restoration, spring flushing and channel maintenance; and release 150 cfs or less, from July through September to maintain < 60°F temperatures in stream sections utilized by spring-run Chinook salmon." Until a Fishery Management Plan is developed, Reclamation proposes an adaptive management approach to higher releases during the summer, which involves recommendations from the Clear Creek Technical Team and the B2 Interagency Team.

The USFWS is currently conducting an IFIM flow study to determine the habitat suitability of the current release pattern for rearing juvenile salmon and CV steelhead. Given the small size of Clear Creek, the flows are comparable to the Stanislaus River, which supports far fewer CV steelhead and fall-run.

6.2.2 Assess Species Exposure

The purposes of this analysis are to define the temporal and spatial co-occurrence of spring-run and CV steelhead life stages and their stressors associated with the proposed project. First we identify the life stages and associated timings for spring-run and CV steelhead in Clear Creek.

Adult CV steelhead immigration into Clear Creek usually occurs from August through March with a peak occurring from September to November (USFWS 2008). Steelhead adults tend to hold in the upper reaches of Clear Creek from September to December, when spawning starts, and goes through early March. Peak spawning occurs from late January to early Febraury (USFWS 2007). The embryo incubation life stage begins with the onset of spawning in late December and generally extends through April.

For spring-run, adult emigration into Clear Creek occurs from April through September. Over summer holding occurs from May through September. Spawning begins in September through October. Egg incubation occurs from September through December. Juveniles rear from October through April.

The second step in assessing spring-run and CV steelhead exposure is to identify the spatial distribution of each life stage. Adult CV steelhead hold and spawn from Whiskeytown downstream to RM 3 in the lower reaches (USFWS 2007, figure 5-1). Spawning is spread out and expands downstream where adults can find suitable areas of newly augmented gravels. The juvenile life stage occurs throughout the entire river, with rearing generally occurring near spawning areas.

Adult spring-run tend to move as far upstream as possible to access cooler temperatures below Whiskeytown Dam, then spread downstream prior to spawning. Juvenile spring-run emigration in Clear Creek appears to be as YOY only, as identified in RSTs from May through December (USFWS 2008). Peak emigration occurs in November and December before the start of juvenile fall-run emigration. Trap data indicates that 93 percent of the juveniles identified as spring-run leave as fry, measured at 30-39 millimeters (USFWS 2008).

The last step in assessing spring-run and CV steelhead exposure is to overlay the temporal and spatial distributions of proposed action-related stressors on top of the temporal and spatial distributions of Clear Creek spring-run and CV steelhead. This overlay represents the completed exposure analysis and is described in the first three columns of tables 6-1 and 6-2.

6.2.3 Assess the Species Response

This section will assess how spring-run and CV steelhead in Clear Creek will likely respond to the proposed action-related stressors. Life stage-specific responses to specific stressors related to the proposed action are summarized in the last two columns of tables 6-1 and 6-2 and described in detail below.

Table 6-1. Summary of proposed action-related effects and responses on Clear Creek spring-run.

Life Stage/ Location	Life stage Timing	Stressor	Response	Probable fitness reduction
Adult immigration,	April - July	Smaller spawning area due to temperature management down to Igo Gage and physical barrier at fish weir	Introgression/hybridization w/fall-run; density dependency effects & redd superimposition; limited carrying capacity of stream will dictate population size, possible loss of some individuals that spawn below Igo TCP, or come in late and spawn below weir with fall-run	Reduced reproductive success and reduce survival
Adults, immigration	same	Lack of attraction flows	Fail to migrate far enough upstream to avoid unsuitable temperatures while spawning	
Adults, holding	May - August	Temp > 60ºF during summer holding period	None expected - temp control to Igo; possibly some pre-spawn mortality in critically dry years when not enough cold water in Whiskeytown Lake	Reduced reproductive success
Adults, spawning	Sept - Oct	Loss of spawning gravel below Whisketown Dam	Reduced spawning areas; spawning success diminishes	Reduced reproductive success
Adults, spawning	Sept - Oct	Temp > 56ºF during spawning, due to low flow conditions	Loss of eggs and sac-fry; fewer juveniles survive	Reduced reproductive success
Egg incubation	Sept - Dec	Exposure to temp. > 56ºF in September only for fish that spawn below TCP	Mortality varies with exceedance rate and number of redds; loss of some portion of those eggs	Reduced reproductive success
Juvenile rearing	October-April	Exposure to temp. > 65ºF during rearing period	Truncated emigration timing, reduced survival; poor in-river survival, reduced numbe of juveniles produced	Reduced survival and growth

All modeled runs assume the use of CVPIA b(2) water would continue into the future. In critically dry years, modeled releases decrease to 40 to 70 cfs from October through May, but would not be significant because they occur during the winter. Releases in dry years (*i.e.*, 20 percent probability of occurring) in June drop to 100 cfs, which may impact the ability to control water temperatures. Low flows in June would be expected to limit the space available to juvenile CV steelhead and Chinook salmon that are rearing in Clear Creek. However, since water temperatures have been maintained at lower flows in July and August (*i.e.*, typically 85 cfs in recent years), low flows in June of 100 cfs are not expected to cause significant temperature related effects.

Table 6-2. Summary of proposed acton-related effects and responses on Clear Creek steelhead.

Life Stage/ Location	Life stage timing	Stressor	Response	Probable fitness reduction
Adults	August - March	Water temp. > 65ºF for migration rarely occurs due to temp. control at Igo, possible in lower reach near confluence with Sacramento River during August and September	Some adults may not enter mouth of Clear Creek, 1) delayed run timing, 2) seek other tributaries, 3) spawn in mainstem Sac. R.	Reduced reproductive success
Adults	Dec - March	Lack of adequate spawning gravels	Adults spawn in same areas, greater competition for suitable sites	Reduced reproductive success
Adults	April -June	Lack of channel forming flows due to presence of dam, reduces gravel transport	Less diversity, adults tend to spawn in same areas every year, reduced egg and fry production, competition for redd sites with other species (fall/late fall-run)	Reduced reproductive success
Egg incubation	Dec - March	Water temp. < 56ºF during spawning and incubation	Late hatch, lower growth rate to fry stage	None expected
Juvenile rearing	May - Sept	Low summer flows (< 80 cfs)	Higher water temp., less food, less space, less growth, > predation	Reduced survival
Smolts	same	High water temps > 60ºF in July and August	Move to cooler areas, perish, or more likely to be predated upon	
all stages	adults August - March, juveniles all year	Nimbus Fish Hatchery releases steelhead juveniles into the river as mitigation for loss habitat above Folsom Dam	Hatchery smolts compete with wild fish for food and space in river, also cause wild fish to immigrate at same time (Pied Piper effect), increased straying rate	Reduced fitness, reduce growth rates of wild fish

The higher flow rates [in part due to the additional water provided through b(2)], along with channel restoration, McCormick-Saeltzer Dam removal, and gravel augmentation have lead to increasing populations of spring-run (figure 5-2) and CV steelhead (figure 5-3) in Clear Creek. It is uncertain how much is attributable to just the increase in flows (proposed action). Low flows and warm temperatures during 10 percent of years (critical drought year conditions) will limit steelhead and spring-run recruitment because it depends completely on cold water releases from Whiskeytown (an artifact of diverting colder water through the reservoir from Trinity River). During extended drought periods, when the cold water reserve in Whiskeytown is exhausted, temperatures could be lethal for spring-run eggs and steelhead juveniles. Flows drop to their lowest point during the summer, typically to about 85 cfs, and temperatures limit juvenile steelhead rearing. The 1986 IFIM studies found optimum rearing flows for steelhead and salmon during May through October are 300 cfs (CVP/SWP operations BA figure 5-4). Existing operations tend to flat-line flows at 200 cfs throughout the year, which reduces the habitat variability and diversity of life stages essential for survival (*i.e.*, diverse habitats and variable flows tend to buffer fish populations from changes in the environment).

6.2.3.1 Whiskeytown Releases to Clear Creek

All modeled runs in the CVP/SWP operations BA assume the use of b(2) water. Reclamation proposes to maintain flows at 200 cfs throughout the year, except during the summer months. However, CALSIM modeling (CVP/SWP operations BA figures 6.1 and 6.3) shows that slightly less than the AFRP guidelines will be released over the long-term (*i.e.*, approximately 180 cfs). Flow releases less than 200 cfs are expected to occur in 25 percent of years during steelhead upstream migration. During the driest years (4 percent of historical years modeled), the flows could drop to as low as 30 cfs without b(2) water to support releases. Historical flow studies showed optimal spawning flows for steelhead were estimated to be 87 cfs in the upstream reaches and 250 cfs for rearing downstream of the old Saeltzer Dam site (CVP/SWP operations BA). In the worst-case scenario, flows would be below 87 cfs in the upstream areas 4-5 percent of historically modeled conditions (figure 6-1). However, since steelhead spawning has currently been observed expanding throughout the 17 miles of Clear Creek (USFWS 2007a, 2008a), it is reasonable to assume that spawning habitat would be reduced by low flows more often in dry years. The CVP/SWP operations BA states that, "during dry years flows for attraction, holding, and upstream migration could be less than optimal" for steelhead on Clear Creek.

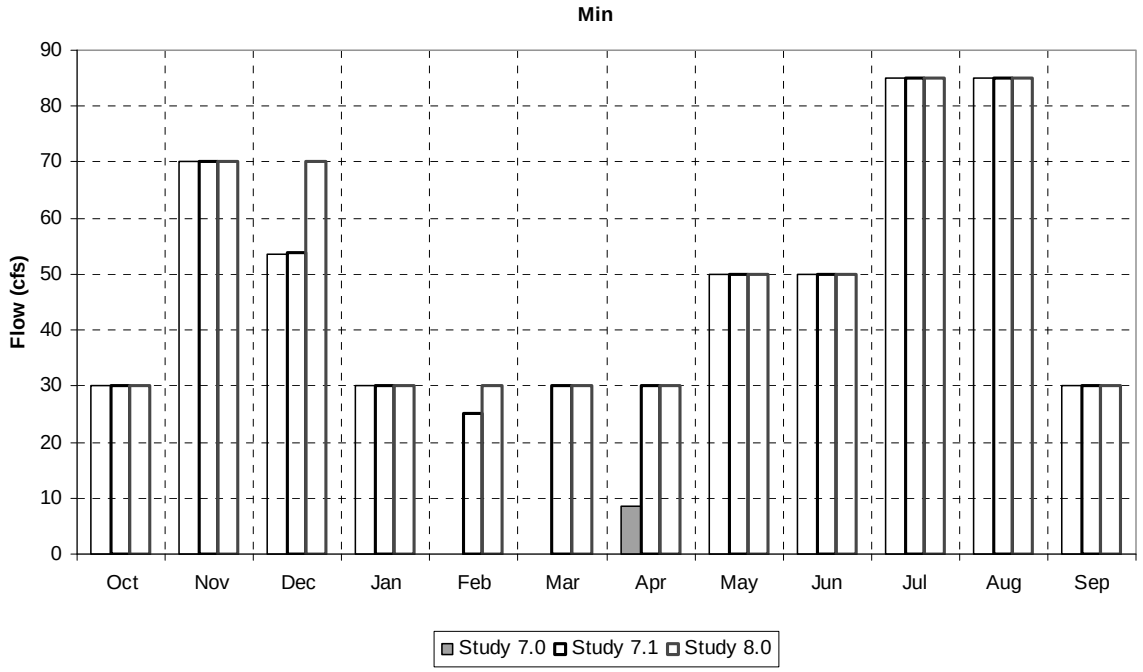


Figure 6-1. Clear Creek minimum flow conditions based on historical conditions (CVP/SWP operations BA).

Spring-run enter Clear Creek from April through September and spawn from September through October. Modeled and actual flows in July and August are 85 cfs in all years (figure 5-5 and 5-7). Flows in September would be 150 cfs, except in critically dry years when minimum flows could drop to as low as 30 cfs in 4-5 percent of historical conditions. During the driest of years, low flows would be expected to cause competition for suitable spawning sites and redd superimposition. In the past, Instream Flow Incremental Methodology (IFIM) studies based on

Physical Habitat Simulation (PHABSIM) developed for fall-run[9] estimated optimum flows in the upstream reach to be 62 cfs for spawning and 75 cfs for rearing, provided incubation and rearing temperatures were provided (CVP/SWP operations BA). Flows of 30 cfs in September during dry years would limit suitable spawning habitat and block upstream migration, since a bedrock chute limits access to the upper reaches of Clear Creek at low flow levels. Spawning attraction flows of 500 cfs were recommended by Denton (1986 *op. cit*. CVP/SWP operations BA) in October and November for fall-run. Similar attraction or pulse flows could be used in April and May to attract spring-run spawners. The interim flow schedule (CVP/SWP operations BA figure 5-4) developed for Clear Creek in the 1980s (pre-AFRP guidelines) was intended to maintain salmon and steelhead habitat until the current studies, described below, could be conducted to fine-tune the releases.

Recent IFIM studies using an improved 2-dimensional hydraulic and habitat model (RIVER2D) showed that the current AFRP guidelines are significantly limiting the amount of habitat available for spring-run spawning (Gard 2006, 2008). The RIVER2D model more accurately predicts depths and velocities over a range of flows than the traditional PHABSIM component of IFIM. In addition, RIVER2D modeling can handle complex habitat types and alternative habitat suitability criteria. Spawning habitat for spring-run salmon and CV steelhead was calculated at a range of flows from 50 cfs (minimum required) to 900 cfs (75 percent of the outlet capacity from Whiskeytown Dam) using the weighted useable area (WUA) developed from habitat suitability curves (HSCs). The HSCs are used to translate hydraulic data into indices of habitat quality. The results of the 2007 flow study indicated that flows greater than 600 cfs in the upper canyon reaches are needed from September through December to increase spring-run habitat availability and productivity (*i.e.*, based on providing 96 percent of the WUA). At the current maintenance flows (*i.e.*, 200 cfs), only 50 percent of the habitat in the upper reach, and only 30 percent of the habitat in the lower reach (to Clear Creek Road Bridge) are available for spring-run spawning. The same study found for steelhead that flows of 200 cfs achieved maximum habitat availability and productivity (*i.e.*, > 91 percent of the WUA) for spawning from January through June (Gard 2008). Based on the results of these new studies, the current releases from September through June are limiting the available spawning habitat for spring-run, but are maximizing suitability for CV steelhead spawning. Although the current success of spring-run spawning does not appear to be limited by spawning habitat availability, as the number of spring-run in Clear Creek increases, the availability of spawning habitat will be limited by the lack of suitable flows, which, in turn, reduces the reproductive success of an individual and eventually results in a decrease or suppression in the population.. Additional flow studies are planned for 2009 and 2010 that evaluate juvenile rearing habitat.

Ramping rates for non-flood control releases are limited to 14-16 cfs per hour up to 600 cfs. Ramping rates for releases greater than 300 cfs must be made after consultation with the Clear Creek Technical Team, which is made up of inter-agency fisheries biologists and non-governmental organizations. Uncontrolled flood releases are made through a Glory Hole into Clear Creek. These flows have the potential to strand and/or isolate salmon and CV steelhead juveniles, but they also provide channel-forming flows that move spawning gravel that is added annually at the base of the dam as part of the restoration projects.

[9] Fall-run are used here as a surrogate for spring-run since they have similar life history stages and temperature requirements, and specific flows requirements for spring-run are still being developed by the USFWS.

Historically, releases from Whiskeytown Dam were greater than the minimum instream flows proposed in table 6-3, until water year 1995 when the flow requirements switched to the b(2) flows, and water was being released through the spillway. Without the addition of b(2) flows throughout the year, Clear Creek flows could revert back to schedule in table 6-3, below, as described in the project description. Based on the more recent IFIM studies, minimum flows of 50 cfs in September and October (table 6-3) would not be sufficient to support water temperature objectives and instream habitat needs for spring-run spawning and incubation. For modeling purposes, CALSIM II assumed no b(2) water is available for Clear Creek when Trinity Reservoir drops below 600 TAF (worst case). This would only occur in the driest 10 percent of years (CVP/SWP operations BA figure 10-12).

Table 6-3. Minimum flow schedule at Whiskeytown Dam from 1963 USFWS proposal and 2001 CVPIA AFRP flow guideline (Appendix 1 to this Opinion table 4).

Period	1963 Minimum flow (cfs)	2001 AFRP flows (cfs)
Normal year flow:		*All water year types:*
January 1 - October 31	50	200 cfs October - June
November 1 - December 31	100	150 cfs July- September
Critical year flow:		
January 1 - October 31	30	
November 1 - December 31	70	

When not spilling through the Glory Hole, Whiskeytown Dam buffers Clear Creek from the impact of high flow events that might cause stranding and isolation of juveniles and redds. Releases typically remain at a constant rate during the majority of flood events. The probability of an uncontrolled spill from Whiskeytown Dam is 50 percent, or every other year (CVP/SWP operations BA). The reservoir also acts to spread out the change in flow rate following rapidly declining river stage.

6.2.3.2 Water Temperatures

Since 1999, mean daily water temperatures have been maintained at 60°F or less down to the USGS gage at Igo (RM 10.9) consistent with the 2004 NMFS Opinion for CV steelhead over summering requirements. Although temperatures may exceed 60°F downstream of the Igo gage, mean daily temperatures near the confluence with the Sacramento River (RM 1.7) rarely exceed 70°F (USFWS 2007a). Since 2002, Reclamation has managed releases to meet a daily average water temperature of 56°F at the Igo Gauge (4 miles downstream of Whiskeytown Dam) from September 15 through October 30, to provide for spring-run spawning (figure 5-6). In 2004, an additional daily average temperature of 60°F was implemented from June 1 to September 15 to protect over-summering juvenile CV steelhead and holding adult spring-run. There is no TCD on Whiskeytown Dam, and storage capability is limited to 700 TAF. Therefore, water temperature can only be managed by controlling releases (figure 6-2).

In general, the water temperature objectives are met in each month that was modeled except from August through October, which is the spring-run spawning period. September is shown as an example because it has the lowest objective (56°F at Igo) and therefore, would be the hardest to meet (figure 6-3). For each month, there is little difference between the current operations and future conditions (Study 7.0 vs Study 8.0) because there is little change in the flows (figure 5-5). The analysis shows difficulty meeting water temperature objectives in 5 percent to 10 percent of the water years. In the more recent years, since the Trinity ROD flows have been implemented, real time operations have experienced difficulty in meeting the temperature objectives due to longer residency time in Whiskeytown Reservoir (*i.e.*, water is not transported through to Spring Creek tunnel in the volume and pattern that it used to be, causing warming). These changes in water diversion pattern indicate that the model results probably underestimated aclievable water temperatures in Clear Creek. Therefore, NMFS would expect water temperatures to be exceeded more often in the future. In addition, climate change, as a future baseline stressor, will likely result in an increased reliance on Whiskeytown Dam and Shasta Dam releases for temperature control instead of Trinity River diversions. Unfortunately, the Salmon Mortality Model could not be used on Clear Creek. However, since the water temperature objective would be exceeded in September and October in 10 percent of years, NMFS would anticipate some egg mortality for spring-run during dry water years.

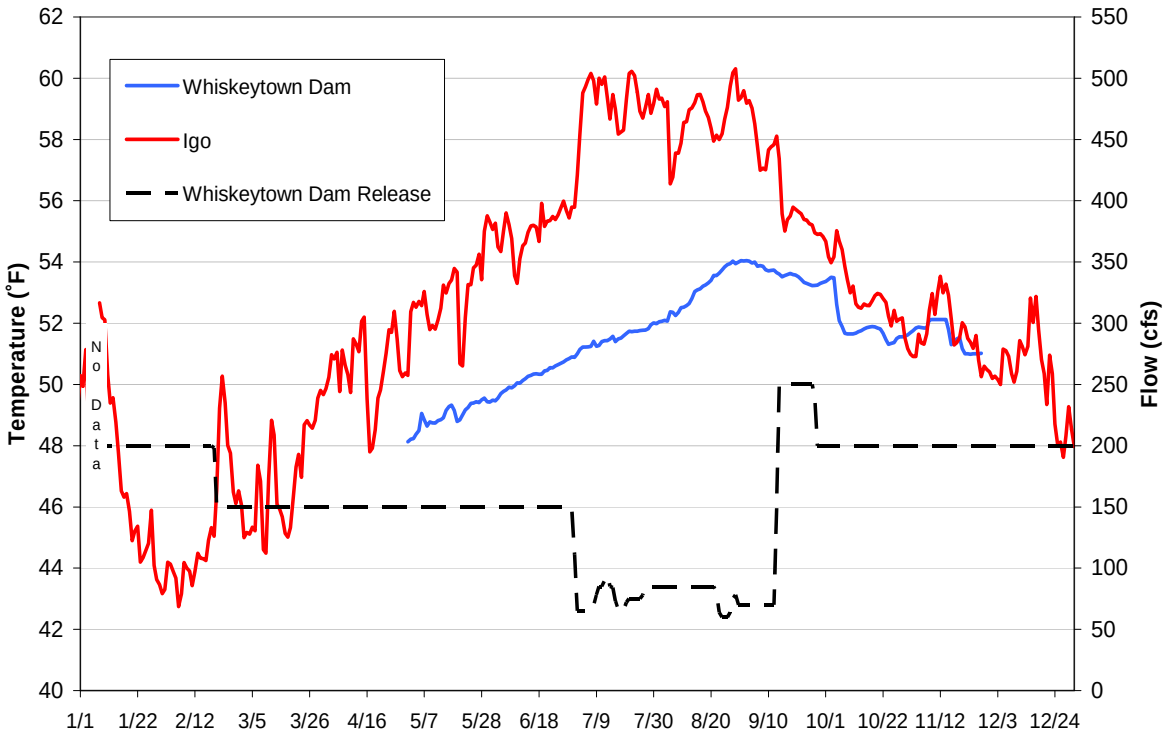


Figure 6-2. Actual Clear Creek mean daily temperatures at Igo (red), Whiskeytown (blue), and flow (dashed line) measured in 2002, a dry year (CVP/SWP operations BA figure 11-12).

Water temperature in Clear Creek is maintained with b(2) releases. Typically, flows are increased after September 15 to meet the temperature objectives in NMFS' 2004 CVP/SWP operations Opinion. In order to meet the 200 cfs flow objective, Reclamation uses

approximately 60-70 TAF of b(2) water that is dedicated for upstream uses (*i.e.*, anadromous fish species are considered for primary purposes). NMFS assumes that most of the b(2) water in the future will be available for this purpose, as described in the CVP/SWP operations BA, however, there is considerable uncertainty regarding this assumption, given the new restrictions put on Delta exports by the USFWS' December 15, 2008, Delta smelt biological opinion (USFWS 2008). For example, based on the actual operations that occurred in 2008, b(2) water was used to offset Delta pumping restrictions (court ordered) and the balance of b(2) water held for upstream purposes was uncertain. Realizing this uncertainty in b(2) water, but also realizing the need for additional flows down Clear Creek, Reclamation made water available on Clear Creek through re-operations at Shasta Reservoir. It is unknown how (b)2 water will be apportioned between the Delta and upstream areas given the new USFWS RPA.

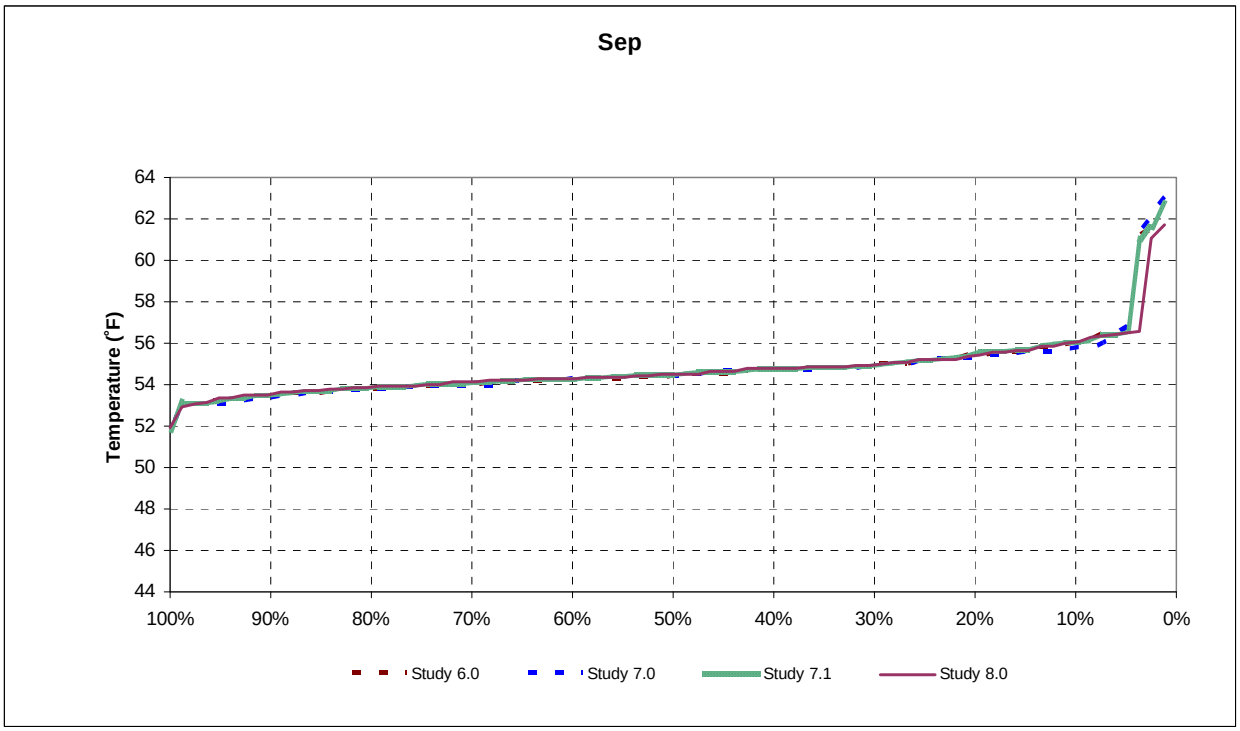


Figure 6-3. Clear Creek September water temperature exceedence plot at Igo gauge (CVP/SWP operations BA figure 10-42).

Restoration efforts have been implemented on Clear Creek to target the recovery of salmonids. These projects have been funded by the CVPIA Clear Creek Fish Restoration Program and the CALFED ERP. These programs have focused on channel restoration that has filled in gold mining ponds (reducing predation from warm water predators), added LWD, and augmented spawning gravel. Results of a recent monitoring study (USFWS 2007a) suggest that these restoration programs and gravel supplementation have benefited CV steelhead and Chinook salmon. Gravel supplementation has substantially increased the amount of available spawning habitat. In 2007, injection gravel was found in an average of 40 percent of the CV steelhead redds, as compared with an average of 30 percent in 2001 and 2002. Smaller gravel size of 1-2 inches was specifically added for CV steelhead in the Whiskeytown Dam injection site. Two of the three areas with the highest CV steelhead redd density were found below injection sites.

6.2.3.3 Geomorphic Effects of Altered Hydrology

Extensive studies on Clear Creek have shown the negative impacts to habitat below Whiskeytown Dam from years of reduced magnitude and duration of flood events [McBain and Trush 1999, 2001; USFWS 2007, 2008; Graham Mathews & Associates (GMA) 2007]. Clear Creek is basically starved of sediment by Whiskeytown Dam and has loss its ability to contribute spawning gravel to the Sacramento River. The reduction in flood events has lead to channel down cutting and a loss of spawning gravel. To compensate for the loss in spawning gravel, Reclamation has annually funded a gravel augmentation program through the CVPIA. This program provides gravel at key locations below Whiskeytown Dam, but leaves it up to the flows in Clear Creek to move gravels downstream so that they can be utilized for spawning. However, the gravel augmentation program does not provide enough gravel to make up the deficit caused by Whiskeytown Dam. Over 100,000 tons of gravel have been injected since 1996, but GMA (2007) estimated that it would take 560,000 tons to recharge the length of Clear Creek from Whiskeytown Dam to the Sacramento River.

The impact of reduced high flow events in Clear Creek has decreased channel geometry and increased riparian encroachment (Vizcaino *et al*. no date). The loss of high flows and immobilization of sediments has resulted in reductions in fish habitat and establishment of introduced warm water fish species better adapted to the new conditions. Effects of reduced coarse sediment supply include: riffle coarsening, fossilization of alluvial features, loss of fine sediments available for overbank deposition, and a reduction in the amount and quality of spawning gravels available for anadromous salmonids (GMA 2006 *op. cit*. USFWS 2008).

The importance of these high flows (*i.e*., flood control releases or Glory Hole spills) for providing sediment transport and channel morphology cannot be overstated. In Clear Creek, gravels are mobilized at 2,000 cfs, and channel bed mobilization occurs at 3,000 cfs (McBain and Trush 2001). Only three channel bed mobilization events have occurred since gravel injection began in 1998 (GMA 2007).

Overall, the loss of these channel-forming flows is reducing the temporal and spatial diversity for both spring-run and CV steelhead in Clear Creek.

6.2.4 Assess the Risk to Individuals

Spring-run and steelhead abundances in Clear Creek are increasing as a result of passage improvements, gravel augmentation, restoration projects, temperature control, and the addition of b(2) water. However, continuing the proposed release pattern (*i.e.*, 200 cfs through most of the year) does not allow for habitat diversity and the expression of multiple life-history traits essential for spring-run and steelhead survival and recovery. Therefore, the future risk to the individuals in Clear Creek is that they will most likely experience reduced fitness, reduced reproductive success, and reduced growth rates (tables 6-1 and 6-2). The consequence of the lack of variability in flows is less complexity in the habitat, leading to truncated run timing and ultimately, a loss of diversity (VSP parameters). In the worst-case scenario, flows would drop to 30 to 50 cfs in a dry year, which would prevent passage upstream to spring-run spawning areas below Whiskeytown Dam and in turn, result in reduced reproductive success. Current flows may

limit the carrying capacity of spring-run and result in the underutilization of the existing amount of habitat available for spring-run spawning (USFWS 2007b), and suppress the potential for population increases. Redd superimposition would likely result. The proposed flow pattern, as described, lacks the high flows necessary to move spawning gravel downstream. The lack of spawning gravel limits the reproductive success of individuals and, as a consequence, reduces the potential for the population to increase.

Implementation of the Trinity ROD flow schedule will cause water temperatures to increase slightly in Clear Creek. Higher water temperatures in September will cause some spring-run egg mortality in 10 percent of the years (dry years) and reduce reproductive success in those years. Progeny of those individuals that spawn in the middle to lower reaches due to improvements in spawning gravel will likely die from lethal temperatures in dry to critical years. Studies on the American River have shown that juvenile steelhead exhibit site fidelity during over-summer rearing and do not move upstream into cooler habitats when temperatures warm to levels exceeding physiological tolerances (Water Forum 2005a). Therefore, the proposed flow regime is likely to reduce the chances of an individual surviving in the future as the habitat upstream is fully utilized, forcing individuals into less suitable habitat downstream (*i.e.*, lower reaches below the TCP at Igo). The impact of drought years is likely to increase in the future with climate change impacts. The consequence to individuals is that spawning is less likely to be successful in approximately 20 percent of years (*i.e.*, dry years). Whiskeytown Dam operations will continue to prevent the spatial and temporal separation of spring-run from fall-run, thus reducing the individual's expression of life history traits that are unique to that species (*e.g.*, anadromy in steelhead, and over-summer holding in spring-run).

6.2.5 Effects of the Action on Spring-Run and CV Steelhead Critical Habitat in Clear Creek

Clear Creek is designated critical habitat for spring-run and CV steelhead. The PCEs of critical habitat for both species include freshwater spawning sites, freshwater rearing areas, and freshwater migration corridors. This analysis on the effects of the proposed action on spring-run and CV steelhead critical habitat is based on information presented in the preceding sections regarding the effects of project operations, and are summarized below as they relate to the PCEs of critical habitat.

Spawning and rearing habitat in Clear Creek is expected to be negatively affected by flow and water temperature conditions associated with the proposed action. The value of critical habitat for the conservation of the species is reduced by not providing sufficient flows to maintain the suitability and availability of spawning habitat for spring-run. Reducing the depth and velocity of flows will reduce the suitability and availability of both spawning and rearing sites for both spring-run and steelhead. The lack of high enough flows (*i.e.*, from flood control releases stored behind Whiskeytown Dam) will limit the space available for salmonids downstream of Whiskeytown Dam and reduce the ability of the populations to increase.

For CV steelhead, the conservation value of critical habitat will be further reduced in dry years by unsuitable water temperatures in the lower reaches of Clear Creek during the summer rearing period. Recent steelhead spawning surveys (USFWS 2008a) indicate that the use of the lower

reaches below the TCP is increasing. Juveniles that rear over the summer in these lower reaches (*i.e.*, downstream of the Igo Guage) are much more vulnerable to high water temperatures. As a result, the ability of the habitat to support the current population and future recovering population is reduced or nullified.

Recent studies on Clear Creek (USFWS 2007) using smaller gravel size suitable for steelhead have found that steelhead have utilized all newly added injection sites. Spawning habitat on Clear Creek is improving with restoration efforts, gravel augmentation, and increased flows from b(2) water for temperature control. However, the value of spawning habitat for the conservation of the species is reduced under future operations in critically dry years when cold water releases cannot be maintained from Whiskeytown Dam (*i.e.*, years when Trinity River diversions are reduced).

6.3 Shasta Division and Sacramento River Division

Figure 5-8 provides a map of the upper Sacramento River. Table 5-1 provides the life history timing for anadromous fish species, including winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon in the upper Sacramento River. Figure 5-14 provides a conceptual model of the future baseline stressors and project-related stressors that act on the listed anadromous species and their proposed and designated critical habitats in the upper Sacramento River mainstem.

Life stage-specific responses to specific stressors related to the proposed action are summarized in the following tables; for winter-run, table 6-4; for spring-run, table 6-5; for CV steelhead, table 6-6; and for green sturgeon, table 6-7. Major project-related stressors are analyzed in the following sections. Due to the large number of stressors and species, this effects analysis intends to identify and describe the most important project-related stressors, prioritized by the greatest magnitude and duration of effects, and based on a literature review, knowledge and experience with project operations.

Table 6-4. Summary of proposed action-related effects and responses on winter-run in the Sacramento River.

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Adult Immigration RBDD	May – Jul.	RBDD gate closures from May 15 - Sept 15 every year until 2019	~15 % of adults delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity; continues every year until 2019	Reduced survival and reduced reproductive success
Adult Immigration RBDD	May – Jul.	RBDD emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed; sub lethal effects on eggs in fish and energy loss. These emergency gate closures have occurred twice in the past 10 years and the frequency of occurrence may increase with climate change.	Reduced survival and reduced reproductive success
Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year	Introgression or hybridization with spring/fall run/late-fall Chinook salmon; loss of genetic integrity and expression of life history	Reduced reproductive success
Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year	Density dependency - aggressive behavior among spawning fish could cause higher prespawn mortality, increased fighting for suitable spawning sites, adults forced downstream into unsuitable areas	Reduced survival and reduced reproductive success
Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year	Redd superimposition - spawning on top of other redds, destroys eggs	Reduced egg survival and reduced reproductive success
Spawning Primarily upstream of RBDD	Apr. – Aug.	Water temperatures warmer than life history stage requirements below TCP	Prespawn mortality; reduced fecundity, reduced spawning habitat available, less likely to re-colonize and expand into areas below TCP, reduces likelihood of recovery	Reduced survival and reduced reproductive success

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Embryo Incubation Primarily upstream of RBDD	Apr. – Oct.	Water temperatures warmer than life history stage requirements, every year. (No carry-over storage target designed for fish protection is included in the proposed action. Without such a target, the risk of running out of coldwater in Shasta Reservoir increases.)	Egg mortality - 16 % in critically dry years and increases to 65% in critically dry years with climate change. On average, for all water year types, mortality is 5-12% with climate change and 2-3% without. 56ºF is exceeded at Balls Ferry in 30% of the years in August and 55% of the years in September Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of winter-run to survive during subsequent life stages (Campbell et al. 1998). Campbell et al. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	Reduced survival
Embryo Incubation Primarily upstream of RBDD	Apr. – Nov	Flow fluctuations for ACID dam installation, 2 x /year	Redd dewatering and stranding; loss of a portion, or all eggs in redd	Reduced reproductive success
Juvenile rearing Upstream of & including RBDD	Jul. – Mar.	Water temperatures warmer than life stage requirements	Increased susceptibility to predation and disease in passing through Lake Red Bluff, gates at RBDD, fish screens, and bypass	Reduced survival
Juvenile rearing Upstream of & including RBDD	Jul. – Mar.	RBDD passage downstream through dam gates May 15 - Sept 15	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 10% of winter-run would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	Reduced survival

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Juvenile rearing Upstream of & including RBDD	Jul. – Mar.	Lake Red Bluff, river impounded May 15 - Sept 15	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	Reduced survival and reduced growth
Juvenile rearing Upstream of & including RBDD	Jul. – Mar.	Flow fluctuations caused by ACID dam removal in November	Fry standing and juvenile isolation; juveniles killed or subjected to predation and higher temps in side channels. Flow fluctuations from the dam removal occur over a short time period, limiting the exposure to potential fry stranding and juvenile isolation.	Reduced reproductive success
Juvenile rearing Upstream of & including RBDD	Jul. – Mar.	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency)	Reduced survival
Juvenile rearing/smolt emigration RBDD to Colusa	Sep. – Nov.	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment and greater predation	Reduced survival
Juveniles and smolts RBDD to Colusa	Sep. – Nov.	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Loss of rearing and riparian habitat and natural river function impaired (*e.g.*, formation of side channels, sinuosity); loss of cottonwood recruitment = less food available, juveniles hang up and don't migrate downstream until appropriate cues (*i.e.*, first storm > turbidity, < temp); juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	Reduced survival and reduced growth
Juveniles and smolts Colusa to Sacramento	Sep. – Nov.	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few winter-run are expected to be in this area during the fall.	Reduced survival

Table 6-5. Summary of proposed action-related effects and responses on mainstem Sacramento River spring-run.

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Adult immigration RBDD	Mar. – Sep.	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) force fish to use inefficient ladders	~70% of the spring-run that spawn upstream of RBDD are delayed by approximately 20 days on average, more energy consumed, greater pre-spawn mortality, less fecundity	Reduced reproductive success
Spawning Sacramento River	Sep. – Oct.	No temporal separation between spring-run and fall-run spawning due to delays at RBDD (no spatial separation due to Keswick and Shasta dams)	Introgression -Hybridization with fall run and competition for habitat	loss of genetic integrity and expression of life history
Embryo incubation	Sep. – Dec.	Water temperatures warmer than life history stage requirements, during September and October	Under near-term operations (Study 7.1) mortality is expected to range from approximately 9% in wet years up to approximately 66 % in critically dry years, with an average of approximately 21 % over all water year types; under modeled climate change projections, average egg mortality over all water year types is expected to be 50 % and during the driest 15 % of years is expected to be 95 %. Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of spring-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	Reduced survival
Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 5 percent of the spring-run ESU that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	Reduced survival

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	Reduced survival and reduced growth
Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (e.g., 95% efficiency).	Reduced survival
Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment and greater predation	Reduced survival
Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Loss of rearing habitat and riparian habitat and natural river function impaired (*e.g.*, formation of side channels, sinuosity); loss of cottonwood recruitment = less food available, juveniles hang up and don't migrate downstream until appropriate cues (*i.e.*, first storm > turbidity, < temp); juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	Reduced survival and reduced growth
Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few spring-run are expected to be in this area during the fall.	Reduced survival

Table 6-6. Summary of proposed action-related effects and responses on mainstem Sacramento River steelhead.

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Adult immigration RBDD	Aug. – Mar.	RBDD gate closures from May15 – Sept. 15 force adults to use inefficient fish ladders	17 % of those that spawn above RBDD, delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity	Reduced reproductive success
Spawning Sacramento River	Dec. – Mar.	Straying of Nimbus Hatchery steelhead to mainstem Sacramento River spawning habitats	Reduced genetic fitness of Sacramento River steelhead through the spread of Eel River genes and potentially hatchery rainbow trout genes to many below-barrier sites in the Central Valley (Garza and Pearse 2008).	Reduced genetic fitness
Egg incubation Sacramento River	Dec. - May	Water temperatures warmer than life history stage requirements	Sub-lethal effects - reduced early life stage viability; direct mortality in critically dry years; restriction of life history diversity (i.e., directional selection against eggs deposited in Mar.).	Reduced survival
Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Reduction in rearing habitat quality and quantity; delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	Reduced survival and reduced growth
Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 1 % of the steelhead DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	Reduced survival
Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency).	Reduced survival

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Provision of higher flows and cooler water temps during the summer than occurred prior to the construction of Shasta Dam	Potential fitness advantage for resident *O.mykiss* over the anadromous form, which would drive an evolutionary (*i.e*., genetic) change if life history strategy is heritable (Lindley *et al*. 2007).	Reduced reproductive success
Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	Reduced survival
Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process	Loss of rearing habitat and riparian habitat and natural river function impaired (e.g., formation of side channels, sinuosity); loss of cottonwood recruitment impacting food availability, juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	Reduced survival and reduced growth
Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. However, few steelhead are expected to be in this area during the fall.	Reduced survival

Table 6-7. Summary of proposed action-related effects and responses on the Southern DPS of green sturgeon in the Sacramento River.

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Adult Immigration Delta to KeswickDam	Feb. – Sep. (peak in Apr.)	Low flows during March - June	Adults need large spring flows to trigger movement upstream to spawn, low flows may delay migration enough that they encounter RBDD closed gates and are forced to spawn downstream in less suitable habitat	Reduced survival and reduced reproductive success

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Adult Immigration & emmigration RBDD	Mar. - Dec.	RBDD gate closures from May 15 - Sept 15 (every year until 2019).	Passage blocked, 55 miles of spawning habitat made inaccessible upstream of RBDD after May 15. Large aggragations (25-30) of adults observed below RBDD gates. Estimate 30 percent of run blocked based on run timing. Also, mortalities associated with downstream paasage under gates post-spawn, or after fish move above gates. Mortality greater on larger, more fecund females that cannot fit through 18" opening.	Reduced survival and reduced reproductive success.
Adult Immigration RBDD	Apr. – May 15.	Emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed (40 -50%) based on run timing; Greater mortalities associated with downstream passage under gates post spawn, or after moving above gates, sub lethal effects on eggs in fish and energy loss. Occurred twice in the past 10 years, but the frequency of occurrence may increase with climate change.	Reduced survival and reduced reproductive success. (note: 12 adults were observed killed by gates in 2006)
Adult Immigration ACID	Apr. – May 15.	ACID installed April to November	Passage blocked to 5 miles of spawning habitat below Keswick Dam.	Reduced habitat and reduced spawning success.
Adult Holding	Jun. – Dec.	Water temperature and low flows	Some adults may hold for up to 9 months in the upper Sacramento River post-spawn waiting for an increase in flows to move downstream. Water temperatures in September and October may stress individuals after the cold water pool is depleted. Dam controlled releases reduce the first pulse flow in the fall that may trigger adults to move out, so they stay longer in upstream areas. Delayed emigration, reduced fitness, longer periods between spawning runs.	Reduced probability of repeat spawning
Spawning	Apr. – Jul.	Blocked access to individuals above RBDD	Spawners that are blocked by RBDD are prevented from spawning with the portion of the run already above RBDD. Reduced genetic variability, may reduce fecundity, or size of fish if smaller adults arrive first.	Reduced survival and reduced reproductive success
Embryo Incubation	Apr. – Aug.	Water temperatures warmer than life history stage requirements below Hamilton City.	For eggs and fry that are spawned in areas from RBDD to Hamilton water quality is less suitable than above RBDD where temperatures are controlled for winter-run. Eggs suffocate from less flow, physiological effects, delayed hatch, greater predation on eggs due to presence of non-native introduced warm-water species.	Reduced egg survival and reduced reproductive success
Juvenile rearing to Hamilton City	Jun. – Nov.	Water temperatures warmer than life history stage requirements.	Juveniles move downstream immediately after hatching and encounter sub-optimum temperatures below Hamilton City due to truncated spawning distribution. May reduce growth, feeding, delay emigration, and increase predation from warm water species.	Reduced survival

Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Probable Fitness Reduction
Juvenile rearing Upstream of and including RBDD	Jun. – Nov.	Lake Red Bluff, river impounded May15 - Sept 15	Reduction in rearing habitat quality and quantity; increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967.	Reduced survival and reduced growth
Juvenile rearing Upstream of and including RBDD	Jun. – Nov.	RBDD passage downstream through dam gates May15 - Sept 15	Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 100% of the green sturgeon DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008). Approximately 70% of the entire green sturgeon DPS spawns above RBDD. Mortality of juvenile salmon emigrating past RBDD when the gates are in ranges from 5 -50% (Vogel *et al*. 1988; Tucker 1998); mortality of juvenile green sturgeon emigrating past RBDD has not been estimated, but is expected to increase when the gates are in.	Reduced survival
Juvenile rearing RBDD to Colusa	Jul. - Nov.	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Loss of rearing and riparian habitat and natural river function impaired (*e.g*., formation of side channels, sinuosity); loss of cottonwood recruitment = less food available, juveniles hang up and don't migrate downstream until appropriate cues (*i.e*., first storm > turbidity, < temp); juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	Reduced survival and reduced growth
Juveniles Colusa to Sacramento and enter Delta	Jun. – Nov.	Low fall flows	Emigration delayed, higher predation; fewer juveniles survive to the Delta	Reduced survival

6.3.1 Red Bluff Diversion Dam

6.3.1.1 Deconstruct the Action

The RBDD gates are proposed to be operated in the open position from September 15 through May 15 until a new pumping plant can be built just upstream (table 6-8). This is the same 8

months out, 4 months in operation that has occurred for the last 10 years. The CVP/SWP operations BA proposed this operation throughout the near term (up to year 2019)[10]. Once the new pumping plant becomes operational, the gates will be opened for 10 months, closed for 2 months plus closed for 10 days in May to accommodate boat race in Lake Red Bluff (table 6-8). Future operations will close the gates 5 days later (*i.e.*, May 20 instead of May 15) which would allow unimpeded passage to more adult winter-run at the tail end of their spawning migration in the long term. The delay in closure will also improve passage for spring-run spawning above RBDD. Currently, an estimated 35-40 percent of the green sturgeon in the mainstem Sacramento River are completely blocked from passing RBDD by the May 15 gate closure.

Table 6-8. Proposed Red Bluff Diversion Dam Gate Closures (CVP/SWP operations BA).

Near-Term (2009-2019)	Full Build Out (2020-2030) with new Pumping Plant
May 15 – Sept. 15	4 days prior to through 3 days following Memorial Day weekend; and July 1 through the end of Labor Day weekend
10-day emergency closure	*[11]
4 months gates in	2 ½ months gates in

Interim gate operations in 2009 were ordered by Federal court[12] to cover the period prior to NMFS' issuance of the new CVP/SWP operations Opinion. These interim gate operations specify gate closures no earlier than June 15, and gate opening on September 1, to protect listed salmonids and green sturgeon. TCCA has installed temporary pumps at RBDD to continue diverting water while the gates are not in place (May 15-June 15).

6.3.1.2 Assess Species Exposure and Response to RBDD

Based on recent RBDD ladder counts, the percentage of adults encountering delays when the gates go down on May 15 are approximately 15 percent for winter-run, 72 percent of spring-run, 17 percent for CV steelhead, and 35 percent for green sturgeon (TCCA 2008 Appendix B1; figure 6-4). Delays will impact adults spawning in the mainstem or tributaries above RBDD, and especially in Clear Creek, Cow Creek, and Cottonwood Creek. Spring-run that are delayed at RBDD and cannot access tributaries as a result of low flows end up spawning in the mainstem Sacramento River with the fall-run.

[10] Subsequent to Reclamation's request to initiate formal consultation on the CVP/SWP operations, Reclamation, TCCA, and NMFS engaged in discussions to expedite the time frame to construct and implement the new pumping plant. However, the Reclamation has not modified the CVP/SWP operations BA to reflect any change in schedule for the new pumping plant.

[11] Although Reclamation proposes to reoperate the RBDD after the near term, it did not mention the need (or lack of need) to retain its provision for a 10-day emergency pre-irrigation gate closure. However, with the approximately 10-day closure for the Lake Red Bluff boat races, and a pumping plant in place, NMFS did not see a need for Reclamation to retain the 10-day emergency pre-irrigation gate closure provision, and likewise, did not analyze the effect of that provision beyond the near term.

[12] Judge Wanger issued interim gate orders as part of ongoing litigation (*PCFFA et al. vs. Gutierrez et al.)*

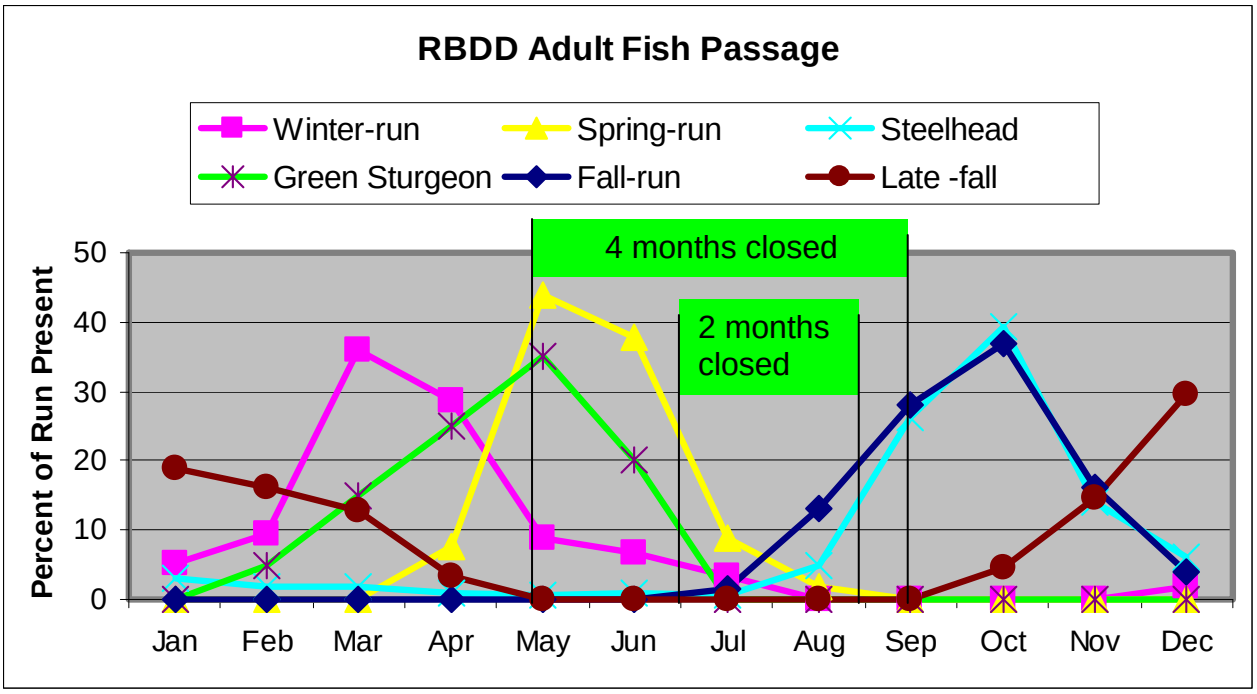


Figure 6-4. Run timing by month at Red Bluff Diversion Dam for adult winter-run, spring-run, fall-run, late fall-run, CV steelhead, and Southern DPS of green sturgeon (TCCA 2008).

Adult CV steelhead encountering RBDD in the gates down position in September may also experience delays in migration. Approximately 20 percent of those adult CV steelhead spawning in tributaries above RBDD (*i.e.*, Battle Creek, Clear Creek, Cow Creek; figure 5-12) would experience delays in passage. However, since CV steelhead spawn later in January and February, a delay of 1-2 weeks (September 1-15) at RBDD is not expected to reduce appreciably their ability to enter tributaries and successfully spawn. The pattern of delays for winter-run and spring-run adults at RBDD is expected to continue for the next 11 years until a new pumping plant increases the gates open from 8 months to 10 months per year. After the new Red Bluff Pumping Plant is built and operational, delays to Chinook salmon migration would be reduced, but still present for spring-run. Green sturgeon will still be completely blocked from upstream spawning areas during the 10-day May closure for the Red Bluff boat races in both the near-future and future operation, since they are not able to use the fish ladders (Heublein 2006, Brown 2007). Overall, the problems with passage at RBDD have been studied for years and are summarized in TCCA (2008, Appendix B1), as follows: "The biological consequences of blockage or passage delay at RBDD results in changes in spawning distribution (Hallock 1987), hybridization with fall chinook (CDFG 1998), increased adult pre-spawning mortality (Reclamation 1985), and decreased egg viability (Vogel *et al.*1988), all of which result in the reduction of annual recruitment of this species."

Adult green sturgeon migrate upstream from March through July, with the peak of spawning occurring from April through June (September 8, 2008, 73 FR 52084). Spawning habitat for green sturgeon occurs both above and below RBDD and ACID (Heublein 2006, Brown 2007, Poytress *et al*. 2009). The RBDD gate closure blocks approximately one-third of the spawning adults from accessing the upper Sacramento River. Large aggregations of green sturgeon have been observed in the pool below the diversion dam during May and June after the gates are closed (Brown 2007, Corwin 2008, Urkov 2008). The upper Sacramento River is the only

known spawning area for the Southern DPS of green sturgeon. Those individuals that do not pass RBDD before May 15 are forced to spawn downstream in habitat that is less suitable (*i.e.*, higher temperatures, less water velocity, and less bedrock habitat). Heublein (2006) and Lindley (2006) indicate that adult green sturgeon drop back downstream after encountering RBDD to as far as the GCID diversion, a distance of 41 miles. A large aggregation of adults has been observed holding through the summer in a 15-foot deep pool at GCID (Vogel 2008). Acoustic tag studies from 2004-2006 showed an increase in sturgeon density in reaches below RBDD after the May 15 closure truncated upstream migration (Heublein 2006).

In 2007, approximately 10-12 adult green sturgeon were observed killed (figure 6-5) before they could spawn by the RBDD gates due to an early gate closure (USFWS 2007). Early gate closures before May 15 are allowed during extreme dry conditions when not enough water can be pumped from the Sacramento River into the Tehama-Colusa Canal. Emergency closures have occurred twice in the last 10 years. It is unknown how many adult green sturgeon are killed during normal operations. However, the loss of 10 adult spawners represents a significant reduction in the only known spawning population in the Sacramento River (*i.e.*, represents 10 percent of the adults counted below RBDD in tagging studies). Reclamation proposes to change the opening under the gates (figure 6-6) from 6 inches to 12 inches during all gate closures to allow downstream passage of adults that have passed above RBDD. This change in the gate opening has not been evaluated and may eliminate the installation of the temporary fish ladder in the middle of RBDD, which would further reduce the ability of Chinook salmon and CV steelhead to pass RBDD with the gates in. The CVP/SWP operations BA asserts that adult green sturgeon can pass through a 6- to 10-inch opening based on limited (*i.e.*, 3 acoustically-tagged adults) data and undefined body depth. However, experts in green sturgeon from U.C. Davis have stated that a 12-inch opening is not large enough to pass green sturgeon adults without injury. Regardless of whether the opening is large enough to avoid impingement (since adults can reach a length of 5-6 feet they have to be perfectly lined up to pass through a 12-inch opening) the gates would still injure fish due to the turbulence after they pass through. Therefore, even though mortality may be reduced with the proposed 12-inch opening, NMFS anticipates some green sturgeon adults will be killed and/or injured in passing downstream while the RBDD gates are in operation from May through September.

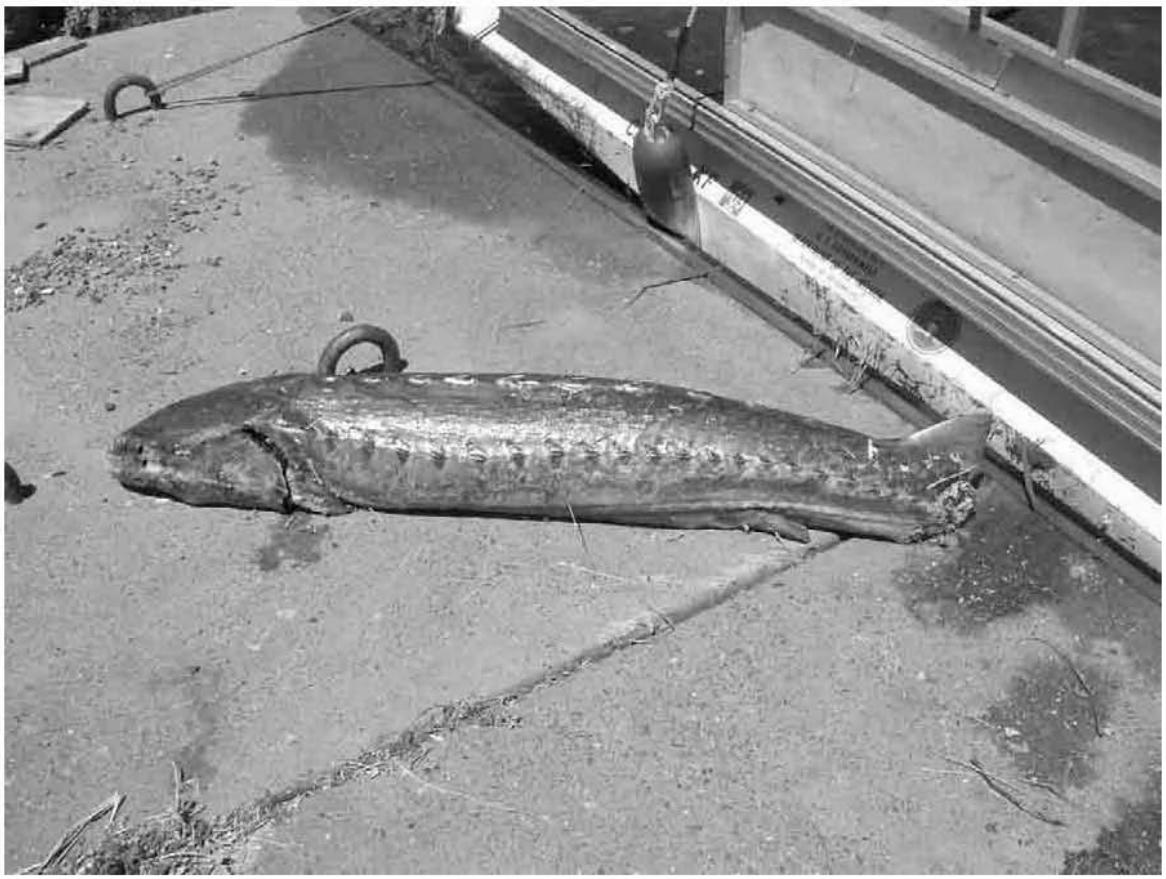


Figure 6-5. Adult female green sturgeon still with eggs, removed by divers after being found lodged under RBDD gate #6 on May 21, 2007 (USFWS 2007).

Juvenile salmonids and green sturgeon that encounter the RBDD (figure 6-7) experience higher predation rates from predatory fish that wait below the dam for fish that are swept under the gates and through the fish screen bypass. Vogel *et al.* (1988) have shown that predation may be as high as 50 percent for those juveniles that encounter the gates down (table 6-9). However, a more recent study (Tucker 1998) has shown that since the RBDD gates have been operating to the current 4 months (May 15 –September 15) closure, fewer predatory fish are present at the gates when juvenile salmonids are migrating downstream (figures 6-7 and 6-8, table 6-10). Thus, although not quantified, the predation rates are believed to be less than 50 percent. Predation on juvenile salmonids is expected to be greatest when they encounter the gates in. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007 *op cit*. TCCA 2008), approximately 99 percent of green sturgeon, 39 percent of winter-run, 1 percent of spring-run, and 37 percent of CV steelhead would be exposed to higher concentrations of predators when the gates are in (figure 6-7, table 6-10). These percentages represent only the proportion of the runs that spawn above RBDD and not the entire populations. The presence of predators below RBDD is most abundant from April to July when large numbers of juvenile spring-run, steelhead, and green sturgeon are migrating downstream (figure 6-8).

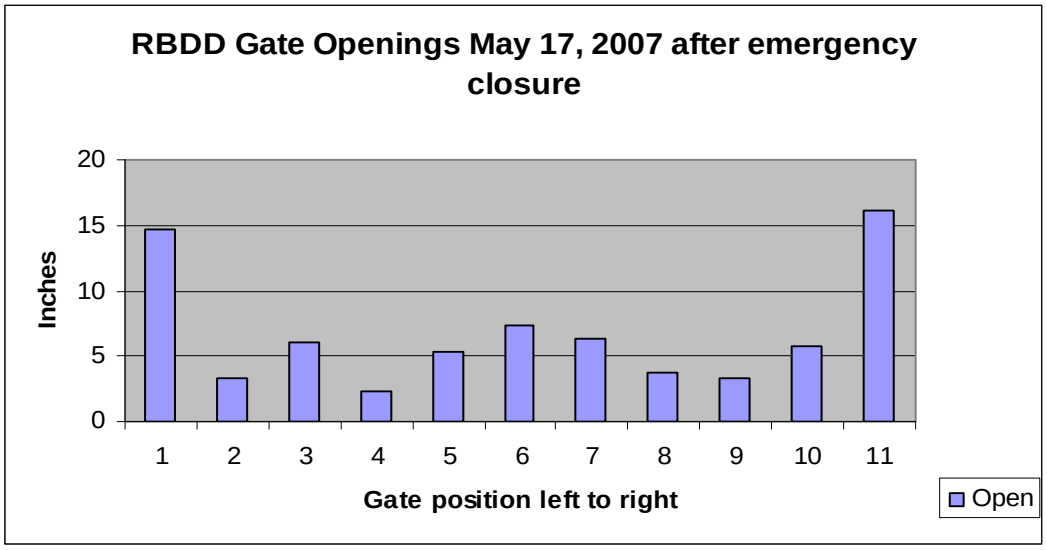


Figure 6-6. Red Bluff Diversion Dam gate position and size of openings after May 15 closure, data from Reclamation Daily Reservoir Operations Report May 2007. Note gates #5, 6, and 7 where green sturgeon mortalities were reported by Reclamation (USFWS 2007)

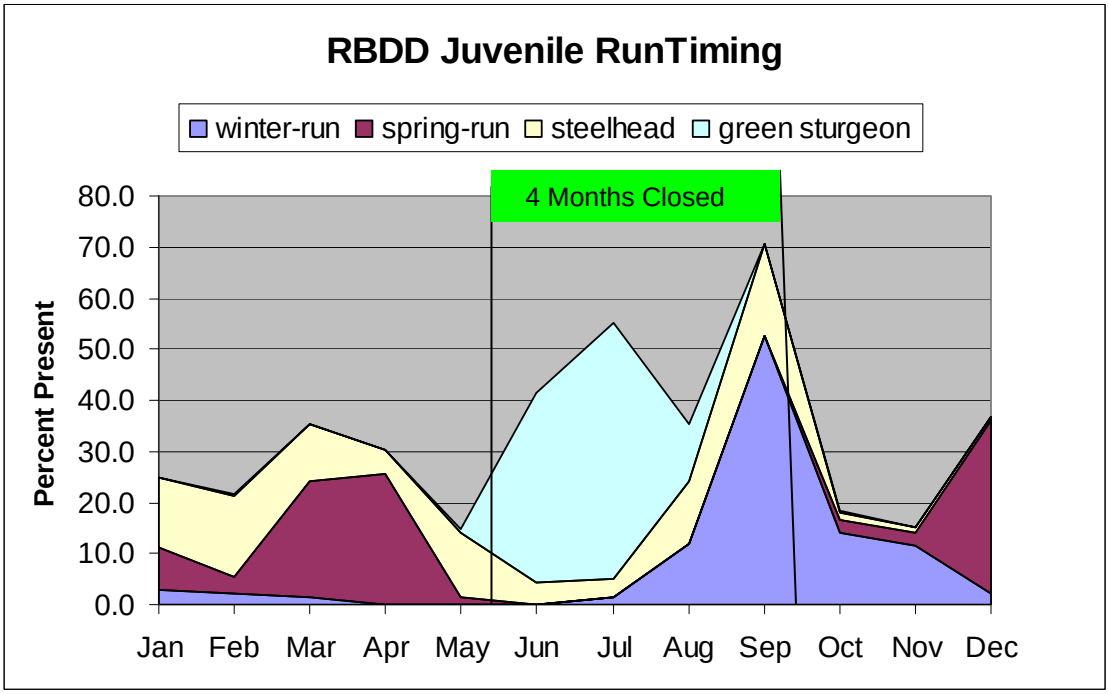


Figure 6-7. Juvenile run timing and exposure by month at Red Bluff Diversion Dam for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon based on USFWS trapping data (TCCA 2008).

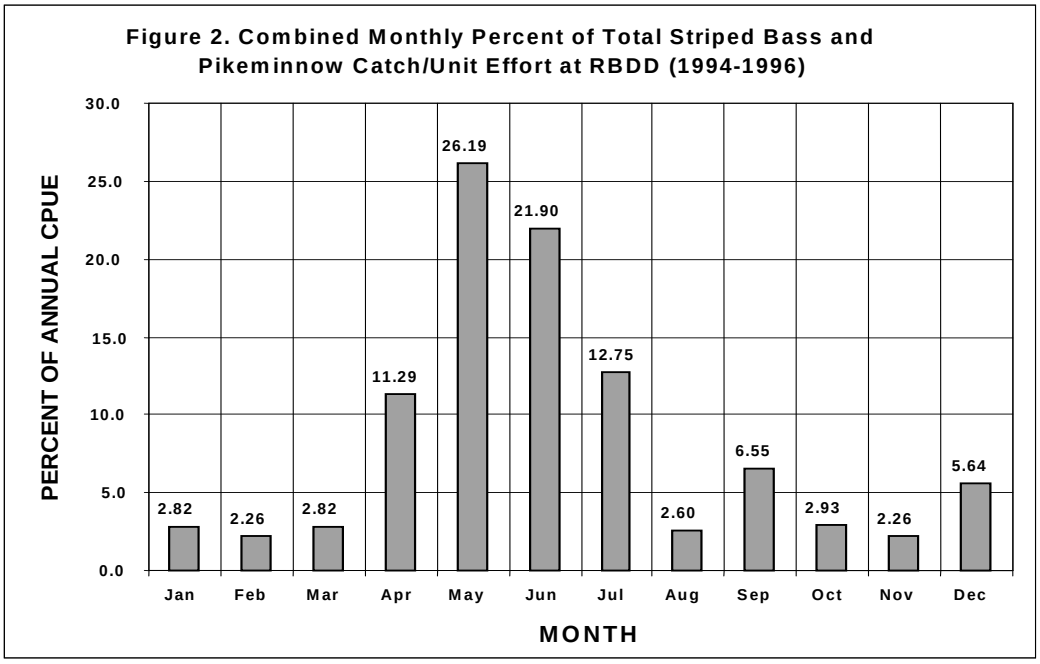


Figure 6-8. Presence of predators at RBDD by month from 1994-1996 (TCCA 2008).

Table 6-9. Estimated monthly hazard estimate used to assess predation in the *E.A. Gobbler* sub-routine of the Fishtastic! juvenile analysis model (Tucker 1998, Vogel *et al.* 1988).

Month	CPUE (% of yearly total)	Scaled Predation Rate (%)	Hazard Multiplier (0-1)
Jan	2.82	5.88	0.94
Feb	2.26	4.83	0.95
Mar	2.82	5.88	0.94
Apr	11.29	23.72	0.76
May	26.19	55.00	0.45
Jun	21.90	45.97	0.54
Jul	12.75	26.87	0.73
Aug	2.60	5.46	0.95
Sept	6.55	13.85	0.86
Oct	2.93	6.09	0.94
Nov	2.26	4.83	0.95
Dec	5.64	11.76	0.88

Table 6-10. Percent of juveniles exposed to RBDD gates closed condition (*e.g.*, increased predation, disorientation, *etc*.).

Species	May (16-30)	Jun	Jul	Aug	Sep (1-15)	Total
Winter-run	0.0	0.0	1.3	11.8	26.3	39.4
Spring-run	0.6	0.1	0.0	0.0	0.0	0.7
Steelhead	6.2	4.4	3.7	12.3	10.0	36.6
Green Sturgeon	0.5	37.1	50.1	11.1	0.0	98.8

"Operation of the gates at RBDD may not directly adversely affect populations of most of the resident species, but operations may seasonally limit their access into optimal habitats. Rates of predation on juveniles of species such as rainbow trout and other native species near RBDD may be affected by the operations of the RBDD because of the congregation of adult pikeminnows and striped bass. Except for juvenile rainbow trout, predation on juvenile resident native and non-native fish may be inconsequential, as these species are less-preferred prey." (TCCA 2008)

6.3.2 Shasta/Keswick Dam Water Releases

6.3.2.1 Carryover Storage in Shasta Reservoir

6.3.2.1.1 Deconstruct the Action

Carryover storage in September will be significantly reduced in the long-term (-121 TAF) future compared to current operations (Study 8.0 vs 7.0, table 6-11). The loss in carryover storage is due to less water diverted from the Trinity River (- 42 TAF in dry years), increased demand on the American River (800 TAF), and increased demand throughout the Central Valley. The long-term trend indicates that as water management changes in other CVP reservoirs and demand increases to 2030, the summertime releases from Keswick increase incrementally.

Table 6-11. End of September storage differences for Shasta storage, Spring Creek Tunnel flow, and Keswick release for the long-term annual average and the 1928 to 1934 drought period (CVP/SWP operations BA table 10-3).

Long term Annual Average

Difference in Thousands of Acre-feet [TAF]	Study 7.0 - Study 6.0	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Shasta End-of-September Storage	26	-121	-121	0
Annual Keswick Release	1	8	6	-2
Annual Spring Creek Powerplant Flows	3	-1	-2	-2

29- 34 Difference

Difference in Thousands of Acre-feet [TAF]	Study 7.0 - Study 6.0	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Shasta End-of-September Storage	-24	-258	-100	158
Annual Keswick Release	59	-18	-92	-74
Annual Spring Creek Powerplant Flows	45	-18	-42	-24

Before the TCD was built, NMFS required that a 1.9 MAF end-of-September (EOS) minimum storage level be maintained to protect the cold water pool in Shasta Reservoir, in case the following year was critically dry (drought year insurance). This was because a relationship exists between EOS storage and the cold water pool. The greater the EOS storage level, typically the greater the cold water pool. The requirement for 1.9 MAF EOS was a reasonable and prudent alternative (RPA) in NMFS' winter-run opinion (NMFS 1992). Since 1997, Reclamation has been able to control water temperatures in the upper Sacramento River through use of the TCD. Therefore, NMFS changed the RPA to a target, and not a requirement, in the 2004 CVP/SWP operations Opinion.

Reclamation proposes continuation of the 90 percent exceedence forecast for determining water allocations early in the year, starting with the February 15 forecast. However, Reclamation has proposed not to manage Shasta operations to a 1.9 MAF EOS target, although CALSIM assumes this target in all studies. Given the increased demands for water by 2030 and less water being diverted from the Trinity River, it will be increasingly difficult to meet the various temperature compliance points, even with a TCD, especially since Reclamation is not proposing any EOS storage target. Based on the historical 82-year period, CALSIM II results show that there will be about a 4 percent increase in the number of years that 1.9 MAF will not be met (figure 6-9). Overall, there is not much difference between model runs. In about 10 percent of years (typically the driest water years) a 1.9 MAF EOS would not be met. Additional modeled runs using higher carry over storage targets were provided to NMFS after the BA was completed (this run assumed conditions today with EWA or 7.0 Study). These runs revealed that a higher target of 2.2 MAF EOS improved the probability of meeting the Balls Ferry temperature target about 10 percent over the previous 1.9 MAF target (figure 6-10). There was no difference in meeting the Bend Bridge temperature target. At the higher carry over target Shasta Reservoir would have to be 75 percent full (volume > 3.6 MAF) by the end of April in each year. This would mean that Shasta Reservoir would be kept higher through the winter months and be more likely to spill for flood control.

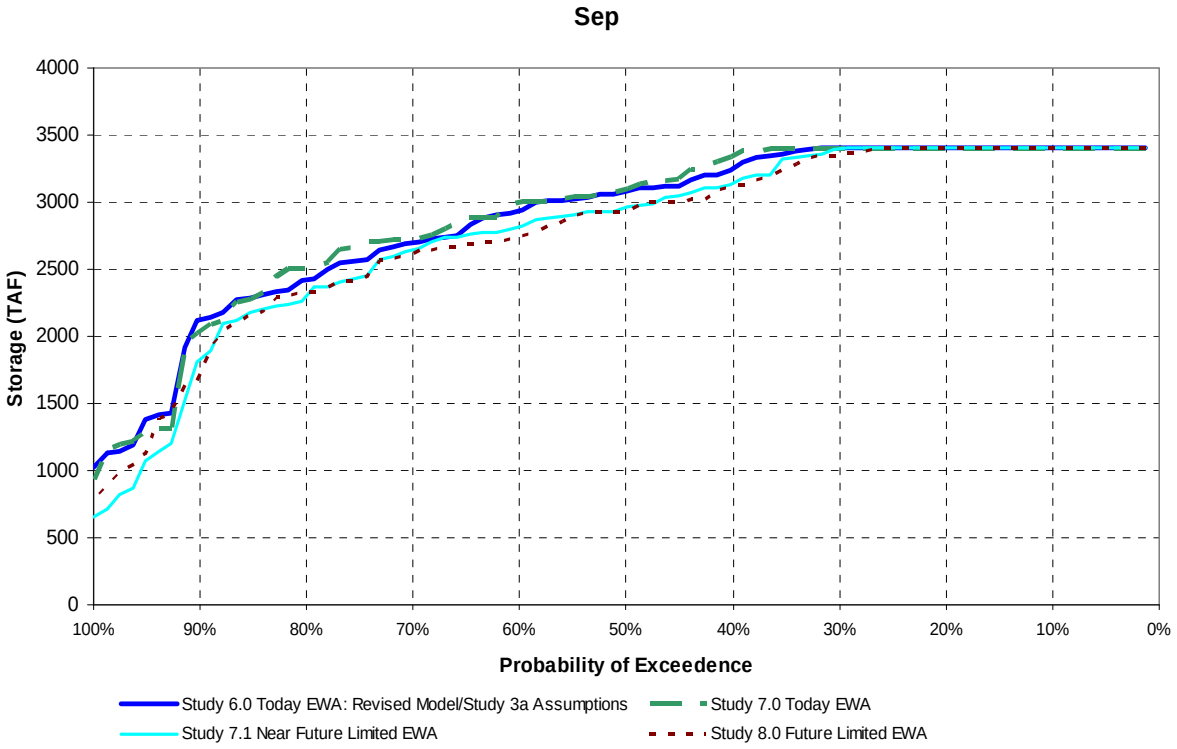


Figure 6-9. Exceedance plot of Shasta 1.9 MAF target September storage in Shasta Reservoir. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and study 8.0 represents future operations (CVP/SWP operations BA figure 11-37).

Reclamation has not proposed any alternative EOS storage target, but instead relies on the TCD capabilities to maintain cold water throughout the summer spawning period. Typically, by April 15, the amount of cold water in Shasta Reservoir is determined by the amount of snowmelt and inflow into the reservoir. Figure 6-9 shows that end of September storage would be reduced in the future compared to current operations in the drier 70 percent of years. EOS storage would be below 1.9 MAF in about 10-12 percent of the years in the future (Studies 7.1 and Study 8.0). With climate change, the long-term average September storage levels will be reduced by approximately 800 TAF in Study 9.5 drier, more warming (CVP/SWP operations BA table 9-23). Model results indicate that climate change will reduce EOS storage to below 1.9 MAF in about 25 percent of the years in all but the wetter, less warming scenario (figure 6-11). What this means for fish is a loss in the ability to control water temperatures, which will in turn result in greater egg and fry mortality for winter-run, spring-run, and fall-run in the future (see also temperature related effects of climate change in section 6.3.3.2, figure 6-20). With climate change, coldwater storage at the end of April in Shasta Reservoir is reduced in the future for all water year types under all but the wettest scenario (Study 9.4) wetter, less warming (figure 6-12). Climate change will put additional stressors on the already limited coldwater pool. The impact on winter-run and spring-run is greater mortality of eggs and pre-emergent fry in the spawning habitat.

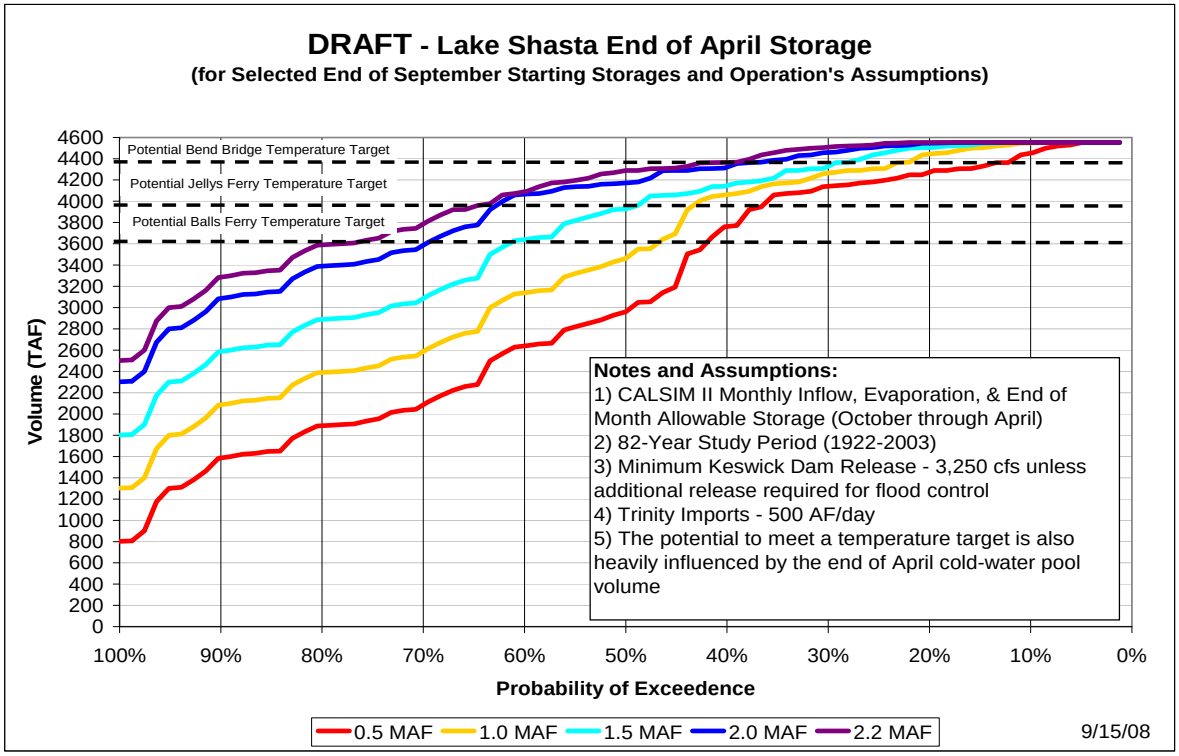


Figure 6-10. Draft exceedance plot of Shasta End of April Storage using selected End of September starting storages and operational assumptions (Supplemental data included with Reclamation's October 1, 2008, transmittal letter).

The minimum flows proposed in the CVP/SWP operations BA are 3,250 cfs from September to February and 2,300 cfs in a critically dry year (table 6-12). Typically, flows are much higher than 3,250 cfs in the spring and summer (April through September) because releases are made to support temperature control, irrigation demand (releases average between 10,000 and 14,000 cfs), and D-1641 requirements in the Delta (*e.g.*, water quality standards, Delta outflow).

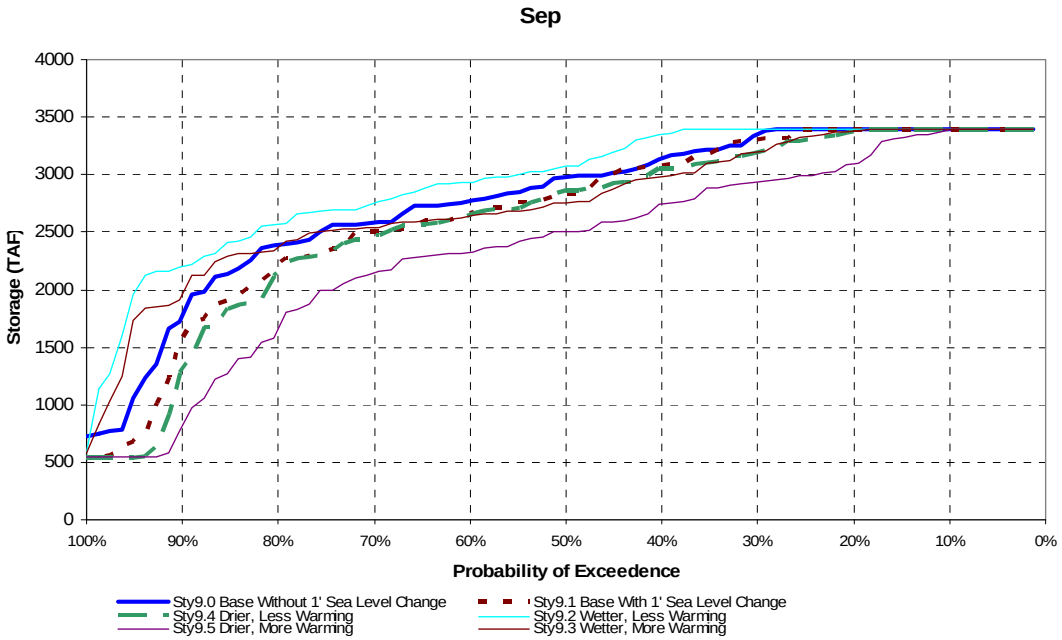


Figure 6-11. Exceedance plot of Shasta 1.9 MAF target September storage in Shasta Reservoir. Under future climate change scenarios (CVP/SWP operations BA, Appendix R, figure 37).

6.3.2.1.2 Assess Species Exposure and Response to Carryover Storage

Therefore, since b(2) water is not reasonably certain to be available, fall releases would most likely reduce fall-run spawning habitat and potentially dewater redds that were spawned at higher flows. The worst-case scenario, which is a rapid reduction in flows from 7,000 cfs in September to 3,250 cfs in November without b(2) water to conserve storage, could also strand newly emerged spring-run fry (note: spring-run juveniles start showing up in the RBDD trap data in November).

Flow studies using IFIM and PHABSIM have shown that winter-run salmon WUA peaked around 10,000 cfs when the ACID gates are in (usually from April to November), and 4,000 - 5,000 cfs with the gates out. Therefore, proposed and modeled releases provide suitable flows for winter-run spawning and rearing. In-stream flow objectives from October 1 to April 15 (April 15 is the start of temperature control for winter-run) are usually selected to minimize dewatering of redds and provide suitable habitat for salmonid spawning, incubation, rearing, and migration. These flows are generally suitable for spring-run, except in the worst-case scenario mentioned above for dry years when conserving storage drives the flows to minimums in the fall. The impact flows have on water temperatures will be discussed in section 6.3.3.2.

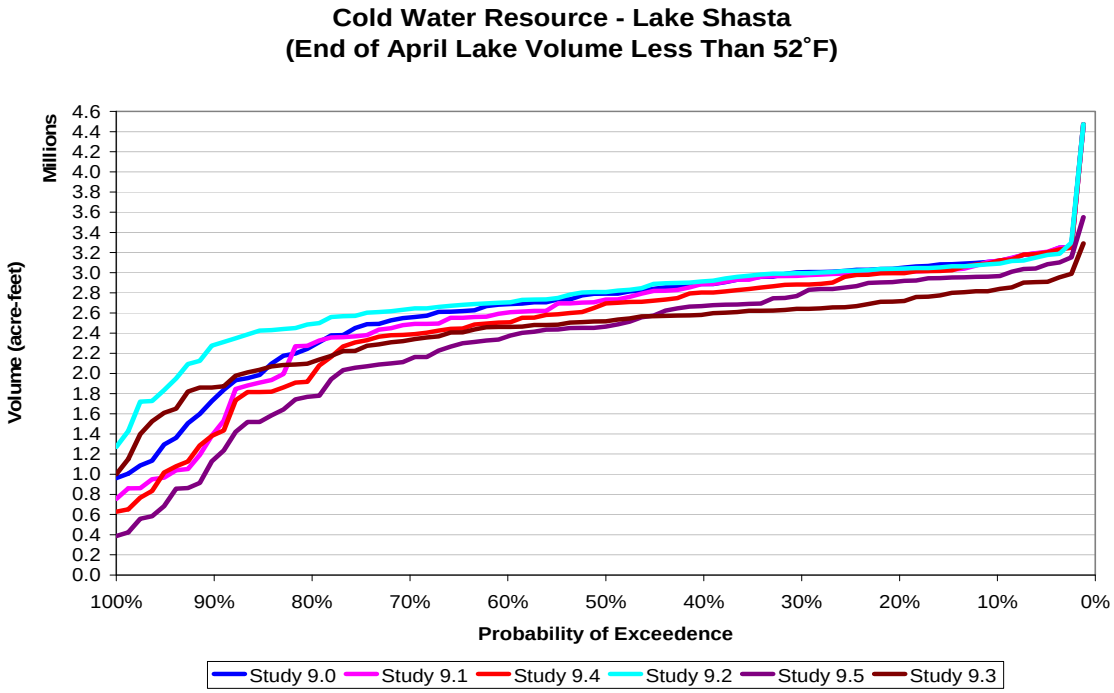


Figure 6-12. Shasta Lake coldwater pool volume at end of April with climate change scenarios. All studies except 9.0 include 1 foot sea level rise. Study 9.0 is future conditions with D-1641. (CVP/SWP operations BA figure 11-83).

Further downstream, Reclamation proposes to continue managing Sacramento River flows to the discontinued Wilkins Slough Navigation Requirement at Chico Landing (RM 118) in all but the most critical water supply conditions. Historically, a minimum flow of 5,000 cfs was required to support commercial boat traffic. However, the Corps has not dredged this reach to maintain channel depth since 1972. The flow requirement is now used to support long-time water diversions that have set their intake pumps just below this level. Diverters are able to operate for extended periods at flows as low as 4,000 cfs and for short periods at 3,500 cfs. Releases are made to meet the Wilkins Slough requirement in the spring and fall that impact the carryover storage and cold water pool in Shasta. Operating to flows less than 5,000 cfs would conserve storage in Shasta Reservoir in critically dry years.

Table 6-12. Proposed minimum flow requirements and objectives (cfs) on the Sacramento River below Keswick Dam (project description table 5).

Water year type	MOA	WR 90-5	MOA and WR 90-5	Proposed Flow Objectives below Keswick
Period	**Normal**	**Normal**	**Critically dry**	**All**
January 1 - February 28(29)	2600	3250	2000	3250
March 1 - March 31	2300	2300	2300	3250
April 1 - April 30	2300	2300	2300	---*
May 1 - August 31	2300	2300	2300	---*

September 1 - September 30	3900	3250	2800	---*
October 1 - November 30	3900	3250	2800	3250
December 1 - December 31	2600	3250	2000	3250

* No regulation. NMFS assumes that D-1641 standards, temperature control, and water allocations would result in higher flows.

In addition, Reclamation proposed to meet Delta water quality and flow standards contained in D-1641 with releases from Shasta Dam. Delta outflow and salinity requirements both require significant volumes of water to be released from upstream reservoirs. These releases are coordinated with releases from Oroville Dam and Folsom Dam, but the majority of flow usually comes from Shasta Dam. In accordance with the COA between the CVP and the SWP, Reclamation provides 75 percent of the required flows into the Delta and the SWP provides 25 percent. At times during critical years and after extremely wet months, the Delta standards can have significant upstream effects on water temperature control. The effect of the SWRCB Delta standards on upstream ESA-listed fish species was never analyzed during the 1995 Delta Accord, and has since become a greater problem as additional species have been listed (*i.e*. spring-run, CV steelhead, and long-fin smelt). For example, Delta outflow and salinity standards required in D-1641 are met with reservoir releases in dry springs when natural runoff cannot support the standards. These releases can account for a significant portion of storage that influences the total cold water volume available for release later in the summer.

6.3.2.2 Water Temperatures in the Sacramento River

6.3.2.2.1 Deconstruct the Action

A TCD has been in operation at Shasta Dam since 1998. TCD operations are capable of maintaining 56°F water downstream to Balls Ferry Bridge in most years through the summer spawning period for winter-run (table 6-13). The State Water Resources Control Board Water Rights Order 90-5 requires temperature control for winter-run salmon downstream to the RBDD, "to the extent controllable." The ability to control water temperatures depends on a number of factors and usually ends in October when the cold water in Shasta Reservoir is used up. The general factors that influence water temperature management are: (1) the volume of cold water available by April 15; (2) TCD operational flexibility; (3) mixing of Shasta releases with flows from Spring Creek Power Plant in Keswick Reservoir (*i.e*., Trinity River diversions); and (4) designation of the temperature compliance location. As explained above, NMFS has already analyzed Spring Creek Power Plant and Shasta carryover storage and expects the capability of both to be limited by Trinity River operations, increased future demands for water, and climate change. Real time experience operating the TCD has found that it is most efficient within normal lake levels. However, in wet years, warm surface water over tops the TCD, and in very dry years, leakage allows warmer water to mix with the cold water at the bottom. In 2008 (a critically dry year) a test of the lower river outlets for temperature control concluded that they were ineffective at providing temperature benefits (Manza 2008). In addition, a warm water bypass conducted in the spring of 2008 to conserve cold water provided less than one degree of temperature benefit (Fugitani 2008).

Table 6-13. Temperature targets from the 2004 CVP/SWP operations Opinion used as evaluation criteria. Temperature targets are mean daily degrees F. Target points in the Sacramento and American River are determined yearly with input from the SRTTG and American River Operations Group.

River	Target Species and Lifestage	Temperature Target Point	Miles Below Dam	Date	Temperature Target	Comment
Sacramento	Winter run egg incubation	Balls Ferry	26	4/15 - 9/30	56	Location depends on coldwater availability
	Winter run egg incubation	Bend Bridge	44	4/15 - 9/30	56	Location depends on coldwater availability
	Spring run and winter run	Balls Ferry	26	10/1 - 10/31	60	Location depends on coldwater availability
	Spring run and winter run	Bend Bridge	44	10/1 - 10/31	60	Location depends on coldwater availability
Clear Creek	Spring run prespawn and steelhead rearing	Igo	7.5	6/1 - 9/15	60	
	Spring run spawning and steelhead rearing	Igo	7.5	9/15 - 10/31	56	
Feather River	steelhead rearing	Robinson's Riffle	6	6/1 - 9/30	65	
American River	steelhead rearing	Watt Avenue	13.4	plan May 1	68	Target based on yearly plan
Stanislaus River	steelhead rearing	Orange Blossom	12	6/1 - 11/30	65	

6.3.2.2.2 Assess Species Exposure and Response to Water Temperatures

Table 6-14 shows the relationship between water temperature and mortality of Chinook salmon eggs and pre-emergent fry compiled from a variety of studies. This is the relationship used for comparing egg mortality between scenarios. USFWS (1998) conducted studies to determine winter-run and fall-run early life temperature tolerances. It found that higher alevin mortality can be expected for winter-run between 56°F and 58°F. Mortality at 56°F was low and similar to fall-run mortality at 50°F. The relationships between egg and pre-emergent fry mortality and water temperature determined by USFWS (1998) were about the same as that used by Reclamation in the salmon mortality model.

For purposes of this analysis, NMFS used the Balls Ferry temperature compliance point to evaluate effects, since most winter-run (98 percent) spawning distribution has shifted upstream of this point in recent years (CVP/SWP operations BA figure 11-38). Water temperatures exceed the 56°F objective at Balls Ferry in 50 percent of years in September and 10 percent of years from May through June under future conditions (Study 8.0, figure 6-13). Using the incremental exposure rates in table 6-14 and the modeled temperatures in figure 6-13, the loss rates for winter-run would be 8 percent egg mortality for those eggs exposed to 57°F in 50 percent of the years, 15 percent egg mortality for those eggs exposed to 58°F in 25 percent of years, 25-50 percent egg mortality for those eggs exposed to 59-60°F, in 10 percent of years, and 50-100 percent egg mortality for those eggs exposed to 60-62°F in 5 percent of years. In addition, exposure of newly hatched fry to lethal thermal stress would occur from 5-25 percent of years during August and September under future conditions. These conditions do not include the future baseline projected temperature increases resulting from climate change.

Table 6-14. Relationship between water temperature and mortality of Chinook salmon eggs and pre-emergent fry used in the Reclamation egg mortality model (CVP/SWP operations BA table 6-2).

Water Temperature (EF)[a]	Egg Mortality[b]	Instantaneous Daily Mortality Rate (%)	Pre-Emergent Fry Mortality[b]	Instantaneous Daily Mortality Rate (%)

Water Temperature (EF)[a]	Egg Mortality[b]	Instantaneous Daily Mortality Rate (%)	Pre-Emergent Fry Mortality[b]	Instantaneous Daily Mortality Rate (%)
41-56	Thermal optimum	0	Thermal optimum	0
57	8% @ 24d	0.35	Thermal optimum	0
58	15% @ 22d	0.74	Thermal optimum	0
59	25% @ 20d	1.40	10% @ 14d	0.75
60	50% @ 12d	5.80	25% @ 14d	2.05
61	80% @ 15d	10.70	50% @ 14d	4.95
62	100% @12d	38.40	75% @ 14d	9.90
63	100% @11d	41.90	100% @ 14d	32.89
64	100% @ 7d	65.80	100% @10d[c]	46.05

[a] This mortality schedule was compiled from a variety of studies each using different levels of precision in temperature measurement, the lowest of which was whole degrees Fahrenheit ($\pm$0.5°F). Therefore, the level of precision for temperature inputs to this model is limited to whole degrees Fahrenheit.

[b] These mortality schedules were developed by the USFWS and CDFG for use in evaluation of Shasta Dam temperature control alternatives in June 1990 (Richardson *et al*. 1990)

[c] This value was estimated similarly to the preceding values but was not included in the biological assumptions for Shasta outflow temperature control FES (Reclamation 1991b).

This temperature analysis (table 6-15) shows for all four CALSIM II Studies that water temperature control is problematic from May through October, with the most significant (over half of the 82 years modeled) exceedance occurring in September when Shasta Reservoir runs out of cold water. At that point, temperature control is reliant on ambient air temperatures and shorter days to cool down the river. Cold water availability is a significant factor in 15 to 20 percent of the Keswick release cases by September, and 20 to 30 percent of cases by late October.

There is a great deal of uncertainty in the temperature model results used for the Sacramento River. The above CALSIM II monthly model is disaggregated into a weekly time step (a sizable improvement since 2004), but it is unable to show the actual operational strategies used when adaptively managing temperature objectives. In addition, there is uncertainty in the performance of the TCD on Shasta Dam. Due to hydraulic characteristics of the TCD such as leakage, overflow, and performance of the side intakes, the typical modeled releases are cooler than what can be achieved, therefore, Reclamation has modeled a more conservative approach than what it can realistically operate to.

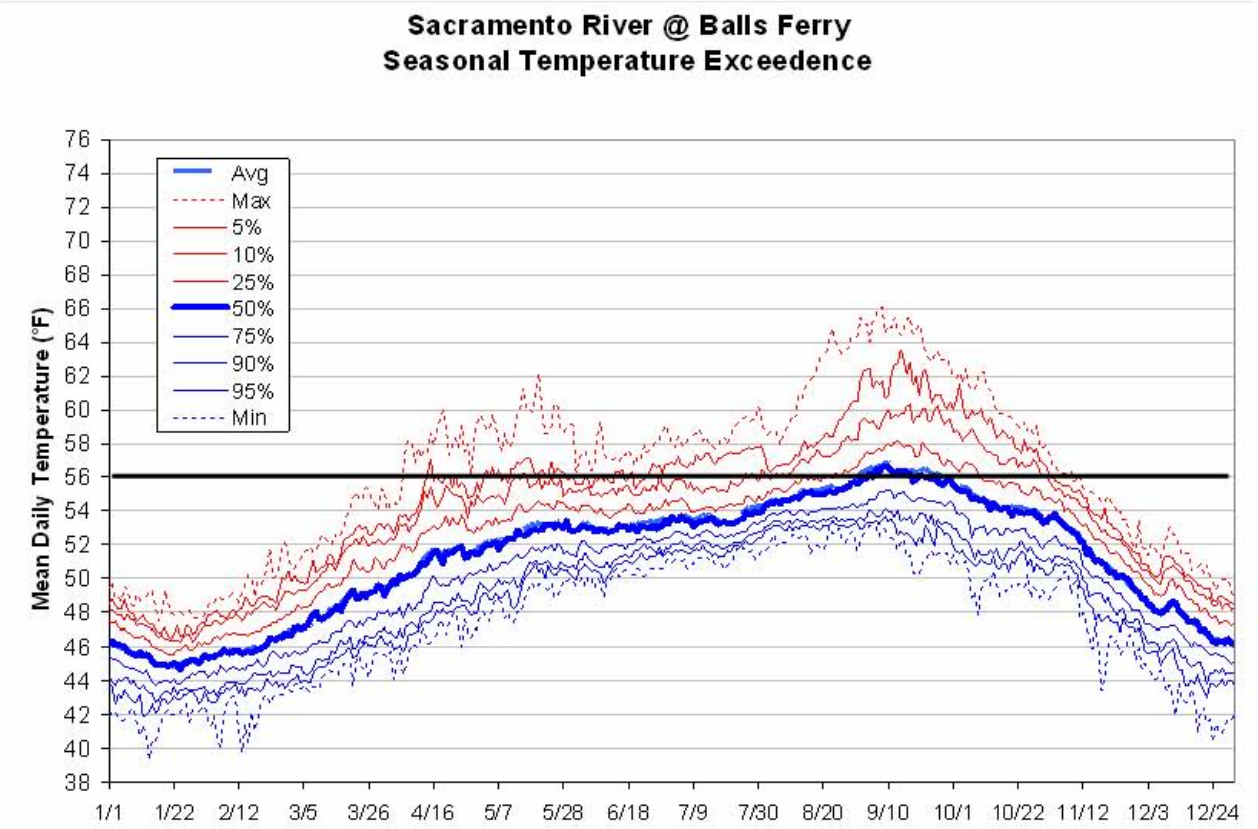


Figure 6-13. Water temperature exceedence at Balls Ferry under Study 8.0 from CALSIM and weekly temperature modeling results (CVP/SWP operations BA figure 11-35). For this analysis, the bold black line indicates the 56°F temperature compliance line.

Table 6-15. Balls Ferry water temperature exceedance by month from SRWQCM.

Month	Temperature (F)	Probability of Exceedance (%)	CALSIM Study
April 15	56		6.0, 7.0, 7.1, 8.0
May	56	5	6.0, 7.0, 7.1, 8.0
June	56	8	6.0, 7.0, 7.1, 8.0
July	56	11	6.0, 7.0, 7.1, 8.0
August	56	30	6.0, 7.0, 7.1, 8.0
September 15	56	40	6.0, 7.0 (base)
September 15	56	55	7.1, 8.0 (future)
October	60	4	6.0, 7.0, 7.1, 8.0

Reclamation's salmon mortality model shows the average percent mortality of eggs and pre-emergent fry while in the gravel for all years modeled (1922-2003). In comparison to the above temperature exposure analysis, Reclamation's model shows far less mortality due to water temperatures in all years. When comparing 2008 results at Balls Ferry with the same analysis performed in 2004, the 2008 results show approximately 5 percent less mortality on average, and in critical years, 30 percent less mortality (figure 6-14 compared to figure 6-15). This difference in mortality results is due to improvements in the SRWQM, which is the main driver for the mortality model. The temperature model disaggregates the monthly results into a weekly time-

step. Therefore, the more realistic time-step should make the mortality model results more accurate. In most years, average mortality is now predicted to be 1-2 percent due to water temperature effects. During critically dry years, mortality under near future operations (study 7.1) is about 15 percent, while under future operations (study 8.0), mortality is about 10 percent (figure 6-14). The critically dry years represent 15 percent of the years modeled.

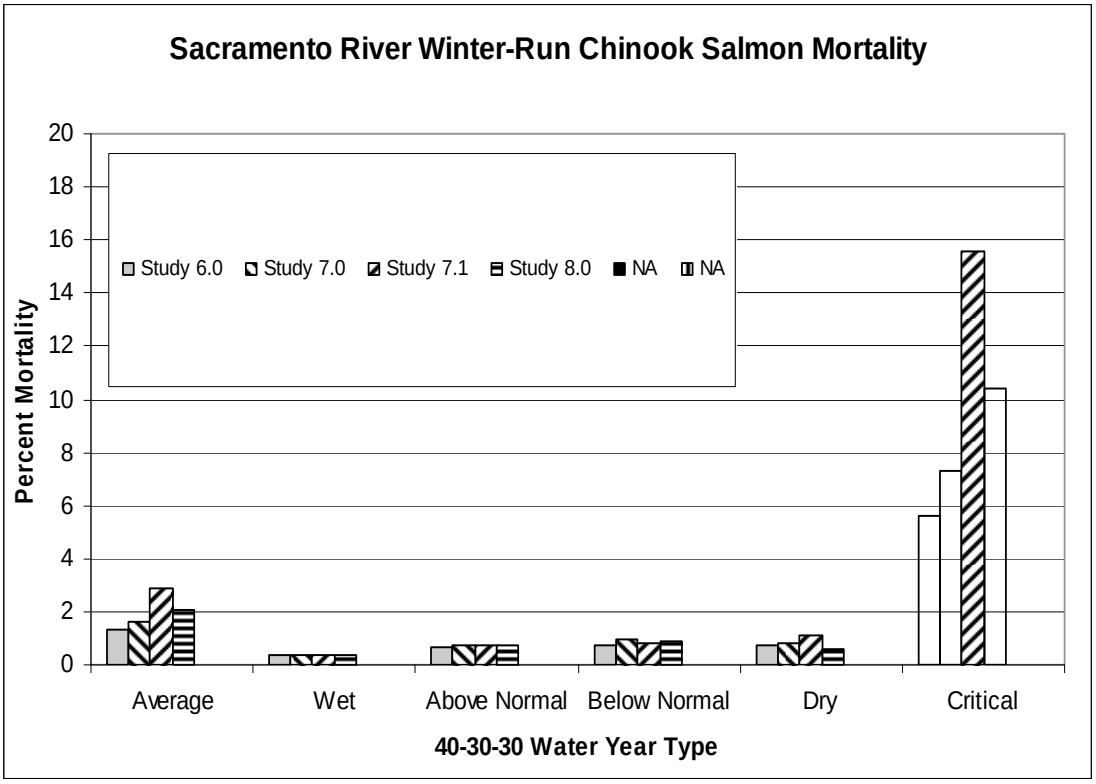


Figure 6-14. 2008 Winter run average egg mortality by water year type at Balls Ferry. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-39).

Water temperatures at Bend Bridge would be unsuitable for spawning and incubation (exceed 56°F) in 80 percent of the years in August and September. Bend Bridge is used as the most downstream temperature compliance point. Therefore, it is unlikely that through the adaptive management process the compliance point would move downstream of Balls Ferry except in extremely wet year types. The constriction of the available habitat for winter-run and spring-run only in an upstream direction as water temperatures increase may limit these fish from expanding their population size. Spring-run show a similar pattern of egg mortality, based on Reclamation's egg mortality model (figure 6-16). However, their egg mortality rates are just slightly less than twice that of winter-run, likely owing to the fact that they spawn later in the year, and Shasta Reservoir runs out of cold water for temperature control.

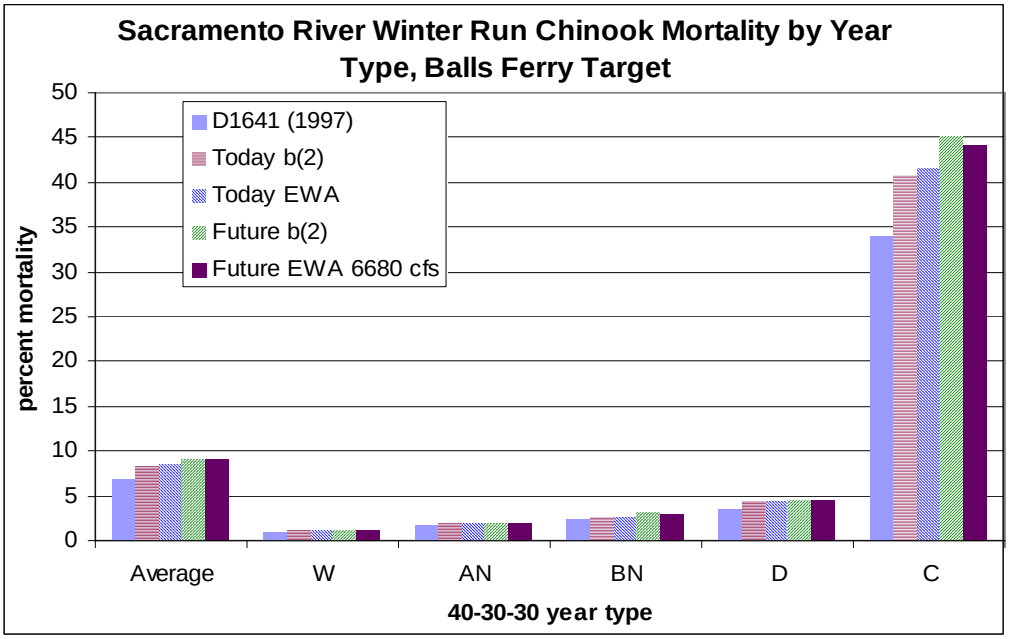


Figure 6-15. 2004 winter-run average egg mortality by water year type at Balls Ferry temperature target, with 5 model runs represented (CVP/SWP operations BA).

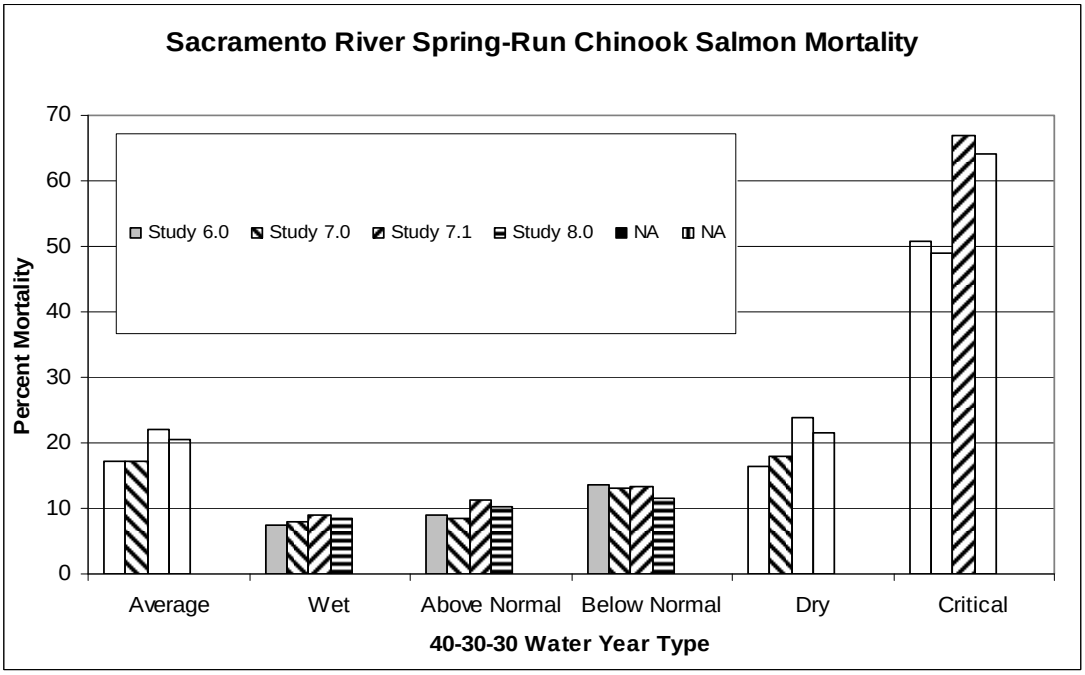


Figure 6-16. Spring-run egg mortality from Reclamation egg mortality model by water year type. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-41).

Juvenile winter-run typically leave the upper Sacramento River (Keswick Dam to RBDD) between September and October (figure 6-17), when they are beyond the reach of temperature

control. Temperature control is usually not necessary after October 30, as ambient air temperatures cool the river.

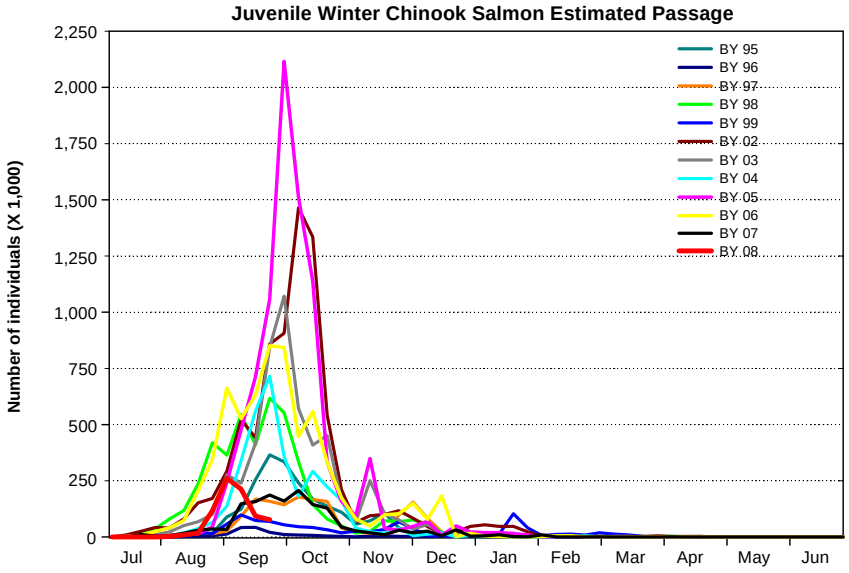


Figure 1. Weekly estimated passage of juvenile winter Chinook salmon at Red Bluff Diversion Dam (RK391), by brood-year (BY). Fish were sampled using rotary-screw traps for the period July 1, 1995 through June 2000 and July 1, 2002 to present.

Figure 6-17. Juvenile winter-run passage at Red Bluff Diversion Dam 1995 through 2008 (USFWS BDAT 2008).

CV steelhead mortality was not estimated using Reclamation's Mortality Model, but using late fall-run as a surrogate (since they spawn at the same time of year), the water temperature effects would be minimal. Late fall-run show on average a 4 percent increase in egg and fry mortality from temperature increases. With climate change, mortality of CV steelhead on the mainstem Sacramento River would increase 2-3 percent. Therefore, temperature related mortality is not considered a significant stressor because it would not occur every year. However, the lack of suitable habitat (*i.e.*, small gravel, small side channels, access to higher elevation tributaries) limits reproductive success, and the current coldwater management encourages the expression of only one life history pattern (residency).

In almost all years since the TCD has been installed, the TCP has been moved upstream by the SRTTG in response to one of the 4 factors above to protect winter-run eggs and fry (figure 6-18). Multiple day exceedences have become the norm and can be expected to continue under future operations. The SRTTG is responsible for adaptively managing the compliance point based on real-time data (*i.e.*, Shasta Reservoir temperature profiles, aerial redd counts, carcass surveys, and predictive temperature model runs). The SRTTG priorities are to provide enough cold water through the summer to protect: (1) winter-run spawning (April 15 - September 30), (2) spring-run spawning (September - October), and (3) fall-run spawning (October – November). This adaptive management process works well for protecting winter-run, but typically creates tradeoffs when considering how much cold water is left for spring-run and fall-run.

Water temperatures at Colusa are 64-66°F in both wet and dry years in September (figure 6-19) when the peak of the juvenile winter-run are emigrating downstream. The preferred optimum

water temperature for juvenile rearing is 53-57°F, and water temperatures less than 64°F are required for smoltification (CVP/SWP operations BA table 6-1). Therefore, for roughly half of their juvenile emigration (Colusa to the Delta), winter-run are exposed to sub-lethal temperature effects and greater predation due to nonindigenous (Sanderson *et al.* 2009). Once they reach the Delta, tidally-influenced flows cool the water temperatures to the range a juvenile can begin the process of smolting (64°F) by November (CVP/SWP operations BA figure 6-6). Past studies using CWT (such as CVPIA, Delta Action 8 Studies) showed poor survival rates for hatchery released fall-run and late-run juveniles from the upper Sacramento River (Battle Creek) to Chipps Island (Brandes and McLain 2001, USFWS 2003 and 2006, Newman 2008). Delta Action 8 studies, Newman 2008). Recent studies using acoustic tags on hatchery late-fall and CV steelhead showed both species had average survival rates of only 10 percent to the Delta, and 1-2 percent to the Golden Gate Bridge (MacFarlane 2008). These low survival rates indicate rearing habitat has been degraded by a whole suite of stressors such as; increased concentration of introduced warm-water predators, unscreened diversions, sublethal water temperatures, contaminants, agricultural return water, wastewater treatment plant discharges, shortened emigration timing, and smaller size.

Upper Sacramento River Temperature Control History						
Water Year	Oct. 1 Shasta Storage (TAF)	April 30 Shasta Storage (TAF)	Starting Compliance Point	Month	Action	Change in Compliance Point
1987-1996					Use of low-level outlets, power costs	
1992					CVPIA passed, construct TCD	
1993	1683	4263	Bend Bridge			
1994	3102	3534	Jelly's Ferry			
1995	2102	4165	Bend Bridge	July	Conserve cold water	Jelly's Ferry
1996	3136	4308	Bend Bridge	April	Exceed 56 °F 4/26	
				May	Exceed 56 °F 5/27	
				July	Conserve cold water	Jelly's Ferry
				August	Conserve cold water	Ball's Ferry
				Sept	Transition to stable min flow	Clear Creek
					for fall-run salmon by Oct 15	
1997*	3089	3937	Bend Bridge	May	Exceed 56 °F at Bend 3 days	
				July	Exceed 56 °F at Bend 4 days	
	*First year that TCD was used				Conserve cold water	Jelly's Ferry
				Sept	Exceed 56 °F at Jelly's 8/29	
					to 9/13	
				Oct	Exceed 56 °F at Jelly's 9/20-9/30	
1998	2308	4061	Bend Bridge	June	Exceed 56 °F at Bend 3 days	
				June	Exceed 56 °F at Bend 4 days	
				Sept	temp exceed 56 since Sep 12	Jelly's Ferry
1999	3441	4256	Bend Bridge	August	Exceed 56 °F at Bend 4 days	
2000	3327	4153	Bend Bridge	June	Exceed 56 °F at Bend 3 days	
				July	Conserve cold water	Jelly's Ferry
				August	Conserve cold water	Ball's Ferry
				Oct	Exceed 56 °F at Balls 3 days	
2001	2985	4020	Jelly's Ferry	July	Exceed 56.5 °F at Jelly's 2 days	
				August	Exceed 56 °F at Jelly's 8/28/2001	
					to 9/1/2001 and 9/152001 to	
				Sept	9/30/2001	
2002	2200	4297	Jellys' Ferry	May	Exceed 56 °F at Jelly's 5/18/2003	
2003	2558	4537	Bend Bridge	May	Exceed 56 °F at Bend 5/14/2003	
				Aug. 6		Jellys Ferry
				Aug. 8		Balls Ferry
				Aug. 28	Conserve cold water	
2004	3159	4060	Bend Bridge	May 7.	Exceed 56 °F at Bend	Jellys Ferry
				May 27.		Balls Ferry
2005	2183	4207	Balls Ferry	May 8.		Jellys Ferry
				Aug. 5		Balls Ferry
2006	3035	4057	Balls Ferry	May 1.		Bend Bridge
2007	3205	3901	Balls Ferry	May 7.		Jellys Ferry
				June 8.		Balls Ferry
2008	1879	3066	Balls Ferry	Apr.15	Conserve cold water	Jellys Ferry
			Airport Road	May 8.	Exceed 56 °F at Bend 3 days	Airport Road
			(below Clear Creek)			
Key:						
Above Normal & Wet						
Below Normal & Dry						
Critical						

Figure 6-18. Historical exceedances and temperature control point locations in the upper Sacramento River from 1992 through 2008.

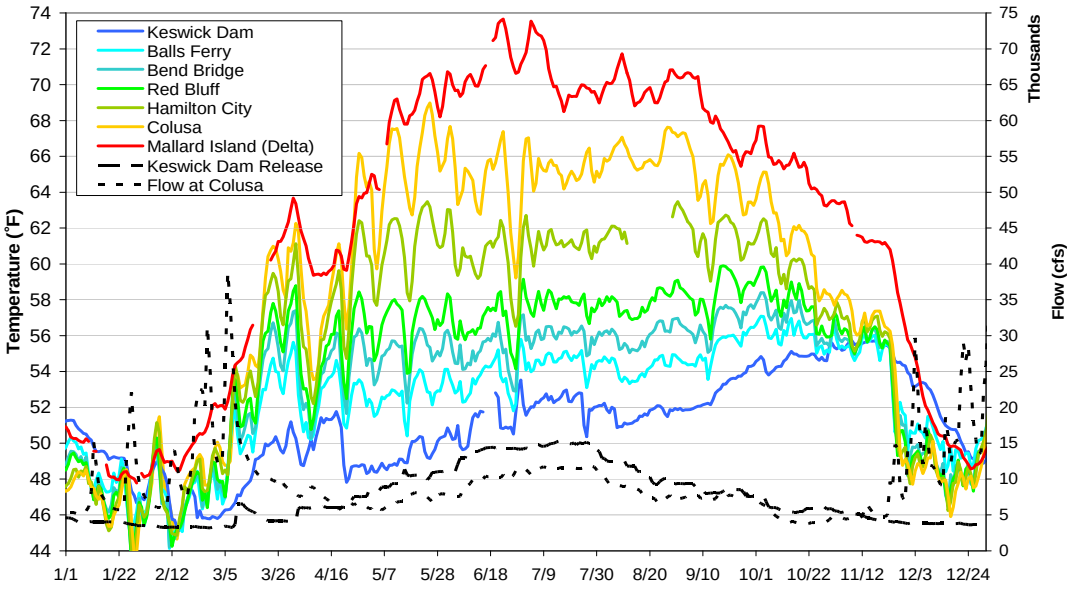


Figure 6-19. Sacramento River mean daily temperature and flow at selected locations in a dry water year, actual measured temperatures in 2001 (CVP/SWP operations BA figure 11-1).

6.3.2.2.2.1 Green Sturgeon

Based on table 6-16, water temperatures are unsuitable for green sturgeon spawning and rearing downstream of Hamilton City, which is also the location of the GCID diversion. Recent studies by Vogel (2008) indicated that large aggregations of adult green sturgeon have been observed congregating near Hamilton City.

Table 6-16. Temperature norms for green sturgeon life stages in the Central Valley (Mayfield and Cech 2004, NMFS 2006).

General Life Stage	Suitable	Tolerable[a]	Lethal
adult immigration	52 to 59°F	61 to 66°F	80°F
spawning & incubation	46 to 57°F	57 to 65°F	72°F
rearing	59 to 61°F	61 to 65°F	72°F
Juvenile emigration	60 to 65°F	65 to 69°F	77°F

[a]Sublethal effects occur in this temperature range

Adult green sturgeon blocked by RBDD are known to drop back downstream and hold in large pools below at the confluence of Deer and Mill creeks (Heublein et al. 2009). It is unknown how far downstream spawning occurs, but the conditions at Hamilton City are most likely suboptimal for developing eggs, larval, and rearing juveniles from March through September (figure 6-19). Water temperatures are tolerable for adults that may hold after spawning between RBDD and GCID.

6.3.3 Losses from Screened and Unscreened Diversions on the Sacramento River

Listed juvenile salmonids and green sturgeon are entrained in both screened and unscreened diversions on the Sacramento River. The loss is greatest in the upstream areas close to the spawning habitat where life stages are the smallest. The entrainment rate for screened diversions is small (< 1 percent) based on monitoring at RBDD. There are approximately 68 screened diversions in the Sacramento River (Calfish database). NMFS assumes if fish screens are meeting current screening criteria they are 95 percent effective, or that it is likely that 5 percent of the fish that come in contact with the fish screen could be killed through repeated contact with the screen, impingement, or contact with the cleaning mechanism. Actual mortality to screens is probably much less, as measured at the RBDD Pilot Pumping Plant (Borthwick and Corwin 2001 *op.cit*. CVP/SWP operations BA) and are more likely to represent less than one percent of the fish that come in contact with the screen (table 6-17). If the mortality from all screened diversions in the Sacramento River were summed it would be an insignificant amount when compared at the population level. Reclamation, as part of its mitigation responsibility under CVPIA section 3406(b)(21), funds the AFSP. The AFSP has screened most of the larger diversions in the Sacramento River. However, a few remain to have screens completed.

Estimates of the mortality at unscreened diversions in the Sacramento River (*i.e.*, 792 unscreened diversions listed in the Calfish data base and AFSP annual work plan 2009) are small, but when taken together, the cumulative impact is likely to reach the level where they would impact ESA species at the population level (table 6-17). The AFSP has screened most of the diversions larger than 250 cfs, and is now focusing on monitoring the losses occurring at smaller unscreened diversion to guide future fish screen projects. On the Sacramento River, losses of juvenile salmon are likely to continue at the following large diversions that are unscreened; Natomas Mutual, Reclamation District 2035, Meridian Farms, and Pleasant Grove-Verona.

Table 6-17. Estimated annual entrainment at water diversions based on size (volume of water diverted) and fish monitoring data (RBDD pumping plant) summarized from CVP/SWP operations BA tables 11-12 through 11-16).

Number of juvenile fish entrained	Screened Diversions*(ACID, TCCA, GCID)	123 unscreened Diversions (Project water only)	Percentage of juvenile population impacted by unscreened diversions**
Winter-run	50	7,440	0.37
Spring-run	5	537	0.0537
Fall-run/late fall-run	126	18,775	0.00653
CV steelhead	2	393	0.00677
Green sturgeon	unknown	199	unknown

* screened diversion calculated from 11 year average mortality observed at TCCA times number of screens in upper Sacramento River (3 largest).

** number of juveniles entrained at unscreened diversion/JPI average from 1994-1999 May through October passage at RBDD (Gaines and Martin 2002 *op. cit*. CVP.SWP operations BA).

Juvenile salmonids are more vulnerable to unscreened diversions than adults due to their size and behavior (*i.e.*, moving downstream with the flow). Unscreened diversions in the upper

Sacramento River are more likely to kill juvenile salmonids and green sturgeon due to their close proximity to spawning areas where newly hatched fry and larvae have weak swimming abilities. For green sturgeon, newly hatched larvae are subject to impingement on screened diversion, if they are located near areas where adults are spawning. Mefford and Sutphin (2009) have shown that for pallid sturgeon, which are smaller in size than green sturgeon, larvae in the 25-60 mm range became impinged on fish screens built to salmonid criteria. Juvenile green sturgeon that pass RBDD are typically within that range, therefore, likely some are likely loss to screened diversions at and above RBDD. Juvenile green sturgeon are also more likely to be impinged on fish screens because of the location of the intake near the bottom or in deep water.

6.3.4 Sacramento River Water Reliability Project (SRWRP)

The project description in the October 1, 2008, final CVP/SWP operations BA included the construction of a new water diversion intake structure, fish screen, water treatment plant and support facilities with a 365 cfs capacity in the Sacramento River at RM 74.6 (north of Elverta Road between the confluences of American and Feather River). However, as discussed in section 3.1 of this Opinion, in January 2009, Reclamation transmitted to NMFS an edited form of the CVP/SWP operations project description (Appendix 1 to this Opinion) that is consistent with that of the USFWS' Delta smelt biological opinion (USFWS 2008a). That project description did not contain the SRWRP, however, it did not remove the water associated from the SRWRP from the modeling.

Impacts considered under the CVP/SWP operations consultation from the SRWRP include impacts to aquatic species throughout the CVP and SWP due to the increase in the total amount of water being diverted from the Sacramento and American rivers relative to existing conditions. Although this project is not ready to be constructed, NMFS assumes, for modeling purposes, that there will be a decrease in the amount of water available on the Sacramento River from this project.

NMFS considers any further withdrawals of water from the Sacramento River will negatively impact the amount of freshwater that enters the Delta and the availability of cold water in Shasta Reservoir since this project shifts water demands from the American River to the Sacramento River. Such a shift creates tradeoffs between ESA-listed species (*i.e.*, steelhead on the American River v. winter-run and spring-run on the Sacramento River). When the project design is completed and Reclamation requests consultation on the SRWRP, the operational impacts to both upstream and Delta areas must be included, in addition to the construction-related impacts.

6.3.5 Climate Change

As discussed in sections 2.3.3 and 5.1, climate change is an environmental phenomenon that is part of the future baseline and would occur irrespective of any operations of the CVP or SWP. Although parts of section 6.3.2, above, discusses the climate change stressor on water storage at Shasta Reservoir, water temperature management in the Sacramento River, and mortality of early life stages of anadromous species, this section focuses on the effect of climate change on the larger ecosystem, and as modeled by Reclamation in study suite 9.

The impact of climate change in the future introduces greater uncertainty into the way in which water is managed in California. The historic hydrologic pattern represented by CALSIM II modeling in CVP/SWP operations (past 82 years of record) can no longer be solely relied upon to forecast the future. Precipitation and runoff patterns are changing, creating increased uncertainty for ecosystem functions. The average snowpack in the Sierra Nevada decreased by 10 percent in the last century, which translates into a loss of 1.5 MAF of snowpack storage (DWR 2008). California's air temperature has already increased by 1°F, mostly at night in winter, with the higher elevations experiencing the highest increase. A corresponding increase in water temperature is likely to reduce the available habitat for species that depend on cold water like spring-run that require over summer holding pools. Increasing water temperatures will also accelerate biological processes that impact anadromous fish like increased algae growth and decreased dissolved oxygen. Climate change will affect the entire life cycle of salmonids and sturgeon through warmer ocean periods, changes in age and size at maturity, decline in prespawn survival and fertility due to higher stream temperatures, and a loss of lower elevation habitat (Crozier *et al*. 2008).

In the Sacramento River, comparing climate change scenarios (Study 9.0 base vs Study 9.5 drier, more warming) shows that average winter-run and fall-run mortality increases from 15 percent to 25 percent, and average spring-run mortality increases from 20 percent to 55 percent (figure 6-20). Reclamation's mortality model was not run for CV steelhead because steelhead have a shorter incubation period than salmon, and the model would have to be changed. However, late-fall salmon can be used as a surrogate for CV steelhead since they spawn at similar times in the winter. Late fall-run mortality increases in Study 9.5 (drier, more warming) and Study 9.3 (wetter, more warming) under all water year types on average 4 percent over the future full build out scenario (Study 9.0). EOS carryover storage at Shasta is less than 1.9 MAF during average dry years (1928 to 1934) in all scenarios except Study 9.2 wetter, less warming (CVP/SWP operations BA table 9-23). Under these conditions, winter-run and spring-run would experience a loss of spawning habitat, as water temperatures below dams becomes harder to control and the cold water pool in Shasta diminishes.

CV steelhead would experience less of a loss on the mainstem Sacramento River, since they spawn in the late winter when water temperatures are not as critical to incubation. However, resident forms of *O. mykiss* spawn in May, when water temperatures exceed 56°F at Bend Bridge in 25 percent of future water years (CVP/SWP operations BA figure 10-83). This resident life history pattern represents a reserve that anadromous fish can interbreed with if there are too few CV steelhead (Zimmermen *et al.* 2008). It is likely that given warmer water temperatures resident *O. mykiss* would move upstream closer to Keswick Dam where temperatures are cooler, or into smaller tributaries like Clear Creek.

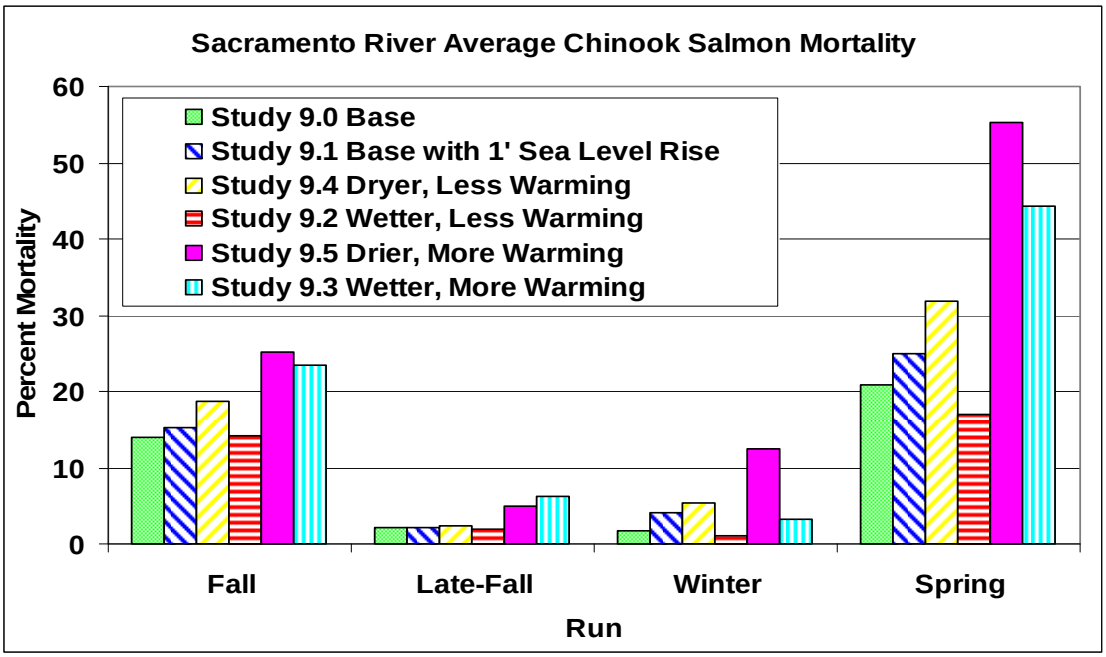


Figure 6-20. Sacramento River average Chinook salmon mortality by run and climate change scenario from Reclamation salmon egg mortality model. All studies except 9.0 include 1-foot sea level rise. Study 9.0 is future conditions with D-1641 (CVP/SWP operations BA figure 11-82).

Water temperatures in the Sacramento River at Balls Ferry increase under all climate change scenarios except for Study 9.2 (wetter, less warming). Temperatures exceed the 56 ^{o}F objective at Balls Ferry in July, August, September, and October. The highest water temperatures approach 60°F in September in Study 9.5 (drier, more warming), which is when spring-run salmon begin spawning. The climate change scenarios do not incorporate day-to-day adaptive management decisions of the SRTTG. Given the current prioritization of using cold water first for winter-run salmon during the summer, it would be logical to assume that spring-run and fall-run would experience greater impacts than those modeled.

Similar climate change modeling was conducted using a quantitative model (WEAP21) of the Sacramento River flow and temperature regime downstream to Hamilton City (Yates *et al*. 2008). This model compared water temperatures at Shasta Dam with and without managed releases for temperature control. In the unmanaged regime, the model assumes that Shasta Dam does not exist and that there is no irrigation demand. Using the observed historical record for years before the TCD was installed, Yates *et al*. (2008) used the WEAP21 model to calculate effects on winter-run, spring-run, and fall-run under a 3.5^{o} F and 7°F water temperature warming change. Under a 3.5^{o}F warming scenario, water temperatures at Keswick would be at or below the optimum upper temperature of 56°F for spawning and rearing, and then increase from that point downstream, except in the driest years. Under a 7°F warming scenario, even in wet years, spawning and rearing water temperature requirements would be exceeded in September and October from Keswick Dam to Hamilton City (Yates *et al*. 2008). The results of the WEAP21 modeling suggest that even with the use of the TCD on Shasta Dam, water managers will be challenged to maintain suitable water temperatures in the upper Sacramento River (*i.e*., Keswick to Hamilton City). Yates *et al*. (2008) concluded that cold water releases from Shasta Reservoir play a role in maintaining suitable habitat for spawning and rearing Chinook salmon as far

downstream as Hamilton City, and that climate change could be a major determinant of the future viability of adult and juvenile reproduction and migration strategies. Winter-run and spring-run were shown to be most at risk due to the timing of their reproduction. Without the cold water releases from Shasta Dam, water temperatures would exceed the physiological tolerances by 5°F or more, and winter-run and spring-run populations would not likely persist in the mainstem. The study also found that the availability of cold water releases is reduced as warming increases the demand for water and evaporative losses in Shasta Reservoir.

6.3.6 Assess the Risk to the Individuals

Based on the effects of the proposed action on winter-run, spring-run, CV steelhead and the Southern DPS of green sturgeon in the mainstem Sacramento River, as described above, fitness consequences to individuals include loss of genetic integrity and expression of life history, reduced reproductive success during spawning, reduced survival during embryo incubation, reduced survival and growth during juvenile rearing, and reduced survival and growth during smolt emigration (see tables 6-4 through 6-7).

6.3.7 Population Response to Project Effects Using SALMOD Modeling Winter-Run, Spring-Run, and CV Steelhead in the Upper Sacramento River

SALMOD modeling was used only on the Sacramento River to simulate population level responses to habitat changes caused by project operations. The study area extended from Keswick Dam downstream to the point at which the RBDD inundates riverine habitat upstream (53 miles). The pool backed up by RBDD has not been modeled for habitat value. The study area includes winter-run, spring-run, steelhead and green sturgeon spawning and rearing habitat. SALMOD uses PHABSIM and RIVER2D modeling to analyze habitat that has been classified according to mesohabitat type (*i.e.* pool, riffle, run). Unlike Northcoast streams, most Central Valley rivers and streams have not been habitat typed, limiting the use of SALMOD to just the upper Sacramento River. SALMOD functions to integrate microhabitat and mesohabitat limitations to a fish population through time and space. It is a spatially explicit model, which means the model tracks a population as it grows from one life stage to another. SALMOD uses a weekly time step derived from CALSIM monthly averages and HEC-5Q models. The SALMOD model is capable of processing spawning losses due to redd superimposition, redd scouring, dewatering, mortality due to water temperature, and seasonally induced changes in habitat. Habitat quality is categorized by channel structure, hydraulic geometry, and fish cover using changes in response to discharge. Habitat area is quantified using WUA described previously for PHABSIM and RIVER2D. Tributary production was also added to the upper Sacramento River as fry and juveniles. The SALMOD model takes density dependence into account down to Red Bluff, but the mortality model and delta survival make no adjustments for density dependence. Since density dependence is overlooked in the rivers (other than the Sacramento) and in the Delta the estimates of survival are lower than what would occur with compensatory mortality, where it occurs.

Uncertainty in the model comes from input values. Input variables include weekly average streamflow derived from monthly average CALSIM model results. Water temperature values are derived from the SRWQM daily results, which are disaggregated from monthly averages.

Numbers and distribution of fish were based on average escapement from 1999 to 2006 and may not accurately represent current populations. SALMOD is designed to represent population means based on large numbers. When populations are low (which they are now), they are more sensitive to individual variability and environmental stochasticity. SALMOD is not designed to address small population characteristics. Populations under 500 spawners were identified as being too low for accurate results. SALMOD used a starting population of 1,000 spring-run even though current redd surveys indicate less than 100 spawners in the mainstem. 8,591 winter-run spawners were used to start even though current population estimates are less than 3,000. Each year the population is reset to the starting level making it difficult to ascertain trend information. Confidence intervals or other measures of uncertainty have not been estimated for any of the models used in the CVP/SWP operations BA.

Steelhead were not used in SALMOD, however, NMFS assumed that late fall-run could be used as a surrogate, since they have similar life history stages and spawn at the same time of year. Additional uncertainty comes from not using the most recent years (*i.e.*, 2003-2008), which incorporate adaptive management, EWA, Trinity ROD flows, and changes in operations due to ESA-listed fish species not represented in the historical data.

Most model runs using SALMOD showed that there was not much difference between current and future operations (CVP/SWP operations BA Figures 11-44 through 11-54) except during critical years when juvenile production is reduced by up to 40 percent. Years of low production were 1925, 1932, 1935, 1977, and 1992 when cold water releases are limited. Most mortality occurred during the more sensitive egg and fry stage rather than presmolts and smolts. Winter-run fry mortality due to habitat limitations from water project operations increased gradually over time from less than 400,000 in 1923 to greater than 800,000 in 2002 (figure 6-21).

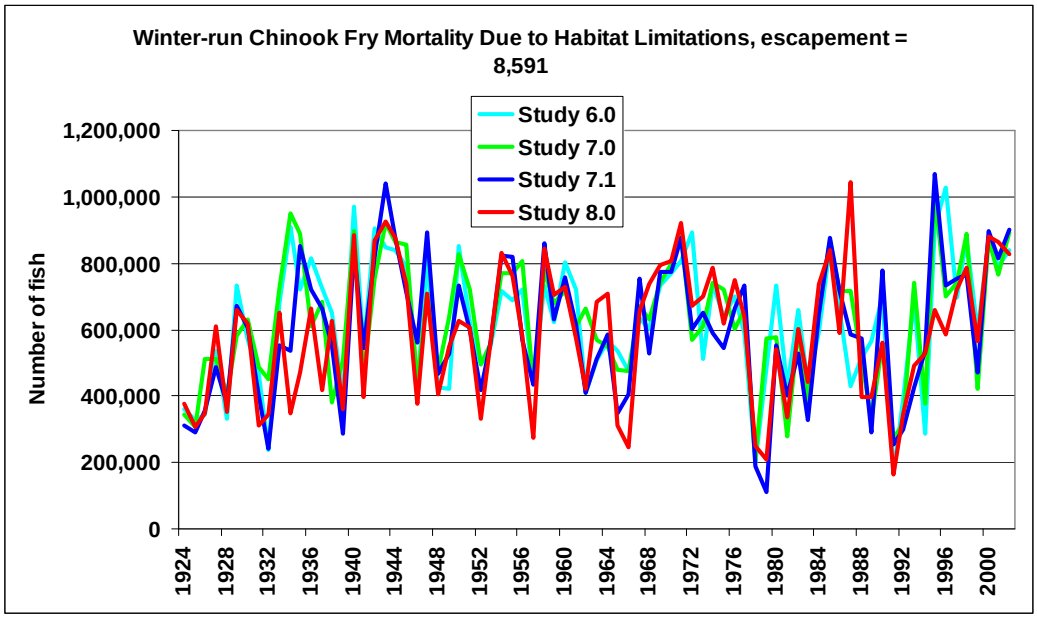


Figure 6-21. Winter-run Chinook salmon fry mortality due to habitat limitations by water operational scenario, 1923-2002 from SALMOD model. Study 6.0 represents 2004 operations, study 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-49).

Spring-run model results using SALMOD were similar to winter-run in that most of the mortaility due to project operations occurred in the egg and pre-emergent fry stage. There was no mortality of fry, presmolts or smolts due to water temperatures. Most spring-run and winter-run are classified as pre-smolts upon passing the downstream end of the study area (RBDD). Spring-run egg mortality due to water temperature reached 2,200,000 of 2,400,000 potential eggs modeled (or 92 percent) in critically dry years (figure 6-22) indicating most of the spring-run would not survive the effects of the proposed action. Since the SALMOD model resets the number of adults each year, it is difficult to predict what would happen in the years following this significant reduction.

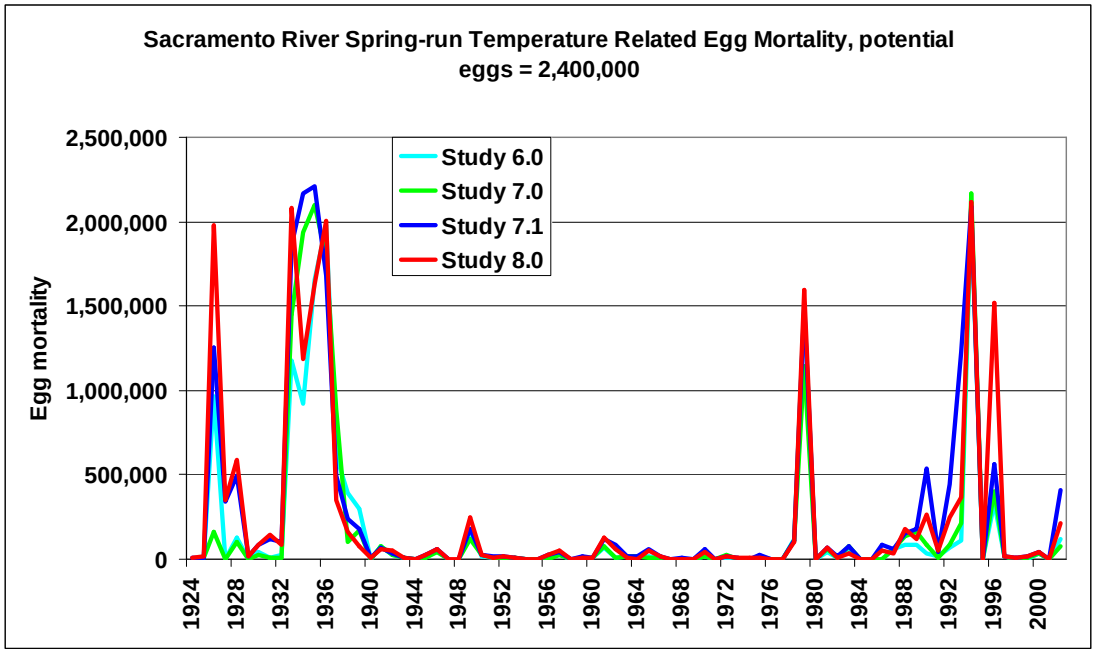


Figure 6-22. Sacramento River spring-run egg mortality due to water temperature by operational scenario with 2,400,000 total potential eggs, 1923-2002 from SALMOD model. Study 6.0 represents 2004 operations, 7.0 represents current operations, 7.1 represents near future operations, and 8.0 represents future operations (CVP/SWP operations BA figure 11-53).

Using SALMOD results for late fall-run as a surrogate, steelhead showed, on average, juvenile production was reduced by 10 percent during most years, but some years experienced up to a 60 percent reduction. The reduction in juveniles compared to the maximum production per year is shown in figure 6-23 for each operational scenario.

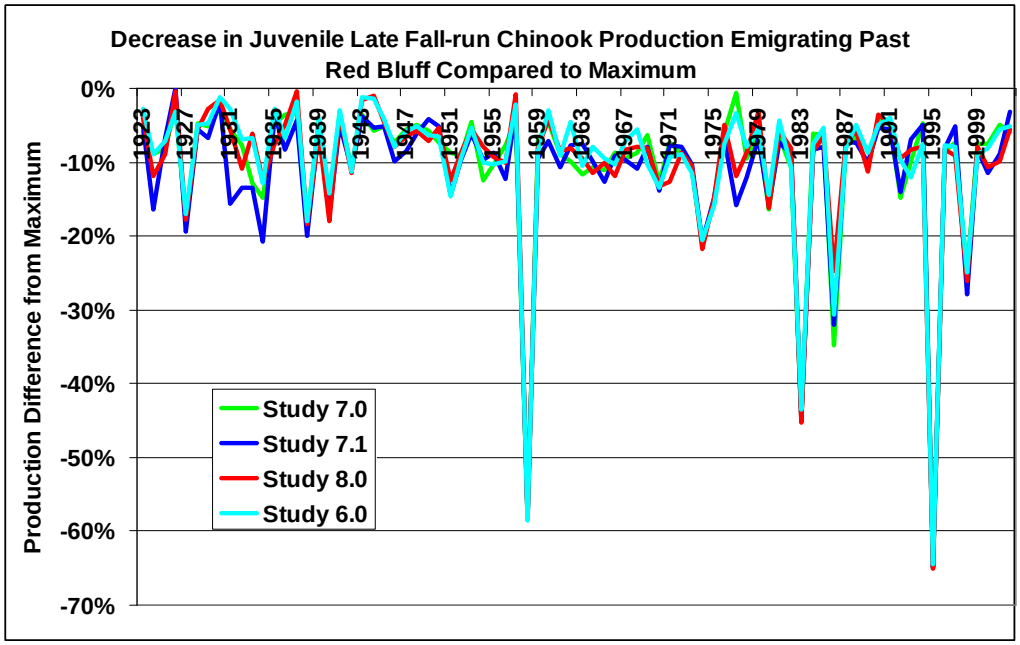


Figure 6-23. Reduction in upper Sacramento River juvenile late fall-run Chinook salmon production during each year of the CALSIM II modeling period relative to the maximum production year. Production was based on 12,051 adults and an average of 7 million juveniles produced in most years.

The SALMOD model shows a reduction in juvenile production resulting from project operations. The differences between Studies 6.0, 7.0, 7.1 and 8.0 are not apparent, however, when taken together and added to the existing stress regime. However, winter-run and spring-run on the mainstem Sacramento River never recover from critical years. The CVP/SWP operations BA concluded, "that episodic reduction in juvenile survival (particularly in critically dry years) leads to an average annual reduction of 6,200 adult spawners for 7.1 and 3,600 for 8.0 (relative to study 7.0). The effect of this reduced escapement through an 80-year period of simulation is sensitive to effects external to the proposed action (*e.g.*, increased harvest rate or loss of hatchery supplementation)."

6.3.8 Effects of the Action on Critical Habitat in the Sacramento River

As described in the critical habitat designation final rules (June 16, 1993, 58 FR 33212; September 2, 2005, 70 FR 52488), critical habitat provides PCEs, which are physical or biological elements essential for the conservation of the species. The Sacramento River provides 3 of the 6 PCEs essential to support one or more life stages, including freshwater spawning sites, rearing sites, and migration corridors for winter-run, spring-run, and CV steelhead. The Sacramento River is also proposed for critical habitat for Southern DPS of green sturgeon (proposed September 8, 2008, 73 FR 52084). Critical habitat impacted by the proposed action includes the Sacramento River from Keswick Dam to the Delta (302 miles).

6.3.8.1 Spawning Habitat

Steelhead spawning in the mainstem Sacramento River is probably limited to the area upstream of RBDD where spawning gravel has been added for Chinook salmon. However, surveys have

never been conducted to determine where or when CV steelhead spawn in the mainstem. Most steelhead prefer to spawn in smaller tributaries, except where blocked by impassible dams. Similar habitat conditions found in the upper Sacramento River exist in all core populations of CV steelhead, such as on the American River, Feather River, and Stanislaus River. Based on redd surveys conducted in other rivers, it is plausible that CV steelhead could utilize some areas as spawning habitat. The CVPIA spawning gravel program has historically used larger size gravel suitable for salmon, therefore, spawning gravel of suitable size for steelhead may be limiting in this area.

For winter-run and spring-run, potential spawning habitat is constrained by temperature control to smaller and smaller areas below Keswick Dam. The impacts of operations on cold water have already been described above. However, the changes to the habitat downstream are far more widespread and difficult to detect. The volume of water stored in Shasta reservoir tends to dampen the seasonal variation in water temperatures. This moderation of water temperatures, combined with a loss in spawning habitat above Shasta and Keswick dams, may have profound effects on life history patterns. Warmer water temperatures during the spring-run and CV steelhead egg incubation have resulted in earlier emergence time. Spawning habitat, which is now located 60 to 240 miles downstream from historical sites above Shasta Dam, truncates the juvenile emigration timing by 2-3 months. Therefore, juveniles leave the spawning area at much smaller size and are less likely to survive downstream. For steelhead the cold summer-time flow regime favors residency over anadromy, which reduces the variability in life history that distinguished runs. In addition, with more spatial and temporal overlap between the listed anadromous salmonid species, competition for space reduces the value of the spawning habitat for the conservation of any one species.

The value of spawning habitat for the conservation of the species is also reduced by flow fluctuations twice a year every year to install and remove the ACID diversion dam. These sudden drops in flow strand and/or isolate juveniles rearing along 5 miles of habitat above the diversion dam, and likely for miles downstream. Flow fluctuations can also dewater winter-run and fall-run redds. Since the majority of winter-run have shifted to spawning above the ACID diversion dam (*e.g.*, 62 percent in 2006), flow fluctuations are likely to have greater impacts in future years.

Climate change, as a modeled future baseline stressor, is likely to reduce the conservation value of the spawning habitat PCE of critical habitat by increasing water temperatures, which will reduce the availability of suitable spawning habitat. Cold water in Shasta Reservoir will run out sooner in the summer, impacting winter-run and spring-run spawning habitat. This reduction in an essential feature of the spawning habitat PCE will reduce the spatial structure, abundance, and productivity of salmonids.

6.3.8.2 Rearing Habitat

Stream flows within the Sacramento River have been altered by the operations of Shasta and Keswick dams. Generally, the changes have increased flows during the summer and fall, and decreased flows in the winter and spring compared to historical conditions (figure 5-13). The result of the change in historical flow patterns has been a decrease in the hydrologic variability

and a loss of complexity in the freshwater aquatic habitat. Specific areas of rearing habitat loss due to changes in the flow pattern include fewer oxbows, side channels, braided channels, less LWD, and less shaded aquatic riparian habitat. The Nature Conservancy (2007) model shows that these are necessary for proper functions of riverine ecosystems. A more natural flow regime with higher spring flows and lower summer flows would support riverine functions like the creation of oxbows, side channels and more varied riparian communities. In turn, this would increase cottonwood regeneration, shaded aquatic habitat, food supply, rearing areas, and LWD recruitment, all important components that are being degraded under continued project operations.

The decrease in the biological value of the rearing habitat is due to the simplification of the processes that create these important areas. The CVP and SWP have for years used the river as a conveyance system, neglecting the natural processes that are necessary to support river dependent species. This altered stream flow pattern has indirectly led to an increase in bank stabilization, levees, riprap, and armoring to keep the river in place. The reduction in rearing habitat quality has decreased the survival of juvenile salmonids and favored the proliferation of introduced non-native species that prey or compete with juvenile salmonids. Due to the stream flow changes, introduced warm water predators are much more numerous today than historically. Therefore, the conservation value of rearing habitat along the entire 300 miles has been degraded by project operations.

Rearing habitat for CV steelhead has been modified in the Sacramento River to cooler summer time releases for winter-run spawning. This change in summer temperature regime has increased the resident rainbow trout population. The change in summer temperatures may reduce the number of steelhead that choose to migrate to the ocean because conditions are too favorable. If the resident trout population is as large as the trout population above Shasta dam (*i.e.*, estimated at 10,300 trout per mile), then competition for food and space could reduce the value of the rearing habitat PCE.

Climate change, as modeled future baseline stressor, is likely to reduce availability of rearing habitat, and in turn, the value of the rearing habitat PCE of critical habitat, by increasing water temperatures. As the juveniles migrate downstream, they will emigrate earlier, encounter thermal barriers sooner, and be subjected to predators for longer periods of time. This reduction in the essential elements of critical habitat will reduce the spatial structure, abundance, and productivity of salmonids. Juveniles would be expected to concentrate in areas of cold water refugia, like in the few miles below Keswick Dam, where competition for food, space, and cover would be intense. Those individuals that stayed to over summer would be forced into one life history pattern consistent with project operations (*i.e.*, yearling life history and emigration during the following spring). Those juveniles that did emigrate early would be exposed to greater stress regimes as they encounter higher water temperatures and greater concentrations of predators downstream.

6.3.8.3 Migratory Corridors

The conservation value of the migratory corridor along the mainstem Sacramento River for all 4 listed species is degraded by the presence of barriers to upstream and downstream migrations.

An essential feature of the migratory corridor PCE is unobstructed passage of emigrating fish through the upper Sacramento River to the spawning areas. This characteristic of the PCE will continue to be degraded by the continued operation of the RBDD and ACID diversion dam. Adult salmonids are blocked and/or delayed in passing these obstructions. Juveniles are subjected to higher concentrations of predators at these locations. Entrainment losses will continue into the future from operation of fish screens at these diversions.

RBDD backs up water on the Sacramento River to form Lake Red Bluff during the summer months, when juvenile winter-run are migrating downstream. This action reduces the conservation value of the critical habitat within the 6–mile lake (or 15 miles of shoreline) for winter-run, spring-run and CV steelhead (TCCA 2008). The inundation of the Sacramento River slows down flows, covers riparian areas, warm water predators become more numerous, and the value of the habitat is reduced. Juvenile salmon and steelhead are disoriented and confused as they migrate downstream through the lake, similar to what happens on the Columbia River above its dams. Stranding and isolation occur in sloughs adjacent to the lake when the gates come out in September (USFWS 1998). The rising waters in the spring kill any vegetation along the sides by submerging it underwater and covering it with silt. Water temperatures increase in the lake as flows are slowed and surface water is heated by the sun. Large shade trees and riparian areas are prevented from becoming established leaving the near shore areas devoid of vegetation. Food supply, shelter and cover are reduced by this action and will continue to be reduced under future operations until a new pumping plant is built and operational.

Approximately, 8 miles of river habitat is modified (or 13.3 percent of the available habitat above RBDD) to less suitable lake habitat for 4 to 6 months of every year when the diversions are in place (*i.e*., 6 miles above RBDD, and 2 miles above ACID). This seasonal loss of habitat reduces food availability, shelter, and cover, and causes permanent changes that reduce the value of that habitat for the rest of the year (*i.e.,* from sedimentation, loss of shaded aquatic habitat, loss of riffle areas that produce food). The loss of habitat value leads to a reduction in the abundance of juvenile winter-run and spring-run that enter the Delta. Productivity and growth are also reduced from modified habitat and reduced complexity. Juvenile salmonids reach the Delta sooner and at a smaller size, making them more vulnerable to predation. Larger fish are more likely to survive the stressful transition into the marine environment than smaller fish, which have less energy reserves stored in their bodies. Therefore, salmonids with life history stages (representing a year in freshwater) like spring-run yearlings and CV steelhead smolts are less likely to be affected by these habitat changes in the migratory corridor, since they move through mainstem quickly prior to entering the ocean.

6.3.8.4 Green Sturgeon Proposed Critical Habitat

The installation and operation of the RBDD gates on May 15 of each year in the near term (through year 2019) blocks access to 53 miles of the Sacramento River to approximately 35 to 40 percent of the spawning population that arrive after May 15, and as a result, impairs the function of the Sacramento River as a migratory corridor for both green sturgeon adults and larvae/juveniles. After May 15, the river no longer has unobstructed access to habitat above RBDD, and changes the function of the river to such an extent that fish survival and viability are compromised. Reclamation proposes to reoperate RBDD in the future full build out scenario

(beginning in year 2020), so the RBDD gates would be in for approximately 2½ months each year rather than the current 4 months. After the near term (beginning in year 2020), the value of the migratory corridor PCE will improve each year through 2030 with the gates out longer, however, it will still be degraded.

RBDD backs up water on the Sacramento River to form Lake Red Bluff during the summer months, when some green sturgeon are migrating downstream. The inundation of the Sacramento River slows down flows, covers riparian areas, warm water predators become more numerous, and the value of the habitat is reduced. Juvenile green sturgeon are disoriented and confused as they migrate downstream through the lake, similar to what happens on the Columbia River above its dams. Stranding and isolation occur in sloughs adjacent to the lake when the gates come out in September (USFWS and Reclamation 1998). The rising waters in the spring kill any vegetation along the sides by submerging it underwater and covering it with silt. Water temperatures increase in the lake as flows are slowed and surface water is heated by the sun. Large shade trees and riparian areas are prevented from becoming established leaving the near shore areas devoid of vegetation. Food supply, shelter and cover are reduced by this action and will continue to be reduced under future operations until a new pumping plant is built and operational.

Approximately, 8 miles of river habitat is modified (or 13.3 percent of the available habitat above RBDD) to less suitable lake habitat for 4 to 6 months of every year when the diversions are in place (*i.e.*, 6 miles above RBDD, and 2 miles above ACID). This seasonal loss of habitat reduces food availability, shelter, and cover, and causes permanent changes that reduce the value of that habitat for the rest of the year (*i.e.,* from sedimentation, loss of shaded aquatic habitat, loss of riffle areas that produce food). The loss of habitat value leads to a reduction in the abundance of juvenile green sturgeon that enter the Delta. Productivity and growth are also reduced from modified habitat and reduced complexity.

The near term and long term operation of RBDD decreases the conservation value of suitable water quality conditions for green sturgeon spawning and rearing. Water temperature for spawning and egg incubation is near optimal (15°C/ 59°F)) from RBDD upriver during the spawning season. Below RBDD, water quality, in terms of water temperature, gradually degrades and eventually exceeds the thermal tolerance level for egg incubation, when egg hatching success decreases and malformations in embryos increase above 17 ^{o}C/62 ^{o}F, at Hamilton City.

The closed gates also decrease the conservation value of proposed critical habitat by: (1) increasing the potential for predation on downstream emigrating larvae in the slow moving water upstream of the RBDD (Lake Red Bluff), (2) increasing predation below the location of the RBDD due to the turbulent boil created below the structure and the concentration of predators located, and (3) creating increased potential for adults to be injured as they try to pass beneath the gates during the closed operations. The closed gate configuration also has the potential to alter the genetic diversity of the population by separating the population into upstream and downstream spawning groups based on run timing.

The installation of the RBDD blocks green sturgeon from known holding pools above the structure. Although known holding areas exist below the RBDD, such as the hole just above the GCID diversion, the RBDD decreases the number of deep holding pools the adult fish can access through its operation, thereby degrading the conservation value of the water depth PCE.

6.4 American River Division

6.4.1 Deconstruct the Action

This section is intended to describe how we have deconstructed the proposed action into stressors that affect CV steelhead, the only ESA-listed species that occurs within the American River. Naturally-produced CV steelhead in the lower American River are affected by many different stressors, which, for the purpose of this analysis, are categorized into two groups based on whether they do, or do not result from CVP operations (figure 5-19). The "future baseline" characterizes those stressors which are not the result of CVP operations, although CVP operations may exacerbate the effect of the stressor. An example of a future baseline stressor that is exacerbated by CVP operations is predation. Steelhead co-evolved with predators such as pikeminnow, but exposure to both elevated water temperatures and limited flow-dependent habitat availability resulting from CVP operations make juvenile steelhead more susceptible to predation (Water Forum 2005a). A detailed description of the future baseline is provided above in section 5.4.3, while project-related stressors are discussed below in section 6.4.3.

6.4.2 Assess Species Exposure

For the purposes of this analysis, "exposure" is defined as the temporal and spatial co-occurrence of a natural origin steelhead life stage and the stressors associated with the proposed action. A few steps are involved in assessing steelhead exposure. First, the steelhead life stages and associated timings are identified. Adult steelhead immigration in the American River generally occurs from November through April with a peak occurring from December through March [Surface Water Resources, Inc. (SWRI) 2001]. Spawning reportedly occurs in late December to early April, with the peak occurring in late February to early March (Hannon and Deason 2008). The embryo incubation life stage begins with the onset of spawning in late December and generally extends through May, although, in some years incubation can occur into June (SWRI 2001). Juvenile steelhead rear in the American River for a year or more before emigrating as smolts from January through June (SWRI 2001).

The second step in assessing steelhead exposure is to identify the spatial distribution of each life stage. The steelhead immigration life stage occurs throughout the entire lower American River with adults holding and spawning from approximately RM 5 to Nimbus Dam at RM 23 (Hannon and Deason 2008). Approximately 90 percent of spawning occurs upstream of the Watt Avenue bridge area located at about RM 9.4 (Hannon and Deason 2008). The juvenile life stage occurs throughout the entire river, with rearing generally occurring in the vicinity of the upstream areas used for spawning. Most juvenile steelhead are believed to migrate through the lower sections of the American River into the Sacramento River as smolts.

The last step in assessing steelhead exposure is to overlay the temporal and spatial distributions of proposed action-related stressors on top of the temporal and spatial distributions of lower American River steelhead. This overlay represents the completed exposure analysis and is described in the first three columns of table 6-18. Unless otherwise specified in table 6-18, the temporal and spatial distributions of proposed action-related stressors are the same as the temporal and spatial distributions of steelhead life stages as specified in table 6-18.

6.4.3 Assess Species Response

Now that the exposure of American River steelhead to the proposed action has been described, the next step is to assess how these fish are likely to respond to the proposed action-related stressors. In general, responses to stressors fall on a continuum from slight behavioral modifications to certain death. Life stage-specific responses to specific stressors related to the proposed action are described in detail in the following paragraphs and are summarized in table 6-18. There may be other project stressors acting on lower American River steelhead than those identified in table 6-18. However, this effects analysis intends to identify and describe the most important project-related stressors to these fish. These stressors were identified based on a comprehensive literature review, which included the following documents:

- Lower American River State of the River Report (Water Forum 2005a);
- Aquatic Resources of the Lower American River: Baseline Report (SWRI 2001);
- Impacts on the Lower American River Salmonids and Recommendations Associated with Folsom Reservoir Operations To Meet Delta Water Quality Objectives and Demands (Water Forum 2005a);
- American River Steelhead Spawning 2001 – 2007 (Hannon and Deason 2008);
- Steelhead Restoration and Management Plan for California (McEwan and Jackson 1996);
- Evaluation of Effects of Flow Fluctuations on the Anadromous Fish Populations in the Lower American River (CDFG 2001); and
- The CVP/SWP operations BA.

Table 6-18. Exposure and summary of responses of American River steelhead to the proposed action.

Life Stage/ Location	Life Stage Timing	Stressor	Response	Probable Fitness Reduction
Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr	Folsom/Nimbus releases – flow fluctuations	Redd dewatering and isolation prohibiting successful completion of spawning	Reduced reproductive success
Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr.	Nimbus Hatchery – hatchery *O. mykiss* spawning with natural-origin steelhead	Reduced genetic diversity. Garza and Pearse (2008) showed that genetic samples from the population spawning in the river and the hatchery population were "extremely similar".	Reduced genetic diversity
Embryo incubation Primarily upstream of Watt Ave. area	Late-Dec - May	Water temperatures warmer than life stage requirements, particularly occurring upstream of Watt Ave. in April and May	Sub-lethal effects - reduced early life stage viability; direct mortality; restriction of life history diversity (i.e., directional selection against eggs deposited in Mar. and Apr.)	Reduced survival
Embryo incubation Primarily upstream of Watt Ave. area	Late-Dec. - May	Folsom/Nimbus releases – flow fluctuations	Redd dewatering and isolation. Hannon *et al.* (2003) reported that 5 steelhead redds were dewatered and 10 steelhead redds were isolated at the lower Sunrise side channel when Nimbus Dam releases were decreased on February 27, 2003. When releases were decreased on March 17, 2003, seven steelhead redds were dewatered and five additional redds were isolated from flowing water at the lower Sunrise side channel. In April 2004 at the lower Sunrise side channel, five steelhead redds were dewatered and "many" redds were isolated (Water Forum 2005a). Redd dewatering at Sailor Bar and Nimbus Basin occurred in 2006 (Hannon and Deason 2008).	Reduced survival

Life Stage/ Location	Life Stage Timing	Stressor	Response	Probable Fitness Reduction
Juvenile rearing Primarily upstream of Watt Ave. area	Year-round	Folsom/Nimbus releases – flow fluctuations; low flows, particularly during late summer and early fall	Fry stranding and juvenile isolation; low flows limiting the availability of quality rearing habitat including predator refuge habitat	Reduced survival
Juvenile rearing Primarily upstream of Watt Ave. area	Year-round	Water temperatures warmer than life stage requirements, particularly occurring upstream of Watt Ave. during June through September	Physiological effects - increased susceptibility to disease (e.g., anal vent inflammation) and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures at Watt Avenue from August through September were warmer than 65°F for approximately 81 percent of the days, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 30a). Under a drier and warmer climate change scenario (Study 9.5), modeled water temperatures at Watt Avenue from June through September under full build out of the proposed Project range from 65°F to 82°F (Reclamation 2009). Even if no regional climate change is assumed (Study 9.1), water temperatures at this location during this time period are expected to range from 63°F to 79°F.	Reduced growth; Reduced survival
Smolt emigration Throughout entire river	Jan. - Jun.	Water temperatures warmer than life stage requirements, particularly occurring downstream of Watt Ave. during March through June	Physiological effects – reduced ability to successfully complete the smoltification process, increased susceptibility to predation	Reduced growth; Reduced survival

This effects analysis assumes that impacts on lower American River steelhead expected to occur with implementation of the proposed action will be similar to, or more severe than, the impacts associated with the recent past operations of the American River Division of the CVP. This assumption is reasonable because the proposed action includes the continued operation of the American River Division through 2030 to meet increasing water demands. From 2000 through 2006, annual water deliveries from the American River Diversion ranged from 196 TAF in 2000 to 297 TAF in 2005. In the CVP/SWP operations BA, present level water demands for the American River Division were modeled at 325 TAF per year and the 2030 water demands are modeled at nearly 800 TAF per year, an annual demand about 2.7 to 4.0 times higher than the annual deliveries from 2000 through 2006.

Although the CVP/SWP operations BA indicates that Reclamation intends to operate to a new flow management standard whenever additional b(2) water is available - a change in operations from the recent past - the major stressors included in this effects analysis associated with Folsom Reservoir operations are not expected to be minimized. That is, Reclamation's conditional implementation of the new flow management standard, whenever additional b(2) water is available [see table 2-3 for NMFS' assumption on b(2)], is not expected to reduce water temperature-related or flow fluctuation impacts.

The CVP/SWP operations BA states that the "*project description…is consistent with the proposed flow management standard*." Based on the information provided in the CVP/SWP operations BA, it is unclear whether Reclamation intends to achieve this consistency by adhering to the water temperature standards described in the flow management standard (Water Forum 2004):

- "*Reclamation shall operate Folsom Dam and Reservoir and Nimbus Dam to meet daily average water temperatures of 60ºF or less, striving to achieve 56°F or less as early in the season as possible, in the lower American River at Watt Avenue from October 16 through December 31 for fall-run Chinook salmon spawning and egg incubation; and*

- *Reclamation shall operate Folsom Dam and Reservoir and Nimbus Dam to maintain daily average water temperatures that do not exceed 65°F in the lower American River at Watt Avenue from June 1 through October 15 for juvenile steelhead over-summer rearing*."

Reclamation does not identify lower American River water temperature standards, objectives, or targets in the CVP/SWP operations BA. NMFS assumes that, even if Reclamation intends to do so, they will not achieve the water temperature standards described in the flow management standard with implementation of the proposed action because: (1) the availability of b(2) water that would allow Reclamation to "*operate to the proposed flow management standard*" is uncertain (see general assumption in section 2.4.3); (2) operational (*e.g*., Folsom Reservoir operations to meet Delta water quality objectives and demands and deliveries to M&I users in Sacramento County) and structural (*e.g*., limited reservoir water storage and coldwater pool) factors not associated with the flow management standard limit the availability of coldwater for water temperature management; (3) in most years since the late 1990s, Reclamation has not achieved the temperatures specified in the flow management standard (see section 6.4.3.2 Water

Temperature below); and (4) annual water demands for full build-out (year 2030) of the proposed action are expected to substantially increase from present day levels, which will likely further constrain lower American River water temperature management.

6.4.3.1 Folsom/Nimbus Releases

Releases from Folsom Dam are re-regulated approximately 7 miles downstream by Nimbus Dam. Releases from Nimbus Dam to the American River affect the quantity and quality of steelhead habitat (Water Forum 2005a, CDFG 2001), water quality, water temperature, and entrainment[13]. Water quality can affect steelhead embryo incubation if Nimbus Dam releases are too low to flush silt and sediment from redds (Lapointe *et al.* 2004, Greig *et al.* 2005, Levasseur *et al.* 2006). Conversely, if instream flows are too high, scour and increased sedimentation could result in egg mortality (Kondolf *et al.* 1991). Steelhead egg and alevin mortality associated with high flows in the American River has not been documented, although flows high enough to mobilize spawning gravels do occur during the spawning and embryo incubation periods (*i.e.*, late-December through early-April).

As described in the CVP/SWP operations BA, Ayres Associates (2001) indicated that spawning bed materials in the lower American River may begin to mobilize at flows of 30,000 cfs, with more substantial mobilization occurring at flows of 50,000 cfs or greater. Flood frequency analysis for the American River at Fair Oaks gauge shows that, on average, flood control releases will exceed 30,000 cfs about once every 4 years and exceed 50,000 cfs about once every 5 years (CVP/SWP operations BA). During flood control releases made in January 1997, considerable morphological changes occurred in the American River, including streambed alterations at several salmonid spawning sites that caused redd scouring (USFWS 2003a).

Releases from Folsom Reservoir, are made, in part, for flood control and to meet Delta water quality objectives and demands. These operations can result in release events during the winter and spring that are characterized by rapid flow increases for a period of time followed by rapid flow decreases. A few examples of these types of flow fluctuations can be seen in the Nimbus Dam release pattern, which occurred in 2004 (figure 6-24).

Flow fluctuations in the lower American River have been documented to result in steelhead redd dewatering and isolation (Hannon *et al*. 2003, Water Forum 2005, Hannon and Deason 2008). Redd dewatering can affect salmonid embryos and alevins by impairing development and causing direct mortality due to desiccation, insufficient oxygen levels, waste metabolite toxicity, and thermal stress (Becker *et al.* 1982, Reiser and White 1983). Isolation of redds in side channels can result in direct mortalities due to these factors, as well as starvation and predation of emergent fry. Hannon *et al*. (2003) reported that five steelhead redds were dewatered and 10 steelhead redds were isolated in a backwater pool at the lower Sunrise side channel when

[13] In general, a positive relationship exists between upstream reservoir releases (*e.g.*, Folsom Reservoir) and the volume of water exported from the Delta through the Jones and Banks pumping plants (SWRCB 2000). Because a positive relationship between water exported from these pumping plants and juvenile salmonid entrainment has also been reported (Kimmerer 2008), it is reasonable to assume that releases from Nimbus Dam likely contribute to the entrainment of juvenile salmonids in the Delta, including American River steelhead. Additionally, some level of entrainment may occur in the lower American River, but it is not believed to be a major stressor to steelhead and will not be further discussed in this effects analysis.

Nimbus Dam releases were decreased on February 27, 2003. When releases were decreased on March 17, 2003, seven steelhead redds were dewatered and five additional redds were isolated from flowing water at the lower Sunrise side channel. In April 2004 at the lower Sunrise side channel, five steelhead redds were dewatered and "*many*" redds were isolated (Water Forum 2005a). Redd dewatering at Sailor Bar and Nimbus Basin occurred in 2006, with most of the redds being identified as Chinook salmon redds, at least one was positively identified as a steelhead redd, and several more redds were of unknown origin (Hannon and Deason 2008) (figure 6-25).

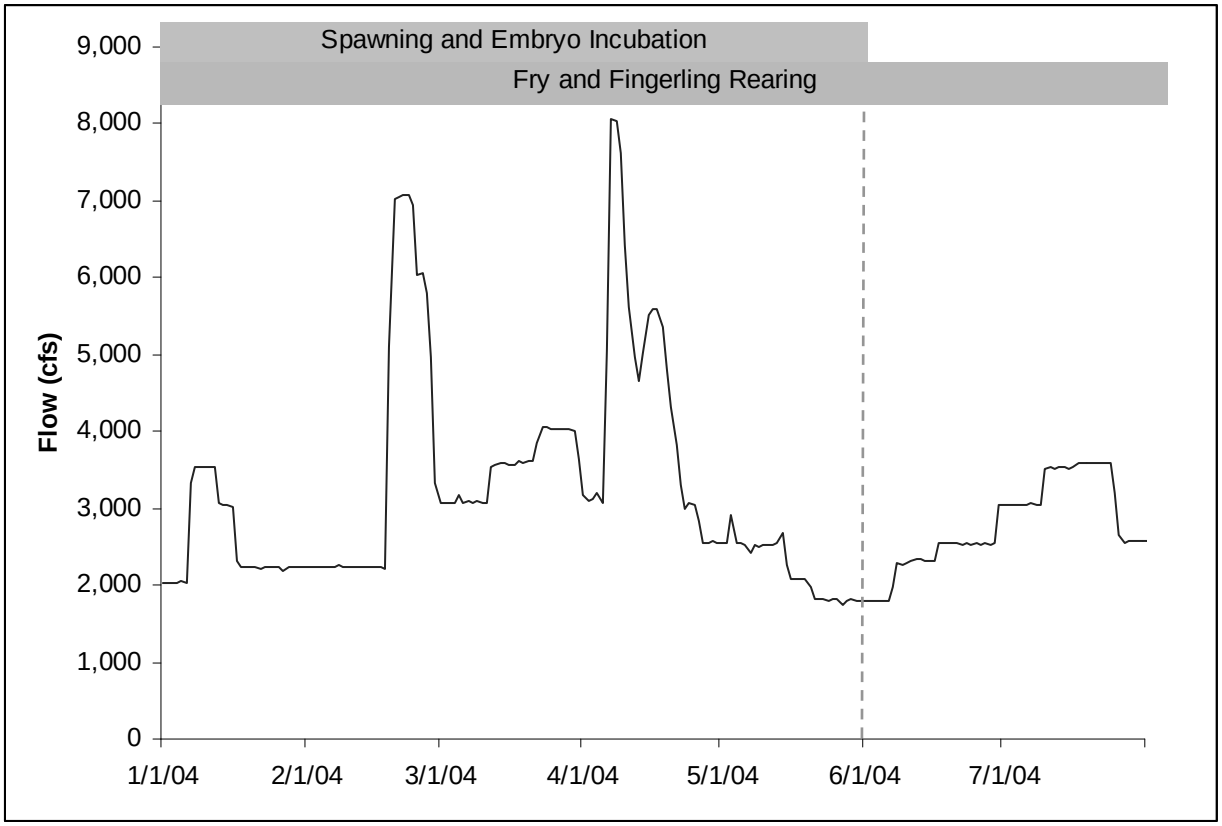


Figure 6-24. Mean daily release rates from Nimbus Dam in January through July of 2004. The timing of the steelhead life stages that are most vulnerable to flow fluctuations during these months are displayed.

Although reports of steelhead redd dewatering and isolation in the American River are limited to 2003, 2004, and 2006, these effects have likely occurred in other years because: (1) the pattern of high releases followed by lower releases which occurred during the steelhead spawning period (*i.e.*, primarily January through March) in 2003, 2004, and 2006, is similar to the pattern observed during the spawning period in many other years [CDEC data (http://cdec.water/ca/gov/) from 1994 through 2007]; and (2) monitoring was not conducted during many release events and, consequently, impacts were not documented. Impacts associated with flow fluctuations are expected to continue to occur with implementation of the proposed project through 2030 because changes from past operations that would address this stressor were not identified in the project description

Juvenile steelhead isolation has also been reported to occur in the lower American River. For example, Water Forum (2005a) reported that juvenile steelhead became isolated from the river channel in both 2003 and 2004 following a flow increase and decrease event associated with meeting Delta water quality objectives and demands (Water Forum 2005a).

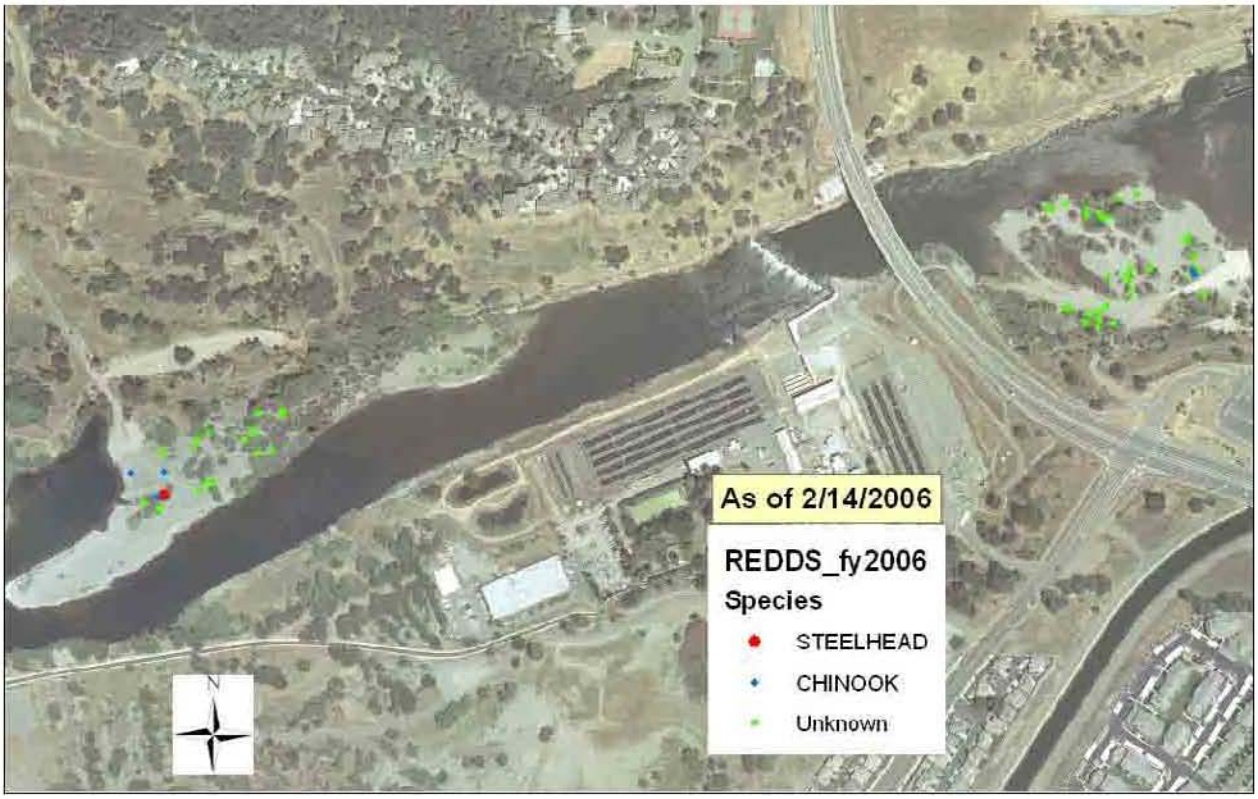


Figure 6-25. Dewatered redds at Nimbus Basin and Sailor Bar, February 2006 (figure was modified from Hannon and Deason 2008).

In addition to flow fluctuations, low flows also can negatively affect lower American River steelhead. Yearling steelhead are found in bar complex and side channel areas characterized by habitat complexity in the form of velocity shelters, hydraulic roughness elements, and other forms of cover (SWRI 2001). At low flow levels, the availability of these habitat types becomes limited, forcing juvenile steelhead densities to increase in areas that provide less cover from predation. With high densities in areas of relatively reduced habitat quality, juvenile steelhead become more susceptible to predation as well as disease. Exposure of juvenile steelhead to these low flow conditions is expected to continue to occur with implementation of the proposed Project through 2030."

6.4.3.2 Water Temperature

Water temperature is perhaps the physical factor with the greatest influence on American River steelhead. Water temperature directly affects survival, growth rates, distribution, and developmental rates. Water temperature also indirectly affects growth rates, disease incidence, predation, and long-term survival (Myrick and Cech 2001). Water temperatures in the lower American River are a function of the timing, volume, and temperature of water being released

from Folsom and Nimbus dams, river distance, and environmental heat flux (Bartholow 2000). Thus, water temperatures in the lower American River are influenced by proposed action operations.

Myrick and Cech (2001) examined the effects of water temperature on steelhead (and Chinook salmon) with a specific focus on Central Valley populations and reported that steelhead egg survival declines as water temperature increases past 50°F. In a summary of technical literature examining the physiological effects of temperature on anadromous salmonids in the Pacific Northwest, EPA (2001) reported that steelhead egg and alevin survival would decline with exposure to constant water temperatures above 53.6°F. Although supporting references were not provided, the CVP/SWP operations BA states that: *"Temperatures of 52°F or lower are best for steelhead egg incubation. However temperatures less than 56 F are considered suitable."* Rombough (1988) as cited in EPA (2001) found less than four percent embryonic mortality of steelhead incubated at 42.8, 48.2, and 53.6°F, but noted an increase to 15 percent mortality at 59°F. In this same study, alevin mortality was less than five percent at all temperatures tested, but alevins hatching at 59°F were considerably smaller and appeared less well developed than those incubated at the lower test temperatures.

In a recent laboratory study examining survival and development of steelhead eggs incubated at either 46.4°F or 64.4°F, Turner *et al*. (2007) found that eggs incubated at the higher temperature experienced higher mortality, with 100 percent mortality of eggs from one of three treatments at the higher temperature. Also, those fish incubated at the higher temperature that did survive exhibited greater structural asymmetry than fish incubated at the lower temperature. Similar to Turner *et al.* (2007), Myrick and Cech (2001) reported an increase in physical deformities in steelhead that were incubated at higher water temperatures. Structural asymmetry has been negatively correlated with fitness in rainbow trout (Leary *et al.* 1984).

Based on the thermal requirements reported above and the temporal distribution of steelhead egg incubation (*i.e*., January through May), some level of egg mortality and/or reduced fitness of those individuals that survive is expected with exposure to the water temperatures that are expected to occur with implementation of the proposed action. For example, mean water temperatures at Watt Avenue from 1999 through 2008 ranged from about 48°F to 54°F in March, 50°F to 59°F in April, and 56°F to 64°F in May (figure 6-26).

Modeled water temperatures also demonstrate that steelhead eggs will be exposed to stressful conditions with implementation of the proposed action. Exceedence plots of water temperatures near Sunrise are expected to always be at or above 50°F during March, April, and May (figures 6-27, 6-28, and 6-29). Water temperatures during these months are expected to be over 54°F for about 30, 95, and 100 percent of the cumulative water temperature distribution, respectively; water temperatures are expected to be above 56°F for about 10, 70, and 100 percent. During the warmest 10 percent of the cumulative water temperature distribution during April and May, water temperatures are expected to exceed 62°F and 66°F, respectively. It is important to note that these modeled water temperature results do not incorporate effects of climate change.

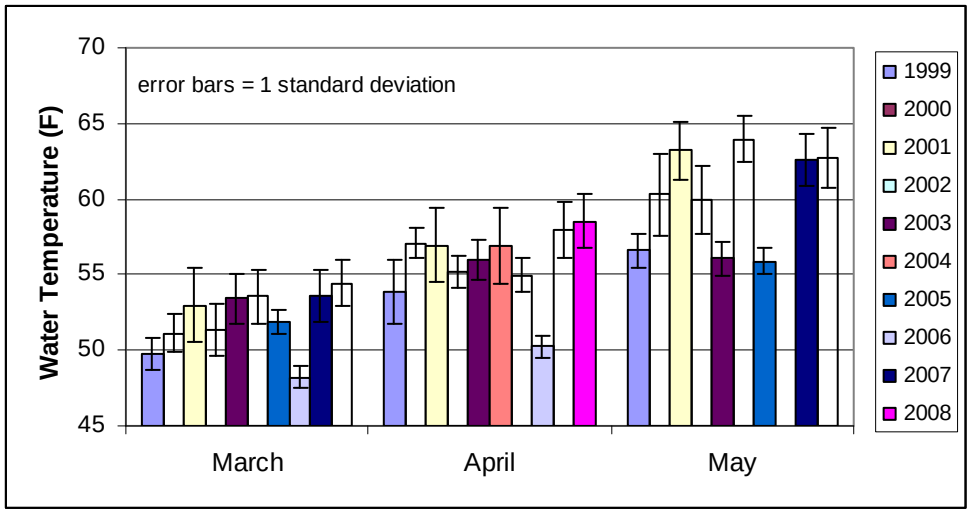


Figure 6-26. Lower American River water temperature during March, April, and May from 1999 through 2008 represented as the mean of the daily average at the Watt Avenue gage (Original data were obtained from http://cdec.water.ca.gov/).

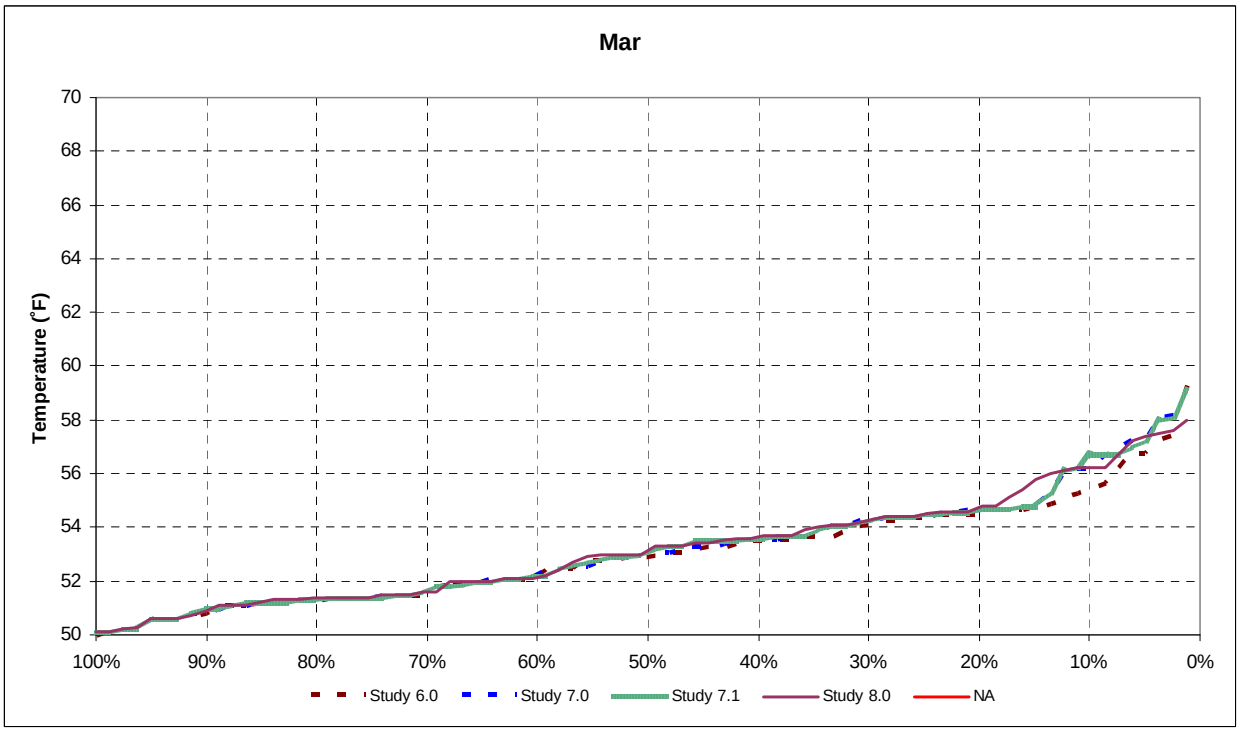


Figure 6-27. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during March (CVP/SWP operations BA appendix I).

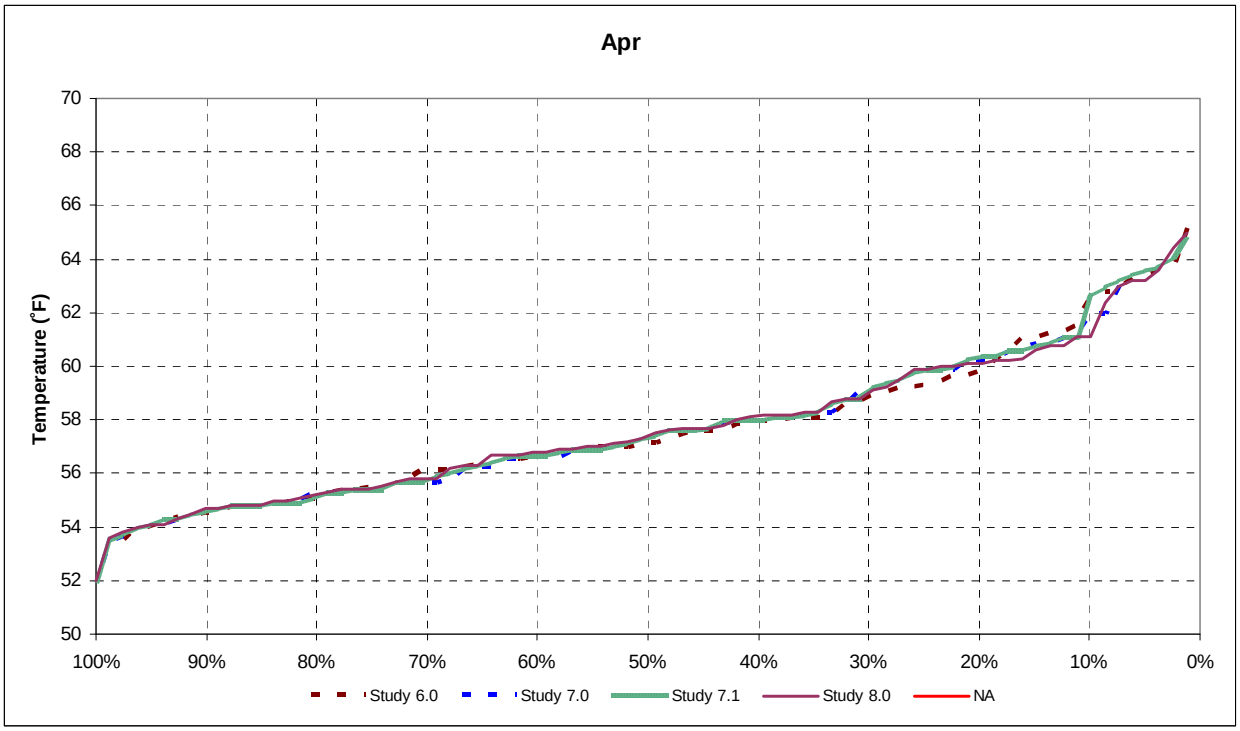


Figure 6-28. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during April (CVP/SWP operations BA appendix I).

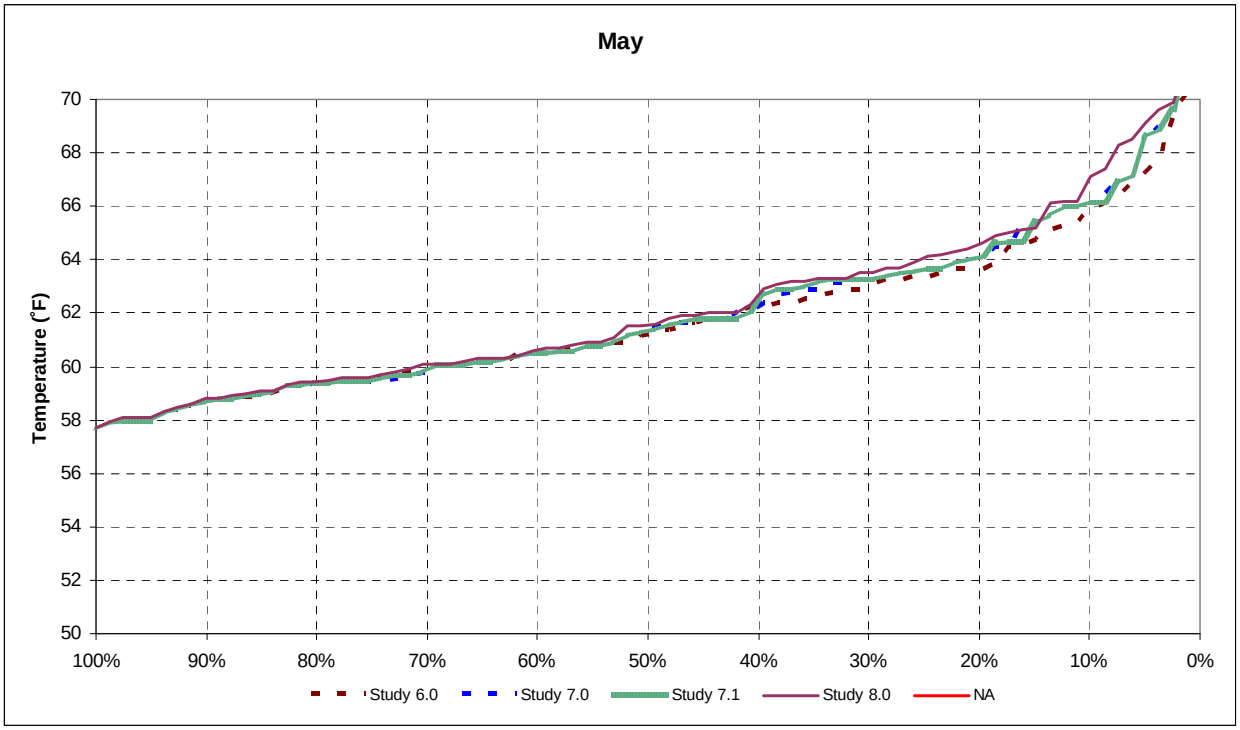


Figure 6-29. Exceedence plot of modeled water temperatures in the lower American River near the Sunrise area during May (CVP/SWP operations BA appendix I).

For the purposes of this analysis, NMFS assumes that climate change could account for a 1-3°F increase in water temperatures within the time frame of the proposed action (see Appendix R of the CVP/SWP operations BA). If this level of warming occurs, mean water temperatures in the lower American River could range from about 51°F to 57°F in March, about 53°F to 62°F in April, and 59°F to 67°F in May (figure 6-30). Under these conditions, higher egg mortality and increased fitness consequences would occur for steelhead eggs and alevins that were spawned later in the spawning season (*e.g.*, spawned in March rather than January). This selective pressure towards earlier spawning and incubation would truncate the temporal distribution of spawning, resulting in a decrease in population diversity, and consequently a likely decrease in abundance.

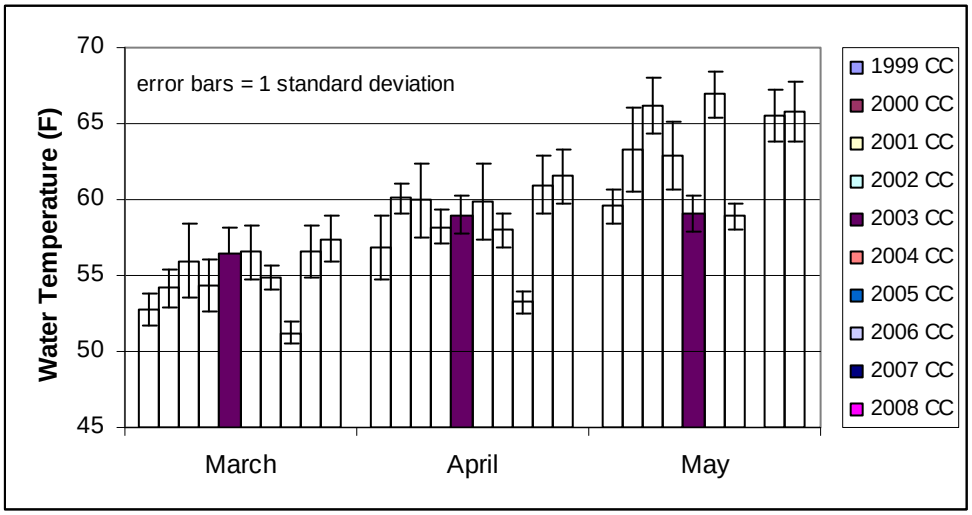


Figure 6-30. Lower American River water temperature during steelhead from 1999 through 2008 represented as the mean of the daily average at the Watt Avenue gage plus 3°F to incorporate potential climate change effects (see Key Assumptions in section 2). Years are labeled in the legend with "CC" to denote the intended application of this figure as an analysis of climate change effects. Original data were obtained from http://cdec.water.ca.gov/.

High water temperatures are a stressor to juvenile rearing steelhead in the American River, particularly during the summer and early fall. Unfortunately, assessing the response of American River steelhead juveniles to water temperatures is not straightforward, as no studies of the effects of temperature on Central Valley juvenile steelhead have yet been published in the primary literature (Myrick and Cech 2004). Myrick and Cech (2004) state that, "*The scarcity of information on the effects of temperature on the growth of juvenile steelhead from central valley systems is alarming, and should be rectified as quickly as possible.*"

The available information suggests that American River steelhead may be more tolerant to high temperatures than steelhead from regions further north (Myrick and Cech 2004). Cech and Myrick (1999) reported that when American River steelhead were fed to satiation at constant temperatures of 51.8°F, 59.0°F, and 66.2°F, growth rates increased with temperature, whereas Wurtsbaugh and Davis (1977) found that maximal growth of juvenile steelhead from North Santiam River in Oregon occurred at a cooler temperature (*i.e.*, 62.6°F). Both of these studies were conducted in a controlled laboratory setting with unlimited food availability. Under more

variable conditions, such as those experienced in the wild, the effect of water temperature on juvenile steelhead growth would likely be different.

Even with this tolerance for warmer water temperatures, steelhead in the American River exhibit symptoms of thermal stress. For example, the occurrence of a bacterial-caused inflammation of the anal vent (commonly referred to as "rosy anus") of American River steelhead has been reported by CDFG to be associated with warm water temperatures (figure 6-31). Sampling in the summer of 2004 showed that this vent inflammation was prevalent in steelhead throughout the river and the frequency of its occurrence increased as the duration of exposure to water temperatures over 65°F increased. At one site, the frequency of occurrence of the anal vent inflammation increased from about 10 percent in August, to about 42 percent in September, and finally up to about 66 percent in October (Water Forum 2005a).

Figure 6-31. Anal vent inflammation in a juvenile steelhead from the American River (Water Forum 2005a).

The juvenile steelhead immune system properly functions up to about 60°F, and then is dramatically compromised as water temperatures increase into the upper 60°Fs (Water Forum 2005a). CDFG reports that, in 2004, the anal vent inflammation occurred when juvenile steelhead were exposed to water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures during the summer at Watt Avenue were most often above 65°F, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 6-32a).

If the assumed effects of climate change (*i.e.*, a 1°F to 3°F increase in water temperatures) are applied to these data, water temperatures would be even more stressful for juvenile steelhead (figure 6-32b), with levels over 65°F throughout August and September in all years if temperatures increase by 3°F (figure 6-32c). Figures 6-32a, b, and c are likely conservative general representations of the range of summer water temperatures that are expected with

implementation of the proposed action given that annual water demands from 2000 through 2006 ranged from 196 TAF in 2000 to 297 TAF in 2005 and under full build-out conditions in 2030 annual water demands are modeled in the CVP/SWP operations BA to be 800 TAF.

Based on water temperature modeling results presented in the CVP/SWP operations BA, water temperatures associated with visible symptoms of thermal stress in juvenile steelhead (*i.e*., >65°F) are expected to occur from June through September with implementation of the propose Project. Exceedence plots of monthly water temperatures at Watt Avenue show that temperatures are expected to be at or above 65°F for about 70 percent of the cumulative distribution in June, 100 percent in July and August, and about 95 percent in September (figures 6-33 and 6-34). It should be noted that the modeled water temperatures presented in figures 6-33 and 6-34 are monthly estimates, which do not capture diurnal variation. As such, NMFS assumes that with the continued implementation of the proposed action, juvenile steelhead will be exposed to daily mean and maximum temperatures warmer than those presented in these figures. This is significant, as the monthly estimates during the warmest conditions in July and August are approaching the lethal limits (~77.0 °F) of Nimbus Fish Hatchery steelhead under laboratory conditions (Myrick and Cech 2004).

To successfully complete the parr-smolt transformation, a physiological and morphological adaptation to life in saline water, steelhead require cooler water temperatures than for the rearing life stage. Adams *et al*. (1975) reported that steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at warmer water temperatures. In a report focusing on the thermal requirements of Central Valley salmonids, Myrick and Cech (2001) came to a similar conclusion stating that steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range. Others have suggested that water temperatures up to about 54°F will allow for successful steelhead smoltification (Zaugg *et al*. 1972, Wedemeyer *et al.* 1980, EPA 2001).

Steelhead smolt emigration in the American River occurs from January through June (SWRI 2001). Monitoring data from 1999 through 2008 showed that lower American River water temperatures frequently exceeded 52°F by March and exceeded 54°F in all but 2 years by April (figure 6-26). Based on the thermal requirements for steelhead smolts described above, smolt transformation is likely inhibited by exposure to lower American River water temperatures. With increased warming associated with climate change, it is likely that by March steelhead parr will not be able to successfully transform to smolts in the American River (figure 6-30).

Modeled water temperatures demonstrate that even without warming associated with climate change, the proposed action is expected to result in conditions that will inhibit the successful transformation from parr to smolts. For example, exceedence plots show that water temperatures at Watt Avenue will be warmer than 54°F for 30 percent of the cumulative water temperature distribution during March (figure 27) and for 95 percent of the distribution in April (figure 6-28). By May water temperatures are expected to nearly always be warmer than about 58°F (figure 6-29) and in June modeling results suggest that they will always be over 62°F (figure 6-33a).

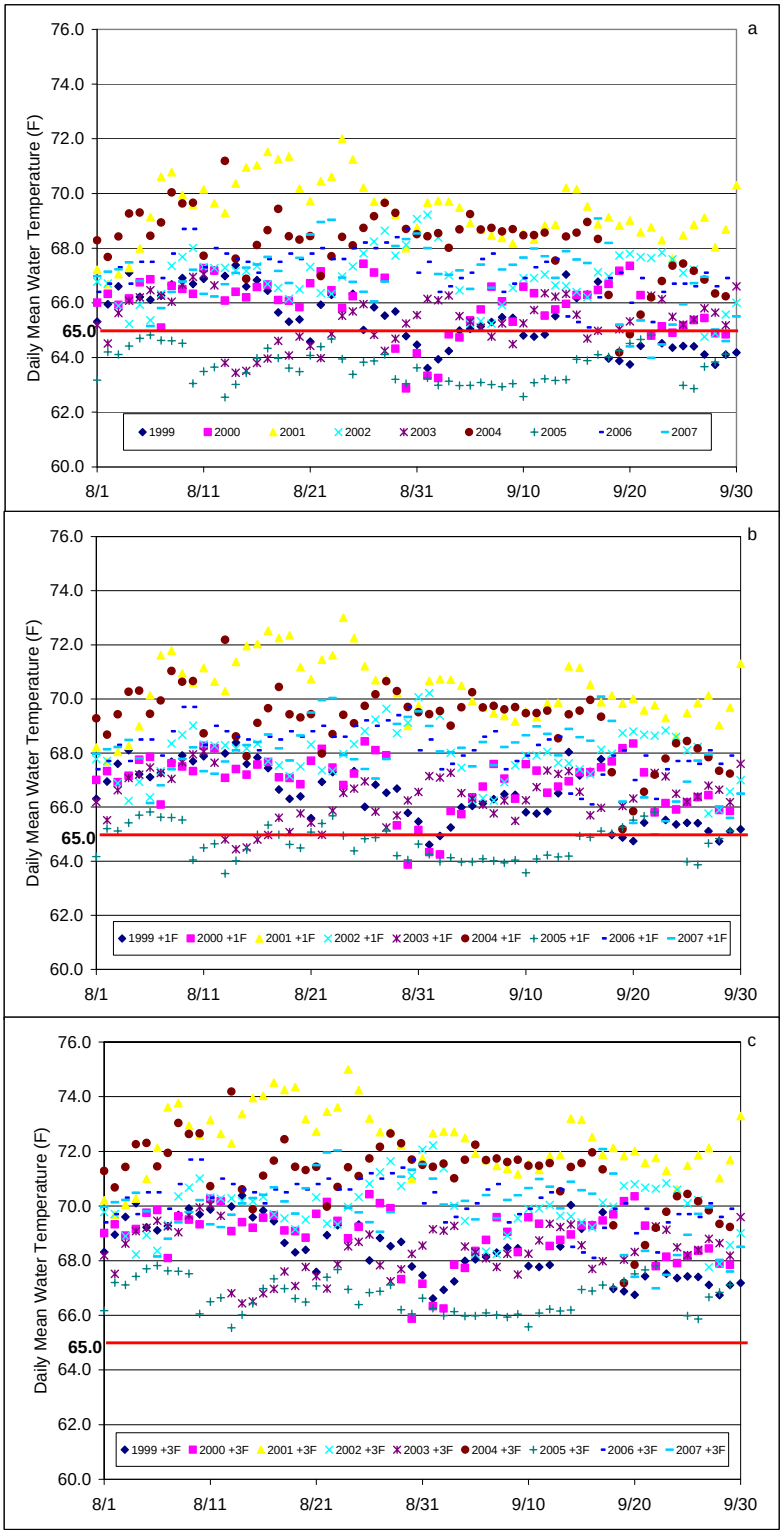


Figure 6-32 a, b, and c. Lower American River water temperature during August and September from 1999 through 2007 represented as the daily mean at the Watt Avenue gage (a). Figures b and c show these same water temperatures plus 1°F and 3°F, respectively, to incorporate potential climate change effects (see Key Assumptions in Chapter 2). The 65°F line is indicated in red because visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F. Data were obtained from http://cdec.water.ca.gov/.

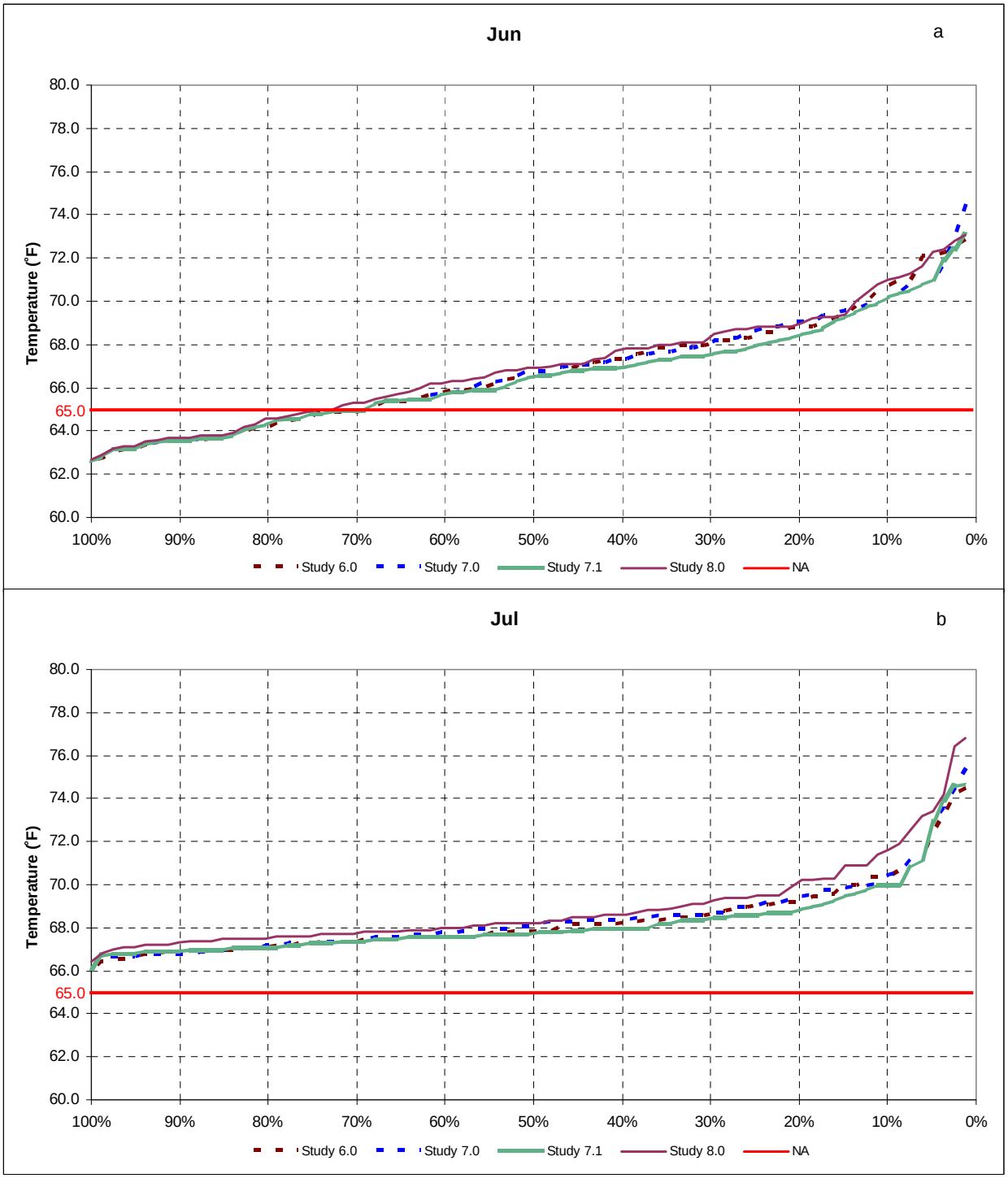
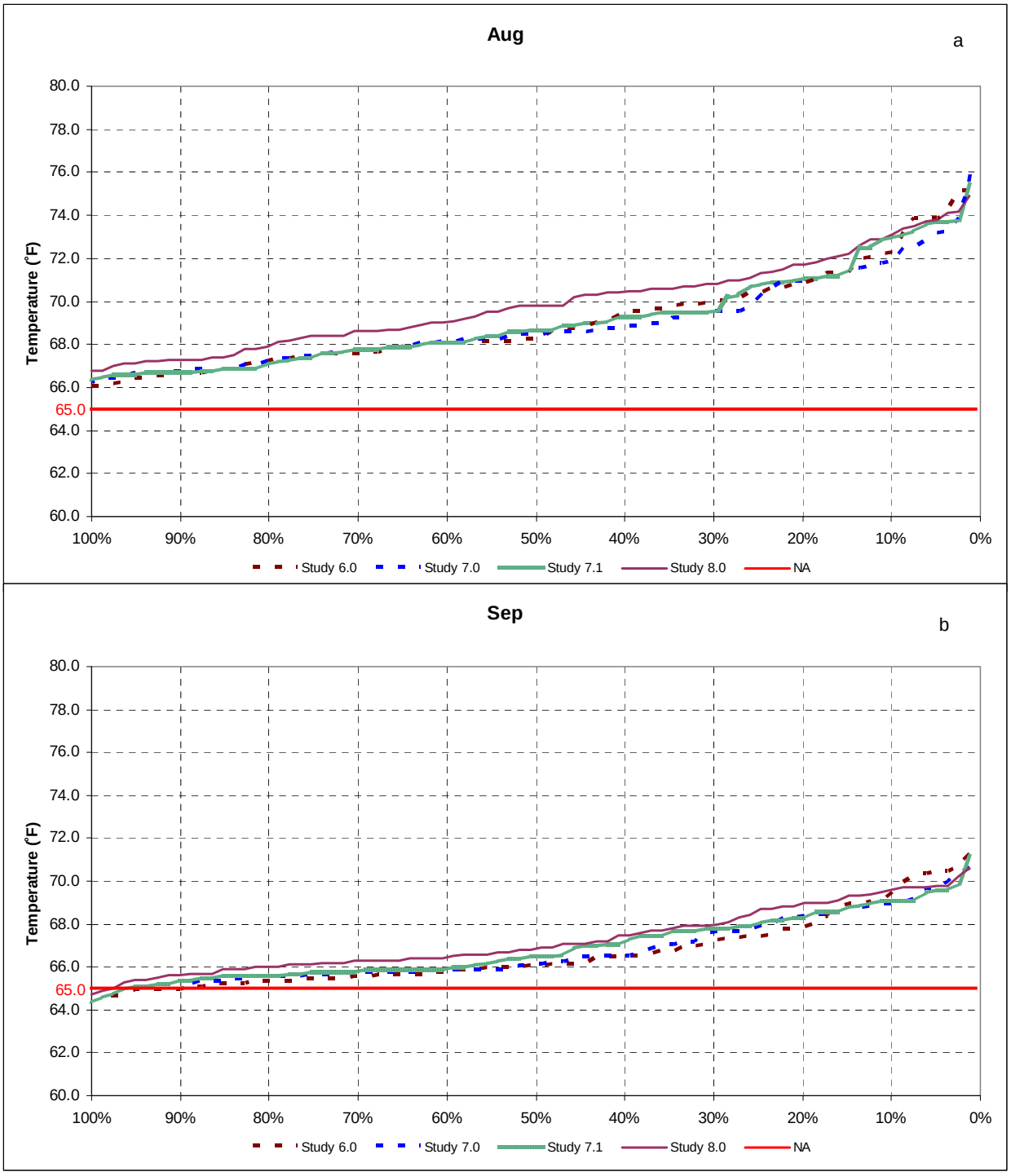


Figure 6-33a and b. Exceedence plots of modeled water temperatures in the lower American River near Watt Avenue during June (a) and July (b) (CVP/SWP operations BA figures 10-114 and 10-115, respectively). For this analysis, the 65°F line was added in red because visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F.



Figures 6-34a and b. Exceedence plots of modeled water temperatures in the lower American River near Watt Avenue during August (a) and September (b) (CVP/SWP operations BA figures 10-116 and 10-117, respectively). For this analysis, the 65°F line was added in red because visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F.

6.4.3.3 Predation

As described in Water Forum (2005a), Folsom Reservoir is commonly operated to meet water quality objectives and demands in the Delta. These operations limit coldwater pool availability in Folsom Reservoir, thereby potentially resulting in elevated water temperatures in the lower American River, which likely results in increased predation rates on juvenile rearing steelhead. According to CDFG (2005 *op. cit*. Water Forum 2005a), water temperatures above 65°F are associated with a large (*i.e*., 30-40 species) complex warmwater fish community, including highly piscivorous fishes such as striped bass (*Morone saxatilis)*, largemouth bass (*Micropterus salmoides*), and Sacramento pikeminnow (*Ptychocheilus grandis*). Juvenile rearing steelhead may be exposed to increased predation due to both increased predator abundance and increased digestion and consumption rates of these predators associated with higher water temperature (Vigg and Burley 1991, Vigg *et al*. 1991).

Some striped bass reportedly reside in the lower American River year-round, although their abundance greatly increases in the spring and early summer as they migrate into the river at roughly the same time that steelhead are both emerging from spawning gravels as vulnerable fry and migrating out of the river as smolts (SWRI 2001). Striped bass are opportunistic feeders, and almost any fish or invertebrate occupying the same habitat eventually appears in their diet (Moyle 2002). Empirical data examining the effect of striped bass predation on steelhead in the American River have not been collected, although one such study was recently conducted in the Delta (DWR 2008). Results of this study concluded that steelhead of smolt size had a mortality rate within Clifton Court Forebay that ranged from 78 ± 4 percent to 82 ± 3 percent over the various replicates of the study. The primary source of mortality to these steelhead is believed to be predation by striped bass. Although Clifton Court Forebay and the lower American River are dramatically different systems, this study does demonstrate that striped bass are effective predators of relatively large-sized steelhead. Considering that striped bass are abundant in the lower American River during the spring and early summer (SWRI 2001), when much of the steelhead initial rearing and smolt emigration life stages are occurring, striped bass predation on juvenile steelhead is considered to be a very important stressor to this population. Although predation by striped bass is considered a baseline stressor, the proposed action is expected to exacerbate the stressor. As described above, low releases from Nimbus Dam force juvenile steelhead into areas that provide less cover from predation.

6.4.3.4 Nimbus Fish Hatchery

The Nimbus Fish Hatchery stock is not part of the CV steelhead DPS, and its impacts to the natural American River population include both genetic and behavioral effects (Myers *et al*. 2004). As described in Pearsons *et al*. (2007), the selective pressures in hatcheries are dramatically different than in the natural environment, which can result in genetic differences between hatchery and wild fish (Weber and Fausch 2003), and subsequently differences in behavior (Metcalfe *et al*. 2003). Early Nimbus Fish Hatchery broodstock included naturally-produced fish from the American River and stocks from the Wahougal (Washington), Siletz (Oregon), Mad, Eel, Sacramento and Russian Rivers, with the Eel River stock being the most heavily used (Staley 1976, McEwan and Jackson 1996).

There is additional concern regarding the effects of Nimbus Fish Hatchery on naturally-spawned steelhead. Analysis of genotype data collected from 18 highly variable microsatellite molecular markers from adult *O. mykiss* entering Nimbus Fish Hatchery showed that over one third of the fish were identified as hatchery rainbow trout (Garza and Pearse 2008). NMFS does not know whether these trout were used as broodstock for steelhead production, although they could have been, considering that there was overlap in length between the trout and steelhead that entered the hatchery. Garza and Pearse (2008) state that, "*Integration of these trout into steelhead production is likely to have a number of detrimental effects, because of their reduced genetic variation, genetic predisposition against anadromy and past hatchery selection pressures*." The authors also suggest that Nimbus Fish Hatchery operations may have affected the genetic integrity of other Central Valley populations:

> "*Since Eel River origin broodstock were used for many years at Nimbus Hatchery on the American River, it is likely that Eel River genes persist there and have also spread to other basins by migration, and that this is responsible for the clustering of the below-barrier populations with northern California ones. This, in combination with the observation of large numbers of hatchery rainbow trout entering Nimbus Hatchery and potentially spawning as steelhead, suggest that the below-barrier populations in this region appear to have been widely introgressed by hatchery fish from out of basin broodstock sources* (Garza and Pearse 2008)."

6.4.4 Assess Risk to Individuals

Based on the responses of steelhead exposed to the proposed action described above, fitness consequences to individuals include reduced reproductive success during spawning, reduced survival during embryo incubation, reduced survival and growth during juvenile rearing, and reduced survival and growth during smolt emigration (see table 6-12).

6.4.5 Effects of the Action on CV Steelhead Designated Critical Habitat in the American River Division

The lower American River is designated critical habitat for CV steelhead. The PCEs of critical habitat in the lower American River include freshwater spawning sites, freshwater rearing areas, and freshwater migration corridors. This analysis on the effects of the proposed action on steelhead critical habitat is based on information presented in preceding sections regarding its effects on CV steelhead, and are summarized below as they relate to the PCEs of critical habitat.

Spawning and rearing PCEs in the American River are expected to be negatively affected by flow and water temperature conditions associated with the proposed action. High flows during flood control operations can negatively affect steelhead spawning habitat by mobilizing gravels. Spawning bed materials in the lower American River may begin to mobilize at flows of 30,000 cfs, with more substantial mobilization occurring at flows of 50,000 cfs or greater (CVP/SWP operations BA, Ayres Associates 2001). Flood frequency analysis for the American River at Fair Oaks gauge shows that, on average, flows will exceed 30,000 cfs about once every 4 years and exceed 50,000 cfs about once every 5 years (CVP/SWP operations BA).

Rearing habitat in the lower American River is negatively affected by flow fluctuations, which can result in redd dewatering and isolation, fry stranding, and juvenile isolation. Additionally, steelhead egg incubation and juvenile rearing habitat quality is expected to be reduced by the occurrence of warm water temperatures. These relatively warm water temperatures also increase susceptibility of juvenile steelhead to predation due to both increased predator abundance and increased digestion and consumption rates of these predators associated with higher water temperature (Vigg and Burley 1991, Vigg *et al*. 1991).

Freshwater migration corridors also are PCEs of critical habitat. They are located downstream of spawning habitat allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat conditions for steelhead smolt emigration are expected to be impaired with implementation of the proposed action, because of exposure to water temperatures that are too warm to allow for successful transformation from parr-to-smolt life stages.

Based on the above discussion, the conservation value of spawning, rearing, and migratory habitats are negatively affected as a result of the proposed action

6.5 East Side Division, New Melones Reservoir

Operational effects of dams on rivers and the species that live in them are multi-faceted and complex. This analysis focuses on key elements of Reclamation's operations of the New Melones Dam, and related dams of the East Side Division, that may affect particular life history stages of CV steelhead when they are in the Stanislaus River. CV steelhead are the only listed anadromous fish in the Stanislaus River.

6.5.1. Deconstruct the Action

The action elements analyzed for proposed operations of the East Side Division can be broken down into two general categories: management of proposed operational releases of water, and modification of the hydrograph of the lower Stanislaus River.

Dam operations typically alter the downstream hydrograph from the unimpaired hydrograph. The CVP/SWP operations BA is inconsistent regarding the current and proposed operations of New Melones Reservoir. The project description indicates that New Melones has been operating under an Interim Plan of Operations (IPO), although frequently, these operational criteria are not met. There are references to a New Melones Draft Transitional Operation Plan in CVP/SWP operations BA chapters 9 and 10, but no narrative description was provided. New Melones appears to be operated within the bounds of the fundamental operating criteria (project description starting on page 74), and the actual annual allocations are negotiated through a stakeholder group process. For modeling purposes, Reclamation selected a monthly flow allocation based on a look up table, which assumes a distribution of flows linked to an unspecified process. This is suitable to make some comparisons among model runs, but does not realistically assess operations. Consequently this analysis makes the following assumptions about the proposed New Melones operations:

1. Operations will continue to apply the fundamental operating criteria (appendix 1 to this Opinion, starting on page 74), which, as written, include poorly defined decision trees and adaptive management processes;
2. Poorly defined decision trees and adaptive management processes limit the utility of model runs to assess likely operational conditions;
3. Recent operations (10-20 years) reflect a pattern that closely resembles the IPO, although the CVP/SWP operations BA suggests that many operational criteria of the IPO were not met;
4. Future operations under the New Melones Transitional Operation Plan (NMTP) will reflect a pattern that closely resembles the IPO, except the only discernable difference appears to be that in Mid-Allocation years under the NMTP, if b(2) water is provided to fish, an equal amount is also provided to contract deliveries. The step change of these allocations is not described in the text of the CVP/SWP operations BA, but the model outputs are driven by a look-up table that sets monthly flow levels for 6 different scenarios in mid-allocation years;
5. Because (NMTP) operational criteria are not substantially different from IPO operational criteria, recent operational data are used to assess likely instream conditions, rather than relying on model outputs alone; and
6. The amount, timing, and duration of b(2) water, is not secured in any year, unless end of year storage exceeds 1.7 MAF (High Allocation Years).

6.5.2 Assess the Species Exposure

For the purposes of this analysis, "exposure" is defined as the temporal and spatial co-occurrence of a CV steelhead life stage and the stressors associated with the proposed action. A few steps are involved in assessing CV steelhead exposure. First, the CV steelhead life stages and associated timings are identified. The second step in assessing CV steelhead exposure is to identify the spatial distribution of each life stage. The last step is to overlay the temporal and spatial distributions of proposed action-related stressors on top of the temporal and spatial distributions of Stanislaus River CV steelhead. This overlay represents the completed exposure analysis and is described in table 6-19.

Table 6-19. Summary of proposed action-related effects on Stanislaus River steelhead.

Life Stage/ Location	Life Stage Timing	Stressor	Response	Probable Fitness Reduction
Adult Immigration Delta to Riverbank	Oct-Dec	Water temperatures warmer than life history stage requirements	Delayed entry into river; pre-spawn mortality; reduced condition factor	Reduced reproductive success; Reduced survival to spawn
Spawning Goodwin Dam to Riverbank	Dec-Feb	Unsuitable flows restrict spawnable habitat and dewater redds	Limited spawning habitat availability; egg mortality resulting from dewatered redds.	Reduced reproductive success
Spawning Goodwin Dam to Riverbank	Dec-Feb	Excessive fines in spawning gravel resulting from lack of overbank flow	Reduced suitable spawning habitat; For individual: increased energy cost to attempt to "clean" excess fine material from spawning site	Reduced reproductive success
Egg incubation and emergence Goodwin Dam to Riverbank	Dec-May	Excessive fines in spawning gravel resulting from lack of overbank flow	Egg mortality from lack of interstitial flow; egg mortality from smothering by nest-building activities of other CV steelhead or fall-run; suppressed growth rates	Reduced survival
Egg incubation and emergence Goodwin Dam to Riverbank	Dec-May	Water temperatures warmer than life history stage requirements	Egg mortality, Embryonic deformities	Reduced survival
Juvenile rearing Goodwin Dam to Riverbank	Year round	Contaminants (particularly dormant sprays) from land uses made possible by operations	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation; indirect: loss to predation; poor energetics; indirect stress effects.	Reduced growth rates; Reduced survival
Juvenile rearing Goodwin Dam to Riverbank	Year round	Lack of overbank flow to inundate rearing habitat	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Reduced growth rates; Reduced survival
Juvenile rearing Goodwin Dam to Riverbank	Year round	Reduction in rearing habitat complexity due to reduction in channel forming flows	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Reduced growth rates; Reduced survival

Juvenile rearing Goodwin Dam to Riverbank	Year round	Unsuitable flows for maintaining juvenile habitat	Crowding and density dependent effects relating to reduced habitat availability. Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Reduced growth rates; Reduced survival
Juvenile rearing and out-migration Stanislaus River	All year with increase Feb-May during out-migration	Predation by non-native fish predators because rearing habitat is lacking	Juvenile mortality; Reduced juvenile production	Reduced survival
Juvenile rearing Stanislaus River	Year round Jan-April (14 months)	End of summer water temperatures warmer than life history stage requirements	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Reduced growth rates; Reduced survival
Smoltification and emigration Stanislaus River at mouth	Jan. - Jun.	Water temperatures warmer than life history stage requirements (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress;	Reduced diversity.
Smolt emigration Stanislaus River	Jan. – Jun.	Suboptimal flow (March – June)	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection through Delta leading to increased residence time and higher risk of predation	Reduced survival; Reduced diversity

As information on CV steelhead in the San Joaquin River system is limited, we assume that CV steelhead life history timing is similar throughout the Central Valley streams, although timing for CV steelhead use on the Stanislaus River is used where known (figure 5-21 above). A map of the lower Stanislaus River and key reaches is presented in figure 5-20. The CV steelhead adult immigration life stage occurs throughout the entire lower Stanislaus River. Because CV steelhead are unable to reach their historical spawning areas above Goodwin Dam, they are dependent on East Side Division operations maintaining instream temperatures suitable for spawning below the dam where appropriate gravel and gradient conditions occur. No CV steelhead spawning surveys have been conducted on the Stanislaus River, but fall-run surveys indicate that spawning may occur from Goodwin Dam (RM 59) almost to the city of Riverbank (RM 33), with the highest use occurring above Knights Ferry (RM 55). During fall-run redd surveys in 1995, Mesick (2001) observed the highest fall-run redd density between Goodwin Dam and Knights Ferry (6 to 50 redds/riffle), an average of 5 redds/riffle from Knights Ferry to Orange Blossom Bridge (RM 47), and an average of less than 2 redds/riffle between Orange Blossom Bridge and Riverbank. Fall-run spawning use is a reasonable indicator of likely CV steelhead early spawning activity in mid-December to January as there is some overlap in spawning timing, more overlap in egg incubation timing, and the temperature requirements for egg incubation is comparable for both species. Based on observations of trout fry, most spawning occurs upstream of Orange Blossom Bridge (Kennedy and Cannon 2002). The juvenile life stage occurs throughout the entire river, with rearing generally occurring in the vicinity of the upstream areas used for spawning. Most juvenile CV steelhead are believed to migrate through the lower sections of the Stanislaus River into the San Joaquin River as smolts.

6.5.3 Assess the Species Response

Now that the exposure of Stanislaus River CV steelhead to the deconstructed action has been described, the next step is to assess how these fish are likely to respond to the proposed action-related stressors. In general, responses to stressors fall on a continuum from slight behavioral modifications to certain death. Life stage-specific responses to specific stressors related to the proposed action are described in detail in the following paragraphs and are summarized in table 6-19. There may be other project stressors acting on Stanislaus River CV steelhead than those identified in table 6-19. However, this effects analysis intends to identify and describe the most important project-related stressors to these fish.

This effects analysis assumes that impacts on CV steelhead in the Stanislaus River (figure 54-20) expected to occur with implementation of the proposed NMTP action will be similar to, or more severe than, the impacts associated with the East Side Division operations under the IPO to this point of consultation, which have occurred in the recent past (*e.g.*, within the last 10-28 years). This assumption is reasonable because the proposed action includes the continued operation of the East Side Division through 2030 to meet increasing water demands.

The future baseline of the existing dams prevents access to historical habitat, but the proposed operations of the dams control the quality and quantity of available alternative habitat below Goodwin Dam and the suitability of the physical conditions to support CV steelhead at various

life history stages. Survival of CV steelhead may be affected by operations of the East Side Division in the following ways:

- Operational releases control extent of cool water habitat available below Goodwin Dam.
- Operational release levels control the quantity and functionality of instream habitat for spawning, egg incubation, juvenile rearing and smoltification.
- Operational releases are typically lower than unimpaired flows, requiring smolting juveniles to expend more energy to outmigrate and lower stream velocities increase the exposure of juveniles and smolts to predation.

The proposed operation of the East Side Division modifies the hydrograph from the unimpaired flow pattern with which CV steelhead evolved. Such modifications may affect survival and critical habitat for CV steelhead in the following ways:

- Peak flood flows are dampened, reducing floodplain inundation and impairing rearing ability;
- Flow variability is muted, eliminating migratory cues that prompt migration and anadromy;
- Flow variability is muted, causing channel incision, reducing available rearing habitat, simplifying channel complexity and allowing land use encroachment into riverside habitats; and
- Channel forming flows are reduced or eliminated, resulting in fossilization of gravel bars and degradation of spawning habitat.

The proposed New Melones operations will create an altered hydrograph as compared to the unimpaired flows and as compared to the future baseline. The dampening of flood events and freshets eliminates the geomorphic processes that are important to CV steelhead to replenish and rejuvenate spawning riffles and to inundate floodplain terraces to provide nutrients and rearing habitat for juvenile salmonids. The Corps has limited controlled flood releases from New Melones Dam to 8,000 cfs. The dampening of flood events also eliminates or reduces the intensity and duration of freshets and storm flows that would otherwise convey smolting CV steelhead to the ocean and create a clear signature for the river. A more moderated hydrograph has eliminated periodic channel forming flows. The dams (a future baseline condition) capture sediment that would otherwise be transported downstream for geomorphic processes. Operations of the dams result in channel incision that further reduces the chance of inundated floodplain habitat and degrades spawning habitat quality. Releases from New Melones can affect downstream temperatures at critical times to affect adult migration, spawning, egg incubation success, juvenile survival and anadromy. Predicted increases in temperature as a result of climate change will affect instream water temperatures directly, and will affect New Melones operations as more precipitation will fall as rain, rather than snow, and as storm event intensity is expected to increase. Climate change may affect the types and cover rates of vegetation upslope of the river, potentially increasing the rate of fine sediment transport to the river and to spawning areas. Future baseline stressors that are exacerbated by the proposed East Side Division operations include increased vulnerability to non-native fish predators owing to flow velocities and downstream temperatures conducive to these species and competition from resident *O. mykiss*, which may be more abundant as a result of less variability in instream conditions.

6.5.3.1 Temperature Effects

Water temperature can be a stressor in the Central Valley floor segments of the rivers of the San Joaquin Basin, particularly in summer months. The literature and scientific basis for life stage related temperature requirements for CV steelhead are described in section 6.4.3.2. A summary of those requirements relevant to CV steelhead use of the Stanislaus River is presented in table 6-20.

Table 6-20. CV steelhead temperature requirements by life stage and probability of exceedance under proposed action at relevant locations on the Stanislaus River.

Life Stage and Temperature Requireiment (EPA 2003)	Criterion and Temperature Compliance Location	Probability of Exceedance Study 8					
Adult migration		Oct	Nov	Dec			
<64°F	Temperature below 64°F at Orange Blossom Bridge (OBB)	1%	0%	0%			
	Temperature below 64°F at Confluence	0%	0%	0%			
Smoltification		Jan	Feb	Mar	Apr	May	
<57°F or <52°F	Temperature below 52°F at Knights Ferry	0%	1%	17%	32%	60%	
	Temperature below 57°F at OBB	0%	0%	1%	1%	15%	
Spawning and incubation		Jan	Feb	Mar	Apr	May	
<55°F	Temperature Below 55°F at OBB	0%	0%	1%	5%	32%	
	Temperature Below 55°F at Riverbank	0%	2%	21%	46%	80%	
Juvenile rearing		Jun	Jul	Aug	Sept		
<61°F (early)	Temperature below 61°F at OBB	62%	80%	85%	75%		
<64°F (late)	Temperature below 65°F at OBB	4%	19%	14%	9%		

Modeled temperatures under the proposed action are likely to be suitable for adult CV steelhead migration into the Stanislaus River. Modeled temperatures indicate temperature exceedances for juvenile rearing, both early and late criteria, through most of the summer months at Orange Blossom Bridge. This can result in sublethal effects including increased susceptibility to disease, increased metabolic demands and poorer condition if food resources are not more available, as well as lethal effects. Cooler temperatures may be found further upstream and juveniles could conceivably move upstream. This would increase the net density in the upper reaches, resulting in increased crowding in available habitat, density dependent competition with resident *O. mykiss*, and increased risk of predation by adult resident *O. mykiss* and other predatory fishes. These factors would reduce the survival and fitness of juveniles CV steelhead.

The literature regarding appropriate criteria for smoltification is varied and suggests optimal temperatures of less than 52 °F (Adams *et al*. 1975, Myrick and Cech 2001) to less than 57°F

(EPA 2003). This life history stage is uniquely important for the expression of anadromy in *O. mykiss*. This analysis looked at the modeled likelihood of achieving 57°F or less at Orange Blossom Bridge, which is lower in the system, and of achieving 52°F or less at Knights Ferry where temperatures are typically cooler. The 52°F criterion at Knights Ferry is not achieved 17-60 percent of the time in the months of March through May. The warmer 57°F criterion is not achieved 15 percent of the time in May at Orange Blossom Bridge, but is generally achievable in other critical months. Although the precise temperature required for smoltification is uncertain, even with a warmer criterion of 57°F, the proposed operations will truncate the successful smoltification of late developing smolts.

Salmonid spawning occurs from below Goodwin Dam to Riverbank. Consequently, specific temperature criteria of 55ºF or less at Riverbank should be met from December through May to ensure that temperatures are suitable for all available spawning habitat and for incubating eggs. However, modeled results and CDEC data (figure 6-35) indicate that temperatures at Riverbank are likely to exceed this level from March through May. Appropriate incubation temperatures are generally exceeded at Orange Blossom Bridge in May. This combination of conditions increases the likelihood that CV steelhead that spawn later in the season, or farther downstream will have reduced to failed reproductive success. In addition to this individual and population effect, it affects the diversity of the population by truncating the timing and area available for successful spawning.

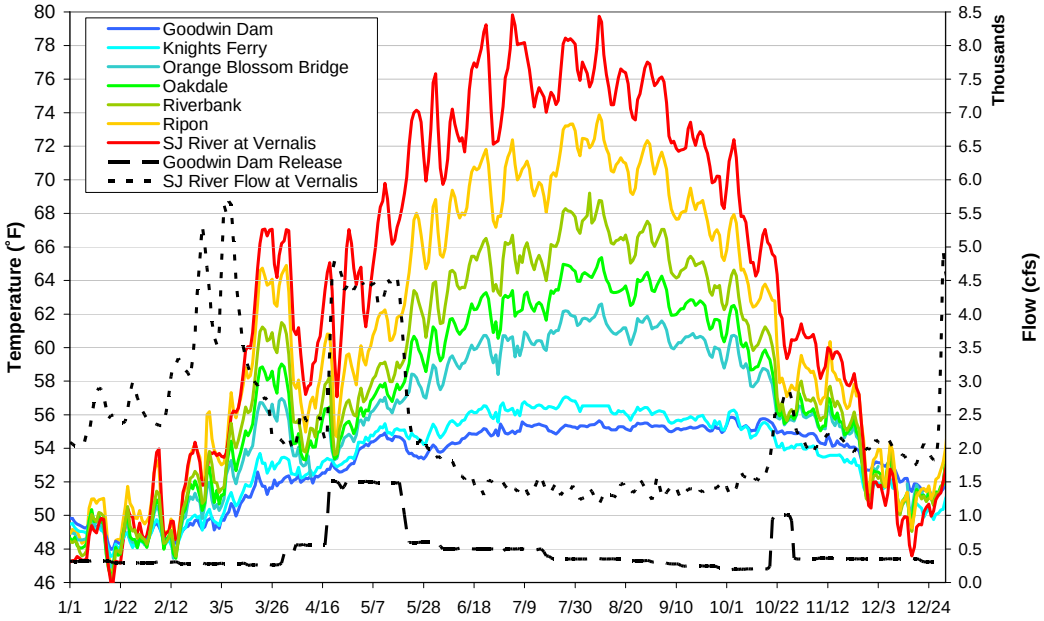


Figure 6-35. Stanislaus and San Joaquin river temperatures and flow at selected locations in a dry year, actual measured water temperatures (2001, CVP/SWP operations BA figure 11-20).

Modeling results provide information that may indicate how a system may perform if operated under a particular set of rules and conditions. In practice, the actual operations are usually somewhat different than what was modeled and the system response is different. The CDFG has petitioned the California State Water Resources Control Board to list the Stanislaus River, along

with the Merced, Tuolumne and San Joaquin rivers as impaired under the Clean Water Act [303(d)] with respect to temperature suitability for anadromous fish (CDFG 2007a). Based on actual temperature data from 2000 through 2006, it concluded that "water temperatures in all four river systems are too warm for anadromous fish during all four of thir life stages" (CDFG 2007a page 9). That report does identify that modeling results include levels of uncertainty and that actual operational conditions may have greater or lesser effects on CV steelhead.

Lindley *et al*. (2007) has identified the need for upstream habitat for salmonids, given predicted climate change in the next century. This may be particularly relevant for CV steelhead on the Stanislaus River where Goodwin Dam blocks all access to historical spawning and rearing habitat and where the remaining population survives as a result of dam operations in downstream reaches that are historically unsuitable habitat because of high summertime temperatures.

Construction of the dams on the Stanislaus River has prevented anadromous *O. mykiss* from accessing its entire historical habitat. The population persists in a reach of the river that historically was unsuitable because of high temperatures (Lindley 2006) only if dam operations are managed to maintain suitable temperatures for all life history stages of CV steelhead. There are no temperature control devices on any of the East Side Division facilities, so the only mechanism for temperature management is direct flow management. This has been achieved in the past through a combination of augmenting baseline water operations, for meeting senior water right deliveries and D-1641 water quality standards, with additional flows from (1) the CDFG fish agreement, and (2) from b(2) or b(3) water acquisitions. The analysis of temperature effects presented in the CVP/SWP operations BA, Appendix I, assumes that these augmentations will be available. If water for fish needs is indeed allocated as their model suggests, future operations likely would meet CV steelhead temperature needs, except in July through September in dry or critical years, when the average temperature would exceed 65ºF at Orange Blossom Bridge by 1-4°F, depending on the future climate change.

The project pescription does not specify how b(2) or b(3) water are committed for fishery uses of any particular amount, timing or duration. The CVP/SWP operations BA analysis does not evaluate their assumptions without the addition of CVPIA assets for fish, so the change in temperature of these reduced flows for fish cannot be quantified with available data. Table 6-21 compares the flow schedule used for critically dry years in the model Study 7.0 [current conditions, including use of b(2) and b(3)] with the September 2008 50 percent flow projection, which expresses the real-time operation plan [current conditions, but with b(2) and b(3) assets committed to other uses]. The projection identifies significantly lower flows than what are modeled for a similar year type, and likely resulting in unsuitable temperatures for CV steelhead. Given that the allocation process for b(2) and b(3) assets in the project description does not differ from current application practices, it is reasonable to expect that access to these resources to offset operational temperature effects on CV steelhead in the Stanislaus River will continue to be limited, particularly in Conference Years and in drier Mid-Allocation Years, and the effect is likely to be greater than what is modeled.

Table 6-21. Comparison of projected monthly Stanislaus River flows (cfs) from September 2008 50 percent forecast and CVP/SWP operations BA Study 7.0, 50 percent projected flows from look-up table.

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep

Sept 2008 50% forecast	200	210	200	135	135	268	754	739	556	396	352	240
Modeled 50% forecast *	494	340	351	298	362	401	1122	1299	286	267	267	240

If future conditions are warmer, drier or both, summer temperature conditions at Orange Blossom Bridge will be more likely to exceed 65˚F, resulting in a constriction of suitable rearing habitat, encroachment of warm-water predatory fishes into more of the freshwater migration habitat, and decreased CV steelhead survival owing to temperature stress, increased disease, and increased competition for food and space with resident *O. mykiss*.

The CVP/SWP operations BA modeled the effect of future climate scenarios on Chinook salmon egg mortality, as a surrogate to assess the effect of future project operations on CV steelhead in the Stanislaus River. As modeled, temperature caused salmon egg mortality will increase by approximately 1 to 5 percent in wet years and by 1 to 14 percent in critically dry years (figure 6-36). CV steelhead eggs require lower incubation temperatures than Chinook salmon, so this analysis presents an underestimate of the project effect.

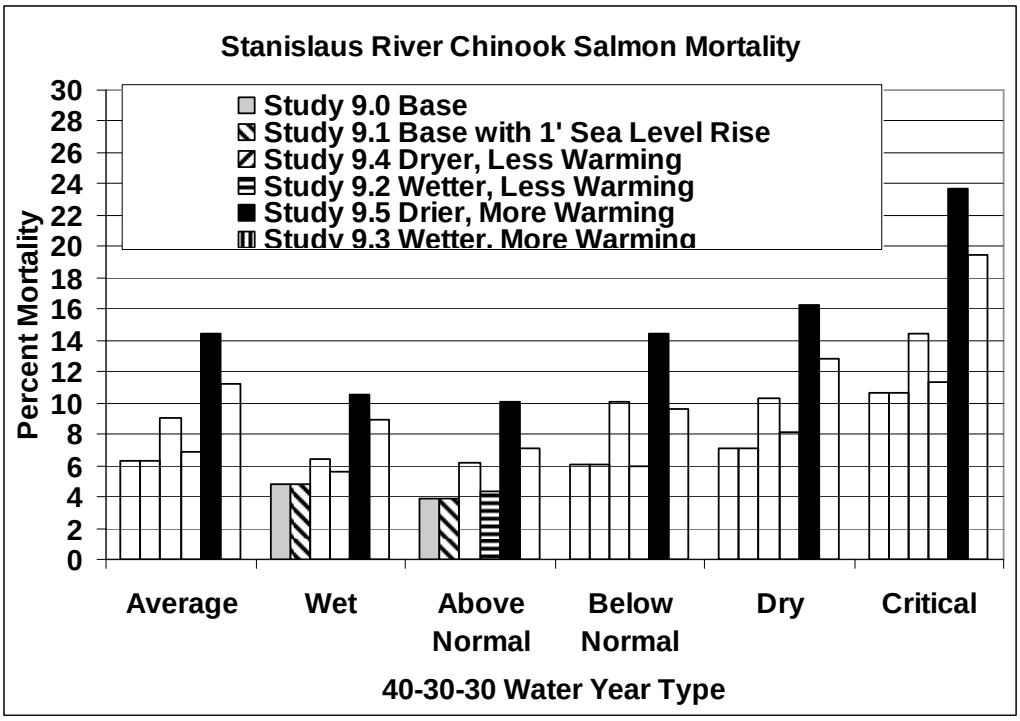


Figure 6-36. Stanislaus River fall-run Chinook salmon egg mortality with climate change scenarios from Reclamation salmon egg mortality model. All studies except 9.0 include 1-foot sea level rise. Study 9.0 is future conditions with D-1641 (CVP/SWP operations BA figure 11-89).

The CVP/SWP operations BA noted that under actual operational conditions in 2001, a dry year, the temperature at Orange Blossom Bridge did exceed 65°F, but not for extended periods of time

(figure 6-35). A limitation of the modeling studies is that, while they were improved to use a daily time step in the BA, these daily temperatures were derived from disaggregated monthly temperatures. Consequently the frequency and duration of temperature exceedances in a month cannot be evaluated. Short duration exceedances as measured in 2001 would have less effect on the species than extended exposure to unsuitable temperatures. Temperature exceedances of short duration and low magnitude can also be addressed with minor operational changes. Without clearer operational criteria to ensure that instream temperature standards are met, CV steelhead will be subjected to increased sublethal and lethal temperature effects in the Stanislaus River from the egg through smolt stages and potentially as adults.

6.5.3.2 Instream Flow and Seasonal Hydrograph

Aceituno (1993) applied the instream flow incremental methodology to the Stanislaus River between Riverbank and Goodwin Dam (24 river miles) and determined that 155 TAF was needed to maximize weighted usable habitat area for salmon, not including outmigration flows or fall attraction flows. This study also identified that instream flow needs for each life history stage are somewhat different between CV steelhead and fall-run (table 6-22). CV steelhead flow needs are somewhat lower than fall-run needs for some life stages, but potentially higher for adult migration. The total amount of water needed for maximum instream habitat support is equal to or greater than 155 TAF, which is also greater than the fishery agreement allottment to CDFG in Mid-Allocation Year, and probably Conference Year, categories (table 6-23).

Table 6-22. Comparison by life stage of instream flows which would provide maximum weighted usable area of habitat for steelhead and Chinook salmon in the Stanislaus River, between Goodwin Dam and Riverbank, California (adapted from Aceituno 1993). No value for Chinook salmon adult migration flows was reported.

Life Stage	Steelhead Flow	Steelhead Timing	Fall-Run Flow	Fall-Run Timing
Spawning	200	Dec-Feb	300	Oct 15-Dec 31
Egg incubation/fry rearing	50	Jan - Mar	150	Jan. 1-Feb 15
Juvenile rearing	150	all year	200	Feb 15-Oct 15
Adult migration	500	Oct-April	-	

The proposed allocation year strategy for the East Side Division fundamental operating principles only commits to providing sufficient water for fisheries in 41 percent of the years, based on operations since 1982 (table 6-23). The CDFG Fish Agreement allotment alone is less than what CV steelhead need, and the CDFG allocation schedule is predominantly directed by Chinook salmon needs. Consequently, CV steelhead are likely to have unmet flow needs in 59 percent of years, based on actual operations since 1982, and may also be negatively affected by operations that target higher flows for salmon than are appropriate for CV steelhead, unless channel complexity is sufficient to provide a range of instream flow conditions for a set release flow from the dams. If b(2) or b(3) water is available, this effect could be reduced in some Mid-Allocation years. Because the guidance for allocation of b(2) and b(3) water for the Stanislaus River is not specific, the magnitude of this reduction cannot be determined.

Table 6-23. Occurrence of High Allocation, Mid-Allocation and Conference Year types for New Melones Transitional Operation Plan, based on New Melones Operations since 1982 (CDEC data).

Allocation Year Type	Fishery Allocation	% occurrence 1982-2008
High Allocation Years New Melones Index is greater than 1.7 MAF	457 TAF	41 %
Mid-Allocation	98.3 TAF	33%
"Conference Year" conditions - New Melones Index is less than 1.0 MAF	unspecified	26%

The IFIM analysis did not include an assessment of the volume of water needed for a spring pulse flow to convey CV steelhead or fall run from the Stanislaus River into the Delta. The San Joaquin River Agreement (SJRA) and associated VAMP were agreed upon by the SWRCB and the signatory parties as a mechanism to address this fishery need in the context of refining the understanding of what specific flow standards are needed to meet the requirements of the 1995 Water Quality Control Plan. The SJRA will conclude in 2011 and the funding for VAMP studies and flows is scheduled to end in 2009. The project description indicates that Reclamation and DWR intend to "continue VAMP-like flows" but the description of these flows lacks critical fish benefits now provided by the SJRA and VAMP. Under the SJRA, operators on the Tuolumne River and the Merced River release spring pulse flows in a manner coordinated with Stanislaus River pulse flows to convey salmonids from these tributaries into the San Joaquin River and to the Delta. When the SJRA concludes, there will be no commitment by operators on the Merced and Tuolumne Rivers to continue with spring pulse flows. This will affect CV steelhead in the Stanislaus in two ways: modification of New Melones operations to affect conditions on the Stanislaus and modification of conditions on the Merced and Tuolumne Rivers that affect the diversity group.

Without the SJRA in effect, Reclamation is solely responsible to meet water quality standards (flow and salinity) at Vernalis. Without the contribution from rivers upstream of the Stanislaus, Reclamation likely will be required to release more water from New Melones in order to meet that standard. This can result in unsuitable flows and temperatures for CV steelhead, dewatering of redds, and reduction of storage volumes at the end of September. This last factor will result in more years falling into the Conference Year or Mid-Allocation Year categories, which provide less suitable conditions for CV steelhead as described above on a more frequent basis.

CV steelhead in all three of these rivers represent three of the four populations of the Southern Sierra Diversity Group of the Central Valley steelhead DPS. Straying of individuals among these rivers likely occurs at some level and is a mechanism for recolonization of populations within the diversity group, should a catastrophic event eliminate one or more. Lack of spring flows to encourage anadromy from the other San Joaquin River tributaries will further reduce those CV steelhead populations and reduce the diversity potential of the Stanislaus River CV steelhead population.

As indicated above, the SJRA and VAMP flows provide benefit to enable outmigrating CV steelhead smolts. However, the pulse flow period is constrained to occur only in a 31-day period

during April and May. As indicated in the CVP/SWP operations BA (page 11-81), rotary screw traps on the Stanislaus capture *O. mykiss* with smolting characteristics from January through mid-April. This represents the majority of the captures. *O. mykiss* with smolting characteristics have also been captured as late as the end of May. McEwan (2001) infers that CV steelhead would normally have exhibited a protracted outmigration period, peaking in March but extending as late as June. Although the CVP/SWP operations BA suggests that CV steelhead smolts are sufficiently strong swimmers to exit the river at any time, trawl sampling at Mossdale collects CV steelhead at times that coincide with pulse flow releases. Thus, while the VAMP pulse flows provide more benefit to CV steelhead than no pulse flow at all, the narrow window of time when it occurs also constrains diversity and plasticity that are important to the survival of the species.

6.5.3.3 Geomorphic Effects of Altered Hydrograph

Past operations of the East Side Division have eliminated channel forming flows and geomorphic processes that maintain and enhance CV steelhead spawning beds and juvenile rearing areas associated with floodplains and channel complexity. The reduction in peak, channel-forming, flows over time is summarized in table 6-24 (from Kondolf *et al.* 2001). Since the operation of New Melones Dam, channel-forming flows above 8,000 cfs have been reduced to zero and mobilizing flows in the 5,000-8,000 cfs range have only occurred twice in the past 10 years. Channel-forming flows are important to rejuvenate spawning beds and floodplain rearing habitat and to recruit allochthonous nutrients and large wood into the river. Floodplain and side channel habitats provide important juvenile refugia and food resources for juvenile salmonid growth and rearing (Sommers *et al.* 2001a, 2001b, 2005; Jeffres *et al.* 2008; Heady and Merz 2007).

Salmonid spawning habitat availability and quality has been reduced on the order of 40 percent since 1994 (Kondolf *et al*. 2001). Mesick (2001) hypothesized that this reduction is likely underestimated based on the sampling methodology of that assessment. His results indicated that higher concentrations of fine sediments and low intragravel dissolved oxygen in riffles downstream of Orange Blossom Bridge would be expected to reduce fall-run egg survival by 23 percent, as compared to the natural riffles at the Orange Blossom Bridge and upstream. CV steelhead prefer spawning gravels with a greater proportion of smaller gravels than fall-run (Kondolf and Wolman 1993). As smaller particles are mobilized at lower flows than larger particles, the degradation of spawning gravels has a greater proportionate effect on CV steelhead, although not quantified by the study. Operational criteria have resulted in channel incision of 1-3 feet since the construction and operation of New Melones Reservoir (Kondolf *et al*. 2001). This downcutting, combined with operational criteria, have effectively cut off overbank flows which would have inundated floodplain rearing habitat, as well as providing areas for fine sediment deposition, rather than within spawning gravels, as occurs now. Additionally, the flow reductions in late spring and early summer are too rapid to allow recruitment of large riparian trees such as Fremont cottonwoods. Consequently, within 10 to 20 years as existing trees scenesce and fall, there will be no younger riparian trees to replace them, resulting in less riparian shading, higher instream temperatures, less food production from allochtonous sources, and less LWD for nutrients and channel complexity

Table 6-24. Summary of flow conditions on the Stanislaus River during historical periods from 1904-1998. New Melones Dam construction was completed in 1979. Goodwin Dam was completed in 1912 and the first dam in the basin dates at 1853 (Kondolf *et al.* 2001, table 5.2).

Period	Years	Total Years	% Years Peak over 8,000 cfs	% Years Peak over 16,000 cfs	Max Flow (cfs)	Max Flow (date)
I.	1904-1937	34	68%	32%	64,500	3/19/1907
II.	1938-1957	20	60%	25%	62,900	12/23/1955
III.	1958-1978	21	29%	14%	40,200	12/24/1964
III.	1979-1998	20	0%	0%	7,350	1/03/1997

Status quo operations will result in further degradation of spawning habitat and rearing habitat. Reduction and degradation of spawning gravels directly reduces the productivity of the species by reducing the amount of usable habitat area and causing direct egg mortality. Lower productivity leads to a reduction in abundance. The specific population decrement cannot be measured owing to the very low numbers of CV steelhead observed in the Stanislaus River.

6.5.3.4 Effects of Climate Change

Lindley *et al.* (2007) has identified the need for upstream habitat for salmonids, given predicted climate change in the next century. This may be particularly relevant for CV steelhead on the Stanislaus River where Goodwin Dam blocks all access to historical spawning and rearing habitat and where the remaining population survives as a result of dam operations in downstream reaches that are historically unsuitable habitat because of high summertime temperatures. If future conditions are warmer, drier or both, summer temperature conditions at Orange Blossom Bridge are likely to exceed 65˚F, resulting in a constriction of suitable rearing habitat, encroachment of warm-water predatory fishes into more of the freshwater migration habitat, and decreased CV steelhead survival owing to temperature stress, increased disease, and increased competition for food and space with resident *O. mykiss*.

If future conditions are drier, warmer or a combination of both, temperature caused egg mortality will increase by approximately 2 percent in wet years to 13 percent in critically dry years (figure 6-36).

6.5.4 Assess Risk to Individuals

Based on the effects to CV steelhead associated with the proposed action described above, fitness consequences to individuals include reduced reproductive success during spawning, reduced survival during embryo incubation, reduced survival and growth during juvenile rearing, and reduced survival and growth during smolt emigration (see table 6-19).

6.5.5 Effects of the Action on CV Steelhead Critical Habitat

Critical habitat has been designated up to Goodwin Dam, to include currently occupied areas. Extension of critical habitat above the dams was deemed premature until recovery planning determines a need for these areas in the recovery of the DPS (September 2, 2005, 70 FR 52488). Lindley (2006) identifies that these habitat areas are intrinsically unsuitable habitat owing to high water temperatures, but suitable and occupied habitat does occur below the East Side Division dams as a result of dam operations that can be managed to maintain suitable temperature regimes. The remaining areas below major dams also may not have optimal habitat characteristics. For example, lower elevation rivers have substantially different flow, substrate, cover, nutrient availability, and temperature regimes than headwater streams.

The PCEs of critical habitat include sites essential to support one or more life stages of the DPS (sites for spawning, rearing, migration, and foraging). The specific PCEs relevant to the Stanislaus River and San Joaquin River to Vernalis include:

1. Freshwater spawning sites
2. Freshwater rearing sites
3. Freshwater migration corridors

Where specific information regarding CV steelhead habitat use in the Stanislaus River is not available, relevant information for fall-run may be used as a surrogate comparison, where comparisons are appropriate.

6.5.5.1 Spawning Sites

CV steelhead spawning habitat on the Stanislaus River is affected by East Side Division operations in four categories: (1) flow releases may not maintain appropriate temperatures for spawning and egg incubation, particularly in April and May; (2) flow releases are not operated to maximize the amount of spawnable habitat available or prevent reductions that could dewater redds; (3) gravel replenishment is too little to offset the lost spawnable material blocked by the dams or to offset material transported away from spawnable riffles and list to in-river pits; and (4) flow releases do not support geomorphic processes that would remove fine sediment from spawning gravels and maintain interstitial flows to attract spawners and allow egg incubation.

6.5.5.2 Temperature

Because CV steelhead are unable to reach their historical spawning areas above Goodwin Dam, they are dependent on East Side Division operations maintaining instream temperatures suitable for spawning below the dam where appropriate gravel and gradient conditions occur. No CV steelhead spawning surveys have been conducted on the Stanislaus River, but fall-run surveys indicate that spawning may occur from Goodwin Dam (RM 59) almost to the city of Riverbank (RM 33), with the highest use occurring above Knights Ferry (RM 55). Based on observations of trout fry, most spawning occurs upstream of Orange Blossom Bridge (Kennedy and Cannon 2002). Modeling results indicate that temperature conditions for spawning CV steelhead likely cannot be met in April and May for future operations, even without climate change, and reduction in available coldwater for spawning habitat could occur in critically dry water years in the future if conditions are drier, warmer or a combination of both. This would result in reducing the amount of suitable spawning habitat, and compressing it further upstream closer to the

terminal dams. Operational criteria are not clearly described in the CVP/SWP operations BA to assure that modeled conditions reflect proposed operations.

6.5.5.3 Spawnable Area

Aceituno (1993) applied the IFIM to the Stanislaus River between Riverbank and Goodwin Dam (24 river miles) to help to determine instream flow needs for Chinook salmon and CV steelhead. The PHABSIM results indicated CV steelhead spawning was maximized at 200 cfs. Using the CALSIM II results presented in the CVP/SWP operations BA Appendix E and CV steelhead habitat area curves from Aceituno (1993), we assessed that flows that fall below that level between December and February are projected to occur 50 percent of the time in January and 10 percent of the time in February and would reduce spawnable area by approximately 30 percent. December flows are projected to exceed 200 cfs in all years reducing spawnable area 15 percent in 50 percent of years. Flows that exceed 400 cfs are projected to occur in all months 25 percent of the time and could result in reduction of spawnable habitat from 60-95 percent.

Flows to maximize fall-run spawning are higher than CV steelhead needs, thus management actions to protect both species may conflict. Channel complexity can allow for greater variety in meso habitats, so that for a given flow release level at the dam, some portions of the river will have higher velocities than other areas. Thus more channel complexity could avoid adverse effects to CV steelhead as a result of implementing optimal flows for fall-run, such as those called for in the CVPIA. Unfortunately, past and continuing operations have reduced channel forming and channel maintaining flows, which have resulted in channel incision and loss of channel complexity (Kondolf *et al*. 2001). Therefore, the conservation value of spawning habitat in the form of gravel bedded reaches has been, and will continue to be, reduced with the implementation of the proposed action.

6.5.5.4 Spawning Gravel Quality and Quantity

Pebble counts and sediment size analysis of spawning areas has shown an increase in sand and fine material in spawning beds since construction of New Melones Dam (Kondolf *et al.* 2001, Mesick 2001). Most non-enhanced riffles had sufficient fine material to impair egg incubation and survival.

Gravel replenishment actions below Goodwin Dam add suitably-sized gravel for CV steelhead spawning, but it is rapidly mobilized at flows as low as 280 cfs (Kondolf *et al*. 2001). CVPIA spawning gravel additions have targeted 3,000 cubic yards per year. This is not of sufficient volume to offset the deficits created by the loss of recruitment from upstream sources (over 1 million cubic yards, Kondolf *et al*. 2001). At best, these additions may strategically maintain the quality of few spawning riffles. The project description does not specify a level of spawning gravel addition to be performed on the Stanislaus River.

6.5.5.5 Spawning Habitat Quality and Geomorphic Processes

Since the construction of New Melones Dam, channel-mobilizing flows of 5,000 cfs have increased in return interval from 1.5 years to over 5 years. Overbank flows are critical for redistributing fine sediments out of spawning beds and onto the floodplain terrace. Current operations have also caused channel incision of up to 1-3 feet since the construction of New Melones Dam. Channel incision further increases the flows needed to obtain overbank flow and decreases the likelihood of occurrence. Without sufficient flows for geomorphic processes to manage fine sediment deposition in spawning gravels, spawning beds will be increasingly choked with sediment and unsuitable for spawning.

Lack of flow fluctuation and channel forming flows has also resulted in the stabilization of gravel bars by thick riparian vegetation at the river edges. Lack of scouring prevents mobilization of spawnable material to refresh degraded riffles. Proposed operations will continue this degradation of spawning habitat conditions.

6.5.5.6 Freshwater Rearing Sites

The project operations would not change rearing habitat availability, but current operations do not allow for overbank flow to maintain floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility. Since the construction of New Melones Dam, channel-mobilizing flows of 5,000 cfs have increased from a return interval of 1.5 years to over 5 years. Lack of flow fluctuation and channel forming flows has also resulted in the stabilization of gravel bars by thick riparian vegetation at the river edges. Lack of scouring prevents introduction of LWD, which provides cover, nutrients and habitat complexity, including undercut banks and side channels. Additionally, the flow reductions in late spring and early summer are too rapid to allow recruitment of large riparian trees such as Fremont cottonwoods. Consequently, within 10 to 20 years as existing trees scenesce and fall, there will be no younger riparian trees to replace them, resulting in less riparian shading, higher instream temperatures, less food production from allochtonous sources, and less LWD for nutrients and channel complexity. Proposed operations will continue this degradation of rearing habitat conditions.

6.5.5.7 Freshwater Migration Corridors

Under proposed operations the freshwater migration corridors on the Stanislaus River will continue to require juvenile CV steelhead to pass through predator-rich abandoned mining pits, incised channels that limit channel complexity and water temperatures that may be physiologically lethal or sublethal. The spring pulse flows defined in VAMP are generally less than the spring pulse flows measured in 1989, a critically dry year (Kondolf *et al.* 2001), hence the operational assistance provided to assist CV steelhead outmigrants is only representative of the lowest migratory volumes historically experienced by CV steelhead.

Channel incision resulting from post New Melones operations has produced overhanging large wood and river edge aquatic vegetation but the lack of scouring and channel forming flows has effectively channelized and simplified the corridor. The variety of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological

changes needed for life in the ocean, and reach the ocean in a timely manner has been limited by operational conditions. Obstruction of access to historic spawning and rearing habitat requires CV steelhead to utilize these freshwater migration corridors at times that may not be optimal with respect to temperature, forage availability and exposure to predators.

Adult CV steelhead migrating upstream frequently are delayed entering the river owing to poor water quality conditions in the Delta. Fall attraction flows released for Fall Run typically improve conditions for steelhead migration also, hence steelhead tend to be observed on the Stanislaus River earlier in the year than in other Central Valley streams.

6.6 Delta Division

6.6.1 Deconstruct Actions in the Delta Division

The proposed action within the Delta is comprised of several different elements. Some of the elements, such as the proposed intertie between the Delta Mendota Canal and the California Aqueduct, were integrated into the assumptions for the CALSIM II modeling for the near future conditions (Study 7.1) and the future conditions (Study 8.0) and thus could not be analyzed separately without running the models individually with the explicit actions separated out from the combined assumptions. Others aspects of the action were modeled, such as export rates and gross channel hydraulics (flow rates, flow percentages, *etc.*) and could be assessed for their effects. NMFS chose to look at modeled water diversion actions in total, without disaggregating individual components of the water demands on the CVP and SWP actions in the Delta. NMFS assumed that the baseline conditions included the current natural and anthropogenic conditions in the Delta region (levees, dredging, contaminants, urban development, non-native species, predation, *etc.*) without the effects of the ongoing operations (*i.e.*, discretionary actions) of the Project.

In general, the effects of the actions in the Delta will result in: (1) increased export rates at the CVP and SWP facilities, resulting in increased salvage and loss at the CVP and SWP fish collection facilities, (2) alterations to the hydrodynamics in the Delta, resulting in increased vulnerabilities to entrainment into the central and southern Delta water ways, exposure to predation losses within the central and southern Delta waterways, delays in migration, increased residence time in the Delta due to delays in migration, and loss of migratory cues due to flow alterations, (3) exposure of green sturgeon to herbicides in Clifton court forebay, and (4) installation and operation of physical structures in the South Delta that will alter hydraulics, increase predation vulnerability and degrade habitat functions for listed salmonids and green sturgeon in the affected waterways.

The action elements analyzed by NMFS for the Delta Division are:

1. Exports from the CVP and SWP water diversions facilities which include changes in delta hydrodynamics, direct entrainment of listed fish at the project facilities, and indirect mortality within the delta related to exports and non-export factors;

2. Application of the copper based herbicide Komeen® to Clifton Court Forebay as part of the SWP aquatic weed control program;
3. The effects of the South Delta Improvement Program, Stage 1;
4. The effects of the Delta Cross Channel;
5. Contra Costa Water District diversions from delta facilities;
6. North Bay Aqueduct on Barker Slough; and
7. Vernalis Adaptive Management Plan effects.

In addition to the elements of the project action, the effects of climate change are assessed in conjunction with the implementation of the project actions. NMFS utilized the output of the climate change modeling presented in the BA to conduct this evaluation.

6.6.2 Proposed Delta Exports and Related Hydrodynamics

6.6.2.1 Deconstruct the Action

The proposed action will result in increased levels of water diversions from the CVP and SWP export facilities in the near future (Study 7.1) and future (Study 8.0) conditions over the current export levels (Study 7.0). Increased exports result in increased net flows towards the export facilities through the waterways of the central and south Delta. The effects of these increased exports are analyzed below in relation to the current level of exports. The effects of the current exports are discussed in both the environmental baseline and the current effects section. The temporal and spatial occurrence of listed fish in the Delta region as well as the baseline stressors have been described in Section 5.5, "*Status of the Species and Critical Habitat in the Delta Division.*"

6.6.2.2 Elements of the Action

6.6.2.2.1 Modeling Results for Proposed Delta Actions

Reclamation used the computer simulation models CALSIM II and DSM2 to model the effects of the proposed action. The effects modeled are based on the assumptions in the changes in operations and demands between the four CVP/SWP operations studies (6.0, 7.0, 7.1, and 8.0) as well as five climate change scenarios modeled in the future Study 9 series. (See CVP/SWP operations BA page 9-32 and 9-107, and table 9-4 for a more complete description of the models)

6.6.2.2.2 Delta Inflow

Total Delta inflow in the models is calculated as the sum of water entering the Delta from the Yolo bypass, the Sacramento River, the Mokelumne River, the Calaveras River, the Cosumnes River, and the San Joaquin River (at Vernalis). Historical Delta inflow for the period between 1980 and 1991 averaged 28 MAF, with the inflow from the Sacramento and San Joaquin rivers contributing approximately 75 percent of the inflow (DWR 1995). Based on the four modeling comparisons done for the CVP/SWP operations BA, the annual average Delta inflow decreases

in all study comparisons when future long term annual average conditions are compared to current conditions (table 6-25). Although not specifically called out, north of Delta demands increase in the future with the addition of the Freeport Regional Water Project intake as well as increases in future demands for municipal and industrial (M&I) water deliveries and settlement contracts. The overall result is more water is diverted for upstream demands prior to reaching the Delta in the near future and future conditions.

Table 6-25. Differences in long-term average annual Delta inflow and the 1929 – 1934 drought as modeled under the four CVP/SWP operations studies (CVP/SWP operations BA table 12-1).

Difference in Thousand acre feet (TAF)	Study 7.0 – Study 6.0	Study 7.1 – Study 7.0	Study 8.0 – Study 7.0	Study 8.0 – Study 7.1
Long-term annual average Total Delta Inflow	-69	-201	-270	-70
1929 -34 Annual average Total Delta Inflow	136	-272	-403	-130

The differences between studies 6.0, 7.0, 7.1, and 8.0 show relatively little difference in the 50th percentile flows (Total Delta inflow) when compared on a monthly basis (figure 6-37). The highest modeled inflows occur in the period from December through March due to flood flows and increased runoff in the basin. However, in all four modeling studies, there are distinct increases in Delta inflow during July to support increased pumping in below normal, dry, and critically dry year types (figures 6-38 through 6-43). Reclamation has stated that "current" model runs (6.0 and 7.0) have slightly higher inflow than the future runs (7.1 and 8.0) during the summer of dry and critically dry years due to the extra pumping required for EWA transfers being wheeled between the facilities. Since the future studies have limited EWA assets, this additional inflow is not required. Conversely, more water arrives in the Delta in June and July during above normal and below normal years in the future operations, apparently for export purposes. Summer time Delta inflow may have an effect on emigrating juvenile green sturgeon or their distribution in the Delta following emigration, based on the occurrence of juvenile green sturgeon at the South Delta salvage facilities in July and August. However, the lack of data concerning the movements of juvenile sturgeon during their downstream migration make definitive assessments difficult at best concerning the role of Delta inflow on their movements.

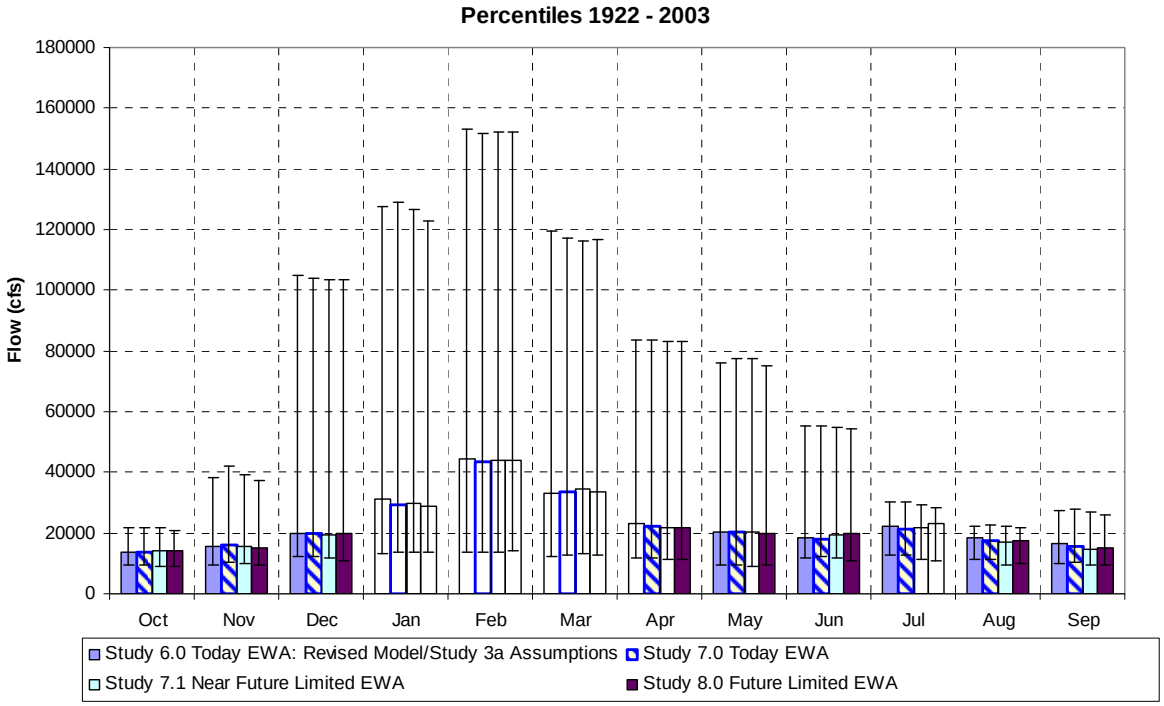


Figure 6-37. Monthly Delta inflow as measured at the 50th Percentile with 5th and 95th percentile whisker bars shown (CVP/SWP operations BA figure 12-2).

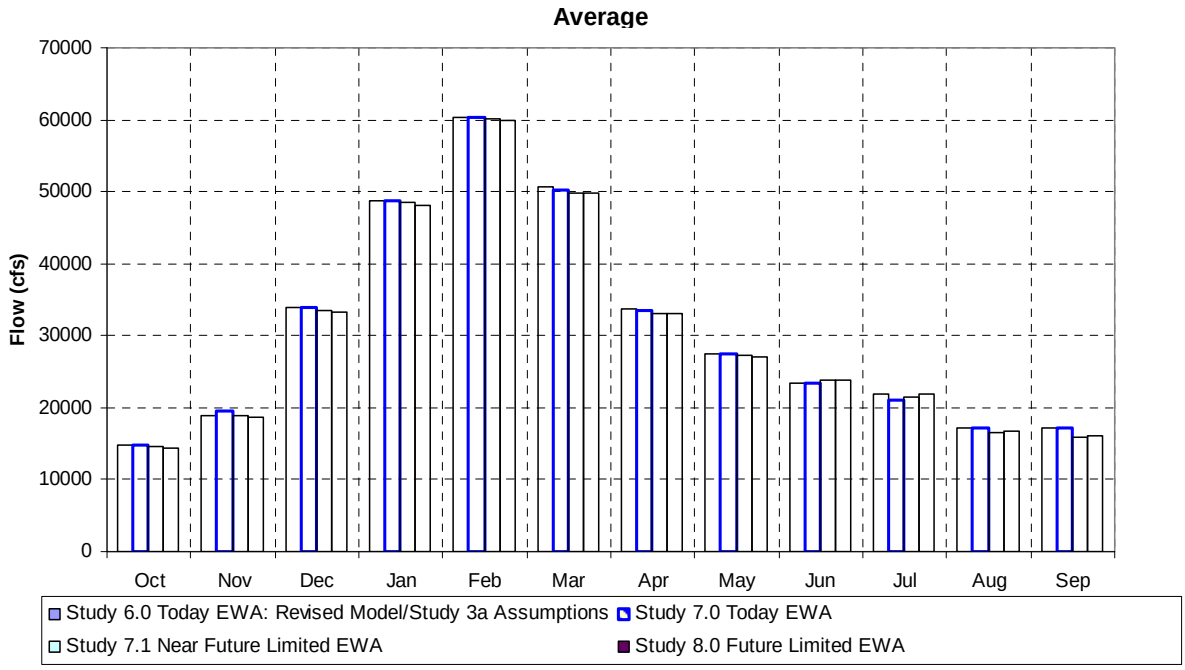


Figure 6-38. Average monthly Total Delta Inflow (CVP/SWP operations BA figure 12-3).

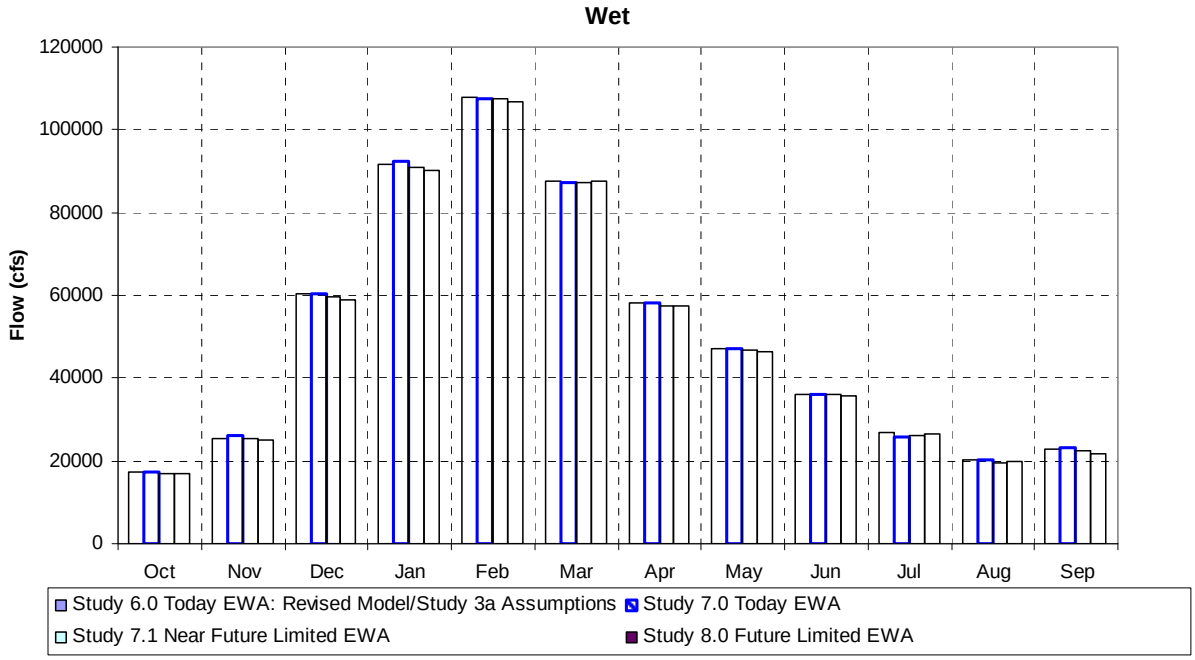


Figure 6-39: Average wet year (40-30-30[14]) monthly total Delta inflow (CVP/SWP operations BA figure 12-4).

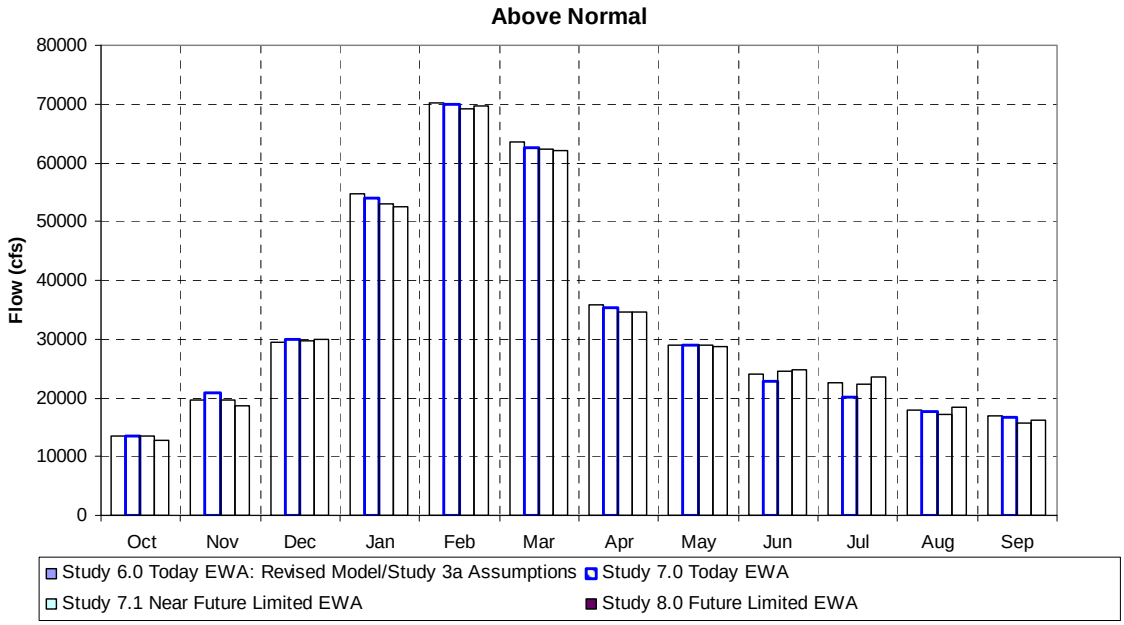


Figure 6-40: Average above normal year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-5).

[14]40-30-30, also known as the "Sacramento River Index," was "previously used to determine year type classifications under SWRCB Decision 1485," and is equal to 0.4 * Current Apr-Jul Runoff + 0.3 * Current Oct-Mar Runoff + 0.3 * Previous Year's Index, where runoff is the sum of unimpaired flow in MAF at: Sacramento River above Bend Bridge, Feather River at Oroville (aka inflow to Lake Oroville), Yuba River near Smartville, and American River below Folsom Lake; and previous year's index is a maximum 10.0 (http://cdec.water.ca.gov/cgi-progs/iodir/wsi).

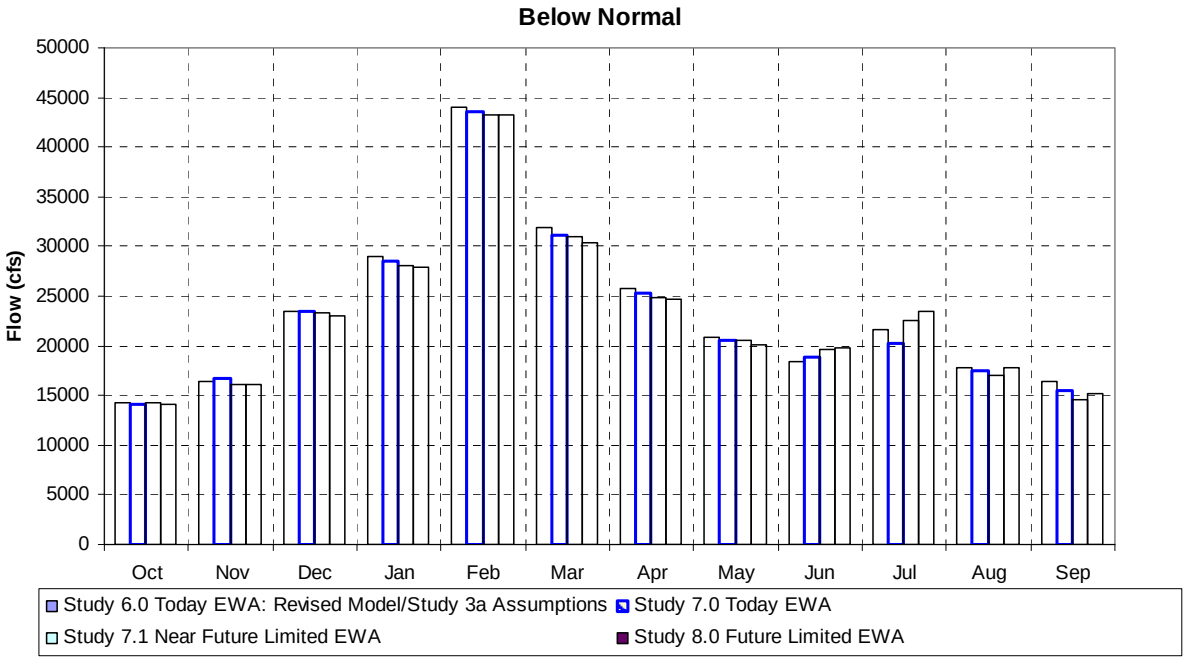


Figure 6-41: Average below normal year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-6).

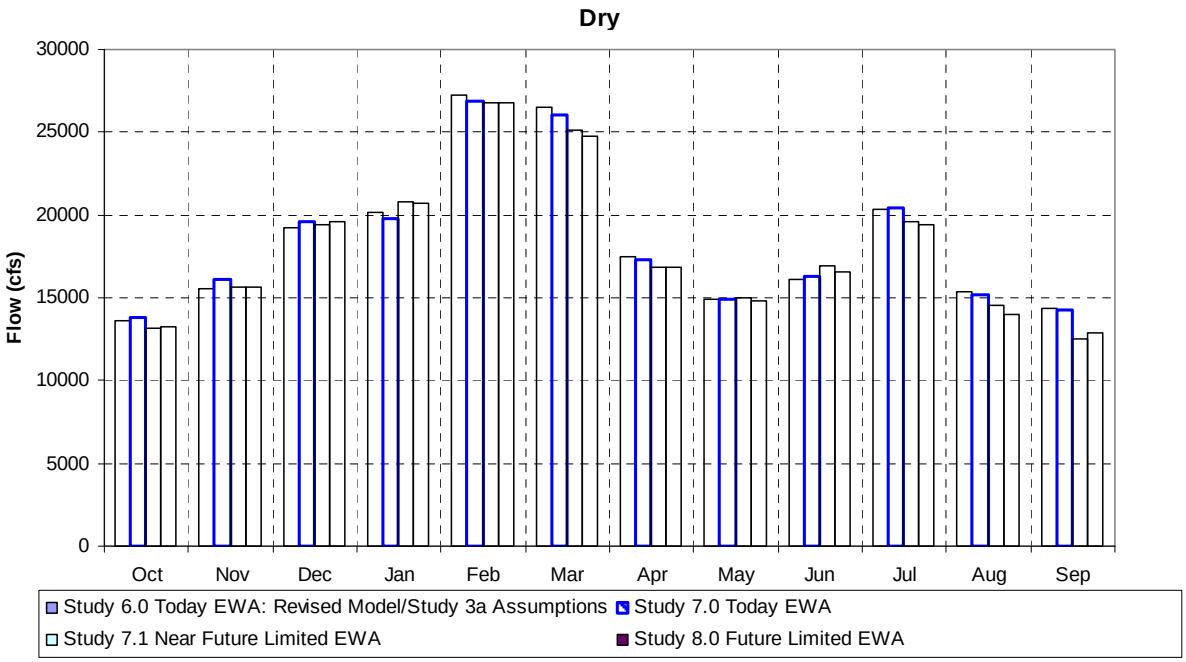


Figure 6-42: Average dry year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-7).

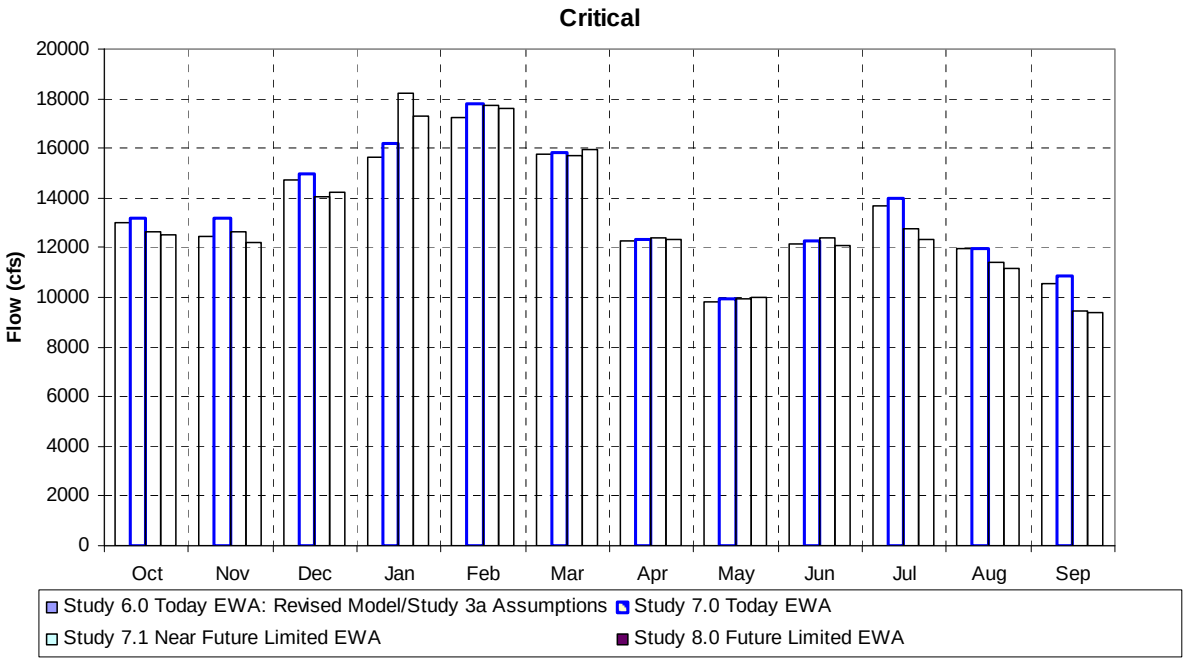


Figure 6-43: Average critically dry year (40-30-30) monthly total Delta inflow (CVP/SWP operations BA figure 12-8).

6.6.2.2.3 Delta Outflow

Historical Delta outflow values are described in DWR's Delta Atlas (DWR 1995). Of the 28 MAF of Delta inflow, approximately 19 MAF flows out to the ocean through the Delta. The remaining 9 MAF is captured by water diversions in the Delta, of which the CVP and SWP account for approximately 6 to 8 MAF (or 20 to 28 percent of the inflow) depending on water year type (DWR 1995; Healey *et al*. 2008; California, State of 2008). When comparing the differences between the future studies (7.1 and 8.0) with the current conditions (study 7.0), the average annual Delta outflow decreases by 300 to 400 TAF. Most of this decrease is seen in the immediate future (Study 7.1 compared to Study 7.0) with a reduction of 296 TAF. Study 8.0 reduces the delta outflow average an additional 104 TAF (see table 6-26). This represents an increase of approximately 5 percent in water "lost" in the Delta to diversions over historic conditions.

Table 6-26. Differences in long-term average annual Delta outflow and the 1929 – 1934 drought as modeled under the four CVP/SWP operations studies (CVP/SWP operations BA table 12-2).

Differences in Thousands of Acre-Feet (TAF)	Study 7.0 – Study 6.0	Study 7.1 – Study 7.0	Study 8.0 – Study 7.0	Study 8.0 – Study 7.1
Long-term Annual Average Total Delta Outflow	-149	-296	-400	-104
1929 -34 Annual average Total Delta Outflow	-93	-195	-164	32

The studies indicate that there are seasonal differences in the outflow, particularly in winter and spring. The biggest differences occur in below normal, dry, and critically dry years. The obvious differences are seen in late winter, where outflow increases are seen in Studies 6.0 and 7.0, when pumping reductions for "fish actions" are taken and thus, more water is allowed to

flow out of the Delta. Conversely, these pumping reductions are not taken in the future since the models were designed with limited EWA assets available to the Projects. In general, the Delta outflow decreases during the winter and spring seasons are greater for the future studies (7.1 and 8.0) than they are for the current studies (6.0 and 7.0), indicating that less water is available to assist emigrating fish to leave the Delta during this period (figures 6-44 through 6-50).

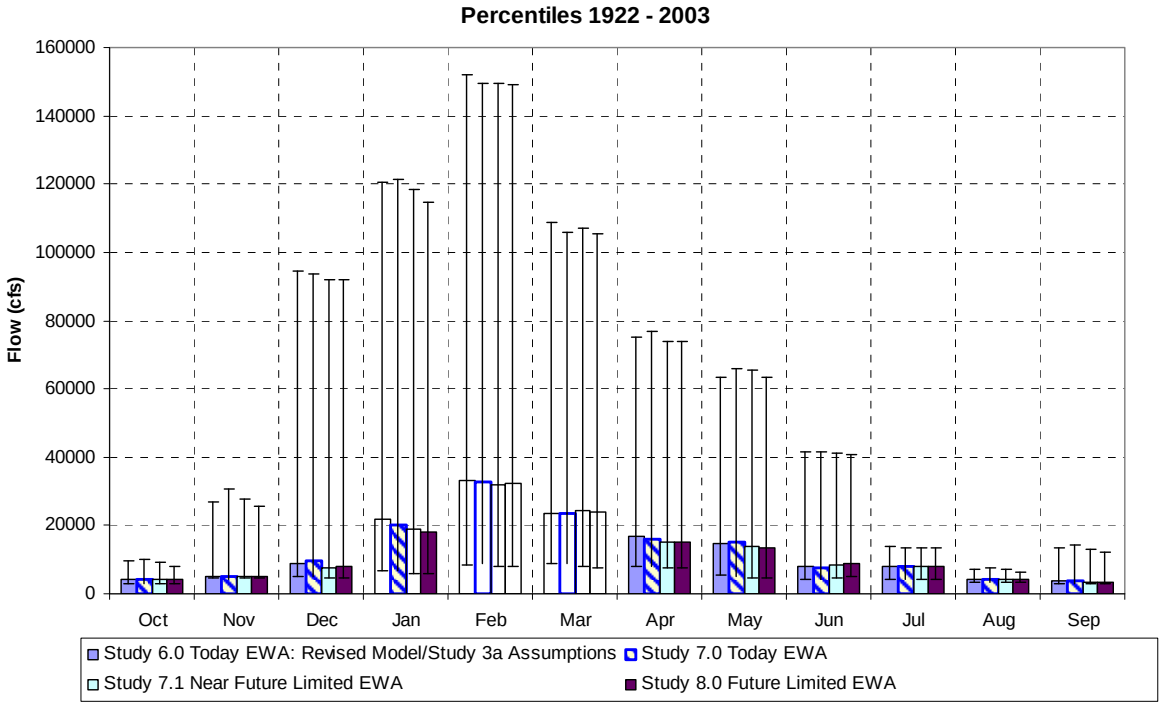


Figure 6-44. Monthly Delta outflow as measured at the 50th percentile with 5th and 95th percentile whisker bars shown (CVP/SWP operations BA figure 12-10).

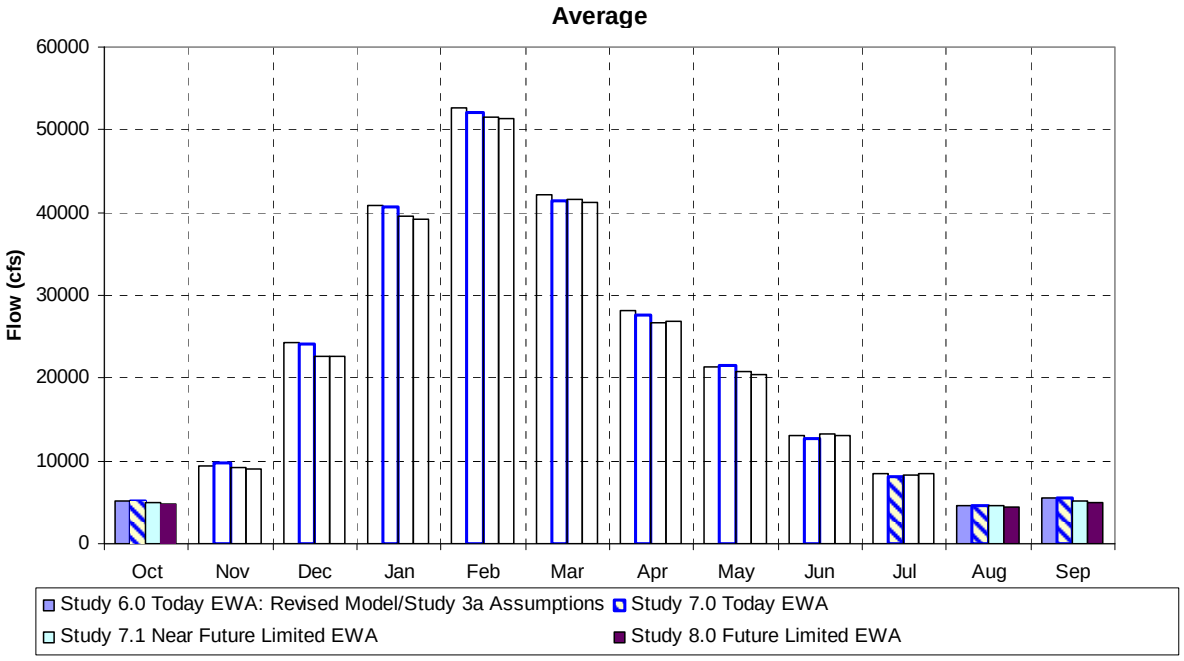


Figure 6-45. Average monthly total Delta outflow (CVP/SWP operations BA figure 12-11).

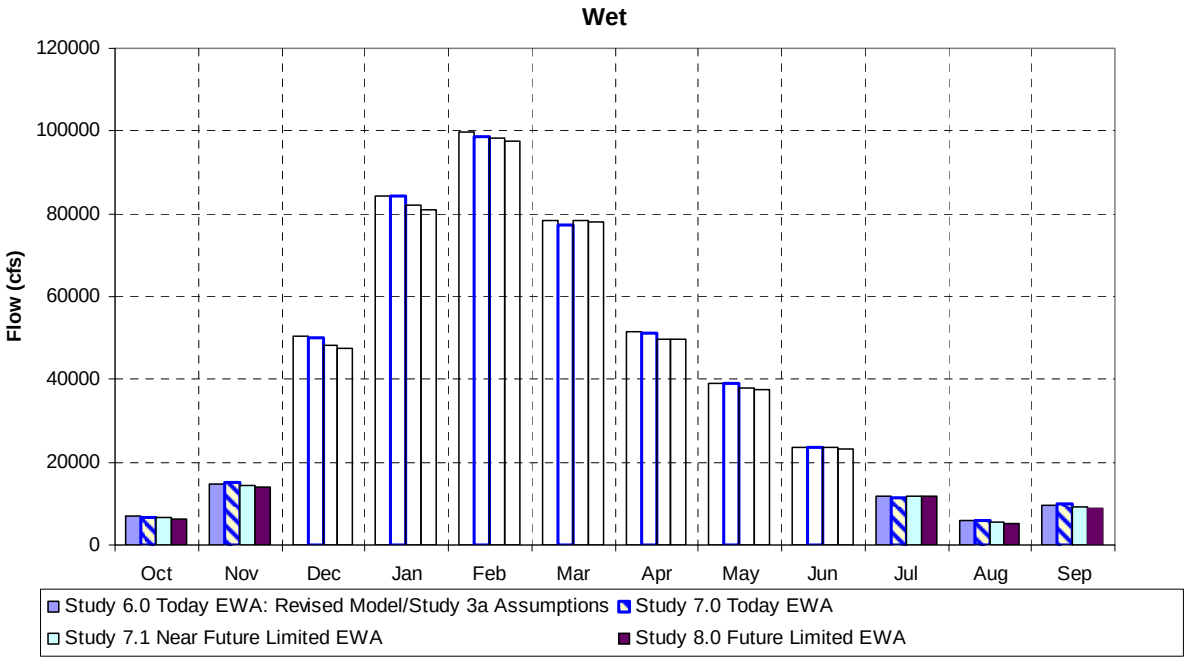


Figure 6-46. Average wet year (40-30-30) monthly delta outflow (CVP/SWP operations BA figure 12-12).

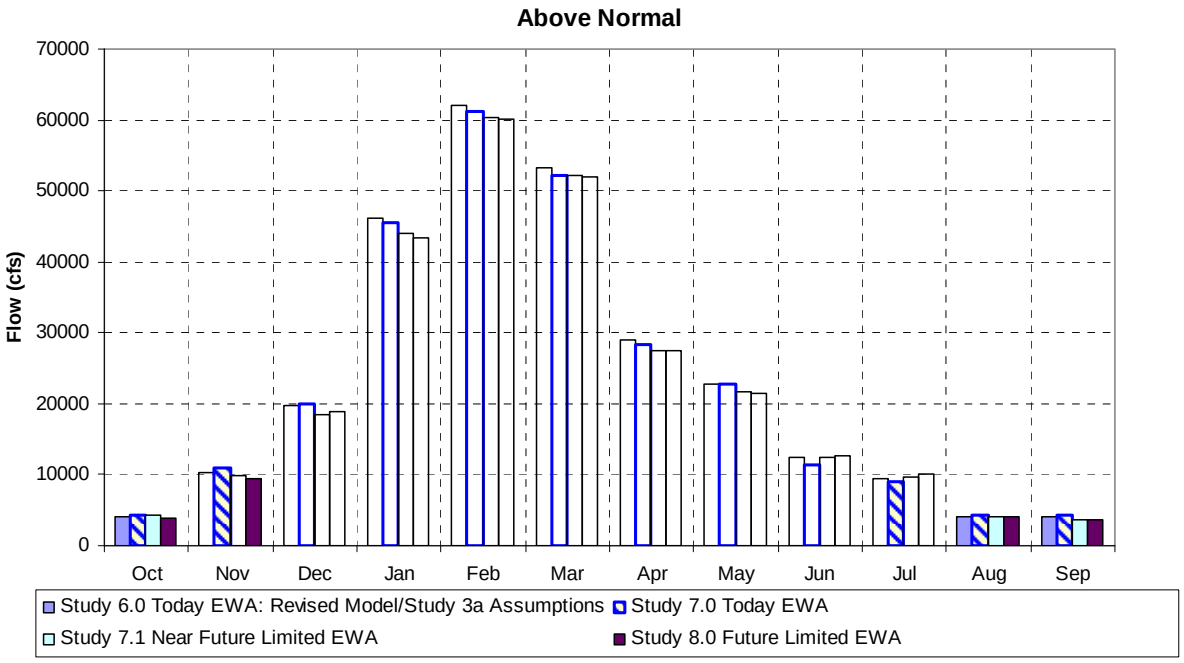


Figure 6-47. Average above normal year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-13).

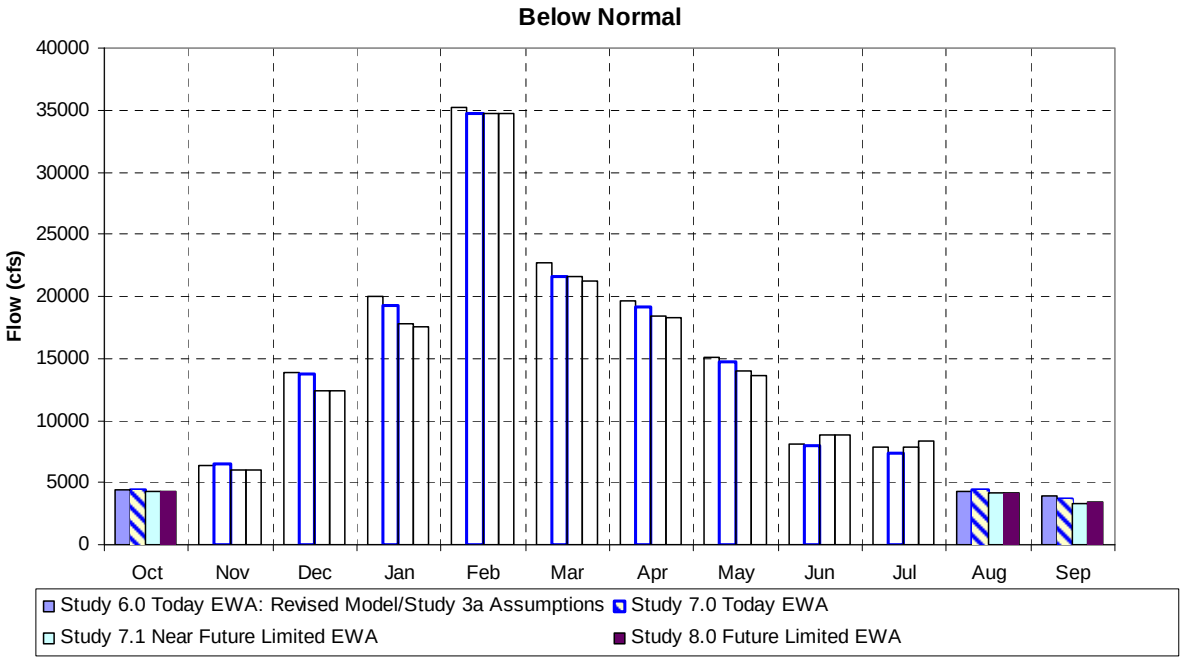


Figure 6-48. Average below normal year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-14).

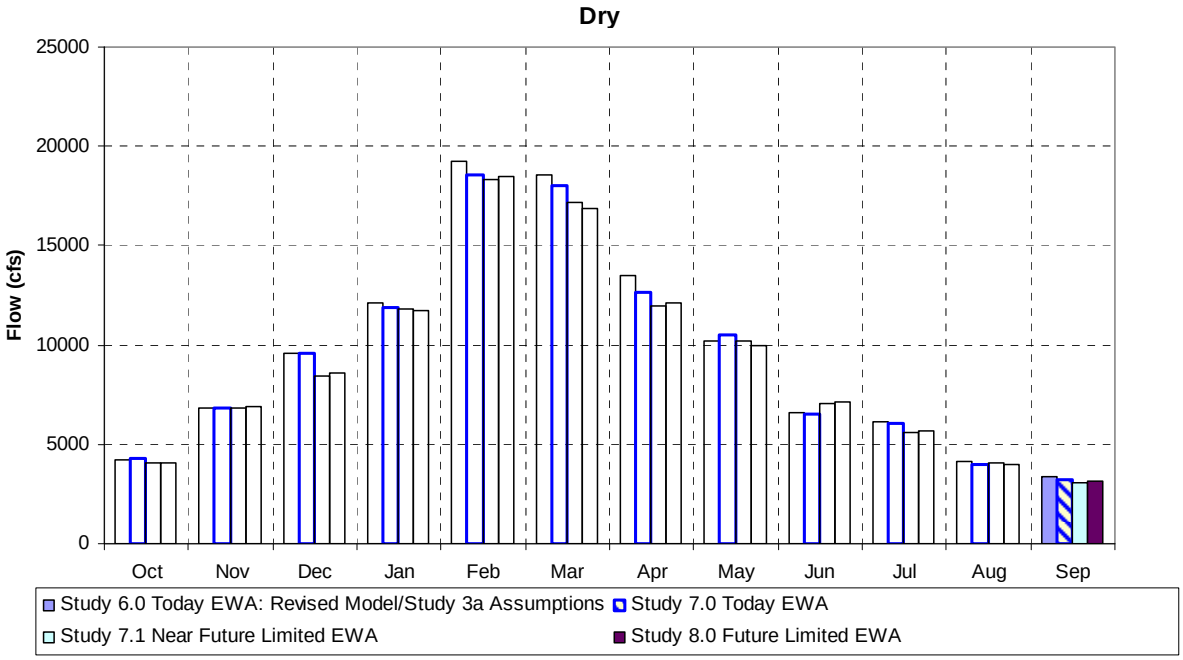


Figure 6-49. Average dry year (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-15).

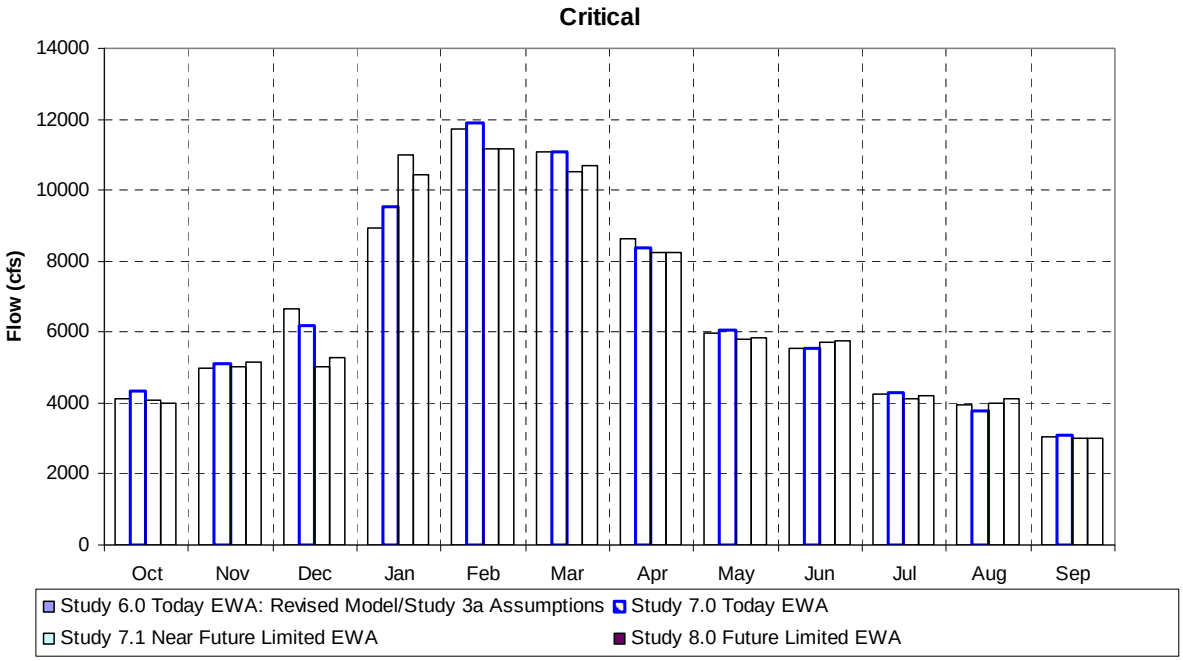


Figure 6-50. Average critically dry (40-30-30) monthly Delta outflow (CVP/SWP operations BA figure 12-16).

6.6.2.2.4 Exports from the Project Facilities

The exports modeled are Reclamation's at the Bill Jones Pumping Plant, the State's pumping at the Harvey O. Banks Pumping Plant, joint point diversions by Reclamation at Banks, and

diversions for the Contra Costa Water District and the North Bay Aqueduct on Barker Slough. The future scenario, as modeled by Study 8.0, shows a pumping pattern with increased levels of exports due to the greater future demands south of the Delta, and reduced export curtailments due to EWA actions relative to current practices as modeled in studies 6.0 and 7.0. The near future condition, as represented by study 7.1, also shows an elevated pumping pattern compared to the current operations as represented by studies 6.0 and 7.0.

Reclamation indicates that pumping at the Bill Jones Pumping Plant is limited to 4,200 cubic feet per second (cfs) in studies 6.0 and 7.0, which represent current operations (no intertie). In studies 7.1 and 8.0, pumping rates at Jones are increased to a maximum of 4,600 cfs in anticipation of the Delta-Mendota Canal intertie with the California Aqueduct. The future conditions indicate that Reclamation will maximize its pumping during the months of November through January (*i.e.*, 4,600 cfs) as often as possible. Figure 6-51 (the 50th percentile monthly export rates) indicates that these maximum rates will occur in most months when conditions permit as illustrated by the 95th percentile whisker bars, leaving only April, May, and June below the maximum pumping rate. Wet years tend to present the conditions when Reclamation can take advantage of the intertie and maximal pumping at 4,600 cfs compared to other water year types (figures 6-52 through 6-57). The comparisons between the current studies (6.0 and 7.0) and the future studies (7.1 and 8.0) indicate that only in the months of March and April are pumping rates typically lower in the future operations than in the current operations. The month of May, particularly in drier water years, has higher pumping rates than current operations. In critically dry years, the future conditions have higher pumping rates during the October through May period compared to those seen in the current operations. In the current studies (6.0 and 7.0), pumping is reduced in December, January, and February by the 25 TAF restrictions imposed by the EWA Program. Additional reductions occur in all four studies during the VAMP export reductions, but only the current studies have additional reductions associated with the EWA expenditures to supplement the VAMP shoulders in May for continued export reductions. The future studies (7.1 and 8.0) do not include these additional export reductions, presumably due to the limited EWA assets available. All four studies indicate that pumping will increase during the summer (July through September) for irrigation deliveries. The future studies increase the most during wet and above normal water year types, reaching near maximal pumping rates, while the drier water year types show mixed increases between the different modeling runs.

The modeling studies completed for the CVP/SWP operations BA indicate that total Banks exports increase in December, January and February for studies 7.1 and 8.0 due to the lack of full EWA assets as compared to the full EWA assets modeled for the current conditions (Studies 6.0 and 7.0). The modeling also indicates that the 50th percentile pumping rates approach or exceed 7,000 cfs during wet years and can exceed 8,000 cfs during January and February at the 95th percentile (see figure 6-58). Furthermore, the reductions in pumping during the April and May VAMP export curtailment are less than under the current operational conditions. This is created by the lack of sufficient volumes of water available (including the 48,000 AF available in-Delta from the Yuba River Accord) to offset the export reductions at Banks. During summer months (July to September), the future operations are modeled to include an additional 500 cfs above the 6,880 cfs maximum to offset “fish” related export reductions earlier in the year. The average

monthly pumping levels at Banks are shown in figure 6-59 and clearly indicate that on average, the future operational conditions will have higher pumping rates from December through May than under the present conditions. This trend holds through most of the water year types, with future pumping levels being equivalent to or higher than the current operations during the winter and spring months in just about all monthly comparisons (figures 6-60 through 6-64).

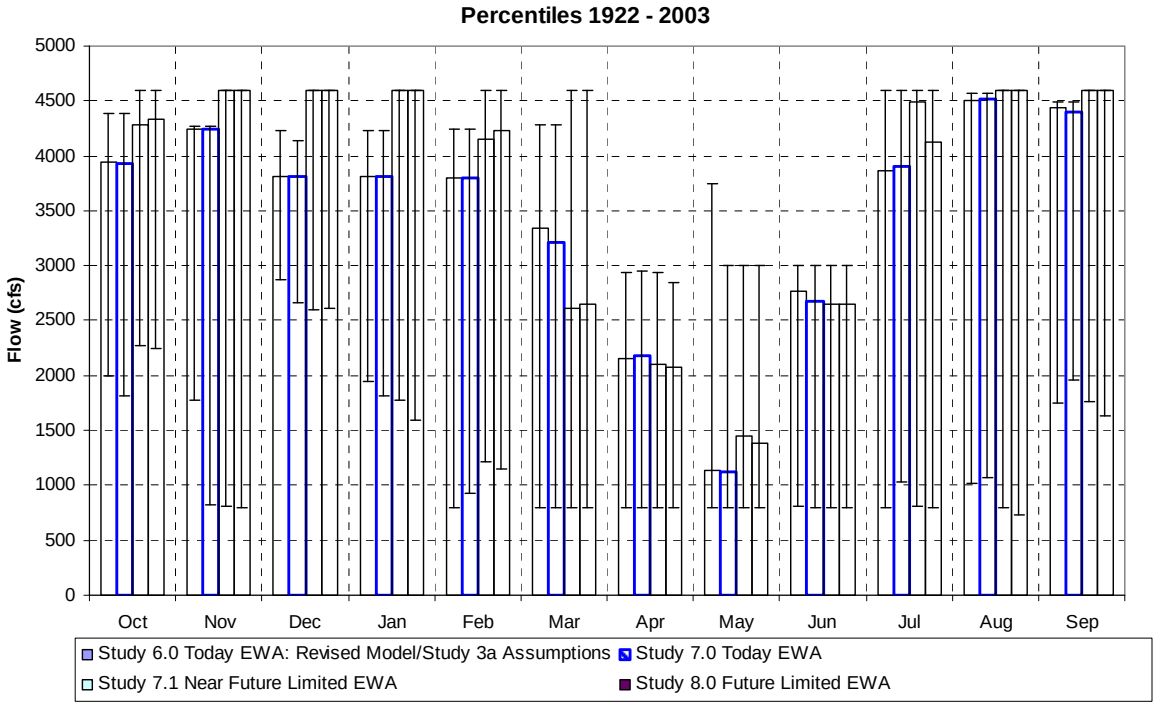


Figure 6-51. Monthly CVP export pumping rate, 50th percentile with 5th and 95th percentile whisker bars (CVP/SWP operations BA figure 12-18).

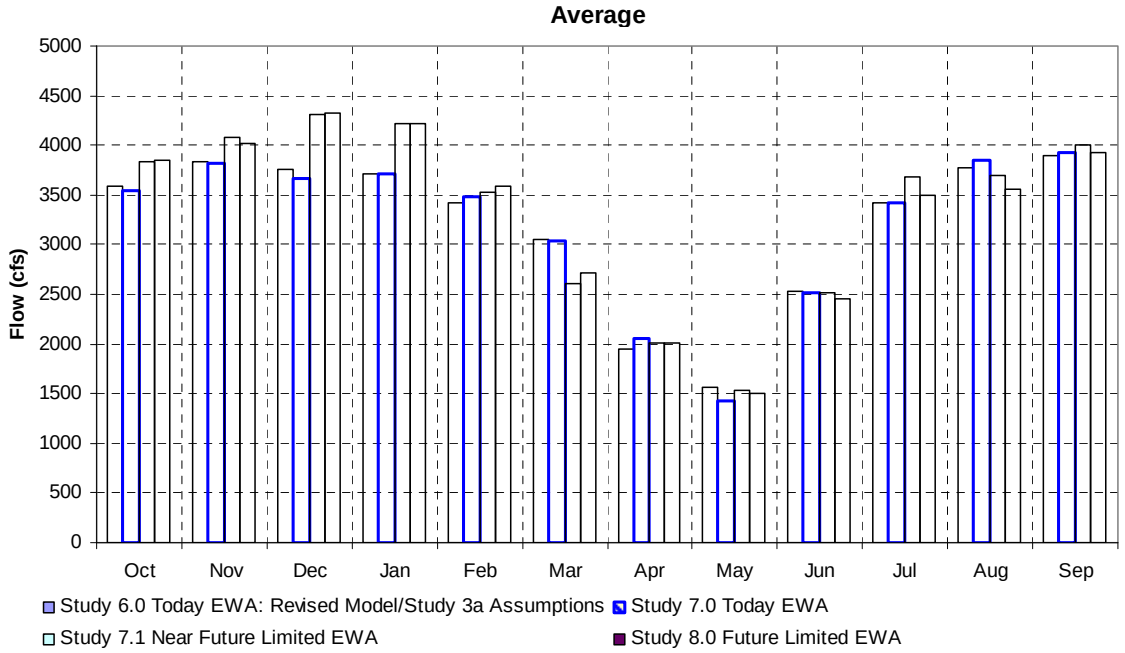


Figure 6-52. CVP monthly average export rate (CVP/SWP operations BA figure 12-19).

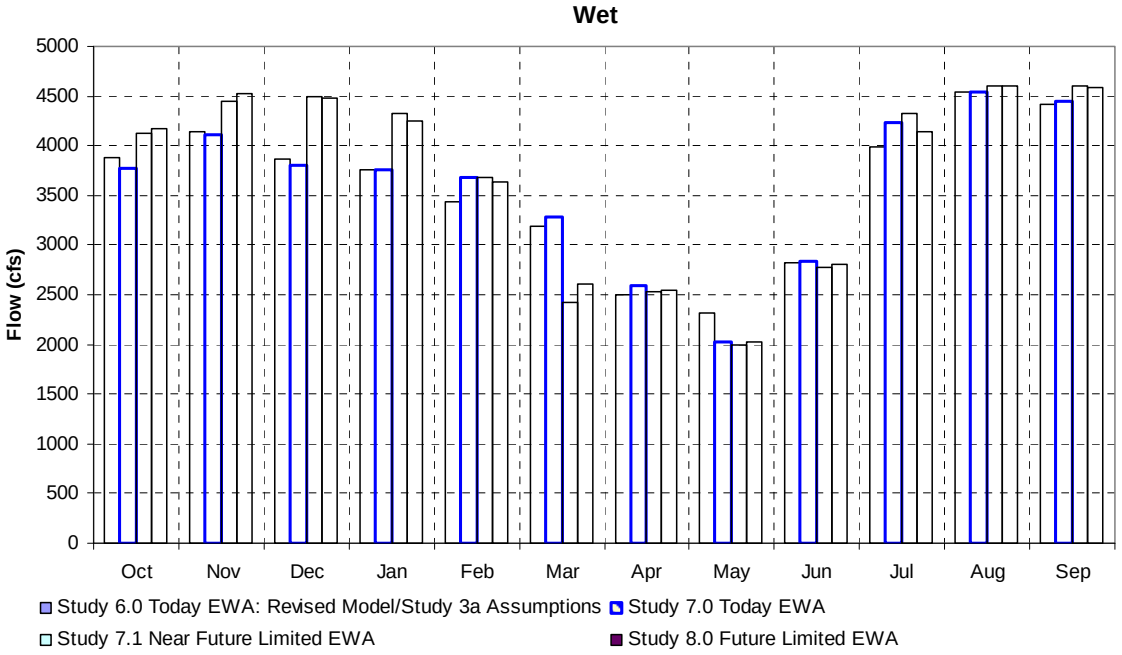


Figure 6-53. Average wet year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-20).

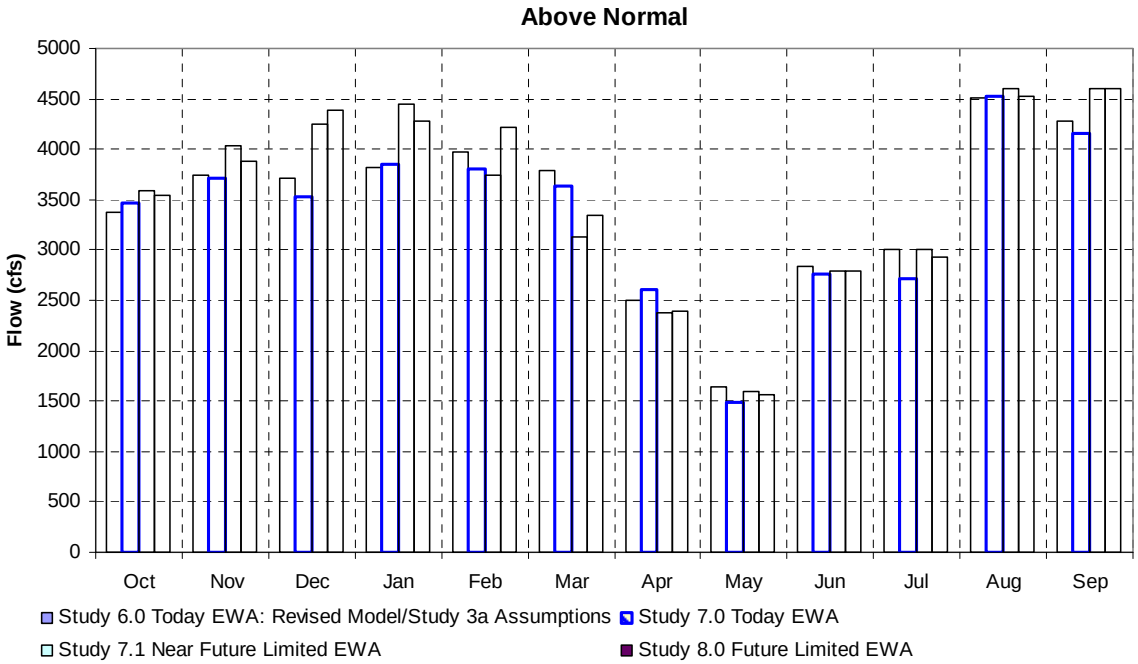


Figure 6-54. Average above normal year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-21).

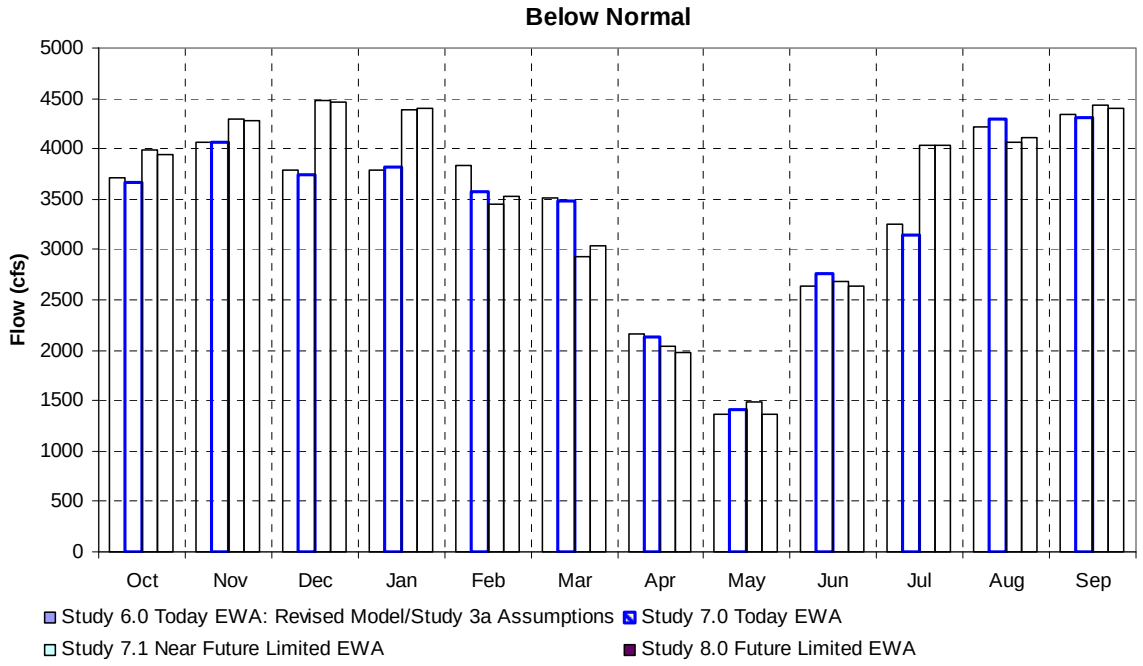


Figure 6-55. Average below normal year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-22).

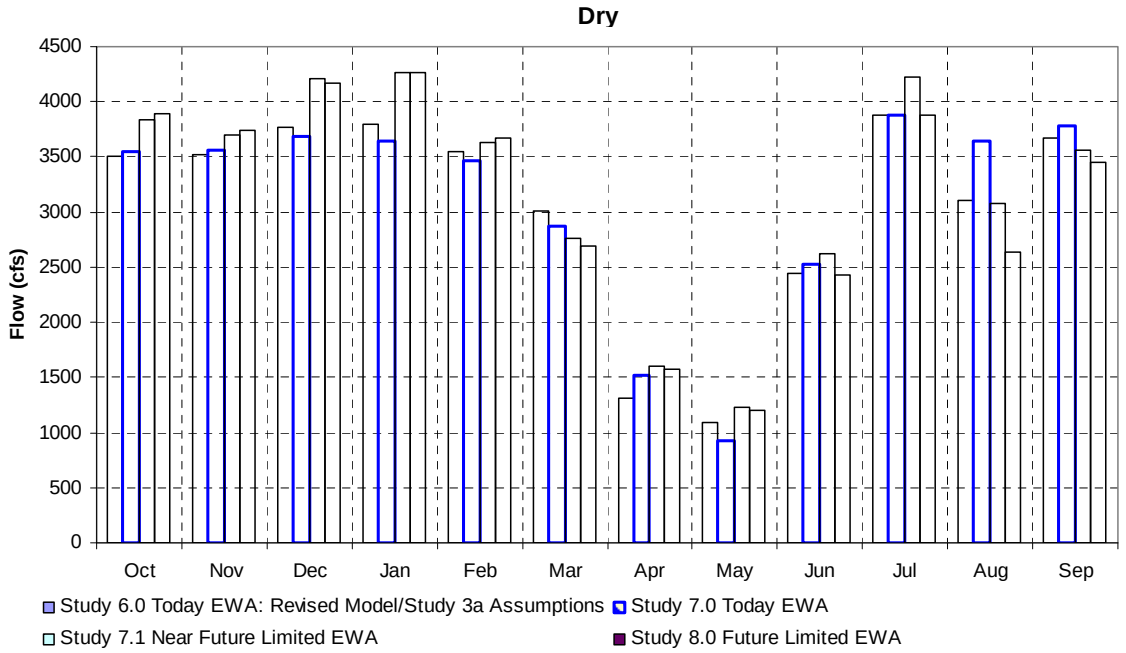


Figure 6-56. Average dry year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-23).

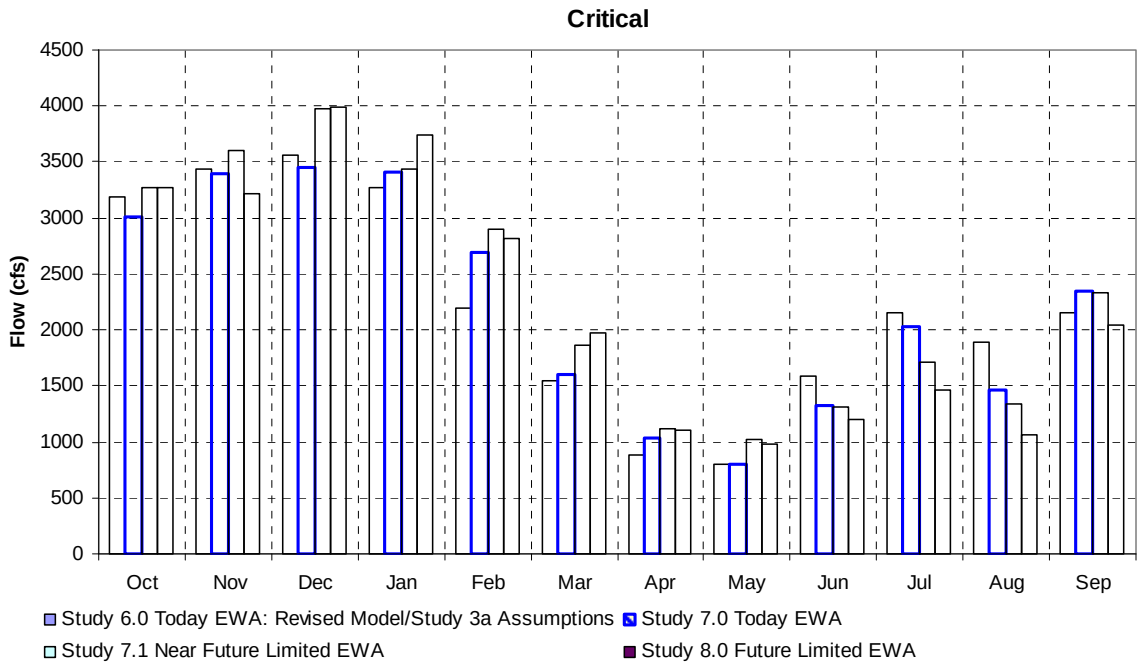


Figure 6-57. Average critically dry year (40-30-30) monthly CVP export rate (CVP/SWP operations BA figure 12-24).

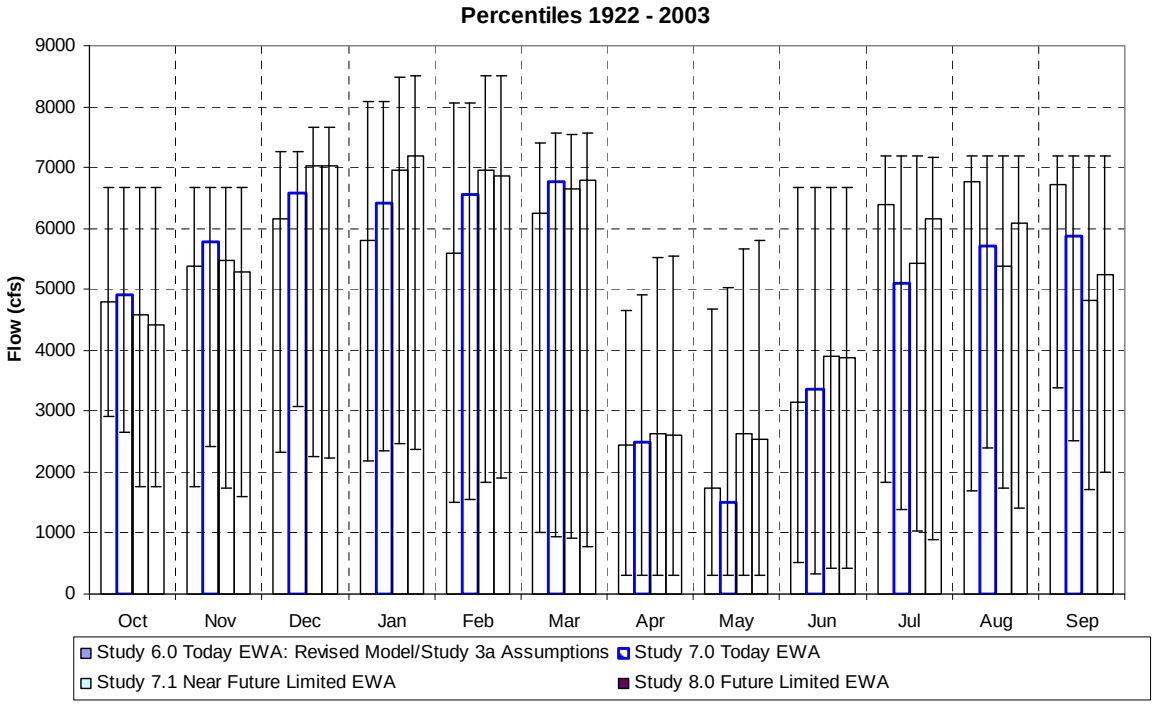


Figure 6-58. Monthly SWP export pumping rate, 50th percentile with 5th and 95th percentile whisker bars (CVP/SWP operations BA figure 6-25).

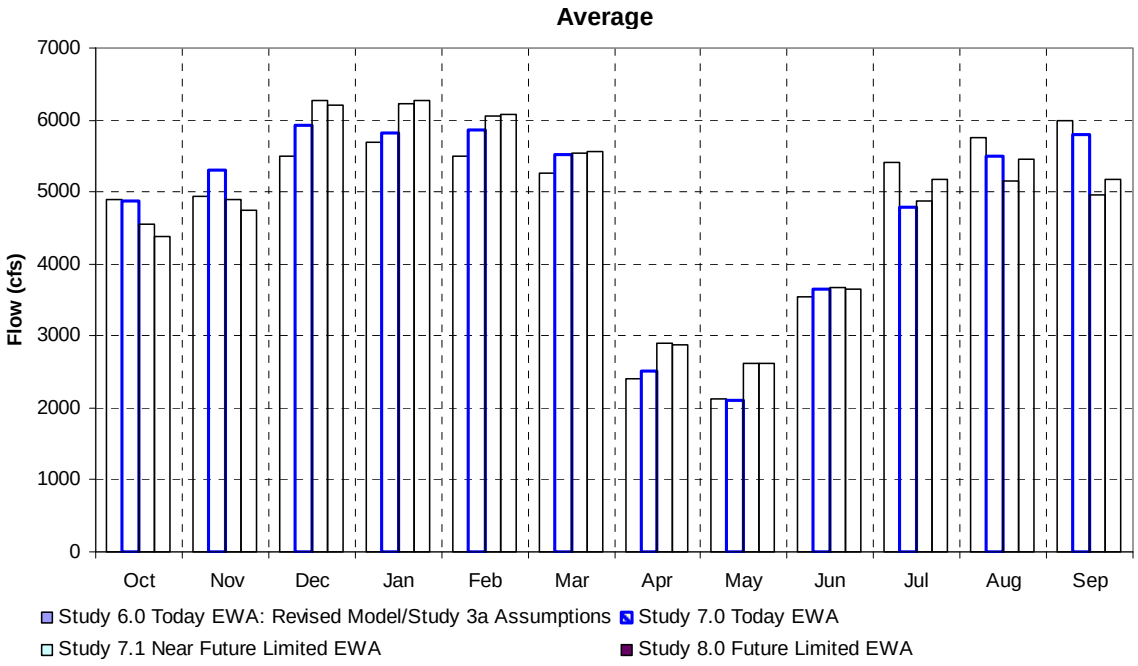


Figure 6-59. SWP monthly average export rate (CVP/SWP operations BA figure 12-26).

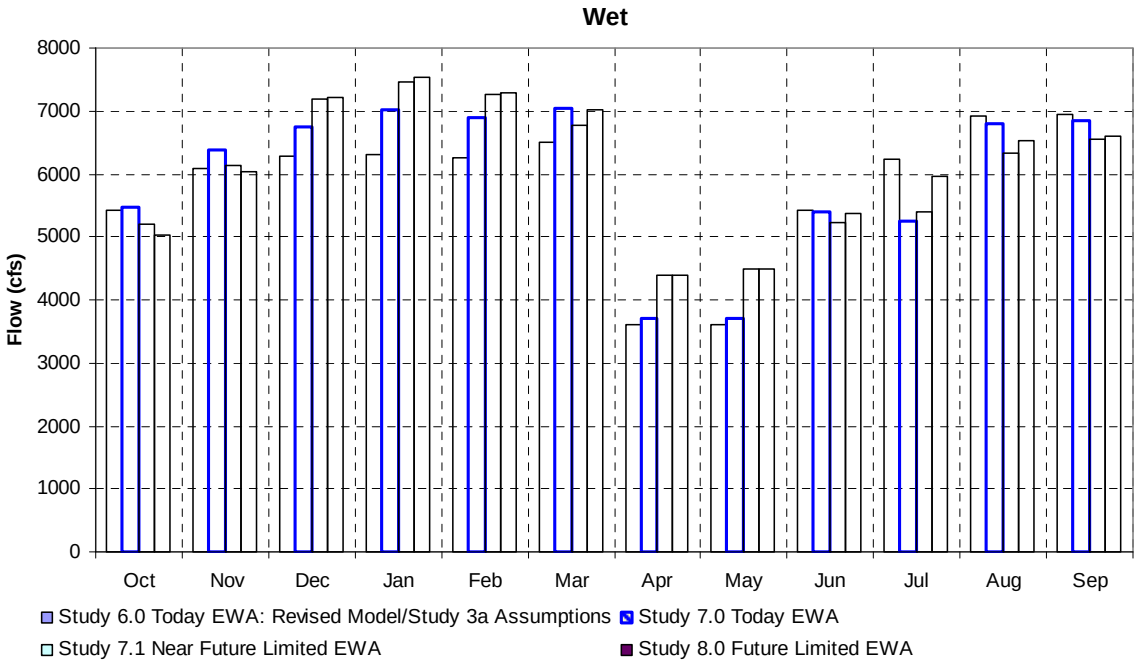


Figure 6-60. Average wet year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-27).

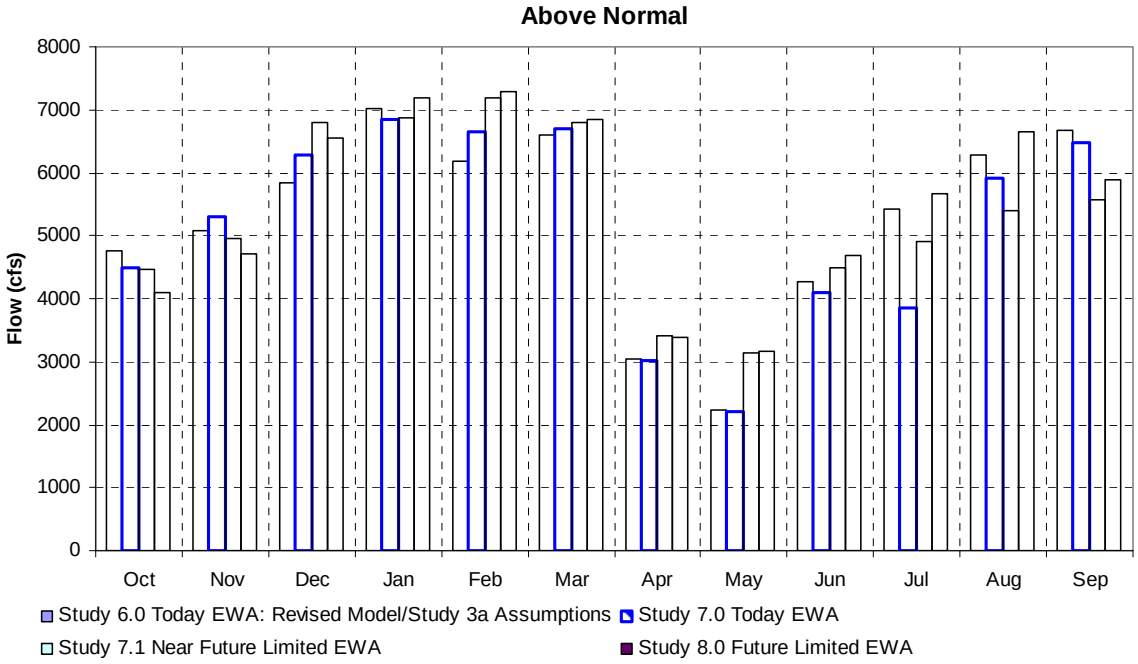


Figure 6-61. Average above normal year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-28).

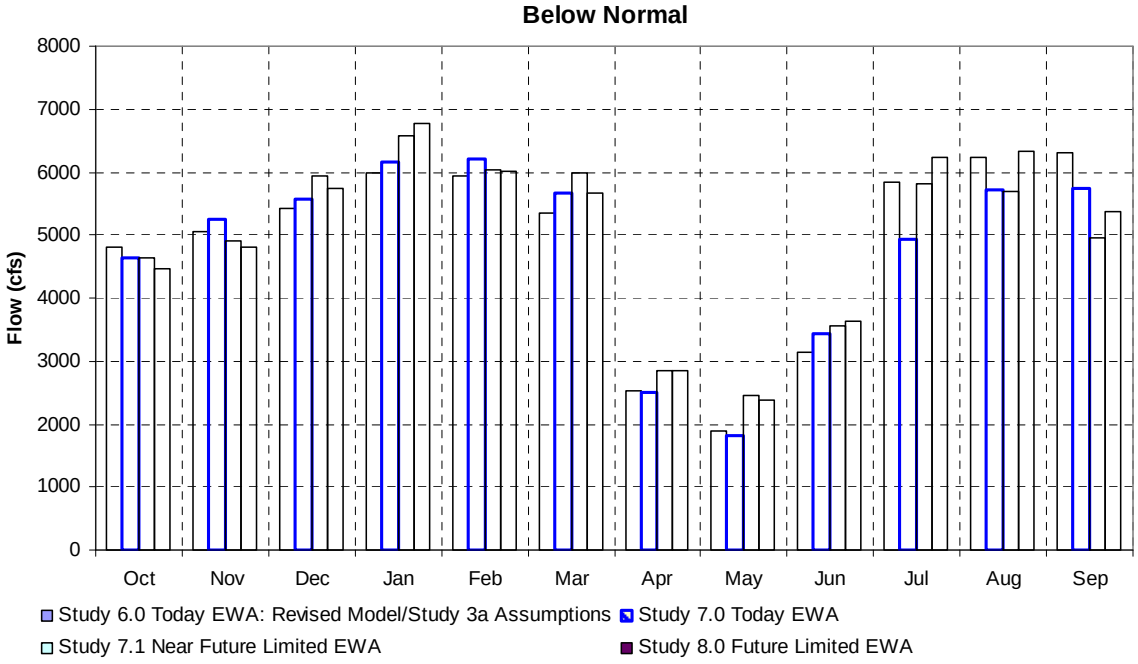


Figure 6-62. Average below normal year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-29).

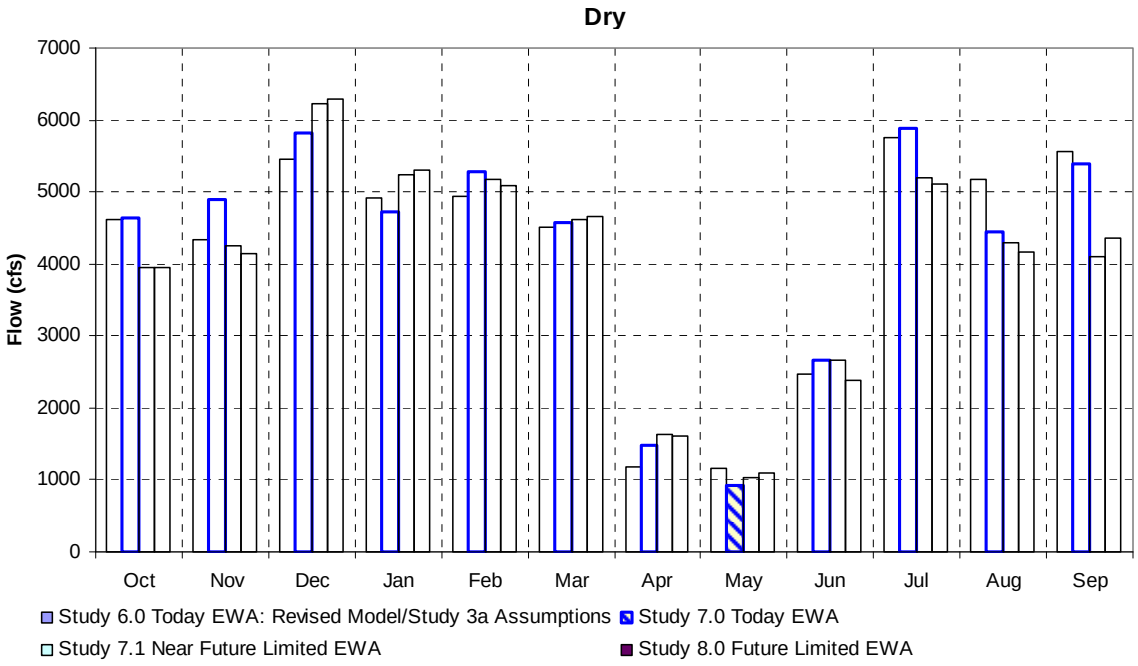


Figure 6-63. Average dry year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-30).

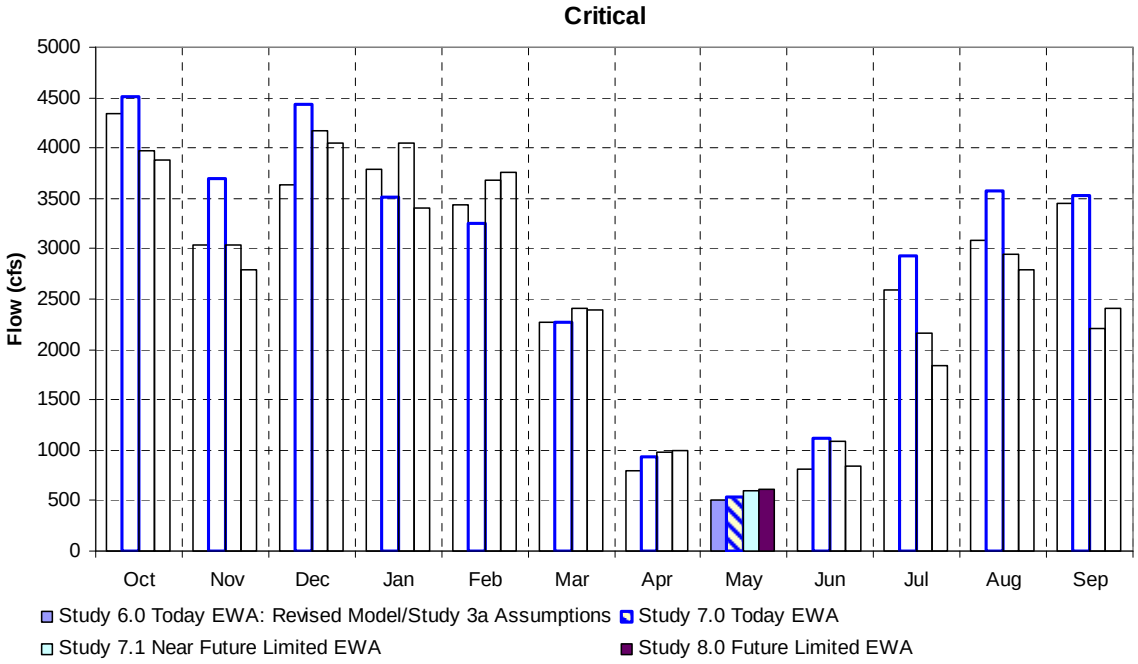


Figure 6-64. Average critically dry year (40-30-30) monthly SWP export rate (CVP/SWP operations BA figure 12-31).

Federal pumping at the Banks facility typically occurs in late summer and extends through October. Additional pumping to supply Cross Valley Contractors may occur during the winter months (November through March). The modeling indicates that the average Federal pumping

at the Banks facility is approximately 80 TAF with the future operations having slightly higher pumping needs than the current operations as modeled in Study 7.0. Pumping in Study 7.1 is slightly higher (5 TAF) due to the lack of EWA wheeling relative to Study 7.0. The available capacity at Banks for Federal pumping is reduced in Study 8.0 due to increased SWP demands South of Delta, which reduces the frequency of the pumping availability for Federal use.

The Barker Slough pumping plant diverts water from Barker Slough into the North Bay Aqueduct (NBA) for delivery to Napa and Solano Counties. Current pumping capacity is 140 cfs due to limitations in the number of pumps at the facility. An additional pump is required to reach the pipeline design capacity of 175 cfs. During the past several years, daily pumping rates have ranged between 0 and 140 cfs. There has been no discernable trend in monthly pumping levels since 2000 (Dayflow database) although the annual pumping rate for water year 2007 was higher than in previous years (83 cfs). Seasonal pumping rates during the years 2005 to 2007 were 109 cfs in summer (June to August), 94 cfs in fall (September through November), 39 cfs in winter (December through February), and 36 cfs in spring (March through May). The recent historical data indicates that actual pumping levels are substantially less than those predicted in the CALSIM II current conditions scenario (Study 7.0) during the winter and spring months. For instance, the month of December has an average historical export rate of 52 cfs for the years 2005 through 2007. The estimated export rate for December from Study 7.0 is 116 cfs. The historical rate is only 44 percent of the modeled export rate. Similarly, the historical export rate for the month of April (2005 through 2007) is 31 cfs, while the estimate from Study 7.0 is 133 cfs. The historical export rate is only 23 percent of the modeled export rate.

During the summer, seasonal pumping rate for the modeled studies 7.0 and 7.1 are not substantially different from each other (average rates were 115 cfs and 107 cfs, respectively) but both were lower than the future condition modeled in Study 8.0 (135 cfs), a difference of 15 to 20 percent. The historical value for the summer season (2005 to 2007) is 109 cfs, relatively similar to the modeled current conditions. NBA diversions are lowest in fall, averaging 101 cfs in study 7.0, 99 cfs in study 7.1, and 123 cfs in study 8.0. The historical pumping rate during the fall (2005 to 2007) was 94 cfs. Modeled NBA diversions are highest during the winter months. There was very little difference between Studies 7.0 and 7.1 during the winter. However, study 8.0 differed from the other two studies, being greater in December (142 cfs versus 116cfs and 112 cfs) and lower in January (112 cfs versus 157 cfs and 155 cfs) and February (126 cfs versus 155 cfs and 154 cfs). All of the modeled pumping estimates are significantly greater than the historical average of 39 cfs for the period between December and February (2005 to 2007). Modeling estimates for the spring period also were substantially greater than the historical values from 2005 to 2007. The estimates for Study 8.0 export rates were also greater than those for Studies 7.0 and 7.1. For April, Study 8.0 had a diversion rate of 145 cfs while study 7.0 (133 cfs) and Study 7.1 (128 cfs) were lower, a difference of approximately 10 percent. For May, Study 8.0 also had a diversion rate of 145 cfs, which is approximately 25 percent higher than the estimated rates for Studies 7.0 and 7.1 (both 116 cfs). Study 8.0 estimated an export rate of 148 cfs for June, approximately 18 percent higher than the estimates for Study 7.0 (126 cfs), and Study 7.1 (123 cfs). The historical export rate for the spring period between 2005 and 2007 was 36 cfs.

Under the current operating parameters, the projects must comply with California State Water Resources Control Board (SWRCB) D-1641 limitations on the ratio of project exports to the volume of water entering the Delta during the year. This is termed the E/I ratio. The E/I ratio regulates the proportion of water that can be exported by the CVP and SWP in relation to the water that is entering the Delta and is thus available for export. During the summer and fall, E/I ratios are permitted to be higher (a maximum of 65 percent July through December) and therefore pumping rates are increased, allowing the facilities the flexibility to maximize exports (within the constraints of D-1641 and other regulatory limits) during the lower summer and fall Delta inflows. The E/I ratio is restricted to a 35 percent maximum during the February through June period when Delta inflows are typically higher. However, the actual volume of exports can increase significantly when the inflow volumes are high, while still maintaining the same overall E/I ratio. Furthermore, the E/I ratio is essentially determined by the flow volume of the Sacramento River, which comprises approximately 80 percent of the Delta river inflow. This creates a situation where the near field hydraulic conditions in the central and southern Delta waterways are affected to a greater extent than the northern delta waterways due to their proximity to the Project's points of diversion in the South Delta. The modeling for E/I ratios indicate that future operations (Studies 7.1 and 8.0) will have greater E/I ratios during the months of December, January, February, April, May and June compared to Studies 6.0 and 7.0, which typically allocated EWA assets in these months to decrease pumping levels. The limited EWA conditions in the future do not take any actions to reduce exports in the winter and only implement limited actions in the spring (*i.e.*, VAMP). Both current and future operations show increased E/I ratios in the summer months, except during dry and critically dry months, where the future models show decreases in some years. The CVP/SWP operations BA indicates that this is due to low reservoir storage or water quality issues, such as salinity, limiting the ability to pump. The modeling results indicate that due to the increased E/I ratios, the waterways of the South and Central Delta will experience more situations where flows towards the pumps are enhanced than under the current operating conditions.

In summary, historical average annual Delta inflow (1980 – 1991) is approximately 28 MAF (DWR 1995). Current operations divert approximately 6 to 8 MAF of water annually from the Delta (DWR 1995, CALFED 2008, State of California 2008). The modeling completed for the CVP/SWP operations BA indicates that Delta inflows will decrease approximately 200 to 300 TAF annually under the future conditions beyond those already occurring under the current operational scenario. The historical inflow has already been reduced by upstream water diversions to meet current demands in the Central Valley. The additional upstream withdrawals act on top of these withdrawals, thus further diminishing the volume of water reaching the Delta.

Likewise, annual Delta outflow will decrease approximately 300 to 400 TAF under the future operations as compared to the current operations (21 MAF). Most of this decrease will occur in the winter and spring due to limited EWA resources to decrease pumping levels during this time period. This exacerbates an already adverse situation for listed salmonids and green sturgeon created by the current CVP and SWP operations which have elevated winter/spring export levels. This period of elevated exports in winter and spring occurs during the season in which most salmonid runs emigrate through the Delta, as described in the environmental baseline. The lack of data for juvenile and sub-adult green sturgeon makes the effects determination less clear for

this species of fish. Under the proposed action, the CVP will increase its pumping limits from 4,200 cfs to 4,600 cfs in response to the proposed intertie between the Delta-Mendota Canal and the California Aqueduct. Reclamation intends to maximize its pumping capacity between November and January by utilizing the 4,600 cfs capacity to its fullest extent. This will result in higher future pumping levels during this time period compared to the current operations, which will increase the exposure of early migrating salmonids to the effects of the exports. Modeling of future conditions also indicates that pumping will decrease, on average, in March and April. Future conditions also indicate that pumping in May will increase over current levels following the VAMP reductions, ultimately resulting in less protection for fish. This action will curtail the extent of post-VAMP shoulders. The future conditions also indicate that pumping will be increased, on average, during the summer in wet years compared to current operations. The modeling for the future SWP operations indicates that it will increase its exports in the months of December, January, and February to the greatest extent possible within the constraints of the regulatory environment. The rationale offered is that since it has limited EWA assets, the SWP will not be able to make any reductions in pumping for fish-related actions, which would normally be offset by EWA assets. The future modeling results also indicate that pumping rates will frequently be over 7,000 cfs during these months and as high as 8,000 cfs when San Joaquin River flows permit the additional capacity. Furthermore, average pumping rates are forecast to be higher during the December through May period than current averages, with less reductions occurring in April and May for VAMP due to less EWA assets available for fish protection measures.

This change in the export regime increases the vulnerability of listed salmonids emigrating through the Delta. The effects on listed green sturgeon are less clear due to the more ambiguous period of juvenile emigration into the Delta. Currently, the CVP and SWP have elevated export schedules during the early winter and late spring period (except for the period encompassing the VAMP experiment) to take advantage of higher flows of water passing through the Delta. The result of this export paradigm is that listed salmonids emigrating through the Delta with these flows are exposed to the increased exports.

The Federal use of the SWP facilities will amount to approximately 80 TAF per year, and will change little between the current and future conditions. Maximal usage of the SWP facilities by Reclamation will occur during the summer months and may result in an increase of up to 1,000 cfs of pumping in years with above normal hydrology, but is more likely to range between 400 and 600 cfs. The E/I ratios are more likely to be higher, on average, in the future compared to current operations, particularly during the critical salmonids migration months of December, January, February, April, May, and June. The explanation offered in the CVP/SWP operations BA is that the limited EWA assets will preclude pumping reductions to benefit fish.

6.6.2.3 Assess Species Exposure

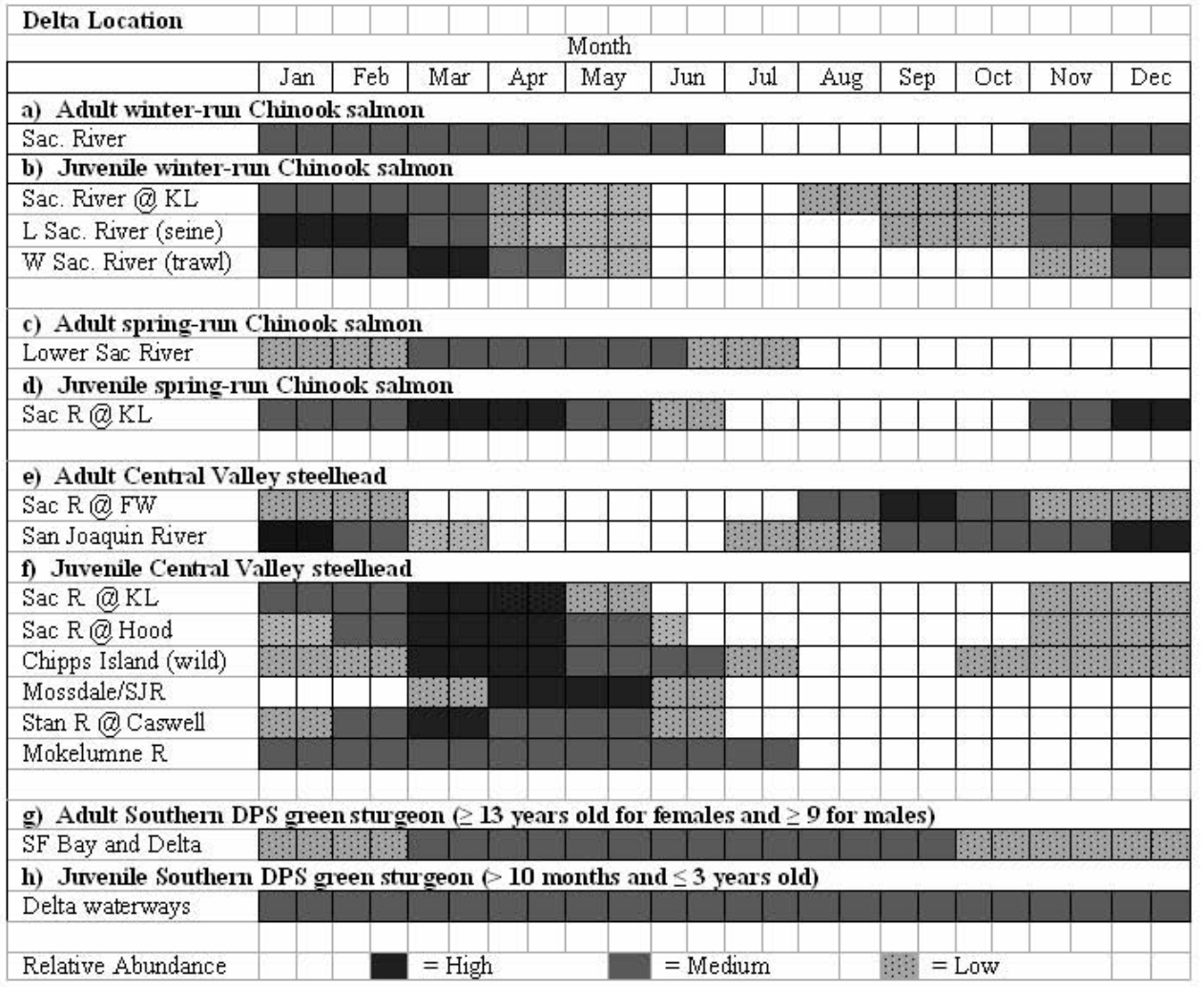
The Sacramento-San Joaquin Delta (figure 5-23) serves as the gateway through which all listed anadromous species in the Central Valley must pass through on their way to spawning grounds as adults or returning to the ocean as juveniles, or post-spawn steelhead and green sturgeon adults. For the purposes of this analysis, “exposure” is defined as the temporal and spatial co-

occurrence of adult and juvenile (smolts and fry) life stages of the four listed species and the stressors associated with the proposed action. The temporal and spatial occurrence of each of the runs of Chinook salmon, CV steelhead, and green sturgeon in the Delta is intrinsic to their natural history and the exposure to the proposed action can be anticipated based on their timing and location.

6.6.2.3.1 Temporal Occurance

Table 6-27 provides the temporal distribution of listed anadromous fish species within the Delta.

Table 6-27. Temporal distribution of anadromous fish species within the Delta (KL = Knights Landing, FW = Fremont Weir).



6.6.2.3.1.1 Winter-Run

Adult winter-run first enter the San Francisco Bay Estuary from the Pacific Ocean starting in November. Adults continue to enter the bay throughout the winter months and into late spring

(May/June), passing through the Delta region as they migrate upriver towards their spawning grounds below Keswick Dam (CVP/SWP operations BA; USFWS 2001, 2003).

The main pulse of emigrating juvenile winter-run from the upper Sacramento River enter the Delta in December and January and can extend through April, depending on the water year type. Beach seines and mid-water trawls on the mainstem Sacramento River near the City of Sacramento indicate that some fish enter the Delta as early as mid-November and early December (USFWS 2001, 2003). Monitoring by the USFWS at Chipps Island in the western Delta indicates that winter-run are detected leaving the Delta from September through June, with a peak in emigration occurring in March and April. This peak in emigration timing is supported by the pattern of recoveries of winter-run sized Chinook salmon at the SWP's Skinner Fish Protection Facility and the CVP's Tracy Fish Collection Facility (TFCF) in the South Delta. In addition to the seasonal component of juvenile emigration, distinct increases in recovered fish appear to be correlated with high precipitation events and increases in-river flow and turbidity following rain events (USFWS 2001, 2003). Based on analysis of scales, winter-run smolts enter the ocean environment at an average fork length of 118 mm, indicating a freshwater residence time of approximately 5 to 9 months, most of which is presumed to occur upstream between RBDD and the Delta.

Juvenile winter-run are present in the waterways of the North Delta (*i.e.*, Sacramento River, Steamboat Slough, Sutter Slough, Miner Slough, and Cache Slough complex), Central Delta (Georgiana Slough, DCC, Snodgrass Slough, and Mokelumne River complex below Dead Horse Island), South Delta leading to the CVP and SWP pumping facilities including Old and Middle Rivers, and the interconnecting waterways between these main channels such as Victoria Canal, Woodward Canal, and Connection Slough, and the western Delta including the main channels of the San Joaquin and Sacramento rivers and Three Mile Slough. NMFS does not anticipate seeing adult winter-run upstream of Middle River on the San Joaquin River mainstem or within the waterways of the South Delta in any appreciable numbers. NMFS does not anticipate seeing any significant numbers of juvenile winter-run in the Eastern Delta near Stockton (*i.e.*, White Slough, Disappointment Slough, Fourteenmile Slough), or the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts. Presence of winter-run adults and juveniles may occur in other parts of the Delta not described above.

6.6.2.3.1.2 Spring-Run

Adult spring-run enter the San Francisco Bay Estuary from the ocean in January to late February. They move through the Delta prior to entering the Sacramento River system. Spring-run show two distinct juvenile emigration patterns in the Central Valley. Fish may either emigrate to the Delta and ocean during their first year of life as YOY, typically in the following spring after hatching, or hold over in their natal streams and emigrate the following fall as yearlings. Typically, yearlings enter the Delta as early as November and December and continue to enter the Delta through at least March. They are larger and less numerous than the YOY smolts that enter the Delta from January through June. The peak of YOY spring-run presence in the Delta is during the month of April, as indicated by the recoveries of spring-run size fish in the CVP and SWP salvage operations and the Chipps Island trawls. Frequently, it is difficult to distinguish

the YOY spring-run outmigration from that of the fall-run due to the similarity in their spawning and emergence times. The overlap of these two runs makes for an extended pulse of Chinook salmon smolts through the Delta each spring, frequently lasting into June.

Juvenile spring-run are present in the same waterways as winter-run in the North Delta, Central Delta, South Delta, and the interconnecting waterways, including the main channels of the San Joaquin and Sacramento rivers and Three Mile Slough. NMFS does not anticipate seeing any significant numbers of juvenile spring-run in the Eastern Delta or the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts.

6.6.2.3.1.3 CV Steelhead

Adult steelhead have the potential to be found within the Delta during any month of the year. Unlike Chinook salmon, steelhead can spawn more than once, so post-spawn adults (typically females) have the potential to move back downstream through the Delta after completing their spawning in their natal streams. These fish are termed runbacks or kelts. Typically, adult steelhead moving into the Sacramento River basin begin to enter the Delta during mid to late summer, with fish entering the Sacramento River system from July to early September. Kelts are typically seen later in the spring following spawning. Steelhead entering the San Joaquin River basin are believed to have a later spawning run. Adults enter the system starting in late October through December, indicating presence in the Delta a few weeks earlier. Typically water quality in the lower San Joaquin River is marginal during this time, with elevated water temperatures and low DO levels presenting barriers to upstream migration. Early winter rains help to break up these barriers and provide the stimulus to adult steelhead holding in the Delta to move up river towards their spawning reaches in the San Joaquin River tributaries. Fish may continue entering the system through the winter months. Juvenile steelhead are recovered in the USFWS Chipps Island trawls from October through July. There appears to be a difference in the emigration timing between wild and hatchery-reared steelhead smolts. Adipose fin-clipped hatchery fish are typically recovered at Chipps Island from January through March, with the peak in recoveries occurring in February and March. This time period corresponds to the schedule of hatchery releases of steelhead smolts from the different Central Valley hatcheries (Nobriga and Cadrett 2003, CVP/SWP operations BA). The timing of wild steelhead (unclipped) emigration is more spread out. Emigration occurs over approximately 6 months, with peaks in February and March, based on salvage records at the CVP and SWP fish collection facilities. Individual unclipped fish first begin to be collected in fall and early winter, and may extend through early summer (June and July). Wild fish that are collected at the CVP and SWP facilities late in the season may be from the San Joaquin River system, based on the proximity of the basin to the pumps and the timing of the spring pulse flows in the tributaries (April-May). The size of emigrating steelhead smolts typically ranges from 200 to 250 mm in length, with wild fish tending to be at the upper end of this range (Nobriga and Cadrett 2003, CVP/SWP operations BA).

Given the multiple points of entry into the Delta system, CV steelhead are likely to be found in any of the waterways of the Delta, but particularly in the main channels leading to their natal river systems.

6.6.2.3.1.4 Southern DPS of Green Sturgeon

Adult green sturgeon enter the San Francisco Bay estuary in early winter (January/February) before initiating their upstream spawning migration into the Delta. Adults move through the Delta from February through April, arriving in the upper Sacramento River between April and June (Heublein 2006, Kelly *et al.* 2007). Following their initial spawning run upriver, adults may hold for a few weeks to months in the upper river (*i.e.*, GCID aggregation site; see Vogel 2005, 2008) or immediately migrate back down river to the Delta. Those fish that hold upriver move back downstream later in the fall. Radio-tagged adult green sturgeon have been tracked moving downstream from the GCID aggregation site past Knights Landing during the summer and fall into November and December, following their upstream migrations the previous spring. It appears that pulses of flow in the river "trigger" downstream migration in the late fall, similar to behavior exhibited by adult green sturgeon on the Rogue and Klamath River systems (Erickson *et al.* 2002, Benson *et al.* 2007).

Adults and sub-adults may also reside for extended periods in the western Delta as well as in Suisun and San Pablo bays. Like other estuaries along the west coast of North America, adult and sub-adult green sturgeon (from both Northern and Southern DPSs) frequently congregate in the tidal portions of the San Francisco Bay estuary during the summer and fall. It is not known exactly why these congregations occur, but they do not appear to be related to spawning activities, as most fish do not move upriver out of tidewater. Based on radio and acoustic tag data gathered to date from adult green sturgeon, fish that spawn in one river system do not spawn in other river systems.

Juveniles are believed to use the Delta for rearing for the first 1 to 3 years of their life before moving out to the ocean. Green sturgeon are likely to be found in the main channels of the Delta and the larger interconnecting sloughs and waterways, with western Delta waterways having a higher likelihood of presence than eastern Delta waterways. Juveniles are recovered at the SWP and CVP fish collection facilities year round and range in size from 136 mm to 774 mm, with an average size of 330 mm.

6.6.2.3.2 Spatial Distribution

6.6.2.3.2.1 Winter-Run

The main adult winter-run migration route through the Delta region is believed to be the mainstem of the Sacramento River. However, there is the potential for adults to "stray" into the San Joaquin River side of the Delta while on their upstream migration, particularly early in the migratory season (November and December). Significant amounts of Sacramento River water flow into the San Joaquin River side of the Delta through the DCC (when open in November, December, and January), Georgiana Slough, and Three Mile Slough. These sources of Sacramento River water can create false attraction into the lower San Joaquin River. Adult winter-run that choose this path would be delayed in their upstream migration while they mill in the lower San Joaquin River, searching for the distinctive olfactory cues of the Sacramento River. Adults could re-enter the Sacramento River through Georgiana Slough or the Delta

reaches of the Mokelumne River system when the DCC is open. The extent of this delay and the proportion of adults moving into the lower San Joaquin River are unknown. Adult winter-run do not typically inhabit the San Joaquin River mainstem upstream of Middle River or within the waterways of the South Delta in any appreciable numbers (Yoshiyama *et al*. 1996, 1998, 2001.

Juvenile winter-run are present in the waterways of the North Delta (*i.e.*, Sacramento River, Steamboat Slough, Sutter Slough, Miner Slough, and Cache Slough complex), Central Delta (Georgiana Slough, DCC, Snodgrass Slough, and Mokelumne River complex below Dead Horse Island), South Delta leading to the CVP and SWP pumping facilities including Old and Middle Rivers, and the interconnecting waterways between these main channels such as Victoria Canal, Woodward Canal, and Connection Slough, and the western Delta including the main channels of the San Joaquin and Sacramento rivers and Three Mile Slough. Juvenile winter-run do not typically inhabit the channels of the Eastern Delta near Stockton (*i.e.*, White Slough, Disappointment Slough, Fourteenmile Slough), or the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts.

6.6.2.3.2.2 Spring-Run

Currently, the only recognized populations of spring-run occur in the Sacramento River basin. Historical populations that occurred in the river basins to the south (*i.e.*, southern Sierra watersheds) have been extirpated. The main migration route for adult spring-run is the Sacramento River channel through the Delta. Similar to winter-run, adults may stray into the San Joaquin River side of the Delta due to the inflow of Sacramento River basin water through one of the interconnecting waterways branching off of the mainstem Sacramento River towards the San Joaquin River. Starting in February, the closure of the DCC radial gates minimizes the influence of this pathway, but flows in the channels of Georgiana and Three Mile Slough provide sufficient flows of water to the San Joaquin River to induce straying from “spurious” olfactory cues present in these waterways.

Juvenile spring-run are present in the same waterways as winter-run in the North Delta, Central Delta, South Delta and the interconnecting waterways, including the main channels of the San Joaquin and Sacramento rivers and Three Mile Slough. Juvenile spring-run do not typically inhabit the channels of the Eastern Delta or the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts.

6.6.2.3.2.3 CV Steelhead

Populations of CV steelhead occur throughout the watersheds of the Central Valley; however, the primary population source occurs within the watersheds of the Sacramento River basin. Small, apparently self-sustaining populations of steelhead exist in the Mokelumne River system (although influenced by the Mokelumne River Hatchery steelhead program), the Calaveras River (natural) and the Stanislaus River (natural). Furthermore, otilith microchemistry analysis has shown that juvenile *O. mykiss* collected from the Tuolumne and Merced rivers had maternal steelhead origins (Zimmerman *et al*. 2008). Upstream migrating adult steelhead enter both the Sacramento River basin and the San Joaquin River basin through their respective mainstem river

channels. Adult steelhead entering the Mokelumne River system (including Dry Creek and the Cosumnes River) and the Calaveras River system are likely to move up the mainstem San Joaquin River channel before branching off into the channels of their natal rivers. It is also likely that some adult steelhead bound for the San Joaquin River system may detour through the South Delta waterways and enter the San Joaquin River through the Head of Old River near Mossdale. However, due to the number of potential routes, the early entrance of adults into the Delta, and the potential for the DCC to remain open for a substantial portion of the upstream spawning migration, the "actual" route that an adult steelhead follows before committing to its natal watershed could be quite complex. Therefore, adult steelhead could be in any of the larger channels in the Delta region during their spawning migrations. Likewise, steelhead kelts could also be found in any of the channels of the Delta during their return to the ocean. Data for this particular life stage is lacking.

Outmigrating steelhead smolts enter the Delta primarily from the Sacramento River (North Delta region) and from the San Joaquin River (South Delta region). Steelhead smolts from the Mokelumne River system and the Calaveras River system enter the Eastern Delta. The Mokelumne River fish can either follow the north or south forks of the Mokelumne River through the Central Delta before entering the San Joaquin River at RM 22. Some fish may enter the San Joaquin River farther upstream if they diverge from the South Fork of the Mokelumne River into Little Potato Slough. Fish from the Calaveras River enter the San Joaquin River downstream of the Port of Stockton near RM 38. Steelhead smolts from the San Joaquin River basin enter the Delta at Mossdale. Prior to the installation of the Head of Old River Barrier (HORB) on approximately April 15 (start of VAMP), steelhead smolts exiting the San Joaquin River basin can follow either of two routes to the ocean. Fish may either stay in the mainstem of the San Joaquin River and move northwards towards the Port of Stockton and the Central Delta, or they may enter the South Delta through the Head of Old River and move northwards towards the lower San Joaquin River through Old and Middle rivers and their associated network of channels and waterways. When the HORB is not installed, approximately 50 percent of the San Joaquin River flow is directed into Old River. This percentage increases if the CVP and SWP are pumping at elevated levels. In fact, in low flow conditions with high pumping rates, the net flow in the mainstem of the San Joaquin between the Port of Stockton and Old River may reverse direction and flow upstream into the Head of Old River. When the HORB is installed, flow in the San Joaquin River is retained in the mainstem and fish are directed northwards towards the Port of Stockton and eventually through the Central Delta. Given the multiple points of entry into the Delta system, CV steelhead are likely to be found in any of the waterways of the Delta, but particularly in the main channels leading to their natal river systems.

6.6.2.3.2.4 Southern DPS of Green Sturgeon

Adult green sturgeon are presumed to primarily use the mainstem of the Sacramento River through the Delta when making their upstream spawning migrations. During high water conditions that result in the flooding of the Yolo bypass, adult green sturgeon may also utilize the floodplain of the Yolo bypass to move northwards from Cache Slough to the Sacramento River at Fremont Weir. During other times of the year, green sturgeon may be present in any of the waterways of the Delta, based on sturgeon tag returns. The draft report on the 2007 CDFG

Sturgeon Fishing Report Card (CDFG 2008) indicates that 311 green sturgeon were reported caught by sport anglers during 2007. Green sturgeon were caught in both the mainstem of the San Joaquin River between Sherman Island and Stockton (48 fish) and between Rio Vista and Chipps Island (62 fish), with most catches occurring in the fall, although fish were caught throughout the year in both reaches. Additional green sturgeon were caught and released in Suisun (30), Grizzly (14), and San Pablo (20) bays, as well as between Rio Vista and Knights Landing in the Sacramento River (16).

Juvenile and sub-adult green sturgeon are also found throughout the waters of the Delta. They have been recovered at the CVP and SWP fish collection facilities and from areas on the San Joaquin River near San Andreas Shoals.

6.6.2.4 Assess Species Response to the Proposed Action

6.6.2.4.1 Direct Entrainment Due to Exports

6.6.2.4.1.1 Tracy Fish Collection Facility - Current and Future Operations

The TFCF is located in the southwest portion of the Sacramento-San Joaquin Delta near the City of Tracy and Byron. It uses behavioral barriers consisting of primary and secondary louvers to guide entrained fish into holding tanks before transport by truck to release sites within the Delta. The original design of the TFCF focused on smaller fish (<200 mm) that would have difficulty fighting the strong pumping plant-induced flows, since the intake is essentially open to the Delta and also impacted by tidal action.

The primary louvers are located in the primary channel just downstream of the trashrack structure. The secondary louvers are located in the secondary channel just downstream of the traveling debris screen. The primary louvers allow water to pass through into the main Delta-Mendota intake channel and continue towards the Bill Jones Pumping Plant located several miles downstream. However, the openings between the louver slats are tight enough and angled against the flow of water in such a way as to prevent most fish from passing between them and, instead, guide them into one of four bypass entrances positioned along the louver arrays. The efficiency of the louver guidance array is dependent on the ratio of the water velocity flowing into the bypass mouth and the average velocity in the main channel sweeping along the face of the louver panels.

When south Delta hydraulic conditions allow, and within the original design criteria for the TFCF, the louvers are operated with the D-1485 objectives of achieving water approach velocities for striped bass of approximately 1 foot per second (fps) from May 15 through October 31, and for salmon of approximately 3 fps from November 1 through May 14. Channel velocity criteria are a function of bypass ratios through the facility. Due to changes in south Delta hydrology over the past 50 years, the present-day TFCF is able to meet these conditions approximately 55 percent of the time. This indicates that 45 percent of the time, the appropriate velocities in the primary channel and the corresponding bypass ratio are not being met and fish are presumed to pass through the louvers into the main collection channel behind the fish screen

leading to the pumps. The lack of compliance with the bypass ratios during all facility operations alters the true efficiency of louver salvage used in the expansion calculations and therefore under-estimates loss at the TFCF. The salvage estimates provided by the TFCF have not been recalculated to address these periods of noncompliance when the bypass ratios do not meet the specified operating criteria. The efficiency of the louvers is likely to vary in relation to the actual bypass ratio encountered.

Based on the project description, fish passing through the TFCF are required to be sampled for periods of no less than 20 minutes at intervals of every 2 hours when listed fish are present. This sampling protocol is expected to be implemented in the future operations of the TFCF. This is generally from December through June. Currently, sampling intervals are frequently 10 minutes every 2 hours, even though this sampling protocol is supposed to be used when listed fish are not present. Fish observed during sampling intervals are identified to species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites in the North Delta away from the pumps. Fish may be held for up to 24 hours prior to loading into the tanker trucks. Hauling trucks used to transport salvaged fish to release sites inject oxygen and contain an eight parts per thousand salt solution to reduce stress. The CVP uses two release sites, one on the Sacramento River near Horseshoe Bend and the other on the San Joaquin River immediately upstream of the Antioch Bridge.

It has been known for some time that the efficiencies of the TFCF can be compromised by changes in hydrology, debris clogging the louvers, the size of the fish being entrained, and the number of predators present in the collection facilities (Reclamation 1994, 1995). The louvers were originally designed for fish >38 mm in length. Studies by Reclamation in 1993 tested three size ranges of Chinook salmon for primary, secondary, and overall louver efficiency. The test fish ranged in size from 58 mm to 127 mm with the averages of the three test groups being 74.3, 94.0, and 97.5 mm in length. The average efficiency of the primary louvers at the TFCF was found to be 59.3 percent (range: 13 - 82 percent) and the secondary louvers averaged 80 percent (range: 72 - 100 percent) for Chinook salmon. Overall efficiency averaged 46.8 percent (range 12 - 71.8 percent) for Chinook salmon. Recent studies (Reclamation 2008) have indicated that under the low pumping regimen required by the VAMP experiment, primary louver efficiencies (termed capture efficiencies in the report since only one bypass was tested) can drop to less than 35 percent at the TFCF. The reductions in pumping create low velocities in the primary channel, and the necessary primary bypass ratios (>1) cannot be maintained simultaneously with the secondary channel velocities (3.0 to 3.5 fps February 1 through May 31) required under D-1485. These study results indicate that loss of fish can potentially increase throughout the entire louver system if the entire system behaves in a similar way as the test section performed in the experiments. Screening efficiency for juvenile green sturgeon is unknown, although apparently somewhat effective given that green sturgeon, as well as white sturgeon, have been collected during fish salvage operations. Studies by Kynard and Horgan (2001) tested the efficiency of louvers at guiding yearling shortnose sturgeon (*Acipenser brevirostrum*) and pallid sturgeon (*Scaphirhynchus albus*) under laboratory conditions. They found that louvers were 96 to 100 percent efficient at guiding these sturgeon species past the experimental array and to the flume bypass. However, both sturgeon species made frequent contacts with the louver array with their bodies while transiting the louver array. The authors also found that sturgeon would rest at the

junction between the louver array and the tank bottom for extended periods. This behavior may degrade the effectiveness of the louver array to guide fish towards the bypass.

In light of the data from the screen efficiency studies, the overall efficiency of the screens for Chinook salmon (46.8 percent) is approximately 62 percent of the "nominal" value of 75 percent efficient, the previously believed efficiency of the louvers. Bates and Jewett (1961 *op. cit*. Reclamation 1995) found the secondary louvers of the TFCF to be approximately 90 percent efficient for young Chinook salmon (> 38 mm in length), while Hallock *et al.* (1968) reported that the primary louvers had an efficiency of approximately 85 percent for similar-sized fish. This gives an overall efficiency of approximately 75 percent (0.90 x 0.85 = 0.765), which has been used in the calculations for determining salvage and loss at the TFCF. During the VAMP experimental period from approximately April 15 to May 15, the potential loss of Chinook salmon may be even greater. The efficiency of the primary louvers may only be 44 percent of the "standard" 80 percent efficiency originally claimed based on the 35 percent "capture" efficiency found in the low flow studies recently completed (Reclamation 2008). This essentially doubles the loss of fish moving through the screens due to the reduction in louver efficiency. It is likely that juvenile green sturgeon are also affected in a similar fashion as lower flows increase the potential for fish to slip through the angled louvers rather than being guided to the bypasses.

Currently, the louvers are cleaned from once to three times a day, depending on the debris load in the water. The salvage efficiency is significantly reduced during the louver cleaning process. During cleaning of the primary louvers, each one of the 36 individual louver panels is lifted by a gantry and cleaned with a stream of high-pressure water. The removal of the louver plate leaves a gap in the face of the louver array approximately 8 feet wide by 20 feet tall. The main pumps at the Bill Jones Pumping Plant continue to run during this process, pulling water through the gap in the louver array at a high velocity. The cleaning process for the primary array can take up to 3 hours to complete, during which time the efficiency of the louver system to screen fish is severely compromised. Similarly, the secondary louvers require that the four bypasses be taken off line to facilitate the cleaning of the louvers in the secondary channel. This process takes approximately 45 minutes to complete. When the bypasses are taken off line, fish are able to pass through the primary louvers due to the high primary channel velocity, which is often greater than the swimming capacity of the fish, pushing them through the louvers. Depending on the frequency of cleaning, screen efficiency is compromised from approximately 4 hours to 12 hours (1 to 3 cleaning cycles) per day, and substantial errors in the number of fish salvaged are likely to occur. Green sturgeon are also likely to be affected in a similar fashion by the removal of the louver screens during cleaning, perhaps even to a greater extent, since any gap along the bottom of the louver array where the louver panel comes in contact with the channel bottom could provide an access point to pass downstream of the louvers. Debris or sediment buildup could provide such a gap.

In response to the 2004 CVP/SWP operations Opinion issued by NMFS, Reclamation is conducting, or has proposed to conduct, studies designed to address the loss of listed fish caused by the louver cleaning operation (*Evaluation of the percent loss of salmonid salvage due to cleaning the primary and secondary louvers at the TFCF*. B. Bridges; principle investigator.

Report was scheduled to be completed by 2008), formulate alternative cleaning operations (*Design and evaluation of louvers and louver cleaners.* B. Mefford, R. Christensen, D. Sisneros, and J. Boutwell, principle investigators. Report was scheduled to be completed by 2008), and investigate the impacts of predators on juvenile Chinook salmon and Delta smelt in the primary channel (*Predator impacts on salvage rates of juvenile Chinook salmon and Delta smelt.* R. Bark, B. Bridges, and M.D. Bowen, principle investigators. This report is due in 2010). However, the project description does not contain any commitment to address these deficiencies and it may be several years before these reports and their proposed remedies transform the operations of the TFCF.

The TFCF will primarily have direct impacts on emigrating salmonids during their juvenile and smolt life history stages, as well as juvenile green sturgeon rearing in the south Delta region. These life history stages are vulnerable to the entrainment effects of the pumping actions of the Bill Jones Pumping Facility, which draws water from the channels of the South Delta to supply the Delta-Mendota Canal and furnish water to the CVP's water contractors south of the Delta. Adult fish are less susceptible to the effects of the screening process. However, some adverse effects have been observed in association with the trash racks in front of the screens. Adult fish cannot fit through the narrow gap between the steel slats on the trash rack. This serves as a physical barrier to their passage. Observations of sea lions "corralling" adult fall-run in front of the TFCF trash rack have been observed by TFCF staff and a NMFS biologist. In addition, adult sturgeon in moribund conditions have been observed impinged upon the trash rack. The causative factor for the sturgeon's initial condition is unknown, but the fish eventually perish against the racks unless rescued and rehabilitated in the aquaculture facility at the TFCF. Predation by sea lions on sturgeon at the TFCF has not been observed to the best of NMFS' knowledge. The anticipated effects of the screening operation upon juvenile salmon and smolts are the direct loss of fish through the louvers. Based upon the information already presented above, this could be more than half of the fish that encounter the screens initially (46.8 percent overall louver efficiency during normal operations, <35 percent overall efficiency during VAMP operations, potential total failure during screen cleaning operations). Fish that pass through the louver array are lost forever to the population. This loss represents not only the loss of individual fish, but a decline in the population abundance as a whole, as these fish represent the survivors of the initial downstream emigration from the spawning areas upstream to the Delta, a journey with its own intrinsically high rate of mortality. The initial loss of fish emigrating downstream in the Sacramento River may be potentially as high as 80 percent based on MacFarlane's (2008) acoustic tagging study. There is additional loss of these fish as they cross the Delta and arrive at the fish collection facilities.

Salmonids and sturgeon that are successfully screened still face adverse factors during the collection phase of the screening process. The physical process of screening exposes the fish to sustained flows along the face of the louver array, to which the fish will typically try to swim against before being entrained into the bypass orifice. Once entrained into the primary bypass, the fish is carried in a dark turbulent flow through the bypass pipeline to the secondary screening channel, where it is again screened by louvers into a second pipeline that finally discharges to the holding tanks for final collection and salvage. During this process, the fish are subjected to turbulent flows, encounters with the walls of the pipeline and screening channels, debris in the

flow stream, and predators. This creates stressful conditions for the fish and reduces its physiological condition. These external stressors lead to the release of stress hormones (i.e., catecholamines and corticosteroids) from the fish's endocrine system. Following the release of these stress hormones, a stage of resistance occurs, during which the stress hormones induce changes in the physiological processes in the fish that either help repair any damage (*e.g.*, if the stressor caused a physical injury) or help the animal adapt to the stressors (*e.g.*, if the stressor is a change in environmental conditions like temperature or turbulence) by changing the rate of body functions beyond the "normal" range. If adaptation to the stressors is not possible, because of either the severity or prolongation of the challenge, exhaustion ensues followed by permanent malfunctioning, possibly disease, and ultimately death to the exposed fish (Fagerlund *et. al.* 1995). In other words, delayed responses to the stress of screening are very likely, and could lead to ultimate morbidity or mortality subsequent to the collection procedure. Due to the short period of "observation" of collected fish during the collection, handling, trucking and release (CHTR) process, the ultimate fate of the salvaged fish following release is unknown, particularly in the open Delta/ocean environment following release where additional environmental stressors are present and to which the emigrating fish will be exposed. The CHTR process will be described in more detail in a following section.

Based upon the projected increases in pumping rates modeled in the near future and future conditions (Studies 7.1 and 8.0), the number of fish entrained at the pumps is predicted to increase in proportion to the pumping increases and thus in general be greater than current levels, particularly in the early winter (December through February) and during the VAMP experiment. Furthermore, the proportion of fish salvaged may be overestimated while those lost to the system are likely to be underestimated using the current values for screening efficiencies (75 percent) rather than the 46.8 percent overall efficiency determined in the 1995 studies and the recent VAMP period studies (Reclamation 2008). This would indicate that the TFCF has a greater adverse impact than currently acknowledged. Specific effects to listed salmonid ESUs will be discussed in the salvage section below.

6.6.2.4.1.2 John E. Skinner Fish Protection Facilities – Current and Future Operations

The John E. Skinner Fish Protection Facility was built in the 1960s and designed to prevent fish from being entrained into the water flowing to the Harvey O. Banks Pumping Facility, which lifts water from the inlet canal into the California Aqueduct. The fish screening facility was designed to screen a maximum flow of 10,300 cfs. Water from the Delta is first diverted into Clifton Court Forebay, a large artificially flooded embayment that serves as a storage reservoir for the pumps, prior to flowing through the louver screens at the Fish Protection Facility. After water enters the forebay through the radial gates, it first passes a floating debris boom before reaching the trashrack. The floating debris boom directs large floating material to the conveyor belt that removes the floating material for disposal in an upland area. Water and fish flow under the floating boom and through a trashrack (vertical steel grates with 2-inch spacing) before entering the primary screening bays. There are 7 bays, each equipped with a flow control gate so that the volume of water flowing through the screens can be adjusted to meet hydrodynamic criteria for screening. Each bay is shaped in a "V" with louver panels aligned along both sides of the bay. The louvers are comprised of steel slats that are aligned 90 degrees to the flow of water

entering the bay with 1-inch spacing between the slats. The turbulence created by the slats and water flowing through the slats guides fish to the apex of the "V" where bypass orifices are located. Fish entrained into the bypass orifice are carried through underground pipes to a secondary screening array. The older array uses the vertical louver design while the newer array uses a perforated flat plate design. Screened fish are then passed through another set of pipes to the holding tanks. Fish may be held in the holding tanks for up to 8 hours, depending on the density of salvaged fish and the presence of listed species.

Like the TFCF, the louvers are not 100 percent efficient at screening fish from the water flowing past them. Louver efficiency is assumed to be approximately 75 percent (74 percent, DWR 2005b) for calculating the loss through the system, although this value may eventually be shown to be incorrect (see TFCF discussion). Recent studies examining pre-screen predation in Clifton Court Forebay on steelhead smolts (DWR 2008) have tracked a tagged steelhead through the screens into the inlet channel leading to the Banks Pumping plant and then back into the forebay by the trash boom. This passage through the louvers occurred during a period of low pumping rates, indicating that this steelhead was able to negotiate the louvers and the water velocities flowing through it in both directions. Like the TFCF, the individual louver panels are lifted by a gantry crane from their position in the louver array and cleaned with high-pressure water stream to remove debris and vegetation that clog the louver slats. However, flow into each bay can be manipulated or turned off, thereby reducing potential loss through open louver racks. Nevertheless, it should be noted that any fish within the bay following the closure of the bay during cleaning would be vulnerable to loss through the open louver panel slots. This may be of greater concern for sturgeon based on their behavioral response to the louvers as previously described.

The Skinner Fish Protection Facility will primarily have direct impacts on emigrating salmonids during their juvenile and smolt life history stages, although adult salmon, steelhead, and sturgeon (both white and green) are also likely to be entrained into the forebay (adult striped bass move freely into and out of the forebay when hydraulic conditions at the radial gates permit it). Adult and juvenile sturgeon have been observed in the forebay and juveniles appear in the fish salvage collections. These juvenile salmonid life history stages are vulnerable to the entrainment effects of the pumping actions of the Harvey O. Banks Pumping Facility, which draws water from the channels of the South Delta to supply the California Aqueduct and furnish water to the SWP's water contractors. The anticipated effects of the screening operation are the direct loss of fish through the louvers. As discussed for the TFCF, this loss represents not only the loss of individual fish, but a decline in the Chinook salmon population abundance as a whole due to the loss of several hundred to several thousand individual fish annually at the SWP facilities. These fish represent the survivors of the initial downstream emigration from the upstream spawning areas to the Delta. This journey has its own intrinsically high rate of mortality. Overall loss during this portion of the emigration to the ocean may be potentially as high as 80 percent based on MacFarlane's (2008) acoustic tagging study. There is additional loss of these fish as they cross the Delta and arrive at the fish collection facilities, so that only a fraction of the downstream emigrating population survives to encounter the screens.

As previously described for the TFCF operations, salmonids and sturgeon that are successfully screened still face adverse factors during the collection phase of the screening process at the Skinner facility. Like the TFCF, fish are moved through bypass pipelines from the primary louvers to the secondary louver and thence to the collection tanks. Fish are subjected to stressful conditions during this phase of the salvage and collection operations. Following discharge to the collection tanks, fish are processed through the CHTR operation and returned to the western delta. Delayed responses to the stress of screening are very likely, as previously described in the discussion for the TFCF, and could lead to ultimate morbidity or mortality subsequent to the collection procedure (Fagerlund *et al*. 1995). Due to the short period of "observation" of collected fish during the CHTR process, the ultimate fate of the salvaged fish following release is unknown. The CHTR process will be described in more detail in a following section.

Based upon the projected increases in pumping rates modeled in the near future and future conditions (Studies 7.1 and 8.0) for the SWP, the number of fish entrained at the Skinner Fish Protection Facility is predicted to increase in proportion to the pumping increases and, thus, in general, be greater than current levels, particularly in the early winter (December through February) and during the VAMP experiment. The experimental data indicating that "large" fish, such as a steelhead smolt, can pass through the louvers in both directions calls into question the stated efficiency of the louvers in screening out fish in the size range of interest for listed salmonid species (DWR 2008). If the stated efficiencies for the louvers are less than expected, as appears to be the case for the TFCF, then the numbers of fish salvaged and the numbers of fish lost to the system is suspect. Like the TFCF, the impacts to listed salmonids (and potentially green sturgeon) would be greater than anticipated, both currently and in the modeled future. Regardless of the actual efficiencies of the louver screens, the increased pumping predicted by the modeling scenarios will increase the number of fish lost to the system and increase the adverse effects upon listed salmonids in general. Specific effects to listed salmonid ESUs/DPS and green sturgeon will be discussed in the salvage section below.

6.6.2.4.1.3 Clifton Court Forebay Predation Losses

Clifton Court Forebay is operated as a regulating reservoir for the SWP's Harvey O. Banks Pumping Plant in the tidally influenced southern Delta. The forebay allows the SWP to take in water during different portions of the tidal cycle, as permitted by water rights and legal constraints, contain the water by closing radial gates at the inlet of the forebay, and subsequently operating its pumps more efficiently. The forebay was created in 1969 by flooding a 2.6-mile by 2.1-mile tract of agricultural land near Byron, California, creating a 2,200-acre impoundment. The five radial gates at the inlet of the forebay leading to Old River are typically opened following the peak of the high tide and held open for a portion of the ebb tide when the water elevation outside the gates is higher than that inside the gates in the forebay. Water velocities passing through the gates typically approach 14 fps at maximal stage differential, and may for brief periods even surpass this. However, the design criteria for the gates discourage these excursions due to scouring through the mouth of the gates and the surrounding channel area. Currently, a very deep scour hole (approximately 60 feet deep) has formed just inside the forebay, adjacent to the location of the radial gates. When the gates are open, and the flow of water enters the forebay, numerous aquatic species, including many species of fish, are

entrained. Included among these species of fish are Chinook salmon (including endangered winter-run and threatened spring-run), threatened CV steelhead, and threatened North American green sturgeon from the Southern DPS (DWR 2005, 2008).

Losses of fish entrained into Clifton Court Forebay occur during passage from the radial gates across the 2.1 miles of open water in the forebay to the salvage facility. This is termed pre-screen loss, and includes predation by fish and birds. Much of this pre-screen loss is thought to be attributable to predation by piscivorous fish, such as striped bass (Gingras 1997, DWR 2008). Gingrass (1997) described a series of survival studies conducted in Clifton Court Forebay using juvenile Chinook salmon and juvenile striped bass. Of the 10 studies cited, 8 evaluated losses of hatchery-reared juvenile Chinook salmon, and 2 evaluated losses of hatchery-reared juvenile striped bass. The calculated loss across Clifton Court Forebay ranged from 63 to 99 percent for juvenile Chinook salmon and 70 to 94 percent for the juvenile striped bass. Gingras (1997), however, opined that naïve hatchery fish introduced directly into Clifton Court Forebay may be more susceptible to predation than wild fish or fish already acclimated to the natural environment, but of hatchery origin (habituated fish). Gingras (1997) states that "introduction of experimental fish directly into Clifton Court Forebay may contribute a large portion of observed pre-screen loss, regardless of other experimental and/ or operational variables (*e.g.*, release group size, experimental fish size, degree of habituation, and export rate). Experimental fish are typically subject to varying degrees of (1) temperature shock (Orsi 1971, Coutant 1973, Kjelson and Brandes 1989), (2) altered salinity, and (3) altered light regime, in addition to turbulent flow and predation at the radial gates. Habituated fish entrained into Clifton Court Forebay would only be subject to turbulent flow and predation near the radial gates. The combined and differential effect of these "acute stressors" on experimental fish should increase vulnerability to predation (Coutant 1969, Orsi 1971, Olla *et al.* 1992, Young and Cech 1994, Mesa 1994, Cech *et al.* 1996)." Gingras (1997) also identified potential biases resulting from the calculation of salvage and pre-screen loss due to expansion of enumerated fish in the salvage counts and estimates of total fish released per experiment based on weight and lengths, effects of introducing large numbers of fish at one time on the efficiency of predators (protective schooling effect), and fish remaining in Clifton Court after the cessation of the experimental period which are not enumerated as surviving the experiment. However, Greene (2008) stated that "In light of Gingras 1997's recognition that introduction of experimental fish would increase the likelihood of predation found in the studies, it is my opinion that a pre-screen mortality rate of 75% at the SWP pumping facilities is a reasonable estimate of pre-screen mortality." Additional predation rates by birds is unknown at this time, but observations by biologist at the forebay have indicated that bird density can be quite high for species that prey on fish as part of their diet, such as Double crested Cormorants (*Phalacrocorax auritus*), Great Egrets (*Ardea albus*), White Pelicans (*Pelacanus erythroryhnchus*), Clark's Grebe (*Aechmophorus clarkia*), Western Grebes (*Aechmophorus occidentalis*), Great Blue Herons (*Ardea nerodias*) and several species of gulls.

A recent study was conducted (DWR 2008) utilizing hatchery steelhead (average size 245 ±5 mm) to examine the pre-screen loss for this species of fish. Results of this study concluded that steelhead of smolt size had a pre-screen loss rate within Clifton Court Forebay that ranged from 78 ± 4 percent to 82 ± 3 percent over the various replicates of the study. These values are similar to smaller Chinook salmon and juvenile striped bass studies conducted previously. The study

also found that the screening loss at the Skinner Fish Protection Facility for tagged steelhead was 26 ± 7 percent. This level of screening is equivalent to 67 to 81 percent efficiency, which is comparable with the 75 percent overall efficiency stated for the facility previously. The study also verified that tagged steelhead could exit the forebay under the right hydraulic conditions and enter the channel of Old River. Tagged fish were recorded in Old River outside of the radial gates and one passive integrated transponder (PIT) tagged steelhead was recovered in the TFCF salvage after release in the forebay. In addition, the study also tagged large striped bass with acoustic transmitters and monitored their movements within the forebay. The study found that the striped bass typically moved between the radial gates and the inlet channel/debris boom area of the forebay, apparently congregating in these areas, perhaps to feed, while others moved into the northern area of the forebay. Several of the striped bass (16 of 30 tagged fish) were shown to have left the forebay and reenter Old River and the Delta. Striped bass leaving the forebay were detected as far away as the Golden Gate Bridge and above Colusa on the Sacramento River.

The studies described above (Gingras 1997, DWR 2008) indicate that mortality (*i.e.*, predation) is very high in the forebay for listed salmonids, whether they are smaller-sized Chinook salmon juveniles or larger smolt-sized steelhead. For every one fish salvaged, typically 4 to 5 fish entered the forebay (75 to 80 percent pre-screen loss). Based on the increased frequency of elevated pumping rates described in the near term and future modeling runs for the SWP, NMFS anticipates that substantial numbers of additional Chinook salmon and steelhead will be lost to predation in the forebay. This conclusion is based on the presumption that increased pumping will require the forebay to be operated in such a manner as to supply the additional volumes of water pumped by the Banks Pumping Plant over the current levels. Increased levels of pumping will draw down the forebay water elevation when the gates are closed. With each operation of the radial gates, the difference in hydrostatic head between the outside channel (following the peak of the high tide) and the elevation within the forebay will cause water to flow into the forebay. The greater the elevation differential, the greater the flow (velocity) into the forebay and the greater the volume of water moved in a unit time. This change has the potential to draw additional listed salmonids and green sturgeon into the forebay. The additional increases in the pumping rates seen in the period between December and May corresponds to the time period when listed salmonids are in the system, and thus vulnerable to the effects of the forebay operations. The proposed near term and future operations of the SWP, through the operations of the Clifton Court Forebay, will exert additional adverse effects upon the listed salmonid populations. The loss of these additional individual fish will further reduce the populations of listed salmonids (*i.e.*, the annual loss of hundreds to thousands of wild winter-run, spring-run, and CV steelhead, as enumerated in the annual salvage and loss reports presented by the Interagency Ecological Program for the San Francisco Estuary). These fish, which have survived to reach the South Delta, represent the survivors of the hundreds of thousand to millions of fry that hatched up river in their natal stream reaches. Loss of an appreciable number of these fish represent a loss of abundance in the current population, and perhaps a reduction in future productivity if these fish represent the “hardiest” fish of the current brood year, based on their surviving to the Delta (and through it to the South Delta). These fish represent those fish which have successfully hatched, successfully initiated exogenous feeding, avoided upstream predation during natal rearing, successfully negotiated the migratory corridor from natal rearing areas to the delta, and have shown the ability to avoid predation and successfully forage during their

downstream migration through the delta. These fish have the necessary traits, both physiologically and behaviorally, to survive the multiple stressors encountered in the environment and thus, through natural selection, represent the best adapted fish to the current conditions in the Central Valley.

Green sturgeon may be entrained during any month of the year by the operations of the Clifton Court Forebay radial gates. It is unknown what percentage of these fish return to the waters of the Delta through the radial gates, like striped bass, or remain within the forebay for extended periods of time. Based on salvage data, it appears that green sturgeon juveniles are present in the forebay year round, but in varying numbers. NMFS expects that predation on green sturgeon during their stay in the forebay is minimal, given their size and protective scutes, but this has never been experimentally verified.

6.6.2.4.1.4 Collection, Handling, Trucking, and Release Operations

Following the successful screening and redirection of the entrained fish to the holding tanks, both the TFCF and the Skinner Fish Protection Facility engage in a process of CHTR to return the salvaged fish to the waters of the Delta outside the influence of the pumps (DWR 2005a, b). The following general description explains the CHTR procedure for both the TFCF and the Skinner Fish Protection Facility. During the collection phase, the fish are contained within large cylindrical holding tanks, which may collect fish for several hours (up to 24 hours at the TFCF). The holding times are a function of fish density and the presence of listed fish in the collection tanks. High densities or the presence of listed fish require more frequent salvage operations. During the collection phase of salvage, the tanks are dewatered, and the fish are collected in a large conical sample bucket that is lowered into the sump of the holding tank. Fish that are not immediately collected into the sample bucket are washed into the bucket with a stream of water, along with any debris that has accumulated in the holding tank (*i.e.*, plant material such as *Egeria densa* or sticks and branches). Once dewatering and final wash down have been completed, the sample bucket is lifted out of the holding tank by a gantry hoist and moved to either the handling - sorting platform adjacent to the holding tank or directly to the waiting tanker truck. The handling phase requires the collection facilities staff to sort through the collected fish at predetermined intervals (*i.e.*, 20 minute counts every 2 hours at the TFCF when listed fish are present) and identify the captured fish to species, enumerate the species taken, particularly the listed species, and provide data for estimating the salvage numbers for the total operation of the two facilities. These counts also determine the frequency that the other holding tanks must be drained and fish loaded into the trucks and transported to the release sites.

Fish are transferred to tanker trucks following the dewatering procedure in the large conical collecting baskets used in the draining of the holding tanks. Typically fish and the water that remains in the conical basket are released into the waiting truck through the hatch on the top of the truck. Frequently there is a high debris load in the conical collecting basket that is also transferred to the truck along with the fish and water in the basket. Numerous problems associated with fish density, debris load, and loading practices, as well as the physical stress of transport, have been identified as potential stressors to the transported fish, affecting eventual survival.

Fish are driven to one of four sites located in the western Delta. The TFCF releases its fish at a site on Horseshoe Bend on the Sacramento River or adjacent to the State Route 160 highway bridge in Antioch, California. The Skinner Fish Protection Facility releases its salvaged fish at a separate Horseshoe Bend release site, a site on Sherman Island on the north bank of the San Joaquin River, and shares the site at Antioch with the TFCF. Releases are made to the river through pipes that reach from the roadside to the river, and extend 100 or more feet offshore into deeper water. The pipes are typically primed with a flow of river water from onsite pumps to make sure that the walls of the pipe are wetted prior to fish being passed down the pipe to the river. Once the pipe has been primed with the river water, the valve on the tanker truck is opened and the contents of the truck are flushed into the release pipe, using a hose to help wash the tank's contents through the valve orifice with river water. The flow down the lumen of the pipe is turbulent and of fairly high velocity (aided by the injection of flushing flows into the start of the pipeline). Problems associated with the release operations have been identified and include, but are not limited to, high turbulence and shear forces in the pipeline during release; contact with debris during the release, causing injury or death; potential stranding of fish in the tanker truck due to debris clogging the orifice during dewatering; disorientation following release, creating higher potentials for predation; attraction of predators to the pipe outfall structure; delayed mortality due to injuries in the release procedure; and physiological shock due to water quality parameters changing too quickly during the release procedure (DWR 2005a, b).

Current estimates of mortality associated with the CHTR operations indicate that Chinook salmon experience approximately 2 percent mortality after 48 hours following the release of fish through the pipe. Additional mortality associated with predation is likely, but as of yet, experimental data is lacking. A study completed by DWR was expected to be issued by the end of 2008 which addresses the potential for post-release predation at the Delta release points. Estimates of post release predation rates given by DWR range from 10 percent to 30 percent for juvenile salmonids, depending on the density of predators at the release site and the number of fish released per episode (Orsi 1967, Pickard *et al.* 1982, Greene 2008). Estimates are crude and several potential biases in the earlier studies are present, including net sampling efficiency, susceptibility of predators to capture, and estimation of predator populations within the study area. Recent evidence obtained using acoustic imaging equipment (DIDSON cameras) has shown that predators are quickly attracted to the discharge pipelines upon the startup of the priming water flow, indicating a learned response to the discharge of salvaged fish at the release sites.

In summary, the CHTR process has inherent risks to salvaged fish, including listed salmonids such as winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon. Fish are exposed to debris and turbulent flow during their movements through pipes, holding tanks, trucks and the discharge pipes. Such activities increase the stress level in the fish and elevate their corticosteroids and catecholamine levels, as previously described. Predation of disoriented and confined fish may occur by predators in the same holding tanks and during transport. There is a high probability that injury and stress will occur during the release phase back into the river and that post release morbidity or mortality will occur in the riverine environment (*e.g.*, infections, reduced swimming ability, or disorientation). Estimates of post release predation

range from 10 to 30 percent of the salvaged fish released. Since salvage of listed fish primarily occurs to juveniles or smolt-sized fish, it is this life stage that is most affected by the CHTR process. Loss, including post release mortality, is approximately 12 to 32 percent of the fish salvaged.

NMFS estimates that the direct loss of fish associated with the screening and salvage process is 83.5 percent for the SWP and approximately 65 percent for the CVP for fish from the point they enter Clifton Court Forebay or encounter the trashracks at the CVP (table 6-28).

Table 6-28. Overall survival of fish entrained by the export pumping facilities at the Tracy Fish Collection Facilities and the John E. Skinner Fish Protection Facilities.

Estimate of Survival for Screening Process at the SWP and CVP[1]		
SWP	Percent survival	Running Percent
Pre-screen Survival[2]	25 percent[3] (75 percent loss)	25
Louver Efficiency	75 percent (25 percent loss)	18.75
CHTR Survival	98 percent (2 percent loss)	18.375
Post Release Survival (predation only)	90 percent (10 percent loss)[4]	16.54
CVP[5]	Percent survival	Running Percent
Pre-screen Survival[6]	85 percent (15 percent loss)	85
Louver Efficiency[7]	46.8 (53.2 percent loss)	39.78
CHTR Survival	98 percent (2 percent loss)	38.98
Post Release Survival (predation only)	90 percent (10 percent loss)	35.08

[1]These survival rates are those associated with the direct loss of fish at the State and Federal fish salvage facilities. Please see the text for a more thorough description.

[2]Prescreen loss for the SWP is considered to be those fish that enter Clifton Court Forebay that are lost due to predation or other sources between entering the gates and reaching the primary louvers at the Skinner Fish Protection Facility.

[3]Estimates have ranged from 63 to 99 percent (Gingras 1997). Recent steelhead studies indicate a loss rate of approximately 78 to 82 percent (DWR 2008).

[4]Predation following release of salvage fish ranges from less than 10 percent to 30 percent according to DWR (2009). NMFS uses the lower estimate to give a conservative estimate of loss. Actual loss may be greater, particularly in the winter when the density of salvage fish released is low, and predators can consume a greater fraction of the released fish (DWR 2009).

[5]These values do not incorporate the 45 percent of the operational time that the louvers are in noncompliance with the screening criteria. The actual values of the lover efficiency during this time are not available to NMFS. These values would determine the percentage of survival through the facility under real time circumstances.

[6]Prescreen survival in front of the trashracks and primary louvers at the TFCF have not been verified, but are assumed to be 15 percent.

[7]Overall efficiencies of the louver arrays at the TFCF have been shown to be 46.8 percent (59.3 percent primary, 80 percent secondary). Recent studies indicate overall efficiencies during low flow periods could be less than 35 percent (Reclamation 2008). This value does not include periods when the louvers are being cleaned, where overall efficiency drops towards zero.

6.6.2.4.1.5 Estimates of Direct Loss to Entrainment by the CVP and SWP Export Facilities under the Proposed Action

Individual winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon are entrained by the south Delta export facilities, with most dying or being "lost" to the population in the process. Because all of the different populations are migratory, entrainment is seasonal, based on their presence in the waters of the Delta. Juvenile sized winter-run are vulnerable from approximately December through April, with a peak in February and March. Spring-run juveniles and smolts are vulnerable from approximately November through March (as yearlings) and January through June as YOY. Wild (unclipped) CV steelhead have a longer period of vulnerability, based on their extended periods of emigration as 1 to 2 year old smolts. Wild juvenile steelhead are recovered in the USFWS Chipps Island trawls from October through July. There appears to be a difference in the emigration timing between wild and hatchery reared steelhead smolts, primarily due to the narrow window of hatchery steelhead smolt releases into the system versus the protracted emigration from natal streams by wild fish. Adipose fin-clipped hatchery fish are typically recovered at Chipps Island from January through March, with the peak in recoveries occurring in February and March. The timing of wild steelhead (unclipped) emigration is more spread out. Their emigration occurs over approximately six months, with peaks in February and March, based on salvage records at the CVP and SWP fish collection facilities.

To evaluate the effects of direct entrainment, Reclamation assembled the total CVP + SWP pumping projections (as "Jones" plus "Total Banks") in the CALSIM II output for the years between 1921 to 2003 and compared the current (Study 7.0), with the near future (Study 7.1), and future (Study 8.0) operations of the project and their anticipated effects on entrainment due to changes in pumping rates. For each comparison presented in table 6-29, the CALSIM II output for the monthly averages of the combined pumping levels of the Jones and Banks facilities are given for the different water year types. Utilization of salvage rates to express the effects of exports on the salmonid populations relies on the fish of interest actually reaching the point of enumeration, where they can be counted. Failure to reach the salvage facilities results in the perception that exports may not have an effect on those populations. Other factors in the Delta, such as predation, and at the salvage facilities (*e.g.*, low louver efficiency, or elevated pre-screen losses), can mask the effects of exports by removing the fish from the system prior to reaching the salvage facilities to be enumerated. Under such circumstances, even though the movement of water southwards towards the pumps due to exports was affecting the movement of fish, it cannot be determined by salvage alone, since the loss of fish prior to the salvage facilities prevents them from being enumerated in the salvage counts and showing any correlation with the exports. An alternative approach to estimating entrainment risk is the magnitude and direction of flows in Old and Middle Rivers under the different future modeling scenarios compared to the current levels. Table 6-30 gives the median net flows in Middle and Old Rivers under Studies 7.0, 7.1, and 8.0, as modeled for the years between 1922 and 2003 by the CALSIM model (CVP/SWP operations BA Appendix E). Both Reclamation and DWR, as well as the USFWS, have used this metric as a tool for evaluating entrainment risk to Delta smelt, and NMFS will incorporate the same tool as an additional ecological surrogate for evaluating the risk of entrainment to salmonids within the same water bodies. Although salmonids and green sturgeon are not water particles, they do use water movement (flow and direction) as cues for their behavioral movements. NMFS will use the movement of particles as a measure of the potential fate of water from the point of the particle injection through the channels of the central and

southern Delta based on the eventual disposition of the particle at the end of the model run. In table 6-31, the monthly percentile differences between future CALSIM II Study cases (7.1 and 8.0) with the current Study (7.0) are presented, grouped by water year type and pumping facility.

The modeling runs indicate that export rates will increase over the current operations, as modeled by Study 7.0, through the late fall period and early winter period. Average export rates in November typically increase a modest 2 to 4 percent in most water year types. Under the near future and future operational models, average export rates increase about 10 percent in both December and January (range 5.84 to 15.12 percent increase). These increases can be expected to enhance the potential for fish entrainment (due to higher average export rates) at a time when winter-run juveniles and yearling spring-run are entering the Delta system. These increases in export are seen in all water year types, although the magnitude varies.

Table 6-29. Comparison of predicted monthly total export pumping from the CVP (Jones) and SWP (Banks) facilities for Studies 7.0 (current), 7.1 (near future) and 8.0 (future). The percentage difference is calculated for the percentage change from the near future and future conditions to the current operations. Highlighted cells are where future conditions have less pumping than current conditions.

October	Study 7.0	Study 7.1	% Difference 7.1 - 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	9054	8915	-1.54	9083	0.32
Above Normal	7982	7362	-7.77	7722	-3.26
Below Normal	8100	7717	-4.73	7729	-4.58
Dry	8111	7325	-9.69	7567	-6.71
Critically Dry	6799	6460	-4.99	6468	-4.87

November	Study 7.0	Study 7.1	% Difference 7.1 - 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10503	10743	2.29	10699	1.87
Above Normal	8414	8581	1.98	8422	0.10
Below Normal	8851	8829	-0.25	8922	0.80
Dry	7416	7717	4.06	7748	4.48
Critically Dry	6278	6391	1.80	5801	-7.60

December	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10438	11515	10.32	11585	10.99
Above Normal	8870	10012	12.87	9662	8.93
Below Normal	8770	9829	12.08	9876	12.61
Dry	8924	9816	10.00	9817	10.01
Critically Dry	7107	7855	10.52	7522	5.84

January	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10686	11537	8.15	11425	7.10
Above Normal	10074	11433	13.49	11539	14.54
Below Normal	9908	10815	9.15	10960	10.62
Dry	8410	9584	13.96	9682	15.12
Critically Dry	7224	7646	5.84	7986	10.55

February	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10295	10507	2.06	10617	3.13
Above Normal	10143	10738	5.87	11062	9.06

Below Normal	9759	9625	-1.37	9171	-6.03
Dry	8322	7982	-4.09	8137	-2.22
Critically Dry	5154	6061	17.60	5853	13.56

March	Study 7.0	Study 7.1	% Difference 7.1 – 8.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10099	9138	-9.52	9524	-5.69
Above Normal	10386	9660	-6.99	10138	-2.39
Below Normal	8692	8387	-3.51	8472	-2.53
Dry	7367	7270	-1.32	7188	-2.43
Critically Dry	3798	4316	13.64	4241	11.66

April	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	6226	6944	11.53	6987	12.22
Above Normal	5488	6173	12.48	6226	13.45
Below Normal	4472	4737	5.93	4708	5.28
Dry	2716	3329	22.57	3339	22.94
Critically Dry	1780	2035	14.33	1893	6.35

May	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	6114	6950	13.67	6924	13.25
Above Normal	4174	5193	54.41	5011	20.05
Below Normal	3069	4149	35.19	4051	32.00
Dry	2222	3259	46.67	3073	38.30
Critically Dry	1595	1751	9.78	1644	3.07

June	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	8414	8635	2.63	8616	2.40
Above Normal	7344	7961	8.40	7802	6.24
Below Normal	6480	6988	7.84	6890	6.33
Dry	5621	6212	10.51	6118	8.84
Critically Dry	3540	2754	-22.20	2416	-31.75

July	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	10154	10773	6.10	10875	7.10

Above Normal	8899	10037	12.79	9736	9.41
Below Normal	10476	11111	6.06	10641	1.58
Dry	10593	10539	-0.51	10123	-4.44
Critically Dry	5270	3675	-30.27	3359	-36.26

August	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	11549	11491	-0.50	11627	0.68
Above Normal	11474	11082	-3.42	11168	-2.67
Below Normal	10514	9814	-6.66	9717	-7.58
Dry	7611	5720	-24.85	5277	-30.67
Critically Dry	4224	2020	-52.18	1880	-55.49

September	Study 7.0	Study 7.1	% Difference 7.1 – 7.0	Study 8.0	% Difference 8.0 – 7.0
WY Type	CFS	CFS		CFS	
Wet	11469	11249	-1.92	11315	-1.34
Above Normal	10498	10325	-1.65	10710	2.02
Below Normal	10128	9755	-3.68	9924	-2.01
Dry	8571	7024	-18.05	6838	-20.22
Critically Dry	5828	4922	-15.55	4777	-18.03

Table 6-30. Projected Average Old and Middle River Flows by Water Year Types and Months

Projected Average Old and Middle River Flows (in cfs) in Wet and Above Normal Water Years for the Months of December through March (CVP/SWP operations BA Appendix E CALSIM Output).

Study	December	January	February	March	Average
Study 7.0	-8350	-6391	-7322	-6858	-7230
Study 7.1	-8083	-6511	-7377	-7956	-7482
Study 8.0	-8230	-6276	-7203	-7890	-7400

Projected Average Old and Middle River Net Flows (in cfs) in Wet and Above Normal Water Years for the months of April through July.

Study	April	May	June	July	Average
Study 7.0	-5847	-4381	-4118	-643	-3747
Study 7.1	-6561	-4652	-3450	-1146	-3952
Study 8.0	-6611	-4941	-3792	-1193	-4134

Projected Average Old and Middle River Net Flows (in cfs) in Below Normal and Dry Water Years for the months of December through March.

Study	December	January	February	March	Average
Study 7.0	-7668	-6125	-6767	-7117	-6919
Study 7.1	-6687	-6098	-6504	-8063	-6838
Study 8.0	-6946	-6030	6435	-8004	-6854

Projected Average Old and Middle River Net Flows (in cfs) in Below Normal and Dry Water Years for the months of April through July.

Study	April	May	June	July	Average
Study 7.0	-6889	-6052	-5573	-1064	-4895
Study 7.1	-7889	-5897	-5440	-1442	-5167
Study 8.0	-8038	-5989	-5407	-1428	-5215

Projected Average Old and Middle River Net Flows (in cfs) in Critically Dry Water Years for the months of December through March.

Study	December	January	February	March	Average
Study 7.0	-4576	-5633	-5293	-6158	-5415
Study 7.1	-3375	-5399	-4892	-6389	-5014
Study 8.0	-3312	-5317	-4333	-6315	-4819

Projected Average Old and Middle River Net Flows (in cfs) in Critically Dry Water Years for the months of April through July.

Study	April	May	June	July	Average
Study 7.0	-5368	-4250	-2514	-797	-3232
Study 7.1	-5903	-4744	-2824	-842	-3578
Study 8.0	-5618	-4865	-3024	-870	-3594

February has mixed export patterns. In wet and above normal water years, exports increase modestly, compared to modest decreases in below normal and dry years. Critically dry years see a larger increase in average exports (17.6 percent in Study 7.1 and 13.56 in Study 8.0), which is anticipated to have negative impacts on emigrating fish during this month. The reductions in exports during the below normal and dry water years are expected to benefit outmigrating salmonids, including steelhead, which are entering the system in increasing numbers. Less pumping is believed to reduce the draw of water from the main channel of the San Joaquin River into the South Delta channels leading towards the pumps, and thereby reduce the effects of farfield entrainment of fish into these channels. In particular, fish from the Southern Sierra Diversity groups which include CV steelhead from the San Joaquin River basin, the Calaveras River basin, and wild CV steelhead from the Mokelumne River basin must pass several points of potential entrainment into the South Delta prior to reaching the western Delta. Conversely, increasing exports in the wet, above normal and critically dry water years will adversely affect emigrating salmonids.

Table 6-31. Average change in Banks and Jones pumping grouped by water year type. Highlighted cells indicate conditions where pumping is greater than the Study 7.0 current condition during the primary salmonid migration period (November through June).

Facility	WaterYearType	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Study 7.1 compared to 7.0													
Banks	Critical	7.7%	-8.2%	-6.1%	15.5%	18.2%	8.7%	6.4%	8.8%	25.1%	-7.0%	-11.9%	-13.1%
Banks	Dry	0.2%	-5.3%	7.2%	10.5%	0.0%	4.7%	10.3%	12.4%	3.5%	-8.4%	1.1%	-12.8%
Banks	Bl Normal	11.4%	-4.1%	6.6%	6.1%	-2.4%	7.2%	14.0%	34.3%	6.9%	14.4%	0.9%	-8.3%
Banks	Ab Normal	14.5%	-5.5%	8.3%	-0.3%	7.3%	4.3%	13.1%	42.2%	13.4%	32.5%	-8.5%	-10.2%
Banks	Wet	6.1%	-3.1%	6.6%	5.3%	4.9%	-0.2%	19.2%	20.9%	1.2%	4.2%	-7.8%	-2.9%
Jones	Critical	8.5%	6.2%	15.1%	1.0%	7.9%	16.4%	8.2%	28.6%	-1.0%	-16.6%	-1.7%	-4.3%
Jones	Dry	3.8%	4.5%	11.9%	17.2%	5.1%	-4.2%	6.3%	32.3%	3.9%	7.8%	-13.5%	-7.7%
Jones	Bl Normal	7.5%	6.1%	19.7%	15.0%	-3.4%	-15.7%	-4.3%	5.3%	-2.3%	24.3%	6.6%	-7.5%
Jones	Ab Normal	-0.5%	8.3%	20.6%	15.5%	-1.5%	-13.6%	-9.0%	6.9%	1.2%	9.3%	13.6%	3.3%
Jones	Wet	6.2%	9.0%	18.4%	15.1%	-0.1%	-25.9%	-2.3%	-1.1%	-2.5%	4.5%	5.7%	3.3%
Study 8.0 compared to 7.0													
Banks	Critical	4.8%	-17.5%	-8.7%	-2.9%	20.3%	7.4%	6.7%	13.8%	-11.9%	-22.0%	-17.1%	-2.9%
Banks	Dry	0.3%	-7.8%	8.1%	12.4%	-1.8%	5.3%	8.2%	18.5%	-8.3%	-8.8%	-2.4%	-7.0%
Banks	Bl Normal	7.0%	-5.6%	3.4%	9.9%	-3.1%	1.5%	13.9%	31.3%	9.3%	22.3%	12.9%	-0.2%
Banks	Ab Normal	4.8%	-10.1%	4.4%	4.6%	8.1%	4.8%	12.2%	43.1%	16.9%	51.9%	17.3%	-5.3%
Banks	Wet	2.5%	-4.7%	6.8%	6.1%	5.1%	2.7%	19.2%	20.9%	4.0%	16.1%	-3.8%	-2.7%
Jones	Critical	11.6%	-4.6%	17.5%	9.9%	4.8%	23.4%	5.9%	22.0%	-10.1%	-31.4%	-19.8%	-16.5%
Jones	Dry	8.1%	6.1%	11.9%	17.1%	5.9%	-6.6%	4.2%	29.1%	-3.8%	-0.4%	-29.3%	-8.3%
Jones	Bl Normal	13.8%	7.7%	20.2%	15.6%	-1.6%	-12.9%	-7.2%	-2.6%	-4.2%	19.8%	3.8%	-5.1%
Jones	Ab Normal	-1.6%	4.9%	24.2%	11.2%	11.0%	-7.9%	-8.4%	5.3%	1.2%	7.4%	-0.7%	13.4%
Jones	Wet	8.6%	11.5%	17.9%	13.1%	-1.4%	-20.3%	-1.5%	-0.1%	-1.0%	-8.1%	5.5%	5.1%

The average combined exports for March decrease in all water year types except critically dry years, when the export rate increases approximately 12 percent in the future compared to current operations (13.64 percent increase in Study 7.1 versus Study 7.0 and 11.66 percent increase in Study 8.0 compared to Study 7.0). Therefore, in critically dry years, based on the anticipated export rate increases, risk to winter-run and CV steelhead will increase, particularly since March is typically the peak of their outmigration through the Delta. On the other hand, risk of entrainment, as measured by salvage and export levels, declines during the month of March in the wet, above normal, below normal and dry hydrologic year types.

The months of April and May have significant increases in the export rates under the near future and future modeling runs when compared to the current operations model (Study 7.0). Export rates can increase by as much as 46.67 percent in the month of May during dry water year types, and are only moderately less than this in other water year types. Typically, the increases in exports range from approximately 10 percent to 40 percent during the April and May time period. These increases will likewise negatively affect emigrating salmonids, particularly spring-run and fall-run juveniles that are moving through the Delta during these months. San Joaquin River and Calaveras River basin fish, (*i.e.*, steelhead and fall-run Chinook salmon) are particularly vulnerable due to the proximity of their migration corridor to the location of the CVP and SWP pumping facilities and the multiple pathways leading from their migration corridor to the export facilities (*e.g.*, Head of Old River, Turner and Columbia Cuts, Middle River, and Old River).

The month of June has exports increasing approximately 2.5 percent to 10 percent over current conditions, except for critically dry years when exports are sharply reduced (-22 percent in Study 7.1 and -32 percent in Study 8.0). Overall, actual June export rates are increasing over the April and May levels, so that while the percentage of increases looks smaller than in the previous two months, the total volume of water diverted is actually increasing. This is expected to pull more water southwards through the central and southern Delta waterways towards the pumps. This, in turn, increases the risk of drawing any late emigrating fish present in the central and south Delta towards the pumps as well. This will adversely impact the migration rate of these late emigrating fish during a time when water quality, particularly water temperature, is becoming unfavorable to salmonids.

The month of July has exports that are increasing in the near future and future over the current model levels in wet, above normal, and below normal water year types. Similar to June, the drier water year types see a pattern of decreasing export levels between the future modeling runs and the current modeling run. For the remainder of the summer months, i.e., August and September, the future modeling studies indicate that combined export rates will be equivalent to or lower in than the current conditions as modeled in Study 7.0. Reductions are greatest in the drier water year types. Reductions in summer exports could reduce the vulnerability of green sturgeon juveniles in the central and south Delta from becoming entrained by the pumps.

In the analysis completed for Delta smelt, the CVP/SWP operations BA concluded that upstream flows, *i.e.*, flows that were negative, that were greater than -2000 cfs ± 500 cfs effectively prevented entrainment of Delta smelt that were north of the sampling stations in Old and Middle

River. A linear relationship between Delta smelt entrainment and flow exists at flows greater than -4000 cfs (more seaward flow). At flows less than -4000 cfs (more landward flow) the entrainment rate for Delta smelt begins to take on an exponential characteristic. Based on particle tracking modeling, the Delta smelt work group concluded that net river flows greater than -2000 ± 500 cfs in the Old River and Middle River complex reduced the zone of entrainment so that particles injected into the central Delta at Potato Slough would not be entrained towards the pumps (Kimmerer and Nobriga 2008 *op cit*. CVP/SWP operations BA). NMFS considers this information useful in analyzing the potential "zone of effects" for entraining emigrating juvenile and smolting salmonids. A similar pattern is observed in material (figures 6-65 and 6-66) provided to NMFS by DWR (Greene 2009). Loss of older juveniles at the CVP and SWP fish collection facilities increase sharply at Old and Middle River flows of approximately -5,000 cfs and depart from the initial slope at flows below this. Given the data derived from the CVP/SWP operations BA Appendix E, flows in Old and Middle River are consistently in excess of the -2000 ± 500 cfs threshold for entrainment (*i.e.*, more upstream flow). Assuming that in the normal (natural) flow patterns in the Delta, juvenile and smolting Chinook salmon and steelhead will use flow as a cue in their movements and will orient to the ambient flow conditions prevailing in the Delta waterways, then upstream flows will carry fish towards the pumps during current operations. General tendencies of the modeling results indicate that Old River and Middle River net flows trend towards greater upstream flow in the near future and future conditions, resulting in even more fish carried towards the pumps.

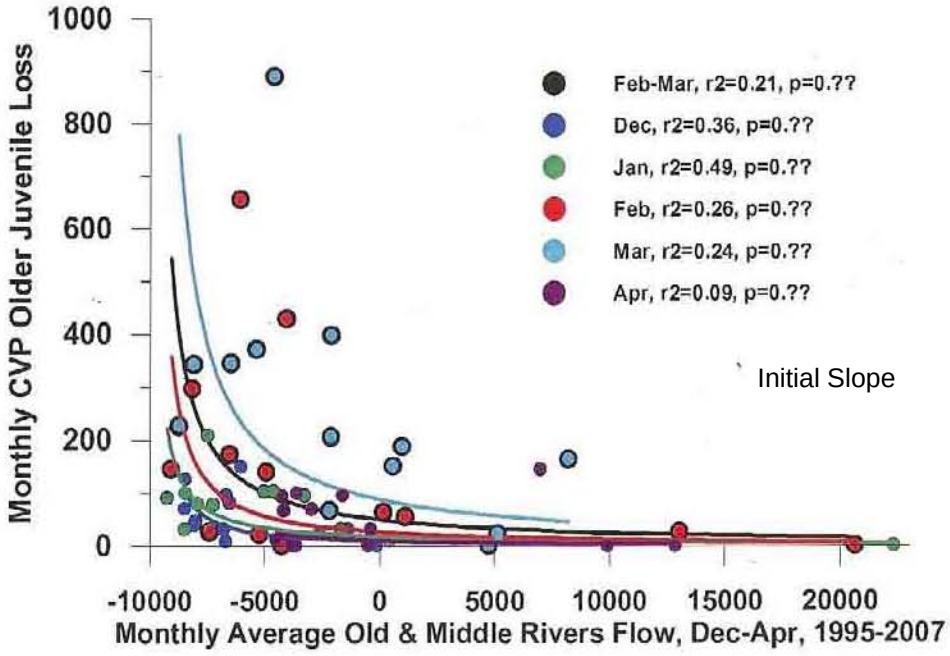


Figure 6-65. Relationship between OMR flows and entrainment at the CVP, 1995-2007 (DWR 2008).

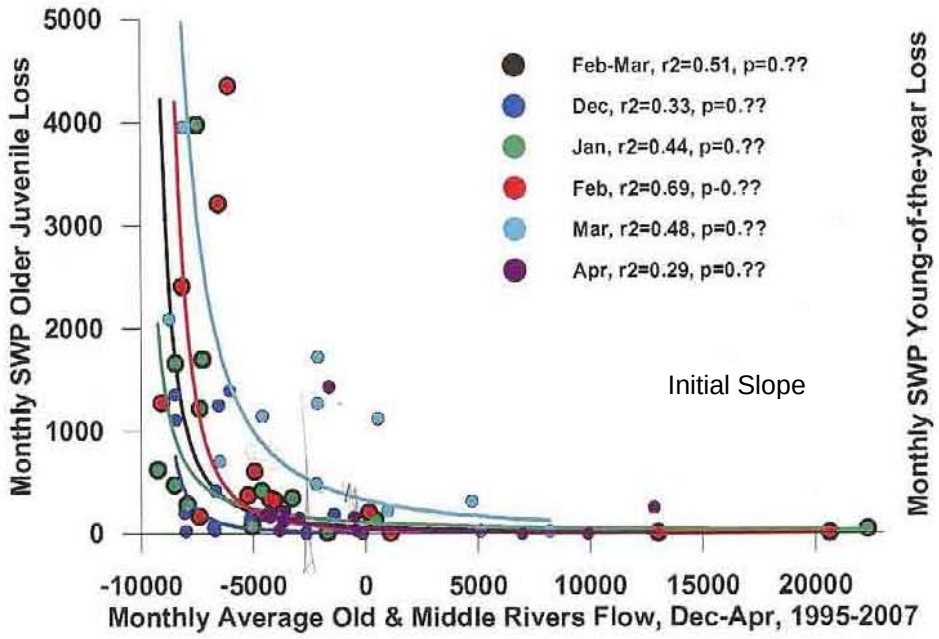


Figure 6-66. Relationship between OMR flows and entrainment at the SWP, 1995-2007 (DWR 2007).

During wet, above normal and critically dry water year types, the greatest level of negative net flows in Old and Middle rivers are seen during the months of December, January, and July. The months of December and January coincide with onset of movement of winter-run and yearling spring–run into the north Delta from the Sacramento River. NMFS believes that these elevated levels of net negative flow present a risk to emigrating fish that have entered the central Delta through Georgiana Slough or, when the DCC is open, the Mokelumne River system. In below normal and dry water year types, the Old and Middle River flows have high levels of net negative flow from December through March and again in June and July. This overlaps with a significant proportion of the salmonid emigration period through the Delta, particularly for winter-run Chinook salmon and Central Valley steelhead. In all water year types, the net negative flows in Old and Middle River are attenuated in April and May in response to the reduced pumping (export levels) required for the VAMP experiments.

The CALSIM II and DSM II modeling also indicates that the magnitude of the net negative flows in Old and Middle rivers generally get "larger" (*i.e.*, more negative, reverse landward flow) with the future conditions in wet, above normal, below normal and dry water year conditions. This corresponds with the trend in increased level of exports described earlier for these water year types. The enhancement of net negative flows in Old and Middle rivers in the near future and future conditions indicate an increasing level of vulnerability to the entrainment for emigrating fish located in the central and southern Delta regions.

Inspection of the salvage and loss records from the CVP and SWP fish collection facilities available through the Central Valley Operations web site (http://www.usbr.gov/mp/cvo/fishrpt.html) indicates that recovery of winter-run sized juvenile Chinook salmon begins in December and continues through approximately the end of March.

Roughly 50 percent of the total annual salvage of juvenile winter-run sized Chinook salmon occurs in March, with the previous 3 months (December, January, and February) accounting for the other 50 percent. Very few winter-run sized Chinook salmon juveniles are captured after the end of March. Likewise, the salvage of steelhead smolts at the fish collection facilities starts as early as November, but is primarily observed in the months of January, February, and March. The salvage of spring-run sized fish is primarily observed in the months of March, April, and May. Nearly two thirds of the spring-run sized Chinook salmon juveniles are collected during the month of April alone. This temporal pattern indicates that listed salmonids are within the waterways of the central and south Delta as early as November and December, but typically are most prevalent from January through May. Southern DPS of green sturgeon are also present during this time frame, as they occupy the waters of the Delta year round.

The presence of listed salmonids and green sturgeon in the salvage collections during the winter and spring months points out their vulnerability to negative flows in Old and Middle River during this time period. Particle tracking model simulations conducted for the Delta smelt consultation indicate that at flows more positive than -2,500 cfs, the probability of a neutrally buoyant particle injected at monitoring Station #815 eventually being entrained at the export facilities is less than 10 percent (see figures 6-67 and 6-68). Station #815 is on the San Joaquin River adjacent to the confluence of the Mokelumne River. This site is a valuable reference point as it is the location at which fish from the Sacramento River are likely to enter the Central Delta and the San Joaquin River system after traveling through Georgiana Slough or the Mokelumne River system. With increasing export pumping under a set of given conditions, the Old and Middle River flows become more negative, and a higher percentage of injected particles from Station #815 are entrained by the export pumps. Similarly, the closer a group of particles is injected to the export facilities, the higher the risk of eventual entrainment at the export facilities. The current profile of listed salmonid entrainment and the estimated Old and Middle River flows from the CALSIM II modeling indicate that fish entering the San Joaquin River from the Sacramento River at the confluence of the Mokelumne River are at an elevated risk of entrainment by the export facilities. Likewise, fish entering the Delta from the San Joaquin River basin, the Calaveras River or the Mokelumne River system are vulnerable to entrainment due to their proximity to the exports (station 912 and Mossdale), and the length of the migration corridor they must travel that is under the influence of the export actions (see figures 6-57c and 6-57d). Pumping rates predicted for the months of December through March create conditions in which the net flows in Old and Middle rivers average less than -4000 cfs (note: more negative values indicate higher export levels and the direction of flow is landwards), with drier years being more negative. The absolute magnitude of Old and Middle River negative flows generally increases (*i.e.*, more flow towards the pumps) under the near term and future modeling studies (see table 6-30).

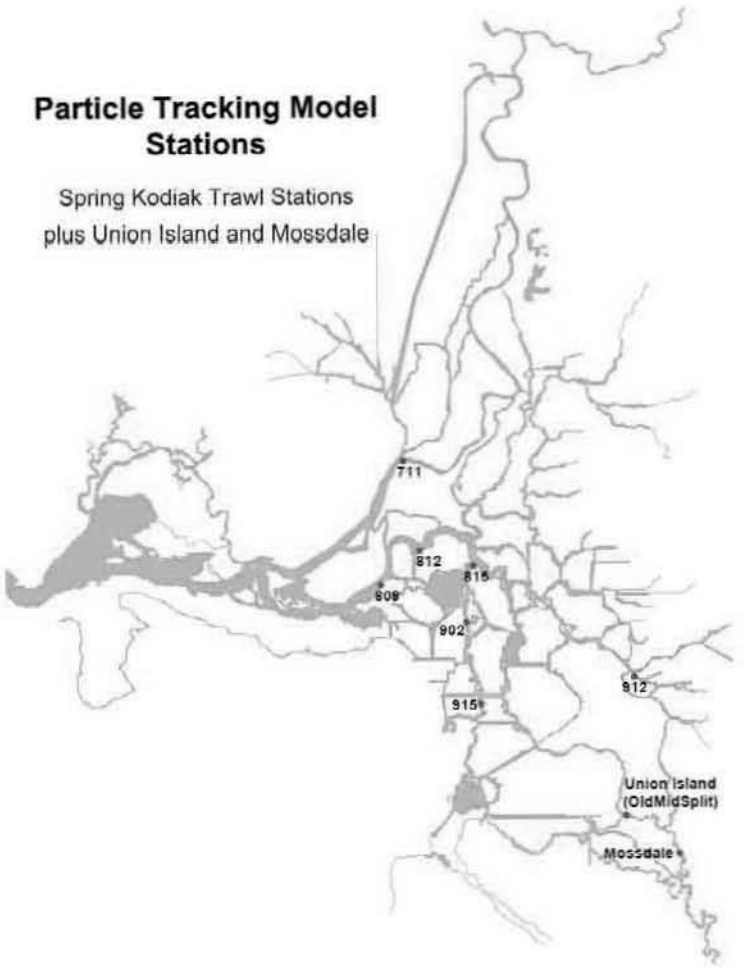
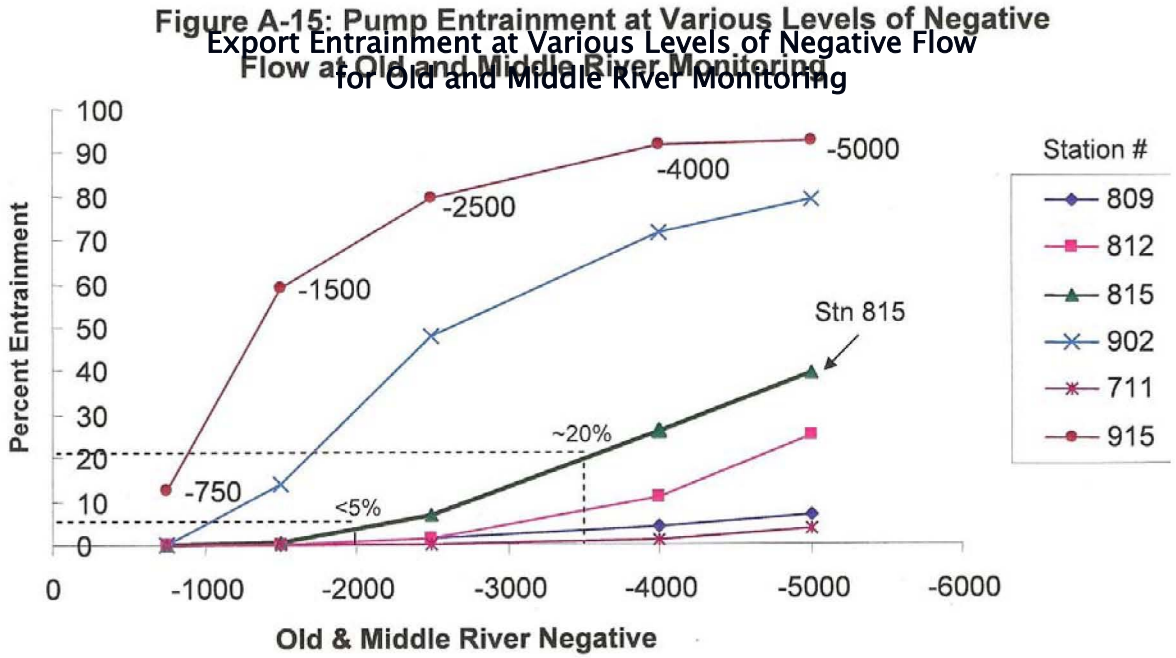


Figure 6-67. Location of particle injection points for the Particle Tracking Model simulations (Hinojosa 2009).



Station Key: Station 809 is located on the San Joaquin River (SJR) at Jersey Point, Station 812 is located on the SJR at Fisherman's Cut, Station 815 is located at the confluence of the Mokelumne River with the SJR, Station 915 is located on Old River at Orwood Tract, Station 902 is on Old River near Rhode Island/ Quimby Island, and Station 711 is on the Sacramento River near Rio Vista and Cache Slough.

Figure 6-68. Calculated percentages of entrainment at the CVP and SWP export facilities for different levels of flow in Old and Middle Rivers. Particles are injected at different locations in the Delta (USFWS 2008a).

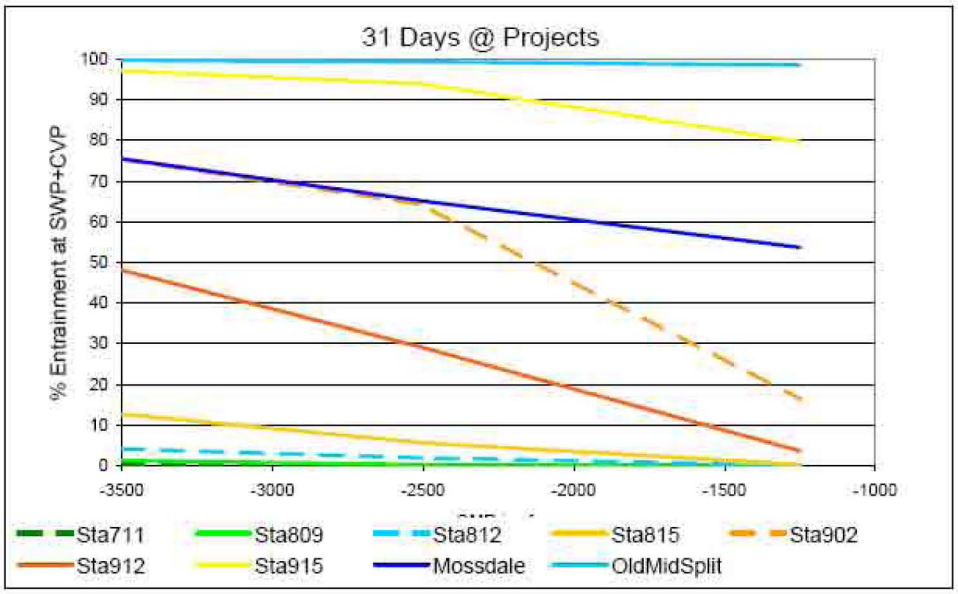


Figure 6-69. Calculated percentage of particles entrained by the CVP and SWP after 31 days at Old and Middle River flows of -3,500 cfs, -2,500 cfs, and -1,250 cfs. Particles were injected at various locations in the Delta. This figure was for March 2005, a "wet" year (Hinojosa 2009).

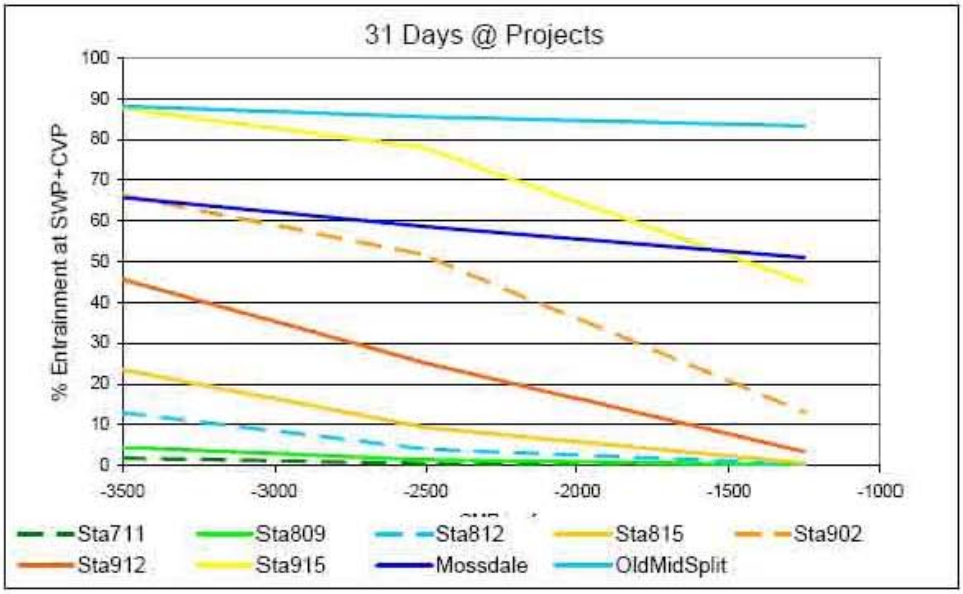


Figure 6-70. Calculated percentage of particles entrained by the CVP and SWP after 31 days at Old and Middle River flows of -3,500 cfs, -2,500 cfs, and -1,250 cfs. Particles were injected at various locations in the Delta. This figure was for March 2008, a "dry" year (Hinojosa 2009).

NMFS uses the findings of the PTM simulations to look at the eventual fate of objects in the river over a defined period of time from a given point of origin in the system. While salmonids and green sturgeon are not "neutrally buoyant particles", they can be represented to some degree by the PTM modeling results. The fish occupy a given body of water in the river and that body of water has eventual fates in the system, as represented by the dispersion of the injected particles. The salmonids have volitional movement within that body of water and react to environmental cues such as tides, water velocity vectors, and net water flow movement within the channel. The eventual fate of that body of water signifies the potential vulnerabilities of fish within that body of water to external physical factors such as export pumping or river inflows. For example, if exports increase, and the eventual fate of the water body indicates that it has a higher probability of entrainment compared to other conditions (*i.e.*, lower export pumping), then NMFS believes that salmonids within that same body of water will also experience a higher probability of entrainment by the export pumping. Conversely, under conditions where the eventual fate of injected particles indicate a high probability of successfully exiting the Delta at Chipps Island, NMFS believes salmonids traveling in the same body of water will have a higher probability of exiting the Delta successfully. Furthermore, conditions which delay movement of particles out of the Delta yet don't result in increased entrainment at the export facilities would indicate conditions that might delay migration through the Delta, which would increase vulnerabilities to predation or contaminant exposure. Finally, flow conditions at river channel splits indicate situations where migrating fish must make a "decision" as to which channel to follow. If water is flowing into a given channel, then fish closer to that channel bifurcation are more likely to be influenced by the flow conditions adjacent to the channel opening than fish located farther away from the channel mouth. Burau *et al.* (2007) describes the complexity of these temporal and spatial conditions and their potential influence on salmonid movement. PTM

simulations currently do not give the necessary fine scale resolution both temporally (minutes to fractions of hours) and spatially (three dimensional on the scale of meters) to give clear results at these channel splits. Burau states that spatial distribution of fish across the river channel occurs upstream of the channel splits and is dependent "upon the interaction between local hydrodynamic processes (*e.g.*, secondary currents) and subtle behaviors that play out in a Lagrangian reference frame. These spatial structures evolve over fractions of hours to hours. Junction interactions, on the other hand, happen very rapidly, typically within minutes. Thus, route selection may only minimally depend on behavioral responses that occur in the junction, depending to a greater degree on spatial distributions that are created by subtle behavioral responses/interactions to geometry-mediated current structures that occur up-current of a given junction." This description illustrates the complexity of route selection. Based on Burau's explanation, fish upstream of the split are dispersed by the environmental conditions present in the channel into discrete locations across the channel's cross section. The proximity of these locations to the channel mouth is predictive of the risk of diversion into the channel itself. PTM data can be useful to indicate the magnitude of the net movement of water through the channel after the junction split (and the route selected by the fish), and thus can be used to infer the probable fate of salmonids that are advected into these channels during their migrations.

The comparison of study runs as represented by the percentile differences of monthly pumping rates from both the CVP and SWP facilities are grouped over water year types and compare the future study cases against the current modeled pumping rates (see table 6-29). This table gives better resolution regarding the details of the individual pumping operations of the two pumping plant facilities. The data from the modeling runs for the Banks pumping facility indicates that the comparison between the near term (Study 7.1) and the current pumping levels (Study 7.0) will have a higher rate of pumping increases over the different water year types then decreases during the period when salmonids are emigrating to the ocean (November through June). In particular, the months of April and May will have consistent increases in pumping levels, with rates in wet, above normal and below normal hydrologic years in the month of May showing the greatest relative increases (as high as 42 percent). This is a period of time when YOY spring-run are common in the Delta, as well as fall-run. Therefore increased pumping in April and May has the potential to entrain more individuals from these two runs in the near future and future cases than in the current operational regime. In general, pumping in the near future shows consistent increases at the Banks facility in the period between December and March. These increases place emigrating winter-run, CV steelhead and yearling spring-run at risk of entrainment. As described in the previous section regarding entrainment at the Clifton Court Forebay structure and the operations of the Skinner Fish Protection Facility, loss of entrained salmonids can be quite high for any fish entering this unit.

The pattern of operations for the Jones Pumping Plant facility is slightly different than that of the Banks Facility. In the near future (Study 7.1), pumping is increased over the current levels during the period between November and January. Pumping rates increase modestly in November in all water year types, ranging from 4.5 percent to 9 percent. The following two months, December and January, see pumping increase over 10 percent in almost all cases. This period corresponds to the time when winter-run Chinook salmon juveniles and spring-run Chinook salmon yearlings are entering the Delta from the Sacramento River system. Steelhead

smolts are also beginning to enter the Delta waters from their upstream natal streams during this time period. Pumping at the Jones Facility generally decreases during the 3-month period between February and April in below normal, above normal and wet water year types. In dry and critically dry water years, the pumping rates at the Jones Facility tend to increase in the near-term future Study (7.1) over the current modeled conditions (Study 7.0). The reductions in pumping rates are considered to be beneficial to emigrating salmonid populations, particularly since March and April are peak months of movement through the Delta by listed salmonid species.

The modeled pumping rates at the state and Federal pumping plants for the future Study (8.0) are similar to those for the near-future conditions (Study 7.1), therefore the differences between the current operational conditions as modeled by Study 7.0 and the future conditions as modeled by Study 8.0 are not substantially different than those seen in the previous comparisons. The future pumping rates at the Banks pumping plant are still elevated for most of the period between December and May compared to the current operational conditions, and therefore present the same anticipated risk to emigrating salmonid stocks. As seen in the Study 7.1 modeling scenario, pumping rates, as determined by the percentage change from the current level, are substantially increased in the April and May period, which corresponds to the peak of outmigration for YOY spring-run and YOY fall-run. It also overlaps with the VAMP experiment on the San Joaquin River. The modeled pumping rates at the Jones facility under the future conditions in Study 8.0 show a similar pattern to those modeled under Study 7.1.

In summary, the overall pumping rates in the two future modeling scenarios elevate risk to emigrating salmonids in December, January, April, May, and June compared to the current conditions. However, entrainment risks in March are reduced due to pumping reductions taken by the facilities. There are mixed risks in the month of February due to differences in pumping strategy based on the type of water year modeled. In wet, above normal and critically dry water year types, overall pumping is increased. Conversely, pumping is reduced in below normal and dry conditions. The proposed actions also reduce pumping in the summer relative to the current modeling scenario. This benefits green sturgeon that may be rearing in the vicinity of the pumps during the summer, and reduces their risk of entrainment. The most obvious difference in pumping patterns between the current and future scenarios outside of the increases in December and January is the substantial increase in pumping that will occur in April and May at the SWP facilities. This increase in pumping corresponds to the period in which the majority of YOY fall-run and spring-run Chinook salmon are entering the Delta and moving towards the ocean, thus increasing their vulnerability to entrainment. In particular, San Joaquin River basin fish will be exposed to increased entrainment risks due to their migration route's proximity to the pump's entrainment field. This includes the basin's fall-run Chinook salmon population, as well as its severely limited steelhead population.

6.6.2.4.1.6 Discussion of Relationship of Exports to Salvage

There has been considerable debate over the relationship of salvage numbers and the export rate for many years. In addition, the survival rate of salmonid populations passing through the Delta towards the ocean, and the impact of the export facilities on those populations is also an area of

controversy. The CVP/SWP operations BA presented data that regressed the loss of older juvenile Chinook salmon against exports (figure 6-71) and found that a significant relationship existed. The relationship was stronger for exports at the SWP ($p = 0.000918$) than for exports at the CVP ($p = 0.0187$). The months of December through April resulted in the most informative relationship based on the historical number of older juvenile Chinook salmon salvaged each month and the relationship of each month to salvage and exports. Conversely, regressions performed for monthly salvage of YOY Chinook salmon against exports did not result in a significant relationship at either the SWP or CVP facilities. Potential problems in this analysis may stem from the reduction of pumping for 30 days during the height of the YOY Chinook salmon emigration for the VAMP experiment, which may skew the data set. Likewise, as previously mentioned, loss of fish in the system prior to reaching the salvage facilities and their enumeration in the salvage will mute the response of the salvage numbers to any increase in exports until an apparent threshold level has been reached. It appears that pre-facility losses reach a saturation point, after which salvage numbers increase in accordance with increases in export rates. The shallow slope of the response curve is an indication of the relative insensitivity of the salvage numbers to the increases in exports. In order to see a large change in salvage numbers, a substantial increase in exports is required. The pattern of data points for larger juveniles indicates that at low export rates, very little increase in salvage is seen with increasing export rates. However, as exports increase further, the scatter in the salvage data points increases with both high and low salvage numbers occurring at the same export level. Interactions with predators may explain this pattern. Increased pumping moves fish past the predators faster within the affected channels, reducing their exposure time to the predators. Thus more fish show up to be counted at the salvage facilities once the threshold for predator success has been surpassed.

Regressions of monthly older Chinook salmon loss against export/inflow ratio between December and April did not result in significant relationships at either the SWP or CVP facilities. There is an inherent problem with using the E/I ratio exclusively in that significantly different pumping rates at the CVP and SWP can have the same E/I ratio when the inflow to the Delta is allowed to vary also. Better resolution of the relationship between the salvage to E/I ratio is achieved when at least one of the variables to the E/I ratio is held constant. In such instances, the relative importance of exports or inflow can be teased out of the relationship. Decisions as to which variable has more influence on the level of salvage can thus be made.

Reclamation also regressed data for steelhead salvage against exports in the CVP/SWP operations BA. The regressions resulted in significant relationships between exports and the salvage of steelhead at the facilities, more so for the SWP than the CVP (figure 6-72). The months of January through May produced the most informative relationships based on the historical number of steelhead salvaged each month and the relationship of each month between salvage and exports. Reclamation found that the months of December and June, due to the low number of salvaged steelhead in those months, had very poor and insignificant relationships to exports. Unlike the regressions performed for juvenile Chinook salmon, Reclamation found significant relationships between steelhead salvage and the E/I ratio for both the SWP and CVP (figure 6-73).

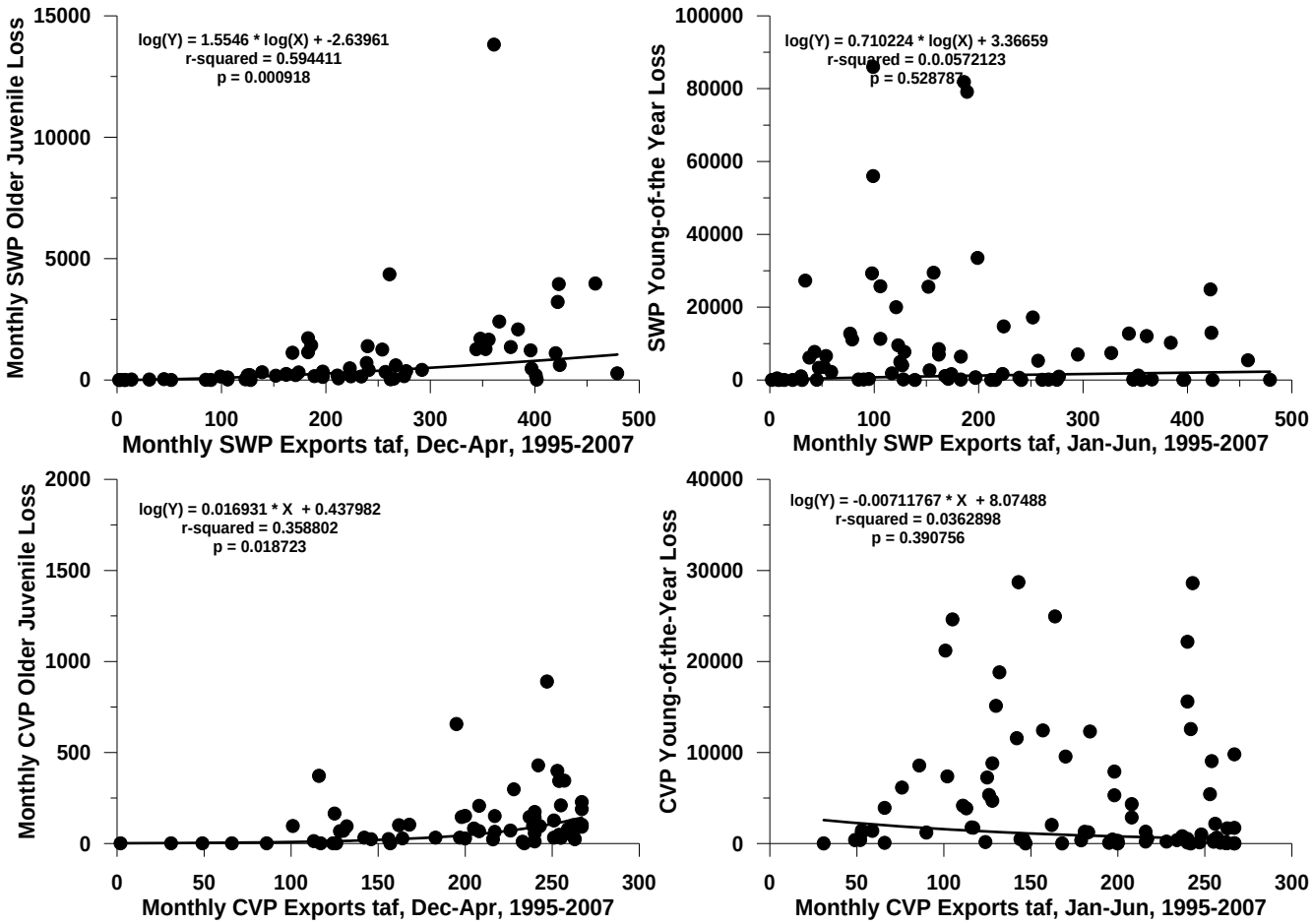


Figure 6-71. Monthly juvenile Chinook salmon loss versus average exports, December through June, 1993 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-40).

Recent analyses of the interaction of export rates and the salvage of salmonids at the CVP and SWP have arrived at differing conclusions based on past release and recapture studies conducted in the Delta. Newman (2008) analyzed the results of studies conducted in support of the DCC experiments, the Delta Interior experiments, the Delta Action 8 experiments, and the VAMP experiments. Newman used Bayesian hierarchical models (BHMs) to analyze the data collected from the multiple years of data generated by these four studies. The BHM framework explicitly defines probability models for the release and recovery data gathered and subsequently accounted for the unequal sampling variation and between release pair variation inherent in the raw data pool. Recoveries from multiple locations in the Delta were analyzed in combination rather than separately. According to Newman, the BHM framework is more statistically efficient and coherent than the previous methods of analysis used in these experiments. It is able to address deficiencies in the experimental designs and the high level of variability in the dependent data (*e.g.*, salvage and survival). Several levels of uncertainty can be accounted for using recoveries from multiple locations simultaneously to increase precision. Nevertheless, the original release and recovery data has several significant limitations, such as that fish can be captured only once, the low level of fish salvaged at the CVP and SWP from individual releases

and the large variation between such releases under similar conditions, the low probability of capture in the recovery process (trawling), the relatively high level of environmental variation present in the data, and the lack of balance in the release strategy (VAMP experiments) all reduce the accuracy of the estimates of the desired endpoint, *i.e.*, survival of released fish. Newman explains that given the apparently high environmental variation present in these experiments, it could take many more replications of the temporally paired releases to provide a more accurate estimate of the effects of the DCC gate position, the effects of exports and river flow, and the placement of the HORB on the survival of released fish.

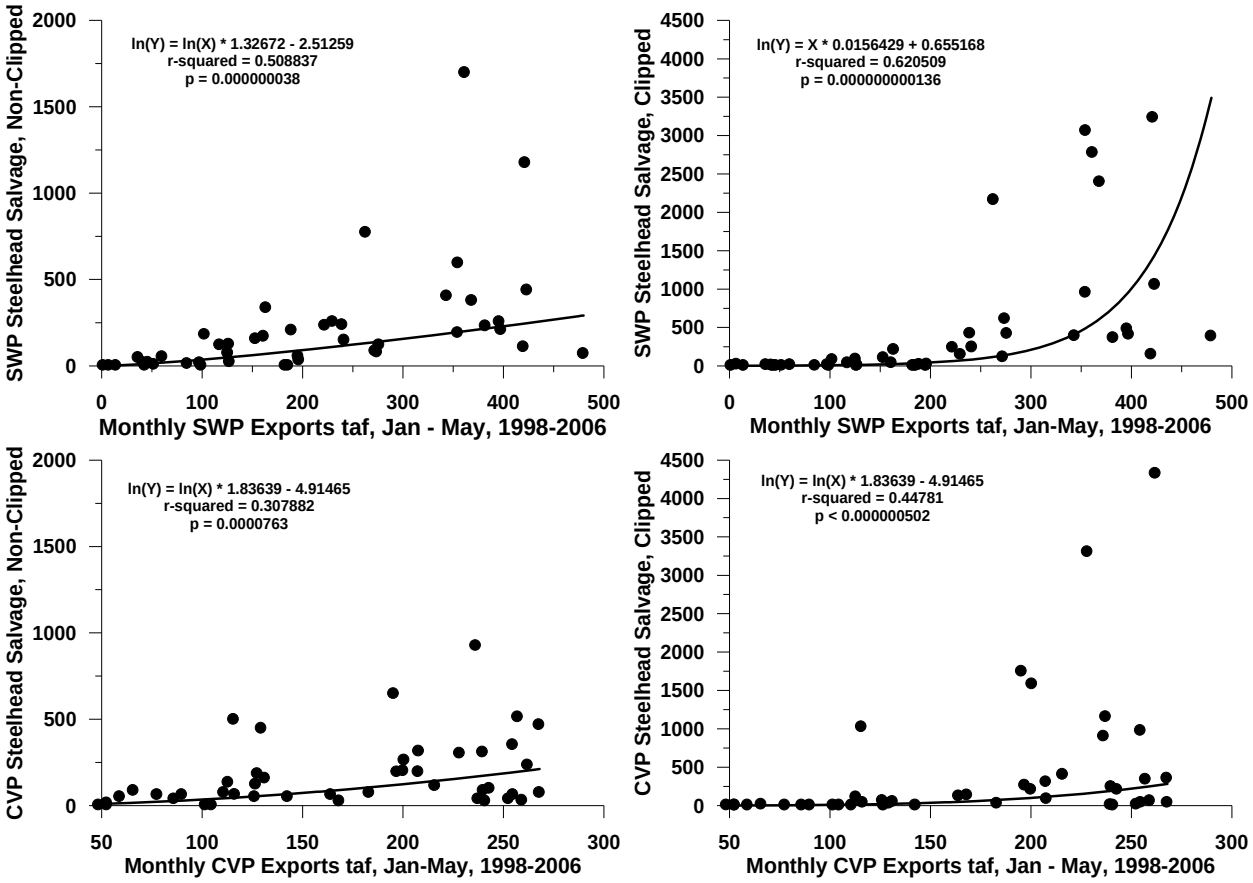


Figure 6-72. Monthly steelhead salvage versus average exports, January through May, 1998 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-45).

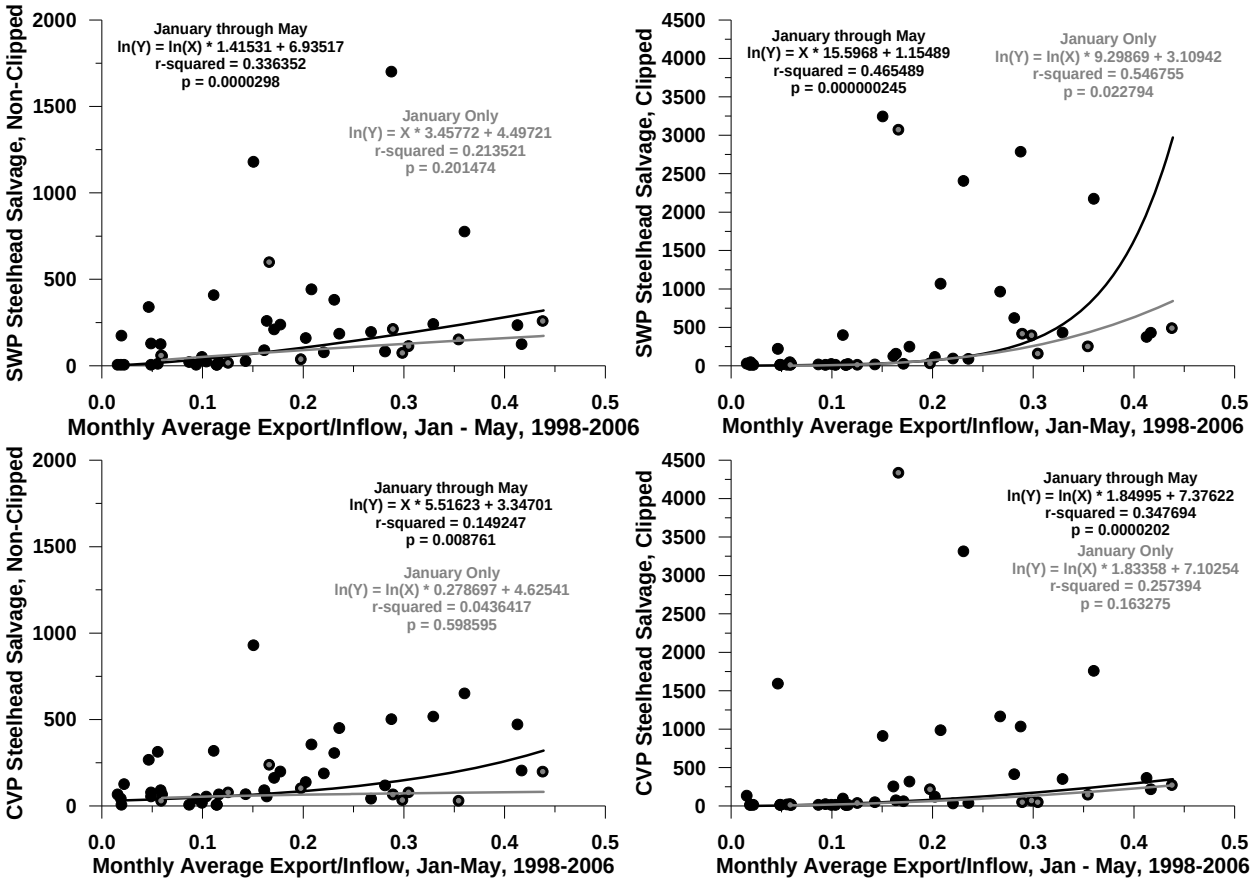


Figure 6-73. Monthly steelhead salvage versus average Export/Inflow ratio in TAF, January through May, and January alone, 1998 through 2006, at each facility; SWP and CVP (CVP/SWP operations BA figure 13-46).

Notwithstanding these limitations, Newman reached the following conclusions:

Delta Cross Channel Experiments: There was modest evidence (64 to 70 percent probability) that survival of fish released at Courtland (upstream of the DCC gates) to Chipps Island relative to the survival of releases made from Ryde (downstream of the DCC) increased when the DCC gates were closed.

Interior Studies: Although there was considerable variation between paired releases, the overall recovery fractions for Ryde releases remained higher than the Georgiana Slough releases in all cases. The means of the ratios for Ryde to Georgiana Slough recoveries were 0.26, 0.43, and 0.39 at Chipps Island, in the ocean, and inland sites, respectively, which is consistent evidence that fish released in Georgiana Slough had a lower probability of surviving than fish released in the Sacramento River at Ryde. Conversely, the relative fraction of fish that were salvaged at the CVP or SWP pumps was approximately 16 times greater for fish released in Georgiana Slough than for fish released in the Sacramento River at Ryde.

Delta Action 8 Experiments: There was a negative association between export volumes and the relative survival of released salmonids (*i.e.*, a 98 percent chance that as exports increased the relative survival of released Chinook salmon juveniles decreased). However, environmental variation in this set of experiments was very large and interfered with the results. There is also a positive association between exports and the fraction of Georgiana Slough releases that are eventually salvaged. With only one exception, (1995 release group), the fraction of fish salvaged from Ryde releases appear to be unrelated to the level of exports (Ryde is downstream of both the DCC and Georgiana Slough channel openings on the Sacramento River)

*VAMP***:** The expected probability of surviving to Jersey Point was consistently greater for fish staying in the San Joaquin River (*i.e.*, passing Dos Reis) than fish entering Old River, but the magnitude of the difference varied between models somewhat. The placement of the HORB effectively keeps fish from entering Old River; therefore the survival of out-migrants should increase. There was a positive association between flow at Dos Reis and subsequent survival from Dos Reis and Jersey Point to Chipps Island. If data from 2003 and later were eliminated from data set, then the strength of the association with flow increased and a positive association between flow in Old River and survival in Old River also appeared. Finally, any associations between water export levels and survival probabilities were weak to negligible. This may have been due to the correlation between flow and export rates during the VAMP experiments. Given the complexity and number of potential models for the VAMP data, Newman recommends a more thorough model selection procedure using Reversible Jump MCM. An alternative analysis by Hanson (2008) did not find any significant relationship between exports and survival. Hanson also analyzed the relationship between exports and entrainment at the CVP and SWP as measured by salvage. Hanson (2008) referred to this fraction as direct losses. In Hanson's analysis, he examined the data from 118 studies involving approximately 14.2 million fish. Hanson found that on average, for fish released into the upper Sacramento River, direct losses due to the CVP and SWP pumps averaged 0.03 percent (sample size n = 118, 95 percent confidence interval (CI) = 0.0145) with a range of 0 to 0.53 percent. Hanson does not elaborate where these fish were released in the Sacramento River, what survival rates where prior to entering the Delta (losses may be as high as 80 percent in the Sacramento River prior to reaching the Delta, MacFarlane *et al*. 2008), whether these releases were paired in both spatial and temporal aspects to minimize environmental variance, the level of variance in pumping rates during his selected time frames of sampling, and how the inefficiency of the trawling recoveries and low recoveries rates at the fish collection facilities may have biased his results (see Newman 2008). Whereas Newman found increasing trends for fish in Georgiana Slough to be entrained with increases in exports (Delta Action 8 Studies), Hanson's analysis did not find this pattern. Likewise, the decrease in survival for fish in Georgiana Slough with increasing export rates found by Newman's analysis were not found in Hanson's analysis of the data. It is not apparent in Hanson's explanation of his analysis how he separated the different experimental studies into subgroups for statistical analysis with the goal of reducing bias and sampling variability, and thereby increasing the precision of his analysis.

Results from the different statistical analyses indicate that the data from the multiple releases-recapture studies are very "noisy" due to high levels of environmental variability. Finding clear cut results is a difficult task in which the various sources of error in the data, whether due to

experimental design, sampling efficiency, hydrological conditions, temporal and spatial variability, or inability to maintain constant conditions during the duration of the experiment, all lead to a lack of resolution in determining the final result of interest. Future studies utilizing acoustic tagging are aimed at reducing these confounding factors. In particular, acoustic tagging gives fine scale temporal and spatial resolution to the movements and behavior of fish over an extended period of time. Unlike the release–recapture studies, individual fish can be "sampled" continuously without loss of the test subject (*i.e.*, captured in the trawl or salvage facility). They can be followed after flow splits into different channels and their final disposition determined by reach, if necessary, to calculate their survival without the uncertainty of the current recapture methods employed in studies to date.

6.6.2.5 Indirect Mortality Within the Delta

6.6.2.5.1 Overview of Mortality Sources

Survival of salmonids migrating through the Delta is affected by numerous variables, some related to the proposed action, others independent of the project. As fish move down the mainstem Sacramento River into the North Delta, the intersecting channels splitting off of the main river channel provide alternative routes for migration. For each of these routes, a different probability exists for taking that alternative channel or remaining in the main stem of the river. Within each channel, additional factors come into play that determines the ultimate survival of fish moving through that reach of water. Survival is affected by the degree of predation within each individual channel, which is itself a function of predator types and density. Some predators, such as striped bass, are highly efficient at feeding on various aquatic organisms and quite mobile, thus moving from location to location, opportunistically preying on emigrating salmonids when they encounter them. Others, such as centrarchids (*i.e.*, largemouth bass) are more localized and ambush prey as it moves past their location in a given channel. They are unlikely to follow a migrating school of prey any great distance from their home territory. The suitability of habitat for emigrating salmonids can affect whether sufficient food and cover is available to emigrating fish, which then influences the survival of fish moving through that waterway. For example, a heavily riprapped channel that has essentially a trapezoidal cross section is unlikely to provide suitable foraging habitat or habitat complexity necessary for migrating salmonids. This condition can be further exacerbated if the margins of the channel are vegetated with the non-native *Egeria densa* which provides excellent cover for ambush predators like largemouth bass. Likewise, residence time required for passage of the fish through the alternative channel determines the duration of exposure to the stressors present in that channel. For example, a short residence time in a channel with extreme predation may have the same effect on survival as a prolonged residence time in a channel with low predation.

The exposures to toxicants in these channels are also likely to vary substantially. Passage through a channel with outfalls from a domestic wastewater treatment facility (WWTF) is likely to have a very different profile of chemical exposure compared to a channel dominated by agricultural return water runoff. A further layer of complexity is created by precipitation events that create the "first flush" effects that discharges surface runoff from urbanized and agricultural areas into local streams and waterways through stormwater conveyance systems or irrigation

return ditches. Fish swimming through these plumes are exposed to elevated levels of contaminants, as well as reduced water quality parameters (*e.g.*, lowered dissolved oxygen due to high organic matter loading) that have a high potential for compromising the physiological status of the exposed fish, and increasing the level of morbidity or mortality in those fish. In addition, regional effects such as river flows, tides, and export actions are superimposed on top of these localized effects. These large-scale factors can influence the route taken by the fish initially and subsequently determine its eventual disposition due to changes in local hydraulics and flow patterns.

6.6.2.5.2 Applicable Studies

Based on previous studies to date, it is assumed that fish remaining in the main channel of the Sacramento River have a higher survival rate than fish which move into other distributary channels splitting off from the main channel. Survival indices calculated for paired releases on the lower Sacramento River indicated that Chinook salmon smolts released into Georgiana Slough were between 1.5 times to 22 times more likely to be "lost"[15] to the system than fish released in the main stem of the Sacramento River below the head of Georgiana Slough at the town of Ryde, based on the recoveries of marked fish at Chipps Island (Brandes and McLain 2001, table 3). This is equivalent to a mortality rate of 33 to 95 percent. Statistical analysis by Newman (2008) found an average ratio of survival between the Georgiana Slough releases and the Ryde releases of 0.26, 0.43, and 0.39 for recoveries at Chipps Island, in the ocean harvest, and inland sites where adults were subsequently collected following spawning, respectively. Thus, survival in Georgiana Slough is less than one-half of that in the main stem Sacramento River, based on the Ryde releases. In comparison, Vogel (2004) found that approximately 23.5 percent of the radio tagged fish released in the mainstem Sacramento River during his radio telemetry tagging studies in the winter of 2002 were "lost," presumably to predation, leaving 76.5 percent of the fish reaching the Cache Slough Confluence near Rio Vista. Concurrent releases in Georgiana Slough during January and February of 2002 had mortality rates of 82.1 percent. In a similar study conducted in 2000 by Vogel, when ambient flows in the mainstem were higher (22,000 to 50,000 cfs compared to 14,000 to 23,000 cfs), the predicted predation rate on Chinook salmon smolts in the Sacramento River fell to 20 percent, while predicted predation in Georgiana Slough fell to 36 percent of the released fish. Vogel (2008a) conducted another study with acoustically tagged Chinook salmon smolts released on the Sacramento River near Old Town Sacramento in late 2006 and early 2007. While Vogel (2008a) presented preliminary general statistics, the full statistical analysis of this study will be reported by the U.S. Geological Survey (USGS). This study provided preliminary information on the behavior of fish as they passed side channels within the mainstem of the Sacramento River, and reach specific losses of tagged fish (assumed to be due to predation). Two releases were made, one on December 11-12, 2006 (n=96 fish in 4 groups of 24 fish) and one on January 22-23, 2007 (n=150 fish, released 8 groups). Although Vogel (2008a) presented only general summary statistics, he found that losses of fish that remained in the mainstem during the December study were approximately 20 to 22 percent, while those fish that moved into Georgiana Slough and the open DCC channels

[15] For this discussion loss is equivalent to mortality, although the studies to date cannot determine whether loss is the result of mortality from predation or other sources, or the inability to detect and account for all released fish in the Chipps Island trawls or subsequent ocean recoveries.

experienced much higher levels of loss (55 percent in Georgiana Slough, 80 percent in the DCC). The January 2007 loss rates were slightly higher, approximately 35 percent of the mainstem fish were lost, while approximately 73 percent of the fish that entered Georgiana Slough were lost. A fairly large fraction of fish entered the Sutter Slough and Steamboat Slough reaches (37 percent of the fish in the mainstem) with loss rates of approximately 40 percent (see Vogel 2008a for more details). These data indicate that there are reach specific characteristics for loss rates due to intrinsic factors in those channels (*e.g.*, predation). The release of fish in December occurred approximately three days before the DCC was closed due to rising flows in the Sacramento River (DCC was closed on December 15, 2006 at 1000 hours). Sacramento River flows increased to approximately 26,000 cfs during December before receding. Therefore, fish released in West Sacramento had at most 3.5 days to travel downstream and encounter the open DCC gates and enter into the delta interior through this route. Fish traveling downstream during this release encountered a rising hydrograph on the Sacramento River. Conversely, the January 2007 release had closure of the DCC gates during the entire experimental period, with relatively stable flows below 12,000 cfs.

A more detailed report concerning fish releases in mid December 2006 and mid-January 2007 was provided by Burau *et al*. (2007), which statistically analyzed the distribution and survival of tagged salmon released during the same study as Vogel (2008a; December 11-12, 2006 and January 22-23, 2007). Burau *et al*. (2007) estimated that 22 percent (22.2 ±0.065) of released fish entered Sutter Slough and approximately 4 percent (3.7 ± 0.021 percent) entered Steamboat Slough during the December release, the same percentages as Vogel (2008a). Of the fish that reached the vicinity of the second junction point, approximately 18 percent (17.9 ± 0.057) went into the channel of the DCC, and an additional 20 percent (19.6 ± 0.053) went into the channel of Georgiana Slough. Approximately 62 percent (62.5 ± 0.065) continued downstream in the Sacramento River channel below the second junction point. Following the January releases, with the DCC gates closed for the entire experimental period, approximately 30 percent (29.9 ± 0.046) of the fish entered Sutter Slough and 7 percent (7.2 ± 0.026) entered Steamboat Slough. Of the fish that reached the vicinity of the second junction point, approximately 29 percent (28.9 ± 0.063) entered Georgiana Slough (DCC closed) with the remainder moving downstream in the Sacramento River channel (71.1 ±0.063 percent). The first release in December was made on a rising hydrograph with flows of approximately 19,600 cfs and 3 days before the DCC gates closed in response to the increasing flows. The January releases were made under conditions in which the flows in the Sacramento River were much lower, approximately 11,300 cfs at Freeport. The preliminary results from this study indicate that both route selection and reach specific-survival depend on Sacramento River discharge and DCC gate position. Burau *et al*. (2007) states that these data indicate that: (1) when the DCC gates are closed the probability that salmon are entrained in Sutter, Steamboat, and Georgiana sloughs increases, which is consistent with increases in discharge in each of these channels when the gates are closed; (2) survival in every channel was higher at the higher discharge: survival in the Sacramento River increased by approximately 20 percent between the City of Sacramento and Sutter Slough, by approximately 8 percent in the reach between Steamboat Slough and the DCC, and approximately 15 percent between Georgiana Slough and Cache Slough; (3) survival in Georgiana Slough is consistently lower than in any other channel when survivals were estimated (DCC channel and Mokelumne River survival were not estimated); and finally, (4) the precision in the survival estimates are

progressively lower (increasing error bars) the farther into the system the measurements are made due to the reduction in fish passing through the lower reaches of these channels. The number of fish passing through the river sections farther from the release sites are reduced due to: (1) the total number of fish is progressively distributed into a greater number of pathways, and (2) mortality occurs as fish traverse the system, leaving fewer viable fish to traverse channels at a greater distance from the release site. The preliminary results from this study suggest that survival increased with increasing flows in the different river channels when comparisons could be made. The interpretation of the DCC gate position with survival was complicated by the very short duration of the "open" gate configuration (3 days) coupled with an increasing hydrograph during this period. Conversely, the "closed" gate condition occurred during lower river flows than the open gate configuration, and thus the comparison of the gate position is confounded by the flow variable between the two studies.

A study run by Perry and Skalski (2008) in the same region and general time frame produced similar results to the Vogel (2008a) and Burau *et al*. (2007) studies in some aspects, but different results in others. They developed a mark-recapture model that explicitly estimated the route-specific components of population-level survival in the Delta. The point estimate of survival through the Delta for the first release made on December 5, 2006 ($\hat{S}_{Delta}$ = 0.351, SE = 0.101, n=66 fish), was lower than the subsequent release made on January 17, 2007 ($\hat{S}_{Delta}$ = 0.543, SE = 0.070, n=80 fish). The authors attributed the observed difference in $\hat{S}_{Delta}$ between releases to (1) changes in the proportion of fish migrating through each distinct route through the Delta, and (2) differences in the survival for each given route traveled. Survival estimates for the routes through the interior of the Delta were lower than for the mainstem Sacramento River during both releases, however only 9 percent of the fish migrated through the interior of the Delta during the January release compared to 35 percent for the December release (table 6-32). The DCC gates closed on December 15, 2006 at 1000 hours, 10 days after the first release of fish on December 5, 2006. Passage data indicated that approximately 95 percent of the fish had passed through the second junction reach by the time the gates were closed. The first release was also made at Sacramento River flows of approximately 11,700 cfs at Freeport. Flows remained below 12,900 cfs until December 9, 2006, giving approximately 4 to 5 days of steady flow before increasing. Approximately 50 percent of the fish were detected arriving at the second junction prior to this date, and 75 percent of the fish had passed by approximately December 12, 2006. In comparison, the release of fish in January corresponded with steady flows of approximately 12,000 cfs for 10 days following the release and the gates in a closed position. Fish passage in January occurred much more quickly than in December, taking only 3 to 4 days to pass through the second junction. Perry and Skalski (2008) concluded that the operation of the DCC gates affected the route selection of fish during the study. The gates were closed on December 15, 2006, approximately half way through the first release study period and remained closed during the entire second study release period. The operation of the DCC affected both route selection and the distribution of flows within the channels of the north Delta. These effects were captured by the mark-recapture modeling of the study (figure 6-74).

Although the Vogel (2008a), Burau *et al*. (2007), and Perry and Skalski (2008) acoustic tagging studies have relatively small sample sizes, each fish provides valuable data concerning route selection, migration speed, and predation (loss) vulnerabilities. The two studies provide

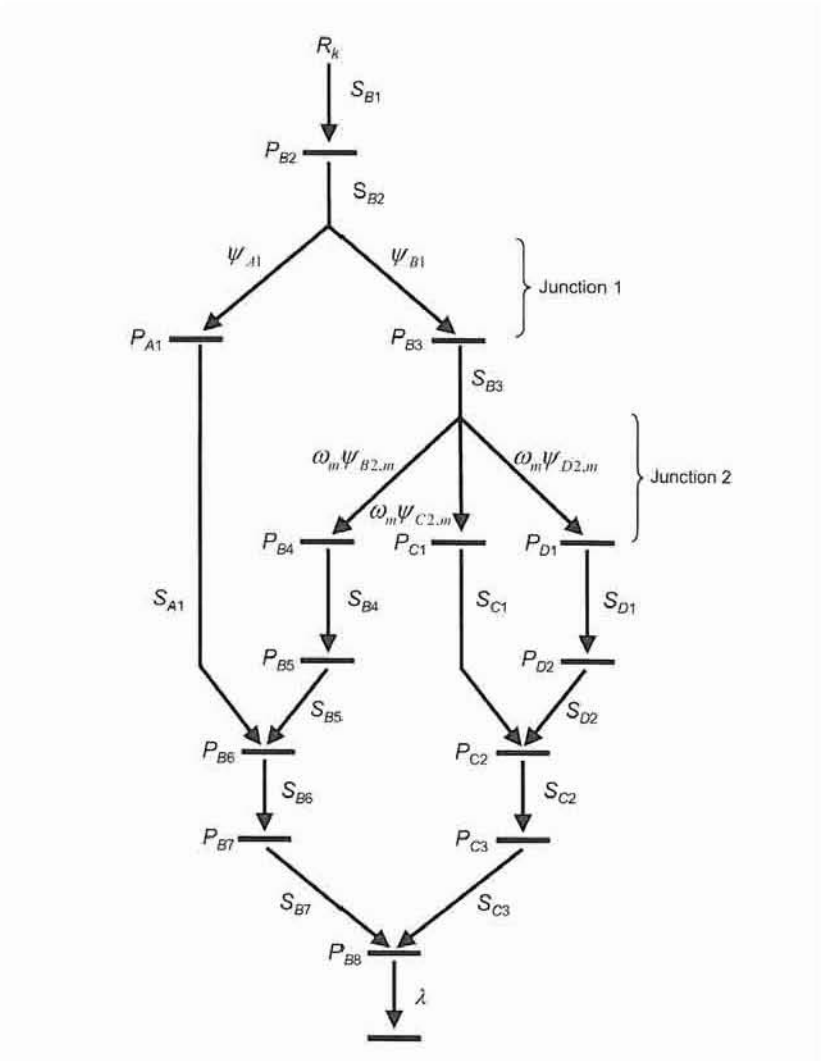
information that corresponds to the trends observed in previous CWT studies. These more recent studies verify that survival is lower within the channels of the interior delta and that higher flows benefit survival during fish movement downstream. Although the Vogel (2008a) and Burau *et al*. (2007) studies could not adequately address the effect of DCC gate position on survival due to confounding effects of increasing river flows and the short period between release of study fish and the gate closure, the results from the Perry and Skalski study indicate that population level survival can be increased by closing the gates. This results in reducing the fraction of the fish population entering the inerior of the Delta and increasing the fraction migrating through the northern system of channels, which include the Sacramento River, Sutter Slough and Steamboat Slough channels, where survival was higher relative to the interior Delta. If replications of the acoustic tag studies continue to provide similar outcomes, a more defined and accurate model of routing and predation vulnerabilities can be developed that is statistically robust and could provide a more thorough understanding of the system for ongoing management needs.

Table 6-32. Route-specific survival through the Sacramento-San Joaquin Delta ($\hat{S}_h$) and the probability of migrating through each route (Ψ_h) for acoustically tagged juvenile fall-run released on December 5, 2006, (R_1) and January 17, 2007, (R_2). Also shown is the population survival through the delta (S_{Delta}), which is the average of route specific survival weighted by the probability of migrating through each route (from Perry and Skalski 2008).

Migration Route	Survival $\hat{S}_h$ (SE)	95% Profile Likelihood Interval	Probability of Migratory Route Ψ_h (SE)	95% Profile Likelihood Interval
R_1 ; December 2006 (n=66)				
A) Steamboat & Sutter Sloughs	0.263 (0.112)	0.102, 0.607	0.296 (0.062)	0.186, 0.426
B) Sacramento River	0.443 (0.146)	0.222, 0.910	0.352 (0.066)	0.231, 0.487
C) Georgiana Sloughs	0.332 (0.179)	0.087, 0.848	0.117 (0.045)	0.048, 0.223
D) Delta Cross Channel	0.332 (0.152)	0.116, 0.783	0.235 (0.059)	0.133, 0.361
S_{Delta} (All Routes)	0.351 (0.101)	0.200, 0.692		
R_2: January 2007 (n=80)				
A) Steamboat & Sutter Sloughs	0.561 (0.092)	0.388, 0.747	0.414 (0.059)	0.303, 0.531
B) Sacramento River	0.564 (0.086)	0.403, 0.741	0.498 (0.060)	0.383, 0.614
C) Georgiana Sloughs	0.344 (0.200)	0.067, 0.753	0.088 (0.034)	0.036, 0.170
D) Delta Cross Channel	NA		0.0	NA
S_{Delta} (All Routes)	0.543 (0.070)	0.416, 0.691		

The mainstem Sacramento River channel has generally lower loss rates than the smaller distributary channels that diverge from it and loss rates appear to be affected by river flow levels. The subsequent total survival of fish leaving the Delta at Chipps Island is the sum of survival rates in each route multiplied by the probability of selecting that route multiplied by the "detection" probability for that group from all of the different potential routes that fish may take upon entering the north Delta from the Sacramento River, including the Yolo bypass in flood. This survival number is the fraction of total fish entering the Delta, which have avoided all of the potential sources of mortality to survive to Chipps Island. The number of fish entering the Delta from the Sacramento River is itself approximately 20 percent of the total number of fish that started migrating downstream in the Sacramento River from their natal rearing areas (MacFarlane *et al*. 2008a). This low survival number is due to the intrinsic losses in the

migrating population of fish as they encounter the natural and anthropogenic sources of mortality along the migration route.



A1 = Steamboat Slough/Sutter Slough, B1 = West Sacramento, B2 = Freeport, B3 = Courtland, B4 = Walnut Grove/upstream of the DCC, B5 = Ryde, B6 = Rio Vista, B7 = Emmaton, B8 = Chipps Island, B9 = pooled survival from SF Bay stations (λ), C1 = Georgiana Slough, C2 = lower Mokelumne River system, C3 = Antioch/ lower San Joaquin River, D1 = DCC, D2 = Downstream of DCC, upper branches of Mokelumne River. Releases (R_k) are made into the Sacramento River at West Sacramento. Junction 1 is the reach which includes the Steamboat/Sutter Slough junction with the Sacramento River, Junction 2 is the river reach which contains the Sacramento River with the DCC and Georgiana Slough.

Figure 6-74. Schematic of the mark recapture model used by Perry and Skalski (2008) used to estimate survival (S_{hi}), detection (P_{hi}), and route entrainment (ψ_{hi}) probabilities of juvenile late-fall Chinook salmon migrating through the Sacramento-San Joaquin River Delta for releases made on December 5, 2006, and January 17, 2007.

Population level survival through the Delta was estimated from the individual components as:

$$S_{Delta} = \sum_{h=A}^{D} \psi_h S_h$$

where h = the four potential routes, A – D; A = Sutter/Steamboat Slough, B = Sacramento River, C = Georgiana Slough, and D = Delta Cross Channel.

Telemetry tagging also was instrumental in describing movement patterns in the channels of the Central Delta (Vogel 2004, radio telemetry) and the South Delta (SJRGA 2008, acoustic telemetry). Fish released in the mainstem San Joaquin River near Fourteenmile Slough in the spring of 2002 and 2003 showed distinct movement patterns based on the level of export pumping and tides. When the combined exports created negative flows in the channels feeding into the South Delta, (*i.e.*, Turner and Columbia Cuts), a significant proportion of the released fish moved into those channels and were followed in a southerly direction towards the pumps. Conversely, when the VAMP experiment reduced export levels and increased flows in the San Joaquin River, more fish stayed in the main channel of the San Joaquin River and headed downstream with the net flow towards San Francisco Bay. This study also determined that Chinook salmon smolts were not "holding" on the flood tide and then going downstream with the ebb tide (tidal surfing behavior). Fish were observed to move significant distances with the tidal oscillation, and their net movement downstream did not occur at obvious times of the tidal cycle. The data from this study and the North Delta study indicate that fish may be vulnerable to flow split selection several times depending on the magnitude and timing of the tidal oscillation, thus the probability of selecting one route over another is more complex than just a one time exposure to the channel split (see also Horn and Blake 2004). The acoustic tagging studies conducted during the VAMP experiments (SJRGA 2007) indicated that fish responded to flow and presumably export levels when moving downstream in the San Joaquin River past Turner and Columbia Cuts, and the mouths of Middle and Old River. The study also found that fish could pass through the culverts on the HORB and be subsequently detected downstream at the CVP and SWP facilities. Likewise, some fish that passed by the HORB and continued downstream into the Delta proper, were also detected moving southwards towards the pumps, presumably under the influence of the net negative flows in those channels. Preliminary predation hot spots, (*e.g.*, the scour hole in front of the HORB) were also detected, as well as areas with potential water quality concerns (City of Stockton WWTF outfall), which corresponded to increased losses of tagged fish passing through those reaches.

The tagging data and the results of theoretical particle tracking models (see Kimmerer and Nobriga 2008) support the position that movement of fish (or particles), at least in part, are influenced by the inflow of water into the Delta from the surrounding tributaries, and the volume of water being exported from the Delta by the CVP and SWP, thus affecting the flow patterns within the Delta channels. While the correlation of the survival rates of fish released in the Delta Action 8 and the Interior Delta CWT studies with the percentages of particles reaching Chipps Island is poor under most of the runs, Kimmerer and Nobriga (2008) offer potential causes for these differences. They opine that the lack of correlation may be merely due to the differences in the behavior between salmon and neutrally buoyant particles, or, on the other hand, that artifacts of the experiments such as the survival potential of fish traveling through the different waterways (*i.e.*, predation on the CWT fish) or the lack of efficiency in the trawl recapture rates for Chipps

Island biases the results of the CWT studies and results in lower numbers of fish reaching the terminal endpoints than suggested by the PTM results. They conclude that "despite all these differences, the PTM results suggests that river flow may be an important variable in determining which way the salmon go and their probability of survival, and should be included in the design and analysis of future studies" (Kimmerer and Nobriga 2008 page 19). Operations of the CVP and SWP, since they are supplied by the flow of water in the Sacramento and San Joaquin Rivers, set the hydraulic boundary conditions in conjunction with the two main sources of water flowing into the Delta. The boundary conditions, in part, dictate the flow percentage splits into distributary channels, in concert with the overlying tidal signal (see Horn and Blake, 2004). Operations of program infrastructures, such as the DCC radial gates and the South Delta temporary barriers, further influence the probability of entrainment into side channels leading off of the main river channel. The influence of the export pumps becomes more pronounced the closer to the pumps the fish or experimental particle gets, until entrainment is essentially certain.

DWR created a Delta Survival Model as part of their declarations to the court in September, 2008 (Greene 2008). The model provides estimates of survival through the Delta interior for a population of "fish" that enter the Delta from the Sacramento River. The model, using inputs for exports and Delta inflow, calculates percentage splits of the migrating fish population moving downstream in the Sacramento River into the interior of the Delta. The percentage splits are based on PTM simulations with injection points at Hood (upstream of the DCC and Georgiana Slough and indicating movement into the Delta interior) and in the South Mokelumne River (movement towards the export facilities in the South Delta and westwards towards Chipps Island). Interpolation of data provided in the Newman (2008) analysis estimated non-export and export related loss encountered in the Delta based on export levels. From the data output of the model, a final estimate of the survival through the Delta can be derived with losses calculated for export and non-export related mortality. The model is strongly driven by the export/inflow ratio which determines the PTM output and hence the particle fates (*i.e.*, fish) and by the export rate which determines relative survival rate between the Sacramento River and the Delta interior and the export related interior Delta survival rate. NMFS biologists used the summary output from the three studies (7.0, 7.1, and 8.0) simulated with the CALSIM II model over the different water year types for the months between December and June to estimate the different rates of mortality expected under the different CALSIM II scenarios for emigrating salmonids. Loss associated with exports ranged from 0.3 percent of the total population entering the Delta to slightly more than 15 percent of the population entering the Delta over the different simulation runs. The loss associated with non-export factors ranged from 3.3 percent to approximately 31.5 percent of the population. Total survival of the emigrating fish population was estimated to range between 41 and 77 percent. The data indicated that lower survival rates were predicted when E/I ratios were high, and more particles were moved into the Delta interior and thence southwards towards the export facilities. Losses were higher in drier years and during the early season of fish migration (December through February). The data also indicated that the near future and future studies would have higher levels of loss due to higher export levels and thus higher E/I ratios.

6.6.2.5.3 Environmental Factors

In addition to the "direct" effects of the CVP and SWP operations manifested by flows and exports, the modification of the Delta hydraulics for the conveyance of water has altered the suitability of the Delta for native species of fish, such as Chinook salmon, steelhead, and green sturgeon. Since the inception of the CVP and later the SWP, the natural variability in the hydrology of the Delta has been altered. As previously explained, the amount and timing of runoff from the Sacramento and San Joaquin Rivers has been altered and shifted to accommodate human needs. When large-scale exports of water were initiated in the South Delta, it became necessary to "freshen up" the Delta to guarantee high quality fresh water was available to export from the facilities on a reliable basis (*e.g.*, construction of the DCC). This necessitated an increase in the stability of the Delta's hydrology and the formation of a large freshwater "lake" for the reliable conveyance of water from the river sources to the export facilities. The enhanced stability of the freshwater pool in the Delta enabled non-native species, such as centrarchids and catfish, as well as invasive plants, such as *Egeria densa* and water hyacinth, to thrive in this "new" Delta hydrology (Brown and Michniuk 2007). In addition, the altered ecological characteristics of the Delta have been proposed as a contributing factor in the recent Pelagic Organism Decline (POD) observed in the Delta. The combination of these exotic species and altered ecological characteristics of the Delta interact to decrease the suitability of the Delta for native species of fish and have increased the potential for predation and loss (see 2008 CVP/SWP operations BA, Delta smelt sections for a more detailed explanation).

6.6.2.5.4 Summary

Many of the indirect mortality events are interrelated to the operations of the CVP and SWP. As previously discussed, the Delta has been operated as a freshwater conveyance instrument for the past half century. The necessity for the stable and reliable transfer of freshwater from the Sacramento River across this large expanse of waterways has required that natural hydrologies and circulation patterns be altered to maximize the efficiency of the water operations. This change has benefited non-native species to the detriment of native species, which evolved with a more dynamic habitat, which included variable hydrographs and seasonal fluxes of salinity into the western Delta. In light of the POD phenomenon that has become evident in the Delta in recent years, the aspect of a bottom to top reorganization of the ecosystem during the past decade indicates that the Delta is "unhealthy" and even the exotic, introduced species (*i.e.*, striped bass, thread fin shad, *etc*.) are in decline. Continued operations of the CVP and SWP are unlikely to benefit the health of the Delta, and increases of the facility operations are likely to degrade the system beyond their current conditions, rather than return the Delta to a more natural condition, with more functional hydraulics conducive to a healthy ecosystem.

6.6.2.6 Assess Risk to Individuals

This section summarizes the potential risks faced by individual fish of the winter-run population, the spring-run population, the CV steelhead population, and the Southern DPS of green sturgeon in the Delta region. The previous sections have described in detail, the effects of the proposed export operations on these fish.

Increased pumping, as proposed in the project description will increase the vulnerability of individual fish to entrainment at the TFCF and the SFPF in the South Delta. Salmonids entrained at the Federal facility, the TFCF, have a maximal survival estimate of approximately 35 percent under normal operating conditions. However this survival rate may decrease even further depending on louver cleaning frequency, pumping operations, and predation following CHTR releases. The survival rate of salmonids at the state's facility, the SFPF, is estimated to be approximately 16 percent under normal operating conditions. Unlike the Federal facility, where most of the salmonid loss is attributed to the louvers, the state's facility has relatively efficient louvers, but substantially greater predation risks. Predation loss within CCF is the main variable driving survival of entrained fish with little difference evident between the smaller salmon smolts and the larger steelhead smolts. It is estimated that only one out of every four to five fish entering the forebay survive their transit across this water body to be salvaged at the louvers. This predation risk is dependent on predator density and behavior in the forebay. Additional changes to the survival estimate can occur due to changes in export levels at the Banks Pumping Plant and predation risks following release back into the system at the CHTR release stations. It is unknown what percentages of juvenile and sub-adult green sturgeon are lost at the fish collection facilities. Based on the studies by Kynard and Horgan (2001), salvage rates should be almost 100 percent for green sturgeon based on the efficiencies for shortnose and pallid sturgeon. However, cleaning of the louvers where the louvers are lifted out of their guides and reductions in flow along the louver face during export reductions may degrade the louver efficiency for green sturgeon and loss of individual fish becomes greater under such conditions.

Salmonids are also subject to loss as they cross the Delta during their downstream migration towards the ocean. As shown by the Burau *et al*. (2007), Perry and Skalski (2008) and Vogel (2008a) studies, individual fish risk entrainment into the channels of Georgiana Slough under all conditions and into the Mokelumne River system when the DCC gates are open as they migrate downstream in the Sacramento River. Estimated average survival is only 33 percent with a range of approximately 10 percent to 80 percent survival. Most of this loss is believed to be associated with predation, but may also include prolonged exposure to adverse water quality conditions represented by temperature or contaminants. Several years of salmonid survival studies utilizing both CWT and acoustically tagged fish indicate that survival is low in the interior Delta waterways compared to the mainstem Sacramento River. Likewise, survival in the upper San Joaquin River between Durham Ferry and Jersey Point is substantially lower than survival from Jersey Point to Chipps Island (VAMP studies), indicating that transiting the Delta interior is a very risky undertaking for fish exiting from the San Joaquin River basin or the east side tributaries (Mokelumne and Calaveras River basins). The probability of ending up at the Delta export facilities or remaining in the interior delta waterways increases with increased export pumping, particularly for those fish in the San Joaquin River system.

NMFS estimates that loss associated with exports for fish emigrating downstream in the Sacramento River and entering the Delta ranged from 0.3 percent of the total population entering the Delta to slightly more than 15 percent of the population entering the Delta based on the different CALSIM II simulation runs for current (Study 7.0), near future (Study 7.1) and future conditions (Study 8.0) and the Delta Survival Model developed by DWR. The loss associated with non-export factors ranged from 3.3 percent to approximately 31.5 percent of the population.

Total survival of the emigrating fish population from the Sacramento River basin was estimated to range between 41 and 77 percent for fish entering the Delta and subsequently reaching Chipps Island in the western edge of the delta. These values most accurately represent losses to winter-run Chinook salmon and spring-run Chinook salmon since loss rates in the DWR model were constructed from studies of CWT tagged Chinook salmon. NMFS will also use these loss rates for CV steelhead migrating downstream in the Sacramento River for lack of species-specific studies for steelhead predation losses. Loss rates due to predation in the CCF were similar between the smaller Chinook salmon smolts and the larger steelhead smolts, and therefore provide a level of justification in making this assumption. The loss of juvenile and sub-adult green sturgeon in the delta due to exports is unknown. To date, NMFS is not aware of any studies designed to quantify the loss of these fish to export related actions. Only recently have acoustic tagging studies been undertaken to study the movement of fish through the delta and results are still being interpreted by the study investigators. The fact that some individual green sturgeon are collected at the export fish salvage facilities indicates that these fish are vulnerable to the exports and may incur population level effects. Loss rates for CV steelhead emigrating from the San Joaquin River basin and the east side tributaries of the Calaveras River and Mokelumne River systems are expected to be substantially higher than those experienced by the Sacramento River basin fish due to the proximity of the main migration corridor (the San Joaquin River) to the export facilities. Stronger flow effects from the pumps are observed on the San Joaquin River waterways and the nature of the south Delta channels provide multiple access points to the exports when water is being diverted.

Loss rates at the export facilities typically account for several hundred to several thousand individual wild fish per year from the different salmonid populations. As previously discussed, the importance of these wild fish to the population is potentially greater than their actual numbers. These fish represent individuals who have survived the numerous stressors present in the system between their natal streams and the Delta, and therefore represent behavioral and physiological traits that are necessary for survival in the natural environment. Loss of these individuals represents a loss of survival traits that would be beneficial to the population as a whole.

An historical assessment of estimated survival of fall-run smolts through the Delta by water year type at different levels of development in the Central Valley was calculated by Kjelson and Brandes (1989). They found that water development has adversely affected smolt survival over the period spanning 1920 to 1990. The authors reggressed smolt survival estimates on the Sacramento River with river flows at the City of Sacramento and applied this to monthly estimates of smolt migration through the Delta. These parameters were then used to calculate average survival rates using estimated historic flow patterens at Sacramento under four different water development scenarios. The results indicted that reduced inflow to the Delta caused by water development in the Sacramento Valley has reduced smolt survival substantially (table 6-33). The greatest differences in survival occurred in dry and critical years. The estimated maximum decrease in survival associated with the 1990 level of development occurred with the no development scenario. The authors estimated that between 1940 and 1990, survival of fall-run smolts decreased about 30 percent. These are considered minimal estimates of survival decline, since greater survival per unit flow would have occurred prior to the operations of the

DCC in the 1950s than was deduced form the current survival relationships. Survival is more than likely less now than the estimates for the 1990 level of development due to the increased demands in the Central Valley over the intervening 20 years.

Table 6-33. Average estimated Delta survival indices of fall-run Chinook salmon smolts by water year type at different levels of development: unimpaired (no development), and at 1920, 1940, and 1990 levels of development (Table 7 in Kjelson and Brandes 1989).

Water Year Type	Sample Size	Unimpaired No Development	1920 Level of Development	1940 Level of Development	1990 Level of Development
Wet	**19**	**0.97**	**0.92**	**0.91**	**0.83**
Above Normal	**10**	**0.91**	**0.85**	**0.83**	**0.61**
Below Normal	**10**	**0.84**	**0.69**	**0.66**	**0.41**
Dry	**10**	**0.76**	**0.57**	**0.55**	**0.33**
Critical	**8**	**0.33**	**0.17**	**0.21**	**0.12**
Mean		**0.76**	**0.64**	**0.63**	**0.46**

Annual survivals were estimated by weighting monthly survival indices by the average percent from 1978 to 1986 of total outmigrants going to sea (Table 6 in Kjelson and Brandes 1989). Monthly survival indices were estimated from monthly flows using linear relationships between salmon survival and flow at Sacramento where y = 0.00005x – 0.465 when y = survival and x = mean monthly Sacramneto River flow. Data from 1969-71 and 1978-81 were used to derive the equation. Monthly flows for the four different levels of developemnt were obtained from the California Department of Water Resources planning simulation Model studies.

6.6.2.7 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

The proposed export actions represent an adverse impact to the PCEs of the designated and proposed critical habitats in the Delta region. As discussed in the preceding effects section, the exports divert a substantial amount of water (approximately 6 to 8 MAF annually) from the Delta environment. The hydraulic changes created by the export actions have altered the suitability of the delta as a rearing area and migratory corridor for juvenile salmonids, particularly for Central Valley steelhead which has designated critical habitat in the accessible waterways throughout the entire legal Delta. Likewise, the proposed critical habitat for the Southern DPS of green sturgeon encompasses the accessible waterways of the Delta, and overlaps the geographical area of the designated critical habitat for CV steelhead. Designated critical habitat for winter-run and spring-run is primarily confined to the north Delta region and the waterways associated with the main channel of the Sacramento River.

The effects of the CVP/SWP on the rearing qualities of the Delta are related to the removal or reduction of potential forage species from the Delta environment. Juvenile salmonids and green sturgeon rely on both benthic and pelagic microinvertebrates for their forage base. The actions of the exports directly remove the pelagic forms of these microinvertebrates (copepods, diatoms, cladocerans, *etc*.) through water diversion while also indirectly affecting the benthic forms.

These forage species rely on food webs in which phytoplankton and detritus serve as energy sources. Removal of the phytoplankton from the Delta due to water diversions by the CVP/SWP exports disrupts the flow of energy available to these other pelagic and benthic invertebrate communities, as well as reduces the creation of detrital matter from the decomposition of these organisms in the system along with other organic matter.

The actions of the CVP and SWP contribute to the degradation of the waterways in the Delta as migratory corridors. As described in the effects of the export actions above, emigrating juvenile salmonids are adversely affected by the withdrawal of water from the Delta by the export pumps. The flow of water southwards towards the pumps disrupts the natural flow cues used by emigrating salmonids to reach the lower estuary and the ocean beyond. The alteration in the hydrodynamics can entrain fish southwards from the Central Delta towards the pumps, delay migration by disrupting the normal flow cues associated with net downstream flow, and increase the vulnerability of fish to predation by lengthening their migratory route or directing them into new channels not normally used for emigration to the ocean. The effects on San Joaquin River basin steelhead are most pronounced as the conservation value of the migratory corridors in the south and central Delta are the most degraded. Under current conditions, few steelhead are expected to successfully reach the western Delta and the ocean beyond. Impacts to juvenile and sub-adult green sturgeon are less clear as these fish spend 1 to 3 years rearing in the Delta environment before transitioning to their marine life history stage. During this Delta rearing phase, fish are free to migrate throughout the Delta. Entrainment by the net negative export flows in the central and southern delta may cause fish to be pulled into the southern Delta waterways in an unnatural proportion to their normal movements. Ongoing acoustic tracking studies should provide more detailed information on the movements of this life stage in the Delta.

6.6.3 Clifton Court Aquatic Weed Control Program

6.6.3.1 Deconstruct the Action

The SWP has proposed treating the waters of Clifton Court Forebay with copper-based herbicides, including Komeen®, Nautique® and copper sulfate pentahydrate to reduce the standing crop of the invasive aquatic weeds or algal blooms growing in the water body. The dominant species of aquatic weed in the forebay is *Egeria densa*, however other native and invasive aquatic weeds are present. Excessive weeds fragment and clog the trashracks and fish screens of the Skinner Fish Protection Facility reducing operating efficiency and creating conditions in which the screens fail to comply with the appropriate flow and velocity criteria for the safe screening of listed fish. In addition, the weeds create sufficient blockage to the flow of water through the trashracks and louver array, that the pumps at the Banks Pumping Facility begin to reduce the water level downstream of the Skinner Facility and the loss of hydraulic head creates conditions that lead to cavitation of the impeller blades on the pumps if pumping rates are not quickly reduced. The algal blooms do not affect the pumps, but rather reduce the quality of the pumped water by imparting a noxious taste and odor to the water, rendering it unsuitable for drinking water.

DWR has applied herbicides in Clifton Court Forebay since 1995, typically during the spring or early summer when listed salmonids have been present in the forebay. Applications, however, have occurred as early as May 3rd and as late as September 10th during this time. Copper based herbicides present toxicity issues to salmonids and green sturgeon due to their high sensitivity to copper at both sublethal and lethal concentrations.

DWR, in response to NMFS' concern over the use of Komeen® during periods when listed salmonids may be present in the Clifton Court Forebay, has altered its operational procedure for application of copper-based herbicides from previous operations. DWR has proposed to apply copper sulfate or Komeen® between July 1 and August 31 of each year as needed. In addition, DWR will conduct the following actions:

1. Monitor the salvage of listed fish at the Skinner Facility prior to the application of the herbicides in Clifton Court Forebay.
2. Close the radial intake gates at the entrance to Clifton Court Forebay 24 hours prior to the application of herbicides to allow fish to move out of proposed treatment areas and towards the salvage facility.
3. The radial gates will remain closed for 24 hours after treatment to allow for at least 24 hours of contact time between the herbicide and the treated vegetation in the forebay. Gates will be reopened after a minimum of 48 hours.
4. Komeen® will be applied by boat, starting at the shore and moving sequentially farther offshore in its application. Applications will be made be a certified contractor under the supervision of a California Certified Pest Control Advisor.
5. Application of the herbicides will be to the smallest area possible that provides relief to the project.
6. Monitoring of the water column concentrations of copper is proposed during and after herbicide application. No monitoring of the copper concentration in the sediment or detritus is proposed.

6.6.3.2 Assess the Species Exposure

The timing of the application of the aquatic herbicide Komeen® to the waters of the forebay will occur during the summer months of July and August. The probability of exposing salmonids to the copper-based herbicide is very low due to the life history of Chinook salmon and steelhead in the Central Valley's Delta region. Migrations of juvenile winter-run and spring-run fish primarily occur outside of the summer period in the Delta. The presence of juvenile winter-run and spring-run in the Delta is described in *Section 5.5 Status of the Species and Critical Habitat in the Delta Division.* CV steelhead have a very low probability of being in the South Delta during the July through August period proposed for herbicide treatments. Historical salvage data indicates that in wet years, a few steelhead may be salvaged as late as early July, but this is uncommon and the numbers are based on a few individuals in the salvage collections. Based on typical water temperatures in the vicinity of the salvage facilities during this period, the temperatures would be incompatible with salmonid life history preferences, generally exceeding 70°F by mid-June. In contrast, juvenile and sub-adult green sturgeon are recovered year-round at the CVP/SWP facilities, and have higher levels of salvage during the months of July and August

compared to the other months of the year. The reason for this distribution is unknown at present. Therefore, juvenile and sub-adult green sturgeons are likely to be present during the application of the copper-based herbicide Komeen®.

6.6.3.3 Assess Species Response to the Application of Herbicides for the Aquatic Weed Control Program in Clifton Court Forebay

Previous applications of Komeen® have followed the label directions of the product, which limits copper concentration in the water to 1,000 µg/L [1 part per million (ppm) or 1,000 parts per billion (ppb)]. Under the current proposal, DWR intends to apply Komeen® at a working concentration in the water column of 640 ppb as Cu^{2+} from the Komeen® formulation. The copper in Komeen® is chelated, meaning that it is sequestered within the Komeen® molecule and is not fully dissociated into the water upon application. Therefore, not all of the copper measured in the water column is biologically available at the time of application. Toxicity studies conducted by the California Department of Fish and Game (CDFG 2004a, b) measured the concentrations of Komeen® that killed 50 percent of the exposed population over 96 hours (96hr-LC_{50}) and 7 days (7d LC_{50}) as well as determining the maximum acceptable toxicant concentration level (MATC) to exposed organisms. CDFG found that the 96hr-LC_{50} for fathead minnows (*Pimephales promelas*) was 310 ppb (180 – 530 ppb 95 percent confidence limit) and the 7d- LC_{50} was 190 ppb. The MATC was calculated as 110 ppb Komeen® in the water column. Splittail (*Pogonichthys macrolepidotus*), a native cyprinid minnow, was also tested by CDFG. The 96hr-LC_{50} for splittail was 510 ppb.

NMFS did not find toxicity data for exposure of sturgeon to Komeen®, however exposure to other compounds including pesticides and copper were found in the literature (Dwyer *et al*. 2000, Dwyer *et al.* 2005a, b). From these studies, sturgeon species appeared to have sensitivities to contaminants comparable to salmonids and other highly sensitive fish species. Therefore, NMFS will assume that green sturgeon will respond to Komeen® in a fashion similar to that of salmonids and should have similar mortality and morbidity responses.

Pacific salmonids (*Oncorhynchus* spp.) are very susceptible to copper toxicity, having the lowest LC_{50} threshold of any group of freshwater fish species tested by the EPA in their Biotic Ligand Model (BLM; EPA 2003a) with a Genus Mean Acute Value (GMAV) of 29.11 µg/l of copper. In comparison, fathead minnows (*Pimephales promelas*), the standard EPA test fish for aquatic toxicity tests, have a GMAV of 72.07 µg/l of copper. Therefore, salmonids are approximately 3 times more sensitive to copper than fathead minnows, the standard test fish in EPA toxicity testing. NMFS assumes that sturgeon will have a similar level of sensitivity. Hansen *et al.* (2002) exposed rainbow trout to sub-chronic levels of copper in water with nominal water hardness of 100 mg/l (as $CaCO_3$). Growth, whole body copper concentrations, and mortality were measured over an 8-week trial period. Significant mortality occurred in fish exposed to 54.1 µg/l copper (47.8 percent mortality) and 35.7 µg/l copper (11.7 percent mortality). Growth and body burden of copper were also dose dependent with a 50 percent depression of growth occurring at 54.0 µg/l, but with significant depressions in growth still occurring at copper doses as low as 14.5 µg/l after the 8-week exposure.

In a separate series of studies, Hansen *et al.* (1999a, b) examined the effects of low dose copper exposure to the electrophysiological and histological responses of rainbow trout and Chinook salmon olfactory bulbs, and the two fish species behavioral avoidance response to low dose copper. Chinook salmon were shown to be more sensitive to dissolved copper than rainbow trout and avoided copper levels as low as 0.7 μg/l copper (water hardness of 25 mg/l), while the rainbow trout avoided copper at 1.6 μg/l. Diminished olfactory (*i.e.*, taste and smell) sensitivity reduces the ability of the exposed fish to detect predators and to respond to chemical cues from the environment, including the imprinting of smolts to their home waters, avoidance of chemical contaminants, and diminished foraging behavior (Hansen *et al.* 1999b). The olfactory bulb electroencephalogram (EEG) responses to the stimulant odor, L-serine (10^{-3} M), were completely eliminated in Chinook salmon exposed to ∃50 μg/l copper and in rainbow trout exposed to ∃200 μg/l copper within 1 hour of exposure. Following copper exposure, the EEG response recovery to the stimulus odor were slower in fish exposed to higher copper concentrations. Histological examination of Chinook salmon exposed to 25 μg/l copper for 1 and 4 hours indicated a substantial decrease in the number of receptors in the olfactory bulb due to cellular necrosis. Similar receptor declines were seen in rainbow trout at higher copper concentrations during the one-hour exposure, and were nearly identical after four hours of exposure. A more recent olfactory experiment (Baldwin *et al.* 2003) examined the effects of low dose copper exposure on coho salmon (*O. kisutch*) and their neurophysiological response to natural odorants. The inhibitory effects of copper (1.0 to 20.0 μg/l) were dose dependent and were not influenced by water hardness. Declines in sensitivity were apparent within 10 minutes of the initiation of copper exposure and maximal inhibition was reached in 30 minutes. The experimental results from the multiple odorants tested indicated that multiple olfactory pathways are inhibited and that the thresholds of sublethal toxicity were only 2.3 to 3.0 μg/l above the background dissolved copper concentration. The results of these experiments indicate that even when copper concentrations are below lethal levels, substantial adverse effects occur to salmonids exposed to these low levels. Reduction in olfactory response is expected to increase the likelihood of morbidity and mortality in exposed fish by impairing their homing ability and consequently migration success, as well as by impairing their ability to detect food and predators [Also see the technical white paper on copper toxicology issued by NMFS (Hecht *et al.* 2007)]. Given that sturgeon use their sense of smell and tactile stimulus to find food within the bottom substrate, degradation of their olfactory senses could diminish their effectiveness at foraging and compromise their physiological condition through decreases in caloric intake following copper exposure.

In addition to these physiological responses to copper in the water, Sloman *et al.* (2002) found that the adverse effect of copper exposure was also linked to the social interactions of salmonids. Subordinate rainbow trout in experimental systems had elevated accumulations of copper in both their gill and liver tissues, and the level of adverse physiological effects were related to their social rank in the hierarchy of the tank. The increased stress levels of subordinate fish, as indicated by stress hormone levels, is presumed to lead to increased copper uptake across the gills due to elevated ion transport rates in chloride cells. Furthermore, excretion rates of copper may also be inhibited, thus increasing the body burden of copper. Sloman *et al.* (2002) concluded that not all individuals within a given population will be affected equally by the presence of waterborne copper, and that the interaction between dominant and subordinate fish

will determine, in part, the physiological response to the copper exposure. It is unknown how social interactions affect juvenile and sub-adult green sturgeon in the wild.

Current EPA National Recommended Water Quality Criteria and the California Toxics Rule standards promulgate a chronic maximum concentration (CMC) of 5.9 µg/l and a continuous concentration criteria of 4.3 µg/l for copper in its ionized form. The dissociation rate for the chelated copper molecule in the Komeen® formulation was unavailable at the time of this consultation, so that NMFS staff could not calculate the free ionic concentration of the copper constituent following exposure to water. However, the data from the CDFG toxicity studies indicates that a working concentration of 640 ppb Komeen® will be toxic to salmonids if they are present, either causing death or severe physiological degradation, and therefore green sturgeon would likely be similarly affected based on their similar sensitivities to copper toxicity.

6.6.3.4 Assess Risks to Individuals

The proposed modifications to the herbicide application program's period of application (July 1 through August 31) will substantially avoid the presence of listed salmonids in the Clifton Court Forebay due to the run timing of the juveniles through the Delta. As described earlier, Central Valley steelhead smolts may arrive during any month of the year in the delta, but their likelihood of occurrence is considered very low during the summer months of July and August. It also is highly unlikely that any winter-run or spring-run will be present during this time period in the South Delta. Unlike the salmonids, however, representatives of the Southern DPS of green sturgeon are routinely salvaged during the summer at both the CVP and SWP fish salvage facilities. This is related to their year round residency in the Delta during their first 3 years of life. The numbers salvaged typically increases during the summer (see figure 4-11). It is therefore likely that individuals from the Southern DPS of green sturgeon will be exposed to the copper herbicides, and based on the comparative sensitivities of sturgeon species with salmonids, some of these fish are likely to be killed or otherwise negatively affected. The exact number of fish exposed is impossible to quantify, since the density of green sturgeon residing or present in the forebay at any given time is unknown. The short duration of treatment and rapid flushing of the system will help to ameliorate the adverse conditions created by the herbicide treatment.

The application of Komeen® to Clifton Court Forebay under the Aquatic Weed Control Program will not affect the populations of winter-run or spring-run. These populations of salmonids do not occur in the South Delta during the proposed period of herbicide applications and thus exposure to individuals is very unlikely. Since no individual fish are exposed, population level effects are absent. Exposure of CV steelhead is also very unlikely; however some individual fish may be present during July as indicated by the historical salvage record and thus occurrence of fish in the forebay during the Komeen® treatment is not impossible. The numbers of steelhead that may be potentially exposed to the copper-based herbicide is believed to be very small, and therefore demonstrable effects at the population level resulting from Komeen® exposure are unlikely.

The effects to the green sturgeon population are much more ambiguous due to the lack of information regarding the status of the population in general. Although NMFS estimates that

few green sturgeons will be exposed during the 2 to 3 days of herbicide treatment; the relative percentage of the population this represents is unknown. Likewise, the number of green sturgeon that reside in the forebay at any given time and their susceptibility to entrainment is also unknown. This uncertainty complicates the assessment of both population and individual exposure risks. This area of green sturgeon life history needs further resolution to make an accurate assessment of the impacts to the overall status of the population.

6.6.3.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

Clifton Court Forebay is not part of the designated critical habitat for CV steelhead and thus actions taken within the forebay itself do not affect PCEs in the Delta for rearing habitat or migratory corridors. The design of the herbicide application protocol prevents movement of the copper-based herbicide from the forebay into the waters of the Delta outside of the forebay through the closure of the radial gates. After the exposure period, residual herbicide is pulled into the California Aqueduct via the pumps when the radial gates are opened to let in fresh water from the Delta. The flushing of the forebay with external Delta water should reduce any remaining Komeen® to insignificant levels and move the treated water volume into the aqueduct system of the SWP. There should be no discernable effects on designated critical habitat outside of the forebay. The proposed critical habitat for the Southern DPS of green sturgeon also does not include the forebay. As previously discussed above, measures to prevent movement of the copper-based herbicide outside of the forebay treatment area should preclude any discernable effects on proposed critical habitat for green sturgeon.

6.6.4 South Delta Improvement Program – Stage 1

6.6.4.1 Deconstruct the Action

The South Delta Improvement Program (SDIP) Stage 1 involves the placement of four permanent gates in the channels of the South Delta already affected by the temporary rock barriers installed under the TBP action. Three of the location, Old River at Tracy, Middle River near Victoria Canal, and the Head of Old River are essentially the same as the locations for the temporary barriers previously discussed in section 5.6.3. The fourth location, the channel formed by Fabian - Bell and Grant Line Canals will have the permanent structure located several miles to the west of the temporary barrier location. The permanent operable gate will be near the confluence of the Fabian - Bell and Grant Line Canal channel with Old River. This location is between the CVP and SWP facilities on Old River just south of Coney Island. For a short period, during the construction of the permanent gates, the rock barriers will continue to be installed and operated and there will be an overlap between the two actions. NMFS expects that the operation of the permanent gates proposed for the SDIP will have many of the same effects as described for the TBP in regards to changes in the regional hydrodynamics and the increase in predation levels associated with the physical structures and near-field flow aspects of the barriers. The effects of the temporary barriers have been described in NMFS (2009). The CALSIM II and DSM 2 modeling conducted for this consultation incorporated the permanent barriers into the modeling assumptions for Studies 7.1 and 8.0 while including the temporary

barriers as part of the current conditions under the assumptions for Study 7.0. Therefore, individual effects of the barriers on the future conditions must be inferred from the modeling output, or derived from other sources of information. The future baseline conditions include the ongoing natural and anthropogenic activities in the Delta not associated with the project (levees, dredging, contaminants, urban development, non-native species, predation, *etc*.). NMFS considers the 4-month winter "no barrier" situation to be the most conservative future baseline condition with regard to the TBP. It represents a "no action" condition for the barrier operations. In winter, the HORB is completely removed while the majority of the three agricultural rock barriers are removed, leaving only portions of the the side abutments containing the culverts remaining in the river channel. The channels are open to river flow and tidal circulation with a minimum of channel obstruction. The projects would be operated to Study 7.0, the purported baseline condition present under current operations in the simulation modeling. Addition of the barriers in spring is in response to the ongoing export actions of the project and the requirement to provide suitable water surface elevations in the south Delta for agricultural diversions.

As described in previous sections, future pumping rates are expected to increase during the April and May time frame over the current conditions due to the reduction in "environmental" water available to make export curtailments. Although the reduction in "environmental water" is not related to the proposed SDIP action, it does coincide with the proposed operations of the permanent gates in April and May, and therefore has bearing on the effects of the gates on fish drawn into the South Delta by the export actions. Based on the description and analysis for the SDIP in the draft EIR/EIS (DWR 2005) and the SDIP Action Specific Implementation Plan (DWR 2006), the stated purposes for the permanent gates, includes maintaining surface water elevations for South Delta agricultural diverters and enhancing the flexibility to operate the CVP and SWP exports without impacting the South Delta diverters. Operations of the inflatable gates from June through November likewise enable the projects to more frequently sustain higher levels of pumping within regulatory and operational parameters by avoiding impacting South Delta water elevations and reducing the electrical conductivity levels in the South Delta waterways. It does this by "trapping" high quality Sacramento River water upstream of the permanent operable gates and redirecting its flow within the channels to improve water quality and circulation between the three agricultural gates. During the flood tide, higher quality water with Sacramento River origins flows upstream past the position of the gates and provides the desired water quality conditions within the South Delta channels. Without the gates, this higher quality water would flow back downstream on the ebb tide and not provide the desired water quality improvements upstream of the gate positions during all phases of the tidal cycle.

6.6.4.2 Assess Species Exposure

The permanent operable gates proposed under the SDIP action will be present year round in the four locations in the South Delta identified for the operable gates. Winter-run juveniles will be exposed to the effects of the gates from December through June when they have been documented to occur in the channels of the South Delta based on the salvage records of the projects. Predation associated with the physical structures of the operable gates will occur year round and effect juvenile winter-run when they are present in the vicinity of the gates. Operations of the gates will occur from April through November and affect juvenile winter-run

when they are present during this time period (April through June). In addition to predation, delays in migration and hydraulic effects linked to the operation of the inflatable gates will affect winter-run juveniles during this period. No adult winter-run are expected to be present at any time in the channels influenced by the operable gates.

Juvenile spring-run are expected to be present from January through June based on historical salvage records. Predation associated with the physical structures of the operable gates will occur year round and effect juvenile spring-run when they are present in the vicinity of the gates. Operations of the gates will occur from April through November and affect juvenile spring-run from approximately April through June. In addition to predation, delays in migration and hydraulic effects linked to the operation of the inflatable gates will affect juvenile spring-run during this period. No adult spring-run are expected to be present at any time in the channels influenced by the operable gates.

CV steelhead smolts may be present from approximately November through the end of June based on historical salvage records. Predation associated with the physical structures of the operable gates will occur year round and affect steelhead smolts when they are present in the vicinity of the gates. Operations of the gates will occur from April through November and affect juvenile spring-run from approximately April through June and late fall (November). In addition to predation, delays in migration and hydraulic effects linked to the operation of the inflatable gates will affect steelhead smolts during this period. Adult steelhead from the San Joaquin River basin are expected to be present in the channels influenced by the operable gates during their upstream spawning run. This is typically the fall through the winter period (September through approximately March) with the highest numbers occurring in December.

Green sturgeon have the potential to be present year round in the areas affected by the operable gates. Historical salvage records indicate that juveniles (≈130 mm to 750 mm) have been salvaged in every month of the year at the CVP and SWP fish collection facilities. Fishing records (CDFG 2008) provided by the new sturgeon report card for sport fishermen indicate that adults and sub-adults are caught by fisherman year round in the San Joaquin River.

6.6.4.3 Assess Species Response to the Proposed Action

The operation of the permanent agricultural gates allows the manipulation of water circulation in the channels of the South Delta by redirecting flows “upstream” in Old and Middle rivers and downstream through Grant Line and Fabian/Bell canals. This redirection of flows in the channels of the South Delta is accomplished through the operation of the inflatable gates (“Obermeyer” style dams). Gates are fully deflated when the downstream tidal elevations match the upstream water elevations. At this time, flooding tides are allowed to flow over the fully lowered dam and into the channels upstream of the gate structures. Estimates of the volume of flood tide allowed to pass over the gates are approximately 80 percent of the unimpeded flow without the barriers (or their operations). The current temporary rock barriers allow significantly less, water to flow over them, passing approximately 50 percent of the unimpeded tidal flow upstream of the barriers. The current temporary barriers present a greater physical barrier to tidal upstream flows, allowing water to pass through the culverts or over the top of the weir when tidal

elevations are sufficient, while blocking a large fraction of the tidal volume with the rock weir structure.

After the flood tide has reached its peak, the gates are inflated and their crest elevations manipulated to retain the water pushed upstream by the flood tides before it starts to recede on the ebbing tide. By manipulating the elevations of the three agricultural dams (Old River at Tracy, Grant Line/ Fabian–Bell, and Middle River), water circulation can be "forced" to move through the channels in whichever direction deemed necessary for circulation needs. Under proposed operations, the crests of the Obermeyer dams at Old River at Tracy and Middle River will be retained at slightly higher elevations than the dam crest on Grant Line/ Fabian-Bell Canal. Typically, flow will not be allowed to move back over these two dam crests on the falling tide, since the crests of the two dams will be maintained above the high tide elevation (Appendix 1 to this Opinion, pages 133-134). The remaining dam on Grant Line/ Fabian–Bell Canal will be operated to maintain a minimum water surface elevation of 0.00 feet msl in the channels of the South Delta. This method of gate operations results in a larger volume of water past the locations of the inflatable gates on each flood tide (80 percent of normal tidal volume). This "cell" of water will then essentially become trapped behind the inflated gates and forced to flow progressively "upstream" in the direction of the lowest dam crest elevation between the three agricultural barriers. Frequently this means the net flow is negative to the normal flow of water in the channel, such as in Old River and Middle River. The larger volume of water will carry any fish within that body of water with it above the barrier. It is expected that these fish will then be exposed to predation pressures above the barriers, changes in water quality conditions that may occur, and irrigation diversions associated with South Delta agriculture.

Under the current temporary barriers operational conditions, fish (*i.e.*, juvenile salmon, steelhead) that have not been entrained by the SWP at Clifton Court Forebay, or the CVP pumps have the potential to move upstream on the incoming flood tide into the channels of Old River or Grant Line/Fabian-Bell Canal. These fish are currently blocked by the rock barriers upstream of the project facilities. Fish are also likely to enter Middle River before encountering the project facilities farther south in the Delta and likewise encounter the rock weir on Middle River upstream of its confluence with Victoria Canal. These conditions are also encountered on the rising tide in future operations by the upright Obermeyer dams located on these channels. In the current conditions, some fish pass upstream through the tied open culverts (typical spring operations for Delta smelt protection), prior to the tide overtopping the crest of the rock weir. Under future conditions, no fish will pass upstream until the dam is deflated. Once the dam is deflated however, a greater proportion of the fish congregating below the barrier will be entrained upstream of the gate, and thus more will be "trapped" by the raised gate on the falling tide due to the greater volume of water passed through the position of the gate. The differences in the level of predation associated with the alternative operations protocols between barriers and gates are difficult to determine without empirical data. Both scenarios are likely to have high levels of predation associated with their implementation. In both cases, fish are blocked, at least initially, in their movement upstream on the flooding tide by the structures. In the current operations, some fish are passed through culverts, and predation is expected to be high following their discharge from the culverts on the down current side of the culvert where predators are expected to be waiting to prey on the disoriented fish [detailed analysis provided in NMFS

(2009)]. In both the current and future operations, fish are expected to be carried past the main portion of the barriers when tidal levels reach their peak. In the current operations, fish would be carried over the top of the weir through a turbulent flow field. It is expected that predators will be located on either side of the weir and that some of those predators down current of the barrier will follow the prey fish upstream over the weir. Some prey fish may remain below the barrier and attempt to flee to the margins of the channel or into the deeper water at the foot of the barrier. In the future operational conditions, the Obermeyer dam will drop to its fully open position on the channel floor once downstream water elevations are equal to the upstream water elevations. This creates an essentially unimpeded channel cross section at the barrier location which allows for almost total unobstructed flow upstream. This design is intended to have flows always moving upstream with the flooding tide, thus fish will move with the current upstream. Predators will likely follow the prey species upstream above the barrier location, and will be "trapped" with them following the inflation of the dam on the ebbing tide. Predation rates will be dependent on predator density and occurrence of prey species in the channels, as well as length of exposure to the predators in these channels.

The physical structures of the permanent barriers also create predator habitat within the channels of the South Delta. The designs of the four barriers include substantial amounts of riprapped levee facing coupled with sheet pile walls. The sheet pile walls have large indentations created by the corrugated nature of the metal sections, with each section having an approximately 36-inch long by 18-inch deep depression associated with it (DWR 2006). At each barrier location, the foundation for the multiple Obermeyer dam sections comprising the barrier will span the entire width of the channel (several hundred feet). The width of the foundation for each Obermeyer dam section is approximately 10 to 15 meters and is not completely flat to the channel bottom, but rises slightly due to the curved hydrofoil shape of the dam structure itself. Preliminary design drawings indicate that at low tide, water elevations over the dam will only be a few feet (approximately 1 to 1.5 meters at the Middle River and Old River at Tracy sites, slightly deeper, approximately 2 meters, at the Head of Old River) except for the Grant Line/ Fabian–Bell location which will be installed in deep water (6 m deep). This condition is expected to create localized turbulent flow over the structure on a fine spatial scale. Fine scale flow disruption creates microhabitats by increasing the complexity of the boundary layer along the channel bottom or margins. Predators can utilize these microhabitats to hold station in while waiting for prey to pass by. This disruption of the flow field is on the order of a few meters or less and would not be captured by the hydraulic modeling previously done for the project. An example of such microhabitat would be a boulder or ledge in a stream, which provides relief from the stream flow to a fish, such as a trout, holding below it. The placement of the four gates will ensure that any fish entering the channels of the South Delta, whether from the San Joaquin River side via the Head of Old River or from the western side via one of the three channels with gates, will have to negotiate at least two gates to move through the system. The argument that the gates only occupy a small footprint in the South Delta and therefore do not create an additional risk of predation is false. The physical structures of the gates create a point where predation pressure is increased and which migrating fish must negotiate to complete their downstream journey if they enter the South Delta channels. The environmental stressors created by the implementation of the SDIP will add to the already existing stressors present in the San Joaquin River basin.

The analysis of the SDIP presented in the draft EIR/EIS (DWR 2005 Appendix J) also included numerous PTM runs which analyzed various combinations of flow, export pumping levels, and gate operations (and by reference SDIP gate operations at the Head of Old River). The particle tracking simulations conducted for the SDIP proposal indicated that entrainment in the lower San Joaquin River watershed is of great concern to fisheries management. In the simulations without the HORB installed, nearly 100 percent of the particles injected above the Head of Old River split at Mossdale are entrained by the CVP and SWP pumps after 30 days, regardless of the level of pumping at the two facilities. This situation is greatly exacerbated when flows on the San Joaquin River flow are less than or equal to the level of exports. Entrainment of particles injected at other points in the South Delta, along the San Joaquin River as far west as Jersey Point, and in the Mokelumne River/ Georgiana Slough system are also subject to entrainment. The PTM results indicate that the rates of entrainment increase in concert with increasing pumping rates when the flows on the San Joaquin River are low. The conclusions drawn from these findings are that even with a 30-day reduction in pumping (*i.e.*, a VAMP-like scenario or an EWA style export curtailment) significant levels of particle entrainment still occurs in the channels of the South Delta and Central Delta and that 30 days of pumping reduction may not be sufficient to reduce overall entrainment. This situation is exacerbated by low inflows from the San Joaquin River basin, even if delta outflow is increasing due to higher Sacramento River flows occurring simultaneously.

Entrainment of particles from the North Delta region and the Sacramento River also can be significant under the baseline operational conditions tested in the SDIP proposal. Particle injections made at Freeport with the DCC open, exports at the CVP equal to 4,600 cfs and the SWP equal to 6,680 cfs, had project entrainment levels of 50 to 60 percent depending on the Delta outflow level (5,000; 7,000; and 12,000 cfs). Even with the higher Delta outflow levels, approximately 15 percent of the particles "lingered" within the Delta after the 30-day period of the simulation run. This scenario represents the type of conditions expected in the late fall and early winter before the DCC is closed (October through January) and represented by the CALSIM II modeling for the CVP/SWP operations consultation.

Therefore, the simulations completed for the SDIP (DWR 2005) indicate that under typical conditions found in the South Delta with low San Joaquin River inflows, nearly all the particles entering the South Delta from the San Joaquin River basin will be entrained by the project exports. The "zone of entrainment" extends into the central and northern regions of the Delta, with particles either being entrained directly by the project exports or "lingering" in the south Delta after 30-days of simulation. This "baseline" operational condition is further degraded by the future export increases modeled in Studies 7.1 and 8.0 as modeled in the CVP/SWP operations BA, which have extended periods of elevated pumping levels over the current conditions.

The PTM simulations for the SDIP proposal also addressed the gate operations at the Head of Old River during VAMP conditions. Results indicated that when the gate was in, the level of entrainment for the Mossdale injections was still exceptionally high and nearly all of the particles were either captured by the project exports at the CVP and SWP or other diversions in the South

Delta (approximately 30 to 50 percent) or otherwise retained within the waterways of the South and Central Delta. With the Head of Old River gate closed, particles travelled downstream in the San Joaquin River past Stockton, but were subsequently entrained into the channels of Turner and Columbia Cuts, Middle River, and Old River. The radio and acoustic telemetry work done by Vogel (2004) and SJRGA (2007) support this aspect of the modeling results. Another characteristic of the closed Head of Old River gate condition is the increase in entrainment of particles released farther downstream in the San Joaquin River system at Prisoners Point and Jersey Point as well as in the Mokelumne River system. Since exports could not divert water from the San Joaquin River entering through the Head of Old River, the additional water was pulled from the lower San Joaquin River reaches, thus increasing the risk of entrainment in these lower segments. This characteristic of the hydraulic environment created by the Head of Old River gate places fish entering the Central Delta from the Sacramento River at greater risk of entrainment. The simulated fraction of particles escaping the Delta and reaching Chipps Island was consistently low under all of the tested parameters for passive particles, never exceeding 15 percent of the Mossdale injections. The highest San Joaquin River flow to export pumping ratio tested was 2:1 with 3,000 cfs combined pumping coupled with 7,000 cfs San Joaquin River outflow (reduced pumping scenario). This resulted in 14.9 percent of the particles reaching Chipps Island after 30 days. In simulations where the Head of Old River gate was not installed, a lower percentage of the particles reached Chipps Island then under the gate installed situation, having been quickly entrained into Old River and subsequently captured at the CVP.

Based on the PTM simulations and the initial results of radio and acoustic telemetry studies, the proposed SDIP still has significant effects on San Joaquin River basin fish. The eventual entrainment of San Joaquin River fish by the SWP and CVP after they have passed the head of Old River through the channels lower down on the San Joaquin River (*e.g.*, Turner and Columbia Cuts) is contradictory to the stated purpose of the fish barrier portion of the SDIP proposal. The agricultural gates component of the proposal benefits agricultural interests without apparent detriment to those interests and allows the CVP and SWP to enhance their water diversion opportunities by providing greater flexibility to their operations within the constraints of existing regulatory criteria. As described previously, the agricultural gates and the enhanced pumping regimen under studies 7.1 and 8.0 are detrimental to listed fish occurring in the South Delta, regardless of their origins (*i.e.*, spring-run from the Sacramento River or CV steelhead from the San Joaquin River basin) and the proposed action (which include the enhanced pumping schedule under studies 7.1 and 8.0) will increase the loss of fish over the current conditions. The purported benefit of the SDIP proposal to fisheries management was the Head of Old River gate, which was supposed to reduce the entrainment of fall-run originating from the San Joaquin River basin during their spring out migration period. CV steelhead migrating from the San Joaquin Basin during the Head of Old River gate operations were also believed to have been protected by the gate. Based on the PTM simulation results and the telemetry findings, this protective aspect of the Head of Old River operable gate appears to be overstated, and in fact the operation of the gate may place fish entering the system from other tributaries such as the Calaveras River, Mokelumne River, and Sacramento River at greater risk of entrainment when it is in operation. In order to achieve the proposed benefits of the operable gate at the Head of Old River, reductions in exports, coupled with increases in San Joaquin River flows to move fish through

the system are needed. Without these concurrent actions, the full benefit of the operable gate cannot be realized. The proposed SDIP action did not make this linkage part of the operations.

6.6.4.4 Assess Risks to Individuals

Many of the effects described in NMFS (2009) for the TBP apply to the proposed SDIP action. The significant difference is the additional predation impacts that can occur during the December through March period. Under the SDIP action, physical structure remains in the channel year round and thus provides habitat and hydraulic conditions that are beneficial to predators in the area. NMFS expects that this will increase the predation potential for listed salmonids present in the South Delta channels during this period. Migratory delays are not anticipated to occur during this period due to the gates lowered condition. Passage past the locations of the gates during the winter period should not be affected except for the previously mentioned predation issues.

NMFS does not anticipate that the permanent gates will increase predation on green sturgeon during the winter period. As described in NMFS (2009), any green sturgeon present in the South Delta channels are typically large enough to be at low risk of predation by predators such as largemouth bass or striped bass. The operations of the gates in the period between April and November may impede passage during the gates up condition, but passage should be available when the gates are lowered during the flood tide.

Spring-run Chinook salmon - The affects to the spring-run population under the SDIP actions are expected to be comparable to the effects already described for the temporary barriers discussion in NMFS (2009). Since approximately 80 percent of the spring-run population presence occurred during the April through June period, the predation effects and migrational delays should be similar in magnitude between the two projects. The difference between the two actions is the additional predation risk to early migrating spring-run prior to April. These fish would encounter the permanent physical structures of the SDIP gates and the predator issues associated with them. NMFS does not expect more than approximately 3 percent of the total annual spring-run population in the Central Valley to be present in the South Delta waters within the vicinity of the permanent gates.

Winter-run Chinook salmon – Since the permanent gates are in place year round, the entire population of winter-run that enter the waters of the South Delta has the potential to encounter the predation effects associated with the SDIP gates. This is in contrast to the temporary barriers, in which only 3 percent of the winter-run population in the South Delta was exposed to the rock barriers during the April through June period of their operations. Migrational delays should be similar to those described for the temporary barriers in NMFS (2009). The period of gate operations during winter-run presence is the same as previously described for the operations of the rock barriers. NMFS anticipates that approximately 3 percent of the winter-run population is present in the waters of the South Delta within the vicinity of the permanent gates and the export facilities when the permanent gates will be operated for water surface elevation control.

Central Valley steelhead – The permanent gates have the potential to affect all of the CV steelhead that move through the South Delta. Previously, only about 9 percent of the annual

presence of steelhead in the South Delta was affected by the temporary barriers and their operations. Due to the year round presence of the physical structures in the channels of the South Delta related to the permanent gates, steelhead smolts are exposed to the predation issues whenever they are present in the waters adjacent to the gate locations. Delays in migration should remain comparable to the temporary barriers, affecting only 9 percent of the annual steelhead presence in the South Delta, since the operations of the permanent gates occur during the same months as the temporary barriers' operations. However, San Joaquin River basin steelhead are disproportionately affected due to their close proximity to the project and the overlap of their migratory corridor with the action's location. Adult effects should also be comparable between the two actions. This should primarily be delays in migration due to gate operations, rather than blockage of migration since the gates are operated in concert with the tidal stages in the south Delta.

Green Sturgeon – The proposed SDIP permanent barriers will be operated during the same seasonal periods as has been done previously for the TBP (April through November). Therefore, effects to the green sturgeon population are expected to generally be comparable between the two programs. The operations of the permanent gates may expose more fish during the operational season to migrational delays due to the tidal operation of the gates allowing passage upstream of the gates; however, the length of delay should be considerably shorter than the temporary barriers due to the same tidal operations which allow the gates to be opened on each tidal cycle, thereby allowing the opportunity for sturgeon to pass downstream of the gates. Nevertheless, the permanent gates do represent a barrier to free movement of fish in the waterways of the South Delta even if it is only for a short time.

Little is known about the population size or the movements of green sturgeon within the Delta, therefore assessments of population effects are difficult at best to make. In order to make any reasonable assessment, the number of green sturgeon present in the population, as well as the frequency of occurrence in the South Delta would need to be known. NMFS does not have this information. Monitoring studies using acoustic tags aimed at assessing the behavior of green sturgeon in relation to the barriers and the movements of green sturgeon within the channels of the South Delta are planned for the near future but have not been implemented to date.

6.6.4.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

The conservation value of CV steelhead designated critical habitat in the South Delta will be degraded as a result of the SDIP impacts. Part of the intrinsic values of the PCEs listed for critical habitat in the South Delta is unobstructed passage of emigrating fish through the region. This characteristic of the PCE's will be permanently modified by the construction and operation of the proposed barriers as well as additional risks of entrainment and predation presented by the modified pumping environment fostered by the SDIP proposal. As described above, listed steelhead will be prevented from using portions of the Delta by the Head of Old River permanent gate. Migration will be restricted to one channel initially until the fish pass the Port of Stockton. The risk of entrainment by the export facilities appears to have been delayed until the fish pass into the lower sections of the river, rather than prevented as proposed. Furthermore, delays in

migration appear to be a distinct possibility following the movement of steelhead into the lower San Joaquin River below the Port of Stockton. The functioning of the lower San Joaquin River as a migratory corridor has not been improved by the action; rather migration has been redirected into only one possible route to avoid adverse impacts in another migratory route. Although the selected mainstem San Joaquin River route apparently has better overall survival than the southern Delta waterways, it does place the San Joaquin River basin at increased risk for catastrophic events that could impact the one selected migratory route, particularly since the selected route passes a major waste water treatment plant in the City of Stockton and the industrialized Port of Stockton. Accidental chemical spills are potential catastrophes that could severely impact a given year class or more depending on its severity.

In addition to the installation of the gates, the SDIP proposes to dredge certain channels of the South Delta to enhance conveyance of water for agricultural diversion and circulation flow patterns (portions of Old and Middle River), reduce scouring (West Canal), and increase water depth for private water diversions located upstream of the proposed agricultural gates. This will, at the minimum, reduce the benthic communities in the affected channels for a short period of time until the substrate is recolonized. It is also likely that the profile of the new benthic community will be different than surrounding areas for a considerable period of time (climax community versus disturbed community effect) as well as whether native or exotic species are better situated to take advantage of the newly disturbed substrate. These newly created channels with greater depth will also alter the community complexity and species profiles of organisms that will inhabit them. For instance, greater depth may alter the species profiles of predatory fish inhabiting these channels by providing additional cover in the form of deeper waters in the dredged channels thus allowing larger predatory fish or greater numbers of fish to inhabit them. Listed fish will more than likely pass through these channels when the Head of Old River permanent gate is not in operation, and the altered habitat will become part of their migrational corridor. It is likely that the value of the future aquatic habitat within the boundaries of the proposed SDIP project will reflect a more degraded value to migrating San Joaquin River basin CV steelhead compared to the current situation. The proposed action does not incorporate any actions to enhance the aquatic environment beyond its current standing nor does it reverse any of the anticipated adverse alterations to the aquatic habitat considered above. Therefore, NMFS believes that the future habitat condition will be adversely modified and provide a less suitable suite of PCEs to listed steelhead that will diminish their likelihood of survival through the South Delta. Likewise, the value of the aquatic habitat to fall-run will be diminished by the SDIP proposal. Although fall-run are unlisted, they share similar habitat requirements with CV steelhead for migration and rearing and their future use of the habitat will be adversely modified by the proposed actions. Therefore the value of the South Delta waterways as essential fish habitat also will be diminished.

The waterways of the South Delta have also been proposed as critical habitat for the Southern DPS of green sturgeon (September 8, 2008, 73 FR 52084). Like the CV steelhead, green sturgeon critical habitat in the South Delta requires unobstructed passage through the channels of the South Delta during their rearing and migratory life stages. The operation of the barriers as proposed will create obstructions to their free passage when the gates are in their upright positions. It is unknown whether sturgeon will volitionally move against the current of an

incoming tide to pass back downstream over the barriers when they are lowered on the incoming flood tide. Furthermore, the duration of time in which the gates are lowered compared to the periods in which they are raised is unequal. The gates are predominately in the raised position throughout the tidal cycle, except for the few hours they are lowered on the incoming tides. DWR and Reclamation believe that theoretically sturgeon may pass through the boat locks associated with the barriers during their operations and thus not be obstructed in their passage. This theory has not been proven satisfactorily by the information provided in their analysis. It is based on the belief that the boat locks will be used frequently enough to allow fish to move through the structures without undue delays. Unlike the Suisun Marsh Salinity Control Gates, the boat locks will not be left open the majority of the time, but will remain closed to retain stage elevations until needed for boat passage.

6.6.5 Delta Cross Channel

6.6.5.1 Deconstruct the Action

The DCC was constructed by Reclamation in the early 1950s to redirect high quality Sacramento River water southwards through the channels of the Mokelumne River system towards the South Delta and the CVP pumps at Tracy. This modification of the Delta's hydraulics prevented the mixing of the Sacramento River water with water in the western Delta, with its higher salinity load, prior to diverting it to the CVP pumps. Originally the gates remained open except during periods of high Sacramento River flow (> 20,000 to 25,000 cfs) when scouring of the channel or flooding risks downstream of the gates warranted closure. Currently, Reclamation operates the DCC in the open position to (1) improve the transfer of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce saltwater intrusion rates in the western Delta.

The conditions for closing the DCC gates to protect fishery resources were first instituted in the State Water Resource Control Board's D-1485 decision in 1978. In 1995, the Water Quality Control Plan (WQCP) for the Bay Delta (95-1) instituted additional operations of the DCC for fisheries protection (SWRCB 1995). These criteria were reaffirmed in the SWRCB's D-1641 decision. The DCC gates may be closed for up to 45 days between November 1 and January 31 for fishery protection purposes. From February 1 through May 20, the gates are to remain closed for the protection of migrating fish in the Sacramento River. From May 21 through June 15, the gates may be closed for up to 14 days for fishery protection purposes. Reclamation determines the timing and duration of the closures after discussion with USFWS, CDFG, and NMFS. These discussions will occur through the water operations management team (WOMT) as part of the weekly review of CVP/SWP operations. WOMT uses input from the Salmon Decision Process to make its gate closure recommendations to Reclamation.

The Salmon Decision Process (CVP/SWP operations BA Appendix B) includes "Indicators of Sensitive Periods for Salmon" such as hydrologic changes, detection of spring-run salmon or spring-run salmon surrogates at monitoring sites or the salvage facilities, and turbidity increases at monitoring sites to trigger the Salmon Decision Process. The Salmon Decision Process is used by the fishery agencies and project operators to facilitate the complex coordination issues

surrounding DCC gate operations and the purposes of fishery protection closures, Delta water quality, and/or export reductions. Inputs such as fish life stage and size development, current hydrologic events, fish indicators (such as the Knight's Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions.

The primary avenue for juvenile salmonids emigrating down the Sacramento River to enter the interior Delta, and hence becoming vulnerable to entrainment by the export facilities, is by diversion into the DCC and Georgiana Slough. Therefore, the operation of the DCC gates may significantly affect the survival of juvenile salmonids emigrating from the Sacramento River basin towards the ocean. Survival in the Delta interior is considerably lower than the mainstem Sacramento River. This has previously been discussed in section 6.6.2.5 *Indirect Mortality Within the Delta*.

6.6.5.2 Assess the Species Exposure

The proportion of juvenile Chinook salmon that enter the Delta from the Sacramento River is given in table 6-34. Salvage and loss across months (http://www.usbr.gov/mp/cvo/fishrpt.html) represents fish presence in the South Delta (table 6-27). The closure of the DCC gate under the current schedule protects 100 percent of the migrating fish from February 1 through May 20 from entering the DCC channel and entering the Mokelumne River system through Snodgrass Slough. Prior to February 1, the gates can be closed for up to 45 days between November 1 and January 31 (maximum 50 percent). After May 20, the gates can be closed for up to 14 days through June 15.

Table 6-34. The proportion of juvenile Chinook salmon and steelhead production entering the Delta from the Sacramento River by month.

Month	Sacramento River Total[1,2]	Fall-Run[3]	Spring-Run[3]	Winter-Run[3]	Sacramento Steelhead[4]
January	12	14	3	17	5
February	9	13	0	19	32
March	26	23	53	37	60
April	9	6	43	1	0
May	12	26	1	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	4	1	0	0	0
September	4	0	0	0	1
October	6	9	0	0	0
November	9	8	0	03	1
December	11	0	0	24	1
Total	100	100	100	100	100

Notes:
[1] Mid Water trawl data
[2] All runs combined

[3] Runs from Sacramento River basin only
[4] Rotary screw trap data from Knights Landing
Source: DWR and Reclamation (2005 Tables J-23 and J-24, Appendix J).

Winter-run Chinook salmon - Prior to the DCC gate closures in February, approximately 44 percent of the annual winter-run juvenile population is vulnerable to entrainment into the DCC. Emigration of winter-run juveniles during December and January accounts for nearly all of this entrainment. Loss records from the CVP and SWP fish collection facilities (http://www.usbr.gov/mp/cvo/fishrpt.html) have a slightly lower fraction of the winter-run juvenile population present in the Delta during December and January (≈21 percent of the annual total), which may represent the lag in movement across the delta or potentially holding and rearing behavior. The majority of adult winter-run will migrate upstream through the Delta during the period when the DCC gates are closed.

Spring-run Chinook salmon – Only 3 percent of the annual juvenile spring-run emigration occurs prior to February in the Sacramento River basin. However, this fraction represents the yearling spring-run life history stage, an important alternative to the more common YOY life history stage where fish emigrate during their first spring after hatching. Spring-run juveniles are not represented in the salvage and loss records at the CVP/SWP facilities until March and April. Adult spring-run migrating through the Delta will encounter the DCC gates in both the closed position prior to May 15 and the open gate configuration after May 15.

Central Valley steelhead – Approximately 7 percent of the steelhead form the Sacramento River basin emigrate prior to February in any given year and thus would be vulnerable to open DCC gates and diversion into the Delta interior. Steelhead begin showing up in the salvage at the CVP and SWP fish collection facilities in January and February and most likely represent the steelhead moving out of the Mokelumne system during December and January. Adult steelhead are likely to encounter the DCC gates in both an open and closed configuration through out their extended spawning migration. Most steelhead have entered the Sacramento system prior to February and therefore would have been exposed to open gates.

Green sturgeon – Little is known about the migratory behavior of juvenile green sturgeon in the Sacramento River basin. It is likely that juvenile green sturgeon (larger than the 75 mm) will not enter the Delta prior to their first winter and thus would not be exposed to the open DCC gates. It is likely that these fish will enter the Delta sometime in the winter or spring following their hatching upriver and encounter both types of gate configurations as they enter the Delta. More information is required to accurately assess the migratory movements of juvenile sturgeon in the river system, as well as their movements within the Delta during their rearing phase in estuarine/Delta waters. Adult green sturgeon are likely to encounter closed DCC gates during their upstream spawning migration in winter and early spring, but encounter open gates during their downstream migration in summer and fall following spawning.

6.6.5.3 Assess Species Response to the Proposed Action

The DCC can divert a significant proportion of the Sacramento River's water into the interior of the Delta. The DCC is a controlled diversion channel with two operable radial gates. When

fully open, the DCC can allow up to 6,000 cfs of water to pass down the channel into the North and South Forks of the Mokelumne River in the central Delta (Low *et al*. 2006, CVP/SWP operations BA Appendix E). During the periods of winter-run emigration (*i.e*., September to June) through the lower Sacramento River, approximately 45 percent of the Sacramento River flow (as measured at Freeport) can be diverted into the interior of the Delta through the DCC and Georgiana Slough when both gates are open. When the gates are closed, approximately 15 to 20 percent (as measured at Freeport) of the Sacramento River flow is diverted down the Georgiana Slough channel[16] (CVP/SWP operations BA Appendix E). Peak flows through Georgiana Slough can be almost 30 percent of the Sacramento River flows. Together, the DCC and Georgiana Slough can divert nearly half of the Sacramento River's flow into the Delta interior.

In most years, the peak of winter-run emigration past the DCC occurs from late November through February, based on USFWS trawl and seining data (USFWS 2001, 2003, 2006; Low *et al.* 2006, DWR 2005); when 10 to 25 percent of the Sacramento River flow can be diverted through the DCC and an additional 17 to 20 percent is diverted down Georgiana Slough. There is little change between the current and future conditions (Study 7.0 compared to Studies 7.1 and 8.0). Kjelson and Brandes (1989) found that survival of tagged Chinook salmon smolts was negatively correlated (r= -0.63) with the percentage of water diverted through the DCC from the Sacramento River. When diversion rates were high (> 60 percent) with the DCC gates open, the survival of smolts released above the DCC was about 50 percent less than those releases which occurred below the DCC. When the gates were closed, there was no difference between the two release points under high flow conditions, however, under low flow conditions, the survival of the upper release point was about 25 percent less than the downstream release point. Kjelson and Brandes (1989) attributed this lower survival rate to the effect of the fish being diverted into Georgiana Slough. Low *et al.* (2006) found significant linear relationships between the proportion of Sacramento River flow diverted into the interior of the Delta in December and January and the proportion of the juvenile winter-run lost at the CVP/SWP export facilities. Analysis of 2-week intervals found highly significant relationships between these proportions in late December (December 15 to 31) and early January (January 1 to 15) periods before the DCC gates are closed. A series of studies conducted by Reclamation and USGS (Horn and Blake 2004) supports the previous report's conclusion of the importance of the DCC as an avenue for entraining juvenile salmonids into the central Delta. These studies used acoustic tracking of released juvenile Chinook salmon to follow their movements in the vicinity of the DCC under different flows and tidal conditions. The study results indicate that the behavior of the Chinook salmon juveniles increased their exposure to entrainment through both the DCC and Georgiana Slough. Horizontal positioning along the east bank of the river during both the flood and ebb tidal conditions enhanced the probability of entrainment into the two channels. Upstream movement of fish with the flood tide demonstrated that fish could pass the channel mouths on an ebb tide and still be entrained on the subsequent flood tide cycle. In addition, diel movement of fish vertically in the water column exposed more fish at night to entrainment into the DCC than during the day, due to their higher position in the water column and the depth of the lip to the DCC channel mouth (-2.4 meters). The study concluded that juvenile Chinook salmon entrainment at a channel branch will not always be proportional to the average amount of flow

[16] Instantaneous percentages can be much higher depending on the interaction of river flow and tidal flow as describe in Horn and Blake (2004).

entering that branch, and can vary considerably throughout the tidal cycle. Furthermore, secondary circulation patterns can skew juveniles into the entrainment zones surrounding a given branch, thus resulting in a disproportionately high entrainment rates. This characteristic was observed in the recent acoustic tagging studies (Burau *et al*. 2007, Perry and Skalski 2008, Vogel 2008a) experiments at the mouth of Sutter and Steamboat sloughs. The percentage of fish selecting the alternative routes from the mainstem Sacramento River was different than the percentage of water entering the channel, indicating spatial distribution in the channel may play an important role in entrainment rates.

Fish that are diverted into the Delta interior and survive the high loss rates migrating through Georgiana Slough and the lower Mokelumne River system are eventually discharged into the San Joaquin River system near RM 22. As presented previously in the Delta Division discussion, changes in Delta hydrodynamic conditions associated with CVP and SWP export pumping inhibit the function of Delta waterways as migration corridors. When pumping is elevated, the flows in the river reaches surrounding this confluence are directed towards the export facilities, indicated by negative flows in Old and Middle River. Additional loss is experienced during this movement of fish towards the CVP/SWP facilities and throughout the salvage process. With mandatory closure of the DCC gates from February 1 through May 20 (pursuant to current criteria in SWRCB D-1641), approximately 50 percent of juvenile winter-run outmigration and 70 to 90 percent of the steelhead and spring-run juveniles migrating downstream in the Sacramento River are not exposed to the open DCC gate configuration and are therefore expected to have a greater likelihood of remaining in the Sacramento River (including Sutter and Steamboat sloughs) and surviving to Chipps Island. These fish will be less vulnerable to decreased survival rates through the Delta interior and any subsequent losses related to the effects of CVP and SWP Delta export pumping from the San Joaquin River confluence southwards. That segment of the respective salmonid populations which migrates earlier than the mandatory closures will be exposed to the effects of the DCC gates when they are in the open configuration. All fish will be exposed to entrainment into Georgiana Slough, which has the potential to capture approximately 15 to 20 percent of the downstream migrants moving past it.

Several years of USFWS fisheries data indicate that the survival of salmon smolts in Georgiana Slough and the central Delta is significantly reduced when compared to the survival rate for fish that remain in the Sacramento River (Kjelson and Brandes 1989, Brandes and McLain 2001). Data from investigations conducted since 1993 with late fall-run during December and January are probably the most applicable to emigrating steelhead and spring-run yearlings due to their comparable sizes. These survival studies were conducted by releasing one group of marked (*i.e.*, CWT and adipose fin clipped) hatchery-produced salmon juveniles into Georgiana Slough, while a second group was released into the lower Sacramento River. Results have repeatedly shown that survival of juvenile salmon released directly into the Sacramento River while the DCC gates are closed are, on average, two to eight times greater than survival of those released into the central Delta via Georgiana Slough (CDFG 1998, Newman 2008). More recent acoustic tagging studies support these earlier findings (Perry and Skalski 2008) indicating that when the DCC is closed, survival through the delta can increase approximately 50 percent compared to open DCC conditions (35.1 percent survival with the DCC open versus 54.3 percent survival with the DCC

closed; data from Perry and Skalski 2008). In comparison, Burau *et al*. (2007) found that increasing flows influenced survival in the Sacramento River, *e.g.*, higher flows correlated to higher survival in the different channels. These results were described previously in the Delta Division section assessing indirect mortality within the Delta.

The results of these studies demonstrate that the likelihood of survival of juvenile salmon, and probably steelhead, is reduced by deleterious factors encountered in the central Delta. In addition to predation, water quality parameters such as temperature can have significant effects on survival. Baker *et al.* (1995) showed that the direct effects of high water temperatures are sufficient to explain a large part (*i.e.*, 50 percent) of the smolt mortality actually observed in the Delta. The CVP and SWP export operations are expected to contribute to these deleterious factors through altered flow patterns in the Central and South Delta channels. In dry years, flow patterns are altered to a greater degree than in the wet years and are expected to result in a higher level of impact to emigrating steelhead and winter-run and spring-run smolts (Kjelson and Brandes 1989). If the DCC gates are opened for water quality improvements or other purposes, a significantly greater proportion of Sacramento River flow and juvenile fish will be diverted into the central Delta.

False Attraction and Delayed Migration - From November through May, adult winter-run and spring-run and steelhead migrate through the Delta for access to upstream spawning areas in the Sacramento and San Joaquin basins. Changes in Delta hydrodynamics from CVP and SWP export pumping in the South Delta may affect the ability of adult salmon and steelhead to successfully home in on their natal streams. Radio tagging studies on adult fall-run indicate that these fish frequently mill about in the Delta, often initially choosing the wrong channel for migration (CALFED 2001). CVP and SWP export pumping alters Delta hydrodynamics by reducing total Delta outflows by as much as 14,000 cfs and reversing net flows in several central and south Delta channels. Adults destined for the Sacramento Basin may experience some minor delays during passage through the Delta by straying temporarily off-course in northern and central Delta waterways. Closure of the DCC gates from November 1 through May 20 may block or delay adult salmonids that enter the Mokelumne River system and enter through the downstream side of the DCC. However, it is anticipated that closure of the DCC gates during this period will reduce diversion of Sacramento River water into the Central Delta, thereby improving attraction flows for adults in the mainstem Sacramento River. Intermittent openings to meet water quality standards or tidal operations are not expected to cause significant delays to adults because of their temporary nature and the ability of adults to drop back and swim around the DCC gates. Acoustic tracking studies by Odenweller of CDFG (CALFED 2001) indicated that adult fall-run may make extensive circuitous migrations through the Delta before finally ascending either the Sacramento or San Joaquin Rivers to spawn. These movements included "false" runs up the mainstems with subsequent returns downstream into the Delta before their final upriver ascent.

Within the south Delta, several studies have indicated that adult fall-run may be negatively impacted by the operations of the export facilities during their upstream spawning migration (Hallock *et al.* 1970, Mesick 2001). The reduced fall flows within the San Joaquin system, coupled with the elevated pumping actions by the SWP and CVP during the fall to "make up" for

reductions in pumping the previous spring, curtails the amount of San Joaquin River basin water that eventually reaches the San Francisco Bay estuary. It is necessary for the scent of the San Joaquin basin watershed to enter the Bay in order for adult salmonids to find their way back to their natal river. Reductions, or even the elimination, of this scent trail has been postulated by Mesick (2001) to increase the propensity for fall-run to stray from their natal San Joaquin River basin and into the adjacent Mokelumne River or Sacramento River basins. This problem may exist for CV steelhead that utilize the San Joaquin River basin or the Calaveras River for their olfactory cues during their upstream spawning migrations back to their natal stream. The increased time spent by adults searching for the correct olfactory cues in the Delta could lead to a decrease in the fish's overall health, as well as a reduction in the viability of its gametes. Increased exposure to elevated water temperatures, chemical compounds and bacterial or viral infections present in the Delta increases the likelihood that adult Chinook salmon and their eggs may experience negative effects on the behavior, health, or reproductive success of the fish (Meehan and Bjornn 1991, Rand *et. al.* 1995).

In addition, the existence of the chronic DO sag in the San Joaquin River between the Port of Stockton and Turner Cut can delay the upstream migration of adult salmonids. The ambient DO levels in this portion of the San Joaquin can drop below 4 mg/L during the fall and early winter periods. Hallock *et al.* (1970) found that most adult fall-run would not migrate through water with less than 5 mg/L DO. Laboratory data for juvenile Chinook salmon (Whitmore *et al.* 1960) supports this finding as the juvenile Chinook salmon avoided water with less than 4.5 mg/L under controlled laboratory conditions. Flow levels in the mainstem San Joaquin below the head of Old River are inherently dependent on the status of the HORB, reservoir releases, and the operation of the CVP pumps. When flow rates are high, the DO sag does not set up. Conversely, when flows drop below approximately 1,500 cfs, the conditions in the deep-water ship channel become conducive to creating the low DO situation.

6.6.5.4 Assess Risks to Individuals

As previously described earlier in the Delta division analysis, individual juvenile fish that move into the Delta interior through the DCC or Georgiana Slough are at a much higher risk of mortality from predation or other stressors in the environment. These other stressors can take the form of delayed migration; water quality issues such as temperature and low DO, and prolonged exposure to contaminants in the system. Individual winter-run juveniles and spring-run juveniles are at an increased risk of entrainment if they move downstream earlier in the season than later, or respond to increases in river flows upstream of the Delta in the Sacramento River or reductions in river temperature. These environmental cues typically induce winter-run juveniles and yearling spring-run to initiate downstream movement towards the Delta and the ocean. Individuals that display this sensitivity to early triggers are at a higher risk of mortality due to the open configuration of the DCC gates. Fish that are successful in surviving the Delta interior by passing through Georgiana Slough or the Mokelumne River system still must negotiate the effects of the export pumps and the altered hydraulics in the San Joaquin River main stem. If exports are high, individual fish face a greater probability of being entrained towards the export facilities. Such increased exports are modeled for the current, near future, and future conditions of the CVP/SWP operations action. Survival from the San Joaquin River southwards towards

the pumps is considered to be low for salmonids. It is thought that this is primarily a result of intense predation pressure within the waterways leading to the facilities. Fish that ultimately reach the salvage facilities still face a high probability of mortality from that encounter. Calculated losses (mortalities) at the CVP are approximately 2 out of every 3 fish that enter the salvage operation. Fish survival is far worse at the SWP facility where 1 out of 6 fish survive the salvage operation, primarily due to high predation losses in the forebay. Steelhead smolts, although larger than spring-run or winter-run emigrants, are also likely to have low survival rates if they are diverted into the Delta interior. Recent studies in Clifton Court Forebay verified that 200- to 250-mm long steelhead smolts were just as likely to be eaten by predators as the smaller Chinook salmon smolts.

Little information is available regarding juvenile green sturgeon movements in the lower Sacramento River and Delta waterways. It is unknown how vulnerable these juvenile sturgeons are to diversion into the DCC or Georgiana Slough or their risk to predation by the larger predators such as striped bass and largemouth bass that inhabit the Delta system. Additional research is required to answer these questions before a thorough assessment can be made.

Winter-run Chinook salmon – Nearly half of the annual winter-run population emigrates during the gates open period in late fall and early winter. These early emigrating winter-run are vulnerable to the effects of the open DCC gates as previously explained. The loss of individuals from this segment of the winter-run population may decrease the population's future expression of varied life history strategies, such as early migrational behavior. Having a broad representation of different life history strategies enables the population to spread its survival risk over time, rather than having one monotypic life history. By varying the time that individuals emigrate to the Delta and the ocean, the population can take advantage of potentially better environmental conditions outside of the normal migration period. In the case where environmental conditions may be poor for most of the run during the "normal" migration period due to stochastic variation in the environment (*e.g.*, poor upwelling conditions in the coastal ocean), those segments of the population that migrated at different times may find more suitable conditions and thus perpetuate the population. Maintaining those segments of the winter-run population that exhibit different life history behavioral traits is central to the long-term viability of the population. Based on the data generated from the acoustic tracking studies of Perry and Skalski (2008) and Burau *et al.* (2007), NMFS has estimated that losses to the winter-run population associated with the operations of the DCC range from 6 to 20 percent of the winter-run population entering the Delta. These estimates used the percentage of fish entering the Delta interior through either the DCC or Georgiana Slough channels (based on acoustic tracking data of Chinook salmon smolts: 28 percent when DCC open, 18 percent when closed), the survival estimates within those channels (35 percent survival base case, 10 percent survival when high losses occur, 75 percent survival when losses are low), the monthly position of the DCC gates, and the percentage of the winter-run population entering the Delta from the Sacramento River each month from table 6-26.

Spring-run Chinook salmon – The DCC gates are open during the period when yearling spring-run are emigrating into the Delta from their upstream natal tributaries. Like the early migrating winter-run juveniles, the yearling spring-run life history strategy represents an important

component of the overall spring-run life history. Yearling fish are larger than young of the year emigrants, having spent additional time growing in their natal streams over the summer before emigrating downstream. They have a higher success rate at transitioning to the ocean environment than the smaller YOY. They also represent a mechanism to spread out the risk to an individual brood year's population by going out later than the more common first spring emigration life history strategy expressed by the young of the year emigrants. By having more opportunities to enter the ocean at different times, the probability of finding suitable conditions increases. This in turn increases the likelihood that the population will endure. Maintaining those segments of the spring-run population that exhibit different life history behavioral traits is central to the long-term viability of the population. Based on the data generated from the acoustic tracking studies of Perry and Skalski (2008) and Burau *et al.* (2007), NMFS has estimated that losses to the spring-run population associated with the operations of the DCC and fish entering the Delta interior range from approximately 5 to 17 percent of the spring-run population entering the Delta. These estimates used the percentage of fish entering the Delta interior through either the DCC or Georgiana Slough channels (based on acoustic tracking data of Chinook salmon smolts: 28 percent when DCC open, 18 percent when closed), the survival estimates within those channels (35 percent survival base case, 10 percent survival when high losses occur, 75 percent survival when losses are low), the monthly position of the DCC gates, and the percentage of the spring-run population entering the Delta from the Sacramento River each month from table 6-26.

Central Valley steelhead – As discussed for the winter-run and spring-run populations, diversity of life history strategies represents a mechanism by which the population can take advantage of variability in the natural environment and spread its risks across a larger temporal period. By encountering many different environmental conditions, the probability of finding an environment with suitable conditions increases. Although only a small proportion of the Sacramento Valley steelhead are emigrating during the period when the gates are open in late fall and early winter, they represent an important component of the life history strategy of the CV steelhead. These early migrants are vulnerable to the open gates and the expected high loss rate in the Delta interior would remove an important component of the steelhead life history strategy from the population. Based on the data generated from the acoustic tracking studies of Perry and Skalski (2008) and Burau *et al.* (2007), NMFS has estimated that losses to the CV steelhead population associated with the operations of the DCC ranage from approximately 5 to 17 percent of the CV steelhead population entering the Delta from the Sacramento River basin. These estimates used the percentage of fish entering the Delta interior through either the DCC or Georgiana Slough channels (based on acoustic tracking data of Chinook salmon smolts: 28 percent when DCC open, 18 percent when closed), the survival estimates within those channels (35 percent survival base case, 10 percent survival when high losses occur, 75 percent survival when losses are low), the monthly position of the DCC gates, and the percentage of the winter-run population entering the Delta from the Sacramento River each month from table 6-26.

Green sturgeon – It is unknown what population effects the DCC gate operations will have on the green sturgeon population in the Delta. The behavior of green sturgeon juveniles in relation to the gate operations is unknown. The situation is further complicated by the lack of knowledge of migrational timing for juvenile green sturgeon entering the Delta from the Sacramento River

and thus the timing of their exposure to the gate operations. Adult green sturgeon may be impacted by the potential for delay behind the closed gates during their upstream migration. However, acoustic tagging efforts to date indicate that tagged fish move upriver through the mainstem of the Sacramento River in the Delta and not within the interior delta waters adjacent to the downstream channel of the DCC. Only those fish that entered the downstream sections of the Mokelumne River system and continued upstream in this system would be subject to migrational delays below the DCC gates during their spawning runs. This may change as more fish are tagged and a greater knowledge of adult fish movement is gained.

6.6.5.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

For both the winter-run and spring-run, designated critical habitat lies adjacent to the location of the DCC gates. In the case of designated critical habitat for the winter-run (58 FR 33212) the DCC is specifically not included because the biological opinions issued by NMFS in 1992 and 1993 concerning winter-run included measures on the operations of the gates that were designed to exclude winter-run from the channel and the waters of the Central Delta. For the spring-run, designated critical habitat (70 FR 52488) includes the DCC from its point of origin on the Sacramento River to its terminus at Snodgrass Slough, including the location of the gates. Designated critical habitat for CV steelhead includes most of the Delta and its waterways; however, the DCC waterway was not included in the text or maps of the Federal Register notice as being part of the Delta waters designated as critical habitat. Nevertheless, actions of the DCC gates affect the critical habitat PCEs designated for the spring-run and CV steelhead populations as well as the essential fish habitat functions for winter-run Chinook salmon. Primarily, DCC gate operations interfere with the performance of the Sacramento River as a migratory corridor for spring-run and CV steelhead and as essential habitat for winter-run by preventing access downstream from the spawning grounds to San Francisco Bay and the Pacific Ocean. Fish entrained into the DCC and the Mokelumne River systems are at a greater risk of mortality than their counterparts who have remained in the mainstem of the Sacramento River. The operations of the gates permit fish to enter habitat and waterways they would not normally have access to with substantially higher predation risks than the migratory corridor available in the Sacramento River channel. Operations of the gates have a direct effect on the entrainment rate and hence the functioning of the Sacramento River as a migratory corridor.

6.6.6 Contra Costa Water District Diversions

6.6.6.1 Deconstruct the Action

CCWD currently operates three facilities to divert water from the Delta for irrigation and Municipal and Industrial (M&I) uses. These are the facilities at Mallard Slough on the lower San Joaquin River near Chipps Island, on Rock Slough near Oakley, and on Old River near the Highway 4 Bridge. The fourth diversion to be added to those facilities operated by CCWD is the "Alternative Intake Project" on Victoria Slough in the South Delta. Reclamation owns the Contra Costa Canal and shortcut pipeline, as well as the Rock Slough Intake and pumps. The CCWD operates and maintains these facilities under contract to Reclamation. CCWD owns

Mallard Intake, Old River Intake and Los Vaqueros Reservoir, and the proposed Alternative Intake on Victoria Canal. Separate Opinions have been issued for these structures.

The Rock Slough Intake is an unscreened diversion owned by Reclamation and one of three operated in the Delta by CCWD. Pumping Plant 1, located several miles downstream from the canal's headworks on Rock Slough, has the capacity to pump 350 cfs into the concrete lined portion of the Contra Costa Canal. The Rock Slough intake currently accounts for approximately 17 percent of the total water diverted by the CCWD in the Delta. Pursuant to the USFWS' (1993) Opinion for the Los Vaqueros Project, the positively screened Old River Facility is now the primary diversion point for CCWD, accounting for approximately 80 percent of the annual water supply diverted by CCWD. In the future, when the positively screened Alternative Intake comes on line, the share of CCWD water diverted from the Old River and Victoria Canal intakes will account for approximately 88 percent of the annual water diversions for the CCWD, while the Rock Slough intake will be reduced to approximately 10 percent of the annual diversions. All three current intakes are operated as an integrated system to minimize impacts to listed fish species. CCWD diverts approximately 127 TAF per year in total, of which approximately 110 TAF is CVP contract supply. In winter and spring months when the Delta is relatively fresh (generally January through July), demand is supplied by direct diversion from the Delta. In addition, when salinity is low enough, Los Vaqueros Reservoir is filled at a rate of up to 200 cfs from the Old River Intake. However, the biological opinions for the Los Vaqueros Project and the Alternative Intake Project, CCWD's memorandum of understanding with the CDFG, and SWRCB D-1629 of the State Water Resources Control Board, include fisheries protection measures consisting of a 75-day period during which CCWD does not fill Los Vaqueros Reservoir and a concurrent 30-day period during which CCWD halts all diversions from the Delta, provided that Los Vaqueros Reservoir storage is above emergency levels. The default dates for the no-fill and no-diversion periods are March 15 through May 31 and April 1 through April 30, respectively.

6.6.6.2 Assess Species Exposure

At least one of the listed species are present in the south Delta waterways adjacent to the CCWD diversion intakes in all months of the year. Winter-run are present from approximately December through June based on salvage records from the CVP/SWP fish collection facilities. The peak occurrence of winter-run in the south Delta is from January through March. Juvenile spring-run are present in the South Delta in the vicinity of the CCWD diversions from January through June with peak occurrence from March through May. Central Valley steelhead may be present in the waters of the South Delta from October through July, but have peak occurrence from January through March. Both juvenile and sub-adult green sturgeon are expected to be present year round in the South Delta as indicated by the salvage record. Adult green sturgeon have been caught by sport fisherman in the mainstem of the San Joaquin River from Sherman Island to the Port of Stockton in most months of the year based on the draft 2007 sturgeon report card (CDFG 2008). Presence in the South Delta is assumed for the same period. During the 75 day pumping reduction from March 15 to May 31 and the 30 day no pumping period (April 1 to April 30), the effects of the CCWD action is significantly reduced or eliminated.

6.6.6.3 Assess Species Response to the Proposed Action

In the 1993 winter-run Opinion, NMFS required monitoring for winter-run. Based on the CDFG sampling during the period from 1994 through 1996, mortality from entrainment in the Rock Slough Intake occurred from January to June. Annual numbers captured in a sieve-net downstream of the pump plant for the years 1994-1996 were 2 to 6 winter-run, 25 to 54 spring-run, and 10 to 14 steelhead (Morinaka 2003). Additional losses (8 to 30 percent) due to predation in the canal and fish being killed passing through the intake also were determined to occur. Extrapolated numbers of juvenile Chinook salmon (all races) entrained at Rock Slough between 1994 and 1996 ranged from 262 to 646 fish per year.

Since that time, most of CCWD water diversions have shifted to newer, screened facilities on Old River near Highway 4. These screens are designed to exceed NMFS' juvenile salmon screening criteria since they also must be protective of juvenile and larval delta smelt which co-occur in the same waters. In addition, the current pumping rates at Rock Slough have been reduced in the winter months compared to the historical conditions (CVP/SWP operations BA Appendix E). Before 1998, the Rock Slough Intake was CCWD's primary diversion point. It has been used less since 1998 when Los Vaqueros Reservoir and the Old River Pumping Plant began operating. The diversion at the headworks structure is currently sampled with a sieve net three times per week from January through June and twice per week from July through December. A plankton net is fished at the headworks structure twice per week during times larval delta smelt could be present in the area (generally March through June). A sieve net is fished at Pumping Plant #1 two times per week from the time the first winter-run is collected at the CVP and SWP (generally January or February) through June. Since 1998, the expanded fish monitoring has only recovered 1 winter-run sized Chinook salmon, 14 spring-run sized Chinook salmon, 6 unclipped steelhead, 8 clipped steelhead, and one steelhead of indeterminate origin. During the same period of time, 19 wild fall-run and 2 clipped fall-run have been recovered (table 6-35) at the Rock Slough Headworks and Pumping Plant 1. NMFS previously estimated that annual take of listed fish at the Rock Slough Intake will be 50 spring-run, 50 winter-run, and 20 steelhead. In all of the years of fish monitoring, no green sturgeon has ever been recovered in the seines or plankton nets.

Table 6-35. Summary of listed fish captured at the Rock Slough Headworks and Pumping Plant 1 and amount of water diverted each year, 1998 – 2008.

Summary of Sieve Net and Plankton Net Monitoring Conducted at the Rock Slough Headworks and Pumping Plant 1 (PP1) from August 1998 through March 2008.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Totals
Months Monitoring Occurred	Aug-Dec	Mar-Dec	Mar-Dec	Jan-Aug	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Mar	
Amount of Water Diverted at Rock Slough Acre Feet	68,683	43,037	51,421	26,749	35,904	27,302	31,283	35,686	43,273	39,366	5,848	408,552
Number of Headworks &PP1 Sieve Net Surveys	Unknown	Unknown	Unknown	Unknown	Unknown	35	102	131	133	107	54	**562**
Number of Headworks Plankton Net Surveys	Unknown	Unknown	Unknown	Unknown	10	0	34	26	15	23	10	**118**
Winter-run Chinook	Dec=1	0	0	0	0	0	0	0	0	0	0	**1**
Spring-run Chinook	0	0	0	0	0	0	Mar=1 Apr=5	May=4	May=4	0	0	**14**
Central Valley steelhead (unclipped)	0	0	0	0	0	0	0	Mar=2 Apr=1	Jan=1 Mar=1	May=1	0	**6**
Central Valley steelhead (clipped)	0	0	0	0	0	0	0	0	0	0	Feb=6 Mar=2	**8**
Central Valley steelhead (unknown)	0	0	0	0	0	0	0	Feb=1	0	0	0	**1**
Fall run/late fall run Chinook (unclipped)	0	0	May=3	0	0	0	Mar=2 Apr=3 May=1	Apr=2 May=6 Jun=1	May=1	0	0	**19**
Fall run/late fall run Chinook (clipped)	0	0	0	0	0	0	May=1	May=1	0	0	0	**2**
Green sturgeon	0	0	0	0	0	0	0	0	0	0	0	**0**
Delta smelt	0	0	0	0	0	0	0	Feb=1*	0	0	0	**1**
Longfin smelt	0	0	0	0	0	0	0	0	0	0	Mar=1**	**1**

Future entrainment is expected to be reduced with the addition of CCWD's Alternative Intake Project. As previously stated, the percentage of water diverted from the Delta via the Rock Slough Intake will fall from 17 percent to approximately 10 percent of the annual CCWD diversions when the Alternative Intake Project comes on line. Furthermore, the use of the Rock Slough Intake will move into the summer months, when listed salmonids will be less likely to be present in the waters adjacent to the intake. The two other intakes on Old River and Victoria Canal will both be positively screened. Approach velocities and sweeping velocities for these two facilities will exceed NMFS' criteria for screening since they are designed to also meet Delta smelt criteria (see NMFS 2007). Estimates of future losses of spring-run and winter-run at the Rock Slough Intake with the Alternative Intake Project in service have been made assuming

future CCWD demands of 188,000 af/year. Based on average densities of the salmon in channels (from monitoring programs over the past 10 years), losses were estimated at about 5 winter-run and 16 spring-run juveniles per year.

6.6.6.4 Assess Risk to Individuals

Individual salmonids are likely to be present in the waters of the South Delta near the Old River Intake and the future Alternative Intake site on Victoria Canal during the winter and spring periods. Since the fish screens of the Old River Intake and the future Alternative Intake have been designed to meet Delta smelt standards, NMFS does not expect any salmonids to be entrained by these facilities, as the Delta smelt screening criteria are more stringent than those required for the protection of salmon fry or juveniles. The past several years of monitoring at the Old River Intake Facility has not recovered any listed fish from behind the screens, indicating that they are effective for salmonids. Individual fish may become impinged on the outside of the screens and incur some level of injury from the contact with the screens or become susceptible to localized predation adjacent to the screens while holding position in front of the screens. Experiments by Swanson *et al.* (2004) exposed juvenile Chinook salmon to a simulated fish screen in a large annular flume. Juvenile Chinook salmon tended to exhibit positive rheotaxis, swimming against the resultant current at all times. The incidence of impingement was very low (< 1 percent) in experimental fish. However, juvenile Chinook salmon experienced frequent temporary contacts with the screen surface, particularly with their tails (80 percent of contacts). The rate of morbidity was very low following the incidental contacts with the screen in these experiments. However, this could be a reflection of the benign environmental conditions under which the experiments took place. There were no predators, and the post-experiment observation period only lasted 48 hours. In the field, screens may have debris and other anomalies on their surface, which could produce abrasions to the skin of the fish. These wounds to the skin of the juvenile salmonid would create an opening for pathogens to colonize, and possibly cause morbidity or mortality in the affected fish later on. In addition, predators may seize the opportunity to mount attacks on juvenile salmonids that are dazed by the contact with the screen, or otherwise concentrated around the surface of the screen while holding position against the current. NMFS assumes a 5 percent loss for fish exposed to the screens (95 percent effective) due to these various effects.

NMFS does not anticipate that the screens will have any demonstrable effect on green sturgeon juvenile and sub-adults. The size of the sturgeon present in the south Delta would preclude them from being entrained through the small perforations in the screen. Green sturgeon rearing in the south Delta are considerably larger than the small perforations in the screen. Salvaged green sturgeons are bigger than 125 mm and average 330 mm. Studies with pallid and shortnose sturgeon (Kynard and Horgan 2001) previously mentioned had nearly 100 percent efficiency with louver arrays with considerably larger gaps in the screen than present at the CCWD's intake facilities. NMFS does not anticipate that there will be any significant loss of green sturgeon related to the operation of the positive barrier screens.

Entrainment at the Rock Slough diversion is expected to be minimal based on the past several years of monitoring data at this facility. Although the diversion is not screened, current

operations which minimize water diversions from this facility have substantially reduced the number of listed salmonids entrained. Future plans to further reduce exports to only the summer months will have additional benefits as listed salmonids will be less likely to be present in the regional waters. Risk to individual fish will remain, but overall risk will be reduced since pumping is minimized during periods when fish are present in the system, and the likelihood of entrainment within the flow to the Rock Slough intake is reduced due to its lower volume. No green sturgeon have ever been recovered during the 10 years of monitoring the Rock Slough canal and NMFS does not expect this to change. Risk to individual sturgeon is considered to be very low to nonexistent.

Increased flows in the future could affect OMR flows in the region. This could lead to increased impacts on individual fish moving in the region's waterways by increasing their vulnerability to the CVP/SWP export facilities.

Based on the efficiency of the positive barrier screens in the Old River and Alternative Intake facilities, the risks to the populations of winter-run and spring-run, CV steelhead, and green sturgeon present in the South Delta during the year are believed to be minimal. As mentioned in the above section, NMFS assumes that the screens are 95 percent efficient and are likely much better than this in reality. Although individual fish my suffer mortality or morbidity, it is not anticipated that this will occur at a scale that would have population level ramifications. Likewise, given the very low numbers of listed salmonids and the complete absence of green sturgeon from the monitoring records over the past 10 years at the Rock Slough facility, its operation is believed to have negligible effects on the populations of listed salmonids or green sturgeon present in the South Delta. The combined diversions from all three intakes however, may affect the OMR flows in the region and could make them more negative. This would create additional stresses on the hydrodynamics in the South Delta, which can translate into greater impacts on fish movements in the region and a greater likelihood of encountering the flow fields around the CVP/SWP export facilities.

6.6.6.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

The effects of the CCWD on the designated critical habitat of CV steelhead and proposed critical habitat for Southern DPS green sturgeon in the South Delta is anticipated to be minimal by themselves. The current and future levels of exports are substantially below those envisioned for the CVP and SWP facilities. Nevertheless, the exports from the CCWD intakes do contribute to the additive net negative flow in Old and Middle Rivers and thus, in combination with the much larger CVP and SWP exports, negatively impact the hydrodynamics of the South Delta. This affects the value of the South Delta waterways as migratory corridors for steelhead and green sturgeon.

6.6.7 North Bay Aqueduct at Barker Slough Intake

6.6.7.1 Deconstruct the Action

DWR operates the North Bay Aqueduct (NBA) intake in the North Delta through the operation of the Barker Slough Pumping Plant. The NBA delivers water to Solano and Napa Counties. The plant's exports currently range from 30 to 140 cfs. Current pumping capacity is limited to 140 cfs due to capacity of the existing pumps at the facility. An additional pump is required to reach the pipeline design capacity of 175 cfs. The Barker Slough Pumping Plant facility is equipped with a positive barrier fish screen designed and constructed to meet NMFS' fish screening criteria. The Barker Slough Pumping facility entrains water from Barker Slough and surrounding waterbodies including Campbell Lake, Calhoun Cut, and Lindsey Slough. It is approximately 7 to 10 miles upstream of the confluence of Lindsey Slough with Cache Slough. Due to the entrainment of water from the surrounding sloughs, the intake has the potential to entrain migrating salmonids and green sturgeon that may be present in the Cache Slough complex of channels, including waters from the Yolo Bypass and Miners Slough.

6.6.7.2 Assess Species Exposure

Listed salmonids may be present in the waterways adjacent to the Barker Slough Pumping Plant, however several years of monitoring have failed to consistently capture any salmonids during the winter Delta smelt surveys (1996 to 2004) in Lindsey Slough or Barker Slough. Captures of Chinook salmon have usually occurred in the months of February and March and typically are only a single fish per net haul (http://www.delta.dfg.ca.goc/data/nba). Most Chinook salmon captured have come from Miners Slough, which is a direct distributary from the Sacramento River via Steamboat and Sutter Sloughs. No steelhead have been captured in the monitoring surveys between 1996 to 2004, the dates available on the DFG website. Green sturgeon are assumed to occur in the waters of Cache Slough and the Sacramento ship channel as green sturgeon have been caught in these waters by sport fisherman.

6.6.7.3 Assess Species Response to the Proposed Action

Seasonal pumping rates during the years 2005 to 2007 were 109 cfs in summer (June to August), 94 cfs in fall (September through November), 39 cfs in winter (December through February), and 36 cfs in spring (March through May). The recent historical data indicates that actual pumping levels are substantially less than those predicted in the CALSIM II current conditions scenario (Study 7.0) during the winter and spring months. For instance, the month of December has an average historical export rate of 52 cfs for the years 2005 through 2007. The estimated export rate for December from Study 7.0 is 116 cfs. The historical rate is only 44 percent of the modeled export rate. Similarly, the historical export rate for the month of April (2005 through 2007) is 31 cfs, while the estimate from Study 7.0 is 133 cfs. The historical export rate is only 23 percent of the modeled export rate. Therefore under the current historical conditions, relatively little exports are diverted from the Barker Slough Pumping Plant. In the modeled export scenario representing current conditions (Study 7.0), pumping is increased nearly two fold over historical conditions and increases even more during the near future and future conditions modeled for the action. This would increase the potential for entrainment over the current historical conditions observed at the pumping plant.

During the summer, seasonal pumping rates for the modeled studies 7.0 and 7.1 are not substantially different from each other (average rates were 115 cfs and 107 cfs, respectively) but both were lower than the future condition modeled in Study 8.0 (135 cfs), a difference of 15 to 20 percent. The historical value for the summer season (2005 to 2007) is 109 cfs, relatively similar to the modeled current conditions. NBA diversions are lower in fall, averaging 101 cfs in study 7.0, 99 cfs in study 7.1, and 123 cfs in study 8.0. The historical pumping rate during the fall (2005 to 2007) was 94 cfs, which is similar to Study 7.0 which modeled the current conditions. Modeled NBA diversions are highest during the winter months. There was very little difference between Studies 7.0 and 7.1 during the winter. However, study 8.0 differed from the other two studies, being greater in December (142 cfs versus 116cfs and 112 cfs) and lower in January (112 cfs versus 157 cfs and 155 cfs) and February (126 cfs versus 155 cfs and 154 cfs). All of the modeled pumping estimates are significantly greater than the historical average of 39 cfs for the period between December and February (2005 to 2007). This represents a substantial increase between historical conditions and the modeled conditions. Modeling estimates for the spring period also were substantially greater than the historical values from 2005 to 2007. The estimates for Study 8.0 export rates also were also greater than those for Studies 7.0 and 7.1. For April, Study 8.0 had a diversion rate of 145 cfs while study 7.0 (133 cfs) and Study 7.1 (128 cfs), a difference of approximately 10 percent. For May, Study 8.0 also had a diversion rate of 145 cfs, which is approximately 25 percent higher than the estimated rates for Studies 7.0 and 7.1 (both 116 cfs). Study 8.0 estimated an export rate of 148 cfs for June, approximately 18 percent higher than the estimates for Study 7.0 (126 cfs), and Study 7.1 (123 cfs). The historical export rate for the spring period between 2005 and 2007 was 36 cfs. Again the modeled rates are substantially greater than the historical pumping rates.

Overall, the modeled exports represent a significant increase in export levels and thus a greater risk to salmonids and green sturgeon in the waters adjacent to the pumping facility compared to their historical vulnerability. The increased export rates increase the potential exposure of fish to the fish screen over the historical conditions. However, the screens, which were designed to protect juvenile salmonids per NMFS criteria, should prevent entrainment and greatly minimize any impingement of fish against the screen itself. Furthermore, the location of the pumping plant on Barker Slough is substantially removed from the expected migrational corridors utilized by emigrating Chinook salmon and steelhead smolts in the North Delta system. Green sturgeon may be present in the waters of Lindsey and Barker sloughs since they are present in Cache Slough and the Sacramento Ship Channel. Green sturgeon are expected to be fully screened by the positive barrier fish screen in place at the pumping facility.

6.6.7.4 Assess Risks to Individuals

Based on the increases in modeled pumping rates over the historical export rates between 2005 and 2007, individual fish would be at a greater risk of exposure to the screens in response to the proposed action's greater export rates. However, the presence of salmonids in the waters of Barker Slough does not appear to be likely based on the monitoring data available. If the fish are not present in the vicinity of the export pumps, then there is no increase in the encounter rates with the screens. NMFS does not expect to see a demonstrable increase in the take of salmonids from the increased exports of the Barker Slough pumps for this reason.

The presence of green sturgeon is possible at the Barker Slough Pumping facility, but the entrainment risks presented by the pumps are minimized by the design of the screens. NMFS does not expect that individual green sturgeon will be harmed by the screens.

There is no discernable effect to the populations of winter-run or spring-run due to the operations of the Barker Slough Pumping Facility. The infrequent presence of Chinook salmon in the monitoring surveys indicates that Chinook salmon are at low risk of entrainment. Density appears to be quite low, and those Chinook salmon that have been captured in the monitoring surveys have tended to be in Miners Slough, a waterway to the east of Barker Slough. If Chinook salmon were to be pulled into the vicinity of the screened pumps by the increased exports, the screens are designed to effectively prevent the entrainment of these fish.

No steelhead have been recovered during the monitoring surveys conducted for the NBA at any of the monitoring sites sampled in the region. Therefore, it would appear that steelhead are rare in these waters and very few would have the potential to be affected by the screened export pumps. The take of very few fish would not be sufficient to have a population effect on Central Valley steelhead.

6.6.7.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

The location of the Barker Slough Pumping Plant lies within the regional waterways designated as critical habitat for both spring-run and CV steelhead. The Federal Register (September 2, 2005, 70 FR 52488) identifies the upstream tidal limits of Cache Slough and Prospect Slough, as well as Miners Slough and the Yolo Bypass within the Sacramento Delta Hydrologic Unit 5510 as critical habitat. Barker Slough and Lindsey Slough are interconnected with the Cache Slough complex of waterways and were not specifically excluded as critical habitat as was the Sacramento DWSC. The proposed critical habitat for Southern DPS of green sturgeon includes the Yolo bypass as well as waters of the legal Delta. Designated critical habitat for winter-run is more ambiguous, as only the Sacramento River was named as critical habitat (58 FR 33212) and not any of the tributaries or side channels and sloughs associated with the north Delta system.

The footprint of the Barker Slough Pumping Plant is relatively small and located approximately 7 to 10 miles upstream from Cache Slough on Barker Slough. Barker Slough is a dead-end Slough without any significant sources of inflow. It does not physically block a migratory corridor, nor does it occur in habitat that appears to be utilized extensively by Chinook salmon, steelhead, or green sturgeon based on the monitoring surveys mentioned previously. The primary effects of the NBA and the Barker Slough Pumping Plant are related to the entrainment of water from the Cache Slough complex of waterways. The entrainment of water from these waterways can redirect or delay listed salmonids present in those waterways. This can affect the PCE concerned with the preservation of the functionality of the migratory corridors for listed salmonids or green sturgeon. However the effect the Barker Slough Pumping on this PCE is believed to be negligible due to the relatively small magnitude of the diversion, even with the predicted increases in exports in the near future and future conditions.

6.6.8 Vernalis Adaptive Management Plan

6.6.8.1 Deconstruct the Action

The VAMP is an experimental study that provides for a steady 31-day pulse flow of water (target flow) at the Vernalis gage on the San Joaquin River during the months of April and May. The target flow is calculated from a formula which takes into account the existing flows in the San Joaquin River and the current and past 2 year's hydrology, based on the San Joaquin River Basin 60-20-20[17] water year classification scheme. In addition to the target flow, there are corresponding restrictions in the export levels of the CVP and SWP pumping facilities as well as the installation of the fish barrier at the Head of Old River. Both Reclamation and DWR are signatories to the SJRA and have agreed to pay 4 million dollars per year ($4,000,000) to the SJRGA to cover the authorities' contribution of water to the plan from their respective water supplies. Reclamation's share of this payment is $3,000,000 per year, and DWR, as part of its CVPIA cost share obligations, will furnish the remaining $1,000,000. This funding agreement is set to terminate on December 31, 2009, while the SJRA sunsets in 2012 unless it is extended.

During the early discussions regarding modeling assumptions, Reclamation and DWR committed to providing a VAMP-like river flow in the San Joaquin River and export reductions during the VAMP operational period, should the agreement not be extended into the future (project description, pages 76-77). The VAMP target flows and export rates are contained in table 6-36, below. For the purposes of the combined CVP/SWP operations forecasts, the VAMP target flows are simply assumed to exist at the Vernalis gage compliance point. Currently, supplemental volumes of water needed to reach the annual target flow are released on each of the three east side tributaries, *i.e.* the Stanislaus River, the Tuolumne River, and the Merced River, in a coordinated fashion to provide pulse flows down each river channel while maintaining the target flow at the Vernalis gage. These pulse flows are believed to stimulate outmigration of fall-run (the target species for the VAMP experiments) downstream towards the Delta. However, it also is acknowledged that other species of fish, including the CV steelhead, benefit from these pulses. NMFS believes that these pulse flows are critical cues for the listed steelhead in these tributaries to initiate their downstream emigration to the ocean (see SJRGA annual reports 2001-2008).

[17] 60-20-20, also known as the San Joaquin Valley's water year type index, equals 0.6 * Current Apr-Jul Runoff + 0.2 * Current Oct-Mar Runoff + 0.2 * Previous Year's Index, where runoff is the sum of unimpaired flow in MAF at: Stanislaus River below Goodwin Reservoir (aka inflow to New Melones Res.), Tuolumne River below La Grange (aka inflow to New Don Pedro Reservoir), Merced River below Merced Falls (aka inflow to Lake McClure), and San Joaquin River inflow to Millerton Lake, and the previous year's index is a maximum of 4.5 (http://cdec.water.ca.gov/cgi-progs/iodir/wsi).

Table 6-36. Scheduled VAMP target flows and export reductions required under the San Joaquin River Agreement.

VAMP Vernalis Flow and Delta Export Targets		
Forecasted Existing Flow (cfs)	Vamp Target Flow (cfs)	Delta Export Target Rates (cfs)
0 to 1,999	2,000	
2,00 to 3,199	3,200	1,500
3,200 to 4,449	4,450	1,500
4,450 to 5,699	5,700	2,250
5,700 to 7,000	7,000	1,500 or 3,000
Greater than 7,000	Provide stable flow to extent possible	1,500, 2,250, or 3,000

Reclamation and DWR did not provide further resolution of their future operations other than to provide VAMP-like flows at Vernalis. NMFS has considerable interest in how the flows in the two other tributaries, besides the Stanislaus River, will be affected by the future CVP/SWP operations. As mentioned above, the Tuolumne River and Merced River release a portion of the total supplemental water required to meet the targeted flows required under the VAMP experiment each year. These flows are integral to stimulating outmigration of both the threatened CV steelhead, and fall-run, a species of concern under the ESA, from the Tuolumne River and Merced River. Furthermore, decreases in the pulse flows on these rivers would be an adverse modification of critical habitat designated for CV steelhead in regards to flow related decreases in rearing area suitability and physical and flow related obstructions in the migration corridors from the rearing areas below the dams, downstream to Vernalis on the San Joaquin River where the Stanislaus River enters.

6.6.8.2 Assess Species Exposure

VAMP actions will primarily affect CV steelhead originating in the San Joaquin River basin. Under historical and current conditions, pulse flows in the tributaries will affect steelhead originating in the Stanislaus, Tuolumne, and Merced rivers. These pulse flows are typically staggered among the tributaries to maintain the desired target flows at Vernalis, with the Stanislaus River generally contributing the greatest volume. San Joaquin River basin steelhead within the mainstem San Joaquin River from the Merced River confluence through the Delta benefit from the VAMP pulse flows.

Within the Delta proper, other runs of listed salmonids and the Southern DPS of green sturgeon may benefit from the additional water flowing downstream and the export reductions taken as part of the experiment. During the 31 day pulse flow (typically April 15 through May 16), spring-run from the Sacramento River basin, steelhead from several watersheds outside of the San Joaquin River basin (*i.e.*, the Sacramento River basin, Feather River, American River, Mokelumne River and Calaveras River), the tail end of the winter-run outmigration, and rearing green sturgeon in the Delta all may benefit from the VAMP operations due to their potential presence in the Delta during this time period.

6.6.8.3 Assess Species Response to the Proposed Action

The VAMP experiments were designed to examine the relationships between upstream flows as measured at Vernalis, the role of exports, and the eventual survival of fall-run migrating through the Delta. The experiments provided sufficient in-river flows to provide migratory cues in the three San Joaquin River tributaries to fall-run and subsequently to test the relationship of flows with survival through the lower river reaches of the mainstem San Joaquin River and subsequently through the Delta. CV steelhead co-occurring with fall-run in these tributaries were also expected to benefit from these flow manipulations.

Under the future proposed VAMP-like operations, spring pulse flows are only linked to the Vernalis standard. Reclamation and DWR have not elaborated the details of this plan, particularly if pulse flows will continue on the Merced and Tuolumne rivers as has occurred historically in the VAMP experiment. Decreased flows on these rivers would create a situation in which the downstream water temperatures on the valley floor would become warmer with the progressively increasing air temperatures experienced during a typical spring in the Central Valley. As spring progressed, the increasing air temperature would continue to warm the river water and create thermal barriers within the downstream reaches of the river channel. Without a suitable pulse of cooler water moving downstream from increased dam releases to breakdown this thermal barrier, juvenile salmonids would be unlikely to survive their migration downstream to the Delta, dying from excessive thermal exposure en route. The only recourse is to remain within the reaches immediately below the terminal dams and reside in the cool tailwater reaches of the river over the summer and emigrate the following fall or winter when air temperatures decrease with the onset of winter. Unfortunately, due to the restricted habitat available below the dams with sufficient cool water to maintain suitable habitat requirements for either steelhead or fall-run Chinook salmon, density dependent mortality is anticipated to occur. There is currently insufficient space in the tailwater sections of these tributaries to support a large population of over summering salmonids under current summertime releases, and this is itself identified by NMFS as a limiting factor in steelhead recovery in the San Joaquin River basin. Forcing increased numbers of Chinook salmon and steelhead to compete for the limited over summering habitat and their resources (food, holding areas, cover, *etc*.) due to lack of sufficient outmigration spring pulse flows, would place additional stressors on the remaining populations of CV steelhead that would "normally" be present in these areas over the summer.

NMFS reviewed several reports in assessing the effects of flow in the San Joaquin River basin on the salmonid populations residing in the basin. Skinner (1958) reported that Central Valley populations of Chinook salmon exhibited wide fluctuations in abundance from 1870 onward by examining landings of Chinook salmon in California. The overall trend in abundance was negative, but every 30 years or so, particularly large landings occurred. Skinner (1958) opined that the declines in the Chinook salmon fisheries appear to be chronologically associated with water development projects in California, and the increase in the ocean troll fishery. Skinner (1958) describes the effects of the construction of Friant Dam on the upper San Joaquin River on the extirpated the spring-run population that formerly inhabited that watershed. Skinner (1958) stated:

> "Friant Dam on the San Joaquin River has had multiple effects on the spring fishery. In the first place the dam has cut off a third or more of the spawning area. Secondly, flows below the dam were inadequate during normal migration periods to assure passage of the fish either up or down the river. Only enough water is permitted to flow down the river to fulfill irrigation commitments. The released water flows to the delta Mendota Pool and a small amount reaches the 'Sack Dam' at Temple Slough where it is diverted for agricultural purposes. Below this point, the river goes dry except for small amounts of water received from its downstream tributaries. Because of these conditions, salmon obviously cannot ascend to the spawning area in the vicinity of Friant Dam."

Skinner (1958) also makes the observation that with the extirpation of the San Joaquin River spring run population that the commercial catches of spring run plummeted from 2,290,000 pounds in the 1946 season to 14,900 pounds in 1953. Functional extirpation of the San Joaquin River spring-run population occurred following the completion of the Madera Canal in 1944, and the completion of the Friant-Kern canal in 1949, allowing full use of the distributional system under Reclamation's operational plan. Skinner (1958) concluded that the last successful spawn of spring run in the San Joaquin River has not occurred "since the spring of 1946." This is an example of the direct consequences resulting from the alteration and loss of necessary in-stream flows to support salmonid populations below dams in the San Joaquin River basin.

Kjelson *et al.* (1981) described the effects of freshwater inflow on survival, abundance, migration, and rearing of Chinook salmon in the upstream (Delta) portions of the Sacramento-San Joaquin Estuary. Kjelson *et al*. (1981) pointed out that additional inflows of freshwater at the appropriate time during the winter and spring will increase the numbers of fry and juvenile salmon utilizing the estuary and the survival of juveniles in the estuary. Flow-related concerns for salmon in the estuary stem from water development activities in the Central Valley that have altered the distribution of flow resulting in impacts on juvenile and adult salmon migrations, as well as the lack of comprehensive flow standards on the tributaries and mainstem river reaches that are protective of salmon. The authors further explain that water development projects have caused major changes in the flow patterns within the estuary and the amount of flow entering the ocean from upstream sources. The San Joaquin River system has been particularly altered as most of the upstream inflow to the basin has been captured and utilized in regions upstream of the Delta. Typical export rates substantially exceed the flow of the San Joaquin River; hence most of the San Joaquin River flow goes to the export pumps rather than to the ocean. The authors concluded that the distribution and flow of water through the Delta waterways are heavily influenced by the design and operation of the state and federal water projects. Kjelson *et al.* (1981) report that analysis of data gathered between 1957 and 1973 indicates that the numbers of adult Chinook salmon spawners returning to the San Joaquin River system are influenced by flows 2.5 years earlier during their rearing and downstream emigration life history phases. In general, higher flows resulted in greater numbers of adults returning to spawn. Kjelson *et al.* (1981) also implicate the potential adverse effects of the pumps in the reduced survival of fish emigrating through the Delta, indicating that as export rates are increased, more downstream migrating salmon are drawn to the fish screens. Kjelson *et al.* (1981) estimate that the number of fish observed at the fish screens is probably only 5 percent of the total downstream migration in the system, but that a "much larger fraction probably is drawn out of their normal migration path" by the effects of the pumps on water flow in the Delta's channels. Kjelson *et al*. (1981)

state that the "alteration in flow distribution caused by drafting increased volumes of water across the Delta to the pumps apparently increases the mortality of salmon that do not ever reach the fish screens." In support of this statement, Kjelson *et al*. (1981) point out those mark-recapture studies in which fish that migrate downstream in waterways that are far removed from the effects of the pumps had higher relative survival rates than those released in waterways under the influence of the pumps.

Kjelson *et al.* (1982) reiterate the reduced survival of salmon in the delta due to influences of natural and anthropogenic sources. They found that Chinook salmon smolt survival decreased as flow rates decreased and water temperatures increased, particularly in the later portions of the outmigration period. Furthermore, they restated their belief that the influence of the state and federal exports negatively impacted the survival of emigrating smolts through the Delta.

In a study assessing the influence of San Joaquin River inflows, state and Federal exports, and migration routes, Kjelson *et al.* (1990) released experimental fish (coded wire tagged hatchery Chinook salmon) during the spring of 1989 at Dos Reis on the San Joaquin River below the head of Old River, and in Old River itself downstream of the head under conditions with low San Joaquin River flow (≈ 2,000 cfs) and high/low export conditions (10,000 cfs and 1,800 cfs). The results of the study were unexpected as the rate of survival was not greater for the low export conditions compared to the higher export conditions. Upon further examination of the data, Kjelson *et al*. (1990) found that survival was comparatively lower for all upstream release groups that year compared to other studies conducted in previous years. In addition, Kjelson *et al.* (1990) surmised that the short period of reduced exports (7 days) was not long enough to allow fish to exit the system and move beyond the influence of the exports when higher pumping resumed. Based on the times to recovery at Chipps Island, it was concluded that a sizeable proportion of the released fish were still in the Delta when the higher export levels resumed. This conclusion is further reinforced by the salvage of fish released at Jersey Point, indicating that fish were drawn upstream into the interior of the Delta and towards the pumps from their release points in the western Delta. The study, although having several significant flaws, did conclude that survival was higher in the mainstem San Joaquin River compared to Old River and that survival in the Delta interior was lower compared to the western Delta (*i.e.*, Jersey Point releases). Kjelson *et al*. (1990) cautioned about drawing conclusions about export rates and survival from the data due to its obvious flaws.

Kjelson and Brandes (1989) reports on the results of ongoing mark-recapture studies conducted in the Sacramento-San Joaquin Delta and the effects of river flows, percent diversion of Sacramento River water through the DCC, and river temperatures. The findings of that paper also conclude that elevated flows, as measured at Rio Vista on the Sacramento River, increase survival of Chinook salmon smolts from the Sacramento River basin through the Delta as measured by both ocean recoveries of adults and recaptures of tagged smolts at Chipps Island in the mid-water trawls. Similarly, adult escapement in the San Joaquin River basin also increases with spring time flows at Vernalis 2.5 years earlier. Increasing water temperature was also shown to decrease smolt survival through the Delta during the critical April through June outmigration period of fall-run.

In a more recent report, Mesick *et al.* (2007) assessed the limiting factors affecting populations of fall run and steelhead in the Tuolumne River. The paper describes potential limiting factors which may affect the abundance of fall-run and both resident and anadromous (steelhead) forms of rainbow trout in the Tuolumne River. This information was then synthesized into conceptual models to help guide management decisions in regards to steelhead and fall-run. In general, Mesick *et al.* (2007) found that river flows were the limiting factor with the greatest influence on the salmonid populations in the Tuolumne River. As found in previous studies, there is a strong relationship between adult escapement and spring-time river flows during the juvenile/smolt outmigration stage. Flows measured over the period between March 1 and June 15 explained over 90 percent of the variation in the escapement data. However, Mesick *et al*. (2007) identified two critical flow periods for salmon smolts on the Tuolumne River: winter flows which affect fry survival to smolt stage, and spring flows which affect the survival of smolts migrating from the river through the delta. Based on results from ongoing VAMP studies, Mesick *et al.* (1990) also noted that increased flows at Vernalis also increased survival of smolts emigrating through the Delta. Water temperature in the river was also identified as a potential limiting factor for salmonid survival within the emigration time period. Flows have a substantial role in maintaining suitable water temperatures within the river system, with higher flows prolonging and extending the cool water migratory corridor downstream than low flow conditions. Mesick *et al.* (1990) found that for Tuolumne River fall-run escapement data, that exports had little effect on adult production compared to winter and spring flows. Flows were the primary factor, beyond all other factors, in determining adult production from smolts.

NMFS also reviewed the restoration reports for the CVPIA, including the three volumes of "Working Paper on Restoration Needs" for the AFRP (USFWS 1995) and the Final Restoration Plan for the AFRP (USFWS 2001). The plan identified the Delta as the highest priority for restoration actions (USFWS 2001 page 17), given that it was highly degraded, due in part to CVP (and SWP) operations, and that all anadromous fish must pass through the delta as juveniles and adults. In addition, the San Joaquin River mainstem and its tributaries below Mendota Pool were assigned a high priority (but lower than the Delta) due to its highly degraded habitat and substantially reduced production of fall-run. Specific actions in each watershed and the Delta were identified to address the limiting factors present in those areas and were prioritized as to their ability to implement the "doubling goal" for affected fish populations. In general, actions scored a high priority if they promote natural channel and riparian habitat values and natural processes, such as those affecting stream flow, water temperature, water quality, and riparian areas. Actions are assigned medium priority if the affect emigration or access to streams, such as sites of entrainment into diversions and migration barriers. Like the previous reports, the AFRP Restoration Plan recommended increasing flows within the tributaries and mainstem San Joaquin River as a high priority action to increase salmonid production. Within the Delta, actions which would provide protection to juvenile salmonids migrating through the Delta from November 1 through June 30, equivalent to the protection provided by restricting exports to minimal levels, were given high priority. The specific increases in flow were developed to achieve the targeted doubling of fish populations as required under the CVPIA, and are not necessarily the flows needed to sustain or protect populations from further decline or achieve population stability. Targeted flows are typically much greater than the average or median flows observed in the rivers under current conditions. In addition to flows, maintaining appropriate water temperatures in the tributaries for salmonid life history stages were also given a high priority. The AFRP

restoration plan recommended that actions be implemented "to maintain suitable water temperatures or minimize length of exposure to unsuitable water temperatures for all life stages of Chinook salmon in the San Joaquin River and Delta." Targeted water temperatures are 56°F between October 15 and February 15 and 65°F between April 1 and May 31 for Chinook salmon in the mainstem San Joaquin River. Furthermore, the construction and operation of a barrier at the head of Old River to improve conditions for Chinook salmon migration and survival was given a high priority so long as its operation had minimal adverse effects on other delta fish species.

An additional reference used by NMFS during the evaluation of flow impacts in the San Joaquin River Basin is CDFG's "Final Draft 11-28-05 San Joaquin River Fall-run Chinook salmon Population Model," which evaluated various parameters that have been identified as influencing abundance of escapement of fall-run into the San Joaquin River. These parameters included such variables as ocean harvest, Delta exports and survival, abundance of spawners, and spring flow magnitude, duration, and frequency. The model was developed in response to the SWRCB call for comments and recommendations to the 1995 WQCP San Joaquin River spring Vernalis flow objectives in 2005. CDFG determined that the Vernalis spring flow objectives were not adequate for the long-term protection of fall-run beneficial uses in the San Joaquin River basin because: (1) the San Joaquin River salmon population trend continues to be below the 1967 - 1991 historic average upon which the narrative Doubling Goal was established (CVPIA Restoration Plan goals); (2) salmon smolts are not afforded the level of protection as envisioned by the 1995 WQCP; (3) the VAMP experiment is not working because it has not been implemented as designed; and (4) spring outflow is the primary factor controlling fall-run population in the San Joaquin River basin. CDFG summarized the shortfalls of the 1995 WQCP Vernalis flow objectives as being due to: (1) the diminished magnitude of the Vernalis flow objective; (2) the narrowness of the pulse flow protection window; (3) the infrequent occurrence of elevated flow objective levels; and (4) the frequent occurrence of reduced flow objective levels. CDFG found in the development of their spreadsheet model that non-flow parameters had little or no relationship to fall-run population abundance and that spring-time flow magnitude, duration, and frequency were the dominant factors influencing Chinook salmon abundance in the basin. In their analysis of the influence of exports and flow on salmon production, CDFG could not find a statistically significant role for exports compared to the influence of the spring time flows. The role of flow always dominated the interaction of exports and flow on salmon abundance. However, it should be noted that exports typically increase when San Joaquin River flows increase, thereby making exact relationships difficult to determine and that only a narrow range of river flows and exports were tested in the VAMP experiments to date. CDFG summarized the relationship between export, flow, and salmon production to be that when the ratio of exports to Vernalis flow decreases both escapement and cohort production increases. The relationships that suggest flow is the dominant factor influencing salmon production, rather than exports, are: (1) when the ratio of spring exports to spring Vernalis flows decreases, Vernalis flow greatly increases and San Joaquin River basin production greatly increases; (2) when the ratio of spring exports to spring Vernalis flows increases, Vernalis flow greatly decreases and San Joaquin River basin salmon production substantially decreases; (3) juvenile salmon survival increases when spring Vernalis flows increase; (4) spring export to spring Vernalis flow ratio has little influence upon juvenile salmon survival; and (5) as the difference between spring Vernalis flow level and spring export flow level increases, escapement

increases. Nevertheless, CDFG recognized that the influence of delta exports upon San Joaquin River salmon production was not totally clear but that its influence was not as negative, at least compared to flows, as it had previously been thought to be. Its analysis indicated that comparatively, flows were the much more influential variable in determining production levels in the basin compared to exports.

The model results indicated that in all scenarios tested, increasing the magnitude of spring outflow resulted in increased salmon production for all water year types. Likewise, in all scenarios tested, expanding the window of protection resulted in increased salmon production. The greatest increment in salmon production associated with increasing the window of protection was from 30 days to 60 days. Further increases in the window of protection beyond 60 days produced smaller incremental gains in salmon production. The 60-day period roughly encompasses the majority of the salmon outmigration window. When both flow magnitude and the window of protection are increased together, the salmon production in the basin increases substantially. Based on the model results, CDFG concluded that the optimal mix of flows and window of protection was: (1) wet years=20,000 cfs for 90 days; (2) above normal years=15,000 cfs and a 75-day window; (3) below normal years = 10,000 cfs for 60 days; (4) dry years = 7,000 cfs for 45 days; and (5) critical years = 5,000 cfs for 30 days. The model suggests that these flow objectives at Vernalis would accomplish the Doubling Goals of the CVPIA-AFRP, improve the fall-run replacement ratio, and would, as compared to other possible flow objective windows simulated with the model which met the Doubling Goals; result in the lowest water demand. This mixture of flows and protective windows, however, still used approximately 1 million additional acre feet of water from the reservoirs, on average, to meet its needs.

Recent papers examining the effects of exports on salmon survival have been unable to prove a statistically significant reduction in survival related to exports (Newman 2008). However Newman also caveats these findings by indicating that the data used in his analysis had a very low signal to noise ratio and that substantially greater numbers of observations were needed to more precisely estimate the effects of exports on salmon survival (Newman and Brandes in review). The final resolution of the impacts of exports on survival is still being assessed and the inability of the statistical analysis to detect true impacts is not surprising given the high level of environmental variation in the data sets analyzed. The inability to find a significant relationship between exports and salmon survival in a data set with a high noise to signal ratio does not mean that a relationship does not exist, but that further work is warranted to reduce the level of noise and clarify the relationship between these two factors.

6.6.8.4 Assess Risk to Individuals

The alterations of flow in the future VAMP-like action will affect individual steelhead residing in the Tuolumne and Merced rivers, based on the assumption that Reclamation and DWR will provide the water necessary for the Vernalis flow standards solely from the Stanislaus River. Reduced flows on the Tuolumne and Merced rivers will lead to declines in the suitability of the riverine habitats for steelhead, increased intra- and interspecies competition for resources and space in the remaining cold water reaches below the terminal dams, and a diminishment in the opportunity to emigrate successfully from these basins in the spring. This may cause individual steelhead to residualize in the tailwater sections of the rivers and forego their steelhead life

history expression. Steelhead that are successful in leaving the Tuolumne and Merced River basins will encounter conditions similar to the current VAMP operations once they pass Vernalis, as the flows are required to be comparable to the historical VAMP conditions at this point. Conditions through the Delta should also be comparable to current conditions, as a commitment to continue export reductions has been made by Reclamation and DWR as part of the project description. In light of the results from the recent years of the VAMP experiment, steelhead survival through the Delta is expected to be low. The loss of individually marked Chinook salmon between the upstream release points and downstream recapture locations remains high, and the survival of steelhead smolts is expected to be similar to these experimental fish since they travel through the same migratory corridor at the same time.

The expected changes in the VAMP water releases among the three tributaries is expected to decrease the viability of the San Joaquin River basin steelhead population. The diminishment of the steelhead habitat in the Tuolumne and Merced River tailwaters essentially reduces the available functioning habitat to only the Stanislaus River. This increases the risk to the population as only the Stanislaus River can be operated to support the basin's remaining population with any certainty. Risks associated with catastrophic events increase dramatically when the population is reduced to only one stream for its survival in the basin and the viability of the Southern Sierra steelhead diversity group becomes more tenuous as a result. This decreases the overall viability of the CV steelhead DPS by reducing the survival capacity of one of its original diversity groups.

6.6.8.5 Effects of the Action on Designated and Proposed Critical Habitat in the Delta Division

The potential changes in the VAMP springtime pulses have the potential to substantially reduce the function of the designated critical habitat on the Tuolumne and Merced River for steelhead. The reductions in springtime pulses on these tributaries reduce the values of PCEs associated with freshwater rearing and freshwater migratory corridors. As previously explained in the effects section for this action, reductions in springtime pulses reduce the cues for steelhead to initiate their downstream emigration at an appropriate time. The pulses help to connect the upper tailwater sections of the rivers with the lower valley floor reaches. Temperatures during spring increase on the valley floor and the altered hydrology of the tributaries due to dams prevents runoff from spring snowmelt from providing a continuous corridor of appropriately cool water between the rearing areas (now below the dams) with the lower valley floor reaches running down the middle of the San Joaquin Valley. This connection must now be made from controlled releases from the terminal dams. Without the releases, the downstream sections of the tributaries and valley floor sections of the San Joaquin River are too warm to provide appropriate thermal conditions for emigrating steelhead. Warmer temperatures may prove to be fatal in their own right, but are also expected to reduce the condition of the emigrating steelhead and make them more susceptible to predators and disease. Reduced flows are also likely to increase the population density of steelhead in the shrinking habitat below the dams as the weather warms. The outcomes of this truncated rearing habitat were previously explained in the effects section for this action. Overall survival is expected to decrease with the reduction in the value of the freshwater rearing habitat available to the steelhead.

6.6.9 Climate Change

The results from Reclamation's climate modeling show that climate change typically had more effect on Delta flows during wetter years than during drier years. This result seems related to how CVP and SWP operations occur with more flexibility during wet years, within the constraints of flood control requirements, compared to drier years when the CVP and SWP operations may be more frequently constrained to maintain in-stream flows and other environmental objectives.

- Head of Old River Flows
  - Remained positive (oceanward) for all scenarios
  - Decreased in winter and spring of wetter years for the drier climate change scenarios (studies 9.4 and 9.5)
  - Increased in winter of wetter years for the wetter climate change scenarios (studies 9.2 and 9.3)
  - Changes were minor during drier years for all climate change scenarios
- Old and Middle River Flows
  - Flows were typically negative (landward) except for a flow reversal in winter of wetter years for the wetter, less warming scenario (study 9.2)
  - Fall and winter flows are the most sensitive to climate change
  - Negative winter flows decreased for the wetter scenarios and increased for the drier scenarios
  - Negative fall flows increased for the wetter scenarios and decreased for the drier scenarios
- QWEST Flows (westward flows from the Delta towards the ocean)
  - Magnitude and direction of QWEST is affected by climate change scenario and season.
  - Flow direction is
    - typically positive during wetter water years except for summer for the drier climate change scenarios
    - always positive in the spring
    - typically negative in the summer of drier years except for the drier, more warming scenario
    - positive in the fall of drier years for the drier climate change scenarios and negative in fall of drier years for the wetter climate change scenarios
  - Winter flows are the most sensitive to climate change and response varies by scenario
- Cross Delta Flows
  - Winter flows were the most sensitive to climate change, flows decreased for the drier climate scenarios and increased for the wetter climate scenarios

Results show that climate change typically had more effect on Delta velocities during wetter years than during drier years. This result is consistent with the Delta flow results

- Head of Old River Velocities

  - Are positive (oceanward) for all scenarios
  - Increased in winter and spring of wet years for the wetter climate change scenarios
  - Decreased in winter and spring of wet years for the drier climate change scenarios
  - Changes were typically less than 0.05ft/s during drier years for all climate change scenarios

- Middle River at Middle River Velocities
  - Are negative (landward) for all scenarios except for a slight reverse flow in winter of the wetter, less warming scenario
  - During wetter years, negative winter velocities decreased for the wetter climate change scenarios and increased for the drier climate change scenarios
  - Changes were typically less than 0.05ft/s for drier climate change scenarios

- San Joaquin River at Blind Point Velocities
  - Are positive (oceanward) for all scenarios
  - Changes were typically less than 0.05ft/s

- Cross Delta Velocities (Georgiana Slough)
  - Are positive (oceanward) for all sceanarios
  - Increased in winter for the wetter climate change scenarios and decreased in winter for the drier climate change scenarios

The fall and winter periods appear to have the most sensitivity to climate changes. In general, the pattern of study results suggests that OMR flow during January through June becomes more negative during dry years in the drier/less warming and drier/more warming scenarios, but with some substantial changes that are mostly either increases in negative flow or decreases in positive flow compared to the other scenarios. In other words, in the drier climate change scenarios it is expected that fish in the channels surrounding the CVP and SWP projects will be exposed to higher entrainment risks during the January through June time frame than under projected future conditions without climate change. Wetter climate patterns appear to present less entrainment risk during the January through June period in wet and above normal water year types, but elevated risks during the below normal, dry and critically dry water year types. The late fall period (October through December) also had consistently higher risks of entrainment in the wetter climate scenarios than the base case modeled in Study 9.0 for the future climate change models (see tables 6-37 and 6-38).

Table 6-37. Trends for Average Changes in Flow for Climate Change Scenarios Relative to the Base Case.

Trends and flow directions are based on 50 percent values. Trends are rounded to nearest 250 cfs. No shading (white) indicates locations with positive (oceanward) flows. Dark shading (blue) indicates locations with negative (landward) flows. Light shading (yellow) indicates locations with mixed flow regimes (sometimes positive and sometimes negative). Seasons are defined as winter is Jan-Mar, spring is Apr-Jun, summer is Jul-Sep, and fall is Oct-Dec. Wetter year types are those classified as wet or above normal. Drier year types are those classified as below normal, dry or critically dry.

Name	Year Type	Wetter, Less Warming Flow	Wetter, More Warming Flow	Drier, Less Warming Flow	Drier, More Warming Flow
Head of Old River	Wetter	Increased by 1750cfs in spring, 1000cfs in summer, 250cfs in fall, and 750cfs in winter	Increased by 500cfs in winter, decreased by 1500cfs in spring, decreases were less than 250cfs in summer and fall	Decreased by 3500cfs in winter and spring, and decreased by 250cfs in summer and fall	Decreased by 2750cfs in winter and 3000cfs in spring, decreases were less than 250cfs in summer and fall
	Drier	Changes were less than 250cfs	Changes were less than 250cfs	Changes were less than 250cfs	Changes were less than 250cfs
Old and Middle River	Wetter	In winter flows changed from negative 3200cfs (landward) to positive 100cfs (oceanward). The rest of the year, negative (landward) flows decreased by 750cfs in spring, 250cfs in summer, and increased by 500cfs in fall	Negative (landward) flows decreased by 2500cfs in winter, 750cfs in spring, and 250cfs in summer. Negative flows increased by 750cfs in fall.	Negative (landward) flows increased by 3250cfs in winter, 500cfs in spring and 1000cfs in summer. Negative flows decreased by 500cfs in fall.	Negative (landward) flows increased by 1250cfs in winter. Negative flows decreased by 250cfs in spring and by 1750cfs in fall. Summer flow changes were less than 250cfs.
	Drier	Negative (landward) flows increased by less than 250cfs in winter, 750cfs in spring, 1000cfs in summer and 1750cfs in fall.	Negative (landward) flows increased by 500cfs in winter, spring, fall, and 750cfs in summer.	Changes were less than 250cfs in spring and fall. Negative (landward) flows decreased by 750cfs in summer and increased by 500cfs in winter.	Negative (landward) flows decreased by 250cfs in winter, 500cfs in spring, 1000cfs in summer and 750cfs in fall
QWEST	Wetter	Increased by 4000cfs in winter, 3000cfs in spring, 1500cfs in summer and 500cfs in fall	Increased by 3750cfs in winter, changes were less than 250cfs in spring, increased by 250cfs in summer, and decreased by 500cfs in fall	Positive (oceanward) flows decreased by 6500cfs in winter, 1750cfs in spring, 750cfs in summer, and 250cfs in winter.	Positive (oceanward) flows decreased by 4250cfs in winter and 1250cfs in spring, 250cfs in summer. Positive fall flows increased by 250cfs.
	Drier	Negative (landward) winter flows of 0cfs changed to positive (oceanward) flows of 400cfs. Positive spring flows increased by 250cfs. Summer flow changes were less than 250cfs. Positive flows of 200 fall flows changed to negative flow of 300cfs.	Changes were less than 250cfs	Flow changes were less than 250cfs in winter. Positive flows increased by 250cfs in spring and fall, 750cfs in summer.	Flow changes were less than 250cfs in winter. Positive (oceanward) flows increased by 750cfs in spring, summer, and fall.
Cross Delta	Wetter	Increased by 1000cfs in winter, decreased by 250cfs in spring and summer, changes were less than 250cfs in fall	Increased by 2000cfs in winter, 750cfs in spring, and decreased by 750cfs in summer and 500cfs in fall	Decreased by 1250cfs in winter, 500cfs spring and fall, increased by 250cfs in summer	Decreased by 2250cfs in winter, 500cfs in spring, 250cfs in summer and 1000cfs in fall
	Drier	Increased by 250cfs in winter and summer, 750cfs in fall, changes were less than 250cfs in spring	Increased by 500cfs in winter, 250cfs in fall, changes were less than 250cfs in spring and summer	Decreased by 250cfs in winter, summer and fall, decreased by 500cf in spring	Decreased by less than 500cfs in winter, spring and fall, decreased by 750cfs in summer

Table 6-38. Trends for Average Changes in Delta Velocities for Climate Change Scenarios Relative to the Base Case.
Trends and velocity directions are based on 50 percent values. Trends are rounded to nearest 0.05ft/s. No shading (white) indicates locations with positive (oceanward) velocities. Solid shading (blue) indicates locations with negative (landward) velocities. Lighter shading (yellow) indicates locations with mixed velocity regimes (sometimes positive and sometimes negative). Seasons are defined as winter is Jan-Mar, spring is Apr-Jun, summer is Jul-Sep, and fall is Oct-Dec. Wetter year types are those classified as wet or above normal. Drier year types are those classified as below normal, dry or critically dry.

Name	Year Type	Wetter, Less Warming Velocity	Wetter, More Warming Velocity	Drier, Less Warming Velocity	Drier, More Warming Velocity
Head of Old River	Wetter	Increased by 0.05ft/s in winter, 0.25-0.50ft/s in spring and summer, and 0.15ft/s in fall	Increased by 0.05ft/f in winter, increased by 0.35ft/s in spring, and changes were less than 0.05ft/s in summer and fall	Decreased by 0.70ft/s in winter, 0.9ft/s in spring, 0.1ft/s in summer and less than 0.15ft/s in fall	Decreased by 0.5ft/s in winter, 0.75ft/s in spring, 0.05ft/s in summer and fall
	Drier	Increased by 0.05ft/s in spring, changes were less than 0.05ft/s in summer, fall and winter	Changes were less than 0.05ft/s	Decreased by 0.05ft/s in winter, spring and summer, decreased by less than 0.05ft/s in fall	Decreased by 0.05ft/s in winter and changes were less than 0.05ft/s in spring, summer and fall
Middle River at Middle River	Wetter	Winter velocities changed negative (landward) 0.1ft/s to nearly 0ft/s. Negative velocity changes were less than 0.05ft/s in spring and summer. Changes were less than 0.05ft/s in fall	Negative (landward) velocities decreased by 0.05ft/s in winter, changes were less than 0.05ft/s in spring, summer and fall	Negative (landward) velocities increased by by 0.1ft/s in winter. Velocity changes were less than 0.05ft/s in spring, summer and fall.	Negative (landward) velocities increased by 0.05ft/s in winter and decreased by 0.05ft/s in fall. Velocity changes were less than 0.05ft/s in spring and summer.
	Drier	Negative (landward) velocities decreased by 0.05ft/s in fall, changes were less than 0.05ft/s in winter, spring and summer	Changes were less than 0.05ft/s	Changes were less than 0.05ft/s	Changes were less than 0.05ft/s
San Joaquin River at Blind Pt.	Wetter	Increased by 0.05ft/s in winter and spring, changes were less than 0.05ft/s in summer and fall	Increased by 0.05ft/s in winter, changes were less than 0.05ft/s in spring, summer and fall	Decreased by 0.05ft/s in winter, changes were less than 0.05ft/s in spring, summer and fall	Decreased by 0.05ft/s in winter, changes were less than 0.05ft/s in spring, summer and fall
	Drier	Changes were less than 0.05ft/s	Changes were less than 0.05ft/s	Changes were less than 0.05ft/s	Changes were less than 0.05ft/s
Georgiana Slough	Wetter	Increased by 0.10ft/s in winter, 0.05ft/s in spring, 0.25ft/s in fall, and changes were less than 0.05ft/s in summer	Increased by 0.15ft/s in winter, changes were less than 0.05ft/s in spring, summer and fall	Decreased by 0.1ft/s in winter and fall, increased by 0.05ft/s in summer and changed less than 0.05ft/s in spring	Decreased by 0.15ft/s in winter, 0.10ft/s in spring, 0.05ft/s in summer and fall
	Drier	Changes were less than 0.05ft/s	Increased by 0.05ft/s in winter, spring and fall, and changes were less than 0.05ft/s in summer	Decreased by 0.05ft/s in winter, spring and summer, changes were less than 0.05ft/s in fall	Decreased by 0.05ft/s in winter, summer and fall, and 0.1 ft/s in spring

6.6.10 Summary of the Delta Effects

The quality of the Delta has been diminished over the past hundred years. Human activities in the surrounding watershed during this period have led to the removal of vast stands of riparian forests and severe reductions in the fringing marshland habitat surrounding the Delta waterways, creation of armored levees throughout the valley floor watershed, channelization of waterways and construction of new channels to aid water conveyance in the interior of the delta (*e.g.*, Victoria Canal, Grant Line Canal) and commercial shipping traffic (The Bay Institute 1998, Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Monroe *et al.* 1992, Goals Project 1999). Over the past half century, substantial increases in the volume and frequency of water diversions by the CVP and SWP have occurred. The value of the Delta as a rearing habitat for juvenile salmonids has been incrementally diminished with each modification to the system. Current data indicating that survival is substantially better for those fish that remain in the main channel of the Sacramento River rather than dispersing into the side channels and interconnected waterways (Brandes and McLain 2001; Vogel 2004, 2008a) indicate that the Delta has lost its ecological function for these fish and that human induced conditions, such as exotic introduced predators, pollution, and water diversion operations have negated the benefits of these habitats for rearing fish during their outmigration to the ocean. Likewise, fish emigrating from the San Joaquin River basin are very unlikely to survive their passage through the Delta to enter the San Francisco Bay estuary at Chipps Islands (SJRGA 2001-2008) for many of the same reasons. As described above, substantial reductions in the basin's salmonid population have occurred as a direct result of these anthropogenic actions as well as those occurring upstream in the tributaries. Population impacts can be so severe that they may lead to the extirpation of a population as seen in the loss of the sizeable spring-run population that once inhabited the San Joaquin River Basin (Skinner 1958). Currently, the San Joaquin River basin's population of fall-run is decline, and the CV steelhead population is comprised of very limited number of fish.

The current suite of projects under consultation for the CVP/SWP operations in the Delta includes continued water diversions at the CVP and SWP facilities in the South Delta, which will increase under the near term and future conditions over the already substantial level of diversions. Increased water diversions during the periods of listed salmonid outmigrations will unquestionably lead to increased loss of listed salmonids from both the Sacramento River and San Joaquin River basins at the water diversion facilities, either through direct or indirect means. The magnitude of these increases remains uncertain. For example, the estimates of loss and salvage at the fish collection facilities have inherent assumptions that can lead to errors in the final calculation of these values. For instance, the assumption that fish are passed through the facility at a consistent level; thereby allowing subsamples to be taken at timed intervals to determine overall salvage and loss estimates is likely an inaccurate assumption. Fish are more than likely to come through the facilities in an episodic pattern, with pulses of high numbers of fish followed by periods of low to no fish in the samples. This would be particularly relevant for fish that are rare or low in numbers to begin with. The assumption that a 10 minute or 20 minute count every 2 hours would always capture these events needs to be more thoroughly evaluated. Furthermore, the variations in louver efficiencies related to bypass flows and the impacts of operations such as louver cleaning need to be more adequately addressed in calculating the loss and salvage numbers. Likewise, the uncertainty of the extent of the contribution of indirect or interrelated losses related to fish moving across the Delta towards the pumps under the influence

of the water withdrawals (*i.e.*, net negative flows) to the overall loss estimate continues to remain a significant area of concern. As described earlier in the Delta effects analysis, many of the sources of loss associated with moving fish through the Delta, such as predator populations and the increased prevalence of non-native aquatic weeds such as *Egeria densa*, have their own interconnections with the operations of the CVP and SWP, and their continued presence is linked to maintaining an artificially stable Delta environment conducive to moving freshwater towards the pumps.

Given the current fragility of the winter-run, spring-run, and CV steelhead populations, additional levels of take will create a disproportionate level of adverse effects upon these groups of fish[18]. The low numbers of individuals in these populations and the current and future disability of their habitats to support spawning and rearing reduce the ability of the fish populations to recover from chronic take issues as current reproductive success likely cannot compensate for additional losses of individuals. Historical data indicate that entrainment of fish at the CVP and SWP is likely to occur in a more episodic fashion, when pulses of fish move through the system under the influence of environmental factors that are not easily captured in averaged data. The proposed Delta operations of the CVP and SWP under CVP/SWP operations not only maintain the current trajectory of loss seen today, but increase that trajectory through increased pumping rates and greater amounts of water diverted annually. Therefore, it is unlikely that the listed fish populations will experience any form of recovery and/or reduced vulnerability to loss resulting from these operations as described.

In addition to these core environmental conditions in the Delta, the future project actions will continue to expose fish to the salvage facilities as a consequence of the pumping operations resulting in continued losses into the future. Furthermore, operation of the permanent gates will lead to losses associated with predation at the physical structures and the local and farfield hydraulic conditions created by the barriers. Due to the geometry and hydraulic conditions in the South Delta, the interactions of the CVP and SWP with populations of salmonids in the San Joaquin River basin are exceptionally adverse. Under current operating conditions, significant reductions in the abundance of CV steelhead and fall-run originating in the San Joaquin River basin, (as well as the Calaveras River and Mokelumne River basins) are likely to continue to occur. This not only decreases the abundance of the San Joaquin River basin populations as they emigrate to the sea, but also reduces the genetic diversity and spatial distribution of the Central Valley salmonid populations by placing an inordinate amount of risk in this region of the ESU. This violates the "representation and redundancy rule" of having viable populations represented in each of the historic geographical regions in which the different populations originally occurred.

6.7 Suisun Marsh Facilities

DWR operates several facilities within Suisun Marsh that may affect listed anadromous salmonids and threatened green sturgeon. The SMSCG are operated seasonally to improve water quality in Suisun Marsh. At Roaring River and Morrow Island, DWR operates water distribution

[18] The resilience of the Southern DPS of green sturgeon is unknown. Currently, there are no accurate estimates of the standing population of green sturgeon (*i.e.*, abundance) comprising the Southern DPS and therefore estimates of the different population parameters are unavailable.

systems that serve both public and privately managed wetlands in the marsh. DWR also operates the Goodyear Slough Outfall to provide lower salinity water to wetland managers along Goodyear Slough.

6.7.1 Suisun Marsh Salinity Control Gates

Located in the southeastern corner of Suisun Marsh, the SMSCG span the 465-foot width of Montezuma Slough. The facility consists of three radial gates, a boat lock structure, and a maintenance channel that is equipped with removable flashboards. When the SMSCG are in operation, the flashboards are installed at the maintenance channel and the gates are operated tidally. Fish migrating through Montezuma Slough must pass through this structure, which extends across the full width of Montezuma Slough. DWR proposes to operate the SMSCG periodically for approximately 10 to 20 days per year between October and May; however, the facility may operate more frequently in critically dry years and less in wet years. During the period between October and May, listed anadromous salmonids and green sturgeon migrating in Montezuma Slough will periodically encounter the SMSCG in operation and fish passage may be affected.

Operation of the SMSCG from October through May coincides with the upstream migration of adult Central Valley anadromous salmonids and green sturgeon. The late winter and spring downstream migration of Central Valley salmonids also overlaps with the operational period of the SMSCG. As adult Central Valley anadromous salmonids travel between the ocean and their natal Central Valley streams, Montezuma Slough provides an alternative route to their primary migration corridor through Suisun Bay. Fisheries sampling conducted by CDFG indicates many adult Central Valley salmon migrate upstream through Montezuma Slough (Edwards *et al*. 1996, Tillman *et al*. 1996), but the proportion of the total run utilizing this route is unknown. Sub-adult green sturgeon can be found in Suisun Marsh year-round (Matern *et al*. 2002), and adult green sturgeon may also use Montezuma Slough as a migration route between the ocean and their natal spawning areas in the upper Sacramento River.

To evaluate the potential effects of the SMSCG operations on adult salmonid passage, telemetry studies were initiated in 1993 on adult Chinook salmon. In seven different years (1993, 1994, 1998, 2001, 2002, 2003, and 2004), migrating adult fall-run were tagged and tracked by telemetry in the vicinity of the SMSCG. These studies showed that the operation of the SMSCG delays passage of some adult Chinook salmon. While other adult salmon never pass through the SMSCG and instead swim downstream for approximately 30 miles to Suisun Bay and then access their natal Central Valley streams via Honker Bay. Based on the results of studies conducted during the early 1990s, the CDFG recommended modifications to the structure to improve passage (Edwards *et al.* 1996, Tillman *et al*. 1996).

Telemetry studies conducted in 1998, 1999, 2001, 2002, 2003, and 2004, were designed to evaluate adult salmonid passage rates under various SMSCG configurations and operational conditions. In 1998, modifications were made to the flashboards at the SMSCG maintenance channel to include two horizontal openings, but telemetry monitoring indicated that the modified flashboards did not improve salmon passage (Vincik *et al*. 2003). Telemetry studies conducted in 2001, 2002, 2003, and 2004, evaluated the use of the existing boat lock as a fish passageway.

These results indicated that fish passage improved when the boat lock was opened. Successful passage rates improved by 9, 16, and 20 percent in 2001, 2003, and 2004, respectively, when compared to full SMSCG operation with the boat lock closed. In addition, opening of the boat lock reduced mean passage time by 19 hours, 3 hours, and 33 hours in 2001, 2003, and 2004, respectively. The 2002 results did not confirm these findings, but equipment problems at the structure during the 2002 season likely confounded the 2002 fish passage studies (Vincik 2004).

DWR proposes to operate the SMSCG as needed from October through May to meet salinity standards set by the State Water Resources Control Board and Suisun Marsh Preservation Agreement. In 2006 and 2007, the gates were operated periodically for 10-20 days annually. DWR anticipates this level of operational frequency (10-20 days per year) can generally be expected to continue in the future except during the most critical hydrological conditions. When the SMSCG are not operated, the gates remain in the open position and fish passage at the facility is not impeded.

Full operation of the SMSCG includes the flashboards installed and the gates tidally operated. Based on the results of fish passage studies, DWR proposes to hold the boat lock portion of the structure in an open position at all times during SMSCG operation to allow opportunities for fish passage during all phases of the tidal cycle. Under this operational plan, NMFS expects that between 55 and 70 percent of the adult salmonids arriving at the SMSCG during its 10-20 days of annual operation will successfully pass upstream at the structure. This rate of passage is virtually identical to the passage rate when the SMSCG is not operational (DWR and CDFG 2004). CDFG telemetry studies indicate 30 to 45 percent of the adult salmonids do not pass the structure even when the gates are not operating. Adult salmonids that do not continue upstream past the SMSCG are expected to return downstream by backtracking through Montezuma Slough to Suisun Bay, and they likely find the alternative upstream route to their natal Central Valley streams through Suisun and Honker Bays.

Little is known about adult green sturgeon upstream passage at the SMSCG. Acoustic tagging results from 2007 indicate adult green sturgeon migrate to the upper Sacramento River via Suisun and Honker Bays, not Montezuma Slough (Woodbury 2008); although the NMFS study's sample size was small (six adult sturgeon) and limited to 1 year of results. The results of the 2007 acoustic tagging study also suggest that green sturgeon require 4 to 6 weeks to pass upstream from San Francisco Bay to the upper Sacramento River, and it was not uncommon for sturgeon to interrupt their migration and linger in the vicinity of Rio Vista for up to 2 weeks (NMFS unpublished data).

When the gates of the SMSCG are operating, green sturgeon will have an opportunity to pass upstream through the boat locks as salmon do or through the open gates during ebb tide. Based on the results of salmon telemetry studies, the operation of the SMSCG may also delay the upstream passage of an actively migrating adult green sturgeon by 3 to 4 days. Fish are likely impeded by the flashboards of the SMSCG along the northern shoreline and the tidally-operated gates reduce the hydrodynamic effect of flood tides downstream of the structure. Many species of fish are known to synchronize their movements through estuaries with the ebb and flow of the tides (Gibson 1992). Kelly *et al*. (2007) report sub-adult sturgeon in San Francisco and San Pablo Bays typically move in the same direction as the prevailing current. The results of the

2007 acoustic tagging study indicate adult green sturgeon in the upper Delta and lower Sacramento River typically move against the prevailing tidal current (NMFS, unpublished data). Thus, adult green sturgeon are likely capable of continuing their upstream migration by navigating through the SMSCG on an ebb tide or through the continuously open boat lock when the SMSCG are being operated.

During the majority of the period between October and May, the SMSCG will not be operated and no fish passage delays due to the gates are anticipated. However, during the annual 10-20 days of periodic operation, individual adult salmonids and green sturgeon may be delayed in their spawning migration from a few hours to several days. The effect of this delay is not well understood. Winter-run are typically several weeks or months away from spawning and, thus, they may be less affected by a migration delay in the estuary. Steelhead migrate upstream as their gonads are sexually maturing and a delay in migration may negatively impact their reproductive viability. Spring-run are typically migrating through the estuary several months before spawning, but an extended delay in the estuary may affect their ability to access their natal spawning streams. Spring-run generally utilize high stream flow conditions during the spring snowmelt to assist their upstream migration. Rapid upstream movement may be needed to take advantage of a short duration high stream flow event, particular in dry years when high flow events may be uncommon. If the destination of a pre-spawning adult salmon or steelhead is among the smaller tributaries of the Central Valley, it may be important for migration to be unimpeded, since access to a spawning area could diminish with receding flows. Green sturgeon spawn in the deep turbulent sections of the upper reaches of the Sacramento River, and spring stream flows in the mainstem Sacramento River are generally not limiting their upstream migration. It is also common for green sturgeon to linger for several days in the Delta prior to initiating their active direction migration to the upper Sacramento River (NMFS unpublished data). However, delays at the SMSCG may affect the time of arrival at the RBDD and exacerbate the fish passage problems at RBDD, as discussed above.

Downstream migrating juvenile salmonids and green sturgeon may also be affected by the operation of the SMSCG. The operational season of the SMSCG overlaps with the outmigration period of Central Valley salmonid smolts. As juvenile salmon and steelhead emigrate downstream, some fish will pass through Montezuma Slough as they travel towards the ocean. If the SMSCG are in operation, the gates will open and close twice each day with the tides. On the ebb tide, the gates are open and fish will pass downstream into Montezuma Slough without restriction. On the flood tide, the gates are closed and freshwater flow and the passage of juvenile fish will be restricted. Most juvenile listed salmonids in the western Delta entering San Francisco Bay are expected to be actively emigrating smolts. Smolts are likely taking advantage of the ebb tide to pass downstream (Vogel 2004), and, thus, the operation of the SMSCG is not expected to significantly impede their downstream movement in the estuary. Juvenile green sturgeon are thought to remain in the estuary for several years, feeding and growing before beginning their oceanic phase. These juvenile green sturgeon typically display lengthy periods of localized, non-directional movement interspersed with occasional long distance movements (Kelly *et al*. 2007). This behavior and movement by green sturgeon is not likely to be negatively affected by periodic delays of a few hours to several days at the SMSCG.

Salmonid smolt predation by striped bass and pikeminnow could be exacerbated by operation of the SMSCG. These predatory fish are known to congregate in areas where prey species can be easily ambushed. Pikeminnow are not typically major predators of juvenile salmonids (Brown and Moyle 1981), but both pikeminnow and striped bass are opportunistic predators that will take advantage of localized, unnatural circumstances. The SMSCG provides an enhanced opportunity for predation because fish passage is blocked or restricted when the structure is operating. However, DWR proposes to limit the operation of the SMSCG to only periods required for compliance with salinity control standards, and this operational frequency is expected to be 10-20 days per year. Therefore, the SMSCG will not provide the stable environment which favors the establishment of a local predatory fish population and the facility is not expected to support conditions for an unusually large population of striped bass and pikeminnow. In addition, most listed Central Valley salmonid smolts reach the Delta as yearlings or older fish. Since the size and type of prey taken by pikeminnow varies with the size and age of the fish (Brown and Moyle 1981), the relatively large body size and strong swimming ability of listed salmon and steelhead smolts reduce the likelihood of being preyed upon. Juvenile green sturgeon in the estuary are also relatively large and unlikely prey for striped bass and pikeminnow.

Montezuma Slough is designated critical habitat for endangered winter-run and proposed for designation as critical habitat for the Southern DPS of green sturgeon. PCEs of designated critical habitat for salmon in the action area include water quality and quantity, foraging habitat, natural cover including large substrate and aquatic vegetation, and migratory corridors free of obstructions. The specific PCEs of proposed critical habitat for the Southern DPS of green sturgeon in estuarine areas include: food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. As discussed above, fish passage will be affected by the operation of the SMSCG. The tidally-operated gates are also expected to influence water currents and tidal circulation periodically during the 10-20 days of annual operation. However, these changes in water flow will be limited to the flood portion of the tidal cycle and will generally be limited to a few days during each periodic operational episode. Overall, the short-term changes to tidal flow patterns in Montezuma Slough due to operation of the SMSCG are not expected to significantly change habitat availability or suitability for rearing of listed anadromous salmonids and green sturgeon.

6.7.2 Roaring River Distribution System

The water intake for the Roaring River Distribution System (RRDS) on Montezuma Slough is located immediately downstream of the SMSCG. The eight 60-inch diameter culverts of the Roaring River intake are equipped with fish screens and operated to maintain a screen approach velocity of 0.2 feet per second. During high tide, water is diverted through the RRDS intakes to raise the water surface elevation within the RRDS. The low screen velocity at the intake culverts combined with a small screen mesh size are expected to successfully prevent listed salmonids and green sturgeon from being entrained into the RRDS.

As discussed above, Montezuma Slough is designated critical habitat for endangered winter-run and proposed for designation as critical habitat for green sturgeon. The operation of the RRDS may affect some PCEs of designated and proposed critical habitat. Fish passage and the

migration corridor will not be affected, because the RRDS intakes are properly screened. However, water withdrawals at RRDS could influence flow, water quality, and food resources. The water surface elevation and water circulation at this location on Montezuma Slough is dominated by tides. The diversion is also tidally-operated by filling the intake pond at the RRDS during high tide. Since high tide conditions raise the water surface elevation throughout Montezuma Slough, water withdrawals at the RRDS intake do not reduce the quantity of available habitat and are not expected to negatively affect the condition of estuarine habitat for listed salmonids or green sturgeon in Montezuma Slough

6.7.3 Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) diverts water from Goodyear Slough through three 48-inch diameter culverts during high tide. Although the MIDS intakes do not currently have fish screens, it is unlikely a listed salmonid or green sturgeon will be entrained into the water distribution system. Fisheries monitoring performed in 2004-05 and 2005-06 identified entrainment of 20 fish species. However, no listed salmonids or green sturgeon were observed in the MIDS entrainment studies. Two non-listed fall-run fry (39-44 mm) were captured, but this was likely due to their small size and poor swimming ability. Fall-run fry commonly arrive in the Delta and estuary at a very small size and they outmigrate as smolts at a very early age compared to Central Valley listed anadromous salmonids. The large size and better swimming ability of juvenile listed salmonids in the Delta allow these fish to avoid entrainment at MIDS. In addition, the location of the MIDS intake on Goodyear Slough further reduces the risk of entrainment. Goodyear Slough is not a migratory corridor for listed salmonids or green sturgeon.

Goodyear Slough is not designated critical habitat for anadromous salmonids, but is proposed for designation as critical habitat for green sturgeon. The slough is subject to tidal influence and the MIDS intake is also tidally-operated. High tide conditions raise the water surface elevation throughout the area and, thus, the withdrawal of water at MIDS during high tide does not reduce the volume of aquatic habitat in the marsh. Low water intake velocities minimize the loss of aquatic organisms to entrainment. Overall, the quality of habitat, foraging of prey organisms by juvenile sturgeon, and the other specific PCEs for proposed green sturgeon critical habitat are not likely to be negatively affected by the operation of MIDS.

6.7.4 Goodyear Slough Outfall

DWR operates the Goodyear Slough Outfall to improve water circulation in the marsh. This structure consists of four 48-inch diameter culverts with flap gates designed to drain water from the southern end of Goodyear Slough into Suisun Bay. On flood tides, the gates reduce the amount of tidal inflow into Goodyear Slough. Due to its location and design, listed salmonids and green sturgeon are not likely to encounter this structure or be negatively affected by its operation. Improved water circulation by the operation of the Goodyear Slough Outfall likely benefits juvenile salmonids and sturgeon in Suisun Marsh by improving water quality and increasing foraging opportunities. PCEs of proposed critical habitat for green sturgeon are not likely to be negatively affected by the operation of the Goodyear Slough Outfall.

6.8 Effects of the Action on Southern Resident Killer Whales

The proposed action has the potential to affect Southern Residents indirectly by reducing availability of their preferred prey, Chinook salmon. Central Valley Chinook salmon stocks are available to Southern Residents across their coastal range (based on coded wire tag recoveries, Weitkamp 2007); and available in greater magnitude south of Cape Falcon (O'Farrell *et al.* 2008). Any proposed action-related effects that decrease the availability of salmon, and Chinook salmon in particular, could adversely affect Southern Residents in their coastal range.

Section 3 of this Opinion defines the proposed action as the continued operation of the CVP and SWP, effective through December 31, 2030. In addition to current day operations, several other actions are included in this consultation. These actions are: (1) an intertie between the CA and the DMC; (2) FRWP; (3) the operation of permanent gates, which will replace the temporary barriers in the South Delta; (4) changes in the operation of the RBDD; and (5) Alternative Intake Project for the Contra Costa Water District. Additionally, the operation of Nimbus Fish Hatchery and production from Trinity River Fish Hatchery are interrelated and interdependent to the proposed action (section 1.5.2). Any changes to these hatchery programs that may be required, either as a result of HGMP development and implementation or other long-term planning processes will be subject to separate section 7 consultation. The time lines to implement hatchery reform at Nimbus and Trinity are currently unknown. Therefore, the effects of current hatchery practices at Nimbus and Trinity are considered for the term of this Opinion.

Most of the direct effects of the proposed action occur within freshwater and estuarine systems of the Sacramento and San Joaquin rivers, the Sacramento-San Joaquin Delta, and San Francisco Bay (Section 3.2, Action Area); effects experienced by Southern Residents in their coastal range are indirect. That is, the proposed action affects the abundance of prey for Southern Residents in the ocean. Changes in prey abundance would affect the entire DPS of Southern Resident killer whales. The best available information indicates that salmon are the preferred prey of Southern Residents year round (Krahn *et al.* 2002, 2007), including in coastal waters, and that Southern Residents require regular supplies of adult Chinook salmon prey coast-wide, likely including stocks from the Sacramento and San Joaquin rivers of California's Central Valley (*Status of the Species* section).

In this analysis, NMFS considers effects of the proposed action on the Southern Residents by evaluating prey reduction caused by the action. Where appropriate, NMFS also considers prey production contributed by hatchery mitigation programs that are interrelated and interdependent to the action.

6.8.1 Effects on the Southern Residents' Prey Base

Our analysis of effects on Southern Residents follows from the salmon analysis on listed Chinook salmon in this Opinion, as well as additional information on non-listed Chinook salmon. We evaluate effects on the Southern Residents considering: (1) NMFS' effects analysis for listed winter-run and spring-run, and (2) effects on non-listed Chinook salmon, also part of Southern Residents' prey base.

6.8.1.1 Prey Reduction of ESA-listed Chinook Salmon ESUs

The effects analysis of this Opinion for winter-run and spring-run finds that the proposed action is likely to appreciably reduce the likelihood of their survival and recovery. In other words, thr proposed action appreciably increases the risk of extinction of these listed entities of salmon. Additionally, NMFS has concluded that the proposed action is likely to reduce the conesrvaton value of designated critical habitats of winter-run and spring-run.

NMFS evaluated effects on the Southern Residents qualitatively. We assessed the likelihood for localized depletions, and long-term implications for Southern Residents' survival and recovery, resulting from extirpations of winter-run and spring-run ESUs. In this way, NMFS can determine whether the increased likelihood of extinction of prey species is also likely to appreciably reduce the likelihood of survival and recovery of Southern Residents.

A reduction in prey would occur over time as winter-run and spring-run abundance declines. Hatchery programs, which account for a portion of the winter- run and spring-run ESUs, may provide a short-term buffer, but it is uncertain whether hatchery-only stocks could be sustained indefinitely. Although not currently large in numbers (20-year average adult escapements from 1986-2007 were 4,066 and 12,889, respectively; CDFG 2008), the loss of these ESUs would also preclude the potential for their future recovery to healthy, more substantial numbers.

Differences in adult salmon life histories and locations of their natal streams likely affect the distribution of salmon across the Southern Residents' coastal range. The continued decline and potential extinction of winter-run and spring-run populations, and consequent interruption in the geographic continuity of salmon-bearing watersheds in the Southern Residents' coastal range, is likely to alter the distribution of migrating salmon and increase the likelihood of localized depletions in prey, with adverse effects on the Southern Residents' ability to meet their energy needs. A fundamental change in the prey base originating from California's Central Valley is likely to result in Southern Residents abandoning areas in search of more abundant prey or expending substantial effort to find depleted prey resources.

6.8.1.2 Other Effects on Southern Residents' Prey Base

In addition to effects on winter-run and spring-run, the proposed action will affect non-listed fall-run and late fall-run in California's Central Valley, and non-listed spring-run and fall-run in the Trinity River watershed. We quantify the effects of hatchery production and project operations on non-listed Chinook salmon prey available to Southern Residents. The analysis considers effects of the proposed action and interrelated and interdependent actions over the effective term of this Opinion (through December 31, 2030).

6.8.1.2.1 Effects of Artificial Production

Effects from artificial propagation of non-listed fall-run from the Central Valley (Nimbus Fish Hatchery) and for non-listed spring- and fall-run from the Trinity River watershed (Trinity River Fish Hatchery) are included in the analysis because Nimbus Fish Hatchery production, and Chinook salmon production from Trinity River Fish Hatchery, are interrelated and interdependent to the proposed action. These hatcheries produce Chinook salmon that is

available to Southern Residents as prey. This analysis uses the current levels of funding and production, which are proposed to continue over the term of the proposed action (as discussed above, any changes to current funding and production as a result of a HGMP or other long-term planning processes are beyond the scope of this action, and will be subject to separate section 7 consultation).

Nimbus Hatchery is one of the five hatchery programs that produce Central Valley fall-run. In total, approximately 90 percent of fall-run returning to the Central Valley are hatchery-origin fish, and the remaining 10 percent are natural-origin (± 6 percent; based on Barnett-Johnson *et al*. 2007). Only a portion of hatchery-origin fall-run available to Southern Residents are produced by interrelated or interdependent actions, those of Nimbus Fish Hatchery in the Central Valley and the Trinity River Fish Hatchery. The Nimbus Fish Hatchery program produces an average of 13.3 percent of the Central Valley fall-run available to Southern Residents in the near-term (current and 5- to 10-year horizon) and projected for the long-term (30-year horizon, range: 12.9 to 15.1 percent; table 6-39).

The Trinity River Fish Hatchery is the sole producer of hatchery-origin spring- and fall-run that return to the Trinity River watershed. The Trinity River Fish Hatchery program produces 57 percent of the Trinity spring- and fall-run available to Southern Residents (based on the average hatchery proportion of Chinook salmon escapements to the watershed from 1991-2006; Appendix 3). Currently, the Trinity River Fish Hatchery's mitigation goal is to produce 45 percent of escapement (Hannon 2009a).

Table 6-39. Percent of Central Valley fall- and late fall-fun annually available to killer whales that are produced by the Nimbus Fish Hatchery program over the duration of the proposed action (Appendix 3).

Time Horizon	Average (percent)	Range[a] (percent)
Current[b]	13.3	12.9 to 14.8
5- to 10-year projection[c]	13.3	12.9 to 15.1
30-year projection[d]	13.3	12.9 to 15.0

[a] Range incorporates variability in adult escapement over the past 20 years.
[b] Study 7.0
[c] Study 7.1
[d] Study 8.0

The potential harmful effects of artificial propagation on the long-term fitness of salmon populations are discussed previously in this Opinion (section 4.2.4.8, Hatchery Operations and Practices). Specifically, hatcheries can adversely affect population viability by reducing abundance, productivity, spatial distribution and/or diversity of natural-origin fish (McElhany *et al*. 2000). The immediate cause of the recent fall-run decline is most likely a result of ocean conditions (Lindley *et al*. 2009). However, freshwater impacts, including hatchery programs, most likely contributed to the collapse (Lindley *et al.* 2009). Continued hatchery funding is not likely to change over the term of this Opinion, and time lines for implementing hatchery reform at Nimbus and Trinity River fish hatcheries are currently uncertain. We evaluate potential long-term effects of current practices at Nimbus and Trinity River fish hatcheries by considering

practices that may be detrimental to natural fish and any best management practices in place to avoid harmful effects on natural fish (CDFG and NMFS 2001).

Both hatchery programs include current practices that negatively affect natural fish and could diminish the productivity, distribution, and diversity of non-listed stocks over the long-term. Such effects could make these stocks less resilient to the effects of disease, climate change, and stochastic events. These hatchery programs also include some practices that are designed to maintain stock integrity.

At Nimbus Fish Hatchery, fall-run smolts are trucked to San Pablo Bay for release in the western Delta. Trucking smolts before release increases the straying of Nimbus Fish Hatchery fall-run escapement to rivers throughout the Central Valley, and causes demographic and genetic risks to natural fall-run populations. Additionally, Nimbus Fish Hatchery transfers Chinook salmon eggs to other hatcheries in the Central Valley, which reinforces homogenization of fall-run. At Trinity River Fish Hatchery, current practices for brood stock collection are based on observed phenotypic differences between spring and fall races, which is potentially unreliable and may contribute to genetic introgression between spring and fall hatchery runs. Nimbus and Trinity River fish hatcheries also employ practices that protect the natural fish and genetic diversity, including broodstock collection across run-timing for full representation of runs in hatchery programs, and marking hatchery smolts at a constant 25 percent rate of all releases (since spring of 2007 at Nimbus Fish Hatchery and for at least 10 years at Trinity River Fish Hatchery). These marking practices are parallel to methods under development to standardize data collection and increase monitoring programs in the Central Valley (CDFG and NMFS 2001).

6.8.1.2.2 Effects of Project Operations

6.8.1.2.2.1 Central Valley

Project operations in the Central Valley reduce reproductive success of adult and increase mortality of early life-stage (egg through smolt) fall- and late fall-run (Appendix 3). If considered alone, project operations would reduce the abundance of adult Chinook salmon in the ocean and reduce prey available to Southern Residents. To determine whether the Chinook salmon prey base for Southern Residents is reduced by the proposed action, we compare the decrease in the prey base for Southern Residents resulting from project-caused mortality on Central Valley fall- and late fall-run to the increase in the prey base resulting from the Nimbus Fish Hatchery program production of fall- and late fall-run. As described above, the Nimbus Fish Hatchery program produces an average of 13.3 percent of the Central Valley fall- and late fall-run available to Southern Residents. In the short-term, the proposed action would have to cause a greater percent reduction in the Central Valley fall- and late fall-run than this production from hatcheries to result in an overall reduction in prey for Southern Residents. Although we consider these net effects of project operations and hatchery production in the short-term, we also separately considered the long-term effects of hatchery production on prey available to Southern Residents above (section 6.8.1.2.1), and identified that hatchery practices could diminish the productivity, distribution and diversity of non-listed stocks over the long term.

NMFS quantified freshwater mortality sources for Central Valley fall- and late fall-run to evaluate an overall change in freshwater mortality attributed to project operations. Overall mortality from early life-stages was used to estimate the effective reduction in ocean abundance of fall and late fall-run and quantify effects on Southern Residents' prey base (methods described in Appendix 3). Mortality sources quantified include high water temperature and low flow upstream, and direct entrainment in the Delta. Although not quantified, project operations also cause mortality from fish stranding, redd dewatering and predation (Appendix 3).

Project operations in the Central Valley reduce the total hatchery and natural fall- and late fall-run available to Southern Residents by between 1.9 and 2.3 percent annually (average) over the project duration (range: 1.1 to -13.5 percent; table 6-40). Hatchery production interrelated and interdependent to the proposed action more than offsets the overall losses of Central Valley fall- and late fall-run (compare tables 6-39 and 6-40). Although fall- and late fall-run mortality does not result in a net reduction in the Southern Residents' prey base, project operations disproportionately affect natural-origin fish with potential long-term effects on fall- and late fall-run stocks, discussed further below.

Table 6-40. Percent annual reduction in hatchery and natural Central Valley fall- and late fall-run available to Southern Residents from project-caused mortality over the duration of the proposed action (Appendix 3).

Time Horizon	Average (percent)	Range[a] (percent)
Current[b]	-1.9	1.1 to -11.8
5- to 10-year projection[c]	-2.3	1.1 to -13.9
30-year projection[d]	-2.3	1.1 to -13.5

[a] Range incorporates variability in adult escapement over the past 20 years.
[b] Study 7.0
[c] Study 7.1
[d] Study 8.0

The project operations disproportionately affect nautral-origin fish because all of the natural-origin fish are exposed to in-river mortality sources, while the majority of the hatchery smolts, post-smolts and yearlings (20,660,000 out of a total Central Valley Chinook salmon hatchery release of 34,660,000) are released in San Francisco Bay and are not exposed to in-river mortality sources. As discussed above, natural-origin returns contribute approximately 10 percent of the available Central Valley fall- and late fall-run, and the remainder is hatchery-origin fish. Natural-origin salmon are important to the long-term maintenance of population distribution and diversity, both important factors for retaining population viability (McElhany *et al*. 2000) and buffering environmental variation (Lindley *et al*. 2009). Therefore, we also quantified the prey reduction specific to natural-origin fall and late fall-run.

Project operations in the Central Valley reduce natural-origin fall- and late fall-run by between 9.8 and 10.7 percent annually (average) over the project duration (range: -0.7 to -41.9 percent, table 6-41). Currently, and in the future, there is a potential for an annual reduction of as much as 40 percent from project operations, depending in part on environmental variability. Up to 40 percent annual reductions in the natural-origin component of Central Valley fall- and late fall-run

could further diminish the 10 percent contribution of natural adults, and potentially compromise the retention of diversity in the Central Valley fall- and late fall- run stocks over the long term.

Table 6-41. Percent annual reduction in natural Central Valley fall- and late fall-run Chinook salmon available to Southern Residents from project-caused mortality over the duration of the proposed action (Appendix 3).

Time Horizon	Average (percent)	Range[a] (percent)
Current[b]	-9.8	-0.9 to -39.0
5- to 10-year projection[c]	-10.7	-0.7 to -41.9
30-year projection[d]	-10.7	-0.7 to -40.6

[a] Range incorporates variability in adult escapement over the past 20 years.
[b] Study 7.0
[c] Study 7.1
[d] Study 8.0

6.8.1.2.2.2 Trinity River Watershed

Project operations in the Trinity River affect Chinook salmon populations in the Klamath/Trinity River watershed. The implementation of the Trinity River Restoration Program has provided increased flows from the Trinity River and stream habitat improvements. These actions should positively affect Chinook salmon production in the Klamath/Trinity River watershed (CVP/SWP operations BA, DOI 2000). Therefore, project operations in the Trinity River will have no adverse effects on ocean abundance of Chinook salmon and Southern Residents' prey base. As stated above, production from the Trinity River Fish Hatchery program is interrelated and interdependent to the proposed action. The Trinity River Fish Hatchery produces between 45 and 57 percent of the Trinity River spring- and fall-run available to Southern Residents (based on hatchery returns in the recent past and current mitigation goals). In the short-term, these components of the interrelated and interdependent action increase prey available to Southern Residents from the Trinity River watershed. Long-term concerns about the effects of hatchery practices on availability of Southern Resident prey resources were addressed above.

6.8.1.2.3 Effects of Climate Change

We also considered the sensitivity of project operations and system conditions with future climate change over the term of the Opinion, using a worst case scenario represented by drier, warmer conditions (Appendix 3). The scenario was based on changes in system hydrology and upstream survival of early life-stage Chinook salmon under drier, warmer climate conditions. We cannot directly compare the climate change scenario to previous analysis of project operations projected for the term of the Opinion, because the climate scenario evaluated includes different assumptions about system hydrology that complicates our ability to separate out project vs. non-project related effects. The climate scenario does indicate that drier, warmer conditions would cause greater reductions in natural Central Valley fall- and late-fall run (compare table 6-41 with table 6-42), even though overall returns and hatchery returns are affected similarly with or without the change in climate regime (compare tables 6-39 and 6-40 with table 6-42).

Table 6-42. Percent annual change in Central Valley fall- and late fall-run Chinook available to Southern Residents under a drier, warmer climate scenario (based on Study 9.5, Appendix 3).

Change in Adult Returns	Average (percent)	Range[a] (percent)
Overall returns	-3.0	0.6 to -14.9
Hatchery-origin returns	13.4	13.0 to 15.3
Natural-origin returns	-16.7	-4.4 to -51.7

[a] Range incorporates variability in adult escapement over the past 20 years.

7.0 Interrelated or Interdependent Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02).

7.1 Nimbus Fish Hatchery

Nimbus Fish Hatchery is interrelated to the operations of the CVP and SWP, as it was designed to mitigate for the loss of fish habitat above Folsom Dam. The effects of steelhead produced at Nimbus Fish Hatchery is a major stressor to the survival and recovery of CV steelhead in the lower American River. Therefore, the effects of Nimbus Fish Hatchery steelhead on American River steelhead are addressed in section 6.4.3.4.

8.0 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

8.1 Water Diversions

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, their tributaries, and the Delta, and many of them remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (Herren and Kawasaki 2001).

8.2 Agricultural Practices

Agricultural practices may negatively affect riparian and wetland habitats through upland modifications that lead to increased siltation or reductions in water flow in stream channels flowing into the action area, including the Sacramento River and Delta. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into receiving waters. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

8.3 Increased Urbanization

The Delta, East Bay, and Sacramento regions, which include portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo counties, are expected to increase in population by nearly 3 million people by the year 2020 (California Commercial, Industrial, and Residential Real Estate Services Directory 2002). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. For example, the General Plans for the cities of Stockton, Brentwood, Lathrop, Tracy and Manteca and their surrounding communities anticipate rapid growth for several decades to come. City of Manteca (2007) anticipates 21 percent annual growth through 2010 reaching a population of approximately 70,000 people. City of Lathrop (2007) expects to double its population by 2012, from 14,600 to approximately 30,000 residents. The anticipated growth will occur along both the I-5 and US-99 transit corridors in the east and Highway 205/120 in the south and west. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This, in turn, would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the Delta.

8.4 Activities within the Nearshore Pacific Ocean

Future tribal, state and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities are primarily those conducted under state, tribal or Federal government management. These actions may include changes in ocean policy and increases and decreases in the types of activities that currently occur, including changes in the types of fishing activities, resource extraction, or designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to the geographic scope, which encompasses several government entities exercising various authorities, and the changing economies of the region, make analysis of cumulative effects speculative.

A Final Recovery Plan for Southern Resident killer whales was published in 2008 (NMFS 2008a). Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA-listed salmonids, green sturgeon, and Southern Residents, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably certain to occur" in its analysis of cumulative effects.

Private activities are primarily associated with commercial and sport fisheries, construction, and marine pollution. These potential factors are ongoing and expected to continue in the future, and the level of their impact is uncertain. For these reasons, it is not possible to predict beyond what is included in the subsections pertaining to cumulative effects, above whether future non-Federal actions will lead to an increase or decrease in prey available to Southern Resident, or have other effects on their survival and recovery.

9.0 INTEGRATION AND SYNTHESIS OF THE EFFECTS

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of implementation of the proposed action through year 2030. In this section, we integrate effects within a year and across the 21 years of operations, and then add these effects to the baseline (section 5.0) and cumulative effects (section 8.0) to assess whether it is reasonable to expect that the proposed action is <u>not</u> likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution, or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (section 4.0). The *Analytical Approach* (section 2) described the analyses and tools we have used to complete our assessments.

This section is organized by species such that we integrate and synthesize the effects to the species survival and recovery first, and the effects to that species' critical habitat second. For species with multiple populations, such as spring-run and steelhead, populations are organized by diversity groups. The information for the survival and recovery analysis is presented in the following stepwise order: (1) Status of the Species; (2) Future Environmental Baseline to which we will add the effects of the action; (3) Summary of Effects to Individuals; (4) Risk to the Population; and (5) Risk to the ESU. This same general order was used to present the critical habitat analysis, with the exceptions that steps (1) and (2) are combined into one step titled, the

Status of Critical Habitat; and steps (3) and (4) are accomplished in one step titled, Project Effects on Critical Habitat. The last step was used to assess the risk to critical habitat as designated or proposed.

Anderson *et al*. (2009) stated the following:

- NMFS addressed a long list of stressors, but it is not evident which ones NMFS has determined are most important;
- The jeopardy decision tables need to be filled out with key lines of evidence;
- There needs to be a connection between the most important stressors, the determination of jeopardy, and the RPA actions that address those key stressors; and
- Risk needs to be consistently conveyed through examining the range of information regarding a particular stressor or response, and whether the effect is high, medim, or low.

For each CVP-controlled stream, NMFS compiled a table that summarized the stressors and their responses for each population of fish, by species, while following their life cycle in the freshwater environment. For each response, NMFS assigned a relative magnitude of effect (high, medium, or low), which was a qualitative assessment of the likelihood of a fitness consequence occurring. The categories to assign magnitude of risk of stressors that were analyzed were defined as follows:

- High – lethal effect due to stressor that had a broad effect on population at significant frequency
- Medium – between high and low
- Low – generally, sublethal effect, or lethal effect on a very small percentage of one population at a very infrequent interval

NMFS then determined the weight of evidence (high, medium, or low) that it had for the effect. The weight of evidence was based on the best available scientific information, and categorized as follows:

- High certainty – multiple scientific and technical publications, especially if conducted on the species within the area of effect, quantitative data, and/or modeled results; generally from the BA.
- Medium certainty – between high and low
- Low – one study, or unpublished data, or scientific hypotheses that had been articulated but not tested.

High magnitude of effect coupled with high weight of evidence for that effect indicated a greater likelihood of a fitness consequence, whereas a high magnitude of effect with a low weight of evidence provided little certainty of a fitness consequence. The fitness consequences, by life history stage, were considered in context of the status of the species and future environmental baseline, in order to evaluate the effect of the action at the population scale. The summary tables were used to evaluate the effects of the action in the context of the viability parameters of abundance, growth rate, spatial structure, and diversity.

9.1 Sacramento River Winter-Run Chinook Salmon

9.1.1 Status of Sacramento River Winter-Run Chinook Salmon

Historically, independent winter-run populations existed in Battle Creek, and in the Pit, McCloud, and Little Sacramento rivers in the Upper Sacramento River. One-hundred percent of historic winter-run spawning habitat in the upper Sacramento River has been blocked by Shasta and Keswick Dams, resulting in one remaining population, limited to the mainstem Sacramento River. Winter-run no longer inhabit Battle Creek as a self-sustaining population, probably because hydropower operations make conditions for eggs and fry unsuitable (NMFS 1997).

Historical winter-run population estimates, which included males and females, were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run included a high of 17,205 (table 4-2) in 2006, followed by a precipitous decline to about 2,500 cfs in 2007 and about 2,800 fish in 2008.

We used the cohort replacement rate, and also a 5-year running average of the cohort replacement rate, as a representation of population growth rate. When the cohort replacement rate is 1.0, the population is stable and replacing itself. Table 4-2 provides cohort replacement rates since 1986. As shown, the cohort replacement rates from 1995 through 2006 were stable or increasing, indicating a positive growth rate trend. However, in the last 2 spawning seasons, the cohort replacement rate was less than one, which means a short-term decline in population growth rate.

In the most recent status assessment of winter-run, Lindley *et al.* (2007) determined that the winter-run population is at a moderate extinction risk according to PVA, and at a low risk according to other criteria (*i.e.*, population size, population decline, the risk of wide ranging catastrophe, hatchery influence). However, hatchery-origin winter-run from LSNFH have made up more than 5 percent of the natural spawning run in recent years and in 2005, their contribution exceeded 18 percent of the in-river escapement. Lindley *et al*. (2007) recommended that if hatchery-origin fish continued to contribute more than 15 percent of the returning spawners, then the population would be reclassified from low to moderate extinction risk. In addition, data used for Lindley *et al*. (2007) did not include the significant decline in escapement numbers in 2007 and 2008, which are reflected in the population size and population decline, nor the current drought conditions.

Lindley *et al.* (2007) also states that the winter-run ESU fails the "representation and redundancy rule" because it has only one population, and that population spawns outside of the ecoregion in which it evolved. An ESU represented by only one spawning population at moderate risk of extinction is at a high risk of extinction (Lindley *et al*. 2007). A single catastrophe could extirpate the entire Sacramento River winter-run Chinook salmon ESU, if its effects persisted for four or more years. The entire stretch of the Sacramento River used by winter-run is within the zone of influence of Mt. Lassen, an active volcano, which last erupted in 1915. Some other possible catastrophes include a prolonged drought that depletes the cold water storage of Shasta Reservoir or some related failure to manage cold water storage, a spill of toxic materials with effects that persist for four years, or a disease outbreak (Lindley *et al*. 2007).

NMFS concludes that the winter-run ESU remains at a high risk of extinction. Key factors upon which this conclusion is based include: (1) the ESU is composed of only one population, which has been blocked from all of its historic spawning habitat; (2) the ESU has a risk associated with catastrophes, especially considering the remaining population's proximity to Mt. Lassen and its dependency on the coldwater management of Shasta Reservoir; and (3) the population has a "high" hatchery influence (Lindley *et al*. 2007).

9.1.2 Future Baseline of Winter-Run Chinook Salmon Excluding CVP/SWP Effects

This section describes the environmental baseline upon which we will add the effects of the proposed action in order to help assess the response and risk to the species. The general baseline stress regime for Chinook salmon in the freshwater, estuarine, and marine environment is depicted in figure 9-1.

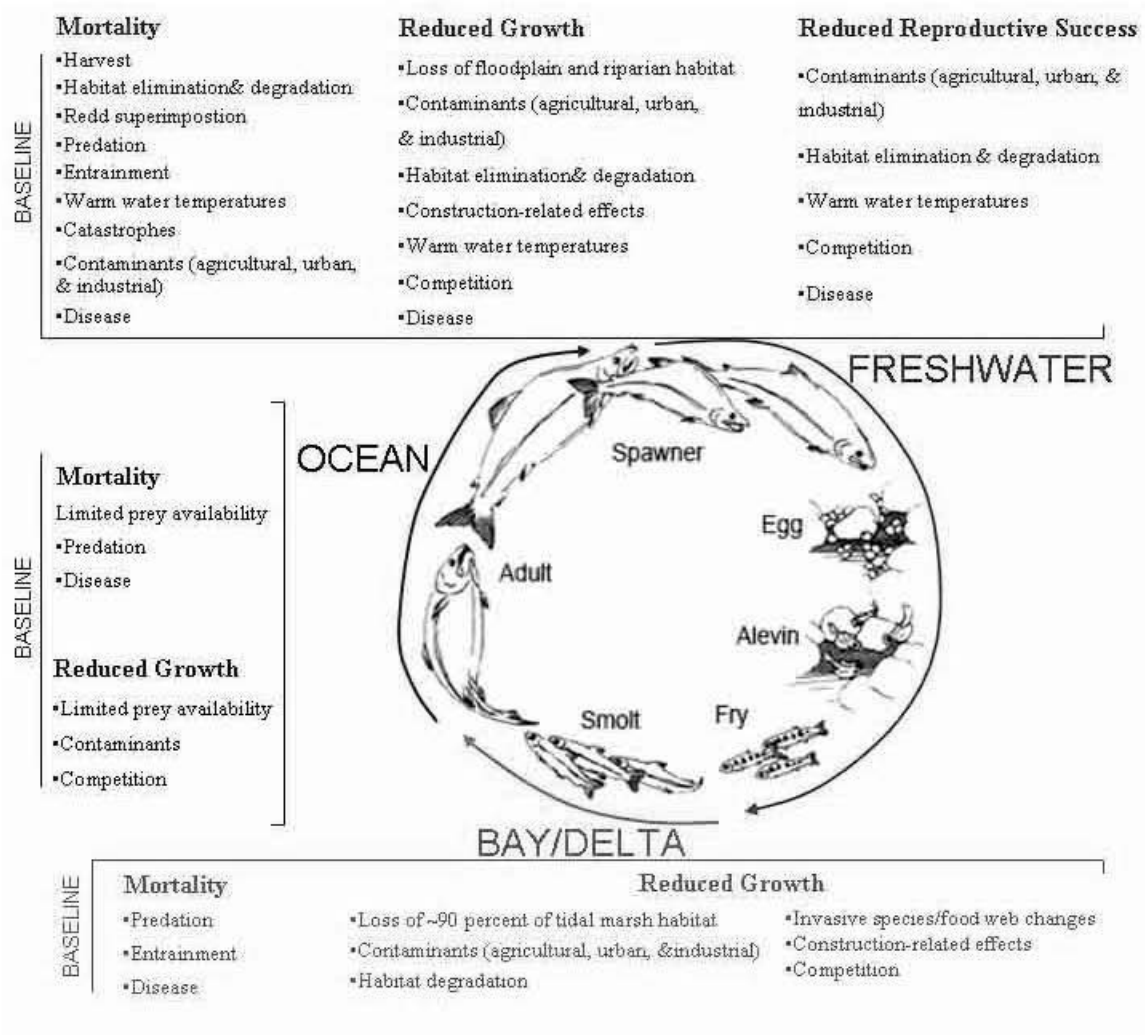


Figure 9-1. Chinook salmon stressors excluding CVP/SWP-related effects (*i.e.*, the figure represents the general baseline stress regime). Chinook salmon are in freshwater during their adult immigration and holding, spawning, egg incubation, alevin, fry, and fingerling life stages. They are in the Bay/Delta as smolts and in the ocean as sub-adults and adults. Although not depicted in the figure, climate change is a baseline stressor expected to exacerbate many of the depicted conditions for anadromous salmonids throughout their

life cycle, particularly with respect to water temperature in all environments, inland hydrology, and ocean productivity (*e.g.*, upwelling).

A key aspect of the baseline stress regime that warrants discussion here is climate change. Lindley *et al*. (2007) summarized several studies (Hayhoe *et al*. 2004, Dettinger *et al*. 2004, Dettinger 2005, VanRheenen *et al*. 2004, Knowles and Cayan 2002) on how anthropogenic climate change is expected to alter the Central Valley, and based on these studies, described the possible effects to anadromous salmonids. Climate models for the Central Valley are broadly consistent in that temperatures in the future will warm significantly, total precipitation may decline, the variation in precipitation may substantially increase (*i.e.*, more frequent flood flows and critically dry years), and snowfall will decline significantly (Lindley *et al*. 2007). Not surprisingly, temperature increases are expected to further limit the amount of suitable habitat available to anadromous salmonids. The potential for more frequent flood flows might be expected to reduce the abundance of populations, as egg scour becomes a more common occurrence. The increase in the occurrence of critically dry years also would be expected to reduce abundance, as, in the Central Valley, low flows during juvenile rearing and outmigration are associated with poor survival (Kjelson and Brandes 1989, Baker and Morhardt 2001, Newman and Rice 2002). In addition to habitat effects, climate change may also impact Central Valley salmonids through community effects. For example, warmer water temperatures would likely increase the metabolism of predators, reducing the survival of juvenile salmonids (Vigg and Burley 1991). Peterson and Kitchell (2001) showed that on the Columbia River, pikeminnow predation on juvenile salmon during the warmest year was 96 percent higher than during the coldest. In summary, climate change is expected to exacerbate existing stressors and pose new threats to Central Valley salmonids by reducing the quantity and quality of inland habitat (Lindley *et al*. 2007).

9.1.3 Summary of Proposed Action Effects on Winter-Run Chinook Salmon

Proposed action-related effects to winter-run are summarized in table 9-1. Detailed descriptions regarding the exposure, response, and risk of winter-run to these stressors are presented in section 6.

As shown in table 9-1, proposed action-related stressors reduce the fitness of individuals in all inland life stages. The cumulative effect of these stressors throughout the life cycle likely has important consequences for the viability of the population, as Naiman and Turner (2000) demonstrated that it is possible to drive a Pacific salmon population to extinction (or to increase population size), by only slight changes in survivorship at each life history stage (see figure 2-3). It is important to recognize that the proposed action directly or indirectly affects the survivorship of each life stage, including fish that do not survive in the ocean because they do not enter the ocean in "top form." In addition, as discussed below, other factors beyond abundance govern the viability of a species and its extinction risk.

Table 9-1. Summary of proposed action-related effects on winter-run.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult Immigration Delta	Dec.-Apr.	DCC gate closures	Winter-run could be delayed in the Delta resulting in greater exposure to both the in-river sport fishery and contaminants (reduced egg fertility or reduced viability and motility of spermatocytes during spawning).	Low	Low - based on limited supporting data	Reduced survival and reduced reproductive success
2	Adult Immigration RBDD	May – Jul.	RBDD gate closures from May 15 - Sept 15 every year until 2019	~15 % of adults delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity; continues every year until 2019	High	High - based on TCCA (2008) and CVP/SWP operations BA, including many historical cited studies	Reduced survival and reduced reproductive success
3	Adult Immigration RBDD	May – Jul.	RBDD emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed; sub lethal effects on eggs in fish and energy loss. These emergency gate closures have occurred twice in the past 10 years and the frequency of occurrence may increase with climate change.	High	High - based on TCCA (2008) and CVP/SWP operations BA	Reduced survival and reduced reproductive success
4	Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year from April 15 to Sept 30	Introgression or hybridization with spring/fall run/late-fall Chinook salmon; loss of genetic integrity and expression of life history	High	Low	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
4	Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year from April 15 to Sept 30	Density dependency - aggressive behavior among spawning fish could cause higher prespawn mortality, increased fighting for suitable spawning sites, adults forced downstream into unsuitable areas	Medium - may increase as abundance increases	Medium	Reduced survival and reduced reproductive success
4	Spawning Primarily upstream of RBDD	Apr. – Aug.	Reduced spawning area from moving TCP upstream in almost every year from April 15 to Sept 30	Redd superimposition - spawning on top of other redds, destroys eggs	Medium - may increase as abundance increases	Low	Reduced egg survival and reduced reproductive success
5	Spawning Primarily upstream of RBDD	Apr. – Aug.	Water temperatures warmer than life history stage requirements below TCP, every year April 15 -Sept 30)	Prespawn mortality; reduced fecundity	High	High - based on CVP/SWP operations BA models and laboratory and hatchery evidence of temperature tolerances	Reduced survival and reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
6	Embryo Incubation Primarily upstream of RBDD	Apr. – Oct.	Water temperatures warmer than life history stage requirements, every year from April 15 - Sept 30. (No carry-over storage target designed for fish protection is included in the proposed action. Without such a target, the risk of running out of coldwater in Shasta Reservoir increases.)	Egg mortality - 16% in critically dry years and increases to 65% in critically dry years with climate change. On average, for all water year types, mortality is 5-12% with climate change and 2-3% without. 56ºF is exceeded at Balls Ferry in 30% of the years in August and 55% of the years in September Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of winter-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	High - based on water temperature and salmon mortality modeling presented in the CVP/SWP operations BA and on scientific literature. Significance of sub-lethal effects cited in Deas *et al*. (2008)	Reduced survival
7	Embryo Incubation Primarily upstream of RBDD	Apr. – Oct.	Flow fluctuations caused by ACID dam installation, 2 x /year, every year in April - November	Redd dewatering and stranding; loss of a portion, or all eggs in redd	Low	High - based on hydrology, but low based on redd surveys and low rate of redd dewatering historically observed	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
8	Juvenile rearing Upstream of and including RBDD	Jul. – Mar.	Water temperatures warmer than life stage requirements	Increased susceptibility to predation and disease	Medium	High - based on modeled water temps presented in CVP/SWP operations BA and scientific literature regarding temperature tolerances (EPA 2001; Myrick and Cech 2001, 2004)	Reduced survival
9	Juvenile rearing Upstream of and including RBDD	Jul. – Mar.	RBDD passage downstream through dam gates May15 - Sept 15	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 10% of winter-run would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	High - based on mortality studies at RBDD and timing of emigration (Vogel *et al.* 1988; Tucker 1998; TCCA 2008)	Reduced survival
10	Juvenile rearing Upstream of and including RBDD	Jul. – Mar.	Lake Red Bluff, river impounded May15 - Sept 15	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967.	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11	Juvenile rearing Upstream of and including RBDD	Jul. – Mar.	Flow fluctuations caused by ACID dam removal in November	Fry standing and juvenile isolation; juveniles killed or subjected to predation and higher temps in side channels. Flow fluctuations from the dam removal occur over a short time period, limiting the exposure to potential fry stranding and juvenile isolation.	Low	High - based on real-time management of dam removal	Reduced reproductive success
12	Juvenile rearing Upstream of and including RBDD	Jul. – Mar.	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency)	Low	High - based on annual monitoring of fish screens	Reduced survival
13	Juvenile rearing/smolt emigration RBDD to Colusa	Sep. – Nov.	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High - based on CVP/SWP operations BA	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
14	Juveniles and smolts RBDD to Colusa	Sep. – Nov.	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on Co-manager review draft of Central Valley Salmon Recovery Plan and CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
15	Juveniles and smolts Colusa to Sacramento	Sep. – Nov.	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few winter-run are expected to be in this area during the fall.	Low	Low - based on lack of monitoring	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
16a-e	Juvenile/ Smolt emigration Delta	Nov. - May	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	During dry and critical years in December and January, modeling estimates of monthly mortality of up to approximately 15% of the total winter-run population entering the Delta at Freeport is associated with exports (Greene 2008). Of those winter-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66% (range of 35-90% mortality). This equates to approximately 5-20% of the total population entering the Delta at Freeport. Anticipated delays in migration due to export operations.	High	Low to High (see below) 15% mortality estimates are from DWR PTM modeling (Greene 2008) Delta interior mortality estimated from acoustic tagging studies (Vogel 2003; Horn and Blake 2004; Perry and Skalski 2008; Vogel 2008a)	Reduced survival
16a	Juvenile/ Smolt emigration Delta	Nov. - May	DCC operations - open gate configurations from November through January	Increased vulnerability of entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Open gate configuration in December and January exposes approximately 45% of the winter-run population estimated at Knights Landing to risk of diversion into the interior Delta	High	High – Numerous studies *i.e.*, Delta Action 8, DCC, and Delta Interior experiments confirm low survival of fish entrained into the delta interior. Acoustic tagging studies provide similar conclusions for survival within the Delta interior	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
16b	Juvenile/ Smolt emigration Delta	Nov. - May	Loss in Delta interior	Diversion of emigrating fish into the delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Island) are observed for fish migrating through the Delta interior. Loss of up to 15% of winter-run population entering the Delta	High	High – numerous studies find similar high loss rates for fish relased in the Delta interior.	Reduced survival
16c	Juvenile/ Smolt emigration Delta	Nov. - May	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately two thirds of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85% of the exposed fish. The percentage of the population exposed is variable, typically less than 2-3%, and frequently is much lower (0.5%) based on salvage recovery estimates. Percentage of population actually arriving at the export facilities and entering the salvage process is low.	Low	High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations survival	Reduced survival
16d	Juvenile/ Smolt emigration Delta	Nov. - May	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on salmon as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta	High	Low to Medium. Invasion of non-native species into delta is well documented, interaction with salmonid populations less well documented	Reducted survival, Reduced growth

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
16e	Juvenile/ Smolt emigration Delta	Nov. - May	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, *etc*.). Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics well studied. Effects of Delta hydrodynamics on organisms relatively unstudied	Reduced survival, reduced growth

9.1.4 Assess Risk to the Population

Population viability is determined by four parameters: spatial structure, diversity, abundance, and productivity (growth rate). Both population spatial structure and diversity (behavioral and genetic) provide the foundation for populations to achieve abundance levels at or near potential carrying capacity and to achieve stable or increasing growth rates. Spatial structure on a watershed scale is determined by the availability, diversity, and utilization of properly functioning conditions (habitats) and the connections between such habitats (McElhany *et al*. (2000). Properly functioning condition defines the inland habitat conditions necessary for the long-term survival of Pacific salmon populations (McElhany *et al*. (2000). As described in section 6, habitat conditions in the Sacramento River and Delta are adversely affected by the proposed action in a number of ways, including, but not limited to: (1) delaying adult immigration through RBDD operations; (2) moving the TCP upstream during spawning and embryo incubation; (3) creating conditions favorable for predators as juveniles migrate downstream of RBDD during the gates in period; (4) pulling more water and juvenile salmon into the Central and South Delta; and (5) changing the Delta from a variable salinity system to one that is predominantly freshwater. In these ways, the proposed action reduces the population's current spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the winter-run population, and consequently the ESU.

The diversity of winter-run continues to be limited as a result of the proposed action. The release of cold water to accommodate adult winter-run migration, holding, spawning, and egg incubation is predictable, beginning and ending on specific dates, leaving little room for variability in both the run and spawn timing within the species, both of which have been identified as key diversity traits (McElhany *et al*. 2000).

In addition, the diversity of winter-run is reduced by proposed operations due to effects which truncate the timing of particular life stages. RBDD (gates down) delays up to approximately 15 percent of the adults, some of which suffer pre-spawn mortality or have reduced spawning success. This delay at RBDD effectively reduces the numbers of potentially fit spawners from the tail end of the spawning population, thereby reducing genetic and life history diversity. In addition, while the gates are still down, RBDD results in the increased mortality of the first 10 percent of the juveniles outmigrating, thereby truncating the first part of the outmigration period. Furthermore, a portion of winter-run smolts are expected to be entrained into the Central and South Delta through the DCC when the gates are open during the November 1 through January 31[19] time frame. Our analysis in section 6.6, above, shows that the survival of winter-run juveniles is considerably lower through the Central and South Delta than if the juveniles stayed within the mainstem Sacramento River. The lower survival rates of the juveniles through the Central and South Delta are attributable to the direct and indirect effects of the Federal and State pumps. Because the DCC is open during the beginning of the winter-run smolt outmigration period, entrainment of juveniles through the DCC again truncates the first part of the outmigration period of smolts. The near term and future operations would likely result in more of the Sacramento River being diverted to the Central and South Delta through the DCC, thereby resulting in increased entrainment (and subsequent mortality) of winter-run smolts during the early part of their outmigration period. Thus, the combined effects of RBDD gates down and

[19] D-1641 provides for a 45-day discretionary closure of the DCC gates from November 1 though January 31.

DCC gates open result in constricting the period of survival of winter-run during their inland residency (figure 9-2).

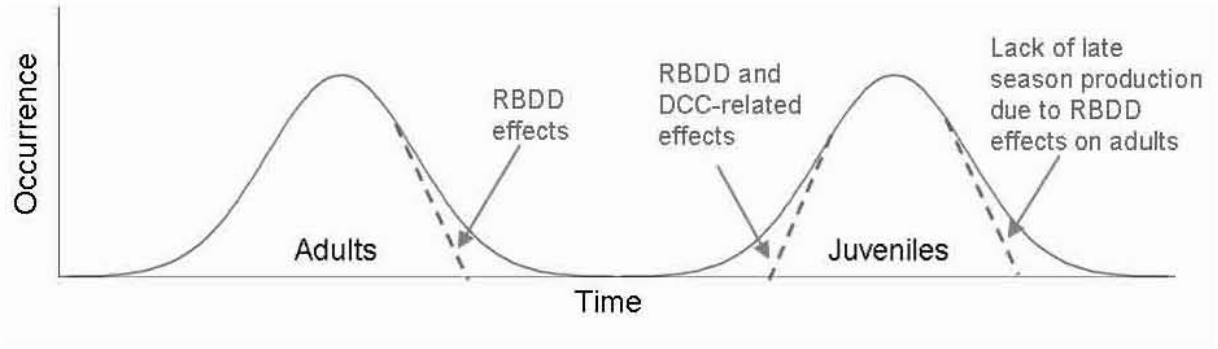


Figure 9-2. General depiction of proposed action-related effects on the temporal distribution of adult and juvenile winter-run during their inland residency. Winter-run adults delayed or blocked by RBDD during the late portion of their spawning run effectively reduces their occurrence on the spawning grounds, which reduces overall production during this time period. This has a negative impact on the spawning success of winter-run that have not migrated upstream of RBDD after the gates are down, which consequently limits the potential for juvenile production during the late part of this life stage period. Juvenile production also is limited during the early part of this life stage period by RBDD- and DCC-related effects.

The timing of winter-run smolt ocean entry, coupled with the timing, location, and magnitude of ocean upwelling and related prey availability, is critical to the growth and survival of these fish. Research suggests that juvenile Chinook salmon that migrate from natal rearing areas during the early part of this life stage period enter the ocean earlier than juveniles that leave during the later part of the life stage period (MacFarlane and Norton 2002, MacFarlane *et al*. 2008). Put another way, Chinook salmon that are spawned first, are generally the ones that hatch, emerge, rear, and migrate to the ocean first. As the timing of winter-run ocean entry is constricted by the proposed action, the probability that smolts will enter an ocean environment with favorable conditions for growth and survival decreases because ocean productivity often varies considerably within one season (Lenarz *et al*. 1995). A wider temporal distribution of ocean entry increases the chance that at least some smolts will enter a productive ocean. As described in Lindley *et al*. (2009), the proximate cause of a recent collapse in fall-run was that the 2004 and 2005 brood years entered the ocean during a period of low ocean productivity[20]. One recommendation by those authors to improve the resiliency of fall-run is to increase the stock's diversity by evaluating hatchery practices that increase the variation in timing of ocean entry.

In addition to impacts to the spatial structure and diversity, the proposed action is expected to result in substantial mortality to winter-run as a combined result of: (1) delays at RBDD during adult immigration resulting in prespawn mortality; (2) moving the TCP upstream during embryo incubation, thereby exposing eggs that were incubating downstream of the adjusted TCP at water temperatures at or below the upper limit for optimal survival (*i.e*., 56° F) to water temperatures associated with higher egg mortality; (3) increasing predation of juveniles when the RBDD gates are down; (4) entraining juveniles into the Central and South Delta (figure 9-3); (5) entraining

[20] Lindley *et al*. (2009) state that the rapid and likely temporary deterioration in ocean conditions is acting on top of a long-term, steady degradation of the freshwater and estuarine environment.

and impinging juveniles at the pumps (both direct and indirect loss); and (6) loss associated with the CHTR program.

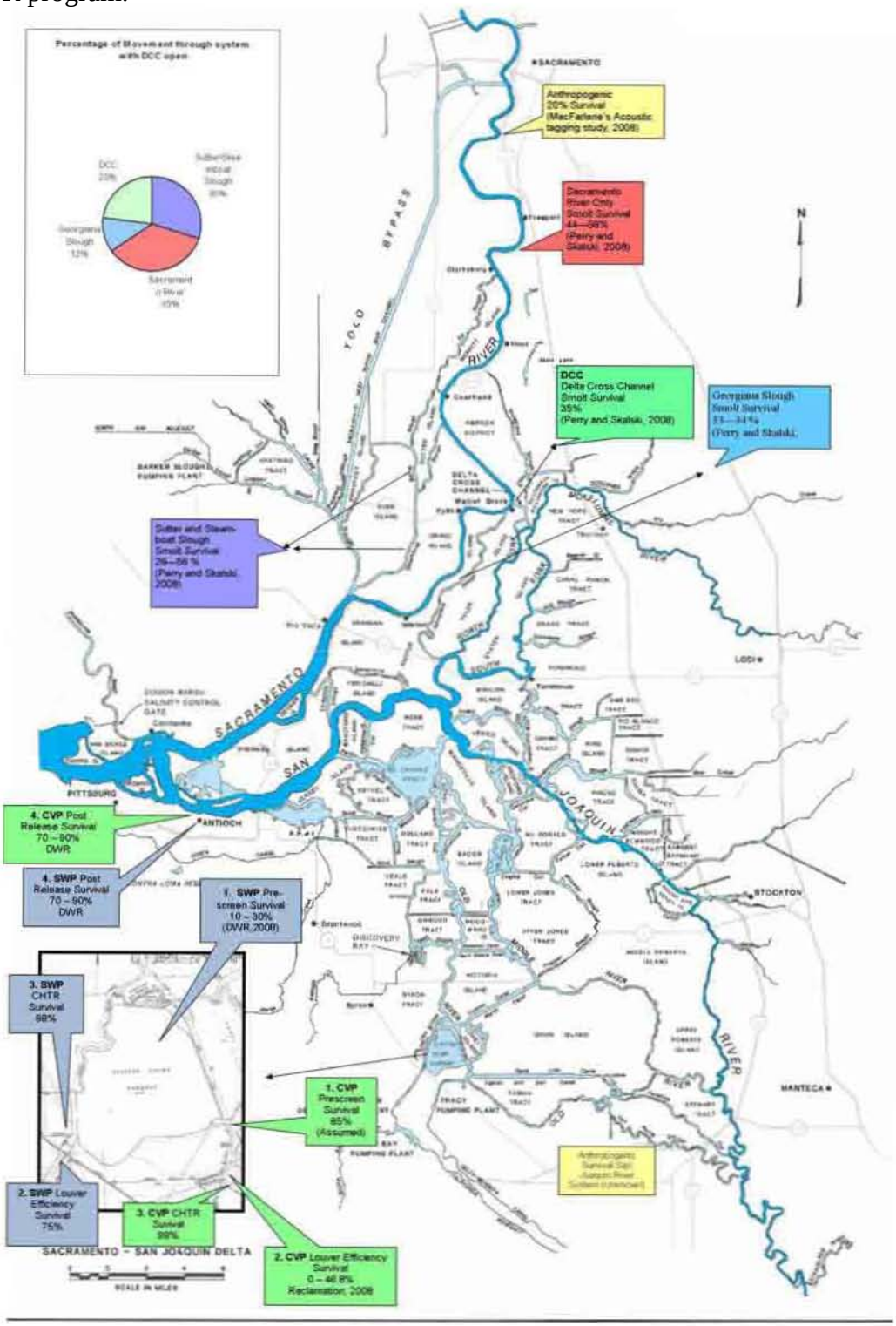


Figure 9-3. Relative magnitude and location of juvenile salmonid survival throughout the Delta.

The cumulative effect of proposed action-related mortality at multiple life stages every year, continues to increase the extinction risk of the winter-run population. Furthermore, most of this mortality is expected to occur during the juvenile and smolt life stages prior to ocean entry – a key transition in the life cycle that has been shown to be most limiting to salmon production in the Central Valley (Bartholow 2003) and in other systems (Wilson 2003). Results from a recent study indicate that about 80 to 90 percent of Chinook salmon juveniles die when migrating from the mainstem Sacramento River near Battle Creek through the San Francisco Estuary (Delta, Suisun, San Pablo, and San Francisco bays; MacFarlane *et al*. 2008). This range was derived from an acoustic tagging study of hatchery-produced late fall-run released as smolts. Mortality of naturally-produced winter-run, which must avoid predators immediately upon emerging from spawning gravels as fry, is most likely higher than that reported for the late fall-run smolts because of size-related differences in vulnerability to predation (*i.e*., fry are more vulnerable to predation than smolts).

All of the above factors which reduce the spatial structure, diversity, and abundance of winter-run, further compromise the capacity of this population to respond and adapt to environmental changes. Future projections over the duration of the proposed action (*i.e*., through 2030), considering both increasing water demands and climate change, exacerbate risks associated with the proposed action, further increasing the risk to the population.

In the Sacramento River, comparing climate change scenarios (Study 9.0 base vs Study 9.5 drier, more warming) shows that average winter-run mortality increases from 15 percent to 25 percent. EOS carryover storage at Shasta is less than 1.9 MAF during average dry years (1928 to 1934) in all scenarios except Study 9.2 wetter, less warming (CVP/SWP operations BA table 9-23). Under these conditions, winter-run would experience a loss of spawning habitat, as water temperatures below dams becomes harder to control and the cold water pool in Shasta diminishes.

At the population level, the added impacts of the proposed action with climate change in the future baseline decreases adult abundance for all listed fish species. Crozier *et al*. (2008) predicted the probability of quasi-extinction in 4 populations of Snake River spring/summer Chinook salmon using a life-cycle model for the 2040 timeframe. They found that mean Chinook salmon population size decreased from 20-37 percent in the more moderate climate scenarios (1.77^{o}C rise in average temperature) to 37-50 percent in the hottest and driest scenarios (2.6^{o}C warming). Lower flows in October and higher temperatures caused parr-to-smolt survival to decline from 18-19 percent in the more moderate scenario to 34-35 percent in the drier scenario. Although density-dependent processes compensated for declines in par-to-smolt survival, the probability of extinction still fell below the critical thresholds. Population growth rate (lamda) declined under all climate change scenarios. The risk of dropping below the lowest historical level of abundance shifted from a range of 6-36 percent in the current climate to 54-86 percent in the drier hotter climate. Maintaining habitat diversity could potentially help buffer against the impacts of climate change (Lindley *et al*. 2009).

9.1.5 Assess Risk to the Sacramento River Winter-Run Chinook Salmon ESU

Because winter-run is solely composed of one population, the risks to this population described in the previous section represent the risks to the ESU. As previously stated, the winter-run ESU is currently at a high risk of extinction in large part because: (1) the ESU is composed of only one population, which has been blocked from all of its historic spawning habitat; (2) the ESU has a risk associated with catastrophes, especially considering the remaining population's proximity to Mt. Lassen and its dependency on the coldwater management of Shasta Reservoir; and (3) the population has a "high" hatchery influence (Lindley *et al*. 2007). The proposed action does not improve any of these factors; it increases the population's extinction risk by adding numerous stressors on top of to the species' baseline stress regime, as is generally depicted in figure 9-4. With implementation of the proposed action, winter-run will have to cope with these additional stressors, which will adversely affect each life stage throughout the species' life cycle every year for the next 21 years. NMFS expects that the adverse affects will increase as the proposed action advances to full build out. Most winter-run exhibit a 3-year life cycle, indicating that seven generations of winter-run will be affected by the proposed action.

Given the evidence of the reduction in numbers, reproduction and/or distribution of the species, NMFS concludes that Reclamation has not ensured that the proposed action is not likely to appreciably reduce the likelihood of viability, and therefore the likelihood of both the survival and recovery of the Sacramento River winter-run Chinook salmon ESU (table 9-2).

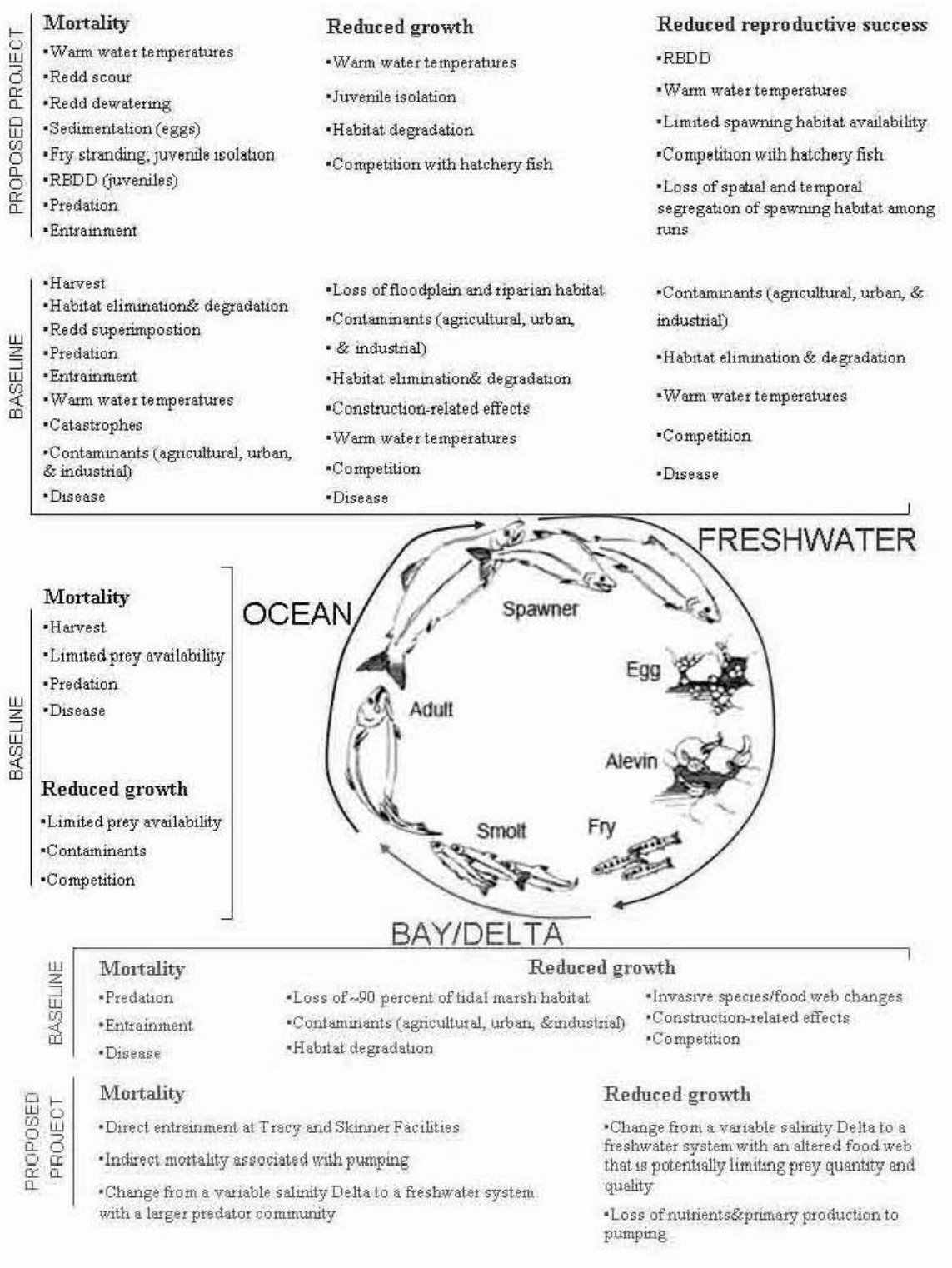


Figure 9-4. Chinook salmon stressors, both baseline and those that will result from the proposed action. Chinook salmon are in freshwater during their adult immigration and holding, spawning, egg incubation, alevin, fry, and fingerling life stages. They are in the Bay/Delta as smolts and in the ocean as sub-adults and adults. Although not depicted in the figure, climate change is a baseline stressor expected to exacerbate the depicted conditions for anadromous salmonids throughout their life cycle, particularly with respect to water temperature in all environments, inland hydrology, and ocean productivity (*e.g.*, upwelling).

Table 9-2. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Sacramento River Winter-Run Chinook Salmon ESU. Application of Key Evidence is Provided in Italics. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Not Likely/Likely to Jeopardize (NLJ/LJ).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River;; and (4) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants).*	True	End
		False	Go to B
B	**Winter-run are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to delay ~15% of winter-run adults migrating upstream; ~10% of winter-run juveniles emigrating past RBDD would be exposed to greater predation. (2) All freshwater life stages of winter-run will be exposed to regulated Sacramento River flows and their effects on river processes and morphology every year through 2030. (3) Each year through 2030, winter-run are expected to be exposed to water temperatures warmer than life stage requirements during spawning, egg incubation, and juvenile rearing and outmigration. (4) As water is moved from the north Delta to the export facilities in the south Delta, each year through 2030, winter-run juveniles will have increased exposure to an abundant predator community, an aquatic environment degraded by pesticides and contaminants, and direct entrainment at the Federal and State pumping plants.*	True	NLAA
		False	Go to C
C	**Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Delayed upstream migration at RBDD causes individual adults to consume more energy, which limits the amount of energy available for reproduction, resulting in the deposition of fewer and/or less viable eggs. Mortality of juvenile salmon migrating downstream past RBDD reportedly ranges from 5 to 50%. (2) Loss of natural river function resulting from flow regulation has reduced the quality and quantity of rearing and migratory habitats, thereby reducing the growth and survival of individual winter-run juveniles. (3) Egg mortality resulting from exposure to warm water temperatures is expected to range up to 65% in critically dry years with climate change. Individuals are expected to experience sub-lethal effects due to warm water temperatures during the spawning, embryo incubation, and juvenile rearing life stages. (4) Mortality of winter-run juveniles that enter the Delta interior is expected to range from 35 to 90 %, resulting in the loss of approximately 5-20 percent of the entire ESU.*	True	NLAA
		False	Go to D
D	**Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed.** *Key Evidence: (1) The reduction in energy available for egg production associated*	True	NLAA

	with delayed upstream migration at RBDD reduces the fitness of individuals by reducing their reproductive capacity. (2)"Take"of winter-run individuals in the form of reduced growth and survival is expected due to the loss of natural river function associated with flow regulation. (3) and (4) As described in step C, "take" of winter-run individuals, in the form of mortality, is expected particularly during the egg incubation (water temperature effects) and juvenile rearing/smolt emigration (predation and entrainment in the Delta) life stages.	False	Go to E
E	**Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent.** *Key Evidence: The cumulative effects of RBDD operations, flow regulation, warm water temperatures, project-related impacts in the Delta, and other project-related stressors (see table 9-1) are expected to sufficiently reduce the survival and/or reproductive success of winter-run individuals at multiple life stages every year through 2030 such that key population parameters (i.e., spatial structure, diversity, and abundance) will be appreciably reduced (see section 9.1.4 Assess Risk to the Population). Reductions in these parameters over the next 21 years will likely reduce the viability of the population.*	True	NLJ
		False	Go to F
F	**Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species.** *Key evidence: The winter-run ESU is solely composed of the Sacramento River population. Therefore, because the viability of this population is expected to be reduced by stressors related to the proposed Action, the viability of the species also is expected to be reduced.*	True	NLJ
		False	LJ

9.2 Sacramento River Winter-Run Chinook Salmon Critical Habitat

9.2.1 Status of Sacramento River Winter-Run Chinook Salmon Critical Habitat

As described in section 4.2.1.2.4.3, winter-run critical habitat is composed of seven physical and biological features that are essential for the conservation of winter-run. All of those physical and biological features can be characterized as suitable and necessary habitat features that provide for successful spawning, rearing, and migration. Therefore, we will be evaluating the effect of the proposed action in terms of its effect on spawning and rearing habitat and migratory corridors.

Currently, many of the physical and biological features that are essential for the conservation of winter-run are impaired, and provide limited conservation value. For example, when the gates are in, RBDD reduced the value of the migratory corridor for upstream and downstream migration. Unscreened diversions throughout the mainstem Sacramento River, and the DCC when the gates are open during winter-run outmigration, do not provide a safe migratory corridor to San Francisco Bay and the Pacific Ocean.

In addition, the annual change in TCP has annually degraded the conservation value of spawning habitat by reducing the amount of spawning habitat based on preferred spawning water temperature (56°F). The current condition of riparian habitat for winter-run rearing is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system. However, some complex, productive habitats with floodplains remain in the system (*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa) and flood bypasses (*i.e.*, Yolo and Sutter bypasses).

Based on the impediments caused by RBDD (gates in), unscreened diversions, DCC (gates open during the winter-run outmigration period), and the degraded condition of spawning habitat and riparian habitat, the current condition of winter-run critical habitat is degraded, and does not provide the conservation value necessary for the recovery of the species.

9.2.2 Project Effects on Sacramento River Winter-Run Chinook Salmon Critical Habitat

Critical habitat for winter-run is comprised of physical and biological features that are essential for the conservation of winter-run, including freshwater spawning sites, rearing sites, and migration corridors to support one or more life stages of winter-run. As summarized below, the conservation value of critical habitat throughout the Sacramento River from Keswick Dam to the Delta (302 miles) will be degraded by the proposed action.

9.2.2.1 Spawning Habitat

As future water demands increase, and in consideration of climate change scenarios, potential spawning habitat will be consistently reduced by temperature control to smaller and smaller areas below Keswick Dam as Reclamation's ability to provide spawning habitat necessary for the conservation of the species will be reduced. The value of spawning habitat is also reduced by flow fluctuations twice a year every year to install and remove the ACID diversion dam. These sudden drops in flow degrade successful spawning, incubation, and larval development by reducing and dewatering some of the available habitat.

9.2.2.2 Rearing Habitat

The value of rearing habitat will continue to be degraded as hydrologic conditions resulting from operations favor the proliferation of introduced non-native warm water predators of juvenile salmonids.

Reclamation will continue to operate RBDD (modification of 6 miles of free-flowing riverine habitat to lake-like habitat) and the ACID diversion dam (modification of 3 miles of free-flowing riverine habitat to lake-like habitat) for 4 to 6 months of every year. Food supply, shelter, and cover will continue to be reduced during the 4 months that the gates are in. In the future full build out scenario, the value of rearing habitat will improve when the gates are out for up to 10 months of each year. However, stranding and isolation in sloughs adjacent to the lake would still occur, and riparian habitat will not likely establish.

9.2.2.3 Migratory Corridors

The value of upstream and downstream migratory corridors will continue to be degraded as a result of the continued operation of RBDD and the ACID diversion dam, which preclude unobstructed passage. The creation of Lake Red Bluff results in the reduction in value of rearing habitat and degradation of 15 miles of shoreline that slows down flows, inundates riparian areas, and increases habitat for warm water predators. The value of the migratory corridor will also continue to be degraded when the RBDD gates come out in September and cause stranding and isolation in sloughs adjacent to the lake. In the future full build out scenario (2030, which we

assume the effects will be realized starting in year 2019), the 10-month gates out and 2-month (which is really 2½ months) gates in scenario will improve the value of the migratory corridor by providing unobstructed passage.

During outmigration, the DCC, when the gates are open, continues to degrade the value of the mainstem Sacramento River as a migratory corridor by entraining a portion of the outmigrating juveniles into the Central Delta, where survival and successful outmigration to the Pacific Ocean is lower than if the juveniles remained in the main migratory corridor of the Sacramento River. The proposed action exacerbates this problem by altering water movement through the Sacramento River and Delta such that water in the north part of the Delta (*e.g.*, immediately upstream of the DCC) is pulled southward towards the Federal and State pumping plants through the DCC and/or Georgiana Slough.

9.2.3 Assess Risk to the Winter-Run Chinook Salmon Critical Habitat

Many of the physical and biological features that are essential for the conservation of winter-run are currently degraded. As a result of implementing the proposed action, some of those physical and biological features will likely remain the same, which will keep their conservation value low. However, the conservation value of many of the physical and biological features will likely be further degraded. For example, the proposed action will further degrade the value of spawning, rearing, and migratory habitat. Reoperation of RBDD in the future full build out scenario, so that the gates are down for 2½ months instead of the 4-month near-future (*i.e.*, 2009-2019) scenario, will slightly improve the value of rearing and migratory habitat. However, the conservation value of these habitats will remain degraded by other stressors related to both the proposed action and the baseline (see figure 9-4).

The effects of the proposed action under climate change scenarios would likely further degrade the value of spawning and rearing habitat by increasing water temperatures. Cold water in Shasta Reservoir will run out sooner in the summer, degrading winter-run spawning habitat, and the value of rearing habitat would likely be further degraded by juveniles emigrating earlier, encountering thermal barriers sooner, and be subjected to predators for longer periods of time. Juveniles that do not emigrate earlier will likely congregate in areas of cold water refugia, like in the few miles below dams where competition for food, space, and cover would be intense.

Based on the analysis of available evidence, NMFS concludes that the proposed action is likely to reduce the conservation value of the critical habitat, as designated, for the conservation of Sacramento River winter-run Chinook salmon (table 9-3).

Table 9-3. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Sacramento River Winter-Run Chinook Salmon Designated Critical Habitat. Application of Key Evidence is Provided in Italics. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct of indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the*	True	End

	environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River; and (4) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants).	False	Go to B
B	**Areas of designated critical habitat are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, the migratory corridor for winter-run adult immigration and juvenile emigration is expected to be affected by RBDD operations; rearing habitat will be affected by the formation of Lake Red Bluff. (2) Holding, spawning, rearing, and migratory habitats in the Sacramento River will be exposed to regulated flows and their effects on river processes and morphology every year through 2030. (3) Each year through 2030, winter-run spawning, egg incubation, and juvenile rearing habitats are expected to be affected by water temperatures warmer than life stage-specific requirements. (4) Each year through 2030, as water is moved from the north Delta through the DCC towards the pumping plants in the south Delta, a portion of outmigrating winter-run juveniles will be entrained into the central Delta, where survival and successful outmigration to the Pacific Ocean is expected to be lower than if the juveniles remained in the main migratory corridor of the Sacramento River.*	True	NLAA
		False	Go to C
C	**The quantity, quality, or availability of all constituent elements of critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations will reduce the quality of habitat for winter-run adult immigration and juvenile emigration, as well as the quality and quantity of rearing habitat through the formation of Lake Red Bluff. (2) Loss of natural river function resulting from flow regulation has reduced the quality and quantity of rearing and migratory habitats. (3) Each year through 2030, the provision of water temperatures warmer than life stage-specific requirements will reduce the quantity and quality of winter-run spawning, egg incubation, and juvenile rearing habitats. (4) Each year through 2030, the quality of migratory habitats is reduced by entraining juvenile winter-run into low quality rearing/migratory habitat in the central Delta.*	True	NLAA
		False	Go to D
D	**Any reductions in the quantity, quality, or availability of one or more constituent elements of critical habitat are not likely to reduce the conservation value of the exposed area.** *Key Evidence: Reductions in the conservation value of migratory, spawning, and rearing habitats are expected due to reductions in the quantity, quality, or availability of critical habitat constituent elements resulting from RBDD operations, flow regulation, the provision of water temperatures in the Sacramento River warmer than life stage-specific requirements, and the movement of water towards the Federal and State pumping plants.*	True	NLAA
		False	Go to E
E	**Any reductions in the conservation value of the exposed area of critical habitat are not likely to reduce the conservation value of the critical habitat designation.** *Key Evidence: Because the conservation value of all inland habitat types (migratory, spawning, and rearing) necessary to complete the salmon life cycle are expected to be reduced with implementation of the proposed Action, it is likely that the conservation value of the critical habitat designation will also be reduced.*	True	No AD MOD
		False	AD MOD

9.3 Central Valley Spring-Run Chinook Salmon ESU

In this section, we describe how the proposed action is expected to affect the likelihood of survival and recovery of the Central Valley spring-run Chinook salmon ESU by summarizing how project operations will affect each extant spring-run population. We will first summarize the status of the Central Valley spring-run Chinook salmon ESU. Next, within each diversity group, the risk to each population will be assessed by considering its status, baseline stress regime, and how the proposed action is expected to affect individuals of the population throughout their life cycle.

The risk to the species will be assessed by considering the risk of the various diversity groups and populations. As stated in the Analytical Approach, if appreciable reductions in any population's viability are expected to result from implementation of the proposed action, then this would be expected to appreciably reduce the likelihood of both the survival and recovery of the diversity group the population belongs to, as well as the listed ESU/DPS. This assumption is based on the recommendation from the TRT that every extant population is necessary for the recovery of the species (Lindley *et al.* 2007). NMFS interprets this assumption to indicate that an increase in the extinction risk of one or more of the populations increases the extinction risk of the species.

9.3.1 Status of Central Valley Spring-Run Chinook Salmon ESU

Lindley *et al*. (2007) stated that perhaps 15 of the 19 historical (independent) populations of spring-run are extinct, with their entire historical spawning habitats behind various impassable dams. Those authors only considered Butte, Deer, and Mill creeks as watersheds with persistent populations of Chinook salmon confirmed to be spring-run, although they recognized that Chinook salmon exhibiting spring-run characteristics persist within the Feather River Hatchery population spawning in the Feather River[21] below Oroville Dam and in the Yuba River below Englebright Dam. The populations in butte, Deer, and Mill creeks and in the Feather and Yuba rivers fall within the Northern Sierra Nevada diversity group. Butte and Deer creek spring-run populations are at low risk of extinction, and the Mill Creek population is at either a moderate of low risk (Lindley *et al*. 2007). Other spring-run populations seem to persist in this diversity group in Antelope and Big Chico creeks, albeit at an annual population size in the tens or hundreds of fish, with no returning spawners in some years.

In addition, populations of spring-run may occur in the Basalt and Porous lava diversity group in the mainstem Sacramento River[22] and in Battle Creek, although, similar to the Antelope and Big Chico Creek population, these populations are made up of only tens or hundreds of fish. These populations are presumably dependent on strays from other populations, although the extent of

[21] An analysis of the proposed action effects on Feather River spring-run will be covered in a separate Opinion related to the relicensing of Oroville Dam.

[22] The presence of Keswick and Shasta dams has resulted in a spatial and temporal overlap of spring-run and fall-run spawning. Considerable hybridization between these runs has occurred. Genetic analyses of early-returning Chinook salmon in the mainstem Sacramento River have not been conducted. Without specific genetic information to consider, for the purposes of this Opinion, NMFS assumes that the Chinook salmon exhibiting spring-run behavior (*e.g.*, upstream migration during spring and spawning during early fall) in the mainstem Sacramento River represent a distinct spring-run population. This assumption is supported by a recent study of Central Valley steelhead genetics, which generally indicated that run timing remains an important factor in describing genetic structure in the Central Valley (Garza and Pearse 2008).

this dependency is not known. Lindley *et al.* (2007) concluded that these populations are entirely composed of strays, as those authors stated that the spring-run have been extirpated from the entire diversity group.

Ephemeral populations are found in the Northwestern California Diversity Group in Beegum and Clear creeks, and salmon have been observed in Thomes Creek during the spring, although monitoring in that creek has not been conducted consistently due to poor access and difficult terrain. Returning adult spring-run population sizes in Beegum and Clear creeks have generally ranged from tens up to a few hundred fish. Habitat restoration in Clear Creek has improved conditions for spring-run and the population has been responding positively to these improvements.

With the exception of Clear Creek, the Sacramento River, and the Feather River, the proposed action does not affect spring-run within the above listed tributaries. However, spring-run produced in all of these tributaries are affected by the proposed action as they migrate, hold, or rear within the Sacramento River and Delta.

Historically, the majority of spring-run in the Central Valley were produced in the Southern Sierra Nevada Diversity Group, which contains the San Joaquin River and its tributaries. All spring-run populations in this diversity group have been extirpated (Lindley *et al*. 2007).

With demonstrably viable populations in only one of four diversity groups that historically contained them, spring-run fail the representation and redundancy rule for ESU viability (Lindley *et al*. 2007). The current distribution of viable populations makes spring-run vulnerable to catastrophic disturbance. All three extant independent populations are in basins whose headwaters occur within the debris and pyroclastic flow radii of Mt. Lassen, an active volcano that the USGS views as highly dangerous (Hoblitt *et al*. 1987). The current ESU structure is, not surprisingly, also vulnerable to drought. Even wildfires, which are of much smaller scale than droughts or large volcanic eruptions, pose a significant threat to the ESU in its current configuration. A fire with a maximum diameter of 30 km, big enough to burn the headwaters of Mill, Deer and Butte creeks simultaneously, has roughly a 10 percent chance of occurring somewhere in the Central Valley each year (Lindley *et al*. 2007).

9.3.2 Future Baseline of Central Valley Spring-Run Chinook Salmon Excluding CVP/SWP Effects

This section describes the environmental baseline upon which we will add the effects of the proposed action in order to help assess the response and risk to the species. Habitat elimination and degradation has been a primary factor causing the threatened status of spring-run in the Central Valley. Physical habitat modifications (*e.g*., dam construction and river straightening and associated riprap applications) and other anthropogenic and natural effects in freshwater, estuarine, and marine environments have greatly diminished the viability of the ESU, and continue to do so. These baseline stressors are similar to those that affect winter-run (see figure 9-1) and include harvest, predation, water management, agricultural, urban, and industrial land use, competition, and invasive species and associated food web changes.

9.3.3 Northwestern California Diversity Group

9.3.3.1 Clear Creek Spring-Run Chinook Salmon

9.3.3.1.1 Status of Clear Creek Spring-Run Chinook Salmon

Spring-run are increasing in abundance in Clear Creek due to habitat restoration funded by CALFED and the CVPIA, including the removal of McCormick-Saeltzer Dam, habitat restoration, gravel augmentation, temperature control and increased flows. The spring-run population in Clear Creek has gone from zero to about a few hundred adults annually in the last 12 years. Most of the spring-run are descendents from introduced Feather River Hatchery stock in the 1990s.

Although the abundance of Clear Creek spring-run has been increasing over the last decade, it is still at an abundance level that makes the population vulnerable to extirpation from demographic stochasticity - seemingly random effects of variation in individual survival or fecundity with little or no environmental pressure (Shaffer 1981, Allendorf *et al*. 1997, McElhany *et al*. 2000). As such, the population would fall into the high risk of extinction category based on abundance, as described in Lindley *et al*. (2007, see table 4-3).

9.3.3.1.2 Future Baseline of Clear Creek Spring-Run Chinook Salmon Excluding CVP/SWP Effects

The general baseline stress regime for Clear Creek spring-run in freshwater, estuarine, and the marine environment is depicted in figure 9-1. More specifically, baseline stressors within Clear Creek include Whiskeytown Dam blocking access to historic habitat (Yoshiyama *et al*. 1996), a lack of natural recruitment of spawning gravels and a lack of suitable habitat during the summer for juvenile rearing and adult holding. The dam forces spring-run to hold and spawn at a relatively low elevation in habitats that were not historically used for those life stages. The dam also limits the availability of spawning gravels, and as such, the availability of spawning habitat.

9.3.3.1.3 Summary of Proposed Action Effects on Clear Creek Spring-Run Chinook Salmon

Proposed action-related effects to spring-run within Clear Creek are summarized in table 9-4. Detailed descriptions regarding the exposure, response, and risk of spring-run to these stressors are presented in section 6.2.

Table 9-4. Summary of proposed action-related effects on Clear Creek spring-run.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult immigration Delta	Mar. – Sep.	DCC gate closures	Spring-run could be delayed in the Delta resulting in greater exposure to both the in-river sport fishery and contaminants (reduced egg fertility or reduced viability and motility of spermatocytes during spawning).	Low	Low - based on limited supporting data	Reduced survival and reduced reproductive success
2	Adult immigration RBDD	Mar. – Sep.	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) force fish to use inefficient ladders	~72 % of the spring-run that spawn upstream of RBDD are delayed by approximately 20 days on average, more energy consumed, greater pre-spawn mortality, less fecundity	High	High - based on TCCA EIS/EIR on RBDD and CVP/SWP operations BA, including many historical cited studies	Reduced reproductive success
3	Adult immigration Clear Creek	Mar. – Sep.	Water temperatures warmer than life history stage requirements during summer holding period	Water temp control to Igo; possibly some pre-spawn mortality in critically dry years when not enough cold water in Whiskeytown Lake	High	High - based on temperature data, USFWS reports, and CVP/SWP operations BA	Reduced reproductive success
4	Adult immigration Clear Creek	Mar. – Sep.	Lack of variable flows in spring and low summer flows (50 cfs), when b2 is unavailable	Limited cues for upstream migration resulting from spring flows with little variation. With low summer flows, adults are impeded from accessing upstream holding areas.	High	High - based on CVP/SWP operations BA (chpt 4) and CALSIM modeling runs	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
5	Spawning Clear Creek	Sep. - early Oct.	Spawning area limited due to temperature management and limited spawning habitat availability down to Igo Gage	Density dependency effects & redd superimposition; limited carrying capacity of stream will dictate population size; possible loss of some individuals that spawn below Igo	Low currently - with potential to increase if gravel augmentation creates more spawnable habitat below the Igo gage.	High - based on water temperature data and the CVP/SWP operations BA	Reduced reproductive success and reduce survival
6	Spawning Clear Creek	Sep. - early Oct.	Low summer flows (50 cfs), when b(2) is unavailable	Adults spawn further downstream in less suitable conditions (*i.e.*, in areas with relatively warm water temps.)	High	High - based on CVP/SWP operations BA (chpt 4)	Reduced survival, Reduced reproductive success
7	Embryo incubation	Sep. – Dec.	Water temperatures warmer than life history stage requirements in September only for fish that spawn below TCP (Igo)	Mortality varies with exceedance rate and number of redds; loss of some portion of those eggs; reduced chance of survival for fry	High	High - based on CVP/SWP operations BA models and laboratory evidence of temperature tolerances	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
8	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 5 % of the spring-run ESU spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	High - based on mortality studies at RBDD and timing of emigration from Clear Creek (Vogel *et al.* 1988, Tucker 1998, TCCA 2008)	Reduced survival
9	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth
10	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency).	Low	High - based on annual monitoring of fish screens	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High - based on CVP/SWP operations BA	Reduced survival
12	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on Co-manager review draft of Central Salmon Recovery Plan and CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
13	Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few spring-run are expected to be in this area during the fall.	Low	Low - based on lack of monitoring	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
14a-e	Juvenile rearing/smolt emigration Delta	Nov-June	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Project-related mortality is significant (figure 9-3). Of the spring-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66% (range of 35-90% mortality) (Brandes and McClain 2001, Newman 2008, Perry and Skalski 2008).	High for yearlings Low for YOY	Low to High (see below)	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
14a	Juvenile rearing/smolt emigration Delta	Nov. - Jun.	DCC operations - open gate configurations from November through January	Increased vulnerability of entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Yearling spring-run more vulnerable to effects of open DCC gates than YOY spring-run. Open gate configuration in December and January exposes approximately 3 % of the total spring-run ESU to entrainment into the DCC, but exposes a high proportion of yearling emigrants during this period (DWR 2005). Yearlings have a higher likelihood of survival to adults and are more important to the population. Hence a small loss can have a greater magnitude of effect.	High for yearlings Low for YOY	High – Numerous studies *i.e.*, Delta Action 8, Delta Cross channel, and Delta Interior experiments confirm low survival of fish entrained into the delta interior. Acoustic tagging studies provide similar conclusions for survival within the delta interior.	Reduced survival Reduced life history diversity
14b	Juvenile rearing/smolt emigration Delta	Nov. - Jun.	Loss in interior Delta	Diversion of emigrating fish into the Delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Isalnd) are observed for fish migrating through the Delta interior. Loss of up to 15 % of spring-run ESU entering the Delta based on modeling	Medium	High – numerous studies find similar high loss rates for fish relased in the Delta interior.	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
14c	Juvenile rearing/smolt emigration Delta	Nov. - Jun.	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately 66 % of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85 % of the exposed fish. The percentage of the ESU exposed is variable, typically less than 2-3 %, and frequently is much lower (0.5 %) based on salvage recovery estimates. Percentage of ESU actually arriving at the export facilities and entering the salvage process is low.	Low	High - numerous studies have evaluated screening efficiency, predation, and overall salvage operations survival	Reduced survival
14e	Juvenile rearing/smolt emigration Delta	Nov. - Jun.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on salmon as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta.	High	Low to medium. Invasion of non-native species into delta is well documented, interaction with salmonid populations is not as well documented	Reducted survival, Reduced growth

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
14f	Juvenile rearing/smolt emigration Delta	Nov. - Jun.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, *etc.*). Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics well studied. Effects of Delta hydrodynamics on organisms is not as well understood.	Reduced survival, reduced growth

9.3.3.1.4 Assess Risk to Clear Creek Spring-Run Chinook Salmon

The risk to Clear Creek spring-run is determined by effects to the population's spatial structure (habitat), diversity, and abundance, and productivity. As described in section 6, habitat conditions in Clear Creek, the Sacramento River, and the Delta are adversely affected by the proposed action in a number of ways, including, but not limited to: (1) delaying adult immigration resulting from DCC and RBDD operations; (2) providing flows and water temperatures within Clear Creek under dry hydrologic conditions that are stressful to spring-run; (3) entraining juveniles into the Central and South Delta; and (4) entraining and impinging juveniles at the Jones and Banks pumping plants. In these ways, the proposed action reduces the population's current spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the spring-run population.

The spring-run population in Clear Creek (200 adults in 2008) represents a small, but important, part of the west side diversity group of the ESU. However, of all the west side tributaries, Clear Creek has the highest abundance. A loss of this population would significantly reduce the diversity of the entire spring-run population. Under the proposed operations, the spring-run population is near the maximum capacity that can be maintained on Clear Creek, since spawning locations are limited in the upper reaches (*i.e*., 8 of 18 miles are confined to a narrow canyon). Therefore, even if flows were to be increased the amount of spawning habitat available to spring-run would not increase significantly, unless gravel can be added. The behavioral and genetic diversity of the spring-run population is expected to be negatively affected by the proposed action. Spring-run that spawn further downstream where the channel is mostly alluvial are exposed to unsuitable over summer holding and spawning temperatures. They are also more likely to hybridize with early returning fall-run.

The population is likely to persist in most years, but experience higher mortality as it expands downstream due to the limited amount of suitable spawning and rearing habitat, thus reducing the likelihood of recovery. High water temperatures in the lower reaches and continuation of a static flow pattern (*i.e*., 200 cfs throughout most the year) as proposed action will substantially limit the quantity and quality of habitat, thereby limiting the spatial structure of the spring-run population in Clear Creek. Uncertainty in how b(2) water is applied and how Trinity River diversions will impact flows on Clear Creek increase the risk of extinction to this population. An extended drought period lasting more than 3 years would compromise the spring-run population's ability to persist, unless hatchery strays recolonizing the area below the dam. Based on CALSIM modeling, there are 2 periods when drought conditions persist for up to 6 years. In the future, due to climate change, drought conditions will likely occur more often and of greater severity

Operation of the CVP/SWP negatively affects the diversity of Clear Creek spring-run and the proposed action is expected to continue these effects. The operation of RBDD affects the temporal distribution of adult spring-run on their spawning migration to Clear Creek holding and spawning grounds. Spawning run timing is considered a key diversity trait for salmon species (McElhany *et al*. 2000). Based on recent population estimates (CVP/SWP operations BA page 6-22), the abundance of spring-run spawners attempting to migrate upstream of RBDD accounts

for about 10 percent of the entire run in the Sacramento River basin. Of this 10 percent, approximately 70 percent attempt to migrate past RBDD after the gates are down, and therefore are delayed for an average of 21 days until they locate and navigate the fish ladders. During low flow conditions, spring-run passage to upstream holding and spawning habitats in the tributaries may be impeded at falls, critical riffles and man-made segregation weirs intended to separate spring-run from fall-run, presumably forcing these fish to either back track and hold and spawn within the mainstem Sacramento River or remain in unsuitable lower tributary habitats. Spring-run that are delayed at RBDD and cannot access Clear Creek holding and spawning habitats as a result of low flows or the erection of a segregation weir may end up spawning with spring-run and fall-run originating from the mainstem Sacramento River.

In addition to impacts to the spatial structure and diversity, the proposed action is expected to result in substantial mortality to spring-run juveniles, including those from Clear Creek. Results from a recent study indicate that about 80 to 90 percent of Chinook salmon smolts die when migrating from the mainstem Sacramento River near Battle Creek through the San Francisco Estuary (Delta, Suisun, San Pablo, and San Francisco bays; MacFarlane *et al*. 2008). This range was derived from an acoustic tagging study of hatchery-produced late fall-run released in the Sacramento River as smolts. Mortality of Clear Creek spring-run migrating downstream through the system is most likely even higher than that which is reported for the late fall-run smolts because: (1) spring-run emigrate from Clear Creek as post-emergent fry and are generally less robust and more vulnerable to predation smolts; and (2) studies suggest that there is a positive relationship between juvenile salmon mortality and emigration distance (Anderson *et al*. 2005, MacFarlane *et al*. 2008). Fish leaving Clear Creek must travel about 18 miles further in the Sacramento River, than the fish in the MacFarlane *et al*. (2008) study, which were released near the mouth of Battle Creek (and at 2 other downstream locations).

Although the survival data presented in MacFarlane *et al*. (2008) includes natural and anthropogenic sources of mortality, much of this mortality is believed to be attributed to proposed action-related effects. For example, as described in section 6.6, project-related entrainment into the Central and South Delta greatly increases the risk of mortality from direct (entrainment and impingement at the pumps) and indirect (predation) effects (figure 9-3).

In addition, proposed action-related loss of juveniles passing RBDD may be an important source of mortality to Clear Creek spring-run. Spring-run emigrate from Clear Creek primarily as post emergent fry during December and January and if those emigrants continued moving downstream without rearing in the mainstem Sacramento River for an extended period of time they would encounter RBDD when the gates are out, and thus would not be subject to higher mortality. However, if the post-emergent fry leaving Clear Creek rear over the winter and spring in the mainstem Sacramento River above RBDD and emigrate from May through September, they would encounter RBDD when the gates are in, in which case, they would be more susceptible to predation.

In the year 2019, modifications to RBDD operations will be implemented such that the gates will be in for about 2½ months per year, instead of the current practice of about 4 months per year. Although this modification will lessen the adverse effects of RBDD on spring-run populations

which occur above the dam, such as Clear Creek, the dam will likely remain to function as a stressor to these fish on their upstream and/or downstream migrations.

Due to habitat restoration efforts in Clear Creek, the spring-run population has been growing over the past 15 years from essentially zero fish in the early 1990s up to nearly 200 in 2007. It is uncertain how long this population will continue on its current positive trajectory. However, the proposed Project's effects on the habitat conditions, diversity, and abundance of Clear Creek spring-run are expected to reduce or limit the population's growth rate over the next 21 years. NMFS expects that the adverse affects will increase as the proposed action advances to full build out.

All of the above factors which reduce the spatial structure, diversity, abundance, and productivity of Clear Creek spring-run, compromise the capacity for this population to respond and adapt to environmental changes. Future projections over the duration of the proposed action (*i.e.*, through 2030), considering both increasing water demands and climate change, exacerbate risks associated with continuation of the proposed action, further increasing the risk to the population.

9.3.3.2 Cottonwood/Beegum and Thomes Creek Spring-Run Chinook Salmon

Returning adult spring-run population size in Beegum Creek has generally ranged from tens up to a few hundred fish and even fewer spring-run return to Thomes Creek. Clearly, both of these populations fall into the high risk of extinction category based on abundance (see table 4-3).

The general baseline stress regime for Chinook salmon in the freshwater, estuarine, and marine environment is depicted in figure 9-1. More specifically, baseline stressors to spring-run in Thomes Creek include high water temperatures, low flows, water diversions and associated seasonal diversion dams, gravel mining, and other habitat alterations such as levee construction and bank protection actions (*i.e.*, rip rapping). In the Cottonwood/Beegum watershed, baseline stressors include high water temperatures, low flows, diversions, and gravel mining.

The proposed action will affect Beegum Creek and Thomes Creek spring-run every year through 2030 when these fish are migrating upstream through the Delta and Sacramento River as adults and as juveniles migrating downstream through these areas. The proposed action stressors for these life stages and locations for spring-run from Beegum and Thomes creeks are similar to the stressors described for Clear Creek spring-run in table 9-4 (except spring-run in Thomes Creek are not exposed to the stressors of RBDD, as Thomes Creek enters the Sacramento River downstream of the Sacramento River). Specifically, the DCC affects the adult immigration life stage and RBDD delays adult spring-run for an average of 21 days during the middle portion of their upstream migration. These delays decrease the probability that spring-run returning to tributaries above RBDD will encounter potentially critical riffles when spring run-off flows are high enough for salmon to successfully pass them. Also, the survival of juvenile spring-run migrating downstream from Beegum and Thomes creeks is expected to be reduced by proposed action-related factors in the Delta, as well as by RBDD, depending on whether outmigrants encounter the dam while the gates are in. Considering the extremely small spring-run population sizes in these creeks, and the 21 year duration of the proposed Project, proposed project actions

(*i.e.*, DCC, RBDD, and direct and indirect loss in the Delta) will likely have population-level consequences for both of these populations.

9.3.4 Basalt and Porous Lava Diversity Group

9.3.4.1 Mainstem Sacramento River Spring-Run Chinook Salmon

9.3.4.1.1 Status of Mainstem Sacramento River Spring-Run Chinook Salmon

There are few data available to describe the population size of spring-run spawning in the mainstem of the Sacramento River. Counts of spring-run passing upstream of RBDD have been made since 1969, but these fish may have spawned in one of several systems which support spring-run populations, including Clear Creek, Cottonwood/Beegum Creek, Battle Creek, or the mainstem Sacramento River. As such, the abundance of adults returning to spawn in the mainstem Sacramento River cannot be estimated from monitoring at RBDD.

General information on the abundance of adult spring-run spawning in the mainstem Sacramento River may be inferred from redd survey monitoring. Since 1995, Chinook salmon redd survey data from the mainstem Sacramento River have been collected by CDFG. These data, although not collected with consistent sampling methods from year to year, do provide some indication of the number of spring-run redds constructed in the mainstem Sacramento River. In general, newly constructed salmon redds observed in September have been classified as spring-run, whereas August redds are classified as winter-run and October redds are classified as fall-run. Redd-based spawning population estimates generally require information on the number of redds counted, the number of redds per female, and the ratio of males per female in the river. The number of putative spring-run redds has ranged from 11 to 105 since 1995, with a median value of about 30 redds (unpublished data from CDFG). Chinook salmon females reportedly utilize one redd, increasing the size of the redd in an upstream direction as the spawning season progresses (Healey 1991). McReynolds *et al*. (2007) reported a female-to-male sex ratio of about 3 to 1 for spring-run spawning in Butte Creek. Similarly, the sex ratio of winter-run spawners is generally 3 females for every male. Applying these redd per female and sex ratio observations to the range of mainstem Sacramento River spring-run redds that have been observed, results in a rough approximation of abundance ranging from 15 to 140 fish. Spawner abundance estimates at these levels places the mainstem Sacramento River spring-run population at high risk of extinction based on the population size criteria described in Lindley *et al*. (2007).

9.3.4.1.2 Future Baseline of Mainstem Sacramento River Spring-Run Chinook Salmon Excluding CVP/SWP Effects

The general baseline stress regime for mainstem Sacramento River spring-run in the freshwater, estuarine, and marine environment is depicted in figure 9-1. More specifically, baseline stressors to spring-run within the mainstem Sacramento River include a loss of spatial separation from fall-run resulting from the presence of Keswick and Shasta dams. Historically, spring-run spawned at higher elevations than fall-run. This inability to migrate to higher elevation holding and spawning habitat, coupled with an overlap in the temporal distribution of spring-run and fall-run spawning, has led to introgression between these runs. In addition, because spring-run and

fall-run now must use the same spawning habitat, spring-run likely have suffered greater mortality at the embryo incubation life stage. The spring-run spawning period begins earlier than that of fall-run. Thus, embryos incubating in spring-run redds are vulnerable to disturbance when the fall-run returns to the spawning grounds and begins moving gravels around for redd construction. Incubating embryos are sensitive to physical disturbance, particularly during the early part of incubation.

9.3.4.2 Summary of Proposed Action Effects on Mainstem Sacramento River Spring-Run Chinook Salmon

Proposed action-related effects to spring-run within the mainstem Sacramento River are summarized in table 9-5. Detailed descriptions regarding the exposure, response, and risk of spring-run to these stressors are presented in section 6.

9.3.4.1.4 Assess Risk to Mainstem Sacramento River Spring-Run Chinook Salmon

Population viability is determined by four parameters: spatial structure, diversity, abundance, and productivity (growth rate). Both population spatial structure and diversity (behavioral and genetic) provide the foundation for populations to achieve abundance levels at or near potential carrying capacity and to achieve stable or increasing growth rates. Spatial structure on a watershed scale is determined by the availability, diversity, and utilization of properly functioning conditions (habitats) and the connections between such habitats. Properly functioning condition defines the inland habitat conditions necessary for the long-term survival of Pacific salmon populations. As described in section 6, habitat conditions in the Sacramento River and the Delta are negatively affected by the proposed action in a number of ways, including, but not limited to: (1) delaying adult immigration through the DCC and RBDD operations; (2) providing water temperatures that are stressful to spring-run; (3) entraining juveniles into the Central and South Delta; and (4) changing the Delta from a natural, variabale salinity system to an unnatural freshwater system with a more abundant predator community. In these ways, the proposed action reduces the population's current spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the mainstem Sacramento River spring-run population.

Table 9-5. Summary of proposed action-related effects on mainstem Sacramento River spring-run.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult immigration Delta	Mar. – Sep.	DCC gate closures	Spring-run could be delayed in the Delta resulting in greater exposure to both the in-river sport fishery and contaminants (reduced egg fertility or reduced viability and motility of spermatocytes during spawning).	Low	Low based on limited supporting data	Reduced survival and reduced reproductive success
2	Adult immigration RBDD	Mar. – Sep.	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) force fish to use inefficient ladders	~72% of the spring-run that spawn upstream of RBDD are delayed by approximately 20 days on average, more energy consumed, greater pre-spawn mortality, less fecundity	High	High based on TCCA EIS/EIR on RBDD and CVP/SWP operations BA, including many historical cited studies	Reduced reproductive success
3	Spawning Sacramento River	Sep. – Oct.	No temporal separation between spring-run and fall-run spawning due to delays at RBDD (no spatial separation due to Keswick and Shasta dams)	Introgression -Hybridization with fall run and competition for habitat	High	High based on RBDD genetics report (USFWS 2008b)	loss of genetic integrity and expression of life history

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
4	Embryo incubation	Sep. – Dec.	Water temperatures warmer than life history stage requirements, during September and October	Under near-term operations (Study 7.1) mortality is expected to range from approximately 9% in wet years up to approximately 66 % in critically dry years, with an average of approximately 21 % over all water year types; under modeled climate change projections, average egg mortality over all water year types is expected to be 50 % and during the driest 15 % of years is expected to be 95 %. Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of spring-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	High based on past exceedances of temp. criteria (see figure 6-14 in CVP/SWP operations BO)	Reduced survival
5	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 5 percent of the spring-run ESU that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	High - based on mortality studies at RBDD and timing of emigration from Clear Creek (Vogel *et al.* 1988; Tucker 1998; TCCA 2008)	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
6	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth
7	Juvenile rearing and downstream movement Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency).	Low	High - based on annual monitoring of fish screens	Reduced survival
8	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High - based on CVP/SWP operations BA	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
9	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on Co-manager review draft of Central Valley Salmon Recovery Plan and CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
10	Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few spring-run are expected to be in this area during the fall.	Low	Low - based on lack of monitoring	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11a-e	Juvenile rearing/smolt emigration Delta	Nov - Jun.	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Project-related mortality is significant. Of the spring-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66 % (range of 35-90 % mortality) (Brandes and McClain 2001; Newman 2008; Perry and Skalski 2008).	High	Low to High (see below)	

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11a	Juvenile rearing/smolt emigration Delta	Nov - Jun.	DCC operations - open gate configurations from November through January	Increased vulnerability of entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Yearling spring-run are more vulnerable to the effects of open DCC gate than YOY spring-run. Open gate configuration in December and January exposes approximately 3 % of spring-run ESU to entrainment into the DCC, but exposes a high proportion of yearling emigrants during this period.	Low	High – Numerous studies *i.e.*, Delta Action 8, Delta Cross channel, and Delta Interior experiments confirm low survival of fish entrained into the delta interior. Acoustic tagging studies provide similar conclusions for survival within the delta interior	Reduced survival Reduced life history diversity
11b	Juvenile rearing/smolt emigration Delta	Nov - Jun.	Loss in interior Delta	Diversion of emigrating fish into the delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Isalnd) are observed for fish migrating through the Delta interior. Loss of up to 15 % of spring-run ESU entering the Delta based on modeling	Medium	High – numerous studies find similar high loss rates for fish relased in the Delta interior.	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11c	Juvenile rearing/smolt emigration Delta	Nov - Jun.	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately two thirds of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85 % of the exposed fish. The percentage of the population exposed is variable, typically less than 2-3 %, and frequently is much lower (0.5 %) based on salvage recovery estimates. Percentage of population actually arriving at the export facilities and entering the salvage process is low.	Low	High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations survival	Reduced survival
11d	Juvenile rearing/smolt emigration Delta	Nov - Jun.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on salmon as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta.	High	Low to medium. Invasion of non-native species into delta is well documented, interaction with salmonid populations is not as well understood	Reducted survival, Reduced growth

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11e	Juvenile rearing/smolt emigration Delta	Nov - Jun.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, etc.). Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics well studied. Effects of Delta hydrodynamics on organisms not as well studied.	Reduced survival, reduced growth
12	All stages	Not applicable	Nimbus Hatchery fall-run production straying to mainstem Sacramento River	Competition for habitat and hybridization with hatchery fall-run	Low	Low because Nimbus fall-run have historically not been marked, so the degree of straying to spring-run habitats is not well understood	Reduced fitness of wild fish

Operation of the CVP and SWP negatively affects the diversity of spring-run in the mainstem Sacramento River, and the proposed action is expected to continue these effects. The operation of the DCC and RBDD affects the temporal distribution of adult spring-run on their spawning migration to mainstem Sacramento River spawning grounds. Spawning run timing is considered a key diversity trait for salmon species (McElhany *et al*. 2000). Based on recent population estimates (CVP/SWP operations BA page 6-22), the abundance of spring-run spawners attempting to migrate to the mainstem Sacramento River spawning grounds and to tributaries (*e.g*., Cottonwood/Beegum, Clear, and Battle creeks) upstream of RBDD accounts for about 10 percent of the entire run in the Sacramento River. Of this 10 percent, approximately 70 percent attempt to migrate past RBDD after the gates are down, and therefore are likely delayed until they locate and navigate the fish ladders. During low flow conditions, spring-run passage to upstream holding and spawning habitats in the tributaries may be impeded at falls or critical riffles, presumably forcing these fish to either back track and hold and spawn within the mainstem Sacramento River or remain in highly unsuitable habitats in the tributaries. Spring-run that are delayed at RBDD and cannot access tributary spawning habitats as a result of low flows may end up spawning with spring-run and fall-run originating from the mainstem Sacramento River, which continues the pattern of genetic introgression and hybridization that has occurred since RBDD was built in the late 1960s (CDFG 1988, NMFS 2004b, TCCA 2008).

In addition to impacts to the spatial structure and diversity, the proposed action is expected to result in substantial mortality to spring-run juveniles, including those produced in the mainstem Sacramento River. Results from a recent study indicate that about 80 to 90 percent of Chinook salmon smolts die when migrating from the mainstem Sacramento River near Battle Creek through the San Francisco Estuary (Delta, Suisun, San Pablo, and San Francisco bays; MacFarlane *et al*. 2008). Mortality of spring-run that are naturally-produced within the Sacramento River, which must avoid predators immediately upon emerging from spawning gravels as fry, is most likely higher than the mortality reported for the late fall-run smolts based on size-related differences in vulnerability to predation (*i.e*., fry are more vulnerable to predation than smolts). Although the survival data presented in MacFarlane *et al*. (2008) includes natural and anthropogenic sources of mortality, much of this mortality is believed to be attributed to proposed action-related effects. For example, Project-related entrainment into the Central and South Delta greatly increase the risk of mortality from direct (entrainment and impingement at the pumps) and indirect (predation) effects (figure 9-3).

All of the above factors which reduce the spatial structure, diversity, and abundance of mainstem Sacramento River spring-run, compromise the capacity for this population to respond and adapt to environmental changes. Future projections over the duration of the proposed action (*i.e*., through 2030), considering both increasing water demands and climate change, exacerbate risks associated with continuation of the proposed action, further increasing the risk of the population.

In the Sacramento River, comparing climate change scenarios (Study 9.0 base vs Study 9.5 drier, more warming) shows that average spring-run mortality increases from 20 percent to 55 percent (figure 6-20). EOS carryover storage at Shasta is less than 1.9 MAF during average dry years (1928 to 1934) in all scenarios except Study 9.2 wetter, less warming (CVP/SWP operations BA table 9-23). Under these conditions, spring-run would experience a loss of spawning habitat, as

water temperatures below dams becomes harder to control and the cold water pool in Shasta diminishes.

9.3.4.3 Battle Creek Spring-Run Chinook Salmon

Returning adult spring-run population size in Battle Creek has generally ranged from tens up to a few hundred fish, placing the population at a high risk of extinction based on abundance (see table 4-3).

The general baseline stress regime for Chinook salmon in the freshwater, estuarine, and marine environment is depicted in figure 9-1.

The proposed action affects Battle Creek spring-run when these fish are migrating upstream through the Delta and Sacramento River as adults and as juveniles migrating downstream through these areas. The proposed action stressors for these life stages and locations for spring-run from Battle Creek are the same stressors described above for mainstem Sacramento River spring-run in table 9-5. That is, the DCC and RBDD adversely affect adult immigration and proposed action-related factors in the Delta decrease juvenile/smolt survival. RBDD delays adult spring-run during the middle portion of their upstream migration for about 21 days. This delay exposes spring-run to thermally stressful conditions, which may result in prespawn mortality, reduce overall fecundity, or reduce egg viability (EPA 2001). Considering the extremely small spring-run population sizes in Battle Creek, along with the effect of the DCC and RBDD on upstream migration and the magnitude of proposed action-related loss of juvenile Chinook salmon migrating through the Delta (figure 9-3), it is likely that the proposed action also has population-level effects for this population.

9.3.5 Northern Sierra Nevada Diversity Group

9.3.5.1 Antelope, Mill, Deer, Big Chico, and Butte Creeks and Yuba River Spring-Run Chinook Salmon

Antelope, Mill, Deer, Big Chico, and Butte creeks and the Yuba River enter the Sacramento River below RBDD and thus, spring-run returning to those watersheds are not affected by the dam. The baseline stress regime for these spring-run populations includes all non-CVP/SWP stressors that were previously described (see figure 9-1) as well as stressors within each watershed, such as high water temperatures and agricultural diversions that diminish instream flows, act as passage impediments for adult immigration, and entrain juveniles as they rear and migrate downstream. The spring-run produced in these watersheds are also expected to be adversely affected by the effects of the proposed action in the Delta, as they are migrating upstream as adults or downstream as juveniles. Given that these watersheds do not contain any CVP or SWP facilities, hatcheries, or other direct effects from the proposed action, it is less likely that the proposed action will have population-level effects as compared to watersheds above RBDD (*e.g.*, Battle, Beegum and Clear Creeks). Nevertheless, the abundance of every spring-run population within the Northern Sierra Nevada diversity group is expected to be reduced by proposed action-related factors in the Delta.

9.3.6 Assess Risk to the Central Valley Spring-Run Chinook Salmon ESU

As previously stated, the spring-run ESU is currently likely to become endangered within the foreseeable future in large part because: (1) the ESU is currently composed of only one diversity group containing extant independent populations; (2) habitat elimination and modification throughout the Central Valley have drastically altered the ESU's spatial structure and diversity; and (3) the ESU has a risk associated with catastrophes, especially considering the remaining independent populations' proximity to Mt. Lassen and the probability of a large scale wild fire occurring in those watersheds (Lindley *et al*. 2007). In addition, population growth rate (lamda) declined under all climate change scenarios considered by Crozier *et al*. (2008). The risk of dropping below the lowest historical level of abundance shifted from a range of 6-36 percent in the current climate to 54-86 percent in the drier hotter climate (Crozier *et al*. 2008). Maintaining habitat diversity could potentially help buffer against the impacts of climate change (Lindley *et al*. 2009). The proposed action does not improve any of these factors. Our VSP analysis at the population and diversity group scales show that the proposed action reduces the viability of every extant spring-run population and diversity group. Thereefore, the viability of the ESU is expected to be significantly reduced with implementation of the proposed action.

Given the evidence of the reduction in numbers, reproduction and/or distribution of the species, NMFS concludes that Reclamation has not ensured that the proposed action is not likely to appreciably reduce the likelihood of viability, and therefore the likelihood of both the survival and recovery of the Central Valley spring-run Chinook salmon ESU (table 9-6).

Table 9-6. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Central Valley Spring-Run Chinook Salmon ESU. Application of Key Evidence is Provided in Italics. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Not Likely/Likely to Jeopardize (NLJ/LJ).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River and Clear Creek flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River and Clear Creek; and (4) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants).*	True	End
		False	Go to B
B	**CV spring-run are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to delay ~70% of the spring-run adults that spawn upstream of RBDD (i.e., approximately 10% of the total run size returning to the Sacramento River) and ~5% of spring-run juveniles emigrating past RBDD would be exposed to greater predation. (2) All*	True	NLAA

	freshwater life stages of Sacramento River and Clear Creek spring-run will be exposed to regulated flows and their effects on river processes and morphology every year through 2030. (3) Each year through 2030, Clear Creek and mainstem Sacramento River spring-run are expected to be exposed to water temperatures warmer than life stage requirements during egg incubation. (4) As water is moved from the north Delta to the export facilities in the south Delta, each year through 2030, spring-run juveniles will have increased exposure to an abundant predator community, an aquatic environment degraded by pesticides and contaminants, and direct entrainment at the Federal and State pumping plants.	False	Go to C
C	**CV spring-run are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Delayed upstream migration at RBDD causes individual adults to consume more energy, which limits the amount of energy available for reproduction, resulting in the deposition of fewer and/or less viable eggs. Mortality of juvenile salmon migrating downstream past RBDD reportedly ranges from 5 to 50 %. (2) Loss of natural river function resulting from flow regulation in the Sacramento River and in Clear Creek has reduced the quality and quantity of rearing and migratory habitats, thereby reducing the growth and survival of individual spring-run juveniles in those systems. (3) .Under near-term operations (Study 7.1) spring-run egg mortality from exposure to warm water temperatures in the mainstem Sacramento River is expected to range from approximately 9% in wet years up to approximately 66% in critically dry years, with an average of approximately 21% over all water year types; under modeled climate change projections, average egg mortality over all water year types is expected to be approximately 50 % and during the driest 15 % of years is expected to be approximately 95%. In addition to mortality, individual spring-run from the mainstem Sacramento River are expected to experience sub-lethal effects during the egg incubation life stage resulting from exposure to warm water temperatures. Individual Clear Creek spring-run are expected to experience lethal and sub-lethal effects due to warm water temperatures during the adult immigration and holding, and egg incubation life stages. (4) Mortality of spring-run juveniles that enter the Delta interior is expected to range from 35 to 90%, resulting in the loss of approximately 5-16 percent of the entire ESU.*	True	NLAA
		False	Go to D
D	**Any responses are not likely to constitute "take" or reduce the fitness of CV spring-run that have been exposed.** *Key Evidence: (1) The reduction in energy available for egg production associated with delayed upstream migration at RBDD reduces the fitness of individuals by reducing their reproductive capacity; RBDD operations are expected to increase "take" of spring-run juveniles migrating downstream. (2) "Take"of spring-run individuals in the form of reduced growth and survival is expected due to the loss of natural river function associated with flow regulation in the Sacramento River and in Clear Creek. (3) and (4) As described in step C, "take" of spring-run individuals, in the form of mortality and sub-lethal effects, is expected particularly during the egg incubation (water temperature effects) and juvenile rearing/smolt emigration (predation and entrainment in the Delta) life stages.*	True	NLAA
		False	Go to E
E	**Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent.** *Key Evidence: The cumulative effects of RBDD operations, flow regulation, warm water temperatures, project-related impacts in the Delta, and other project-related stressors (see tablse 9-4 and 9-5) are expected to sufficiently reduce the survival and/or reproductive success of spring-run individuals at multiple life stages every year through 2030 such that key population parameters (i.e. spatial structure, diversity, and abundance) are appreciably reduced for all extant spring-run populations. Reductions in these parameters over the next 21 years will likely reduce the viability of every extant spring-run population.*	True	NLJ
		False	Go to F

F	**Any reductions in the viability of the exposed populations are not likely to reduce the viability of CV spring-run.** *Key Evidence: Considering the greatly diminished status of the CV spring-run ESU, NMFS assumes that if a population-level effect on any of the populations within the ESU is expected from implementation of the proposed action, then a species-level effect will be expected as well. The proposed action reduces the viability of every extant spring-run diversity group and population. Therefore, the viability of the ESU is expected to be significantly reduced with implementation of the proposed action.*	True	NLJ
		False	LJ

9.4 Central Valley Spring-Run Chinook Salmon Critical Habitat

9.4.1 Status of Central Valley Spring-Run Chinook Salmon Critical Habitat

Critical habitat for spring-run is composed of primary constituent elements that are essential for the conservation of the species including, but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Most of the historic spawning and rearing habitat for spring-run is above impassable dams[23] as is the case for the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers. Due to this habitat elimination, current spring-run spawning habitat largely occurs in areas that historically functioned as either rearing habitat or migratory corridors for spring-run, or spawning habitat for fall-run. The quality of spawning habitat used by spring-run in the Central Valley is diminished when fall-run, which spawn later than but still during spring-run spawning, arrive at the spawning grounds and physically disturb spring-run redds during their redd construction. This competition for spawning habitat between spring-run and fall-run, which was created by dam construction, occurs on several Central Valley rivers, including the mainstem Sacramento River. Spawning habitat for spring-run in the mainstem Sacramento River is often negatively affected by operation of the CVP through warm water releases from Shasta Reservoir. Additionally, the status of spring-run critical habitat is degraded by CVP operations and infrastructure such as the DCC and RBDD.

Substantial habitat degradation and alteration also has affected the rearing, migratory, and estuarine areas used by spring-run. Some general examples of how spring-run critical habitat has been degraded include the loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use. One specific example of degradation to estuarine habitats used by spring-run is that human activities in the San Francisco Bay-Delta Estuary have caused the loss or conversion of more than 500,000 acres of tidal wetlands and thousands of acres of shoreline and stream habitat (http://sfep.abag.ca.gov/pdfs/fact_sheets/SF_Bay_Delta_Estuary.pdf). Perhaps the most striking indication that the status of estuarine habitats used by spring-run has been degraded is the collapse of the pelagic community in the Delta that has been observed in recent years (Sommer *et al*. 2007). It is not immediately clear how the changes in the Delta ecosystem affect spring-run, but it is certain that substantial changes to spring-run estuarine habitat are occurring. It should be noted that the area in which the pelagic organism collapse is occurring does overlap

[23] All critical habitat for spring-run occurs below impassable barriers.

with spring-run critical habitat in the Delta, but the area of collapse also occurs in areas of the Delta that are not designated as spring-run critical habitat.

Due to past and present day effects to spring-run habitat, the current condition of spring-run critical habitat is considered to be highly degraded, and does not provide the conservation value necessary for the survival and recovery of the species.

9.4.2 Northwestern California Diversity Group

9.4.2.1 Spring-Run Chinook Salmon Critical Habitat in Clear Creek

9.4.2.1.1 Status of Spring-Run Chinook Salmon Critical Habitat in Clear Creek

Whiskeytown Dam at RM 18.1 is an impassable barrier to adult anadromous salmonids and marks the upstream extent of potential spring-run habitat. Prior to 2000, the McCormick-Saeltzer Dam presented a barrier to upstream migration for anadromous salmonids. Following removal of the Dam in 2000, access to approximately 12 miles of coldwater habitat upstream to Whiskeytown Dam was restored. The construction of Whiskeytown Dam, gold mining, and significant gravel mining in the Clear Creek watershed has diminished the availability and recruitment of suitable spawning gravels. Gravel injection projects are conducted to make up for this loss of spawning gravel recruitment, but limited spawning habitat availability is a problem in Clear Creek.

Currently the release schedule from Whiskeytown Dam calls for flows of 200 cfs from October 1 to June 1 and 150 cfs, or less, from July through September in order to maintain water temperatures below 60°F. Under dry and warm climate conditions, water temperatures above 60° F occur in Clear Creek. Lindley *et al*. (2004) suggested that Clear Creek appears to offer habitat of marginal suitability to spring-run, having limited area at higher elevations and being highly dependent on rainfall.

9.4.2.1.2 Project Effects on Spring-Run Chinook Salmon Critical Habitat in Clear Creek

The proposed action adversely affects Clear Creek spring-run critical habitat in a few ways. As shown in table 9-4 above, the proposed action is expected to produce stressors to habitats within Clear Creek used for spring-run adult immigration and holding, spawning, and egg incubation. Those stressors include warm water temperatures, and low summer flows. Under dry and warm climate conditions, the proposed action is expected to provide water temperatures warmer than is required for successful holding, spawning and egg incubation.

9.4.2.1.3 Assess Risk to Spring-Run Chinook Salmon Critical Habitat in Clear Creek

At least six factors, when considered concurrently, suggest that implementation of the proposed action is expected to place critical habitat for Clear Creek spring-run at considerable risk. First, Clear Creek habitat below Whiskeytown Dam is believed to be of marginal suitability for spring-run (Lindley *et al*. 2004). Records reviewed by Yoshiyama *et al*. (1996) do not suggest that spring-run were historically abundant in Clear Creek indicating limitations to the quantity and/or

quality of habitat even before the construction of Whiskeytown Dam (Lindley *et al*. 2004). Third, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Fifth, under current usage practices, human population growth will place an increasing demand on limited water supplies, potentially exacerbating adverse effects to spawning, rearing, migratory, and estuarine habitats. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will decrease the conservation value of these habitats (see table 9-4).

9.4.2.2 Spring-Run Chinook Salmon Critical Habitat in Cottonwood/Beegum and Thomes Creeks

Like Clear Creek, Cottonwood/Beegum and Thomes creeks appear to offer habitat of marginal suitability to spring-run Chinook salmon, having limited area at higher elevations and being highly dependent on rainfall, instead of snowmelt like the Sierra watersheds (Lindley *et al.* 2004). It is also worth noting that Cottonwood/Beegum, Thomes, and Clear creeks are on the east side of the coast range and, thus, lie in that mountain range's rain shadow (Lindley *et al*. 2004). Unlike Clear Creek, Cottonwood/Beegum and Thomes creeks do not have a large reservoir constructed on them, and thus are characterized by a more natural hydrograph. Water temperatures are generally warmer and flows are generally lower on these creeks than on Clear Creek. Spring-run critical habitat in Thomes Creek is degraded by high water temperatures, low flows, water diversions and associated seasonal diversion dams, gravel mining, and other habitat alterations such as levee construction and bank protection actions (*i.e*., rip rapping). In the Cottonwood/Beegum watershed, critical habitat is degraded by high water temperatures, low flows, diversions, and gravel mining.

9.4.3 Basalt and Porous Lava Diversity Group

9.4.3.1 Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River

9.4.3.1.1 Status of Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River

Within the range of the spring-run ESU, biological features of the designated critical habitat that are considered vital for spring-run include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. As generally described above in section 9.4.1, the status of critical habitat in each of these biological features is considered to be highly degraded, particularly with respect to habitats within the mainstem Sacramento River. The quality of spawning habitat used by spring-run in the mainstem Sacramento River is diminished when fall-run, which commence spawning slightly later in the season than spring-run, arrive at the spawning grounds, move gravels around for redd construction, and physically disturb spring-run redds during that process. Spawning and egg incubation habitat for spring-run in the mainstem Sacramento River is often adversely affected by operation of the CVP through warm water releases from Shasta Reservoir. Freshwater rearing and migration habitats have been degraded by RBDD operations which delay upstream migration, reduce the availability of quality rearing habitat through the related seasonal creation of Lake Red Bluff, and create

improved feeding opportunities for predators such as pikeminnow and striped bass. Additional adverse effects to rearing and migration habitats within the Sacramento River include loss of natural river function and floodplain connectivity through flow regulation,levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use.

9.4.3.1.2 Project Effects on Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River

The proposed action negatively affects mainstem Sacramento River critical habitat in several ways. As shown in table 9-5 above, the proposed action produces stressors to spawning, rearing, and migratory habitats in the mainstem Sacramento River. Those stressors include operation of RBDD, limited spawning habitat availability resulting from water temperature management, exposure to warm water temperatures during egg incubation and juvenile rearing, and loss of natural river function and morphology, affecting all habitat types and rearing habitat quanity and quality in particular.

9.4.3.1.3 Assess Risk to Spring-Run Chinook Salmon Critical Habitat in the Mainstem Sacramento River

At least four factors, when considered together, suggest that implementation of the proposed action is expected to place spring-run critical habitat in the mainstem Sacramento River at considerable risk. First, spawning, rearing, and migratory habitats within the mainstem Sacramento River are believed to be substantially degraded and generally would be considered as not properly functioning (McElhany *et al*. 2000, NMFS 1996b). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Third, under current usage practices, human population growth will place an increasing demand on limited water supplies, potentially exacerbating adverse effects to spawning, rearing, and migratory habitats. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will further compromise the conservation value of each of these habitats (see table 9-5).

9.4.3.2 Spring-Run Chinook Salmon Critical Habitat in Battle Creek

Spring-run habitat on Battle Creek is generally considered to be suitable largely due to many cold springs which feed the creek and the fact that the watershed receives a considerable amount of snowmelt during the spring and early summer. However, Battle Creek habitat is affected by several PG&E owned and operated diversion facilities on the North and South Forks. These facilities allow PG&E to control the majority of the flows in the anadromous fish reaches of the Battle Creek watershed. Because these facilities limit the availability of suitable anadromous salmonid habitat within the watershed, a cooperative partnership among Federal, State, and local entities was formed to develop and implement the Battle Creek Salmon and Steelhead Restoration Project. Specific restoration components, include improved instream flow releases, selected decommissioning of dams at key locations in the watershed, dedication of water diversion rights for instream purposes at decommissioned sites, construction of tailrace

connectors, and installation of Fail-Safe Fish Screens and Fish Ladders (http://www.usbr.gov/mp/battlecreek/pdf/main/MOU.pdf). This restoration project has not yet been implemented, but is expected to be in the near future.

9.4.4 Northern Sierra Nevada Diversity Group

The proposed action does not affect spring-run critical habitat within any of the watersheds in the Northern Sierra Nevada Diversity Group with the exception of the Feather River. The effects to Feather River spring-run critical habitat are being evaluated in a separate Opinion related to the FERC relicensing of Oroville Dam.

9.4.5 Assess Risk to Central Valley Spring-Run Chinook Salmon Critical Habitat

At least five factors, when considered concurrently, suggest that implementation of the proposed action is expected to place spring-run critical habitat at considerable risk. First, the status of spring-run critical habitat is one characterized by severe degradation, including factors such as warm water temperatures and low flows, loss of natural river function and floodplain connectivity through flow regulation and levee construction, direct loss of floodplain and riparian habitat, loss of tidal wetland habitat, a collapsed pelagic community in the Delta, and poor water quality associated with agricultural, urban, and industrial land use. In general, much of the spawning, rearing, migratory, and estuarine habitat would be considered as not properly functioning (NMFS 1996b). For example, NMFS (1996b) suggests that floodplain connectivity would be considered not properly functioning if the following description applied: "*severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly*." That descriptor certainly fits the Central Valley situation where only about 5 percent of Delta wetlands remain available due to levee construction and conversion to agricultural land (Williams 2006). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, overall drier conditions (Lindley *et al*. 2007), and altered estuarine habitats through changes in hydrology and sea level rise. Third, under current practices, human population growth will place an increasing demand for limited water supplies, potentially exacerbating adverse effects to spawning, rearing, migratory, and estuarine habitats. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will continue to compromise the conservation value of spring-run spawning and rearing habitats in Clear Creek and the mainstem Sacramento River, and compromise the conservation value of migratory and estuarine habitats for all extant spring-run populations.

Based on the analysis of available evidence, NMFS concludes that the proposed action is likely to reduce the conservation value of the critical habitat, as designated, for the conservation of Central Valley spring-run Chinook salmon (table 9-7).

Table 9-7. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Central Valley Spring-Run Chinook Salmon Designated Critical Habitat. Application of Key Evidence is Provided in Italics. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action

A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River and Clear Creek flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River and Clear Creek; and (4) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants).*	True	End
		False	Go to B
B	**Areas of designated critical habitat for CV spring-run are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, the migratory corridor for spring-run adult immigration and juvenile emigration is expected to be affected by RBDD operations; rearing habitat will be affected by the formation of Lake Red Bluff. (2) Holding, spawning, rearing, and migratory habitats in the Sacramento River and Clear Creek will be exposed to regulated flows and their effects on river processes and morphology every year through 2030. (3)Each year through 2030, spring-run egg incubation habitats are expected to be affected by water temperatures warmer than life stage-specific requirements. (4) Each year through 2030, as water is moved from the north Delta through the DCC towards the pumping plants in the south Delta, a portion of outmigrating spring-run juveniles will be entrained into the central Delta, where survival and successful outmigration to the Pacific Ocean is expected to be lower than if the juveniles remained in the main migratory corridor of the Sacramento River.*	True	NLAA
		False	Go to C
C	**The quantity, quality, or availability of all constituent elements of CV spring-run critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations will reduce the quality of habitat for spring-run adult immigration and juvenile emigration, as well as the quality and quantity of rearing habitat through the formation of Lake Red Bluff. (2) Loss of natural river function resulting from flow regulation has reduced the quality and quantity of rearing and migratory habitats in the Sacramento River and in Clear Creek. (3)Each year through 2030, the provision of water temperatures warmer than life stage-specific requirements will reduce the quantity and quality of spring-run egg incubation habitats in the mainstem Sacramento River; and adult immigration and holding and egg incubation habitats in Clear Creek. (4) Each year through 2030, the quality of migratory habitats is reduced by entraining juvenile spring-run into low quality rearing/migratory habitat in the central Delta.*	True	NLAA
		False	Go to D
D	**Any reductions in the quantity, quality, or availability of one or more constituent elements of spring-run critical habitat are not likely to reduce the conservation value of the exposed area.** *Key Evidence: Reductions in the conservation value of migratory, egg incubation, and rearing habitats are expected due to reductions in the quantity, quality, or availability of critical habitat constituent elements resulting from RBDD operations, flow regulation in the Sacramento River and Clear Creek, the provision of water temperatures in the Sacramento River and Clear Creek warmer than life stage-specific requirements, and the movement of water towards the Federal and State pumping plants.*	True	-
		False	Go to E
E	**Any reductions in the conservation value of the exposed area of spring-run critical habitat are not likely to reduce the conservation value of the critical habitat designation.** *Key Evidence: Because the conservation value of all inland habitat types*	True	No AD MOD

	(migratory, spawning/egg incubation, and rearing) necessary to complete the salmon life cycle are expected to be reduced with implementation of the proposed action, it is likely that the conservation value of the critical habitat designation will also be reduced.	False	AD MOD

9.5 Central Valley Steelhead

In this section, we describe how the proposed action is expected to affect the likelihood of survival and recovery of the CV steelhead DPS by summarizing how Project operations will affect steelhead from Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River. We will focus on these four populations for a few reasons. First, they are the only populations that are affected by the proposed action within their respective watersheds as well as in the migratory corridors (*i.e*., mainstem Sacramento River, mainstem San Joaquin River, and Delta). Second, these four populations are from each of the four diversity groups (biogeographical regions) that are composed of extant steelhead populations, and thus proposed action effects that are common to every extant steelhead population in the migratory corridors (including the Delta) will be described as these four populations are described in turn. To illustrate this, consider the Calaveras and Stanislaus rivers, both from the Southern Sierra Nevada Diversity Group. Steelhead from the Calaveras River are only affected by the proposed action when they occur in the Delta, and although the effects will not be discussed as they relate to the Calaveras River steelhead population, Delta effects to steelhead from the southern Sierra Nevada Diversity Group are described in the Stanislaus River analysis. Lastly, as described in Lindley *et al*. (2007), there are almost no data with which to assess the status of any of the extant steelhead populations in the Central Valley. As such, it did not make sense to attempt to assess whether stressors to individuals from populations that are only affected in the migratory corridors would constitute population-level effects. However, it does seem reasonable to assess whether effects to individual steelhead from Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River add up to population-level consequences, as some status information for each of these steelhead populations is available and the individuals from these four populations are affected by the proposed action throughout their inland life cycle.

This section will first summarize the status of CV steelhead. Next, within each diversity group, the risk to one of the four populations identified above will be assessed by considering its status, baseline stress regime, and how the proposed action is expected to affect individuals from that population throughout their life cycle. These effects and associated risk to individuals are considered concurrently with the population status and baseline, to reason whether or not the proposed action is expected to have a population-level effect. Finally, the risk to the species will be assessed by considering the risk to the various populations associated with implementation of the 21-year long proposed action. As stated in the Analytical Approach, if a population-level effect on any of the populations within the ESU is expected from implementation of the proposed action, then a species-level effect will be expected as well, based on the recommendation from the TRT that every extant population is necessary for the recovery of the species. NMFS interprets this to indicate that an increase in the extinction risk of one or more of the populations increases the extinction risk of the species.

9.5.1 Status of the Central Valley Steelhead DPS

CV steelhead were listed as threatened on March 19, 1998. Their classification was retained following a status review on January 5, 2006 (71 FR 834). This DPS consists of steelhead populations in the Sacramento and San Joaquin River (inclusive of and downstream of the Merced River) basins in California's Central Valley. Steelhead historically were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al*. 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick dams), south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alteration from water diversion projects), and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al*. 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996), with nearly all historic spawning habitat blocked behind impassable dams in many major tributaries, including in the Northwestern California (Clear Creek), the Basalt and Porous Lava (Sacramento, Pit, and McCloud rivers), the northern Sierra Nevada (Feather, Yuba, American Rivers, and Mokelumne rivers), and the southern Sierra Nevada (Stanislaus, Tuolumne, Merced, Calaveras, and San Joaquin rivers) diversity groups (Lindley *et al*. 2007).

Historic CV steelhead run size is difficult to estimate given limited data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996; McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

The only consistent data available on steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (CDFG 2003). In 2004, a total of 12 steelhead smolts were collected at Mossdale (CDFG unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks. A few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Snorkel surveys from 1999 to 2002 indicate that steelhead are present in Clear Creek (J. Newton, FWS, pers. comm. 2002, *op. cit*. Good *et al*. 2006). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated. Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (Demko and Cramer 2000). It is possible that naturally spawning populations exist in

many other streams. However, these populations are undetected due to lack of monitoring programs (IEPSPWT 1999).

The majority (66 percent) of BRT votes was for "in danger of extinction," and the remainder was for "likely to become endangered." Abundance, productivity, and spatial structure were of highest concern. Diversity considerations were of significant concern. The BRT was concerned with what little new information was available and indicated that the monotonic decline in total abundance and in the proportion of wild fish in the CV steelhead DPS was continuing.

9.5.2 Baseline Stress Regime for the Central Valley Steelhead DPS

Extensive habitat elimination and degradation has been a primary factor causing the threatened status of CV steelhead. Physical habitat modifications (*e.g.*, dam construction and river straightening and associated riprap applications) and many other anthropogenic effects on habitat have greatly diminished the viability of the DPS. The general future baseline for steelhead in the freshwater, estuarine, and marine environment is similar to that of winter-run (figure 9-1), with an exception that there is no targeted ocean fishery for steelhead. Detailed descriptions of baseline stressors to CV steelhead are provided in section 4.2.4, *Factors Responsible for the Current Status of Winter-Run, Spring-Run, CV Steelhead, and the Southern DPS of Green Sturgeon.* Future baseline stressors on CV steelhead are similar to those that affect winter-run, spring-run, and the Southern DPS of green sturgeon.

9.5.3 Northwestern California Diversity Group

9.5.3.1 Clear Creek Steelhead

9.5.3.1.1 Status of Clear Creek Steelhead

An abundant resident *O. mykiss* population in Clear Creek has prohibited obtaining estimates of steelhead abundance. However, snorkel surveys conducted from 1999 to 2002 suggest that anadromous steelhead are present in Clear Creek (Newton 2002 *op. cit*. Good *et al*. 2005). Although the overall status of this population is largely unknown, the observation that steelhead are present in Clear Creek is important to the spatial structure and overall viability of the DPS.

9.5.3.1.2 Future Baseline of Clear Creek Steelhead Excluding CVP/SWP Effects

The general baseline stress regime for steelhead in the freshwater, estuarine, and marine environment is depicted in figure 9-1[24]. Within Clear Creek, specific stressors include warm water temperatures in the lower reaches and a lack of natural gravel recruitment resulting in limited spawning habitat availability. Lindley *et al*. (2004) suggested that Clear Creek appears to offer habitat of marginal suitability to steelhead, having limited area at higher elevations and being highly dependent on rainfall.

[24] The stressor identified in figure 9-1 generally apply to all Central Valley anadromous salmonids with the exception that ocean harvest would not be considered an important stressor for steelhead as there is no targeted ocean fishery for that species.

9.5.3.1.3 Proposed Action Effects on Clear Creek Steelhead

Proposed action-related effects to steelhead within Clear Creek are summarized in table 9-8. Detailed descriptions regarding the exposure, response, and risk of steelhead to these stressors are presented in section 6.

9.5.3.1.4 Assess Risk to Clear Creek Steelhead

As described in section 6, habitat conditions in Clear Creek, the Sacramento River, and the Delta are adversely affected by the proposed action in a number of ways, including, but not limited to: (1)regulating flows in a way that impairs natural river processed; (2) providing flows and water temperatures in the lower reaches of Clear Creek that are stressful to steelhead; (3) delaying the upstream migration of adult steelhead through RBDD operations; (4) reducing the availability of quality rearing habitat through the seasonal creation of Lake Red Bluff; (5) creating improved feeding opportunities at RBDD for predators such as pikeminnow and striped bass; and (6) entraining juveniles into poor quality habitats in the Central and South Delta. In these ways, the proposed action reduces the population's current spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the Clear Creek steelhead population.

Table 9-8. Summary of proposed action-related effects on Clear Creek steelhead.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult immigration and holding Clear Creek	Aug. – Mar.	Water temperatures warmer than life history stage requirement for migration possible in lower reach near confluence with Sacramento River during August and September	Some adults may not enter mouth of Clear Creek, (1) delayed run timing, (2) seek other tributaries, (3) spawn in mainstem Sac. R.; reduced in vivo egg viability	Low- except for critically dry years	Medium - based on modeled water temps.	Reduced reproductive success
2	Adult immigration RBDD	Aug. – Mar.	RBDD gate closures from May15 – Sept. 15 force adults to use inefficient fish ladders	17% of those that spawn above RBDD, delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity	High	Medium - based on run timing and ability to hold until spawning	Reduced reproductive success
3	Spawning Clear Creek	Dec. – Mar.	Reduction in frequency and magnitude of peak flows due to the operation of Whiskeytown Dam	Less habitat diversity, limited spawning habitat availability; reduced production of eggs and fry, possible crowding and competition from late-fall Chinook salmon	Medium to High	High - based on spawning surveys	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
4	Egg incubation Clear Creek	Dec. - May	Water temperatures warmer than life history stage requirements	In critically dry years, higher egg mortality and sub-lethal effects for eggs spawned in March	Low	High - based on temperature modeling, scientific literature on life stage requirements (*e.g.*, EPA 2001, Myrick and Cech 2001), and observed spawning surveys	Reduced survival
5	Juvenile rearing Clear Creek	May – Sep.	Low summer flows (50 cfs), when b(2) is unavailable	Limited rearing habitat availability; less food, reduced growth, increased predation risk	High	High - based on modeled flows (CVP/SWP operations BA), uncertain availability of b(2), and historical data (http://cdec.water.ca.gov/)	Reduced survival
6	Juvenile rearing Clear Creek	May – Sep.	Water temperatures warmer than life history stage requirements	Limited over-summering habitat, reduced growth, increased susceptibility to disease and predation	High	High - based on modeled water temperature (CVP/SWP operations BA), uncertain availability of b(2), and historical data (http://cdec.water.ca.gov/)	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
7	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 1% of the steelhead DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	Low	High - based on tagging studies for juveniles passing RBDD (Vogel *et al*. 1988; Tucker 1998) and timing of steelhead emigration (TCCA 2008)	Reduced survival
8	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Reduction in rearing habitat quality and quantity; delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth
9	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g*., 95% efficiency).	Low	High - based on annual monitoring of fish screens	Reduced survival
10	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High - based on CVP/SWP operations BA	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on Co-manager review draft of Central Salmon Recovery Plan and CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
12	Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. Few steelhead are expected to be in this area during the fall.	Low	Low - based on lack of monitoring	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
13a-e	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality related to the proposed action (figure 9-2).	High	Low to High (see below)	Reduced survival
13a	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	DCC operations	Open gate configurations from late May through January increases vulnerability of steelhead entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Open gate configuration exposes less than 10 % of steelhead smolt population to entrainment into the DCC.	Low	Medium– numerous studies with Chinook salmon indicate poor survival in Delta interior. Steelhead predation studies in CCF indicate steelhead and Chinook vulnerabilities are similar to predation	Reduced survival Reduced life history diversity

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
13b	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Loss in interior Delta	Diversion of emigrating fish into the delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Island) are observed for fish migrating through the Delta interior. Most Clear Creek steelhead should remain in the Sacramento River past the DCC because it is closed from Feb. – June, but there is risk of diversion through Georgiana Slough. Mortality of juvenile steelhead entering CCF ranging from approximately 74 to 85% (DWR 2008).	Medium	Medium– numerous studies find high loss rates for Chinook salmon relased in the Delta interior. CCF predation reports indicate that steelhead and Chinook salmon have similar predation vulnerabilities	Reduced survival
13c	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately two thirds of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85 % of the exposed fish. Plus an additional loss of approximately 10 % of all species released in the CHTR program. In January – March, when steelhead are present, loss ranges up to 100 % (DWR 2009). Percentage of steelhead produced in the Sacramento River and its tributaries actually arriving at the export facilities and entering the salvage process is expected to be low.	Low	Medium to High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations for Chinook salmon survival. Recent steelhead predation studies completed	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
13d	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on steelhead as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta.	High	Low to medium. Invasion of non-native species into delta is well documented, interaction with steelhead populations is not well documented	Reducted survival, Reduced growth
13e	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, etc.). Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics well studied. Effects of Delta hydrodynamics on organisms is not as well understood.	Reduced survival, reduced growth

Recent redd surveys indicate a small, self-sustaining population (~300 adults) is increasing in abundance. This is most likely a result of intensive restoration efforts combined with increased flows, dam removal, and water temperature control. As CV steelhead expand throughout the 18 miles of stream they are likely to be impacted more often by low flows and high temperatures during the summer rearing period. Recent surveys (USFWS 2008) show a shift in spawning distribution downstream to between 4 and 6 miles above the confluence where over summer temperatures exceed the 60°F temperature compliance location set at Igo (RM 14.1). This shift in spawning is most likely a result of gravel augmentation and restoration efforts in key areas downstream. In 2008, 94 of 148 steelhead redds (63 percent) were observed downstream of the TCP. Since most juveniles stay within close proximity to where they are born during the first year this shift would expose a majority of the Clear Creek steelhead population to unsuitable habitat conditions. Exposure to stressful water temperatures during spawning, embryo incubation, juvenile rearing, and smolt emigration is likely to reduce the spatial structure and growth rate, thus adding to the risk of extinction.

The diversity of Clear Creek steelhead also may be affected by the proposed action. Water releases from Whiskeytown Dam has changed the thermal regime and likely the food web structure of Clear Creek (Lieberman *et al*. 2001) such that a resident life history strategy may have fitness advantages over anadromous forms (Lindley *et al*. 2006). Little is known about the relationship of resident and anadromous forms of *O. mykiss*. Without knowing the role that resident *O. mykiss* play in population maintenance and persistence of anadromous *O. mykiss*, it is difficult to assess whether the current conditions on Clear Creek, which may favor residency, are detrimental to the anadromous population in Clear Creek or not (Lindley *et al*. 2007). Zimmerman *et al*. (2008) did demonstrate that resident rainbow trout can produce anadromous smolts and anadromous steelhead can produce resident rainbow trout in the Central Valley. However, the study indicated that the proportion of resident rainbow trout to anadromous steelhead in the Central Valley is largely in favor of the resident form with 740 of 964 *O. mykiss* examined being the progeny of resident rainbow trout.

In addition to impacts to the spatial structure and possibly life history diversity, the proposed action is expected to result in direct mortality to steelhead. Proposed action-related sources of steelhead mortality include: (1) increasing predation of juveniles when the RBDD gates are down; (2) entraining juveniles into the Central and South Delta (figure 9-3); (3) entraining and impinging juveniles at the pumps (both direct and indirect loss); and (4) loss associated with the CHTR program.

In the driest 4 percent of years, steelhead abundance and productivity will be reduced due to less habitat available and sublethal water temperatures. With climate change, warmer conditions would reduce the rearing habitat in all water years, therefore fewer steelhead would likely be produced.

All of the above factors, which reduce the spatial structure, diversity, and abundance of Clear Creek steelhead, compromise the capacity for this population to respond and adapt to environmental changes. Future projections over the duration of the proposed action (*i.e.*, through

2030), considering both increasing water demands and climate change, exacerbate risks associated with continuation of the proposed action, further increasing the risk of the population.

9.5.4 Basalt and Porous Lava Diversity Group

9.5.4.1 Mainstem Sacramento River Steelhead

9.5.4.1.1 Status of Mainstem Sacramento River Steelhead

The status of the CV steelhead on the mainstem Sacramento River is mainly unknown since there is no direct monitoring. However, we know that historically the population that spawns above RBDD is decreasing based on dam counts at RBDD and 3 of the major tributaries (*i.e.*, Battle Creek, Clear Creek, and Cottonwood Creek). Since the RBDD gates started operation in 1967, the CV steelhead abundance in the upper Sacramento River has declined from 20,000 to less than 1,200 adults. The current abundance is less than 10 percent of the CVPIA doubling goal of 13,000 adults in the upper Sacramento River. Redd surveys for winter-run indicate that resident *O. mykiss* do spawn in the mainstem in May. A significant tailwater trout population supports a thriving recreational fishery due to the cold water releases for winter-run. This resident trout population can cross with anadromous forms of *O. mykiss* (common in some San Joaquin River tributaries). Rotary screw trap data at RBDD indicate that most juvenile steelhead observed there are resident forms based on timing and size. Zimmerman *et al*. (2008), found that the vast majority of *O. mykiss* collected from the Sacramento River exhibited a resident life history strategy.

9.5.4.1.2 Future Baseline of Mainstem Sacramento River Steelhead Excluding CVP/SWP Effects

The stressors that CV steelhead experience in the mainstem are the same as previously mentioned for winter-run with the addition of the following; no access to high elevation spawning and over summer habitat, lack of LWD and Shaded Riparian Habitat, increase in warm water predator populations, exposure to pesticides and herbicides in agricultural return water, urbanization, fragmentation-loss of core populations, loss of anadromous life history, competition from resident forms of *O. mykiss*, competition from introduced fish species more suited to regulated rivers, lack of small stream habitat, lack of smaller size gravel for spawning, fishing pressure, climate change, and the lack of policies aimed at changing the current regime (*i.e.*, water for fish second).

9.5.4.1.3 Proposed Action Effects on Mainstem Sacramento River Steelhead

Proposed action-related effects to steelhead within the Sacramento River are summarized in table 9-9. Detailed descriptions regarding the exposure, response, and risk of steelhead to these stressors are presented in section 6.

9.5.4.1.4 Assess Risk to Mainstem Sacramento River Steelhead

As described in section 6 and summarized in table 9-9, habitat conditions in the mainstem Sacramento River and the Delta are adversely affected by the proposed action in a number of ways, including, but not limited to: (1) delaying the upstream migration of adult steelhead through RBDD operations; (2) reducing the availability of quality rearing habitat through the seasonal creation of Lake Red Bluff; (3) creating improved feeding opportunities at RBDD for predators such as pikeminnow and striped bass; and (4) entraining juveniles into poor quality habitats in the Central and South Delta. In these ways, the proposed action reduces the population's current spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the mainstem Sacramento River steelhead population.

The diversity of mainstem Sacramento River steelhead also may be affected by the proposed action. Water releases from Shasta Dam has changed the thermal regime and the food web structure of the Sacramento River (Lieberman *et al*. 2001) such that a resident life history strategy may have fitness advantages over anadromous forms (Lindley *et al*. 2006, McEwan 2001). Little is known about the relationship of resident and anadromous forms of *O. mykiss*. Without knowing the role that resident *O. mykiss* play in population maintenance and persistence of anadromous *O. mykiss*, it is difficult to assess whether the current conditions on the Sacramento River, which may favor residency, are detrimental to the anadromous population in the Sacramento River or not (Lindley *et al*. 2007). Zimmerman *et al*. (2008) did demonstrate that resident rainbow trout can produce anadromous smolts and anadromous steelhead can produce resident rainbow trout in the Central Valley. However, the study indicated that the proportion of resident rainbow trout to anadromous steelhead in the Central Valley is largely in favor of the resident form with 740 of 964 *O. mykiss* examined being the progeny of resident rainbow trout. This proportional imbalance is even more prominent in the Sacramento River River where about 92 percent (142 out of 154) of *O. mykiss* sampled were offspring of resident adults (Zimmerman *et al*. 2008). Only 1 out of the 154 *O. mykiss* sampled showed an anadromous migratory history, although the sampling was not intended to be selective for adults, so some fish sampled may not yet have made their downstream migration to the ocean.

In addition to impacts to the spatial structure and possibly life history diversity, the proposed action is expected to result in direct mortality to steelhead. Proposed action-related sources of steelhead mortality include: (1) increasing predation of juveniles when the RBDD gates are down; (2) entraining juveniles into the Central and South Delta (figure 9-3); (3) entraining and impinging juveniles at the pumps (both direct and indirect loss); and (4) loss associated with the CHTR program.

All of the above factors, which reduce the spatial structure, diversity, and abundance of mainstem Sacramento River steelhead, compromise the capacity for this population to respond and adapt to environmental changes. Future projections over the duration of the proposed action (*i.e.*, through 2030), considering both increasing water demands and climate change, exacerbate risks associated with continuation of the proposed action, further increasing the risk of the population.

Table 9-9. Summary of proposed action-related effects on mainstem Sacramento River steelhead.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult immigration RBDD	Aug. – Mar.	RBDD gate closures from May15 – Sept. 15 force adults to use inefficient fish ladders	17% of those that spawn above RBDD, delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity	High	Medium - based on run timing and ability to hold until spawning	Reduced reproductive success
2	Spawning Sacramento River	Dec. – Mar.	Straying of Nimbus Hatchery steelhead to mainstem Sacramento River spawning habitats	Reduced genetic fitness of Sacramento River steelhead through the spread of Eel River genes and potentially hatchery rainbow trout genes to many below-barrier sites in the Central Valley (Garza and Pearse 2008).	High	High – based on the genetic structure of CV steelhead described in Garza and Pearse (2008)	Reduced genetic fitness
3	Egg incubation Sacramento River	Dec. - May	Water temperatures warmer than life history stage requirements	Sub-lethal effects - reduced early life stage viability; direct mortality in critically dry years; restriction of life history diversity (i.e., directional selection against eggs deposited in Mar.).	Medium	High - based on temperature modeling, scientific literature on life stage requirements (e.g., EPA 2001, Myrick and Cech 2001), and observed spawning surveys	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
4	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Reduction in rearing habitat quality and quantity; delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth
5	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 1 % of the steelhead DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	Low	High - based on tagging studies for juveniles passing RBDD (Vogel et al. 1988; Tucker 1998) and timing of steelhead emigration (TCCA 2008)	Reduced survival
6	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Screened CVP diversions including continuing operation of the RBDD Research Pumping Plant	Mortality from contact with fish screen, diversion pumps, and bypasses; sub lethal effects from going through pumps, loss of scales, disorientation. All screens were designed to meet NMFS fish screen criteria (*e.g.*, 95% efficiency).	Low	High - based on annual monitoring of fish screens	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
7	Juvenile rearing/smolt emigration Upstream of and including RBDD	Year-round	Provision of higher flows and cooler water temps during the summer than occurred prior to the construction of Shasta Dam	Potential fitness advantage for resident *O.mykiss* over the anadromous form, which would drive an evolutionary (*i.e*., genetic) change if life history strategy is heritable (Lindley *et al*. 2007).	High	Medium to High Medium because the degree to which life history strategy is controlled by genetics is not clear. High because resident *O. mykiss* are the dominant form in the Sacramento River, as indicated in a recent study which reported that approximately 92 % (142 out of 154) of *O. mykiss* sampled from the Sacramento River were offspring of resident adults (Zimmerman *et al*. 2008).	Reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
8	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High - based on CVP/SWP operations BA	Reduced survival
9	Juvenile rearing/smolt emigration RBDD to Colusa	Year-round	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on Co-manager review draft of Central Valley Salmon Recovery Plan and CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
10	Juvenile rearing/smolt emigration Colusa to Sacramento	Year-round	Low fall flows	Yearling emigration delayed, higher predation; fewer smolts survive to the Delta. However, few steelhead are expected to be in this area during the fall.	Low	Low - based on lack of monitoring	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11a-e	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality related to the proposed action (figure 9-2)	High	Low to High (see below)	Reduced survival
11a	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	DCC operations	Open gate configurations from late May through January increases vulnerability of steelhead entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Open gate configuration exposes less than 10 % of the steelhead that are produced in the Sacramento River and its tributaries to entrainment into the DCC.	Low	Medium– Numerous studies with Chinook salmon indicate poor survival in Delta interior. Steelhead predation studies in CCF indicate steelhead and Chinook vulnerabilities are similar to predation	Reduced survival Reduced life history diversity

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11b	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Loss in interior Delta	Diversion of emigrating fish into the delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Isalnd) are observed for fish migrating through the Delta interior. Most Sacramento steelhead should remain in the Sacramento River as the open gate configuration of DCC exposes less than 10 % of the steelhead that are produced in the Sacramento River and its tributaries.	Medium	Medium– numerous studies find high loss rates for Chinook salmon relased in the Delta interior. CCF predation reports indicate that steelhead and Chinook salmon have similar predation vulnerabilities	Reduced survival
11c	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately two thirds of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85 % of the exposed fish. Percentage of Sacramento River steelhead population actually arriving at the export facilities and entering the salvage proccess is expected to be low.	Low	Medium to High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations for Chinook salmon survival. Recent steelhead predation studies completed	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
11d	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on steelhead as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta.	High	Low to medium. Invasion of non-native species into delta is well documented, interaction with steelhead populations is not as well documented	Reducted survival, Reduced growth
11e	Juvenile rearing/smolt emigration Delta	Oct. - Jul.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, etc.) Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics well studied. Effects of Delta hydrodynamics on organisms is not as well studied.	Reduced survival, reduced growth

Reclamation's mortality model was not run for CV steelhead to determine the effects of different climate change scenarios because steelhead have a shorter incubation period than salmon, and the model would have to be changed. However, late-fall salmon can be used as a surrogate for CV steelhead since they spawn at similar times in the winter. Late fall-run mortality increases in Study 9.5 (drier, more warming) and Study 9.3 (wetter, more warming) under all water year types on average 4 percent over the future full build out scenario (Study 9.0). EOS carryover storage at Shasta is less than 1.9 MAF during average dry years (1928 to 1934) in all scenarios except Study 9.2 wetter, less warming (CVP/SWP operations BA table 9-23).

9.5.5 Northern Sierra Nevada Diversity Group

9.5.5.1 American River Steelhead

9.5.5.1 Status of American River Steelhead

Historically, the American River supported three separate runs of steelhead corresponding to the summer, fall, and winter seasons. Mining activities and dam construction during the late 1800s and early 1900s drastically degraded and eliminated anadromous salmonid habitat. By 1955, summer-run steelhead (and spring-run Chinook salmon) were completely extirpated and only remnant runs of fall- and winter-run steelhead persisted in the American River (Gerstung 1971). Stressors, including the construction of the American River Division facilities of the CVP, contributed to the subsequent extirpation of fall-run steelhead. The current population size of about a few hundred in-river spawning steelhead (Hannon and Deason 2008) is much lower than estimates from the 1970s (Staley 1975), and is primarily composed of fish originating from Nimbus Hatchery. This means that the listed population (*i.e*., naturally-produced fish) in the lower American River is at an abundance level lower than the estimates provided by Hannon and Deason (2008) and is likely on the order of tens.

In addition to small population size, other major factors influencing the status of naturally spawning steelhead in the American River include: (1) a 100 percent loss of historic spawning habitat resulting from the construction of Nimbus and Folsom Dams (Lindley *et al*. 2007), which has obvious and extreme implications for the spatial structure of the population; and (2) the operation of Nimbus Fish Hatchery, which has completely altered the diversity of the population.

Lindley *et al*. (2007) classifies the natural population of American River steelhead at a high risk of extinction because this population is reportedly mostly composed of steelhead originating from Nimbus Fish Hatchery. The small population size and complete loss of historic spawning habitat and genetic composition further support this classification.

9.5.5.1.2 Future Baseline of American River Steelhead Excluding CVP/SWP Effects

Excluding stressors resulting from American River Division operations, baseline stressors to American River steelhead include the presence of Folsom and Nimbus dam, loss of natural riverine function and morphology, predation, and water quality. A detailed description of how these stressors affect steelhead in the American River is provided in section 5.4.3.

9.5.5.1.3 Proposed Action Effects on American River Steelhead

Proposed action-related effects to steelhead within the American River are summarized in table 9-10. Detailed descriptions regarding the exposure, response, and risk of steelhead to these stressors are presented in section 6. Additionally, an analysis related to potential climate change effects on American River steelhead is presented in that section.

Table 9-10. Summary of proposed action-related effects on American River steelhead.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr.	Folsom/Nimbus releases – flow fluctuations	Redd dewatering and isolation prohibiting successful completion of spawning	Medium	Medium	Reduced reproductive success
2	Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr.	Nimbus Fish Hatchery – hatchery *O. mykiss* spawning with natural-origin steelhead	Reduced genetic diversity. Garza and Pearse (2008) showed that genetic samples from the population spawning in the river and the hatchery population were "extremely similar".	High	High – based on Garza and Pearse (2008)	Reduced reproductive success
3	Embryo incubation Primarily upstream of Watt Ave. area	Late-Dec. - May	Water temperatures warmer than life stage requirements	Sub-lethal effects - reduced early life stage viability; direct mortality; restriction of life history diversity (i.e., directional selection against eggs deposited in Mar. and Apr.)	Medium	High – based on past water temperature data, CVP/SWP operations BA water temp. modeling, published literature regarding the thermal tolerance of steelhead eggs	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
4	Embryo incubation Primarily upstream of Watt Ave. area	Late-Dec. - May	Folsom/Nimbus releases – high instream flows resulting in redd scour	Egg and alevin mortality. Spawning substrate mobilization in the American River reportedly begins to occur at flows of 30,000 -50,000 cfs (Ayres Associates 2001). Flood frequency analysis for the American River at the Fair Oaks gauge shows that, on average, flows will reach 30,000 cfs approximately once every 4 years and 50,000 cfs approximately once every 5 years (CVP/SWP operations BA).	Medium	High – based on evidence of the flow magnitude required to mobilize spawning substrate (Ayres Associates 2001) and the frequency of such flows (CVP/SWP operations BA, USFWS 2003)	Reduced survival
5	Embryo incubation Primarily upstream of Watt Ave. area	Late-Dec. - May	Folsom/Nimbus releases – flow fluctuations	Redd dewatering and isolation. Hannon *et al.* (2003) reported that 5 steelhead redds were dewatered and 10 steelhead redds were isolated at the lower Sunrise side channel when Nimbus Dam releases were decreased on February 27, 2003. When releases were decreased on March 17, 2003, seven steelhead redds were dewatered and five additional redds were isolated from flowing water at the lower Sunrise side channel. In April 2004 at the lower Sunrise side channel, five steelhead redds were dewatered and "many" redds were isolated (Water Forum 2005a). Redd dewatering at Sailor Bar and Nimbus Basin occurred in 2006 (Hannon and Deason 2008).	High	High – based on Hannon et al. (2003), Water Forum (2005a), and Hannon and Deason (2008).	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
6	Juvenile rearing Primarily upstream of Watt Ave. area	Year-round	Folsom/Nimbus releases – flow fluctuations; low flows	Fry stranding and juvenile isolation - observations of juvenile steelhead isolation in the American River were made in both 2003 and 2004 (Water Forum 2005a). Low flows limiting the availability of quality rearing habitat including predator refuge habitat	High	High – based on past studies (CDFG 2001; Water Forum 2005a)	Reduced survival
7	Juvenile rearing Primarily upstream of Watt Ave. area	Year-round	Water temperatures warmer than life stage requirements	Physiological effects - increased susceptibility to disease (*e.g.*, anal vent inflammation) and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures at Watt Avenue from August through September were warmer than 65°F for approximately 81 percent of the days, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 30a). Under a drier and warmer climate change scenario (Study 9.5), modeled water temperatures at Watt Avenue from June through September under full build out of the proposed Project range from 65°F to 82°F (Reclamation 2009). Even if no regional climate change is assumed (Study 9.1), water temperatures at this location during this time period are expected to range from 63°F to 79°F.	High	High – based on actual (cdec data) and modeled water temps, published literature regarding the thermal tolerance of steelhead juveniles (e.g., EPA 2001; Myrick and Cech 2001), and past studies (Water Forum 2005a).	Reduced growth; Reduced survival
8	Smolt emigration Throughout entire river	Jan. – Jun.	Water temperatures warmer than life stage requirements	Physiological effects – reduced ability to successfully complete the smoltification process, increased susceptibility to predation	Medium	Medium	Reduced growth; Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
9a-e	Smolt emigration Delta	Jan. – Jun.	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality related to the proposed action (figure 9-3)	High	Low to High (see below)	Reduced survival
9a	Smolt emigration Delta	Oct. - Jul.	DCC operations	Open gate configurations from late May through January increases vulnerability of steelhead entrainment into the Delta interior where survival is considerably lower than within the Sacramento River mainstem. Mandatory gate closure from Feb 1 through end of May prevents entrainment into the DCC. Open gate configuration exposes less than 10 % of the steelhead that are produced in the Sacramento River and its tributaries to entrainment into the DCC.	Low	Medium– Numerous studies with Chinook salmon indicate poor survival in Delta interior. Steelhead predation studies in CCF indicate steelhead and Chinook vulnerabilities are similar to predation	Reduced survival Reduced life history diversity

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
9b	Smolt emigration Delta	Oct. - Jul.	Loss in interior Delta	Diversion of emigrating fish into the delta interior exposes fish to increased loss. Lower survival rates to the western Delta (Chipps Isalnd) are observed for fish migrating through the Delta interior. Most American River steelhead should remain in the Sacramento River as the open gate configuration of DCC exposes less than 10 % of the steelhead that are produced in the Sacramento River and its tributaries.	Medium	Medium– numerous studies find high loss rates for Chinook salmon relased in the Delta interior. CCF predation reports indicate that steelhead and Chinook salmon have similar predation vulnerabilities	Reduced survival
9c	Smolt emigration Delta	Oct. - Jul.	Loss at export facilities	Entrainment of fish at the CVP results in loss of approximately two thirds of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85% of the exposed fish. Percentage of American River steelhead population actually arriving at the export facilities is expected to be low.	Low	Medium to High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations for Chinook salmon survival. Recent steelhead predation studies completed	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
9d	Smolt emigration Delta	Oct. - Jul.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Direct predation on steelhead as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta	High	Low to medium. Invasion of non-native species into delta is well documented, interaction with steelhead populations is not as well documented	Reducted survival, Reduced growth
9e	Smolt emigration Delta	Oct. - Jul.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (predation, poor water quality, contaminants, etc.). Affects a large fraction of the Central and Southern Delta.	High	Low to High. Delta hydrodynamics is well studied. Effects of Delta hydrodynamics on organisms are not as well understood.	Reduced survival, reduced growth

9.5.5.1.4 Assess Risk to American River Steelhead

Population viability is determined by four parameters: spatial structure, diversity, abundance, and productivity (growth rate). Both population spatial structure and diversity (behavioral and genetic) provide the foundation for populations to achieve abundance levels at or near potential carrying capacity and to achieve stable or increasing growth rates. Spatial structure on a watershed scale is determined by the availability, diversity, and utilization of properly functioning conditions (habitats), as defined in McElhany *et al*. (2000), and the connections between such habitats. NMFS defines properly functioning condition as the freshwater habitat conditions necessary for the long-term survival of Pacific salmon populations (McElhany *et al*. 2000). As described above, habitat conditions in the lower American River are adversely affected by the proposed action to such a degree that the survival, growth, and reproductive success of multiple steelhead life stages is reduced. For example, American River steelhead are exposed to stressful water temperatures during spawning, embryo incubation, juvenile rearing, and smolt emigration. Based on the entire effects analysis, it is apparent that the water temperatures and flows expected with implementation of the proposed action will continue to substantially limit the quantity and quality of habitat, thereby limiting the spatial structure of American River steelhead. These limitations to the spatial structure of a population which have already been blocked off from all of its historic spawning habitat certainly adds to its risk of extinction.

The behavioral and genetic diversity of American River steelhead also is expected to be negatively affected by the proposed action. Warm water temperatures in the American River under the proposed action are expected to result in higher fitness for steelhead spawned early (*e.g.*, January) in the spawning season, as eggs spawned later (*e.g*., March) would be exposed to water temperatures above their thermal requirements (see *Assess Species Response*, section 6.4.3, above). This selective pressure towards earlier spawning and incubation would truncate the temporal distribution of spawning, resulting in a decrease in population diversity. Additionally, the genetic diversity of steelhead in the river has been completely altered by Nimbus Fish Hatchery operations, relative to the historic diversity.

In addition to the negative effects on the spatial structure and diversity, the proposed action is expected to reduce the abundance of American River steelhead. Direct mortality (*e.g*., redd scour, redd dewatering, and potential water temperature-related egg mortality) associated with proposed operations has been documented at both the egg and juvenile life stages. The fitness consequences from water temperature-related anal vent inflammation of the juveniles (*e.g*., compromised immune system, resulting in increased predation, reduced energy for growth) also would be expected to negatively affect the population growth rate.

The combined effects of the proposed action on the spawning, embryo incubation, juvenile rearing, and smolt emigration life stages of steelhead in the American River, reduces the viability of the population and places the population, which was already at high risk of extinction (see section 9.5.5.1.,1 *Status of American River Steelhead*), at even greater risk. This notion is especially supported considering that Naiman and Turner (2000) demonstrated how even slight reductions in survival from one life stage to the next at each and every life stage can have serious

consequences for the persistence of a population, and the proposed action reduces the survival of each and every steelhead life stage, including the life stage transition from smolt to adult-sized fish in the ocean. Although the proposed action does not directly affect steelhead in the ocean, it indirectly lowers their ocean survival because they are entering it in a weakened state.

Future projections over the duration of the proposed action (*i.e.*, through 2030), considering both increasing water demands and climate change, exacerbate risks associated with continuation of current American River Division operations, further increasing the risk of extinction of naturally-spawned American River steelhead. For example, comparing annual water deliveries from the American River Division in recent years (*e.g.*, about 300 TAF in 2006) to annual demands that were modeled in the CVP/SWP operations BA for full build out of the proposed action (*i.e.*, 800 TAF in 2030), suggests that annual demands by 2030 are expected to be about three to four times higher than current levels. This increased water demand is expected to result in considerable challenges to flow and water temperature management for American River aquatic resources below Nimbus Dam, and will likely exacerbate the adverse habitat conditions already occurring in the river under present day water demands. In addition to increasing water demands, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al.* 2007).

9.5.6 Southern Sierra Nevada Diversity Group

9.5.6.1 Stanislaus River Steelhead

9.5.6.1.1 Status of Stanislaus River Steelhead

Studies have documented the occurrence of CV steelhead in the Stanislaus River based on incidental observations obtained from fall-run sampling (Anderson *et al.* 2007; S.P. Crammer and Associates Inc. 2000, 2001) as well as from otolith microchemistry analyses (Zimmerman *et al.* 2008). However, information regarding the abundance of Stanislaus River steelhead is very limited. In the 2006-7 season, 12 steelhead were observed passing through a Stanislaus River counting weir (Anderson *et al.* 2007). One of the steelhead observed at the weir had an adipose fin clip, indicating some opportunity for genetic introgression from hatchery operations on other Central Valley rivers. Steelhead smolts also have been captured in the Stanislaus River in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001), but the numbers are very low, ranging from 10 to 30 annually. Most of the steelhead smolts are captured from January to mid-April, are 175 to 300 mm fork length, and display morphological characteristics associated with smoltification, indicating these fish are exhibiting an anadromous life form. These fish are physiologically prepared to leave the river at a time well after the scheduled VAMP pulse flows, but not later than when historical unimpaired rain-on-snow events would have provided out migration flows.

9.5.6.1.2 Future Baseline of Stanislaus River Steelhead Excluding CVP/SWP Effects

Excluding stressors resulting from proposed action operations, baseline stressors to Stanislaus River steelhead include the presence of Goodwin, Tulloch and New Melones dams, loss of

natural riverine function and morphology, agricultural and urban land uses, gravel mining, predation, and water quality, particularly temperature, contaminants and suspended sediment. A detailed description of how these stressors affect steelhead in the Stanislaus River is provided in section 5.5.3.

9.5.6.1.3 Proposed Action Effects on Stanislaus River Steelhead

Proposed action-related effects to Stanislaus River steelhead are summarized in table 9-11. Detailed descriptions regarding the exposure, response, and risk of steelhead to these stressors are presented in section 6. Additionally, an analysis related to potential climate change effects on Stanislaus River steelhead is presented in that section.

9.5.6.1.4 Assess Risk to Stanislaus River Steelhead

Population viability is determined by Spatial structure, diversity, abundance, and productivity (growth rate). Both population spatial structure and diversity (behavioral and genetic) provide the foundation for populations to achieve abundance levels at or near potential carrying capacity and to achieve stable or increasing growth rates. Spatial structure on a watershed scale is determined by the availability, diversity, and utilization of properly functioning conditions (habitats), as defined in McElhany *et al*. (2000). Thus, reductions in the quantity or quality of available habitat are assumed to reduce a population's spatial structure.

Habitat conditions in the Stanislaus River and Delta are negatively affected by the proposed action to such a degree that the survival, growth, and/or reproductive success of all inland life stages of steelhead is reduced (see table 9-11). For example, Stanislaus River steelhead are exposed to stressful water temperatures during adult immigration, embryo incubation, juvenile rearing, and smolt emigration. In addition, flow-dependent habitat availability is limited, particularly for the spawning, juvenile rearing, and smolt emigration life stages. Based on the effects analysis throughout the steelhead life cycle, it is apparent that the proposed action has substantial negative effects on the habitat, and therefore spatial structure, in the Stanislaus River and Delta. A further reduction to the spatial structure of a population which has already been blocked off from its historic spawning habitat certainly adds to its risk of extinction.

Table 9-11. Summary of proposed action-related effects on Stanislaus River steelhead.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult Immigration Delta to Riverbank	Oct-Dec	Water temperatures warmer than life history stage requirements	Delayed entry into river (CDFG 2007a); pre-spawn mortality; reduced condition factor.	Medium	Medium – based on CDFG (2007a)	Reduced reproductive success; Reduced survival to spawn
2	Spawning Stanislaus River	Dec-Feb	Unsuitable flows restrict spawnable habitat and dewater redds	Limited spawning habitat availability according to Aceituno (1993). Instream flows typically drop in January from higher December levels when San Joaquin River water quality objectives are met. This increases the risk for redd dewatering and direct egg mortality.	High	Low- populations so low that direct observation is difficult	Reduced reproductive success
3	Spawning Stanislaus River	Dec-Feb	Excessive fines in spawning gravel resulting from lack of overbank flow	Reduced suitable spawning habitat; For individual: increased energy cost to attempt to "clean" excess fine material from spawning site Fine material deposited in gravel beds because of lack of overbank flow to inundate floodplain and deposit fine material on floodplain, instead of in river (Kondolf *et al*. 2001).	High	Medium- deposition documented by Kondolf *et al*. (2001) and reduced permeability in spawning beds measured by Mesick (2001); energetic effects not documented for steelhead.	Reduced reproductive success

4	Egg incubation and emergence Stanislaus River	Dec-May	Excessive fines in spawning gravel resulting from lack of overbank flow	Egg mortality from lack of interstitial flow; egg mortality from smothering by nest-building activities of other steelhead or fall-run; suppressed growth rates.	High	High – based on reduced permeability in spawning beds measured by Mesick (2001); and geomorphic assessment (Kondolf *et al*. (2001)	Reduced survival
5	Egg incubation and emergence Stanislaus River	Dec-May	Water temperatures warmer than life history stage requirements	Egg mortality, especially for eggs spawned in or after March; Embryonic deformities (Deas *et al*. 2008) Temperatures may be operationally managed, depending on year type	Medium	High – based on actual (CDEC) data and modeled (CVP/SWP operations BA) water temperatures, published literature regarding the thermal tolerance of steelhead juveniles (*e.g*., EPA 2003a; Myrick and Cech 2001)	Reduced survival
6	Juvenile rearing Stanislaus River	Year round	Contaminants (particularly dormant sprays)	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation; indirect: loss to predation; poor energetics; indirect stress effects.	Low	Low – limited information for Stanislaus River fish	Reduced growth rates; Reduced survival

7	Juvenile rearing Stanislaus River	Year round	Operations can create usable habitat conditions below dam equivalent to 50% of historic linear stream access and only in reaches that were historically seasonably unsuitable for rearing.	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation.	High	Medium to High – based on Lindley *et al.* (2007)	Reduced growth rates; Reduced survival
8	Juvenile rearing Stanislaus River	Year round	Lack of overbank flow to inundate rearing habitat	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration.	High	High – based on geomorphic studies (Kondolf *et al*. 2001), and floodplain habitat literature (Sommer *et al.* 2001a, 2001b, 2005; Jeffres *et al.* 2008; Heady and Merz 2007)	Reduced growth rates; Reduced survival

9	Juvenile rearing Stanislaus River	Year round	Reduction in rearing habitat complexity due to reduction in channel forming flows	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration.	High	High – based on geomorphic studies (Kondolf *et al*. 2001), and floodplain habitat literature (Sommer *et al.* 2001a, 2001b, 2005; Jeffres *et al.* 2008; Heady and Merz 2007)	Reduced growth rates; Reduced survival
10	Juvenile rearing Stanislaus River	Year round	Unsuitable flows for maintaining juvenile habitat	Crowding and density dependent effects relating to reduced habitat availability. Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth.	High	High – based on IFIM analysis (Aceituno 1993)	Reduced growth rates; Reduced survival
11	Juvenile rearing and out-migration Stanislaus River	All year with increase Feb-May during out-migration	Predation by non-native fish predators because rearing habitat is lacking	Juvenile mortality; Reduced juvenile production.	High	High – based on geomorphic studies (Kondolf *et al*. 2001), and predation analyses on Stanislaus and Tuolumne Rivers (Demko *et al*.1999, Stillwater Sciences 2000)	Reduced survival
12	Juvenile rearing Stanislaus River	Year round Jan-April (14 months)	End of summer water temperatures warmer than life history stage	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth.	High	High – based on actual (CDEC) data and modeled (CVP/SWP operations BA) water temperatures.	Reduced growth rates; Reduced survival

13	Smoltification and emigration Stanislaus River at mouth	Jan. - Jun.	Water temperatures warmer than life history stage (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress.	High	High – based on actual (CDEC) data and modeled (CVP/SWP operations BA) water temperatures	Reduced diversity.
14	Smolt emigration Stanislaus River	Jan. – Jun.	Suboptimal flow (March – June)	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection through Delta leading to increased residence time and higher risk of predation.	High	High – based on actual (CDEC-temperature, smolted steelhead occurrence at Oakdale/Caswell rotary screw-traps) data and modeled (CVP/SWP operations BA) water temperatures	Reduced survival; Reduced diversity
15a-d	Smolt emigration Delta	Jan. – Jun.	Cumulative direct and indirect loss associated with export operations (Loss in Southern Delta, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality to steelhead from the southern Sierra Nevada diversity group. Based on VAMP studies of fall-run, mortality ranges from 90 – 99 % from San Joaquin River release points to Chipps Island (SJRGA 2006). Similar results are assumed for steelhead, as shown through the CCF studies showing similar loss rates between steelhead and Chinook salmon (DWR 2008).	High	Low – based on lack of steelhead-specific data High – based on studies of Chinook salmon mortality using acoustic tags, PTM modeling (CVP/SWP operations BA), and supplemental PTM model runs.	Reduced survival

15a	Smolt emigration Delta	Jan-Jun.	Loss in Southern Delta	Exports increase residence time of emigrating fish by diverting juveniles into the channels of the South Delta. This exposes steelhead to increased losses to predation and contaminants. Vulnerability to entrainment into the channels of the South Delta is elevated during high export operations. Lack of HORB increases entrainment into Old River (SJRGA 2006). Lower survival rates to the western Delta (Chipps Island) are observed for fish migrating through the South Delta interior (USFWS 2006).	High–	Medium– numerous studies find high loss rates for Chinook salmon released in the Delta interior. CCF predation reports indicate that steelhead and Chinook salmon have similar predation vulnerabilities. Supplemental PTM model runs indicate a high rate of entrainment of particles to the pumps.	Reduced survival
15b	Smolt emigration Delta	Jan-Jun.	Loss at export facilities	Percentage of the southern Sierra Nevada steelhead diversity group exposed to salvage process is considered high due to high rate of diversion of flows and particles to the export facilities. Entrainment of fish at the CVP results in loss of approximately 66 % of the exposed fish. Entrainment of fish at the SWP results in the loss of approximately 85 % of the exposed fish (see table 6-28).	High	Medium to High- numerous studies have evaluated screening efficiency, predation, and overall salvage operations for Chinook salmon survival. Recent steelhead predation studies completed (DWR 2008).	Reduced survival

15c	Smolt emigration Delta	Jan-Jun.	Project operations create a stabilized freshwater ecosystem in Delta all year, every year, instead of allowing for salinity variability.	Stabilized freshwater environment is conducive to the propagation of non-native species such as large mouth bass and other centrarchids, water hyacinth, *Egeria densa*, and asian clams. Predation on steelhead as well as shifts in useable habitat and food resources occur due to non-native species presence. Non-native species have altered the balance of the ecosystem and have increased the level of loss for fish emigrating through the Delta.	High	Low to medium. Invasion of non-native species into Delta is well documented (Cohen and Moyle 2004; Brown and Michniuk 2007; Ford and Brown 2001) interaction with steelhead populations is not as well documented	Reduced survival, Reduced growth
15d	Smolt emigration Delta	Jan-Jun.	Altered Delta hydrodynamics	Creation of reverse flows within Central and Southern Delta waterways, reduced primary and secondary productivity due to export of food web base, delay in migration through Delta due to altered hydrodynamics and loss of migratory cues. Delays increase exposure to sources of mortality and morbidity (poor water quality, contaminants, *etc.*). Affects a large fraction of the Central and Southern Delta which encompasses the migratory route of southern Sierra Nevada diversity group steelhead.	High	Low to High. Delta hydrodynamics is well studied (IEP 2008; Herbold and Moyle 1989) Effects of Delta hydrodynamics on organisms are not as well understood.	Reduced survival, reduced growth

Of equal importance to spatial structure in determining population viability is the presence of sufficient behavioral and genetic diversity within the population to allow it to be flexible and adapt to changing environmental conditions through utilization of a wide range of habitats. Some evidence indicates that the life history diversity of steelhead may be affected by CVP operations. For example, water releases from Shasta Dam have changed the thermal regime and the food web structure of the Sacramento River (Lieberman *et al*. 2001) such that a resident life history strategy may have fitness advantages over anadromous forms (Lindley *et al*. 2006). A similar situation likely applies to the Stanislaus River, which also has a hydrograph and thermal regime much different than what steelhead in that river evolved with. Little is known about the relationship of resident and anadromous forms of *O. mykiss*. Without knowing the role that resident *O. mykiss* play in population maintenance and persistence of anadromous *O. mykiss*, it is difficult to assess whether the current conditions on the Stanislaus River, which may favor residency, are detrimental to the anadromous population or not (Lindley *et al*. 2007). Zimmerman *et al*. (2008) demonstrated that resident rainbow trout can produce anadromous smolts and anadromous steelhead can produce resident rainbow trout in the Central Valley. However, the study indicated that the proportion of resident rainbow trout to anadromous steelhead in the Central Valley is largely in favor of the resident form with 740 of 964 *O. mykiss* examined being the progeny of resident rainbow trout. This proportional imbalance is even more prominent in the Stanislaus River where nearly 90 percent (139 out of 157) of *O. mykiss* sampled were offspring of resident adults (Zimmerman *et al*. 2008). In addition, the lack of specificity in how decisions will be made under real-time operations and by whom can have unpredictable effects on steelhead. The uncertain participation of Merced and Tuolumne River water operations in spring pulse flows in the future can affect the diversity and continued existence of the Stanislaus River population and of the Southern Sierra diversity group.

In addition to the negative effects on the spatial structure and life history diversity, the proposed action is expected to reduce the abundance of Stanislaus River steelhead. Mortality associated with the proposed action is expected through such sources as potential water temperature-related pre-spawn adult mortality, redd dewatering, egg suffocation from deposition of fines, and direct and indirect losses in the Delta.

The combined effects of the proposed action on the adult immigration, spawning, embryo incubation, juvenile rearing, and smolt emigration life stages of steelhead in the Stanislaus River, reduces the viability of the population and places the population, which was already at high risk of extinction due to extremely low abundance, at even greater risk. As previously described, Naiman and Turner (2000) demonstrated how even slight reductions in survival from one life stage to the next at each and every life stage can have serious consequences for the persistence of a populations. Considering that the proposed action reduces the survival of each and every steelhead life stage, including the life stage transition from smolt to adult-sized fish in the ocean, Stanislaus River steelhead may not persist with implementation of the proposed action.

Future projections over the duration of the proposed action (*i.e*., through 2030), considering both increasing water demands and climate change, exacerbate risks to Stanislaus River steelhead. For example, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007).

9.5.7 Assess Risk to the Central Valley Steelhead DPS

The proposed action is expected to expose individual steelhead from Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River to stressors that have fitness consequences for each inland life stage. Cumulatively, these fitness reductions throughout the inland steelhead life cycle, are expected to result in population level consequences for each of the four populations, reducing their viability. For Central Valley ESUs and DPSs, reductions in population viability are assumed to also reduce the viability of the diversity group the population belongs to as well as the species. Because the four diversity groups with extant steelhead populations are represented by these four populations[25], the viability of all four extant steelhead diversity groups is expected to be decreased with implementation of the proposed action. In consideration of the status and baseline stress regime of the species, these diversity group- and population-level consequences identified above greatly increase the extinction risk of the species. Given the evidence of the reduction in numbers, reproduction and/or distribution of the species, NMFS concludes that Reclamation has not ensured that the proposed action is not likely to appreciably reduce the likelihood of viability, and therefore the likelihood of both the survival and recovery of the CV steelhead DPS (table 9-12).

Table 9-12. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the CV steelhead DPS. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Not Likely/Likely to Jeopardize (NLJ/LJ).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River, Clear Creek, and Stanislaus River flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River, Clear Creek, the American River, and the Stanislaus River; (4) low late-summer flows in Clear Creek and in the American and Stanislaus rivers; and (5) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants).*	True	End
		False	Go to B
B	**CV steelhead individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to delay ~17% of the steelhead adults that spawn upstream of RBDD and all of the progeny from those adults are faced with reduced rearing habitat quantity and quality resulting from the formation of Lake Red Bluff. (2) All freshwater life stages of*	True	NLAA

[25] Clear Creek belongs to the Northwestern California diversity group; the mainstem Sacramento River population belongs to the Basalt and Porous Lava diversity group; the American River belongs to the Northern Sierra Nevada diversity group; and the Stanislaus River belongs to the Southern Sierra Nevada diversity group.

	Sacramento River, Clear Creek, and Stanislaus River steelhead will be exposed to regulated flows and their effects on river processes and morphology every year through 2030. (3) Each year through 2030, steelhead in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River are expected to be exposed to water temperatures warmer than life stage-specific requirements during multiple life stages, including egg incubation and juvenile rearing. (4) Steelhead rear in their natal stream year-round for 1 to 2 years, and thus are expected to be exposed to low late-summer flows in Clear Creek and in the American and Stanislaus rivers. (5) As water is moved from the north Delta and from the San Joaquin River to the Federal and State export facilities, each year through 2030, CV steelhead juveniles will have increased exposure to an abundant predator community, an aquatic environment degraded by pesticides and contaminants, and entrainment at the facilities.	False	Go to C
C	**CV steelhead individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Delayed upstream migration at RBDD causes individual adults to consume more energy, which limits the amount of energy available for reproduction, resulting in the deposition of fewer and/or less viable eggs. (2) Loss of natural river function resulting from flow regulation in the Sacramento River, Clear Creek, and the Stanislaus River has reduced the quality and quantity of rearing and migratory habitats, thereby reducing the growth and survival of individual steelhead juveniles in those systems. (3) Exposure to warm water temperatures in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River is expected to cause eggs deposited later (i.e., March) in the spawning season to suffer increased mortality and structural deformities during incubation, particularly during critically dry years. Thermal stress responses (e.g., reduced immune system function) are also expected to occur in individual juvenile steelhead rearing over the summer in Clear Creek and the American River. (4) Low late-summer flows limit the availability of quality rearing habitat, including predator refuge areas. Under these low flow conditions, juvenile steelhead have an increased susceptibility to predation and density dependent related factors (e.g., disease and competition for prey and habitat). (5) Mortality of juvenile steelhead migrating from the San Joaquin River to Chipps Island is expected to range from 90 to 99 %, with most of the mortality coming from project-related sources. Mortality of steelhead that enter the Delta interior from the Sacramento River is expected to range from 35 to 90 %, resulting in the loss of approximately 5-17 percent of the Sacramento River basin population of the Central Valley DPS.*	True	NLAA
		False	Go to D
D	**Any responses are not likely to constitute "take" or reduce the fitness of the CV steelhead individuals that have been exposed.** *Key Evidence: (1) The reduction in energy available for egg production associated with delayed upstream migration at RBDD reduces the fitness of individuals by reducing their reproductive capacity. (2) "Take"of steelhead individuals in the form of reduced growth and survival is expected due to the loss of natural river function associated with flow regulation in the Sacramento River, Clear Creek, and the Stanislaus river. (3) and (4) As described in step C, "take" of steelhead individuals, in the form of mortality and sub-lethal effects, is expected with exposure to warm water temperatures particularly during the egg incubation and juvenile rearing life stages, and with exposure to low flows during juvenile rearing. (5) As described in step C, "take" of steelhead individuals, in the form of mortality, is expected in the Delta during juvenile rearing/smolt emigration.*	True	NLAA
		False	Go to E
E	**Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent.** *Key Evidence: The cumulative effects of RBDD operations, flow regulation, warm water temperatures, low flows, project-related impacts in the Delta, and other project-related stressors (see tables 9-8 through 9-11) are expected to sufficiently*	True	NLJ

	reduce the survival, growth, and/or reproductive success of steelhead individuals at multiple life stages every year through 2030 such that key population parameters (i.e. spatial structure, diversity, and abundance) are appreciably reduced for steelhead populations in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River. Reductions in these parameters are of sufficient magnitude for one to reasonably expect a reduction in the viability of each of the four populations.	False	Go to F
F	**Any reductions in the viability of the exposed populations are not likely to reduce the viability of CV steelhead the species.** *Key Evidence: Considering the greatly diminished status of the CV steelhead DPS, NMFS assumes that if a population-level effect on any of the populations within the DPS is expected from implementation of the proposed action, then a species-level effect will be expected as well. The proposed action is expected to reduce the viability of at least four steelhead populations. Therefore, the viability of the DPS is expected to be significantly reduced with implementation of the proposed action.*	True	NLJ
		False	LJ

9.6 Central Valley Steelhead Critical Habitat

Following much of the same logic introducing the integration and synthesis of the CV steelhead species analysis presented in section 9.5, the following discussion will not address effects to critical habitat for every extant population affected by the proposed action, but will focus on how critical habitat for steelhead in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River is expected to be affected by the proposed action. By focusing on these four areas, all steelhead critical habitat that is affected by the proposed action is evaluated.

9.6.1 Status of Central Valley Steelhead Critical Habitat

It is estimated that 80 percent of the historic spawning and rearing habitat for CV steelhead is above impassable dams as is the case for the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers. All critical habitat for Central Valley steelhead occurs below impassable barriers. As such, steelhead critical habitat largely occurs in areas that historically functioned as either rearing or migratory habitats.

Critical habitat for CV steelhead is composed of PCEs that are essential for the conservation of the species including, but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Stressors to CV steelhead PCEs are similar to the stressors described for spring-run critical habitat and include water diversions and water management, dams and other structures, loss of floodplain connectivity, loss of natural riverine function, bank protection; dredging, sediment disposal, gravel mining, invasive aquatic organisms, and agricultural, urban, and industrial land use (McEwan 2001). In addition, unlike spring-run critical habitat which excludes much of the Delta, steelhead critical habitat includes the Delta – an ecosystem that has had dramatic habitat changes in recent years related to water quality, toxic algae blooms (*e.g.*, Microcystis), and invasive species (*e.g.*, the aquatic macrophyte *Egeria densa*). Based on the host of stressors to spawning, rearing, migratory, and estuarine habitats in the Central Valley, it is apparent that the current condition of CV steelhead critical habitat is degraded, and does not provide the conservation value necessary for the survival and recovery of the species.

9.6.2 Northwestern California Diversity Group

9.6.2.1 Steelhead Critical Habitat in Clear Creek

9.6.2.1.1 Status of Steelhead Critical Habitat in Clear Creek

Whiskeytown Dam at RM 18.1 is an impassable barrier to adult anadromous salmonids and marks the upstream extent of potential steelhead habitat. Prior to 2000, the McCormick-Saeltzer Dam presented a barrier to upstream migration for anadromous salmonids. Following removal of the Dam in 2000, access to approximately 12 miles of coldwater habitat upstream to Whiskeytown Dam was restored. The construction of Whiskeytown Dam, gold mining, and significant gravel mining in the Clear Creek watershed has diminished the availability and recruitment of suitable spawning gravels. Gravel injection projects are conducted to make up for this loss of spawning gravel recruitment, but limited spawning habitat availability is a problem in Clear Creek.

Currently the release schedule from Whiskeytown Dam calls for flows of 200 cfs from October 1 to June 1 and 150 cfs, or less, from July through September in order to maintain water temperatures below 60°F. Under dry and warm climate conditions, water temperatures above 60°F occur in Clear Creek. Lindley *et al*. (2004) suggested that Clear Creek appears to offer habitat of marginal suitability to steelhead, having limited area at higher elevations and being highly dependent on rainfall.

9.6.2.1.2 Project Effects on Steelhead Critical Habitat in Clear Creek

The proposed action adversely affects Clear Creek critical habitat for steelhead in a few ways. The proposed action produces stressors to steelhead critical habitat in Clear Creek that primarily affect rearing habitat. Flow regulation impairs natural river processes and decreases habitat complexity and variability, which limits the quality and quantity of rearing habitat. Additionally, low flows and warm water temperatures during the summer limit the availability of quality rearing habitat.

9.6.2.1.3 Assess Risk to Steelhead Critical Habitat in Clear Creek

At least six factors, when considered together, suggest that implementation of the proposed action is expected to place critical habitat for Clear Creek steelhead at considerable risk. First, the habitat within Clear Creek is believed to be of marginal suitability for steelhead (Lindley *et al*. 2004). Second, rearing and migratory habitats within the Sacramento River are believed to be substantially degraded and generally would be considered as not properly functioning (NMFS 1996b). Third, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Fourth, estuarine habitats have been substantially degraded (*e.g*., Sommer *et al*. 2007) and climate change is expected to further alter estuarine habitats through sea level rise and hydrological changes. Fifth, under current usage practices, human population growth will place an increasing demand on limited water supplies, potentially exacerbating adverse effects to spawning, rearing, migratory,

and estuarine habitats. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will decrease the conservation value of these habitats (table 9-8).

9.6.3 Basalt and Porous Lava Diversity Group

9.6.3.1 Steelhead Critical Habitat in the Mainstem Sacramento River

9.6.3.1.1 Status of Steelhead Critical Habitat in the Mainstem Sacramento River

Within the range of CV steelhead, biological features of the designated critical habitat that are considered vital for steelhead include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. As generally described above in section 9.6.1, the status of critical habitat in each of these biological features is considered to be degraded. Freshwater rearing and migration habitats have been degraded by RBDD operations which delay upstream migration, reduce the availability of quality rearing habitat through the related seasonal creation of Lake Red Bluff, and create improved feeding opportunities for predators such as pikeminnow and striped bass. Additional adverse effects to rearing and migration habitats within the Sacramento River include loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use. The status of estuarine habitats for steelhead also is considered to be highly degraded as is evident by the collapse of pelagic organisms in the Delta (Sommer *et al*. 2007, IEP 2008). It is not immediately clear how the changes in the Delta ecosystem affect steelhead, but it is certain that substantial changes to steelhead estuarine habitat are occurring.

9.6.3.1.2 Project Effects on Steelhead Critical Habitat in the Mainstem Sacramento River

The proposed action negatively affects critical habitat for steelhead from the mainstem Sacramento River in several ways. As shown in table 9-9 above, the proposed action produces stressors to rearing (RBDD, Lake Red Bluff), migratory (RBDD), and estuarine (entrainment of juveniles into central and south Delta) habitats for mainstem Sacramento River steelhead.

9.6.3.1.3 Assess Risk to Steelhead Critical Habitat in the Mainstem Sacramento River

At least five factors, when considered together, suggest that implementation of the proposed action is expected to place critical habitat for mainstem Sacramento River steelhead at considerable risk. First, spawning, rearing, and migratory habitats within the mainstem Sacramento River are believed to be substantially degraded and generally would be considered as not properly functioning (NMFS 1996b). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Third, estuarine habitats also have been substantially degraded (*e.g*., Sommer *et al*. 2007) and climate change is expected to further alter these habitats through sea level rise and hydrological changes. Fourth, under current usage practices, human population growth will place an increasing demand on limited water supplies, potentially creating or exacerbating adverse effects to spawning, rearing, migratory, and estuarine habitats. Lastly, the

proposed action is expected to produce stressors every year for the next 21 years that will further compromise the conservation value of rearing, migratory, and estuarine habitats (see table 9-9).

9.6.4 Northern Sierra Nevada Diversity Group

9.6.4.1 Steelhead Critical Habitat in the American River

9.6.4.1.1 Status of Steelhead Critical Habitat in the American River

The PCEs of critical habitat for lower American River steelhead include freshwater spawning, freshwater rearing, freshwater migration, and estuarine habitats. There is a general consensus in the available literature suggesting that habitat for steelhead in the American River is impaired (CVP/SWP operations BA; Water Forum 2005a,b; SWRI 2001; McEwan and Nelson 1991; CDFG 2001). Of particular concern are warm water temperatures during embryo incubation, rearing, and migration, flow fluctuations during embryo incubation and rearing, and limited flow-dependent habitat availability during rearing. All of these concerns are related to water management operations of the CVP.

In addition, the status of estuarine habitats for steelhead also is considered to be highly degraded as is evident by the collapse of pelagic organisms in the Delta (Sommer *et al*. 2007, IEP 2008). It is not immediately clear how the changes in the Delta ecosystem affect steelhead, but it is certain that substantial changes to steelhead estuarine habitat are occurring.

9.6.4.1.2 Project Effects on Steelhead Critical Habitat in the American River

Steelhead spawning (embryo incubation) and rearing PCEs in the American River are expected to be negatively affected by flow and water temperature conditions associated with the proposed action. For example, steelhead spawning, egg incubation, and rearing habitat in the lower American River is adversely affected by flow fluctuations, which can result in redd dewatering and isolation, fry stranding, and juvenile isolation. Additionally, steelhead egg incubation, juvenile rearing, and migratory habitat quality is expected to be reduced by the occurrence of warm water temperatures.

9.6.4.1.3 Assess Risk to Steelhead Critical Habitat in the American River

At least five factors, when considered together, suggest that implementation of the proposed action is expected to place critical habitat for American River steelhead at considerable risk. First, spawning, rearing, and migratory habitats within the American River are believed to be substantially degraded and generally would be considered as not properly functioning (NMFS 1996b). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Third, estuarine habitats also have been substantially degraded (*e.g*., Sommer *et al*. 2007) and climate change is expected to further alter these habitats through sea level rise and hydrological changes. Fourth, annual water demands by 2030 are expected to be about three to four times higher than current levels. This increased water demand is expected to result in considerable challenges to flow and

water temperature management for American River aquatic resources below Nimbus Dam, and will likely exacerbate the adverse habitat conditions already occurring in the river under present day water demands. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will further compromise the conservation value of spawning (*i.e*., embryo incubation), rearing, migratory, and estuarine habitats (see table 9-10).

9.6.5 Southern Sierra Nevada Diversity Group

9.6.5.1 Steelhead Critical Habitat in the Stanislaus River

9.6.5.1.1 Status of Steelhead Critical Habitat in the Stanislaus River

Steelhead critical habitat on the Stanislaus River has been designated up to Goodwin Dam. The PCEs of critical habitat for Stanislaus River steelhead include freshwater spawning, freshwater rearing, freshwater migration, and estuarine habitats. Although Stanislaus River water temperatures are generally suitable for spawning and rearing, during the smolt emigration life stage (January through June), steelhead are exposed to water temperatures that would prohibit successfully completing transformation to the smolt stage. In addition, steelhead spawning and rearing habitat on the Stanislaus River is affected by the limited occurrence of flows that are sufficient to carry out natural geomorphic processes. As such, sediment deposition on spawning habitats has decreased the availability of suitable spawning areas. Without strategic releases for geomorphic processes to manage fine sediment deposition in spawning gravels, spawning beds will be increasingly choked with sediment and unsuitable for spawning. The relatively low and uniform releases in the Stanislaus River adversely affect rearing habitat by reducing habitat complexity and decreasing connectivity with flood plains, areas proven to be high quality rearing habitats (Sommer *et al*. 2005). In addition, the status of estuarine habitats for steelhead also is considered to be highly degraded as is evident by the collapse of the pelagic community in the Delta. This collapse is, in part, related to dramatic habitat changes in recent years related to water quality, toxic algae blooms (*e.g*., Microcystis), and invasive species (*e.g*., the aquatic macrophyte *Egeria densa*). It is not immediately clear how the changes in the Delta ecosystem affect steelhead, but it is certain that substantial alterations to steelhead estuarine habitat are occurring.

9.6.5.1.2 Project Effects on Steelhead Critical Habitat in the Stanislaus River

Aside from the effect to estuarine habitats, the factors affecting the current status of critical habitat for Stanislaus River steelhead are all related to operations of the East Side Division of the CVP. Because the proposed action is the continued operation of the East Side Division in a manner that is presumably[26] generally consistent with past operations, it is expected that the proposed action will continue to compromise the conservation value of the spawning, freshwater rearing, and freshwater migration corridors PCEs of critical habitat within the Stanislaus River. In addition, Delta division operations are expected to compromise estuarine habitat for steelhead by effects to outflow and water quality.

[26] Many details of East Side Division operations were not clearly described in the project description.

9.6.5.1.3 Assess Risk to Steelhead Critical Habitat in the Stanislaus River

At least five factors, when considered together, suggest that implementation of the proposed action is expected to place critical habitat for Stanislaus River steelhead at considerable risk. First, spawning, rearing, and migratory habitats within the Stanislaus River are believed to be degraded and generally would be considered as not properly functioning (NMFS 1996b). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley *et al*. 2007). Third, estuarine habitats also have been substantially degraded (*e.g.*, Sommer *et al*. 2007) and climate change is expected to further alter these habitats through sea level rise and hydrological changes. Fourth, under current usage practices, human population growth will place an increasing demand on limited water supplies, potentially creating or exacerbating adverse effects to spawning, rearing, migratory, and estuarine habitats for steelhead from the Stanislaus River. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will further compromise the conservation value of spawning, rearing, migratory, and estuarine habitats (see table 9-11).

9.6.6 Assess Risk to Central Valley Steelhead Critical Habitat

At least five factors, when considered concurrently, suggest that implementation of the proposed action is expected to place CV steelhead critical habitat at considerable risk. First, the status of steelhead critical habitat is one characterized by severe degradation including factors such as warm water temperatures and low flows, loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, loss of tidal wetland habitat, a collapsed pelagic community in the Delta, and poor water quality associated with agricultural, urban, and industrial land use. In general, much of the spawning, rearing, migratory, and estuarine habitat for steelhead would be considered as not properly functioning (NMFS 1996b). Second, climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, overall drier conditions (Lindley *et al*. 2007), and altered estuarine habitats through changes in hydrology and sea level rise. Third, under current practices, human population growth will place an increasing demand for limited water supplies, potentially exacerbating adverse effects to spawning, rearing, migratory, and estuarine habitats. Lastly, the proposed action is expected to produce stressors every year for the next 21 years that will further compromise the conservation value of steelhead spawning and rearing habitats in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River, and further compromise the conservation value of migratory and estuarine habitats for all extant steelhead populations.

Based on the analysis of available evidence, NMFS concludes that the proposed action is likely to reduce the conservation value of the critical habitat, as designated, for the conservation of CV steelhead (table 9-13).

Table 9-13. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Central Valley Steelhead Designated Critical Habitat. Application of Key Evidence is Provided in Italics. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment.** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, and creating favorable conditions for predators); (2) Sacramento River, Clear Creek, and Stanislaus River flow regulation disrupting natural river function and morphology; (3) warm water temperatures in the mainstem Sacramento River, Clear Creek, the American River, and the Stanislaus River; (4) low late-summer flows in Clear Creek and in the American and Stanislaus rivers; (5) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants) and (5) construction of the South Delta Permanent Gates.*	True	End
		False	Go to B
B	**Areas of designated critical habitat for CV steelhead are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to delay ~17% of the steelhead adults that spawn upstream of RBDD and all of the progeny from those adults are faced with reduced rearing habitat quantity and quality resulting from the formation of Lake Red Bluff. (2) Holding, spawning, rearing, and migratory habitats in the Sacramento River, Clear Creek, and the Stanislaus River will be exposed to regulated flows and their effects on river processes and morphology every year through 2030. (3) Each year through 2030, multiple habitat types including those supporting egg incubation and juvenile rearing in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River are expected to be exposed to water temperatures warmer than life stage-specific requirements. (4) Each year through 2030, rearing habitats in Clear Creek and in the American and Stanislaus rivers will be exposed to low flows particularly during the late-summer. (5) As water is moved from the north Delta and from the San Joaquin River to the Federal and State export facilities, each year through 2030, a large portion of emigrating steelhead will be entrained in low quality habitats characterized by an abundant predator community, an aquatic environment degraded by pesticides and contaminants, and increased risk of direct entrainment at the facilities. (5) Constructio of South Delta Permanent Gates will alter approximately 25 miles of waterways resulting in additional predator structure, altered hydrodynamics, and impacted migratory corridors for CV steelhead originating in the San Joaquin River basin.*	True	NLAA
		False	Go to C
C	**The quantity, quality, or availability of all constituent elements of CV steelhead critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed action.** *Key Evidence: (1) Each year through 2019, RBDD operations will reduce the quality of migratory habitat for steelhead adult immigration, as well as the quality and quantity of juvenile rearing habitat through the formation of Lake Red Bluff. (2) Loss of natural river function resulting from flow regulation has reduced the*	True	NLAA

	quality and quantity of rearing and migratory habitats in the Sacramento River, Clear Creek, and the Stanislaus River. (2) Each year through 2030, the provision of water temperatures warmer than life stage-specific requirements will reduce the quantity and quality of steelhead egg incubation habitats in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River; the quality of rearing habitats in Clear Creek and the American River also will be reduced. (3) Low late-summer flows limit the availability of quality rearing habitat, including predator refuge areas. (4) Each year through 2030, the quality of rearing and migratory habitats is reduced by entraining juvenile steelhead into low quality habitats in the central and south Delta. (5) Construction of South Delta Permanent Gates will increase structure for predators and diminish migratory corridor value of the South Delta waterways to CV steelhead originating in the San Joaquin River basin.	False	Go to D
D	**Any reductions in the quantity, quality, or availability of one or more constituent elements of CV steelhead critical habitat are not likely to reduce the conservation value of the exposed area.** *Key Evidence: Reductions in the conservation value of migratory, egg incubation, and rearing habitats are expected due to reductions in the quantity, quality, or availability of critical habitat constituent elements resulting from (1) RBDD operations; (2) flow regulation in the Sacramento River, Clear Creek, and Stanislaus River; (3) the provision of water temperatures warmer than life stage-specific requirements in Clear Creek, the mainstem Sacramento River, the American River, and the Stanislaus River; (4) low late-summer flows in Clear Creek, and the American and Stanislaus rivers; (5) the movement of water towards the Federal and State pumping plants; and (6) Construction of South Delta Permanent Gates creates impediments to migration and increased predator habitat.*	True	-
		False	Go to E
E	**Any reductions in the conservation value of the exposed area of CV steelhead critical habitat are not likely to reduce the conservation value of the critical habitat designation.** *Key Evidence: Because the conservation value of all inland habitat types (migratory, spawning/egg incubation, and rearing) necessary to complete the steelhead life cycle are expected to be reduced with implementation of the proposed Action, it is likely that the conservation value of the critical habitat designation will also be reduced.*	True	No AD MOD
		False	AD MOD

9.7 Southern DPS of North American Green Sturgeon

9.7.1 Status of Southern DPS of Green Sturgeon

Information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has recently emerged. Lindley (2006) presents preliminary results of large-scale green sturgeon migration studies. Lindley's analysis verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River. This information also agrees with the results of green sturgeon tagging studies completed by CDFG in which a total of 233 green sturgeon were tagged in the San Pablo Bay estuary between 1954 and 2001 (CDFG 2002), and tagged fish were recovered in the Sacramento-San Joaquin Estuary, in the Pacific Ocean off of California, from commercial fisheries off of the Oregon and Washington coasts, and in the Columbia River estuary (CDFG 2002).

Known historic and current spawning occurs in the Sacramento River (Adams *et al.* 2002, Beamesderfer *et al.* 2004). Currently, upstream migrations of sturgeon are permanently blocked by Keswick and Shasta Dams on the mainstem of the Sacramento River. Although no historical accounts exist for identified green sturgeon spawning occuring above the current dam sites, suitable spawning habitat existed based on habitat assessments done for Chinook salmon, and the geographic extent of spawning has been reduced due to the impassable barriers constructed on the river. Seasonal operations of the RBDD have blocked various proportions of the adult spawning population from the river segments upstream of the RBDD location. The initial operations of the RBDD with gates in all year long precluded any spawning above the dams location for green sturgeon. Subsequent modifications in the RBDD gate closures have allowed greater fractions of the population to ascend the Sacramento River and utilize the spawning habitat in the upper 53 mile between the RBDD and the ACID Dam. Today, with gates in from May 15 to September 15, approximately half of the adult spawning run of green sturgeon can move upriver to spawn prior to the closure of the gates.

Green sturgeon spawning on the Feather River (part of the Southern DPS) is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. This continued presence of adults below the dam suggests that fish are trying to migrate to upstream spawning areas now blocked by the dam which was constructed in 1968.

Spawning in the San Joaquin River system has not been recorded historically or observed recently, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the european settlement of the region. During the latter half of the 1800s impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for approximately a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. It is likely that both white and green sturgeon utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

Population abundance information concerning the Southern DPS green sturgeon is described in the NMFS status reviews (Adams *et al*. 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al*. 2002). In the past two years, captures of juvenile and larval green sturgeon have been very low at the monitoring sites at RBDD and GCID, indicating poor

spawning success in those years. Information regarding changes in the abundance of the Southern DPS of green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of North American green sturgeon entrained per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the proportion of the Southern DPS of green sturgeon in the catch is unknown as these captures were primarily located in San Pablo Bay which is known to consist of a mixture of Northern and Southern DPS green sturgeon. Recent spawning population estimates using sibling based genetics by Israel (2006) indicates a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately 2 weeks of age) and GCID (downstream; approximately 3 weeks of age), it appears the majority of Southern DPS of green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously.

Since green stugeon are iteroparous, each adult is capable of making several spawning runs during its lifestime. Individual year class failures may occur, but do not necessarily indicate an eminent decline in the viability of the DPS. Sustained year class failures over multiple years however are cause for concern. In addtion, rapid declines in the abundance of any one of the life history stages would also indicate potential population declines, particularly in the sub-adult or adult life stages. Population modeling by Heppell (2007) indicates that there is a high sensitivity to population growth rate to changes in the survival rate of sub-adult and adult fish. Significant increases in the survival of YOY green sturgeon or annual egg production is required to compensate for even low levels of mortality in the sub-adult or adult life stages (*i.e.*, mortalities associated with RBDD gate operations), since a single female produces between 60,000 and 140,000 eggs (Moyle *et al*. 1992, Moyle 2002), and therefore, contributes significantly to the population. In response to these vulnerabilities, sportfishing for green sturgeon has been eliminated in the west coast waters of the United States where members of the Southern DPS would be vulnerable to harvest. However, hooking mortality of green stugeon incidently caught while fishing for other species (*i.e.*, white stugeon) still remains and significant numbers of green sturgeon remain vulnerable to sportfishing in the Delta and Sacramento River regions. Even low levels of hooking mortality can be detrimental to a long-lived species such as green sturgeon. Long-lived species like sturgeon can experience several encounters with sportfisherman, and each encounter carries a risk of mortal injury from the hooking experience. As the number of encounters increases, the risk of a fatal encounter increases. Southern DPS of green sturgeon become vulnerable to sportfishing when in the Sacramento River and the San Francisco Bay estuary during spawning migrations as well as during summer “congregations” in estuaries along the west coast of the United States. This vulnerability is somewhat mitigated by the dominant

marine orientation of these fish which, distances them from sportfishing exposure for most of their life history. Another factor that influences green sturgeon adult and sub-adult life stages is the bycatch of green sturgeon during the commercial white sturgeon fisheries activities in the northwest. During commercial fishing activities, some green sturgeon are retained as bycatch. This represents a source of mortality to the Southern DPS of green sturgeon due to the high percentage of Southern DPS of green sturgeon in the Columbia River estuary population.

Southern DPS of green sturgeon remain vulnerable to extirpation due to the one extant population in the Sacramento River and the limited region in which they can potentially spawn in the river. No identified spawning activities, let alone separate independent populations, have been identified in the large tributaries to the Sacramento River to date and thus the one spawning population is vulnerable to catastrophes in the spawning reach surrounding the RBDD (*i.e.*, contaminant spills, increasing water temperatures, flow alterations, *etc*.). To further complicate the determination of the status of the Southern DPS of green sturgeon, no empirical estimates of abundance or recruitment exist for this population.

NMFS concludes that the Southern DPS of North American green sturgeon remains vulnerable to becoming endangered in the future. Key factors upon which this conclusion is based include: (1) the DPS is comprised of only one spawning population, which has been blocked from a considerable portion of its potenital spawning range by dams; (2) the DPS has a risk associated with catastrophies and environmental perturbations (*i.e.*¸water temperatures from Shasta Dam) affecting current spawning areas; (3) mortality rates have significant effects on the adult and sub-adult life history phases of this long-lived species. There are both advantages and disadvantages to being long lived. Longevity enables the species to engage in multiple spawning behaviors over a long period of time, thus increasing the probability that at least one brood year will be successful to carry on the population, among many less successful brood years. However, long-lived species tend to be slower in reaching maturity (12 to 20+ years for green sturgeon) and fish may be lost to the population before being able to spawn for the first time. In addition, long-lived species are at agreater risk of mortality due to exposure to fishing presure and contaminants.

9.7.2 Baseline Stress Regime on Southern DPS of Green Sturgeon Excluding CVP/SWP Effects

Adult green sturgeon in the Delta would likely experience sublethal effects through their exposure to a wide spectrum of contaminants, including originating in urban stormwater runoff (which contains petroleum products, heavy metals, and various organic solvents), agricultural derived runoff (*i.e.*, pesticides, herbicides, fertilizers, and animal wastes), and wastewater treatment plants (metals, pharmaceuticals, personal care products, organic compounds). The duration and level of exposure, as well as the toxicity of the contaminant, will determine the physiological response of the exposed organism. Sublethal effects include a diminishment of their reproductive capacity, and incremental increases in the contaminant burden in their body tissues. Reductions in productivity are possible due to the effects of contaminants on the different organ systems and metabolic pathways of the exposed organism, which may lead to reduced egg fertility or reduced viability and motility of spermatocytes during spawning. Furthermore, since sturgeon are long lived (60 to 70+ years) they may make repeated spawning

migrations through the Delta and continually ingest contaminated forage prey or be exposed to contaminants in the water column that would add to their total body burdens during these spawning migrations.

Adult green sturgeon will be exposed to fishing pressure and may experience hooking mortalities due to incidental catches by fisherman targeting other species. Reductions in productivity may occur if gravid females abort their spawning runs following capture and returning downstream without spawning due to excessive stress from the capture and release process. The proportion of the population that will exhibit this behavior is unknown.

9.7.3 Summary of Proposed Action Effects on Southern DPS of Green Sturgeon

Delays in migration of adult green sturgeon due to the installation and operation of the SDIP phase 1 facilities are possible. Adult green sturgeon that are trapped behind the permanent gates could have a reduction in fitness, or eventual mortality of the exposed fish over the course of the irrigation season, if this impedance in movement is prolonged due to lower water quality and limitations in food resources.

Adult green sturgeon encounter major passage impediments due to the installation of dams in the upper Sacramento River. The ACID dam is installed in early April approximately 5 miles below Keswick Dam, effectively blocking utilization of this stretch of river by spawning green sturgeon. Those green sturgeon that pass through the location of the ACID dam prior to its closure in April, are trapped behind it until it is removed in October. The percentage of the green sturgeon spawning run that would be able to access the uppermost 5 miles of the Sacramento River below Keswick Dam is unknown precisely, but is estimated to represent at a maximum only 15 to 20 percent of the spawning run based on fish passage estimates at RBDD 53 miles downstream. It is highly likely that only a small proportion of those fish passing the location of the RBDD prior to April would move all the way up to the location of the ACID dam.

The RBDD is currently installed in the Sacramento River on May 15 and effectively blocks adult green sturgeon movement upstream of its location until it is removed in mid-September. This schedule also will be implemented during the near future operations as described in the CVP/SWP operations BA. Future operations (beginning in 2019) will modify gate closures to 10 days in May, open in June, and closed again during the months of July and August. RBDD blocks access to 53 miles of spawning and rearing habitat between the RBDD location and the ACID dam. Under current operations, an estimated 35 to 40 percent of the potential spawning population moving upstream on the Sacramento River may be blocked by the closure of the RBDD based on run timing. Fish that have successfully passed upstream of the dam before its closure are faced with injury or mortality when they move back downstream following their spawning activities. Such an occurrence was observed in 2007, following the reopening of the RBDD gates with only a 6-inch clearance below the gates, when approximately 10 to 12 adult green sturgeon were killed due to impingement or physical trauma related to the gates. Current and future gate closures will maintain a minimum of 12 inches of clearance below the gates to allow passage of adult sturgeon beneath the gates without impingement. Closure of the RBDD gates also forces green sturgeon to hold below the dam. These fish may not spawn at all before moving back downstream to the Delta and ocean, or are forced to spawn in areas downstream of

the RBDD. Spawning activity has recently been confirmed near the confluence of Antelope Creek with the Sacramento River based on observations of spawning behavior and recovery of eggs downstream of the site. However, relative success of these downstream spawning events compared to the success of spawning events occurring upstream of RBDD are unknown. Conditions may be less favorable downstream of the RBDD location for spawning, however ambient water temperature appears to be generally satisfactory ($\leq 17^{o}$C or 62°F) in the Sacramento River downstream to Hamilton City during the critical egg fertilization and incubation period following spawning activities. Water temperatures in excess of 17°C (62°F) cause substantial increases in egg mortality or deformities in the hatching embryos if they survive to hatching. The suitability of spawning areas below the location of the RBDD may be further restricted in the future due to increased water temperatures resulting from climate warming as modeled under the different climate change scenarios. NMFS anticipates that the closures of the ACID dam and the RBDD will increase the loss of individual fish and reduce the abundance of adult fish in the green sturgeon population.

Additional potential adult migration barriers to green sturgeon on the Sacramento River include the Sacramento Deep Water Ship Channel Locks, Freemont Weir, Sutter bypass, and the DCC gates. Table 9-14 provides a summary of of proposed action-related effects on the Southern DPS of green sturgeon.

9.7.4 Assess Risk to the Population

Events such as the 2007 loss of fish from the gate closures potentially impact a large segment of the spawning adult population that may take years to replace (*i.e.*, large mature females with correspondingly large egg production and spawning success). Blocking access to upstream spawning areas will likely decrease the productivity and spatial structure of the green sturgeon population. Fish forced to spawn below RBDD are believed to have a lower rate of spawning success compared to those fish that spawn above the RBDD. Furthermore, reductions in genetic diversity may occur due to the separation of upstream and downstream populations created anthropogenically by the closure of the RBDD on May 15. The dam closure artificially prevents the interchange of genetic material between early arriving fish that move above the dam prior to closure and those blocked by the dam after May 15. It is unknown whether early migratory behavior is genetically controlled or is a result of random events in the life history of the fish as it migrates from the ocean to the spawning grounds and whether this characteristic is expressed each time the individual fish makes a spawning run during its lifetime. In addition, the population level effects will take several years to manifest themselves due to the longevity of the species. Failure to spawn successfully in one particular year can be mitigated for in a following spawning cycle, giving rise to strong year classes and weaker year classes. The trend over several generations will dictate the trajectory of the population viability over time.

Table 9-14. Summary of proposed action-related effects on green sturgeon.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
1	Adult Immigration Delta	Feb. – Sep. (peak in Apr.)	DCC gate closures & Suisun Marsh Salinity Control gates	Sturgeon adults could encounter gates closed from March to May and may be delayed in the Delta resulting in greater exposure to both the in-river sport fishery and contaminants (reduced egg fertility or reduced viability and motility of spermatocytes during spawning).	Low	Low - based on limited supporting data	Unknown
2	Adult Immigration Delta	Feb. – Sep. (peak in Apr.)	Low flows during March - June	Adults need large spring flows to trigger movement upstream to spawn, low flows may delay migration enough that they encounter RBDD closed gates and are forced to spawn downstream in less suitable habitat	Medium	Low – based on new data from acoustic tagging studies	Reduced survival and reduced reproductive success
3	Adult Immigration & emigration RBDD	Mar. - Dec.	RBDD gate closures from May 15 - Sept 15 (every year until 2019).	Passage blocked, 55 miles of spawning habitat made inaccessible upstream of RBDD after May 15. Large aggregations (25-30) of spawning adults observed below RBDD gates. Estimate 35% of run blocked based on run timing. Also, mortalities associated with downstream passage under gates post-spawn, or after fish move above gates. Mortality greater on larger, more fecund females that can not fit through 18” opening.	High	High - based on run timing and recent tagging studies.	Reduced survival and reduced reproductive success.
4	Adult Immigration RBDD	Apr. – May 15.	Emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed (40 -50%) based on run timing; Greater mortalities associated with downstream passage under gates post spawn, or after moving above gates, sub lethal effects on eggs in fish and energy loss. Occurred twice in the past 10 years, but the frequency of occurrence may increase with climate change.	High	High - based on TCCA EIS/EIR on RBDD and CVP/SWP operations BA	Reduced survival and reduced reproductive success. (note: 12 adults were observed killed by gates in 2006)
5	Adult Immigration ACID	Apr. – May 15.	ACID gate closure April to November	Passage blocked to 5 miles of spawning habitat below Keswick Dam.	Unknown	Low – based on unknown use of this area and how much spawning area is needed.	Reduced habitat and reduced spawning success.

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
6	Adult Holding	Jun. – Dec.	Water temperature and low flows	Some adults may hold for up to 9 months in the upper Sacramento River post-spawn waiting for an increase in flows to move downstream. Water temperatures in September and October may stress individuals after the cold water pool is depleted. Dam controlled releases reduce the first pulse flow in the fall that may trigger adults to move out, so they stay longer in upstream areas. Delayed emigration, reduced fitness, longer periods between spawning runs.	Unknown	Low – no studies to support	Reduced probability of repeat spawning
7	Spawning	Apr. – Jul.	RBDD	Unnatural spawning site created below RBDD, portion of run (only one in CV) spawning in water 2 feet deep, channel aggradation below hydraulics from gates, eggs suffocate, physiological effects, delayed hatch, greater predation on eggs due to accumulation of predators below RBDD.	High	High – based on one year's data on egg and larval spawning habitat (FWS 2009), visual observations, & underwater photography	Reduced reproductive success
8	Spawning	Apr. – Jul.	Blocked access to individuals above RBDD	Spawners that migrate upstream after the RBDD gates go in are prevented from spawning with the portion of the run already above RBDD. Reduced genetic variability, may reduce fecundity, or size of fish if smaller adults arrive first.	Unknown	Low, based on theory	Reduced survival and reduced reproductive success
9	Embryo Incubation	Apr. – Aug.	Water temperatures warmer than life history stage requirements below Hamilton City.	For eggs and fry that are spawned in areas from RBDD to Hamilton water quality is less suitable than above RBDD where temperatures are controlled for winter-run Chinook. Eggs suffocate from less flow, physiological effects, delayed hatch, greater predation on eggs due to presence of non-native introduced warm-water species.	Medium	Low – spawning distribution based on only one year of data.	Reduced egg survival and reduced reproductive success

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
10	Juvenile rearing to Hamilton City	Jun. – Nov.	Water temperatures warmer than life history stage requirements.	Juveniles move downstream immediately after hatching and encounter sub-optimum temperatures below Hamilton City due to truncated spawning distribution. May reduce growth, feeding, delay emigration, and increase predation from warm water species.	Unknown	Low – no studies to support this.	Reduced survival
11	Juvenile rearing Upstream of and including RBDD	Jun. – Nov.	Lake Red Bluff, river impounded May15 - Sept 15	Reduction in rearing habitat quality and quantity; increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967.	High	High - based on number of river miles affected by the formation of Lake Red Bluff	Reduced survival and reduced growth
12	Juvenile rearing Upstream of and including RBDD	Jun. – Nov.	RBDD passage downstream through dam gates May15 - Sept 15	Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 100 % of the green sturgeon DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008). Approximately 70 % of the entire green sturgeon DPS spawns above RBDD. Mortality of juvenile salmon emigrating past RBDD when the gates are in ranges from 5 -50 % (Vogel *et al*. 1988; Tucker 1998); mortality of juvenile green sturgeon emigrating past RBDD has not been estimated, but is expected to increase when the gates are in.	High	High - based on knowledge of predator congregations forming below RBDD when the gates are in (Vogel *et al*. 1988; Tucker 1998) and timing of sturgeon emigration (TCCA 2008).	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
13	Juvenile rearing RBDD to Colusa	Jul. - Nov.	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in fall), modifies critical habitat, including impaired geomorphic process	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	High - based on CALFED funded Ecological Flow Tool model (Sac EFT)	Reduced survival and reduced growth
14	Juvenile rearing	Jul. – Nov.	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	High based on the abundance of unscreened diversions and on Mefford and Sutphin (2009)	Reduced survival
15	Juveniles Colusa to Sacramento and enter Delta	Jun. – Nov.	Low fall flows	Emigration delayed, higher predation; fewer juveniles survive to the Delta	Unknown	Low – no studies to support this.	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
16	Juvenile and subadult Clifton Court Forebay	July and August	Contaminant exposure	Application of copper based herbicides for control of aquatic nuisance weeds and algae in Clifton court Forebay. Copper is a toxicant that affects among other things, olfactory response, animal behavior, and cellular membrane functions at low concentrations. Expected treatment concentrations of dissolved copper, as formulated in the herbicide, exceed lethal levels for salmonids. Presence of green sturgeon during July and August is confirmed by the salvage records of the CVP and SWP facilities	Unkown - Percentage of juvenile Southern DPS population within CCF is unknown during treatment period	High Copper is a known toxicant to sturgeon based on studies with other sturgeon species. Sensitivities are similar to salmonids based on previous studies. Exposure studies of copper herbicide Komeen have indicated potential adverse effects on exposed salmonids	Reduced survival, reduced growth, impaired olfactory response. Alterations to cellular membrane functions.
17	Juvenile and subadult Delta	Year round	Loss at export facilitiest	Entrainment of fish at the CVP and SWP in every month of the year. Louvers function well for larger fish but are inefficient for smaller fish. Fish behavior may make them susceptible to the cleaning practices of louvers. In louver studies, fish position themselves in front of the bottom edge of the louver along the channel bottom, where they held position for prolonged periods of time.	Unknown Percentage of juvenile and subadult population entrained is unknown due to lack of information on the abundance of these life stages.	Medium Studies with other species of sturgeon have assessed louver efficiency. No studies with green sturgeon	Reduced survival

#	Life Stage/ Location	Life Stage Timing	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect (High, Medium, Low)	Weight of Evidence (High, Medium, Low)	Probable Fitness Reduction
18	Juvenile and subadult Delta	Year round	Impaired movements through South Delta waterways due to temporary barriers or permanent gates	Presence of green sturgeon juveniles and subadults in the South Delta as confirmed by salvage records. Presence occurs during operational season of barriers (April through November). Closure of waterways by temporary barriers or permanent gates inhibits movement of green sturgeon through these waterways. Fish located upstream of barriers are potentially trapped or delayed in their movements downstream by structures.	Unknown The percentage of the population present in South Delta waterways is unknown. Movement patterns of green sturgeon in the Delta is unknown.	Low Lack of abundance data for juvenile and subadult green sturgeon limits assessment. Increased collection of green sturgeon movements within Delta waterways from acoustic tagging is in early phases, data is preliminary	Reduced survival, reduced growth

9.7.5 Assess Risk to the Southern DPS of Green Sturgeon

The proposed action is expected to have population level consequences for the single extant population in the mainstem Sacramento River. In consideration of the status and future baseline of the species, these population-level consequences greatly increase the extinction risk of the species. Given the evidence of the reduction in numbers, reproduction and/or distribution of the species, NMFS concludes that Reclamation has not ensured that the proposed action is not likely to appreciably reduce the likelihood of the viability, and therefore the likelihood of both the survival and recovery of the Southern DPS of North American green sturgeon (table 9-15).

Table 9-15. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on the Southern DPS of North American Green Sturgeon. Each selected decision is shaded in gray. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Not Likely/Likely to Jeopardize (NLJ/LJ).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct or indirect adverse consequences on the environment** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream, degrading rearing and migratory habitat through the formation of Lake Red Bluff, creating favorable conditions for predators below the RBBDD structure, and creating lethal conditions for passage under the lowered gates); (2) warm water temperatures in the mainstem Sacramento River below RBDD that exceed green sturgeon egg development criteria; (3) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants); and (4) impediments to free movement in the channels of the South Delta due to construction of the South Delta Permanent Gates.*	True	End
		False	Go to B
B	**Southern DPS of green sturgeon individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to block ~35 to 40 % Southern DPS green sturgeon adults migrating upstream; 100 percent of green sturgeon juveniles spawned above the RBDD would be exposed to greater predation and potential injury due to high turbulence when passing through the RBDD gates from May 15 to September15 while emigrating downstream; adult mortalities have recently been recorded due to "emergency gate operations;" (2) Each year through 2030, green sturgeon are expected to be exposed to water temperatures warmer than life stage requirements during spawning, and egg incubation; (3) As water is moved from the north Delta to the export facilities in the south Delta, each year through 2030, green sturgeon juveniles will have increased exposure to an abundant predator community, an aquatic environment degraded by pesticides and contaminants from domestic and agricultural sources, and direct entrainment at the Federal and State pumping plants; and (4) Operations of the Permanent Gates in the South Delta will impede or block free movement of green sturgeon within the affected channels of the South Delta.*	True	NLAA
		False	Go to C

C	**Southern DPS of green sturgeon individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action** *Key evidence. (1) Operation of the RBDD will block upstream migration of spawning green sturgeon adults, preventing them from accessing spawning habitat above the location of RBDD and separating the spawning population into two subgroups – an early migrating group and a late migrating group based on the gate closure timing. Juvenile green sturgeon are expected to fall prey to predators below the RBDD structure during downstream migrations, adult sturgeon will be vulnerable to impingement or injury by the lowered gates as has occurred in the past; (2) Water temperatures below RBDD become progressively warmer, limiting the success of egg development following spawning for those fish not ascending above the RBDD location. Water temperatures above approximately 17°C increase the rate of mortality or deformities in the developing embryos and larval sturgeon; (3) Operations of the export facilities draw fish into the South Delta and increase their vulnerability to export entrainment resulting in increased levels of death or injury; and (4) Operations of South Delta Permanent gates result in loss of free movement through the channels of the South Delta and increased exposure to water quality issues such as contaminants and high temperatures.*	True	NLAA
		False	Go to D
D	**Any responses are not likely to constitute "take" or reduce the fitness of the Southern DPS of green sturgeon individuals that have been exposed.** *Key evidence. (1) Separation of spawning adult population into two potential subgroups limits the free flow of genetic materials within the spawning population. Increased susceptibility of juveniles to predation or injury occurs during passage through the RBDD structure. Adults passing under the lowered gates are expected to have an increased risk of injury or mortality; (2) Reduced viability of eggs and increases in larval deformities due to elevated water temperatures reduces the overall success of the spawning events; (3) Loss of green sturgeon juveniles occurs through "take" of the fish at the export fish collection facilities, leading to death, injury, or loss to the system by passing through the louvers and into the diversion channels during operational activities such as cleaning; and (4) Operation of the Permanent Gates delays or hinders free movement of fish within the South Delta channels and increases the duration of their exposure to stressors such as contaminants from agricultural drain water discharges, wastewater discharges and .low dissolved oxygen.*	True	NLAA
		False	Go to E
E	**Any reductions in individual fitness are not likely to reduce the viability of the populations those Southern DPS of green sturgeon individuals represent.** *Key Evidence: The cumulative effects of RBDD operations, warm water temperatures (particularly below the RBDD site), project-related impacts in the Delta, and other project-related stressors (see table 9-2) are expected to sufficiently reduce the survival and/or reproductive success Southern DPS green sturgeon individuals at multiple life stages every year through 2030 such that key population parameters (i.e. spatial structure, diversity, and abundance) will be appreciably reduced (see section 9.1.4 Assess Risk to the Population). Reductions in these parameters over the next 21 years will likely reduce the viability of the population.*	True	NLJ
		False	Go to F
F	**Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species.** *Key evidence: The Southern DPS of green sturgeon is solely composed of the Sacramento River population. Therefore, because the viability of this population is expected to be reduced by stressors related to the proposed Action, the viability of the species also is expected to be reduced.*	True	NLJ
		False	LJ

9.8 Southern DPS of Green Sturgeon Proposed Critical Habitat

9.8.1 Status of Proposed Southern DPS of Green Sturgeon Critical Habitat

As described in section 4.2.3.4, proposed critical habitat for the Southern DPS of green sturgeon consists of several physical and biological features occurring in riverine, estuarine, and marine habitats that are essential for the conservation of the species. However, all of those physical and biological features can be characterized as suitable and necessary habitat features that provide for successful spawning, rearing, and migration. Therefore, we will be evaluating the effect of the proposed action in terms of its effect on spawning and rearing habitat and migratory corridors.

9.8.1.1 For Freshwater Riverine Systems

9.8.1.1.1 Water Quality

Currently, the installation and operation of the RBDD gates blocks access to 53 miles of upper river with suitable water quality conditions for green sturgeon spawning and rearing. Water temperature for spawning and egg incubation is near optimal (15°C) from RBDD upriver during the spawning season. Below the RBDD, the water temperature begins to become warmer and exceeds the thermal tolerance level for egg incubation at Hamilton City. The spawning area left for green sturgeon between RBDD and Hamilton City after the gates are lowered has the thermal regime gradually increase from optimal (15°C/ 59°F) to sub optimal where egg hatching success decreases and malformations in embryos increase above 17 ^{o}C/62 ^{o}F.

9.8.1.1.2 Migratory Corridor

The installation of the RBDD impairs the function of the Sacramento River as a migratory corridor for both green sturgeon adults and larvae/juveniles. With the RBDD gates closed, the river no longer has unobstructed access to river habitat above the RBDD and changes the function of the river to such an extent that fish survival and viability are compromised. The closed gates block green sturgeon access to approximately 53 river miles above the dam for approximately 35 to 40 percent of the spawning population that arrive after May 15. The closed gates also decrease the conservation value of water flow by: (1) increasing the potential for predation on downstream emigrating larvae in the slow moving water upstream of the RBDD (Lake Red Bluff), (2) increasing predation below the location of the RBDD due to the turbulent boil created below the structure and the concentration of predators located, and (3) creating increased potential for adults to be injured which try to pass beneath the gates during the closed operations. The closed gate configuration also has the potential to alter the genetic diversity of the population by separating the population into upstream and downstream spawning groups based on run timing.

9.8.1.1.3 Water Depth

The installation of the RBDD blocks green sturgeon from known holding pools above the structure. Although known holding areas exist below the RBDD, such as the hole just above the GCID diversion, the RBDD decreases the number of deep holding pools the adult fish can access through its operation. This affect is a result of blockage of the migratory corridor.

9.8.1.2 For Estuarine Habitats

9.8.1.2.1 Migratory Corridor

The effects of combined exports present an entrainment issue that could delay migration or decrease survival or population viability through entrainment into the facilities itself. These effects increase in magnitude the closer to the export facilities the fish are located. Likewise, the installation of the barriers under the TBP enhance the potential to delay movement and migratory behavior in the channels of the South Delta. Juvenile and adult green sturgeon may be trapped behind the barriers after installation/ operation for varying periods of time. The rock barriers of the TBP present the greatest obstacle to movement during their installation and operation, but are removed from the channels each winter.

9.8.2 Project Effects on Proposed Critical Habitat for Southern DPS of Green Sturgeon

Project effects on proposed critical habitat are very similar to those described above in section 9.8.1, except that:

1. Reclamation proposes to reoperate RBDD in the future full build out scenario (beginning in 2019) so the RBDD gates would be in for approximately 2½ months each year rather than the current 4 months. Beginning in 2019, the conservation value of the migratory corridor PCE would improve, however, it will still be degraded, compared to a migratory corridor with unimpeded passage opportunities throughout the spawning migration season, and

2. The operation of the permanent barriers present differing levels of obstruction, depending on the usage of the inflatable barrier gates. When the gates are up, movement past the gates is precluded, and migrational movement is impeded (migratory corridor PCE). The value of the water quality and food resources PCEs would also be reduced.

9.8.3 Assess Risk to the Proposed Southern DPS of Green Sturgeon Critical Habitat

The value of the upstream migration corridor is currently degraded, mainly by the installation of the ACID Dam and RBDD. When the gates are down, RBDD precludes access to 53 miles of spawning habitat for 35-40 percent of the spawning population of green sturgeon. In the near term (through 2019), Reclamation proposes to continue to operate RBDD with gates in 4 months out of each year, thereby continuing to degrade the value of the migration corridor in two ways. First, RBDD has the potential to directly kill adult green sturgeon, thereby not meeting the essential feature of safe passage. Once the RBDD gates are down, it completely blocks upstream migration, thereby not meeting the essential feature of unobstructed passage. Although

reoperation of RBDD in the future full build out scenario will improve/increase unobstructed passage for adults, they will still experience obstructed passage over half the time.

The conservation value of water quality (in terms of temperature) for successful spawning and egg incubation will likely be compromised downstream of RBDD, so that the progeny of green sturgeon that spawn downstream of RBDD will likely experience sublethal effects.

The effects of the proposed action under climate change scenarios would likely further degrade the water quality PCE. As climate change scenarios model water temperature increases by 1-3°F, cold water in Shasta Reservoir will run out sooner in the summer, especially for those green sturgeon that do not successfully migrate upstream before the RBDD gates down period.

Based on the analysis of available evidence, NMFS concludes that the proposed action is likely to reduce the conservation value of the critical habitat, as designated, for the conservation of the Southern DPS of green sturgeon (table 9-16).

Table 9-16. Reasoning and Decision-Making Steps for Analyzing the Proposed Action's Effects on Southern DPS of Green Sturgeon Proposed Critical Habitat. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	**The proposed action is not likely to produce stressors that have direct of indirect adverse consequences on the environment** *Key Evidence: Proposed action-related stressors adversely affecting the environment include: (1) RBDD operations (i.e., impeding fish passage upstream to spawning areas, degrading rearing and migratory habitat through the formation of Lake Red Bluff, creating favorable conditions for predators below the RBDD location, creating downstream passage impediments to adult green sturgeon); (2) warm water temperatures in the mainstem Sacramento River, particularly below the RBDD location,; (3) modified Delta hydrology associated with export operations (e.g., pulling water towards the Federal and State pumping plants); and (4) migratory corridor and rearing habitat modification due to the South Delta Permanent Gates construction and operation.*	True	End
		False	Go to B
B	**Areas of designated critical habitat are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action** *Key Evidence: (1) Each year through 2019, RBDD operations are expected to diminish the availability of spawning areas by blocking ~35 to 40 % of the Southern DPS of green sturgeon adults migrating upstream and accessing the spawning areas above RBDD; altering the hydraulics of the river for approximately 6 miles upstream of RBDD by the creation of Lake Red Bluff affecting flow and potentially diminish the quality of substrate for spawning in this reach due to sedimentation, increase the risk for 100 percent of green sturgeon juveniles spawned above the*	True	NLAA

	RBDD passing downstream in their migratory corridor through the RBDD gates from May 15 to September15 due to elevated predator densities and extreme turbulence associated with the reach immediately below the RBDD structure; Degrades the quality of emigration corridors for adult green sturgeon that must pass under the closed RBDD gates exposing these fish to potential injury or death; (2) Each year through 2030, diminish the functionality of spawning areas, particularly those that may occur downstream of the RBDD location, by increasing water temperatures above physiological limits for developing eggs; (3) Each year through 2030, migratory corridors in the Sacramento-San Joaquin Delta will be affected year round by the conveyance of water by the export facilities through the waterways of the Delta. Redirection and delay of fish movement and entrainment of fish by the export facilities are anticipated; (4) migratory corridors and water quality in the South Delta will be affected by the operations of the South Delta Permanent Gates following their construction.	False	Go to C
C	**The quantity, quality, or availability of all constituent elements of critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed action** *Key Evidence: (1) Each year through 2019, RBDD operations will reduce the quantity and quality of spawning habitat for adult Southern DPS green sturgeon by blocking access to Sacramento River reaches above RBDD from May 15 to September 15. The quality of the migration corridor for downstream emigration of adult green sturgeon spawning above the RBDD is diminished by the closure of the RBDD. The quality of the migration corridor for juvenile green sturgeon is negatively affected by the operation of the RBDD. The quantity and quality of water quality and flow which influences rearing habitat is diminished by the formation of Lake Red Bluff behind the closed RBDD; (2) Each year through 2030, water temperatures warmer than life stage-specific requirements will reduce the quantity and quality of habitat necessary for Southern DPS green sturgeon spawning and egg incubation; (3) Each year through 2030, the quality of migratory corridor habitats is reduced by entraining juvenile green sturgeon into the South Delta under the influence of export actions; and (4) Each year following the construction of the Permanent Operable Gates in the South Delta, gate operations will impede free movement of green sturgeon in the channels of the South Delta affected by the gates.*	True	NLAA
		False	Go to D
D	**Any reductions in the quantity, quality, or availability of one or more constituent elements of critical habitat are not likely to reduce the conservation value of the exposed area** *Key Evidence: Reductions in the conservation value of migratory, spawning, and rearing habitats for Southern DPS of green sturgeon are expected due to reductions in the quantity, quality, or availability of critical habitat constituent elements resulting from RBDD operations, the provision of water temperatures in the Sacramento River warmer than life stage-specific requirements for Southern DPS of green sturgeon, and the movement of water towards the Federal and State pumping plants.*	True	-
		False	Go to E
E	**Any reductions in the conservation value of the exposed area of critical habitat are not likely to reduce the conservation value of the critical habitat designation** *Key Evidence: Because the conservation value of several of the inland habitat types (migratory corridor ,water quality suitable for spawning and rearing and water flow) necessary to complete the green sturgeon life cycle are expected to be reduced with implementation of the proposed Action, it is likely that the conservation value of the critical habitat designation will also be reduced.*	True	No AD MOD
		False	AD MOD

9.9 Southern Resident Killer Whales

This section discusses the effects of the action in the context of the status of the species, the environmental baseline, and cumulative effects, and offers our opinion as to whether the effects of the proposed action are likely to jeopardize the continued existence of the Southern Residents.

The Southern Resident killer whale DPS has fewer than 90 members and a variable productivity rate. In NMFS' opinion, the loss of a single individual, or the decrease in reproductive capacity of a single individual, is likely to reduce the likelihood of survival and recovery of the DPS. Thus the section 7 analysis must scrutinize even small effects on the fitness of individuals that increase the risk of mortality or decrease the chances of successful reproduction.

A reduction in prey or a requirement of increased foraging efficiency may have physiological effects on Southern Residents. In response to fewer or less dense prey patches, Southern Residents would need to expend additional energy to locate and capture available prey. Increased energy expenditure or insufficient prey may result in poor nutrition, which could lead to reproductive or immune effects or, if severe enough, death. A reduction in prey is also likely to work in concert with other threats to produce an adverse effect. For example, insufficient prey could cause whales to rely upon their fat stores, which contain high contaminant levels, impairing reproductive success or compromising immune function.

Based on persuasive scientific information that Southern Residents prefer Chinook salmon in inland waters of Washington State and British Columbia, they are likely to also prefer Chinook salmon when available in coastal waters of their range, which extends south to Central California. Southern Residents overlap with the occurrence of Central Valley Chinook salmon, which are available to Southern Residents across their coastal range, and in greater magnitude south of Cape Falcon. Some of the numerous sightings of Southern Residents in California waters have coincided with large runs of salmon, with feeding witnessed in Monterey Bay. Additionally, there is genetic and chemical evidence that Chinook salmon from the Central Valley are consumed by Southern Residents (*i.e.*, genetic identity confirmed from prey remains, and DDT-signature in the whales).

In the long-term, the proposed action increases the risk of extinction of winter-run and spring-run ESUs. Their extinction would reduce prey availability and increase the likelihood for local depletions of prey in particular locations and times. In response, the Southern Residents would increase foraging effort or abandon areas in search of more abundant prey. Fewer populations contributing to Southern Residents' prey base reduces the representation of diversity in life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and Southern Residents to withstand catastrophic events. These reductions increase the extinction risk of salmon and Southern Residents.

Additionally, the proposed action reduces the abundance of naturally produced CV fall-run, while increasing the abundance of hatchery produced fall-run. Although the proposed hatchery production may replace the lost natural production in the short term, over the long term it is uncertain whether the lost natural production can be replaced. There is also no evidence that a

population that is predominantly produced in hatcheries can persist over the long term. Moreover, some of the current hatchery practices are likely to diminish the productivity, distribution and diversity of CV fall-run over the long term. We have similar concerns regarding the effects of current hatchery practices on retention of diversity in Trinity River non-listed spring- and fall-runs. Without retention of natural diversity, these stocks likely will be less resilient to the effects of disease, climate change and stochastic events. The long-term potential for these stocks to sustain the same magnitude of ocean abundance currently available to Southern Residents is likely to be compromised by a loss of diversity in CV fall- and late fall-runs and non-listed spring- and fall-runs from the Trinity River watershed.

An increase in the risk of extinction of winter-run and spring-run ESUs, along with loss of diversity in fall-run will likely reduce available prey for Southern Residents. As described above, reductions in prey or a resulting requirement of increased foraging efficiency increase the likelihood of physiological effects. The Southern Residents would likely experience nutritional, reproductive, or other health effects from reduced prey as a result of the proposed action. Because of the small population size, a decrease in reproductive capacity of a single individual from prey reductions, is likely to reduce the likelihood of survival and recovery of the DPS.

In summary:

- Increased risk of extinction of winter-run and spring-run as a long-term consequence of the proposed action increases the risk of a permanent reduction in prey available to Southern Residents, and increases the likelihood for local depletions of prey in particular locations and times.
- Losing the potential for future recovery of winter-run and spring-run diminishes the potential for Southern Residents to recover.
- Over the long term, project operations disproportionately kill naturally spawning Central Valley fall-run. Although the killed naturally produced fish are replaced by hatchery adults in the whales' forage grounds, over the long term, there is no evidence that replacement can be maintained. Moreover, current hatchery practices funded by the proposed action are likely to diminish the productivity, distribution, and diversity of Central Valley fall-run. Current hatchery practices may similarly affect diversity in non-listed Chinook salmon stocks from the Trinity River watershed. This loss of natural diversity will compromise the ability of these stocks to withstand stochastic events or climate effects, and ultimately compromise the availability of fall-run stocks that contribute to Southern Residents' prey base.

10.0 CONCLUSIONS

After reviewing the best scientific and commercial information available, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is NMFS' Opinion that the long-term operations of the CVP and SWP, as proposed, is not likely adversely affect Central California Coast steelhead and their designated critical habitat.

However, the long-term operations of the CVP and SWP are likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Southern DPS of North American green sturgeon, and Southern Resident killer whales. The long-term operations of the CVP and SWP are likely to destroy or adversely modify critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

After reviewing the best scientific and commercial data available, including the current status of proposed Southern DPS of North American green sturgeon critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' conference opinion that the long-term operations of the CVP and SWP are likely to destroy or adversely modify proposed critical habitat for the Southern DPS of North American green sturgeon.

11.0 REASONABLE AND PRUDENT ALTERNATIVE

11.1 OVERVIEW

11.1.1 Approach to the RPA

If NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify its critical habitat, the ESA requires NMFS to suggest those reasonable and prudent alternatives that it believes would enable the project to go forward in compliance with the ESA. By regulation, a RPA is defined as "alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the [NMFS] Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02).

Regulations also require that NMFS discuss its findings and any RPAs with the action agency and utilize the action agency's expertise in formulating the RPA, if requested (50 CFR 402.14(g)(5)). This RPA was developed through a thoughtful and reasoned analysis of the key causes of the jeopardy and adverse modification findings, and a consideration of alternative actions within the legal authority of Reclamation and DWR to alleviate those stressors. NMFS has worked closely with Reclamation and DWR staff and greatly appreciates the expertise contributed by these agencies.

Because this complex action takes place in a highly altered landscape subject to many environmental stresses, it has been difficult to formulate an RPA that is likely to avoid jeopardy to all listed species and meets all regulatory requirements. As detailed in this Opinion, the current status of the affected species is precarious, and future activities and conditions not within the control of Reclamation or DWR are likely to place substantial stress on the species. NMFS

initially attempted to devise an RPA for each species and its critical habitat solely by modifying project operations (*e.g.*, timing/magnitude of releases from dams, closure of operable gates and barriers, and reductions in negative flows). In some cases, however, simply altering project operations was not sufficient to ensure that the projects were likely to avoid jeopardizing the species or adversely modifying critical habitat.

Consequently, NMFS developed focused actions designed to compensate for a particular stressor, considering the full range of authorities that Reclamation and DWR may use to implement these actions. These authorities are substantial. The CVPIA, in particular, provides Reclamation with ample authority to provide benefits for fish and wildlife through measures such as purchasing water to augment in-stream flow, implementing habitat restoration projects, and taking other beneficial actions (Cummins *et al.*, 2008). Some RPA actions, therefore, call for restoring habitat or providing fish passage above dams, even though the water projects are not directly responsible for the impaired habitat or the blocked passage.

NMFS concentrated on actions that have the highest likelihood of alleviating the stressors with the most significant effects on the species, rather than attempting to address every project stressor for each species or every PCE for critical habitat. For example, water temperatures lethal to incubating eggs often occur when the air is warm and flows are low. Fish cannot reach spawning habitat with colder water at higher elevations if it is above currently impassable dams. Accordingly, NMFS' near-term measures provide suitable water temperatures below dams in a higher percentage of years, and long-term measures provide passage to cooler habitat above dams as soon as practicable. Reducing egg mortality from high water temperatures is a critical step in slowing or halting the decline of Central Valley salmonids.

The effects analysis in this Opinion explains that the adverse effects of the proposed action on listed anadromous fish and their critical habitats are both direct and indirect. The USFWS stated in its biological opinion on effects of the projects on Delta smelt that in addition to direct adverse effects such as entrainment at the pumps, the water projects have affected smelt "by creating an altered environment in the Delta that has fostered both the establishment of non-indigenous species and habitat conditions that exacerbate their adverse influence on delta smelt population dynamics." (USFWS 2008a, p. 189) Similarly, NMFS concludes that the water projects have both directly altered the hydrodynamics of the Sacramento-San Joaquin River basins and have interacted with other activities affecting the Delta to create an altered environment that adversely influences salmonid and green sturgeon population dynamics. The altered environment includes changes in habitat formation, species composition, and water quality, among others. Consequently, NMFS must take a broad view of the ways in which the project agencies can improve the ecosystem to ameliorate the effects of their actions.

There are several ways in which water operations adversely affect listed species that are addressed in this RPA. We summarize the most significant here:

1) Water operations result in elevated water temperatures that have lethal and sub-lethal effects on egg incubation and juvenile rearing in the upper Sacramento River. The immediate operational cause is lack of sufficient cold water in storage to allow for cold

water releases to reduce downstream temperatures at critical times and meet other project demands. This elevated temperature effect is particularly pronounced in the Upper Sacramento for winter-run and mainstem spring-run, and in the American River for steelhead. The RPA includes a new year-round storage and temperature management program for Shasta Reservoir and the Upper Sacramento River, as well as long-term passage prescriptions at Shasta Dam and re-introduction of winter-run into its native habitat in the McCloud and/or Upper Sacramento rivers.

2) In Clear Creek, recent project operations have led to increased abundance of Clear Creek spring-run, which is an essential population for the short-term and long-term survival of the species. Nonetheless, in the proposed action, continuation of these operations is uncertain. The RPA ensures that essential flows and temperatures for holding, egg incubation and juvenile survival will be maintained.

3) Red Bluff Diversion Dam (RBDD) on the Sacramento River impedes both upstream migration of adult fish to spawning habitat and downstream migration of juveniles. Effects are significant for winter-run and spring-run, but are particularly pronounced for green sturgeon and its proposed critical habitat in that a significant portion of the population is blocked from its spawning and holding habitat. The RPA mandates gate openings at critical times in the short term while an alternative pumping plant is built, and, by 2012, opening of the gates all year.

4) Both project and non-project effects have led to a significant reduction in necessary juvenile rearing habitat in the Sacramento River Basin and Delta. The project's flood control operations result in adverse effects through reduced frequency and magnitude of inundation of rearing habitat. To minimize these effects, the RPA contains both short-term and long-term actions for improving juvenile rearing habitat in the Lower Sacramento River and northern Delta.

5) Another major effect of water operations is diversion of out-migrating juveniles from the north Delta tributaries into the interior Delta through the open DCC gates. Instead of migrating directly to the outer estuary and then to sea, these juveniles are caught in the interior Delta and subjected to pollution, predators, and altered food webs that cause either direct mortality or impaired growth. The RPA mandates additional gate closures to minimize these adverse effects to winter-run, spring-run, and steelhead.

6) Similarly, water pumping causes reverse flows, leading to loss of juveniles migrating out from the Sacramento River system in the interior Delta and more juveniles being exposed to the State and Federal pumps, where they are salvaged at the facilities. The RPA prescribes Old and Middle River flow levels to reduce the number of juveniles exposed to the export facilities and prescribes additional measures at the facilities themselves to increase survival of fish.

7) The effects analysis shows that juvenile steelhead migrating out from the San Joaquin River Basin have a particularly high rate of loss due to both project and non-project

related stressors. The RPA mandates additional measures to improve survival of San Joaquin steelhead smolts, including both increased San Joaquin River flows and export curtailments. Given the uncertainty of the relationship between flow and exports, the RPA also prescribes a significant new study of acoustic tagged fish in the San Joaquin Basin to evaluate the effectiveness of the RPA and refine it over the lifetime of the project.

8) On the American River, project-related effects on steelhead are pronounced due to the inability to consistently provide suitable temperatures for various life stages and flow-related effects caused by operations. The RPA prescribes a flow management standard, a temperature management plan, additional technological fixes to temperature control structures, and, in the long term, a passage at Nimbus and Folsom Dams to restore steelhead to native habitat.

9) On the Stanislaus River, project operations have led to significant degradation of floodplain and rearing habitat for steelhead. Low flows also distort cues associated with out-migration. The RPA proposes a year-round flow regime necessary to minimize project effects to each life-stage of steelhead, including new spring flows that will support rearing habitat formation and inundation, and will create pulses that cue out-migration.

10) Nimbus Fish Hatchery steelhead program contribute to both loss of genetic diversity and mixing of wild and hatchery stocks of steelhead, which reduces the viability of wild stocks. The Nimbus and Trinity River Hatchery programs for non-listed fall-run also contribute to a loss of genetic diversity, and therefore, viability, for fall-run. The RPA requires development of Hatchery Genetics Management Plans to improve genetic diversity of both steelhead and fall-run, an essential prey base of Southern Resident.

This RPA is composed of numerous elements for each of the various project divisions and associated stressors and must be implemented in its entirety in order to avoid jeopardy and adverse modification. There are several actions that allow the project agencies options for alleviating a particular stressor. Reclamation and DWR may select the option they deem most practical — NMFS cares only that the stressor be sufficiently reduced. There are several actions in which NMFS expressly solicits additional research and suggestions from the project agencies for alternative actions to achieve needed results.

NMFS recognizes that the RPA must be an alternative that is likely to avoid jeopardizing listed species or adversely modifying their critical habitats, rather than a plan that will achieve recovery. Both the jeopardy and adverse modification standards, however, include consideration of effects on an action on listed species' chances of recovery. NMFS believes that the RPA does not reduce the likelihood of recovery for any of the listed species. The RPA cannot and does not, however, include all steps that would be necessary to achieve recovery. NMFS is mindful of potential social and economic consequences of reducing water deliveries and has carefully avoided prescribing measures that are not necessary to meet section 7 requirements.

An RPA must avoid jeopardy to listed species in the short term, as well as the long term. Essential short-term actions are presented for each division and are summarized for each species to ensure that the likelihood of survival and recovery is not appreciably reduced in the short term (*i.e.*, one to five years). In addition, because the proposed action is operation of the CVP/SWP until 2030, this consultation also includes long-term actions that are necessary to address project-related adverse effects on the likelihood of survival and recovery of the species over the next two decades.

Some of these long-term actions will require evaluation, planning, permitting, and funding. These include:

1) Providing fish passage at Shasta, Nimbus, and Folsom Dams, which ultimately is the only means of counteracting the loss of habitat needed for egg incubation and emergence, and steelhead over-summering habitat at lower elevations. This habitat loss has already occurred and will be exacerbated by climate change and increased water demands.

2) Providing adequate rearing habitat on the lower Sacramento River and Yolo Bypass through alteration of operations, weirs, and restoration projects.

3) Engineering projects to further reduce hydrologic effects and indirect loss of juveniles in the interior Delta.

4) Technological modifications to improve temperature management in Folsom Reservoir.

NMFS considered economic and technological feasibility in several ways when developing initial actions in this RPA. The RPA also allows for tailored implementation of many actions in consideration of economic and technological feasibility without compromising the RPA's effectiveness in avoiding jeopardy and adverse modification of critical habitat. Examples include:

1) Providing reasonable time to develop technologically feasible alternatives where none are "ready to go" – *e.g.*, the Delta engineering action (Action IV.1.3), and lower Sacramento River rearing habitat action (Action I.6.1).

2) Calling for a stepped approach to fish passage at dams, including studies and pilot projects, prior to a significant commitment of resources to build a ladder or invest in a permanent trap and haul program.

3) Providing a health and safety exception for export curtailments.

4) Using monitoring for species presence to initiate actions when most needed.

NMFS examined water supply costs of the RPA as one aspect of considering economic feasibility. While only costs to the action agency are considered in determining whether a RPA meets the regulatory requirement of economic feasibility, NMFS is mindful of potential social

and economic costs to the people and communities that historically have depended on the Delta for their water supply. Any water supply impact is undesirable. NMFS made many attempts through the iterative consultation process to avoid developing RPA actions that would result in high water costs, while still providing for the survival and recovery of listed species.

NMFS estimates the water costs associated with the RPA to be 5-7% of average annual combined exports: 5% for CVP, or 130 TAF/year, and 7% for SWP, or 200 TAF/year[27]. The combined estimated annual average export curtailment is 330 TAF/year. These estimates are over and above export curtailments associated with the USFWS smelt Opinion. The OMR restrictions inn both Opinions tend to result in export curtailments of similar quantities at similar times of year. Therefore, in general, these 330 TAF export curtailments are associated with the NMFS San Joaquin River Ratio actions in the RPA. These water costs can be offset by application of b(2) water resources, water conservation, groundwater use, water recycling and toher processes currently underway.

The RPA includes collaborative research to enhance scientific understanding of the species and ecosystems, and to adapt actions to new scientific knowledge. This adaptive structure is important, given the long-term nature of the consultation and the scientific uncertainty inherent in a highly variable system. Monitoring and adaptive management are both built into many of the individual actions and are the subject of an annual program review. NMFS views both the CALFED Science Program and the NMFS Southwest Fisheries Science Center as essential partners in ensuring that the best scientific experts are brought together to assess the implementation and effectiveness of actions in this RPA. We will continue to pursue many of the long-term recommendations for improving science as recommended by the CALFED and CIE peer reviews, and we will seek to incorporate this new science as it becomes available through the adaptive management processes embedded in the RPA.

Finally, we note that the project agencies are currently developing and evaluating a plan to construct a diversion on the Sacramento River and a canal around the Delta, in the BDCP planning effort. Such a reconfiguration of the water conveyance system would take careful planning to avoid jeopardizing Sacramento River and north Delta species, as well as several years of environmental review and permitting, and would trigger a re-initiation of this Opinion. We expect that the collaborative research that is part of this RPA will inform this planning effort as it proceeds.

11.1.2 Organization of the RPA

The specific actions in the RPA are detailed in Section 11.2. That section begins with overarching actions that apply to operations in all geographic divisions of the project, including procedures for orderly functioning of the many technical teams that assist with decision making, research and adaptive management, and monitoring. These are followed by actions specific to each geographic division of the proposed action: Sacramento River, American River, East Side

[27] The proportion share between the CVP and SWP is attributable to CalLite programming and may not represent the true share of export reductions that would be allocated to each facility under actual conditions.

(Stanislaus River), and the Delta. There is a suite of actions for each geographic area. Section 11.2 concludes with subsections regarding fish passage at dams and modification of hatchery practices.

Section 11.3 is a species-by-species explanation of: (1) how each measure contributes to avoiding jeopardy or adverse modification for that species; and (2) the basis for NMFS' conclusion that the RPA measures as a whole are likely to avoid jeopardizing the species or adversely modifying its critical habitat. The information is presented in both narrative and table form. The narrative provides an overview, while the tables add detail. This section also address the other regulatory criteria necessary for a Reasonable and Prudent Criteria.

11.2 Reasonable and Prudent Alternative – Specific Actions

11.2.1. Decision-Making Procedures, Monitoring and Adaptive Management Protocols

11.2.1.1 Responsibilities and Procedures of Technical Teams

There are currently four Fisheries and Operations Technical Teams whose function is to make recommendations for adjusting operations to meet contractual obligations for water delivery and minimize adverse effects on listed anadromous fish species:

- Sacramento River Temperature Task Group (SRTTG)
- Clear Creek Technical Working Group (CCTWG)
- American River Group (ARG)
- San Joaquin River Technical Committee (SJRTC)

This RPA requires the creation of three additional technical teams:

- Delta Operations for Salmon and Sturgeon (DOSS) Group
- Stanislaus Operations Group (SOG)
- Interagency Fish Passage Steering Committee

Each group has responsibility to gather and analyze information, and make recommendations, regarding adjustments to water operations within the range of flexibility prescribed in the implementation procedures for a specific action in their particular geographic area. Under previous operations plans, recommendations for adjustments were made to the Water Operations Management Team (WOMT), a management-level group of representatives of Reclamation, DWR, CDFG, NMFS, and USFWS. The WOMT then made recommendations to state and regional directors for final action.

The Project Description for the proposed action (Appendix 1 to this Opinion), as revised by this RPA, establishes the responsibilities of each technical team. The RPA establishes the operations parameters that are necessary to avoid jeopardizing listed species or adversely modifying their critical habitat. Within those parameters, there is flexibility to adjust actions within a specified

range based on current conditions. The allowed range of flexibility is prescribed in the "implementation procedures" portion of the RPA action. The technical teams and the WOMT will work within those implementation procedures to meet discretionary water contract obligations to the greatest extent consistent with survival and recovery of listed species. The teams also may recommend changes to the measures in this RPA, as detailed in the Research and Adaptive Management section of the RPA. Recommended changes outside the range of flexibility specified in the implementation procedures must receive written review and concurrence by NMFS and may trigger re-initiation.

This action prescribes standard operating procedures for decision-making that will apply to all teams.

1) Within 90 days of issuance of this Opinion, Reclamation shall send to the WOMT members a list of current members of each technical team. The WOMT representatives shall review the membership and make changes, if necessary. All groups shall include members with expertise in fish biology and hydrology. Each group shall designate a group leader to convene meetings and assure that necessary administrative steps are taken, such as recording and distributing meeting notes and recommendations.

2) Each group shall establish a regular meeting schedule at the beginning of each year, based on the anticipated need for adjustments to operations, and distribute the schedule to the members of the group. The group leader may reschedule a meeting, or call a special meeting, with three days notice at his or her discretion, or on request of NMFS or any two or more group members.

3) Brief notes of each meeting shall be recorded, including issues considered, recommendations made, and key information on which recommendations were based. Meeting notes shall be distributed to members within two days of the meeting.

4) Within one day after a technical team advises that an operational action should be initiated, changed, suspended, or terminated, consistent with the implementation procedures specified for actions in this RPA, the group leader shall provide to NMFS and Reclamation written advice and a biological rationale. The technical teams shall use the process described in the applicable RPA implementation procedures to provide a framework for their analysis. NMFS shall determine whether the proposed action is consistent with the implementation procedures in this RPA. If NMFS determines that the proposed action is consistent with the implementation procedures, then it avoids jeopardy to listed species or adverse modification of critical habitat. Both the technical team's advice and NMFS' recommendation shall be presented to the WOMT for discussion and concurrence. In the event that there is not consensus at the workgroup level, the workgroup leader shall convey the options and summary of the technical discussion to NMFS for consideration. NMFS will make a recommendation for action within the procedural guidelines of this RPA. NMFS will present its recommendations to the WOMT for discussion and concurrence (see #6 below).

5) If the recommended action will affect species within the jurisdiction of USFWS as well as NMFS, the technical team making the recommendation shall, to the extent that time allows, first coordinate with the Smelt Working Group (SWG). The technical team and the SWG, to the extent feasible, shall jointly make a recommendation to USFWS and NMFS (the Services), who will jointly determine whether the recommended action is consistent with the actions and implementation procedures of this RPA and is, therefore, necessary to avoid jeopardy to listed species and adverse modification of critical habitat. The Services shall then present their findings and recommendations to the WOMT.

6) The WOMT shall either concur with NMFS' (or the Services', as appropriate) recommendation or provide a written alternative to the recommendation, with biological justification, to NMFS (or the Services) within one calendar day. NMFS (or the Services) shall then make a determination as to whether the action proposed by the WOMT is consistent with this Opinion and ESA obligations.

7) Once NMFS (or the Services) makes a final determination that a proposed operational action is consistent with ESA obligations, Reclamation and DWR shall implement the operational action within two calendar days. Reclamation and DWR shall submit to NMFS (or the Services) data demonstrating the implementation of the action on a weekly basis, or post their operations on their website.

8) The action shall remain in effect until NMFS (or the Services), with advice from the appropriate technical team(s), determines that it should be modified or terminated as inconsistent with the implementation procedures for the RPA. The action shall be modified or terminated within two calendar days of such a determination.

9) These procedures may be modified for a particular team or working group by mutual agreement of NMFS and Reclamation. Modifications to the procedures shall be in writing, dated, and promptly distributed to all members of the group.

11.2.1.2. Research and Adaptive Management

Not later than November 30 of every year, in conjunction with the CALFED Science Program or other Science Peer Review process, Reclamation and NMFS shall host a workshop to review the prior water years' operations and to determine whether any measures prescribed in this RPA should be altered in light of information learned from prior years' operations or research. After completion of the annual review, NMFS may initiate a process to amend specific measures in this RPA to reflect new information, provided that the amendment is consistent with the Opinion's underlying analysis and conclusions and does not limit the effectiveness of the RPA in avoiding jeopardy to listed species or adverse modification of critical habitat. NMFS will ask the appropriate informational and technical teams to assess the need for a particular amendment and make recommendations to NMFS, according to the group processes for decision-making set forth in this RPA in action 11.2.1.1 above.

NMFS and Reclamation will establish a research program in coordination with the CALFED Science Program and other agencies to address key research and management questions arising from this Opinion. Prior to the beginning of a new calendar year, Reclamation shall submit to NMFS a research plan for the following year, developed in coordination with the above programs and agencies. Reclamation also shall provide NMFS access to all draft and final reports associated with this research. Specific research projects that have been identified as important to begin in the first year and complete as soon as possible are:

1) Cooperative development of a salmonid lifecycle model acceptable to NMFS, Reclamation, CDFG, and DWR

2) Temperature monitoring and modeling identified in RPA Action I.5

3) Green sturgeon research described in the RBDD actions

4) Rearing habitat evaluation metrics to guide rearing habitat Action 1.6

5) A 6-year acoustic-tagged study of juvenile salmonids out-migration in the San Joaquin River and through the southern Delta identified in Action IV.2.2.

11.2.1.3. Monitoring and Reporting

1) Reclamation and DWR shall participate in the design, implementation, and funding of the comprehensive CV steelhead monitoring program, under development through ERP, that includes adult and juvenile direct counts, redd surveys, and escapement estimates on CVP- and SWP-controlled streams. This program is necessary to develop better juvenile production estimates that form the basis of incidental take limits and will also provide necessary information to calculate triggers for operational actions.

2) Reclamation and DWR shall ensure that all monitoring programs regarding the effects of CVP and SWP operations and which result in the direct take of winter-run, spring-run, CV steelhead, or Southern DPS of green sturgeon, are conducted by a person or entity that has been authorized by NMFS. Reclamation and DWR shall establish a contact person to coordinate these activities with NMFS.

3) Reclamation and DWR shall submit weekly reports to the interagency Data Assessment Team (DAT) regarding the results of monitoring and incidental take of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of project facilities.

4) Reclamation and DWR shall provide an annual written report to NMFS no later than October 1, following the salvage season of approximately October to May. This report shall provide the data gathered and summarize the results of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon monitoring and incidental take associated with the operation of the Delta pumping plants (including the Rock Slough Pumping

Plant). All juvenile mortality must be minimized and reported, including those from special studies conducted during salvage operations. This report should be sent to NMFS (Southwest Region, Protected Resources Division, Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814-4706).

5) Reclamation and DWR shall continue the real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the lower Sacramento River, the lower San Joaquin River, and the Delta to establish presence and timing to serve as a basis for the management of DCC gate operations and CVP and SWP Delta pumping operations consistent with actions in this RPA. Reclamation and DWR shall conduct continuous real-time monitoring between October 1 and June 30 of each year, commencing in 2009.

6) Reclamation and DWR shall submit weekly DAT reports and an annual written report to NMFS describing the results of real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of the DCC and CVP and SWP Delta pumping facilities, and other Division level operations authorized through this RPA.

7) Reclamation shall coordinate with NMFS, the USFWS, and CDFG to continue implementation and funding of fisheries monitoring of spring-run and CV steelhead (including adult snorkel surveys, population estimates for steelhead, and rotary screw trapping) in Clear Creek to aide in determining the benefits and effects of flow and temperature management.

8) Monitoring Requirements: The following (A-E) are necessary to adaptively manage project operations and are either directly related to management of releases (*e.g*., temperature and flow), or are a necessary component the Salmon Decision Process used to manage Delta operations (*e.g*., DCC gates and export pumping). Reclamation and DWR shall jointly fund these monitoring locations for the duration of the Opinion (through 2030) to ensure compliance with the RPA and assess the performance of the RPA actions. Most of these monitoring stations already exist and are currently being funded through a variety of sources (*i.e*., CDFG, USFWS, Reclamation, DWR, CALFED, and Interagency Ecological Program), however, CALFED funding for monitoring ends in 2009 and CDFG funding has been reduced due to budget cuts.

    a) Upstream: Adult escapement and juvenile monitoring for spring-run, winter-run, and steelhead on the Sacramento River, American River, Feather River, Clear Creek, Mill Creek, Deer Creek and Battle Creek. These may be performed through carcass surveys, redd surveys, weir counts, and rotary screw trapping.
    b) RBDD: Adult counts using the three current fish ladders until the new pumping plant is operational. Rotary screw trapping to determine juvenile Chinook salmon passage or abundance year-round before and after pumping plant is operational. Green sturgeon monitoring, to include adult and juvenile estimates of passage, relative

abundance, and run timing, in order to determine habitat use and population size with respect to management of Shasta Reservoir resources.

c) Sacramento River new juvenile monitoring station: The exact location to be determined, between RBDD and Knights Landing, in order to give early warning of fish movement and determine survival of listed fish species leaving spawning habitat in the upper Sacramento River.

d) Delta: Continuation of the following monitoring stations that are part of the IEP: Chipps Island Trawl, Sacramento Trawl, Knights Landings RST, and beach seining program. Additionally, assist in funding new studies to determine green sturgeon relative abundance and habitat use in the Delta.

e) San Joaquin River monitoring shall include: Adult escapement and juvenile monitoring for steelhead on the Stanislaus River; Mossdale Kodiak Trawling to determine steelhead smolt passage; steelhead survival studies associated with VAMP; monitoring at HORB to determine steelhead movement in and around the barrier; predation studies in front of HORB and at the three agricultural barriers in the South Delta; and new studies to include the use of non-lethal fish guidance devices (*e.g.*, sound, light, or air bubbles) instead of rock barriers to keep juveniles out of the area influenced by export pumping.

11.2.2 Actions Listed by Division

I. SACRAMENTO RIVER DIVISION

Introduction to the Sacramento River Division: Project operations of the Sacramento River Division affect winter-run, spring-run, CV steelhead, the Southern DPS of green sturgeon. In addition, project operations affect fall-run, which are not listed. Fall-run salmon are considered in developing the actions as a prey base for Southern Residents. This Division section of the RPA includes actions related to minimizing adverse effects to spring-run and steelhead spawning and rearing in Clear Creek and all species in the main stem Sacramento River. Actions include those necessary to reduce the risk to temperature effects to egg incubation in the upper river, especially to winter-run and spring-run spawning below Shasta Dam. Also, the RPA contains actions for operation of RBDD – a major impediment to salmonid and green sturgeon migration. In addition, the RPA includes an action related to adjusting the antiquated Wilkins Slough navigation requirement, mandates the continuation of the fish screening program, and calls for restoration of essential rearing habitat in the lower river/northern Delta.

Operations of the Sacramento River Division are interconnected with those of the Trinity River Division. NMFS is in the process of conducting a separate consultation on the effects of the Trinity River Division operations on listed coho salmon in the Trinity River. NMFS is committed to ensuring appropriate coordination between the analysis and results of this Opinion and the forthcoming coho opinion. The Sacramento River Division RPA will be analyzed in that Opinion, and may be adjusted as necessary to avoid jeopardy to coho salmon and adverse modification of critical habitat.

Action Suite I.1. Clear Creek

Suite Objective: The proposed action includes a static flow regime (no greater than 200 cfs all year) and uncertainty as to the availability of b(2) water in the future pose significant risk to these species. The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. Although not all of the flow studies have been completed, NMFS believes these actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.

Action I.1.1. Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem. This may be done in conjunction with channel-maintenance flows (Action I.1.2).

Rationale: In order to prevent spring-run from hybridizing with fall-run in the Sacramento River, it is important to attract early spring-run adults as far upstream in Clear Creek as possible, where cooler water temperatures can be maintained over the summer holding period through releases from Whiskeytown Dam. This action will also prevent spring-run adults from spawning in the lower reaches of Clear Creek, where water temperatures are inadequate to support eggs and pre-emergent fry during September and October.

Action I.1.2. Channel Maintenance Flows

Objective: Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run and CV steelhead

Action: Reclamation shall re-operate Whiskeytown Glory Hole spills during the winter and spring to produce channel maintenance flows of a minimum of 3,250 cfs mean daily spill from Whiskeytown for one day, to occur seven times in a ten-year period, unless flood control operations provide similar releases. Re-operation of Whiskeytown Dam should be implemented with other project facilities as described in the EWP Pilot Program (Reclamation 2008d).

Rationale: Channel maintenance flows are a necessary element of critical habitat (see PCEs) in order to restore proper functioning rivers. This modified operation allows higher flows necessary to move spawning gravels downstream from injection sites, which will increase the amount of spawning habitat available to spring-run and steelhead. Previous studies (McBain and Trush 1999) have shown that Clear Creek lacks sufficient gravel for spawning habitat. Both spring-run and steelhead need higher flows to provide the spawning and rearing habitat elements essential for survival and recovery.

Action I.1.3. Spawning Gravel Augmentation

Objective: Enhance and maintain previously degraded spawning habitat for spring-run and CV steelhead.

Action: Reclamation, in coordination with the Clear Creek Technical team, shall continue spawning gravel augmentation efforts. By December 31 each year, Reclamation shall provide a report to NMFS on implementation and effectiveness of the gravel augmentation program.

Rationale: Similar to above for Action I.1.2. Recent studies (USFWS 2007, 2008) have shown steelhead and spring-run utilize gravel injection sites for spawning. Gravel augmentation has increased the steelhead spawning habitat available in the lower reaches of Clear Creek and directly relates to higher abundance in recent years. The gravel augmentation program also benefits fall-run and late fall-run spawning. Including the gravel augmentation program in the RPA ensures that it is reasonably certain to occur in the future.

Action I.1.4. Spring Creek Temperature Control Curtain *(Note: This action benefits Sacramento River conditions, but is part of Clear Creek operations)*

Objective: Reduce adverse impacts of project operations on water temperature for listed salmonids in the Sacramento River.

Action: Reclamation shall replace the Spring Creek Temperature Control Curtain in Whiskeytown Lake by June 2011 .

Rationale: The Spring Creek Tunnel releases provide cold water to Keswick Reservoir, which improves the ability to lower water temperatures during the summer for winter-run spawning and incubation. Recent underwater surveys concluded that the Whiskeytown Curtain is in poor condition and needs a major overhaul (Reclamation 2008b). Six rips in the fabric run the full depth of the curtain to 55 feet.

Action I.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of:

1) 60°F at the Igo gage from June 1 through September 15; and

2) 56°F at the Igo gage from September 15 to October 31.

Reclamation, in coordination with NMFS, will assess improvements to modeling water temperatures in Clear Creek and identify a schedule for making improvements.

Rationale: The water temperature criteria address the critical need for colder water that historically was available to salmonids above Whiskeytown Dam. If the criteria are not met, juvenile steelhead rearing habitat is limited, predation is higher, and disease is more prevalent. Spring-run adults need colder water to hold over during the summer until September. If water temperature is too warm, spring-run experience pre-spawn mortality and reduced production. The lower water temperature in September is necessary to reduce mortality of spring-run eggs and pre-emergent fry.

Action I.1.6. Adaptively Manage to Habitat Suitability/IFIM Study Results

Objective: Decrease risk to Clear Creek spring-run and CV steelhead population through improved flow management designed to implement state-of-the-art scientific analysis on habitat suitability.

Action: Reclamation shall operate Whiskeytown Reservoir as described in the Project Description with the modifications described in Action I.1 until September 30, 2012, or until 6 months after current Clear Creek salmonids habitat suitability (*e.g.*, IFIM) studies are completed, whichever occurs later.

When the salmonid habitat suitability studies are completed, Reclamation will, in conjunction with the CCTWG, assess whether Clear Creek flows shall be further adapted to reduce adverse impacts on spring-run and CV steelhead, and report their findings and proposed operational flows to NMFS within 6 months of completion of the studies. NMFS will review this report and determine whether the proposed operational flows are sufficient to avoid jeopardizing spring-run and CV steelhead or adversely modifying their critical habitat.

Reclamation shall implement the flows on receipt of NMFS' written concurrence. If NMFS does not concur, NMFS will provide notice of the insufficiencies and alternative flow recommendations. Within 30 days of receipt of non-concurrence by NMFS, Reclamation shall convene the CCTWG to address NMFS' concerns. Reclamation shall implement flows deemed sufficient by NMFS in the next calendar year.

Rationale: Past project operations have reduced spring-run and CV steelhead abundance in Clear Creek by creating passage barriers, raising water temperature, and reducing spawning gravels in key areas of critical habitat. Abundance has increased in recent years as a result of passage improvements, habitat restoration, and operational changes to improve temperature control. Persistence of the population and maintenance of its critical habitat will require continuation of flows adequate for migration and maintenance of spawning gravels and suitable water temperatures.

Action Suite I.2. Shasta Operations

Introduction to Shasta Operations: Maintaining suitable temperatures for egg incubation, fry emergence, and juvenile rearing in the Sacramento River is critically important for survival and recovery of the winter-run ESU. The winter-run ESU has been reduced to a single population, which has been blocked from its historical range above Shasta Dam. Consequently, suitable temperatures and habitat for this population must be maintained downstream of Shasta Dam through management of the cold water pool behind the dam in the summer. Maintaining optimum conditions for this species below Shasta is crucial until additional populations are established in other habitats or this population is restored to its historical range. Spring-run are also affected by temperature management actions from Shasta Reservoir.

The effects analysis in this Opinion highlights the very challenging nature of maintaining an adequate cold water pool in critically dry years, extended dry periods, and under future conditions, which will be affected by increased downstream water demands and climate change. This suite of actions is designed to ensure that Reclamation uses maximum discretion to reduce adverse impacts of the projects to winter-run and spring-run in the Sacramento River by maintaining sufficient carryover storage and optimizing use of the cold water pool. In most

years, reservoir releases through the use of the TCD are a necessity in order to maintain the bare minimum population levels necessary for survival (Yates *et al.* 2008, Angilletta *et al.* 2008).

The effects analysis in this Opinion, and supplemental information provided by Reclamation, make it clear that despite Reclamation's best efforts, severe temperature-related effects cannot be avoided in some years. The RPA includes exception procedures to deal with this reality. Due to these unavoidable adverse effects, the RPA also specifies other actions that Reclamation must take, within its existing authority and discretion, to compensate for these periods of unavoidably high temperatures. These actions include restoration of habitat at Battle Creek that may be support a second population of winter-run, and a fish passage program at Keswick and Shasta dams to partially restore winter-run to their historical cold water habitat.

Objectives: The following objectives must be achieved to address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

1) Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.

2) Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.

3) Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.

4) Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures.

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: The following long-term performance measures shall be attained. Reclamation shall track performance and report to NMFS at least every 5 years. If there is significant deviation from these performance measures over a 10-year period, measured as a running average, which is not explained by hydrological cycle factors (*e.g.*, extended drought), then Reclamation shall reinitiate consultation with NMFS.

Performance measures for EOS carryover storage at Shasta Reservoir:

- 87 percent of years: Minimum EOS storage of 2.2 MAF
- 82 percent of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40 percent of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly's Ferry compliance point in following year)

Measured as a 10-year running average, performance measures for temperature compliance points during summer season shall be:

- Meet Clear Creek Compliance point 95 percent of time
- Meet Balls Ferry Compliance point 85 percent of time
- Meet Jelly's Ferry Compliance point 40 percent of time
- Meet Bend Bridge Compliance point 15 percent of time

Rationale: Evaluating long-term operations against a set of performance measures is the only way to determine the effectiveness of operations in preserving key aspects of life history and run time diversity. For example, maintaining suitable spawning temperatures down to Bend Bridge in years when this is feasible will help to preserve the part of winter-run distribution and run timing that relies on this habitat and spawning strategy. This will help to ensure that diversity is preserved when feasible. The percentages are taken from those presented in the CVP/SWP operations BA, effects analysis in the Opinion, and NMFS technical memo on historic Shasta operations.

Action I.2.2. November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as detailed below.

Action I.2.2.A Implementation Procedures for EOS Storage at 2.4 MAF and Above

If the EOS storage is at 2.4 MAF or above, by October 15, Reclamation shall convene a group including NMFS, USFWS, and CDFG, through B2IT or other comparable process, to consider a range of fall actions. A written monthly average Keswick release schedule shall be developed and submitted to NMFS by November 1 of each year, based on the criteria below. The monthly release schedule shall be tracked through the work group. If there is any disagreement in the group, including NMFS technical staff, the issue/action shall be elevated to the WOMT for resolution per standard procedures.

The workgroup shall consider and the following criteria in developing a Keswick release schedule:

1) Need for flood control space: A maximum 3.25 MAF end-of-November storage is necessary to maintain space in Shasta Reservoir for flood control.

2) Need for stable Sacramento River level/stage to increase habitat for optimal spring-run and fall-run redds/egg incubation and minimization of redd dewatering and juvenile stranding.

3) Need/recommendation to implement USFWS' Delta smelt Fall X2 action as determined by the Habitat Study Group formed in accordance with the 2008 Delta smelt Opinion. NMFS will continue to participate in the Habitat Study Group (HSG) chartered through the 2008 Delta smelt biological opinion. If, through the HSG, a fall flow action is recommended that draws down fall storage significantly from historical patterns, then NMFS and USFWS will confer and recommend to Reclamation an optimal storage and fall flow pattern to address multiple species' needs.

If there is a disagreement at the workgroup level, actions may be elevated to NMFS Sacramento Area Office Supervisor and resolved through the WOMT's standard operating procedures.

Rationale: 2.2 MAF EOS storage is linked to the potential to provide sufficient cold water to meet the minimum Balls Ferry Compliance point in the following year, and it is achievable approximately 85 percent of the time. Based on historical patterns, EOS storage will be above 2.4 MAF 70 percent of the time. The 2.4 MAF storage value provides a reasonable margin above the 2.2 level to increase the likelihood that the Balls Ferry Compliance Point will be reached while also implementing fall releases to benefit other species and life stages.

Therefore, in these circumstances, actions should target the fall life history stages of the species covered by this Opinion *(i.e.*, spring-run spawning, winter-run emigration). The development of a Keswick release schedule is a direct method for controlling storage maintained in Shasta Reservoir. It allows Reclamation to operate in a predictable way, while meeting the biological requirements of the species. The B2IT workgroup has been used in the past to target actions to benefit fall-run during this time of year using b(2) resources, and, because of its expertise, may also be used by Reclamation to develop this flow schedule. In the past, the B2IT group has used the CVPIA AFRP guidelines to target reservoir releases. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.B Implementation Procedures for EOS Storage Above 1.9 MAF and Below 2.4 MAF

If EOS storage is between 1.9 and 2.4 MAF, then Reclamation shall convene a group including NMFS, USFWS, and CDFG, through B2IT or other comparable workgroup, to consider a range of fall actions. Reclamation shall provide NMFS and the work group with storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February, and develop a monthly average Keswick release schedule based on the criteria below. The monthly release schedule shall be submitted to NMFS by November 1.

Criteria for the release schedule shall include:

1) Maintain Keswick releases between 7000 cfs and 3250 cfs to reduce adverse effects on mainstem spring-run and conserve storage for next year's cold water pool.

2) Consider fall-run needs per CVPIA AFRP guidelines, through January, including stabilizing flows to keep redds from de-watering.

3) Be more conservative in Keswick releases throughout fall and early winter if hydrology is dry, and release more water for other purposes if hydrology becomes wet. For example, release no more than 4,000 cfs if hydrology remains dry.

The Keswick release schedule shall follow this or a similar format, to be refined by the workgroup:

	October forecast based on EOS storage	50% hydrology		70% hydrology		90% hydrology	
		Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS
Monthly average Keswick	November						
	December						
	January						

release	February						

Reclamation, in coordination with the work group, shall review updated hydrology and choose a monthly average release for every month (November, December, January, February), based on the release schedule. In the event that the updated hydrology indicates a very dry pattern and consequent likely reduction in storage, the work group may advise Reclamation to take additional actions, including export curtailments, if necessary to conserve storage

If there is a disagreement at the work group level, actions may be elevated to NMFS and resolved through the WOMT's standard operating procedures.

Rationale: It is necessary to be reasonably conservative with fall releases to increase the likelihood of adequate storage in the following year to provide cold water releases for winter-run. This action is intended to reduce adverse effects on each species without compromising the ability to reduce adverse effects on another species. A work group with biologists from multiple agencies will refine the flow schedule, providing operational certainty while allowing for real-time operational changes based on updated hydrology. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.C. Implementation and Exception Procedures for EOS Storage of 1.9 MAF or Below

If the EOS storage is at or below 1.9 MAF, then Reclamation shall:

1) In early October, reduce Keswick releases to 3,250 cfs as soon as possible, unless higher releases are necessary to meet temperature compliance points (see action I.2.3).

2) Starting in early October, if cool weather prevails and temperature control does not mandate higher flows, curtail discretionary water deliveries (including, but not limited to agricultural rice decomposition deliveries) to the extent that these do not coincide with temperature management for the species. It is important to maintain suitable temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition, and any other discretionary purposes at this time of year, may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS, USFWS, and CDFG.

3) By November 1, submit to NMFS storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February. In coordination with NMFS, Reclamation shall: (1) develop a monthly average Keswick release schedule similar in format to that in Action I.2.2.B, based on the criteria below and including actions specified below; and (2) review updated hydrology and choose a monthly average release for every month, based on the release schedule. November releases shall be based on a 90 percent hydrology estimate.

Criteria and actions:

1) Keswick releases shall be managed to improve storage and maintained at 3,250 cfs unless hydrology improves.

2) November monthly releases will be based on 90 percent hydrology.

3) Consider fall-run needs through January as per CVPIA AFRP guidelines, including stabilizing flows to keep redds from dewatering.

4) Continue to curtail discretionary agricultural rice decomposition deliveries to the extent that these do not coincide with temperature management for the species, or impact other ESA-listed species. It is important to maintain suitable temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS. USFWS, and CDFG.

5) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

    a) CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick release (or other planned release based on biological needs of species); and
    b) if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom; and
    c) in general, Reclamation shall increase releases from Keswick as a last resort.
    d) Based on updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

6) If the hydrology and storage have not improved by January, additional restrictions apply – see Action I.2.4.

Rationale: Per actions I.2.3 and I.2.4 below, Reclamation is required to meet 1.9 MAF EOS. The BA's CALSIM modeling shows that during a severe or extended drought, 1.9 EOS storage may not be achievable. In this circumstance, Reclamation should take additional steps in the fall and winter months to conserve Shasta storage to the maximum extent possible, in order to increase the probability of maintaining cold water supplies necessary for egg incubation for the following summer's cohort of winter-run.

Assessment of the hydrologic record and CALSIM modeling shows that operational actions taken during the first year of a drought sequence are very important to providing adequate storage and operations in subsequent drought years. The biological effects of an extended

drought are particularly severe for winter-run. Extended drought conditions are predicted to increase in the future in response to climate change. While it is not possible to predict the onset of a drought sequence, in order to ensure that project operations avoid jeopardizing listed species, Reclamation should operate in any year in which storage falls below 1.9 MAF EOS as potentially the first year of a drought sequence. The CVP storage system is likely to recover more quickly in the winter and spring months if additional storage conservation measures are taken in the fall and winter.

The curtailments to discretionary rice decomposition deliveries and combined export curtailment of 2,000 cfs are necessary to conserve storage when EOS storage is low. These actions were developed through an exchange of information and expertise with Reclamation operators.

This action is consistent with comments from the Calfed Science Peer Review panel. That panel recommended that Shasta be operated on a two-year (as opposed to single year) hydrologic planning cycle and that Reclamation take additional steps to incorporate planning for potential drought and extended drought into its operations.

Action I.2.3. February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Actions:

1) Reclamation shall make its February 15 forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90 percent probability of exceedence. Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90 percent probability of exceedence.

    a) Reclamation shall provide the draft February forecast, and a projection of temperature management operations for the summer months, to NMFS no later than seven business days after receipt of the official DWR runoff forecast.
    b) NMFS shall be provided at 3 three business days to review the draft forecast.
    c) NMFS shall review the draft February forecast to determine whether the predicted delivery schedule is likely to leave sufficient water for temperature management to meet ESA requirements.
    d) NMFS shall provide a written evaluation to Reclamation prior to Reclamation making the first allocation announcements and for each subsequent month for discretionary contract deliveries.
    e) Reclamation shall manage releases from Keswick consistent with the February forecast and subsequent monthly hydrology updates.

2) Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action I.2.3.A Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Balls Ferry Temperature Compliance Point and 2.2 MAF EOS are Both Achievable

NMFS will review the draft February forecast to determine whether both a temperature compliance point at Balls Ferry during the temperature control season (May – October), and EOS storage of at least 2.2 MAF, is likely to be achieved. If both are likely, then Reclamation shall announce allocations and operate Keswick releases in March, April, and May consistent with its standard plan of operation. Preparation of a separate Keswick release schedule is not necessary in these circumstances.

Rationale: The 90 percent forecast is a conservative approach for assessing the potential to meet both the Balls Ferry TCP and 2.2 MAF EOS performance goals. If both of these performance goals are projected to be met at the time of the February forecast, then no restrictions on allocations due to this suite of actions are necessary.

Action I.2.3.B Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Only Balls Ferry Compliance or 2.2 MAF EOS, but Not Both, Is Achievable

1) On or before February 15, Reclamation shall reduce Keswick releases to 3,250 cfs, unless NMFS concurs on an alternative release schedule. This reduction shall be maintained until a flow schedule is developed per procedures below.

2) In coordination with NMFS, by March 1, Reclamation shall develop an initial monthly Keswick release schedule, based on varying hydrology of 50 percent, 70 percent, and 90 percent (similar in format to the fall and winter action implementation procedures – see table above). These schedules shall be used as guidance for monthly updates and consultations.

3) Based on this guidance, Reclamation shall consult with NMFS monthly on Keswick releases. Reclamation shall submit a projected forecast, including monthly average release schedules and temperature compliance point to NMFS every month, within 7 business days of receiving the DWR runoff projections for that month. Within 3 business days of receiving this information from Reclamation, NMFS will review the draft schedule for consistency with the criteria below and provide written recommendations to Reclamation.

4) The initial monthly Keswick release schedule, and subsequent monthly updates, shall be developed based on the following criteria and including the following actions:

a) Maintain minimum monthly average flows necessary to meet nondiscretionary delivery obligations and legal requirements.
b) Provide for flow-related biological needs of spring life stages of all species covered by this Opinion in the Sacramento River and Delta, to the greatest extent possible.
c) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

- CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick Dam release (or other planned release based on biological needs of species); and
- if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom Dam; and
- in general, Reclamation shall increase releases from Keswick Dam as a last resort.
- Based on improvements in updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

Rationale: It is necessary to manage storage for potential dry years, to reduce adverse effects on winter-run egg incubation in summer months, and on spring-run in fall months. According to information provided by Reclamation, the hydrology is too variable this time of year to provide for a meaningful 3-month release schedule. Instead, monthly consultations between NMFS and Reclamation are needed to ensure that operations are based on biological criteria.

Action I. 2.3. C. Drought Exception Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Clear Creek Temperature Compliance Point or 1.9 MAF EOS Storage is Not Achievable

Reclamation shall follow all procedures immediately above (Action I.2.3.B) and, in addition, shall:

1) By March 1, provide a contingency plan with a written justification that all actions within Reclamation's authorities and discretion are being taken to preserve cold water at Shasta Reservoir for the protection of winter-run.

2) The contingency plan shall also, at a minimum, include the following assessments and actions:

    a) Relaxation of Wilkins Slough navigation criteria to at most 4,000 cfs.
    b) An assessment of any additional technological or operational measures that may be feasible and may increase the ability to manage the cold water pool.
    c) Notification to State Water Resources Control Board that meeting the biological needs of winter-run and the needs of resident species in the Delta, delivery of water to nondiscretionary Sacramento Settlement Contractors, and Delta outflow requirements per D-1641, may be in conflict in the coming season and requesting the Board's assistance in determining appropriate contingency measures, and exercising their authorities to put these measures in place.

3) If, during the temperature control season, a Clear Creek TCP on the Sacramento River cannot be achieved, then Reclamation shall bypass power at Shasta Dam if NMFS determines a bypass is necessary for preserving the cold water pool. This power by-pass may be necessary to maintain temperature controls for winter-run, or later in the temperature season, for spring-run.

Rationale: In these circumstances, there is a one-in-ten likelihood that minimal requirements for winter-run egg survival will not be achieved due to depletion of the cold water pool, resulting in temperature-related mortality of winter-run and, in addition, most likely contributing to temperature-related mortality of spring-run spawning in the fall. This is a conservative forecast, since there is a 90 percent probability that conditions will improve. However, the effects analysis in this Opinion concludes that these poor conditions could be catastrophic to the species, potentially leading to a significant reduction in the viability of winter-run. Delta objectives (salinity, X2, E/I ratio, OMR flow restrictions for both smelt and salmon) are also controlling at this time of year. There is potential for conflict between the need to maintain storage at Shasta and other legal and ecological requirements. Consequently, it is necessary to immediately limit releases from Shasta and develop a contingency plan.

Notification to the State Water Resources Control Board (SWRCB) is essential. Sacramento Settlement Contract withdrawal volumes from the Sacramento River can be quite substantial during these months. The court has recently concluded that Reclamation does not have discretion to curtail the Sacramento Settlement contractors to meet Federal ESA requirements. Therefore, NMFS is limited in developing an RPA that minimizes take to acceptable levels in these circumstances. Consequently, other actions are necessary to avoid jeopardy to the species, including fish passage at Shasta Dam in the long term.

Separate from this consultation, NMFS will work with the SWRCB to determine whether contingency plans within the Board's authority are warranted, and to assist in developing such plans that will allow Reclamation to meet ESA requirements. The incidental take statement for this Opinion also provides limitations of ESA incidental take coverage for Settlement Contractors under the terms of this Opinion.

Action 1.2.4 May 15 Through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall develop and implement an annual Temperature Management Plan by May 15 to manage the cold water supply within Shasta Reservoir and make cold water releases from Shasta Reservoir and Spring Creek to provide suitable temperatures for listed species, and, when feasible, fall-run.

Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

1) Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.

2) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

3) As part of the adaptive management process, and in coordination with NMFS, by March 2010, Reclamation shall fund an independent modeler to review these procedures and the recommendations of the Calfed Science Panel report on temperature management and recommend specific refinements to these procedures to achieve optimal temperature management, with due consideration of the Calfed Science panel's recommendations (Deas *et al*., 2009) regarding temperature management. Upon written concurrence of

NMFS, refinements to the implementation procedures for this action suite, based on the independent contractor's report, may be adopted and implemented.

Implementation Procedures: Reclamation shall take the following steps to develop an annual Temperature Management plan:

1) By April 15, Reclamation shall develop and submit to NMFS both 50 percent and 90 percent forecasts, consistent with its draft plan of summer operations. Reclamation shall model two complete runs for each forecast, one with an upstream TCP and one with a downstream TCP. Together, Reclamation will present four risk-management options to NMFS for review. EOS Storage will be projected for each of the four runs. If it is very wet or very dry, there will be fewer options to present to NMFS.
2) NMFS will provide comments within five business days to Reclamation, recommending that Reclamation either: (1) operate to one of the options; or (2) develop an alternative operations plan necessary to meet reasonably attainable preferred TCP and EOS storage.
3) Within five business days of receiving NMFS' recommendations, and based on NMFS' comments, Reclamation will develop an operations plan with specific monthly average Keswick releases to attain both TCP from May 15 through the EOS and EOS storage, and submit the plan to NMFS for concurrence.
4) By May 15, Reclamation and NMFS shall jointly submit a final Temperature Management Plan to meet the SWRCB 90-5 requirements using the SRTTG. From May 15 through October 31, the SRTTG shall track implementation of this plan, and shall refine it based real-time information, including run timing, location of redds, air and surface water temperature modeling, and projected versus actual extent of the cold water pool. Any disagreement at the work group level regarding how to implement or modify the plan will be elevated to NMFS and resolved through WOMT standard operating procedures.

Rationale: Depending on hydrology and air temperature, from May through October, it is necessary to use the cold water pool in Shasta Reservoir to provide cold water releases to maintain suitable water temperatures for listed anadromous fish below Shasta. Without access to the cold water pool, suitable temperatures for egg incubation are not attainable. Preparation of an annual Temperature Management Plan allows Reclamation, in consultation with NMFS, to achieve optimal cold water management in a given year. Temperature management requires tradeoffs between extending the range of suitable habitat by moving the compliance point downstream from Balls Ferry, and conserving EOS storage. The storage level at the EOS is important to manage the risk of unsuitably warm water temperatures for winter-run in the following summer. Maintaining suitable temperatures in September and October is also important to minimize adverse effects of project operations to main stem Sacramento River spring-run. Fall-run, a non-listed species that is important as a prey base for Southern Resident Killer Whale, also benefits from suitable temperatures in the Fall.

Development of 2 to 4 options for temperature management, prior to finalizing a plan allows for meaningful discussion of appropriate risk management strategies in a given year, based

on timely hydrologic and biological considerations. Important factors differ from year to year, and need to be considered in operations planning. They include the projected size of the winter-run year class (and thus the extent of habitat needed); timing and location of spawning and redds based on aerial surveys; the extent of the cold water pool, given air temperatures; and operation of the Temperature Control Device to provide optimal use of the cold water pool. Preparation of a draft plan also allows for iterative planning and feedback. Operations can be tailored each year to achieve the optimal approach to temperature management to maintain viable populations of anadromous fish, based on the best available information.

The Calfed Science Program peer review report on temperature management emphasized the importance of refining temperature management practices in the long term and included recommendations for doing so. The requirement to hire an independent contractor to recommend specific refinements to the procedures in this RPA responds to these recommendations.

Action I.2.5. Winter-Run Passage and Re-Introduction Program at Shasta Dam

See Fish Passage Program, Action V

Action I.2.6. Restore Battle Creek for Winter-Run, Spring-Run, and CV Steelhead

Objective: To partially compensate for unavoidable adverse effects of project operations by restoring winter-run and spring-run to the Battle Creek watershed. A second population of winter-run would reduce the risk of extinction of the species from lost resiliency and increased vulnerability to catastrophic events.

Description of Action: Reclamation shall direct discretionary funds to implement the Battle Creek Salmon and Steelhead Restoration Project. Phase 1A funding is currently allocated through various partners and scheduled to commence in Summer 2009 (Reclamation 2008c). DWR shall direct discretionary funds for Phase 1B and Phase 2, consistent with the proposed amended Delta Fish Agreement by December 31 of each year, Reclamation and DWR will submit a written report to NMFS on the status of the project, including phases completed, funds expended, effectiveness of project actions, additional actions planned (including a schedule for further actions), and additional funds needed. The Battle Creek Salmon and Steelhead Restoration Project shall be completed no later than 2019.

Rationale: Modeling projections in the BA show that adverse effects of ongoing project operations cannot be fully minimized. Severe temperature-related effects due to project operations will occur in some years. This RPA includes an exception procedure in anticipation of these occurrences (see Action I.2.2). Establishing additional populations of winter-run is critical to stabilize the high risk of extinction resulting from the proposed action on the only existing population of this species. $26 million has been identified for this project in the American Recovery and Reinvestment Act of 2009.

Action Suite I.3. Red Bluff Diversion Dam (RBDD) Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action I.3.1. Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish. If the Red Bluff Alternative Intake Structure is not anticipated to be operational by May 15, 2012, Reclamation may submit a request to NMFS, no later than January 31, 2012, to close the gates from June 15 to September 1, 2012. This request must document that all milestones for construction of the alternative pumping plant have been met and that all other conservation measures (see below) have been implemented.

Rationale: RBDD impedes and delays upstream migration of adult winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon. It also impedes and delays downstream passage of juveniles of the same species. It adversely modifies critical habitat for these species by impairing important mainstem passage. Pumps can be used to deliver water currently made available by placing gates in the river, and $109 million has been identified in the recent American Recovery and Reinvestment Act of 2009 for the Red Bluff Pumping Plant.

Action I.3.2. Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

- September 1 - June 14: Gates open. No emergency closures of gates are allowed.
- June 15 - August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Rationale: Having gates out until June 15 is necessary for winter-run, spring-run and green sturgeon adult passage to spawning habitat. TCCA can withdraw 465 cfs without the gates in the river. Their water demand typically reaches 800 cfs by June 15, therefore, TCCA will need supplemental pumping capacity to meet water demand until June 15. NMFS has consulted with Reclamation separately on the effects of an interim pumping operation. Implementation of these improvements to passage conditions at RBDD, in conjunction with several other conservation and research measures proposed by TCCA (Appendix 2-B), is

expected to reduce the effects of continuing (for the next three years) the (modified) operations of RBDD to a level that will not reduce the likelihood of survival and recovery of these ESUs and DPSs.

Action I.3.3. Interim Operation for Green Sturgeon

Objective: Allow passage of green sturgeon during interim operations.

Action: When gates are in, Reclamation shall retain a minimum 18-inch opening under the gates that are open, to allow safe downstream passage of adult green sturgeon. The 18-inch opening may be modified to 12 inches by the RBDD technical team if necessary to maintain the structural integrity of the dam and/or adequate attraction flows for salmonids at the fish ladders, or in consideration of other real-time fish migratory issues.

Rationale: Twelve to 18 inches is the estimated minimum gate opening that would allow adult green sturgeon to pass downstream underneath the RBDD gates uninjured.

Action I.3.4: Measures to Compensate for Adverse Effects of Interim Operations on Green Sturgeon

Objective: Offset short-term effects to green sturgeon due to interim gate operations by investing in geographically specific research needed to determine green sturgeon life history and recovery needs.

Action: Reclamation shall continue ongoing funded research to characterize green sturgeon populations in the upper Sacramento River Basin, their movements, and habitat usage, as planned through fiscal year 2009. In addition, Reclamation (or TCCA) shall convene a technical team, including representatives from NMFS, CDFG, USFWS, Corps, the University of California at Davis (UCD), and other cooperators, to review studies and results and coordinate research needs for green sturgeon. Reclamation and/or TCCA shall provide the necessary funding to insure that research will continue to be conducted in a coordinated and cooperative manner with the express intent of fully implementing the research projects described in the UCD proposal in Appendix 2-B to this Opinion.

Rationale: The exact timing of spawning migration for green sturgeon is not known, and during interim operations the potential remains for late arriving green sturgeon to be blocked by the dam after June 14. There is also a potential for post-spawn adult migrants and post-hatch juvenile migrants to be adversely affected, since they must pass downstream through the narrow clearance and high turbulence caused by the closed dam gates between June 14 and August 31.

Although the proposed studies will not directly benefit the green sturgeon that will be impacted by the dam during the interim period before the gates are permanently lifted, these studies will greatly benefit the Southern DPS of green sturgeon as a whole by revealing important information that will improve their likelihood of survival and recovery over the

long term. The studies will provide vital information on the life history and biological requirements of green sturgeon, which will allow NMFS to develop and implement a comprehensive and effective recovery plan for the DPS. By combining these long-term benefits to the survival and recovery of the Southern DPS of green sturgeon with the other significant improvements to habitat conditions required within this RPA (reduced gates-in periods, increased minimum gate openings, improved water temperature conditions for spawning and rearing, improved migration and rearing conditions in the lower river and Delta), the full implementation of this RPA is expected to offset the effects of continuing (for the next three years) the (modified) operations of RBDD to a level that will not reduce the likelihood of survival and recovery of the green sturgeon DPSs.

Action I.3.5. Measures to Compensate for Adverse Effects of Interim Operations on Spring-Run

Objective: Offset unavoidable short-term effects to spring-run from passage impediments of RBDD by restoring spring-run passage elsewhere in the Sacramento River system.

Action: Reclamation shall provide $500,000 for implementation of spring- run passage improvement projects in the Sacramento River. Appendix 2-B describes specific projects that may be implemented. By December 15, 2009, Reclamation shall provide NMFS with a prioritized list of projects from Appendix 2-B and an implementation schedule. Reclamation shall provide an annual report to NMFS on implementation and effectiveness of projects. Reclamation shall monitor and maintain these projects for five years.

Rationale: During interim operations, late arriving spring-run may be adversely affected by the dam after June 14. Construction and maintenance of the interim pumping facility also may have short-term adverse effects on spring-run.

The proposed passage restoration projects are likely to benefit the spring-run ESU as a whole by improving access to spawning habitat for some of the key populations within the ESU. Although the proposed improvements will not provide passage benefits to the small dependent populations that spawn upstream of RBDD, they will benefit the large independent populations that spawn in downstream tributaries. Passage improvements for the large independent population, in turn, will benefit the smaller populations throughout the Central Valley that depend on these larger populations to supplement their numbers and genetic diversity.

Action I.4. Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: Reclamation shall convene the SRTTG to review past operational data, hydrology, and fisheries needs for Wilkins Slough. The SRTTG shall recommend Wilkins Slough

minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion. Recommendations shall be made to NMFS by December 1, 2009. The recommendations will be implemented upon NMFS' concurrence.

In years other than critically dry years**,** the need for a variance from the 5,000 cfs navigation criterion will be considered during the process of developing the Keswick release schedules (Action I.2.2-4).

Rationale: In some circumstances, maintaining the Wilkins Slough navigation channel at 5,000 cfs may be a significant draw on Shasta reservoir levels and affect the summer cold water pool necessary to maintain suitable temperatures for winter-run egg incubation and emergence. Reclamation has stated that it is no longer necessary to maintain 5,000 cfs for navigation (CVP/SWP operations BA, page 2-39). Operating to a minimal flow level based on fish needs, rather than on outdated navigational requirements, will enhance the ability to use cold-water releases to maintain cooler summer temperatures in the Sacramento River.

Action I.5. Funding for CVPIA Anadromous Fish Screen Program (AFSP)

Objective: To reduce entrainment of juvenile anadromous fish from unscreened diversions.

Action: Reclamation shall screen priority diversions as identified in the CVPIA AFSP, consistent with previous funding levels for this program. In addition, Reclamation/CVPIA Program shall evaluate the potential to develop alternative screened intakes that allow diverters to withdraw water below surface levels required by the antiquated Wilkins Slough navigation requirement criterion of 5,000 cfs.

Rationale: Approximately ten percent of 129 CVP diversions listed in Appendix D-1 of the CVP/SWP operations BA are currently screened. Of these, most of the largest diversions (greater than 250 cfs) have already been screened; however, a large number of smaller diversions (less than 250 cfs) remain unscreened or do not meet NMFS fish screening criteria (NMFS 1997; *e.g.*, CVP and SWP Delta diversions, Rock Slough diversion). The AFSP has identified priorities for screening that is consistent with the needs of listed fish species. Screening will reduce the loss of listed fish in water diversion channels. In addition, if new fish screens can be extended to allow diversions below 5,000 cfs at Wilkins Slough, then cold water can be conserved during critically dry years at Shasta Reservoir for winter-run and spring-run life history needs.

Action Suite I.6: Sacramento River Basin Salmonid Rearing Habitat Improvements

Objective: To restore floodplain rearing habitat for juvenile winter-run, spring-run, and CV steelhead in the lower Sacramento River basin, to compensate for unavoidable adverse effects of project operations. This objective may be achieved at the Yolo Bypass, and/or through actions in other suitable areas of the lower Sacramento River.

The suite of actions includes near term and long-term actions. The near-term action (Action I.6.2) is ready to be implemented and can provide rearing benefits within two years of issuing this Opinion. The long-term actions (Actions I.6.1, I.6.3, and I.6.4) require additional planning and coordination over a five- to ten-year time frame.

These actions are consistent with Reclamation's broad authorities in CVPIA to develop and implement these types of restoration projects. When necessary to achieve the overall objectives of this action, Reclamation and DWR, in cooperation with other agencies and funding sources, including the Delta Fish Agreement and any amendments, shall: (1) apply for necessary permits; (2) seek to purchase land, easements, and/or water rights from willing sellers; (3) seek additional authority and/or funding from Congress or the California State Legislature, respectively; and (4) pursue a Memorandum of Agreement with the Corps.

Similar actions addressing rearing and fish passage are under consideration in the BDCP development process and may ultimately satisfy the requirements in Actions I.6 and I.7. BDCP is scheduled to be completed by December 31, 2010.

Action I.6.1. Restoration of Floodplain Rearing Habitat

Objective: To restore floodplain rearing habitat for juvenile winter-run, spring-run, and CV steelhead in the lower Sacramento River basin. This objective may be achieved at the Yolo Bypass, and/or through actions in other suitable areas of the lower Sacramento River.

Action: In cooperation with CDFG, USFWS, NMFS, and the Corps, Reclamation and DWR shall, to the maximum extent of their authorities (excluding condemnation authority), provide significantly increased acreage of seasonal floodplain rearing habitat, with biologically appropriate durations and magnitudes, from December through April, in the lower Sacramento River basin, on a return rate of approximately one to three years, depending on water year type. In the event that this action conflicts with Shasta Operations Actions I.2.1 to I.2.3, the Shasta Operations Actions shall prevail.

Implementation procedures: By December 31, 2011, Reclamation and DWR shall submit to NMFS a plan to implement this action. This plan should include an evaluation of options to: (1) restore juvenile rearing areas that provide seasonal inundation at appropriate intervals, such as areas identified in Appendix 2-C or by using the Sacramento River Ecological Flow Tool (ESSA/The Nature Conservancy 2009) or other habitat modeling tools; (2) increase inundation of publicly and privately owned suitable acreage within the Yolo Bypass; (3) modify operations of the Sacramento Weir (which is owned and operated by the Department of Water Resources) or Fremont Weir to increase rearing habitat; and (4) achieve the restoration objective through other operational or engineering solutions. An initial performance measure shall be 17,000-20,000 acres (excluding tidally-influenced areas), with appropriate frequency and duration. This measure is based on the work by Sommer *et al*. (2001, 2004) at Yolo Bypass and on recent analyses conducted for the BDCP process of

inundation levels at various river stages. (BDCP Integration Team 2009).[28] The plan may include a proposal to modify this performance measure, based on best available science or on a scientifically based adaptive management process patterned after Walters (1997).

This plan also shall include: (1) specific biological objectives, restoration actions, and locations; (2) specific operational criteria; (3) a timeline with key milestones, including restoration of significant acreage by December 31, 2013; (4) performance goals and associated monitoring, including habitat attributes, juvenile and adult metrics, and inundation depth and duration criteria; (5) specific actions to minimize stranding or migration barriers for juvenile salmon; and (6) identification of regulatory and legal constraints that may delay implementation, and a strategy to address those constraints. Reclamation and DWR shall, to the maximum extent of their authorities and in cooperation with other agencies and funding sources, implement the plan upon completion, and shall provide annual progress reports to NMFS. In the event that less than one half of the total acreage identified in the plan's performance goal is implemented by 2016, then Reclamation and DWR shall re-initiate consultation.

The USFWS' Delta smelt biological opinion includes an action to restore 8,000 acres of tidal habitat for the benefit of Delta smelt. If these 8,000 acres also provide suitable rearing habitat for salmonids, they may be used in partial satisfaction of the objective of this action.

This action is not intended to conflict with or replace habitat restoration planning in the BDCP process.

Rationale: Rearing and migration habitats for all anadromous fish species in the Sacramento basin are in short supply. Project operations limit the availability of such habitats by reducing the frequency and duration of seasonal over-bank flows as a result of flood management and storage operational criteria. Recent evaluations on the Yolo Bypass and Cosumnes River have shown that juvenile Chinook salmon grow faster when seasonal floodplain habitats are available (Sommer *et al*. 2001, 2005; Jeffres *et al*. 2008). Sommer *et al.* (2005) suggest these floodplain benefits are reflected in adult return rates. This action is intended to offset unavoidable adverse effects to rearing habitat and juvenile productivity of winter-run, spring-run, and CV steelhead in the Sacramento River basin, by increasing available habitat that is inundated with the frequency and duration of suitable floodplain rearing habitats during December through April.

In high flow years (*e.g.*, similar to 1998), this action can be achieved solely by inundation of the Yolo Bypass. In other years, this action may be accomplished by a combination of actions such as increasing the year-to-year inundation frequency of existing floodplains such as portions of the Yolo Bypass, by restoring rearing habitat attributes to suitable areas, through restoration or enhancement of intertidal areas such as Liberty Island, creation or re-establishment of side channels, and re-created floodplain terrace areas.

[28] The analyses assumed a notch in the Fremont Weir.

Action I.6.2. Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass

Description of Action: By September 30, 2010, Reclamation and/or DWR shall take all necessary steps to ensure that an enhancement plan is completed and implemented for Liberty Island/Lower Cache Slough, as described in Appendix 2-C. This action shall be monitored for the subsequent five years, at a minimum, to evaluate the use of the area by juvenile salmonids and to measure changes in growth rates. Interim monitoring reports shall be submitted to NMFS annually, by September 30 each year, and a final monitoring report shall be submitted on September 30, 2015, or in the fifth year following implementation of enhancement actions. NMFS will determine at that time whether modification of the action or additional monitoring is necessary to achieve or confirm the desired results. This action shall be designed to avoid stranding or migration barriers for juvenile salmon.

Action I.6.3. Lower Putah Creek Enhancements

Description of Action: By December 31, 2015, Reclamation and/or DWR shall develop and implement Lower Putah Creek enhancements as described in Appendix 2-C, including stream realignment and floodplain restoration for fish passage improvement and multi-species habitat development on existing public lands. By September 1 of each year, Reclamation and/or DWR shall submit to NMFS a progress report towards the successful implementation of this action. This action shall not result in stranding or migration barriers for juvenile salmon.

Action I.6.4. Improvements to Lisbon Weir

Action: By December 31, 2015, Reclamation and/or DWR shall, to the maximum extent of their authorities, assure that improvements to the Lisbon Weir are made that are likely to achieve the fish and wildlife benefits described in Appendix 2-C. Improvements will include modification or replacement of Lisbon Weir, if necessary to achieve the desired benefits for fish. If neither Reclamation nor DWR has authority to make structural or operational modifications to the weir, they shall work with the owners and operators of the weir to make the desired improvements, including providing funding and technical assistance. By September 1 of each year, Reclamation and/or DWR shall submit to NMFS a report on progress toward the successful implementation of this action. Reclamation and DWR must assure that this action does not result in migration barriers or stranding of juvenile salmon.

Rationale for Actions I.6.2 to I.6.4: These actions have been fully vetted by CDFG and found to be necessary initial steps in improving rearing habitat for listed species in the lower Sacramento River basin. These improvements are necessary to off-set ongoing adverse effects of project operations, primary due to flood control operations. Additional descriptions of these actions are contained in the draft amendment to the Delta Fish Agreement (CVP/SWP operations BA appendix Y).

Action I.7. Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass

Objective: Reduce migratory delays and loss of adult and juvenile winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon at Fremont Weir and other structures in the Yolo Bypass.

Description of Action: By December 31, 2011, as part of the plan described in Action I.6.1, Reclamation and/or DWR shall submit a plan to NMFS to provide for high quality, reliable migratory passage for Sacramento Basin adult and juvenile anadromous fishes through the Yolo Bypass. By June 30, 2011, Reclamation and/or DWR shall obtain NMFS concurrence and, to the maximum extent of their authorities, and in cooperation with other agencies and funding sources, begin implementation of the plan, including any physical modifications. By September 30, 2009, Reclamation shall request in writing that the Corps take necessary steps to alter Fremont Weir and/or any other facilities or operations requirements of the Sacramento River Flood Control Project or Yolo Bypass facility in order to provide fish passage and shall offer to enter into a Memorandum of Understanding, interagency agreement, or other similar mechanism, to provide technical assistance and funding for the necessary work. By June 30, 2010, Reclamation shall provide a written report to NMFS on the status of its efforts to complete this action, in cooperation with the Corps, including milestones and timelines to complete passage improvements.

Reclamation and/or DWR shall assess the performance of improved passage and flows through the bypass, to include an adult component for salmonids and sturgeon (*i.e.*, at a minimum, acoustic receivers placed at the head and tail of the bypass to detect use by adults).

Rationale: The Yolo Bypass and Fremont Weir has been a documented source of migratory delay to, and loss of, adult winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon. The existing fish passage structure is inadequate to allow normal passage at most operational levels of the Sacramento River. The project agencies must work with the Corps, which owns and operates Fremont Weir, to achieve improvements for fish. Other structures within the Yolo Bypass, such as the toe drain, Lisbon Weir, and irrigation dams in the northern end of the Tule Canal, also can impede migration of adult anadromous fish. Additionally, stranding of juvenile salmonids and sturgeon has been reported in the Yolo Bypass in scoured areas behind the weir and in other areas. This action offsets unavoidable project effects on adult migration and minimizes the direct losses from flood management activities associated with operations.

II. AMERICAN RIVER DIVISION

Introduction to American River Actions: The CV steelhead DPS is the only species addressed in this Opinion with a spawning population in the American River. The DPS includes naturally spawned steelhead in the American River (and other Central Valley stocks) and excludes steelhead spawned and reared at Nimbus Fish Hatchery. The in-river population is small, with

observations of a few hundred adults returning to spawn in the American River each year. Limited observations made in 2003, 2004, 2005, and 2007 of whether in-river spawners were adipose fin-clipped or not indicate that some in-river spawners are of wild origin (Hannon and Deason 2008). This suggests that the listed stock has some ability to survive habitat conditions in the American River, Delta, and Ocean, even in their degraded state as described in preceding sections of this Opinion.

The in-river population is likely entirely made up of Nimbus Fish Hatchery steelhead or their descendents. Early Nimbus Fish Hatchery broodstock included naturally produced fish from the American River and stocks from the Washougal (Washington), Siletz (Oregon), Mad, Eel, Sacramento and Russian rivers, with the Eel River stock being the most heavily used (Staley 1976, McEwan and Jackson 1996).

Even though the American River steelhead population is small and is entirely influenced by hatchery fish with out-of-basin genetics, NMFS views the population as being important to the survival and recovery of the species. CV TRT shares this view by recommending that, "*every extant population be viewed as necessary for the recovery of the ESU"* (Lindley *et al.,* 2007). In addition, the steelhead population has presumably become somewhat locally adapted to the American River, and it has potential to substantially contribute to the viability of the DPS if water, habitat, and hatchery management efforts are coordinated and directed at achieving such a goal.

Key proposed project-related stressors include: (1) the provision of water temperatures warmer than steelhead life stage-specific requirements; (2) flow fluctuations that dewater redds, strand fry, and isolate fry and juveniles in off-channel pools where they are vulnerable to both predation and exposure to lethal and sub-lethal water temperatures; and (3) low flows limiting the availability of quality rearing habitat including predator refuge habitat.

The most influential baseline stressor to steelhead within the American River Division is the presence of Nimbus and Folsom dams, which block steelhead from all of their historic spawning and rearing habitat. This Opinion concludes that both increased water demands and effects of climate change will lead to further deterioration of suitable habitat conditions, including increased temperatures and decreased flows. Therefore, a passage program to expand the range of the American River steelhead population above Folsom Dam is necessary. If feasible, American River steelhead should be provided access to their full historic range. Given the long-term duration associated with the fish passage actions (see Fish Passage Program below, in Action V), it is necessary to plan and implement actions targeted at improving steelhead habitat below Nimbus Dam. NMFS concludes that coordinated management in four realms - water operations and associated structures, American River habitat, Nimbus Fish Hatchery operations, and in-river harvest – will substantially lower the extinction risk of American River steelhead

Action II.1. Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's[29] Flow Management Standard (FMS), which is summarized in Appendix 2-D of this Opinion. The FMS flow schedule has been developed by the Water Forum, Reclamation, USFWS, NMFS, and CDFG in order to establish required minimum flows for anadromous salmonids in the lower American River. The flow schedule specifies minimum flows and does not preclude Reclamation from making higher releases at Nimbus Dam.

Reclamation shall ensure that flow, water temperature, steelhead spawning, and steelhead rearing monitoring is conducted annually in order to help inform the ARG process and to evaluate take associated with flow fluctuations and warm water temperatures. Steelhead monitoring surveys should follow the objectives and protocols specified in the FMS Monitoring and Evaluation Program relating to steelhead spawning and rearing.

Implementation procedures: Reclamation shall convene the American River Group (ARG), comprised of representatives from Reclamation, NMFS, USFWS, CDFG and the Water Forum, to make recommendations for management within the constraints of the FMS. If there is a lack of consensus, ARG shall advise NMFS, and NMFS will make a recommendation to the WOMT for a decision.

Rationale: Reclamation operates Folsom Dam and Reservoir to provide water for irrigation, municipal and industrial uses, hydroelectric power, recreation, water quality, flood control, and fish protection. Reclamation operates Folsom Dam and Reservoir under a state water right permit and fish protection requirements that were adopted in 1958 as SWRCB Decision 893 (D-893). This decision allows flows at the mouth of the American River to fall as low as 250 cfs from January through mid-September, with a minimum of 500 cfs required between September 15 and December 31.

Biological, socioeconomic, legal, and institutional conditions have changed substantially since the SWRCB adopted D-893 in 1958. For example, D-893 does not address requirements of the CVPIA, the 1995 Bay Delta Plan, or previous Opinions to protect Central Valley anadromous salmonids. The SWRCB, Reclamation and many diverse stakeholders (*e.g.*, Water Forum) involved in various American River actions have agreed that the conditions specified in D-893 are not sufficiently protective of the fishery resources within the lower American River.

The flow schedule specified in Appendix 2-D was developed to require more protective minimum flows in the lower American River in consideration of the river's aquatic resources, particularly steelhead and fall-run.

The monitoring called for in this RPA action including flow, water temperature, steelhead spawning, and steelhead rearing monitoring is necessary for the ARG to responsibly carry

[29] In September 1993, the Water Forum, a diverse group of business and agricultural leaders, citizens groups, environmentalists, water managers, and local governments in the Sacramento Region, was formed to evaluate water resources and future water supply needs of the Sacramento metropolitan region.

out this mission. In addition, this monitoring is necessary to evaluate take associated with American River Division operations.

Action II.2. Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Each year, Reclamation shall prepare a draft Operations Forecast and Temperature Management Plan based on forecasted conditions and submit the draft Plan to NMFS for review by May 1 of each year. The information provided in the Operations Forecast will be used in the development of the Temperature Plan. The draft plan shall contain: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation. Reclamation shall use an iterative approach, varying proposed operations, with the objective to attain the temperature compliance point at Watt Avenue Bridge. Within ten calendar days of receiving the draft Temperature Plan, NMFS will provide a written review of this plan for the purpose of determining whether requirements in this Opinion are likely to be met. Reclamation shall produce a final plan prior to May 15 deliveries and implement the plan upon finalization. Reclamation may update the plan every month based on hydrology and must seek NMFS' concurrence on proposed deviations from the plan that may reduce the likelihood that the temperature objective will be met.

Temperature Requirement: Reclamation shall manage the Folsom/Nimbus Dam complex and the water temperature control shutters at Folsom Dam to maintain a daily average water temperature of 65°F or lower at Watt Avenue Bridge from May 15 through October 31, to provide suitable conditions for juvenile steelhead rearing in the lower American River. If this temperature is exceeded for three consecutive days, or is exceeded by more than 3°F for a single day, Reclamation shall notify NMFS in writing and will convene the ARG to make recommendations regarding potential cold water management alternatives to improve water temperature conditions for fish, including potential power bypasses. If there is a lack of consensus on actions to be taken, the ARG shall advise NMFS and be elevated through the WOMT standard operating procedures.

Exception: When preparing the Operations Forecast and Temperature Management Plan, Reclamation may submit to NMFS a written determination that, after taking all actions within its authorities, it is unlikely to meet the above temperature requirement. This determination must be supported by specific iterative modeling techniques that vary allocations and delivery schedules such as application of the Coldwater Management Pool model (see Appendix 2-D). In the event that Reclamation determines that other nondiscretionary requirements (*e.g.*, D-1641 or requirements of the USFWS' Delta smelt biological opinion) conflict with attainment of the temperature requirement, Reclamation will

convene the ARG to obtain recommendations. If consensus cannot be achieved within the ARG, the ARG shall advise NMFS, and NMFS will make a recommendation to the WOMT, per standard operating procedures.

During the May 15 to October 31 period, when the 65°F temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (*i.e*., no more than one degree Fahrenheit every 12 hours) to as high as 68°F.

The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for steelhead, and thereafter may also be used to provide cold water for fall-run spawning.

Rationale: As demonstrated in section 6.4 of this Opinion, steelhead are frequently exposed to water temperatures warmer than required for juvenile rearing, resulting in reduced fitness as is evident through the expression of visible thermal stress symptoms (*i.e*., bacterial inflammations). This thermal stress decreases steelhead immune system function and increases steelhead vulnerability to other sources of sub-lethal and lethal effects such as disease and predation. Monitoring of juvenile steelhead conducted by CDFG showed that bacterial inflammation was prevalent in steelhead throughout the river and the frequency of its occurrence increased as the duration of exposure to water temperatures over 65°F increased. The 65°F or lower daily average water temperature target was identified based on CDFG's monitoring as well as published scientific literature. Based on past convention of the ARG, the temperature compliance point is maintained at Watt Avenue Bridge, even though suitable rearing habitat is between Watt Avenue and Nimbus Dam.

Action II.3. Structural Improvements

Objective: Improve the ability to manage the cold water pool to provide suitable temperatures for listed fish through physical and structural improvements at the dams.

Action: Reclamation shall evaluate physical and structural modifications that may improve temperature management capability, as detailed below. Upon completion of the evaluation, Reclamation shall select the most promising projects and shall submit, by June 30th 2010, a proposed plan to NMFS to implement selected projects. Reclamation shall seek NMFS' concurrence that the proposed projects are likely to be effective in reducing adverse effects of warm water temperatures on listed fish. With NMFS' concurrence, Reclamation shall implement selected projects by December 15, 2012.

Modifying the following structures may substantially improve the ability to manage temperature in the Lower American River to reduce adverse effects of unsuitably warm water on listed species. The comparative benefits and costs of alternative modifications that will achieve objectives have not been fully analyzed. Reclamation shall analyze alternatives for

each of the objectives listed below and shall implement the most effective alternative(s) for each objective:

1) **Folsom Dam temperature control device.** The objective of this action is to improve access to and management of Folsom Reservoir's cold water pool. Alternatives include enhancement of the existing shutters, replacement of the shutter system, and construction of a device to access cold water below the penstocks. If neither Reclamation nor DWR has authority to make structural or operational modifications to the control device, they shall seek to enter into an MOU with the Army Corps of Engineers to utilize their existing authorities.

2) **Cold water transport through Lake Natoma.** The objective of this action is to transfer cold water from Folsom Dam to Nimbus Dam with minimal increase in temperature. Alternatives include dredging, construction of temperature curtains or pipelines, and changes in Lake Natoma water surface elevation.

3) **El Dorado Irrigation District Temperature Control Device (EID TCD).** The objective of this action is to conserve cold water in Folsom Lake. Alternative intake structures have been analyzed by EID. The most effective device for conserving cold water should be constructed. If neither Reclamation nor DWR has authority to make structural or operational modifications to the EID TCD, they shall work with the owners and operators of the TCD to make the desired improvements, including providing funding and technical assistance

4) **Temperature Management Decision-Support Tools.** The objective of this action is to provide effective tools to make transparent temperature management decisions. Alternatives include decision impact analyses, regular analysis of a broad array of operational scenarios, improved operations group processes, and monitoring.

Rationale: Maintaining suitable water temperatures for all life history stages of steelhead in the American River is a chronic issue because of operational (*e.g*., Folsom Reservoir operations to meet Delta water quality objectives and demands and deliveries to M&I users in Sacramento County) and structural (*e.g*., limited reservoir water storage and coldwater pool) factors. Increased water demand and climate change will lead to further deterioration of suitable habitat conditions, including increased temperatures. Action II.2 provides for a temperature management plan to minimize operational effects to steelhead using current technology. However, the current technology is out-dated resulting in less than optimal ability to access and fully utilize cold water in any given hydrology or ambient temperature regime. Alternative technologies have been studied previously, but not funded or implemented. Because of the significant temperature related effects that will persist despite implementation of Action II.2, all feasible technological options should be pursued. These technological actions will increase the likelihood that temperate control points will be attained, as prescribed in Action II-2, and therefore American River water temperatures will be suitable for steelhead more frequently.

Action II.4. Minimize Flow Fluctuation Effects

Objective: Reduce stranding and isolation of juvenile steelhead through ramping protocols.

Action: The following flow fluctuation objectives shall be followed:

1) From January 1 through May 30, at flow levels <5,000 cfs, flow reductions shall not exceed more than 500 cfs/day and not more than 100 cfs per hour.

2) From January 1 through May 30, Reclamation shall coordinate with NMFS, CDFG, and USFWS to fund and implement monitoring in order to estimate the incidental take of salmonids associated with reductions in Nimbus Dam releases.

3) Minimize the occurrence of flows exceeding 4,000 cfs throughout the year, except as may be necessary for flood control or in response to natural high precipitation events.

Rationale: Flow fluctuations in the lower American River have been documented to result in steelhead redd dewatering and isolation (Hannon *et al.*, 2003, Hannon and Deason 2008), fry stranding, and fry and juvenile isolation (Water Forum 2005a). By limiting the rate of flow reductions, the risk of stranding and isolating steelhead is reduced. Two lower American River habitat evaluations indicate that releases above 4,000 cfs inundate several pools along the river that are isolated at flows below this threshold (CDFG 2001, Hall and Healey 2006). Thus, by maintaining releases below 4,000 cfs the risk of isolating juvenile steelhead is reduced.

Action II.5. Fish Passage at Nimbus and Folsom Dams

Objective: Provide access for steelhead to historic cold water habitat above Nimbus and Folsom dams.

Action: See Fish Passage Program, Action V.

Rationale: The effects analysis in this Opinion leads to the conclusion that steelhead will continue to be vulnerable to serious effects of elevated temperatures in most years and particularly in dry and critically dry years, even if actions are taken to improve temperature management. The frequency of these occurrences is expected to increase with climate change and increased water demands. Therefore, it is essential to evaluate options for providing steelhead to access their historic cold water habitat above Nimbus and Folsom dams and to provide access if feasible.

Action Suite II.6. Implement the Following Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations

Objective of Actions II.6.1-3: The following actions are identified to offset project effects related to Nimbus Fish Hatchery by reducing introgression of out-of-basin hatchery stock with

wild steelhead populations in the Central Valley, including the American River population and other populations in the Sacramento River system (Garza and Pearse 2008). In addition, actions are necessary at both Nimbus and Trinity River fish hatcheries to increase diversity of fall-run production, in order to increase the likelihood of prey availability for Southern Residents and reduce adverse effects of hatchery fall-run straying on genetic diversity of natural fall-run and spring-run.

Action II.6.1. Preparation of Hatchery Genetic Management Plan (HGMP) for Steelhead

Action: Reclamation shall fund CDFG to prepare a complete draft HGMP for steelhead production at Nimbus Fish Hatchery, in accordance with current NMFS guidelines, and submit that draft for NMFS review by June 2011. Specific actions shall include:

1) Reclamation shall fund genetic screening at Nimbus Fish Hatchery for steelhead to determine most appropriate brood stock source. This action shall be completed by March 31, 2012.

2) Reclamation shall fund a study examining the potential to replace the Nimbus Fish Hatchery steelhead broodstock, with genetically more appropriate sources. This action shall be completed by March 31, 2012.

Action II.6.2. Interim Actions Prior to Submittal of Draft HGMP for Steelhead

Action: Reclamation shall use its authorities to ensure that, prior to completion of the draft HGMP, the hatchery is operated according to the following protocols:

1) Release all hatchery-produced steelhead juveniles in the American River at Nimbus Fish Hatchery or at a location in the American River as close to Nimbus Fish Hatchery as is feasible to reduce straying. This action shall be implemented within 30 days of issuance of this Opinion.

2) Release all unclipped steelhead adults returning to Nimbus Fish Hatchery back into the lower American River so they can spawn naturally. This action shall be implemented within 30 days of issuance of this Opinion.

3) Stop inter-basin transfers of steelhead eggs or juveniles to other hatcheries, except upon specific written concurrence of NMFS. This action shall be implemented within 30 days of issuance of this Opinion.

Action II.6.3: **Develop and Implement Fall-run Chinook Salmon Hatchery Management Plans for Nimbus and Trinity River Fish Hatcheries**

Action: By June 2014, develop and begin implementation of Hatchery Management Plans for fall-run production at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery. Reclamation shall fund CDFG to develop and submit draft plans for NMFS

review by June 2013. The goal of the plans shall be to reduce impacts of hatchery Chinook salmon on natural fall-run and spring-run, and increase the genetic diversity and diversity of run-timing for these stocks.

Rationale for actions II.6.1-3: Hatcheries have been established on CVP and SWP rivers to offset effects of dams and project operations. Since these hatcheries were initially put into operation, additional knowledge has been developed that has advanced NMFS understanding of how hatchery operations can affect listed and non-listed salmonids. The operations of Nimbus Fish Hatchery and the spring- and fall-run operations of Trinity River Fish Hatchery are inter-related and interdependent to the proposed action.

Nimbus Fish Hatchery steelhead broodstock is predominantly Eel River stock. Maintaining this genetic broodstock has adverse effects on listed steelhead in the CV steelhead DPS (Garza and Pearse 2008). Based on genetics information presented in Garza and Pearse (2008), *O. mykiss* from the American River above Folsom Dam retain ancestral CV steelhead genetics and potentially could provide a broodstock source to replace the current Nimbus Fish Hatchery steelhead broodstock. This would eliminate the spread of Eel River genetics to CV steelhead. An HGMP is necessary to minimize effects of ongoing steelhead hatchery program on steelhead contained within the DPS.

Southern Residents depend on Chinook salmon as prey. Preparation of hatchery management plans for fall-run at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery is necessary to reduce operational effects on Southern Residents prey over the long term. Improving the genetic diversity and diversity of run timing of Central Valley fall-run will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions (Lindley *et al.*, 2009), and thereby provide a consistent food source in years with overall poor productivity. .

III. EAST SIDE DIVISION

Introduction to Stanislaus River/Eastside Division Actions: The steelhead population on the Stanislaus River is precariously small and limited to habitat areas below the dams that historically were unsuitable owing to high summer temperatures. All of the four steelhead populations in the Southern Sierra Nevada Diversity Group of the CV steelhead DPS are in similar condition and are not presently considered viable. Using the framework in this Opinion for jeopardy analysis, the DPS is not viable if one of the Diversity Groups is not viable. The overall poor status of the Diversity Group increases the importance of minimizing the effects of project operations on the Stanislaus River population.

Modeled operations suggest that it is possible to operate dams of the Eastside Division in a manner that avoids jeopardy to steelhead; however, if future climate conditions are warmer, drier, or both, summertime temperatures will restrict the extent of suitable habitat for steelhead.

The fundamental operational criteria are sufficiently ill-defined in the CVP/SWP operations BA as to provide limited guidance to the Action Agency on how to operate. This suite of actions provides sufficiently specific operational criteria so that operations will avoid jeopardizing steelhead and will not adversely modify their critical habitat. Operational actions to remove adverse modification of critical habitat include a new flow schedule to minimize effects of flood control operations on functionality of geomorphic flows and access of juvenile steelhead to important rearing areas.

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Overall Rationale: Sufficient uncertainty exists as to whether VAMP pulse flows and b(2) allocations are reasonably likely to occur in the future. VAMP, as defined by the SJRA, is due to expire in 2011. The BA commits to subsequent flows similar to VAMP ("Vamp-like flows"), but this is a very vague commitment. The project description does not define the particular contribution, timing, duration, or magnitude of these flows from the tributaries that contribute to VAMP, including the Stanislaus River. In addition, the BA specifies the amount of water designated to offset VAMP export curtailments as 48 TAF; but the need, based on past performance, has varied from approximately 45 to 150 TAF. Additional demands for smelt protection and future drainage settlement terms are being placed on b(2) water, and it is uncertain that b(2) water will be available consistently in each year in the quantity, duration, and timing needed for CV steelhead in the Stanislaus River. The annual water contract allocation process from New Melones is inadequately defined in the project description to assure the proposed action will not prevent the establishment of a viable population of steelhead.

Action III.1.1. Establish Stanislaus Operations Group for Real-Time Operational Decision-Making as Described in These Actions and Implementation Procedures

Action: Reclamation shall create a SOG to provide a forum for real-time operational flexibility implementation of the alternative actions defined in this RPA and for clarification of decision-making processes regarding other allocations of the NMTP. This group shall include Reclamation, NMFS, USFWS, DWR, CDFG, SWRCB, and outside expertise at the discretion of NMFS and Reclamation. This group shall provide direction and oversight to ensure that the East Side Division actions are implemented, monitored for effectiveness and evaluated. Reclamation, in coordination with SOG, shall submit an annual summary of the status of these actions. See introduction to RPA for further information on group procedures.

Action III.1.2. Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to provide suitable temperatures for CV steelhead rearing, spawning, egg incubation smoltification, and adult migration in the

Stanislaus River downstream of Goodwin Dam in order to maintain the following temperature compliance schedule:

Criterion and Temperature Compliance Location	Duration	Steelhead Life Stage Benefit
Temperature below 56°F at Orange Blossom Bridge (OBB)	Oct 1*-Dec 31	Adult migration
Temperature below 52 °F at Knights Ferry and 57°F at OBB	Jan 1-May 31	Smoltification
Temperature Below 55°F at OBB	Jan 1-May 31	Spawning and incubation
Temperature below 65°F at OBB	June 1-Sept 30	Juvenile rearing

***This criterion shall apply as of October 1 or as of initiation date of fall pulse flow as agreed to by NMFS**.

Temperature compliance shall be measured based on a seven-day average daily maximum temperature.

Exception: If any of these criteria is or is expected to be exceeded based on a three-day average daily maximum temperature, Reclamation shall immediately notify NMFS of this condition and shall submit to NMFS a written determination that, after taking all actions within its authorities, it is unlikely to meet the above temperature requirement and the extent and duration of the expected exceedance. This determination must be supported by specific iterative modeling techniques that vary allocations and delivery schedules. In the event that Reclamation determines that other nondiscretionary requirements (*e.g.*, D-1641 or requirements of the USFWS' Delta smelt biological opinion) conflict with attainment of the temperature requirement, Reclamation will convene SOG to obtain recommendations. If consensus cannot be achieved within SOG, then SOG shall advise NMFS, and NMFS will make a recommendation to WOMT per standard operating procedures.

Rationale: CV steelhead are dependent on East Side Division operations to maintain suitable in-stream temperatures. Operational criteria are not clearly described in the CVP/SWP Operations BA to ensure that appropriate temperatures are met for CV steelhead adult migration, spawning, egg incubation, juvenile rearing, and smoltification. The temperature compliance schedule above provides an operational framework to minimize temperature-related effects of proposed operations in the reaches of the river most used by CV steelhead on a year-round basis. Temperature criteria for adult CV steelhead migration in the lower Stanislaus River are included, as we expect that fall attraction flows will improve downstream temperature conditions for adult migration.

Observations at the fish counting weir on the Stanislaus River indicate that apparent CV steelhead enter the river in October, usually coincident with the release of fall attraction flows that provide cooler water and flow cues for fall-run.

The literature regarding appropriate criteria for smoltification suggests optimal temperatures of less than 52°F (Adams *et al.*, 1975, Myrick and Cech 2001) or 57°F (EPA 2001). In order to provide optimal temperatures for smoltification within a feasible operational scenario, the

smoltification temperature criteria are lower for Knights Ferry at 52°F and 57°F for Orange Blossom Bridge.

No steelhead spawning surveys have been conducted on the Stanislaus River, but fall-run surveys indicate that spawning may occur from Goodwin Dam (RM 59) almost to the City of Oakdale (RM 40), with the highest use occurring above Knights Ferry (RM 55). Based on observations of trout fry, most spawning occurs upstream of OBB (Kennedy and Cannon 2002). Consequently, specific temperature criteria of 55ºF or less at Riverbank should be met from December through May to ensure that temperatures are suitable for all available spawning habitat, however, modeled results and CDEC data (figure 6-35) indicates that temperatures at Riverbank are likely to exceed this level. Based on observations of trout fry, most spawning occurs upstream of OBB (Kennedy and Cannon 2002). Suitable spawning temperatures are likely to be met at OBB, except in May in critically dry years, and exception procedures will be implemented.

Action III.1.3. Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam, Characterized in Figure 11-1, and as Specified in Appendix 2-E

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

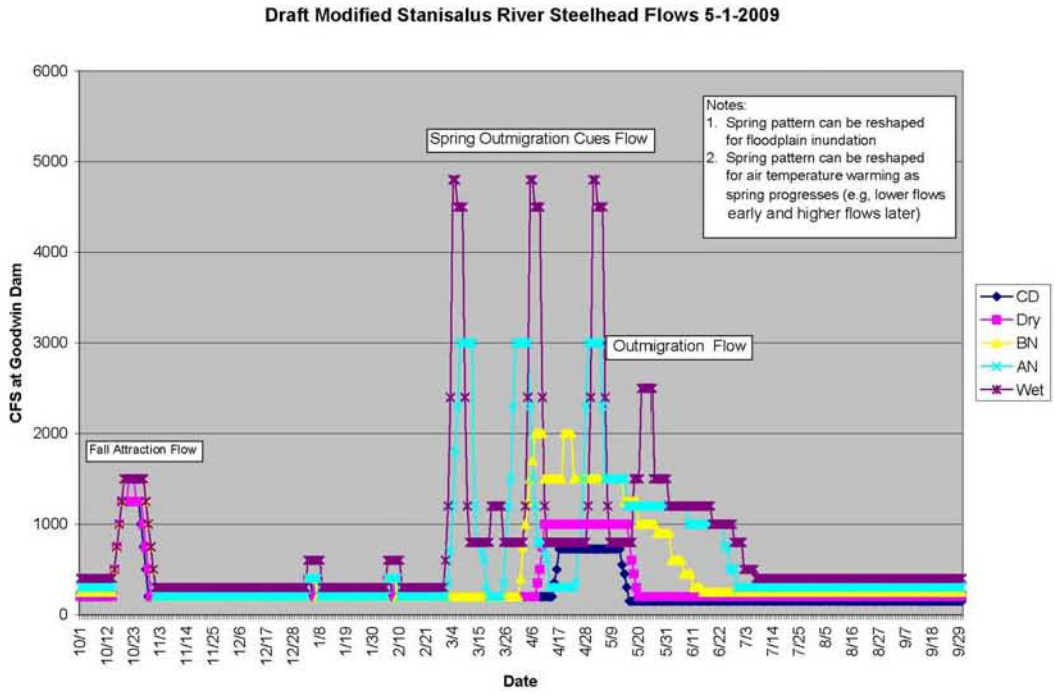


Figure 11-1. Minimum Stanislaus River in-stream flow schedule for CV steelhead as measured at Goodwin Dam

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as prescribed in Appendix 2-E and generally described in figure 11-1 above. This flow schedule specifies minimum flows and does not preclude Reclamation from making higher releases for other operational criteria. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead. In particular, flows that exceed 800 cfs will inundate known side channels that provide habitat, but that also pose stranding risks. When spring pulses greater than 800 cfs are identified in figure 11-1, the declining limb is not reduced below 800 cfs until the late spring flows occur.

Implementation procedures: Reclamation shall convene the SOG to adaptively manage flows according to this schedule. Specifically, upon the recommendations of the team, Reclamation may execute shorter duration pulses more frequently (*e.g.*, 2 – 4 times) during the longer pulse period. Implementation of this action should be coordinated with allocation of water resources dedicated for fish, such as the 98.3 TAF to CDFG and b(2) or b(3), if applied. The SOG shall follow standard operating procedures resolving any conflict through the WOMT process. The team shall also advise Reclamation on operations needed to minimize the adverse effects of flow fluctuations associated with New Melones Reservoir and Goodwin Dam operations on CV steelhead spawning, egg incubation, and fry and juvenile rearing within the Stanislaus River. If new information is developed, such as an update of Stanislaus River CV steelhead in-stream flow needs, more specific geomorphic analyses regarding channel forming flows, or real-time recommendations from the SOG,

Reclamation may submit to NMFS a revised annual minimum flow schedule that may be implemented if NMFS concurs that it is consistent with ESA obligations. These revisions may trigger re-initiation and re-consultation.

Rationale: This flow schedule includes the following components:

1) Minimum base flows based on IFIM (Aceituno 1993) to optimize available CV steelhead habitat for adult migration, spawning, and juvenile rearing. These base flows are scaled to water year type as defined by the Interim Operations Plan (IOP) water supply parameter[30], with lowest flows in critically dry years and highest flows in wet years.

2) Fall pulse flow to improve in-stream conditions sufficiently to attract CV steelhead to the Stanislaus River.

3) Winter instability flows to simulate natural variability in the winter hydrograph and to enhance access to varied rearing habitats.

4) Channel forming and maintenance flows in the 3,000 to 5,000 cfs range in above normal and wet years to maintain spawning and rearing habitat quality. These flows are scheduled to occur after March 1 to protect incubating eggs and are intended to work synergistically with providing outmigration flow cues and late spring flows, described next. These flows are high intensity, but limited duration to avoid potential seepage issues that have been alleged under extended periods of flow greater than 1,500 cfs.

5) Outmigration flow cues to enhance likelihood of anadromy.

6) Late spring flows for conveyance and maintenance of downstream migratory habitat quality in the lowest reaches and into the Delta.

An analysis of Stanislaus River rotary screw trap captures of smolted CV steelhead conducted by Reclamation in April 2009 (Hannon 2009b) identified that the median date for smolt CV steelhead out migration is March 1 (Figure RR- Julian Day 60), ranging from January through June. Juveniles are generally captured in trawls at Mossdale in smolted condition in late May (Julian Day 151 and Figure 4-4). CV steelhead are larger than fall-run smolts and may be less dependent on pulse flows to convey them out of the Stanislaus River, but the variability of pulses provides migratory cues to smolted CV steelhead. Capture information suggests that it is important to maintain suitable migratory conditions from the Stanislaus River to the Delta into the month of June. This action will allow more smolted fish to migrate out of system by extending the declining limb of the outmigration pulse and increasing migratory cues.

[30] The IOP water supply parameter is a function of end of February New Melones Reservoir storage and forecasted inflow from March through September.

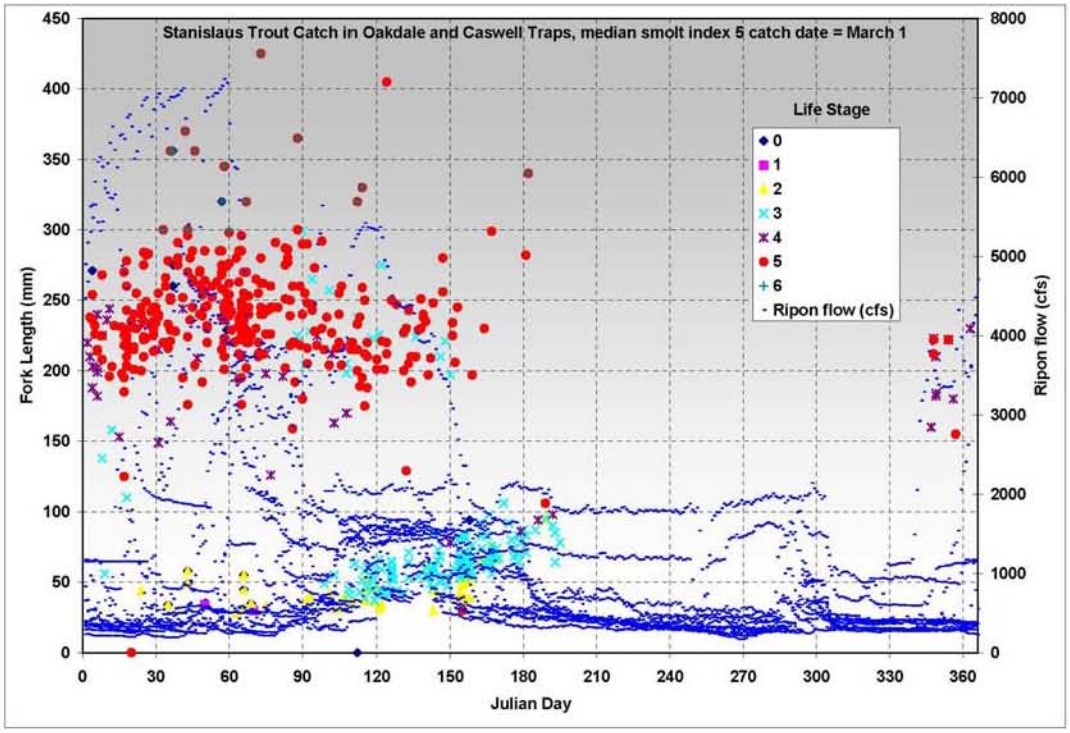


Figure 11-2. Smolt stage *O.mykiss* captured in Stanislaus River Rotary Screw Traps

The fall pulse flow was originally instituted to provide attraction flows for fall-run. Monitoring of adult salmonids at the Stanislaus River counting weir indicates that the fall pulse flow attracts both fall-run and CV steelhead into the Stanislaus River, making freshwater riverine habitat available. These riverine conditions have better temperature and water quality than conditions in the Delta during this period. The purpose of the fall pulse flow is to provide flow cues downstream for incoming adults, as well as providing some remedial effect on the low dissolved oxygen conditions that develop in the Stockton Deep Water Ship Channel. In addition to steelhead, this action also produces ancillary benefits to fall-run EFH.

Modeling conducted in the preparation of this action indicate that the temperature criteria of Action III.1.2 can generally be met under this alternative minimum flow schedule and are often improved, but that exceedances may occur in certain months (*e.g.*, May and early fall) during dry year types. Based on SALMOD analyses, temperature related mortality may be about 2 percent higher in critically dry years, but is reduced by about 1 percent in all other year types under the proposed alternative (Figure 11-3).

Salmon Mortality:

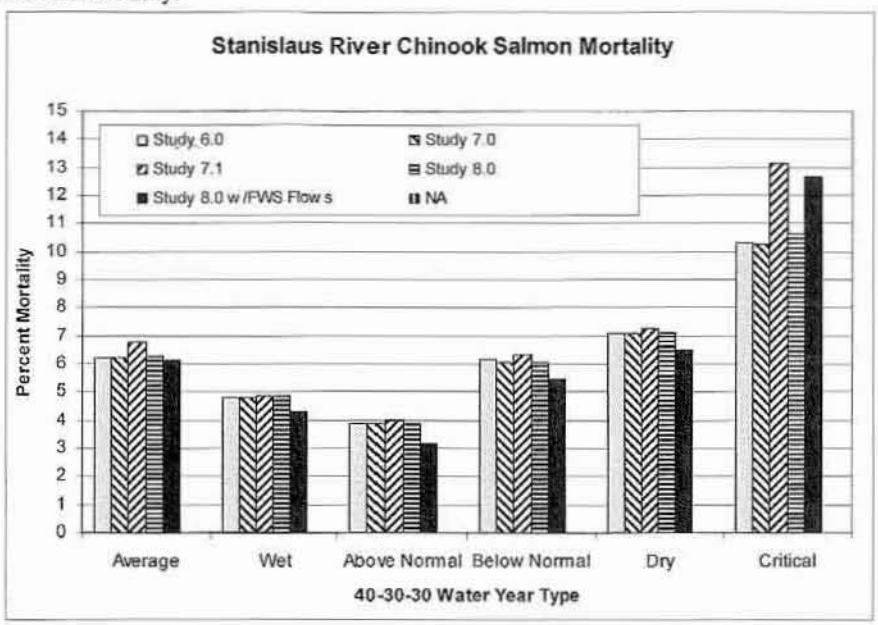


Figure 11-3. Modeled temperature effects of alternative Stanislaus River flows, draft provided by Reclamation on May 5, 2009.

Action Suite III.2. Stanislaus River CV Steelhead Habitat Restoration

Overall objective: Dam operations have and will continue to suppress channel-forming flows that replenish spawning beds. The physical presence of the dams impedes normal sediment transportation processes. This action is necessary to partially alleviate adverse modification of steelhead critical habitat from operations.

Action III.2.1. Increase and Improve Quality of Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration of the Project Actions

Action: Reclamation shall minimize effects of their operations through improving spawning habitat with addition of 50,000 tons of gravel by 2014. Reclamation shall submit a plan, including monitoring, and schedule to NMFS for gravel augmentation by June 2010. Reclamation shall begin gravel augmentations no later than summer 2011. Reclamation shall submit to NMFS a report on implementation and effectiveness of action by 2015. Spawning gravel replenishment sites shall be monitored for geomorphic processes, material movement, and salmonid spawning use for a minimum of three years following each addition of sediment at any given site.

Rationale: Kondolf (*et al.*,) 2001 identified levels of sediment depletion at 20,000 cubic yards per year owing to a variety of factors including mining and geomorphic processes associated with dam operations, past and ongoing. Kondolf (*et al*.,) 2001 and other reports

cited in that work, identify a loss of over 60 percent of spawning area for salmonids since 1966. This level of replenishment will restore adversely affected spawning habitat to relieve adverse habitat conditions and provide sediment to partially offset ongoing loss rates. Sediment addition may also be conducted in a manner to remediate sediment related loss of geomorphic function, such as channel incision, to and allow for inundation of floodplain rearing habitat.

Action III.2.2. Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on One- to Three-Year Schedule.

Action: Reclamation shall seek advice from SOG to develop an operational strategy to achieve floodplain inundation flows that inundate CV steelhead juvenile rearing habitat on a one- to three-year return schedule. Reclamation shall submit a proposed plan of operations to achieve this flow regime by June 2011. This plan shall include the minimum flow schedule identified in Action III.1.2, or shall provide justification for any proposed modification of the minimum flow schedule. NMFS will review and, if satisfactory, approve the operational strategy. Reclamation will implement strategy starting in 2012.

Rationale: Kondolf *et al*., (2001) identified that floodplain terraces and point bars inundated before operation of New Melones Dan have become fossilized with fine material and thick riparian vegetation that is never rejuvenated by scouring. Channel forming flows in the 8,000 cfs range have occurred only twice since New Melones Dam began operation 28 years ago. Lack of channel forming flows and lack of sediment input blocked by the dams has resulted in channel incision of one to three feet over 13 years. Floodplain juvenile rearing habitat and connectivity will continue to be degraded by New Melones operations, as proposed.

Action III.2.3. Restore Freshwater Migratory Habitat for Juvenile Steelhead by Implementing Projects to Increase Floodplain Connectivity and to Reduce Predation Risk During Migration

Objective: This action is necessary to compensate for continued operational effects on rearing and freshwater migratory habitat due to flood control operations. The goal of this action is to improve habitat quality of freshwater migratory habitat for juvenile steelhead.

Action: By June 2010, in cooperation with the SOG, Reclamation shall develop a list of projects to improve the habitat values of freshwater migratory habitat in the Stanislaus River, and associated monitoring, for implementation and submit the list to NMFS for review. Reclamation shall begin implementation of NMFS-approved projects by June 2011. Reclamation shall submit a report of project implementation and effectiveness by June 2016.

These projects may include actions that reduce exposure to predation directly, or projects that may offset predation effects by improving rearing habitat values to allow juveniles to grow larger before outmigration. These projects may include both flow- and non-flow-related actions. Flow-related actions shall be coordinated with operational flows as defined in

Action III.2.2 and Action III.1.2. These projects may also include, but shall not be limited to, evaluations to identify locations or sources of higher juvenile mortality in order to identify and implement projects with the highest likelihood to prevent CV steelhead mortality.

Rationale: Predation studies on the Tuolumne River have shown losses of up to 60 percent of outmigrating salmon smolts in run-of-river gravel mining ponds and dredged areas. Losses on the Stanislaus River have not been similarly quantified, but predation on fall run smolts and *O. mykiss* by striped bass and large mouth bass have been documented. These run-of-river ponds also reduce flow velocities as compared to incoming river channels, requiring outmigrating salmonids to expend more energy to traverse these sections. Operational releases provide flows lower than typical unimpaired flows, which exacerbates the effect of this stressor on outmigrating juveniles and degrades the habitat value of necessary freshwater migratory corridors. Additional flows or flow pulses could alleviate this added energy demand and improve survival through these problem areas. Channel modifications in these problem areas can improve migration success. Improvements in floodplain habitat quality can improve juvenile growth and larger juveniles are more likely to avoid predation mortality.

Action III.2.4. Evaluate Fish Passage at New Melones, Tulloch, and Goodwin Dams

Objective: Evaluate access for steelhead to historic cold water habitat above New Melones, Tulloch, and Goodwin dams.

Action: See Fish Passage Program, Action V.

Rationale: The effects analysis in this Opinion leads to the conclusion that steelhead will continue to be vulnerable to serious effects of elevated temperatures in dry and critically dry years, even if actions are taken to improve temperature management. The frequency of these occurrences is expected to increase with climate change and increased water demands. Therefore, it is essential to evaluate options for providing steelhead to access their historic cold water habitat above New Melones, Tulloch, and Goodwin dams and to provide access if feasible..

IV. DELTA DIVISION

Introduction: An important life history phase for all anadromous fish is their movement through an estuary as adults moving upstream to spawning grounds, and as juveniles moving downstream to the ocean. For some fish, the estuary also serves as a staging area and, for some juveniles, a rearing area prior to their entering the ocean. Within the Central Valley, all anadromous fish, including listed winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon, depend on the Sacramento-San Joaquin Delta environment during these life phases. This dependence was an important factor in designation of critical habitat in the Delta for these species. A properly functioning Delta is critical to migration pathways and rearing habitat, both of which are primary constituent elements of critical habitat for these fish.

Currently, the fish are exposed to a multitude of stressors in the Delta during passage and rearing. The Delta has been severely degraded over the past 150 years, primarily due to anthropogenic actions within its boundaries and in its surrounding watersheds. Nearly 90 percent of its fringing marshes have been lost and replaced with raised levees armored with rock riprap. The channelization of the Delta waterways through the construction of raised levees for flood control has isolated the Delta from its surrounding floodplains. These seasonally inundated floodplains served as important rearing habitats for many of the native fish species occurring in the Delta, including salmonids, and juvenile green sturgeon.

The structure of the Delta, particularly in the central and southern Delta, has been significantly altered by construction of manmade channels and dredging, for shipping traffic and water conveyance. Intentional and unintentional introductions of non-native plant and animal species have greatly altered the Delta ecosystem. Large predatory fish such as striped bass and largemouth bass have increased the vulnerability of emigrating juveniles and smolts to predation, while infestations of aquatic weeds such as *Egeria densa* have diminished the useable near-shore, shallow water habitat needed by emigrating salmonids for rearing.

The use of Delta islands for intensive agriculture has increased demand for irrigation water from the Delta, as well as increased the discharge of agricultural runoff into Delta waterways surrounding these farmed islands. These discharges carry chemicals such as fertilizers, pesticides, herbicides, and excessive nutrients, leading to degradation of water quality parameters such as DO content and suspended sediment, and increasing exposure to toxic compounds. Likewise, increasing urbanization in the areas surrounding the Delta increases the load of contaminants associated with stormwater runoff, discharges from wastewater sanitation plants, and industrial activities. Overall, conditions in the Delta make emigrating anadromous fish highly vulnerable to any added stressors and substantially reduce their chances for survival.

The proposed actions for the CVP and SWP include continued diversion of water from the Delta at the project's export facilities, with increased export levels. These actions will increase the level of stressors in the Delta beyond those previously described and exacerbate many of those already present. NMFS has identified several factors associated with operation of the CVP and SWP that affect the long-term viability and resiliency of winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon in the Central Valley. In addition to these specific factors, the operations of the CVP and SWP alter Delta hydrodynamics and interact with other stressors to enhance the vulnerability of listed fish to morbidity and mortality during their time in the Delta.

The adverse effects of the proposed action identified in this Opinion include:

1) Diversion from the North Delta into the Delta interior of early emigrating winter-run juveniles, yearling spring-run, and CV steelhead, through the operation of the DCC gates in late fall and early winter.

2) Enhanced vulnerability of juvenile salmonids to entrainment and indirect mortality, through alteration of the hydrodynamics of the interior and south Delta waterways, due to the influence of export pumping actions in winter and spring.

3) Enhanced vulnerability of CV steelhead from the San Joaquin River basin to exports and export-related changes in hydrodynamics.

4) Direct mortality from entrainment of juvenile salmonids and green sturgeon at the CVP and SWP export facilities.

The actions prescribed below will minimize or avoid the proposed action's adverse effects on hydraulic patterns in the Delta that affect listed salmonids and green sturgeon. They will modify the interactions that listed fish have with other stressors in the Delta and thereby avoid appreciably reducing the likelihood of survival and recovery of listed fish.

The current metric for monitoring direct take and mortality of listed fish by the CVP and SWP actions is the level of salvage and calculated loss at fish collection facilities. This metric is a reflection of export levels and the diversion of large volumes of water through the facilities. Counting fish at the salvage facilities alone, however, does not account for fish that have been lost prior to the point of collection, and thus is an inaccurate measure of adverse export influence. It does not account for fish that have been drawn into the waters of the central Delta through the DCC gates or Georgiana Slough and lost to predation, toxics, or other factors before reaching the south Delta, nor does it account for fish that make it to the south Delta, where they are further influenced by the reverse flows moving toward the pumps and are delayed in their migration; which increases their vulnerability to predation, toxics, or other forms of loss, such as stranding in agricultural diversions.

Overall Objectives: The juveniles of all four listed species migrating downstream in the Sacramento River have a much greater chance of survival when they migrate directly to the estuary within the Sacramento River than when they are diverted by water operations into the southern or central Delta, where they are exposed to increased risks of predation, exposure to toxic pollutants, and entrainment into water diversions. The Delta Division measures will reduce the likelihood of diversion of emigrating juveniles into the southern or central Delta, and will reduce mortality of emigrating juveniles that have been entrained at the fish collection facilities and entered the salvage process.

There are six actions to be taken in the Delta:

- Action IV.1: Modify DCC gate operations and evaluate methods to control access to Georgiana Slough and the Interior Delta to reduce diversion of listed fish from the Sacramento River into the southern or central Delta.
- Action IV.2: Control the net negative flows toward the export pumps in Old and Middle rivers to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento River into the southern or central Delta.

- Action IV.3: Curtail exports when protected fish are observed near the export facilities to reduce mortality from entrainment and salvage.
- Action IV.4: Improve fish screening and salvage operations to reduce mortality from entrainment and salvage.
- Action IV.5: Establish a technical group to assist in determining real-time operational measures, evaluating the effectiveness of the actions, and modifying them if necessary.
- Action IV.6: Do not implement the South Delta Barriers Improvement Program.

A summary of Actions IV.1 and IV.2 and their timeframes is provided below in Figure 11-4.

Action Suite IV.1 Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Objective: Reduce the proportion of emigrating listed salmonids and green sturgeon that enter the interior delta through either the open DCC gates or Georgiana Slough.

Rationale: Salmon migration studies show losses of approximately 65 percent of groups of outmigrating fish that are diverted from the mainstem Sacramento River into the waterways of the central and southern Delta (Brandes and McLain 2001; Vogel 2004, 2008; Perry and Skalski 2008). Diversion into the internal Delta also increases the likelihood of entrainment and mortality associated with the pumping facilities. These effects are inferred from both particle tracking models, which derive the fate of particles over time, and direct study of acoustically tagged and CWT salmonids (Vogel 2004, SJRGA 2007).

On average, up to 25 percent of Sacramento River flows are diverted into the channels of the DCC when the gates are open, with a maximum of 35 to 40 percent. Approximately 20 percent, on average, of the Sacramento River flow is diverted into Georgiana Slough. During November and December, approximately 25 percent of the Sacramento River flow is diverted into the interior Delta through these two channels. Recent studies by Perry and Skalski (2008) indicate that by closing the DCC gates when fish are present, total through-Delta survival of marked fish to Chipps Island increases by nearly 50 percent for fish moving downstream in the Sacramento River system. Closing the DCC gates appears to redirect the migratory path of emigrating fish into Sutter and Steamboat Sloughs and away from Georgiana Slough, resulting in higher survival rates. Similar benefits have been described in previous studies (Newman 2008, Brandes and McLain 2001) with CWT fish.

Based on data from monitoring studies in the lower Sacramento River, approximately 45 percent of the annual winter-run emigration from the Sacramento River enters the Delta between November and January. During the same period, about eight percent of the annual CV steelhead emigration from the Sacramento River Basin occurs. Yearling spring-run pass into the Delta in January, but these fish account for only three percent of the total annual population of spring-run emigrants entering the Delta.

<table>
<tr><td rowspan="2"></td><td>Action IV. 1.2 - Operation of DCC to enhance protection of emigrating salmonids/green sturgeon</td><td colspan="2">Action IV. 2.1 - Maintain San Joaquin River Inflow/Export ratio</td><td>Action IV. 2.2 - Acoustic Tag Experiment</td><td>Action IV. 2.3 - Reduced exports to limit negative flows in OMR depending on presence of salmonids</td></tr>
<tr><td></td><td>2009 - 2011 Interim Operations</td><td>2012 + Long term Operations</td><td></td><td></td></tr>
<tr><td>Oct.</td><td rowspan="2">Oct. 1 - Nov. 30 - Gates closed if fish are present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Nov.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Dec.</td><td>Dec. 1 - 14 - Gates closed except for experiments/water quality</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jan.</td><td rowspan="3">Dec. 15 - Jan. 31 Gates Closed</td><td></td><td></td><td></td><td rowspan="5">Jan 1 - June 15 - OMR (-5000 to -2500 cfs) until after June 1 water temperature at Mossdale ≥72° F for 7 days</td></tr>
<tr><td>Feb.</td><td rowspan="3">Feb. 1 - May 15 - Gates Closed per D1641</td><td></td><td></td><td></td></tr>
<tr><td>Mar.</td><td></td><td></td><td rowspan="3">March 1 - June 15</td></tr>
<tr><td>Apr.</td><td rowspan="3">April 1 - May 31 - Maintain Vernalis Inflow/Export ratio dependingon IOP water supply parameters</td><td rowspan="3">April 1 - May 31 - Maintain Vernalis Inflow/Export Ratios depending on water year type</td></tr>
<tr><td>May</td><td rowspan="2">May 15 - June 15 - up to 14 days closed per D-1641</td></tr>
<tr><td>Jun.</td><td></td><td></td><td></td><td></td></tr>
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Figure 11-4. A summary of Actions IV.1 and IV.2 and their timeframes.

Percent of Juvenile Chinook salmon and steelhead production entering the Delta from the Sacramento River by month.

Month	Sacramento River Total[1,2]	Fall-Run[3]	Spring-Run[3]	Winter-Run[3]	Sacramento Steelhead[4]
January	12	14	3	17	5
February	9	13	0	19	32
March	26	23	53	37	60
April	9	6	43	1	0
May	12	26	1	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	4	1	0	0	0
September	4	0	0	0	1
October	6	9	0	0	0
November	9	8	0	03	1
December	11	0	0	24	1
Total	100	100	100	100	100

Notes:
[1]Mid Water trawl data
[2]All runs combined
[3]Runs from Sacramento River basin only
[4]Rotary screw trap data from Knights Landing
Source: SDIP Draft EIR/EIS 2005 Tables J-23 and J-24, Appendix J.

Actions taken during the early emigration period (November through January) to reduce diversion of listed salmonids can affect a significant proportion of the populations of listed fish. As discussed earlier in the effects section, these early migrants represent life history strategies that spread the risk of mortality over a greater temporal span, increasing diversity and resiliency of the populations.

Action IV.1.1 Monitoring and Alerts to Trigger Changes in DCC Operations

Objective: To provide timely information for DCC gate operation that will reduce loss of emigrating winter-run, spring-run, CV steelhead, and green sturgeon.

Action: Monitoring of Chinook salmon migration in the Sacramento River Basin and the Delta currently occurs at the RBDD, in spring-run tributaries to the Sacramento River, on the Sacramento River at Knights Landing and Sacramento, and sites within the Delta. Reclamation and DWR shall continue to fund these ongoing monitoring programs, as well as the monitoring of salvage and loss of Chinook salmon juveniles at the Delta fish collection facilities operated by the CVP and SWP. Funding shall continue for the duration of the proposed action (2030). Reclamation and DWR may use their own fishery biologists to conduct these monitoring programs, or they may provide funds to other agencies to do the required monitoring.

Monitoring protocols shall follow established procedures utilized by the USFWS, CDFG, Reclamation, and DWR. Information collected from the monitoring programs will be used to make real-time decisions regarding DCC gate operation and export pumping.

The DOSS group (Action IV.5) and WOMT will use information from monitoring to make decisions regarding DCC closures consistent with procedures below.

The DCC gate operations in the fall are initiated through a series of alerts. These alerts are signals that gate operations may need to be altered in the near future to avoid diversion of juvenile Chinook salmon migrating down the Sacramento River.

There are two initial alerts to warn of salmon presence in the system:

First Alert: There are two components to the first alert. Either condition, when met or identified, can trigger the alert. Capture of yearling-sized (> 70 mm) spring-run at the mouths of natal tributaries between October and April indicates that emigration from the tributaries has started or is occurring. As an environmental surrogate to the capture of the yearling-sized spring-run, which are difficult to capture in the rotary screw traps at the mouths of the natal tributary creeks, tributary flow increases are used to signal conditions conducive to emigration. Starting in October, an increase in tributary flow of more than 50 percent over levels immediately preceding the flow spike is used to indicate the appropriate cues for the initiation of salmon emigration[31].

Second Alert: The second alert is based on two physical hydrologic criteria. When both criteria are met the second alert is triggered. The monitoring station used for these environmental measurements is Wilkins Slough, located near Knights Landing approximately 35 miles upstream of the Delta. When flows are greater than 7,500 cfs as measured at Wilkins Slough, and water temperatures are less than 13.5^{o}C (56.3^{o}F) as measured at Knights Landing, the second alert is triggered. Recoveries of emigrating Chinook salmon at the Knights Landing monitoring location have been associated with these two hydrologic conditions.

Rationale: Monitoring programs are necessary to track the movement of salmon within the Central Valley watersheds so that timely changes can be made when project actions are in conflict with the needs of listed fish. Evidence of initiation of juvenile Chinook salmon migration in the upper tributaries, or environmental conditions that would trigger such migration, is the basis for the alerts. The alerts are important to effective gate operation because the collection and dissemination of field data to the resource agencies, and coordination of responsive actions, may take several days to occur. The first two alerts warn NMFS and Reclamation that changes in DCC gate operations are likely to be necessary within a short time period.

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[31] The first significant flow in October is associated with the beginning of spring-run yearling emigration from natal tributaries - an indication that those fish are on their seaward migration and will soon be entering the Delta where they are susceptible to mortality factors associated with the Delta Cross Channel (DCC) and SWP/CVP export operations. This first tributary flow event, or "First Alert", is the early warning criteria for closing the DCC.

Action IV.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. The operating criteria provide for longer periods of gate closures during the emigration season to reduce direct and indirect mortality of yearling spring-run, winter-run, and CV steelhead. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree (below).

Implementation procedures: Monitoring data related to triggers in the decision tree will be reported on DAT calls and evaluated by DOSS (for formation of DOSS – see Action KK). Reclamation/DWR shall take actions within 24 hours of a triggered condition occurring. If the decision tree requires an evaluation of data or provides options, then DOSS shall convene within one day of the trigger being met. DOSS shall provide advice to NMFS, and the action shall be vetted through WOMT standard operating procedures.

October 1-November 30:

Date	VI. Action Triggers	Action Responses
October 1-November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.

Rationale: Depending on the catch magnitude, there are several options for closing the DCC gates, ranging from not closing them and monitoring catch at Knights Landing and the Sacramento monitoring sites, to closing the DCC gates until the catch index decreases to fewer than three fish per day at the Knights Landing and Sacramento monitoring sites. Fish and water quality needs (*i.e.*, salinity levels) are frequently mutually exclusive, with respect to the DCC position, from November through January.

December 1-14:

Date	Action Triggers	Action Responses
December 1 - December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (*e.g.*, Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
	Water quality criteria are not met but both the KLCI and SCI are less than 3 fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
	Water quality criteria are not met but either of the KLCI or SCI is greater than 3 fish per day.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5

Rationale: The Spring-run Protection Plan (1998 *op. cit*. CVP/SWP operations BA Appendix B) provides that Reclamation will close the DCC gates on December 1 for the protection of spring-run yearlings unless there is a water quality issue. The DOSS can recommend opening the DCC gates for water quality purposes during this period. In addition, CDFG analysis indicates that there is a significant relationship between DCC gate operations and subsequent loss of winter-run at the Delta Fish Facilities. Closing the DCC gates between December 15 and January 15 reduces the total loss of winter-run at the Delta Fish Facilities. The report is posted at: http://www.science.calwater.ca.gov/pdf/ewa/EWA_delta_cross_channel_closures_06_111406.pdf.

The USFWS conducts a juvenile Chinook salmon Delta survival experiment each year in December and January. This is usually conducted in the first two weeks of December and may include experimental openings of the DCC gates. http://www.delta.dfg.ca.gov/jfmp/PatFiles/Delta_Action_8_Workshop.doc. These studies may be implemented if NMFS concurs that the study plan has been adapted to sufficiently reduce loss of salmonids..

December 15 – January 31:

Date	Action Triggers	Action Responses
December 15 – January 31	December 15-January 31	DCC Gates Closed.
	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to five days; NMFS will determine whether opening is consistent with ESA obligations.
	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened one hour after sunrise to one hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.

Rationale: CDFG analysis indicates that there is a significant relationship between DCC gate operations and subsequent loss of winter-run at the Delta Fish Facilities. Closing the DCC gates between December 15 and January 15 reduces the total loss of winter-run at the Delta Fish Facilities. The report is posted at: http://www.science.calwater.ca.gov/pdf/ewa/EWA_delta_cross_channel_closures_06_111406.pdf

If the KLCI or SCI is less than three, and the water temperature and flow criteria are indicative of low risk to listed salmonids, then experiments on fall- and late-fall-run may be permissible; however, in a low production year, trap efficiencies and detection rates may result in under-representation of the number of fish passing these locations. Under such conditions the DOSS group shall act conservatively in this decision process even when no fish have been detected at Knights Landing or Sacramento rotary screw traps. If conditions change, indicating that risks to listed salmonids are elevated, experiments will be suspended and the DCC gates closed if NMFS determines that closure is necessary to reduce the risk to emigrating salmonids.

February 1 – June 15:

Date	Action Trigger	Action Response
February 1 – May 15	D-1641 mandatory gate closure.[9]	Gates closed, per WQCP criteria

Date	Action Trigger	Action Response
May 16 – June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Overall Rationale for Action IV.1.2: Emigrating salmonids are vulnerable to diversion into the DCC when the gates are open. Fish traveling downstream in the Sacramento River move past the mouth of the DCC on the outside bend of the river. A series of studies conducted by Reclamation and USGS (Horn and Blake 2004) used acoustic tracking of released juvenile Chinook salmon to follow their movements in the vicinity of the DCC under different flows and tidal conditions. The study results indicate that the behavior of the Chinook salmon juveniles increased their exposure to entrainment through both the DCC and Georgiana Slough. Horizontal positioning along the east bank of the river during both the flood and ebb tidal conditions enhanced the probability of entrainment into the two channels. Upstream movement of fish with the flood tide demonstrated that fish could pass the channel mouths on an ebb tide and still be entrained on the subsequent flood tide cycle. In addition, diel movement of fish vertically in the water column exposed more fish at night to entrainment into the DCC than during the day, due to their higher position in the water column and the depth of the lip to the DCC channel mouth (-2.4 meters). Additional studies have shown that the mortality rate of the fish diverted into the DCC and subsequently into the Mokelumne river system is quite high (Perry and Skalski 2008; Vogel 2004, 2008). Closure of the DCC gates during periods of salmon emigration eliminates the potential for entrainment into the DCC and the Mokelumne River system with its high loss rates. In addition, closure of the gates appears to redirect the migratory paths of emigrating fish into channels with relatively less mortality (*e.g.*, Sutter and Steamboat Sloughs), due to a redistribution of river flows among the channels. The overall effect is an increase in the apparent survival rate of these salmon populations as they move through the Delta.

The closure of the DCC gates will increase the survival of salmonid emigrants through the Delta, and the early closures reduce loss of fish with unique and valuable life history strategies in the spring-run and CV steelhead populations. Spring-run emigrating through the Delta during November and December are yearling fish. These fish are larger and have a higher rate of success in surviving their entrance into the ocean environment. In addition, variation in the timing of ocean entry distributes the risk of survival over a broader temporal period. This alternative life history strategy reduces the probability that poor ocean

conditions in spring and summer will affect the entire population of spring-run. Since yearling fish enter the marine environment in late fall and winter, they avoid the conditions that young-of-the-year fish encounter in spring and summer, thus increasing the likelihood that at least a portion of the population will benefit from suitable ocean conditions during their recruitment to the ocean phase of their life cycle. For the same reasons, CV steelhead benefit from having their ocean entry spread out over several months.

Action IV.1.3 Consider Engineering Solutions to Further Reduce Diversion of Emigrating Juvenile Salmonids to the Interior and Southern Delta, and Reduce Exposure to CVP and SWP Export Facilities

Objectives: Prevent emigrating salmonids from entering the Georgiana Slough channel from the Sacramento River during their downstream migration through the Delta. Prevent emigrating salmonids from entering channels in the south Delta (*e.g.*, Old River, Turner Cut) that increase entrainment risk to CV steelhead migrating from the San Joaquin River through the Delta.

Action: Reclamation and/or DWR shall convene a working group to consider engineering solutions to further reduce diversion of emigrating juvenile salmonids to the interior Delta and consequent exposure to CVP and SWP export facilities. The working group, comprised of representatives from Reclamation, DWR, NMFS, USFWS, and CDFG, shall develop and evaluate proposed designs for their effectiveness. in reducing adverse impacts on listed fish and their critical habitat. Reclamation or DWR shall subject any proposed engineering solutions to external independent peer review and report the initial findings to NMFS by March 30, 2012. Reclamation or DWR shall provide a final report on recommended approaches by March 30, 2015. If NMFS approves an approach in the report, Reclamation or DWR shall implement it. To avoid duplication of efforts or conflicting solutions, this action should be coordinated with USFWS' Delta smelt biological opinion and BDCP's consideration of conveyance alternatives..

Rationale: One of the recommendations from the CALFED Science Panel peer review was to study engineering solutions to "separate water from fish." This action is intended to address that recommendation. Years of studies have shown that the loss of migrating salmonids within Georgiana Slough and the Delta interior is approximately twice that of fish remaining in the Sacramento River main stem (Kjelson and Brandes 1989; Brandes and McLain 2001; Vogel 2004, 2008; and Newman 2008). Based on the estimated survival rate of 35 percent in Georgiana Slough (Perry and Skalski 2008), the fraction of emigrating salmonids that would be lost to the population is 6 to 15 percent of the number entering the Delta from the Sacramento River basin. Keeping emigrating fish in the Sacramento River would increase their survival rate. This action is also intended to allow for engineering experiments and possible solutions to be explored on the San Joaquin river/Southern Delta corridor to benefit out-migrating steelhead. For example, non-physical barrier (i.e., "bubble curtain") technology can be further vetted through this action.

Action Suite IV.2 Delta Flow Management

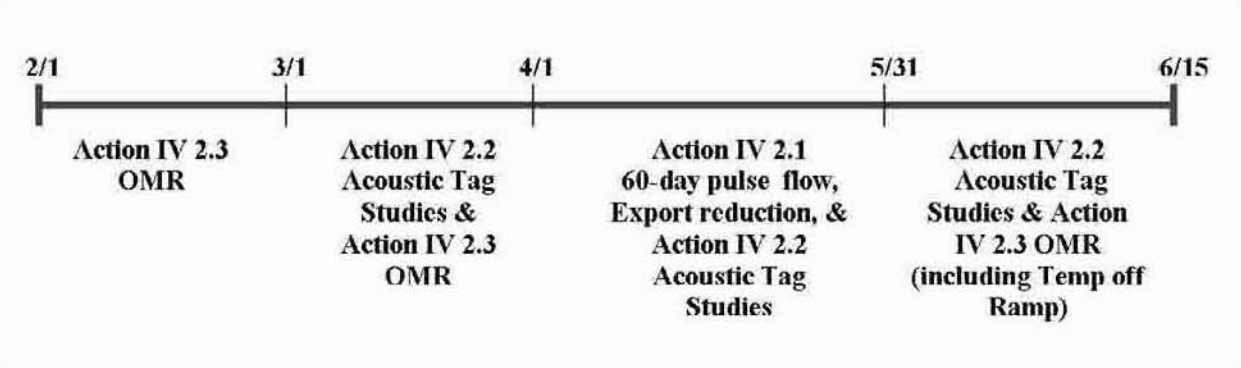
Objective: Maintain adequate flows in both the Sacramento River and San Joaquin River basins to increase survival of steelhead emigrating to the estuary from the San Joaquin River, and of winter-run, spring-run, CV steelhead, and green sturgeon emigrating from the Sacramento River through the Delta to Chipps Island.

Rationale for the Suite of Actions: Numerous studies have found positive associations between increased river flows and increased survival of salmon smolts through the Delta and the adult escapement of that cohort several years later when they return to spawn. Increased flows and greater smolt survival have been positively associated in other river systems as well Increased flows reduce the travel time of smolts moving through the river and Delta system, thus reducing the duration of their exposure to adverse effects from predators, water diversions, and exposure to contaminants.

Action IV.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: The following timeline indicates the annual schedule for implementing related San Joaquin actions that will occur concurrent with this action.



Phase I: Interim Operations in 2010-2011.

From April 1 through May 31:

1. Flows at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones Index[32]. In addition to the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E, Reclamation shall increase its releases at Goodwin Reservoir, if necessary, in order to meet the flows required at Vernalis, as provided in the following table. NMFS expects that tributary contributions of water from the Tuolumne and Merced rivers, through the SJRA, will continue through 2011 and that the installation of a fish barrier at the Head of Old River will continue to occur during this period as permitted.

New Melones Index (TAF)	Minimum flow required at Vernalis (cfs)
0-999	No new requirements
1000-1399	D1641 requirements or 1500, whichever is greater
1400-1999	D1641 requirements or 3000, whichever is greater
2000-2499	4500
2500 or greater	6000

2. Combined CVP and SWP exports shall be restricted through the following:

Flows at Vernalis (cfs)	Combined CVP and SWP Export
0-6,000	1,500 cfs
6,000-21,750[33]	4:1 (Vernalis flow:export ratio)
21,750 or greater	Unrestricted until flood recedes below 21,750

In addition:

1) Reclamation/DWR shall seek supplemental agreement with the SJRGA as soon as possible to achieve minimum long term flows at Vernalis (see following table) through all existing authorities.

San Joaquin River Index (60-20-20)	Minimum long-term flow at Vernalis (cfs)
Critically dry	1,500

[32] The New Melones Index is a summation of end of February New Melones Reservoir storage and forecasted inflow using 50% exceedance from March through September.

[33] Flood warning stage at Vernalis is 24.5 feet, flow is 21,750 cfs at this point. Flood stage is 29 feet with a corresponding flow of 34,500 cfs. Data from CDEC looking at April 8-9, 2006 period. As such, recognizing that the flows associated with these stages do vary, the trigger allowing unrestricted exports will be a Vernalis stage of 24.5 feet.

Dry	3,000
Below normal	4,500
Above normal	6,000
Wet	6,000

Rationale:

1) Flows at Vernalis: Reclamation has limited discretion to require additional flows from the Tuolumne and Merced rivers that are necessary in the long run to meet the needs of outmigrating juvenile steelhead. Modeling for our analysis of the East Side Division show that relying on New Melones Reservoir to provide the flows at Vernalis cannot be sustained, and attempting to do so would likely have additional adverse effects on CV steelhead. Reclamation and DWR have obtained additional flows in the Tuolumne and Merced rivers through CVPIA authorities, including options to purchase water from willing sellers, and entered into the SJRA which expires on December 31, 2009. Reclamation is in negotiations to extend the current agreement to 2011. The flows required in Phase I at Vernalis were developed through iterative modeling and will provide an important increment of additional flow to provide for outmigration of steelhead smolts, while not unduly depleting New Melones Reservoir storage. Using CVPIA authorities, it is important that Reclamation seek to immediately change the terms of the existing SJRA to achieve the long-term flows.

2) The rationale for the export curtailments is provided in the rationale for Phase II.

3) The SWRCB has initiated proceedings to establish minimum flows in the San Joaquin River basin. The proceedings are scheduled to conclude in 2011. Flow requirements for fish will be provided by this action in the interim.

Phase II: Beginning in 2012:

From April 1 through May 31:

1. Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E.

2. Reclamation and DWR shall implement the Vernalis flow-to-combined export ratios in the following table, based on a 14-day running average.

San Joaquin Valley Classification	Vernalis flow (cfs):CVP/SWP combined export ratio[34]
Critically dry	1:1[35]

[34] Exception to the ratio is provided for floods, where exports are not restricted until the flood recedes. See footnote 2 above.

[35] Minimum combined CVP and SWP exports is for health and safety.

Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750.

Exception procedure for multiple dry years: If the previous 2 years plus current year of San Joaquin Valley "60-20-20" Water Year Hydrologic Classification and Indicator as defined in D-1641 and provided in following table, is 6 or less, AND the New Melones Index is less than 1 MAF, exports shall be limited to a 1:1 ratio with San Joaquin River inflow, as measured at Vernalis.

San Joaquin Valley Classification	Indicator
Critically dry	1
Dry	2
Below normal	3
Above normal	4
Wet	5

Exception procedure for Health and Safety: If, by February 28 of a given year, Reclamation and DWR predict that they will not be able to achieve these ratios and make deliveries required for human health and safety, even after pursuing all options to augment inflow while preserving the ability to meet fish flow needs in all seasons, the agencies may submit a plan to NMFS to maximize anadromous fish benefits while meeting health and safety needs. The project agencies' current estimate of health and safety needs is a combined CVP/SWP export rate of 1,500 cfs. The plan must demonstrate that all opportunities for purchasing water in the San Joaquin Basin have been or will be exhausted, using b(3) or other water purchasing authority.

Meeting the long-term biological requirements of listed species and providing adequate water deliveries for these needs under the current system configuration may not be compatible, particularly considering anticipated hydrologic patterns associated with climate change. For this reason, Reclamation and DWR may propose a reconfiguration of the water conveyance system to allow diversion from the Sacramento River. Such an alteration of the conveyance system is being considered in the BDCP planning process. The operation of a conveyance structure that diverts water directly from the Sacramento River carries additional risk for listed species that migrate, spawn, or rear in the Sacramento River or North Delta. As detailed in this Opinion, the status of those species is precarious. Any new conveyance will be subject to section 7 consultation, and issues of injury or mortality of juvenile fish associated with all diversion facilities, reduction of flow variability for fish life history functions, reduction of Shasta Reservoir storage necessary for mainstem temperature control, and other potential adverse effects must be adequately addressed in any conveyance proposal.

Rationale: VAMP studies of CWT Chinook salmon smolts indicate that in general, fish released downstream of the zone of entrainment created by the export pumps (*e.g.*, Jersey Point)

have higher survival indices to Chipps Island than fish released higher up in the system (*e.g.*, Durham Ferry, Mossdale, or Dos Reis). Studies identify increased flows as a factor that increases survival of tagged Chinook salmon smolts. To date, most VAMP experiments have utilized San Joaquin River flows to export pumping ratios of approximately 2:1. Survival to Chipps Island of smolts released upstream has been relatively low under these conditions. (Kjelson *et al*. 1981, Kjelson and Brandes 1989, SJRGA 2007). Historical data indicates that high San Joaquin River flows in the spring result in higher survival of outmigrating Chinook salmon smolts and greater adult returns 2.5 years later (Kjelson *et al.* 1981, Kjelson and Brandes 1989, USFWS 1995) and that when the ratio between spring flows and exports increase, Chinook salmon production increases (CDFG 2005, SJRGA 2007). NMFS, therefore, concludes that San Joaquin River Basin and Calaveras River steelhead would likewise benefit under higher spring flows in the San Joaquin River in much the same way as fall-run do. For a full explanation of data and analysis supporting this action, see appendix 5.

Increased flows within the San Joaquin River portion of the Delta will also enhance the survival of Sacramento River salmonids. Those fish from the Sacramento River which have been diverted through the interior Delta to the San Joaquin River will benefit by the increased net flow towards the ocean caused by the higher flows in the San Joaquin River from upstream and the reduced influence of the export pumps. Such flows will reduce the proportion of Sacramento River fish that continue southwards toward the pumps and increase the percentage that move westwards toward Chipps Island and the ocean. Although the real environment is much more complex than this generality, in theory, increasing the speed of migration through a particular reach of river, or shortening the length of the migratory route decrease the extent of exposure to factors causing loss (Anderson *et al.* 2005)

Action IV.2.2 Six-Year Acoustic Tag Experiment

Objective: To confirm proportional causes of mortality due to flows, exports and other project and non-project adverse effects on steelhead smolts out-migrating from the San Joaquin basin and through the southern Delta.

Action: Reclamation and DWR shall fund a 6-year research-oriented action concurrent with Action IV.2.1.

The research shall be composed of studies utilizing acoustically-tagged salmonids, and will be implemented to assess the behavior and movement of the outmigrating fish in the lower San Joaquin River. The studies will include three releases of acoustic tagged fish, timed to coincide with different periods and operations: March 1 through March 31, April 1 through May 31, and June 1 through June 15. NMFS anticipates that studies will utilize clipped hatchery steelhead and hatchery fall-run as test fish.

During the period from March 1 through March 30, the exports will be operated in accordance with the requirements dictated by action IV.2.3. During the 60-day period between April 1 and May 30, exports will be dictated by the requirements of action IV.2.1. Reclamation shall operate to a minimum 1:1 inflow to export ratio during the period between

June 1 and June 15, allowing exports to vary in relation to inflows from the San Joaquin to test varying flow to export ratios during this period. If daily water temperatures at Mossdale exceed 72°F for seven consecutive days during the period between June 1 and June 15, then the inflow to export ratio may be relaxed. NMFS anticipates that warm water conditions in the lower San Joaquin River will not be suitable for steelhead under these conditions.

Implementation procedures:

1) By September 1, 2009, Reclamation/DWR shall convene DOSS for the purpose of refining the study design for this experiment. The experiments shall be developed to ensure that results are statistically robust and uncertainties due to experimental design have been minimized to the fullest extent possible. Additional expertise may be included in the workgroup, at the discretion of the agencies.

2) Issues relevant to listed anadromous fish species that shall be addressed include, but are not limited to:
   a) Increasing survival of emigrating smolts from the tributaries into the main stem of the San Joaquin River.
   b) Increasing survival of emigrating smolts through the main stem of the San Joaquin River downstream into the Delta.
   c) Increasing survival of emigrating smolts through the Delta to Chipps Island.
   d) The role and influence of flow and exports on survival in these migratory reaches.
   e) Selection of routes under the influence of flows and exports.
   f) Identifying reach-specific mortality and or loss.
   g) The effectiveness of experimental technologies, if any, *e.g.*, non-physical barrier ("bubble curtain**.")**

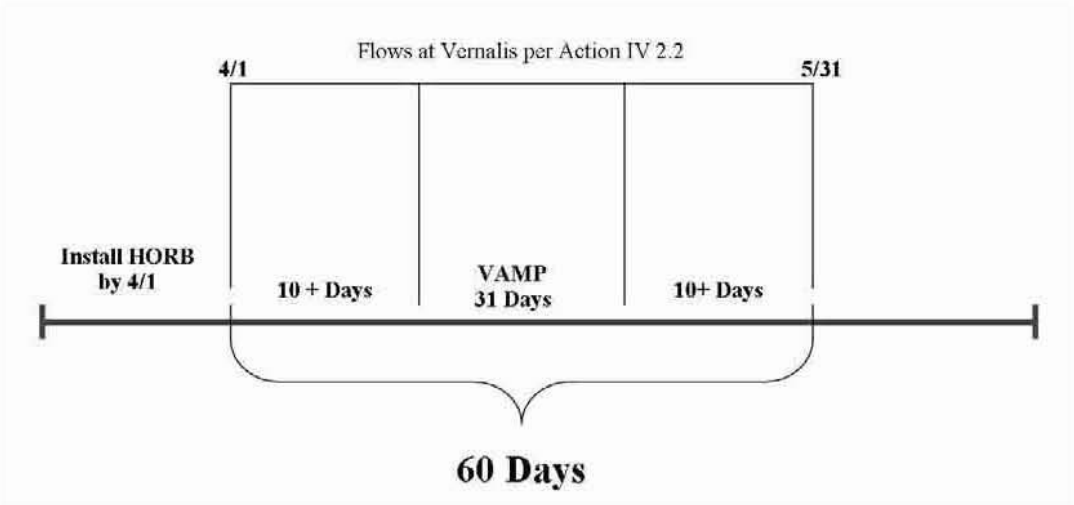
3) Annual reviews of the study results shall be conducted by the DOSS group. At the end of the 6-year period, a status review of Action IV.2.1 shall be prepared by the DOSS group. The status review shall be used to assess the success of Action IV.2.1 in increasing survival through the Delta for San Joaquin River basin salmonids, but in particular, steelhead. Based on the findings of the status review, the DOSS group will make recommendations to NMFS, Reclamation, CDFG, DWR, and USFWS on future actions to be undertaken in the San Joaquin River basin as part of an adaptive management approach to the basin's salmonid stocks.

4) Complementary studies to achieve performance goals**:** At its discretion, Reclamation and DWR also may develop and propose complementary studies to examine alternative actions that would accomplish the targeted survival performance goals. A primary effort of these studies will be to establish an appropriate survival goal for out-migrating steelhead smolts from Vernalis to Chipps Island in all water year types. Reclamation and DWR may propose studies which test actions that incorporate non-flow or non-export related actions. The studies shall contain specific actions within the authority and discretion of Reclamation and/or DWR, an evaluation of the projected benefits of each action with respect to increasing survival to the performance goal, evidence used to

support this evaluation including literature citations, particle tracking modeling and other predictive tools, to demonstrate that the survival will be achieved, and a demonstration that the actions are reasonably certain to occur within the term of the study period. Any complementary study proposal shall be peer reviewed by the Calfed Science Program (or other comparable science group) and by the DOSS workgroup prior to being submitted to NMFS.

Upon receipt of the complementary study proposal, NMFS will review the draft proposal for sufficiency of information, experimental design, and likelihood to meet performance goals and provide comments back to Reclamation and DWR within 30 days of receipt. If NMFS concurs with the complementary study proposal, and finds the studies do not conflict with the actions implemented under the RPA, then the study may be conducted concurrently with the actions set forth above (Action IV.2.1 and IV.2.2). Throughout the six years of study, all new data will be annually evaluated by the proposed DOSS group, which will then provide recommendations through a written report to the management of NMFS and Reclamation for continuing actions in the San Joaquin River basin in support of CV steelhead.

Exception: If, despite Reclamation and DWR's best efforts, the new experiment is not ready for implementation in 2010, then VAMP study design may continue for 1 year, upon written concurrence of NMFS. A generalized representation of the design is provided, as follows:



Rationale: This experiment will provide important information about the response of fish migration to flows, exports, and other stressors in the San Joaquin River corridor. Flows and exports will be varied according to time period. From March 1 through March 31, the studies will assess the relationship of the Vernalis flow-to-export ratio under the OMR flow restriction (see Action IV.2.3) to route selection at channel bifurcations in the South Delta and mainstem San Joaquin River, survival in the different channels reaches of the South Delta, and ultimately through the Delta to Chipps Island as a whole.

From April 1 through May 30, the studies will assess the effectiveness of varying ratios by water year type (see Action IV.2.1) by comparing channel selection, route survival, and

overall through-Delta survival during this period of stabilized conditions to the other two periods.

From June 1 to June 15, the studies will focus on the relative importance of exports, as compared to flows, by deliberately varying exports under similar flow conditions. Acoustic tagging studies have the potential to provide this level of resolution. Results from these studies may be able to indicate, at a fine temporal and spatial scale, how exports and flow influence route selection of migrating fish and their survival probabilities in the different channel reaches. Knowledge of these factors should aid in the management decision process and reduce project impacts to listed salmonids based on findings with strong scientific foundations.

Action IV.2.3 Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. The negative flow objective within the range shall be determine based on the following decision tree:

Date	Action Triggers	Action Responses
January 1 – June 15	January 1 – June 15	Exports are managed to a level that produces a 14-day running average of the tidally filtered flow of (minus) -5,000 cfs in Old and Middle River (OMR). A five-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 14-day average flow.[36]

[36] Daily OMR flows used to compute the 14-day and 5-day averages shall be tidally filtered values reported by the USGS for the Old River at Bacon Island and Middle River at Middle River monitoring stations. The 14-day running average shall be no more negative than the targeted flow requirement. The 5-day running average shall be no more than 25 percent more negative than the targeted flow requirement. (Transition explanations below are based on personal communication Ryan Olah, USFWS, to ensure consistency of OMR measurements and averaging periods with implementation of OMR in Smelt Biological Opinion).

January 1 – June 15 First Stage Trigger (increasing level of concern)	Daily SWP/CVP older juvenile loss density (fish per taf) 1) is greater than incidental take limit divided by 2000 (2 percent WR JPE ÷ 2000), with a minimum value of 2.5 fish per taf, or 2) daily loss is greater than daily measured fish density divided by 12 taf (daily measured fish density ÷ 12 taf) or 3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 12 taf (daily measured fish density ÷ 12 taf)[37]	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The five day running average OMR flows shall be no more than 25 percent more negative than the targeted flow level at any time during the 5-day running average period (*e.g.*, -4,375 cfs average over five days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction[38]. Reductions are required when any one criterion is

Transition to more restrictive (less negative) OMR limit

When a more restrictive Old and Middle River flow (OMR) limit is decided upon, the water projects may continue to operate to the old limit for up to two additional days, with both 5-day and 14-day averaging periods in effect. On the third day, the moving daily OMR will be no more negative than the new limit, and no moving averages will apply. New moving averages will be calculated from the third day forward. On the fourth day, OMR can be no more than 25% more negative than the daily OMR on the third day; On the fifth day, OMR can be no more than 25% more negative than the midpoint between the daily OMRs on the third day and the fourth day; on the sixth day, OMR can be no more than 25% more negative than the average of the OMRs on the third, fourth, and fifth day; and so on. From the 8th day forward, if OMR restrictions due to triggers are still be implemented, a full 5-day moving average will exist, and daily OMR on any day cannot be more than 25% more negative than the 5-day moving average. On the 17th day, a 14-day moving average will be available. Consequently, from the 17th day forward, the 14-day moving average cannot be more negative than the OMR limit.

Transition to less restrictive (more negative) OMR limit

When a less restrictive OMR limit is decided upon, the water projects may begin to operate to that limit on the same day. The 5-day and 14-day averaging periods will continue to be computed through the transition. However, the 5-day averaging period will not provide 25% flexibility from the day the new OMR is imposed through the 7th day after the new limit is adopted. Through the 7th day after imposition, daily OMR may not be more negative than the new limit.

[37] NMFS assumes that the loss of winter-run Chinook salmon and steelhead are similar in nature based on annual loss estimates. As an initial trigger, the density of steelhead, which includes smolts and adults, will be used in the same equation as the older juvenile salmon trigger to change OMR flows. This will be reviewed by the DOSS group annually and recommendations to the trigger criteria made based on an assessment of the results.

[38] Three consecutive days in which the loss numbers are below the action triggers are required before the OMR flow reductions can be relaxed to -5,000 cfs. A minimum of 5 consecutive days of export reduction are required for the protection of listed salmonids under the action. Starting on day three of the export curtailment, the level of fish loss must be below the action triggers for the remainder of the 5-day export reduction to relax the OMR requirements on day 6. Any exceedances of the triggers restarts the 5-day OMR actions with the three day loss monitoring criteria.

		met.
January 1 - June 15 Second Stage Trigger (analogous to high concern level)	Daily SWP/CVP older juvenile loss density (fish per taf) is 1) greater than incidental take limit (2 percent of WR JPE) divided by 1000 (2 percent of WR JPE ÷ 1000), with a minimum value of 2.5 fish per taf, or 2) daily loss is greater than daily fish density divided by 8 taf (daily fish density ÷8 taf), or 3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 8 taf (daily measured fish density ÷ 8 taf)	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for 3 consecutive days following the 5 consecutive days of export reduction. Reductions are required when any one criterion is met.
End of Triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.	If trigger for end of OMR regulation is met, then the restrictions on OMR are lifted.

Implementation procedures: Combined exports will be managed to provide for an OMR flow of -5,000 cfs, tidally filtered over 14-days during the period between January 1 and June 15. The 5-day running average shall be no more than 25 percent more negative than the targeted flow requirement. Further reductions in exports will occur in a tiered fashion depending on the magnitude of Chinook salmon and steelhead salvage at the CVP and SWP fish salvage facilities. There are two export reductions triggered by increases in fish salvage rates at the fish collection. The first reduction decreases exports to achieve a net average

OMR flow of -3,500 cfs over a minimum of 5 consecutive days. The second reduction, based on higher salvage numbers, further reduces exports to achieve a net average OMR flow of -2,500 cfs over a minimum of 5 days.

These actions will be taken in coordination with USFWS RPA for Delta smelt and State-listed longfin smelt 2081 incidental take permit. During the January 1 through June 15 period, the most restrictive export reduction shall be implemented. If the USFWS Delta smelt RPA requires greater reductions in exports than those required by NMFS for salmonids, to achieve a more positive OMR flow, then the smelt action will be implemented, since it also will increase survival of listed salmonids. Likewise, if the NMFS RPA criteria are more restrictive than those called for under the Delta smelt RPA, then NMFS RPA criteria will prevail and will increase survival of Delta smelt as well as salmonids.

Rationale: Juvenile listed salmonids emigrate downstream in the main channel of the San Joaquin River during the winter and spring period. Juvenile listed steelhead from the San Joaquin River basin, the Calaveras River basin, and the Mokelumne River basin also utilize the lower reaches of the San Joaquin River as a migration corridor to the ocean. The river reach between the Port of Stockton and Jersey Point has many side channels leading south toward the export facilities. High export levels draw water through these channels toward the pumps, as these channels are the conduits that supply water to the pumps from the north. Outputs from PTM simulations, as well as data from acoustic tagging studies (Vogel 2004, SJRGA 2006, 2007), show that migrating fish are vulnerable to diversion into these channels and respond to flow within the channels, including the net migration speed downstream (SJRGA 2008).

The acoustic tagging studies also indicate that fish behavior is complex, with fish exhibiting behavior that is not captured by the "tidal surfing' model utilized as one of the options in the PTM simulations. Fish made their way downstream in a way that was more complicated than simply riding the tide, and no discernable phase of the tide had greater net downstream movement than another. Furthermore, tagged fish chose channels leading south more frequently when exports were elevated, than when exports were lower (Vogel 2004). Fish that moved into channels leading south may eventually find their way back to the main channel of the San Joaquin, but this roundabout migratory path exposes fish to higher predation risks as well as the potential to become lost within the Delta interior, increasing migration route length and duration of the outmigration. Increased time in the channels of the Central and South Delta exposes fish to unscreened agricultural diversions, discharges of agricultural irrigation return water to the Delta, increased water temperature later in the season, and the risk of predation from pelagic predators such as striped bass and localized ambush predators such as largemouth bass. In order to increase the likelihood of survival, emigrating steelhead from the San Joaquin Basin and the east-side tributaries should remain in the mainstem of the San Joaquin River to the greatest extent possible and reduce their exposure to the adverse effects that are present in the channels leading south toward the export facilities.

Reducing the risk of diversion into the central and southern Delta waterways also will increase survival of listed salmonids and green sturgeon entering the San Joaquin River via Georgiana Slough and the lower Mokelumne River. As described in the effects section of the Opinion, these fish also are vulnerable to entrainment by the far-field effects of the exports. The data output for the PTM simulation of particles injected at the confluence of the Mokelumne River and the San Joaquin River (Station 815) indicate that as net OMR flow increases southwards from -2,500 to -3,500 cfs, the risk of particle entrainment nearly doubles from 10 percent to 20 percent, and quadruples to 40 percent at -5,000 cfs. At flows more negative than -5,000 cfs, the risk of entrainment increases at an even greater rate, reaching approximately 90 percent at -7,000 cfs. Even if salmonids do not behave exactly as neutrally buoyant particles, the risk of entrainment escalates considerably with increasing exports, as represented by the net OMR flows. The logical conclusion is that as OMR reverse flows increase, risk of entrainment into the channels of the South Delta is increased. Conversely, the risk of entrainment into the channels of the South delta is reduced when exports are lower and the net flow in the OMR channels is more positive -- that is, in the direction of the natural flow toward the ocean.

Action IV.3 Reduce Likelihood of Entrainment or Salvage at the Export Facilities

Objective: Reduce losses of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon by reducing exports when large numbers of juvenile Chinook salmon are migrating into the upper Delta region, at risk of entrainment into the central and south Delta and then to the export pumps in the following weeks.

Action: From November 1 through April 30, operations of the Tracy and Skinner Fish Collection Facilities shall be modified according to monitoring data from upstream of the Delta. In conjunction with the two alerts for closure of the DCC (Action IV.1.1), the Third Alert shall be used to signal that export operations may need to be altered in the near future due to large numbers of juvenile Chinook salmon migrating into the upper Delta region, increasing their risk of entrainment into the central and south Delta and then to the export pumps.

Third Alert: The catch index is greater than 10 fish captured per day from November 1 to February 28, or greater than 15 fish captured per day from March 1 to April 30, from either the Knights Landing catch index or the Sacramento catch index.

Response: From November 1 through December 31, when salvage numbers reach the action triggers, exports shall be reduced as follows:

Date	Action Triggers	**Action Responses**

November 1 – December 31	Daily SWP/CVP older juvenile loss density greater than 8 fish/thousand acre feet (taf), or daily loss is greater than 95 fish per day, or Coleman National Fish Hatchery coded wire tagged late fall-run Chinook salmon (CNFH CWT LFR) or Livingston Stone National Fish Hatchery coded wire tagged winter-run (LSNFH CWT WNT) cumulative loss is greater than 0.5%.	Reduce exports to a combined 6,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.
	Daily SWP/CVP older juvenile loss density greater than 15 fish/taf, or daily loss is greater 120 fish per day, or CNFH CWT LFR or LSNFH CWT WNT cumulative loss greater than 0.5%.	Reduce exports to a combined 4,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.

From January 1 through April 30, implement Action IV.2.3 which include restrictions on OMR flows rather than set levels of combined export pumping. Alert triggers will remain in effect to notify the operators of the CVP and SWP that large numbers of juvenile Chinook salmon are entering the Delta system.

Rationale: As explained previously, juvenile salmonids and green sturgeon have a lower chance of survival to the ocean if they are diverted from their migratory routes on the main Sacramento and San Joaquin Rivers into the central and south Delta. Export pumping changes flow patterns and increases residence time of these diverted fish in the central Delta, which increases the risk of mortality from predation, water diversions, poor water quality, and contaminant exposure, as well as the likelihood of entrainment at the pumps. When more fish are present, more fish are at risk of diversion and losses will be higher. The Third Alert is important for real-time operation of the export facilities because the collection and dissemination of field data to the resource agencies and coordination of response actions may take several days. This action is designed to work in concert with the OMR action in IV.2.3.

Action Suite IV.4 Modifications of the Operations and Infrastructure of the CVP and SWP Fish Collection Facilities

Objective: Achieve 75 percent performance goal for whole facility salvage at both state and Federal facilities. Increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of winter-run, spring-run, CV steelhead, and green sturgeon.

Action: Reclamation and DWR shall each achieve a whole facility salvage efficiency of 75 percent at their respective fish collection facilities. Reclamation and DWR shall implement the following actions to reduce losses associated with the salvage process, including: (1) conduct studies to evaluate current operations and salvage criteria to reduce take associated with salvage,

(2) develop new procedures and modifications to improve the current operations, and (3) implement changes to the physical infrastructure of the facilities where information indicates such changes need to be made. Reclamation shall continue to fund and implement the CVPIA Tracy Fish Facility Program. In addition, Reclamation and DWR shall fund quality control and quality assurance programs, genetic analysis, louver cleaning loss studies, release site studies and predation studies. Funding shall also include new studies to estimate green sturgeon screening efficiency at both facilities and survival through the trucking and handling process.

By January 31 of each year, Reclamation and DWR shall submit to NMFS an annual progress report summarizing progress of the studies, recommendations made and/or implemented, and whole facility salvage efficiency. These reports shall be considered in the Annual Program Review.

Action IV.4.1 Tracy Fish Collection Facility (TFCF) Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency

Objective: Implement specific measures to reduce pre-screen loss and improve screening efficiency at Federal facilities**.**

Action: Reclamation shall undertake the following actions at the TFCF to reduce pre-screen loss and improve screening efficiency:

1) By December 31, 2012, improve the whole facility efficiency for the salvage of Chinook salmon, CV steelhead, and Southern DPS of green sturgeon so that overall survival is greater than 75 percent for each species.

    a) By December 31, 2011, Reclamation shall complete studies to determine methods for removal of predators in the primary channel, using physical and non-physical removal methods (*e.g.*, electricity, sound, light, CO_2), leading to the primary louver screens with the goal of reducing predation loss to ten percent or less. Findings shall be reported to NMFS within 90 days of study completion. By December 31, 2012, Reclamation shall implement measures to reduce pre-screen predation in the primary channel to less than ten percent of exposed salmonids.
    b) By March 31, 2011, Reclamation shall complete studies for the re-design of the secondary channel to enhance the efficiency of screening, fish survival, and reduction of predation within the secondary channel structure and report study findings to NMFS. NMFS shall review study findings and if changes are deemed feasible, Reclamation shall initiate the implementation of the study findings by January 31, 2012.
    c) No later than June 2, 2010, Reclamation shall submit to NMFS, one or more potential solutions to the loss of Chinook salmon and green sturgeon associated with the cleaning and maintenance of the primary louver and secondary louver systems at the TFCF. In the event that a solution acceptable to NMFS is not in place by June 2, 2011, pumping at the Tracy Pumping Plant shall cease during louver cleaning and maintenance operations to avoid loss of fish during these actions.

2) By December 31, 2011, Reclamation shall implement operational procedures to optimize the simultaneous salvage of juvenile salmonids and Delta smelt at the facility.

3) Immediately upon issuance of this biological opinion, Reclamation shall begin removing predators in the secondary channel at least once per week. By June 2, 2010, Reclamation shall install equipment to monitor for the presence of predators in secondary channel during operations. This could include an infrared or low light charged coupled device camera or acoustic beam camera mounted within the secondary channel.

4) Reclamation shall operate the facility to meet design criteria for louver bypasses and channel flows at least 75 percent efficiency.

5) Reclamation shall maintain a head differential at the trash rack of less than 1.5 ft. between the ambient Old River water surface elevation and the primary intake channel at all times.

6) By January 2, 2010, Reclamation shall install and maintain flow meters in the primary and secondary channels to continuously monitor and record the flow rates in the channel. Deviations from design flow criteria shall initiate immediate corrective measures to remedy deficiencies and return channel flows to design flow specifications.

7) Reclamation shall change its operations of the TFCF to meet salvage criteria, while emphasizing the following actions: (a) Primary Bypass Ratio; (b) Secondary Bypass Ratio; (c) Primary Average Channel Velocity; and (d) Secondary Average Channel Velocity.

8) Records of all operating actions shall be kept and made available to NMFS engineers upon request. NMFS shall be notified of any major or long-term deviations from normal operating design criteria within 24 hours of occurrence.

Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency

Objective: Implement specific measures to reduce pre-screen loss and improve screening efficiency at state facilities**.**

Action: DWR shall undertake the following actions at the Skinner Fish Collection Facility:

1) By December 31, 2012, operate the whole Skinner Fish Protection Facility to achieve a minimum 75 percent salvage efficiency for CV salmon, steelhead, and Southern DPS of green sturgeon after fish enter the primary channels in front of the louvers.

2) Immediately commence studies to develop predator control methods for Clifton Court Forebay that will reduce salmon and steelhead pre-screen loss in Clifton Court Forebay to no more than 40 percent.

    a) On or before March 31, 2011, improved predator control methods. Full compliance shall be achieved by March 31, 2014. Failure to meet this timeline shall result in the cessation of incidental take exemption at SWP facilities unless NMFS agrees to an extended timeline.
    b) DWR may petition the Fish and Game Commission to increase bag limits on striped bass caught in Clifton Court Forebay.

3) Remove predators in the secondary channel at least once per week.

Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates

Objective: To improve overall survival of listed species at facilities through accurate, rapid salvage reporting and state-of-the-art salvage release procedures. This reporting is also necessary to provide information needed to trigger OMR actions.

Action: Reclamation and DWR shall undertake the following actions at the TFCF and the Skinner Fish Collection Facility, respectively. Actions shall commence by October 1, 2009, unless stated otherwise.

1) Sampling rates at the facilities for fish salvage counts shall be no less than 30 minutes every 2 hours (25 percent of operational time) year-round to increase the accuracy of salvage estimates used in the determination of trigger levels. Exceptions to the 30-minute count may occur with NMFS' concurrence under unusual situations, such as high fish densities or excessive debris loading.

2) By October 1, 2010, websites shall be created or improved to make salvage count data publicly available within 2 days of observations of the counts. Information available on the website shall include at a minimum:

    a) duration of count in minutes;
    b) species of fish salvaged;
    c) number of fish salvaged including raw counts and expanded counts;
    d) volume of water in acre-feet, and average daily flow in cfs;
    e) daily average channel velocity and bypass ratio in each channel, primary and secondary;
    f) average daily water temperature and electrical conductivity data for each facility; and
    g) periods of non-operation due to cleaning, power outages, or repairs.

3) Release Site Studies shall be conducted to develop methods to reduce predation at the

"end of the pipe" following release of salvaged fish. Studies shall examine but are not limited to:

a) potential use of barges to release the fish in different locations within the western Delta, with slow dispersion of fish from barge holding tanks to Delta waters;
b) multiple release points (up to six) in western Delta with randomized release schedule; and
c) conducting a benefit to cost analysis to maximize this ratio while reducing predation at release site to 50 percent of the current rate.

4) By June 15, 2011, predation reduction methods shall be implemented according to analysis in 3. By June 15, 2014, achieve a predation rate that has been reduced 50 percent from current rate.

5) Add salt to water within the tanker trucks hauling fish to reduce stress of transport. Assess use of other means to reduce stress, protect mucous slime coat on fish, and prevent infections from abrasions (*i.e.*, commercially available products for this purpose).

6) All personnel conducting fish counts must be trained in juvenile fish identification and have working knowledge of fish physiology and biology.

7) Tanker truck runs to release salmonids should be scheduled at least every 12 hours, or more frequently if required by the "Bates Table" calculations (made at each count and recorded on the monthly report).

8) Reclamation and DWR shall use the Bates Table to maintain suitable environmental conditions for fish in hauling trucks. Trucks should never be overcrowded so that the carrying capacity of the tanker truck is exceeded.

Rationale: The process for salvaging listed salmonids and green sturgeon that are drawn into the pumping facilities is not efficient. For salmonids, at the Skinner Fish Protection Facility, loss rates can be as high as five fish lost for every fish salvaged. Most of this loss occurs in the forebay before the fish even encounter the fish screen louvers and the screening process. Conversely, at the Federal TFCF, most loss occurs because of poor screening efficiency in the louver array, although predation also occurs in front of the trash racks and in the primary channel leading to the primary louver array. Louver array cleaning protocols also lead to high loss rates because louvers are removed during cleaning, but pumping continues and fish are drawn directly into the facilities. The efficiency of the salvage process for green sturgeon is unknown, and this is a significant gap in the operational protocol for the facilities. The 2004 CVP/SWP operations Opinion identified terms and conditions to be implemented regarding salvage improvements, including evaluations for operational improvements. Some of those terms and conditions have been implemented but many have not.

Action IV.5 Formation of Delta Operations for Salmon and Sturgeon (DOSS) Technical Working Group

Objective: Create a technical advisory team .that will provide recommendations to WOMT and NMFS on measures to reduce adverse effects of Delta operations of the CVP and SWP to salmonids and green sturgeon and will coordinate the work of the other technical teams.

Action: The DOSS group will be comprised of biologists, hydrologists, and other staff with relevant expertise from Reclamation, DWR, CDFG, USFWS, and NMFS. Invitations to EPA, USGS, and Regional Water Quality Board biologists will be extended to provide expertise on issues pertinent to Delta water quality, hydrology and environmental parameters. By October 1, 2009, Reclamation shall, jointly with NMFS, convene the DOSS working group. The working group will have biweekly phone conferences, or more frequently if necessary for real-time operations, and meet at least quarterly to discuss and review information related to project operations and fisheries issues. Either Reclamation or NMFS may call for a special meeting of the DOSS group if they deem it necessary.

The team will:

1) provide recommendations for real-time management of operations to WOMT and NMFS, consistent with implementation procedures provided in this RPA;
2) review annually project operations in the Delta and the collected data from the different ongoing monitoring programs;

3) track the implementation of Actions IV.1 through IV.4;

4) evaluate the effectiveness of Actions IV.1 through IV.4 in reducing mortality or impairment of essential behaviors of listed species in the Delta;

5) oversee implementation of the acoustic tag experiment for San Joaquin fish provided for in Action IV.2.2;

6) coordinate with the SWG to maximize benefits to all listed species; and

7) coordinate with the other technical teams identified in this RPA to ensure consistent implementation of the RPA.

The DOSS team shall provide annual written reports to Reclamation, DWR, and NMFS, including a summary of major actions taken during the year to implement Action Suite IV of this RPA, an evaluation of their effectiveness, and recommendations for future actions. At the technical staff level, the working group will coordinate with the DAT, the SWG, and other workgroups to ensure coherent and consistent implementation of actions in the Delta. Every five years, the DOSS working group will produce a summary report of the previous five years of operations, actions taken, and the effectiveness of those actions in achieving the objectives of the Delta actions in this RPA. Included in this report will be recommendations

for adaptive management changes consistent with the objectives of this RPA. The report will be provided to NMFS, Reclamation, DWR, CDFG and USFWS.

The DOSS group shall also provide a coordinating function for the other technical working groups, to assure that relevant information from all technical groups is considered in actions to implement this RPA.

Rationale: This RPA contains a series of measures to minimize adverse effects of project operations in the Delta. An interagency technical team is necessary to track implementation of these measures, recommend actions within the boundaries of the implementation procedures in this document, and to build expertise over time to recommend changes to Delta operations. Any significant changes to Operations will trigger re-initiation of this opinion.

Action IV.6 South Delta Improvement Program—Phase I (Permanent Operable Gates)

Action: DWR shall not implement the South Delta Improvement Program, which is a proposal to replace temporary barriers with permanent operable gates.

Rationale: In a separate formal consultation (2009/01239), NMFS issued a 2008 biological opinion on the installation and operation of temporary barriers through 2010 (NMFS 2008). That biological opinion concluded that the temporary barriers would not jeopardize the continued existence of listed species or adversely modify critical habitat. This CVP/SWP operations Opinion concludes that on the basis of the best information available, the proposed replacement of these temporary barriers with permanent operable gates will adversely modify critical habitat. NMFS has not identified an alternative to the proposed permanent gates that meets ESA obligations.

After analyses of the operations of the temporary barriers are completed, as specified in the 2008 biological opinion, DWR may request that Reclamation reinitiate consultation with NMFS on the South Delta Improvement Program or may pursue permitting under ESA section 10. Additionally, DWR may apply information developed from Action IV.1.2 to modify the barrier design.

V. Fish Passage Program

Introduction: The duration of the proposed action is more than two decades. The long time horizon of the consultation requires NMFS to anticipate long-term future events, including increased water demand and climate change. The effects analysis in this Opinion highlights the difficulty of managing cold water aquatic species below impassible barriers, depending entirely on a fluctuating and often inadequate cold water reservoir pool. The analysis shows that even after all discretionary actions are taken to operate Shasta and Folsom reservoirs to reduce adverse effects of water operations on listed anadromous fish, the risk of temperature-related mortality of fish and eggs persists, especially in critically dry years. This mortality can be significant at the population level. The analysis also leads us to conclude that due to climate change, the frequency of these years will increase.

Therefore, NMFS believes it is necessary for Reclamation, in cooperation with NMFS, other fisheries agencies, and DWR, to undertake a program to provide fish passage above currently impassable artificial barriers for Sacramento River winter-run, spring-run, and CV steelhead, and to reintroduce these fish to historical habitats above Shasta and Folsom Dams. Substantial areas of high quality habitat exist above these dams: there are approximately 60 mainstem miles above Lake Shasta and 50 mainstem miles above Lake Folsom. These high-elevation areas of suitable habitat will provide a refuge for cold water fish in the face of climate change.

An RPA requiring a fish passage program has recently been issued by the Northwest Region of NMFS, as part of the Willamette Projects Biological Opinion (NMFS 2008). This jeopardy biological opinion resulted from the operation of a series of Federal projects in Oregon. That RPA represents the state-of-the-art program to address passage concerns such as residualism (failure to complete the downstream migration) and predation. The following suite of actions is similar, but not identical, to those in the Willamette projects Opinion. There are several designs available for passage, and some are likely to be more effective in some locations than others. Consequently, while NMFS suggests that Reclamation learn from the Willamette experience, the actions allow Reclamation to follow different critical paths, particularly with respect to the construction of a downstream passage prototype.

The Fish Passage Program includes a fish passage assessment for evaluating steelhead passage above Goodwin, Tulloch, and New Melones Dams on the Stanislaus River. The assessment will develop information necessary for consideration and development of fish passage options for the Southern Sierra Diversity Group of CV steelhead. Although pilot testing of passage in the Stanislaus is encouraged, it is not specifically required.

The Fish Passage Program Action includes several elements that are intended to proceed in phases. The near-term goal is to increase the geographic distribution and abundance of listed species. The long-term goal is to increase abundance, productivity, and spatial distribution, and to improve the life history and genetic diversity of the target species. Several actions are included in this program, as indicated in the following outline of the program:

Near-Term Fish Passage Actions:

- NF 1. Formation of Interagency Fish Passage Steering Committee
- NF 2. Evaluation of Habitat Above Dams
- NF 3. Development of Fish Passage Pilot Plan
- NF 4. Implementation of Pilot Reintroduction Program
  - NF 4.1. Adult Fish Collection and Handling Facilities
  - NF 4.2. Adult Fish Release Sites above Dams, and Juvenile Fish Sites Below Dams
  - NF 4.3. Capture, Trapping, and Relocation of Adults
  - NF 4.4. Interim Downstream Fish Passage through Reservoirs and Dams
  - NF 4.5. Juvenile Fish Collection Prototype
  - NF 4.6. Pilot Program Effectiveness Monitoring and Evaluation
  - NF 4.7. Stanislaus River Fish Passage Assessment
- NF 5. Comprehensive Fish Passage Report

Long-Term Fish Passage Actions:

- LF 1. Long-term Funding and Support for the Interagency Fish Passage Steering Committee.
- LF 2. Long-term Fish Passage Program
  - LF 2.1. Construction and Maintenance of Adult and Juvenile Fish Passage Facilities
  - LF 2.2. Development of Supplementation and Management Plan
  - LF 2.3. Construction and Maintenance of Long-term Adult and Juvenile Release Locations and Facilities.
  - LF 2.4. Development of Fish Passage Monitoring and Evaluation Plan

NEAR-TERM FISH PASSAGE ACTIONS

NF 1. Formation of Interagency Fish Passage Steering Committee

Objective: To charter, and support through funding agreements, an interagency steering committee to provide oversight and technical, management, and policy direction for the Fish Passage Program.

Action: By December 2009, Reclamation shall establish, chair and staff the Interagency Fish Passage Steering Committee. The Committee shall be established in consultation with and the approval of NMFS and shall include senior biologists and engineers with experience and expertise in fish passage design and operation, from Reclamation, NMFS, DWR, CDFG, and USFWS. The Steering Committee also shall include academic support by including at least one academic member from a California University with and established fishery program. The committee shall be limited to agency membership unless otherwise approved by Reclamation and NMFS. Steering committee membership shall include on lead member and one alternate.

Rationale: Interagency coordination and oversight is critical to ensuring the success of the fish passage program.

NF 2. Evaluation of Salmonid Spawning and Rearing Habitat Above Dams

Objective: To quantify and characterize the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for listed species above dams operated by Reclamation.

Action: Beginning in January 2010 and continuing through January 2012, Reclamation, shall conduct habitat evaluations to quantify and characterize the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for listed species above the project reservoirs. Reclamation shall obtain the Steering Committee's assistance in designing and implementing the habitat evaluations. Evaluations shall be conducted using established field survey protocols such as the USFS Region 5

Stream Condition Inventory, Field Intensive and Field Extensive protocols; and habitat models including the Salmon Habitat Integrated Resource Analysis (Shiraz) in combination with the Distributed Hydrology Soil Vegetated Model (DHSVM) or RIPPLE. Shiraz is a life-cycle model that incorporates stream flow and temperature inputs from DHSVM to develop future projections of salmon population sizes. Ripple uses digital terrain information with aquatic habitat and biological data to identify habitat limitations that affect salmon production. Both modeling approaches have been applied in the Washington and Oregon assess the value of providing passage to salmonids to historically available habitat.

Rationale: The condition and suitability of historical habitats located above impassable barriers is likely to have changed considerably since last occupied by anadromous fish. The location, quantity, and condition of habitat must be inventoried and assessed in order to evaluate the current carrying capacity and restoration potential. This information is essential to determine where passage and reintroduction, if feasible, are most likely to improve reproductive success for listed fish.

NF 3. Development of Fish Passage Pilot Plan

Action: From January 2010 through January, 2011, Reclamation, with assistance from the Steering Committee, shall complete a 3-year plan for the Fish Passage Pilot program. The plan shall include: (1) a schedule for implementing a 3-year Pilot Passage program on the American River above Nimbus and Folsom dams, and on the Sacramento River above Keswick and Shasta dams; and (2) a plan for funding the passage program. This plan and its annual revisions shall be implemented upon concurrence by NMFS that it is in compliance with ESA requirements. The plan shall include, but not be limited to, the following:

1) Identify any operational requirements needed for the passage and re-introduction program.

2) Identify protocols for optimal handling, sorting, and release conditions for ESA-listed fish collected at Reclamation or partner agency-funded fish collection facilities when they are constructed.

3) Identify the number, origin, and species of fish to be released into habitat upstream of Reclamation dams, incorporated into the hatchery broodstock, or taken to other destinations.

4) Identify fish collection and transportation requirements (*e.g.*, four wheel-drive vehicles, smooth-walled annular tanks, large vertical slide gates, provisions for tagging/marking, *etc*.) for moving fish from below project dams to habitats above reservoirs, avoiding the use of facilities or equipment dedicated for other purposes (*e.g.*, existing transport trucks).

5) Identify optimal release locations for fish, based on access, habitat suitability, disease concerns, and other factors (*e.g.*, those which would minimize disease concerns,

recreational fishery impacts, interbreeding with non-native *O. mykiss* strains, regulatory impacts, special authorities for studies/construction, complications from upstream dams, *etc*.).

6) Identify and evaluate options for providing tailored ESA regulatory assurances for non-Federal landowners above the dams where species could be re-introduced.

7) Identify interim downstream fish passage options through reservoirs and dams with the objective of identifying volitional downstream passage scenarios and alternatives for juvenile salmon and steelhead migrating through or around project reservoirs and dams. If these options are not considered feasible, identify interim non-volitional alternatives. Near-term operating alternatives that are determined to be technically and economically feasible and biologically justified shall be identified by Reclamation and the steering committee agencies.

8) Describe scheduled and representative types of unscheduled, maintenance of existing infrastructure (dams, transmission lines, fish facilities, *etc*.) that could adversely impact listed fish, and describe measures to minimize these impacts.

9) Describe procedures for coordinating with Federal and state resource agencies in the event of scheduled and unscheduled maintenance.

10) Describe protocols for emergency events and deviations.

Reclamation and partner agencies shall annually revise and update the Fish Passage Pilot Plan. The revisions and updates shall be based on results of Fish Passage Pilot Plan activities, construction of new facilities, recovery planning guidance, predicted annual run size, and changes in hatchery management. By January 15 of each year, Reclamation shall submit a revised draft plan to NMFS. By February 15, NMFS shall advise Reclamation and partner agencies whether it concurs that the revised Fish Passage Plan is likely to meet ESA requirements. Reclamation and partner agencies shall release a final updated Fish Passage Pilot Plan by March 14 of each year.

Rationale: The Fish Passage Pilot Plan is a critical link between measures in the Proposed Action and this RPA and the long-term fish passage program. The plan will provide a blueprint for obtaining critical information about the chances of successful reintroduction of fish to historical habitats and increasing the spatial distribution of the affected populations. By including emergency operations within the Plan, field staff will have a single manual to rely on for all fish-related protocols, including steps that should be taken in emergency situations to minimize adverse effects to fish.

NF 4. Implementation of Pilot Reintroduction Program

Objective: To implement short-term fish passage actions that will inform the planning for long-term passage actions.

Actions: From January 2012 through 2015, Reclamation shall begin to implement the Pilot Reintroduction Program (see specific actions below). The Pilot Program will, in a phased approach, provide for pilot reintroduction of winter-run and spring-run to habitat above Shasta Dam in the Sacramento River, and CV steelhead above Folsom Dam in the American River. This interim program will be scalable depending on source population abundance, and will not impede the future installation of permanent facilities, which require less oversight and could be more beneficial to fish. This program is not intended to achieve passage of all anadromous fish that arrive at collection points, but rather to phase in passage as experience with the passage facilities and their benefits is gained.

Rationale: The extent to which habitats above Central Valley dams can be successfully utilized for the survival and production of anadromous fish is currently unknown. A pilot reintroduction program will allow fishery managers to incrementally evaluate adult reintroduction locations, techniques, survival, distribution, spawning, and production, and juvenile rearing, migration. The pilot program also will test juvenile collection facilities.

This action requires facility improvements or replacements, as needed, and establishes dates to complete work and begin operation. In some cases, work could be initiated sooner than listed above, and NMFS expects Reclamation and partner agencies to make these improvements as soon as possible.

Because these facilities will be used in lieu of volitional fish passage to provide access to historical habitat above the dams, this measure is an essential first step toward addressing low population numbers caused by decreased spatial distribution, which is a key limiting factor for Chinook salmon and CV steelhead.

Upstream fish passage is the initial step toward restoring productivity of listed fish by using large reaches of good quality habitat above project dams. Restriction to degraded habitat below the dams has significantly impaired reproductive success and caused steep declines in abundance.

NF 4.1. Adult Fish Collection and Handling Facilities

Beginning in 2012, Reclamation, with assistance from the Steering Committee, shall design, construct, install, operate and maintain new or rebuilt adult fish collection, handling and transport facilities at the sites listed below. The objective is to provide interim facilities to pass fish above project facilities and reservoirs.

Reclamation and partner agencies shall incorporate NMFS' Fish Screening Criteria for Anadromous Salmonids (NMFS 1997a) and the best available technology. During the design phase, Reclamation and partner agencies shall coordinate with NMFS to determine if the design should accommodate possible later connection to improved facilities, if necessary in years beyond 2015.

Reclamation and partner agencies shall complete all interim steps in a timely fashion to allow them to meet the following deadlines for completing construction and beginning operation of the facilities listed below. These steps may include completing plans and specifications. Reclamation and partner agencies shall give NMFS periodic updates on their progress. The order in which these facilities are completed may be modified with NMFS' concurrence, based on interim analyses and biological priorities.

1) Sacramento River Fish Facility – Collection facility shall be operational no later than March 2012.

2) American River Fish Facility – Collection facility shall be operational no later than March 2012.

NF 4.2. Adult Fish Release Sites above Dams and Juvenile Fish Sites Below Dams

Reclamation shall provide for the safe, effective, and timely release of adult fish above dams and juvenile fish below dams. The Fish Passage Plan must identify and release sites. Fish transport and release locations and methods shall follow existing State and Federal protocols. With assistance from the Steering Committee, and in coordination with applicable landowners and stakeholders, Reclamation shall complete construction of all selected sites by March 2012.

NF 4.3. Capture, Trapping, and Relocation of Adults

By March 2012, Reclamation shall implement upstream fish passage for adults via "trap and transport" facilities while it conducts studies to develop and assess long-term upstream and downstream volitional fish passage alternatives. At least one fish facility must be in place at terminal upstream passage points for each river that is subject to this measure. Facilities to capture adults currently exist at or below Keswick and Nimbus Dams, though these may need to be upgraded. The Pilot Program is a first step in providing anadromous fish passage to historical habitat above Project dams but will not be sufficient by itself.

The number of fish that shall be relocated is expected to vary depending on the source population, source population size, and the results of fish habitat evaluations and modeling of carrying and production capacity. The Steering Committee will work in consultation with the NMFS Southwest Fishery Science Center to develop adult relocation source populations and abundance targets. The Steering Committee shall evaluate the use of wild and hatchery sources and develop strategies that minimize risk to existing wild populations.

NMFS considers volitional passage via a fish ladder or other fishway to be the preferable alternative in most circumstances. In the short term, upstream passage can be provided with fish trap and transport mechanisms, while Reclamation evaluates program effectiveness and passage alternatives.

NF 4.4. Interim Downstream Fish Passage through Reservoirs and Dams

Beginning in 2012, following the emergence of the first year class of reintroduced fish, and until permanent downstream passage facilities are constructed or operations are established at Project dams, Reclamation shall carry out interim operational measures to pass downstream migrants as safely and efficiently as possible through or around Project reservoirs and dams under current dam configurations and physical and operational constraints, consistent with authorized Project purposes.

Near-term operating alternatives shall be identified, evaluated, and implemented if determined to be technically and economically feasible and biologically justified by Reclamation and partner agencies, within the framework of the Annual Operating Plan updates and revisions, and in coordination with the Fish Passage Plan Steering Committee. Interim devices shall be constructed to collect emigrating juvenile salmonids and emigrating post-spawn adult steelhead from tributaries, main stems above project reservoirs, or heads of reservoirs. Fish shall be safely transported through or around reservoirs as necessary and released below currently impassible dams.

Reclamation and partner agencies shall evaluate potential interim measures that require detailed environmental review, permits, or Congressional authorization as part of the Fish Passage Plan. Reclamation shall complete this component of the Plan by April 30, 2011, including seeking authorization (if necessary) and completing design or operational implementation plans for the selected operations. Measures to be evaluated include, but are not limited to, partial or full reservoir drawdown during juvenile outmigration period, modification of reservoir refill rates, and using outlets, sluiceways, and spillways that typically are not opened to pass outflow.

NF 4.5. Juvenile Fish Collection Prototype

Objective: To determine whether the concept of a head-of-reservoir juvenile collection facility is feasible, and if so, to use head-of-reservoir facilities in Project reservoirs to increase downstream fish survival. Safe and timely downstream passage of juvenile Chinook salmon and juvenile and adult post-spawn steelhead is a critical component to the success of the Fish Passage Program.

Beginning in January, 2010, with input from the CVP/SWP operations Fish Passage Steering Committee, Reclamation shall plan, design, build, and evaluate a prototype head-of-reservoir juvenile collection facility above Shasta Dam. Construction shall be complete by September 2013.

Because the head-of-reservoir fish collection concept is virtually untested, it would be imprudent to require such facilities without prior field studies, design, and prototype testing to validate the concept. For this measure, NMFS defines “prototype” to refer to temporary facilities intended for concept evaluation, not long-term operations. Further, “prototype” does not necessarily refer to a single concept; multiple concepts may be tested simultaneously. Possible options include, among others: (1) floating collectors in the

reservoir near the mouths of tributaries, (2) use of curtained or hardened structures near mouths of tributaries, that block surface passage into reservoirs, (3) fish collection facilities on tributaries above the reservoir pools, and (4) a combination of the above to maximize collection in high flow and low flow conditions.

By the end of 2010, Reclamation, with assistance from the Fish Passage Steering Committee and concurrence by NMFS, shall identify a preferred location(s) and design(s) for construction of the prototype(s). Construction of the prototype facility(s) must be completed in time to conduct two years of biological and physical evaluations of the head-of-reservoir prototype collection facilities by the end of 2016. The Fish Passage Steering Committee shall have opportunity to comment on study proposals and a draft report on the effectiveness of the facilities, including recommendations for installing full-scale head-of-reservoir facilities at this and other reservoirs. By December 31, 2016, after receiving concurrence from NMFS and USFWS on the draft report, Reclamation and partner agencies shall make necessary revisions to the draft report and issue a final report. The report shall recommend technically and biologically feasible head-of-reservoir facilities, capable of safely collecting downstream migrating fish, and capable of increasing the overall productivity of the upper basins, then Reclamation and partner agencies shall include such facilities in the design alternatives that they consider in the Fish Passage Plan studies.

NF 4.6. Pilot Program Effectiveness Monitoring and Evaluation

From 2012 to 2015, Reclamation shall study, and provide annual reports on, the elements of the pilot program, including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. The objective is to gather sufficient biological and technical information to assess the relative effectiveness of the program elements and determine the feasibility of long-term passage alternatives. A final summary report of the 5-year pilot effort shall be completed by December 31, 2015.

NF 4.7. Stanislaus River Fish Passage Assessment

Objective: To develop information needed in order to evaluate options for achieving fish passage on the Stanislaus River above Goodwin, Tulloch, and New Melones Dams.

Action: By March 31, 2011, Reclamation shall develop a plan to obtain information needed to evaluate options for fish passage on the Stanislaus River above Goodwin, Tulloch and New Melones Dams and shall submit this plan to NMFS for review. This plan shall identify reconnaissance level assessments that are needed to support a technical evaluation of the potential benefits to CV steelhead that could be achieved with passage above the dams, a general assessment of logistical and engineering information needed, and a schedule for completing those assessments by December 31, 2016. Reclamation is encouraged to use information developed for the American and Sacramento Rivers in Action NF 3 above, when also applicable for the Stanislaus River.

By December 31, 2016, Reclamation shall submit a report, including the results of the assessments and proposed options for further consideration, to NMFS. By December 31, 2018, Reclamation shall include recommendations for fish passage on the Stanislaus River in the Comprehensive Feasibility Report (Action NF 6.) The report will outline the costs of potential projects, their biological benefits and technical feasibility, potential alternatives, and steps necessary to comply with all applicable statutes and regulations.

Rationale: This assessment process will develop foundational information necessary for consideration and development of fish passage options above New Melones Reservoir to relieve unavoidable effects of project operations on the Southern Sierra Diversity Group of CV steelhead and on adverse modification of critical habitat.

NF 5. Comprehensive Fish Passage Report

Objective: To evaluate the effectiveness of fish passage alternatives and make recommendations for the development and implementation of long-term passage alternatives and a long-term fish passage program.

Action: By December 31, 2016, Reclamation shall prepare a Comprehensive Fish Passage Report. The Report shall include preliminary determinations by Reclamation and partner agencies regarding the feasibility of fish passage and other related structural and operational alternatives. The report should include specific recommendations for improvements to highest priority sub-basins and/or features and to include recommendations for major operational changes. It will also include identification and evaluation of high priority actions and may suggest modifying the scope or timelines of these high priority actions, based on the predicted outcome of long-term efforts.

Re-initiation trigger: If the downstream fish passage improvements are determined not likely to be technically or biologically feasible at this milestone, then Reclamation and the Steering Committee shall identify other alternatives that would be implemented within the same timelines as those identified in this RPA. Reclamation and partner agencies shall submit specific implementation plans for alternative actions to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans are likely to have the biological results that NMFS relied on in this Opinion. The alternatives must be within the same Diversity Group as the affected population, identify high elevation habitats above dams that provide similar habitat characteristics in terms of water temperatures, habitat structure (sufficient pool depths and spawning gravels), ability to withstand long-term effects of climate change, and must demonstrate an ability to support populations that meet the characteristics of a population facing a low risk of extinction according to the population parameters identified in Lindley *et al.* (2007), "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin." If Reclamation and partners believe that the proposed passage locations may not be feasible, the Fish Passage Steering Committee should be directed to develop early assessments of alternative actions that meet the performance standards described above in order to maintain the schedule proposed in this action. NMFS shall notify Reclamation and

partner agencies as to whether the proposal is consistent with the analysis in this Opinion. If not, Reclamation will request re-initiation of consultation.

LONG-TERM FISH PASSAGE ACTIONS

In the event that the decision is made by 2016 to pursue a comprehensive fish passage program, the following actions will be implemented.

LF 1. Long-term Funding and Support to the Interagency Fish Passage Steering Committee

If the Comprehensive Fish Passage Report indicates that long-term fish passage is feasible and desirable, Reclamation shall continue to convene, fund, and staff the Fish Passage Steering Committee.

LF 2. Action Suite: Long-Term Fish Passage Plan and Program

Objective: Provide structural and operational modifications to allow safe fish passage and access to habitat above and below Project dams in the Central Valley.

Actions: Based on the results of the Comprehensive Fish Passage Report, Reclamation, with assistance from the Steering Committee, shall develop a Long-term Fish Passage Plan and implement a Long-term Fish Passage Program. Reclamation and partner agencies shall submit a plan to NMFS on or before December 31, 2016, which shall describe planned long-term upstream and downstream fish passage facilities and operations, based on the best available information at that time. The plan shall include a schedule for implementing a long-term program for safe, timely, and effective anadromous fish passage by January 31, 2020.

The Long-term Fish Passage Plan and Program shall target the following performance standards: (1) demonstrated ability to withstand long-term effects of climate change, (2) must support populations in the target watersheds that meet the characteristics of a population facing a moderate risk of extinction by year 5 (2025) and a low risk of extinction by year 15 (2030), according to the population parameters identified in Lindley *et al.* (2007), "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin."

The structural and operational modifications needed to implement the program shall be developed as high priority measures in the plan. The plan shall include an evaluation of a range of structural and operational alternatives for providing fish passage above Reclamation dams in the Sacramento, American, and Stanislaus River watersheds. Reclamation and partner agencies will evaluate the information gathered through plan development, the NEPA process, ESA recovery planning (including life cycle modeling developed as part of the recovery planning process), university studies, local monitoring efforts public comment, and other relevant sources, to determine which alternative(s), will provide the most cost-effective

means to achieve adequate passage benefits to avoid jeopardy to ESA-listed fish from the water projects in the long term. Reclamation and partner agencies shall proceed with the action(s) that sufficiently address the adverse effects of the Project, in the context of future baseline conditions. Reclamation and DWR shall submit specific implementation plans to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans meet ESA requirements, consistent with this Opinion. NMFS will notify Reclamation and partner agencies as to whether the proposal is consistent with ESA obligations.

Reclamation and DWR also shall analyze structural and operational modifications to provide downstream fish passage as part of the plan, following the same process as that for providing upstream passage.

The time frame for implementing the long-term passage measures may extend beyond the time frame of this Opinion. However, Reclamation and DWR must begin some actions during the term of this Opinion, including as investigating feasibility, completing plans, requesting necessary authorization, and conducting NEPA analysis

Rationale: This suite of actions ensures that fish passage actions will be taken by specified dates, or that the Project will be re-analyzed based upon new information. As noted in this Opinion, lack of passage is one of the most significant limiting factors for the viability of the affected populations of Chinook salmon and steelhead. As described in the effects analysis of the biological opinion, this also exposes populations to additional and significant stressors from project operations that also limits their viability and ability to survive below dams. Providing fish passage to historical spawning and rearing habitats would effectively mitigate for unavoidable adverse impacts of the projects on listed fish.

NMFS chose the passage in the Sacramento and American rivers based on the best available information at the time of this Opinion. The choice of location of passage facilities, as well as the method of passage, may change based on additional information, including additional assessment of necessity and feasibility of passage in the Stanislaus River. Passage methods may vary based on the specific requirements of each site, as well as fish behavior at a specific location. If information indicates that a different location or passage method is preferable, then Reclamation and DWR must coordinate with the Fish Passage Plan committee and obtain NMFS' concurrence that a proposed change is likely to meet ESA obligations.

Long-term fish passage should significantly increase abundance and spatial distribution of winter-run, spring-run, and CV steelhead because the fish will have access to upstream spawning and rearing habitat, and the juveniles will have access downstream to the ocean for growth to maturity. This action will address the Habitat Access pathway of critical habitat by improving access past physical barriers, thereby improving the status of PCEs for spawning, rearing, and migration of winter-run, spring-run, and CV steelhead populations.

LF 2.1. Long-term Adult and Juvenile Fish Passage Facilities

Based on the results of the Comprehensive Fish Passage Report and the Fish Passage Plan, and with the assistance of the Steering Committee, Reclamation shall construct long-term fish passage facilities necessary to successfully allow upstream and downstream migration of fish around or through project dams and reservoirs on the Sacramento and American Rivers by 2020, and Stanislaus River depending on results of study provided for in Action NF 4.7.

LF 2.2. Supplementation and Management Plan

Based on the results of the Comprehensive Fish Passage Report and the Fish Passage Plan, and with the assistance of the Steering Committee, in consultation with the NMFS Southwest Fishery Science Center, Reclamation shall develop and implement a long-term population supplementation plan for each species and fish passage location identified in V. *Fish Passage Program*, with adult recruitment and collection criteria developed with consideration for source population location, genetic and life history diversity, abundance and production. The purpose is to ensure that long-term abundance and viability criteria are met for all reintroduced populations, with contingencies for supplementing populations with wild and/or conservation hatchery fish if necessary. The plan shall be developed by 2020. The plan shall identify wild and/or hatchery sources for adult reintroductions and long-term supplementation, and the specific NMFS-approved hatchery management practices that qualify a hatchery for conservation purposes. Species-specific conservation hatchery programs may be developed to supplement reintroductions and maintain long-term performance standards for abundance and viability.

LF 2.3. Long-term Fish Passage Monitoring and Evaluation

Reclamation, through the Steering Committee shall develop a Long-term Fish Passage Monitoring and Evaluation Plan by 2020, to monitor all elements of the Long-term Fish Passage Program including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. The objective is to gather sufficient biological and technical information to assess the relative effectiveness of the program elements and determine the feasibility of long-term passage alternatives. Annual reports shall be submitted to NMFS by September 30 of each year.

11.3 ANALYSIS OF RPA

This section presents NMFS' rationale for concluding that with adoption of this RPA, Reclamation would avoid jeopardizing the listed species and adversely modifying their proposed and designated critical habitats. This rationale is presented for the following species and critical habitats that NMFS concluded would be jeopardized or adversely modified by the proposed action:

- Sacramento River winter-run and its designated critical habitat,
- CV spring-run and its designated critical habitat,
- CV steelhead and its designated critical habitat,
- Southern DPS of green sturgeon and its proposed critical habitat, and

- Southern Resident killer whales.

Each section summarizes the main stressors and the actions within the RPA that alleviate those stressors, both in the short-term and the long-term. This analysis relies heavily on the tables presented for each species. The supporting biological information for each action referenced in the table is contained in the "objective" and "rationale" sections for each action in the preceding section. Each action of the RPA is linked to at least one main stressor for at least one species, identified in the effects analysis and the integration and synthesis sections of this Opinion. Many RPA actions are designed to minimize adverse effects of project operations on multiple species and life stages.

11.3.1 Sacramento River Winter-Run Chinook Salmon and its Designated Critical Habitat

Throughout this Opinion, NMFS has explained that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS has explained the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.1 and 9.2, NMFS summarized various project-related stressors that reduced the VSP parameters and the conservation value of PCEs.

The winter-run ESU is currently at a high risk of extinction. As described in the Status of the Species section of this Opinion, weaknesses in all four VSP parameters -- spatial structure, population size, population growth rate, and diversity -- contribute to this risk. In particular (1) multiple populations of this ESU have been extirpated; the ESU now is composed of only one population, and this population has been blocked from all of its historical spawning habitat; (2) habitat destruction and modification throughout the mainstem Sacramento River have dramatically altered the ESU's spatial structure and diversity; (3) the ESU is at risk from catastrophic events, considering the remaining population's proximity to Mt. Lassen and its dependency on the cold water management of Shasta Reservoir; (4) the population has a "high" hatchery influence (Lindley *et al*. 2007); and (5) the population experienced an almost seven fold decrease in 2007. In addition, many of the physical and biological features of critical habitat that are essential for the conservation of winter-run are currently impaired and provide limited habitat value.

The proposed action increases the population's extinction risk and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime, as is generally depicted in figure 9-4. The RPA specifies many significant actions that will reduce the adverse effects of the proposed action on winter-run and its critical habitat. Many of the RPA actions specifically address key project-related limiting factors or threats facing the ESU and its critical habitat, as described in the "Objectives" and "Rationale" parts of the actions. Some of these factors are lack of passage to historical spawning habitat above Keswick and Shasta Dams, passage impediments (*e.g.*, RBDD), degraded quantity and quality of the remaining habitat downstream of Keswick and Shasta Dams, and the entrainment influence of the Federal and state export facilities. As shown in table 11-1, there is a need for both short-term and long-term actions, including:

- providing passage to and from historical habitat;
- increasing Shasta reservoir storage to provide for temperature control and improve the quantity and quality of downstream habitat;
- providing interim and long-term modifications to RBDD;
- providing increased rearing habitat;
- modifying operation of the DCC; and
- implementing a revised decision process for Delta operations, including timing and amount of export reduction..

Implementation of some RPA actions will reduce the adverse effects of project operations on winter-run and its critical habitat immediately or in the near term. Other actions will take longer to plan and implement, and will not provide needed results for many years. We discuss the near-term and long-term actions separately.

Near Term

In the near term, adverse effects of project operations to winter-run will be reduced primarily through the following measures:

1) Modifications to Shasta reservoir management will result in more reliable provision of suitable water temperatures for spawning and egg incubation in the summer months. The new year-round Shasta management program is expected to minimize frequency and duration of temperature related egg mortality in dry and critically dry years, thus reducing, though not eliminating, the population level stress of these temperature related mortalities. The new Shasta program will allow for an expanded range of habitat suitable for spawning and egg incubation in wetter year types (i.e. through meeting downstream compliance points more often). Over time, this will help to preserve diversity of run-timing and decrease the risk of a single event in a localized area causing a population level effect. Temperature related effects on winter-run will persist into the future, and cannot be fully off-set through Shasta reservoir storage actions, due to physical and hydrological constraints on the CVP system, and the delivery of water to non-discretionary CVP contractors (e.g. Sacramento River Settlement Contractors). Given a fixed supply of cold water in any given year starting in May, as an overall strategy, the RPA prioritizes temperature management in favor of winter-run due to their endangered status and complete dependence on suitable habitat downstream of Keswick for their continued survival.
2) Interim operations of RBDD (until 2012) will allow for significant increased passage of adult winter-run, a significant reduction in juvenile mortality associated with downstream passage, and elimination of emergency gate closures in early spring.
3) Continuation of installation of fish screens that meet NMFS criteria along the Sacramento River and Delta thereby reducing entrainment of winter run juveniles throughout their migration path down the Sacramento river and through the Delta.;
4) Additional closures of the DCC gates at key times of year triggered to winter-run needs, thereby will keep a greater percentage of winter-run emigrating through the northern Delta out to sea.

5) Old and Middle River reverse flow restrictions on combined exports in January through spring months, will significantly reduce winter-run juveniles that are drawn further into the Interior and Southern Delta, and therefore exposed to risks due to export facilities.
6) Additional measures will reduce entrainment and improve efficiency of salvage operations at both the State and Federal export facilities. Collectively, these measures will ensure that the winter-run that are exposed to the export facilities have a greater likelihood of survival.
7) Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire winter-run life history run-timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the ESU. This diversity of run-timing will ensure greater resiliency of the winter-run ESU to environmental changes. For example, ocean conditions and the timing and duration of upwellings may play a significant role in the survival of any given cohort of winter-run. However, modifying operations to allow for the expansion of ocean entry timing for winter-run will increase the probability that at least a portion of each cohort will enter the ocean when prey are readily available, thereby increasing the cohort's survival.

Long Term

In addition to the continuation of near-term actions, long-term actions are necessary to avoid an appreciable reduction in survival and recovery of the species. The long-term effects analysis for winter-run reveals that climate change and growth are likely to increase adverse effects especially associated with temperature related egg mortality on the Upper Sacramento River in the summertime. A prolonged drought could result in extinction of the species by resulting in significant egg mortality for three years in a row. In order to address the underlying issues of inadequate spatial structure and diversity and quality of critical habitat, and therefore, increased risk of extinction over the long-term, a passage program to provide for winter-run to access their historical habitat is necessary in order to avoid jeopardy. Such a program has many unknowns, and therefore cannot be relied upon to produce results in the near-term. In the long-term however, the RPA includes a structured passage program with pilot reintroductions, an interagency work team, and milestones and re-initiation triggers. This structured program, while not guaranteed to be effective, greatly reduces the likelihood of an appreciable reduction to winter-run survival and recovery in the long-term due to on-going project operations by allowing access of a portion of the population to historical cold-water, high elevation habitat. Furthermore, there are some near-term benefits to the passage pilot reintroduction program, including immediate expansion of the geographical rang of the single population.

In addition to upstream passage, the follow actions will minimize project effects in the long-term to the extent that the species is not jeopardized:

1. The RPA specifies long-term RBDD gate configuration is gates out all year. This will greatly reduce the significant losses associated with current and also the more modest losses associated with interim operations.
2. The RPA ensures that the Battle Creek experimental winter-run re-introduction program will proceed in a timely fashion. This Battle Creek program is critical in creating a second

population of winter-run. This second population increases the species spatial structure and diversity and should increase growth rate and abundance over time as well.

3. The RPA ensures that in the long-term, Salmonid rearing habitat actions in the lower Sacramento River and Northern Delta will minimize adverse effects of project operations on winter-run critical habitat in the long-term and off-set effects of ongoing flood control operations. These habitat actions will increase the growth rates of individuals that utilize this habitat. These fish are predicted to enter the estuary and ocean with a higher degree of fitness, and therefore, greater resiliency to withstand stochastic events in these later phases of their life history, thereby increasing the viability of the ESU and reducing the likelihood of appreciable reductions in the survival or recovery of the species.

In conclusion, NMFS believes that if all parts of the RPA pertaining to Sacramento River winter-run Chinook salmon are implemented, the RPA is not likely to reduce appreciably the likelihood of survival and recovery of winter-run or adversely modify its critical habitat, in either the near term or the long term.

Table 11-1. Summary of actions to minimize or alleviate proposed action-related stressors on Sacramento River winter-run Chinook salmon and its designated critical habitat.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	RBDD gate closures from May 15 - Sept 15 every year until 2019.	~15 % of adults delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity; continues every year until 2019.	High	Action I.3.2: RBDD Interim Operations.	Action I.3.1: RBDD Operations After May 14, 2012.
Adult immigration and holding	RBDD emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed; sub lethal effects on eggs in fish and energy loss. These emergency gate closures have occurred twice in the past 10 years and the frequency of occurrence may increase with climate change.	High	Action I.3.2: RBDD Interim Operations.	Action I.3.1: RBDD Operations After May 14, 2012.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	Reduced spawning area from moving TCP upstream in almost every year from April 15 to Sept 30	Introgression or hybridization with spring/fall-run/late fall-run Chinook salmon; loss of genetic integrity and expression of life history	High	Action I.2.1: Maintain suitable water temperatures for winter-run Chinook salmon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation for the Sacramento River. Action I.1.4: Improve and maintain effectiveness of the Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action I.2.1. Continue implementation of Action I.2.2. Continue implementation of Action I.2.3. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)
		Density dependency - aggressive behavior among spawning fish could cause higher prespawn mortality, increased for suitable spawning sites, adults forced downstream into unsuitable areas	Medium - may increase as abundance increases		
		Redd superimposition - spawning on top of other redds, destroys eggs	Medium - may increase as abundance increases		
Spawning	Water temperatures warmer than life history stage requirements below TCP, every year April 15 -Sept 30)	Prespawn mortality; reduced fecundity	High		

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	Water temperatures warmer than life history stage requirements, every year from April 15 - Sept 30. (No carry-over storage target designed for fish protection is included in the proposed action. Without such a target, the risk of running out of coldwater in Shasta Reservoir increases.)	Egg mortality - 16 % in critically dry years and increases to 65% in critically dry years with climate change. On average, for all water year types, mortality is 5-12% with climate change and 2-3% without. 56F is exceeded at Balls Ferry in 30% of the years in August and 55% of the years in September Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of winter-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	Action I.2.1: Maintain suitable water temperatures for winter-run Chinook salmon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation for the Sacramento River. Action I.1.4: Improve and maintain effectiveness of the Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action I.2.1. Continue implementation of Action I.2.2. Continue implementation of Action I.2.3. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	RBDD passage downstream through dam gates May 15 - Sept 15	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50 %; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 10 % of winter-run would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are in.	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD Interim Operations Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: RBDD Operations After May 14, 2012 Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.
Juvenile rearing and downstream movement	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA anadromous fish screen program	Continue implementation of Action I.5

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process	Loss of rearing habitat and riparian habitat and natural river function impaired (e.g., formation of side channels, sinuosity); loss of cottonwood recruitment impacting food availability, juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	High	Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics).	During dry and critical years in December and January, modeling estimates of monthly mortality of up to approximately 15 % of the total winter-run population entering the Delta at Freeport is associated with exports (Greene 2008). Of those winter-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66 % (range of 35-90 % mortality). This equates to approximately 5-20 % of the total population entering the Delta at Freeport. Anticipated delays in migration due to export operations.	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations. Action IV.1.2: DCC gate operation. Action IV.1.3: Engineering studies of methods to reduce loss of salmonids in Georgiana Slough and South Delta channels. Action IV.2.1: San Joaquin River inflow to export ratio. Action IV.2.2: Old and Middle River Flow Management. Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities. Action IV.4.1: Tracy fish collection facility improvements. Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner	Continue implementation of Actions IV.1 through IV.6.

11.3.2 Central Valley Spring-Run Chinook Salmon and Its Designated Critical Habitat

As previously stated in the Status of the Species section, the spring-run ESU is currently likely to become endangered within the foreseeable future due to multiple factors affecting spatial structure, diversity, productivity and abundance. Specific factors include: (1) the ESU currently has only three independent populations. All three of these independent populations are in one diversity group, the Northern Sierra Nevada Diversity Group. The other diversity groups contain dependent populations; (2) habitat elimination and modification throughout the Central Valley have drastically altered the ESU's spatial structure and diversity; (3) the ESU has a risk associated with catastrophes, especially considering the remaining independent populations' proximity to Mt. Lassen and the probability of a large scale wild fire occurring in those watersheds (Lindley *et al*. 2007), (4) the presence of dams precludes access to historical spawning areas and (5) for some populations, the genetic diversity of spring-run has been compromised by hybridization with fall-run.

The effects of the proposed action and their affect on spring-run are contained in the sections of the Opinion on project effects and integration and synthesis. The effects are presented for the Clear Creek population, the mainstem Sacramento River population and for the other populations that are effected by project operations, by diversity group. Ultimately all spring-run must migrate through the Delta and are affected by Delta operations. The proposed action increases the extinction risk of spring-run and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime and reducing the viability of all extant spring-run populations, as is generally depicted in figure 9-4. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.3 and 9.4, NMFS summarized the various stressors that reduced the VSP parameters and conservation value of the PCEs.

The RPA specifies actions that, in total, will minimize the adverse effects of the proposed action on spring-run individuals, populations and the ESU and bring about the proper functioning of PCEs of its critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the ESU and its critical habitat, for example, lack of passage to historic spawning habitat above Keswick and Shasta Dams, passage impediments (*e.g*., RBDD), degraded water quantity and quality of the habitat, and entrainment influence of the Federal and state export facilities. Table 11-2 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address spring-run in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the ESU in the near-term and the long-term, or adversely modify spring-run critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

The RPA contains numerous actions that minimize project effects to critical habitat of spring-run in both the near-term and the long-term. The rationales for the actions include specific PCEs addressed. It is not technologically or physically feasible, or necessary, to remove all adverse effects of project operations on critical habitat. These actions reduce adverse effects to the point where they no longer adversely modify critical habitat.

Summary of RPA effects on Central Valley Spring-run Chinook Salmon in the Near-Term

RPA actions that reduce adverse effects of project operations to spring-run and its critical habitat in the near-term include:

1) Clear Creek actions will be implemented immediately and will significantly reduce project effects to spring-run by stabilizing that population and thereby increasing the likelihood of survival of that one population in the near-term. Ensuring adequate flows to meet temperature requirements in most years, implementing new pulse flows to assist with adult migratory cues, and implementing geomorphic flows that will disperse restored spawning gravel all will minimize project effects to this population. The Clear Creek population is important to the viability of the ESU as a whole because of its geographic location; ie, if it becomes an independent population it could considerably increase the viability of the ESU. The actions in the RPA are not recovery actions per se, but they will ensure that ongoing project operations do not appreciably reduce the likelihood of recovery of this one population.

2) Modifications to Shasta reservoir management will primarily reduce adverse effects on winter-run. Effects of the year-round Shasta management program on spring-run are more difficult to predict and quantify. The Shasta RPA will result in more carryover storage in some years, as compared to current operations, and therefore, increase ability to meet suitable spring-run spawning and egg incubation temperatures in the Fall in some years, depending on ambient weather conditions and the extent of the cold water pool in Shasta reservoir. The new year-round Shasta management program is expected to minimize frequency and duration of temperature related egg mortality in dry and critically dry years, thus reducing, though not eliminating, the population level stress of these temperature related mortalities. Temperature related effects on spring-run in the mainstem Sacramento River will persist into the future, and cannot be fully off-set through Shasta reservoir storage actions, due to physical and hydrological constraints on the CVP system, and the delivery of water to non-discretionary CVP contractors (e.g. Sacramento River Settlement Contractors). Given a fixed supply of cold water in any given year starting in May, as an overall strategy, the RPA prioritizes temperature management in favor of winter-run due to their endangered status and complete dependence on suitable habitat downstream of Keswick for their continued survival. Despite continued significant project related temperature effects on mainstem spring run, the RPA, in total, does not appreciably reduce the likelihood of survival and recovery of spring-run ESU when all populations and diversity groups are considered.

3) Near-term improvements to Battle Creek through actions identified in the RPA are expected to expand the holding, spawning and rearing habitat for spring-run in Battle Creek. It is difficult to predict the exact timing of Battle Creek projects, though funding has been secured and work is projected to start on the first phase in Summer 2009. NMFS finds that the Battle Creek program is reasonably likely to occur and contribute to the spring-run population in the long-run; however, these beneficial effects to the population may or may not occur in the near-term.

4) Interim operations of RBDD (until 2012, or with an extension until 2013) will allow for significant increased passage of adult spring-run, and a significant reduction in juvenile mortality associated with downstream passage. Extending the "gates out" operation from May 15th until June 15th will allow a very large additional portion of spring run to migrate unimpeded by the diversion dam. This improved passage will increase the likelihood that these individuals will reach cold water pools necessary for summer holding life history in the near-term and will reduce effects of delayed passage on energy consumption and fecundity, thus improving the viability of populations above RBDD. Near-term effects of interim gate operations on remaining spring-run that are delayed due to the June 15th closure of gates will be offset by passage improvement restoration projects implemented over the next few years.. Abundance, growth rate, and spatial structure are expected to increase with the implementation of the passage restoration projects on Mill, Deer, and Antelope creeks.

5) Continuing installation of fish screens through the Anadromous Fish Screen Program along the Sacramento River and Delta will reduce juveniles entrainment of spring run throughout their migration path down the Sacramento river and through the Delta.

6) All populations of spring-run within the ESU must migrate through the Delta. Within the Delta, additional closures of the DCC gates at key times of year triggered to spring-run presence, will ensure that a greater percentage of spring-run emigrate through the northern Delta out to sea. These fish will avoid adverse effects of predation, water quality and hydrology in the Interior and Southern Delta.

7) Old and Middle River reverse flow restrictions on combined exports will significantly reduce project-related adverse effects on spring-run juveniles in January through June 15th. The OMR restrictions, triggered by spring-run (or their surrogates) in the salvage, will reduce the percentage of spring-run juveniles that are drawn further into the Interior and Southern Delta, and exposed to risks due to export facilities.

8) Additional actions at both the State and Federal export facilities will reduce entrainment and improve efficiency of salvage operations. Collectively, these measures will ensure that the spring-run that are exposed to the export facilities have a greater likelihood of survival.

9) Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire spring-run life history run-

timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the ESU. This diversity of run-timing will ensure greater resiliency of the spring-run ESU to environmental changes. For example,, ocean conditions and the timing and duration of upwellings may play a significant role in the survival of any given cohort of spring-run. However, modifying operations to allow for the expansion of ocean entry timing for spring-run will increase the probability that at least a portion of each cohort will enter the ocean when prey are readily available, thereby increasing the cohort's survival.

Summary of RPA effects on Central Valley Spring-run Chinook Salmon in the Long Term

The analysis in the Opinion demonstrates that long-term actions are needed, especially considering continued effects of climate change and increasing water demands due to growth. In addition to a continuation of near-term actions described above, RPA actions that reduce adverse effects of project operations to spring-run and its critical habitat in the long-term include:

1) Additional actions that will minimize project-related effects to the Clear Creek population in the long-term include: replacing the Whiskytown temperature control curtain and adaptively managing to habitat suitability/IFIM study results.

2) In the long-term, improvements to Battle Creek through actions identified in the RPA are predicted to significantly improve spring-run habitat and off-set project-related effects on the mainstem population by creating a stable population in Battle Creek.

3) Starting in 2013, RBDD will be operated in the "gates out" formation all year. This operation will allow for unimpeded spring-run migration upstream and downstream of the diversion dam.

4) Salmonid rearing habitat actions in the lower Sacramento River and Northern Delta will minimize adverse effects of project operations on spring-run critical habitat in the long-term and off-set effects of ongoing flood control operations. These habitat actions will increase the growth rates of individuals that utilize this habitat. These fish are predicted to enter the estuary and ocean with a higher degree of fitness, and therefore, greater resiliency to withstand stochastic events in these later phases of their life history. Because all populations of spring-run migrate through this area, a portion of all populations will be likely to benefit from these rearing actions, thereby increasing the viability of the ESU and reducing the likelihood of appreciable reductions in the survival or recovery of the species.

5) In the long-run, in consideration of climate change, and in order to improve the likelihood of withstanding adverse effects associated with prolonged drought, the passage program will improve the diversity and spatial structure of the ESU by reintroducing spring-run to their historical habitat above Shasta reservoir. There is

uncertainty associated with the likelihood of this action succeeding. This consultation must take a long-term view, given the 21 year time horizon. Within the long-term view, it is likely that advances in technologies and experimental procedures will increase the likelihood of success of this action. In addition, the quality of much of the habitat above Shasta reservoir is in relatively pristine condition, improving the likelihood of success. The RPA includes a reinitiation trigger in the event that passage is deemed to be infeasible. There are also some near-term benefits associated with the pilot reintroduction program, including immediate expansion of the geographic range of the species.

In summary, with full implementation of the RPA, NMFS expects that the RPA will result in minimizing project related effects to the level where these effects do not appreciably reduce the likelihood of survival or recovery of spring-run, or adversely modify its critical habitat.

Table 11-2. Summary of actions to minimize or alleviate proposed action-related stressors on Central Valley spring-run Chinook salmon and its designated critical habitat. The table is organized by life stage then by the number of populations affected by a particular stressor. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) delaying adult immigration	~70 % of the spring-run that spawn upstream of RBDD are delayed by approximately 20 days on average, more energy consumed, greater pre-spawn mortality, less fecundity	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012
Adult immigration and holding	NWC: Clear	Water temperatures warmer than life history stage requirements during summer holding period	Water temp control to Igo; possibly some pre-spawn mortality in critically dry years when not enough cold water in Whiskeytown Lake	High	Action I.1.5: Clear Creek Thermal Stress Reduction.	Continue implementation of Action I.1.5.
Adult immigration and holding	NWC: Clear	Spring flows with little variability. Low summer flows (50 cfs), when b2 is unavailable	Limited cues for upstream migration resulting from spring flows with little variation. With low summer flows, Adults are impeded from accessing upstream holding areas.	High	Action I.1.1. Spring Attraction Flows	Continue implementation of Action I.1.1
Spawning	NWC: Clear	Loss of spawning gravel below Whiskeytown Dam – limited spawning habitat availability	Reduced spawning areas; spawning success diminishes	High	Action I.1.3: Clear Creek spawning gravel augmentation	Continue implementation of Action I.1.3
Spawning	NWC: Clear	Low summer flows (50 cfs), when b2 is unavailable	Adults spawn further downstream in less suitable conditions (*i.e.*, in areas with relatively warm water temps.)	High	Action I.1.6: Adaptively manage to Clear Creek habitat suitability/IFIM study results.	Continue implementation of Action I.1.6

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	NWC: Clear	Water temperatures warmer than life history stage requirements in September only for fish that spawn below TCP (Igo)	Mortality varies with exceedance rate and number of redds; loss of some portion of those eggs; reduced chance of survival for fry	High	Action I.1.5: Clear Creek Thermal Stress Reduction	Continue implementation of Action I.1.5:

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	BPL: Sacramento	Water temperatures warmer than life history stage requirements, during September and October	Under near-term operations (Study 7.1) mortality is expected to range from approximately 9% in wet years up to approximately 66 % in critically dry years, with an average of approximately 21 % over all water year types; under modeled climate change projections, average egg mortality over all water year types is expected to be 50 % and during the driest 15 % of years is expected to be 95 %. Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of spring-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	Action Suite I.2: Shasta operations. Action I.1.4: Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action suite I.2. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 5 % of the spring-run ESU spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD Interim Operations Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: No later than May 2012, Reclamation shall operate RBDD with gates out all year Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	All diversity groups and populations	Lack of channel forming flows in the Sacramento River and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process.	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Project-related mortality is significant. Of the spring-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66 % (range of 35-90 % mortality) (Brandes and McClain 2001; Newman 2008; Perry and Skalski 2008).	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations. Action IV.1.2: DCC gate operation. Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels. Action IV.2.1: San Joaquin River inflow to export ratio. Action IV.2.2: Old and Middle River Flow Management. Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities. Action IV.4.1: Tracy fish collection facility improvements. Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner	Continue implementation of Actions IV.1 through IV. 6.

11.3.3 Central Valley Steelhead and Its Designated Critical Habitat

The proposed action increases the extinction risk of CV steelhead and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime and reducing the viability of all of the extant CV steelhead populations in the CVP-controlled rivers (Clear Creek, Sacramento River, American River, and Stanislaus River) and the Delta. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.5 and 9.6, NMFS summarized the various stressors that reduced the VSP parameters and conservation value of the PCEs. In general, warm water temperatures and low flows, loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, loss of tidal wetland habitat, a collapsed pelagic community in the Delta, and poor water quality associated with agricultural, urban, and industrial land use have caused fitness reductions and degraded the PCEs of critical habitat in the past. The proposed action is expected to continue to degrade the VSP parameters and conservation value of the PCEs, and the effects of climate change and increased water demand in the future are expected to exacerbate conditions that reduce the long-term viability of CV steelhead.

The RPA specifies actions that, in total, will minimize the adverse effects of the proposed action on steelhead individuals, populations and the DPS and bring about the proper functioning of PCEs of its critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the DPS and its critical habitat, for example, lack of passage to historic spawning habitat above Keswick and Shasta Dams, and Nimbus and Folsom Dams, and New Melones, Dam, passage impediments (*e.g.*, RBDD), degraded water quantity and quality of the habitat, hatchery fish compromising the genetic integrity of natural CV steelhead and entrainment influence of the Federal and state export facilities. Table 11-3 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address CV steelhead in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the DPS in the near-term and the long-term, or adversely modify CV steelhead critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

As show in table 11-3, the RPA acknowledges the need for both short-term and long-term actions, including:

- providing safe passage to and from historical habitat;
- improving the quantity and quality of habitat in all of the CVP-controlled streams through water releases;
- providing interim and long-term modifications to RBDD;
- providing increased rearing habitat;
- modifying the operation of the DCC; and

- implementing a revised decision process for Delta operations, including reduced exports.

The anticipated improvements to CV steelhead and its critical habitat are expected to begin immediately through implementation of various actions, and continue to increase over the term of this Opinion (through year 2030) with the implementation of the longer-term actions. While implementation of the RPA will occur during the term of this Opinion, its full effects on population metrics (*e.g*., spatial structure, diversity, abundance, productivity) and the PCEs of critical habitat will occur over a considerable period of time after implementation. Therefore, NMFS expects the project operations, as modified by the RPA, to minimize effects to critical habitat so that it is not adversely modified.

In the near term, the provision of more cold water throughout the species' upstream migration, rearing, holding, and incubation period are expected to increase in-river production. RPA actions that address flow maintenance and stabilization will minimize redd dewatering and scouring, and stranding. Juveniles will be afforded more rearing habitat during their freshwater residency by reducing the inundation duration of Lake Red Bluff, and expanding access to rearing habitat within the Yolo Bypass and other areas within the Sacramento River Basin, in both the near-term and long-term. Modified operations of RBDD will provide unimpeded passage for more of the upstream spawning migration season of the upper Sacramento River and its tributaries populations. More smolts are expected to outmigrate into the Pacific Ocean as operations of the CVP and SWP are modified to reduce entrainment and mortality. Specifically, requirements in Actions Suite IV.2 will significantly increase the survival of CV steelhead smolts outmigrating from the San Joaquin River basin.

Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire steelhead life history run-timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the DPS. This diversity of run-timing will ensure greater resiliency of the CV steelhead DPS to environmental changes, for example, changed productivity in the ocean.

In the long-term, in addition to the continuation of the near-term actions, CV steelhead will be afforded the opportunity to spawn and rear in historical habitat upstream of Nimbus and Folsom Dams. Access to this historical habitat will provide steelhead with cold water temperatures necessary for increased spawning, incubation, and rearing success, especially in consideration of the environmental effects of climate change. Such a program has many unknowns, and therefore cannot be expected to immediately abate all up-river stressors in the near-term, although some near term benefits will occur, such as immediate improvements in the geographic distribution of the population to historic habitats, which would reduce jeopardizing risks to the ESU faced by individuals that remain below project dams. In the long-term however, the RPA includes a structured passage program with pilot reintroductions. Additionally, alternatives to the proposed fish passage actions may also be proposed by Reclamation and the Fish Passage Steering Committee, in the event that the proposed actions are determined to not be technically or biologically feasible, and provided they are capable of meeting similar performance standards in terms of population distribution with Diversity Groups, and viability according the parameters described in Lindley *et al.* (2007).

The long-term operation of RBDD will provide unimpeded passage opportunities for adults and juveniles, and reduce competition and predation from other salmonid species.

The genetic diversity of the CV steelhead DPS is compromised through hatchery operations, including those at Nimbus. Through preparation and implementation of a HGMP, in the long-term, genetic diversity of CV steelhead will increase, thereby increasing the viability of the DPS.

An important aspect of the RPA analysis for steelhead concerns the status of the Southern Sierra Diversity Group, which is critical to preserving spatial structure of the DPS. This diversity group, consisting of extant populations in the Calaveras, Stanislaus, Tuolumne, Merced and Mainstem San Joaquin rivers, is very unstable due to the poor status of each population. This status is due to both project-related and non-project related (baseline) stressors. In the near-term, a new flow schedule for the Stanislaus River and interim actions to increase flows at Vernalis and curtail exports will allow greater out-migration cues and survival of smolts past the state and federal export facilities. In the long-term, additional actions through additional flow to export ratios in the southern Delta, and channel forming flows and gravel augmentations in the Stanislaus river will further reduce project-related adverse-effects to this diversity group. Due to uncertainty in the flow to export ratio, the RPA six year acoustic tag experiment, which can be combined with experimental barrier technologies, will significantly enhance our knowledge base for future consultations and refinements of this RPA action. Ultimately, our analysis is clear that the long-term viability of this diversity group will depend not only on implementation of this RPA, but also on actions outside this consultation, most significantly increasing flows in the Tuolumne and Merced rivers. The State Water Resources Control Board has made establishing additional flows in these rivers a priority and intends to take action within the near-term. A future CVP/SWP operations consultation that will be triggered by implementation of San Joaquin Restoration Program flows will also provide further opportunities to update and refine actions critical to this diversity group.

In summary, with full implementation of the RPA, NMFS expects the adverse effects of project operations will be minimized to the point where the likelihood of survival and recovery of the DPS is not appreciably reduced and its designated critical habitat is not adversely modified.

Table 11-3. Summary of actions to minimize or alleviate proposed action-related stressors to Central Valley steelhead and its designated critical habitat. The table is organized by life stage then by the number of populations affected by a particular stressor. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada; SSN – Southern Sierra Nevada.

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	NWC: Cottonwood / Beegum, Clear; BPL: Sacramento, Battle	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) delaying adult immigration	17 % of those that spawn above RBDD, delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity	High	Action I.3.2: RBDD interim Operations	Action I.3.1: RBDD operations after May 14, 2012
Adult immigration and holding	NWC: Clear	Water temperatures warmer than life history stage requirement for migration possible in lower reach near confluence with Sacramento River during August and September	Some adults may not enter mouth of Clear Creek, 1) delayed run timing, 2) seek other tributaries, 3) spawn in mainstem Sacramento R.; reduced in vivo egg viability	Low- except for critically dry years	Action I.1.5: Clear Creek thermal stress reduction	Continue implementation of Action I.1.5:
Adult immigration	SSN: Stanislaus River	Exposure to stressful water temperatures from the Delta to Riverbank during adult immigration	Delayed entry into river (CDFG 2007a); pre-spawn mortality; reduced condition factor	Medium	Action III.1.1: Establish Stanislaus Operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	NWC: Clear	Loss of spawning gravel below Whiskeytown Dam – limited spawning habitat availability	Limited areas of suitable spawning sites. Spawning in sub-optimal habitat	Medium - but could be high without continued gravel augmentation	Action I.1.3: Clear Creek spawning gravel augmentation	Continue implementation of Action I.1.3
Spawning	NSN: American River	Folsom/Nimbus releases – flow fluctuations in the American River resulting in redd dewatering	Redd dewatering and isolation prohibiting successful completion of spawning	Medium	Action II.1: Lower American River flow management, particularly management following the ARG process	Continue implementation of Action II..1
Spawning	NSN: American River; BPL: Sacramento; and potentially all other populations within the NWC, NSN, and BPL diversity groups	Nimbus Hatchery *O. mykiss* spawning with natural-origin steelhead in the American River and in other CV streams	Reduced genetic fitness of CV steelhead through the spread of Eel River genes and potentially hatchery rainbow trout genes to many below-barrier sites (Garza and Pearse 2008).	High	Action II.6.1: Preparation of hatchery genetic management plan for steelhead Action II.6.2: Interim actions prior to submittal of draft HGMP for steelhead	Continue implementation of Actions II.6.1 and II.6.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	SSN: Stanislaus River	Unsuitable flows in the Stanislaus River restrict spawnable habitat and dewater redds	Limited spawning habitat availability according to Aceituno (1993). Instream flows typically drop in January from higher December levels when San Joaquin River water quality objectives are met. This increases the risk for redd dewatering and direct egg mortality.	High	Action III.1.1: Establish Stanislaus operations group Action III.1.3: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.3
Spawning	SSN: Stanislaus River	Excessive fines in spawning gravel resulting from lack of overbank flow	Reduced suitable spawning habitat; For individual: increased energy cost to attempt to "clean" excess fine material from spawning site Fine material deposited in gravel beds because of lack of overbank flow to inundate floodplain and deposit fine material on floodplain, instead of in river (Kondolf *et al*. 2001).	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2
Embryo incubation	NSN: American River	Exposure to stressful water temperatures in the American River during embryo incubation	Sub-lethal effects - reduced early life stage viability; direct mortality; restriction of life history diversity (*i.e*., directional selection against eggs deposited in Mar. and Apr.)	Medium	Action II.3: Make structural improvements to improve cold water management Action V: Fish passage program (Near-term actions)	Continue implementation of Action II.3 Action V: Fish passage program (Long-term actions)
Egg incubation and emergence	SSN: Stanislaus River	Excessive fines in spawning gravel resulting from lack of overbank flow	Egg mortality from lack of interstitial flow; egg mortality from smothering by nest-building activities of other steelhead or fall-run; suppressed growth rates	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Egg incubation and emergence	SSN: Stanislaus River	Exposure to stressful water temperatures in the Stanislaus River during egg incubation and emergence	Egg mortality, especially for eggs spawned in or after March; Embryonic deformities (Deas *et al*. 2008) Temperatures may be operationally managed, depending on year type	Medium	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2 Action V: Fish passage program (Long-term actions)
Juvenile rearing	BPL: Sacramento River	Provision of higher flows and cooler water temps during the summer than occurred prior to the construction of Shasta Dam	Potential fitness advantage for resident *O.mykiss* over the anadromous form, which would drive an evolutionary (*i.e*., genetic) change if life history strategy is heritable (Lindley *et al*. 2007).	High	Action V: Fish passage program (Near-term actions)	Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood / Beegum, Clear; BPL: Sacramento, Battle	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Reduction in rearing habitat quality and quantity; delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD interim operations Action I.6.1: Restoration of floodplain rearing habitat Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass Action I.6.3: Lower Putah Creek enhancements Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: RBDD operations after May 14, 2012 Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	All diversity groups and populations, excluding the SSN diversity group	Lack of channel forming flows in the Sacramento River and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process.	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	Action I.6.1: Restoration of floodplain rearing habitat Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass Action I.6.3: Lower Putah Creek enhancements Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4
Juvenile rearing	NWC: Clear Creek	Exposure to stressful water temperatures in Clear Creek during juvenile rearing	Limited over-summering habitat, reduced growth, increased susceptibility to disease and predation	High	Action I.1.5: Clear Creek thermal stress reduction	Continue implementation of Action I.1.5
Juvenile rearing	NWC: Clear Creek	Limited rearing habitat availability in Clear Creek resulting from low summer flows (< 80 cfs)	Limited rearing habitat availability; less food, reduced growth, increased predation risk	High	Action I.1.6: Adaptively manage to habitat suitability/IFIM study results	Continue implementation of Action I.1.6

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NSN: American River	Folsom/Nimbus releases resulting in flow fluctuations; low flows	Fry stranding and juvenile isolation - observations of juvenile steelhead isolation in the American River were made in both 2003 and 2004 (Water Forum 2005a). Low flows limiting the availability of quality rearing habitat including predator refuge habitat	High	Action II.4: Minimize lower American River flow fluctuation effects	Continue implementation of Action II.4
Juvenile rearing	NSN: American River	Exposure to stressful water temperatures in the American River during juvenile rearing	Physiological effects - increased susceptibility to disease (e.g., anal vent inflammation) and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures at Watt Avenue from August through September were warmer than 65°F for approximately 81 percent of the days, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 30a). Under a drier and warmer climate change scenario (Study 9.5), modeled water temperatures at Watt Avenue from June through September under full build out of the proposed Project range from 65°F to 82°F (Reclamation 2009). Even if no regional climate change is assumed (Study 9.1), water temperatures at this location during this time period are expected to range from 63°F to 79°F.	High	Action II.2: Lower American River temperature management Action II.3: Make structural improvements to improve management Action V: Fish passage program (Near-term actions)	Continue implementation of Actions II.2 and II.3 Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	SSN: Stanislaus River	Lack of overbank flow in the Stanislaus River to inundate rearing habitat	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action V: Fish passage program (Near-term actions)	Continue implementation of Action III.2.2 Action V: Fish passage program (Long-term actions)
Juvenile rearing	SSN: Stanislaus River	Reduction in rearing habitat complexity in the Stanislaus River due to reduction in channel forming flows	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2
Juvenile rearing	SSN: Stanislaus River	Unsuitable flows in the Stanislaus River for maintaining juvenile rearing habitat	Crowding and density dependent effects relating to reduced habitat availability. Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action III.1.3: Stanislaus River flow management	Continue implementation of Actions III.2.2 and III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	SSN: Stanislaus River	Predation in the Stanislaus River by non-native fish predators because rearing habitat is lacking	Juvenile mortality; Reduced juvenile production	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action III.1.3: Stanislaus River flow management Action III.2.3: Implement predation reduction projects	Continue implementation of Actions III.2.2, III.1.3, and III.2.3
Juvenile rearing	SSN: Stanislaus River	Exposure to stressful water temperatures in the Stanislaus River at the end of summer affecting rearing habitat	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2
Smolt emigration	SSN: Stanislaus River	Water temperatures warmer than life history stage (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.3: Stanislaus River flow management)	Continue implementation of Actions III.1.1 and III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	NSN: American River	Exposure to stressful water temperatures in the American River during smolt emigration	Physiological effects – reduced ability to successfully complete the smoltification process, increased susceptibility to predation	Medium	Action II.3: Make structural improvements to improve cold water management Action V: Fish passage program (Near-term actions)	Continue implementation of Action II.3 Action V: Fish passage program (Long-term actions)
Smolt emigration	SSN: Stanislaus River	Water temperatures warmer than life history stage (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Action III.1.1 and III.1.2
Smolt emigration	SSN: Stanislaus River	Suboptimal flow in the Stanislaus River (March – June)	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection through Delta leading to increased residence time and higher risk of predation	High	Action III.1.3: Stanislaus River flow management	Continue implementation of Action III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality to steelhead from all diversity groups. Based on VAMP studies of fall-run, mortality ranges from 90 – 99 % from San Joaquin River release points to Chipps Island (SJRGA 2006). Similar results are assumed for steelhead, as shown through the CCF studies showing similar loss rates between steelhead and Chinook salmon (DWR 2008).	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations Action IV.1.2: DCC gate operation Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels Action IV.2.1: San Joaquin River inflow to export ratio Action IV.2.2: Old and Middle River Flow Management Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities Action IV.4.1: Tracy fish collection facility improvements Action IV.4.2: Skinner fish collection facility	Continue implementation of Actions IV.1 through IV.6

11.3.4 Southern DPS of Green Sturgeon and Its Proposed Critical Habitat

The Southern DPS of green sturgeon is at substantial risk to future population declines (Adams *et al*. 2007). The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, habitat elimination and modification in the mainstem Sacramento River and Delta, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, and loss of juvenile green sturgeon due to entrainment Federal and State export facilities in the South Delta. In addition, many of the physical and biological features of critical habitat that are essential for the conservation of the Southern DPS of green sturgeon are currently impaired, and provide limited conservation value. The proposed action increases the population's extinction risk and continues to degrade the PCEs of their proposed critical habitat by adding numerous stressors to the species' baseline stress regime. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the proposed critical habitat. In sections 9.7 and 9.8, NMFS summarized various stressors that reduced the VSP parameters and conservation value of the PCEs.

The RPA specifies many significant actions that will reduce the adverse effects of the proposed action on Southern DPS of green sturgeon and bring about the proper functioning of PCEs of its proposed critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the DPS and its proposed critical habitat, for example, passage impediments, degraded water quantity and quality of the remaining habitat downstream of Keswick and Shasta Dams, and entrainment influence of the Federal and state export facilities. Table 11-4 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address the Southern DPS of green sturgeon in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the DPS in the near-term and the long-term, or adversely modify proposed critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

As show in table 11-4, the RPA acknowledges the need for both short-term and long-term actions, including:

- increasing Shasta reservoir storage to provide for temperature control and improve the quantity and quality of downstream habitat;
- providing interim and long-term modifications to RBDD to providing safe passage to and from spawning habitat;
- implementing studies on Southern DPS of green sturgeon population size, and life history and habitat needs in the short-term to improve management of the species and their habitat in the long-term;
- providing increased rearing habitat;
- modifying the operation of the DCC; and

- implementing a revised decision process for Delta operations, including reduced exports.

Minimization of adverse effects of project operations on the Southern DPS of green sturgeon and its proposed critical habitat are expected to begin immediately through implementation of various actions, and continue to increase over the term of this Opinion (through year 2030) with the implementation of the longer-term actions. While implementation of the RPA will occur during the term of this Opinion, its full effects on population metrics (*e.g*., spatial structure, diversity, abundance, productivity) and the PCEs of critical habitat will occur over a considerable period of time after implementation. In the near term, precluding an emergency gate closure, delaying the gate closure until June 15th, and increasing the height of gate openings at RBDD will immediately minimize a significant portion of the adverse effects of RBDD on green sturgeon. An increase in survival of spawning adults, and the availability of more cold water that will provide more spawning habitat in more favorable spawning and embryo incubation temperature ranges, will likely result in an increased growth rate and diversity of the population in the long run. Also in the near-term, actions within the Delta will reduce the influence of the Federal and State export facilities, increase survival of juveniles by keeping them within the mainstem Sacramento River, and reduce entrainment and mortality.

In the long term, in addition to the continuation of the near-term actions, adverse effects of project operations will be further minimized with unimpeded passage opportunities for adults and juveniles at RBDD, and reduced competition and predation. Results from the near-term studies will aid in the management and recovery of the species and their proposed critical habitat on the long-term.

In summary, with full implementation of the RPA, NMFS expects that on-going project effects on Southern DPS of green sturgeon and its proposed critical habitat will be minimized to the extent the survival and recovery are not appreciably reduced, and critical habitat is not adversely modified.

Table 11-4. Summary of actions to minimize or alleviate proposed action-related stressors to the Southern DPS of green sturgeon and its proposed critical habitat.

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	RBDD gate closures from May 15 - Sept 15 every year and emergency 10-day gate closures delaying adult immigration.	Passage blocked, 55 miles of spawning habitat made inaccessible upstream of RBDD after May 15. Large aggregations (25-30) of mature adults observed below RBDD gates. Estimate 30 % of run blocked based on run timing. Also, mortalities associated with downstream passage under gates post-spawn, or after fish move above gates. Mortality greater on larger, more fecund females that can not fit through 18" opening Greater proportion of run blocked or delayed (40 -50%) based on run timing; Greater mortalities associated with downstream passage under gates post spawn, or after moving above gates, sub lethal effects on eggs in fish and energy loss. Occurred twice in the past 10 years, but the frequency of occurrence may increase with climate change	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4
Spawning	RBDD	Unnatural spawning site created below RBDD, portion of run (only one in CV) spawning in water 2 feet deep, channel aggradation below hydraulics from gates, eggs suffocate, physiological effects, delayed hatch, greater predation on eggs due to accumulation of predators below RBDD.	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	Water temperatures warmer than life history stage requirements below Hamilton City.	For eggs and fry that are spawned in areas from RBDD to Hamilton City water quality is less suitable than above RBDD where temperatures are controlled for winter-run. Eggs suffocate from less flow, physiological effects, delayed hatch, greater predation on eggs due to presence of non-native introduced warm-water species.	Medium	Action I.2.1: Maintain suitable water temperatures for Southern DPS of green sturgeon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation.	Continued implementation of Action I.2.1. Continued implementation of Action I.2.2. Continued implementation of Action I.2.3.

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	Increased juvenile mortality related to emigration when RBDD Dam gates are in (*i.e.*, May15 - Sept 15, plus 10 days in April during emergencies)	Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 100 % of the green sturgeon DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008). Approximately 70 % of the entire green sturgeon DPS spawns above RBDD. Mortality of juvenile salmon emigrating past RBDD when the gates are in ranges from 5 -50 % (Vogel *et al.* 1988; Tucker 1998); mortality of juvenile green sturgeon emigrating past RBDD has not been estimated, but is expected to increase when the gates are in.	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4
	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are in.	Reduction in rearing habitat quality and quantity; increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967.	High		
Juvenile rearing	Unscreened CVP diversions	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile and subadult	Loss at export facilitiest Impaired movements through South Delta waterways due to temporary barriers or permanent gates	Entrainment of fish at the CVP and SWP in every month of the year. Louvers function well for larger fish but are inefficient for smaller fish. Fish behavior may make them susceptible to the cleaning practices of louvers. In louver studies, fish position themselves in front of the bottom edge of the louver along the channel bottom, where they held position for prolonged periods of time. Presence of green sturgeon juveniles and subadults in the South Delta as confirmed by salvage records. Presence occurs during operational season of barriers (April through November). Closure of waterways by temporary barriers or permanent gates inhibits movement of green sturgeon through these waterways. Fish located upstream of barriers are potentially trapped or delayed in their movements downstream by structures.	Unknown Unknown	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations Action IV.1.2: DCC gate operation Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels Action IV.2.2: Old and Middle River flow management Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities Action IV.4.1: Tracy fish collection facility improvements Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner fish collection facilities Action IV. 6: Formation of Delta operations for salmon and sturgeon technical working group Action IV.6: South Delta improvement program – phase I	Continue implementation of Actions IV.1 through IV.6

11.3.5 Southern Resident Killer Whales

NMFS evaluated effects of the proposed action on Southern Residents by evaluating effects on the availability of their preferred prey, Chinook salmon. NMFS considered effects on both listed and non-listed Chinook salmon. With respect to the listed winter-run and spring-run ESUs, the proposed action is likely to appreciably reduce the survival and recovery of the listed entities and conservation value of their designated critical habitat, which would increase their risk of extinction in the long term. If these stocks were to become extinct, there would be an increased likelihood of localized killer whale prey depletions on the Pacific coast.

As described in sections 11.3.1 and 11.3.2, full implementation of the RPA is expected to reduce adverse effects of project operations on ESA-listed winter-run and spring-run and their designated critical habitats to the point where there is not an appreciable reduction in the likelihood of survival or recovery or an adverse modification of critical habitat. NMFS anticipates that implementation of RPA actions will decrease the risk of extinction of winter-run and spring-run in the long-term, reducing the risk of localized prey depletions and thereby increasing the prey available to Southern Residents.

NMFS also considered effects of the proposed action on non-listed Chinook salmon that are available to Southern Residents (section 6.8.1.2.2). As discussed in section 6.8.1.2, we quantified effects of hatchery production and project operations on non-listed Chinook salmon available to Southern Residents. Hatchery programs included in the proposed action produce more Chinook salmon than are killed in project operations. However, artificial propagation can have harmful effects on the long-term fitness of salmon populations, and the current hatchery practices at Nimbus and Trinity River fish hatcheries are diminishing the long-term viability of these non-listed stocks over the long term. The proposed action did not identify time lines for reforming harmful hatchery practices that affect these stocks.

RPA Action Suite II.6 calls for development of hatchery management plans for fall-run at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery, by June 2014. New hatchery management will be subject to future section 7 consultations and/or the 4(d) HGMP process. NMFS anticipates that implementing these RPA actions will provide long-range planning to reduce impacts of hatchery operations on natural fall-run and spring-run, increase the genetic diversity and diversity of run-timing for these stocks, and increase the likelihood that these stocks are retained as prey available to Southern Resident killer whales in the long term. Improving the genetic diversity and diversity of run timing of CV fall-run will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions.

Many RPA actions intended to avoid jeopardy to listed winter-run and spring-run, or adverse modification of their critical habitat, are also expected to reduce adverse effects of the action on the short- and long-term abundance and the long-term viability of non-listed fall-run and late-fall run. The immediate cause of the recent fall-run decline is most likely a result of ocean conditions (Lindley *et al*. 2009). However, freshwater impacts and hatchery programs most likely contributed to the collapse (Lindley *et al.* 2009). The RPA actions address many of the freshwater impacts identified in Lindley *et al.* (2009). NMFS expects that these actions would

reduce adverse impacts of the project in all years, under all hydrologic conditions. The actions include:

1) After 2012, there will be unrestricted up-stream and down-stream passage at RBDD. The interim measure of gates out on September 1 allows an additional 14 days unimpeded passage for adult fall-run.

2) A continued investment in fish screens along the Sacramento River and in the Delta would reduce entrainment of juvenile fall-run/late fall-run in unscreened diversions.

3) Improved rearing habitat in both the short-term and long-term in the Delta and lower Sacramento River (Liberty Island/Cache Slough) will improve juvenile fall-run survival.

4) Increased closures of DCC gates from October through January will reduce the percentage of juvenile outmigrants that enter the Interior Delta and are then subject to both direct and indirect mortality.

5) Additional Old and Middle River flow restrictions from January through June will reduce exposure of fall-run and late fall-run juveniles to export facilities and increase survival for fall-run leaving the San Joaquin River.

6) Improvements in salvage procedures at the Delta fish facilities will lead to higher survival of juveniles that enter the facilities and are subjected to the salvage process.

7) In the long term, implementation of fall-run hatchery management plans at Nimbus and Trinity River Hatcheries will increase genetic diversity of fall-run.

8) Increased gravel augmentation on Clear Creek and the Stanislaus River will increase spawning and rearing habitat for listed and non-listed salmonids.

9) Improved flows on Clear Creek, Stanislaus River, and the American River will enhance fall-run spawning and maintain spatial diversity between races.

10) Improved water temperature control on the Sacramento River, Clear Creek, American River, and Stanislaus River will provide more suitable habitat for Chinook salmon.

11) Greater storage levels in the fall for temperature control will improve temperatures for fall-run, as well as winter-run and spring-run.

12) Replacement of the Spring Creek temperature control curtain will provide cooler water temperatures to the Sacramento River in the fall.

13) Implementation of spring-run passage improvement projects (*i.e.*, mitigation for RBDD impacts) in the Sacramento River basin will improve fall-run passage and access to greater spawning and rearing habitat.

14) Improvements in San Joaquin River flows at Vernalis will not only improve survival of juvenile steelhead but fall-run as well

15) Export reductions based on fish densities at the fish salvage facilities will improve survival of non-listed salmonids, since they are similar in size at length.

16) Fish passage above project dams, although not intended for non-listed fish species, will benefit EFH by providing spatial and temporal separation between runs, thereby improving the genetic structure and space available for fall-run spawning (reduced competition, and introgression).

17) Restoration of Battle Creek is expected to improve EFH for fall-run as well as listed species.

18) Improvements in fish passage at flood control weirs will reduce stranding of both adult and juvenile non-listed salmonids and sturgeon.

19) Greater monitoring and reporting requirements for listed species will improve management of non-listed species as well.

20) A 6-year acoustical tag study of juvenile salmonids in the San Joaquin River and Delta will improve understanding of fall-run biological requirements.

The following actions in the RPA are expected to decrease the abundance of fall-run and late fall- run to some extent and may reduce viability in the long term:

1) Temperature control management for winter-run during the summer in the upper Sacramento River can reduce or eliminate the cold water available for fall-run spawning and egg incubation in September and October, most likely in dry or critically dry years. The RPA includes a new year-round program for temperature management at Shasta Reservoir, including requirements for carryover storage, and water temperatures until October 31. The new temperature regime will lead to more frequent End of September storage levels that will support cold water releases for spring-run and fall-run in September and October, thereby reducing the adverse effects of temperatures on fall-run and late fall-run as compared to the proposed action.

2) Temperature control management for steelhead on the American River during the summer can reduce the cold water pool available in October and November.

3) Segregation weirs on Clear Creek to reduce introgression with spring-run reduce habitat available for fall-run spawning.

4) Removal of the middle fish ladder at RBDD for green sturgeon to facilitate additional 18 inch gate opening delays passage of fall-run.

5) Wilkins Slough minimum flows in September and October to preserve cold water storage in Shasta Reservoir can delay upstream migration.

Effects numbered 3 through 5 are expected to occur in all years, during all hydrologic conditions; however, the effects, which include delayed arrival at spawning grounds or less available spawning habitat, are not anticipated to be severe enough to cause mortality of adult spawners. Additionally, RBDD will be removed in approximately three years, after which effects numbered 4 will not occur, and the dam removal will reduce adverse effects on fall-run thereafter.

Temperature control effects numbered 1 and 2 are expected to occur only during critically dry years, which represent less than 10 percent of historic years modeled and up to 25 percent of future years, based on a potential climate change scenario of dry, warming conditions (Study 8.0, 2030 Level of Development). These effects are expected to result in prespawn and early life-stage mortalities for fall-run in the mainstem Sacramento River and American River. In up to 25 percent of future years, temperature control effects numbered 1 and 2 could result in a reduction in future production of fall-run. In critically dry years, up to 8 percent of the Sacramento River population and up to 14 percent of the American River population could experience pre-spawn or egg mortality (Oppenheim 2009). A loss of 8 to13 percent future production from natural spawners in the mainstem Sacramento River and American River, respectively, would be a small reduction in the overall number of adult fish available to the whales from this stock, which is dominated by hatchery produced fish. The RPA is designed to conserve storage and will, therefore, improve the likelihood that sufficient cold water will remain in the fall, and the upper estimate of impacts will not be realized. Some impacts from temperature are likely to occur with or without the RPA, because they are linked to hydrologic factors, such as drought and climate variation.

The RPA will generally reduce adverse effects of project operation on naturally- spawning fall-run and late-fall run by improving adult passage and increasing juvenile survival. Implementation of fall-run hatchery management plans at Nimbus and Trinity River fish hatcheries will increase genetic diversity of fall-run. Increased diversity will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions, and thereby provide a consistent food source in years with overall poor productivity. In some years temperature control actions may result in reductions in future production of fall-run in the Sacramento and American rivers; however, the aggregate of the RPA actions will reduce overall adverse effects of project operations to a level that is not likely to imperil this prey source .

In sum, the RPA is not likely to result in an increased extinction risk of winter-run and spring-run, and it is not likely to imperil the long-term viability of fall-run. Consequently, project operations under the RPA are not likely to result in local depletions of killer whale prey that could appreciably reduce the whales' likelihood of survival and recovery. Therefore, NMFS concludes that the RPA will not jeopardize the continued existence of Southern Resident killer whales.

11.3.6 Economic and Technological Feasibility of the RPA

When developing an RPA, NMFS is required by regulation to devise an RPA that is "economically and technologically feasible" in addition to avoiding jeopardy and adverse

modification. These feasibility concerns were discussed and addressed in many ways throughout the period of November 2008 through May 2009, during the course of the consultation. During this period, NMFS developed an initial RPA by December 11, 2009, revised that RPA in response to feedback from the two science panels and DWR, Reclamation, CDFG, and USFWS. NMFS developed a second draft RPA by March 3, 2009, and revised that draft in response to additional feedback from the agencies prior to providing the final action. Some of the more complex RPA actions, including Shasta Storage, Habitat Rearing Actions, Passage Program, Stanislaus Flows and the San Joaquin River Inflow Export Ratio, went through many iterations of review, re-drafting, and refinement, involving interagency staff and management expertise, including biology, ecology, hydrology, and operations, in order to ensure that the actions were based on best available science, would be effective in avoiding jeopardy, and would be feasible to implement. NMFS also secured outside contractual services to provide additional modeling expertise in evaluating draft RPA actions.

Examples of Feasibility Concerns in RPA Actions

As a result of this iterative consultation process, NMFS considered economic and technological feasibility in several ways when developing the CVP/SWP operations RPA. Examples include:

1) Providing reasonable time to develop technologically feasible alternatives where none are "ready to go" – *e.g.*, the Delta engineering action (Action IV.1.3), and lower Sacramento River rearing habitat action (Action I.6.1);

2) Calling for a stepped approach to fish passage at dams, including studies and pilot projects, prior to a significant commitment of resources to build a ladder or invest in a permanent trap and haul program. A reinitiation trigger is built into this action in the event passage is not deemed feasible, prior to construction of permanent infrastructure;

3) Considering limitations of the overall capacity of CVP/SWP systems of reservoirs in determining feasibility of flow actions below reservoirs, and considering the hydrologic record and CALSIM modeling results (Shasta/Sacramento River, Folsom/American River, New Melones/Stanislaus River).

4) Tiering actions to water year type and/or storage in order to conserve storage at reservoirs and not unduly impact water supplies during drought (*e.g.*, see appendix 5);

5) Providing health and safety exceptions for export curtailments;

6) Using monitoring for species presence to initiate actions when biologically supported and most needed, in order to limit the duration of export curtailments;

7) Incorporating scientific uncertainty into the design of the action, when appropriate, in order to refine the action over time (*e.g.*, 6-year acoustic tag study for San Joaquin steelhead).

8) Incorporating performance goals into more complex actions (for example, Shasta storage, rearing habitat and San Joaquin acoustic tag study). A performance goal approach will allow for adaptation of the action over time to incorporate the most up-to-date thinking on cost-effective technologies or operations.

9) Allowing for interim, further constrained, water deliveries to TCCA through modified RBDD operations for 3 years, while an alternative pumping plant is being built.

The RPA includes collaborative research to enhance scientific understanding of the species and ecosystem, and to adapt actions to new scientific knowledge. This adaptive structure is important, given the long-term nature of the consultation and the scientific uncertainty inherent in a highly variable system. Monitoring and adaptive management are both built into many of the individual actions and are the subject of an annual program review. This annual program review will provide for additional opportunities to address any unforeseen concerns about RPA feasibility that may arise.

The rationale statements for individual actions explain more specific reasoning, and the administrative record contains specific hydrology and modeling results in support of the more complex actions (*e.g.*, Shasta and San Joaquin storage/flows).

Water Supply Costs and Projected Impacts

NMFS examined water supply costs of the RPA as one aspect of considering economic feasibility. While only costs to the action agency are considered in determining whether a RPA meets the regulatory requirement of economic feasibility, NMFS is mindful of potential social and economic costs to the people and communities that historically have depended on the Delta for their water supply. Any water supply impact is undesirable. NMFS made many attempts through the iterative consultation process to avoid developing RPA actions that would result in high water costs, while still providing for the survival and recovery of listed species.

NMFS estimates the water costs associated with the RPA to be 5-7% of average annual combined exports: 5% for CVP, or 130 TAF/year, and 7% for SWP, or 200 TAF/year[39]. The combined estimated annual average export curtailment is 330 TAF/year. These estimates are over and above export curtailments associated with the USFWS' Smelt Opinion. The OMR restrictions in both Opinions tend to result in export curtailments of similar quantities at similar times of year. Therefore, in general, these 330 TAF export curtailments are associated with the NMFS San Joaquin River Ratio actions in the RPA.

NMFS also considered that there may be additional localized water costs not associated with South Delta exports. These may include, in some years, localized water shortages necessitating groundwater use, water conservation measures, or other infrastructure improvements in the New Melones service area, and localized impacts in the North of Delta in some years, associated with

[39] The proportional share between the CVP and SWP is attributable to CalLite programming and may not represent the true share of export reductions that would be allocated to each facility under actual conditions.

curtailments of fall deliveries used for rice decomposition. NMFS considered whether it was feasible to model and estimate any water costs associated with the Shasta or American River RPA actions, and discussed this issue with Reclamation. In general, it was decided that modeling tools were not available to assess these costs and/or that costs would be highly variable depending on adaptive management actions, and therefore, not meaningful to model.

To assess the economic feasibility associated with average annual water costs of 330 TAF, NMFS reviewed CVP/SWP project wide and statewide information regarding water availability. NMFS considered the following information as background to economic feasibility. This information is provided by the State Legislative Analyst's Office (California's Water: An LAO Primer, October 2008):

1) "The federal government has developed the most surface storage capacity in the state with over 17 MAF of capacity in ten reservoirs on multiple river systems. These reservoirs generally are part of the federal Central Valley Project (CVP), which serves about 3.1 million people, and provides irrigation water to over 2.6 million acres of land. The largest reservoir in the system is Shasta Lake with 4.6 MAF of capacity. The state, as part of the development of SWP, built Oroville Dam and reservoir on the Feather River system with a capacity of 3.5 MAF. The SWP provides all or part of the drinking water supply for 23 million people and provides irrigation water to about 755,000 acres of land."
2) "The federal government, through the Bureau of Reclamation, holds the most (in volume) water rights in the state with over 112 MAF of water held, mainly for delivery through the federal CVP. Second to this are the water rights held by the Imperial Irrigation District (44 MAF), serving mainly farms in the Colorado River region. Two private gas and electric companies hold rights to over 41 MAF of water collectively, mainly for hydroelectric power. The state, through DWR, holds rights to about 31 MAF of water."

3) "Water dedicated for environmental uses, including instream flows, wild and scenic flows, required Sacramento-San Joaquin River Delta (the Delta) outflow, and managed wetlands use, declines substantially between wet and dry years—a 62 percent reduction. Available water supplied to agricultural and urban users actually increases in dry years. From wet to dry years, urban use increases by 10 percent and agricultural use increases by 20 percent. The main reason for this increase is the need in dry years for more developed water for agricultural irrigation and residential landscaping."

4) "Agricultural use of water is significant. California agriculture uses roughly 30 MAF of water a year on 9.6 million acres. California's vast water infrastructure— including the development of the State Water Project, Central Valley Project, and Colorado River, as well as local and regional groundwater supply projects—was developed to provide water for irrigation (among other purposes), with agriculture using about 80 percent of California's developed water supply." (LAO, 2008)

NMFS also considered information on relative deliveries of water in the state, including Figure 8 from Blue Ribbon Task Force Delta Vision report, and Figure 10 from the same report, showing the relative importance of Delta exports relative to other sources of water supplies (taken from

DWR 2005 California Water Plan Update). To assess the relative impact of export reductions on Southern California urban uses, NMFS reviewed a presentation by Metropolitan Water District, entitled "Metropolitan's Water Supply Planning," January 31, 2009, and reviewed Figure 11 from the Delta Vision report showing the potential range of demand reductions and supply augmentations from different strategies (taken from DWR 2005 Water Plan Update).

NMFS considered the above water cost estimates in the context of the larger set of facts on California's water supply to determine whether the RPA is economically feasible. NMFS believes that a cost of 5-7 percent of the project capacity is not unreasonable for a multi-species ESA consultation, given the factual context of the Delta ecosystem and water delivery system. 330 taf reduction can be compared to 30 MAF for agriculture statewide, according to LAO. In addition, these amounts can be compared to the water rights held by the federal and state governments (112 MAF, and 31 MAF respectively, according to LAO).

Most important, NMFS evaluated the 5-7 percent combined export reduction in the context of future water demand and supply in California. The Delta is only one source of water supply. According to other planning documents (DWR's California Water Plan Update, 2005), water agencies are already planning for and adjusting to reduced supplies from the Delta. Alternative supplies include: water transfers, demand reduction through conservation, conjunctive use/groundwater use during droughts, wastewater reclamation and water recycling, and desalination. For example, urban water use efficiency is estimated by DWR to potentially result in between 1.2 to 3.1 MAF annual water savings, and recycled municipal water is potentially estimated to result in .9 to 1.4 MAF annual water savings. The state of California has had an active Integrated Watershed Management Program for almost 10 years. Projects funded through these local water infrastructure investments are coming on line, and will help offset decreased water supply from the Delta.

Furthermore, NMFS considered RPA water costs in the context of b(2) water assets of 800 taf. As the Opinion explains, for purposes of the effects analysis, NMFS could not be reasonably certain that b(2) water would be available at a specific place and time needed to address adverse effects of the project on a listed species. Therefore, the Opinion analysis and RPA actions developed to avoid jeopardy and adverse modification of critical habitat are independent of the availability of b(2) assets, and are silent about how these assets should be used. The Secretary of the Interior retains discretions over how b(2) assets are dedicated to eligible water actions throughout the water year. It is NMFS understanding that water actions taken by Reclamation to implement the RPA are eligible actions. If the Secretary of the Interior so chooses, dedication of b(2) water assets to the RPA actions could completely or significantly offset the projected water costs of the RPA. In addition, limited EWA assets associated with the Yuba Accord may be available, in part, to offset water costs of the SWP. In the proposed project description, these assets were dedicated to VAMP export curtailments. The VAMP export curtailments will be replaced, in part, by the new San Joaquin River Ratio action.

In evaluating economic feasibility, NMFS examined the direct costs of the modified operations to the Federal action agency, Reclamation. According to the LAO, 85% of Reclamation's costs are reimbursed by water users, and 95% of DWR's SWP costs are reimbursed:

> Irrigation water users pay about 55 percent of CVP reimbursable costs ($1.6 billion), while municipal and industrial water users are responsible for the remaining 45 percent (or about $1.3 billion). These reimbursements are paid through long-term contracts with water agencies. The total capital cost to construct the CVP as of September 30, 2006, is about $3.4 billion. The federal Bureau of Reclamation calculates how much of the capital construction cost is reimbursable from water users. Currently, users pay about 85 percent of total costs. In contrast, more than 95 percent of SWP's costs are reimbursable from water users. The costs assigned to such CVP purposes as flood control, navigation, and fish and wildlife needs are not reimbursable and are paid by the federal government.

(LAO, 2008) Through this arrangement, costs to the action agency itself are minimized.

NMFS also reviewed and evaluated water cost information provided by DWR. In general, the DWR information reinforced the NMFS estimates of water costs. On March 20, 2009, DWR provided estimates of water costs associated with the March 3, 2009, draft of the RPA (letter from Kathy Kelly to Ronald Milligan; Reclamation 2009b). These modeled costs were discussed in several technical team meetings and remain the only modeled projections of water costs of the RPA that NMFS is aware of. DWR estimated that combined CVP/SWP costs, as compared to operations under D1641, are 800 taf to 1.0 MAF (or about 15%-17%). However, because the salmon and smelt are near the export facilities during much of the same time of year (winter to spring), many export curtailments are multi-species in nature. Therefore, DWR estimates that, the average combined water supply impact of the NMFS RPA, layered on top of the USFWS smelt RPA, is an additional 150 taf to 750 taf, (or about 3% to 15%).

The San Joaquin river ratio action changed significantly between the March 3, 2009, draft of the RPA and the final RPA. Specifically, the duration of the period changed from 90 to 60 days, in order to better focus the action on the species' biological requirements, and the ratios were more closely refined to reflect water year type in order to reflect actual available water in the watershed and in acknowledgement that acquiring (or requiring, if the SRCWB acts) additional flows on the Tuolumne and Merced rivers could be difficult or uncertain in the near-term. Both of these refinements would reduce, perhaps substantially, DWR projected water costs, and would most likely make them consistent with NMFS estimates. On April 28, 2009, DWR provided an additional analysis of on the economic impacts of estimated water costs of the March 3, 2009, draft RPA (letter from Kathy Kelly to Ronald Milligan; DWR 2009). DWR estimated that the impact of the RPA would range from $320 million to $390 million per year. The methodology used multipliers estimated indirect and well as direct impacts. Again, these costs were predicated on RPA actions that were modified after March 3rd, and would have reduced water costs.

Project Costs

In addition to water costs, Reclamation and DWR will incur project costs associated with certain RPA actions (*e.g.*, the fish passage program). The State of California has authorized $19.6 billion in water-related general obligation bonds since 2000, and these bonds often contain

provisions for environmental conservation related purposes (LAO, 2008). Over $3 billion has been spent through the Calfed Bay-Delta Program. The CALFED ROD contains a commitment to fund projects through the Ecosystem Restoration Program. Similarly, the CVPIA AFRP funds eligible restoration projects, using federal authorities. Some of the projects in the RPA may qualify for those sources of funds.

Summary

In summary, for all the above reasons, NMFS finds that the costs associated with the RPA, while not insignificant, do not render the RPA economically infeasible. Overall, the RPA is both technologically and economically feasible.

11.3.7 Consistency with the Intended Purpose of the Action and the Action Agencies' Legal Authority and Jurisdiction

As noted in the introduction to this RPA, regulations provide that an RPA must be an alternative that, "can be implemented in a manner consistent with the intended purpose of the action, [and] that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction." 50 CFR 402.02. This RPA meets both of these criteria.

First, this RPA is consistent with the intended purpose of the action. According to the BA, "[t]he proposed action is the continued operation of the CVP and SWP." (CVP and SWP operations BA, P. 2-1) Specifically, Reclamation and DWR "propose to operate the Central Valley Project (CVP) and State Water Project (SWP) to divert, store, and convey CVP and SWP (Project) water consistent with applicable law and contractual obligations." (CVP and SWP operations BA, p.1-1) Changes in operation of the projects to avoid jeopardizing listed species or adversely modifying their critical habitats require that additional sources of water for the projects be obtained, or that water delivery be made in a different way than in the past (*e.g.*, elimination of RBDD), or that amounts of water that are withdrawn and exported from the Delta during some periods in some years be reduced. These operational changes do not, however, preclude operation of the Projects.

Second, the RPA may be implemented consistent with the scope of the federal agency's legal authority and jurisdiction. The Rivers and Harbors Act of 1937, which established the purposes of the CVP, provided that the dams and reservoirs of the CVP "'shall be used, first, for river regulation, improvement of navigation and flood control; second, for irrigation and domestic uses; and, third, for power.'" (CVP and SWP operations BA, p. 1-2). The CVP was reauthorized in 1992 through the CVPIA, which modified the 1937 Act and added mitigation, protection, and restoration of fish and wildlife as project purposes. The CVPIA provided that the dams and reservoirs of the CVP should be used "'first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses and fish and wildlife mitigation, protection and restoration purposes; and, third, for power and fish and wildlife enhancement." (CVP and SWP operations BA p. 1-3) One of the stated purposes of the CVPIA is to address impacts of the CVP on fish and wildlife. CVPIA, Sec. 3406(a). The CVPIA gives Reclamation broad authority to mitigate for the adverse effects of the projects on fish and

wildlife, and nothing in the Rivers and Harbors Act of 1937 requires any set amount of water delivery.

In addition to adding protection of fish and wildlife as second tier purposes of the CVP, the CVPIA set a goal of doubling the natural production of anadromous fish in Central Valley rivers and streams on a long-term sustainable basis, by 2002. Sec. 3406(b)(1). This goal has not been met. Instead, as detailed in this Opinion, natural production of anadromous fish has declined precipitously. A 2008 report on the CVPIA anadromous fish program by independent reviewers (Cummins *et al*. 2008), recommended by the Office of Management and Budget and requested by Reclamation and the USFWS, stated that

> "it is far from clear that the agencies have done what is possible and necessary to improve freshwater conditions to help these species weather environmental variability, halt their decline and begin rebuilding in a sustainable way. A number of the most serious impediments to survival and recovery are not being effectively addressed, especially in terms of the overall design and operation of the [CVP] system."

One of the review panel's specific recommendations was that the agencies

> "should develop a more expansive view of the authorities at their disposal to address the problems, especially with regard to water management and project operations. The agencies have followed a more restrictive view of their authorities than appears legally necessary or appropriate to the seriousness of the mission. "

The report notes that the CVPIA contains a "long list of operational changes, actions, tools, and authorities – some quite specific and discrete, some general and on-going – that Interior is to use to help achieve the anadromous fish restoration purposes of the CVPIA . . . ." (Cummins *et al*. 2008 at 5) The report then describes development of a Final Restoration Plan that would utilize these authorities, but concludes that "[t]he agencies implement the CVPIA . . . in a way that bears little resemblance to the integrated, coordinated, holistic vision of the Final Restoration Plan." (Cummins *et al*. 2008 at 9)

Most relevant to this consultation, the review panel observed that

> "[i]t would seem that CVPIA activities and personnel should be central to the OCAP plan, the Section 7 consultation, and the agencies' efforts to satisfy the requirements of the ESA (that is, after all, one of the directives of the CVPIA). The panel received no information or presentations on the involvement of the CVPIA program or personnel in the ESA consultation effort . . . and in the determination of what actions the agencies should be taking to meet the ESA."

(Cummins *et al*. 2008 at 11)

Reclamation and DWR operate their respective projects in close coordination, under a Coordinated Operations Agreement (COA). The COA was authorized by Congress in Public Law 99-546. Consequently, the COA "is the federal nexus for ESA section 7 consultation on

operation of the SWP. Because of commitments expressed in the COA and the Congressional mandate to Reclamation to operate the CVP in conjunction with the SWP, the operations of the two projects are linked . . . ." (CVP/SWP operations BA, p. 1-10) DWR stated in a recent letter to Ren Lohoefener, Regional Director of the USFWS, "For purposes of consultations under the . . . ESA, the operations of the SWP and CVP are intentionally and inextricably connected . . . . . ESA protection of Delta species under the BO is impossible without the participation and cooperation of the Department." (DWR 2009a). Consequently, DWR asserted its standing to request reinitiation of consultation, regardless of whether Reclamation did so.

Moreover, state law gives DWR authority to provide for needs of fish and wildlife independent of the connection of the two water projects. According to the BA, DWR

> "is required to plan for recreational and fish and wildlife uses of water in connection with State-constructed water projects and can acquire land for such uses (Wat. Code Sec. 233, 345,346, 12582). The Davis-Dolwig Act (Wat. Code Sec. 11900-11925) establishes the policy that preservation of fish and wildlife is part of State costs to be paid by water supply contractors, and recreation and enhancement of fish and wildlife are to be provided by appropriations from the General Fund."

(CVP/SWP operations BA, page 1-4) DWR, like Reclamation, has broad authority to preserve and enhance fish and wildlife.

The Preamble to the ESA consultation regulations states that "a Federal agency's responsibility under section 7(a)(2) permeates the full range of discretionary authority held by that agency," and that the Services can prescribe a RPA "that involves the maximum exercise of Federal agency authority when to do so is necessary, in the opinion of the Service, to avoid jeopardy." 51 Fed. Reg. 19925, 19937 (June 3, 1986). The independent review panel concluded that despite Congressional authorization and direction more than 16 years ago to restore anadromous fish populations in Central Valley rivers and streams, Reclamation continues to take an unduly narrow view of its authorities in carrying out Congress' mandate. The legal foundation of this RPA is a broader view of Reclamation's authorities, one that is consistent with the CVPIA, the ESA, and the independent review panel's recommendations.

12.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the Project in the Central Valley, California. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

The following are further examples of when reinitiation of consultation is warranted:

1. The project agencies are currently developing and evaluating a plan to construct a diversion on the Sacramento River and a canal around the Delta, as part of the Bay Delta Conservation Plan (BDCP) planning effort. Such a reconfiguration of the water conveyance system would take careful planning to avoid jeopardizing Sacramento River and north Delta species, as well as several years of environmental review and permitting, and would trigger a re-initiation of this Opinion as a result of changing various operations of the CVP and SWP. We expect that the collaborative research that is part of this RPA will inform this planning effort as it proceeds.

2. When performance goals are not met, for example, in RPA Actions I.2.1 and I.6.1.

3. RPA Action V: If the downstream fish passage improvements are determined not likely to be technically or biologically feasible at this milestone, then Reclamation and the Steering Committee shall identify other alternatives that would be implemented within the same timelines as those identified in this RPA. Reclamation and partner agencies shall submit specific implementation plans for alternative actions to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans are likely to have the biological results that NMFS relied on in this Opinion. If Reclamation and partners believe that the proposed passage locations may not be feasible, the Fish Passage Steering Committee should be directed to develop early assessments of alternative actions that meet the performance standards described above in order to maintain the schedule proposed in this action. NMFS shall notify Reclamation and partner agencies as to whether the proposal is consistent with the analysis in this Opinion. If not, Reclamation will request reinitiation of consultation.

4. Recommended changes outside the range of flexibility specified in the "Implementation Procedures" sections of many of the RPA actions must receive written review and concurrence by NMFS and may trigger reinitiation of consultation.

Reclamation may request NMFS to confirm the conference opinion on the proposed critical habitat of the Southern DPS of North American green sturgeon as a biological opinion if the proposed critical habitat designation becomes final. The request must be in writing. If NMFS reviews the proposed action and finds that there have been no significant changes to the action or in the information used during the conference, NMFS will confirm the conference opinion as a biological opinion for the Project, and no further section 7 consultation will be necessary.

13.0 INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits any taking of endangered species without a permit or exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing,

migrating, feeding, or sheltering (50 CFR 222.102). Protective regulations adopted pursuant to section 4(d) of the ESA extend the prohibition to threatened species. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of the incidental take statement (ITS).

The reasonable and prudent measures described below are non-discretionary and must be implemented by Reclamation and DWR, for the exemption in section 7(o)(2) to apply. Reclamation and DWR have a continuing duty to regulate the activity covered in this incidental take statement. If Reclamation and/or DWR fail to comply with the terms and conditions of this incidental take statement, they may no longer be in compliance with the ESA. In order to monitor the impact of incidental take, Reclamation and DWR must report the progress of the action and its impact on each listed species to NMFS, as specified in this incidental take statement [50 CFR 402.14(i)(3)].

This ITS is applicable to all activities related to the long-term operations of the CVP and SWP, as described in appendix 1 to this Opinion and revised by the proposed RPA in section 11 (hereafter referred to as Proposed Action), including dams and reservoirs, power plants and pumping facilities, administration of water contracts, implementation of habitat mitigation measures, operation of hatchery programs, fish salvage facilities, and research and monitoring activities.

Take of threatened green sturgeon is currently not barred by section 9 of the ESA. When the rule proposed on May 21, 2009 (74 FR 23822) under section 4(d) of the ESA becomes effective as a final rule, all take of threatened green sturgeon not in conformance with that rule will be prohibited under the ESA. Upon the effectiveness of the final green sturgeon take rule, compliance with this Incidental Take Statement provides exemption for take under section 7(o).

13.1. Amount or Extent of Anticipated Take

Incidental take of endangered winter-run, threatened spring-run, threatened CV steelhead, and threatened Southern DPS of green sturgeon will occur as a result of implementing the CVP/SWP operations, as described in Appendix 1 of this Opinion, and as modified by the RPA provided in section 11 (hereafter referred to as Proposed Action). Reservoir operations are expected to continue to alter the natural hydrological cycle (*i.e.*, through higher summer releases and lower releases in the spring compared to the historical) in the Sacramento River downstream of Keswick Dam, Clear Creek downstream of Whiskeytown Dam, the American River downstream of Folsom Dam, and the Stanislaus River downstream of New Melones Dam.

Due to the inherent biological characteristics of aquatic species, such as listed anadromous salmonids and sturgeon, the large size and variability of the river systems, and the operational complexities of hatchery actions, it is generally not possible to quantify numbers of individuals that may be taken incidental to the many components of the Proposed Action. Tables 13-1 through 13-4, below, describe the amount or extent of take by listed species, life history stage,

stressor, and location within the action area. The following sections, organized by type of activity within the Proposed Action, specify an *amount* of take where possible (*i.e.,* collection of adults, monitoring programs, fish salvage estimates, unscreened diversions), but otherwise, specify a geographic and temporal *extent* of take. As the Proposed Action is implemented through time, incidental take in the form of adult and juvenile passage mortality and sublethal take due to water quality and quantity are expected to decrease.

If less take occurs from the Proposed Action than is anticipated, this does not indicate that the actions comprising the RPA are not necessary to avoid jeopardizing listed species. The amount or extent of take described below is a maximum to avoid loss of the section 7(o)(2) exemption and reinitiation of consultation. In addition, section 11.2.1.3 of the RPA requires fish monitoring to determine when certain actions must be initiated, modified, or stopped. The numbers of fish detected through monitoring that trigger certain actions should not be confused with predicted (exempted) take.

13.1.1 Administration of Water Supply Contracts

This consultation addresses the long-term operations of the CVP and SWP, including the overall impacts of the total volume of water diverted from the Central Valley (*e.g.*, higher summer flows, lower spring flows, water temperature, *etc*). The volume of water delivered may be reduced from full contract amounts, consistent with the terms of individual contracts. In addition, take from the administration of water transfers is included in CVP/SWP operations for this consultation. However, this consultation does not address ESA section 7(a)(2) compliance for individual water supply contracts. Reclamation and DWR should consult with NMFS separately on their issuance of individual water supply contracts, including analysis of the effects of reduced water quality from agricultural and municipal return flows, contaminants, pesticides, altered aquatic ecosystems leading to the proliferation of non-native introduced species (*i.e.*, warm-water species), or the facilities or activities of parties to agreements with the U.S. that recognize a previous vested water right.

In the event that Reclamation determines that delivery of quantities of water to any contractor is nondiscretionary for purposes of the ESA, any incidental take due to delivery of water to that contractor would not be exempted from the ESA section 9 take prohibition in this Opinion.

Table 13-1. Amount or extent of incidental take of Sacramento River winter-run Chinook salmon.

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adult/ immigration	RBDD gates may be closed starting June 15 of each year until 2012	Non-lethal: delay in spawning, more energy consumed Lethal: pre-spawn mortality, less fecundity.	The extent of incidental take is all winter-run that migrate past RBDD on or after June 15. Incidental take will be exceeded if RBDD gates go down prior to June 15.	None starting in 2012 when the gates are up year round
Spawning	Reduced spawning area	Non-lethal, with long-term viability consequences: Introgression or hybridization with spring-run/fall-run/late fall-run; loss of genetic integrity and expression of life history Sublethal/lethal take: Reduced fecundity, density dependency as population increases (competition for spawning sites, prespawn mortality, redd superimposition)	Extent of incidental take of otherwise suitable spawning habitat downstream of the established TCP where water temperature exceeds 56ºF. Incidental take will be exceeded if the water temperature exceeds 56ºF upstream of the established TCP. In addition, if TCP performance goals in the RPA action are exceeded, then take is exceeded for this action, and Reclamation shall reinitiate consultation.	Extent of incidental take reduced from short term by implementation of Action V: Fish Passage Program (Long-term actions)

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adult migration, spawning	Fish passage	Non-lethal: Handling to capture, trap, and relocate adults Lethal: Handling mortality, pre-spawn mortality	Non-lethal take will be exempted for the number of adult winter-run determined by the Interagency Fish Passage Steering Committee pursuant to Action V, NF3, #1 and 3 as necessary for the pilot program, provided that NMFS concurs in writing with the specific handling procedures associated with the Fish Passage Pilot Plan. Lethal take is covered, provided that the Fish Passage Pilot Plan was implemented in its entirety.	Incidental take is not authorized at this time for the long term fish passage actions.

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Embryo incubation	Water temperatures above 56ºF for optimal incubation and development	Depending on water temperature: Sublethal: Physical and physiological deformities during embryonic development Lethal: Mortality	Extent of incidental take limited to those fish that spawn downstream of the established TCP, where water temperature exceeds 56ºF. All eggs deposited downstream of the established TCP are assumed lethal take. Frequency expected to increase during multiple dry/critically dry years Extent of incidental take reduced by implementation of Action V: Fish Passage Program (Near-term actions). If TCP performance goals in the RPA action are exceeded, then take is exceeded for this action, and Reclamation shall reinitiate consultation	Extent of incidental take reduced from short term by implementation of Action V: Fish Passage Program (Long-term actions)

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing and downstream movement	RBDD passage downstream through dam gates when they are closed June 15 – August 31 of each year	Lethal: Mortality resulting from predation	Extent of incidental take is all juveniles (approximately 13% of each cohort) exposed to predation (which ranges from 5-50%) as they pass through Lake Red Bluff and RBDD from June 15-August 31 of each year. Incidental take will be exceeded if RBDD gates go down any time outside of the June 15-August 31 time period	None starting in 2012 when the gates are up year round.
Juvenile rearing and downstream movement	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are down from June 15-August 31 of each year.	Non-lethal take: Delayed juvenile emigration, change in riparian habitat, change in river conditions, change in food supply	Extent of incidental take is the 6- mile long Lake Red Bluff that forms annually from June 15 through August 31 when the RBDD gates are down. Incidental take will be exceeded if Lake Red Bluff is created (*i.e.*, when the RBDD gates go down) any time outside of June 15-August 31	None starting in 2012 when the gates are up year round

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	Screened CVP diversions on the Sacramento River to the Delta	Non-lethal: Harassment Lethal: Mortality	Extent of incidental take is all juveniles (which may be up to 5%) exposed to the screens. Type of incidental take would be harassment, and most would be returned to the river unharmed through the bypasses. A small portion of the exposed fish would likely die.	Same as short term

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing and downstream movement	Unscreened CVP diversions between Red Bluff and the Delta	Lethal: Mortality	Extent of incidental take is all juveniles exposed to and entrained (with subsequent mortality) through unscreened CVP diversions. This take is exempted for an interim 5 years, pending future section 7 consultations on individual contract renewals and/or individual fish screens associated with the AFSP and implementation of RPA Action I.5. Incidental take is exceeded if a CVP contractor exceeds their diversion volume or if currently compliant screens are removed or allowed to lapse into disrepair to the point that they no longer meet NMFS fish screening criteria (NMFS 1997a).	Less than short-term, as each unscreened CVCP diversion is screened through the CVPIA AFSP

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	Lack of channel-forming flows, loss of rearing habitat and riparian habitat, loss of riparian vegetation, impaired geomorphic process	Non-lethal: Reduced rearing opportunities, reduced growth Lethal: Mortality through predation.	Extent of incidental take is all juveniles exposed to the stressors throughout the mainstem Sacramento River	Extent of incidental take will be reduced from short-term with continued implementation of Action Suite I.6 and Action V: Fish passage program (Long-term actions).

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Smolt emigration	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics).	Non-lethal: monitoring and alerts triggering DCC operations, entrainment into Central and South Delta, harassment, handling, and research at the export facilities Lethal: Indirect mortality associated with predation, direct mortality associated with the Federal and State fish facilities and the CHTR process.	DCC operation: The extent of take is the frequency of DCC opening prior to December 15 (when water, and therefore, fish, are entrained into the interior Delta). Various RPA actions, like OMR flow management and export curtailments, reduce the (1) duration that winter-run are in the Delta, (2) the potential for indirect predation, and (3) the potential for entrainment at the export facilities. Various RPA actions at the fish facilities will reduce entrainment loss and salvage of those fish. Winter-run loss at the Federal and State fish facilities, combined, is not expected to exceed 2 percent of the annual JPE that enters the Delta throughout the cohort-year. If performance goals in any applicable RPA action (that has them) are exceeded, then take is exceeded for that action, and Reclamation shall reinitiate consultation.	Take will be further reduced with implementation of measures to reduce pre-screen loss, improve screening efficiency, and improve predator control methods in Clifton Court Forebay and at the "end of the pipe."

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adults and juveniles	Monitoring as provided in RPA section 11.2.1.3	Non-lethal: Harassment, capture, handling Lethal: Mortality through stress	The amount of non-lethal take is all adults and juveniles that are captured and handled, including incidental mortalities that will likely occur through standard monitoring techniques.	Same as short term
Juvenile/smolt	Contra Costa Water District Pumping Facilities (Rock Slough Diversion): operation of Pumping Plant #1 on Rock Slough (the waters within the Contra Costa Canal and the immediate waters of Rock Slough surrounding the entrance to the Contra Costa Canal);	Lethal: Entrainment, increased predation	5 juvenile winter-run per year entrained and subsequently die.	5 juvenile winter-run per year entrained and subsequently die. When the Rock Slough diversion is screened (expected to be before year 2018) sometime in the future, incidental take will not be expected, and therefore, will not be authorized.

Table 13-2. Summary of incidental take of Central Valley spring-run Chinook salmon. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Adult immigration and holding	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD gates may be closed starting June 15 of each year until 2012	Non-lethal: more energy consumed, delay in migration for an average of 20 days, less fecundity Lethal: pre-spawn mortality,	The extent of incidental take is all spring-run (approximately 15%) that migrate past RBDD on or after June 15. Incidental take will be exceeded if RBDD gates go down prior to June 15.	None starting in 2012 when the gates are up year round
Adult immigration and holding	NWC: Clear	Water temperatures during summer holding period	Non-lethal: more energy consumed, less fecundity Lethal: pre-spawn mortality	Extent of take is the habitat downstream of the Igo gage that exceeds 60°F during summer holding from June 1 through September 15. In critically dry years, extent of incidental take is likely higher when there is not enough cold water in Whiskeytown Lake to sustain 60°F down to the Igo gage.	Same as short term

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Adult immigration and holding	NWC: Clear	Spring attraction flows	Non-lethal: delay in migration, less fecundity Lethal: pre-spawn mortality, limited cues for upstream migration resulting from spring flows with little variation. With low summer flows, Adults are impeded from accessing upstream holding areas.	Extent of incidental take is all spring-run that migrate past RBDD between June 15 and August 31 that cannot migrate up Clear Creek because of lower flows	Incidental take will be reduced starting in 2012, as late-arriving spring-run will not be subjected to migrational delays at RBDD when the gates are up year round.
Spawning	NWC: Clear	Limited spawning habitat availability	Sub-lethal: Increased competition Lethal: reduced spawning success	Extent of take is the proportion of each cohort that is subjected to increased competition and reduced spawning success as a result of limited spawning gravel.	Same as short term
Embryo incubation	NWC: Clear	Warm water temperatures downstream of Igo in September	Depending on water temperature: Sublethal: Physical and physiological deformities during embryonic development Lethal: Mortality	Extent of take is the habitat downstream of Igo where water temperature exceeds 56ºF and redds are constructed	Likely reduced in the future with implementation of Action I.1.6

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Embryo incubation	BPL: Sacramento	Water temperatures warmer than life history stage requirements, during September and October	Depending on water temperature: Sublethal: Physical and physiological deformities during embryonic development Lethal: Mortality	Extent of incidental take limited to those fish that spawn downstream of the established TCP, where water temperature exceeds 56ºF. All eggs deposited downstream of the established TCP is assumed lethal take. Frequency expected to increase during multiple dry/critically dry years If TCP performance goals in RPA action are exceeded, then take is exceeded for this action, and Reclamation shall reinitiate consultation	Extent of incidental take reduced from short term by implementation of Action V: Fish Passage Program (Long-term actions)

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD passage downstream through dam gates when they are closed June 15 – August 31 of each year	Lethal: Mortality resulting from predation	Extent of incidental take is all juveniles (less than 0.1% of each cohort) exposed to predation (which ranges from 5-50%) as they pass through Lake Red Bluff and RBDD from June 15-August 31 of each year. Incidental take will be exceeded if RBDD gates go down any time outside of the June 15-August 31 time period	None starting in 2012 when the gates are up year round.
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are down from June 15-August 31 of each year.	Non-lethal take: Delayed juvenile emigration, change in riparian habitat, change in river conditions, change in food supply	Extent of incidental take is the 6-mile long Lake Red Bluff that forms annually from June 15 through August 31 when the RBDD gates are down. Incidental take will be exceeded if Lake Red Bluff is created (*i.e.*, when the RBDD gates go down) any time outside of June 15-August 31.	None starting in 2012 when the gates are up year round

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Juvenile rearing	All diversity groups and populations	Screened CVP diversions on the Sacramento River to the Delta	Non-lethal: Harassment Lethal: Mortality	Extent of incidental take is all juveniles (which may be up to 5%) exposed to the screens. Type of incidental take would be harassment, and most would be returned to the river unharmed through bypasses. A small portion of the exposed fish would likely die.	Same as short term

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Lethal: Mortality	Extent of incidental take is all juveniles (estimated 538 juveniles annually) exposed to and entrained (with subsequent mortality) through unscreened CVP diversions. This take is exempted for an interim 5 years, pending future section 7 consultations on individual contract renewals and/or individual fish screens associated with the AFSP and implementation of RPA Action I.5. Incidental take is exceeded if a CVP contractor exceeds their diversion volume or if currently compliant screens are removed or allowed to lapse into disrepair to the point that they no longer meet NMFS fish screening criteria (NMFS 1997a).	Less than short-term, as each unscreened CVP diversion is screened through the CVPIA AFSP

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Juvenile rearing	All diversity groups and populations	Lack of channel forming-flows, loss of rearing habitat and riparian habitat, loss of riparian vegetation, impaired geomorphic process.	Non-lethal: Reduced rearing opportunities, reduced growth Lethal: Mortality through predation.	Extent of incidental take is all juveniles exposed to the stressors throughout the mainstem Sacramento River	Extent of incidental take will be reduced from short-term with continued implementation of Action Suite I.6 and Action V: Fish passage program (Long-term actions).

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Non-lethal: monitoring and alerts triggering DCC operations, entrainment into Central and South Delta, harassment, handling, and research at the export facilities Lethal: Indirect mortality associated with predation, direct mortality associated with the Federal and State fish facilities and the CHTR process.	DCC operation: The extent of take is the frequency of DCC opening prior to December 15 (when water, and therefore, fish, are entrained into the interior Delta. Various RPA actions, like OMR flow management and export curtailments, reduce the (1) duration that spring-run are in the Delta, (2) the potential for indirect predation, and (3) the potential for entrainment at the export facilities. Various RPA actions at the fish facilities will reduce entrainment loss and salvage of those fish. Spring-run loss at the Federal and State fish facilities, combined, is not expected to exceed 1 percent based on marked late fall-run as surrogates that enter the Delta throughout the cohort-year. If performance goals in any applicable RPA action (that has them) are exceeded, then take is exceeded for	Take will be further reduced with implementation of measures to reduce pre-screen loss, improve screening efficiency, and improve predator control methods in Clifton Court Forebay and at the "end of the pipe."

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or extent of Take: Long term
Adults and juveniles	All diversity groups and populations	Monitoring as provided in RPA section 11.2.1.3	Non-lethal: Harassment, capture, handling Lethal: Mortality through stress	The amount of non-lethal take is all adults and juveniles that are captured and handled, including incidental mortalities that will likely occur through standard monitoring techniques.	Same as short term
Juvenile/ smolt	All diversity groups and populations	Contra Costa Water District Pumping Facilities (Rock Slough Diversion): operation of Pumping Plant #1 on Rock Slough (the waters within the Contra Costa Canal and the immediate waters of Rock Slough surrounding the entrance to the Contra Costa Canal)	Non-lethal: Harm resulting from delays in migration, diminishment of physical status due to delays in migration; injury due to exposure to reduced water quality parameters (*i.e.*, water temperature, dissolved oxygen, contaminants) Lethal: Entrainment, increased predation	10 juvenile spring-run per year entrained and subsequently die	10 juvenile spring-run per year entrained and subsequently die. When the Rock Slough diversion is screened sometime in the future (expected to be before year 2018), incidental take will not be expected, and therefore, will not be authorized.

Table 13-3. Summary of incidental take of Central Valley steelhead. The table is organized by life stage then by the number of populations affected by a particular stressor. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada; SSN – Southern Sierra Nevada.

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adult immigration and holding	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD gates may be closed June 15 through September 1 of each year until 2012	Non-lethal: more energy consumed, delay in migration for an average of 20 days Lethal: pre-spawn mortality, less fecundity Non-lethal take more likely	The extent of incidental take is all steelhead that migrate past RBDD before September 1. Incidental take will be exceeded if RBDD gates go up after September 1.	None starting in 2012 when the gates are up year round
Adult immigration and holding	NWC: Clear	High water temperatures near confluence with Sacramento River during August and September	Non-lethal: (1) Delayed migration into Clear Creek, (2) seek other tributaries, (3) spawn in mainstem Sacramento R.; reduced in vivo egg viability	Extent of incidental take is the habitat downstream of the Igo gage that exceeds 60°F in August and September. In critically dry years, extent of incidental take is likely higher when there is not enough cold water in Whiskeytown Lake to sustain 60°F down to the Igo gage. Incidental take is exacerbated in the early part of the run by migration delays from RBDD gate closure through September 1	Incidental take will be reduced starting in 2012, as early-arriving steelhead will not be subjected to migrational delays at RBDD when the gates are up year round.
Spawning	NWC: Clear	Limited spawning habitat availability	Sub-lethal: Increased competition Lethal: reduced spawning success	Extent of take is the proportion of each cohort that is subjected to increased competition and reduced spawning success as a result of limited spawning gravel.	Same as short term

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Spawning	NSN: American River	Flood releases	Lethal: Redd scour, resulting in egg mortality	Extent of take is expected to be limited to releases from Nimbus Dam that are greater than 50,000 cfs during egg incubation (*i.e.*, January through May), which occurs approximately once every 5 years (CVP/SWP operations BA).	Same as short term
Spawning	NSN: American River; BPL: Sacramento; and potentially all other populations within the NWC, NSN, and BPL diversity groups	Nimbus Fish Hatchery *O. mykiss* spawning with natural-origin steelhead in the American River and in other CV streams	Non-lethal: Reduced genetic fitness	Extent of incidental take from Nimbus Fish Hatchery is unknown, but will be immediately reduced upon implementation of Action II.6.2	Extent of incidental take should be reduced considerably upon implementation of an HGMP

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Spawning, egg incubation, and emergence	SSN: Stanislaus River	Excessive fines in spawning gravel resulting from lack of overbank flow	Sublethal: Increased energy attempting to "clean" excess fine material from spawning site Lethal: Egg mortality due to superimposition or spawning in suboptimal sites, or from lack of interstitial flow	Incidental take is expected to the extent that poor spawning bed conditions persist, as the proposed frequency of channel mobilizing flows of 5,000 cfs may not result in mobilizing flows at higher levels which perform greater geomorphic work. Incidental take will decrease with implementation of Action V: Fish passage program (Near-term actions)	Through time, the extent of incidental take through poor spawning bed conditions will be reduced from the short term as habitat restoration continues. Incidental take will also decrease with implementation of Action V: Fish passage program (Long-term actions)
Embryo incubation	NSN: American River	Exposure to stressful water temperatures in the American River during embryo incubation	Sub-lethal effects - reduced early life stage viability; restriction of life history diversity (*i.e.*, directional selection against eggs deposited in March and April) Lethal: direct mortality	The extent of incidental take is the stretch of the American River where the mean daily water temperature first begins to exceed 54°F, downstream to the downstream extent of steelhead spawning habitat at approximately RM 6, just upstream of Paradise Beach. Incidental take is expected to be reduced with implementation of Action V: Fish passage program (Near-term actions)	Incidental take will decrease with implementation of the structural improvements to improve cold water management, and Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Egg incubation and emergence	SSN: Stanislaus River	Warm water temperatures during egg incubation and emergence	Depending on water temperature: Sub-lethal: Embryonic deformities Lethal: Egg mortality, especially for eggs spawned in or after March;	Extent of incidental take is the river downstream of Orange Blossom Bridge, where water temperature exceeds 55ºF, from January through May. Extent expected to increase during critically dry years Extent of incidental take reduced by implementation of Action V: Fish Passage Program (Near-term actions)	Extent of take expected to be reduced from short term with implementation of Action V: Fish passage program (Long-term actions)
Juvenile rearing	BPL: Sacramento River	Higher flows and cooler water temperatures during the summer	Non-lethal: Increased residualism, reduced diversity	The amount or extent of take cannot be quanitified. Residualized *O. mykiss* as a result of improved rearing habitat conditions from the cooler water temperatures in the summer could contribute to the steelhead population, but the extent is unknown. The higher flows and cooler water in the summer is certainly a beneficial effect on the juveniles emigrating from the tributaries.	Same as short term

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	Reduction in rearing habitat quantity and quality with the formation of Lake Red Bluff when the RBDD gates are down from June 15-August 31 of each year.	Non-lethal take: Delayed juvenile emigration, change in riparian habitat, change in river conditions, change in food supply	Extent of incidental take is the 6-mile long Lake Red Bluff that forms annually from June 15 through August 31 when the RBDD gates are down. Incidental take will be exceeded if Lake Red Bluff is created (*i.e.*, when the RBDD gates go down) any time outside of June 15-August 31.	None starting in 2012 when the gates are up year round
Juvenile rearing	All diversity groups and populations	Screened CVP diversions on the Sacramento River to the Delta	Non-lethal: Harassment Lethal: Mortality	Extent of incidental take is all juveniles (which may be up to 5%) exposed to the screens. Type of incidental take would be harassment, and most would be returned to the river unharmed through bypasses. A small portion of the exposed fish would likely die.	Same as short term

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Lethal: Mortality	Extent of incidental take is all juveniles (estimated 394 juveniles annually) exposed to and entrained (with subsequent mortality) through unscreened CVP diversions. This take is exempted for an interim 5 years, pending future section 7 consultations on individual contract renewals and/or individual fish screens associated with the AFSP and implementation of RPA Action I.5. Incidental take is exceeded if a CVP contractor exceeds their diversion volume or if currently compliant screens are removed or allowed to lapse into disrepair to the point that they no longer meet NMFS fish screening criteria (NMFS 1997a).	Less than short-term, as each unscreened CVCP diversion is screened through the CVPIA AFSP

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	All diversity groups and populations, excluding the SSN diversity group	Lack of channel-forming flows in the Sacramento River, loss of rearing habitat and riparian habitat, loss of riparian vegetation, impaired geomorphic process.	Non-lethal: Reduced rearing opportunities, reduced growth Lethal: Mortality through predation.	Extent of incidental take is all juveniles exposed to the stressors throughout the mainstem Sacramento River	Extent of incidental take will be reduced from short-term with continued implementation of Action Suite I.6
Juvenile rearing	NWC: Clear Creek	Exposure to high water temperatures	Non-lethal: Limited over-summering habitat, reduced growth, increased competition Sub-lethal: Increased susceptibility to disease and predation Lethal: Increased predation	Extent of incidental take is rearing habitat downstream of Igo from June 1 through September 15 where water temperature exceeds 60ºF. Incidental take is exceeded if water temperature is greater than 60ºF upstream of Igo between June 1 and September 15.	Same as short term

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	NWC: Clear Creek	Limited rearing habitat availability resulting from low summer flows (< 80 cfs)	Non-lethal: reduced growth, increased competition Lethal: increased predation risk	Extent of take is the difference between the habitat necessary and the habitat available for the population of steelhead	Extent of incidental take will be reduced in the future with implementation of Action I.1.6
Juvenile rearing	NSN: American River	Folsom/Nimbus releases resulting in flow fluctuations; low flows	Sub-lethal: Reduced availability of quality rearing habitat Lethal: Fry stranding, juvenile isolation, increased predation	Extent of incidental take is limited to Folsom/Nimbus releases of greater than 4,000 cfs, which is not expected to occur frequently. Ramping rates also minimize incidental take. The extent of incidental take is exceeded if flow increases or decreases exceed the ramping rates	Same as short term

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	NSN: American River	Exposure to stressful water temperatures in the American River during juvenile rearing	Sub-lethal: Disease, thermal stress Lethal: Predation	The extent of take is potential rearing habitat downstream of the Watt Avenue Bridge, or the established TCP, where water temperature exceeds 65°F between May 15 and October 31. Incidental take would be reduced with implementation of the structural improvements and Action V: Fish passage program (Near-term actions) Incidental take is exceeded if the water temperature exceeds 65°F upstream of the Watt Avenue Bridge or TCP between May 15 and October 31	The extent of take will decrease with implementation of the structural improvements and Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	SSN: Stanislaus River	Reduction in rearing habitat complexity due to lack of channel forming flows	Sub-lethal: Stress, suppressed growth rates Lethal: Increased predation	The extent of incidental take will be the frequency and duration of flows that do not inundate the floodplain and provide rearing habitat complexity after implementing Action III.1.3. Take will be higher in the drier water year types than the wetter water year types. Extent of incidental take will be reduced by implementation of Action V: Fish Passage Program (Near-term actions) The extent of incidental take is exceeded if the frequency and duration of flows provided in Action III.1.3 are not met.	Very little amount or extent of take, if any, as a result of implementing the floodplain restoration and inundation flows, coupled with implementation of Action V: Fish passage program (Long-term actions)
Juvenile rearing and downstream movement	SSN: Stanislaus River	Predation	Sub-lethal: Injury Lethal: Mortality	Amount or extent of incidental take is unknown, but the level of predation is expected to be reduced from current levels from increased flows and cold water	Incidental take is expected to decrease with implementation of Action III.2.3

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	SSN: Stanislaus River	Exposure to stressful water temperatures in the Stanislaus River at the end of summer affecting rearing habitat	Sub-lethal: Metabolic stress; starvation; poor growth; Lethal: Loss to predation	Extent of take is habitat that exceeds 65ºF downstream of Orange Blossom Bridge, especially during critically dry years, from July through September Incidental take will be reduced with the implementation of Action V: Fish passage program (Near-term actions). The extent of incidental take is exceeded if the water temperature exceeds 65ºF upstream of Orange Blossom Bridge, during July through September.	Same as short term, but further reduced take with implementation of Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Smolt emigration	SSN: Stanislaus River	Warm water temperatures warmer than life history stage (Mar - June)	Sub-lethal: Thermal stress Lethal: Mortality resulting from failure to escape river before temperatures rise in lower river reaches	Extent of incidental take is the Stanislaus River downstream of Orange Blossom Bridge from January through May when temperatures are above 57ºF. This is likely to occur more frequently during critically dry years, particularly in May. Incidental take will be reduced with the implementation of Action V: Fish passage program (Near-term actions) The extent of incidental take is exceeded if water temperatures exceed 57ºF upstream of Orange Blossom Bridge during January to May, and particularly in May.	Same as short term. Incidental take will be further reduced with implementation of Action V: Fish passage program (Long-term actions)
Smolt emigration	NSN: American River	Exposure to stressful water temperatures in the American River during smolt emigration	Sub-lethal:Physiological effects – reduced ability to successfully complete the smoltification process Lethal: increased susceptibility to predation	Extent of incidental take is habitat that exceeds mean daily water temperatures greater than 54°F during smolt emigration (*i.e.*, January through June). Incidental take will be reduced with implementation of structural improvements and Action V: Fish passage program (Near-term actions)	Extent of incidental take will decrease from short term with the continued implementation of the structural improvements and Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Non-lethal: monitoring and alerts triggering DCC operations, entrainment into Central and South Delta, harassment, handling, and research at the export facilities Lethal: Indirect mortality associated with predation, direct mortality associated with the Federal and State fish facilities and the CHTR process.	DCC operation: The extent of take is the frequency of DCC opening prior to December 15 (when water, and therefore, fish, are entrained into the interior Delta. Various RPA actions, like OMR flow management and export curtailments, reduce the (1) duration that CV steelhead are in the Delta, (2) the potential for indirect predation, and (3) the potential for entrainment at the export facilities. RPA Actions IV.2.1 and IV.2.2 specifically address San Joaquin River flows and export curtailments to minimize take of CV steelhead emigrating from the San Joaquin River basin. Various RPA actions at the fish facilities will reduce entrainment loss and salvage of those fish. Incidental take is limited to the salvage of 3,000 unmarked juvenile and adult CV steelhead that enter the Delta throughout the year from multiple cohorts. If performance goals in any applicable RPA action (that has them) are exceeded, then take is exceeded for that action, and Reclamation shall reinitiate consultation.	Similar to short term. Incidental take of CV steelhead emigrating from the San Joaquin River is expected to decrease with implementation of Action IV.2.1 Phase 2 and utilizing the results of the acoustic tagging studies to increase survival of emigrating CV steelhead from the San Joaquin River Basin.

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adults and juveniles	All diversity groups and populations	Monitoring as provided in RPA section 11.2.1.3	Non-lethal: Harassment, capture, handling Lethal: Mortality through stress	The amount of non-lethal take is all adults and juveniles that are captured and handled, including incidental mortalities that will likely occur through standard monitoring techniques.	Same as short term
Juvenile/ smolt	All diversity groups and populations	Contra Costa Water District Pumping Facilities (Rock Slough Diversion): operation of Pumping Plant #1 on Rock Slough (the waters within the Contra Costa Canal and the immediate waters of Rock Slough surrounding the entrance to the Contra Costa Canal)	Non-lethal: Harm resulting from delays in migration, diminishment of physical status due to delays in migration; injury due to exposure to reduced water quality parameters (*i.e.*, water temperature, dissolved oxygen, contaminants) Lethal: Entrainment, increased predation	10 juvenile steelhead per year entrained and subsequently die.	10 juvenile steelhead per year entrained and subsequently die. When the Rock Slough diversion is screened sometime in the future (expected to be before year 2018), incidental take will not be expected, and therefore, will not be authorized.

Life Stage/ Habitat Type	Diversity Group(s): Population (s)	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juveniles/ smolts	SSN: Stanislaus River	Monitoring	Non-lethal: Handling stress Lethal: Mortality	Non-lethal take of 60-80 juveniles per year, including smolts, from Rotary Screw Traps at Caswell and Oakdale, based on past years' encounter rates (and under current population levels) and longer sampling season of December through June. Incidental mortalities are exempt this monitoring.	Incidental take is expected to increase as the population increases.
Adults	SSN: Stanislaus River	Monitoring	Non-lethal: Harassment, handling stress, delayed migration Lethal: Mortality	Non-lethal take of 10-25 adults per year from the counting weir on the lower Stanislaus River, based on past years' encounter rates (and under current population levels) and a longer sampling season of September through March. Incidental mortalities are expected to be no more than 2 adults per year.	Incidental take is expected to increase as the population increases.

Table 13-4. Summary of incidental take of Southern DPS of green sturgeon.

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adult immigration and holding	RBDD gates may be closed starting June 15 of each year until 2012.	Non-lethal: passage blocked, more energy consumed, less fecundity, studies Lethal: downstream passage of adults under gates	Non-lethal take of adults for studies provided in Appendix 2-B The extent of incidental take is all green sturgeon at the tail end of the spawning migration that are precluded access above RBDD on or after June 15. Injury, impingement, or mortality of adults migrating downstream when RBDD gates are down are also exempt, contingent on notification requirement (see section 13.1.2.2).	None starting in 2012 directly or indirectly resulting from RBDD when the gates are up year round
Spawning	RBDD gates may be closed starting June 15 of each year until 2012.	Non-lethal: eggs suffocate, physiological effects, delayed hatch, greater predation on eggs due to accumulation of predators below RBDD.	All green sturgeon that spawn downstream of RBDD after the RBDD gates close on or after June 15	None starting in 2012 directly or indirectly resulting from RBDD when the gates are up year round

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Embryo incubation	Water temperatures warmer than life history stage requirements from RBDD to Hamilton City.	Lethal and sub-lethal take: Mortality of eggs and fry resulting from less suitable water quality, including suffocation of eggs from less flow, physiological effects, delayed hatch, and greater predation on eggs and fry due to presence of non-native introduced warm-water species.	Extent of incidental take is water temperatures from RBDD to Hamilton City that exceed life history stage requirements following the implementation of Action Suite I.2. Frequency expected to increase during multiple dry/critically dry years If TCP performance goals in the RPA action are exceeded, then take is exceeded for this action, and Reclamation shall reinitiate consultation	Considerably less than short term (if any), as more green sturgeon will spawn upstream of RBDD when the gates are up year round
Eggs, larvae, juvenile, adults	Studies in Appendix 2-B	Non-lethal: adults for radiotelemetry, egg extraction; juvenile tagging, lab experiments Lethal: Eggs, larvae, and juveniles collected for genetic sampling	Amounts of lethal and non-lethal take according to the proposed studies in Appendix 2-B, including: Up to 10 adult green sturgeon annually for 3 years. Of those, up to 2 females and 4 males will be also spawned. Up to 100 juvenile wild green sturgeon will be captured and retained per year for 3 years.	Same as short term until studies are completed

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	Increased juvenile mortality related to emigration when RBDD gates are closed from June 15 through August 31	Lethal take: Mortality resulting from predation	Extent of incidental take is all juveniles exposed to predation as they pass through Lake Red Bluff and RBDD from June 15-August 31 of each year. Incidental take will be exceeded if RBDD gates go down any time outside of the June 15-August 31 time period	None starting in 2012 when the gates are up year round
Juvenile rearing	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are in.	Non-lethal take: Reduction in rearing habitat quality and quantity; change in riparian habitat, change in river conditions, change in food supply.	Extent of incidental take is the 6-mile long Lake Red Bluff that forms annually from June 15 through August 31 when the RBDD gates are down. Incidental take will be exceeded if Lake Red Bluff is created (*i.e.*, when the RBDD gates go down) any time outside of June 15-August 31	None starting in 2012 when the gates are up year round

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Eggs, larvae, juvenile--rearing	Screened CVP diversions on the Sacramento River to the Delta	Non-lethal: Harassment Lethal: Mortality	Extent of incidental take is all eggs, larvae, and juveniles exposed to the screens. Type of incidental take would include harassment for those eggs, larvae, and juveniles that would be returned to the river unharmed through the bypasses. Lethal take through entrainment into the diversions is expected for a portion of the eggs and larvae.	Same as short term

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile rearing	Unscreened CVP diversions	Lethal: Mortality	Extent of incidental take is all juveniles exposed to and entrained (with subsequent mortality) through unscreened CVP diversions. This take is exempted for an interim 5 years, pending future section 7 consultations on individual contract renewals and/or individual fish screens associated with the AFSP and implementation of RPA Action I.5. Incidental take is exceeded if a CVP contractor exceeds their diversion volume or if currently compliant screens are removed or allowed to lapse into disrepair to the point that they no longer meet NMFS fish screening criteria (NMFS 1997a).	Less than short-term, as each unscreened CVP diversion is screened through the CVPIA AFSP.

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Juvenile and subadult	Cumulative direct and indirect loss and salvage associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics).	Non-lethal: entrainment into Central and South Delta, harassment, handling, and research at the export facilities during the salvage and CHTR process. Lethal: Indirect mortality associated with predation, direct mortality associated with the Federal and State fish facilities and the CHTR process.	Various RPA actions, like OMR flow management and export curtailments, reduce (1) the potential for indirect predation, and (2) the potential for entrainment at the export facilities. Various RPA actions at the fish facilities will reduce entrainment loss and salvage of those fish. Green sturgeon salvage and loss is highly variable, but is not expected to exceed the 10-year historical average of 74 and 106 juveniles, respectively, per year. If performance goals in any applicable RPA action (that has them) are exceeded, then take is exceeded for that action, and Reclamation shall reinitiate consultation	Take will be further reduced with implementation of measures to reduce pre-screen loss, improve screening efficiency, and improve predator control methods in Clifton Court Forebay and at the “end of the pipe.”

Life Stage/ Habitat Type	Stressor	Type of incidental take	Amount or Extent of Take: Short term	Amount or Extent of Take: Long term
Adults and juveniles	Monitoring as provided in RPA section 11.2.1.3	Non-lethal: Harassment, capture, handling Lethal: Mortality through stress	The amount of non-lethal take is all adults and juveniles that are captured and handled, including incidental mortalities that will likely occur through standard monitoring techniques.	Same as short term
Green Sturgeon juveniles, subadults, adults	Treatment of Clifton Court Forebay with Cobber-based herbicides	Sublethal: diminishing olfactory responses by altering membrane potentials and responses to odor stimuli, altering cellular membrane function. Lethal: mortality.	4 days between July 1 and August 31, up to twice per season	4 days between July 1 and August 31, up to twice per season

13.1.2 Operation of CVP and SWP Dams and Reservoirs

13.1.2.1 Flood Control Operations

Heavy rainfall within upstream basins during the winter and spring months is likely to trigger flood control operations and reservoir releases to downstream areas at CVP and SWP reservoirs in 10-25% of the years, resulting in short-term, high flow, events in Clear Creek, the upper Sacramento River, American River and the Stanislaus River. Extremely high flow events may:

- scour Chinook salmon and steelhead redds, and result in the injury and mortality of Chinook salmon and steelhead eggs and sac-fry;
- displace and disperse sac-fry and larval fish stages downstream into unsuitable habitats for their life stage.
- strand and isolate winter-run, spring-run, and CV steelhead fry and juveniles from the mainstem river channels. If additional high flow events do not follow within a short period of time, these isolated juveniles may be lost to predation, lethal water temperatures conditions, or dessication.

Flood control releases can occur multiple times a year, depending on the Corps' flood control curves for filling project reservoirs. In general, these impacts are less than an unregulated river due to the presence of the dam. The frequency of occurrence is likely to increase with implementation of the RPA, due to maintaining higher storage levels through the winter months in Shasta Reservoir.

Take of adult winter-run, spring-run, CV steelhead, and green sturgeon is not anticipated due to flood control operations.

13.1.2.2 Red Bluff Diversion Dam

Delays to upstream migration of adult winter-run, spring-run, CV steelhead, and green sturgeon at the RBDD are expected to decrease considerably due to the extended gate openings in the RPA, and completely eliminated after completion of the Red Bluff Pumping Plant. Average delays of 11 days (range from 1- 40 days) have been reported by radio-tagging experiments on spring-run (USFWS 1990). Delays in migration are expected to increase the chance that spawning will be unsuccessful. In 10-25 percent of years (dry and critical), it is expected that some adult spring-run spawners will be unable to access tributary streams above the RBDD, due to low flows and thermal barriers developing at the tributary mouth during the time the fish were delayed in their migration. The potential amount of take is difficult to predict, but take will be reduced due to interim gate openings until 2012, and completely eliminated after 2012 when the new pumping plant becomes operational. Likewise, approximately 30 percent of adult green sturgeon are blocked from spawning above RBDD under current operations. The level of spawning success below RBDD is unknown, but is presumed to be lower than in the river reaches above RBDD. Incidental take in the form of migration delays, pre-spawn mortality, lower fecundity, increased juvenile predation, and reduced rearing habitat associated with the interim operations of the RBDD (incidental take is not expected with gates out year round starting in year 2012)

Interim operations at RBDD for green sturgeon provide for 18-inch gate openings. These gate openings, coupled with a considerably reduced duration of gates down operation (2.5 months compared to 4 months plus a provision for a 10-day emergency closure from the 2004 CVP/SWP operations Opinion), would likely allow adult green sturgeon to pass downstream underneath the RBDD gates uninjured. A provision in RPA Action I.3.3 allows the RBDD technical team to modify the opening to 12 inches if necessary to maintain the structural integrity of the dam and/or adequate attraction flows for salmonids at the fish ladders, or in consideration of other real-time fish migratory issues. In the event that adult green sturgeon are impinged, injured, or suffer mortality as a result of implementing RPA Action I.3.3, that incidental take is covered. As a condition of this take authorization, any observation of an impinged, injured or dead green sturgeon must reported within 24 hours to the NMFS Sacramento Area Office Supervisor At (916) 930-3600, followed by written documentation through electronic mail to maria.rea@noaa.gov.

13.1.2.3 Water Temperatures and Flows

In wet and above normal years, water temperatures are in the preferred range for winter-run, spring-run, CV steelhead, and green sturgeon for at least a portion of: (1) Clear Creek from Whiskeytown Dam to the Powerline Crossing Road (RM 5); (2) the Sacramento River from Keswick Dam to Red Bluff; (3) the American River from Nimbus Dam to Watt Avenue; and (5) the Stanislaus River from Goodwin Dam to Riverbank.

Dry hydrologic conditions or moderate precipitation will create low instream flows below CVP and SWP controlled reservoirs. Operation of the reservoirs during these hydrologic conditions will result in some incidental take, including:

- dewatering of some winter-run, spring-run, and CV steelhead redds, and egg and pre-emergent fry mortality.
- mortality of juvenile CV steelhead resulting from high water temperatures (*e.g.*, Clear Creek and American River).
- Reduced availability and suitability of winter-run, spring-run, and CV steelhead habitat for juvenile rearing and emigration.
- Adult salmonids not being able to reach spawning areas within tributary streams by creating thermal barriers and subjecting them to increased poaching or predation in summer holding pools.

13.1.3 Maintenance of Project Facilities

13.1.3.1 Screened and Unscreened Water Diversions

Take from each screened CVP diversion that meets NMFS (1997a) fish screen criteria is expected to be less than the 5 percent (of the fish exposed to the screen). NMFS (1997a) were specifically designed to protect fry-sized salmonids, and green sturgeon eggs and larvae are smaller. Therefore, a greater proportion of green sturgeon eggs and larvae than salmonid fry are expected to be entrained (and die) at the screened CVP diversions. Non-lethal take is expected to occur as juvenile fish are bypassed through and around pumps back to the river. Additional

mortality occurs from predation at fixed release sites, since predators learn to take advantage of a steady supply of disoriented fish.

The CVP/SWP operations BA analyzed the impact 123 unscreened diversions located downstream of RBDD based on previous studies at unscreened diversions (Hanson 2001), and average juvenile passage from 1994 through 1999 at RBDD (Gaines and Martin 2002 *op. cit*. CVP/SWP operations BA). Timing and quantity of diversions was based on the monthly averages for CVP contractors with unscreened diversions from 1964 through 2003. A summary of the estimated entrainment by month is presented in table 13-5. Adequate funding of the CVPIA - AFSP (RPA Action I.5) is expected to reduce the amount and extent of juvenile loss to unscreened diversions.

Take for unscreened CVP diversions is authorized for an interim 5 years, pending future section 7 consultations on individual contract renewals and/or individual fish screens associated with the AFSP and implementation of RPA Action I.5. Prior to the 5-year time frame, NMFS will reassess the status of screening or protecting fish from these diversions and assess the status of this incidental take exemption.

Table 13-5. Estimated monthly entrainment of juvenile salmonids for 123 unscreened diversions in the Sacramento River based on historic water usage (Project + Base supply) and fish passage estimates from 1994 to 1999 at Red Bluff Diversion Dam (summarized from Tables 11-12 through 11-16 in the CVP/SWP operations BA).

	April	May	June	July	August	Sept.	Oct.	Total
Average flow (cfs)	10,404	9,435	11,110	13,082	9,683	6,730	7,013	
Winter-run	4	2	0	342	3,545	3,241	308	7,442
Spring-run	439	82	3	0	0	0	14	538
O. mykiss	18	132	37	26	117	62	2	394
Fall-run	6,754	4,237	3,645	1,788	685	53	1	17,163
Late fall-run	371	285	127	196	495	117	23	1,613
Green sturgeon	0	24	36	96	43	1	0	200

13.1.4 Monitoring and Research Studies Associated with Project Operations and Facilities

The adaptive management process described in the Proposed Action, is based on the continuation of monitoring programs both upstream and in the Delta. The information obtained from these programs is used in making real time decisions regarding project operations. Incidental take for these monitoring programs can be quantified and has been previously authorized under individual section 10 permits, but presented here as they are interdependent with CVP/SWP operations. Upstream monitoring consists of fish ladder counts at RBDD; carcass surveys; redd counts; and juvenile monitoring on Clear Creek, Sacramento River (RBDD trapping, Knights Landing, Sacramento Trawl), American River, and other tributaries. In the Delta, monitoring consists of Chipps Island Trawl, Tracy and Skinner Fish Collection Facilities (described later), and CCWD monitoring at Old River, Rock Slough and the new Victoria Canal diversions. On the San Joaquin River, juvenile monitoring will continue with trawling at Mossdale and in the Stanislaus River.

Fisheries studies that capture and collect juvenile CV steelhead in the Stanislaus River by screw traps will evaluate New Melones Reservoir operations on anadromous salmonids. Based on past sampling by screw traps at the Oakdale sampling site, up to 60 steelhead smolts and pre-smolts may be captured and released below the trapping site. Previous sampling experience with screw traps in the Stanislaus River indicates that all captured steelhead can be maintained in good physical condition and released unharmed back into the river.

Non-lethal take, and any associated incidental mortalities, associated with all monitoring required in this Opinion are covered through this ITS, including, but not limited to, implementation of the Steelhead Monitoring Program (*e.g.*, through fyke nets on the Sacramento River, rotary screw traps, weirs, and acoustic tagging studies), implementation of the CVPIA Tracy Fish Facility Program research studies, SWP CHTR studies, and creation of a new monitoring site located on the Sacramento River between RBDD and Knights Landing.

Additional take is associated with proposed monitoring and research studies linked with the movements and behavior of green sturgeon in the Sacramento River and Delta systems as part of the RPA for RBDD. Study designs require that up to 10 adult green sturgeon be captured annually for 3 years (30 fish) and tagged with internal acoustic transmitters. Each year, up to 6 adult green sturgeon will be retained for spawning purposes prior to tagging (2 females and 4 males), and then subsequently released back into the river. Furthermore, up to 100 juvenile wild green sturgeon will be captured and retained per year for 3 years (300 fish). The fish will be grown out to a size at which they can also be successfully tagged with acoustic transmitters and released back into the Sacramento River and Delta systems to monitor movements and behavior. Depending on the success of the captive hatchery produced juvenile green sturgeon population, wild fish will be replaced with captive stock as they become available. The above take is expected to be non-lethal. However, incidental mortalities resulting from the green sturgeon monitoring and research studies are covered in this ITS.

13.1.5 Operations in the Delta

In the Delta, incidental take in the form of death, injury, and harm to juvenile and adult winter-run, spring-run, CV steelhead, and southern DPS of green sturgeon is anticipated due to changes in the Delta hydrology created by the operation of the DCC gates and at Jones (CVP) and Harvey Banks (SWP) export pumping plants (Delta pumping plants). This take includes reduced survival of juvenile winter-run, spring-run, CV steelhead, and green sturgeon diverted through the DCC into the central Delta from: (1) elevated water temperatures and poorer water quality within the central Delta; (2) losses due to entrainment at unscreened water diversions within the central Delta; (3) predation associated with the waterways of the central and southern Delta; (4) reverse flow conditions as a result of CVP/SWP pumping; and (5) direct loss at the Delta pumping facilities within the southern Delta. In addition, delays and increased straying are expected when adult salmonids encounter the backside of the DCC gates in the closed position after moving upstream through the Mokelumne River system from the San Joaquin River system.

CV steelhead emigrating from the San Joaquin River basin will also face mortality, injury, and harm through greater diversion into the Old River, Turner Cut, and Columbia Cut due to the

influence of the CVP/SWP export pumps. Negative flows in Old and Middle River will increase exposure time to higher water temperature, increased predation, increased contaminants, and direct losses at CVP/SWP export pumps. Incidental take through the collection, handling, trucking, and release of salvaged juveniles and adults at the Tracy and Skinner Fish Collection Facilities is expected to decrease as exports and negative OMR flows are reduced due this RPA and the USFWS' Opinion on delta smelt.

Incidental take at the unscreened Rock Slough diversion into Contra Costa Canal is expected to continue in the near-term (next 3 years), but at much lower levels than historically due to: (1) less volume of water diverted, (2) greater use of other screened facilities to compensate for Rock Slough diversions, and (3) construction activities associated with the enclosing the canal. In the long-term take is expected to be non-existent due to canal encasement and construction of a new fish screen at the Rock Slough Headworks (Reclamation 2009).

Operation of the DCC gates and Delta pumping plants are expected to cause mortality of winter-run, spring-run, green sturgeon, and CV steelhead emigrating from the Sacramento River basin through entrainment into the central Delta where survival rates are expected to be demonstrably reduced compared to the mainstem Sacramento River and northern Delta channels. In most years these losses will be minimized by intermittent DCC gate closures from October through January and mandatory closures from February 1 to May 20 (SWRCB, D-1641). Current mortality of winter-run, spring-run and CV steelhead juveniles that are diverted into the central Delta ranges from 33 to 95 percent (Brandes and McLain 2001, USFWS 2001-2004) depending on a variety of factors. These mortalities are generally attributed to increased residence time, a longer migration route, reverse flows, altered salinity gradient, predation, elevated water temperatures, contaminants, and reduced food supply (CDFG 1998; McEwan 2001, Vogel 2004) with an estimated reduction of the population entering the Delta from the upper Sacramento River basin of 5 to 20 percent due to the losses in the Delta interior. While losses at the CVP and SWP Delta pumping facilities can generally be quantified through observations of salvaged fish at the Tracy and Skinner Fish collection facilities, the difference in through-Delta mortality as a result of proposed operation of the Delta pumping plants is difficult to detect and quantify because dead or injured juvenile fish cannot be readily observed or accounted for. Overall, implementation of the RPA actions are expected to reduce the level of mortality at the export pumps (*i.e.,* through DCC gate closures, OMR flow restrictions, new flow criteria for the San Joaquin River, and implementation of the actions in the USFWS' 2008 biological opinion to protect Delta smelt.

13.1.6 Quantification of Incidental Take at the CVP and SWP Delta Pumping Facilities

Loss of winter-run, spring-run and CV steelhead juveniles is monitored at the CVP and SWP Delta pumping facilities utilizing different methods, as provided below.

Expanded losses based on salvaged fish are quantified in table 13-6. These numbers are difficult to assess due to the difficulty in determining the race of the salvaged salmonids, which is determined based on the size of the fish at date of capture from look-up tables. There is significant overlap in the size criteria, especially between spring-run and fall-run.

Table 13-6. Combined CVP/SWP salvage and loss by ESA-lised species, hatchery and wild fish combined from 1993-2009 (source: CDFG database).

	Steelhead		Spring-run	Winter-run	Green Sturgeon	
Year	Salvage	Loss[a]	Loss[b,c]	Loss[c]	Salvage	Loss[d]
1993	16,972			1,922		
1994	1,361			1,004		
1995	2,437		38,581	1,351	125	166
1996	5,380		33,466	7,611	108	144
1997	963		57,083	518	113	150
1998	1,008		28,259	2,886	112	149
1999	2,571		128,172	4,173	108	144
2000	9,272		98,801	8,307	21	28
2001	12,819	38,270	41,396	23,392	15	20
2002	3,590	9,435	14,581	10,048	84	112
2003	12,850	29,526	42,904	29,551	18	24
2004	9,773	22,852	11,575	26,591	0	0
2005	3,597	6,960	30,927	5,337	16	21
2006	3,797	11,654	13,633	3,853	204	271
2007	5,635	9,070	5,257	5,332	185	246
2008	3,831	9,529	12,005	6,901	8	11
2009[e]	1,312	3,098	6,916	1,461	0	0
total	97,168	140,394	563,556	140,238	1,117	1,485
average	5,715	15,599	37,570	8,249	74	106

[a] Steelhead loss expansion based on Chinook salmon loss rates for CVP and SWP (Clark 2009),

[b] Spring-run loss represents only those fish identified by length-at-size, unknown how many spring-run are actually salvaged.

[c] Winter-run and spring-run losses include ad-clipped fish

[d] Green sturgeon loss assumes 95 percent louver efficiency (Kynard and Horgan 2001) with cleaning loss applied (*i.e.*, salvage (1/.75) = time louvers are lifted out of water. Cleaning time varies from 4 hrs/day to 12 hrs/day, depending on debris load, averaged to 6 hrs/day or 25% of time

[e] 2009 salvage numbers are preliminary as of 5/04/09

The losses in table 13-3 do not include losses at the Tracy Fish Facility when the louvers are raised for cleaning, nor does it include predation losses at the release site.

13.1.6.1 Juvenile Winter-Run

In an effort to better identify juvenile Chinook salmon, DWR has conducted genetic studies for several years at the CVP and SWP fish facilities. Although preliminary, these studies have shown roughly 50 percent of those fish identified by size as winter-run are genetically winter-run (Sheila Greene, pers. comm. 2008). Based on the actions provided in the RPA to minimize direct and indirect losses, combined incidental take of juvenile winter-run will not exceed 2 percent (based on size criteria described above, which is actually approximately 1 percent genetically determined winter-run) of the estimated JPE between the CVP and SWP pumping plants.

13.1.6.2 Juvenile Spring-Run

Similar to winter-run, genetic studies have been conducted on spring-run (based on the size of the fish at date of capture from look-up tables) at the CVP and SWP fish facilities to determine its genetic race. Although preliminary, these studies have shown that less than 50 percent of those fish identified by size as winter-run are genetically winter-run (most were genetically fall-run). However, for Chinook salmon, the losses are probably overestimated due to the inability to identify individuals to race (*e.g.*, most Chinook salmon reported to be within the spring-run size category are actually fall-run).

Incidental take of yearling spring-run is based on observations of CWT late fall-run uniquely marked at Coleman National Fish Hatchery and released in the upper Sacramento Basin as spring-run surrogates. These uniquely marked late fall-run are expected to serve as appropriate surrogates for spring-run because they would be released to begin their emigration and smoltification passage through the Delta at approximately the same time and size as wild spring-run. Spring-run surrogate release groups will be identified by NMFS, in consultation with USFWS and CDFG. Since the surrogates would experience the same conditions in the Sacramento River, NMFS anticipates that they will be entrained at the export facilities at comparable rates to the wild fish. Using marked late fall-run as surrogates, incidental take of spring-run is not expected to exceed 1 percent. Take will be calculated with the standard loss estimation procedures applicable at the respective fish collection facilities.

Due to expanded monitoring efforts in the upstream tributaries, wild spring-run juveniles are being tagged with CWTs as they migrate downstream to the Sacramento River. In 2003, there were 97,529 tagged in Butte Creek and 36,415 tagged in the Yuba River (CDFG 2004b). Since it is standard practice at the Delta Fish Collection Facilities to kill all Chinook salmon that are CWT tagged for identification purposes, a certain amount of lethal take is expected for these wild spring-run. In the 2002-2003 Sacramento River winter-run Chinook Incidental Take Report (DWR 2004), no wild spring-run were reported at the Delta fish collection facilities, however six tags were recovered from the USFWS Sacramento trawl and Chipps Island trawl studies in April and May. NMFS expects that in April and May a small number of tagged wild spring-run will be entrained and therefore killed during the sampling process (*i.e.*, 10 minute counts) at the Delta Fish Collection Facilities.

13.1.6.3 Juvenile Steelhead

Although estimates of steelhead abundance exist (*e.g.*, figures 4-4 and 5-12), NMFS is not aware of any DPS-wide estimate of CV steelhead abundance in order to determine an appropriate level of incidental take. Therefore, until population estimates can be made that are representative of the DPS, the incidental take will be based on the historical salvage.

Incidental take of steelhead is based on yearly observations of unmarked steelhead at the CVP's Tracy and SWP's Skinner fish collection facilities during the period of October 1 through September 30. Until a suitable JPE is developed, the combined cumulative salvage of unmarked juvenile and adult CV steelhead at the CVP and SWP Delta pumping facilities is not expected to exceed 3,000 unmarked juvenile and adult CV steelhead. Generally, these fish are returned alive to the Delta waters through the collection, trucking and release program at the CVP and SWP pumping facilities.

Given the current status of CV steelhead in the Southern Sierra Nevada Diversity Group, and that at the export facilities, the origin of steelhead cannot be determined, incidental take of CV steelhead will be revisited under term and condition 13.4.2(a) and again following results of the acoustic tagging studies pursuant to RPA Action IV.2.2.

13.1.6.4 Green Sturgeon

There is no known population estimate for green sturgeon in order to determine an appropriate level of incidental take. Therefore, until a population estimate can be made, the incidental take will be based on the historical salvage. Green sturgeon salvage and loss is highly variable, but is not expected to exceed the 10-year historical average of 74 and 106 juveniles, respectively, per year. As the Proposed Action is implemented in the future, the green sturgeon population is expected to increase to varying degrees, resulting in an increase in incidental take. Therefore, incidental take should be reassessed at every NMFS status review (*i.e.*, every 5 years) and adjusted as new information becomes available.

13.1.7 Fish Facilities Studies

Incidental take associated with Fish Facilities studies and evaluations are conducted with the objective of improving the fish salvage process (table 13-5). These studies include incidental take that occurs above and beyond the normal salvage operations due to additional handing and stress associated with such actions as gill netting, electro-shocking, and seining within or around the facility. No direct mortality was reported in 2008, however, the estimated non-lethal take based on salvage data and run timing was 232 winter-run, 6,679 spring-run, 791 steelhead, and 11 green sturgeon (table 13-7). Studies are also conducted on fish collection, trucking, and handling at the Skinner Fish Facility. The added stress of these studies on fish could potentially disrupt feeding, reduce the health, and impair the smoltification process.

Table 13-7. Estimated incidental take associated with studies conducted at the Tracy Fish Facility based on historical salvage data from 1998-2002.

Estimated incidental take from Tracy Fish Facility Studies 2008- 2010								
Proposed Studies	**Winter-run**		**Spring-run**		**Steelhead****		**Green**	**Sturgeon**
	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal
Abandoned Intake Channel	0	0	0	0	0	0	0	1
CO2 Predator Removal	16	1	38	1	25	1	1	1
Fish Holding	18	0	0	0	6	0	1	0
Holding Tank Screen	2	0	268	0	6	0	2	0
Debris Study	0	1	2	1	0	1	1	1
New Secondary System (lab)	0	0	0	0	0	0	0	0
Predator Numbers	12	60	29	60	19	60	0	0

Above Ground Tank	5	0	4	0	3	0	1	0
Crab Screen Study	36	0	445	0	118	0	1	0
Full Facility Evaluation	71	0	2888	0	161	0	1	0
Holding Tank Swirl Test	71	0	2895	0	132	0	1	0
Louver Cleaning Test	0	1	0	1	2	1	1	1
Predator Impacts for VAMP	1	0	110	0	319	24	1	0
Total by species*	232	**63**	6679	**63**	791	**87**	11	**4**

*2008 actual mortality reported = 0
**steelhead includes hatchery+ wild

13.1.8 CCWD Diversion

From 1994 to 1996, CDFG estimated expanded juvenile losses (*i.e.*, entrainment losses plus losses due to predation) of 257 winter-run, 2,215 spring-run, and 738 steelhead. Since NMFS' 2004 CVP/SWP operations Opinion was issued, CCWD initiated several improvements that reduce the entrainment at the Rock Slough diversion. These include: (1) the Canal Encasement Project currently under construction; (2) the Alternative Intake Project scheduled to be completed in the summer of 2010; (3) reduced diversions at Rock Slough, since Old River Intake became operational in 1998; and (4) a Water Use Efficiency Program. The Canal Encasement Project will eliminate tidal flows into the unscreened canal, significantly reducing entrainment, predation, and improving the feasibility of screening the Rock Slough intake. In addition, due to other agreements with CDFG, SWRCB, and USFWS, the CCWD must cease diversions for 30 days in April in order to protect larval delta smelt that can become entrained in the fish screen. These operating criteria minimize contact between juvenile salmonids and their food supply, and the fish screen, in the spring. Direct losses due to entrainment are not expected to exceed 5 winter-run juveniles, 10 spring-run juveniles, and 10 steelhead annually based on the last 10 years of monitoring behind the Pumping Plant and Headworks (table 13-8). This incidental take does not account for extrapolated losses due to predation in the Contra Costa Canal and losses through the pumping plant.

Under CVPIA section 3406(b)(5), Reclamation is required to construct a fish screen at CCWD's Rock Slough intake. The USFWS granted Reclamation an extension on fish screen construction until December 2008. On March 26, 2009, Reclamation again requested a 10-year extension of the construction completion date until 2018 and amendment of the Los Vaqueros Biological Opinion (letter from Carl Dealy, Reclamation, to Susan Moore, USFWS). If, and when, a fish screen is eventually built on Rock Slough, incidental take is not expected to occur. At such time as a fish screen on Rock Slough becomes operational, the authorized incidental take in this ITS will no longer apply.

Table 13-8. Summary of ESA listed fish captured at the Rock Slough Headworks and Pumping Plant #1 and water diverted from 1998-2008 (Source CVP/SWP operations BA table 13-30).

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	totals

Winter	1	0	0	0	0	0	0	0	0	0	0	1
Spring	0	0	0	0	0	0	6	4	4	0	0	14
Fall/LF	0	0	3	0	0	0	7	10	1	0	0	21
Steelhead (Ad-clip)	0	0	0	0	0	0	0	0	0	0	8	8
Steelhead (no-clip)	0	0	0	0	0	0	0	3	2	1	0	6
Steelhead unknown	0	0	0	0	0	0	0	1	0	0	0	1
Green Sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Water diverted in TAF	68	43	51	27	36	27	31	35	43	39	6	408

13.1.9 Implementation of Sacramento River Basin Salmonid Rearing Habitat Improvements (*i.e.*, RPA Action Suite I.6)

Rearing habitat improvement projects described in the RPA could be implemented in the mainstem Sacramento River and in any part of the tributary subbasins (*e.g.*, Feather River, American River, San Joaquin River, and Clear Creek). Some habitat projects will have negative effects during construction (*e.g.*, increased turbidity, sediments, short-term and temporary disturbances, and contamination from machinery). These are expected to be minor, occur only at the project scale, and persist for a short time. The inundation of the Yolo Bypass is expected to cause incidental take from these short-term adverse effects, and from predation within the project area from non-native introduced fish species.

Take of listed salmonids resulting from rearing habitat improvement projects developed to implement this RPA and authorized, funded, or carried out by Reclamation and DWR that are consistent in type, design, and implementation to those covered by the ESA Section 7 Formal Programmatic Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Implementation of the CVPIA and CALFED CY 2003-2010, falls within the take provisions of that Biological Opinion (NMFS 2003). Take resulting from projects that fall outside of the explicit criteria in the CVPIA or CALFED Opinions will require separate and subsequent consultation.

13.1.10 Operation of the Nimbus Fish Hatchery Steelhead Program

The RPA requires actions to ensure that the Nimbus Fish Hatchery Steelhead Program does not reduce the viability of the listed steelhead residing in the lower American River (*i.e.*, below Nimbus Dam). NMFS considers fish that are the offspring of hatchery and wild, or hatchery fish that spawn in-river, to be natural, non-hatchery fish. Thus, the juveniles that result from hatchery fish spawning in-river would be protected under the ESA (*e.g.*, progeny of hatchery

spring-run that spawn in the Feather River, or progeny of hatchery-reared steelhead that spawn in the American River would be considered listed under the ESA). Incidental take associated with the Nimbus Fish Hatchery Steelhead Program is covered through this ITS for an interim period of 2 years from issuance of this Opinion, with the expectation that a Nimbus Fish Hatchery HGMP will be completed at that time and subsequent take will be authorized through the 4(d) process.

Nimbus Fish Hatchery annually handles wild steelhead that return with hatchery steelhead up the fish ladder. Current hatchery protocol is to release all unclipped steelhead back to the river to spawn. These fish undergo some handling stress and disorientation in the process. Adults may be delayed from spawning by 1 to 2 days, or may drop back downstream from the stress of handling. Additional stress will result from those fish that encounter the hatchery barrier weir and are blocked from migrating further upstream to spawn. These fish may become injured while trying to pass through the weir and drop back downstream. Steelhead and salmon have been observed to drop back downstream after entering fish ladders and encountering barrier weirs at RBDD and Iron Gate Hatchery on the Klamath River. It is likely that steelhead that drop back downstream on the American River will either spawn later in time or stray into other rivers to spawn.

Based on the historical rate of steelhead that enter the Nimbus Fish Hatchery (table 13-9), NMFS anticipates that less than 150 wild steelhead will enter the Nimbus Fish Hatchery annually. The number of unmarked steelhead that encounter the Nimbus Fish Hatchery represents a significant (*i.e.*, 30 to 50 percent) portion of the in-river spawning population below Nimbus Dam. The average in-river population is 300 adult spawners based on redd counts from 2002 through 2007 (Hannon and Deason 2007).

Table 13-9. Steelhead adult returns to Nimbus Fish Hatchery (source: CVP/SWP operations BA)

Year	total return (hatchery + wild)	Number unclipped (wild)	Percent unclipped
2001	2,877	50	1.7
2002	1,253	69	5.5
2003	873	27	3.1
2004	1,741	17	1.0
2005	2,772	118	4.3
2007	2,673	116	4.3

An unquantifiable amount of take is also anticipated as a result of the interrelated and interdependent effects of Nimbus Fish Hatchery operations. These effects primarily stem from straying, competition for space, and hybridization between wild fish and hatchery-produced salmon and steelhead. A recent report examining the decline of the Sacramento River fall-run found that hatcheries have reduced the variation and diversity of the overall abundance of Chinook salmon in the Central Valley, leaving them unsuited to handle varying changes in ocean conditions (Lindley *et al*. 2009). Remnant populations of spring-run and winter-run were found better suited to cope with recent changes in ocean conditions because of life-history diversity that can buffer environmental changes (*e.g.*, spawning in summer, or at higher elevations leads to

delayed ocean entry at a larger size than fall-run) that confers survival advantages upon entry into the ocean environment.

13.1.11 Fish Passage Program

RPA Action V, NF4, requires the implementation of a Pilot Reintroduction Program, in January 2013. As there is currently only one population of winter-run, non-lethal take will be exempted for the number of adult winter-run determined by the Interagency Fish Passage Steering Committee, pursuant to Action V, NF3, #1 and 3, as necessary, for the pilot program, provided that NMFS concurs in writing with the specific handling procedures associated with the Fish Passage Pilot Plan. NMFS does not anticipate any pre-spawn mortality associated with the pilot program. However, any incidental mortality associated with the pilot program is covered.

Incidental take through this ITS is not covering spring-run above Shasta Dam on the Sacramento River, CV steelhead above Folsom Dam on the American River, or CV steelhead above New Melones Dam on the Stanislaus River. The Interagency Fish Passage Steering Committee shall convene and determine the best source population of spring-run and steelhead to utilize for each of the rivers in this pilot reintroduction program. Once this is established, Reclamation shall apply for an ESA section 10(a)(1)(A) research permit to cover the activities.

In addition, NMFS is not approving any incidental take coverage for the long-term fish passage actions.

13.2 Effect of the Take

In the accompanying formal biological opinion, NMFS has determined that the anticipated level of incidental take associate with project operations, as modified by the RPA, is not likely to jeopardize the continued existence of winter-run, spring-run, CV steelhead, or Southern DPS of green sturgeon.

13.3 Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon.

1. Reclamation and DWR shall monitor the extent of incidental take of winter-run, spring-run, green sturgeon, and CV steelhead, associated with the operation of the CVP's Jones and SWP's Harvey Banks pumping facilities.

2. Reclamation shall seek to develop an alternative technique to quantify incidental take of listed anadromous salmonid species at the Federal and State export facilities.

3. Reclamation shall minimize the adverse effects of flow fluctuations associated with CVP-controlled stream operations on listed anadromous fish species spawning, egg incubation, and fry and juvenile rearing.

4. Reclamation and DWR shall monitoring all incidental take associated with CVP and SWP operations.

5. Reclamation and DWR shall annually report to NMFS the incidental take resulting from the implementation of the Proposed Action.

13.4 Terms and Conditions

Reclamation and DWR must comply or ensure compliance by their contractor(s) with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. Reclamation and DWR shall monitor the extent of incidental take of winter-run, spring-run, green sturgeon, and CV steelhead, associated with the operation of the CVP's Jones and SWP's Harvey Banks pumping facilities.

    a. Reclamation and DWR shall calculate winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon loss at the Jones and Banks pumping plants on a real-time basis from October 1 through June 30 each year. Loss and salvage shall be computed using formulas developed in consultation with CDFG and USFWS and approved by NMFS.

    b. Reclamation and DWR shall monitor the loss of juvenile winter-run at the CVP and SWP Delta pumping facilities and will use that information to determine whether the anticipated level of loss is likely to exceed the authorized level of 2 percent, cumulatively, of the estimated number of juvenile winter-run entering the Delta annually.

    c. Reclamation and DWR shall monitor the loss of identified spring-run surrogate release groups at the CVP and SWP Delta pumping facilities and use that information to determine whether the cumulative estimated level of loss is expected to exceed 1%.

    d. Reclamation and DWR shall monitor the salvage of CV steelhead at the CVP and SWP Delta pumping facilities and use that information to determine whether the cumulative estimated level of salvage is expected to exceed 3,000 unclipped steelhead (juveniles and adults combined) at the CVP and SWP Delta pumping facilities. Incidental take of CV steelhead shall be reported as salvage and calculated loss.

    e. Reclamation and DWR shall monitor the loss of juvenile green sturgeon at the CVP and SWP Delta pumping facilities and use that information to determine whether the cumulative estimated level of loss is expected to exceed 110 juveniles annually (previous 10-year average).

    f. If the estimated rate of loss approaches the incidental take level anticipated for any of the anadromous fish species at the SWP Harvey Banks pumping facility combined with the estimated take at the CVP Jones pumping facility is exceeded, Reclamation and DWR shall immediately convene the WOMT to explore additional measures which can be

g. DWR shall collect additional data at the Clifton Court Forebay, the John Skinner Fish Collection Facility, and the Harvey Banks pumping plant to monitor the incidental take of winter-run, spring-run, steelhead, and green sturgeon and to develop and implement improvements to pumping facility operations to further reduce or minimize losses of listed salmonids.

h. DNA tissue samples and CWT samples from juvenile winter-run, spring-run, and steelhead at the Tracy and Skinner fish collection facilities shall be collected by DWR or CDFG for genetic analysis or tag removal/reading pursuant to the sampling protocols established by the IEP Salmon Genetics Project Work Team. Tissues shall be stored at the CDFG tissue bank at Rancho Cordova for subsequent analysis by Oregon State University or similar lab approved by NMFS. Whole fish or heads for CWT processing and identification shall be stored at the USFWS Bay/Delta Office in Stockton. All samples shall be clearly marked according to office protocol and a log maintained at each storage facility.

b. Reclamation and DWR shall submit weekly reports to the interagency DAT and an annual written report to NMFS describing, as a minimum, the estimated salvage and loss of winter-run, spring-run, steelhead, and green sturgeon associated with operations of the Jones and Harvey Banks pumping facilities, respectively.

2. Reclamation shall seek to develop an alternative technique to quantify incidental take of listed anadromous salmonid species at the Federal and State export facilities.

a. In coordination with NMFS, Reclamation shall select and fund an independent contractor to determine the best technique to quantify incidental take of winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon at the Federal and State export facilities. Reclamation shall submit a final report to NMFS by December 31, 2010, summarizing the recommendations for quantifying incidental take, with the selection of a proposed technique. The technique for quantifying take shall be implemented immediately upon NMFS' concurrence. In the event that this measure is not implemented immediately and reflected in the annual report per term and condition 3.a. below, take authorization for CV steelhead shall cease on December 31, 2011. Incidental take, especially for CV steelhead, but for the other listed anadromous fish species as well, may be adjusted based on the application of the new technique to quantify incidental take at the Federal and State export facilities.

3. Reclamation shall minimize the adverse effects of flow fluctuations associated with CVP-controlled stream operations on listed anadromous fish species spawning, egg incubation, and fry and juvenile rearing.

a. Reclamation shall schedule maximum ramping down rates of non-Glory Hole (*i.e.*, non-flood control) releases from Whiskeytown Reservoir according to the table, below (estimated at RM 3.03). Ramping rates for releases greater than 300 cfs shall be made after consultation with the Clear Creek Technical Team, considering: time of year, time of day, timing the change to occur with natural changes in-flow and/or turbidity, size of fish present in the creek, species and protected status of vulnerable fish, the amount of water required, and relative costs or benefits of proposed flow. Reclamation shall time flow decreases so that the most juvenile Chinook salmon and steelhead experience the stage decrease during darkness. Maximum ramping rate of flow releases from Whiskeytown Dam into Clear Creek shall be accomplished based on the following targets within the precision of the outlet works or the City of Redding powerplant equipment.

Discharge	**Ramping Rate**
600-330 cfs	16 cfs / hour
330-105 cfs	15 cfs / hour
105-50 cfs	14 cfs / hour

b. During periods outside of flood control operations and to the extent controllable during flood control operations, Reclamation shall ramp down releases in the American River below Nimbus Dam as follows:

Lower American River Daily Rate of Change (cfs)	Amount of decrease in 24 hrs (cfs)	Maximum change per step (cfs)
20,000 to 16,000	4,000	1,350
16,000 to 13,000	3,000	1,000
13,000 to 11,000	2,000	700
11,000 to 9,500	1,500	500
9,500 to 8,300	1,200	400
8,300 to 7,300	1,000	350
7,300 to 6,400	900	300
6,400 to 5,650	750	250
5,650 to 5,000	650	250
<5,000	500	100

c. During periods outside of flood control operations and to the extent controllable during flood control operations, Reclamation shall ramp releases in the Stanislaus River below Goodwin Dam as follows:

Existing Release Level (cfs)	Rate of Increase (cfs)	Rate of Decrease (cfs)

at or above 4,500	500 per 4 hours	500 per 4 hours
2,000 to 4,499	500 per 2 hours	500 per 4 hours
500 to 1,999	250 per 2 hours	200 per 4 hours
300 to 499	100 per 2 hours	100 per 4 hours

4. Reclamation and DWR shall monitor all incidental take associated with CVP and SWP operations.

   a. Reclamation shall implement all aspects of RPA section 11.2.1.3

5. Reclamation and DWR shall annually report to NMFS the incidental take resulting from the implementation of the Proposed Action.

   a. Reclamation and DWR shall provide an annual written report to NMFS no later than October 1 of each year. This report shall provide the data gathered and summarize the results of winter-run, spring-run, CV steelhead, and green sturgeon monitoring and incidental take associated with the CVP and SWP operations. All mortalities must be minimized and reported, including those from special studies conducted during salvage operations.

   b. Reclamation and DWR shall provide reports and updates to NMFS by the specified dates, as provided in various RPA actions (*e.g.*, section 11.2.1.3 #3, Action I.1.3, Action Suite I.2).

   c. Unless otherwise specified during the implementation of these terms and conditions, all reports and updates shall be sent to:

      Supervisor
      Sacramento Area Office
      National Marine Fisheries Service
      650 Capitol Mall, Suite 8-300
      Sacramento California 95814-4706
      FAX: (916) 930-3629
      Phone: (916) 930-3600

14.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS thinks the following

conservation recommendations are consistent with these obligations, and therefore, should be implemented by Reclamation:

1. In proposing the SRWRP for a future section 7 consultation, Reclamation should first ensure that Shasta Reservoir storage and cold water pool requirements are met, as provided in RPA Action I.2.2, and that all construction-related and operational impacts of the SRWRP, both upstream and in the Delta, are analyzed in consideration of the operations and effects on listed species and critical habitats of the CVP and SWP that were analyzed in this consultation.

2. Reclamation and DWR should continue to work with the BDCP process to develop a scientifically-based, alternative conveyance program for the Delta that conserves all ESA-listed anadromous fish species in the Central Valley. This effort should evaluate a new point of diversion in the Sacramento River without adding new stressors to listed fish and their critical habitats. If NMFS determines that locations and operations are available which minimize adverse effects to all listed species and designated critical habitats, then Reclamation and DWR should pursue alternative locations and operations for Delta diversions.

3. Reclamation should continue to fund CALFED ERP restoration actions, consistent with previous commitment and funding levels, and to fulfill CALFED ROD commitments. DWR should support continued state funding to CDFG to further implementation of the CALFED ERP.

4. Reclamation should conduct studies to determine the economic feasibility and extent of biological benefits to listed species and critical habitats of completely removing the RBDD from the Sacramento River.

5. DWR should continue to fund the Amended Delta Fish Agreement (Amendment) to mitigate, compensate for, and enhance habitat for anadromous salmonids in the Central Valley. Past actions under this agreement have improved upstream habitats and conditions for spring-run, fall-run, and steelhead and have contributed to the current status of the species. Ongoing actions identified in the Amendment should be continued, if the benefits of past actions are to be maintained. NMFS expects that this Amendment will also support implementation of actions specified in this RPA, such as re-introduction of winter-run to Battle Creek and habitat improvements at the Yolo Bypass, Liberty Island and other areas.

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Volume 70 pages 52488-52627. September 2, 2005. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule.

Volume 70 pages 69903-69912. November 18, 2005. Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whales. Final Rule.

Volume 71 pages 834-862. January 5, 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead; Final Rule.

Volume 71 pages 17757-17766. April 7, 2006. Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon.

Volume 71 page 53421. September 11, 2006. Endangered and Threatened Species: Recovery Plan Preparation for 5 Evolutionarily Significant Units (ESUs) of Pacific Salmon and 5 Distinct Population Segments (DPSs) of Steelhead Trout.

Volume 73 pages 52084-52110. September 8, 2008. Endangered and Threatened Wildlife and Plants: Proposed Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon.

NOAA/NMFS release summarizing the 2009 Biological Opinion, June 4, 2009

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

NOAA Biological Opinion Finds California Water Projects Jeopardize Listed Species; Recommends Alternatives

June 4, 2009

NOAA released its final biological opinion today that finds the water pumping operations in California's Central Valley by the federal Bureau of Reclamation jeopardize the continued existence of several threatened and endangered species under the jurisdiction of **NOAA's Fisheries Service**.

The bureau has provisionally accepted NOAA's recommended changes to its water pumping operations, and said it will begin to implement its near-term elements as it carefully evaluates the overall opinion.

Federal biologists and hydrologists concluded that current water pumping operations in the Federal Central Valley Project and the California State Water Project should be changed to ensure survival of winter and spring-run Chinook salmon, Central Valley steelhead, the southern population of North American green sturgeon and Southern Resident killer whales, which rely on Chinook salmon runs for food.

Two independent peer review panels were conducted to ensure the opinion is solidly grounded in the best available science. The package was peer reviewed by the CalFed Independent Science Board and the Center for Independent Experts.

"What is at stake here is not just the survival of species but the health of entire ecosystems and the economies that depend on them," said Rod Mcinnis, southwest regional director for NOAA's Fisheries Service. "We are ready to work with our federal and state partners, farmers and residents to find solutions that benefit the economy, environment and Central Valley families."

As part of the final opinion, NOAA's Fisheries Service has provided a number of ways the bureau can operate the water system to benefit the species, including increasing the cold water storage and flow rates. Such methods will enhance egg incubation and juvenile fish rearing, as well as improve the spawning habitat and the downstream migration of juvenile fish.

Changing water operations will impact an estimated five to seven percent of the available annual water on average moved by the federal and state pumps, or about 330,000 acre feet per year. Agricultural water use in California is roughly 30 million acre feet per year. Water operations will not be affected by the opinion immediately and will be tiered to water year type. The opinion includes exception procedures for drought and health and safety issues.

In addition, the opinion calls for the bureau to develop a genetics management plan and an acoustic tagging program to evaluate the effectiveness of the actions and pilot passage programs at Folsom and Shasta reservoirs to reintroduce fish to historic habitat.

The American Recovery and Reinvestment Act will mitigate some costs resulting from the opinion's recommended actions. The Department of the Interior identified $109 million to construct a Red Bluff Pumping Plant that will allow the old Red Bluff Diversion Dam to be operated in a "gates out" position to allow salmon and green sturgeon unimpeded passage. In addition, the Act contains $26 million to restore Battle Creek, a salmon tributary to the Sacramento River.

The water projects included in the opinion are Shasta Dam at the upper headwaters of the Sacramento River, Folsom and Nimbus dams on the American River, and New Melones Dam on the Stanislaus River. The opinion also covers the state and federal export facilities in the Delta, the Nimbus hatchery on the American River, and the operations of diversion structures, including the Red Bluff Diversion Dam on the mainstem Sacramento and the Delta Cross Channel gates in the Delta.

The bureau initiated the formal phase of consultation in May 2008 and then cooperated with NOAA's Fisheries Service throughout the development of the biological opinion and alternative actions in coordination with the U.S. Fish and Wildlife Service and the California Departments of Water Resources and Fish and Game.

A copy of the final biological opinion and alternative actions may be found online.

NOAA understands and predicts changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and conserves and manages our coastal and marine resources.

DWR release responding to the 2009 Biological Opinion, June 4, 2009

News for Immediate Release

June 4, 2009

Contacts:

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DWR Responds to New Biological Opinion to Protect Salmon

SACRAMENTO -- The Department of Water Resources (DWR) today responded to the new biological opinion by the National Marine Fisheries Service (NMFS) intended to protect salmon and several other species.

"Today's Biological Opinion on salmon reaffirms the need for a comprehensive solution to the water and environmental conflicts in the Delta," said DWR Director Lester A. Snow. "The new Opinion, which could reduce Delta export on average by about 300,000 to 500,000 acre feet, further chips away at our ability to provide a reliable water supply for California. A multi-species approach, as envisioned in the Bay Delta Conservation Plan, is the best approach to achieve habitat and species conservation and a reliable water supply."

NMFS (NOAA Fisheries) calculates that its biological opinion that addresses salmon, steelhead and green sturgeon will reduce by 5 to 7 percent combined the amount of water state and federal projects will be able to deliver from the Delta to the San Francisco Bay Area, San Joaquin Valley, Central Coast and Southern California. DWR's initial estimates show the average year impacts closer to 10 percent. That is in addition to current pumping restrictions imposed by biological opinions to protect Delta smelt and other species.

DWR will continue to work with the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, NMFS, California Fish and Game and others on the BDCP steering committee to develop a collaborative habitat conservation plan under the Endangered Species Act and the California Natural Community Conservation Planning Act, with the goal of creating a long-term strategy for Delta sustainability that complies with state and federal environmental laws.

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The Department of Water Resources operates and maintains the State Water Project, provides dam safety and flood control and inspection services, assists local water districts in water management and water conservation planning, and plans for future statewide water needs.

Contact the DWR Public Affairs Office for more information about DWR's water activities.

SWP Contractors' release concerning the litigation filed challenging the 2009 Biological Opinion, August 6, 2009

FOR IMMEDIATE RELEASE:
August 6, 2009

CONTACT:
Ann Newton
(818) 760-2121

STATE WATER CONTRACTORS ASKS COURT TO INVALIDATE FEDERAL REGULATIONS THAT LIMIT WATER SUPPLY FOR PEOPLE, FARMS AND BUSINESSES

Biological Opinion for Salmon Based on Flawed Science, Violates Endangered Species Act

Sacramento, CA – The State Water Contractors (SWC) filed a lawsuit today against federal agencies challenging regulations that further limit the amount of water that can be pumped through the Sacramento-San Joaquin Delta (Delta). The regulations, outlined in a biological opinion for Chinook salmon, steelhead and green sturgeon, failed to take into account the many other factors contributing to the fish population decline, such as changing ocean conditions. It also failed to consider the very real impacts that the regulations would have on people, a requirement of the National Environmental Policy Act.

The California Department of Water Resources has estimated that the new salmon regulations will result in average cuts of 300,000 to 500,000 acre-feet each year. This is on top of the cutbacks already in place because of another fish species, the Delta smelt. So far in 2009, 430,000 acre-feet of water – enough to serve more than two million people for one year – has been cut from the state's water supply in order to satisfy the requirements of the Delta smelt biological opinion.

"Public water agencies recognize the regulators' concerns about the decline in fisheries, but we must be strategic in how we address the decline," said Laura King Moon, assistant general manager of the State Water Contractors. "This is a substantial cutback on top of already greatly curtailed supplies due to the effects of a three-year drought."

Although the regulatory response to the decline in salmon populations has focused solely on the state and federal water projects, federal wildlife agencies recently identified changing ocean conditions as the primary cause, in addition to significant ocean harvests (http://swr.nmfs.noaa.gov/media/SalmonDeclineReport.pdf). Other factors impacting fish populations include invasive plants and animals that are upsetting chemical and biological balances in the Delta, toxic runoff from pesticides and wastewater treatment plant discharges, and predation by sport fishing species – all of which have dramatically altered the natural food web.

"These cuts have real costs to our customers and to the state's economy. It is not at all clear that additional supply cutbacks will help improve the fishery any better than previous cutbacks," added Moon. "We need to use the best available science and that means taking a close look at the many other factors contributing to the fish decline."

At the center of these regulatory restrictions is the failing Delta – a critical estuary and the hub of California's primary water delivery systems. Public water agencies, environmental organizations, and state and federal agencies are working together to develop a long-term solution. The Bay Delta Conservation Plan (BDCP), a comprehensive conservation plan for the Delta, will provide a basis for addressing the many threats to the Delta needed for fishery and ecosystem recovery, while finding a way to continue to deliver water to Californians throughout the state.

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The State Water Contractors is a statewide, non-profit association of 27 public agencies from Northern, Central and Southern California that purchase water under contract from the California State Water Project. Collectively the State Water Contractors deliver water to more than 25 million residents throughout the state and more than 750,000 acres of agricultural lands. For more information on the State Water Contractors, please visit www.swc.org.

Coalition for a Sustainable Delta/Kern County Water Agency release concerning the litigation filed challenging the 2009 Biological Opinion, August 28, 2009

Coalition for a Sustainable Delta

PRESS RELEASE

FOR IMMEDIATE RELEASE
August 28, 2009

Coalition for a Sustainable Delta
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Kern County Water Agency
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San Joaquin Valley Water Users File Suit Over Water Restrictions
Federal Actions To Protect Salmon Based On Flawed Science

Bakersfield, CA – The Coalition for a Sustainable Delta (Coalition) and the Kern County Water Agency jointly filed suit against the United States Department of Commerce, National Marine Fisheries Service (NMFS) for their continued failure to address all factors or stressors that impact the Delta ecosystem and its fish species. The suit focuses on recent federal actions, designed to protect salmon populations, which will bring great harm to California's economy and ongoing water crisis, but provide little help to the ecosystem or its fisheries.

The water pumping restrictions contained in the revised NMFS salmon biological opinion (BiOp) will further reduce water supplies for 25 million Californians, millions of acres of farmland and countless businesses throughout the state.

"Federal regulators are layering bad decisions on bad decisions and exacerbating California's water crisis. Residents, farmers, farm workers and our economy are already paying a high price for the inability of federal regulators to address the real problems regarding a declining Delta ecosystem," said Jim Beck, Kern County Water Agency General Manager. "The salmon BiOp adds to the problem without providing any real solutions."

Federal regulators continue to focus their attention only on the water projects and continue to ignore the effects of other stressors on the Delta and its native fish species. The suit focuses on three main issues:

1. Failure to use the best available science and data;
2. Failure to properly analyze the effects of all stressors on listed species; and
3. Failure of federal agencies to demonstrate the benefit to the listed species from further pumping restrictions.

The overall health of the Delta ecosystem, including the health of salmon and green sturgeon, is in decline due to a number of stressors. Among the well known factors contributing to the decline are contaminated run-off; pesticide discharges; predation from striped bass, black bass and other non-native species; widespread pollution from wastewater treatment plants; development of levees; dredging; operation and expansion of shipping channels; and land-use activities.

"We cannot allow federal bureaucrats to continue destroying our economy based on bad science and untested theories. By again focusing only on water pumping and failing to address all the Delta stressors, our economy will be further damaged, businesses and workers will unnecessarily suffer, and the Delta ecosystem and fish populations will continue to decline," said Michael Boccadoro, a spokesperson for the Coalition.

The Coalition for a Sustainable Delta (Coalition) is an ad hoc group of water users who depend on conveyance through the Delta for a large portion of their water supplies. The Coalition is dedicated to protecting the Delta and is committed to promoting a strategy to ensure its sustainability.

The Kern County Water Agency (Agency) was created in 1961 by a special act of the State Legislature and serves as the local contracting entity for the State Water Project. The Agency participates in a wide scope of management activities, including water quality, flood control and groundwater operations to preserve and enhance Kern County's water supply—the main ingredient for a healthy economy.

# # #

For more information, including a copy of the lawsuit, visit the Coalition's web site at: www.sustainabledelta.com

Coalition for a Sustainable Delta/Kern County Water Agency release concerning the litigation filed challenging the 2009 Biological Opinion, August 28, 2009

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DWR, 2009 Comprehensive Water Package, Special Session Policy Bills and Bond Summary, November 2009

2009 Comprehensive Water Package

Special Session Policy Bills and Bond Summary

November 2009

The California
Department of
Water Resources

2009 Comprehensive Water Package

Bill Summary SB 1

November 2009 | Department of Water Resources

Governor Schwarzenegger and state lawmakers successfully crafted a plan to meet California's growing water challenges. A comprehensive deal was agreed to, representing major steps towards ensuring a reliable water supply for future generations, as well as restoring the Sacramento-San Joaquin Delta and other ecologically sensitive areas.

The plan is comprised of four policy bills and an $11.14 billion bond. The package establishes a Delta Stewardship Council, sets ambitious water conservation policy, ensures better groundwater monitoring, and provides funds for the State Water Resources Control Board for increased enforcement of illegal water diversions. The bond will fund, with local cost-sharing, drought relief, water supply reliability, Delta sustainability, statewide water system operational improvements, conservation and watershed protection, groundwater protection, and water recycling and water conservation programs.

Senate Bill No. 1
Delta Governance / Delta Plan

SB 1 establishes the framework to achieve the co-equal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The co-equal goals will be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta. Specifically, this bill:

- Creates the Delta Stewardship Council, consisting of seven members with diverse expertise providing a broad statewide perspective. The Chairperson of the Delta Protection Commission is a permanent member of the Council. The Council is also tasked with:
  - Developing a Delta Plan to guide state and local actions in the Delta in a manner that furthers the co-equal goals of Delta restoration and water supply reliability;
  - Developing performance measures for the assessment and tracking of progress and changes to the health of the Delta ecosystem, fisheries, and water supply reliability;
  - Determining if a state or local agency's project in the Delta is consistent with the Delta Plan and the co-equal goals, and acting as the appellate body in the event of a claim that such a project is inconsistent with the goals; and
  - Determining the consistency of the Bay-Delta Conservation Plan (BDCP) with the co-equal goals.
- Ensures that the Department of Fish and Game and the State Water Resources Control Board identify the water supply needs of the Delta estuary for use in determining the appropriate water diversion amounts associated with BDCP.

- Establishes the Sacramento-San Joaquin Delta Conservancy to implement ecosystem restoration activities within the Delta. In addition to the restoration duties the Conservancy is required to:
  - Adopt a strategic plan for implementation of the Conservancy goals;
  - Promote economic vitality in the Delta through increased tourism and the promotion of Delta legacy communities;
  - Promote environmental education about, and the public use of, public lands in the Delta; and
  - Assist in the preservation, conservation, and restoration of the region's agricultural, cultural, historic, and living resources.

- Restructures the current Delta Protection Commission (DPC), reducing the membership from 23 to 15 members, and tasks DPC with the duties of:
  - Adopting an economic sustainability plan for the Delta, which is to include flood protection recommendations to state and local agencies;
  - Submitting the economic sustainability plan to the Delta Stewardship Council for inclusion in the Delta Plan.

- Appropriates funding from Proposition 84 to fund the Two-Gates Fish Protection Demonstration Program, a project in the central Delta which will utilize operable gates for protection of sensitive species and management of water supply.

2009 Comprehensive Water Package

Bill Summary SB 6

November 2009 | Department of Water Resources

Senate Bill No. 6
Groundwater Monitoring

SB 6 requires, for the first time in California's history, that local agencies monitor the elevation of their groundwater basins to help better manage the resource during both normal water years and drought conditions. Specifically, this bill:

- Requires the Department of Water Resources (DWR) to establish a priority schedule for the monitoring of groundwater basins and the review of groundwater elevation reports, and to make recommendations to local entities to improve the monitoring programs.

- Requires DWR to assist local monitoring entities with compliance with this statute.

- Allows local entities to determine regionally how best to set up their groundwater monitoring program, crafting the program to meet their local circumstances.

- Provides landowners with protections from trespass by state or local entities.

- Provides that if the local agencies fail to implement a monitoring program and/or fail to provide the required reports, DWR may implement the groundwater monitoring program for that region.

- Provides that failure to implement a monitoring program will result in the loss of eligibility for state grant funds by the county and the agencies responsible for performing the monitoring duties.

2009 Comprehensive Water Package

Bill Summary SB 7

November 2009 | Department of Water Resources

Senate Bill No. 7
Statewide Water Conservation

SB 7 creates a framework for future planning and actions by urban and agricultural water suppliers to reduce California's water use. For the first time in California's history, this bill requires the development of agricultural water management plans and requires urban water agencies to reduce statewide per capita water consumption 20 percent by 2020. Specifically, this bill:

- Establishes multiple pathways for urban water suppliers to achieve the statewide goal of a 20 percent reduction in urban water use. Specifically, urban water suppliers may:
  - Set a conservation target of 80 percent of their baseline daily per capita water use;
  - Utilize performance standards for water use that are specific to indoor, landscape, and commercial, industrial and institutional uses;
  - Meet the per capita water use goal for their specific hydrologic region as identified by DWR and other state agencies in the 20 percent by 2020 Water Conservation Plan; or
  - Use an alternate method that is to be developed by DWR before December 31, 2010.

- Requires urban water suppliers to set an interim urban water use target and meet that target by December 31, 2015 and meet the overall target by December 31, 2020.

- Requires DWR to cooperatively work with the California Urban Water Conservation Council to establish a task force that shall identify best management practices to assist the commercial, industrial and institutional sector in meeting the water conservation goal.

- Requires agricultural water suppliers to measure water deliveries and adopt a pricing structure for water customers based at least in part on quantity delivered, and, where technically and economically feasible, implement additional measures to improve efficiency.

- Requires agricultural water suppliers to submit Agricultural Water Management Plans beginning December 31, 2012 and include in those plans information relating to the water efficiency measures they have undertaken and are planning to undertake.

- Makes ineligible for state grant funding any urban or agricultural water supplier who is not in compliance with the requirements of this bill relating to water conservation and efficient water management.

- Requires DWR to, in 2013, 2016 and 2021, report to the Legislature on agricultural efficient water management practices being undertaken and reported in agricultural water management plans.

- Requires DWR, the State Water Resources Control Board, and other state agencies to develop a standardized water information reporting system to streamline water reporting required under the law.

2009 Comprehensive Water Package

Bill Summary SB 8

November 2009 | Department of Water Resources

Senate Bill No. 8
Water Diversion and Use / Funding

SB 8 improves accounting of the location and amounts of water being diverted by recasting and revising exemptions from the water diversion reporting requirements under current law. Additionally, this bill appropriates existing bond funds for various activities to benefit the Delta ecosystem and secure the reliability of the state's water supply, and to increase staffing at the State Water Resources Control Board to manage the duties of this statute. Specifically, this bill:

- Provides a stronger accounting of water diversion and use in the Delta by removing an exemption from reporting water use by in-Delta water users.
- Redefines the types of diversions that are exempt from the reporting requirement.
- Assesses civil liability and monetary penalties on diverters who fail to submit the required reports, and for willful misstatements, and/or tampering with monitoring equipment.
- Appropriates $546 million from Propositions 1E and 84, in the following manner:
  - $250 million (Proposition 84) for integrated regional water management grants and expenditures for projects to reduce dependence on the Delta;
  - $202 million ($32 million Proposition 84 and $170 million Proposition 1E) for flood protection projects in the Delta to reduce the risk of levee failures that would jeopardize water conveyance;
  - $70 million (Proposition 1E) for stormwater management grants; and
  - $24 million (Proposition 84) for grants to local agencies to develop or implement Natural Community Conservation plans.
- Appropriates $3.75 million from the Water Rights Fund to the State Water Resources Control Board for staff positions to manage the duties in this bill relating to water diversion reporting, monitoring and enforcement.

Safe, Clean, and Reliable Drinking Water Supply Act of 2010

Water Bond Summary

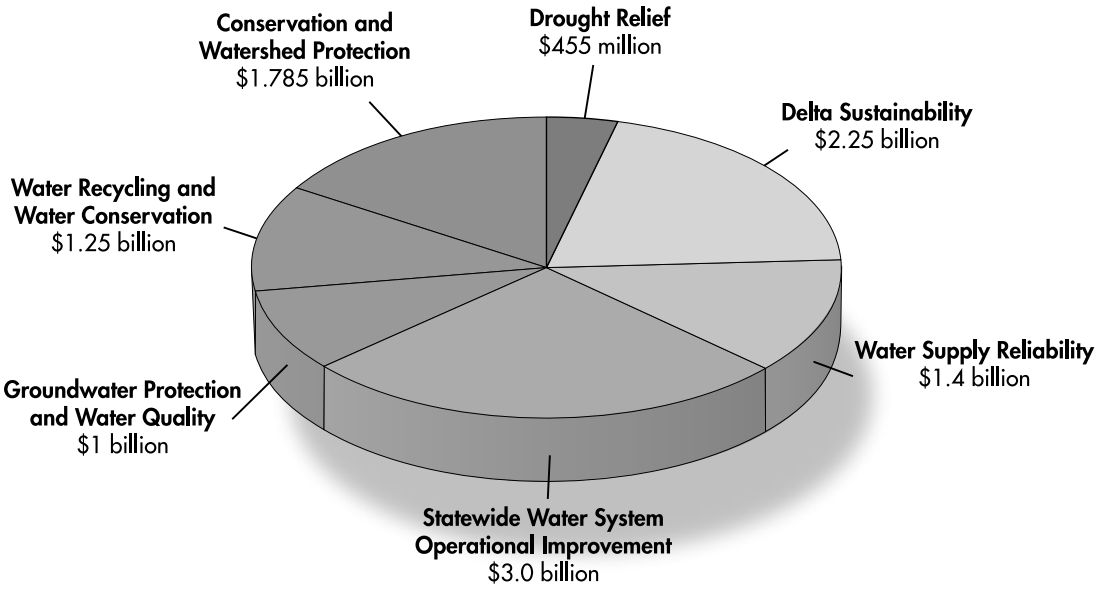
November 2009

The Safe, Clean, and Reliable Drinking Water Supply Act of 2010 is an $11.14 billion general obligation bond proposal that would provide funding for California's aging water infrastructure and for projects and programs to address the ecosystem and water supply issues in California. The bond is comprised of seven categories, including drought relief, water supply reliability, Delta sustainability, statewide water system operational improvement, conservation and watershed protection, groundwater protection and water quality, and water recycling and water conservation.

Total: $11.14 billion

Drought Relief - $455 million. This funding will be available for local and regional drought relief projects that reduce the impacts of drought conditions, including the impacts of reductions to Delta diversions. Projects will include water conservation and water use efficiency projects, water recycling, groundwater cleanup and other water supply reliability projects including local surface water storage projects that provide emergency water supplies and water supply reliability in drought conditions. Funds will be available to disadvantaged communities and economically distressed areas experiencing economic impacts from the drought for drought relief projects and programs. Funds will also be available to improve wastewater treatment facilities to protect water quality or prevent contamination of surface water or groundwater resources.

Delta Sustainability - $2.25 billion. This bond will provide funds for projects to assist in maintaining and restoring the Delta as an important ecosystem. These investments will help to reduce the seismic risk to water supplies derived from the Delta, protect drinking water quality and reduce conflict between water management and environmental protection.



Water Supply Reliability - $1.4 billion. These funds would be in addition to prior funding provided by Proposition 50 and Proposition 84 and would support the existing Integrated Regional Water Management (IRWM) program. IRWM is designed to encourage integrated regional strategies for management of water resources that will protect communities from drought, protect and improve water quality and improve local water security by reducing dependence on imported water. The bond would provide funds for water supply projects in 12 regions throughout the state and would also be available for local and regional conveyance projects that support regional and interregional connectivity and water management.

North Coast	$45,000,000
San Francisco Bay	$132,000,000
Central Coast	$58,000,000
Los Angeles subregion	$198,000,000
Santa Ana subregion	$128,000,000
San Diego subregion	$87,000,000
Sacramento River	$76,000,000
San Joaquin River	$64,000,000
Tulare/Kern	$70,000,000
North/South Lahontan	$51,000,000
Colorado River Basin	$47,000,000
Mountain Counties Overlay	$44,000,000
Interregional Projects	$50,000,000

Statewide Water System Operational Improvement - $3.0 billion. This funding would be dedicated to the development of additional water storage, which, when combined with other water management and flood system improvement investments being made, can increase reliability and offset the climate change impacts of reduced snow pack and higher flood flows. Eligible projects for this funding include surface storage projects identified in the CALFED Bay-Delta Record of Decision; groundwater storage projects and groundwater contamination prevention or remediation projects that provide water storage benefits; conjunctive use and reservoir reoperation projects; local and regional surface storage projects that improve the operation of water systems in the state and provide public benefits.

The bond provides that water suppliers who would benefit from new storage will pay their share of the total costs of the project while the public benefits of new water storage can be paid for by this general obligation bond.

Groundwater Protection and Water Quality - $1 billion. To protect public health, funds will be available for projects to prevent or reduce the contamination of groundwater that serves as a source of drinking water. Funds will also be used to finance emergency and urgent actions on behalf of disadvantaged communities and economically distressed areas to ensure that safe drinking water supplies are available to all Californians.

Water Recycling and Water Conservation - $1.25 billion. Funds will be available for water recycling and advanced treatment technology projects that recycle water or that remove salts and contaminants from water sources. Funds will also be available for urban and agricultural water conservation and water use efficiency plans, projects, and programs. These funds will assist urban water users in achieving water conservation targets.

Conservation and Watershed Protection - $1.785 billion. Funds will be available, through a 50-50 cost share program, for ecosystem and watershed protection and restoration projects in 21 watersheds throughout the state, including coastal protection, wildlife refuge enhancement, fuel treatment and forest restoration, fish passage improvement and obsolete dam removal.

Coastal counties and watersheds	$250,000,000
Wildlife Conservation Board	$365,000,000
San Gabriel and Lower Los Angeles River watersheds	$75,000,000
Santa Monica Mountains Conservancy	$75,000,000
Baldwin Hills Conservancy	$20,000,000
Santa Monica Bay watershed	$25,000,000
Coastal salmonid restoration	$50,000,000
Lake Tahoe watershed restoration	$100,000,000
Farmland Conservancy Program	$20,000,000
River parkways and urban streams restoration	$50,000,000
Sierra Nevada Conservancy	$75,000,000
Salton Sea restoration	$100,000,000
Watershed climate change impacts and adaptation	$10,000,000
Watershed education facilities	$30,000,000
Waterfowl habitat preservation	$10,000,000
Forest restoration	$100,000,000
Klamath dam removal	$250,000,000
Siskiyou County economic development offset	$20,000,000
Agricultural water use efficiency research	$50,000,000
Ocean protection	$50,000,000
CVPIA fish passage improvement	$60,000,000

Office of the Governor's release regarding passage of history comprehensive water package, November 4, 2009

Office of the Governor
ARNOLD SCHWARZENEGGER
THE PEOPLE'S GOVERNOR

PRESS RELEASE

11/04/2009 GAAS:669:09 FOR IMMEDIATE RELEASE

Gov. Schwarzenegger Applauds Passage of Historic Comprehensive Water Package

Governor Arnold Schwarzenegger today issued the following statement regarding the legislature's passage of an historic package to reform and rebuild California's water system:

"Water is the lifeblood of everything we do in California. Without clean, reliable water, we cannot build, we cannot farm, we cannot grow and we cannot prosper. That is why I am so proud that the legislature, Democrats and Republicans, came together and tackled one of the most complicated issues in our state's history. This comprehensive water package is an historic achievement.

"I particularly want to applaud the leadership of Senate President Darrell Steinberg. He has been a tireless leader, a relentless advocate for the environment and a true statesman."

On October 11, 2009, Governor Schwarzenegger issued a proclamation calling for the legislature to meet in an extraordinary session to address California's water crisis, urging the passage of legislation on the many issues facing the state's water system which were ultimately addressed by the water package passed today.

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APPENDIX 3.18

Draft City of Santa Clarita General Plan Noise Element; February 2009

ONE VALLEY ONE VISION (OVOV)
NOISE ELEMENT OF THE GENERAL PLAN
TECHNICAL APPENDIX

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February 16, 2009

ONE VALLEY ONE VISION NOISE ELEMENT TECHNICAL APPENDIX

Table of Contents

1.0 INTRODUCTION 2
2.0 BACKGROUND INFORMATION ON NOISE 3
2.1 Characteristics of Sound 3
2.2 Factors Influencing Human Response to Sound 6
2.3 Sound Rating Scales 7
3.0 HEALTH EFFECTS 11
4.0 Noise Measurements 16
4.1 Methodology 16
4.2 Results 16
4.3 Detailed Discussion of Noise Measurements 17
5.0 NOISE CONTOURS 23
5.1 Projected Noise Impacts 25
6.0 Noise Issues 29
6.1 High-Speed Rail Line 29
6.2 High Density Development Along Railroad 29
6.3 Mixed-Use Developments 30
6.4 Agua Dulce Airport 31
6.5 Magic Mountain 32
6.6 Special Events 32
6.7 Emergency Vehicles 32
7.0 Policy Recommendations 33
7.1 Expand Use of Santa Clarita Noise Element to Entire OVOV 33
7.2 Modifications to Compatibility Matrix 33
7.3 Indoor Noise Criteria 34
7.4 Outdoor Noise Criteria 34
7.5 Development of Sensitive Land Uses Along Interstate 5 35
7.6 Disclosure Statements for Special Areas 35

1.0 INTRODUCTION

The Noise Element of a General Plan is a comprehensive program for including noise management in the planning process. It is a tool for local planners to use in achieving and maintaining land uses that are compatible with environmental noise levels. The Noise Element identifies noise sensitive land uses and noise sources, and defines areas of noise impact for the purpose of developing programs to ensure that residents in the One Valley One Vision (OVOV) area will be protected from excessive noise intrusion.

The OVOV planning area includes all of the City of Santa Clarita and portions of the County of Los Angeles. The current Noise Element of the General Plan for the City of Santa Clarita was last updated in May 2000. It identifies roadways as the most significant source of noise in the City. While traffic noise is still the major noise source in the City, other sources have become a concern. Additionally, the method for controlling noise and incorporating noise concerns into planning decisions has become more sophisticated over the years since the first Element was adopted. Thus, the decision was made by the City and the County to update the planning for the OVOV area to more effectively protect and plan for the residents of the area.

This document constitutes the Technical Appendix of the Noise Element and provides the technical background for the Noise Element. Topics covered in the Technical Appendix include background information on noise, health effects related to noise pollution, methodologies used to monitor and model noise levels throughout the study area, the results of the noise monitoring program, and the noise contours for the area. Additionally, the noise impacts of the OVOV plan are discussed, specific noise issues for the OVOV are addressed, and policy recommendations are made.

The Noise Element, including the Technical Appendix, follows the revised State guidelines ("General Plan Guidelines," Governors Office of Planning and Research, October 2003) and State Government Code Section 65302(f). The Element quantifies the community noise environment in terms of noise exposure contours for both near and long-term levels of growth

and traffic activity. The information will become a guideline for the development of land use policies to achieve compatible land uses and provide baseline levels and noise source identification for local noise ordinance enforcement.

2.0 BACKGROUND INFORMATION ON NOISE

This section presents background information on the characteristics of noise and summarizes the methodologies used to study the noise environment. This section will give the reader an understanding of the metrics and methodologies used to assess noise impacts. The section is divided as follows:

- *Properties of sound that are important for technically describing sound*
- *Acoustic factors influencing human subjective response to sound.*
- *Potential disturbances to humans and health effects due to sound.*
- *Sound rating scales used in this study*
- *Summary of noise assessment criteria*

2.1 Characteristics of Sound

Sound Level and Frequency. Sound can be technically described in terms of the sound pressure (amplitude) and frequency (similar to pitch). Sound pressure is a direct measure of the magnitude of a sound without consideration for other factors that may influence its perception.

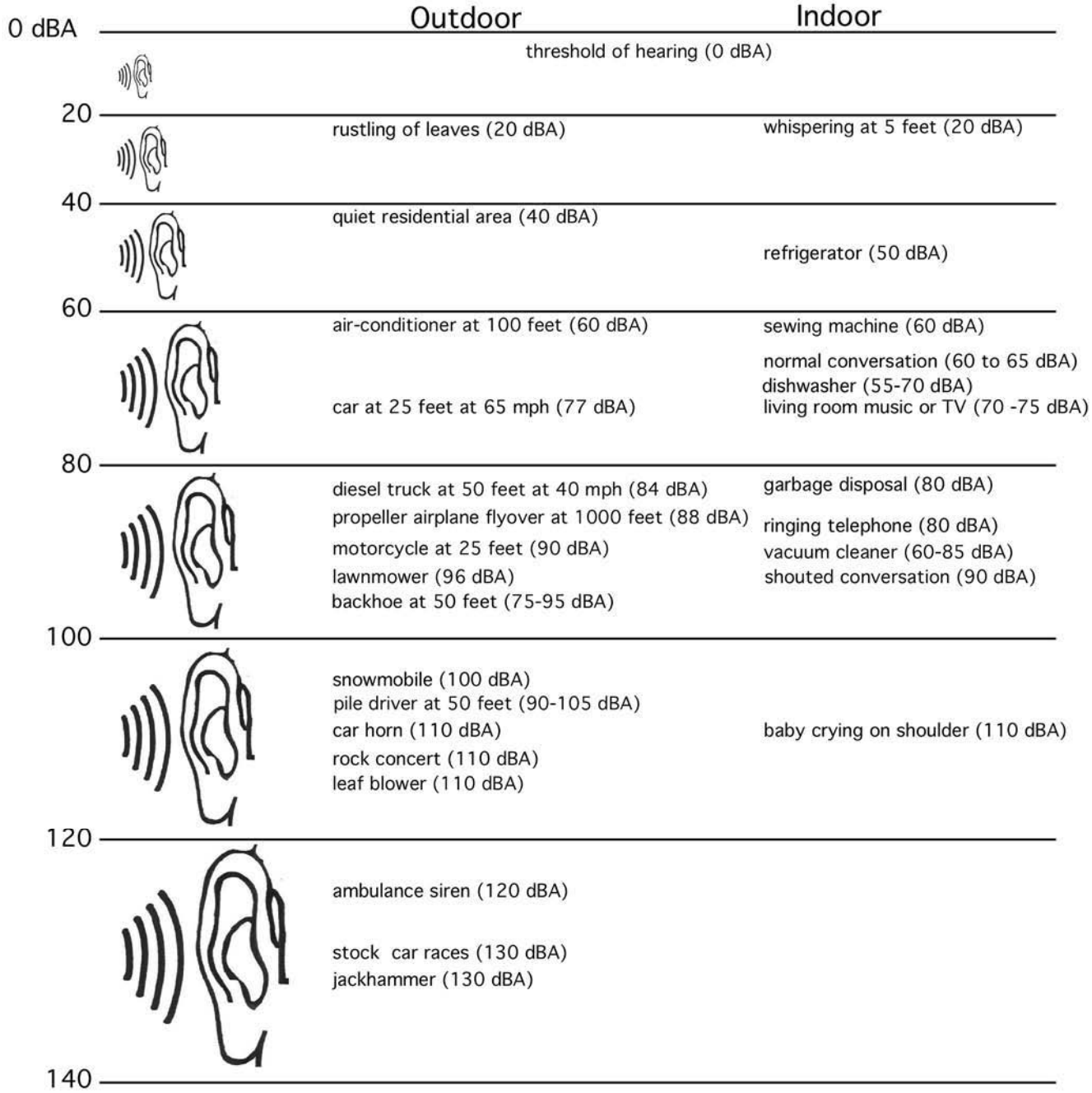
The range of sound pressures that occur in the environment is so large that it is convenient to express these pressures as sound pressure levels on a logarithmic scale which compresses the wide range of sound pressures to a more usable range of numbers. The standard unit of measurement of sound is the decibel (dB), which describes the pressure of a sound relative to a reference pressure.

The frequency (pitch) of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency for young adults is 20 Hz to 20,000 Hz. Community noise, including aircraft and motor vehicles, typically ranges between 50 Hz and 5,000 Hz. The human ear is

not equally sensitive to all frequencies, with some frequencies judged to be louder for a given signal than others. As a result of this, various methods of frequency weighting have been developed. The most common weighting is the A-weighted noise curve (dBA). The A-weighted decibel scale (dBA) performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear. In the A-weighted decibel, everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud). Most community noise analyses are based upon the A-weighted decibel scale. Examples of various sound environments, expressed in dBA, are presented in Exhibit 1.

Propagation of Noise. Outdoor sound levels decrease as the distance from the source increases, and as a result of wave divergence, atmospheric absorption and ground attenuation. Sound radiating from a source in a homogeneous and undisturbed manner travels in spherical waves. As the sound wave travels away from the source, the sound energy is dispersed over a greater area decreasing the sound power of the wave. Spherical spreading of the sound wave reduces the noise level at a rate of 6 dB per doubling of the distance.

Atmospheric absorption also influences the levels received by the observer. The greater the distance traveled, the greater the influence of the atmosphere and the resultant fluctuations. Atmospheric absorption becomes important at distances of greater than 1,000 feet. The degree of absorption varies depending on the frequency of the sound as well as the humidity and temperature of the air. For example, atmospheric absorption is lowest (i.e., sound carries farther) at high humidity and high temperatures. A schematic diagram of how weather including temperature gradients and wind can affect sound propagation is shown in Exhibit 2. Turbulence and gradients of wind, temperature and humidity also play a significant role in determining the degree of attenuation. Certain conditions, such as inversions, can channel or focus the sound waves resulting in higher noise levels than would result from simple spherical spreading. Absorption effects in the atmosphere vary with frequency. The higher frequencies are more readily absorbed than the lower frequencies. Over large distances, the lower frequencies become the dominant sound as the higher frequencies are attenuated.



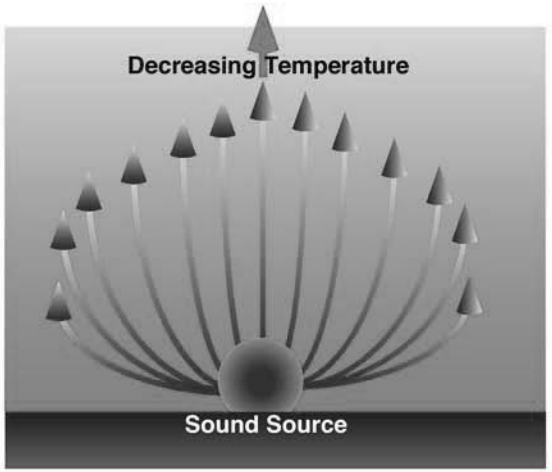
Sources: League For The Hard Of Hearing, www.lhh.org
Handbook of Noise Control, McGraw Hill, Edited byCyril Harris, 1979
Measurements by Mestre Greve Associates

Exhibit 1
Typical Sounds Levels in A-Weighted Decibels (dBA)

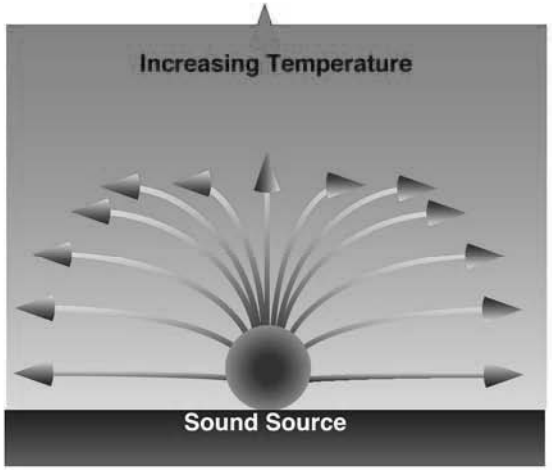
Exhibit 2

THE EFFECTS OF WEATHER ON SOUND PROPAGATION

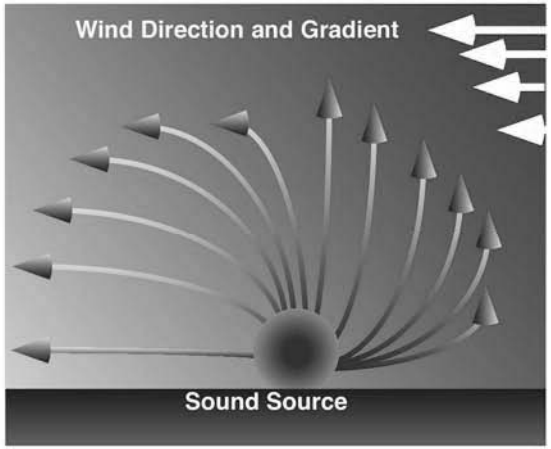
Refraction of sound in an atmosphere with a normal lapse rate. Sound rays are bent upwards.



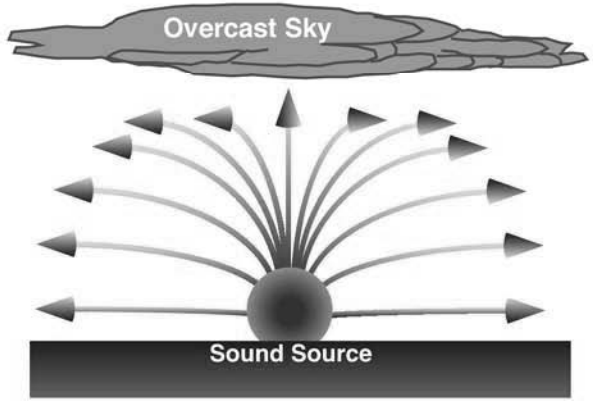
Refraction of sound in an atmosphere with an inverted lapse rate. Sound rays are bent downward.



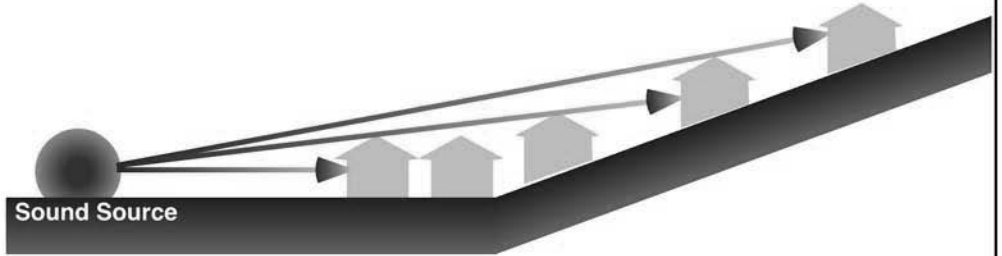
Refraction of sound in an atmosphere with a wind present. Sound rays are bent in the direction of the wind.



Refraction of sound in an atmosphere with overcast sky conditions. Sound rays are bent downward.



Propagation of sound over terrain. Ground absorption and shielding may be present for buildings at the same elevation as the source. No shielding is present for buildings which can 'see' the source.



Source: Adapted from Vancouver International Airport, Noise Management Report.

Duration of Sound. Annoyance from a noise event increases with increased duration of the noise event, i.e., the longer the noise event, the more annoying it is. The "*effective duration*" of a sound is the time between when a sound rises above the background sound level until it drops back below the background level. Psycho-acoustic studies have determined the relationship between duration and annoyance and the amount a sound must be reduced to be judged equally annoying for increased duration. Duration is an important factor in describing sound in a community setting.

The relationship between duration and noise level is the basis of the equivalent energy principal of sound exposure. Reducing the acoustic energy of a sound by one half results in a 3 dB reduction. Doubling the duration of the sound increases the total energy of the event by 3 dB. This equivalent energy principal is based upon the premise that the potential for a noise to impact a person is dependent on the total acoustical energy content of the noise. Defined in subsequent sections of this study, noise metrics such as CNEL, DNL, LEQ and SENEL are all based upon the equal energy principle.

Change in Noise. The concept of change in ambient sound levels can be understood with an explanation of the hearing mechanism's reaction to sound. The human ear is a far better detector of relative differences in sound levels than absolute values of levels. Under controlled laboratory conditions, listening to a steady unwavering pure tone sound that can be changed to slightly different sound levels, a person can just barely detect a sound level change of approximately one decibel for sounds in the mid-frequency region. When ordinary noises are heard, a young healthy ear can detect changes of two to three decibels. A five decibel change is readily noticeable while a 10 decibel change is judged by most people as a doubling or a halving of the loudness of the sound. It is typical in environmental documents to consider a 3 dB change as potentially discernable.

Masking Effect. The ability of one sound to limit a listener from hearing another sound is known as the masking effect. The presence of one sound effectively raises the threshold of audibility for the hearing of a second sound. For a signal to be heard, it must exceed the

threshold of hearing for that particular individual and exceed the masking threshold for the background noise.

The masking characteristics of sound depend on many factors including the spectral (frequency) characteristics of the two sounds, the sound pressure levels, and the relative start time of the sounds. Masking effect is greatest when the frequencies of the two sounds are similar or when low frequency sounds mask higher frequency sounds. High frequency sounds do not easily mask low frequency sounds.

2.2 Factors Influencing Human Response to Sound

Many factors influence sound perception and annoyance. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. Molino, in the *Handbook of Noise Control* describes human response to sound in terms of both acoustic and non-acoustic factors. These factors are summarized in Table 1.

Sound rating scales are developed in reaction to the factors affecting human response to sound. Nearly all of these factors are relevant in describing how sounds are perceived in the community. Many non-acoustic parameters play a prominent role in affecting individual response to noise. Background sound, an additional acoustic factor not specifically listed, is also important in describing sound in rural settings. Researchers have identified the effects of personal and situational variables on noise annoyance, and have identified a clear association of reported annoyance and various other individual perceptions or beliefs.

Thus, it is important to recognize that non-acoustic factors as well as acoustic factors contribute to human response to noise.

Table 1
Factors that Affect Individual Annoyance to Noise

Primary Acoustic Factors
Sound Level
Frequency
Duration
Secondary Acoustic Factors
Spectral Complexity
Fluctuations in Sound Level
Fluctuations in Frequency
Rise-time of the Noise
Localization of Noise Source
Non-acoustic Factors
Physiology
Adaptation and Past Experience
How the Listener's Activity Affects Annoyance
Predictability of When a Noise will Occur
Is the Noise Necessary?
Individual Differences and Personality

Source: C. Harris, 1979

2.3 Sound Rating Scales

The description, analysis, and reporting of community sound levels is made difficult by the complexity of human response to sound and myriad sound-rating scales and metrics developed to describe acoustic effects. Various rating scales approximate the human subjective assessment to the "loudness" or "noisiness" of a sound. Noise metrics have been developed to account for additional parameters such as duration and cumulative effect of multiple events.

Noise metrics are categorized as single event metrics and cumulative metrics. Single event metrics describe the noise from individual events, such as one aircraft flyover. Cumulative metrics describe the noise in terms of the total noise exposure throughout the day. Noise

metrics used in this study are summarized below. First single event metrics are discussed followed by discussions of the cumulative metrics.

Single Event Metrics

Frequency Weighted Metrics (dBA). In order to simplify the measurement and computation of sound loudness levels, frequency weighted networks have obtained wide acceptance. The A-weighting (dBA) scale has become the most prominent of these scales and is widely used in community noise analysis. Its advantages are that it has shown good correlation with community response and is easily measured. The metrics used in this study are all based upon the dBA scale.

Maximum Noise Level or Lmax is the highest noise level reached during a noise event. For example, as an aircraft approaches, the sound of the aircraft begins to rise above ambient noise levels. The closer the aircraft gets the louder it is until the aircraft is at its closest point directly overhead. Then as the aircraft passes, the noise level decreases until the sound level again settles to ambient levels. Such a history of a flyover is plotted at the top of Exhibit 3. It is this metric to which people generally instantaneously respond when an aircraft flyover or a loud vehicle like a truck or motorcycle passes by.

Single Event Noise Exposure Level (SENEL) or Sound Exposure Level (SEL) is computed from dBA sound levels, and is used to quantify the total noise associated with an event such as an aircraft overflight or a train pass-by. Referring again to the top of Exhibit 3, the shaded area, or the area within 10 dB of the maximum noise level, is the area from which the SENEL is computed. The SENEL value is the integration of all the acoustic energy contained within the event. Speech and sleep interference research can be assessed relative to Single Event Noise Exposure Level data.

The SENEL metric takes into account the maximum noise level of the event and the duration of the event. Single event metrics are a convenient method for describing noise from individual aircraft events. This metric is useful in that airport noise models contain aircraft

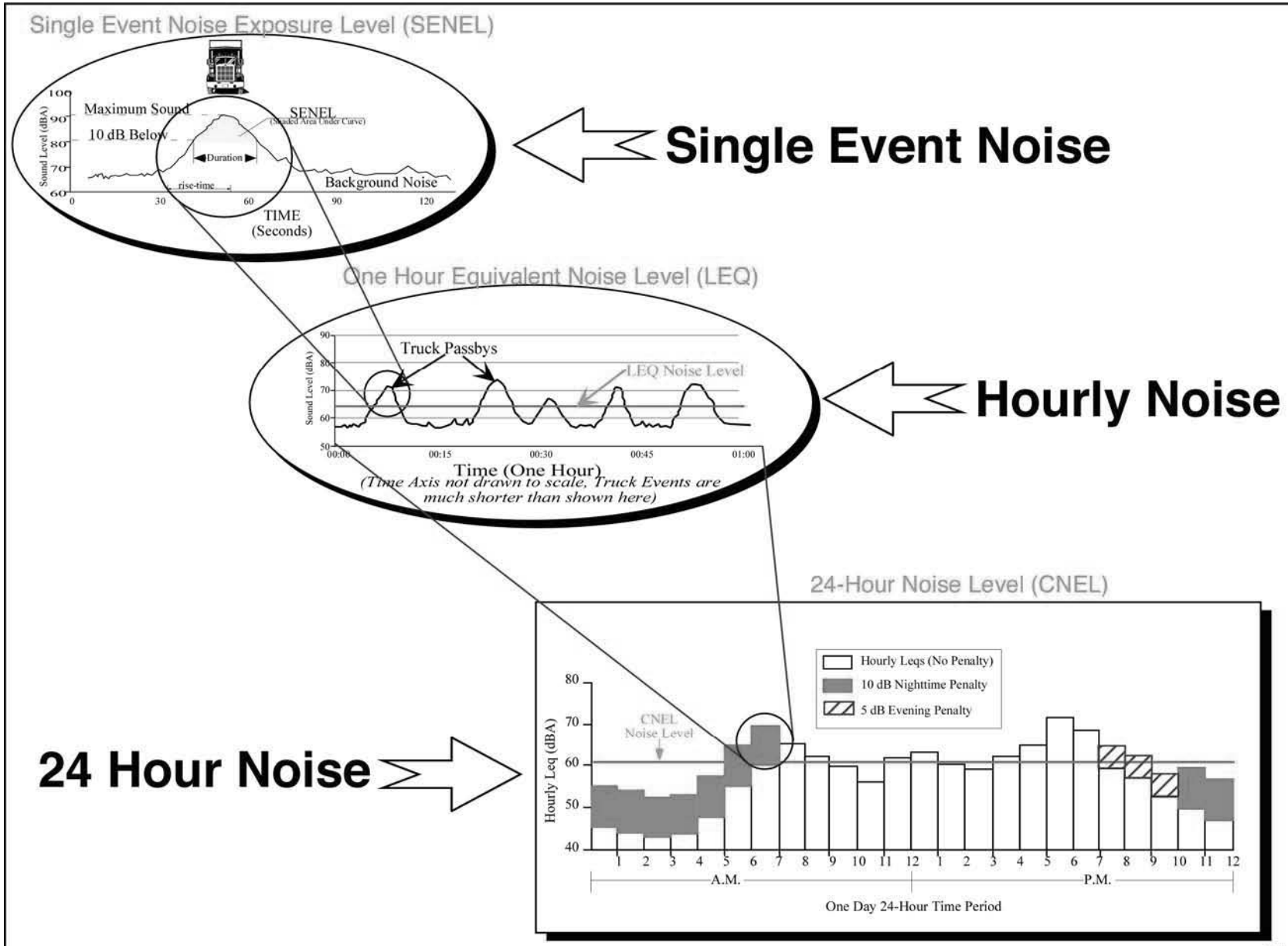


Exhibit 3
Single and Cumulative Noise Metric Definitions
Source: Mestre Greve Associates 1998

noise curve data based upon the SENEL metric. In addition, cumulative noise metrics such as LEQ, CNEL and DNL can be computed from SENEL data.

Cumulative Metrics

Cumulative noise metrics assess community response to noise by including the loudness of the noise, the duration of the noise, the total number of noise events and the time of day these events occur into one single number rating scale.

Equivalent Noise Level (Leq) is the sound level corresponding to a steady-state A-weighted sound level containing the same total energy as several SEL events during a given sample period. Leq is the "energy" average noise level during the time period of the sample. It is based on the observation that the potential for noise annoyance is dependent on the total acoustical energy content of the noise. This is graphically illustrated in the middle graph of Exhibit 3. Leq can be measured for any time period, but is typically measured for 15 minutes, 1 hour or 24-hours. Leq for a one hour period is used by the Federal Highway Administration for assessing highway noise impacts. Leq for one hour is called Hourly Noise Level (HNL) in the California Airport Noise Regulations and is used to develop Community Noise Equivalent Level (CNEL) values for aircraft operations.

Community Noise Equivalent Level, or CNEL is a 24-hour, time-weighted energy average noise level based on the A-weighted decibel. It is a measure of the overall noise experienced during an entire day. The term “time-weighted” refers to the penalties attached to noise events occurring during certain sensitive time periods. In the CNEL scale, noise occurring between the hours of 7 p.m. and 10 p.m. is penalized by approximately 5 dB. This penalty accounts for the greater potential for noise to cause communication interference during these hours, as well as typically lower ambient noise levels during these hours. Noise that takes place during the night (10 p.m. to 7 a.m.) is penalized by 10 dB. This penalty was selected to attempt to account for the higher sensitivity to noise in the nighttime and the expected further decrease in background noise levels that typically occur in the nighttime.

CNEL is graphically illustrated in the bottom of Exhibit 3. Examples of various noise environments in terms of CNEL are presented in Exhibit 4. CNEL is specified for use in California by local planning agencies in their General Plan Noise Element for land use compatibility planning.

The DNL index is very similar to CNEL, but does not include the evening (7 p.m. to 10 p.m.) penalty that is included in CNEL. It does include the nighttime (10 p.m. to 7 a.m.) penalty. Typically, DNL is about 1 dB lower than CNEL, although the difference may be greater if there is an abnormal concentration of noise events in the 7 to 10 p.m. time period. DNL is specified for use in all States except California.

L(%), Lmax and Lmin are statistical methods of describing noise which accounts for variance in noise levels throughout a given measurement period. L(%) is a way of expressing the noise level exceeded for a percentage of time in a given measurement period. For example since 5 minutes is 25% of 20 minutes, L(25) is the noise level that is equal to or exceeded for five minutes in a twenty minute measurement period. It is L(%) that is used for most Noise Ordinance standards. Lmax represents the loudest noise level that is measured. The Lmax only occurs for a fraction of a second with all the other noise less than the Lmax level. Lmin represents the quietest noise level during a noise measurement. All other noise during the measurement period is louder than the Lmin.

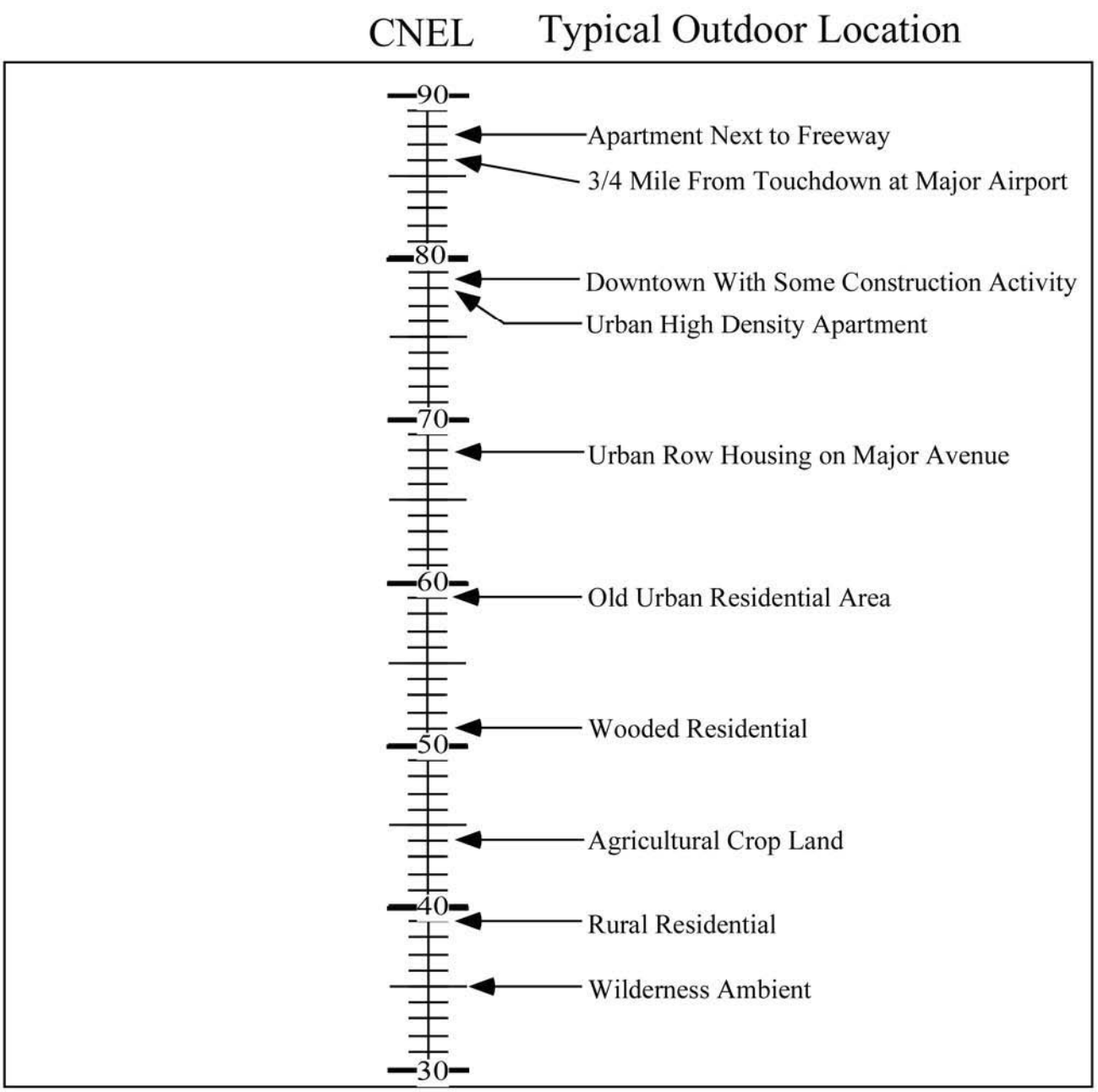


Exhibit 4

Examples of Typical Outdoor CNEL Levels

Source: Adapted from "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety", EPA, 1974

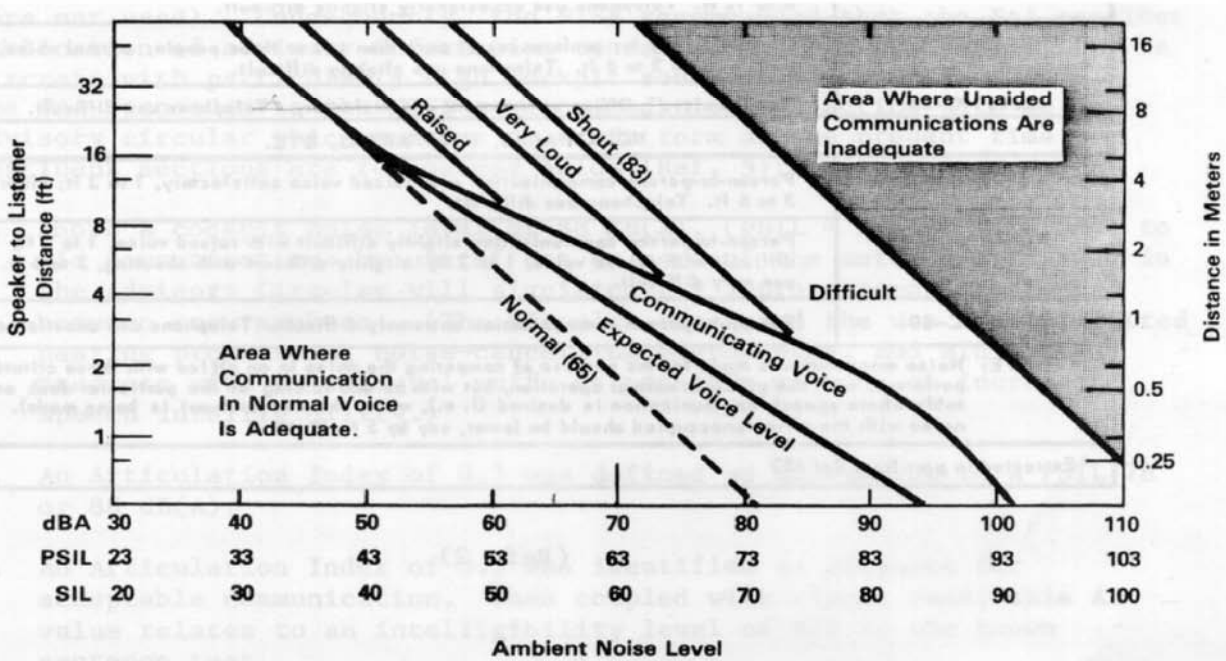
3.0 HEALTH EFFECTS

Noise, often described as unwanted sound, is known to have several adverse effects on humans. From these known adverse effects of noise, criteria have been established to help protect the public health and safety and prevent disruption of certain human activities. These criteria are based on effects of noise on people such as hearing loss (not a factor with typical community noise), communication interference, sleep interference, physiological responses, and annoyance. Each of these potential noise impacts on people are briefly discussed in the following narrative:

Hearing Loss is generally not a concern in community noise problems, even very near a major airport or a major freeway. The potential for noise induced hearing loss is more commonly associated with occupational noise exposures in heavy industry, very noisy work environments with long term exposure, or certain very loud recreational activities such as target shooting, motorcycle or car racing, etc. The Occupational Safety and Health Administration (OSHA) identifies a noise exposure limit of 90 dBA for 8 hours per day to protect from hearing loss (higher limits are allowed for shorter duration exposures). Noise levels in neighborhoods, even in very noisy neighborhoods, are not sufficiently loud to cause hearing loss.

Communication Interference is one of the primary concerns in environmental noise problems. Communication interference includes speech interference and interference with activities such as watching television. Normal conversational speech is in the range of 60 to 65 dBA and any noise in this range or louder may interfere with speech. There are specific methods of describing speech interference as a function of distance between speaker and listener and voice level. Exhibit 5 shows the relation of quality of speech communication with respect to various noise levels.

Sleep Interference is a major noise concern in noise assessment and, of course, is most critical during nighttime hours. Sleep disturbance is one of the major causes of annoyance due to community noise. Noise can make it difficult to fall asleep, create momentary disturbances



Permissible Distance Between a Speaker and Listeners for Specified Voice Levels and Ambient Noise Levels

(The Levels in Parantheses Refer to Voice Levels Measured One Meter From the Mouth.)

Exhibit 5
Speech Interference and Noise Levels

of natural sleep patterns by causing shifts from deep to lighter stages and cause awakening. Noise may even cause awakening that a person may or may not be able to recall.

Extensive research has been conducted on the effect of noise on sleep disturbance with varying results. Recommended values for desired sound levels in residential bedroom space range from 25 to 45 dBA with 35 to 40 dBA being the norm. In 1981, the National Association of Noise Control Officials published data on the probability of sleep disturbance with various single event noise levels. Based on laboratory experiments conducted in the 1970's, this data indicated noise exposure, at 75 dBA interior noise level event will cause noise induced awakening in 30 percent of the cases. Recent research from England, however showed that the probability for sleep disturbance is less than what had been earlier reported. Field studies conducted during the 1990's, using new sophisticated techniques, indicated that awakenings can be expected at a much lower rate than had been expected based on earlier laboratory studies. This research showed that once a person was asleep, it is much more unlikely that they will be awakened by a noise. The significant difference in the recent English study is the use of actual in-home sleep disturbance patterns as opposed to laboratory data that had been the historic basis for predicting sleep disturbance. Some of this research has been criticized because it was conducted in areas where subjects had become habituated to aircraft noise. On the other hand, some of the earlier laboratory sleep studies had been criticized because of the extremely small sample sizes of most laboratory studies, and because the laboratory was not necessarily a representative sleep environment. The 1994 British sleep study compared the various causes of sleep disturbance using in home sleep studies. This field study assessed the effects of nighttime aircraft noise on sleep in 400 people (211 women and 189 men; 20-70 years of age; one per household) habitually living at eight sites adjacent to four U.K. airports, with different levels of night flying. The main finding was that only a minority of aircraft noise events affected sleep, and, for most subjects, that domestic and other non-aircraft factors had much greater effects. As shown in the Exhibit 6, aircraft noise was a minor contributor among a host of other factors that lead to awakening response.

The Federal Interagency Committee on Noise (FICON) in 1992 in a document entitled *Federal Interagency Review of Selected Airport Noise Analysis Issues* recommended an interim dose-

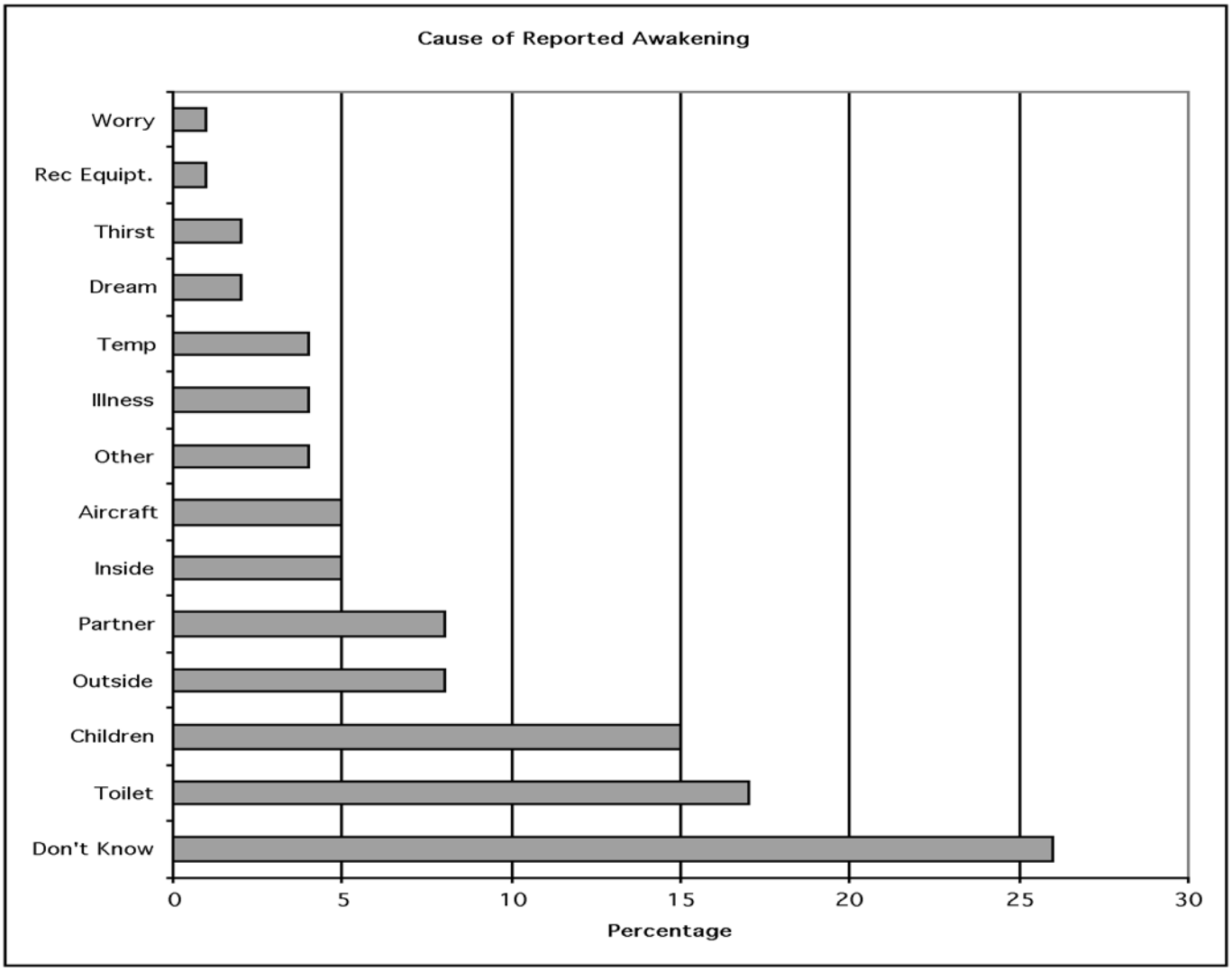


Exhibit 6
Causes and Prevalence of All Awakenings

response curve for sleep disturbance based on laboratory studies of sleep disturbance. In June of 1997, the Federal Interagency Committee on Aviation Noise (FICAN) updated the FICON recommendation with an updated curve based on the more recent in-home sleep disturbance studies which show lower rates of awakening compared to the laboratory studies. FICAN recommended a curve based on the upper limit of the data presented and therefore considers the curve to represent the "maximum percent of the exposed population expected to be behaviorally awakened," or the "maximum awakened." The FICAN recommendation is shown on Exhibit 7. This is a very conservative approach. A more common statistical curve for the data points reflected in Exhibit 7, for example, would indicate a 10% awakening rate at a level of approximately 100 dB SENEL, while the "maximum awakened" curve reflected in Exhibit 7 shows the 10% awakening rate being reached at 80 dB SENEL. (The full FICAN report can be found on the internet at www.fican.org.)

Physiological Responses are those measurable effects of noise on people that are realized as changes in pulse rate, blood pressure, etc. While such effects can be induced and observed, the extent is not known to which these physiological responses cause harm or are a sign of harm. Generally, physiological responses are a reaction to a loud short term noise such as a rifle shot or a very loud jet over flight.

Health effects from noise have been studied around the world for nearly thirty years. Scientists have attempted to determine whether high noise levels can adversely affect human health-apart from auditory damage-which is amply understood. These research efforts have covered a broad range of potential impacts from cardiovascular response to fetal weight and mortality. While a relationship between noise and health effects seems plausible, it has yet to be convincingly demonstrated--that is, shown in a manner that can be repeated by other researchers while yielding similar results.

While annoyance and sleep/speech interference have been acknowledged, health effects, if they exist, are associated with a wide variety of other environmental stressors. Isolating the effects of aircraft noise alone as a source of long term physiological change has proved to be almost impossible. In a review of 30 studies conducted worldwide between 1993 and 1998, a team of

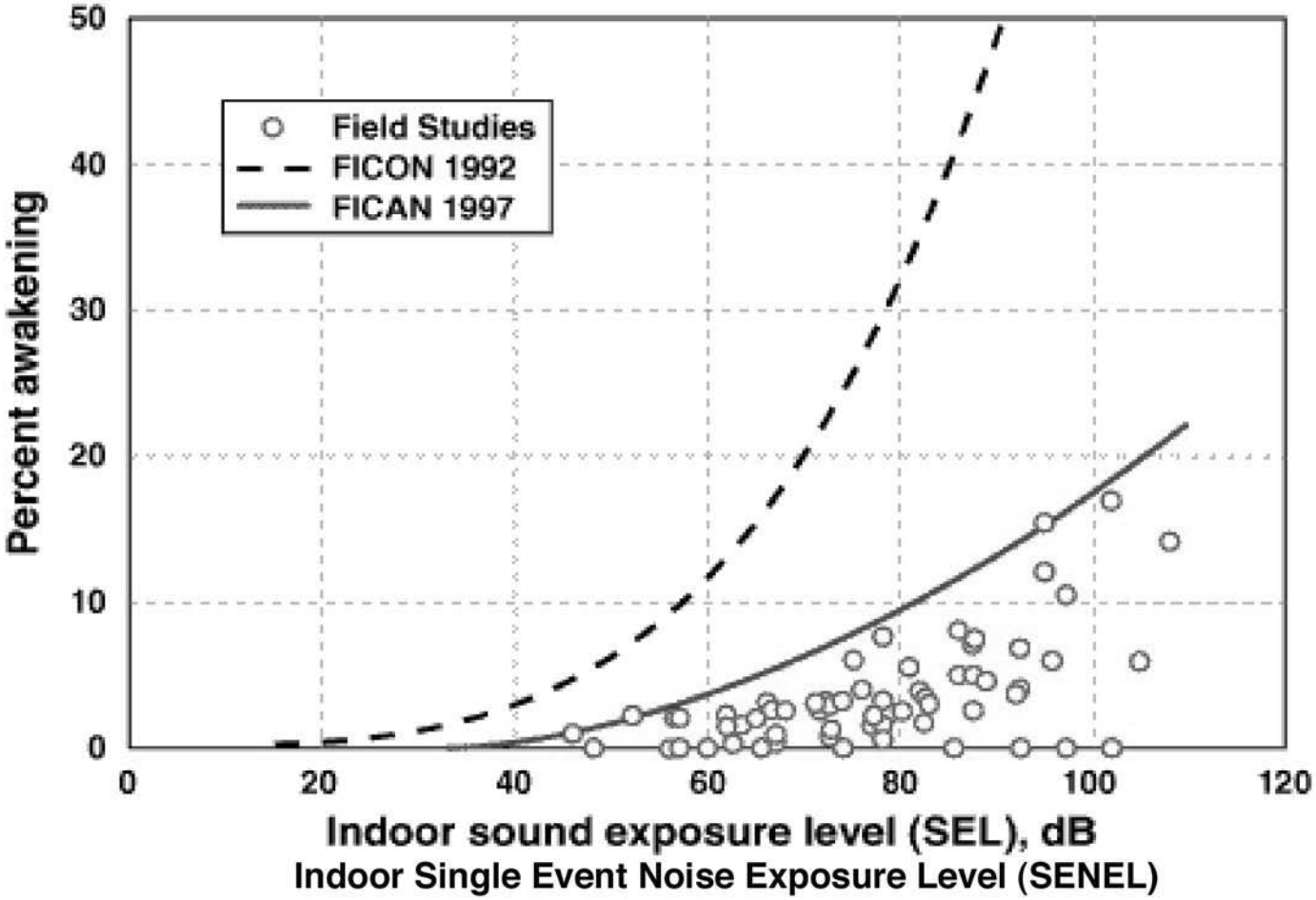


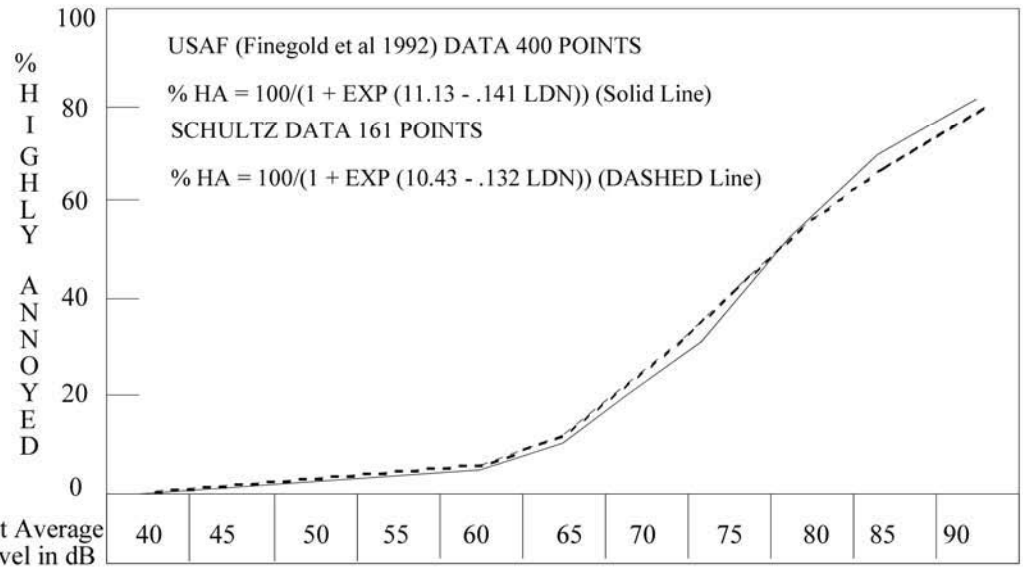
Exhibit 7
Sleep Interference and Noise Level

international researchers concluded that, while some findings suggest that noise can affect health, improved research concepts and methods are needed to verify or discredit such a relationship. They called for more study of the numerous environmental and behavioral factors than can confound, mediate or moderate survey findings. Until science refines the research process, a direct link between aircraft noise exposure and non-auditory health effects remains to be demonstrated.

Annoyance is the most difficult of all noise responses to describe. Annoyance is a very individual characteristic and can vary widely from person to person. What one person considers tolerable can be quite unbearable to another of equal hearing capability. The level of annoyance, of course, depends on the characteristics of the noise (i.e.; loudness, frequency, time, and duration), and how much activity interference (e.g. speech interference and sleep interference) results from the noise. However, the level of annoyance is also a function of the attitude of the receiver. Personal sensitivity to noise varies widely. It has been estimated that 2 to 10 percent of the population is highly susceptible to annoyance from any noise not of their own making, while approximately 20 percent are unaffected by noise. Attitudes are affected by the relationship between the person and the noise source (Is it our dog barking or the neighbor's dog?). Whether we believe that someone is trying to abate the noise will also affect our level of annoyance.

Annoyance levels have been correlated to CNEL levels. Exhibit 8 relates DNL noise levels to community response from two of these surveys. One of the survey curves presented in Exhibit 8 is the well-known Schultz curve, developed by Theodore Schultz. It displays the percent of a populace that can be expected to be annoyed by various DNL (CNEL in California) values for residential land use with outdoor activity areas. At 65 dB DNL the Schultz curve predicts approximately 14% of the exposed population reporting themselves to be “highly annoyed.” At 60 dB DNL this decreases to approximately 8% of the population.

However, the Schultz curve and recent updates include data having a very wide range of scatter with communities reporting much higher percentages of population highly annoyed at these noise exposure levels. For example, under contract to the FAA, Bolt Beranek & Newman



Calculated % HA Points

USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81.0

Exhibit 8

Comparison of logistic fits to original 161 data points of Schultz (1978) and USAF analysis with 400 points (data provided by USAF Armstrong Laboratory).

Source: Ficon 1992

conducted community attitude surveys in the residential areas south of John Wayne Airport in Orange County in 1981 as part of a study of possible "power cutback" departure procedures. That study concluded that the surveyed population (principally in Santa Ana Heights and various Newport Beach neighborhoods) had more highly annoyed individuals at various CNEL levels than would be predicted by the Schultz curve. When plotted similar to the Schultz curve, this survey indicated the populations in Santa Ana Heights and Newport Beach were approximately 5 dB CNEL more sensitive to noise than the average population predicted by the Schultz curve. While the precise reasons for this increased noise sensitivity were not identified, it is possible that non-acoustic factors, including political or the socio-economic status of the surveyed population may have played an important role in increasing the sensitivity of this community during the period of the survey. Annoyance levels have never been correlated statistically to single event noise exposure levels in airport related studies.

School Room Effects. Interference with classroom activities and learning from aircraft noise is an important consideration and the subject of much recent research. Studies from around the world indicate that vehicle traffic, railroad and aircraft noise can have adverse effects on reading ability, concentration, motivation, and long term learning retention. A complicating factor in this research is the extent of background noise from within the classroom itself. The studies indicating the most adverse effects examine cumulative noise levels equivalent to 65 CNEL or higher and single event maximum noise levels ranging from 85 to 95 dBA. In other studies the level of noise is unstated or ambiguous. According to these studies, a variety of adverse school room effects can be expected from *interior* noise levels equal to or exceeding 65 CNEL and or 85 dBA SEL.

Some interference with classroom activities can be expected with noise events that interfere with speech. As discussed in other sections of this report, speech interference begins at 65 dBA that is the level of normal conversation. Typical construction attenuates outdoor noise by 20 dBA with windows closed and 12 dBA with windows open. Thus some interference of classroom activities can be expected at outdoor levels of 77 to 85 dBA.

4.0 Noise Measurements

4.1 Methodology

Twenty (20) sites were selected for measurement of the noise environment in the OVOV planning area. A review of noise complaints, discussions with City staff and identification of major noise sources in the community provided the initial base for development of the community noise survey. The measurement locations were selected on the basis of proximity to major noise sources and noise sensitivity of the land use. The measurement locations are depicted in Exhibit 9.

Noise measurements were made of the short term Leq values. These measurements provide a short 'snapshot' view of the noise environment. The noise measurements were made at a normal receptor height of about 5 feet above the ground. Measurements were made on August 7 and 8, 2007. The measurements were made with a Bruel & Kjaer Type 2236 Sound Level Meter, and calibrated every few hours. These noise measurement systems meet the American National Standards Institute "Type 1" specifications, which is the most accurate for community noise measurements. The meter and calibrator have current certification traceable to the National Institute of Standards and Technology (NIST).

4.2 Results

The results of the noise measurements are shown in Exhibit 10. These figures also depict the date and time of the measurement. The cause of the loudest event is identified and the most predominant noise source(s) are identified. The quantities measured were the Equivalent Noise Level (Leq), the maximum noise level (Lmax) and the minimum noise levels (Lmin).

When examining the noise data shown in Exhibit 10 it is important to note that these data are intended to identify noise levels over a broad range of the study area and are not an assessment of impacts at these sites. In almost all cases the major sources of noise are motor vehicles. The noise levels measured cover a wide range of noise exposure throughout the OVOV area. The quietest environment was in a residential area in the back hills, where noise levels were often below 50 dBA. The loudest events were buses and trucks and these events would push the noise levels into the mid 80 dBA range. In general, aircraft noise, industrial noise, and commercial noise sources did not appear to contribute significantly to the noise levels measured. A discussion of the noise measurements is presented below on a site by site basis.

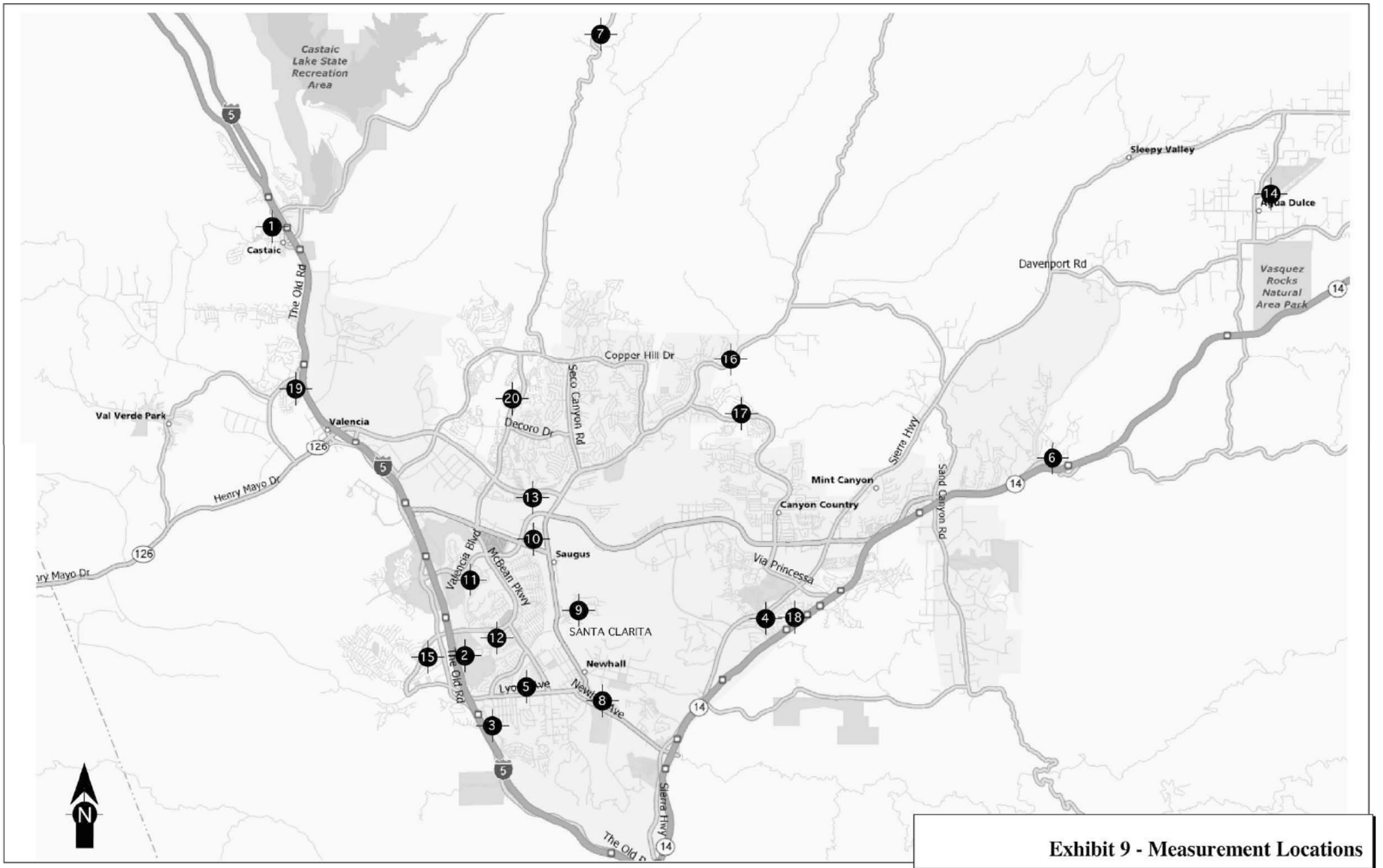
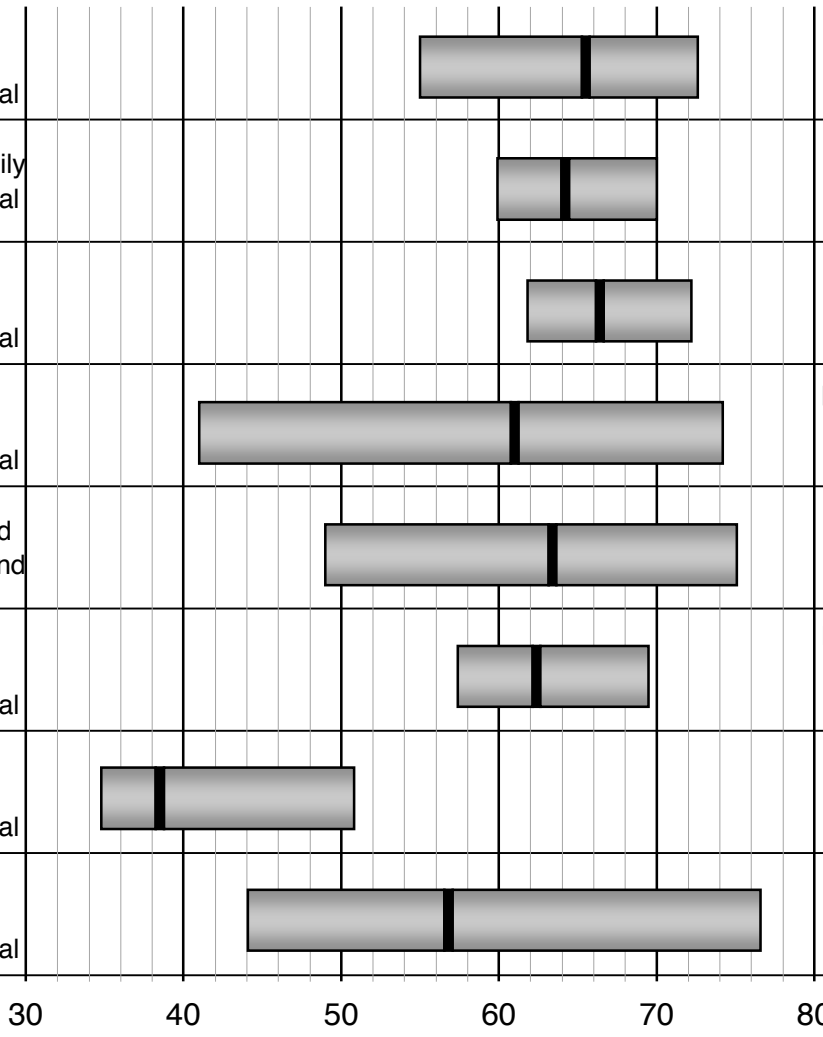


Exhibit 9 - Measurement Locations

MESTRE GREVE ASSOCIATES

Exhibit 10
Graphic Summary of Short-Term Ambeint Noise Measurment Results

Site	Location	Date	Time	Land Use	Noise Sources
1	End of Hunter Ln	8/8	9:45 a.m.	single family residential	traffic
2	End of Golfview Dr	8/7	1:44 p.m.	multi-family residential	traffic, trucks on fwy
3	Corner of Wabuska St and Hawkbryn Ave	8/7	12:20 p.m.	single family residential	traffic, cars on local streets
4	Playground next to Sierra Hwy	8/8	1:32 p.m.	single family residential	pickup trucks were loudest; other traffic
5	Park next to Lyons Ave	8/7	11:50 a.m.	Park and Playground	bus was loudest; other traffic
6	End of Fuji St	8/8	3:22 p.m.	single family residential	heavy truck on fwy was loudest; other traffic
7	End of Stator Ln	8/8	9:18 a.m.	single family residential	Neighbors, planes
8	Corner of 4th and Pine St	8/8	12:39 p.m.	single family residential	pickup truck was loudest; other traffic

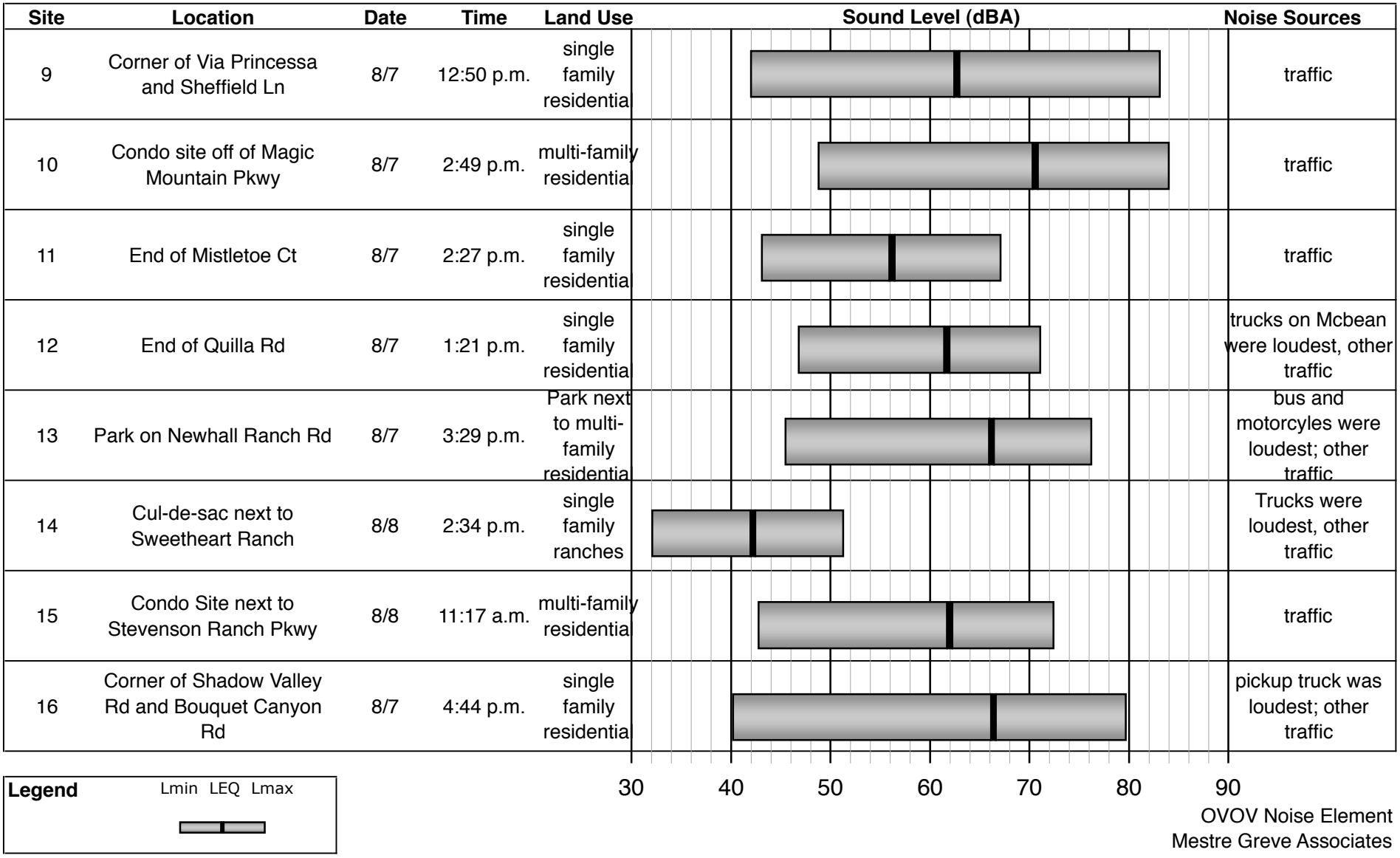


Legend Lmin LEQ Lmax

OVOV Noise Element
Mestre Greve Associates

Exhibit 10 (cont'd)
Graphic Summary of Short-Term Ambeint Noise Measurment Results

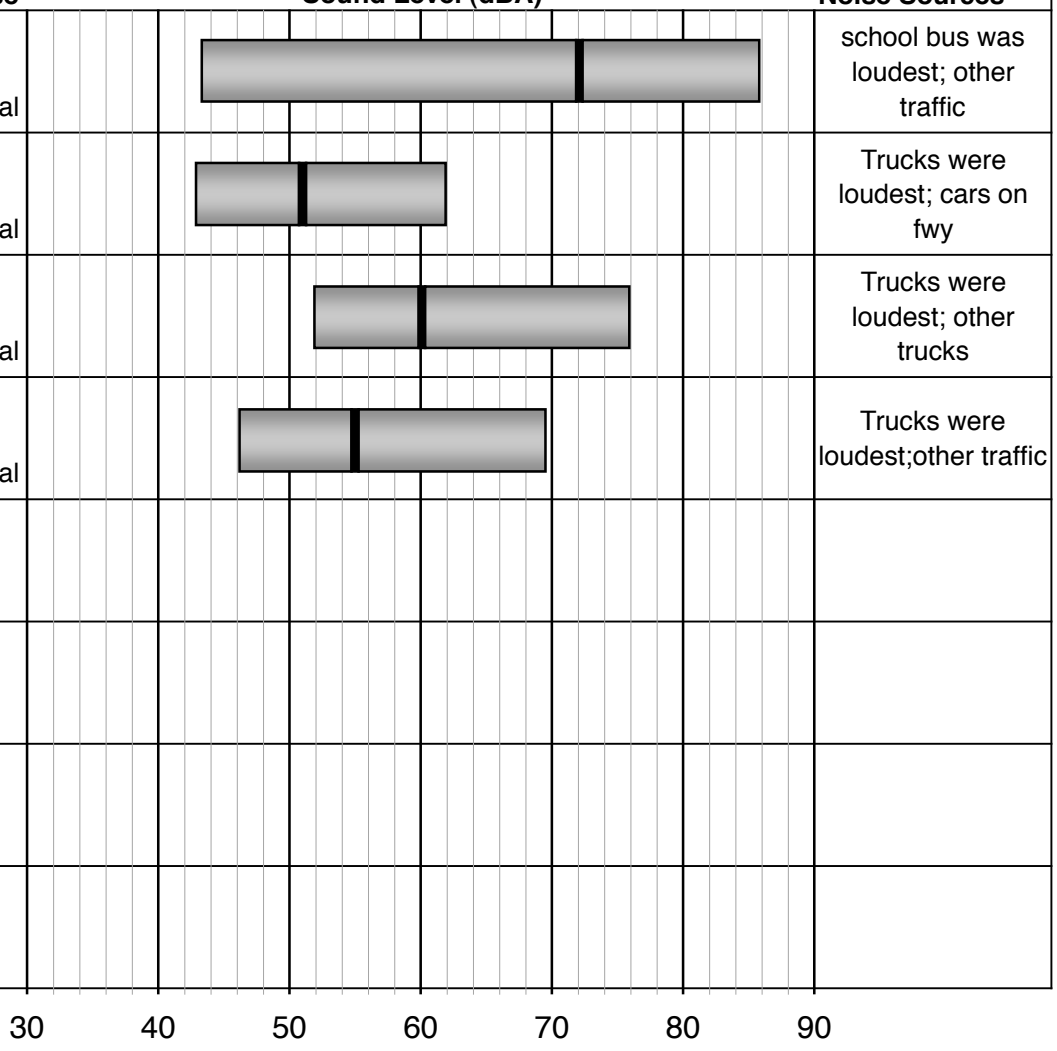
Site	Location	Date	Time	Land Use	Noise Sources
9	Corner of Via Princessa and Sheffield Ln	8/7	12:50 p.m.	single family residentia	traffic
10	Condo site off of Magic Mountain Pkwy	8/7	2:49 p.m.	multi-family residentia	traffic
11	End of Mistletoe Ct	8/7	2:27 p.m.	single family residentia	traffic
12	End of Quilla Rd	8/7	1:21 p.m.	single family residentia	trucks on Mcbean were loudest, other traffic
13	Park on Newhall Ranch Rd	8/7	3:29 p.m.	Park next to multi-family residentia	bus and motorcyles were loudest; other traffic
14	Cul-de-sac next to Sweetheart Ranch	8/8	2:34 p.m.	single family ranches	Trucks were loudest, other traffic
15	Condo Site next to Stevenson Ranch Pkwy	8/8	11:17 a.m.	multi-family residentia	traffic
16	Corner of Shadow Valley Rd and Bouquet Canyon Rd	8/7	4:44 p.m.	single family residentia	pickup truck was loudest; other traffic



OVOV Noise Element
Mestre Greve Associates

Exhibit 10 (cont'd)
Graphic Summary of Short-Term Ambeint Noise Measurment Results

Site	Location	Date	Time	Land Use	Sound Level (dBA)	Noise Sources
17	Corner of Plum Valley Rd and Golden Valley Rd	8/7	4:22 p.m.	single family residential		school bus was loudest; other traffic
18	End of Larkhaven Pl	8/8	1:52 p.m.	single family residential		Trucks were loudest; cars on fwy
19	End of Salem Ct	8/8	10:13 a.m.	single family residential		Trucks were loudest; other trucks
20	End of Robindale Ct	8/7	5:19 p.m.	single family residential		Trucks were loudest;other traffic



Legend Lmin LEQ Lmax

OVOV Noise Element
Mestre Greve Associates

4.3 Detailed Discussion of Noise Measurements

Twenty (20) sites were monitored as part of the measurement program. Each site is discussed below. Exhibit 10, previously presented, includes the time of day, exact location, general land use around the site, and more detail on the measurement results, It may be useful for the reader to refer back to this exhibit during the following discussions.

Site 1- This site was at the edge of an old residential area, at the end of a cul-de-sac. The nearby houses were small and distanced from each other. The next neighborhood south is new, with many homes placed into a small space. The houses receive traffic noise from the 5 freeway and the frontage road. The frontage road, called the Old Road, receives truck traffic as well as normal passenger traffic. According to a neighbor the noise from the freeway is the worst at six o'clock AM, when the road receives the most noise from passenger traffic, no doubt workers entering the city. The traffic is also bad at 4:00 PM, when dozens of trucks pass by. In the middle of the night the neighbors also receive noise from the trucks, which use their brakes on the steep hill. The measurements were taken at 10:00 in the morning, which is a time of minimum traffic. The other noise the sound meter may have received includes the sound of a passing mail truck, as well as the neighbors entering and exiting their homes. The average sound level (Leq) was 65.5 dBA. The levels fluctuated between 55.0 dBA, which was the minimum, and 72.6 dBA, which was the maximum. The maximum was caused by passing trucks. While the average sound level is acceptable, the chain link fences between the neighbors and the traffic may not be enough blockage, especially during peak hours.

Site 2- This site was in a residential district with a golf course that borders it. Past the golf course is the 5 freeway. There was a little noise coming from a light breeze in the trees, as well as some noise from neighbors entering and exiting their homes. There was also a little noise from a lawnmower in the distance, and the golfers on the golf course. However, the main source of noise was from large trucks on the freeway. The maximum, caused by one of these large trucks, registered 70.0 dBA. The average was 64.2, caused by the noise from the freeway.

Site 3- This site is on the corner of two streets which intersect right behind a sound wall, in a residential area. Across the street from the houses by which the sound meter was placed, there was a preschool. There were several exiting vehicles from the school's parking lot during the time of the measurement. There was also a car sitting with its engine on about a half a block away. There was also a significant amount of passenger vehicles that drove by, in the neighborhood itself. However, the main source of sound was from the 5 freeway. The average sound level was 66.4 dBA, which implies that the sound barrier is effective in shielding the noise of the freeway. The loudest sound reached 72.2 dBA, which was caused by a large truck passing by on the freeway.

Site 4- This site was at the end of a cul-de-sac, within the bounds of a playground. The street ends, and then a small path winds around to a tiny playground about ten feet away. There is a metal fence which borders the playground from the road. The area receives noise from Sierra Highway, which borders it, as well as the 14 freeway, which is just slightly off in the distance. There was also a small amount of noise coming from the neighbors in the house next door, who were outside washing their car. The playground was not in use at the time of the measurements. The Leq was 61.0 dBA, while the maximum was 74.2 dBA. This maximum was caused by a pickup truck that drove by on Sierra Highway.

Site 5- This site is located in Old Orchard Park, on a sidewalk next to a grassy area, between a baseball field and a playground. The park borders Lyons Avenue. At the time there was construction being done on an area right next to playground, within the realm of the park. However, during most of the measurements the noise effecting the meter coming from this source was barely audible. The park was active, with several families playing with their small children. The measurements were conducted in order see how loud the traffic from Lyons Ave was. The Average (Leq) noise level for the park was 63.4, while the noise levels ranged from 49.0 dBA to 75.1 dBA. The loudest measurements were taken from passing trucks.

Site 6- This site was at the end of a street which overlooked Freeway 14. The neighbors had a small wall (about three feet) surrounding the property, which may have helped to block sound. The freeway was quite a bit far below. Besides the sound of the freeway, the street also receives noise from Soledad Canyon Road, as well as Sequoia Rd, which is at the end of the street, in the opposite direction. In addition, there is a large construction area across the 14, and the neighbors on the left side of the meter were building on the outside, though they were on a break at the time of the measurements, and several planes flew overhead. The noise levels were fairly regular, with little variation. The average (Leq) level was 62.4 dBA, while the maximum and minimum were 69.5 dBA and 57.4 dBA, respectively. These levels are fairly low in comparison to the amount of traffic nearby, and thus this area is well shielded.

Site 7- This location was near the end of Stator Road, back in the hills of the Los Angeles National Forest. It is in a very small residential district. Practically the only sounds reaching to the microphone were those from the residents. There were a few cars passing on San Francisquito Canyon Road, about one every five or ten minutes. Even the noise emanating from these cars barely reached the microphone. The loudest noises were from two planes, a neighbor's air conditioning, someone moving boxes inside of their home. The maximum sound level was 50.8 dBA, and the average (Leq) was 38.5 dBA. This is very low for a residential area.

Site 8 – This site was on the corner 4th and Pine Street. It was on the edge of a residential area, right next to Pine Street. Beyond Pine Street is the railroad tracks, which is separated by a chain link fence and a few feet of ground. About a half a block from the railroad is San Fernando Road. The neighborhood receives sound from all three of these sources, as well as the sound coming from the streets within the neighborhood itself, which are rather busy, and the traffic from a nearby school. Besides these sources, the measurements include a dog barking, neighbors getting in and out of their vehicles, and two planes. The loudest measurement was 76.6 dBA, which was caused by the sound of a truck passing by on San Fernando Road. The measurements did not include the sound of a train passing by, or else no doubt the noise levels would have been much higher. The average noise level (Leq) was 56.8, which is actually rather low considering how many sound sources there are in the area.

Site 9- Site 9 was on the edge of a residential district, next to Via Princessa. There was a considerable amount of traffic on both Via Princessa and within the neighborhood. There was a helicopter that flew overhead, as well as several planes. There were also carpenters working in the distance. The largest sound levels were caused by trucks turning the corner, which measured at 83.1 dBA, because they were right next to the meter. The average measurement was 62.7 dBA.

Site 10- This site was on the corner of the entrance to a residential area, adjacent to Magic Mountain Parkway. Across the street from the area is a car dealership, which has cars constantly entering and leaving. There is also a considerable amount of traffic entering and exiting the residential area, as well as the sound of golf carts driving around the community. The highest sound levels came from the motorcycles and large trucks that accelerate going up the road. These measured a maximum of 84.0 dBA. When there was a break between cars the sound levels were rather low, with a minimum of 48.8 dBA. However, these spaces were rare. The average sound level was 70.6 dBA, which is from the large amount of traffic on Magic Mountain Parkway.

Site 11- This site was at the end of a cul-de-sac which ends right before Valencia Boulevard. There was noise from neighbors, cars on the local neighborhood streets, and a barking dog as well. The traffic was not exceedingly heavy on Valencia Boulevard, with mainly passenger vehicles. The average sound level (Leq) was 56.2 dBA. The maximum sound level was 67.1 dBA, which was caused by a large truck on Valencia.

Site 12- This site was at the edge of residential district bordering McBean Parkway. It was at the end of cul-de-sac, with a small sound wall around the area. The main noise besides the traffic on McBean was the barking dog, and the wind in the trees, as well as neighbors entering and exiting their homes. The loudest noise was a truck on McBean, measuring 71.1 dBA. The average sound level was 61.7 dBA, which is relatively low for a residential area.

Site 13- This site was in a park, along Newhall Ranch Road. The park was adjacent to a residential area, with a iron fence separating the two. There is, however, a sound wall that separates the residential area from Newhall Ranch Road. The measurements were taken when the park was not active. There were several soccer players off in the distance, but other than that the field was not being used. The loudest noises were the cars passing by, with several small trucks and a motorcycle. The small trucks were the largest source of noise, causing the maximum to be 76.2 dBA. When there were few cars the sound levels were low, with at minimum at 45.5 dBA. The average sound level (Leq) was 66.2 dBA, which is not high for a park setting.

Site 14- This site was off of Agua Dulce Road, right next to Sweetheart Ranch. This area is off of Sierra Highway, far back in the hills. There was very little noise in this area at all. The only few audible noises were due to wind chimes, the breeze in nearby bushes, and the occasional plane which passed by. The area received no traffic noise from Sierra Canyon Road. The average noise level (Leq) was 42.2. The maximum noise level was 51.3, which was caused by a car passing by on Agua Dulce Road.

Site 15- This site was at the end of a cul-de-sac, within a gated area with several apartment complexes. The main sources of noise were both from the 5 freeway and from Steinbeck Road. There was also a small amount of noise from planes, birds, and children playing nearby. The loudest event, measured at 72.4 dBA, was a pickup truck on Steinbeck Road. The average noise level (Leq) was 62.0, dBA, which is low for an area that includes both roads, most likely because few cars pass by on Steinbeck.

Site 16- This site was on the corner of Shadow Valley Road and Bouquet Canyon Road. The measurements were taken in order to test the amount of traffic traveling on the main road. We found that there were few cars that passed by, though there were several large trucks and several very loud motorcycles. There were also several planes that passed overhead. The loudest noise, at 79.7 dBA, was a pickup truck that turned the corner onto Shadow Valley Road. The average noise level (Leq) was 66.4 dBA, which reaches the residential area directly behind the noise measuring site.

Site 17- This site was on the corner of Santa Catarina Road and Plum Canyon Road. The site was chosen in order to test the amount of sound the residential district adjacent to Plum Canyon road receives. The main noise was from the cars on the road. Although there were mainly passenger vehicles, because Plum Canyon is a very open road there is an excess of speeding. The acceleration often occurs right next to the neighborhood. Because site only received noise from passing vehicles, there was a large range of noise, from a maximum sound level of 85.8 dBA, to a minimum sound level of 43.3 dBA. The highest noise levels were caused by a school bus, a motorcycle, a garbage truck, and several cars accelerating up the hill. The average noise level was 72.1 dBA, which is too high for a residential area. However, there is a sound wall built around the residential area, but it does not reach around to the corner, where the measurements were taken.

Site 18- This site was at the end of a cul-de-sac. Measurements were taken in order to test the sound levels caused by the nearby road, freeway 14. There were a few birds, as well as two planes, but besides these the only sound was that of the freeway. The average noise level was 51.0 dBA. The maximum was 61.9 dBA, which was caused by several passing trucks. Although the freeway is nearby, it is elevated from the neighborhood and distanced enough to have a fairly low sound impact.

Site 19- These measurements were taken in a residential neighborhood, on the bend right before a cul-de-sac. The cul-de-sac ends next to the Old Road, which is a frontage road next to the 5 freeway. The meter received the most noise from the 5 freeway, though there is considerable traffic on the Old Road. The measurements were taken to consider both noise sources. Also effecting the noise levels was a siren that passed on the 5 freeway, as well as a dog barking in the neighborhood, and a moving van that stopped at the beginning of the street, and then made a U-turn. The loudest noise, at 75.9 dBA, was from a large truck passing by on the Old Road. The average noise level (Leq) was 60.1 dBA, which is moderate for a neighborhood next to a freeway.

Site 20- This site is in a residential area with a main road, McBean Parkway, running adjacent to it. There was a considerable amount of traffic along McBean, mainly passenger vehicles. In addition, the neighborhood was fairly active, with sprinklers going off in two different yards, as well as several neighbors entering and exiting their homes. There was also a plane that flew overhead. The loudest event was a large truck that drove by. The maximum sound level was 69.5 dBA, and the average was 55.0 dBA. This is quite low for a residential area, thanks to a sound was that borders it.

5.0 NOISE CONTOURS

The noise environment in Santa Clarita is attributable primarily to roadways, which include both surface roadways and freeways. The Southern Pacific Railroad is also a significant noise source, which runs from the southern portion of the City to the center of the City and then directly to the east. Sporadic airplane or helicopter operations occur across the OVOV study area that are not loud enough and consistent enough to be significant. The Agua Dulce Airport is located in the study area.

The noise contours for the City of Santa Clarita are presented in Exhibit 11 for existing conditions. Exhibits 12 and 13 are for buildout conditions for the Current General Plan and the OVOV Plan, respectively. The existing contours are based on the existing conditions of traffic volumes and other sources of noise in the community. The future contours represent a year 2030 scenario. (The traffic noise contours, including the average daily traffic, are also presented in a tabular form as an appendix to this report.)

The noise contours were generated using a mathematical model developed by the Federal Highway Administration ("Traffic Noise Model," Version 2.5, April 14, 2004). The Traffic Noise Model (TNM) model uses traffic volume, vehicle mix, average vehicle speed, roadway geometry, and sound propagation path characteristics to predict hourly A-weighted Leq values adjacent to a road. Vehicle mix is reported in terms of the number of automobiles, medium trucks, and heavy trucks. The truck categories are defined in the TNM model by number of axles and weight. In order to compute a CNEL value for roadways the hourly data for a 24

EXHIBIT 11

EXISTING NOISE CONTOURS

(BEING PREPARED BY CITY)

EXHIBIT 12

CURRENT GENERAL PLAN NOISE CONTOURS

(BEING PREPARED BY CITY)

EXHIBIT 13

OVOV NOISE CONTOURS

(BEING PREPARED BY CITY)

hour period are used according to the CNEL formula. Vehicle distribution over the 24 hour day must be known, i.e., the percent of vehicles in the daytime period (7 a.m. to 7 p.m.), evening period (7 p.m. to 10 p.m.) and night period (10 p.m. to 7 a.m.). The mix of automobiles, medium trucks and heavy trucks has an effect on noise levels. The assumption used to model noise is based on known traffic mix data. For arterial roadways the vehicle mix data are obtained from mix data collected by the County of Orange during extensive surveys of 53 intersections within the County. This survey is the most comprehensive conducted in Southern California and is considered representative for the vast majority of arterial highways throughout Southern California. Caltrans conducts periodic traffic counts on freeways and publishes them on the internet (www.dot.ca.gov/hq/traffops/saferesr/trafdata/). The various truck percentages reported by Caltrans were used for the projections. The arterial roadway mix data are provided in Table 2. Freeway mix data are provided in Tables 3 and 4.

Table 2
Arterial Roadway Vehicle Mix Data
(Traffic distribution per time of day in percent of Average Daily Traffic – ADT)

VEHICLE TYPE	DAY (7 a.m. to 7 p.m.)	EVENING (7 p.m. to 10 p.m.)	NIGHT (10 p.m. to 7 a.m.)	TOTAL
Automobile	75.51	12.57	9.34	97.42
Medium Truck	1.56	0.09	0.19	1.84
Heavy Truck	0.64	0.02	0.08	0.74

Table 3
Interstate 5 Vehicle Mix Data
(Traffic distribution per time of day in percent of Average Daily Traffic – ADT)

VEHICLE TYPE	DAY (7 a.m. to 7 p.m.)	EVENING (7 p.m. to 10 p.m.)	NIGHT (10 p.m. to 7 a.m.)	TOTAL
Automobile	57.72	9.48	18.95	86.15
Medium Truck	1.96	0.32	0.64	2.92
Heavy Truck	7.32	1.20	2.40	10.93

Table 4
State Route 14 Vehicle Mix Data
(Traffic distribution per time of day in percent of Average Daily Traffic – ADT)

VEHICLE TYPE	DAY (7 a.m. to 7 p.m.)	EVENING (7 p.m. to 10 p.m.)	NIGHT (10 p.m. to 7 a.m.)	TOTAL
Automobile	63.05	10.51	21.97	95.53
Medium Truck	1.04	0.17	0.36	1.57
Heavy Truck	1.91	0.32	0.67	2.90

The Southern Pacific Railroad line handles two types of train in the Santa Clarita area; Metrolink, and freight. In terms of noise freight is the dominant noise source. Published train schedules were consulted and it was determined that 24 Metrolink trains run through Santa Clarita each day. No precise numbers of daily freight train operations could be provided, however, we estimated that 12 freight trains pass through each day. The number of freight trains is not expected to increase dramatically. By the year 2030 Metrolink trains are anticipated to double each day. Freight train usage was increased to 15 trains per day. These data were used to generate the train noise contours included in Exhibits 11 through 13.

Noise contours represent lines of equal noise exposure, just as the contour lines on a topographic map are lines of equal elevation. The contours shown on the map are the 60, 65 and 70 dB CNEL noise level. The noise contours presented can be used as a guide for land use planning. The 60 CNEL contour defines the Noise Referral Zone. This is the noise level for which noise considerations should be included when making land use policy decisions.

The contours presented in this report are a graphic representation of the noise environment. These distances to contour values are also shown in tabulated format in the appendix. Topography and intervening buildings or barriers have a very complex effect on the propagation of noise. To present a worst case estimate, the topographic affect is not included in these contours to present a worst case projection.

5.1 Projected Noise Impacts

The traffic levels will change throughout the study area in future years, and the noise levels will also undergo a corresponding change. Many comparisons can be made, but the

comparisons of most interest are between the existing noise levels and future noise levels with the OVOV plan (i.e., cumulative noise increase), and the comparison of noise levels between what would occur with the current General Plan and the proposed OVOV plan (i.e., increase due to project). The traffic study divided up the roadway network into 318 roadway links. Table 5 shows the expected incremental traffic noise level increases on the most important roadways. A significance threshold of 5 dB is often used for a change in environmental noise that occurs slowly over a long period of time. Therefore, all roadway links that show a change in noise level between the existing and future buildout of the OVOV of 5 dB or more are shown in Table 5. Additionally, any roadway links that will experience an increase of 1 dB with the OVOV compared to the Current General Plan is also included in the table. The roadway segment number corresponds to the segment number identified by the traffic engineer.

Table 5
CNEL Noise Increases (dB)

Segment No.	Roadway Link	Cumulative Increase	Increase Due to Project	Land Use
2	Agua Dulce n/o Davenport	6.4	0.0	Sparse Residential
3	Agua Dulce n/o SR-14	6.7	0.0	Open Space
4	Agua Dulce s/o SR-14	4.8	1.8	Open Space
8	Ave Stanford s/o Vanderbilt	5.3	0.8	Commercial
29	Chiquito Cyn (Long Cyn) n/o SR-126	11.0	-0.3	Open Space
41	Copper Hill e/o Haskell	5.3	-0.2	Residential
43	Davenport e/o Sierra Hwy	4.8	1.8	Commercial
53	Dockweiler w/o Sierra Hwy	6.8	-0.2	Sparse Residential
55	Franklin e/o Wolcott Way	9.0	0.0	Open Space
57	Golden Valley s/o Plum Cyn	7.8	0.0	Residential
59	Golden Valley n/o Soledad	5.0	0.0	Comercial/Indust.
68	Hasley Cyn w/o Del Valle	6.4	0.7	Open Space
77	Lake Hughes e/o Castaic	6.1	-0.7	Mixed
78	Lake Hughes e/o Ridge Route	5.4	-2.3	Commercial
87	Lost Cyn s/o Via Princessa	7.4	-0.4	Residential
98	Magic Mtn w/o The Old Road	7.3	0.1	Open Space
99	Magic Mtn e/o The Old Road	5.0	0.2	Office
105	Magic Mtn e/o Valencia	5.3	0.2	Mixed
128	Newhall Ranch e/o Bouquet Cyn	8.2	0.2	Mixed
143	Pico Cyn w/o Stevenson Ranch	9.9	0.0	Residential
161	Ridge Route n/o Lake Hughes	8.5	-0.1	Mixed
162	Ridge Route n/o Castaic	2.0	3.0	Commercial
172	San Martinez Grande Cyn n/o SR-126	7.0	-1.5	Open Space
233	Stevenson Ranch n/o Poe	-0.7	1.4	Open Space
238	The Old Road n/o Hillcrest	6.4	-0.3	Mixed
254	Tibbitts s/o Newhall Ranch	5.8	0.0	Commercial
262	Valencia w/o The Old Road	5.8	0.1	Residential
276	Via Princessa e/o Oak Ridge	5.7	0.0	Residential
279	Via Princessa w/o Rainbow Glen	11.3	0.7	Residential
280	Via Princessa e/o Rainbow Glen	7.6	0.5	Residential
283	Via Princessa n/o Lost Cyn	6.8	0.2	Residential
290	Wiley Cyn e/o Orchard Village	5.8	0.4	Residential
295	Wolcott n/o SR-126	7.8	0.0	Open Space

n/a – existing traffic volumes were not available.

Table 5 shows that 29 roadway segments will experience a cumulative noise increase of 5 dB or greater. The land uses as observed from aerials and on-site visits are shown in the table. (Land use listed may not be the same as the zoning designation.) The OVOV will experience substantial population growth in upcoming years and as a result noise levels will increase significantly along many roadways. Some of the roadway links that will experience much of the noise increase and are bordered by residential uses include portions of Wiley Canyon, Via

Princessa, and Lost Canyon Road. There will be a significant cumulative noise impact along many roads in the OVOV.

With the proposed OVOV plan the noise levels will go down on more roadways than will go up in comparison to the current General Plan. There are only 7 roadway links out of the 318 links that make up the entire roadway network where the noise levels with the OVOV plan increase by 1 dB or more in comparison to the current General Plan. For environmental noise, a difference of 3 dB is barely discernable. Only one roadway link, specifically Ridge Route north of Castaic, will experience a noise increase of 3 dB in comparison to the current General Plan. This area is primarily commercial uses which are very insensitive to noise and therefore, no project specific impacts are projected for the OVOV plan. Even for the residential areas where the noise levels are projected to increase by more than 1 dB, our review of the sites indicate that the residences are currently protected by an existing soundwall or are setback far enough from the roadway so that future noise levels with the OVOV plan will be acceptable. Therefore, although the OVOV will experience substantial increases in traffic over existing levels and corresponding increases in traffic noise, the proposed OVOV plan will result in slightly lower noise levels for more streets than with the current General Plan and will not result in any significant noise increases in comparison to the current General Plan.

Noise levels were projected for the railroad line that pass through the OVOV study area. Both Metrolink and freight trains utilize the railroad line. In future years both the operations of freight and Metrolink are expected to increase. A moderate increase in the CNEL noise level of 2.4 dB is projected to occur between existing levels and buildout. This level of noise increase is expected to occur with both the current General Plan and the proposed OVOV plan. The 2.4 dB increase is not considered to be a significant noise increase.

6.0 Noise Issues

A number of noise issues have arisen during the development of the OVOV plan. Some of the issues have a direct effect on the planning for the OVOV, while other issues are more for informational purposes only.

6.1 High-Speed Rail Line

A high speed rail line is being planned by the California High-Speed Rail Authority. The first route would likely be from Sacramento to Los Angeles, and would likely run through the OVOV area. A separate environmental study will be done as the plans for the high-speed rail are developed. At this time the potential route or routes through the OVOV area are not know, and the type of train and corresponding noise levels are not known. Therefore, no substantive planning in regards to noise can be done at this time.

6.2 High Density Development Along Railroad

High density residential development and mixed-use commercial district, which may contain residential uses, is being planned along portions of the railroad. Most notably this will occur in the areas where the railroad parallels San Fernando Road, and to a lesser extent where the railroad is adjacent to Soledad Canyon Road. Developing residential along railroads presents special challenges. First, constructing soundwalls along railroads is often not feasible. Soundwalls that are constructed may provide some protection for lower residential floors, but provide little or no protection for the upper floors. Secondly, although the CNEL noise scale is the best scale for use for environmental noise it does have a weakness when dealing with train events (and to a similar extent aircraft noise). Specifically, train noise is what is referred to single event noise. A train event will occur and generate loud levels of noise and then there will be no railroad noise for an extended period of time. The CNEL scale accounts for the number of trains, the time of day that they occur, and how loud the trains are; but some argue that the annoyance and activity disruption that is generated by the single event of a train is not fully accounted for. For example, if a train passes by and awakens you, your main focus is on that one train and not on the other factors that go into the CNEL scale calculation. The use of CNEL (or the similar Ldn scale) for noise/land use planning is required by State code. And in

fact the use of the CNEL scale provides the best correlation with how people view the noise environment. However, some people express annoyance due to the loudness of the single events, and an extra margin of satisfaction with the noise environment can be achieved through the use of a buyer/renter notification program. Basically the notification provides information on the location and type of noise source in the area and the fact that there may loud events generated by these sources.

For high density residential uses (and mixed-use) there are no outside private areas where quiet is anticipated. Generally, these uses might have a small balcony but there is little expectation that the noise levels for these balcony areas will be low. This is especially true when one considers that a balcony noise barrier, often made of glass, is about the only way to provide noise protection for a small balcony area. Balcony barriers are often disliked by the residents because they close-in the balcony too much. For a high density residential use the expectation is that there will be a place in the complex where peace and quiet can be found. It may be communal courtyards or a pool area to lay around and relax. It is important to provide noise protection for these areas. These areas can often be protected through site design, such as locating buildings or parking structures between the noise source and the area to be protected. Recommendations for noise standards and buyer notification are provided in Section 7.0 – Policy Recommendations.

6.3 Mixed-Use Developments

As part of the development of the downtown area mixed-use projects may be constructed. The commercial/residential interface presents special problems. The primary concern is that the commercial uses may operate through the evening hours and into the nighttime hours. Clubs, late-night restaurants, and banquet facilities are some examples of commercial uses that could locate in the mixed-use area and generate noise into nighttime hours. Another characteristic of the commercial areas is that the tenants in a building may change over time. For example, a bookstore that did not operate at night could be replaced by a popular restaurant where operations could extend through the evening and into nighttime hours. Simply stated, the noise levels that are present today will change and noise environment will change accordingly. For

these reasons it is very difficult to properly soundproof residences that are constructed in a mixed-use development.

It would be desirable to take some additional action in mixed-use developments so that residents would view the noise environment as favorable. Putting time limits on the commercial uses might be viable in some cases, but it may also deter some of the specific commercial uses that the City is trying to attract from locating in or near a mixed-use development. The State requires that buildings be designed to meet a 45 CNEL indoor noise standard for multi-family residences. Therefore, it would not be possible to set an indoor noise standard more restrictive than the State standard because the State law has precedence.

Buyer and renter notification is often the only recourse in trying to improve the noise acceptability for residents in mixed-use projects. The notification should inform the potential residents that commercial uses are located nearby, the their hours of operation may change from time to time, and that the use within the commercial area along with the noise generation potential may also change over time. Specific recommendations are made in Section 7.0 – Policy Recommendations.

6.4 Agua Dulce Airport

The Agua Dulce Airport is located in the northeast quadrant of the OVOV study area. The airport is located in a sparsely populated area of the County. The airport is privately owned but open to the public. The airport has a single 4,600 foot long runway and serves general aviation aircraft only. There are many noise restrictions in place for flight operations. No night operations are allowed at the airport. Aircraft are not allowed to fly within 1,000 feet of the school which is located 1 mile southwest of the airport. If aircraft depart to the north on Runway 4, they are to avoid flying over the home 2,000 feet northeast of the end of the runway. Finally, touch and go practices are not allowed at the airport. A 65 CNEL noise contour has been generated for the airport and was provided by the County of Los Angeles. The noise contour barely extends past the ends of the runway and does not impact any residences (Exhibit 14).

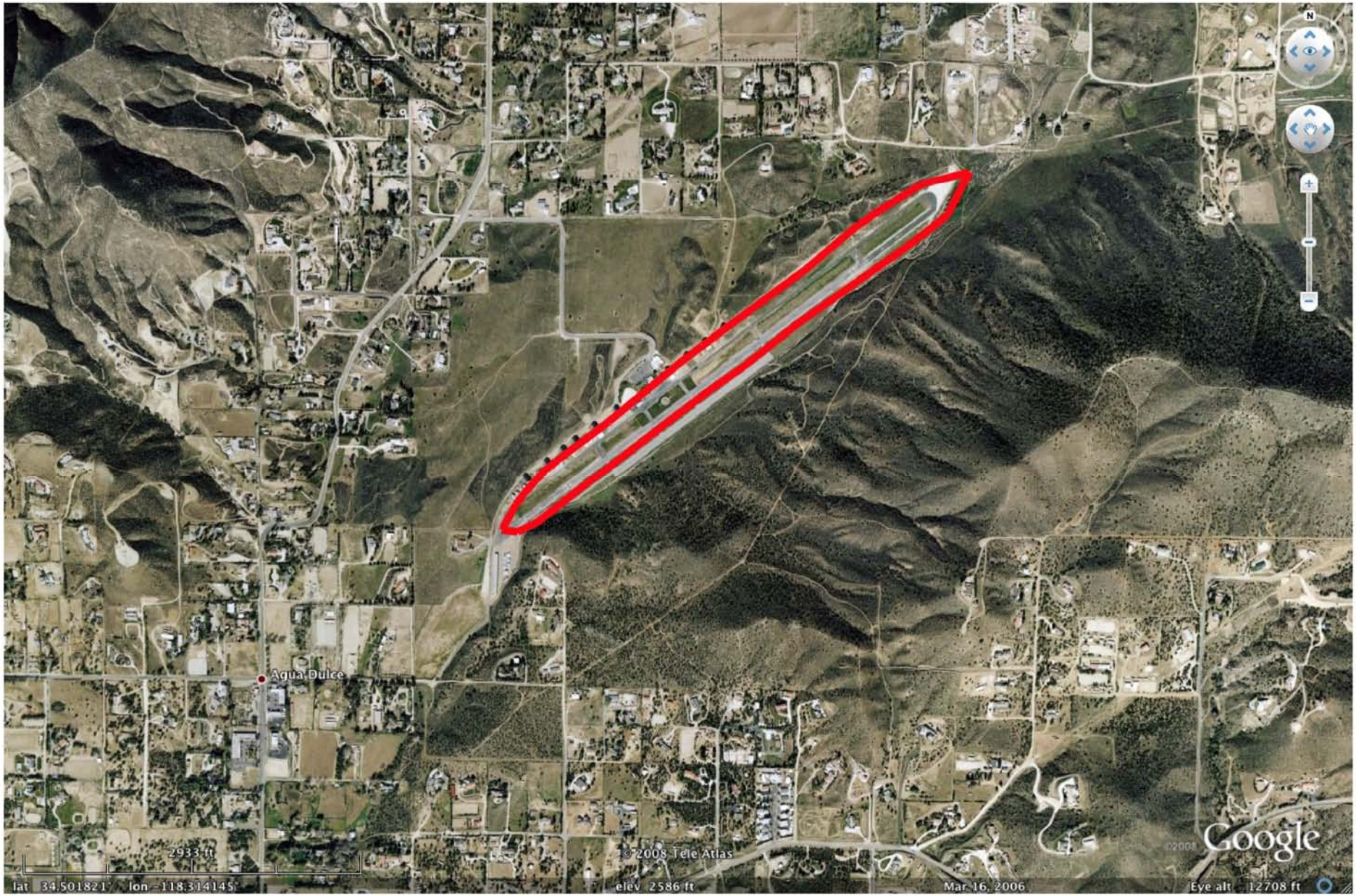


Exhibit 14

Agua Dulce Airport 65 CNEL Contour

Mestre Greve Associates

6.5 Magic Mountain

Six Flags Magic Mountain is an amusement park located in the southwest quadrant of the study area. The park has a large number of thrill rides including 17 roller coasters, has live entertainment, and periodically has firework displays. The noise levels and hours of operation around the park vary considerably depending on the time of day, the day of the week, the presence of holidays, and the season of the year. The noise levels generated by park activities can be heard for a considerable distance around the park at certain times. People buying or renting in the area may be surprised later when they can hear park activities. A buyer/renter notification program may be appropriate for new developments that locate in the area. See Section 7.0 – Policy Recommendations.

6.6 Special Events

Special events, such as outdoor concerts, may be held in the study area on an irregular or regular basis. The noise levels as they impact surrounding parcels would be limited per the Los Angeles County Noise Ordinance and the Santa Clarita Noise Ordinance. The noise ordinances apply to any events that are held on private property. The Santa Clarita Noise Ordinance consists of Chapter 11.44 of municipal code. The limits contained in the ordinance would apply to any special event with only "lawfully conducted parades" and "emergency work" exempted from the ordinance. The Los Angeles County noise ordinance is contained in Chapter 12.08 of the county code. Similar to the Santa Clarita ordinance, the Los Angeles County ordinance contains specific noise limits that can not be exceeded at the property boundary. The limits vary depending on the time of day and land uses involved. Finally, it should be noted that the noise ordinances are contained in the city or county code, and are not part of the Noise Element of the General Plan. Control of noise sources on private property is usually regulated through the imposition of a city or county regulation and is not usually part of the General Plan.

6.7 Emergency Vehicles

Noise generated by emergency vehicles is not under the control of the City or County. Both the City and County noise ordinances exempt emergency operations from regulation. The State has preempted local jurisdictions from controlling noise generated by emergency equipment. The use of sirens on police vehicles, ambulances, and fire trucks can not be

controlled by the City or County. Similarly, emergency flights of helicopters and airplanes can not be controlled by the City or County.

7.0 Policy Recommendations

The Santa Clarita Noise Element of the General Plan was updated in May 2000. The Goals and Policies section of the document is excellent. Suggested modifications to the Goals and Policies are made below. In some cases, the change suggested simply provides a clarification to existing policies. Other suggested changes reflect the need to address noise issues that concern higher density developments that will occur as the area develops further.

7.1 Expand Use of Santa Clarita Noise Element to Entire OVOV

The use of the Santa Clarita Noise Element should be expanded to cover the entire OVOV area. Specifically, the Noise and Land Use Compatibility Guidelines (contained in the Element as Exhibit N-2) with the recommended changes suggested below and the Goals and Policies contained in the Noise Element should be applicable to all of OVOV. The Goals and Policies contained in the Noise Element are very appropriate for a developing area and are needed for the OVOV.

7.2 Modifications to Compatibility Matrix

A land use compatibility matrix is presented in the Noise Element as Exhibit N-2. The exhibit identifies the level of acceptability for land use and noise exposure combinations. For example, a land planner may consult the matrix for a residential project that is being considered where the noise exposure is 72 CNEL. The matrix would inform the planner that the compatibility is "normally unacceptable," but if the project does proceed a detail acoustical analysis will be needed as well as noise insulation features in the design. One concern with the matrix is that many categories overlap. For example, if the planner consulted the chart for a residential project in a 57 CNEL noise zone, it would be discovered that the project would fall into two categories; "normally acceptable" and "conditionally acceptable." This ambiguity is makes the matrix less useful.

A revised matrix is shown in Exhibit 15. The overlapping categories have been removed. Additionally, clarifying language has been added to language below the matrix and to the description of the normally unacceptable category.

7.3 Indoor Noise Criteria

Policy 3.1 of the Noise Element identifies the need to protect indoor noise levels. However, it provides a threshold level based on daytime and nighttime noise levels. Normally these levels are not readily available, however, the CNEL noise levels as presented in the noise contour exhibits for the area are easily accessed. Therefore, we are recommending that the threshold level cited should be changed to an equivalent CNEL level. Additionally, a specific indoor criterion should be cited rather than a vague phrase such as "provide mitigation measures." The recommended language for Policy 3.1 is as follows:

> *Require that developers of new single-family and multi-family residential neighborhoods in areas where the projected noise levels exceeds 60 CNEL to provide mitigation measures for new residences to reduce indoor noise levels to 45 CNEL based on future traffic and railroad noise levels.*

7.4 Outdoor Noise Criteria

The Noise Element does not contain any specific standards in regards to outdoor areas for new residential developments. It is important to protect certain outdoor areas for the benefit of the residents. In fact, the City generally imposes an outdoor noise standard as a condition of approval on new residential developments. However, this standard should be included in the Noise Element so that the planning for new developments will clearly addresses the need to protect certain outdoor areas. A new Policy 3.5 is recommend and would read as follows:

> *Require that developers of new single-family and multi-family residential neighborhoods in areas where the projected noise levels exceeds 65 CNEL to provide mitigation measures (e.g., noise barriers, setbacks, site design) for new residences to reduce outdoor noise levels to 65 CNEL based on future traffic conditions. This criteria would apply to rear yard areas for single family*

developments and private patio areas and community recreation facilities (e.g., parks and swimming pools) for multi-family developments.

7.5 Development of Sensitive Land Uses Along Interstate 5

The noise levels along Interstate 5 are projected to increase with either the Current General Plan or the proposed OVOV Plan. Traffic levels are projected to increase and the percent of nighttime traffic will also continue to increase. Residential development very close to the freeway results in very high soundwalls, or in some cases, wall height requirements that are infeasible. (Generally soundwall heights greater than 16 feet are considered infeasible.) Very high soundwalls are also not consistent with the area's character that is suburban or even rural in some locations. Additionally, the California Air Resources Board has recommended that residences be located 500 feet from the edge of the freeway due to potential air toxic impacts unless detailed air studies are done. Therefore, a new Policy 3.6 is recommended below which prohibits residential buildings within 150 feet of the Interstate 5 centerline. The purpose of the policy is to avoid placing residential uses in an area that can not adequately be noise mitigated, and to reduce the use of high soundwalls along the I-5. It should be noted that the centerline was utilized as a reference instead of the right of way, because the right of way width varies greatly as the freeway passes through the study area. The proposed Policy 3.6 reads as follows:

New residential buildings shall not be located within 150 feet of the Interstate 5 centerline.

7.6 Disclosure Statements for Special Areas

Three land use situations were identified above where buyer/renter notification programs would be beneficial. A new Policy 3.7 is recommended and would read as follows:

A buyer and renter notification program should be developed for new residential developments to educate and inform potential buyers and renters of the sources of noise in the area or new sources that may occur. Potential buyers and renters within 1 mile of Magic Mountain or within 1,000 feet of the railroad should receive notice that these sources occasionally generate high levels of noise and

that the frequency and loudness of these noise events may change over time. Potential buyers and renters in or within 200 feet of high-density mixed use developments should be noticed that the commercial uses within the mixed use developments may generate noise in excess of levels typically found in residential areas, and that the commercial uses may change over time and the associated noise levels and frequency of noise events may also change along with the use.

APPENDIX

Traffic Noise Contours

Santa Clarita Noise Element / Existing Traffic Noise Contours (Arterial):

ROAD	End 1	End 2	ADT	SPEED	CNEL 50' from CL	70	65	60
LAKE HUGHES ROAD	North Section	North Section	9,000	50	66.9	36	61	106
SAN FRANCISQUITO CANYON	South of Dry Gulch Road	North of Dry Gulch Road	0	45	0	0	0	0
BOUQUET CANYON ROAD	North End	North End	5,000	40	61.4	19	33	59
SIERRA HIGHWAY	Aqua Dolce Canyon Road	E of Aqua Dolce Canyon	2,000	40	57.4	12	21	37
LAKE HUGHES ROAD	Mid-Section	North Section	2,000	45	58.9	14	25	44
SAN FRANCISQUITO CANYON	Mid-Section	South of Dry Gulch Road	0	45	0	0	0	0
RIDGE ROUTE ROAD	Lake Hughes Road	N of Lake Hughes Road	5,000	50	64.3	27	46	80
LAKE HUGHES ROAD	Castaic Road	Ridge Route Road	9,000	45	65.5	30	53	92
RIDGE ROUTE ROAD	Castaic Road	Lake Hughes Road	5,000	50	64.3	27	46	80
CASTAIC ROAD	Parker Road	Lake Hughs Road	12,000	50	68.1	41	70	121
THE OLD ROAD	Parker Road	Sloan Canyon Road	2,000	50	60.4	17	30	52
AGUA DULCE CANYON ROAD	Escondido Canyon Road	Sierra Highway	4,000	45	61.9	20	35	62
ESCONDIDO CANYON ROAD	Aqua Dolce Cyn Road	East End	3,000	45	60.7	18	31	54
AGUA DULCE ROAD	Davenport Road	Escondido Canyon Road	3,000	55	63.5	25	43	72
DAVENPORT ROAD	Tick Canyon Road	Aqua Dulce Road	2,000	45	58.9	14	25	44
DAVENPORT ROAD	Sierra Highway	Tick Canyon Road	2,000	35	55.8	9	17	30
SAN FRANCISQUITO CANYON	N of Copper Hill Drive	Mid-Section	0	45	0	0	0	0
MCBEAN PARKWAY	North of Copperhill		0	40	0	0	0	0
SECO CANYON ROAD	Copper Hill Drive	N of Copper Hill Drive	10,000	35	62.8	21	38	69
COPPER HILL DRIVE	Sycamore	High Ridge	5,000	55	65.7	32	54	91
COPPER HILL DRIVE	Haskell Canyon Road	Sycamore	5,000	45	62.9	23	40	69
COPPER HILL DRIVE	Seco Canyon Road	Haskell Canyon Road	20,000	55	71.7	60	102	173
BOUQUET CANYON ROAD	David Way	Vasquez Canyon Road	11,000	50	67.8	39	68	116
HASLEY CANYON ROAD	Del Valle Road	Sloan Canyon Road	3,000	40	59.2	14	26	46
SIERRA HIGHWAY	Vasquez Canyon Road	Davenport Road	11,000	40	64.8	28	49	87
HASLEY CANYON ROAD	The Old Road	Commerce Center Drive	17,000	40	66.7	34	61	108
SIERRA HIGHWAY	Sand Canyon Road	Vasquez Canyon Road	11,000	35	63.2	22	40	73
SIERRA HIGHWAY	S of Vasquez Canyon Rd	Vasquez Canyon Road	11,000	45	66.3	33	58	102

COPPER HILL DRIVE	Decoro Drive	McBean Parkway	26,500	45	70.2	51	89	156
PLUM CANYON ROAD	West of Golden Valley	West of Golden Valley	24,000	45	69.7	48	85	149
COPPER HILL DRIVE	Alta Vista Way	Decoro Drive	33,000	60	73.9	76	128	218
DECORO DRIVE	Rye Canyon	Dickason Drive	12,000	35	63.6	23	42	76
DECORO DRIVE	Dickason Drive	McBean Parkway	14,000	55	70.2	51	86	147
PLUM CANYON ROAD	West of Golden Valley	South of Skyline Ranch Rd	24,000	45	69.7	48	85	149
THE OLD ROAD	Newhall Ranch Road	N of Newhall Ranch Road	10,000	45	65.9	32	55	97
THE OLD ROAD	Henry Mayo Drive	Newhall Ranch Road	15,000	55	70.5	53	89	152
RYE CANYON ROAD	Avenue Scott	Newhall Ranch Road	25,000	50	71.3	58	100	172
WHITES CANYON ROAD	South of Skyline Ranch Rd	Skyline Ranch Road	13,000	55	69.8	49	84	142
AGUA DULCE ROAD	Soledad Canyon Road	Davenport Road	3,000	55	63.5	25	43	72
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	5,000	45	62.9	23	40	69
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	5,000	40	61.4	19	33	59
DICKASON DRIVE	Newhall Ranch Road	Decoro Drive	13,000	50	68.5	42	73	126
NEWHALL RANCH ROAD	Dickenson Drive	Rye Canyon Road	21,000	50	70.6	53	92	158
SOLEDAD CANYON ROAD	Aqua Dolce Road	East of Aqua Dolce Rd	8,000	55	67.7	39	67	114
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	5,000	45	62.9	23	40	69
AVE TIBBITTS	Avenue Scott	Newhall Ranch Road	9,000	35	62.3	20	36	66
THE OLD ROAD	Rye Canyon Road	Henry Mayo Drive	33,000	50	72.5	66	114	196
AVE SCOTT	Avenue Tibbitts	Rockefeller Avenue	10,000	35	62.8	21	38	69
AVE TIBBITTS	Avenue Scott	Hopkins	0	35	0	0	0	0
NEWHALL RANCH ROAD	Bouquet Canyon Road	E of Bouquet Canyon Rd	7,000	50	65.8	32	55	94
NEWHALL RANCH ROAD	West of Golden Valley		0	45	0	0	0	0
SANTA CLARITA PARKWAY	Newhall Ranch Road	Bouquet Canyon Road	0	45	0	0	0	0
AVE TIBBITTS	Hopkins	Magic Mountain Parkway	0	55	0	0	0	0
BOUQUET CANYON ROAD	Soledad Canyon / Valencia	Newhall Ranch Road	63,000	45	73.9	77	136	237
THE OLD ROAD	Magic Mountain Parkway	Rye Canyon Road	31,000	35	67.7	38	69	125
HENRY MAYO DRIVE	Commerce Center Drive	Chiquito Canyon Road	5,000	40	61.4	19	33	59

MAGIC MOUNTAIN PARKWAY	The Old Road	Magic Mountain Theme Park	16,000	55	70.7	54	92	156
LOST CANYON ROAD	Sand Canyon Road	East of Sand Canyon Rd	0	45	0	0	0	0
MAGIC MOUNTAIN PARKWAY		East of Commerce Ctr Dr	0	50	0	0	0	0
SAND CANYON ROAD	South of Jakes Way	Jakes Way	9,000	45	65.5	30	53	92
MAGIC MOUNTAIN PARKWAY	Bouquet Canyon Road	Valencia Blvd	21,000	50	70.6	53	92	158
HENRY MAYO DRIVE	West of Chiquito Cyn Rd	West of Chiquito Cyn Rd	5,000	45	62.9	23	40	69
WHITES CANYON ROAD	Via Princessa	Soledad Canyon Road	25,000	50	71.3	58	100	172
THE OLD ROAD	North of Valencia Blvd	Magic Mountain Parkway	15,000	55	70.5	53	89	152
TOURNEY ROAD	Valencia Boulevard	Magic Mountain Parkway	6,000	35	60.5	16	29	53
VALENCIA BOULEVARD	Tourney Road	Rockwell Canyon Road	43,000	45	72.3	64	113	197
VALENCIA BOULEVARD	Interstate 5	Tourney Road	44,000	45	72.4	65	114	199
THE OLD ROAD	Valencia Blvd	North of Valencia Blvd	15,000	40	66.2	32	57	102
VALENCIA BOULEVARD	The Old Road	Interstate 5	21,000	45	69.1	45	80	139
HENRY MAYO DRIVE	Wes of Chiquito Cyn Rd	to West End	5,000	40	61.4	19	33	59
VIA PRINCESSA	North of Lost Canyon	Sierra Highway	24,000	35	66.6	33	60	109
VIA PRINCESSA	Lost Canyon Road	North of Lost Canyon	5,000	35	59.7	15	27	49
MAGIC MOUNTAIN PARKWAY	Commerce Center Drive	Valencia Blvd	0	45	0	0	0	0
VIA PRINCESSA	East of Golden Valley Rd		0	35	0	0	0	0
VIA PRINCESSA	Santa Clarita Pkwy	Golden Valley Road	0	40	0	0	0	0
GOLDEN VALLEY ROAD	Sierra Highway	Via Princessa	20,000	60	71.7	60	102	173
ROCKWELL CANYON ROAD	McBean Parkway	Valencia Blvd	15,000	50	69.1	45	78	135
VIA PRINCESSA	Railroad Avenue	West of Railroad Canyon	2,000	40	57.4	12	21	37
RAILROAD AVENUE	Via Princessa	South of Via Princessa	36,000	40	70.0	50	89	158
16TH STREET	Newhall Avenue	Orchard Village Road	9,000	35	62.3	20	36	66
STEVENSON RANCH PARKWAY	The Old Road	North of Pico Canyon Road	28,000	50	71.8	61	105	181
LYONS AVENUE EXTENSION	Railroad Canyon	Walnut	20,000	55	71.7	60	102	173
THE OLD ROAD	Pico Canyon Road	Stevensons Ranch Parkway	25,000	40	68.4	42	74	132
SAND CANYON ROAD	Placerita Canyon Road	South of Jakes Way	9,000	45	65.5	30	53	92

LYONS AVENUE	Newhall Avenue	Walnut	38,000	45	71.7	61	106	186
NEWHALL AVENUE	Lyons Avenue	16th Street	1,000	45	55.9	10	18	32
PICO CANYON ROAD	The Old Road	Stevenson Ranch Parkway	16,000	55	70.7	54	92	156
STEVENSON RANCH PARKWAY	Pico Canyon Road	North of Pico Canyon Road	8,000	50	66.4	34	58	100
WILEY CANYON ROAD	Lyons Avenue	Tournament Canyon Road	18,000	40	67.0	35	63	112
LYONS AVENUE EXTENSION		East of Railroad Canyon	0	55	0	0	0	0
NEWHALL AVENUE	Market Street	Lyons Avenue	22,000	45	69.3	46	81	142
SIERRA HIGHWAY	Intersection Dockweiler	Intersection Dockweiler	16,000	45	68.0	40	70	122
SIERRA HIGHWAY	Newhall Avenue	Dockweiler Drive	16,000	45	68.0	40	70	122
NEWHALL AVENUE	Sierra Highway	East of Sierra Highway	39,000	45	71.8	61	107	188
CALGROVE BOULEVARD	Wiley Canyon	East End	600	55	56.5	12	20	34
CALGROVE BOULEVARD	The Old Road	Wiley Canyon	11,000	55	69.1	46	77	132
THE OLD ROAD	Calgrove Boulevard	North of Calgrove Blvd	5,000	45	62.9	23	40	69
THE OLD ROAD	North of Calgrove Blvd	Pico Canyon Road	5,000	35	59.7	15	27	49
THE OLD ROAD	Sierra Highway	Calgrove Boulevard	7,000	45	64.4	27	47	82
SAN FERNANDO RD (LA)	Sierra Highway	S of Sierra Highway	0	45	0	0	0	0
CHIQUITO CANYON ROAD	Lower Mid Point	North End	2,000	45	58.9	14	25	44
CHIQUITO CANYON ROAD	South End	Lower Mid-Point	17,000	45	68.2	41	72	126
HILLCREST PARKWAY	The Old Road	Sloan Canyon Road	15,000	45	67.7	39	68	118
SAND CANYON ROAD	S of Placerita Canyon	Little Tujunga Canyon Rd	9,000	45	65.5	30	53	92
PLACERITA CANYON ROAD	W of Sand Canyon Road	W of Sand Canyon Road	4,000	40	60.4	17	30	53
PLACERITA CANYON ROAD	Mid-Section	Mid-Section	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	Sierra Highway	East of Sierra Highway	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	Mid-Section	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	4,000	45	61.9	20	35	62
SOLEDAD CANYON ROAD	Shadow Pines Blvd	Aqua Dolce Road	8,000	55	67.7	39	67	114
SIERRA HIGHWAY	Davenport Road	North of Davenport Rd	2,000	45	58.9	14	25	44
SIERRA HIGHWAY	North of Davenport Rd	Aqua Dolce Canyon Road	2,000	45	58.9	14	25	44
BOUQUET CANYON ROAD	Vasquez Canyon Road	Mid Section	5,000	50	64.3	27	46	80
BOUQUET CANYON ROAD	Mid Section	North End	5,000	50	64.3	27	46	80

VASQUEZ CANYON ROAD	Sierra Highway	North of Sierra Highway	8,000	45	65.0	28	50	87
VASQUEZ CANYON ROAD	North of Sierra Highway	East of Bouquet Canyon	8,000	40	63.5	24	42	74
SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	W of Shadow Pines Blvd	12,000	50	68.1	41	70	121
SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	Shadow Pines Blvd	12,000	35	63.6	23	42	76
SOLEDAD CANYON ROAD	West of Sand Canyon	Sand Canyon Road	26,000	40	68.6	42	75	134
SOLEDAD CANYON ROAD	East of Sand Cayon	Sand Canyon Road	33,000	50	72.5	66	114	196
SOLEDAD CANYON ROAD	East of Sand Cayon	East of Sand Cayon	33,000	50	72.5	66	114	196
SAND CANYON ROAD	Jakes Way	South of Soledad Canyon	28,000	45	70.4	52	91	160
SAND CANYON ROAD	South of Soledad Canyon	Soledad Canyon Road	28,000	50	71.8	61	105	181
SOLEDAD CANYON ROAD	West of Sand Canyon	West of Sand Canyon	26,000	50	71.5	59	101	175
SOLEDAD CANYON ROAD	East of Sierra Highway	Sierra Highway	35,000	50	72.8	68	117	201
SOLEDAD CANYON ROAD	East of Sierra Highway	West of Sand Canyon	35,000	45	71.4	58	102	178
SOLEDAD CANYON ROAD	East of Sierra Highway	East of Sierra Highway	35,000	45	71.4	58	102	178
SOLEDAD CANYON ROAD	East of Whites Canyon	Whites Canyon Road	46,000	40	71.0	56	100	178
SOLEDAD CANYON ROAD	East of Whites Canyon	East of Whites Canyon	46,000	45	72.5	67	116	204
SOLEDAD CANYON ROAD	West of Sierra Highway	Sierra Highway	46,000	45	72.5	67	116	204
SOLEDAD CANYON ROAD	West of Sierra Highway	East of Whites Canyon	46,000	45	72.5	67	116	204
SOLEDAD CANYON ROAD	West of Whites Canyon	Whites Canyon	46,000	45	72.5	67	116	204
WHITES CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	41,000	40	70.5	53	95	168
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	41,000	50	73.5	73	126	217
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	41,000	40	70.5	53	95	168
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	41,000	30	67.1	35	65	121
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	41,000	55	74.8	83	142	241
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	41,000	35	68.9	44	80	144
WHITES CANYON ROAD	N of Soledad Canyon Road	South of Plum Canyon	41,000	45	72.0	63	110	193
WHITES CANYON ROAD	South of Plum Canyon	Plum Canyon Road	41,000	35	68.9	44	80	144

PLUM CANYON ROAD	West of Golden Valley	East of Bouquet Canyon	24,000	40	68.2	41	72	129
PLUM CANYON ROAD	Bouquet Canyon Road	East of Bouquet Canyon	24,000	40	68.2	41	72	129
BOUQUET CANYON ROAD	David Way	Susan	11,000	45	66.3	33	58	102
BOUQUET CANYON ROAD	Plum Canyon	Susan	10,000	45	65.9	32	55	97
COPPER HILL DRIVE	High Ridge	Benz Road	5,000	60	65.7	32	54	91
HASKELL CANYON ROAD	Jeffers Lane	Copper Hill Drive	12,000	45	66.7	35	61	106
HASKELL CANYON ROAD	Bouquet Canyon Road	Ridgegrove Drive	12,000	35	63.6	23	42	76
HASKELL CANYON ROAD	Jeffers Lane	Ridgegrove Drive	12,000	45	66.7	35	61	106
BOUQUET CANYON ROAD	Urbandale Avenue	Plum Canyon	30,000	45	70.7	54	95	166
BOUQUET CANYON ROAD	Haskell Canyon Road	Urbandale Avenue	30,000	45	70.7	54	95	166
BOUQUET CANYON ROAD	Alamogordo Road	Centurion Way	52,000	45	73.1	71	124	216
BOUQUET CANYON ROAD	Centurion Way	Haskell Canyon Road	38,000	45	71.7	61	106	186
BOUQUET CANYON ROAD	Seco Canyon Road	Santa Clarita Parkway	42,000	50	73.6	74	127	219
BOUQUET CANYON ROAD	Santa Clarita Parkway	Urbandale Avenue	30,000	40	69.2	46	81	144
SECO CANYON ROAD	Bouquet Canyon Road	N of Bouquet Canyon Rd	23,000	40	68.0	40	71	126
SECO CANYON ROAD	N of Bouquet Canyon Rd	Decoro Drive	23,000	35	66.4	32	59	107
SECO CANYON ROAD	Decoro Drive	North of Decoro Drive	23,000	35	66.4	32	59	107
SECO CANYON ROAD	North of Decoro Drive	S of Copper Hill Drive	19,000	35	65.5	29	53	97
SECO CANYON ROAD	S of Copper Hill Drive	Copper Hill Drive	19,000	35	65.5	29	53	97
COPPER HILL DRIVE	San Francisquito Canyon	Seco Canyon Road	35,000	35	68.2	40	73	133
COPPER HILL DRIVE	McBean Parkway	San Francisquito Canyon	35,000	50	72.8	68	117	201
MCBEAN PARKWAY	Sunset Hills Drive	Copper Hill Drive	22,000	40	67.8	39	69	123
MCBEAN PARKWAY	South of Sunset Hills	Sunset Hills Drive	22,000	40	67.8	39	69	123
MCBEAN PARKWAY	Decoro Drive	North of Decoro Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	South of Sunset Hills	North of Decoro Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	North of Decoro Drive	North of Decoro Drive	27,000	40	68.7	43	77	137
DECORO DRIVE	McBean Parkway	Grandview	19,000	45	68.7	43	76	133
DECORO DRIVE	Grandview	Hillsburough	14,000	45	67.4	37	65	114
DECORO DRIVE	Hillsburough	Bidwell Lane	17,000	45	68.2	41	72	126
DECORO DRIVE	Bidwell Lane	Delgado Drive	11,000	55	69.1	46	77	132
DECORO DRIVE	Delgado Drive	Seco Canyon Road	11,000	60	69.1	46	77	132
MCBEAN PARKWAY	Newhall Ranch Road	Fairveiw Drive	32,000	40	69.5	47	84	149
MCBEAN PARKWAY	Fairveiw Drive	Decoro Drive	32,000	40	69.5	47	84	149

COPPER HILL DRIVE	Alta Vista Way	Smyth Drive	35,000	55	74.1	78	132	224
COPPER HILL DRIVE	Newhall Ranch Road	Smyth Drive	35,000	60	74.1	78	132	224
AVE SCOTT	Avenue Tibbitts	Stanford Avenue	14,000	45	67.4	37	65	114
AVE SCOTT	Stanford Avenue	Rye Canyon	10,000	40	64.4	26	47	83
NEWHALL RANCH ROAD	Rye Canyon Road	Interstate 5 ramp	25,000	45	69.9	49	87	151
BOUQUET CANYON ROAD	Newhall Ranch Road	Espuella Avenue	52,000	55	75.9	93	158	269
BOUQUET CANYON ROAD	Espuella Avenue	Seco Canyon Road	52,000	45	73.1	71	124	216
NEWHALL RANCH ROAD	Bouquet Canyon Road	Hillsburough	37,000	45	71.6	60	105	183
NEWHALL RANCH ROAD	Hillsburough	West of Hillsburough	37,000	45	71.6	60	105	183
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	7,000	45	64.4	27	47	82
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	7,000	50	65.8	32	55	94
NEWHALL RANCH ROAD	W of Hillsburough	East of McBean Pkwy	37,000	50	73.0	70	120	207
NEWHALL RANCH ROAD	East of McBean Pkwy	McBean Parkway	37,000	50	73.0	70	120	207
MCBEAN PARKWAY	Avenue Scott	Newhall Ranch Road	47,000	45	72.6	67	118	206
AVE SCOTT	Rockefeller Avenue	McBean Parkway	14,000	35	64.2	25	46	83
NEWHALL RANCH ROAD	Interstate 5 ramp	Interstate 5 ramp	28,000	50	71.8	61	105	181
NEWHALL RANCH ROAD	E of Interstate 5 ramp	E of Interstate 5 ramp	28,000	45	70.4	52	91	160
COMMERCE CENTER DRIVE	Magic Mountain Parkway	Henry Mayo Drive	0	55	0	0	0	0
COMMERCE CENTER DRIVE	Henry Mayo Drive	Hasley Canyon Road	17,000	55	71.0	56	95	161
THE OLD ROAD	South of Hasley Canyon	Hasley Canyon Road	9,000	40	64.0	25	44	79
RIDGE ROUTE ROAD	N of Lake Hughes Road	Templin Parkway	5,000	50	64.3	27	46	80
THE OLD ROAD	Sloan Canyon Road	N of Sloan Canyon Road	9,000	40	64.0	25	44	79
THE OLD ROAD	Hasley Canyon Road	S of Hillcrest Parkway	16,000	40	66.5	33	59	105
THE OLD ROAD	S of Hillcrest Parkway	Hillcrest Parkway	16,000	50	69.4	47	81	139
LONG CANYON ROAD	Henry Mayo Drive	Potrero Canyon	0	45	0	0	0	0
STEVENSON RANCH PARKWAY	The Old Road	East of the Old Road	13,000	50	68.5	42	73	126
MCBEAN PARKWAY	Rockwell Canyon Road	Interstate 5 ramp	47,000	45	72.6	67	118	206
MCBEAN PARKWAY	Interstate 5 ramp	Interstate 5 ramp	47,000	45	72.6	67	118	206
PICO CANYON ROAD	The Old Road	Interstate 5 ramp	40,000	55	74.7	83	140	239
LYONS AVENUE	Interstate 5 ramp	Interstate 5	38,000	50	73.1	70	121	209
PICO CANYON ROAD	Interstate 5 ramp	West of Wiley Canyon	40,000	40	70.4	53	94	166
LYONS AVENUE	Wiley Canyon Road	Interstate 5 ramp	38,000	50	73.1	70	121	209
LYONS AVENUE	Interstate 5 ramp	Interstate 5	44,000	50	73.8	75	130	224
RYE CANYON ROAD	The Old Road	NE of The Old Road	35,000	50	72.8	68	117	201

RYE CANYON ROAD	South of Avenue Scott	Avenue Scott	23,000	45	69.5	47	83	145
RYE CANYON ROAD	NE of The Old Road	South of Avenue Scott	35,000	45	71.4	58	102	178
MAGIC MOUNTAIN PARKWAY	The Old Road	Interstate 5	26,000	50	71.5	59	101	175
MAGIC MOUNTAIN PARKWAY	Interstate 5	Tourney Road	30,000	50	72.1	63	109	187
MAGIC MOUNTAIN PARKWAY	Interstate 5	Interstate 5	26,000	45	70.1	50	88	154
MAGIC MOUNTAIN PARKWAY	Int of Mag Mt. & Tibbitts	Int of Mag Mt. & Tibbitts	30,000	45	70.7	54	95	166
MAGIC MOUNTAIN PARKWAY	Tourney Road	West of McBean Parkway	21,000	45	69.1	45	80	139
MAGIC MOUNTAIN PARKWAY	McBean Parkway	West of McBean Parkway	21,000	45	69.1	45	80	139
MAGIC MOUNTAIN PARKWAY	West of McBean Parkway	West of McBean Parkway	21,000	50	70.6	53	92	158
MCBEAN PARKWAY	Magic Mountain Parkway	Creekside	51,000	45	73.0	70	122	214
MCBEAN PARKWAY	Creekside	Avenue Scott	58,000	45	73.6	74	130	228
MAGIC MOUNTAIN PARKWAY	McBean Parkway	East of McBean Parkway	16,000	45	68.0	40	70	122
MAGIC MOUNTAIN PARKWAY	East of McBean Parkway	East of McBean Parkway	21,000	40	67.6	38	68	121
MAGIC MOUNTAIN PARKWAY	Valencia Blvd	West of Valencia Blvd	21,000	40	67.6	38	68	121
MAGIC MOUNTAIN PARKWAY	West of Valencia Blvd	West of Valencia Blvd	21,000	40	67.6	38	68	121
MCBEAN PARKWAY	South of Magic Mountain	Magic Mountain Parkway	43,000	40	70.8	55	97	172
MCBEAN PARKWAY	Valencia Blvd	North of Valencia Blvd	43,000	45	72.3	64	113	197
MCBEAN PARKWAY	North of Valencia Blvd	South of Magic Mountain	43,000	45	72.3	64	113	197
VALENCIA BOULEVARD	McBean Parkway	East of McBean Parkway	48,000	45	72.7	68	119	208
VALENCIA BOULEVARD	East of McBean Parkway	SW of Magic Mountain Pkwy	48,000	45	72.7	68	119	208
VALENCIA BOULEVARD	SW of Magic Mountain Pkwy	East of McBean Parkway	48,000	45	72.7	68	119	208
VALENCIA BOULEVARD	McBean Parkway	West of McBean Parkway	51,000	50	74.4	81	140	241
VALENCIA BOULEVARD	West of McBean Parkway	Rockwell Canyon Road	51,000	40	71.5	59	106	188
MCBEAN PARKWAY	Del Monte Drive	Valencia Blvd	35,000	45	71.4	58	102	178
MCBEAN PARKWAY	Arroyo Park Drive	Del Monte Drive	35,000	45	71.4	58	102	178
MCBEAN PARKWAY	South of Arroya Park Dr	Arroyo Park Drive	35,000	45	71.4	58	102	178

MCBEAN PARKWAY	Orchard Village Road	North of Orchard Village	38,000	45	71.7	61	106	186
MCBEAN PARKWAY	North of Orchard Village	South of Arroya Park Dr	38,000	45	71.7	61	106	186
MCBEAN PARKWAY	Rockwell Canyon Road	Singing Hills Drive	30,000	45	70.7	54	95	166
MCBEAN PARKWAY	East of Singing Hills Dr	Orchard Village Road	30,000	45	70.7	54	95	166
MCBEAN PARKWAY	Singing Hills Drive	East of Singing Hills Dr	30,000	45	70.7	54	95	166
TOURNAMENT ROAD	Wiley Canyon Road	Mid-Section	6,000	40	62.2	20	36	64
TOURNAMENT ROAD	Mid-Section	South of McBean Parkway	6,000	55	66.5	34	59	99
WILEY CANYON ROAD	Lyons Avenue	South of Lyons Avenue	7,000	35	61.2	18	32	58
WILEY CANYON ROAD	Calgrove Boulevard	North of Calgrove Blvd	9,000	35	62.3	20	36	66
WILEY CANYON ROAD	North of Calgrove Blvd	South of Lyons Avenue	9,000	40	64.0	25	44	79
VALLEY STREET	Lyons Avenue	South of Lyons Avenue	9,000	45	65.5	30	53	92
LYONS AVENUE	Apple Street	Orchard Village Road	37,000	50	73.0	70	120	207
LYONS AVENUE	Apple Street	Rotella	37,000	50	73.0	70	120	207
LYONS AVENUE	Wiley Canyon	Everette Drive	38,000	50	73.1	70	121	209
LYONS AVENUE	Newhall Avenue	Arcadia Street	38,000	50	73.1	70	121	209
LYONS AVENUE	Arcadia Street	Valley Street	38,000	55	74.5	81	137	233
RAILROAD AVENUE	Lyons Avenue	North of Lyons Avenue	35,000	40	69.9	49	88	156
RAILROAD AVENUE	North of Lyons Avenue	South of Via Princessa	35,000	45	71.4	58	102	178
RAILROAD AVENUE	South of Via Princessa	South of Via Princessa	35,000	45	71.4	58	102	178
WILEY CANYON ROAD	East of Tournament	Orchard Village Road	13,000	45	67.1	36	63	110
WILEY CANYON ROAD	Tournament	East of Tournament	13,000	40	65.6	30	53	95
ORCHARD VILLAGE ROAD	Wiley Canyon Road	Mill Valley	29,000	45	70.5	53	93	163
ORCHARD VILLAGE ROAD	Mill Valley	McBean Parkway	29,000	50	72.0	62	107	184
ORCHARD VILLAGE ROAD	Lyons Avenue	Dalbey Drive	21,000	50	70.6	53	92	158
ORCHARD VILLAGE ROAD	Dalbey Drive	16th Street	21,000	35	66.0	31	56	102
RAILROAD AVENUE	Via Princessa	North of Via Princessa	36,000	45	71.5	59	103	181
RAILROAD AVENUE	North of Via Princessa	South of Magic Mountain	36,000	50	72.9	69	118	204
RAILROAD AVENUE	South of Magic Mountain	Magic Mountain Parkway	38,000	50	73.1	70	121	209
MAGIC MOUNTAIN PARKWAY	Via Princessa	Bouquet Canyon Road	0	40	0	0	0	0
VALENCIA BOULEVARD	Magic Mountain Parkway	N of Magic Mountain Pkwy	52,000	45	73.1	71	124	216

VALENCIA BOULEVARD	N of Magic Mountain Pkwy	W of Bouquet Canyon	52,000	35	69.9	50	90	163
VALENCIA BOULEVARD	West of Bouquet Canyon	Bouquet Canyon Road	48,000	50	74.2	79	136	234
VALENCIA BOULEVARD	West of Bouquet Canyon	West of Bouquet Canyon	48,000	50	74.2	79	136	234
BOUQUET CANYON ROAD	Magic Mountain Parkway	Cenema Drive	38,000	45	71.7	61	106	186
BOUQUET CANYON ROAD	Cenema Drive	Valencia Blvd	38,000	45	71.7	61	106	186
VIA PRINCESSA	Railroad Avenue	East of Railroad Canyon	2,000	35	55.8	9	17	30
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	2,000	35	55.8	9	17	30
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	2,000	55	61.7	21	35	60
VIA PRINCESSA	West of Magic Mountain		0	55	0	0	0	0
VIA PRINCESSA	West of Magic Mountain		0	50	0	0	0	0
VIA PRINCESSA	East of Magic Mountain		0	40	0	0	0	0
VIA PRINCESSA	West of Santa Clarita Pkwy		0	50	0	0	0	0
SANTA CLARITA PARKWAY	Via Princessa	South of Via Princessa	0	45	0	0	0	0
SANTA CLARITA PARKWAY	South of Via Princessa	South of Via Princessa	0	45	0	0	0	0
SANTA CLARITA PARKWAY	Sierra Highway	West of Sierra Highway	0	45	0	0	0	0
SANTA CLARITA PARKWAY	Soledad Canyon Road	South of Soledad Canyon	0	45	0	0	0	0
SANTA CLARITA PARKWAY	Via Princessa	North of Via Princessa	0	45	0	0	0	0
DOCKWEILER DRIVE	Mid-Section	Mid-Section	5,000	25	56.3	9	16	31
NEWHALL AVENUE	Sierra Highway	Valle Del Oro	45,000	45	72.5	66	115	202
NEWHALL AVENUE	NW of Valle Del Oro	NW of Valle Del Oro	48,000	50	74.2	79	136	234
SIERRA HIGHWAY	The Old Road	North of The Old Road	13,000	45	67.1	36	63	110
SIERRA HIGHWAY	North of The Old Road	Newhall Avenue	13,000	45	67.1	36	63	110
SIERRA HIGHWAY	Dockweiler Drive	North of Dockweiler	16,000	45	68.0	40	70	122
SIERRA HIGHWAY	North of Dockweiler	Placerita Canyon Road	16,000	50	69.4	47	81	139
GOLDEN VALLEY ROAD	Sierra Highway	SR-14	14,000	50	68.8	44	76	130
GOLDEN VALLEY ROAD	SR-14	East of SR-14	0	55	0	0	0	0
GOLDEN VALLEY ROAD	S of SR-14	Via Princessa	0	40	0	0	0	0
GOLDEN VALLEY ROAD	East of SR-14	East End	0	50	0	0	0	0

SIERRA HIGHWAY	Golden Valley Road	North of Golden Valley Rd	33,000	50	72.5	66	114	196
SIERRA HIGHWAY	North of Golden Valley Rd	North of Golden Valley Rd	33,000	50	72.5	66	114	196
SIERRA HIGHWAY	North of Golden Valley Rd	South of Via Princessa	33,000	45	71.1	57	99	173
SIERRA HIGHWAY	South of Via Princessa	Via Princessa	33,000	45	71.1	57	99	173
SIERRA HIGHWAY	Via Princessa	North of Via Princessa	38,000	45	71.7	61	106	186
SIERRA HIGHWAY	North of Via Princessa	Jakes Way	38,000	45	71.7	61	106	186
JAKES WAY/CANYON PARK BL	Sierra Highway	Lost Canyon	7,000	25	57.8	10	20	37
VIA PRINCESSA	Whites Canyon	West of Whites Canyon	2,000	40	57.4	12	21	37
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	2,000	40	57.4	12	21	37
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	2,000	60	61.7	21	35	60
VIA PRINCESSA	SE of Whites Canyon	NW of Sierra Highway	32,000	50	72.4	65	112	193
SOLEDAD CANYON ROAD	West of Whites Canyon	West of Whites Canyon	46,000	45	72.5	67	116	204
SOLEDAD CANYON ROAD	West of Whites Canyon	East of Golden Valley Rd	46,000	45	72.5	67	116	204
SOLEDAD CANYON ROAD	East of Golden Valley Rd	East of Golden Valley Rd	57,000	45	73.5	74	129	226
SOLEDAD CANYON ROAD	Golden Valley Road	East of Golden Valley Rd	57,000	40	72.0	63	112	199
SOLEDAD CANYON ROAD	West of Golden Valley	E of Santa Clarita Pkwy	62,000	45	73.8	77	135	236
SOLEDAD CANYON ROAD	Golden Valley Road	West of Golden Valley	62,000	45	73.8	77	135	236
SOLEDAD CANYON ROAD	West of Golden Valley	West of Golden Valley	62,000	45	73.8	77	135	236
SOLEDAD CANYON ROAD	E of Santa Clarita Pkwy	W of Santa Clarita Pkwy	57,000	50	74.9	85	147	254
SOLEDAD CANYON ROAD	W of Santa Clarita Pkwy	Bouquet Canyon Road	64,000	50	75.4	90	155	268
SANTA CLARITA PARKWAY	Soledad Canyon Road	Newhall Ranch Road	0	45	0	0	0	0
GOLDEN VALLEY ROAD	Soledad Canyon Road	Nth of Soledad Cyn Road	14,000	50	68.8	44	76	130
NEWHALL AVENUE	Railroad Avenue	Market Street	22,000	50	70.8	54	94	162
NEWHALL AVENUE	SE of Railroad Avenue	Railroad Avenue	22,000	50	70.8	54	94	162
TICK CANYON ROAD	Shadow Pines Blvd	South of Davenport Road	0	45	0	0	0	0
LYONS AVENUE	Rotella	Peachland Avenue	37,000	55	74.4	80	135	230

LYONS AVENUE	Peachland Avenue	Everette Drive	37,000	55	74.4	80	135	230
ORCHARD VILLAGE ROAD	16th Street	North of 16th Street	29,000	35	67.4	37	66	121
ORCHARD VILLAGE ROAD	North of 16th Street	Wiley Canyon Road	29,000	50	72.0	62	107	184
TOURNAMENT ROAD	South of McBean Parkway	McBean Parkway	6,000	55	66.5	34	59	99
NEWHALL AVENUE	Valle Del Oro	NW of Valle Del Oro	48,000	55	75.5	90	153	259
NEWHALL AVENUE	NW of Valle Del Oro	SE of Railroad Avenue	48,000	50	74.2	79	136	234
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	33,000	50	72.5	66	114	196
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	33,000	50	72.5	66	114	196
SIERRA HIGHWAY	Placerita Canyon Road	Golden Valley Road	27,000	45	70.2	51	90	157
SIERRA HIGHWAY	Golden Valley Road	N of Golden Valley Rd	33,000	45	71.1	57	99	173
DOCKWEILER DRIVE	Sierra Highway	Mid-Section	5,000	35	59.7	15	27	49
HASLEY CANYON ROAD	Commerce Center Drive	Del Valle Road	7,000	50	65.8	32	55	94
WILEY CANYON ROAD	Orchard Village Road	E of Orchard Village Rd	13,000	40	65.6	30	53	95
THE OLD ROAD	Hillcrest Parkway	South of Parker Road	3,000	50	62.1	21	36	63
THE OLD ROAD	South of Parker Road	Parker Road	3,000	45	60.7	18	31	54
LAKE HUGHES ROAD	The Old Road	Castaic Road	9,000	35	62.3	20	36	66
THE OLD ROAD	Stevensons Ranch Parkway	Valencia Boulevard	17,000	45	68.2	41	72	126
NEWHALL RANCH ROAD	McBean Parkway	Avenue Tibbitts	36,000	45	71.5	59	103	181
GOLDEN VALLEY ROAD	Plum Canyon Road	South of Plum Cyn Rd	2,000	55	61.7	21	35	60
GOLDEN VALLEY ROAD	North of Newhall Ranch		0	50	0	0	0	0
SIERRA HIGHWAY	South of Sand Canyon	South of Sand Canyon	10,000	45	65.9	32	55	97
SIERRA HIGHWAY	North of Skyline Ranch Rd	South of Sand Canyon	10,000	40	64.4	26	47	83
SIERRA HIGHWAY	North of Skyline Ranch Rd	North of Skyline Ranch Rd	15,000	40	66.2	32	57	102
SIERRA HIGHWAY	South of Skyline Ranch Rd	North of Skyline Ranch Rd	15,000	40	66.2	32	57	102
SIERRA HIGHWAY	Soledad Canyon Road	South of Skyline Ranch Rd	26,000	40	68.6	42	75	134
SAND CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	8,000	50	66.4	34	58	100
SAND CANYON ROAD			7,000	45	64.4	27	47	82
SHADOW PINES BOULEVARD	North of Soledad Canyon	South of Davenport Road	6,000	40	62.2	20	36	64
LOST CANYON ROAD	East of Lost Canyon		0	45	0	0	0	0
LOST CANYON ROAD	South of Jakes Way		0	45	0	0	0	0

LOST CANYON ROAD	Jakes Way	North-East of Jakes Way	0	55	0	0	0	0
VIA PRINCESSA	Sierra Highway	NW of Sierra Highway	32,000	40	69.5	47	84	149
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	2,000	40	57.4	12	21	37
SIERRA HIGHWAY	Jakes Way	Soledad Canyon Road	38,000	45	71.7	61	106	186
HASLEY CANYON ROAD	The Old Road	North of The Old Road	17,000	40	66.7	34	61	108
PARKER ROAD	The Old Road	Sloan Canyon Drive	1,000	50	57.3	13	22	37
PARKER ROAD	The Old Road	Interstate 5	6,000	50	65.1	29	51	87
PARKER ROAD	Interstate 5	Castaic Road	6,000	45	63.7	25	43	76
LAKE HUGHES ROAD	Ridge Route Road	North-East of Ridge Route	2,000	35	55.8	9	17	30
LAKE HUGHES ROAD	North-East of Ridge Route	Mid-Section	2,000	50	60.4	17	30	52
LAKE HUGHES ROAD	North-East of Ridge Route	North-East of Ridge Route	2,000	50	60.4	17	30	52
SHADOW PINES BOULEVARD	North of Soledad Canyon	North of Soledad Canyon	6,000	40	62.2	20	36	64
SHADOW PINES BOULEVARD	Soledad Canyon Road	North of Soledad Canyon	6,000	40	62.2	20	36	64
VIA PRINCESSA	Lost Canyon Road	Golden Valley Road	0	35	0.2	0	0	0
LOST CANYON ROAD	Via Princessa	Jakes Way	10,000	50	67.3	37	65	111
VASQUEZ CANYON ROAD	East of Bouquet Canyon	East of Bouquet Canyon	7,000	35	61.2	18	32	58
VASQUEZ CANYON ROAD	East of Bouquet Canyon	Bouquet Canyon Road	7,000	35	61.2	18	32	58
GOLDEN VALLEY ROAD	Via Princessa	Soledad Canyon Road	14,000	60	70.2	51	86	147
COPPER HILL DRIVE	Benz Road	David Way	5,000	45	62.9	23	40	69
DRY GULCH RD			0	45	0	0	0	0
TEMPLIN PK	Interstate 5	Ridge Route Road	0	50	0	0	0	0
	Templin Highway	North of Templin Highway	0	40	0	0	0	0
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	5,000	40	61.4	19	33	59
SLOAN CANYON RD	Hasley Canyon Road	Hillcrest Parkway	0	40	0	0	0	0
SLOAN CANYON RD	Parker Road	The Old Road	1,000	40	54.4	8	15	26
SLOAN CANYON RD	Parker Road	West of Parker Road	1,000	40	54.4	8	15	26
POTRERO CANYON RD	Henry Mayo Drive	Valencia Blvd	0	40	0	0	0	0
VALENCIA BLVD	Magic Mountain Parkway	West of Magic Mountain	0	45	0	0	0	0

VALENCIA BLVD	West of Pico Canyon	South of Magic Mountain	0	55	0	0	0	0
VALENCIA BLVD	Pico Canyon Road	East of Pico Cyn Road	0	50	0	0	0	0
VALENCIA BLVD	The Old Road	West of The Old Road	16,000	45	68.0	40	70	122
PICO CANYON ROAD	South of Valencia		0	45	0	0	0	0
PICO CANYON ROAD	Stevenson Ranch Parkway	W of Stevenson Ranch	3,000	55	63.5	25	43	72
SKYLINE RANCH RD	Whites Canyon	Sierra Highway	0	45	0	0	0	0
LOST CANYON ROAD	Sand Canyon Road	West of Sand Canyon Rd	0	40	0	0	0	0
NEWHALL RANCH ROAD	Interstate 5 ramp	The Old Road	28,000	55	73.2	70	119	202
COPPER HILL DRIVE	David Way	Bouquet Canyon Road	0	55	0	0	0	0
JAKES WAY	Jakes Way	Lost Canyon	7,000	40	62.9	22	39	70
NEWHALL RANCH ROAD	Santa Clarita Pkwy	E of Santa Clarita Pkwy	7,000	45	64.4	27	47	82
LITTLE TUJUNGA CANYON RO	Sand Canyon Road	South	0	40	0	0	0	0
RAILROAD AVENUE	Newhall Avenue	Lyons Avenue	26,000	50	71.5	59	101	175

Existing Freeway Noise Contour Distances for Freeways

STREET	ADT	FREEWAY	CNEL @50'	Distance to CNEL Contour (ft.) 70	65	60
I-5 n/o Lake Hughes	78,000	I5	84.1	251	445	789
I-5 s/o Lake Hughes	84,000	I5	84.4	261	462	818
I-5 s/o Parker	102,000	I5	85.3	287	509	901
I-5 s/o Hasley Cyn	114,000	I5	85.8	303	537	952
I-5 s/o SR-126	124,000	I5	86.1	316	560	993
I-5 s/o Rye Cyn	133,000	I5	86.4	328	580	1028
I-5 s/o Magic Mtn	155,000	I5	87.1	353	626	1109
I-5 s/o Valencia	178,000	I5	87.7	379	671	1188
I-5 s/o McBean	188,000	I5	87.9	389	689	1221
I-5 s/o Lyons	197,000	I5	88.1	398	705	1250
I-5 s/o Calgrove	198,000	I5	88.2	399	707	1253
SR-14 n/o Aqua Dulce	103,000	SR14	83.8	216	366	622
SR-14 s/o Aqua Dulce	105,000	SR14	83.9	217	369	628
SR-14 s/o Soledad Cyn	107,000	SR14	84.0	219	373	633
SR-14 s/o Sand Cyn	118,000	SR14	84.4	229	390	662
SR-14 s/o Via Princessa	148,000	SR14	85.4	255	433	735
SR-14 s/o Sierra Hwy	148,000	SR14	85.4	255	433	735
SR-14 s/o Golden Valley	151,000	SR14	85.4	257	437	742
SR-14 s/o Placerita Cyn	160,000	SR14	85.7	264	448	762
SR-14 n/o I-5	173,000	SR14	86.0	274	465	790

Santa Clarita Noise Element / Current General Plan Traffic Noise Contours (Arterial):

ROAD	End 1	End 2	ADT	SPEED	CNEL 50' from CL	70	65	60
LAKE HUGHES ROAD	North Section	North Section	12,000	50	68.1	41	70	121
SAN FRANCISQUITO CANYON	South of Dry Gulch Road	North of Dry Gulch Road	7,000	45	64.4	27	47	82
BOUQUET CANYON ROAD	North End	North End	6,000	40	62.2	20	36	64
SIERRA HIGHWAY	Aqua Dolce Canyon Road	E of Aqua Dolce Canyon	2,000	40	57.4	12	21	37
LAKE HUGHES ROAD	Mid-Section	North Section	12,000	45	66.7	35	61	106
SAN FRANCISQUITO CANYON	Mid-Section	South of Dry Gulch Road	7,000	45	64.4	27	47	82
RIDGE ROUTE ROAD	Lake Hughes Road	N of Lake Hughes Road	36,000	50	72.9	69	118	204
LAKE HUGHES ROAD	Castaic Road	Ridge Route Road	43,000	45	72.3	64	113	197
RIDGE ROUTE ROAD	Castaic Road	Lake Hughes Road	4,000	50	63.4	24	42	72
CASTAIC ROAD	Parker Road	Lake Hughs Road	25,000	50	71.3	58	100	172
THE OLD ROAD	Parker Road	Sloan Canyon Road	4,000	50	63.4	24	42	72
AGUA DULCE CANYON ROAD	Escondido Canyon Road	Sierra Highway	8,000	45	65.0	28	50	87
ESCONDIDO CANYON ROAD	Aqua Dolce Cyn Road	East End	5,000	45	62.9	23	40	69
AGUA DULCE ROAD	Davenport Road	Escondido Canyon Road	13,000	55	69.8	49	84	142
DAVENPORT ROAD	Tick Canyon Road	Aqua Dulce Road	3,000	45	60.7	18	31	54
DAVENPORT ROAD	Sierra Highway	Tick Canyon Road	4,000	35	58.8	13	24	43
SAN FRANCISQUITO CANYON	N of Copper Hill Drive	Mid-Section	7,000	45	64.4	27	47	82
MCBEAN PARKWAY			9,000	40	64.0	25	44	79
SECO CANYON ROAD	Copper Hill Drive	N of Copper Hill Drive	10,000	35	62.8	21	38	69
COPPER HILL DRIVE	Sycamore	High Ridge	18,000	55	71.3	57	97	165
COPPER HILL DRIVE	Haskell Canyon Road	Sycamore	18,000	45	68.5	42	74	129
COPPER HILL DRIVE	Seco Canyon Road	Haskell Canyon Road	29,000	55	73.3	71	121	206
BOUQUET CANYON ROAD	David Way	Vasquez Canyon Road	20,000	50	70.4	52	90	154
HASLEY CANYON ROAD	Del Valle Road	Sloan Canyon Road	11,000	40	64.8	28	49	87
SIERRA HIGHWAY	Vasquez Canyon Road	Davenport Road	15,000	40	66.2	32	57	102
HASLEY CANYON ROAD	The Old Road	Commerce Center Drive	40,000	40	70.4	53	94	166
SIERRA HIGHWAY	Sand Canyon Road	Vasquez Canyon Road	15,000	35	64.5	26	47	86
SIERRA HIGHWAY	S of Vasquez Canyon Rd	Vasquez Canyon Road	15,000	45	67.7	39	68	118

COPPER HILL DRIVE	Decoro Drive	McBean Parkway	47,500	45	72.7	68	118	207
PLUM CANYON ROAD	West of Golden Valley	West of Golden Valley	13,000	45	67.1	36	63	110
COPPER HILL DRIVE	Alta Vista Way	Decoro Drive	54,000	60	76.0	95	161	274
DECORO DRIVE	Rye Canyon	Dickason Drive	9,000	35	62.3	20	36	66
DECORO DRIVE	Dickason Drive	McBean Parkway	14,000	55	70.2	51	86	147
PLUM CANYON ROAD	West of Golden Valley	South of Skyline Ranch Rd	13,000	45	67.1	36	63	110
THE OLD ROAD	Newhall Ranch Road	N of Newhall Ranch Road	23,000	45	69.5	47	83	145
THE OLD ROAD	Henry Mayo Drive	Newhall Ranch Road	19,000	55	71.5	59	100	169
RYE CANYON ROAD	Avenue Scott	Newhall Ranch Road	46,000	50	74.0	77	133	229
WHITES CANYON ROAD	South of Skyline Ranch Rd	Skyline Ranch Road	19,000	55	71.5	59	100	169
AGUA DULCE ROAD	Soledad Canyon Road	Davenport Road	14,000	55	70.2	51	86	147
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	10,000	45	65.9	32	55	97
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	10,000	40	64.4	26	47	83
DICKASON DRIVE	Newhall Ranch Road	Decoro Drive	21,000	50	70.6	53	92	158
NEWHALL RANCH ROAD	Dickenson Drive	Rye Canyon Road	48,000	50	74.2	79	136	234
SOLEDAD CANYON ROAD	Aqua Dolce Road	East of Aqua Dolce Rd	22,000	55	72.1	63	107	181
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	17,000	45	68.2	41	72	126
AVE TIBBITTS	Avenue Scott	Newhall Ranch Road	34,000	35	68.1	40	72	131
THE OLD ROAD	Rye Canyon Road	Henry Mayo Drive	49,000	50	74.2	79	137	236
AVE SCOTT	Avenue Tibbitts	Rockefeller Avenue	23,000	35	66.4	32	59	107
AVE TIBBITTS	Avenue Scott	Hopkins	32,000	35	67.8	39	70	127
NEWHALL RANCH ROAD	Bouquet Canyon Road	E of Bouquet Canyon Rd	44,000	50	73.8	75	130	224
NEWHALL RANCH ROAD			49,000	45	72.8	69	120	210
SANTA CLARITA PARKWAY	Newhall Ranch Road	Bouquet Canyon Road	38,000	45	71.7	61	106	186
AVE TIBBITTS	Hopkins	Magic Mountain Parkway	32,000	55	73.8	74	127	215
BOUQUET CANYON ROAD	Soledad Canyon / Valencia	Newhall Ranch Road	75,000	45	74.7	84	148	258
THE OLD ROAD	Magic Mountain Parkway	Rye Canyon Road	54,000	35	70.1	51	92	167
HENRY MAYO DRIVE	Commerce Center Drive	Chiquito Canyon Road	10,000	40	64.4	26	47	83

MAGIC MOUNTAIN PARKWAY	The Old Road	Magic Mountain Theme Park	83,000	55	77.9	116	196	334
LOST CANYON ROAD	Sand Canyon Road	East of Sand Canyon Rd	14,000	45	67.4	37	65	114
MAGIC MOUNTAIN PARKWAY			60,000	50	75.1	87	151	260
SAND CANYON ROAD	South of Jakes Way	Jakes Way	14,000	45	67.4	37	65	114
MAGIC MOUNTAIN PARKWAY	Bouquet Canyon Road	Valencia Blvd	48,000	50	74.2	79	136	234
HENRY MAYO DRIVE	West of Chiquito Cyn Rd	West of Chiquito Cyn Rd	10,000	45	65.9	32	55	97
WHITES CANYON ROAD	Via Princessa	Soledad Canyon Road	50,000	50	74.3	80	138	238
THE OLD ROAD	North of Valencia Blvd	Magic Mountain Parkway	33,000	55	73.9	76	128	218
TOURNEY ROAD	Valencia Boulevard	Magic Mountain Parkway	15,000	35	64.5	26	47	86
VALENCIA BOULEVARD	Tourney Road	Rockwell Canyon Road	57,000	45	73.5	74	129	226
VALENCIA BOULEVARD	Interstate 5	Tourney Road	66,000	45	74.1	79	139	243
THE OLD ROAD	Valencia Blvd	North of Valencia Blvd	33,000	40	69.6	48	85	151
VALENCIA BOULEVARD	The Old Road	Interstate 5	59,000	45	73.6	75	131	230
HENRY MAYO DRIVE	Wes of Chiquito Cyn Rd	to West End	10,000	40	64.4	26	47	83
VIA PRINCESSA	North of Lost Canyon	Sierra Highway	44,000	35	69.2	45	82	150
VIA PRINCESSA	Lost Canyon Road	North of Lost Canyon	23,000	35	66.4	32	59	107
MAGIC MOUNTAIN PARKWAY			45,000	45	72.5	66	115	202
VIA PRINCESSA			50,000	35	69.7	49	88	160
VIA PRINCESSA			50,000	40	71.4	59	105	186
GOLDEN VALLEY ROAD	Sierra Highway	Via Princessa	57,000	60	76.3	97	165	281
ROCKWELL CANYON ROAD	McBean Parkway	Valencia Blvd	26,000	50	71.5	59	101	175
VIA PRINCESSA	Railroad Avenue	West of Railroad Canyon	23,000	40	68.0	40	71	126
RAILROAD AVENUE	Via Princessa	South of Via Princessa	41,000	40	70.5	53	95	168
16TH STREET	Newhall Avenue	Orchard Village Road	9,000	35	62.3	20	36	66
STEVENSON RANCH PARKWAY	The Old Road	North of Pico Canyon Road	30,000	50	72.1	63	109	187
LYONS AVENUE EXTENSION	Railroad Canyon	Walnut	49,000	55	75.6	91	154	262
THE OLD ROAD	Pico Canyon Road	Stevensons Ranch Parkway	41,000	40	70.5	53	95	168
SAND CANYON ROAD	Placerita Canyon Road	South of Jakes Way	14,000	45	67.4	37	65	114
LYONS AVENUE	Newhall Avenue	Walnut	49,000	45	72.8	69	120	210
NEWHALL AVENUE	Lyons Avenue	16th Street	2,000	45	58.9	14	25	44

PICO CANYON ROAD	The Old Road	Stevenson Ranch Parkway	47,000	55	75.4	89	151	257
STEVENSON RANCH PARKWAY	Pico Canyon Road	North of Pico Canyon Road	11,000	50	67.8	39	68	116
WILEY CANYON ROAD	Lyons Avenue	Tournament Canyon Road	31,000	40	69.3	46	82	146
LYONS AVENUE EXTENSION			30,000	55	73.5	72	123	209
NEWHALL AVENUE	Market Street	Lyons Avenue	27,000	45	70.2	51	90	157
SIERRA HIGHWAY	Intersection Dockweiler	Intersection Dockweiler	43,000	45	72.3	64	113	197
SIERRA HIGHWAY	Newhall Avenue	Dockweiler Drive	27,000	45	70.2	51	90	157
NEWHALL AVENUE	Sierra Highway	East of Sierra Highway	58,000	45	73.6	74	130	228
CALGROVE BOULEVARD	Wiley Canyon	East End	19,000	55	71.5	59	100	169
CALGROVE BOULEVARD	The Old Road	Wiley Canyon	30,000	55	73.5	72	123	209
THE OLD ROAD	Calgrove Boulevard	North of Calgrove Blvd	14,000	45	67.4	37	65	114
THE OLD ROAD	North of Calgrove Blvd	Pico Canyon Road	24,000	35	66.6	33	60	109
THE OLD ROAD	Sierra Highway	Calgrove Boulevard	24,000	45	69.7	48	85	149
SAN FERNANDO RD (LA)	Sierra Highway	S of Sierra Highway	20,000	45	68.9	44	78	136
CHIQUITO CANYON ROAD	Lower Mid Point	North End	27,000	45	70.2	51	90	157
CHIQUITO CANYON ROAD	South End	Lower Mid-Point	27,000	45	70.2	51	90	157
HILLCREST PARKWAY	The Old Road	Sloan Canyon Road	18,000	45	68.5	42	74	129
SAND CANYON ROAD	S of Placerita Canyon	Little Tujunga Canyon Rd	14,000	45	67.4	37	65	114
PLACERITA CANYON ROAD	W of Sand Canyon Road	W of Sand Canyon Road	8,000	40	63.5	24	42	74
PLACERITA CANYON ROAD	Mid-Section	Mid-Section	8,000	55	67.7	39	67	114
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	8,000	55	67.7	39	67	114
PLACERITA CANYON ROAD	Sierra Highway	East of Sierra Highway	8,000	55	67.7	39	67	114
PLACERITA CANYON ROAD	East of Sierra Highway	Mid-Section	8,000	55	67.7	39	67	114
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	8,000	45	65.0	28	50	87
SOLEDAD CANYON ROAD	Shadow Pines Blvd	Aqua Dolce Road	22,000	55	72.1	63	107	181
SIERRA HIGHWAY	Davenport Road	North of Davenport Rd	2,000	45	58.9	14	25	44
SIERRA HIGHWAY	North of Davenport Rd	Aqua Dolce Canyon Road	2,000	45	58.9	14	25	44
BOUQUET CANYON ROAD	Vasquez Canyon Road	Mid Section	20,000	50	70.4	52	90	154
BOUQUET CANYON ROAD	Mid Section	North End	20,000	50	70.4	52	90	154
VASQUEZ CANYON ROAD	Sierra Highway	North of Sierra Highway	11,000	45	66.3	33	58	102
VASQUEZ CANYON ROAD	North of Sierra Highway	East of Bouquet Canyon	11,000	40	64.8	28	49	87

SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	W of Shadow Pines Blvd	12,000	50	68.1	41	70	121
SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	Shadow Pines Blvd	12,000	35	63.6	23	42	76
SOLEDAD CANYON ROAD	West of Sand Canyon	Sand Canyon Road	24,000	40	68.2	41	72	129
SOLEDAD CANYON ROAD	East of Sand Cayon	Sand Canyon Road	34,000	50	72.7	67	115	199
SOLEDAD CANYON ROAD	East of Sand Cayon	East of Sand Cayon	34,000	50	72.7	67	115	199
SAND CANYON ROAD	Jakes Way	South of Soledad Canyon	29,000	45	70.5	53	93	163
SAND CANYON ROAD	South of Soledad Canyon	Soledad Canyon Road	29,000	50	72.0	62	107	184
SOLEDAD CANYON ROAD	West of Sand Canyon	West of Sand Canyon	24,000	50	71.1	57	98	168
SOLEDAD CANYON ROAD	East of Sierra Highway	Sierra Highway	39,000	50	73.3	71	123	212
SOLEDAD CANYON ROAD	East of Sierra Highway	West of Sand Canyon	39,000	45	71.8	61	107	188
SOLEDAD CANYON ROAD	East of Sierra Highway	East of Sierra Highway	39,000	45	71.8	61	107	188
SOLEDAD CANYON ROAD	East of Whites Canyon	Whites Canyon Road	43,000	40	70.8	55	97	172
SOLEDAD CANYON ROAD	East of Whites Canyon	East of Whites Canyon	43,000	45	72.3	64	113	197
SOLEDAD CANYON ROAD	West of Sierra Highway	Sierra Highway	43,000	45	72.3	64	113	197
SOLEDAD CANYON ROAD	West of Sierra Highway	East of Whites Canyon	43,000	45	72.3	64	113	197
SOLEDAD CANYON ROAD	West of Whites Canyon	Whites Canyon	38,000	45	71.7	61	106	186
WHITES CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	43,000	40	70.8	55	97	172
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	43,000	50	73.7	75	129	222
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	43,000	40	70.8	55	97	172
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	43,000	30	67.4	36	67	124
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	43,000	55	75.0	85	145	247
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	43,000	35	69.1	45	81	148
WHITES CANYON ROAD	N of Soledad Canyon Road	South of Plum Canyon	43,000	45	72.3	64	113	197
WHITES CANYON ROAD	South of Plum Canyon	Plum Canyon Road	43,000	35	69.1	45	81	148
PLUM CANYON ROAD	West of Golden Valley	East of Bouquet Canyon	13,000	40	65.6	30	53	95
PLUM CANYON ROAD	Bouquet Canyon Road	East of Bouquet Canyon	22,000	40	67.8	39	69	123

BOUQUET CANYON ROAD	David Way	Susan	23,000	45	69.5	47	83	145
BOUQUET CANYON ROAD	Plum Canyon	Susan	23,000	45	69.5	47	83	145
COPPER HILL DRIVE	High Ridge	Benz Road	18,000	60	71.3	57	97	165
HASKELL CANYON ROAD	Jeffers Lane	Copper Hill Drive	12,000	45	66.7	35	61	106
HASKELL CANYON ROAD	Bouquet Canyon Road	Ridgegrove Drive	12,000	35	63.6	23	42	76
HASKELL CANYON ROAD	Jeffers Lane	Ridgegrove Drive	12,000	45	66.7	35	61	106
BOUQUET CANYON ROAD	Urbandale Avenue	Plum Canyon	23,000	45	69.5	47	83	145
BOUQUET CANYON ROAD	Haskell Canyon Road	Urbandale Avenue	33,000	45	71.1	57	99	173
BOUQUET CANYON ROAD	Alamogordo Road	Centurion Way	53,000	45	73.2	71	125	218
BOUQUET CANYON ROAD	Centurion Way	Haskell Canyon Road	53,000	45	73.2	71	125	218
BOUQUET CANYON ROAD	Seco Canyon Road	Santa Clarita Parkway	53,000	50	74.6	82	142	245
BOUQUET CANYON ROAD	Santa Clarita Parkway	Urbandale Avenue	33,000	40	69.6	48	85	151
SECO CANYON ROAD	Bouquet Canyon Road	N of Bouquet Canyon Rd	33,000	40	69.6	48	85	151
SECO CANYON ROAD	N of Bouquet Canyon Rd	Decoro Drive	33,000	35	67.9	39	71	129
SECO CANYON ROAD	Decoro Drive	North of Decoro Drive	33,000	35	67.9	39	71	129
SECO CANYON ROAD	North of Decoro Drive	S of Copper Hill Drive	19,000	35	65.5	29	53	97
SECO CANYON ROAD	S of Copper Hill Drive	Copper Hill Drive	19,000	35	65.5	29	53	97
COPPER HILL DRIVE	San Francisquito Canyon	Seco Canyon Road	40,000	35	68.8	43	78	143
COPPER HILL DRIVE	McBean Parkway	San Francisquito Canyon	40,000	50	73.4	72	124	214
MCBEAN PARKWAY	Sunset Hills Drive	Copper Hill Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	South of Sunset Hills	Sunset Hills Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	Decoro Drive	North of Decoro Drive	35,000	40	69.9	49	88	156
MCBEAN PARKWAY	South of Sunset Hills	North of Decoro Drive	35,000	40	69.9	49	88	156
MCBEAN PARKWAY	North of Decoro Drive	North of Decoro Drive	35,000	40	69.9	49	88	156
DECORO DRIVE	McBean Parkway	Grandview	19,000	45	68.7	43	76	133
DECORO DRIVE	Grandview	Hillsburough	14,000	45	67.4	37	65	114
DECORO DRIVE	Hillsburough	Bidwell Lane	17,000	45	68.2	41	72	126
DECORO DRIVE	Bidwell Lane	Delgado Drive	11,000	55	69.1	46	77	132
DECORO DRIVE	Delgado Drive	Seco Canyon Road	11,000	60	69.1	46	77	132
MCBEAN PARKWAY	Newhall Ranch Road	Fairveiw Drive	47,000	40	71.1	57	101	180
MCBEAN PARKWAY	Fairveiw Drive	Decoro Drive	47,000	40	71.1	57	101	180
COPPER HILL DRIVE	Alta Vista Way	Smyth Drive	55,000	55	76.1	96	162	276
COPPER HILL DRIVE	Newhall Ranch Road	Smyth Drive	55,000	60	76.1	96	162	276
AVE SCOTT	Avenue Tibbitts	Stanford Avenue	35,000	45	71.4	58	102	178

AVE SCOTT	Stanford Avenue	Rye Canyon	16,000	40	66.5	33	59	105
NEWHALL RANCH ROAD	Rye Canyon Road	Interstate 5 ramp	68,000	45	74.2	80	141	246
BOUQUET CANYON ROAD	Newhall Ranch Road	Espuella Avenue	48,000	55	75.5	90	153	259
BOUQUET CANYON ROAD	Espuella Avenue	Seco Canyon Road	48,000	45	72.7	68	119	208
NEWHALL RANCH ROAD	Bouquet Canyon Road	Hillsburough	67,000	45	74.2	80	140	245
NEWHALL RANCH ROAD	Hillsburough	West of Hillsburough	67,000	45	74.2	80	140	245
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	44,000	45	72.4	65	114	199
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	44,000	50	73.8	75	130	224
NEWHALL RANCH ROAD	W of Hillsburough	East of McBean Pkwy	65,000	50	75.5	91	156	270
NEWHALL RANCH ROAD	East of McBean Pkwy	McBean Parkway	65,000	50	75.5	91	156	270
MCBEAN PARKWAY	Avenue Scott	Newhall Ranch Road	55,000	45	73.3	73	127	222
AVE SCOTT	Rockefeller Avenue	McBean Parkway	23,000	35	66.4	32	59	107
NEWHALL RANCH ROAD	Interstate 5 ramp	Interstate 5 ramp	65,000	50	75.5	91	156	270
NEWHALL RANCH ROAD	E of Interstate 5 ramp	E of Interstate 5 ramp	65,000	45	74.0	79	138	241
COMMERCE CENTER DRIVE	Magic Mountain Parkway	Henry Mayo Drive	35,666	55	74.2	78	133	226
COMMERCE CENTER DRIVE	Henry Mayo Drive	Hasley Canyon Road	43,000	55	75.0	85	145	247
THE OLD ROAD	South of Hasley Canyon	Hasley Canyon Road	18,000	40	67.0	35	63	112
RIDGE ROUTE ROAD	N of Lake Hughes Road	Templin Parkway	36,000	50	72.9	69	118	204
THE OLD ROAD	Sloan Canyon Road	N of Sloan Canyon Road	24,000	40	68.2	41	72	129
THE OLD ROAD	Hasley Canyon Road	S of Hillcrest Parkway	24,000	40	68.2	41	72	129
THE OLD ROAD	S of Hillcrest Parkway	Hillcrest Parkway	24,000	50	71.1	57	98	168
LONG CANYON ROAD			33,000	45	71.1	57	99	173
STEVENSON RANCH PARKWAY	The Old Road	East of the Old Road	8,000	50	66.4	34	58	100
MCBEAN PARKWAY	Rockwell Canyon Road	Interstate 5 ramp	55,000	45	73.3	73	127	222
MCBEAN PARKWAY	Interstate 5 ramp	Interstate 5 ramp	55,000	45	73.3	73	127	222
PICO CANYON ROAD	The Old Road	Interstate 5 ramp	45,000	55	75.2	87	148	252
LYONS AVENUE	Interstate 5 ramp	Interstate 5	39,000	50	73.3	71	123	212
PICO CANYON ROAD	Interstate 5 ramp	West of Wiley Canyon	45,000	40	71.0	56	99	176
LYONS AVENUE	Wiley Canyon Road	Interstate 5 ramp	39,000	50	73.3	71	123	212
LYONS AVENUE	Interstate 5 ramp	Interstate 5	49,000	50	74.2	79	137	236
RYE CANYON ROAD	The Old Road	NE of The Old Road	57,000	50	74.9	85	147	254
RYE CANYON ROAD	South of Avenue Scott	Avenue Scott	47,000	45	72.6	67	118	206
RYE CANYON ROAD	NE of The Old Road	South of Avenue Scott	57,000	45	73.5	74	129	226

MAGIC MOUNTAIN PARKWAY	The Old Road	Interstate 5	80,000	50	76.4	100	173	298
MAGIC MOUNTAIN PARKWAY	Interstate 5	Tourney Road	56,000	50	74.8	85	146	251
MAGIC MOUNTAIN PARKWAY	Interstate 5	Interstate 5	80,000	45	75.0	87	152	267
MAGIC MOUNTAIN PARKWAY	Int of Mag Mt. & Tibbitts	Int of Mag Mt. & Tibbitts	56,000	45	73.4	73	128	224
MAGIC MOUNTAIN PARKWAY	Tourney Road	West of McBean Parkway	58,000	45	73.6	74	130	228
MAGIC MOUNTAIN PARKWAY	McBean Parkway	West of McBean Parkway	58,000	45	73.6	74	130	228
MAGIC MOUNTAIN PARKWAY	West of McBean Parkway	West of McBean Parkway	58,000	50	75.0	86	148	256
MCBEAN PARKWAY	Magic Mountain Parkway	Creekside	67,000	45	74.2	80	140	245
MCBEAN PARKWAY	Creekside	Avenue Scott	73,000	45	74.6	83	146	255
MAGIC MOUNTAIN PARKWAY	McBean Parkway	East of McBean Parkway	52,000	45	73.1	71	124	216
MAGIC MOUNTAIN PARKWAY	East of McBean Parkway	East of McBean Parkway	52,000	40	71.6	60	107	190
MAGIC MOUNTAIN PARKWAY	Valencia Blvd	West of Valencia Blvd	48,000	40	71.2	58	102	182
MAGIC MOUNTAIN PARKWAY	West of Valencia Blvd	West of Valencia Blvd	48,000	40	71.2	58	102	182
MCBEAN PARKWAY	South of Magic Mountain	Magic Mountain Parkway	59,000	40	72.1	64	114	202
MCBEAN PARKWAY	Valencia Blvd	North of Valencia Blvd	59,000	45	73.6	75	131	230
MCBEAN PARKWAY	North of Valencia Blvd	South of Magic Mountain	59,000	45	73.6	75	131	230
VALENCIA BOULEVARD	McBean Parkway	East of McBean Parkway	47,000	45	72.6	67	118	206
VALENCIA BOULEVARD	East of McBean Parkway	SW of Magic Mountain Pkwy	47,000	45	72.6	67	118	206
VALENCIA BOULEVARD	SW of Magic Mountain Pkwy	East of McBean Parkway	47,000	45	72.6	67	118	206
VALENCIA BOULEVARD	McBean Parkway	West of McBean Parkway	60,000	50	75.1	87	151	260
VALENCIA BOULEVARD	West of McBean Parkway	Rockwell Canyon Road	60,000	40	72.2	64	115	204
MCBEAN PARKWAY	Del Monte Drive	Valencia Blvd	50,000	45	72.9	69	121	212
MCBEAN PARKWAY	Arroyo Park Drive	Del Monte Drive	50,000	45	72.9	69	121	212
MCBEAN PARKWAY	South of Arroya Park Dr	Arroyo Park Drive	50,000	45	72.9	69	121	212
MCBEAN PARKWAY	Orchard Village Road	North of Orchard Village	43,000	45	72.3	64	113	197

MCBEAN PARKWAY	North of Orchard Village	South of Arroya Park Dr	43,000	45	72.3	64	113	197
MCBEAN PARKWAY	Rockwell Canyon Road	Singing Hills Drive	44,000	45	72.4	65	114	199
MCBEAN PARKWAY	East of Singing Hills Dr	Orchard Village Road	44,000	45	72.4	65	114	199
MCBEAN PARKWAY	Singing Hills Drive	East of Singing Hills Dr	44,000	45	72.4	65	114	199
TOURNAMENT ROAD	Wiley Canyon Road	Mid-Section	6,000	40	62.2	20	36	64
TOURNAMENT ROAD	Mid-Section	South of McBean Parkway	6,000	55	66.5	34	59	99
WILEY CANYON ROAD	Lyons Avenue	South of Lyons Avenue	17,000	35	65.1	28	50	91
WILEY CANYON ROAD	Calgrove Boulevard	North of Calgrove Blvd	19,000	35	65.5	29	53	97
WILEY CANYON ROAD	North of Calgrove Blvd	South of Lyons Avenue	19,000	40	67.2	36	64	115
VALLEY STREET	Lyons Avenue	South of Lyons Avenue	10,000	45	65.9	32	55	97
LYONS AVENUE	Apple Street	Orchard Village Road	39,000	50	73.3	71	123	212
LYONS AVENUE	Apple Street	Rotella	39,000	50	73.3	71	123	212
LYONS AVENUE	Wiley Canyon	Everette Drive	39,000	50	73.3	71	123	212
LYONS AVENUE	Newhall Avenue	Arcadia Street	49,000	50	74.2	79	137	236
LYONS AVENUE	Arcadia Street	Valley Street	49,000	55	75.6	91	154	262
RAILROAD AVENUE	Lyons Avenue	North of Lyons Avenue	39,000	40	70.3	52	92	164
RAILROAD AVENUE	North of Lyons Avenue	South of Via Princessa	39,000	45	71.8	61	107	188
RAILROAD AVENUE	South of Via Princessa	South of Via Princessa	39,000	45	71.8	61	107	188
WILEY CANYON ROAD	East of Tournament	Orchard Village Road	29,000	45	70.5	53	93	163
WILEY CANYON ROAD	Tournament	East of Tournament	29,000	40	69.0	45	80	142
ORCHARD VILLAGE ROAD	Wiley Canyon Road	Mill Valley	54,000	45	73.2	72	126	220
ORCHARD VILLAGE ROAD	Mill Valley	McBean Parkway	54,000	50	74.7	83	143	247
ORCHARD VILLAGE ROAD	Lyons Avenue	Dalbey Drive	32,000	50	72.4	65	112	193
ORCHARD VILLAGE ROAD	Dalbey Drive	16th Street	32,000	35	67.8	39	70	127
RAILROAD AVENUE	Via Princessa	North of Via Princessa	41,000	45	72.0	63	110	193
RAILROAD AVENUE	North of Via Princessa	South of Magic Mountain	41,000	50	73.5	73	126	217
RAILROAD AVENUE	South of Magic Mountain	Magic Mountain Parkway	50,000	50	74.3	80	138	238
MAGIC MOUNTAIN PARKWAY			46,000	40	71.0	56	100	178
VALENCIA BOULEVARD	Magic Mountain Parkway	N of Magic Mountain Pkwy	61,000	45	73.8	76	134	234
VALENCIA BOULEVARD	N of Magic Mountain Pkwy	W of Bouquet Canyon	61,000	35	70.6	54	98	177

VALENCIA BOULEVARD	West of Bouquet Canyon	Bouquet Canyon Road	51,000	50	74.4	81	140	241
VALENCIA BOULEVARD	West of Bouquet Canyon	West of Bouquet Canyon	51,000	50	74.4	81	140	241
BOUQUET CANYON ROAD	Magic Mountain Parkway	Cenema Drive	48,000	45	72.7	68	119	208
BOUQUET CANYON ROAD	Cenema Drive	Valencia Blvd	48,000	45	72.7	68	119	208
VIA PRINCESSA	Railroad Avenue	East of Railroad Canyon	23,000	35	66.4	32	59	107
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	23,000	35	66.4	32	59	107
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	23,000	55	72.3	64	109	185
VIA PRINCESSA			55,000	55	76.1	96	162	276
VIA PRINCESSA			55,000	50	74.7	84	145	249
VIA PRINCESSA			55,000	40	71.8	62	110	195
VIA PRINCESSA			55,000	50	74.7	84	145	249
SANTA CLARITA PARKWAY	Via Princessa	South of Via Princessa	38,000	45	71.7	61	106	186
SANTA CLARITA PARKWAY	South of Via Princessa	South of Via Princessa	38,000	45	71.7	61	106	186
SANTA CLARITA PARKWAY	Sierra Highway	West of Sierra Highway	48,000	45	72.7	68	119	208
SANTA CLARITA PARKWAY	Soledad Canyon Road	South of Soledad Canyon	31,000	45	70.8	55	96	168
SANTA CLARITA PARKWAY	Via Princessa	North of Via Princessa	39,000	45	71.8	61	107	188
DOCKWEILER DRIVE	Mid-Section	Mid-Section	22,000	25	62.7	20	37	71
NEWHALL AVENUE	Sierra Highway	Valle Del Oro	47,000	45	72.6	67	118	206
NEWHALL AVENUE	NW of Valle Del Oro	NW of Valle Del Oro	39,000	50	73.3	71	123	212
SIERRA HIGHWAY	The Old Road	North of The Old Road	37,000	45	71.6	60	105	183
SIERRA HIGHWAY	North of The Old Road	Newhall Avenue	42,000	45	72.2	64	111	195
SIERRA HIGHWAY	Dockweiler Drive	North of Dockweiler	43,000	45	72.3	64	113	197
SIERRA HIGHWAY	North of Dockweiler	Placerita Canyon Road	43,000	50	73.7	75	129	222
GOLDEN VALLEY ROAD	Sierra Highway	SR-14	39,000	50	73.3	71	123	212
GOLDEN VALLEY ROAD	SR-14	East of SR-14	18,000	55	71.3	57	97	165
GOLDEN VALLEY ROAD			39,000	40	70.3	52	92	164
GOLDEN VALLEY ROAD	East of SR-14	East End	18,000	50	69.9	49	85	147
SIERRA HIGHWAY	Golden Valley Road	North of Golden Valley Rd	32,000	50	72.4	65	112	193
SIERRA HIGHWAY	North of Golden Valley Rd	North of Golden Valley Rd	32,000	50	72.4	65	112	193

SIERRA HIGHWAY	North of Golden Valley Rd	South of Via Princessa	32,000	45	71.0	56	98	171
SIERRA HIGHWAY	South of Via Princessa	Via Princessa	32,000	45	71.0	56	98	171
SIERRA HIGHWAY	Via Princessa	North of Via Princessa	37,000	45	71.6	60	105	183
SIERRA HIGHWAY	North of Via Princessa	Jakes Way	37,000	45	71.6	60	105	183
JAKES WAY/CANYON PARK BL	Sierra Highway	Lost Canyon	18,000	25	61.9	17	33	64
VIA PRINCESSA	Whites Canyon	West of Whites Canyon	23,000	40	68.0	40	71	126
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	23,000	40	68.0	40	71	126
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	23,000	60	72.3	64	109	185
VIA PRINCESSA	SE of Whites Canyon	NW of Sierra Highway	55,000	50	74.7	84	145	249
SOLEDAD CANYON ROAD	West of Whites Canyon	West of Whites Canyon	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	West of Whites Canyon	East of Golden Valley Rd	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	East of Golden Valley Rd	East of Golden Valley Rd	48,000	45	72.7	68	119	208
SOLEDAD CANYON ROAD	Golden Valley Road	East of Golden Valley Rd	48,000	40	71.2	58	102	182
SOLEDAD CANYON ROAD	West of Golden Valley	E of Santa Clarita Pkwy	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	Golden Valley Road	West of Golden Valley	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	West of Golden Valley	West of Golden Valley	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	E of Santa Clarita Pkwy	W of Santa Clarita Pkwy	48,000	50	74.2	79	136	234
SOLEDAD CANYON ROAD	W of Santa Clarita Pkwy	Bouquet Canyon Road	42,000	50	73.6	74	127	219
SANTA CLARITA PARKWAY	Soledad Canyon Road	Newhall Ranch Road	31,000	45	70.8	55	96	168
GOLDEN VALLEY ROAD	Soledad Canyon Road	Nth of Soledad Cyn Road	44,000	50	73.8	75	130	224
NEWHALL AVENUE	Railroad Avenue	Market Street	27,000	50	71.7	60	103	178
NEWHALL AVENUE	SE of Railroad Avenue	Railroad Avenue	27,000	50	71.7	60	103	178
SHADOW PINES BOULEVARD		South of Davenport Road	12,000	45	66.7	35	61	106
LYONS AVENUE	Rotella	Peachland Avenue	39,000	55	74.6	82	139	236
LYONS AVENUE	Peachland Avenue	Everette Drive	39,000	55	74.6	82	139	236

ORCHARD VILLAGE ROAD	16th Street	North of 16th Street	43,000	35	69.1	45	81	148
ORCHARD VILLAGE ROAD	North of 16th Street	Wiley Canyon Road	43,000	50	73.7	75	129	222
TOURNAMENT ROAD	South of McBean Parkway	McBean Parkway	6,000	55	66.5	34	59	99
NEWHALL AVENUE	Valle Del Oro	NW of Valle Del Oro	39,000	55	74.6	82	139	236
NEWHALL AVENUE	NW of Valle Del Oro	SE of Railroad Avenue	39,000	50	73.3	71	123	212
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	33,000	50	72.5	66	114	196
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	33,000	50	72.5	66	114	196
SIERRA HIGHWAY	Placerita Canyon Road	Golden Valley Road	28,000	45	70.4	52	91	160
SIERRA HIGHWAY	Golden Valley Road	N of Golden Valley Rd	32,000	45	71.0	56	98	171
DOCKWEILER DRIVE	Sierra Highway	Mid-Section	25,000	35	66.7	34	62	112
HASLEY CANYON ROAD	Commerce Center Drive	Del Valle Road	17,000	50	69.6	48	83	143
WILEY CANYON ROAD	Orchard Village Road	E of Orchard Village Rd	38,000	40	70.2	51	91	162
THE OLD ROAD	Hillcrest Parkway	South of Parker Road	14,000	50	68.8	44	76	130
THE OLD ROAD	South of Parker Road	Parker Road	14,000	45	67.4	37	65	114
LAKE HUGHES ROAD	The Old Road	Castaic Road	43,000	35	69.1	45	81	148
THE OLD ROAD	Stevensons Ranch Parkway	Valencia Boulevard	47,000	45	72.6	67	118	206
NEWHALL RANCH ROAD	McBean Parkway	Avenue Tibbitts	69,000	45	74.3	81	142	248
GOLDEN VALLEY ROAD	Plum Canyon Road	South of Plum Cyn Rd	44,000	55	75.1	86	147	249
GOLDEN VALLEY ROAD			39,000	50	73.3	71	123	212
SIERRA HIGHWAY	South of Sand Canyon	South of Sand Canyon	19,000	45	68.7	43	76	133
SIERRA HIGHWAY	North of Skyline Ranch Rd	South of Sand Canyon	15,000	40	66.2	32	57	102
SIERRA HIGHWAY	North of Skyline Ranch Rd	North of Skyline Ranch Rd	36,000	40	70.0	50	89	158
SIERRA HIGHWAY	South of Skyline Ranch Rd	North of Skyline Ranch Rd	36,000	40	70.0	50	89	158
SIERRA HIGHWAY	Soledad Canyon Road	South of Skyline Ranch Rd	50,000	40	71.4	59	105	186
SAND CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	14,000	50	68.8	44	76	130
SAND CANYON ROAD			8,000	45	65.0	28	50	87
SHADOW PINES BOULEVARD	North of Soledad Canyon	South of Davenport Road	10,000	40	64.4	26	47	83
LOST CANYON ROAD			15,000	45	67.7	39	68	118
LOST CANYON ROAD			18,000	45	68.5	42	74	129

LOST CANYON ROAD	Jakes Way	North-East of Jakes Way	14,000	55	70.2	51	86	147
VIA PRINCESSA	Sierra Highway	NW of Sierra Highway	55,000	40	71.8	62	110	195
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	23,000	40	68.0	40	71	126
SIERRA HIGHWAY	Jakes Way	Soledad Canyon Road	37,000	45	71.6	60	105	183
	The Old Road	North of The Old Road	6,000	40	62.2	20	36	64
PARKER ROAD	The Old Road	Sloan Canyon Drive	1,000	50	57.3	13	22	37
PARKER ROAD	The Old Road	Interstate 5	11,000	50	67.8	39	68	116
PARKER ROAD	Interstate 5	Castaic Road	11,000	45	66.3	33	58	102
LAKE HUGHES ROAD	Ridge Route Road	North-East of Ridge Route	12,000	35	63.6	23	42	76
LAKE HUGHES ROAD	North-East of Ridge Route	Mid-Section	12,000	50	68.1	41	70	121
LAKE HUGHES ROAD	North-East of Ridge Route	North-East of Ridge Route	12,000	50	68.1	41	70	121
SHADOW PINES BOULEVARD	North of Soledad Canyon	North of Soledad Canyon	10,000	40	64.4	26	47	83
SHADOW PINES BOULEVARD	Soledad Canyon Road	North of Soledad Canyon	10,000	40	64.4	26	47	83
VIA PRINCESSA	Lost Canyon Road	South of Lost Canyon	4,000	35	58.8	13	24	43
LOST CANYON ROAD	Via Princessa	Jakes Way	20,000	50	70.4	52	90	154
VASQUEZ CANYON ROAD	East of Bouquet Canyon	East of Bouquet Canyon	6,000	35	60.5	16	29	53
VASQUEZ CANYON ROAD	East of Bouquet Canyon	Bouquet Canyon Road	6,000	35	60.5	16	29	53
GOLDEN VALLEY ROAD	Via Princessa	Soledad Canyon Road	30,000	60	73.5	72	123	209
COPPER HILL DRIVE	Benz Road	David Way	18,000	45	68.5	42	74	129
DRY GULCH RD			4,000	45	61.9	20	35	62
TEMPLIN PK	At Interstate 5	At Interstate 5	4,000	50	63.4	24	42	72
	Templin Highway	North of Templin Highway	6,000	40	62.2	20	36	64
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	10,000	40	64.4	26	47	83
SLOAN CANYON RD	Hasley Canyon Road	Hillcrest Parkway	4,000	40	60.4	17	30	53
SLOAN CANYON RD	Parker Road	The Old Road	2,000	40	57.4	12	21	37
SLOAN CANYON RD	Parker Road	West of Parker Road	2,000	40	57.4	12	21	37
POTRERO CANYON RD			11,000	40	64.8	28	49	87

VALENCIA BLVD	Magic Mountain Parkway	West of Magic Mountain	29,000	45	70.5	53	93	163
VALENCIA BLVD	Magic Mountain Parkway	South of Magic Mountain	55,000	55	76.1	96	162	276
VALENCIA BLVD	Pico Canyon Road	East of Pico Cyn Road	31,000	50	72.3	64	110	190
VALENCIA BLVD	The Old Road	West of The Old Road	60,000	45	73.7	76	132	232
PICO CANYON ROAD			45,000	45	72.5	66	115	202
PICO CANYON ROAD	Stevenson Ranch Parkway	W of Stevenson Ranch	29,000	55	73.3	71	121	206
SKYLINE RANCH RD	Whites Canyon	Sierra Highway	16,500	45	68.1	40	71	124
LOST CANYON ROAD	Sand Canyon Road	West of Sand Canyon Rd	10,000	40	64.4	26	47	83
NEWHALL RANCH ROAD	Interstate 5 ramp	The Old Road	65,000	55	76.8	103	176	298
COPPER HILL DRIVE			47,500	55	75.5	89	152	258
JAKES WAY	Jakes Way	Lost Canyon	18,000	40	67.0	35	63	112
NEWHALL RANCH ROAD	Santa Clarita Pkwy	E of Santa Clarita Pkwy	44,000	45	72.4	65	114	199
LITTLE TUJUNGA CANYON RO	Sand Canyon Road	South	20,000	40	67.4	37	66	118
RAILROAD AVENUE	Newhall Avenue	Lyons Avenue	28,000	50	71.8	61	105	181

Current General Plan Freeway Noise Contour Distances for Freeways

STREET	ADT	FREEWAY	CNEL @50'	Distance to CNEL Contour (ft.) 70	65	60
I-5 n/o Lake Hughes	191,000	I5	88.0	392	695	1230
I-5 s/o Lake Hughes	206,000	I5	88.3	407	721	1278
I-5 s/o Parker	240,000	I5	89.0	439	778	1378
I-5 s/o Hasley Cyn	249,000	I5	89.2	447	792	1404
I-5 s/o SR-126	225,000	I5	88.7	425	753	1335
I-5 s/o Rye Cyn	247,000	I5	89.1	445	789	1398
I-5 s/o Magic Mtn	257,000	I5	89.3	454	805	1426
I-5 s/o Valencia	269,000	I5	89.5	465	823	1459
I-5 s/o McBean	284,000	I5	89.7	477	846	1499
I-5 s/o Lyons	299,000	I5	90.0	490	868	1537
I-5 s/o Calgrove	308,000	I5	90.1	497	881	1560
SR-14 n/o Aqua Dulce	195,000	SR14	86.6	289	491	834
SR-14 s/o Aqua Dulce	200,000	SR14	86.7	293	497	844
SR-14 s/o Soledad Cyn	228,000	SR14	87.2	311	528	897
SR-14 s/o Sand Cyn	240,000	SR14	87.5	318	540	918
SR-14 s/o Via Princessa	250,000	SR14	87.6	324	551	936
SR-14 s/o Sierra Hwy	279,000	SR14	88.1	341	579	984
SR-14 s/o Golden Valley	268,000	SR14	87.9	335	569	966
SR-14 s/o Placerita Cyn	291,000	SR14	88.3	348	591	1003
SR-14 n/o I-5	316,000	SR14	88.7	361	613	1042

Santa Clarita Noise Element / Proposed General Plan Traffic Noise Contours (Arterial):

ROAD	End 1	End 2	ADT	SPEED	CNEL 50' From CL	70	65	60
LAKE HUGHES ROAD	North Section	North Section	7,000	50	65.8	32	55	94
SAN FRANCISQUITO CANYON	South of Dry Gulch Road	North of Dry Gulch Road	7,000	45	64.4	27	47	82
BOUQUET CANYON ROAD	North End	North End	6,000	40	62.2	20	36	64
SIERRA HIGHWAY	Aqua Dolce Canyon Road	E of Aqua Dolce Canyon	2,000	40	57.4	12	21	37
LAKE HUGHES ROAD	Mid-Section	North Section	7,000	45	64.4	27	47	82
SAN FRANCISQUITO CANYON	Mid-Section	South of Dry Gulch Road	7,000	45	64.4	27	47	82
RIDGE ROUTE ROAD	Lake Hughes Road	N of Lake Hughes Road	35,000	50	72.8	68	117	201
LAKE HUGHES ROAD	Castaic Road	Ridge Route Road	37,000	45	71.6	60	105	183
RIDGE ROUTE ROAD	Castaic Road	Lake Hughes Road	8,000	50	66.4	34	58	100
CASTAIC ROAD	Parker Road	Lake Hughs Road	24,000	50	71.1	57	98	168
THE OLD ROAD	Parker Road	Sloan Canyon Road	3,000	50	62.1	21	36	63
AGUA DULCE CANYON ROAD	Escondido Canyon Road	Sierra Highway	8,000	45	65.0	28	50	87
ESCONDIDO CANYON ROAD	Aqua Dolce Cyn Road	East End	5,000	45	62.9	23	40	69
AGUA DULCE ROAD	Davenport Road	Escondido Canyon Road	13,000	55	69.8	49	84	142
DAVENPORT ROAD	Tick Canyon Road	Aqua Dulce Road	3,000	45	60.7	18	31	54
DAVENPORT ROAD	Sierra Highway	Tick Canyon Road	6,000	35	60.5	16	29	53
SAN FRANCISQUITO CANYON	N of Copper Hill Drive	Mid-Section	7,000	45	64.4	27	47	82
MCBEAN PARKWAY			9,000	40	64.0	25	44	79
SECO CANYON ROAD	Copper Hill Drive	N of Copper Hill Drive	10,000	35	62.8	21	38	69
COPPER HILL DRIVE	Sycamore	High Ridge	17,000	55	71.0	56	95	161
COPPER HILL DRIVE	Haskell Canyon Road	Sycamore	17,000	45	68.2	41	72	126
COPPER HILL DRIVE	Seco Canyon Road	Haskell Canyon Road	30,000	55	73.5	72	123	209
BOUQUET CANYON ROAD	David Way	Vasquez Canyon Road	19,000	50	70.1	51	87	151
HASLEY CANYON ROAD	Del Valle Road	Sloan Canyon Road	13,000	40	65.6	30	53	95
SIERRA HIGHWAY	Vasquez Canyon Road	Davenport Road	16,000	40	66.5	33	59	105
HASLEY CANYON ROAD	The Old Road	Commerce Center Drive	38,000	40	70.2	51	91	162
SIERRA HIGHWAY	Sand Canyon Road	Vasquez Canyon Road	16,000	35	64.8	27	49	89
SIERRA HIGHWAY	S of Vasquez Canyon Rd	Vasquez Canyon Road	16,000	45	68.0	40	70	122
COPPER HILL DRIVE	Decoro Drive	McBean Parkway	45,500	45	72.5	66	116	203
PLUM CANYON ROAD	West of Golden Valley	West of Golden Valley	12,000	45	66.7	35	61	106
COPPER HILL DRIVE	Alta Vista Way	Decoro Drive	52,000	60	75.9	93	158	269
DECORO DRIVE	Rye Canyon	Dickason Drive	8,000	35	61.8	19	34	62
DECORO DRIVE	Dickason Drive	McBean Parkway	14,000	55	70.2	51	86	147

PLUM CANYON ROAD	West of Golden Valley	South of Skyline Ranch Rd	13,000	45	67.1	36	63	110
THE OLD ROAD	Newhall Ranch Road	N of Newhall Ranch Road	21,000	45	69.1	45	80	139
THE OLD ROAD	Henry Mayo Drive	Newhall Ranch Road	16,000	55	70.7	54	92	156
RYE CANYON ROAD	Avenue Scott	Newhall Ranch Road	48,000	50	74.2	79	136	234
WHITES CANYON ROAD	South of Skyline Ranch Rd	Skyline Ranch Road	19,000	55	71.5	59	100	169
AGUA DULCE ROAD	Soledad Canyon Road	Davenport Road	14,000	55	70.2	51	86	147
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	9,000	45	65.5	30	53	92
HENRY MAYO DRIVE	The Old Road	East of Commerce Ctr Dr	9,000	40	64.0	25	44	79
DICKASON DRIVE	Newhall Ranch Road	Decoro Drive	21,000	50	70.6	53	92	158
NEWHALL RANCH ROAD	Dickenson Drive	Rye Canyon Road	49,000	50	74.2	79	137	236
SOLEDAD CANYON ROAD	Aqua Dolce Road	East of Aqua Dolce Rd	17,000	55	71.0	56	95	161
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	16,000	45	68.0	40	70	122
AVE TIBBITTS	Avenue Scott	Newhall Ranch Road	34,000	35	68.1	40	72	131
THE OLD ROAD	Rye Canyon Road	Henry Mayo Drive	48,000	50	74.2	79	136	234
AVE SCOTT	Avenue Tibbitts	Rockefeller Avenue	25,000	35	66.7	34	62	112
AVE TIBBITTS	Avenue Scott	Hopkins	32,000	35	67.8	39	70	127
NEWHALL RANCH ROAD	Bouquet Canyon Road	E of Bouquet Canyon Rd	46,000	50	74.0	77	133	229
NEWHALL RANCH ROAD			49,000	45	72.8	69	120	210
SANTA CLARITA PARKWAY	Newhall Ranch Road	Bouquet Canyon Road	38,000	45	71.7	61	106	186
AVE TIBBITTS	Hopkins	Magic Mountain Parkway	32,000	55	73.8	74	127	215
BOUQUET CANYON ROAD	Soledad Canyon / Valencia	Newhall Ranch Road	77,000	45	74.8	85	150	262
THE OLD ROAD	Magic Mountain Parkway	Rye Canyon Road	52,000	35	69.9	50	90	163
HENRY MAYO DRIVE	Commerce Center Drive	Chiquito Canyon Road	9,000	40	64.0	25	44	79
MAGIC MOUNTAIN PARKWAY	The Old Road	Magic Mountain Theme Park	85,000	55	78.0	117	199	338
LOST CANYON ROAD	Sand Canyon Road	East of Sand Canyon Rd	16,000	45	68.0	40	70	122
MAGIC MOUNTAIN PARKWAY			60,000	50	75.1	87	151	260
SAND CANYON ROAD	South of Jakes Way	Jakes Way	14,000	45	67.4	37	65	114
MAGIC MOUNTAIN PARKWAY	Bouquet Canyon Road	Valencia Blvd	52,000	50	74.5	82	141	243

HENRY MAYO DRIVE	West of Chiquito Cyn Rd	West of Chiquito Cyn Rd	9,000	45	65.5	30	53	92
WHITES CANYON ROAD	Via Princessa	Soledad Canyon Road	48,000	50	74.2	79	136	234
THE OLD ROAD	North of Valencia Blvd	Magic Mountain Parkway	30,000	55	73.5	72	123	209
TOURNEY ROAD	Valencia Boulevard	Magic Mountain Parkway	14,000	35	64.2	25	46	83
VALENCIA BOULEVARD	Tourney Road	Rockwell Canyon Road	59,000	45	73.6	75	131	230
VALENCIA BOULEVARD	Interstate 5	Tourney Road	68,000	45	74.2	80	141	246
THE OLD ROAD	Valencia Blvd	North of Valencia Blvd	30,000	40	69.2	46	81	144
VALENCIA BOULEVARD	The Old Road	Interstate 5	61,000	45	73.8	76	134	234
HENRY MAYO DRIVE	Wes of Chiquito Cyn Rd	to West End	9,000	40	64.0	25	44	79
VIA PRINCESSA	North of Lost Canyon	Sierra Highway	41,000	35	68.9	44	80	144
VIA PRINCESSA	Lost Canyon Road	North of Lost Canyon	24,000	35	66.6	33	60	109
MAGIC MOUNTAIN PARKWAY			46,000	45	72.5	67	116	204
VIA PRINCESSA			52,000	35	69.9	50	90	163
VIA PRINCESSA			52,000	40	71.6	60	107	190
GOLDEN VALLEY ROAD	Sierra Highway	Via Princessa	51,000	60	75.8	92	157	267
ROCKWELL CANYON ROAD	McBean Parkway	Valencia Blvd	23,000	50	71.0	55	96	165
VIA PRINCESSA	Railroad Avenue	West of Railroad Canyon	27,000	40	68.7	43	77	137
RAILROAD AVENUE	Via Princessa	South of Via Princessa	40,000	40	70.4	53	94	166
16TH STREET	Newhall Avenue	Orchard Village Road	9,000	35	62.3	20	36	66
STEVENSON RANCH PARKWAY	The Old Road	North of Pico Canyon Road	33,000	50	72.5	66	114	196
LYONS AVENUE EXTENSION	Railroad Canyon	Walnut	52,000	55	75.9	93	158	269
THE OLD ROAD	Pico Canyon Road	Stevensons Ranch Parkway	35,000	40	69.9	49	88	156
SAND CANYON ROAD	Placerita Canyon Road	South of Jakes Way	14,000	45	67.4	37	65	114
LYONS AVENUE	Newhall Avenue	Walnut	52,000	45	73.1	71	124	216
NEWHALL AVENUE	Lyons Avenue	16th Street	1,000	45	55.9	10	18	32
PICO CANYON ROAD	The Old Road	Stevenson Ranch Parkway	41,000	55	74.8	83	142	241
STEVENSON RANCH PARKWAY	Pico Canyon Road	North of Pico Canyon Road	13,000	50	68.5	42	73	126
WILEY CANYON ROAD	Lyons Avenue	Tournament Canyon Road	34,000	40	69.7	48	86	153
LYONS AVENUE EXTENSION			30,000	55	73.5	72	123	209
NEWHALL AVENUE	Market Street	Lyons Avenue	27,000	45	70.2	51	90	157

SIERRA HIGHWAY	Intersection Dockweiler	Intersection Dockweiler	40,000	45	71.9	62	109	190
SIERRA HIGHWAY	Newhall Avenue	Dockweiler Drive	23,000	45	69.5	47	83	145
NEWHALL AVENUE	Sierra Highway	East of Sierra Highway	50,000	45	72.9	69	121	212
CALGROVE BOULEVARD	Wiley Canyon	East End	19,000	55	71.5	59	100	169
CALGROVE BOULEVARD	The Old Road	Wiley Canyon	18,000	55	71.3	57	97	165
THE OLD ROAD	Calgrove Boulevard	North of Calgrove Blvd	13,000	45	67.1	36	63	110
THE OLD ROAD	North of Calgrove Blvd	Pico Canyon Road	13,000	35	63.9	24	44	80
THE OLD ROAD	Sierra Highway	Calgrove Boulevard	20,000	45	68.9	44	78	136
SAN FERNANDO RD (LA)	Sierra Highway	S of Sierra Highway	20,000	45	68.9	44	78	136
CHIQUITO CANYON ROAD	Lower Mid Point	North End	25,000	45	69.9	49	87	151
CHIQUITO CANYON ROAD	South End	Lower Mid-Point	25,000	45	69.9	49	87	151
HILLCREST PARKWAY	The Old Road	Sloan Canyon Road	17,000	45	68.2	41	72	126
SAND CANYON ROAD	S of Placerita Canyon	Little Tujunga Canyon Rd	14,000	45	67.4	37	65	114
PLACERITA CANYON ROAD	W of Sand Canyon Road	W of Sand Canyon Road	4,000	40	60.4	17	30	53
PLACERITA CANYON ROAD	Mid-Section	Mid-Section	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	Sierra Highway	East of Sierra Highway	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	Mid-Section	4,000	55	64.7	29	49	83
PLACERITA CANYON ROAD	East of Sierra Highway	East of Sierra Highway	4,000	45	61.9	20	35	62
SOLEDAD CANYON ROAD	Shadow Pines Blvd	Aqua Dolce Road	17,000	55	71.0	56	95	161
SIERRA HIGHWAY	Davenport Road	North of Davenport Rd	2,000	45	58.9	14	25	44
SIERRA HIGHWAY	North of Davenport Rd	Aqua Dolce Canyon Road	2,000	45	58.9	14	25	44
BOUQUET CANYON ROAD	Vasquez Canyon Road	Mid Section	19,000	50	70.1	51	87	151
BOUQUET CANYON ROAD	Mid Section	North End	19,000	50	70.1	51	87	151
VASQUEZ CANYON ROAD	Sierra Highway	North of Sierra Highway	10,000	45	65.9	32	55	97
VASQUEZ CANYON ROAD	North of Sierra Highway	East of Bouquet Canyon	10,000	40	64.4	26	47	83
SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	W of Shadow Pines Blvd	10,000	50	67.3	37	65	111
SOLEDAD CANYON ROAD	W of Shadow Pines Blvd	Shadow Pines Blvd	10,000	35	62.8	21	38	69
SOLEDAD CANYON ROAD	West of Sand Canyon	Sand Canyon Road	22,000	40	67.8	39	69	123
SOLEDAD CANYON ROAD	East of Sand Cayon	Sand Canyon Road	31,000	50	72.3	64	110	190
SOLEDAD CANYON ROAD	East of Sand Cayon	East of Sand Cayon	31,000	50	72.3	64	110	190
SAND CANYON ROAD	Jakes Way	South of Soledad Canyon	25,000	45	69.9	49	87	151
SAND CANYON ROAD	South of Soledad Canyon	Soledad Canyon Road	25,000	50	71.3	58	100	172

SOLEDAD CANYON ROAD	West of Sand Canyon	West of Sand Canyon	25,000	50	71.3	58	100	172
SOLEDAD CANYON ROAD	East of Sierra Highway	Sierra Highway	34,000	50	72.7	67	115	199
SOLEDAD CANYON ROAD	East of Sierra Highway	West of Sand Canyon	34,000	45	71.2	57	101	176
SOLEDAD CANYON ROAD	East of Sierra Highway	East of Sierra Highway	34,000	45	71.2	57	101	176
SOLEDAD CANYON ROAD	East of Whites Canyon	Whites Canyon Road	44,000	40	70.9	55	98	174
SOLEDAD CANYON ROAD	East of Whites Canyon	East of Whites Canyon	44,000	45	72.4	65	114	199
SOLEDAD CANYON ROAD	West of Sierra Highway	Sierra Highway	44,000	45	72.4	65	114	199
SOLEDAD CANYON ROAD	West of Sierra Highway	East of Whites Canyon	43,000	45	72.3	64	113	197
SOLEDAD CANYON ROAD	West of Whites Canyon	Whites Canyon	38,000	45	71.7	61	106	186
WHITES CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	41,000	40	70.5	53	95	168
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	42,000	50	73.6	74	127	219
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	42,000	40	70.7	54	96	170
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	42,000	30	67.3	36	66	123
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	42,000	55	74.9	84	144	244
WHITES CANYON ROAD	N of Soledad Canyon Road	N of Soledad Canyon Road	42,000	35	69.0	44	81	146
WHITES CANYON ROAD	N of Soledad Canyon Road	South of Plum Canyon	42,000	45	72.2	64	111	195
WHITES CANYON ROAD	South of Plum Canyon	Plum Canyon Road	42,000	35	69.0	44	81	146
PLUM CANYON ROAD	West of Golden Valley	East of Bouquet Canyon	13,000	40	65.6	30	53	95
PLUM CANYON ROAD	Bouquet Canyon Road	East of Bouquet Canyon	23,000	40	68.0	40	71	126
BOUQUET CANYON ROAD	David Way	Susan	23,000	45	69.5	47	83	145
BOUQUET CANYON ROAD	Plum Canyon	Susan	23,000	45	69.5	47	83	145
COPPER HILL DRIVE	High Ridge	Benz Road	17,000	60	71.0	56	95	161
HASKELL CANYON ROAD	Jeffers Lane	Copper Hill Drive	13,000	45	67.1	36	63	110
HASKELL CANYON ROAD	Bouquet Canyon Road	Ridgegrove Drive	13,000	35	63.9	24	44	80
HASKELL CANYON ROAD	Jeffers Lane	Ridgegrove Drive	13,000	45	67.1	36	63	110
BOUQUET CANYON ROAD	Urbandale Avenue	Plum Canyon	23,000	45	69.5	47	83	145
BOUQUET CANYON ROAD	Haskell Canyon Road	Urbandale Avenue	32,000	45	71.0	56	98	171
BOUQUET CANYON ROAD	Alamogordo Road	Centurion Way	54,000	45	73.2	72	126	220
BOUQUET CANYON ROAD	Centurion Way	Haskell Canyon Road	49,000	45	72.8	69	120	210
BOUQUET CANYON ROAD	Seco Canyon Road	Santa Clarita Parkway	54,000	50	74.7	83	143	247
BOUQUET CANYON ROAD	Santa Clarita Parkway	Urbandale Avenue	31,000	40	69.3	46	82	146

SECO CANYON ROAD	Bouquet Canyon Road	N of Bouquet Canyon Rd	34,000	40	69.7	48	86	153
SECO CANYON ROAD	N of Bouquet Canyon Rd	Decoro Drive	34,000	35	68.1	40	72	131
SECO CANYON ROAD	Decoro Drive	North of Decoro Drive	34,000	35	68.1	40	72	131
SECO CANYON ROAD	North of Decoro Drive	S of Copper Hill Drive	19,000	35	65.5	29	53	97
SECO CANYON ROAD	S of Copper Hill Drive	Copper Hill Drive	19,000	35	65.5	29	53	97
COPPER HILL DRIVE	San Francisquito Canyon	Seco Canyon Road	41,000	35	68.9	44	80	144
COPPER HILL DRIVE	McBean Parkway	San Francisquito Canyon	41,000	50	73.5	73	126	217
MCBEAN PARKWAY	Sunset Hills Drive	Copper Hill Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	South of Sunset Hills	Sunset Hills Drive	27,000	40	68.7	43	77	137
MCBEAN PARKWAY	Decoro Drive	North of Decoro Drive	35,000	40	69.9	49	88	156
MCBEAN PARKWAY	South of Sunset Hills	North of Decoro Drive	35,000	40	69.9	49	88	156
MCBEAN PARKWAY	North of Decoro Drive	North of Decoro Drive	35,000	40	69.9	49	88	156
DECORO DRIVE	McBean Parkway	Grandview	19,000	45	68.7	43	76	133
DECORO DRIVE	Grandview	Hillsburough	14,000	45	67.4	37	65	114
DECORO DRIVE	Hillsburough	Bidwell Lane	17,000	45	68.2	41	72	126
DECORO DRIVE	Bidwell Lane	Delgado Drive	11,000	55	69.1	46	77	132
DECORO DRIVE	Delgado Drive	Seco Canyon Road	11,000	60	69.1	46	77	132
MCBEAN PARKWAY	Newhall Ranch Road	Fairveiw Drive	48,000	40	71.2	58	102	182
MCBEAN PARKWAY	Fairveiw Drive	Decoro Drive	48,000	40	71.2	58	102	182
COPPER HILL DRIVE	Alta Vista Way	Smyth Drive	55,000	55	76.1	96	162	276
COPPER HILL DRIVE	Newhall Ranch Road	Smyth Drive	54,000	60	76.0	95	161	274
AVE SCOTT	Avenue Tibbitts	Stanford Avenue	37,000	45	71.6	60	105	183
AVE SCOTT	Stanford Avenue	Rye Canyon	10,000	40	64.4	26	47	83
NEWHALL RANCH ROAD	Rye Canyon Road	Interstate 5 ramp	72,000	45	74.5	83	145	253
BOUQUET CANYON ROAD	Newhall Ranch Road	Espuella Avenue	54,000	55	76.0	95	161	274
BOUQUET CANYON ROAD	Espuella Avenue	Seco Canyon Road	54,000	45	73.2	72	126	220
NEWHALL RANCH ROAD	Bouquet Canyon Road	Hillsburough	68,000	45	74.2	80	141	246
NEWHALL RANCH ROAD	Hillsburough	West of Hillsburough	68,000	45	74.2	80	141	246
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	47,000	45	72.6	67	118	206
NEWHALL RANCH ROAD	E of Bouquet Canyon Rd	E of Bouquet Canyon Rd	47,000	50	74.1	78	134	231
NEWHALL RANCH ROAD	W of Hillsburough	East of McBean Pkwy	68,000	50	75.7	93	160	276
NEWHALL RANCH ROAD	East of McBean Pkwy	McBean Parkway	68,000	50	75.7	93	160	276
MCBEAN PARKWAY	Avenue Scott	Newhall Ranch Road	58,000	45	73.6	74	130	228
AVE SCOTT	Rockefeller Avenue	McBean Parkway	27,000	35	67.1	35	64	116
NEWHALL RANCH ROAD	Interstate 5 ramp	Interstate 5 ramp	66,000	50	75.5	91	158	272
NEWHALL RANCH ROAD	E of Interstate 5 ramp	E of Interstate 5 ramp	66,000	45	74.1	79	139	243

COMMERCE CENTER DRIVE			35,666	55	74.2	78	133	226
COMMERCE CENTER DRIVE	Henry Mayo Drive	Hasley Canyon Road	43,000	55	75.0	85	145	247
THE OLD ROAD	South of Hasley Canyon	Hasley Canyon Road	16,000	40	66.5	33	59	105
RIDGE ROUTE ROAD	N of Lake Hughes Road	Templin Parkway	35,000	50	72.8	68	117	201
THE OLD ROAD	Sloan Canyon Road	N of Sloan Canyon Road	20,000	40	67.4	37	66	118
THE OLD ROAD	Hasley Canyon Road	S of Hillcrest Parkway	23,000	40	68.0	40	71	126
THE OLD ROAD	S of Hillcrest Parkway	Hillcrest Parkway	23,000	50	71.0	55	96	165
LONG CANYON ROAD			32,000	45	71.0	56	98	171
STEVENSON RANCH PARKWAY	The Old Road	East of the Old Road	11,000	50	67.8	39	68	116
MCBEAN PARKWAY	Rockwell Canyon Road	Interstate 5 ramp	53,000	45	73.2	71	125	218
MCBEAN PARKWAY	Interstate 5 ramp	Interstate 5 ramp	53,000	45	73.2	71	125	218
PICO CANYON ROAD	The Old Road	Interstate 5 ramp	44,000	55	75.1	86	147	249
LYONS AVENUE	Interstate 5 ramp	Interstate 5	44,000	50	73.8	75	130	224
PICO CANYON ROAD	Interstate 5 ramp	West of Wiley Canyon	44,000	40	70.9	55	98	174
LYONS AVENUE	Wiley Canyon Road	Interstate 5 ramp	44,000	50	73.8	75	130	224
LYONS AVENUE	Interstate 5 ramp	Interstate 5	52,000	50	74.5	82	141	243
RYE CANYON ROAD	The Old Road	NE of The Old Road	58,000	50	75.0	86	148	256
RYE CANYON ROAD	South of Avenue Scott	Avenue Scott	49,000	45	72.8	69	120	210
RYE CANYON ROAD	NE of The Old Road	South of Avenue Scott	58,000	45	73.6	74	130	228
MAGIC MOUNTAIN PARKWAY	The Old Road	Interstate 5	82,000	50	76.5	101	175	301
MAGIC MOUNTAIN PARKWAY	Interstate 5	Tourney Road	58,000	50	75.0	86	148	256
MAGIC MOUNTAIN PARKWAY	Interstate 5	Interstate 5	83,000	45	75.1	89	155	272
MAGIC MOUNTAIN PARKWAY	Int of Mag Mt. & Tibbitts	Int of Mag Mt. & Tibbitts	57,000	45	73.5	74	129	226
MAGIC MOUNTAIN PARKWAY	Tourney Road	West of McBean Parkway	60,000	45	73.7	76	132	232
MAGIC MOUNTAIN PARKWAY	McBean Parkway	West of McBean Parkway	60,000	45	73.7	76	132	232
MAGIC MOUNTAIN PARKWAY	West of McBean Parkway	West of McBean Parkway	59,000	50	75.0	87	149	258
MCBEAN PARKWAY	Magic Mountain Parkway	Creekside	72,000	45	74.5	83	145	253
MCBEAN PARKWAY	Creekside	Avenue Scott	77,000	45	74.8	85	150	262
MAGIC MOUNTAIN PARKWAY	McBean Parkway	East of McBean Parkway	54,000	45	73.2	72	126	220
MAGIC MOUNTAIN PARKWAY	East of McBean Parkway	East of McBean Parkway	54,000	40	71.7	61	109	193
MAGIC MOUNTAIN PARKWAY	Valencia Blvd	West of Valencia Blvd	51,000	40	71.5	59	106	188
MAGIC MOUNTAIN PARKWAY	West of Valencia Blvd	West of Valencia Blvd	51,000	40	71.5	59	106	188
MCBEAN PARKWAY	South of Magic Mountain	Magic Mountain Parkway	63,000	40	72.4	66	117	209

MCBEAN PARKWAY	Valencia Blvd	North of Valencia Blvd	63,000	45	73.9	77	136	237
MCBEAN PARKWAY	North of Valencia Blvd	South of Magic Mountain	63,000	45	73.9	77	136	237
VALENCIA BOULEVARD	McBean Parkway	East of McBean Parkway	53,000	45	73.2	71	125	218
VALENCIA BOULEVARD	East of McBean Parkway	SW of Magic Mountain Pkwy	53,000	45	73.2	71	125	218
VALENCIA BOULEVARD	SW of Magic Mountain Pkwy	East of McBean Parkway	53,000	45	73.2	71	125	218
VALENCIA BOULEVARD	McBean Parkway	West of McBean Parkway	61,000	50	75.2	88	152	262
VALENCIA BOULEVARD	West of McBean Parkway	Rockwell Canyon Road	61,000	40	72.3	65	116	205
MCBEAN PARKWAY	Del Monte Drive	Valencia Blvd	54,000	45	73.2	72	126	220
MCBEAN PARKWAY	Arroyo Park Drive	Del Monte Drive	54,000	45	73.2	72	126	220
MCBEAN PARKWAY	South of Arroya Park Dr	Arroyo Park Drive	54,000	45	73.2	72	126	220
MCBEAN PARKWAY	Orchard Village Road	North of Orchard Village	43,000	45	72.3	64	113	197
MCBEAN PARKWAY	North of Orchard Village	South of Arroya Park Dr	43,000	45	72.3	64	113	197
MCBEAN PARKWAY	Rockwell Canyon Road	Singing Hills Drive	44,000	45	72.4	65	114	199
MCBEAN PARKWAY	East of Singing Hills Dr	Orchard Village Road	44,000	45	72.4	65	114	199
MCBEAN PARKWAY	Singing Hills Drive	East of Singing Hills Dr	44,000	45	72.4	65	114	199
TOURNAMENT ROAD	Wiley Canyon Road	Mid-Section	7,000	40	62.9	22	39	70
TOURNAMENT ROAD	Mid-Section	South of McBean Parkway	7,000	55	67.2	37	63	107
WILEY CANYON ROAD	Lyons Avenue	South of Lyons Avenue	20,000	35	65.8	30	55	100
WILEY CANYON ROAD	Calgrove Boulevard	North of Calgrove Blvd	20,000	35	65.8	30	55	100
WILEY CANYON ROAD	North of Calgrove Blvd	South of Lyons Avenue	19,000	40	67.2	36	64	115
VALLEY STREET	Lyons Avenue	South of Lyons Avenue	11,000	45	66.3	33	58	102
LYONS AVENUE	Apple Street	Orchard Village Road	42,000	50	73.6	74	127	219
LYONS AVENUE	Apple Street	Rotella	42,000	50	73.6	74	127	219
LYONS AVENUE	Wiley Canyon	Everette Drive	44,000	50	73.8	75	130	224
LYONS AVENUE	Newhall Avenue	Arcadia Street	52,000	50	74.5	82	141	243
LYONS AVENUE	Arcadia Street	Valley Street	52,000	55	75.9	93	158	269
RAILROAD AVENUE	Lyons Avenue	North of Lyons Avenue	36,000	40	70.0	50	89	158
RAILROAD AVENUE	North of Lyons Avenue	South of Via Princessa	36,000	45	71.5	59	103	181
RAILROAD AVENUE	South of Via Princessa	South of Via Princessa	36,000	45	71.5	59	103	181
WILEY CANYON ROAD	East of Tournament	Orchard Village Road	32,000	45	71.0	56	98	171
WILEY CANYON ROAD	Tournament	East of Tournament	32,000	40	69.5	47	84	149

ORCHARD VILLAGE ROAD	Wiley Canyon Road	Mill Valley	54,000	45	73.2	72	126	220
ORCHARD VILLAGE ROAD	Mill Valley	McBean Parkway	54,000	50	74.7	83	143	247
ORCHARD VILLAGE ROAD	Lyons Avenue	Dalbey Drive	34,000	50	72.7	67	115	199
ORCHARD VILLAGE ROAD	Dalbey Drive	16th Street	34,000	35	68.1	40	72	131
RAILROAD AVENUE	Via Princessa	North of Via Princessa	40,000	45	71.9	62	109	190
RAILROAD AVENUE	North of Via Princessa	South of Magic Mountain	40,000	50	73.4	72	124	214
RAILROAD AVENUE	South of Magic Mountain	Magic Mountain Parkway	54,000	50	74.7	83	143	247
MAGIC MOUNTAIN PARKWAY			45,000	40	71.0	56	99	176
VALENCIA BOULEVARD	Magic Mountain Parkway	N of Magic Mountain Pkwy	60,000	45	73.7	76	132	232
VALENCIA BOULEVARD	N of Magic Mountain Pkwy	W of Bouquet Canyon	60,000	35	70.5	53	97	176
VALENCIA BOULEVARD	West of Bouquet Canyon	Bouquet Canyon Road	50,000	50	74.3	80	138	238
VALENCIA BOULEVARD	West of Bouquet Canyon	West of Bouquet Canyon	50,000	50	74.3	80	138	238
BOUQUET CANYON ROAD	Magic Mountain Parkway	Cenema Drive	54,000	45	73.2	72	126	220
BOUQUET CANYON ROAD	Cenema Drive	Valencia Blvd	54,000	45	73.2	72	126	220
VIA PRINCESSA	Railroad Avenue	East of Railroad Canyon	27,000	35	67.1	35	64	116
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	27,000	35	67.1	35	64	116
VIA PRINCESSA	East of Railroad Canyon	East of Railroad Canyon	27,000	55	73.0	69	117	199
VIA PRINCESSA			55,000	55	76.1	96	162	276
VIA PRINCESSA			55,000	50	74.7	84	145	249
VIA PRINCESSA			55,000	40	71.8	62	110	195
VIA PRINCESSA			55,000	50	74.7	84	145	249
SANTA CLARITA PARKWAY	Via Princessa	South of Via Princessa	38,000	45	71.7	61	106	186
SANTA CLARITA PARKWAY	South of Via Princessa	South of Via Princessa	38,000	45	71.7	61	106	186
SANTA CLARITA PARKWAY	Sierra Highway	West of Sierra Highway	39,000	45	71.8	61	107	188
SANTA CLARITA PARKWAY	Soledad Canyon Road	South of Soledad Canyon	30,000	45	70.7	54	95	166
SANTA CLARITA PARKWAY	Via Princessa	North of Via Princessa	34,000	45	71.2	57	101	176
DOCKWEILER DRIVE	Mid-Section	Mid-Section	18,000	25	61.9	17	33	64
NEWHALL AVENUE	Sierra Highway	Valle Del Oro	40,000	45	71.9	62	109	190
NEWHALL AVENUE	NW of Valle Del Oro	NW of Valle Del Oro	33,000	50	72.5	66	114	196
SIERRA HIGHWAY	The Old Road	North of The Old Road	30,000	45	70.7	54	95	166
SIERRA HIGHWAY	North of The Old Road	Newhall Avenue	33,000	45	71.1	57	99	173
SIERRA HIGHWAY	Dockweiler Drive	North of Dockweiler	39,000	45	71.8	61	107	188
SIERRA HIGHWAY	North of Dockweiler	Placerita Canyon Road	39,000	50	73.3	71	123	212

GOLDEN VALLEY ROAD	Sierra Highway	SR-14	36,000	50	72.9	69	118	204
GOLDEN VALLEY ROAD	SR-14	East of SR-14	15,000	55	70.5	53	89	152
GOLDEN VALLEY ROAD			37,000	40	70.1	51	90	160
GOLDEN VALLEY ROAD	East of SR-14	East End	15,000	50	69.1	45	78	135
SIERRA HIGHWAY	Golden Valley Road	North of Golden Valley Rd	30,000	50	72.1	63	109	187
SIERRA HIGHWAY	North of Golden Valley Rd	North of Golden Valley Rd	30,000	50	72.1	63	109	187
SIERRA HIGHWAY	North of Golden Valley Rd	South of Via Princessa	30,000	45	70.7	54	95	166
SIERRA HIGHWAY	South of Via Princessa	Via Princessa	30,000	45	70.7	54	95	166
SIERRA HIGHWAY	Via Princessa	North of Via Princessa	34,000	45	71.2	57	101	176
SIERRA HIGHWAY	North of Via Princessa	Jakes Way	34,000	45	71.2	57	101	176
JAKES WAY/CANYON PARK BL	Sierra Highway	Lost Canyon	12,000	25	60.1	14	27	51
VIA PRINCESSA	Whites Canyon	West of Whites Canyon	27,000	40	68.7	43	77	137
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	27,000	40	68.7	43	77	137
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	27,000	60	73.0	69	117	199
VIA PRINCESSA	SE of Whites Canyon	NW of Sierra Highway	52,000	50	74.5	82	141	243
SOLEDAD CANYON ROAD	West of Whites Canyon	West of Whites Canyon	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	West of Whites Canyon	East of Golden Valley Rd	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	East of Golden Valley Rd	East of Golden Valley Rd	50,000	45	72.9	69	121	212
SOLEDAD CANYON ROAD	Golden Valley Road	East of Golden Valley Rd	50,000	40	71.4	59	105	186
SOLEDAD CANYON ROAD	West of Golden Valley	E of Santa Clarita Pkwy	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	Golden Valley Road	West of Golden Valley	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	West of Golden Valley	West of Golden Valley	38,000	45	71.7	61	106	186
SOLEDAD CANYON ROAD	E of Santa Clarita Pkwy	W of Santa Clarita Pkwy	50,000	50	74.3	80	138	238
SOLEDAD CANYON ROAD	W of Santa Clarita Pkwy	Bouquet Canyon Road	45,000	50	73.9	76	131	227
SANTA CLARITA PARKWAY	Soledad Canyon Road	Newhall Ranch Road	30,000	45	70.7	54	95	166
GOLDEN VALLEY ROAD	Soledad Canyon Road	Nth of Soledad Cyn Road	44,000	50	73.8	75	130	224
NEWHALL AVENUE	Railroad Avenue	Market Street	27,000	50	71.7	60	103	178
NEWHALL AVENUE	SE of Railroad Avenue	Railroad Avenue	27,000	50	71.7	60	103	178
SHADOW PINES BOULEVARD		South of Davenport Road	12,000	45	66.7	35	61	106
LYONS AVENUE	Rotella	Peachland Avenue	43,000	55	75.0	85	145	247
LYONS AVENUE	Peachland Avenue	Everette Drive	42,000	55	74.9	84	144	244
ORCHARD VILLAGE ROAD	16th Street	North of 16th Street	44,000	35	69.2	45	82	150

ORCHARD VILLAGE ROAD	North of 16th Street	Wiley Canyon Road	44,000	50	73.8	75	130	224
TOURNAMENT ROAD	South of McBean Parkway	McBean Parkway	7,000	55	67.2	37	63	107
NEWHALL AVENUE	Valle Del Oro	NW of Valle Del Oro	33,000	55	73.9	76	128	218
NEWHALL AVENUE	NW of Valle Del Oro	SE of Railroad Avenue	33,000	50	72.5	66	114	196
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	32,000	50	72.4	65	112	193
SOLEDAD CANYON ROAD	East of Sand Canyon	East of Sand Canyon	32,000	50	72.4	65	112	193
SIERRA HIGHWAY	Placerita Canyon Road	Golden Valley Road	25,000	45	69.9	49	87	151
SIERRA HIGHWAY	Golden Valley Road	N of Golden Valley Rd	30,000	45	70.7	54	95	166
DOCKWEILER DRIVE	Sierra Highway	Mid-Section	24,000	35	66.6	33	60	109
HASLEY CANYON ROAD	Commerce Center Drive	Del Valle Road	14,000	50	68.8	44	76	130
WILEY CANYON ROAD	Orchard Village Road	E of Orchard Village Rd	41,000	40	70.5	53	95	168
THE OLD ROAD	Hillcrest Parkway	South of Parker Road	13,000	50	68.5	42	73	126
THE OLD ROAD	South of Parker Road	Parker Road	13,000	45	67.1	36	63	110
LAKE HUGHES ROAD	The Old Road	Castaic Road	37,000	35	68.4	42	75	137
THE OLD ROAD	Stevensons Ranch Parkway	Valencia Boulevard	41,000	45	72.0	63	110	193
NEWHALL RANCH ROAD	McBean Parkway	Avenue Tibbitts	71,000	45	74.4	82	144	252
GOLDEN VALLEY ROAD	Plum Canyon Road	South of Plum Cyn Rd	44,000	55	75.1	86	147	249
GOLDEN VALLEY ROAD			39,000	50	73.3	71	123	212
SIERRA HIGHWAY	South of Sand Canyon	South of Sand Canyon	17,000	45	68.2	41	72	126
SIERRA HIGHWAY	North of Skyline Ranch Rd	South of Sand Canyon	17,000	40	66.7	34	61	108
SIERRA HIGHWAY	North of Skyline Ranch Rd	North of Skyline Ranch Rd	38,000	40	70.2	51	91	162
SIERRA HIGHWAY	South of Skyline Ranch Rd	North of Skyline Ranch Rd	38,000	40	70.2	51	91	162
SIERRA HIGHWAY	Soledad Canyon Road	South of Skyline Ranch Rd	52,000	40	71.6	60	107	190
SAND CANYON ROAD	Soledad Canyon Road	N of Soledad Canyon Road	14,000	50	68.8	44	76	130
SAND CANYON ROAD			8,000	45	65.0	28	50	87
SHADOW PINES BOULEVARD	North of Soledad Canyon	South of Davenport Road	9,000	40	64.0	25	44	79
LOST CANYON ROAD			15,000	45	67.7	39	68	118
LOST CANYON ROAD			16,000	45	68.0	40	70	122
LOST CANYON ROAD	Jakes Way	North-East of Jakes Way	16,000	55	70.7	54	92	156
VIA PRINCESSA	Sierra Highway	NW of Sierra Highway	52,000	40	71.6	60	107	190
VIA PRINCESSA	West of Whites Canyon	West of Whites Canyon	27,000	40	68.7	43	77	137

SIERRA HIGHWAY	Jakes Way	Soledad Canyon Road	36,000	45	71.5	59	103	181
	The Old Road	North of The Old Road	6,000	40	62.2	20	36	64
PARKER ROAD	The Old Road	Sloan Canyon Drive	1,000	50	57.3	13	22	37
PARKER ROAD	The Old Road	Interstate 5	10,000	50	67.3	37	65	111
PARKER ROAD	Interstate 5	Castaic Road	10,000	45	65.9	32	55	97
LAKE HUGHES ROAD	Ridge Route Road	North-East of Ridge Route	7,000	35	61.2	18	32	58
LAKE HUGHES ROAD	North-East of Ridge Route	Mid-Section	7,000	50	65.8	32	55	94
LAKE HUGHES ROAD	North-East of Ridge Route	North-East of Ridge Route	7,000	50	65.8	32	55	94
SHADOW PINES BOULEVARD	North of Soledad Canyon	North of Soledad Canyon	9,000	40	64.0	25	44	79
SHADOW PINES BOULEVARD	Soledad Canyon Road	North of Soledad Canyon	9,000	40	64.0	25	44	79
VIA PRINCESSA	Lost Canyon Road	South of Lost Canyon	3,000	35	57.5	11	21	37
LOST CANYON ROAD	Via Princessa	Jakes Way	21,000	50	70.6	53	92	158
VASQUEZ CANYON ROAD	East of Bouquet Canyon	East of Bouquet Canyon	6,000	35	60.5	16	29	53
VASQUEZ CANYON ROAD	East of Bouquet Canyon	Bouquet Canyon Road	6,000	35	60.5	16	29	53
GOLDEN VALLEY ROAD	Via Princessa	Soledad Canyon Road	32,000	60	73.8	74	127	215
COPPER HILL DRIVE	Benz Road	David Way	17,000	45	68.2	41	72	126
DRY GULCH RD			4,000	45	61.9	20	35	62
TEMPLIN PK	At Interstate 5	At Interstate 5	8,000	50	66.4	34	58	100
	Templin Highway	North of Templin Highway	6,000	40	62.2	20	36	64
HENRY MAYO DRIVE	East of Commerce Ctr Dr	Commerce Center Drive	9,000	40	64.0	25	44	79
SLOAN CANYON RD	Hasley Canyon Road	Hillcrest Parkway	3,000	40	59.2	14	26	46
SLOAN CANYON RD	Parker Road	The Old Road	2,000	40	57.4	12	21	37
SLOAN CANYON RD	Parker Road	West of Parker Road	2,000	40	57.4	12	21	37
POTRERO CANYON RD			9,000	40	64.0	25	44	79
VALENCIA BLVD	Magic Mountain Parkway	West of Magic Mountain	30,000	45	70.7	54	95	166
VALENCIA BLVD	Magic Mountain Parkway	South of Magic Mountain	51,000	55	75.8	92	157	267
VALENCIA BLVD	Pico Canyon Road	East of Pico Cyn Road	33,000	50	72.5	66	114	196
VALENCIA BLVD	The Old Road	West of The Old Road	61,000	45	73.8	76	134	234
PICO CANYON ROAD			44,000	45	72.4	65	114	199

PICO CANYON ROAD	Stevenson Ranch Parkway	W of Stevenson Ranch	29,000	55	73.3	71	121	206
SKYLINE RANCH RD	Whites Canyon	Sierra Highway	16,500	45	68.1	40	71	124
LOST CANYON ROAD	Sand Canyon Road	West of Sand Canyon Rd	12,000	40	65.2	29	51	91
COPPER HILL DRIVE			45,500	55	75.3	88	149	253
NEWHALL RANCH ROAD	Interstate 5 ramp	The Old Road	66,000	55	76.9	104	177	300
JAKES WAY	Jakes Way	Lost Canyon	12,000	40	65.2	29	51	91
NEWHALL RANCH ROAD	Santa Clarita Pkwy	E of Santa Clarita Pkwy	47,000	45	72.6	67	118	206
LITTLE TUJUNGA CANYON RO	Sand Canyon Road	South	20,000	40	67.4	37	66	118
RAILROAD AVENUE	Newhall Avenue	Lyons Avenue	26,000	50	71.5	59	101	175

Proposed General Plan Freeway Noise Contour Distances for Freeways

STREET	ADT	FREEWAY	CNEL @50'	Distance to CNEL Contour (ft.) 70	65	60
I-5 n/o Lake Hughes	193,000	I-5	88.0	394	698	1237
I-5 s/o Lake Hughes	205,000	I-5	88.3	406	719	1275
I-5 s/o Parker	239,000	I-5	89.0	438	776	1375
I-5 s/o Hasley Cyn	245,000	I-5	89.1	444	786	1393
I-5 s/o SR-126	219,000	I-5	88.6	420	743	1317
I-5 s/o Rye Cyn	239,000	I-5	89.0	438	776	1375
I-5 s/o Magic Mtn	249,000	I-5	89.2	447	792	1404
I-5 s/o Valencia	259,000	I-5	89.3	456	808	1431
I-5 s/o McBean	264,000	I-5	89.4	460	816	1445
I-5 s/o Lyons	271,000	I-5	89.5	466	826	1464
I-5 s/o Calgrove	267,000	I-5	89.5	463	820	1453
SR-14 n/o Aqua Dulce	154,000	SR-14	85.5	259	441	749
SR-14 s/o Aqua Dulce	158,000	SR-14	85.6	262	446	757
SR-14 s/o Soledad Cyn	177,000	SR-14	86.1	277	470	798
SR-14 s/o Sand Cyn	185,000	SR-14	86.3	282	479	814
SR-14 s/o Via Princessa	193,000	SR-14	86.5	288	489	830
SR-14 s/o Sierra Hwy	217,000	SR-14	87.0	304	516	877
SR-14 s/o Golden Valley	202,000	SR-14	86.7	294	499	848
SR-14 s/o Placerita Cyn	216,000	SR-14	87.0	303	515	875
SR-14 n/o I-5	231,000	SR-14	87.3	313	531	902